



Evaluation of Precipitation Fields for National Water Model Prediction over Large Lakes and International Basins

H431-2136

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Background

One important advancement in the next release of the National Water Model (NWMv2.1) will be the expansion of modeling into the Canadian portion of the Great Lakes basin (described by Mason et al 2019 and shown in **Figure 1**). This provides new opportunities to forecast changes in water levels and coastal hazards, such as the widespread lakeshore flooding and coastal erosion that has recently been occurring due to record high water levels. Because nearly half of the Great Lakes basin lies in Canada, the expansion of the model domain requires development and evaluation of data products that are consistent across the U.S.-Canada border. The Analysis of Record for Calibration (AORC) is the official forcings dataset for calibration of the NWM.

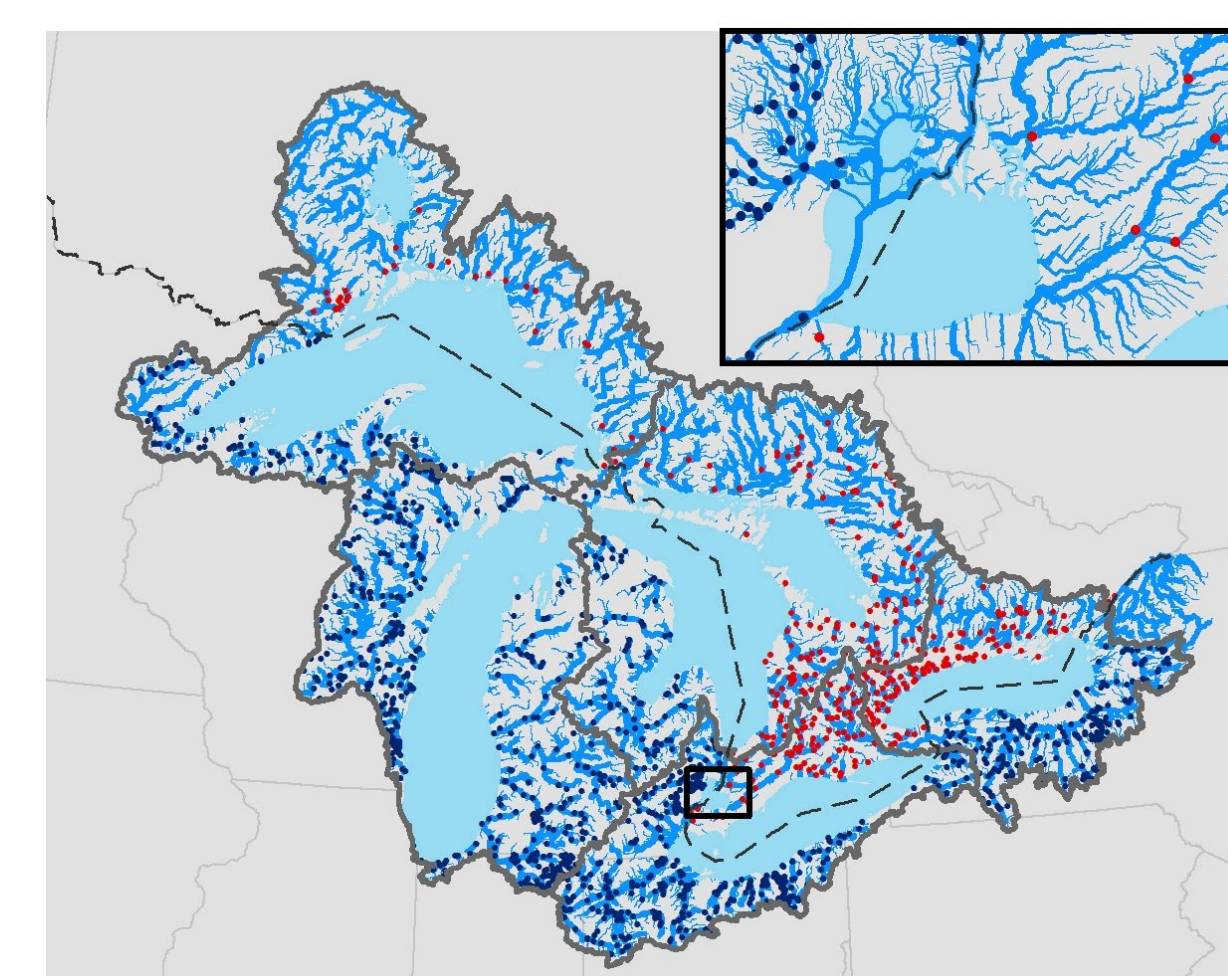


Figure 1. Great Lakes Hydrofabric for the NWM

Although the AORC precipitation has been evaluated extensively across the United States, it has not yet been rigorously examined for use over the Canadian land surface portion of the basin, nor has it been tested for simulating overlake precipitation. This presentation highlights results from an evaluation of the AORC precipitation over the land surface of the Great Lakes basin, including Canada, and over the lakes themselves, and provides a comparison with the Canadian Precipitation Analysis (CaPA) dataset.

Precipitation Datasets

The Analysis of Record for Calibration (AORC), the official dataset used for calibration of the NWM, is a high-resolution dataset of near-surface weather based on surface, radar, and satellite observations.

The Canadian Precipitation Analysis (CaPA), described by Lespinas et al (2015), combines surface observations with a background field obtained from short-term forecasts from Canada's Regional Deterministic Prediction System (RDPS) which relies on the Global Environmental Multiscale (GEM) model.

