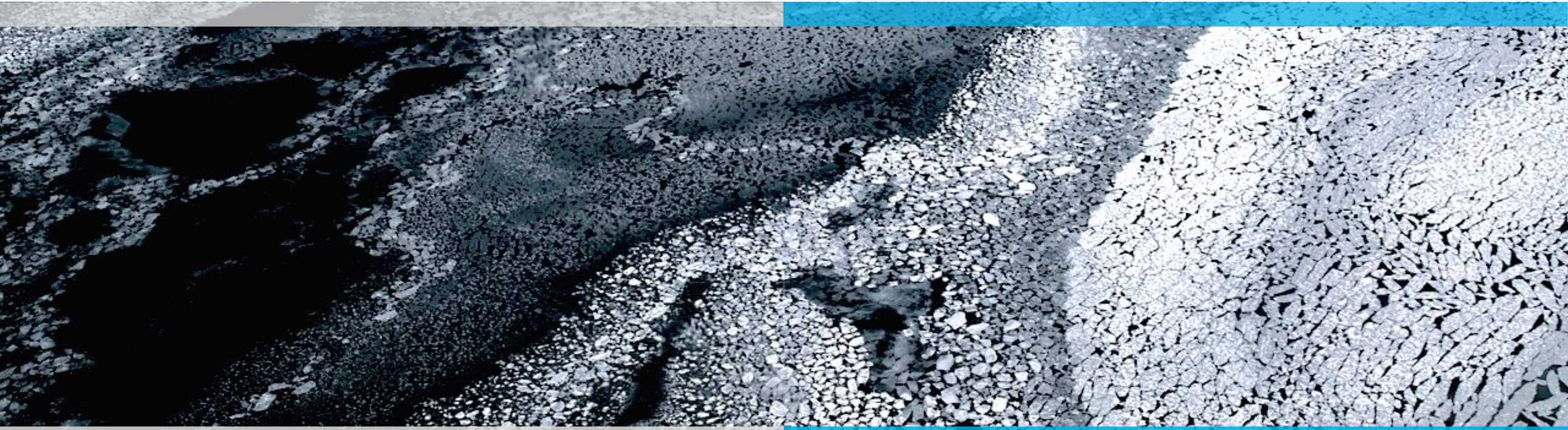
AGU FALL MEETING
New Orleans 11-15 Dec. 2017

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Sea ice thickness derived from radar altimetry: achievements and future plans



Robert Ricker[1], S. Hendricks[1], S. Paul[1], L. Kaleschke[2], X. Tian-Kunze[2]

[1] Alfred Wegener Institute for Polar and Marine Research
[2] University of Hamburg

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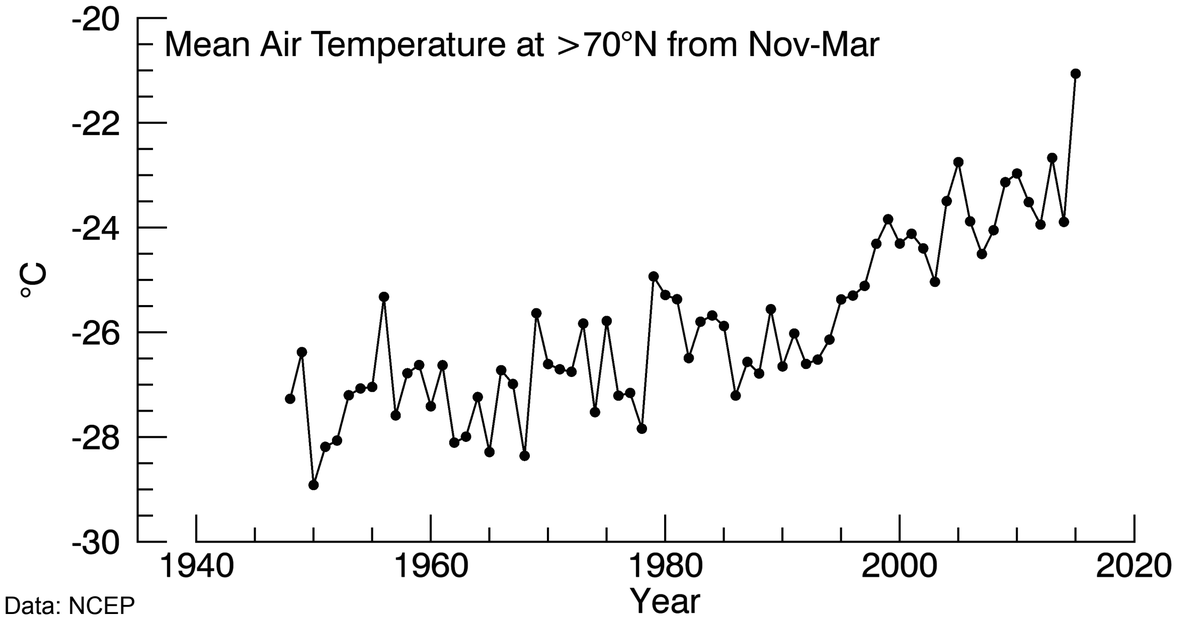
HELMHOLTZ ASSOCIATION

Rationale



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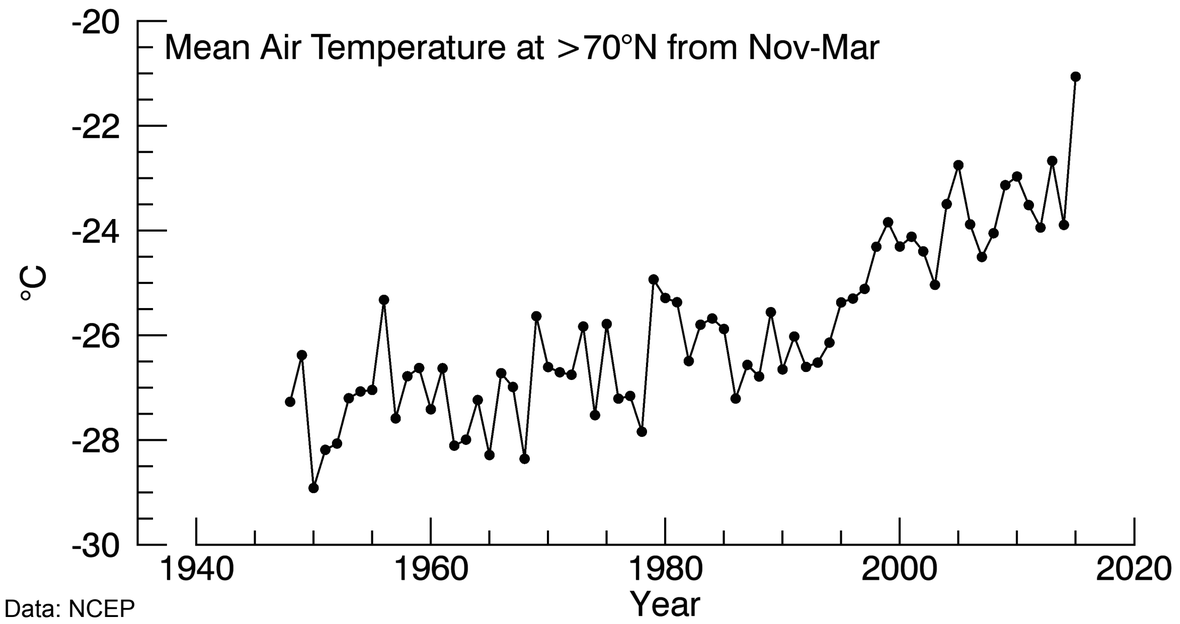

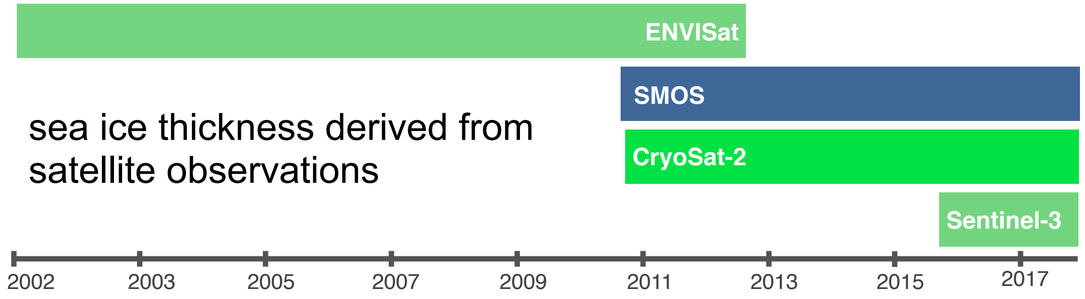

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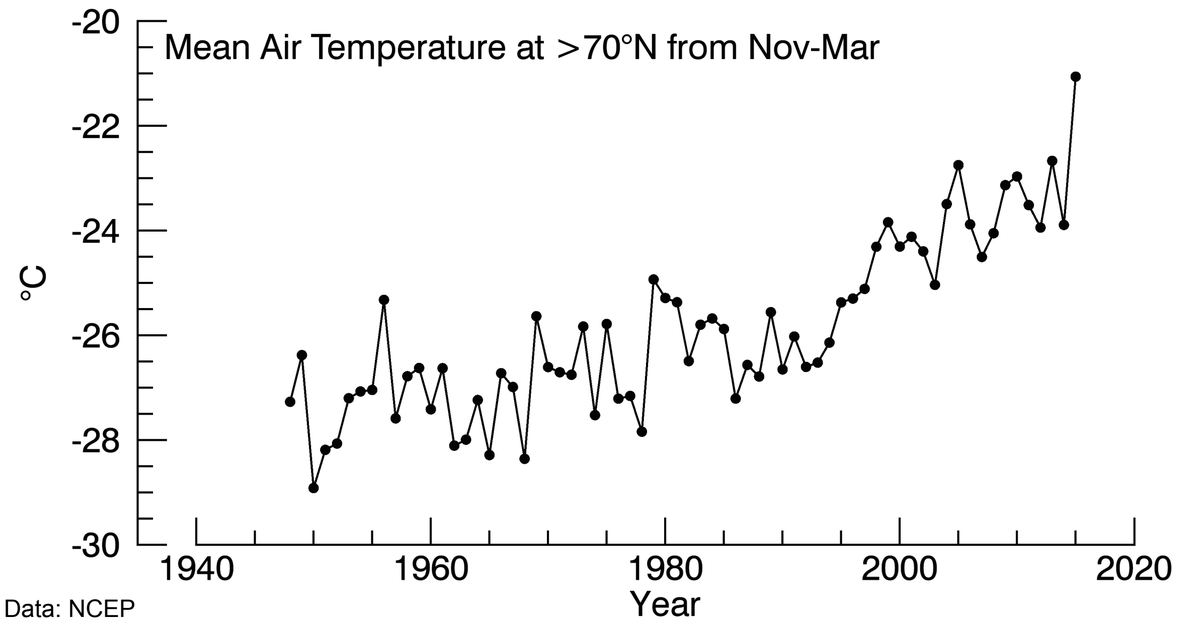

