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Sea level in the Arctic Ocean from satellite radar altimetry

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cpom

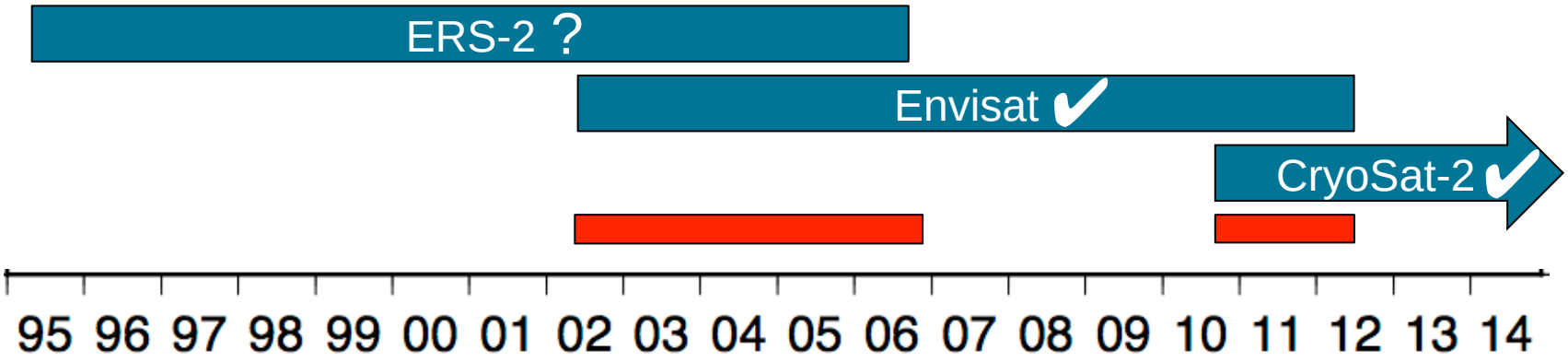
NERC SCIENCE OF THE ENVIRONMENT

Contents

- Arctic Ocean data
- Trends in Arctic sea level over ~18 years
  - Whole basin (up to 82N)
  - Western Arctic (Beaufort sea)
- Beaufort Gyre freshwater storage
- Trends in ocean geostrophic circulation
- Western Arctic sea level seasonal cycle

Data

- Can cross-calibrate between satellites in overlap periods
  - After Giles et al. (2012)
- >18 years of data in the Arctic
- CS2 and Envisat agree well
- Envisat & ERS-2 less so:
  - Need to process REAPER data



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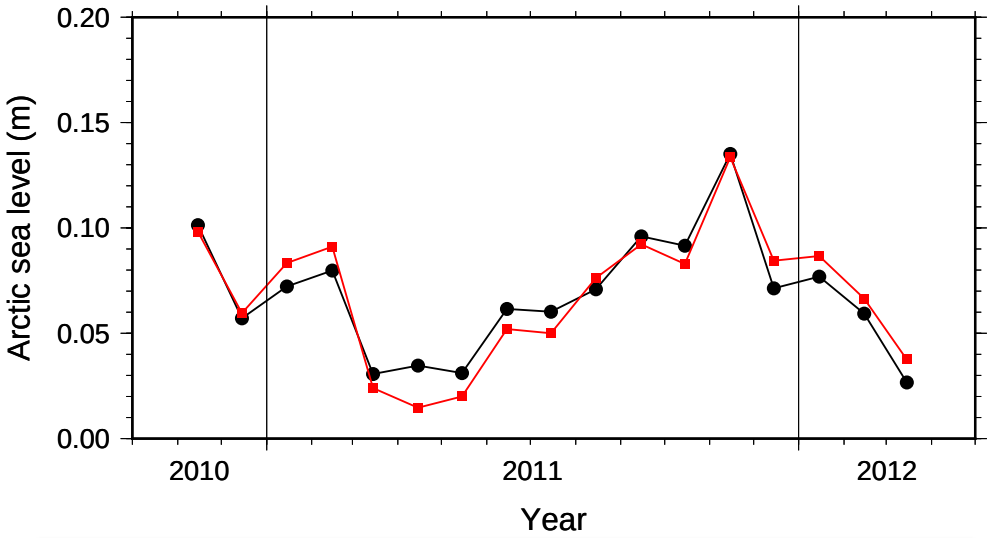

