Sea Ice Observations for use in SPARSE

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SPARSE KO meeting - Tromsø - 8th and 9th november 2016

Norwegian Meteorological Institute

Outline

1. Introduction
2. Sea Ice …
    a. … Concentration
    b. … Thickness
    c. … Drift
    d. … Type/Age
    e. … Melt Ponds
3. Conclusion

Introduction

- SPARSE will use models to assess predictability of sea ice, perform seasonal forecast, evaluate the forecasts.

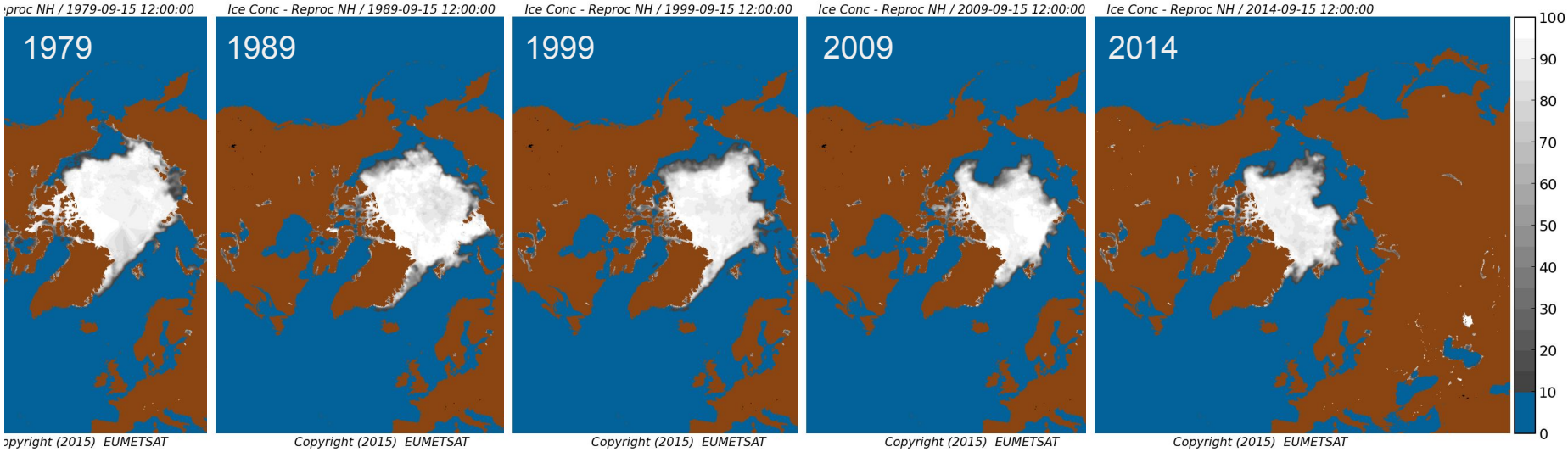
- For all these modelling activities, satellite observation of sea ice will be required. Yet no such data will be developed during the project.

- My role is thus to be an interface with other initiatives, that are specialized in satellite sea ice data (e.g. H2020 SPICES, EUMETSAT OSISAF, CMEMS, C3S, ESA CCI, other research institutes, universities, etc...).

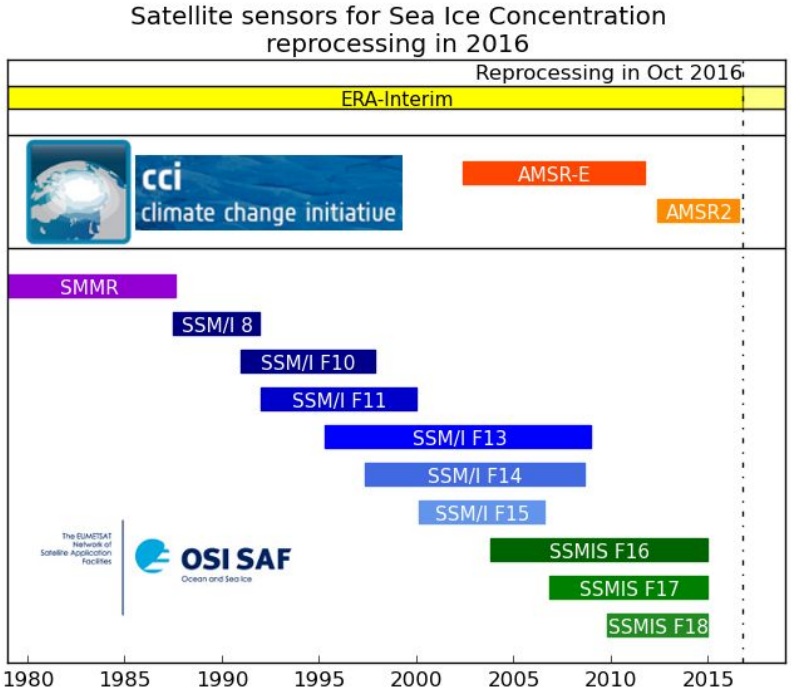
- A first review is presented here, and will be refined and updated when requirements from SPARSE are better known.

