SST related activities at ESA

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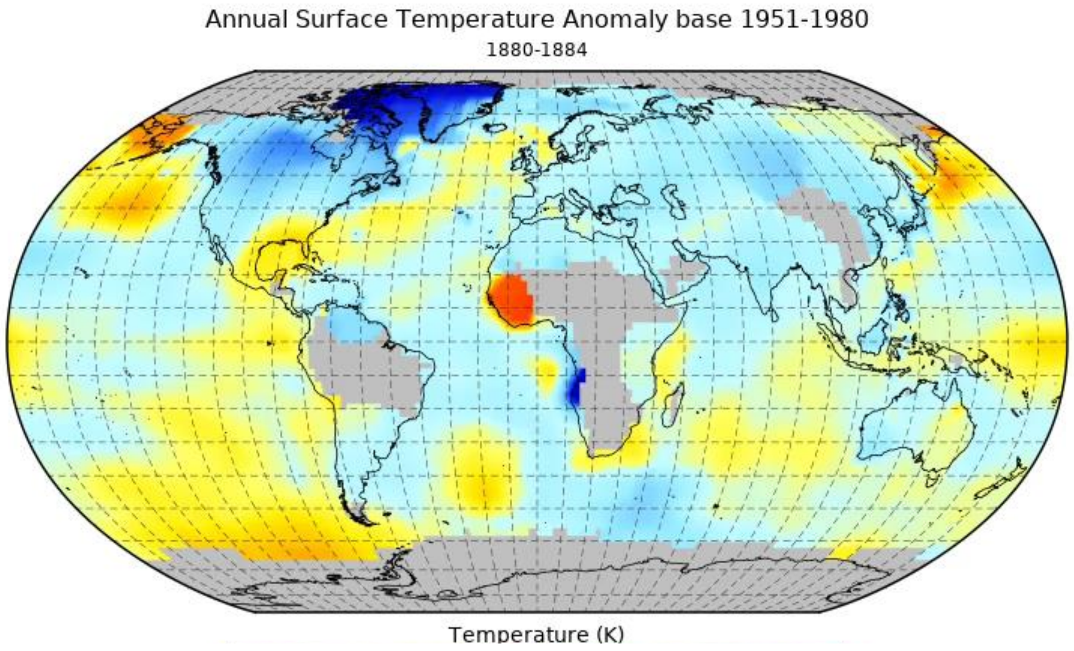
ESA/ESTEC, Noordwijk, The Netherlands

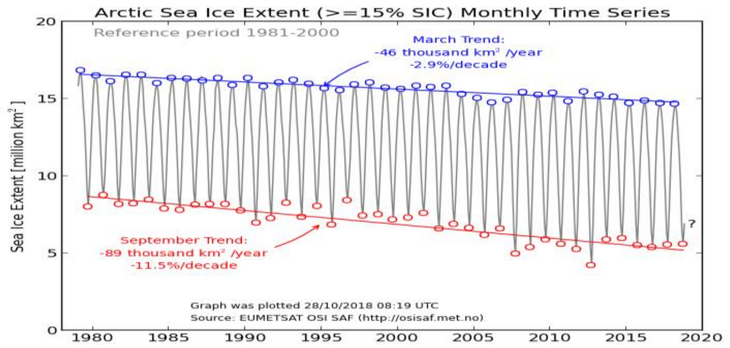
GHRSST XX, Frascati, Italy 3 – 7 June 2019

Overview

- Welcome to GHRSST-XX
- ESA: EO oceanography
- SST: On-going validation work
- SST: Sentinel-3 work
- SST: New Missions
  - Land surface Temperature Mission

    (shh! It's an SST coastal dream machine ;-)
  - CIMR: The future SST mega-mission
- Ocean Training #OTC2019





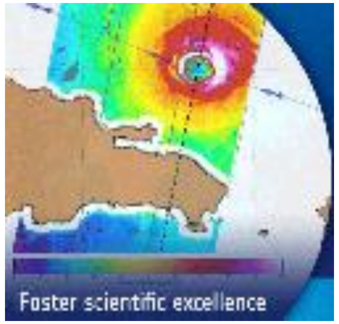
EO Science for Society #EO4society

EO Science for Society (EOEP5 Block 4) built on successes of previous ESA exploitation activities:

- adapting them to the new European EO context
- responding to recommendations of programmatic and scientific review.

MAIN OBJECTIVES

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



22 on-going and planned projects

✓ Physical Oceanography

- OVALIE Oceanic intrinsic Variability versus Atmospheric forced variabiLIty of sea level change (2018-2020)

Living Planet Fellowship

- SMOWS: Satellite Mode Waters Salinity (2018-2020)

Living Planet Fellowship

- Wind/wave/current from Sentinel-1
- Extreme
- World Ocean Circulation
- SMOS10

✓Biogeochemistry

- Ocean SODA (2019-2021)
- Physioglob (2018-2020)

Living Planet Fellowship

- Carbon+ project (2019-2021)
- Sentine-5P-OC (2019-2021)

✓ Climate Change Initiative (2010-2024)

✓ Regional Initiatives

- Baltic Sea (2018-2020)
  - Altimetry, Salinity, SeaLaBio
- Black Sea (2018-2020)
- Atlantic Ocean
- Mediterranean Sea

✓ Coastal Projects

- RACZIW: Radar Altimetry for COASTAL ZONE and INLAND WATER (2019-2021)
- Coastal Erosion (2019-2021)

✓Polar Seas

- Arctic ocean (2019-2021)
- Antarctic ocean mesoscale dynamics;

ESA Climate Change Initiative

ESA's R&D Programme (2010-2024) **to exploit the full potential of Earth Observation in support of Climate Research and Assessment**

Objective: Produces long time-series of Essential Climate Variables (ECV)

sea ice cci

sst cci

salinity cci

ocean colour cci

sea state cci

sea level cci

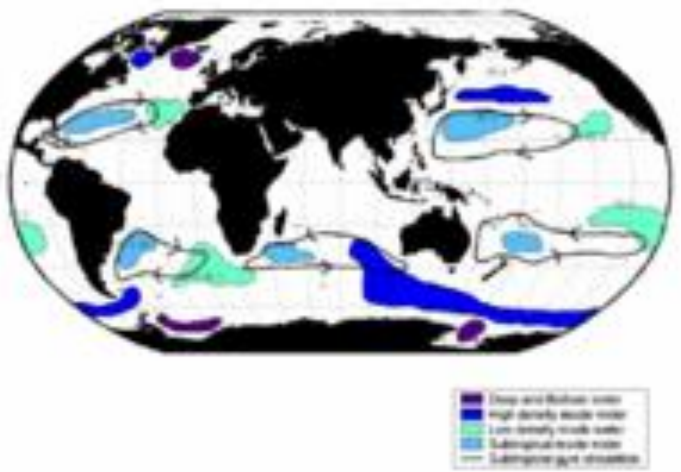
SMOWS project

Living Planet Fellowship

Audrey Hasson, CNRS, FR

SMOWS: Satellite Mode Waters Salinity

'Mode Water' is the name given to a layer of nearly vertically homogeneous water found over a relatively large geographical area. Mode waters (MWs) transport a large volume of heat, carbon and other properties across basins at seasonal to longer time-scales and thus play a major role in the modulation of the Earth climate.

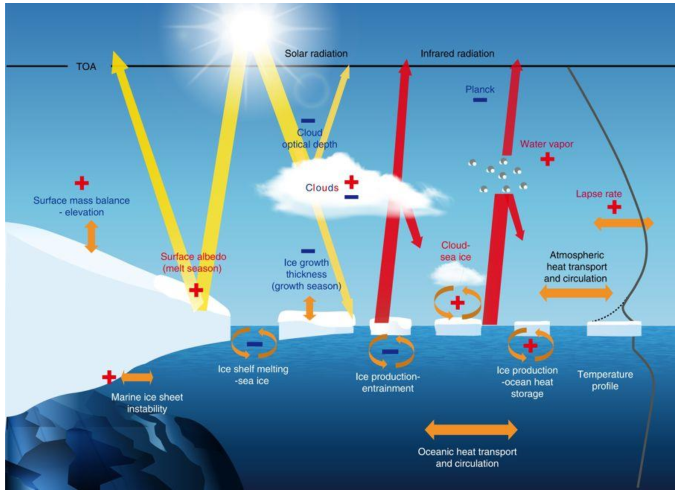


Objective: investigate the MWs characteristics in surface salinity (SSS), temperature (SST) and sea level (SL), which are all Essential Climate Variables (ECV) emphasized by three European Climate Change Initiatives (CCIs). Their link with interannual to longer time scale variability, more specifically in the South Pacific where their implication for the long-term changes in El Nino Southern Oscillation (ENSO) remains unknown

Polar Seas

Arctic+ Ocean (2019-2021)

Objective: Investigate the main big challenges in the Arctic using EO **data synergy**. Main scientific questions will tackle Arctic Amplification, impact of more open water on sea ice dynamics, extreme storm events…



Major climate feedbacks operating in polar regions. [Credit: Fig 1 from Goosse et al. (2018)].

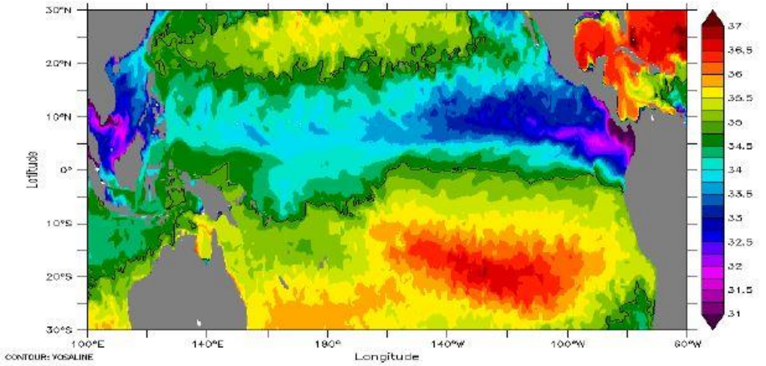
Antarctic project (2019-2021)

Objective: Better understand the mesoscale variability in the Southern Ocean including the better retrieval of mesoscale eddies in the leads.

SMOS El Niño: Assessing impact of SMOS in Ocean models

- **Non negligible impact** overall from the SMOS assimilation on the ocean analysis and forecast
  - The RMSE of in-situ SSS **are reduced:**
    - **~5%** (global domain)
    - **~8%** (Tropical Pacific)
    - **~10%** (North tropical Pacific
    - **~6.5%** (South Tropical Pacific)
- **Small impact overall** only in the **first 50 meters** on RMSE of salinity profiles and no impact on RMSE of temperature profiles: ➔regional differences
- **Independent data**: Small positive impact overall from the SMOS assimilation ➔ reduction in RMSD of TAO mooring: ~**5.5%**

- Impact on **SLA** at larger time scales➔ reinforcement of TIW



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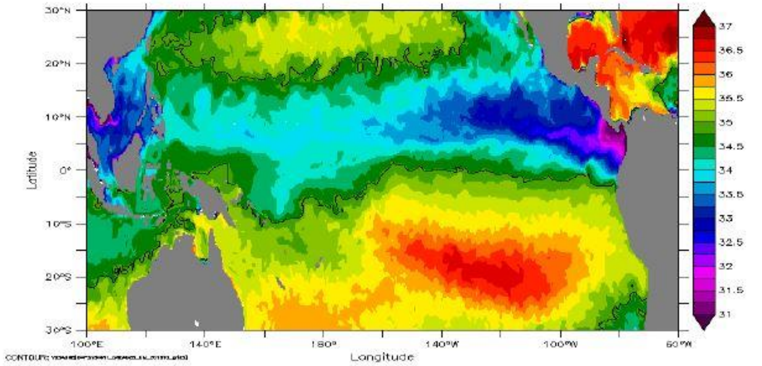
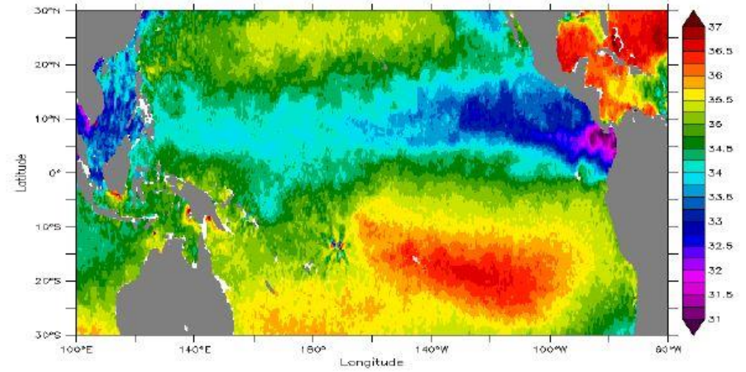
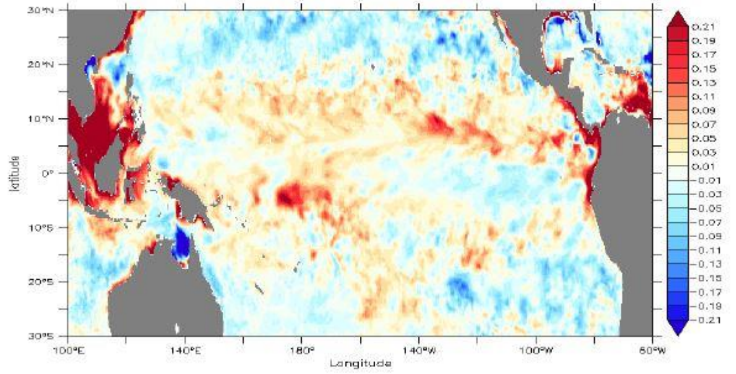


SMOSexp



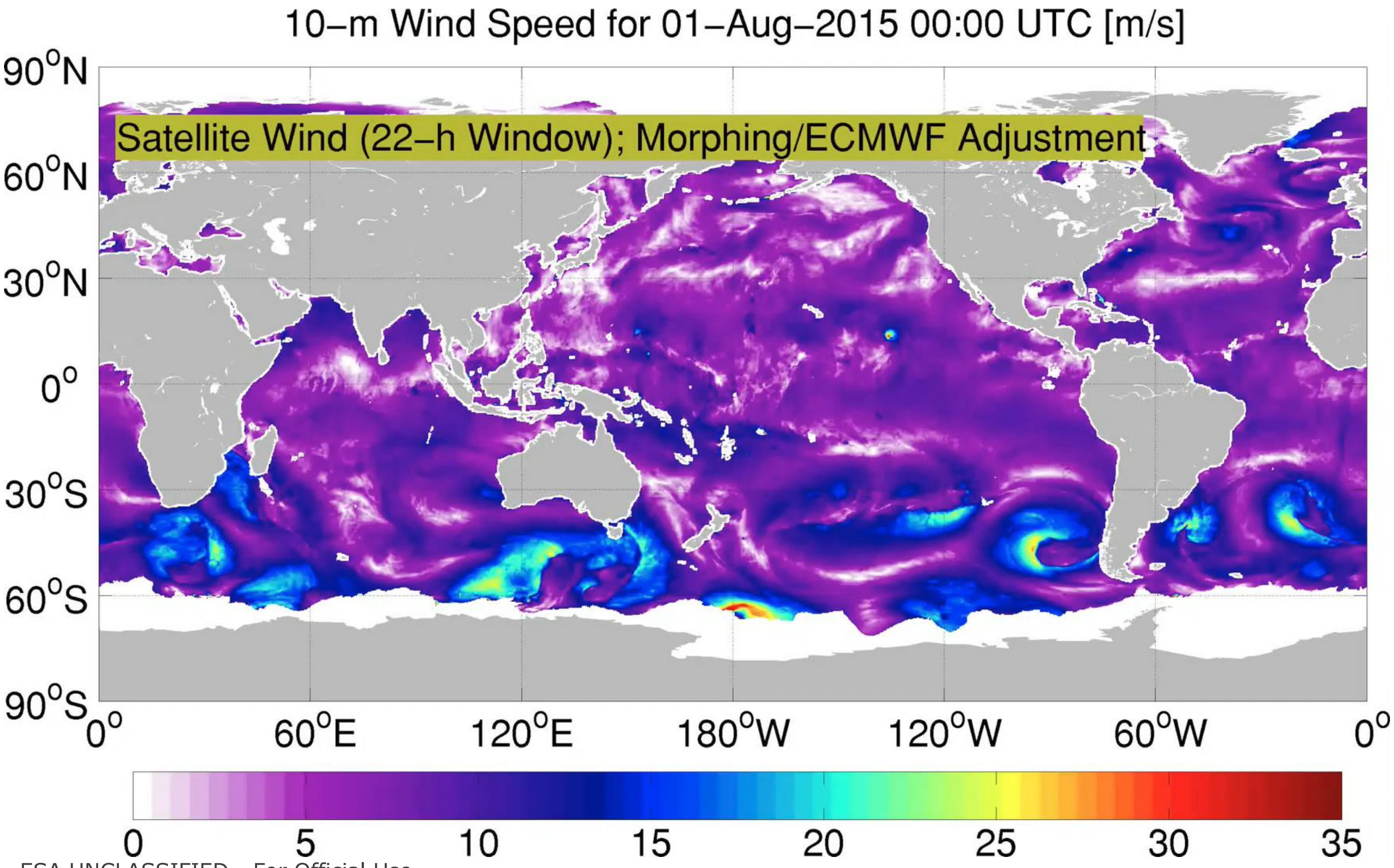
SMOS LOCEAN data



SMOSexp -REF

Source: CLS, MERCATOR

SMOS ocean winds: New multi-satellite blended product



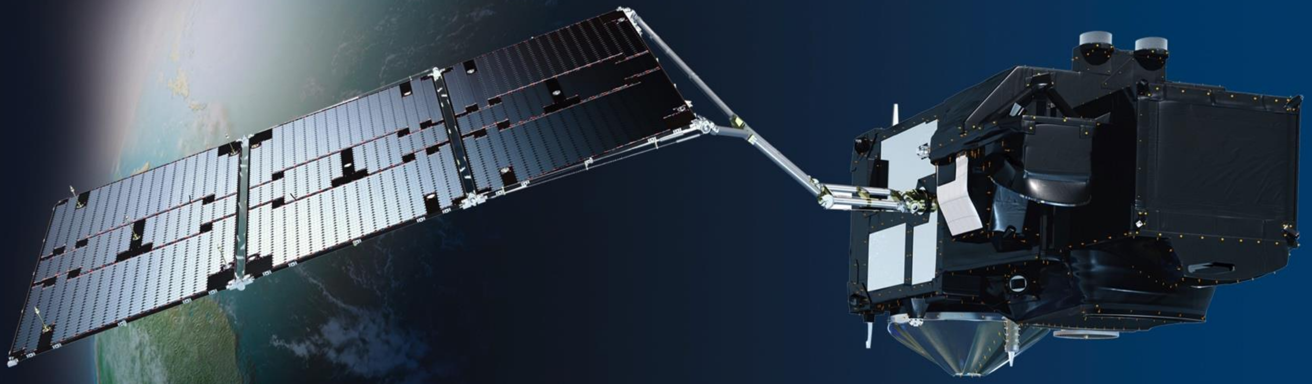
SMOS data has been proved to be a valid imput to provide strong ocen wind speeds without saturation even over 35 m/s.

A new approach for combining non-synoptic satellite wind speeds (SMOS, SMAP and AMSR-2) to create synoptic wind maps is showed here that use variational data assimilation together with an atmospheric model (such as ECMWF).

