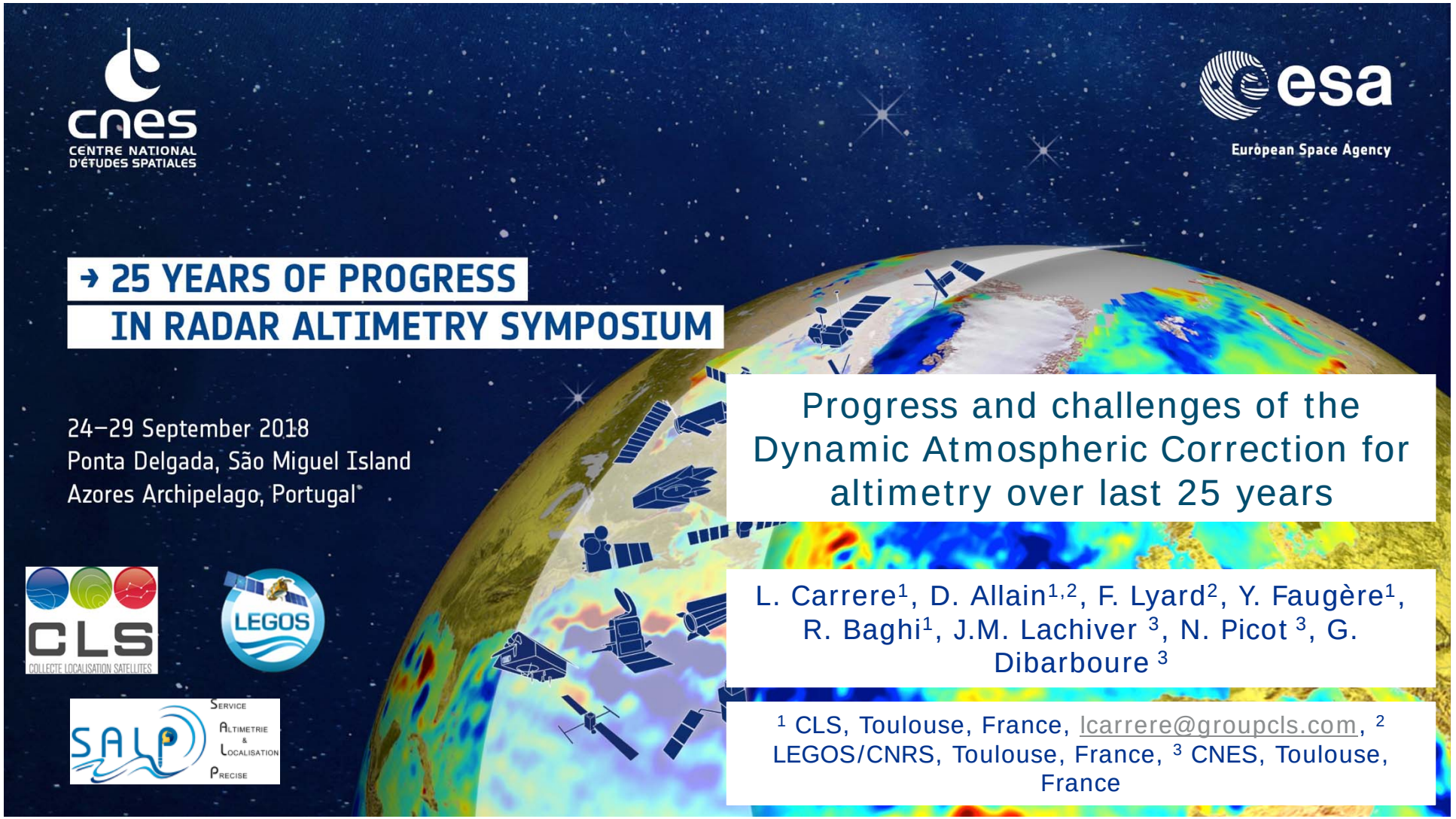

Progress and challenges of the Dynamic Atmospheric Correction for altimetry over last 25 years

