



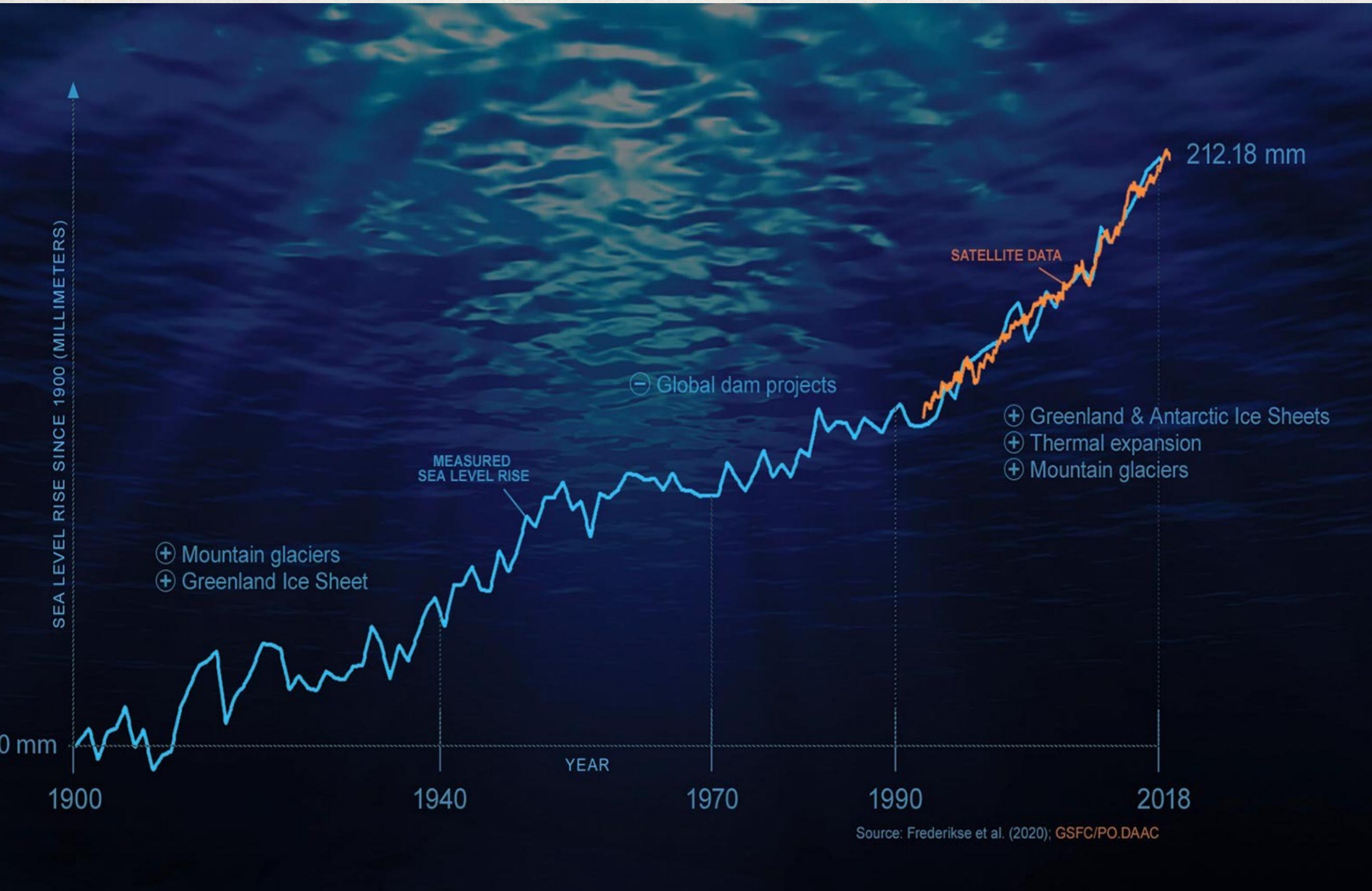
An initial investigation of multi-sensor coastal zone altimetry

Brett Buzzanga, Ben Hamlington

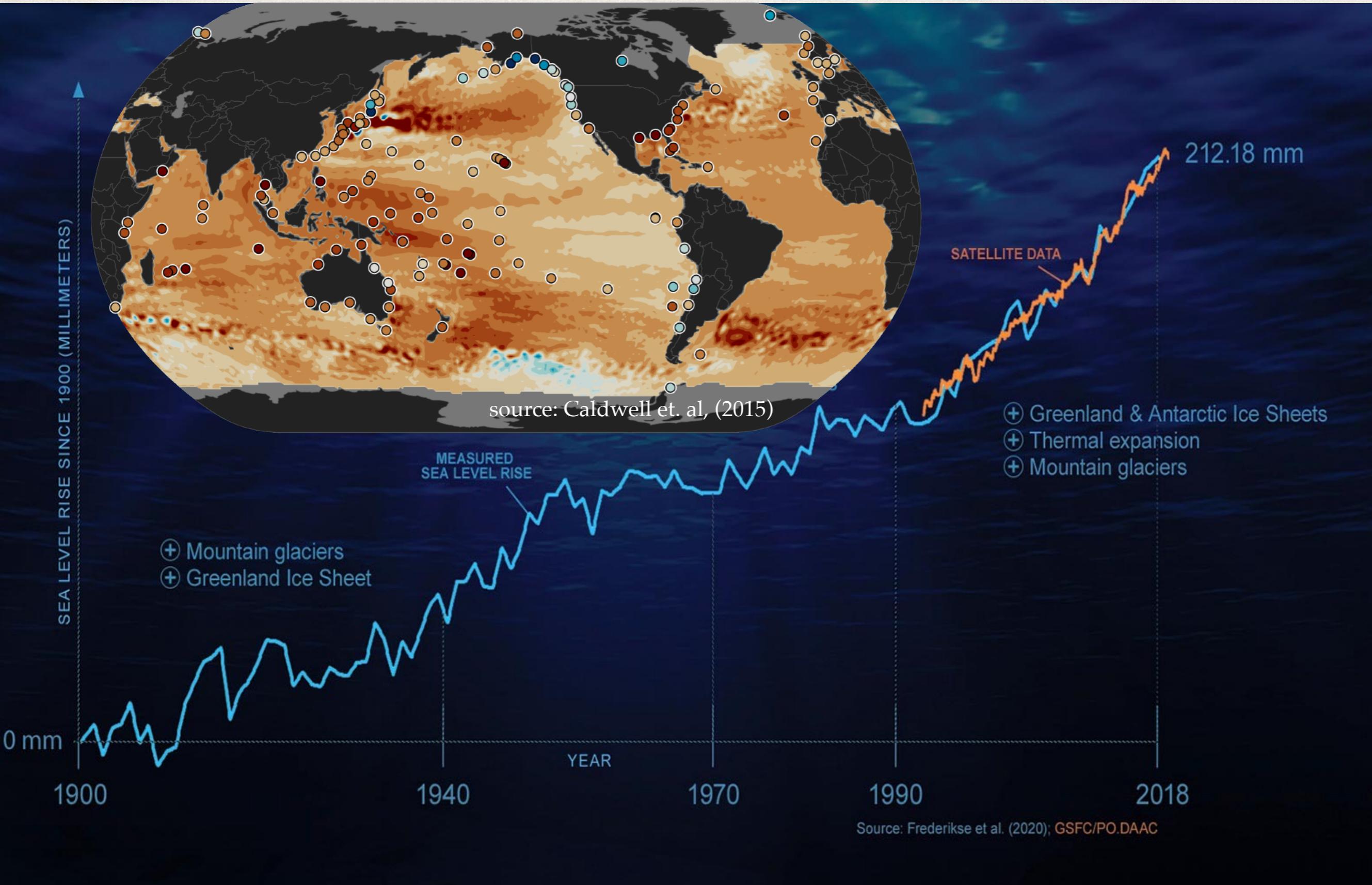
October, 2022

✉ buzzanga@jpl.nasa.gov

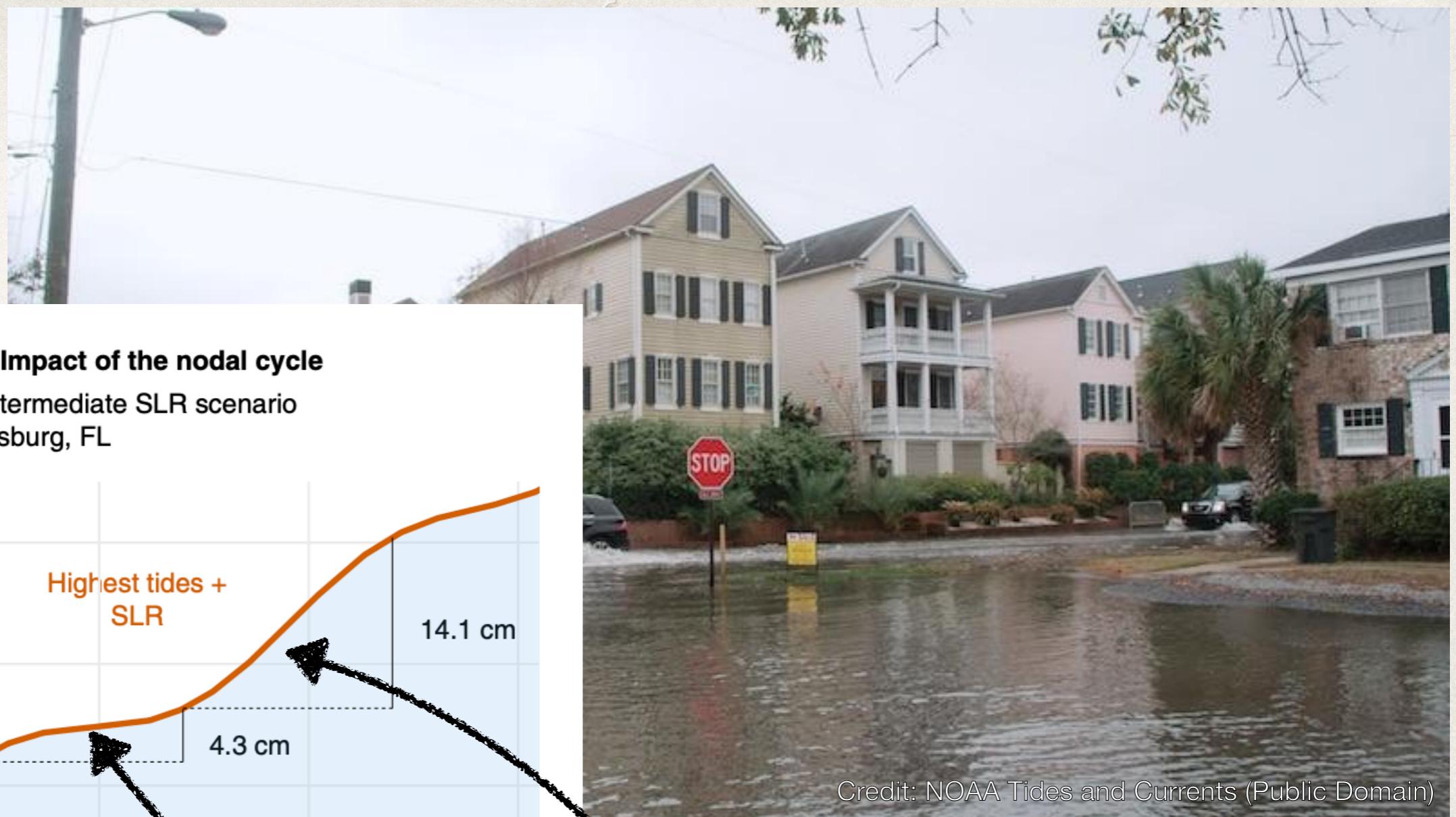
🐦 [@brettbuzz](https://twitter.com/brettbuzz)



Global sea-level rise: $\sim 3.3 \pm 0.4$ mm/yr (1993-Present)



Global sea-level rise: $\sim 3.3 \pm 0.4$ mm/yr (1993-Present)



Credit: NOAA Tides and Currents (Public Domain)

Rapid sea-level rise

~Stable sea level



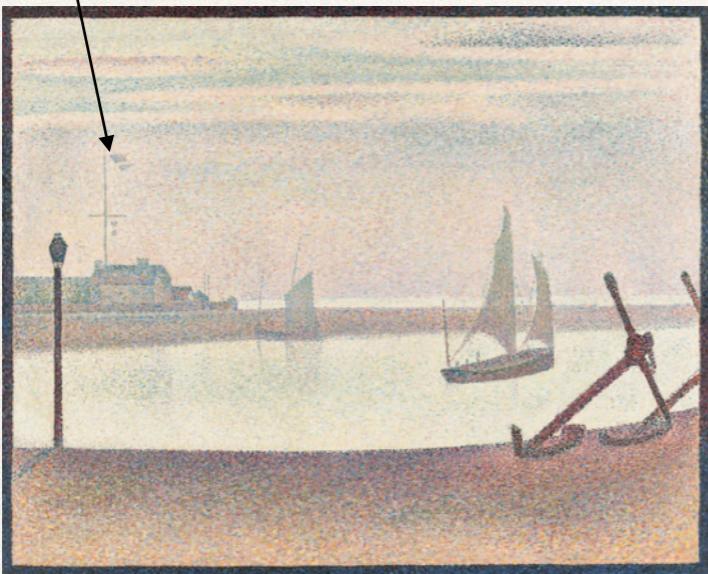
Credit: NASA-JPL/Caltech/NOAA

- ♦ Satellite radar altimetry

- ♦ ~300 km between ground tracks

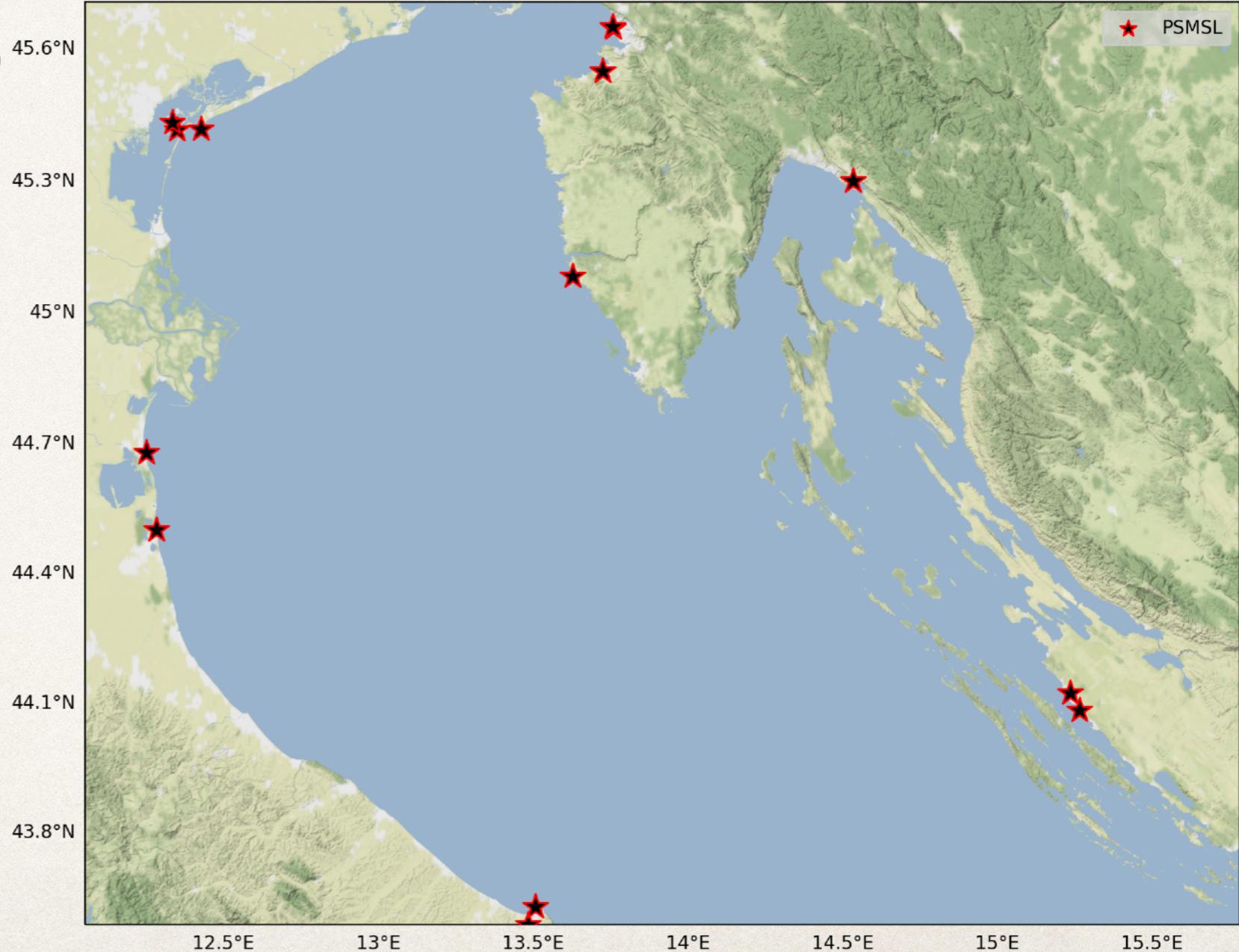
- ♦ Land contaminates coastal retrievals (< ~25 km)