Source: IFREMER, OceanDataLab (FR)

European Commission

esa
European Space Agency



The Copernicus Sentinel-3 Mission: Tandem

Craig Donlon Sentinel-3 Mission Scientist (ESA/ESTEC), J. Nieke (ESA/ESTEC), S. Clerc, N. Lamquin (ACRI-ST), D. Smith (RAL/STFC), J. Mittaz (U. Reading), M. McMillin (U. Lancaster), P. Thibeux (CLS), E. Woolliams, S. Hunt (NPL), M. Hammond, C. Banks (NOC)

Sentinel-3 Validation Team, ESA, Frascati, Italy 7-9th May 2019

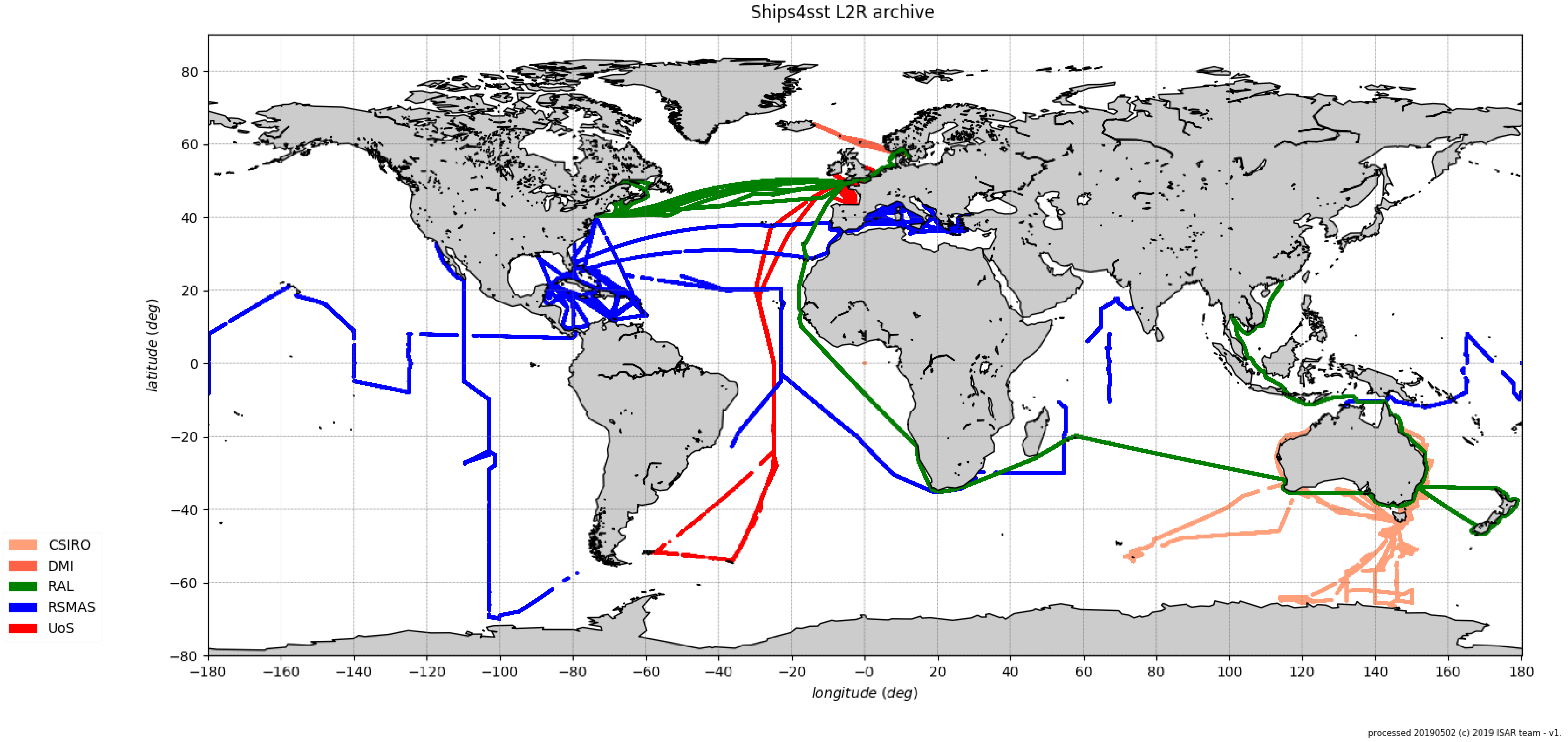
Sentinel-3 SLSTR SST validation using a Fiducial Reference Measurements (FRM) service

Werenfrid Wimmer, Tim Nightingale, Jacob Høyer, Jean-Francois Piolle, Ruth Wilson, Hugh Kelliher, Steffen Dransfeld, Slivia Scifoni

ships4sst

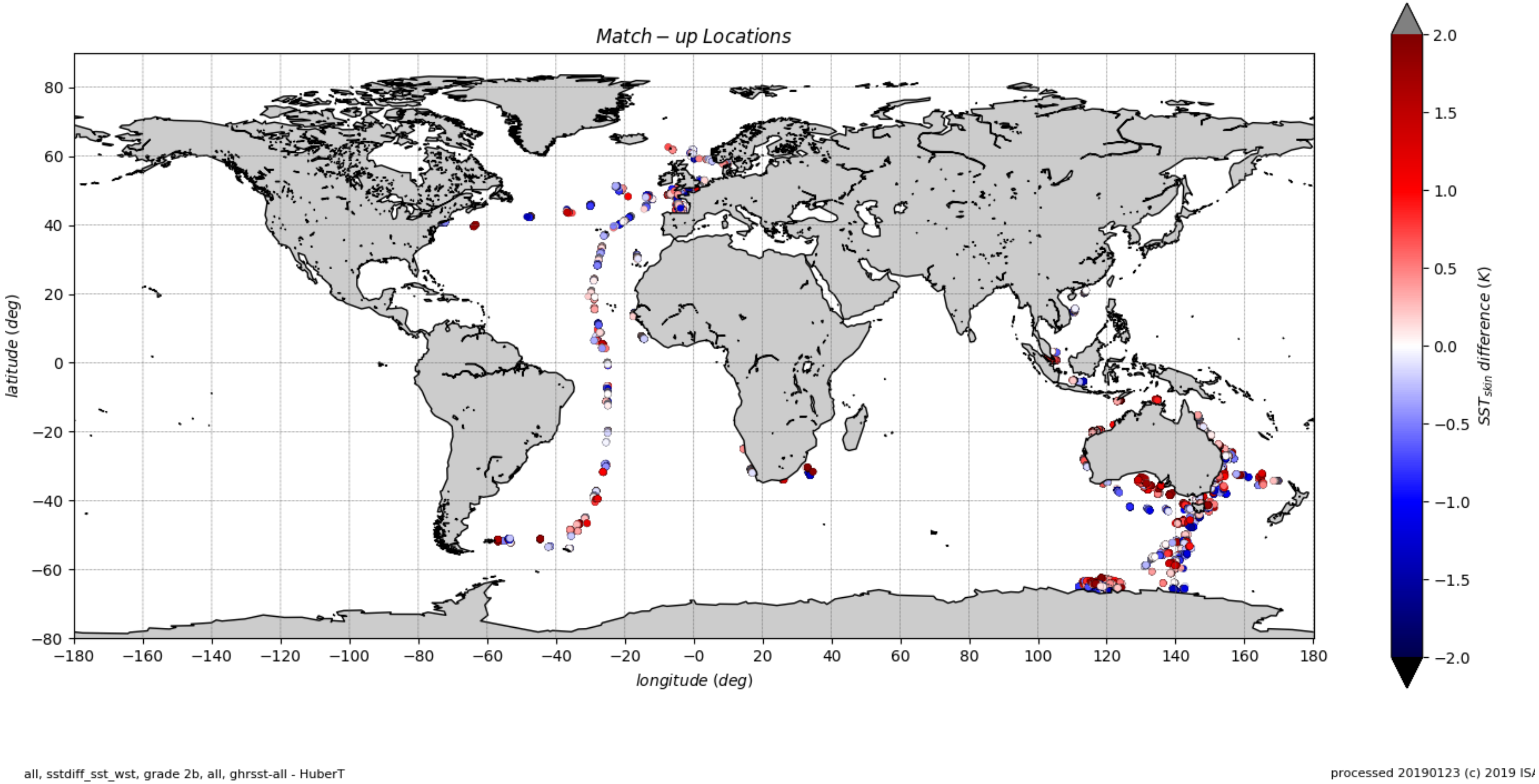
- 3 main project partners
  - UoS, RAL, DMI
- International collaboration
  - Invite other TIR operators to convert/produce data in L2R format and upload it to the ships4sst archive.
  - RSMAS, CISRO have produce L2R data for M-AERI and ISAR
- webpage
  - www.ships4sst.org
  - Information, protocols, data format, archive
  - Format converter tools
- Twitter
  - @ships4sst

Ships4sst –archive

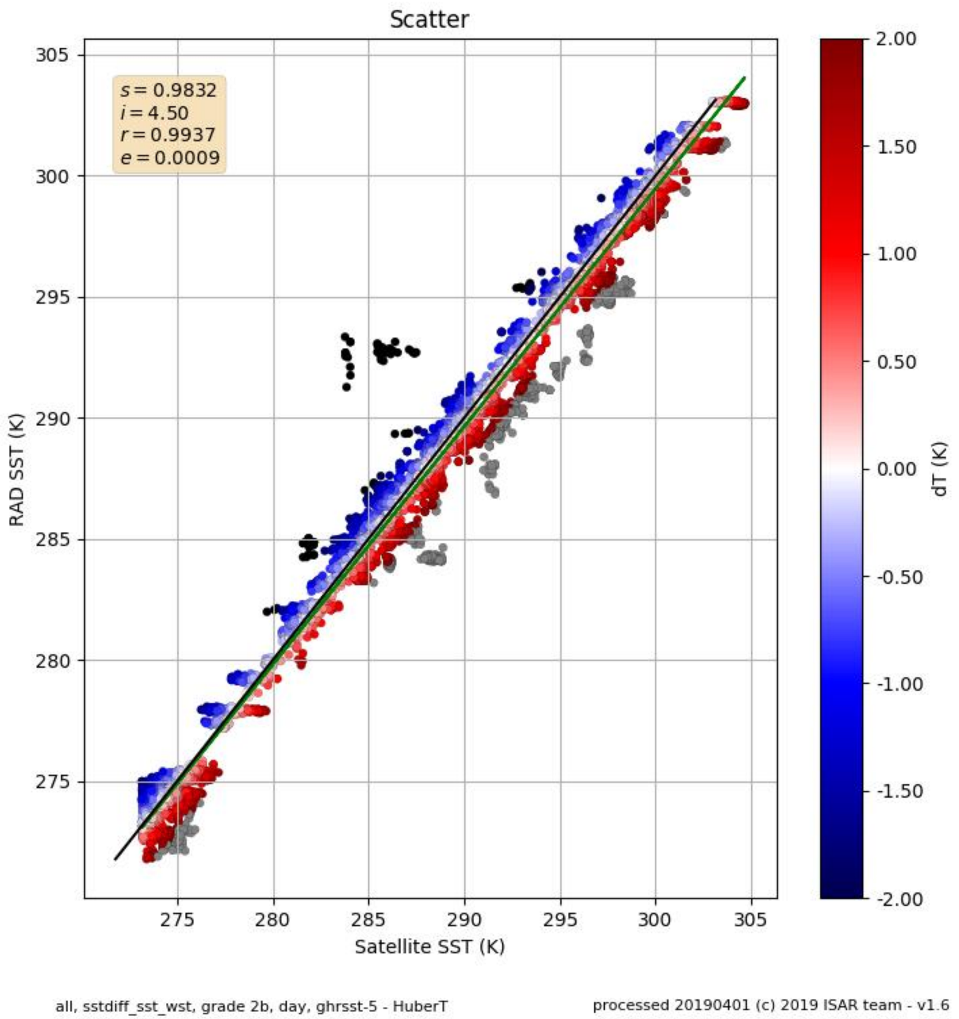


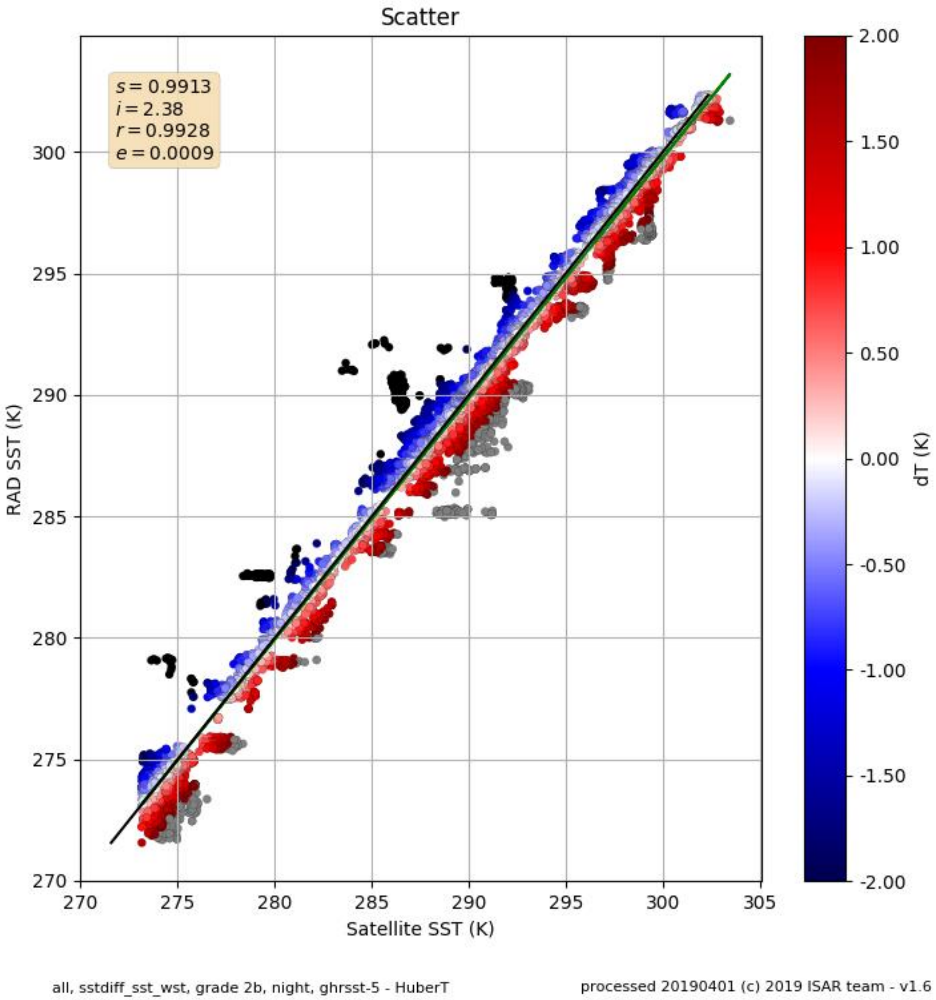
Validation results - global

- August 2016 – April 2018 - CV 5



Validation – scatter, CV 5



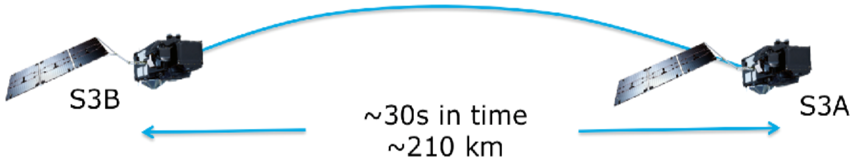


Conclusions

- Ships4sst
  - FRM data
  - Archive
- SLSTR Validation
  - Globally
    - Day mean 0.24 K, rsd 0.59 K
    - Night mean 0.09 K, rsd 0.44 K
  - Reginally
    - Day mean 0.01 K, rsd 0.27 K
    - Night mean -0.02 K, rsd 0.25 K
  - WST product
- Future work
  - D3, D3, N3,N2 SLSTR validation
  - Implement AATSR matchup uncertainty methods

Why a Tandem Mission for Sentinel-3A and 3B?

- While in tandem, S3A and S3B Instruments view the same area, almost simultaneously.
- This will allow:
  - **direct comparisons of the data** without the need for geometric and temporal corrections,
  - **minimising uncertainty introduced by ocean and atmospheric variability** in the measurements,
  - **minimising the uncertainties of atmospheric and surface reflectance variations** between the S3A and S3B optical instruments with respect to the ocean/land signal.
- This will result in:
  - **statistically significant data sets** in a relatively short period of time.
  - **Inter-calibration over all surfaces**, including the most homogeneous ocean gyres.
- The approach was exercised for all Altimetry missions in the reference Jason orbit allowing **to computing accurate sea level relative biases between two missions** and linking their global and regional Mean Sea Level (MSL) time series.



S3B and S3A will fly in Tandem
S3A will follow S3B with same ground track

S3A/B Tandem Constellation Phases

1. **Drift phase 1, Duration: 1.5 months post launch (Launch: 25/04/18)**
    - LEOP, SIOV and instrument tests, first light images.
2. **Tandem phase, Duration: 4.5 months (Tandem acquired: 06/06/18)**
    - **S-3B will fly ahead of S-3A with a nominal time separation of 30 seconds**, which corresponds to a separation in position around the orbit of approximately 210 km;
    - S-3B will fly on the **same ground track as S-3A**;
    - S-3B will be controlled to maintain the required **±1 km** ground track;
3. **Drift Phase 2: Duration 1.5 months (Drift initiated: 16/10/18)**
    - S-3B manoeuvred into a drift orbit; **lower the orbit of S-3B to initiate the separation of the two satellites and then to raise it**,
    - **First a phase of 8 days with a slow drift (1.1 km lower orbit)** to allow the SLSTR-B oblique swath overlapping with the nadir swath of the SLSTR-A satellite. Second phase of 28 days with a faster drift (4.3 km lower orbit)
    - S-3B not yet be flying over its nominal ground-track (no valid OLTC)
4. **Duration 1.5 months (Handover to EUM FOS 28/11/18, Operations start: Alt: 12/18, Opt: 01/19)**
    - S-3B is at the baseline position at ±140° to S-3A;
    - Validation and of the Sentinel-3B SRAL OLTC for the 140° phase operational ground track

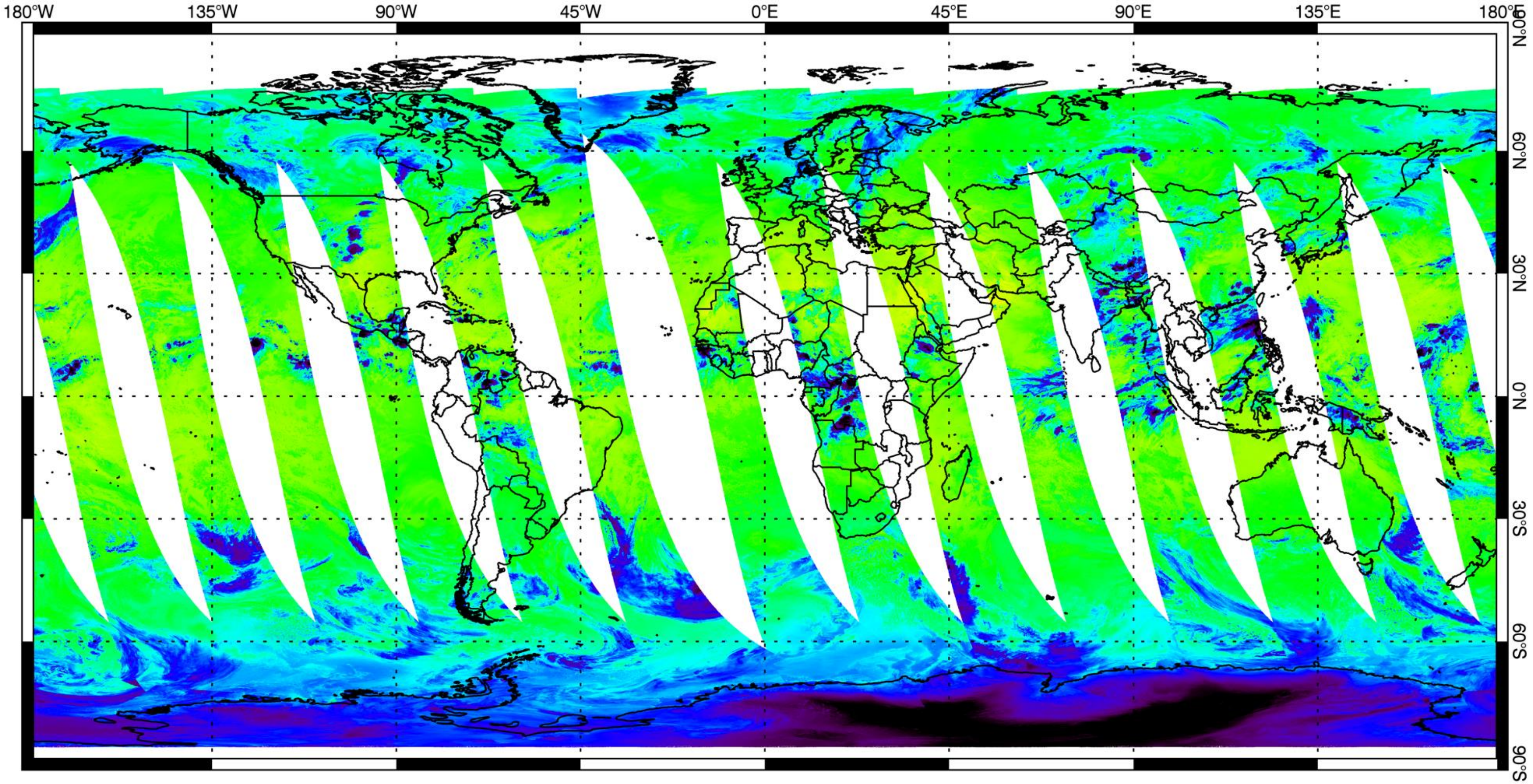
TIR Channel Radiometric Comparisons

- Comparisons of S3B vs S3A have been performed for selected days during tandem phase using L1 products remapped to 0.05degree cells.
    - Comparisons are for corresponding 0.05degree cells

- Averages are filtered to use spatially uniform cells with standard deviations <0.1K and BTs within valid range.
    - Invalid BTs are not included in averages

