Subglacial flood event observed using *in situ* GPS data, CryoSat-2 altimetry, and MODIS image differencing on the Whillans Ice Plain

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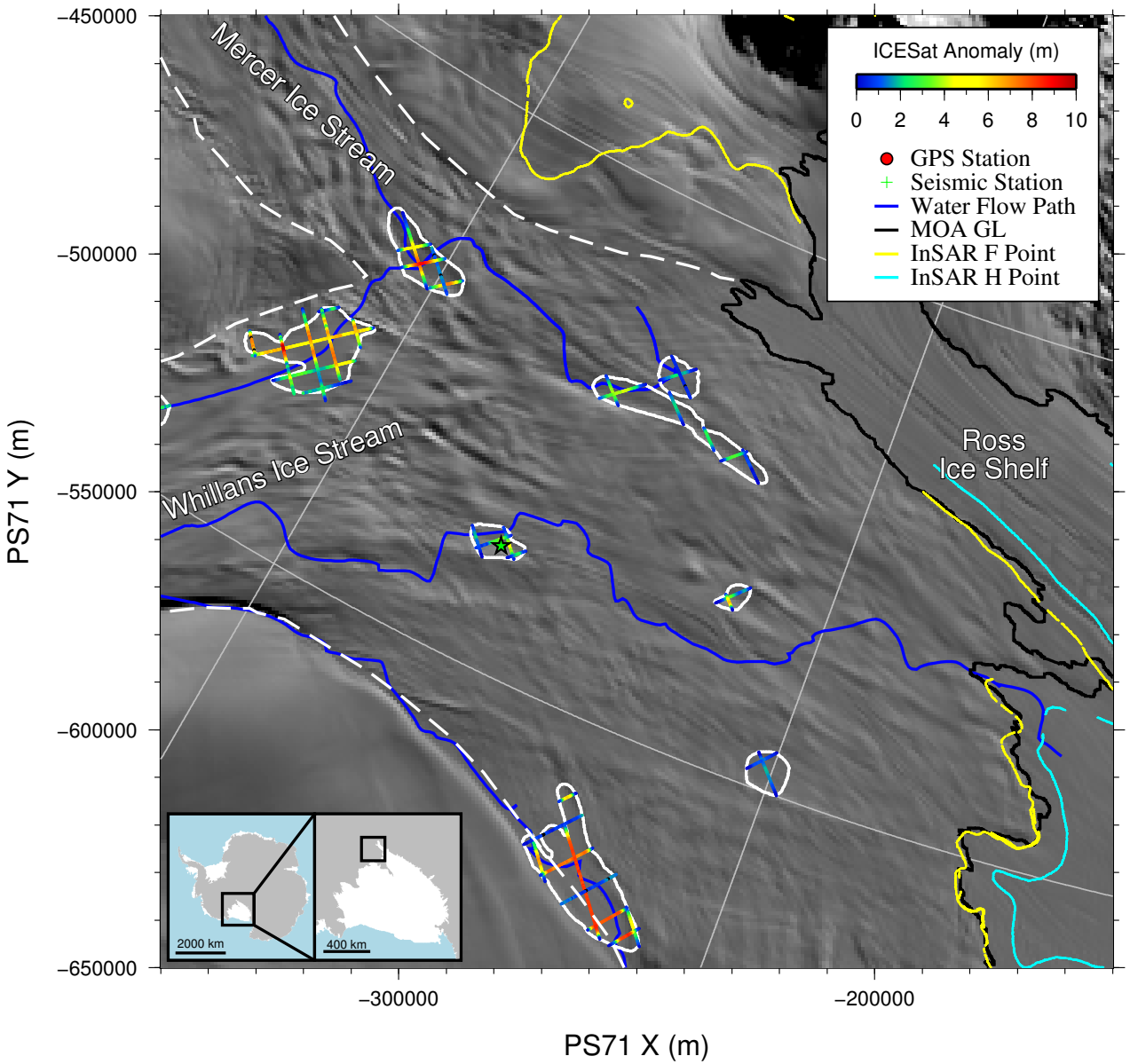
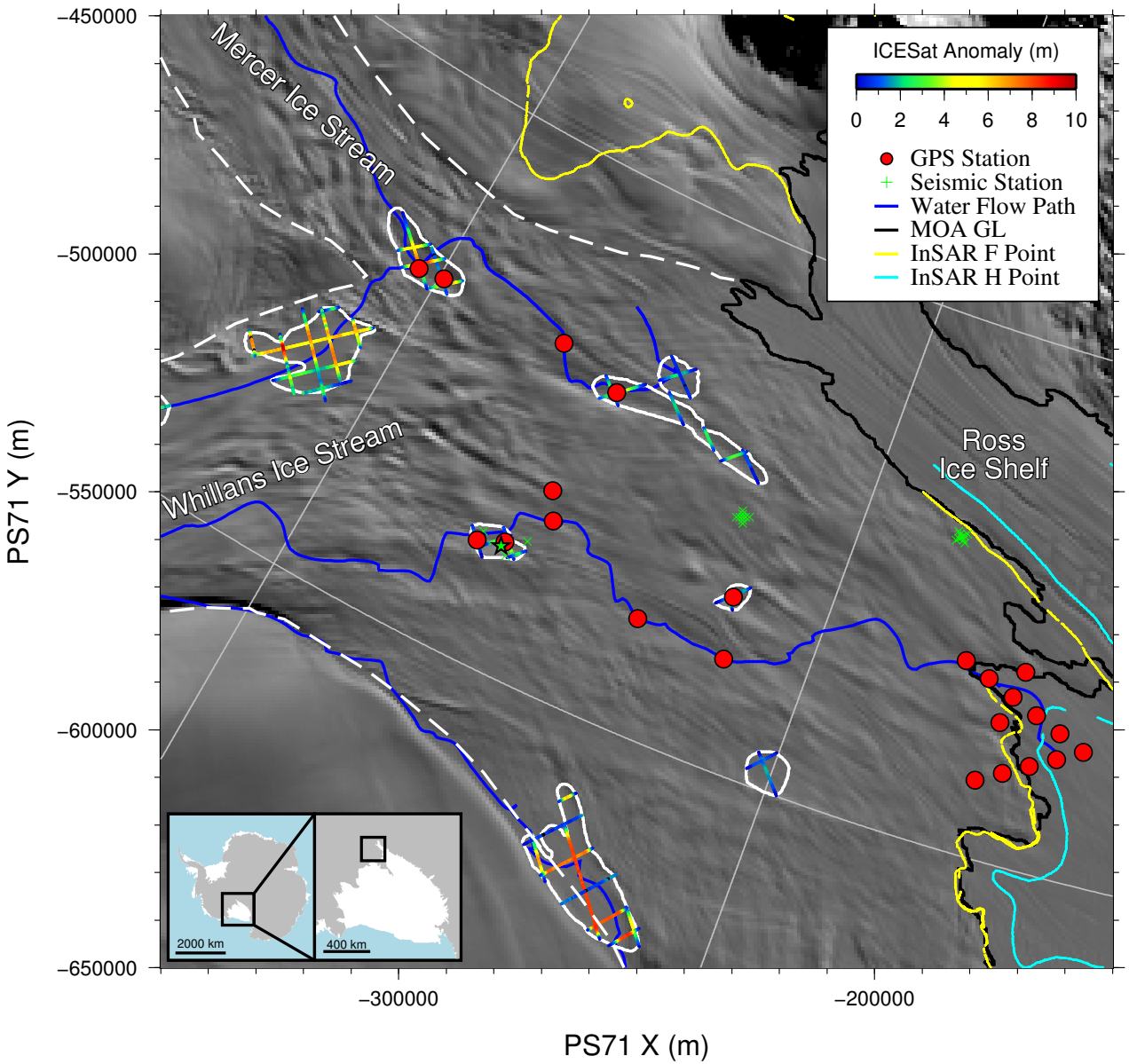
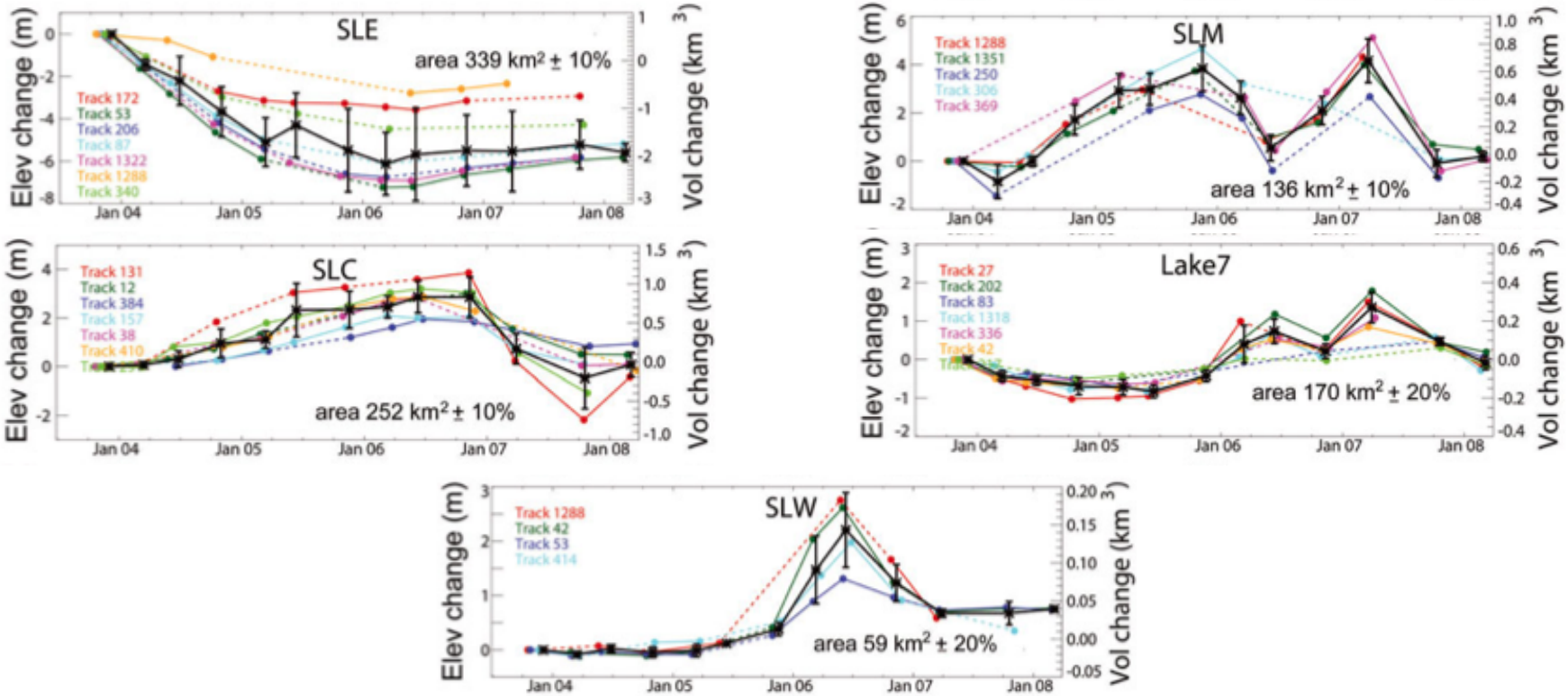
Whillans Ice Plain Overview



