



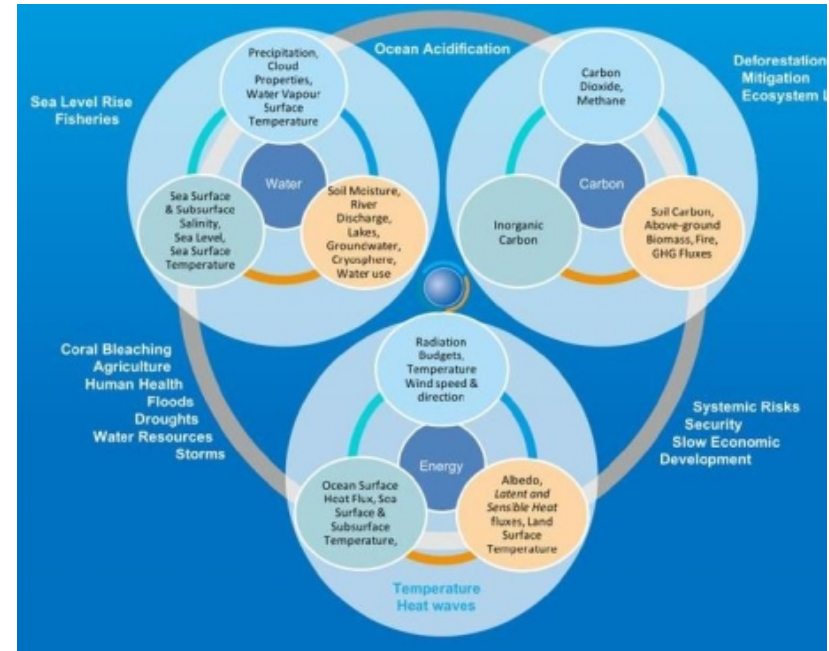
Status report on the current and future satellite systems by CNES

Presented to CGMS-50 plenary session, agenda item 2
Olivier MARSAL, Adrien DESCHAMPS, Selma CHERCHALI

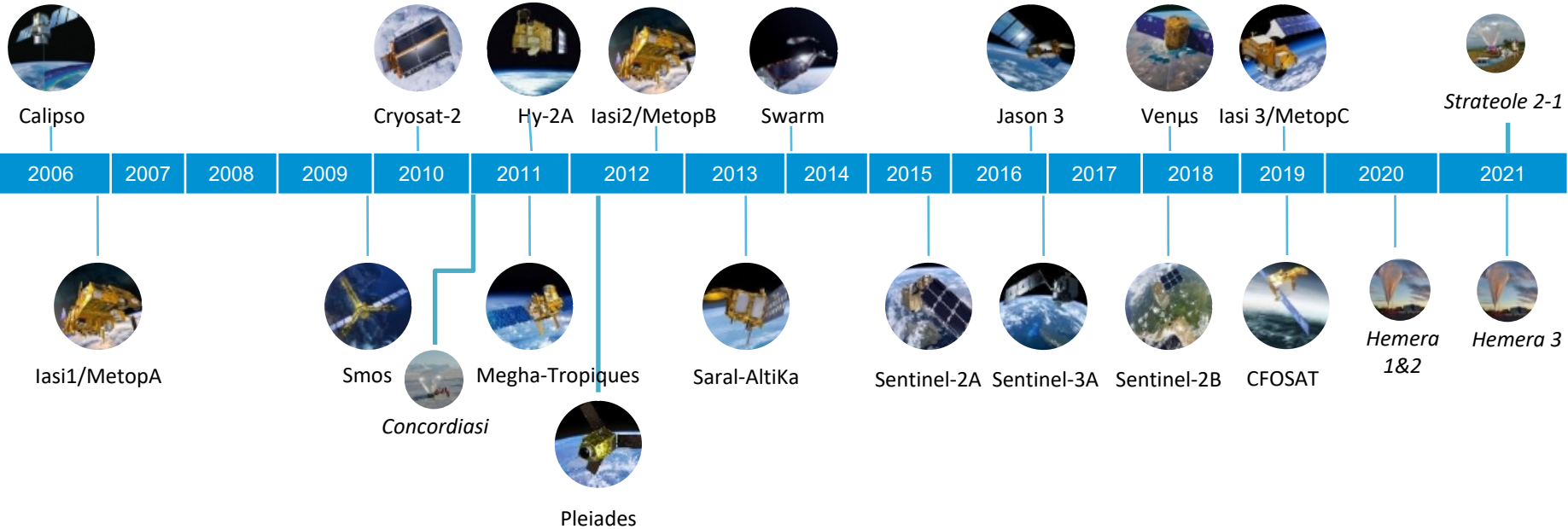
Observing the Earth, monitoring changes and understanding processes