- Summary plots have been averaged over 5K intervals

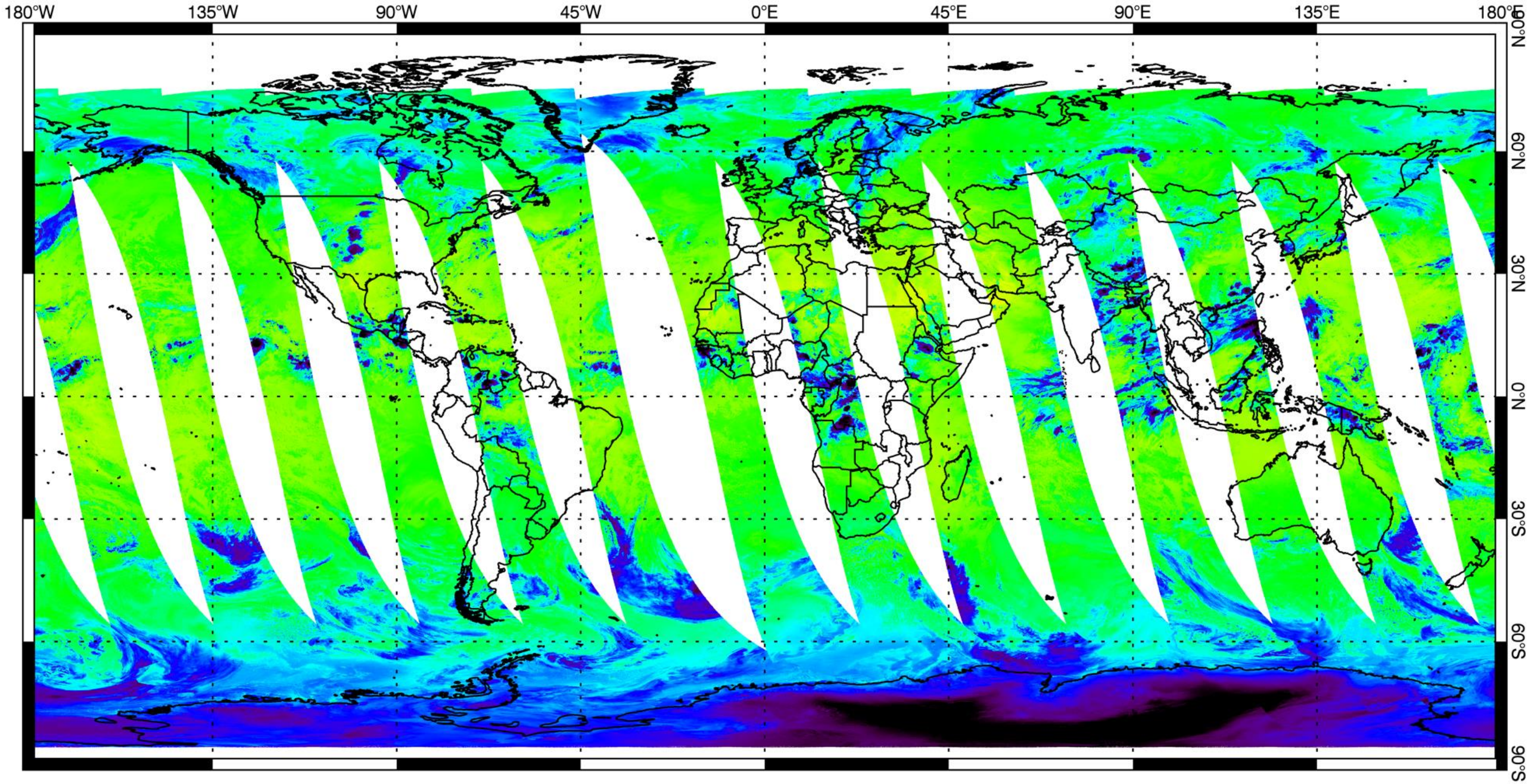
SLSTR-A S8 – Night Time - Nadir



Data for 26-August-2018

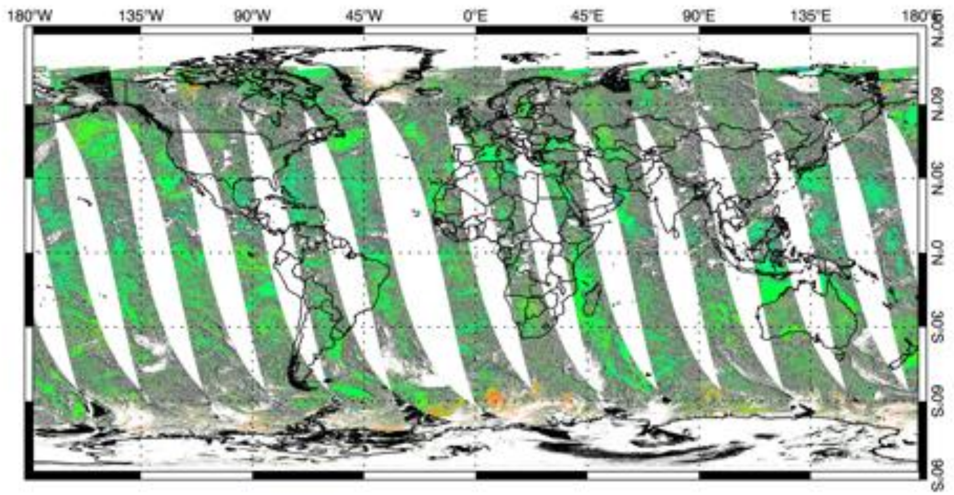
Science & Technology Facilities Council
RAL Space

SLSTR-B S8 – Night Time - Nadir

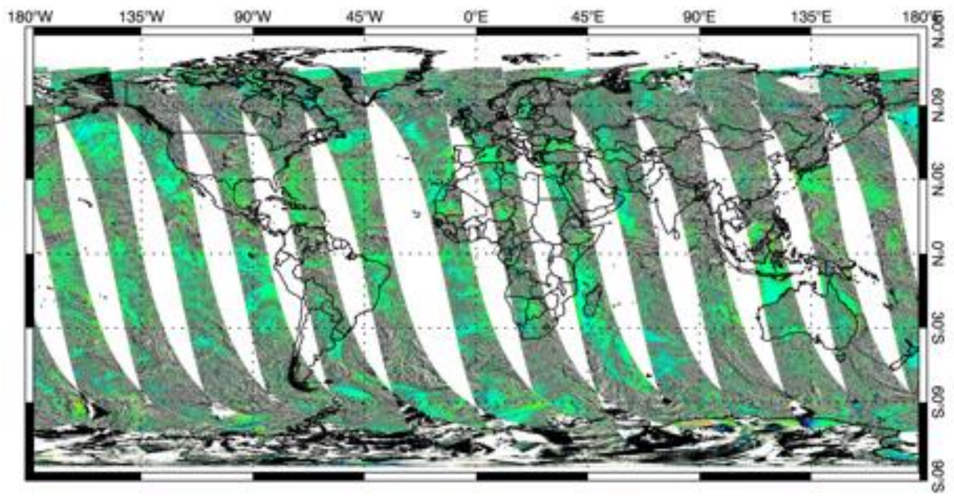


Data for 26-August-2018

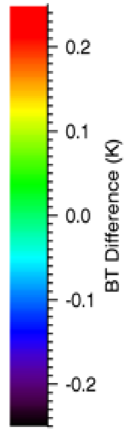
S3B-S3A Tandem Comparisons

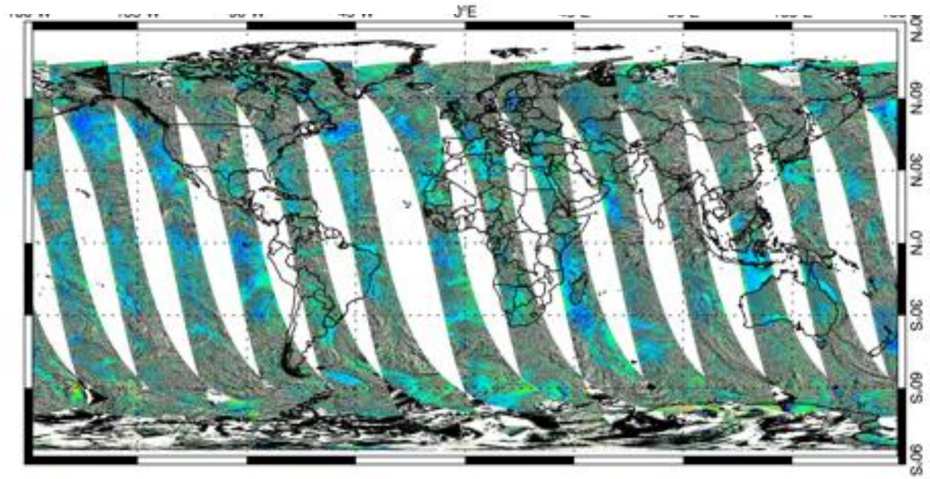


S7



S8





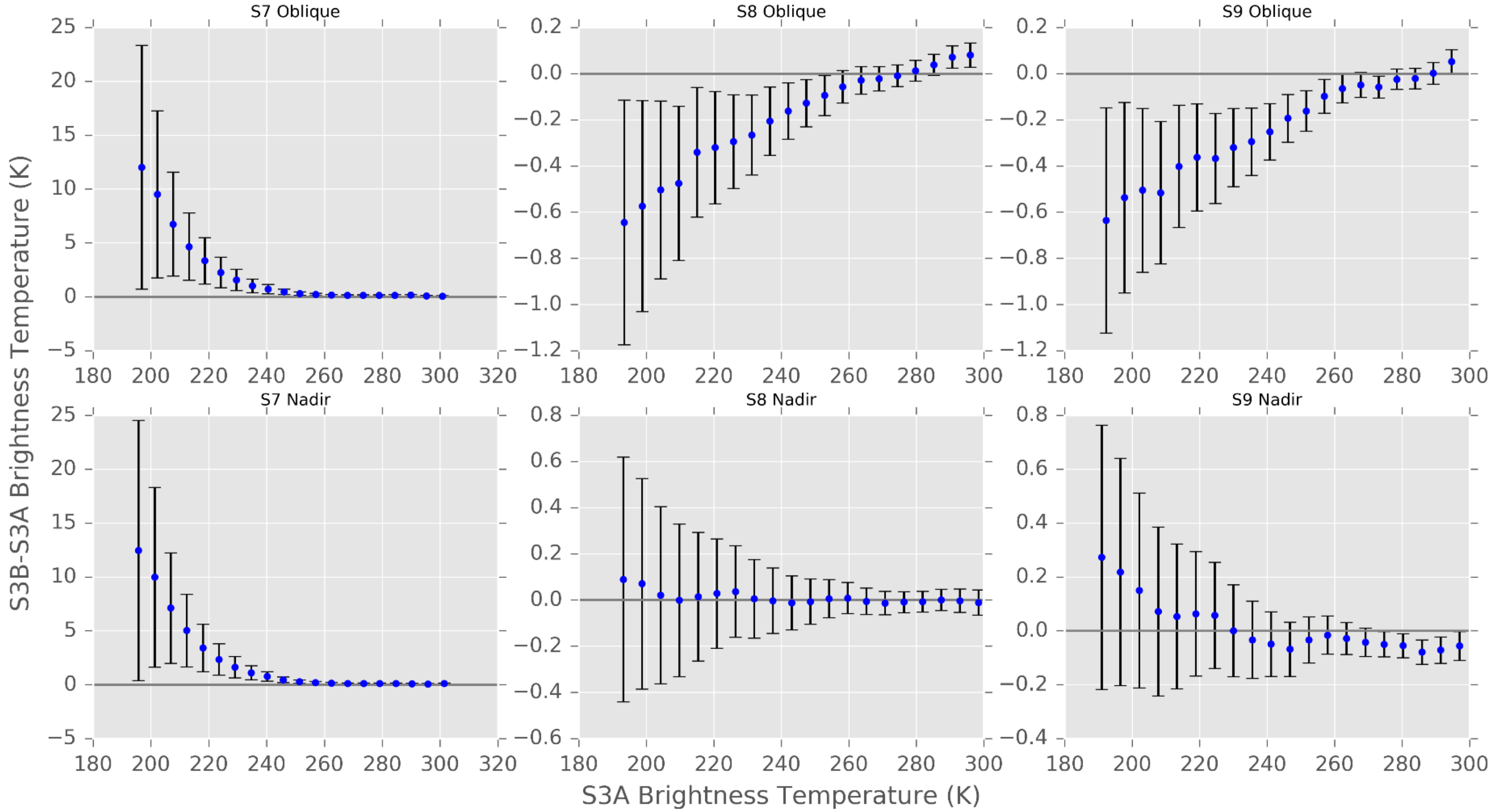
S9

Level-3 data for 26th August 2018

BT Differences S3B - S3A

Science & Technology Facilities Council
RAL Space

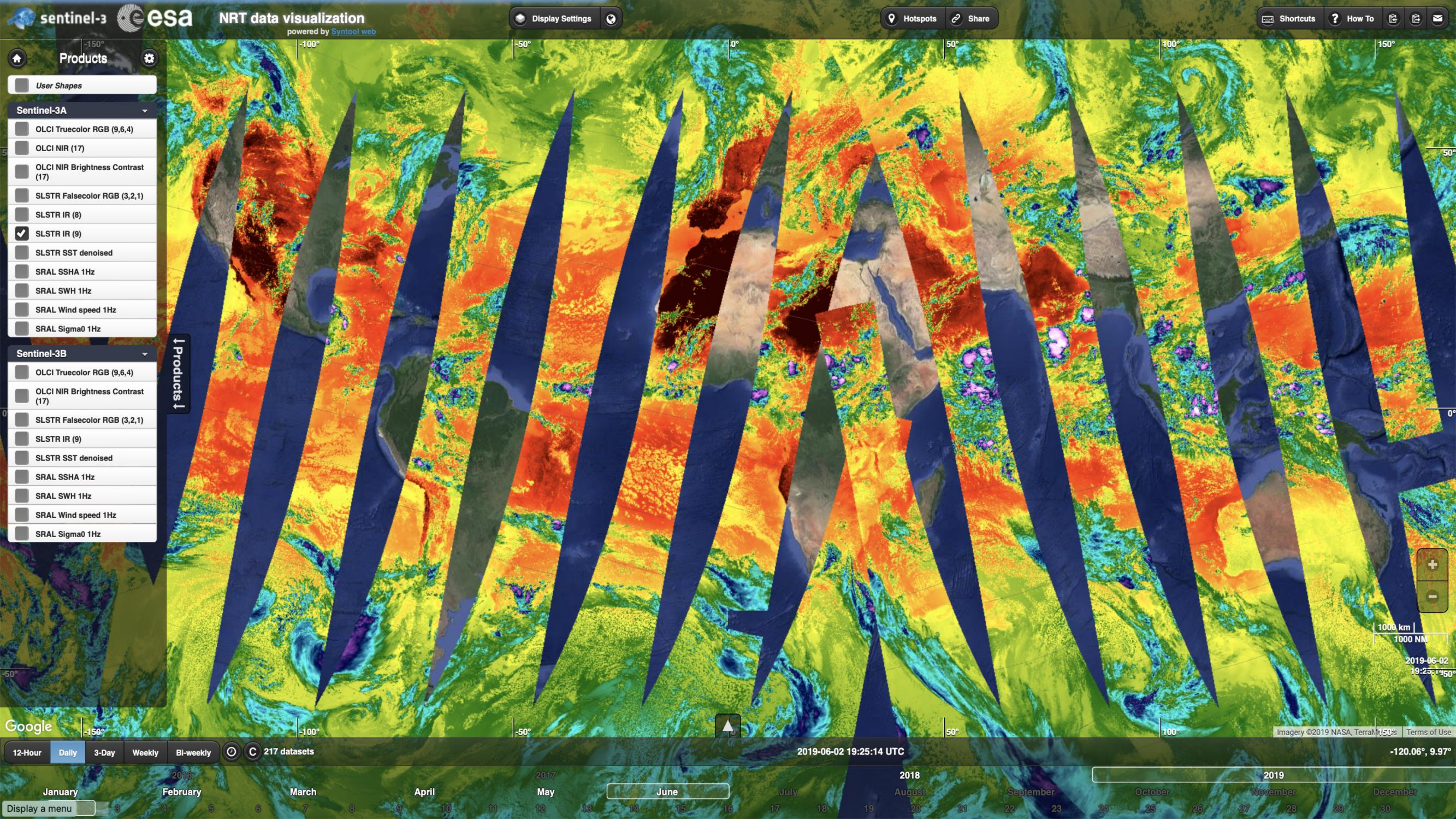
Grid Cell Differences Binned by BT
- Fully propagated uncertainties



Results, presented with fully propagated uncertainties at k = 1, show agreement for all channels at approximately this level across range.

Conclusions so far L1 SLSTR analysis

- Sentinel-3A/B Tandem phase has provided a unique opportunity to cross-compare twin instruments in near ideal conditions
- Preliminary analysis shows:
  - Good agreement between S3B and S3A in nadir view
  - Differences in oblique view consistent with pre-launch calibration
  - Both nadir and oblique show residual non-linearity error for T_E below 220K (note design range 220K – 330K)
- SNO comparisons are so-far limited to match-ups with IASI-A
  - Limited to high latitude observations – $T_E < 280K$
  - Cross calibration with other sensors would be useful – VIIRS, AIRS…
- Study with NPL is in progress to document and publish current status of the traceability of SLSTR TIR channels
- More information at https://s3tandem.eu/ and https://sentinel.esa.int/web/sentinel/missions/sentinel-3


sentinel-3
esa
NRT data visualization
powered by Syntool web
Display Settings
Hotspots
Share
Shortcuts
How To
Products
User Shapes
Sentinel-3A
OLCI Truecolor RGB (9,6,4)
OLCI NIR (17)
OLCI NIR Brightness Contrast (17)
SLSTR Falsecolor RGB (3,2,1)
SLSTR IR (8)
SLSTR IR (9)
SLSTR SST denoised
SRAL SSHA 1Hz
SRAL SWH 1Hz
SRAL Wind speed 1Hz
SRAL Sigma0 1Hz
Sentinel-3B
OLCI Truecolor RGB (9,6,4)
OLCI NIR Brightness Contrast (17)
SLSTR Falsecolor RGB (3,2,1)
SLSTR IR (9)
SLSTR SST denoised
SRAL SSHA 1Hz
SRAL SWH 1Hz
SRAL Wind speed 1Hz
SRAL Sigma0 1Hz
Products
-150° -100° -50° 0° 50° 100° 150°
1000 km
1000 NM
2019-06-02
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Imagery ©2019 NASA, TerraMetrics
Terms of Use
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2018
2019
January
February
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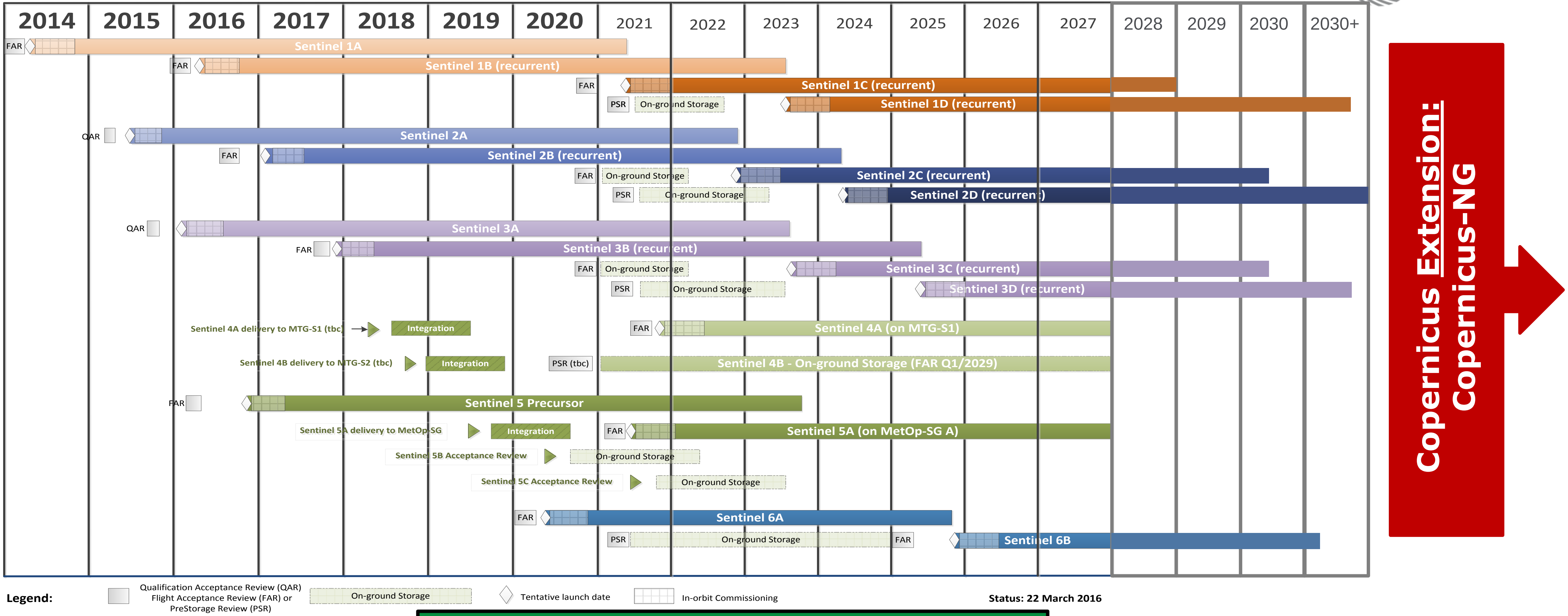
September
October
November
December
Display a menu

SST related mission development

CSC Segment-4 (2020-2029)



Copernicus Expansion:
High Priority Candidate Missions

Land Surface Temperature Monitoring
LSTM Mission
A Copernicus Candidate Mission for **Agricultural Monitoring**

Benjamin Koetz, Wim Bastiaanssen, Michael Berger, Joris Blommaert, Pierre Defourney, Umberto Del Bello, Matthias Drusch, Mark Drinkwater, Ricardo Duca, Valerie Fernandez, Darren Ghent, Radoslaw Guzinski, Jippe Hoogeveen, Simon Hook, Yann Kerr, Jean-Pierre Lagouarde, Guido Lemoine, Ilias Manolis, Philippe Martimort, Jeff Masek, Michel Massart, Massimo Mementi, Claudia Notarnicola, Inge Sandholt, Jose Sobrino, Peter Strobl, Thomas Udelhoven

