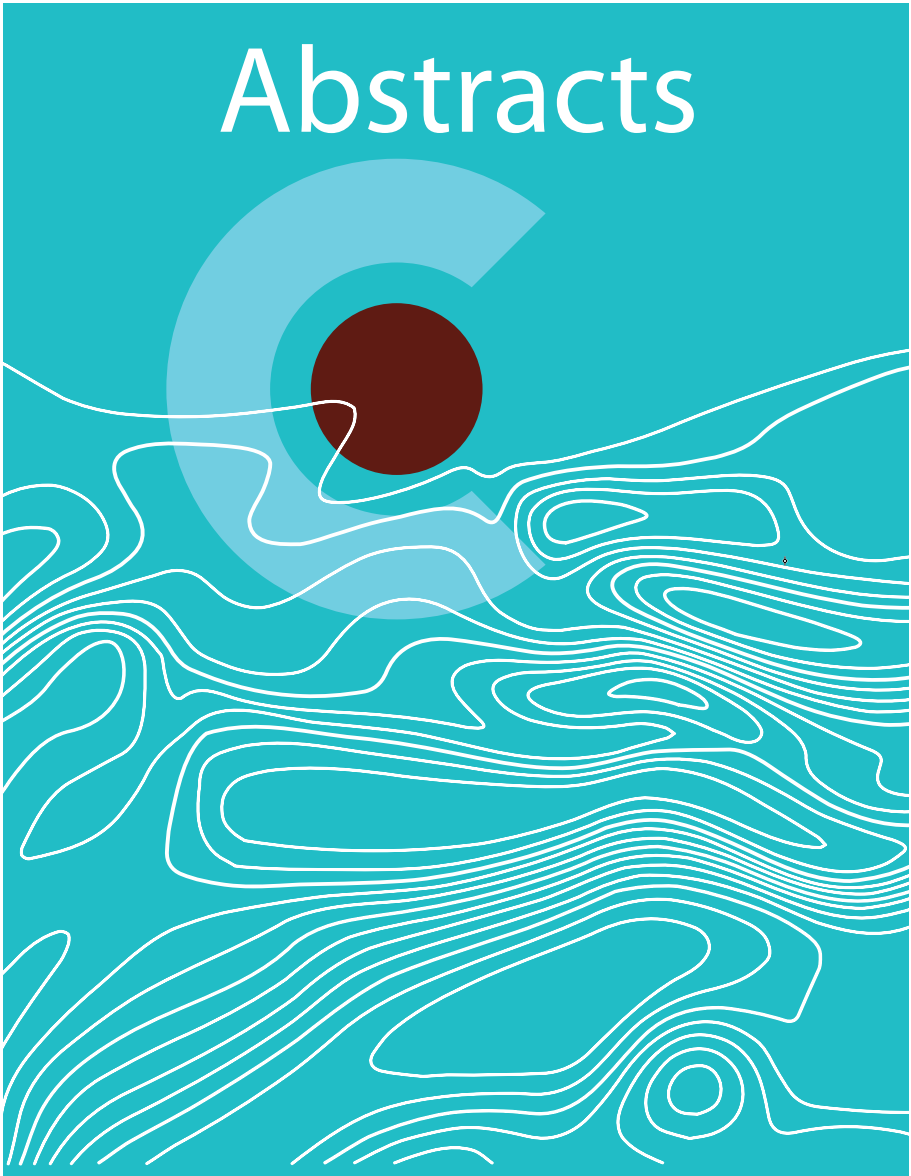
NETHERLANDS EARTH SCIENCES CONFERENCE

Abstracts



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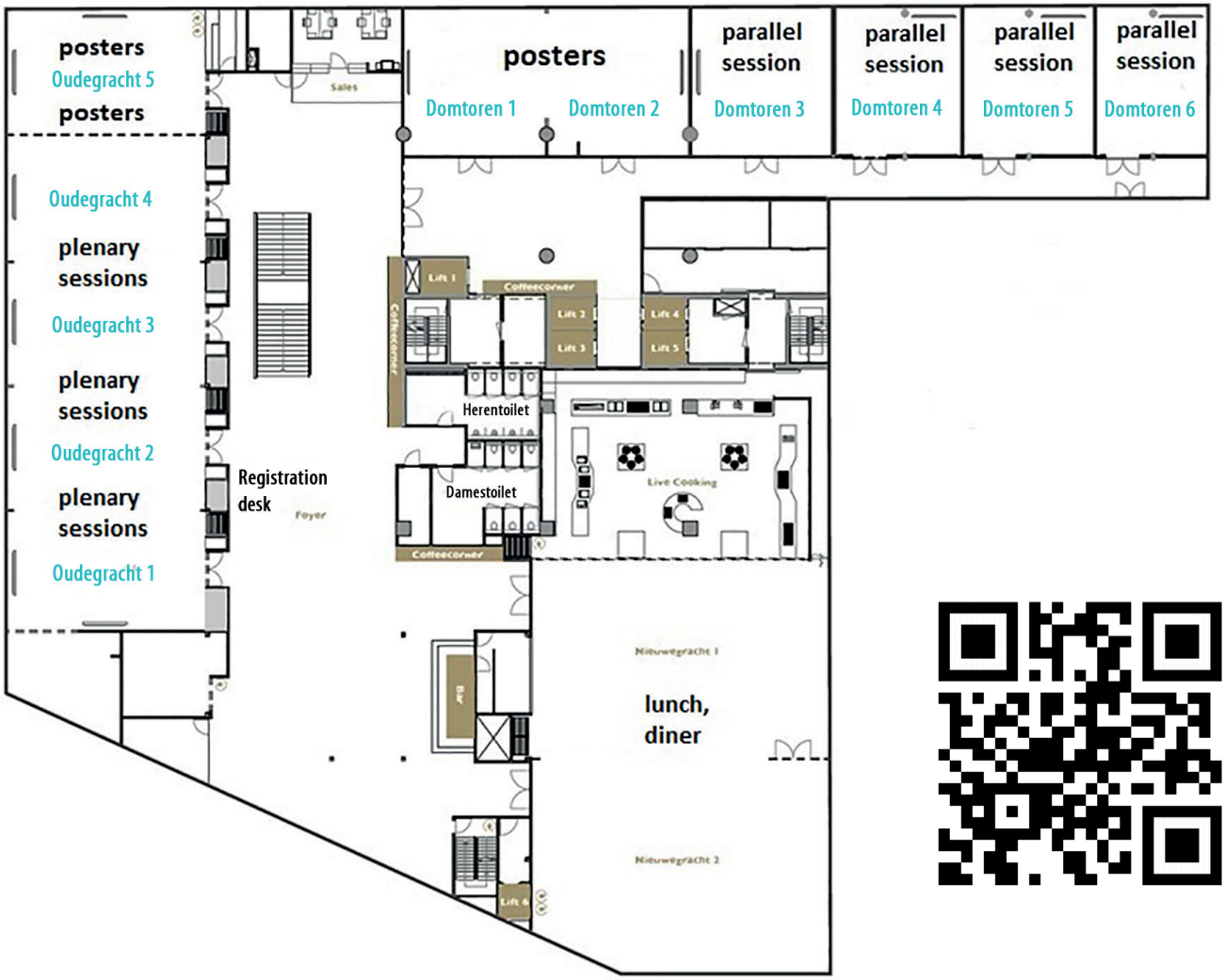
NWO Netherlands Organisation for Scientific Research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Thursday 14 March 2019

From	Foyer	Dining room	Plenary / 'Grand' parallel session		Poster rooms	Parallel sessions			
			Oudegracht 1-4			*Domtoren 3*	*Domtoren 4*	*Domtoren 5*	*Domtoren 6*
8:30	*Registration*				*Hanging up posters*				
9:30			Opening: **Arian Steenbruggen** NWO, director Science Domain						
9:45			Keynote lecture: **Jan Smit**, VU. Chicxulub crater, highlights of the IODP/ICDP scientific drillholes						
10:45			Buzzmaster matchmaking						
11:00	Coffee break				Visit to posters and exhibition				
11:30			Keynote lecture: **Douwe van Hinsbergen**, UU. Kinematic reconstruction and tectonic evolution of the Mediterranean region since the Triassic						
12:15	Lunch				Poster session 12:15-12:45 Odd numbers 13:00-13:30 Even numbers				
13:30			IODP / ICDP	The New Delta		Deep-Earth Geochemistry	Soils System Sciences	Seismology, Geodesy & Rock Physics	Regional Ocean Circulation& Ecosystems
14:30	Coffee break				Poster session 14:30-15:00 Odd numbers 15:00-15:30 Even numbers				
15:30			IODP / ICDP	The New Delta		Deep-Earth Geodynamics & Tectonics	Hydrological Sciences	Seismology, Geodesy & Rock Physics	Cryosphere, Sea-level Change, Impacts on Deltas
16:30									
17:15			Day closure (Buzzmaster)						
17:45	Drinks				Optional: visit to posters and exhibition				
19:00		Dinner							
21:00	Evening programme: 21:30-22:30 Geology on tap: a pubquiz by student organisations 21:30-00:30 Live music Band								
1:00									

Friday 15 March 2019

From:	Foyer	Plenary / 'Grand' parallel session		Poster rooms		Parallel sessions			
		Oudegracht 1-4		*Oudegracht 5*	*Domtoren 1&2*	*Domtoren 3*	*Domtoren 4*	*Domtoren 5*	*Domtoren 6*
8:30	*Registration*								
9:00		Opening & Poster Prize							
9:15		Keynote lecture: **Hester Jiskoot**. A whale of a tale in 1710: East Greenland's oldest weather, sea ice and earth science observations							
10:00				Main poster session 10:00-11:00 Odd numbers 11:00-12:00 Even numbers		NWA ORC call	Open data & data mangement	NWO grant workshop	
10:30						NWA Experiences	Elsevier Author Workshop		
11:00			National Earth Observation Research Strategy 2019-2025			NWA ORC call	Open data & data mangement	NWO grant workshop	
11:30						NWA Experiences	Elsevier Author Workshop		
12:00	*Lunch*								
13:00		Subsurface Processes Associated with Mining in the Netherlands	Oudegracht 3: Sea-Level Rise: Local Aspects	Oudegracht 4: Lowland Evolution & Management		Biogeochemistry of Sedimentary Environments	Earth and Planetary Science: Surface Processes & Remote Sensing	Observing and modeling the atmosphere	Paleoclimate
14:00	*Coffee break*			Optional: visit to posters and exhibit					
14:30		Subsurface Processes Associated with Mining in the Netherlands	Oudegracht 3: Sea-Level Rise: Local Aspects	Oudegracht 4: Global Ocean Dynamics		Biogeochemistry of Sedimentary Environments	Origins and evolution of life, planets and the Universe	The Atmosphere from Remote Sensing Perspective	Paleoclimate
15:30	*Coffee break*			Optional: visit to posters and exhibit					
16:00		Keynote lecture: **Jan Polcher**, LMD Paris. Representing human water management in Earth system models							
16:45		Plenary closing NAC 2019 - with Photo, Escher-, Jelgersma Prize and NJG Award							
17:15	*Final drinks*								
17:45									

Programme parallel sessions

Day 1

Deep Earth Geochemistry – **Domtoren 3 – Convenors: Pieter Vroon, Janne Koornneef**

13.30–13.45 **Fiorenza Deon**, Electron microprobe combined with spectral techniques application in geothermal exploration **pg 4**
13.45–14.00 **Leo Kriegsman**, Zircon U-Pb geochronology of the Marowijne Greenstone Belt, Suriname, with general comments on statistics **pg 5**
14.00–14.15 **Antoine Bracco Gartner**, Primitive post-collisional magmatism tracks breakoff of the subducted East Carpathian slab **pg 6**
14.15–14.30 **Floris Teuling**, The Bemau Ultramafic Complex on the Guiana Shield: an Alaskan-type intrusion recording modern-style Paleoproterozoic subduction? **pg 7**

Soils System Sciences – Domtoren 4 – Convenors: Boris Jansen, Erik Cammeraat

13.30–13.45 **Fabio Corradini**, Microplastic accumulation in agricultural soils by sewage sludge disposal **pg 39**
13.45–14.00 **Tamara Jonkman**, The effects of rock dust on soil microbial activity: a study from the urban gardens of Kisumu, Kenya and Ouagadougou, Burkina Faso **pg 40**
14.00–14.15 **Olaf Brock**, Molecular characteristics of dissolved organic matter determined by high resolution mass spectrometry (LC-QTOF-MS) affected by precipitation with aluminium **pg 41**
14.15–14.30 **Jingjing Guo**, Tracing soil organic carbon transport in the Carminowe Creek catchment (southwest England) using branched tetraether membrane lipids **pg 42**

Seismology, Geodesy & Rock Physics – Domtoren 5 – Convenors: Martyn Drury, Oliver Plümper

13.30–13.45 **Simon Schneider**, Towards toroidal sensitivity to mantle anisotropy **pg 31**
13.45–14.00 **Cedric Thieulot**, Forward gravity modelling using Newton integrals on a hollow sphere **pg 32**
14.00–14.15 **Arwen Deuss**, The sensitivity of whole earth oscillations to attenuation: a new tool to constrain temperature, water and partial melt in Earth's mantle **pg 33**
14.15–14.30 **Rob Govers**, Linking Seismicity and (Paleo)Geodetic Observations to Megathrus Earthquake Cycle Processes **pg 34**

Regional Ocean Circulation and Ecosystems – Domtoren 6 v Convenors: Caroline Katsman, Furu Mienis

13.30–13.45 **Stefanie Ypma**, Role of heat exchange across the Mohn-Knipovich Ridge: an idealized study of the Nordic Seas **pg 27**
13.45–14.00 **Ulrike Hanz**, Long-term environmental conditions at an Arctic deep-sea sponge ground **pg 28**
14.00–14.15 **Anne Kruijt**, Transport of planktic foraminifera at the Uruguayan margin **pg 29**
14.15–14.30 **Niels van Helmond**, Efficient removal of nitrogen and phosphorus in the Stockholm Archipelago, Baltic Sea **pg 30**

IODP/ICDP – Oudegracht 1-2 – Convenor: Martin Ziegler

13.30–14.00 **Kenneth Miller**, An overview of climate and global sea-level changes over the past 100 Myr from IODP drilling **pg 20**

The New Delta – Oudegracht 3-4 – Convenor: Marc Bierkens

13.30–13.45 **Joeri van Engelen**, 3D Paleohydrogeological modelling of the Nile Delta **pg 49**
13.45–14.00 **Imme Benedict**, Mississippi's moisture sources shift from land to ocean in a future climate **pg 50**
14.00–14.15 **Roeland van de Vijsel**, Intertidal drainage patterns as indicator for biostabilising ecosystem development **pg 51**
14.15–14.30 **Wim Joost van Hoek**, Global scale process-based modelling of the origins and fates of carbon in the aquatic continuum **pg 52**

Deep-Earth Geodynamics & Tectonics – Domtoren 3 – Convenor: Wouter Schellart

15.30–15.45 **Suzanne van de Lagemaat**, Southwest Pacific Absolute Plate Kinematic Reconstruction Reveals Major Cenozoic Tonga-Kermadec Slab Dragging **pg 8**
15.45–16.00 **Vincent Strak**, 2-D thermo-mechanical numerical modelling of the South American subduction zone **pg 9**
16.00–16.15 **Lydian Boschman**, Reconstructing spreading ridge subduction within the Mesozoic Panthalassa Ocean using stratigraphic and paleomagnetic constraints from Hokkaido, Japan **pg 12**
16.15–16.30 **Maaike Weerdesteijn**, The potential of numerical modeling for glaciation-induced true polar wander of the Earth **pg 13**
16.30–16.45 **Markus Ohl**, Nanomechanics in crustal fault zones: Mechanical amorphisation and colloid-suspension formation weakens crustal faults **pg 10**

16.45–17.00 **Ylona van Dinther**, Models Bridging Subduction and Earthquake Dynamics Show Fault Strength as a Strain-average Quantity **pg 11**

Hydrological Sciences – Domtoren 4 – Convenor: Martijn Westhoff

15.30–15.45 **Alraune Zech**, Field Scale Dispersivity: Do Rules of Thumb Hold Versus Field Data? **pg 14**
15.45–16.00 **Inti Pelupessy**, HyMUSE: a user friendly multi-model framework for Hydrology **pg 15**
16.00–16.15 **Ronja Ebner**, Rivers as input path of anthropogenic substances into the biosphere of Lake Constance – a numerical modelling approach **pg 16**
16.15–16.30 **Amirhossein Dehghanipour**, A WEAP-MODFLOW model for conjunctive water management in the Urmia Lake Basin, Iran **pg 17**
16.30–16.45 **Willem Zaadnoordijk**, Grondwatertools: 4D information on heads and groundwater system characteristics for the Netherlands **pg 18**
16.45–17.00 **Rike Wagner-Cremer**, Linking long-term CO2 induced leaf stomatal conductance decrease to vegetation greening through gsmax –- NDVI comparison in Scandinavia **pg 19**

Seismology, Geodesy & Rock Physics – Domtoren 5 – Convenors: Martyn Drury, Oliver Plümper

15.30–15.45 **Johno van Ijsseldijk**, Local imaging of the shallow crust using distant, high magnitude earthquakes **pg 35**
15.45–16.00 **Ranajit Ghose**, Monitoring change in flow properties in a porous formation from intrinsic dispersion of seismic waves **pg 36**
16.00–16.15 **Britt Vleut**, Characterising the seismic signal of individual wind turbines in the Borgsweer area **pg 37**
16.15–16.30 **Jelle Assink**, A Seismo-Acoustic Analysis of the 2017 North Korean Nuclear Test **pg 38**

The Cryosphere, Sea-level Change, and Impacts on Deltas – Domtoren 6 – Convenors: Michiel van den Broeke, Aimée Slangen

15.30–15.45 **Martyn Drury**, Deformation mechanisms and rheology of polar ice in the NEEM ice core **pg 43**
15.45–16.00 **Isolde Glissenaar**, Recent mass changes of the Novaya Zemlya Ice Cap from CryoSat-2 **pg 4**
16.00–16.15 **Runa Magnússon**, Cyclical development of thaw ponds in Siberian lowland tundra? **pg 45**

16.15–16.30 **Jaap Nienhuis**, Can barrier islands survive sea level rise? Tidal inlets versus storm overwash **pg 46**

16.30–16.45 **Wim Hoek**, Climate and environmental changes during the last 3000 years on Barentsøya (E-Svalbard) **pg 47**

16.45–17.00 **Martijn Hermans**, High-resolution simulations of sea-level change processes on the North-western European shelf **pg 48**

IODP/ICDP – Oudegracht 1-2 – Convenor: Martin Ziegler

15.30–15.45 **Peter Bijl**, The Eocene southwest Pacific 'warm pool' revisited **pg 21**

15.45–16.00 **Ilja Kocken**, North Atlantic sea surface temperature evolution across the Eocene-Oligocene transition **pg 22**

16.00–16.15 **Francesca Sangiorgi**, Ocean properties and Antarctic cryosphere dynamics during the Miocene Climatic Optimum: results from the IODP Expedition 374 (Ross Sea) in a circum-Antarctic context **pg 23**

16.15–16.30 **Jan-Berend Stuut**, A 5.3-million-year history of monsoonal precipitation in northwestern Australia **pg 24**

16.30–16.45 **William Gosling**, Fire and the development of woody vegetation in equatorial West Africa during the last c. 520,000 years **pg 25**

16.45–17.00 **Aleksandra Cvetkoska**, IODP Expedition 381: Corinth Active Rift Development **pg 26**

The New Delta – Oudegracht 3-4 – Convenor: Marc Bierkens

15.30–15.45 **Joep Langeveld**, Estimating dissolved carbon leaching: a global database and model of carbon fluxes from soils to groundwater **pg 53**

15.45–16.00 **Maarten van der Vegt**, Ebb-tidal deltas on the move: The effect of nourishments on channel-shoal dynamics **pg 54**

16.00–16.15 **Merel Verbeek**, Modelling weir-mounted tidal turbines **pg 55**

16.15–16.30 **Ruud Bartholomeus**, Water in the circular economy: Matching agricultural freshwater supply and demand using recycled water for sub-irrigation purposes **pg 56**

16.30–16.45 **Jan Weijma**, Redirecting nutrients in urban waste to urban agriculture **pg 57**

Day 2

Biogeochemistry of Sedimentary Environments – Domtoren 3 – Convenor: Mónica Sánchez Román

13.00–13.15 **Linda Kooijmans**, Carbonyl sulfide as tracer for stomatal conductance and photosynthesis **pg 58**
13.15–13.30 **Liesbeth Florentie**, Exploiting sun–induced fluorescence and temperature anomalies to enhance biosphere flux estimates in an atmospheric CO2 inversion **pg 59**
13.30–13.45 **Linda Dämmer**, Light impacts Mg incorporation in the benthic foraminifer Amphistegina lessonii **pg 60**
13.45–14.00 **Sigrid van Grinsven**, Methane oxidation stimulated by nitrate and sulfate in an anoxic lake mediated by Methylobacter species **pg 61**

Earth and Planetary Science: Surface Processes & Remote Sensing – Domtoren 4 – Convenor: Oscar Kamps

13.00–13.15 **Jos de Laat**, Satellite-remote-sensing-based monitoring of volcanic ash plumes **pg 66**
13.15–13.30 **Yue Zhao**, Inferring Global Patterns of Lunar Surface Mineralogy from Elemental Abundance Data Using Artificial Neural Networks **pg 67**
13.30–13.45 **Frank van Ruitenbeek**, Infrared Spectral Imaging of Rock Mineralogy and Microstructur **pg 68**
13.45–14.00 **Susan Steele-Dunne**, Using radar to study vegetation water dynamics: From field-scale to regional analysis **pg 69**

Observing and modeling the atmosphere – Domtoren 5 – Convenor: Maarten Krol

13.00–13.15 **Herman Russchenberg**, The Ruisdael Observatory: a new facility for atmospheric research in the Netherlands **pg 78**
13.15–13.30 **Marco de Bruine**, Explicit aerosol-cloud interaction in DALES **pg 79**
13.30–13.45 **Truls Andersen**, Quantifying methane emissions from coal mining shafts in Silesia, Poland using an active AirCore system **pg 80**
13.45–14.00 **Maria Popa**, New high-resolution isotope mass spectrometry applications for atmospheric sciences **pg 81**

Paleoclimate – Domtoren 6 – Convenor: Francien Peterse

13.00–13.15 **Karlijn van den Broek**, Glacial-interglacial North Atlantic surface circulation strength; a novel dinocyst carbon isotope approach **pg 86**
13.15–13.30 **Margriet Lantink**, Milankovitch cycles in early Paleoproterozoic Banded Iron Formation **pg 87**
13.30–13.45 **Jan-Berend Stuut**, Present-day Saharan dust deposition in the Atlantic Ocean and its marine-environmental consequences **pg 88**
13.45–14.00 **Kimberley Hagemans**, El Niño variability reflected in a high resolution pollen record from a lake in the Tropical Andes of Ecuador **pg 89**

Subsurface Processes Associated with Mining in the Netherlands – Oudegracht 1–2 – Convenors: Suzanne Hangx, Ipo Ritsema

13.00–13.15 **Kees Wapenaar**, Virtual seismology: a new methodology for induced earthquake monitoring **pg 101**
13.15–13.30 **Jesper Spetzler**, Mapping seismicity in Groningen **pg 102**
13.30–13.45 **Wen Zhou**, The Groningen reservoir monitored by deep borehole noise **pg 103**
13.45–14.00 **Reuben Zotz-Wilson**, Coda-Wave based monitoring of pore–pressure depletion compaction on Slochteren Sandstone samples from the Groningen gas field, the Netherlands **pg 104**

Sea–Level Rise: Local Aspects – Oudegracht 3 – Convenor: Aimée Slangen

13.15–13.30 **Stephanie Janssen**, Added value of joint action- a game-based methodology applied to the pilot Noard-Fryslân Bûtendyks **pg 94**
13.30–13.45 **Piet Hoekstra**, Hydrodynamics and sediment transport during barrier island inundation **pg 95**
13.45–14.00 **Celine van Bijsterveldt**, Mangrove Atlantis: Can mangroves keep up with extreme land-subsidence? **pg 96**

Lowland Evolution & Management – Oudegracht 4 – Convenors: Jakob Wallinga, Kim Cohen

13.00–13.15 **Marc Hijma**, 21 m sea-level rise in 9000 years: the Holocene sea-level database for the Rhine-Meuse Delta, The Netherlands **pg 74**
13.15–13.30 **Kay Koster**, 10,000 years of carbon sequestration in the Holland coastal plain **pg 75**
13.30–13.45 **Kay Beets**, Holocene wet-dry cycles interrupted by a 'Rhine river' pulse after a marine incursion in the central Netherlands **pg 76**

13.45–14.00 **Jasper Candel**, Why do not all meandering rivers actively meander? **pg 77**

Biogeochemistry of Sedimentary Environments – Domtoren 3 – Convenors: Furu Mienis, Monica Sanchez Roman

14.30–14.45 **Martijn Hermans**, Phosphorus sequestration in manganese(II) and iron(II) minerals in coastal sediments populated by cable bacteria **pg 62**
14.45–15.00 **Marijn den Boer**, The link between methane seepage and glendonites: An insight from gas inclusions and biomarkers **pg 63**
15.00–15.15 **L.M. Bröder**, Sources and degradation status of particulate organic carbon in the Kolyma River watershed **pg 64**
15.15–15.30 **Tanya Lippman**, The impact of reverse drainage on greenhouse gas fluxes during a hot and dry summer in the Netherlands **pg 65**

Origins and evolution of life, planets and the Universe – Domtoren 4 – Convenors: Dennis Höning, Jan Willem Mantel

14.30–14.45 **Dennis Höning**, Feedbacks in continental growth and implications for habitability **pg 82**
14.45–15.00 **Eloi Camprubi-Casas**, An origins simulator: Could natural pH gradients have powered the origin of life? **pg 83**
15.00–15.15 **Dario Campisi**, Aqueous alteration of forsterite: the face matters **pg 84**
15.15–15.30 **Arjen Boosman**, Extra-Martian organics: a viable source of atmospheric methane? **pg 85**

The Atmosphere from Remote Sensing Perspective – Domtoren 5 – Convenor: Ilse Aben

14.30–14.45 **Gerbrand Koren**, Biosphere-atmosphere exchange of CO2 over the Amazon **pg 109**
14.45–15.00 **Sander Houweling**, The challenge of monitoring CO2 emissions from space **pg 110**
15.00–15.15 **Jiyunting Sun**, The role of TROPOMI aerosol layer height in quantifying aerosol absorption **pg 111**
15.15–15.30 **Jochen Landgraf**, Tropomi methane and carbon monoxide total column measurements at unprecedented temporal and spatial resolution: validation results and applications **pg 112**

Paleoclimate – Domtoren 6 – Convenor: Francien Peterse

14.30–14.45 **Pieter Dirksen**, Transient model analysis of salinity and oxygen dynamics in the Holocene Black Sea **pg 90**
14.45–15.00 **Peter Nooteboom**, Transport by ocean currents influences the sedimentary dinoflagellate cyst distributions: Implications for paleoceanographic reconstructions **pg 91**
15.00–15.15 **Allix Baxter**, Lipid biomarkers in Lake Chala record African Megadroughts during MIS5 **pg 92**
15.15–15.30 **Tobias Agterhuis**, Eastern tropical Atlantic climate variability and dinoflagellate cyst ecology during the early Eocene **pg 93**

Subsurface Processes Associated with Mining in the Netherlands – Oudegracht 1–2 – Convenors: Suzanne Hangx, Ipo Ritsema

14.30–14.45 **Martyn Drury**, The EPOS–NL research infrastructure **pg 105**
14.45–15.00 **Erik van Linden**, Land–surface deformation resulting from Dutch, Belgium and German coal mines **pg 106**
15.00–15.15 **Jeroen Bartol**, First outline of a disposal concept in Zechstein salt **pg 107**
15.15–15.30 **Jan Fokkens**, Is Geothermal energy the solution for the energy transition? Fake or true! **pg 108**

Sea-Level Rise: Local Aspects – Oudegracht 3 – Convenor: Aimée Slangen

14.30–14.45 **Bert Vermeersen**, Sea-Level Change Projections for the Dutch Wadden Sea During the 21st Century **pg 97**
14.45–15.00 **Peter Fokker**, Subsidence in the Dutch Wadden Sea **pg 98**
15.00–15.15 **Zheng Bing Wang**, Response of the Dutch Wadden Sea to future relative sea-level rise **pg 99**
15.15–15.30 **Ad van der Spek**, Response of the Dutch Wadden Sea to future relative sea-level rise. Part 1: Sediment budget over the past century **pg 100**

Global Ocean Dynamics – Oudegracht 4 – Convenor: Jan-Berend Stuut

14.30–14.45 **David Wichmann**, Mixed up at the ocean surface: how garbage patch dynamics causes initial information to be lost in particle dispersion models **pg 70**
14.45–15.00 **Rob Middag**, Dissolved iron in the Southern Ocean and coastal seas **pg 71**
15.00–15.15 **René van Westen**, Mechanisms of Multidecadal Variability in the Southern Ocean **pg 72**
15.15–15.30 **Daniele Castellana**, Stochastic transitions of the AMOC in ocean models **pg 73**

Abstracts

[1] Keynote lectures
[2] Abstracts in chronological order

Keynote lecture 1: Prof Jan Smit, VU

Chicxulub crater, highlights of the IODP/ICDP scientific drillholes

ICDP Holes Yaxcopoil-1 and IODP exp364 recovered a ~1.5 km thick sequence of deformed target rocks, suevitic impact breccia and crater fill. Yax-1 recovered non-deformed Cretaceous dolomites and evaporites from the mega-block zone and exp364 highly shocked granitic basement with melt injection dikes on the peak-ring. Target rocks of exp364 are overlain by a 25m thick melt sheet and in both holes by a graded sequence of polymict suevitic impact breccia, mostly emplaced as result of tsunami-like catastrophic back-flow in the crater. The last impact related sediments are a 60–80 cm thick 'transitional interval' of cross-bedded fine sand to silt, an interval reflecting the final backwash and settling lasting presumably a few days to weeks after impact. Fine climbing-rippled sand laminae demonstrate that seiches developed in the crater basin. The top of the transitional interval contains an iridium anomaly. The first background sediments are fine, fully pelagic limestones containing basalmost Paleocene biota, because Chicxulub crater formed –almost immediately– a deep ocean basin. The basin became restricted in the early Eocene, because of the rhytmic, laminated black-shales alternating with limestone. The peak of the PETM, a laminated black shale on top of a hardground with shallow-water benthic foraminifers, indicate that part of the peak-ring was raised above sea-level around PETM.