Tide Gauges (~1900 - pres)



The Channel at Gravelines, Evening summer 1890

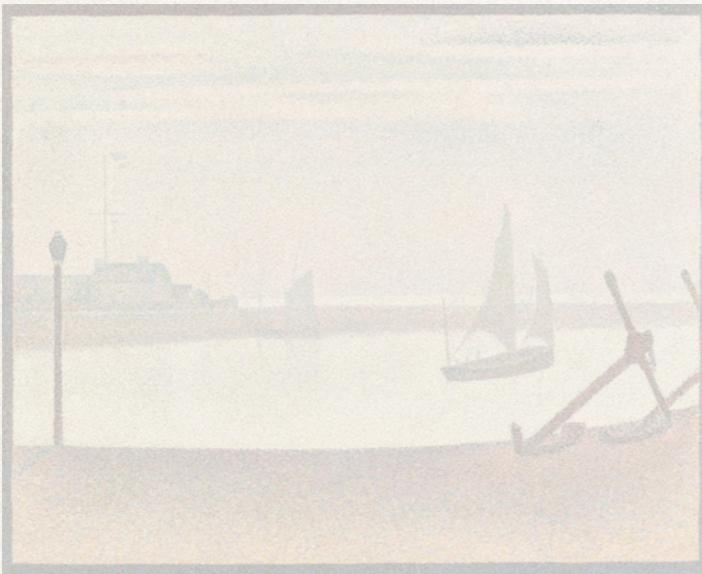
Claude Monet





- ❖ Satellite radar altimetry
 - ❖ ~300 km between ground tracks
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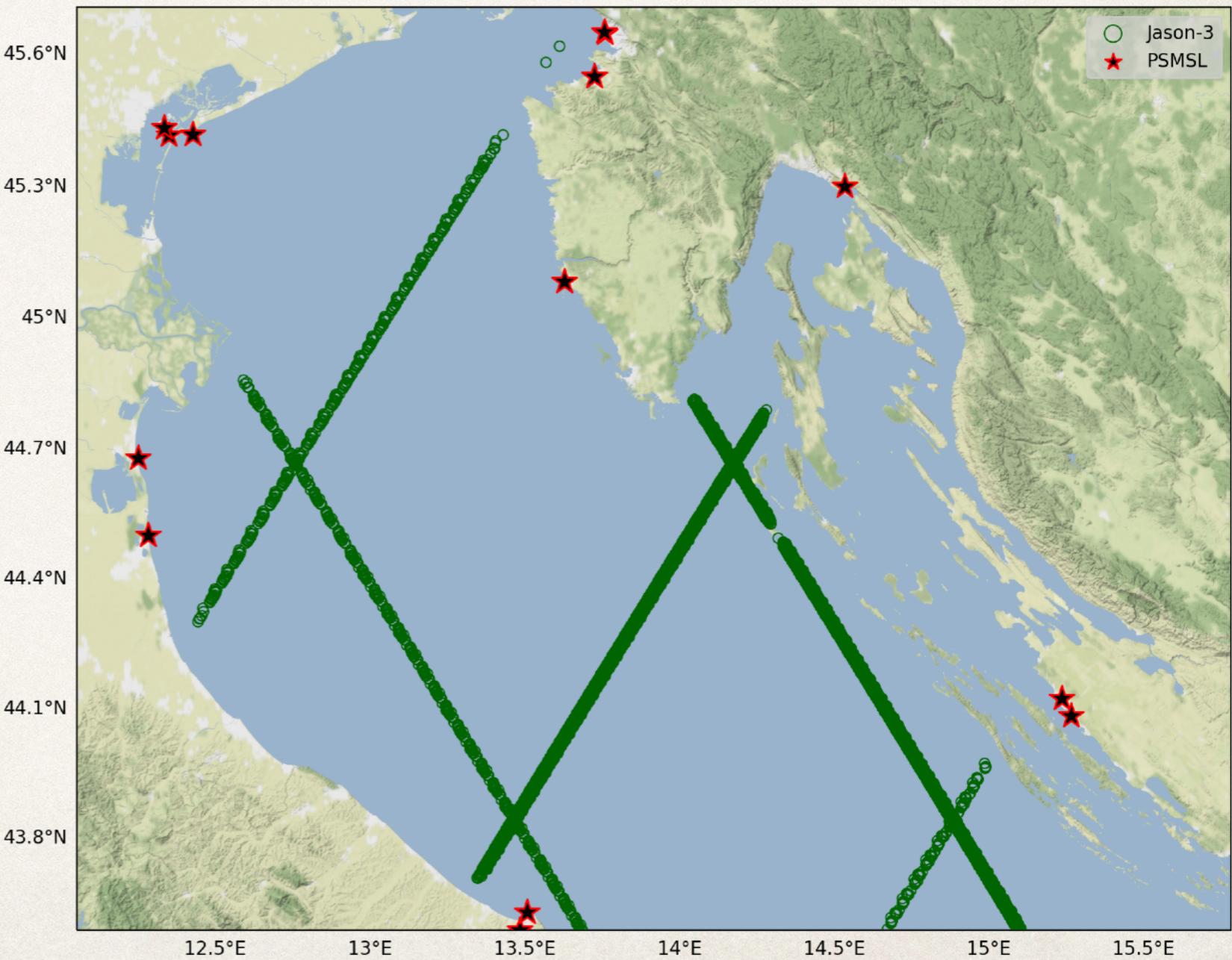
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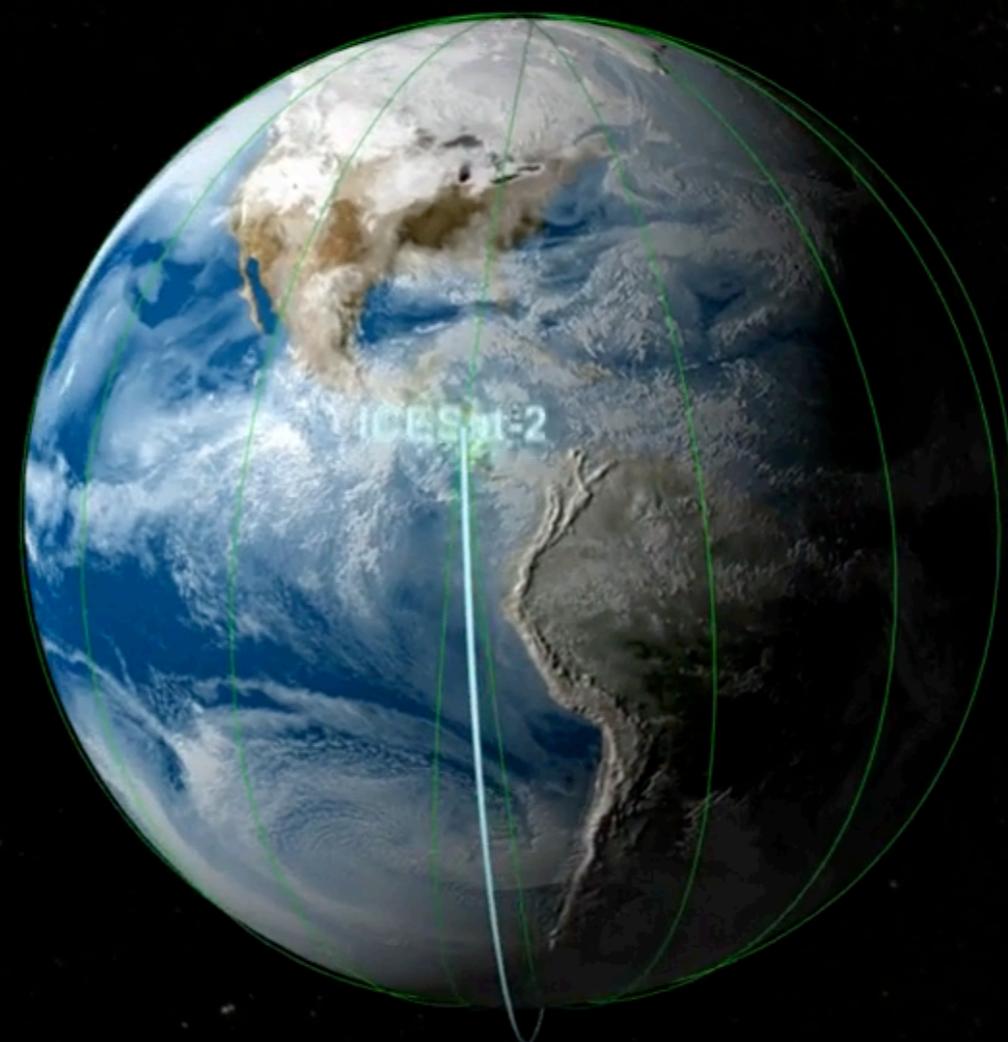


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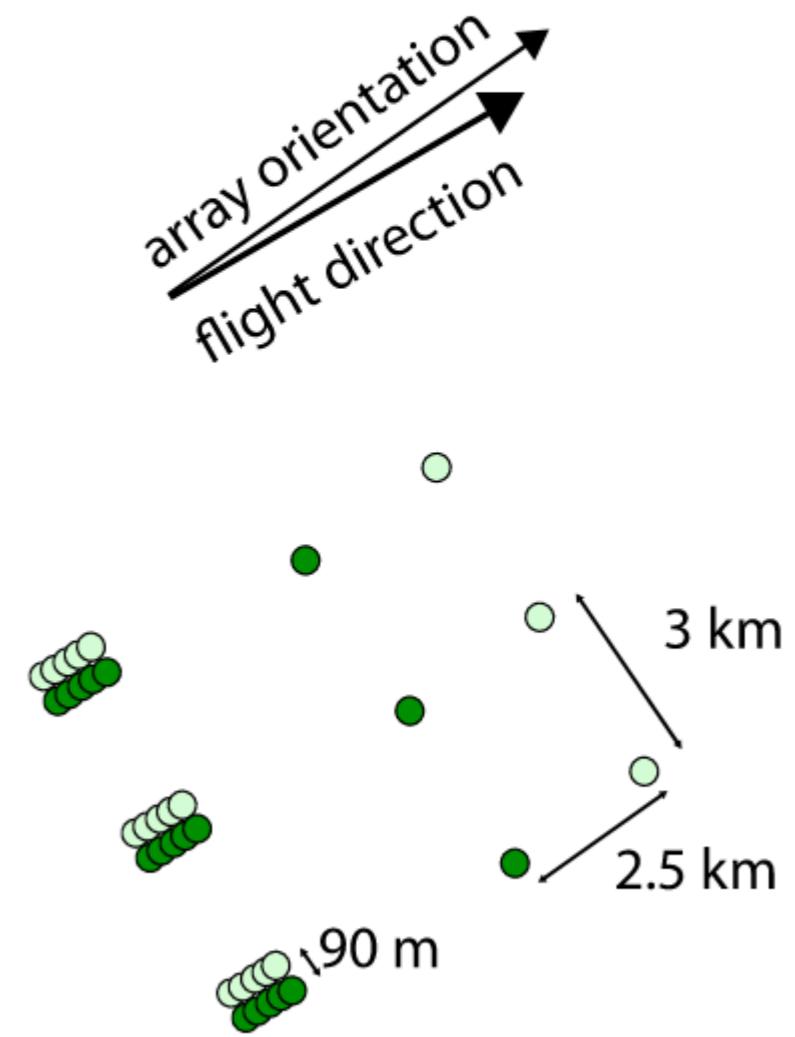
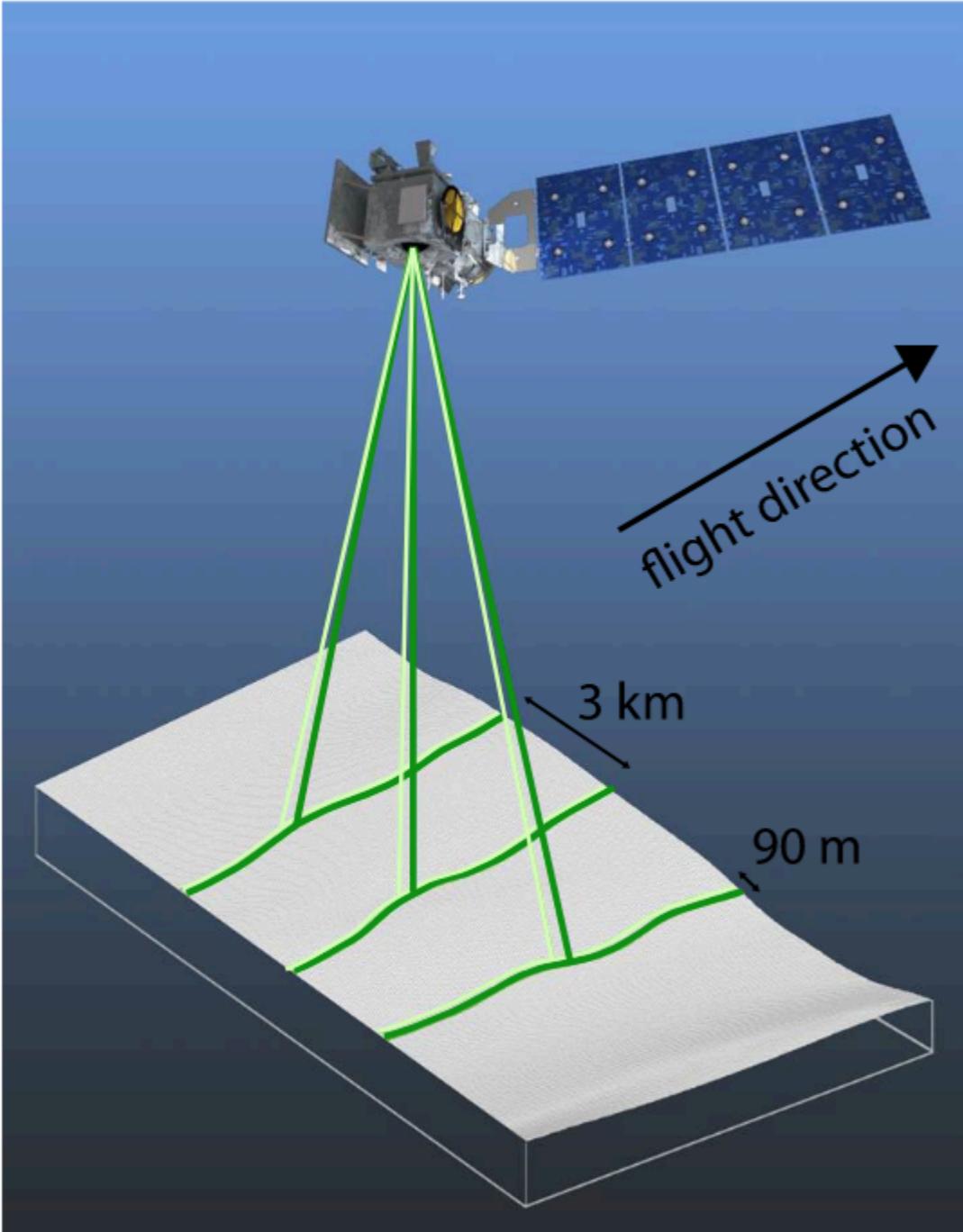
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- ❖ Satellite **laser** altimetry?
- ❖ 2018 - present





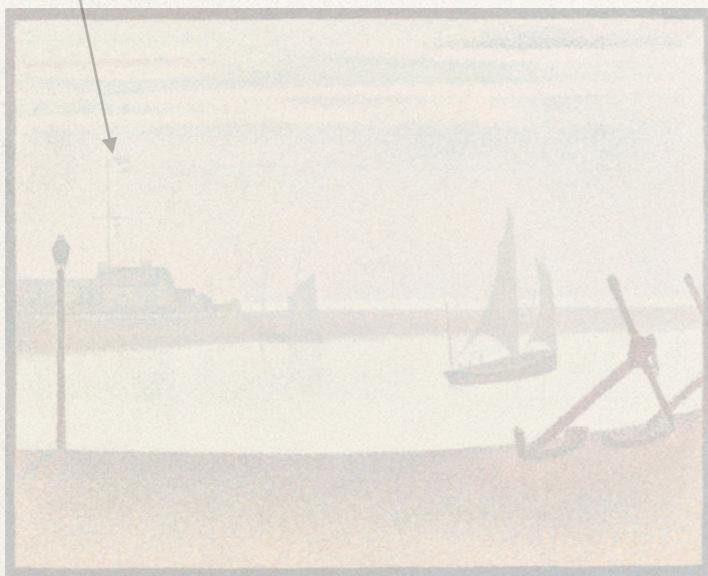
- ♦ ~90 day repeat cycle
- ♦ 3 beams pairs of beams, ~3 km apart



- ◆ Each pair of beams \sim 90 m apart
- ◆ Across track: beam width \sim 15 m
- ◆ Along track: 70 m to 7 km (Morison et al, 2020)



Tide Gauges (~1900 - pres)



