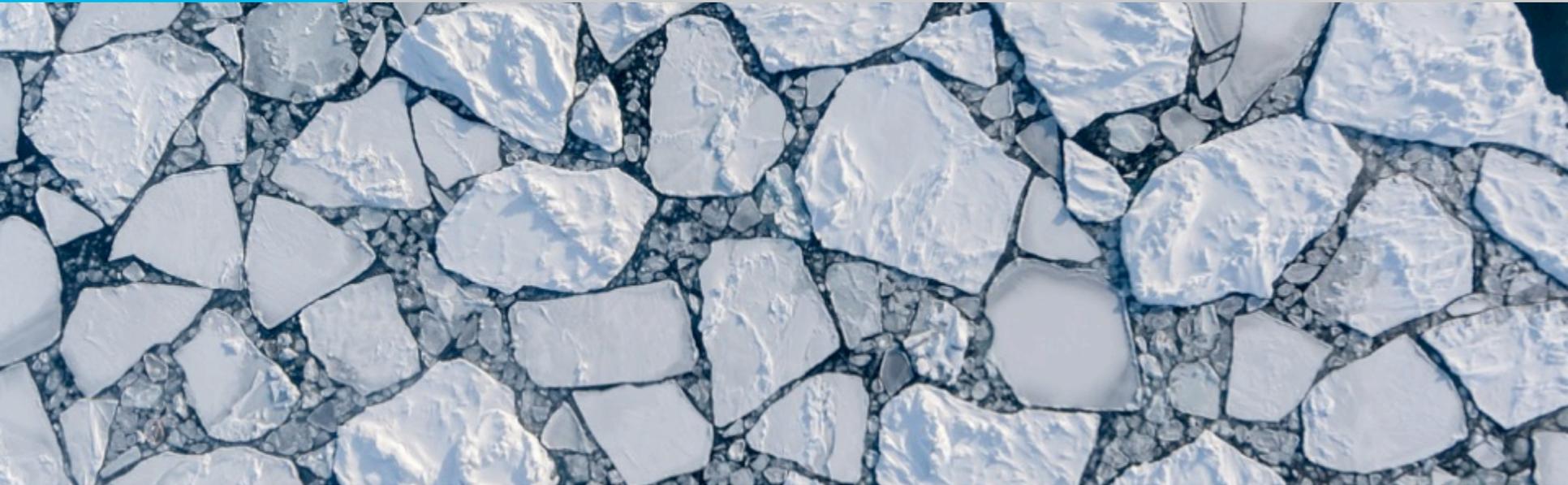


M. Nicolaus, S. Hendricks, and R. Ricker



Arctic Sea Ice Decline Results from Winter 2015/16

21 Apr 2016



Snow Buoy Measurements

Parameters

Snow depth

Air Temperature / Air Pressure

Deployments

40 deployments since 2012 (Arctic + Antarctic)