Keynote lecture 2: Prof. Douwe van Hinsbergen, UU

Kinematic reconstruction and tectonic evolution of the Mediterranean region since the Triassic

The Mediterranean region has accommodated the Early Mesozoic breakup of Pangea and the subsequent convergence between Africa and Eurasia. The region hosts a complex series of arcuate fold-thrust belts, often overprinted by extension, resulting in high mountain ranges and deep basins. Many of these fold-thrust belts reveal that they were formed by stacking of continent-derived upper crustal nappes, decoupled from their now-subducted underpinnings. This has long been interpreted to show that much of the Mediterranean region prior to convergence was occupied by a stretched micocontinental domain – (Greater) Adria – that rifted off and became separated by oceanic basins from Africa, Iberia, and Eurasia upon Pangea breakup.

The paleogeography of Adria, and its evolution during incorporation into fold-thrust belts, has long been attempted, whereby reconstructions were cast in the Atlantic plate circuit that defines the relative positions of Africa and Eurasia in the past, but were otherwise schematic, mainly inspired by sedimentary and metamorphic facies and magmatic geochemistry. In this contribution, we show a kinematic restoration, made in GPlates plate reconstruction software, whereby we systematically reconstruct the Mediterranean region, from Iberia in the west to the Caucasus in the east, back to the Early Triassic, 250 million years ago. Our reconstruction is cast in the Atlantic plate circuit, and applies a strict reconstruction hierarchy based on orogenic structure – normal faults and detachments, strike-slip faults, and thrusts – and paleomagnetism. To this end, we provide a new tectonic map of the Mediterranean region, give a full review of the architecture of the Mediterranean orogens and basins, and analyse the >2300 published paleomagnetic sites to arrive at a quantitatively described kinematic restoration. This restoration is shown as 11 paleo-tectonic maps.

We will use these maps to identify episodes of major back-arc basin formation – some well-known, some becoming more obvious from our restoration. In addition, we distinguish two styles of orogenesis in the Mediterranean region. Most fold-thrust belts are related to nappe stacking during subduction, whereby the underpinnings of the nappes are lost to subduction. In Central Anatolia since the Late Eocene, and proposed here, in the Dinarides-Tisza-Datca domain in the Cretaceous, however, orogenesis appears to occur in the upper plate of subduction zones as plateaus. We tentatively propose the conceptual 'Tisza-plano' may have been highly elevated, but was destroyed during Neogene Pannonian basin extension.

Keynote lecture 3: Dr. Hester Jiskoot, University of Lethbridge, Can

A whale of a tale in 1710: East Greenland's oldest weather, sea ice and earth science observations

In 1710, the Dutch whaling ship Den Dam embarked on an adventurous whaling expedition to the Greenland Sea where it became beset in sea ice for several months, slowly drifting southwards. When a companion whaler became shipwrecked Den Dam took on its crew. Eventually reaching open sea, and after repairs in Iceland, Den Dam was able to return to Holland. In 1711, the ship's helmsman published their ordeal which has been transcribed and translated. Next daily weather, sea ice, nautical, and geographical data were extracted from the records. These data were calibrated and compared to paleoclimatic data, historical maps and manuscripts. This perilous whaling expedition and its lessons in survivorship, are placed in its geographic-historical context highlighting the cultural and economic relevance of 17th and 18th century whaling to the Netherlands. In addition, the scientific value of these oldest weather and sea ice records off the coast of East Greenland are explained.

Keynote lecture 4: Dr. Jan Polcher, Laboratoire de Météorologie Dynamique, Paris

Representing human water management in Earth system models

The World Climate Research Program (WCRP) has identified Water for the Food Baskets of the World as one of its seven grand challenges. It wishes to mobilize the research community to make significant progress within the next 10 years on our understanding of the interactions between climate and environmental change and the usage of water resources in critical regions.

The continental hydrological cycle in many regions of the world is heavily modified by human water usages, essentially to optimize food production. It is thus impossible today to consider the continental water cycle, as seen by geophyscial sciences, without taking into account the various infrastructures humans have built for water usages as they significantly affect observed fluxes. In the same way, predictions of the water cycle in a changed climate need to take into account the water usage as it has repercussions on other components of the Earth system, like for instance the atmospheric boundary layer or coastal oceans.

The proposed presentation will describe the various efforts under way to try and integrate human water management in current land surface models, which are the components of global or regional Earth system models which deal with continental processes. This will allow to better reproduce the observations of the water cycle currently available and predict how climate change and climate variability will interact with the managed land surfaces we have created. This will provide more relevant information to our societies which rely on this managed hydrological cycle for food production and other usages.

Abstracts in chronological order

Domtoren 3	**Deep-Earth Geochemistry**
Day 1	13:30 – 13:45

Electron microprobe combined with spectral techniques application in geothermal exploration

Fiorenza Deon

Frank Ruitenbeeck, Caroline Lievens, Chris Hecker, Agung Harijoko, Freek van der Meer, Franziska Wilke, David Bruhn

Several field campaigns have been conducted in order to detect hydrothermal alteration in rocks outcropping in the green field (not yet explored) geothermal areas under the GEOCAP (Geothermal Capacity Building program Indonesia-the Netherlands) cooperation. The aim of this study is to establish the application of the electron microprobe (EMP) on hydrothermally altered samples and to validate the results with a spectral technique (SPECIM camera). The use of the EMP allows a quicker and more reliable detection of the clay fraction directly on the thin sections if compared to the XRD where the clay component needs to be extracted and separately measured.

The field missions have been carried out in Java trying to visit geothermal fields with a different geological background in order to collect a big variety of rock types from andesite to breccia to travertine. Very recently Dutch and Indonesian universities have visited the Bajawa field on Flores island where the same sampling strategy has been adopted.
The novelty of this application is the combination of traditional destructive techniques such as XRD, the use of field-based emission devices to detect small clay fraction (EMP) validated by spectral techniques to exactly determine the clay component in geothermal systems.

Domtoren 3	**Deep-Earth Geochemistry**
Day 1	13:45 – 14:00

Zircon U-Pb geochronology of the Marowijne Greenstone Belt, Suriname, with general comments on statistics

Leo Kriegsman

Paul R.D. Mason, Salomon Kroonenberg

The Marowijne Greenstone Belt in Suriname is among the world's youngest greenstone belts. The talk will discuss new zircon U-Pb ages from this mineralised belt, based on an LA-ICP-MS dating programme involving Utrecht MSc students. So far, we have measured ~20 samples, including metasediments and plutonic rocks (early TTG and younger granites). Our age patterns, consistent with those from French Guiana, show that the main events are due to the Trans-Amazonian Orogen between 2.26 and 1.98 Ga. The scarcity of older grains may indicate a juvenile setting, but more evidence is needed from other isotopic systems. Lu-Hf analyses are currently being done in Perth. Some late Archaean to earliest Proterozoic zircons are present, suggesting the proximity of an older craton during part of the history. The youngest detrital grains in conglomerates give an age of 2.16±0.01 Ma (1 sigma), providing a maximum deposition age, with nearby TTGs as likely source rocks. Field data and U-Pb age patterns suggest various pulses of magmatism within the period 2.26–2.08 Ga that can only be separated with difficulty in view of the >10–20 Ma uncertainties (1 sigma) in ages. Young plutomic rocks have commonly inherited zircons from earlier pulses, indicating crustal reworking. Magmatism is younging from S to N and becomes increasingly aluminous.

Given enough time, the talk will also address some problems of statistics in geochronology, notably the tendency to report low uncertainties. Uncertainties far below the standard deviation of the underlying data set must be treated with caution.

Domtoren 3	**Deep-Earth Geochemistry**
Day 1	14:00 – 14:15

Primitive post-collisional magmatism tracks breakoff of the subducted East Carpathian slab

Antoine Bracco Gartner

I. Seghedi, P.R.D. Mason

Causes of melt generation in post-collisional tectonic settings range from slab breakoff, lithospheric delamination, toroidal mantle flow to crustal exhumation. The nature and interaction of mantle and subduction components in these magma sources are often difficult to decipher and reconcile with melting mechanisms, especially given the widespread modification of parental magmas by secondary processes during magma evolution. Here we present geochemical data on olivine-hosted melt inclusions and early liquidus assemblages (spinel inclusions, olivine and clinopyroxene) in the most primitive rock samples from the calc-alkaline Neogene-Quaternary East Carpathian volcanic chain in Romania at Călimani, Southern Harghita (Pilişca, Bicsad and Malnaş) and the Na-alkalic Perşani Mountains (Racoş) in order to provide unique insights into the characteristics of the near-primary melts that gave rise to subduction-related, post-collisional magmatism. Systematic geochemical diversity in these primitive phases suggests the melting of (1) sediment-metasomatized, inhomogeneous lithospheric mantle at Călimani; (2) subduction-modified lithospheric mantle below Southern Harghita, generating adakite-like compositions; and (3) modified OIB-like, asthenospheric mantle below the Perşani Mountains. Coupled with independent geophysical observations, the melt generation in these respective areas can be resolved with asthenospheric upwelling induced by (1) slab breakoff; (2) slab pull and tearing; and (3) a slab-driven convective current associated with the Vrancea Zone. We infer that the geochemical characteristics of the primitive magmas reflect both the temporal and spatial, southeast-directed progression of subduction segmentation in the East Carpathians.

Domtoren 3	**Deep-Earth Geochemistry**
Day 1	14:15 – 14:30

The Bemau Ultramafic Complex on the Guiana Shield: an Alaskan-type intrusion recording modern-style Paleoproterozoic subduction?

Floris Teuling

Paul R.D. Mason, Salomon B. Kroonenberg, Renousha Naipal

Interpretation of greenstone belts within the framework of modern plate tectonics remains controversial due to the common absence of ophiolites and high-pressure/low-temperature (HP/LT) metamorphism. The Paleoproterozoic Marowijne Greenstone Belt (MGB) (~2.2–1.95 Ga) on the Guiana Shield in Suriname hosts multiple mafic-ultramafic complexes that are poorly understood. One, the small (~50 km^2) Bemau Ultramafic Complex (BUC) in the MGB, consists of dunites, wehrlites, pyroxenites, gabbros and diorite, has previously been suggested to be an Alaskan-type complex. Almost all Alaskan-type intrusions are found in modern arc terranes, so a Paleoproterozoic occurrence could suggest early operation of modern tectonic processes. We analyzed the bulk rock composition of BUC drill cores with X-ray fluorenscence and the elemental composition of relict clinopyroxene and olivine with the microprobe and Laser Ablation Inductively Coupled Mass Spectrometry. Our geochemical and petrographic data identifies these rocks as cumulates, allowing for calculation of melt composition in equilibrium with clinopyroxene. Enrichments in large ion lithophile elements, depletions in high field strength elements and the crystallization sequence point towards accumulation from a hydrous subalkaline basaltic parental magma. The composition of olivine (CaO <0.06%, Fo74–80), AlIV vs TiO2 in diopisidic clinopyroxene and lack of early crystallizing orthopyroxene further indicate that the BUC is an Alaskan-type intrusion. Its position within an arc-like stratigraphy implies that the MGB is a Paleoproterozoic arc. Rigorous inspection of the literature reveals 74 Alaskan-type intrusions, mainly younger than 900 Ma, coincidental to the advent of HP/LT metamorphism. This temporal distribution could reflect an ultimate Neoproterozoic transition to modern-style tectonics.

Domtoren 3	**Deep-Earth Geodynamics & Tectonics**
Day 1	15:30 – 15:45

Southwest Pacific Absolute Plate Kinematic Reconstruction Reveals Major Cenozoic Tonga-Kermadec Slab Dragging

Suzanne van de Lagemaat

D.J.J. van Hinsbergen, L.M. Boschman, P.J.J. Kamp, W. Spakman

Tectonic plates subducting at trenches having strikes oblique to the absolute subducting plate motion undergo trench-parallel slab motion through the mantle, recently defined as a form of "slab dragging." We investigate here long-term slab-dragging components of the Tonga-Kermadec subduction system driven by absolute Pacific plate motion. To this end we develop a kinematic restoration of Tonga-Kermadec Trench motion placed in a mantle reference frame and compare it to tomographically imaged slabs in the mantle. Estimating Tonga-Kermadec subduction initiation is challenging because another (New Caledonia) subduction zone existed during the Paleogene between the Australia and Pacific plates. We test partitioning of plate convergence across the Paleogene New Caledonia and Tonga-Kermadec subduction zones against resulting mantle structure and show that most, if not all, Tonga-Kermadec subduction occurred after ca. 30 Ma. Since then, Tonga-Kermadec subduction has accommodated 1,700 to 3,500 km of subduction along the southern and northern ends of the trench, respectively. When placed in a mantle reference frame, the predominantly westward directed subduction evolved while the Tonga-Kermadec Trench underwent ~1,200 km of northward absolute motion. We infer that the entire Tonga-Kermadec slab was laterally transported through the mantle over 1,200 km. Such slab dragging by the Pacific plate may explain observed deep-slab deformation and may also have significant effects on surface tectonics, both resulting from the resistance to slab dragging by the viscous mantle.

Domtoren 3	**Deep-Earth Geodynamics & Tectonics**
Day 1	15:45 – 1600

2-D thermo-mechanical numerical modelling of the South American subduction zone

Vincent Strak

Vincent Strak (1) and Wouter P. Schellart (1)

(1) Department of Earth Sciences, Vrije Universiteit Amsterdam, Amsterdam, Netherlands

Here we will present a parametric study of the South American subduction zone to investigate what combination of parameters best reproduces the present-day geometry of the slab observed in tomography studies. Tomography models indicate that the slab in the center of the subduction zone dips eastward in the whole mantle, but the dip angle changes with depth and a thick high density anomaly is observed in the lower mantle, suggesting some folding of the slab. Replicating this disctinct slab geometry using geodynamic modelling may help us better constrain variables that are commonly used in the literature. Using the code Underworld 2, we ran 2-D buoyancy-driven thermo-mechanical subduction models extending down to the core mantle boundary and with a large horizontal dimension of 11600 km to extend up to the Atlantic mid-oceanic ridge. We studied the effect of varying lower mantle viscosity and density, upper mantle rheology (linear or non-linear viscous), cohesion at the subduction interface, as well as the temperature dependence of the slab viscosity. Preliminary results show that using a non-linear rheology for the upper mantle is more efficient to produce slab folding in the lower mantle, while other parameters including lower mantle viscosity and density control the dip angle in the lower mantle.

Domtoren 3	**Deep-Earth Geodynamics & Tectonics**
Day 1	16:00 – 16:15

Nanomechanics in crustal fault zones: Mechanical amorphisation and colloid-suspension formation weakens crustal faults

Markus Ohl

Helen King, Andre Niemeijer, Martyn Drury, Oliver Plümper

Earthquakes are one of the most devastating and unpredictable natural disasters. Geographic regions prone to high magnitude seismic events, like the Mediterranean, are often densely populated suffering human casualties and costly infrastructural damage. The resulting fault products can reach extremely small grains sizes of about 100 nm. In addition, fault zones are major fluid conduits warranting research on the deformation and weakening processes under conditions where fluids are present.

To investigate the involved deformation processes we combine research on natural faults with laboratory deformation experiments using stable isotope doped fluid (H218O). Our research on carbonate fault gouges show a strong slip localization taking place on top of a previously recrystallized fault gouge. The energy dissipation during seismic slip produces an amorphous slip surface coating which infiltrates cavities also deeper into the fault gouge volume. The amorphisation product is the host of new calcite grains (<50 nm) which are most likely the result of a back-reaction from lime and portlandite. Stable isotope distribution suggests that a major part of the fault gouges goes into solution forming a colloid suspension.

These results imply that mechanical amorphisation and decarbonation of calcite play a central role for fault rock deformation and fault plane reactivation. Especially the formation of a colloid suspension weakens the faults because colloids can exhibit a weak rheological behavior. The results further imply that powder lubrication by nanograin surface coating is not a necessary scenario to explain fault weakening in carbonate rocks.

Domtoren 3	**Deep-Earth Geodynamics & Tectonics**
Day 1	16:15 – 16:30

Models Bridging Subduction and Earthquake Dynamics Show Fault Strength as a Strain-average Quantity

Ylona van Dinther

The strength of faults provides one of the enigmatic topics of discussion throughout various Earth Scientific disciplines. Geodynamic models require very low effective strengths ($\mu<0.05$), while at the same time realizing mountains need to be sustained. Fault orientations and low slip rate laboratory experiments suggest high static friction ($0.5<\mu<1$), while coseismic slip rate experiments reveal low dynamic friction ($0.03<\mu<0.3$). Considering large-scale frictional strength as a strain-averaged quantity to some degree unites these perspectives. Seismo-Thermo-Mechanical models simulating both long-term subduction and short-term seismogenesis dynamics show that most deformation occurs over a very small space and time during which friction is exceptionally low, thus making the representative long-term strength low. They sustain mountain building, while representative earthquake-like events occur on highly fluid over-pressurized faults ($0.005<\mu<0.125$). The presence of weak faults and the need for distinctly fluid over-pressurized faults also deduces from analytical considerations that account for strain-averaging using mechanical energy dissipation. Constraining the four parameters of the resulting equation through observations indicate the importance of fluid weakening for long-term weakening with respect to the dynamic frictional weakening and low static friction coefficients. Recent simulations of earthquake rupture dynamics now also prefer distinct fluid over-pressured faults to allow for laboratory-observed dynamic weakening (70-90%) and reasonable stress drops. In summary, this cross-scale perspective supports effective friction values μ in the range of about 0.03 to 0.2.

Domtoren 3	**Deep-Earth Geodynamics & Tectonics**
Day 1	16:30 – 16:45

Reconstructing spreading ridge subduction within the Mesozoic Panthalassa Ocean using stratigraphic and paleomagnetic constraints from Hokkaido, Japan

Lydian Boschman

Hayato Ueda, Douwe J.J. van Hinsbergen, Cor G. Langereis, Wim Spakman

The vast majority of the tectonic plates of the Panthalassa Ocean that once surrounding the supercontinent Pangea were consumed by subduction. Tectonic reconstructions generally portray the Panthalassa Ocean as a four-plate system containing spreading ridges only, but the accretionary geological record of Hokkaido (Japan), includes remnants of a Jurassic intra-oceanic island arc (the Oku-Niikappu Complex). Here, we aim at reconstructing the evolution of Mesozoic intra-oceanic subduction within the northwestern Panthalassa Ocean. First, we show that published marine magnetic anomaly data of the Pacific Plate record a change in spreading orientation between the Pacific and the conceptual Izanagi Plate between 146.6 and 137.9 Ma, coeval with Oku-Niikappu arc extinction. Second, we present an analysis of sequences of Ocean Plate Stratigraphy (OPS) exposed on both sides of the Oku-Niikappu Complex, revealing that accretion of the Oku-Niikappu Complex was paired with a major jump in age of the subducting lithosphere at the Hokkaido trench, reflecting previously subducted lithosphere. Furthermore, it reveals that at 145 Ma, the lithosphere that subducted in the intra-oceanic Oku-Niikappu trench was close to 0 Myr old, indicating that cessation of subduction was caused by ridge subduction. We reconstruct the Oku-Niikappu arc at ~145 Ma using Pacific magnetic anomalies to a paleolatitude of ~10°N, consistent with our new paleomagnetic data. This study illustrates the value of accreted materials in ancient subduction records and the concept of OPS on the development of plate kinematic reconstructions of lost oceanic plates.

Domtoren 3	**Deep-Earth Geodynamics & Tectonics**
Day 1	16:45 – 17:00

The potential of numerical modeling for glaciation-induced true polar wander of the Earth

Maaike Weerdesteijn

Haiyang Hu, Wouter van der Wal, Riccardo Riva

The C2,1 and S2,1 spherical harmonic coefficients of glacial isostatic adjustment (GIA) models are dominated by true polar wander (TPW), the secular drift of the position of the Earth's rotational axis w.r.t the Earth's surface. The Earth's rotational state and its interior are closely linked. The deformation of the body induced by a surface load depends on the local viscosity, while the adjustment of the equatorial bulge to the position perpendicular to the rotational axis depends on the average global viscosity of the body. Therefore, lateral viscosity variations could play a role in GIA-induced TPW. Our goal is to extend an existing GIA model based on a finite element method (FEM) with a simulation for TPW (Hu et al., JGR 2017).

The model is based on FE software ABAQUS coupled to the solution of the Laplace equation. The perturbed gravitational potential is a function of the radial displacements. Therefore, an iterative process is required to solve for the displacements in the body. Our TPW approach allows for large-angle TPW and non-stationary surface loads w.r.t. the rotational axis. We find that when the perturbed gravitational potential is not fully converged, it affects the perturbed gravitational potential in future time steps and thus TPW. The centrifugal and perturbed gravitational potential cannot simultaneously for all time steps be iterated for. Therefore, to be able to study the effect of lateral viscosity variations on GIA-induced TPW, the iteration between radial displacements and centrifugal potential needs to occur per time step.

Domtoren 4	**Hydrological Sciences**
Day 1	15:30 – 15:45

Field Scale Dispersivity – Do Rules of Thumb Hold Versus Field Data?

Alraune Zech

Macrodispersion coefficients are relevant to predict reactive transport. Longitudinal macrodispersivity impacts the travel distance whereas transverse dispersivity is crucial for biodegradation and mixing of reactive solutes. Dispersion is well understood at laboratory scale but results cannot be referred to field scale, where coefficients are much larger due to aquifer heterogeneity. Inference from field experiments is difficult, costly and error prone and thus commonly not available in applications. Scaling laws and rules of thumb have been introduced for estimating dispersivity coefficients, particularly for numerical models. Typical approaches apply regression to an ensemble of field experiment although the data base is questionable.

We revisited the concept of universal scaling and common rules of thumb through a detailed analyses of field scale dispersivities from existing publications.* Our investigation concludes that transport parameters are formation-specific. They span several orders of magnitude and lack a scale-dependence to the plume traveled distance. Similarly, ratios between longitudinal and transverse dispersivities are site-specific and vary in the same proportion.

Reliable field data does not support a universal scaling law. If dispersion is of relevance, the parameters should be inferred from site characterization. Otherwise, values from structurally similar sites can offer a first guess, but sensitivity should be tested. In any case, using estimated rather then measured values in subsurface transport models is related to large uncertainties.

*Is unique scaling of aquifer macrodispersivity supported by field data?; A. Zech et al.; WRR; 2015; http:/dx.doi.org/10.1002/2015WR017220

*A Critical Analysis of Transverse Dispersivity Field Data; A. Zech et al.; Groundwater; 2018; https://doi.org/10.1111/gwat.12838

Domtoren 4	**Hydrological Sciences**
Day 1	15:45 – 16:00

HyMUSE: a user friendly multi-model framework for Hydrology

Inti Pelupessy

Niels Drost, Rolf Hut, Jerome Aerts, Simon Portegies Zwart, Arjen van Elteren, Gijs van den Oord, Ben van Werkhoven, Stefan Verhoeven, Berend Weel

Neth. eScience Center; TUD Fac. Civil Eng. & Geosci.; Leiden Obs., Leiden Univ.

The Hydrological Multipurpose Software Environment (HyMUSE) is a Python framework for Hydrological model simulations, currently in development as part of the computational core of the eWaterCycle II project. The eWaterCycle II project aims to be a platform for researchers to easily formulate and run hydrological models and compara with data. HyMUSE is being developed at the Netherlands eScience Center using technology developed for AMUSE and OMUSE (Pelupessy et al., 2013, 2017), which are its sibling implementations for the astrophysical and oceanographic domains.

HyMUSE presents the user with a homogeneous interface to different hydrological simulation codes. For this it provides a number of services such as unit conversion, encapsulation of the internal model data to a common object oriented representation and maintaining the simulation in a consistent state. HyMUSE can be accessed from within the online notebook environment of the eWaterCycle toolset, where researchers can explore, adapt and collaborate on simulations models. The use cases for HyMUSE range from running simple numerical experiments with single codes and the addition of data analysis tools in model runs, to running large model run ensembles or setting up coupled solvers for problems where different types of physics interact. HyMUSE is open source, freely available and extendable. We strive to engage the community in the development of HyMUSE.