LSTM – Managing Water for Agriculture

What

- Provides Thermal Infra-Red observations in high spatial resolution and temporal frequency ***in support of agriculture management services***

Why

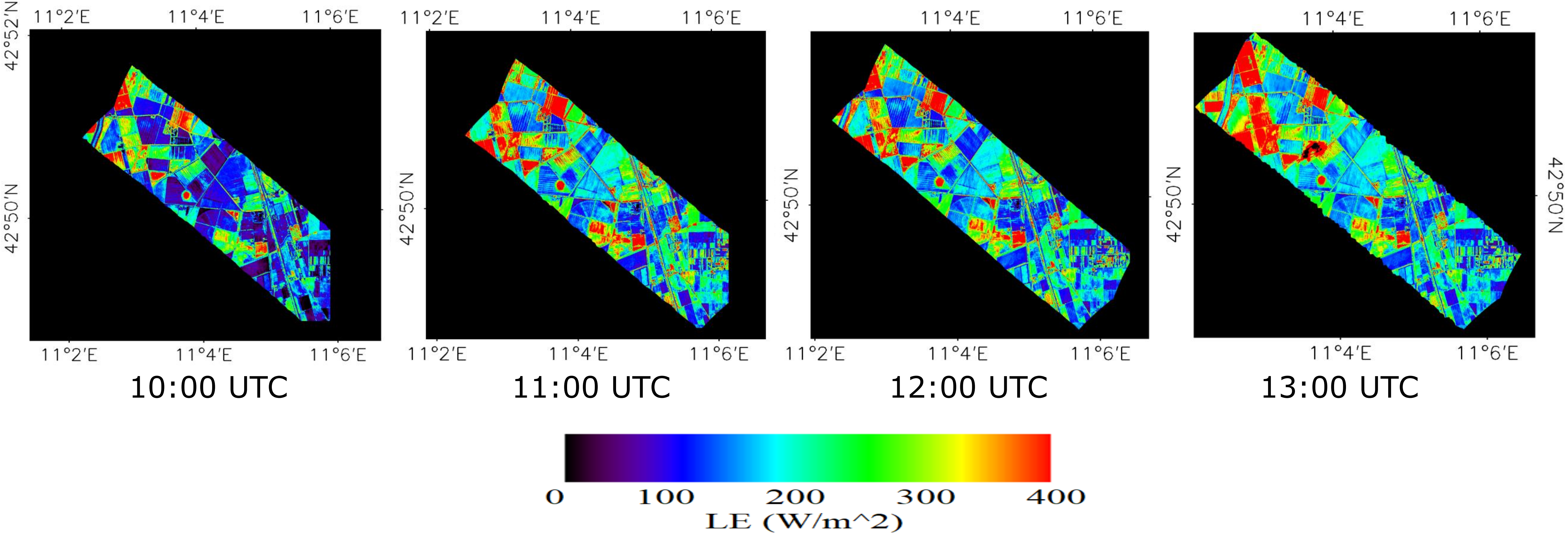
- Improves sustainable **water productivity at European field scale**
- Addresses increasing **Water and Food Security** issues in a world of increasing water scarcity and variability
- Responds to major **EU agricultural & environmental policies**

How

- Unprecedented **30-50 meter** observations in **3-5 thermal bands**
- Frequent Land Surface Temperature (LST) at **daily to 3 days revisit**
- World-class instrument providing **1-1.5K LST** radiometric accuracy

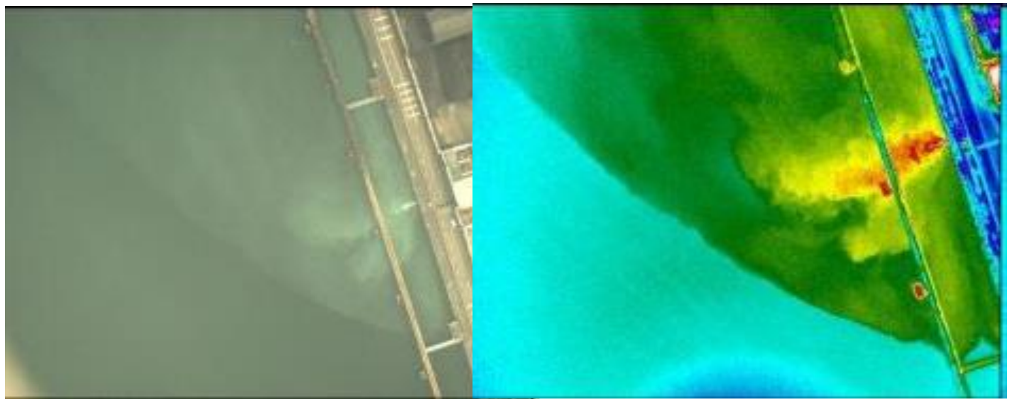
Diurnal ET time series - Grosseto

- Latent Heat (LE) time series capturing the diurnal cycle of plant-water dynamics and related water demand/stress
- Based on airborne TASI data, LE derived with SSEBI

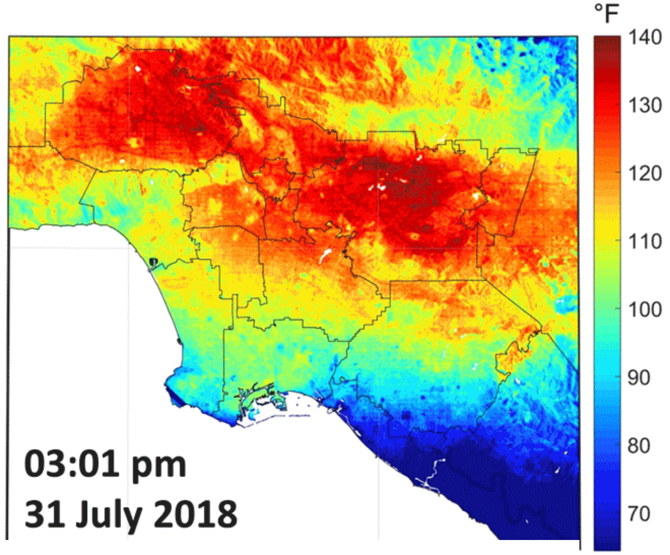


Examples for LST applications – Complementary Objectives

Inland & Coastal Water Quality

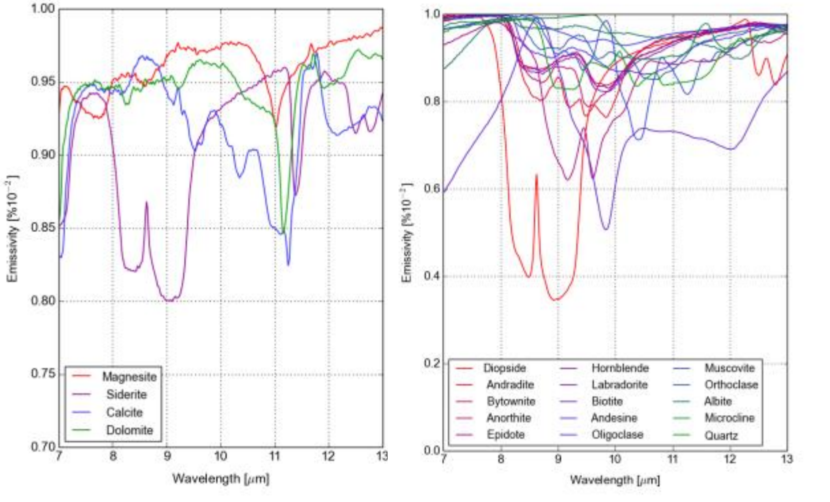


Urban Heat Islands

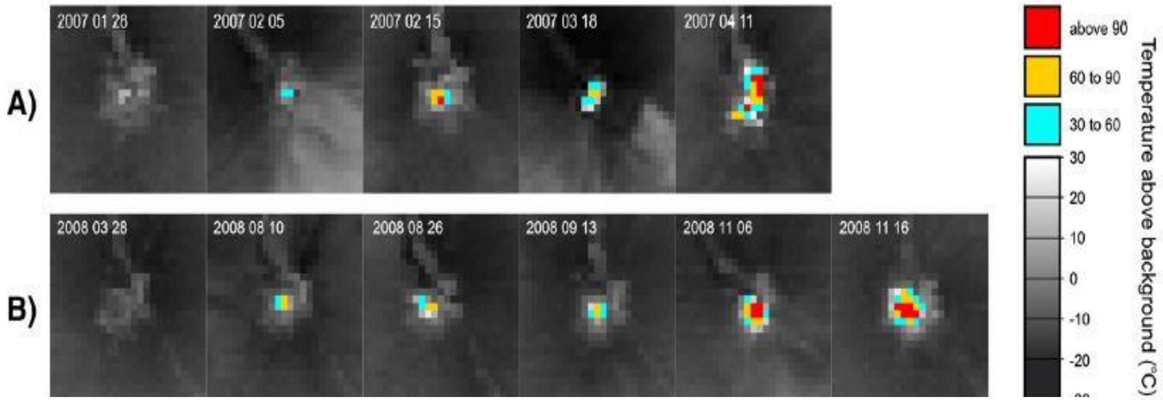


Ecostress 2018, Los Angeles

Soil composition & Mineralogy



Monitoring Volcanoes Activities



Thermal precursors to lava flow at Kliuchevskoi: anomalies in the crater, ASTER data (Murphy et al., 2013)

LSTM Mission: Observation Requirements

- **Spatial resolution: 30-50 m** to match European/African field scale variability
- LST observations should optimally be **acquired daily (goal)**, with a minimum threshold of 3 days
- LST over all land surfaces with an **uncertainty of 1 K (goal)** to 1.5 K (threshold)
- **Minimum 3 bands in TIR** range for ET rate estimation – recommended additional narrow thermal bands for improved LST/emissivity separation
- **Simultaneous VIS/NIR/SWIR** observations are required for atmospheric correction, cloud detection and emissivity estimations
- Collocation of S-2 & S-3 observations within +/-3 days for ancillary parameters
- Optimal LST observations **early afternoon** (goal around 13:00 hrs).

LSTM Mission: Spectral Requirements

- 3 (threshold) to 5 (goal) spectral bands in the TIR spectral range (8 - 12.5 µm)
- 6 (threshold) spectral bands in the VNIR-SWIR spectral range (0.4 - 2.5 µm)

TIR spectral bands for the primary mission objectives:

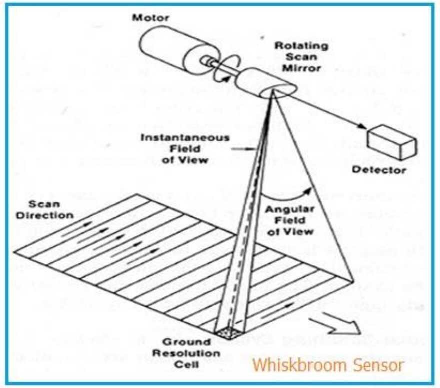
Band #	Goal/Threshold	Centre λ_{centre} (µm)	Spectral width $\Delta\lambda$ (µm)	Tolerance λ_{centre} (± nm)	Tolerance $\Delta\lambda$ (± nm)	Knowledge λ_{centre} (± nm)	Knowledge $\Delta\lambda$ (± nm)
TIR-1	G	8.6	0.18 (G)/0.30 (T)	10	10	5	5
TIR-2	G	8.9	0.18 (G)/0.30 (T)	10	10	5	5
TIR-3	T	9.2	0.18 (G)/0.30 (T)	10	10	5	5
TIR-4	T	10.9	0.40 (T)	10	10	5	5
TIR-5	T	12.0	0.47 (T)	10	10	5	5

LSTM System Design

Key requirement	Free-flyer
Geometrical revisit	1 day/4 sats (2d/2s)
Local time	13:00 (Europe)
SSD	50 m (37m at nadir)
Spectral Bands	5 TIR, 4 VNIR, 2 SWIR
Swath	700 km, at 640 km altitude
Acquisition system	Whiskbroom scanner
Geo-location L1c	1 SSD
MTF	0.2-0.3
Data latency (L2)	6-12 hours
NeDT	< 100 mK
ARA	< 0.5 K
Satellite mass	about 1.1 ton

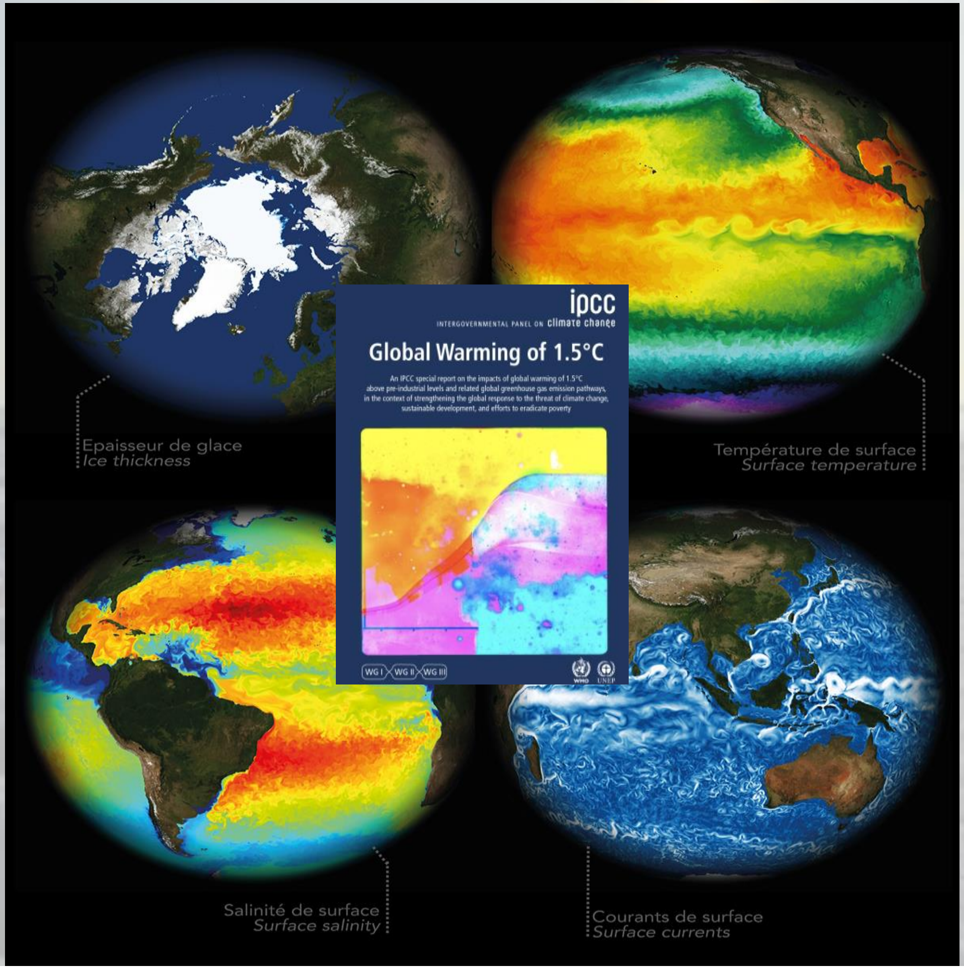
System design and Preparation:

- 2 parallel industrial **system studies**
- **Airborne Campaign & Scientific Studies** to support MRD requirements consolidation
- **End-to-End Simulator** activities for performance modeling
- LWIR **Detectors pre-development** activity



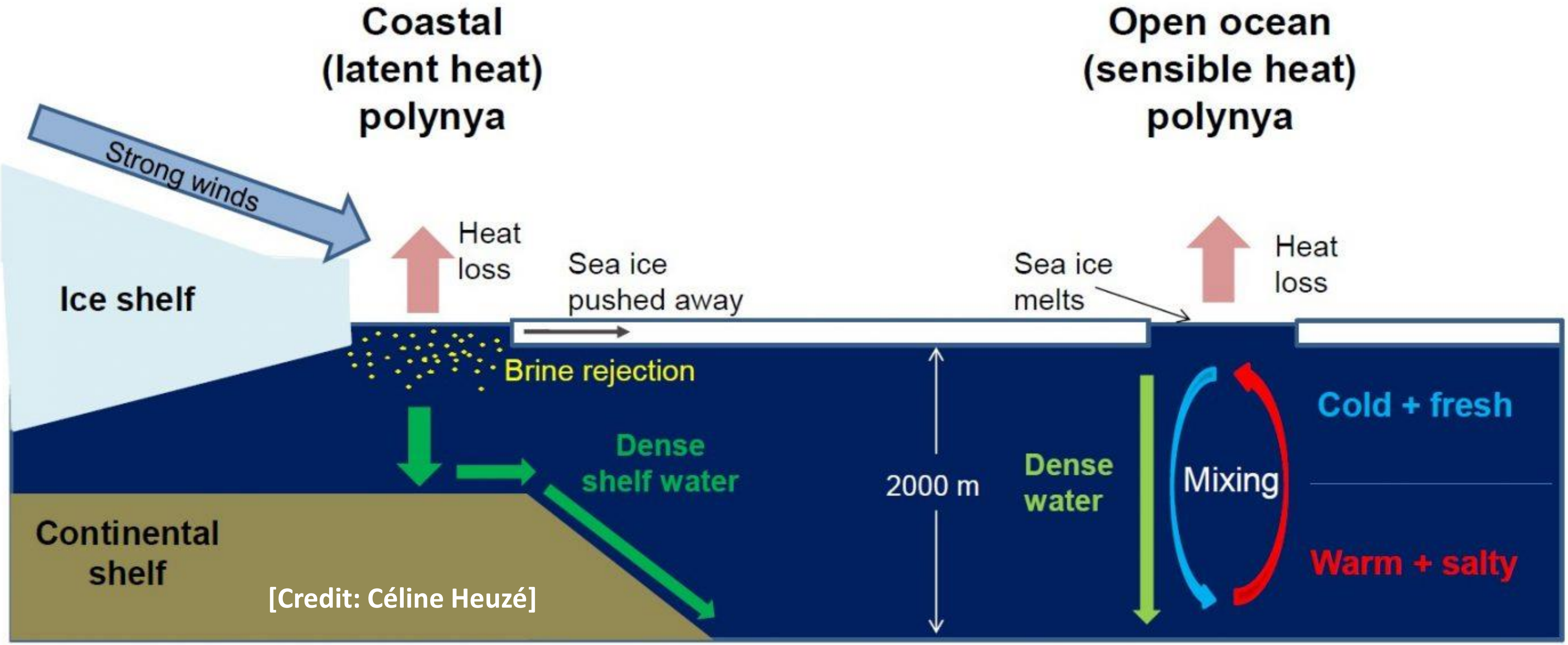
EU Arctic policy

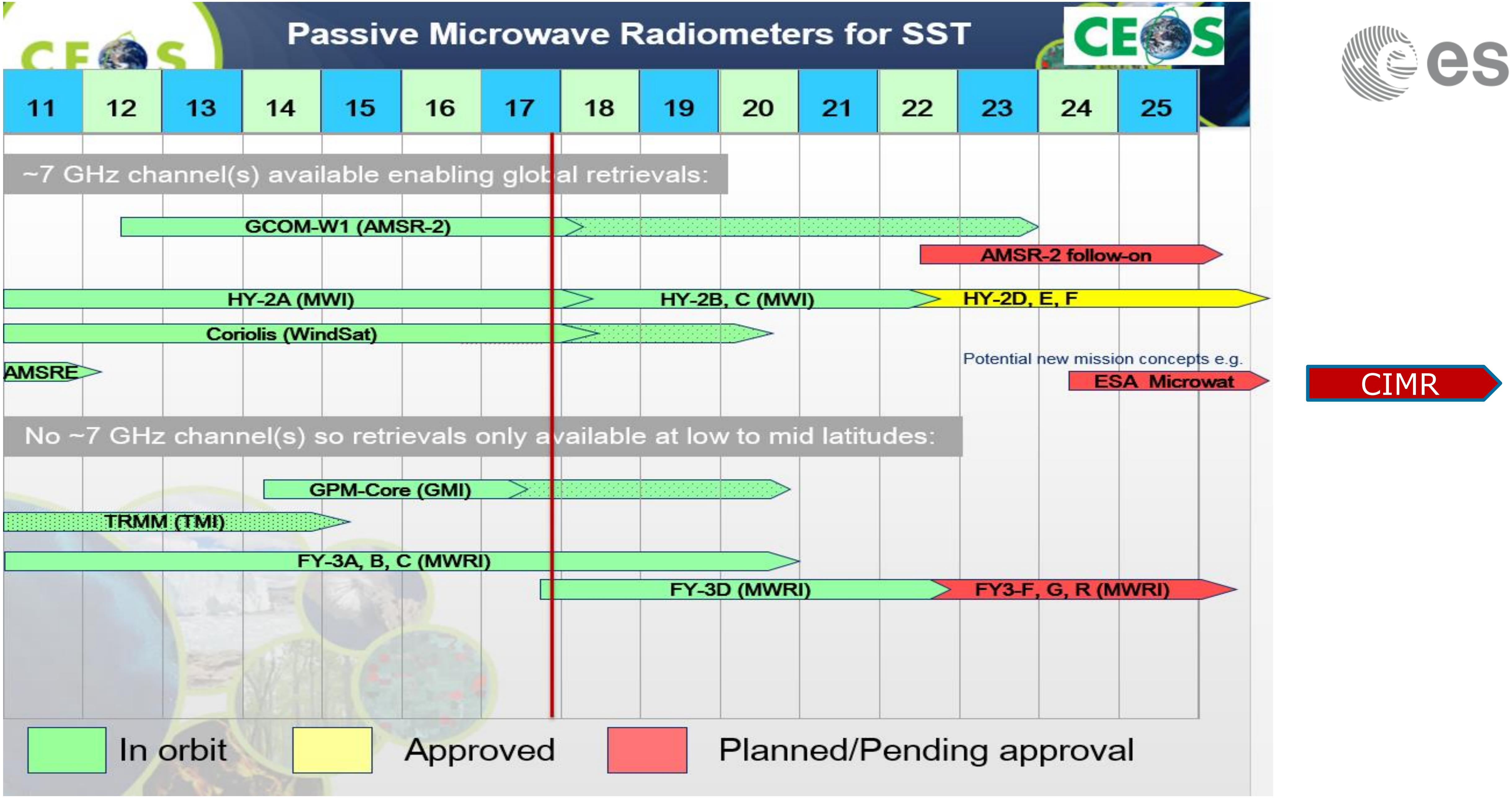
The Copernicus Imaging Microwave Radiometer



