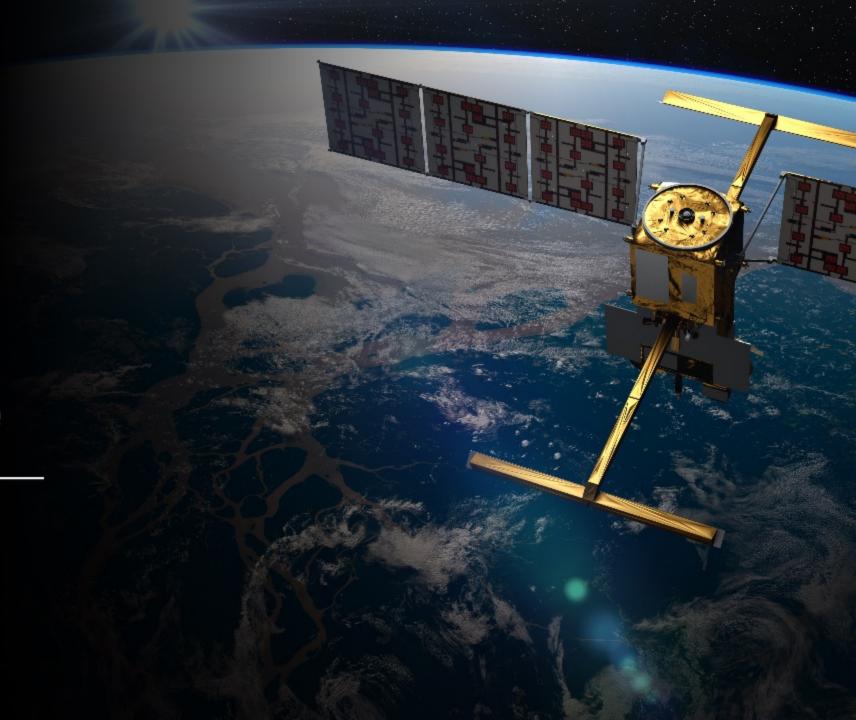


# NASA OSTST update

Nadya Vinogradova Shiffer

NASA HQ

October 30 — November 4, 2022 · Venice, Italy







S6 MF GMSL reference 3.46 mm/yr · 0.82 mm/yr/decade





CRISTAL, CIMR, S6-B

Mission Development





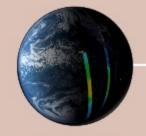
SEA LEVEL TEAM
Actionable sea level science
COP26, 27, IPCC, WH



## OSTST = Infrastructure + Research

65 members · 19 projects · \$15M





#### Infrastructure

Production of climate data records, mission cal/val, S6VT, POD, etc.

Non-competed



### Research

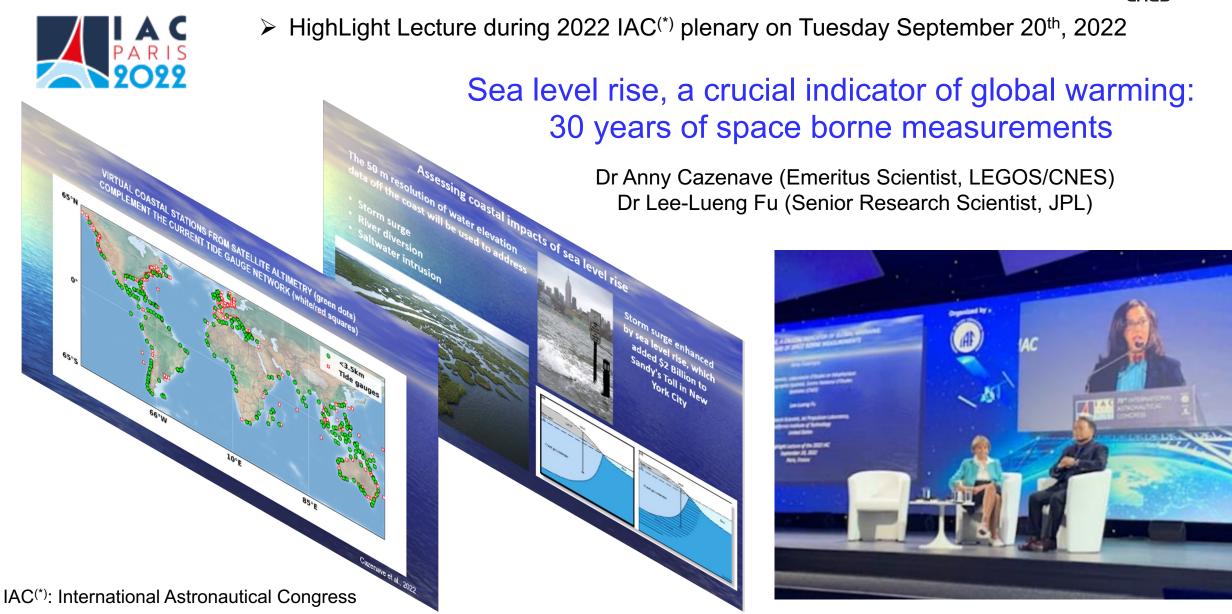
- Climate processes, ocean warming, tidal energy, GMSL –
   Zaron, Johnson, Nerem, Han, Hamlington
- Mesoscales, energy cascade, mapping –
   Lilly, Manucharyan, Qiu, Samelson, Wortham, Melnichenko
- 3. Coastal processes, lakes, rivers, Arctic –
  Gille, Strub, Wilkin, Song, Birkett, Farrell
- Hurricane forecast, SAR –
   Carton, Egido