Co-deployment with other units

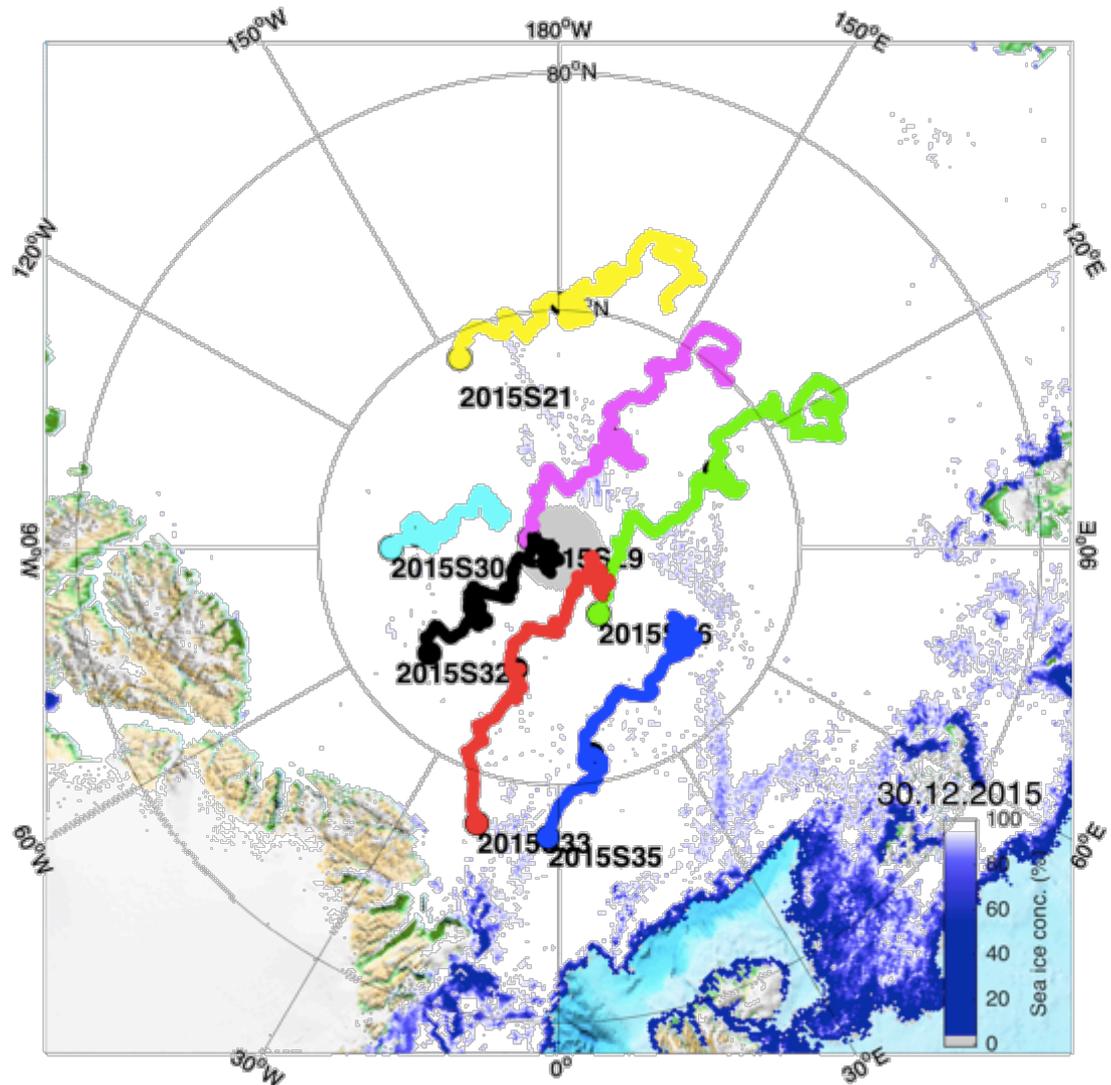
Concept

Simple and affordable instrument

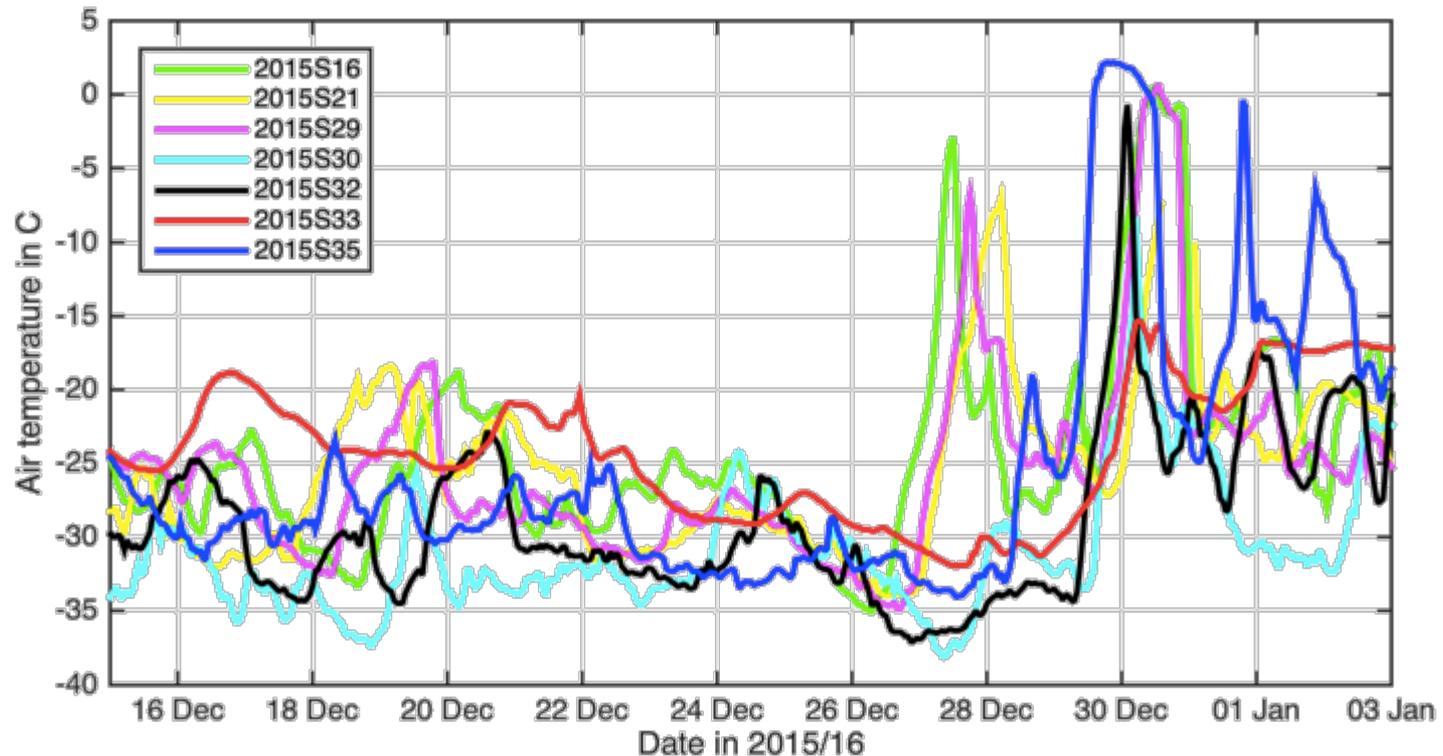
Arctic Snow Buoys in 2015/16

Deployments during Polarstern PS94

- 7 Snow Buoys since Sep/Oct 2015
- Air temperature coverage of entire winter
- Snow depth time series = indicator of surface melt



