ESA Earth Observation

Missions and Programmes for measuring the state of the Crysophere

CTC 2018

Yves-Louis DESNOS

Head of Data Applications Division

Directorate of Earth Observation Programmes

D/EOP Mission

Develop world-class Earth Observation systems addressing scientific & societal challenges with European and global partners

Directorate of Earth Observation Programmes

Personnel

555

234	321
Contractors	Staff

Budget

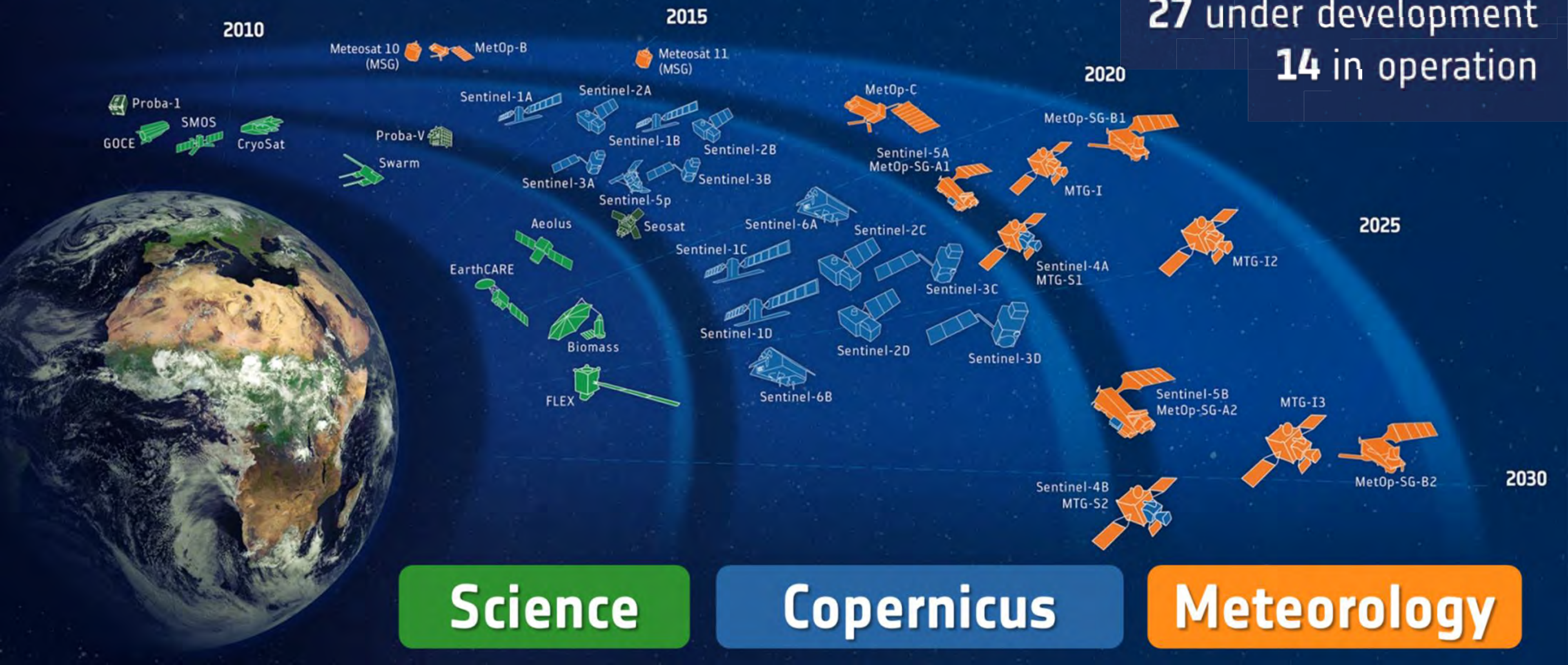
€ 1.5 bn in 2018

5 Sites

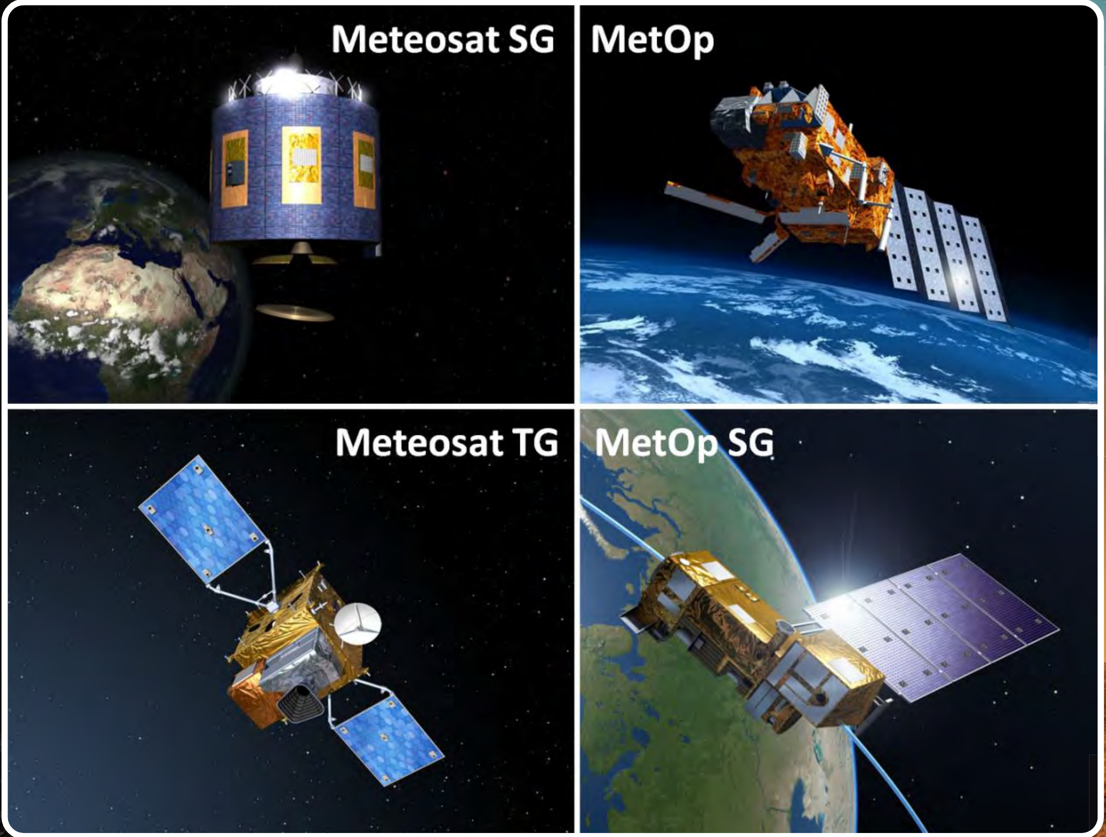
ESRIN, ECSAT, HQ, ESTEC, EBO

ESA-DEVELOPED EARTH OBSERVATION MISSIONS

Satellites
27 under development
14 in operation



Meteorological Missions

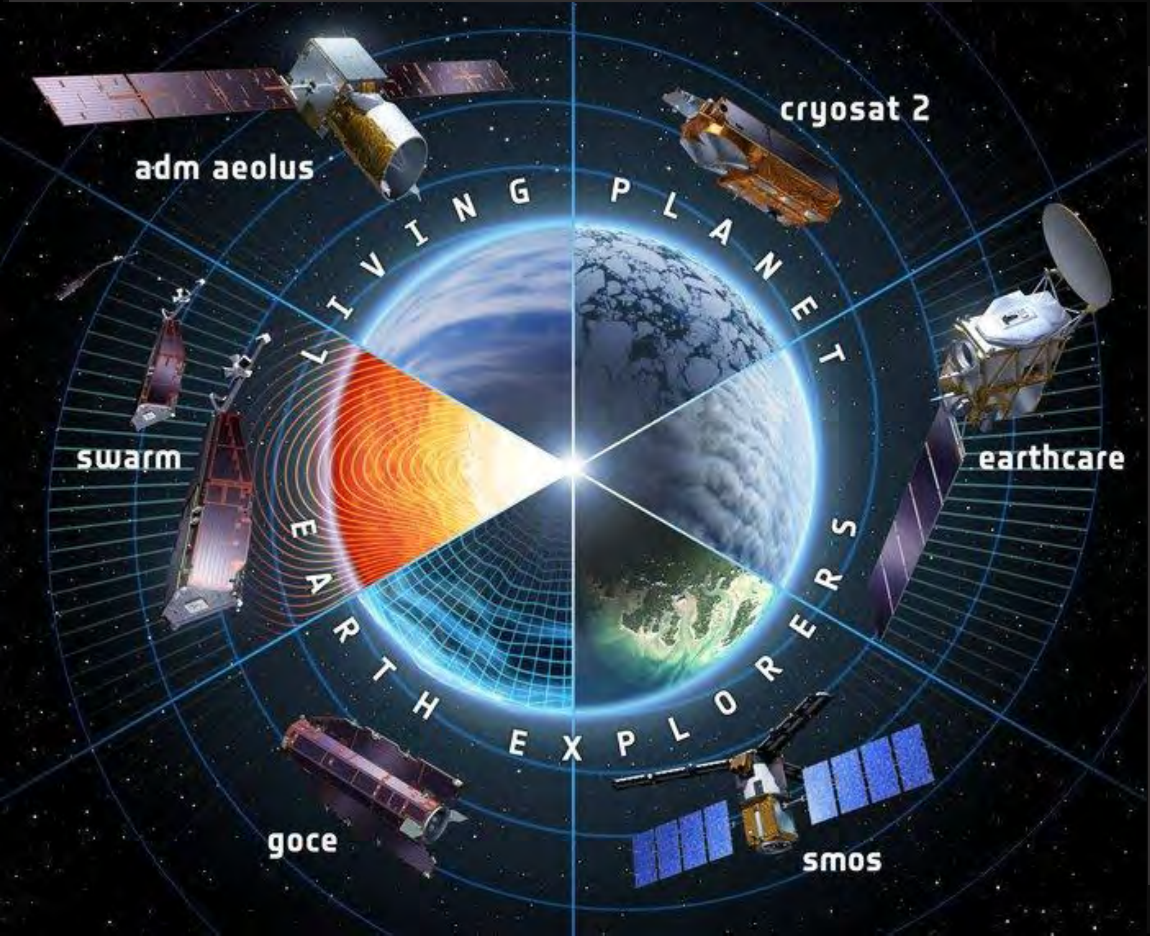


New Generations of Systems coming up

< Current Systems

< Post-2020 Systems

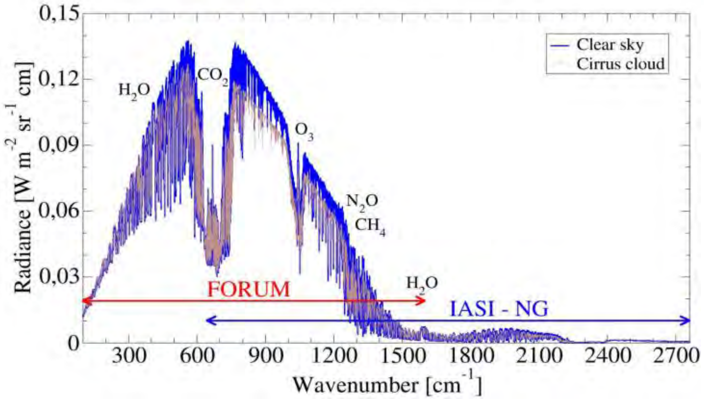
Science: Earth Explorers

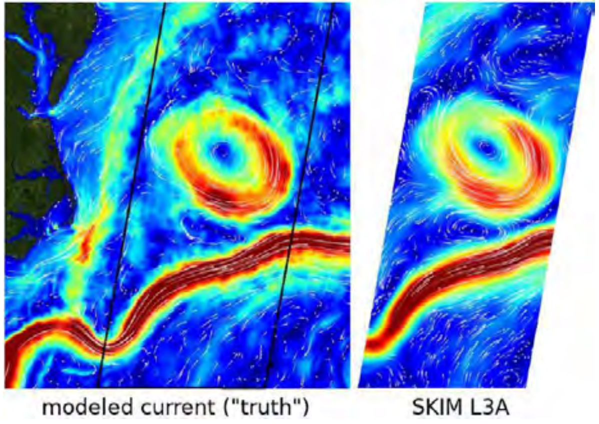


GOCE	2009 – 2013
SMOS	2009 – Present
Cryosat	2010 – Present
SWARM	2013 – Present
Aeolus	2018
EarthCARE	2019
Biomass	2021
FLEX	2022

