Climate-Cryosphere-Tectonics*

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CReSIS
Center for Remote Sensing of Ice Sheets

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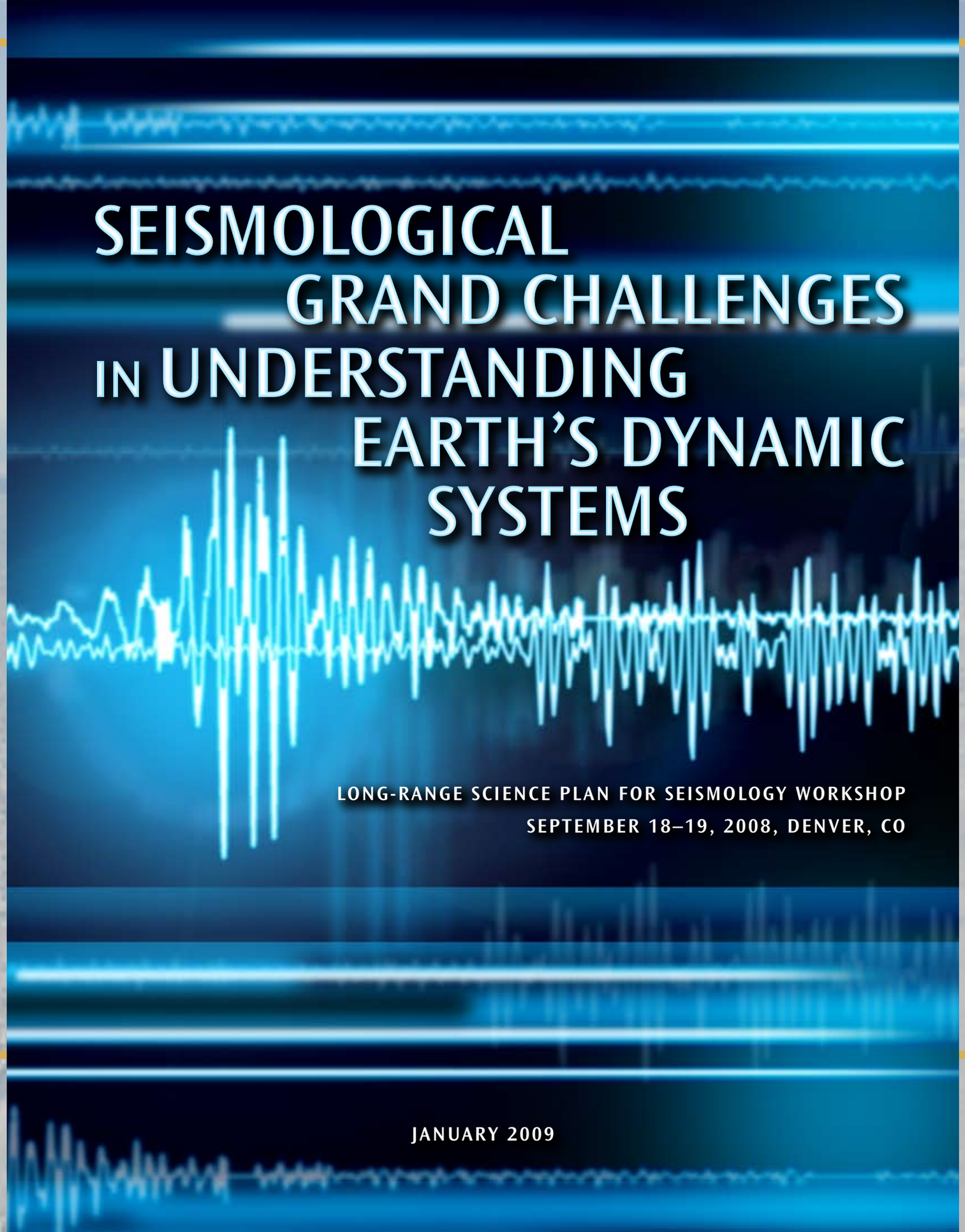

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Grand Challenges

- Near-surface effects on Natural Hazards and Resources
- Ocean/Atmosphere/Cryosphere Interactions with the solid Earth
- Understanding Fault Slip