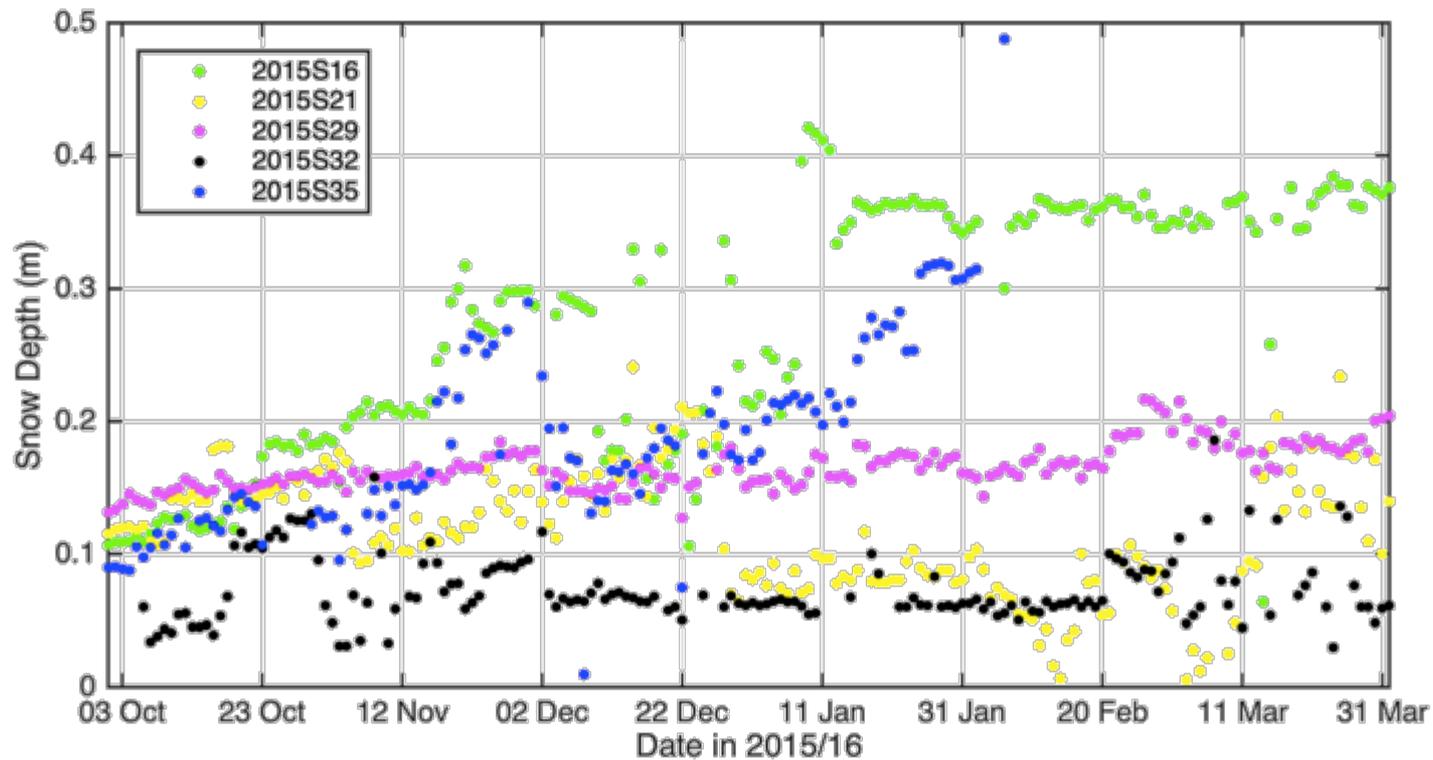
Warm Winter 2015/16



Snow Buoy Results

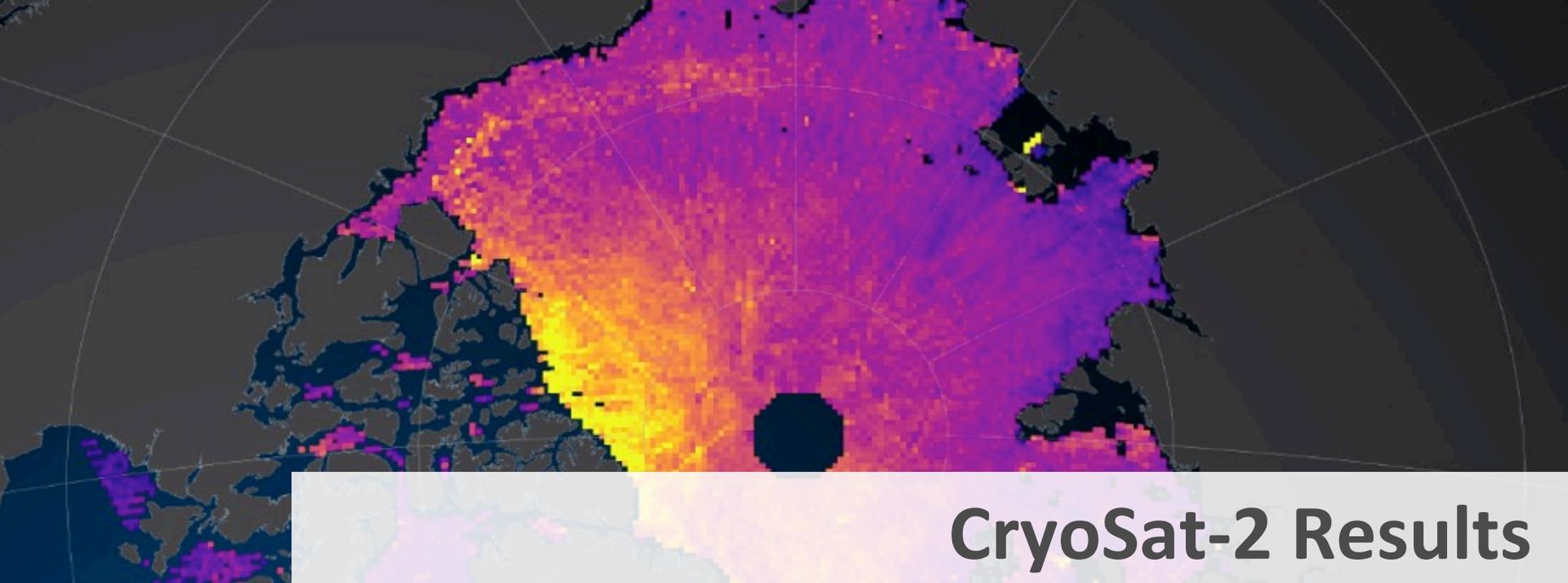
- Exceeding 0°C end of December 2015
 - => **NEWS** (through GTS reports & Arctic Buoy Program)
- Caused by warm air advection through Fram Strait

Effects on Snow Depth



Snow Buoy Results

- No snow or sea ice melt detected
- Only buoy S21 shows decrease of 0.1m