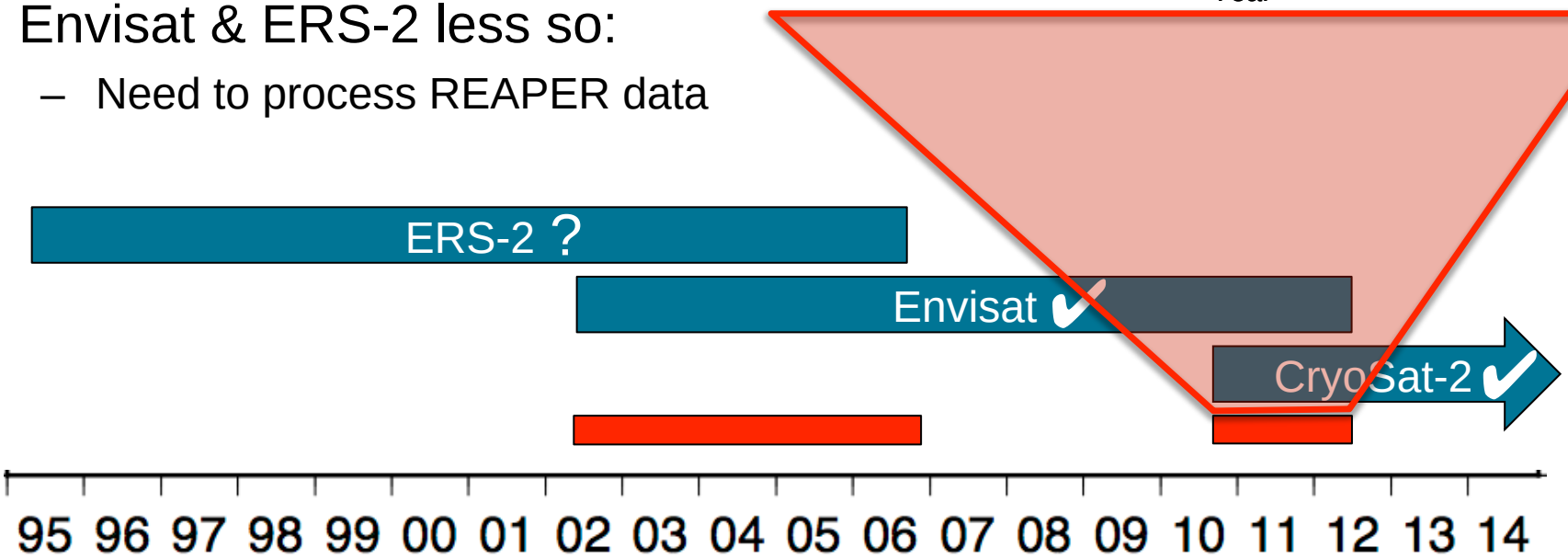

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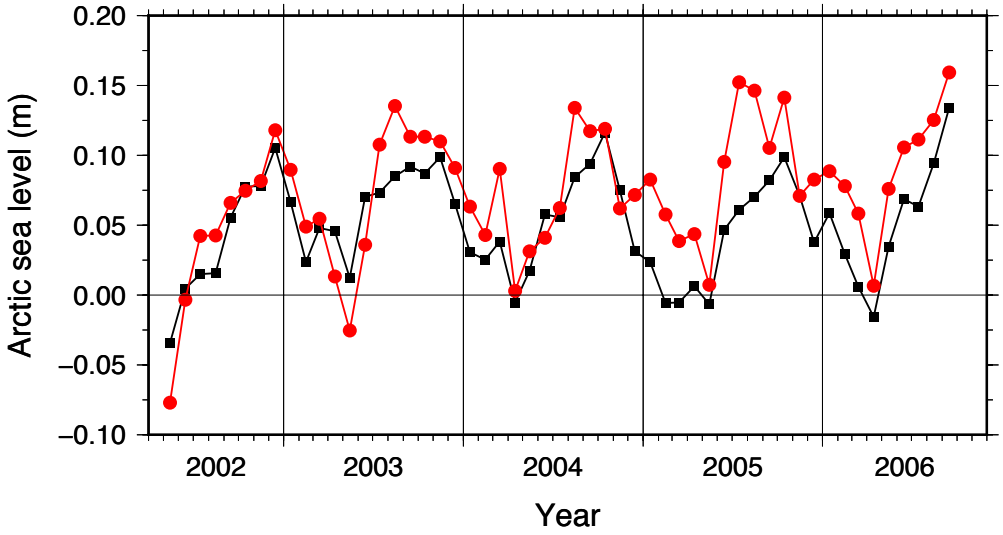
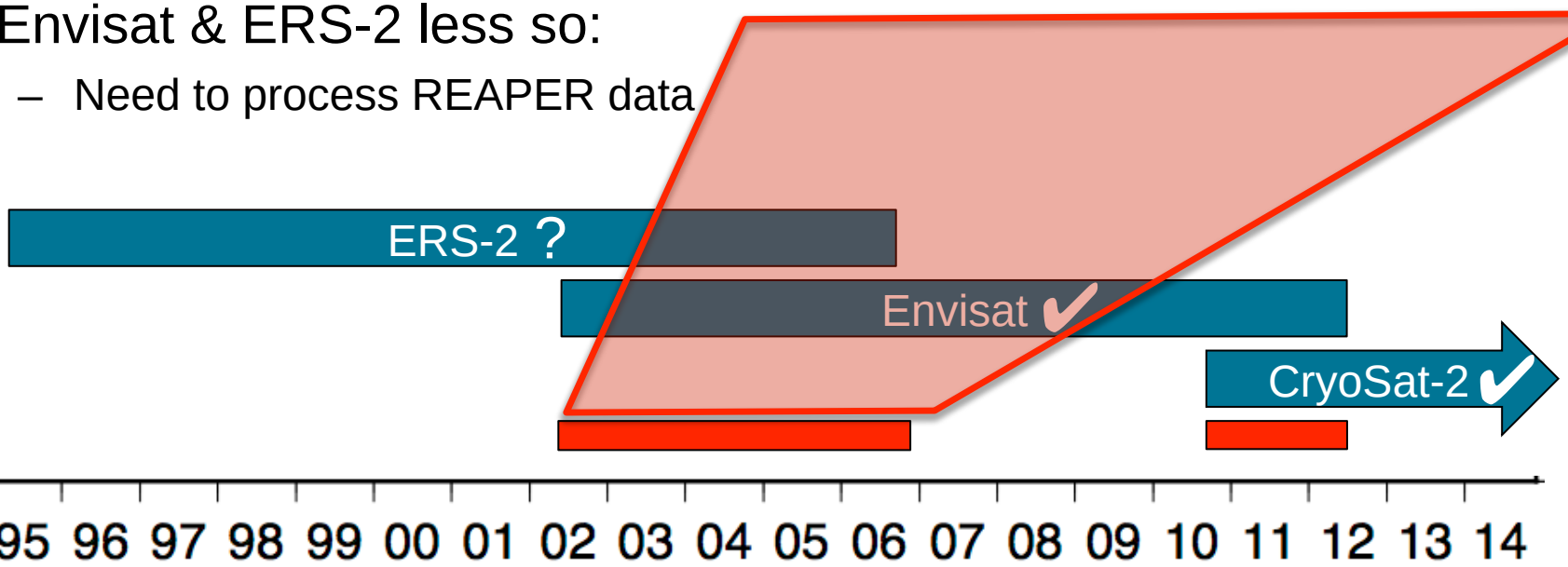
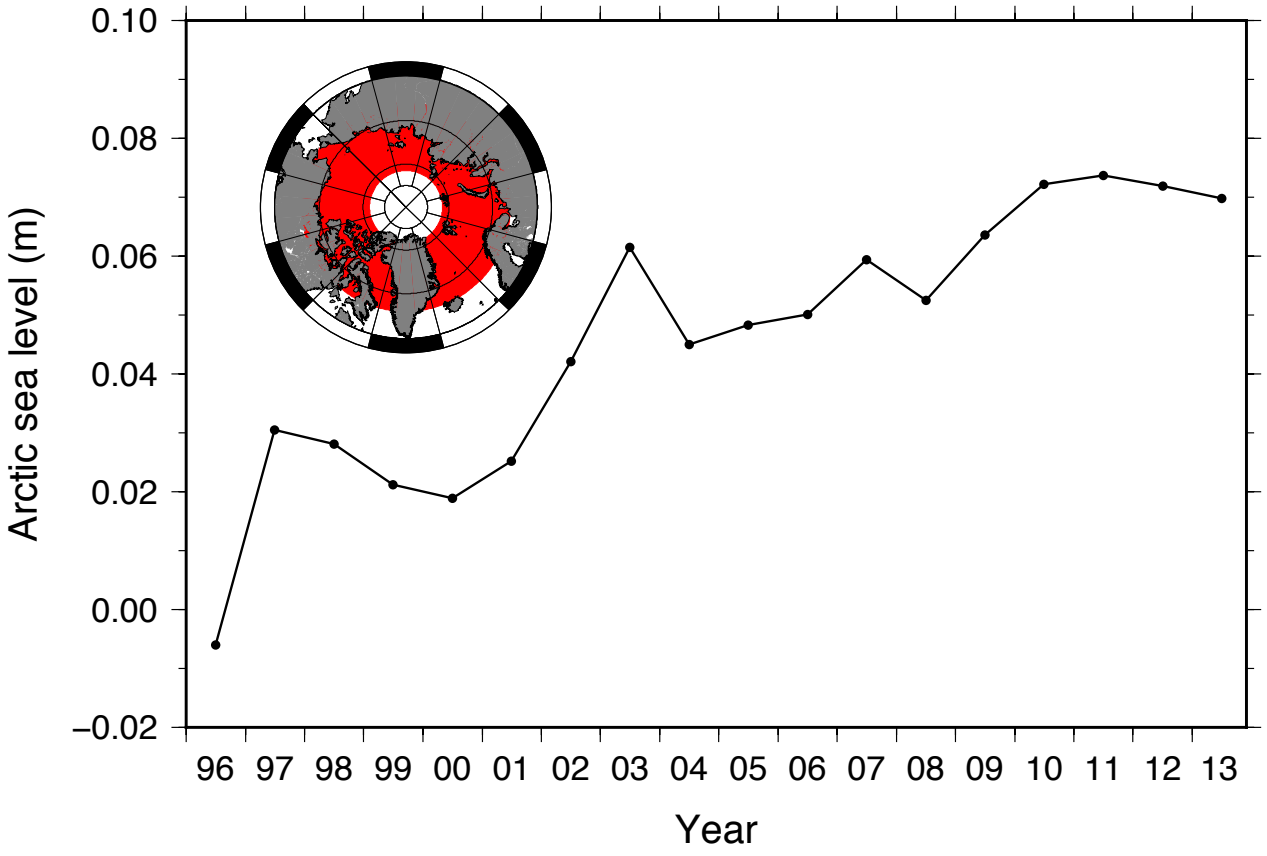




