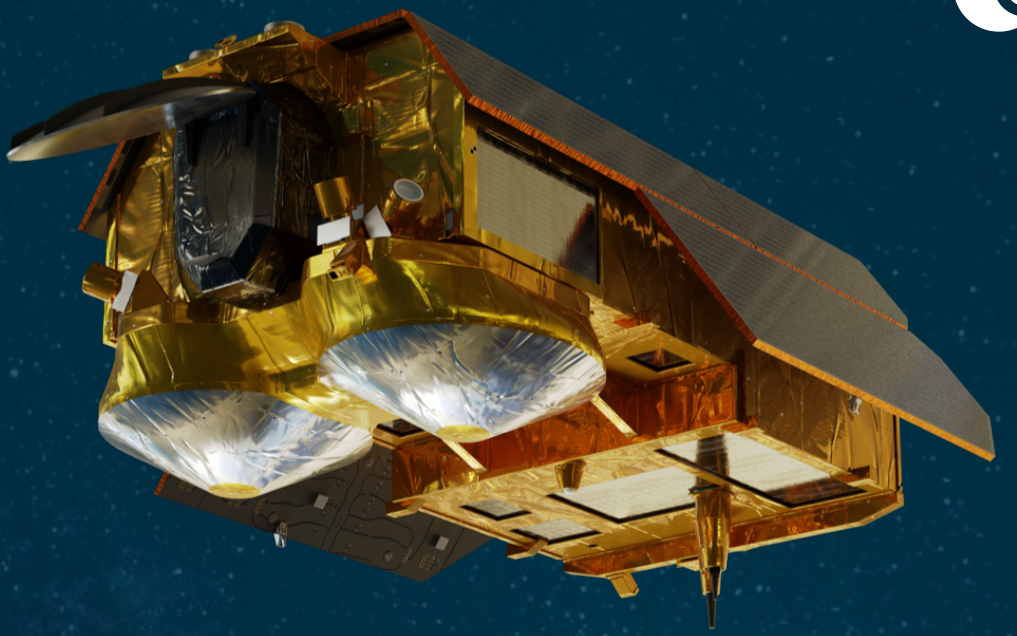


# CRISTAL Mission Status

Paolo Cipollini (CRISTAL Mission Scientist, ESA), Cristina Martin-Puig (EUMETSAT)

OSTST 2022, Venice

# CRISTAL – a Copernicus Expansion mission

Objectives: Monitor sea ice, icebergs, land ice, glaciers (primary), but also ocean, coasts and inland waters

**High inclination mission (92 deg), continues the legacy of CryoSat-2, with improved performance → *talk in Science IV session, Thurs pm***

