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Supplement of

Revisiting the observed surface climate response to large volcanic eruptions

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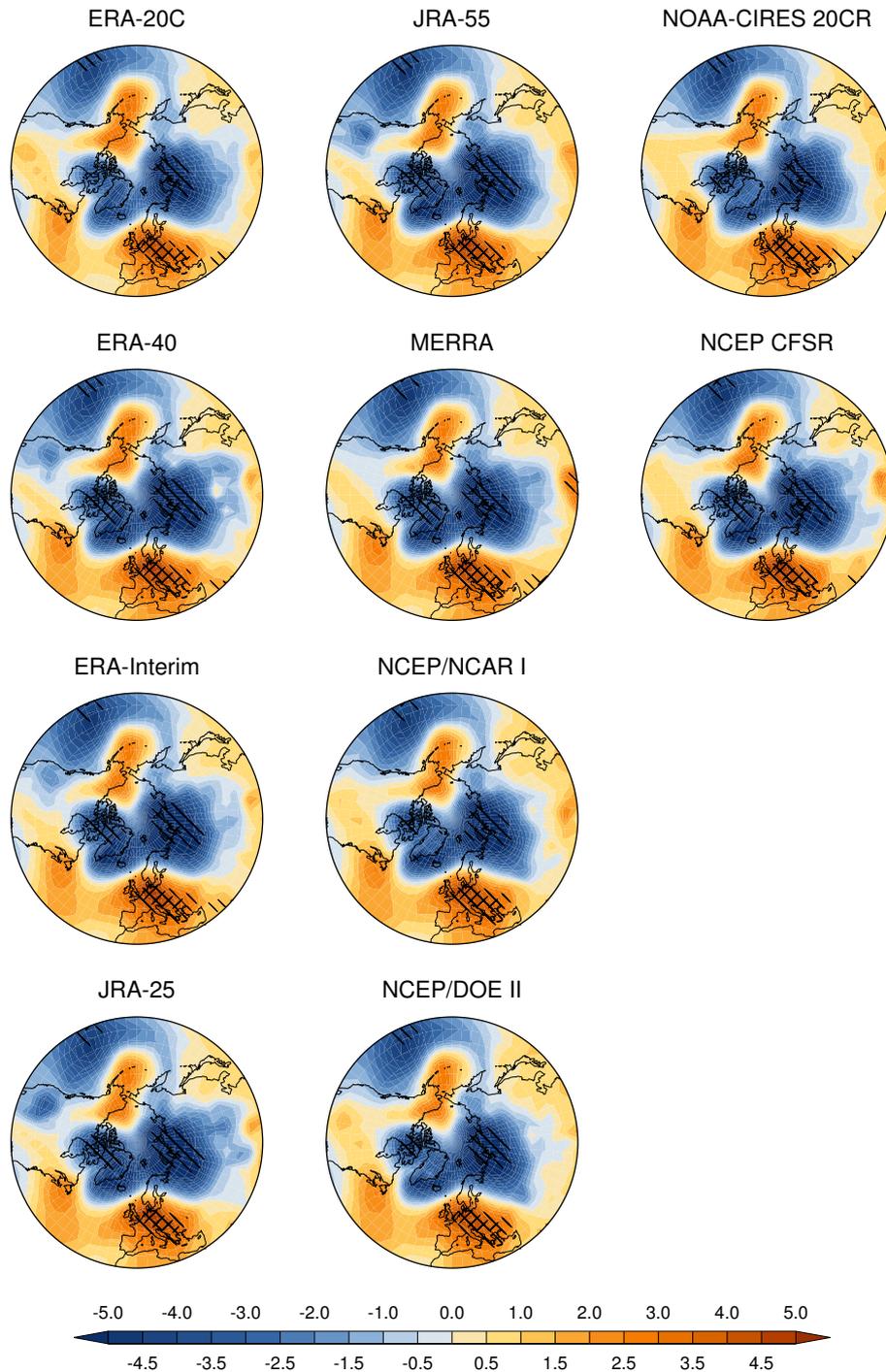


Figure S1. SLP anomalies (hPa) in the Northern Hemisphere in the first post volcanic winters (DJF) averaged over the two volcanic eruptions of Mt. Pinatubo (1991) and El Chichón (1982) for all 10 reanalysis datasets. Anomalies are calculated with respect to the mean for the years 1979-2012, excluding the following two years after the eruptions. Single diagonal lines correspond to the 90% and double diagonal lines to the 95% confidence level obtained with a Monte Carlo test of two independent samples.

