Recent results and products from remote sensing of ice sheet velocities

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55 study glaciers: Marine-terminating, fast-flowing

Study period: 2009-2013

Runoff data: RACMO2.3
Terminus data: Landsat 7 and 8 TerraSAR-X
Velocity data: TerraSAR-X InSAR & speckle tracking

Distinct patterns of seasonal Greenland glacier velocity -- Moon et al. (2014), GRL
Mechanisms for speedup

1. Terminus retreat with reverse slope bed

2. Increase in basal water pressure

[Creyts and Clarke, 2010]

[Carr et al., 2013]

[Creyts and Clarke, 2010]
Type 1: Sustained summer speedup
Type 1: High sensitivity to terminus

- Slow speed
- Faster speed

[Graph showing relative terminus position and detrended velocity over years 2009 to 2014]

[Diagram showing faster and slower speeds]
Type 2: Distributed network
Type 2: Distributed network

Velocity is determined by runoff *without* distributed—channelized switch.
Type 3: Channelized drainage evolves
Type 3: Channelized drainage evolves

Velocity is determined by runoff with distributed—channelized switch.
- 2010 & 2012 response: 5 glaciers
- 2012 response: 7 glaciers
- Regional distribution of seasonal terminus behavior suggests that supraglacial or englacial water storage may be important.
- Initial look consistent with along-glacier evolution of hydrology system.
Measuring broad-area surface velocity with Landsat 8

Ice Flow Speed (m/d)

- 0.00
- 1.25
- 2.50
- 3.75
- 5.00

2013-2014
Excellent spatial and temporal coverage

- Taking advantage of Landsat 8’s improved radiometric resolution and geolocation accuracy
- Creating both annual mosaics and seasonal scale time series
- Fast processing speed for near real time measurements
Pairing Landsat 7 and Landsat 8

“There is variability in flow rate on any time scale you care to consider--from hours to decades to centuries. Pretty cool.”

- Christina Hulbe

[from Christina Hulbe]
Forthcoming MEAsUREs dataset for ice front position

- Terminus position maps for: 2000/01 and annually 2005/06 – 2009/10
- 228 glaciers
- Land- and marine-terminating
- Making Earth System Data Records for Use in Research Environments (MEAsUREs), hosted at the NSIDC (nsidc.org/data/measures)
Summary

- Seasonal velocity patterns:
  - High sensitivity to seasonal terminus behavior for some glaciers, but more glaciers respond primarily to changes in the hydrologic system
  - Signature velocity patterns for glaciers *with* distributed--channelized switch and glaciers *without* distributed--channelized switch
  - Hydrologic link has dynamic implications for annual melt, supra/englacial water storage, along-glacier evolution of hydrology

- Glacier and ice sheets surface velocities from Landsat 8
- Forthcoming MEAsUREs dataset for annual terminus positions for Greenland
Type 2: Summer spike
Type 3: Late summer deceleration
Record Greenland surface melt: 2010 & 2012

[2010 Melt Day Anomaly][Tedesco et al., 2011]

[2012 Melt Day Anomaly][Tedesco et al., 2013]