Project: **169**

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

HAVE TO BE CHANGED IN "*Klimamodellierung mit dem Virtuellen Labor für Erdsystem Studien***"**

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Report period: **2019-01-01 to 2019-12-31**

Sensitivity experiments for studying the monsoon effect of explosive volcanic eruptions (Zhihong Zhuo, Ingo Kirchner)

Some sensitivity tests are made to explore whether extratropical volcanic eruptions have larger climate effects than tropical volcanic eruptions, to study the spatio-temporal characteristics of climate response to volcanic eruptions in different hemispheres, and to investigate the mechanisms behind the climate responses to volcanic eruptions at different latitudes. Explorations on the impact of volcanic eruptions on the El Niño-Southern Oscillation (ENSO) are also made. We coupled the volcanic forcing data produced from the Easy Volcanic Aerosol (EVA) module (Toohey et al. 2016) to the low-resolution (LR) version of MPI-ESM model (Giorgetta et al., 2013) to simulate the 1991 Pinatubo eruption-like volcanic eruptions at different latitudes, specifically, 0° for the equatorial eruption (EQ case), and 30° N and 30° S for the Northern and Southern hemispheric eruption (NH and SH cases). After 50 model years of spin-up run, we made 23 ensembles of control run without any volcanic eruption in the modeled year of 1986-1996, then 10 ensemble members were selected with a neutral or weak ENSO condition in the period of 1990-1992, then 10 ensemble members were simulated in the period of 1990-1996 for each of the three eruptions cases (i.e. NH, EQ, SH cases). These simulations contribute to the third research tasks of my PhD studies. Analysis are also directly made at DKRZ. Experiments and analysis results are summarized in the second and fifth chapter of my PhD thesis. The results will also be written into articles to be published in peer-reviewed journals. Following figures shows the volcanic forcing produced from EVA (Toohey et al. 2016) which was used in the model MPI-ESM-LR (Giorgetta et al., 2013).

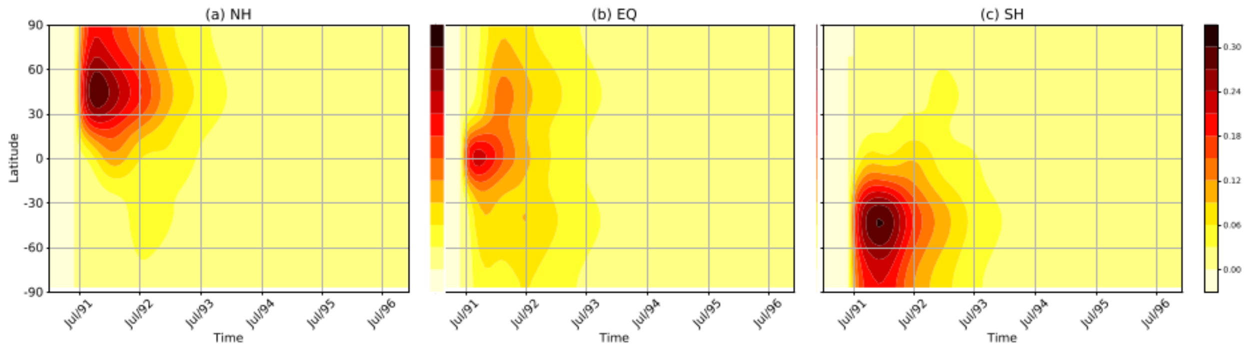

Figure 1: The zonal mean distributions for the NH (a), EQ (b) and SH (c) volcanic eruption cases generated by Easy Volcanic Aerosol forcing generator (Toohey et al. 2016).

So far, for the three volcanic eruption cases, only summer eruptions on June 15 were simulated. To better understanding the impact of eruption season on the climate response, simulations for winter eruptions on December 15, 1990 will be performed in the next two months, which includes 30 ensemble members of simulations for the period of 1990-1996. It takes around 8 hours to finish one simulation year with 2 nodes for our experiment, this means that with 1 node, we need at least another 3360 node hours (16 hours *7 years * 30 ensembles) for these simulations.

Following figures shows the global distribution of surface temperature response to the simulated volcanic eruptions at different latitudes.

