Mass budget reassessment of the Abbot and Getz sectors of West Antarctica

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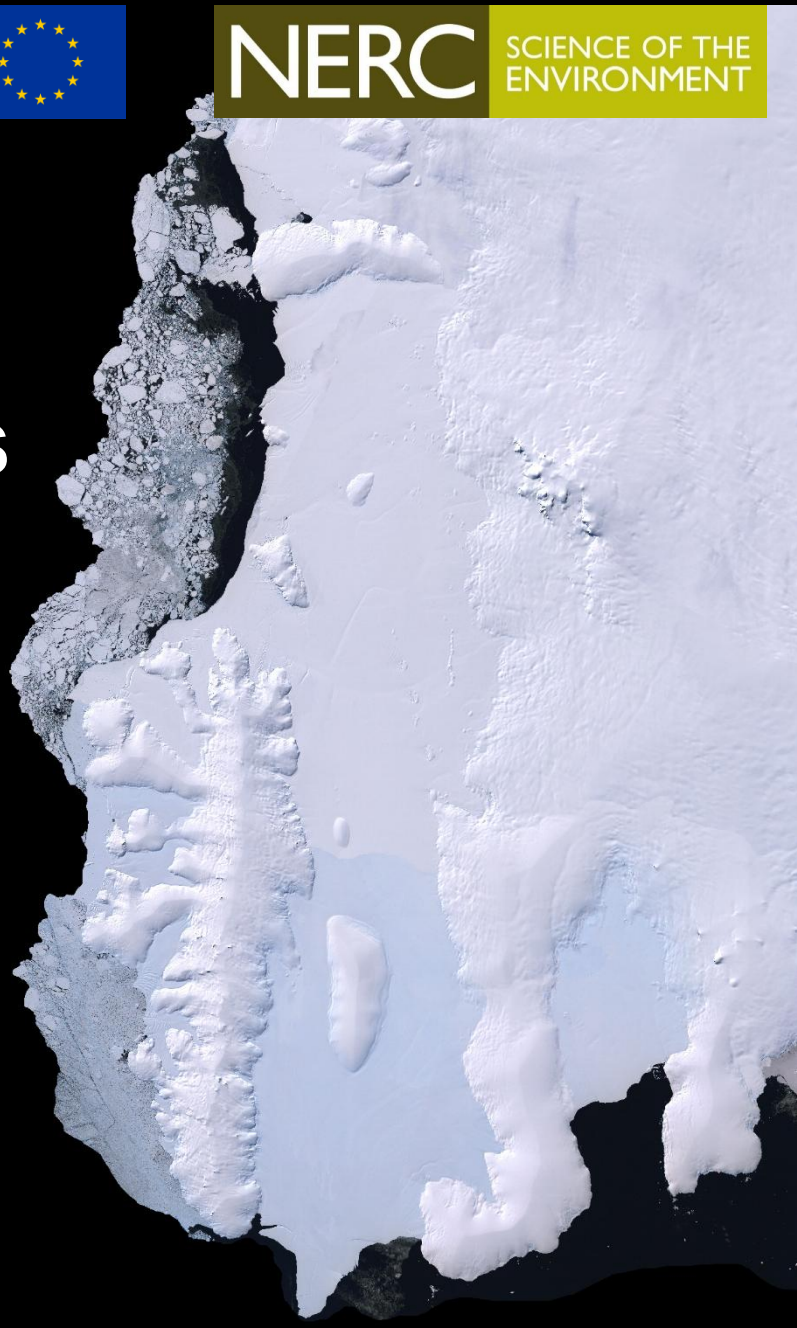
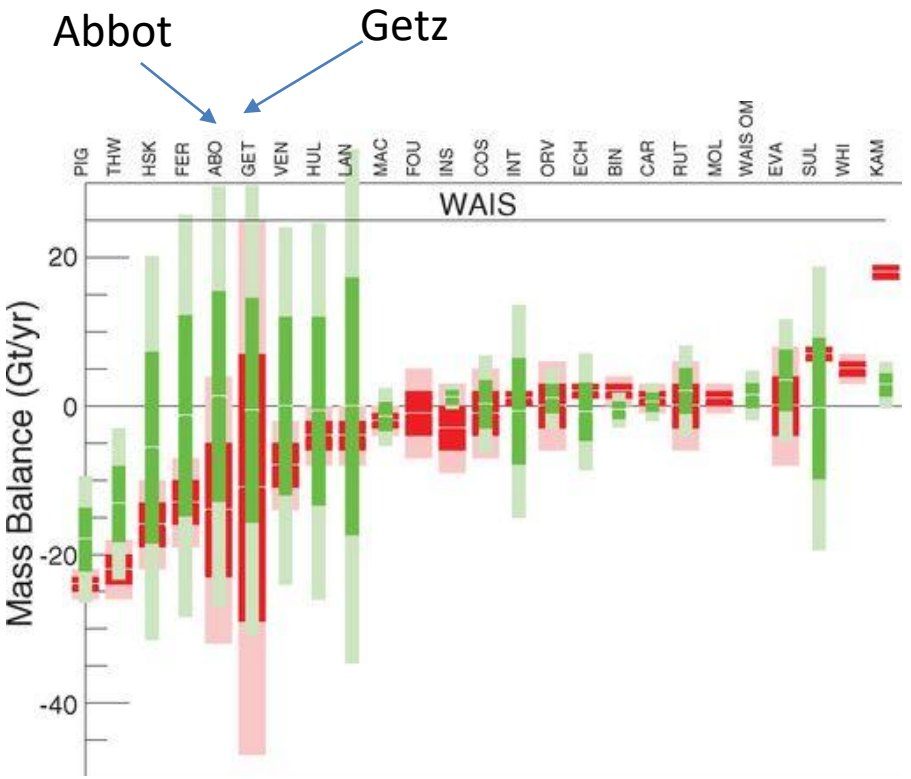


