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Cyclic variations of Antarctic sea ice cover during the Holocene: Combination of solar and internal forcing

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Diatom census counts in core MD03-2601 (66˚S – 138.5˚E – 750m) retrieved in the Adélie Trough off Dumont D'Urville, East Antarctica, allow to estimate regional sea ice history during the 9000-1000 calendar yrs BP period at decadal scale.

Sea ice was less present during the 7500-4000 yrs BP period (Hypsithermal) than during the 4000-1000 yrs BP period (Neoglacial). The transition between the Hypsithermal and the Neoglacial is very abrupt in the diatom records occurring in ∼200 years. Long-term changes in sea-surface temperature (SST) and sea ice cover (SIC) can be attributed to the combination of a delayed response to local orbital forcing and an oceanic storage of warmth (Renssen et al., 2005).

Diatom records show high amplitude variations at decadal to centennial timescales. Spectral analyses (Redfit – Schulz and Mudelsee, 2002 – and wavelets – Torrence and Compo, 1998) calculate periods at ∼1600 years, ∼1000 years, ∼575 years, ∼320 years, ∼230 years, ∼170 years, ∼110 years, and ∼90 years during the Hypsithermal and ∼1200 years, ∼580 years, ∼250 years, ∼150 years, ∼110 years and ∼90 years during the Neoglacial.

These periods are in agreement with periods of solar activity estimated from the $\Delta^{14}C_{residual}$ (Dean, 2000; this study). This suggests a casual impact of solar activity on SST and SIC during the Holocene. Because solar activity changes are very small it is however necessary to call on amplifying mechanisms such as UV radiations-ozone production (Shindell et al., 1999, 2001) and cosmic rays-cloud cover (Svensmark and

Friis-Christensen, 1997; Svensmark, 2000) to account for the amplitude of the climate response.

Periods at $\sim$1200 years and $\sim$320 years are comparable to periods of the "Southern Ocean flip-flop oscillator" (Pierce et al., 1995; Drijfhout et al., 1996; Osborn, 1997) demonstrating that internal climate variability also has an important impact on SST and SIC changes during the Holocene.

The two forcing interplay during the Holocene and possibly amplify one another. The shift from the 1600 yrs period to the 1200 yrs period at the Hypsithermal-Neoglacial transition however argues for a Early Holocene climate dominated by solar activity to a Late Holocene climate dominated by the thermohaline circulation as predicted from the spectral analysis of the$\mathrm{g}\Delta^{14}\mathrm{C}_{residual}$ (Debret et al., 2006).