Currently, a basic capability is accessible through the eWaterCycle system.

Domtoren 4	**Hydrological Sciences**
Day 1	16:00 – 16:15

Rivers as input path of anthropogenic substances into the biosphere of Lake Constance – a numerical modelling approach

Ronja Ebner

Thomas Wolf, Thomas Pflugbeil, Franziska Pöschke, Vera Winde

In 2015, as a reaction to discussions about fracking in Germany, the interdisciplinary ReWaM project SEEZEICHEN was launched. It focussed on Lake Constance, a freshwater reservoir with high importance for Germany, Austria and Switzerland, which is embedded into the North Alpine foreland basin. In order to gain insight into the spreading of discharges that could carry pollutants, investigating lake internal circulation and river water plumes was one of the main objectives of this project. Besides extensive measurements, a numerical model for the whole lake was set up using the Delft3D suite to meet this task. Equipped with a decay-rate varying tracer cascade, this model was used to calculate spreading scenarios of anthropogenic substances of different persistence groups. This set-up was applied to investigate the behaviour of five river discharges for time spans of three to 18 years. Comparing the results for two geographically close rivers with comparable discharges showed a huge influence of the river mouth's geometry on the settling depth. While the water of the first river stayed within the epilimnion while the water of the second dived into the hypolimnion.

Due to the dynamics of this monomictic lake, this difference leads to a change in spreading direction, as well as the days per year a concentration would be above a certain threshold (i.e. accumulation areas). These results show that this kind of tracer modelling can not only be used to identify areas with higher risk of pollution, but also to gain insight to circulations and flow direction.

Domtoren 4	**Hydrological Sciences**
Day 1	16:15 – 16:30

A WEAP-MODFLOW model for conjunctive water management in the Urmia Lake Basin, Iran

Amirhossein Dehghanipour
Gerrit Schoups, Bagher Zahabiyoun

The Urmia Lake Basin in Iran suffers from limited water resources and competing demands from urban areas, irrigated agriculture, and the lake ecosystem. Sustainable water management in this region requires a conjunctive approach that takes account of the coupled surface water (SW) and groundwater (GW) systems. We present the first SW-GW model for the Miyandoab Plain, a strategic irrigated agricultural region within the larger Urmia Lake Basin. The model consists of spatially distributed monthly water balances for the aquifer, root-zone, rivers, canals, and reservoirs. A water allocation module is used to match available water supply with irrigation water demand. Model implementation is based on a dynamic coupling between MODFLOW and WEAP. Model parameters are estimated using multi-objective calibration with river discharge and groundwater level data; this leads to better constrained parameter values compared to using either data source alone. The model is subsequently used to reconstruct impacts of historical droughts. Results show that crop water demand cannot be met during droughts due to limited GW pumping capacity, and that increased GW pumping has a relatively strong impact on groundwater levels due to the small specific yield of the aquifer. The simulations further highlight the importance of accounting for SW-GW interactions, in order to explain a long-term decrease in GW storage even though GW recharge has historically exceeded GW pumping. The SW-GW model provides a unique tool for exploring management options that sustain agricultural production and downstream flow to the shrinking Urmia Lake.

Domtoren 4	**Hydrological Sciences**
Day 1	16:30 – 16:45

Grondwatertools: 4D information on heads and groundwater system characteristics for the Netherlands

Willem Zaadnoordijk

TNO Geological Survey of the Netherlands makes groundwater information available on https://www.grondwatertools.nl/grondwatertools-viewer in addition to the measured heads at https://www.dinoloket.nl/ondergrondgegevens: (1) piezometric contours and (2) time series models with precipitation and evaporation as explanatory variables. Head time series implicitly contain information about the groundwater system. This information is reflected in response of the head to precipitation.

The database with ±34000 acceptable time series models throughout the Netherlands may serve many purposes. Examples are:

- Spatial patterns (1) of heads as indication of groundwater flow directions and (2) of precipitation response quantity and response time which gives information of the aquifer system, e.g. the presence of a confining layer or aquitard;
- Improvement of bad time series models using spatial correlation of the precipitation response between neighboring monitoring wells;
- Detection of changes over time (in groundwater heads only or also the groundwater system); this can be done by e.g. (1) evaluating trends in the residuals (difference between measurements and model predictions – indicative for influences not in the time series model), (2) comparing models of different periods, (3) estimating a trend as explanatory variable in the time series model;
- Determination of status: the percentile of the actual groundwater head with respect to a standardized period and frequency. The time series models allow to fill gaps or extend measurement series so calculated percentiles are comparable.

The time series models and piezometric contouring of http://www.grondwatertools.nl offer valuable 4D information for management and research on groundwater heads in the Netherlands.

Domtoren 4	**Hydrological Sciences**
Day 1	16:45 – 17:00

Linking long-term CO2 induced leaf stomatal conductance decrease to vegetation greening through gsmax – NDVI comparison in Scandinavia

Rike Wagner-Cremer

F. Wagner-Cremer (1), M. Vogels (1), K. Nijhuis (1), H.J. de Boer (2)

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(2) Department of Environmental Sciences, Utrecht University, The Netherlands

The inherent CO2 regulated link between climate and vegetation affects the hydrological cycle. Reduced water loss through leaf stomata under current CO2 increases has the potential to induce a wide range of changes in the global hydrological cycle such as H2O fluxes, run-off rates, cloud formation and precipitation. Especially in the northern latitudes, photosynthetically active, and thus transpiring leaf area is maintained for an increasingly longer period throughout the year due to the lengthening of the growing season under ongoing warming.

The increasing CO2 availability moreover allows plants to optimize carbon uptake versus water loss through adjustment of their leaf stomatal conductance. The resulting increases in water use efficiency, defined as the ratio of carbon uptake to actual water loss, regulates the canopy transpiration and therewith the evapotranspiration of the vegetated areas.

On plant leaf level, the structural maximum stomatal conductance (gsmax) adaptation can be quantified by microscopic analysis of the epidermal cell morphology in modern and fossil plant leaf material, providing an important tool to determine the long-term trends in plant hydrological properties under anthropogenic CO2 increase.

Gsmax records produced for the past 150 years spanning the anthropogenic CO2 increase reveal a substantial decrease in gsmax. The hydrological properties of plant foliage are thus indicating a downregulation of the vegetation transpiration with the potential to act on the hydrological cycle. This pattern however is not clearly visible in the instrumental records and increasing leaf area through CO2 fertilization has been offered as a buffering mechanism.

We here test this hypothesis by directly comparing gsmax records from Scandinavia with satellite imagery based NDVI data of the regions covered by the proxy data. Our results show that gsmax rate of change is by far exceeding NDVI increments leaving a large part of the vegetation induced changes unexplained.

Oudegracht 1-2	**IODP/ICDP**
Day 1	13:30 – 14:00

An overview of climate and global sea-level changes over the past 100 Myr from IODP drilling

Kenneth Miller

Sea-level history reflects the thermal and cryospheric evolution of the Earth, providing a history of ice sheet behavior and operation of the climate systems under ice-free and glaciated conditions. IODP Drilling on the "passive" continental margin of the mid-Atlantic U.S. by Legs 150, 150X, 174A, 174AX, and Expedition 313 has provided unprecedented recovery of Upper Cretaceous to Holocene sequences. Backstripping of these sequences, progressively accounting for the effects of compaction, loading, and thermal subsidence, provides a record of GMSL and non-thermal subsidence largely due to mantle dynamic topography, though the differentiation between these effects is not possible using the mid-Atlantic records alone. Ocean drilling has also provided a global array of ocean coreholes allowing application of the δ18O-Mg/Ca proxy for ice volume. We spliced together astronomically calibrated Pacific deep sea benthic foraminiferal δ18O records from the past 66 Myr. The splice was scaled to sea level using a smoothed record (>2 Myr) of Cenozoic Mg/Ca variations to account for long-term bottom-water temperature changes and provides an estimate of ice-volume and attendant GMSL changes due to ice (volume with errors of approximately ±10 m. We compare Late Cretaceous to Cenozoic sea-level variations from backstripping and from scaling deep-sea the δ18O-Mg/Ca record. Peak warmth, sea levels, and ice-free condition occurred in the Hothouse intervals of the Cenomanian-Santonian (ca. 100–80 Ma) and Early Eocene (56–50 Ma). Hothouse global average sea level falls of ~15 m are associated with δ18O increases that reflect primarily high latitude coolings and may reflect the growth of small ice sheets in elevated regions of Antarctica. Cool greenhouse (Campanian to Paleocene, Middle to Late Eocene) sea-level changes of 15–25 m were caused by growth and decay of small (25-35% of modern) ice sheets, reaching ice-free condition during most, but not all, of the Early Eocene and much of the Paleocene and Middle Eocene. For example, the Middle Eocene Climate Optimum (MECO) was bracketed by ~30 m glacioeustatic falls. Warm periods in the Icehouse of the past 34 Myr displayed different sea-level responses. During the largely unipolar Icehouse of the Oligocene to Early Miocene, the East Antarctic Ice Sheet (EAIS) was not permanently developed, with periods of with large-scale (~40–55 m sea level equivalent) growth and collapse. During peak warmth of the Miocene Climate Optimum (MCO; ~17–15 Ma) ice volume changes were small (generally <20 m), with ice free conditions likely attained. A permanent EAIS developed following 3 middle Miocene oxygen isotope increases (14.7, 13.8, and 13.2 Ma) that were largely cooling events associated with <40 m sea-level falls; the subsequent EAIS post 13.8 Ma was stable (~20–30 m sea-level variations on Myr scale). Despite only moderate atmospheric CO2 levels (400±50 ppm), during the peak warmth interval of the Pliocene, sea levels peaked in Chron G17 (ca. 3 Ma) at 22±10 m and 31±10 m during Gi13 (ca. 3.8 Ma) requiring loss of Greenland, West Antarctica, the Wilkes and Aurora Basins of East Antarctica.

Oudegracht 1-2	**IODP/ICDP**
Day 1	15:30 – 15:45

The Eocene southwest Pacific 'warm pool' revisited

Peter Bijl

Joost Frieling, Margot J. Cramwinckel, Lineke Woelders, Emiel Huurdeman, Michiel Baatsen, Irene Waaijen, Rein Nijhof, Inigo A. Müller, Martin Ziegler, Appy Sluijs

The Eocene is characterized by globally declining temperatures, which suggests atmospheric CO2 concentrations forced Eocene climate change. Yet, a mismatch exists in sea surface temperature (SST) estimates from state-of-the-art Eocene climate model simulations and those from proxy-data in the southwest Pacific Ocean: the latter are 4–6 degrees warmer. This 'model-data mismatch' exposes a fundamental lack in understanding of Eocene climate dynamics, regional paleogeography and/or proxy behaviour.

We will present new results in our efforts to understand the climatic/oceanographic conditions in the Eocene southwest Pacific Ocean. We present new microplankton-based ocean surface current and paleotemperature reconstructions from west Australia (Otway Basin), and from within the Tasmanian Gateway (ODP Site 1170), as well as new high-resolution Eocene numerical model simulations and advancements in paleobathymetry in the Southwest Pacific Ocean. We show that (1) the 'southwest pacific warm pool' extends into the South East Indian Ocean, and thus ΔSST across the -presumably- mostly closed Tasmanian Gateway is surprisingly small, despite fundamentally different ocean current regimes (2) clumped isotope paleotemperature estimates confirm other proxy-based high temperature reconstructions (3) models still fail to reproduce the combination of proxy evidence for warmth ocean current configuration, in spite of improved physics, spatial resolution and paleogeographic constraints. We propose, in the absence of a better alternative explanation, that additional missing paleogeographic constraints must be responsible for the proxy-model mismatch.

Oudegracht 1-2	**IODP/ICDP**
Day 1	15:45 – 16:00

North Atlantic sea surface temperature evolution across the Eocene-Oligocene transition

Ilja Kocken

Anne van der Meer, Inigo R. Müller, Anna Nele Meckler, Martin Ziegler

The Eocene-Oligocene Transition (EOT, ~34 Ma), is marked by the rapid development of semi-permanent Antarctic ice-sheet. Foraminiferal stable oxygen isotopes ($\delta^{18}O$) as well as Mg/Ca and other indicators (e.g. ice-rafted debris) indicate the development of permanent glaciation that potentially coincides with ~2.5 °C deep-sea cooling. However, due to the nature of the $\delta^{18}O$ proxy, uncertainties in the Mg/Ca concentrations of the palaeo-seawater, and calibration extrapolation/saturation to/at higher temperatures for organic proxies, it remains unclear how sea surface temperature (SST) changed across the EOT.

In this study, we apply clumped-isotope palaeothermometry to well-preserved planktic foraminifera from the drift sediments of IODP Site 1411, Newfoundland, across four intervals bracketing the EOT. Initial findings indicate minor cooling across the interval, with absolute temperatures that are significantly lower than those reconstructed using other proxies, a discrepancy that warrants further research.

Oudegracht 1-2	**IODP/ICDP**
Day 1	16:00 – 16:15

Ocean properties and Antarctic cryosphere dynamics during the Miocene Climatic Optimum: results from the IODP Expedition 374 (Ross Sea) in a circum-Antarctic context

Francesca Sangiorgi

Evi Wubben, Imogen Browne, Amelia Shevenell, Frida Hoem, Peter K. Bijl, Robert M. McKay, Laura De Santis, Denise K. Kulhanek, the Expedition 374 Scientists

Observational data and model experiments highlight consistently that the influx of warm waters onto the Antarctic continental shelf invigorates ice retreat. The rate of melting of the Antarctic ice sheet and consequent global sea level rise depend thus heavily on the ocean-ice interaction. Geological records, mostly far field, indicate that the Antarctic ice sheet was highly dynamic in the past, and underwent phases of remarkable melting during its warmest intervals. One of such intervals is the Miocene Climatic Optimum (MCO~17-15 Ma), when the Southern Ocean was several degrees warmer than at present and likely sustained ice sheet melting. Assessing the role of oceanic forcing on the (West) Antarctic Ice Sheet (in)stability during the Neogene was one of the key targets of International Ocean Discovery Program (IODP) Exp. 374 (January-March 2018). Sediments recovered from the Pennell Trough in the Ross Sea mid to outer-shelf at Site U1521 (75°41.0351'S, 179°40.3108'W, 562-m water depth) contain an expanded MCO interval (~17-15.8 Ma).

Our first palynological and lipid biomarker data indicate high variability in the upper ocean temperature, sea-ice, productivity, and stratification. A first phase of high productive cold waters with (seasonal) sea-ice precedes an interval with reduced to absent sea-ice and warm waters, while vegetation grows on land. Afterwards, the Antarctic ice sheet expands during the globally warm MCO. Our novel results will be presented in the context of results from previous Antarctic drilling expeditions to obtain a circum-Antarctic view of cryosphere dynamics during the MCO related to ocean temperature and other oceanographic features.

Oudegracht 1-2	**IODP/ICDP**
Day 1	16:15 – 16:30

A 5.3-million-year history of monsoonal precipitation in northwestern Australia

Jan-Berend Stuut

Patrick De Deckker, Franck Bassinot

Australia is the driest inhabited continent on the planet, with its moisture mostly sourced from the tropical monsoon in the north and the southern westerlies in the south. The continent has experienced large climate fluctuations in the geologic past, but long continuous records of palaeo-environmental changes are lacking, particularly prior to ~0.55Ma. Here, we address this paucity by presenting a continuous record of continental aridity and monsoonal activity in northwestern Australia since the Pliocene (5.3 Ma). Our records are based on bulk-chemical XRF-scans and particle-size distributions of the terrigenous fraction, in two cores from the northwestern Australian continental shelf: MD002361 and ODP122-762B. In our records we distinguish between aeolian- and fluvial sediments that were deposited at sea. Support for the distinction between aeolian and fluvial sediment fractions in the two marine sediment cores is found in the bulk-chemical composition of aeolian- and fluvial material in the potential source areas in northern West Australia. Our records show a warm and dry early Pliocene (~5.3 Ma) on the northwestern Australian continent, which experienced a gradual increase in humidity peaking at about 3.8 Ma with higher than present-day rainfall. Between 3.8 and about 2.8 Ma, climate became progressively more arid with more rainfall variability. Coinciding with the onset of the northern hemisphere glaciations and the intensification of the northern-hemisphere monsoon, aridity continued to increase overall from 2.8 Ma until today, with greater variance in precipitation and an increased frequency of large rainfall events. We associate the observed large-scale fluctuations in Australian aridity with variations in Indian Ocean sea-surface temperatures, which largely control the monsoonal precipitation in northwestern Australia.

Oudegracht 1-2	**IODP/ICDP**
Day 1	16:30 – 16:45

Fire and the development of woody vegetation in equatorial West Africa during the last c. 520,000 years

William Gosling

Charlotte S. Miller (3), Adele C.M. Julier (1,2)

(1) IBED, UvA; (2) School of Environment, Earth & Ecosystem Sciences, The Open University; (3) MARUM, Bremen

Fossil charcoal recovered from the sediments contained within Lake Bosumtwi (Ghana, West Africa) reveal that for the majority of the last 520,000 years fire played was an important component of the regional landscape dynamics. Today the lake is surrounded by moist semi-deciduous forest and natural fires are rare. The sedimentary record demonstrates that frequent, probably annual, fires occurred in the landscape around Lake Bosumtwi for most of the last 520,000 years. Despite the near continual presence of fire within the landscape the fossil pollen record indicates that the woody component of the vegetation did oscillate in concert with major global climate change (glacial-interglacial cycles) throughout most of the last 520,000 years. The increase in the woody vegetation component is coincident with warmer interglacial periods when more moisture is available; however, these woody vegetation formations were more similar to the woody vegetation found near to the forest-savannah transition zone today (70 km north). Around 15,000 years ago fire disappeared from the landscape at Lake Bosumtwi and then during the Holocene vegetation similar to that found in the region today appeared. It seems that fire around Lake Bosumtwi had a significant impact on the type of woody vegetation development at Lake Bosumtwi during the last 520,000 years, but that this influence was insufficient to completely override the impact of a changing global climate.

Oudegracht 1-2	**IODP/ICDP**
Day 1	16:45 – 17:00

IODP Expedition 381: Corinth Active Rift Development

Aleksandra Cvetkoska

K. Panagiotopoulos (3), M. Phillips (4), G. Carter (5), J. Everest (5), D. Shillington (6), L. McNeill (7), Expedition 381 Scientists

IODP Expedition 381 in the Gulf of Corinth drilled the longest and highest resolution record from an active rift system. The expedition was operated as a Mission Specific Platform onboard the industry drilling vessel Fugro Synergy between October and December 2017. A total 1645m of core were retrieved from three sites, capturing ~1–2 Myr of sediment flux and paleoenvironments in the center of the Gulf of Corinth (M0078, M0079) and the Alkyonides Gulf (M0080, McNeill et al., in press).

The main objectives of the expedition are to: (i) obtain a high-resolution fault slip and rift evolution history; (ii) determine the surface processes that controlled the sediment supply through time; (iii) generate new high-resolution record of Quaternary Mediterranean paleo-climate and paleoenvironment and (iv) improve the regional assessment of geohazards.

The onshore phase of the expedition took place at MARUM, IODP Bremen Core Repository, Germany in February 2018. The preliminary results produced during this phase already show a great potential for obtaining a unique record of substantial temporal variations in the paleoenvironment of the Gulf, manifested via varying microfossil assemblages, lithology and geochemistry of the sediments. Namely, shifts between typically marine and complex, often non-marine microfossil assemblages are recorded during interglacial, marine and glacial, isolated/semi-isolated environments, respectively (Shillington et al., 2019, McNeill et al., in press). Further post-expedition research is expected to provide better understanding to these environments and provide a new, long Quaternary record of Mediterranean-type climate.

Domtoren 6	**Regional Ocean Circulation and Ecosystems**
Day 1	13:30 – 13:45

Role of heat exchange across the Mohn-Knipovich Ridge: an idealized study of the Nordic Seas

Stefanie Ypma

S. Georgiou, J.M. Sayol, J.D. Pietrzak , C.A. Katsman

The Nordic Seas are an important production region for dense water masses that feed the lower limb of the Atlantic Meridional Overturning Circulation. They display a pronounced hydrographic asymmetry, with a warm eastern basin, and a cold western basin. Previous studies have shown that this asymmetry is set by the interplay between large eddies shed near the coast of Norway where the continental slope steepens, and the Mohn-Knipovich Ridge that separates the Lofoten Basin in the east from the Greenland Basin in the west. Observations show that eddy-induced transport must take place across this ridge to close the heat balance. However, little is known about this cross-frontal exchange and its role for the spreading of dense waters in the Nordic Seas.

In this study, we investigate a high resolution, idealized model configuration of the MITgcm, that reproduces the main characteristics of the Nordic Seas, including a warm cyclonic boundary current, a strong eddy field in the east and the asymmetry in temperature between eastern and western basin. The idealized approach enables multiple sensitivity studies of the model dynamics to changes in the surface forcing and provides the possibility to investigate cause and effect relations, while keeping the set-up simple. We will present a detailed analysis of the mechanism of the cross-frontal exchange across the Mohn-Knipovich Ridge, and of the spreading of dense water as revealed by passive tracers.

Domtoren 6	**Regional Ocean Circulation and Ecosystems**
Day 1	13:45 – 14:00

Long-term environmental conditions at an Arctic deep-sea sponge ground

Ulrike Hanz

Gerard Duineveld, Emyr Roberts, Hans-Tore Rapp, Gert-Jan Reichard, Furu Mienis

Deep-sea reefs are hotspots of benthic biomass and diversity in the otherwise barren deep-sea. In order to explain which environmental factors allow the establishment of a thriving ecosystem in such an extreme environment, we investigated a dense sponge ground on the summit of an Arctic Mid Atlantic ridge seamount. We performed hydrocast transects combined with a long-term deployment of a bottom lander, which recorded near bottom physical properties as well as vertical fluxes of organic material throughout a whole year. The seamount summit is situated at the interface between two water layers, which allows inertial waves to disseminate and interact with the seamount topography. This produces high internal waves and high currents of up to 0.7 m s-1, leading to turbulent mixing. These internal waves resuspend organic matter as well as it deliver organic material and nutrients from water layers above and below towards the sponge ground. In the benthic boundary layer these tidal currents are weakened, which allows organic material to remain in the water column 2–4 m above the bottom throughout the year. Only one major carbon flux event during the year is refueling this system with a small amount of fresh organic matter from the surface ocean. Therefore, it is likely that the carbon flux cannot sustain such a dense benthic ecosystem and more probably sponges are able to exploit additional food resources, which is indicated by their atypical isotopic composition.

Domtoren 6	**Regional Ocean Circulation and Ecosystems**
Day 1	14:00 – 14:15

Transport of planktic foraminifera at the Uruguayan margin

Anne Kruijt

Peter Nooteboom, Peter Bijl, Erik van Sebille, Anna von der Heydt, Henk A. Dijkstra

The carbonate shells of planktonic foraminifera found in marine sediments are used widely as a proxy for past ocean conditions. It is often assumed that these proxies represent ocean conditions above the location of deposition. However, foraminifera are transported by ocean currents. Hence, the paleoclimatic conditions recorded from their shells may originate far from the core site (up to a thousand kilometres depending on life traits such as preferred depth habitat, life span and sinking speed), which can generate large footprints in foraminifera-based paleoclimatic proxies.

In this project we aim to quantify the influence of the transport on the proxy signal of foraminifera found at core sites in the Uruguayan margin of the Argentine basin. This is a region of strong and shifting ocean currents, and thus well suited to serve as a case study for developing an understanding of transportation effects. This will be done with use of a high-resolution global ocean model, in which pathways of virtual particles are traced. Furthermore, the sensitivity of the modelled proxy signal to different life traits is investigated. These model results are compared to proxy- and species analysis from the core sites. Both warm- and cold-water species have already been found at the core sites after first analysis of core material, suggesting the presence of strong and distinct ocean currents transporting these foraminifera from elsewhere. A better understanding of the interplay between transportation effects and the life traits of foraminifera is crucial for the interpretation of these proxies.

Domtoren 6	**Regional Ocean Circulation and Ecosystems**
Day 1	14:15 – 14:30

Efficient removal of nitrogen and phosphorus in the Stockholm Archipelago, Baltic Sea

Niels van Helmond

Elizabeth K. Robertson, Wytze K. Lenstra, Martijn Hermans, Christoph Humborg, L. Joelle Kubeneck, Daniel J. Conley, Caroline P. Slomp

Increased anthropogenic input of nutrients from land have led to eutrophication of marine environments globally. Coastal systems reduce the flux of nutrients from land to the open sea, thereby acting as a coastal filter. The key processes that remove nitrogen and phosphorus in coastal areas are denitrification and phosphorus burial. Recent modeling of nutrient dynamics in the Stockholm Archipelago suggests that at least 72% of the nitrogen input and 62% of the phosphorus input from land is retained in the archipelago. In contrast, on average only 16% of nitrogen and 53% of phosphorus is retained in coastal environments in the Baltic Sea. Here, we assess the benthic processes controlling the efficient removal of nutrients in the Stockholm Archipelago. Based on data for four locations, we demonstrate that area-specific rates of nitrogen removal due to benthic denitrification are highest in the inner archipelago and decrease towards the open sea. The recycling of N through DNRA and production of N2 by anammox play only minor roles. Rates of phosphorus burial in the archipelago are high due to the combined effect of high concentrations of phosphorus in the sediment and high rates of sediment accumulation. Most of the phosphorus is buried in the form of organic matter. Inorganic forms act as both temporary and permanent sinks for phosphorus. We will discuss potential future trends in nitrogen and phosphorus removal in the archipelago, the link with changes in bottom water hypoxia, and the potential role of import of nutrients from the open Baltic Sea.

Domtoren 5	**Seismology, Geodesy & Rock Physics**
Day 1	13:30 – 13:45

Towards toroidal sensitivity to mantle anisotropy

Simon Schneider
A. Deuss

Seismic anisotropy is known as a useful parameter for constraining deformation and mantle flow. Its specification can improve our understanding of dynamic processes inside the Earth. A good tool to measure anisotropy are normal modes, which are whole Earth oscillations excited after strong earthquakes. These modes are standing waves along Earth's surface and radius. They provide strong constraints on 3D variations in velocity (both isotropic and anisotropic) structure of the Earth's mantle. Therefore, studying these modes is fundamental to seismology. Due to their large period, normal mode observations represent averages of the Earth's compositional properties. Measuring them enables us to recover radial and azimuthal anisotropy for P- and S-velocity simultaneously.

Based on their nature normal modes can be divided in toroidal modes, dominated by horizontal surface motion, and spheroidal modes, involving a combination of horizontal and vertical surface motion. Toroidal modes, which involve horizontal SH-motion at the Earth's surface and are similar to Love waves, are our main interest here. In combination with spheroidal modes, which involve P-SV motion, they provide important constraints on anisotropy.

Toroidal modes haven't been measured for 20 years, since Resovsky & Ritzwoller (1998) and Tromp & Zanzerkia (1995). Here, we will expand the more recent study by Deuss et al. (2013), that only used vertical components to measure spheroidal modes, by adding horizontal component data for all new large earthquakes from the last 20 years.

By adding new horizontal data recordings we refine and extent these isolated self-coupling measurements and compare horizontal and vertical data recordings for toroidal modes. Next, we look for cross-coupling (i.e. exchange of energy) between fundamental toroidal and spheroidal modes. Due to cross-coupling, toroidal mode energy may become visible on the vertical component instead of only on the horizontal components.

