Supplementary Materials for

21st-Century Evolution of Greenland Outlet Glacier Velocities

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Supporting Online Material for
21st century evolution of Greenland outlet glacier velocities
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**Methods:** We sampled glacier velocity measurements at the center of the flow field (roughly coincident with maximum cross-glacier velocity) approximately one half-width upstream of the point of greatest retreat between 1992-2008 (35). The point was adjusted if the ice front subsequently retreated past the measurement point (observed using MODIS or RADARSAT data) or to maximize data return. Below the 2000 m contour, where we sample glacier velocity, bedrock control points create control-related errors <10 m/yr.

Beginning with 206 outlet glaciers, we first use a linear interpolation to add data for missing data points ($x$) with measurements in the year before and after ($x+1$ and $x-1$) (thus, only for $x = 2006$ through 2009) (interpolated points indicated in Fig. S2-S3). Data are then separated into the following categories (also indicated in Fig. 1):

1. Land-terminating glaciers
2. Ice-shelf terminating glaciers (ice shelf >10 km long)
3. Marine-terminating outlet glaciers with average velocity <200 m/yr
4. Glaciers with insufficient data: Glaciers that lack one or two measurements for 2000-2005 have insufficient data (28 glaciers total), as are glaciers that have fewer than 2 measurements for 2005-2010 (11 glaciers).

The remaining marine-terminating glaciers are each fit with a linear regression for 2000-2005 and evaluated for misfit to a linear trend ($mf$), which allows a comparison between the measured speeds ($s$) and the linear regression ($m\bar{t}+b$):

\[
 mf(\%) = \frac{\|s - (m\bar{t} + b)\|}{\|s\|} \cdot 100
\]

We separate all glaciers with $mf>15\%$ to avoid representing erratic or highly variable behavior with a consistent trend. The remaining fast-flow marine-terminating glaciers are fit with linear regressions through all available data for 2000-2005 and 2005-2010. These trends are used to fill any remaining data gaps, so that data presented in, for example, Fig. 2 are complete for all glaciers (interpolated points indicated in Fig. S2-S3).

Using the completed dataset of fast-flow marine-terminating glaciers, we also review the results by 1) width-weighting the glaciers:

\[
 \left( \frac{v}{w \cdot \bar{w}} \right)
\]

where $v =$ measured velocity, $w =$ glacier width, and $\bar{w} =$ mean regional width and 2) removing the 5 fastest 2010 glaciers: Jakobshavn and Upernavik North in the northwest and Helheim, Kangerdlugssuaq, and Ieq Fjord glaciers in the southeast. When width-
weighted, the general pattern of northwest and southeast regional annual mean remains the same, though the decadal regional mean is increased in both cases. Removing the top-5 fastest glaciers also has a negligible affect on the regional patterns, but does decrease the decadal mean velocity.
Figure S1. Names and locations of glaciers referenced in the text. The background map is a 2007-2010 composite velocity map.
Figure S2. Annual velocity change (% change from previous year) for northwest marine-terminating glaciers with sufficient data and mean velocity >200 m/yr. Interpolated data for the most recent year (e.g., 2010 for 09-10 change) is indicated with a white circle. An additional cross on the marker indicates interpolated data for 2005. The background velocity map in each case is for the most recent year of data (e.g., winter 2010 map for 09-10 change).
Figure S3. Annual velocity change (% change from previous year) for southeast (and some east) marine-terminating glaciers with sufficient data and mean velocity >200 m/yr. Interpolated data for the most recent year (e.g., 2010 for 09-10 change) is indicated with a white circle. An additional cross on the marker indicates interpolated data for 2005. The background velocity map in each case is for the most recent year of data (e.g., winter 2010 map for 09-10 change).
Table S1. Summary of data source used and acquisition date range for each winter velocity map.

<table>
<thead>
<tr>
<th>Map year</th>
<th>Data type</th>
<th>Acquisition date range</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000/01</td>
<td>RADARSAT</td>
<td>Sept 2000-Jan 2001</td>
</tr>
<tr>
<td>2005/06</td>
<td>RADARSAT</td>
<td>Dec 2005-Apr 2006</td>
</tr>
<tr>
<td>2006/07</td>
<td>RADARSAT</td>
<td>Dec 2006-Apr 2007</td>
</tr>
<tr>
<td>2008/09</td>
<td>RADARSAT</td>
<td>Dec 2008-Feb 2009</td>
</tr>
<tr>
<td>2009/10</td>
<td>TerraSAR-X, ALOS</td>
<td>Oct 2009-Feb 2010</td>
</tr>
</tbody>
</table>
References and Notes


16. Materials and methods are available online as Supplementary Materials.