Spatial observations, combined with in situ measurements and models enable to understand, monitor and predict the state of our planet for a better adaptation to climate changes, locally and globally

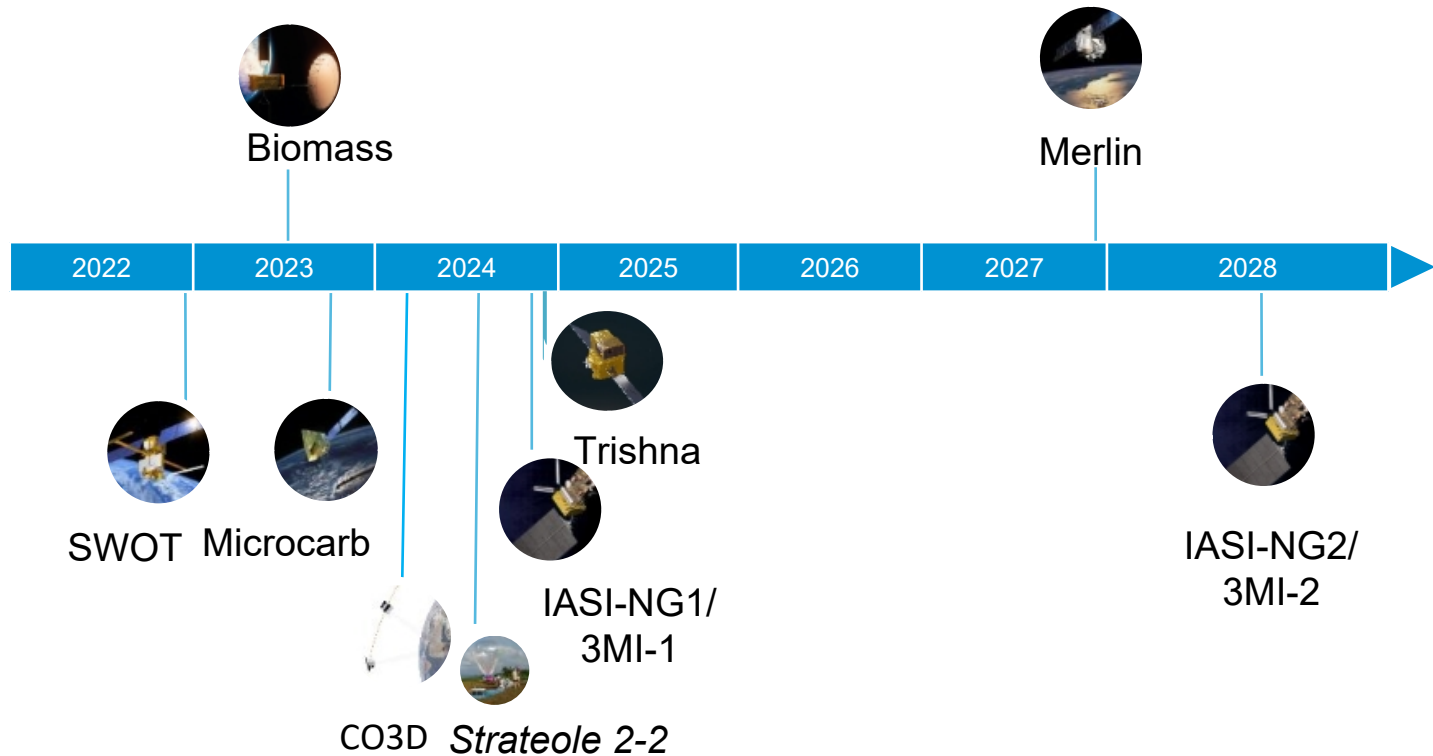
The CNES Earth Observation program - in strong collaboration with international partners - focuses on innovative missions with this objective