Reconciling Mass Balance Estimates

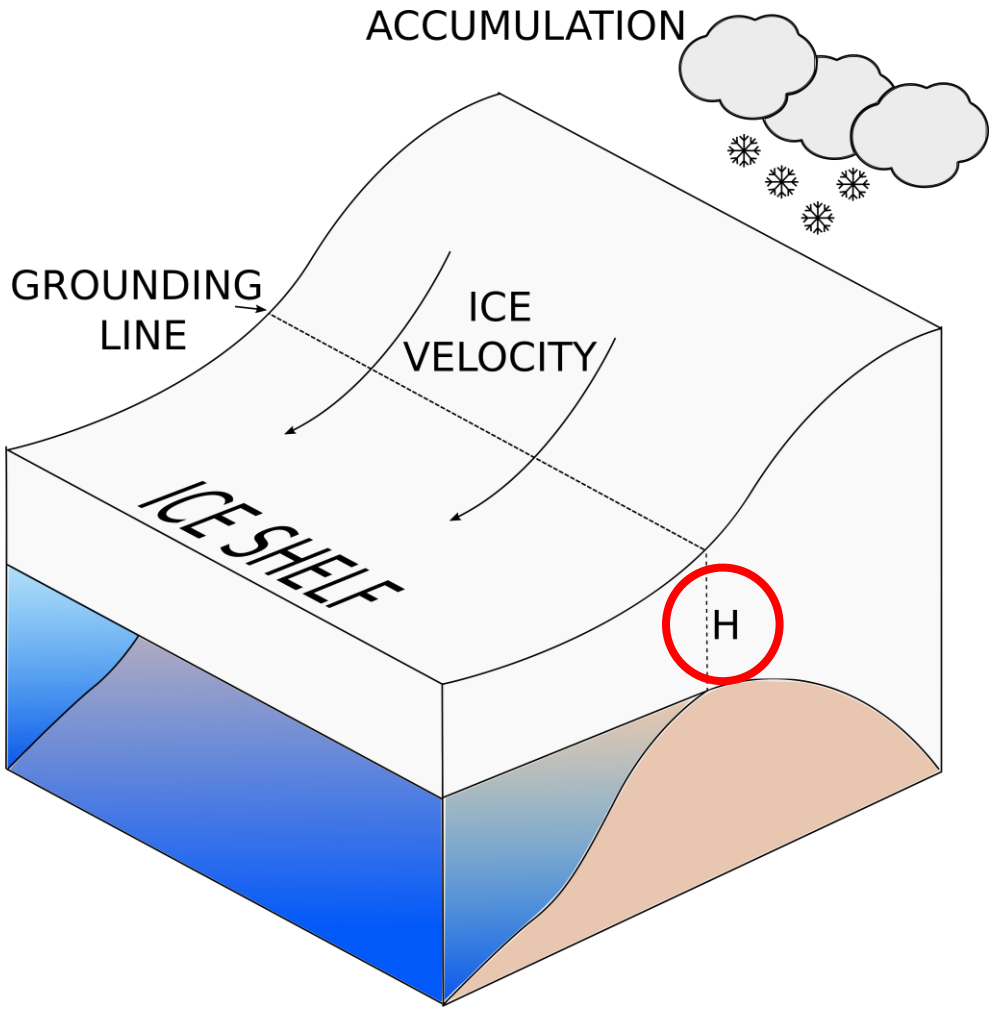
- IOM, Gravimetry, Altimetry operate on different spatio-temporal length scales
- forward modelling solutions to resolve for unobserved processes
- RATES – Statistical Bayesian Framework using source separation to attribute mass changes to different process and reduce reliance on forward models.



(Shepherd *et al*, 2012)

Input-Output Method (IOM)

- Best thickness data from RES
- **30%** of the grounding line has no direct observations
- Therefore satellite altimetry and the assumption of HE is used
- HE derived ice thickness is currently one of the **largest sources of uncertainties**.



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Altimetry Derived Ice Thickness

ERS-1

- Loss of lock issues, poor coverage near GL
- Mean 50 m bias towards thicker ice near the GL

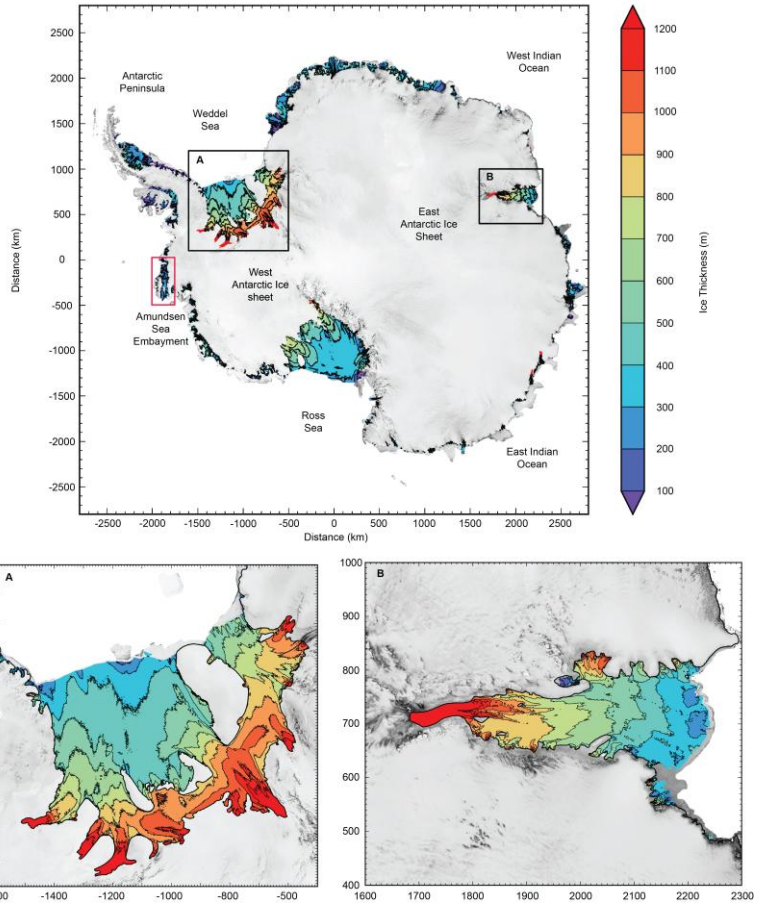
Bedmap-2

- Integrates ERS-1 product with RES where available
- Excludes all data within 5 km of the GL

CryoSat-2

- 2011-2014 ice shelf DEM
- Mean thickness bias < 10 m near the GL

(Griggs and Bamber, 2011), (Fretwell et al, 2013)



