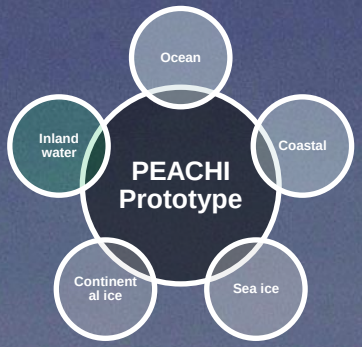
Surveillance des régions polaires par Altika



N. Tran
F. Rémy, A. Guillot, N. Picot

Glaces de mer:

- Région Arctique
- Région Antarctique

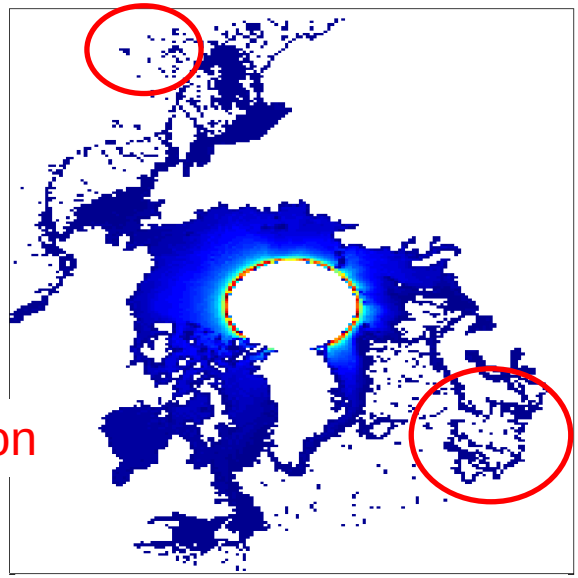
Calottes glaciaires

- Groenland
- Antarctique

CLS COLLECTE LOCALISATION SATELLITES
LEGOS
cnes CENTRE NATIONAL D'ÉTUDES SPATIALES
SARAL

Sea-ice classification

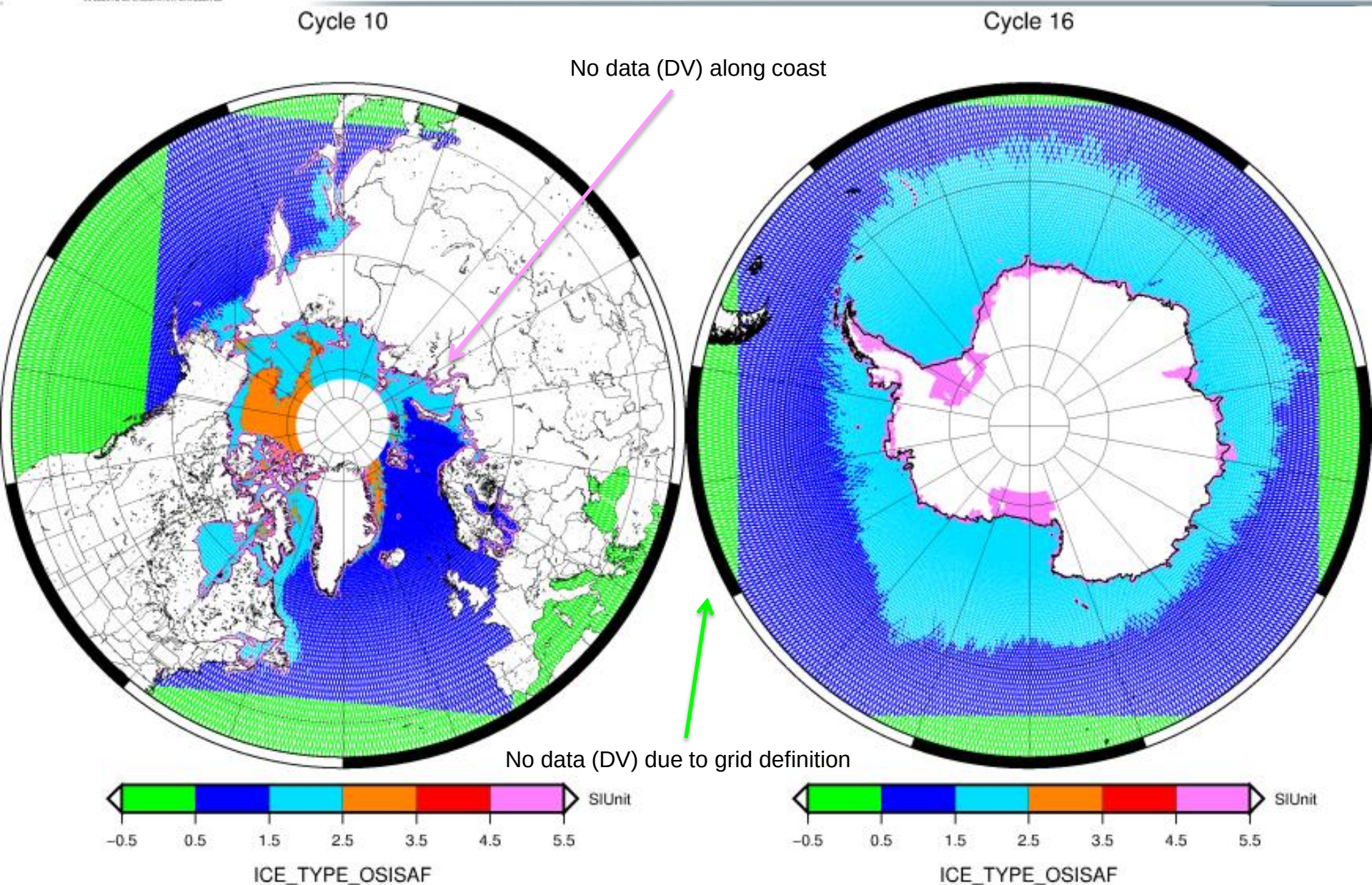
- Improvement of the sea-ice detection in current Altika product



false detection

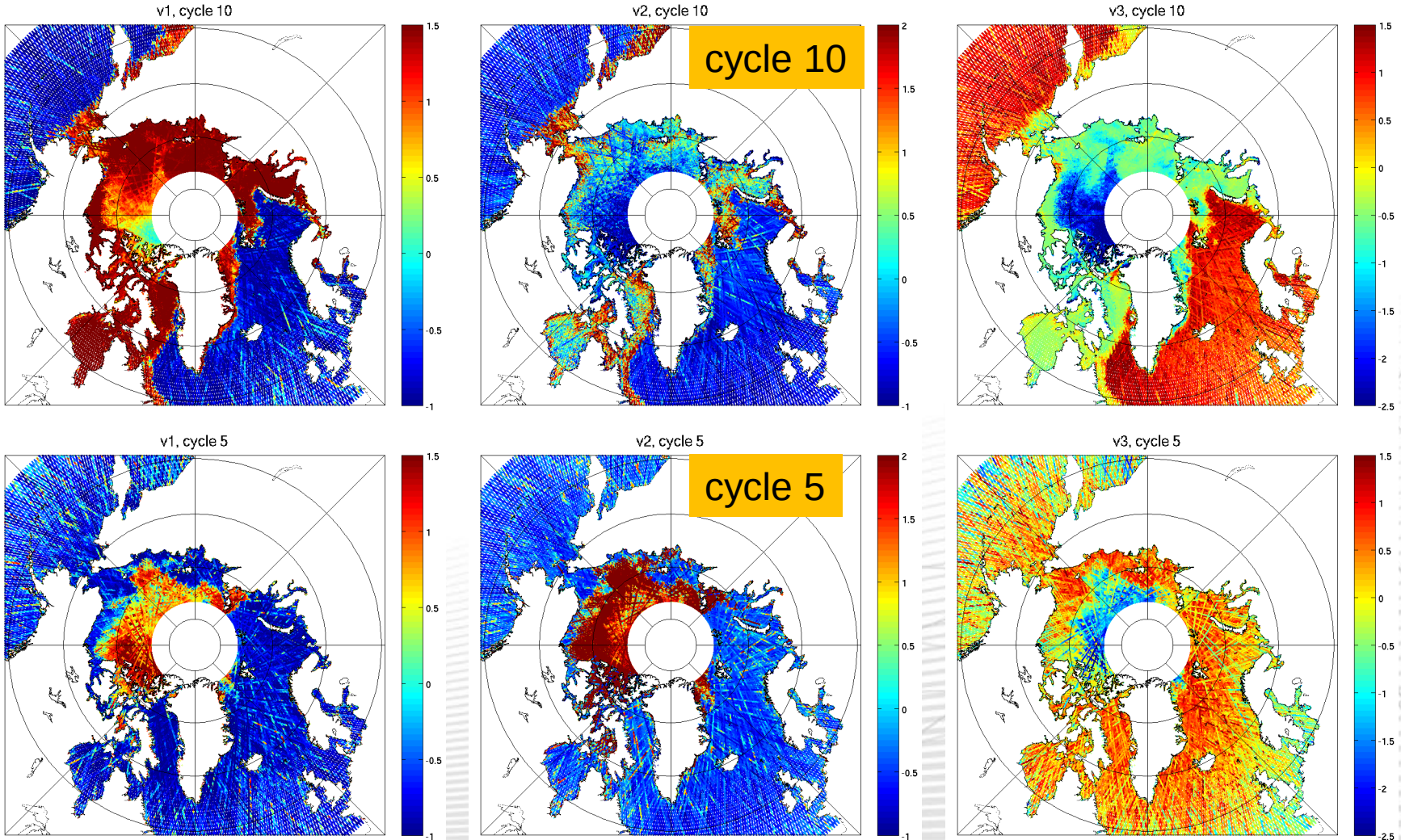
- Development of a multi-state sea-ice flag at 1-Hz as for Envisat mission (ocean, FYI, MYI, ambiguous) to help both oceanic and cryosphere studies in data selection
- Differences: Envisat (ocean, FYI, MYI, WI, ambiguous = mixture) vs Altika (ocean, FYI, MYI, ambiguous = FYI or MYI during summer, mixture)
- Two algorithms: one for each polar region
- Extension of the monitoring of the SI extent started with ENVISAT altimetric data

