Interruption of the Whillans Ice Stream stick-slip cycle by a subglacial lake discharge event

Matthew R. Siegfried
Helen Fricker, Sasha Carter
Scripps Institution of Oceanography
Slawek Tulaczyk
University of California, Santa Cruz

WAIS Workshop
Julian, CA
mrsiegfried@ucsd.edu

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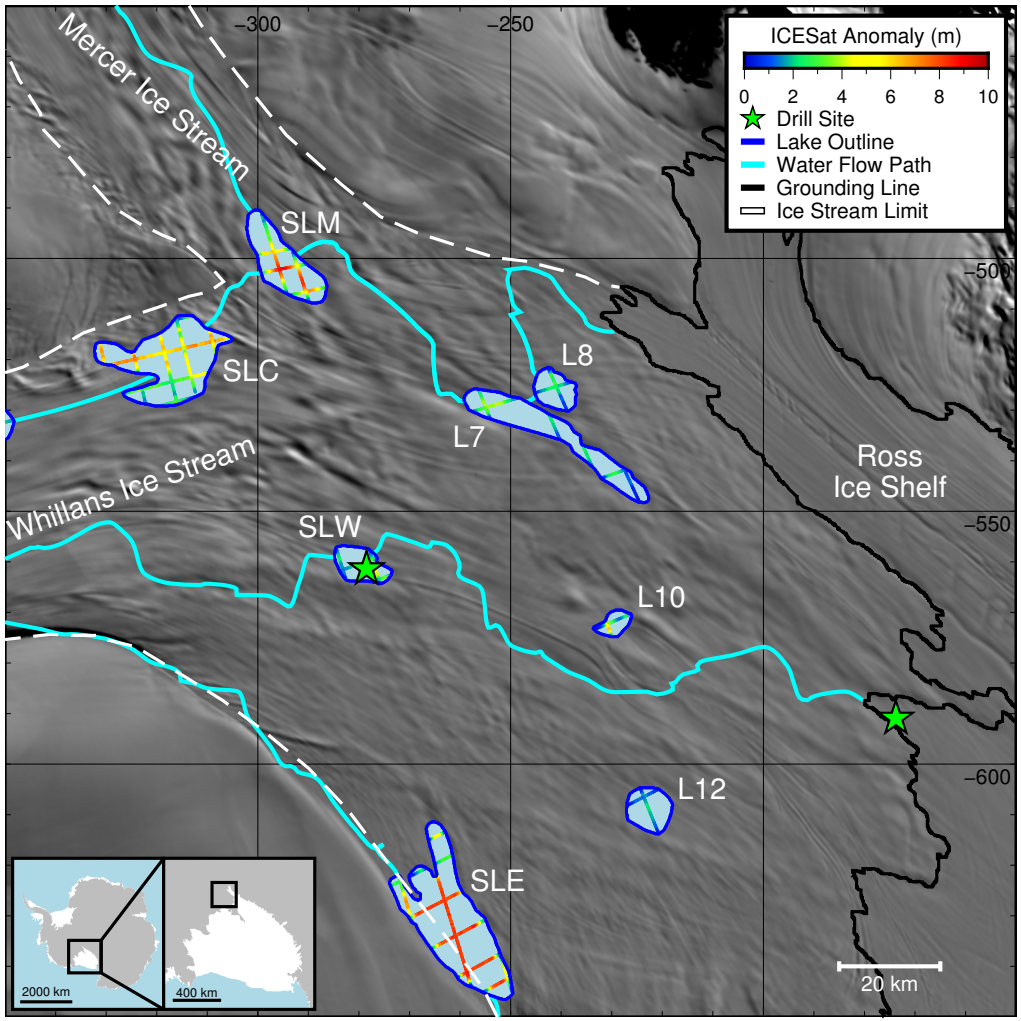
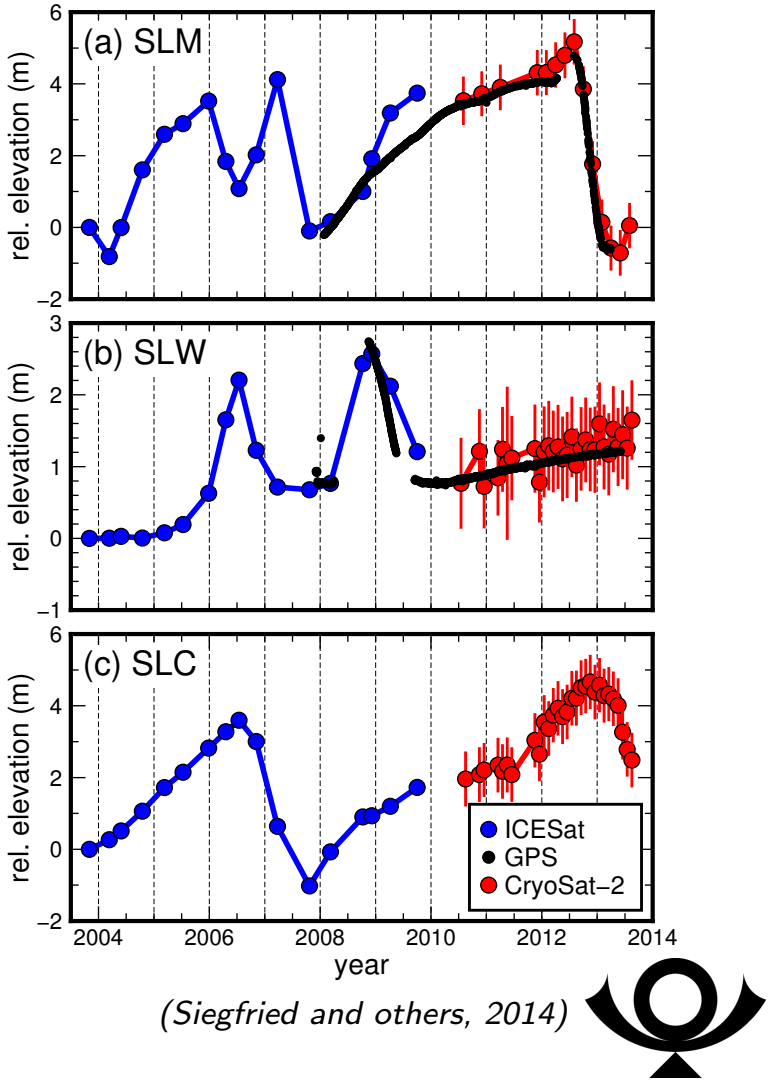
Our Question

How do **subglacial lakes** affect **ice dynamics**?

Whillans Ice Plain

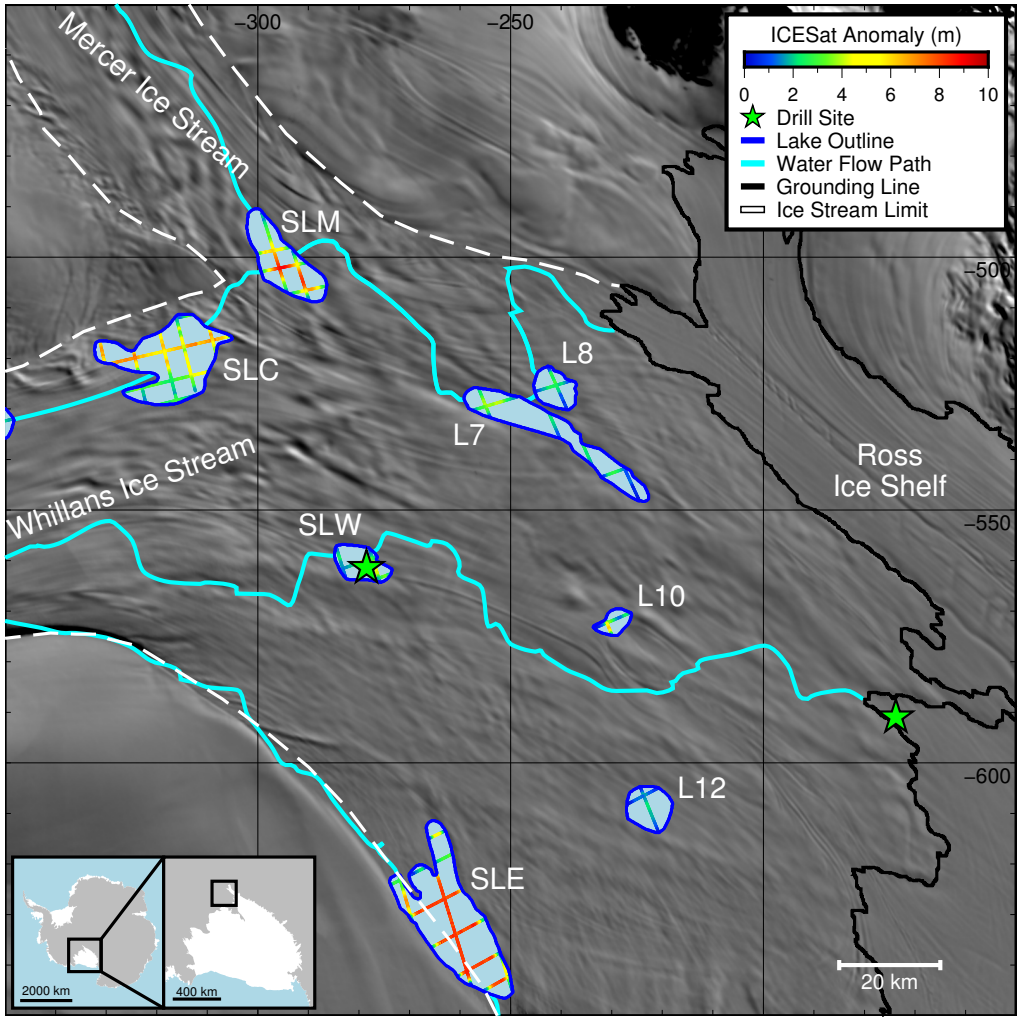
⇒Active subglacial hydrology





(Siegfried and others, 2014)

