A path to dynamic subglacial water systems and why they matter

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Subglacial Water Introduction

- Water is important for basal lubrication
- Water source is basal melt
- Transported down hydraulic potential
Subglacial lakes

- Fill and drain on time frames of months to decades
- To incorporate into model:
  - Filling lake = sink
  - Draining lake = source
  - For now we use lake distribution and volume time series from (Fricker et al., 2009; 2010 and Smith et al., 2009)
- Goal: to identify a simple rule to parameterize lakes in absence of such data

(Carter et al., in review)
MacAyeal Ice Stream

Time series from Fricker et al., 2010.
Discharge with time

(Carter et al., in review)
Discharge with time

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(Carter et al., in review)
Discharge with time

(Carter et al., in review)
Kamb and Whillans ice streams

Water Budget Balances But . . .

- Only as good as your melt rates
- Needs really precise Surface bed topography
- Precise lake geometry
- ICESat I time series (2003-2009)
- Works great for well surveyed Siple Coast
- Other places and time periods lack sufficient data
Small changes in surface elevation redistribute water substantially

• Lakes are prevalent in most fast flowing regions of Antarctica
• Where they are present water distribution varies considerably over the ICESat Observation cycle
Ongoing work

- Flood evolution
  - Channelization
  - Triggering
  - Effective pressure / sliding
- Lake / ice velocity /
  basal traction feedback
- Surging Ice sheets?

(Carter et al., 2009)
Hope and approximations

- Floods primarily affect flow paths (we can do 1-D water flood models)
- Lakes seem to be very close to flotation when they flood
- Flood duration and magnitude relates to surface slope

More data arriving all the time
Conclusions

- Lakes greatly influence water distribution over time
- Outbursts could either deliver more water to areas which would otherwise not receive it or channelize water and limit its ability to lubricate
- Subglacial water systems in fast flowing regions highly sensitive to small changes in surface elevation

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Vogel et al., 2007