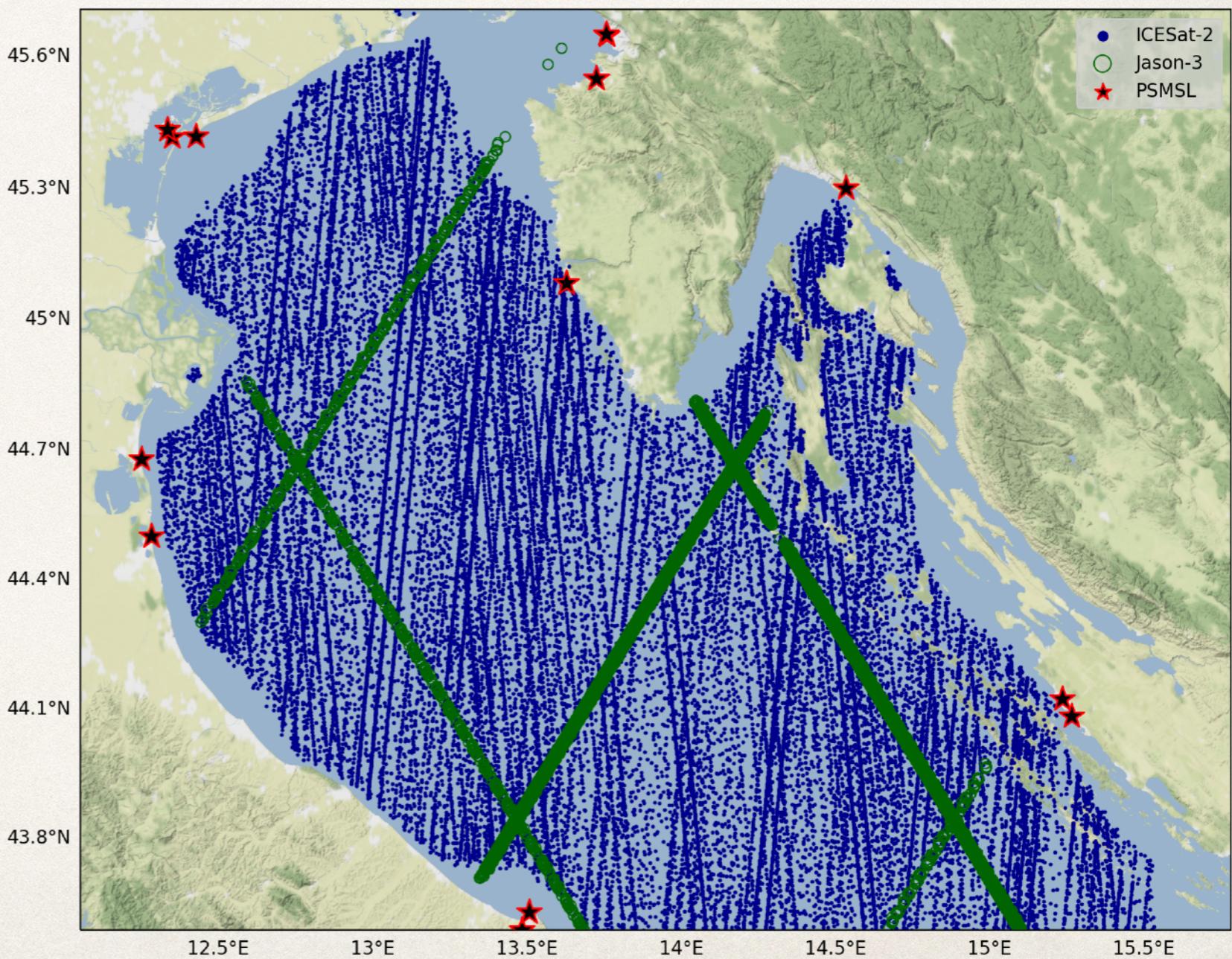
The Channel at Gravelines, Evening summer 1890

Claude Monet

- ♦ Satellite **laser** altimetry!

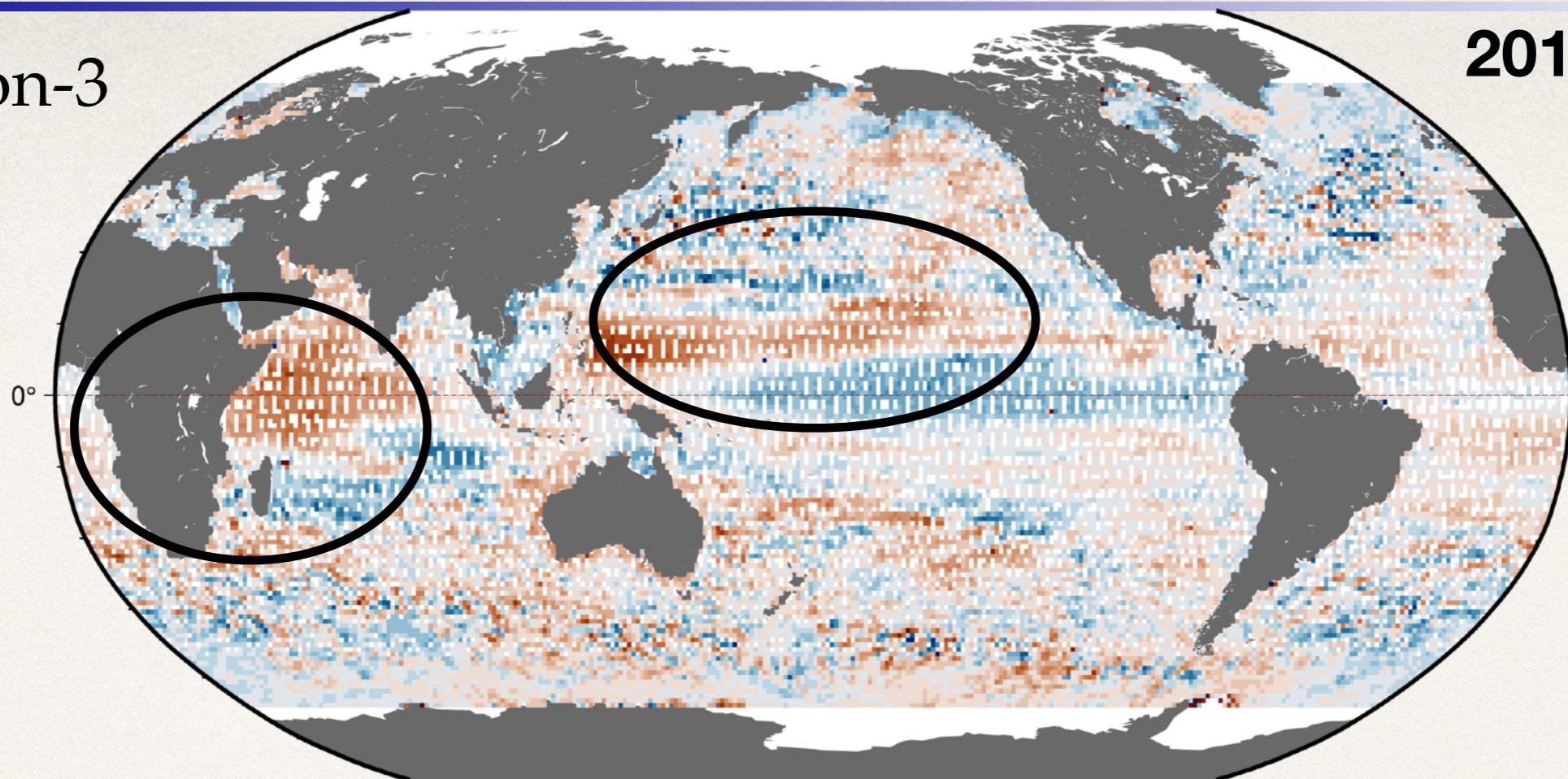
- ♦ 2018 - present

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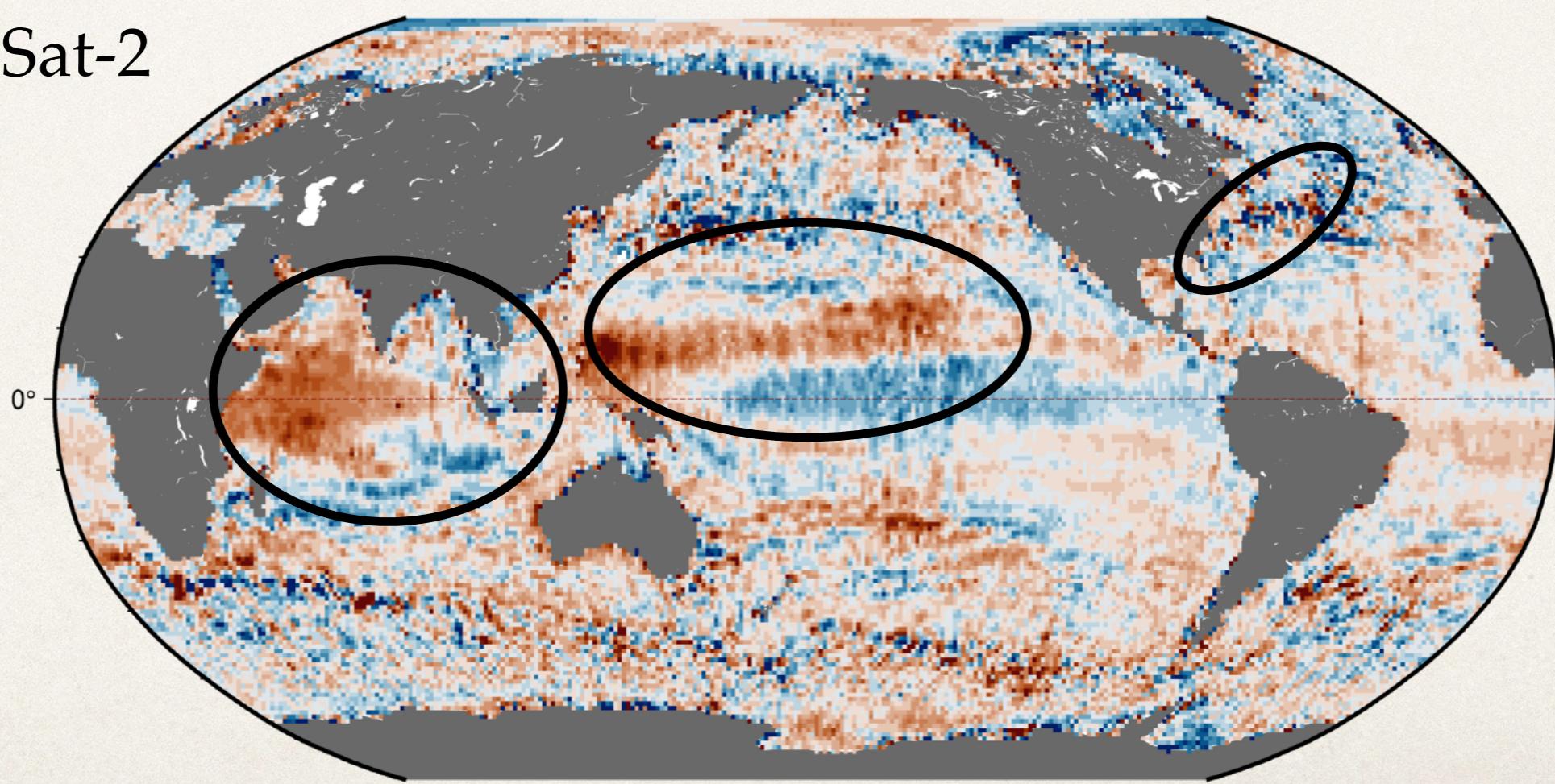


Jason-3

2018 to 2020

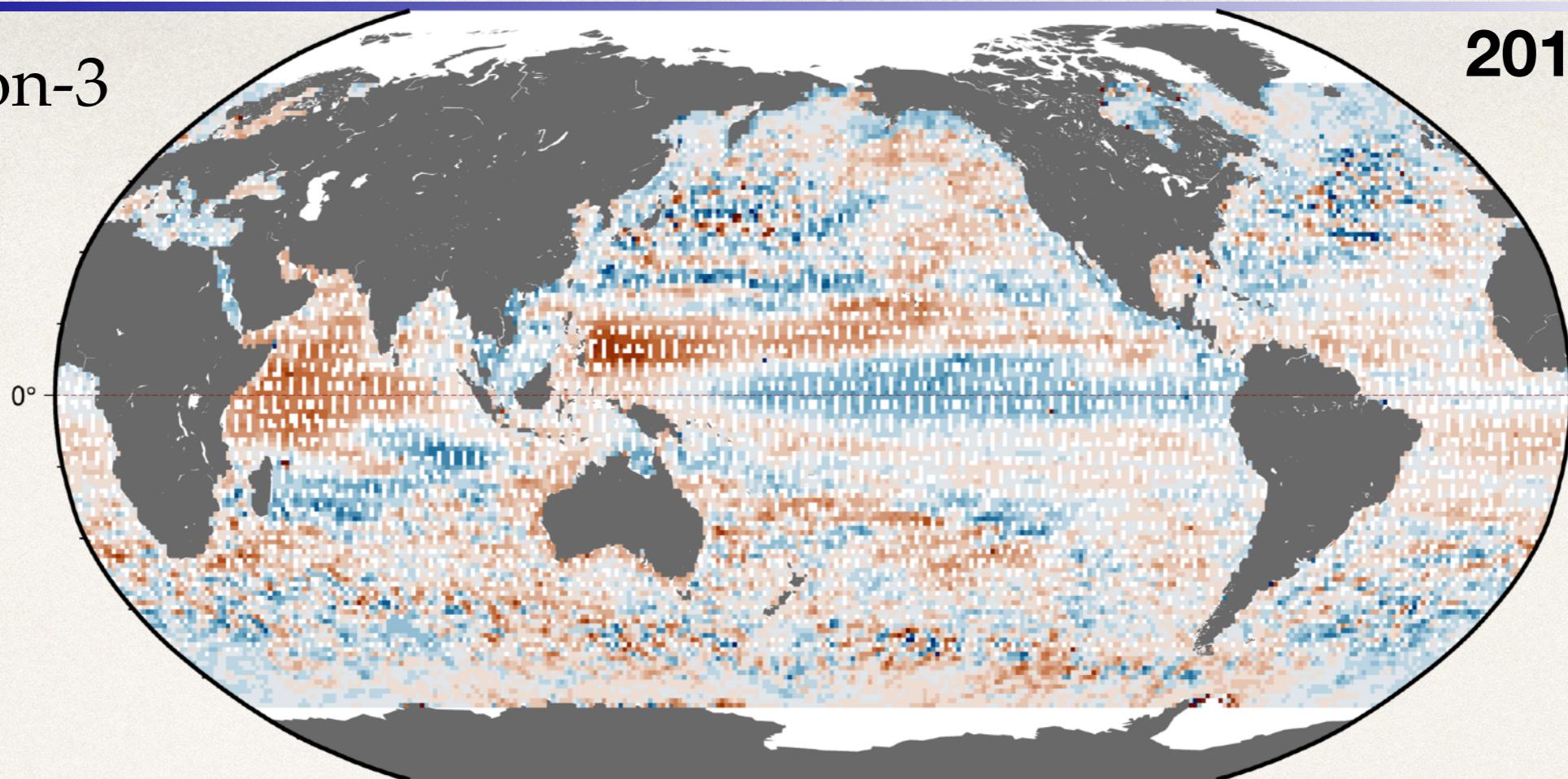


ICESat-2

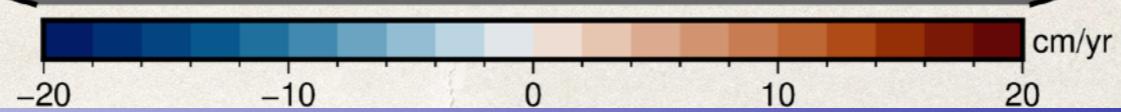
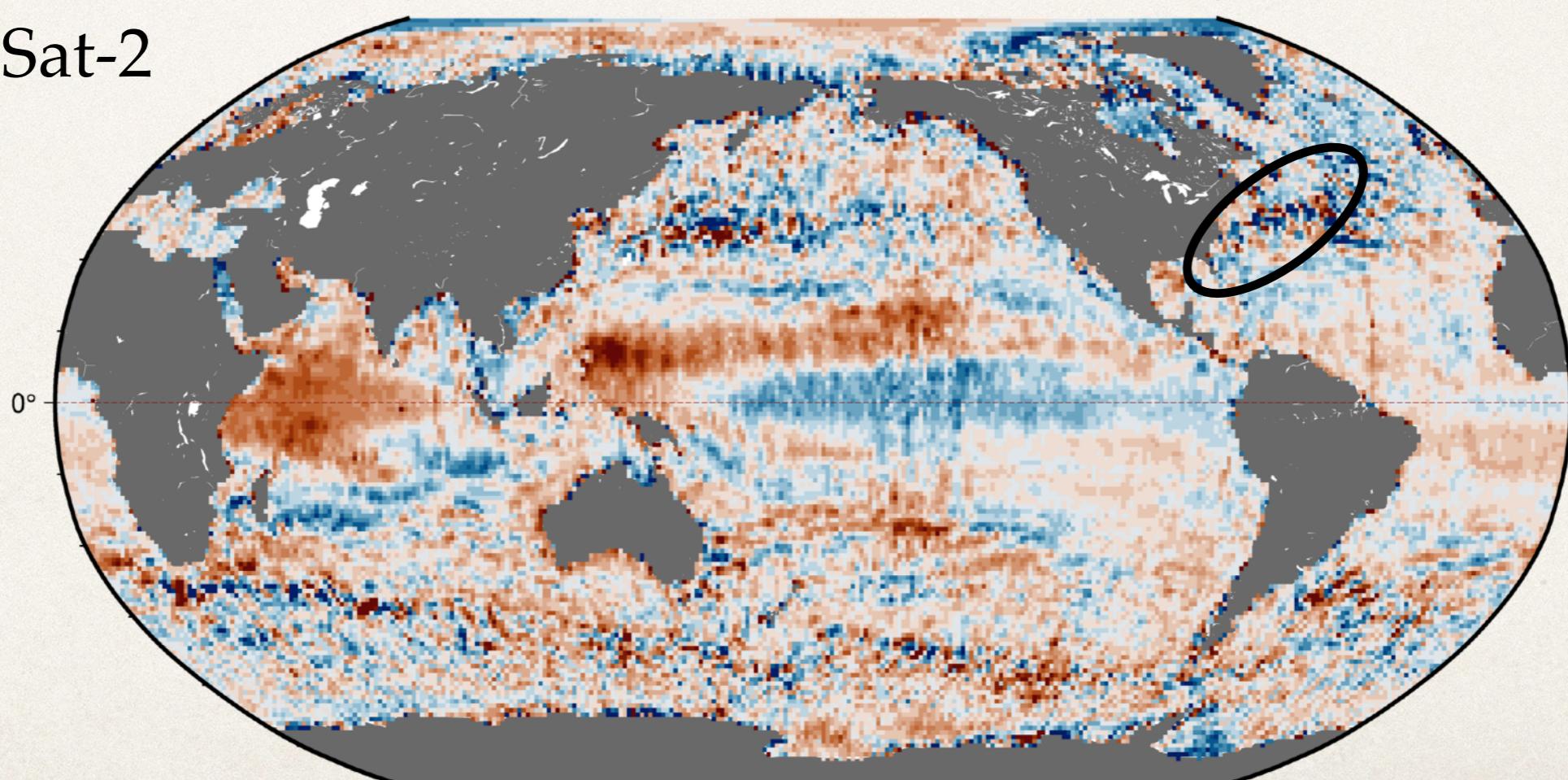