Ice Motion



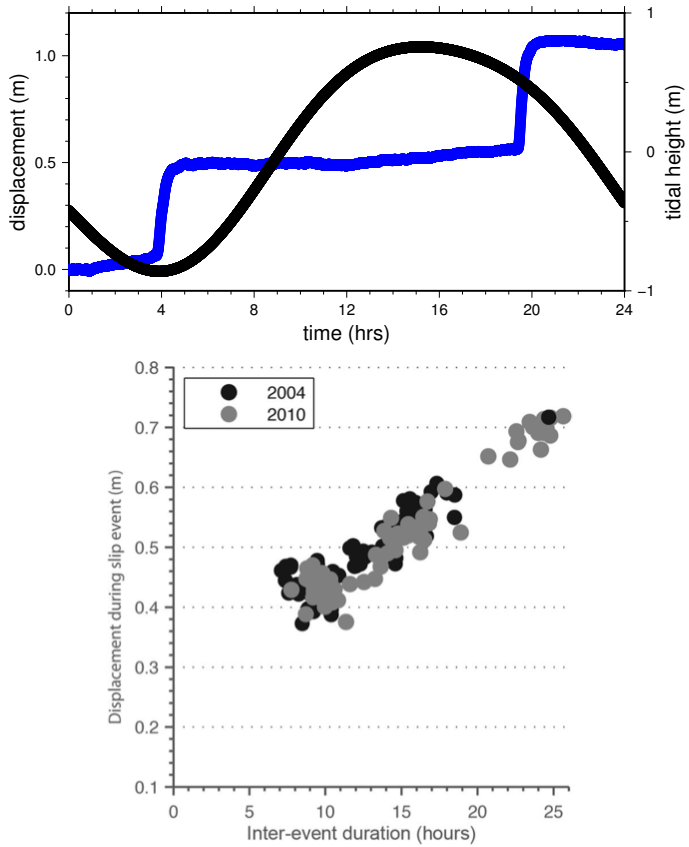
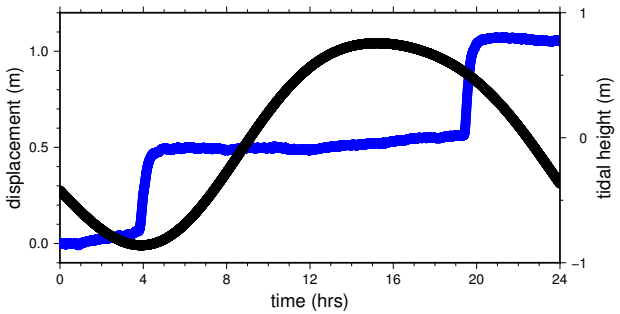


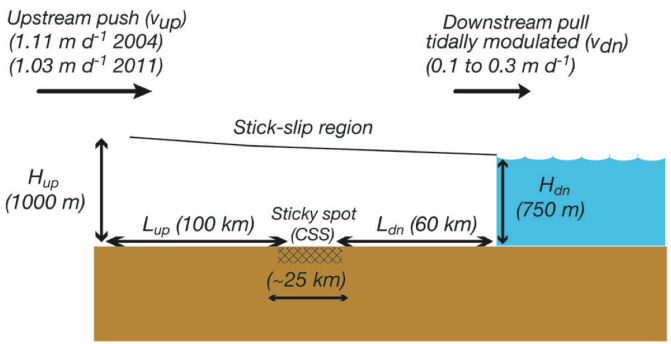
Fig. 6. The relationship between displacement occurring during a slip event and the inter-event duration preceding the slip event at station W2B.

(Winberry and others, 2014)

Our Question (revisited...)

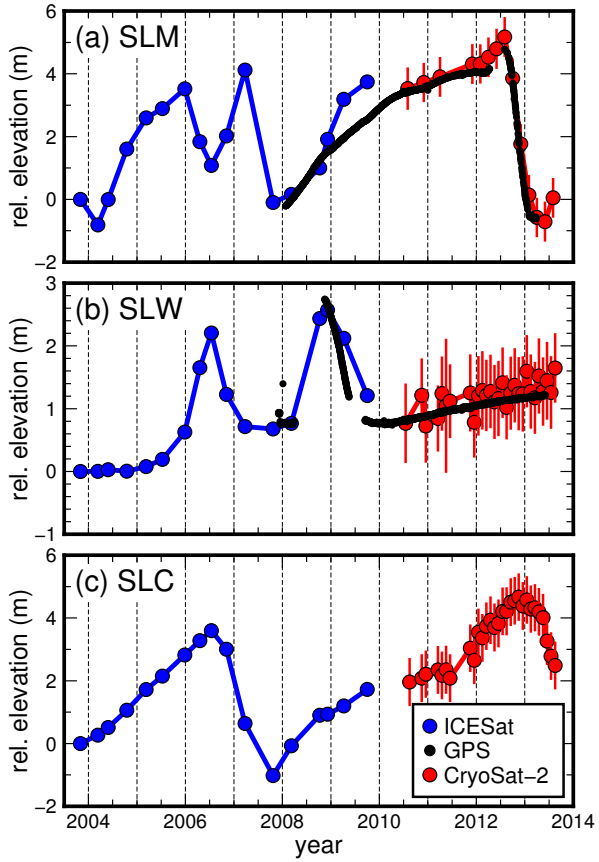
(sensitive force balance)





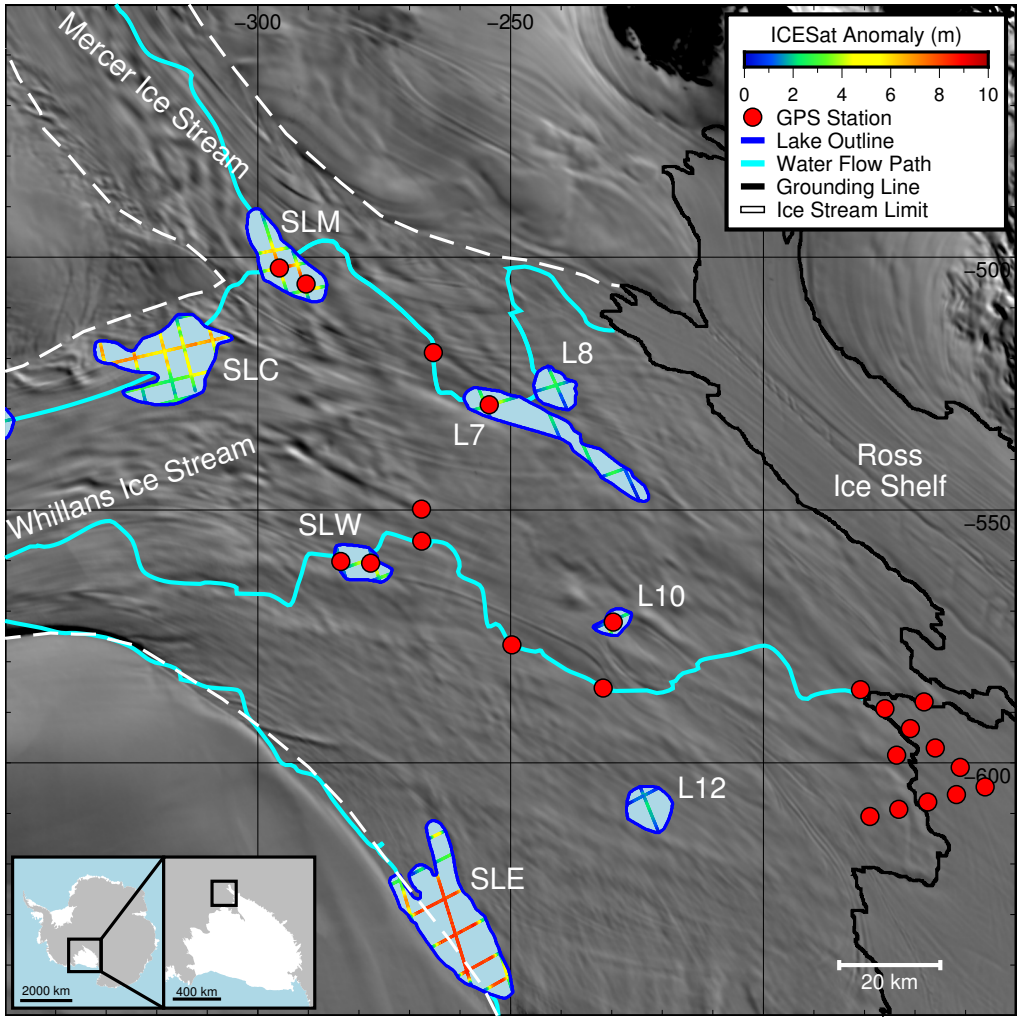
+

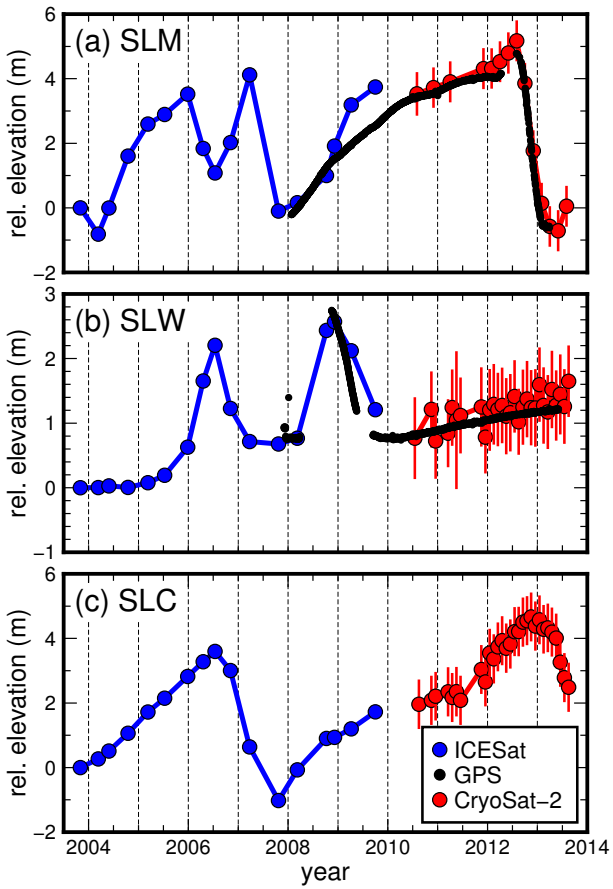
(lake activity)



