Workshop on CMIP5 Model Analysis and Scientific Plans for CMIP6

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SESSION 3: Thursday 22nd October (morning)

No	Abstract title	Presenter
1	Integrated assessment of CMIP5 simulations in terms of climate classification	**BELDA**
2	Sources of multi-decadal predictability in the Mediterranean region: the role of forced versus internal variability	**BELLUCI**
3	Towards a limited-area climate ensemble prediction system for decadal forecasts	**BRAUCH**
4	Impact of permafrost relevant processes on hydrological change using MPI-ESM	**BROVKIN**
5	Climate indicators of the pace of change using CMIP5 projections	**CHAVAILLAZ**
6	Sources of uncertainties in projections of marine ecosystem drivers	**FROELICHER**
7	ENSO in a changing climate in the CMIP suite of model	**GUILYARDI**
	Carbon cycle feedback of land ecosystems in response to atmospheric CO2 increase	**HAJIMA**
8	Improving the Norwegian Earth System Model (NorESM) for CMIP6	**IVERSEN**
9	Complementing thermosteric sea-level rise estimates	**LORBACHER**
10	Atlantic Multidecadal Variability in a multi-model ensemble of CMIP5 simulations: an assessment of its spectral characteristics and its non-stationary behaviour	**MAVILIA**
11	Equatorial Atlantic Ocean dynamics in a coupled ocean-atmosphere model simulation	**NOBRE**
12	Reducing Uncertainty in Future Projections of the Northern Annular Mode	**SCINOCCA**
13	Rapid cooling in the subpolar North Atlantic: a real eventuality or a sporadic model propensity?	**SGUBIN**
14	Do we need coupled models to simulate anthropogenic climate change?	**SODEN**
15	Increasing potential of biomass burning over Sumatra, Indonesia induced by anthropogenic tropical warming	**TATEBE**
16	Changes in the Weddell Sea Warm Deep Water in CMIP5 models from the 20th into the 21st Century?	**WAINER**
17	Ocean Downscaling of CMIP5 1990-2100 climate projections for the Arabian Gulf	**WAINER**
18	Evaluation of seasonal and decadal predictions on regional and global scale	**WEHRING**
19	Understanding the source of uncertainty in Arctic sea ice projections in CMIP5	**YANG**

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Integrated assessment of CMIP5 simulations in terms of climate classification

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Abstract

The analysis of climate patterns can be performed for each climate variable separately or the data can be aggregated using e.g. some kind of climate classification. Classifications based on the correspondence of climate to vegetation distribution divide climate system into vegetation zones or eco-regions. Climate classifications represent a convenient tool for the assessment and validation of climate models and for the analysis of simulated future climate changes and their potential impact to the ecosystems.
The K´oppen-Trewartha classification is used on CMIP5 family of GCM simulations and global CRU data for comparison. This evaluation provides first insight on the GCM performance and errors. The CMIP5 family of models shows many common features. Many models have problems with capturing the rainforest climate type, mainly in the Amazonia. Desert climate type is underestimated by as much as half of the models. Boreal climate type E is overestimated by many models, mostly spreading over to the areas of observed tundra type. All applied metrics indicate that with the current generation of GCMs there is no clear tendency for models to improve the representation of climate types with higher spatial resolution.
The analysis of the CMIP5 ensemble for RCP 4.5 and 8.5 is performed to assess the climate change for future. There are significant changes for some types in most models, when analysing the area fraction we can point out e.g. increase of savana and decrease of tundra for the future. For some types significant shift of them in latitude can be seen when studying their geografical loction in selected continental areas, e.g. toward higher latitudes for boreal climate. However, for many climate types the changes are smaller than model errors in the present climate validation.

Keywords: climate classification, K´oppen, Trewartha classification, model evaluation, climate type changes

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Sources of multi-decadal predictability in the Mediterranean region: the role of forced versus internal variability

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Abstract

The Mediterranean is among the most sensitive regions to the effects of climatic change, and is often identified as a climatic "Hot Spot". This region is also among the few land areas where a linkage with North Atlantic multi-decadal variability, a potential source of predictability, is found. A better characterization of both anthropogenic and natural sources of climate predictability, would be greatly beneficial for improving our understanding of the potential to predict future regional climate fluctuations, over the multi-annual and longer range. A CMIP5-based multi-model analysis of the multi-decadal variability over the Mediterranean region is presented, focusing on the relative role played by internal and external (natural and anthropogenic) sources of variability. In this analysis, we exploit a multi-model ensemble of CMIP5 HistMisc simulations (i.e., idealized historical integrations using various combinations of anthropogenic and natural agents) and near-term initialized predictions. The joint analysis of historical projections and decadal hindcasts aims at disentangling the relative role played by individual forcings versus the internal (mostly ocean-driven) variability, on the 20th Century climatic fluctuations observed over the Mediterranean basin and the adjacent Atlantic sector.