Whillans Ice Plain instrumentation



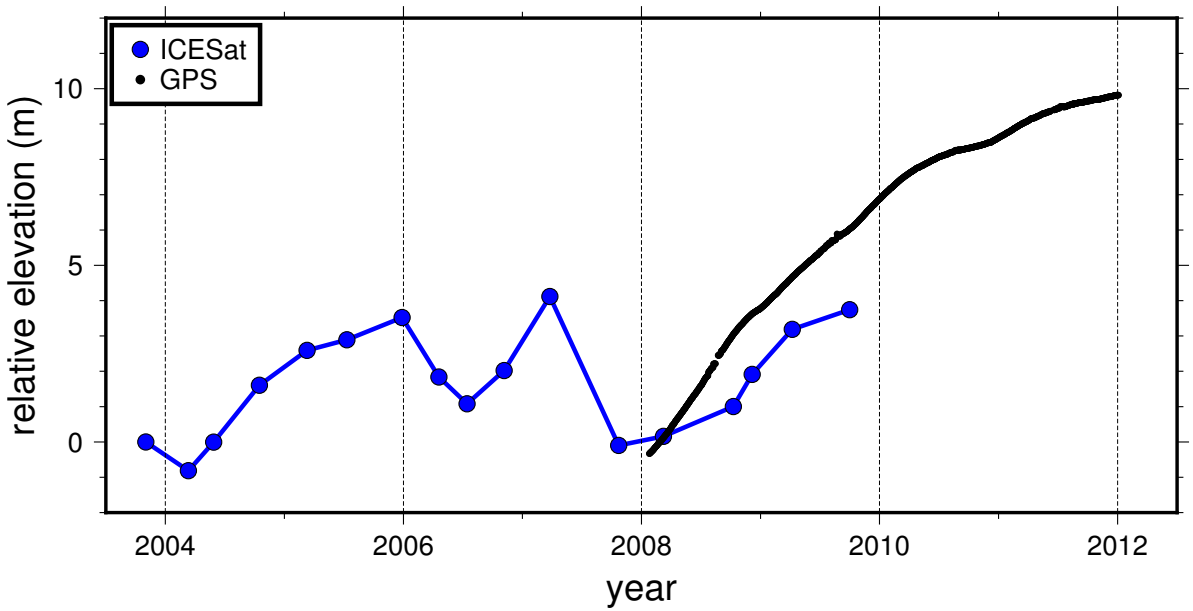
ICESat Time Series: 2003–2009



(Fricker and Scambos, 2009)

Precise, but spatially and temporally discontinuous

Subglacial Lake Mercer: ICESat and GPS



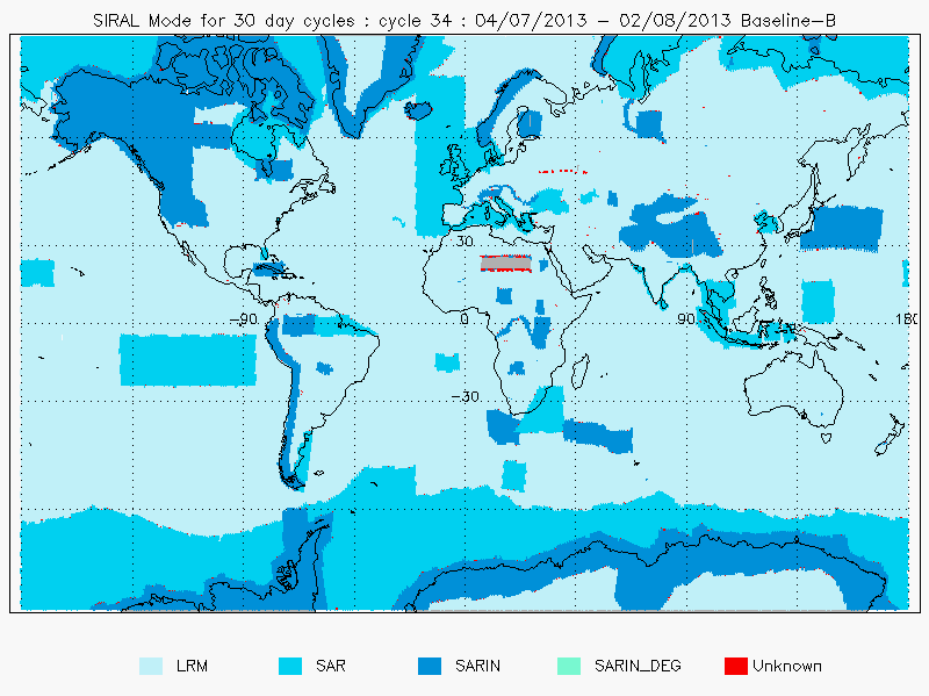
Disconnect between ICESat time-series and GPS observations.

Advection upslope? Change in hydropotential regime?

Ready to burst?!

CryoSat-2: 2010–present

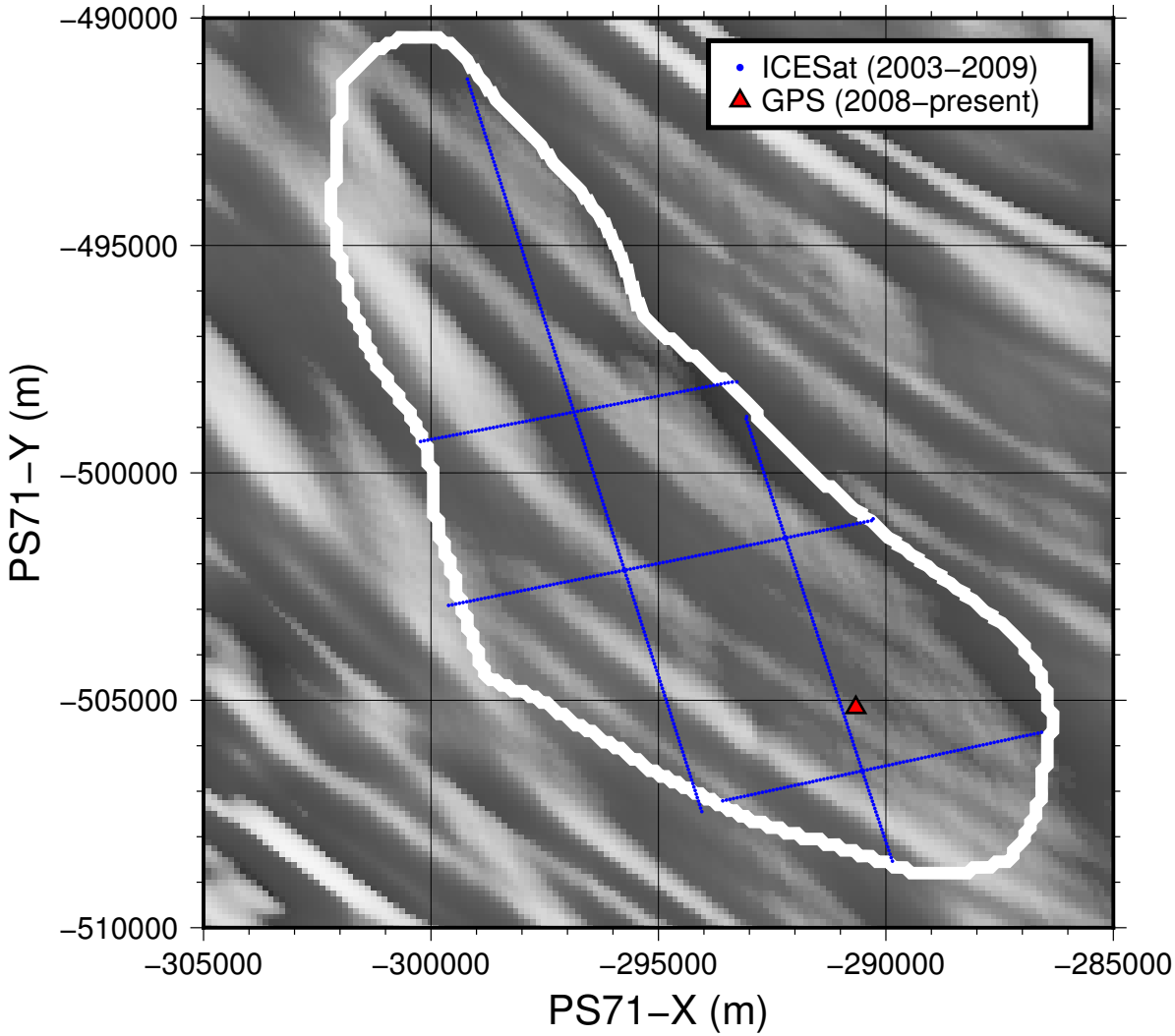
Radar altimeter, 92° inclination, 369-day orbit, 30-day sub cycle



