Why It Matters

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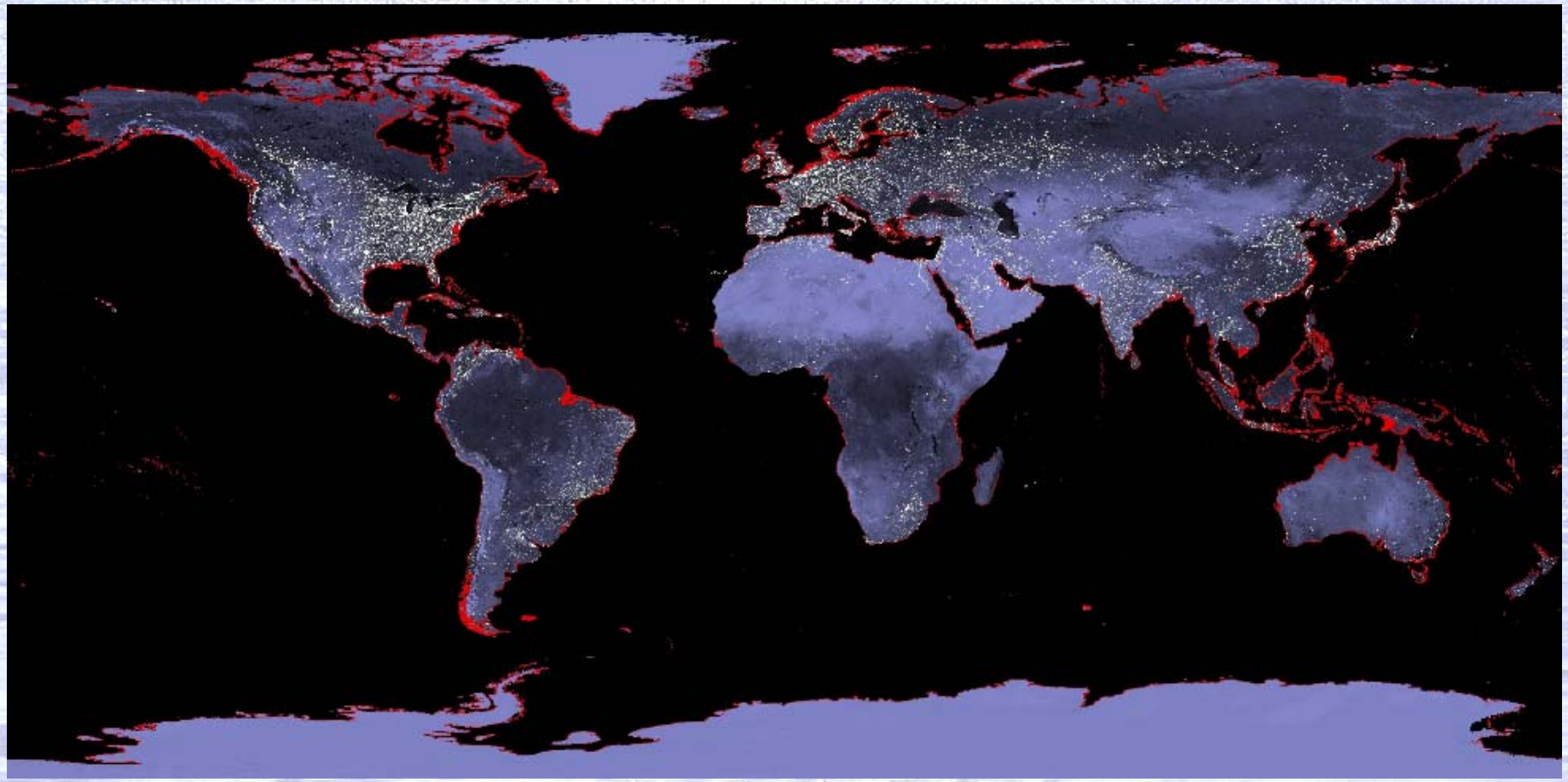