Keywords: Decadal predictability, Mediterranean climate variability, Atlantic multidecadal variability

*Speaker

Towards a limited-area climate ensemble prediction system for decadal forecasts

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Abstract

Within the BMBF-funded programme MiKlip one main focus is on the decadal climate prediction on the regional scale. The general goal of the project LACEPS (A Limited-Area Climate Ensemble Prediction System) within MiKlip is the development of an ensemble climate prediction system for the decadal forecast for Europe employing the regional climate model COSMO-CLM.
In this study, an application of the results from the regional decadal climate hindcasts for the time period 1961–2010 carried out with the COSMO-CLM is presented. The hindcasts use the coupled model MPI-ESM-LR (MPIOM/ECHAM) decadal hindcasts as driving data. The "initial conditions" perturbation strategy with 1-day-lagged initialization is the basis for the ensemble system with 10 members passed over from MPI-ESM-LR. The parameter under investigation is the near surface air temperature.

The presentation will focus on the evaluation of the COSMO-CLM simulations and the reliability of the ensemble achieved on the basis of hindcasts. We also address the added value of the regional compared to the global hindcasts.
Results show generally a higher reliability for the 2 m temperature than for precipitation. For the near surface temperature the reliability is higher in the winter than in the summer months, but for precipitation it is vice-versa. The reliability of the COSMO-CLM ensemble 2 m temperature is in most regions higher than that of the driving global model.

Keywords: regional decadal climate prediction, reliability of forecasts

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Impact of permafrost relevant processes on hydrological change using MPI-ESM

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Abstract

Permafrost or perennially frozen ground is an important part of the terrestrial cryosphere; roughly one quarter of Earth's land surface is underlain by permafrost. As it is a thermal phenomenon, its characteristics are highly dependent on climatic factors. The impact of the currently observed warming, which is projected to persist during the coming decades due to anthropogenic CO2 input, certainly has effects for the vast permafrost areas of the high northern latitudes. The quantification of these effects, however, is scientifically still an open question. This is partly due to the complexity of the system, where several feedbacks are interacting between land and atmosphere, sometimes counterbalancing each other. Moreover, until recently, many global circulation models (GCMs) and Earth system models (ESMs) lacked the sufficient representation of permafrost physics in their land surface schemes.

Within the European Union FP7 project PAGE21, the land surface scheme JSBACH of the Max-Planck-Institute for Meteorology ESM (MPI-ESM) has been equipped with the representation of relevant physical processes for permafrost studies. These processes include the effects of freezing and thawing of soil water for both energy and water cycles, thermal properties depending on soil water and ice contents, and soil moisture movement being influenced by the presence of soil ice. In the present study, it will be analysed how these permafrost relevant processes impact projected hydrological changes over northern hemisphere high latitude land areas. For this analysis, the atmosphere-land part of MPI-ESM, ECHAM6-JSBACH, is driven by prescribed SST and sea ice in an AMIP2-type setup with and without the newly implemented permafrost processes. Observed SST and sea ice for 1979-1999 are used to consider induced changes in the simulated hydrological cycle. In addition, simulated SST and sea ice are taken from a MPI-ESM simulation conducted for CMIP5 following the RCP8.5 scenario. The corresponding simulations with ECHAM6-JSBACH are used to assess differences in projected hydrological changes induced by the permafrost relevant processes.