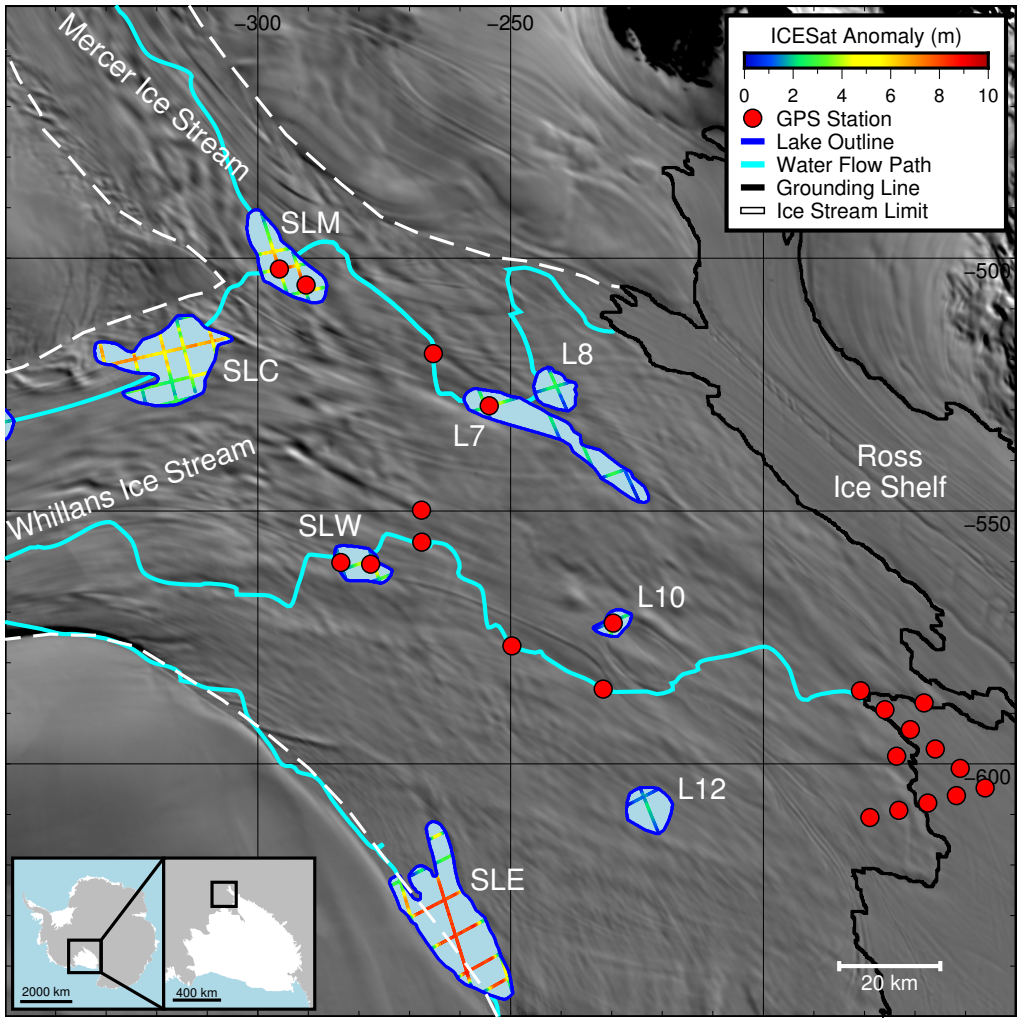
= ?