# **CNES Ocean Program Status**

Annick Sylvestre-Baron (CNES Ocean Program manager)

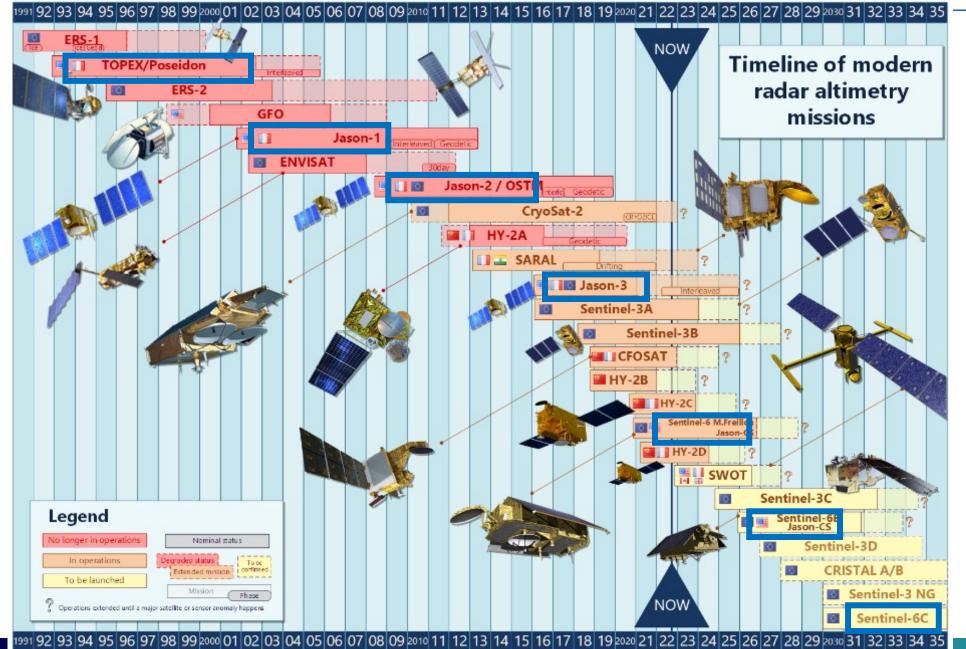






### Altimetry Missions Constellation timeline – 2022 update





# 2022, a symbolic year, linking the...

- past: 30th birthday for TOPEX/POSEIDON launched in August 1992
- present: S6 Michael Freilich: new altimetry reference satellite since April 7th, 2022
- ➢ future: SWOT innovative wide swath altimeter - Launch date: NET Dec 5th, 2022

Reference altimetry satellite











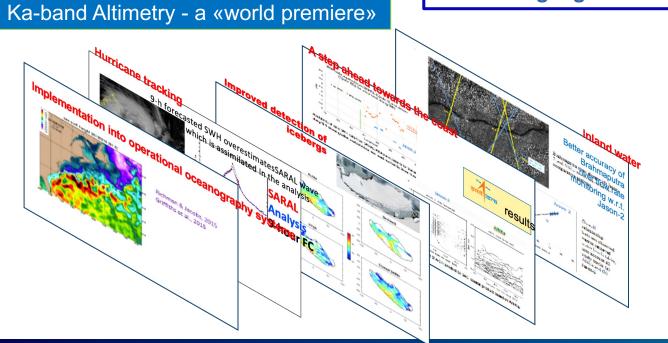


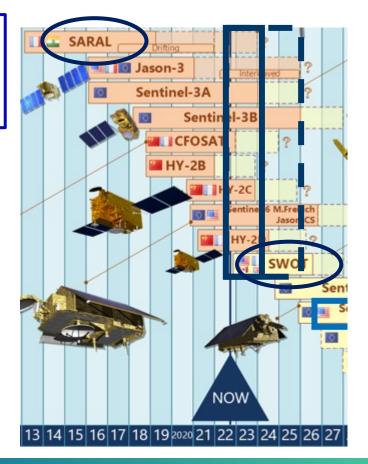
Launch on Feb. 25, 2013

Third mission extension for 2 years → until End of 2023

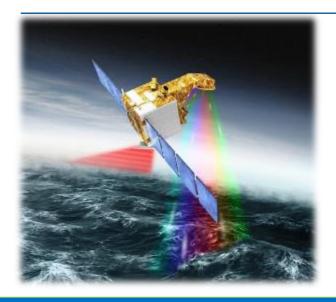
Excellent behavior of SARAL/Altika satellite, in Drifting orbit Phase

