



0.1 Migration Pulses of Arctic dinoflagellates during the mid-Oligocene Glacial Maximum

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A multitude of geochemical and biotic climate proxies indicates that the Eocene 'greenhouse' Earth gradually evolved towards an earliest Oligocene 'icehouse' Earth, eventually marked by the onset of Antarctic glaciation at ~ 33.3 Ma (Oi-1 event). This, however, was only the first of two major glacial events in the Oligocene. Subsequent to the Oi-1 event, benthic foraminiferal $\delta^{18}\text{O}$ records show a second positive excursion in the mid-Oligocene, consistent with a significant ice-sheet expansion and/or cooling at 27.1 Ma (Oi-2b) during magnetosubchron C9n. Here, we report on a mid-Oligocene, globally synchronous migration event of Arctic dinoflagellates towards lower latitudes during the upper half of magnetosubchron C9n. The sudden appearance and abundance increase of the dinoflagellate cyst genus *Svalbardella* at lower to middle latitudes in both hemispheres coincides with the Oi-2b benthic $\delta^{18}\text{O}$ event at ~ 27.1 Ma. This phenomenon has been observed in chronostratigraphically well-calibrated, continuous mid-Oligocene sections from the Tethys (Central Italy), Southern Ocean (ODP Site 1168, off Tasmania), and the North Sea Basin. Since representatives of *Svalbardella* are only known to consistently occur in the Eocene and Oligocene at northern high latitudes, thus suggesting that they represent cold-water elements, our records suggest that a marked SST decrease allowed this genus to mani-

fest itself at distinctly lower latitudes. Since *Svalbardella* has to date not been recorded from Eocene or Oligocene deposits at southern high latitudes, the record may suggest a trans-equatorial migration. However, since early Oligocene Southern Hemisphere high-latitude dinocyst records are yet scarce, this may also be due to a sampling artefact. Either way, we attribute the recorded invasion(s) of *Svalbardella* into low middle latitudes to a distinct episode of global surface-water cooling. The duration of the *Svalbardella* migrations and the episode of profound cooling is estimated as ~ 500 ka.