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Extreme turbulent air-sea heat fluxes over the global World ocean and their climate variability

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We developed probability distributions for surface turbulent fluxes of heat and moisture over the global ocean. These distributions are two-parametric and belong to the family of the Fisher-Tippett distribution. Using the modified Fisher-Tippett (MFT) distribution we provide a novel framework for the analysis of surface turbulent fluxes at the ocean surface. Our analysis allows for the estimation of fluxes of the rare occurrences which cannot be accurately directly derived from observations or reanalyses but may occur under the extreme air-sea interaction conditions. Extreme turbulent fluxes corresponding from 99th and 99.99th percentiles were estimated using MFT distributions from NCEP/NCAR and ERA-20 reanalyses as well as from the fluxes derived from Voluntary Observing Ship (VOS) data. Extreme turbulent sensible and latent heat fluxes may amount to 1000-2000 W/m2. They are identified in the regions of western boundary currents during the winter season. Although spatial distribution of turbulent flux extremes is quite similar to the mean surface fluxes, climate variability of extreme turbulent fluxes exhibit significant differences from that for the mean fluxes. This is especially true for the subpolar regions and the Atlantic and Pacific tropics where surface flux probability density functions undergo significant changes during the last decades. In particular, trends in extreme fluxes in the subpolar and mid latitudinal North Atlantic are highly positive during the cold season while mean flux values show patterns of both positive and negative trends. In other words, the probability distributions of surface fluxes were changed during the last decades in a way leading to the higher occurrence of extreme fluxes. Comparison of extreme turbulent flux characteristics in the reanalyses and VOS data allowed for the development of formalism for fitting of MFT PDFs of different products and minimization of sampling errors in the VOS fluxes.