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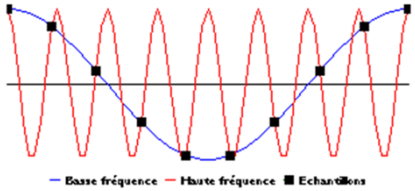
Introduction

- Due to coarse altimeter time sampling, high-frequency ocean signals are aliased into the lower-frequencies (tides and atmospheric forced signal)



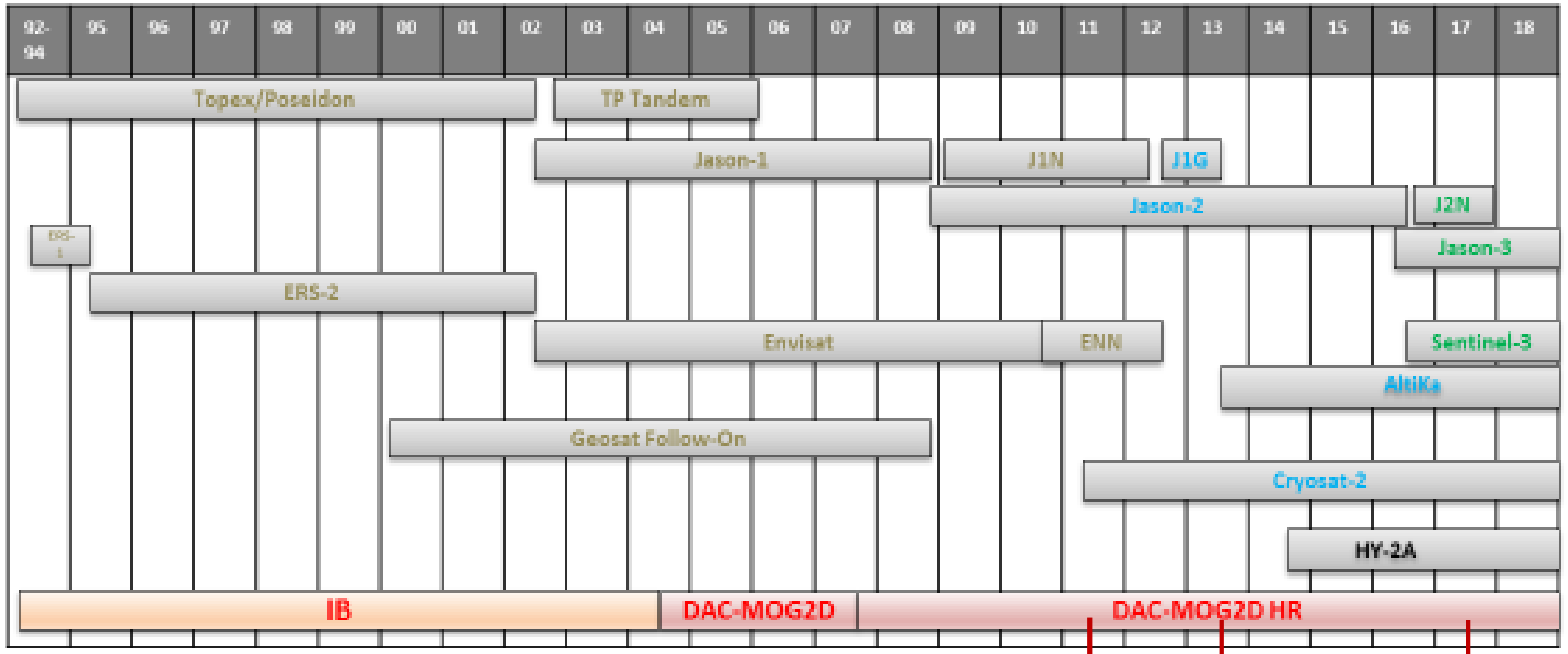
Aliasing phenomena

- Altimeter measurements are corrected for these high-frequency geophysical effects in order to isolate the oceanic variability: the DAC is the second most important one after the tide correction
- The accuracy of the DAC has been improved over the last 25 years leading to centimetric accuracy in open ocean
- However significant errors still remain mainly in shallow waters and in polar regions, due to bathymetric errors, to atmospheric forcing errors, to local lack of resolution, or to sea ice effects ...

