SUPPLEMENTARY INFORMATION

Nuisance Flooding and Relative Sea-Level Rise: The Importance of Present-Day Land Motion

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Figure S1. Map showing the location of GPS sites and 18 regions (boxes) for which the geologic rate is known. Circle color indicates decadal average vertical land motion in IGb08 reference frame. Black triangles are locations of tide gauges for which nuisance flooding level data and nuisance flooding frequency are available. The GPS rates and nuisance flooding level data shown in Figure 2 and Figure S2-S5 are average values for all stations in the boxes. Map is
Figure S2. Comparison of spatially averaged GPS (gray triangles), geologic data (red circles), and GIA model ICE6G-VM5a (green circles) for eighteen coastal sites in the US and southern Canada (Figure S1). Error bars are 1σ.
Figure S3. Comparison of nuisance flood level (red circles) as standardized by tidal range (MHHW- MLLW), GPS rate (blue triangles) and geologic rate (green circles) as a function of latitude along the US eastern seaboard. Figure S3 is an alternative plot to Figure 2. Here the possible effects of tidal range variations are isolated by dividing the nuisance flood level (measured from MHHW) and tidal range. As in Figure 2, the same relationships are seen between nuisance flood level and GPS rate. Note that the GPS rates and standardized nuisance flooding level data are averaged for all stations and tide gauges in the boxes shown in Figure S1 where geologic data are available.
**Figure S4.** Comparison of GIA-corrected GPS-derived vertical rate (red dots) and average trend in groundwater-level changes (gray dots). The black and red solid curves are quadratic polynomials fit to the groundwater and vertical rate data, respectively.
Figure S5. Map of Lake-Dam system in Quebec, Canada. Lakes with water-level data (virtual gauges) are numbered. For time series see Figure S6. Lake area and annual rate of water-level change are listed in Table S2. Map is generated using GMT software version 5.1.0 (http://gmt.soest.hawaii.edu/) (Wessel et al. 2013).
Figure S6. Time series of water-level change from satellite altimetry measurements produced by different processing centers. Lake level products are courtesy of (a) USDA/NASA G-REALM. (b) database for Hydrological Time Series of Inland Waters (DAHITI) (c) HYDROWEB database from Legos and THEIA platform. A least squares model fit was used to
define the rate. Model parameters include an initial offset, a constant rate and fixed amplitude annual variation.

**Figure S7.** Comparison of trend in total water storage (in equivalent water height) from three GRACE solutions: The University of Texas Center for Space Research (CSR), Geoforschungszentrum (GFZ), and NASA Jet Propulsion Lab (JPL) (Top panel) GRACE
Stokes coefficients were smoothed by applying the non-isotropic filter DDK2 (Kusche, 2007). (Bottom panel) Post-processed gridded monthly TWS data provided by NASA JPL Tellus were used. Trend is corrected for the GIA model of Geruo et al. (2013). The location of active major dams (red dots) and formal boundaries for the James Bay hydroelectric project (yellow line) are also shown. The white dashed circle with radius 400 km approximates the excess mass observed in Quebec with GRACE. Map is generated using GMT software version 5.1.0 (http://gmt.soest.hawaii.edu/) (Wessel et al. 2013).

Figure S8. Sum of groundwater and soil moisture storage trend (in equivalent water height) from WaterGap Global Hydrological Model (WGHM, version 2.2b) (Döll et al. 2014; Müller Schmied
et al. 2014). Map is generated using GMT software version 5.1.0 (http://gmt.soest.hawaii.edu/)
(Wessel et al. 2013).