- 4/7 buoys cover the entire time



CryoSat-2 Results

Data set

Monthly sea ice thickness (since Nov 2010)
Near real time (NRT) product for March 2016
25 km resolution
AWI processor (see data.seaiceportal.de)
 Ricker et al. (2014, The Cryosphere)

Parameters

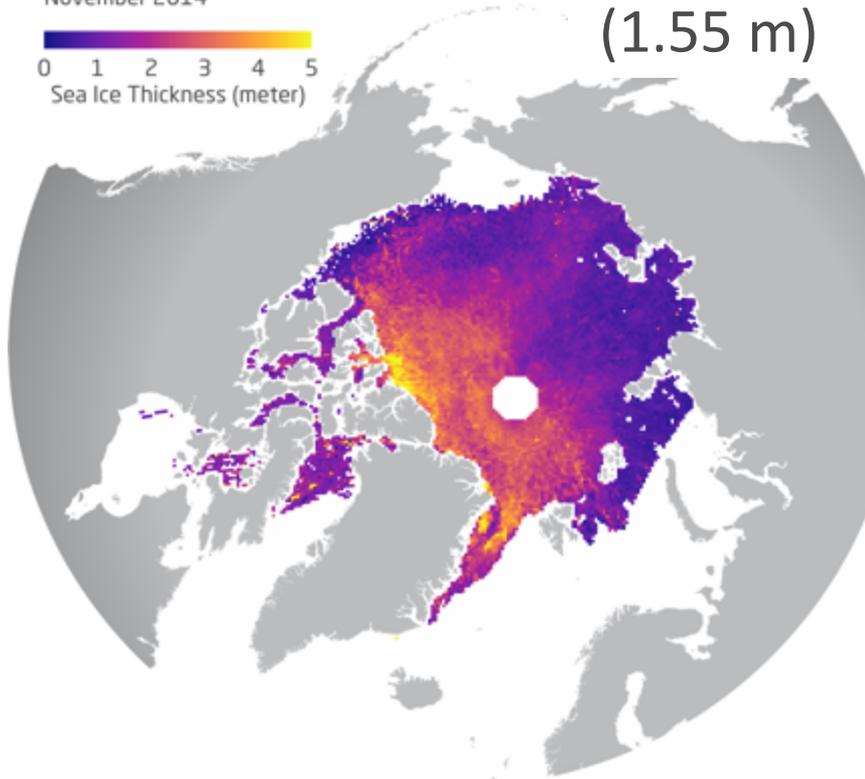
Sea ice thickness (with uncertainties)
Freeboard (with uncertainties)
Additional fields