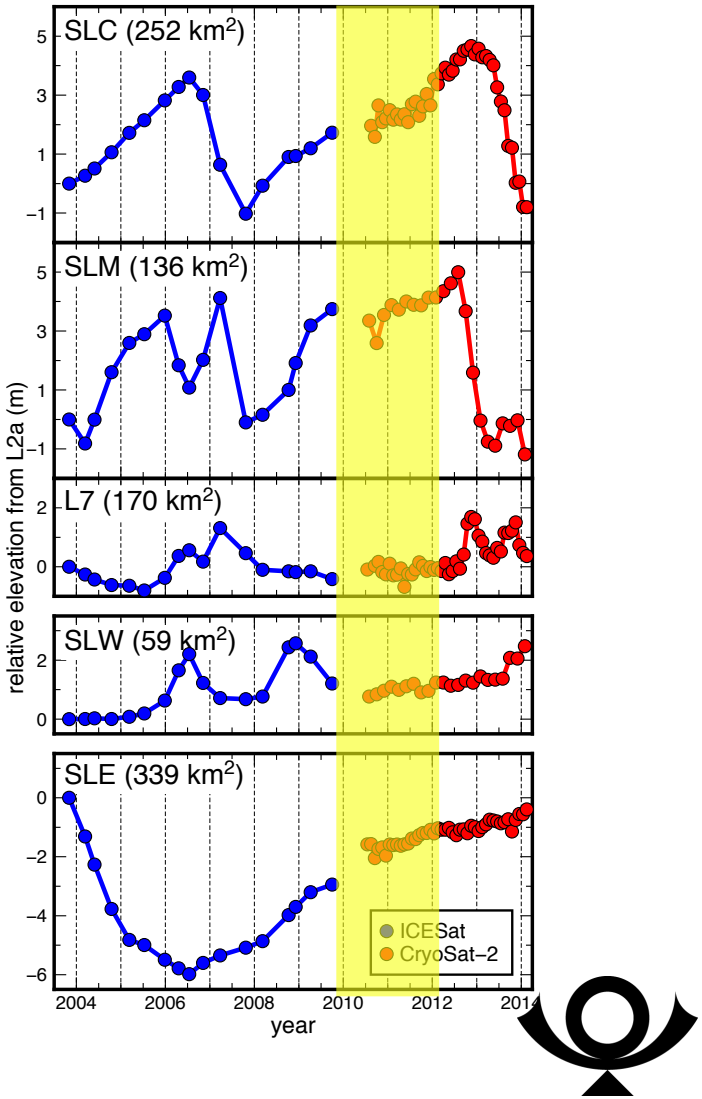
WhIP Instrumentation



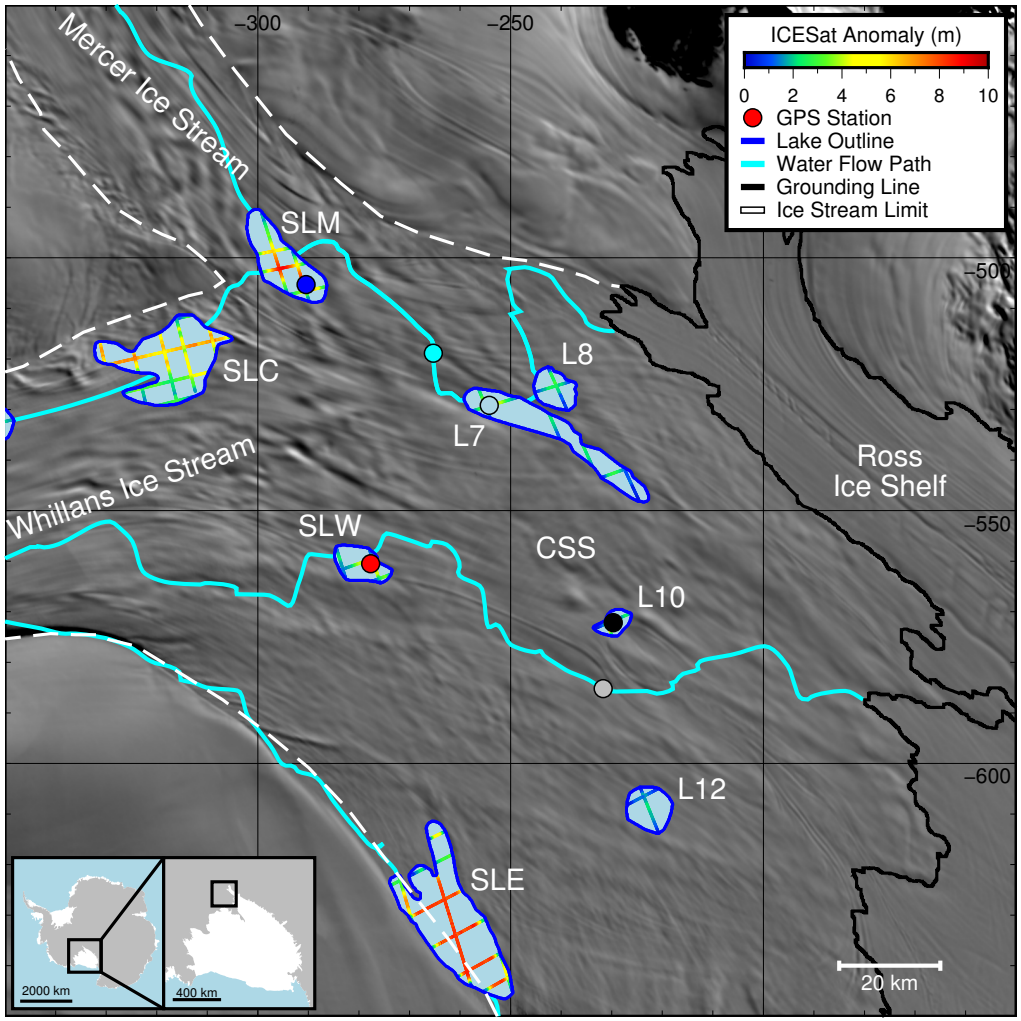


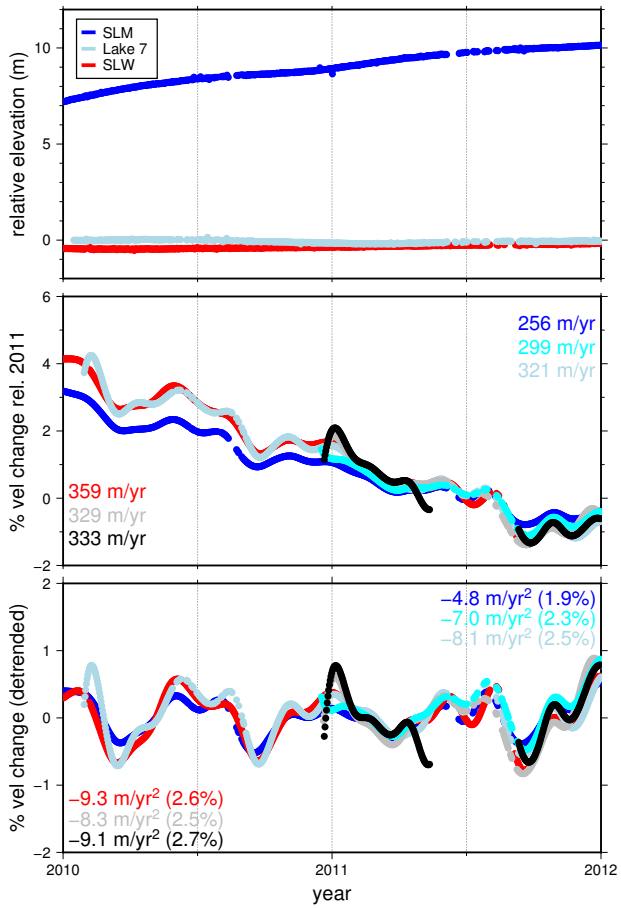
WhIP Instrumentation





Background Velocity

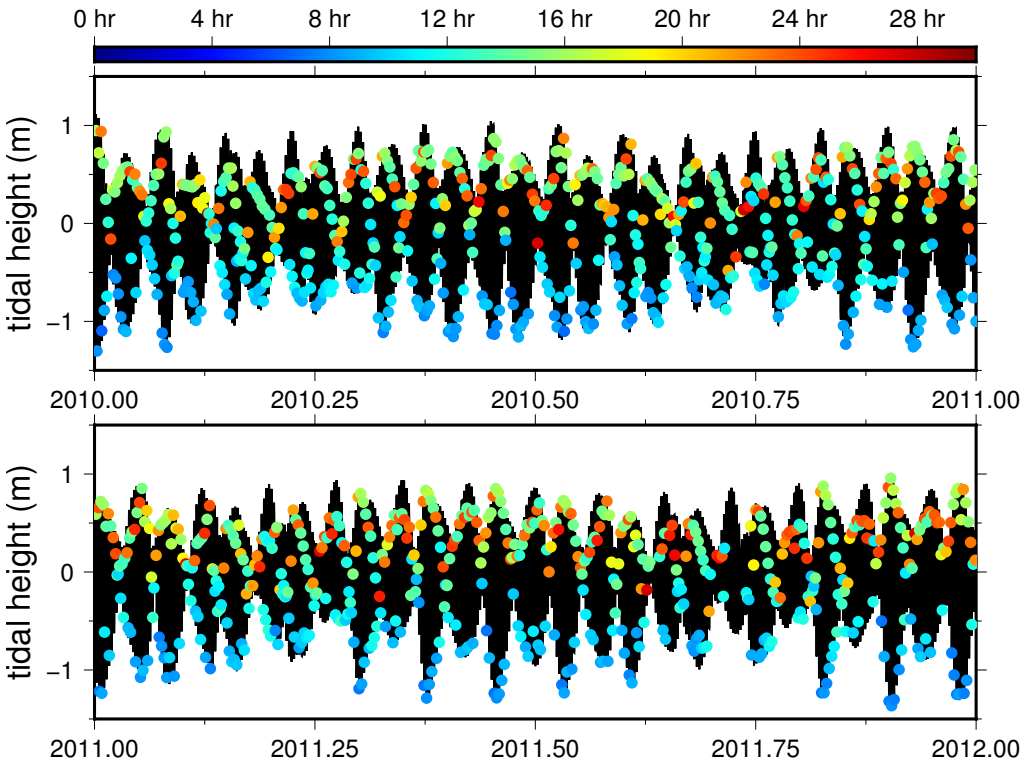




consistent deceleration

semi-annual cycle?

Background Stick-Slip

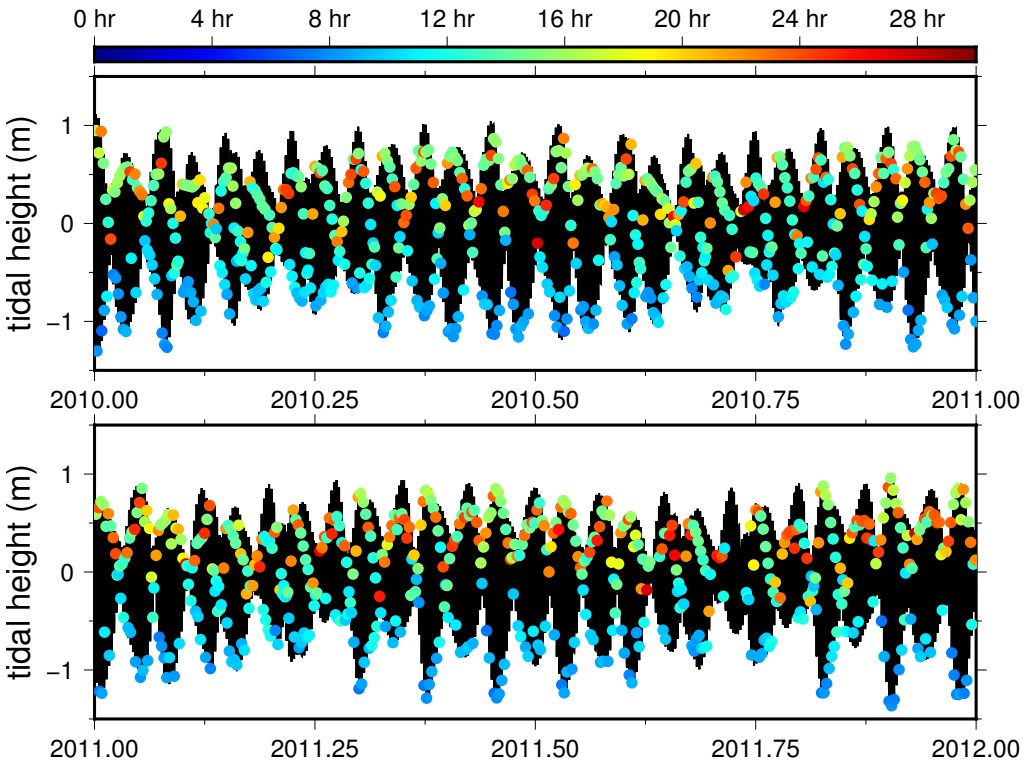


cold colors at low tide

medium to hot colors at high tide

$(\mathrm{n} = 1144)$

Background Stick-Slip



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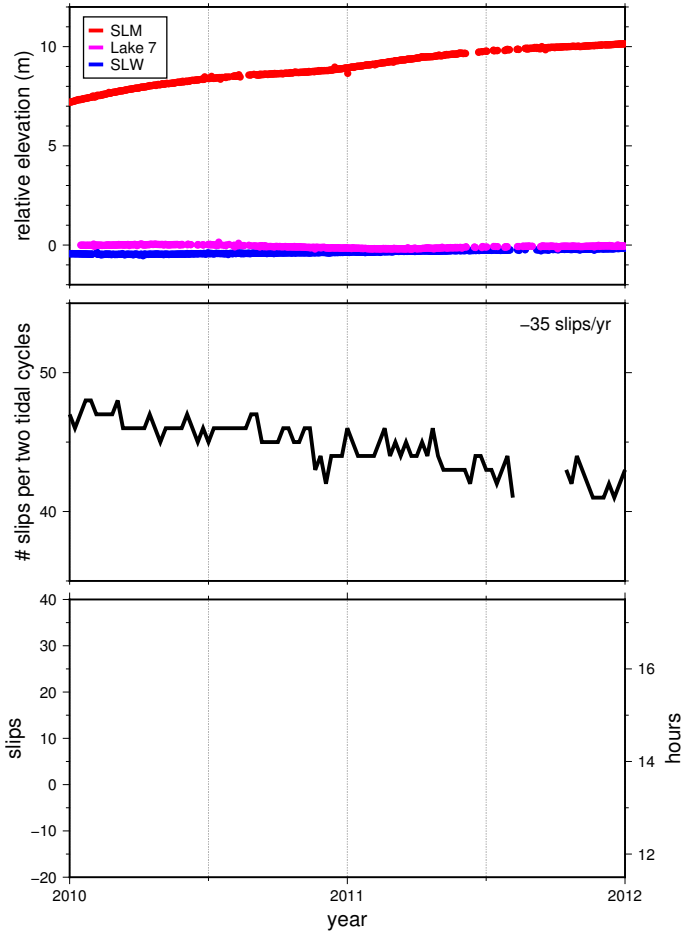
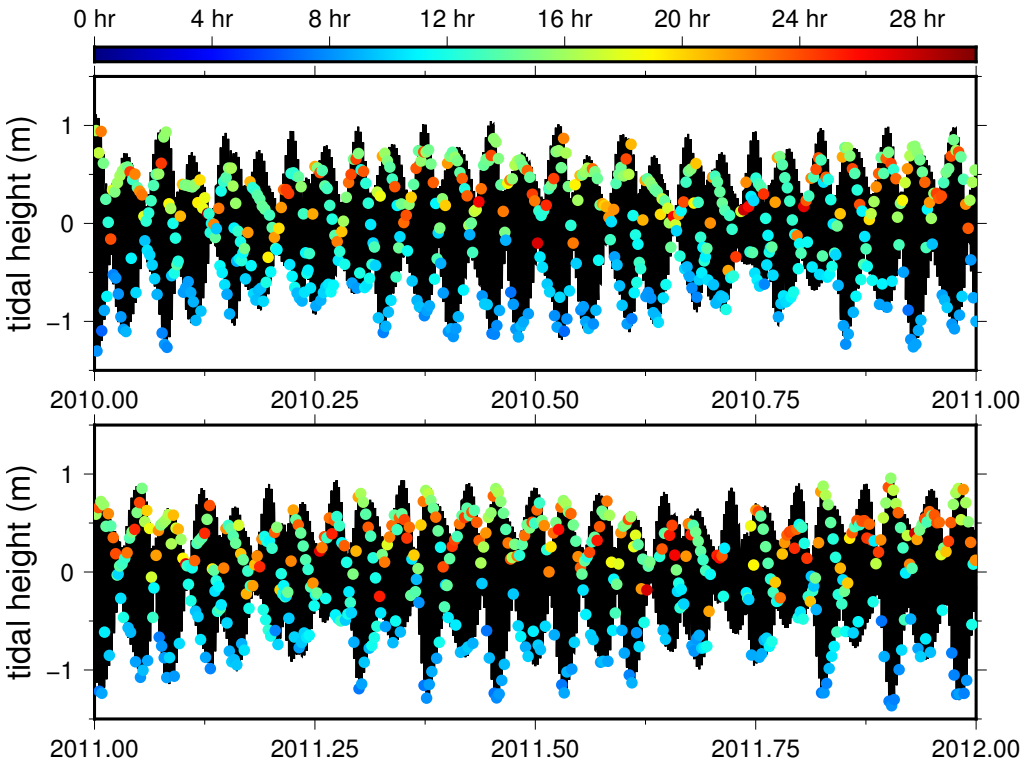


semi-annual cycle.

easy to alias.

