# Developing and Operating the Sea Ice Concentration ECV: the ESA CCI and EUMETSAT OSISAF join forces.

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The EUMETSAT Network of Satellite Application Facilities — OSI SAF Ocean and Sea Ice

sea ice cci

## Take-home messages

• Polar sea ice concentration (SIC), extent, and area are key indicators and strong drivers in a global changing climate.

• Satellite sensors are key for this ECV, with data back to 1978.

• The ESA CCI and EUMETSAT OSISAF collaborate and coordinate their plans for achieving best accuracy and re-use of existing capabilities.

**And finally:**
• The Copernicus Marine Core Service has a formal agreement with EUMETSAT OSISAF and MET Norway for provision and redistribution of SIC ECV data. Similar solutions can be discussed with the C3S.
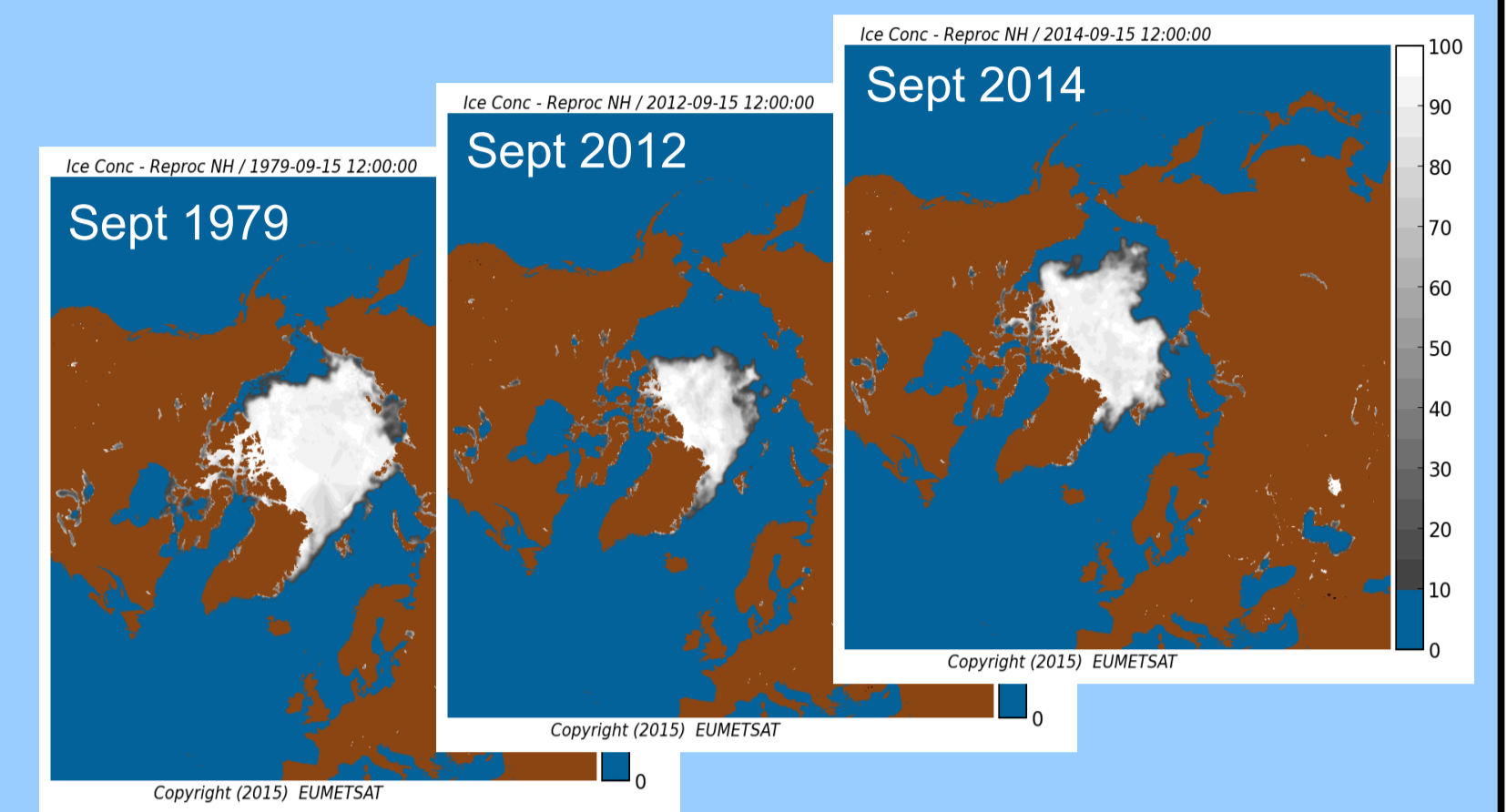