Extension post 2023 is to be envisaged allowing a good overlap with SWOT

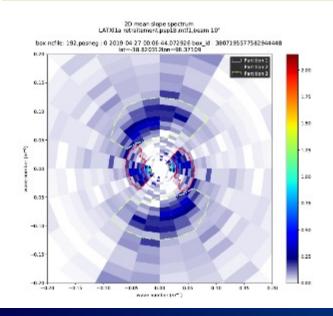








### Wave spectra: a «world premiere»









Launch on Oct. 29, 2018

First mission extension for 2 years planned

- Outstanding results on wave physics, wind-wave interactions in extreme conditions (cyclones,...) and impact on ocean circulation
- Very promising use for sea-ice (synergy SWIM & SCAT), Stokes drift (oil spills and drifting bodies,...), coastal applications, and beyond...

See CFOSAT session on Thursday 09:00

CFOSAT a key role for CalVal phases: SWOT, Harmony, Seastar...

https://aviso-data-center.cnes.fr/ https://resources.marine.copernicus.eu/





Sea ice param. (SWIM&SCAT) wave/ice interactions

- CNSA and CNES renew the CFOSAT ST for 2023-2027
  - ✓ International (except China) Call released by CNES on **April 2022 - Proposal due date on June 2022**
  - ✓ 22 projects received
  - ✓ Selection in Fall 2022
  - ✓ Official information to PI by mid of November 2022

### 22 Pls CFOSAT projects from 13 Countries :

- 13 Europe: 1 Finland, 6 France, 1 Germany,
- 1 Netherland, 3 UK, 1 Spain 9 International: 2 Australia, 1 Canada, 1 Chili, 1 Japan, 1 Mexico, 2 Russia, 1 South Korea

Extreme sea states (Extra-tropical hurricanes,...) Rogue indicators

> Wave/ocean/atmosphere Sub-meso and meso circulations

Regional and coastal Validation & assessment (IBI, Baltic, Med, NW-Pacific)

> Wave param. retrieval (rain impact) MSS analysis

Wave climate analysis (regional&Coastal) synergy with other sensors (S1, S2,HY2,...)





# SWOT COES

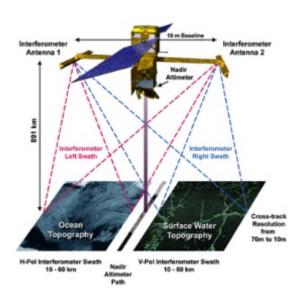






### THE mission to be launched this year NET Dec 5<sup>th</sup>, 2022

Wide-swath Altimetry - a «world premiere»



With the innovative wide-swath altimetry, SWOT will surveying coastal waters and observe ocean waters with a resolution 10 better than currently and will be also the first mission dedicated to the globe's land waters.

- Very promising results for science and applications
- > Data release to the community: launch + 14 months
- **SWOT** satellite in Vanderberg Launch campaign is ongoing



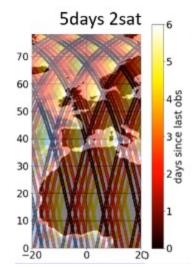






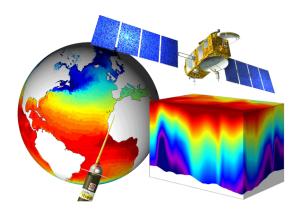
### **CNES** High priority ocean topics for the coming years

