30 Years of Progress in Radar Altimetry Symposium

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GDR-G Altimetry Standards

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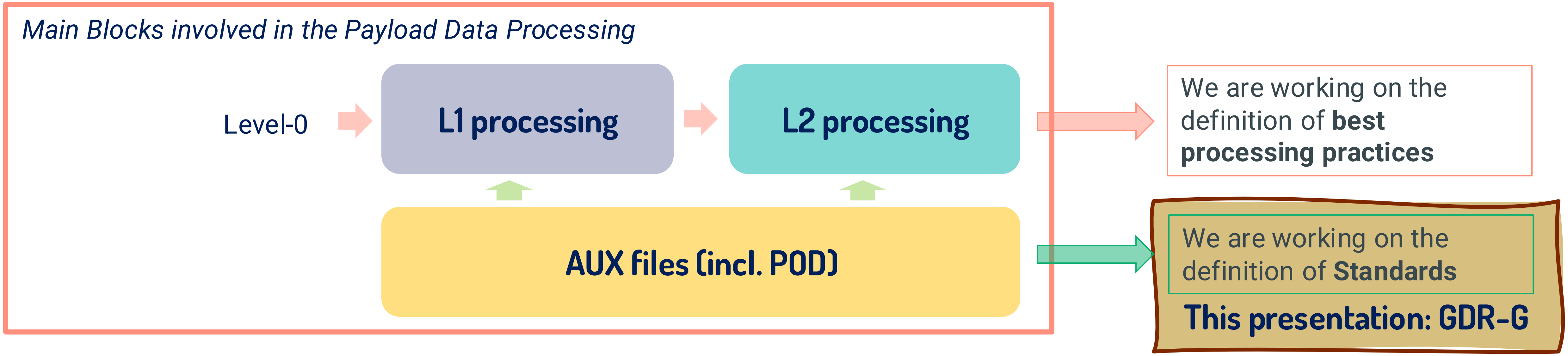
Outline

- Motivation
- GDR history
- GDR-G
  - Static auxiliary data
    - Expected impact
  - Dynamic auxiliary data
  - Implementation Timeline
- Conclusions

Motivation

- ***Technical Standard definition:*** *a technical standard is an established norm or requirement for a repeatable technical task which is applied to a common and repeated use of rules, conditions, guidelines or characteristics for products or related processes and production methods, and related management systems practices.*

➢ With the increase of missions, with the existence of different altimeter instruments, with different processing needs, the Agencies agree the following approach will facilitate the harmonization among missions:



GDR history on the reference missions

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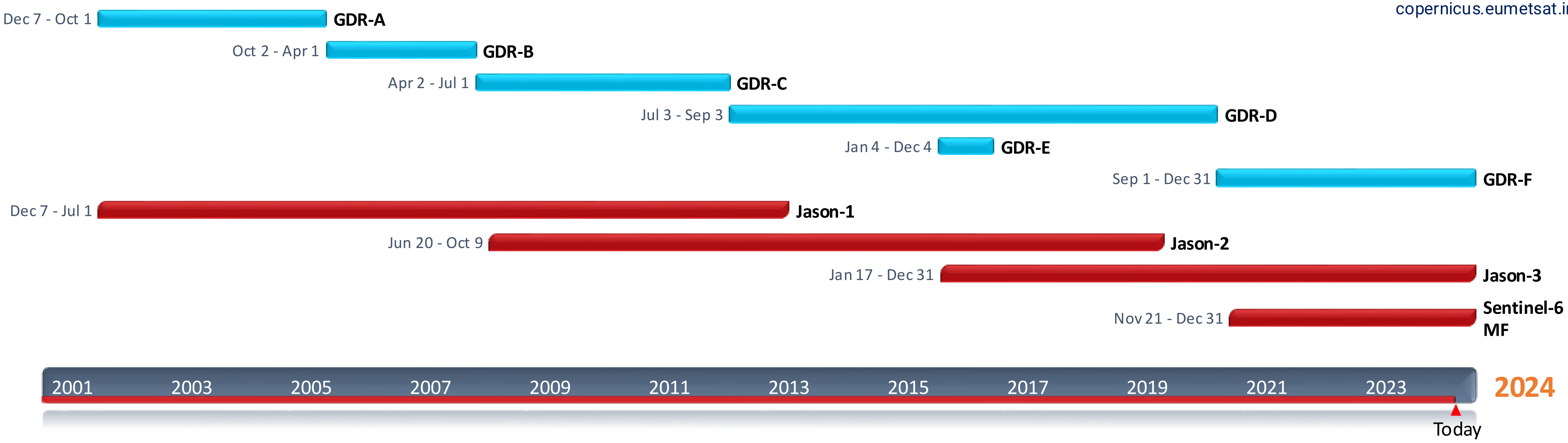