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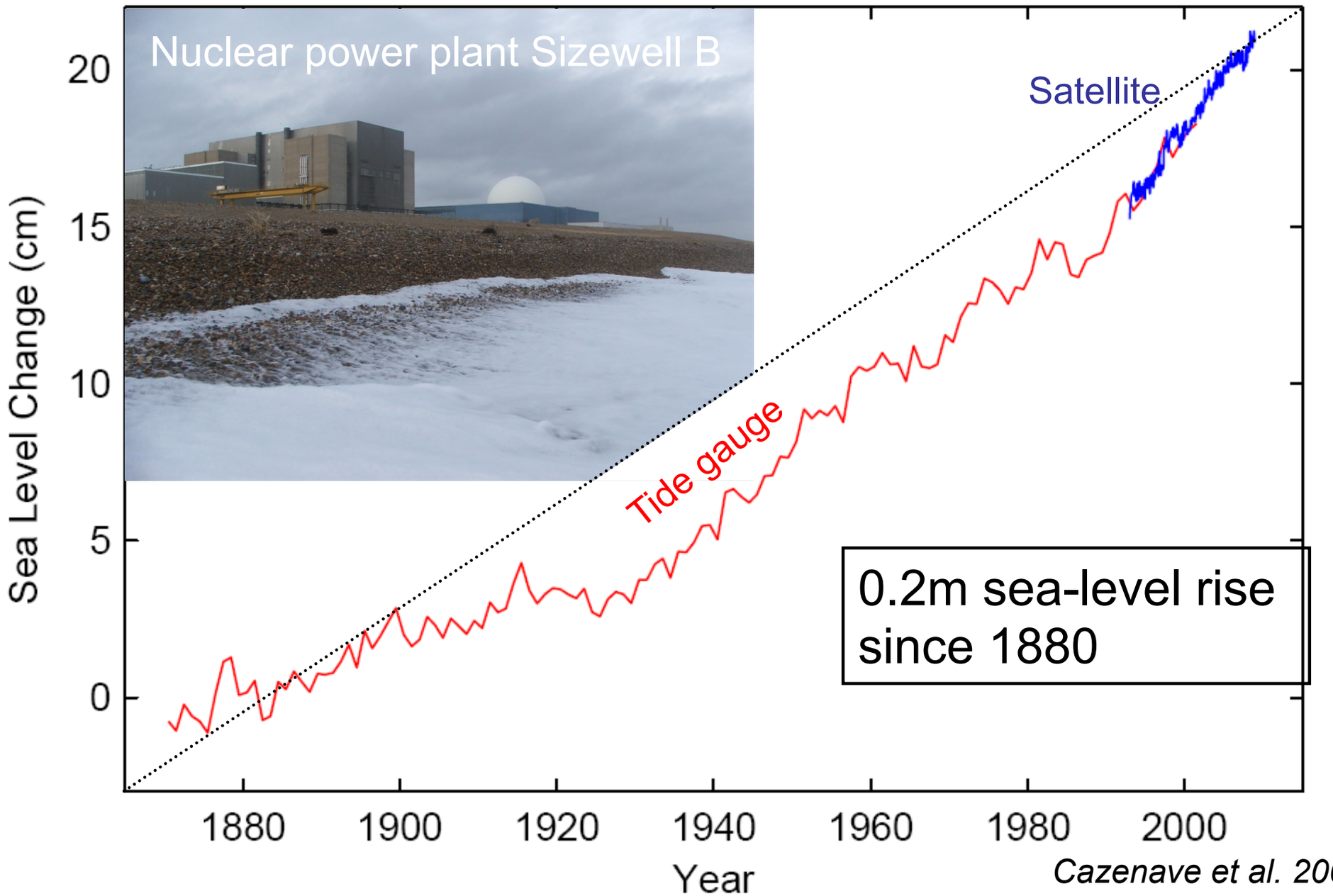
Observed sea level change