External data for validation (OSI-SAF daily-grids, 10 km)

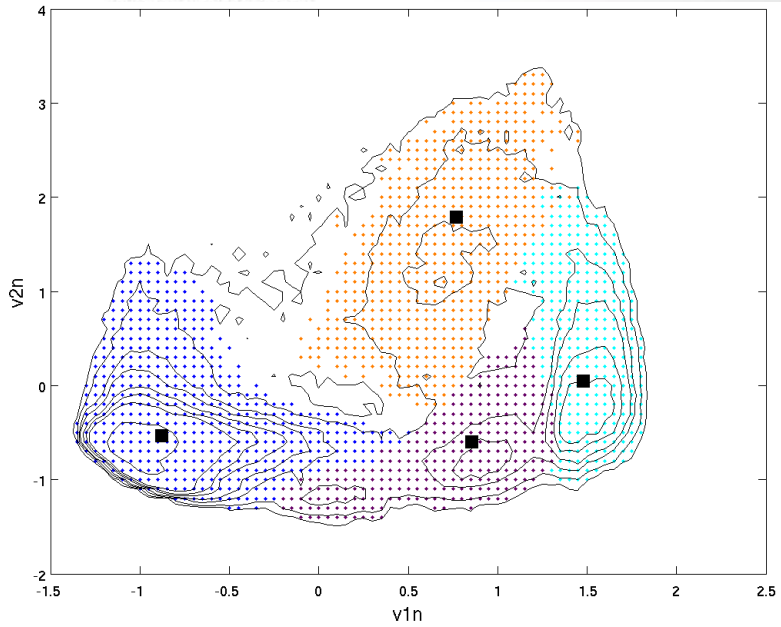


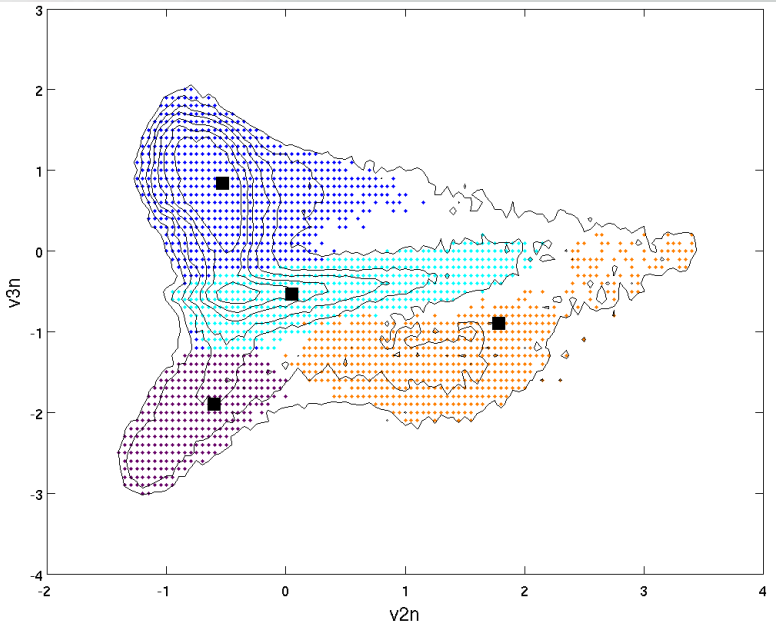
3-input parameters for classification

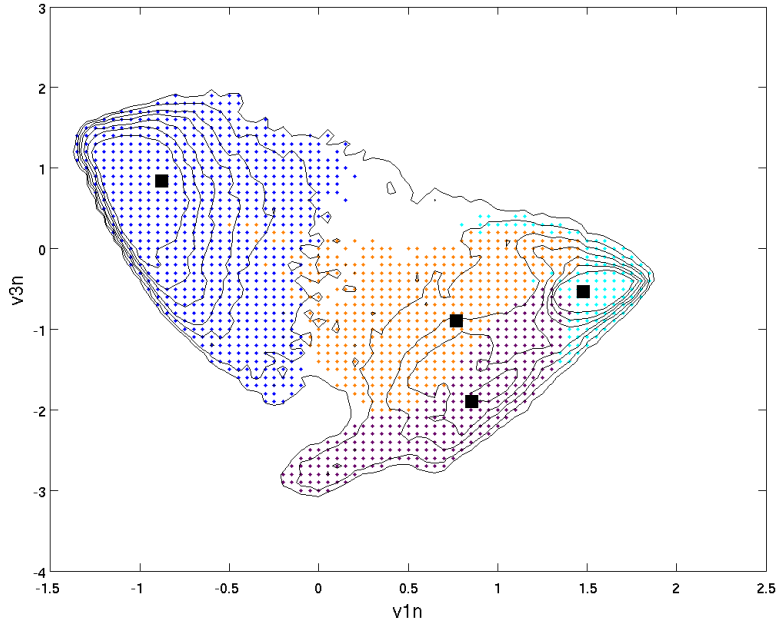
V1: average of the two MWR brightness temperatures (TB_23.8+TB_36.5)/2
V2: Ka-band backscatter (MLE3 retracking algorithm output)
V3: difference between the two brightness temperatures (TB_36.5-TB_23.8)



Tie-points obtained (cycles 5 & 10) for Arctic region





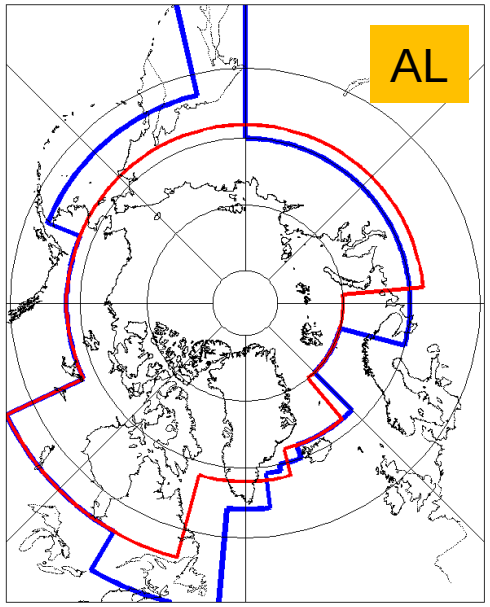


class	v1n	v2n	v3n
Ocean	-0.8769	-0.5328	0.8429
Ambiguous ice	0.7685	1.7855	-0.9004
MYI	0.8567	-0.6012	-1.8990
FYI	1.4765	0.0457	-0.5338

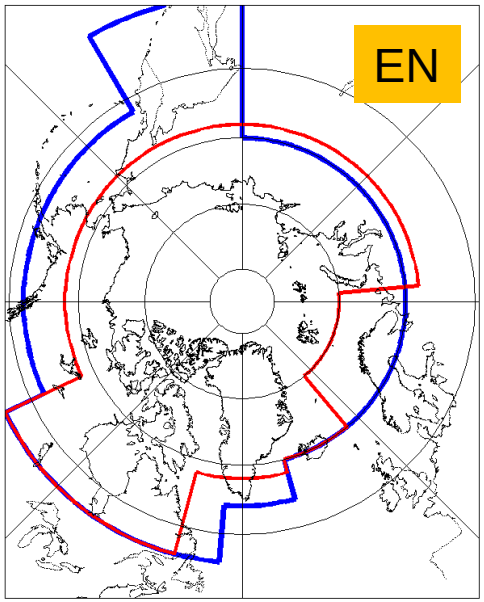
- There are some overlaps between classes → definition of an additional class (**mixture of ices**)
- 4 membership values associated to each measurements