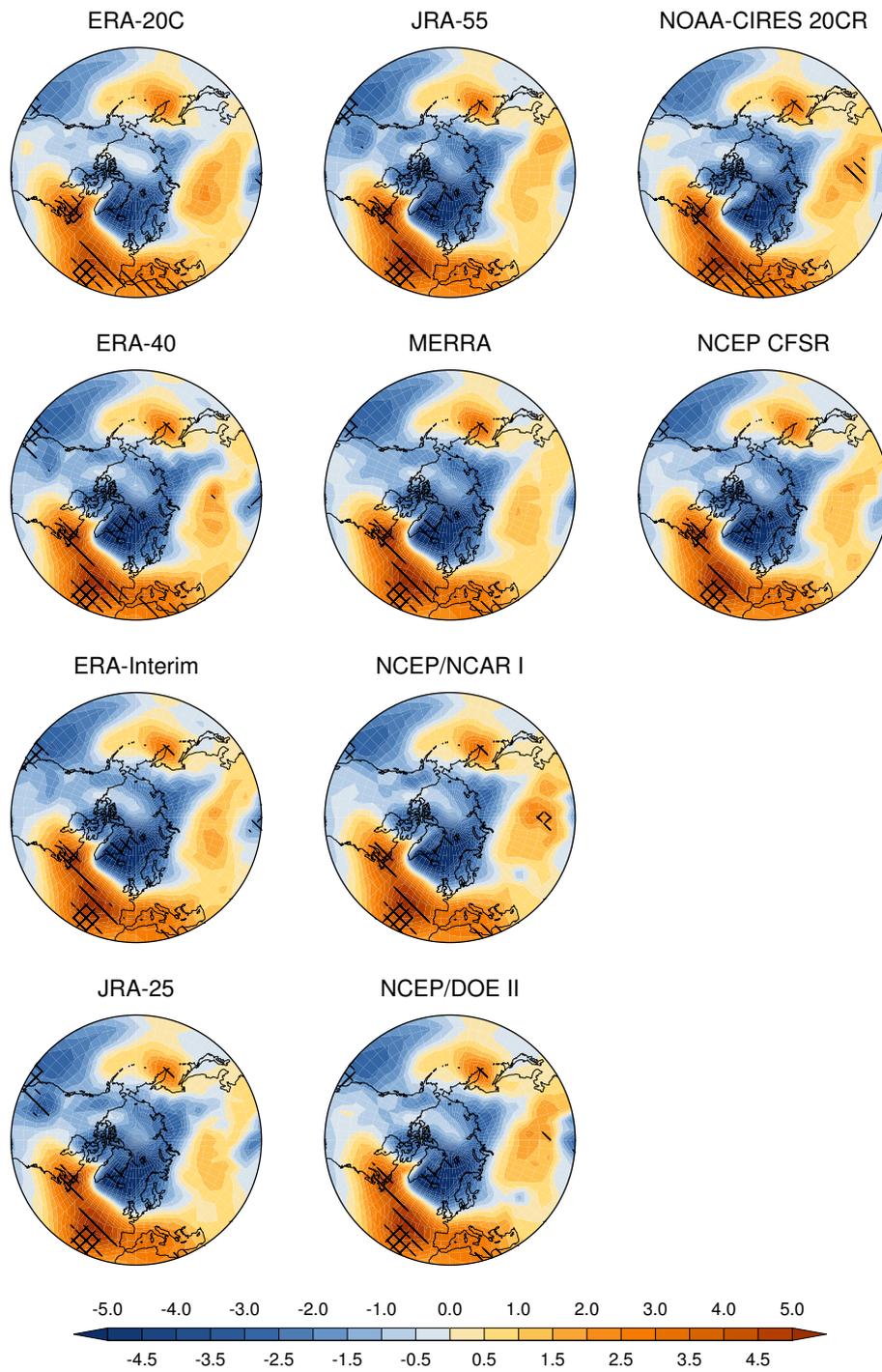


Figure S2. As Figure 1, but for the second post volcanic winter.