Arctic sea level change



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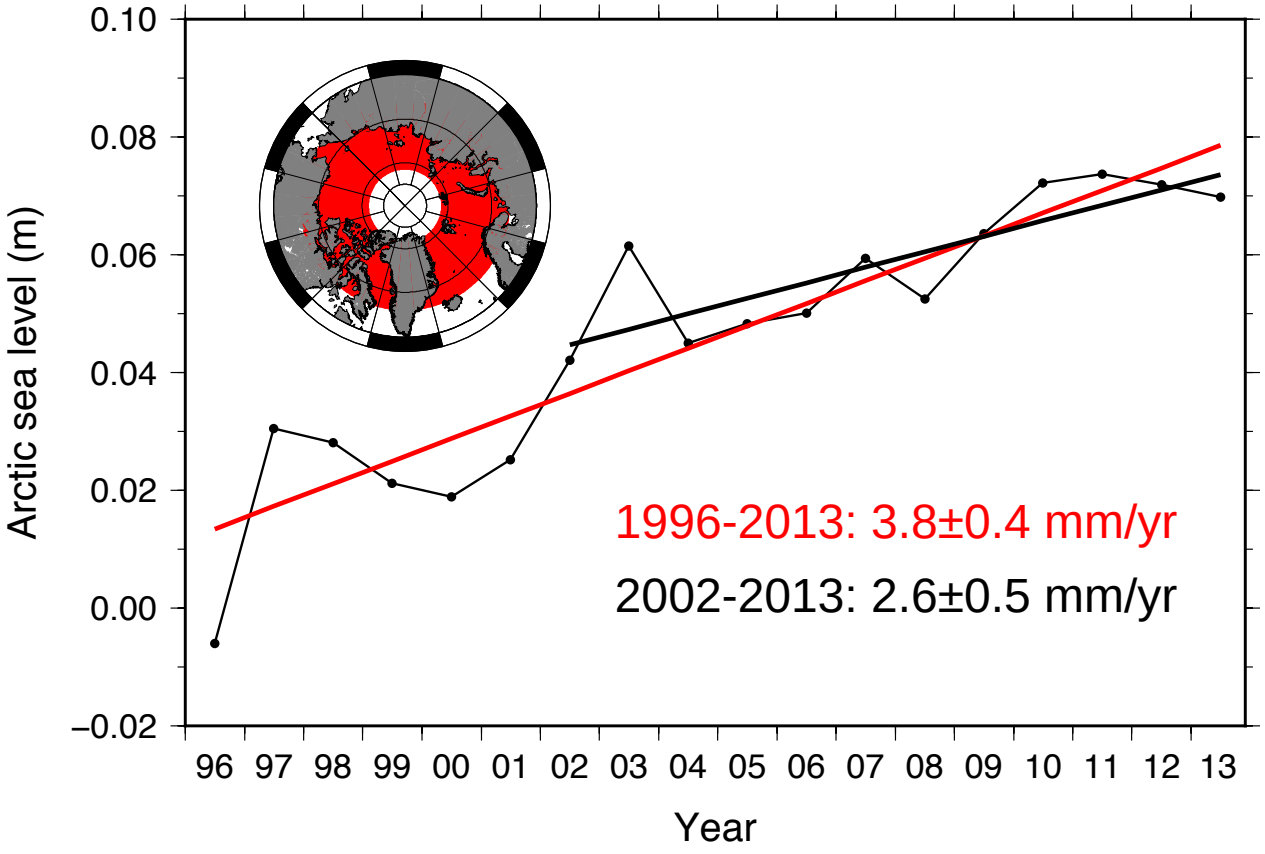
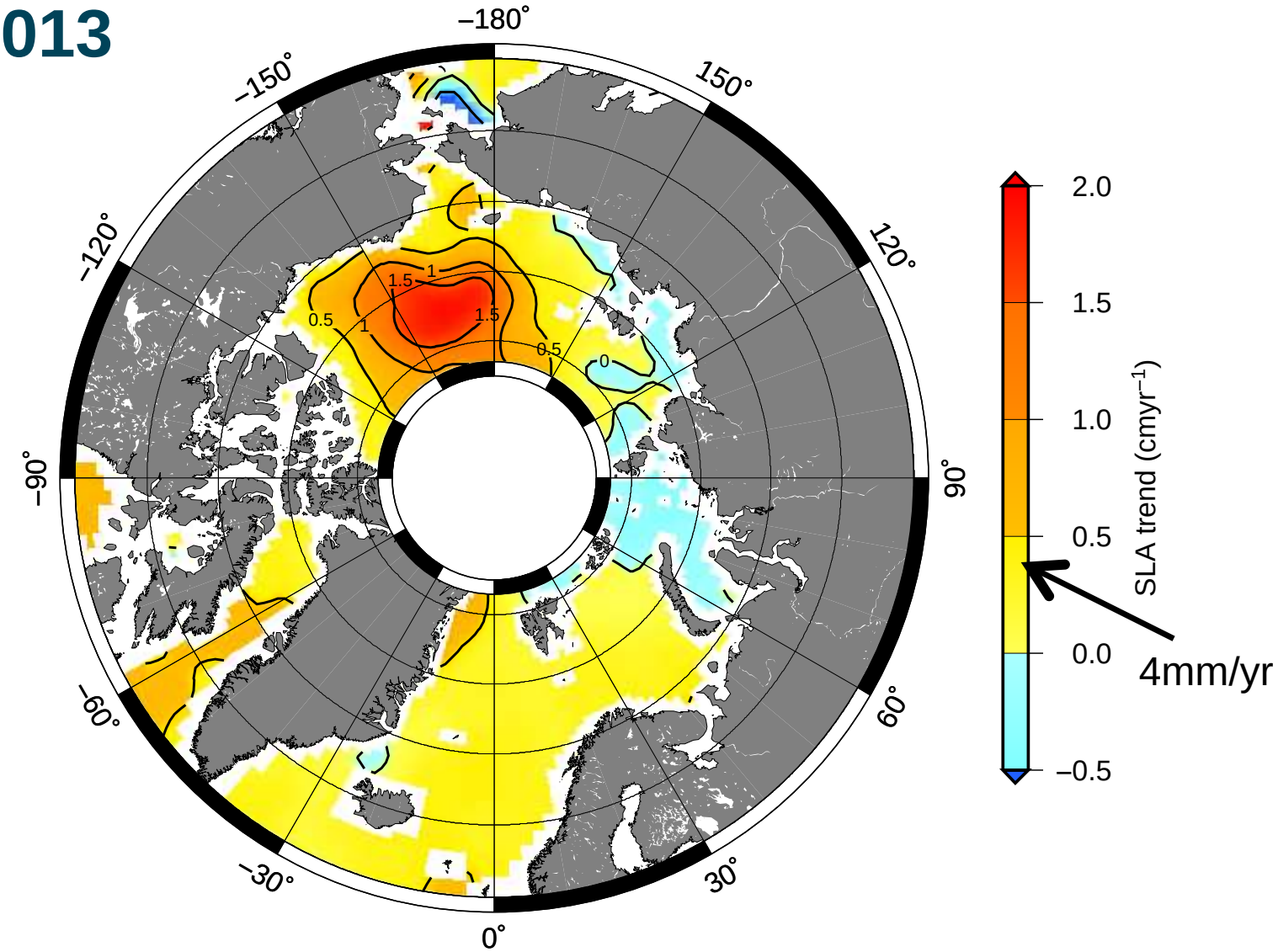
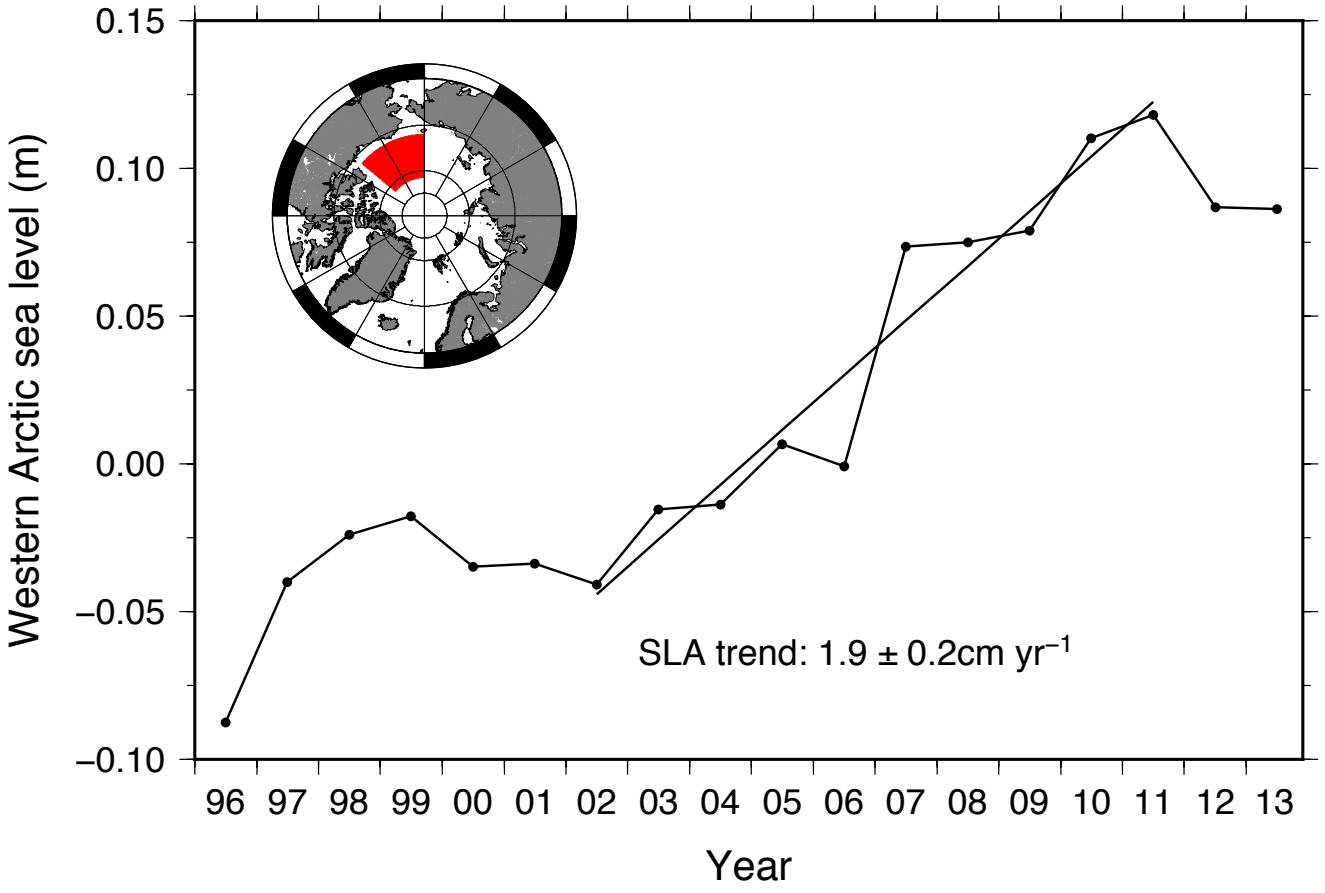