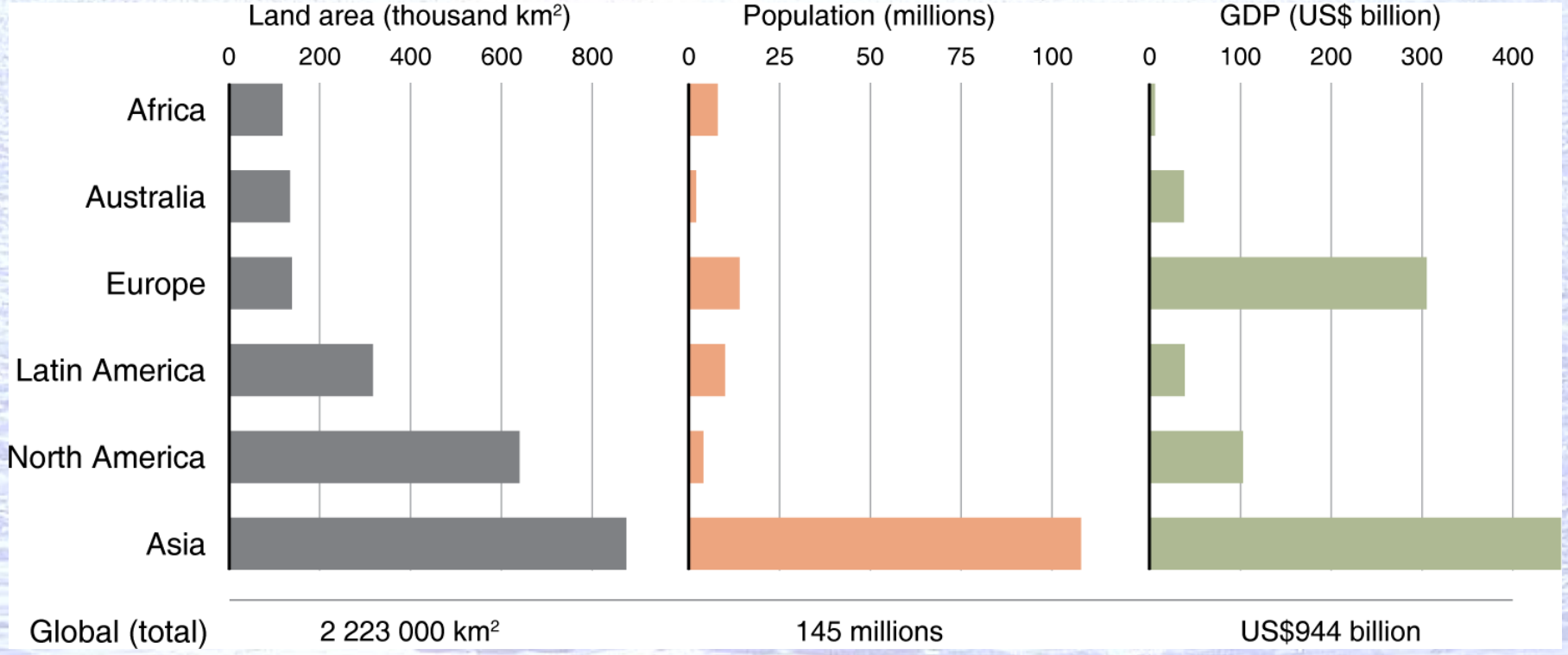
Land area lost by 1-meter rise in sea level