#### **Operational wide-swath mission**



Ocean TSCV<sup>(\*)</sup> mission







Areas of strong challenge

Coastal

Polar areas



**Digital Twin Ocean** 



TSCV<sup>(\*)</sup>:Total Surface Current Velocity

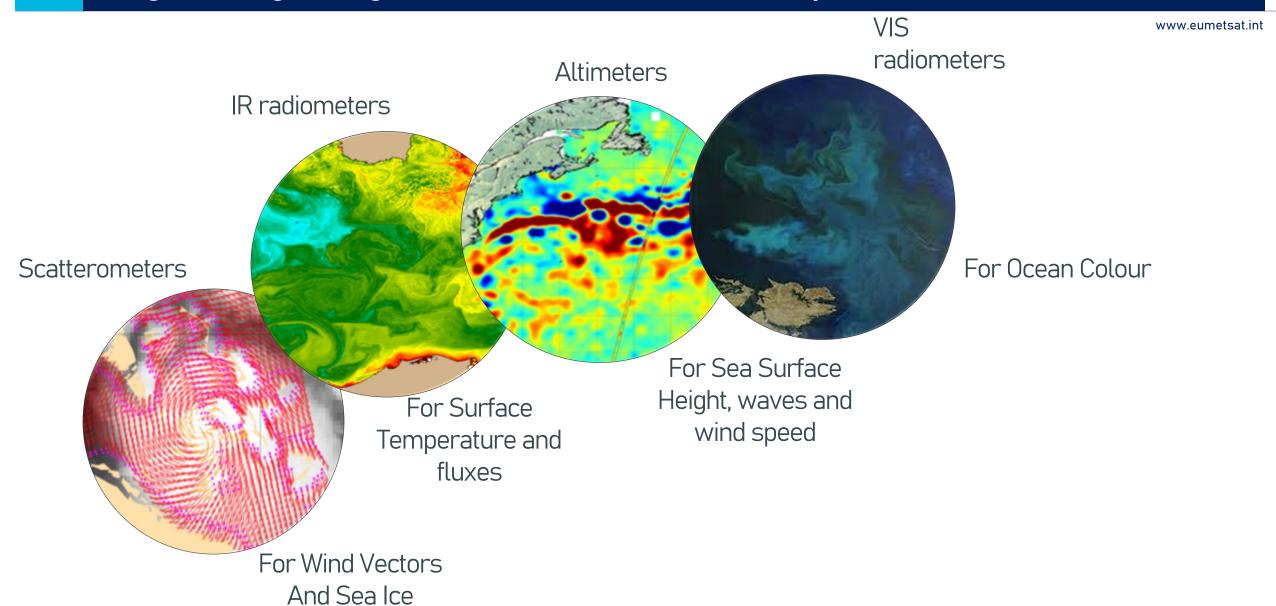




EUM/RSP/VWG/22/1319699, v1 Draft, 25 July 2022



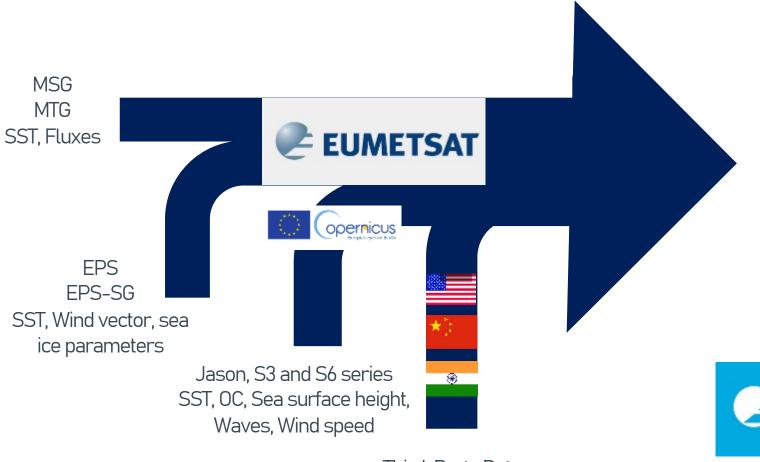
# A growing integrated stream of marine products



Parameters

# Our Programmes

www.eumetsat.int



NWP and Met Services
Value added services
End users
CMEMS and C3S



Third-Party Data NOAA NPP, 20 ISRO Oceansat, Altika CMA HY, FY

. . .

# Exciting (and busy) years to come





### **SUMMARY**

www.eumetsat.int

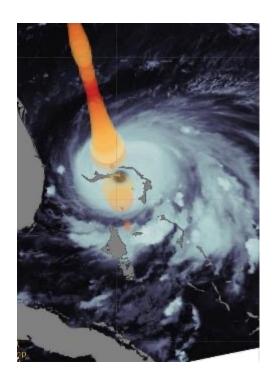
EUMETSAT aim at releasing reference products for ocean observations needed by its users

Altimetry
products with
Sentinel-6 as a
foundation
element for an
operational
integrated multimission
framework
combining S6, S3,
CRISTAL, NG

SST products
from Sentinel-3
SLSTR are
becoming the
reference product
endhorsed by the
international
community
represented by
GHRSST.

Wind products
from ASCAT / SCA
scatterometers
with absolute
calibration to
support
operational
oceanography and
climate
monitoring.

Ocean Colour products from Sentinel-3 OLCI with state of the art processing, the development of the Copernicus Ocean Colour Vicarious Calibration System and of GEO products from **EUMETSAT** missions.





### TAKE HOME MESSAGE

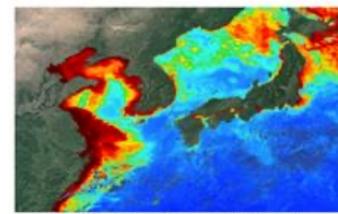
#### EUMETSAT DELIVERS MATURE MARINE SERVICES

- From R&D to Operational Services
  - ✓ Numerical modelling with commensurate IT resources (e.g. high-res, coupled models, data volumes, etc.)
  - Sustainable long-term (and international) space programmes
- Increasing Scope
  - ✓ From Physical Oceanography to Environment Monitoring to Climate Monitoring to Weather Prediction
- Increasing Societal Impact and Demand
  - ✓ From blue (physical ocean parameter), to green (bio-geo chemistry, aqua culture) and white economy (high-latitude)

The role of EUMETSAT to deliver these operational products has significantly increased these last years, and will continue with new EUMETSAT and Copernicus missions

> Sustained Long Term Ocean Observations – 2040+!