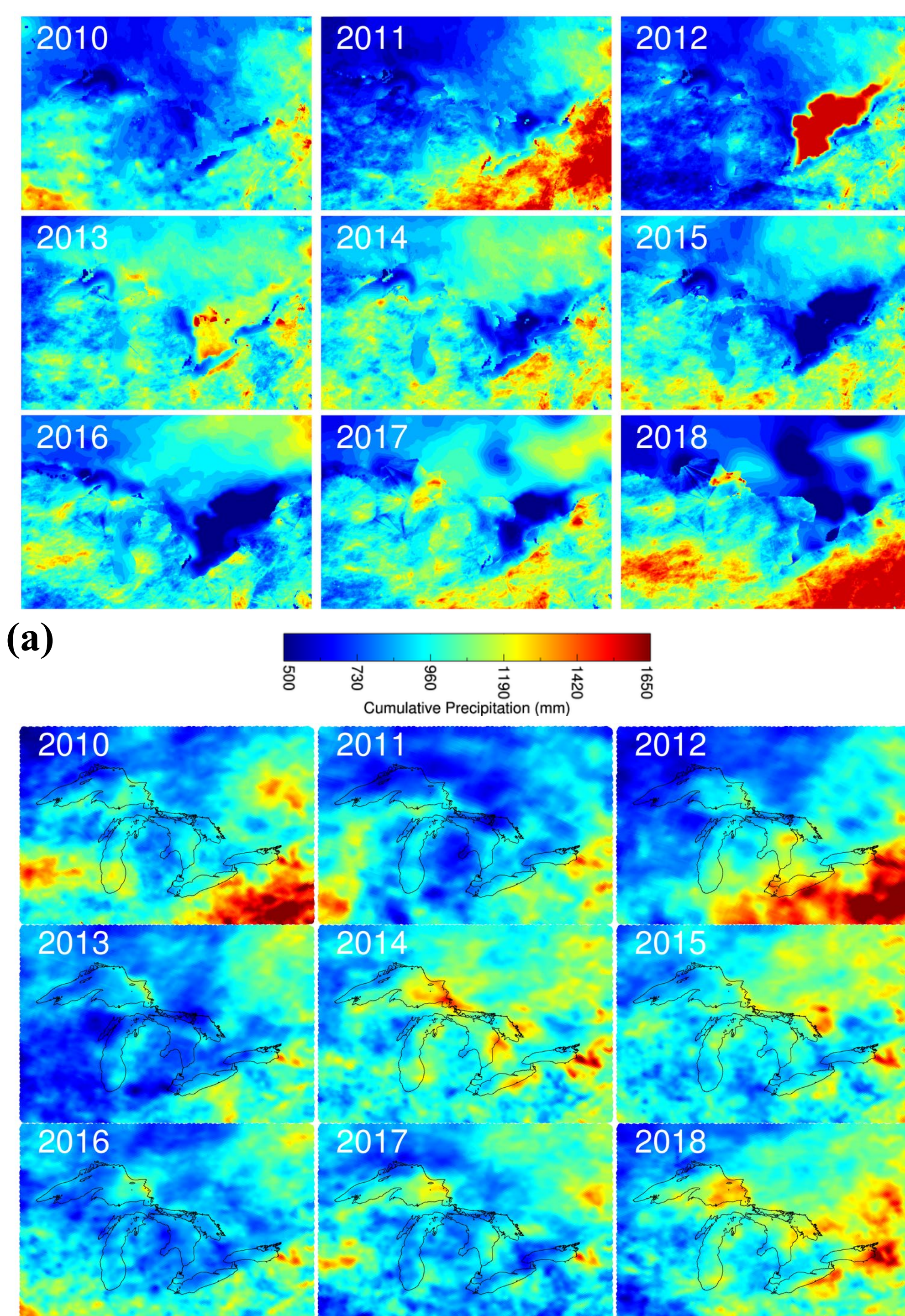


Figure 2. Precipitation datasets evaluated for the NWM over the Great Lakes basin. (a) Analysis of Record for Calibration (AORC). (b) the Canadian Precipitation Analysis (CaPA).

Methods

Evaluation over the land

Daily accumulations were compared against surface observations from the Integrated Surface Hourly Data Base, retrieved from the National Centers for Environmental Information. Comparisons were conducted for stations with data available since 2010, shown in **Figure 3**. At each station, the RMSE was computed for all data pairs within each calendar month. In addition to comparing the datasets with observations at stations, the NWM was run in one Canadian watershed using both datasets in order to identify potential changes in model skill that would result from changes in precipitation fields.

Evaluation over the lakes

Very few surface observations exist over the lakes themselves, and those that do exist have limited temporal coverage. The Large Lake Statistical Water Balance Model (L2SWBM) is a tool that reconciles each lake's cumulative water balance over a period using a Bayesian modeling framework to infer posterior probability distributions for monthly hydrometeorological variables (see Gronewold et al 2019 for a description of the model and an example application for evaluating overlake evaporation). For this study, prior probability distributions are determined using the Midwest Regional Climate Center's blended product incorporating the Canadian Precipitation Analysis (CaPA) and the Multi-sensor Precipitation Estimate (MPE) datasets. Independent estimates of the water balance components for a 10-year analysis period are provided by AORC and CaPA for precipitation and readily available datasets for runoff, evaporation, connecting channel flows, and diversions. In addition to evaluating overlake precipitation using a water balance perspective, comparisons were made at two stations where sufficient precipitation data were available.

Results – Overland

Figure 3 shows skill metrics computed for the AORC and CaPA relative to surface observations. In general, the RMSE is smaller for the CaPA dataset, and, as seen in **Figure 3(b)**, the MAE is also smaller for CaPA. Interestingly, despite the dramatic extremes in precipitation in southern Ontario evident in the AORC dataset from 2012-2018 (**Figure 2**), the RMSE values at stations in that region do not stand out as being poor. We attribute this to the AORC not incorporating many of the observations in this region during this time period.

