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Yara Mohajerani¹, Enrico Ciraci¹, Tyler Sutterley³,

COLLABORATION:

David Wiese² and JPL team, Minkang Cheng⁴

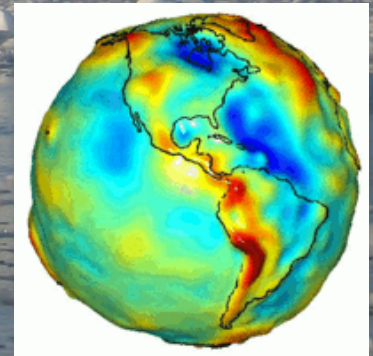
1 -- University of California Irvine, Irvine, California, USA;

2 -- Jet Propulsion Laboratory-NASA, USA.

3-- GSFC-NASA, USA.

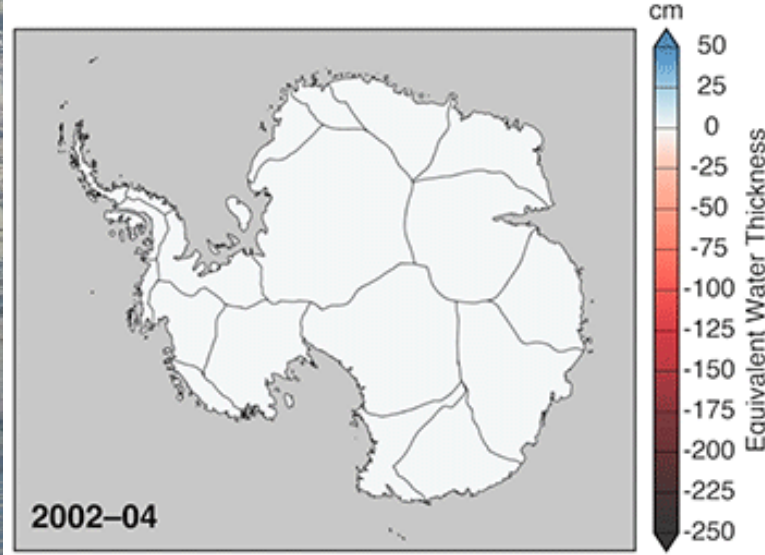
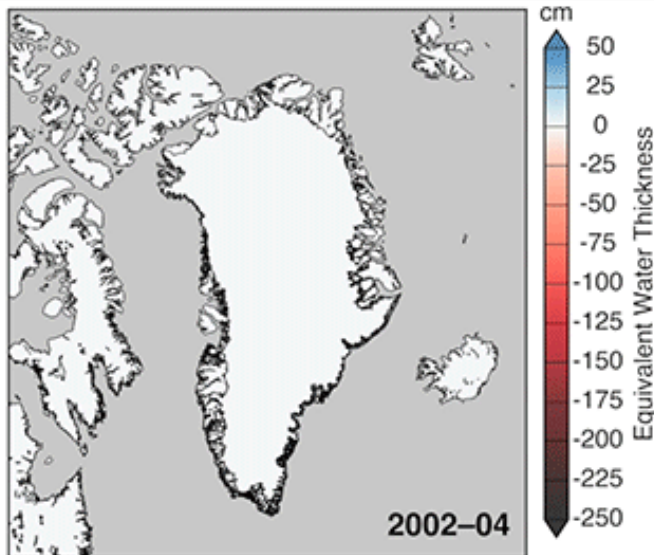
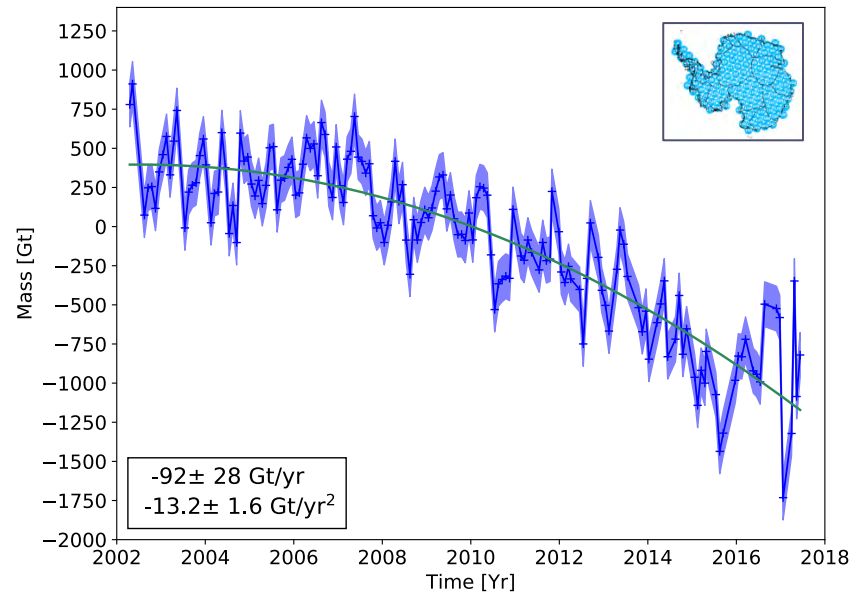
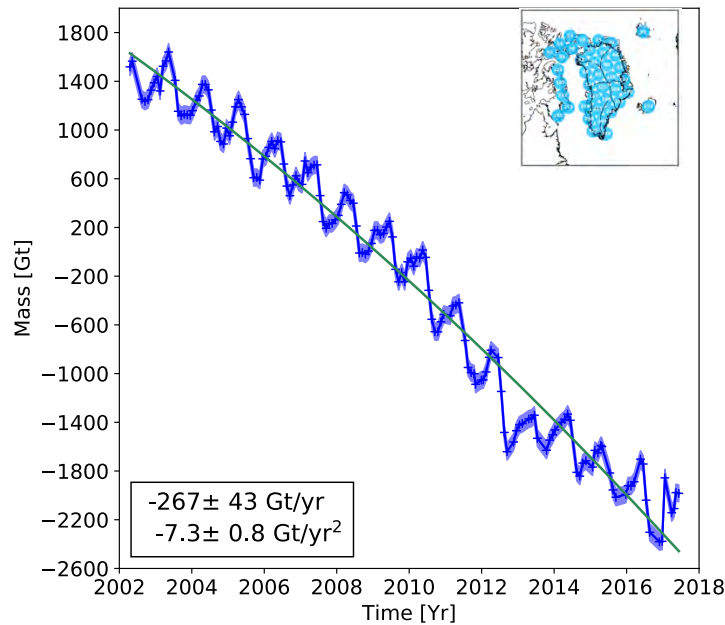
4- CSR, UT, USA.

