Length scale of the turbulent heat fluxes in the Southern Ocean

ChuanLi Jiang
Sarah T. Gille
Janet Sprintall
Kei Yoshimura
Masao Kanamitsu

Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, 92093. chjiang@ucsd.edu

Abstract

High-resolution underway shipboard atmospheric and oceanic observations collected in Drake Passage from 2000 to 2009 have been used to examine the length and time scales of turbulent heat fluxes and flux-related state variables. These eddy scales (of order minutes and kilometers) are often unresolved in the available gridded heat flux products. The magnitude of the seasonal cycle of sea surface temperature (SST) south of the Polar Front is found to be twice that north of the Front, but seasonal cycles of the turbulent heat fluxes show no differences on either side of the Polar Front. Frequency spectra of the turbulent heat fluxes and related variables are red, with no identifiable spectral peaks. SST and air temperature are coherent over a range of frequencies corresponding to periods between 2 hours and 2 days, with air temperature leading SST. The horizontal decorrelation scale of the sensible heat flux (64±4km) is consistent with the decorrelation scale for air-sea temperature differences rather than either SST or air temperature alone. In contrast, the decorrelation scale of latent heat flux (79±4km) matches the decorrelation scale of wind speed.

We compare the ship measurements with two recently available higher resolution gridded turbulent heat flux products: ECMWF-YOTC (at 0.5 degree) and the DPRD10 regional downscaling product (at 10 km). The accuracies of the state variables from both ECMWF-YOTC and DPRD10 are found to be within the accuracy of the ship measurements. However, the decorrelation scales of the air-sea temperature difference and wind speed from ECMWF-YOTC are significantly larger than the shipboard measurements, while the decorrelation scales of the flux-related state variables from DPRD10 are found to be comparable.