



Does the Southern Ocean have sleep apnea?

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Satellite microwave observations of Antarctic sea ice started in 1973, just in time to capture a massive open water area enclosed in winter sea ice, known as a polynya, within the Weddell Sea. This polynya was roughly the size of the United Kingdom and it lasted thru the winters of 1974-1976 with mixed layer depths >3000m observed in its vicinity. A similar Weddell Sea polynya hasn't been seen since. However, September 2017 satellite observations indicate that a new Weddell Sea polynya may be starting to form. The first aim of this research is to determine the impact (magnitude and duration) of the 1970s polynya on ocean carbon, biology, temperature, and volume transports. Secondly, how will the formation of a new large polynya impact 21st century climate projections? We address these questions with a coupled ocean (MOM5), sea-ice (SIS), biogeochemistry (WOMBAT) model at $\frac{1}{4}^\circ$ resolution with 50 vertical levels. In the model, we create a polynyas of similar size and duration as observed in the 1970s with a small wind perturbation localised over Maude Rise. We find that most of the observed deep Southern Ocean warming and deoxygenation, as well as the slowdown of the lower cell of the Southern Ocean overturning since the 1980s can be attributed to the multi-decadal recovery from the 1970s Weddell Sea polynya event. The polynya also increases the ocean-to-atmosphere carbon flux by >200% in the Atlantic sector of the Southern Ocean. In essence, the Southern Ocean breathed deeply from 1974-1976, and has been holding its breath since. When the Southern Ocean takes its next deep breath, the climate impacts will be pronounced and last for decades.