Outline

- Quick overview of DAC evolution since 25 years
- Presentation of recent improvements and challenges
    - DAC-ERA and climate applications
    - Operational altimetry challenge
    - Challenges in coastal ocean and for HR satellites
    - Some results with TUGO model on global ocean
- Conclusion-perspectives

Satellites timeline and evolution of DAC products



Continuous improvement of ECMWF operational model

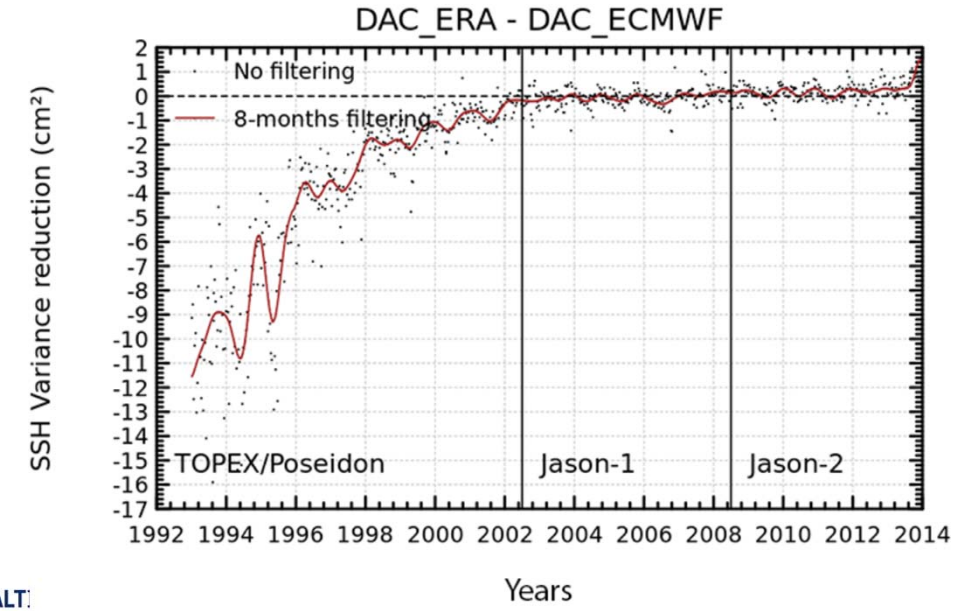
→ 25

DAC IGDR

0

Climate applications – DAC-ERA

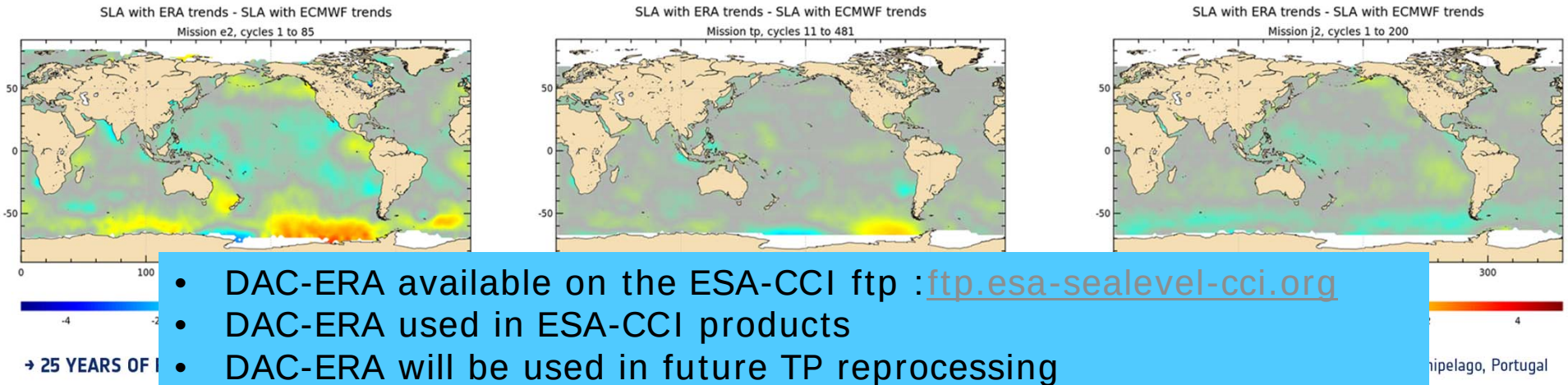