*Speaker

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Keywords: Permafrost, hydrology, Earth System Modelling, climate change, biases

Climate indicators of the pace of change using CMIP5 projections

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Abstract

In most studies, climate change is approached by focusing on the evolution between a fixed current baseline and a future period. This long-term vision is not well suited to discussing how coming generations might experience these changes. In this study, we propose an alternative approach that considers indicators of pace of changes using CMIP5 simulations of several runs of 18 GCMs. It consists in tracking statistics and their projected changes with a 20-year running baseline, defining the time evolution of the pace at which climate changes on the scale of an average generation. We focus here on the annual and seasonal evolution of surface air temperature and precipitation.
Under RCP8.5, temperature indicators of pace of change become far stronger over the twenty-first century, with a maximum reached around 2060. While northern high-latitudes witness a higher temperature rise, all other latitudes highlight at least a doubling in the warming rate compared to the current period. The largest "perceived" occurrence of extremely warm years takes place in the tropics, especially in West Africa and South-East Asia. Latitudinal dissimilarities are due to differences both in year-to-year variability and in the climate response to a radiative forcing.

As for precipitation under the same pathway, moistening and drying rates strongly increase at the global scale. Regions with significant pace of change expand more and more over the twenty-first century. Moreover, rate patterns tend to spatially stabilize, making them persistent in some regions that also exhibit the largest rates and the largest increases of rate by 2080: e.g. the Mediterranean Sea, Central America, South Asia and the Arctic. The spatial stabilization is due to the decreasing relative influence of global circulation compared to thermodynamical processes.
These trends are already visible in the current period regardless of the selected RCP, but could almost disappear if strong mitigation policies were quickly implemented. This alternative way to analyse CMIP5 projections brings new elements to better interact with other involved communities. Future studies should focus on the impacts of these rates, whilst considering vulnerability and exposure of human and natural systems.

*Speaker

Keywords: pace of change, warming rate, extremely warm years, rate of precipitation change, spatial stabilization

Sources of uncertainties in projections of marine ecosystem stressors

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Abstract

Marine organisms and ocean ecosystems are increasingly stressed by human-induced changes. Ocean warming, ocean acidification, ocean deoxygenation and changes in primary productivity by marine phytoplankton (i.e. nutrient stress) have been identified to be among the stressors of greatest concern. On a global scale, the development of these stressors is largely a consequence of rising atmospheric CO2 levels and associated climate change. Ocean heat uptake leads to a warmer ocean and rising atmospheric levels causes ocean acidification. The warming and freshening of the ocean tends to stratify the upper ocean leading to a reduced supply of nutrients to the upper ocean, but also to a reduced resupply of oxygen to the ocean's interior, driving deoxygenation and an expansion of low oxygen-content water. Projections of these stressors are available but are subject to large uncertainties, especially on regional scales. A quantitative picture of the uncertainty associated with the expected changes on regional and global scales is crucial, however, in order to quantify impacts and to decide on adaption and mitigation measures.

Here, we assess the sources of uncertainties in multiple ocean ecosystem stressor projections using results from a wide range of CMIP5 Earth System Models (ESMs) and from a large (30-member) ensemble suite with a single Earth System Model (GFDL ESM2M). We calculate the relative importance of internal variability (natural fluctuation that arise in the absence of any external forcing), model uncertainty (different CMIP5 ESMs yield different response to same forcing) and scenario uncertainty (uncertainty of external factors that influence the climate system) on different spatial and temporal scales for each individual marine ecosystem stressor, as well as for stressors considered to be acting in parallel. We apply a similar framework to ocean ecosystem stressors that was applied to surface atmospheric temperature in a previously published study.

Preliminary results for sea surface temperature suggest that model uncertainty is dominant in medium term projections (2030-2050) while the long-term projections (2080-2100) are dominated by scenario uncertainty (Fig. 1). However, the relative importance of different uncertainty sources varies between different regions. In the Northeast Atlantic, the relative importance of scenario uncertainty is smaller than for projections considered instead at global scales, while both internal variability and scenario uncertainty become more important. The implications of our results for the development of strategies for reducing uncertainty in regional projections of marine ecosystem stressors, and for uncertainties in projections of higher trophic organisms, will be discussed.