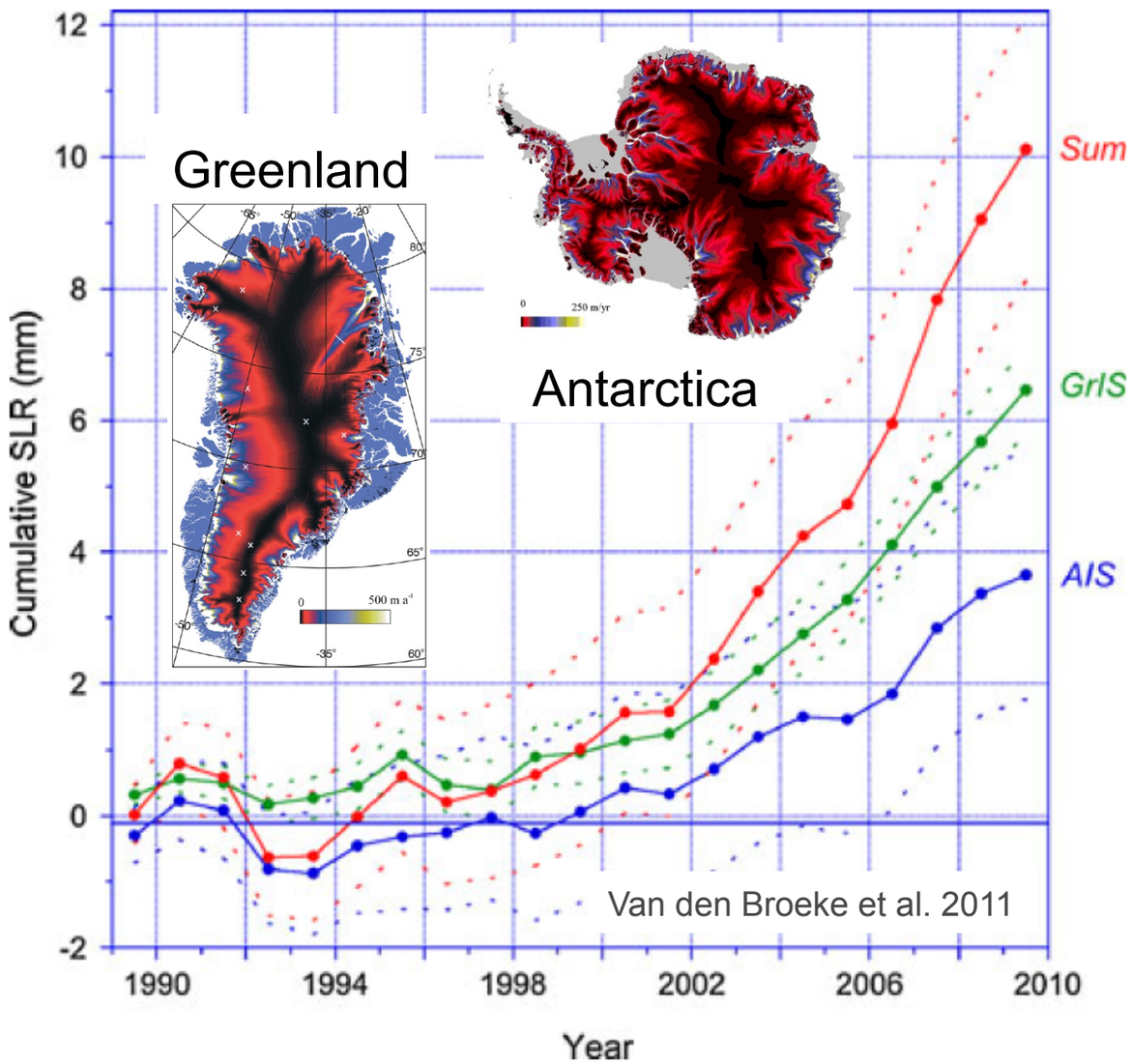


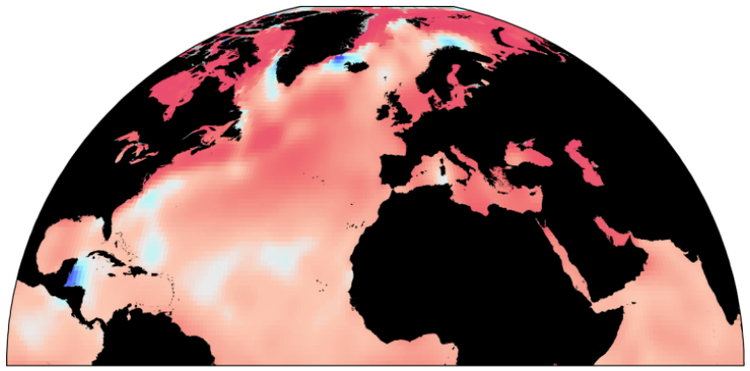
0.2m sea-level rise since 1880

Cazenave et al. 2008.
Church & White, 2006.