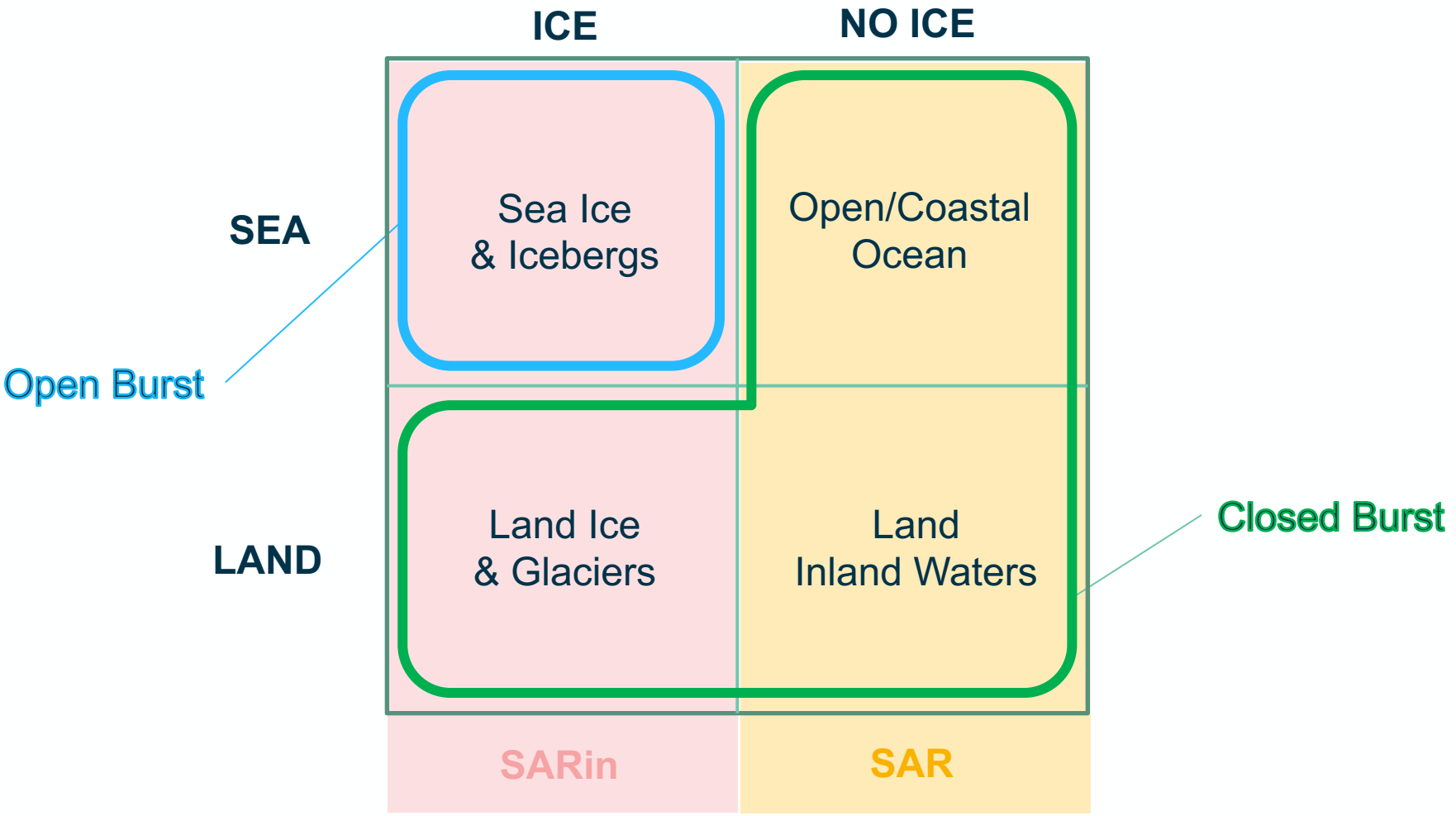
**Dual-frequency Ku/Ka SAR altimeter, Ku is interferometric**

**Improved bandwidth: 500 MHz in both Ku and Ka**

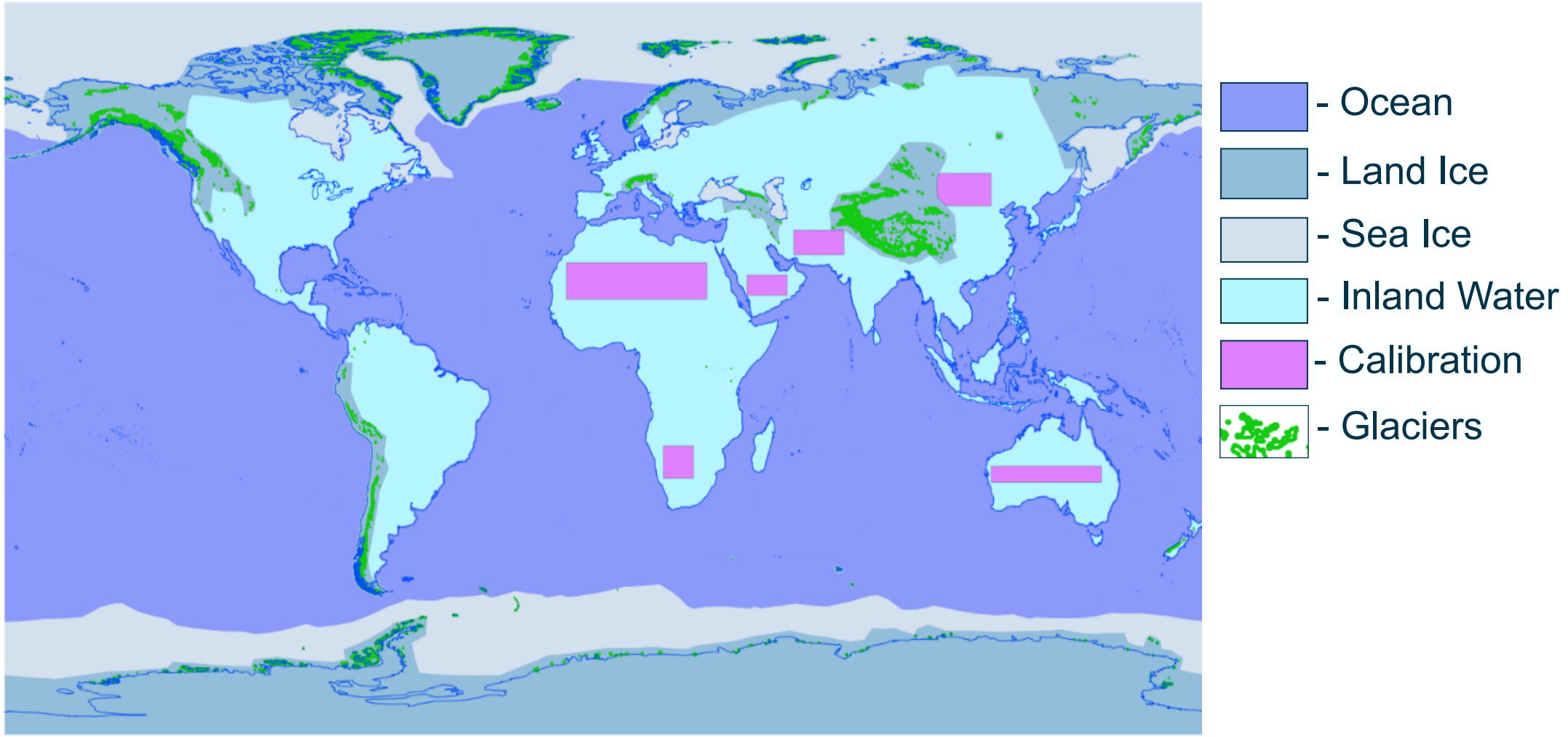
- Open burst over sea ice and icebergs → improved azimuth (along-track) resolution & range precision
- Flexible open loop/closed loop tracking everywhere
- AMR-CR radiometer with HRMR for oceanography, coastal altimetry, ice classification

