Climate-Cryosphere-Tectonics*

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* Change and Interactions among Climate, Hydrology, Surface Processes, and Tectonics:
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Grand Challenges

• Near-surface effects on Natural Hazards and Resources
• Ocean/Atmosphere/Cryosphere Interactions with the solid Earth
• Understanding Fault Slip
Satellite tide gauge
0.2m sea-level rise since 1880

Nuclear power plant Sizewell B

Observed sea level change

Modified from Levermann et al., 2013

Cazenave et al. 2008.
Church & White, 2006.
Contributions to sea-level rise

Greenland contribution of last 20 years: ~10% and rising.

Van den Broeke et al. 2011

Modified from Levermann et al., 2013
Colors are ice flow speed (purples are 500 m/year). Bottom end of Thwaites and PIG are more like a few km/year.

Big Red Circles are total loss per year.
Projected 21\textsuperscript{st} century sea level rise (RCP8.5)

- Extrapolation (Extrap)
- FAR
- SAR
- TAR
- AR4
- AR4+
- SEM
- AR5

Larger values cannot be excluded

Antarctic collapse

http://goo.gl/AAkYHl, Grinsted glaciology blog
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Grounding Zone Features

The Siple Coast Grounding Zone

Observations

Left: Circulation beneath the Ross Ice Shelf (Smethie and Jacobs, 2005). Right: Grounding line melt rates versus thermal forcing (Rignot and Jacobs, 2002).
Ocean/ice interactions

- Ice shelf calving rates & mechanisms
- Ice shelf cavity geometry
- Ocean circulation and temperature structure
Over a mile high...

Almost a mile deep...
Glaciers matter

• Glaciers make spectacular features
• Glaciers can modify their beds faster than rivers can
• Numbers range from m/yr (Taku, Nolan et al., 1995; Hallet; Powell) to...
• Zero (observations of parts of Laurentide; parts of Antarctica)

15
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Earthquakes to slow-slip

Peng and Gomberg, 2010
- Seismicity recorded in Antarctica
- Repeated, regular, likely same location, same mechanism.
• Earthquakes associated with iceberg calving
• Ice flow speed changes
Stick-Slip motion

- Whillans is the only such glacier ... yet...
IRIS contributions

• Englacial and subglacial properties using active source methods
• Dynamics of flow (in collaboration with UNAVCO)
• Polar earth structure for mantle viscosity
• Polar earth structure for heat flow
• Glacier flow as a fault-rupture process
• Poles as a low-noise observing “platform”
Looking forward

• Expand Polar broadband networks/arrays
• Improve instrumentation for polar deployments.
• Improve 3D active-source imaging capability
• Glaciers as laboratories for understanding fault processes