Modified from Levermann *et al., 2013*

Contributions to sea-level rise



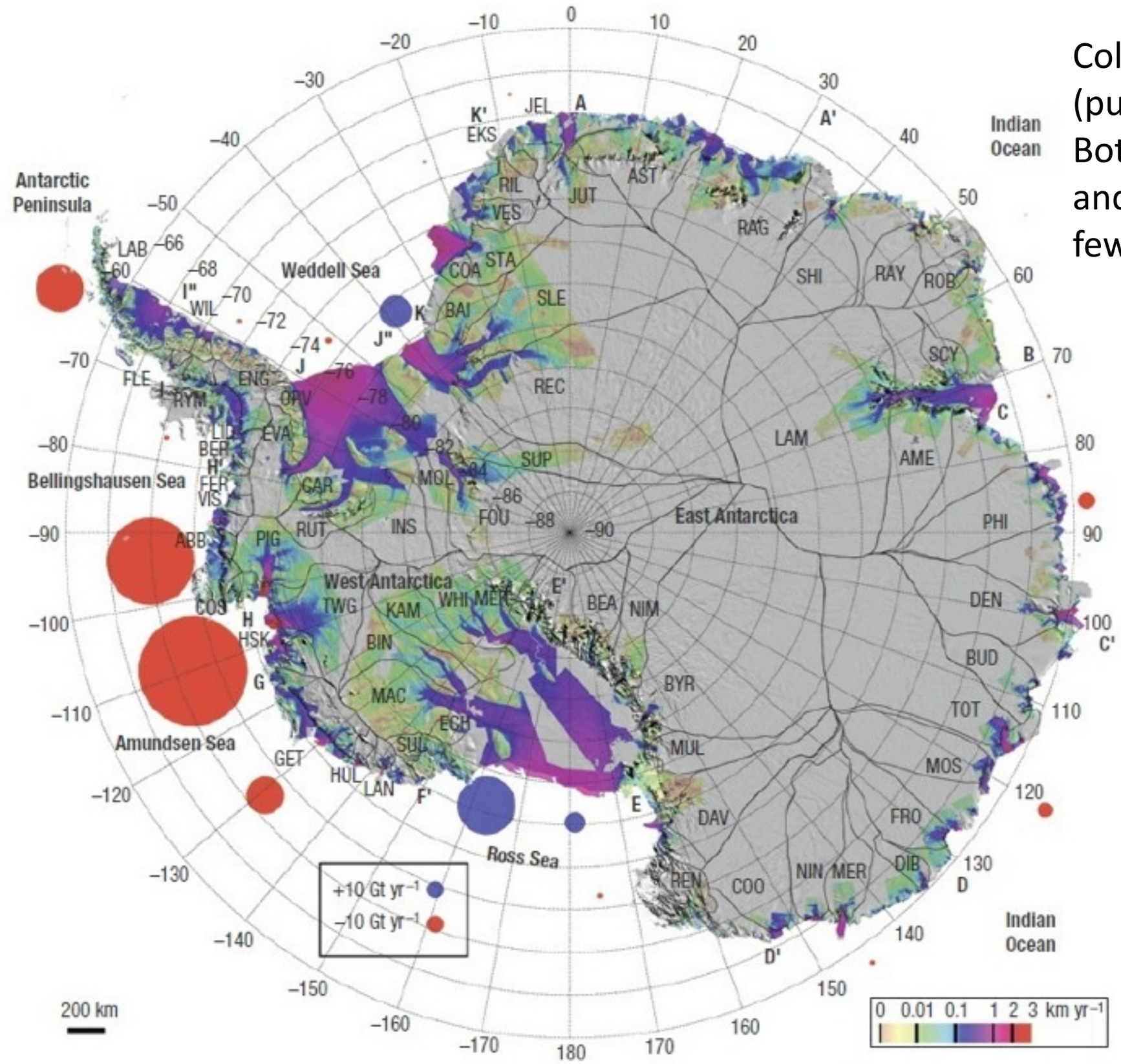


Ocean expansion

Mountain glaciers

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

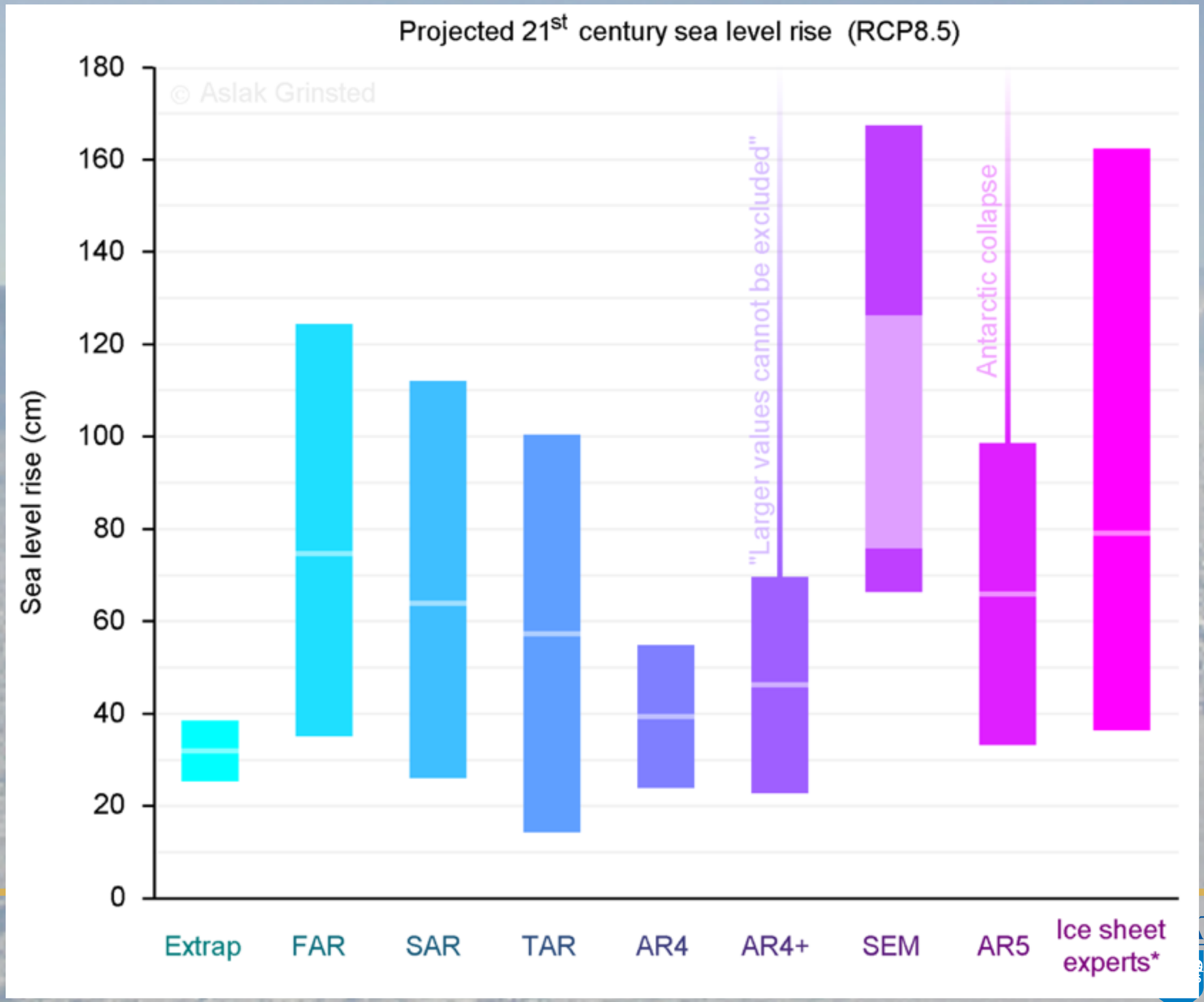
Modified from Levermann *et al., 2013*



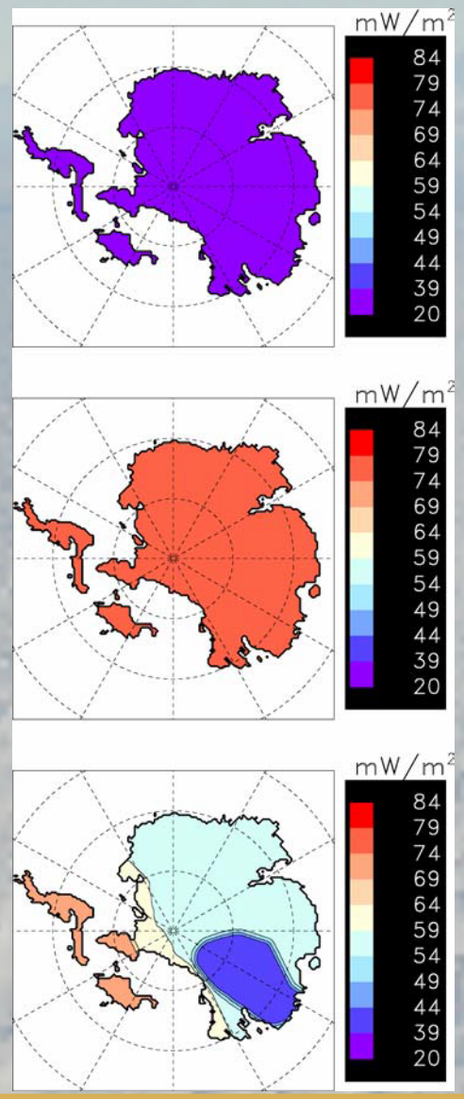
Colors are ice flow speed (purples are 500 m/year). Bottom end of Thwaites and PIG are more like a few km/year