(Chuter and Bamber, 2015)

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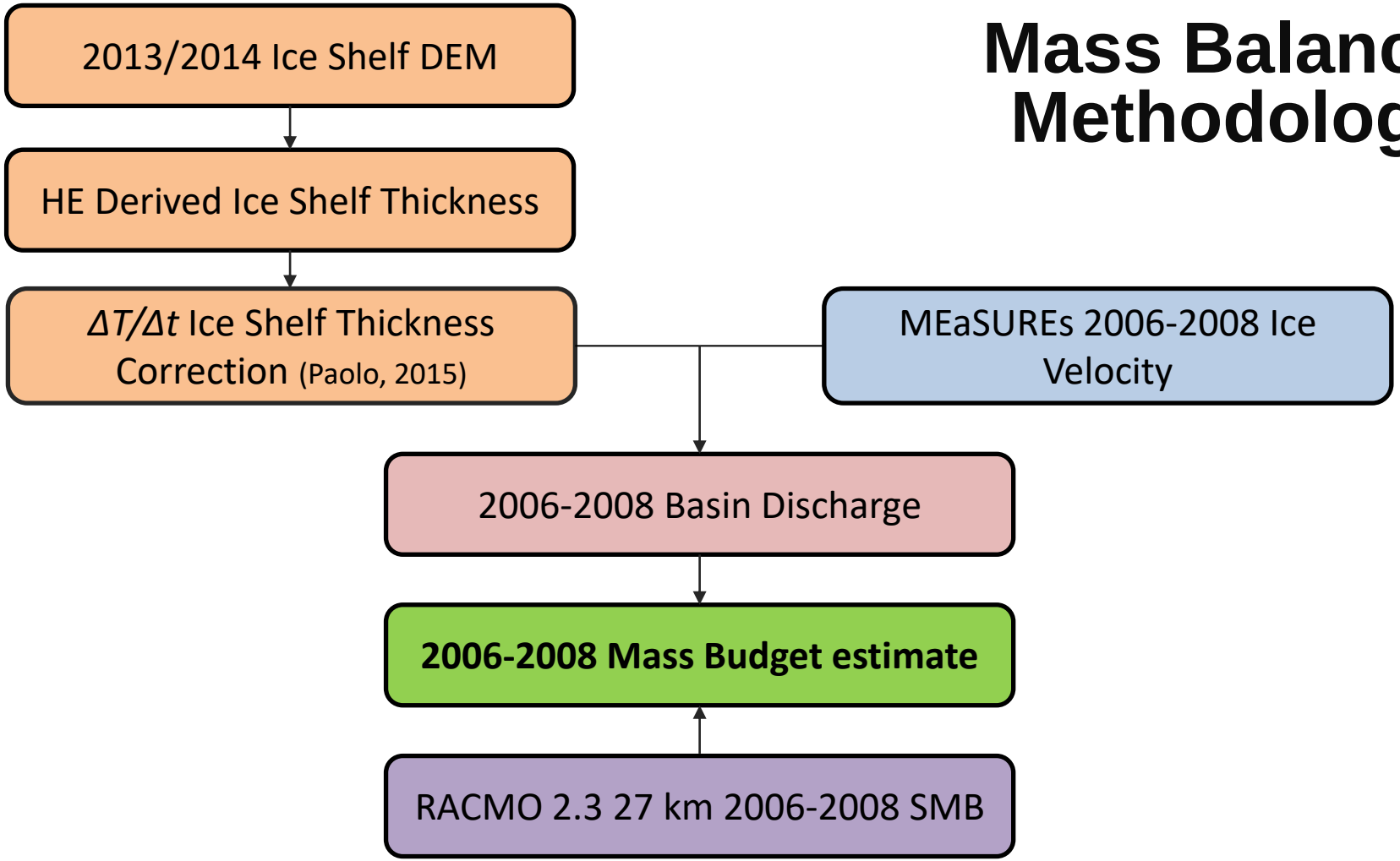
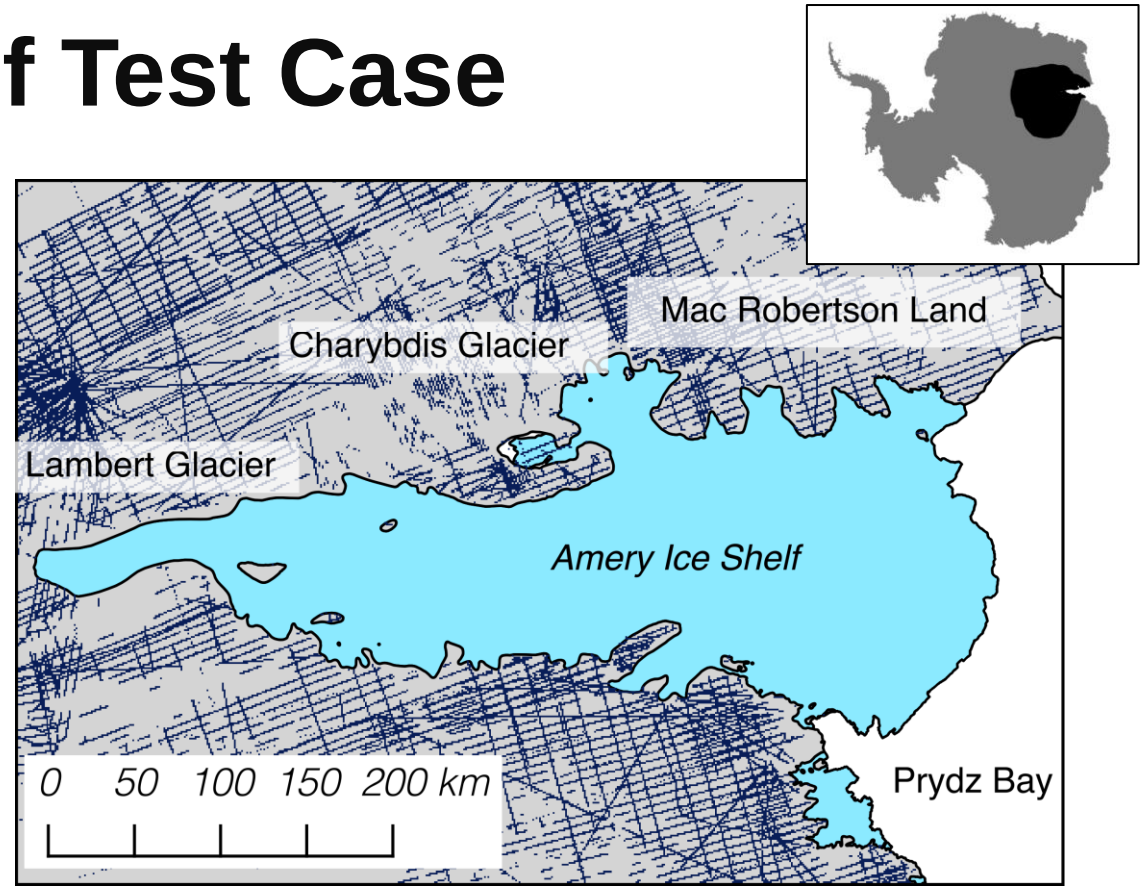
Mass Balance Methodology