Candidate Earth Explorer - 9

FORUM: Far-infrared-Outgoing-Radiation Understanding and Monitoring will provide the first global, spectrally resolved observations of the outgoing longwave radiation from 100 to 1600 cm^{-1} (100 – 6.25 µm) with a resolution of 0.3 cm^{-1} and 0.1 K accuracy to improve climate models.





SKIM: Sea surface KInematics Multiscale monitoring will measure total ocean surface velocity vector using a high-resolution Ka-band Doppler altimeter, measuring at nadir and rotating off-nadir beams (0, 6 and 12° incidence angles) providing accuracy on horizontal current velocity is 0.1 m/s, at a resolution of about 40 km with swath of 270Km and coverage up to 82° N.

Sentinel Launches

S-1

Radar

- A — 3 Apr. 2014
- B — 25 Apr. 2016
- C — 2022/23
- D — > 2022/23

S-2

High Resolution Optical

- A — 23 Jun. 2015
- B — 6 Mar. 2017
- C — 2022/23
- D — > 2022/23

S-3

Medium Resolution Optical & Altimetry

- A — 16 Feb. 2016
- B — 27 Apr. 2018
- C — 2023
- D — > 2023

S-4

Atmospheric Chemistry (GEO)

- A — 2021
- B — 2027

S-5P

Atmospheric Chemistry (LEO)

- A — 13 Oct. 2017

S-5

Atmospheric Chemistry (LEO)

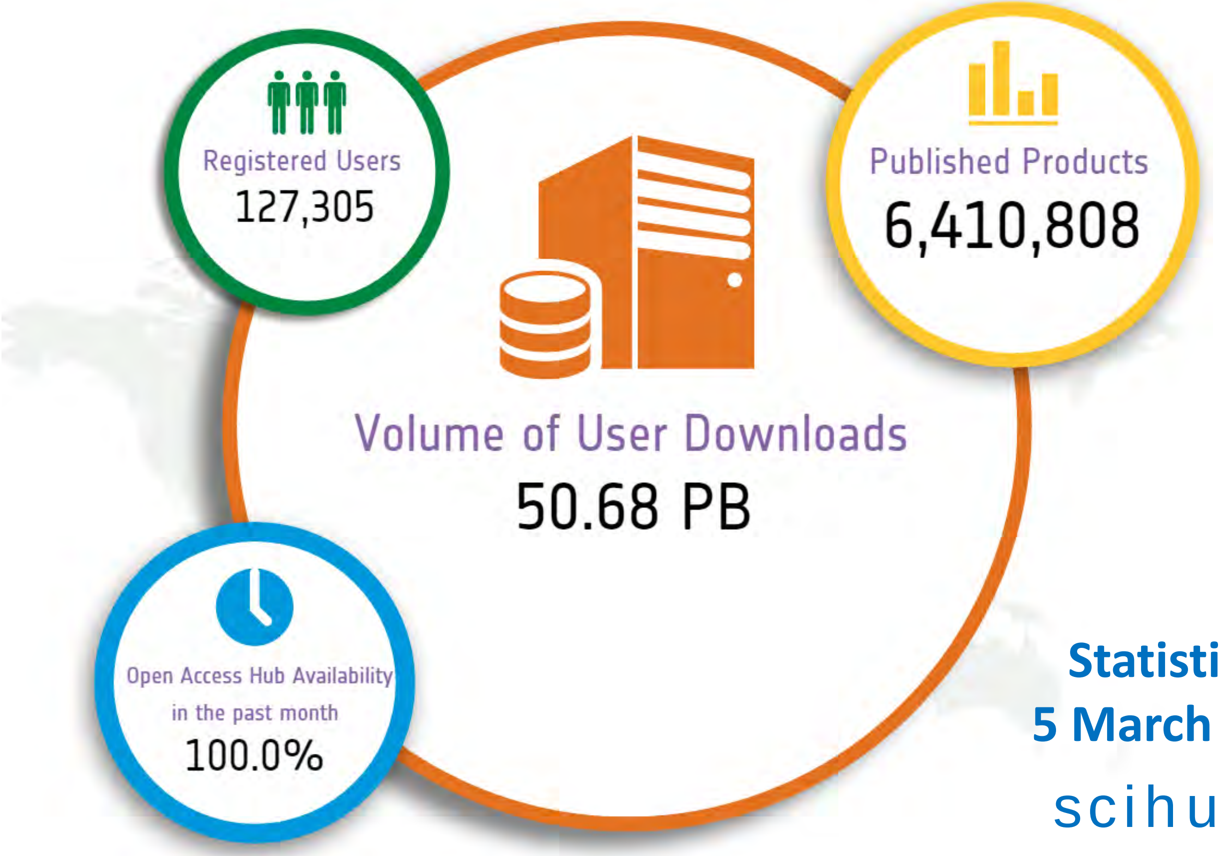
- A — 2021
- B — 2027
- C — > 2027

S-6

Altimetry

- A — 2020
- B — 2025

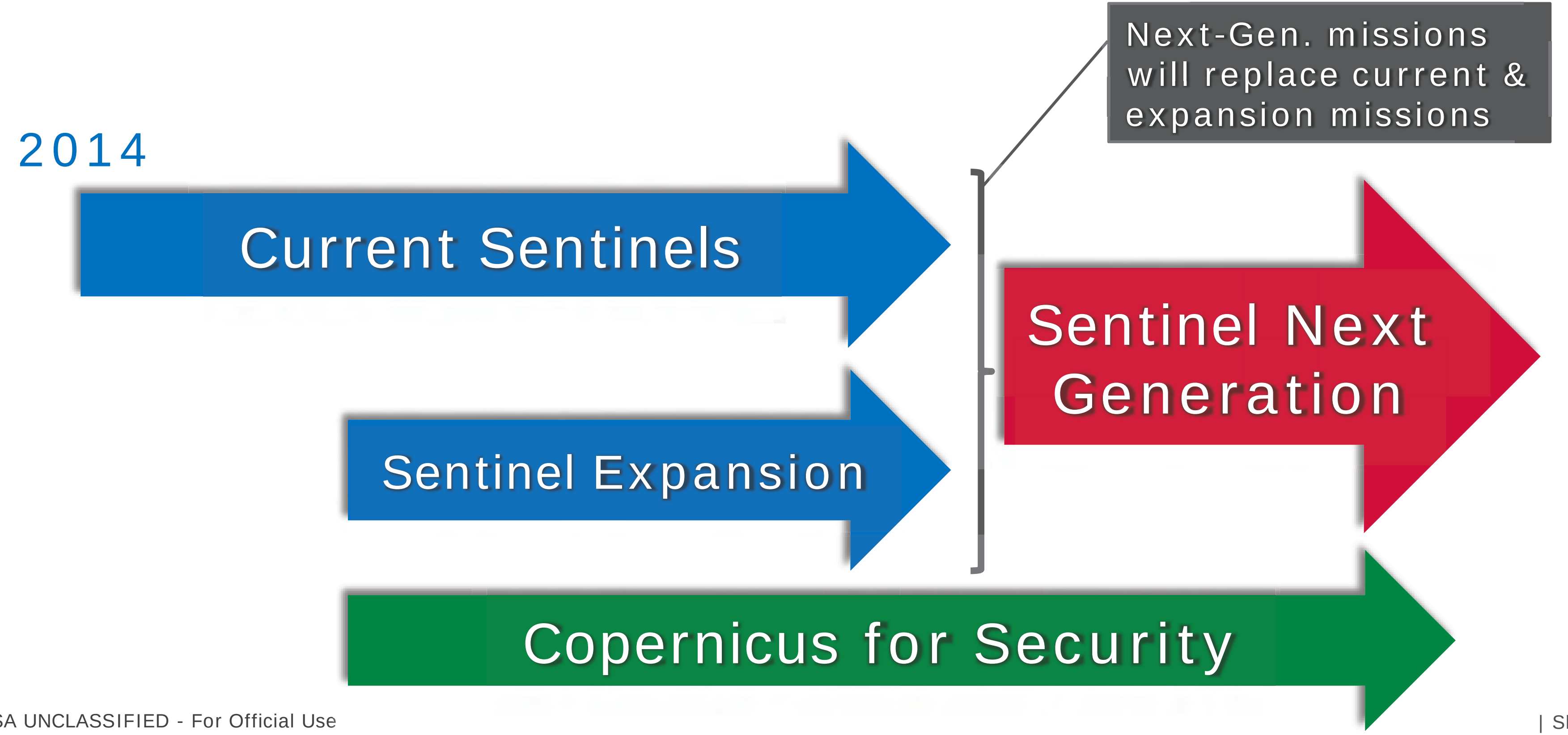
Sentinel Open Access Data Hub



Statistics on
5 March 2018

scihub.copernicus.eu

Copernicus Space Component Evolution



Sentinel Expansion – Candidate Missions

- **Anthropogenic CO2 Monitoring Mission** to analyse through the use of CO2 satellite imagers the man-made CO2 emissions and overall CO2 budget at country and regional/megacity scales.
- **Polar Ice and Snow Topographic Mission** (building on Cryosat experience) to provide enhanced land ice elevation and sea ice thickness measurements implementing higher spatial resolution for improved lead detection and additional capability to determine snow loading on sea ice
- **Passive Microwave Imaging Mission** to provide improved continuity of sea ice concentration monitoring missions, in particular in terms of spatial resolution (15 km), temporal resolution (sub-daily) and accuracy (in particular near the ice edges).
- **L band SAR Mission** responding to the of both the Land Monitoring and the Emergency Management services. Its target applications are: soil moisture, crop type discrimination, forest type/forest cover (in support to biomass estimation), food security and precision farming. In addition the mission will contribute to the monitoring of ice extent in the polar region.
- **HyperSpectral Imaging Mission** to complement Copernicus observations with an imaging spectroscopy observational capability for products, applications and services supporting the management of natural resources and related policies
- **High Spatio-Temporal Resolution Land Surface Temperature Mission** providing high spatio-temporal resolution Thermal Infrared observations over land and coastal regions

→ EO SCIENCE FOR SOCIETY

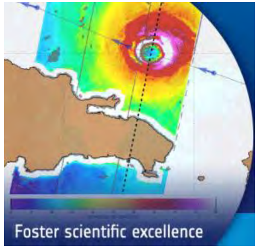
EOEP5-Block4 Industry Info Day

#EO4Society

EO Science for Society #EO4society

MAIN OBJECTIVES

- Foster scientific excellence
- Pioneer new EO applications
- Stimulate downstream industry growth
- Support international responses to global societal c
- Develop platforms technical capabilities
- Build network of resources



#EO4society – Components

Scientific Exploitation

EO Exploitation Platforms

EO for Sustainable Development

Public Sector Applications

Industry Growth New Partners

Federated Collaborative Platforms

New: Some 10% of the total budget will be assigned via open calls to support industry/users initiatives.