Modes:

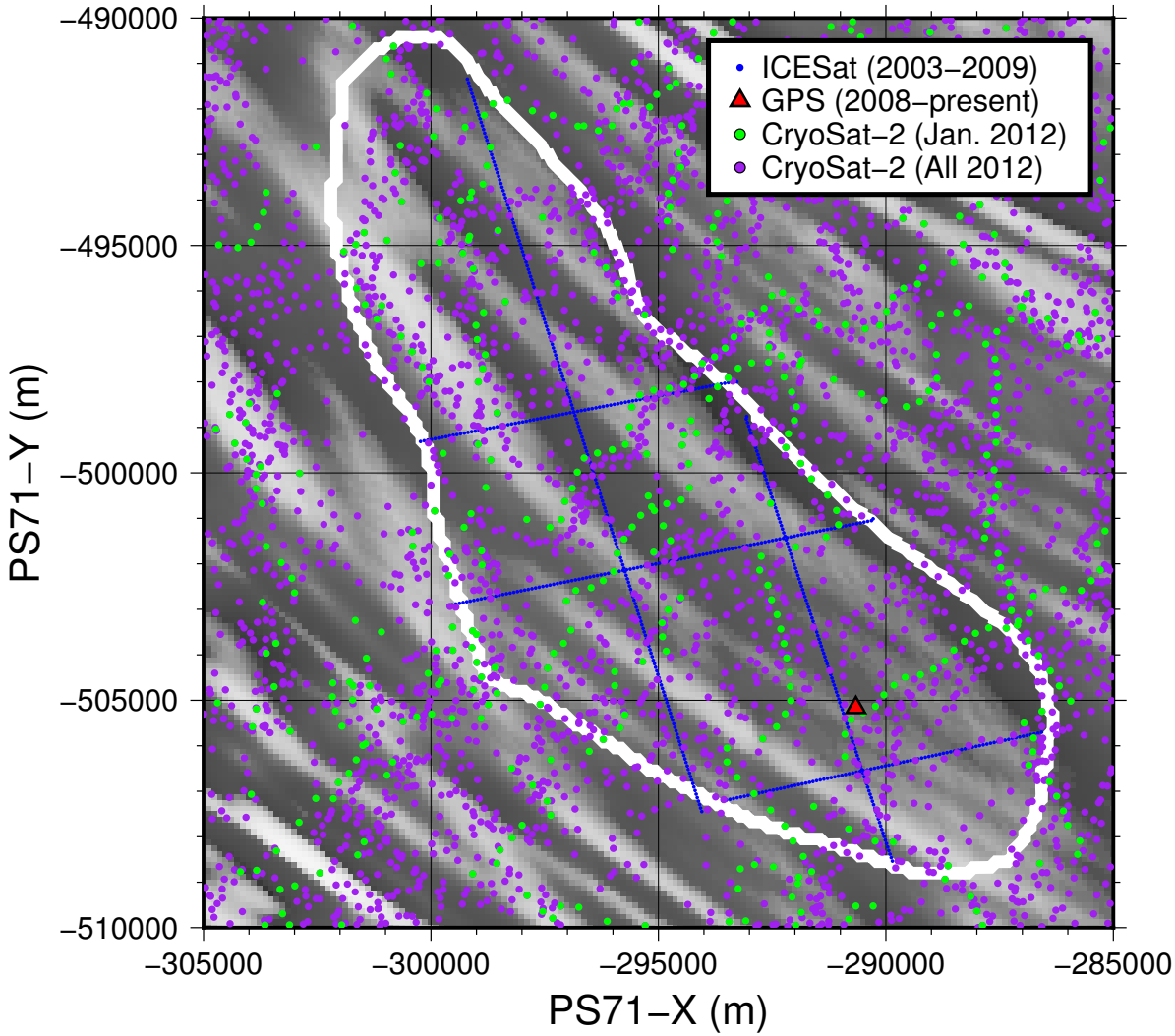
- LRM: conventional pulse-limited radar ($\sim$ kms x kms)
- SAR: traditional synthetic aperture radar ($\sim$ 300m x kms)
- SARin: short-baseline interferometer ($\sim$ 300m x 300m)

Comparing satellites. . .



5 lines defining 136 km^2 lake

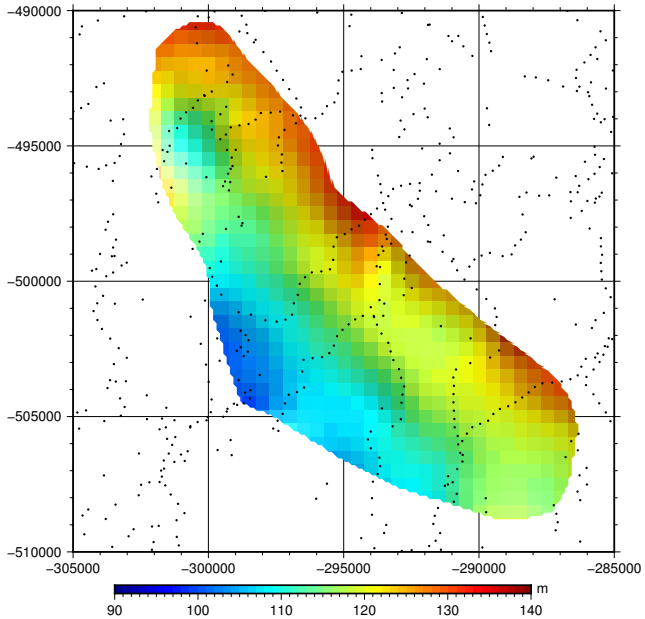
Comparing satellites. . .



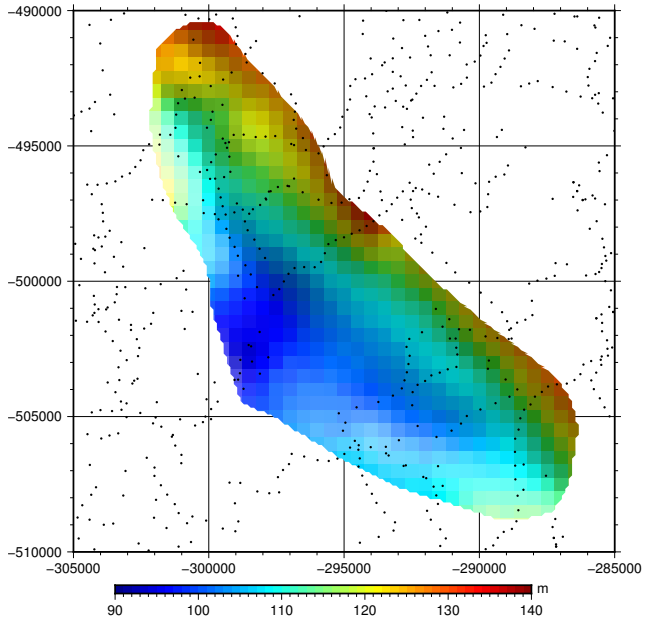
1 year of wandering ground tracks

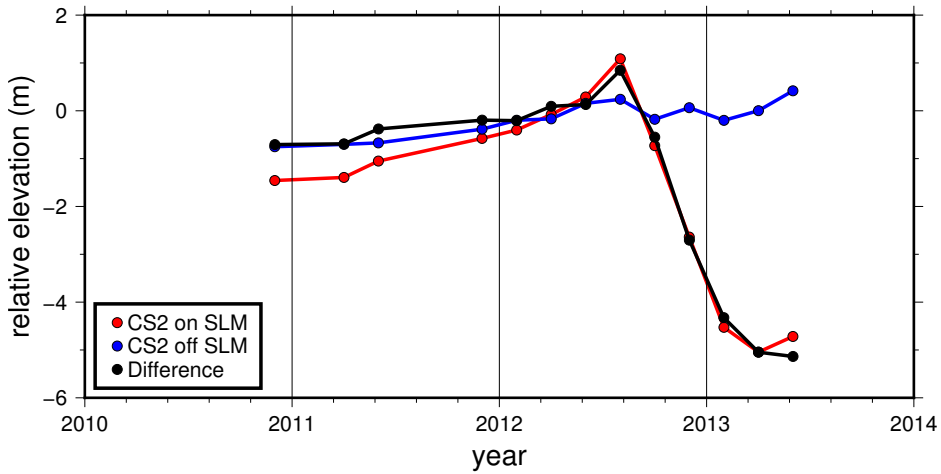
Spatial and temporal monitoring of *dh/dt*