Fig 1: Maps of Northern Hemisphere Sea Ice Concentration (SIC) for end of summer season (September) in 1979, 2012, and 2014

## Research and Development : What we know, and what we still don't

• The ESA CCI Sea Ice (Ivanova et al. 2015), and EUMETSAT OSISAF (Andersen et al. 2007) confirm that a good SIC algorithm for climate monitoring combines the following 3 elements:

  • A pair of SIC algorithms (for example Comiso-F for open water, and Bristol for closed ice);
  • Correction of the brightness temperatures with Radiative Transfer Modeling (RTM);
  • Dynamic tuning of the algorithm coefficients (aka dynamic tie-points).

• Per-pixel uncertainties are provided with the SIC maps (see Fig 2), but more R&D will allow refinement and increased confidence in these uncertainties.

• Additional CCI R&D indicates that even better algorithms exist, but that the final accuracy is now limited by our approach to atmospheric correction (see Fig 3). We must move to Inverse / Optimal Estimation (OE) techniques in the future.



All algorithms give the same answer after atmospheric correction, indicating that we must seek and revise this step, moving to Optimal Estimation (OE) techniques.

Fig 3: New research from the ESA CCI Phase 2 project points out that more accurate algorithms can be designed with continuous R&D efforts. The limiting factor now seems the way RTM correction is done.