- Comparison with SMB from RCM and GCM
- Solutions inter-comparison (eg)
- Evaluating 2016-2017 solutions
- Using C3,0 from SLR



Update on the state of the Cryosphere with GRACE

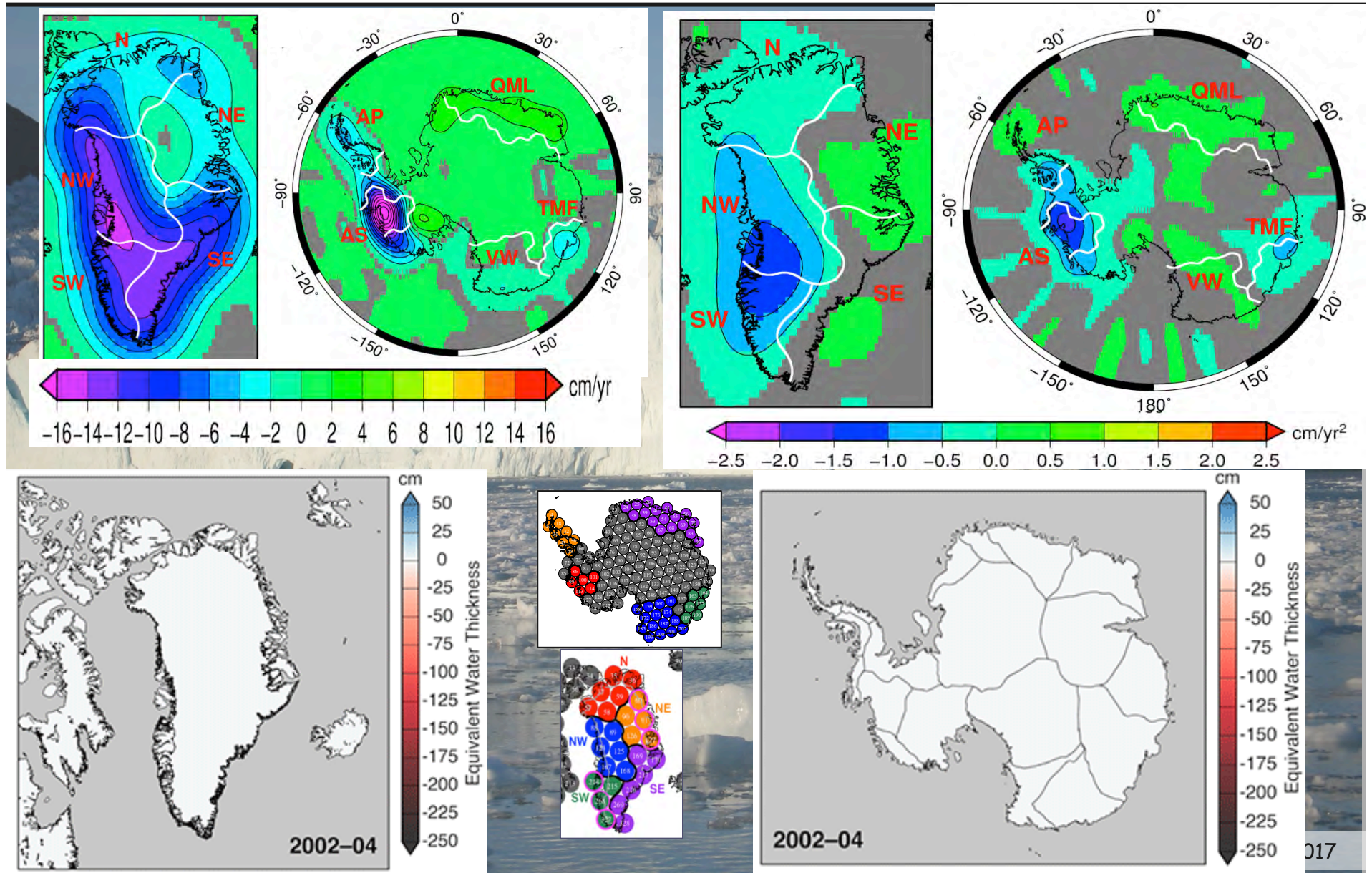
Ice sheet mass balance using GRACE data: 2002-2017



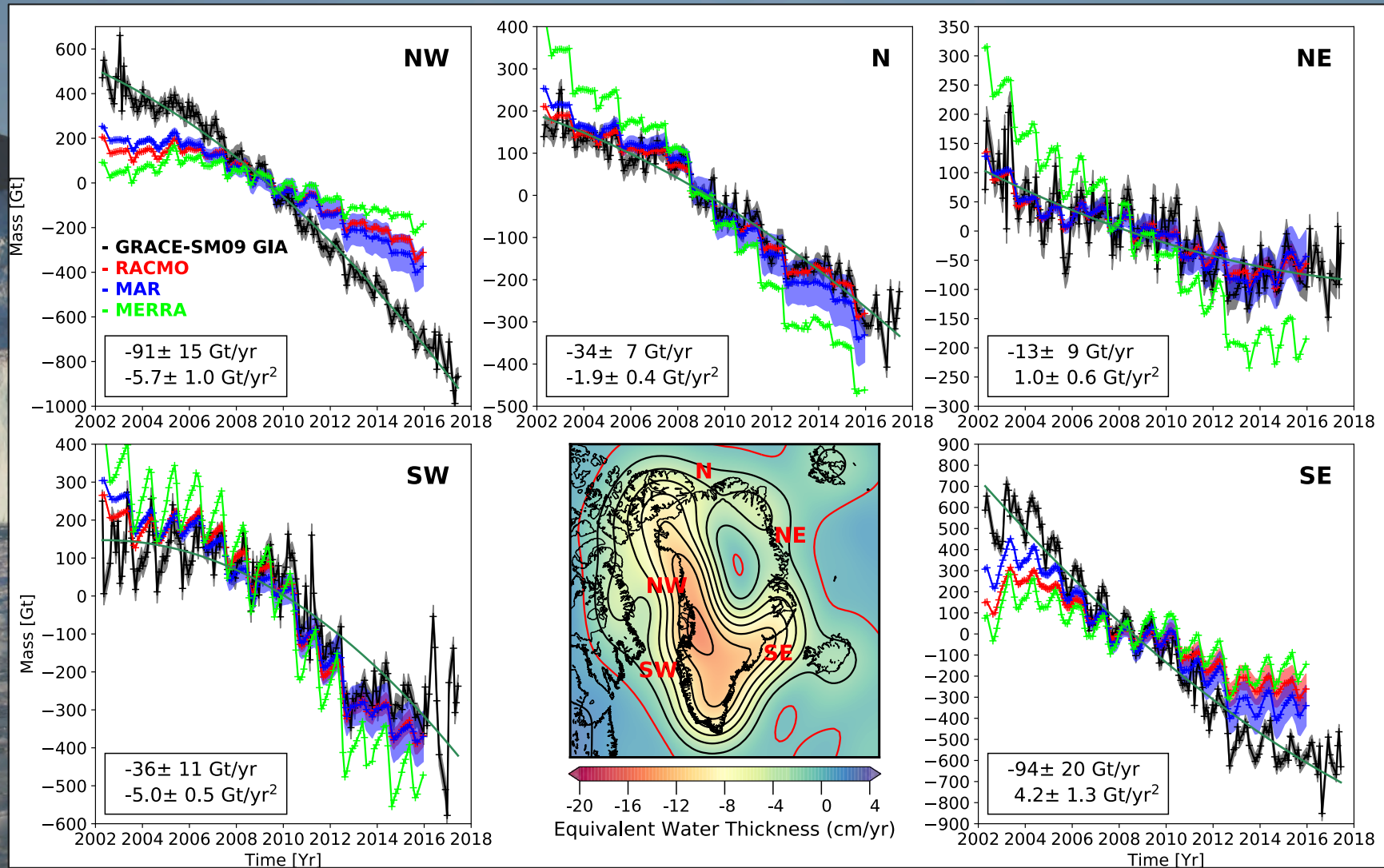
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Update on the state of the Cryosphere with GRACE