Opportunities – Open call

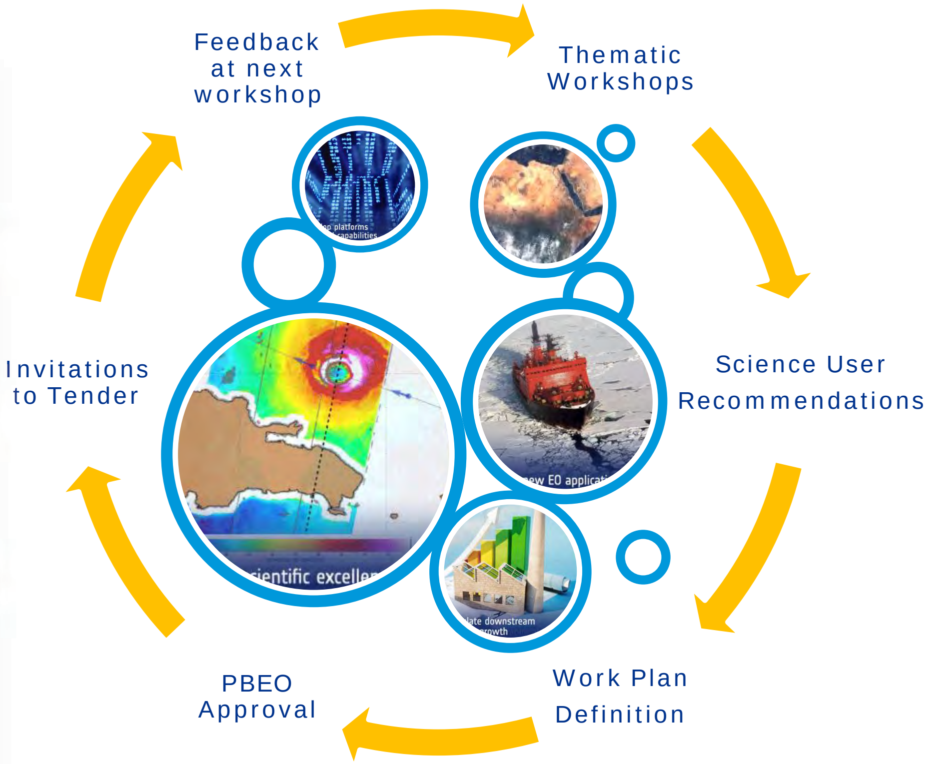
EO Science for Society Open call for proposals
EOEP-5 Block 4

- Permanently open call
- Framework to rapidly respond to new innovative ideas from bidders.
- Submission deadline for the fourth batch of proposals:

  1st September 2018
- Applications:

http://emits.sso.esa.int/

#EO4society – Consultations



esa

living planet symposium

MILAN
13–17 May
2019

UNDERSTANDING THE EARTH SYSTEM

SPACE 4.0 AND EARTH OBSERVATION

BENEFITS FOR A RESILIENT SOCIETY

PUBLIC AND PRIVATE SECTOR INTERACTIONS

Deadlines

Session Proposals
17 June 2018

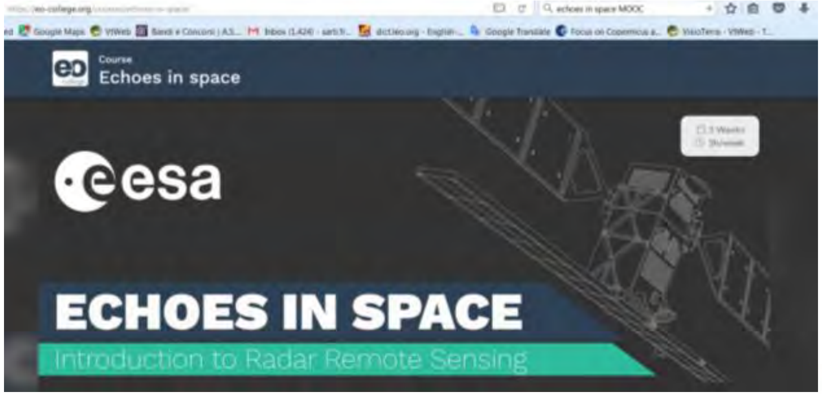
Abstracts
11 November 2018

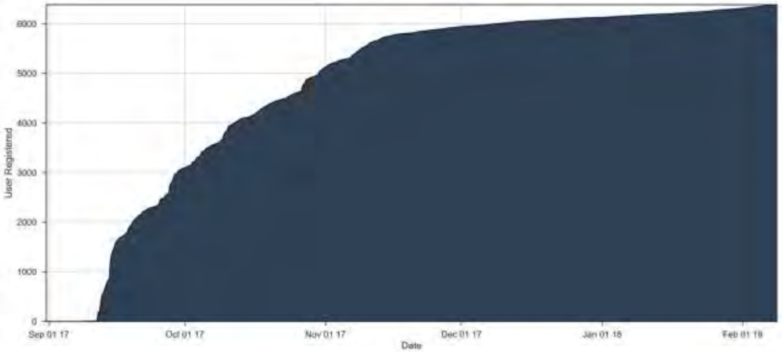
Registration
April 2019

lps19.esa.int

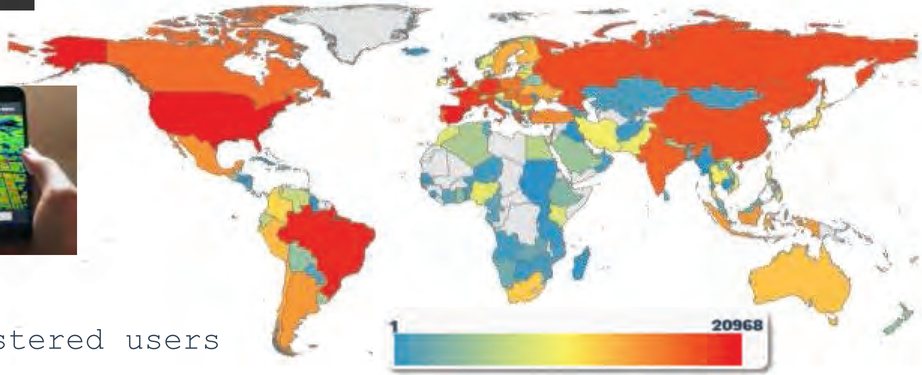
European Space Agency

1st SAR MOOC “Echoes from space: Introduction to Radar Remote Sensing”





- Next: Re-run of the SAR MOOC with CSA focused on applications in the Northern Hemisphere (Water/Ice)
- Potential/future project proposal: EO Mobile MOOC (Suitable for developing world)



September 2017

> 640.000 pageviews

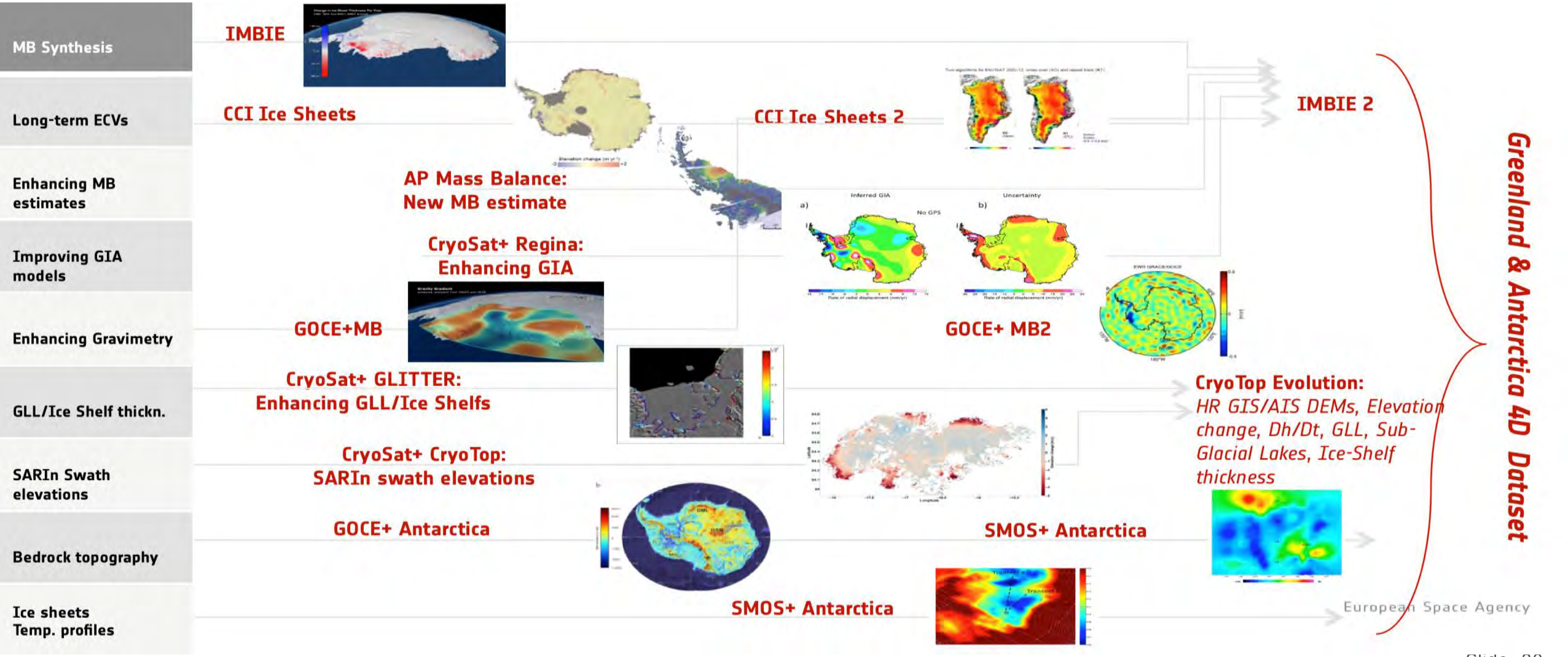
> 6.800 registered users

> 22.500 h spent on page

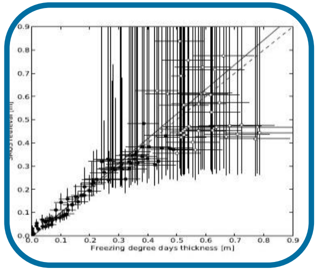
Statistics partially based on Browser language