CryoSat-2, July/Aug 2012

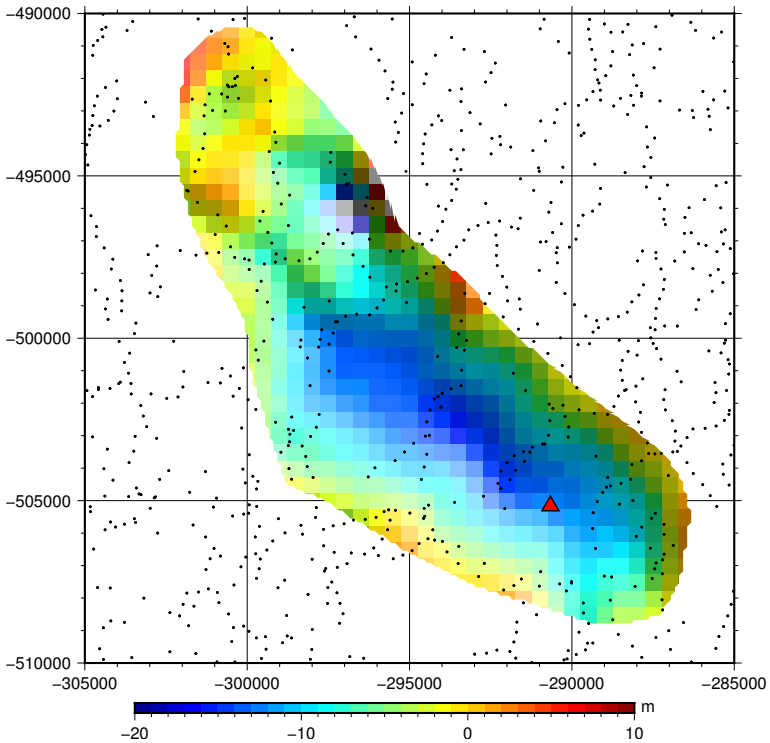


CryoSat-2, Jan/Feb 2013

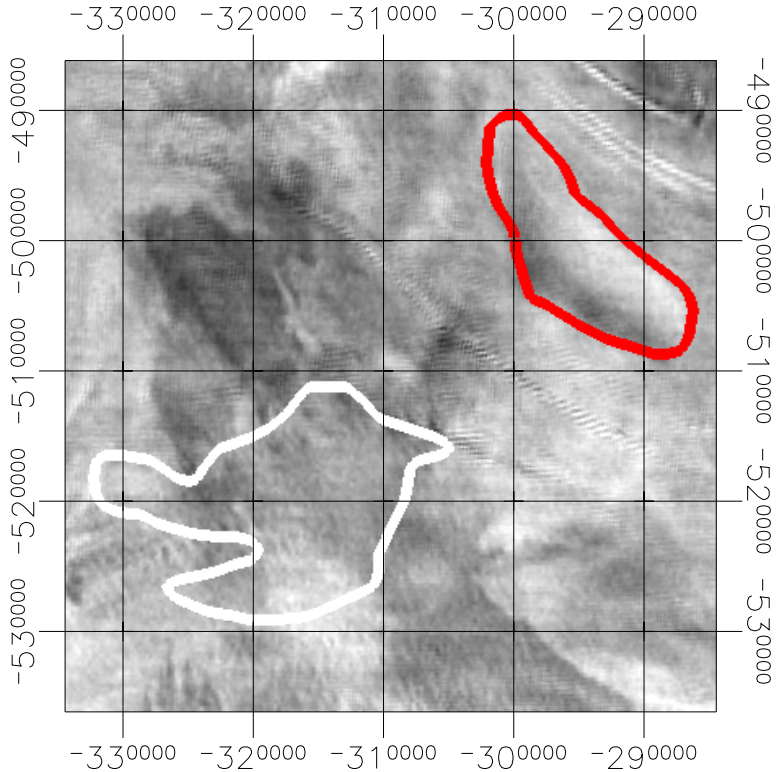




Spatial Validation: MODIS image differencing

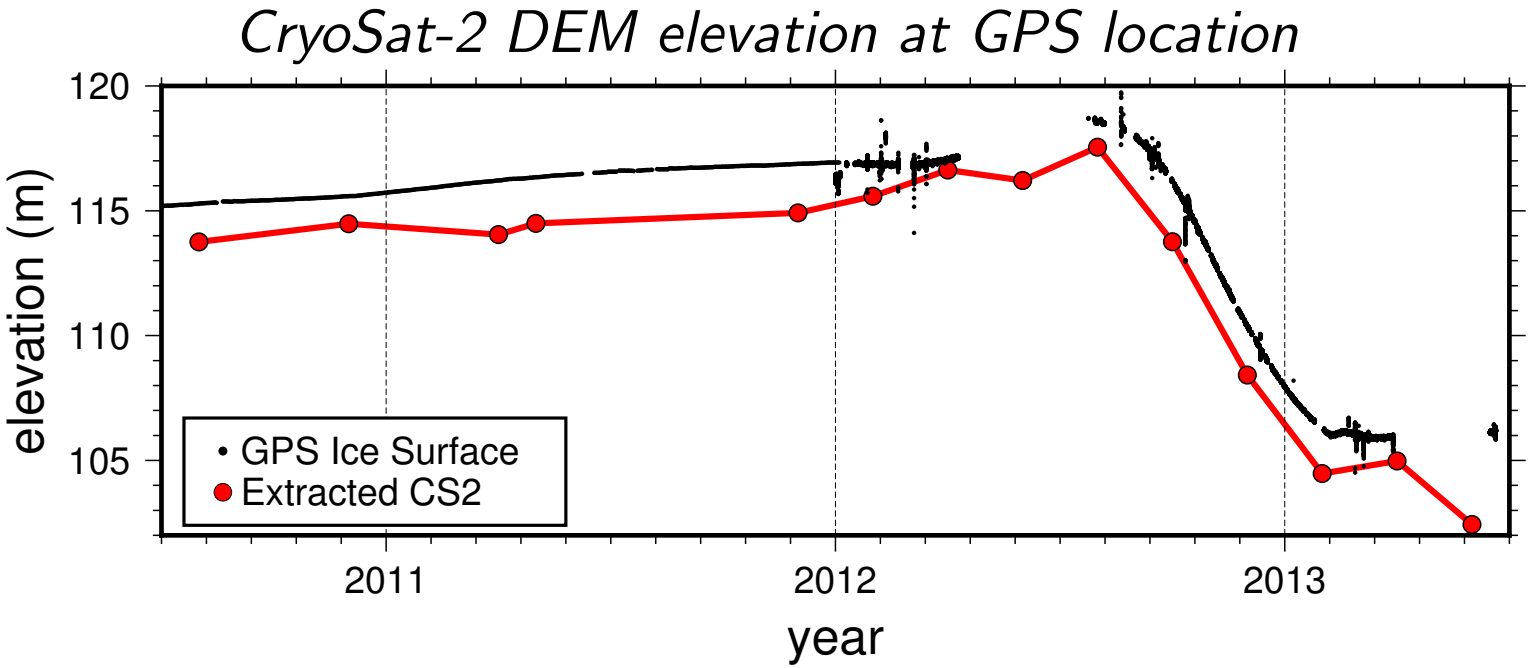


Early 2013-Mid 2012
CryoSat-2



Early 2013-Late 2011
MODIS Image Differencing

Temporal Validation: GPS surface elevation



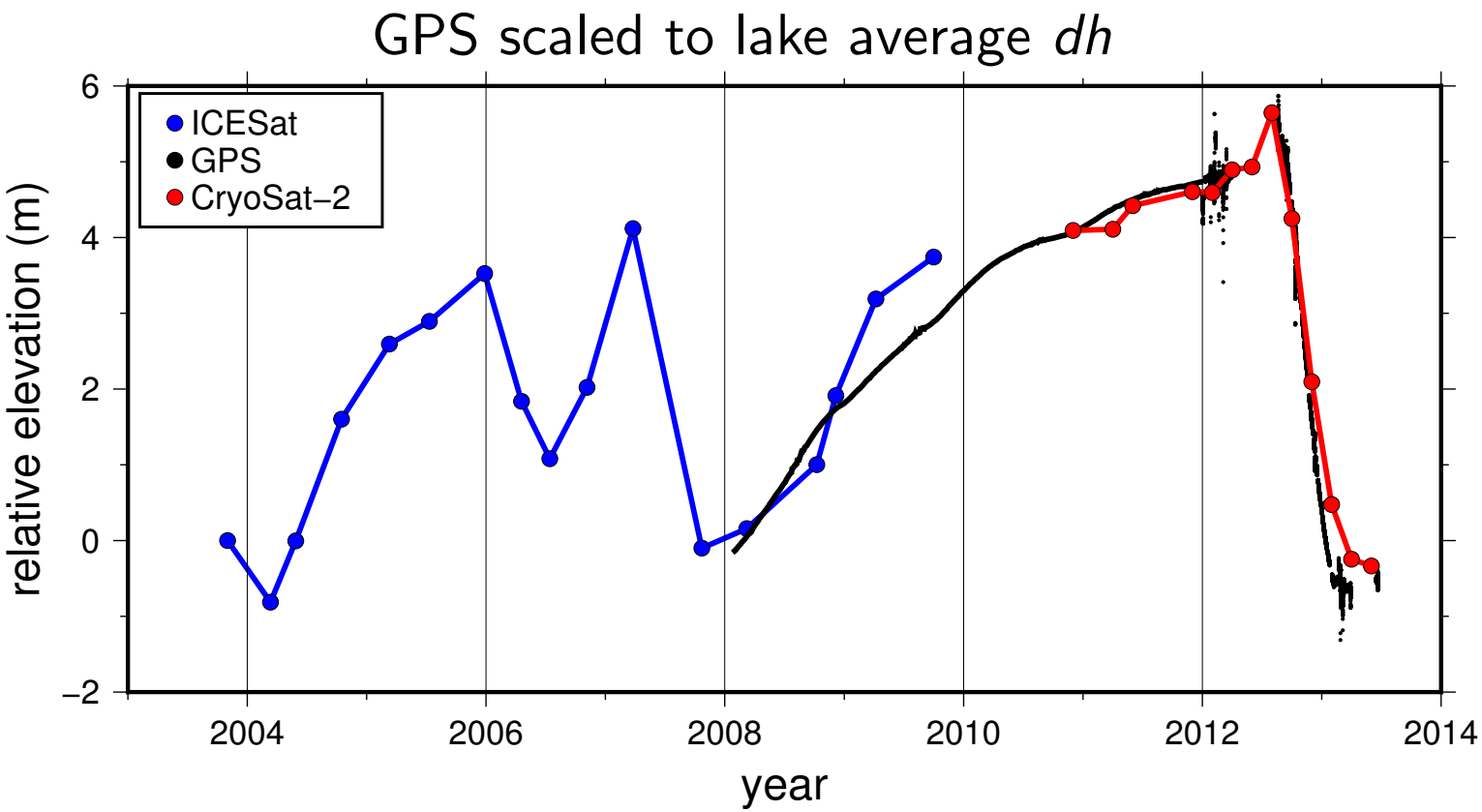