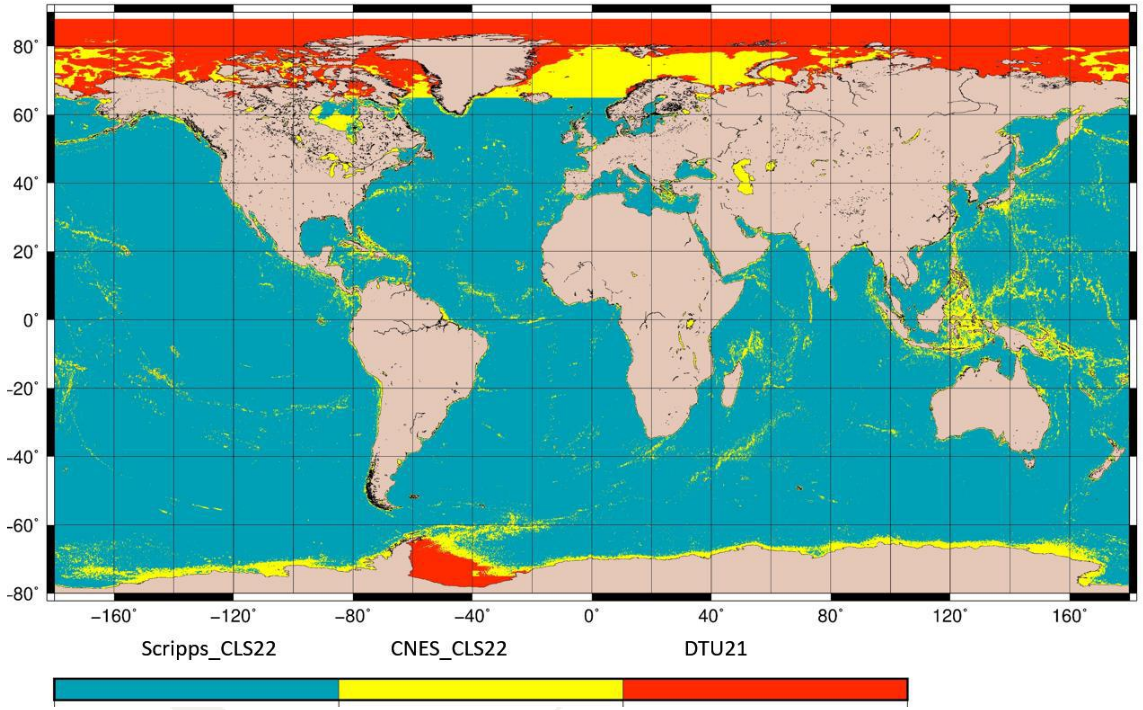
- **Version "a"** first version released after Jason-1 launch.(Dec 2001)
- **Version "b"** first implemented operationally from Oct 2005 for the Jason-1 GDRs. Reprocessing performed in 2006.
- **Version "c"** first implemented operationally from April 2008 for the Jason-1 GDRs. Reprocessing performed in 2008/2009. Version used for Jason-2 GDRs since launch. (2008)
- **Version "d"** first implemented operationally from July 2012 for the Jason-2 GDRs. Reprocessing performed in 2012
- **Version "e"** limited to Jason-1 reprocessing in 2016
- **Version "f"** first implemented operationally from Sept 2020 for the Jason-3 GDRs. Reprocessing performed in 2020 for AltiKa, 2022 for Jason-3 , in 2023/2024 for Jason-2.

GDR-G Updated Static Auxiliary data

	Sentinel-3	Sentinel-6	Jason-3	
Meteo Altimetry Gaussian Grid	ECMWF			
Ocean Tide Solution 1	GOT 4.10C			
Ocean Tide Solution 2	FES2022B			updated
Pole Tide	Desai et al., 2015			
MSS Solution 1	Hybride2023: CNES/CLS 2022 + Scripps + DTU21			updated
MSS Solution 2	DTU 2021	DTU 2021	DTU 2021	updated
MSS/Geoid Slopes Map	CNES	DNS2008	CNES	
Geoid Height Map	EGM2008			
Ocean Depth and Land Elevation (Bathymetry)	ACE2 (2008)			
Wind Tables	1D Abdalla 2007 + 2D (Gourrion et al. 2002; Collard 2005)	2D (Gourrion et al. 2002; Collard 2005)	2D (Gourrion et al. 2002; Collard 2005)	
Solid Earth Tide	Cartwright and Edden			
Climatological Pressure Grids	RDRay and RMPonte 2003			
Pressure Variability File (S1/S2)	RDRay and RMPonte 2003			
Mean Dynamic Topography	CNES_CLS_MDT_2022			updated
Distance and Angle To Coast	Scharroo 2019 based on GSHHG			
Sea State Bias	Non param SSB, Tran 2021	SSB_2020_J3_GDRF	SSB_2020_J3_GDRF	
Internal Tide	Internal tide [Zaron, 2019] HRET v8.1			

