AEROCLOUD Event
10 May 2019, Brussels


# Coordinating sea ice prediction for the Southern Ocean

François Massonnet

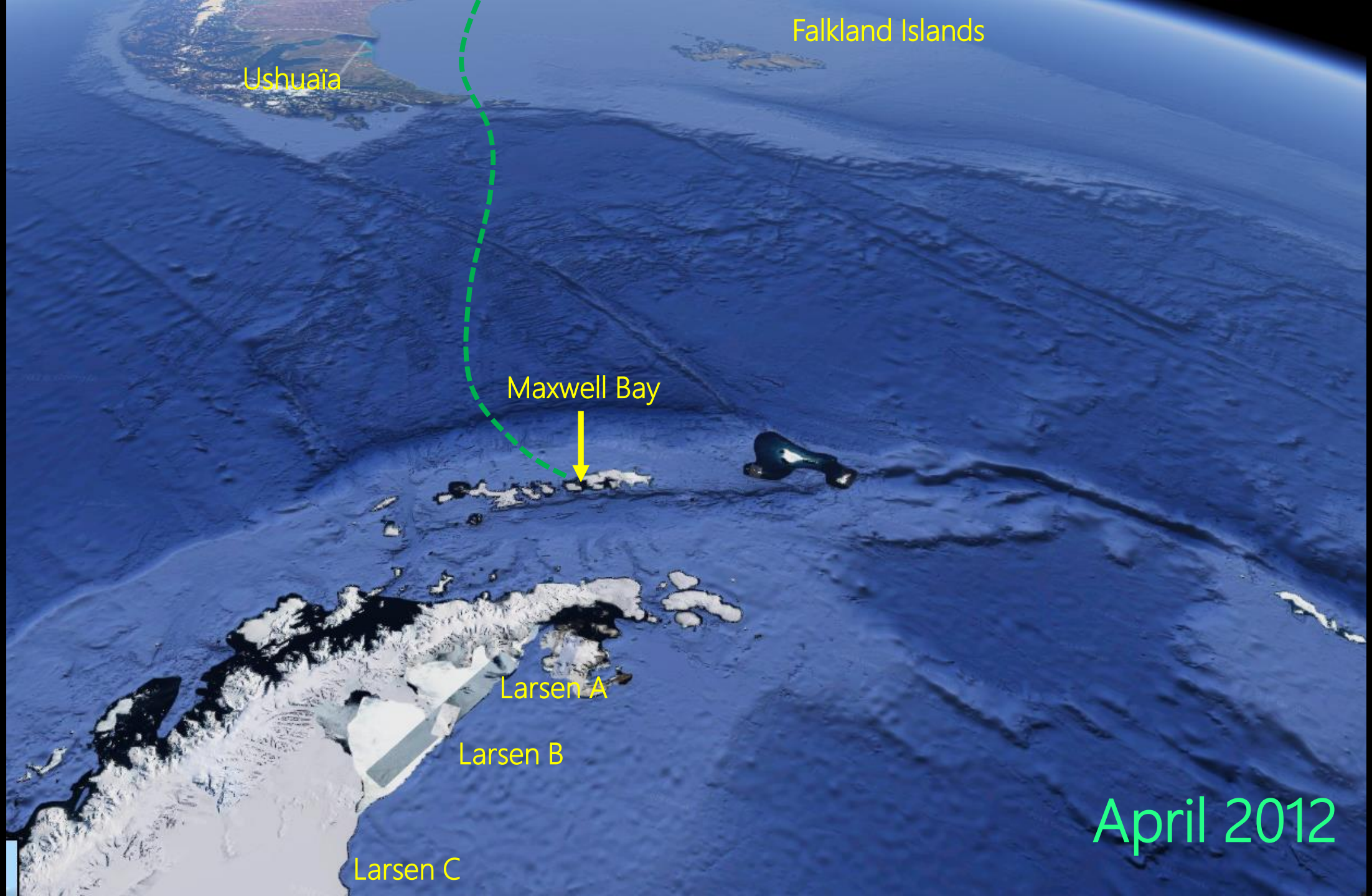
J. Lieser, P. Reid, J. Fyfe, C. M. Bitz, W. Hobbs

UCLouvain

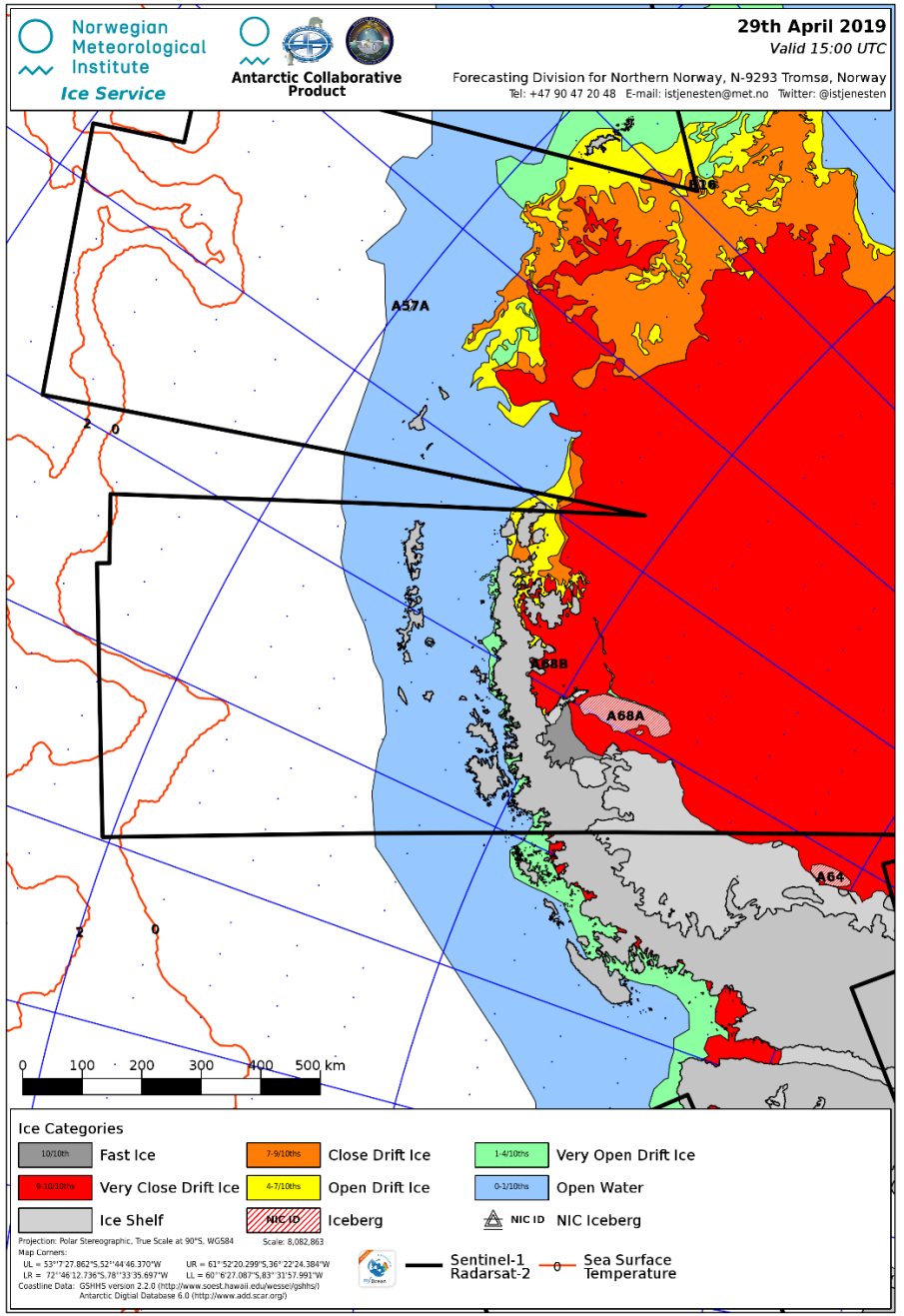
EARTH & LIFE INSTITUTE

fnrs LA LIBERTÉ DE CHERCHER


https://sometimes-interesting.com/2013/03/06/chilling-remains-of-the-mar-sem-fim/


Falkland Islands
Ushuaïa
Maxwell Bay
Larsen A
Larsen B
Larsen C
April 2012

# Ice charts: best available information on current sea ice conditions




http://polarview.met.no/antarctic/peninsula_20190429.png

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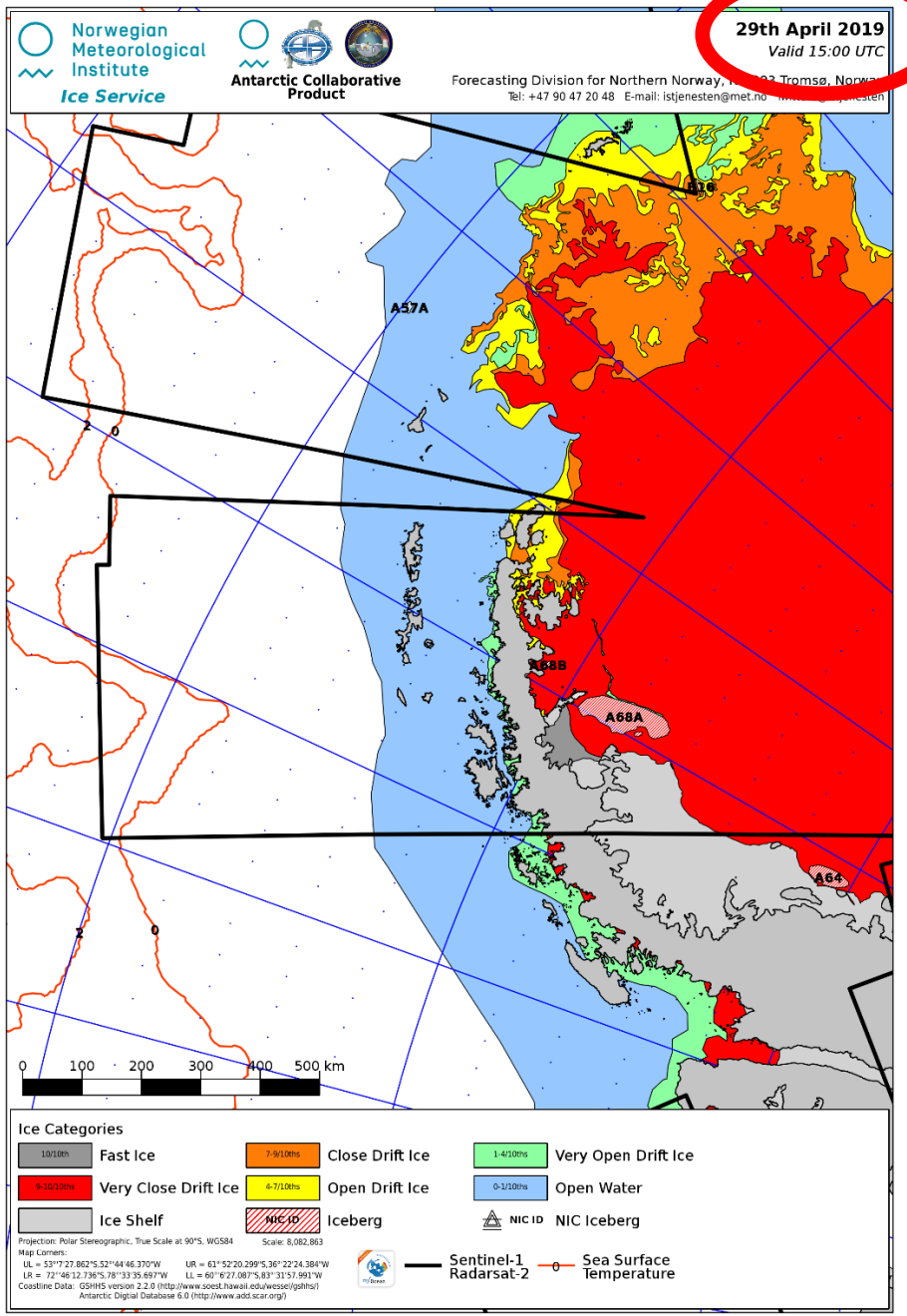


« Now-casting »

http://polarview.met.no/antarctic/peninsula_20190429.png

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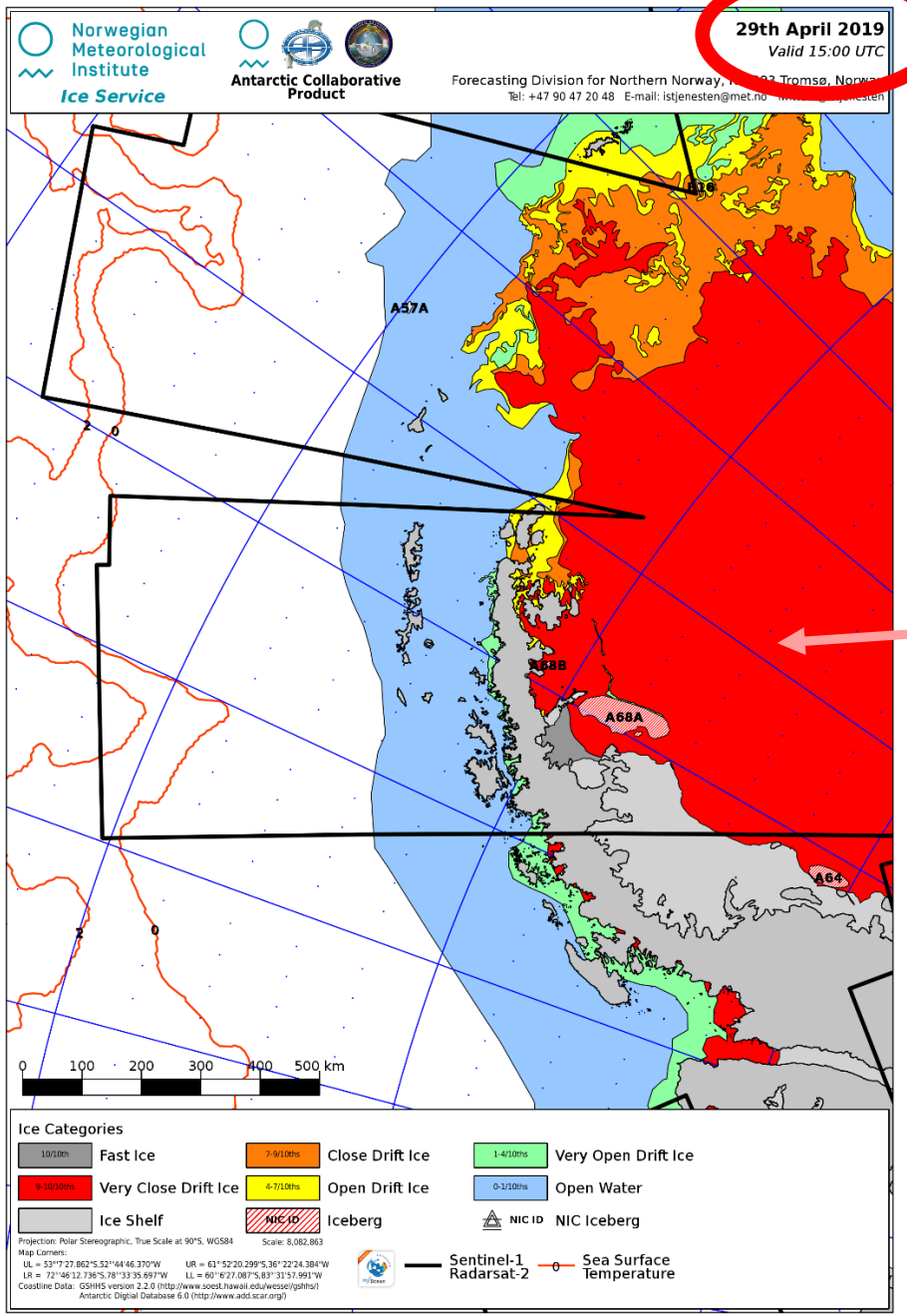



« Now-casting »

How about sea ice thickness here?

