Challenges and Activity in the Polar Regions:

Technology, Measurement and Information

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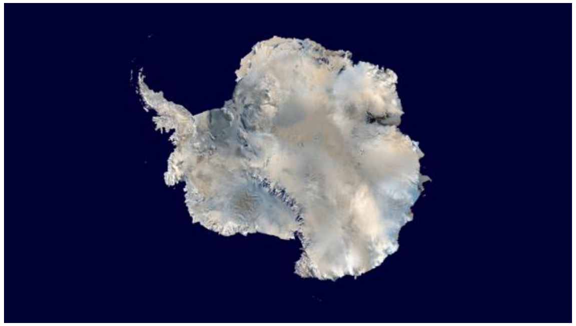
IEEE Technical Activities Board 2017 Ad-hoc Committee

Contribution to Side Event:
Vision for the WMO Global Observing System in 2040

INSIGHT FOR A CHANGING WORLD
GEO WEEK 2017
23-27 OCTOBER 2017

Polar Caps



Size of Polar Arctic

The area can be defined as North of the Arctic Circle (66° 33'N)

Areas defined by:

- geology and geography,

- weather and climate,

- population, culture, and history

- resources.

Size of Polar Antarctica

Including all the islands and ice shelves, Antarctica is nearly twice the size of Australia, covering 13,661,000 km².