Jason-3

2018 to 2020



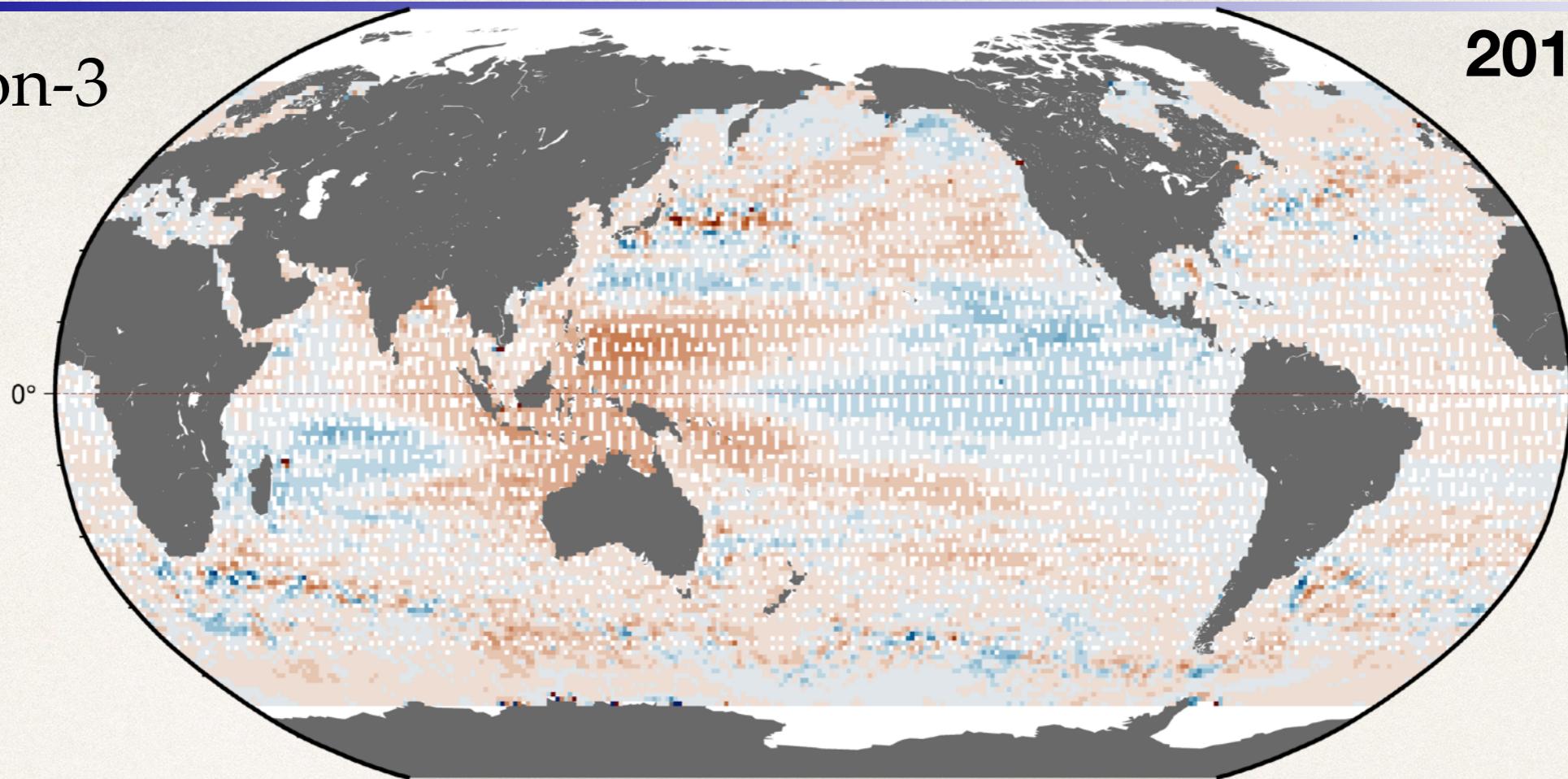
ICESat-2



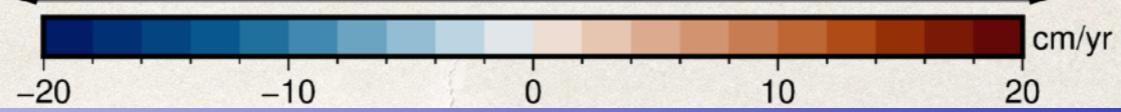
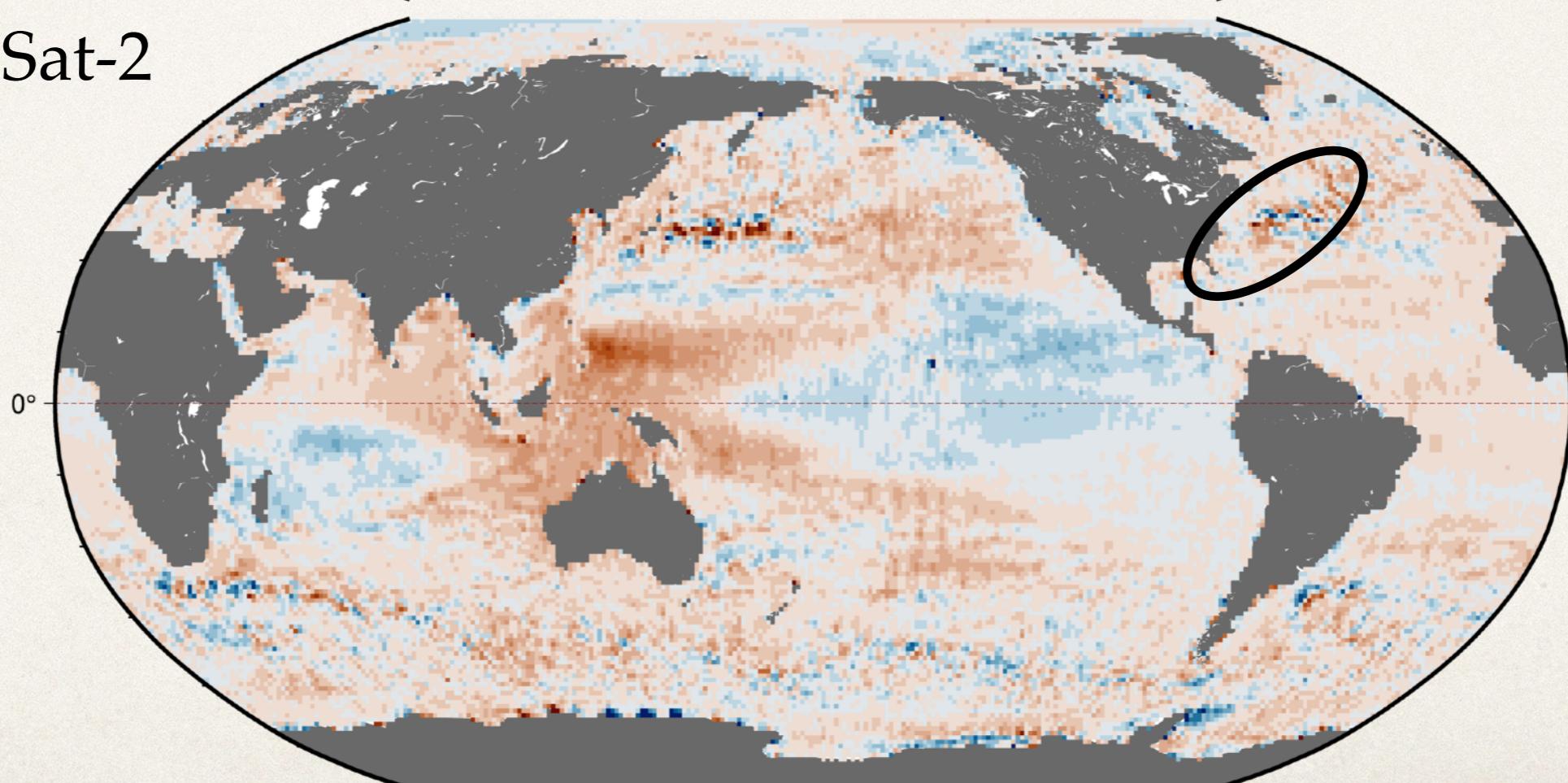
1° grid

