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Short-term water level forecasts for the Laurentian Great Lakes using coupled atmosphere, land-surface and lake models

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Over the Gulf of St. Lawrence, Environment Canada operates a very successful short-term (48-h) environmental prediction system which includes the GEM atmospheric model, the ISBA land-surface model and the NEMO-CICE ice-ocean model. The positive impact of two-way coupling between the atmosphere and ocean is most clearly seen in winter, due to the presence of a dynamic ice cover and large heat fluxes over the ocean. This system is now being tested over the Laurentian Great Lakes, with the same objective of improving forecasts both for the atmosphere and the water bodies. In order to account for the significant impact of streamflow on the water level and water temperature of the Great Lakes, routing models for river flow and for connecting channels between lakes were added to the system. Offline tests demonstrated the capacity of the system to accurately simulate seasonal and multi-annual fluctuations in water levels and ice cover, as well as the need for consistent heat flux calculations in the atmospheric and ocean models. In this presentation, we focus on the skill of short-term water level forecasts. Over a few days, water levels of the Great Lakes mainly respond to the wind stress, but also change with surface pressure, precipitation, evaporation and river flow. The approach taken to account for each of these factors is described, and the skill of the resulting water level forecast is assessed over the fall of 2014 and the winter of 2015. It is shown that the system can accurately predict storm surges and seiches at the hourly time scale, with a skill that decreases slowly over 48-h, suggesting that skillful forecasts with longer lead times are feasible. A plan for increasing the lead time up to one month is presented.