Ice mass trend and acceleration (2002-2017)



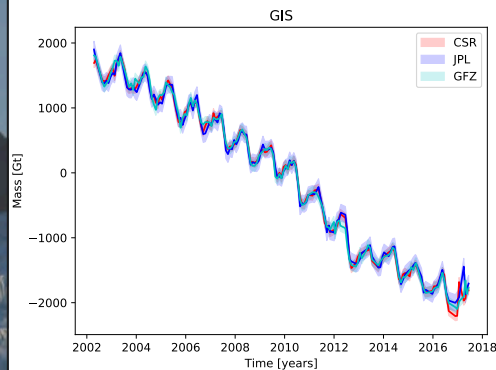
Evaluation of climate models: Greenland



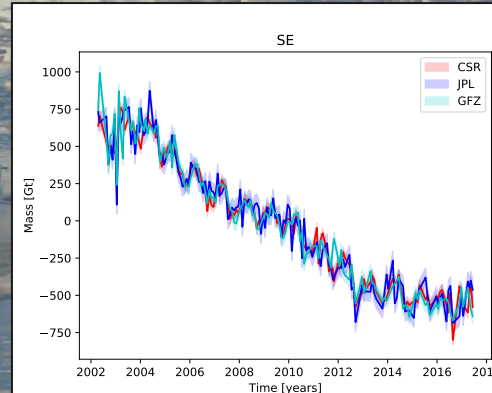
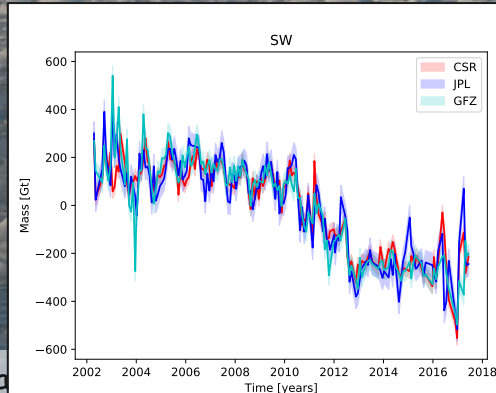
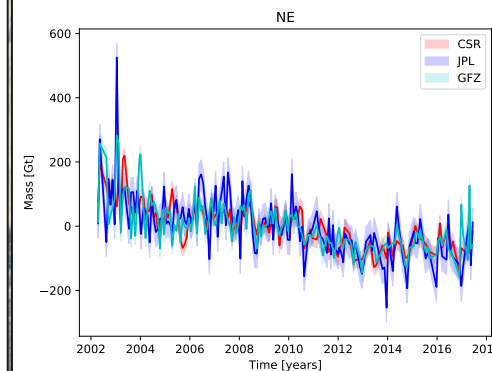
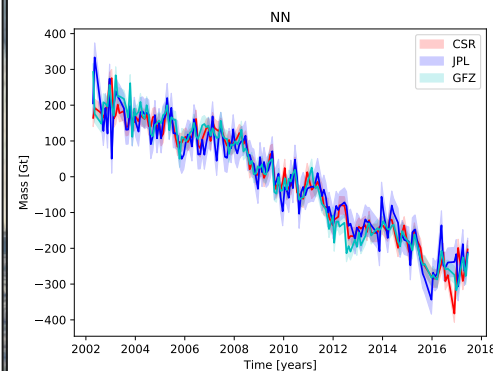
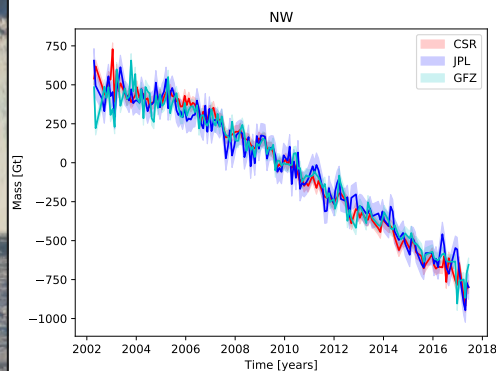
Velicogna et al., GRL, 2014, updated.

Update on the state of the Cryosphere with GRACE

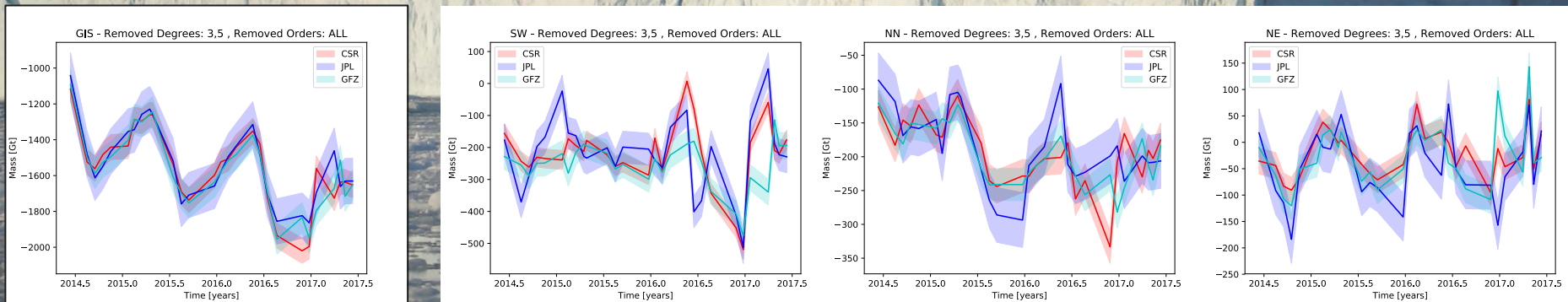
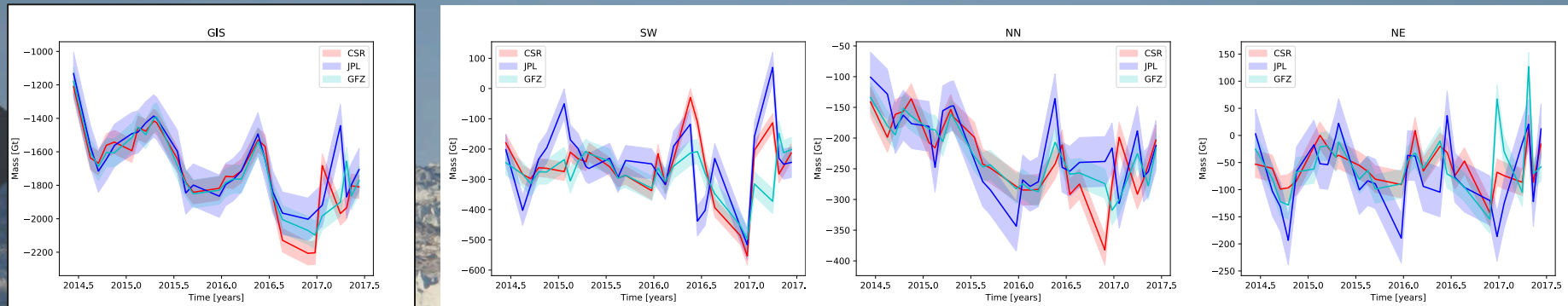
Comparison GFZ-CSR-JPL harmonics



