Transient simulations of the last deglaciation in the framework of the PalMod project as contributions to PMIP4

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Abstract

The last deglaciation (21-9 kyr BP), which marked the transition between the last glacial and present interglacial period, was punctuated by a series of rapid (centennial and decadal) climate changes. Numerical climate models are useful for investigating mechanisms that underpin these events, especially now that – due to availability of increased computational power – some of the complex models can be run over the period of multiple millennia. In phase 1 of the Palmod project, we aim to perform transient simulations of the last deglaciation in order to quantify contributions of different climatic factors using complementary models and coupling strategies, including a setup in which the climate models are fully coupled to land-ice sheet models. In a 2nd phase also the full interaction with biogeochemical cycles is envisaged. Within PalMod continuous time series of the three greenhouse gases CO_2, CH_4, and N_2O have now been constructed, based on a state-of-the-art compilation of available ice core data, which have been carefully selected, partially corrected and spline-smoothed to an equidistant time step of 1 year. The full data sets, including uncertainty estimates, are covering the last 156 kyr and are supported by instrumental measurements until the year 2016 CE. These data might be used for the deglaciation and other PMIP4 related experiments covering parts of the last 150 kyr, We suggest that other PMIP participants use the same GHG data sets to force their models, which might then facilitate the intercomparisons. This GHG data compilation is documented here:

Köhler, P., Nehrbass-Ahles, C., Schmitt, J., Stocker, T. F., and Fischer, H. (2017) A 156 kyr smoothed history of the atmospheric greenhouse gases CO_2, CH_4, and N_2O and their radiative forcing, Earth Syst. Science Data, 9, 363-387, doi: 10.5194/essd-2017-6. The related GHG data and simplified estimates of the related radiative forcing can be accessed at doi: 10.1594/PANGAEA.871273. Link to the project: www.palmod.de

Figure 1 (below): CO_2 spline covering all data: 2016CE–156307BP. Error bars around the ice core data points are ±2σ. WDC data have been adjusted to reduce offsets. In (a) the right axis contains the resulting radiative forcing calculated after Myhre et al. (1998). (b) Total uncertainty of the spline based on three individual error sources. (c) Temporal resolution of the CO_2 data points underlying the spline on a log scale. Additionally, the prescribed time-dependent cutoff period P_c is plotted, including its variation by ±50 %, which has been used to determine σ_1.

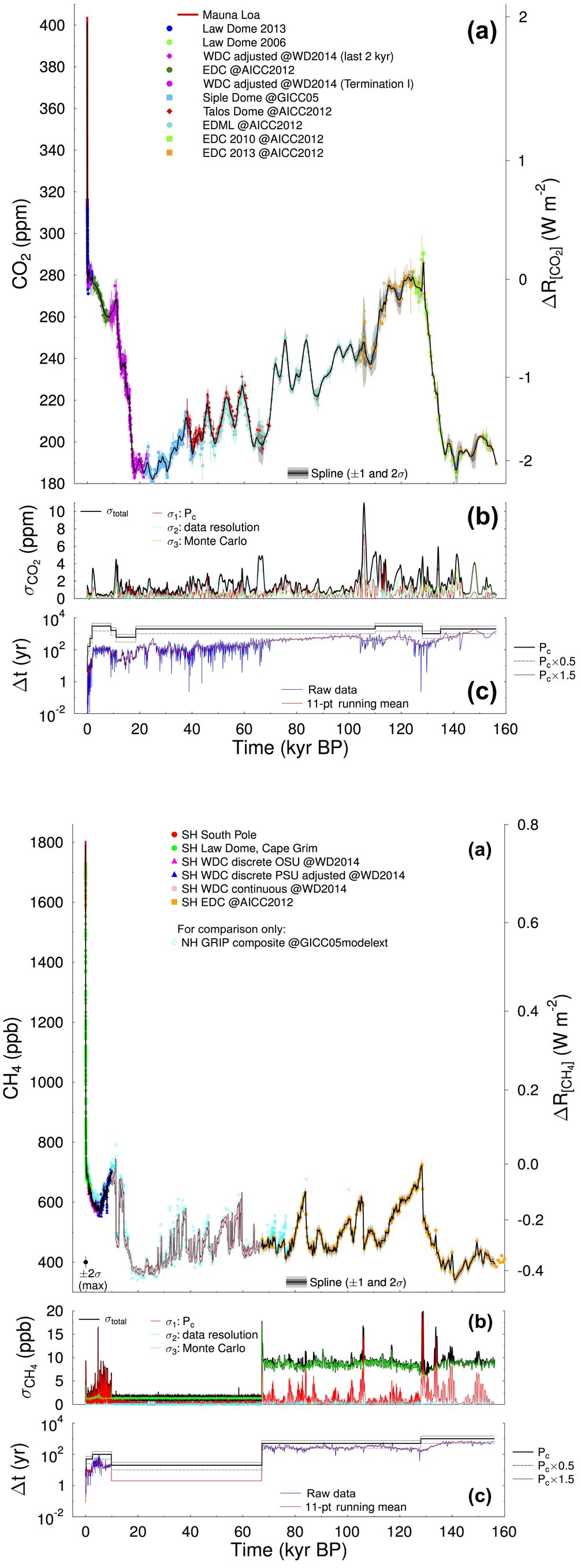

Figure 3 (below): N_2O spline covering all data: 2016CE–134519BP. The maximum ice core data uncertainty (±2σ) is sketched in the lower left corner. In (a) the right axis contains the resulting radiative forcing approximated after Myhre et al. (1998), neglecting interacting effects of CH_4 and N_2O. Filled symbols: data taken for spline; open symbols: data not taken for spline. (b) Total uncertainty of the spline based on three individual error sources. (c) Temporal resolution of the N_2O data points underlying the spline on a log scale. Additionally, the prescribed time-dependent cutoff period P_c is plotted, including its variation by ±50 %, which has been used to determine σ_1.