Sea Ice … Concentration

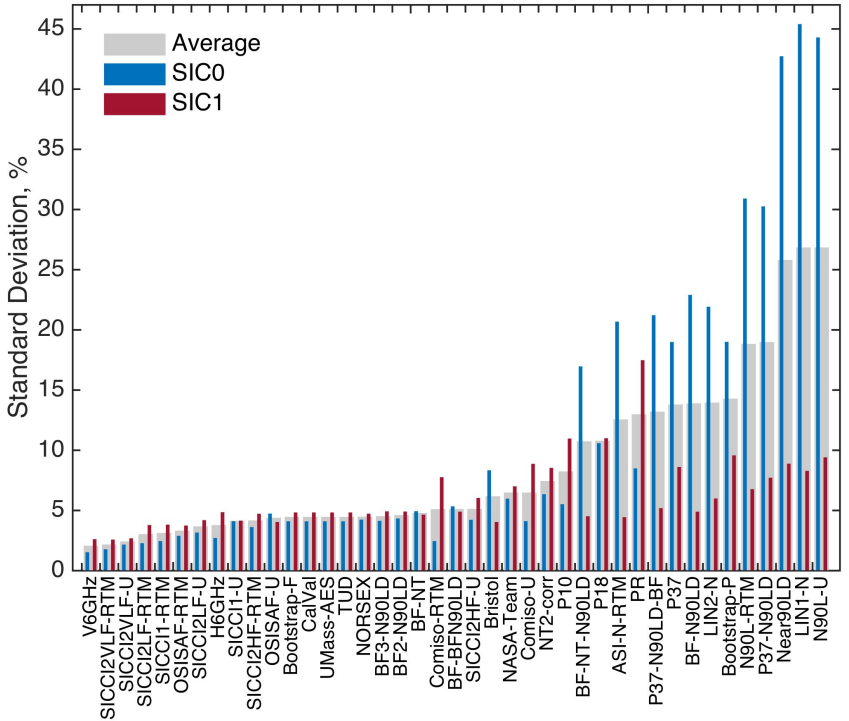
- The most important (and most covered) sea ice variable.
- Available since 1978, with daily complete maps (~25km sensor resolution).
- Since 2000's availability of higher resolution sensors (~10km).
- Later, more SAR coverage (~100m, but SIC from SAR is challenging).



Sea Ice … Concentration (from OSISAF and CCI)

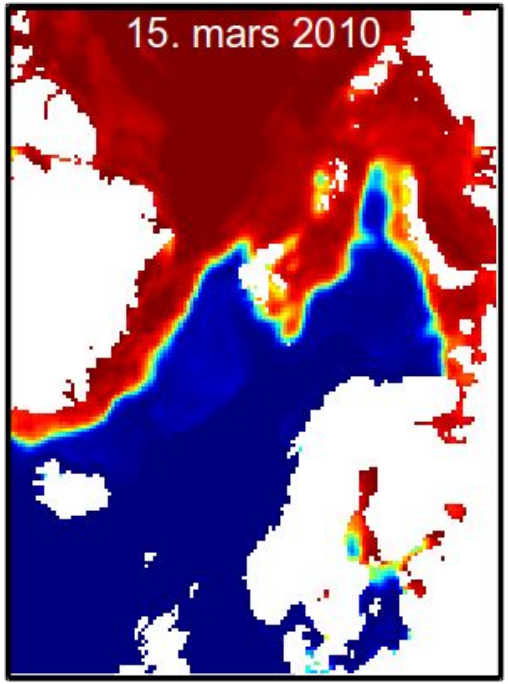


In late 2016, MET Norway processes SIC CDRs for both OSISAF and SICCI.

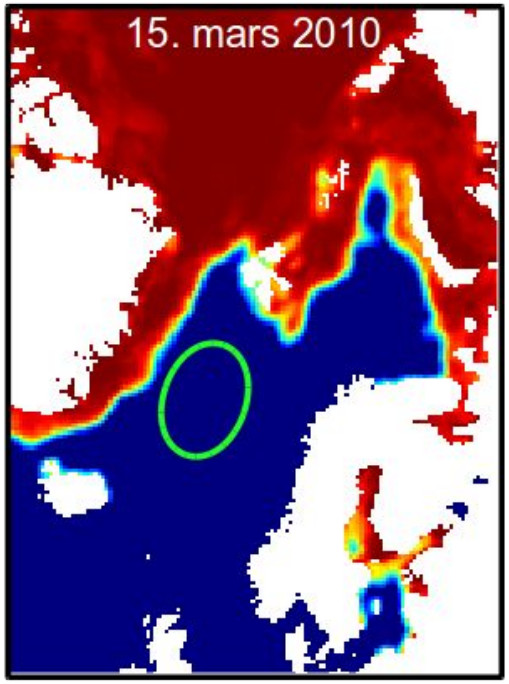


CCI tested 30+ published algorithms and designed a set of new ones, that are now being used.