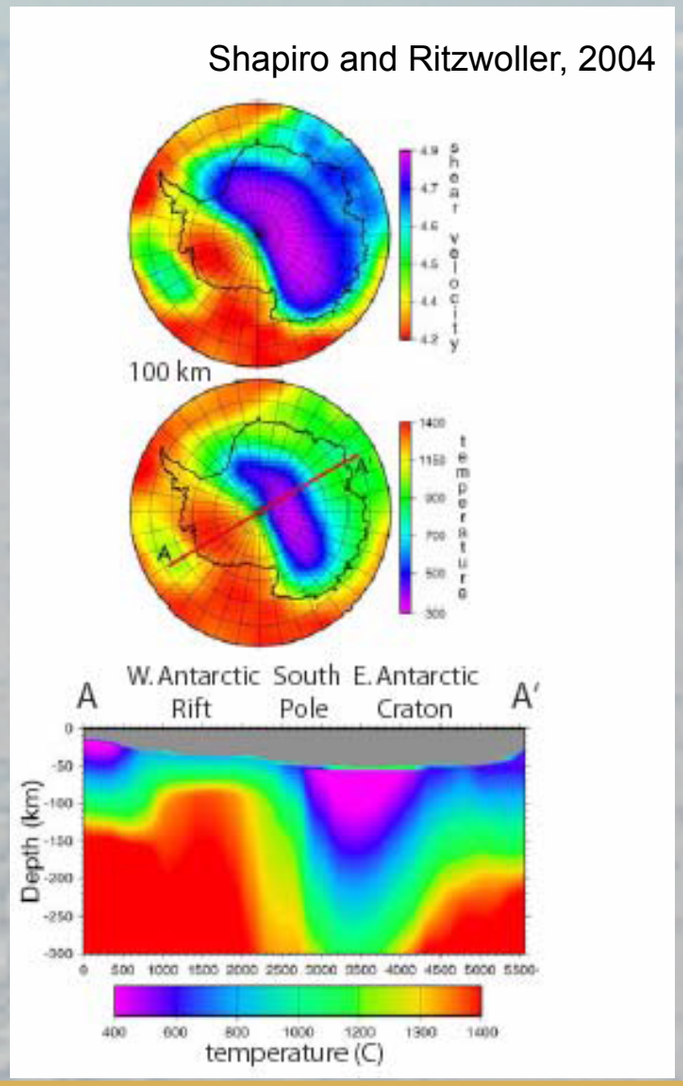
Big Red Circles are total loss per year

Rignot et al., 20



http://goo.gl/AAkYHl, Grinsted glaciology blog





Modified from Pollard et al., 2005

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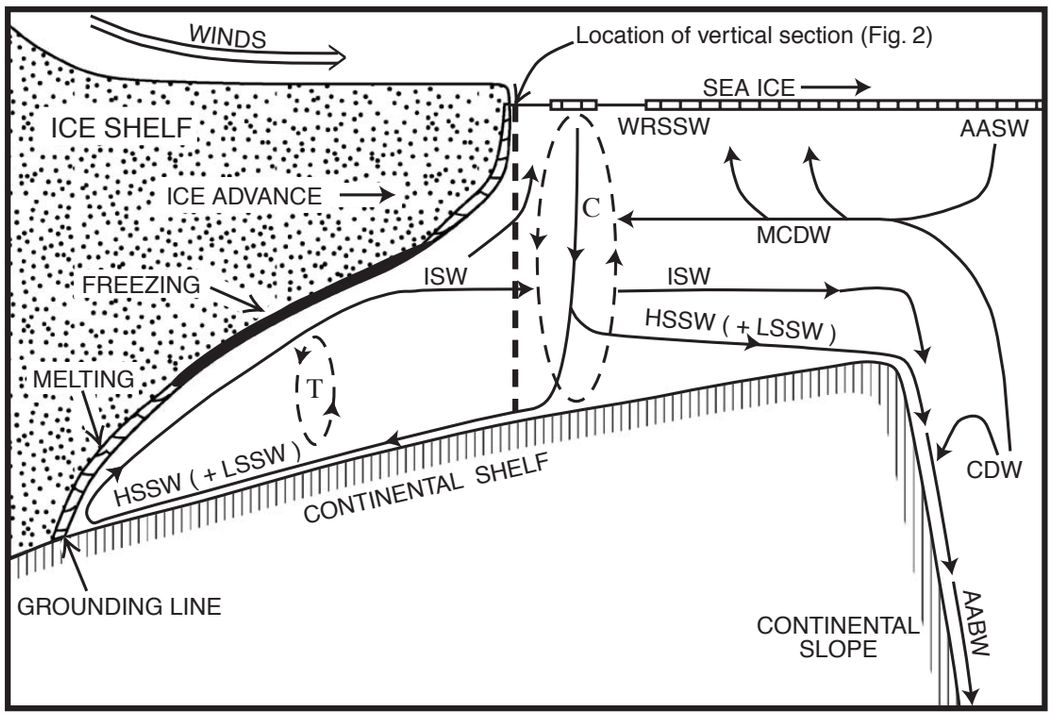