- **Polar Oceans are fundamental to understanding the global environment**
- **CIMR will:**
  - **Prevent the anticipated Gap in capability**
  - **Be “ready” for an ice free Arctic**
  - **Key variables:** *Sea Ice Concentration, Sea Surface Temperature, thin Sea Ice Thickness, Sea Surface Salinity, Wind Speed, soil moisture…*
  - Low frequency/High Spatial resolution (5–15 km)
  - **Measurements every ~6 hours** in the Polar regions, no hole at the pole
  - 95% global coverage every day for **application in all Copernicus Services**
- Directly addresses the EU Arctic Policy.
- **A ‘Game Changer’ for Copernicus**
- **100% +Delta**

Arctic Sea Ice




Passive Microwave Radiometers for SST
CEOS
11
12
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14
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20
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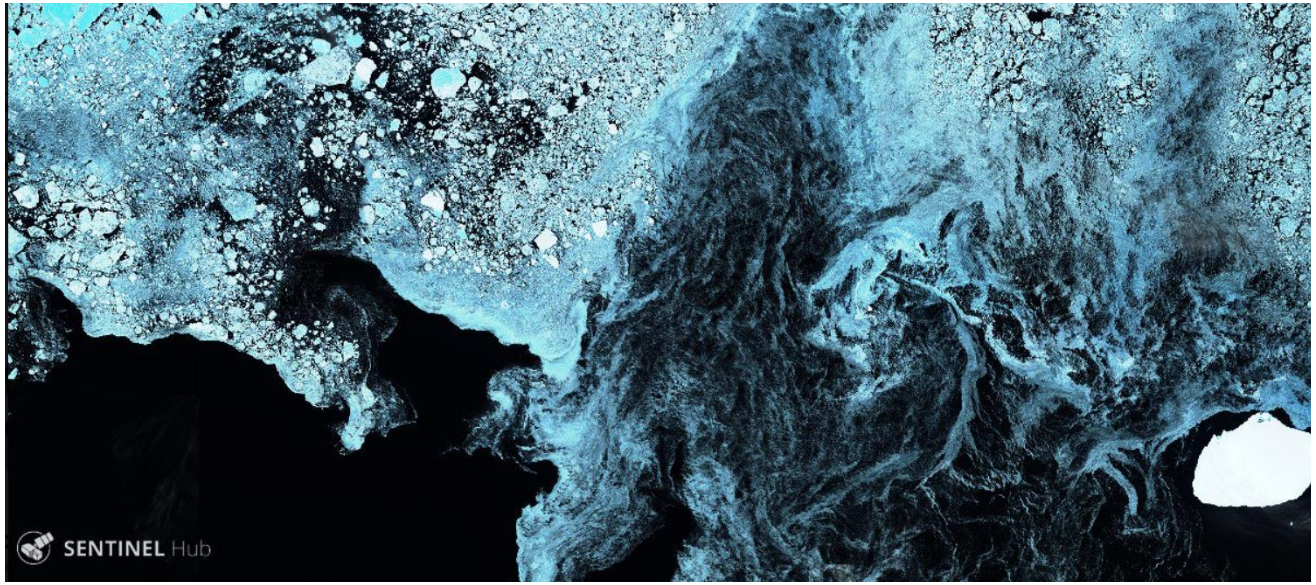
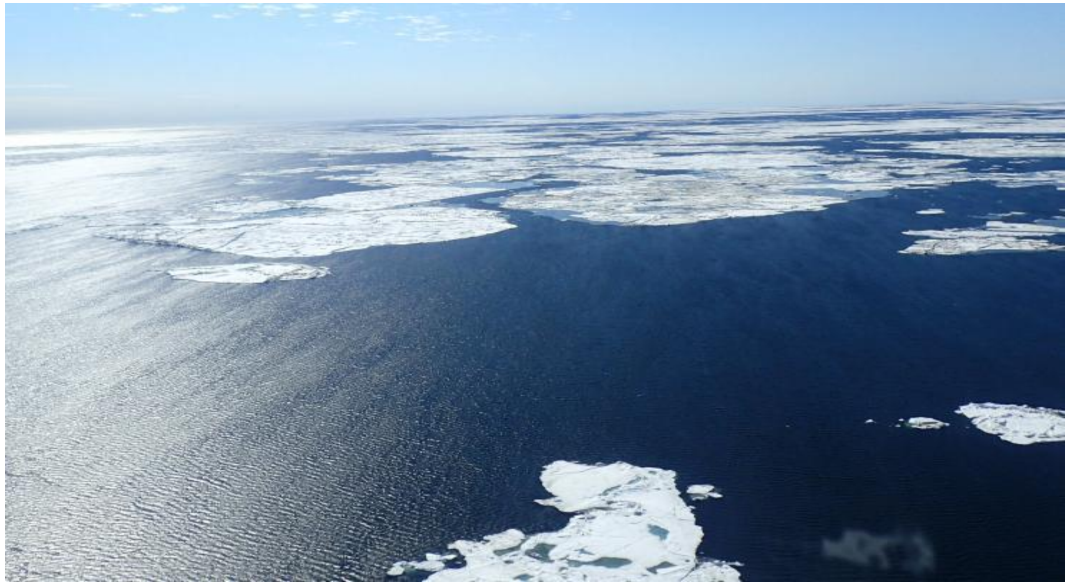
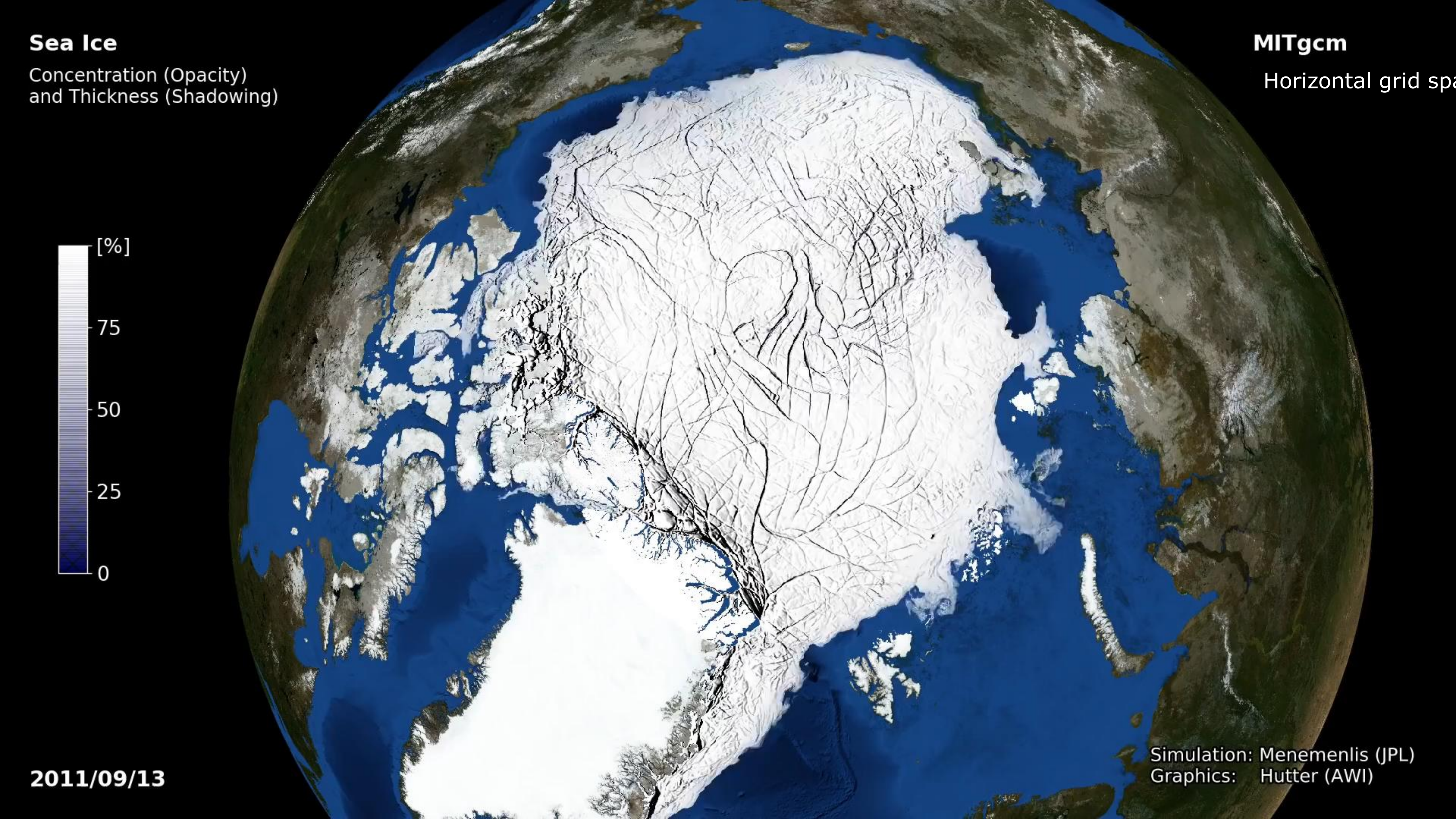
22
23
24
25
~7 GHz channel(s) available enabling global retrievals:
GCOM-W1 (AMSR-2)
AMSR-2 follow-on
HY-2A (MWI)
HY-2B, C (MWI)
HY-2D, E, F
Coriolis (WindSat)
AMSRE
Potential new mission concepts e.g.
ESA Microwat
CIMR
No ~7 GHz channel(s) so retrievals only available at low to mid latitudes:
GPM-Core (GMI)
TRMM (TMI)
FY-3A, B, C (MWRI)
FY-3D (MWRI)
FY3-F, G, R (MWRI)
In orbit
Approved
Planned/Pending approval

Sea Ice spatial characteristics are complex

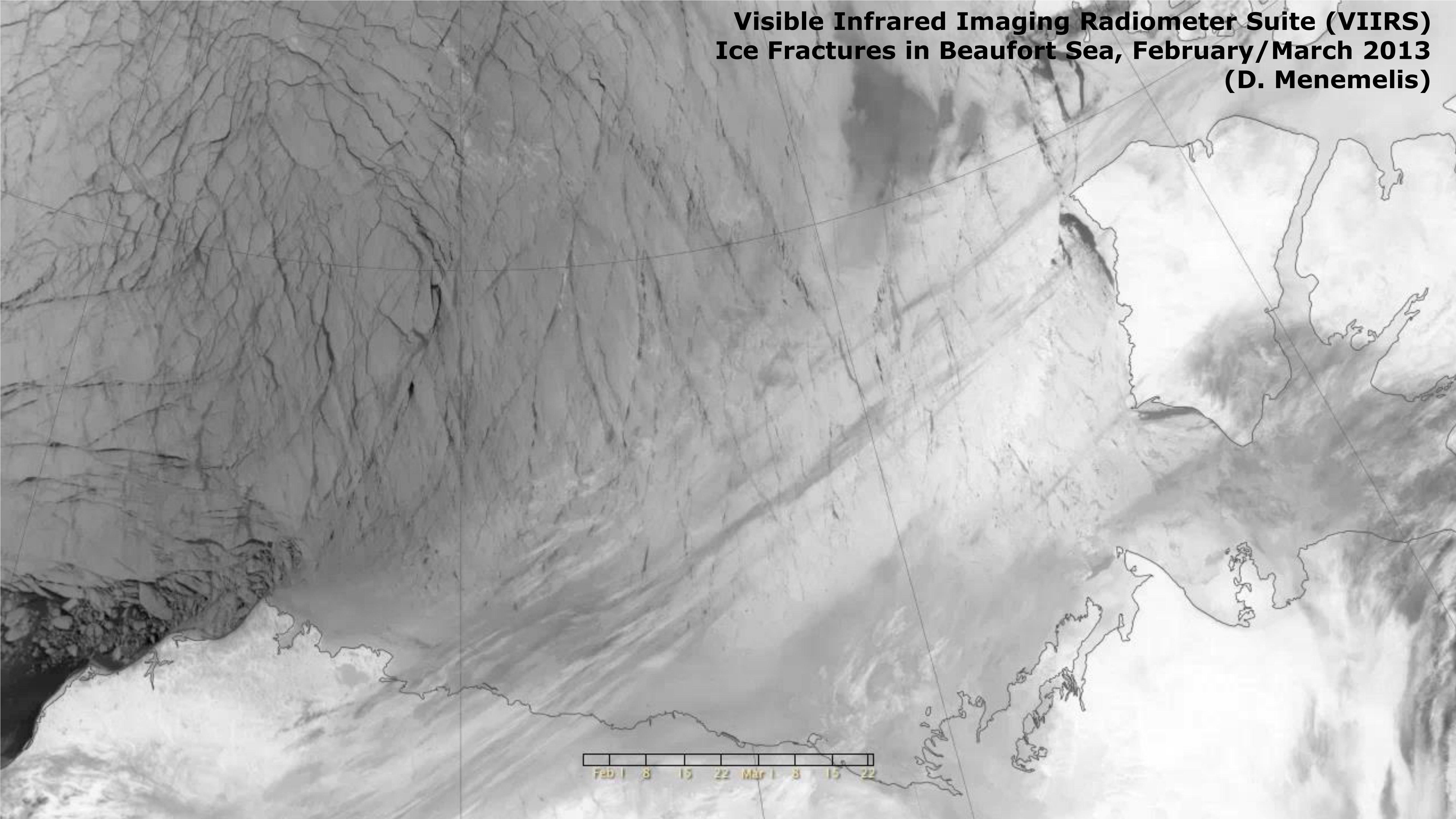






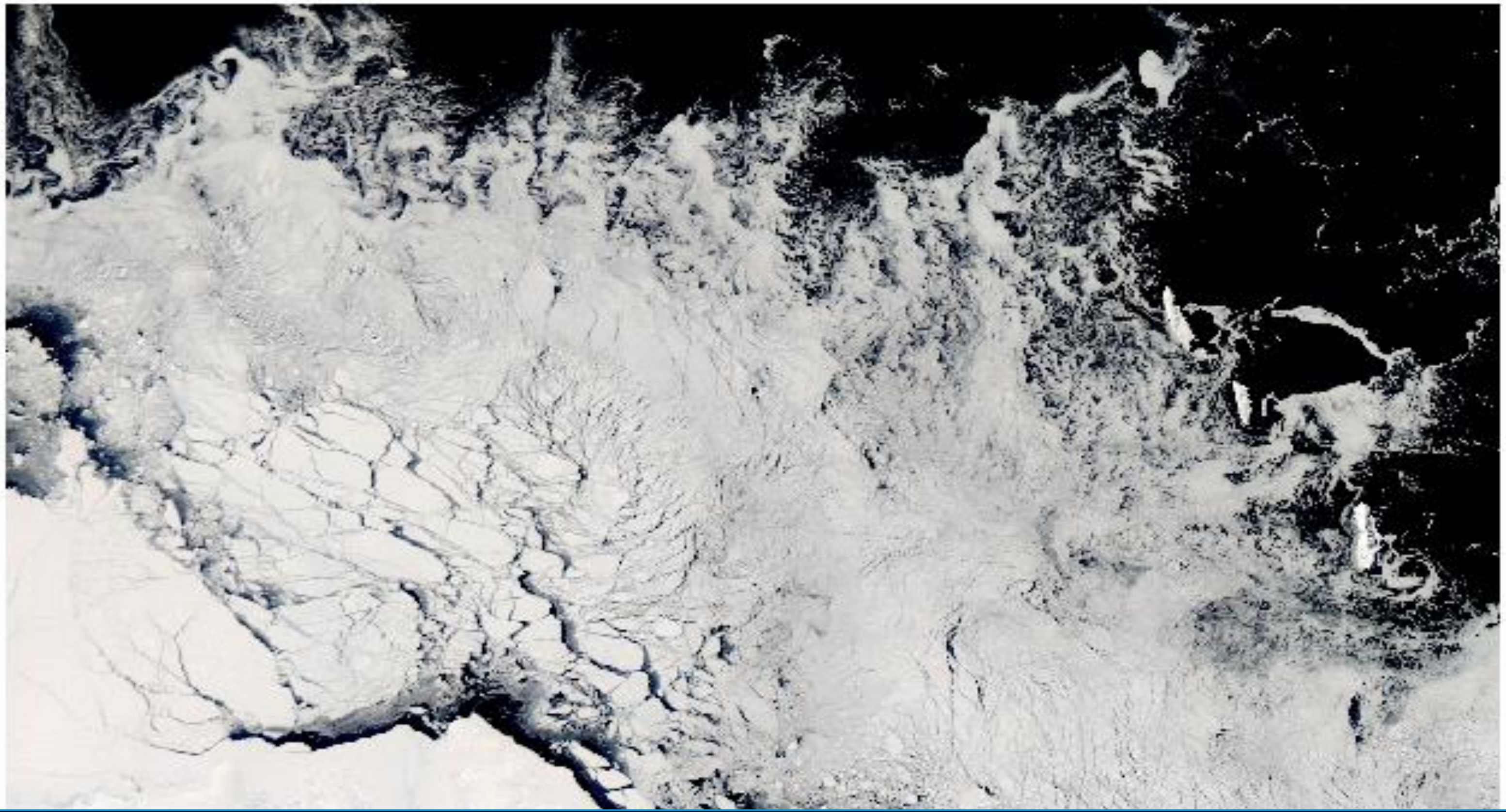

Sea Ice
Concentration (Opacity)
and Thickness (Shadowing)
MITgcm
Horizontal grid
[%]
75
50
25
0
2011/09/13
Simulation: Menemenlis (JPL)
Graphics: Hutter (AWI)

Visible Infrared Imaging Radiometer Suite (VIIRS)
Ice Fractures in Beaufort Sea, February/March 2013
(D. Menemelis)



Drivers: Spatial Resolution

Reference



<=5 km @ Ka (goal: 4km)

<=5 km @ Ku

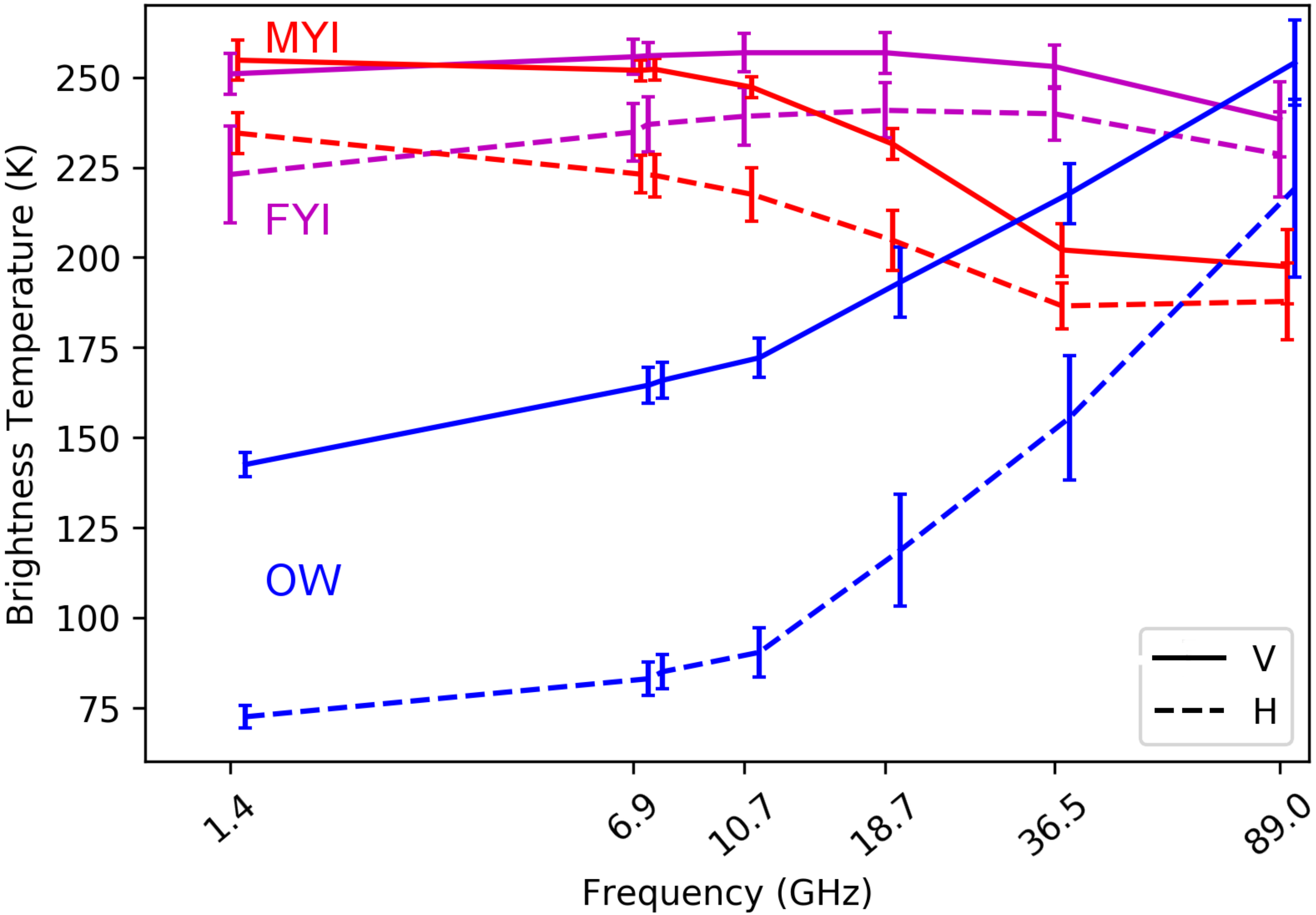
<=15 km @ C/X

DMI
Vejr, klima og hav

(Slide: R. Tonboe)