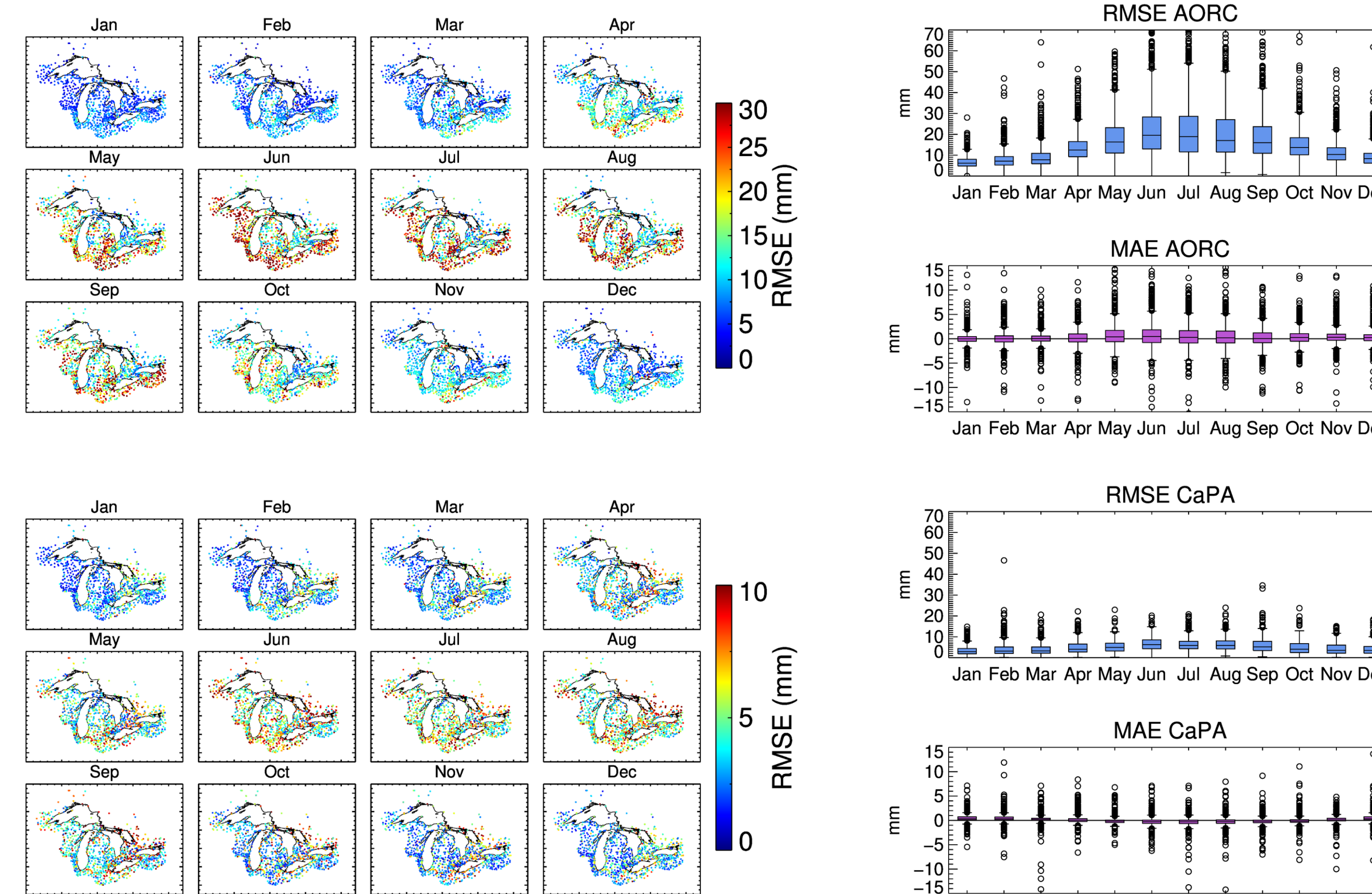


Figure 3. Precipitation datasets evaluated for the NWM over the Canadian land surface of the Great Lakes basin and over the lakes themselves. (a) Analysis of Record for Calibration (AORC). (b) the Canadian Precipitation Analysis (CaPA).

Results - Overlake

Figure 4 shows the ranked the monthly precipitation from AORC, CaPA, and the L2SWBM. Ranking reveals biases and commonalities among the datasets. In general, on Lakes Superior and Michigan-Huron, the AORC matches the L2SWBM 90% credible interval more closely, suggesting that AORC is a better estimate of overlake precipitation on these lakes.