The effect of rotation of the Earth on cross-coupling has been well documented in previous studies, we will investigate the occurrence of additional cross-coupling due to anisotropy. Toroidal-spheroidal mode cross-coupling may provide important information of the azimuthal anisotropic structure of Earth's mantle (Beghein et al., 2008).

Domtoren 5	**Seismology, Geodesy & Rock Physics**
Day 1	13:45 – 14:00

Forward gravity modelling using Newton integrals on a hollow sphere

Cedric Thieulot

L. Jeanniot

In order to compute synthetic Earth gravity data a detailed Earth structure and density model is needed, as well as a discrete representation of the geometry. We have recently extended the state-of-the-art geodynamics ASPECT parallel code (Heister et al, GJI, 2017) to include such gravity functionalities and we use a Gauss-Legendre direct integration method to compute the Newton integrals for the gravity potential, field and its gradients.

We first present the results of a benchmark for the gravity post-processor plugin (Thieulot, Solid Earth, 2018) and perform a series of numerical experiments to test the sensitivity of gravity calculations to the numerical discretisation of the hollow sphere, the use of octree-based mesh refinement, the quadrature order and the altitude at which gravity is calculated.

Various density models are then tested separately for the mantle, such as the one obtained with the S40RTS tomographic model data (Ritsema et al, GJI, 2011) and we explore the sensitivity of the results to the depth-dependent Vs/dlnrho coefficient.

Domtoren 5	**Seismology, Geodesy & Rock Physics**
Day 1	14:00 – 14:15

The sensitivity of whole earth oscillations to attenuation: a new tool to constrain temperature, water and partial melt in Earth's mantle

Arwen Deuss

Lisanne Jagt, Haydar Karaoglu, Simon Schneider, Sujania Talavera

Seismic tomography has made great progress in mapping Earth's internal velocity structure. However, seismic velocity alone does not provide us with enough information to determine temperature, composition and partial melt, and make direct links with surface tectonics and mantle convection. Thus, fundamental questions remain unanswered: Do subducting slabs bring water into the lower mantle? Are the large low-shear velocity provinces under the Pacific and Africa mainly thermal or compositional? Is there any partial melt or water near the mantle transition zone or core mantle boundary?

Seismic attenuation, or loss of energy, is key to obtaining information about partial melt, water and temperature variations, because these parameters impact attenuation in a much different way than velocity. Unfortunately, only few global attenuation models exist. Attenuation has only been imaged using short- and intermediate-period seismic data, and no reliable lower mantle models have been made so far. Scattering and focussing – which are difficult to separate in shorter period techniques – are easily included using cross-coupling (or resonance) between free oscillations not requiring approximations. We will present normal mode measurements for 3D variations in attenuation structure and investigate if simple scaling laws between velocity and attenuation (assuming that all heterogeneity is due to variations in temperature only) are able to explain normal mode data, or if more complicated attenuation models will be required.

Domtoren 5	**Seismology, Geodesy & Rock Physics**
Day 1	14:15 – 14:30

Linking Seismicity and (Paleo)Geodetic Observations to Megathrust Earthquake Cycle Processes

Rob Govers

Rob Govers, Taco Broerse, Matthew W. Herman, Mario D'Acquisto, Kevin P. Furlong

Recent seismological and geodetic observations, as well as sophisticated regional models, indicate that similar physical processes are active during the earthquake cycle at different subduction margins. Part of the observed complexity at these margins is controlled by the fact that they are in different stages of the earthquake cycle. The observations capture critical physical processes like (partial) locking of the plate interface, the detailed co-seismic slip, and mantle relaxation and afterslip (Govers et al., 2018; outreach movie at: https://youtu.be/T1QKPoxMdGg).

We use evolving 3D mechanical models to understand various observations. During the interseismic part of the megathrust earthquake cycle, geodetic velocities show that overriding plates shorten from the trench to a "backstop", where they become close to zero. Co-seismic displacements extend well beyond these backstops. Particularly relevant for understanding kinematic friction on the interface, we also use GPS velocities to unravel the spatial distribution and temporal behavior of asperities on the subduction interface, where most of the seismic energy is released during the largest earthquakes. We dramatically improve previous estimates of asperity locations (Herman et al., 2018).

An enigmatic observation is that recent great earthquakes were followed by significant normal faulting earthquakes in the overriding plate. Seafloor geodetic observations after the Japan 2011 earthquake hint at rapid re-locking of asperities and we use cyclic 3D geodynamic models to further substantiate these interpretations..

Domtoren 5	Seismology, Geodesy & Rock Physics
Day 1	15:30 – 15:45

Local imaging of the shallow crust using distant, high magnitude earthquakes

Johno van IJsseldijk
Elmer Ruigrok, Arie Verdel, Cornelis Weemstra

Global phases, viz. seismic phases that travel through the earth's core, can be used to locally image the crust by means of seismic interferometry. This method is known as GloPSI. Traditionally, GloPSI retrieves low frequency (up to 1 Hz) information. Recent studies, however, suggest that there is high frequency signal present in the coda of strong, distant earthquakes. This research quantifies the potential of these high frequency signals, by analyzing a multitude of high magnitude (~ 6 Mw) earthquakes and their coda on a selection of permanent USArray stations. 49 percent of the P- PKP- and PKIKP phases is recorded with a signal-to-noise ratio of at least 5 dB at 3 Hz.

To assess the viability of using the high frequency signal, the second part of the paper concerns two case studies. First, a known sedimentary structure is imaged in Malargüe, Argentina. Secondly, the method is used on a basin structure overlaying the Midcontentintal Rift below the SPREE Array in Minnesota, US. Both studies retrieved structural information of the shallow crust (< 5 km) below the arrays and the interpreted thickness of the sedimentary layer below the Malargüe array is in agreement with earlier studies in the same area.
Using data with a maximum of frequency of at least 3 Hz the sedimentary structure of upper crust can be imaged, this opens the way for industrial applications of GloPSI.

Domtoren 5	**Seismology, Geodesy & Rock Physics**
Day 1	15:45 – 16:00

Monitoring change in flow properties in a porous formation from intrinsic dispersion of seismic waves

Ranajit Ghose
Deyan Draganov

In case of induced seismicity due to fluid depletion or fluid injection, it is beneficial if we can monitor the change in in-situ fluid-flow properties (viz. porosity and permeability) through time-lapse geophysical measurements. In this vein, there is a growing interest in the recent years in modelling the frequency-dependent seismic amplitude change as a function of fluid saturation and surface seismic source-receiver offset. It has also been possible, from VSP data, to estimate for a porous layer the representative values of seismic intrinsic attenuation, separated from the effect of multiple scattering. Using such estimated values of intrinsic velocity dispersion and attenuation, and pertinent models of poroelasticity, we will illustrate the possibility of inversion of fluid flow properties in a subsurface porous layer.

Domtoren 5	**Seismology, Geodesy & Rock Physics**
Day 1	16:00 – 16:15

Characterising the seismic signal of individual wind turbines in the Borgsweer area

Britt Vleut

Wind turbines (WTs) emit seismic signals due to the rotation of the blades and the movement of the tower. These signals can be characterized based on frequency, radiation pattern, and type of seismic wave. The objective of this research is characterizing individual seismic signals of wind turbines in the Borgsweer area, Groningen. A spectral analysis was conducted to untangle the individual signal from the signal of multiple WTs in two steps: (I) finding the local combined WT signal by producing power-spectrum densities (PSDs), and (II) using a cross-correlation beamforming algorithm to localize the individual WTs. A dispersion curve is constructed to estimate the travel times of the seismic waves for optimizing the beamforming. The radiation pattern and the type of seismic wave are characterized as a function of wind direction. Using the PSDs, the influence of wind speed on the signal is determined. The input to this research is 34 days of recorded noise by the NAM Borgsweer flexible three-component array. The small spacing of the stations provides the opportunity to characterize individual signals of WTs in contrast to other studies that only were able to detect WT parks due to the large spacing between their stations. It is important to characterize the seismic signal of WTs since it can be used in the future to study the inversion of subterranean parameters. WT signals are a good source for seismic interferometry due to the continuous signal and stable distribution.

Domtoren 5	**Seismology, Geodesy & Rock Physics**
Day 1	16:15 – 16:30

A Seismo-Acoustic Analysis of the 2017 North Korean Nuclear Test

Jelle Assink

Gil Averbuch, Shahar Shani-Kadmiel, Pieter Smets, Läslo Evers

The 2017 North Korean nuclear test gave rise to seismic and low-frequency acoustic signals, that is, infrasound. The infrasonic signals are due to seismo-acoustic coupling and have been detected on microbarometer array I45RU in the Russian Federation at 401 km from the test site. I45RU is part of the International Monitoring System for the verification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT). We analyze the seismo-acoustic coupling by making use of array-processing and backprojection techniques. The backprojections show that infrasound radiation is not confined to the epicentral region. More distant regions are found to be consistent with locations of topography, sedimentary basins, and underwater evanescent sources. The backprojections can be used to estimate the average infrasonic propagation speed through the atmosphere. We dis- cuss these findings in the context of infrasound propagation conditions during the sixth nuclear test. It is suggested that propagation from the test site to I45RU may have occurred along unexpected paths instead of typical stratospheric propagation. We present several scenarios that could be considered in the interpretation of the observations.

The Royal Netherlands Meteorological Institute (KNMI) advices the Dutch Ministry of Foreign Affairs on the technical aspects of CTBT verification, in its role as National Data Centre (NDC).

Domtoren 4	**Soils System Sciences**
Day 1	13:30 – 13:45

Microplastic accumulation in agricultural soils by sewage sludge disposal

Fabio Corradini

Esperanza Huerta-Lwanga, Violette Geissen

Microplastics are emerging pollutants that pose an environmental threat. Their presence in continental environments has risen scientific concern. Wastewater treatment plants efficiently remove microplastics from sewage, trapping the particles in the sludge, preventing their entrance in aquatic environments. Sludge application in agricultural soils is a common practice. Hence, the aim of the work was to assess the implications of successive sludge applications over the total count of microplastic in soil samples. Thirty-one agricultural fields with different sludge application records and similar edaphoclimatic conditions were selected, covering a period of ten years. Three soil samples were taken per field. Microplastics were extracted by flotation and counted with a microscope. Soils where 1, 2, 3, 4, and 5 applications of sludge had been done presented a median of 1.1, 1.6, 1.7, 2.3, and 3.5 particles g-1 dry soil, respectively. There were statistical differences in the microplastic content according to the number of applications that a field had undergone (0 < 1, 2 , 3 < 4, 5). Sludge microplastic content ranged from 18 to 41 particles g-1, with a median of 34 particles g-1. The majority of the observed microplastics were fibres (90% in sludge, and 97% in soil). Our results revealed that microplastic counts increase over time where successive sludge applications are performed. The data revealed a high concentration of microplastics in soils, stressing out the relevance of sludge as a driver of soil microplastic pollution.

Domtoren 4	**Soils System Sciences**
Day 1	13:45 – 14:00

The effects of rock dust on soil microbial activity: a study from the urban gardens of Kisumu, Kenya and Ouagadougou, Burkina Faso

Tamara Jonkman

Dr. Boris Jansen, Prof. Dr. Karsten Kalbitz, Ing. Huig Bergsma

As part of an interdisciplinary project aimed at empowering women food entrepreneurs in urban areas in the developing world we studied the potential for rock dust as a soil improver. Rock dust has the potential to add (micro)nutrients and secondary minerals to the soil, but earlier research on rock dust has been ambiguous. In this study we aim to explore rock dust as a cheap and sustainable alternative to artificial fertilizers in the urban gardens of Kisumu, Kenya and Ouagadougou, Burkina Faso. We did an incubation study to explore the effects of rock dust on the productivity of the soil microbial community. Soil gathered in an urban garden in Kisumu was treated with one of four different rock dusts from either Kenya or Burkina Faso, a locally produced compost, an NPK, or a combination of rock dust with compost and/or NPK. Soil CO2 output was monitored for approximately 3 months. Initial results show that CO2 output was significantly higher when the soil was treated with locally sourced rock dust in comparison with other treatments. These results may indicate that the home field advantage is one of the factors determining the success in the application of rock dust; meaning that the soil microbial community is adapted to eroding and weathering minerals from local sources and will process these preferentially to other sources of nutrients. Another incubation study was done with soil from an urban garden in Ouagadougou, the results of which may further support the home field advantage theory.

Domtoren 4	**Soils System Sciences**
Day 1	14:00 – 14:15

Molecular characteristics of dissolved organic matter determined by high resolution mass spectrometry (LC-QTOF-MS) affected by precipitation with aluminium

Olaf Brock

Rick Helmus, Karsten Kalbitz, Boris Jansen

The interaction of metal cations – iron and aluminium – with dissolved organic matter (DOM) derived from leaf litter leads to the formation of the dark coloured and resistant Bh layers in podzols. The characteristics of these Bh layers – especially the effect on water permeability – partly inspired the innovative SoSEAL project (Soil Sealing by Enhanced Aluminium and DOM Leaching). SoSEAL aims at making dykes more stable by reducing water permeability through the dyke body by enhancing metal-DOM precipitation. In order to use metal-DOM interaction for engineering purposes, it is important to identify the DOM molecular characteristics involved in metal-DOM interaction. This allows us to select suitable DOM sources and be able to better control the formation of metal-DOM flocs. Molecular characterisation of DOM was done with a new non-target screening method using liquid chromatography (LC) coupled to high resolution quadrupole time-of-flight mass spectrometry (QTOF-MS). DOM solutions were prepared from coniferous, deciduous and mixed leaf litter and from HUMIN-P 775, a leonardite material which dissolves completely in water, has a high number of carboxylic groups and is the current DOM source in SoSEAL pilots. We measured the molecular characteristics of the DOM solutions before and after the addition of aluminium. The amount of precipitation was quantified by measuring aluminium and dissolved organic carbon content. Preliminary results show that humin-DOM precipitation is up to twice as high as that of leaf litter DOM. We expect that especially molecular compound groups with many carboxylic groups and high relatively masses are involved in metal-DOM interaction.

Domtoren 4	**Soils System Sciences**
Day 1	14:15 – 14:30

Tracing soil organic carbon transport in the Carminowe Creek catchment (southwest England) using branched tetraether membrane lipids

Jingjing Guo

Jingjing Guo (1), Frederique Kirkels (1), Miriam Glendell (2), Jeroen Meersmans (3), Francien Peterse (1)

(1) Utrecht University, the Netherlands; (2) The James Hutton Institute, United Kingdom; (3) Cranfield University, United Kingdom)

Soils represent the largest reservoir of organic carbon (OC) on land. Upon mobilization, this OC is either returned to the atmosphere, or transported and ultimately locked into (marine) sediments, where it will act as a long-term sink of atmospheric CO2. However, these fluxes of soil OC are poorly quantified, mostly due to the lack of a soil-specific tracer.

Here we use a suite of branched Glycerol Dialkyl Glycerol Tetraethers (brGDGTs), which are membrane spanning lipids of soil bacteria, as specific tracers for soil (OC) from source (soil) to sink (a lake) in the small catchment of the Carminowe Creek located in southwest England. The relative distribution of brGDGTs differs among land use types (arable land, ley, grassland and woodland), which we subsequently use as fingerprint to monitor soil mobilization along 14 transects, from hilltops downslope into the streams and finally, the lake. Downcore analysis of brGDGT signatures in a 50 cm long sediment core from the Lake Loe Pool then enables us to reconstruct soil OC inputs over the past 100 years. Additionally, the temperature-sensitivity of the brGDGT-producers also allows to reconstruct the local mean air temperature (MAT) over this time interval, and to assess the influence of climate on soil mobilization in this catchment.

Domtoren 6	**The Cryosphere, Sea-level Change, and Impacts on Deltas**
Day 1	15:30 – 15:45

Deformation mechanisms and rheology of polar ice in the NEEM ice core

Martyn Drury

Ernst-Jan Kuiper, G.M. Pennock, I. Weikusat, J.H.P. de Bresser, M.R. Drury

Understanding the flow of ice is essential to predict the contribution of the polar ice sheets to global mean sea level rise. In this study the mechanisms that govern the flow of ice were studied along the length of the North Greenland Eemian Ice Drilling (NEEM) ice core in northwest Greenland. We used (i) cryogenic electron microscopy and (ii) flow law modelling. Microstructures indicate that the Holocene ice deforms by the easy basal slip system accommodated by the harder slip systems (non-basal slip), and by recovery via strain induced boundary migration (SIBM), which removes dislocations and stress concentrations and allows further deformation to occur. The amount of non-basal slip that is activated is controlled by the extent of SIBM. The strain variability is relatively high in the glacial ice as a result of variability in grain boundary sliding (GBS) with depth that accommodates basal slip (GBS-limited creep). Grain boundary sliding in the glacial ice is particularly strong in fine grained sub-horizontal bands which contain many aligned grain boundaries. It is argued that the glacial ice in the Eemian-glacial facies deforms almost entirely by GBS-limited creep at high strain rates, while the Eemian ice in the Eemian-glacial facies deforms at much lower strain rates. The large difference in microstructure, and consequently viscosity, between impurity-rich glacial ice and impurity-depleted interglacial ice in the pre-melting layer (262K<T<273K) of polar ice sheets can have important consequences for ice dynamics.

Domtoren 6	**The Cryosphere, Sea-level Change, and Impacts on Deltas**
Day 1	15:45 – 16: 00

Recent mass changes of the Novaya Zemlya Ice Cap from CryoSat-2

Isolde Glissenaar
Bert Wouters

Despite accounting for approximately 20% of the Arctic glacier ice outside the Greenland Ice Sheet (Dowdeswell et al., 1997; Radic et al., 2014), the mass budget of the Russian High Arctic (RHA) has received less scientific attention than other glaciated regions (Brassford et al., 2006). Over 80% of the mass loss in the RHA in the period 2003–2009 occurred on the Novaya Zemlya archipelago (Moholdt et al., 2012). This study assesses the glacier mass budget for Novaya Zemlya in the more recent period between October 2010 and October 2018 using CryoSat-2 radar altimetry data (Wingham et al., 2006). The CryoSat-2 radar altimeter gives the possibility of studying the elevation rates in rough topography with a high spatial coverage. The elevation change rates were determined using the plane-fitting technique as in Wouters et al. (2015). It was found that the average thinning rate over the studied period was -0.336 m/yr. The elevation change rates show a spatial pattern of low-elevation thinning and high-elevation balance and modest thickening. Higher thickening rates are found in the northern part of the archipelago. Further study will involve determining the mass loss of the Novaya Zemlya ice cap and investigating possible causes for the spatial pattern.

Domtoren 6	**The Cryosphere, Sea-level Change, and Impacts on Deltas**
Day 1	16:00 – 16:15

Cyclical development of thaw ponds in Siberian lowland tundra?

Runa Magnússon

Dr. Monique Heijmans (Plant Ecology & Nature Conservation – WUR), Dr. Juul Limpens (Plant Ecology & Nature Conservation – WUR)

Will a warming climate in the Arctic lead to a gradual thawing of permafrost and expansion of woody vegetation – so called Arctic greening? Or does warming lead to soil subsidence of ice-rich permafrost resulting in drowning of woody vegetation and formation of thaw ponds? The implications for the greenhouse gas balance of Arctic tundra ecosystems for these two scenarios are wildly different. At the Kytalyk Tundra station, we observe a highly dynamic dwarf shrub dominated landscape with appearing and disappearing thaw ponds. Previous research indicated that the dominant dwarf shrub vegetation is a sink for greenhouse gases, whereas thaw ponds are a source of methane. We aim to describe dynamics of expansion and decline of thaw ponds relative to intact shrub vegetation in support of climate modelling. We hypothesize that thaw ponds display a distinct vegetation succession through which they may eventually restabilize in terms of vegetation cover and permafrost stability (see figure).

We monitor vegetation composition and abiotic conditions in thaw ponds of various ages and expansion trends, identified using multi-temporal satellite imagery. Our preliminary results are in correspondence with our hypothesis. Using mixed effects models, we find distinct differences in relative surface elevation, water table and thawing depth under different vegetation cover types in thaw ponds. These differences in vegetation cover in turn, are well explained by thaw pond age and expansion dynamics.

This illustrates how monitoring and understanding of ecological feedbacks is necessary for future projections of permafrost carbon emissions.

Domtoren 6	**The Cryosphere, Sea-level Change, and Impacts on Deltas**
Day 1	16:15 – 16:30

Can barrier islands survive sea level rise? Tidal inlets versus storm overwash

Jaap Nienhuis
Jorge Lorenzo-Trueba

The response of barrier islands such as the Wadden Sea Islands to sea level rise depends on their ability to transgress and move sediment from the shoreface to the back barrier. Transgressive sediment movement occurs through tidal inlets or storm overwash and dune building. Our understanding of these processes over decadal to centennial time scales, however, is limited and poorly constrained. Here we present a new model to investigate barrier transgression, and show that tidal inlets can contribute a significant fraction of the total transgressive sediment flux, in particular in micro-tidal and wave-dominated environments.

Climate and environmental changes during the last 3000 years on Barentsøya (E-Svalbard)

Wim Hoek

Lineke Woelders (Atmospheric and Oceanic Sciences, University of Colorado Boulder, USA), Keechy Akkerman (Geography, Loughborough University, UK), Stan Schouten (Physical Geography, Utrecht), Friederike Wagner-Cremer (Physical Geography, Utrecht)

During the 2015 NWO-SEES expedition (http://www.sees.nl/) the first lake sediment records from Barentsøya and Edgeøya (E Svalbard) have been collected. The presence of abundant Salix polaris leaf remains allows for plant palaeophysiological paleoclimate estimates, which together with pollen and diatom analysis provides a high detail palaeoenvironmental reconstruction for the last 3000 years. Age assessment of the sediments is based on Pb-210 and AMS C-14 dating on botanical macrofossils, while indications for the presence of Icelandic tephras opens up the potential for additional tephochronological time-control.

The first results on a shallow gravity core from Lake Andsjøen, Barentsøya have been published recently and show a strong increase in organic production during the last decades. This increase in organic production appears to be the result of temperature rise and prolonged ice-free period rather than eutrophication (Woelders et al., 2018). Here we focus on the deeper part of the core where more subtle changes in organic production after the initial isolation are recorded. It appears that these organic changes reflects natural climate changes which correlate to the Roman Warm Period, Dark Age Cold Period, Medieval Climate Optimum, and Little Ice Age. The recent climate warming trends seems to be out of range compared to the natural climate and environmental changes during the last 3000 years in this vulnerable area.

Reference: Woelders, L., J.T.M. Lenaerts, K. Hagemans, K. Akkerman, T.B. van Hoof & W.Z. Hoek (2018) Recent climate warming drives ecological change in a remote high-Arctic lake. Scientific Reports 8-6858. https://www.nature.com/articles/s41598-018-25148-7

Domtoren 6	**The Cryosphere, Sea-level Change, and Impacts on Deltas**
Day 1	16:45 – 17:00

High-resolution simulations of sea-level change processes on the North-western European shelf

Martijn Hermans

Aimée Slangen, Jonathan Tinker, Matthew Palmer, Bert Vermeersen

Regional sea-level change (SLC) due to changes in sea water density and ocean circulation, as a response to radiative forcing, can be simulated with global climate models. However, global climate models often omit processes important to shallow shelf seas, have a relatively coarse horizontal resolution, and the number of vertical levels are typically limited in shallow seas. Thus, the simulations of such models may not be adequate for SLC projections in coastal regions.

In this study we investigate the impact of high-resolution simulations of SLC processes in the Northwestern European shelf (NWES) area for coastal sea level projections. The simulations make use of the regional NEMO AMM7 CO6 coastal ocean model, driven by two example global models from the Coupled Model Intercomparison Project 5 (CMIP5). The ocean model has a nominal horizontal resolution of 7 by 7 km, terrain-following vertical coordinates and includes tidal processes.

Compared to global climate model simulations, the downscaled simulations of SLC on the NWES show enhanced regional detail and have a higher correla-tion with satellite altimetry. Projected SLC over the coming century differs es-pecially near important features in model bathymetry and coastlines, and near strong currents. Along the coast, differences in long-term trends of over 1 mm/yr are found. By beginning to quantify the uncertainties in projections of SLC due to the coarse resolution of global climate models, we can improve the fidelity of SLC projections for European coastal regions and add more realistic information on variability to SLC projections.

Oudegracht 3-4	**The New Delta**
Day 1	13:30 – 13:45

3D Paleohydrogeological modelling of the Nile Delta

Joeri van Engelen

Jude King, Jarno Verkaik, Marc Bierkens, Gualbert Oude Essink

The Nile Delta in Egypt is a heavily populated area with high agro- and socio-economic importance for Egypt. Though its lands are traditionally irrigated with surface water from the Nile, the discharge of this river is reduced due to the building of large upstream dams. This reduced surface water availability will probably lead to an increased use of groundwater for irrigation. Adding to this stress on the groundwater system, there is a strongly growing population which further amplifies extraction rates. These stresses will cause the country to increasingly rely on groundwater in the near-future. Therefore, an assessment of the current and future status of the groundwater resources is critical to safeguard these precious resources for the coming generations.

The area's groundwater is vulnerable to salt water intrusion due to its shallow topography and the high transmissivity of the aquifer. Furthermore, hydrogeochemical measurement campaigns have shown the strong influence of paleohydrogeologic processes on the current groundwater salinity distribution. However, the previous numerical models created for this area ignored the influence of the paleohydrogeology, likely due to computational limitations. In this study, we model the complete Nile Delta Aquifer in 3D over several thousands of years. To tackle the computational burden this model created, we use the new iMOD-SEAWAT code, that allows parallel computation on a super computer. In this presentation, we show the results of our efforts and compare these to a database, compiled of data from the published articles. The influence of paleohydrogeological circumstances and the (uncertain) lithology is shown.

Mississippi's moisture sources shift from land to ocean in a future climate

Imme Benedict
Chiel van Heerwaarden, Ruud van der Ent, Albrecht Weerts, Wilco Hazeleger

It is important to know if the moisture sources of a basin are from a continental or oceanic origin, and if these sources are changing towards the future. One can determine the moisture sources of a basin, i.e. the evaporative areas which contribute to precipitation over a basin, by tracking moisture using atmospheric data. So far, atmospheric moisture tracking has mostly been applied to re-analysis data, only giving estimations for present climate. Therefore, an important open question is: how are moisture sources of river basins affected by climate change?

Here, we apply the Eulerian offline moisture tracking method WAM2-Layers to high spatial resolution (~25 km) global climate simulations from EC-Earth for present and future climate (RCP4.5), to determine changes in moisture sources of the Mississippi basin under climate change.

We find that the most important continental moisture sources are the Mississippi basin itself (recycling of moisture) and the area South-West of the Mississippi. Sources from the oceans are primarily transported from the Gulf of Mexico/Caribbean and the Pacific to the Mississippi basin. All sources vary per season, with more recycling of moisture within the river basin in summer and more transport of moisture from the ocean towards the river basin in winter. In the future, we find an increase in moisture sources from the oceans (related to higher sea surface temperatures in the future), which results in more precipitation over the Mississippi basin in winter. In summer, we find a decrease in moisture sources from the basin itself (i.e. lower recycling ratios within the basin), although precipitation is not decreasing. We conclude that the moisture sources of the Mississippi basin will become less local in a future climate, with more water originating from the oceans.

