15.5

Modeling the impact of polar mesocyclones on ocean circulation

Alan Condron[1], Grant R. Bigg[2], and Ian A. Renfrew[3]

[1]Department of Earth, Atmospheric and Planetary Sciences,
Massachusetts Institute of Technology, Cambridge, Massachusetts, USA.
[2]Department of Geography, University of Sheffield, Sheffield, UK.
[3]School of Environmental Sciences, University of East Anglia, Norwich, UK.

Abstract

Subsynoptic polar mesoscale cyclones (or mesocyclones) are underrepresented in atmospheric reanalysis data sets and are subgrid scale processes in most models used for seasonal or climate forecasting. This lack of representation, particularly over the Nordic Seas, has a significant impact on modeled ocean circulation due to a consequent underestimation of atmospheric forcing at the air–sea boundary. Using Rankine vortices and a statistically significant linear relationship between mesocyclone diameter and maximum wind speed, a novel parameterization is developed that allows the bogusing in of missing or underrepresented vortices by exploiting a satellite-derived mesocyclone database. From October 1993 to September 1995, more than 2500 cyclones known to be missing from reanalysis data over the northeast Atlantic are parameterized into the forcing fields for a global ocean-only numerical modeling experiment. A comparison of this perturbed forcing simulation to a control simulation shows enhanced surface latent and sensible heat fluxes and a dramatic increase in the cyclonic rotation of the Nordic Seas gyre by four times the average interannual variability. In response to these changes, Greenland Sea Deep Water (GSDW) formation generally increases by up to 20% in 1 month, indicating more active open ocean convection. However such enhancements are smaller than the considerable monthly variability in GSDW production. An accompanying increase in the volume transport of intermediate and deep water overflowing the Denmark Strait highlights an important coupling between short-lived, intense atmospheric activity and deep ocean circulation. The parameterization scheme has the potential to be adapted for use in coupled climate models.

For further details please see:

Condron, A., G. R. Bigg, and I. A. Renfrew (2008), Modeling the impact of polar mesocyclones on ocean circulation, *J. Geophys. Res.,* **113**, C10005, doi:10.1029/2007JC004599.