Post-classification rules to limite erroneous classification

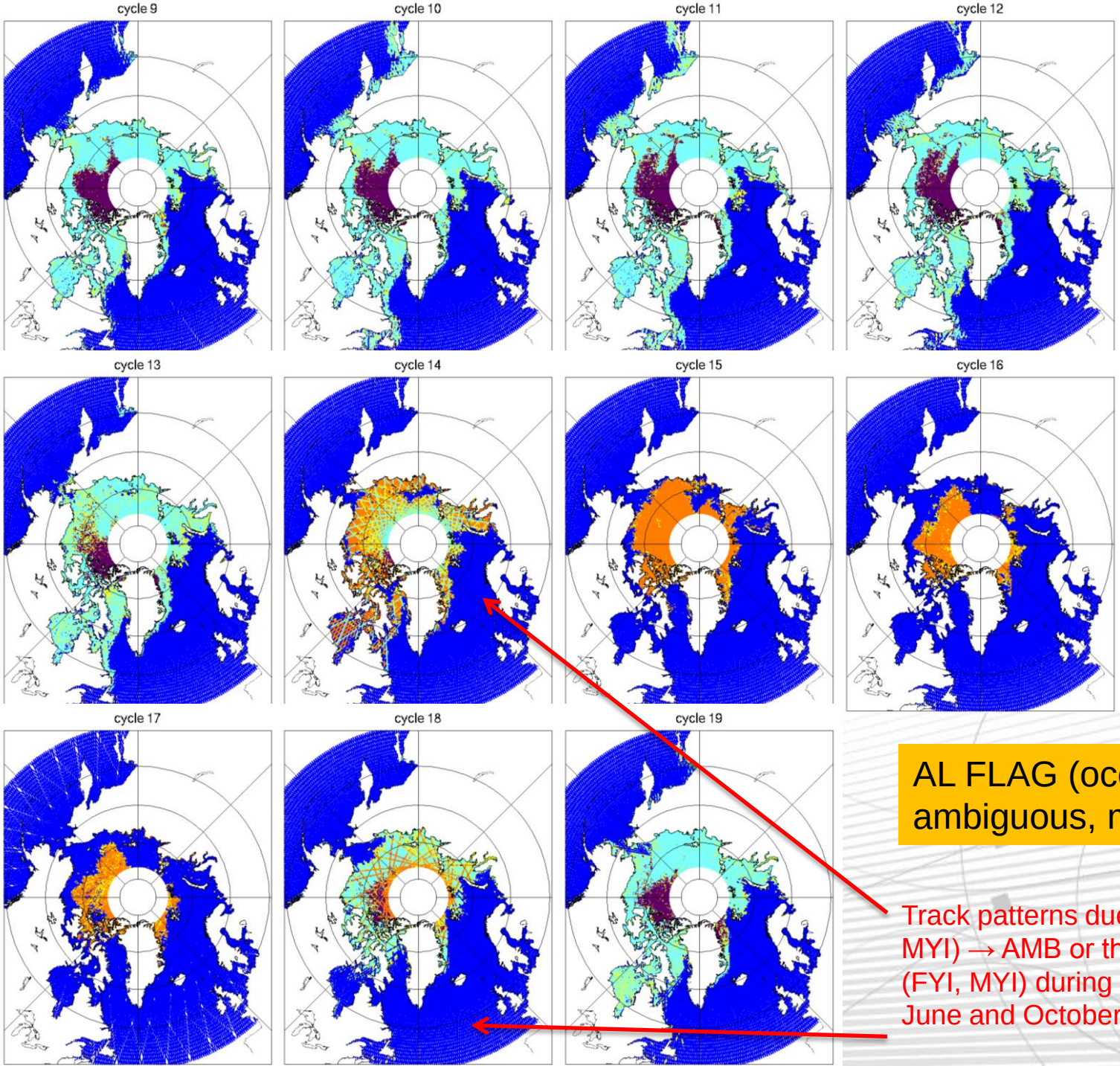
Blue: winter mask, Red: summer mask



Blue: winter mask, Red: summer mask



- **Use of masks** to overrule the erroneous classification and ensure ocean (some differences with Envisat ones)
- **Use of the waveform classification (PEACHI / Poisson et al, [2014])** in some areas to change (FYI, MYI, ambiguous, mixture) for ocean
- **Use of distance to coast** during summer to change (FYI, MYI, ambiguous, mixture) for ocean
- No ambiguous data during winter → to change to FYI
- No FYI or MYI during summer → to change to ambiguous
- No MYI in some areas → to change to FYI



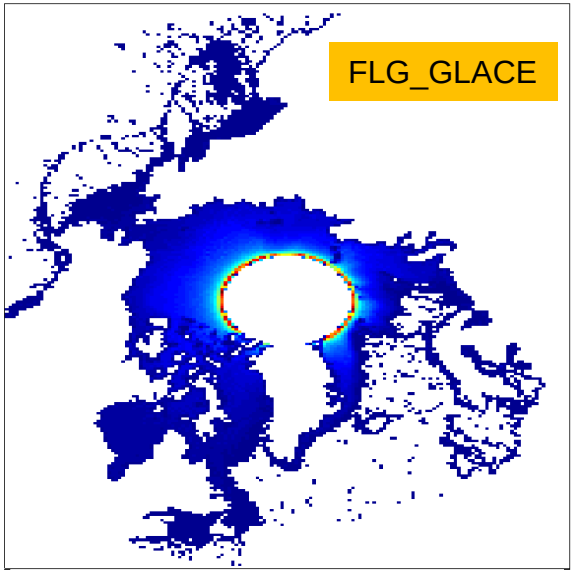
2014

AL FLAG (ocean, FYI, MYI, ambiguous, mixture)

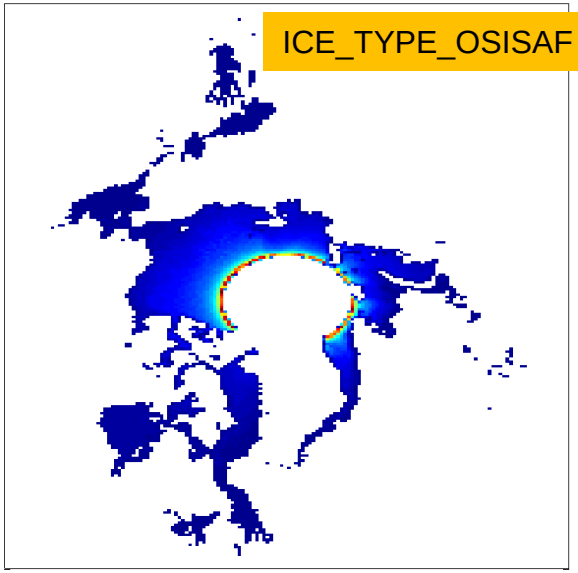
Track patterns due to change (FYI, MYI) → AMB or the opposite AMB → (FYI, MYI) during transition periods in June and October

sea-ice flags set and cumulated over cycles 9 to 19 period

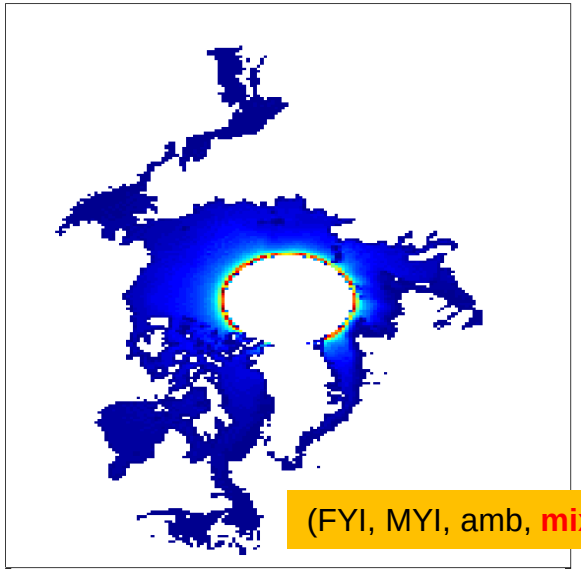
FLG_GLACE (cycles 9 to 19)



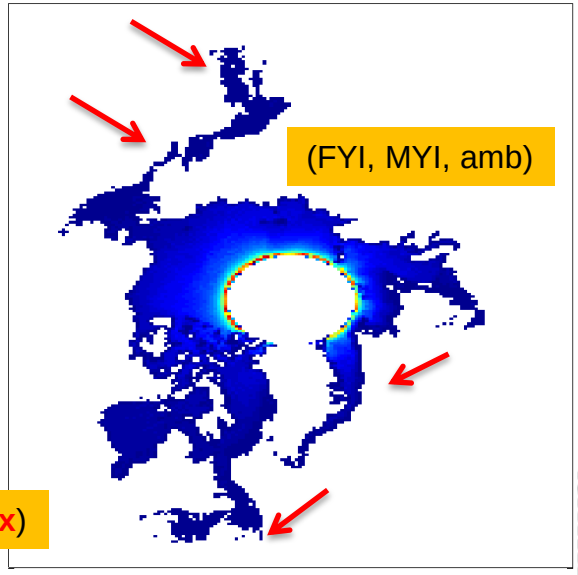
ICE_TYPE_OSISAF (cycles 9 to 19)



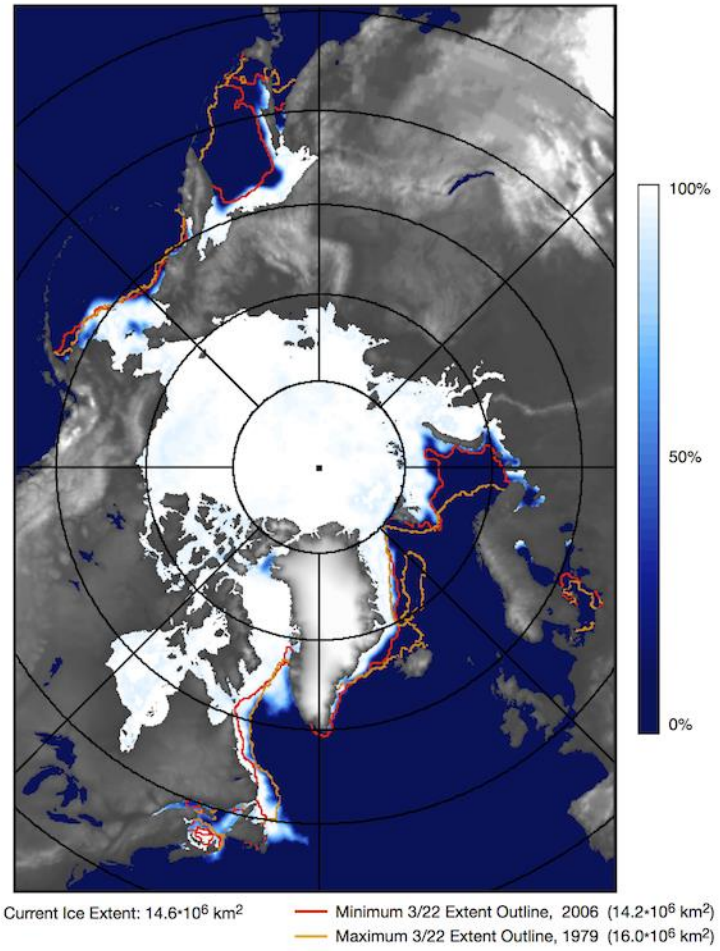
New Altika flag



New Altika flag (without MIX)