*Speaker

Keywords: marine ecosystem stressors, ocean acidification, ocean deoxygenation, nutrient stress, ocean warming, 30, member ensemble simulation, CMIP5

ENSO in a changing climate in the CMIP suite of model

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Abstract

Since the establishment of the basic physical mechanisms 30 years ago, major progress in ENSO research has been made. New theoretical insights, together with longer and more comprehensive observations, increased computer power, and improved physical parameterizations of subgrid-scale processes, have resulted in better understanding of ENSO dynamics and much improved simulations of ENSO statistics in CGCMs. If the basic properties of ENSO are now better understood and simulated, the community is nevertheless now faced with the much harder problem of addressing its detailed properties (e.g. skewness, diversity of events, physical feedbacks, asymmetries between El Niño and La Niña, etc.) and how these interact with the slowly (decadally to centennially) varying background. Further progress requires coordination of diverse research communities, a process recently undertaken through intercomparison of state-of-the-art CGCMs (CMIP3 and CMIP5). We here report on the progress made in the newly established CLIVAR ENSO Research Focus group that seeks to 1) better understand processes that control ENSO characteristics in nature and in the models, 2) propose a standard ENSO evaluation protocol for CGCMs as a resource for model developers and impacts studies and 3) understand how ENSO characteristics, particularly ENSO extremes, might be modified in the next decades, namely under the influence of anthropogenic climate change.

Keywords: ENSO, CMIP

*Speaker

Carbon cycle feedback of land ecosystems in response to atmospheric CO2 increase

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Abstract

CO2 increase in the atmosphere stimulates plant growth, and hence promote carbon uptake by land ecosystems (so called "CO2 fertilization effect"). This forms a negative feedback loop between atmospheric CO2 concentration and terrestrial carbon uptake: "CO2–carbon feedback" of land ecosystem. Although the feedback is now regarded to have a strong impact on long-term climate change, CMIP5-Earth system models (ESMs) predict different magnitude of the feedback strength.
In order to reveal the cause of the different magnitude of the "CO2-land carbon feedback" in CMIP5-ESMs, we examined in detail the changes in the carbon pools and fluxes of the models. The analysis showed that CO2 increase stimulate several carbon cycle processes (such as plant production, litter fall, and heterotrophic respiration), and the degree of the responses are different among the models. However, the large spread in CO2–carbon feedback among the ESMs was well explained by the sensitivity of plant productivity to the elevated CO2 concentration. To reduce this spread in the strength of the CO2 –carbon feedback among ESMs, more investigations are required into plant production sensitivity to elevated CO2 concentration.
In addition, it has been known that the feedback strength of land ecosystem can be changed depending on the rate of CO2 increase. By applying several types of CO2 scenarios into a single ESM and comparing the simulation results, we confirmed that higher carbon accumulation is achieved in scenarios with slower CO2 increase rates. In the simulations, we clearly demonstrated that a time lag of terrestrial carbon with atmospheric CO2 increase is the crucial process for the dependency of CO2–carbon feedback on CO2 scenarios. This result strengthens the conclusions of previous studies that quantities for evaluating the feedback are incapable of capturing the land carbon storage state, and provide important information for understanding the almost constancy of the transient climate response to cumulative carbon emission in regardless of applied scenarios.

Keywords: Carbon cycle, Earth system model, land ecosystem, feedback

*Speaker

Improving the Norwegian Earth System Model (NorESM) for CMIP6

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Abstract

NorESM is belongs to the family of models based on the NCAR CESM. The CMIP5-versions of were based on CESM-versions released in 2010, while CMIP6-versions will be based on versions released in 2015 and possibly later. The spatial resolution will increase in the CMIP6-version; from 1 to 0.25 degrees in the ocean model, and from _˜2 to _˜1 degrees in the atmosphere and the land models. The potentials for even higher horizontal atmospheric resolution and more layers are under investigation.
In short, NorESM employs own developed schemes for aerosol-cloud-climate interactions, a further developed version of the MICOM isopycnic-coordinate ocean model and with the HAMOCC ocean carbon cycle model. CMIP5- versions showed several positive features, in particular for the tropics. Major systematic deficencies included a very strong AMOC, misrepresentations of NAO and Euro-Atlantic blocking, global cloudiness and cloud liquid water, and the free tropospheric burdens of some anthropogenic aerosols.