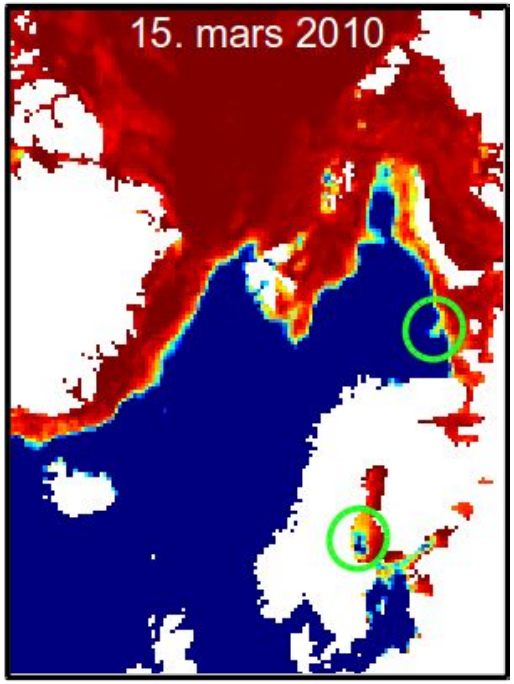
Recent developments on SIC products



current OSI SAF SIC CDR
(OSI-409)



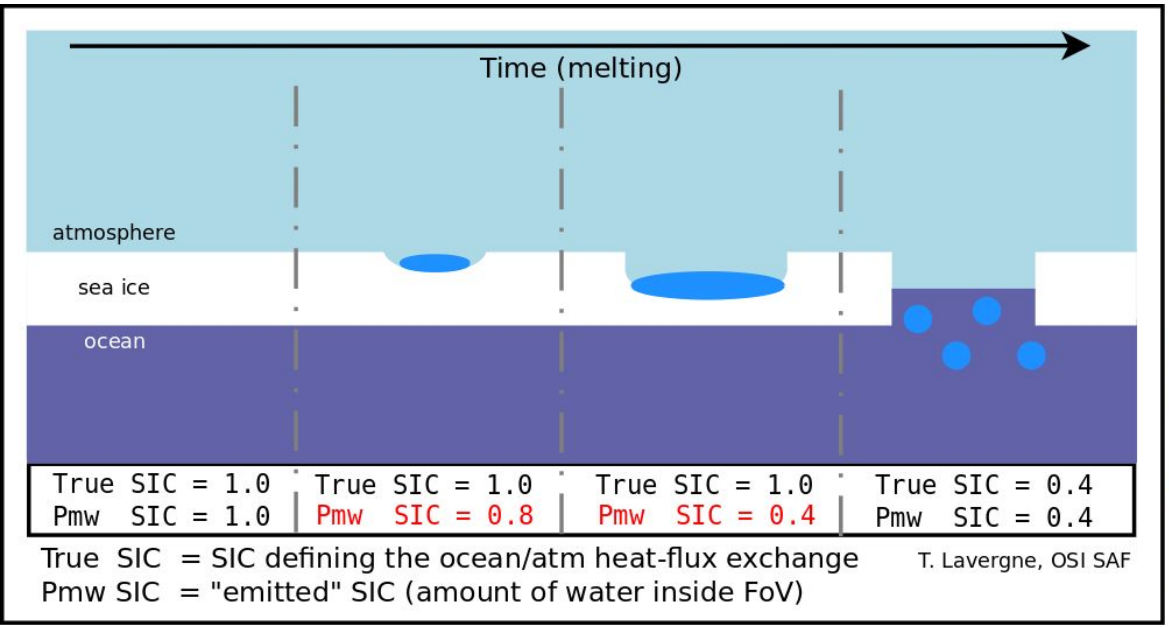
new OSI SAF SIC CDR
(OSI-450)



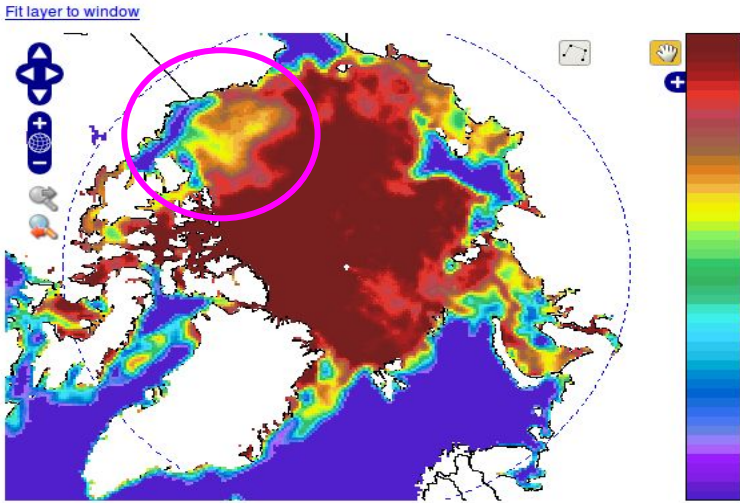
new ESA CCI SIC CDR
(shorter but more accurate)

Some challenges with SIC products.