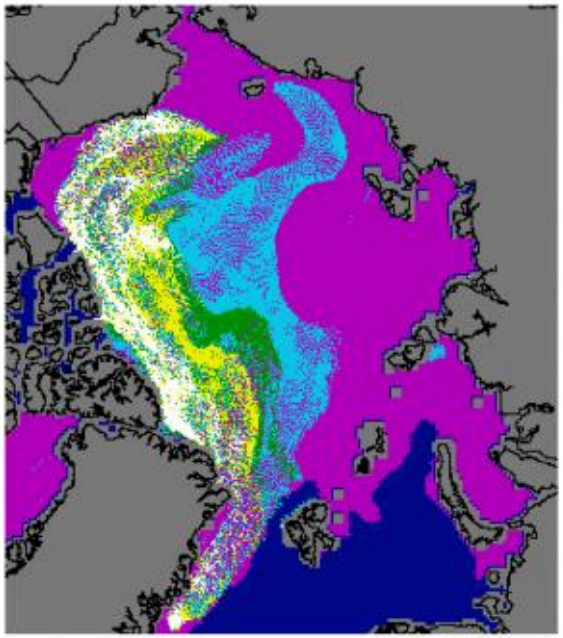
Northern Hemisphere, March 22, 2015

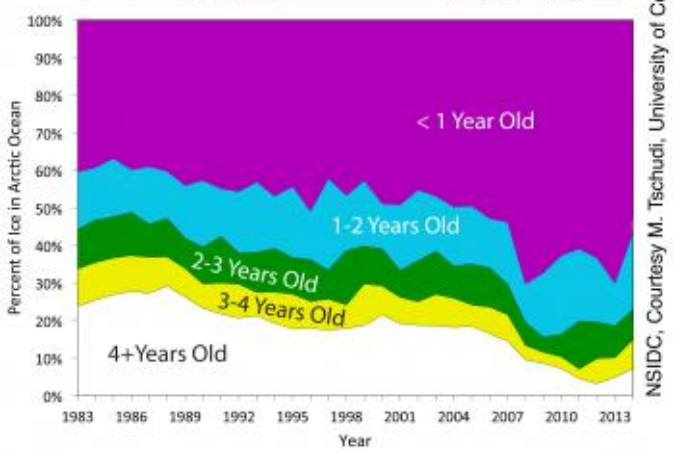


http://neptune.gsfc.nasa.gov/uploads/images_db/CSIC_figure2.png

MYI extent for cycle 11 (March 2014)

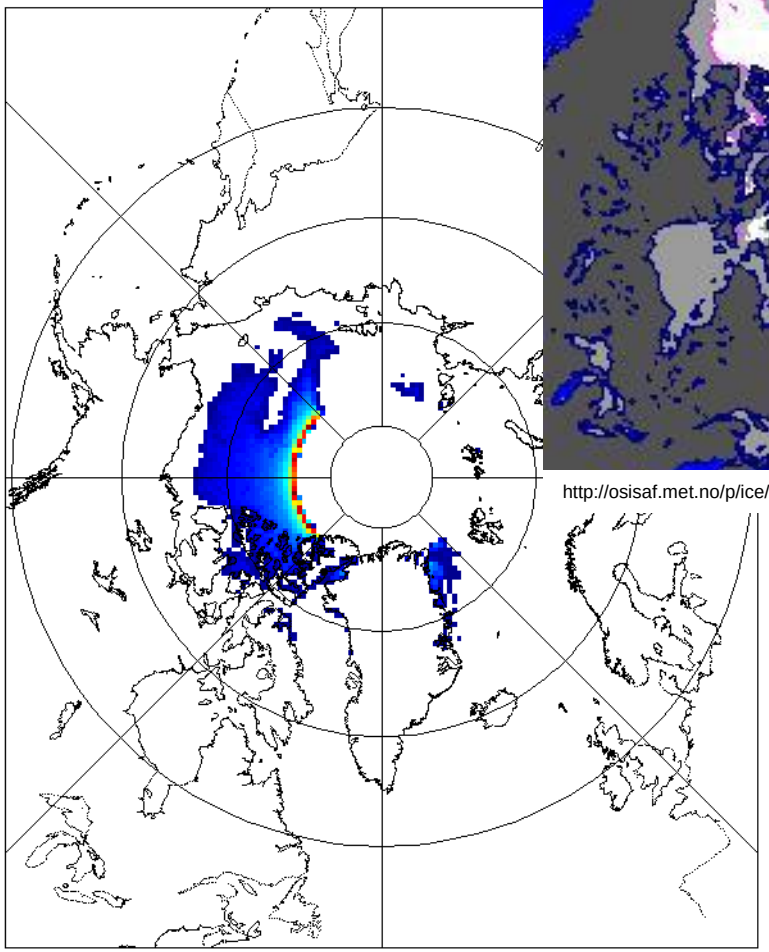
Arctic Sea Ice Age, March 2014

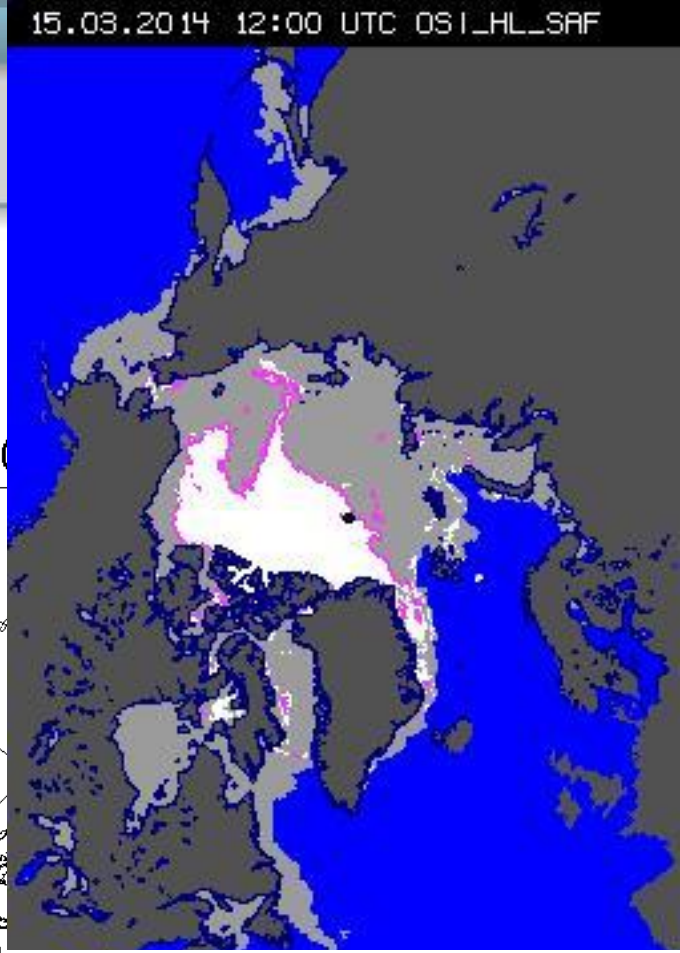




http://nsidc.org/arcticseaicenews/2014/04/

cycle 11: New Altika flag (

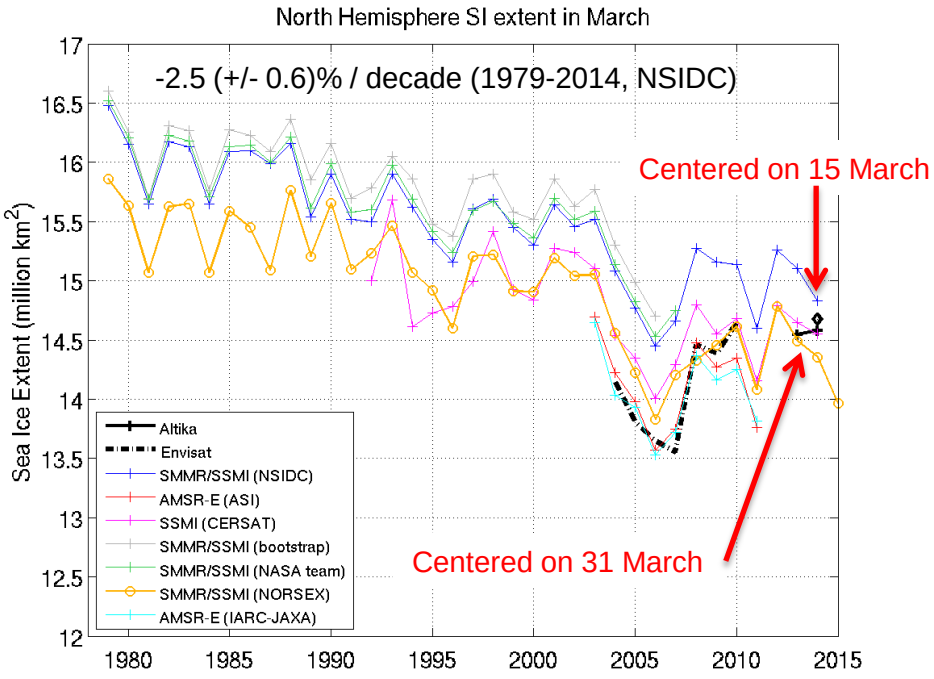


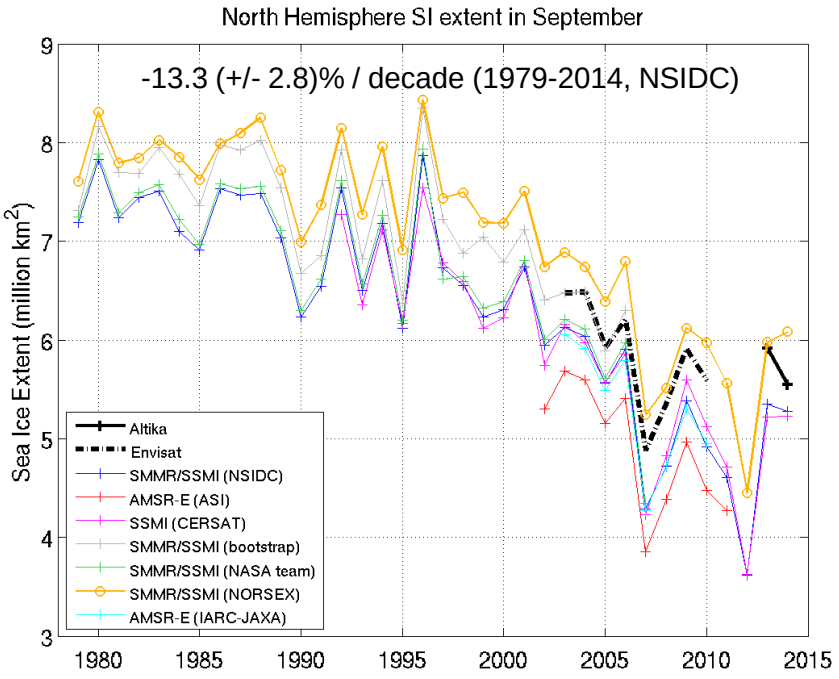


http://osisaf.met.no/p/ice/nh/type/tums/OSI_HL_SAF_201403151200_pal.jpg

→ qualitative agreement

Monitoring of extents in March (maximum) and September (minimum) that define the annual cycle (35-day period + pole hole filled)