Mean Sea Surface: MSS Hybrid 2023

- This new MSS has been determined using a combination of recent models considered as the most precise which are the SCRIPP_CLS22, CNES_CLS22, and DTU21 MSS's.
- The aim was to generate a new MSS by taking advantage of the best properties of each model based on various validation of these 3 models. This work focused on the following points:
  - achieving centimetric accuracy,
  - while minimizing residual ocean variability,
  - and obtaining the most accurate mapping of the finest topographic structures down to wavelengths of less than 10 km.
- Particular attention was also been paid to the Arctic and Antarctic areas.



Credits: "The 2023 Hybrid Mean Sea Surface" by Schaeffer et al. 2023
(DOI: 10.24400/527896/a03-2023.3717)

Available at: https://doi.org/10.24400/527896/A01-2024.002

Ocean Tide Model: FES 22B

- New global tide model FES2022 has been developed, focusing particularly on shallow waters and high latitudes.

- This new tidal solution uses higher spatial resolution in coastal areas, extending systematically the model mesh to the narrowest coastal systems (fjords, estuaries, …), and the model bathymetry has been upgraded in many places thanks to an international collaboration effort.

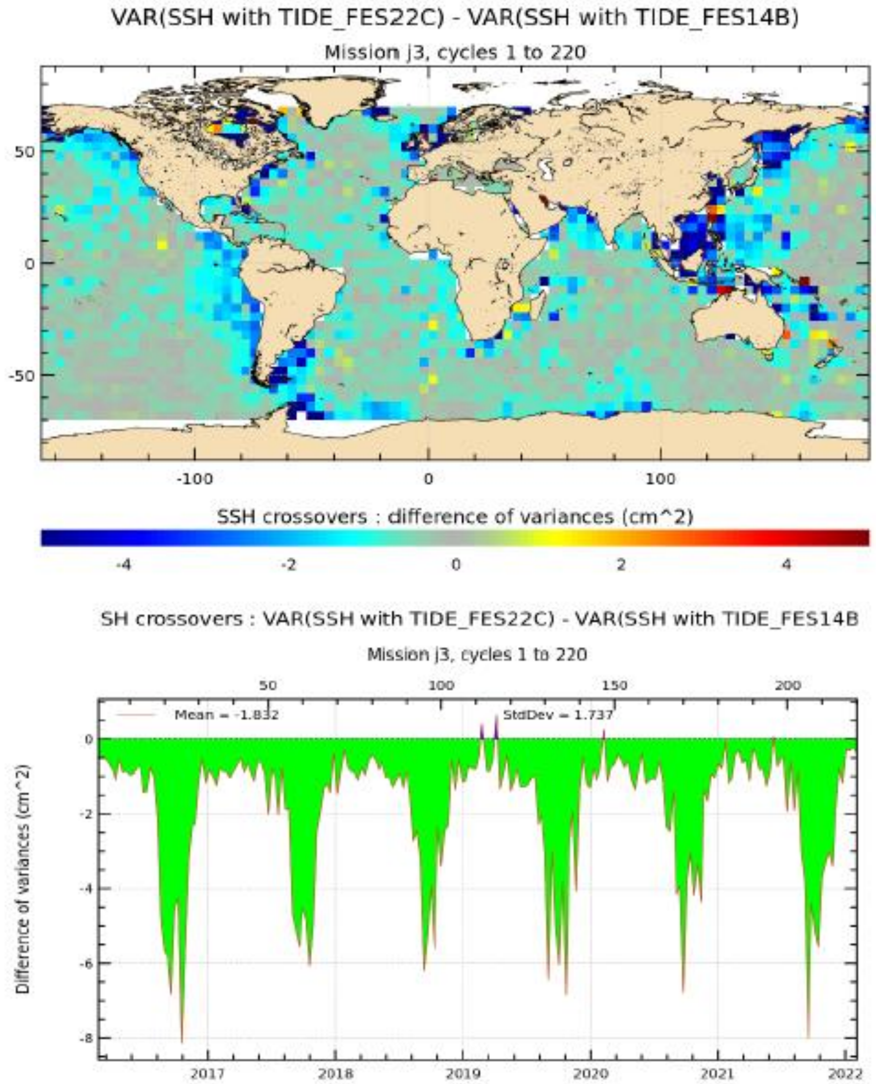
- The hydrodynamic modelling benefits also from further improvements which allows producing very accurate hydrodynamic simulations.