Although we are far from being able to draw final conclusions at the time of this abstract, preliminary experiments indicate that increased spatial resolution will improve on some of these weaknesses, in particular the ocean circulation and Euro-Atlantic flow regimes. The new cloud schemes also produce reduced and partly changed systematic errors in the global cloud pattern, which also influence the atmospheric residence time of aerosols and how aerosols are calculeated to impact on radiative forcing and climate change. The production of aerosol components are now also more interactively involved in the earthj system processes rather than being prescribed, thus adding to the degrees of freedom of the model.
In CMIP6, it is of very high importance for NorESM to deliver to ScenarioMIP, C4MIP, DAMIP, CFMIP, LUMIP, OCMIP6, RFMIP, OMIP and AerChemMIP and a few others.

Keywords: ocean resolution, atmospheric resolution, AMOC, flow regimes, aerosols, cloud properties

*Speaker

Complementing thermosteric sea-level rise estimates

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Abstract

Thermal expansion of seawater is one of the most important contributors to global sea-level rise (SLR) in the past 100 years. Yet, observational estimates of thermal expansion are sparse, mostly limited to the upper ocean layers, and only a part of the available climate model data is sufficiently diagnosed. In order to support usage of Coupled Model Intercomparison Project Phase 5 (CMIP5) results, complement observations and enable the development of surrogate techniques to project thermosteric sea-level rise, we extend corresponding diagnostics of CMIP5 models. We calculate 30% more thermal expansion estimates than currently published. For the period 1993-2010 we arrive at exactly the observational trend of global mean thermosteric SLR of 1.1±0.3 mmy-1 listed in IPCC-AR5's chapter 13 whilst the currently published multi-model dataset overestimates the observational estimate by 13%. We find that upper 700 m (2000 m) observational estimates need to be augmented by 36±9% (15±6%) on average to be considered for a global sea level budget. Half of the total expansion originates from depths below 480±250 m with the range indicating scenario-to-scenario variations. Lastly, to support the development of surrogate methods to project thermal expansion, we calibrate two simplified parameterisations against CMIP5 estimates of thermosteric SLR: One parameterisation is suitable for scenarios where only hemispheric ocean temperature profiles are available, the other one, where total ocean heat uptake is known (goodness-of-fit: 5% and 9%, respectively). In a further step, we investigate correlations between multi-model-mean natural variability and both large-scale surface air temperatures and ocean heat uptake in CMIP5 results. In particular, parameters capturing ENSO, AMO, PDO and the baroclinic mass transport (BMT) that estimates the strength between of the baroclinic gyre circulation in the Gulf Stream and North Atlantic system are subject to a more in-depth analyses.

Keywords: themosteric sea, level change, simplified parameterisations, model response uncertainties, multi, model natural variability, model response uncertainties

*Speaker

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Atlantic Multidecadal Variability in a multi-model ensemble of CMIP5 simulations: an assessment of its spectral characteristics and its non-stationary behaviour

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Abstract

The Atlantic Multidecadal Variability (AMV) is a coherent pattern of variability of the North Atlantic Sea Surface Temperature (NA SST) field affecting several components of the climate system in the Atlantic region and the surrounding areas. Our current knowledge of the AMV is based on a relatively short observational record, which severely limits our understanding of the mechanisms involved, as well as the characterization of the low-frequency tail of the variability spectrum. In order to quantify accurately the contribution of anthropogenic forcings to the observed climatic changes, it is essential to understand better the natural climate variability occurring at long time scales. Here, the behaviour of the AMV is examined in a set of multi-century CMIP5 pre-industrial climate simulations performed with different Coupled General Circulation Models (CGCMs). Only the longest simulations (minimum 500-year long) of the CMIP5 archive have been used. In these simulations the AMV exhibits a non-stationary behaviour, which is objectively assessed. A multi-model analysis of the AMV allows us to investigate similarities and differences across an ensemble of state-of-the-art climate models and to identify the prominent simulated mechanisms of air-sea interaction at mid-latitude and over decadal and longer time scales. The relationship between the detected AMV behaviour and the variability of the Atlantic meridional overturning circulation (AMOC) is also examined. In some of the models a shorter time scale mode (∼20 years) seems to alternate with a longer time scale mode (∼60 years) with a gradual shift from one to another across different epochs, involving also their co-existence. The non-stationary behaviour identified in most models suggests that the character of the observed AMV may undergo significant changes in the future. This ongoing analysis will provide further insight into the dynamics of the AMV variability.

