

Roles of Air/Sea Exchange in the Cycles of Energy, Moisture and CO₂

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Air/sea interaction plays critical roles in the exchanges of energy, moisture, and CO₂ between the ocean and atmosphere. The ocean acts as a buffer by absorbing most of the Earth's anthropogenic energy and CO₂ increases. The rate at which the ocean can absorb this energy and CO₂ is limited by (1) the values of these quantities on both sides of the air-sea interface and (2) the mixing of these quantities to and from the air-sea interface. GCOS goals are to measure air/sea exchanges or variables from which these changes can be estimated.

Rates of moisture exchange are monitored through precipitation and evaporation. Energy exchange rates are the sum of radiative flux (solar and long-wave), sensible heat flux (SHF) and latent heat flux (LHF; which is LHF is proportional to evaporation). Over the oceans, the net radiative flux is approximately balanced by the LHF (SHF is a small term). Changes in either the radiative budget or ocean mixing rates, which depend largely on surface vector stress (a new ECV), will also modify the LHF, and hence modify weather patterns.

SHF and LHF can be parameterized with observations of SST, near surface air temperature and humidity, surface pressure, and surface stress (a combination of wind and sea state). The GCOS requirements for these results in a 25Wm⁻² uncertainty, which is less accurate than the 10Wm⁻² desired to understand the circulation pathways of water masses modified by air/sea interaction. The 10Wm⁻² goal might eventually be achieved through satellite observations, which would require in-situ observations for calibration.

The long term ocean sequestration of carbon is limited by transport to the ocean interior. Accurate observation of surface pCO₂ is currently the only way to quantify ocean CO₂ uptake on an annual time-scale. Currently the pCO₂ observations are sparse, and extrapolation techniques have to be deployed to estimate annual air-sea fluxes of CO₂.

This interplay between satellite and in situ observations will be discussed, in the context of reducing uncertainty. The observational goals will be discussed in the contexts of roles of air/sea fluxes on synoptic to multi-decadal variability for both ocean and atmospheric impacts.