For Sea Ice concentration (and SST) measurements:
There is a clear need to improve the spatial resolution of Microwave Radiometer measurements

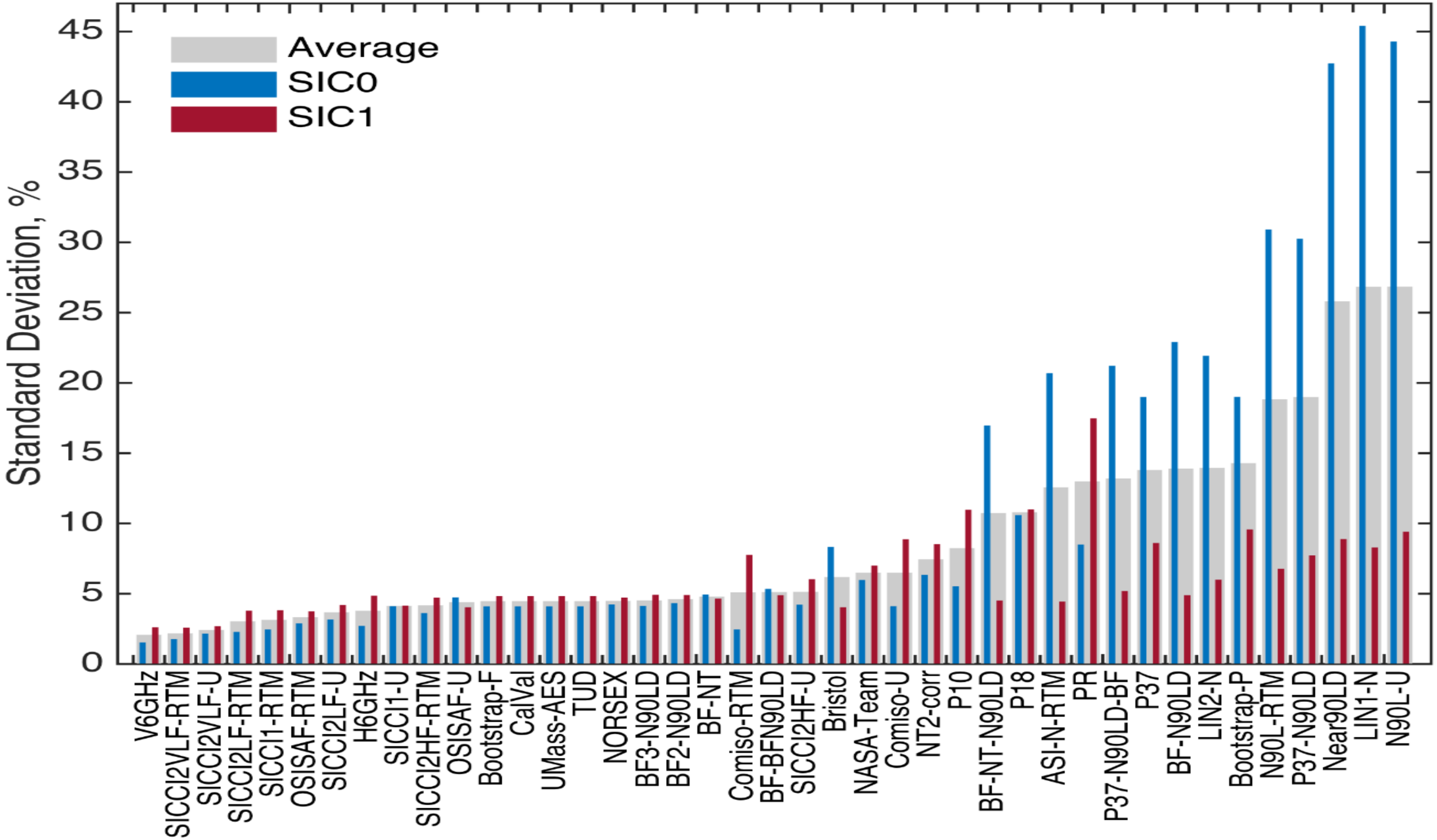
AMSR-E/2 and SMOS Brightness Temperatures of Surface Types



FYI=First-Year Ice
MYI=Multi-Year Ice
OW-=Open Water

V=Vertical Polarization
H=Horizontal Polarization

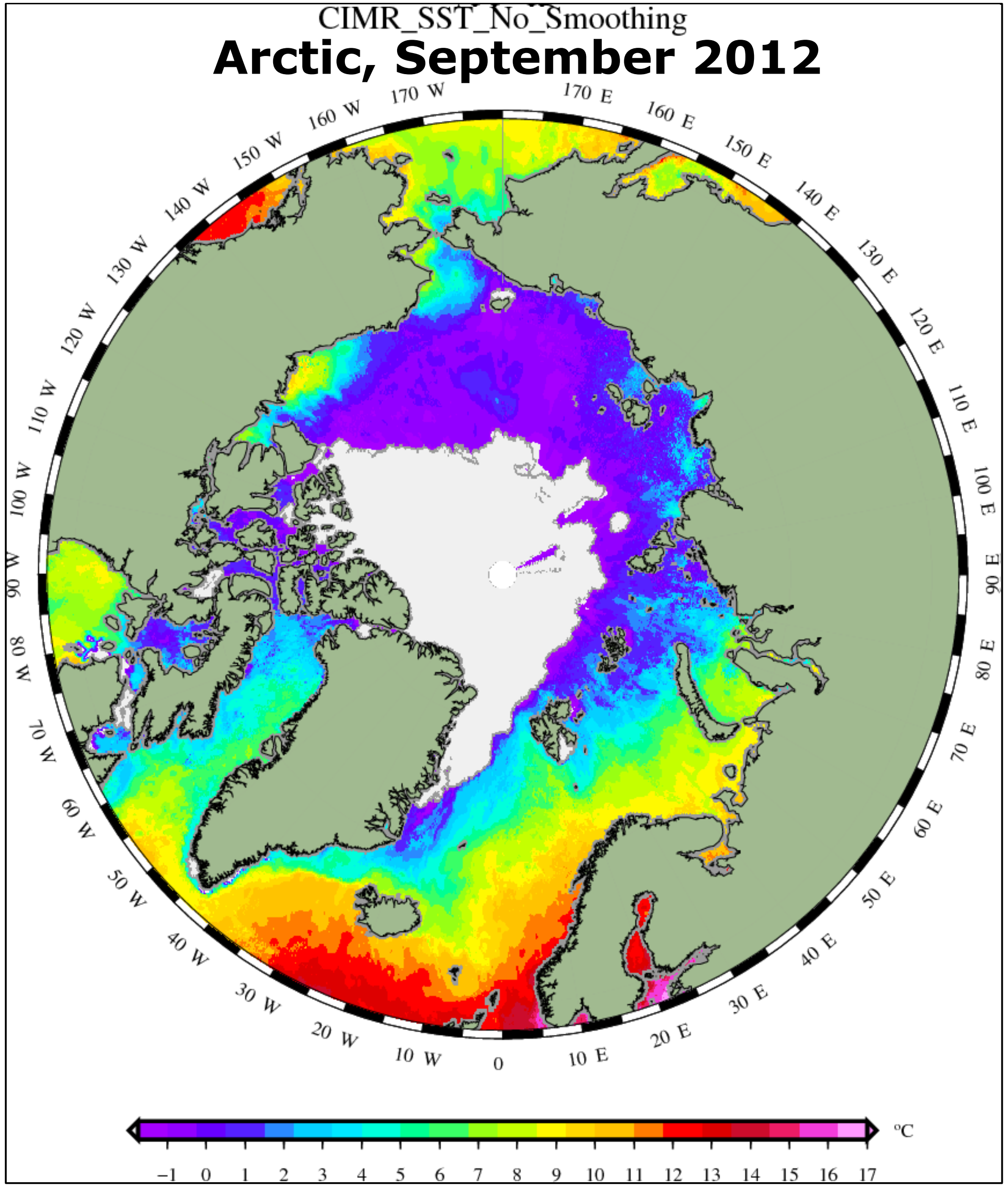
SIC algorithms : all (the best) use Ka



Sea Surface Temperature

- Workhorse thermal Infrared Measurements of SST cannot ”see” through clouds
- C- and X-band microwave measurements are sensitive to SST and are not affected by cloud.
- Many areas are persistently covered by cloud!
- “Clear sky bias” in climate record

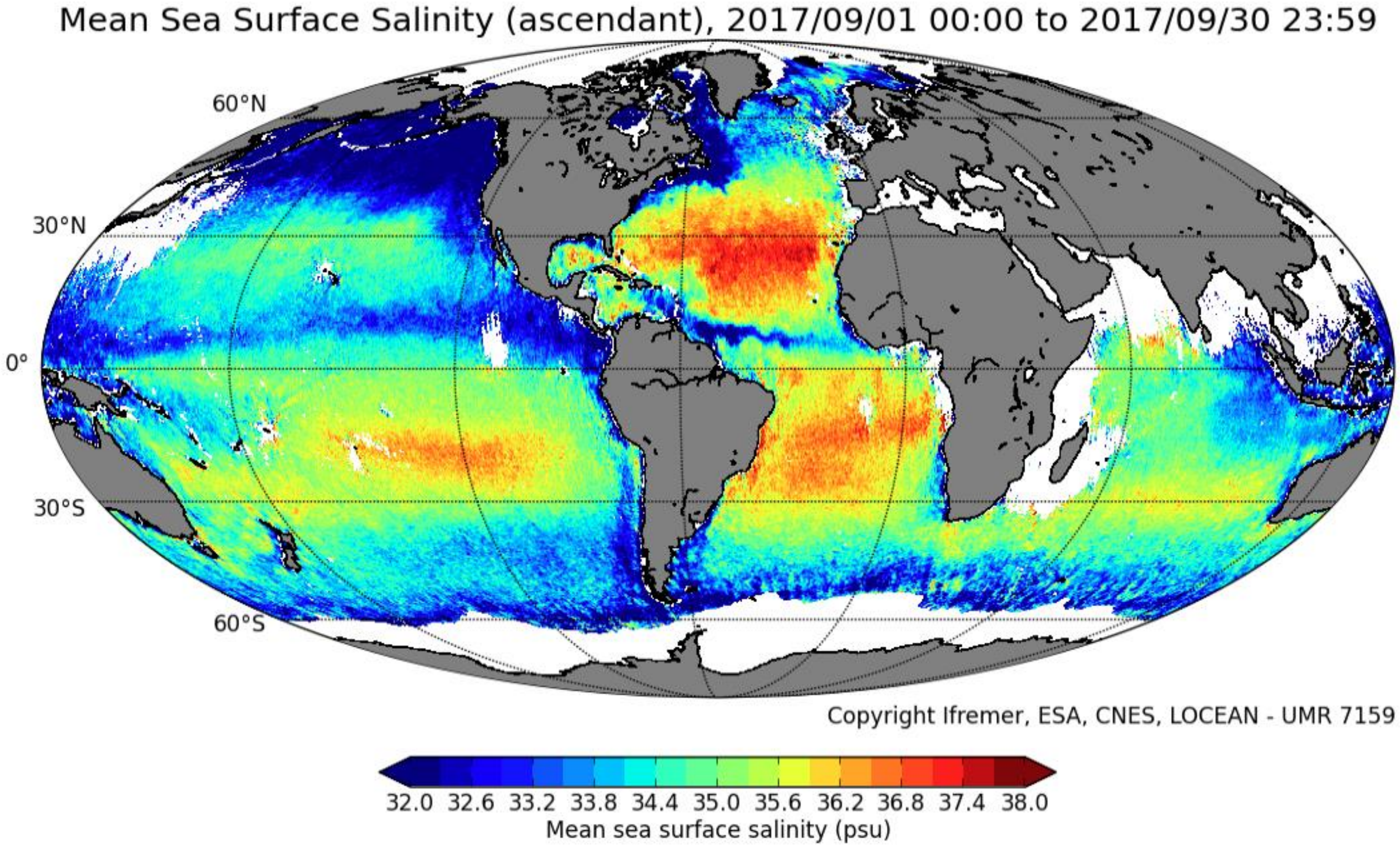
•CIMR Delta for Copernicus = 100%



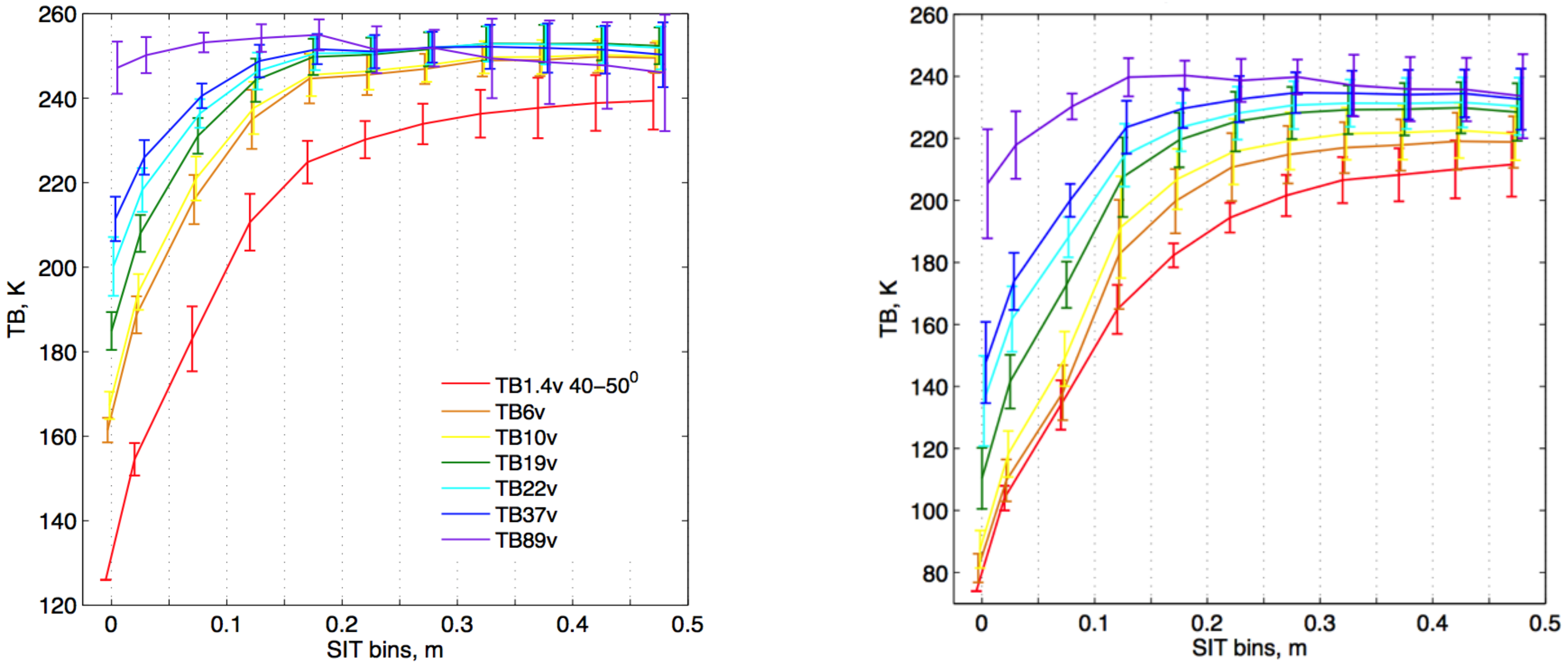
Høyer, Jacob (2018): IR versus PMW SST coverage in the Arctic, September 2012.

https://doi.org/10.6084/m9.figshare.6969422.v1

Sea Surface Salinity (following SMOS, SMAP)

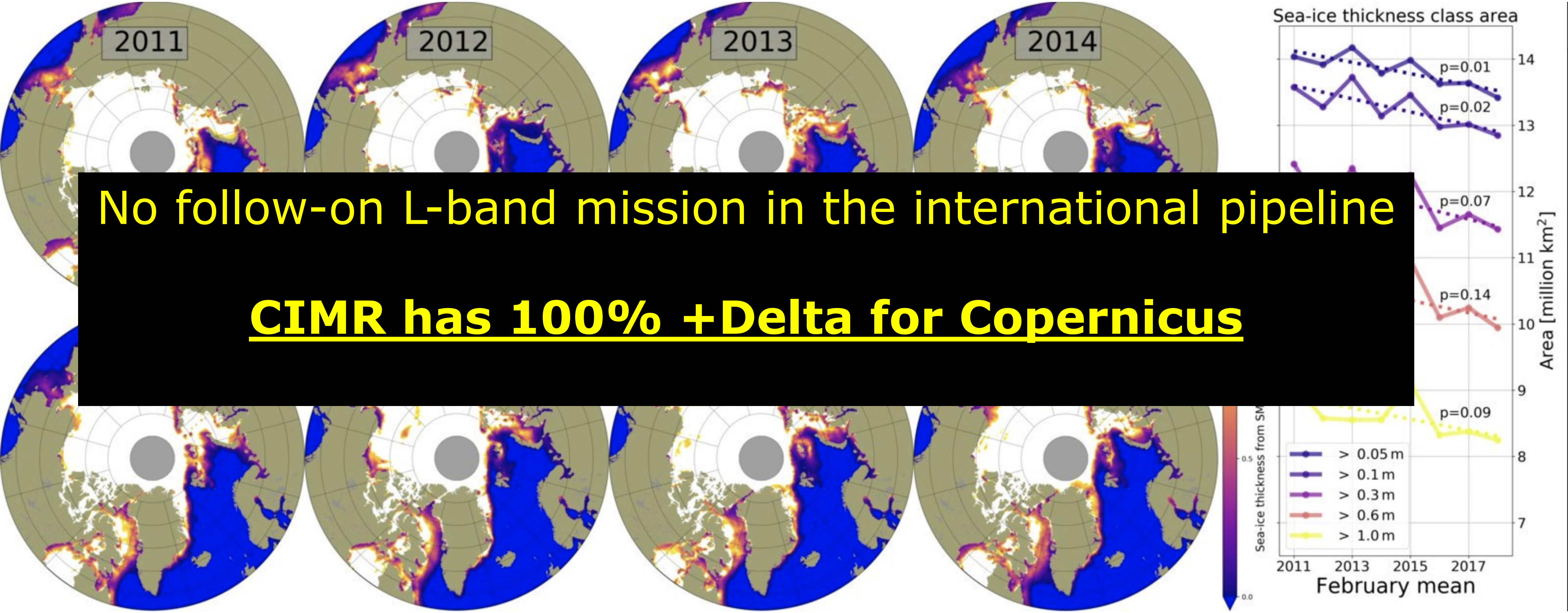


SIT Algorithms channel selection



Vertically (left), horizontally (right) polarized brightness temperatures as function of sea ice thickness for various frequencies (from *Heygster et al,* 2014). The best performing frequency for thin sea ice determination is 1.4 GHz.