- JPL and GFZ time series are noisier
- Differences in the 2016/2017 time series
- Trends agree within error
- Months 179-186 do not affect significantly trends, spurious picks, may have a larger impact on the acceleration



GFZ-CSR-JPL harmonics: 150-186, Impact of C_{30} - C_{50}

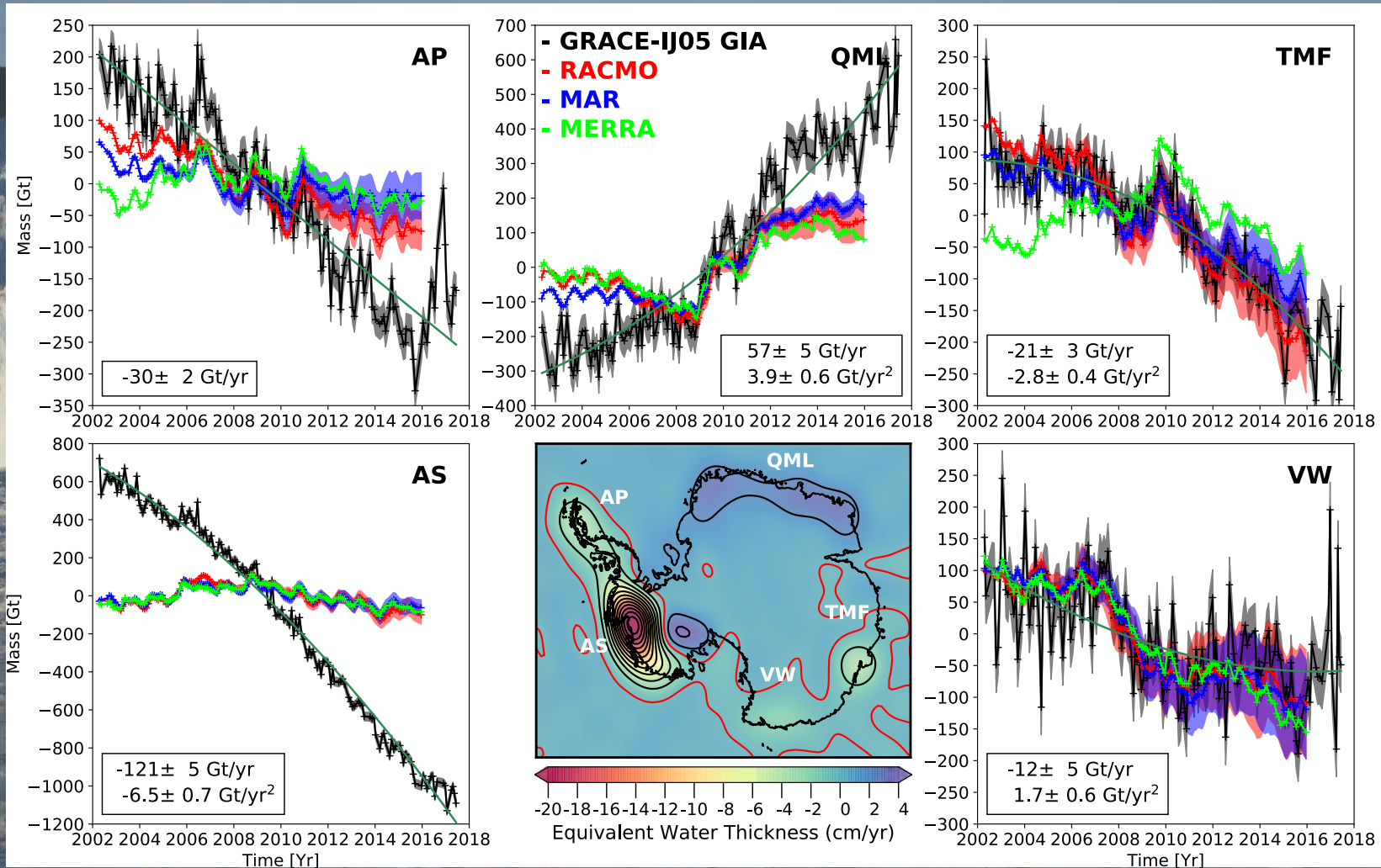


mid-2016 - 2017

- $C_{3,0}/C_{5,0}$ do not explain most of the differences
- Error impact all coefficients (not only zonal)

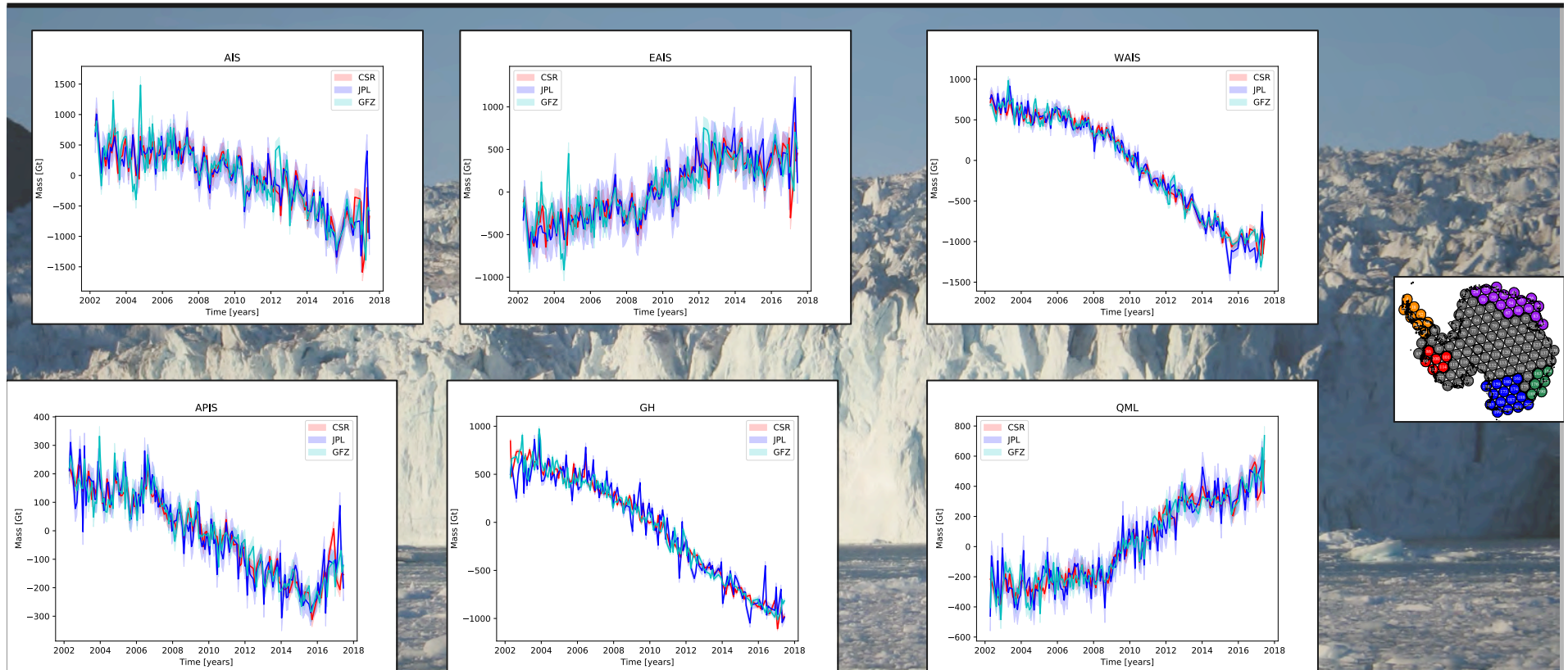
Update on the state of the Cryosphere with GRACE