Melt season: OSISAF SIC ~= 1 - OpenWaterFraction = 1 - (Leads + MeltPond) !

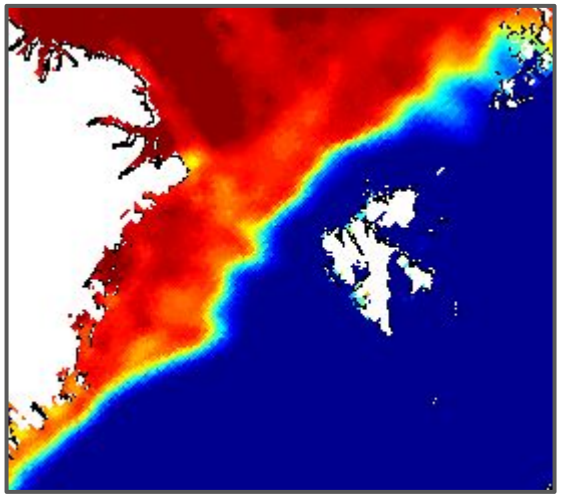


25th June 2014

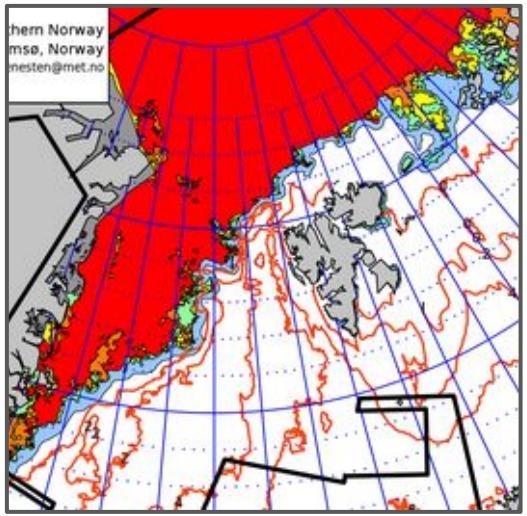


Some challenges with SIC products.

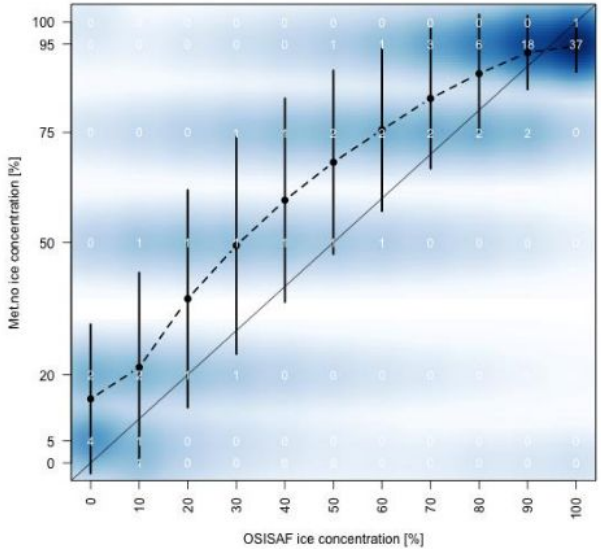
OSISAF SIC != Ice Chart SIC!