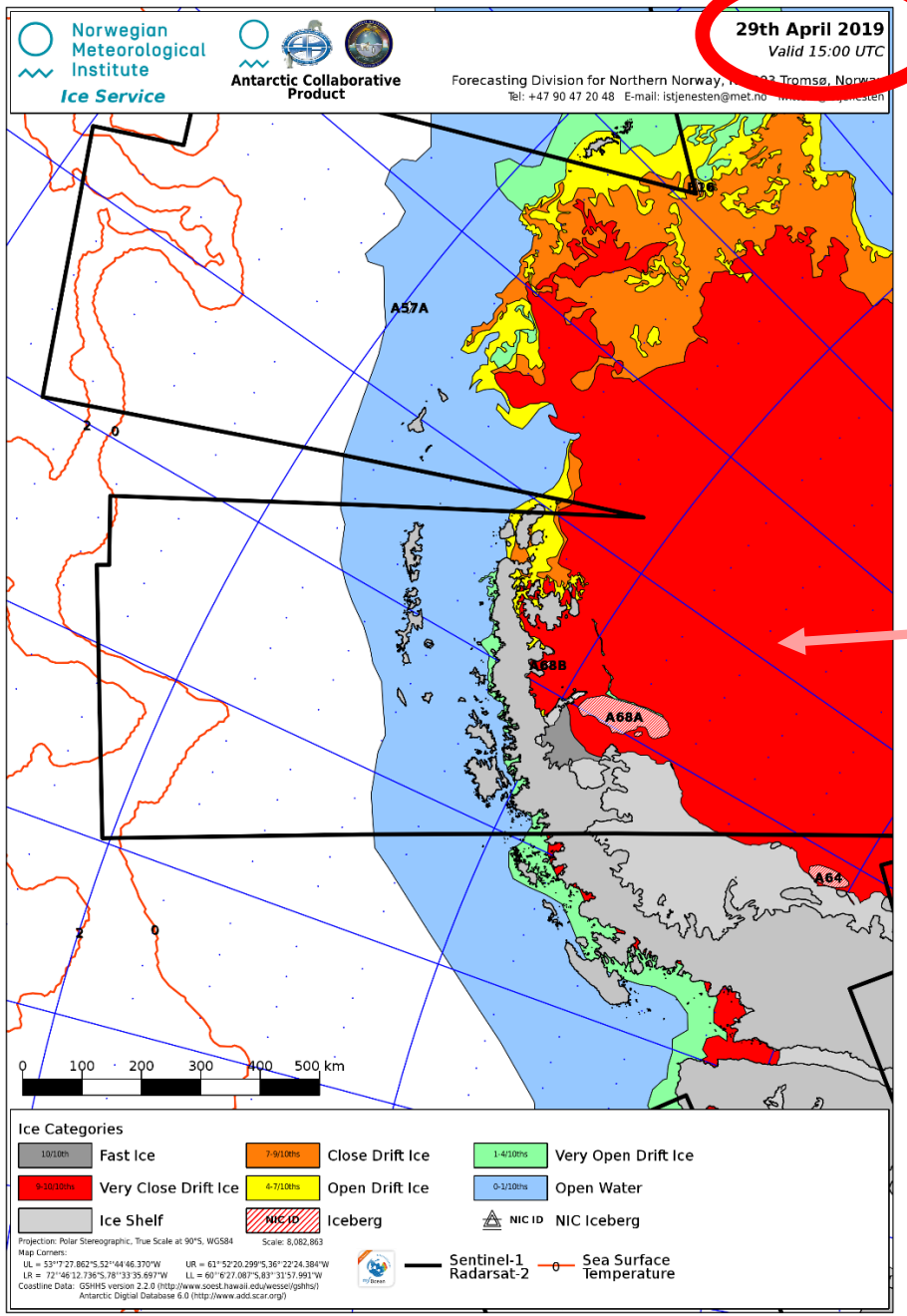
http://polarview.met.no/antarctic/peninsula_20190429.png

# Ice charts: best available information on current sea ice conditions

Strong need for

- Information on date of **sea ice edge retreat and advance**
- Information on sea ice **conditions inside the ice pack**

possibly **several weeks/months ahead**



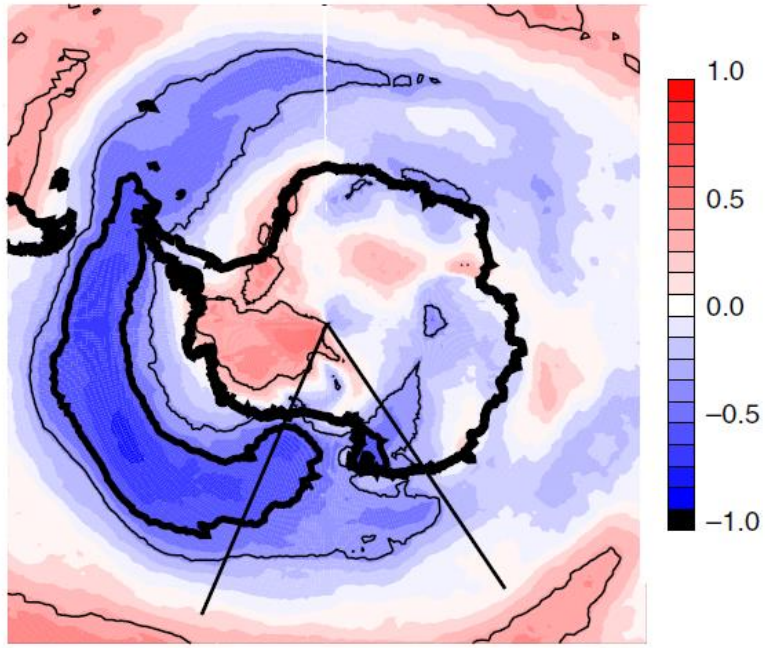

« Now-casting »

How about sea ice thickness here?

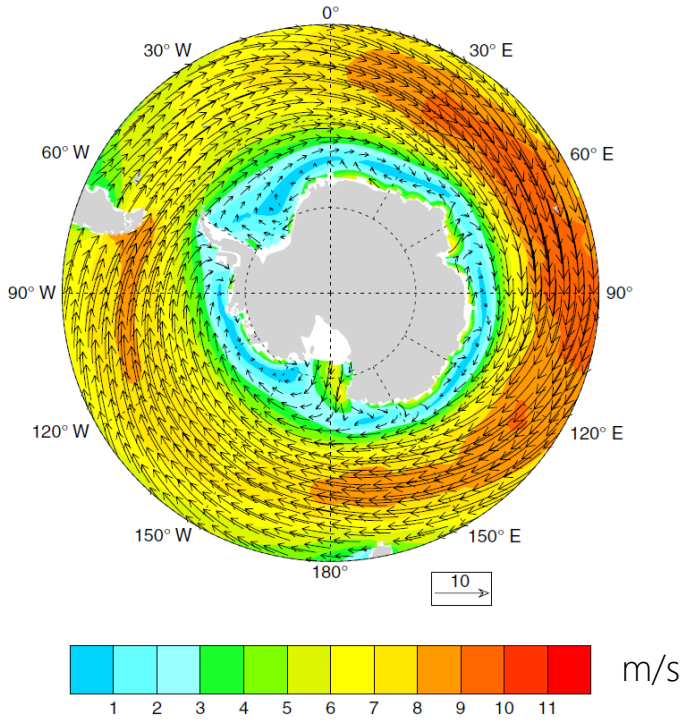
http://polarview.met.no/antarctic/peninsula_20190429.png

# A mechanism for summer sea ice predictability in the Southern Ocean

**Correlation** of October grid-point zonal **wind speed** with following March western Ross Sea **sea ice area** (1979-2015)




Climatology of ERA-Interim winds (1979-2015)




Holland et al., *Nat. Commun.*, 2017

Enhanced October zonal winds → Increased ice divergence → Lower ice concentration → Lower albedo → Enhanced shortwave absorption → Increased oceanic heat storage → Delayed sea ice formation


YOPP
YEAR OF
POLAR
PREDICTION

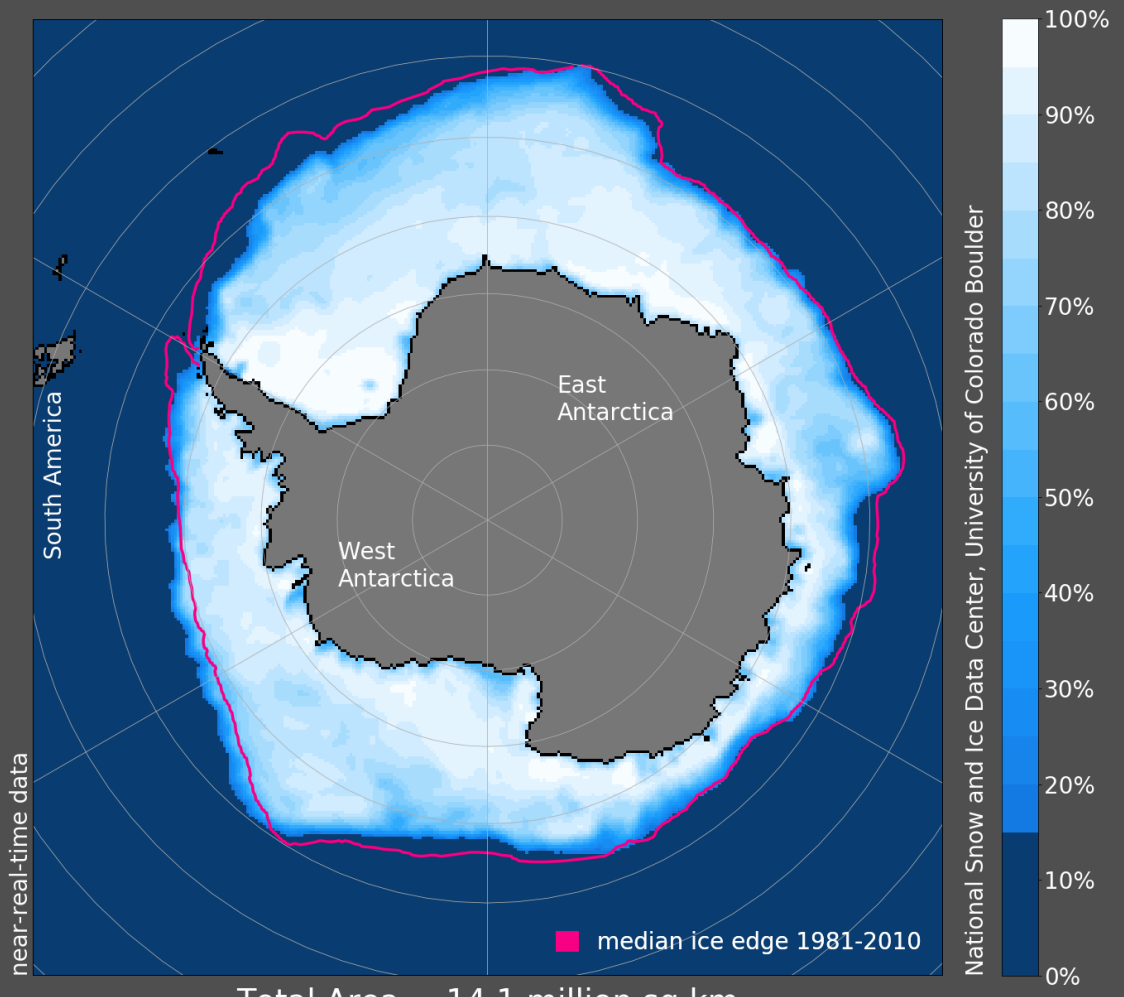
The Sea Ice Prediction Network South (SIPN South) has three main goals:

1) Identify existing efforts in Southern Ocean seasonal sea ice forecasting (currently scattered) and build an international network;

2) Coordinate realistic prediction test cases and evaluate the skill of current forecast systems;

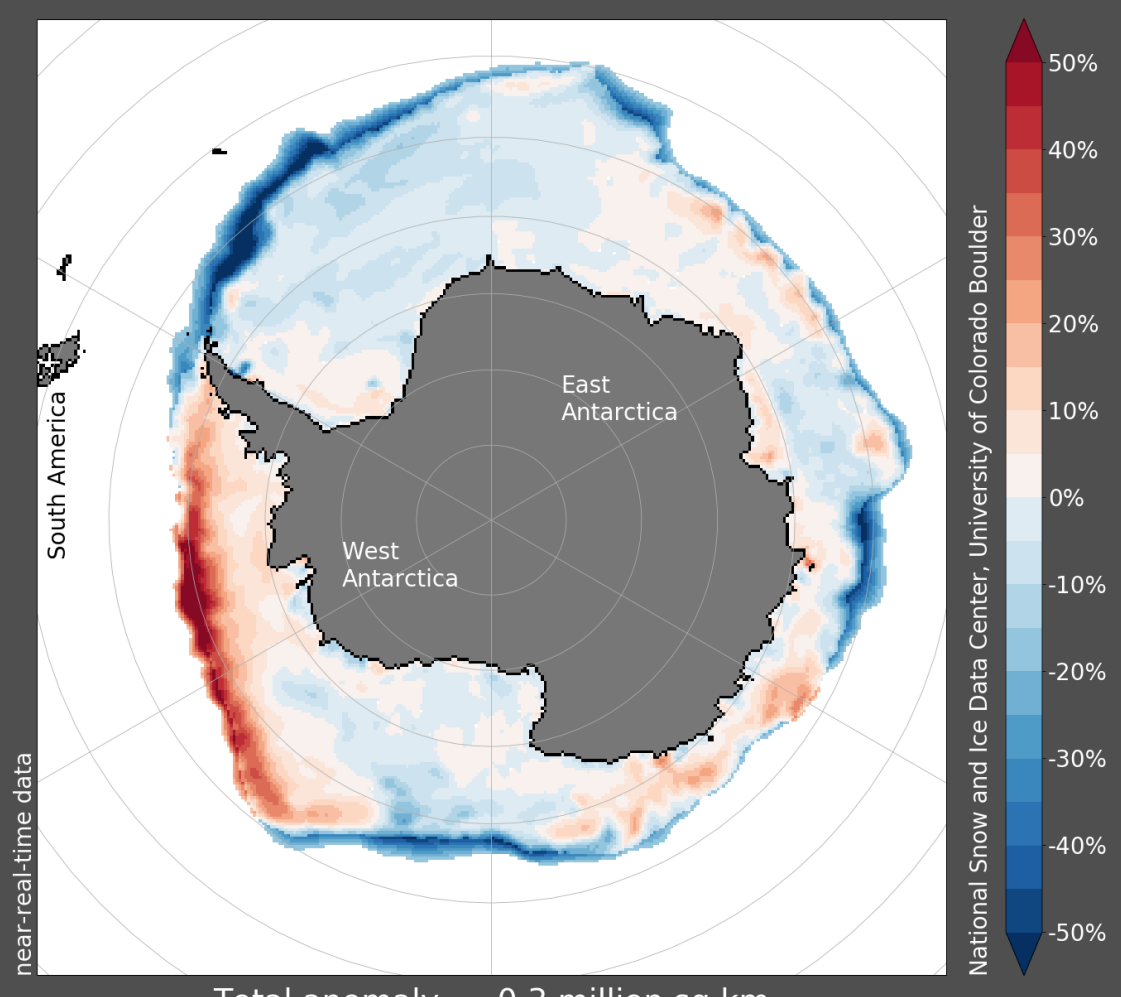
3) Lay the foundations for systematic evaluation of forecasts in the coming years.

