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Development of Satellite-Based Surface Fluxes of Heat and Moisture in the Arctic Ocean for Understanding Impacts of Changing Arctic Environments

Improving knowledge of exchanges of heat and moisture fluxes between the ocean and the atmosphere is critical to understanding energy and water cycle, and climate variability. This is particularly true in the Arctic Ocean, where rapid environmental changes are occurring. Surface turbulent heat and moisture fluxes in the Arctic Ocean have variability associated with a broad range of processes. However, observations of surface turbulent heat and moisture fluxes are extremely scarce in the Arctic Ocean. Extremely cold environment, seasonal sea ice, and the remoteness of the area make observations difficult to obtain. This contributes to current large uncertainty in estimates of northern mid- and high-latitude climate variability, hampers our understanding of critical air-sea interaction processes, and limits our ability to validate climate models used to project the 21st century climate. To date, there is no specific surface heat and moisture flux data set that can be recommended as adequate for Arctic Ocean applications.

This project targets the developing of a new satellite-based surface turbulentheat and moisture flux data set for the Arctic/subarctic Ocean from a combination of progress in satellite retrievals and a new approach to compute surface fluxes. This new flux data set is used to provide critical insight into impacts of rapid changes of Arctic environments on climate variability and meaningful evaluation of NOAA-supported climate model simulations. This new flux data set also serves as an important incremental step toward achieving globally balanced energy and freshwater budgets. This data-driven project will:

-Evaluate the accuracy and uncertainty associated with surface radiative fluxes and surface temperature for available satellite products using the assembled in-situ data.

-Create a new satellite-based surface heat and moisture flux data set by combining the best estimates of satellite-derived surface radiation fluxes andtemperature, and a recently developed flux algorithm based on the theory of maximum entropy productionthat is generalized to sea ice and water surfaces.

-Evaluate the new flux data set using the in-situ data base that we are currently assembling for the Arctic/subarctic Ocean and in the context of basin net heat and freshwater budgets.

-Produce a ~30 year new surface flux data set covering the Arctic/subarctic Ocean from 1983 to present, and make the data easily accessible to the research community.

-Use the new flux data set to document distribution and variability of the fluxes in the Arctic/subarctic Ocean, and further investigate impacts of the flux changes on atmospheric and oceanic processes in the Arctic, and their feedbacks on northern mid- and high latitude climate variability.

-Use the new flux data set to evaluate the capability of the different versions of the GFDL coupled climate models to simulate surface fluxes of heat and freshwater in the Arctic/subarctic Ocean, and understand attributions to the disagreements.

This project directly addresses Competition 1 of Climate Observations and Monitoring (Data Sets and Indicators). The data set produced by this project provides “meaningful, authoritative climate-relevant and observation-based indicator addressing the status, trends, extremes, and variability in physical climate system over time scales of daily to decades”. This project is directly relevant to NOAA’s long-term climate goal towards “improved scientific understanding of the changing climate system and its impacts”.