Seminar on Physics and Chemistry
of the Atmosphere
25.05.2018, SoSe 2018, IUP Bremen

Climate variability across time scales: challenges from limited instrumental, paleoclimate data and modeling

Professor Dr. Gerrit Lohmann

(AWI Bremerhaven & IUP)

Abstract

Weather and climate vary on broad ranges of spatial and temporal scales. The extremes of the major climate variables, temperature and precipitation, have a crucial influence on society and economy. Examples for the last century include the Early Arctic warming in the 1930ies, the Great Salinity Anomaly in the 1970ies, the European heatwave in summer 2003, droughts and floods etc. Climate extremes and transitions are known also from the paleoclimatic records where the North Atlantic has abruptly cooled or warmed (Heinrich and Dansgaard-Oeschger events) during the last glacial-interglacial cycle. The disintegration of the West Antarctic ice sheet is another example of abrupt climate extreme with several meters of sea level rise. Simulations of the future of the West Antarctic ice sheet in a warming world indicate an abrupt loss, in a similar way as it was predicted for the last interglacial. All of these changes were local, but with large-scale teleconnections and have global consequences. Furthermore, paleoclimate data brings the relatively short time series into a long-term perspective. As the climate is changing and the system is itself variable, decisions shall not only be based on past mean patterns, but should build in thresholds that correctly estimate potential threats and goes beyond decisions based on expectations that allow for changes in climatic means. To remedy this situation, time-series analyses from instrumental data and environmental archives are combined with the development and application of Earth system models for past, present and future scenarios. Examples are shown for the Great Salinity Anomaly in the 1970ies which seems to be related to long-term variability in atmospheric blocking. Finally, model-data inconsistencies of long-term variability and sensitivity are shown to be related, following the general fluctuation-dissipation theorem in physics.

Selected References:

Sutter, J., P. Gierz, K. Grosfeld, M. Thoma, and G. Lohmann, 2016: Ocean temperature thresholds for Last Interglacial West Antarctic Ice Sheet collapse. Geophysical Research Letters, 43 (6), 2675–2682. doi: 10.1002/2016GL067818 (link) (press release) (German press release)

Ionita, M., P. Scholz, G. Lohmann, M. Dima, and M. Prange, 2016: Linkages between atmospheric blocking, sea ice export through Fram Strait and the Atlantic Meridional Overturning Circulation. Scientific Reports 6:32881, DOI: 10.1038/srep32881 (link)

Seminar on Physics and Chemistry of the Atmosphere
25.05.2018, SoSe 2018, IUP Bremen

Rimbu, N., G. Lohmann, M. Werner, and M. Ionita, 2016: Links between central Greenland stable isotopes, blocking and extreme climate variability over Europe at decadal to multidecadal time scales. Climate Dynamics, 49 (1–2), 649–663. doi:10.1007/s00382-016-3365-3 (link)

Zhang, P., M. Ionita, G. Lohmann, D. Chen, H. Linderholm, 2017: Can tree-ring density data reflect summer temperature extremes and associated circulation patterns over Fennoscandia? Climate Dynamics, 49: 2721. doi:10.1007/s00382-016-3452-5 (link)

Lohmann, G., 2017: Atmospheric bridge on orbital time scales. Theoretical and Applied Climatology, 128 (3), 709–718. DOI: 10.1007/s00704-015-1725-2 (link)

Zhang, X., G. Knorr, G. Lohmann, S. Barker, 2017: Abrupt North Atlantic circulation changes in response to gradual CO2 forcing in a glacial climate state. Nature Geo. 10, 518–523. DOI: 10.1038/NGEO2974 (link) (press release) (press release German)

Lohmann, G., M. Pfeiffer, T. Laepple, G. Leduc, and J.-H. Kim, 2013: A model-data comparison of the Holocene global sea surface temperature evolution. Clim. Past, 9, 1807-1839, doi:10.5194/cp-9-1807-2013 (link) (pdf)