# Sea Ice Concentration, Sep 2018




Total Area = 14.1 million sq km

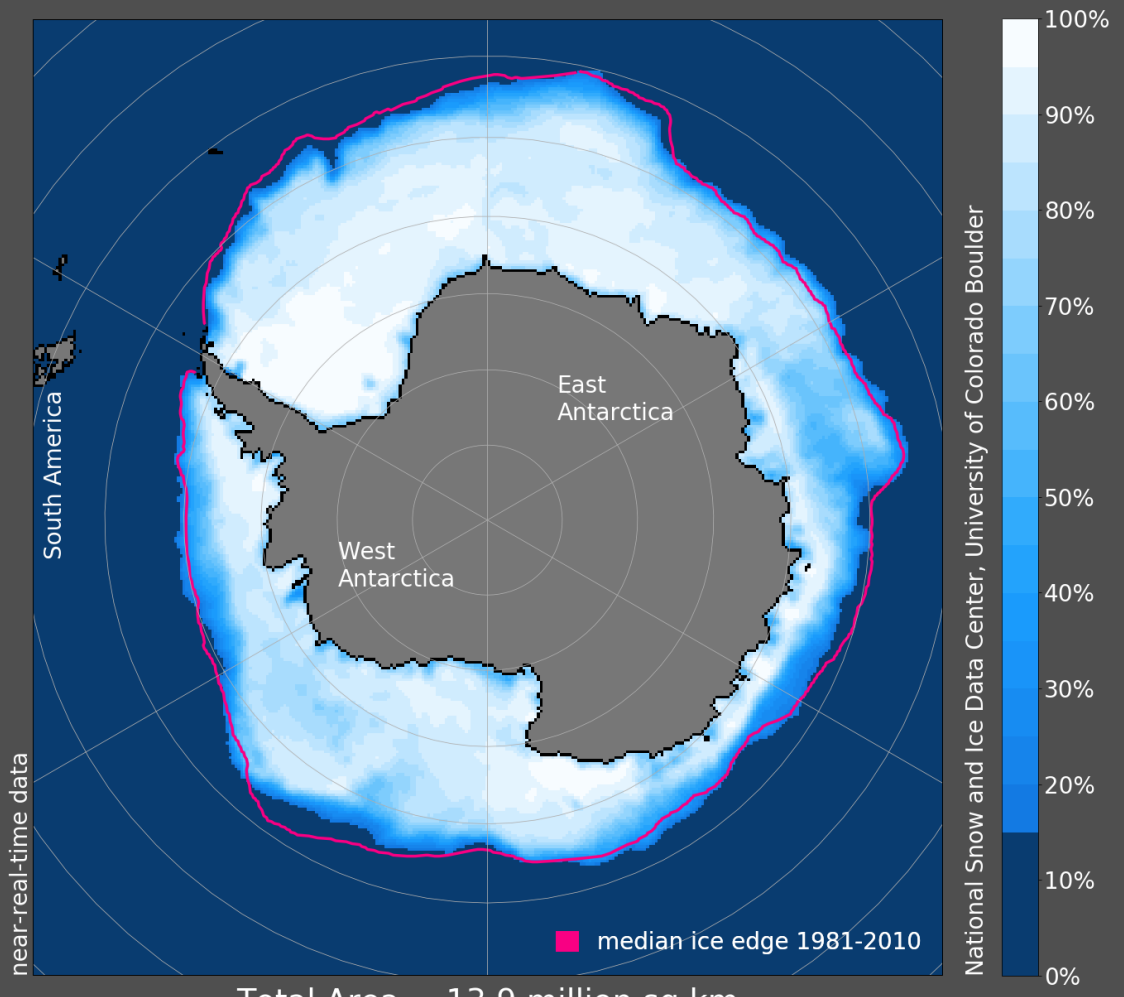
# Sea Ice Concentration Anomalies, Sep 2018




Total anomaly = -0.3 million sq km

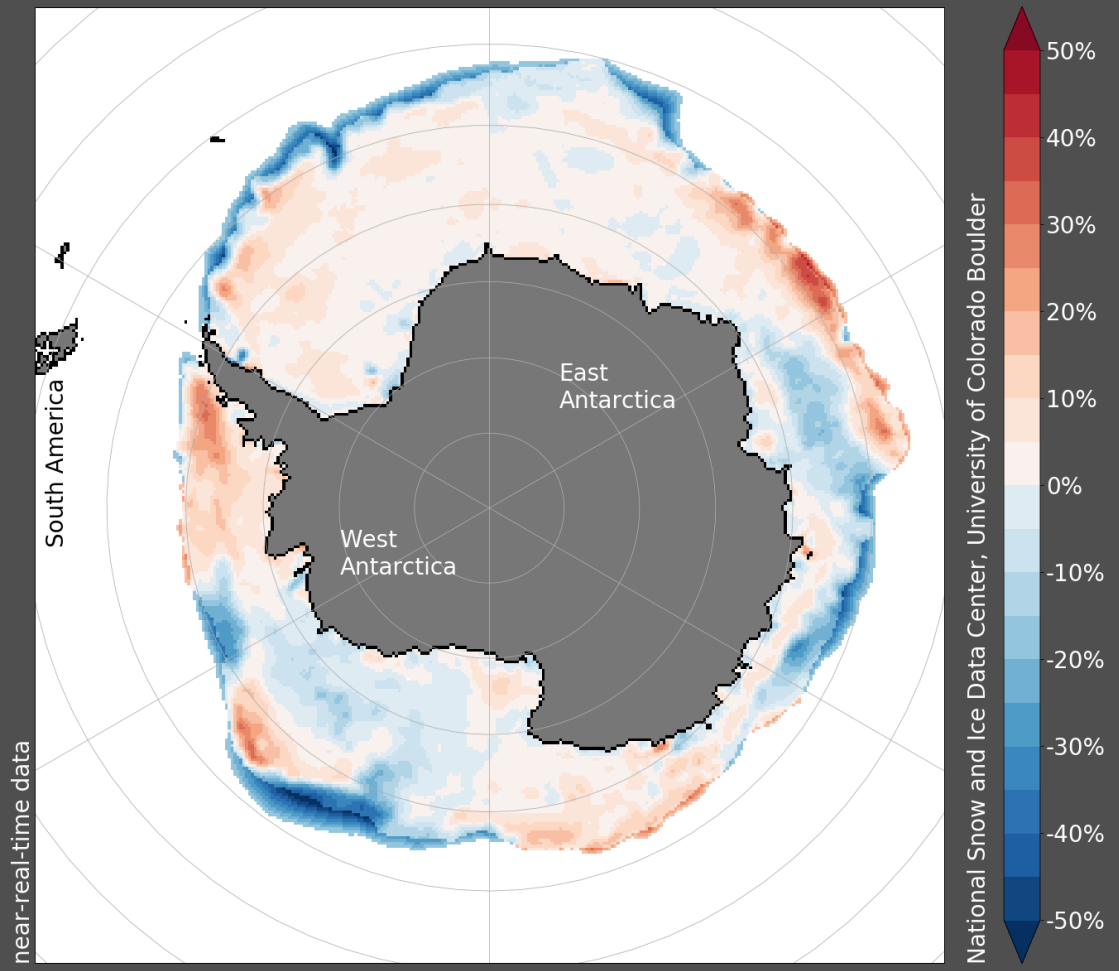
Source: www.nsidc.org

# Sea Ice Concentration, Oct 2018



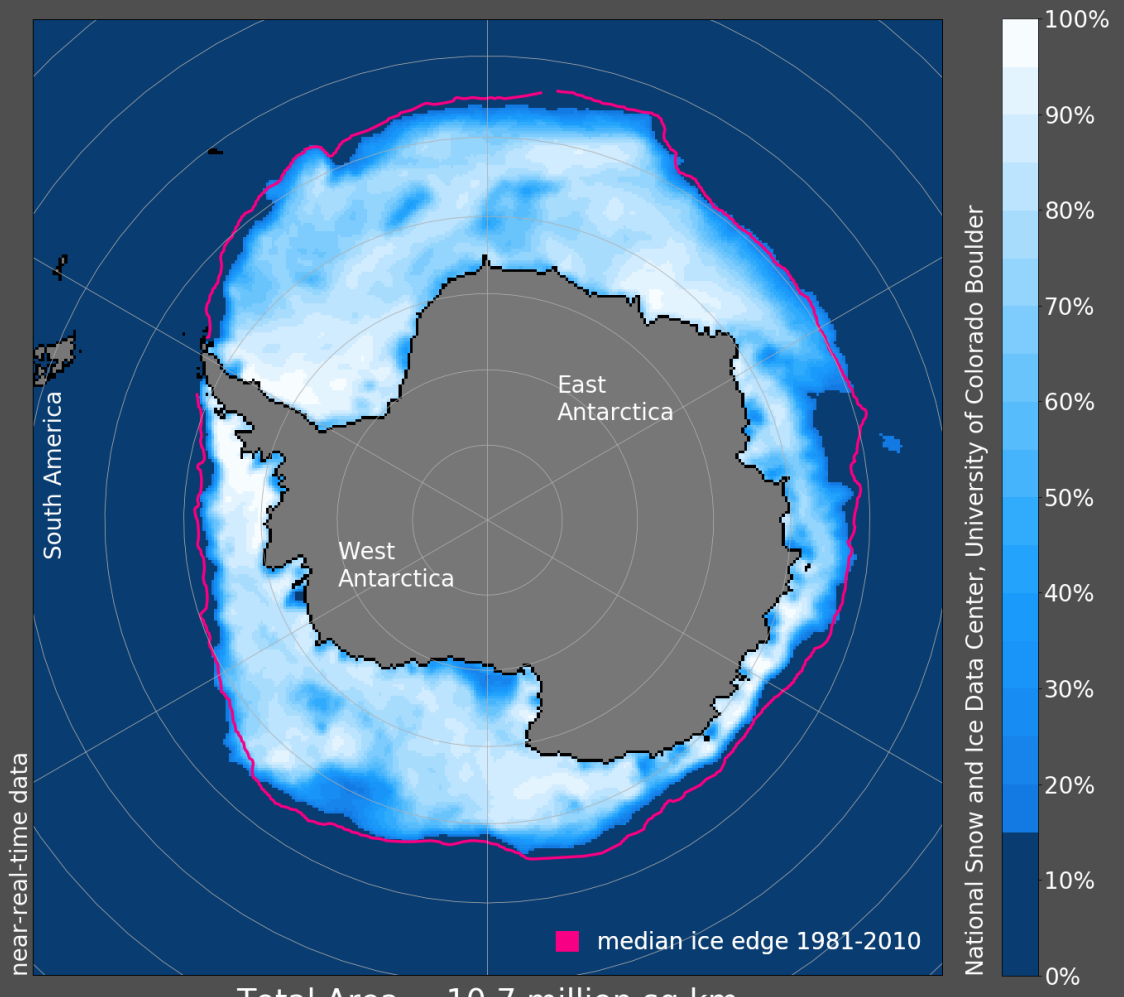

Total Area = 13.9 million sq km

# Sea Ice Concentration Anomalies, Oct 2018



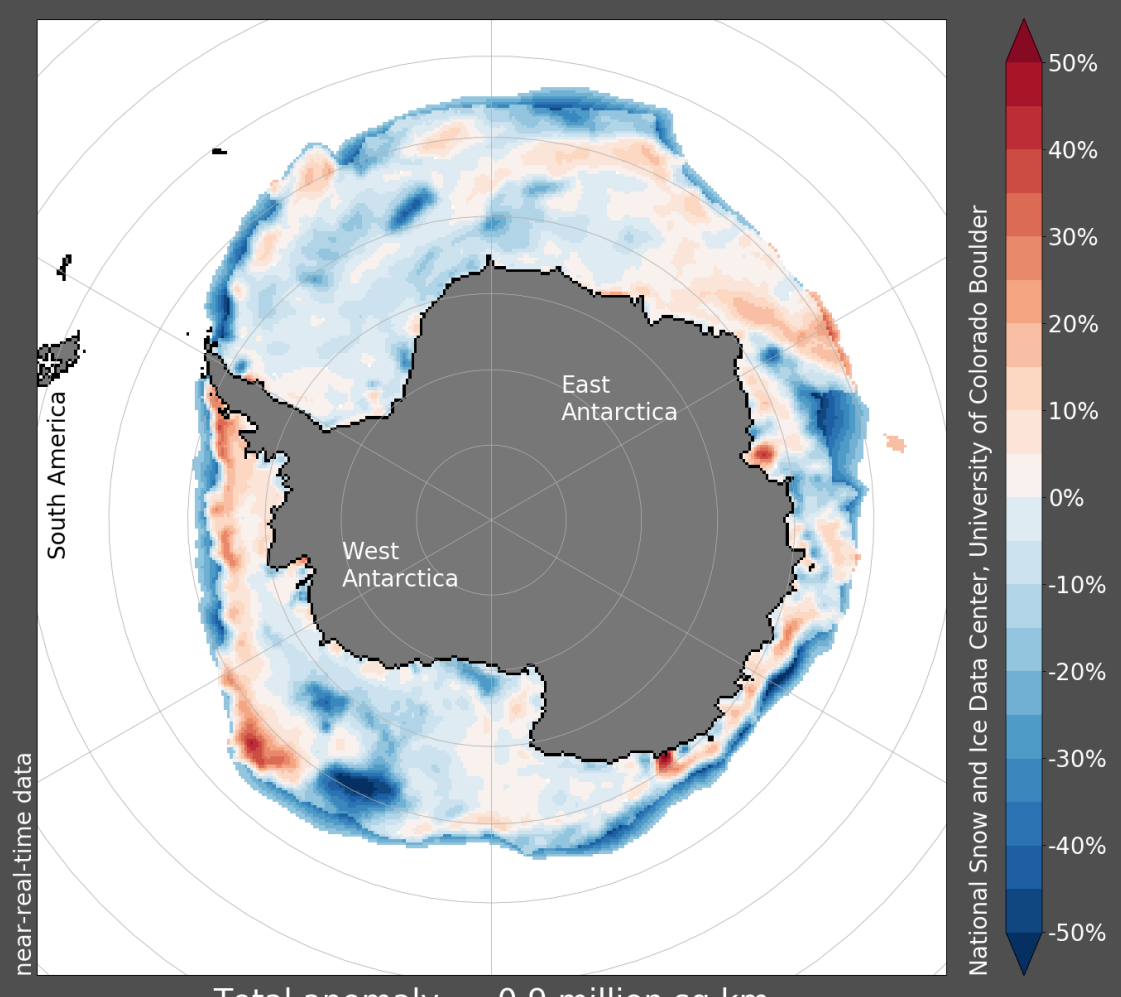

Source: www.nsidc.org

# Sea Ice Concentration, Nov 2018




Total Area = 10.7 million sq km

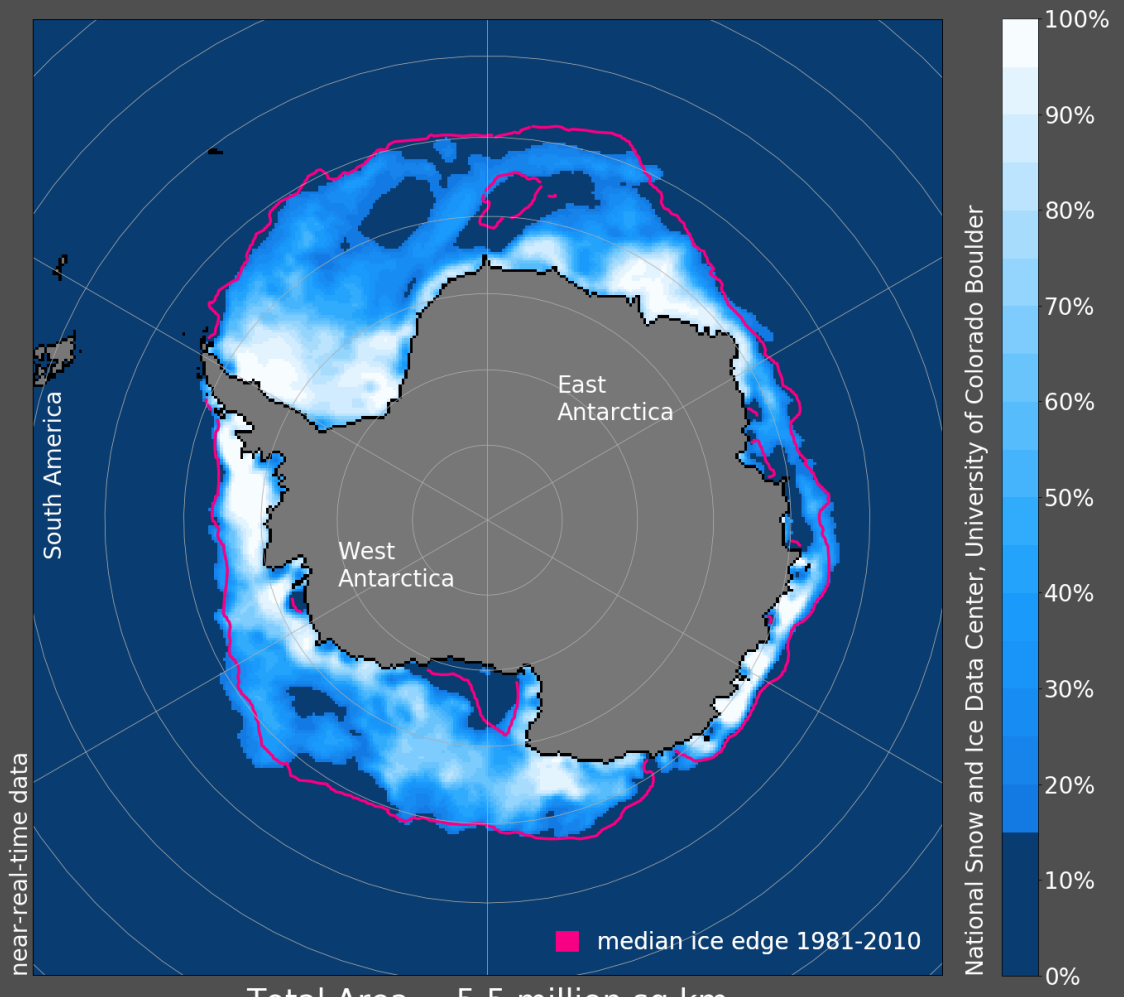
# Sea Ice Concentration Anomalies, Nov 2018