| | Open ocean (OCO) + Hydrology SAR CB | Sea Ice & Icebergs (SII) SARIn OB | | Land Ice & Glaciers (LIG) SARin CB | | |
|---|---|---|---|---|---|---|
| | | Sea Ice | Icebergs | Ice sheet interior (Ice sheet / Ice cap) | Ice margin | Glaciers |
| Measurement mode in Ku | SAR-CB | SARIn Open-Burst | | SARIn-CB | | |
| Measurement mode in Ka | SAR-CB | SAR Open-Burst | | SAR-CB | | |
| Range window size | 256 pts | 256 pts | 256 pts | 1024 pts | 1024 pts | 1024 pts |
| Tracking window size | 256 pts | 256 pts | 256 pts | 2048 pts | N/A | N/A |
| Range window size | 32 m (due to RMC) | 64 m | 64 m | 256 m | 256 m | 256 m |
| Tracking window size | 64 m | 64 m | 64 m | 512 m | N/A | N/A |
| Tracking mode | Closed/Open-loop | Closed/Open-loop | Closed/Open-loop | Closed/Open-loop | Closed/Open-loop | Closed/Open-loop |
| On-board processing | RMC | N/A | N/A | N/A | N/A | N/A |

# CRISTAL Modes of Operation



# CRISTAL Mode Mask (preliminary)

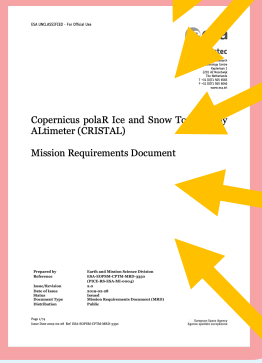



See also the poster by Mank et al. in Science IV Poster session (which also has a few other posters on CRISTAL)