Sea Ice Thickness - November

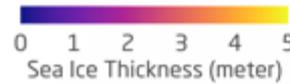
CryoSat-2
November 2014



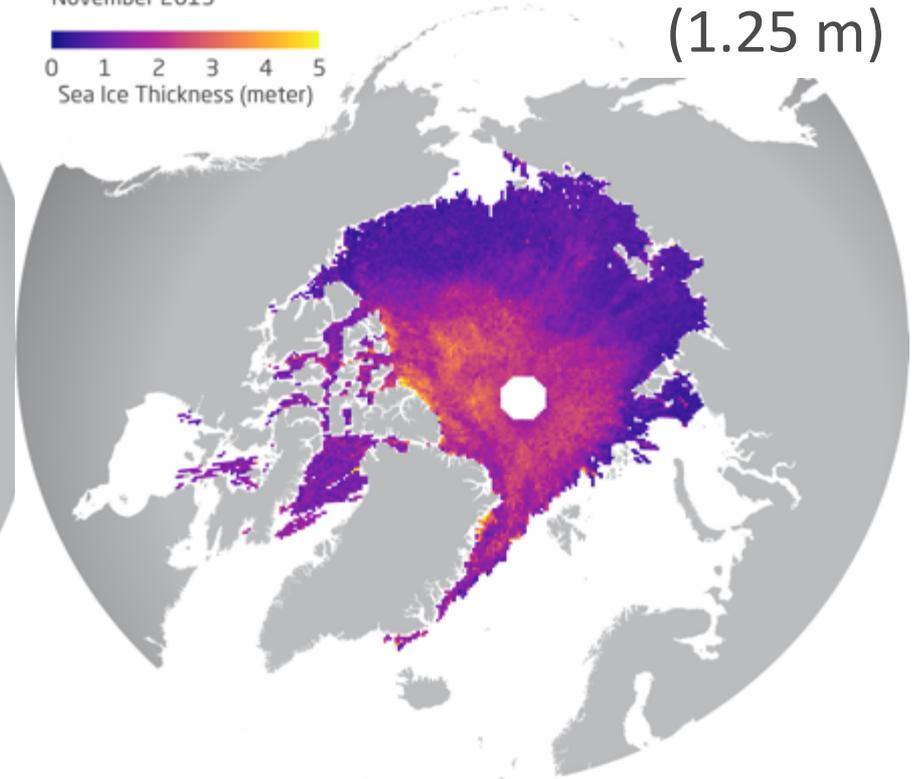
2014
(1.55 m)



CryoSat-2
November 2015



2015
(1.25 m)



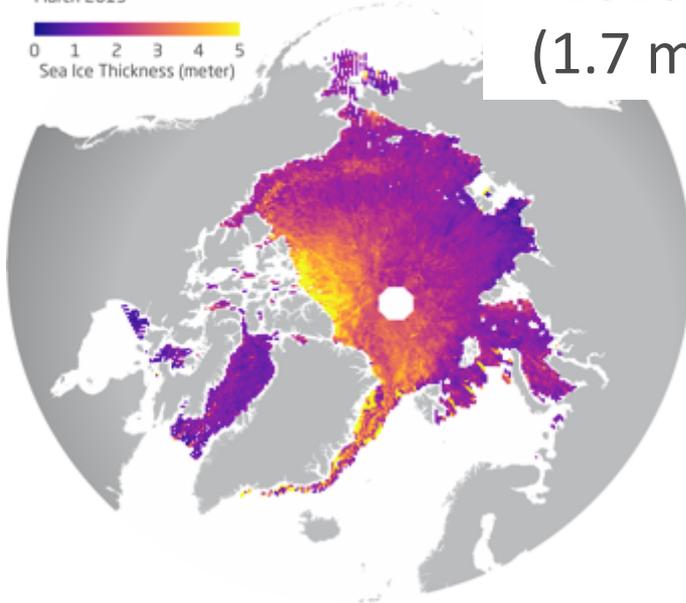
CryoSat-2 Results

- Strong summer melt in 2015
- Loss of thick sea ice
- But no extremely low extent