Amery Ice Shelf Test Case

- Equates to a **4.7%** error in total ice thickness
- CryoSat-2 GLF shows excellent agreement with fluxes calculated from RES
- Ice shelf close to balance for the last two decades (Paolo et al, 2015)



Amery RES GLF (Yu *et al*, 2010): **63 ± 5 Gt yr^{-1}**

CS2 GLF: **64.3 ± 3.2 Gt yr^{-1}**

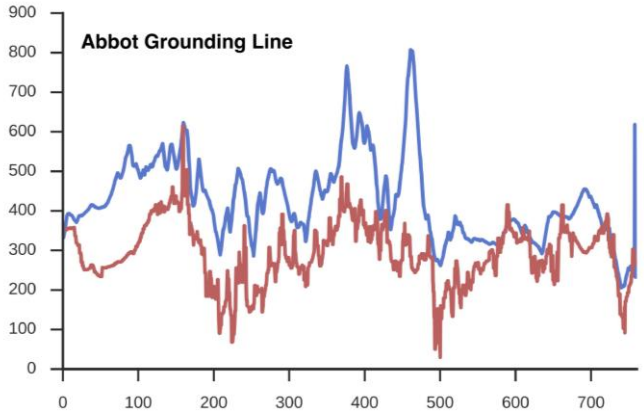
Abbot Sector Reassessment

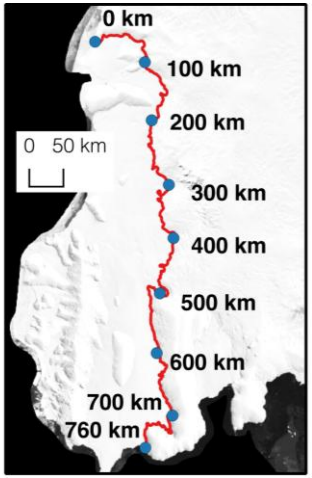
Previous IOM GLF (Rignot, 2008):

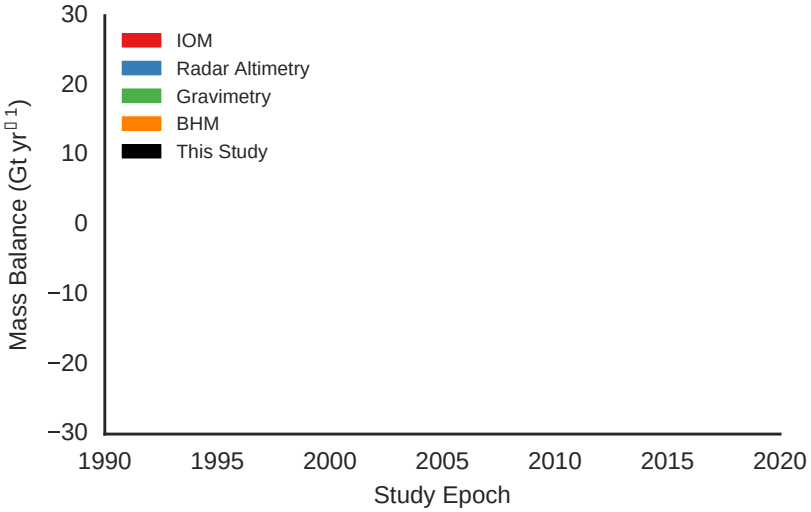
31 ± 10 Gt yr^{-1}

CryoSat-2 IOM GLF:

18 ± 3 Gt yr^{-1}







Previous IOM (Rignot, 2008):

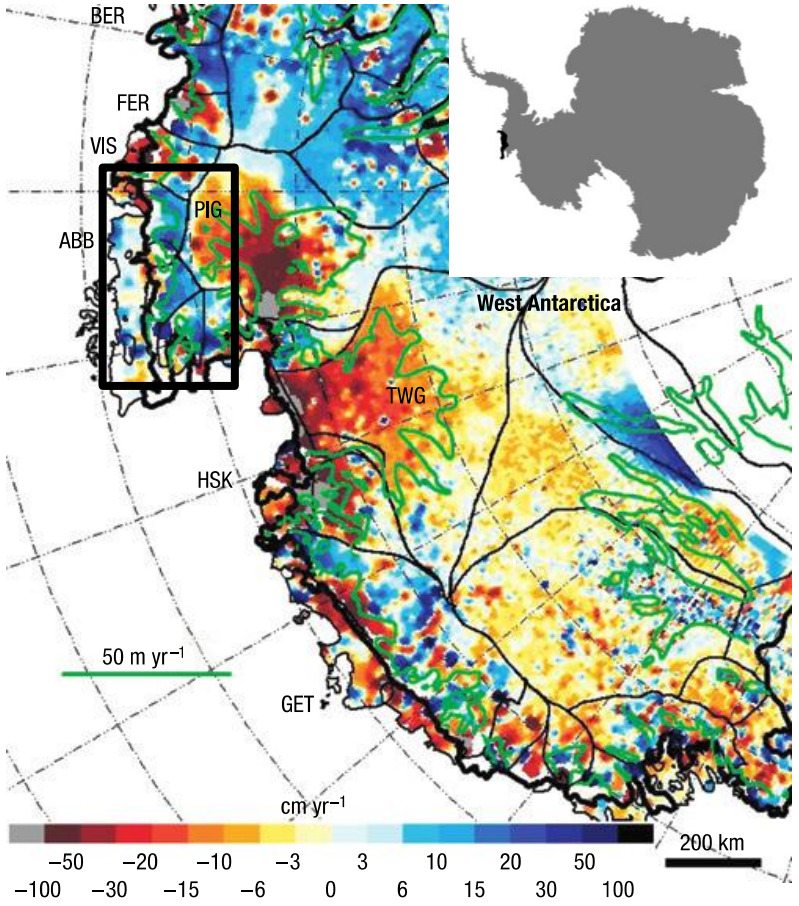
-14 ± 10.6 Gt yr^{-1}

CS2 2006-2008 Mass Balance:

