Supporting Information for "A tug-of-war within the hydrologic cycle of a continental freshwater basin"

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Contents

This document contains Supporting Information for the above-referenced manuscript. Table S1 includes a comparison between different historical estimates of river discharge from North America. Figure S1 includes a long-term historical time series of Great Lakes water level data. Figure S2 includes a comparison between different potential sources of information on the Great Lakes water balance. The following is a summary of notes related to those data sources:

- **GLM-HMD**: The Great Lakes Monthly Hydrometeorological Database [*Hunter et al.*, 2015].
- **ERA5**: The Copernicus Climate Change Service climate reanalysis data product [*Copernicus Climate Change Service (C3S)*, 2017]. Available at 9km resolution from 1981 onward.
- **L15**: A gridded hydrometeorological data product for North America developed at the University of Washington, with lead author Dr. Ben [L]ivneh [*Livneh et al.*, 2015]. Data is available from 1950 through 2013.
- **L2SWBM**: the large lake statistical water balance model [*Gronewold et al.*, 2020; *Do et al.*, 2020].

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- **Residual ET (via L2SWBM and GLM-HMD)**: evapotranspiration was calculated using a land surface water balance equation $ET = P–R–D_{sw}$ where ET is evapotranspiration, P is land precipitation from the GLM-HMD, R is total lake inflow from the L2SWBM, and D_{sw} is the month-to-month change in soil moisture storage based on monthly soil moisture data from the NOAA Climate Prediction Center [*van den Dool et al.*, 2003].
- **WCPS**: simulations from the Environment and Climate Change Canada (ECCC) Water Cycle Prediction system [*Deacu et al.*, 2012; *Durnford et al.*, 2018].
- **AHPS**: the Advanced Hydrologic Prediction System, developed by the NOAA Great Lakes Environmental Research Laboratory and operated by the United States Army Corps of Engineers [*Gronewold et al.*, 2011; *Apps et al.*, 2020].
- **WATFLOOD**: simulations from the Watflood model, developed at the University of Waterloo [*Kouwen*, 1988].
- **CaPA**: the Canadian Precipitation Analysis, developed by the Meteorological Service of Canada [*Mahfouf et al.*, 2007; *Lespinas et al.*, 2015].
- **MPE**: NOAA National Weather Service multisensor precipitation estimates [*Seo*, 1998; *Seo and Breidenbach*, 2002].
- **Merge**: merged product combining over-lake precipitation estimates from CaPA and MPE; developed by the NOAA Midwest Regional Climate Center [*Gronewold et al.*, 2018]. Available at:
`https://mrcc.illinois.edu/cliwatch/northAmerPcpn/getArchive.jsp`.

Table S1. Range of historical estimates of annual average discharge (in cubic meters per second, cms) for North America's largest rivers. Note that the data source for column A[*Kammerer*, 1990] includes only United States rivers. Estimates of flow for the St. Lawrence River vary depending on definition of the outlet. The data source for column C, for example, provides two estimates; one based on an outlet at Quebec City and another (identified in table as "alternate") downstream of the Saguenay River.

River	Approximate annual average discharge (cms)			
	A[*Kammerer*, 1990]	B[*Nilsson et al.*, 2005]	C[*Benke and Cushing*, 2011]	C (alternate)
Mississippi	16,792	18,400	15,200	
St. Lawrence	9,854	10,800	12,101	16,800
Mackenzie	-	9,910	9,020	
Columbia	7,503	7,500	7,730	
Yukon	6,371	6,370	6,340	
Fraser	-	3,620	3,972	
Koksoak	-	2,420	-	
Nelson	-	2,830	2,480	