Credits: "A new barotropic tide model for global ocean: FES2022" by Carrere et al. 2022 (DOI: https://doi.org/10.24400/527896/a03-2022.3287)

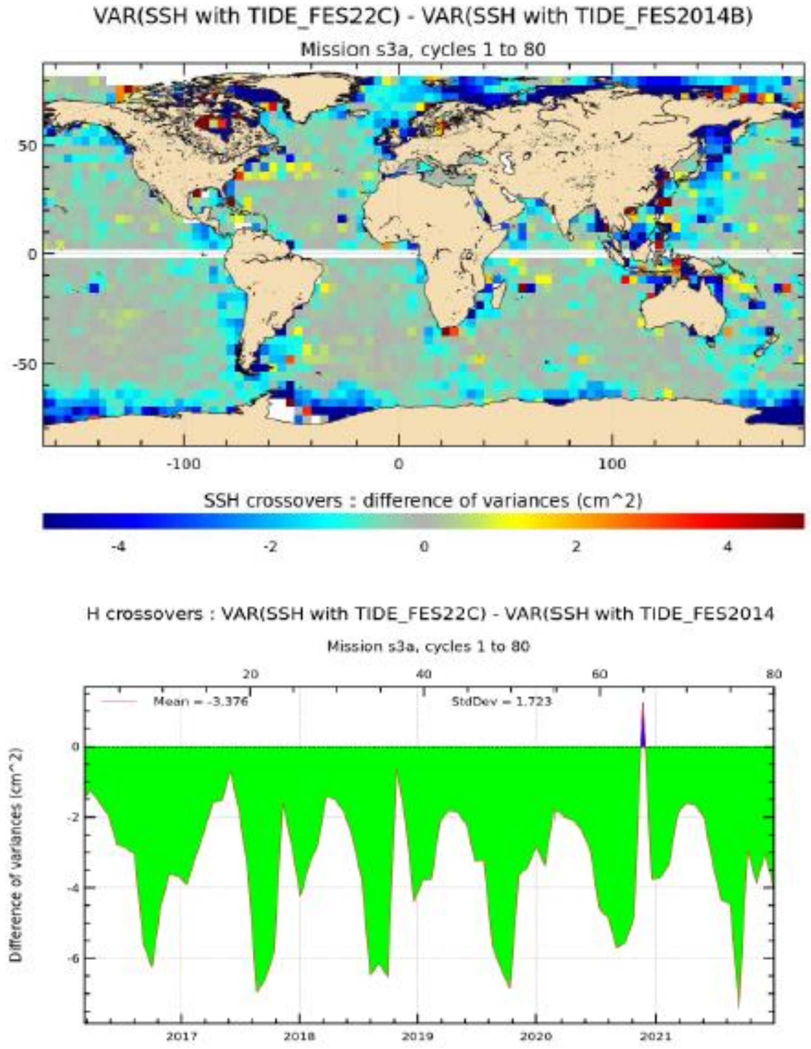
Available at: https://doi.org/10.24400/527896/A01-2024.004

Ocean Tide Model: FES 22B (II)