Norsk Romsenter
NORWEGIAN SPACE CENTRE
UNIS
SIOS
esa
→ ESA CRYOSPHERE REMOTE SENSING
TRAINING COURSE 2018
11–16 June 2018
UNIS, University Centre in Svalbard | Longyearbyen, Svalbard

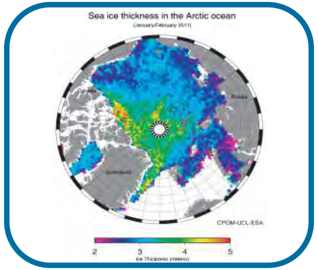
Arctic & Polar Science: Ensuring coherence



ESA EO Arctic Activities



Advancing Science



Climate Change

Novel Applications

Training & Open Tools

Data Infrastructure

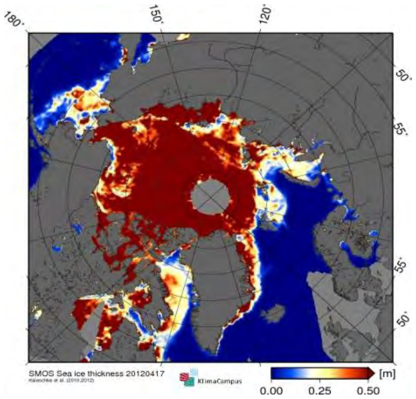
Campaigns

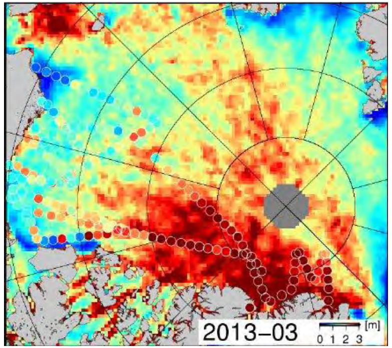
Future Missions

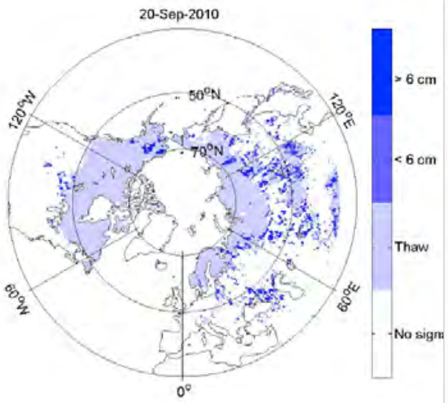
PSTG: EO Data Coordination

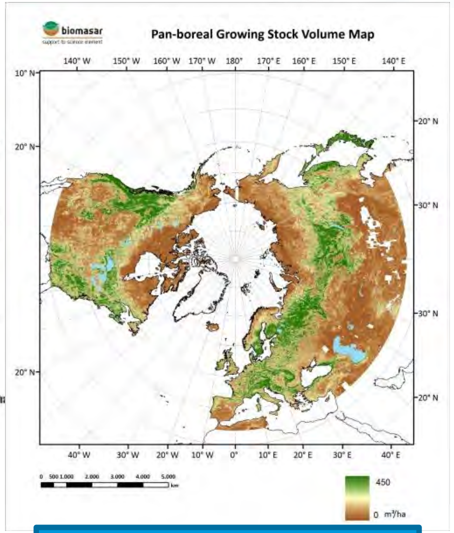
#EO4Society Results

Advancing Science: Some achievements









SMOS very thing sea ice measurements (<0.5m) complementing Cryosat measurements

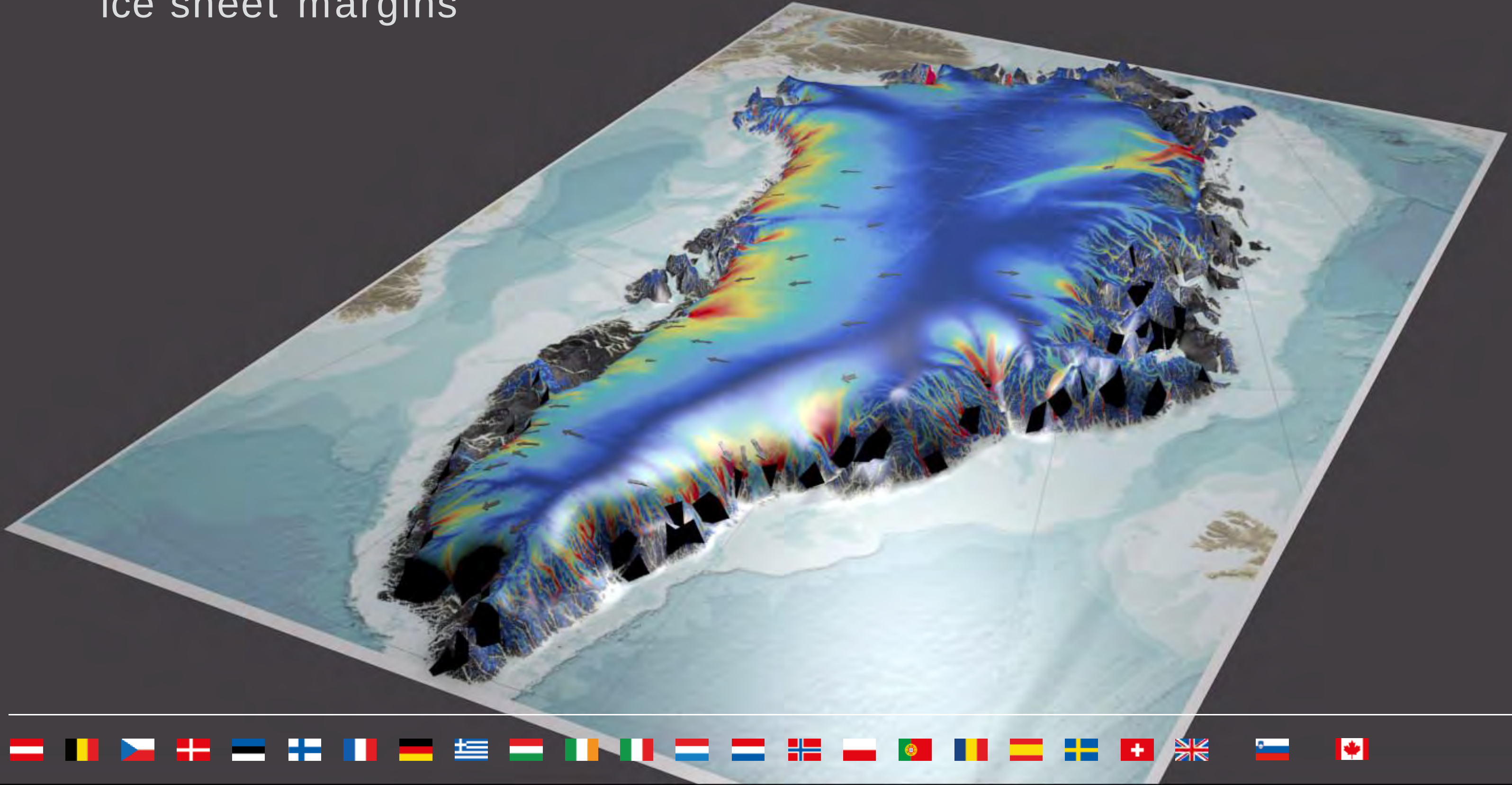
Novel merged Cryosat+SMOS product covering the full thickness range (dots are NASA Icebridge airborne measurements

Novel pan-Arctic frozen soil estimates rom SMOS

Novel pan-Arctic growing stock volume from hyper-temporal SAR (ASAR) processing

Ice Sheet Monitoring

Routine observations of
ice sheet margins



enveo

European Space Agency

CryoSat: Sea Ice Thickness & Volume

- Autumn 2010 - 2013, reduction in Arctic sea ice volume consistent with change in extent
- Replenishment in ice volume from 2013 – 2014 indicating resilience but large multi-year oscillation
- Recent decline from 2014 – 2016 with anomalously low cumulative growth in autumn 2016

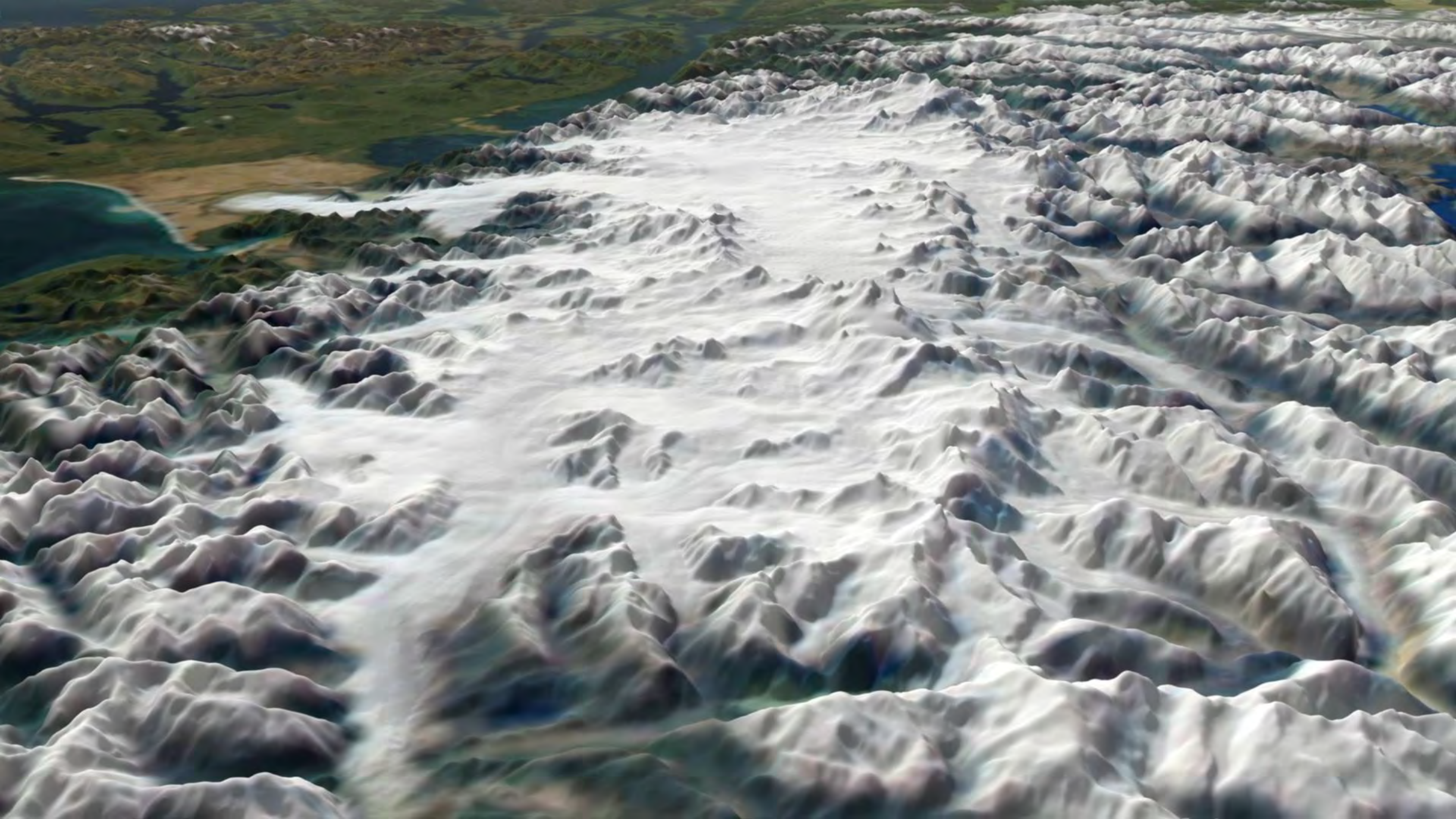
Cryosat Swath processing: High-res view on Greenland