Jason-3

2018 to 2022

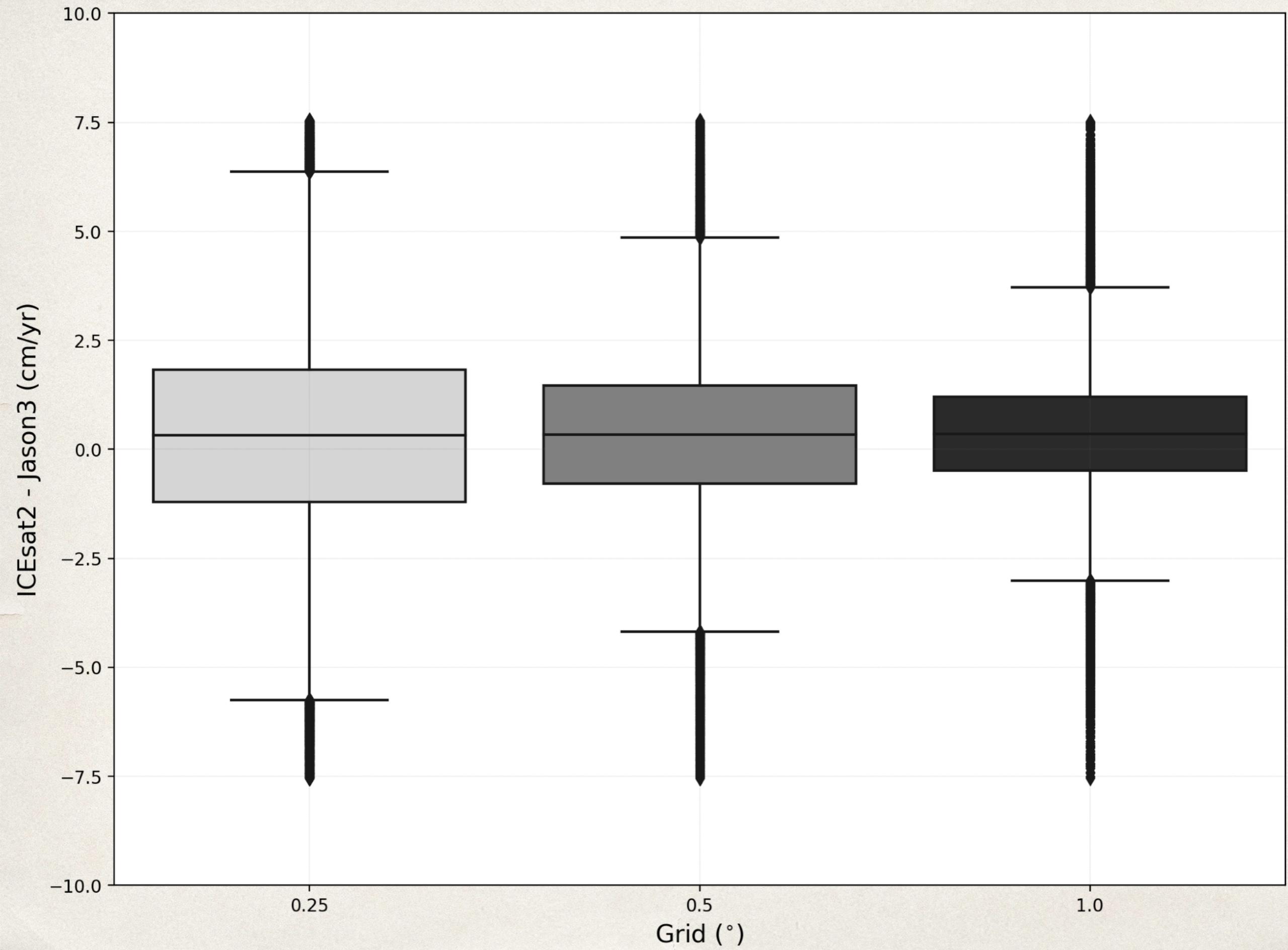


ICESat-2

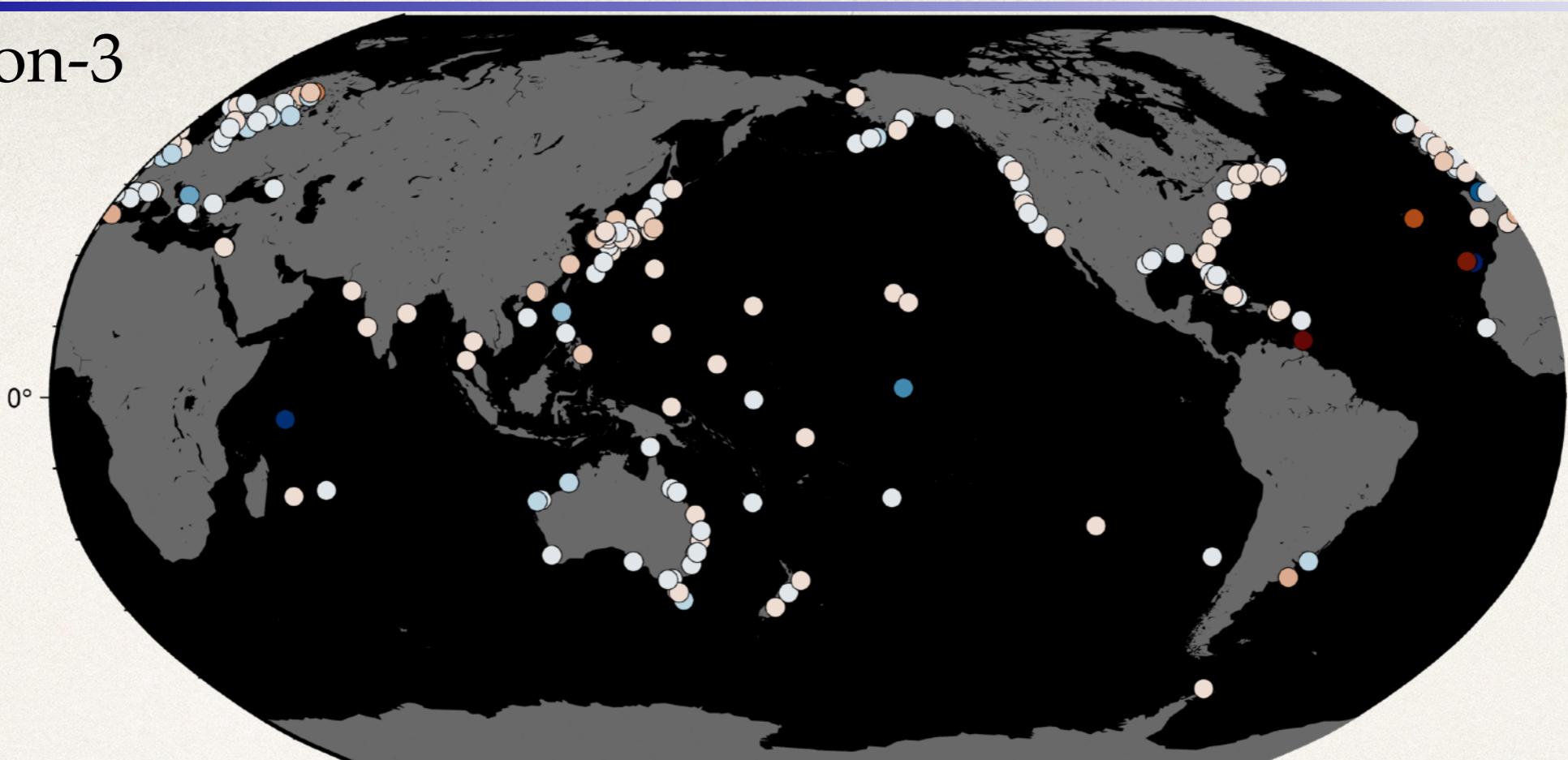


1° grid

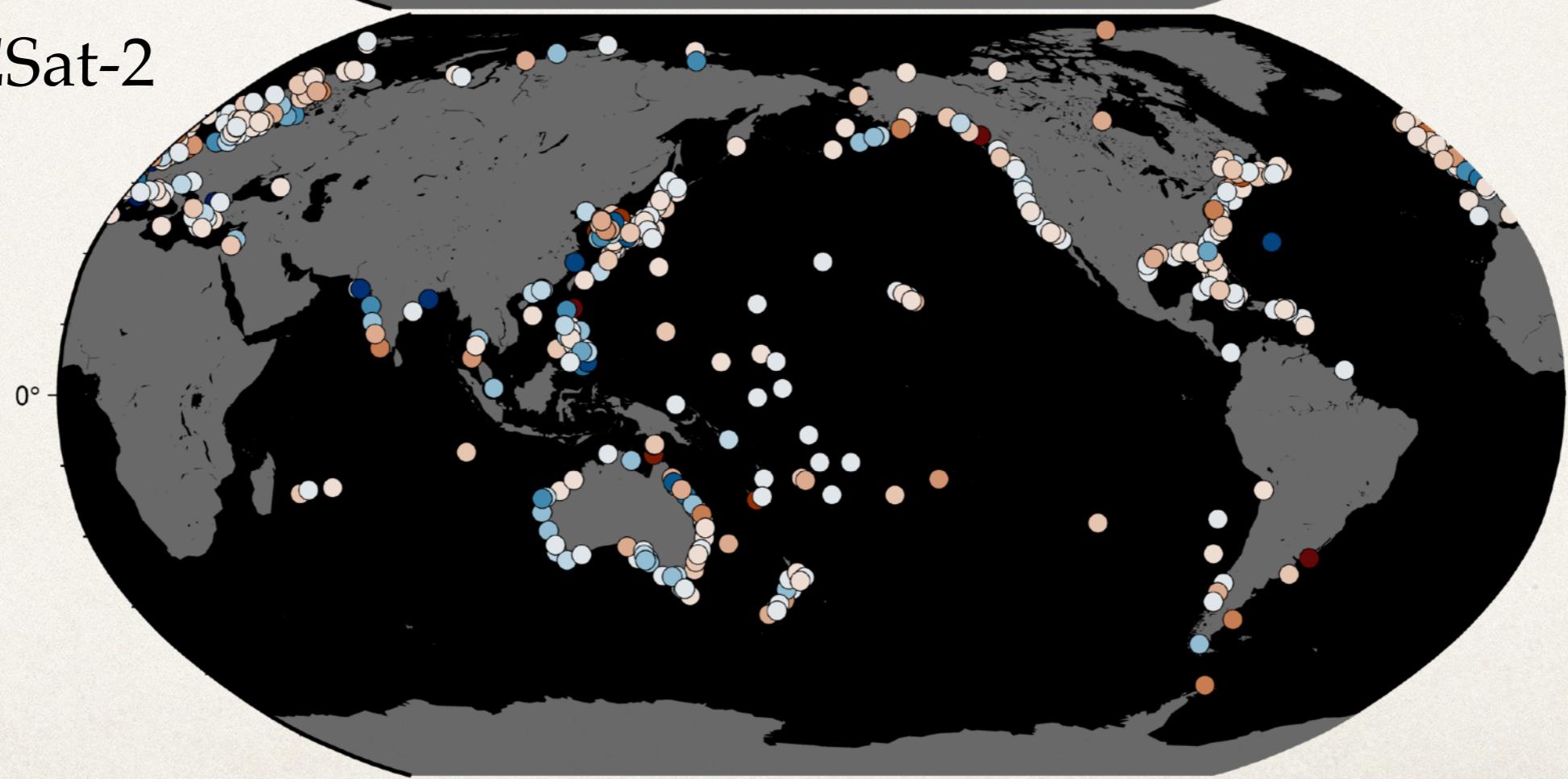
ICESat-2 - Jason-3



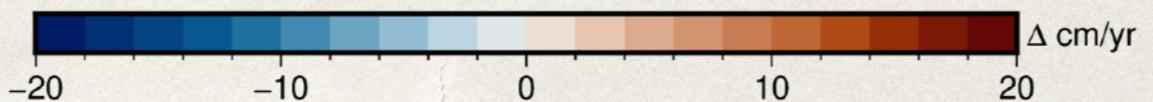
Jason-3



ICESat-2

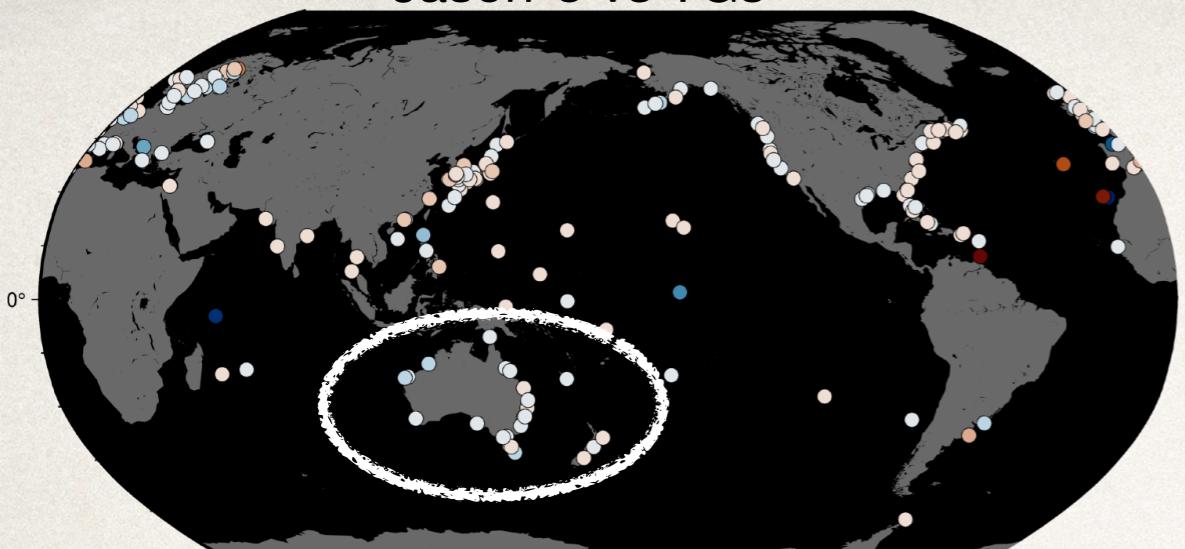


vs PSMSL

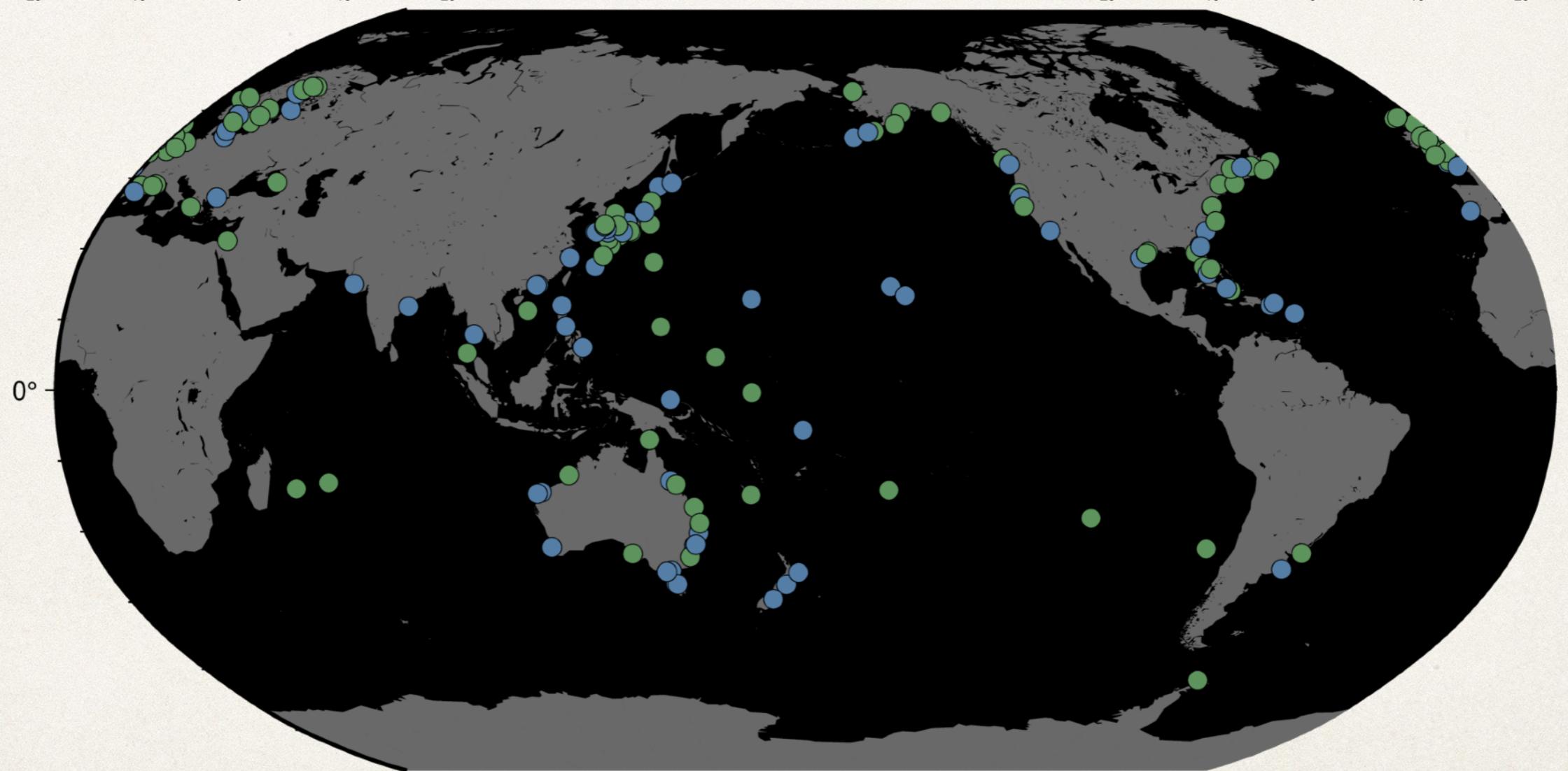
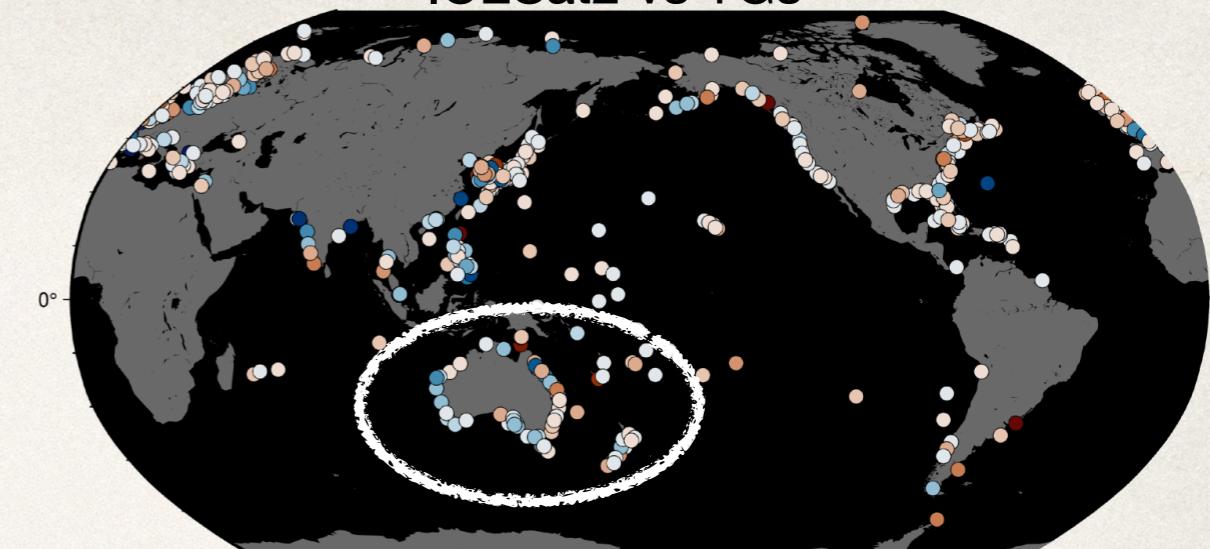


0.5° grid

Jason-3 vs TGs



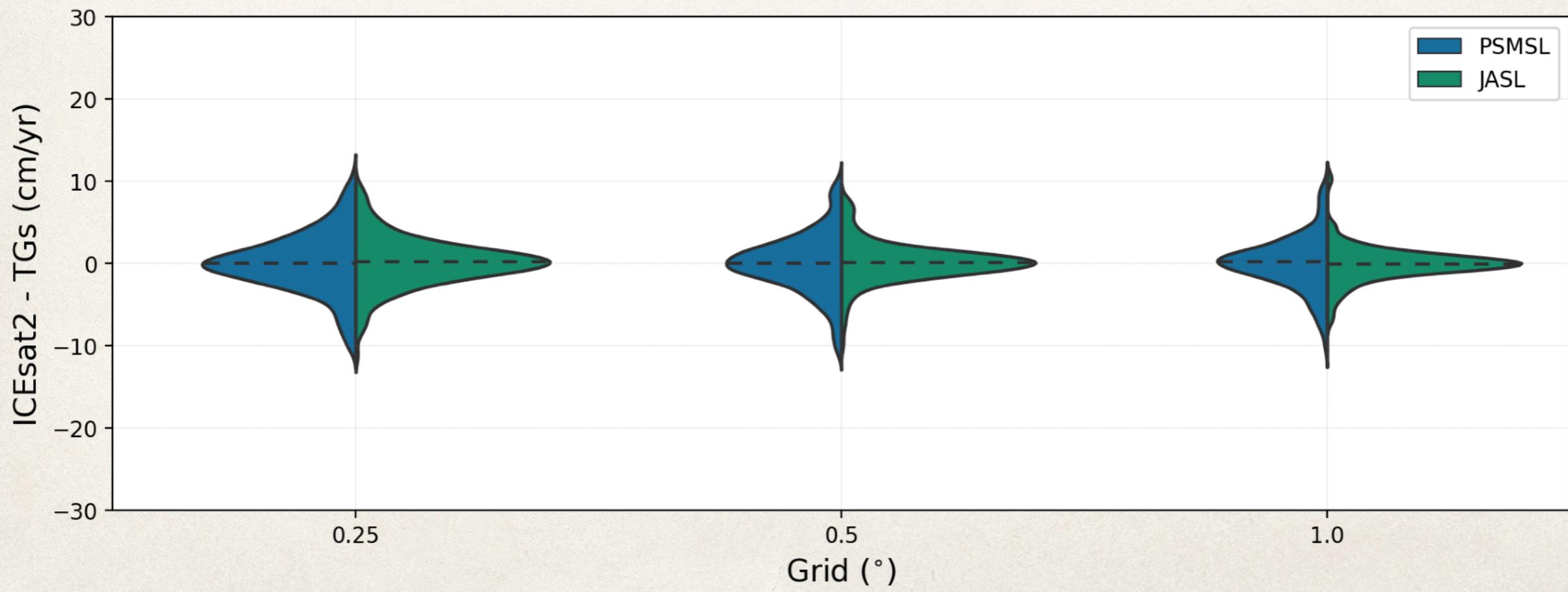
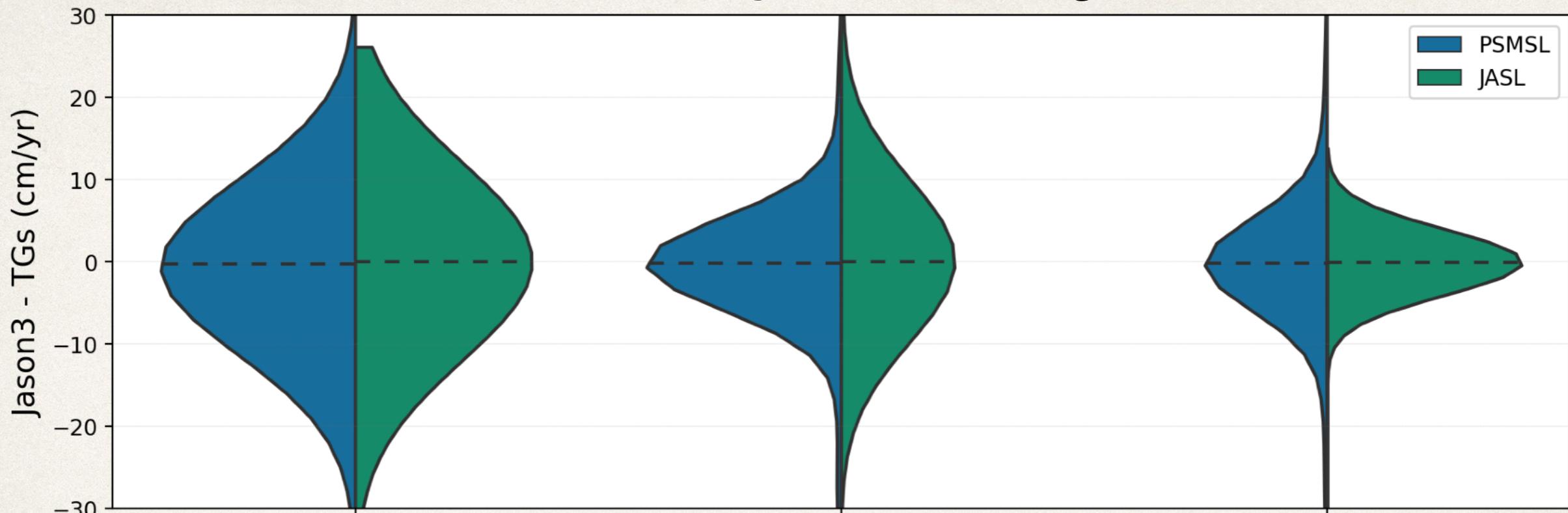
ICESat2 vs TGs