XOVERS J3



XOVERS S3A



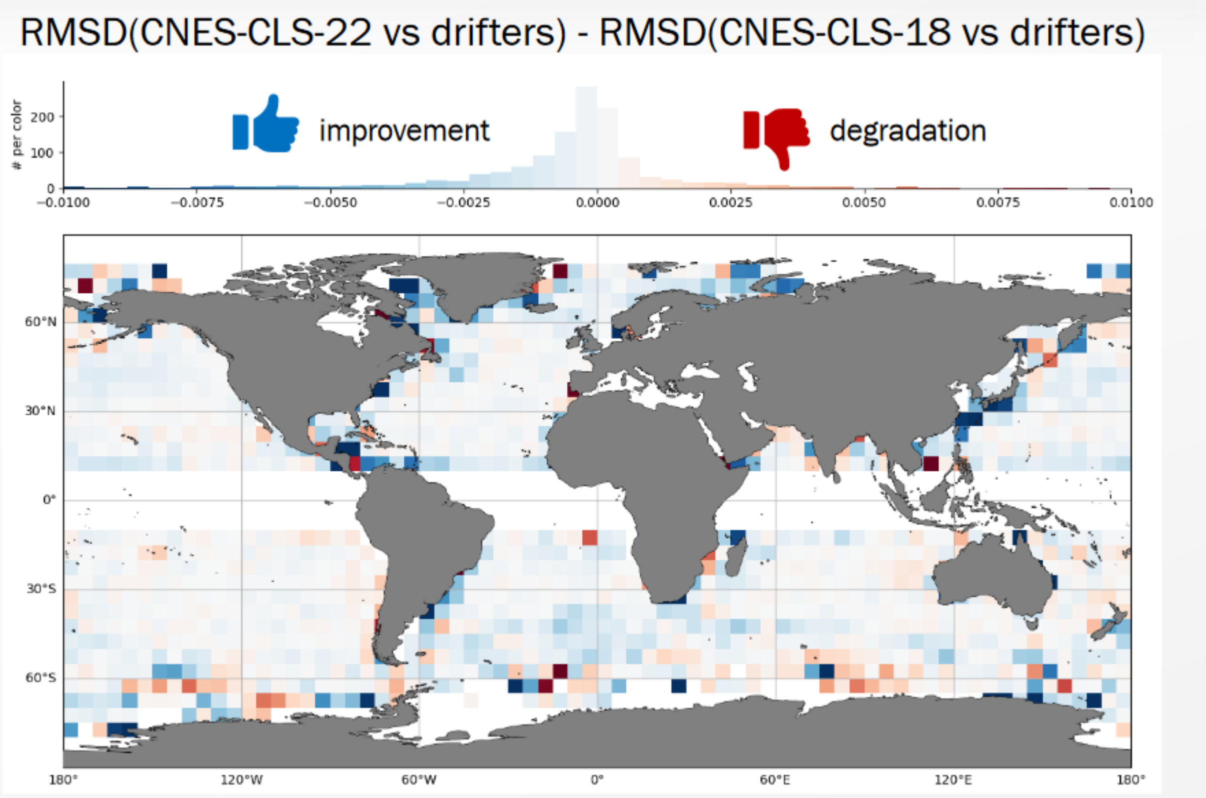
Improved Variance at Crossovers (mono-mission) when compared to FES14B

Credits: "A new barotropic tide model for global ocean: FES2022" by Carrere et al. 2022 (DOI: https://doi.org/10.24400/527896/a03-2022.3287)

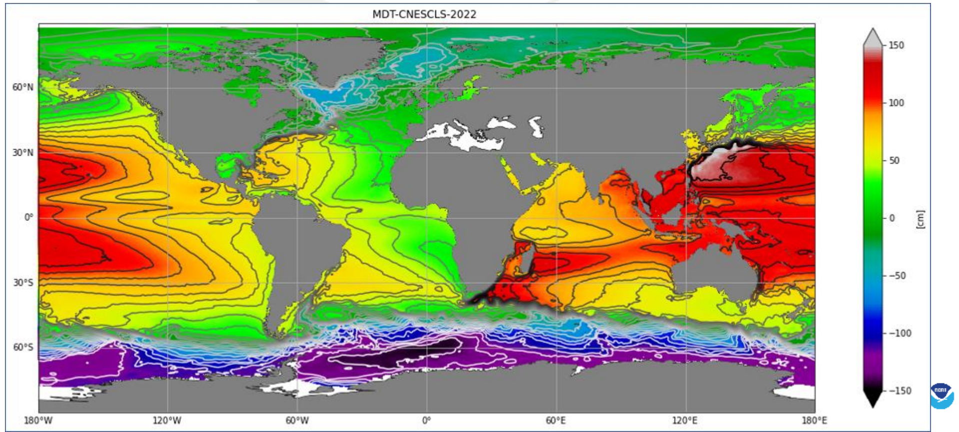
Available at: https://doi.org/10.24400/527896/A01-2024.004

Mean Dynamic Topography: MDT CNES/CLS 22

- Latest GOCO06S geoid model (based on the complete GOCE mission fully reprocessed and 14 years of GRACE data) and 30 years of altimetry and *in-situ* data (hydrologic, drifters and High Frequency radar on a limited area):
  - better coverage and
  - better representation of the structures in the Arctic
  - better representation of the shelf-break current