STSE CryoTop:

First Greenland DEM at 500m pacing by exploiting the SARIN swath processing potential of CryoSat;

SARIN Swath processing technique:

- Enhance the number of elevation samples by several orders of magnitude;
- Enhance DEM resolution down to <500m;
- Allows retrieval of elevation on areas uncovered by traditional altimetry



ESA/NASA IMBIE (1992-2012)

While the rate of ice loss from Greenland has increased almost five-fold since the mid-1990s, in Antarctica the overall balance has remained fairly constant....

ESA/NASA IMBIE-2 (1992-2017)

esa

nature International weekly journal of science

ANALYSIS

https://doi.org/10.1038/s41586-018-0179-y

Mass balance of the Antarctic Ice Sheet from 1992 to 2017

The IMBIE team*

The Antarctic Ice Sheet is an important indicator of climate change and driver of sea-level rise. Here we combine satellite observations of its changing volume, flow and gravitational attraction with modelling of its surface mass balance to show that it lost 2,720 ± 1,390 billion tonnes of ice between 1992 and 2017, which corresponds to an increase in mean sea level of 7.6 ± 3.9 millimetres (errors are one standard deviation). Over this period, ocean-driven melting has caused rates of ice loss from West Antarctica to increase from 53 ± 29 billion to 159 ± 26 billion tonnes per year; ice-shelf collapse has increased the rate of ice loss from the Antarctic Peninsula from 7 ± 13 billion to 33 ± 16 billion tonnes per year. We find large variations in and among model estimates of surface mass balance and glacial isostatic adjustment for East Antarctica, with its average rate of mass gain over the period 1992–2017 (5 ± 46 billion tonnes per year) being the least certain.

The ice sheets of Antarctica hold enough water to raise global sea level by 58 m[1]. They channel ice to the oceans through a network of glaciers and ice streams[2], each with a substantial inland catchment[3]. Fluctuations in the mass of grounded ice sheets arise owing to differences between net snow accumulation at the surface, meltwater runoff and ice discharge into the ocean. In recent decades, reductions in the thickness[4] and extent[5] of floating ice shelves have disturbed inland ice flow, triggering retreat[6,7], acceleration[8,9] and drawdown[10,11] of many marine-terminating ice streams. Various techniques have been developed to measure changes in ice-sheet mass, based on satellite observations of their speed[12], volume[13] and gravitational attraction[14] combined with modelled surface mass balance (SMB)[15] and glacial isostatic adjustment (GIA; the ongoing movement of land associated with changes in ice loading)[16]. Since 1989, there have been more than 150 assessments of ice loss from Antarctica based on these approaches[17]. An inter-comparison of 12 such estimates[18] demonstrated that the three principal satellite techniques provide similar results at the continental scale and, when combined, lead to an estimated mass loss of 71 ± 53 billion tonnes of ice per year (Gt yr^{-1}) averaged over the period 1992–2011 (errors are one standard deviation unless stated otherwise). Here, we extend this assessment to include twice as many studies, doubling the overlap period and extending the record to 2017.

Satellite observations

We collated 24 independently derived estimates of ice-sheet mass balance (Fig. 1) that were determined within the period 1992–2017 and based on the techniques of satellite altimetry (seven estimates), gravimetry (15 estimates) or the input–output method (two estimates). Altogether, 24, 24 and 23 individual estimates of mass change were computed within defined geographical limits[3,19] for the East Antarctic Ice Sheet (EAIS), West Antarctic Ice Sheet (WAIS) and Antarctic Peninsula Ice Sheet (APIS), respectively. We compared the rates of ice-sheet mass change (see Methods) over common intervals of time[18]. We then averaged the rates of ice-sheet mass balance using the same class of satellite observations to produce three technique-dependent time series of mass change in each geographical region (see Methods). Within each class, we computed the uncertainty in the annual mass rate as the mean uncertainty of the individual contributions. The final, reconciled estimate of ice-sheet mass change for each region was computed as the mean of the technique-dependent values available at each epoch (Fig. 1). In computing the associated uncertainty, we assume that the errors for each technique are independent. To estimate the cumulative mass change and its uncertainty (Fig. 2), we integrated the reconciled estimates for each ice sheet and weighted the annual uncertainty by $1/\sqrt{n}$, where n is the number of years since the start of each time series. We computed Antarctic Ice Sheet (AIS) mass trends as the linear sum of the regional trends and the uncertainties in the mass trends as the root-sum-square of the regional uncertainties (Table 1).

Trends in Antarctic ice-sheet mass

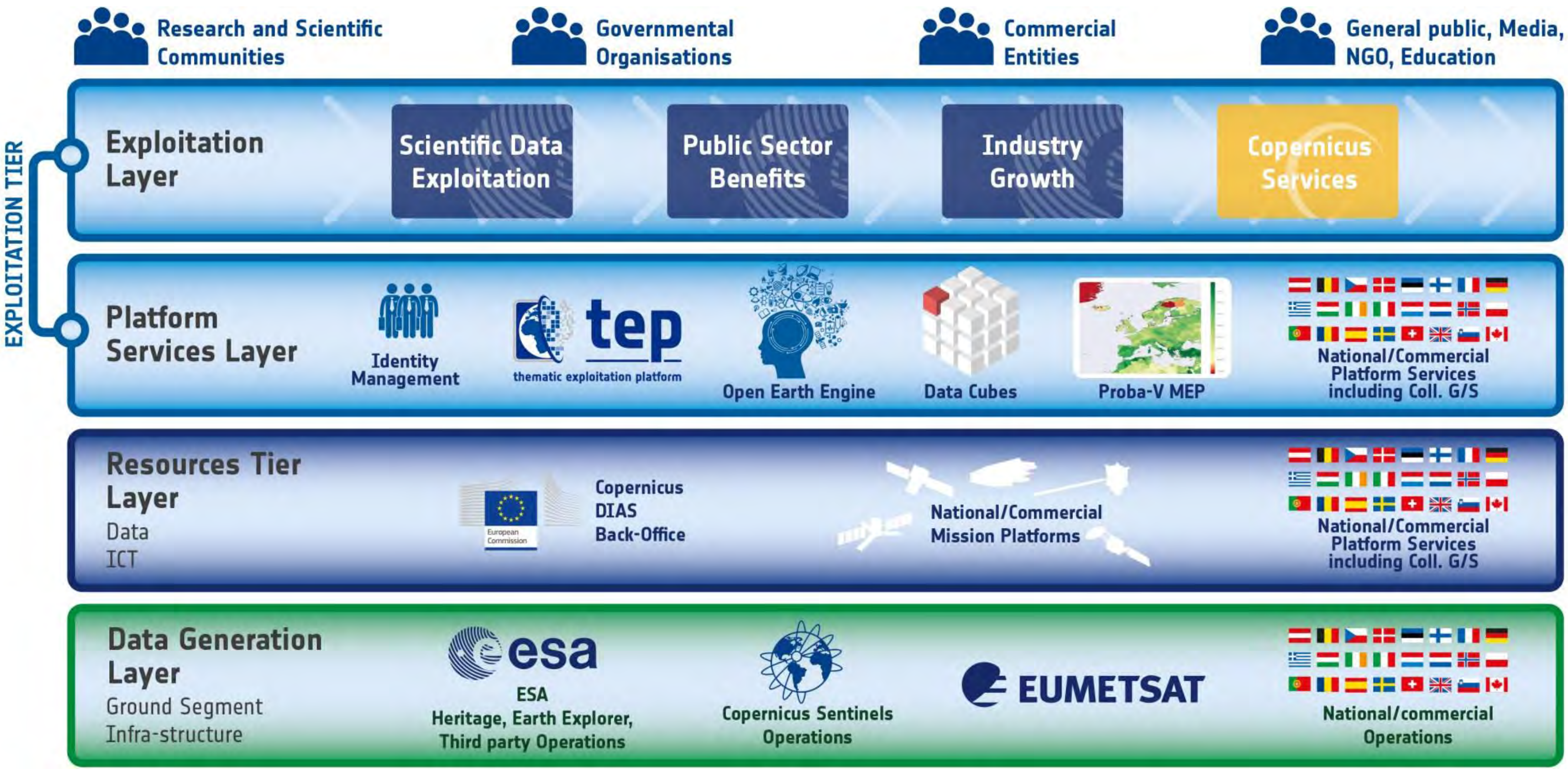
The level of disagreement between individual estimates of ice-sheet mass balance increases with the area of each ice-sheet region, with average per-epoch standard deviations of 11 Gt yr^{-1}, 21 Gt yr^{-1} and 37 Gt yr^{-1} at the APIS, the WAIS and the EAIS, respectively (Fig. 1, Methods). Among the techniques, gravimetric estimates are the most abundant and also the most closely aligned, although their spread increases in East Antarctica, where GIA remains poorly constrained[20] and is least certain when spatially integrated[21–32], owing to the vast extent of the region. Solutions based on satellite altimetry and the input–output method run for the entire record, roughly twice the duration of the gravimetry time series. Although most (59%) estimates are within one standard deviation of the technique-dependent mean, a few (6%) depart by more than three standard deviations. At the Antarctic Peninsula, the 25-year average rate of ice-sheet mass balance is −20 ± 15 Gt yr^{-1}, with an increase of about 15 Gt yr^{-1} in losses since 2000. The strongest signal and trend has occurred in West Antarctica, where rates of mass loss increased from 53 ± 29 Gt yr^{-1} to 159 ± 26 Gt yr^{-1} between the first and final five years of our survey; the largest increase occurred during the late 2000s when ice discharge from the Amundsen Sea sector accelerated[33]. Both of these regional losses are driven by reductions in the thickness and extent of floating ice shelves, which has triggered the retreat, acceleration and drawdown of marine-terminating glaciers[34]. The least certain result is in East Antarctica, where the average 25-year mass trend is 5 ± 46 Gt yr^{-1}. Overall, the AIS lost 2,720 ± 1,390 Gt of ice between 1992 and 2017, an average rate of 109 ± 56 Gt yr^{-1}.

