UP 4: Climate; jointly with Arbeitsgruppe Junge DPG (AGjDPG)

Time: Wednesday 14:00–16:30 Location: HSZ 201

Invited Talk UP 4.1 Wed 14:00 HSZ 201

The role of clouds in climate forcing and feedbacks — •Johannes Quaas — Max Planck Institute for Meteorology, Hamburg

Global climate change is forced by anthropogenic activities, and dampened and/or amplified by feedbacks within the climate system. Second to the greenhouse gases, anthropogenic aerosols are a main forcing agent, and an important pathway of this forcing is the "indirect" one, via the capability of aerosols to serve as cloud condensation nuclei. This aerosol indirect forcing, in which clouds are involved, is the most uncertain one among the most important climate forcings. The presentation demonstrates how satellite observations can be used to reduce this uncertainty. In the purely physical climate system (as opposed to the Earth system where biogeochemical feedbacks also play a role), five feedback mechanisms are known, which are the fundamental dampening "Planck feedback", the dampening "lapse rate" feedback, and the amplifying feedbacks due to water vapour, snow/ice albedo, and clouds. The presentation will explain these feedbacks, demonstrate how these can be quantified, and show how their uncertainty - especially due to the cloud feedback - leads to substantial uncertainties in projected future climate change. Approaches to improve the climate change projects are discussed.

Invited Talk UP 4.2 Wed 14:30 HSZ 201

Measuring cloud droplets: one step towards a better understanding of clouds — •Johanna Katharina Spiegel[1], Thomas Peter[2], Nina Buchmann[1], and Werner Eugster[1] — [1]Institute for Agricultural Sciences, ETH Zurich, Zurich, Switzerland — [2]Institute for Atmospheric and Climate Science, ETH Zurich, Zurich, Switzerland

The bulk properties of clouds and therefore their behaviour in the global climate system are determined by microphysical properties. For example, optical properties of warm and mixed-phase clouds strongly depend on droplet size and number distribution. For the validation of climate models as well as to generally improve the understanding of the physical properties of clouds, measurements of cloud droplet size and number in combination with meteorological variables and aerosol properties are important. In this study we present preliminary results from several cloud and fog characterization campaigns, where droplets were measured using a forward scattering spectrometer probe (DMT Fog Monitor FM-100, Droplet Measurement Technologies, Boulder, CO, USA). We highlight the challenges of our measurement technique, focusing on the uncertainty associated with the determination of droplet sizes and hence liquid water content of clouds and fog, and will make an attempt to link cloud properties to other measured variables such as aerosol properties.

Break (15 min)

UP 4.3 Wed 15:15 HSZ 201

Initiation of a Marinoan Snowball Earth in a state-of-the-art atmosphere-ocean general circulation model — •Aiko Voigt[1,2], Dorian S. Abbot[3], Raymond T. Pierrehumbert[3], and Jochem Marotzke[1] — [1]Max Planck Institute for Meteorology, Hamburg, Germany — [2]International Max Planck Research School on Earth System Modelling, Hamburg, Germany — [3]Department of Geophysical Sciences, University of Chicago, Chicago, Illinois, USA

The apparent existence of low-latitude land glaciers at sea level during the Marinoan (∼635 Ma) has led to the proposal that these glaciations were accompanied by completely ice-covered oceans. These states have become popular under the term "Snowball Earth." In this contribution, we study the initiation of a Marinoan Snowball Earth with the most sophisticated model ever used for this purpose, the atmosphere-ocean general circulation model ECHAM5/MPI-OM. In particular, we focus on the total solar irradiance and atmospheric concentration of carbon dioxide needed to trigger a Marinoan Snowball Earth. We find that Snowball initiation in this model is much easier than found in various previous modelling studies. A zero-dimensional energy balance model is used to predict the Snowball Earth bifurcation point from only the equilibrium global mean ocean potential temperature for present-day TSI. We do not find stable states with sea-ice cover above 55%, and land conditions are such that glaciers could not grow with sea-ice cover of 55%. Therefore, none of our simulations qualifies as a "slushball" solution, with the caveat that mountains are not included in our study.

UP 4.4 Wed 15:30 HSZ 201

Das warme Klima des Mittleren Miozäns — •Mario Krapp[1,2] und Johann Jungclaus[1] — [1]Max-Planck-Institut für Meteorologie, Hamburg, Deutschland — [2]IMPRS on Earth System Modelling, Hamburg, Deutschland

Untersuchungen mariner Sedimentkerne zeigen, dass der Ozean während des Mittleren Miozäns (vor 15 Millionen Jahren) um bis zu 3-6 Grad wärmer gewesen ist als heute, was auch pflanzliche Fossilreste bestätigen. Boreale Wälder erstreckten sich jenseits des Polarkreises. Der atmosphärische CO_2-Gehalt war im Gegensatz zu früheren Warmzeiten geringer, CO_2-Rekonstruktionen ergeben Werte von 190 bis 300 ppm, einige auch bis zu 700 ppm.

Anhand eines voll gekoppelten Zirkulationsmodells für die Atmosphäre und den Ozean zeigen wir, dass sich das warme Klima unter Bedingungen des Mittleren Miozäns nur durch erhöhte CO_2-Konzentrationen einstellen kann. Das steht der Annahme entgegen, dass die Ozeanzirkulation aufgrund tektonischer Veränderungen einen verstärkten polwärtigen Wärmetransport bewirkt. Stattdessen zeigen wir, dass der Treibhauseffekt ein wichtiger Faktor für die warme Periode des Mittleren Miozäns ist.

UP 4.5 Wed 15:45 HSZ 201

Ocean, ice and climate in high latitudes: Example Laptev Sea — •Florian Greil — Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

Interactions between land surfaces, ocean, ice and atmosphere determine the Earth's climate. The variability of the planet's radiation balance is largely determined by the snow and ice-coverage in the high latitudes.

Since the beginning of remotely sensed sea ice observations in 1979, the sea ice extent of the Northern hemisphere retreats on average with 4.7±1.1% per decade. The sea areas over the Arctic continental shelves harbour key oceanic and atmospheric processes and are therefore monitored by long-term observations.

The Laptev Sea is a key region for sea ice formation, advection and export. During winter, wind-ice dynamics repeatedly produce open water areas (polynyas) with extensive heat fluxes, sea ice formation and water mass modification. In summer, the oceanic processes are strongly influenced by the enormous freshwater discharge of Siberian rivers.

The talk will include an introduction to observational oceanography, illustrated by the experiences of a four week expedition on the hydrographic survey vessel Nikolai Jevgenov, but also preliminary results.

Invited Talk UP 4.6 Wed 16:00 HSZ 201

Subglacial lakes in Antarctica: Origin, Fate and Relevance — •Malte Thoma[1], Sebastian Göller[2], Klaus Grosfeld[2], and Christoph Mayer[1] — [1]Bavarian Academy of Sciences, Commission for Glaciology, München, Germany — [2]Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

One of the most remote and undiscovered regions on Earth are subglacial lakes in Antarctica. More than 300 of these lakes have been identified so far. The probably largest of these lakes is Lake Vostok, which is about 250 km long, 50 km wide, and up to 1 km deep, covering an area of 16000 km^2 (30x Lake Constance) and a volume of 5000 km^3 (100x Lake Constance). According to the pressure-dependent freezing point of water and the semi-empirical Equation of State, the water circulates within these lakes. This flow is geo-thermally and buoyancy (by melt and freeze processes) driven. We present an overview of mapped and modelled lakes within Antarctica, their impact on the ice flow/motion, hypothesis about a hydrological network, as well as their contribution to the total Antarctic fresh water budget.