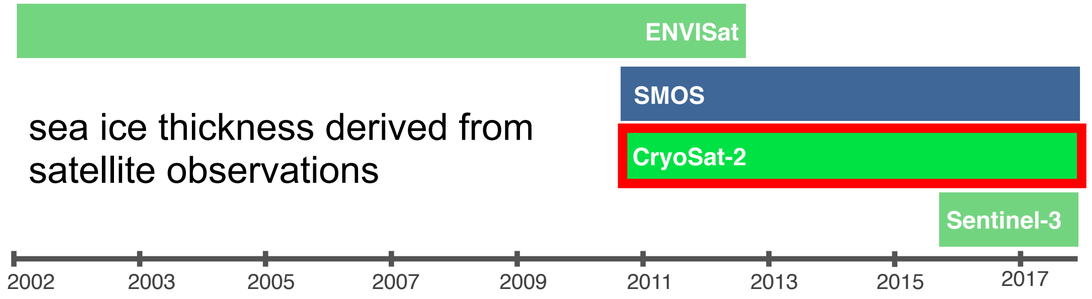

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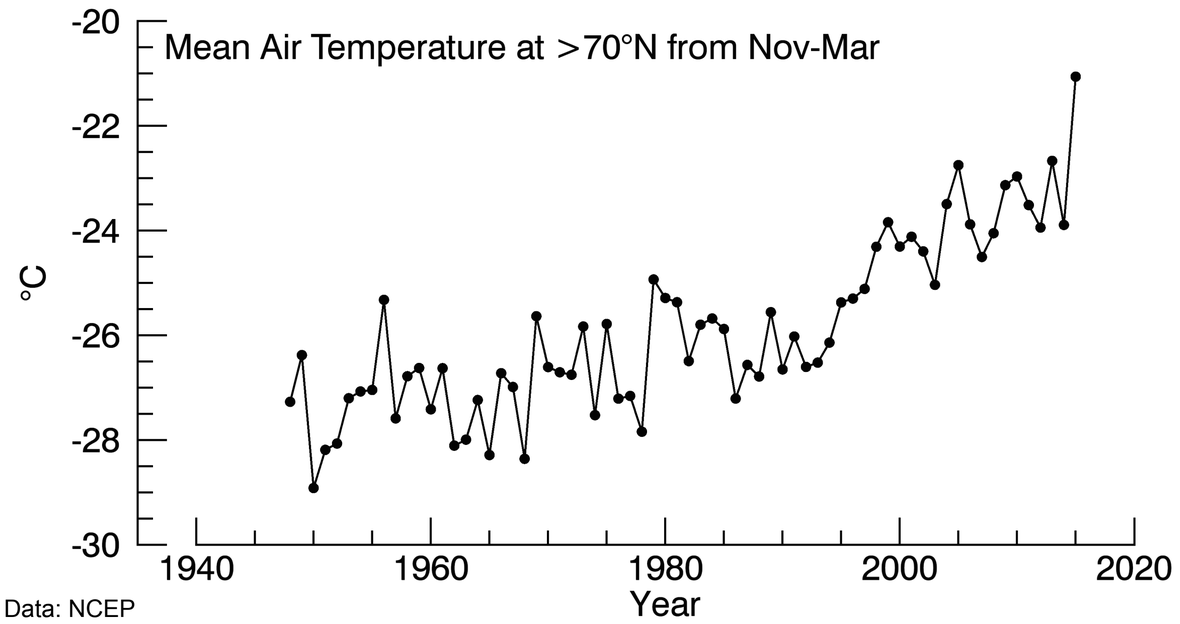

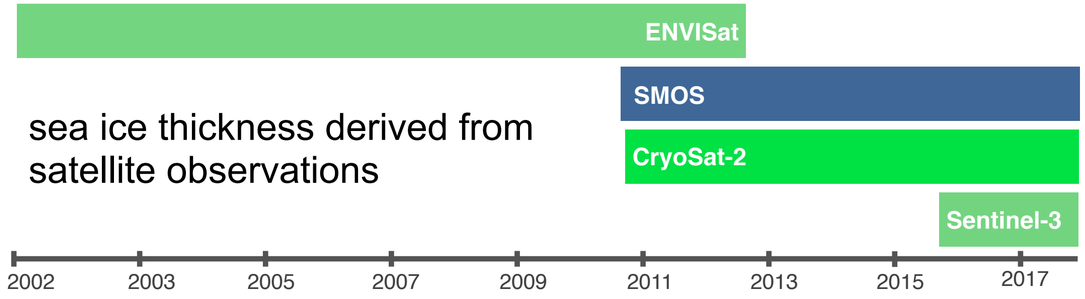

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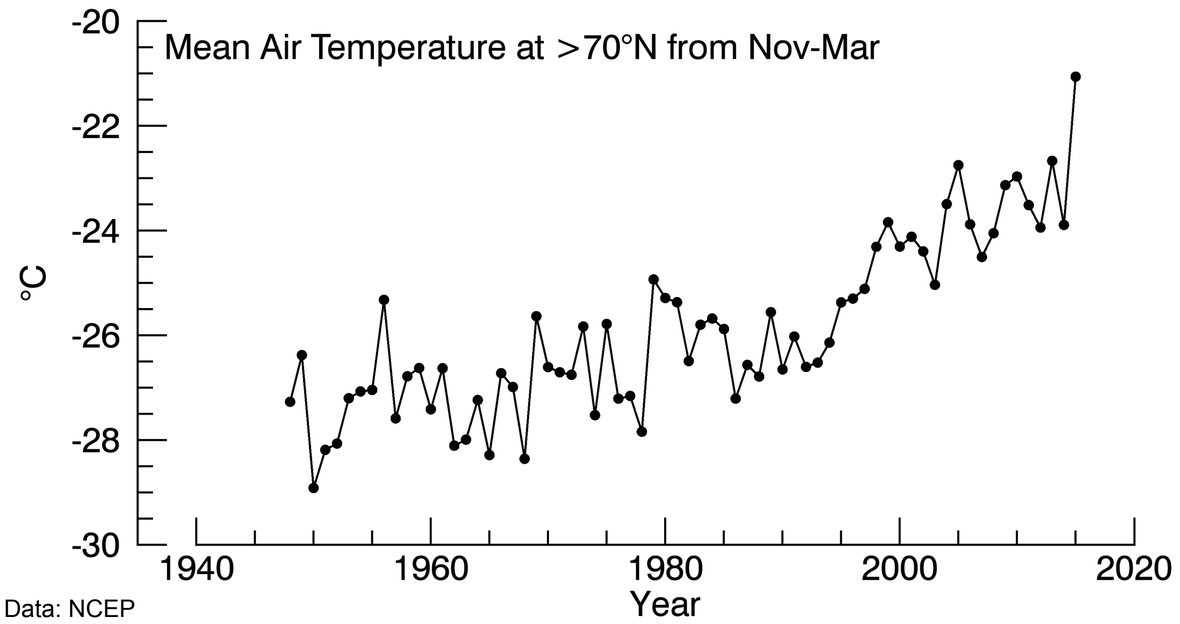

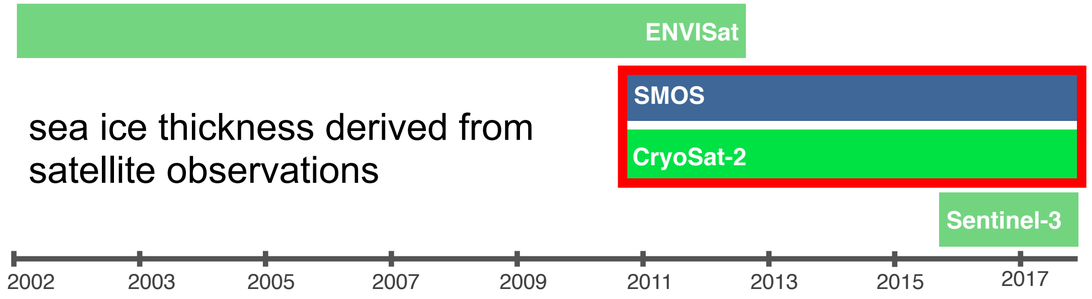

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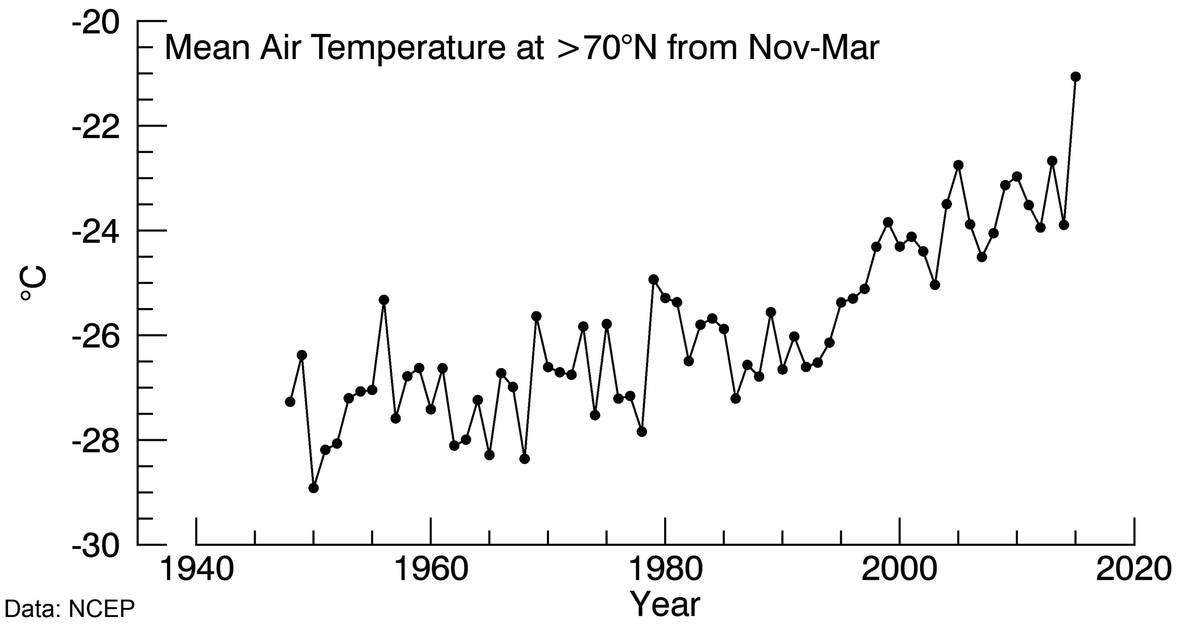

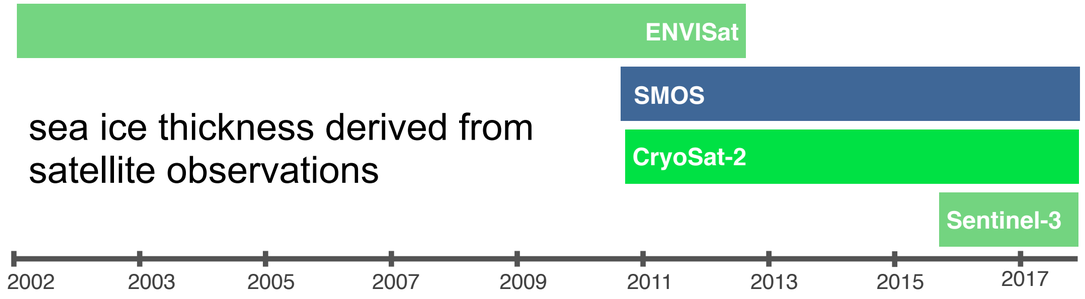

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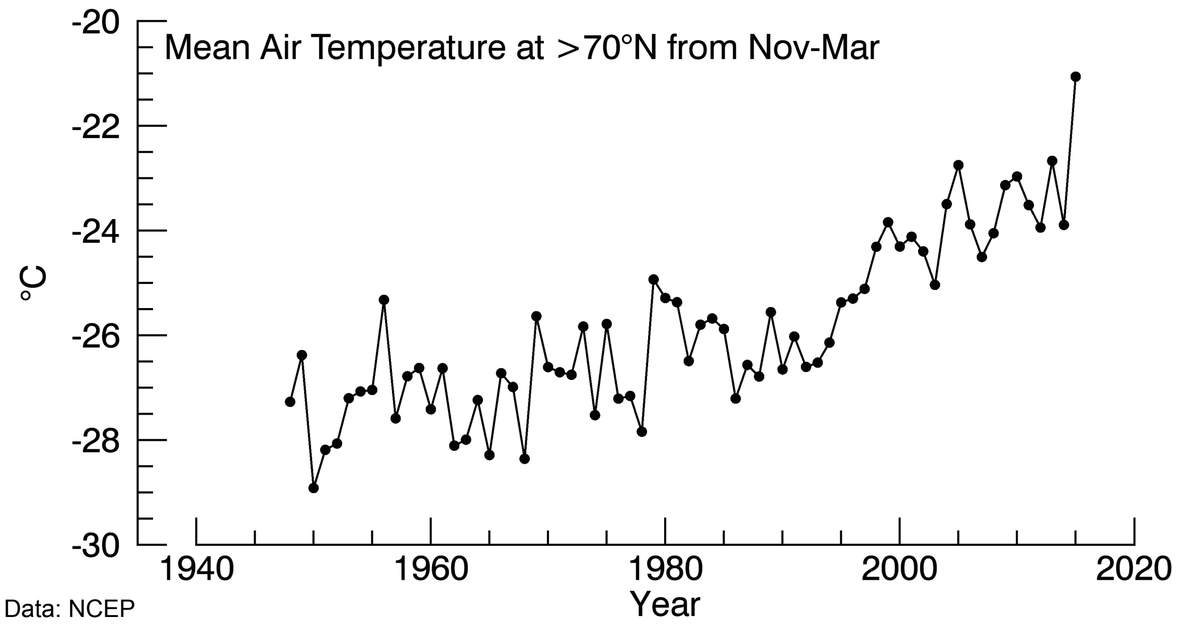