Total anomaly = -0.9 million sq km

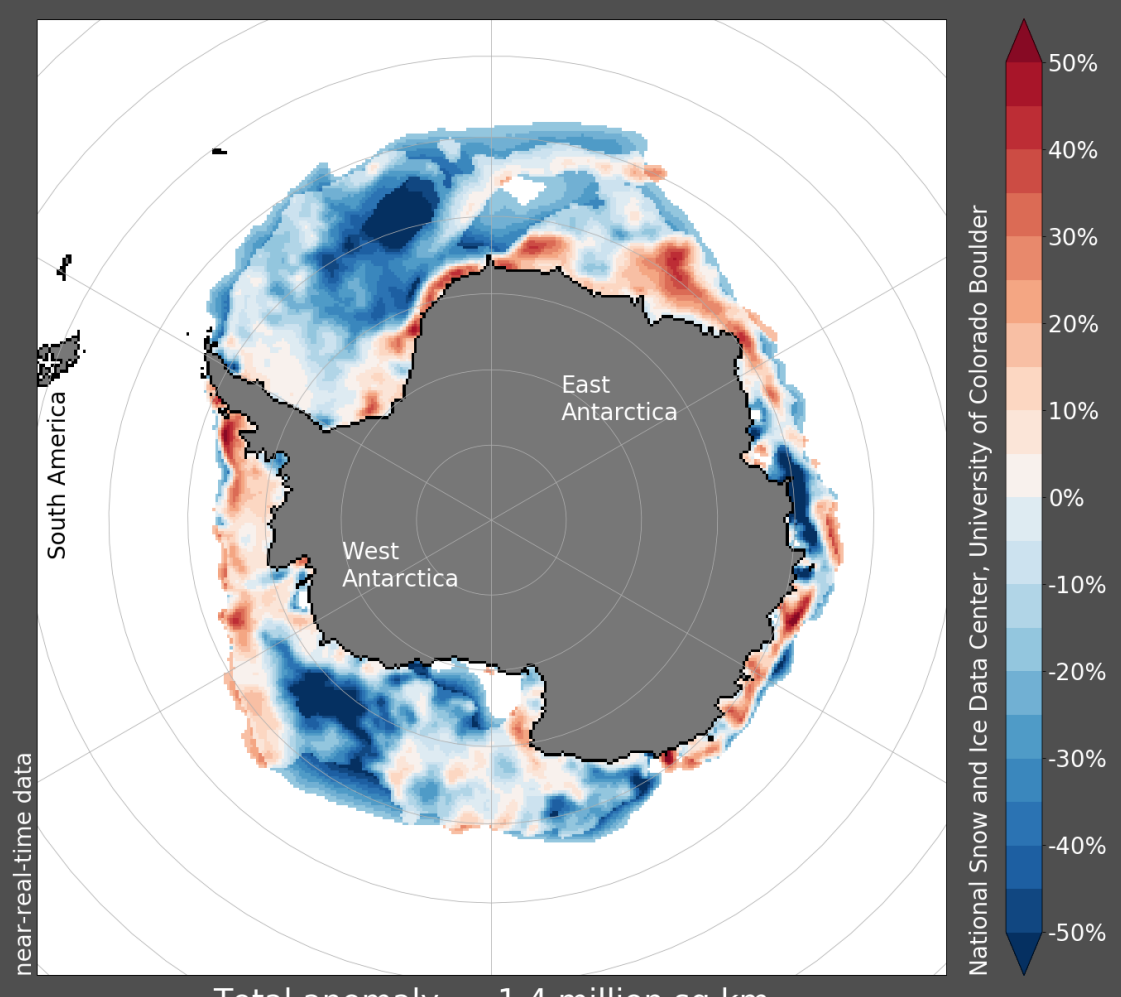
Source: www.nsidc.org

# Sea Ice Concentration, Dec 2018




Total Area = 5.5 million sq km

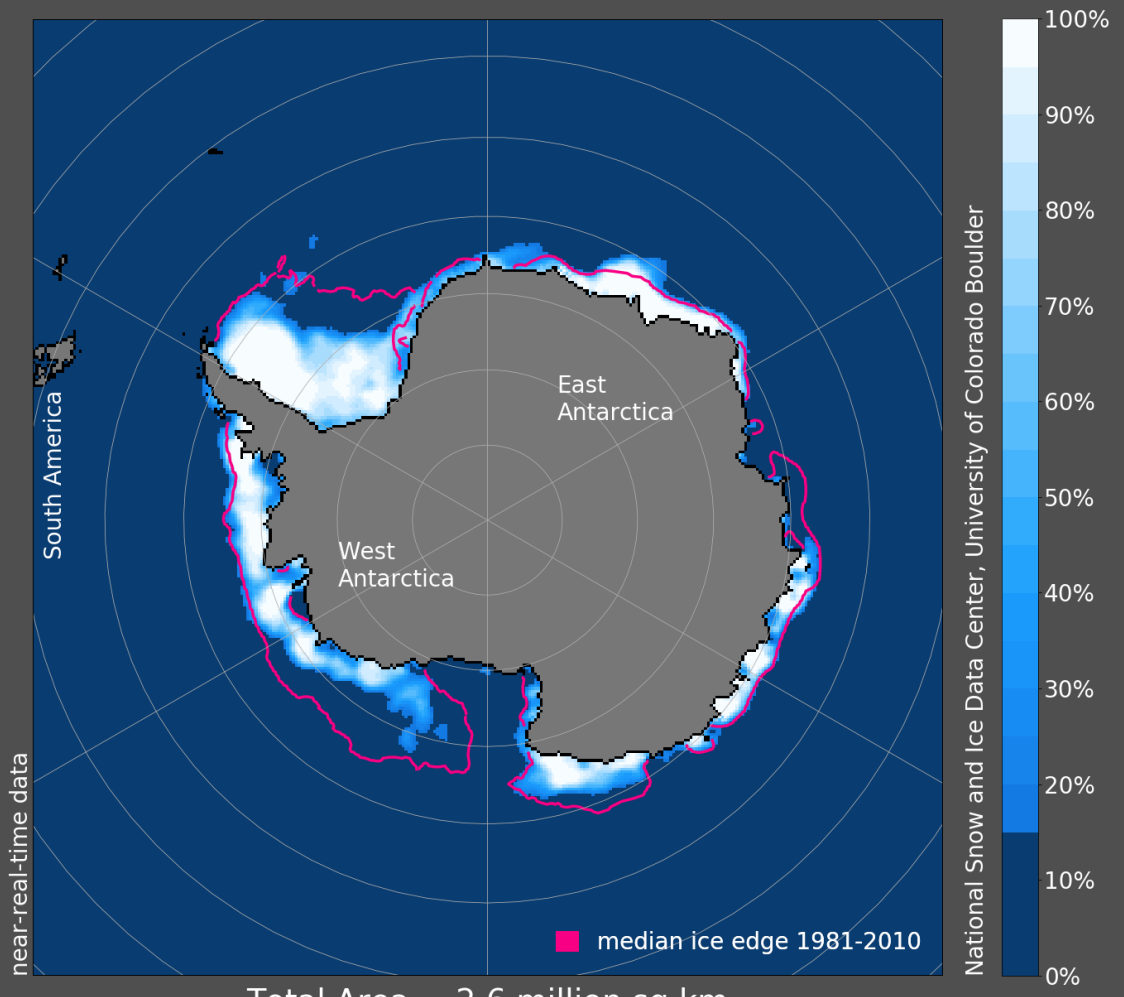
# Sea Ice Concentration Anomalies, Dec 2018




Total anomaly = -1.4 million sq km

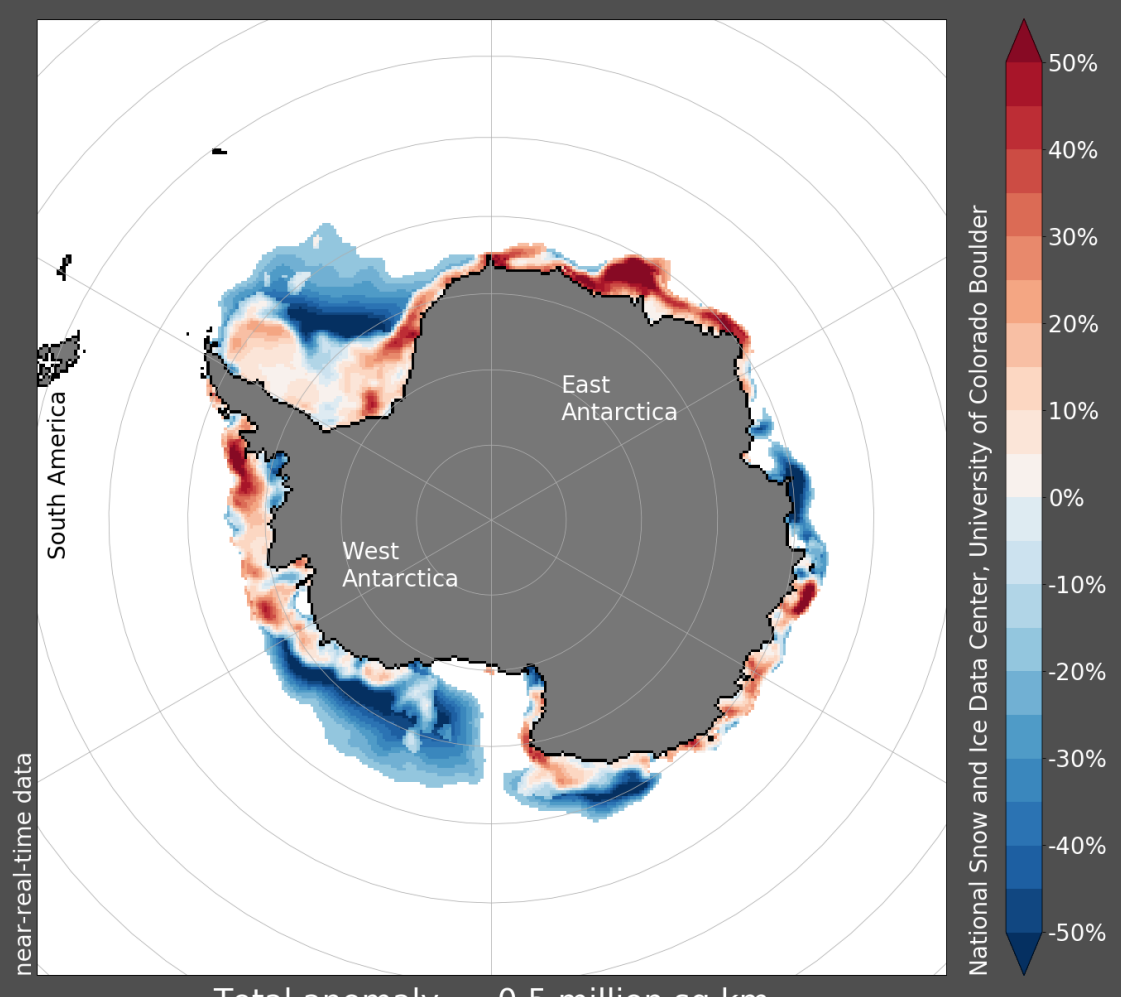
Source: www.nsidc.org

# Sea Ice Concentration, Jan 2019




Total Area = 2.6 million sq km

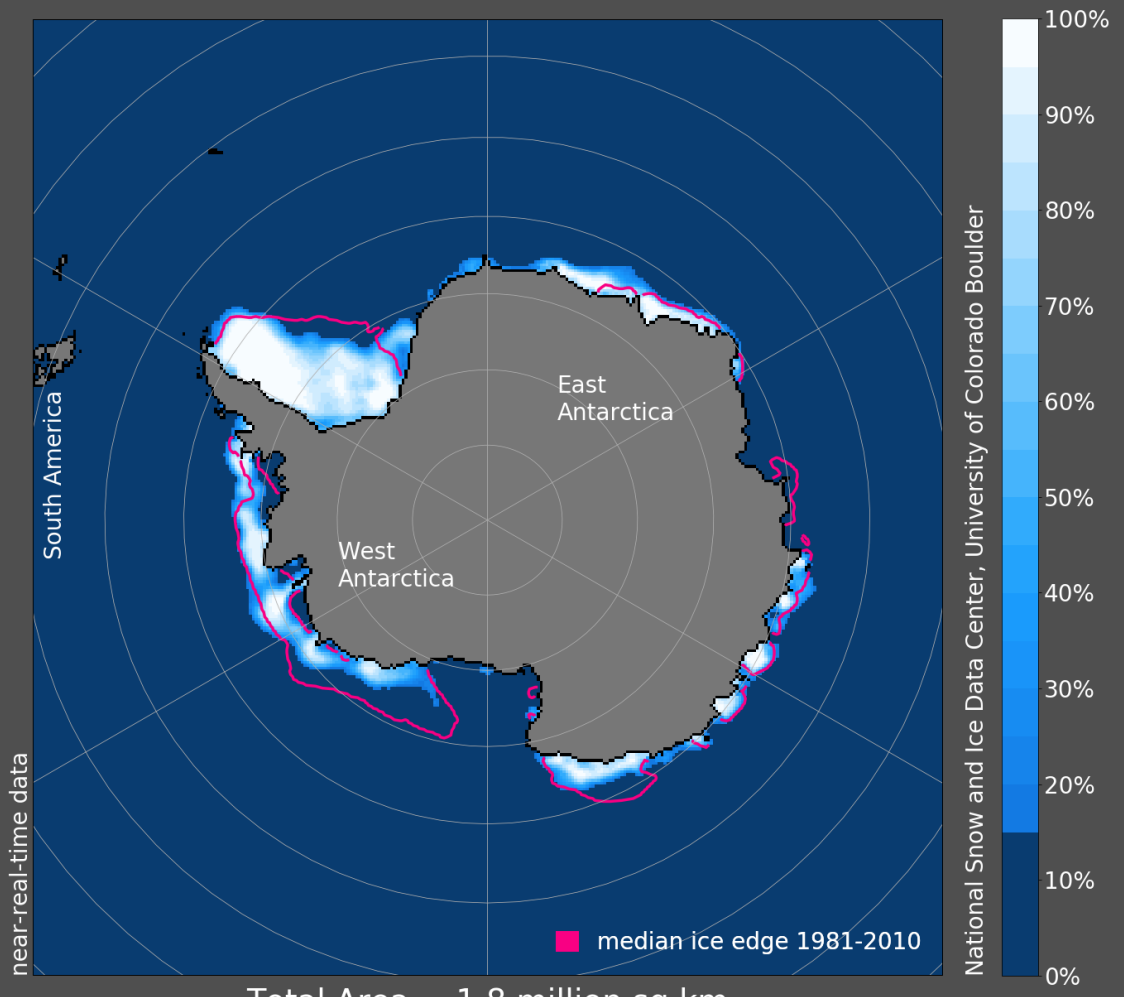
# Sea Ice Concentration Anomalies, Jan 2019