### Arctic and Antarctic ice concentration 01 March 2008



Ice concentration in % — Uncertainty in %
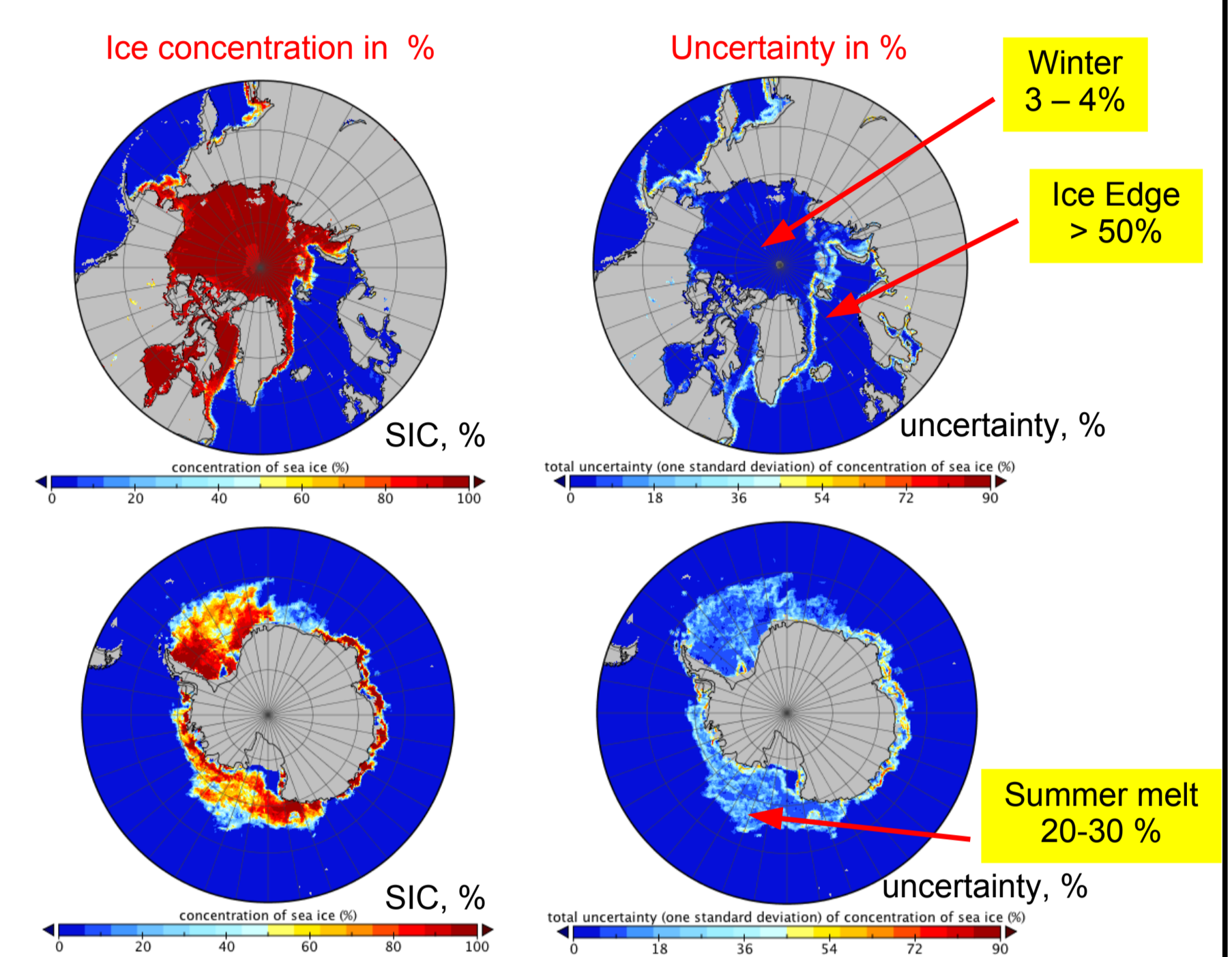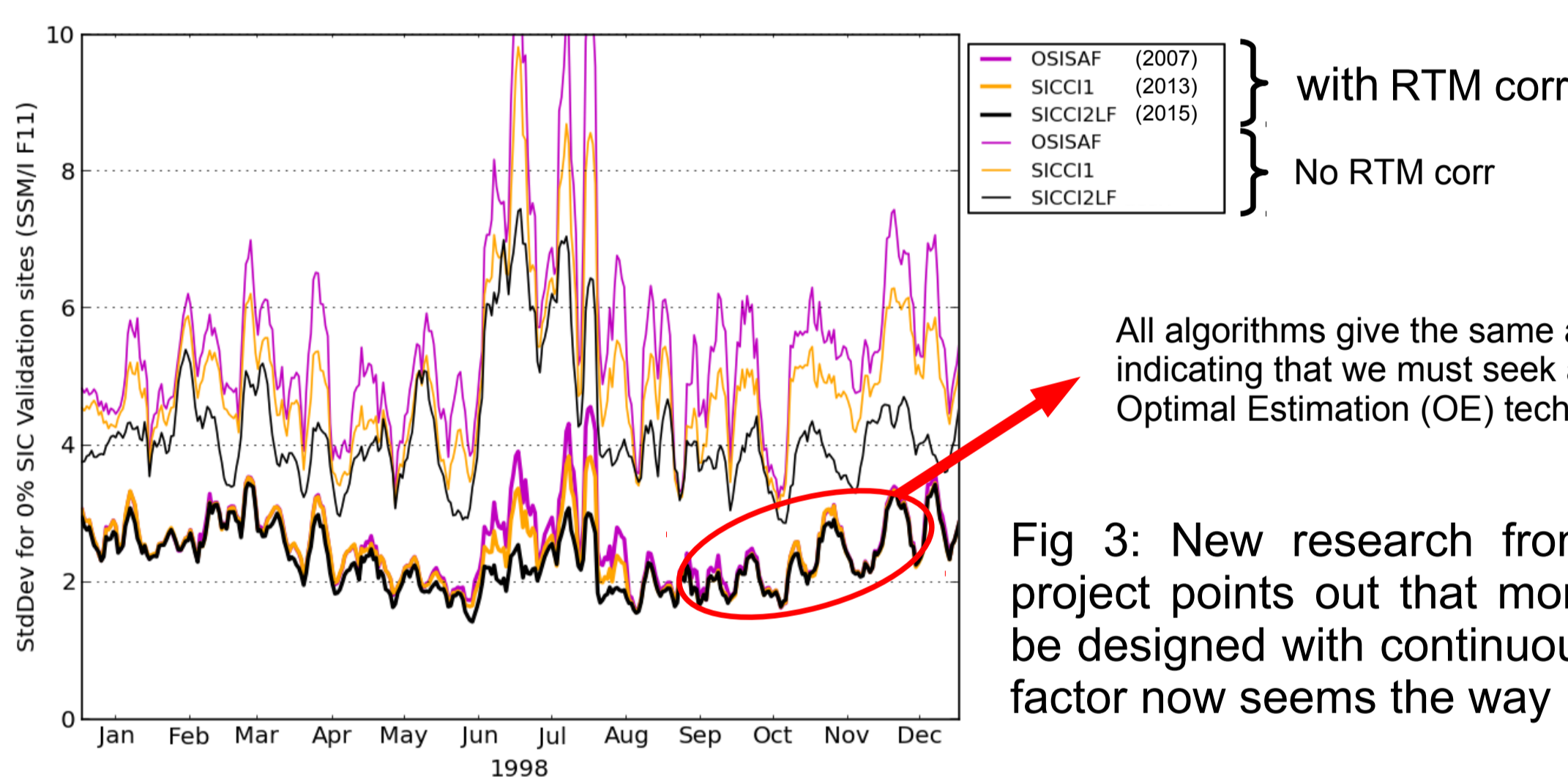Winter 3 – 4%
Ice Edge > 50%
Summer melt 20-30 %

