Project: **549**

Project title: **Modellierung von Klimaeffekten von mittel und suedamerikansichen Vulkanen**

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Report period: **1.1.2014 - 31.12.2015**

Building upon expertise gained in prior years within the Project 549 (Metzner et al., 2012; Toohey et al., 2013), substantial progress was achieved within the past reporting period in investigating the climate anomalies of the decades following 536 CE, which is speculated to be connected to the Ilopango eruption of Central America.

The 536/540 volcanic double event (Toohey et al., submitted)

Volcanic activity in and around the year 536 CE led to severe cold, famines, and has been speculatively linked to large-scale societal crises around the globe. Using the MAECHAM5-HAM coupled aerosol-climate model, with eruption parameters constrained by recently re-dated ice core records and historical observations of the aerosol cloud, we have reconstructed the radiative forcing resulting from a sequence of two unknown major volcanic eruptions in 536 and 540 CE (Fig 1). We estimate that the decadal-scale Northern Hemisphere (NH) extra-tropical radiative forcing from this volcanic “double event” was larger than that of any period in existing reconstructions of the last 1200 years.

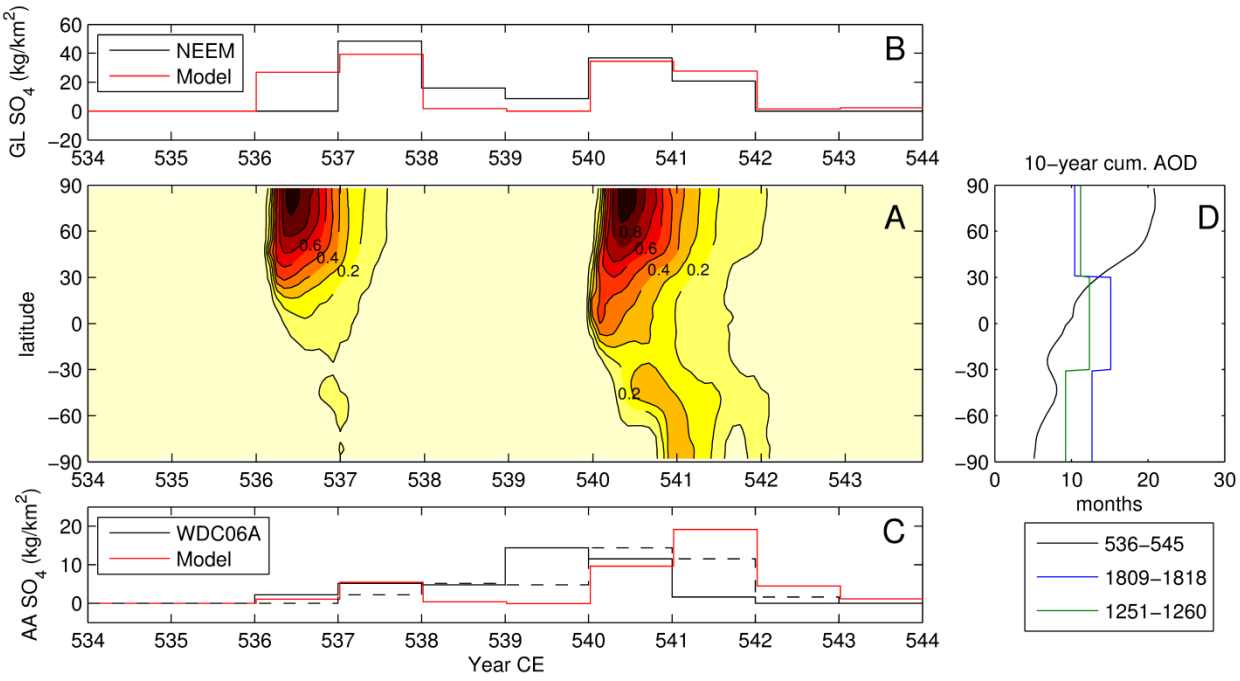

Figure 1: Volcanic radiative forcing 536-544 CE estimated from ice core records. (A) Reconstructed zonal mean aerosol optical depth at 550 nm from MAECHAM5-HAM and used as radiative forcing in MPI-ESM simulations. Timeseries of annual volcanic sulfate deposition from the (B) Greenland NEEM(-2011-S1) ice core (Sigl et al., 2012) and (C) Antarctic WDC06A ice core (Sigl et al., 2012) compared to bias-corrected sulfate flux to Greenland and Antarctica in MAECHAM5-HAM simulations (Toohey et al., 2013). Antarctic ice core flux shifted by +1 year is shown by dashed black line. (D) Decadal cumulative AOD, compared to that of the two largest NH decadal forcings of the volcanic AOD reconstruction of Ref (Crowley and Unterman, 2013).

Simulations of the time period with the MPI-ESM, including the volcanic forcing, show peak NH mean temperature anomalies reaching more than -2°C (Fig. 2), and show agreement with the limited number of available maximum latewood density temperature reconstructions. The simulations also produce decadal-scale anomalies of Arctic sea ice. The simulated cooling is interpreted in terms of probable impacts on agricultural production in Europe, and implies a high likelihood of multiple years of significant decreases in crop production across Scandinavia in the years following 536 CE, supporting the theory of a connection between the 536 and 540 eruptions and evidence of societal crisis dated to the mid-6th century.

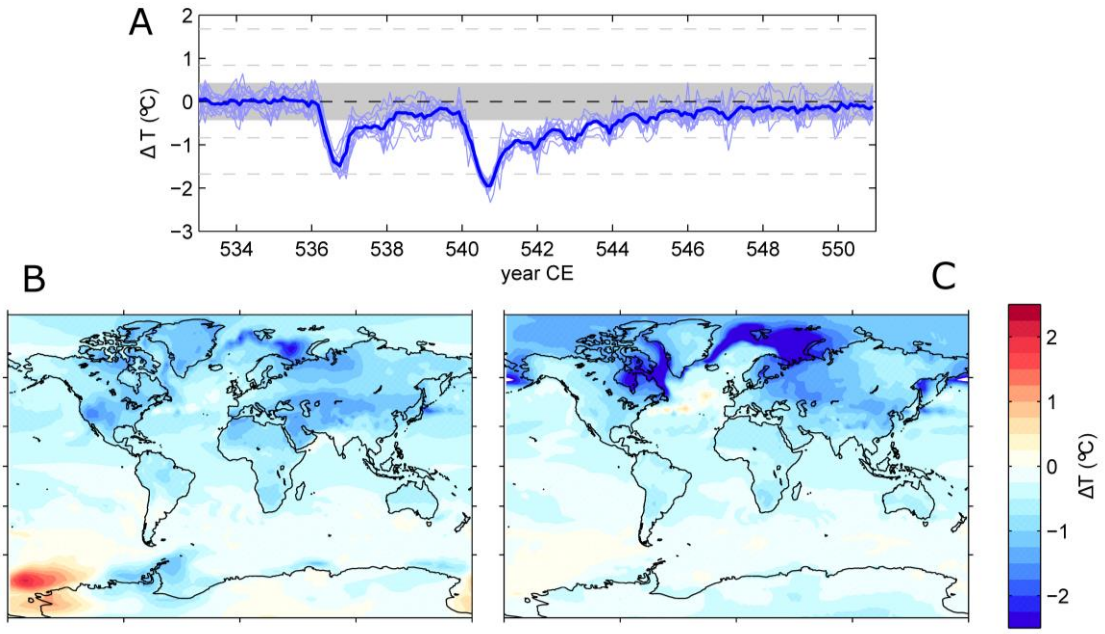

Figure 2: Surface temperature anomalies simulated by the MPI-ESM. (A) Timeseries of Northern Hemisphere mean monthly mean surface temperature anomalies: individual ensemble members shown in light blue, ensemble mean in thick blue. Gray shading show the ±2σ variability of the control run, dashed grey lines show the ±4σ and ±8σ variability levels. Global maps of the 536-545 CE decadal mean boreal (B) summer and (C) winter mean temperature anomalies

References

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