# CRISTAL Products and Copernicus Services

**Copernicus Polar Expert Group (PEG) Reports (2017)**

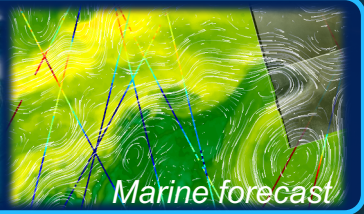

**ESA CRISTAL Mission Requirements Document**




**C3S**
- Ice sheet topography
- Sea ice thickness & volume
- Snow depth
- Global sea level

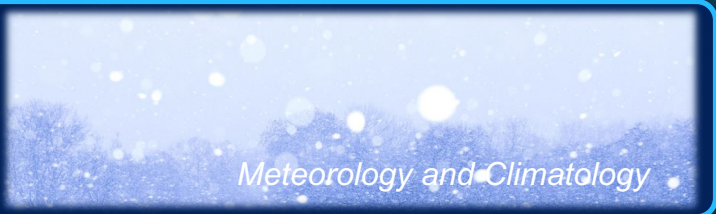


**CMEMS**
- Sea ice thickness
- Sea level anomaly & currents
- Waves and winds


**CLMS**
- Ice sheet and glaciers topography
- Snow depth


**CAMS**
- Snow depth

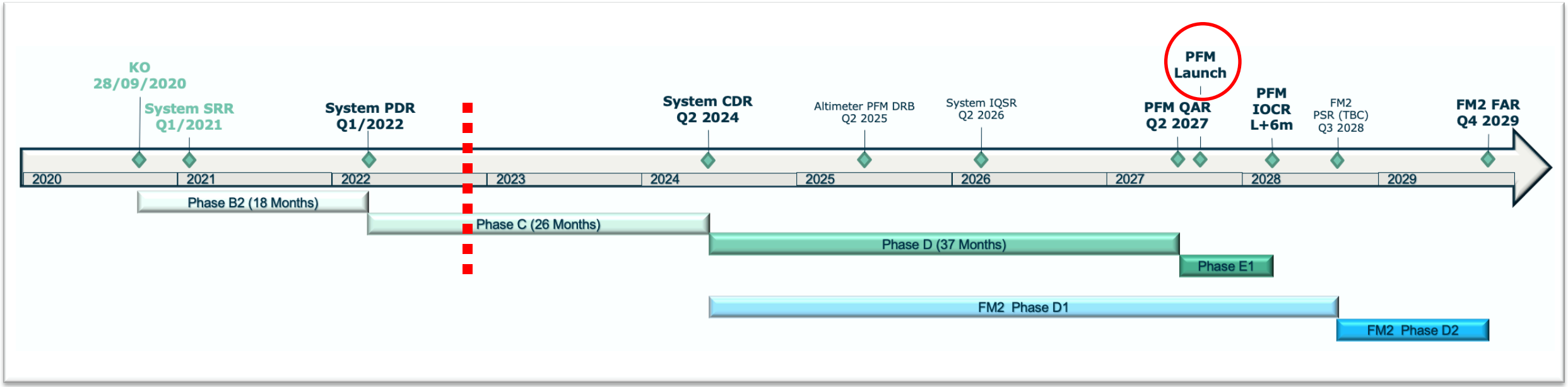



**EMS**
- Snow depth
- Global sea level
- Lake and river level



Product from:
ESA EUMETSAT

# CRISTAL Main project phases and milestones




| | KO | SRR | PDR | CDR | PFM QAR | FM2 FAR |
|---|---|---|---|---|---|---|
| Satellite | 28/09/20 ✓ | Feb-Mar'21 ✓ | Feb-Mar'22 ✓ | May'24 | Jun'27 | Oct'29 |
| Altimeter | 28/09/20 | Feb-Mar'21 | Feb-Mar'22 | Apr'24 | May'25 | Jan'26 |