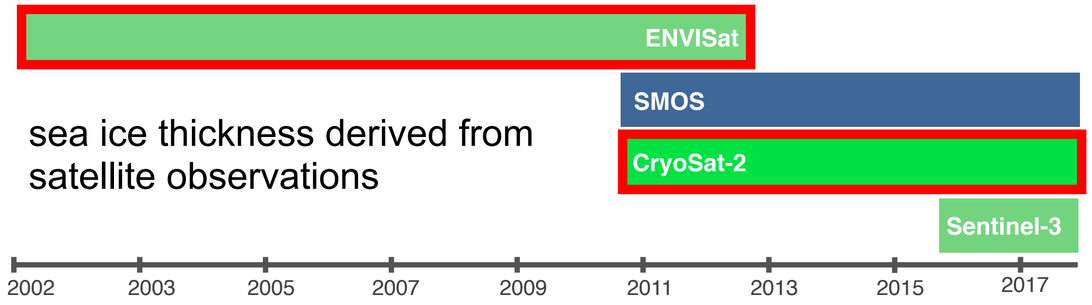

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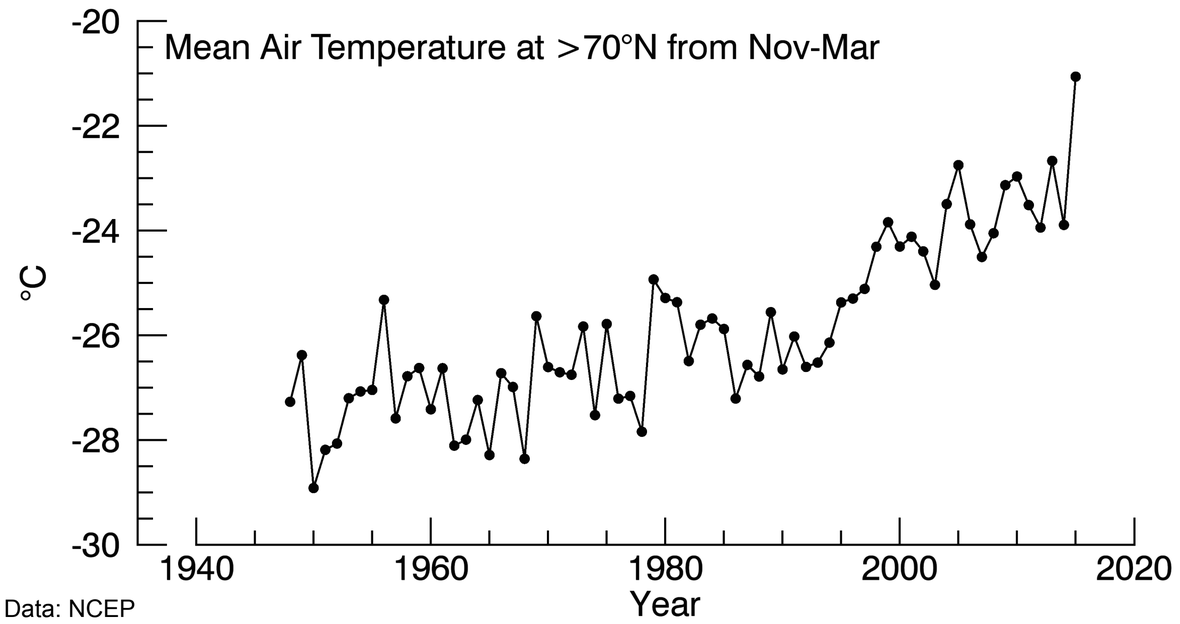

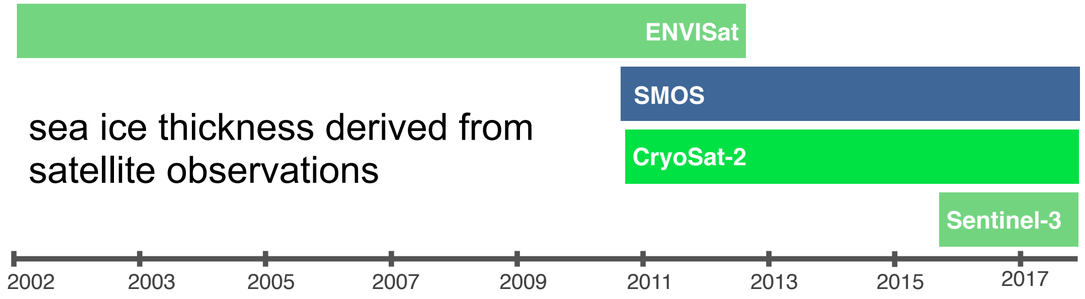

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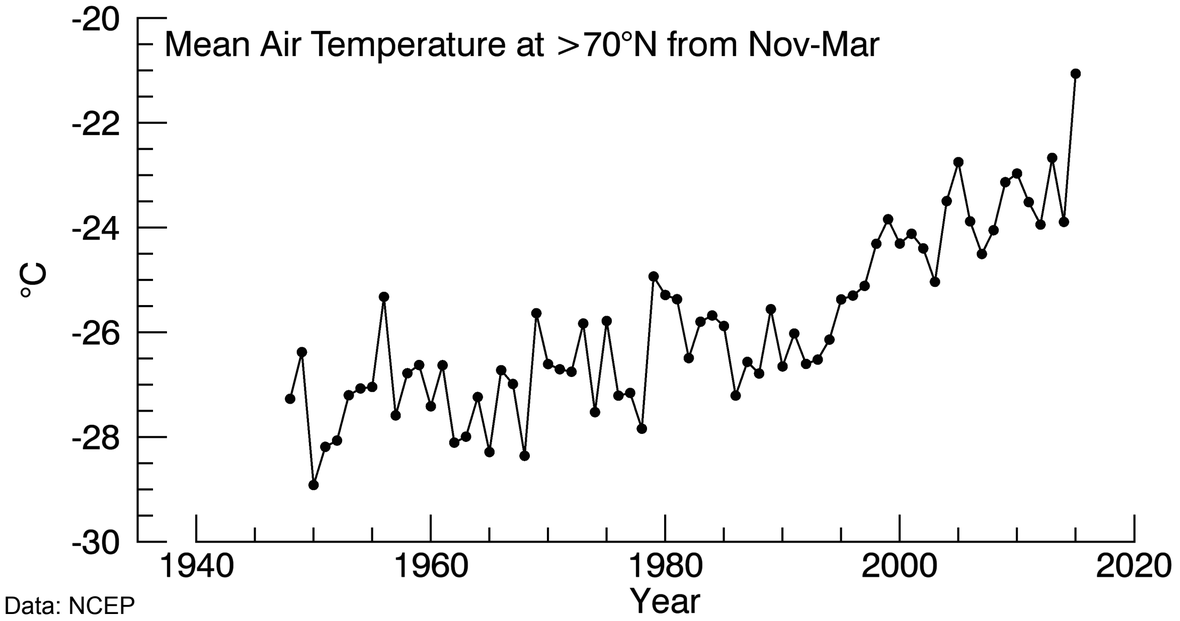

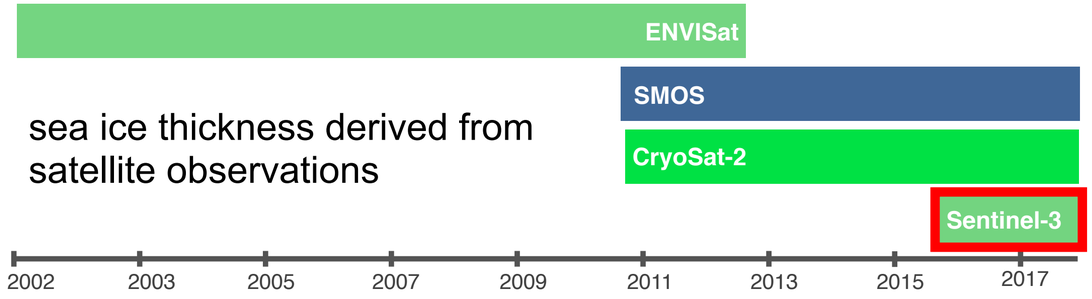

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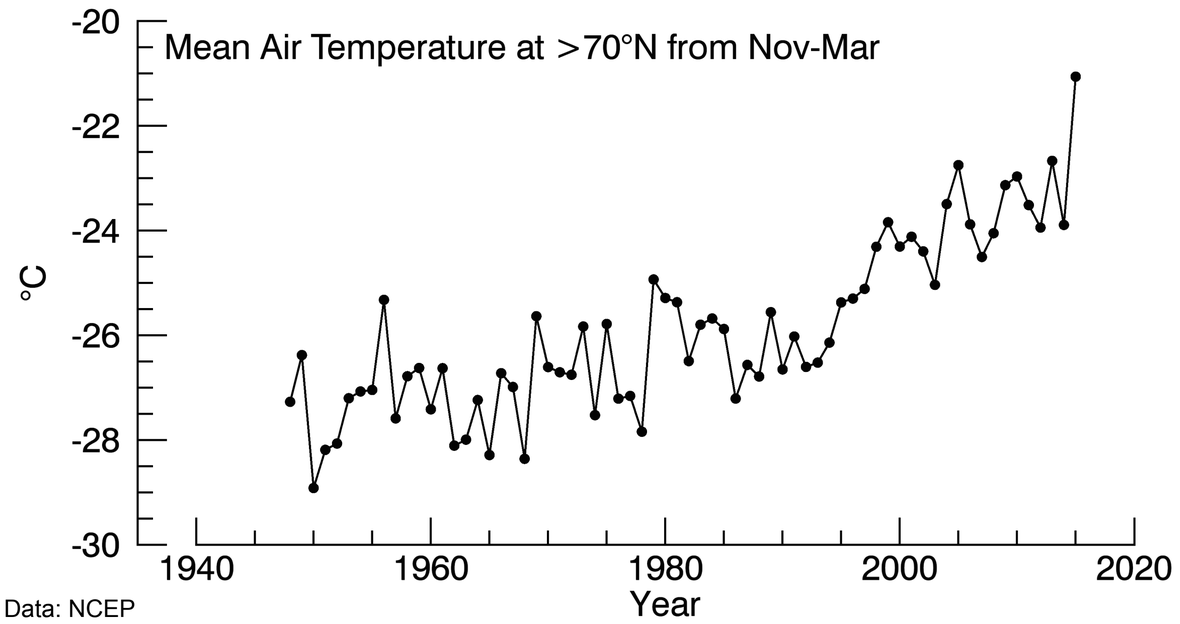