Keywords: Atlantic multidecadal variability (AMV), Atlantic meridional overturning circulation (AMOC), Internal climate variability, Stationarity

*Speaker

Equatorial Atlantic Ocean dynamics in a coupled ocean-atmosphere model simulation

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Abstract

The ocean temperatures and zonal currents at the equatorial Atlantic simulated by an improved version of the brazilian earth system model (BESM), with changes in the cloud cover scheme and optical properties of the atmospheric component, are analyzed and compared to those obtained from a previous version of BESM and also from other seven selected CMIP5 models. It is shown that this updated version of BESM, despite some persistent biases, more accurately represents the surface temperature variation at the Equator and the equatorial thermocline east-west slope. These improvements are associated to a more realistic seasonal cycle achieved for the Atlantic equatorial undercurrent, as well as sea surface temperatures and zonal wind stress. The better simulation of the equatorial undercurrent is, in its turn, credited to a more realistic representation of the surface winds position and strength at the tropical Atlantic by the coupled model. With many of the systematic errors noticed in the previous version of the model alleviated, this version of BESM can be considered as a useful tool for modelers involved in Atlantic variability studies.

Keywords: coupled ocean–atmosphere models, Atlantic equatorial undercurrent, Atlantic equatorial thermocline, CMIP5 models.

*Speaker

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Reducing Uncertainty in Future Projections of the Northern Annular Mode

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Abstract

The Northern Annular Mode (NAM) represents the dominant mode of extra-tropical variability in the Northern Hemisphere (NH). Currently, the response of the NAM to increased green-house gas (GHG) concentrations in the atmosphere remains highly uncertain from multi-model intercomparison projects. Both CMIP3 and CMIP5 models show a large intermodel spread in the NAM response at the end of the 21st Century relative to the the end of the 20th Century and in more idealized experiments where CO2 concentrations are increased by 1% per year (Miller et al. 2006, Manzini et al 2014). Recently, idealized CO2 doubling experiments conducted by Sigmond and Scinocca (2009; SS09) have revealed a potential sensitivity of the NAM response to lower stratospheric wind biases in NH winter in the basic state upon which the CO2 perturbation is applied. If the CO2 increase is applied to a basic state with climatologically weak winds in this region, the NAM response to CO2 increases is neutral. Whereas, if the winds have no bias in this region the NAM response is positive. SS09 have identified a planetary wave mechanism to explain this sensitivity of the NAM response to the strength of winds in this region and have suggested that this mechanism might be responsible for the large spread in modelled responses of the NAM to green-house gas increases in CMIP3 and CMIP5. By compositing CMIP5 models with positive and neutral NAM responses to GHG increases, Manzini et al. (2014) have verified that a present-day weak wind bias exists in those models with a neutral NAM response relative to those with a positive NAM response. This provides further support for the SS09 mechanism and suggests that it likely accounts for much of the spread in modelled NAM responses to GHG forcing. Based on these results, it is argued here that a reduction in present-day NH lower-stratospheric winter wind biases in CMIP6 models will served to reduce uncertainty in future projections of the NAM.

Keywords: Northern Annular Mode, climate change, uncertainty

*Speaker

Rapid cooling in the subpolar North Atlantic: a real eventuality or a sporadic model propensity?

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Abstract

In opposition to the sea surface temperature (SST) global increase experienced throughout the 20th century, there are evidences of a simultaneous cooling over the subpolar North Atlantic (NA). Such a multidecadal trend, mostly sharpened because of an SST drop registered around 1970s, thus disclosing the concrete possibility of regional abrupt cooling under global warming conditions. Here, a survey among forty state-of-the-art Global Circulation Models (GCMs) partecipating to the CMIP5 project enables to analyse the SST response under different scenarios of increasing radiative forcing. Results exhibit large model uncertainty over the subpolar NA, as different models predict indistinctly warming or cooling trends for the same scenario. Nevertheless, in a sizeable number of experiments the SST decrease emerges as an abrupt event caused by a suspension of the convection activity. An increase of stratification is the key process provoking a convection collapse and the onset of the SST drop. We assert that the source of uncertainty in reproducing SST evolution in the subpolar NA possibly lies behind different model representations of the present-day stratification over deep convection sites. Comparisons with observational data reveal that those models showing a warming trend over the subpolar NA are, on average, too stratified to permit the external forcing to establish a new state for the deep convection. The subpolar NA may be therefore more sensitive to changes in radiative forcing than what most of the current generation of GCMs have shown so far. This possibility would have strong implications in the evaluation of future climate change impacts.