Total anomaly = -0.5 million sq km

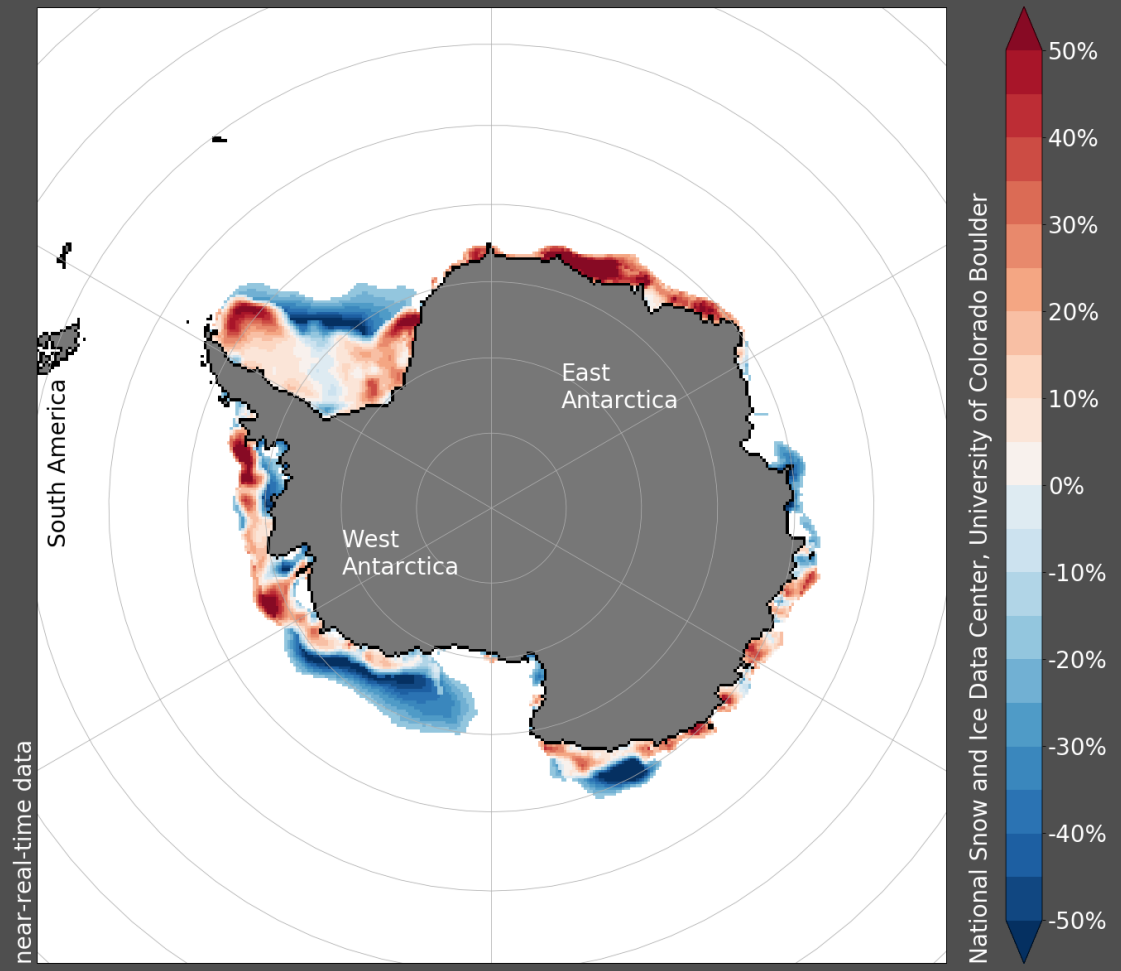
Source: www.nsidc.org

# Sea Ice Concentration, Feb 2019




Total Area = 1.8 million sq km

# Sea Ice Concentration Anomalies, Feb 2019

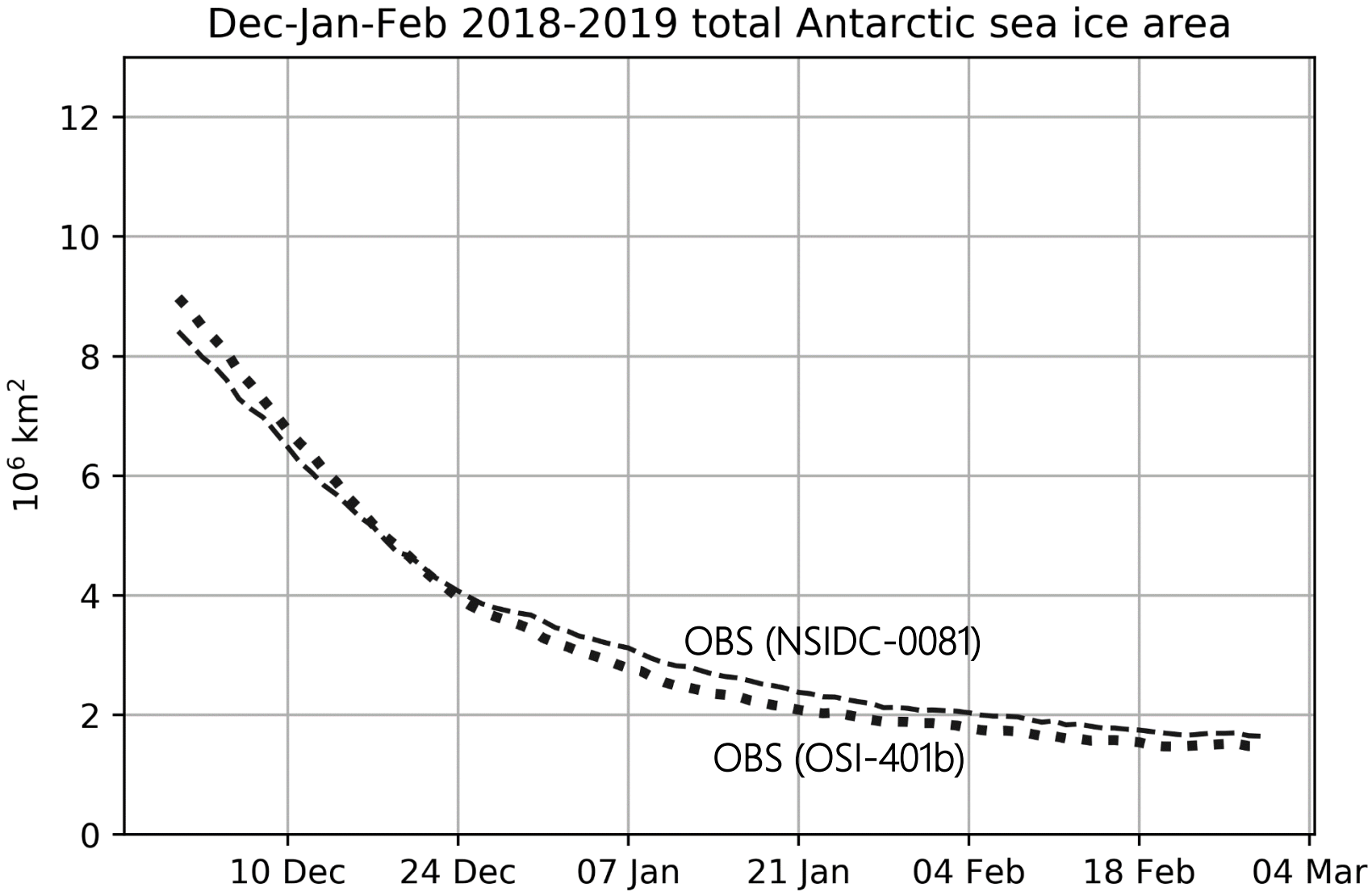



Source: www.nsidc.org

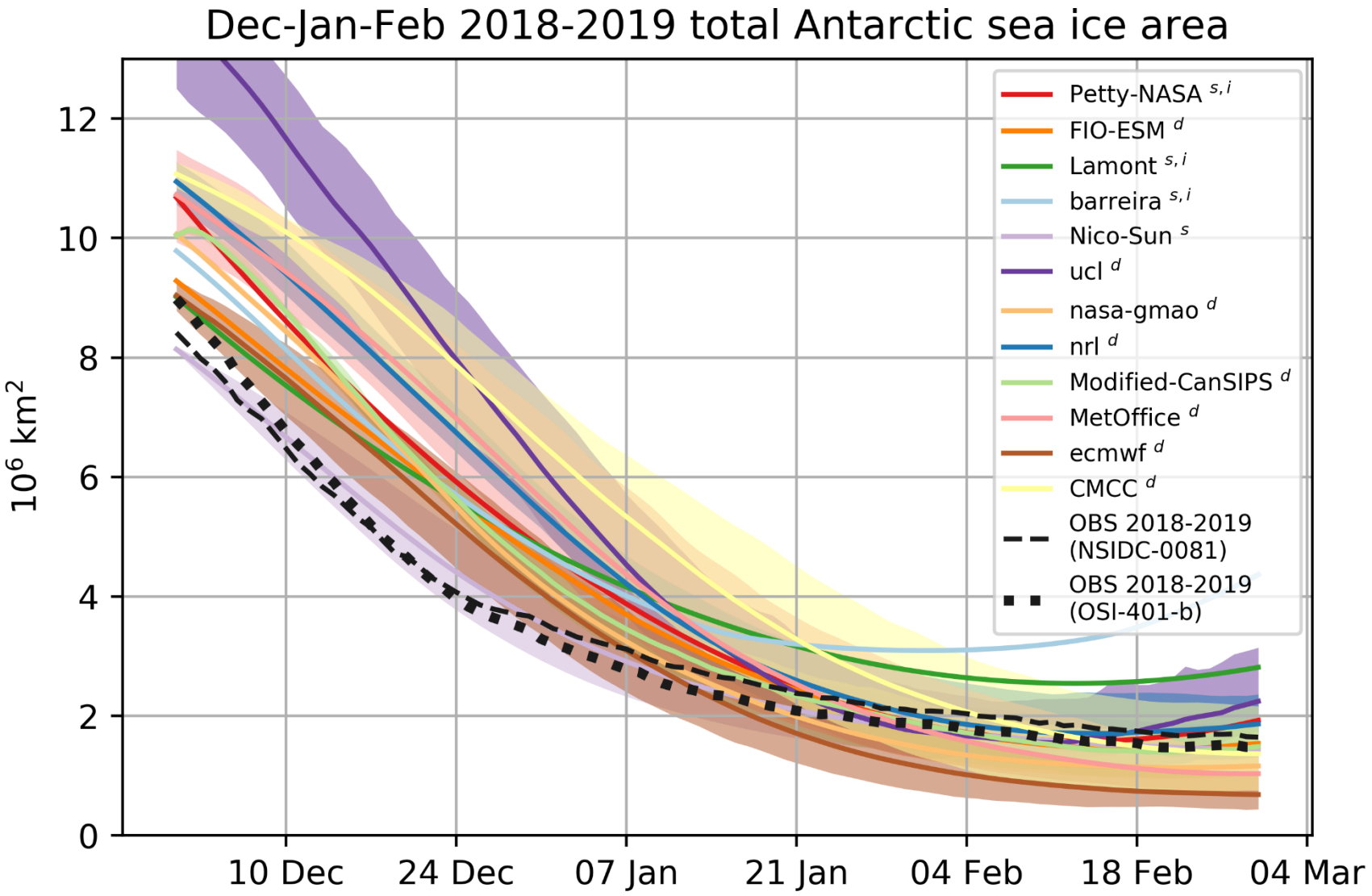
# Coordinating 2018-2019 Southern Ocean summer sea ice forecasts

| | *Contributor name* | *Short name (in figures)* | *Forecasting method* | *Nb. of forecasts* | *Initialization date* | *Diagnostics provided* |
|---|---|---|---|---|---|---|
| 1 | Naval Research Lab | nrl | Coupled dynamical model | 9 | Oct. 31st, 2018 | SIA + rSIA + SIC |
| 2 | Nico Sun | Nico-Sun | Statistical model | 3 | Nov. 30th, 2018 | SIA + SIC |
| 3 | NASA-GMAO | nasa-gmao | Coupled dynamical model | 10 | Nov. 27th, 2018 | SIA + SIC |
| 4 | FIO-ESM | FIO-ESM | Coupled dynamical model | 1 | Nov. 1st, 2018 | SIA |
| 5 | ECMWF | ecmwf | Coupled dynamical model | 50 | Dec. 1st, 2018 | SIA + rSIA |
| 6 | Lamont Sea Ice Group | Lamont | Statistical model | 1 | Oct. 31st, 2018 | SIA + rSIA + SIC (monthly, interp. daily) |
| 7 | Alek Petty | Petty-NASA | Statistical model | 1 | Nov. 30th, 2018 | SIA (monthly, interp. daily) |
| 8 | Modified CanSIPS | Modified-CanSIPS | Coupled Dynamical Model | 20 | Nov. 30th, 2018 | SIA + rSIA |
| 9 | Met Office | MetOffice | Coupled Dynamical Model | 42 | Nov. 25th, 2018 | SIA + rSIA + SIC |
| 10 | CMCC | CMCC | Coupled Dynamical Model | 50 | Nov. 1st, 2018 | SIA |
| 11 | UCL | ucl | Ocean—sea ice Dynamical Model | 10 | July 1st, 2018 | SIA + rSIA + SIC |
| 12 | Sandra Barreira | Barreira | Statistical model | 1 | Dec. 1st, 2018 | SIA + rSIA + SIC (monthly, interp. daily) |