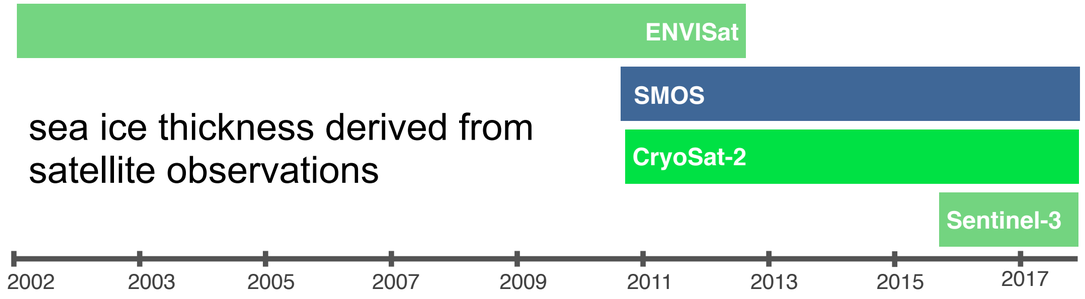

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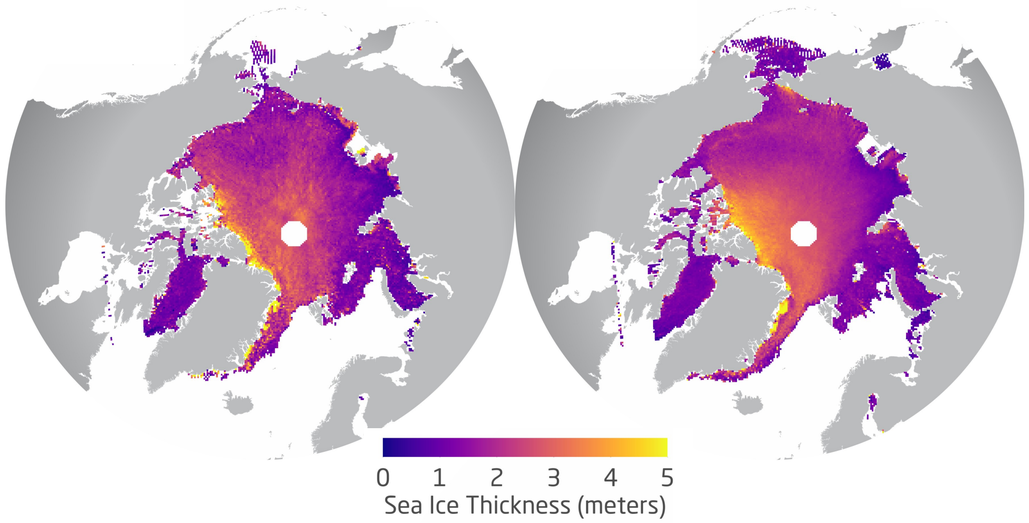
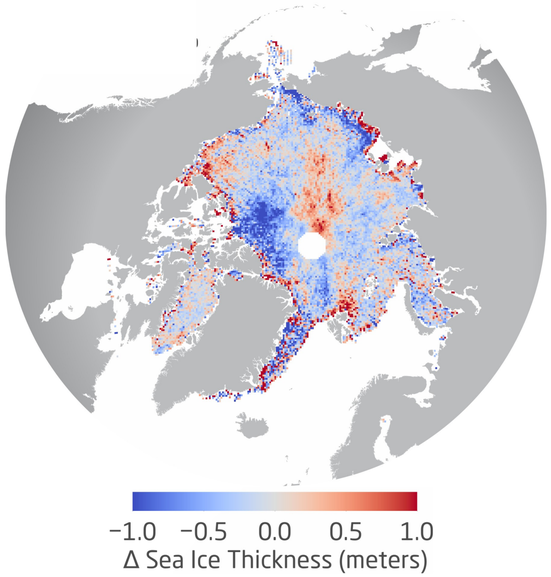
CryoSat-2 sea ice thickness and volume

April 2017

April 2011-2016



April 2017 Anomaly



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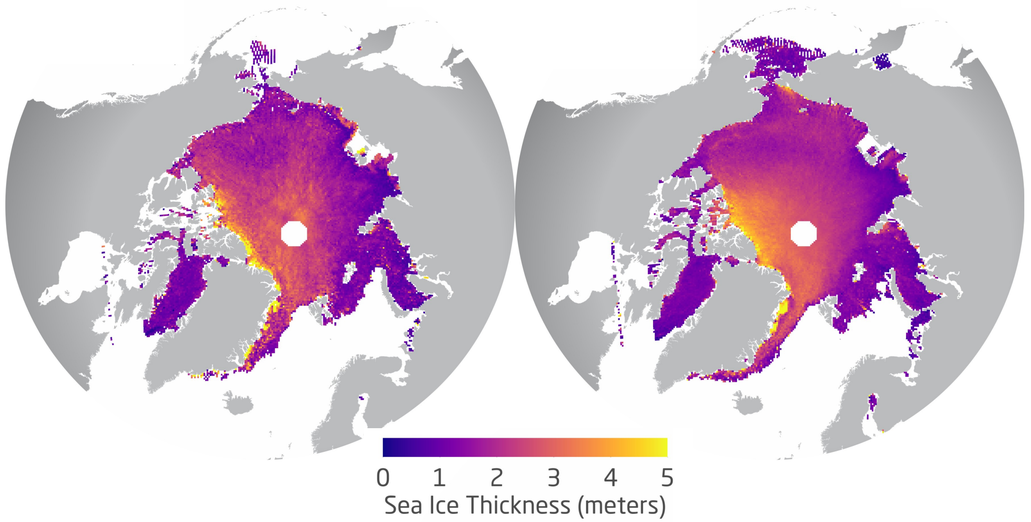

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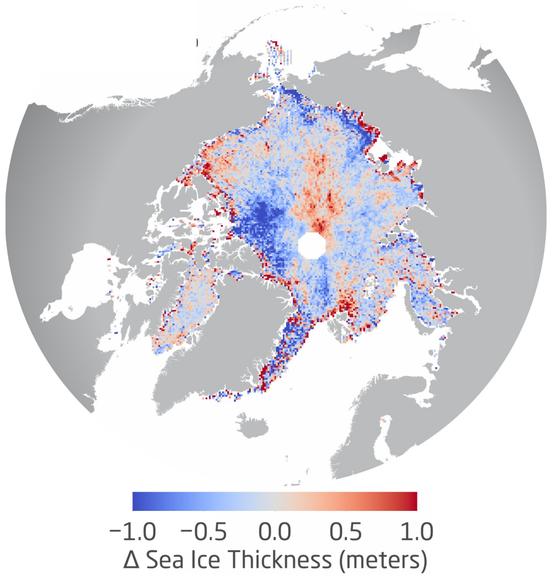
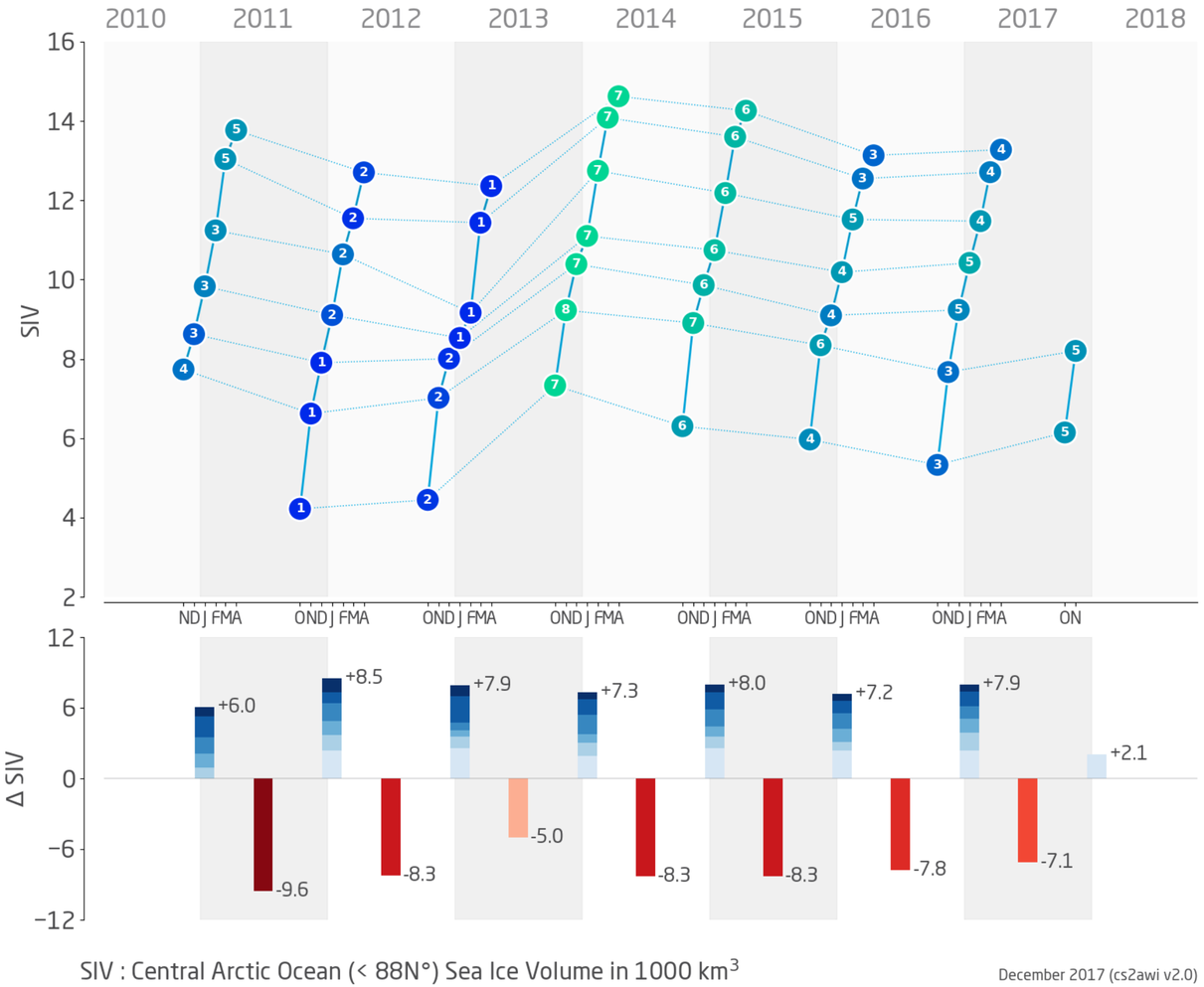


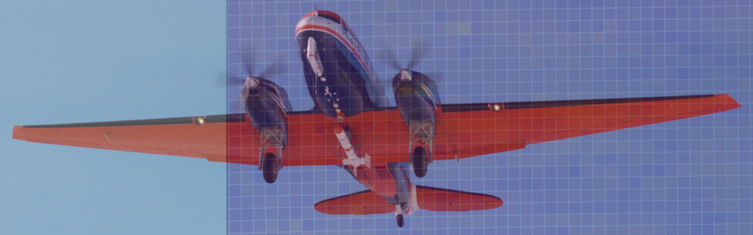


SIV : Central Arctic Ocean (< 88N°) Sea Ice Volume in 1000 km^3

December 2017 (cs2awi v2.0)

Airborne validation

Polar-5 with EM-Bird



Airborne Validation March/April 2017

(CryoSat Mean: 2.57m, Airborne-EM Mean: 2.65m)

