2016 OCEAN SCIENCES MEETING | AGU • ASLO • The Oceanography Society

21–26 February • New Orleans, Louisiana, USA

Abstract #90338

Global decadal climate variability driven by Southern Ocean convection

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Abstract Text:

Here we suggest a set of new “teleconnections” by which the Southern Ocean (SO) can induce anomalies in the tropical oceans and atmosphere. A 5000-year long control simulation in a coupled atmosphere-ocean model (CM2Mc, a low-resolution GFDL model) shows a natural, highly regular multi-decadal oscillation between periods of SO open sea convection and non-convective periods. This process happens naturally, with different frequencies and durations of convection across the majority of CMIP5 under preindustrial forcing (deLavergne et al., 2014).

In our model, oscillations in Weddell Sea convection drive multidecadal variability in SO and global SSTs, as well as SO heat storage, with convective decades warm due to the heat released from the Circumpolar Deep Water and non-convective decades cold due to subsurface heat storage. Convective pulses drive local SST and sea ice variations south of 60S, immediately triggering changes in the Ferrell and Hadley cells, atmospheric energy budget and cross-equatorial heat exchange, ultimately influencing the position of the Intertropical Convergence Zone and rain patterns in the tropics. Additionally, the SO convection pulse is propagated to the tropics and the North Atlantic MOC via oceanic pathways on relatively fast (decadal) timescales, in agreement with recent observational constraints.

Open sea convection is the major mode of Antarctic Bottom Water (AABW) formation in the CMIP5 models. Future improvements in the representation of shelf convection and sea-ice interaction in the SO are a clear necessity. These model improvements should render the AABW representation more realistic, and might influence (a) the connectivity of the SO with the rest of the planet, as described above and (b) the oceanic and global carbon cycle, of which the AABW is a fundamental conduit.

Topic Selection: Physical and Biogeochemical Processes in the Southern Ocean: Observations, State Estimation and Modeling

Title: Global decadal climate variability driven by Southern Ocean convection
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Preferred Presentation Format: Assigned by Session Chairs/Program Committee (Oral or Poster)
Scheduling Request: Second choice: 9498

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