Oudegracht 3-4	**The New Delta**
Day 1	14:00 – 14:15

Intertidal drainage patterns as indicator for biostabilising ecosystem development

Roeland van de Vijsel

J. van Belzen, D. van der Wal, T.J. Bouma, J. van de Koppel

Estuaries are changing rapidly due to climate change and direct human interventions, urging for indicators of critical transitions causing loss or recovery of valuable biostabilising ecosystems (e.g., algal biofilms, vegetation). Self-organisation theory provides an indicator framework based on spatial patterns that can be observed in many natural systems. We lay the foundations for deriving an intertidal indicator system by constructing an idealised numerical model that couples the dynamics of water flow, morphology and biostabilisers.

Model simulations show that self-organisation due to one scale-dependent feedback explains a wide range of intertidal drainage structures. This scale-dependent feedback consists of a local positive feedback due to sediment biostabilisation and a scour-induced long-range negative feedback. These feedbacks create regularly spaced, linear drainage channels around biostabilised banks. Weak feedbacks (e.g., when sediment cohesion in the system is low) create a flat drainage landscape. Stronger feedbacks create steeper channel banks, inducing flow and hence a secondary drainage pattern across these primary channel banks. This ‘cascade’ of scale-dependent feedbacks can hence form complex drainage morphologies.

Our results point out that the degree of drainage pattern complexity (flat, linear, higher-order) is an important indicator for intertidal ecosystem transitions, as its biostabilisers strongly rely on drainage. Moreover, our findings may provide insight in how landscapes formed in biofilm-dominated ecosystems in the Precambrian and how they changed through geological time, after the evolution of higher plants.

Oudegracht 3-4	**The New Delta**
Day 1	14:15 – 14:30

Global scale process-based modelling of the origins and fates of carbon in the aquatic continuum

Wim Joost van Hoek

L. Vilmin, X. Liu, A. Beusen, J. Mogollon, J. Langeveld, L. Bouwman, J. Middelburg

Here, we present the implementation of the riverine C cycle in the Dynamic In-stream Chemistry module (CARBON-DISC), which is part of the Integrated Model to Assess the Global Environment (IMAGE) Dynamic Global Nutrient Model (IMAGE-DGNM). The model explicitly resolves the mass and fluxes of DIC, DOC, terrestrial POC, autochthonous POC from headwaters to mouth (hydrology, climate and biogeochemical sources) on a global scale. This approach accounts for the spatio-temporal variability in dynamic physical conditions in the aquatic continuum. This is a major step forward in basin scale modelling of freshwater systems. We present model estimates of the delivery, retention, biogeochemical transformations, export and emission to the atmosphere of carbon in the form of DIC, DOC and POC at the global scale.

Oudegracht 3-4	**The New Delta**
Day 1	15:30 – 15:45

Estimating dissolved carbon leaching: a global database and model of carbon fluxes from soils to groundwater

Joep Langeveld

Lex Bouwman, Wim Joost van Hoek, Arthur Beusen, José Mogollon, Lauriane Vilmin, Jack Middelburg

The transport of dissolved carbon in water leaching from soils to groundwater, and further to surface waters, may play an important role in connecting the terrestrial and aquatic carbon budgets. However, it has not been previously quantified on a global scale. Therefore large uncertainties remain regarding the size, drivers and global distribution of the dissolved carbon flux from soil solution to groundwater. In order to estimate the fluxes of dissolved carbon leaching from soils, an extensive global database on dissolved organic (DOC) and inorganic carbon (DIC) in soil solution is compiled, including a range of potential drivers. The database is used to construct a globally distributed multi-regression model calculating annual average topsoil concentrations as well as concentration profiles in the subsoil. Dissolved carbon concentrations in soil solution are described as a function of climate, soil type, land use, precipitation and depth. DIC is also constrained by the level of surface CO2. Hydrology is provided through a hydrological model, PCR-GLOBWB. We present a global spatially explicit distribution of the annual average DOC and DIC leaching from soils to the groundwater. Our first estimate of the carbon leaching flux from soils enables not only to better understand but also to quantify this 'missing link' between the global terrestrial and aquatic carbon budgets.

Ebb-tidal deltas on the move: The effect of nourishments on channel-shoal dynamics

Maarten van der Vegt
Klaas Lenstra, Linxi Fu

Sedimentation of the Dutch Wadden Sea during the last century was a direct result of human interventions, such as the construction of the Afsluitdijk and the closure of the Lauwerszee. Most of the sediment was supplied by the ebb-tidal deltas, which are eroding. Therefore, mega nourishments (~20•10^6 m^3) are considered and in 2018 a nourishment of ~5•10^6 m^3 was implemented at the ebb-tidal delta of Ameland. The question is how ebb-tidal deltas will respond to these nourishments.

Here, using an idealized geometry and simplified forcing in Delft3D/SWAN, we studied the long-term (>years) morphological effect of nourishments as a function of size, location and phase of the cyclic behavior. We compared our results with a base case model simulation without nourishment which showed clear patterns of cyclic channel-shoal dynamics resembling those observed in the Wadden Sea.

Our results show that the nourishments accelerate the natural cyclic behavior of the ebb-tidal delta. Nourishing the updrift shoal could potentially reduce the period between successive shoal attachments by 30%, but this is only 15% if the nourishment is placed in one of the channels. The results further indicate that the nourished sediment causes morphological changes by adjusting the patterns of sediment transport rather than directly feeding the shoal. As a result, the volume of the ebb-tidal delta is higher than in the base case model simulation, even after several shoal attachments. Furthermore, nourishments cause additional sediment transport into the tidal basin.

Modelling weir-mounted tidal turbines

Merel Verbeek

Robert Jan Labeur, Wim S.J. Uijttewaal

Coastal infrastructure, such as bridges and storm surge barriers, provides an attractive location for harvesting renewable energy using tidal turbines. These structures constrict the tidal flow - leading to relatively strong local currents – which favors a large energy yield by the turbines. Moreover, the structure provides access from the nearby coast which facilitates the turbine mounting and grid connection. When the flow passes the turbines, it accelerates and subsequently expands which influences the hydraulic load on nearby constructions while also the morphology of the adjacent water system may be affected. A calculation tool is therefore needed to safely design turbines mounted in coastal infrastructure, evaluating both the energy output of the turbines and their impact on the surroundings.

The Eastern Scheldt Storm Surge barrier in the Netherlands houses the world's first array of tidal turbines. The location is ideally suited to investigate the energy output of the turbines, and their influence on the local flow field. Based on field monitoring executed at this site, this research develops a theoretical model to quantify the energy production and the hydraulic resistance of free-stream turbines in barriers. The field data analysis shows that the drag of the turbines does not simply add to that of the barrier due to so-called by-pass effects, which reduce the combined resistance. This also implies that part of the energy that is normally dissipated in turbulence swirls or eddies downstream of the barrier, becomes available to enhance the energy yield. These results are particularly encouraging for the further development of tidal energy turbines in coastal structures.

Water in the circular economy: Matching agricultural freshwater supply and demand using recycled water for sub-irrigation purposes

Ruud Bartholomeus
G. van den Eertwegh, A. van Loon, M. van Huijgevoort, K.J. Raat

Available groundwater sources for irrigation purposes are increasingly under pressure due to the regional coexistence of land use functions that compete for available water. At the same time, treated wastewater from industries and domestic wastewater treatment plants are quickly discharged via surface waters towards sea. Exploitation of these freshwater sources may be an effective strategy to balance regional water supply and agricultural water demand. We present results of two pilot studies in drought sensitive regions in the Netherlands, concerning agricultural water supply through reuse of industrial and domestic treated wastewater. In these pilots, excess wastewater is delivered to the plant root zone through sub-irrigation by drainage systems. In a pilot project in the eastern part of the Netherlands, treated domestic wastewater is applied to a corn field by sub-irrigation, using a climate adaptive drainage system. The different chemical composition of treated domestic wastewater is used to describe water and solute transport in the soil system. In the south of the Netherlands, the Bavaria Beer Brewery abstracts a large volume of groundwater and discharges treated wastewater to local surface water. At the same time, neighbouring farmers invest in sprinkler irrigation systems. Within a pilot study, a sub-irrigation system has been installed and tested. We combine both process-based modelling of the soil-plant-atmosphere system and field experiments to (i) investigate the amount of water that needs to be and that can be sub-irrigated, and (ii) quantify the effect on soil moisture availability and herewith reduced needs for aboveground irrigation.

Oudegracht 3-4	**The New Delta**
Day 1	16:30 – 16:45

Redirecting nutrients in urban waste to urban agriculture

Jan Weijma

Rosanne Wielemaker, Grietje Zeeman

Until the 19th century ‘nightsoil’ and organic waste were recycled to agriculture to replenish farm land with nutrients and organic matter in (peri-)urban areas. However, with the onset of cheap chemical fertilizer production, nightsoil use was abandoned. This development facilitated the geographical disconnection between food production and consumption, leading to the expansion of agriculture on distant soils. The current interest in economically developed countries to implement urban agriculture and resource-oriented sanitation systems brings about new narratives to the status quo of both food production and ‘waste’ management, and reintroduces the opportunity to partially close nutrient cycles at the urban scale. While many concepts have been developed there remain several challenges. This paper discusses the opportunities and constraints of recycling human excreta to urban agriculture as a means to restore the nutrient cycle in the food system.

Domtoren 3	**Biogeochemistry of Sedimentary Environments**
Day 2	13:00 – 13:15

Carbonyl sulfide as tracer for stomatal conductance and photosynthesis

Linda Kooijmans

Wu Sun, Kukka-Maaria Erkkilä, Juho Aalto, Albert Porcar-Castel, Chao Zhang, Jon Atherton, Kadmiel Maseyk, Ulli Seibt, Ivan Mammarella, Timo Vesala, Huilin Chen, Maarten Krol

It is crucial for projections of the future land carbon cycle that we understand the climate controls on the amount of CO2 being fixed by plants during photosynthesis (Gross Primary Production, GPP). However, measurements of the net ecosystem exchange of CO2 over an ecosystem do not allow for separation of the concurrent GPP and respiratory fluxes. The plant uptake of the gas carbonyl sulfide (COS) is closely linked to that of CO2 as these gases follow the same diffusional pathway into the plant. COS can therefore be used to quantify GPP. The realization of the COS tracer method requires proper characterization of all ecosystem components in the COS budget. Besides, the accuracy of COS–based estimates of GPP depends on how we relate the COS uptake to that of CO2.

This presentation will show results of field measurements that were performed between 2015 and 2017 at the SMEAR II site in Hyytiälä, Finland, which was aimed to provide better constrained COS flux data for boreal forests. A complete set of COS and CO2 exchange measurements were made, including branch, soil and ecosystem fluxes and atmospheric profile concentrations, along with leaf measurements of chlorophyll fluorescence.

The results confirm that vegetation is the dominant sink of COS in the ecosystem and that the COS plant uptake is strongly dependent on stomatal conductance. In contrast to CO2, COS uptake is not light-dependent and COS uptake is more strongly limited by stomatal conductance than CO2 uptake is. It is therefore important that these different controls on COS and CO2 uptake are considered when COS flux measurements are used to interpret changes in photosynthesis. The strong dependence of COS uptake to stomatal conductance makes COS a highly suitable tracer for stomatal diffusion and thereby COS can also help to understand the plant water status.

Domtoren 3	**Biogeochemistry of Sedimentary Environments**
Day 2	13:15 – 13:30

Exploiting sun-induced fluorescence and temperature anomalies to enhance biosphere flux estimates in an atmospheric CO2 inversion

Liesbeth Florentie

Wouter Peters, Gerbrand Koren, Erik van Schaik, Folkert Boersma, Maarten Krol

One of the challenges in obtaining accurate estimates of CO2 fluxes at the Earth's surface is the still high uncertainty related to biospheric carbon exchange. The net uptake of CO2 by the biosphere (NEE) is the result of the imbalance between gross primary production (GPP) and terrestrial ecosystem respiration (TER), both of which respond individually to environmental drivers. NEE estimates are typically obtained by assimilating measurements of atmospheric CO2 mole fractions into a framework that includes biospheric surface fluxes. Due to the sparse coverage of observation locations and the poorly known error covariance structure, the resulting spatial NEE patterns remain to a large extent determined by the patterns of GPP and TER predicted by the original biosphere model. As these can be validated at only a limited set of surface eddy-covariance sites, global NEE fluxes remain only weakly constrained by observations.
We aim to alleviate these limitations by making use of sun-induced fluorescence (SIF) and temperature observations, which are both available at high spatial and temporal coverage. In Rödenbeck et al. (2018) it was shown that the mean seasonal cycle and long-term trend of NEE can generally be represented by a simple statistical function, and that interannual variability in NEE can be introduced through a linear regression of temperature anomalies onto NEE anomalies. Additionally, remotely-sensed SIF recently emerged as a powerful proxy for GPP anomalies on regional to global scale.

Inspired by these findings, the CarbonTracker data assimilation system (which is based on a sequential ensemble square root filter algorithm) was modified to allow for direct optimization of statistical function parameters that describe long-term and seasonal NEE, and monthly anomaly sensitivities. A single set of these parameters, valid for the full temporal window, is optimized per ecoregion subject to an atmospheric CO2 constraint in a global inversion. Like for temperature, we will show that SIF anomalies can be used in a similar way to capture NEE anomalies on interannual time scales. We will present how this new set-up exploits the spatiotemporal patterns of SIF and temperature to improve NEE estimates. It is expected that this approach can be of value to separately estimate GPP and TER responses to large climate anomalies.

References: Rödenbeck et al., How does the terrestrial carbon exchange respond to inter-annual climatic variations? A quantification based on atmospheric CO2 data, Biogeosciences, 15, 2481-2498, https://doi.org/10.5194/bg-15-2481-2018, 2018

Domtoren 3	**Biogeochemistry of Sedimentary Environments**
Day 2	13:30 – 13:45

Light impacts Mg incorporation in the benthic foraminifer Amphistegina lessonii

Linda Dämmer

Lennart J. de Nooijer, Gert-Jan Reichart

Mg incorporated into foraminiferal carbonate (Mg/Cacc) is a popular tool to reconstruct past sea water temperatures. Its application is being complicated by other environmental factors affecting the Mg/Cacc, including salinity and the ratio between sea water [Mg2+] and [Ca2+]. Furthermore, there is considerable intra-specimen variability in Mg/Ca in the form of alternating high- and low-concentration bands. This banding has recently been linked to diurnal cyclicity, in which bands with relatively high Mg/Ca are precipitated during night time. Here we show that light not only impacts variability due to banding but also significantly affects average chamber Mg/Ca in the large benthic, symbiont-bearing foraminifer Amphistegina lessonii. These ratios are higher in foraminifera that calcify for a longer time in the dark, with a difference in Mg/Ca of 22 mmol/mol between carbonate formed completely in the dark versus completely in the light. We propose that individual timing of chamber formation and thus presence or absence of light during calcification is an important driver of inter-specimen variability in foraminiferal Mg/Ca.

Domtoren 3	**Biogeochemistry of Sedimentary Environments**
Day 2	13:45 – 14:00

Methane oxidation stimulated by nitrate and sulfate in an anoxic lake mediated by Methylobacter species

Sigrid van Grinsven

Jaap Sinninghe Damsté, John Harrison, Laura Villanueva

Methanotrophic bacteria play a key role in limiting methane emissions from stratified lakes. It is generally assumed that methanotrophic bacteria are active in the oxic-anoxic transition zone, where they make use of the available oxygen to oxidize methane. However, our research on a eutrophic, seasonally stratified lake shows that a formerly known aerobic methanotroph of the genera Methylobacter is performing methane oxidation in the anoxic water column. Likely, this Methylobacter couples nitrate reduction to methane oxidation, as genes encoding for nitrate reductases were detected in its genome. This is supported by the experimental observation that the addition of nitrate to incubation experiments strongly enhanced the methane oxidation rate. Methane oxidation by Methylobacter was observed in both oxic and anoxic incubations, with anoxic rates being 3 times higher than oxic methane oxidation rates, accompanied by an increased relative abundance of Methylobacter from 7% in oxic incubations to 35.4% in anoxic incubations. PmoA protein analysis showed that this type of Methylobacter is most closely related to Methylobacter tundripaludum, and likely represents a novel species.

Domtoren 3	**Biogeochemistry of Sedimentary Environments**
Day 2	14:30 – 14:45

Phosphorus sequestration in manganese(II) and iron(II) minerals in coastal sediments populated by cable bacteria

Martijn Hermans

Marina Astudillo Pascual, Thilo Behrends, Wytze K. Lenstra, Daniel J. Conley, Caroline P. Slomp

Excessive phosphorus inputs in the Baltic Sea as a result of human-activities have led to eutrophication and widespread seasonal bottom water oxygen depletion ('hypoxia'). Filamentous cable bacteria can enhance the formation of manganese-oxides and iron-oxides and sequestration of phosphorus in sediments of such systems. Here we assess the manganese, iron and phosphorus dynamics in sediments at three seasonally hypoxic sites in the Gulf of Finland, using a combination of porewater analyses, sequential sediment extractions and synchrotron-based X-ray spectroscopy. At sites where bottom waters are oxic in spring, the surface sediments were heavily populated by cable bacteria at the time of sampling1. We argue that their metabolic activity led to porewater acidification in the preceding months, resulting in dissolution of iron-monosulphides, iron-carbonates and manganese-carbonates and strong surface enrichments of manganese and iron-oxides. Strikingly, the sediment at one of the oxic sites was characterized by a surface layer (2 mm) that primarily consisted of manganese-oxides and iron-oxides but contained little phosphorus. Underneath this surface layer we found a ~3 mm thick layer that was highly enriched in phosphorus. In this layer, individual enrichments in phosphorus were strongly correlated with those in manganese and iron and synchrotron-based X-ray spectroscopy revealed the abundant presence of manganese(II)-phosphates and the iron(II)-phosphorus mineral vivianite. Our results suggest that formation of manganese(II)-phosphates and vivianite may contribute greatly to efficient sequestration of phosphorus in sediments due to cable bacteria activity.

References: Hermans, M.; et al., Abundance and Potential Biogeochemical Impact of Cable Bacteria in the Baltic Sea (in prep)

Domtoren 3	**Biogeochemistry of Sedimentary Environments**
Day 2	14:45 – 15:00

The link between methane seepage and glendonites: An insight from gas inclusions and biomarkers

Marijn den Boer

B. van de Schootbrugge, M. Schobben, F. Peterse, K.G.J. Nierop, J. Weijers

Glendonites, pseudomorphs after the fossilization of ikaite, have been used as indicators of past cold water conditions. Ikaite is thought to be only stable at low temperatures and to rapidly decompose above 7°C. However, recent studies have shown that ikaite precipitates in surrounding temperatures of up to 15°C. Modern environment observations indicate that there might be a link between the presence of methane and the precipitation of ikaite.

To test if the presence of methane, and the associated physicochemical conditions, is indeed a prerequisite for the precipitation of ikaite, we here study gas inclusions and biomarkers for Lower Cretaceous and Paleogene glendonites from Spitsbergen. The gas has been analyzed for its C1–C5 composition, along with their δ13C signal, and additional δD analysis for methane to provide insight in the genetic source of the gas. Lipid biomarkers are used to identify microbial communities present during the formation of ikaite, and to estimate the maturity of the organic material.

Although the gas composition in all glendonite samples is relatively comparable, there are subtle differences between glendonites from different sections. The gas wetness and the isotopic values of the methane indicate a thermogenic origin, rather than a biogenic origin. Furthermore, the organic material in glendonites from the Lower Cretaceous is much more mature than in those from the Paleogene. These Lower Cretaceous samples also contain significant amounts of (nor)hopanes, which are not present in the Paleogene samples. These differences combined may suggest different microbial communities present during ikaite precipitation.

Domtoren 3	**Biogeochemistry of Sedimentary Environments**
Day 2	15:00 – 15:15

Sources and degradation status of particulate organic carbon in the Kolyma River watershed

L.M. Bröder

Anya Davydova, Nikita Zimov, Negar Haghipour, Timothy Eglinton, Jorien Vonk

Ongoing permafrost thaw potentially increases the organic matter loads of Arctic rivers. Organic carbon remobilized by abrupt thaw processes such as thermokarst, river bank and coastal erosion is mostly released in the particulate form (POC) and may either enhance or attenuate global warming, depending on its propensity for decomposition. Strong seasonality in discharge and soil hydrological flow paths in watersheds underlain by permafrost enable transport of different carbon pools with contrasting lability. For this study, we focus on the Kolyma River watershed in Northern Siberia, the world's largest watershed entirely underlain by continuous permafrost. To evaluate seasonal differences in carbon delivery to the rivers, we collected POC samples every 4–7 days from late May to early October from the Kolyma River mainstem close to its delta near Cherskiy and from a small nearby tributary draining an area completely underlain by Yedoma permafrost (Pleistocene ice and organic matter rich loess deposits). Concentrations of POC along with carbon (δ13C, Δ14C) and hydrogen isotope analysis on bulk POC and lipid biomarkers (long-chained n-alkanoic acids and n-alkanes) will be used to study the contributions of different sources (contemporary terrestrial versus deeper permafrost/Yedoma), as well as their qualitative degradation state. This high-resolution POC sampling combined with isotopic fingerprinting and extensive geochemical analysis will allow us to assess present-day fluvial release and fate of POC from permafrost thaw in a major Arctic watershed.

Domtoren 3	**Biogeochemistry of Sedimentary Environments**
Day 2	15:15 – 15:30

The impact of reverse drainage on greenhouse gas fluxes during a hot and dry summer in the Netherlands

Tanya Lippmann

Ko van Huissteden, Michel de Kroo

Over the last thousand years, peat drainage in the Netherlands has led to substantial land subsidence and a significant decrease in the soil carbon pool. A mitigation option, known as reverse drainage, has been proposed to prevent land subsidence and elevated carbon dioxide emissions from continuing. Reverse drainage consists of subsurface drains capable of transporting water in (i.e. rewetting the drained peat meadows) and out, to maintain a consistent water level throughout the year.

The aim of this study is to measure the effect of reverse drainage on greenhouse gas-fluxes. Measurements of CO2 and CH4 were collected in the summer of 2018 at a peat meadow site in the Netherlands. A reverse-drainage containing peat meadow is compared against a neighboring peat meadow where the system has not been installed. It is important to highlight that these measurements were taken during the extremely hot and dry summer of 2018.

Previous works on the subject show reductions in CO2 fluxes of 50–66% as a result of this system. In this study such differences in emissions have not been found. A difference of less than 10% was found between the field with reverse drainage and the field without.

Whilst, this is a timely study because hot and dry summers have occurred more frequently in recent years, it is not recommended that these results be used to evaluate the efficacy of reverse drainage. These initial results are a doorway to discussion on the monitoring, installation, set-up and evaluation methods surrounding the extremely new reduce drainage concept.

Domtoren 4	**Earth and Planetary Science: Surface Processes & Remote Sensing**
Day 2	13:00 – 13:15

Satellite-remote-sensing-based monitoring of volcanic ash plumes

Jos de Laat

Ronald van der A, Piet Stammes, Pepijn Veefkind, Wim Som de Cerff, Saskia Wagenaar (all KNMI)

Satellite-remote-sensing-based monitoring of volcanic ash plumes.
("State Of The Art and the role of KNMI and the Netherlands")

Volcanic eruptions are an important global geophysical hazard, causing devastation, mass evacuations of people, destruction of property by deposition of ash, lava flows, or tsunamis in the direct vicinity of the volcano, but can also affect humanity much further away. Who doesn't remember the disruption of global aviation during the 2010 eruption of the Icelandic volcano Eyjafjallajokull. European air space was closed for weeks and millions of passengers were stranded? Volcanic eruptions also are also of importance for climate, for example cooling the planet during several years after a large eruption.

The advance of atmospheric remote sensing technology in the 21st century has led to a rapid growth in R&D of methods for detection and monitoring of volcano ash clouds. This talk will present an overview of the State of the Art of satellite remote sensing techniques for monitoring volcanic ash clouds. It will be discussed what methods are available, how these methods have been developed, how they currently are applied, and what role the Netherlands and the Royal Netherlands Meteorological Institute has been playing. The talk will end with some highlights of very recent developments, exciting new results from the Dutch satellite TROPOMI, and a glimpse of what the future may hold.

Domtoren 4	**Earth and Planetary Science: Surface Processes & Remote Sensing**
Day 2	13:15 – 13:30

Inferring Global Patterns of Lunar Surface Mineralogy from Elemental Abundance Data Using Artificial Neural Networks

Yue Zhao

M. Laneuville, N. Guttenberg, W. van Westrenen

Global surface mineralogical maps are both valuable for understanding the Moon's geological history and challenging to obtain due to the degeneracy between elements and minerals. Previous estimates of large-scale lunar surface mineralogy are typically obtained by using visible and near-infrared spectroscopy, multi-spectral imaging, and thermal emission spectroscopy. We explore patterns in elemental abundance data directly to further constrain large-scale distributions of major minerals on the Moon.

We train an artificial neural network to recognize relations among the chemical elements by calculating the predictability of one element (target) from one or more other elements (input). Where a common factor influences both the input and target elements in a significant area, the neural network learns the pattern in the relation between the input(s) and target, and the predictability is expected to be good. We use this predictability analysis to explore regions in which certain elements are influenced by a common chemical process (e.g. formation of a specific mineral), without prior assumptions about correlations between the elements. This serves as an independent way to identify patterns in global mineralogical distribution.

We find that our global patterns of plagioclase and olivine distributions are in good agreement with previous studies. We predict that high-Ca pyroxenes are distributed in relatively high amounts in the mare regions and the South Pole-Aitken basin, the latter hosting the first soft landing on the far side of the Moon by the Chinese Chang'e 4 lander in January 2019. On the other hand, the near-side anorthositic crust contains mainly low-Ca pyroxenes.

Infrared Spectral Imaging of Rock Mineralogy and Microstructur

Frank van Ruitenbeek
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Infrared spectral imaging techniques measure spectral properties of rocks and other materials in the laboratory and the field at close range. By measuring infrared hyperspectral reflectance at close range, we acquire detailed mineralogical information. With the current generation of hyperspectral sensors, we can measure hyperspectral imagery at pixels-sizes down to 26 Âµm, which makes the level of detail comparable to that of thin section studies. The interpretation of high-resolution hyperspectral imagery produces mineral maps that show distribution and abundances of minerals and variations in mineral chemistry. The spatial arrangement of minerals and aggregates provides information on the microstructure of the rock. In this paper, we will show infrared spectral imaging applications for resources and geological exploration. Indicator minerals of mineralization were mapped in drill core from the Sadiola gold deposit in Mali and Cortez gold deposit in Nevada. Mineral abundances and mineral assemblages were mapped to estimate metamorphic grade of rock samples from Archean greenstone terrains in Australia. Rock microstructures were measured from mineral maps of hydrothermal systems in the Pilbara craton in Australia and the Los Bronces porphyry-Cu deposit in Chile. Infrared spectral imaging enables the automated interpretation of composition of drill core, rock samples, outcrop, and rock faces and provides objective and reproducible information about the mineralogical composition and rock microstructure.

Domtoren 4	**Earth and Planetary Science: Surface Processes & Remote Sensing**
Day 2	13:45 – 14:00

Using radar to study vegetation water dynamics: From field-scale to regional analysis

Susan Steele-Dunne

Spaceborne radar delivers observations at a range of spatial resolutions from meters to tens of kilometers. Radar backscatter is sensitive to soil moisture, and vegetation water content as well as surface and vegetation geometry. Radar observations have been used operationally for soil moisture retrieval, land cover classification and above ground biomass monitoring for a wide range of applications. An implicit assumption in each of these applications is that the vegetation constitutes a relatively static and uniform dielectric medium.