Background Stick-Slip



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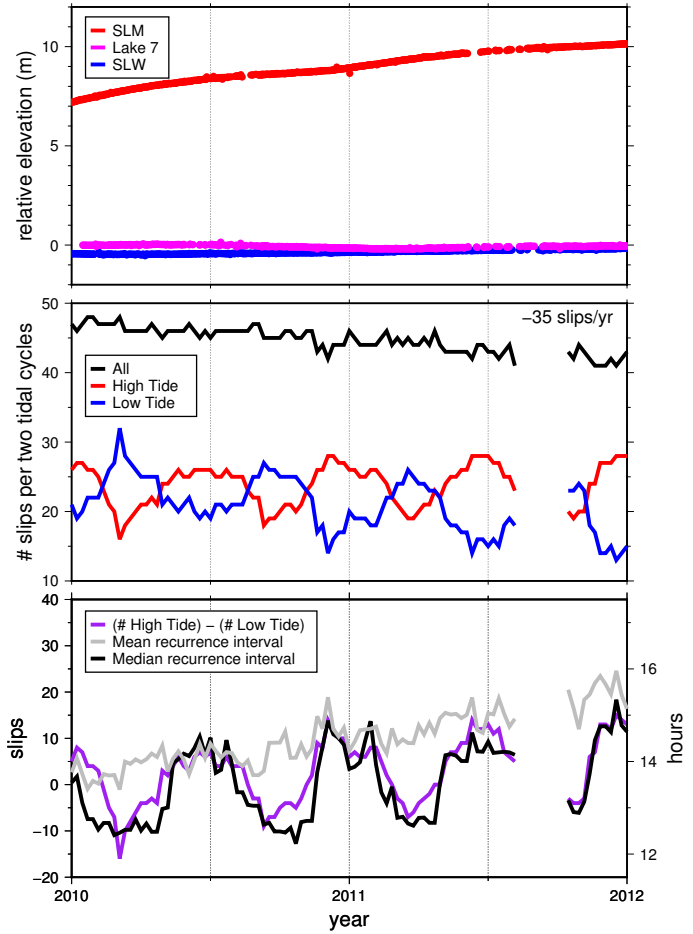

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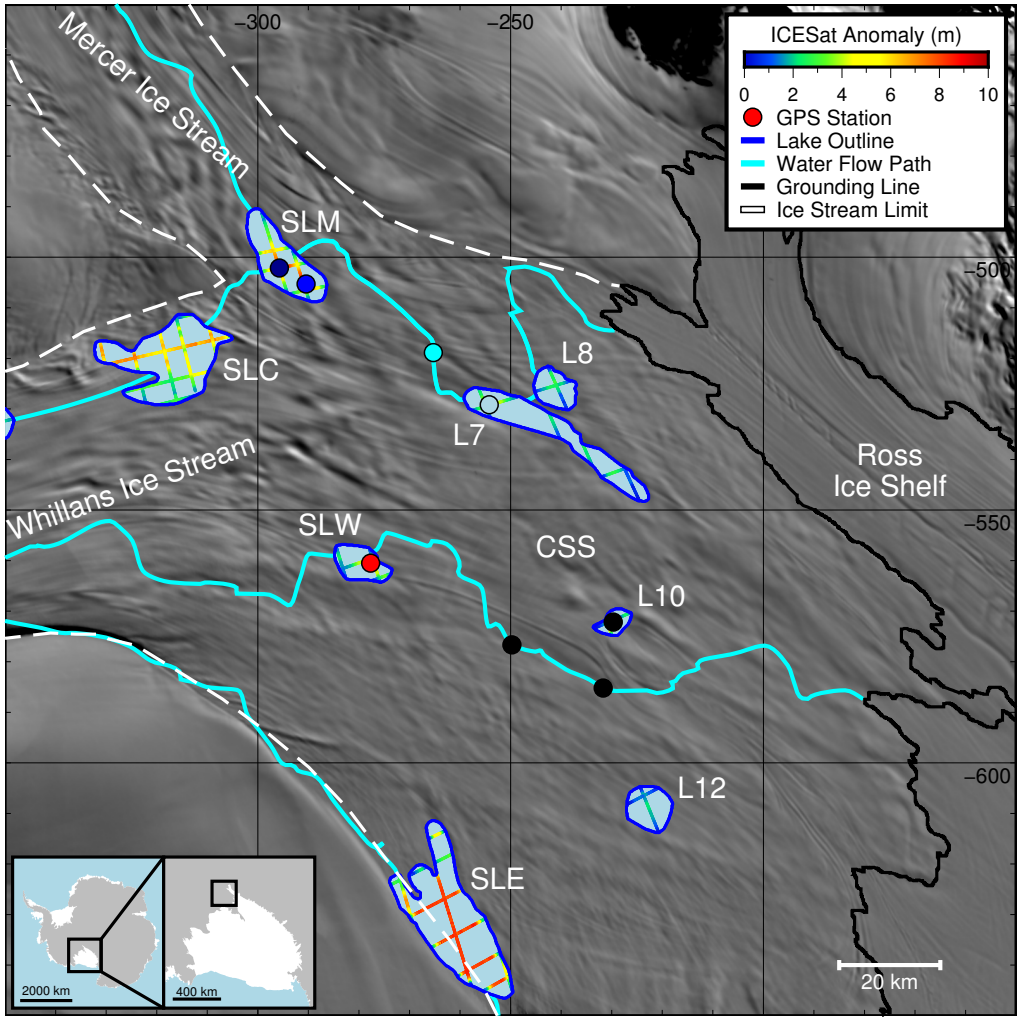
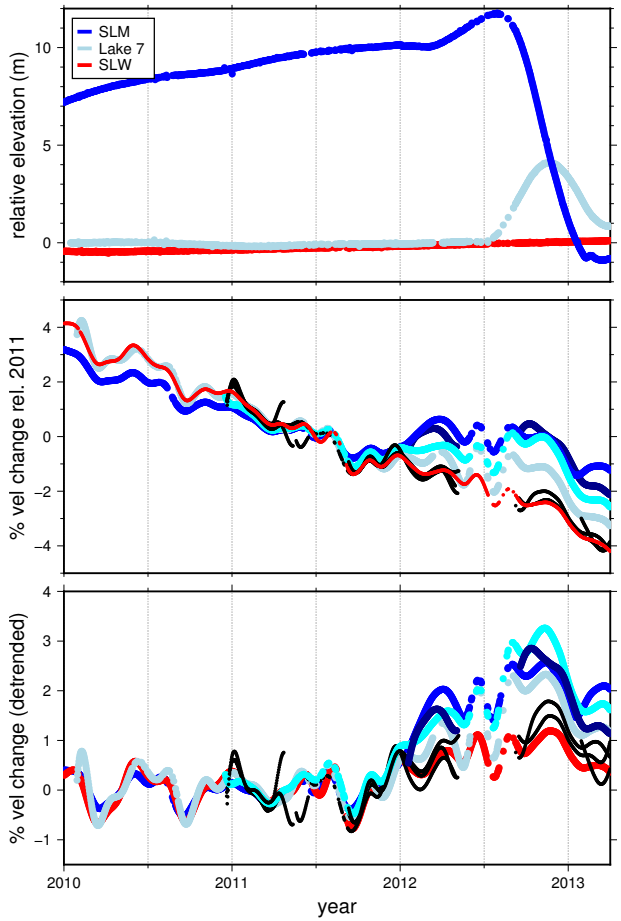
Flood Velocity





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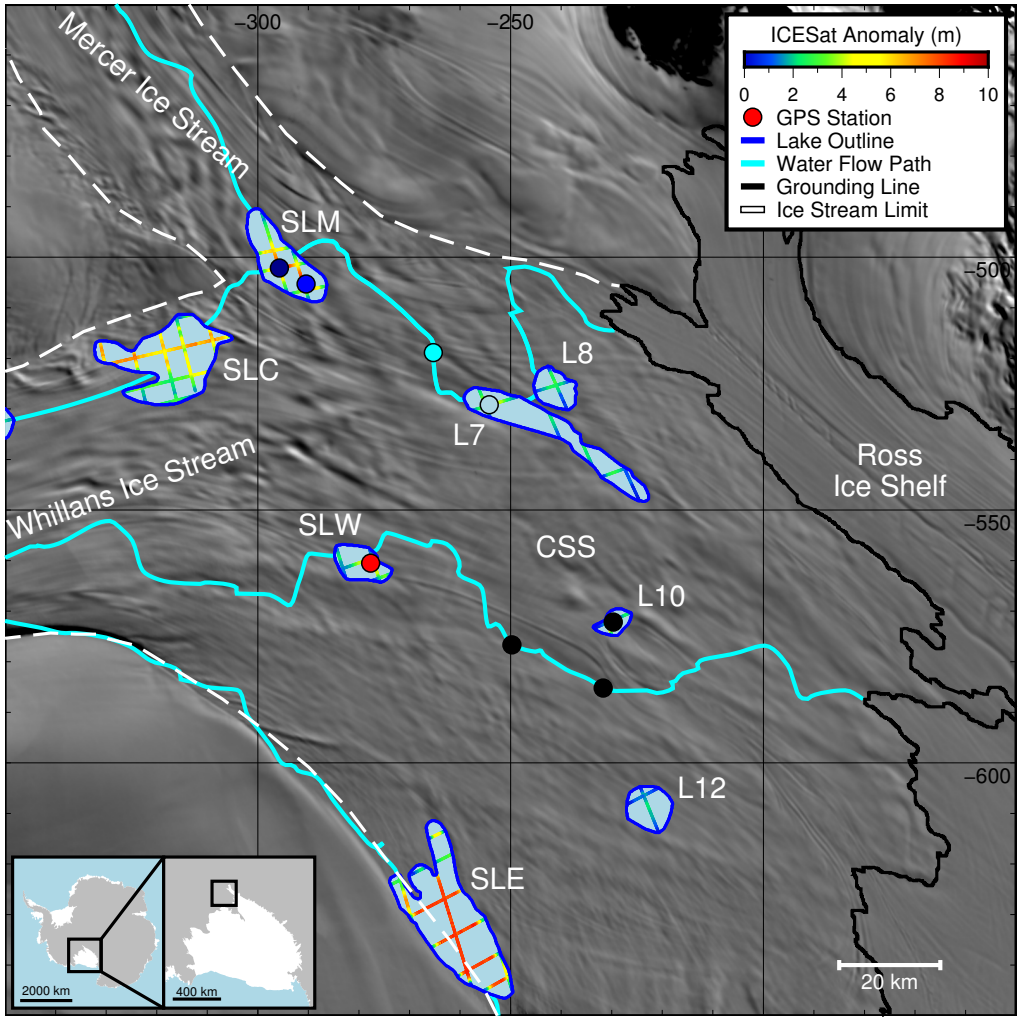