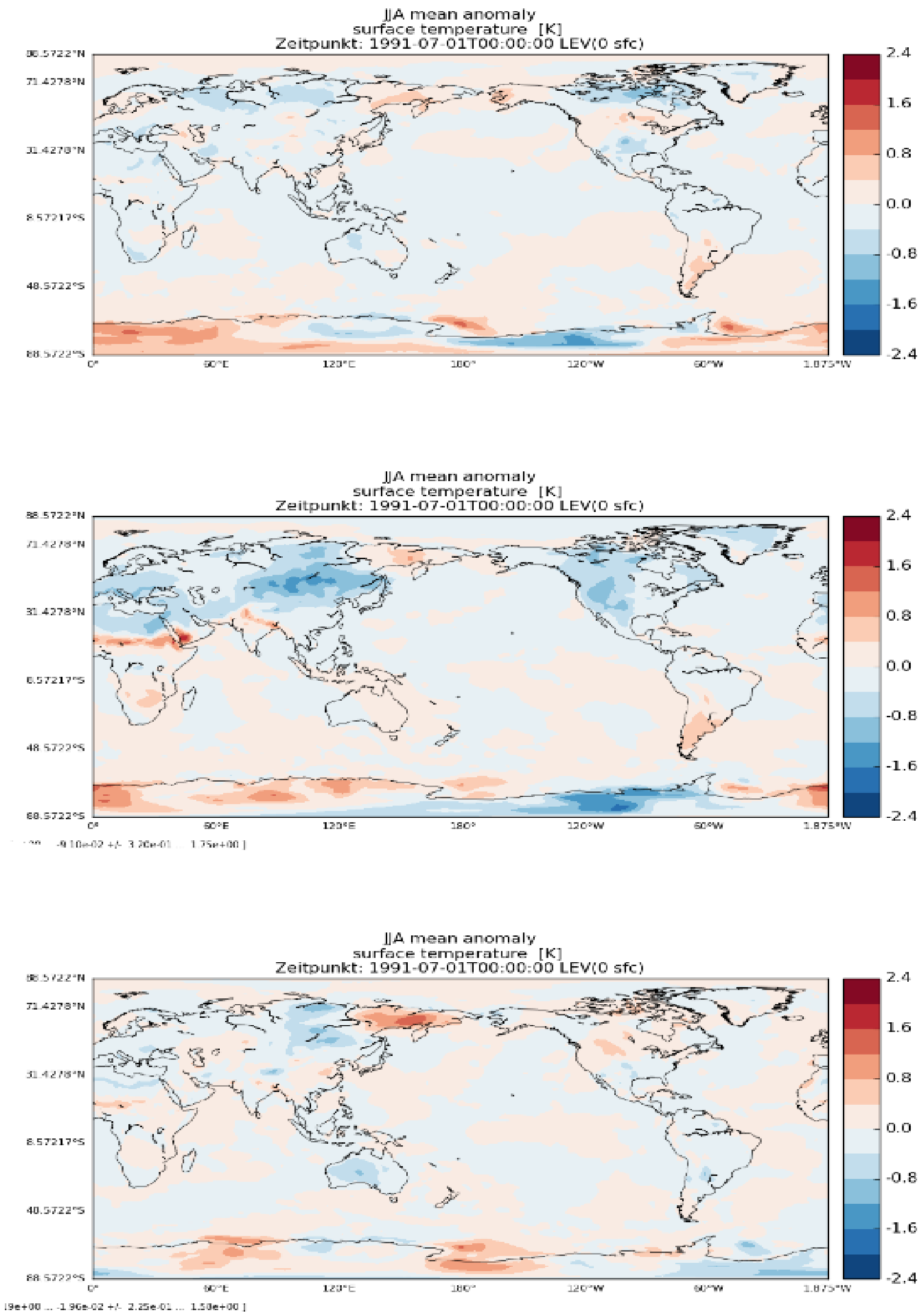

Figure 2: Spatial distribution of surface temperature (T) anomaly after the EQ (top), NH (middle) and SH (bottom) volcanic eruptions in 1991 July.

References:

Giorgetta, M. A., Jungclaus, J., Reick, C. H., Legutke, S., Bader, J., Böttinger, M., . . . Stevens, B. (2013). Climate and carbon cycle changes from 1850 to 2100 in MPI-ESM simulations for the Coupled Model Intercomparison Project phase 5. *Journal of Advances in Modeling Earth Systems, 5*(3), 572-597. doi:10.1002/jame.20038

Toohey, M., Stevens, B., Schmidt, H., & Timmreck, C. (2016). Easy Volcanic Aerosol (EVA v1.0): an idealized forcing generator for climate simulations. *Geoscientific Model Development, 9*(11), 4049-4070. doi:10.5194/gmd-9-4049-2016

Zhihong Zhui (2019). The hydrological effects of explosive volcanic eruptions in the Asian monsoon region. Dissertation FUB.

