

# Imminent re-opening of the Weddell Polynya detectable days ahead by spaceborne infrared

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That's the polynya!  
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- 30 Weddell polynya or halo events since 1980, from sea ice concentration products;
- Multi-band, single infrared image criteria robustly detect all these events days ahead;
- Infrared-based imagery + in-situ observations explain why the polynyas opened.

# Brief Motivation

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We want to know when sea ice will open for

- Economic activities (fisheries, navigation incl. tourism);
- Scientific activities (expedition planning, instrument deployment).

But so far, there is no early warning / early detection system.

Dramatic (scientifically speaking) example in 2016, when the Weddell Polynya\* opened for the first time since 1976.

\*large hole in the Southern Ocean winter sea ice, crucial for the climate. Likely opens as sea ice is melted from below by upwelled comparatively warm water.

Hypothesis: we could detect the upwelling and/or sea ice thinning that leads to the polynya in spaceborne infrared imagery.



# 1- The polynya events

- Polynya = sea ice concentration < [threshold] in winter.
- Test of literature thresholds, on NSIDC sea ice since 1980 (Fig. 1).

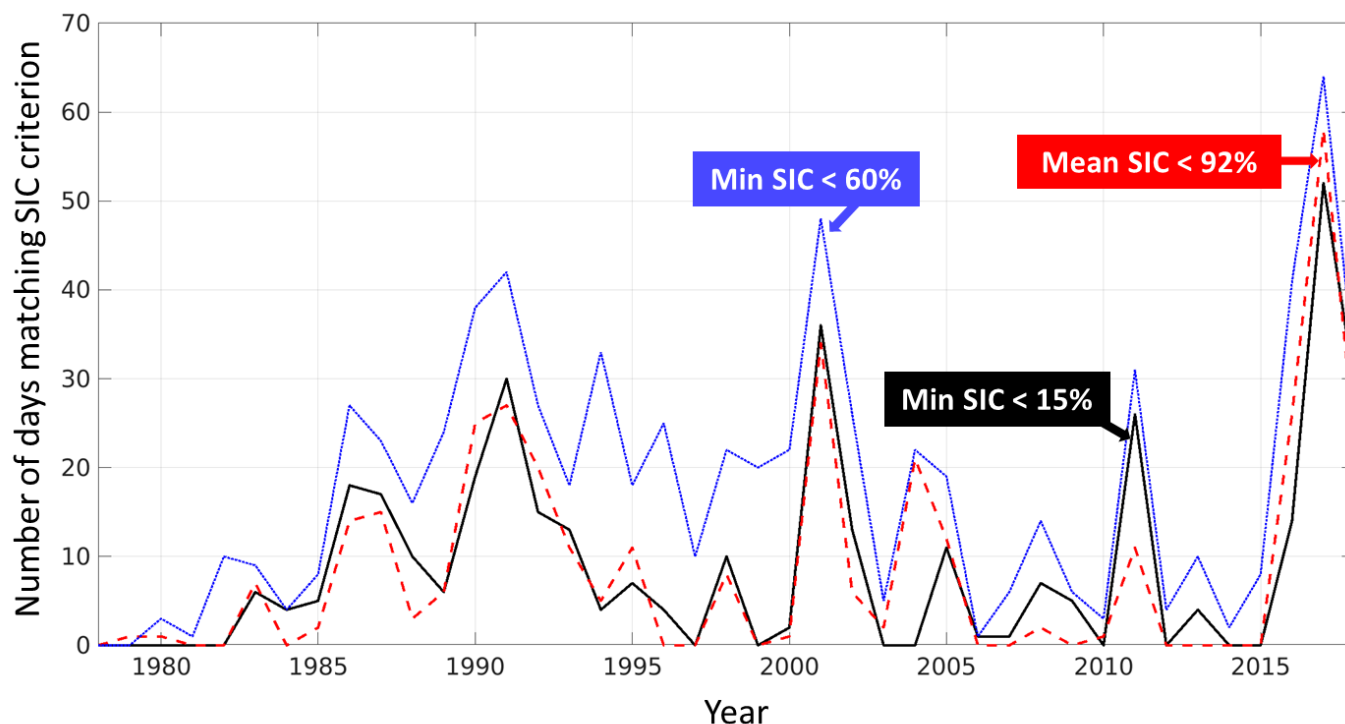


Fig. 1 from [Heuzé and Lemos \(2020\)](#)

Blue= Campbell *et al.* (2019); Red= Gordon *et al.* (2007);

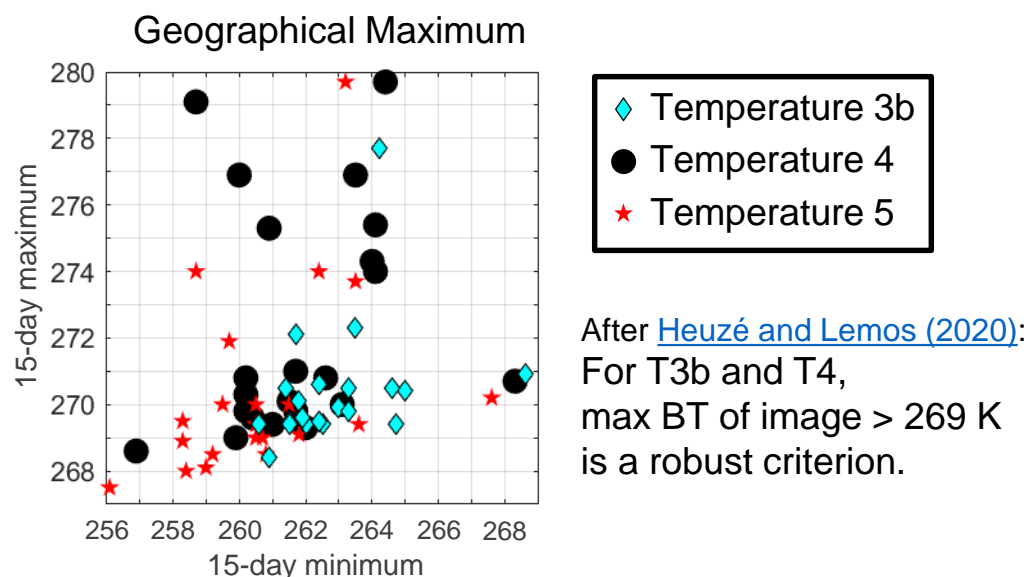
Black= standard, e.g. Gloersen *et al.* (1992)