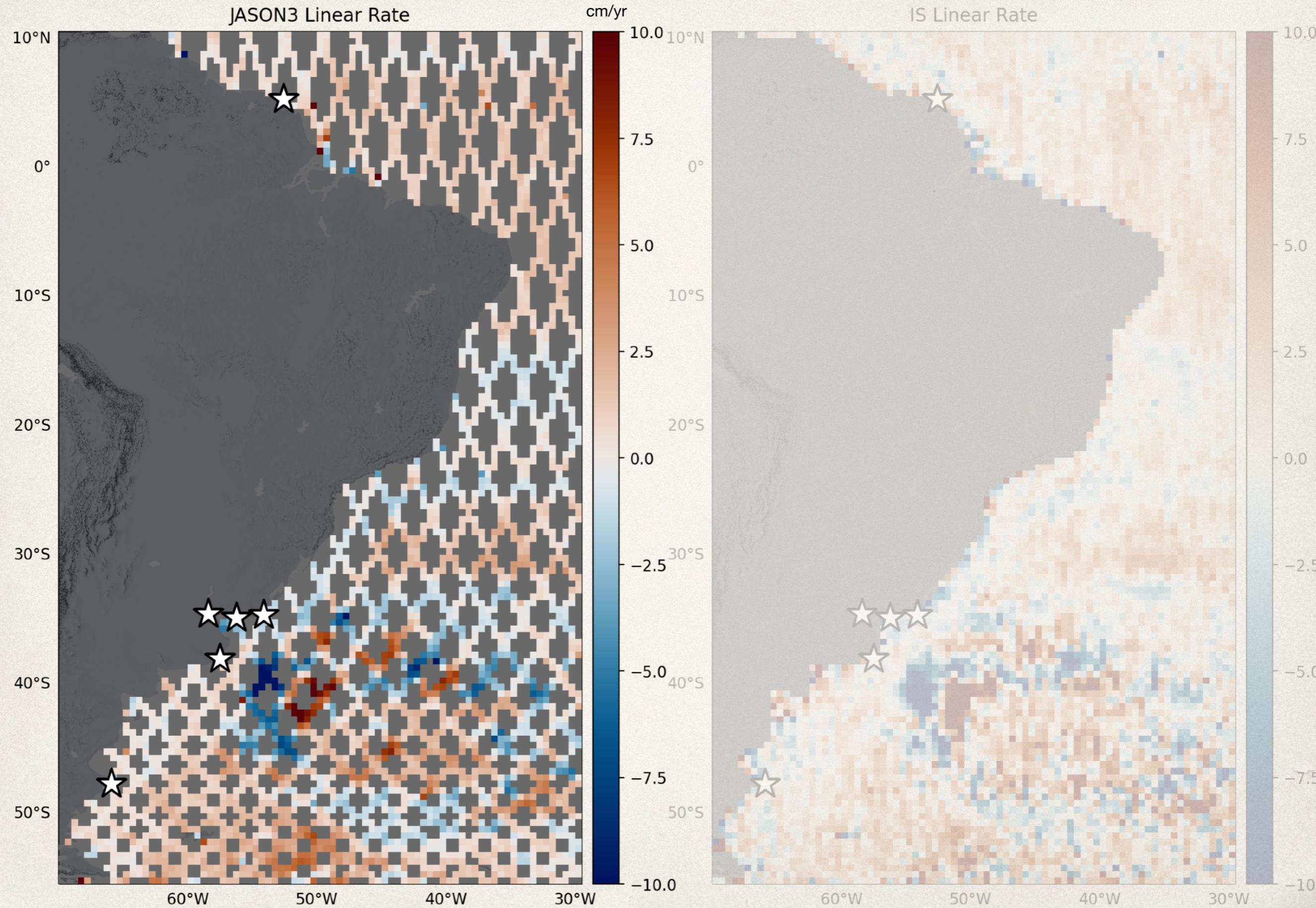
-1.0 -0.5 0.0 0.5 1.0

ICESat-2 'better' Jason-3 'better' Δ cm/yr

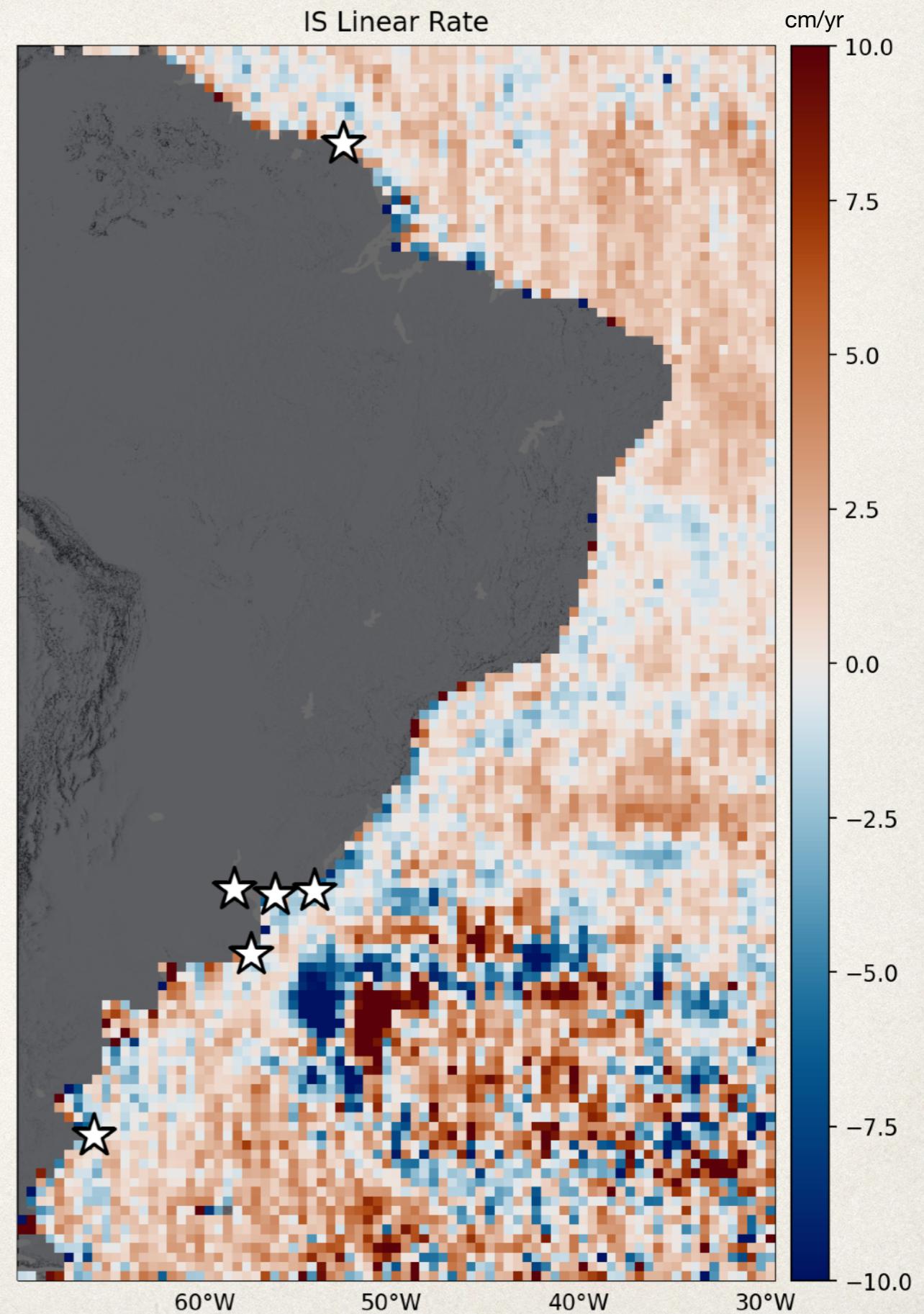
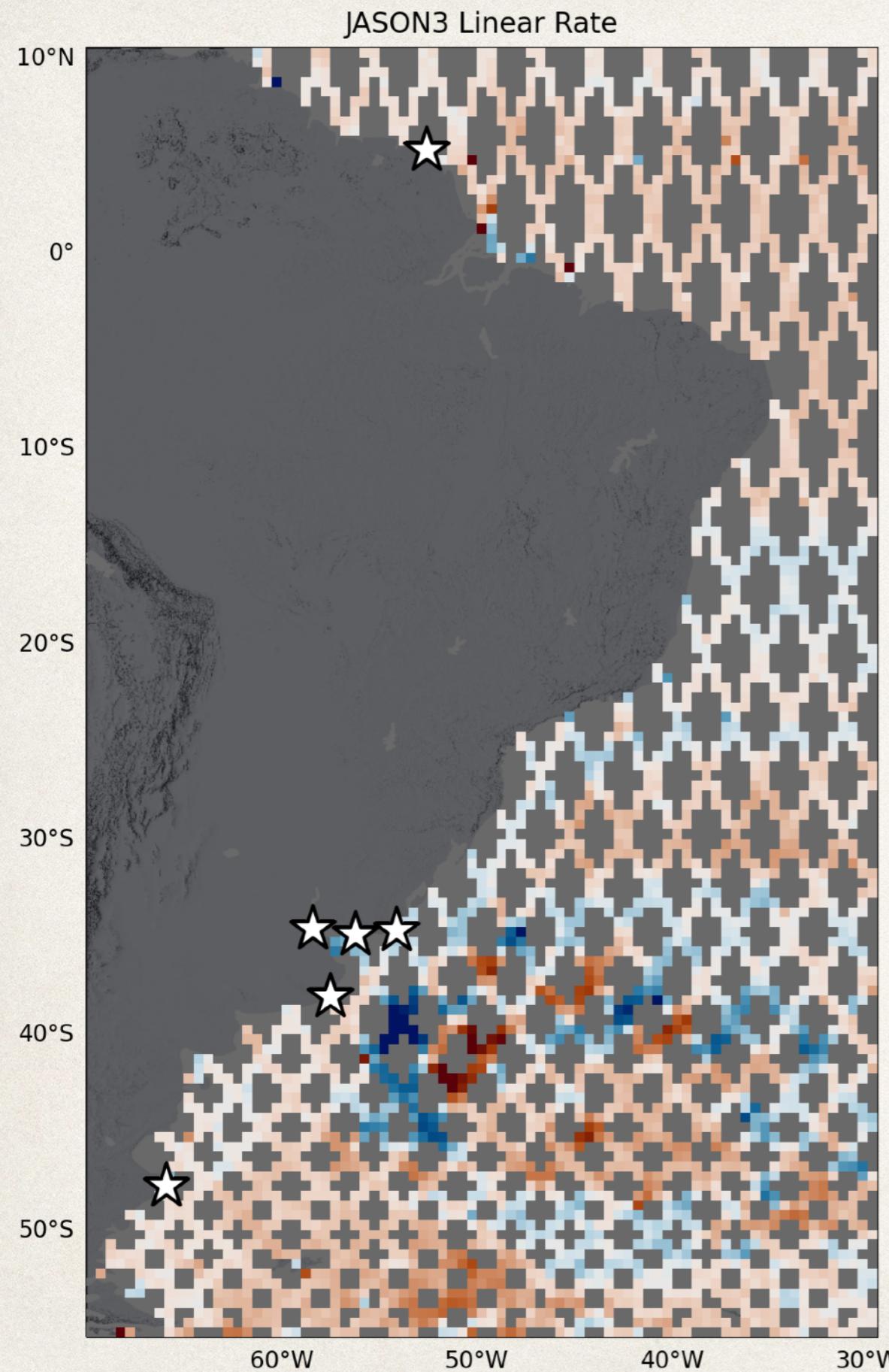
Altimetry at Tide Gauges