OSISAF SIC map
02/11/2016



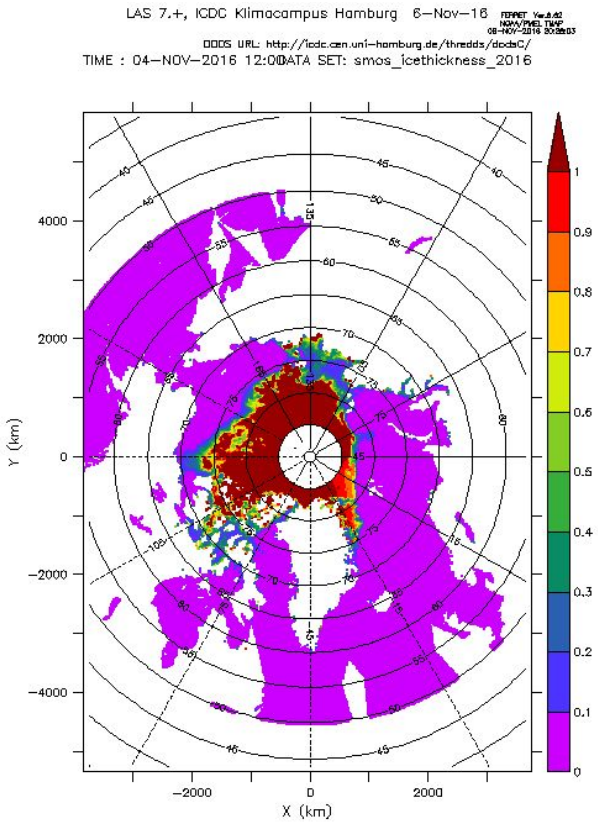
Ice Chart (MET Norway)
02/11/2016



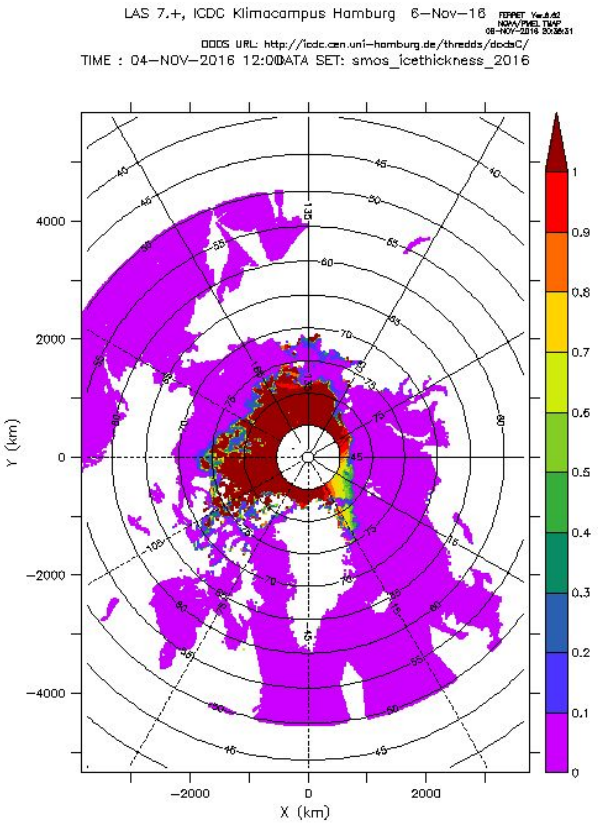
Comparison (2010-2013)
done by DMI in CMEMS

Sea Ice … Thickness

- The 2nd most important variable.
- From satellites, a variety of methods are available, but it is difficult to achieve consistency across the instruments, and across the range of thicknesses.
- Two promising approaches:
  - SMOS-based “thin” ice thickness (Univ. Hamburg or Bremen):
    - Works best in 0-50cm range, freezing season (not summer);
    - Univ Hamburg: http://icdc.cen.uni-hamburg.de/1/daten/cryosphere/l3c-smos-sit.html
    - Univ Bremen: www.iup.uni-bremen.de:8084/databrowser.html
  - Merged SMOS/CS-2 maps (AWI + Univ.Hamburg)
    - Supposedly good for 0-5m range, winter only (not summer);



SMOS sea ice thickness (m)



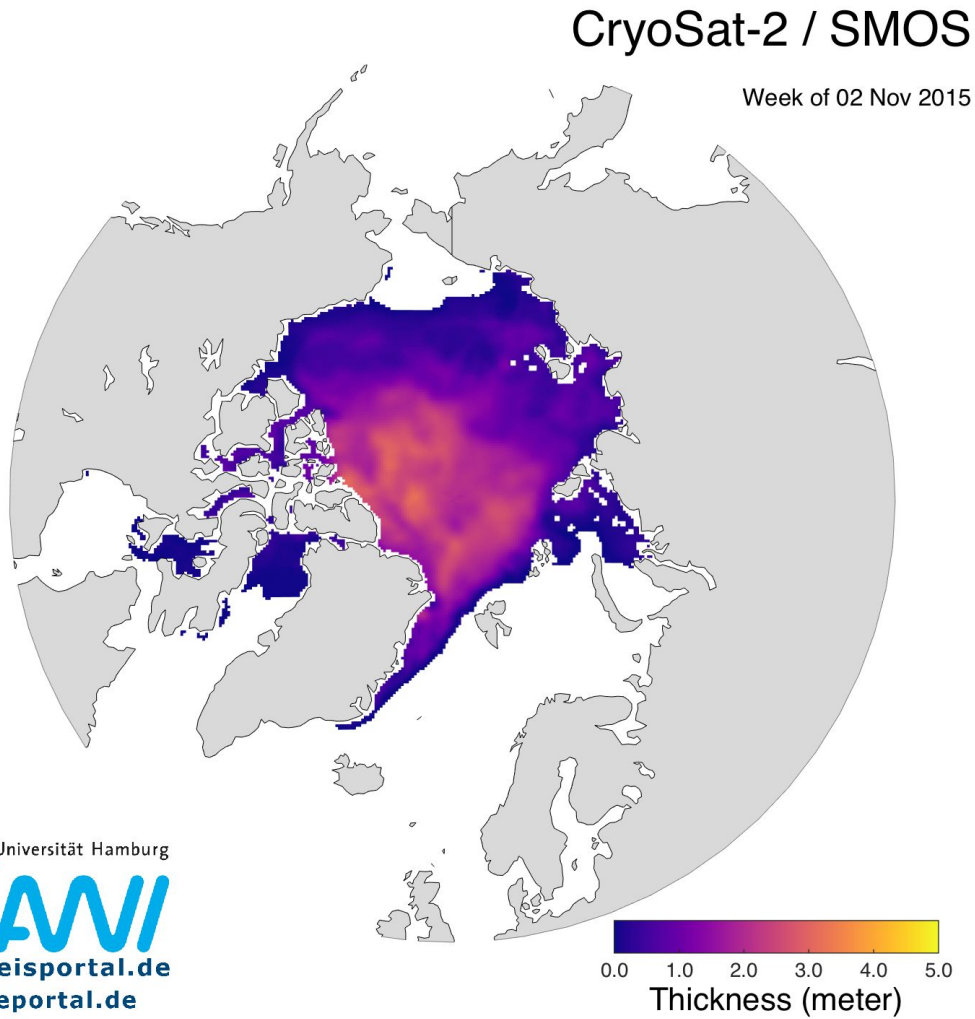
sea ice thickness total uncertainty (m)