In reality, vegetation acts as an interface between the earth's surface and the atmosphere, modulating exchanges of water, carbon and energy and responding to environmental stressors. Potential gradients between the root zone and atmosphere drive moisture transport within the vegetation, influencing both the total amount of water in the vegetation and its internal distribution at sub-daily scales.

Here, results will be presented to highlight recent research at TU Delft on the development of radar as a tool for monitoring canopy water dynamics. Results will be presented from both field-based experiments, and spaceborne SAR and scatterometer data. We will demonstrate that phenomena observed at field scale are also observed at footprint scale, yielding new opportunities to observe vegetation water dynamics in agricultural and natural ecosystems.

Oudegracht 4	**Global Ocean Dynamics**
Day 2	14:30 – 14:45

Mixed up at the ocean surface: how garbage patch dynamics causes initial information to be lost in particle dispersion models

David Wichmann

Philippe Delandmeter, Hendrik A. Dijkstra, Erik van Sebille

The tracking of virtual particles has been one of the main numerical tools to understand the global dispersion of marine plastic debris in the recent literature. Used in combination with plastic input scenarios, individual particle trajectories can be computed, and final particle distributions can be compared to actual plastic measurements.

Although this method has been successful in explaining the global-scale accumulation patterns of surface micro plastic ('garbage patches'), this does not necessarily imply that the transport pathways of individual particles are well-represented by these models. In fact, the surface ocean is a chaotic dynamical system that tends to amplify small uncertainties coming from initial conditions or numerical errors. This fact, together with the inherent imprecision of plastic input scenarios and ocean circulation models make the surface ocean a mixing dynamical system: given the finite precision, the information of an initial particle location is lost over time, and the correlation between initial and final plastic distributions decays.

We use mixing entropy and the second eigenvalue of the transfer operator associated with surface ocean transport to analyze this mixing property. We find a mixing time at the order of 5 years for all subtropical basins (depending on the precision of available input data), which is lower than typical simulation times for surface plastic simulations. Our results have important implications for global dispersion modelling of floating materials as they demonstrate that correlations between initial and final particle distributions should not be over-interpreted, and that precise initial information is irrelevant for long-term simulations.

Oudegracht 4	**Global Ocean Dynamics**
Day 2	14:45 – 15:00

Dissolved iron in the Southern Ocean and coastal seas

Rob Middag

E.M. Bertrand (2), C.P.D. Brussaard (1), I. Ardiningsih (1), C.U.M. Eich (1), L.J.A. Gerringa (1), M.H. van Manen (1), J.S.P. McCain (2), S.B.E.H. Pont, (1), G.J. Reichart (1), H.A. Tian (1)

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During the two last Antarctic summer seasons, shipboard measurements of dissolved iron (DFe) concentrations were made in the central Amundsen Sea (2018) and Weddell Sea (2019). Surface concentrations were depleted (<0.2 nM) thoughout, even close to the continent. The exceptions were the Dotson Ice Shelf outflow and near the Antarctic Peninsula in the Weddell Sea. However, elevated surface concentrations did not persist far off shore, most likely due to a combination of precipitation and biological uptake. In the subsurface part of the water column, DFe concentrations were generally low offshore. Concentrations increased with depth but the highest concentrations in the deepest samples remained around 0.5 nM in Circumpolar Deep Water (CDW). Several bio-assay experiments were performed in both the open ocean and closer to shore. Shipboard measurements demonstrate that the dFe concentrations remained low throughout the experiments in the non-amended controls. The addition of iron however improved the photosynthetic capacity, Fv/Fm, and had a profound effect on the amount of biomass and nutrient uptake. Besides the effect of iron, also the effect of temperature was tested. In both the Fe addition treatment as well as in the non-amended treatment, a 2 degree increase in the incubation temperature had a positive effect on the nutrient uptake. These results are of importance for our understanding of the consequences of climate change in this iron limited region. We demonstrate both the Fe concentration and the water temperature affect primary productivity and thus carbon uptake as well as the Antarctic ecosystem.

Oudegracht 4	**Global Ocean Dynamics**
Day 2	15:00 – 15:15

Mechanisms of Multidecadal Variability in the Southern Ocean

René van Westen
Henk A. Dijkstra

The physical processes which control (deep) convection in the Southern Ocean have been studied in many low-resolution global climate models. However, the timescale of variability of convection is irregular and not consistent among different models. High-resolution global climate models reveal significant differences compared to low-resolution models, for example in the background stratification and the timescale of variability of convection.

Here we present results of an analysis of model output from a long (250 years) simula- tion of a high-resolution (0.1◦ horizontally) version of the fully coupled Community Earth System Model. We find multidecadal variability in the Southern Ocean with a period of about 25 years for different quantities, such as sea-ice concentration, temperature, salinity and deep convection. The occurrence of the Weddell Polynya near Maud Rise also varies with the same 25-year period in our model. The 25-year period is related to the Southern Ocean Mode, which is an intrinsic mode of variability due to interactions of ocean ed- dies with the background flow. Observations and output of re-analysis indicate the same timescale of variability in the Southern Ocean. We provide a new mechanism to explain multidecadal variability in the Southern Ocean.

Oudegracht 4	**Global Ocean Dynamics**
Day 2	15:15 – 15:30

Stochastic transitions of the AMOC in ocean models

Daniele Castellana
Henk Dijkstra

The Atlantic Ocean circulation, in particular its Meridional Overturning Circulation (MOC), is sensitive to freshwater anomalies. A tipping point may exist such that the present-day MOC will collapse if the northern North Atlantic freshwater forcing is gradually increased. In addition, if the MOC is in a multiple equilibrium regime, it may undergo transitions due to the impact of noise (e.g. rapid changes of the freshwater input in the North Atlantic). Whether the present-day AMOC is in a bistable regime is under debate in the climate community. However, if that is actually the case, there are still no indications about the probability that such a collapse can happen.

Finding this probability is not an easy challenge for ocean models, as the computations it involves are often not feasible. Nevertheless, one can decide to work on simple models and relate the results to more complex ones, by means of certain physical indicators, that can be calculated in both classes of models.

The aim of this work is to determine the probability of collapse of the AMOC in a stochastic ocean box model and relate the results to state-of-the-art ocean models.

Oudegracht 4	**Lowland Evolution & Management**
Day 2	13:00 – 13:15

21 m sea-level rise in 9000 years: the Holocene sea-level database for the Rhine-Meuse Delta, The Netherlands

Marc Hijma

Kim Cohen

(1) Utrecht University, Utrecht, The Netherlands; (2) Deltares, Utrecht, The Netherlands

The Netherlands has a long tradition of sea-level research from which vast amounts of data accumulated over the last 60 years. The results, however, have scattered availability and as a whole had not been uniformly scrutinized on quality and usability today. We present new results for Greater Rotterdam (RMD) and from offshore regions within the southern North Sea.

For the RMD and the transgressed palaeovalley below it, we have recently re-assessed the available sea-level data. Following documented protocols, index points tied to radiocarbon dates from peat beds were selected (catalogued), then documented and screened individually in a database, and then further screened in ensemble on quantified age-depth position and inshore palaeotidal setting. The RMD database holds 50 sea-level index points (SLIPs) and 56 upper limiting data points. The SLIPs cover an age-range of 8.8–3.0 ka, beginning at -21 m O.D., while the limiting points have coverage back to 11 ka BP and down to -34 m O.D.

Between 8.0 and 4.5 ka, relative sea-level rise gradually decelerated from 0.9 to 0.2 m/cy. Between 9.0 and 8.0 ka, rates of rise were much higher (on average 1 m/cy), with peaks of 2 m/cy during a superimposed 'sea-level jump'. For this jump, the RMD resolves a magnitude of 1.7±0.6m for the first phase (starting 8.45 ka), and a few more decimetres in a second phase (8.3–8.25 ka). This corresponds to globally-averaged jump components of 2.5±0.9m (1σ) and 0.1–0.4m respectively, caused by drainage of Lake Agassiz-Ojibway also known from the 8.2-ka cold event.

Oudegracht 4	**Lowland Evolution & Management**
Day 2	13:15 – 13:30

10,000 years of carbon sequestration in the Holland coastal plain

Kay Koster

The Holland coastal plain sequestrated carbon in stacked peat layers from c. 11,000 to 1000 cal year BP. At present, this area contains c. 11.8 km3 of peat, equaling 75% of all Holocene peat in the Netherlands. In total, peat embedded in the Holland coastal plain contains 0.87 Gton carbon.

Here, rates of carbon sequestration in the Holland coastal plain during the period 11,000 to 1000 cal year BP are presented. The carbon sequestration rates are determined using (1) 3D subsurface models of peat organic matter density distribution to determine the amount of carbon in peat layers, and (2) Holocene groundwater level rise for determining age and depth of peat layers.

The results show that carbon sequestration was the highest (0.30 Gton C) between 6000 and 5000 cal year BP, when vast wetlands formed behind a coastal barrier. During 10,000 to 9000 cal year BP, a mere 0.01 Gton C was sequestered, as a result of local inundations induced by relative sea-level rise. Shallow peat layers younger than 5000 cal year BP contain in total only 0.13 Gton C, because vast quantities have disappeared by anthropogenic processes.

This study indicated that rates in carbon sequestration and its preservation is influenced by an interplay between geomorphology, relative sea-level rise, and anthropogenic activity.

Oudegracht 4	**Lowland Evolution & Management**
Day 2	13:30 – 13:45

Holocene wet-dry cycles interrupted by a 'Rhine river' pulse after a marine incursion in the central Netherlands

Kay Beets

Simon R. Troelstra, Maarten A. Prins

Sediment cores obtained from the Marker Wadden site provide an excellent possibility to reconstruct the peri-marine Holocene environmental development. The deposits reveal the detailed sedimentary history of the central part of the Netherlands following the Holocene sea level rise conform to the classical dutch stratigraphy from late-glacial coversands onwards. Grain size and thermo-gravimetric analyses coupled to micro-palaeontological and stable isotope data provide a solid framework for a detailed reconstruction of the landscape during this time interval. Intriguingly, the oxygen (delta18O) and strontium (87Sr/86Sr) isotope composition of double-valved specimen of in-situ ostracod Cyprideis torosa indicate recurrent dry-wet episodes of ~1500 years between ~7000 and 500 years BP. Brackish water isotope signatures dominate before 4000 BP and after 3000 BP. A strong break in this pattern occurs when the relatively sudden nearly fully-marine isotope signature around 4000 BP is succeeded by a build-up to a strong fresh-water signature around 3000 BP. Based on the ostracods' strontium isotopic composition the Rhine river acted as the dominant fresh-water source to this part of the central Netherlands. This study shows that ostracod isotope geochemistry can provide valuable information necessary for the reconstruction of the (Holocene) environment.

Oudegracht 4	**Lowland Evolution & Management**
Day 2	13:45 – 14:00

Why do not all meandering rivers actively meander?

Jasper Candel

Bart Makaske, Niels Kijm, Maarten Kleinhans, Joep Storms, Jakob Wallinga

Meandering rivers are usually associated with active meandering processes. However, many meandering rivers are relatively laterally stable, and can have very complex planforms. We show that these rivers became autogenically constrained within their self-formed, heterogeneous floodplain, by a reconstruction of the Late-Glacial to Holocene planform evolution of a small meandering river; the Dommel River in The Netherlands. Here we combined coring, ground-penetrating radar (GPR), optically stimulated luminescence (OSL) dating and radiocarbon (14C) dating. The Dommel River developed a complex sinuous planform with very limited lateral migration due to insufficient flow strength to erode its self-formed cohesive banks, which largely consist of oxbow channel fills and counterpoint deposits. We compared data on river energy, bank strength and planform complexity of 48 rivers from around the world, which confirmed that complex planforms occur where rivers are constrained within their self-formed cohesive banks. This self-constraining of rivers is initiated once river energy decreases. Due to better preservation of cohesive deposits compared to non-cohesive deposits, the required energy needed to break out of the self-constraining tendency increases over time. Self-constraining thereby enhances resilience of the system, but the river is able to escape from the self-constraining tendency if river energy increases to such an extent that the threshold for erosion of cohesive bank material is crossed, leading to highly non-linear morphodynamic changes. Our study provides a novel explanation for meandering planforms and meandering dynamics.

Domtoren 5	**Observing and modeling the atmosphere**
Day 2	13:00 – 13:15

The Ruisdael Observatory: a new facility for atmospheric research in the Netherlands

Herman Russchenberg
The Ruisdael Consortium

In the next decades, governments worldwide are planning to spend enormous amounts of public funds to cope with expected climate change. To effectively prioritize measures to be taken, there is an urgent need for reliable short term forecasts of weather, and to assess the effects of climate change on local extreme weather events. Reliable predictions are however severely hindered by an incomplete representation of short-lived climate forcers and processes that operate in the climate system, and their small-scale spatial and temporal variability. Present permanent facilities to study these processes lack the required ability to couple data and models at different spatial and temporal scales.

The Ruisdael Observatory will operate at the full scale of The Netherlands at the unprecedented spatial resolution of hundred meter. The Ruisdael Observatory will merge observations and models in real time, at different spatial and temporal scales, to form a virtual laboratory for studying multi-scale processes in atmospheric chemistry and physics, and by doing so improve the accuracy of climate, weather and air quality models.

The Ruisdael Observatory will consist of:
- a nationwide network of sensors to measure the 3D physical and chemical state of the atmosphere and its interaction with the land surface,
- four advanced anchor stations: the rural CESAR Observatory, a new urban station in Rotterdam, a coastal station and one in forestry,
- mobile facilities,
- a computational facility for real-time simulations.

Explicit aerosol-cloud interaction in DALES

Marco de Bruine

Maarten Krol, Jordi Vila-Guerau de Arellano, Thomas Röckmann

In this work, an aerosol framework is implemented in the Dutch Atmospheric Large-Eddy Simulation model (DALES, Heus et al., 2010). The modal representation of M7 (Vignati et al., 2004) is linked to the existing cloud microphysics scheme (Seifert & Beheng, 2006). Key component of the framework is the aerosol activation scheme, with explicit calculation of critical activation radius based on aerosol hygroscopicity.

The aim of this framework is to simulate aerosol-cloud interaction in a cloud-resolving model. In particular to study the effects of this interaction on the aerosol distribution. Because the framework (partly) resolves the aerosol composition it is possible to study the relative importance of microphysical processes for different species.

Results for precipitating shallow cumulus clouds (RICO campaign, Rauber et al., 2007) show that most aerosols leave their in-cloud and in-rain 'state' through evaporation, despite the strong formation of precipitation. Cloud and rain droplets grow during their lifetime. However, aerosols resuspended with cloud evaporation are of similar size as the aerosols initially taken up by the cloud processes. This is caused by the preference for evaporation to act on the small cloud drops (and smaller associated aerosols). The larger droplets are transformed to rain. Consequently, evaporating raindrops do yield large aerosols several ten times larger than the initial aerosols.

Domtoren 5	**Observing and modeling the atmosphere**
Day 2	13:30 – 13:45

Quantifying methane emissions from coal mining shafts in Silesia, Poland using an active AirCore system

Truls Andersen

Marcel de Vries, Bert Kers, Jaroslaw Necki, Justna Swolkien, Anke Roiger, Wouter Peters, Huilin Chen

A strong contributor to the annual European CH4 emissions comes from the black coal (anthracite) mines in Silesia, Poland, where large quantities of CH4 are emitted to the atmosphere via ventilation shafts of underground coal mines. As part of the Carbon Dioxide and Methane mission 0.5 (CoMet 0.5) and 1.0 (CoMet 1.0), a study of the Silesia coal mining region CH4 emissions took place in August 2017, and May 2018. We flew a recently developed active AirCore system aboard an unmanned aerial vehicle (UAV) to obtain CH4 mole fractions downwind of five individual coal mining shafts. The flights were made between 150 and 300 m downwind of the shafts. Besides CH4 mole fraction measurements, we have also measured CO2, CO, atmospheric temperature, pressure, and relative humidity. Ground wind measurements were made to obtain horizontal wind speeds and directions. To quantify the shaft's emission rate, we employ two different techniques; a mass balance approach (MB), and a gaussian inversion (GI) technique. 76 flights downwind flights were performed during the campaigns. This effectively builds a 'curtain' of CH4 mole fractions in a two-dimensional plane. The preliminary estimates of the CH4 emission rates from the sampled shafts range from 1.9 to 15.3 kt/year using the mass balance approach, and between 3.0 to 18.5 kt/year using a Gaussian inversion method. The average difference between the mass balance and Gaussian inversion approach is 1.4 kt/year. These emission rates will be compared to detailed inventory values from the individual shafts.

Domtoren 5	**Observing and modeling the atmosphere**
Day 2	13:45 – 14:00

New high-resolution isotope mass spectrometry applications for atmospheric sciences

Maria Popa

Thomas Röckmann, Getachew A. Adnew, Amzad Laskar, Rahul Peethambaran, Magdalena E.G. Hofmann, Dipayan Paul, Christof Janssen, Johannes Schwieters, Gerbrand Koren, Wouter Peters, Jakub Surma, Nina Albrecht, Andreas Pack

Stable isotope measurements have become an important scientific tool to constrain the budgets of atmospheric compounds. Because of analytical limitations, isotope investigations have generally targeted single substituted isotopocules for most species. Recently developed high-resolution, high-sensitivity isotope ratio mass spectrometers enable the measurement of multiply substituted isotopocules, and expand the possibilities to determine isotope ratios on fragment ions that are formed in the ion source of mass spectrometers. We will present several applications that were recently realized with the MAT 253 instrument at Utrecht University: measurements of the clumped isotopes (17O18O and 18O18O) in atmospheric O2, clumped isotopic composition of H2 and CH4, and 17O anomaly of CO_2 on O atom fragments. These measurements offer new possibilities to constraining and understanding some of the atmospheric gases, and the biogeochemical processes affecting them.

Domtoren 4	**Origins and evolution of life, planets and the Universe**
Day 2	14:30 – 14:45

Feedbacks in continental growth and implications for habitability

Dennis Höning
Nicola Tosi, Tilman Spohn

Having both emerged land as well as oceans is an important environmental condition of the present-day Earth for sustaining its biosphere. Upon considering the habitability of other planets, one may be tempted to assume that Earth's potential exoplanetary sister would have a similarly balanced ocean-land fraction as the present-day Earth. But is such a configuration a natural outcome of the evolution of an Earth-like planet with plate tectonics?

In this presentation, we discuss feedback mechanisms that contribute to the production and erosion of the volume of the continental crust. We explore the effect of the combined feedback strength on the feasibility of modeling the observed small positive net continental growth rate over the past 2–3 billion years. Whereas a model with dominating positive feedbacks can readily explain this observation in spite of the cooling of the Earth's mantle acting to reduce the continental production rate, explaining this observation using a model with dominating negative feedbacks would require the continental erosion and production rates to both have the same or a sufficiently similar functional dependence on the thermal state of the mantle. The latter in turn appears unreasonable considering erosion to be largely dominated by the surface relief and weathering, however. Therefore, we suggest a scenario of dominating positive feedbacks, which implies that continental growth is strongly determined by initial conditions. Exoplanets would then substantially differ from the Earth with respect to their relative land/surface ratios. Finally, we discuss the effect of this circumstance on the habitability of exoplanets.

Domtoren 4	**Origins and evolution of life, planets and the Universe**
Day 2	14:45 – 15:00

An origins simulator – Could natural pH gradients have powered the origin of life?

Camprubí-Casas

Eloi Camprubí-Casas, Inge Loes ten Kate

Hadean alkaline hydrothermal vents have been proposed as electrochemical reactors driving an autotrophic origin of life. Theoretical thermodynamics show that the abiotic synthesis of biomass from H2 and CO2 is indeed favoured under these conditions. But CO2 reduction is kinetically extremely tardy, casting doubt on the feasibility of this mechanism. Given that almost all extant life grows by hydrogenating CO2, this question is of central importance to the autotrophic origins hypothesis. Within the newly created Origins Center I am examining the possibility that geochemical proton gradients across inorganic Fe(Ni)S barriers, analogous to methanogenic and acetogenic procaryotes, could have driven CO2 reduction at the origin of life in alkaline hydrothermal vents.

Under these conditions the non-enzymatic synthesis of organics has been successfully reported but has proven difficult to reproduce systematically, most probably due to the high stochasticity inherent to large-scale simulators. A microfluidics approach is optimal at increasing the control exerted over the experimental variables (pH gradient, temperature, mineral crystallinity, etc). Our aim is to explore whether abiotic reactions analogous to those of the acetyl CoA pathway and reverse incomplete Krebs cycle could be catalyzed by Fe(Ni) S minerals tapping into a natural pH gradient. These predicted pathways could proceed via Fischer-Tropsch-type hydrogenations and Koch-type carbonylations, which usually occur at harsher conditions, thanks to the pH-mediated reduction potential modulation.

Domtoren 4	**Origins and evolution of life, planets and the Universe**
Day 2	15:00 – 15:15

Aqueous alteration of forsterite: the face matters

Dario Campisi

N.Y. Dzade, R. Martinazzo, A.G.G.M. Tielens, I.L. ten Kate

Forsterite (Mg2SiO4) is a mineral ubiquitous in all rocky bodies in our Solar System and it was also recently observed in the dusty clouds around a forming star. It is known to interact with water in these regions. Understanding the forsterite-water interface interactions at the molecular level is important for many geochemical and catalytic processes.

In this study, we employed a periodic DFT-D3 approach to study the effect of aqueous alteration on forsterite's surface properties. We modeled several low-Miller index surfaces (010, 001, 100, 111, 110, 011, 101) and predicted their surface stabilities under anhydrous and hydrated conditions. We found that in anhydrous conditions the (010) is the most stable surface, but due to a radical change in the stability, (011) and (110) become the most stable surfaces when forsterite is hydrated through adsorbed water molecules. The major interactions between the adsorbing water molecules and the Mg2SiO4 surfaces are found to occur through oxygen and the topmost Mg atoms. Dissociation of the chemisorbed water molecules (H + OH) resulted in the formation of hydroxylated Mg2SiO4 surfaces (the dissociated H atom adsorbs at an adjacent O surface, while the OH species remains adsorbed at Mg sites). This study reveals that the aqueous alteration conditions have a significant effect on altering the morphology and stability of forsterite crystals under planetary or extraterrestrial environments.

Domtoren 4	**Origins and evolution of life, planets and the Universe**
Day 2	15:15 – 15:30

Extra-Martian organics: a viable source of atmospheric methane?

Arjen Boosman

I.L. ten Kate, P. Mason, L. Polerecky, D. Materic, R. Holzinger, T. Röckmann

The origin of methane in Mars's atmosphere has not yet been identified. Ultra-violet (UV) degradation of extra-Martian organics from meteorites has been shown to produce methane, but the fluxes of methane and potentially other emitted volatiles are not well defined. Identifying and quantifying these fluxes will allow us to assess UV-degradation of organics as a source of Martian methane.

We performed UV-irradiation experiments on freshly ground samples of the Murchison meteorite. Cavity Ring-Down Spectroscopy and Proton Transfer Reaction Time of Flight Mass Spectrometry measured emission of volatiles, including methane. methane was emitted for over 2 weeks at a UV irradiance larger than the maximum irradiance on Mars. Emission rate shows a dependence on irradiance. Extrapolation of the data to the annual Martian meteorite influx does not add up to the methane flux needed for the methane concentration in the Martian atmosphere.

In addition to methane short chain aldehydes/ketones are emitted. The aldehydes/ketones outweigh the methane emission by a factor of 2. Furthermore, we detected volatile compounds up to mass 280 amu, including methanol and compounds still to be identified. Martian methane, if derived from meteoritic carbon, must be accompanied by other detected volatiles.

In the future we will focus on identifying chemical pathways leading to methane emission. While we propose that UV-degradation of delivered organics is not the main contributor of Martian methane, future laboratory studies and measurements on Mars will provide us with new knowledge of the Martian methane cycle.

Domtoren 6	**Paleoclimate**
Day 2	13:00 – 13:15

Glacial-interglacial North Atlantic surface circulation strength; a novel dinocyst carbon isotope approach

Karlijn van den Broek

Joost Frieling, Linda van Roij, Gert-Jan Reichart, Appy Sluijs

The Gulfstream transports warm surface water northwards, sustaining a mild climate in north west Europe. Variations in strength of surface circulation and North-Atlantic deep overturning may have been associated with rapid climatic fluctuations during glacial-interglacial cycles. Although small disturbances may significantly alter this circulation system and regional climates, the sensitivity of the surface circulation to such perturbations remains poorly understood, hampering reliable projections of potential future changes in the Gulfstream.

We employ a new approach based on the air-seawater pCO2 disequilibrium (ΔpCO2) to provide a quantitative measure for surface circulation strength. We utilize the principle that a modern-like circulation results in strongly negative ΔpCO2 at higher latitudes, whereas reduced surface circulation strength should result in small or even positive ΔpCO2.

We used laser-ablation nano-combustion gas chromatography isotope ratio mass spectrometry (LA-nC-GC-IRMS) to analyze the stable carbon isotopic composition of the dinocyst species Operculodinium centrocarpum (δ13CDINO). Culture experiments and field data have showed that stable carbon isotope fractionation (εDINO) in this species is dependent on carbonate speciation, which is here used to reconstruct pCO2. We reconstructed pCO2 across the Holocene and last glaciation using sediments recovered from Rockall Trough, offshore northwest Ireland, calculate local ΔpCO2 and use this to reconstruct relative surface circulation strength.

We find high amplitude variability in surface circulation strength during the last glacial, whereas a more stable modern-like surface circulation persisted through the Holocene. We will present the latest results and insights and compare our new data to existing climate model simulations and proxy data of AMOC strength.

Domtoren 6	**Paleoclimate**
Day 2	13:15 – 13:30

Milankovitch cycles in early Paleoproterozoic Banded Iron Formation

Margriet Lantink

Joshua Davies (University of Montréal, University of Geneva), Paul Mason (Utrecht University), Urs Schaltegger (University of Geneva) and Frits Hilgen (Utrecht University)

Large-scale banded iron formations (BIFs) were deposited during late Archean to early Paleoproterozoic and have been mainly linked to hydrothermal plume activity[1] and the rise of oxygen in the ocean and atmosphere.[2] In this study, we focus on the potential influence of astronomical "Milankovitch" forcing on the deposition of these BIFs. Climate oscillations on the 104–106 year scale must have been operative at that time[3] and may explain rhythmic layering in BIFs.[4,5] However, this hypothesis has previously not been fully tested, partially due to uncertainties associated with BIF depositional rates. For this reason, we carried out cyclostratigraphic analysis on the early Paleoproterozoic Kuruman BIF in South Africa, in combination with high-precision TIMS U-Pb zircon dating of several ash intervals interbedded in the BIF. In field exposures we identified characteristic, rhythmic alternations in the weathering profile of the Kuruman BIF, which we could correlate over a distance of 250 km. Based on spectral analysis results and high-precision U-Pb ages we suggest these patterns are related to orbital forcing. Alternations on a similar scale seem to present in the roughly time-equivalent[6] Australian Dales Gorge Member BIF and may thus have the same origin.

References: [1] Isley, 1995; [2] Lyons et al., 2014; 3 Laskar, J. et al. 2004; [4] Trendall & Blockley, 1970. [5] Beukes, 1980; [6] Pickard, 2003.

