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Combining Satellite Data, Model Experiments And In Situ Measurements To Assess Heat Fluxes Estimates In The Mediterranean Sea

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Air-sea heat fluxes are essential climate variables, required for many studies related with air-sea interaction, global climate change, and atmospheric and oceanic general circulation.
The assessment of air-sea heat fluxes estimated from satellites and numerical weather prediction (NWP) is thus crucial to quantify the associated accuracies and to identify possible improvement strategies.
Assessment can either be based on consistency criteria (e.g., budget closure of semi-enclosed basins) or on comparison with direct in situ measurements.
A budget closure approach has been extensively applied to the case of the Mediterranean Sea by comparing the basin-integrated net surface fluxes and the net fluxes at the Strait of Gibraltar. All studies have required an adjustment of the surface heat flux components' estimates when these are calculated using standard formulae. Very rarely these components have been tested against direct in situ measurements.
Estimates of air-sea radiative fluxes derived either from satellite or applying bulk formulae to measured meteorological parameters have been compared with direct measurements made at the ENEA Station for Climate Observations on the island of Lampedusa (35.5°N, 12.6°E), in the central Mediterranean Sea.
The ENEA Station for Climate Observations at Lampedusa is a research facility in the Mediterranean dedicated to measurements of climatic parameters. Lampedusa is an integrated atmospheric/oceanic observatory composed by two sections: a ground-based laboratory (35.52°N, 12.63°E) operating since 1997, dedicated to the investigation of changes in atmospheric composition and structure and their effects on the surface radiation, and an oceanic buoy (35.49°N, 12.47°E) operating since August 2015, dedicated to the investigation of air-sea interactions and to ground-truth of satellite observations.
The instruments installed on the buoy include a Vaisala MAWS401 meteorological station and Kipp and Zonen CMP21 and CGR4 radiometers for shortwave (SW) and longwave (LW) irradiances. Water temperature is measured at 1 and 2 meters depth using two SBE 39 plus sensors acquiring with a frequency of 1 minute.
The data collected at Lampedusa gave us the chance to evaluate various bulk formulae used to estimate turbulent and radiative heat fluxes, and various satellite products. The determination of radiation components have been investigated in particular showing an overestimation of the surface solar irradiance estimated from SEVIRI data and by bulk formulae currently used in Mediterranean GCM.
The impact of these determinations on 1D numerical simulations of the upper ocean temperature vertical structure evolution have been also investigated and further demonstrated importance of using correct air-sea heat fluxes in reproducing the real surface and vertical temperature evolution.