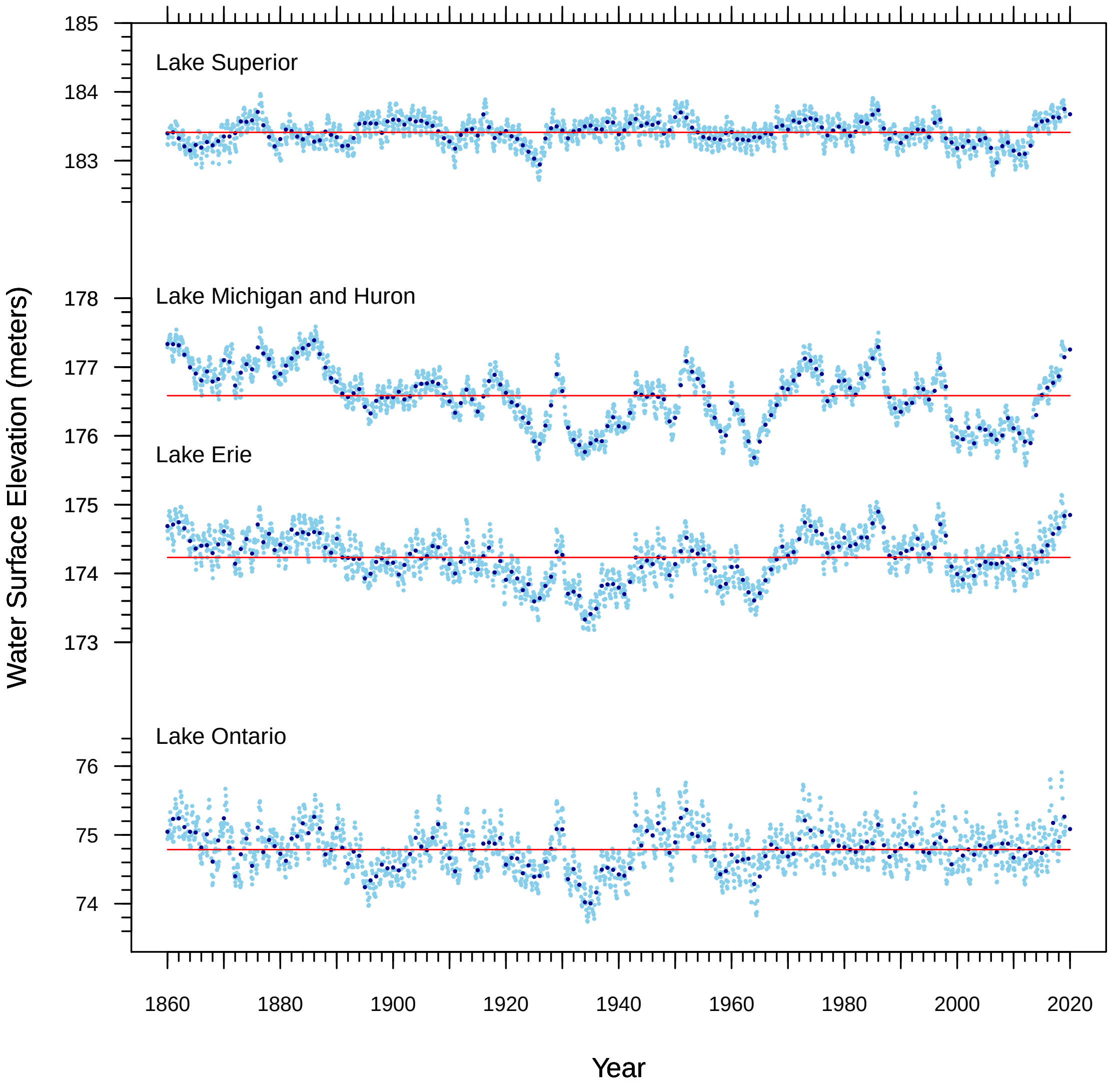

Figure S1. Historical monthly average (light blue), annual average (dark blue) and long-term average (red line) surface water elevations for each of the Great Lakes (Lakes Michigan and Huron are often considered one large lake).