Domtoren 6	**Paleoclimate**
Day 2	13:30 – 13:45

Present-day Saharan dust deposition in the Atlantic Ocean and its marine-environmental consequences

Jan-Berend Stuut

Geert-Jan Brummer, Laura Korte, Michèlle van der Does

Mineral dust plays an important role in the ocean's carbon cycle through the input of nutrients and metals which potentially fertilise phytoplankton, and by ballasting organic matter from the surface ocean to the sea floor. However, time series and records of open-ocean dust deposition fluxes are sparse. Here, we present a two-year time series of the spatial and temporal evolution of dust-deposition fluxes from a trans-Atlantic array of dust-collecting instruments (surface dust collectors and moored submarine traps) directly below the core of the Saharan dust plume along 12°N. By combining observational data of actually deposited dust with model simulations and satellite observations, we argue that dust deposition in the Atlantic is strongly influenced by summer rains. Using in-situ incubation experiments we demonstrate that such wet deposition increases the release of nutrients up to an order-of-magnitude relative to dry deposition. As a result, we hypothesise that rain-amplified bioavailability of these nutrients may well be the key to increased surface-ocean productivity in remote and oligotrophic parts of the oceans and, potentially, continental ecosystems.

Domtoren 6	**Paleoclimate**
Day 2	13:45 – 14:00

El Niño variability reflected in a high resolution pollen record from a lake in the Tropical Andes of Ecuador

Kimberley Hagemans

Martin Stekelenburg, Dunia Urrego, William Gosling, Donald Rodbell, Friederike Wagner-Cremer and Timme Donders

The future frequency and magnitude of the El Niño – Southern Oscillation (ENSO) in a world with global climate change is still highly uncertain and topic of intense debate. High resolution records from sedimentary archives can aid our understanding of ENSO variability under changing climates on the true 2-7 year El Nino timescale. One of the most detailed continuous records of Holocene El Niño dynamics from a terrestrial setting is the Laguna Pallcacocha record from Cajas National Park, Ecuador. Previous analysis revealed hundreds of El Nino-driven light-coloured inorganic, clastic laminations, in the dark organic lake sediments which reflect increased frequency of El Nino events during the past 5000 years, with millennial-scale oscillations. While used worldwide as a key record of ENSO variability, it is essentially a local record with potential complexity in interpretation. High resolution pollen analyses represent a more regional source area that aid the development of our understanding of ENSO intensity through time. We present the first high resolution Holocene pollen record from Laguna Pallcacocha that reveals clear expanses of the montane forest belts to phases of high ENSO frequency. Additionally, an ultra-high resolution pollen analysis of the last century permit to calibrate interannual changes in pollen deposition to variability in regional precipitation and temperature variability forced by ENSO on the true 2–7 year timescale. Application of this approach to an interval during the early Holocene will for the first time detect annual-scale vegetation responses during a phase of proposed reduced ENSO intensity.

Domtoren 6	**Paleoclimate**
Day 2	14:30 – 14:45

Transient model analysis of salinity and oxygen dynamics in the Holocene Black Sea

Pieter Dirksen

S.M. Pit, C.P. Slomp, P.Th. Meijer

Up to approximately 9 ka, the Bosporus Strait was closed and the Black Sea was a brackish lake. The opening of the Bosporus Strait in the early Holocene has been associated with bottom water oxygenation in the Black Sea. The opening may have either been a single event (directly opening the strait permanently), or a more gradual process, with perturbations leading to opening and closing of the strait several times, before its permanent opening. After the initial oxygenation, the Black Sea reached its current state, with a stratified water column and anoxic bottom water. Here we present a transient box model, combining a dynamic representation of water circulation with that of the nutrient phosphorus, to study the bottom water oxygenation in the Black Sea over the Holocene.

When forcing the model with a constantly rising sea level, we find a single period of bottom water oxygenation, while perturbing the sea level rise to open and close the strait multiple times results in several peaks in bottom water oxygenation. When the strait is opened permanently, the model always goes to a stratified state, with anoxic bottom water (i.e. the current situation in the Black Sea). When the strait remains closed, the model eventually reaches a mixed state, which is in line with the occurrence of oxic bottom waters during the lake phase, as deduced from sediment records.

The results of our model highlight the interplay of hydro- and nutrient dynamics in controlling the time line of the development of anoxia in the Holocene Black Sea.

Domtoren 6	**Paleoclimate**
Day 2	14:45 – 15:00

Transport by ocean currents influences the sedimentary dinoflagellate cyst distributions: Implications for paleoceanographic reconstructions

Peter Nooteboom

Peter Bijl, Erik van Sebille, Anna von der Heydt, Henk A. Dijkstra

Sedimentary dinoflagellate cysts (dinocysts) are a widely used tool for paleoceanographic reconstructions. As for all micropaleontological proxies, an often-used underlying assumption in dinocyst-based reconstructions is that the sedimentary assemblages represent local conditions of the overlying ocean surface water. However, any immobile particle sinking down the water column is subjected to horizontal and vertical transport by ocean currents, and the sedimentary microplankton might be transported from a location with different conditions.

We model the transport of the dinocysts in a high-resolution (0.1° horizontally) global model of the present-day ocean, and compare the local surface environment to the environment where the cysts formed and are transported from.
We find that the assumption that sedimentary dinocysts represent overlying surface water conditions is not valid in many regions of the world. The significance of cyst transport depends on ocean current strength and direction, the aggregation probability which could increase the sinking speed, and the depth of a sediment sample. We also identify regions where the particle transport creates an insignificant bias, e.g. in shallow seas.

Our model results provide a way to mechanistically and statistically explain the unexpected occurrences of some dinocyst species outside of their 'normal' occurrence region, such as the northerly occurrence of the sea-ice-affiliated dinocyst Selenopemphix Antarctica in the Southern Ocean: all these northerly occurrences feature a 'cold tail' in their modeled particle origination regions. Exclusion of such outlier occurrences yield much better constrained ecological affinites for dinocyst species, which has implications for dinocyst-based quantitative and qualitative proxies for paleoceanographic conditions.

Domtoren 6	**Paleoclimate**
Day 2	15:00 – 15:15

Lipid biomarkers in Lake Chala record African Megadroughts during MIS5

Allix Baxter

Ellen Hopmans, Stephan Schouten, Francien Peterse, Dirk Verschuren, Jaap Sinninghe Damsté

Much of our knowledge of Earth's Quaternary climate history is derived from deep-sea sediment or ice-sheet cores from high latitudes. Therefore, more long-term records from tropical continental contexts are needed to better appreciate how climate has developed globally. As part of the ICDP project DeepCHALLA, a continuous sediment sequence spanning the last c. 250 kyrs was recovered from Lake Chala in eastern equatorial Africa. The permanently anoxic bottom waters of Lake Chala create excellent preservation conditions for organic materials including glycerol dialkyl glycerol tetraethers (GDGTs), the principal component of the lipid membranes of archaea and bacteria. Subtle changes in their relative distribution down-core can be linked to temperature and precipitation variations in the past. Here we use GDGTs extracted from Lake Chala sediments covering the interval between 140 and 70 kyr to reconstruct climate variability in East Africa throughout MIS5, including the last interglacial period. Our results show evidence for periods of intense aridity, corroborating previous studies on the existence of so-called 'African Megadroughts' during MIS5. Further, fluctuations in temperature at Lake Chala show similar trends as the ice-core record from Antarctica, with the timing of peak temperatures at Lake Chala corresponding roughly to the warmest part of the last interglacial (MIS5e). This study illustrates the versatility and utility of GDGTs to generate continuous and high-resolution records of continental climate in tropical Africa.

Domtoren 6	**Paleoclimate**
Day 2	15:15 – 15:30

Eastern tropical Atlantic climate variability and dinoflagellate cyst ecology during the early Eocene

Tobias Agterhuis

Peter Bijl, Joost Frieling, Francien Peterse, Appy Sluijs

Projecting the future anthropogenic global and regional warming is a major challenge for climate scientists. Significant uncertainty remains in the equilibrium climate sensitivity (ECS), defined as the magnitude of the global warming resulting from a doubling of atmospheric pCO2. Accurate reconstructions of past greenhouse worlds, when CO2 levels and global temperatures were much higher than today, may help reduce uncertainty in ECS. One of those greenhouse periods is the early Eocene (56–49 Ma), which is characterized by regular occurrences of transient global warming events (hyperthermals) that reflect major short-term perturbations of the carbon cycle and climate system. While the high and mid-latitude response to these transient global warming events has been documented, constraints on low-latitude ecological and climate change are more sparse.

We reconstructed high-resolution (~2–5 kyrs) early Eocene climate variability and dinoflagellate cyst ecology using material from Ocean Drilling Program Site 959 in the equatorial Atlantic. Based on a bulk carbonate isotope record we identified negative excursions in δ13C and δ18O, signaling the presence of two hyperthermals. A third hyperthermal may be concealed in a clay-rich, carbonate-free interval. We argue that these isotope excursions and lithological changes represent the I1 or I2, J, and/or ETM-3/K events. We present the first sea surface temperature reconstruction across these events based on TEX86 and a paleoenvironmental reconstruction using dinocyst assemblages. This will allow us to address the temporal scale and magnitude of the tropical climate variability as well as the biotic responses in the surface waters.

Added value of joint action– a game-based methodology applied to the pilot Noard-Fryslân Bûtendyks

Stephanie Janssen

Stephanie Janssen (Deltares, TU Delft), Heleen Vreugdenhil (Deltares, TU Delft), Leon Hermans (TU Delft, IHE Delft), Jill Slinger (TU Delft)

Vegetated foreshores in front of dikes can contribute to flood protection. Cooperation between stakeholders engaging in foreshores is a legal obligation in the Netherlands, and offers opportunities for optimization in the design and management. Issues can be better identified, existing initiatives can be aligned and new opportunities may arise.

To facilitate cooperation a new methodology called 'Added Value of joint action' has been developed within the research project BE SAFE . In this paper we present and discuss the methodology when it was applied to the Dutch pilot Noard-Fryslân Bûtendyks. The methodology is based on principles of cooperative game theory and can help stakeholders to understand the added value of and conditions for cooperation. Steps in the process include (1) getting acquainted, (2) develop opportunities for cooperation, (3) valuation of opportunities, (4) analyzing added value of cooperation, (5) prioritize and (6) action.

For the project Noard-Fryslân Bûtendyks two worksessions were organized in autumn 2018. The outcome of the worksessions was the definition of three pilot projects, a first step towards the development of a vision 'Dike with Foreshore', and prioritizing actions. Stakeholders were able to identify next steps in cooperation.

Lessons learnt with respect to the methodology relate to the practical use of theoretical game-theory concepts. The difference between game-theory and application became apparent. For example, not all potential coalitions are relevant in practice, and a focus on concrete topics and results helps the process.

Oudegracht 3	**Sea-Level Rise: Local Aspects**
Day 2	13:30 – 13:45

Hydrodynamics and sediment transport during barrier island inundation

Piet Hoekstra

M. van der Vegt, A. Engelstad, D. Wesselman, B.G. Ruessink, A. Oost, R. de Winter

Overwash and inundation on barrier islands can transport large amounts of sediment landward, which could potentially increase the aggradation of these islands in times of sea level rise. However, hydrodynamic and sediment transport processes during inundation are still poorly understood. We present field data of suspended sediment, water levels, waves and currents which were collected during a series of inundation events on the Dutch barrier island of Schiermonnikoog. Observations show that even in shallow water depths (<0.5m) wave energy was not completely dissipated as waves propagated from the North Sea onshore. Infragravity waves (~20–200 s) were an important part of the wave field, particularly onshore of the beach crest. Additionally, locally generated wind waves entered the field area also from the Wadden Sea, propagating in the offshore direction. Energy dissipation of both high- and low frequency waves was dominated by wave breaking.

During extreme NW storms elevated water levels developed in the Wadden Sea due to wind set-up. This created an offshore-directed water-level gradient, frequently generating an offshore-directed flow if it was large enough to exceed the cross-shore gradient due to wave set-up.

Cross-shore sand transport showed high variability, where 80% of the combined transport of all inundation events was completed before high tide due to strong cross-shore, landward-directed flows. We identified two transport regimes: (i) a flow-driven regime when flow velocities were high (>0.5 m/s) and the ratio of infragravity and current related shields numbers was below 0.11 and an episodic (infragravity -driven) regime when this ratio exceeded 0.11.

Mangrove Atlantis: Can mangroves keep up with extreme land-subsidence?

Celine van Bijsterveldt

B. van Wesenbeeck, R. Pribadi, M. Helmi, C. Böhm, T. Heuts, T. Bouma

A large portion of the worlds' population lives near the coast, deltas and estuaries. Big cities near the coast are increasingly under thread from processes as sea level rise and subsidence. The coastline of North Java, Indonesia, for instance is subsiding rapidly with rates up to 30 cm per year near big cities as Jakarta and Semarang. At the same time large scale coastal erosion occurs along these coasts due to failing conventional coastal protection and intensive land-use in the form of aquaculture. Governments now look into Building with Nature techniques such as brushwood sediment traps and mangroves stand restoration to restore the sediment balance and protect the coastline. Theoretically Building with Nature has the advantage of self-maintanance and could potential keep pace with sea-level rise. However, recent studies have shown subsidence rates as high as 20 cm per year near large cities as Jakarta and Semarang. We therefore wondered: Will mangroves be able to keep up with land subsidence?

We measured subsidence, sedimentation and erosion rates at 9 mangrove sites with increasing distance from Semarang city, on the coast of North Java, Indonesia. At each site, we investigated mangroves' response to subsidence, sedimentation and erosion through a combination of 'forensic forestry' on dead mangrove trees and monitoring of living trees. Here we present results if and how mangroves can potentially keep up with subsidence.

Oudegracht 3	**Sea-Level Rise: Local Aspects**
Day 2	14:30 – 14:45

Sea-Level Change Projections for the Dutch Wadden Sea During the 21st Century Wadden Sea During the 21st Century

Bert Vermeersen

A.B.A. Slangen, T. Gerkema & 23 co-authors

Sea-level rise is of specific interest for vulnerable ecological and morphodynamical regions, such as the Wadden Sea UNESCO world heritage site.

Commissioned by the Dutch Wadden Academy and Program Towards a Rich Wadden Sea, we present regional sea-level projections for the 21st century for the Wadden Sea region together with a review of the scientific data, understanding and uncertainties underpinning the projections. The sea-level projections are formulated in the framework of the geological history of the Wadden Sea region and are based on regional sea-level projections published in IPCC AR5. These IPCC AR5 projections are compared against updates derived from more recent literature and specifically evaluated for the Wadden Sea region. The projections are further put into perspective by including interannual variability based on long-term tide-gauge records from observing stations at Den Helder and Delfzijl.

We consider three climate scenarios, following the Representative Concentration Pathways (RCPs), as defined in IPCC AR5: the RCP2.6 scenario assumes that greenhouse gas (GHG) emissions decline after 2020; the RCP4.5 scenario assumes that GHG emissions peak at 2040 and decline thereafter; and the RCP8.5 scenario represents a continued rise of GHG emissions throughout the 21st century. For RCP8.5, we also evaluate several scenarios from recent literature where the mass loss in Antarctica accelerates at rates exceeding those presented in IPCC AR5.

For the Dutch Wadden Sea for the 2018-2100 period, projected total changes were found of 0.41±0.25 m for RCP2.6, 0.52±0.27 m for RCP4.5 and 0.76±0.36 m for RCP8.5.

Subsidence in the Dutch Wadden Sea

Peter Fokker

Freek J. van Leijen, Bogdan Orlic, Hans van der Marel, Ramon F. Hanssen

Ground surface dynamics is one of the processes influencing the future of the Wadden Sea area. Vertical land movement, both subsidence and heave, is a direct contributor to changes in the relative sea level. In the present paper, we highlight the processes that cause subsidence, with specific focus on the Wadden Sea area. The focus will be toward anthropogenic causes of subsidence, gas production and solution salt mining, and how to understand them. Understanding firstly requires models; these are available in different forms and on different scales. We highlight the most common analytical and numerical models used. Secondly, it requires data. Subsidence is defined as the change of height of the Earth's surface with respect to a vertical datum. In the Netherlands, the Normaal Amsterdams Peil (NAP) is the official height datum, but its realization via reference benchmarks is not time-dependent. Consequently, NAP benchmarks are not optimal for monitoring physical processes such as land subsidence. However, surface subsidence can be regarded as a differential signal: the vertical motion of one location relative to the vertical motion of another location. In this case, the actual geodetic height datum is superfluous. Thirdly, models and data need to be combined, which is achieved by inverse modelling or data assimilation. In this way the measurements can be used for better characterization and forecasting. With this background information we will discuss the actual operations performed in the Dutch Wadden Sea and list their expected impacts in terms of subsidence until 2030 and 2050.

Response of the Dutch Wadden Sea to future relative sea-level rise

Zheng Bing Wang

E.P.L. Elias, A.J.F. van der Spek, Q.J. Lodder

The Wadden Sea Region consists of an extensive combination of barrier islands, coastal waters with channels and subtidal flats, tidal flats and salt marshes, where many natural abiotic processes still occur almost undisturbed. These processes include sea level movements, seabed movements, sediment transport, deposition and erosion. However, an increasing number of processes are being brought about by humans: creation of polders and enclosure dams, climate change and in that context the expected accelerated rise in sea levels, subsidence, sediment nourishment and sand extraction. An important and current issue is whether and how the present Wadden Sea, with channels and subtidal flats, tidal flats and salt marshes, will be influenced in the next decades by the accelerated rise in sea levels caused by humans. The Wadden Academy and the Programme towards a Rich Wadden Sea have taken the initiative to produce a state-of-the-art report relating to the three processes referred to above: future rise in sea levels, subsidence, sedimentation and their interaction. This has resulted in a series position papers published in Netherlands Journal of Geosciences (Vermeersen et al., 2018; Fokker et al., 2018; Wang et al., 2018; Van de Spek, 2018). This contribution focuses on the future response of the Dutch Wadden Sea to sea-level rise and subsidence according to various scenarios. Special attention will be paid to the differences in the current morphological states of the various tidal inlet systems due to the human interferences in the past, and their consequences on the responses to relative sea level rise.

Oudegracht 3	**Sea-Level Rise: Local Aspects**
Day 2	15:15 – 15:30

Response of the Dutch Wadden Sea to future relative sea-level rise: : Part 1; Sediment budget over the past century

Ad van der Spek

Edwin Elias, Zheng Bing Wang, Quirijn Lodder

The fate of the intertidal flats and salt marshes in the Dutch Wadden Sea under accelerated sea-level rise is a major point of concern. In 2017, the Wadden Academy and the Programme towards a Rich Wadden Sea commissioned a state-of-the-art report on the major processes involved, viz. potential future rise in sea levels, subsidence and the sediment dynamics and budgets of the tidal basins, and the consequences of an increase in relative sea levels for the intertidal morphology. The results have been published in a special issue of the Netherlands Journal of Geosciences (97-3, September 2018), see the contributions of Vermeersen et al., Fokker et al. and Wang et al. to this conference.

This presentation focusses on the morphodynamics and sediment budget of the Dutch Wadden Sea over the last century. The latter shows erosion of the ebb-tidal deltas and barrier islands and sedimentation in the Wadden Sea on a large scale. This turns out to be mainly caused by the impacts of large-scale interventions such as the closures of the Zuiderzee and Lauwerszee in 1932 and 1969 respectively. Comparison of a series of bathymetric surveys shows that the net sedimentation rates in the tidal basins outpace the observed present-day rates of sea-level rise along the Dutch coast.

Virtual seismology: a new methodology for induced earthquake monitoring

Kees Wapenaar
Joeri Brackenhoff, Jan Thorbecke, Evert Slob

Recent developments ''beyond seismic interferometry" have enabled the creation of virtual sources and/or virtual receivers in the subsurface from reflection measurements at the earth's surface. Unlike in classical seismic interferometry, no physical instrument (receiver or source) is needed at the position of the virtual source or receiver. Moreover, no detailed knowledge of the subsurface parameters and structures is required: a smooth velocity model suffices. Yet, the responses to the virtual sources, observed by the virtual receivers, fully account for multiple scattering. The ability to retrieve the entire wave field between (virtual or real) sources and receivers anywhere in the subsurface, without needing a detailed subsurface model, has large potential for monitoring induced seismicity, characterizing the source properties (such as the moment tensor of extended sources along a fault plane), and forecasting the response to potential future induced earthquakes. This will be demonstrated with numerical models and preliminary real-data results.

Mapping seismicity in Groningen

Jesper Spetzler

Elmer Ruigrok, Bernard Dost

Induced earthquakes have been measured in Groningen since the first recorded event in Middelstum in 1991. A new dense station network has been in operation in the last 4 years enabling more data of induced earthquakes. The improved KNMI hypocenter method based on the equal-differential traveltime (EDT) and a 3D velocity model of the complex geological structure in Groningen has been used to relocate induced earthquakes recorded in the new dense network. To date, the 432 events between 2014 and 2018 have been relocated. The relocated hypocenters correlate well with the fault structures in Groningen and show a high degree of clustering. The depth range of the new hypocenters is comparable to the depth of the gas reservoir. The KNMI-EDT hypocenter program has been implemented in the operational software for hypocenter location of earthquakes in the Netherlands at the Royal Netherlands Meteorological Institute.

The Groningen reservoir monitored by deep borehole noise

Wen Zhou

Hanneke Paulssen, André Niemeijer

Zhou & Paulssen (2017) showed that ambient, anthropogenic noise recorded by a geophone array at the reservoir level of a deep borehole in the Groningen gas field allows accurate determination of its P and S velocity structure. Monitoring the temporal variations in the reservoir is not possible with ambient noise because the anthropogenic noise sources are not stable in time and space. With the isolated signals from nearby passing trains we were able to detect small travel time decreases of ~0.05 ms (0.1%) over half a year, associated with compaction of the reservoir. Moreover, we identified a strong travel time anomaly over a period of 1.5 months that is caused by drilling of a new borehole at ~5 km distance.

Coda-Wave based monitoring of pore-pressure depletion compaction on Slochteren Sandstone samples from the Groningen gas field, the Netherlands

Reuben Zotz-Wilson

Reuben Zotz-Wilson, Nikoletta Filippidou, Arjan Van Der Linden, Auke Barnhoorn

Pore-Pressure Depletion in sandstone reservoirs is well known to cause both elastic and inelastic compaction, which often results in noticeable surface subsidence and induced seismicity. There has been considerable effort to quantify the associated risk these subsurface processes represent, though there has been little focus on developing the monitoring tools necessary to inform on the stages of compaction with sufficient spatial coverage or timeliness. With this in mind, we employ three Coda-Wave based processing methods for the active source ultrasonic monitoring of pore-pressure depletion of core samples recovered taken the Slochteren sandstone reservoir in the Groningen gas field. Our results show that Coda-Wave Interferometry tracking relative velocity changes, Coda Wave Decorrelation tracking changes in material scattering properties, and Multi-Lapse Time Window Analysis tracking relative changes in material attenuation properties each provide valuable insight into the rock mechanical processes in play during depletion driven compaction.

The EPOS-NL research infrastructure

Martyn Drury

Richard Wessels, Chris Spiers, Ernst Willingshofer, Mirjam van Kan-Parker, Otto Lange, Kees Wapenaar, David Bruhn, Anke Dähnlmann, Reinoud Sleeman and Bernard Dost

EPOS-NL is the Netherlands National Research Infrastructure (NRIs) within the European Plate Observing System (EPOS). The European Plate Observing System is a long-term plan for the integration of research infrastructures for solid Earth Science in Europe with a principle focus on geophysical infrastructure. With its innovative e-science platform, EPOS will simplify and streamline access to multidisciplinary data, products and services for solid Earth sciences. EPOS is an ESFRI Research Infrastructure, currently in its final year of the Implementation Phase, funded under the H2020 Framework Programme. EPOS-NL will integrate all national geophysics facilities in the Netherlands into a coherent research infrastructure and develop new research facilities and state of the art open access data repositories. EPOS-NL facilities will include (1) system-scale natural laboratories such as the KNMI Groningen gas field seismic network and the DAPwell geothermal deep well and (2) integrated laboratories such as the Earth Simulation laboratory at UU and a new distributed facility for Multi-scale imaging and tomography of geo-materials based at UU and TUD. The new research infrastructure will be established in 2019–2020 and will support multi-scale, multi-physics research in geo-energy, geo-storage and geo-hazards.

Land-surface deformation resulting from Dutch, Belgium and German coal mines

Erik van Linden

Ronald van Balen, Geert-Jan Vis. TNO – Geological Survey of the Netherlands, Utrecht;
Kim Cohen, Utrecht University

The Dutch coal mines closed in the late 1960's and the last groundwater pump was shut down in 1994. It was initially assumed that land-surface deformation (locally subsidence due to coal mining reached 10 m) would cease in Southern Limburg after the closure of the mines. A large-scale investigation issued by the Dutch state in recent years shows that effects can still be detected, including regional land-surface uplift due to groundwater rise. This study builds upon the state-issued investigations and attempts to explain observations at the land-surface in the mining concessions. Observations based on fieldwork, LIDAR, PS InSAR, historical mine charts and topographic maps include linear thresholds and re-activation of faults and fault scarps. Most striking and not extensively reported previously, are large-scale depressions, which are 50–200 m wide and 1–2 m deep. The depressions can be mapped using LIDAR data and show a high density in the German coal-mining districts. In a westward direction their density decreases to very low in Flanders. This trend correlates with a westward increasing depth of the Carboniferous coal seams from tens of meters to more than 1000 m. The depressions are tentatively explained by macro pores or pathways which are hydrologically connecting the land-surface to collapsed stacks of mine galleries. The macro pores or pathways formed along weak zones caused by natural faults and mining-induced cracks in the overburden of the coal-mines. This facilitated the transport of fine-grained sediment to greater depth, causing a depression to form at the land-surface.

First outline of a disposal concept in Zechstein salt

Jeroen Bartol, Ewoud Verhoef

Radioactive substances and ionizing radiation are widely used and generated in medicine, industry, agriculture, research, education and electricity production but also generate radioactive waste. The current policy in the Netherlands is that radioactive waste is collected, treated and stored aboveground for at least 100 years by COVRA, the Central organization for radioactive waste. After the interim storage above ground, disposal radioactive waste is envisaged. There is a world-wide scientific and technical consensus that geological disposal represents a safe disposal option for radioactive waste. Geological disposal is the emplacement of radioactive waste in deep stable underground formations, such as poorly consolidated clay and rock salt formations in the Netherlands. Here we present the first outline of a disposal concept in domal rock salt of the Zechstein formation. In this disposal concept, research topics for a Geological Disposal Facility (GDF) in rock salt are identified that require future research. For rock salt, these include processes that can affect the barrier function of rock salt (diapirism, subrosion, changes in groundwater flow patterns, formation of subglacial channels during an ice age), the mechanical and thermal properties of the rock salt and the interaction between the engineered barrier and rock salt. To address these, Technopolis Group on behalf of COVRA is currently drafting a new research program. This research program will include both new and ongoing research that contributes to a better understanding of the evolution of a GDF in either rock salt or clay formations in the Netherlands.

Is Geothermal energy the solution for the energy transition? Fake or true!