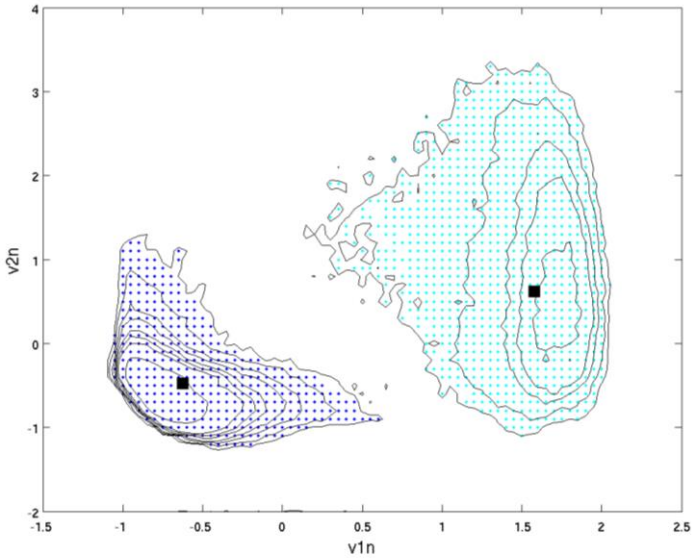


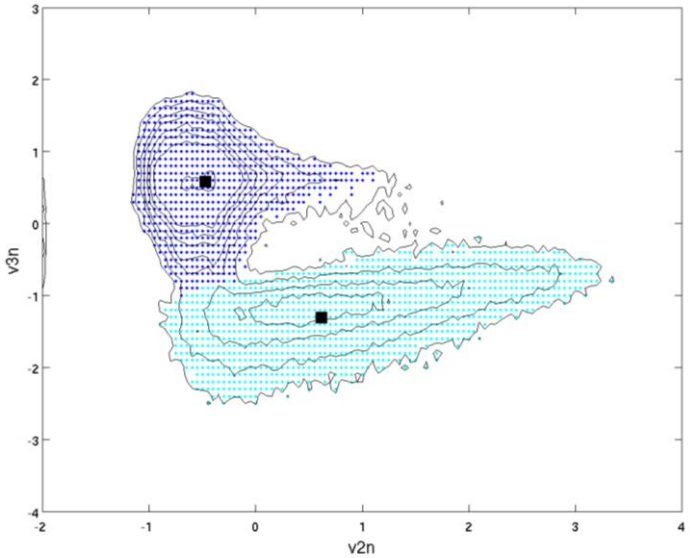
- possible underestimation because of altimeter sampling at mid latitudes

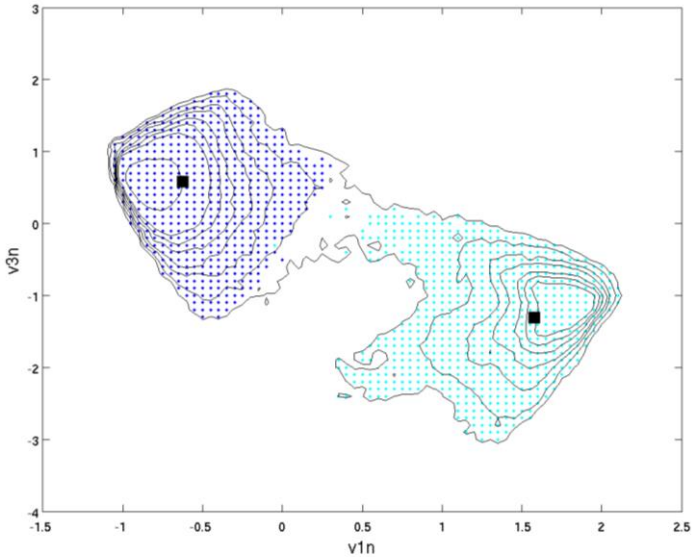
- shift of 15 days (end instead of mid-month) for the extent computation in March 2013 due to availability of first data after launch → start of the melting period that explains the lower sea ice extent estimates when one compares with 2014 one centered on 15 March

- possibility of overestimation for some years because of the assumption of pole hole completely filled with ice (pole hole ~2.6 million km²) that could be wrong

Tie-points obtained for Antarctic region

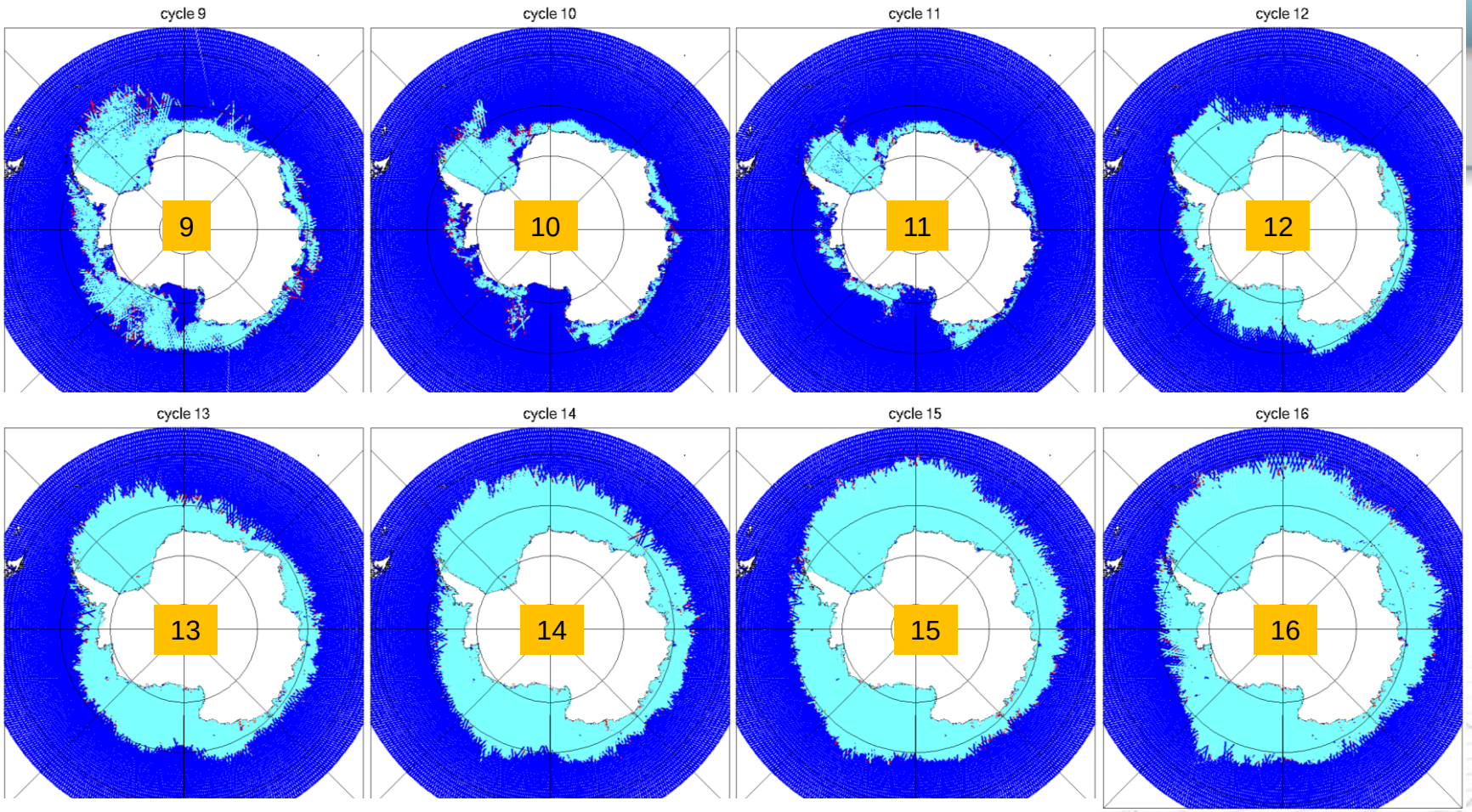


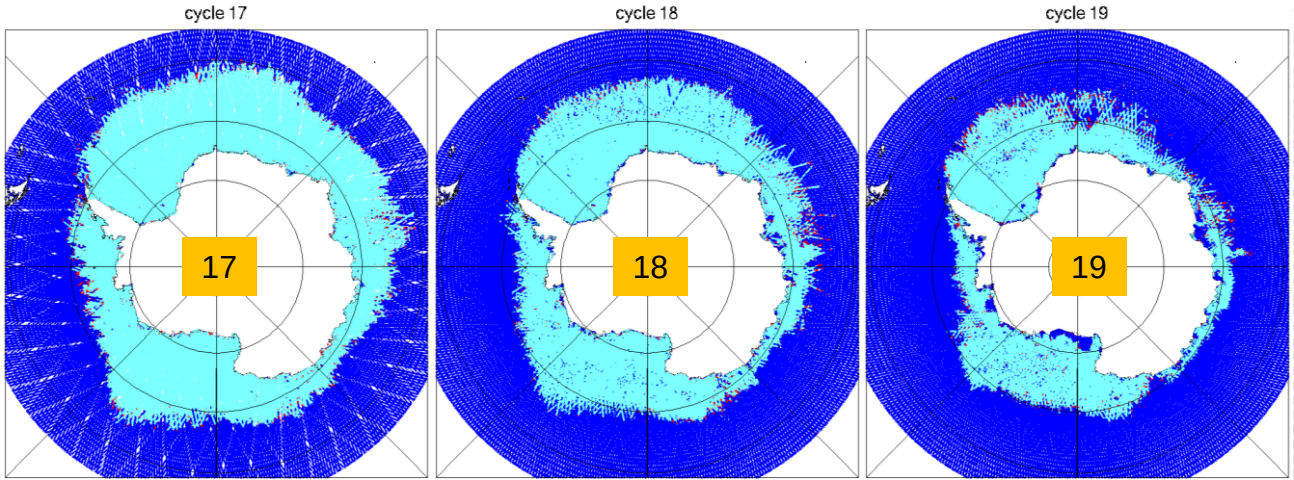




class	v1n	v2n	v3n
ocean	-0.6233	-0.4749	0.5788
FYI	1.5795	0.6161	-1.3051

- There are some overlaps between classes → definition of an additional class (**mixture of ices**)
- 2 membership values associated to each measurements