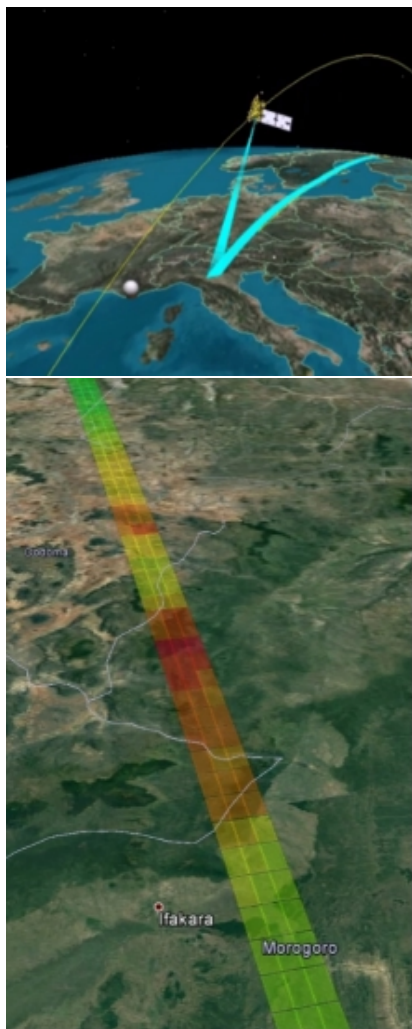
Programmes in exploitation



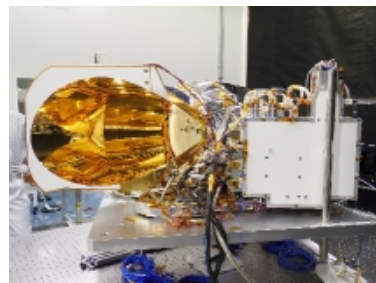
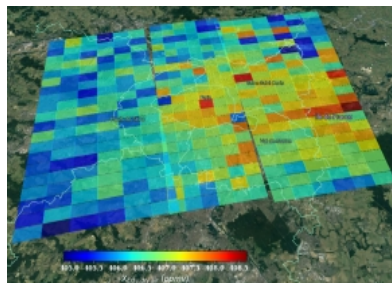
Programmes being prepared or developed



MICROCARB - CO₂ from space



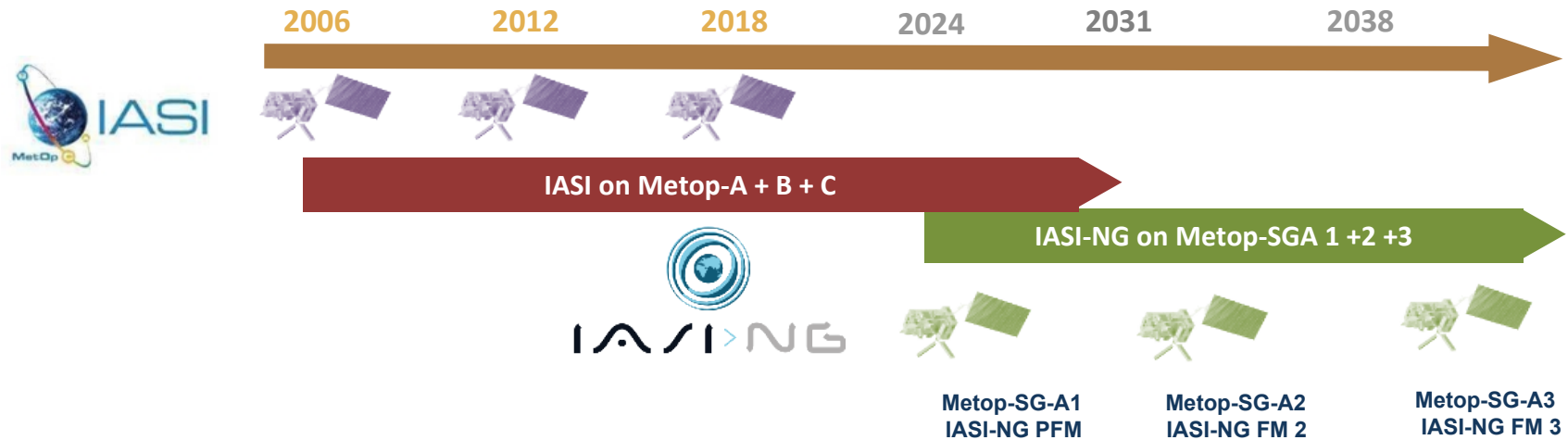
- After OCO2 & 3, GOSAT 1 & 2 and before CO2M, Microcarb paves the way with a compact instrument / microsatellite mission
 - Measurement of atmospheric CO₂ concentration with an accuracy better than 1 ppm (with bias < 0,1ppm) in order to retrieve CO₂ surface fluxes (sources & sinks) and their evolution with global warming
 - Demonstrate capacity over strong emission sites (cities, power plants)
- Myriade platform (180kg) : integration on going at TAS-UK (Cooperation with UKSA)
 - Compact Grating spectrometer with 4 bands (O₂ at 0,76 μm, 2 CO₂ at 1,6 & 2 μm, additional O₂ at 1,27 μm)
 - Launch expected from end 2023
 - 2x 6 months for Cal/Val period + 4 years operations
- Difficulties at detector level (remanence effect) have been solved, and integration is now complete, with mechanical tests ongoing, before Instrument Thermal Vacuum Test mid 2022, including an end to end test facing sunlight through atmosphere
 - The 1.27 μm O₂ (B4) shows very encouraging results for aerosols correction in CO₂ Band
 - Agreement with Eumetsat for operational processing of L1, L2 using 4ARCTIC
 - Data distribution via AERIS & EUMETSAT