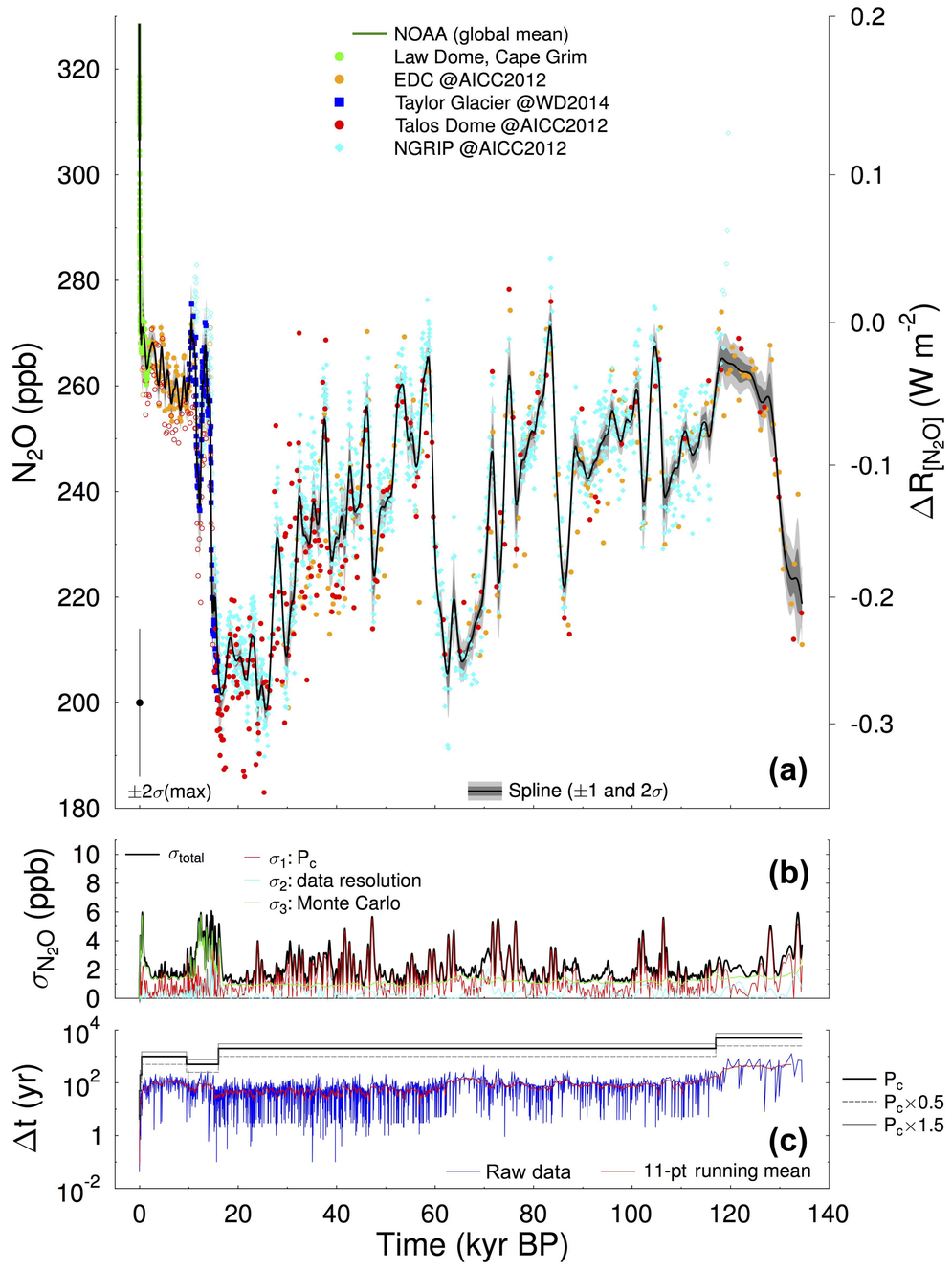

Figure 2 (right): CH_4 spline covering all data: 2016 CE–156 211 BP. The maximum ice core data uncertainty (±2σ) is given in the lower left corner. In (a) the right axis contains the resulting radiative forcing approximated based on Myhre et al. (1998), but neglecting interacting effects of CH_4 and N_2O and considering indirect effects of CH_4 on stratospheric H_2O and tropospheric O_3 (Hansen et al., 2005; Köhler et al., 2010). The latitudinal origin of data is indicated by NH and SH, indicating Northern and Southern Hemisphere, respectively. (b) Total uncertainty of the spline based on three individual error sources. (c) Temporal resolution of the CH_4 data points underlying the spline on a log scale. Additionally, the prescribed time-dependent cutoff period P_c is plotted, including its variation by ±50 %, which has been used to determine σ_1.

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