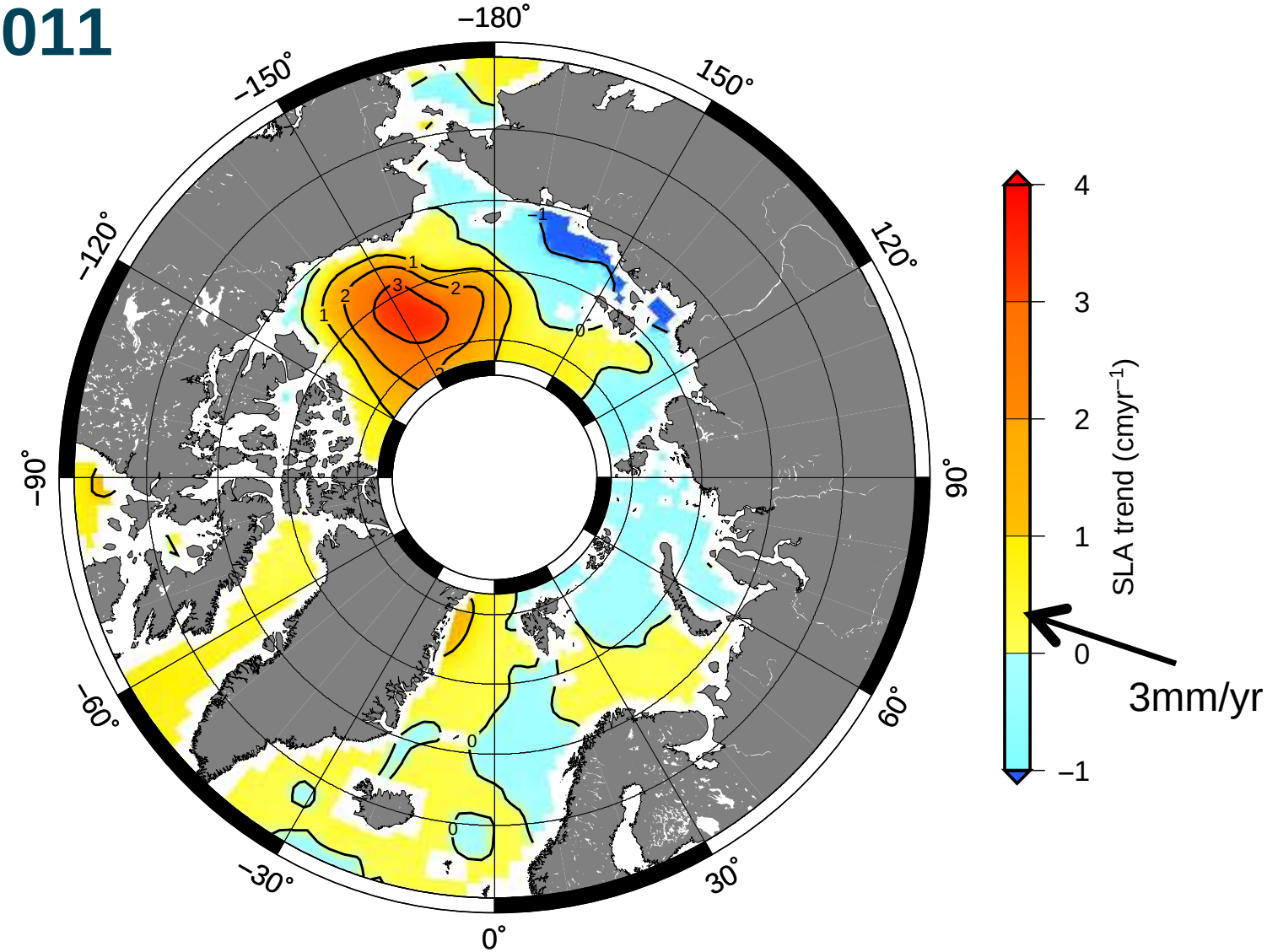
Arctic sea level change 1996-2013



Western Arctic sea level change



Arctic sea level change 2002-2011

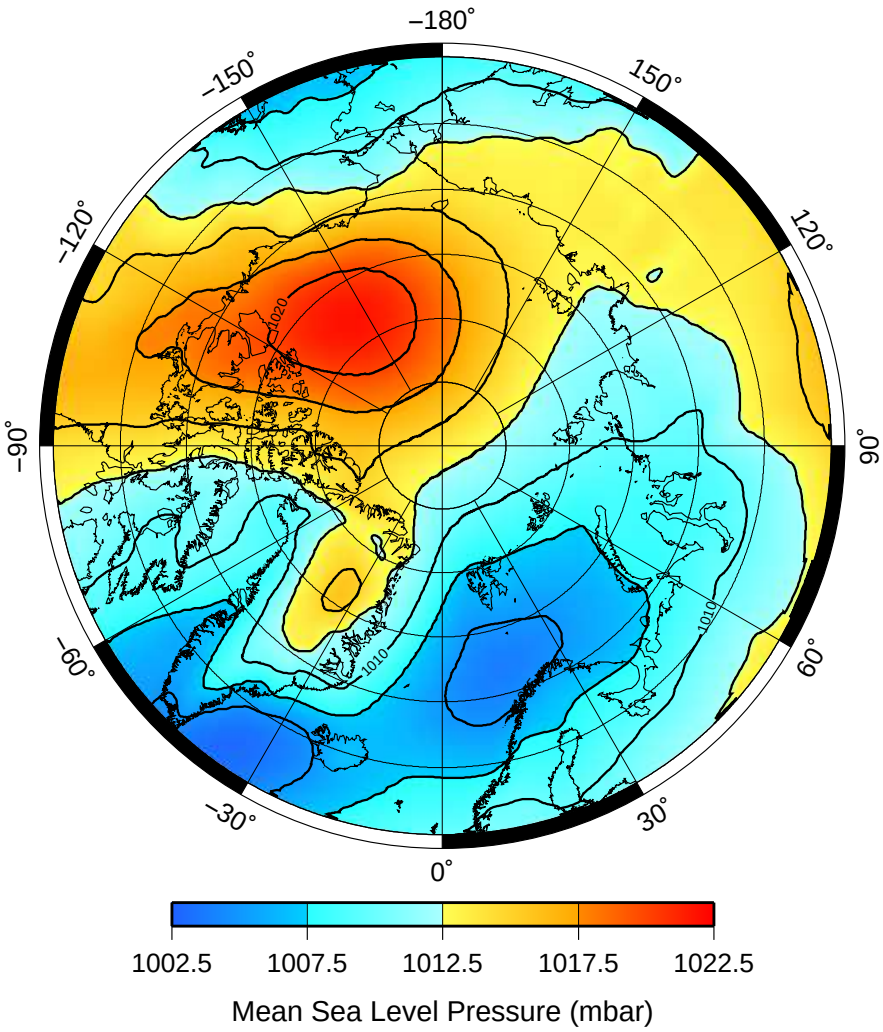


Western Arctic FW chang

- Beaufort Gyre associated with predominant anti-cyclonic atmospheric circulation in region
- Ekman transport causes down-welling and accumulation of fresh water
  - Circulation strengthened during 2000s
  - Loss of sea ice may be changing atmosphere-ocean mom. transfer
- Possible association with North Atlantic salinity anomalies

2000-2010

2007 SLP ERA-Interim



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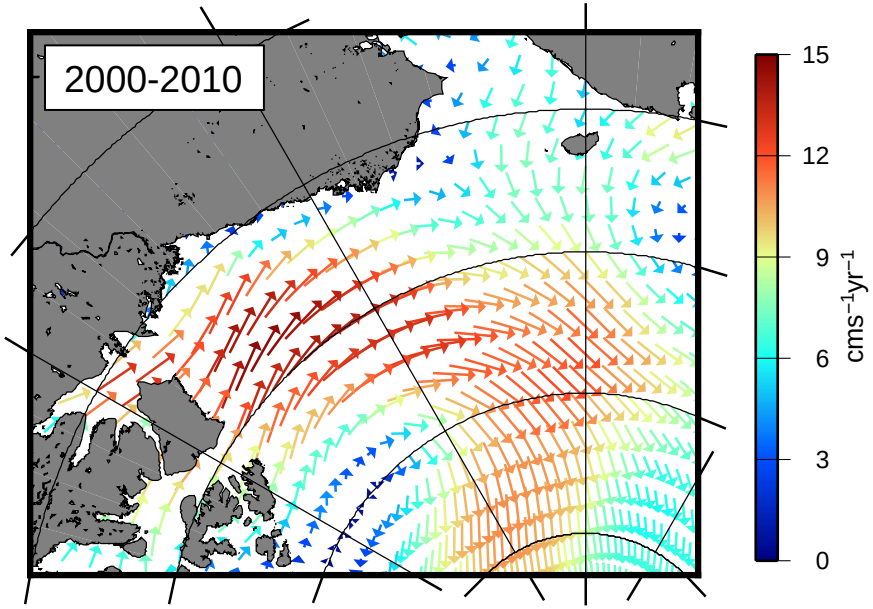

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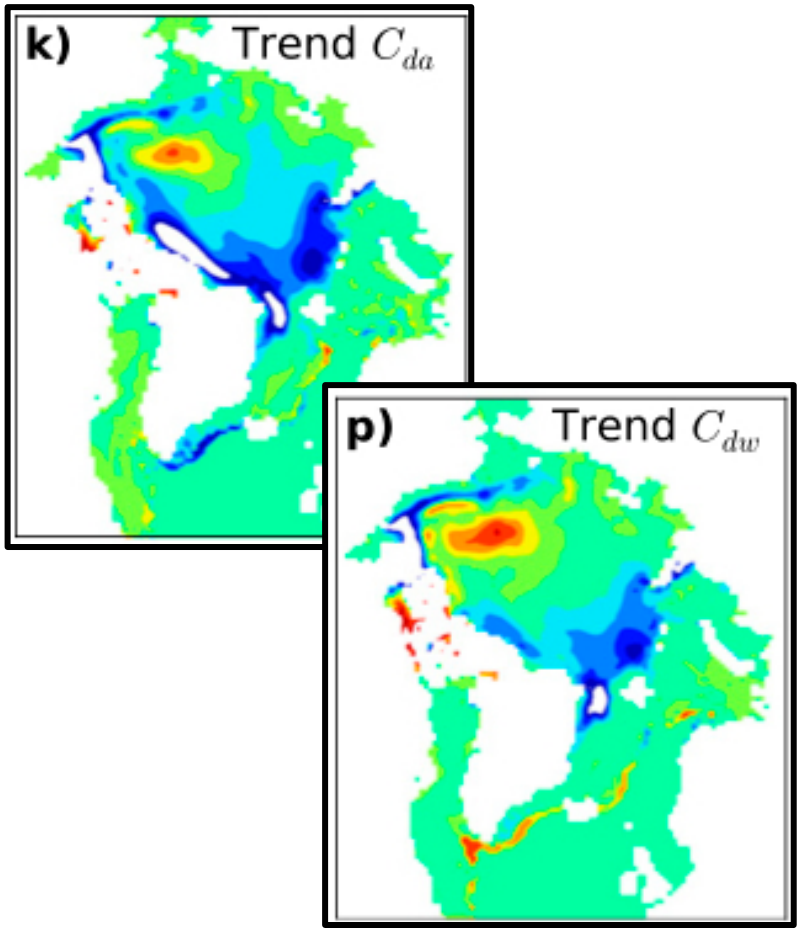

Tsamados et al. (2014)

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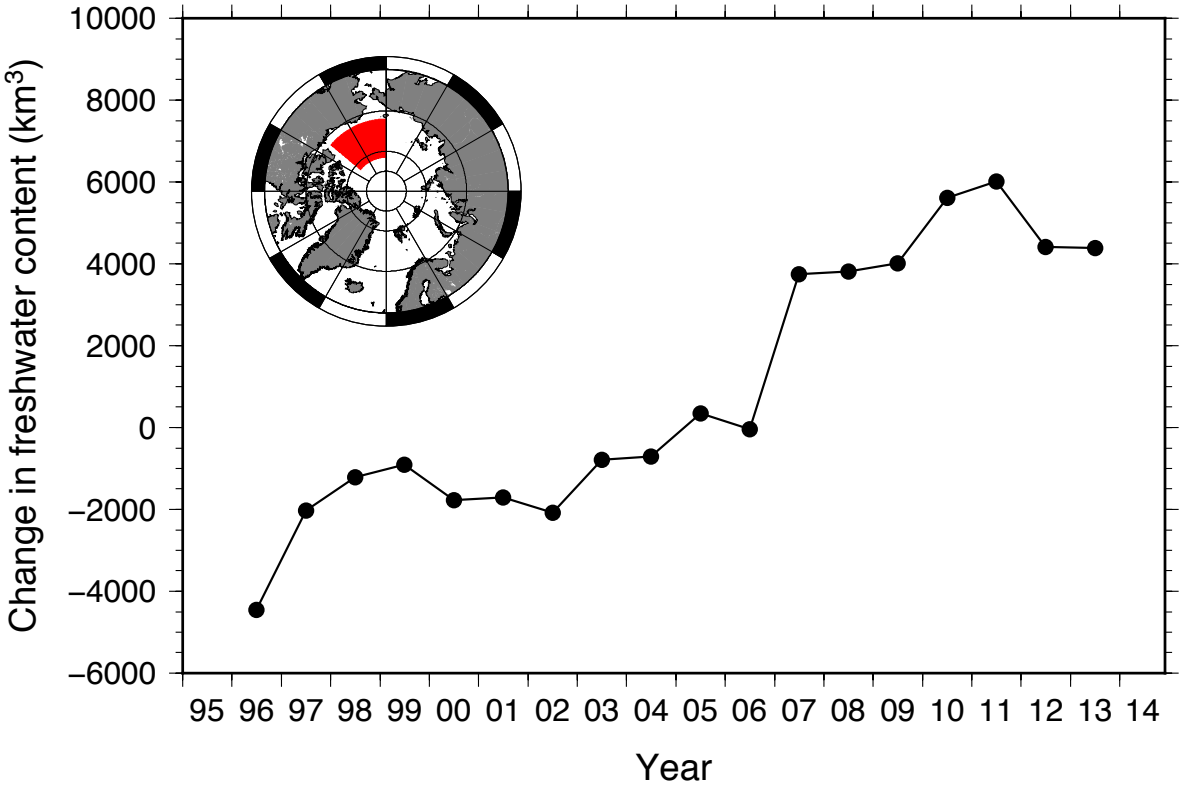