IASI / IASI-NG : a long term program ...



Infrared Atmospheric Sounding Interferometer



The perspective of measurements over 50 years :

A unique opportunity to study climate evolutions with similar instruments

➔ Continuous Calibration is essential

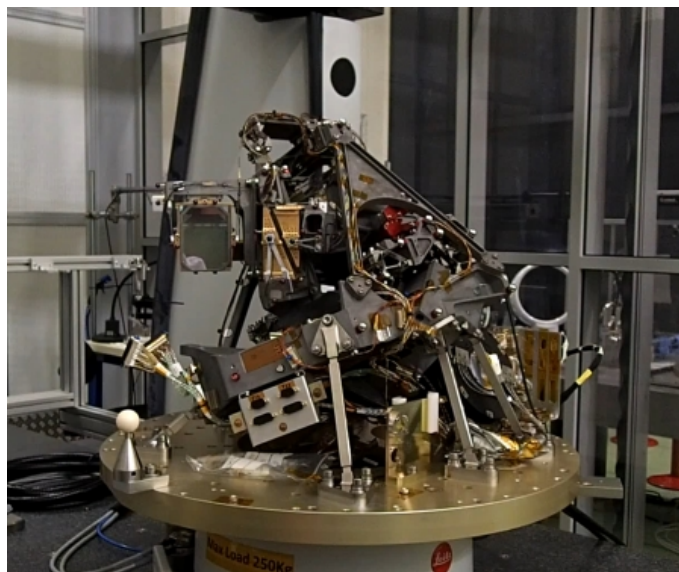
In complement, some new concepts studies at CNES for NWP based on constellation of miniaturized IR & MW sounders with smaller pixels ..

IASI-NG : Infrared Atmospheric Sounding Interferometer New Generation

Started in 2011 and confirmed in December 2015

CNES contribution includes :

- **The development of 3 instruments to be embarked on Metop-SG A1/A2/A3 satellites.**
 - Mertz interferometer
 - As compared with IASI : 2x2 better in spectral resolution and radiometric noise
- **The development of the L1C operational processing chain, to be operated by Eumetsat**
- **The development of e Centre of Expertise (IASTEC) for Flight Performance Monitoring, to be operated by CNES**



- **PFM started performance tests under vacuum in June 2022.** Delivery for integration on the MetopSG-A1 platform planned in septembre 2022, for a launch end 2024
- FM2/FM3 instrument models delivered to Eumetsat in 2023 & 2024