**Table S1.** Statistics of GRACE TWS trends (in equivalent water height) based on three GRACE solutions (CSR, GFZ, and JPL) and two post-processing products including Tellus gridded GRACE TWS data (isotropic filter: Gaussian + de-striping filters) and non-isotropic filter (DDK2 filter). Unit: mm yr$^{-1}$.

| Solution (G+De$^1$/DDK2) | Min.  | Max.  | Mean  | RMS   |
|---------------------------|-------|-------|-------|-------|
| CSR                       | -6.7/-9.9 | 13.1/17.9 | 4.3/6.1 | 6.0/8.5 |
| GFZ                       | -6.6/-11.0 | 13.9/18.5 | 4.7/6.3 | 6.4/8.8 |
| JPL                       | -6.2/-10.8 | 12.0/17.5 | 4.7/6.1 | 6.3/8.5 |

$^1$ G: Gaussian filter, De: de-striping filter
**Table S2.** Characteristics of lakes and annual rate of water-level change from different satellite altimetry missions and processing centers. The non-parametric Mann-Kendall trend test was applied to the water-level change time series. The $P$-value of the two-tailed test at the significance level of 0.05 is listed. The trends are considered statistically significant when the $p$ value falls below a critical value ($P < 0.05$). It is sufficient to conclude that there is a positive trend in the water-level variations for different periods. The total rate of change of water volume from the nine reservoirs listed in Table S2 is about 1.7 km$^3$ yr$^{-1}$ which is ~ 30% - 40% of TWS changes observed by GRACE. Columns 6 and 7 are rate of water-level change and rate of volume change, respectively.

| No. | Name               | Area (km$^2$) | Altimetry data period | Satellite mission              | Rate (m yr$^{-1}$) | Rate (km$^3$ yr$^{-1}$) | $P$-value |
|-----|--------------------|---------------|------------------------|-------------------------------|-------------------|------------------------|-----------|
| 1   | La Grande$^1$      | 78            | 2009 - 2017            | Jason 2 & 3                   | 0.05              | 0.004                  | 0.01      |
| 2   | Robert Bourassa$^1$| 2,900         | 2008 - 2017            | Jason 2 & 3                   | 0.05              | 0.15                   | 0.03      |
| 2   | Robert Bourassa$^4$| 2,900         | 2002 - 2011            | Envisat                       | 0.06              | 0.17                   | 0.06      |
| 3   | La Grande$^2$      | 2,500         | 1992 - 2017            | T/P, Envisat, GFO, Jason 2 & 3| 0.19              | 0.47                   | 0         |
| 3   | La Grande$^3$      | 2,500         | 2002 - 2014            | Jason 1 & 2                   | 0.30              | 0.74                   | 0         |
| 4   | Opinaca$^2$        | 1,100         | 1992 - 2017            | T/P, Envisat, Jason 2 & 3     | 0.13              | 0.12                   | 0         |
| 5   | Low Lake$^1$       | 200           | 2008 - 2017            | Jason 2 & 3                   | 0.27              | 0.06                   | 0         |
| 6   | Manicouagan$^1$    | 1,950         | 2008 - 2017            | Jason 2 & 3                   | 0.07              | 0.14                   | 0.02      |
| 7   | Pipmuacan$^1$      | 980           | 2008 - 2017            | Jason 2 & 3                   | 0.24              | 0.24                   | 1.7E-04   |
| 8   | Lake Saint Jean$^2$| 1,053         | 1992 - 2014            | T/P, Envisat, GFO, Jason 2    | 0.05              | 0.05                   | 9.3E-10   |
| 9   | Gouin$^1$          | 1,600         | 2008 - 2017            | Jason 2 & 3                   | 0.08              | 0.13                   | 2.3E-08   |
Lake level products are from 1. USDA/NASA G-REALM program (https://www.pecad.fas.usda.gov/cropexplorer/global_reservoir/); 2. database for Hydrological Time Series of Inland Waters (DAHITI) developed by the Deutsches Geodätisches Forschungsinstitut der Technischen Universität München (DGFI-TUM) (http://dahiti.dgfi.tum.de/en/map/) (Schwatke et al. 2015); and 3. HYDROWEB database from Legos and THEIA platform (http://hydroweb.theia-land.fr/) (Crétaux et al. 2011).

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