Jan Fokkens

Henk van den Berg (VNG), Astrid Slegers (IPO), Ton Ravesloot, Jan Fokkens (VNO/NCW-MKB)

In the Dutch Climate agreement "klimaatakkoord" the reservation for geothermal energy and district heating has to be 50% of the energy supply of the built environment. The creation of such an amount of energy has an enormous impact on the environment and the subsurface infrastructure. In this presentation we try to figure out what are the implications. Not only technically and financially, but maybe the most important, politically and creation of a support base for the residents in the areas involved. This presentation is a cooperation between the regional government bodies IPO, VNG and the employers association VNO/NCW-MKB.

The first part of the presentation shows the political effects and strugglings of the city councils and regional councils. What is the impact for companies that set their goals on sustainable business? How to cope with issues like the difference between lack of information, knowledge and perception, the "google-effect", geothermal energy as a desired alternative for e.g. wind energy? In the second part of the presentation we would like to council the attendees as geological experts about the do's and don'ts of geothermal energy mining. We hope on some turmoil at the audience. What aspects can give comfort to companies and citizens?

Biosphere-atmosphere exchange of CO2 over the Amazon

Gerbrand Koren

Ingrid van der Laan-Luijkx, Stijn Naus, Narcisa Nechita-Banda, Maarten Krol, Wouter Peters

The tropical carbon balance dominates year-to-year variations in the global CO2 budget through photosynthesis, respiration, and fires. In this study we focus on the Amazon region, containing the largest tropical forest, for the years 2010–2016, which includes two major droughts that have hit this region and significantly affected carbon cycling. Starting from fire emission estimates from the Global Fire Emissions Database version 4 (GFED4) and the Global Fire Assimilation System (GFAS), we employ satellite-observed CO columns from the Infrared Atmospheric Sounding Interferometer (IASI) to optimise fire emissions in our TM5-4DVAR system. As a next step, we propagate the derived CO emissions over the Amazon to the prior CO2 fire emissions of the CarbonTracker South America data assimilation system. CarbonTracker assimilates CO2 surface observations and vertical CO2 profiles from air sampled with small aircraft over the Amazon forest to derive the net carbon exchange with the Amazonian biosphere and the atmosphere. This net exchange and its variability reveals the sensitivity of the Amazon to climate variability. A comparison to independent data (from terrestrial biosphere model SiBCASA, Solar Induced Fluorescence (SIF) and Near-Infrared Reflectance of terrestrial vegetation (NIRv) from satellites) will also be presented.

Domtoren 5	**The Atmosphere from Remote Sensing Perspective**
Day 2	14:45 – 15:00

The challenge of monitoring CO2 emissions from space

Sander Houweling

J. Landgraf, I. Aben, Han Dolman

International agreements to reduce CO2 emissions call for an independent mechanism for evaluating the compliance with emission reduction targets. Atmospheric measurements can provide the information needed to do this. However, to do this globally requires a drastic expansion of the existing monitoring network, using a combination of surface measurements and satellites. CO2 sensing satellites can deliver the required spatial coverage, filling in the gaps that are difficult to cover on ground. However, to reach the accuracy that is required for monitoring CO2 from space is a challenge, and even more so for anthropogenic CO2.

The European space agency is preparing for the launch of a constellation of satellites for monitoring anthropogenic CO2 within the Copernicus program, starting in 2025. Currently, scientific support studies are carried out to define this mission in terms of payload and observational requirements. We report on one of these studies investigating the impact of aerosols in CO2 plumes downwind of large cities, and the potential of an onboard aerosol sensor to help mitigate such errors. In this study, CO2 and aerosol plumes have been simulated at high-resolution for the cities of Berlin and Beijing. The impact of aerosol scattering on space borne CO2 measurements has been assessed, depending on the method that is used to obtain information on aerosols. The results have been used to quantify the accuracy at which the CO2 emissions of Berlin and Beijing can be quantified using inverse modelling.

In this presentation we summarize the outcome of this study, and discuss the implications for the design of the Copernicus CO2 monitoring constellation.

The role of TROPOMI aerosol layer height in quantifying aerosol absorption

Jiyunting Sun

Pepijn Veefkind, Peter van Velthoven, Pieternel Levelt

Aerosols is considered as one of the largest uncertainties in the radiative forcing assessment. The key parameter to quantify its uncertainty is the single scattering albedo (SSA). A daily SSA product with global coverage is desired, which results in our project to retrieve SSA from the near-ultraviolet aerosol index (UVAI). UVAI is a long-term satellite record describing absorption of the elevated aerosol layers. But to quantitatively use UVAI, the aerosol layer height (ALH) is necessary. The lack of ALH data is the key issue in our project. Fortunately, the S5-P/TROPOMI assures a daily and global ALH global access with its wide spatial coverage and high spatial resolution. Our purpose of this study is to illustrate how the upcoming S5-P/TROPOMI ALH product improves the quantitative interpretation of aerosol absorption. We first show the improvement of SSA retrieval with the ALH measurements constraint in the forward radiative transfer simulations. In the second part, we propose a new SSA retrieval algorithm based on statistics among UVAI, ALH and the aerosol optical depth (AOD). Either in the conventional or the new empirical method, ALH plays an important role in retrieving SSA. The upcoming TROPOMI ALH product will contribute greatly to improve the quantitative interpretation of aerosol absorption.

Tropomi methane and carbon monoxide total column measurements at unprecedented temporal and spatial resolution: validation results and applications

Jochen Landgraf
Tobias Borsdorff, Alba Lorente, Joost aan de Brugh, Andreas Schneider, Otto Hasekamp

The TROPOspheric Monitoring Instrument (TROPOMI) aboard of the Sentinel 5 Precursor (S5P) satellite is the first of the ESA's Sentinel missions to monitor air quality and climate change as part of the Copernicus programme. Since November 2017, TROPOMI provides unique global measurements of atmospheric composition at an unprecedented spatial resolution of 7x7 km^2 with daily global coverage. Among the observed species is methane (CH4), the second most important greenhouse gas, and the air pollutant carbon monoxide (CO). For both products, SRON Netherlands Institute for Space Research developed the operational algorithms for data processing. In this work, we present results on the two product from the first year of TROPOMI measurements. Both the CO and CH4 are validated with collocated ground-based measurements at different TCCON sites and shows a very good agreement with the ground-based measurements. Because of the high signal-to-noise ratio of individual measurements, CO pollution hot-spots can be detected from measurements of single orbit overpasses, which opens up new opportunities for emission monitoring of pollution point sources on daily scales. For a set of cases, we demonstrate this application in more detail discussing CO emission estimates from wild fires and industrial activities using TROPOMI observations. Moreover, for CH4 we show first case studies where we analyse the temporal and spatial variability of methane over several regions on the US.

Posters

Poster number, author, affiliation, title

[1] Carrie Thomas, University of Zurich: Soil legacies: using lipid biomarkers to verify illicit whisky distilling sites on the island of Arran, Scotland

[2] Sander Hilgen, Naturalis: Trinil revisited: new data on stratigraphy, age and fossil assemblage from the classical Homo erectus site on Java

[3] Massouda Ben Said, Faculté des sciences de Tunis: Valorization of heritage for tourism purposes Case Study: The Medina of Tunis

[4] Siham de Goeyse, NIOZ: Calcification in foraminifera involves carbonic anhydrase

[5] Dirk Jong, Vrije Universiteit: Composition and fate of permafrost organic matter in the Arctic nearshore zone of Yukon, Canada

[6] Erik van Schaik, Wageningen University: Continental scale droughts increase water-use efficiency of vegetation

[7] Kirsi Keskitalo, Vrije Universiteit, Amsterdam: Degradation of particulate organic carbon in the Kolyma River

[8] Liz Veerman, University of Amsterdam: Drivers of the long-term fate of deposited nitrogen in temperate forest soils

[9] Lennart de Nooijer, Royal NIOZ: Foraminiferal calcification and CO2

[10] Martin Schobben, Utrecht University: Formation of iron-minerals in Late Holocene peat of coastal West-Brabant (Netherlands): Implications for wetland maintenance under a changing climate

[11] Lauriane Vilmin, Universiteit Utrecht: Release of dissolved inorganic phosphorus from lake and reservoir bottom sediments hinders positive effect of eutrophication remediation measures in the Mississippi River basin

[12] Matthias Kuderer, Universiteit Utrecht: Stochastic Lagrangian particle tracking model of bioturbation

[13] João Trabucho Alexandre, Universiteit Utrecht: My smartphone is now my teaching assistant -- problem-based learning in the field

[14] Erik Cammeraat, University of Amsterdam: Teaching soils using a Virtual Globe approach

[15] Pieternel Levelt, KNMI and TU Delft: Air quality from space: indicator of human activity.

[16] Stijn Naus, Wageningen University & Research: Improving constraints on the Atmospherix Oxidative Capacity

[17] Jantiene Baartman, Wageningen University: Isotopic Measurements: A New Tool for Studying Global Carbonyl Sulfide

[18] Sylvia Walter, Utrecht University: MEMO2: MEthane goes MObile -- MEasurements and Modelling

[19] Pepijn Veefkind, KNMI / TU-Delft: Monitoring the Atmospheric Composition from Space using TROPOMI

[20] Gijs van den Oord, Netherlands eScience Center: Regional superparametrization of the ECMWF weather model by 3D LES

[21] Henk Eskes, KNMI: Sentinel-5P TROPOMI high-resolution nitrogen dioxide air pollution observations

[22] Naomi Smith, ICOS Carbon Portal, Wageningen University and Research: The impact of the 2018 summer drought on Europe's terrestrial biospheric carbon exchange from combined remote sensing, crop and forest modeling, and atmospheric inversions

[23] Malika Menoud, Utrecht University: Using continuous high-precision isotope measurements over several months to characterise sources of atmospheric methane at various European locations

[24] Nathalie Van der Putten, Vrije Universiteit Amsterdam: A bipolar climate response to a major solar minimum during the Holocene

[25] Anne van der Meer, Utrecht University: Carbonate clumped isotope thermometry - application in Plio-Pleistocene seawater temperature reconstructions and a study into the potential effects of organic contamination and sample cleaning techniques on clumped isotope results

[26] Niels Meijer, University Potsdam: Central Asian aridification at ~40 Ma revealed by an Eocene dust record, Xining Basin, NE Tibet

[27] Magali Bouquet, Utrecht University: Characterizing climate and Mississippi River input into the Gulf of Mexico during two Pliocene glacials

[28] Joost Frieling, Utrecht University: Core-top calibration and first application of the dinoflagellate cyst based pCO2 barometer

[29] Martin Ziegler, Utrecht University: Extreme summer warming of the East Asian interior during the Paleocene Eocene thermal maximum

[30] Fabian Ercan, Utrecht University: Microphenological response in B. nana to GDD5

[31] Geert-Jan Brummer, NIOZ & VU: Modal shift in North Atlantic seasonality during the last deglaciation

[32] Tian Schuurmans, Utrecht University: On the origin of Milankovitch cycles in the Kuruman Banded Iron Formation, South Africa: bulk carbonate δ13C, major and trace elements

[33] Inigo Müller, Utrecht University: Once upon a time in Maastricht -- clumped isotope climate reconstructions from marine macrofaunal assemblages of the type area of the Maastrichtian Stage

[34] Yord IJedema, Utrecht University: Paleoenvironmental variations inferred from a high resolution pollen record of MIS 9-10 at ancient Lake Ohrid, Macedonia.

[35] Suning Hou, Utrecht University: Reconstructing a Holocene temperature record for the Godavari River Basin, India, using branched tetraether lipids

[36] Joost van Dijk, Utrecht University: Reconstructing climate sensitivity during Middle Miocene

[37] Niels de Winter, Vrije Universiteit Brussel: Reconstructing paleoseasonality in the Late Cretaceous greenhouse world: A multi-proxy approach

[38] Chris Fokkema, Universiteit Utrecht: Reconstruction of North Atlantic surface water temperatures during the Middle Eocene Climatic Optimum

[39] Laurens Vennema, Utrecht University: Tropical climate and ecosystem variability across Eocene Thermal Maximum 2

[40] Thomas Giesecke, Utrecht University: Using postglacial vegetation history to inform on the impact of recent climate change on vegetation

[41] Bert Wouters, TU Delft/Utrecht University: Present and future ice mass loss of the North-Atlantic glaciers estimated from satellite observations

[42] Heiko Goelzer, Utrecht University: Remapping of Greenland ice sheet surface mass balance anomalies for large ensemble sea-level change projections

[43] Aleksandra Galic, Utrecht University: Assessing methane emissions from coal mine activities in Limburg, The Netherlands

[44] Yang Wang, Delft University of Technology: Benchmark of DARTS framework for geothermal applications

[45] Bart Meijninger, TNO Geological Survey of the Netherlands: Geology of the Borssele offshore wind farm zone

[46] Priyanka Agrawal, Utrecht University: Impact of dissolved inorganic carbon concentrations over dissolution patterns in carbonate rocks

[47] Suzanne Hangx, Utrecht University: Impact of geochemical interactions between hydraulic fracturing fluid and Whitby Mudstone on mineralogy and fracture permeability

[48] Alexandros Daniilidis, TU Delft: Lifetime and economic output of a faulted geothermal reservoir under different well placement, hydraulic properties and production scenarios.

[49] Emilie Chaillan, TNO: Numerical modelling for the design of a combined pumping and infiltration test to determine the hydraulic resistance of an aquitard in Zeeland

[50] Maartje Houben, Utrecht University: Permeability of intact and fractured Whitby Mudstone (UK): effect of bedding, fluid and roughness

[51] Baptiste Lepillier, Delft University of Technology: Predictive Mechanical model for fracture stimulation in an enhanced geothermal system (EGS) context

[52] Nicolai Nijholt, TU Delft: Do subduction earthquakes influence slip rates on nearby major faults? The Sulawesi case.

[53] Shahar Shani-Kadmiel, Delft University of Technology: Seismoacoustic Coupled Signals From Earthquakes in Central Italy: Epicentral and Secondary Sources of Infrasound

[54] Manfred Lafosse, Utrecht University: Reappraisal of the Mid-Jurassic Central North Sea doming based on a compilation of the regional stratigraphy and denuation history.

[55] Jeroen Smit, Utrecht University: Bottom up, the North Sea Central Graben in light of crustal structure and tectonic history

[56] Wouter Schellart, Vrije Universiteit Amsterdam: Control of subduction zone age and size on flat slab subduction

[57] Rens Elbertsen, Utrecht University: Early Explorations in Benchmarking Thermal Convection in a Two-Dimensional Spherical Annulus

[58] Kai Xue, Vrije Universiteit Amsterdam: Geodynamic models of East Asian deformation

[59] Antoine Auzemery, Utrecht university: Intra-oceanic subduction Initiation: Insight from analogue modelling

[60] Anouk Beniest, Vrije Universiteit Amsterdam: Numerical models on the subduction initiation at the eastern Scotia Plate boundary

[61] Arijit Laik, Vrije Universiteit Amsterdam: Role of whole mantle flow in driving Continental Collision and Subduction: Preliminary insights from 2D Numerical Models.

[62] Kristof Porkolab, Utrecht University: Thrusting and extensional exhumation in an Accretionary Wedge: The Paleogene evolution of the Northern Sporades (Greece)

[63] Olivier den Ouden, KNMI: Project PIM: a low-cost mobile seismo-acoustic sensor for geophysical deployments

[64] Bas van der Meulen, Utrecht University: Early historic topography of the Lower Rhine valley and upper delta

[65] Jasper Candel, Wageningen University & Research: Empirical river pattern predictors -- why do they work?

[66] Remi Charton, TUDelft: Evolution of Mesozoic source-to-sink systems as constrained by landscape evolution modelling and time-temperature modelling: pilot study in the Anti-Atlas of Morocco.

[67] Ayunda Aulia Valencia, Delft University of Technology: How the consolidation process impact channel flow dynamics?

[68] Harm Jan Pierik, Utrecht University: How tides and rivers shape levees and crevasses

[69] Hessel Woolderink, Vrije Universiteit: Tectonic forcing of the palaeogeographic evolution of the Roer river

[70] Bas Knaake, Universiteit Utrecht: The relation between scour holes and subsurface architecture in the Rhine-Meuse delta, the Netherlands.

[71] Xiaolong Hu, Chengdu University of Technology: Characterization of the Earliest Triassic Dolomite that Formed Shortly After the Latest Permian Mass Extinction Event in Lower Yangtze Block, Southern China

[72] Alix Seegers, VU University: Determination of Iron, Copper and Zinc concentrations and isotopic compositions of metal-silicate partitioning experiments

[73] Paul Mason, Utrecht University: Fluctuations in atmopsheric sulfur isotope signals immediately prior to the Paleoproterozoic Great Oxygenation Event

[74] Casimir Nooitgedacht, Vrije Universiteit Amsterdam: Fluid inclusions in calcite veins reveal ancient fluids circulating the former Ionian Basin

[75] Katharina Boehm, Vrije Universiteit Amsterdam: Mid Miocene Volcanism on Chios - Evidence for slab tear in the Aegean

[76] Sergio Ruiz Hernandez, Universiteit Utrecht: Molecular Dynamics simulations of non-stoichiometric ACC clusters: Influence of charge on the structure and stability of ACC

[77] Shaun Akse, Universiteit Utrecht: Post-mortem diagenesis of diatom frustules in the water column.

[78] Rick Hennekam, NIOZ: Quantitative geochemical analysis of sediments for environmental studies using X-Ray Fluorescence core scanning

[79] Janou Koskamp, Universiteit Utrecht: Reconsidering calcium dehydration as the rate-determining step in calcite growth

[80] Pieter Vroon, VU: The evolution of the Quill volcano (St Eustatius, Dutch Caribbean).

[81] Jeroen Goumans, Utrecht University: The metamorphic evolution of the Sara's Lust Gneiss in the Guiana Shield, Suriname

[82] Islam Fadel, University of Twente: Artificial recharge impact study in a coastal aquifer: An approach using numerical modeling

[83] Jerom Aerts, Delft University of Technology: eWaterCycle II: an online environment for explorative computational Hydrology

[84] Martijn Westhoff, Vrije Universiteit Amsterdam: Maximum Power as Threshold between Matrix Flow and Boil Formation

[85] Jamila Hammami Abidi, Faculty of sciences of Tunis: Modeling and multicriteria quality evaluation of Groundwater in a coastal basin, Tunisia: an insight of drinking and irrigation water suitability

[86] Artemis Roodari, TUDelft: Modelling daily discharge in Upper Helmand Basin of Afghanistan and understand impact of change on downstream water supply in the Sistan region in Iran with a distributed, process-based hydrological model.

[87] Willem-Jan Dirkx, Utrecht University: Piping in practice: Linking subsurface variability to backward erosion experiments

[88] Teun van Woerkom, Utrecht University: Towards the incorporation of 3D subsurface heterogeneity in hydrological models for assessing dike stability

[89] Anna von der Heydt, Utrecht University: Cascading transitions in the Climate System

[90] Tjebbe Hepkema, Institute for Marine and Atmospheric research Utrecht (IMAU), Utrecht University: Nonlinear dynamics of tidal bars, a bifurcation analysis

[91] Jantiene Baartman, Wageningen University: On the complexity of model complexity: how geoscientists see it...

[92] Mikael Kaandorp, Utrecht University: Inverse modelling of microplastics sources and sinks in the Mediterranean by combining observational data and high-resolution simulations

[93] André Jüling, IMAU: Ocean heat content variability in strongly-eddying global climate models

[94] Furu Mienis, NIOZ Royal Netherlands Institute for Sea Research: The unknown role of Whittard Canyon: Pathway or sink for organic carbon?

[95] Inge Loes ten Kate, Utrecht University: A flow chart from extraterrestrial organics to origin of life

[96] Kateryna Frantseva, Kapteyn Astronomical Institute (University of Groningen): Enrichment of planetary surfaces by asteroid and comet impacts

[97] Oscar Kamps, University of Twente: Global geological remote sensing of Mars

[98] Claudia-Corina Giese, Utrecht university + Leiden university: Polycyclic aromatic hydrocarbons - from interstellar medium to asteroids and meteorites

[99] Nina Kopacz, Utrecht University: The catalytic properties of early-Earth minerals and their effects on polycyclic aromatic hydrocarbons

[100] Carlijn Snoek, University of Amsterdam: The influence of hypergravity on particle interactions and runout of granular avalanches

[101] Inge Loes ten Kate, Utrecht University: The Origins Center

[102] Annemijn van Stiphout, Utrecht University: A study of the topography of the mantle seismic discontinuities beneath the Alaskan subduction zone using receiver functions

[103] Haydar Karaoglu, Utrecht University: Azimuthal Anisotropy Structure Beneath North America

[104] Sujania Talavera-Soza, Utrecht University: Constraining inner core structure using new measurements of radial modes

[105] Islam Fadel, University of Twente: Crustal and Upper Mantle Structure of Botswana: Extending the East African Rift System to Central Botswana

[106] Elmer Ruigrok, KNMI: Crustal velocities in Groningen from resonating waves

[107] Deyan Draganov, Delft University of Technology: DeepImage: Layer-Specific Monitoring of Velocities and Q-factors using Seismic Interferometry

[108] Ashim Rijal, Utrecht University: Inferring equations of state of the lower mantle minerals using Artificial Neural Networks (AANs)

[109] Loes Rutten, Universiteit Utrecht: Influence of elastic effects on lower mantle shear attenuation measurements

[110] Henry Brett, Utrecht University: Inner Core Anisotropy Measured using new Ultra-Polar P-Waves and Raypath Analysis

[111] Laura Cobden, Universiteit Utrecht: Investigating the visibility of mantle plumes with seismic array methods

[112] Anne Pluymakers, TU Delft: Ion-species in pore fluids with opposite effects on limestone fracturing

[113] Dagmar Bouwman, Utrecht University: Locating aftershocks of the 2017 Moiyabana, Botswana earthquake

[114] Reinoud Sleeman, KNMI/ORFEUS: Monitoring of volcanoes The Quill and Mt. Scenery in the Caribbean Netherlands by cross correlating seismic ambient noise.

[115] Richard Bakker, TU Delft: Radial jet drilling: micromechanical investigation based on laboratory and numerical work.

[116] Kees Weemstra, Delft University of Technology: Systematic detection and correction of instrumental time shifts using crosscorrelations of ambient seismic noise

[117] Mathijs Koymans,Koninklijk Nederlands Meteorologisch Instituut: The role of KNMI in the European seismological waveform infrastructure -- enabling international collaborations through ORFEUS and EPOS

[118] Lisanne Jagt, Universiteit Utrecht: Towards a 3D mantle model using full spectrum tomography

[119] Auke Barnhoorn, Delft University of Technology: Ultrasonic attenuation analysis to forecast the transition from elasticity to inelasticity in deforming materials

[120] Jeroen Van Stappen, HPT Lab, Utrecht University: Understanding strain-accommodating processes in depleted sandstone gas reservoirs through in-situ triaxial testing and X-ray CT imaging

[121] Janneke van Ginkel, University of Groningen / KNMI: Unveiling Local Shallow Shear Wave Velocities by using Ambient Noise in Groningen

[122] Melanie During, Vrije Universiteit Amsterdam: A Spring Apocalypse at the K-Pg Boundary

[123] Guido van der Molen, Utrecht University: Agulhas Current sea surface temperatures for the past 4 million years based on clumped isotope thermometry (IODP Site U1474)

[124] Maarten Heijnen, National Oceanography Centre Southampton: How is sediment transported through submarine channels and onto the lobe? New insights from integrated monitoring of an active channel

[125] Hans van Hateren, Vrije Universiteit Amsterdam: Identifying transport mechanisms and sediment provenance from grain size-shape distributions

[126] Sverre van Ginneken, University Utrecht: Long eccentricity driven 4th order sea-level cycles in the Fort Union Formation, North Dakota (USA).

[127] Youwei Wang, Delft University of Technology: Numerical modeling of precession-driven deposition and erosion in alluvial settings: Analogue to the lower Eocene Willwood Formation of the Bighorn Basin, Wyoming, USA

[128] Jakob Wallinga, Wageningen University: Poor bleaching of OSL signals; a novel tool to reconstruct sediment pathways

[129] Timothy Baars, TU Delft: Populating 3D digital outcrop models for improved predictions on fluvial systems

[130] Maria Karssenberg, Utrecht University & Deltares: The geology of coastal aquifers worldwide as input for a global coastal groundwater flow model

[131] Bas van de Schootbrugge, Utrecht University: Unraveling carbon isotope signals from glendonites using NanoSIMS

[132] Erik Cammeraat, University of Amsterdam: Lithology and climate controlled soil aggregation and organic carbon stability in the Peruvian Andes

[133] Boris Jansen, University of Amsterdam: Tracing the origin of the remarkably stable organic Carbon in plaggic Anthrosols

[134] Erik Cammeraat, University of Amsterdam: Upscaling sediment yields by measuring surface lowering using UAV flight data

[135] Mathilde Hagens, Wageningen University & Research: Wageningen Soil Conference 2019: Understanding soil functions: from ped to planet

[136] David Fernández-Blanco, Institut de Physique du Globe de Paris: Crustal flexure in the new rift-forming fault of Corinth

[137] Kalijn Peters, Utrecht University: Implications of long-lived metamorphism in metamorphic soles for subduction initiation

[138] Mario D'Acquisto, Utrecht University: Modelling tectonics and seismicity due to slab retreat in the northern Apennines

[139] Alaeddine Ayari, Faculty of science of tunis: Study of Geometric deformations in Bir Mcherga region (Northern Tunisia).

[140] Nalan Lom, Utrecht University: The Protogonos: A Palaeozoic magmatic arc along the northern margin of Gondwana-Land and its disruption during the formation of Pangaea

[141] Bram Vaes, Utrecht University: Towards higher-resolution Apparent Polar Wander Paths for plate tectonic studies: a bootstrap approach

[142] Gert-Jan Marseille, KNMI: Aeolus -- the first Doppler wind lidar in space

[143] Kanayim Teshebaeva, VU Amsterdam: Seasonal permafrost changes from Sentinel-1 data

[144] Paul Vermunt, TU Delft: Understanding seasonal and diurnal vegetation water content dynamics in corn through intensive field measurements

[145] Jaco de Smit, NIOZ: Using field flumes to quantify biogeormophological thresholds in situ

[146] Evi Wubben, Utrecht University: A palynological study of the upper ocean conditions during the Miocene Climatic Optimum in the Ross Sea (Antarctica): results from the IODP Expedition 374 Site U1521 record

[147] Irene Waajen, Utrecht University: A thorough preservation screening of fossil corals for more accurate climate reconstructions of the Early Eocene Otway basin, Australia.

[148] Piet Hoekstra, Faculty of Geosciences, Utrecht University: Late Eocene - Miocene paleoceanographic conditions offshore Ross Sea, Antarctica: palynological and TEX86 results from DSDP Site 274

[149] Margot Cramwinckel, Utrecht University: Warm, fresh and highly dynamic conditions in the middle Eocene Labrador Sea

[150] Michiel Baatsen, Utrecht University: Reconciling Eocene Ice with Antarctic Warmth, Implications for the EOT

Organisation

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Kathelijne Wijnberg, UT
Martin Ziegler, UU

Advisory Council

The Advisory Council consists of Maarten Krol, Luc Lourens (members of the NWO advisory table for Earth Sciences) and Fraukje Brouwer. The Advisory Council is responsible for the composition of the Programme Committee.

Conference Organisers

The team from NWO tasked with the organisation of NAC 2019 consists of Bernard Westerop, Sebastiaan de Vet, René Prop, Debby Liauw