IASI-NG Mission Objectives



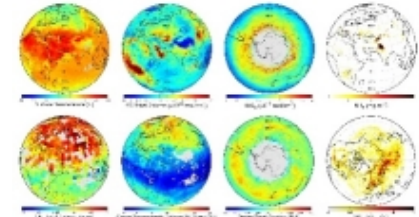
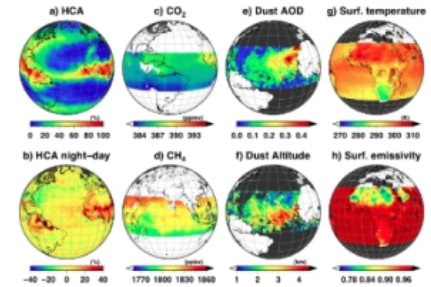
- **Numerical Weather Prediction**

 Temperature
  Water Vapour

- **Atmospheric composition**

 Aerosols
  Pollutants
  Cloud, volcanic ashes

- **Climate**
 Greenhouse gas, ECV Trends
 IR radiative budget, SST



Thanks to its exceptional spectral and radiometric stability, and the continuous work done by CNES, EUMETSAT and the laboratories, **IASI has been selected as the reference instrument for thermal infrared** by the WMO-GSICS program → Expectation is high for IASI-NG 😊



MEGHA-TROPIQUES : cooperation with ISRO

2022 : end of a successful mission after 10 years of exploitation

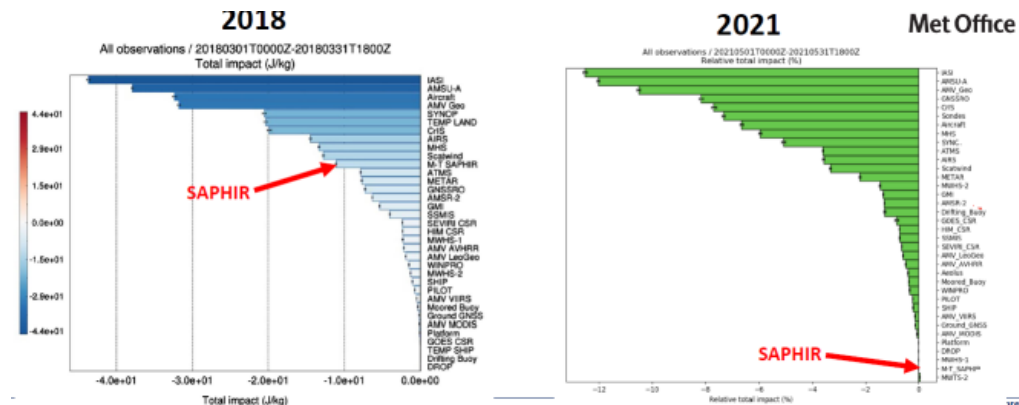
- Characterization of convective systems, estimation of water and energy budget
- Inclined orbit (<30°) to monitor the tropical belt with a high revisit frequency (3-5 times/day)
- Launch date : 2011
- Part of the GPM constellation



Outstanding impacts on Science and NWP

- Relative Humidity profiles and uncertainty estimation
- Daily precipitation and uncertainty estimation (TAPEER products)
- Convective systems monitoring (TOOCAN)
- Mesoscale Convective Systems on a grid 1° x 1day

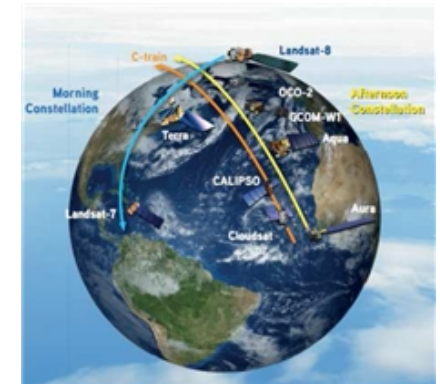
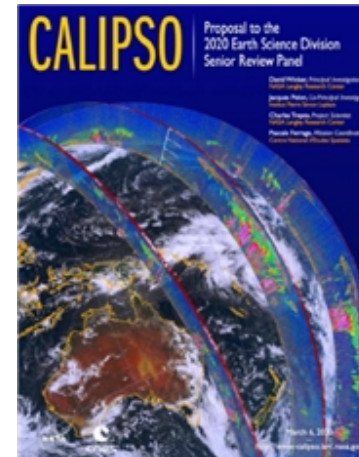
Impact of SAPHIR data on NWP compared to other instruments : positive impact until 2021



CALIPSO : cooperation with NASA

15 years of exploitation and still many publications

- Payload: lidar, camera, IR imager
- Study of clouds and aerosol
- Launch date : 2006
- Part of the A-train constellation