**CRISTAL-A on track for launch in late 2027**
**Followed (towards EOL) by CRISTAL-B**

# CRISTAL L2 development and Science Studies

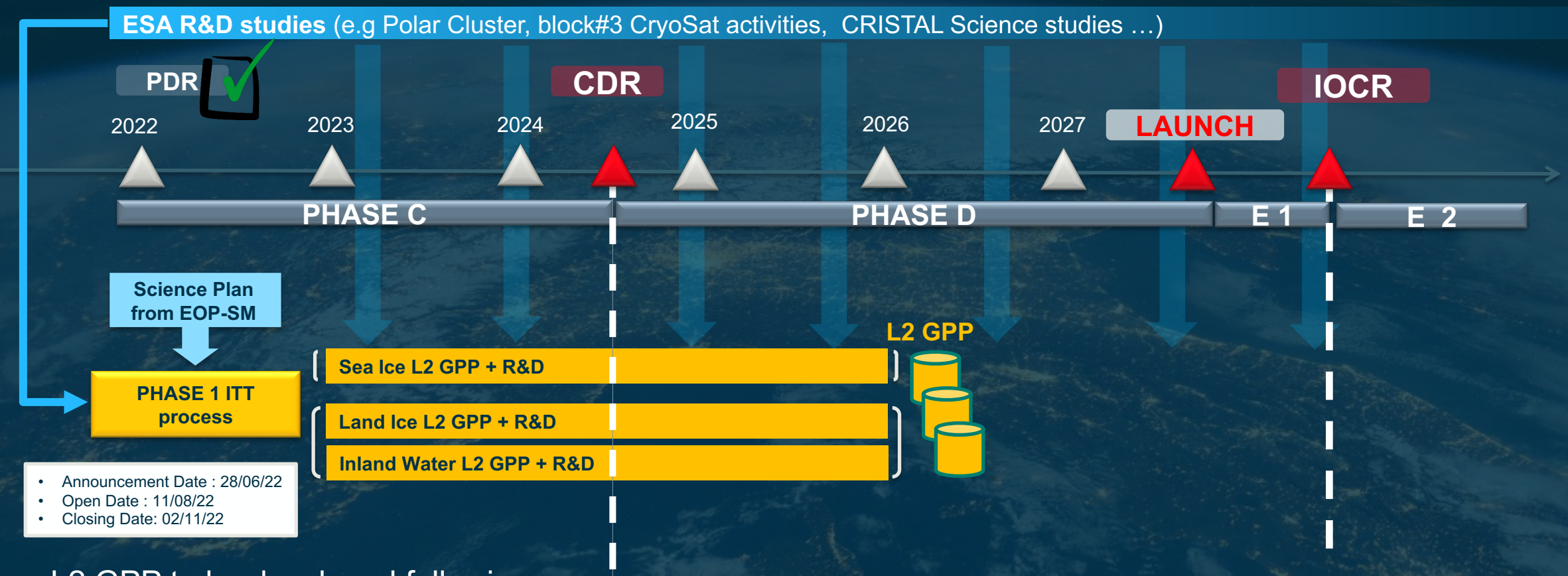
These Activities have two objectives

- the highest priority is the provisioning of the Ground Processor Prototype (GPP) whose first version needs to be available at system CDR
- Also some science activities aiming at improving the Scientific Readiness Level to reach level 6 (Consolidated Science and Products) → contribute to improvement of ATBD
- Two ITTs open at the moment (closing 2 Nov) on L2 algorithm and GPP development for
  - i) sea ice & icebergs
  - ii) land ice + inland waters

- ***Thematic L2 products:*** one L2 GPP for each thematic area (i.e. sea ice, land ice and inland water)
- ***CEM PAL***: L2 GPP to be designed to be integrated and exploited in the Copernicus Expansion Mission Processing Algorithm Laboratory (CEM PAL)

*Contacts: J. Bouffard, P. Cipollini*

# Timeline for L2 development and Science Studies




L2 GPP to be developed following open source software development practices

# CRISTAL Marine Data Centre

Cristina Martin-Puig
*EUMETSAT - RSP*

*OSTST 2022*

# CRISTAL design important information for our oceans



**Ku AND Ka BANDS SIMULTANEOUS**

- Another first of this mission is the **equal exploitation of the Ku and Ka band for oceanography**. Neither serves as a secondary band. Instead, the strengths of both are exploited to enrich the products, e.g., with an improved ionospheric correction, rain flagging, etc.

## CRISTAL'S ORBIT - relevant facts for oceanography

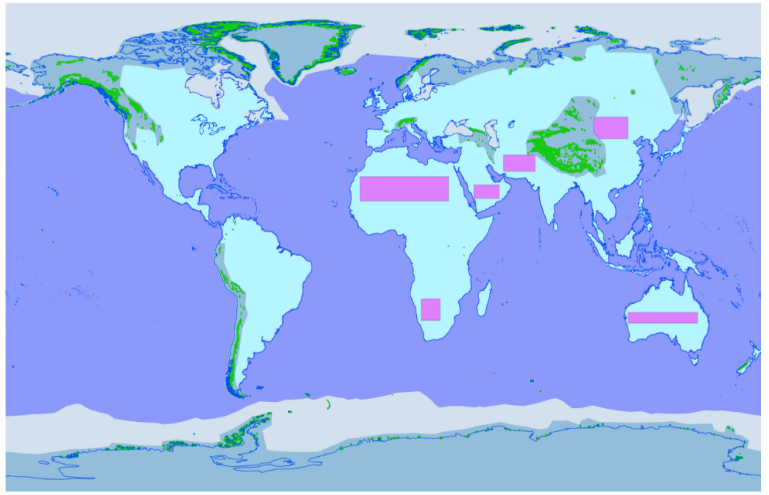
| Inclination | Altitude | Cycle |
|---|---|---|
| • 92 Degrees | • 683.62 Km | • 367 days |
| Sub-cycles | • 2, 5, 7, 12, 19, 31 and 112 days | |

