Summary of the Second SOLARIS Meeting 10.-12. March 2010 at GFZ Potsdam

2 ½ day meeting with 38 participants from 8 countries

Financial aid for 2 PhD students from WCRP/SPARC, coffee breaks and reception was also sponsored by WCRP/SPARC

The first day of the meeting included a series of overview talks from invited speakers that were open to the general public. These overviews covered a wide range of topics starting with new estimates and reconstructions of solar variability in spectral and total solar irradiance going back to 1610 (**S. Solanki**). Preliminary results for the irradiance over the last 11000 years (Holocene) were presented and it was mentioned that the sun is leaving its grand maximum in the current solar cycle 23. **U. Cubasch** presented modeling work with coupled middle atmosphere-ocean models for selected paleo-climate events, i.e. the start and the end of the Eemian (125kyrs before present (BP) and 115 kyrs BP) as an example for the transition to an ice age as well as for the Holocene, the climate optimum 6000 yrs BP. The model simulations combined orbital forcings with solar variability to simulate paleo-climate events, e.g., glacial and interglacials. **K. Labitzke** reviewed and updated observational analysis of the solar signal in the stratosphere focusing on the role of the QBO. Her first papers with Harry van Loon in 1987 and 1988 are now on a much firmer ground with almost 60 years of data (QBO data have been reconstructed back to the mid 1940ies. She highlighted the strong summer signal. **A. Brauer** introduced the data base of annually laminated lake sediments at GFZ Potsdam and showed solar signals from two selected records, i.e. the Meerfelder Maar Lake in the western part of Germany and the Lake Ammersee in Southern Germany that confirm a sun-climate link which needs to be further investigated. **B. Funke** presented results from a SOLARIS related project, the High-Energy Precipitating Particles in the Atmosphere (HEPPA) initiative. A first intercomparison between different 2D and 3D models and MIPA**S** observations focused on the solar proton event in 2003, the Halloween storm. Since solar proton events are occasional events and likely do not have any long-term effects, new intercomparisons will investigate the effect of energetic electron precipitation events that are linked to geomagnetic activity and are modulated by the solar cycle.
Lon Hood reviewed the origin of the tropical lower stratospheric ozone response to the solar cycle, a currently highly discussed topic since earlier 2D and 3D models were not able to reproduce the observed vertical structure in the tropical solar signal in temperature and ozone. **K. Kodera** described some of the dynamical mechanisms through which small direct stratospheric effects can indirectly affect the lower parts of the atmosphere down to the Earth's surface and proposed a mechanism for the modulation of the solar signal by the QBO. **J. E. Kristjansson** reviewed research on the impact of galactic cosmic rays on climate, another proposed mechanism how the solar variability could influence climate. Well established is that charge can enhance aerosol nucleation and that nucleated aerosols may eventually grow to condensation nuclei. Recent studies of Forbush Decrease events give different answers whether cosmic ray induced ionization influences clouds. There is no cosmic ray signal in aerosol nucleation events in Europe, little support from model studies and global temperature is seemingly uninfluenced by cosmic rays. However, ongoing research at CERN may give new insights.

The following talks presented either observational or modeling studies to the solar influence topic.

H. Lu confirmed results by Labitzke and van Loon from extended ERA-40 reanalysis about the QBO modulation of the solar cycle, **C. Blume** investigated the dependence of the occurrence of stratospheric warmings also in extended ERA-40 reanalysis on different natural variability factors (solar cycle, QBO, ENSO, volcanoes) with non-linear time series analysis, i.e. an artificial neural network. QBO and ENSO seem to determine the frequency of stratospheric warmings more than the solar cycle. **Y. Kuroda** showed a solar cycle and QBO modulation of the southern annular mode (SAM).

A. Shapiro from the PMOD in Davos showed reconstructions of spectral and total solar irradiance variations from the Maunder Minimum to today and came up with a much larger increase of 6 W/m² than other estimates, e.g. from Judith Lean or Sami Solanki. **S. Oberländer** and **A. Shapiro** investigated the effect of different spectral solar irradiance measurements on shortwave heating rates and circulation in stand-alone radiation code calculations and online calculations with chemistry-climate models.

T. Reddmann talked about modeling of stratospheric chemistry during solar-induced NOx enhancements observed with the MIPAS instrument onboard ENVISAT in the Kasima model. **I. Cnossen** highlighted the importance of gravity wave effects in modeling the solar signal propagation as well as the importance of a realistic representation of stratospheric sudden warmings in a mechanistic model.

K. Matthes presented an overview about the SPARC CCMVal report which will appear in spring 2010, with special focus on the natural variability chapter and the comparison of the solar signal in the different observational and chemistry climate model analysis. It is still under discussion whether the vertical structure of the tropical solar signal in ozone and temperature, especially the secondary maximum of the lower stratospheric signal is related to non-linear effects of the solar cycle, the QBO, and ENSO or whether it is due to aliasing.

A number of presentations of different chemistry-climate models focused on the more detailed investigation of either the CCMVal reference simulations for the SPARC CCMVal report and the WMO ozone assessement (**A. Kubin, Y. Yamashita, G. Chiodo, K. Shibata**), or idealized solar forcing experiments (**C. Bell, S. Schimanke**), and new simulations for the next IPCC report (**S. Watanabe**). Results from coupled atmosphere-ocean models including the middle atmosphere but no interactive chemistry were presented by **S. Missios** and **T. Spangehl**.

We had fruitful discussions after each presentation and a final discussion at the end in which the following open questions for a realistic representation of the solar signal emerged:

- What is the role of the QBO?

- What is the role of the SSTs for the mean climate (e.g., the occurrence of stratospheric warmings)?
- What is the role of a coupled ocean?
- What is the impact of different spectral solar irradiance data sets?

To approach these questions the following coordinated model studies were proposed at the SOLARIS side meeting at the SPARC general assembly in Bologna in 2008. These were designed to understand whether the solar signal in the tropical lower stratosphere is related to non-linear or aliasing effects with other signals, namely the QBO and ENSO events. The CCMVal REFB1 simulations with increasing GHGs and ODSs, solar, QBO and volcanic forcing as well as prescribed, observed SSTs have been repeated with filtered SST and QBO forcings. The SSTs and the sea ice have been filtered to remove 2-3 year and larger than 10 year signals related to the QBO and solar cycle. And the observed equatorial wind data have been filtered to retain signals only between 9-48 months excluding ENSO and solar cycle signals. Ideally, an ensemble of simulations should be integrated. Three GCMs participate so far, i.e. EMAC (Kubin, Langematz), MRI (Shibata, Kodera), and WACCM (Matthes). First results have been presented from the EMAC run and a more complete comparison will follow at the SCOSTEP meeting this summer. Other possible experiments will be discussed during the SCOSTEP meeting in Berlin.