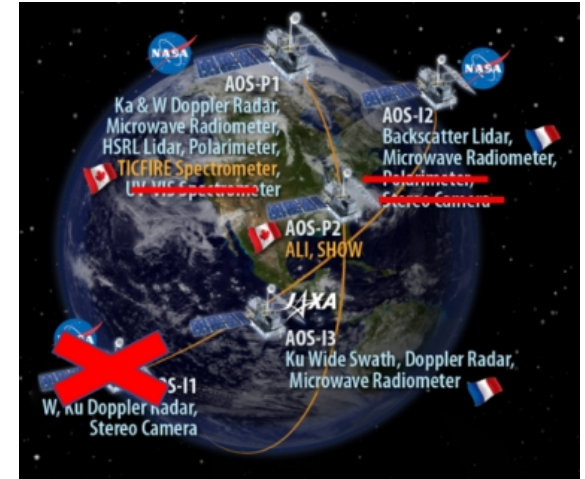


- More than 3200 publications using CALIPSO data
- Better understanding of aerosol distributions,
- Aerosol/clouds interaction and study of clouds evolution
- Extreme events monitoring (biomass burning, volcanic eruption...)
- Aerosol and clouds radiative impact and improvements of climate model

AOS – Atmosphere Observing System

CNES contribution to the AOS observatory

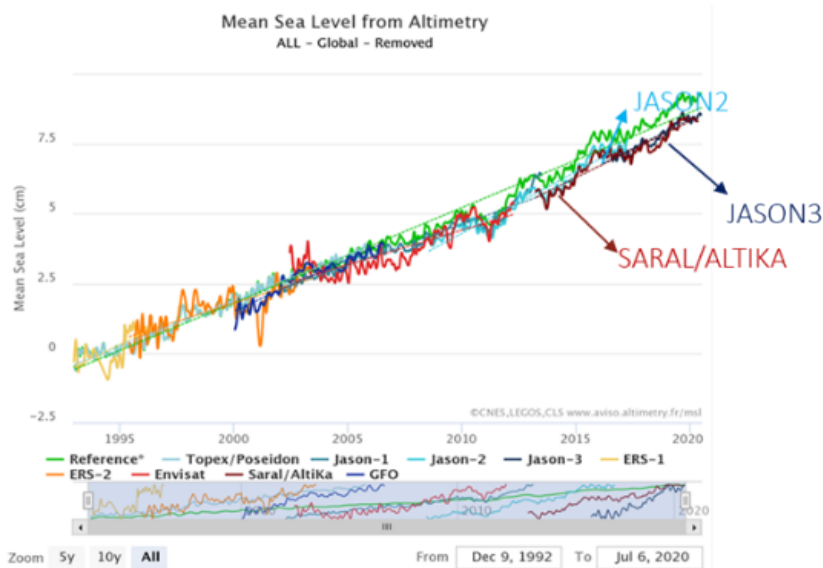
- NASA program in collaboration with CNES, JAXA, CSA
- CNES contribution based on the heritage on both Megha-Tropiques and CALIPSO
 - Tandem of microwave radiometers to study convective systems
 - **Innovative approach based on delta-t measurements** (C2OMODO mission)
 - Participation on lidar WG and developments of new retrieval algorithms for aerosol and clouds
- Phase A will start soon, phase B expected for mid 2023
- Launch target : end 2028 (inclined orbit)