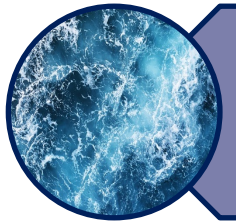
# CRISTAL operational modes over open ocean



**THEMATIC L1B OCEAN PROCESSORS FOR CRISTAL**

- A novelty of CRISTAL is that it will be the **first operational mission** offering the possibility to operationally exploit SAR CB (Ku and Ka), SARin OB (ku) and SAR OB (Ka) over different areas of our ocean (see Figure 1). Sentinel-3 and Sentinel-6 as they are currently operated offer the same acquisition mode over all regions in the Globe. CRISTAL instead will enrich the acquisition spectrum, in turn thematic L1B processing will be needed.



**OCEAN**

- **Ku band SAR – Closed Burst**
- **Ka band SAR – Closed Burst**
- **RMC**

**SSH INTO THE LEADS and over LARGE LAKES**

- **Ku band SAR-in Open Burst**
- **Ka band SAR Open Burst**
- **No RMC**

**COAST**

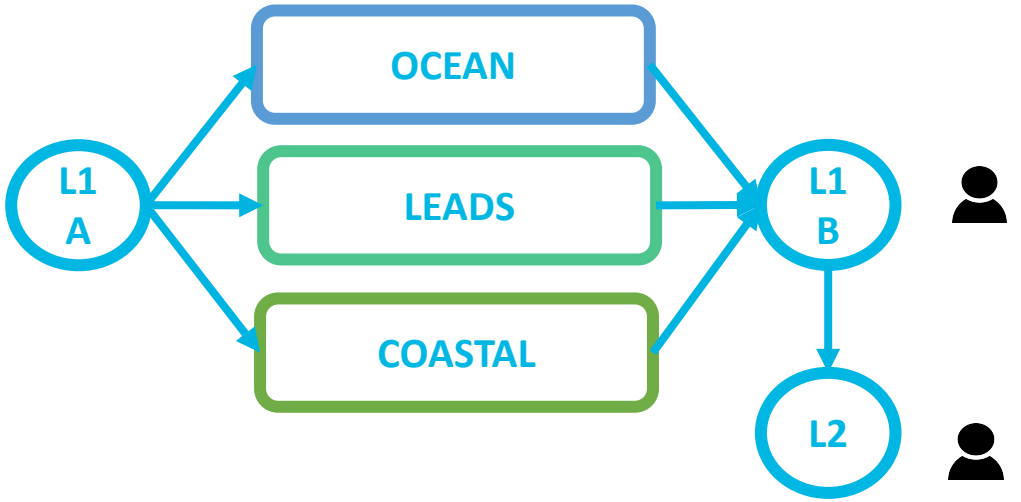
- **Mostly like open ocean, but for some polar regions a combination of the previous two based on CRISTAL's altimeter IRIS acquisition mode mask**

# CRISTAL ocean products



**PRODUCT HERITAGE**

- As per Mission Requirements, ocean products shall be produced at NRT, STC and NTC.
- Products format will resemble to **Sentinel-6**
  - SAFE packaging (Manifest + NetCDF)
  - Separate HR and LR (pseudo-LRM or LRM depending on IRIS mode)
  - NetCDF grouping
  - Maintain variable names as reference mission
  - Products File naming similar to Sentinel-6
- Product design should be completed before next OSTST in 2023




**CRISTAL**

| | | |
|---|---|---|
| • **≤ 3-hours latency (TBC)**<br>• **Level 2:**<br>  • **Standard** (1-Hz and 20-Hz)<br>  • **Reduced** (1-Hz)<br>  • **BUFR** (1-Hz and 20-Hz)<br>• **MWR L2 (TBC):** 16-Hz AMR-C and HRMR measurements | • **≤ 48-hours latency (TBC)**<br>• **Level 1A:** TBC<br>• **Level 1B:** TBC<br>• **Level 2:**<br>  • **Standard & Reduced**<br>• **MWR L2 (TBC):** 16-Hz AMR-C and HRMR measurements | • **TBC**<br>• **Level 1A:** Individual echoes<br>• **Level 1B:**<br>• **Level 2:**<br>  • **Standard & Reduced**<br>• **MWR L2 (TBC):** 16-Hz AMR-C and HRMR measurements |

# CRISTAL Marine data centre – Tentative development timeline



- Preparatory activities at EUMETSAT will initiate this 2023 with the tentative goal of starting the marine data center development beginning of 2024.