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Surface heat budget at the Nordic Seas in Lagrangian observations

Marta S. de La Lama (1), Pål E. Isachsen (2), Inga Koszalka (3), and Joseph H. Lacasce (1)

(1) Institute of Geosciences, University of Oslo,0315 Oslo, Norway, (2) Norwegian Meteorological Institute, 0313 Oslo, Norway, (3) Department of Earth and Planetary Sciences,Johns Hopkins University, Baltimore, MD 21218, USA

In the Nordic Seas, the warm, inflowing Atlantic Water is cooled until it is dense enough to sink. Thereafter it circulates at depth, eventually feeding the North Atlantic Deep Water. The air-sea interaction which facilitates this cooling is a complex process involving diverse phenomena, from surface heating to turbulent entrainment at the base of the ocean surface mixed layer.

In the present study, we use 486 freely-drifting surface buoys to observe temperature changes on water parcels and the response to air-sea heat fluxes. Such Lagrangian observations advantageously "filter out" horizontal heat fluxes, since the buoys are advected by the flow, allowing one to focus on the vertical exchanges.

We examine the temporal evolution of temperature on the drifters and the correlations with surface heat fluxes, obtained from ECMWF ERA-Interim reanalyses. The frequency spectra indicate a clear ω^{-2} dependence at frequencies higher than roughly $1/40$ days^{-1}. The temperature fluctuations on the other hand are correlated with surface fluxes only at the longer time scales.

We then show how the Lagrangian temperature can be represented as a stochastic process, with a deterministic portion determined by the low frequency atmospheric forcing and a white noise perturbation. This is in line with previous studies of the ocean surface response to stochastic wind forcing. What distinguishes the present model is the deterministic part, which must account for the gradual cooling of the water parcels.