<u>Example maps for SMOS thin ice thickness and uncertainties from Univ Hamburg.</u>

Daily 12.5km maps available as netCDF files from ICDC (ftp): http://icdc.cen.uni-hamburg.de/

2010-2016 (on going).

Not available mid-April to mid-September.



Universität Hamburg

meereisportal.de

seaiceportal.de

Example map of CS-2 / SMOS map.

Weekly 25km maps available as netCDF files from AWI's www.seaiceportal.de: http://icdc.cen.uni-hamburg.de/

2010-2016 (currently Feb 2016).

Not available May-September.

No uncertainties.

Optimal Interpolation => use of a background SIT and correlation lengths.

Maybe we should do our own data merge (DA) of CS-2 and SMOS separately (both are in the netcdf files)?

Sea Ice … Thickness

- Some alternatives…
  - CS-2 thicknesses by Kwok (monthly, 100km, not regularly updated)
  - CS-2 thicknesses by UCL (NRT, weekly 5km)
  - ICESat thicknesses (only some winters)
  - Use thicknesses from another model (TOPAZ, PIOMAS, …)

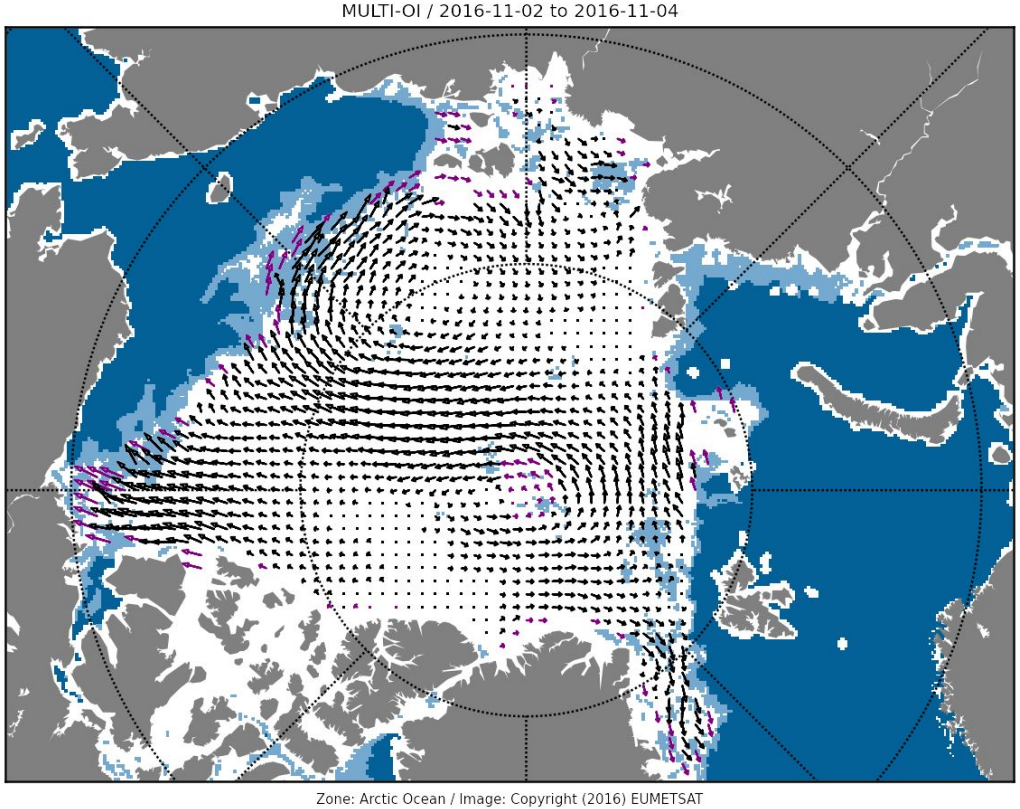
- But in any case:
  - SIT is not an easy variable to measure from satellite => large uncertainty and some biases.
  - No SIT products are really operational.
  - No SIT products during summer.

Sea Ice … Drift

- Sea Ice Drift can be measured from satellite at different scales (from ~100km to ~10km). Buoys are an extra source.