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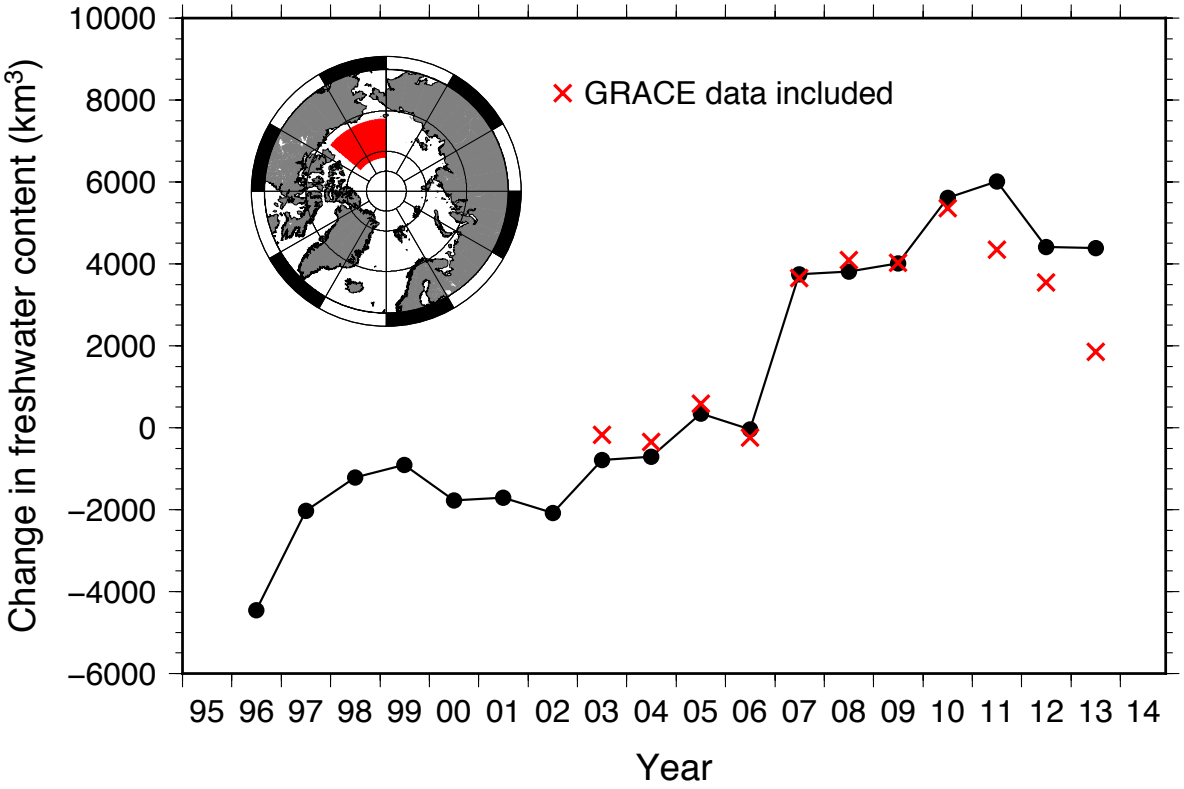

- Increase in FW storage (using Giles et al. (2012) method): ~7,000-8,000km^3 between pre- and post-'spin-up'
- Ocean mass content has increased since 2010, not much change in sea level – FW content decrease

Trends in ocean geostrophic circulation 1996-2013

$$u = -\frac{g}{f}\frac{\partial \eta}{\partial y}$$

$$v = \frac{g}{f}\frac{\partial \eta}{\partial x}$$

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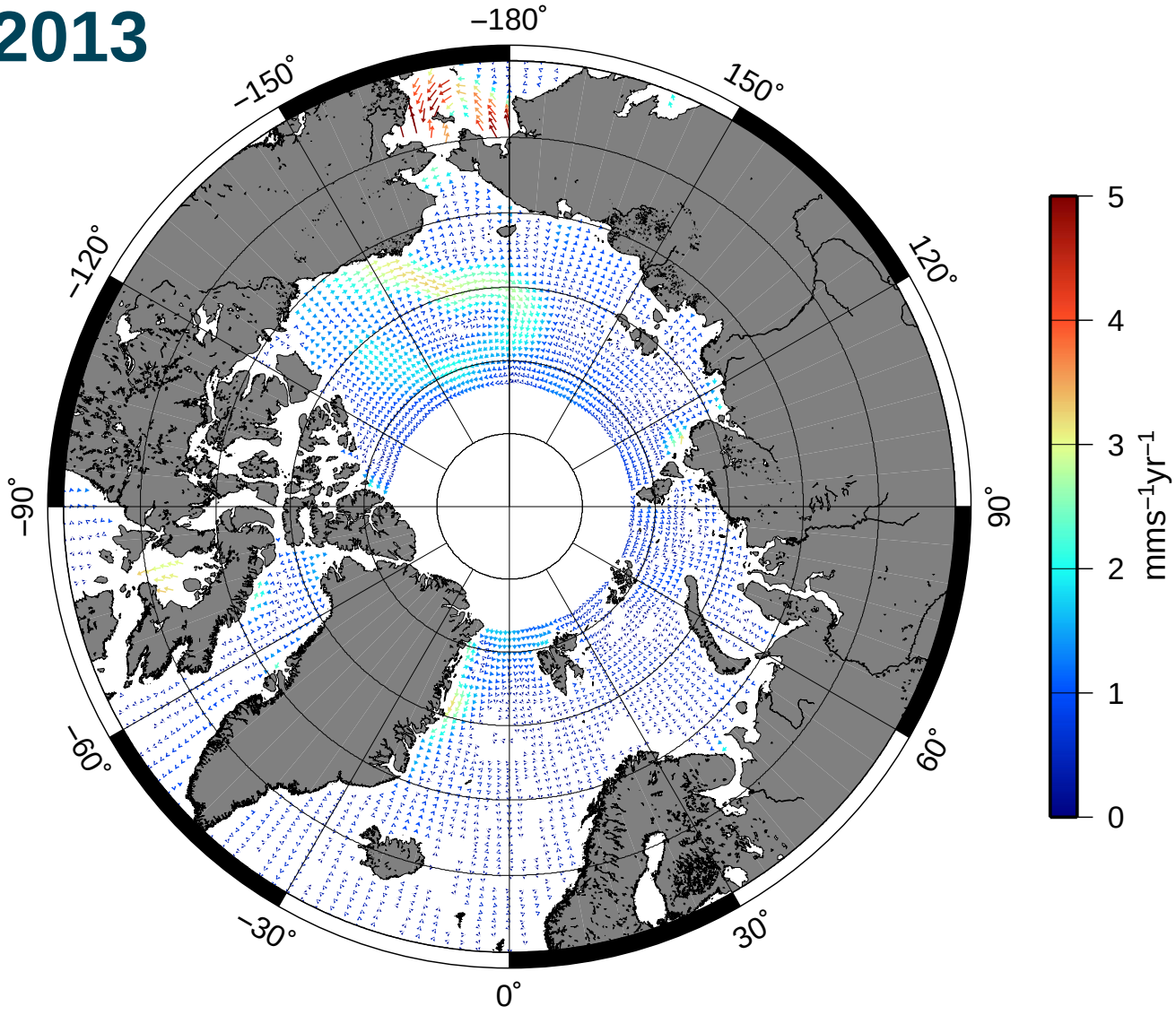

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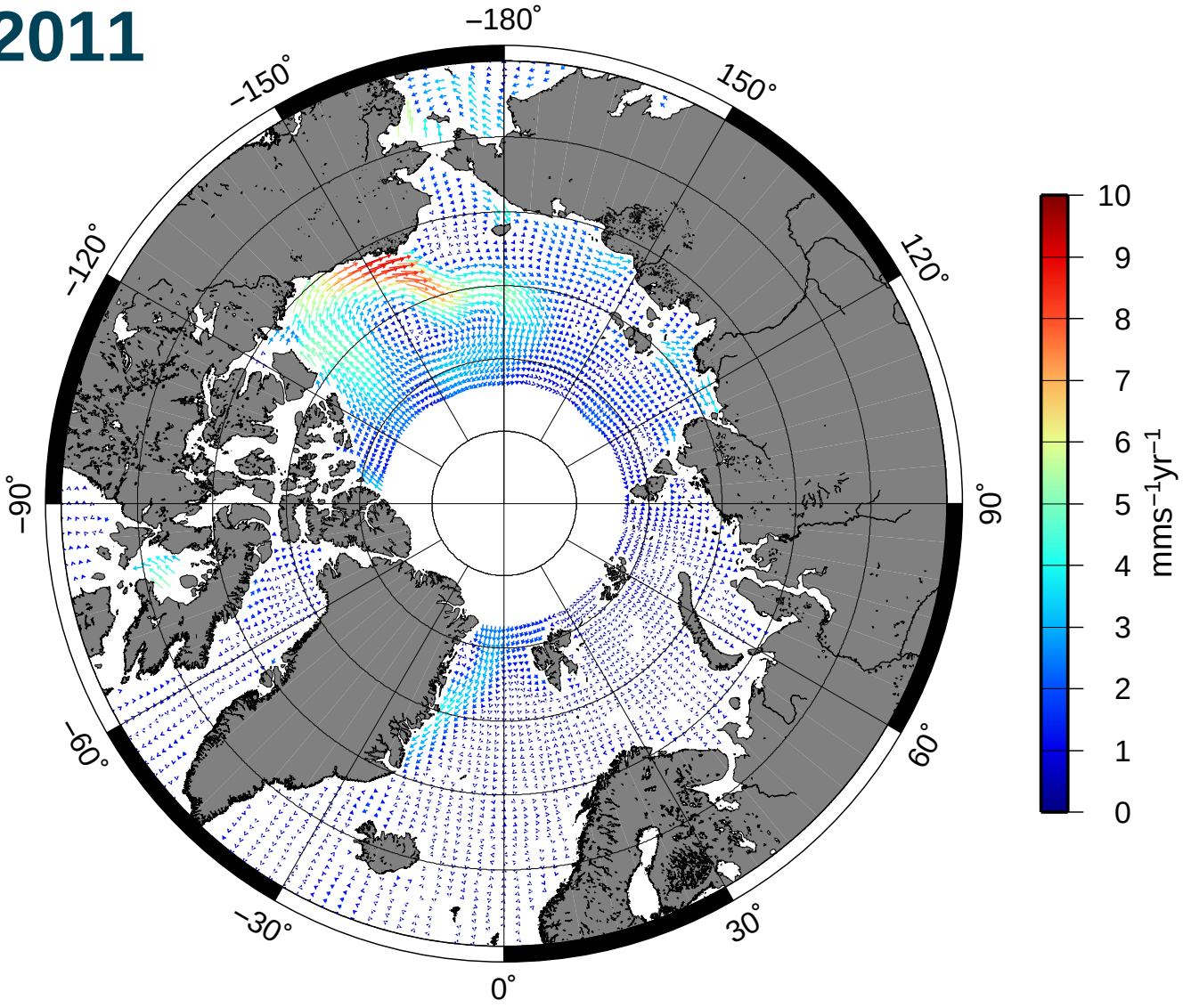