North and South Poles are Experiencing Strong Changes

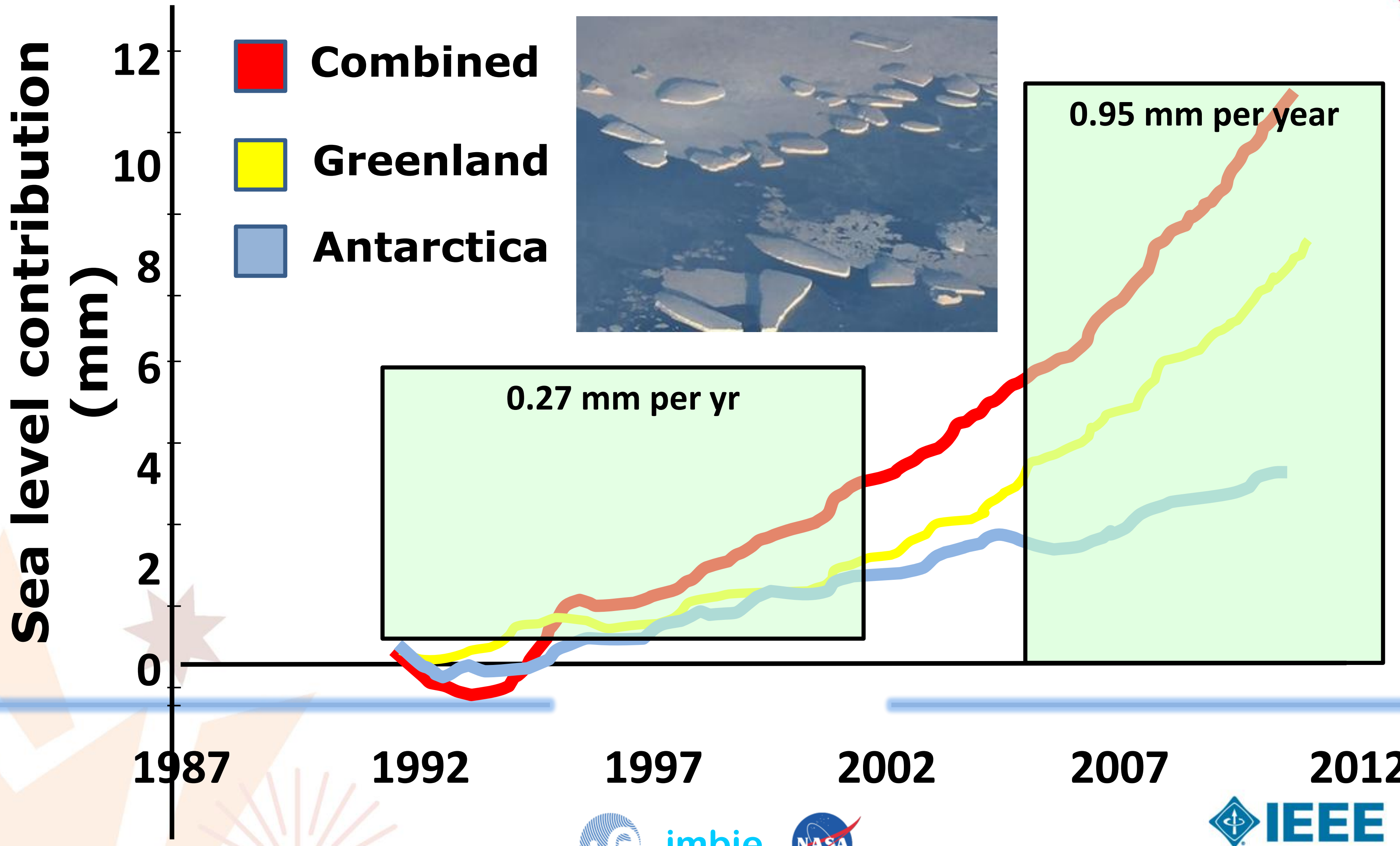
NASA

- ***Arctic ice coverage declining at substantial rate in the past 37 years.***
- ***Antarctic sea ice coverage increasing, but not compensated Arctic decrease.***
- ***For 2016, sea ice extent in both polar regions was well below typical values of the past several decades.***

Larsen Ice Sheet Collapse 12 July 2017

Lauren C. Tierney, NG Staff. Sources: Project MIDAS; Jeremie Mouginot, Bernd Scheuchl, and Eric Rignot, UC Irvine and Nasa Cryospheric Sciences Program and MEaSURes; British Antarctic Survey; NASA LIMA

Increased Ice Sheet Mass Losses and Sea Level Rise



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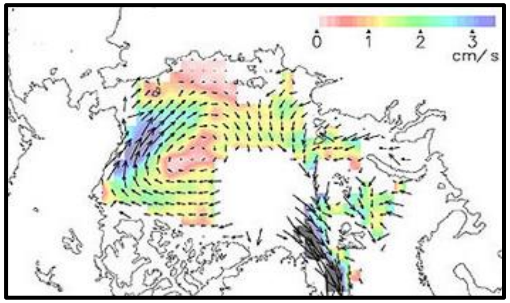
Polar Caps -Sea Ice Surrounds