Evaluation of climate models: Antarctica



Update on the state of the Cryosphere with GRACE

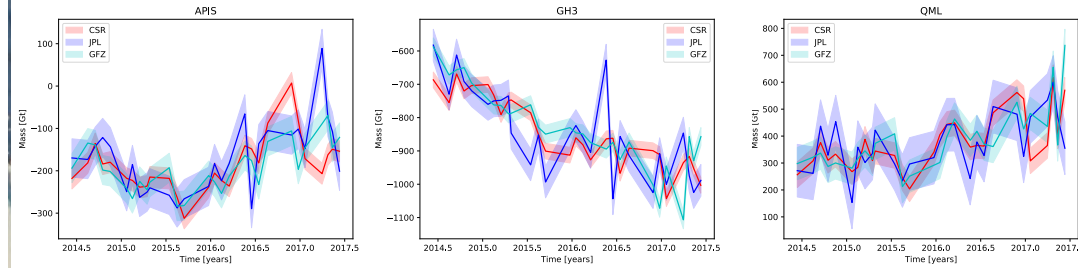
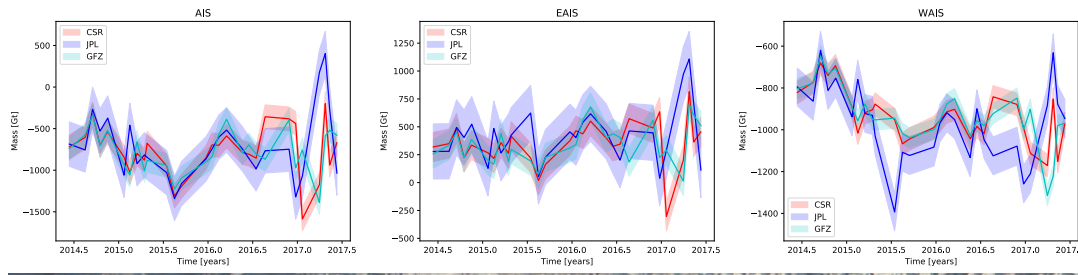
Comparison of GFZ-CSR-JPL harmonics



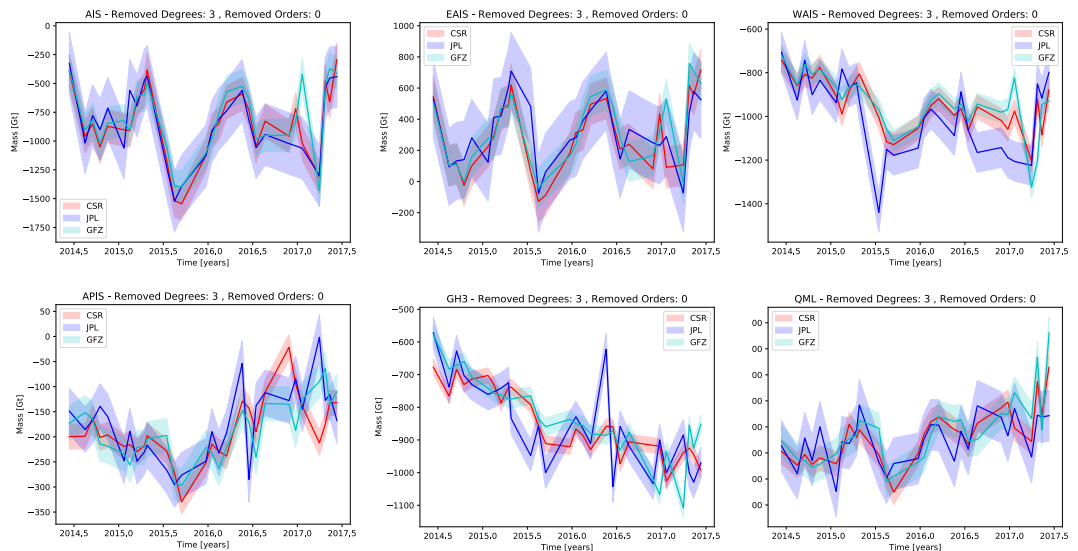
- JPL and GFZ time series are noisier
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Update on the state of the Cryosphere with GRACE

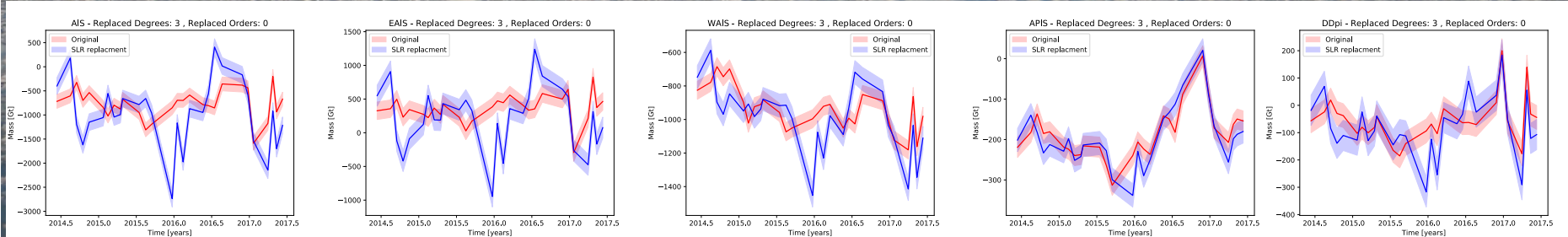
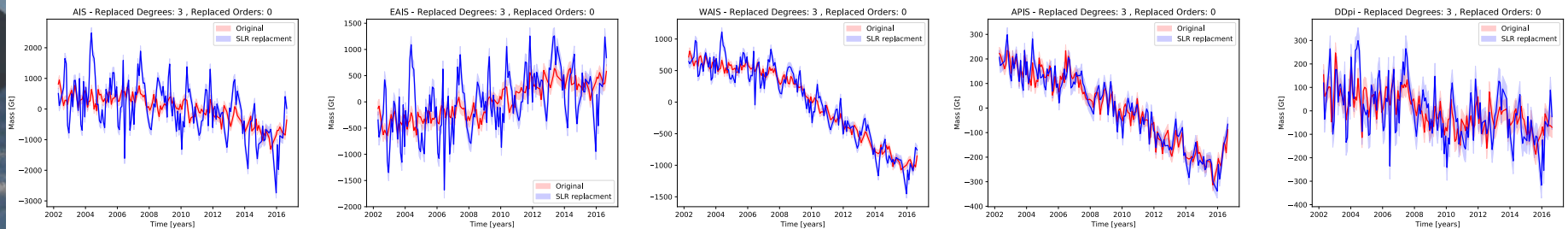
Comparison of GFZ-CSR-JPL harmonics: 150-186, Impact of C_{30}