- Qualitatively similar result.
- Visual validation  
-> removal of late freeze-ups.
- In total, 30 polynyas over 11 different years.

Take home message 1:  
Many polynyas between "the" big ones of 1974-1976 and 2016-2017

## 2- The early detection criteria

- AVHRR Polar Pathfinder by NOAA, daily (2 AM) since 1982.
- Three brightness temperature bands T3b (3.74  $\mu\text{m}$ ), T4 (10.8), T5 (12).
- Cloud filtering after Yamanouchi *et al.* (1987) and Vincent *et al.* (2008).
- Median, min and max over “polynya-prone” area in the 15 days leading to event  
 -> Thresholds in BT for each band that, combined, robustly detect polynya.  
 -> No false positive (see text chat / paper).



Take home message 2:  
 It works!\*

\*for the Weddell Polynya. To be tested on others  
 (e.g. Amundsen Sea, North Water Polynya)



# 3- Cause(s) of opening

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- Debate: did the Weddell polynya open because of wind or ocean?
- $T_{45} < 0$  ( $T_4 - T_5$ ) can indicate leads, while oscillations in BT = upwelling?
- Validation: ERA5 wind, AWI moorings, Sentinel-1 SAR. Extracts from the Sept 2017:

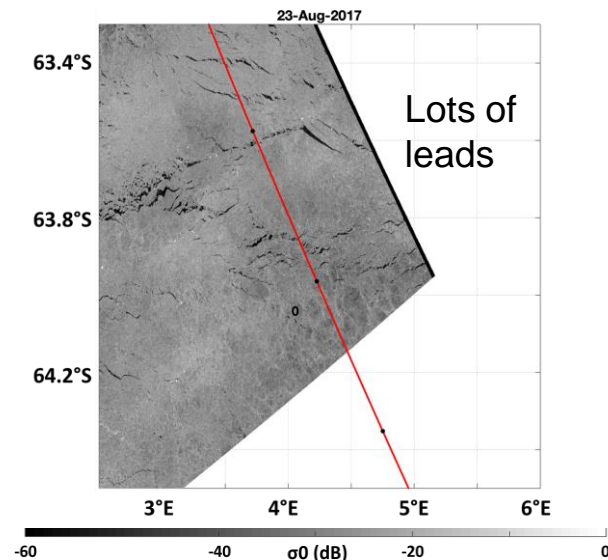
## 1) Wind/lead markers

Polynya -15 days

Positive wind stress curl lasting two days

Record low  $T_{45}$

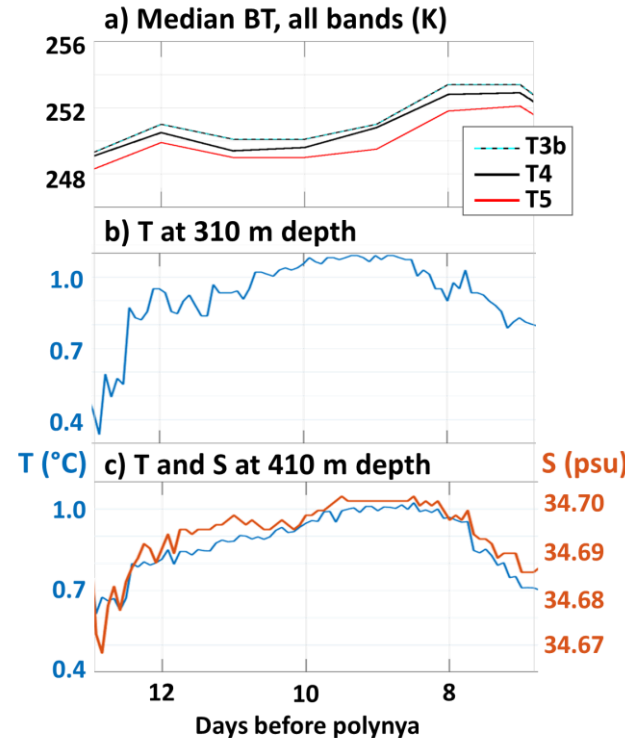
Closest Sentinel-1 image (4 days later):



After [Heuzé and Lemos \(2020\)](#)

Céline Heuzé; Early detection of Weddell Polynya from spaceborne infrared

## 2) Ocean/upwelling markers



After Heuzé and Lemos, subm

Polynya -19 days,  
and again -13 days (shown)  
Brief negative wind stress curl  
Increase of T and S and depth  
+ mild increase of BT

Take home message 3:  
Hybrid polynya?



# Conclusions

- Which size / shape makes a lead a polynya?
- Many polynya events since 1976 (not new) -> change of narrative please.
- They are all detectable in the infrared record several days in advance.
- Several days is not much
  - > SAR work by Adriano Lemos to increase it to weeks / months (this session)
  - > modelling work by Martin Mohrmann (also this session)
- More information in EGU's TC discussions: [HERE](#)
- Otherwise, feel free to contact me: celine.heuze@gu.se