Sea Ice Thickness - March

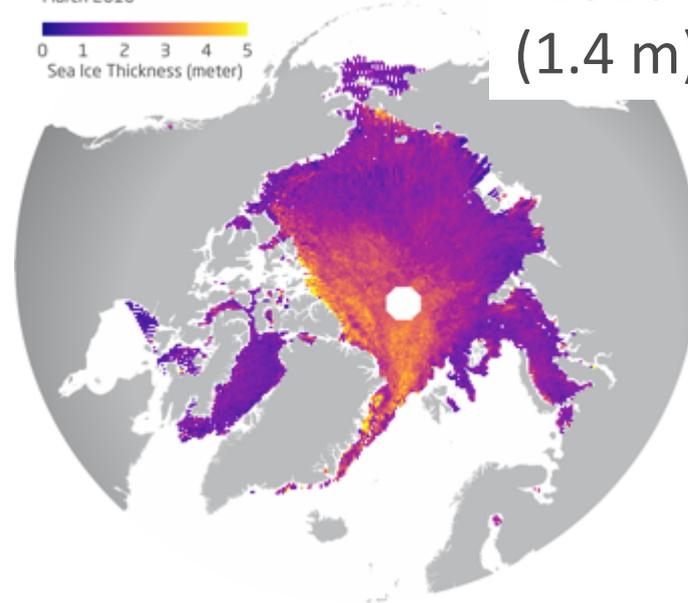


CryoSat-2
March 2015



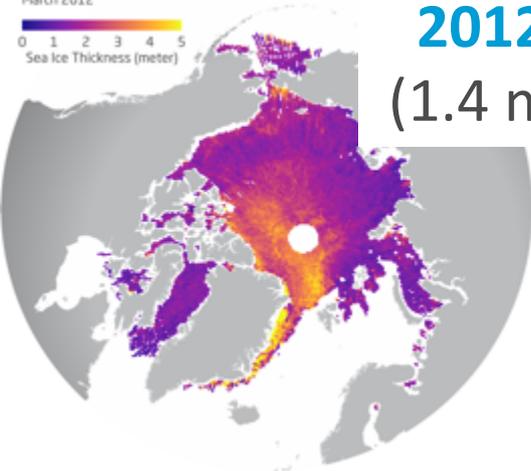
2015
(1.7 m)

CryoSat-2 (NRT)
March 2016



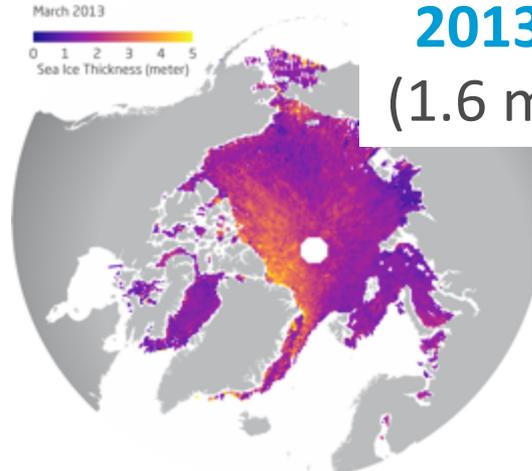
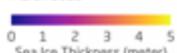
2016
(1.4 m)

CryoSat-2
March 2012



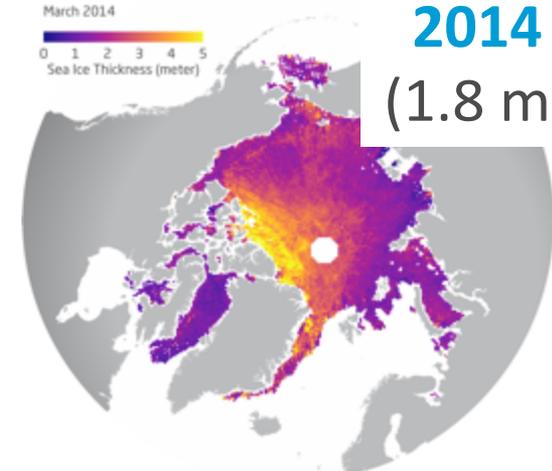
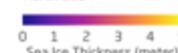
2012
(1.4 m)

CryoSat-2
March 2013



2013
(1.6 m)

CryoSat-2
March 2014



2014
(1.8 m)