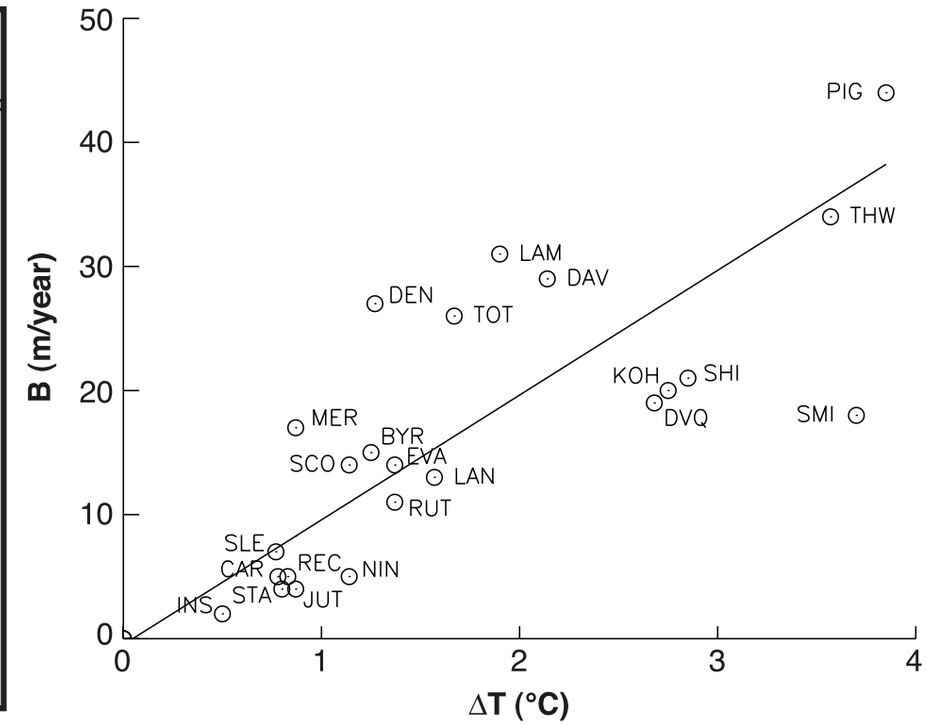

Left: Circulation beneath the Ross Ice Shelf (Smethie and Jacobs, 2005). Right: Grounding line melt rates versus thermal forcing (Rignot and Jacobs, 2002).

Ocean/ice interactions

- Ice shelf calving rates & mechanisms
- Ice shelf cavity geometry
- Ocean circulation and temperature structure

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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)

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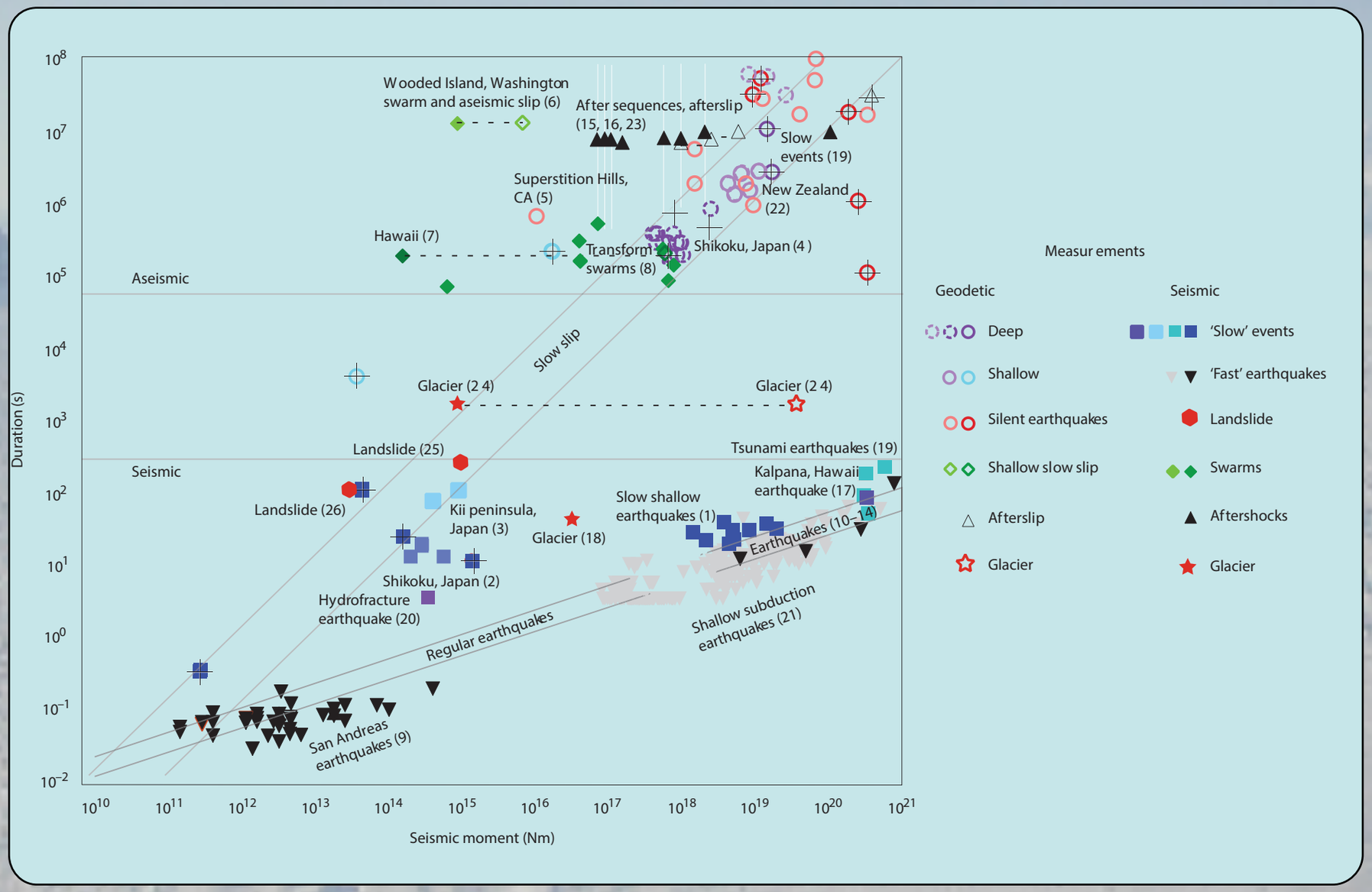
Earthquakes to slow-slip