Join us at the Third Operational Satellite Oceanography Symposium, NOAA, EUMETSAT and KHOA, June 12-15, 2023, Busan, South Korea



KHOA chlorophyll concentration data achieved by GOCI-II - May 2022

### THIRD INTERNATIONAL OPERATIONAL SATELLITE OCEANOGRAPHY SYMPOSIUM

The Executive Steering Committee is pleased to invite community members from all levels of the value chain, from data providers to users of operational satellite oceanographic data, products and applications, to attend the third international Operational Satellite Oceanography Symposium (OSOS-3). This Symposium will be held in-person with limited online viewing access (not fully hybrid). We hope to feature research in Asia and the Pacific, and high latitude. Talks will build upon past efforts engaging users on requirements and priorities, demonstrating the use of satellite data in coupled numerical models and emphasizing socio-economic benefits reaped from Earth Observation investment. Participants may elect to attend free training on accessing satellite data products and tools to enhance research.

12-15 June 2023 Meeting Sessions 16 June 2023 Optional Training

Shilla Stay Hotel

Haeundae, Busan South Korea

15 November 2022 Tentative Abstract Submission Deadline

> Date TBD Registration Deadline

Registration & Abstract Submission Link - TBD

OSOS-3 Save the

Date



# **Science Program Status (NOAA)**

Eric Leuliette (NOAA Program Scientist)



### **NOAA Jason/Sentinel-6 Program**

# **NOAA Support of the OSTST**

Four PIs funded for the 2021-2024 Team (\$800K/year)

In Fiscal Year 2021 the NOAA Office of Ocean Exploration \
 and Research provided matching funding through the
 National Oceanographic Partnership Program (NOPP)



Investigator	Institution	Title
James Carton	University of Maryland	Improving Tropical Cyclone Intensity Forecasts by Assimilating Ocean Surface Drifter paths with altimeter sea level
Alejandro Egido	Global Science & Technology, Inc.	Reconciliation of High- and Low-Resolution Ocean Altimeter Measurements Under Changing Surface Wave Structure Conditions
Sinead Farrell	University of Maryland	High-Latitude Multi-Altimeter Observations of the Arctic Ocean and its Sea Ice Cover
John Wilkin	Rutgers University	Mesoscale to submesoscale ocean state estimation by 2-way nested 4-dimensional variational data assimilation

https://www.star.nesdis.noaa.gov/socd/lsa/OSTST.php

# NOAA @ OSTST

### **Sea Surface Height Science Team and NOAA OSTST Team**

Splinter	Presentations
Instrument Processing	2D SAR Altimetry Retracking – Lessons Learned A Significant Wave Height Correction to Account for Vertical Wave Motion Effects in SAR Altimeter Measurements
Cal/Val	Independent and intermission validations of Sentinel-6 Michael Freilich
S6VT	Assessment of Sentinel 6 altimeter data along the Northwest Atlantic shelf
Science I	Assessing the Closure of the Sea Level Budget in the Southwest Pacific Basin Using Deep Argo
Science III	Development of Multiparameter Mesoscale Eddy Products for Operational Use
Applications	Estimating upper ocean heat content in the North Atlantic Ocean with the NOAA next-generation enterprise ocean heat content algorithm APO2022_001: NOAA's Jason Products APO2022_008: The new daily global mesoscale Blended Ocean Surface Current (BOSC) product
Science IV	Understanding Decadal-scale Trends in Altimeter-derived Significant Wave Height in the Bering

### **NOAA CoastWatch**

The CoastWatch program stands on 3 pillars for efficient R2X transitions: 1) Central Operations; 2) Regional Nodes across NOAA Line Offices; and 3) Research and Applications.



## NOAA CoastWatch: New web site and data portal



Satellite Data Products & Services To Support Ocean, Coastal, and Fresh Water Applications









Prior Website

#### Welcome to NOAA CoastWatch

NOAA CoastWatch exists to help people access and use global and regional satellite data for ocean and coastal applications. Our satellite data products and services can support research, resource management, and decision-making on topics such as understanding, managing and protecting ocean and coastal resources and for assessing impacts of environmental change in ecosystems, weather, and climate.