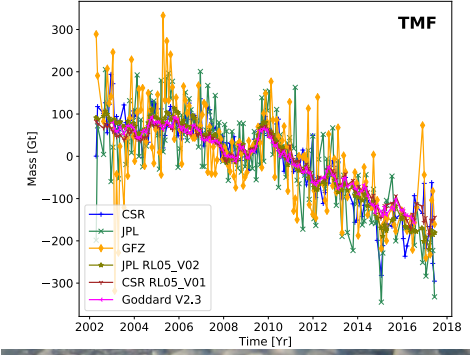
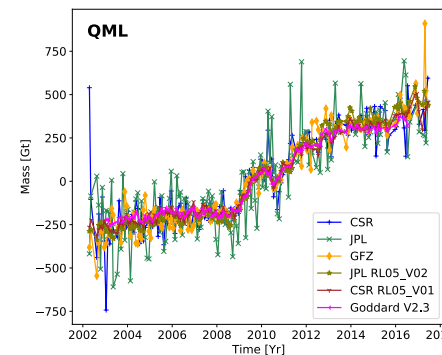
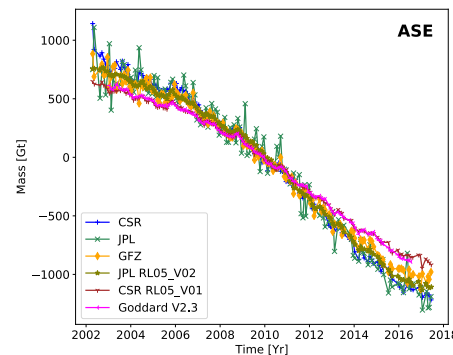
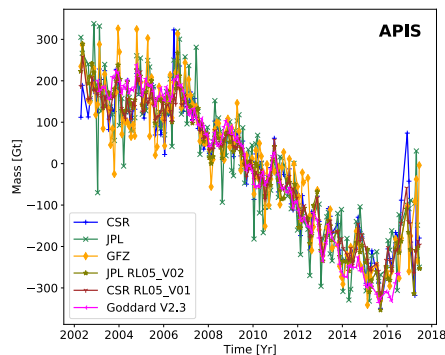
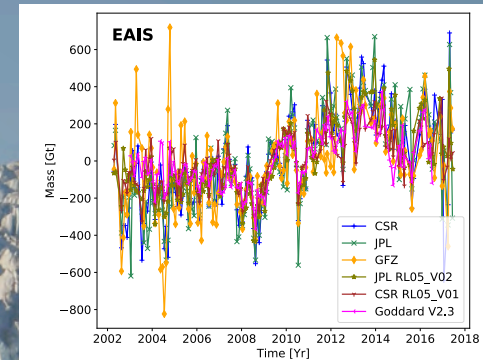
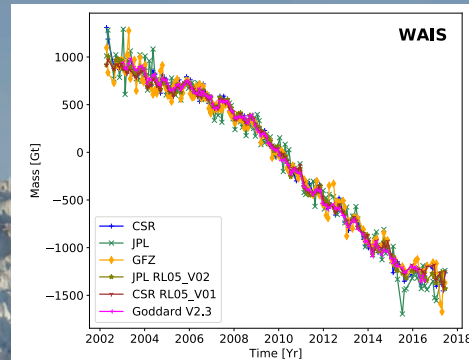
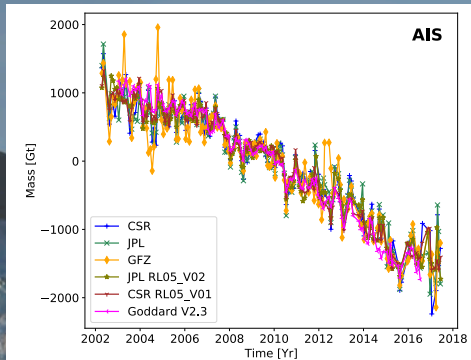


mid-2016 - 2017
- $C_{3,0}$ account for large portion of the differences after Nov 2016



Replacing GRACE C_{30} with C_{30} from SLR

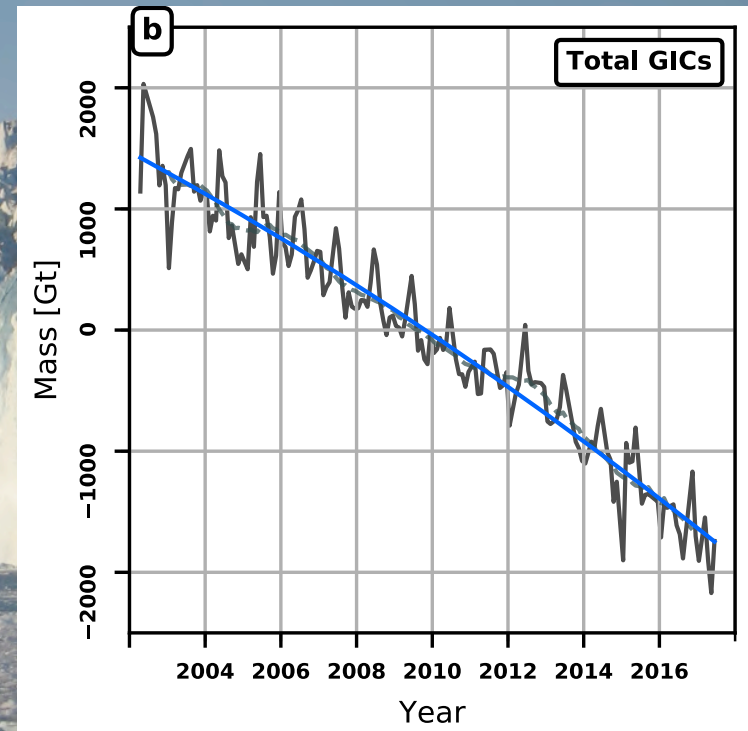
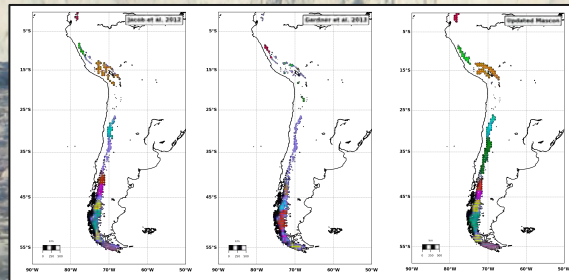
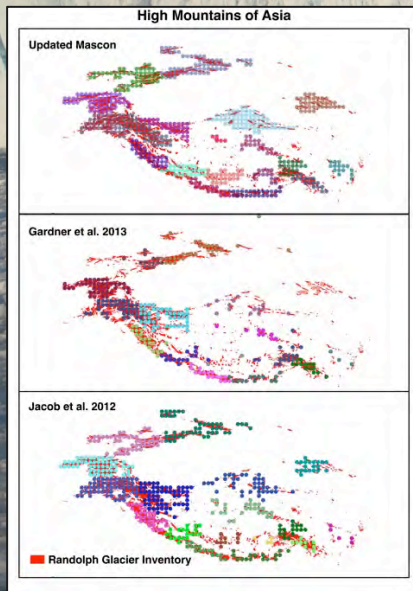
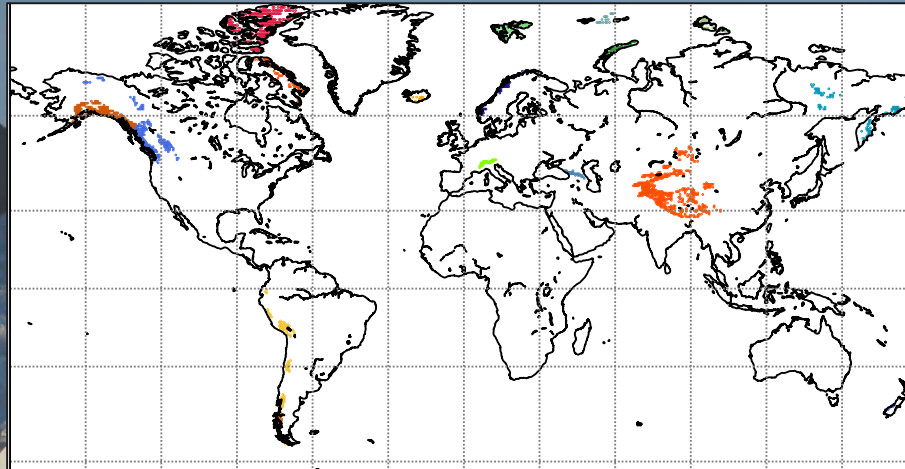