8 ± 6 Gt yr^{-1}

Abbot Sector Reassessment

- Positive elevation rates over the Abbot region up to 2009 (Wouters, 2015; Rignot et al, 2008)
- Reconciles with the positive CS2 IOM mass balance estimate
- Result shows excellent agreement with RATES results, within uncertainty bounds



(Rignot et al, 2008)

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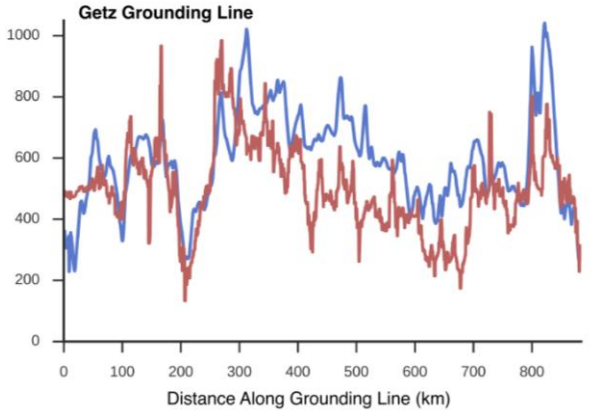
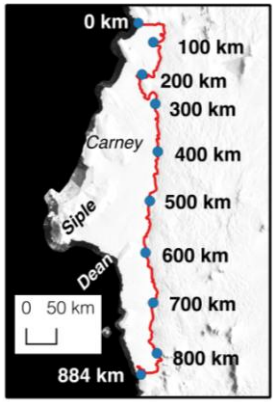
Getz Sector Reassessment

- **48 m** manual adjustment integrating ERS-1 product into BM2
- **80 m** ERS-1 Freeboard bias
- **57 m** underestimation in ice thickness near the GL when compared OIB



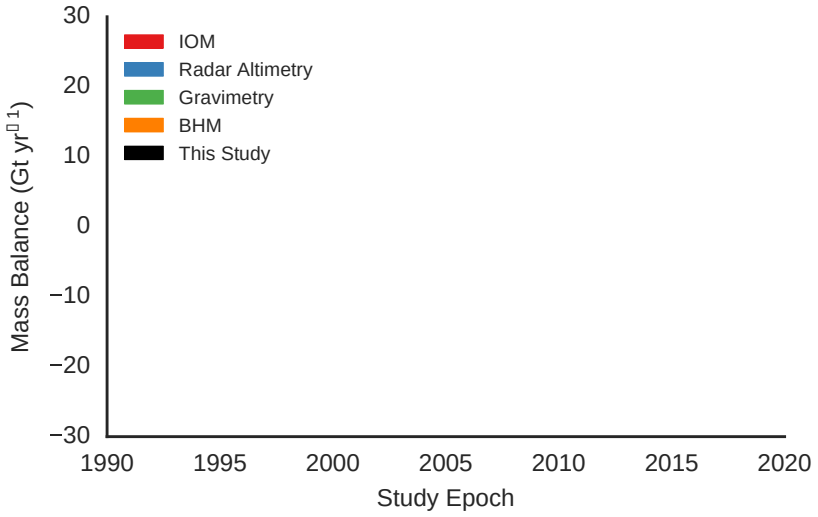


Previous IOM (Rignot, 2008):

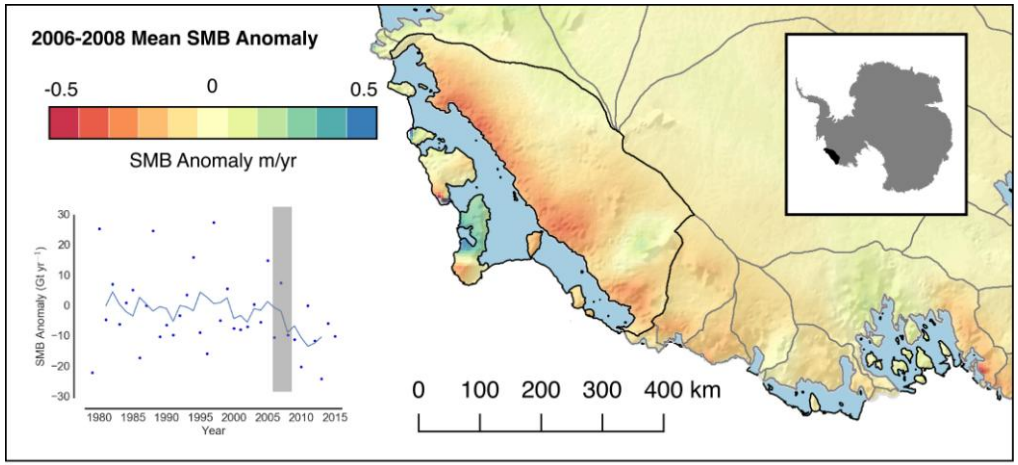
-11 ± 31 Gt yr^{-1}

CS2 2006-2008 IOM:

