Data Resources and a case study from Whillans Ice Stream
You don’t have to collect your own data to be a glacier seismologist
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Paul Winberry
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where are the wiggles?

Spatial and temporal variations in Greenland glacial-earthquake activity, 1993–2010

Stephen A. Veitch¹ and Meredith Nettles¹
Table 1. (continued)

### Centroid Parameters

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y M D</td>
<td>h m sec $\delta t_0$</td>
<td>$\lambda$ $\delta \lambda_0$</td>
<td>$\phi$ $\delta \phi_0$</td>
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<tr>
<td>2010 2 11</td>
<td>1 16 41.6 ± 0.4 −22.4</td>
<td>66.41 ± .02 −0.84</td>
<td>−38.37 ± .03 −0.12</td>
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<tr>
<td>2010 2 21</td>
<td>4 12 20.6 ± 0.3 −3.4</td>
<td>69.19 ± .01 −0.06</td>
<td>−49.52 ± .05 −1.27</td>
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### Scale Factor

<table>
<thead>
<tr>
<th>Scale Factor</th>
<th>M</th>
<th>CSF</th>
<th>$V_r$</th>
<th>$V_{\theta}$</th>
<th>$V_{\phi}$</th>
<th>pl.</th>
<th>azim.</th>
<th>reg.</th>
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<tr>
<td>$10^{13}$</td>
<td>2.9</td>
<td></td>
<td>−0.56 ± 0.09</td>
<td>1.75 ± 0.12</td>
<td>2.19 ± 0.12</td>
<td>11</td>
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<td>2</td>
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<td>−2.80 ± 0.10</td>
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<th>CSF</th>
<th>V&lt;sub&gt;r&lt;/sub&gt;</th>
<th>V&lt;sub&gt;θ&lt;/sub&gt;</th>
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Station map for DK.ILULI
Ilulissat, Greenland

HHZ 80-20 s

Paul Winberry
You’ll need something besides your wiggles.

Some Resources:
- NSIDC
- Polar Geospatial Center
- ESA
- NASA
- USGS
You’ll need something besides your wiggles.

Some Measurements:
- Ice Sheet Velocity
- Ice Sheet Thickness
- Imagery
Stick-slip
Measurements Used:
- InSAR Velocities (Rignot from NSIDC)
- Grounding Line (Scambos NSIDC)
- MOA Imagery (Scambos NSIDC)
The middle of the WIS moves by stick-slip
The timing is modulated by the tides
1) The contribution of “stick-slip” varies

2) The WIS is slowing down (we're going to back to that in a few slides)
Timing between events is controlled by stressing rate.
Upstream push ($v_{up}$)
(1.11 m d$^{-1}$ 2004)
(1.03 m d$^{-1}$ 2011)

Downstream pull tidally modulated ($v_{dn}$)
(0.1 to 0.3 m d$^{-1}$)

$H_{up}$
(1000 m)

$L_{up}$ (100 km)
Sticky spot (CSS)
$L_{dn}$ (60 km)

$(\sim 25$ km$)$

$$\tau_{sticky-spot} = \frac{EWH_{up}x_{up}}{L_{up}A_{sticky-spot}} + \frac{EWH_{dn}x_{dn}}{L_{dn}A_{sticky-spot}}$$
Short inter-event duration events occur due to increased stressing rates from downstream.
Slow-down of Non Stick-slip Locations is ~ constant

Slow-down of Stick-slip Locations is variable
Increased number of single day slip events.
If low tide events are not initiated, the downstream end slows down and a slip event doesn’t occur until the following high tide.

Upstream sites are slowing, reducing the loading rate.
Notice that amount of slip isn’t double.
After ~16 hours you enter the visco-elastic regime.
Satellite altimetry shows a growing bump at the junction between steady and stick-slip regions.
Slow-down of Stick-slip Locations is variable