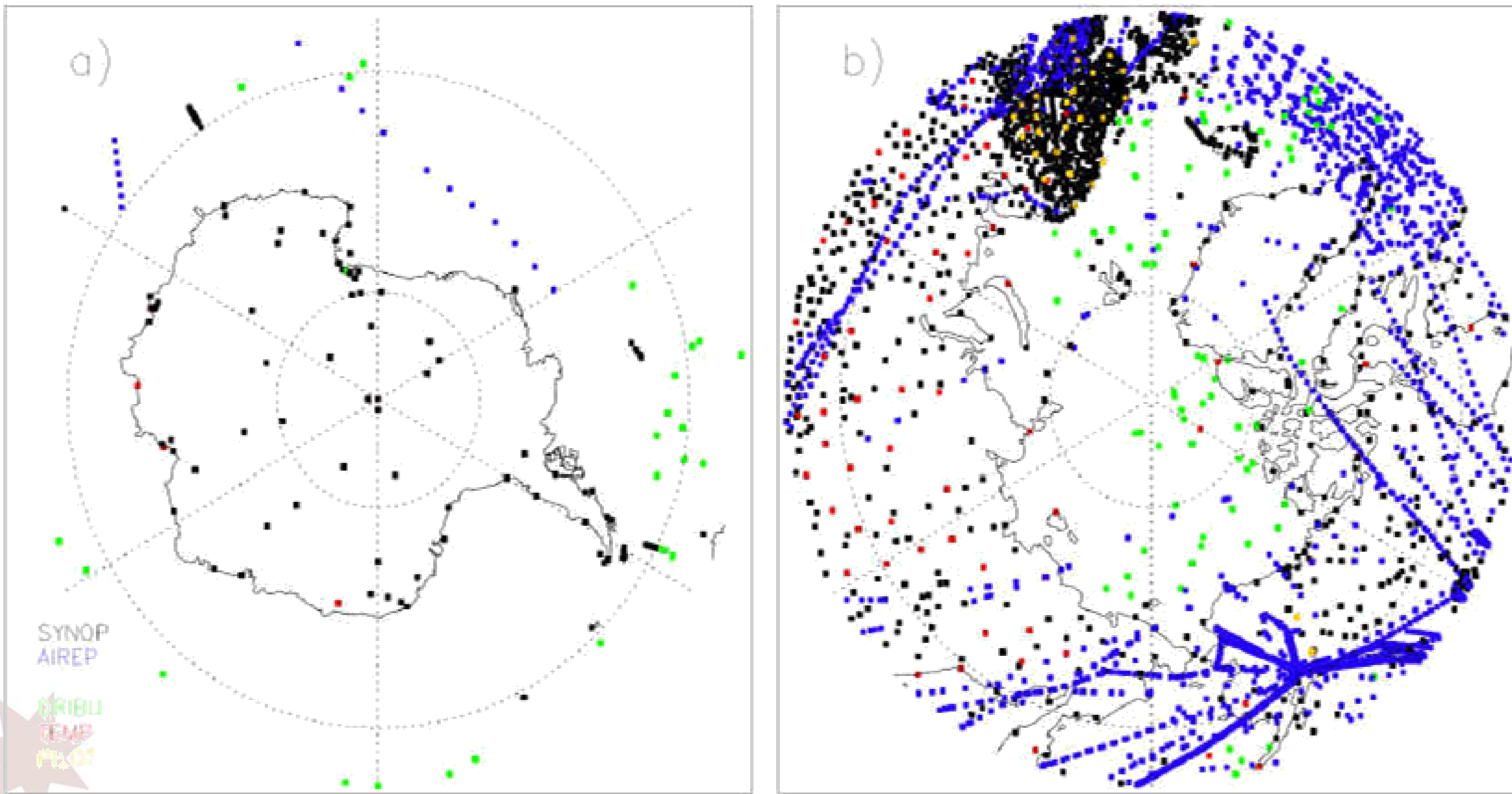
Variable	Requirement
Sea ice thickness	25 km horizontal resolution 24 h revisit time 10 cm accuracy*
Sea ice type	10 km horizontal resolution 3 h revisit time 0.25 / Classes*
Sea ice cover	12 km horizontal resolution 3 h revisit time 5% accuracy**
Sea ice surface temperature	5 km horizontal resolution 3 h revisit time 0.1 K accuracy**
Sea ice motion	25 km horizontal resolution 3 h revisit time 1 km / day*
Ocean imagery and water leaving radiance	4 km horizontal resolution, 24 h revisit time*



Future EU Copernicus Polar mission?

Gaps in the Observing Systems



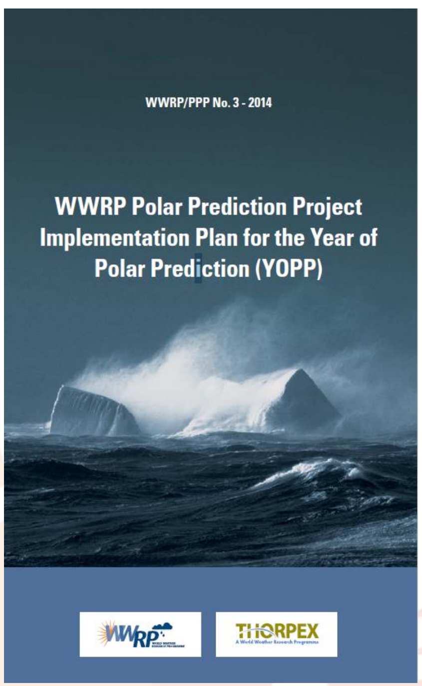
Synop, AIREP, DRIBU, TEMP and PILOT

P. Bauer (ECMWF)

Polar data coverage of conventional observations in the ECMWF operational analysis on a particular winter day