5 ± 17 Gt yr^{-1}



Getz Basin Dynamics - SMB

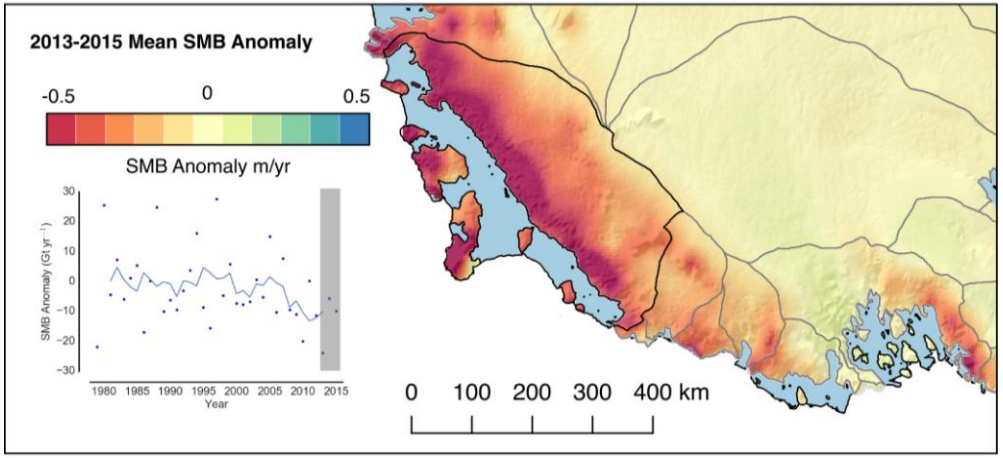


- RACMO 2.3 anomalies
- Compared to a 1979-2005 baseline

-0.33 m yr^{-1} basin mean

-0.80 m yr^{-1} max near GL

Sustained reduction in SMB since 2008



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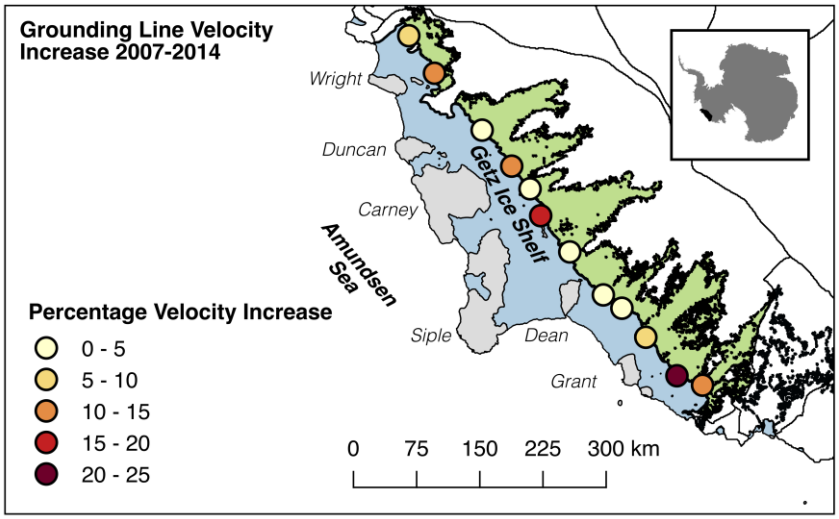
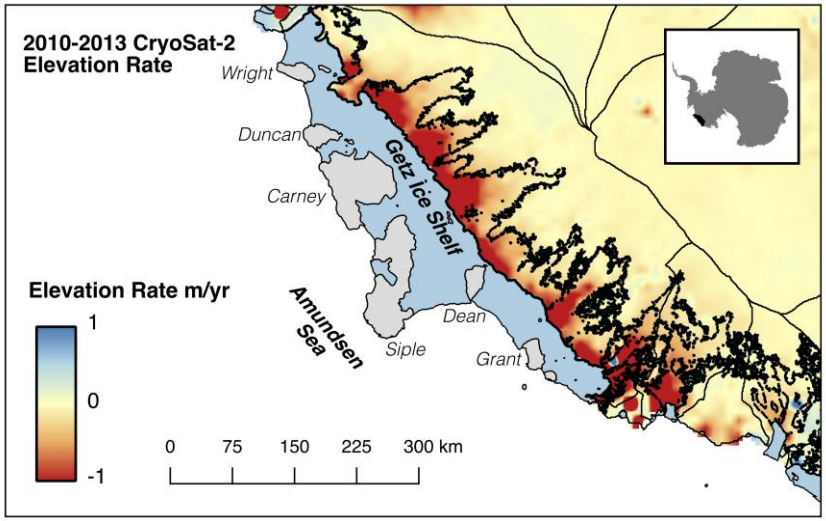
Getz Basin Dynamics – Ice Dynamics