- Comparison on the JPL mascon Grid
- Good agreement in trend and acceleration between CSR- harmonics mascon and JPL 3-deg mascon
- CSR 1-deg mascons appear to underestimate the mass loss → need to account coast line and mascon location
- Goddard mascons show smaller trend in a few regions

Update on the state of the Cryosphere with GRACE

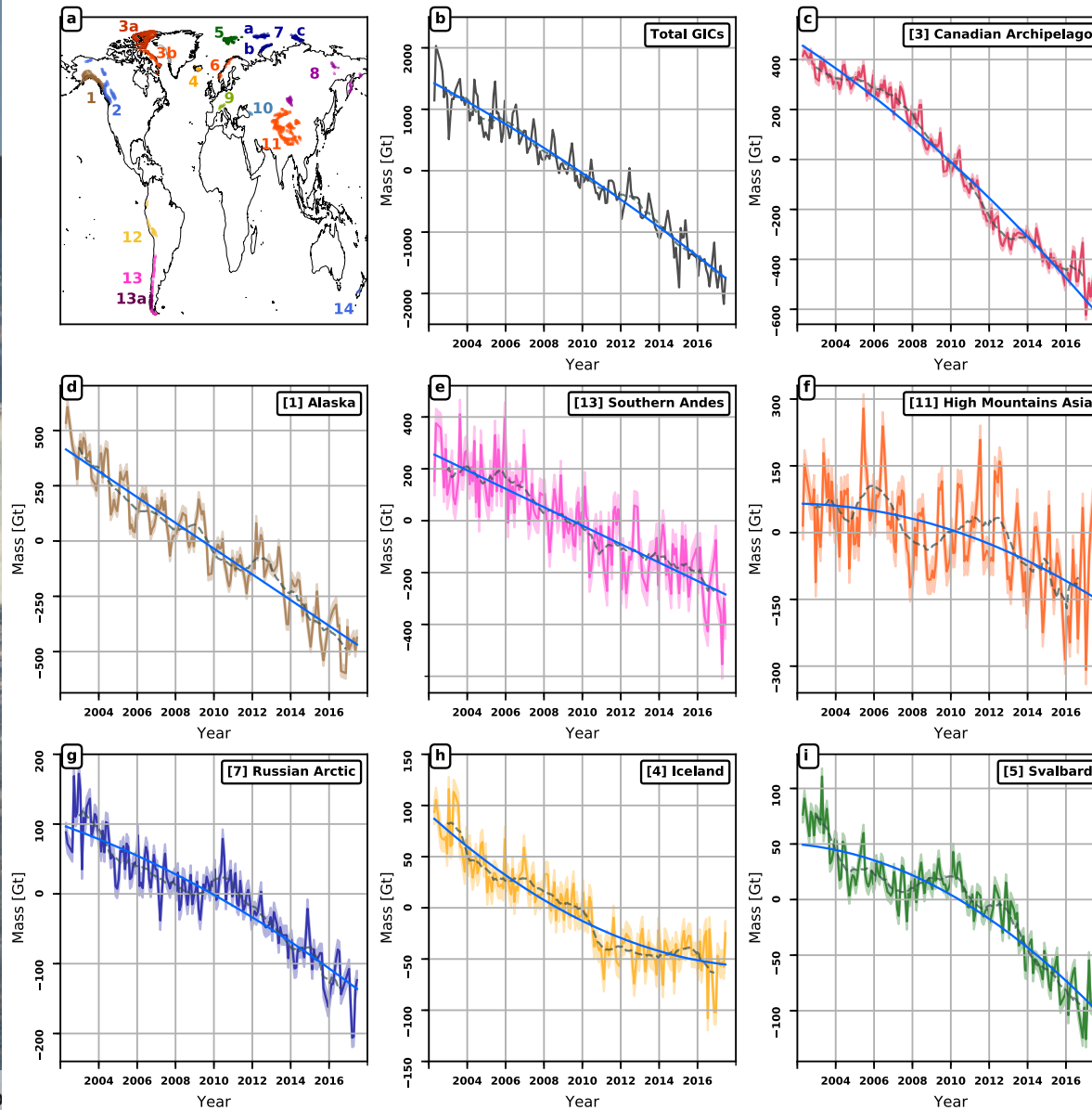
Glaciers and Ice Caps (GIC): End of a difficult problem



Ciraci' et al. in review, 2017
Jacob et al., 2012
Gardner et al. 2013

Update on the state of the Cryosphere with GRACE

GIC mass balance: 2002-2017



99% of the mass loss is from 7 regions representing 94% of the total area, 76% from the Arctic (65% in area).

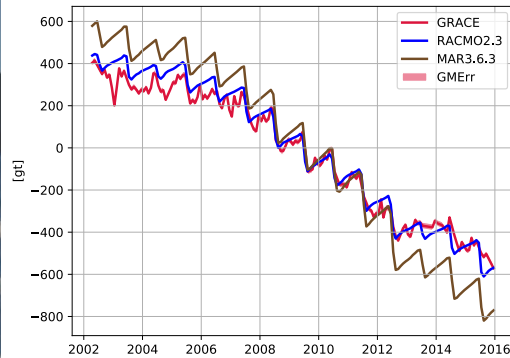
Ciraci' et al., in review 2017

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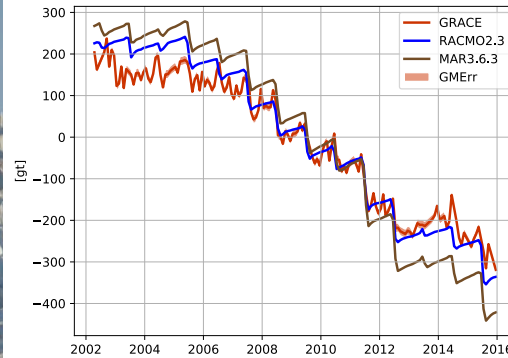
Update on the state of the Cryosphere with GRACE