Source: CReSIS and NASA

Impact of 1-meter sea level rise:



From Anthoff et al., 2006

An immediate and significant impact on economies and ecosystems worldwide

IPCC Report Evolution

- 1990 – no mention of ice dynamics; time-scale thought too long for focus on 2100

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- 2001 – feedback emphasizing importance of ice dynamics all but ignored
- 2007 – dramatic ice dynamics clearly identified as a limitation to prediction

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

Table SPM-3. Projected globally averaged surface warming and sea level rise at the end of the 21st century. {10.5, 10.6, Table 10.7}

Case	Temperature Change (°C at 2090-2099 relative to 1980-1999)[a]		Sea Level Rise (m at 2090-2099 relative to 1980-1999)
	Best estimate	*Likely* range	Model-based range excluding future rapid dynamical changes in ice flow
Constant Year 2000 concentrations[b]	0.6	0.3 – 0.9	NA
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

maximum? **NO!**

"…but..flow rates could increase or decrease in the future."

"Larger values cannot be excluded…"

"…understanding of these effects is too limited to assess their likelihood or provide a best estimate or an upper bound for sea level rise."

It is the responsibility of the glaciological community to help provide quantitative estimates of ice-sheet behavior during this century

Bracketing Uncertainty

- Use history
  - 60 mm/a has happened (20X present rate)
- Use analogues
  - Tidewater glaciers
- Use simplified models to capture quick-response components
  - “big dumb ice sheet”

These can be employed right away

Dramatic Ice Sheet Behavior

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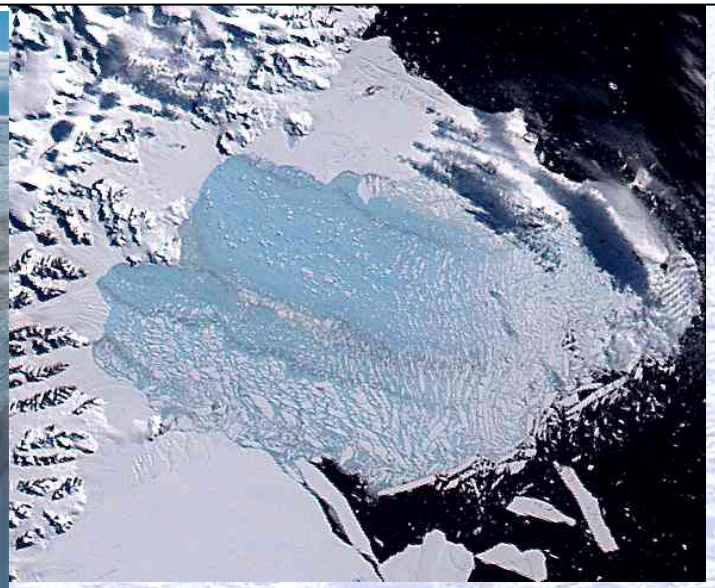

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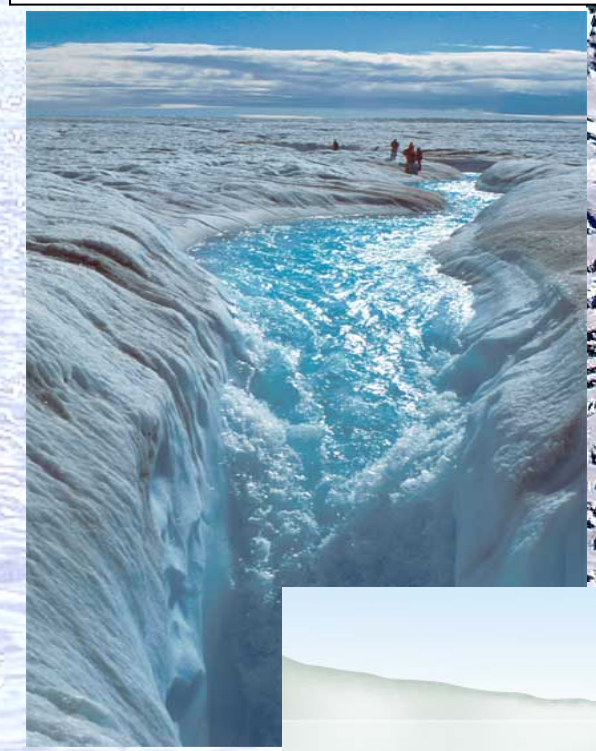

