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Heat exchange between the boundary current of the North Atlantic Subpolar Gyre and the atmosphere: Insights from numerical models

B. Barnier, J. M. Molines, T. Penduff, and P. Mathiot
LEGI-CNRS-UJF, LEGI, MEOM, Grenoble, France (bernard.barnier@hmg.inpg.fr, +33-(0)476-825271)

The role of strong ocean currents in the general circulation is intrinsically linked to the mesoscale turbulence they generate. In the Labrador Sea, the boundary current of the North Atlantic Subpolar Gyre is known to generate a great variety of eddies which have a strong impact on the seasonal cycle of deep convection, fluxing heat from the relatively warm water core of the boundary current into the interior of the Sea. This paper investigate the possible existence of an eddy-driven process that could connect the subsurface core of the boundary current to the atmosphere. The life cycle of Irminger Rings (IRs) in the Labrador Sea is investigated over several seasonal cycles in model simulations carried out with a full primitive equation, eddy resolving (4 km resolution), circulation model driven by realistic air-sea fluxes. It is found that a local topographic feature off Cape Desolation (west coast of Greeland) generates IRs, which are the main source of high EKE levels seen north of about 60°N in satellite altimetry. Model IRs characteristics are found to compare well with recent observations from gliders. Like ocean rings, their peculiar potential vorticity structure (a negative core surrounded by a positive ring) insulates them from surrounding waters, and eddies survive several winters. Model IRs properties primarily evolve through surface exchanges with the atmosphere, especially heat loss, as suggested by recent observations. Lateral exchange of heat with ambient waters appears to be significantly smaller. Under the forcing conditions of our simulations, it takes about two winters to the atmosphere to extract the heat contained in the subsurface core of a ring (at 1000 m depth) and to bring it to a colder temperature comparable to that of the deep convection area. The Ring usually collapses shortly after that. Therefore, the heat extracted by Irminger Rings from the boundary current is not given up to the interior ocean, but to the atmosphere. In that sense, Irminger Rings could be seen as acting as a pipe making the heat of the subsurface western boundary current available to the atmosphere.