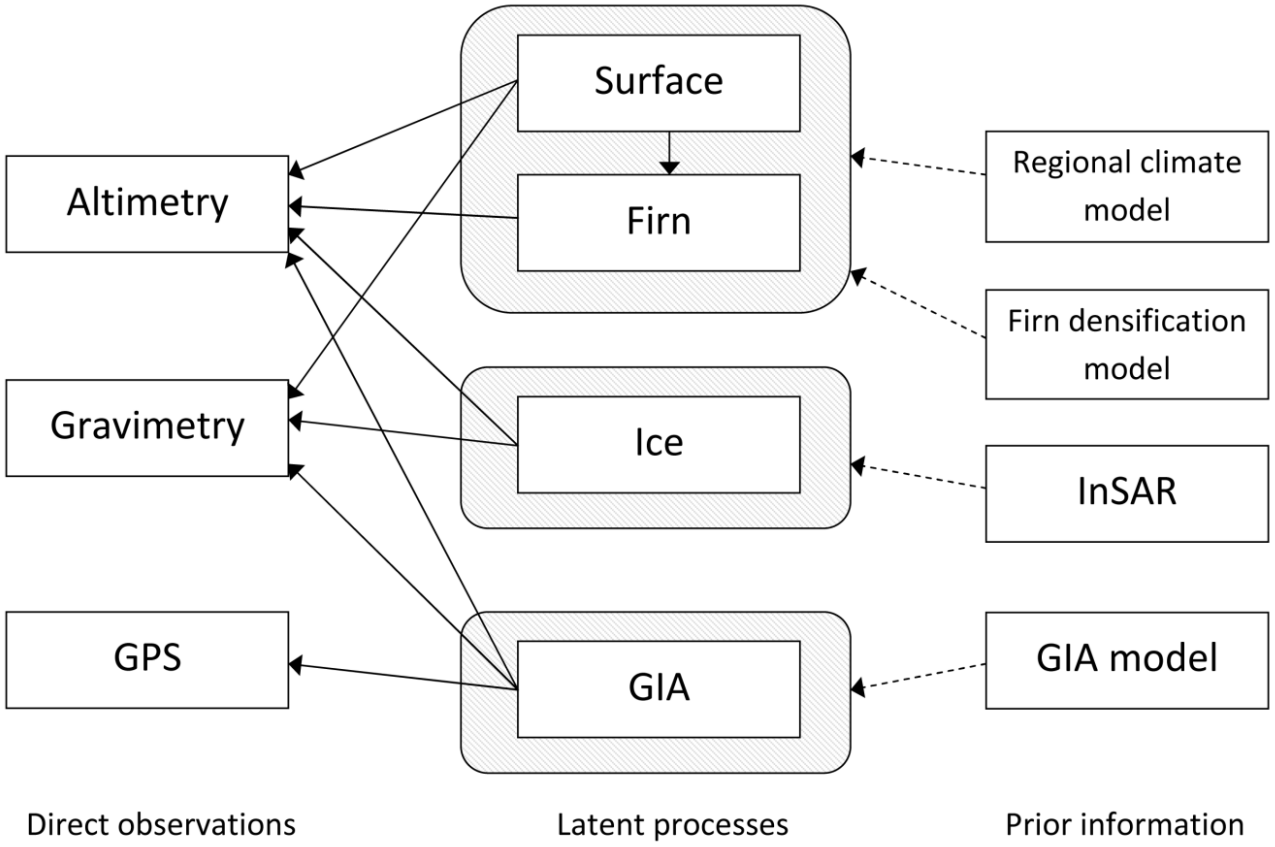


- **-0.67 ± 0.13 m yr^{-1}** $\Delta h/\Delta t$ in fast flow regions (>50 m yr^{-1})
- High likelihood of GL retreat occurring over the region

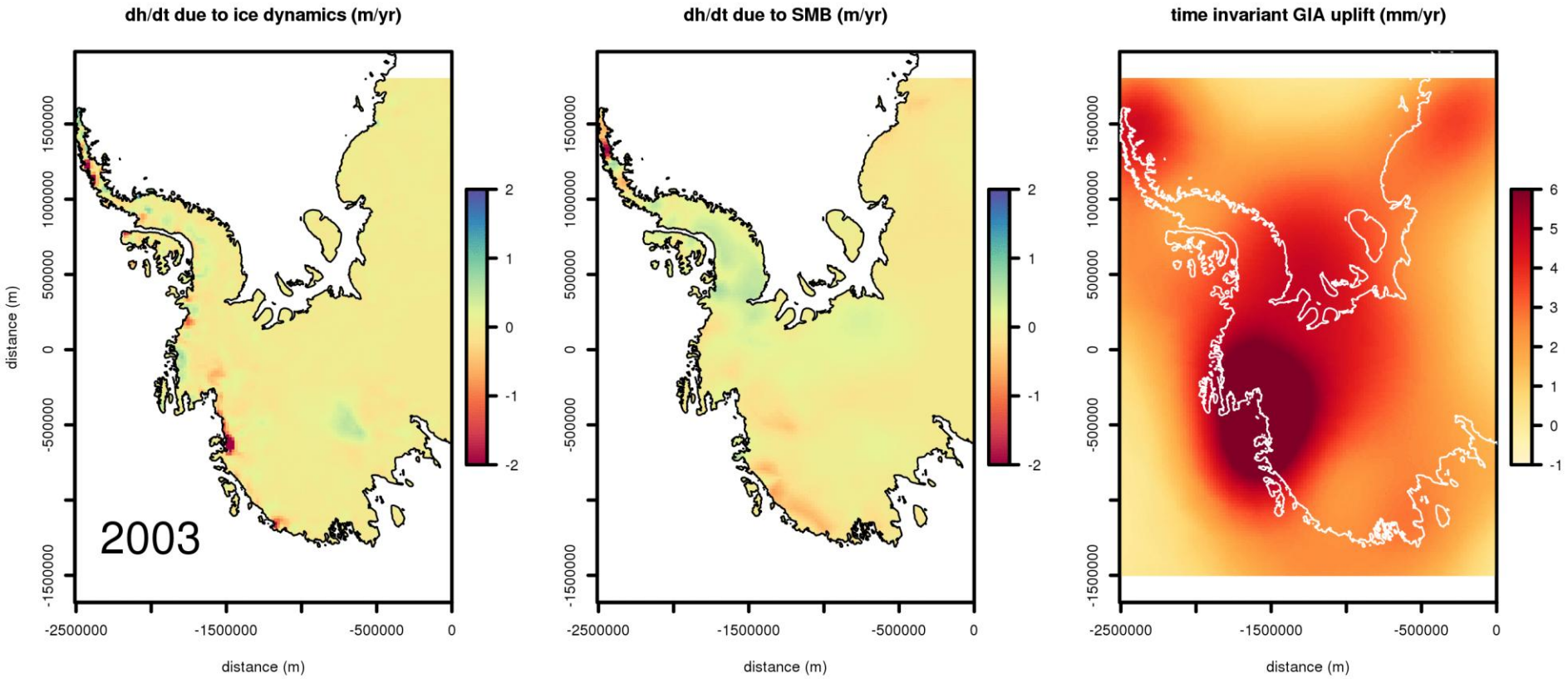
- MEaSUREs 2006-2008 Velocity (Rignot, 2013)
- Landsat-8 2013-2015 feature tracking velocities (Fahnestock, 2015)
- Grounding line velocity increase up to **20%**
- Ice shelf thinning up to 66 m per decade (Paolo, 2015)



