Intercomparisons of Turbulent Heat Fluxes at High-Latitudes in the Northern Hemisphere

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We carried out intercomparison of various turbulent heat flux products at high-latitudes in the northern hemisphere. Eight products are examined, including Japanese Ocean Flux Data Sets with Use of Remote Sensing Observation 2 (J-OFURO2), Hamburg Ocean-Atmosphere Parameters from Satellite Data 3 (HOAPS3), Goddard Satellite-based Surface Turbulent Fluxes (GSSTF)2c , IFREMER, the National Centers for Environmental Prediction-National Center for Atmospheric Research reanalysis (NRA1), and the National Centre for Environmental Prediction/Department of Energy (NRA2) and the European Centre for Medium-Range weather Forecasts reanalysis (ERA) interim and Objective Analyzed Air-Sea Fluxes (OAFlux). The first four products are mainly derived from satellite data, the second three products are reanalysis products and the last product is a hybrid product derived from not only satellite data but also reanalysis data. The analyzed region and period are north of 40°N and from 1996 to 2005.

All data sets show agreement in the spatial distribution of the total-mean fields for both of turbulent heat fluxes. However, NRA2 shows relatively large latent heat flux and IFREMER shows extremely large sensible heat flux, compared with other products. In order to clarify the amplitude of the differences between products, the across-data standard deviation is estimated. The values are similar, from 10 Wm^{-2} to 30 Wm^{-2}, for both of sensible and latent heat fluxes. The large discrepancy of latent heat flux is found in the northwestern part of the Atlantic Ocean, while that of sensible heat fluxes is found in the northern part of the Pacific Ocean. All the products show similar latitudinal variations. The meridional profiles of all latent heat flux products have a local maximum values around 62°N and 72°N and a local minimum values around 65°N. However, the local minimum value of ERA interim is considerably small compared with other products. Also the meridional profiles of all sensible heat flux products have a minimum value around 47°N and 67°N. However, IFREMER shows extremely large values compared with other products and loses the local minimum around 47°N. Moreover, the differences of sensible heat flux are quite large north of 70°N. ERA Interim, HOAPS3 and GSSTF2 give about $30Wm^{-2}$, while other products give larger than $40Wm^{-2}$.

We investigated seasonal variation of total average values north of 40°N. All latent heat flux products show the maximum on July and the minimum from November to December. The minimum values given by each product exist from $10Wm^{-2}$(J-OFURO2) to $30Wm^{-2}$(IFREMER) and most products shows about $20Wm^{-2}$. The differences between products for the maximum are fairly large, including from $70Wm^{-2}$ (ERA Interim) to $110Wm^{-2}$ (NRA2 and GSSTF2) compared with for the minimum. Remaining other products give about $90Wm^{-2}$ of the maximum. It should be noted that the amplitude of seasonal variation for ERA Interim is quite small compared with other products. All sensible heat flux products show the maximum on July and the minimum from December to February. Most products except IFREMER give similar variation not only qualitatively but also quantitatively. The maximum value is about 30 Wm^{-2}, while the minimum value is 0 Wm^{-2} . In summer some of products such as NRA1, NRA2 and HOAPS3 show negative values, which mean the heat transfer form the atmosphere to the ocean.

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