Gaps to be filled - Observation and Modelling, Services

YOPP
YEAR OF POLAR PREDICTION



WMO 2016 Executive Council Decision on YOPP

- ***Increasing the frequency of routine synoptic and radiosonde observations;***
- ***Provide logistical support to planned field campaign activities;***
- ***Promote possible additional observations;***
- ***Provide access to remote-sensing observations over and near the Polar Regions***;

Promote cooperative international research enabling development of improved weather and environmental prediction services for the polar regions, on time scales from hourly to seasonal

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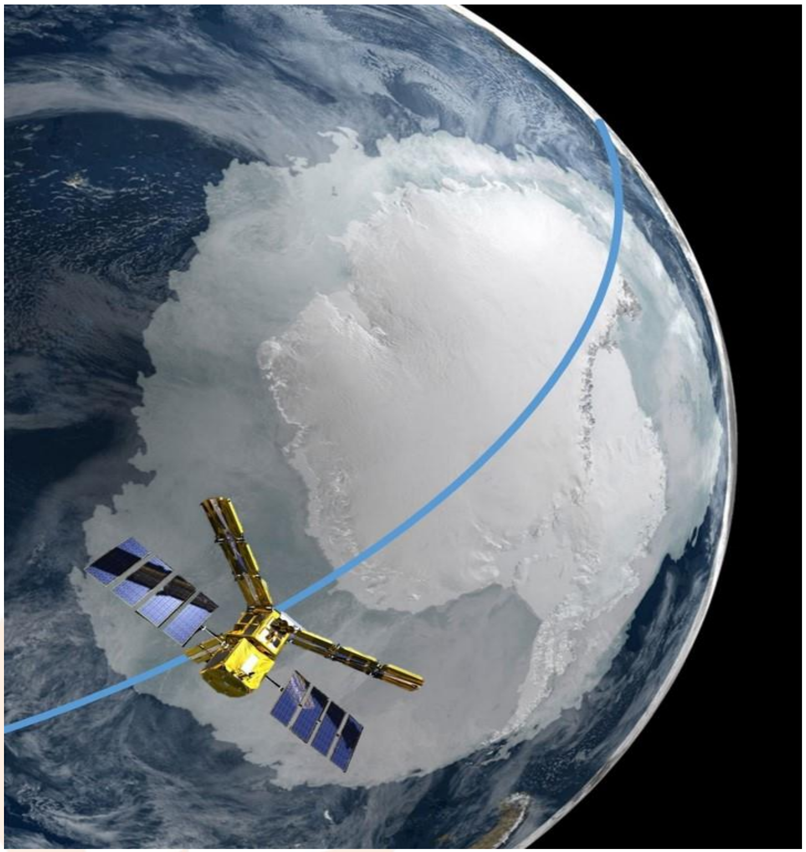
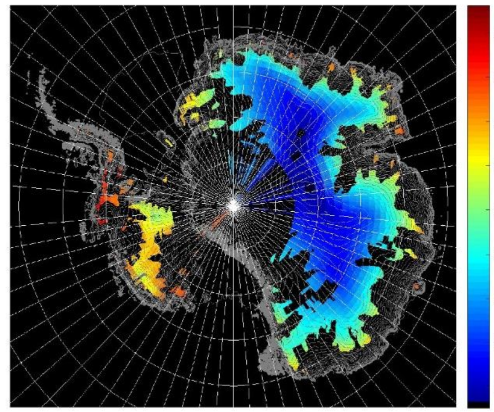
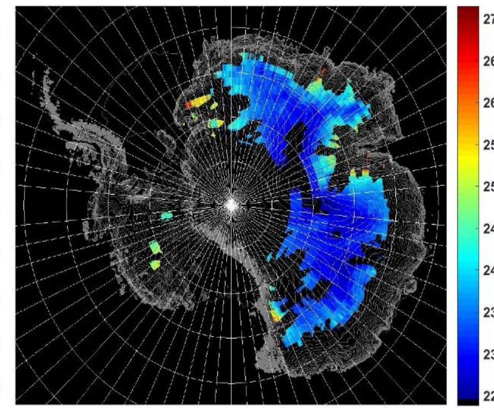
Cryo-SMOS - Estimation of Internal Ice-sheet Temperatures