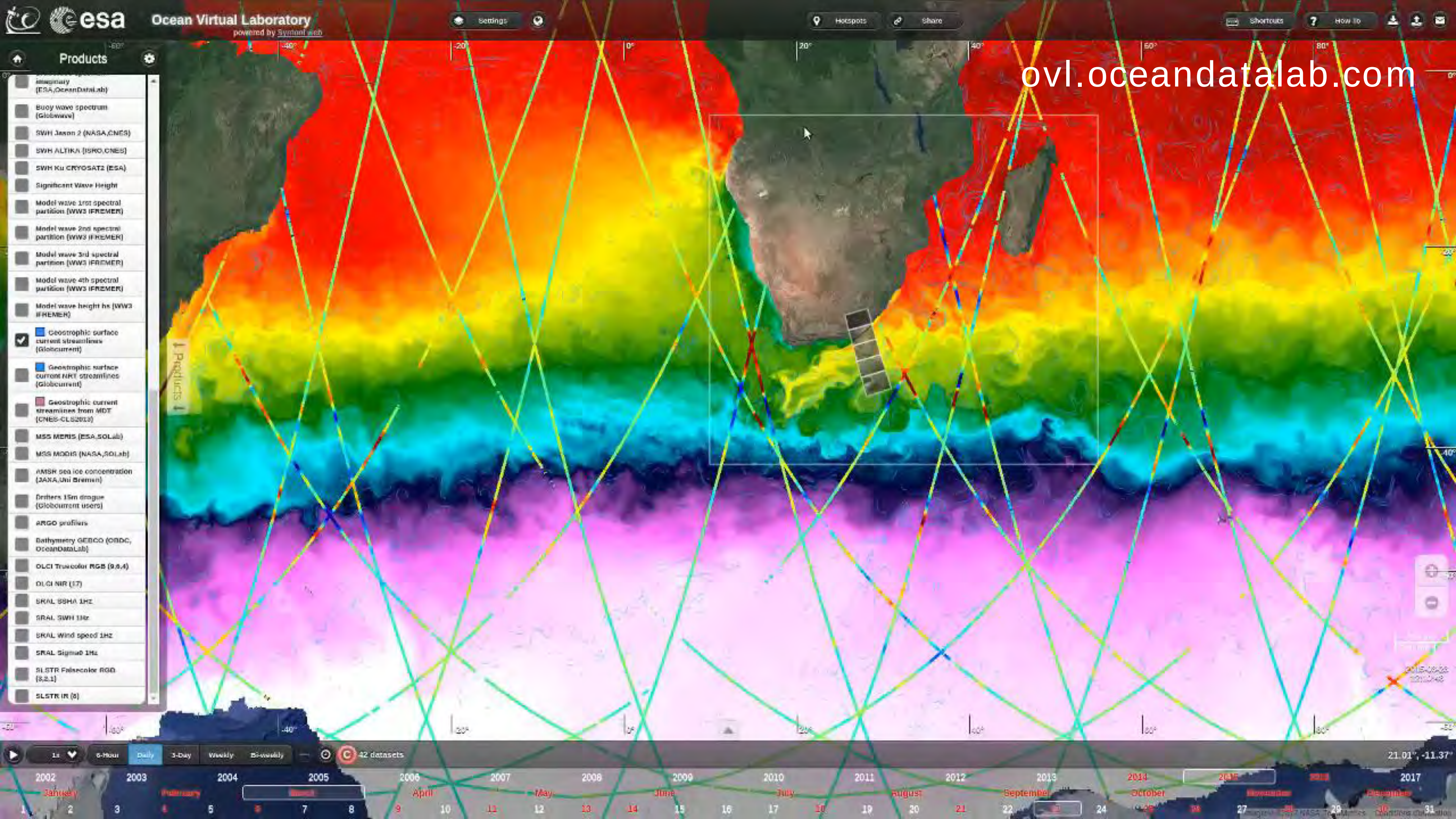
*A list of authors and their affiliations appears at the end of the paper.

- A new assessment has been completed over Antarctica covering the period 1992-**2017…**
- 87 scientists has contributed to the exercise
- For the first time Cryosat-2 and Sentinel-1 data are included in the assessment;
- **The teams have been supported by ESA's** Climate Change Initiative and the Scientific Exploitation element of the EOEP
- Results will be published by Nature the next 14th June.

#EO Exploitation Platforms

The EO Ecosystem:




esa
Ocean Virtual Laboratory
powered by Syntool web
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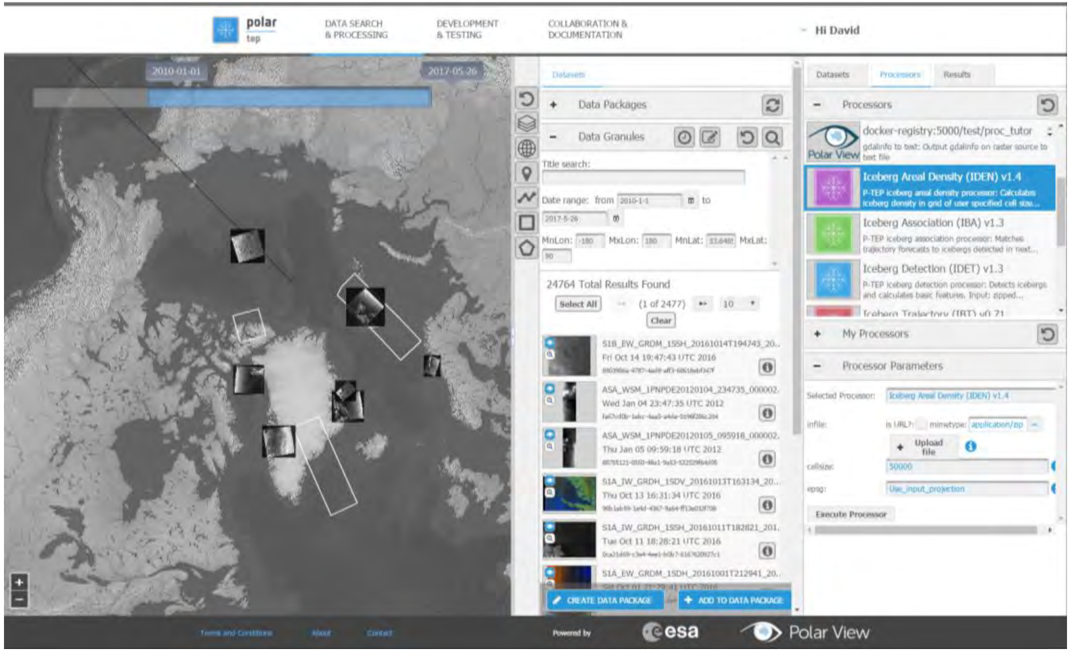
Hotspots
Share
Shortcuts
How to
ovl.oceandatalab.com
Products
Buoy wave spectrum (Globwave)
SWH Jason 2 (NASA,CNES)
SWH ALTIKA (ISRO,CNES)
SWH Ku CRYOSAT2 (ESA)
Significant Wave Height
Model wave 1rst spectral partition (WW3 IFREMER)
Model wave 2nd spectral partition (WW3 IFREMER)
Model wave 3rd spectral partition (WW3 IFREMER)
Model wave 4th spectral partition (WW3 IFREMER)
Model wave height hs (WW3 IFREMER)
Geostrophic surface current streamlines (Globcurrent)
Geostrophic surface current NRT streamlines (Globcurrent)
Geostrophic current streamlines from MDT (CNES-CLS2013)
MSS MERIS (ESA,SOLab)
MSS MODIS (NASA,SOLab)
AMSR sea ice concentration (JAXA,Uni Bremen)
Drifters 15m drogue (Globcurrent users)
ARGO profilers
Bathymetry GEBCO (OBDC, OceanDataLab)
OLCI Truecolor RGB (8,6,4)
OLCI NIR (17)
SRAL SSHA 1Hz
SRAL SWH 1Hz
SRAL Wind speed 1Hz
SRAL Sigma0 1Hz
SLSTR Falsecolor RGB (3,2,1)
SLSTR IR (8)
6-Hour
Daily
3-Day
Weekly
Bi-weekly
42 datasets
21.01°, -11.37°
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
January February March April May June July August September October November December

Polar TEP Overview

- Create a a virtual research platform for Polar communities
- Provide polar-relevant data, tools, and processing in the cloud
- Bring users' algorithms to the data
- To be governed by a Board representing the operational and scientific communities
- Collaborate with various user groups and data providers



https://portal.polar-tep.eo.esa.int/

#EO4Society Outlook

EO for SDGs

2030 Agenda for Sustainable Development: 17 goals, 169 targets, 230 Indicators

New norms to integrate the principles of sustainable development into country policies and programs

EO importance for the SDG’s

Earth Observations potential contribution to the SDG Targets and Indicators

SDGs with most opportunities for EO data and services

Analysis performed by the GEO EO4SDGs initiative

Target *Contribute to progress on the Target yet not the Indicator per se*								***Goal***	***Indicator*** *Direct measure or indirect support*				
							1.5	1					
					2.3	2.4	2.c	2	2.4.1				
				3.3	3.4	3.9	3.d	3	3.9.1				
								4					
								5	5.9.1				
		6.3	6.4	6.5	6.6	6.a	6.b	6	6.3.2	6.4.2	6.5.1	6.6.1	
				7.2	7.3	7.a	7.b	7	7.1.1				
							8.4	8					
				9.1	9.4	9.5	9.a	9	9.1.1				
								10					
	11.3	11.4	11.5	11.6	11.7	11.b	11.c	11	11.3.1	11.6.2	11.7.1		
					12.2	12.a	12.b	12					
					13.1	13.3	13.b	13	13.1.1				
	14.1	14.2	14.3	14.4	14.6	14.7	14.a	14	14.3.1				
15.1	15.2	15.3	15.4	15.5	15.7	15.8	15.9	15	15.1.1	15.2.1	15.3.1	15.4.1	15.4.2
								16					
			17.6	17.7	17.9	17.16	17.17	17					

WHAT: European Press News Survey the Last Few Months

LE FIGARO PREMIUM
économie

Économie › Conjoncture

Le réchauffement climatique inquiète déjà les professionnels de l'immobilier

Par Jean-Bernard Litzler | Publié le 27/10/2017 à 09:00

La station balnéaire de Soulac-sur-Mer (Gironde) témoigne du recul des côtes aquitaines. Des immeubles situés à 200 mètres du rivage il y a 50 ans ne sont plus qu'à quelques mètres de l'Océan, menaçant parfois de s'effondrer. *Bonnaud Guillaume/MAXPPP*

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Science & Environment

Climate change has shifted the timing of European floods

By Matt McGrath
Environment correspondent

10 August 2017 | Science & Environment | Share

The Telegraph

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News

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News

21 Oct 2017

Storm Brian: UK lashed by gale force winds, in pictures

3 of 13 | View All | share

Irish Examiner

An inconvenient truth: Warning of more extreme weather as climate change effects hit home

Thursday, August 24, 2017

Caroline O'Doherty and Stephen Maguire

The country will have to brace itself for more extreme weather events as the effects of climate change hit home with potentially devastating effects on property and infrastructure.