L-band sea ice thickness estimates (SMOS/SMAP)



No follow-on L-band mission in the international pipeline

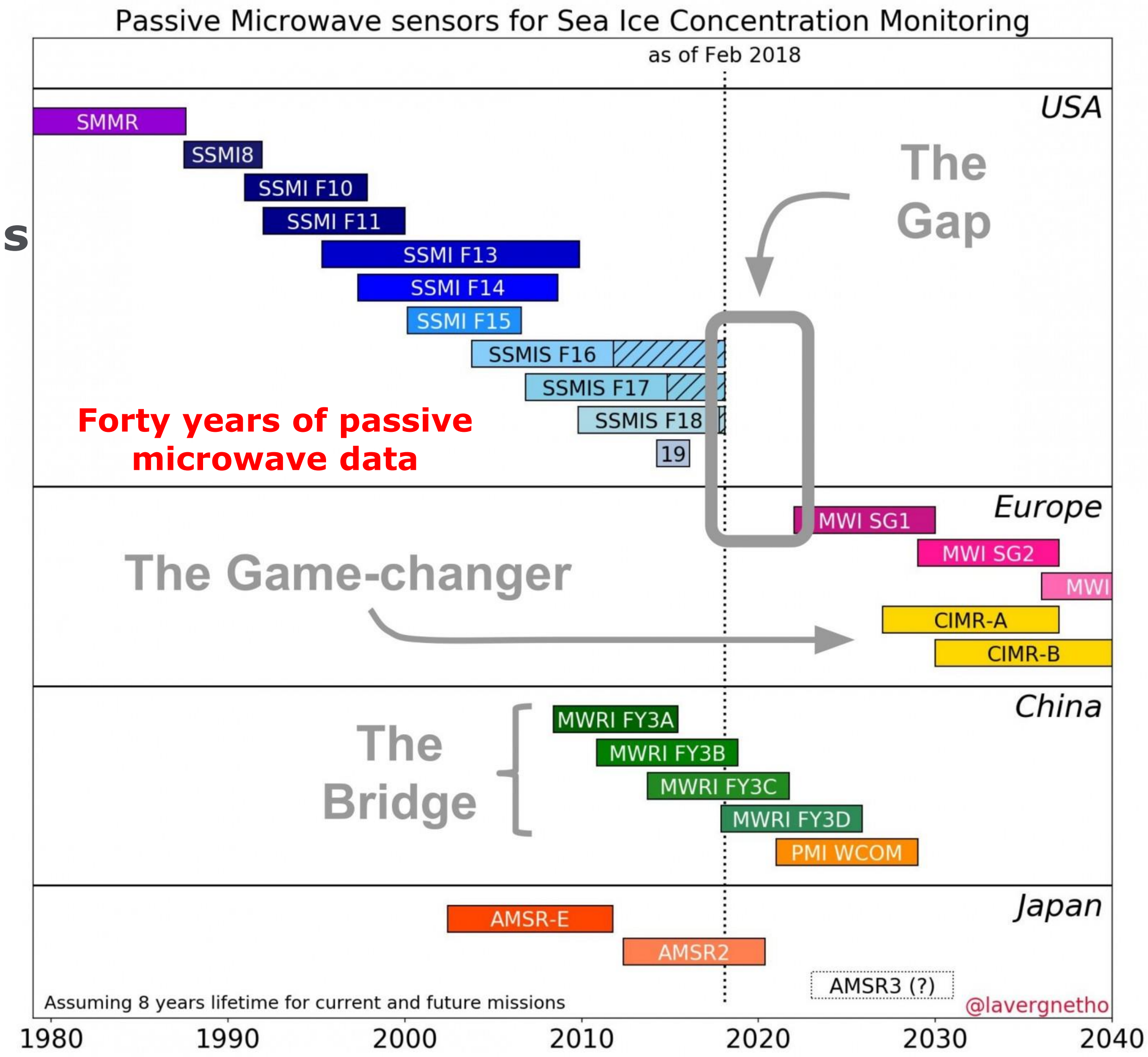
CIMR has 100% +Delta for Copernicus

Lars Kaleschke @seaice_de

Why is CIMR a **High Priority** Copernicus Expansion Mission?

1. Copernicus does not include a microwave imager – yet **CMEMS and 3CS rely on JAXA research missions** for SIC and SST.
2. **Likely that no low-frequency (L to X-band) measurements will be available from space in the 2020+** time frame
3. **MetOp-SG(B) has no channels <18.7GHz and spatial resolution does not satisfy Copernicus needs (50 km)**
4. China's MWRI is a bridge over the SIC data gap (no SST).

- **CIMR Delta for Copernicus = 100%**



https://blogs.egu.eu/divisions/cr/2018/02/09/image-of-the-week-the-gap-the-bridge-and-the-game-changer/

CIMR Primary Objectives

The Aim of the CIMR Mission is to:

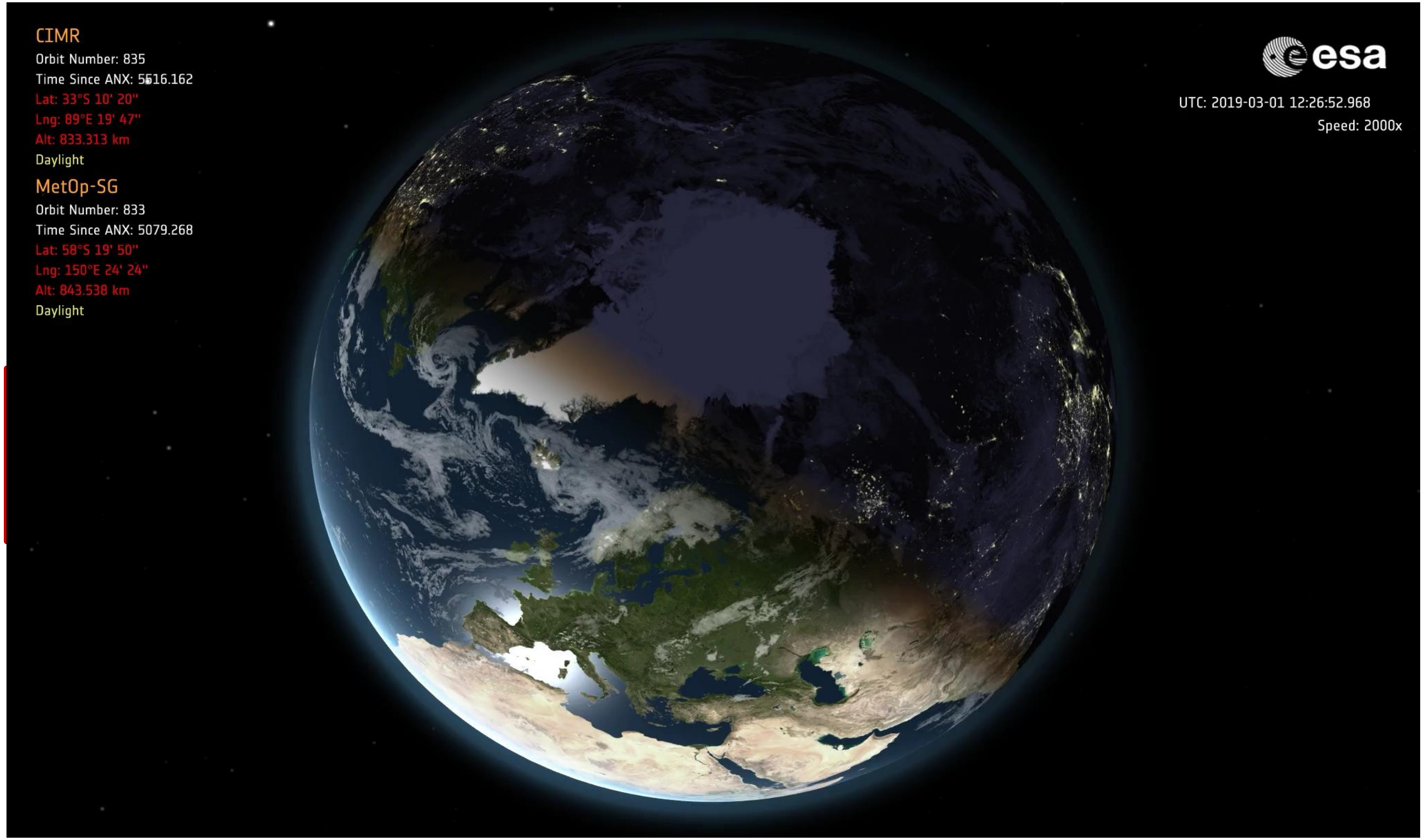
Provide ***high-spatial resolution microwave imaging radiometry measurements & derived products*** *with* ***global coverage*** *and* ***sub-daily revisit in the Polar regions*** *to address Copernicus user needs & the Integrated EU Arctic Policy*

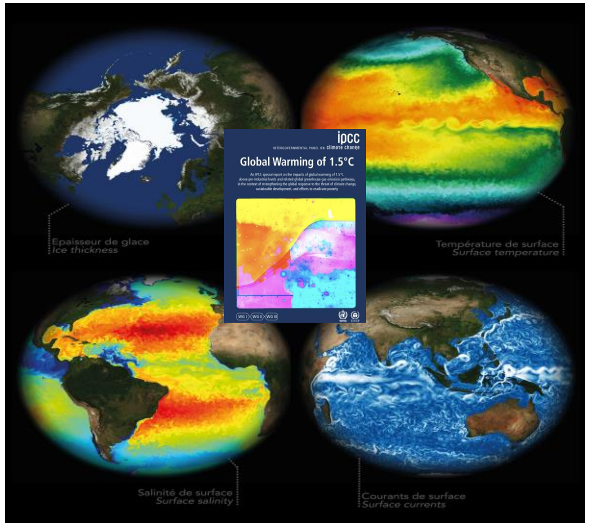
- **PRI-OBJ-1:** Measure **all-weather Sea Ice Concentration** (SIC) and **Sea Ice Extent** (SIE) at a spatial resolution of ≤5 km, with a total standard uncertainty of ≤5%, and **sub-daily coverage** of the Polar Regions and daily coverage of Adjacent Seas [AD-1], [AD-2] and [AD-3].

- **PRI-OBJ-2:** Measure **all-weather Sea Surface Temperature** (SST) at an effective spatial resolution of ≤15 km, with a total standard uncertainty of ≤0.2 K [AD-1] and focussing on **sub-daily coverage** of Polar Regions and daily coverage of Adjacent Seas [AD-1], [AD-2] and [AD-3].

- **PRI-OBJ-3:** Ensure European **continuity of an AMSR-type capability** in synergy with other missions [AD-2] (eg. MetOp-SG(B)).

Copernicus Imaging Microwave Radiometer (CIMR)





Atmosphere (CAMS) | Marine (CMEMS) | Land (CLMS) | Climate (C3S) | Emergency (EMS) | Security

CIMR Channel selection

1.4145 GHz @<60 km: SIT, SIC, SSS, WS, SM, SD

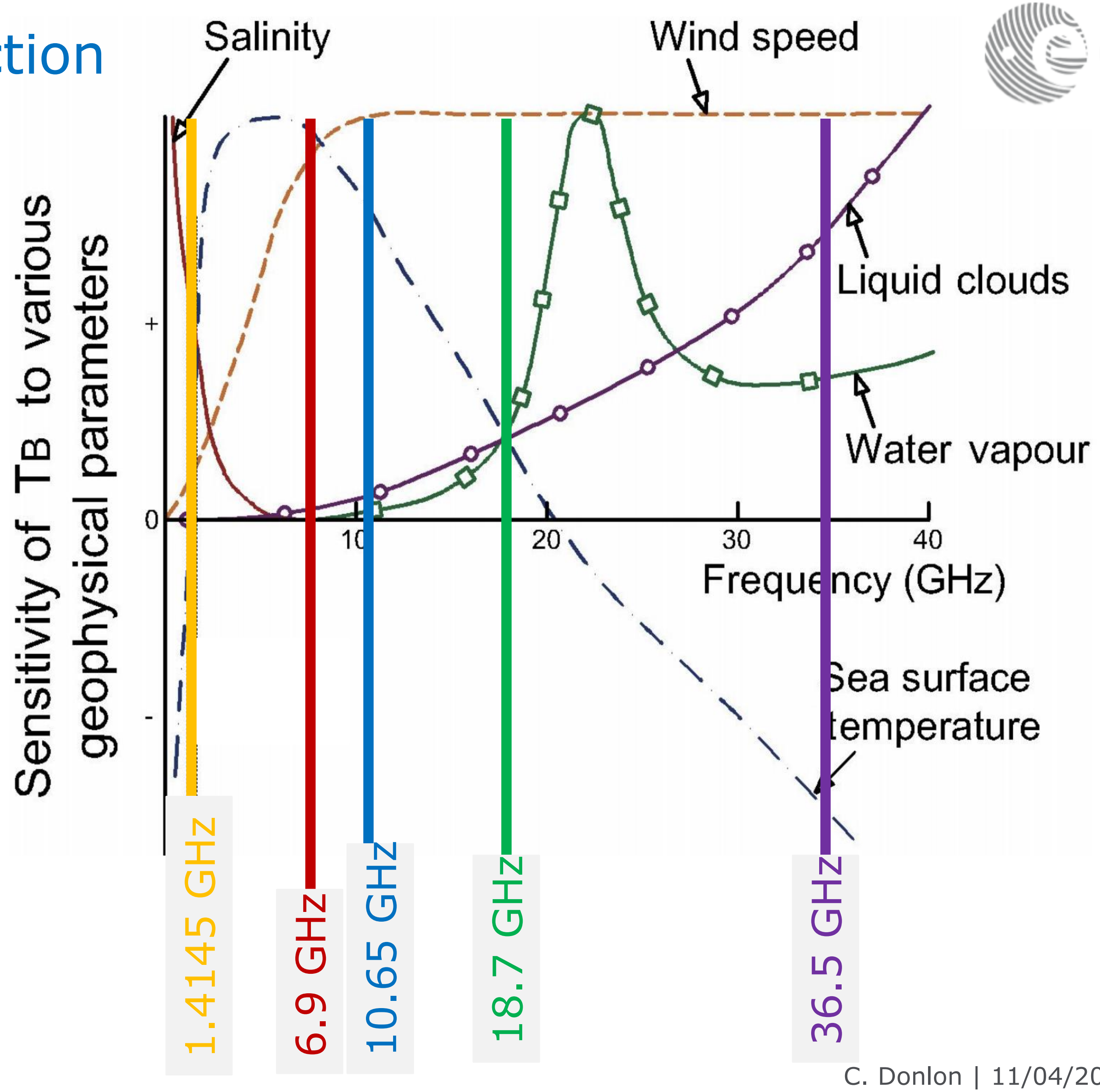
6.9 GHz @<15 km: SIC, SST, SIT, IST, WS, SID, SM, SD

10.65 GHz @<15 km: SST, PCP, WS, SD, SM

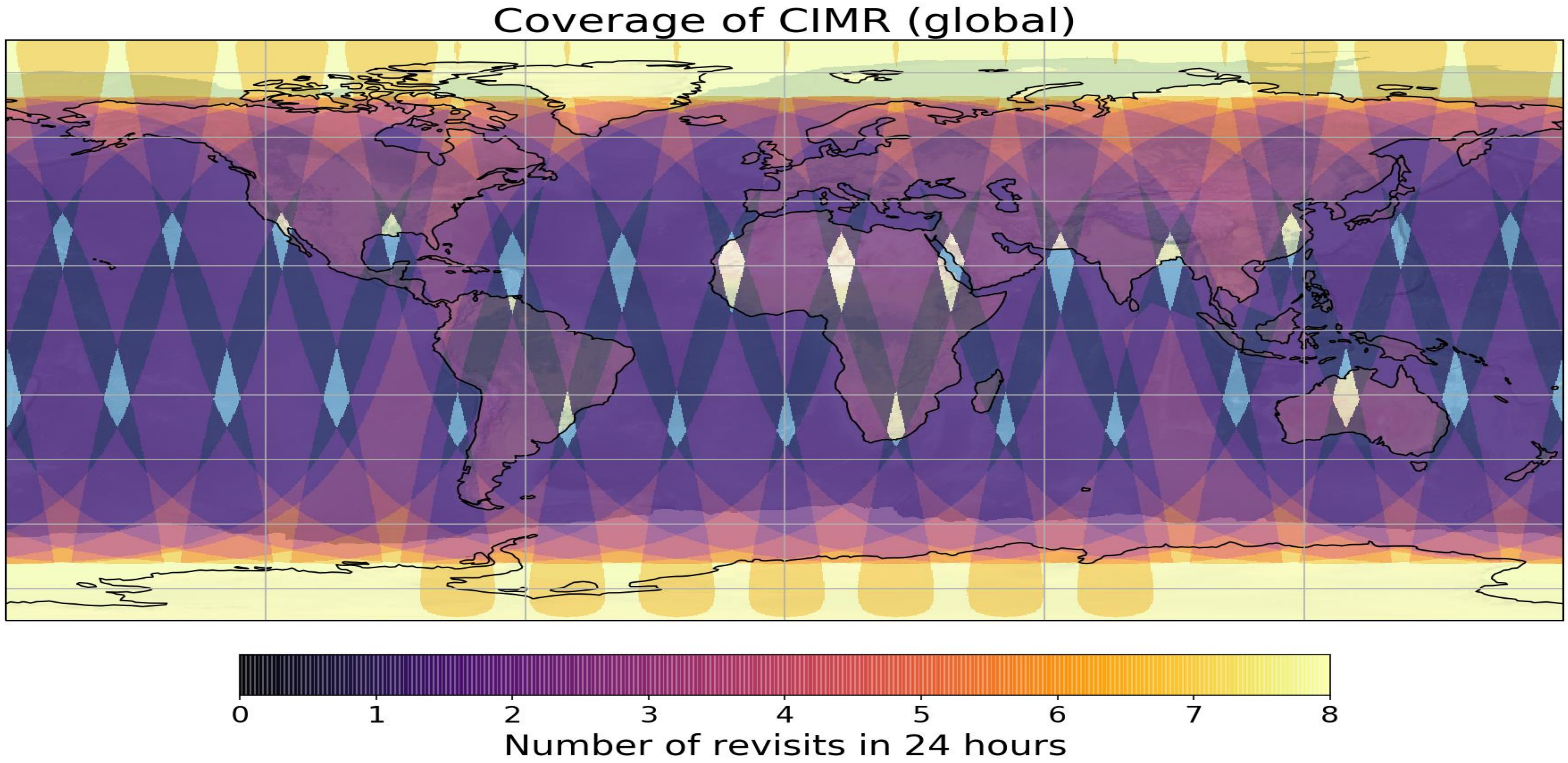
18.7 GHz @5 km: TWV, TCWV, PCP, SIC, SD, SM, SID

36.5 GHz @<5 km: SIC, SST, TWV, TCWV, PCP, SIC, SWE, SD

SIC = Sea Ice Concentration, SST = Sea Surface Temperature, SIT = Sea Ice thickness, SSS= Sea Surface Salinity, WS = Wind speed, TWV = Total Water Vapour, TCWV = Total Cloud-liquid Water Vapour, SD = Snow Depth, SM = Soil Moisture, SWE = Snow Water Equivalent, SID = Sea Ice Drift, PCP=precipitation