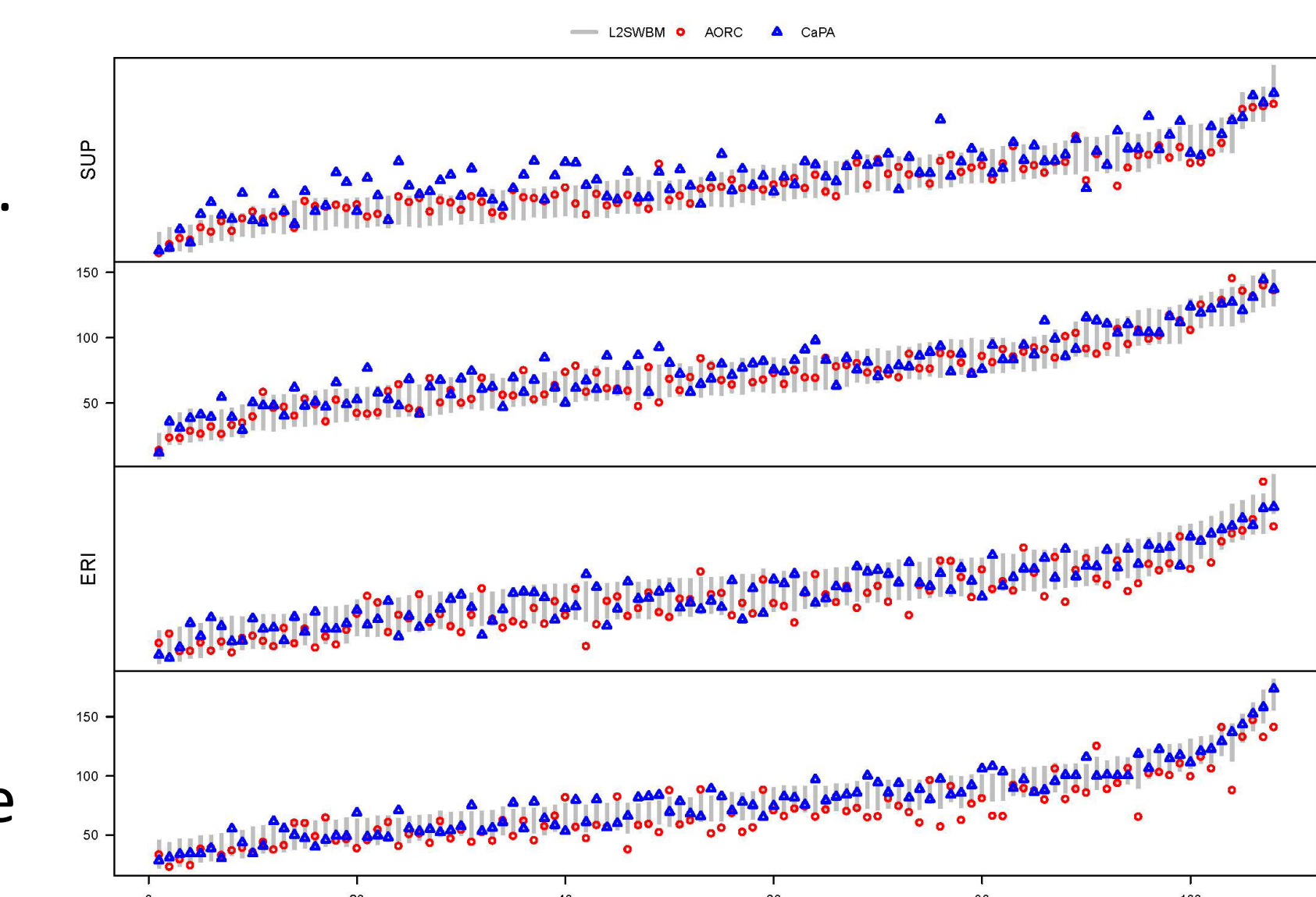


Figure 4. Overlake precipitation estimates by AORC, CaPA, and the L2SWBM 90% credible interval.