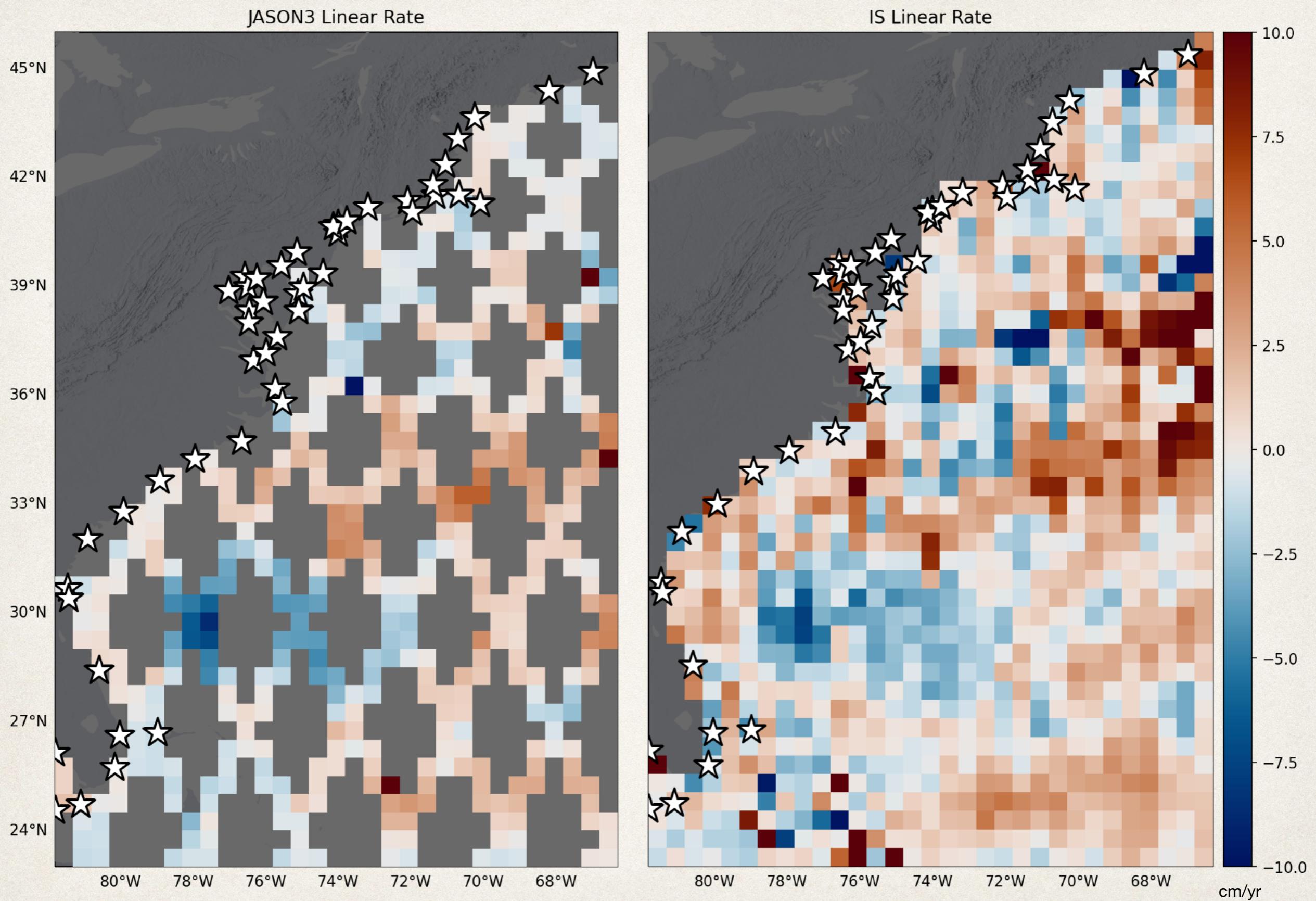
South America



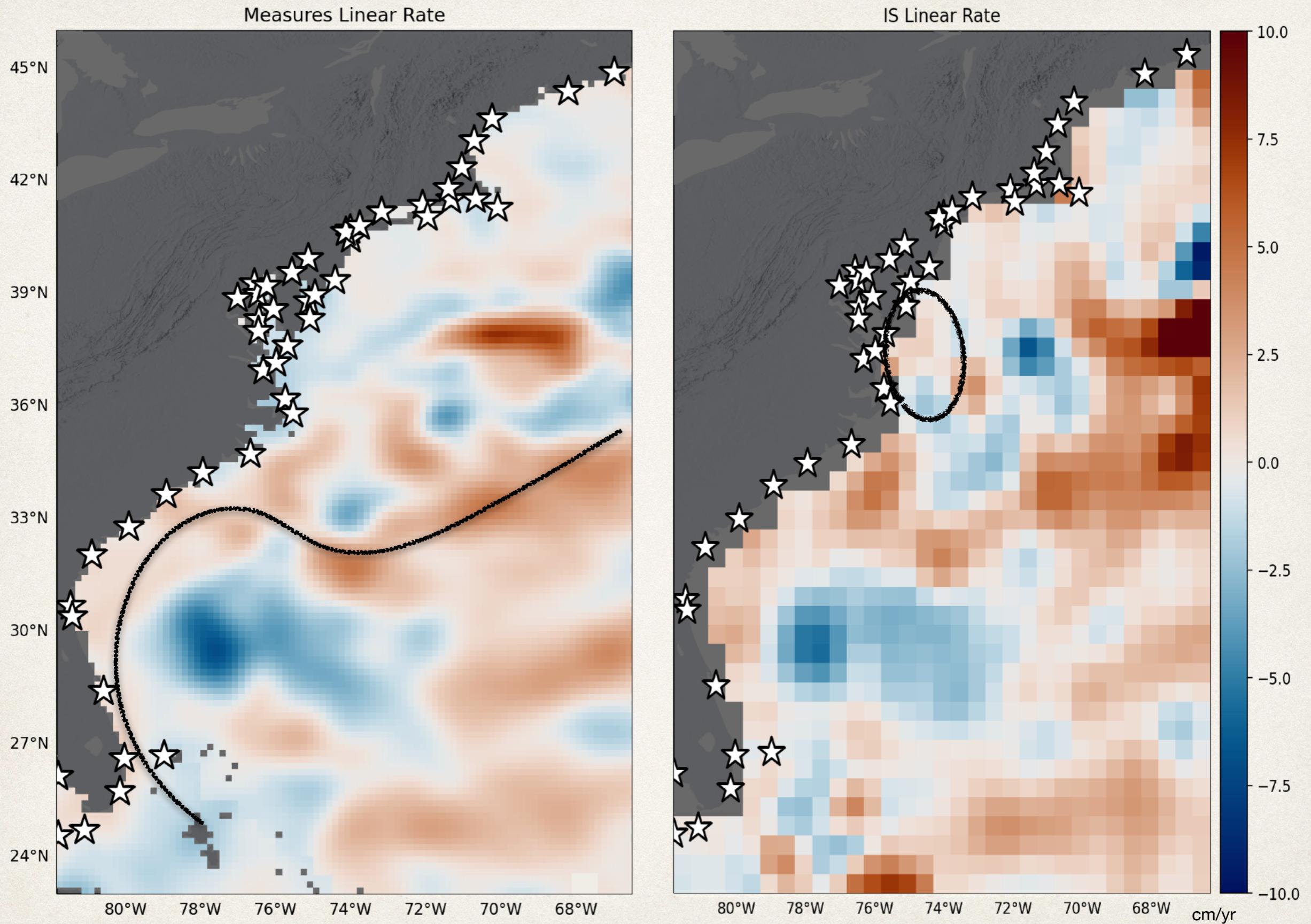
South America



U.S. East Coast

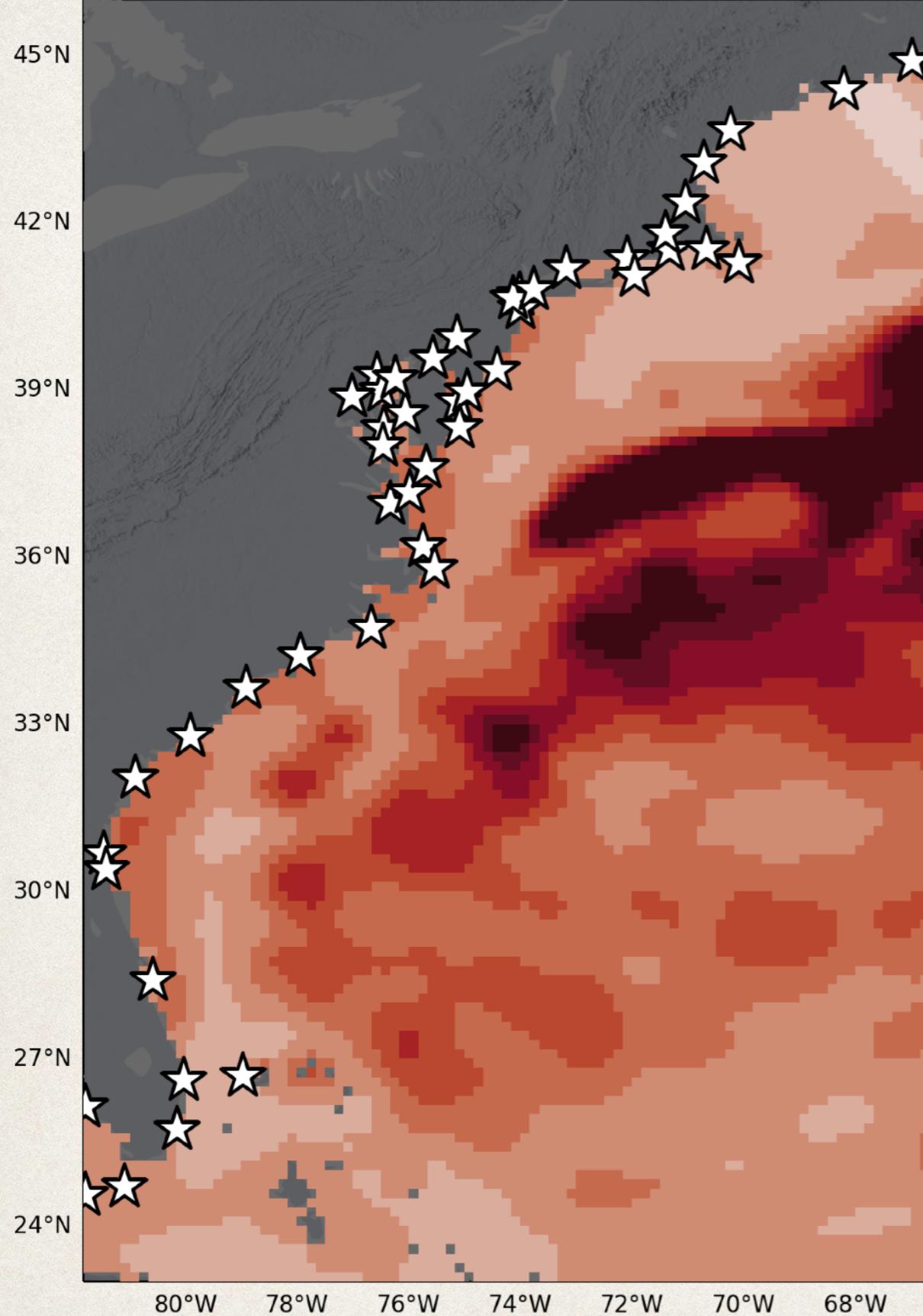


U.S. East Coast

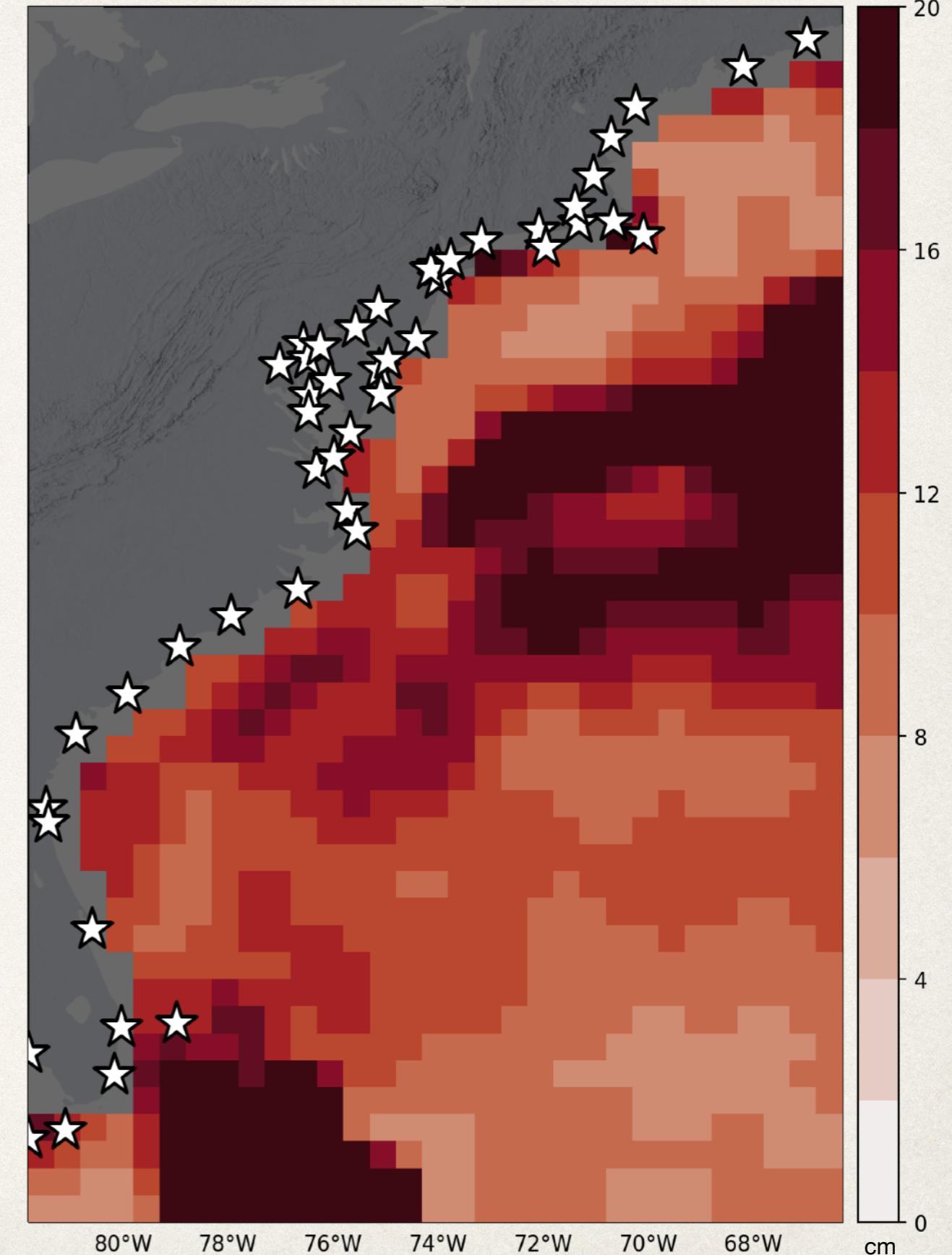


U.S. East Coast

Measures Standard Deviation

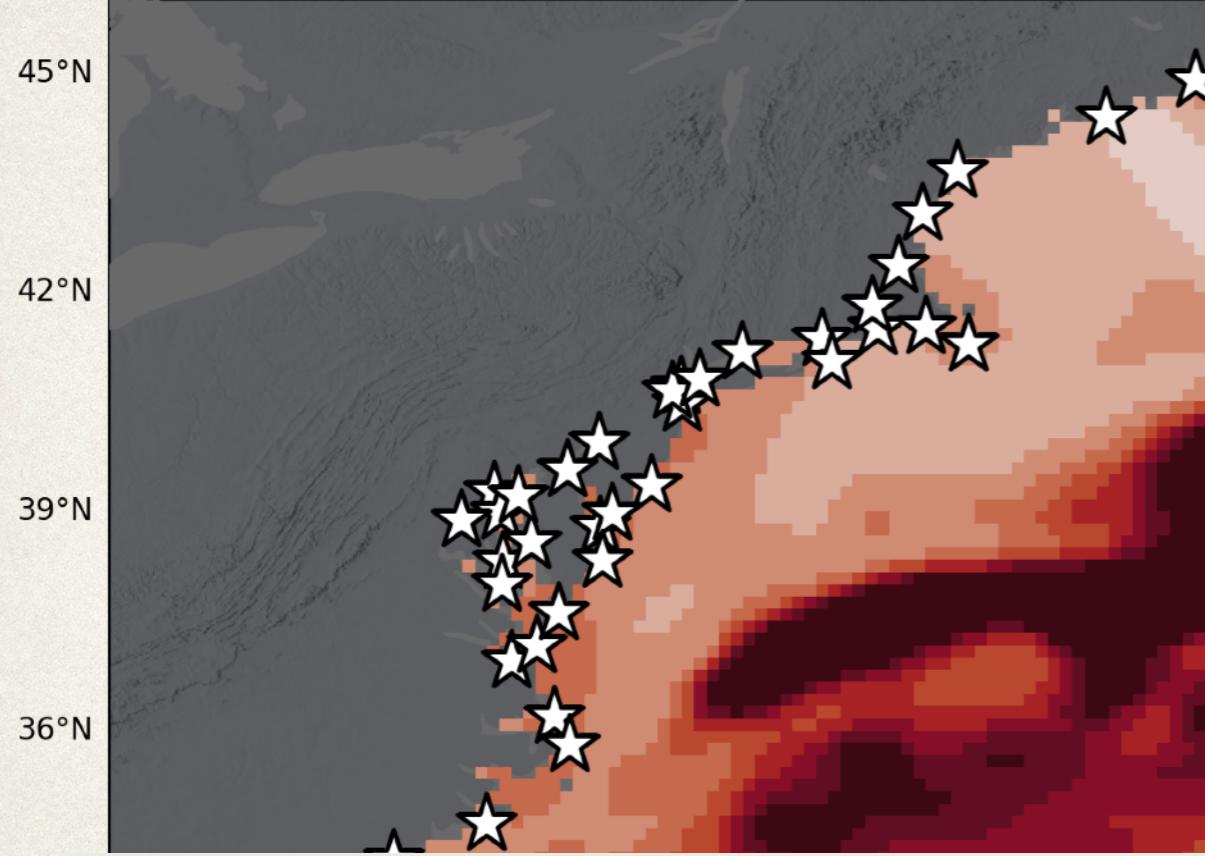


IS Standard Deviation

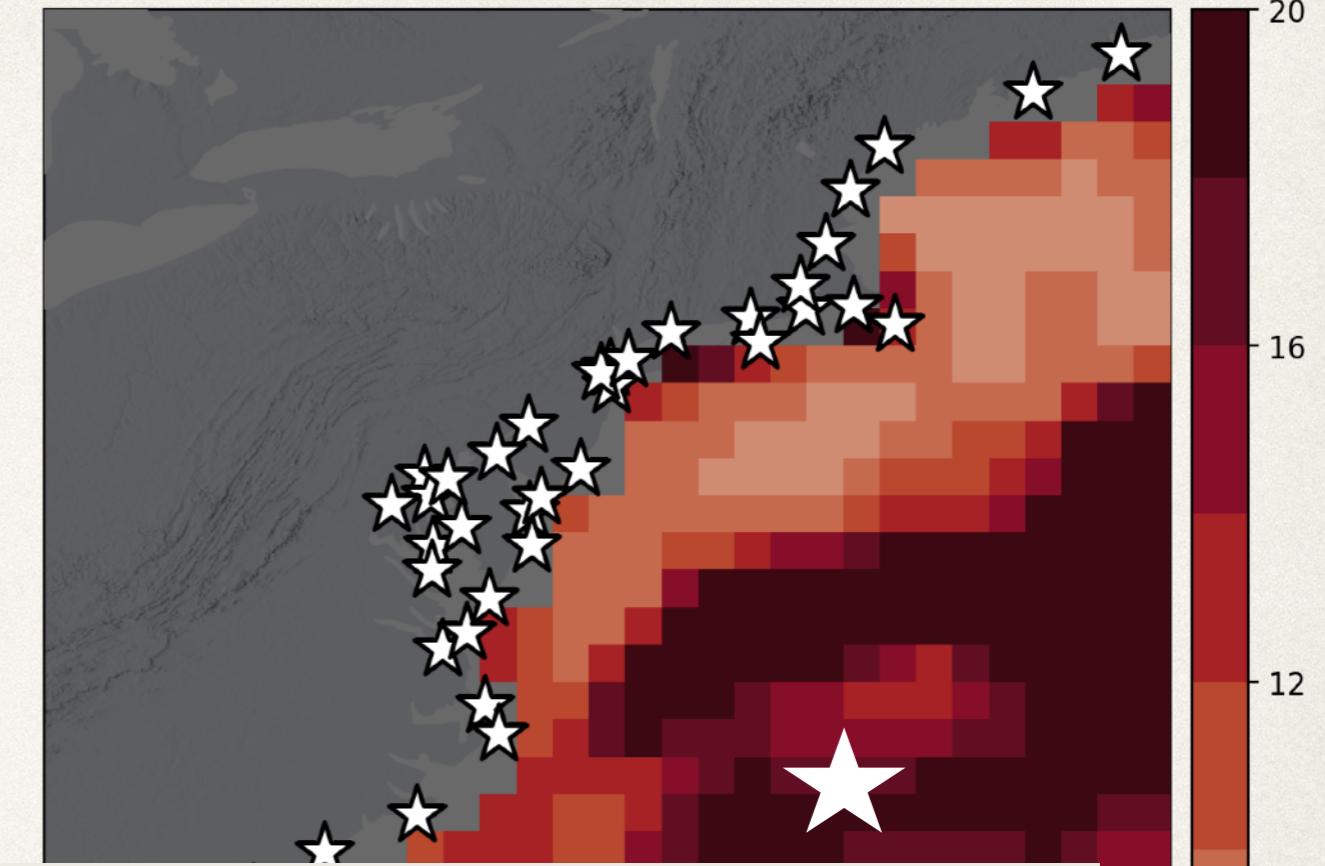


U.S. East Coast

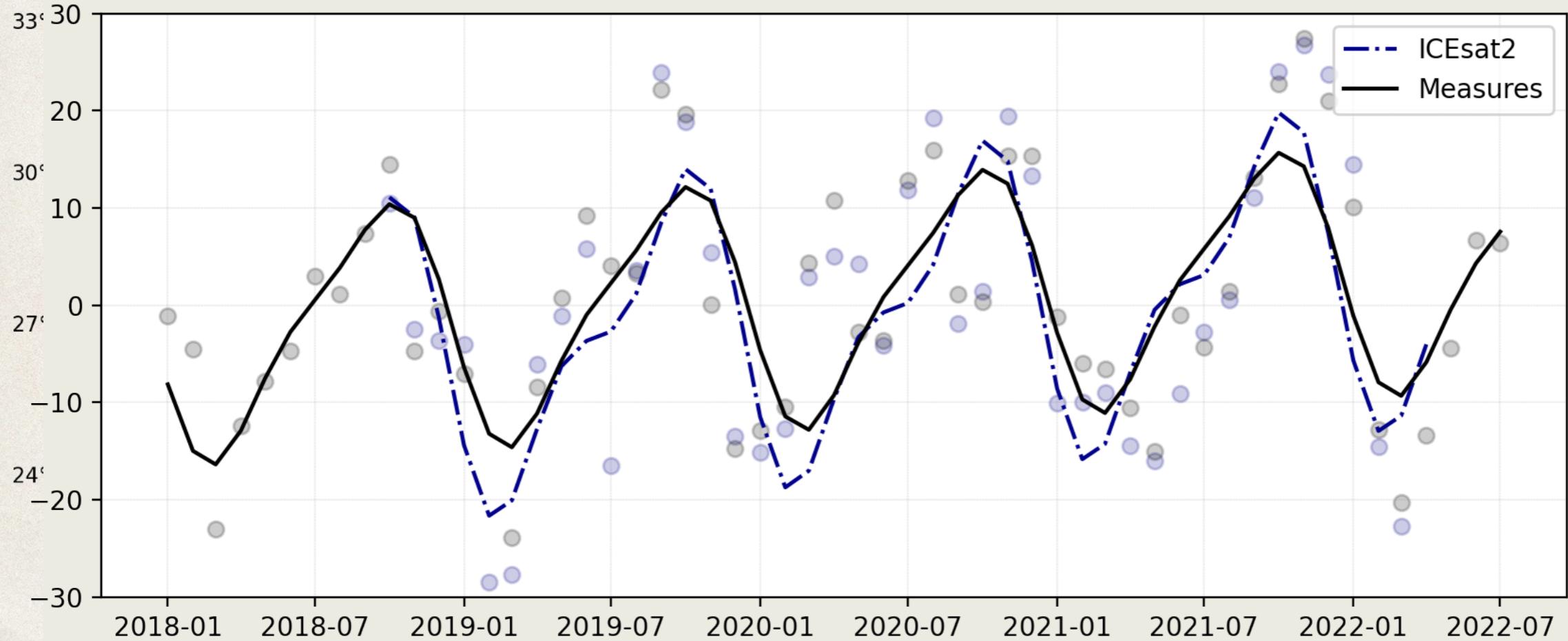
Measures Standard Deviation



IS Standard Deviation



North Atlantic Drift

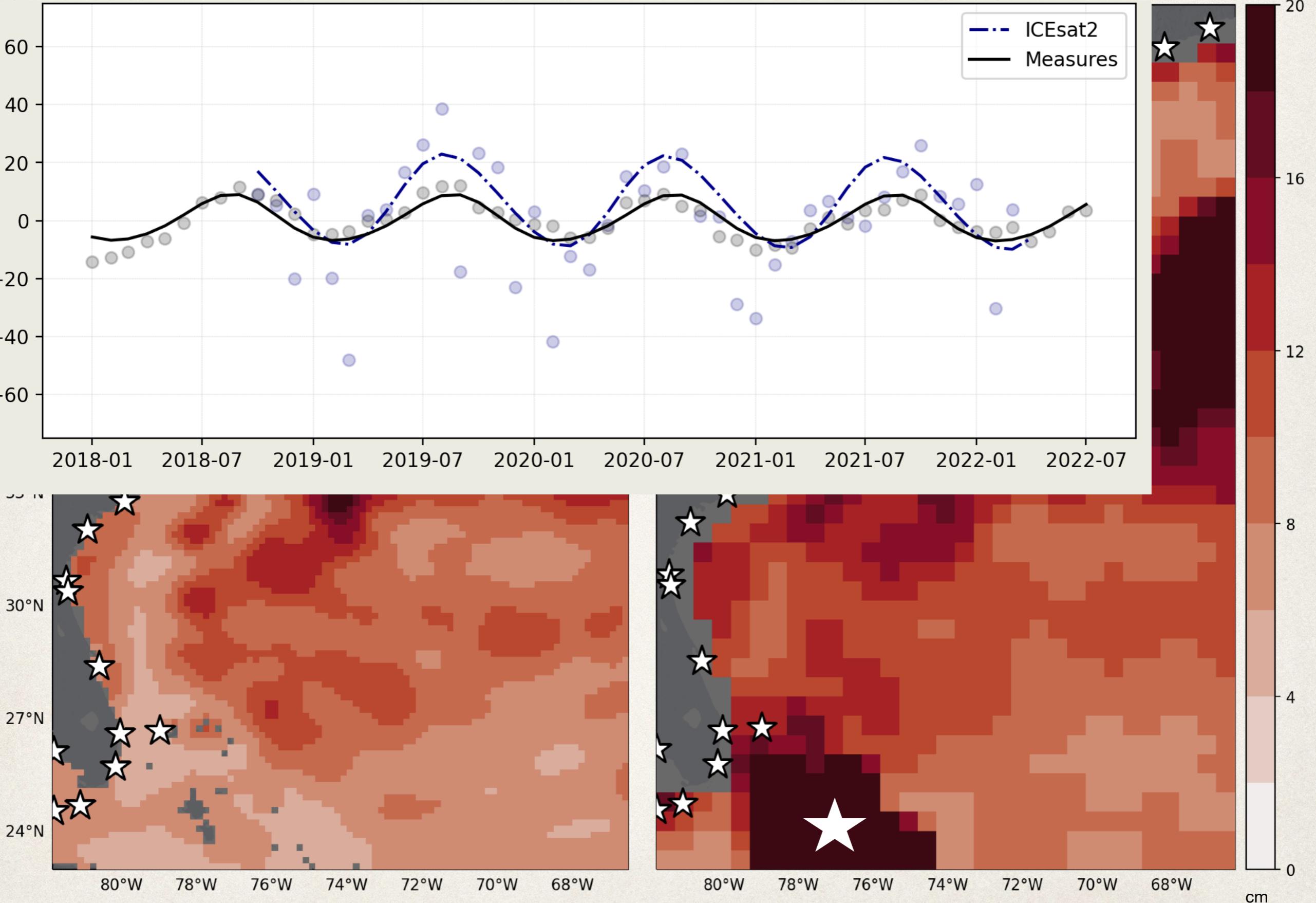


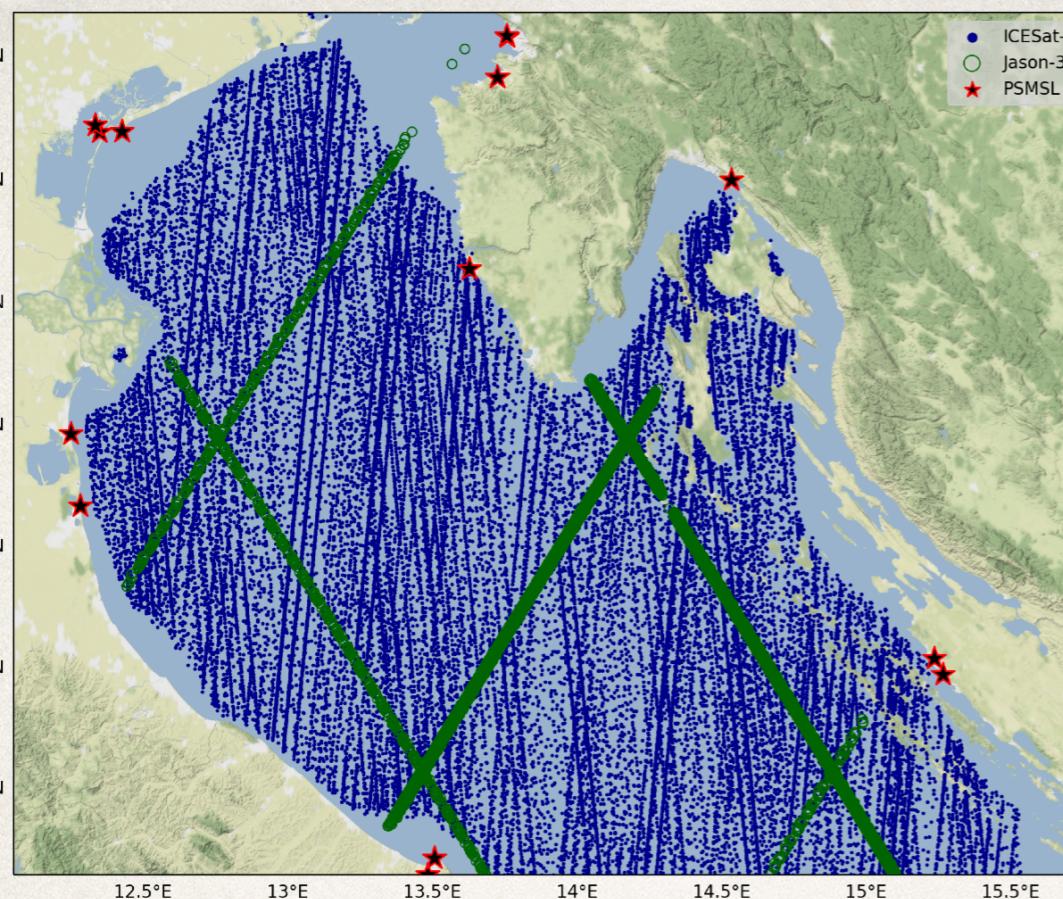
U.S. East Coast

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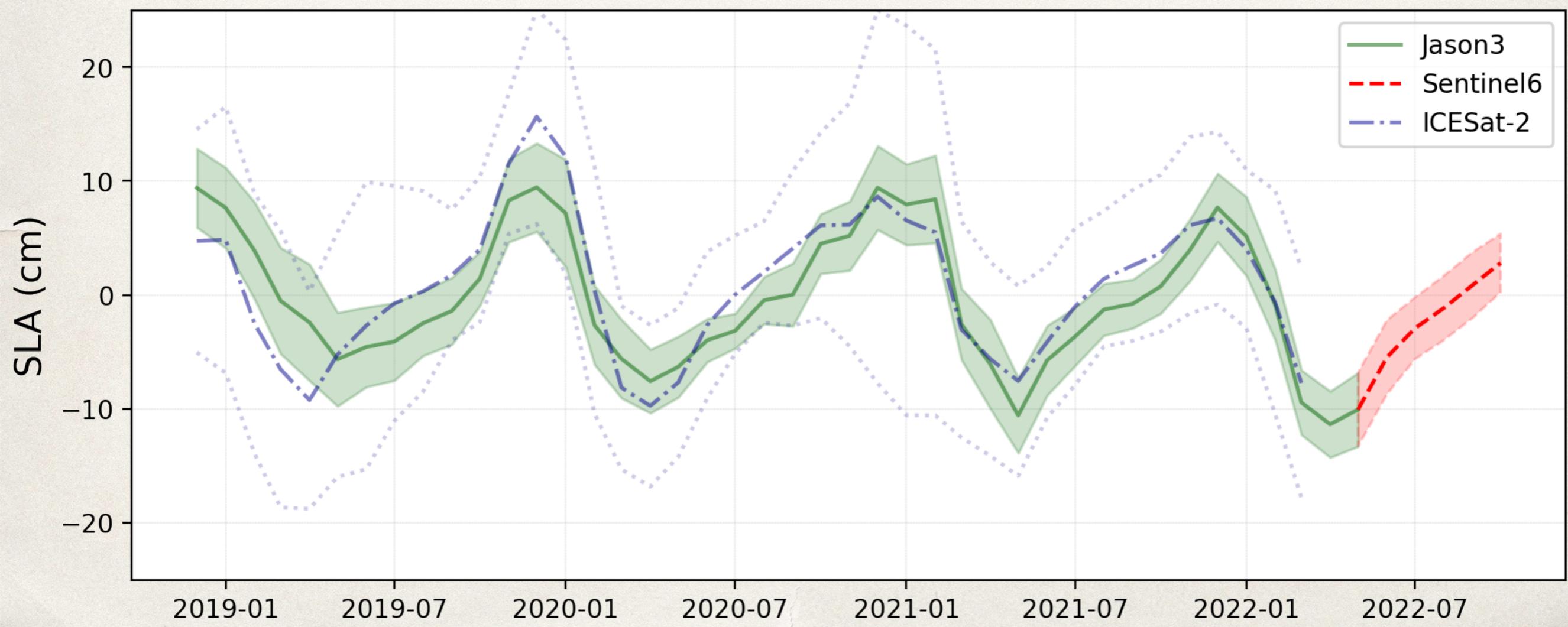
Carribean

IS Standard Deviation





Sentinel 6!



Takeaways

- ◆ ICESat-2 is filling data gaps in the radar altimetry record
- ◆ Full instrumental suite helpful for process-based understanding
- ◆ Sentinel-6 (high-resolution?) yet to be fully explored

References

- ♦ Buzzanga, B., Heijkoop, E., Hamlington, B., Nerem, R., and Gardner, A. S. (2021). An assessment of regional ICESat-2 sea-level trends. *Geophysical Research Letters*.
- ♦ Caldwell, P., Merrifield, M., and Thompson, P. (2015). Sea level measured by tide gauges from global oceans—the Joint Archive for Sea Level holdings (NCEI Accession 0019568), Version 5.5, NOAA National Centers for Environmental Information, Dataset. Centers Environ. Information, Dataset.