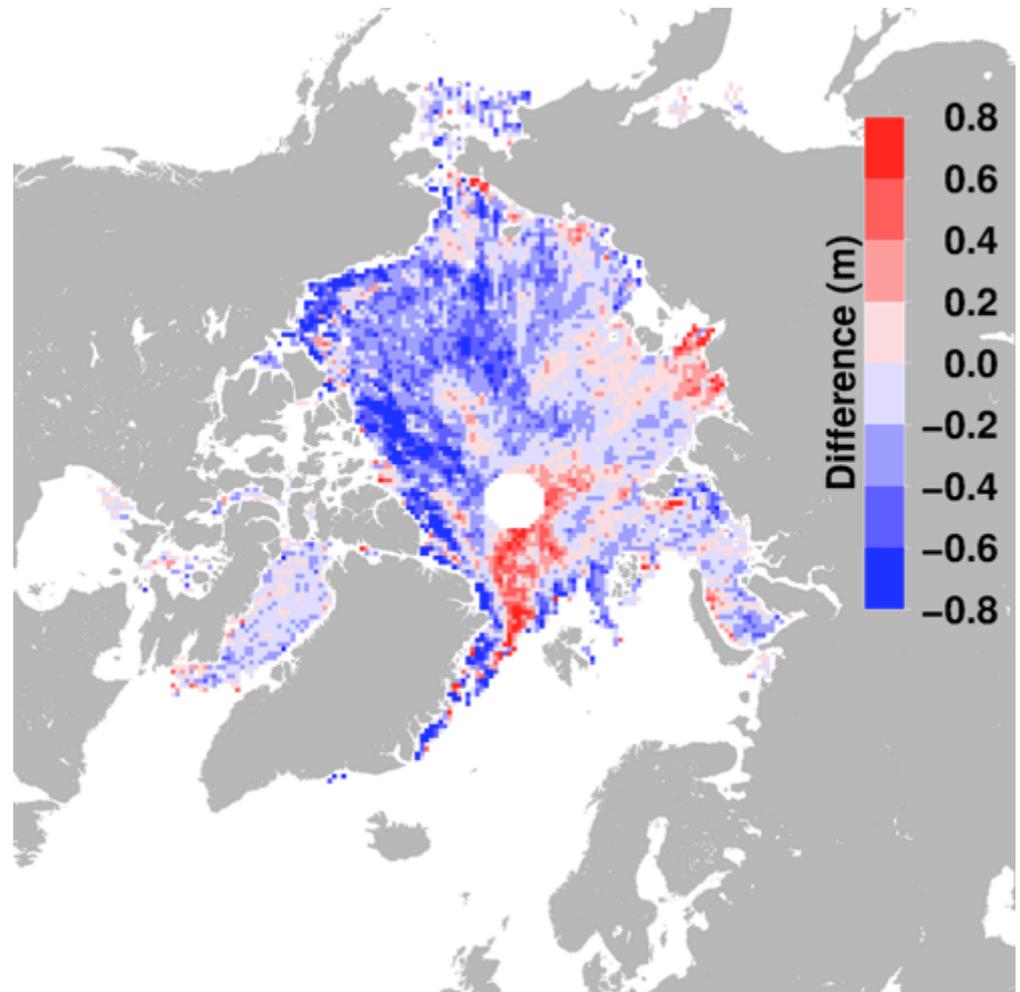
Sea Ice Thickness - Changes

Changes (2016-mean)

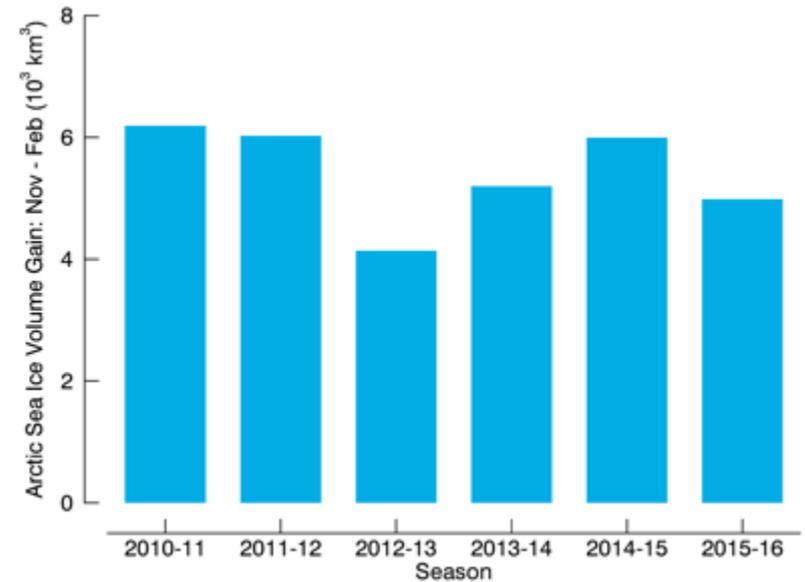
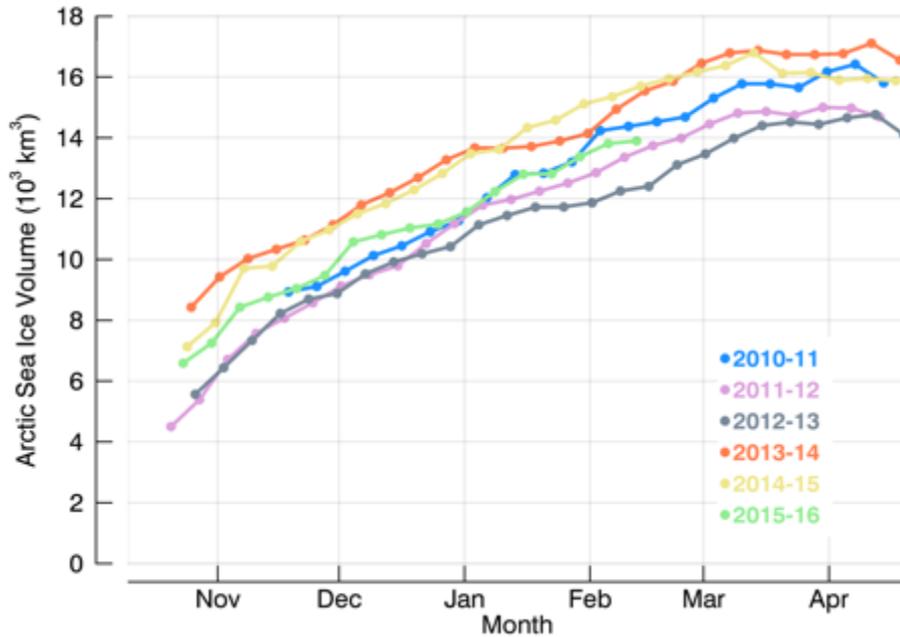
- Beaufort: -0.2 to -0.4 m
- Kara: -0.1 to -0.3 m