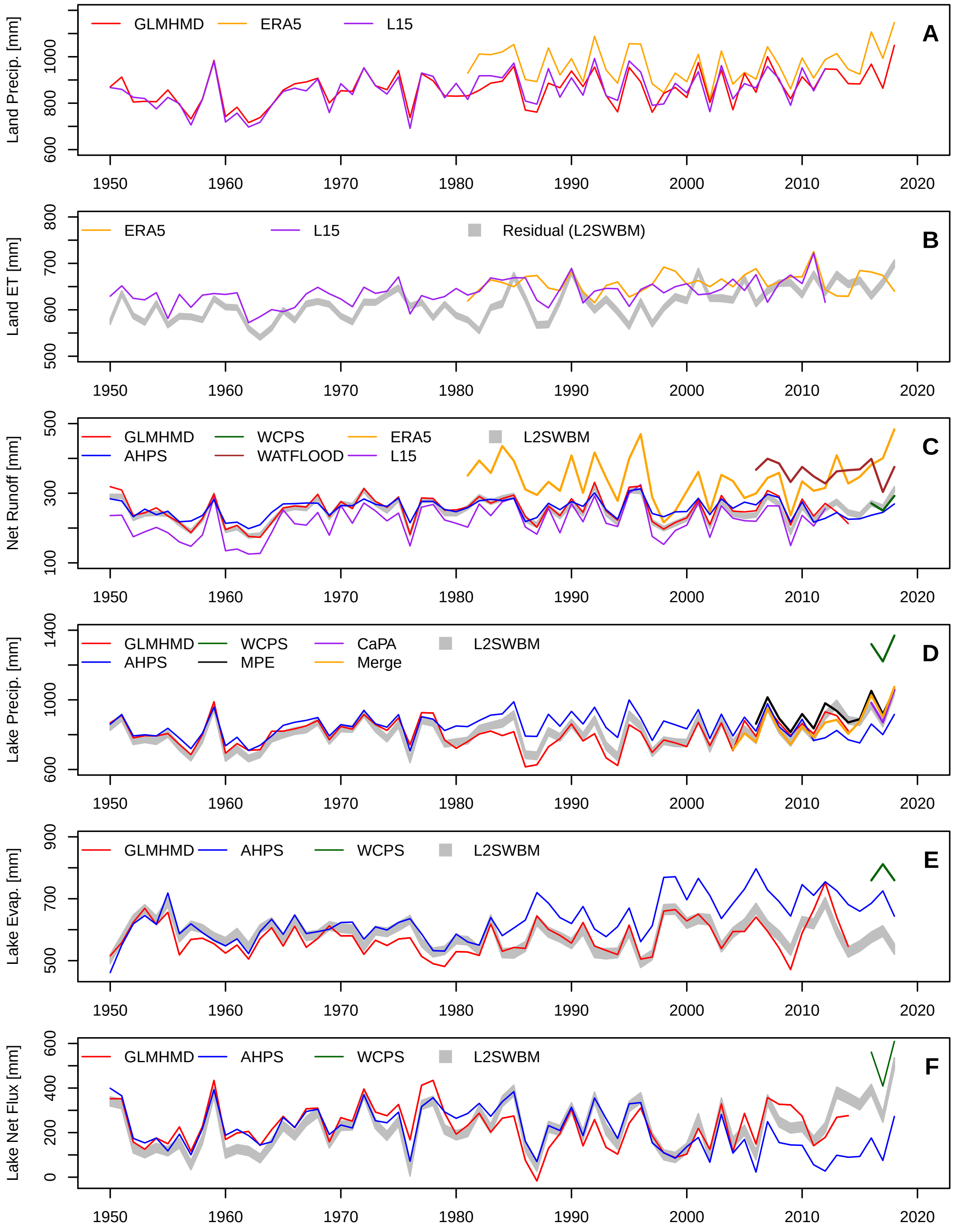

Figure S2. Comparison between candidate historical estimates of water balance components for the Great Lakes system.

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