$\sim$1m offset combination of

known processing issue

and

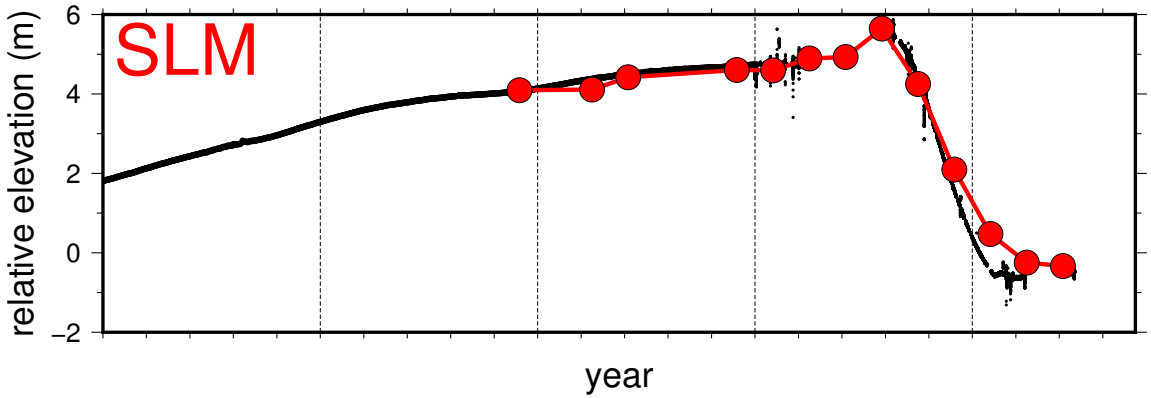
volume scattering

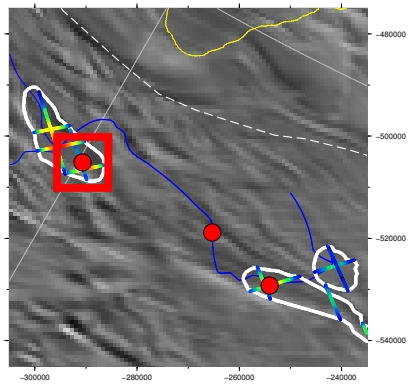
Subglacial Lake Mercer: 10+ years of history



WIP GPS tie together cryo-focused satellite-borne datasets

Where does the water go??





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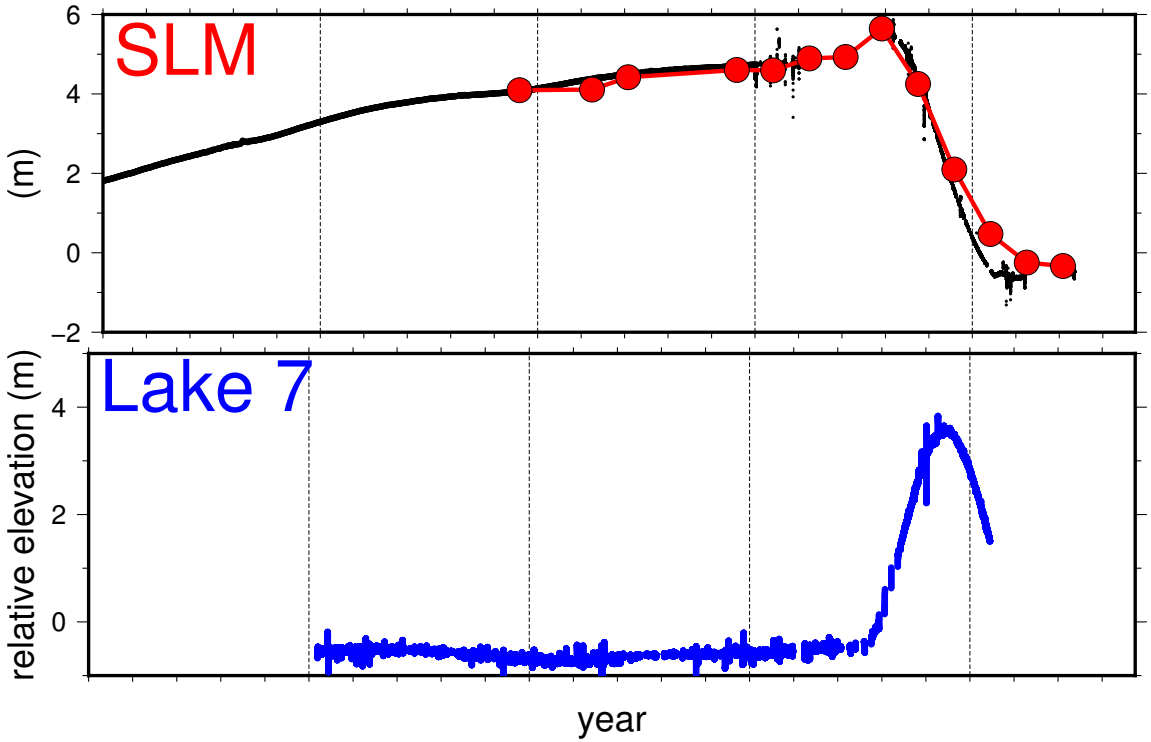