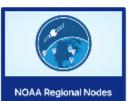




Recent News













#### **Explore Data By Application**



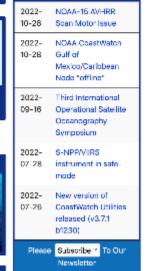






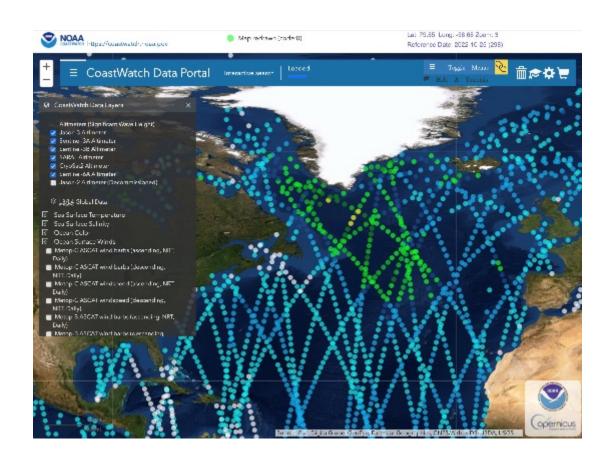




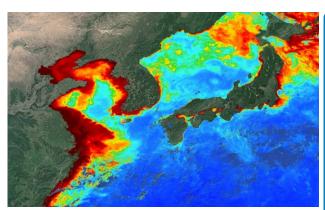


Training Courses

### coastwatch.noaa.gov



# Operational Satellite Oceanography Symposium (OSOS-3)



KHOA chlorophyll concentration data achieved by GOCI-II – May 2022

# THIRD INTERNATIONAL OPERATIONAL SATELLITE OCEANOGRAPHY SYMPOSIUM

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Registration &
Abstract Submission
Link → TBD

**OSOS**-3

Save the Date

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Busan, South Korea

Meeting sessions: 12-15 June 2023

Optional training: 16 June 2023

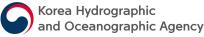
Busan, South Korea

Will focus on Asia, Pacific, and high latitude research and applications.

https://coastwatch.noaa.gov/cw/osos3.html

**OSOS-1 June 2019 (USA) OSOS-2 May 2021 (Virtual)** 







# **ESA Programmes Status**

(S3, S6MF, S3NG-T and CRISTAL in other talks this morning)



Jérôme Benveniste ESA

ESA UNCLASSIFIED - For ESA Official Use Only

# The FDR4ALT Project « in a nutshell »



### Reprocessing of ERS-1, ERS-2, ENVISAT Altimeter and Radiometer

- ❖ Based on the best state-of-the-art algorithms and corrections
- ❖ Innovative level-1 and level-2 products
- 3-year long project planned to end in March 2023 with ERS-1, ERS-2 and ENVISAT fully reprocessed Strong synergies with past, current & future V3.0, SS cci (SL cci)

#### **Fundamental Data Records**

L1B products containing all the ancilliary and instrumental data used to calibrate the instrument





### **Thematic Data Products**

Level-2P, easy to use, validated products with uncertainties included



Ocean & Coastal Topography



Inland water



Land-Ice



Sea-



Atmosphere



Ocean Waves

Find out more about the FDR4ALT project : Piras et al., poster session

# **CryoSat Status**

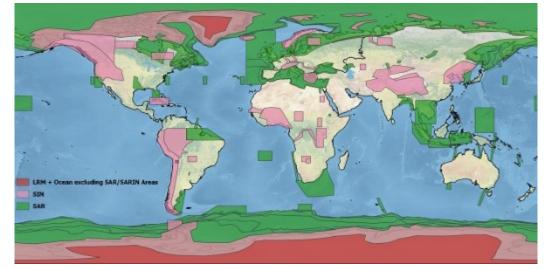


- The overall performance of the mission is excellent (for this now 12 ½ year old mission!).
  - Reaction Control Subsystem switch-over foreseen Pain: Risky business; Gain: Mission life extension!
  - Cryo-TEMPO Products rolling; Cryo-TEMPO Users Consultation Meeting in ESA-ESRIN on 21-22/11
- CryoSat Mode Mask update foreseen User Poll in preparation
  - Maximum exploitation of SARIn mode in the Coastal Zone
  - Reduce the SAR Mode (covered by S3A/B & S6MF)
  - CryoSat for Flooding:
    - too much snagging, SARin would be useful!
    - SARin mode on recurrent flooding areas, e.g., Sudd Marsh, South Sudan.

→ Landy, J.C., Dawson, G.J., Tsamados, M. *et al.*A year-round satellite sea-ice thickness record from CryoSat-2.

Nature 609, 517–522 (2022).

https://doi.org/10.1038/s41586-022-05058-5



Geographical Mode Mask 4.0 - Operational 19 August 2019

### **SMOS (Soil Moisture and Ocean Salinity) Status**

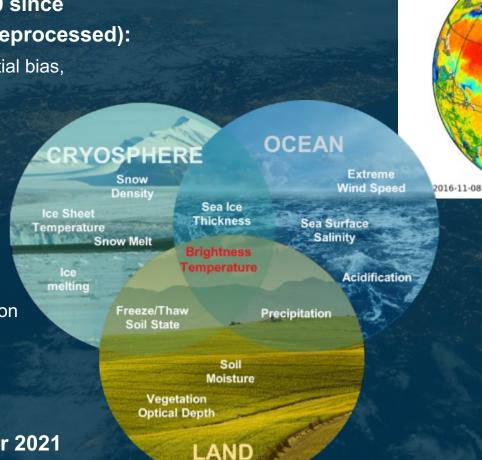


0.33

(C) Dmitry Khvorostyanov, LOCEAN, 2020

Earth seen by SMOS

- Platform and payload in excellent operational condition.
- Level 1 and Level 2 products baseline v700 since
   May 2021 (Entire 12-year mission dataset reprocessed):
  - Level 1: better long term stability, reduced spatial bias, improved RFI flagging.
  - Level 2 SM: better agreement with in situ measurements, improved correlation.
  - Level 2 SSS: better agreement with in situ measurements, less bias in cold waters.
- Near Real Time products baseline since August 2021:
  - Level 2 Soil Moisture for NWP model assimilation
  - Level 2 Sea Surface High Wind Speed for Tropical Cyclone monitoring
- Level 3 and Level 4 Sea Ice Thickness products baseline over Arctic since October 2021