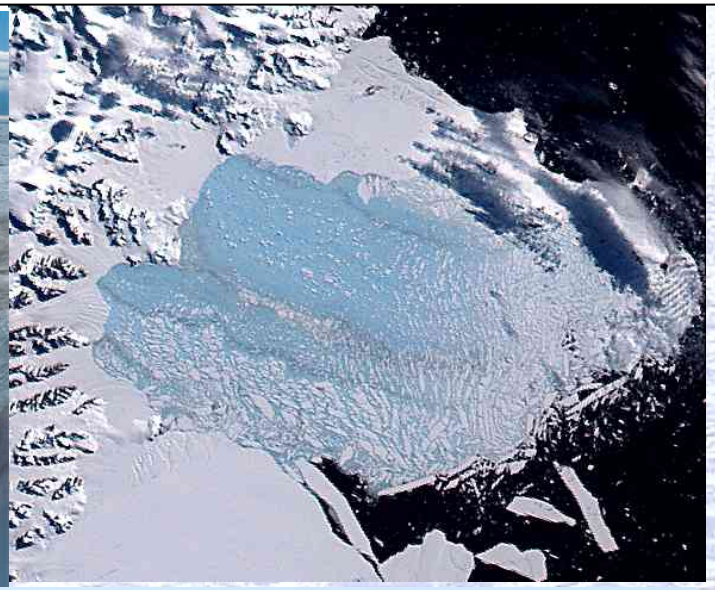

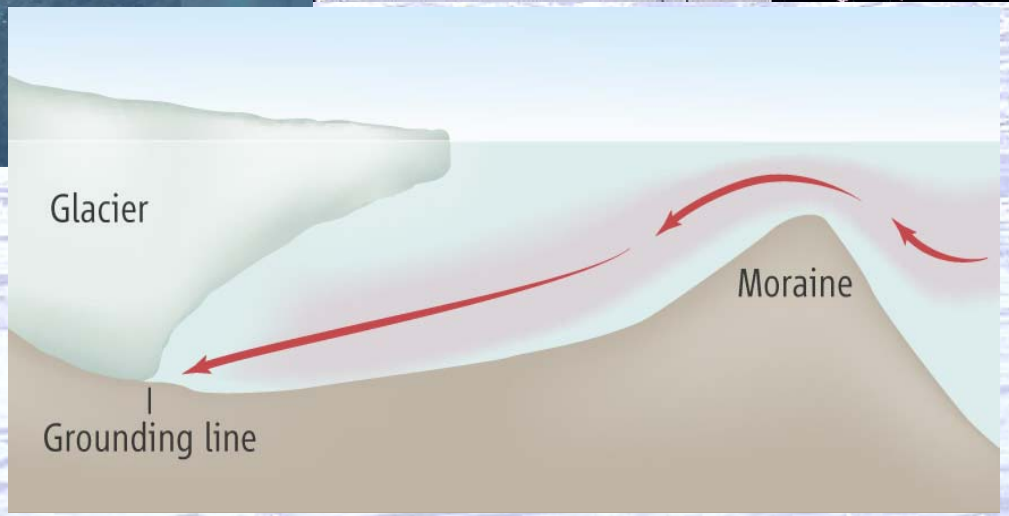

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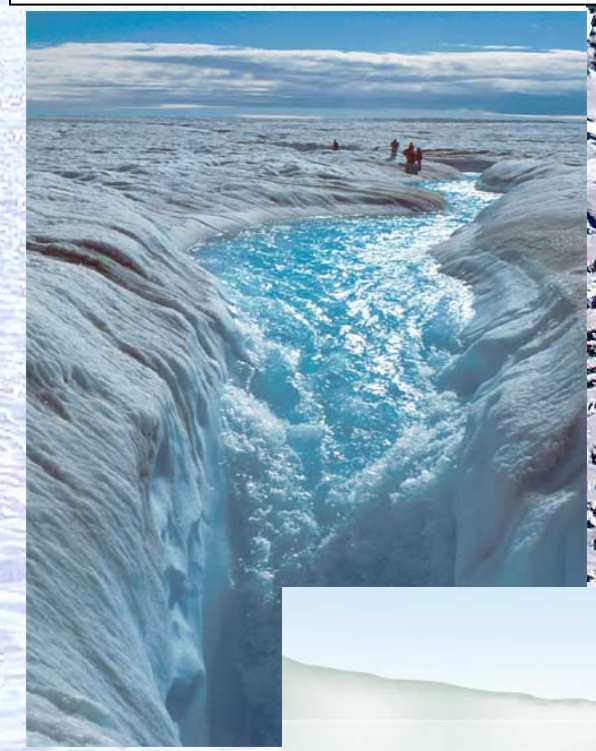