Surface Tb



1000m Tb



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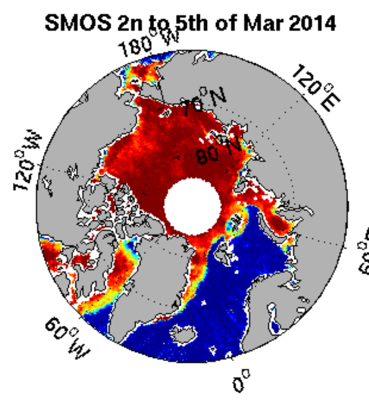
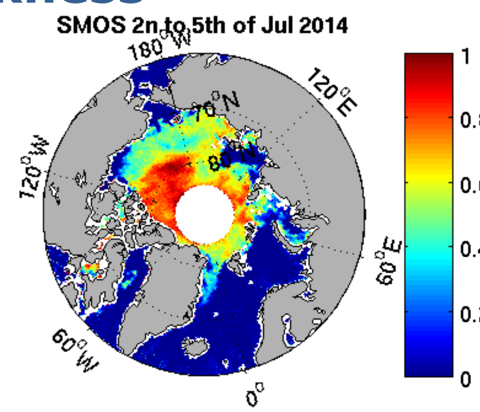
Ice thickness



Ice concentration



Ice concentration

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IEEE in the North and South Poles (INSP) Ad Hoc committee composition

INSP encompasses many different societies:

- *IEEE Education Society*
- *IEEE Society on Social Implications of Technology*
- *IEEE Aerospace and Electronic Systems Society*
- *IEEE Geoscience and Remote Sensing Society - A. Camps (chair)*
- *IEEE Intelligent Transportation Systems Society*
- *IEEE Oceanic Engineering Society – M. Heron (co-chair)*
- *IEEE Vehicular Technology Society*
- *IEEE Power and Energy Society*
- *IEEE Sensors Council*
- *IEEE Nanotechnology Councils*.

IEEE in the North and South Poles (INSP) Current Drivers

1. ***New in-situ and remote sensors** or networks of sensors,*
2. ***Communications** and data from EO sensors for processing and application,*
3. ***communication and **Transportation** issues of local communities,***
4. ***Climate change and ecological issues** associated to an increased human presence in a, so far, pristine environment, and*
5. ***Education and research** on the changes that these regions are undergoing and associated engineering challenges.*

New sensors

Communications

Transport

Ecological issues

Education

IEEE in the North and South Poles (INSP) Current Initiatives

InuCube for polar monitoring

Young Professional in Space - CanSat bootcamp

GRSS Student Grand Challenge: drone-based EO & App

IEEE DataPort - Bringing Polar datasets to a common interrogation server

IEEE ACCESS Special Section on IEEE in the North and South Poles

- www.ypinspace.com
- https://ieee-dataport.org/topic-tags/north-and-south-poles-0
- http://ieeeaccess.ieee.org/special-sections/addressing-economic-environmental-humanitarian-challenges-polar-regions/

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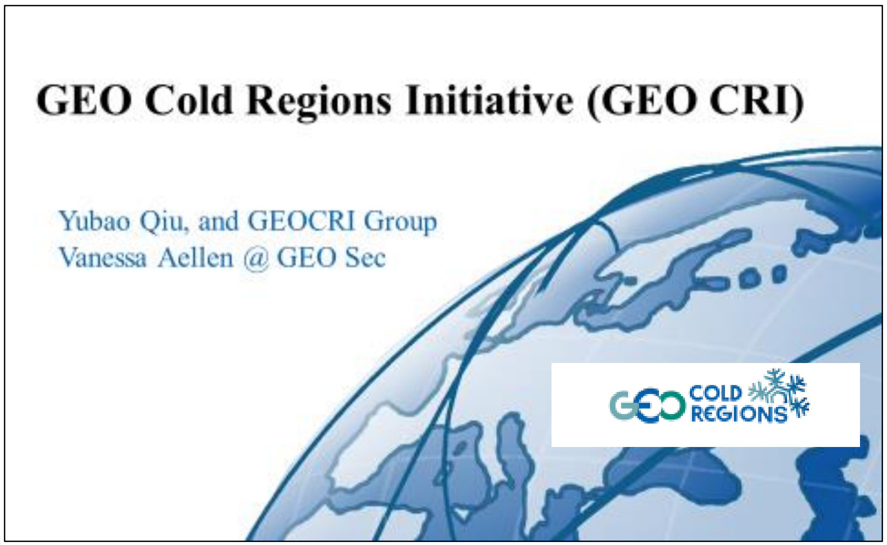
GEO COLD REGIONS (CRI) and IEEE POLE TO POLE - Collaboration

