UP 13: Klimamodellierung

Time: Thursday 12:00–15:00 Location: MAG 100

Invited Talk UP 13.1 Thu 12:00 MAG 100

The 5th IPCC report: climate change and the drivers — •Monika Rhein — IUP, Universität Bremen, Germany

The talk summarizes the results of the 5th IPCC report, WG1 (the physical basis). After presenting the main changes in the climate system in the last 100 years, the drivers of that climate change are identified. The projected changes in the climate system till 2100 are discussed as well as the related scenarios.

Mittagspause, 60 min

Invited Talk UP 13.2 Thu 13:30 MAG 100

Wechselwirkung zwischen arktischem Meereis und der atmosphärischen Zirkulation — •Klaus Dethloff, Dörthe Handorf, Ralf Jaiser und Annette Rinke — Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung, AWI Forschungsstelle Potsdam

Die beobachtete arktische Meereisabnahme fördert durch barokline Instabilität die Entstehung von synoptischen Wettersystemen über dem arktischen Ozean. Diese barokline Verstärkung im Sommer beeinflusst die planetaren Wellen und die grosskalige Zirkulation der Tropo- und Stratosphäre im Winter.

Die mit der globalen Erwärmung einhergehende Meereisabnahme verursacht dabei ein Klimaparadoxon, weil sie negative Phasen der Arktischen Oszillation mit stärker ausgeprägten meridionalen Strömungsmustern anfachen kann. Dadurch treten stabile Hochdruckgebiete und Blockierungslagen über Nordeuropa und Eurasien häufiger auf.

Die Dynamik der atmosphärischen Telekonnektionsmuster wird neben externen Antriebsfaktoren auch durch nichtlineare Wechselwirkungen zwischen planetaren Wellen und synoptischen Zyklonen mit subgridskaligen Prozessen bestimmt.

Klimamodellsimulationen könnnen die beobachteten atmosphärischen Reaktionen auf niedrige und hohe Meereiskonzentrationen nur teilweise reproduzieren, weil das komplexe Zusammenwirken von externen Antriebsmechanismen mit intern erzeugten atmosphärischen Musteränderungen bisher nicht verstanden ist.

UP 13.3 Thu 14:00 MAG 100

A Scale Invariance Criterion for LES Parametrizations — •Urs Schaefer-Rolffs — Institut für Atmosphärenphysik Kühlungsborn

The role of scale invariance (SI) is mandatory to explain a turbulent kinetic energy cascade in different fluid dynamical systems, including rotating and stratified flows. However, the representation of subgrid-scales in large eddy simulations do not necessarily fulfill this constraint. So far, SI has been considered in the context of isotropic, incompressible, and three-dimensional turbulence. In this presentation, the theory is extended to compressible flows that obey the hydrostatic approximation, as well as to corresponding subgrid-scale parametrizations. A criterion is presented to check if the symmetries of the governing equations are correctly translated into the equations used in numerical models. By applying scaling transformations to the model equations, relations between the scaling factors involved are obtained by demanding that the mathematical structure of the equations does not change.

The method is validated by the breakdown of SI occurring in the conventional Smagorinsky model, but not in the Dynamic Smagorinsky Model. Further, the criterion proves that the compressible continuity equation is intrinsically scale invariant, while for the hydrostatic approximation horizontal and vertical scales exhibit different scaling behaviour. The criterion also shows that a simplified kinetic energy equation can be scale invariant. Finally, in models of turbulent transport of a tracer, a constant mixing length must be avoided to allow for SI.

UP 13.4 Thu 14:15 MAG 100

The role of different modes of ice initiation for rain formation — •Thibault Hiron[1,2], Andrea Flossmann[1], and Marie Monier[1] — [1]LaMP, Université Blaise Pascal/CNRS, Clermont-Ferrand, France — [2]IMK-AAF, Karlsruhe Institut für Technologie, Karlsruhe, Germany

In mid-latitudes most clouds develop rain while passing through the ice phase.

In order to initiate the ice phase at temperatures above -35°C, particular aerosol particles are necessary, called IN (ice nuclei). Only little is known regarding the required properties of an aerosol particle to act as IN at a certain temperature region. Furthermore, it is uncertain whether they will act through condensation freezing, immersion freezing or contact freezing.

The detailed bin-resolved microphysics model DESCAM has been used to study the role of the different modes of ice initiation on rain formation using data from the literature, coupled with the sensitivity tests.

Invited Talk UP 13.5 Thu 14:30 MAG 100

A simple physical explanation for the sensitivity of the hydrologic cycle to global climate change — •Axel Kleidon and Maik Renner — Max-Planck-Institut für Biogeochemie, Jena, Germany

The global hydrologic cycle is likely to increase in strength with global warming, although some studies indicate that warming due to solar absorption may result in a different sensitivity than warming due to an elevated greenhouse effect. Here we show that these sensitivities of the hydrologic cycle can be derived analytically from an extremely simple surface energy balance model that is constrained by the assumption that vertical convective exchange within the atmosphere operates at the thermodynamic limit of maximum power. Using current climatic mean conditions, this model predicts a sensitivity of the hydrologic cycle of 2.2 % K^{-1} to greenhouse-induced surface warming which is the sensitivity reported from climate models. The sensitivity to solar-induced warming includes an additional term, which increases the total sensitivity to 3.2 % K^{-1}. These sensitivities are explained by shifts in the turbulent fluxes in the case of greenhouse-induced warming, which is proportional to the change in slope of the saturation vapor pressure, and in terms of an additional increase in turbulent fluxes in the case of solar radiation-induced warming. We illustrate an implication of this explanation for geoengineering, and show that our simple model can explain the result of much more complex climate models very well. We conclude that the sensitivity of the hydrologic cycle to surface temperature can be understood and predicted with very simple physical considerations.