Global improvement even if deterioration in some boxes



Credits: "New global Mean Dynamic Topography CNES-CLS-22 combining drifters, hydrological profiles and High Frequency radar data" by Jousset et al. 2022 (DOI: https://doi.org/10.24400/527896/a03-2022.3292)

Available at: 10.24400/527896/a01-2023.003

Overall impact (preview, introducing MSS+TIDES update)

Sentinel-3B

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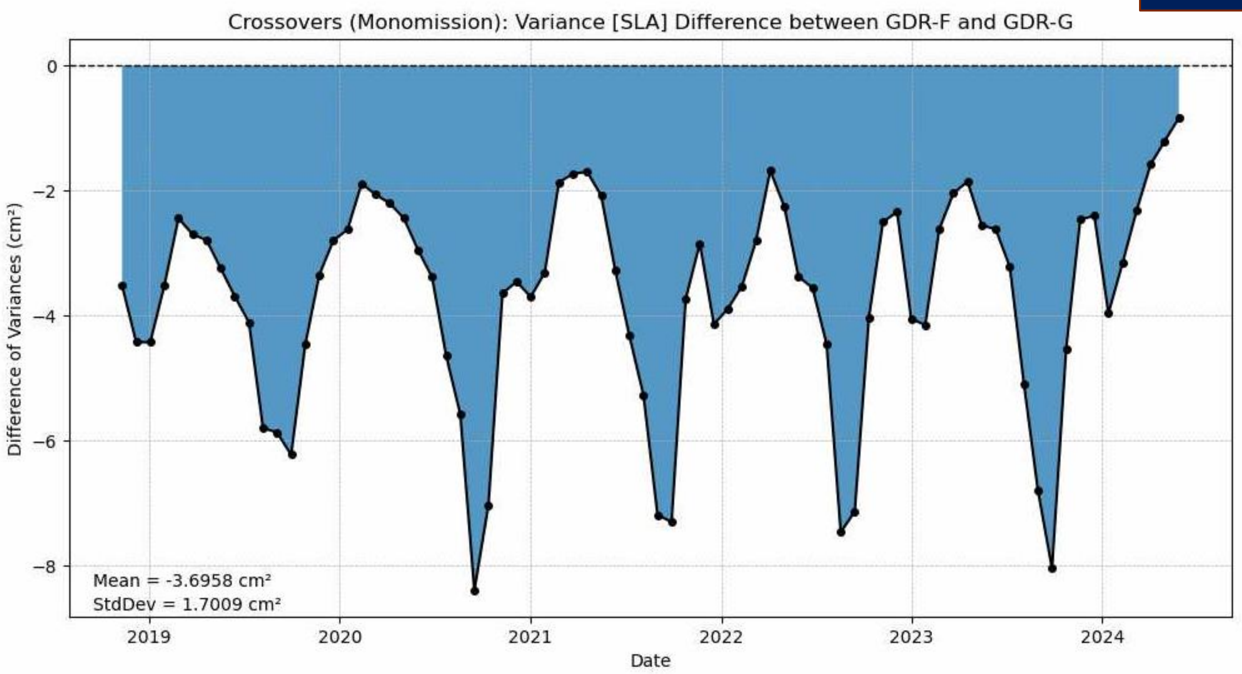
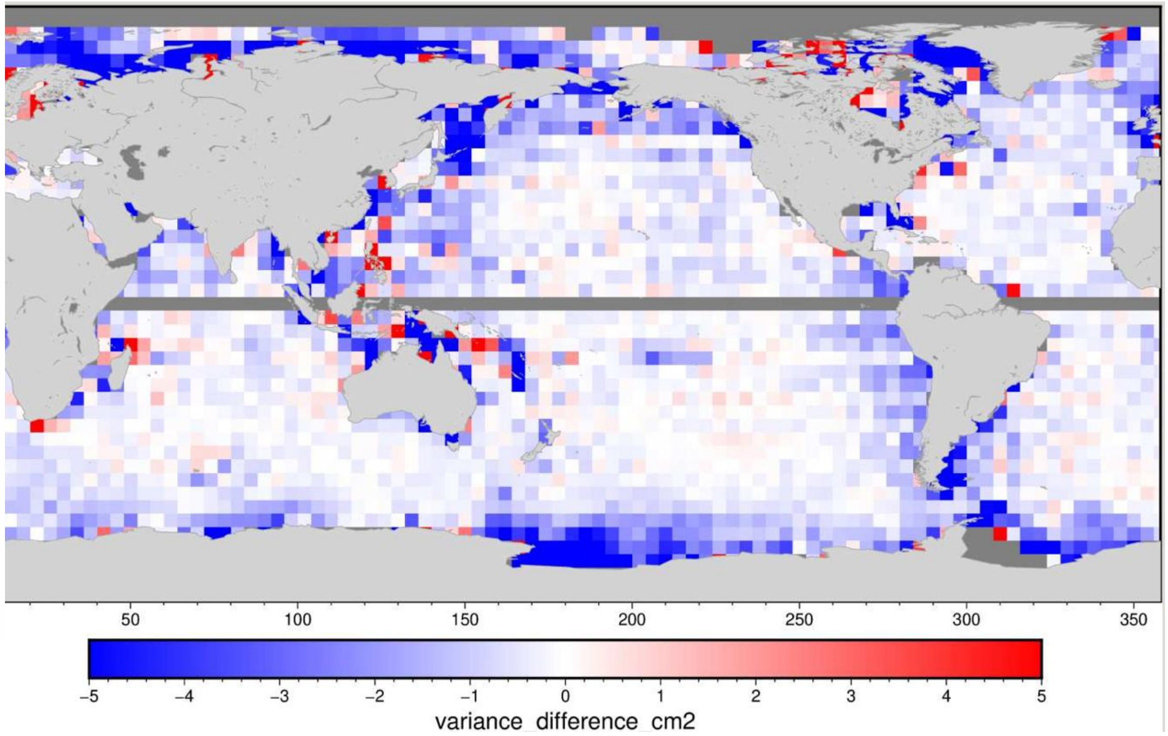




