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Model calculations of the age of firn air across the Antarctic continent

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Abstract. The age of firn air in Antarctica at pore close-off depth is only known for a few specific sites where firn air has been sampled for analyses. We present a model that calculates the age of firn air at pore close-off depth for the entire Antarctic continent. The model basically uses four meteorological parameters as input (surface temperature, pressure, accumulation rate and wind speed). Using parameterisations for surface snow density, pore close-off density and tortuosity, in combination with a density-depth model and data of a regional atmospheric climate model, distribution of pore close-off depth for the entire Antarctic continent is determined. The deepest pore close-off depth was found for the East Antarctic Plateau near 72° E, 82° S, at 150±15 m (2σ). A firn air diffusion model was applied to calculate the age of CO_2 at pore close-off depth. The results predict that the oldest firn gas (CO_2 age) is located between Dome Fuji, Dome Argos and Vostok at 43° E, 78° S being 148±23 (1σ or 38 for 2σ) years old. At this location an atmospheric trace gas record should be obtained. In this study we show that methyl chloride could be recorded with a predicted length of 125 years as an example for trace gas records at this location. The longest record currently available from firn air is derived at South Pole, being 80 years.
Sensitivity tests reveal that the locations with old firn air (East Antarctic Plateau) have an estimated uncertainty (2σ) for the modelled CO_2 age at pore close-off depth of 30% and of about 40% for locations with younger firn air (CO_2 age typically 40 years). Comparing the modelled age of CO_2 at pore close-off depth with directly determined ages at seven sites yielded a correlation coefficient of 0.90 and a slope close to 1, suggesting a high level of confidence for the modelled results in spite of considerable remaining uncertainties.

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