INDEPENDENT

News | InFact | Politics | Voices

Environment

Extreme weather could kill 150,000 people each year in Europe by the end of the century, say scientists

Hundreds of millions of people will be exposed to deadly weather events by 2100, researchers warn

Andrew Griffin Science Reporter | @_andrew_griffin | Friday 4 August 2017 22:30 BST | 331 comments

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Global risks and trends

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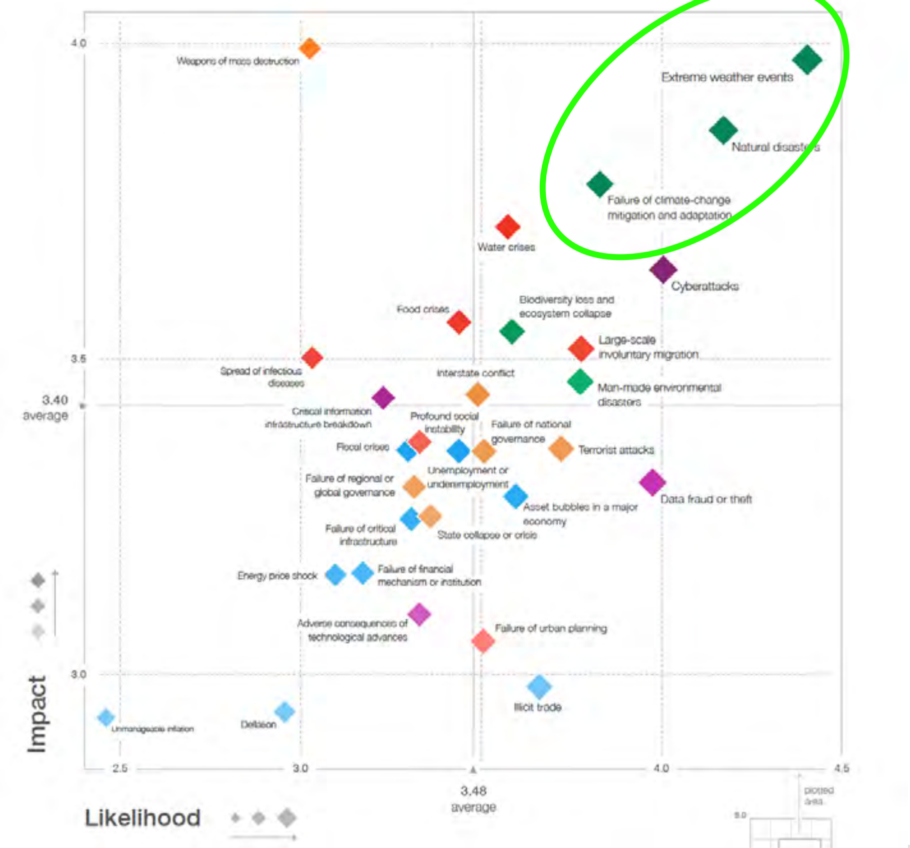
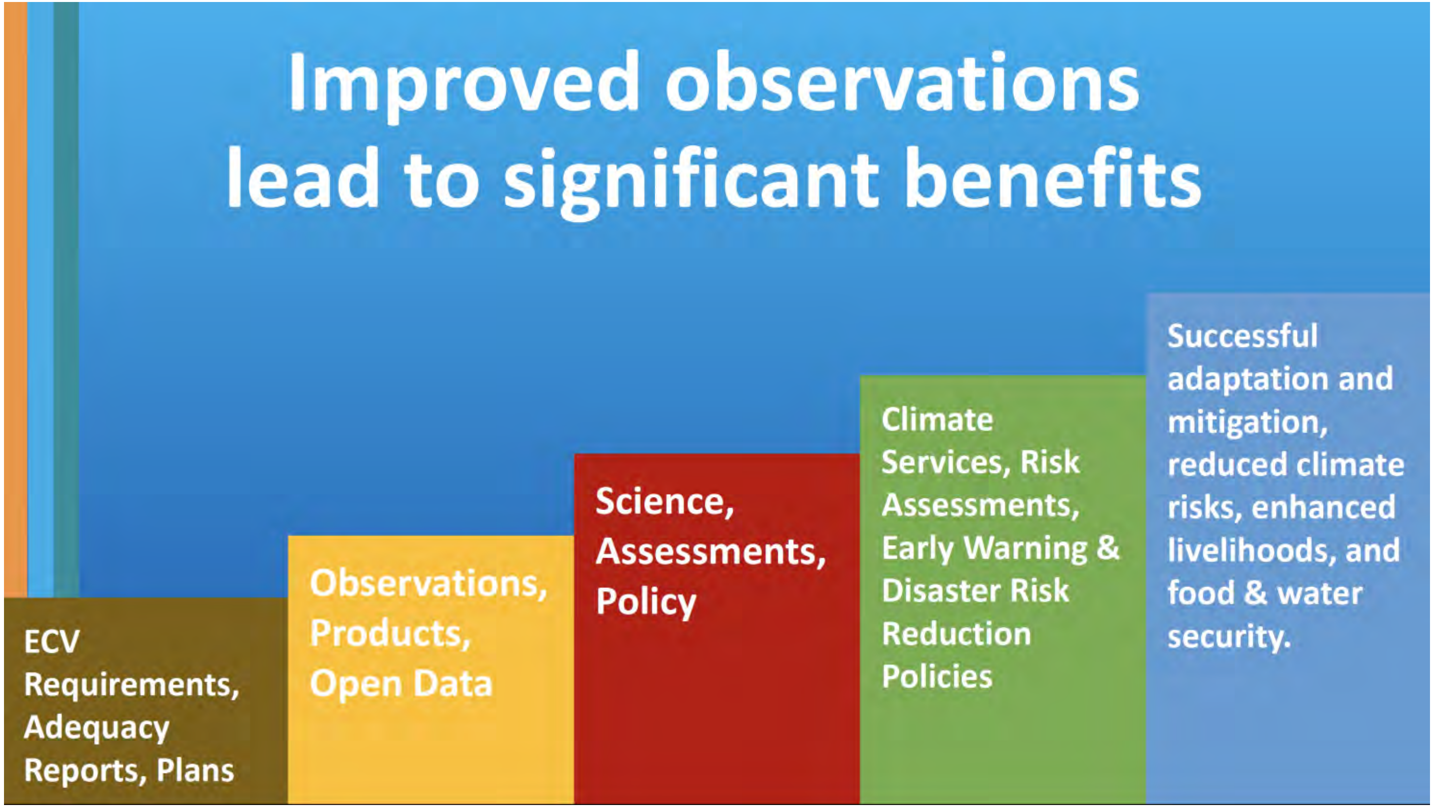
(https://www.weforum.org/reports/the-global-risks-report-2018)



- Extreme Weather,
- Natural Disasters
- Failure of climate change adaptation and mitigation

GCOS and satellite data in climate adaptation and risk management (by S. Briggs GCOS S.C. chair)