Mono-mission Crossover of simulating Sea Level with GDR-F and GDR-G:

- Max delay 10 days
- Aggregated into cycles (top left plot)
- Aggregated into 4x4 degree boxes (top right plot)
- Excluding ice covered areas
- Valid Sea Level < | 1m |

Mainly coming from FES update. Other updates in processing not accounted/simulated.

Variance reduction of ~ 3.7 cm^2

GDR-G: Dynamic Aux data updates

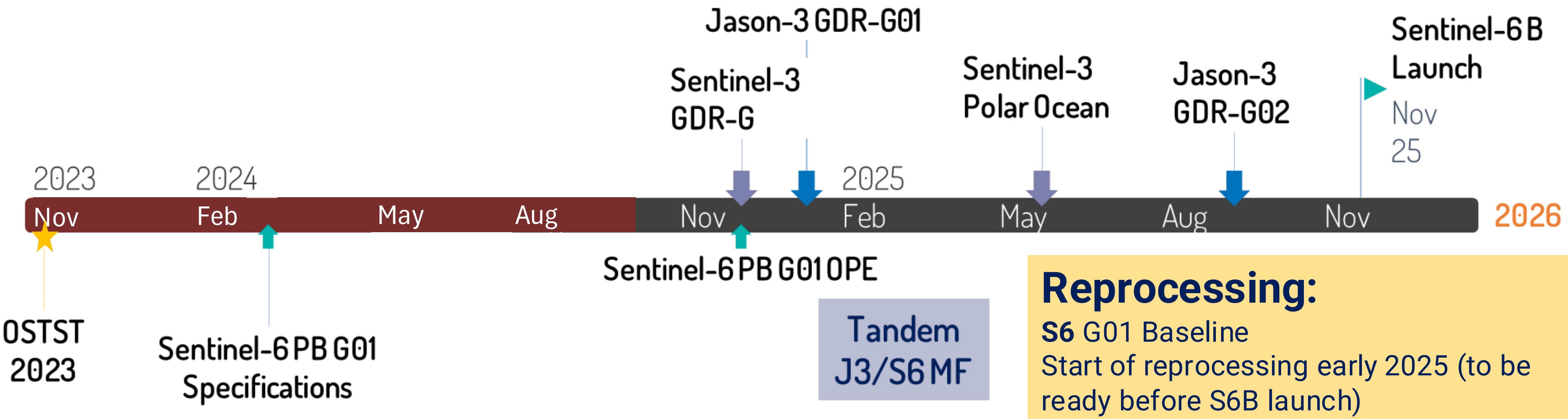
Mission	S3 BC006	S6 PBG01	J3 GDR-G
Dynamic AUX Files			
Meteo Files	ECMWF Op Forecast	ECMWF Op Forecast (MeteoAltimeterGaussian_N640_001.nc)	ECMWF Op Forecast
	ECMWF Op Analysis	ECMWF Op Analysis	ECMWF Op Analysis
	ECMWF Op Analysis	ECMWF Op Analysis	ECMWF Op Analysis
Modelled Ionospheric Correction	GIM preliminary	GIM Preliminary	GIM Forecast
	GIM Restituted	1. GIM Restituted 2. GIM Preliminary	GIM Preliminary
	GIM Restituted	GIM Restituted	GIM Preliminary
Wave Model Files	Wave Model Forecast (WVF) - MeteoFrance	Wave Model Forecast (WVF) - MeteoFrance	Wave Model Forecast (WVF) - MeteoFrance
	1. Wave Model Analysis (WMA) 2. Wave Model Forecast (WMF) All MeteoFrance	1. Wave Model Analysis (WMA) 2. Wave Model Forecast (WMF) All MeteoFrance	CNES/MFWAM Analysis
	Wave Model Analysis (WMA) - MeteoFrance	Wave Model Analysis (WMA) - MeteoFrance	CNES/MFWAM Analysis
Ice Concentration	OSI-SAF SIC: OSI-430a (fast-track)		N/A
	OSI-SAF SIC: OSI-430a (fast-track)		OSI SAF Preliminary
	OSI-SAF SIC: OSI-430a (ICDR)		OSI SAF Analysis
Orbits	1. ROE (CPOD service), 2. DORIS	1. ROE (CPOD service), 2. DORIS	DORIS
	MOE(CNES) MOE (CPOD)	MOE (CNES)	MOE (CNES)
	POE (CNES) POE (CPOD)	POE (CNES)	POE (CNES)