CryoSat-2/SMOS merged ice thickness product

- Radar Altimetry

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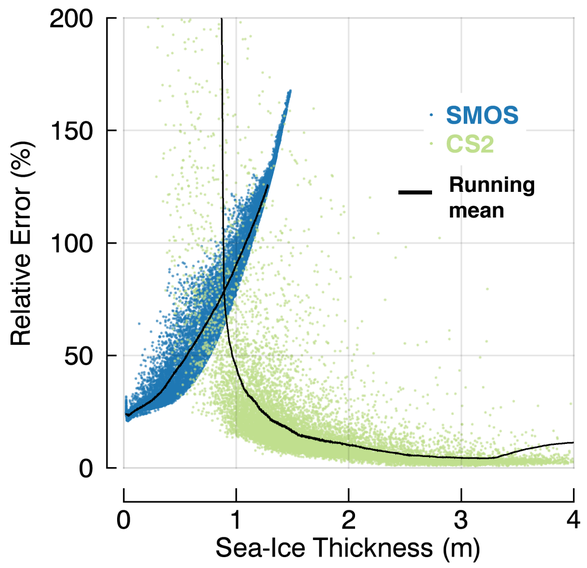
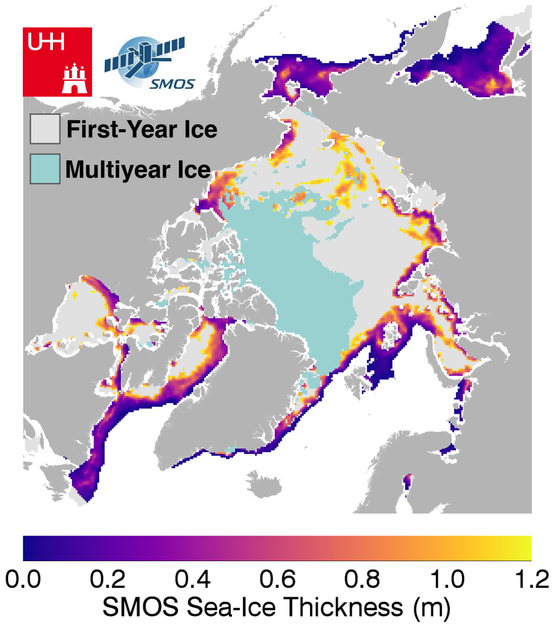
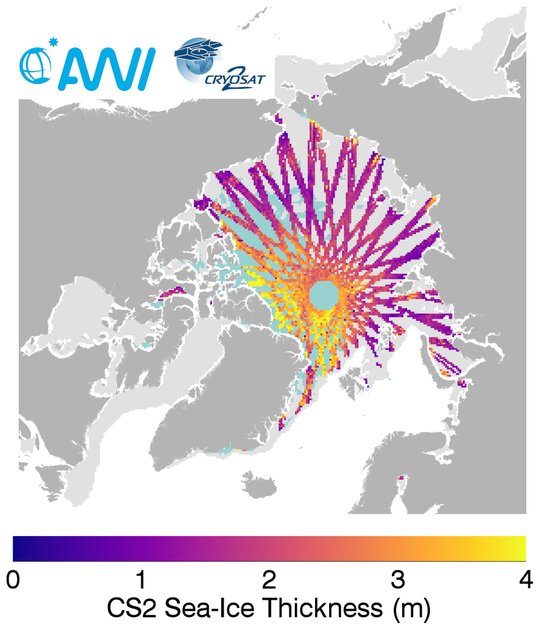
- Radiometry

14-20 March 2016







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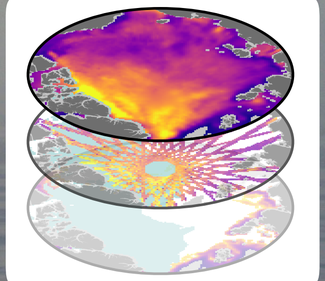

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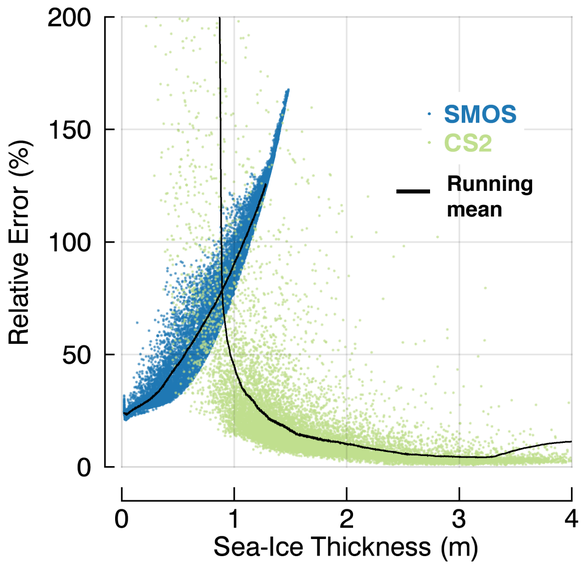

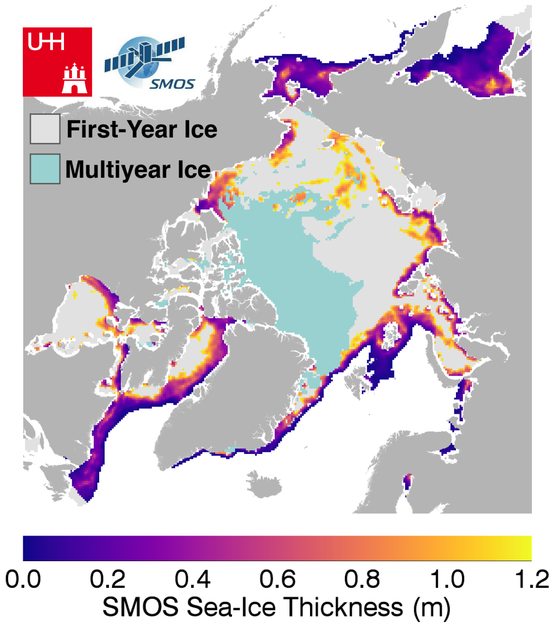

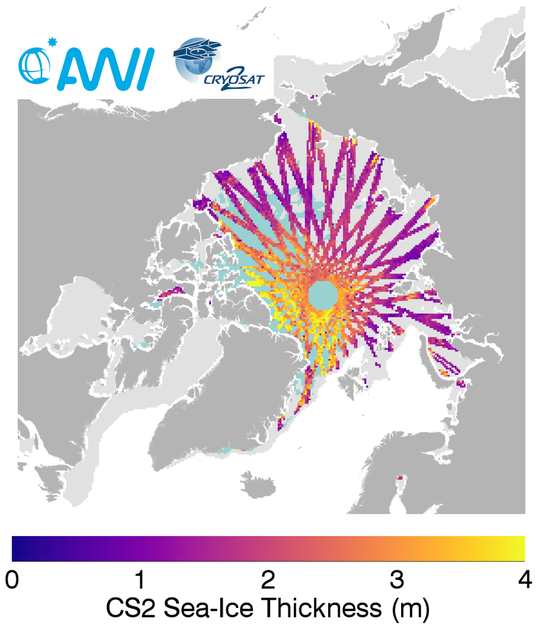

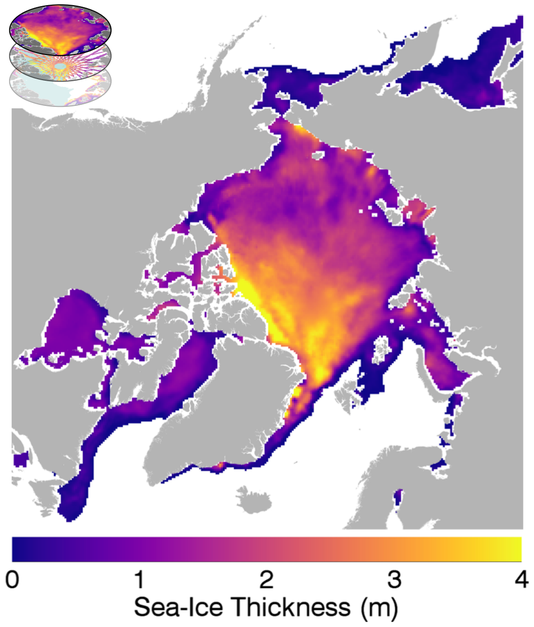

Ricker et al. (2017), A weekly Arctic sea-ice thickness data record from merged CryoSat-2 and SMOS satellite data, The Cryosphere

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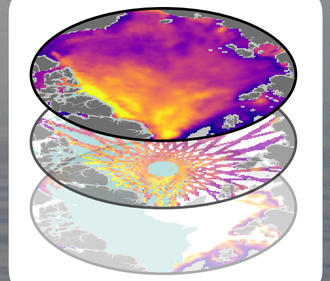

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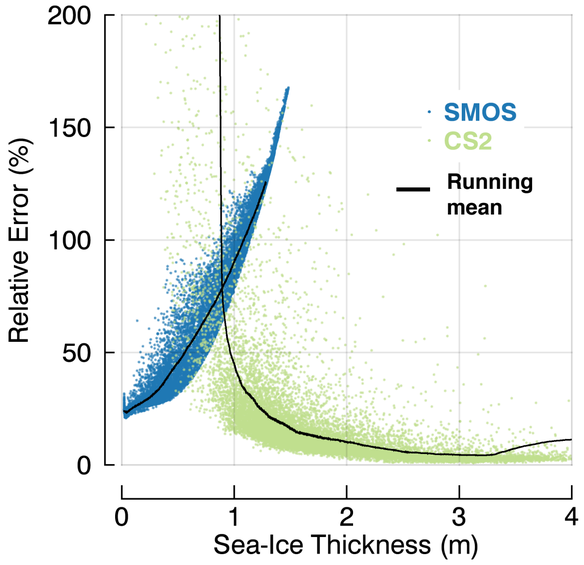

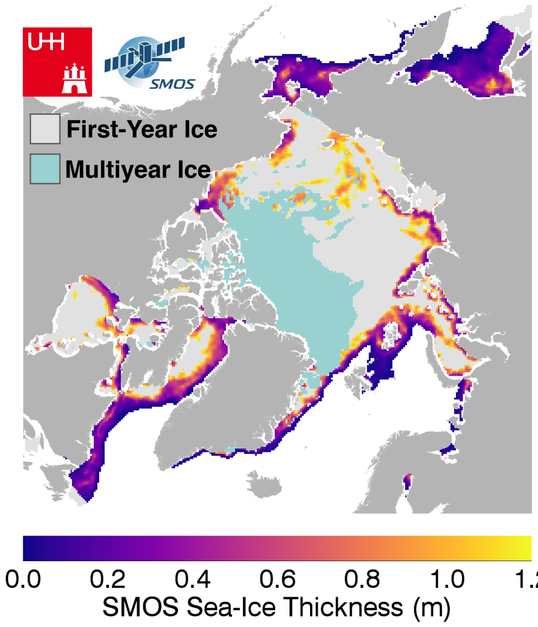

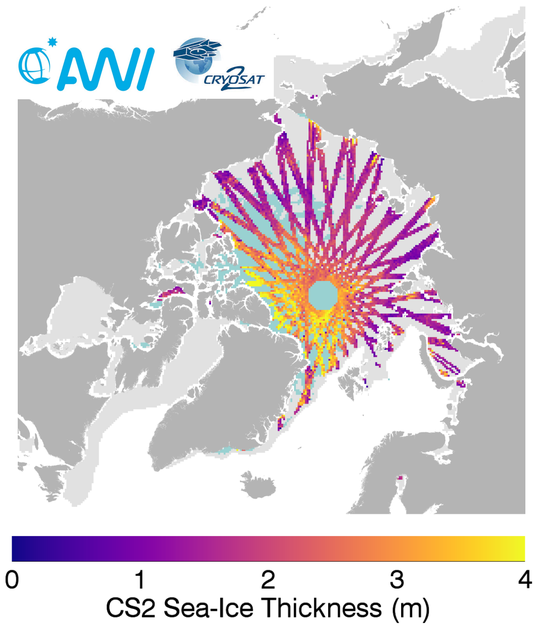

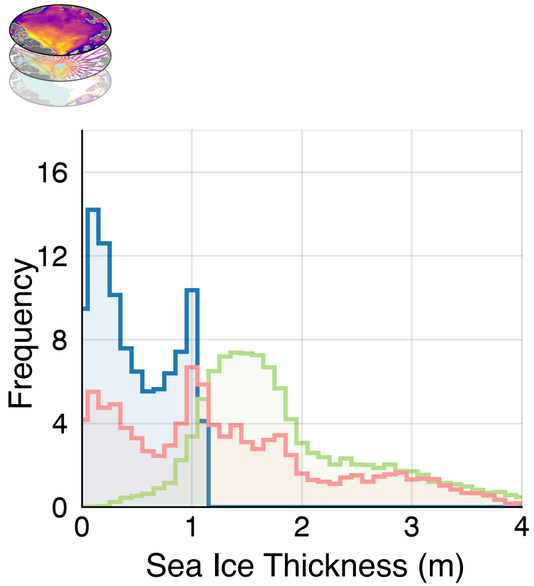

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2015/2016 Sea ice thickness anomaly