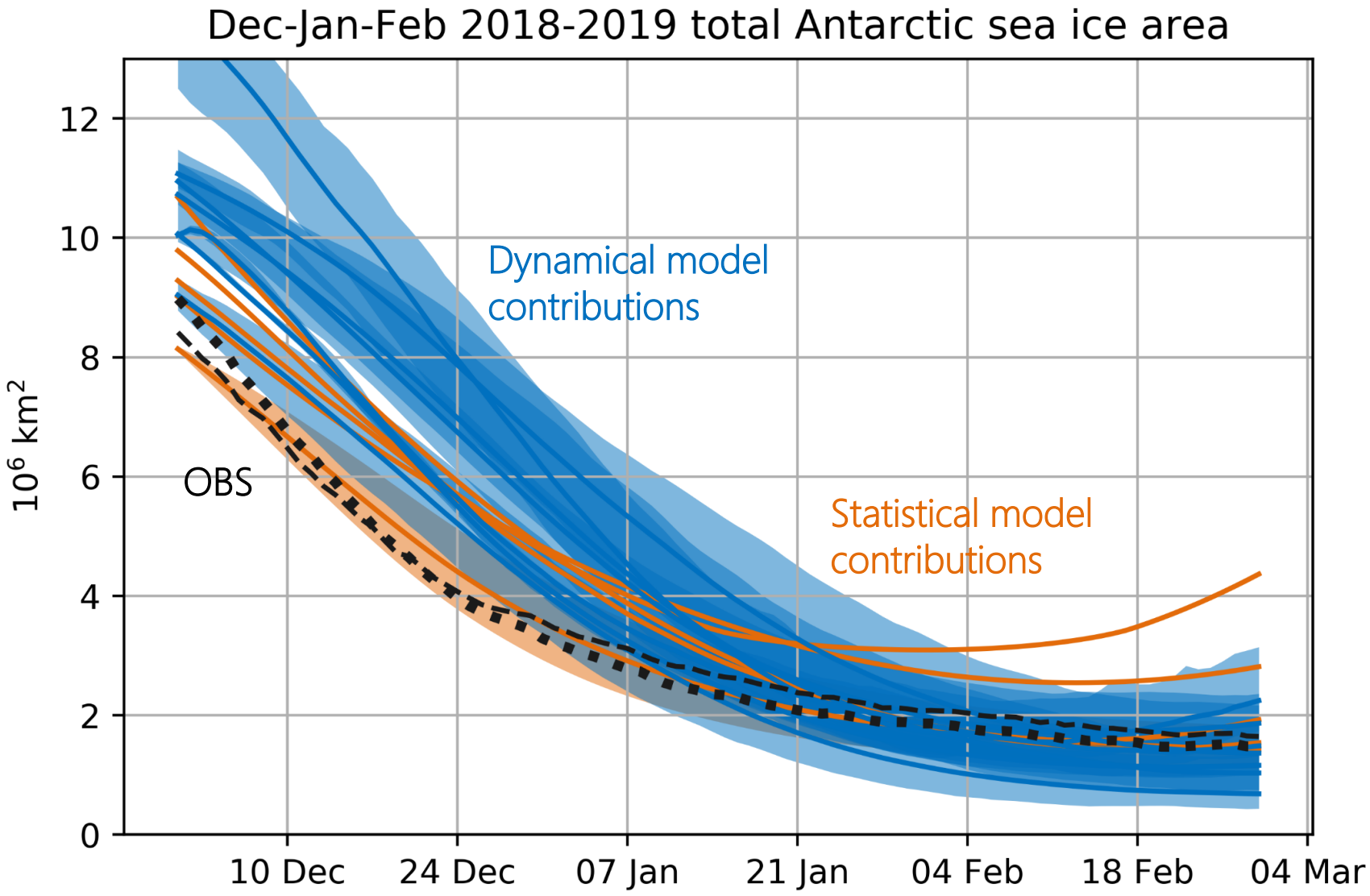
# Rapid ice retreat through December 2018, slowdown in January and February 2019



# SIPN South predictions as submitted on 1 December 2018



# Sea ice area starts biased high in most dynamical contributions



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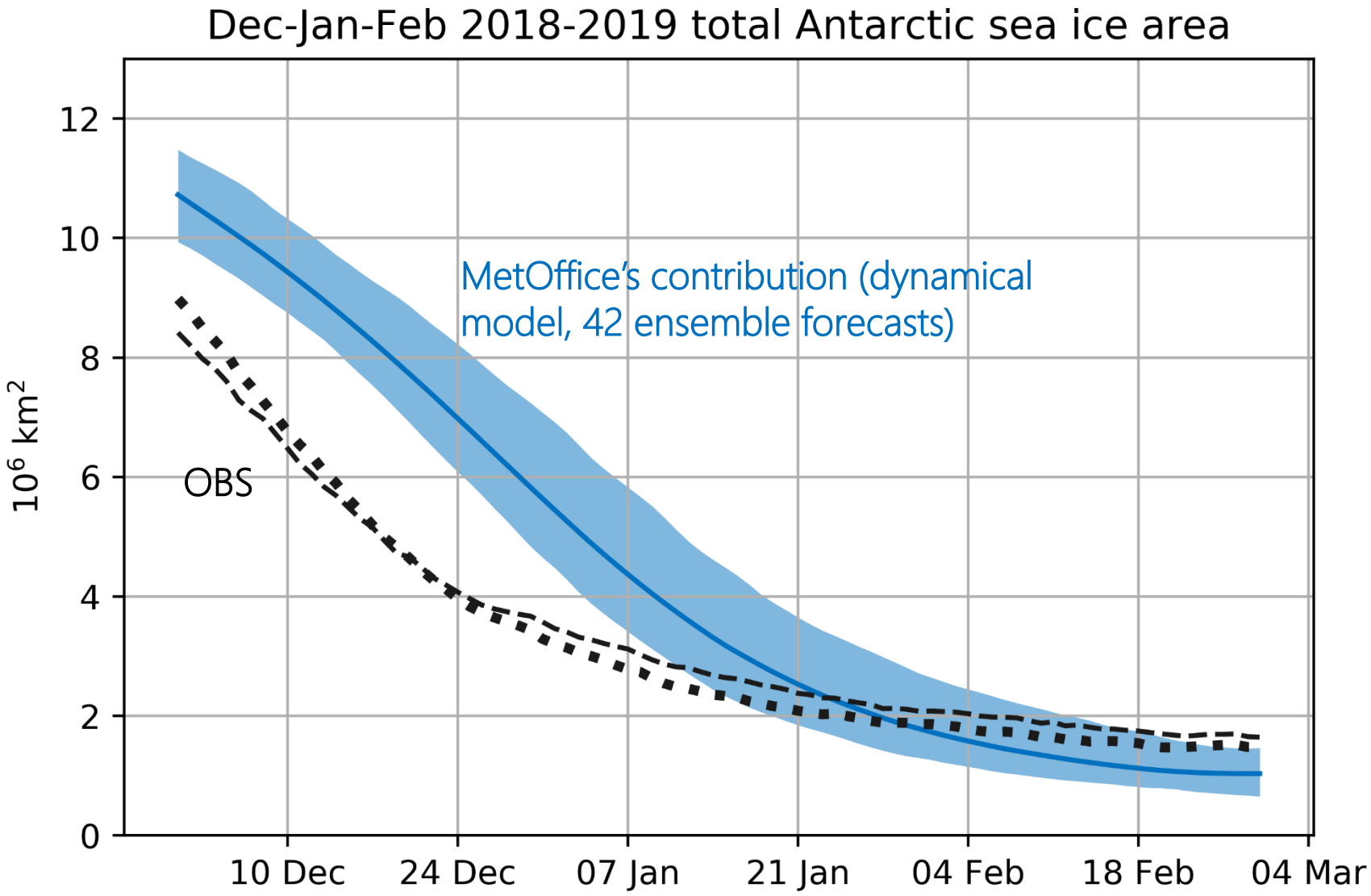

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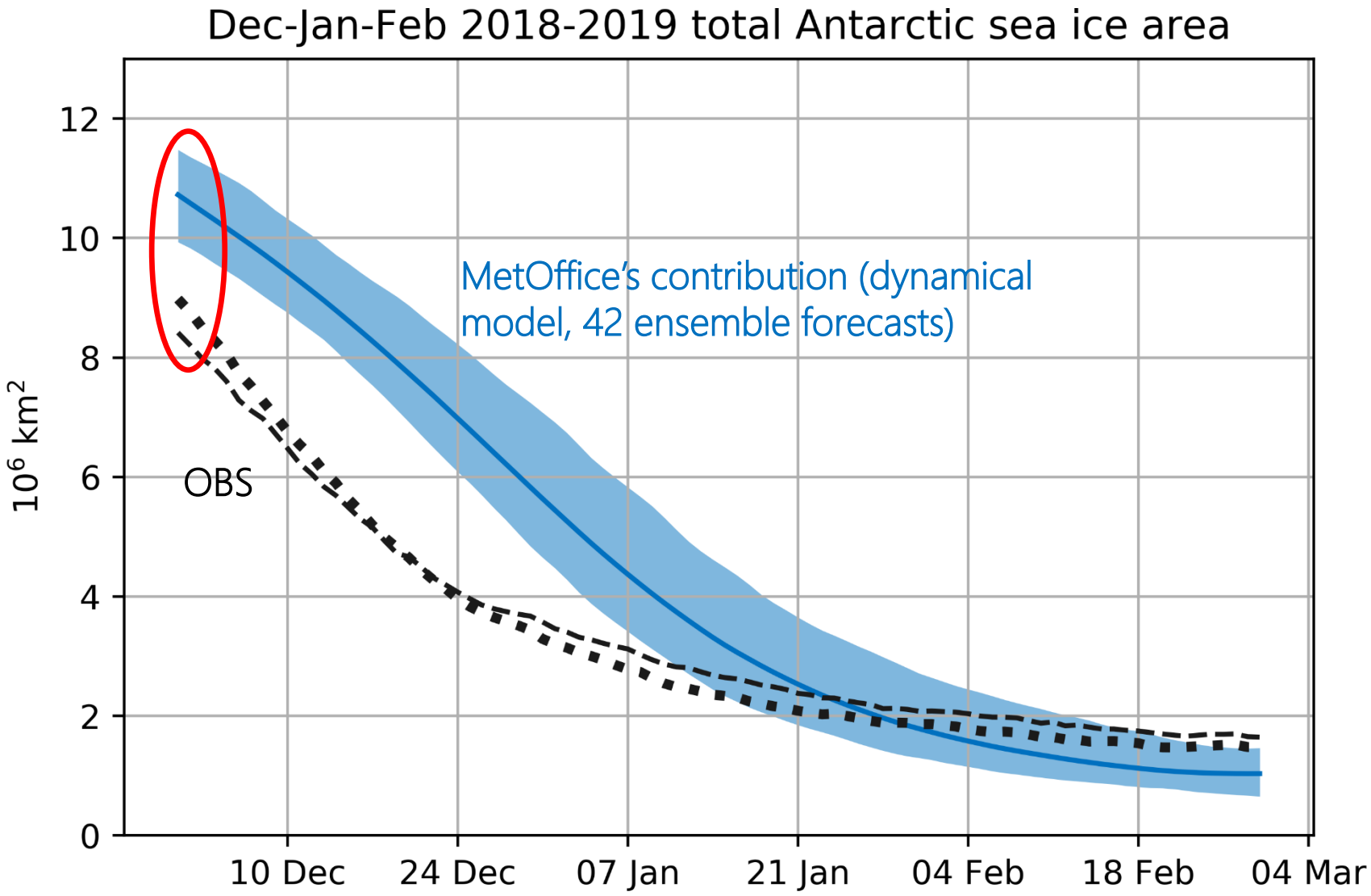
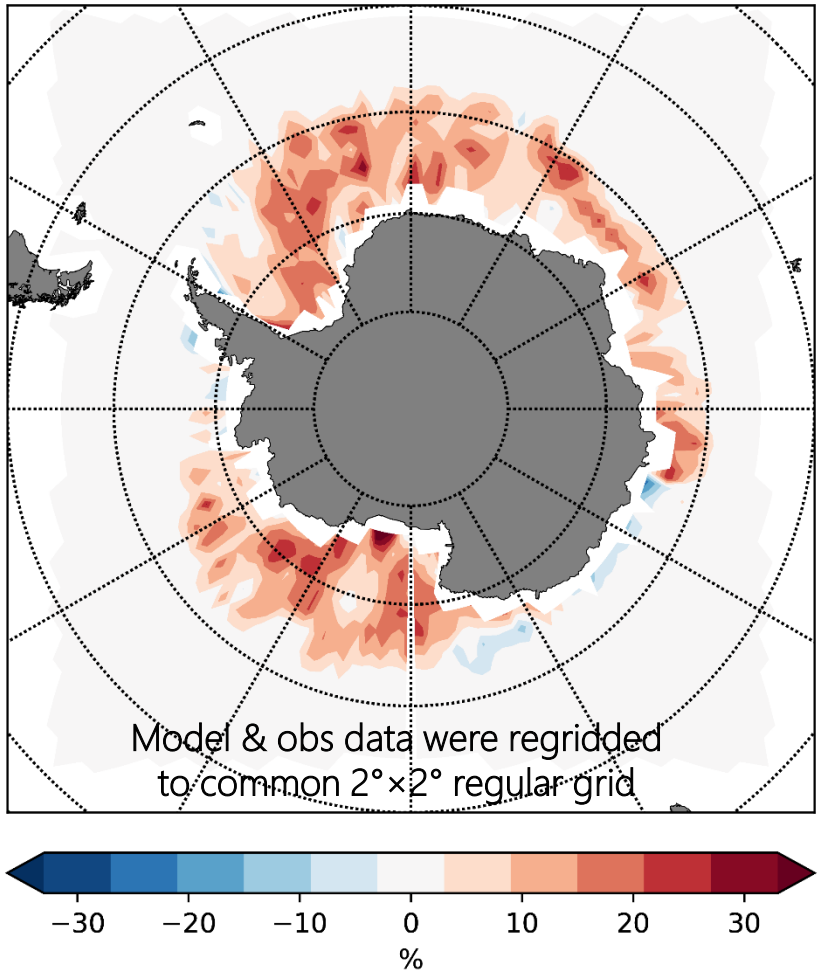


# Challenges in initialization of coupled dynamical models

**Bias in sea ice concentration** at **day 1** of the **MetOffice** forecast (1 December 2018)




personal communication, Ed Blockley

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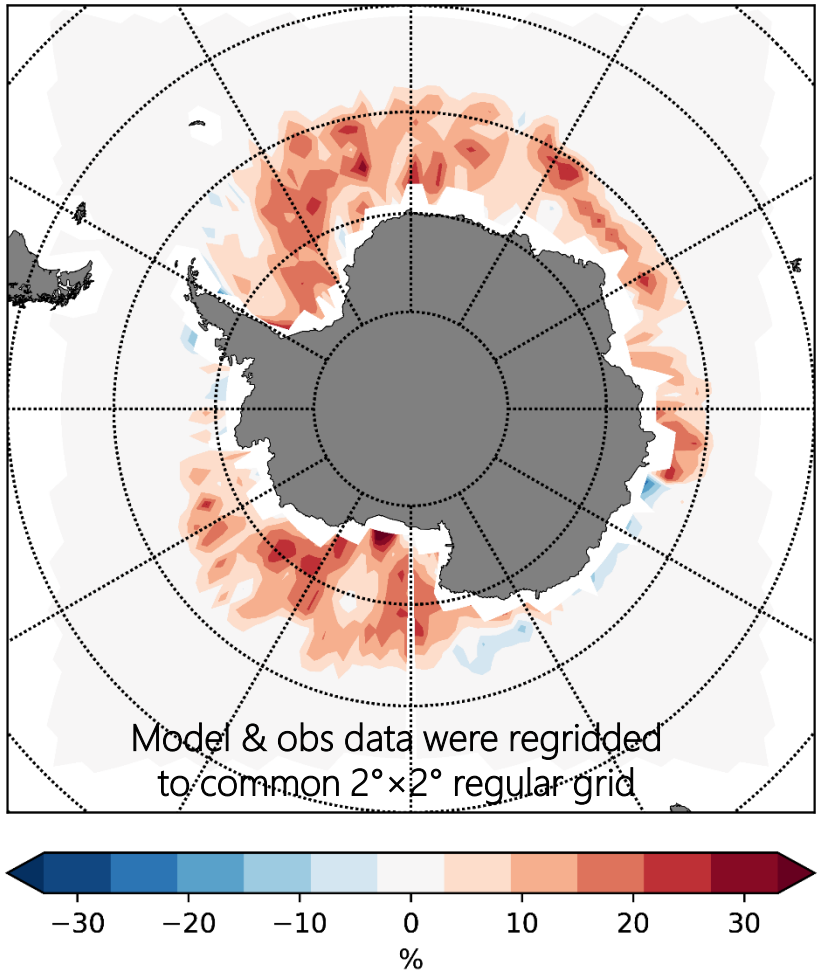
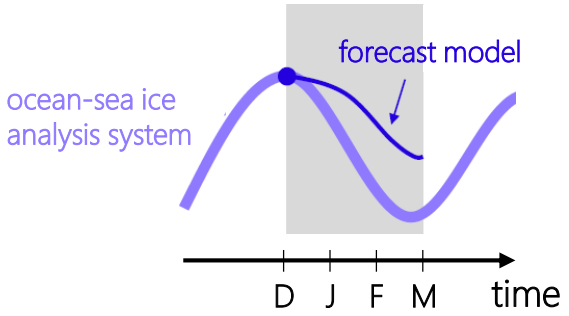



How is this possible?