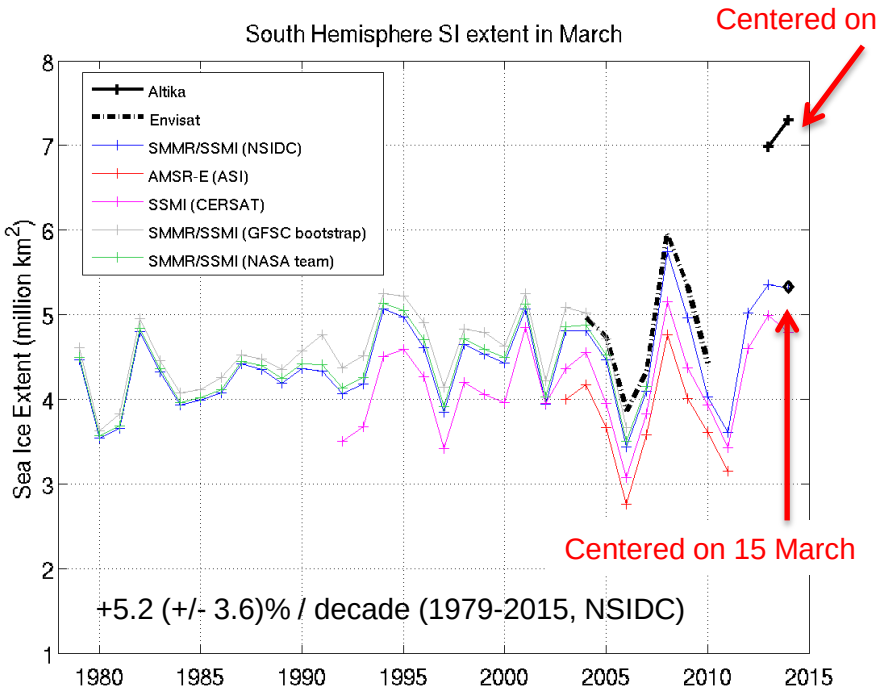


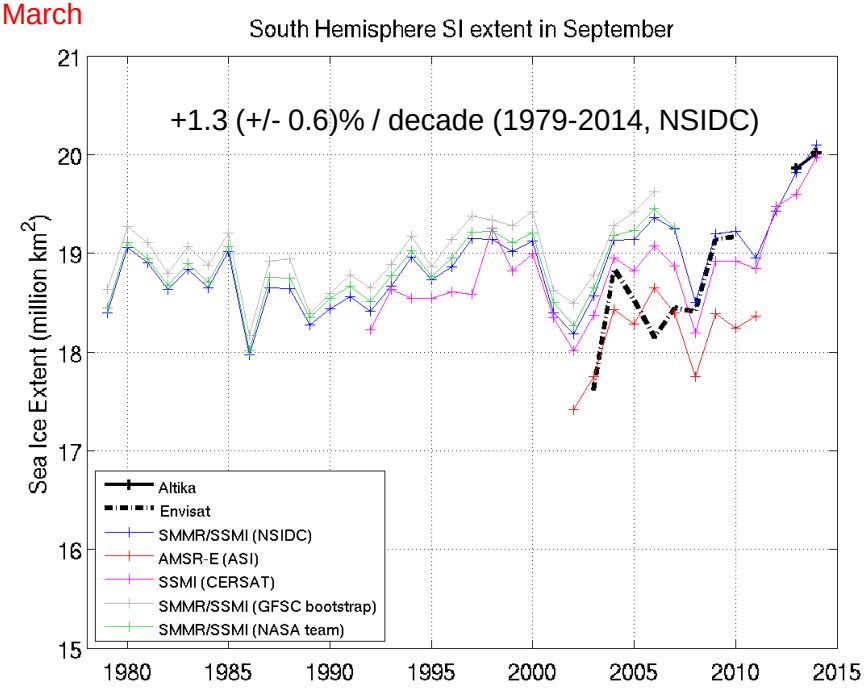


2014

AL FLAG (ocean, FYI, mixture)

Monitoring of extents in March (minimum) and September (maximum) that define the annual cycle (35-day period)





- shift of 15 days (end instead of mid-month) for the extent computation in March 2013 due to availability of first data after launch → start of the freezing period that explain the higher sea ice extent estimate when one compares with other time-series

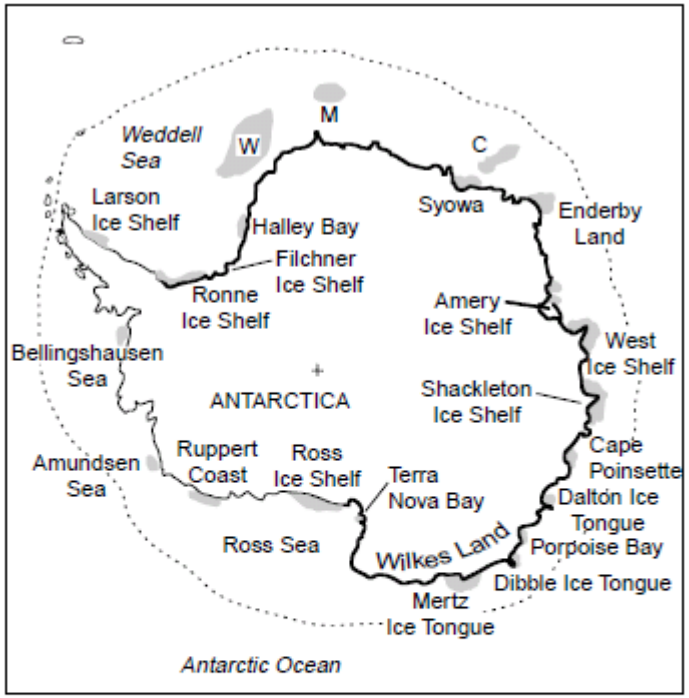
Conclusion about sea-ice

ARCTIC REGION		ICE_TYPE_OSISAF		FLG_GLACE	
		ocean	(FYI, MYI, amb)	ocean	sea-ice
AL FLAG	ocean	-	**0.40-2.36%** **lower differences**	-	1.69-5.34%
	(FYI, MYI, amb, mix)	4.77-12.01%	-	**<0.36%** **(mostly mix)**	-

ANTARCTIC REGION		ICE_TYPE_OSISAF		FLG_GLACE	
		ocean	FYI	ocean	sea-ice
AL FLAG	ocean	-	**0.52-2.85%**	-	0.65-5.19%
	(FYI, mix)	2.07-6.32%	-	**<0.27%**	-

- OSISAF flag indicates “no data” along coasts while the AL flag provides information on the ice type. This could be used to study polynyas extent close to coast.
- Smaller number of wrong sea-ice detection by the AL flag outside the ice-pack (i.e. along coasts) and provision of MYI when compared with FLG_GLACE
- Differences with FLG_GLACE (finer detail about the sea-ice coverage due to smaller altimeter footprint than radiometer ones ?)
- Differences with ICE_TYPE_OSISAF (due to nearest neighbor algorithm used (10 km grid) or to differences in resolution or sensor sensitivity or differences in time between observations (use of daily maps) ?)
- Concerning the extent monitoring: good continuity with the Envisat time-series

