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Estimating the air-sea gas transfer velocity from a statistical reconstruction of ocean turbulence observations

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Although the air-sea gas transfer velocity k is usually parameterized with wind speed, the so-called small-eddy model suggests a relationship between k and the ocean surface turbulence in the form of the dissipation rate of turbulent kinetic energy ε. However, available observations of ε from oceanographic cruises are spatially and temporally sparse. In this study, we use a Gaussian Process (GP) model to investigate the relationship between the observed profiles of ε and co-located atmospheric and oceanic fields from the ERA5 reanalysis. The model is then used to construct monthly maps of ε and to estimate the climatological air-sea gas transfer velocity from existing parametrizations. As an independent validation, the same model is also trained on EC-Earth3 outputs with the objective of reproducing the temporal and spatial patterns of turbulence kinetic energy as simulated by EC-Earth3. The ability to predict ε is instrumental to achieve better estimates of air-sea gas exchange that take into account multiple sources of upper ocean turbulence beyond wind stress.