SMOS mission overview of operational and experimental products

**CATDS** 

# **CIMR** - The Copernicus Imaging Microwave Radiometer



### **CIMR** design:

- 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
- 95% global coverage every day for applications in all Copernicus Services

### Main payload:

Wide-swath conically-scanning multifrequency microwave radiometer Launch of CIMR-A in 2028+ (CIMR-B few years later)

Mission data products under ESA responsibility:

Polar Ice and Global Land

ITT to be issued in Q2 2023 for CIMR Level-2 Product and Algorithm Definition





### MAGIC An international constellation for mass change science and applications



- MAss-change and Geosciences International Constellation (MAGIC) is the joint NASA/ESA two-pair "Bender-type" constellation concept based on NASA's MCDO and ESA's NGGM (Next Generation Gravity Mission).
- Enhanced continuity after GRACE-FO ensured to preserve the climate series, per US Decadal Survey 2018
- Strong user demand expressed by IUGG, IAG, GGOS for improved temporal and spatial resolutions and accuracy in enhanced continuity of observations, paving the way to future sustained observations
- Launch in 2032

• Goal is to implement <u>a (pre-) operational mission</u> with improved observations to meet science and application objectives outlined in ESA/NASA MAGIC **M**ission Requirements **D**ocument (**MRD**).

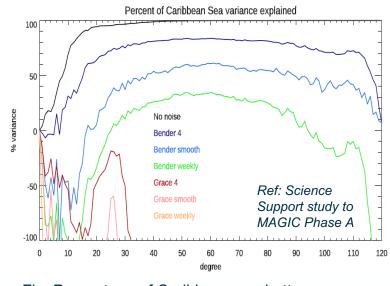


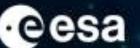
Fig: Percentage of <u>Caribbean sea</u> bottom pressure variance explained by the pressures truncated at different spherical harmonic degree. Bender 4 represents **MAGIC** resolution and leads to a variance explained at **80%-90%.** 





# MAGIC – Baseline implementation scenario





- Two-pair "Bender" constellation acting as precursor of future operational system
- ☐ First satellite pair (P1) (currently under consideration)
  - Implemented via a DE-USA fast-paced cooperation programme to ensure continuity of observations with GRACE-FO, with some potential ESA in-kind contributions (e.g. MicroSTAR accelerometer family, linear cold gas thrusters)
- Second satellite pair (P2)
  - Implemented via a Europe-USA cooperation programme with some potential NASA in-kind contributions with target launch date compatible to maintain at least 4 years of combined operations
  - NASA potential contribution based on elements/units of the Laser Tracking Instrument (LTI)



# MAGIC – P2 baseline configuration



### System:

- Inclined orbit with a target altitude of ~400 km and inclination between 65 deg and 70 deg
- Baseline launcher from Vega family, with other European and US launchers as back-up
- Two spacecraft embarking each of them a Laser Tracking Instrument (LTI), the next-generation
  accelerometers with performance consistent with LTI, and GNSS receivers
- Launch date no later than 2032, with target to maintain 4 years minimum of combined P1-P2 operations

### Spacecraft:

- Three high-performance accelerometers based on ONERA's MicroSTAR family of accelerometers
- Redundant LTI: baseline concept based on the LTI version to be embarked in P1 with European and US
  units, with potential addition of laser acquisition systems. Back-up concept: fully European LTI.
- Geodetic-quality GNSS receiver
- Hybrid propulsion concept: electric propulsion for orbit maintenance and drag compensation/drag free and linear cold gas thrusters for fine attitude control/drag free
- Spacecraft units based on maximum reuse of existing units

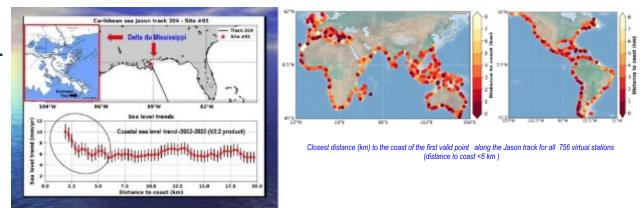
# **Climate Change Initiative**



### Sea Level\_cci+

has issued a new Coastal Sea Level Trends dataset.
 Coastal sea level time series and associated trends
 freely available

SEANOE: https://doi.org/10.17882/74354



### Sea State\_cci+

- Has just issued a new version (v3) of its CDR,
  - first dataset on ocean waves that combines both altimetry and SAR CDR,
- With retracked waveforms: lower noise and more data (coastal), allows to see small scales in unprecedented details (effect of currents on wave heights, coastal areas ...)

