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Comparing inferred surface energy fluxes with observation-based flux estimates over the ocean

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We combine atmospheric energy transports from ECMWF's latest reanalysis dataset ERA5 with observation-based TOA fluxes from CERES-EBAF to infer net surface energy fluxes (FS_{inf}) for the period 1985-2018. We present an extensive comparison at scales ranging from global to local using 15 in-situ buoy measurements, parameterized surface fluxes from ERA5, and previous evaluations of FS_{inf} using ERA-Interim. We also combine FS_{inf} with various estimates of the ocean heat content tendency (OHCT) and observation-based oceanic heat transports from RAPID and moorings in Fram Strait and Barents Sea Opening to evaluate the oceanic energy budget in the North Atlantic Ocean basin.

Our results show that the indirectly estimated FS_{inf} has a 1985-2018 ocean mean of 1.7 W m^{-2} (see J.Mayer et al. (2021); under review), which is in good agreement with the long-term mean OHCT derived from ocean reanalyses as well as independent surface flux estimates presented in recent literature (e.g., von Schuckmann et al. (2020); https://doi.org/10.5194/essd-12-2013-2020), suggesting an only small global ocean mean bias of FS_{inf}. Moreover, our FS_{inf} product is temporally more stable than parameterized surface fluxes from ERA5 and previous FS_{inf} estimates using ERA-Interim, at least from 2000 onwards. The evaluation of the oceanic energy budget in the North Atlantic shows good agreement between FS_{inf} and observation-based divergence of oceanic heat transports and OHCT such that its residual is on the order of <0.2 PW (~7 W m^{-2}). Even on station-scale, FS_{inf} agrees reasonably well with buoy-based surface flux measurements with a bias of 19.7 W m^{-2} over all 15 buoys (compared to 21.7 W m^{-2} for parameterized surface fluxes), with largest biases in the Indian Ocean. This assessment demonstrates that our inferred surface flux estimate using ERA5 data outperforms parameterized fluxes from the model on all considered spatial scales (global-regional-local) in terms of bias and temporal stability and thus is well-suited for climate studies and model evaluations.