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## Observations for climate: Sustained air-sea flux buoy observations for quantifying/characterizing the changes in global ocean surface fluxes in a changing climate

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Long-term, consistent, climate records of air-sea heat (latent, sensible, shortwave, and longwave), momentum, and freshwater (evaporation) fluxes are highly needed by ocean and climate research and modeling community. They are essential for characterizing long-term changes in surface forcing conditions, for attributing the causes of climate variability and change that occurred in both the atmosphere and the ocean, and for quantifying the oceanic role in the global energy budget and water cycle. Constructing global air-sea fluxes is commonly based on flux bulk parameterizations using surface meteorological variables (e.g., wind speed, temperature, humidity, cloud cover, etc) as input. However, these meteorological variables are not immune from errors/biases regardless they are from ship-based measurements, satellite derived products, and atmospheric reanalyses. Charactering errors in flux-related variables is important for optimizing the use (e.g. objective synthesis) of each data source, and such validation study can be done only with the benchmark time series provided by research-quality moored flux buoys. In situ flux buoys are an important validation data base for the Objectively Analyzed air-sea heat Fluxes (OAFlux) project at WHOI, which aims at improving estimates of global flux fields from objective synthesis of existing data sources. At present, the project has constructed time series of ocean evaporation, latent and sensible heat fluxes since 1958. It have also developed high-resolution ocean vector wind daily fields from July 1987 onward through merging 11 satellite sensors including passive radiometers and scatterometers. These datasets provide consistent climate records for global surface forcing fields, revealing striking low-frequency variations in air-sea fluxes in past decades. In particular, increase of ocean evaporation and strengthening of near-surface winds are evident during the 1990s when ocean warming was pronounced. These changes in ocean-surface fluxes have profound impacts on ocean heat content, salinity, and sea level, and on global water cycle and energy budget. The OFlux project is an-ongoing project. The current effort is directed toward a global net heat flux dataset with reduced biases/errors, especially in satellite-based surface radiation estimates.