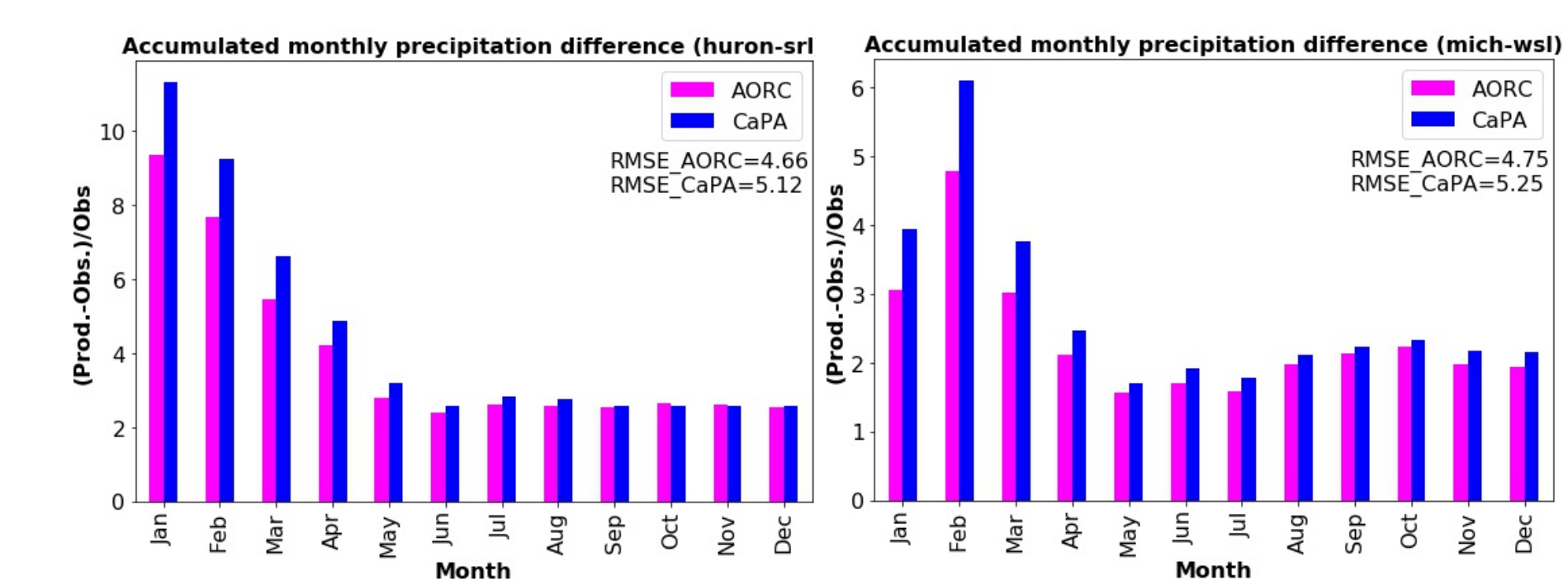


Figure 5. Difference between AORC and CaPA estimates of accumulated monthly precipitation and observed accumulated monthly precipitation at the two offshore stations with available data: (a) Spectacle Reef Lighthouse (Lake Huron) and (b) White Shoal Lighthouse (Lake Michigan).

At two offshore stations with available data, both AORC and CaPA overestimate precipitation, especially in winter (perhaps a result of undercatch of snow). Additionally, CaPA precipitation is generally higher than AORC, especially in the winter.

Conclusions

- AORC precipitation shows unrealistic precipitation over the southern portions of Ontario, which will result in poor calibration of WRF-Hydro for the National Water Model in that region (see poster H431-2136 for details on accommodating this in NWMv2.1). Similar problems were identified previously by Gronewold et al (2018) in southern Ontario for the North American Land Data Assimilation System (NDAS).
- CaPA appears to be a promising dataset to provide the precipitation field for future versions of the AORC over the Canadian portion of the Great Lakes basin.
- Based on analysis using a water budget closure method, monthly precipitation over the lakes themselves appears to be better represented by AORC than by CaPA on Lake Superior and Michigan-Huron, especially for smaller monthly accumulations. At two offshore stations, CaPA estimates are generally higher than AORC, and both are higher than observed accumulations.

Acknowledgements & References

Acknowledgements

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References

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