GROUP ON EARTH OBSERVATIONS



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ONION: Towards a comprehensive observation of the polar regions?

- **"Operational Network of Individual Observation Nodes" (H2020-687490-ONION)** is a **Horizon 2020 project** (2016-2017), the biggest EU Research and Innovation programme
- **Innovation** in **Earth Observation (EO)** world by exploring the potential of **Distributed Satellite Systems (DSS)**
- The project leverages on **two concurrent trends**:
  - Increased **modularity** and **miniaturisation** of technologies
  - "Momentum" of **constellations** of **small satellites** being deployed these years or planned to be deployed within the next decade
- Goal: to design **innovative mission architectures** with competitive advantages for European EO infrastructure, with a special focus on the Copernicus programme

Project achievements

- Selection of **promising use cases** as a combination of **user needs**, technological gaps, and current and planned Copernicus offer in 2020-2030.

- The most relevant use cases are:
  - **Marine observations for weather forecast**
  - Arctic sea-ice monitoring
  - Agricultural hydric stress
  - Fishing pressure monitoring & aquaculture

- To showcase the end-to-end ONION added value, the user advisory board recommended focusing on the Marine Weather Forecast use case, and selected an optimal architecture meeting the user needs linked to the use case considered:

1) Ocean Surface Currents, 2) surface wind speed, 3) Significant Wave Height (SWH), 4) dominant Wave Direction, 5) Sea-Surface Temperature (SST), 6) surface atmospheric pressure, and 7) sea ice cover.