Tr…hic circulation 20…

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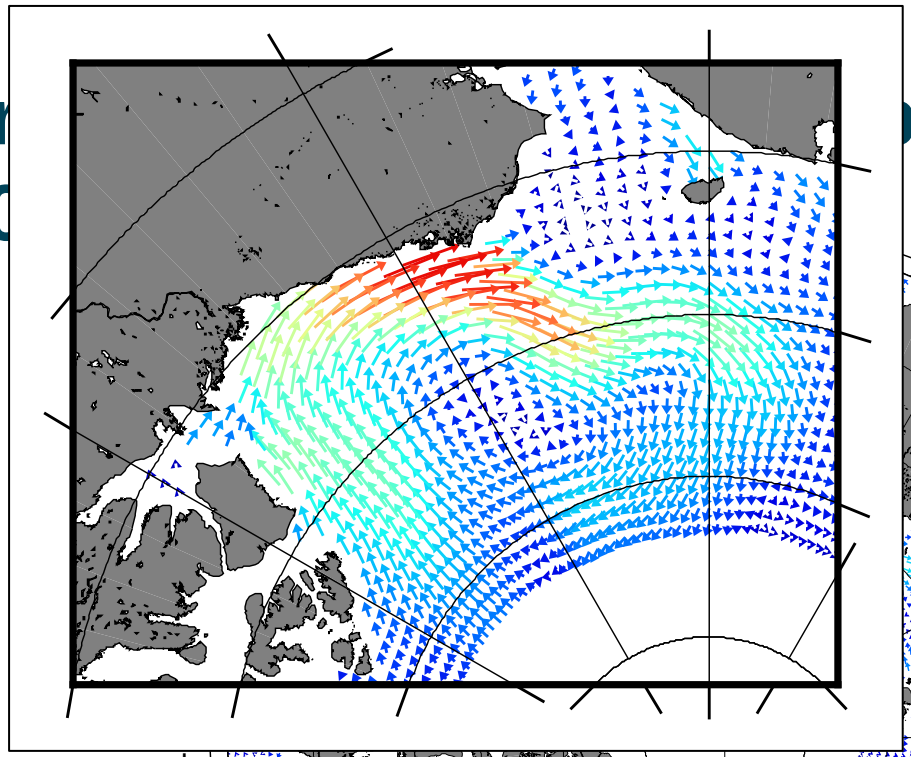
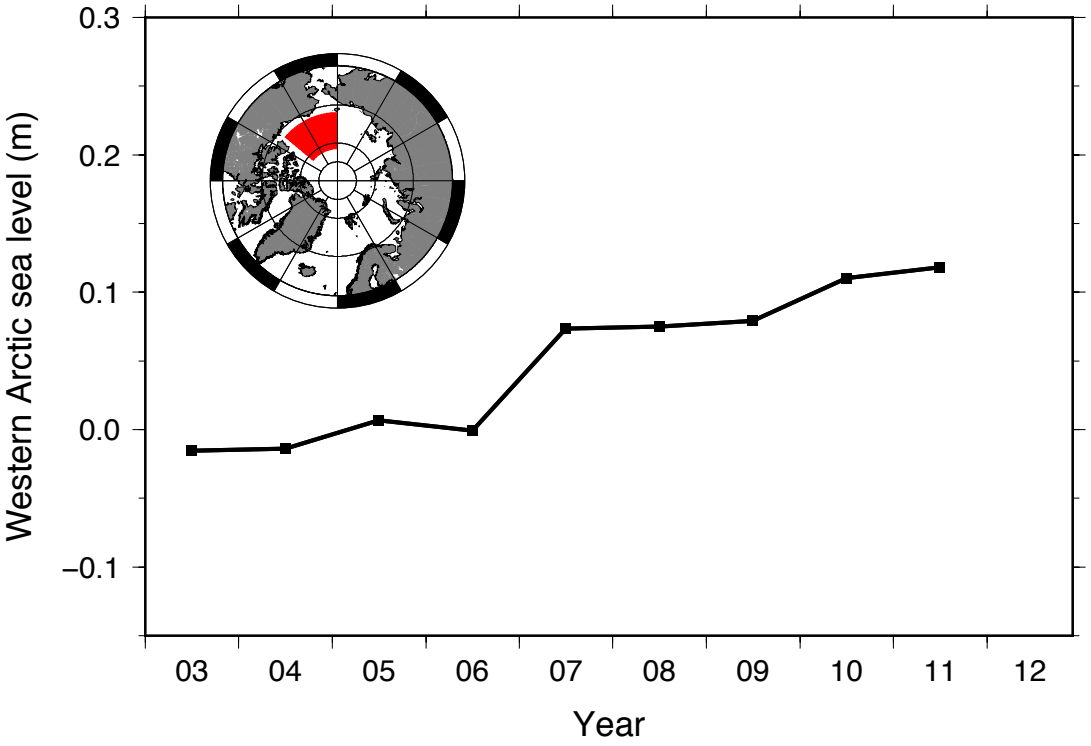


Seasonal cycle



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- Take monthly means instead of annual
- De-trend time series, find [Jan, Feb, Mar…] mean sea level

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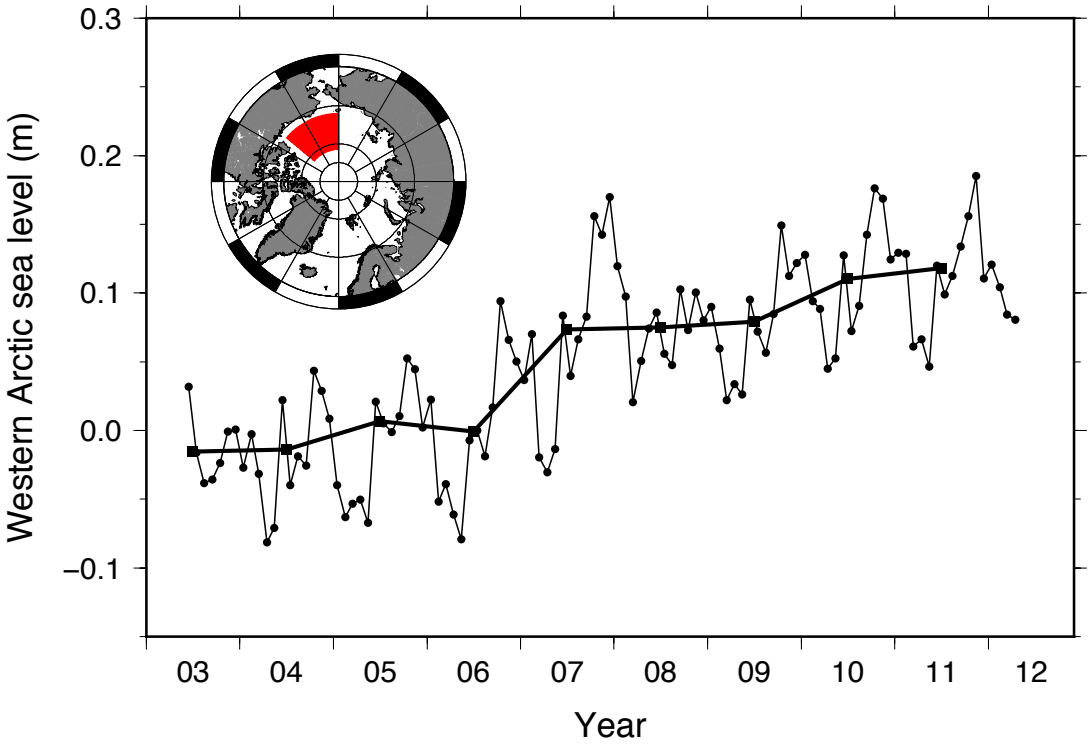

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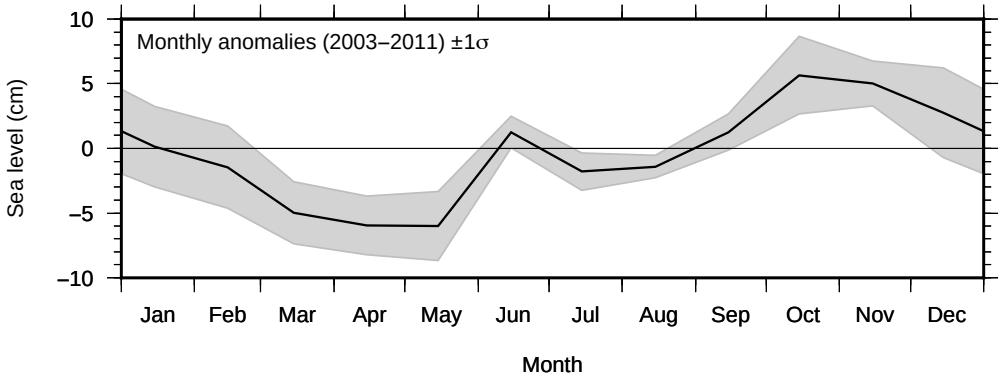

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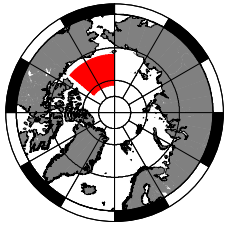

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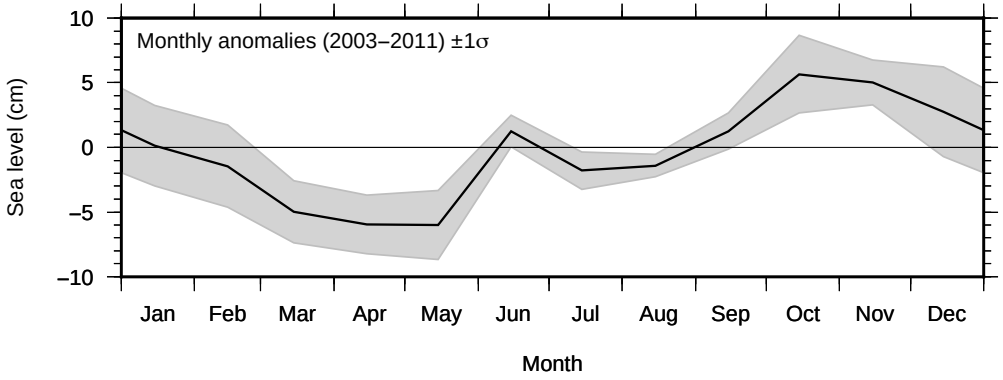

