Wind direction associated with mean air-sea heat exchange

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Air-sea turbulent heat exchange is parameterized with wind speed and the difference in either humidity or temperature across the interface for latent and sensible heat fluxes, respectively. Thus, the wind direction only implicitly influences the fluxes, for example by transport of moisture and heat, which becomes of particular interest for the physical interpretation in regions with large temperature gradients in the atmosphere and ocean. Most of the climatological mean sensible/latent heat flux can be explained by the climatological wind speed and surface temperature/moisture differences. However, the climatological mean wind speed in the mid-latitudes is mainly associated with wind variations on shorter time scales associated with atmospheric eddies. Coincidentally, the variation of the eddy meridional wind is higher along the mid-latitude SST fronts than that of the eddy zonal wind. This suggests that a large fraction of the air-sea heat exchange over mid-latitude SST fronts is associated with episodic events of cross-frontal meridional flow transporting cold air over warmer water. The latter is in contrast with the climatological wind direction in mid-latitudes, which is dominated by along-frontal westerlies. To pinpoint the striking difference between the climatological and synoptic viewpoint, we present air-sea heat-exchange characteristics for the entire globe with respect to the associated wind direction.

We diagnose the latent and sensible air-sea heat exchange using the ERA-Interim data with instantaneous 6-hourly, as well as daily, weekly, and monthly mean fields. Our results show that the interpretation of the fluxes in the lower latitudes is consistent for all type of data, featuring the easterly trade winds as the main wind direction. On the other hand, the associated wind direction differs markedly in the extra-tropics for the different type of data. For weekly and monthly mean fields, the wind direction is mainly westerly, whereas for daily mean and 6-hourly data the wind direction has a dominant meridional component, which would also imply significant flow across the SST front. The dependence of the primary wind direction associated with the strongest heat fluxes at different latitudes and for different type of data pinpoints the necessity to consider sub-weekly time-scales in the mid-latitudes to describe the air-sea heat exchanges in a physically meaningful way.

Keywords: Surface turbulent heat fluxes, SST front, Synoptic scale eddies