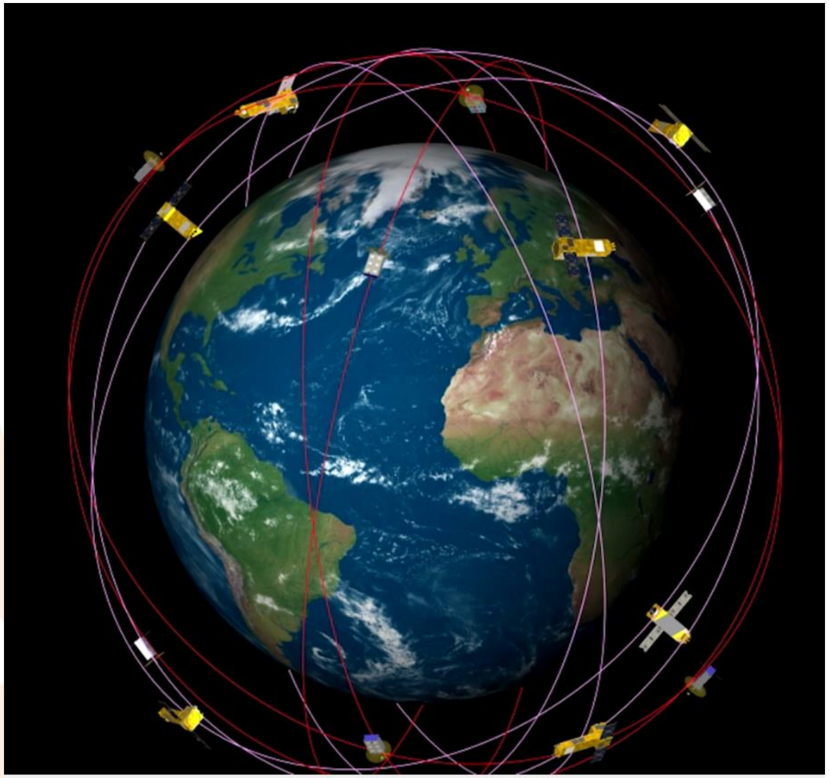
The Marine use case user requirements

Parameter	Spatial resolution	Revisit time	Latency	Accuracy	Coverage
Ocean Surface Currents	1 km	< 24 h	< 1 h	0.5 m/s and 10° accuracy	Arctic and subarctic regions (over latitude 60°N, target value: 50°N)
Wind speed over sea surface (horizontal)	1 km	< 24 h	< 1 h	0.5 m/s	Arctic and subarctic regions (over latitude 60°N, target value: 50°N)
Significant wave height	1 km	< 3 h	< 1 h	0.1 m	Arctic and subarctic regions (over latitude 60°N, target value: 50°N)
Dominant wave direction	1 km	< 3 h	< 1 h	10°	Arctic and subarctic regions (over latitude 60°N, target value: 50°N)
Sea Surface Temperature	1 km	< 24 h	< 1 h	0.3 K	Arctic and subarctic regions (over latitude 60°N, target value: 50°N)
Atmospheric pressure (over sea surface)	1 km	< 24 h	< 1 h	5%	Arctic and subarctic regions (over latitude 60°N, target value: 50°N)
Sea Ice cover	0.01 km	< 3 h	< 1 h	5%	Arctic and subarctic regions (over latitude 60°N, target value: 50°

High-level description of the architecture selected

- Composition = **8 heavy nodes** + **8 small nodes**, in **8 planes**
  - On each plane, 2 heavy nodes and 2 small nodes alternatively

- **Near-polar orbits** at 807 km height in **Walker Delta config.**



- Heavy Nodes: SAR-X + Optical Imager (200 kg P/L,600 kg dry mass).

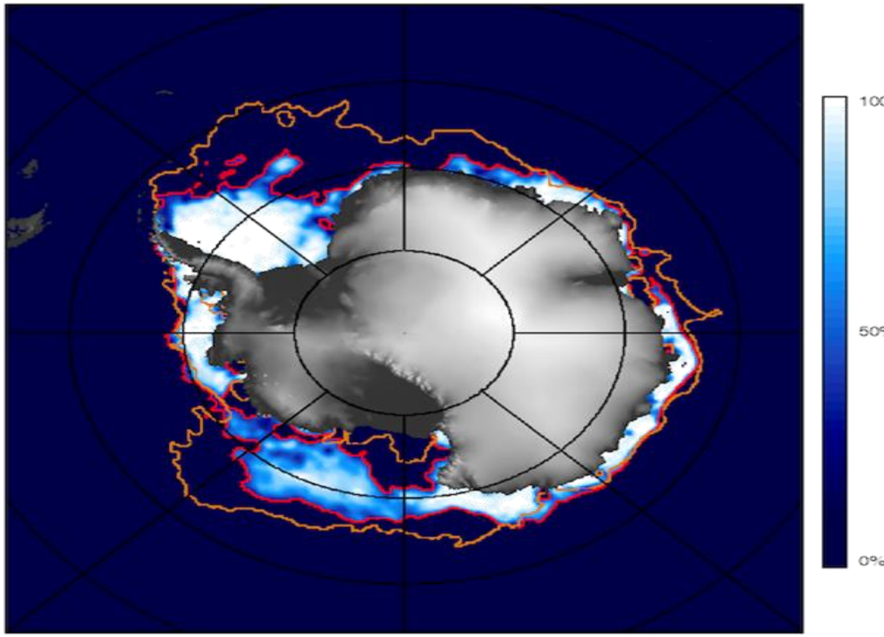
- Small nodes: GNSS-R instrument (10-20 kg CubeSat size)

- Inter-satellite link possible amongst heavy nodes

Thanks

Inputs, contributions, and participation are welcome!

Southern Hemisphere, December 31, 2016



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