- Evolution of operational atmospheric model continuously impacts the quality of DAC
- Use ERA-INTERIM dataset to generate a more homogeneous DAC series (Carrere et al. 2016)



Climate applications – DAC-ERA

- Evolution of operational atmospheric model continuously impacts the quality of DAC
- Use ERA-INTERIM dataset to generate a more homogeneous DAC series (Carrere et al, 2016)

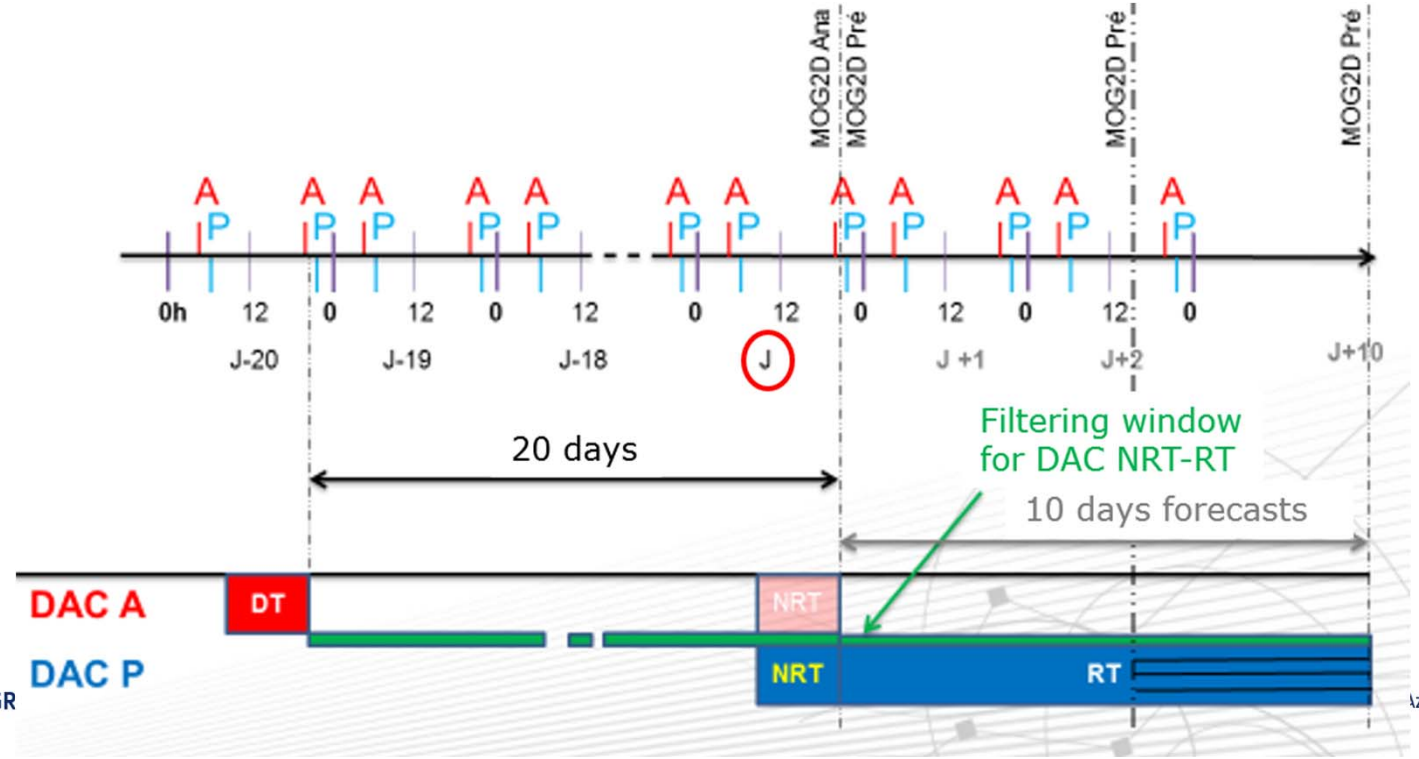
=> Strong impact of using DAC-ERA instead of the operational DAC on the regional MSL trend estimation