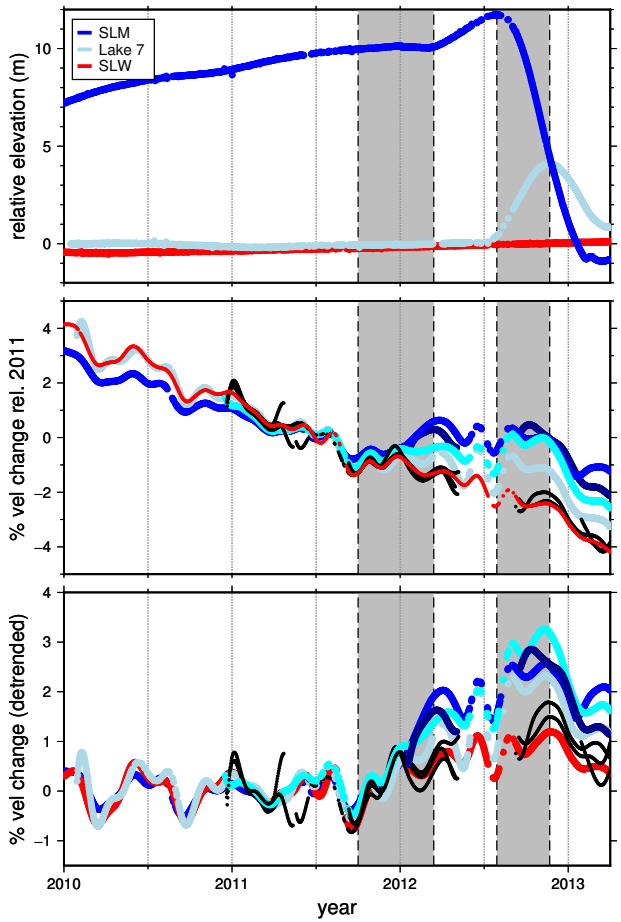

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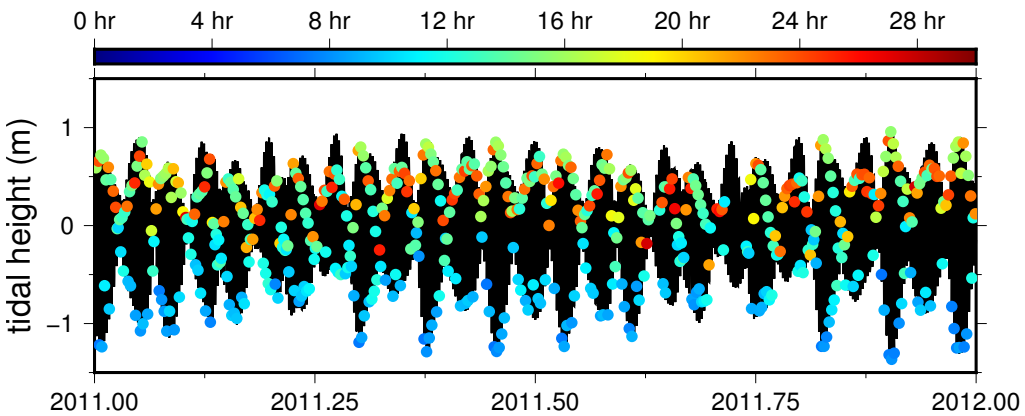

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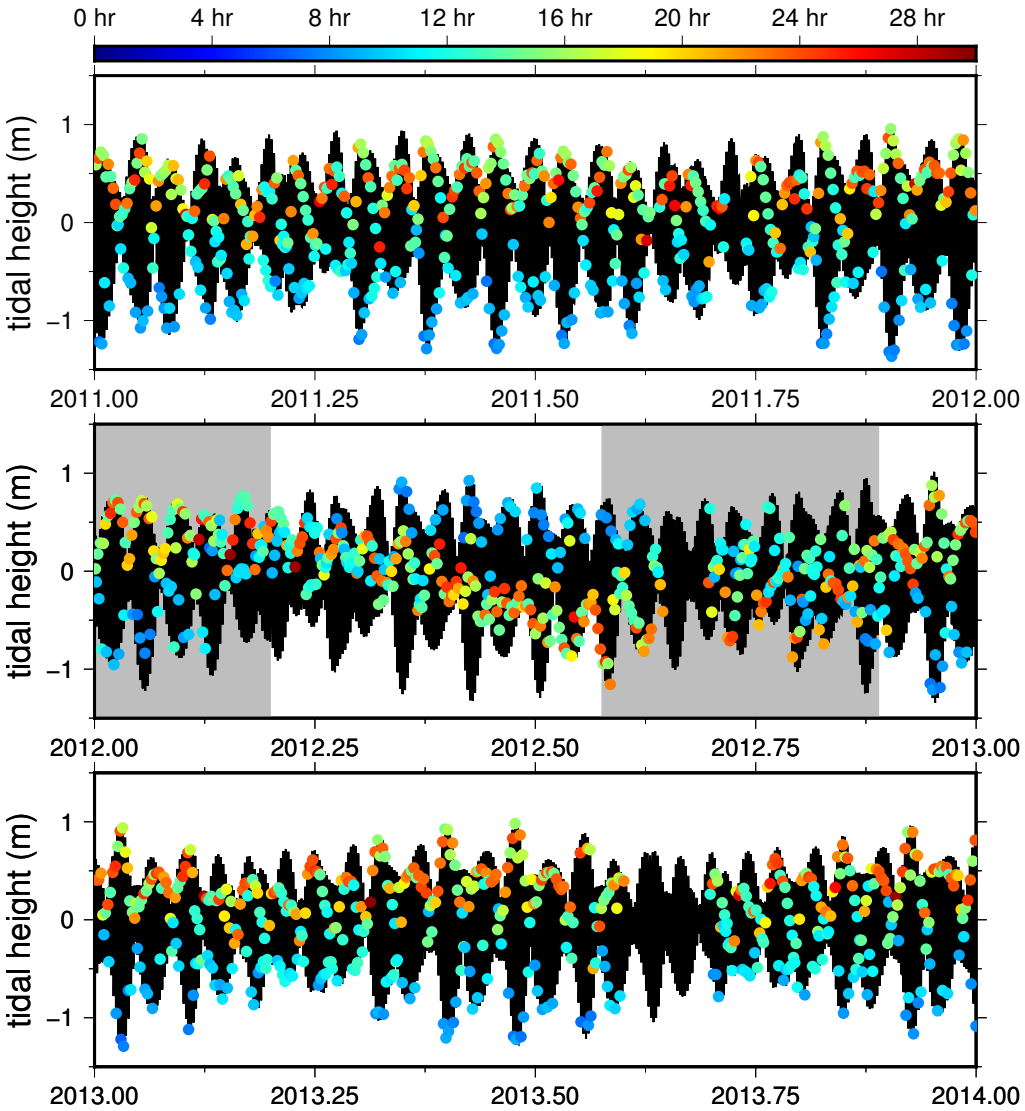