Fig 2: Example SIC fields from AMSR-E as processed in the ESA CCI project. Daily maps of SIC (left) always come with per-pixel uncertainties (right).

**Snow on sea-ice :** Snow-depth on sea-ice is at present still largely unknown, and few retrieval algorithms or validation data exists. It is one of the largest remaining sources of uncertainty for the SIC ECV, as well as for the Sea Ice Thickness retrievals from Radar Altimeters.

Ivanova et al. (2015) Sea ice algorithms inter-comparison and evaluation: towards further identification of challenges and optimal approach using passive microwave observations, The Cryosphere Discussion (under review)
Andersen et al. (2007). Intercomparison of Passive Microwave Sea Ice Concentration Retrievals over the High-Concentration Arctic Sea Ice, J. Geophys. Res., 112, C08004, doi:10.1029/2006JC003543.

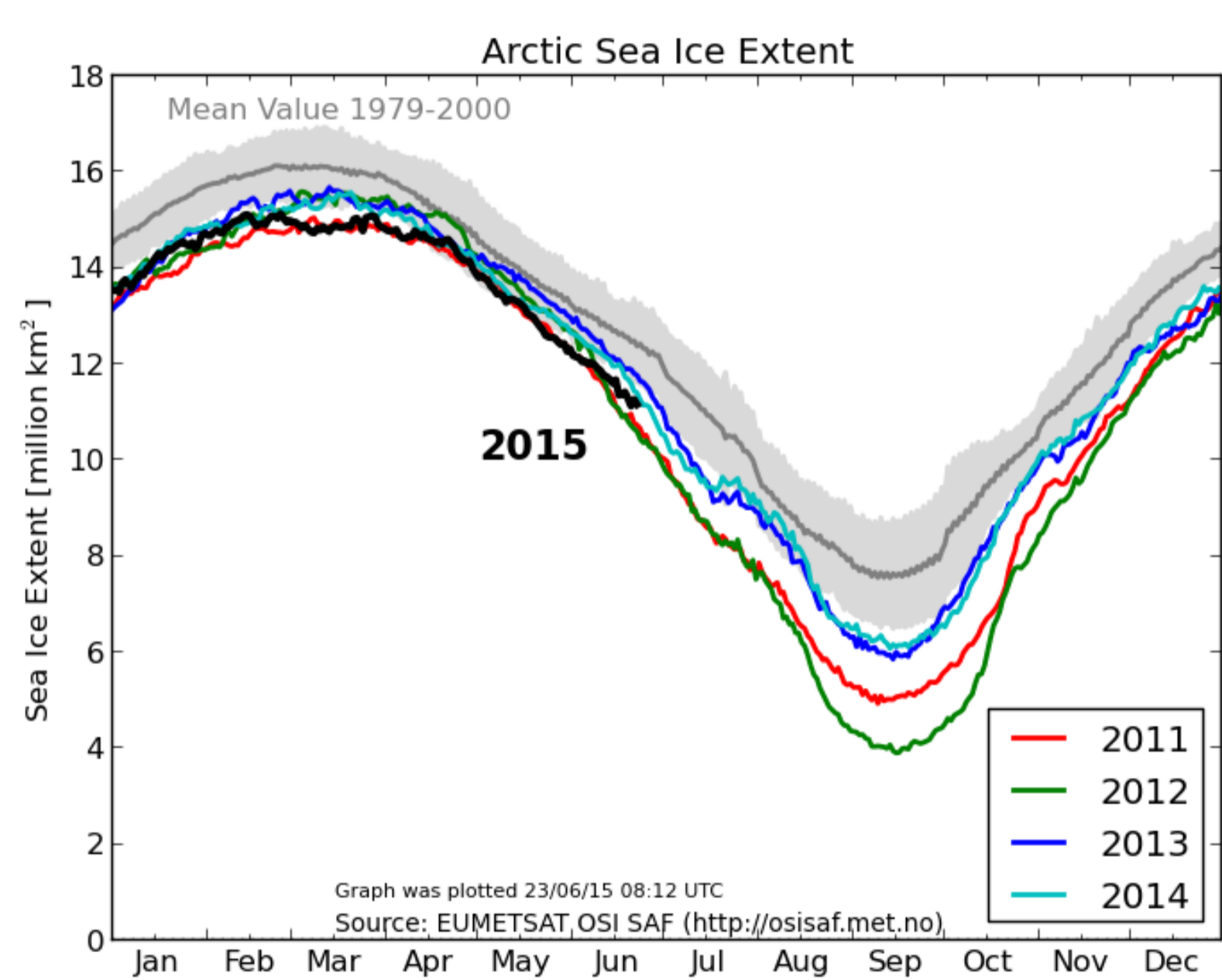## Operations : What is in place, and where to get from here?



Fig 4: Daily-updated Arctic Sea Ice Extent, combining the OSISAF reprocessed dataset and near-real-time products.

• Long-term funding, continuous re-processing, software maintenance, version control, help desk, etc... are needed to transition an R&D effort into an operational ECV service.

• This is the main strength of the EUMETSAT OSISAF since its initial developments (late 1990s). The next 5-year phase (2017-2022) will include a full reprocessing of the SIC ECV.

• The OSISAF processes NRT, and 1-month delayed updates to the SIC dataset, allowing for continuous monitoring of the ECV (see Fig 4).

• EUMETSAT OSISAF and ESA CCI join forces to achieve best accuracy and re-use of capabilities, targeting the next full reprocessing of SIC ECV in late 2016 (see time-line below).

• Copernicus Marine Core Service has formal agreement with OSISAF and MET Norway for re-distribution of SIC data, similar agreements can be discussed with the C3S.

## Past releases, and future scenarios for SIC ECV dataset extension



OSI SAF
CDOP1 (2007 - 2012)    CDOP2 (2012 - 2017)    CDOP3 (2017 - 2022)

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SICCI1 (2012 - 2015)    SICCI2 (2015 - 2018)    CCI+ ?

OSISAF V3
SMMR+SSM/I+SSMIS (1978-2019)
AMSRE+AMSR2 (2002-2019)

2010    2011    2014    June 2015    late 2016    2020

Time

OSISAF V1.0 (1978-2008) SMMR+SSM/I

OSISAF V1.1 (1978-2009) SMMR+SSM/I

SICCI V1.11 (1992-2008) SSM/I (2002-2011) AMSR-E

OSISAF V1.2 (1978-2015) SMMR+SSM/I+SSMIS

OSISAF V2 (1978-2015) SMMR+SSM/I+SSMIS

SICCI V2 (2002-2015) AMSRE + AMSR2

Two distinct projects, but:
• Same processing chain,
• Same algorithms,
• Same file format,
• Same production center.