- The measured Sea Ice Drift is an integrated answer of the ice, involving wind speed + direction, air-ice drag coefficient, internal ice forces (incl rheology and thickness distribution), water drag, and ocean currents. It has little or no memory. It is difficult to assimilate.

OSISAF Low-Resolution sea ice drift product



Fully automated and operational for the EUMETSAT OSI SAF.

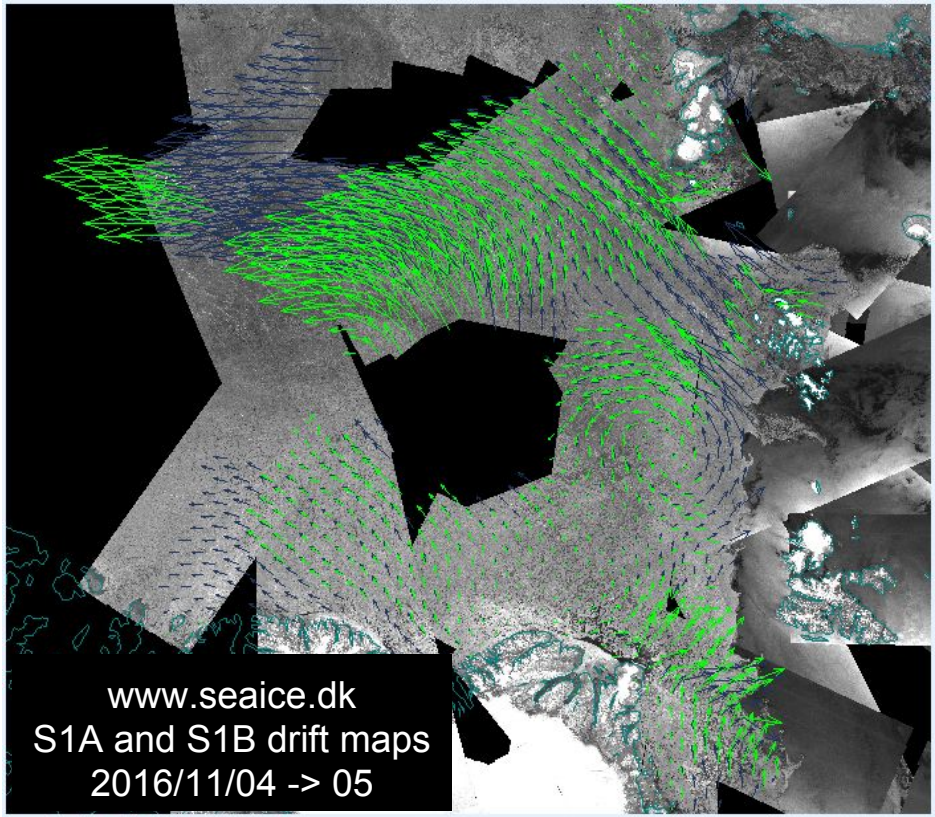
Daily maps, 48 hours drift, 62.5km grid spacing.

Combines SSMIS, AMSR2, and ASCAT (redundancy).

Validation against ice drifters.

Recently extended to summer period (2013 -> today).

CMEMS High-Resolution sea ice drift product



Fully automated and operational for the Copernicus Marine Service.

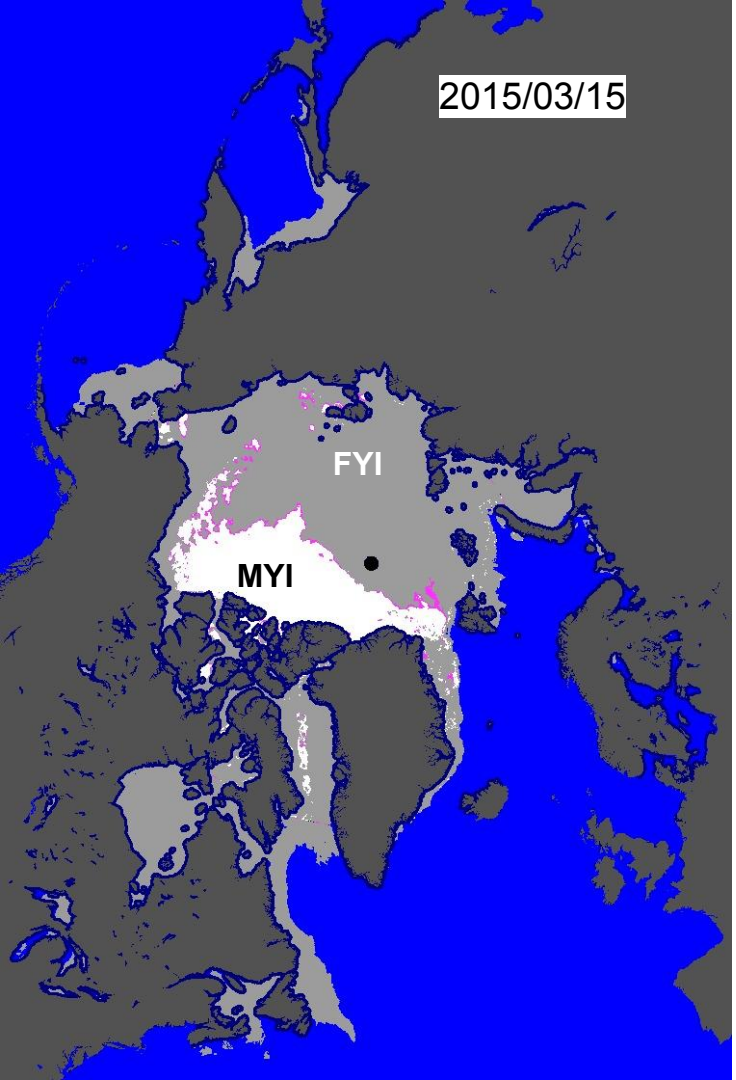
24 hours drift, 10km grid spacing.