Keywords: Global Circulation Models, model uncertainty, impacts of global warming, abrupt changes, feedback mechanisms, Atlantic Meridional Overturning Circulation, Subpolar gyre, Convection

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Do we need coupled models to simulate anthropogenic climate change?

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Abstract

Coupled general circulation models (CGCMs) are traditionally chosen over atmospheric general circulation models (AGCMs) for the simulation of anthropogenic climate change, despite AGCM's superior computational efficiency. This is mainly due to AGCMs' lack of coupling with an underlying ocean and their inconsistency in surface energetics. We evaluated the impact of AGCMs' shortcomings and found that AGCMs are potentially more suitable than CGCMs for the simulation of anthropogenic climate change. First, AGCMs forced with increasing CO2 and a structured SST warming are able to perfectly reproduce the anthropogenic climate change from the coupled simulations, despite the lack of constraints for energetically consistent surface fluxes. This suggests a greater utility for AGCMs as computationally efficient tools for high resolution simulations of anthropogenic climate change. Second, by using AGCMs, in which SST climatology and SST change are arbitrarily prescribed, uncertainties in model projections could be largely reduced. Most importantly, we show that much of the errors in climate projections are related to errors in the simulation of the current climatology and that AGCMs could potentially provide more accurate climate projections by constraining climatological errors with observed SST. Furthermore, we show that climate change over land is very insensitive to the pattern of anthropogenic SST change. Based on this result, we successfully reproduced land climate change from coupled simulations by using AGCMs forced with only a uniform warming and increasing CO2.

Keywords: anthropogenic climate change, AGCM, projection, uncertainty

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Increasing potential of biomass burning over Sumatra, Indonesia induced by anthropogenic tropical warming

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Abstract

Uncontrolled biomass burning in Indonesia during drought periods damages the landscape, degrades regional air quality, and acts as a disproportionately large source of greenhouse gas emissions. The expansion of forest fires is mostly observed in October in Sumatra favored by persistent droughts during the dry season from June to November. The contribution of anthropogenic warming to the probability of severe droughts is not yet clear. Here, we show evidence that past events in Sumatra were exacerbated by anthropogenic warming and that they will become more frequent under a future emissions scenario. By conducting two sets of atmospheric general circulation model ensemble experiments driven by observed sea surface temperature for 1960– 2011, one with and one without an anthropogenic warming component, we found that a recent weakening of the Walker circulation associated with tropical ocean warming increased the probability of severe droughts in Sumatra, despite increasing tropical mean precipitation. A future increase in the frequency of droughts is then suggested from our analyses of the Coupled Model Intercomparison Project Phase 5 model ensembles. Increasing precipitation to the north of the equator accompanies drier conditions over Indonesia, amplified by enhanced ocean surface warming in the central equatorial Pacific. The resultant precipitation decrease leads to a 25% increase in severe drought events from 1951– 2000 to 2001– 2050. Our results therefore indicate the global warming impact to a potential of wide-spreading forest fires over Indonesia, which requires mitigation policy for disaster prevention.

Keywords: biomass burinig, tropics, global warming

*Speaker

Changes in the Weddell Sea Warm Deep Water in CMIP5 models from the 20th into the 21st Centuries

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Abstract

In the Southern Oceans (SO) the dense waters of the Antarctic Bottom Water (AABW) are formed predominantly in the Weddell Sea and then move along density surfaces with very little change due to vertical mixing. Thus water mass properties on these density surfaces (isopycnals) are a faithful representation of the source region surface heat and freshwater fluxes, which provides good indicators of climate change. Export of AABW constitutes a key component of the ocean's meridional overturning circulation (MOC) and thus has a great impact on the Earths Climate. Because of the intrinsic difficulties to observe water mass formation at high latitudes, numerical models become an essential tool for quantifying variations in water masses. This study aims to assess the representation and variability of the Southern Ocean water masses in CMIP5 models for the 20th and 21st Century. Considering the importance of the Weddell Sea in the formation and export of dense waters to the global ocean, its characteristics are investigated. Results show freshening and warming of the Warm Deep Water (WDW) for most models although their physical representation of the water mass distribution in the Weddell Sea is remarkably different. Issues relative to the lack of necessary physical processes in the CMIP5 models to adequately represent the changes in the Weddell Sea that affect the MOC are discussed.