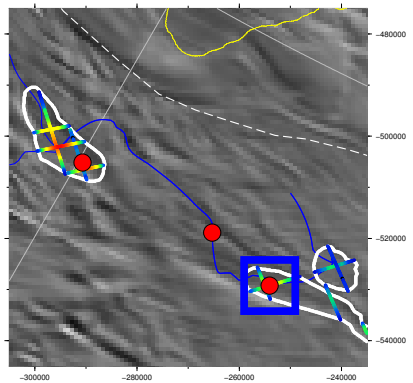

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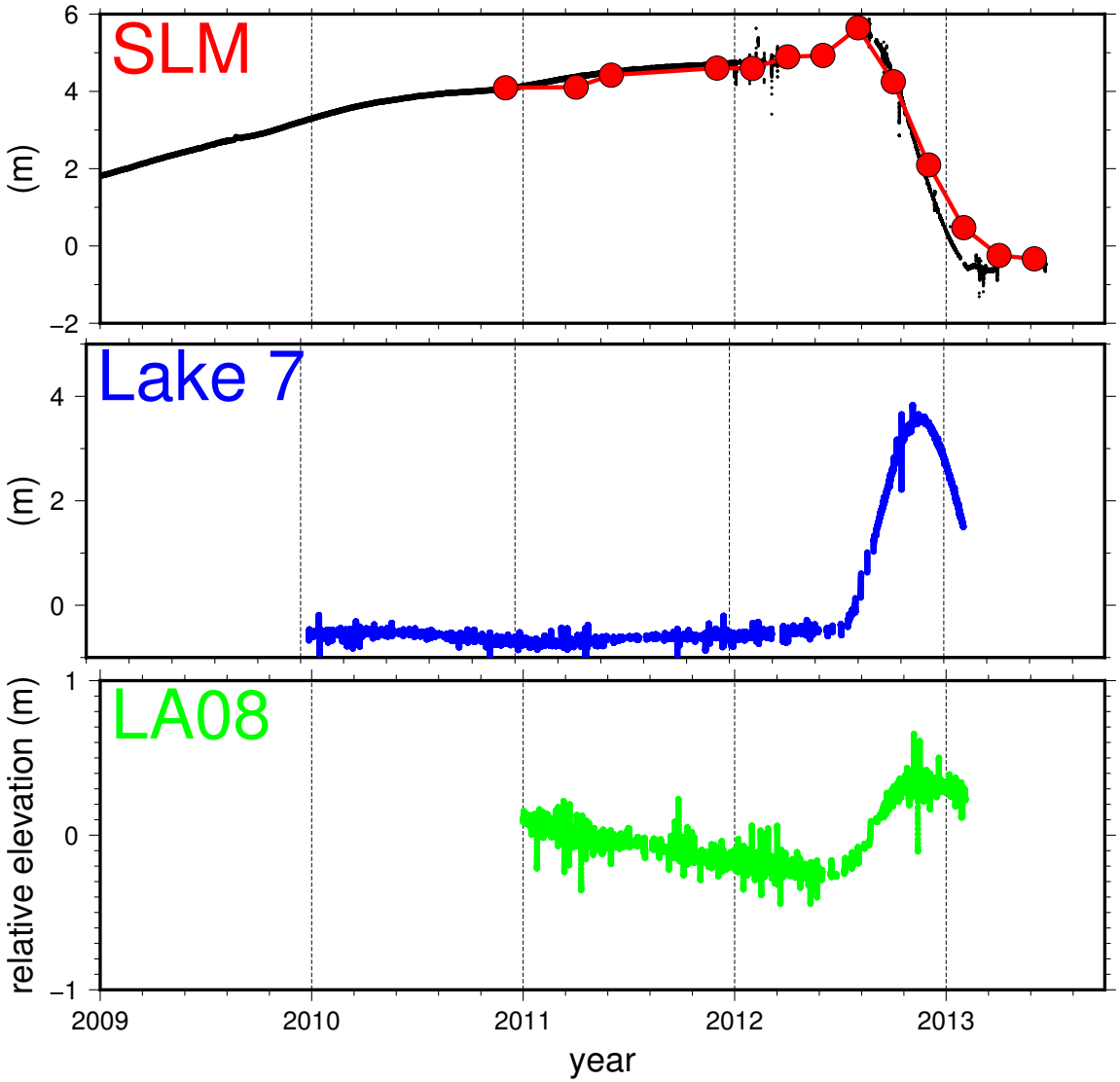
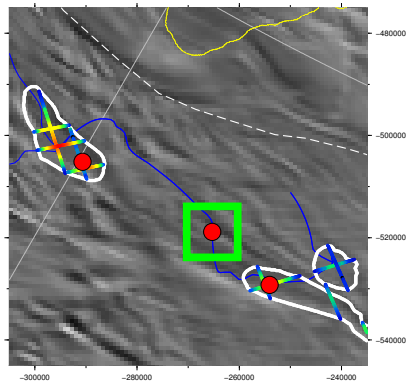
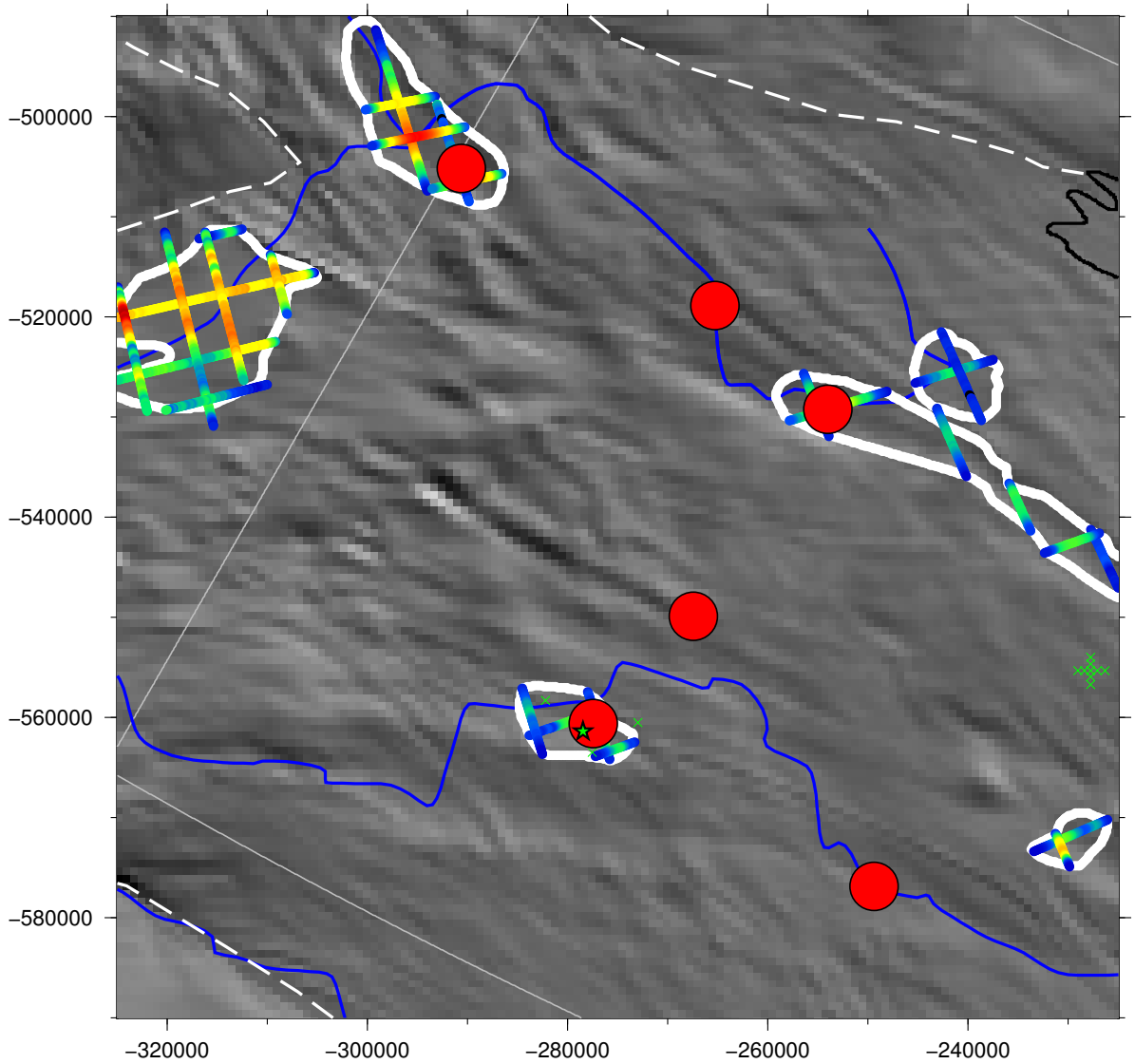