### Lakes\_cci+

- Lake Water Extent & Lake Water Level (coupled), Lake Ice Cover, Lake Surface Water Temperature,
   Lake Water-Leaving Reflectance, Lake Ice Thickness (new)
- New climate data record >2000 Lakes, 1992-2020 => <a href="https://climate.esa.int/en/projects/lakes/data/">https://climate.esa.int/en/projects/lakes/data/</a>.

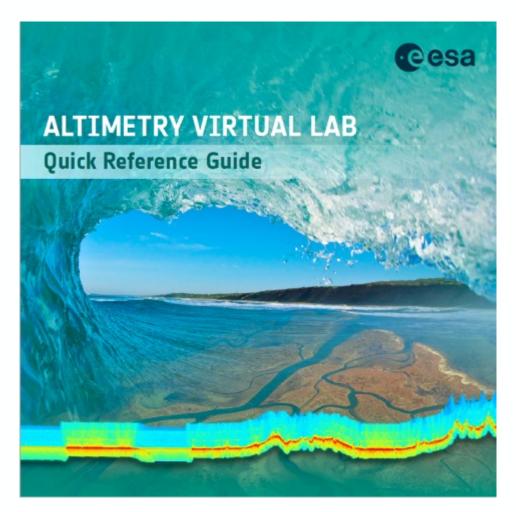
Sea Level Budget Closure\_cci+ & River Discharge\_cci+ to be kicked off before end 2022

# ESA Altimetry Virtual Lab @ EarthConsole®



Ex "GPOD/SARvatore"

https://earthconsole.eu/knowledge-base/





## **HYDROSPACE-2021 => HYDROSPACE-2023**





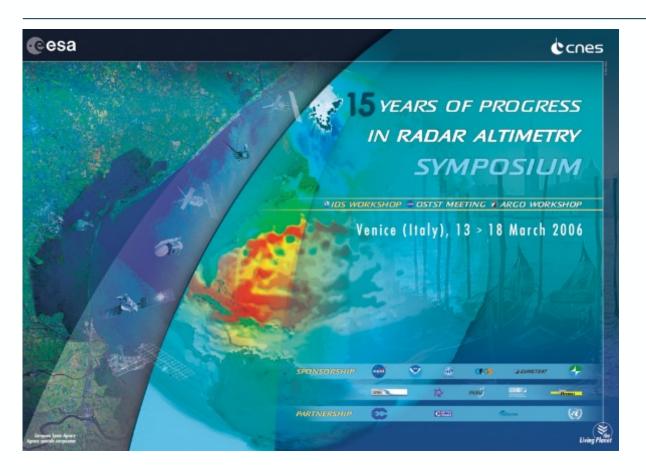
Jérôme Benveniste<sup>(1)</sup>, Alice Andral<sup>(2)</sup>, Angelica Gutierrez<sup>(3)</sup>, Paul Bates<sup>(4)</sup>, Peter Bauer-Gottwein<sup>(5)</sup>, Christophe Brachet<sup>(6)</sup>, Jean-François Crétaux<sup>(7)</sup>, Cesar Ignacio Garay Bohórquez<sup>(8)</sup>, Rodrigo Cauduro Dias de Paiva<sup>(9)</sup>, Philippe Maisongrande<sup>(10)</sup>, Tidiane Ouattara<sup>(11)</sup>, Sushel Unninayar<sup>(12)</sup>, Philippa Berry<sup>(13)</sup>, Cédric H. David<sup>(14)</sup>, Ayan Fleischmann<sup>(15)</sup>, Huilin Gao<sup>(16)</sup>, Andreas Güntner<sup>(17)</sup>, George Huffman<sup>(12)</sup>, Hyongki Lee<sup>(18)</sup>, Karina Nielsen<sup>(19)</sup>, Fabrice Papa<sup>(20)</sup>, Catherine Prigent<sup>(21)</sup>, Christian Schwatke<sup>(22)</sup>, Angelica Tarpanelli<sup>(23)</sup>, Mohammad Tourian<sup>(24)</sup>, Arjumand Z. Zaidi<sup>(25)</sup>

"HYDROSPACE-GEOGLOWS 2021" WORKSHOP

https://hydrospace2021.org/proceedings























an Open Access Journal by MDPI

# Advances in Satellite Altimetry

### **Guest Editors**

Dr. Stelios Mertikas, Dr. Xiaoli Deng, Dr. Jérôme Benveniste

Deadline

31 January 2023

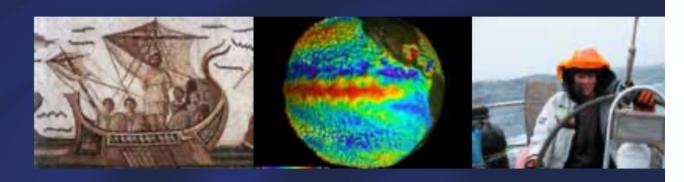
Viewed by 3915

30% Discount for OSTST Participants

Specialsue



### Michel Lefebvre:



# Océanez-vous

La Terre est ton navire, non ta demeure

Ocean yourself

Planet Earth is your vessel, not your dwelling