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Dynamical controls on the longevity of a non-linear vortex: The case of the Lofoten Basin Eddy

Anthony Bosse (1), Ilker Fer (1), Jonathan Lilly (2), and Henrick Søiland (3)

(1) University of Bergen, Geophysical Institute and Bjerknes Center for Climate Research, Bergen, Norway (anthony.bosse@uib.no), (2) Theiss Research, La Jolla, California, (3) Institute of Marine Research and Bjerknes Center for Climate Research, Bergen, Norway

The warm Atlantic water flow in the Nordic Seas is the upper limb of the global overturning circulation, before it is transformed into intermediate and deeper waters through atmosphere-ocean interactions. In this region, the Lofoten Basin is the largest reservoir of heat, and is exposed to the largest surface buoyancy losses. An intense permanent anticyclone, the Lofoten Basin Eddy located in the center of the basin, impacts the hydrography, energetics, and the ecosystem dynamics. While the kinematics and characteristics of the eddy were previously reported from opportunistic observations, the processes contributing to its longevity, the seasonal cycle of associated dynamics and energetics are not known. Here we use observations from underwater gliders, subsurface floats and multiple cruises, to describe the control mechanisms and the seasonality of the Lofoten Basin Eddy. The lateral exchanges between this non-linear eddy and the surrounding are mediated by the changes in the potential vorticity barriers. The 1200-m deep eddy core is highly coherent, characterized by a potential vorticity two to three orders of magnitude smaller compared to a background at rest. A high strain rate at the eddy periphery shields the core from its surroundings. Lateral exchanges are enhanced in early winter, when potential vorticity barrier of the eddy weakens. Mixed layer eddies induce substantial restratifying heat flux in late winter, when the mixed layer depth in the eddy core is maximum. An energy budget for the eddy reveals a timescale of dissipation of approximately 1.5 years, long enough to allow winter convection to restore the eddy's potential energy reservoir and contribute to its longevity.