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Evaluation of different errors in lake dynamics due to a poor determination of cloud cover

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It is well known that numerical modeling of large lakes requires the spatial variability of the wind forcing to correctly reproduce the general circulation. Also the mixing and the heat budget of the lake depend on the accuracy of the surface heat fluxes, which are usually parameterized by bulk formulas that depend on different thermodynamic properties of the air, the wind and the cloud cover.

Cloud cover affects the short wave radiation entering the lake but also the net long wave radiation, which not only depends on the cloud cover but also on the temperatures of the air and of the surface water, this last depending also on the lake hydrodynamics considering the stratification and the heat content of the water column.. Sensible and latent heat fluxes also depend on the temperature of the surface water. The importance of the detailed bathymetry on the heat balance of the lake has been documented by the importance of baroclinic currents in side regions of lakes and between lobes of different depths generated by differential cooling.

Here, based on the net heat flux at the surface, we analyze the relative effect on the heat budget of the lake of the cloud cover, a rough variable not always recorded. Furthermore, considering the bulk formulas for the fluxes, we focus on the relative importance of the cloud cover effect on the incoming short wave radiation and the net long wave radiation. Because short wave radiation penetrates into the water column while long wave is absorbed at the surface, they affect the mixing dynamics of the lake differently, and at the same time the mixing dynamics affects the net long wave radiation through the term containing the surface temperature of the lake. The importance of the variation of latent and sensible heat fluxes is also discussed.

The hydrodynamics vary considerably depending on background stratification, meteorological forcing, and bathymetry, so exploring this topic requires a discussion of a wide range of realistic case conditions. Here we present an initial analysis of the very different bathymetries of the two lobes of the Large Aral Sea in 2006, which have been implemented in the Princeton Ocean Model. The model was run in the autumn using meteorological conditions measured at Uqly station, located close to the eastern shore of the sea. It was initialized with the temperature and salinity profiles measured in the western lobe at the beginning of this period and generalized over the whole lake, including the eastern lobe, where temperature and salinity were definitively different. However, we allowed the model to stabilize and therefore discuss the results only from the last 15 days of the simulation. We consider the extreme cases when the cloud cover fraction is 0 and 1. The importance of resolving spatial variability of the cloud cover is also evaluated.

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