Kevin
Gaastra
Jet Propulsion Laboratory
Donald Argus, Jet Propulsion Laboratory
Felix Landerer, Jet Propulsion Laboratory
David Wiese, Jet Propulsion Laboratory
Athina Peidou, Jet Propulsion Laboratory
Oral
Observations of terrestrial water storage (TWS) from the Gravity Recovery and Climate Experiment (GRACE), its follow-on mission (GRACE-FO), and inversions of the displacements of GNSS stations are critical for estimating regional changes in subsurface water within the scientific community. Agencies, however, need more rapid and reliable estimates of surface water (lakes, rivers, and snow) to accurately estimate subsurface water from GRACE and GNSS and inform management decisions. Here we present estimates of lake water storage (LWS) in 405 lakes in Canada using a combination of altimetric estimates of lake water height from the Global Reservoirs and Lake Monitor (G-REALM) with water gauges from the Water Survey of Canada's National Water Data Archive (HyDAT) since October 1992. This is a 10-fold increase in lake coverage over our previous global lake model which only has 40 of 983 lakes in Canada. The gauge and satellite data agree within uncertainty during times of no ice cover, but due to errors in altimetry during ice cover we prefer gauge data during winter months. We find that the solid Earth is displaced by more than 2 mm at ≈2000 GNSS stations monitored by the Nevada Geodetic Laboratory due to changes in lake water. We remove our estimates of lake water storage and snow water equivalent (SWE) estimated by ERA5-Land from GRACE TWS and find a median RMS reduction of 5% and up to 77%, though northern Quebec increases in RMS. Surface water storage (LWS+SWE) is found to decline across nearly all of Canada, including the Great Lakes, over the last 3 years. We find that when surface water is removed from GRACE subsurface water has decreased more in west Canada than in east Canada since 1992.
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gaastra-kevin.pdf
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