GIC mass balance: Comparison with surface mass balance

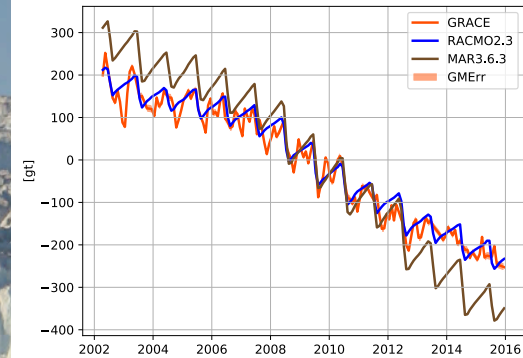
Canadian Archipelago



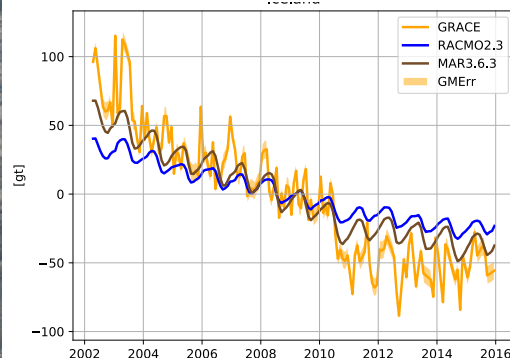
Canadian Archipelago- North



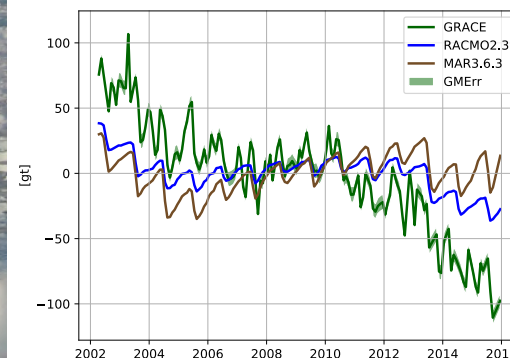
Canadian Archipelago- South



Iceland



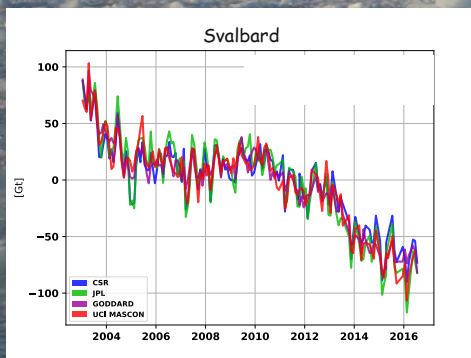
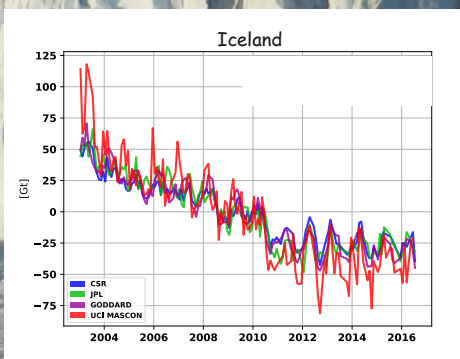
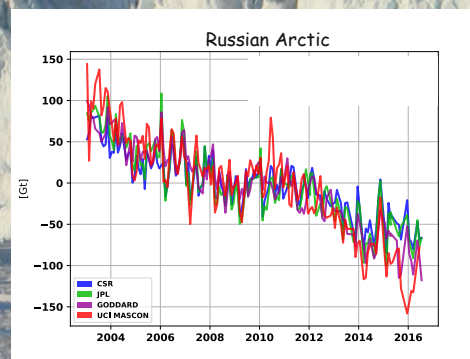
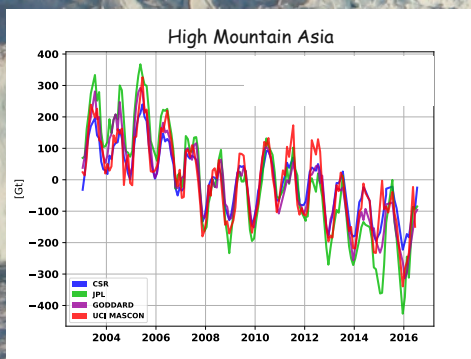
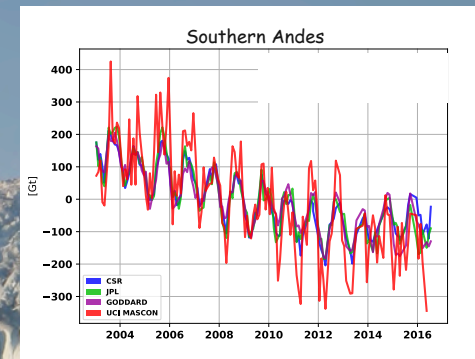
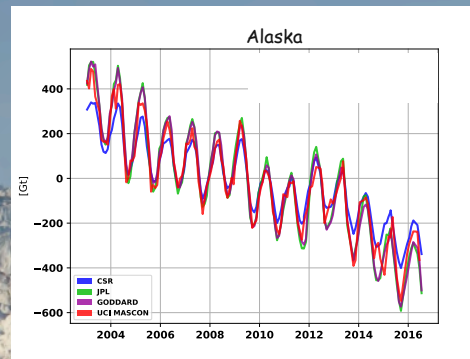
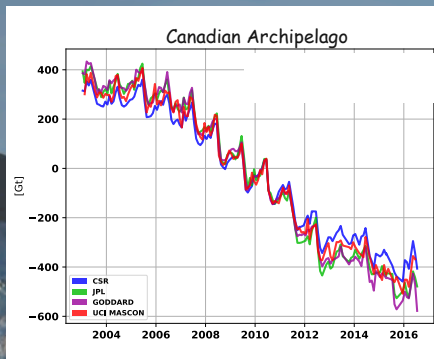
Svalbard



Update on the state of the Cryosphere with GRACE

Comparison of CSR harmonics mascon and JPL-CSR-Goddard mascons

Months 13-175



- Overall trends agree within error
- Good agreement between CSR mascon solutions from harmonics and JPL mascon solution

Update on the state of the Cryosphere with GRACE

Conclusions

- In Antarctica (AIS) and Greenland (GIS) GRACE data can be used to evaluate SMB from regional and global climate model.
- JPL and GFZ solutions are noisier than CSR harmonics solutions.
- Largest differences between mass balance times series from harmonics solution after mid-2016
- Including months after Nov 2016 generally does not impact ice sheet and glacier mass balance estimates trends, but caution should be used in interpreting annual signal and accelerations using these months.
- In Greenland and for the GIC $C_{3,0}/C_{5,0}$ coefficients do not account for much of the difference between the solutions after Nov 2016, in Antarctica $C_{3,0}$ component account for a large portion of the difference. Replacing C_{30} with SLR coefficients is not recommended at this time
- Overall good agreement between different mascon solutions and CSR harmonics based mascon solutions. Need to compare consistently
- Monthly solutions after Mid 2016 should be evaluated using independent datasets.