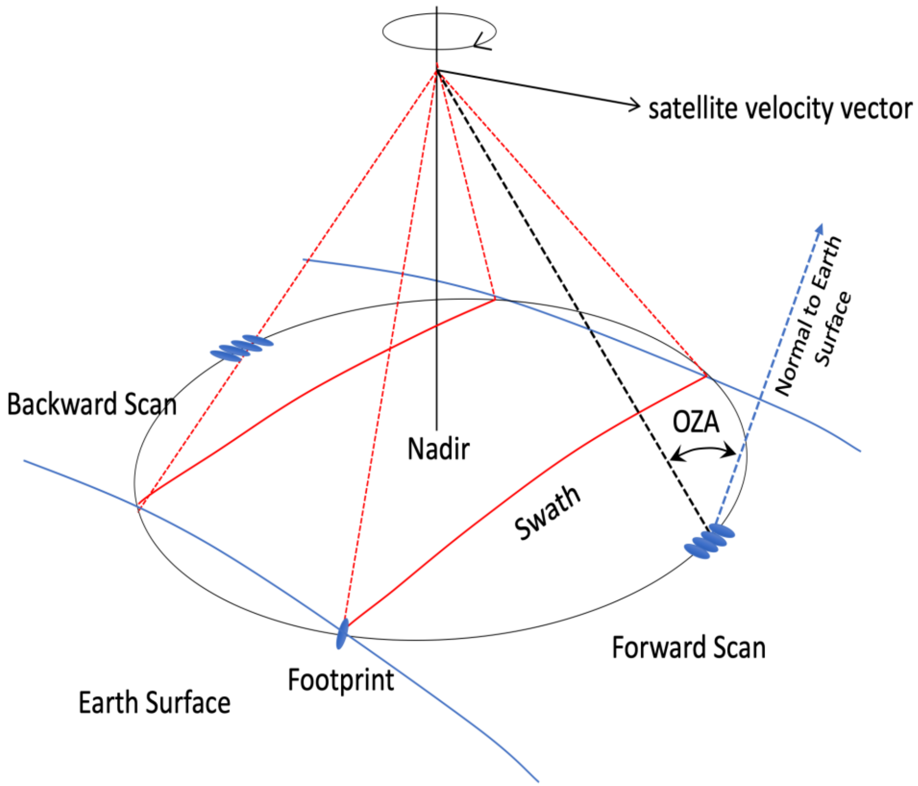


Polar Coverage & Revisit

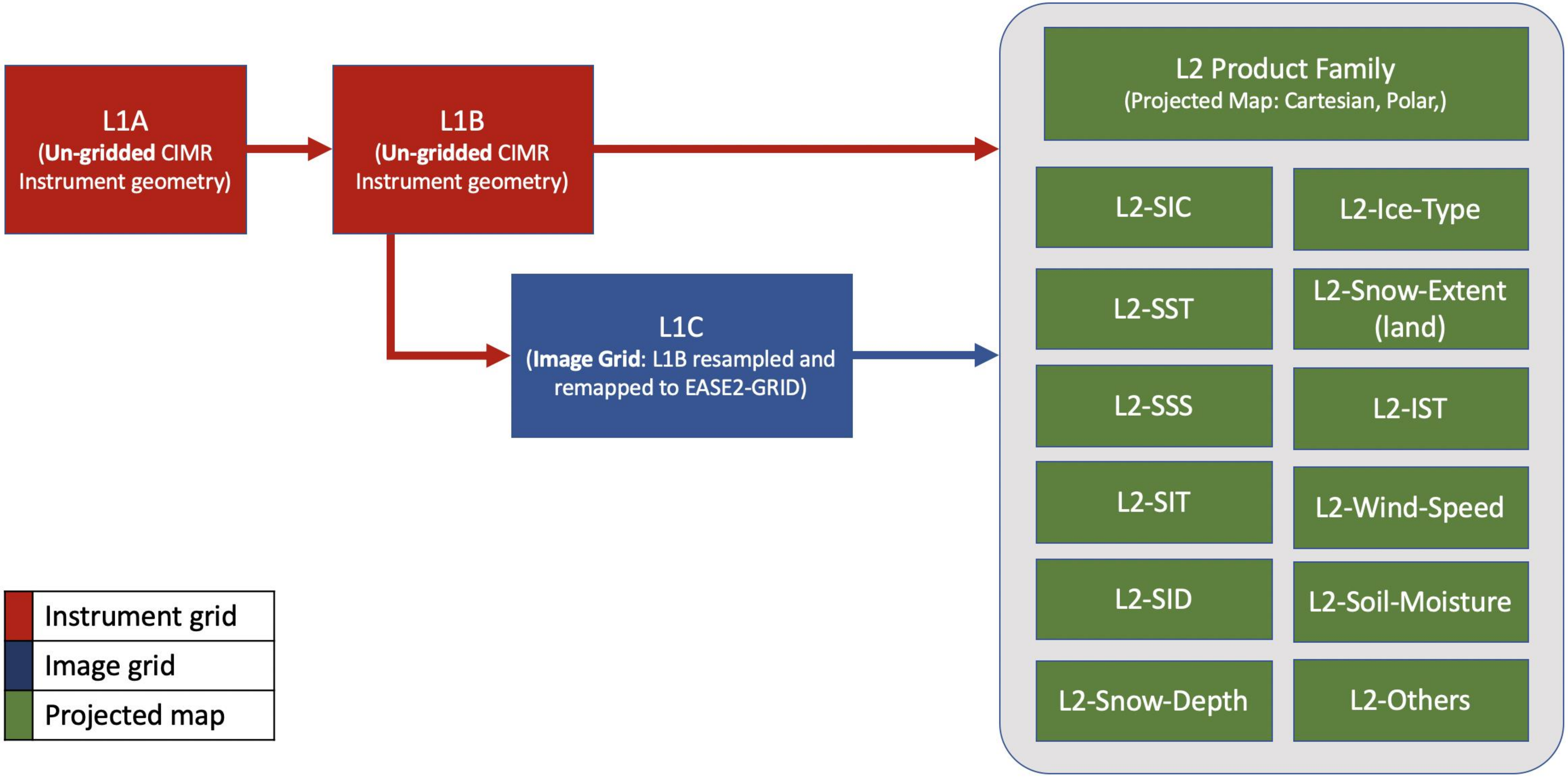


CIMR: Requirements Specification

Label	Priority	Primary	Primary	Primary	Primary	Primary
ID-080-1-1	Addressing CIMR Objectives	ALL	ALL	ALL	ALL	ALL
ID-080-1-2 *(MRD-140)*	Band centre frequency [GHz]	1.413	6.925	10.65	18.7	36.5
ID-080-1-3 *(MRD-270)*	Maximum allocated Bandwidth [MHz]	27	650	100	200	1000
ID-080-1-4 *(MRD-190)*	Footprint Size [km] (see definition)	<60[14]	≤15	≤15	≤5.5	≤5 (goal=4)
ID-080-1-5 *(MRD-280)*	Radiometric resolution [K] NEΔT for zero mean, 1-sigma at 150 K	≤0.3	≤0.2	≤0.3	≤0.4 (goal: ≤0.3)	≤0.7
ID-080-1-6 *(MRD-290)*	Dynamic Range [K]	Kmin=2.7, Kmax=340				
ID-080-1-7 *(MRD-300, MRD-310, MRD-320)*	Radiometric Total Standard Uncertainty[15] [K, zero mean, 1-sigma)]	≤0.5	≤0.5 (goal ≤0.4)	≤0.5 (goal: ≤0.45)	≤0.6 (goal: ≤0.5)	≤0.8
ID-080-1-8 *(MRD-410, MRD-420, MRD-510)*	Polarisation	Acquisition in Vertical and Horizontal with provision of Full Stokes based on computation.				
ID-080-1-9 *(MRD-060)*	Swath width [km]	>1900				
ID-080-1-10 *(MRD-160, MRD-530)*	Observation Zenith Angle [deg]	55.0 ±1.5				
ID-080-1-11 *(MRD-330)*	Radiometric stability over lifetime [K, zero mean, 1-sigma]	≤0.2	≤0.2	≤0.2	≤0.2	≤0.2
ID-080-1-12 *(MRD-340, MRD-350)*	Radiometric stability over orbit [K, zero mean, 1-sigma]	≤0.2	≤0.1	≤0.1	≤0.2	≤0.2
ID-090-1-13 *(MRD-520)*	Geolocation uncertainty [km]	≤1/10 of the footprint size				



CIMR: Product Definitions



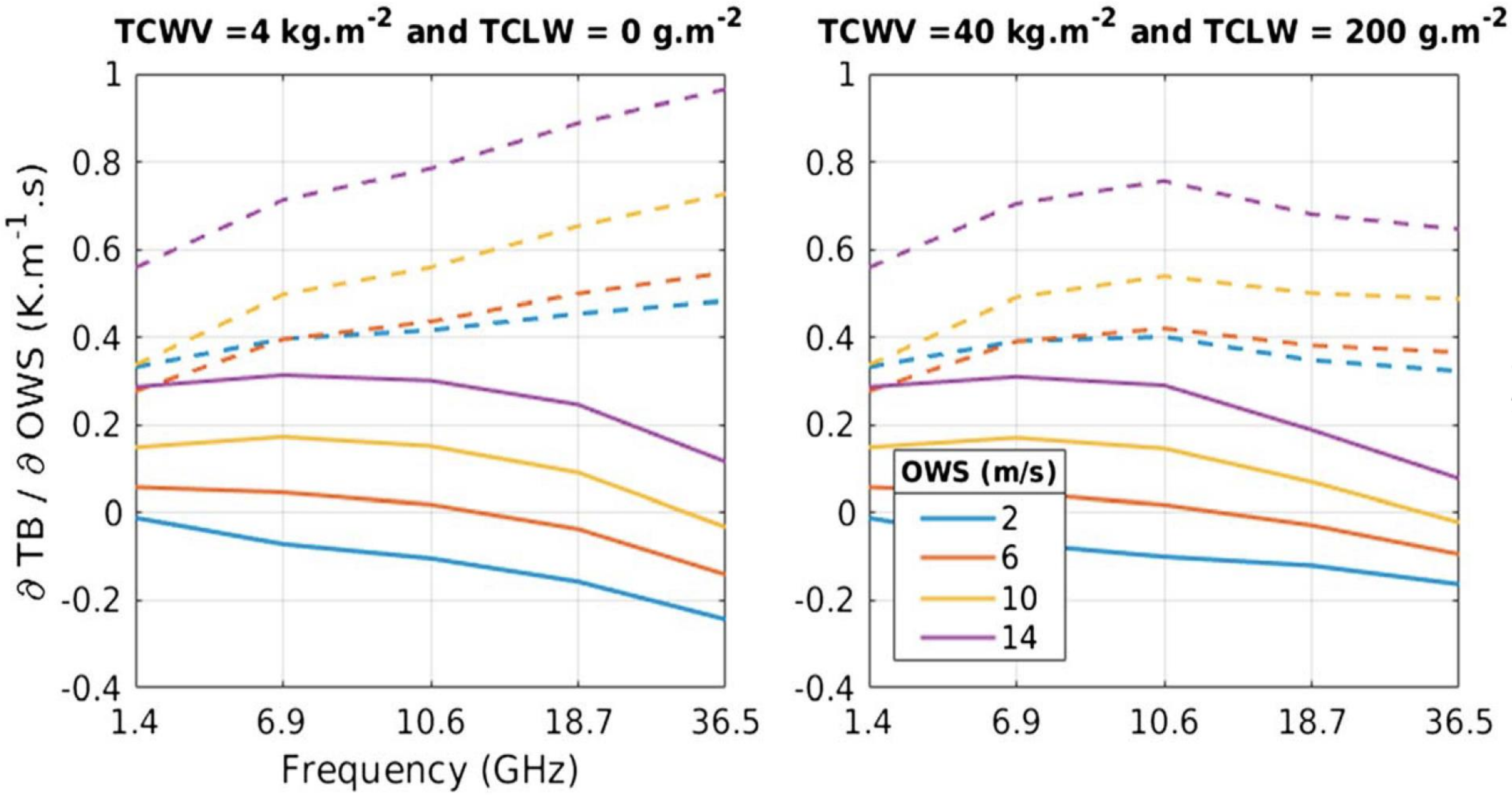


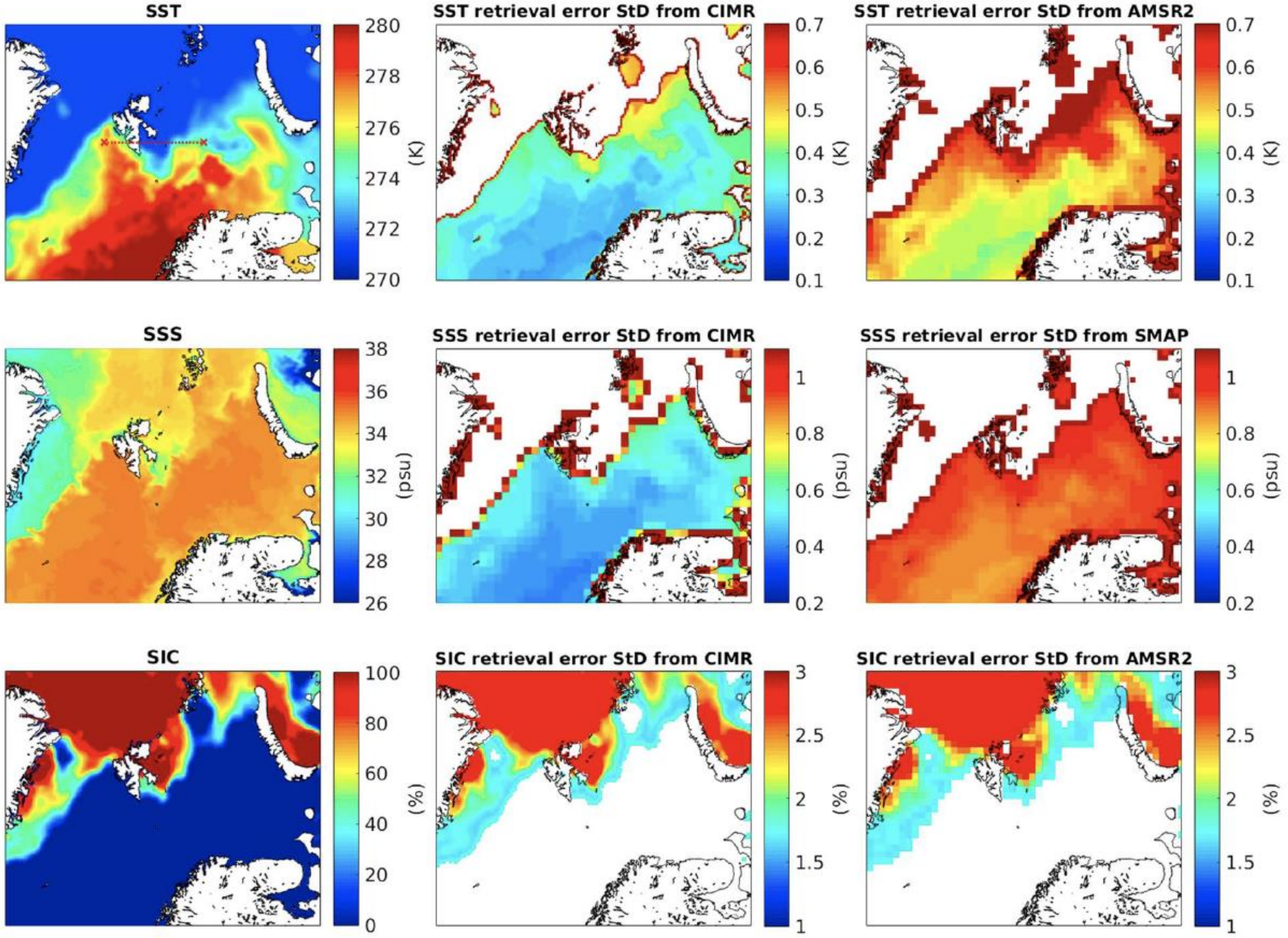
Figure 2. The OWS Jacobians at the Copernicus Imaging Microwave Radiometer channels and at an incidence angle of 55° for different OWSs (colors), TCWV contents, and TCLW contents. Vertical and horizontal polarizations are, respectively, plotted as solid lines and dashed lines. The SST is set at 285 K, and the SSS is set at 36 psu. OWS = ocean wind speed; TB = brightness temperature; TCWV = Total Column Water Vapor; TCLW = Total Column Liquid Water.

Journal of Geophysical Research: Oceans

Expected Performances of the Copernicus Imaging Microwave Radiometer (CIMR) for an All-Weather and High Spatial Resolution Estimation of Ocean and Sea Ice Parameters

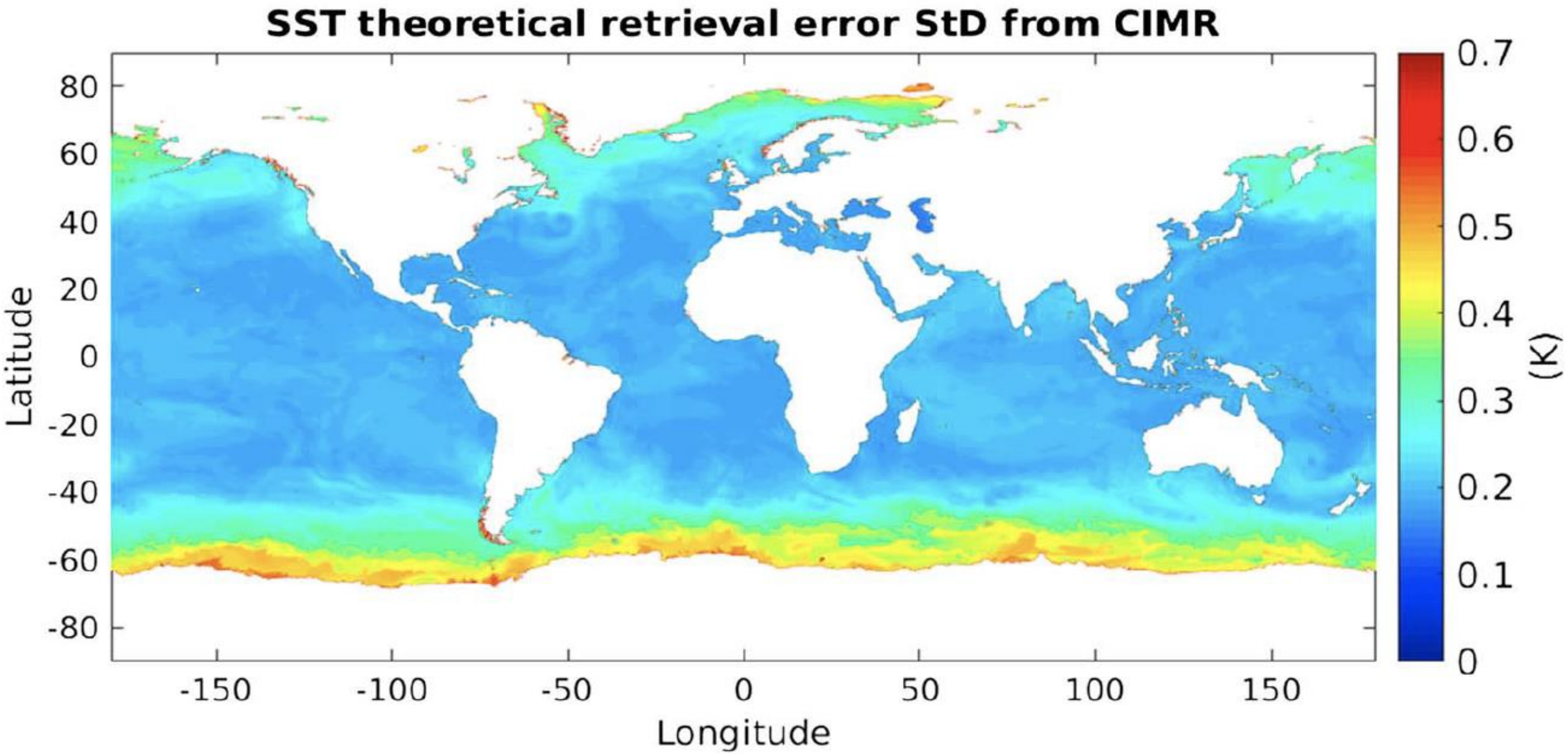
Lise Kilic[1], Catherine Prigent[1,2], Filipe Aires[1,2], Jacqueline Boutin[3], Georg Heygster[4], Rasmus T. Tonboe[5], Hervé Roquet[6], Carlos Jimenez[1,2], and Craig Donlon[7]

CIMR: Anticipated performance



- The SST, SSS, and SIC fields at 2-km resolution on 15 June 2008
- CIMR Theoretical retrieval error StD SST (top), SSS (middle), SIC (bottom) for CIMR column)
- AMSR2/SMAP Theoretical retrieval error StD SST (top), SSS (middle), SIC (bottom) for CIMR column)

SST performance



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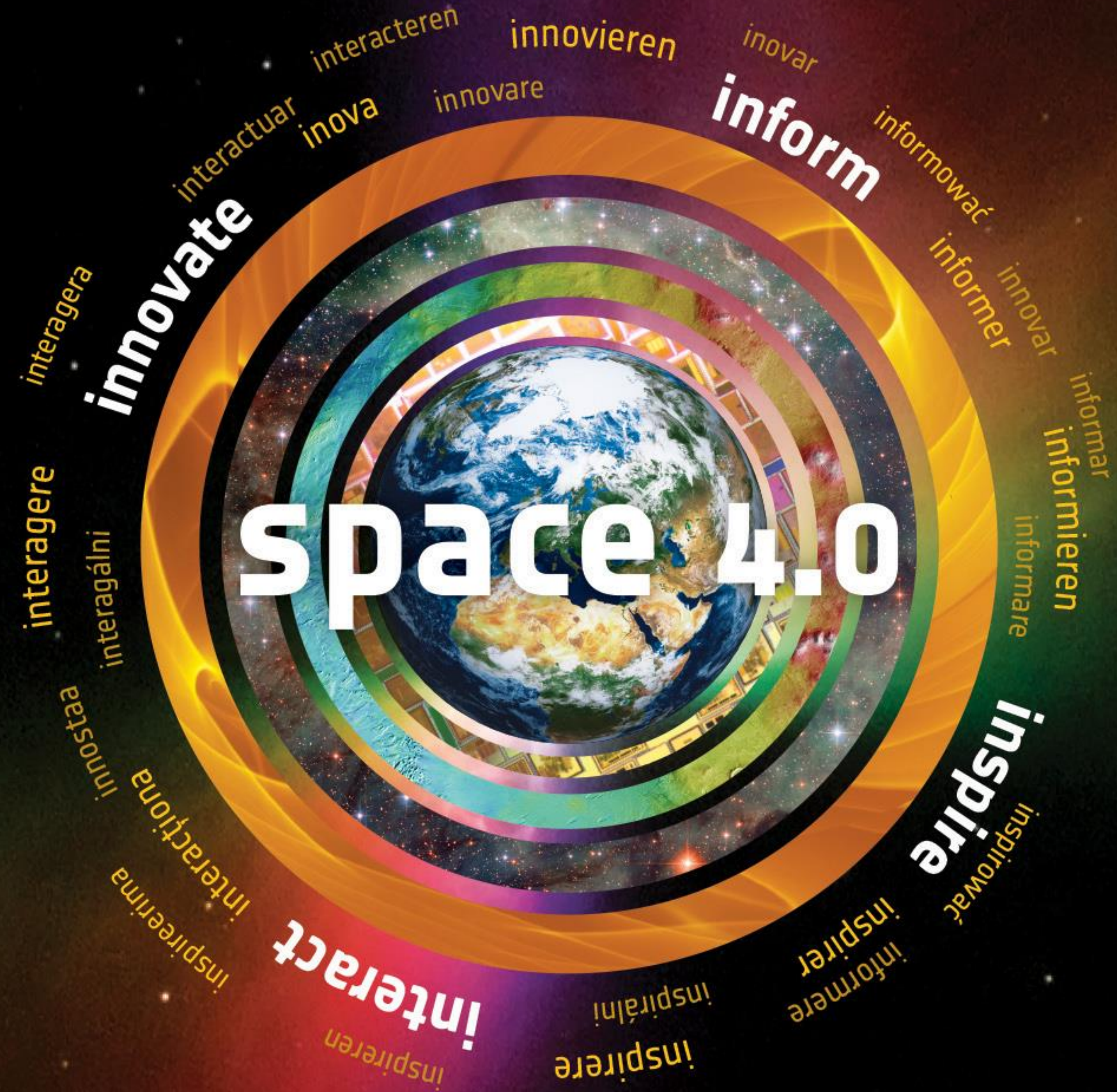
4–8 November 2019 | Technical University of Crete | Chania, Greece

European Space Agency



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