Simulation of Urban Climate of Berlin with WRF (Huidong Li, Sahar Sodoudi)

We run the WRF/CHEM model in mistral cluster to simulate the urban climate and air pollution in Berlin together. The modeling results of air pollution (e.g. aerosols optical depth, PM10 concentration) and meteorological variables (e.g. temperature, radiation) were evaluated. We found the WRF/CHEM model can generally capture the spatiotemporal patterns of observation. For example, both the simulation and observation shows higher PM10 concentrations in urban areas, compared to the surrounding rural areas (Fig. 1). Meanwhile, the model can simulate the urban heat island effect well.

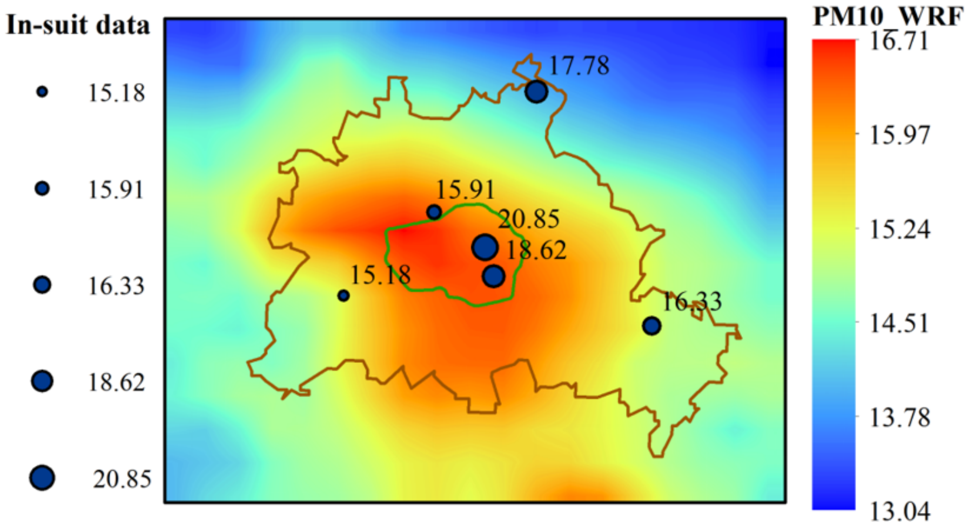

Figure 1. Comparison of the spatial patterns of observed and simulated PM10 concentrations.

We investigated the impact of aerosols on regional climate through scenarios simulation using WRF/CHEM. The comparison between the simulations with and without aerosols effect shows that aerosols can reduce solar radiation reaching to the surface, resulting in the decrease of surface temperature (Figure 2). The reductions of radiation and temperature are positively correlated with AOD.

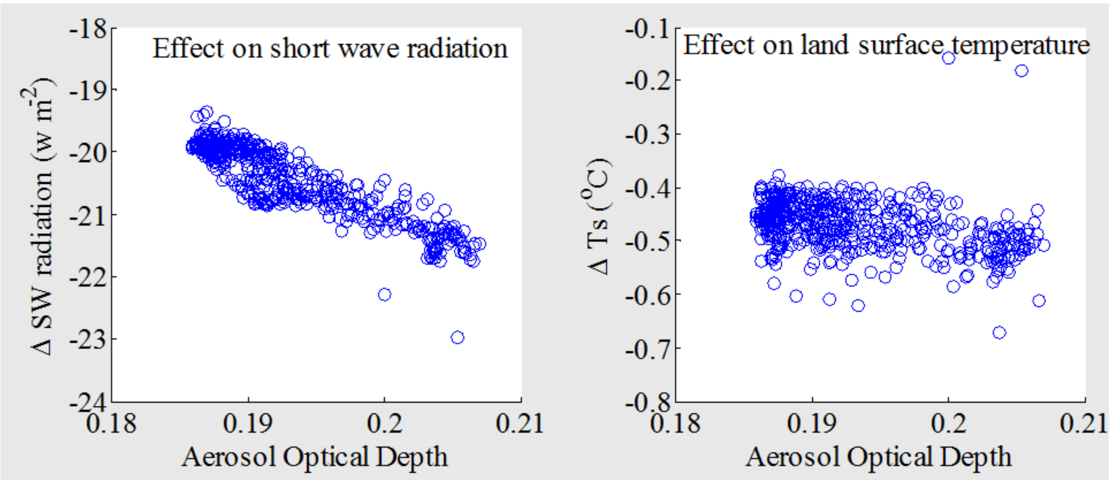

Figure 2. The impact effect of aerosols on radiation and temperature.

References:

Li H., Sodoudi S. et al. Urban Pollution Island and its Relationship with Urban Climate in Berlin. Atmospheric Research. (under review).