Project: **169**

Project title: **Gekoppeltes Ozean-Atmosphären-Stratosphärenmodell**

Project lead: **Ingo Kirchner**

Report period: **2016-01-01 to 2016-12-31**

Schwerpunkte des Projekts

Die Ressourcen des Projektes wurden auf zwei Bereiche aufgeteilt. Einerseits wurden Sensitivitätsexperimente mit dem Hamburger ESM zur Untersuchung des Einflusses von Datenassimilation durchgeführt. Dies wurde im Rahmen einer Kooperation mit dem Institut für Ozeanographie der Russischen Akademie der Wissenschaften "P.P. Shirshov" in Moskau realisiert. Andererseits wurde das WRF Modell mit zusätzlichen Komponenten (UCM und CHEM) zur Untersuchung des Wärmeinseleffekts von Berlin angewendet.

Experiments with Kalman filter assimilation (K.Belyaev, N. Tuchkova)

Several ensemble experiments have been performed with and without data assimilation with Kalman filter assimilation scheme and its modifications. In these experiments the initial conditions of temperature and salinity have set up which corresponded to the conditional 1850 year and then spin up procedure has been realized during 150 years until the model reaches the stable current state in the ocean. After that the model output has been corrected by sea level data over entire ocean using the data assimilation. Results have been analyzed and investigated mostly focused in the Arctic Zone of Russian Federation.

Along with the standard Extended Kalman filter scheme the author’s assimilation method has been exploited. Both schemes have been applied to the Earth System Model (ESM) of Max Planck Institute for Meteorology. The results of those experiments have been compared and analyzed. In particularly, it has been demonstrated that the author’s method is more general and the EnKF is the special case of his method if parameters are selected by specific ways.

Data from archive AVISO (Archiving, Validating and Interpolating Satellite Ocean Data) over the entire ocean have been used in the assimilation experiments. The computations have been executed from 2000 until 2016 during 15 years and data were assimilated each 3 month from 2010 until 2012.

The output results of the ESM have been investigated and the specific characteristics in the a priori selected Arctic zone have been examined. The chosen characteristics are the ice thickness and ice compactness (or concentration).

Fig 1 and 2 show the ice thickness coverage in Arctic region. Fig 1 shows the difference between analysis and control (i.e. free run model without assimilation) after assimilation on the middle of 2011.

Fig1 demonstrates that after assimilation the ice thickness valuable decreases almost everywhere in Arctic including Russian Arctic Region except narrow zone northward of Canada. These results have very good evidence from independent observations. For instance, according to Canadian arctic Institute the observed ice concentration is close to 70-75%, the model calculations after assimilation give about 70% and without assimilation give more than 80%.

The ice thickness difference between the assimilated (analyzed) and control (without assimilation) fields witnesses to the temperature grows in Arctic zone which regards to the natural tendencies.

Fig 2 shows the substantial difference of time variability of the ice thickness between analyses and control. It is seen that the model demonstrates the overestimation in its forecast for 2010 -2012 under holding the general trend which corresponds to the natural data.