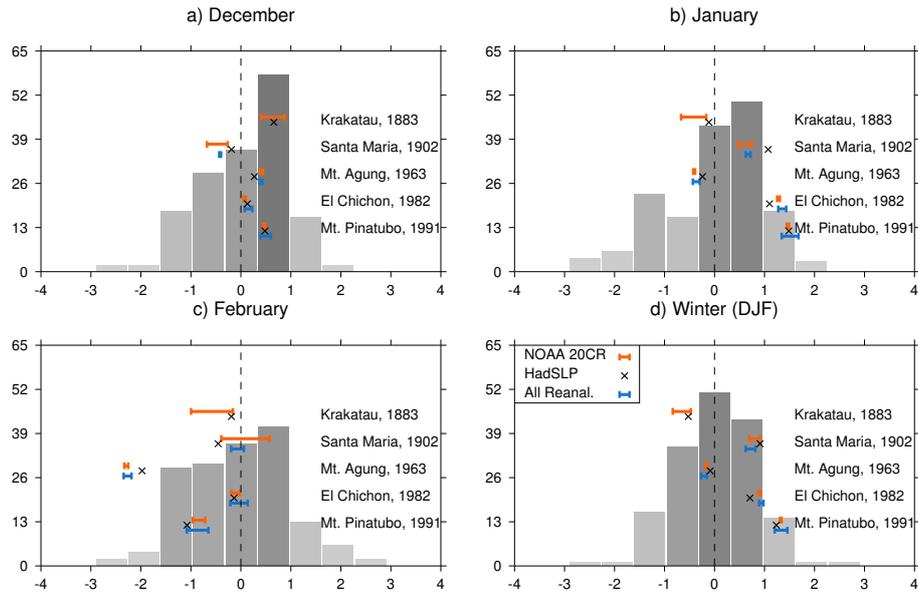


Figure S3. Monthly North Atlantic Oscillation (NAO) index of the second winter after 5 volcanic eruptions (a-c) and the winter mean (d), calculated with HadSLP2 observation data and reanalysis data. All data is calculated with respect to the mean for the years 1979-2012, excluding the following two years after the two eruption. The EOF is calculated over the period 1979-2012 for every product separately. The histogram shows the NAO index of the 163 years of observation data (1850-2012). The blue lines show the reanalysis data spread of the NAO index for the winter after Mt. Pinatubo and El Chichón. The orange lines show the 90% ensemble spread of the NAO after all 5 volcanic eruptions calculated with the NCEP-20CR dataset.

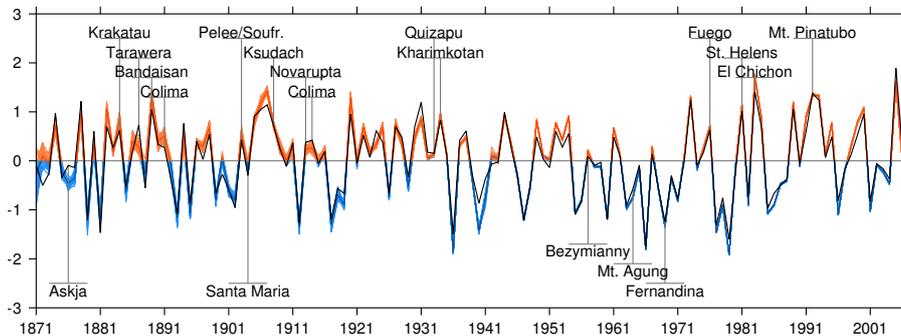


Figure S4. Winter mean NAO index from 1871 until present, calculated with HadSLP2 observation data and NCEP-20CR ensemble data. All data is calculated with respect to the mean for the years 1979-2012, excluding the following two years after the two eruption. The EOF is calculated over the period 1979-2012. Every single thin coloured line represents one ensemble of the NCEP-20CR reanalysis. Thick coloured line shows the NCEP-20CR ensemble mean and black line shows HadSLP2 data. All volcanoes from Figure 2 are indicated by a grey line at the first winter after the eruption or at the second winter after the eruptions in the case of Fuego and Santa María. All volcano names which are above the zero line were followed by a positive NAO in the first (or second) winter after the eruption according to the HadSLP2 data and all volcano names which are below the zero line were followed by a negative NAO.