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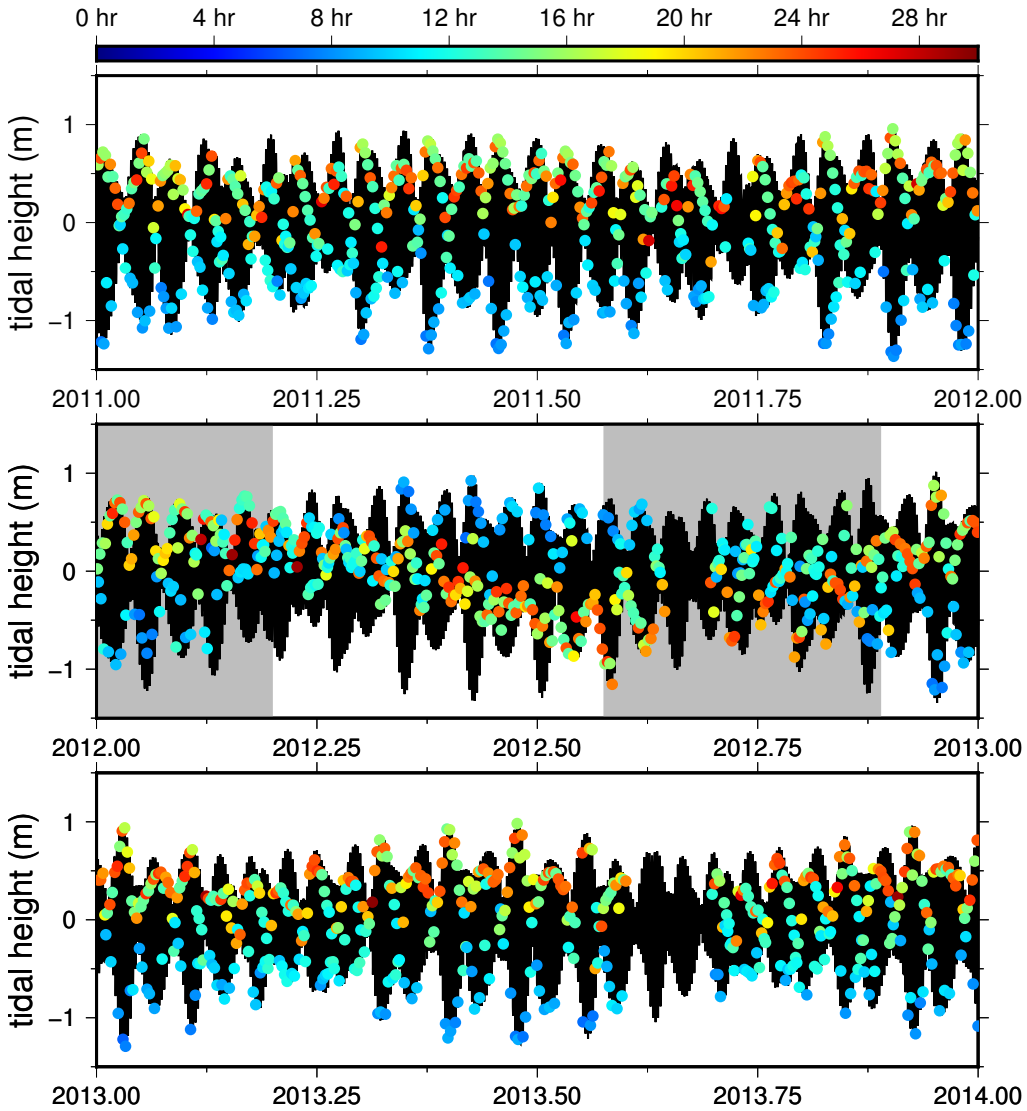
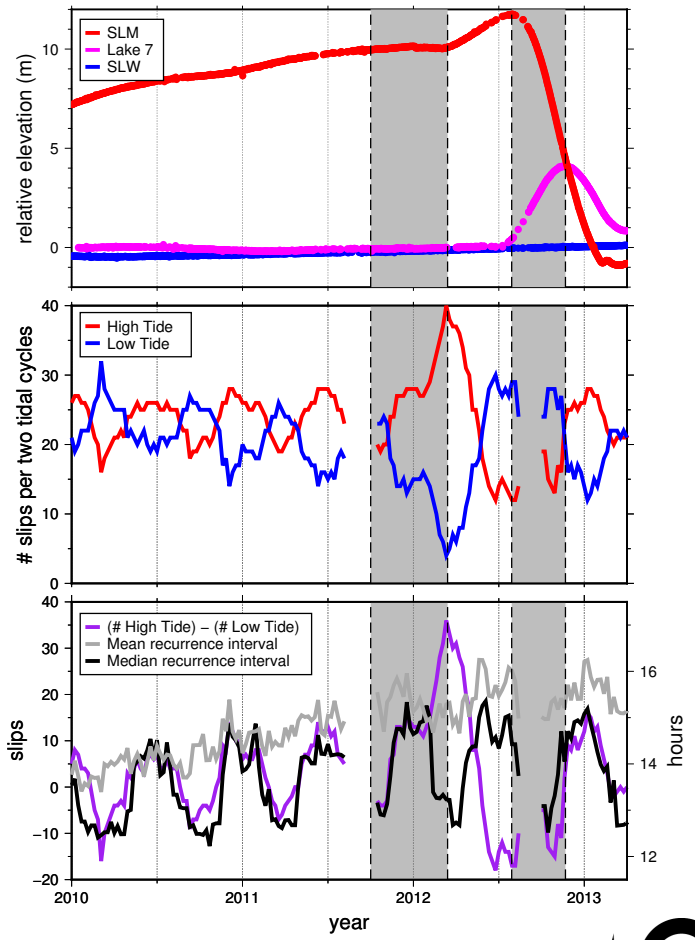
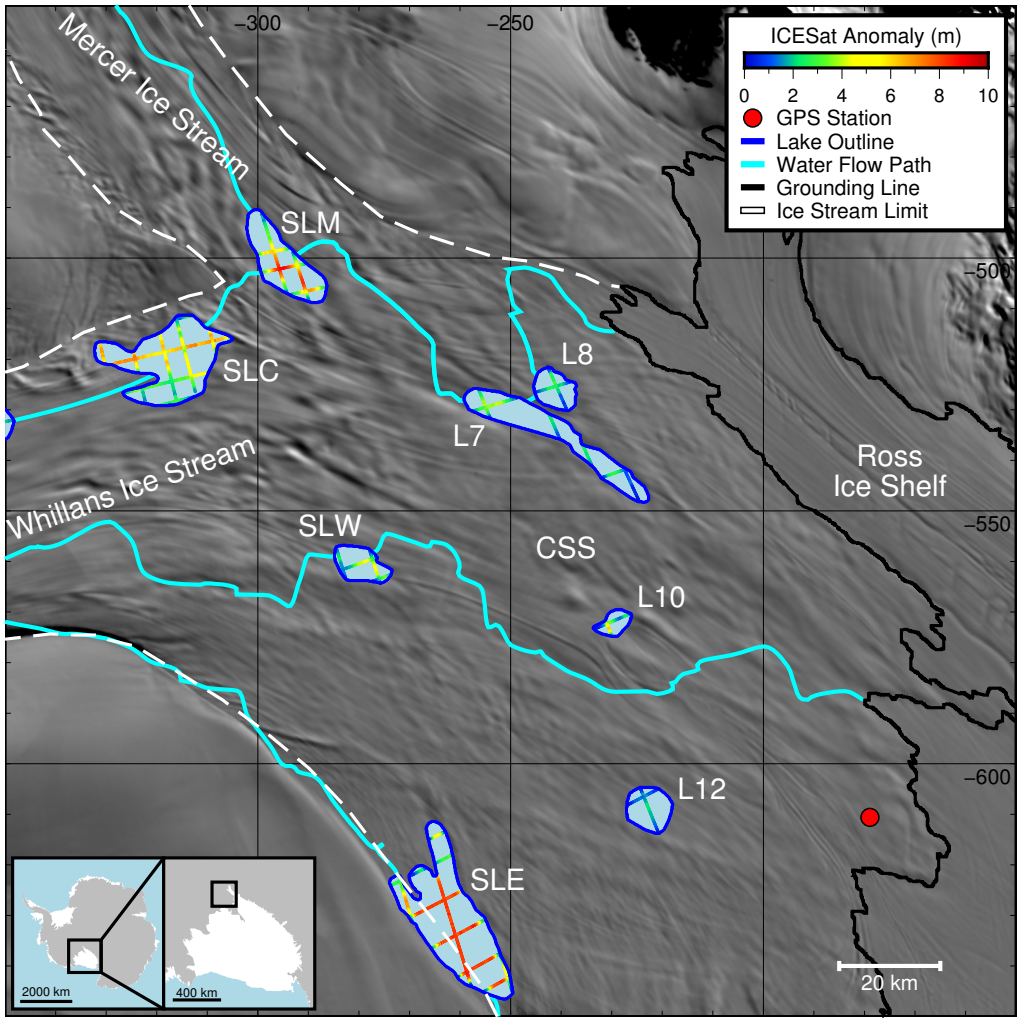
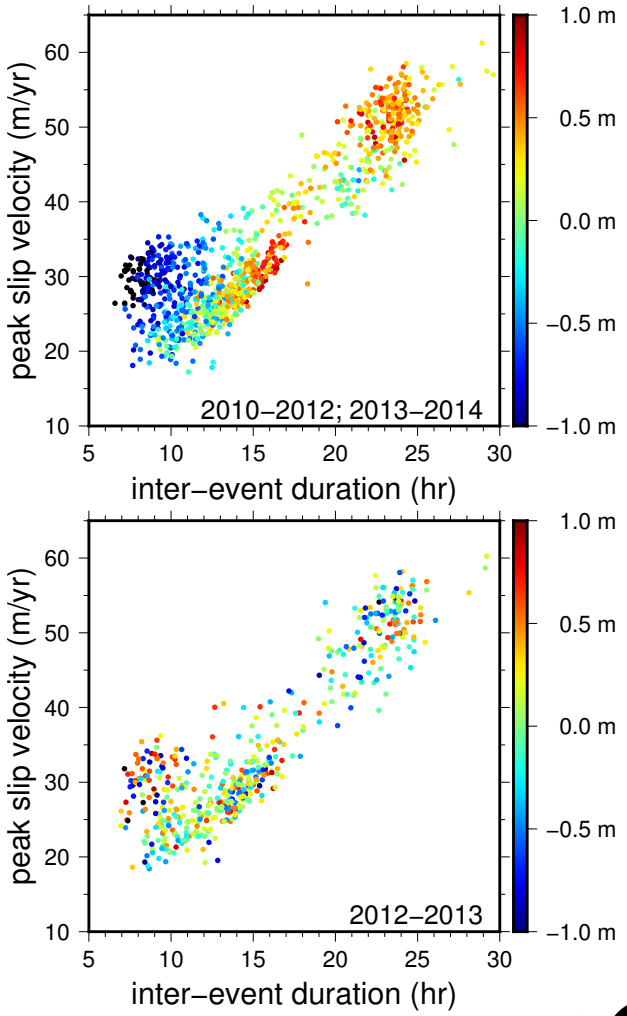




