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Arctic freshwater and heat fluxes: variability, and assessment

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Paucity of measurements means that quantifying and evaluating the Arctic thermal and hydrological cycles is problematic. For example: atmospheric reanalyses are not well constrained by observations; for river runoff measurements, there are un-gauged flows to consider; and until the relatively recent advent of autonomous measurement systems, ocean measurements outside the summer melt season were rare. It has proved possible, however, to design a metric based on sea ice and ocean measurements which captures net surface fluxes (atmosphere-ocean and land-ocean, including sea ice) of freshwater and heat. A closed circuit is formed around the Arctic Ocean boundary by moored measurement systems and land, supplemented by remote-sensed and other measurements. Occasionally "patching" with coupled ice-ocean general circulation model (GCM) output is required; if so, the output water properties are validated and calibrated against climatology. This approach enables application of inverse modelling methods through the use of conservation constraints, and consequent generation of monthly-mean ocean (including sea ice) fluxes of freshwater and heat, and a draft version of a single annual cycle will be presented (2005-6). Availability of an objective metric permits subsequent intercomparison, and ultimately assessment, of the performance of GCMs and climate models in terms of Arctic ice and ocean surface fluxes. Illustrations will be given of the dependence of both surface (air-sea-ice) and ocean boundary fluxes from GCMs and their dependence both on model resolution and on surface forcing fields, and these in turn will be compared with an example of the same quantities calculated from a coupled climate model. These are steps towards (i) designing a viable Arctic Ocean boundary observation system, and (ii) quantification of Arctic fluxes.