Polynyas location



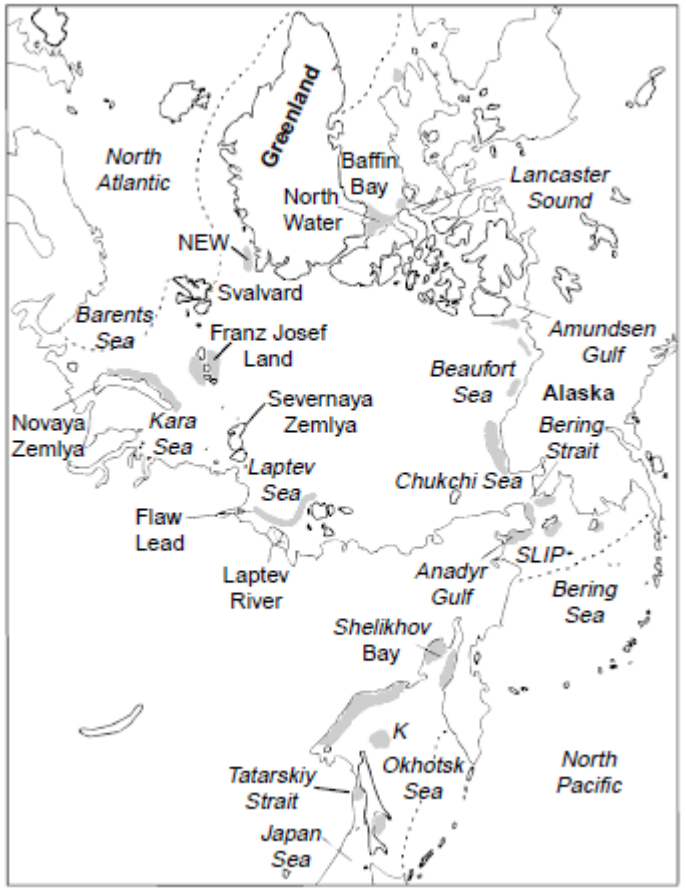


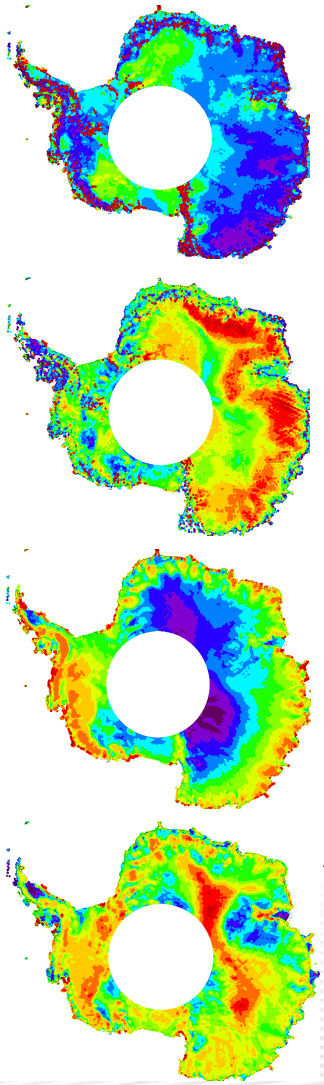
Figure 1 Geographic distribution of polynyas. (A) The Arctic, where SLIP is the St. Lawrence Island Polynya, NEW is the North-east Water, and K is the Kashevarov Bank polynya. (B) The Antarctic, where W is the Weddell polynya, M is the Maud Rise polynya and C is the Cosmonaut Sea polynya. On both figures the dashed line indicates the position of the maximum ice edge. Polar stereographic map projection courtesy of the National Snow and Ice Data Center (NSIDC).

Copied from [Martin, 2001] from http://polar.ocean.washington.edu/PAPERS/Polynya_encyclo.pdf

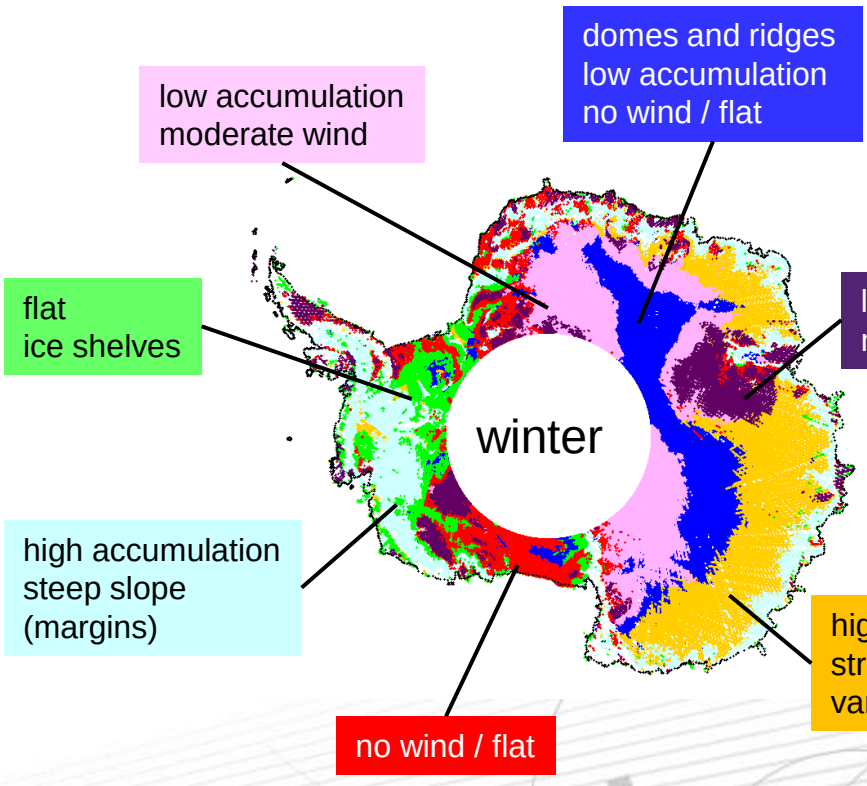
Ice sheets' snow facies

- There are uncertainties in estimating the correct height over ice sheet because of the radar wave penetration within the cold and dry snow medium. They display dependencies on snowpack characteristics which vary seasonally and spatially.
- Partition of ice sheet into different homogeneous regions can help for the interpretation of altimetry data.
- The monitoring of the extent changes of these regions could help to highlight some climate change effects on Greenland and Antarctica.

Envisat: Antarctica partition (winter)



(Ku σ0, Ku-S σ0, Avg_TB, ratio_TB)



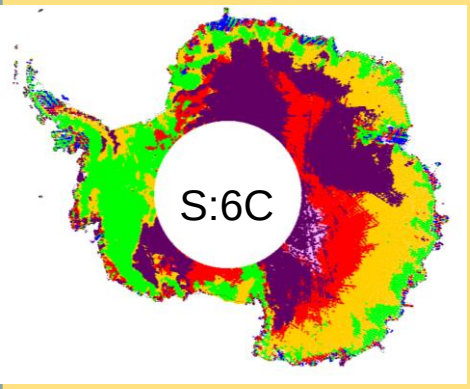
No other study to compare with.

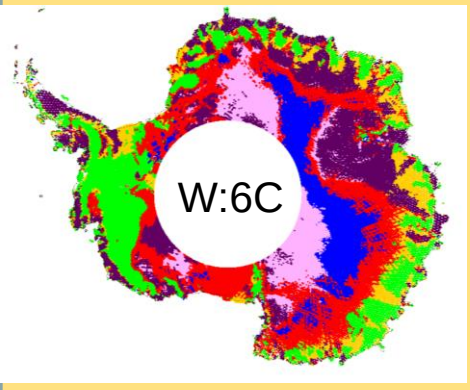
Related to **accumulation patterns** and **snow layering** as a consequence of the **topographically-influenced wind regime**.

ALTIKA

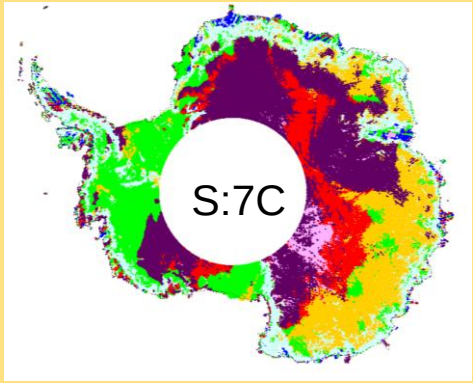
ENVISAT

2P: (TB only)

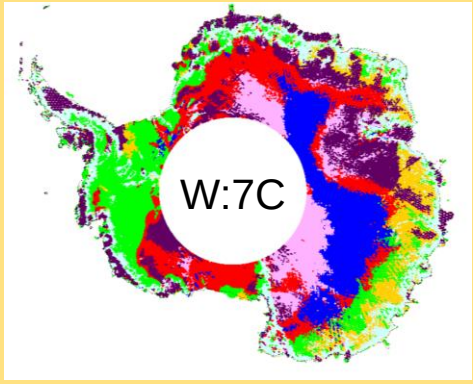




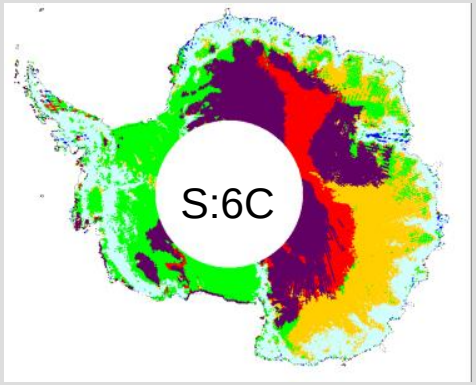
3P: (TB + Ka σ0)

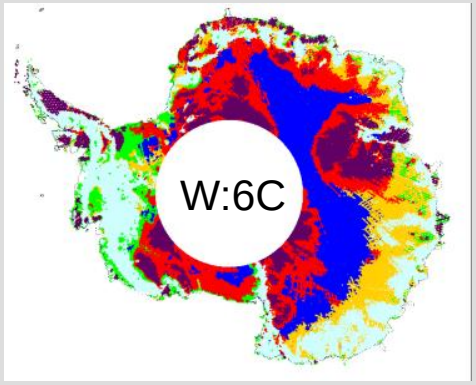


Addition of light blue class

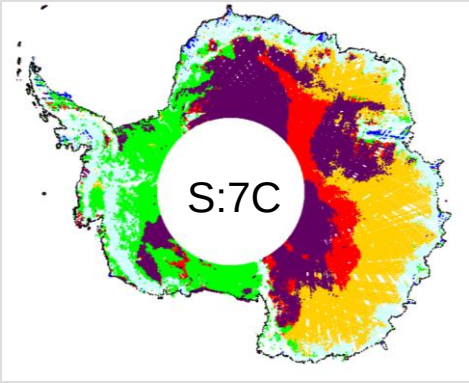


3P: (TB + Ku σ0)

