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Probability distributions for air-sea surface turbulent heat fluxes: applications for long-term surface flux climatologies and climate variability

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The accurate derivation of the probability distributions for air-sea surface fluxes is required for estimation of surface flux statistics, minimization of sampling errors and quantifying extreme fluxes at sea surface. In order to describe air-sea surface flux probability distributions worldwide we apply the modified Fisher-Tippett (MFT) distribution which allows for highly accurate estimation of all statistical moments and quantitative estimation of turbulent surface fluxes of rare occurrences. Furthermore this approach allows for effective analysis of poorly sampled marine meteorological data and accurate derivation of long-term space-time series of surface fluxes. We demonstrate characteristics of MFT distribution worldwide using data from reanalyses and Voluntary Observing Ship (VOS) archives. Using MFT distribution and 127 years (1880-2006) of VOS observations from ICOADS we reconstruct surface ocean-atmosphere heat fluxes over the North Atlantic with monthly resolution in time and variable (2-degree to 5-degree) resolution in space. Reconstructed fluxes reveal long-term trends, implying, for example, about 4 W/m2 per decade growing sensible heat fluxes in the Labrador Sea and about 2 W/m2 per decade secular increase in the Central subpolar gyre in the Atlantic. Non-secular signals are represented by the decadal-scale and multidecadal (about 40-50 years variability). Decadal scale signal has a clear association with the NAO-like atmospheric circulation variability during 1880-1915 and after 1955, but has a little association with NAO between 1915 and 1955. The approach formulated allows also for the derivation of the heat energy budgets in different regions of the Atlantic and Pacific. These budgets can be alternatively quantified form the oceanographic full-depth sections. Time series of the budget estimates will be derived for the 2 large regions (subpolar, mid latitudes) and their association with surface water mass transformation, ocean dynamics and atmospheric circulation anomalies will be discussed.