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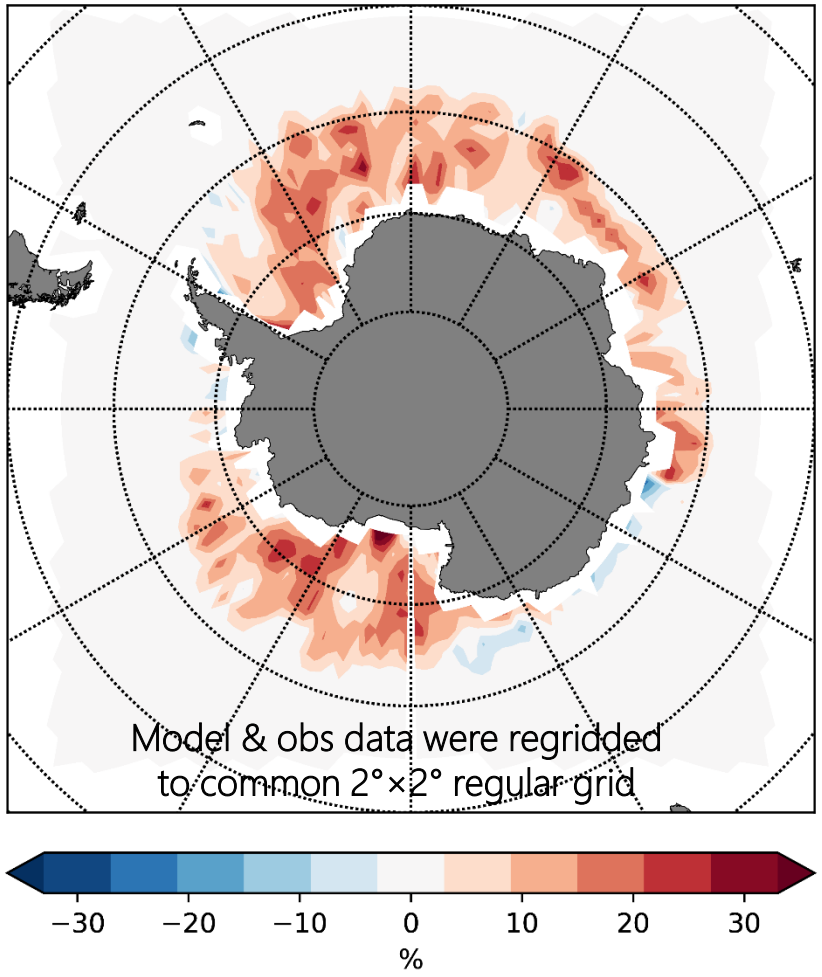
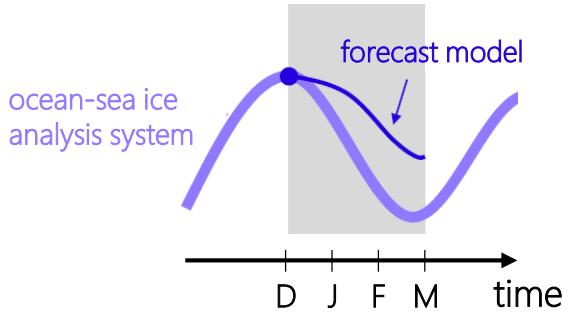



How is this possible?

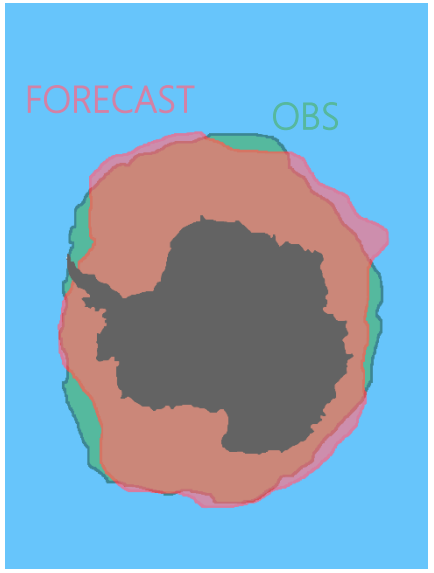
The **forecast model** assumes constant freezing temperature: $T_{frz} = -1.8°C$

The **ocean-sea ice analysis system** uses salinity-dependent freezing temperature: $T_{frz} = T_{frz}(S)$

In the Southern Ocean, salinity is higher than in the Arctic Ocean so that $T_{frz} < -1.8°C$. The analysis system produces open water at freezing temperature, which freezes rapidly as soon as the forecast model starts running.

personal communication, Ed Blockley

# Integrated Ice Edge Error: quantification of spatial errors in forecasted sea ice concentration




Integrated Ice Edge Error =
Area of overestimation
+
Area of underestimation

Goessling et al., *Geophys. Res. Lett., 2016*

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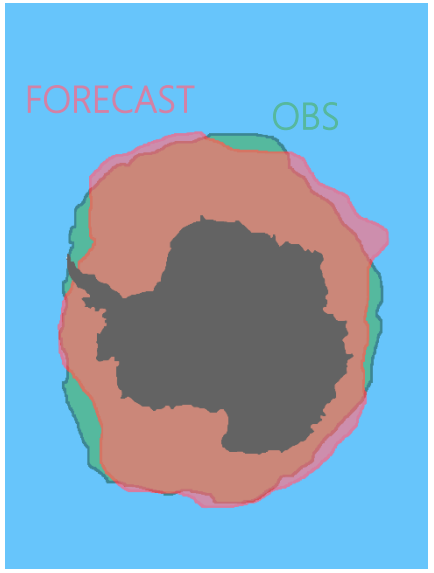


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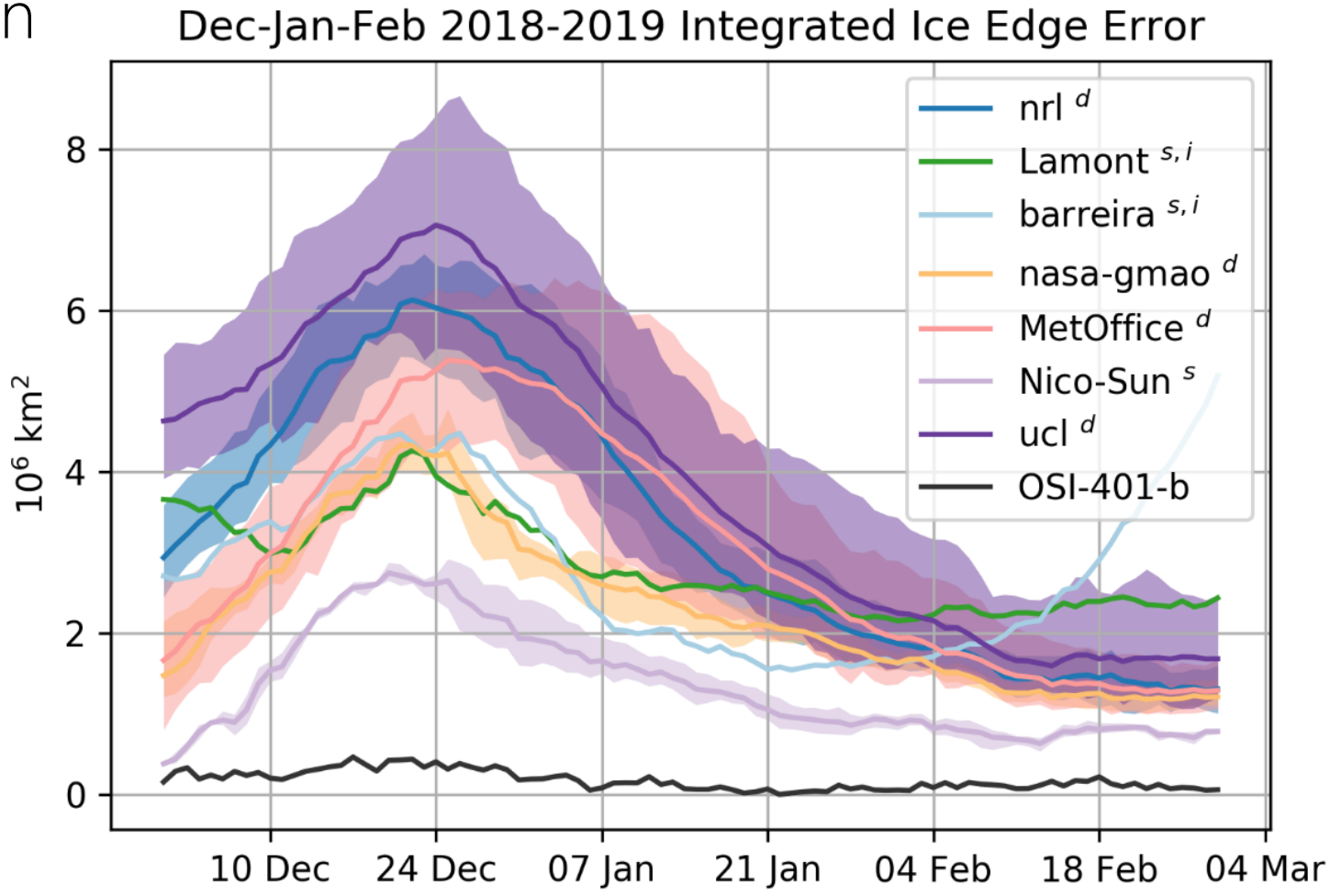


Goessling et al., *Geophys. Res. Lett., 2016*

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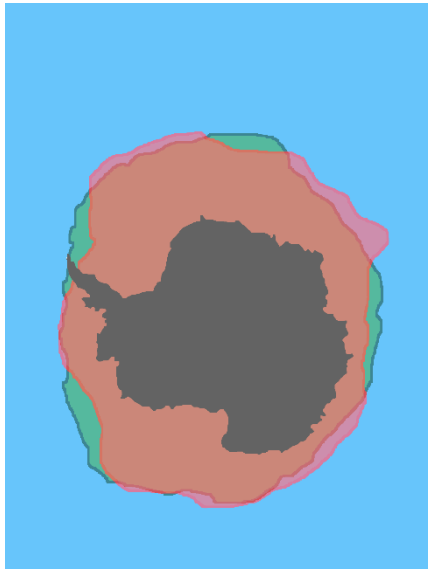

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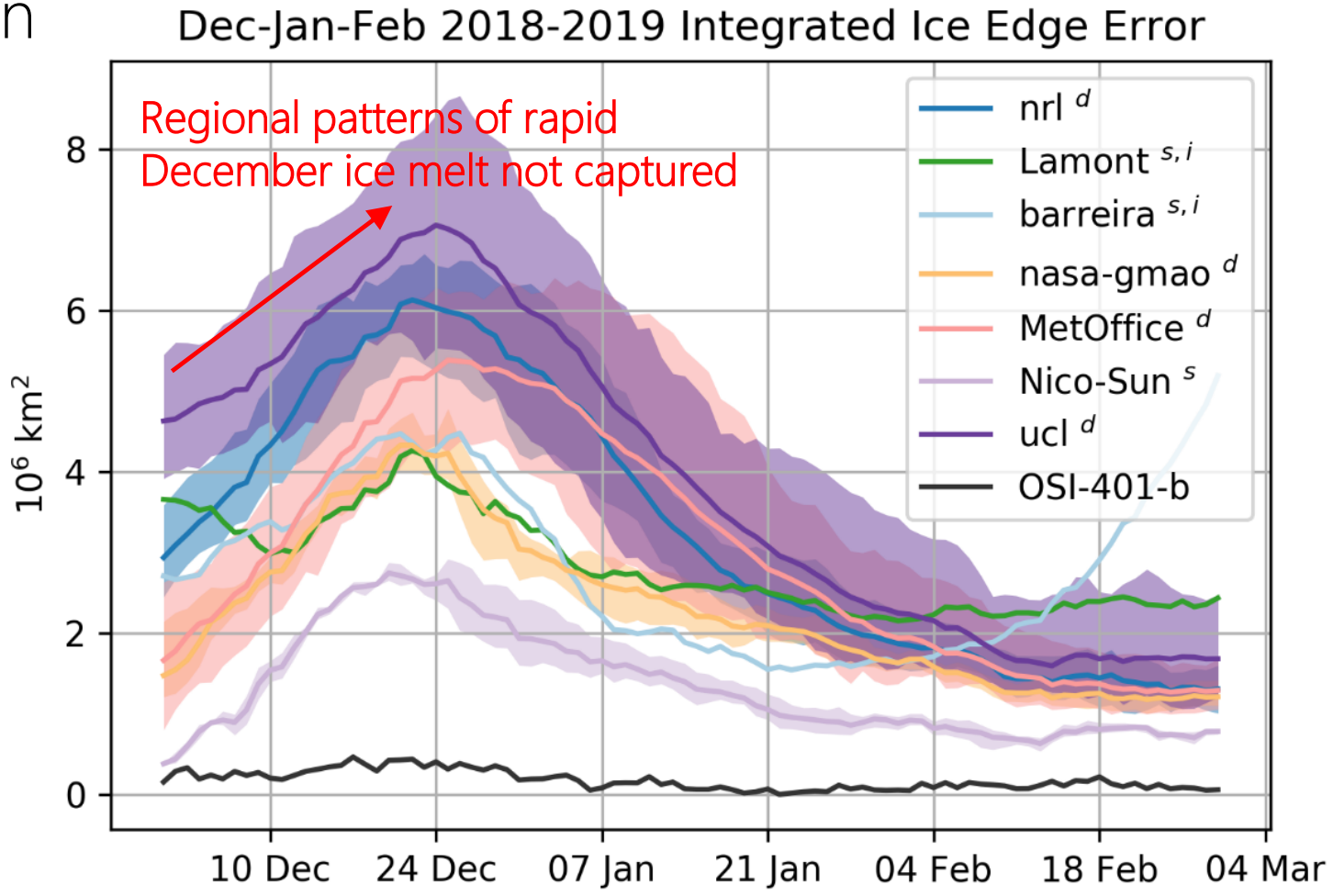


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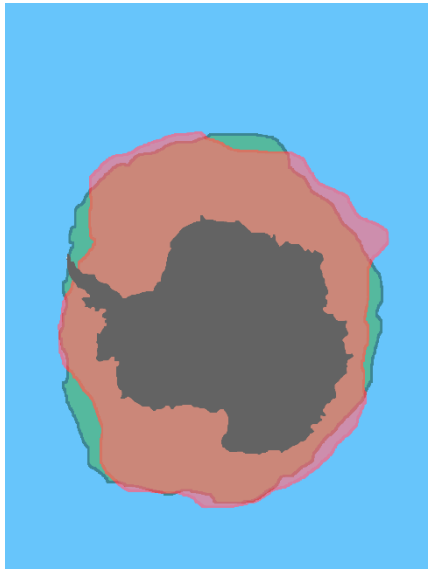