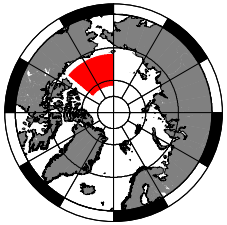

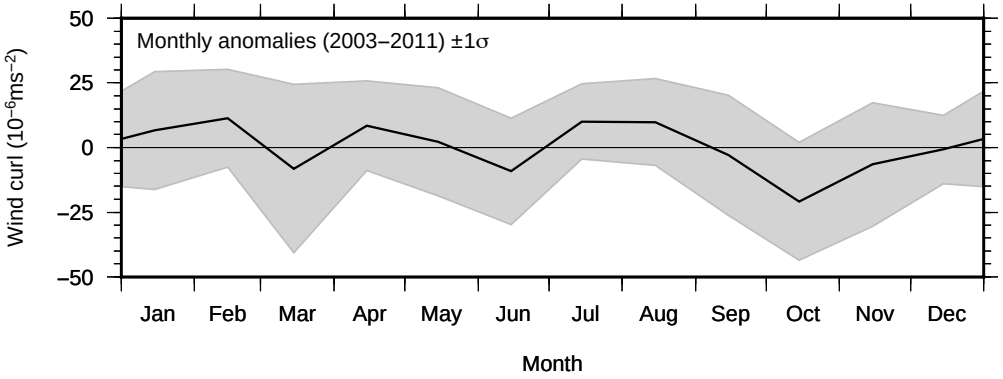

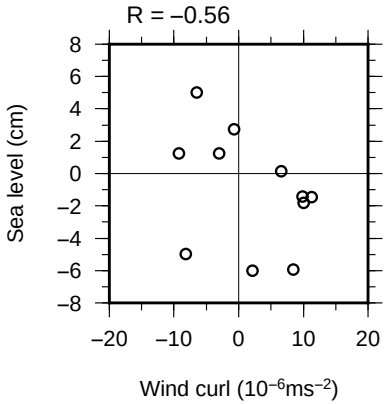

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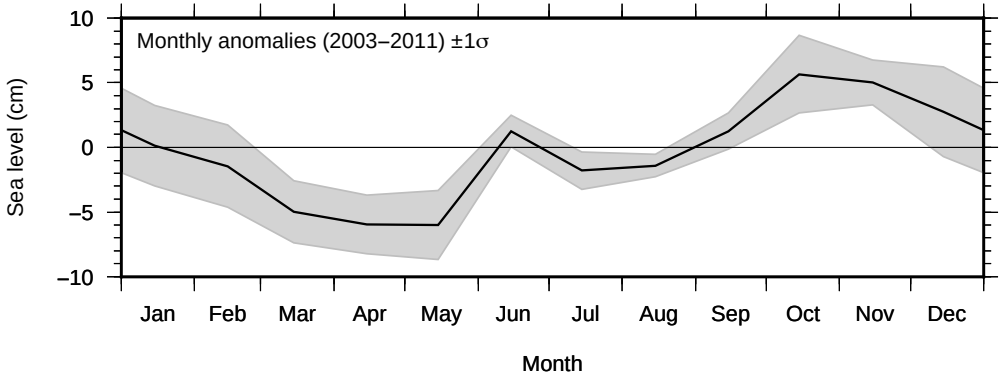