EO Supporting Global Policies

Sustainable Development

UN SDGs

Measuring Status & Progress

Climate Action

Paris Agreement

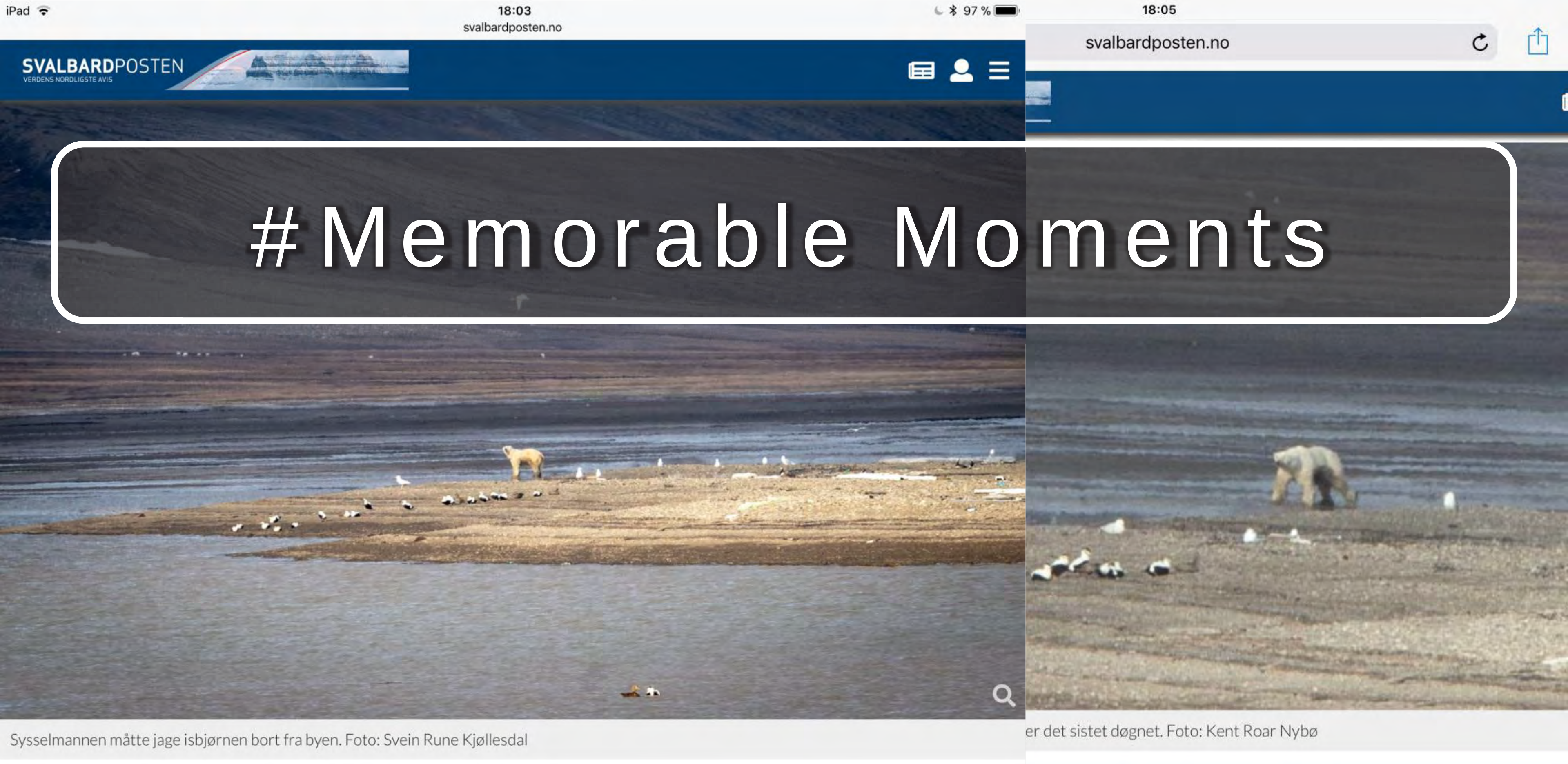
Monitoring & Understanding

Adaptation & Disaster Risk Reduction

Sendai Framework

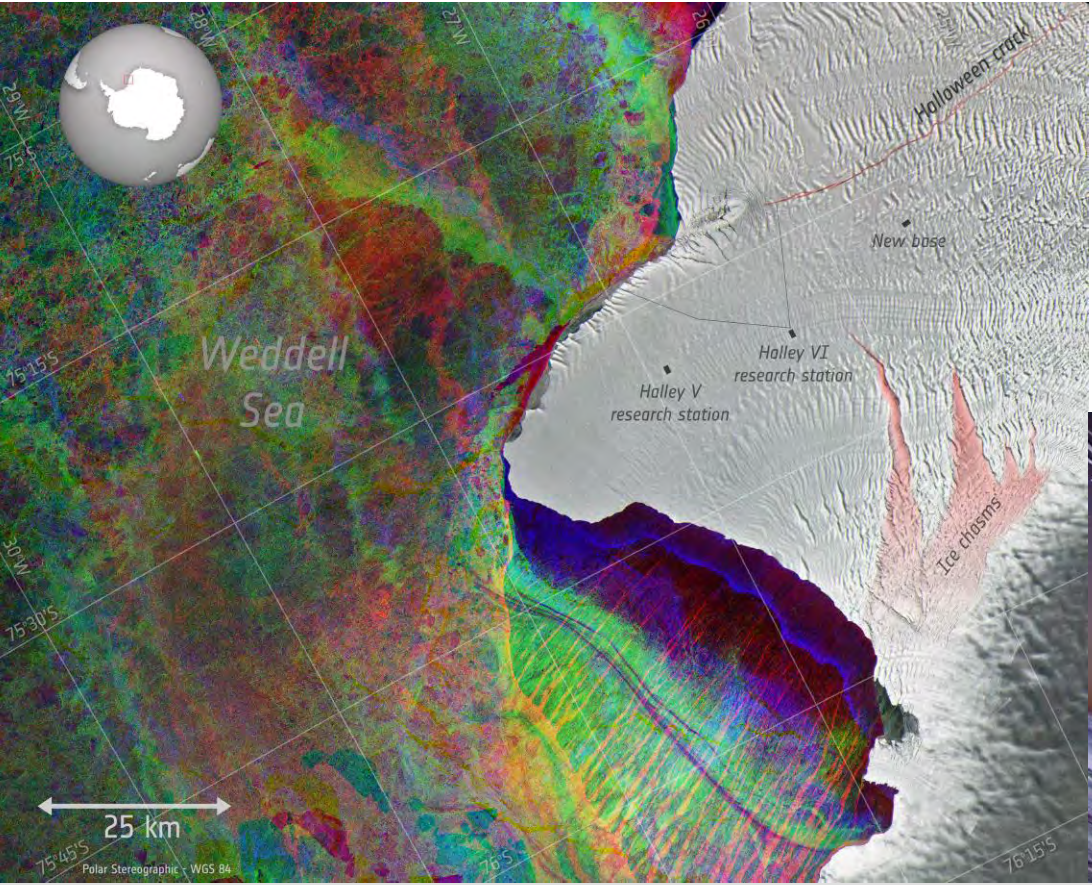
Supporting Resilient Infrastructure

Svalbard News Survey.... the Last Days



#Memorable Moments

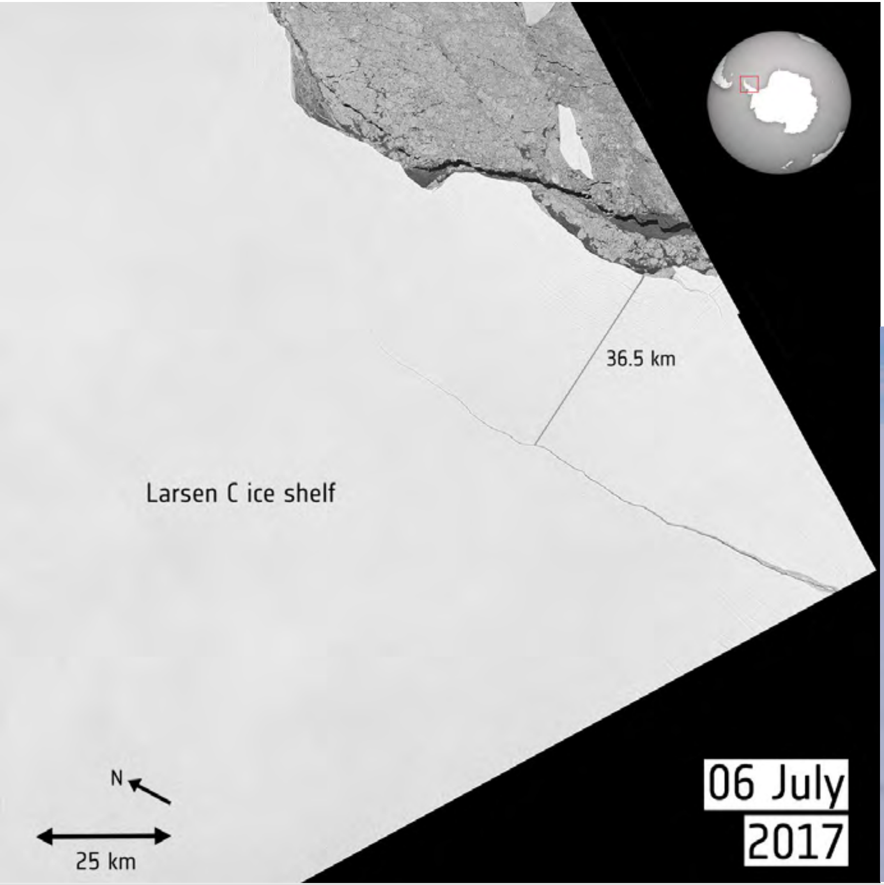
Recent memorable EO moments



The British Antarctic Survey's Halley Research Station was moved due to the progressing Halloween crack (discovered on 31 October 2016) on the Brunt Ice Shelf.

Crack clearly visible in SAR imagery.
Both Sentinel-1 and -2 data were used in the decision making process of the move.

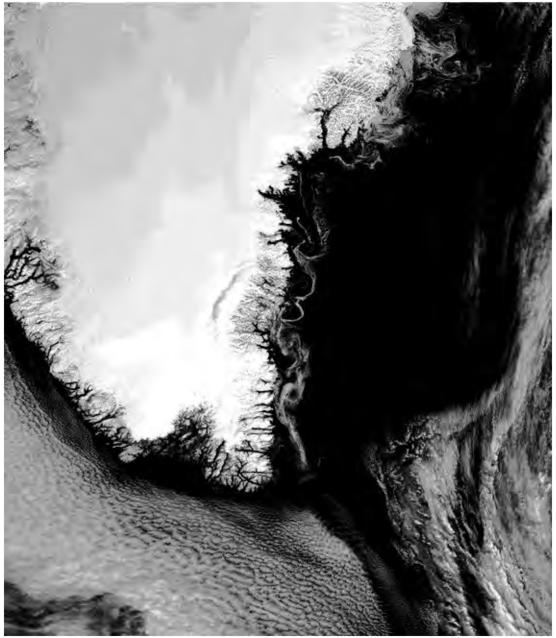
Recent memorable EO moments

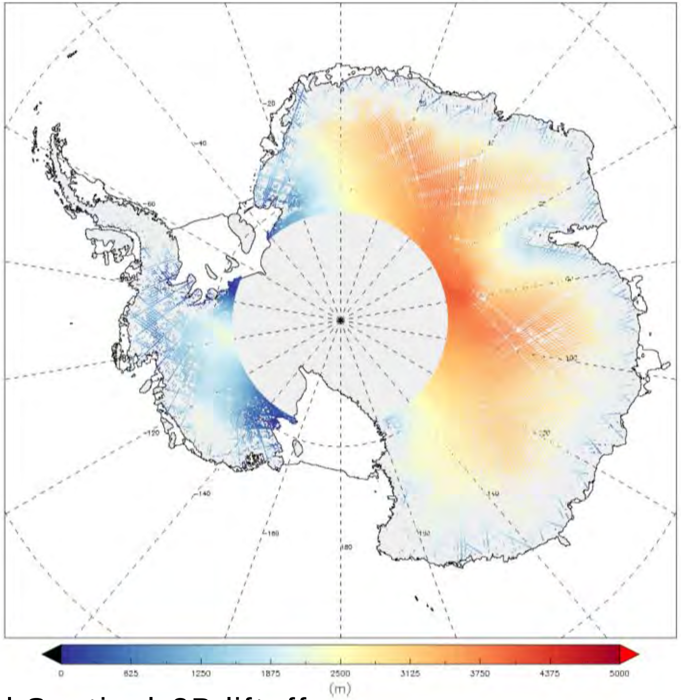


The rift in the Larsen C ice shelf in Antarctica began to lengthen drastically from January to July 2017.

On 12 July, Sentinel-1 captured one of the largest icebergs on record (iceberg A68) calving off the ice shelf.

Recent memorable EO moments





In April 2018 we had the successful Sentinel-3B liftoff.

OLCI for monitoring ice albedo.
SRAL for monitoring sea ice thickness and ice sheet topography.

Recently launched and upcoming NASA missions

GRACE-FO

GRACE Follow-On mission launched in May 2018

ICESat-2

Will carry a single sensor:

- Advanced Topographic Laser Altimeter System (ATLAS)
- Current launch date September 2018

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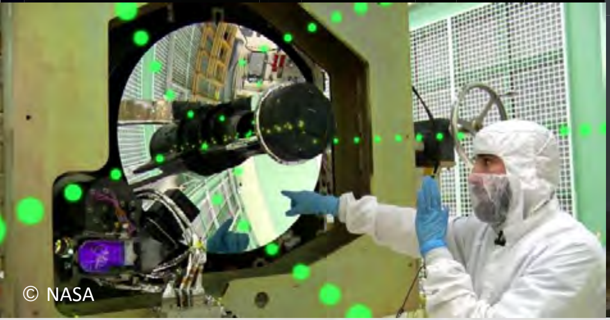

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Wish you a good week in Svalbard
Thank you for your attention!
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