Keywords: Southern Ocean, Weddell Sea

*Speaker

Ocean Downscaling of CMIP5 1990-2100 climate projections for the Arabian Gulf

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Abstract

The goal of this study is to develop projections of regional climate for the Arabian Gulf (AG) at fine spatial and temporal scales. To achieve this, a Regional Ocean Model System (ROMS) was used to dynamically downscale the climate of the AG using ground truth data to evaluate the model. An Earth System Model (ESM) is used to force ocean boundaries and Atmospheric fluxes (The Max Planck Institute ESM), hereafter MPI-MR. The final results show what global climate change likely means for the AG waters regarding main ocean properties, like sea surface temperature, salinity, sea level height, and currents up through the year 2100, from the "business as usual" RCP8.5 scenario. Pondering the natural limitations from the ESM results and the downscaling process, the results are expected to lighten the likely climate changes effect on the Gulf ocean dynamics. There is also confidence that these results have created a baseline to insight new experiments, concerning the gulf dynamics, to quantify and increase the accuracy of the carbon related warming effects as well as the local anthropogenic changes on the salinity generation processes. The results from the experiments will be available to be used in support of climate change impact research planning in the marine environment throughout the Gulf.

Keywords: ocean downscaling, regional climate

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Evaluation of seasonal and decadal predictions on regional and global scale

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Abstract

The Deutscher Wetterdienst (DWD), the German Meteorological Service, aims to provide long-term predictions such as seasonal and decadal forecasts. The seasonal forecasts will soon be produced operationally. The forecasting system used is developed in close cooperation with Max-Planck-Institute for Meteorology (MPI-M) and the University of Hamburg. Decadal predictions are subject of the German BMBF-funded research programme MiKlip aiming as well for operational forecasts at DWD.
In order to assess the model's robustness and quality for multi-year and multi-member numerical simulations a proper evaluation tool is needed. Within MiKlip a user applicable system, called INTEGRATION, and evaluation tools are developed by FU Berlin and are already implemented at DWD. In the framework of the OceanEval project INTEGRATION is adapted to seasonal purposes for analysing oceanic parameters from seasonal forecasts of the Earth System Model of Max-Planck-Institute for Meteorology "MPI-ESM". In collaboration to FU Berlin DWD is extending the system with additional deterministic and probabilistic scores for seasonal and decadal forecasts.
To give an overview over the evaluation tool we will present results from pre-operational global seasonal forecasts as well as regional downscaled decadal predictions

Keywords: seasonal, decadal, forecast, prediction, evaluation, INTEGRATION

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Understanding the source of uncertainty in Arctic sea ice projections in CMIP5

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Abstract

Several recent studies showed that, while climate models in general predict declines in Arctic sea ice extent and volume from late 20th century through the next decades in response to increase of anthropogenic forcing, the model simulated Arctic sea ice demonstrates considerable biases in both the mean and the declining trend in comparison with the observations over the satellite era (1979-2011). In particular, large intermodel spread remains in both the simulated climatological state of the ice cover and the ice retreating rate. Various metrics have been proposed to constrain the analysis to selected models in order to reduce the uncertainty in projected ice conditions through the 21st century and the timing of a seasonally ice free Arctic Ocean. However, all the suggested metrics are based solely on the modeled sea ice characteristics disregarding the respective atmospheric or the ocean states. In order to understand the source of model uncertainties in the Arctic sea ice projection, we analyze the ice extent under the context of surface air temperature (SAT) as simulated in the historical, RCP4.5 and RCP8.5 experiments by 27 CMIP5 models. It is found that the relationship between changes in total Arctic sea ice in various seasons and changes in global mean SAT in the corresponding model appears very similar in all models and agrees well with that in the observational data. In the phase plane plots, the ratio of the total Arctic sea ice changes in March, September and annual mean with respect to the baseline climatology (1979-2008) are linearly correlated to the global mean annual SAT anomaly in the respective model. This implies that the model spread in the projected sea ice extent may result from the SAT biases in models. Further investigation is underway to understand how the patterns of the projected sea ice changes are related to the model biases, and whether there are common characteristics in these patterns among models.

Keywords: Arctic sea ice, uncertainty, model biases

*Speaker