GDR-G: Dynamic Aux data updates

Mission	S3 BC006	S6 PBG01	J3 GDR-G
Dynamic AUX Files			
Meteo Files	ECMWF Op Forecast	ECMWF Op Forecast (MeteoAltimeterGaussian_N640_001.nc)	ECMWF Op Forecast
	ECMWF Op Analysis	ECMWF Op Analysis	ECMWF Op Analysis
	ECMWF Op Analysis	ECMWF Op Analysis	ECMWF Op Analysis
Modelled Ionospheric Correction	GIM preliminary	GIM Preliminary	GIM Forecast
	GIM Restituted	1. GIM Restituted 2. GIM Preliminary	GIM Preliminary
	GIM Restituted	GIM Restituted	GIM Preliminary
Wave Model Files	Wave Model Forecast (WVF) - MeteoFrance	Wave Model Forecast (WVF) - MeteoFrance	Wave Model Forecast (WVF) - MeteoFrance
	1. Wave Model Analysis (WMA) 2. Wave Model Forecast (WMF) All MeteoFrance	1. Wave Model Analysis (WMA) 2. Wave Model Forecast (WMF) All MeteoFrance	CNES/MFWAM Analysis
	Wave Model Analysis (WMA) - MeteoFrance	Wave Model Analysis (WMA) - MeteoFrance	CNES/MFWAM Analysis
Ice Concentration	OSI-SAF SIC: OSI-430a (fast-track)		N/A
	OSI-SAF SIC: OSI-430a (fast-track)		OSI SAF Preliminary
	OSI-SAF SIC: OSI-430a (ICDR)		OSI SAF Analysis
Orbits	1. ROE (CPOD service), 2. DORIS	1. ROE (CPOD service), 2. DORIS	DORIS
	MOE(CNES) MOE (CPOD)	MOE (CNES)	MOE (CNES)
	POE (CNES) POE (CPOD)	POE (CNES)	POE (CNES)

POE-G in preparation for late 2024/early 2025 for S6, J3 and S3

Timeline



Reprocessing:

S6 G01 Baseline
Start of reprocessing early 2025 (to be ready before S6B launch)

S3 "Polar Ocean" 006.02 baseline:
Start of reprocessing mid 2025

J3 Reprocessing based on G02 expected to start late 2025

GDR-G going into operations: End of 2024/early 2025
Further evolutions are planned for S3 and J3 later in 2025, but the standards will be maintained

Cryosat2 (Ocean Products) will adopt the standards in a different timeline

Conclusions

- GDR-G update
  - Newer standards
    - FES22B
    - MSS Hybrid 2023
    - MDT CNES/CLS 2022
    - POE-G (dynamic, not in sync with the processors)
  - Better interoperability
    - Same standards as DT24 (CMEMS L3 product)
    - Preparation/facilitation for higher level products
  - Better alignment of processing practices
    - *Not discussed on this presentation*
  - **>>> Data quality improvement <<<**
    - To be used on the reprocessing campaigns in 2025

In operations for Winter 24/25

J3 / S6 / S3

Cryosat2 (Ocean Products) will adopt the standards in a different timeline

- **Recommendation:** Further continue standardization of Radar Altimeter processing for all missions

Thank you !