# Advances in the estimation of global surface net heat flux based on satellite observation: J-OFURO3 V1.1

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Surface net heat flux, defined as the total heat exchange between the atmosphere and oceans, affects both atmospheric and oceanic processes. Global estimates based on observations are necessary to understand long-term climate change and related responses and to validating climate model results. Consequently, estimating and improving surface net heat flux using satellite observations are of vital importance. The reliability of surface net heat flux data obtained from the latest satellite-based estimation (the third-generation Japanese Ocean Flux Data Sets with Use of Remote Sensing Observations [J-OFURO3, V1.1]) was investigated. Three metrics were utilized: 1) the long-term (30 years) mean for 1988–2017, 2) the local accuracy evaluation based on comparison with observations recorded at buoys located at 11 global oceanic points with varying climatological characteristics, and 3) the physical consistency with the freshwater balance related to the global water cycle. The globally averaged value of the surface net heat flux of J-OFURO3 was −22.2 W $m^{-2}$, which is largely imbalanced to heat the ocean surface. This imbalance was due to the turbulent heat flux being smaller than the net downward surface radiation. On the other hand, compared with the local buoy observations, the average difference was −5.8 W $m^{-2}$, indicating good agreement. These results indicate a paradox of the global surface net heat flux. In relation to the global water cycle, the balance between surface latent heat flux (ocean evaporation) and precipitation was estimated to be almost 0 when river runoff from the land was taken into consideration. The reliability of the estimation of the latent heat flux was reconciled by two different methods. Systematic ocean heating biases by surface sensible heat flux (SHF) and longwave radiation were identified. The bias in the SHF was globally persistent and especially large in the mid- and high latitudes. The correction of the bias has an impact on improving the global mean net heat flux by +5.5 W $m^{-2}$. Furthermore, since J-OFURO3 SHF has low data coverage in high-latitudes areas containing sea ice, its impact on global net heat flux was assessed using the latest atmospheric reanalysis product. When including the sea ice region, the globally averaged value of SHF was approximately 1.4 times larger. In addition to the bias correction mentioned above, when assuming that the global ocean average of J3 SHF is 1.4 times larger, the net heat flux value changes to the improved value (-11.3 W $m^{-2}$), which is approximately half the original value (-22.2 W $m^{-2}$).

Keywords: surface flux, air-sea interaction, satellite remote sensing

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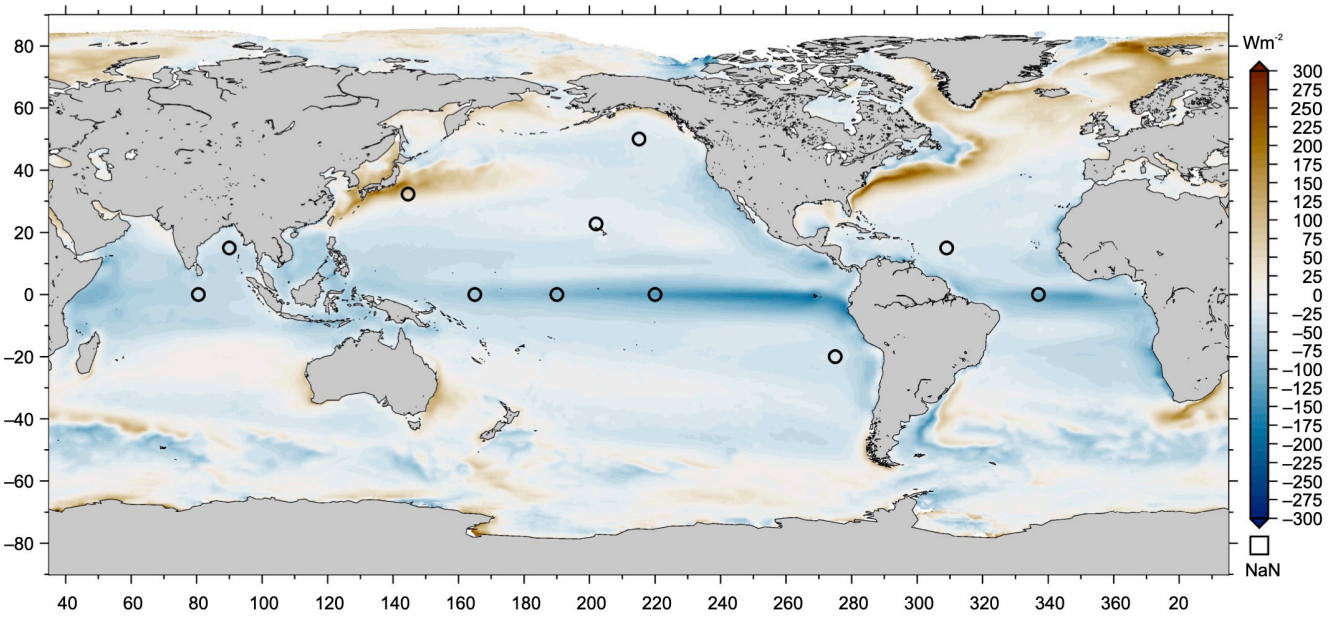


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