- ♦ Frederikse, T., Landerer, F., Caron, L., Adhikari, S., Parkes, D., Humphrey, V. W., Dangendorf, S., Hogarth, P., Zanna, L., Cheng, L., and Wu, Y.-H. (2020). The causes of sea-level rise since 1900. *Nature*, 584(7821):393–397.
- ♦ Morison, J. H., Hancock, D., Dickinson, S., Robbins, J., Roberts, L., Kwok, R., Palm, S. P., Smith, B., Jasinski, M. F., and the ICESat-2 Science Team (2020). ATLAS/ICESat-2 L3A Ocean Surface Height, Version 5. NASA National Snow and Ice Data Center Distributed Active Archive Center, Boulder, Colorado USA.
- ♦ Neumann, T., Brenner, A., Hancock, D., Robbins, J., Saba, J., Harbeck, K., and Gibbons, A. (2019). Ice, Cloud, and land Elevation Satellite–2 (ICESat-2) project: Algorithm theoretical basis document (atbd) for global geolocated photons (ATL03). Technical report, NASA Goddard Space Flight Center.
- ♦ Thompson, P. R., Widlansky, M. J., Hamlington, B. D., Merrifield, M. A., Marra, J. J., Mitchum, G. T., and Sweet, W. (2021). Rapid increases and extreme months in projections of united states high-tide flooding. *Nature Climate Change*, 11(7):584–590.

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Questions?