



Linking submesoscale fronts and air-sea heat fluxes in the Southern Ocean: Results from the first Saildrone circumnavigation of Antarctica

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The role of the Southern Ocean in the global heat and carbon cycle is fundamental towards our climate, but observational data to quantify air-sea fluxes, such as surface heat fluxes, are still scarce. In order to investigate the effects of fine-scale oceanic fronts (0.1 km–10 km) on air-sea fluxes in the Southern Ocean, high-resolution hydrographic and meteorological data collected by three un-crewed surface vehicles (Saildrones) during their first Circumnavigation of Antarctica in 2019 was assessed. Comparisons of key variables from the in situ Saildrones datasets with those from ERA5 and a stationary mooring show good agreement. Temperature-driven density fronts were detected in the Saildrone data and their impact on the turbulent heat flux was quantified during steady atmospheric conditions. Over 2000 surface ocean temperature dominated density fronts were detected at length-scales (i.e. front width) ranging from sub-kilometer to mesoscale (order of 0.1 km–100 km).

Temperature-driven density fronts with a length scale (as seen from the Saildrones perspective) smaller than 1 km contributed 75% and 51% of the sensible and latent heat flux changes, respectively. The direct link between the fronts and the impact on the heat fluxes decreases sharply when the front length increases. This suggests that smaller (submesoscale) fronts have a larger impact on heat flux variability than larger (balanced) fronts. The parametrization of these fine-scale ocean-atmospheric processes in global climate models could lead to more accurate representations of the heat flux variability both at local and global scale.