- DAC-ERA available on the ESA-CCI ftp : ftp.esa-sealevel-cci.org
- DAC-ERA used in ESA-CCI products
- DAC-ERA will be used in future TP reprocessing

Operational altimetry challenge

- Specific NRT and RT DAC products
- Using 10-days ECMWF atmospheric forecasts since oct-2017

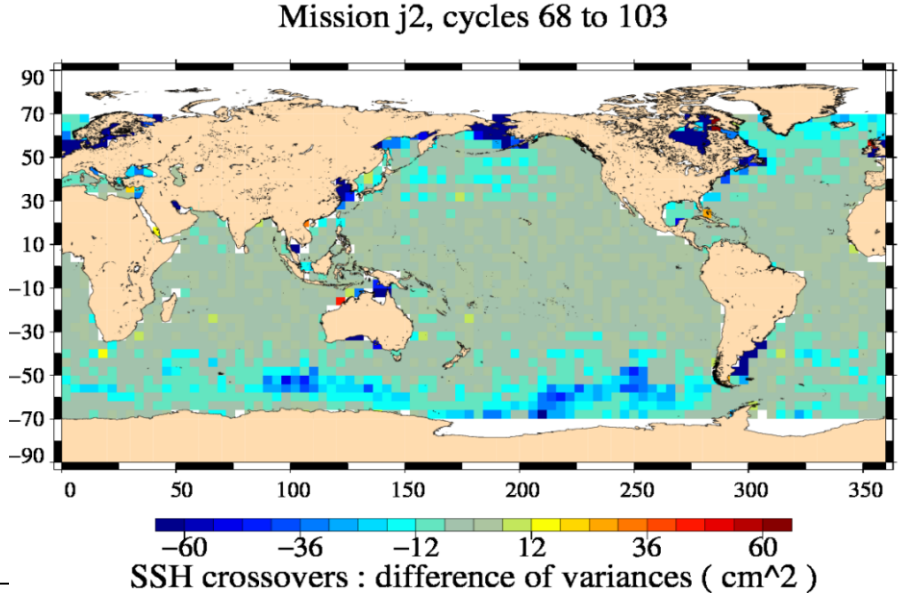


Operational altimetry challenge

- Specific NRT and RT DAC products
- Using 10-days ECMWF atmospheric forecasts since oct-2017