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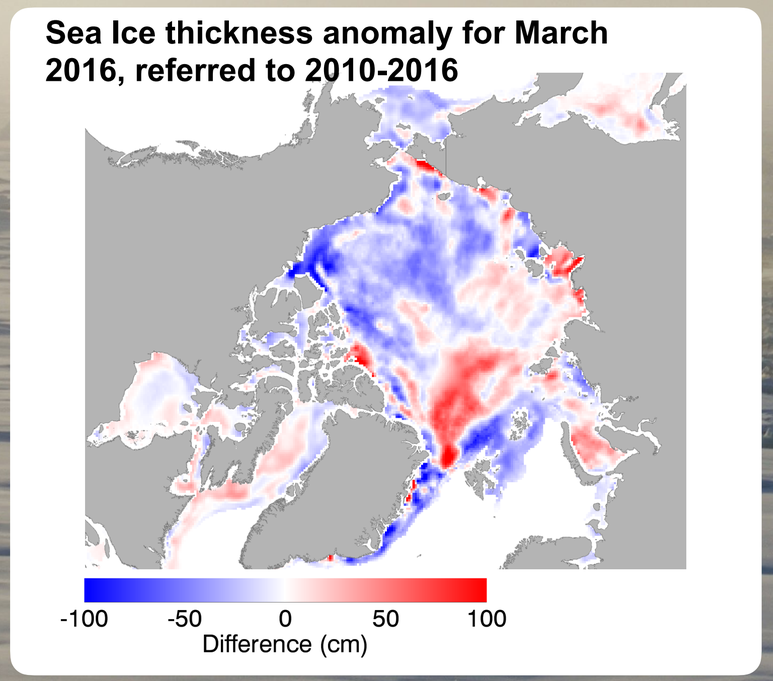

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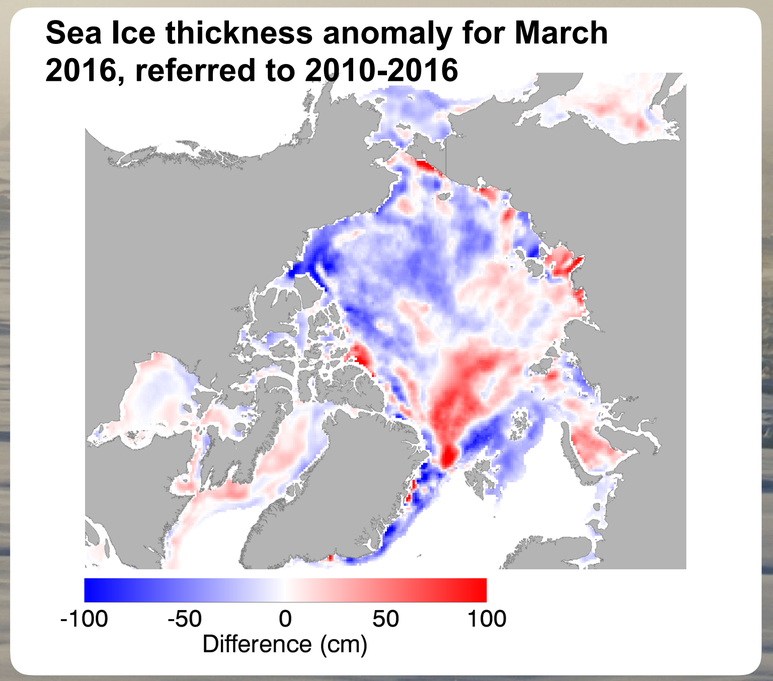

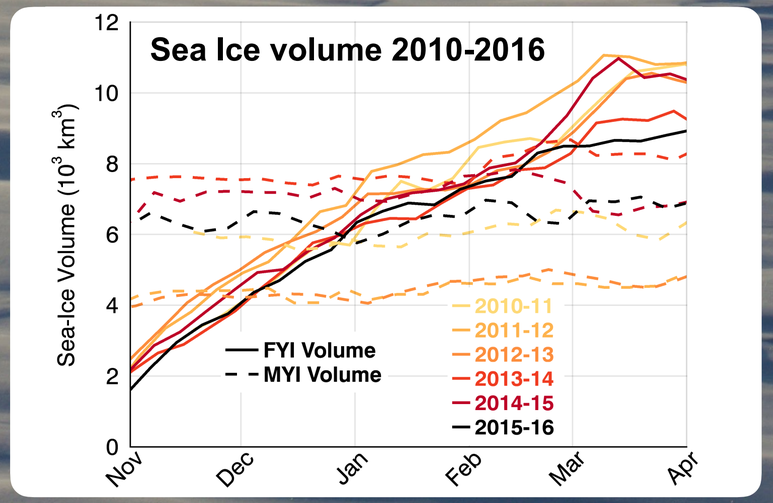

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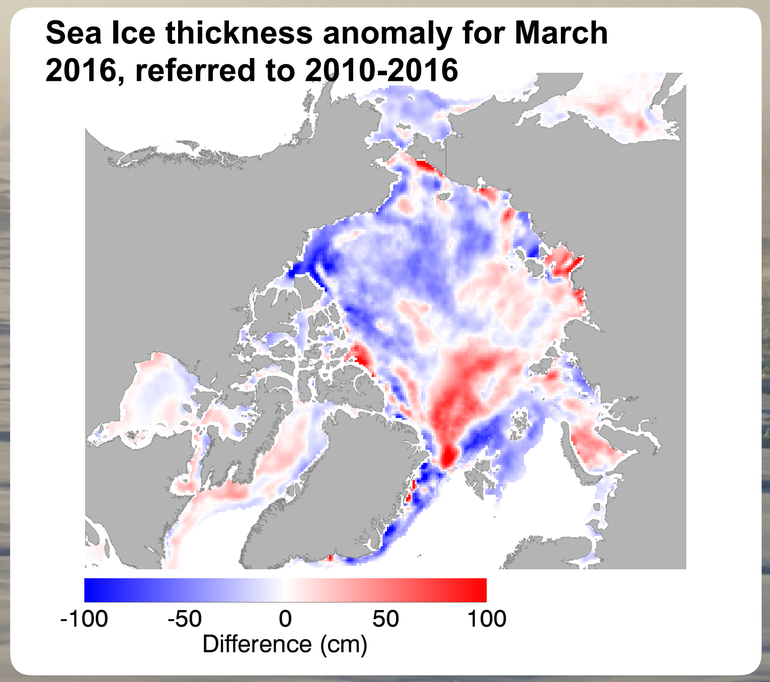
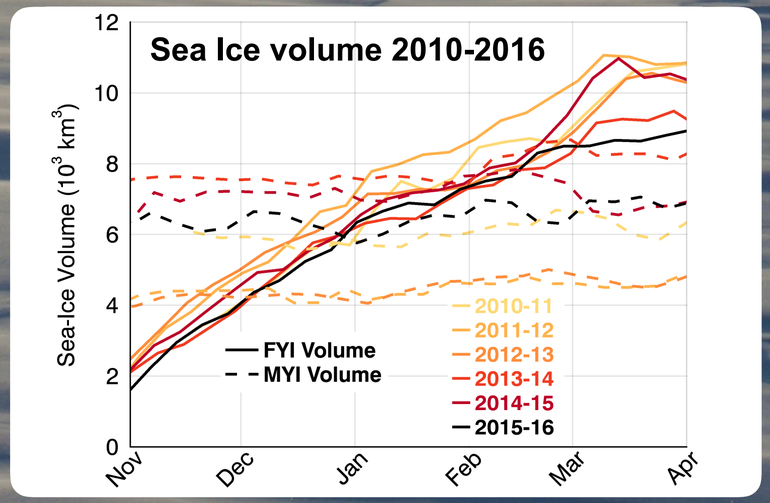
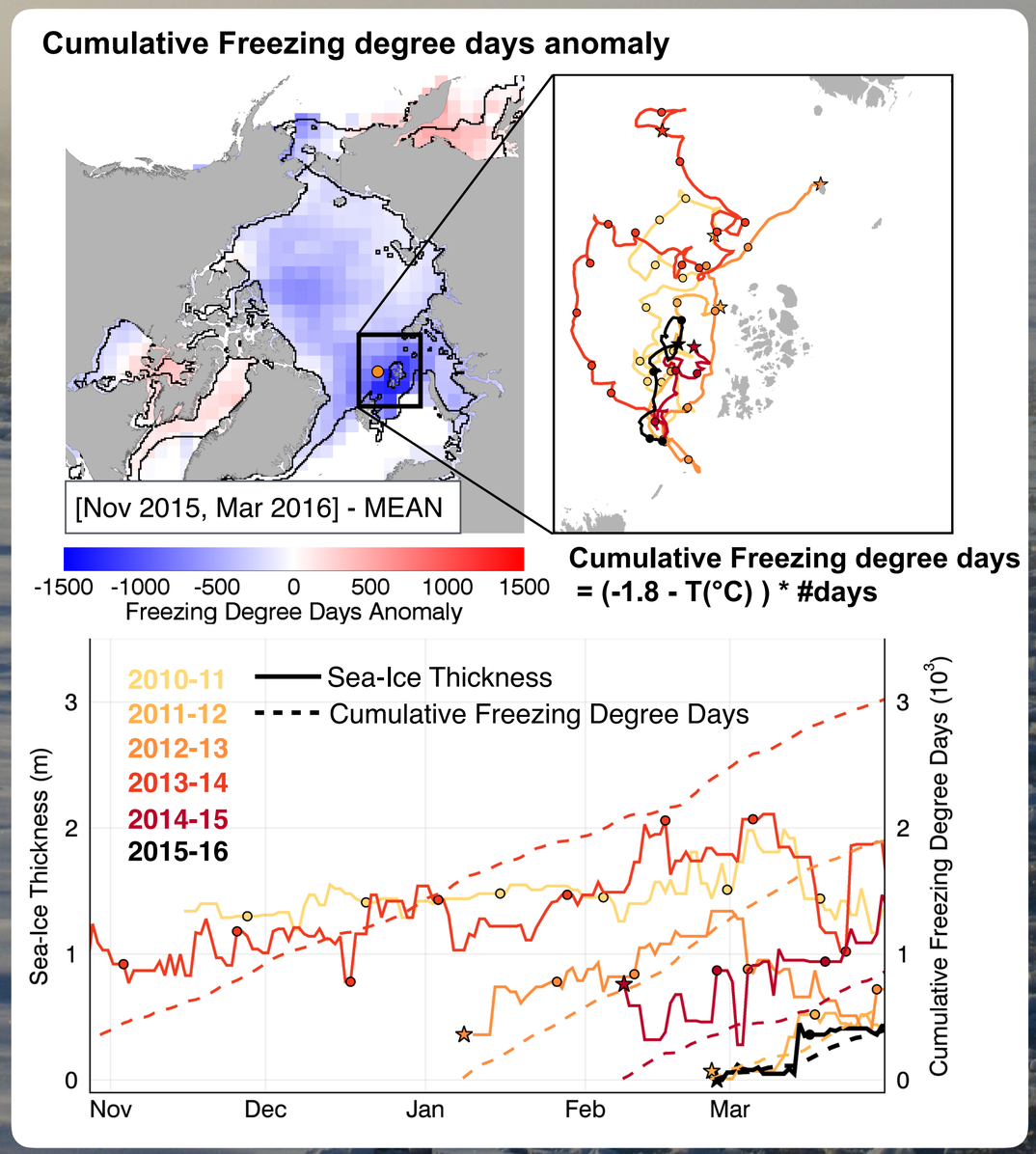