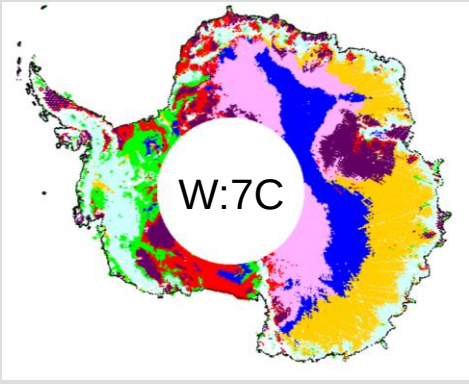




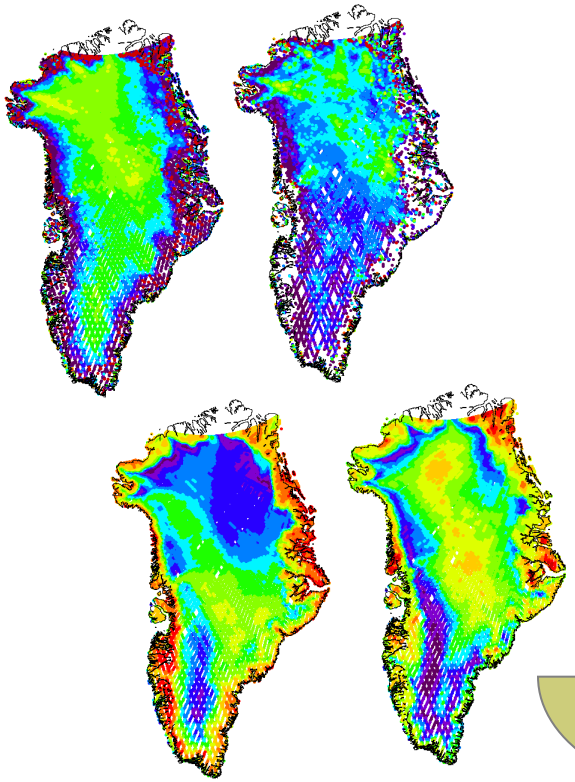
4P: (TB + Ku/S σ0)



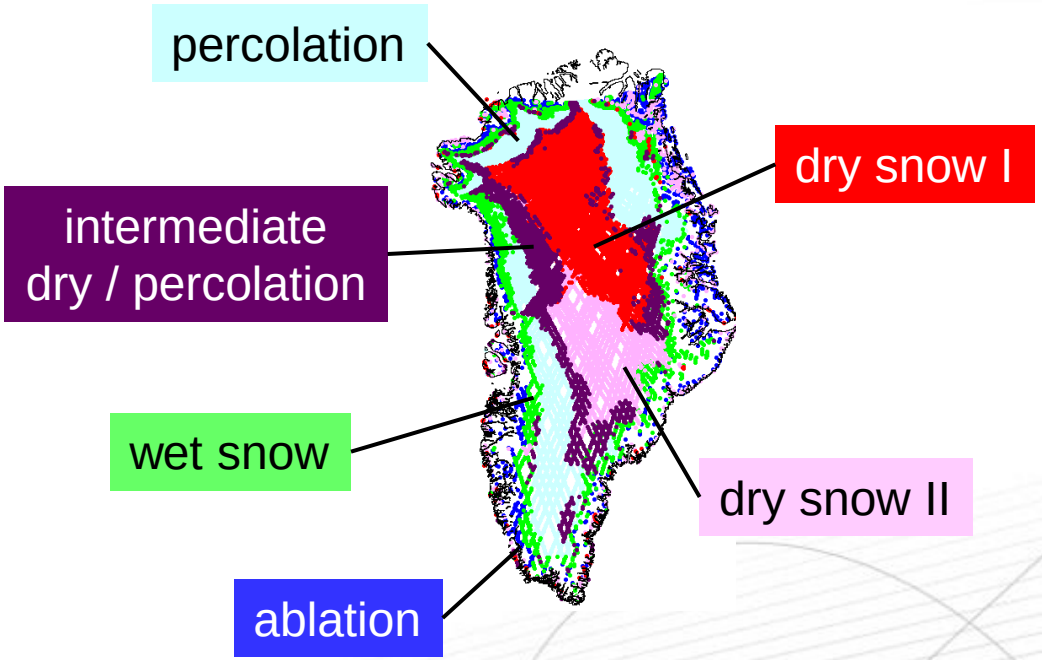
Addition of pink class



Envisat: Greenland partition (winter)



(Ku σ0, Ku-S σ0, Avg_TB, ratio_TB)



Related to accumulation patterns, snow layering as a consequence of the topographically - influenced wind regime, temperature and local melt effects.

Benson's classification (1962):

Dry snow zones I / II : difference in accumulation, wind patterns and air temperatures, no summer melting

Percolation zone: meltwater forming ice pipes or glands

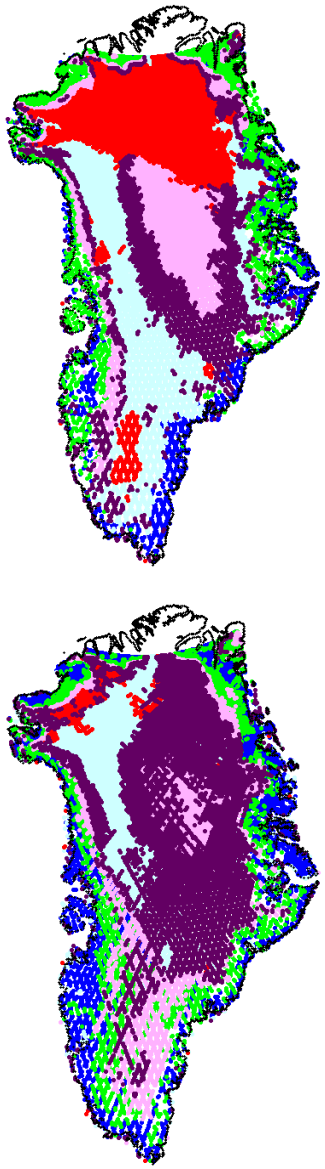
Wet snow zone: intense surface melting, snow is damp throughout the summer season

Ablation zone: all winter snow accumulation melts exposing the underlying ice

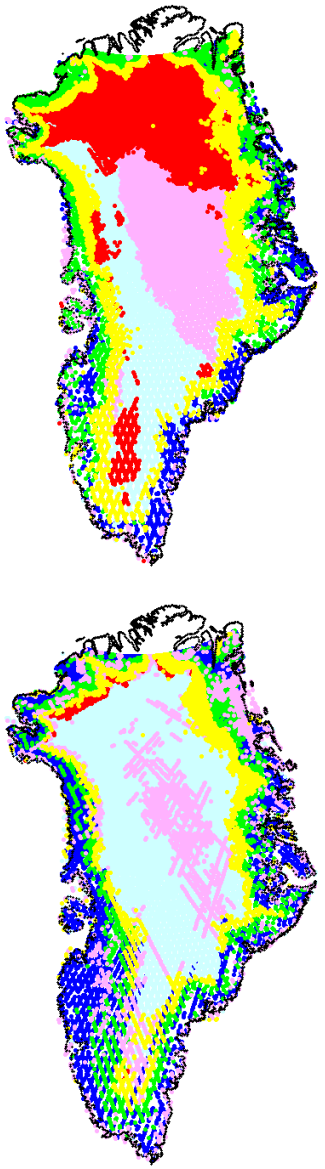
ALTIKA

ENVISAT

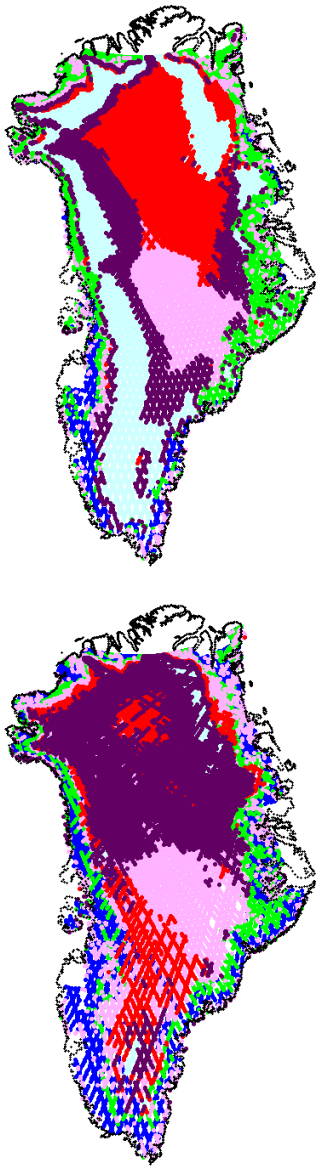
2P: (TB only)



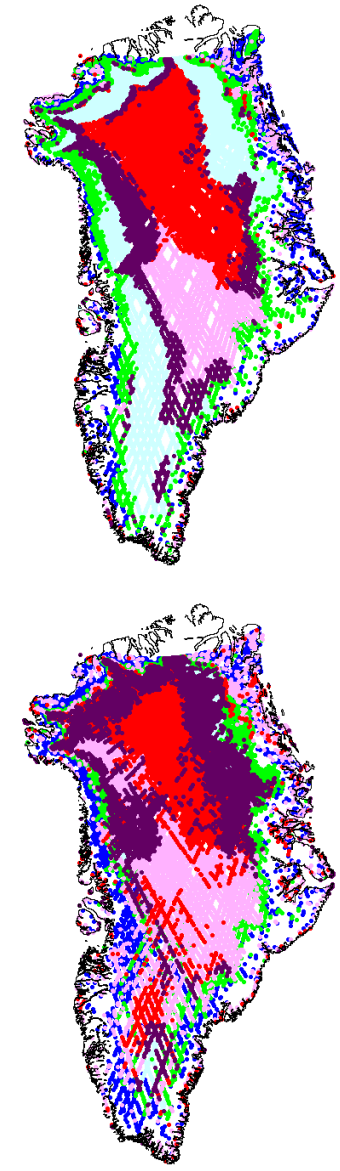
3P: (TB + Ka σ0)



3P: (TB + Ku σ0)



4P: (TB + Ku/S σ0)



6-class solutions

Conclusion about snow facies

- The snow facies classifiers partition the 2 ice sheets into regions with similar microwave signatures.
  - The difference in snow morphology is due to variable conditions in local climate (accumulation rate, air temperature, wind) which is governed by topography.
  - Presence of surface liquid water changes also the microwave signatures.

  - TB behaviors contribute the most in the partition
  - Less differences between Altika and Envisat over Antarctica
  - Differences over Greenland related to changes from 2012 summer more than differences between Ku / Ka (need to validate this assumption with Sentinel-3 data) ?

- A partition into 7 classes looks interesting over Antarctica while a 6-class solution is preferred for Greenland based on Altika data.

- Perspectives to extent the monitoring: need of very long time-series to be interpretable for climate change
  - Application to Sentinel-3 records


Thanks !