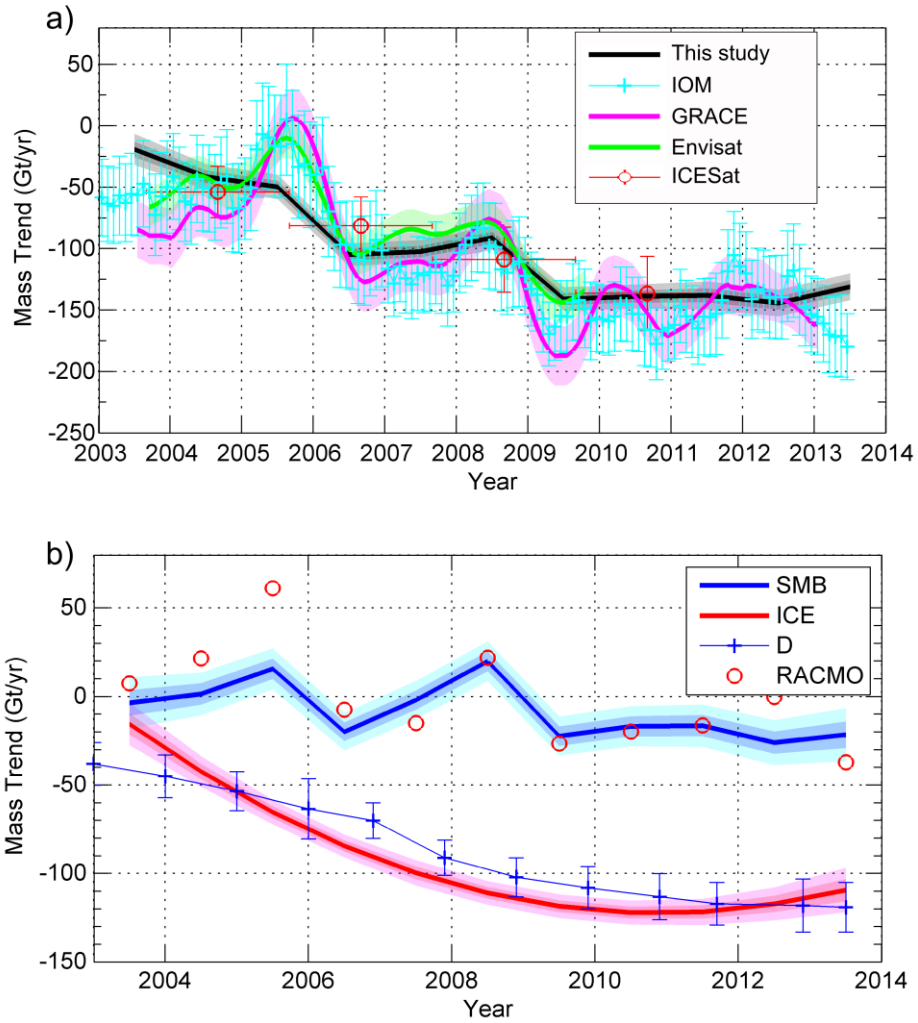
Resolving Antarctic Mass TrEndS (RATES)



(Zammit-Mangion *et al*, 2015)

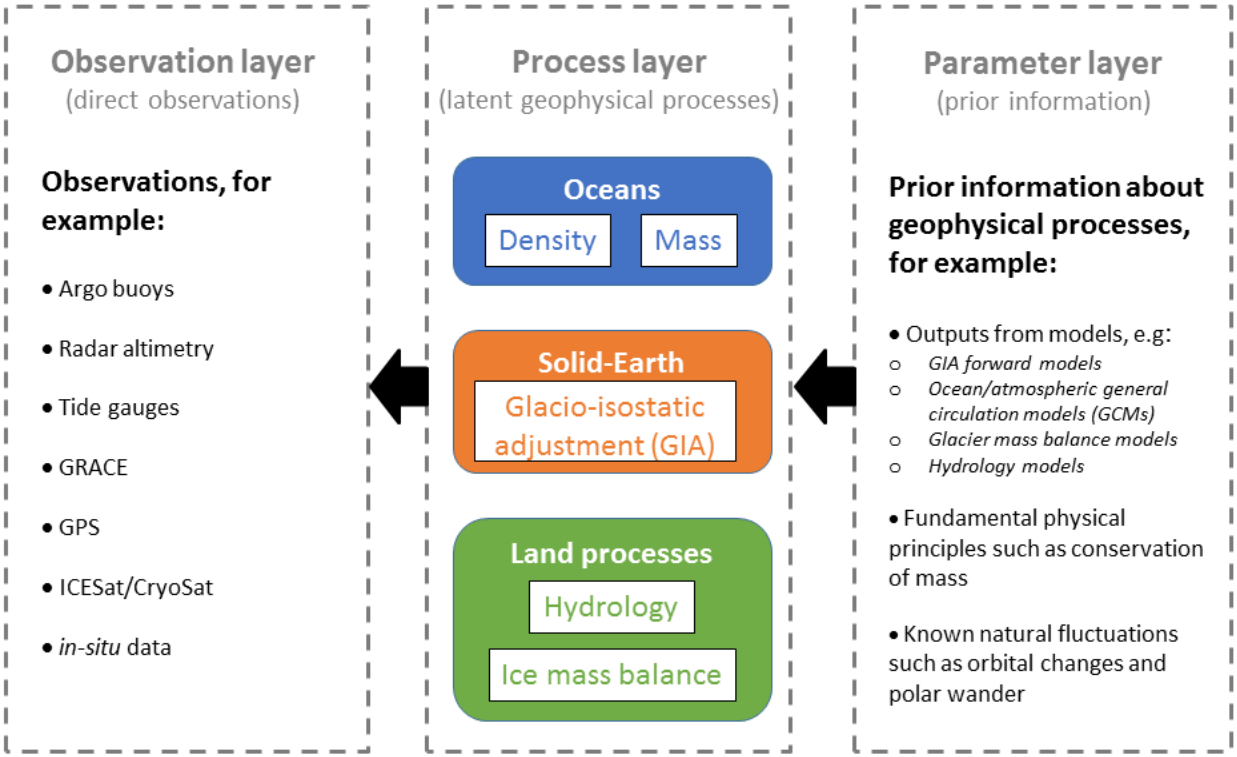


(Martín-Español *et al*, 2016)



(Martín-Español *et al*, 2016)

Sea Level Budget Application – Global Mass



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Conclusions

- CryoSat-2 reconciles inconsistencies for the 2006-2008 period over the Abbot drainage basin
- Previous IOM estimates in this region are likely to be negatively biased due to errors in ice thickness measurements.
- CS2 should allow for better determination of GLF in regions without RES observations - ~30% of the grounding line.
- Mass loss in Getz since 2006-2008 driven by surface processes, ice dynamics and likely grounding line retreat.
- Modeled Firn Air Content correction still an issue – Mass balance inter-comparisons and new approaches (e.g RATES) necessary.

Thanks for listening!


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