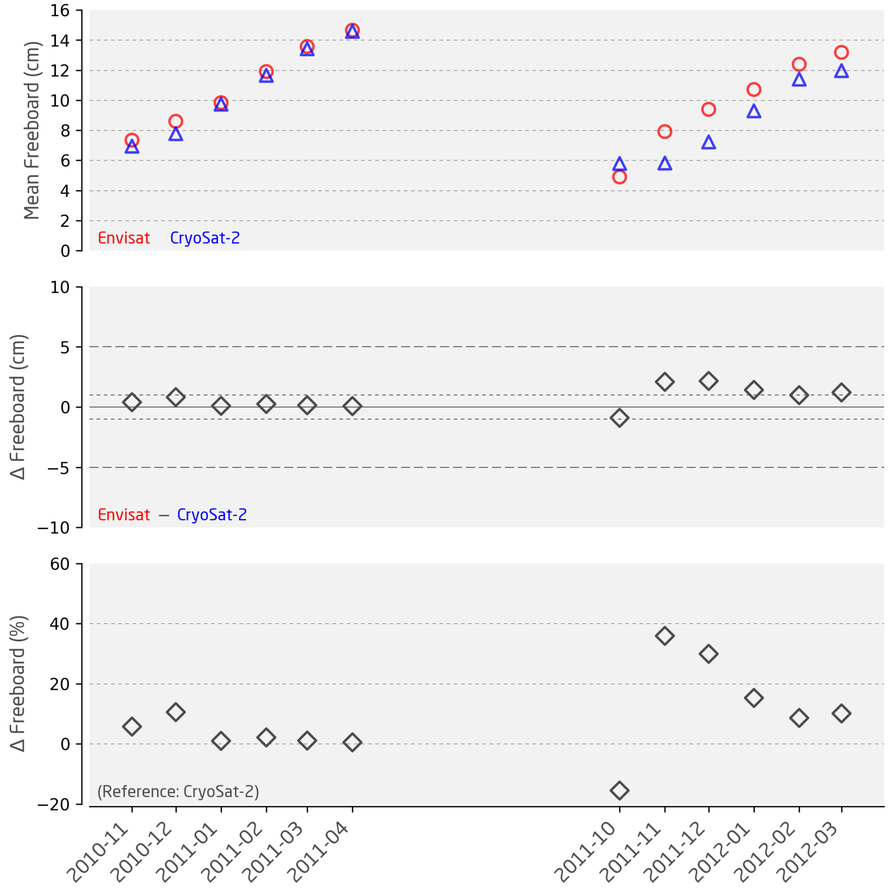




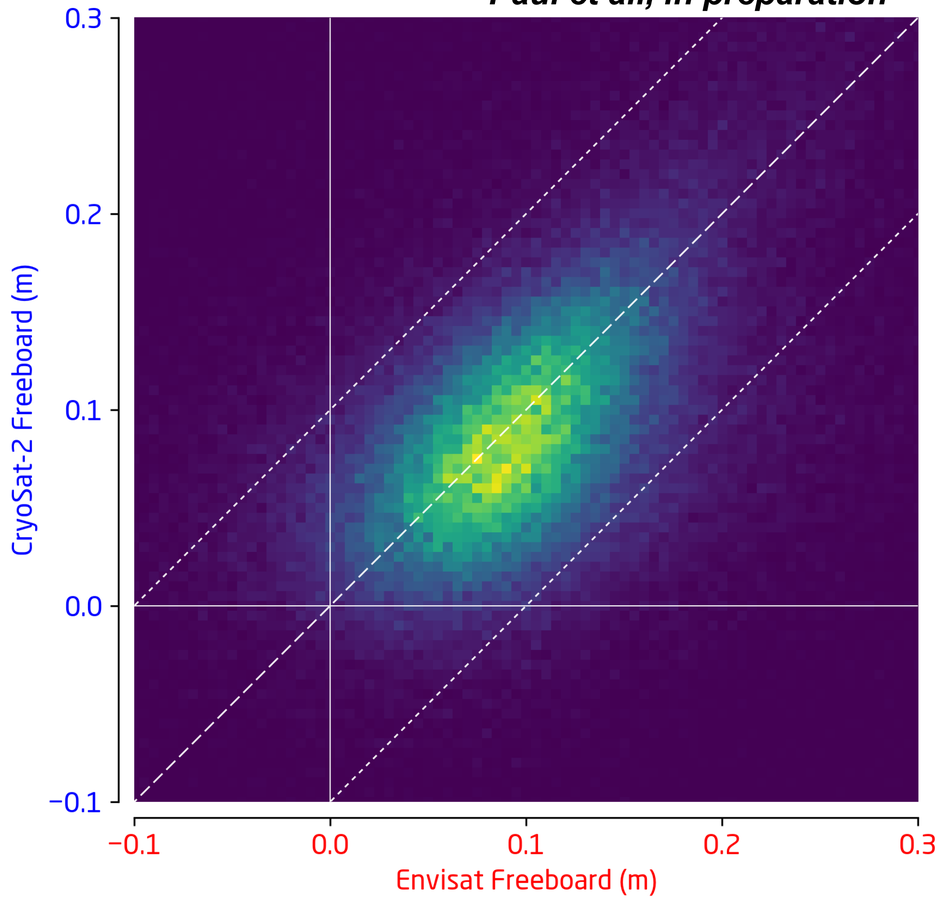
Ricker et al. (2017), Satellite-observed drop of Arctic sea ice growth in winter 2015–2016, GRL

Combining Envisat and Cryosat-2

- Minimize inter-mission biases between subsequent satellite missions
  - Consistent surface-type classification scheme
  - Adaptive retracker threshold that depends on waveform-characteristics

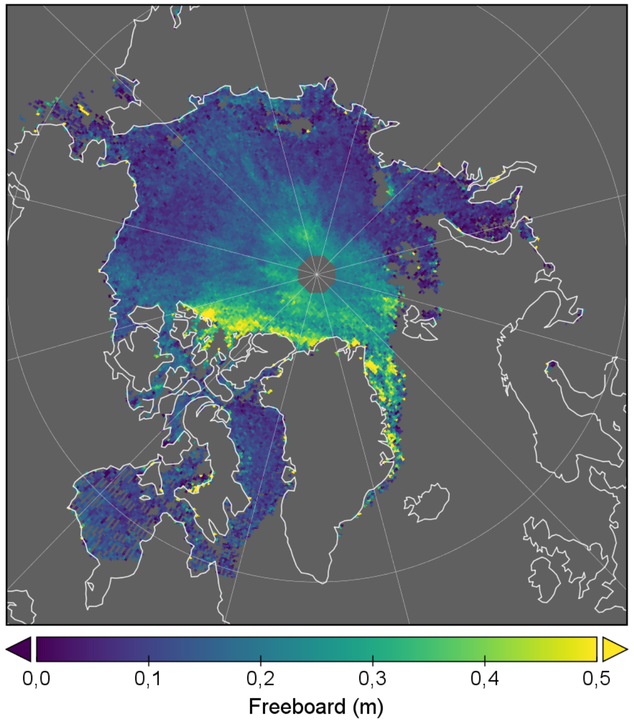


Paul et al., in preparation

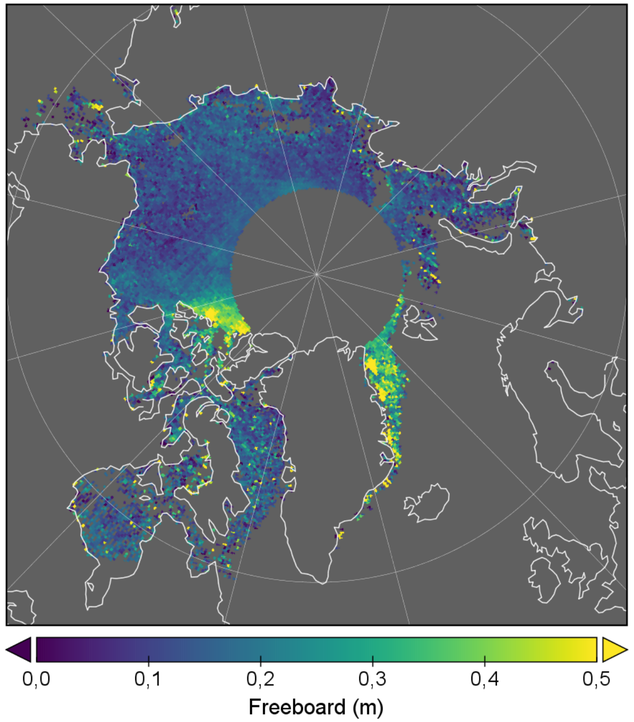


First Sentinel-3 freeboard retrieval

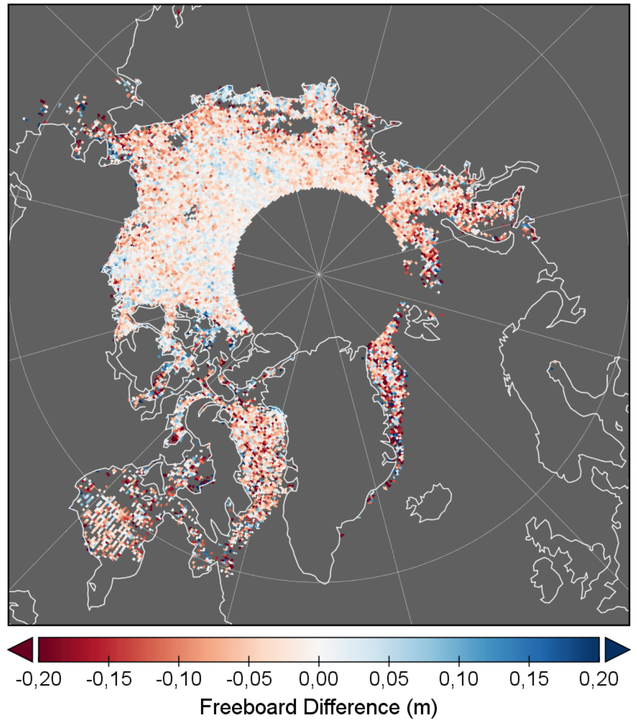
CryoSat-2
February 2017 (ccicdr v1.0)



Sentinel-3A
February 2017 (pysiral-0.5.0dev)



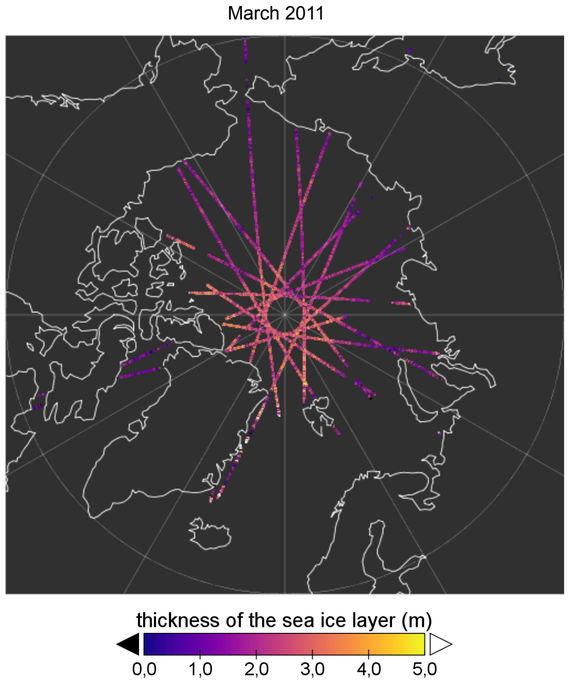
CryoSat-2 - Sentinel3A
February 2017



- First **Sentinel-3** sea ice freeboard retrievals look promising and show a similar pattern as CryoSat-2
- Sentinel-3 data are not suitable to solely maintain the sea ice thickness CDR