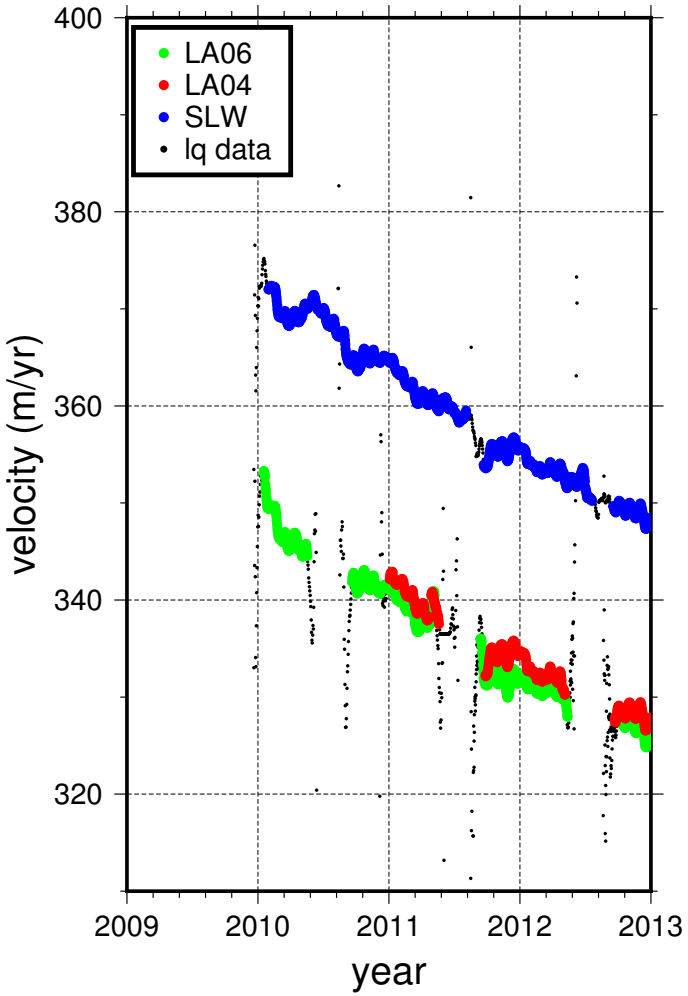


Ice Stream Velocity

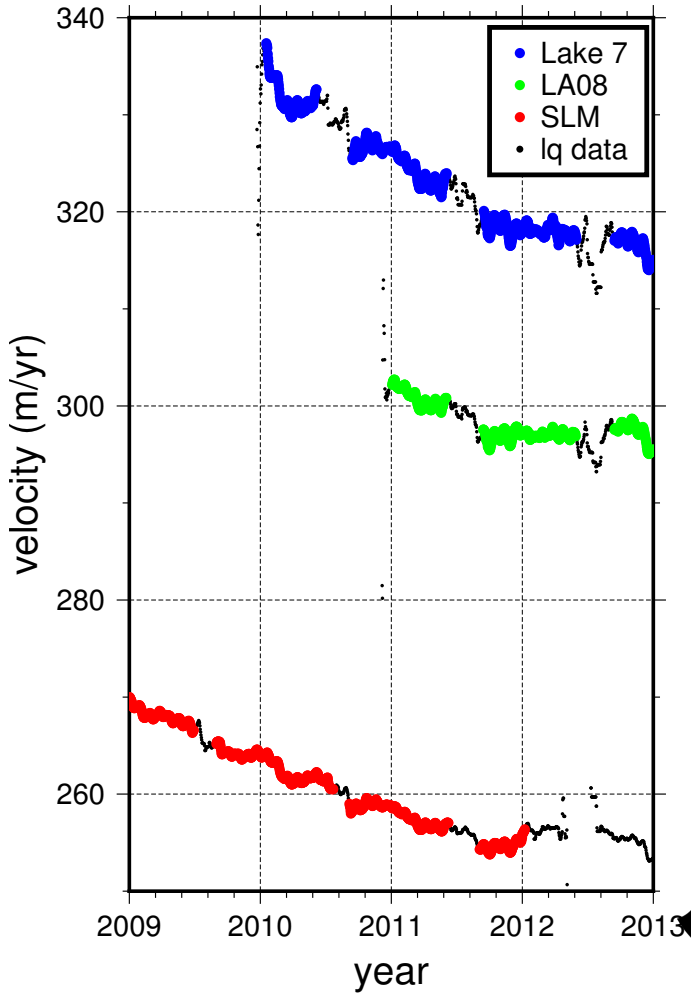


Ice Stream Velocity

Whillans Ice Stream

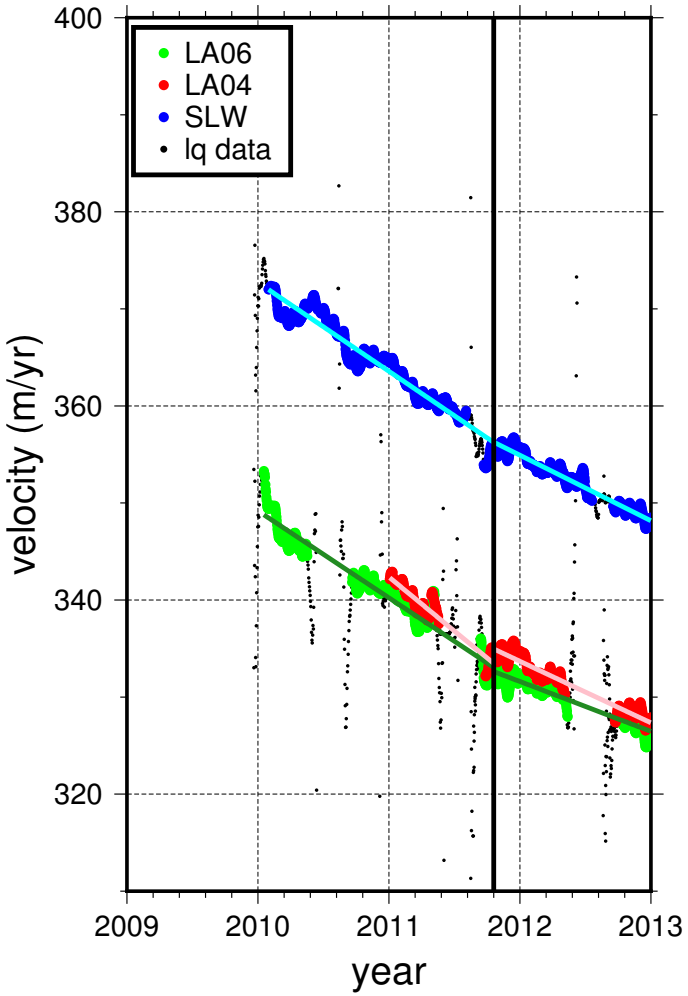


Mercer Ice Stream

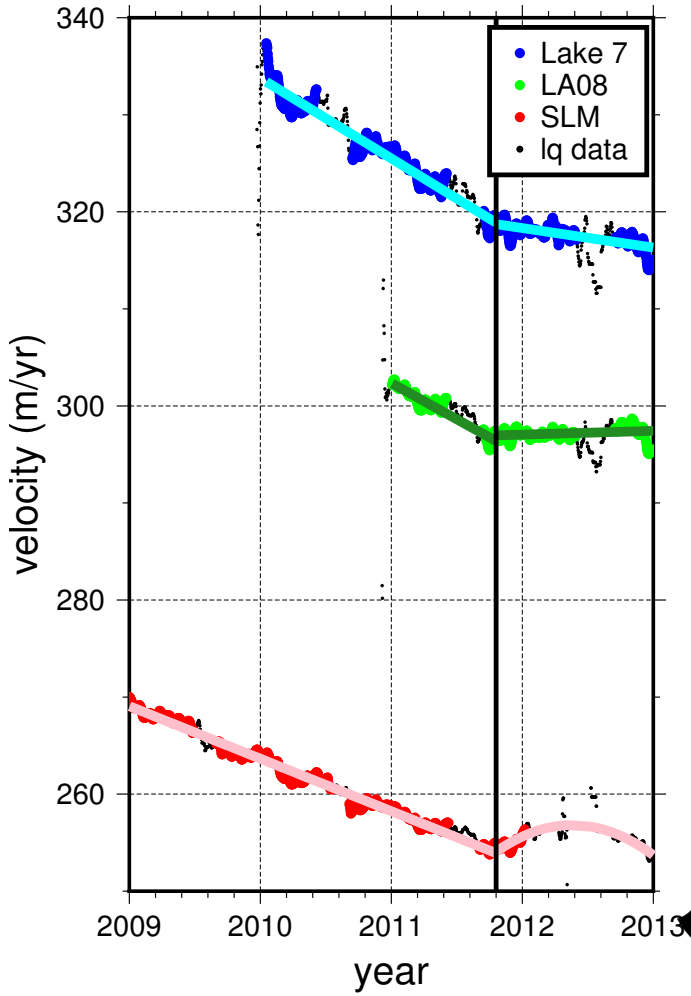


Ice Stream Velocity

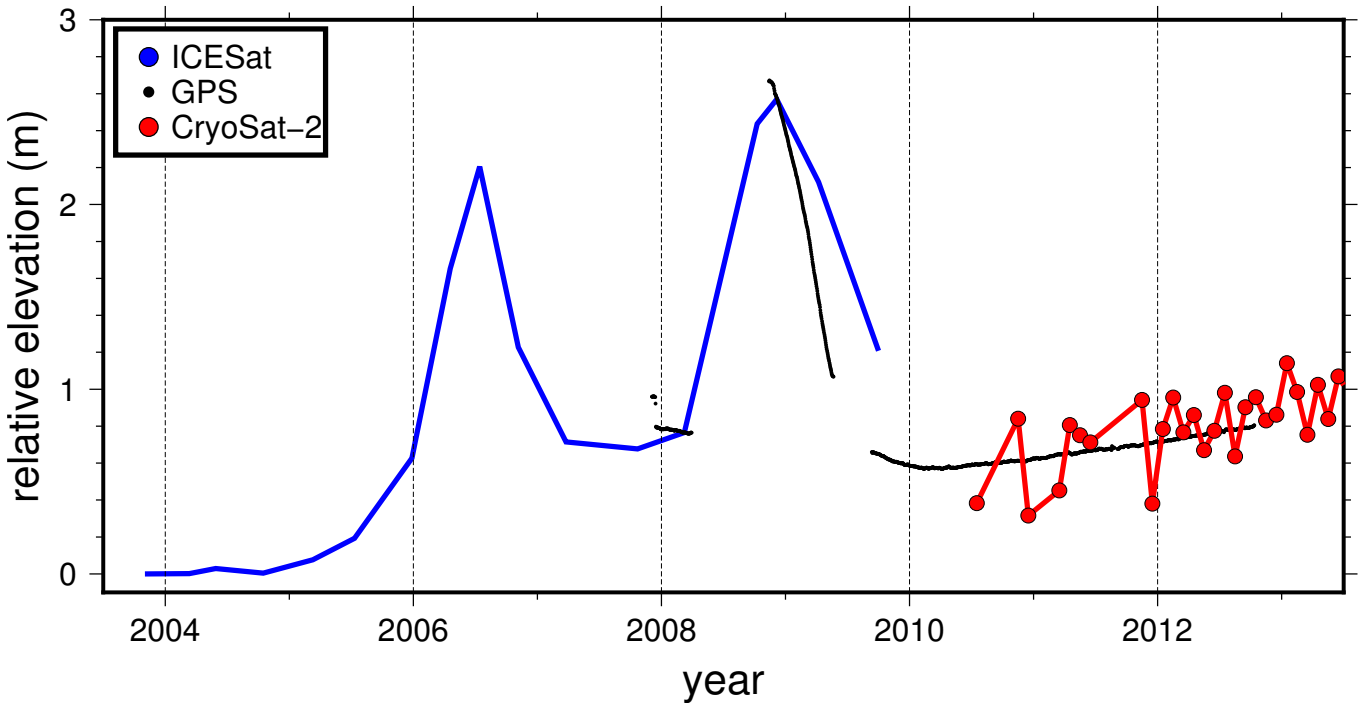
Whillans Ice Stream



Mercer Ice Stream

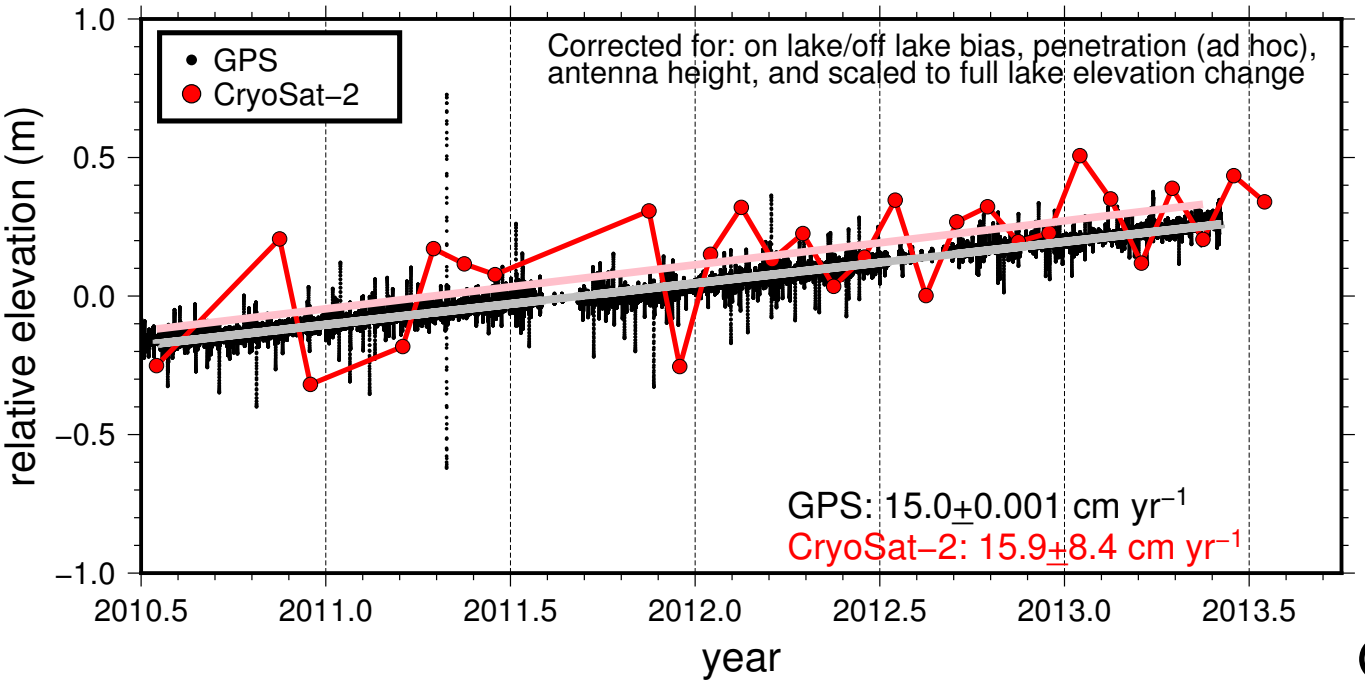


Subglacial Lake Whillans



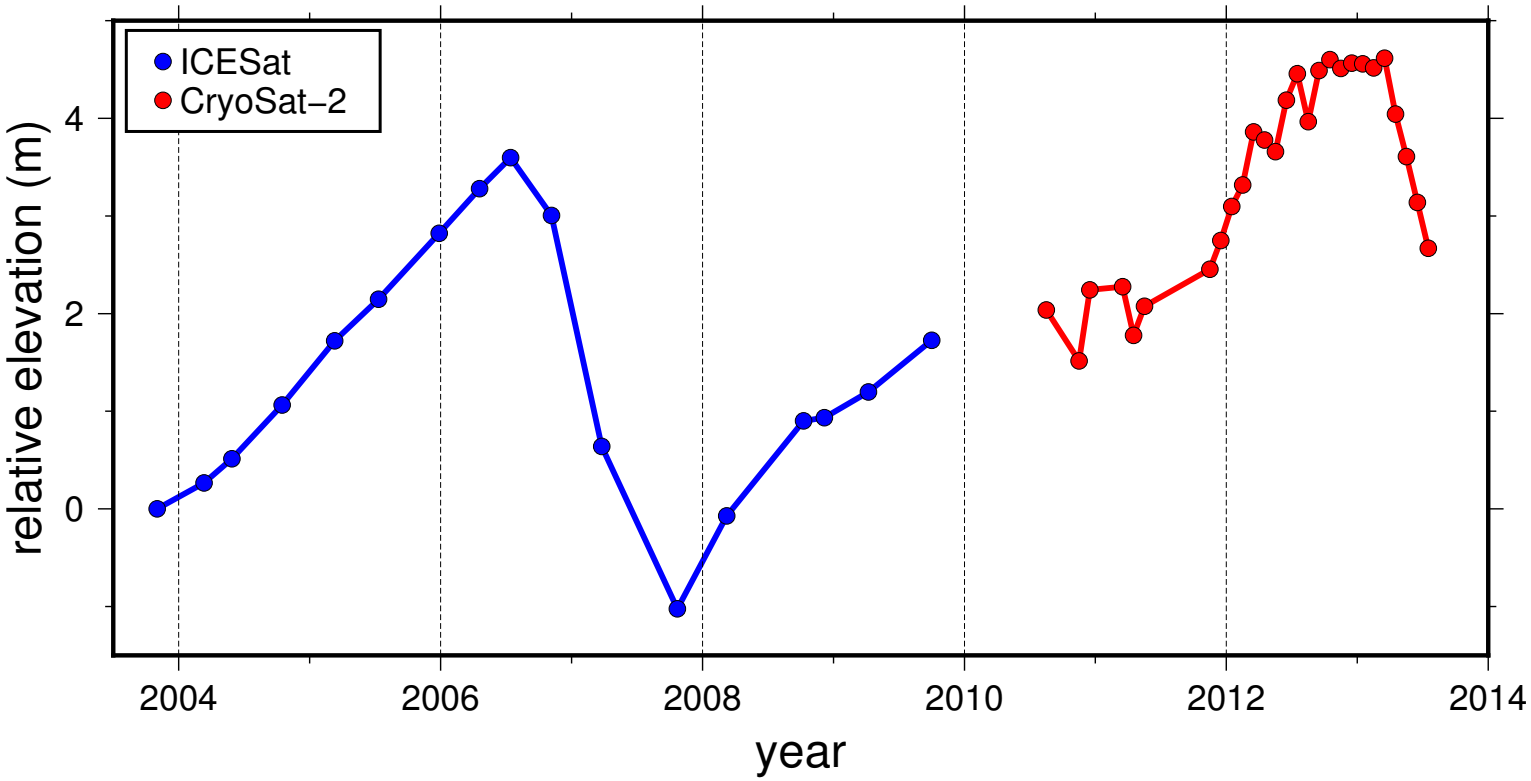
More overlap between GPS and satellite missions than at SLM

Subglacial Lake Whillans



CryoSat-2 can recover small dh/dt signals.

More lake action. . .



Conclusions

- Independent, coincident measurements of a subglacial lake discharge event with high spatial and temporal resolution
- SLM discharge corresponds to a measurable increase in ice velocity
- CryoSat-2 is quite adept at measuring dynamic dh/dt
- We need high quality datasets between major satellite missions

Thank You!

- NSF-OPP, NASA, SIO, UCSD
- KBA, NYANG, UNAVCO
- WISSARD 2011/2012, 2012/2013 field teams
- POLENET

CryoSat-2 Validation: salar de Uyuni