Geophysical Research Abstracts
Vol. 18, EGU2016-12718, 2016
EGU General Assembly 2016

The mechanism of polar vortex strengthening after large tropical volcanic eruptions as simulated in the MPI-ESM

Matthias Bittner (1,2), Claudia Timmreck (1), Hauke Schmidt (1), Matthew Toohey (1,3), and Kirstin Krueger (4)

(1) Max-Planck-Institut für Meteorology, Hamburg, Germany , (2) International Max Planck Research School on Earth System Modeling (IMPRS), Hamburg, Germany, (3) GEOMAR Helmholtz-Centre for Ocean Research Kiel, Kiel, Germany , (4) University of Oslo, Oslo, Norway

State-of-the-art climate models that have participated in the recent CMIP5 model intercomparison activity do, on average, not produce the strengthened northern hemispheric (NH) polar vortex after historical large tropical volcanic eruptions as suggested by observations. Here, we study the impact of volcanic eruptions of different strength on the NH winter stratosphere in the MPI-ESM Earth system model. We compare the dynamical impact in ensemble simulations of a very large Tambora eruption in 1815 with the response to the two largest eruptions of the CMIP5 historical simulations (Krakatau, 1883; and Mt. Pinatubo, 1991). The mechanism, of the strengthening of the vortex can clearly be identified in the simulations for the Tambora eruption. An increased meridional stratospheric temperature gradient is often assumed to be the cause of the vortex strengthening. The position of the maximum temperature anomaly gradient is located, however, at approximately 30°N, far away from the polar vortex . Hence, the vortex strengthening is caused only indirectly by the changed temperature gradient which first produces a subtropical wind anomaly in early winter. This leads planetary waves propagating more equatorward causing finally the vortex strengthening. The simulated response to the weaker eruptions of Krakatau and Pinatubo is also a slight average strengthening of the polar vortex, but individual ensemble members differ strongly indicating that internal variability can mask the impact on the polar vortex in the NH post-eruption winter under such moderate eruption strengths. The large forcing of the Tambora eruption does not only cause a mean vortex strengthening but also a reduction of the ensemble variability of the vortex.