Providing operational sea ice thickness retrievals

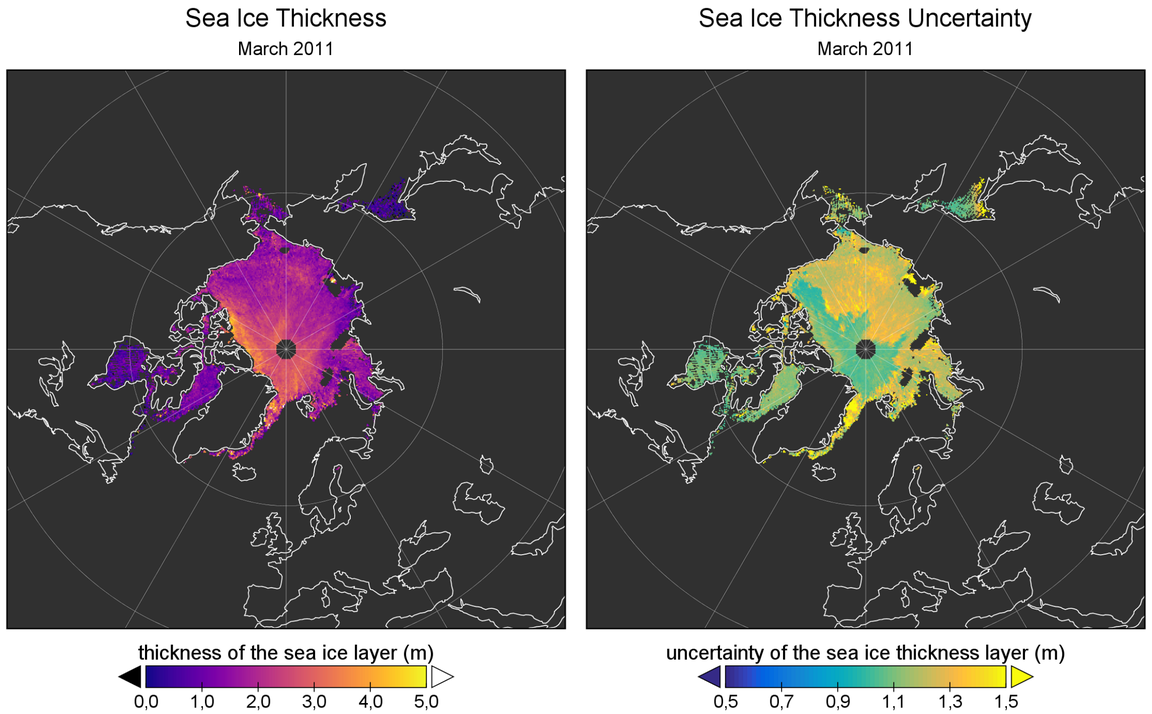
- **Daily** NetCDF vector data of sea ice thickness, freeboard and corresponding uncertainties are provided



Providing operational sea ice thickness retrievals

Providing operational sea ice thickness retrievals

- **Monthly** NetCDF with mean sea ice thickness, freeboard and corresponding uncertainties are provided
- Average uncertainty computed by error propagation: Maximum retrieval uncertainty

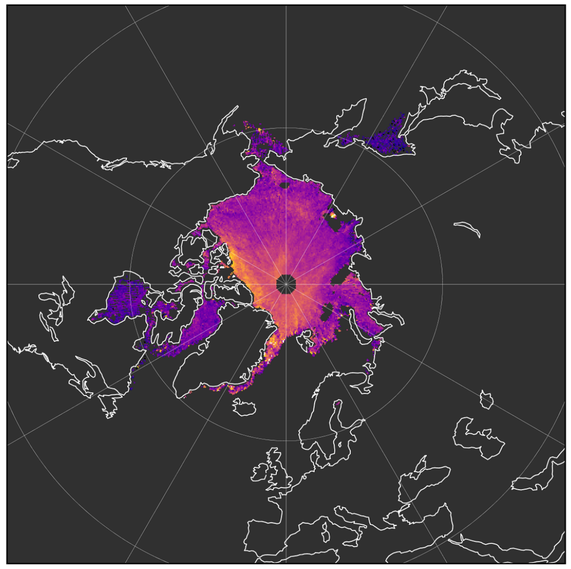


Providing operational sea ice thickness retrievals

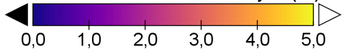
- **Monthly** NetCDF with mean sea ice thickness, freeboard and corresponding uncertainties are provided
- Average uncertainty computed by error propagation: Maximum retrieval uncertainty

- **Retrieval Status Flag** indicates whether thickness retrieval in grid cell was successful or not
- **Retrieval Quality Flag** informs on the quality of the retrieved thicknesses

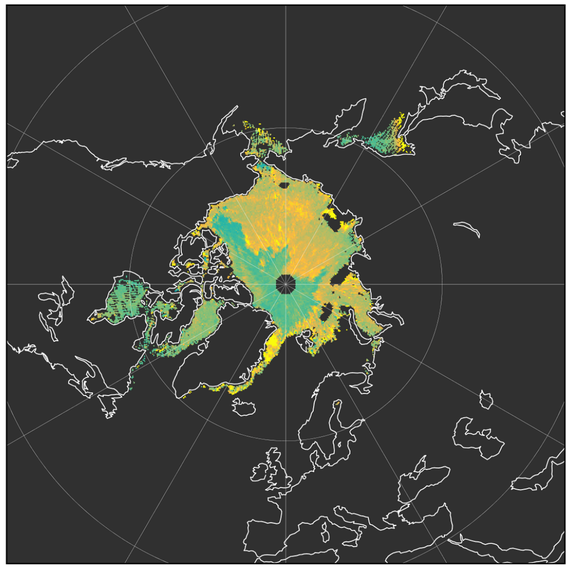
Sea Ice Thickness
March 2011



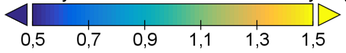
thickness of the sea ice layer (m)



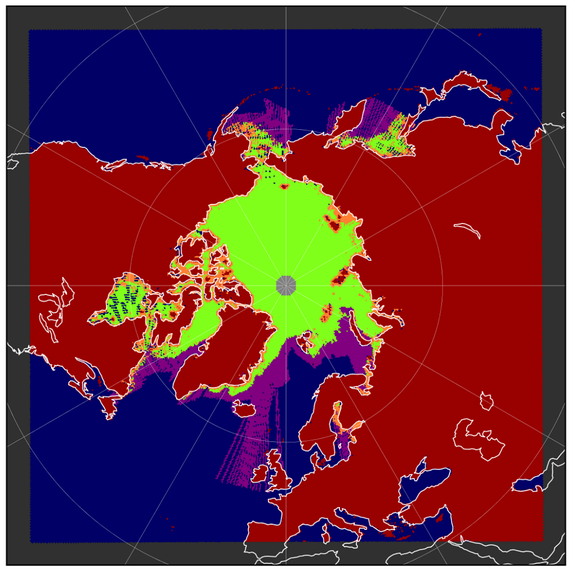
Sea Ice Thickness Uncertainty
March 2011



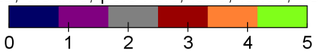
uncertainty of the sea ice thickness layer (m)



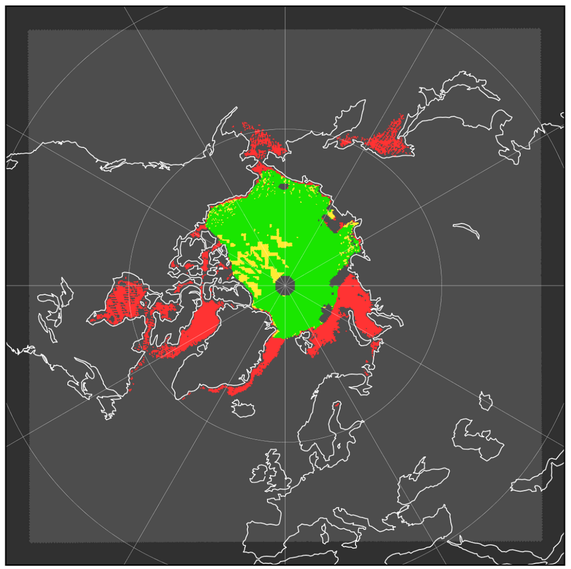
Sea Ice Thickness: Retrieval Status Flag
March 2011



no data, sic thrs, pole hole, land, failed, nominal



Sea Ice Thickness: Retrieval Quality Flag
March 2011



no data, nominal, intermediate, low

Summary & Conclusions

Application of satellite sea ice thickness records

- Reduced first-year ice growth linked with anomalous warm winter 2015/16
- Application in model assimilation, model evaluation, and reanalysis data records (e.g. Mu et al. (2017), accepted)
- Impact of Fram Strait ice volume export on Arctic ice mass balance

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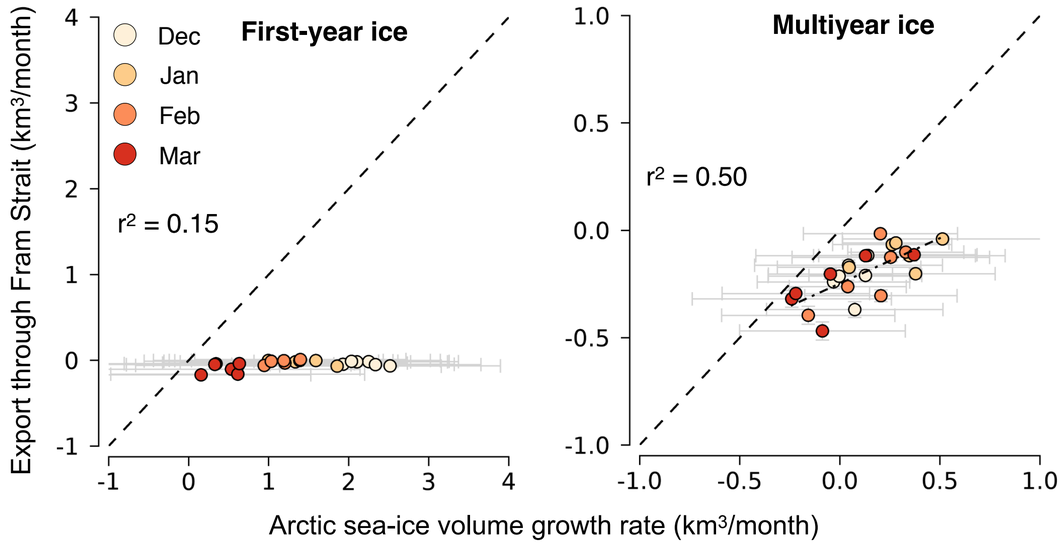

Ricker et al., in preparation

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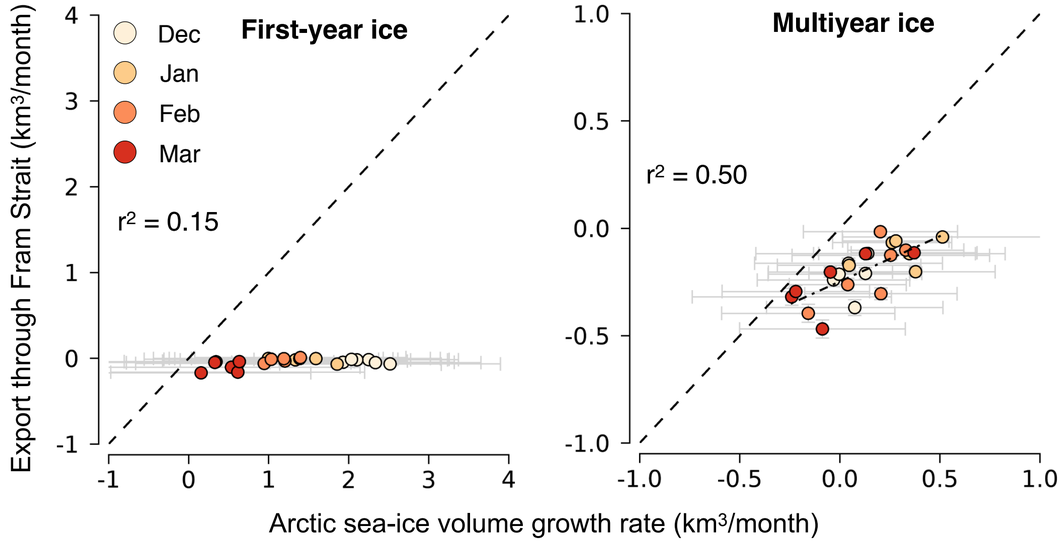
Future Plans

- providing sea ice thickness products by a service that meets the requirements for climate applications and operational systems
- 25 years time series of sea ice thickness data records from radar altimetry



Ricker et al., in preparation