Peng and Gomberg, 2010

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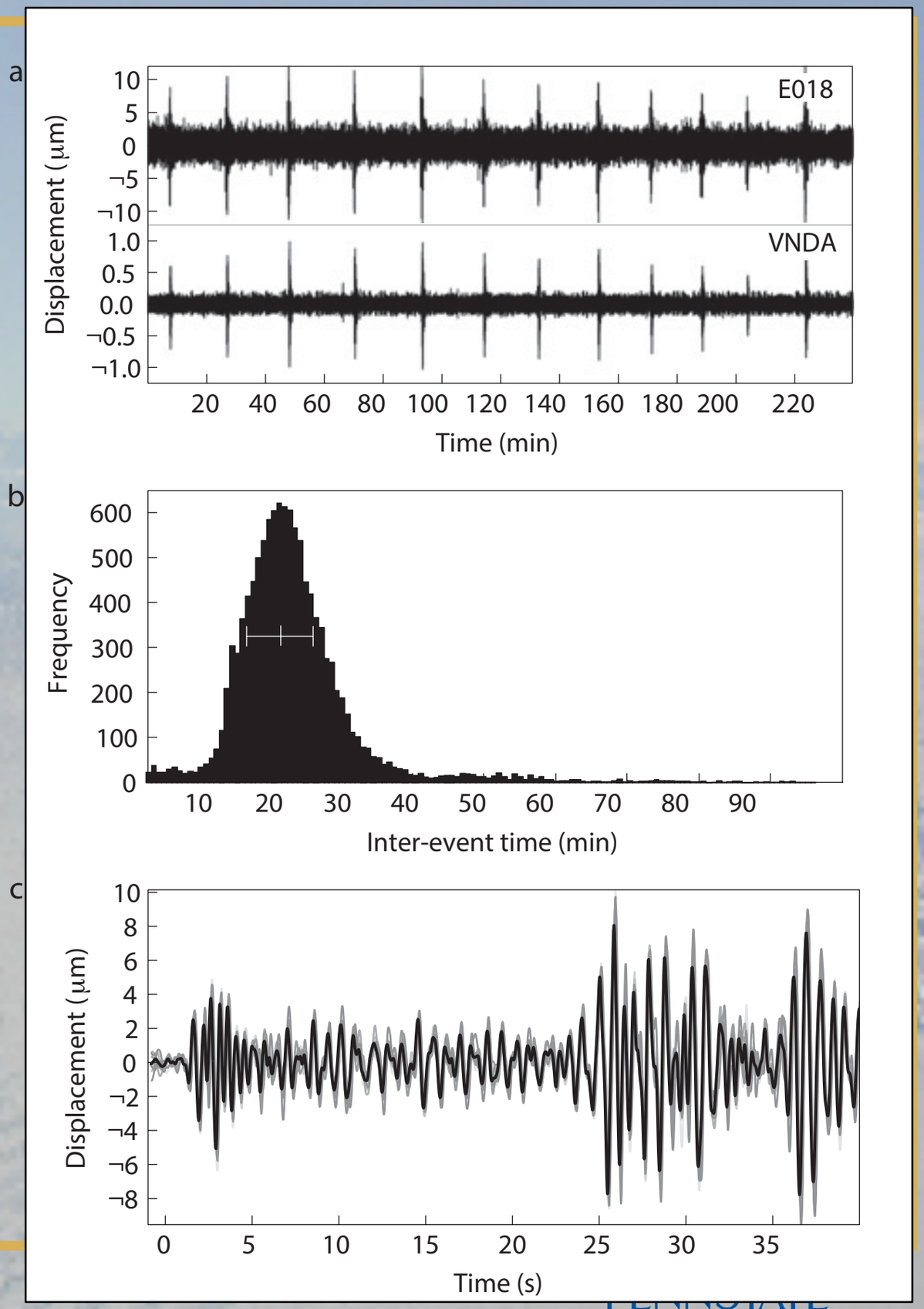
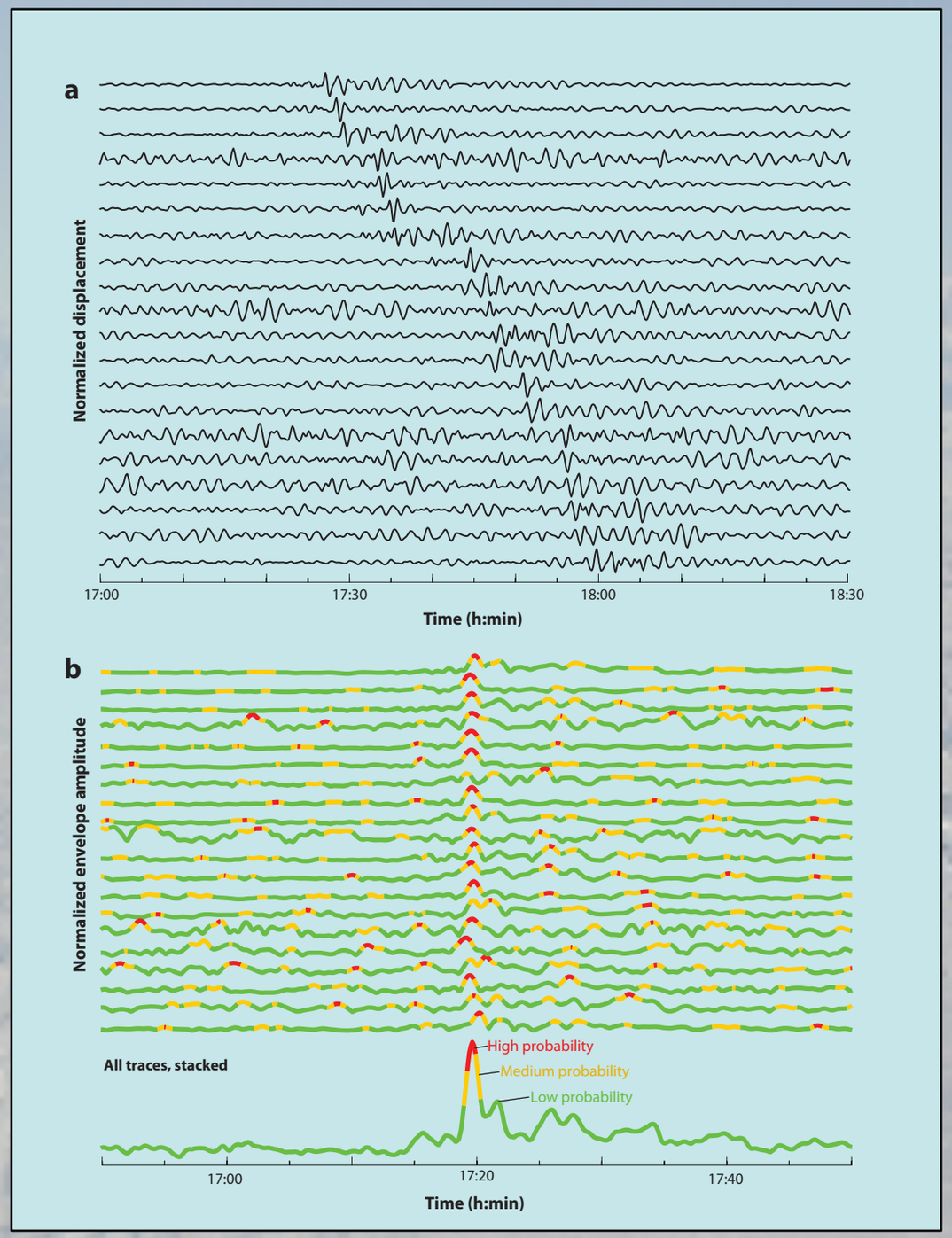
- Seismicity recorded in Antarctica
- Repeated, regular, likely same location, same mechanism.