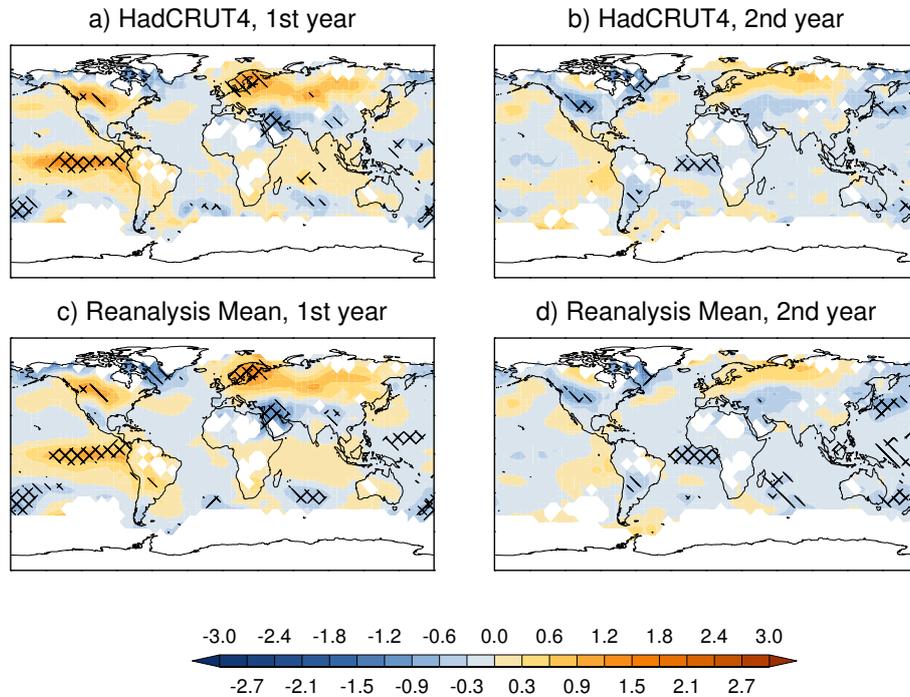


Figure S5. Observed and multi-reanalysis mean TAS anomalies (K) averaged over the first year (a and c) and second year (b and d) after the eruption and over the three volcanic eruptions Mt. Pinatubo (1991), El Chichón (1982) and Mt. Agung (1963). a) and b) show the mean anomaly for the HadCRUT4 observations and c) and d) show respectively the mean anomaly of the five reanalysis datasets, containing this period (Table 1). Anomalies are calculated with respect to the average over the years 1961-1990, consistent to the HadCRUT4 dataset. Single diagonal lines correspond to the 90% and double diagonal lines to the 95% confidence level obtained by a Monte Carlo test of three independent samples. The Figure is similar to Figure 6 with the difference, that no ENSO removal is applied to the data.