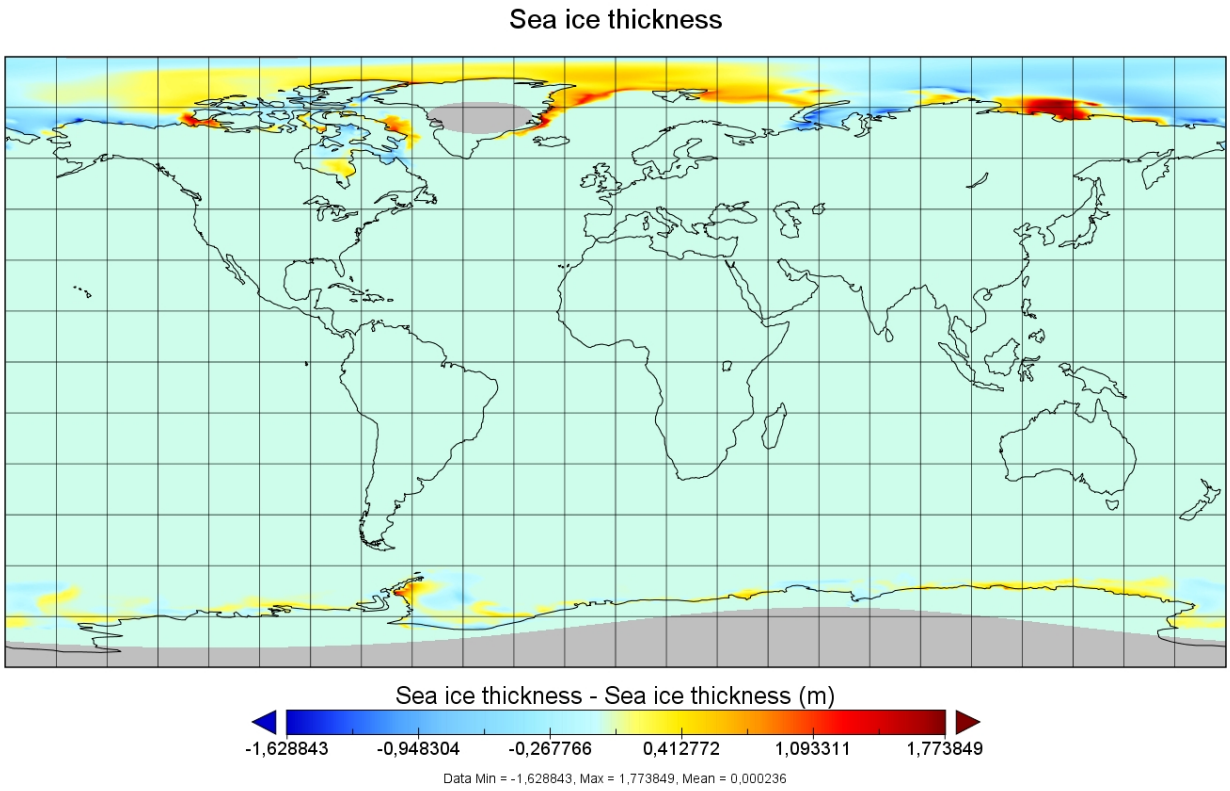

Fig. 1 Ice thickness difference (control-analysis), 30.06.2011

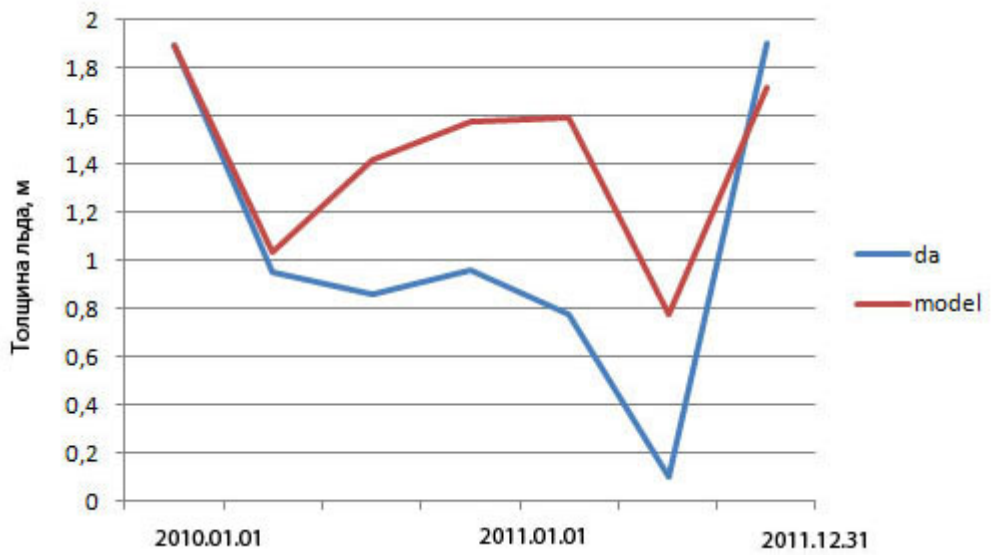

Fig. 2: The time behavior of average ice thickness difference on period 2010-2012. Control- red, Analysis-blue.

Experiments with WRF for urban region of Berlin (Huidong Li)

During report year the meso-scale climate model WRF was coupled with UCM and CHEM on Mistral/DKRZ. The following topics are studied:

1) The impact of different land cover data on the simulation of urban heat island in Berlin using WRF.

In order to evaluate the impact of different land cover data on urban heat island (UHI) simulation, a comparative study between CORINE land cover (CLC) and Urban Atlas (UA) with fine resolution, and United States Geological Survey (USGS) data with coarse resolution, was conducted using the Weather Research and Forecasting Model (WRF) for Berlin. The results show that simulations using the UA and CLC perform better than that using the USGS for both air and land surface temperatures. The USGS simulation underestimates the temperature in rural areas, and overestimates the temperature in central city areas. The UA and CLC simulations more accurately present the distribution of UHI, while the USGS simulation underestimates the extent of UHI. The urban heat island intensity of both air temperature (UHII) and land surface temperature (SUHII) are high at night, and low in daytime, with a sharp decrease and increase process in the early morning and evening, respectively. The SUHII is higher than the UHII, with more drastic diurnal variation. The USGS simulation overestimates UHII and SUHII than the CLC and UA simulations. In daytime, the higher net radiation and Bowen ratio in central city areas, alongside lower net radiation and Bowen ratio in rural areas, leads to a stronger simulated UHI in the USGS simulation. At night, the USGS simulation shows a larger difference of energy loss through longwave radiation and energy release from ground heat flux between central and rural regions, causing the stronger simulated UHI. As the urban fraction increases, both air and land surface temperatures increase, with a particularly strong correlation between land surface temperature and urban fraction. One paper was prepared and submitted. Now it is under review, see Huidong Li, Michael Wolter, Sahar Sodoudi. (2016) Impact of land cover data on urban heat island simulation using the WRF Mesoscale Model. Theoretical and Applied Climatology.

2) The calculation of urban canopy parameters and its application in simulating urban climate and air pollution using WRF/UCM/CHEM

Urban parameters are essential for the simulation of urban climate and air pollution. This research calculated the urban geometry parameters using 3D building and street data, and the optical parameters, including albedo and emissicivity, using remote sensing data for Berlin. Then these parameters were used to updated the urban table within the UCM of WRF, and simulated the urban climate and air pollution in summer and winter. Now the simulations are running. The results will be evaluated later. One paper is in preparation, and will be finished within this year.