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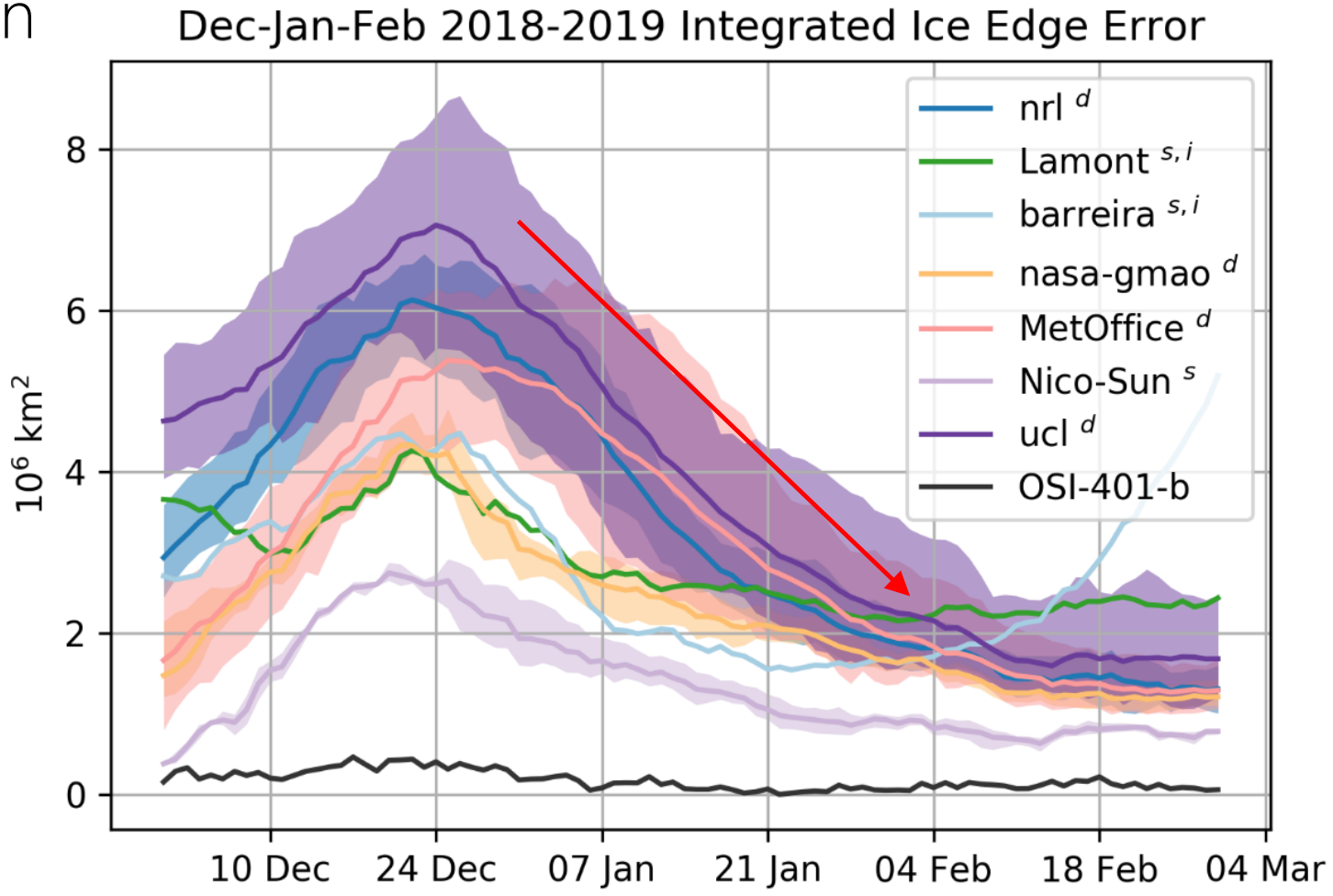
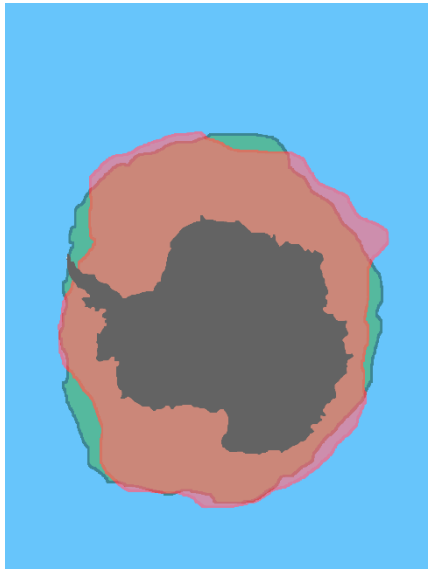



Goessling et al., *Geophys. Res. Lett., 2016*

# Statistical model contributions have on average a lower error



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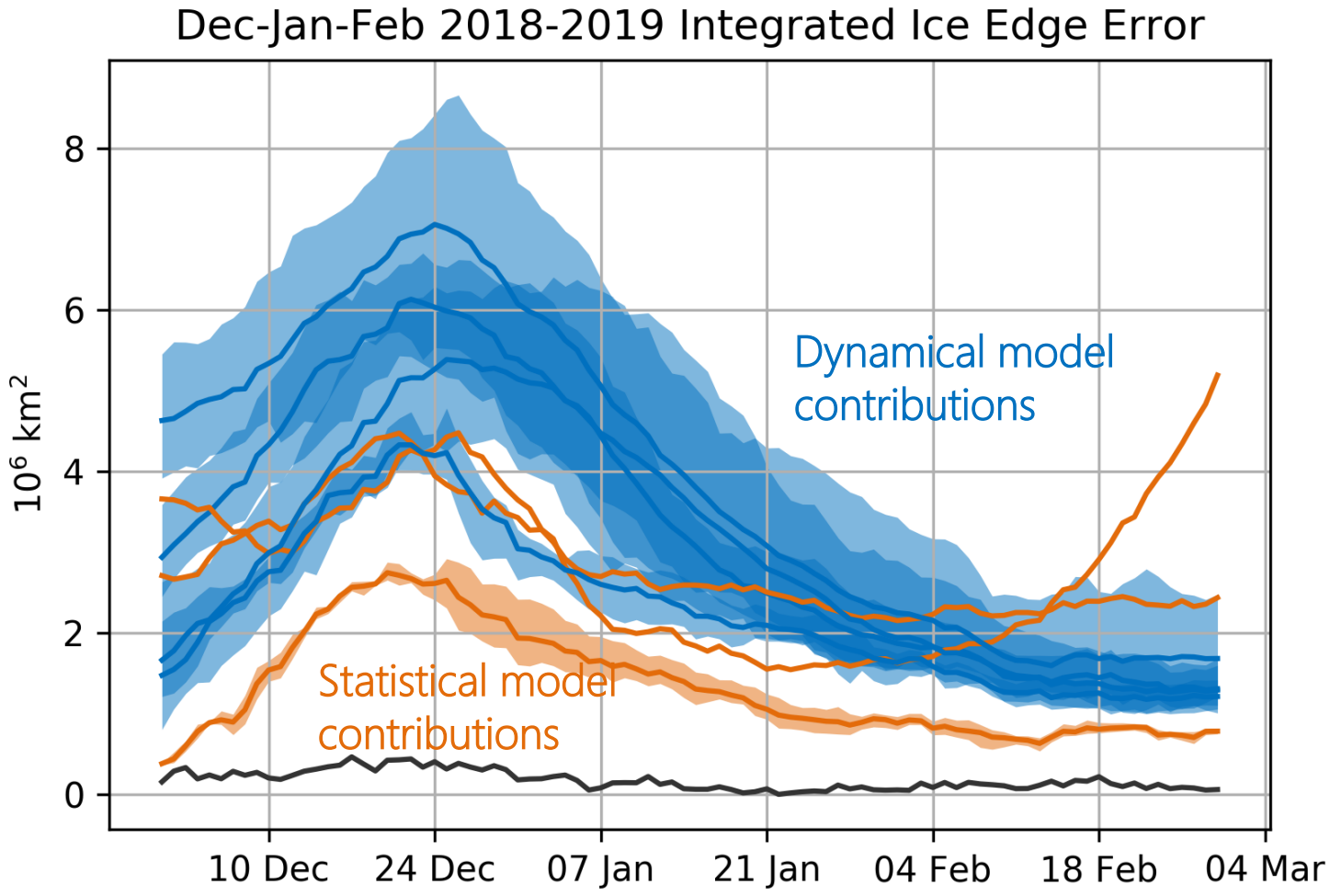
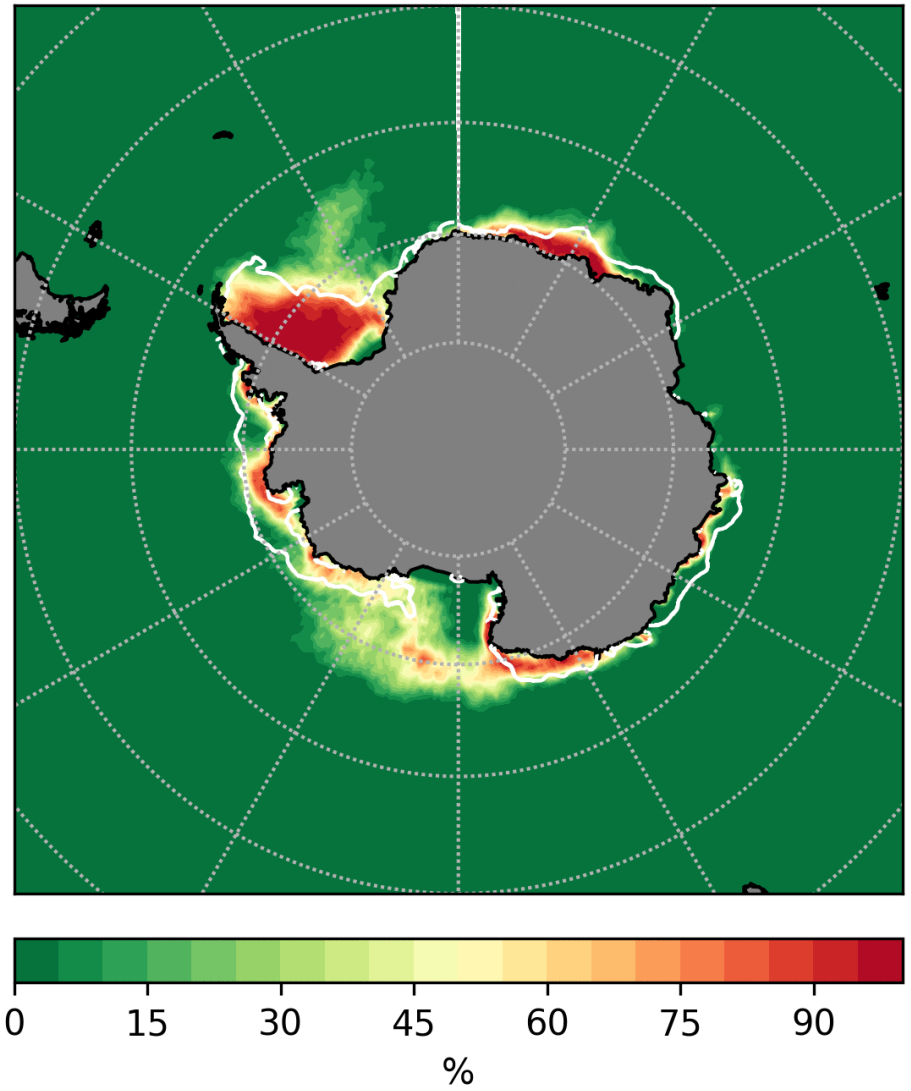



Goessling et al., *Geophys. Res. Lett., 2016*

# Probability of sea ice presence

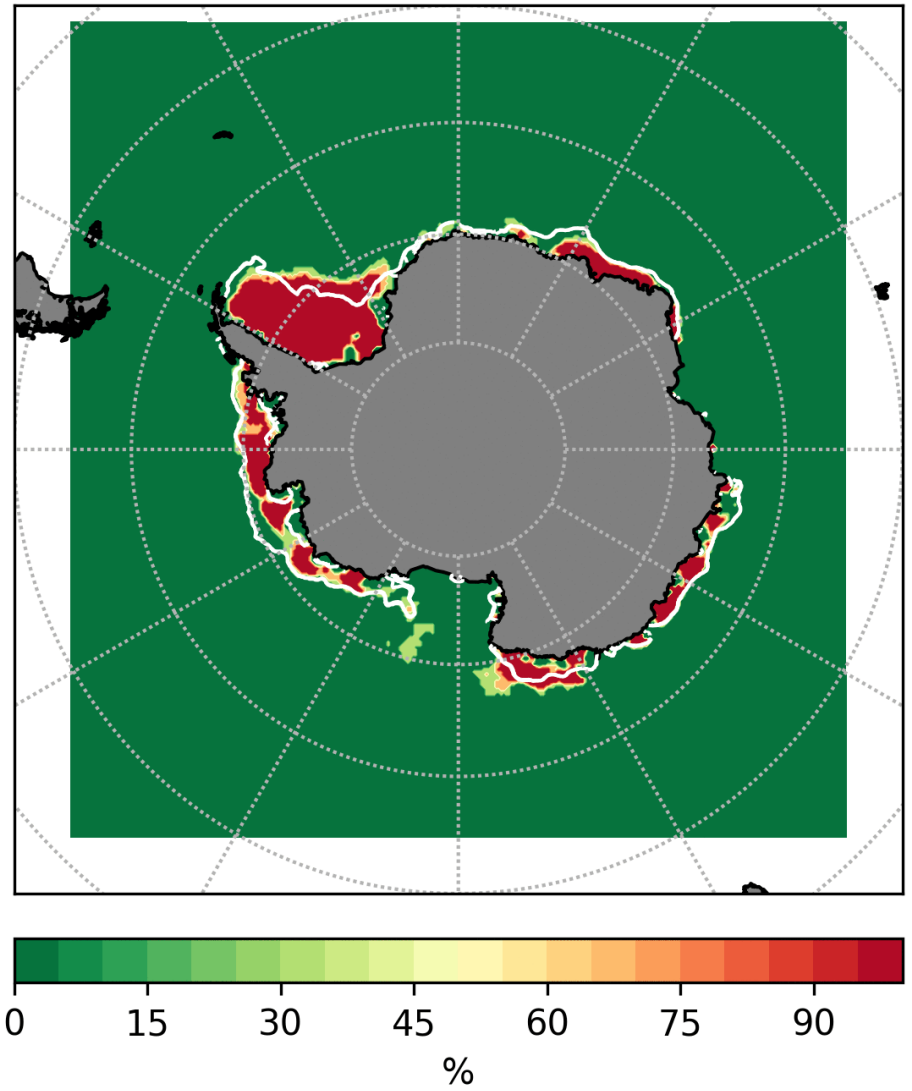
Dynamical model (42 forecasts)

MetOffice | prob > 15% | 01 February 2019




Statistical model (3 forecasts)

Nico-Sun | prob > 15% | 01 February 2019



# Conclusions

- As Antarctica becomes a hot spot for research (and tourism) the **need for sea ice information is greater than ever**
- Currently, ship and vessel route planning relies on classical ice charts, which have severe limitations
- Modeling and observational studies show **evidence for seasonal Antarctic sea ice predictability**
- SIPN South seasonal forecasts **struggle to predict the regional patterns** of sea ice retreat
- Dynamical model contributions have **large biases** even at initial state, and are **outperformed by statistical contributions**

# GitHub

fmassonn / sipn-south-public

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Code | Issues 0 | Pull requests 0 | Projects 0 | Wiki | Insights | Settings

Data and scripts to process Sea Ice Prediction Network South (SIPN South) analyses.

Edit

Manage topics

142 commits | 2 branches | 0 releases | 3 contributors

Branch: master | New pull request | Create new file | Upload files | Find File | Clone or download

fmassonn Fix title Fig IIEE — Latest commit de31b9b 3 days ago

| | | |
|---|---|---|
| data | Fix Barreira's issue (lat used instead of lon, thank W. Hobbs) | 2 months ago |
| doc | Add Doc file | 3 days ago |
| figs | Add Phil's Hovmoeller plot | 11 months ago |
| scripts | Fix title Fig IIEE | 3 days ago |

# Thank you

 @Fmassonnet

francois.massonnet@uclouvain.be

www.climate.be/u/fmasson