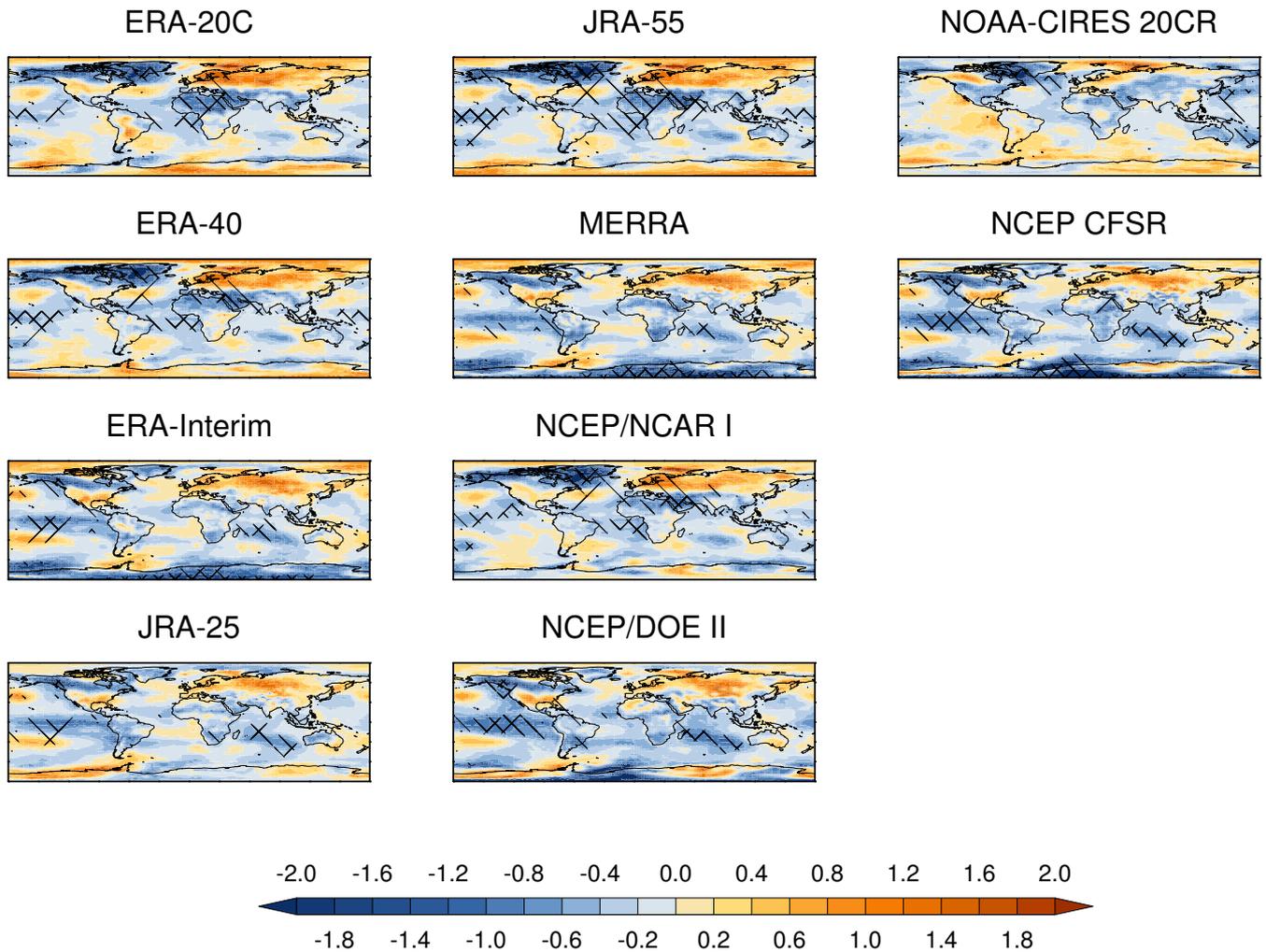


Figure S6. TAS anomalies (K) averaged over the first year after the eruption and over the two volcanic eruptions Mt. Pinatubo (1991) and El Chichón (1982) for all 10 reanalysis products. Anomalies are calculated with respect to the average over the years 1979-2012. Single diagonal lines correspond to the 90% and double diagonal lines to the 95% confidence level obtained with a Monte Carlo test of two independent samples.

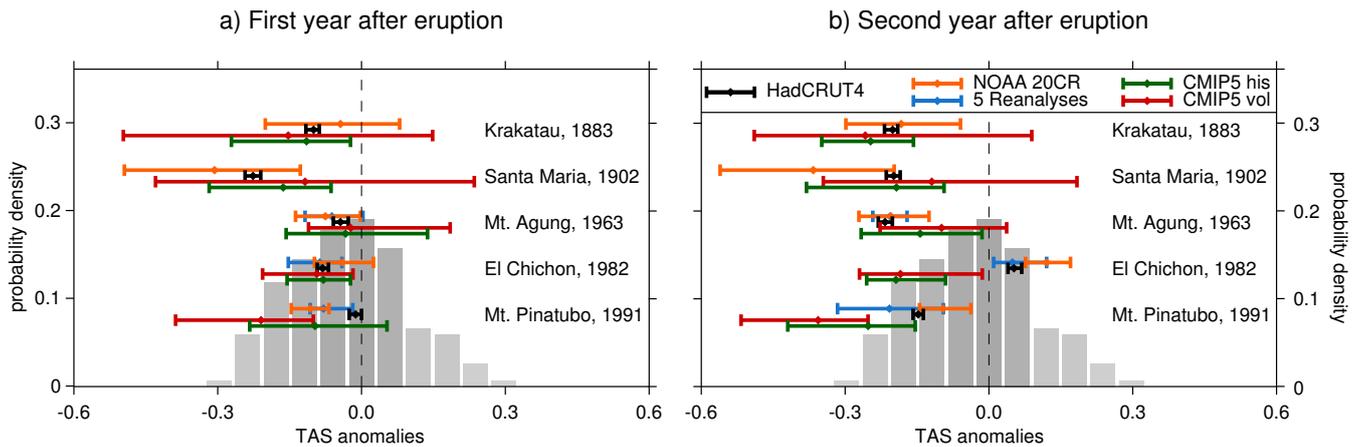


Figure S7. Global TAS anomalies (K) averaged and over the first year (a) and second year (b) after five volcanic eruptions, calculated with HadCRUT4 observation data and reanalysis data. Anomalies are calculated with respect to the average over the years 1961-1990, consistent to the HadCRUT4 dataset. The histogram shows the anomalies of 153 years of observation data (1855-2007). The first and last five years are left out because of the trend removal. The blue lines show the reanalysis data spread of the TAS anomalies for the years after all eruptions except Krakatau and Santa María. The orange lines show the 90% ensemble spread of TAS after all five volcanic eruptions calculated with the NOAA-20CR dataset. The mean response is indicated by the dot between the whiskers.