Thickness distribution

- Thinner sea ice
 - Beaufort
 - North Canada
 - North Greenland
- Thicker sea ice
 - north of Fram Strait (likely export, likely dynamic effect)



Sea Ice Volume – Winter Growth



Combined results (concentration * thickness)

Includes SMOS data for thin sea ice

- Low sea ice growth
- Starting the summer 2016 with similar conditions as 2012

More details here at EGU 2016



Posters today 17:30 Sea ice thickness results Data portal

Robert Ricker^{1,2}, Stefan Hendricks¹, Lars Kaleschke¹, Sandra Schwegmann^{1,3}, Erico Pflaum¹, Volker Heide¹

¹AWI ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Arctic and Antarctic Sea-Ice Thickness Derived from CryoSat-2, SMOS, and Envisat

Introduction

Only sparse sampling allows us to estimate sea ice thickness on a global scale. Remote sensing measurements provide global observations, which are referenced to the sea level to obtain sea thickness that can be transformed into sea ice thickness by assuming hydrostatic equilibrium [1]. In addition, satellite measurements can be converted into sea thickness [2], in order to derive long term trends. It is necessary to combine subsequent satellite mission thickness [Figure 1].

CryoSat-2 Sea-Ice Thickness Product

CryoSat-2 along track measurements are averaged within 1 month [Figure 2]. This series from 2010-2016 reveal strong inter-annual variations and a substantial thickness decrease in 2016, caused by high melting rates in summer 2015 and an earlier melt onset. Data are provided at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI), University of Hamburg. The product is free Climate Data Store data base: http://www.awi.de/awidms_pse/awidms_pse/awidms_pse.html

CryoSat-2 – SMOS Data Fusion

We used CryoSat-2 (CS2) sea ice thickness weekly products by using an iterative approach of optimal interpolation [Figure 3a]. Taking advantage of the complementary characteristics of the individual sensors but for sensitivity according to different sea thickness regimes (CryoSat-2 best ice, SMOS the sea and the melt coverage, high resolution, CryoSat-2, low resolution, SMOS). The obtained southern hemisphere sea ice thickness shows a substantial decrease in winter 2016, compared to the last two winters, caused by high melting rates in summer 2015, and amplified by the following unusual warm winter [Figure 3b].

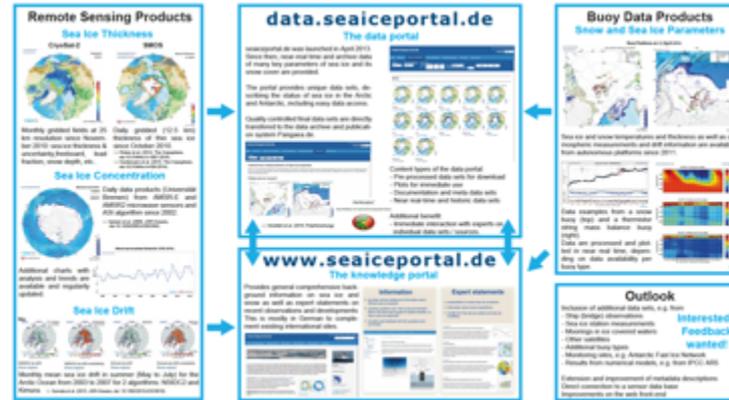
Extending the Time Series with Envisat

In order to continue CryoSat and CryoSat-2 time series, the consistency between both satellite has to be considered. A comparison of water footprint, which is the height of the radar mask scattering horizon above the water level, has been conducted during the overlap period in 2011 [2]. Envisat shows higher footprint in the seasonal ice zone, while CryoSat-2 footprints are higher in the perennial ice zone and near the coast [Figure 4]. Such examples are caused by different sensor characteristics [Figure 4] and different processing algorithms.

Conclusions

- High melt rates during summer 2015 and a warm winter lead to reduced sea ice thickness and ice volume in March 2016.
- The CryoSat-2 – SMOS data fusion takes advantage of the complementary characteristics of both products.
- The optimal interpolation approach can be adopted for the combination with other sea ice thickness products (e.g. Sentinel-3 in the future).
- A comparison between Envisat and CryoSat-2 footprint intervals over Antarctic sea ice shows similar patterns but differences in magnitudes.

Figure 4: Comparison of water radar footprint of CryoSat-2 and Envisat.



Oral today 14:30 Snow buoy data and details

M. Nicolaus, S. Arndt, S. Hendricks, G. Hevgster, M. Hoppmann, M. Huntemann, C. Katlein, D. Langevin, L. Rossmann, S. Schwegmann

Snow depth on Arctic and Antarctic sea ice derived from Snow Buoys

21 Apr 2016

Summary Statements

Thinner sea ice cover than in previous years

- ~15% less sea ice than in 2015 (volume estimate)
- Strong summer melt 2015
- Low sea ice growth rates in winter 2015/16
- But no surface melt during winter

Projection: low sea ice volume (and extent) in summer 2016

- Thin sea ice in spring
- Strong export through Fram Strait (thick ice piled up)
- Similar ice conditions as in 2012
- However: Unknown atmospheric and oceanographic conditions during the coming spring and summer
=> will determine the outcome