Zoet *et al., 2012*

- Earthquakes associated with iceberg calving
- Ice flow speed changes



Nettles & Ekstrom, 2010

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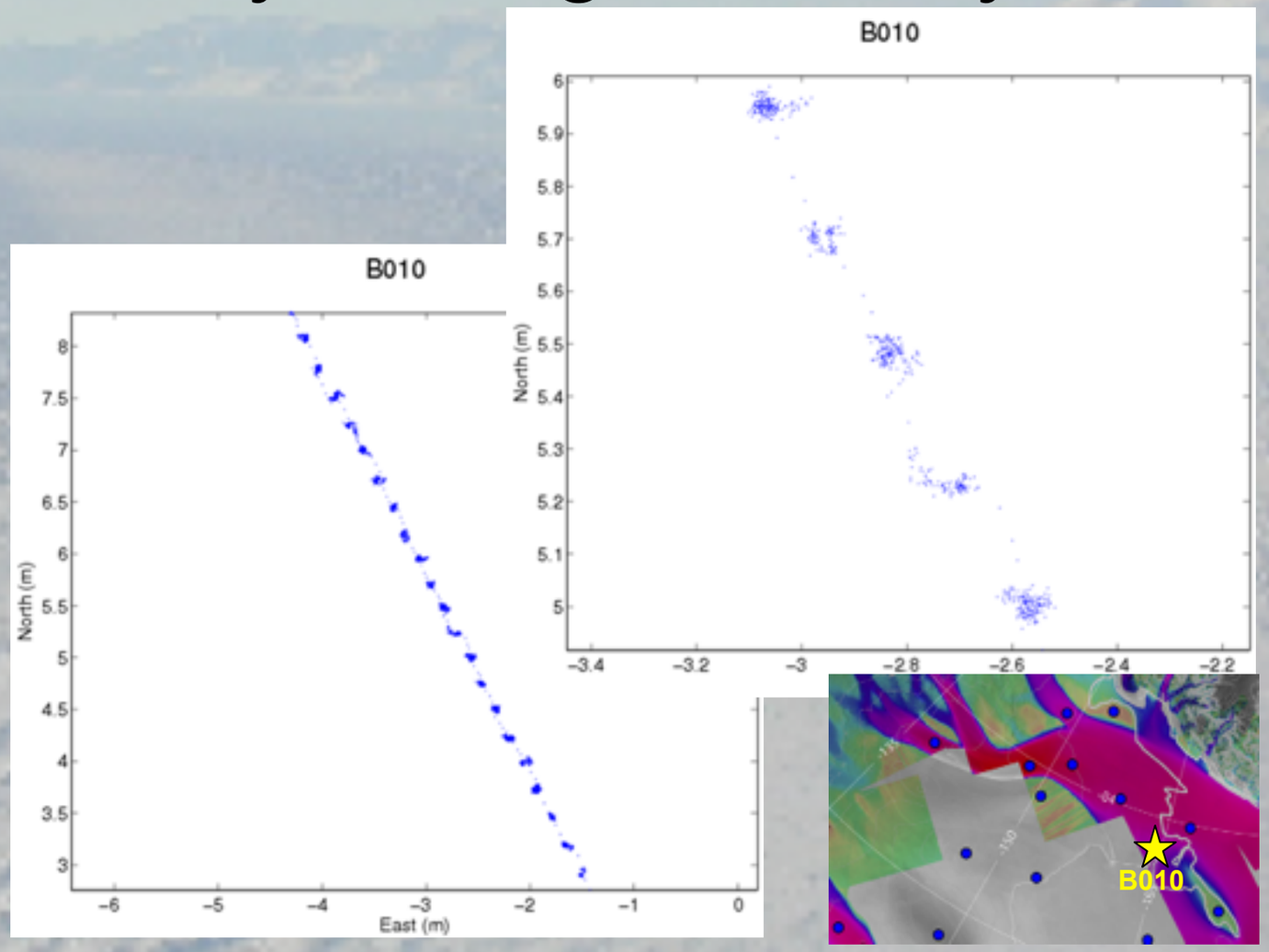
Stick-Slip motion

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



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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

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