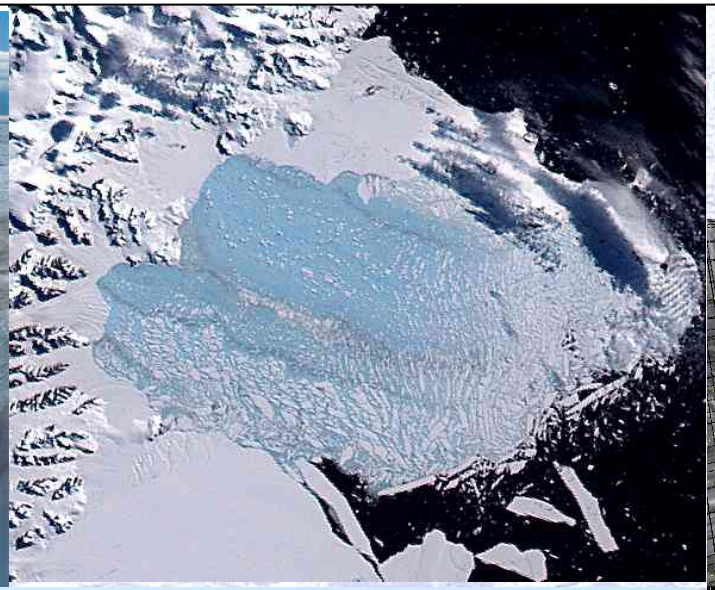

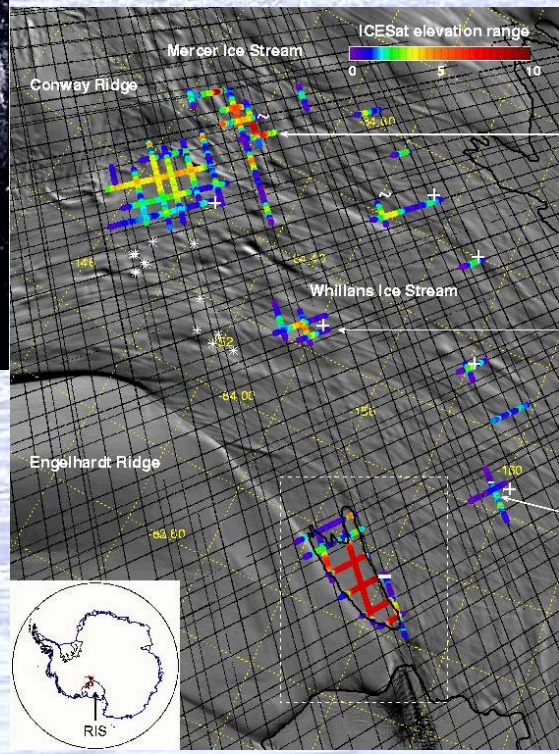

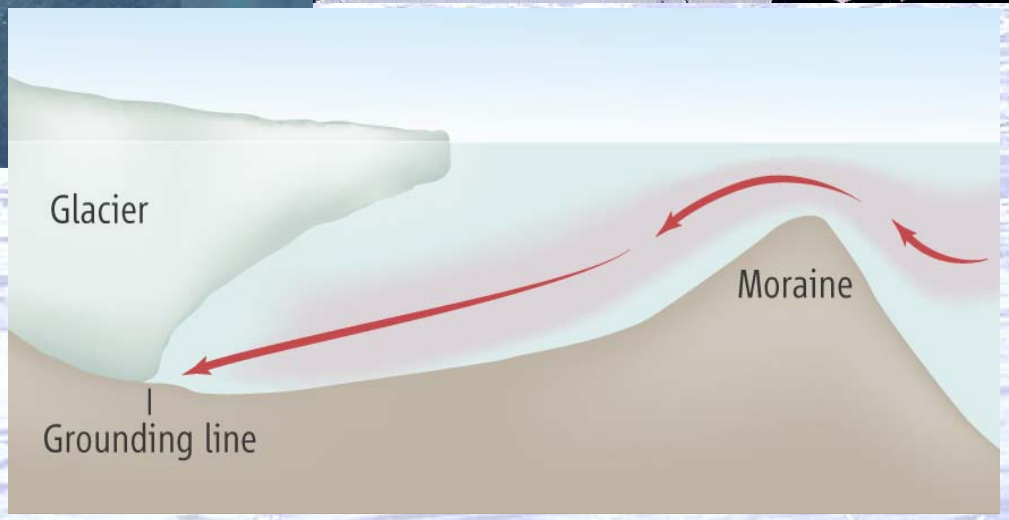

Water drives century-scale (and shorter) ice dynamics

Important Processes

- Subglacial hydrology
  - Meltwater lubrication
    - surface and basal origin
- Ice shelf buttressing
  - Ice shelf disintegration
    - hydraulic and non-hydraulic
- Sub-shelf melting
  - HSSW vs. CDW

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Models will lead field work and produce the first useful quantitative predictions of near-term ice-sheet behavior

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- Get the water right
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- Multiple approaches
  - Simple models with quick results will have enormous impact
  - Full-stress approach requires more time

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Summary

- NOTHING in glaciology is more important than improving short-term ice-sheet behavior predictability (based on cost/benefit ratio)
- Understanding the behavior of the ice sheet edges (i.e., tidewater glaciers and ice shelves) is the key to quantifying the short-term response
- Simpler models will lead the way over the next five years, while field studies continue and more complex models are constructed