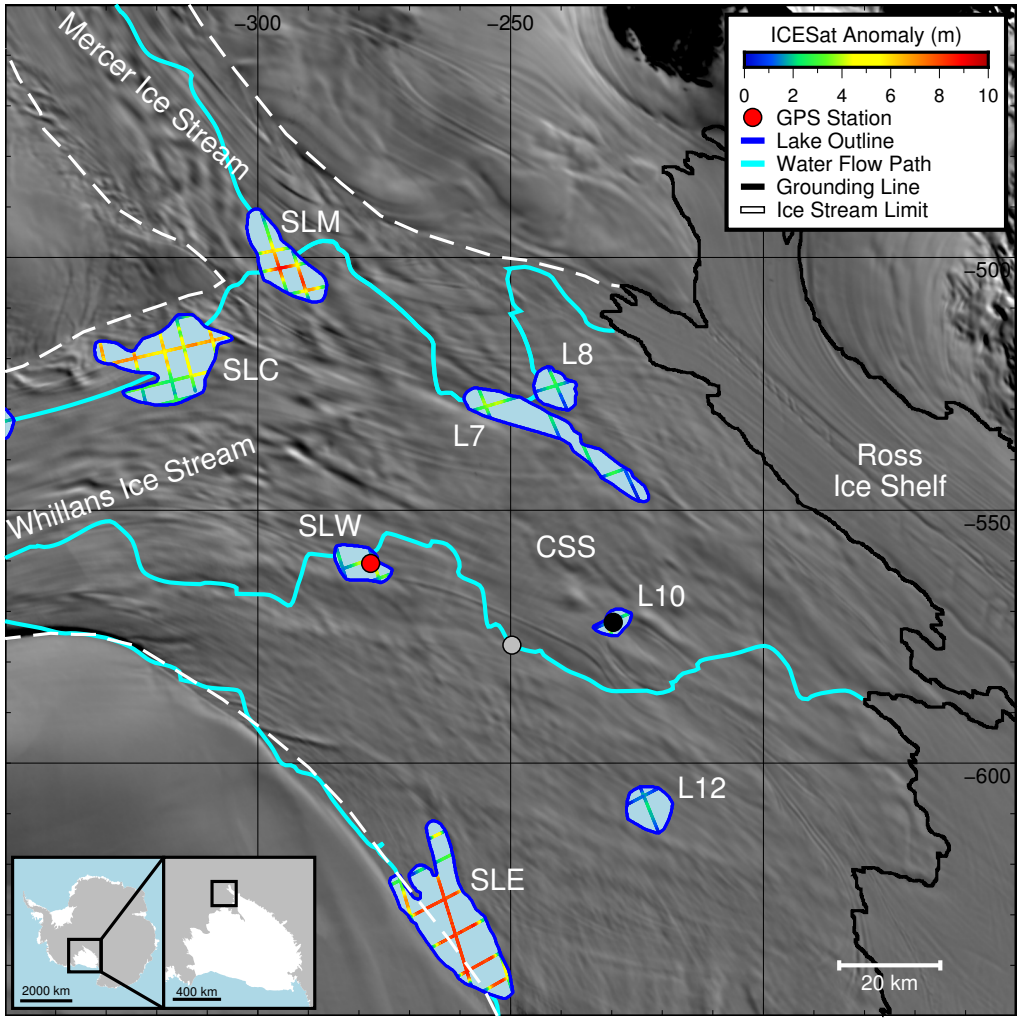
Flood Slip Character: Far(thest) Field

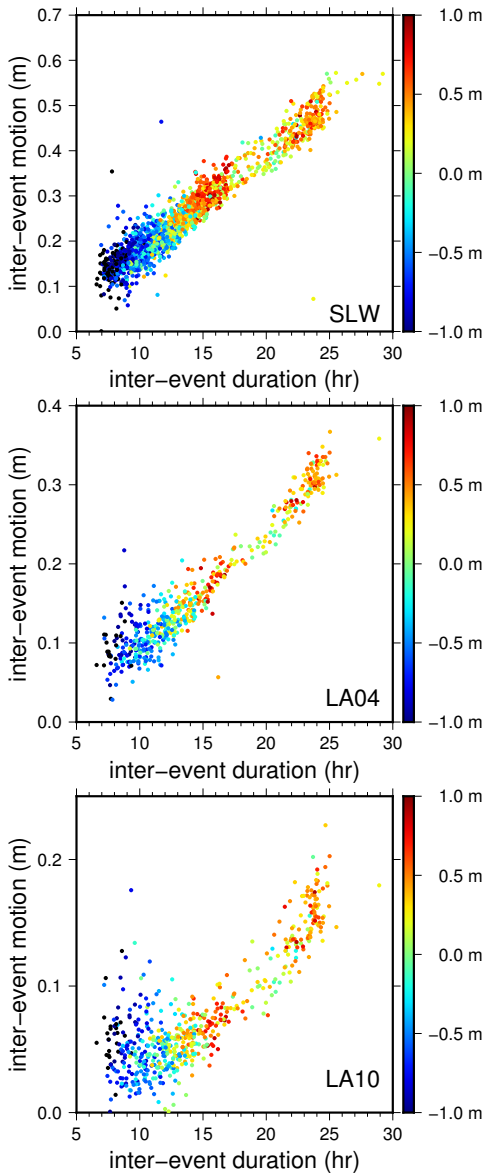




No change?

An Aside: Stick-Slip Details





Conclusions

- Extreme aliasing problems in dynamic areas **requires** continuous monitoring to see the whole story
- Sub-glacial hydrology + aliasing possibly responsible for most of the "variable" deceleration
- Rapid ice dynamical response to subglacial hydrology changes within the (hydrological) basin
- Significant interruption to the nearly predictable WhIP stick-slip cycle: asperity **loading** changes; asperity does **not**
- Through-flowing lake pressure changes likely swamps tidal forcing

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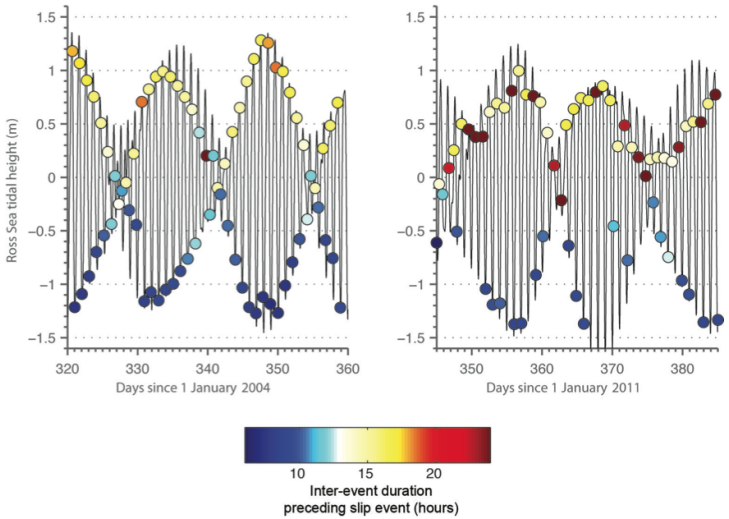
Thank you.

These are not the [slides] you're looking for. . .

Ice Motion



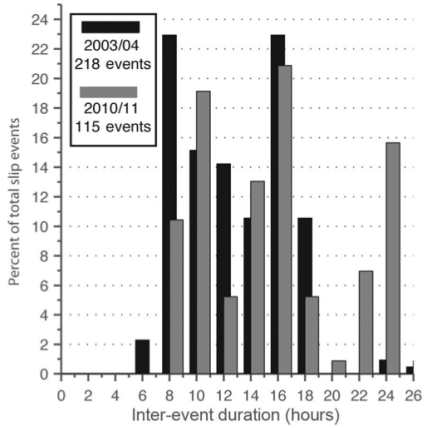


Fig. 8. Histogram of inter-event durations preceding slip events observed during the 2003/04 and 2010/11 field campaigns. Note the increase in long inter-event (>20 hours) durations in 2010/11 resulting from frequent skipped low-tide events.

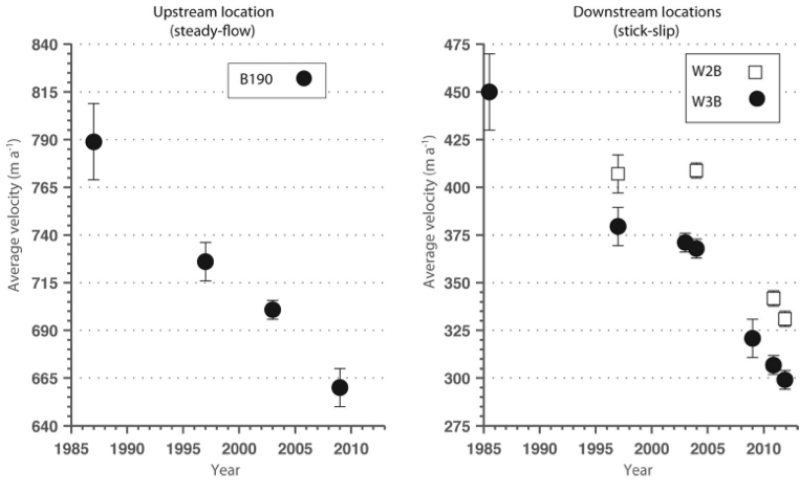
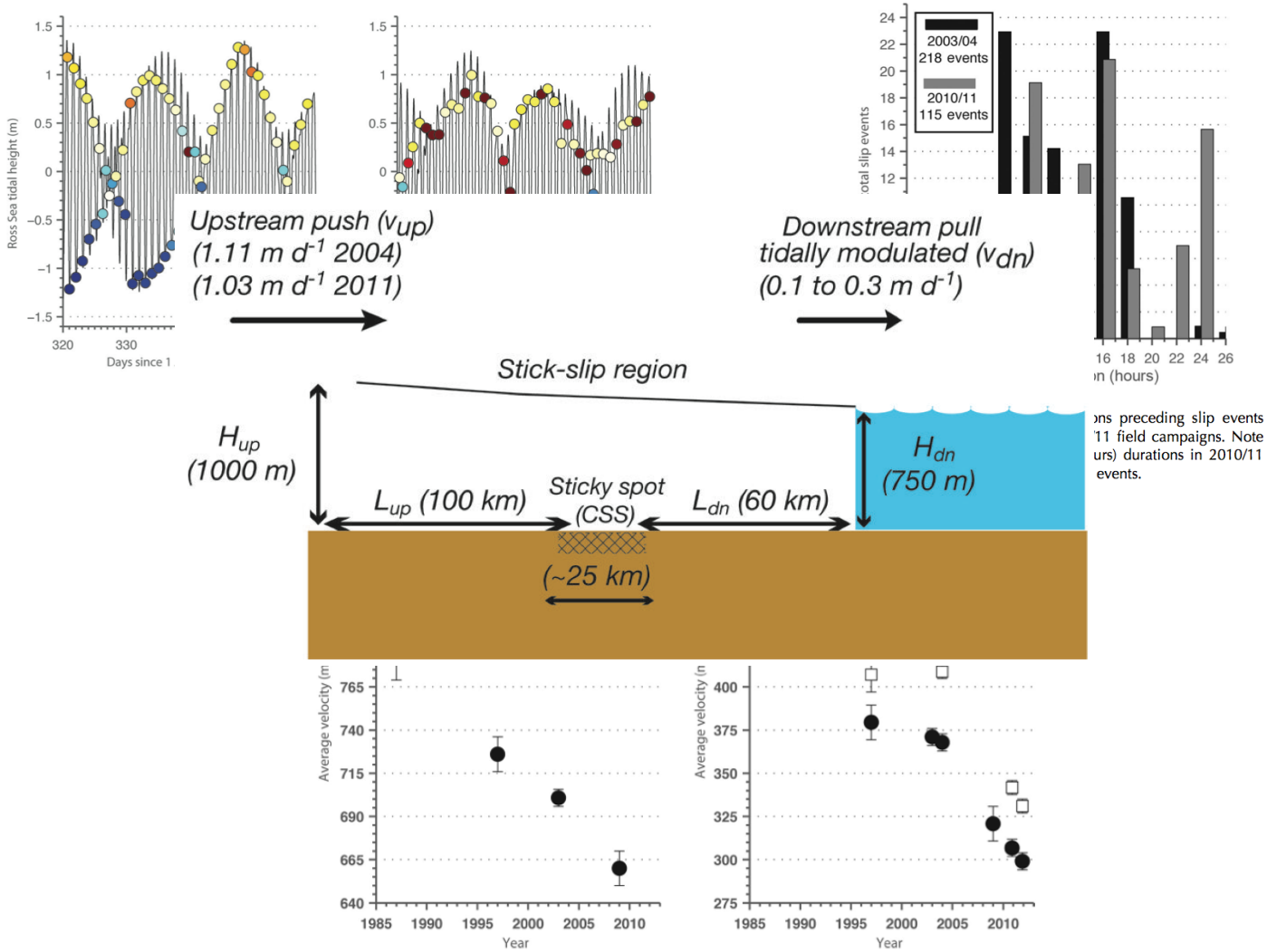


Fig. 7. Long-term deceleration of WIS at non-stick–slip and two stick–slip locations from GPS observations.

(Winberry and others, 2014)

Ice Motion



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