SARAL : Ka band altimetry mission

Launched Feb. 2013

Third mission extension decided → end 2023



CFOSAT : The Chinese French Ocean Satellite

Launched Oct. 2018

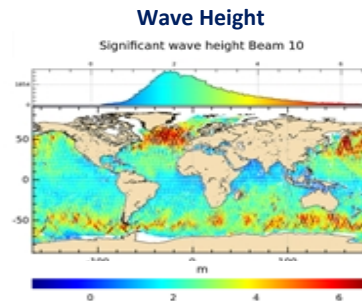
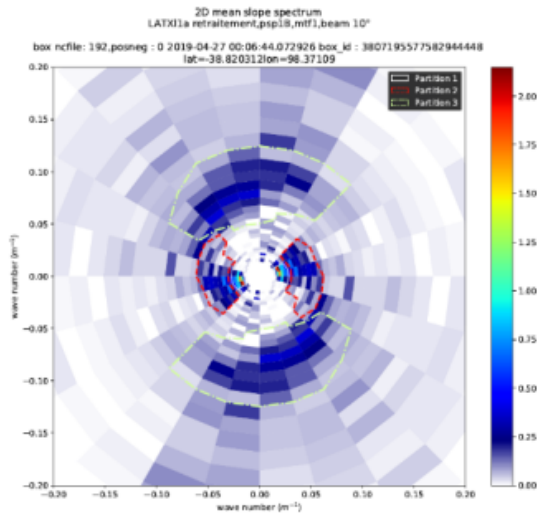
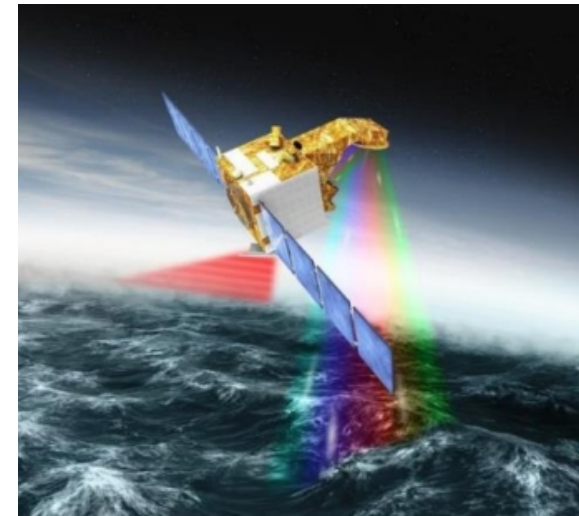
Mission extension process ongoing

Wave spectra : a « world premiere »

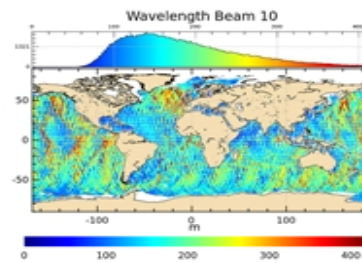
- Impressive research results
- Data assimilated in operational systems for more than one year

<https://aviso-data-center.cnes.fr/>

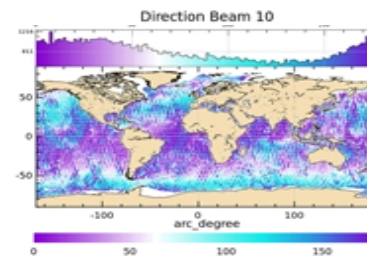
<https://resources.marine.copernicus.eu/>



Dominant wavelength



Dominant direction



SWOT : the wide swath altimetry mission

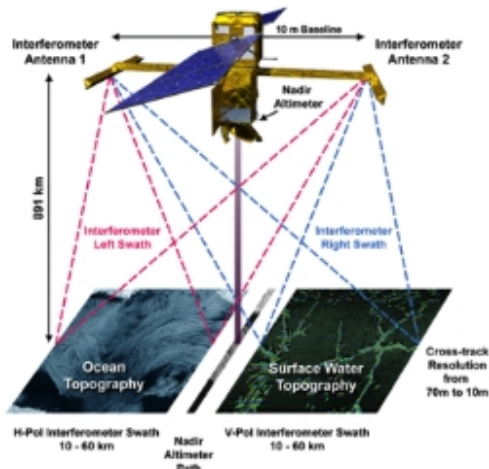
To be launched end of 2022 ! (not earlier than Nov. 18)

Wide swath altimetry : a « world premiere »

SWOT



- Oceanography: characterize the ocean mesoscale and sub-mesoscale circulation at spatial resolutions of 15 km and greater
- Hydrology: will provide a global inventory of all terrestrial water bodies whose surface areas exceed 250m² (lakes, reservoirs, wetlands) and rivers whose width exceeds 100 m.
 - ✓ Will measure the global storage change in fresh water bodies at sub-monthly, seasonal, and annual time scales
 - ✓ Will estimate the global change in river discharge at sub-monthly, seasonal and annual time scales.
- Cooperation with NASA, CSA and UKSA
 - ✓ CNES contribution: platform, nadir altimeter, DORIS, KaIn RFU, ground stations
- Specific SWOT « downstream » programme



Thank you for your attention !