Combines Sentinel-1A and -1B.

Validation against ice drifters.

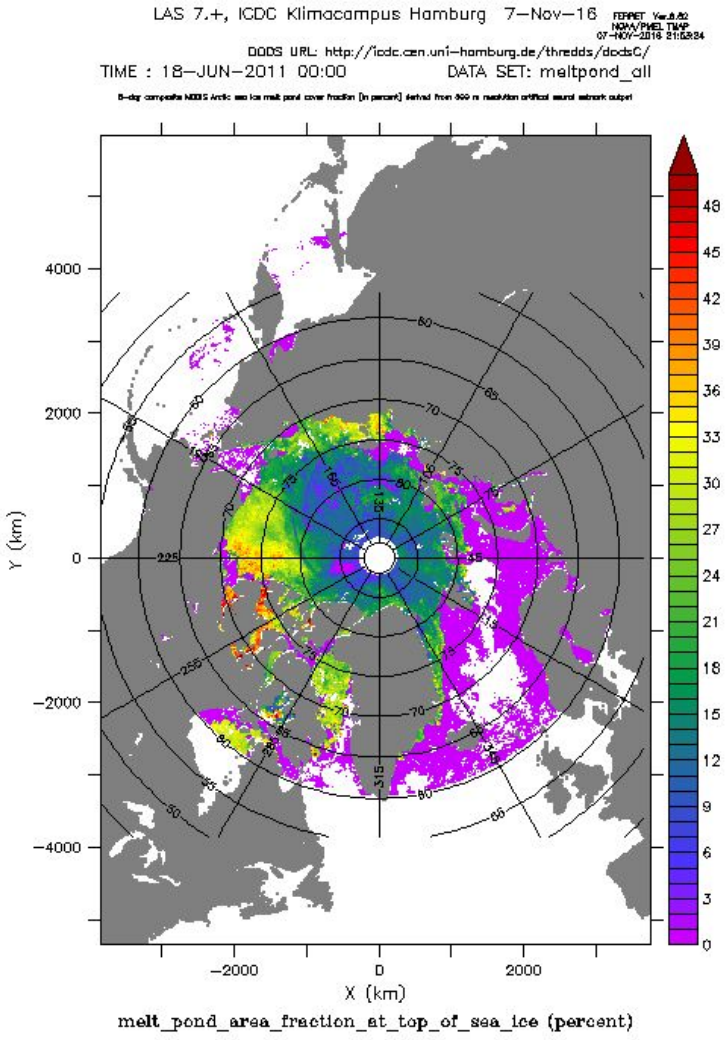
All year round, but not full coverage. A mosaic product is in preparation.

Can be used to derive deformations.



Sea Ice … Type

- A satellite based classification of Arctic sea ice into:
  - First Year Ice (FYI) : ice that did not yet experience a summer melt.
  - Multi Year Ice (MYI): ice that survived at least one summer melt.
- Daily operational maps from OSISAF.
- This product is seldom (never?) used for any modelling/assimilation. Can we try it in SPARSE?
- For example constrain large-scale circulation, or thickness ranges?



Sea Ice … Melt Ponds

- MODIS 8-days maps of melt-pond fractions on top of sea ice (Univ Hamburg, ICDC).
- Based on VIS imagery, thus issue with cloud contamination.
- But good enough quality to conduct science (see Kern et al. 2016).
- 2000 - 2011, 12.5km grid.
- There is also a MERIS dataset (Univ Bremen).

Kern et al. (2016) The impact of melt ponds on summertime microwave brightness temperatures and sea-ice concentrations, doi:10.5194/tc-10-2217-2016

Wrapping-up

1. Introduction
2. Sea Ice … Concentration, Thickness, Drift, Type/Age, Melt Ponds
3. Conclusion:
    a. SPARSE needs satellite observations, but will not develop any;
    b. So we must keep an interface to what is available from other initiatives, both operational and more research oriented.
    c. This presentation is a first review of what is well established at present, it will be refined as we decide more about what SPARSE will do.
    d. The main criteria will be time: which years and which seasons will we focus on?

Sea Ice Observations for use in SPARSE

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Thank you for your attention.
Questions? Remarks? Discussion?

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