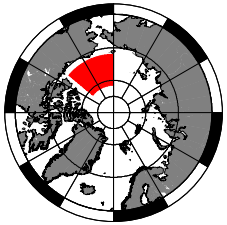

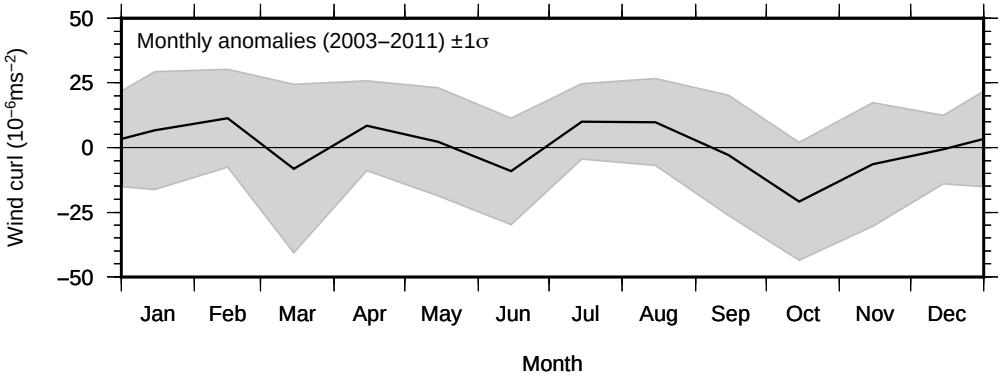

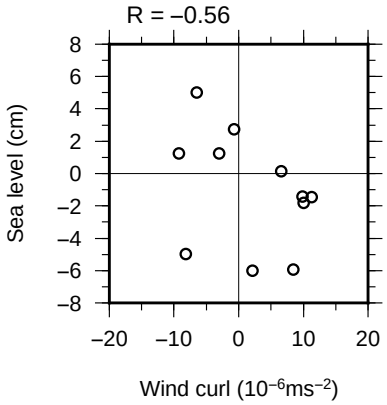

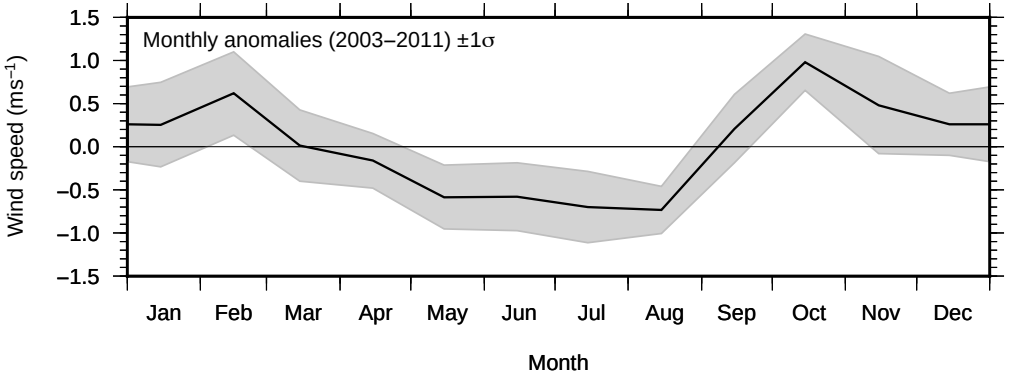

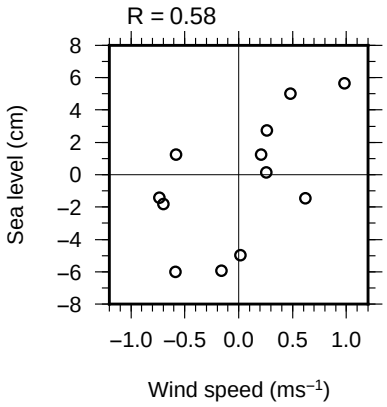

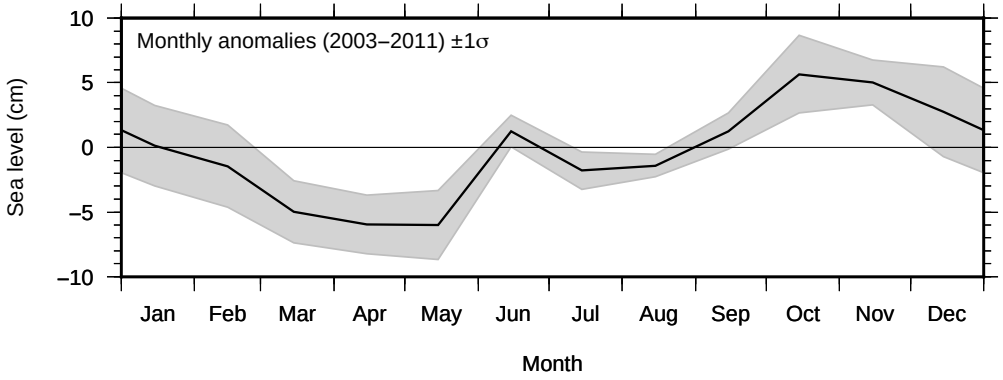

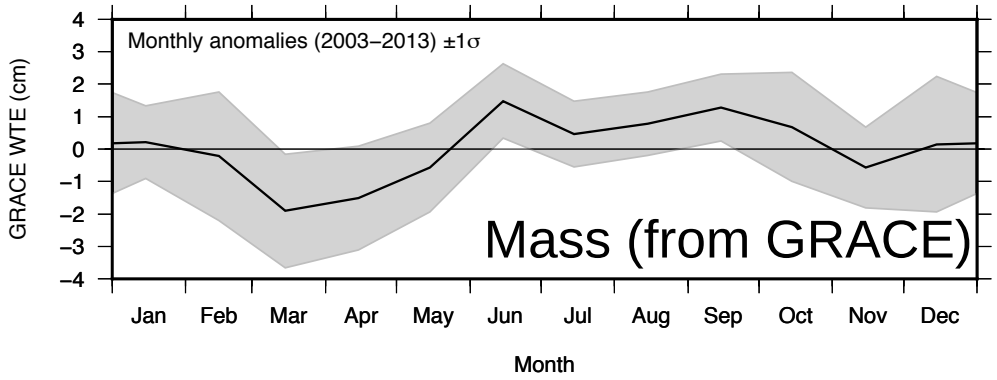

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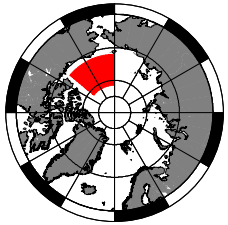
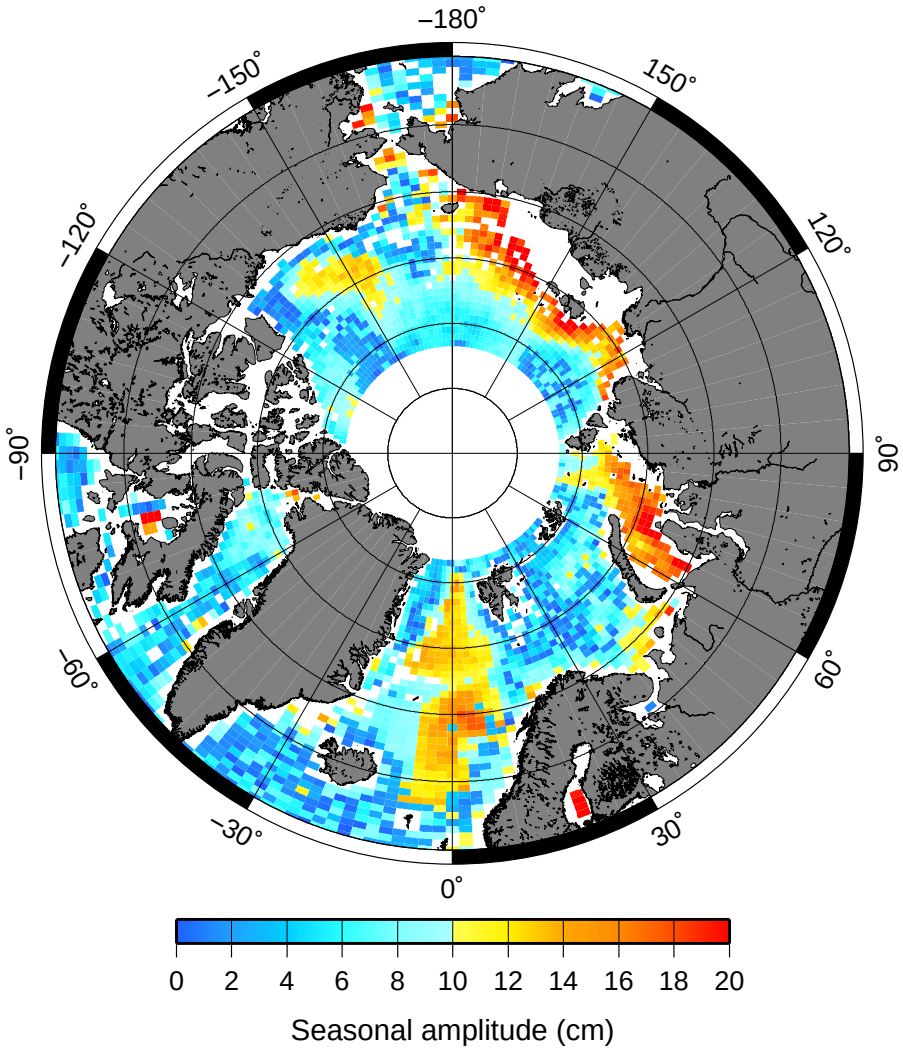
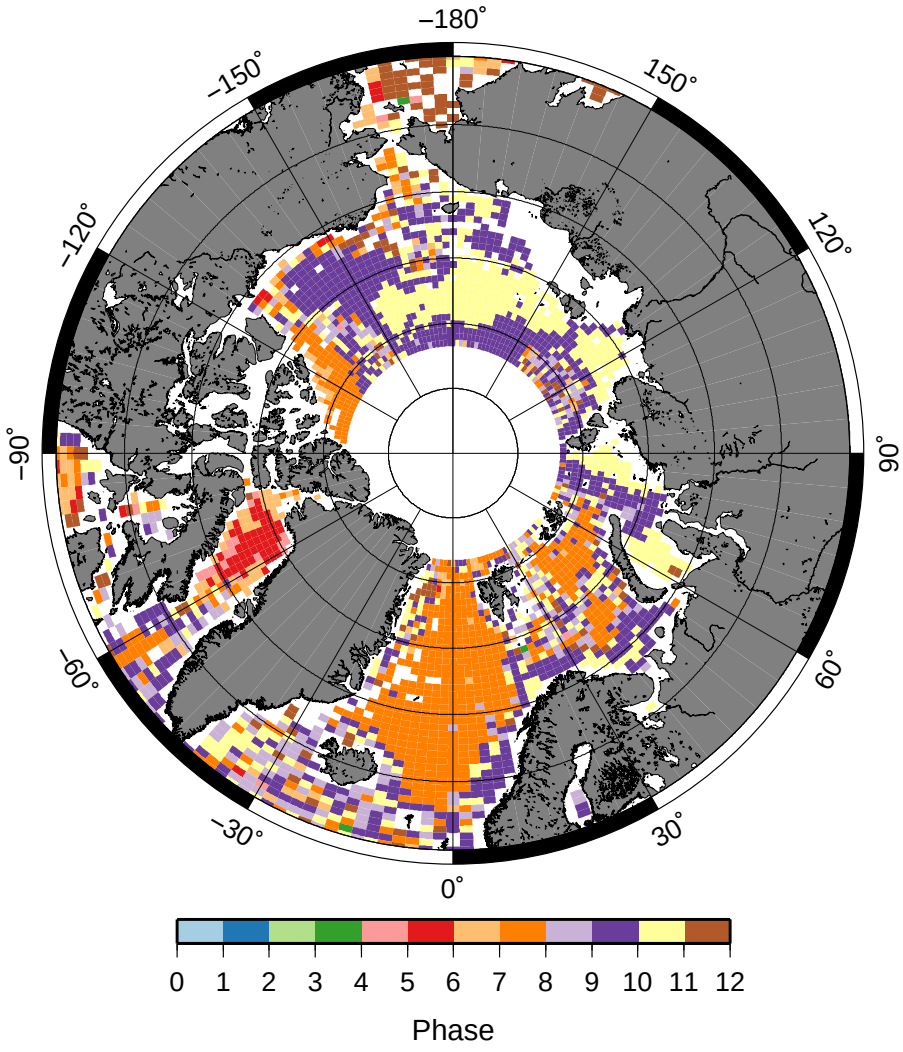


- Seasonal sea level controlled primarily by the seasonal wind cycle
- Also see effects of seasonal fresh water input

Seasonal cycle (2004-2011)





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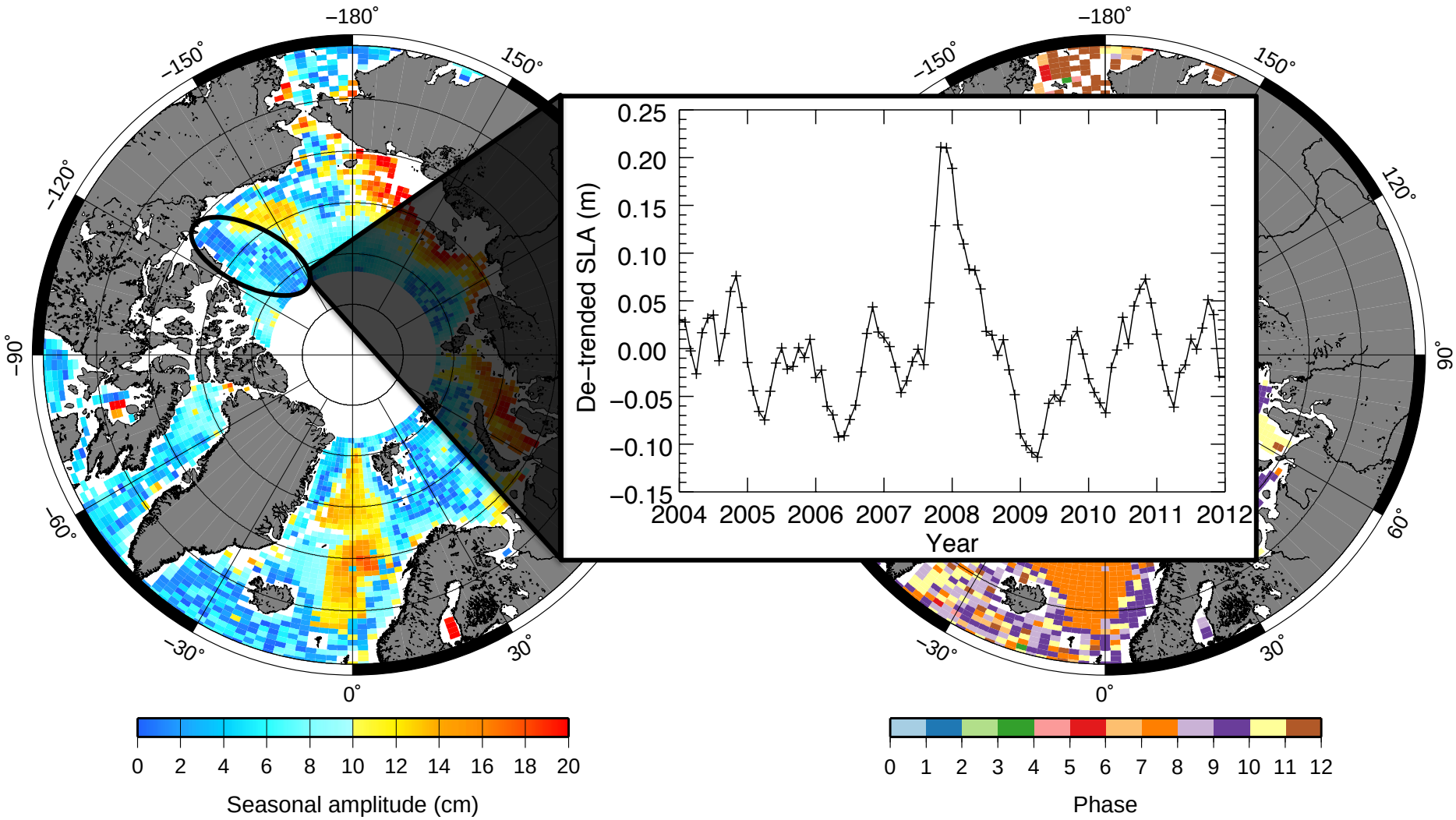

Conclusions

- Radar altimeters are a powerful tool for Arctic ocean observations
- Arctic Ocean sea level rise agrees with global MSL rise but large regional variations
- Western Arctic level peaks in 2011, slight drop since
  - Accompanied by up to 1cm/s per year increase in ocean geostrophic current between 2002-2011
  - Storage of ~7,000-8,000km^3 of freshwater 2002-2010, possible release since 2011
- Double peaked seasonal cycle in Western Arctic
  - Wind driven and FW input driven

References

- Giles et al. (2012), “Western Arctic Ocean freshwater storage increased by wind-driven spin-up of the Beaufort Gyre”, *Nature Geoscience*, 5, 194–197
- Tsamados et al. (2014), “Impact of Variable Atmospheric and Oceanic Form Drag on Simulations of Arctic Sea Ice”, Journal Physical Oceanography, 44, 1329-1353
- GRACE ocean data were processed by Don P. Chambers, supported by the NASA MEaSUREs Program, and are available at http://grace.jpl.nasa.gov.

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Any Questions?