⇒ Very strong impact of using RT DAC for OGDR

VAR(SSH-DAC_RT) – VAR(SSH-IB_Forecast) in cm²

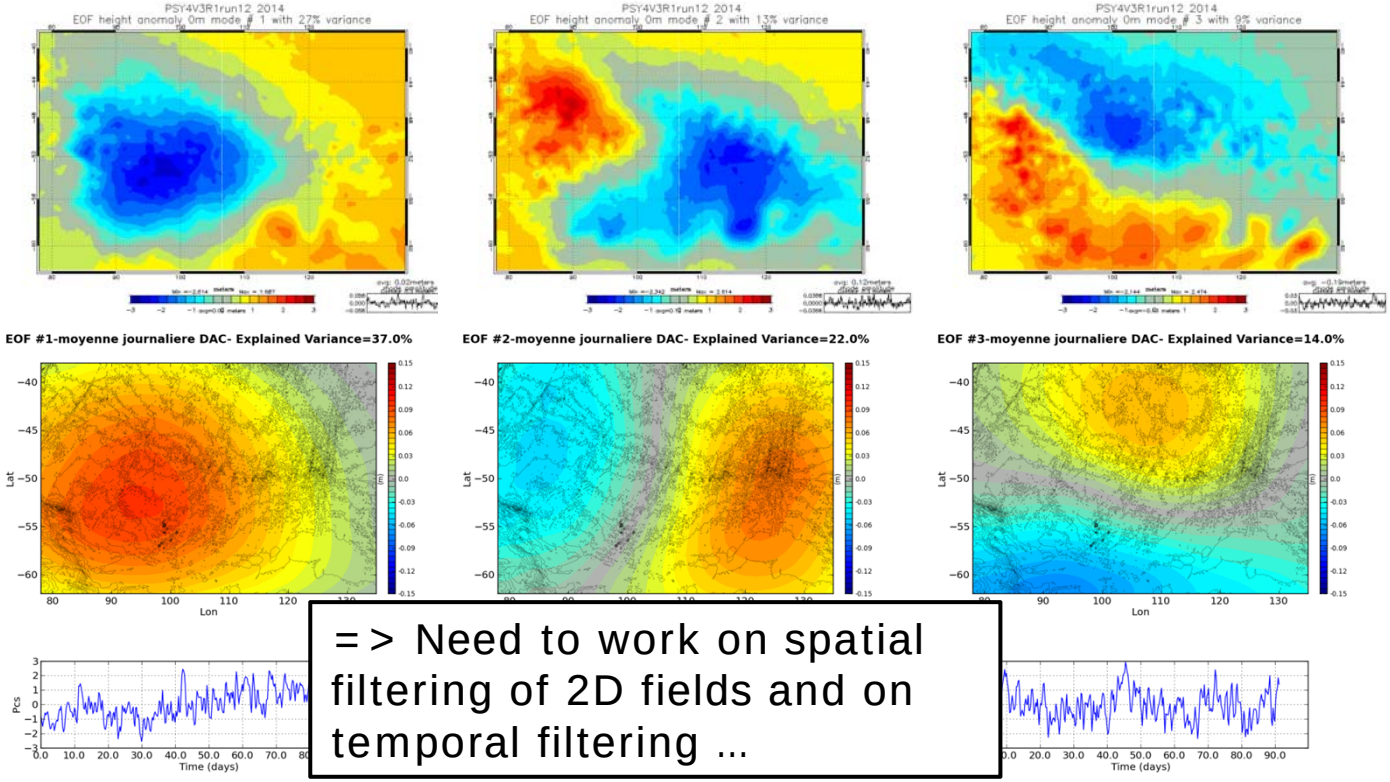


Operational altimetry challenge

- Specific NRT and RT DAC products
- Using 10-days ECMWF atmospheric forecasts since oct-2017
    - => optimized NRT DAC is disseminated to space agencies
    - => RT DAC is used in DUACS products but not yet disseminated
    - => RT DAC included in GDR-E standard to be implemented on Saral, J2-J3 in 2019
- Adequacy of the physical content between operational ocean models and the assimilated altimetry measurements is important:
    - Check processing like high-frequency filtering, S1S2 processing…

Operational altimetry challenge

Comparing equivalent DAC computed from MERCATOR-OCEAN model and the operational DAC – south east Indian Ocean

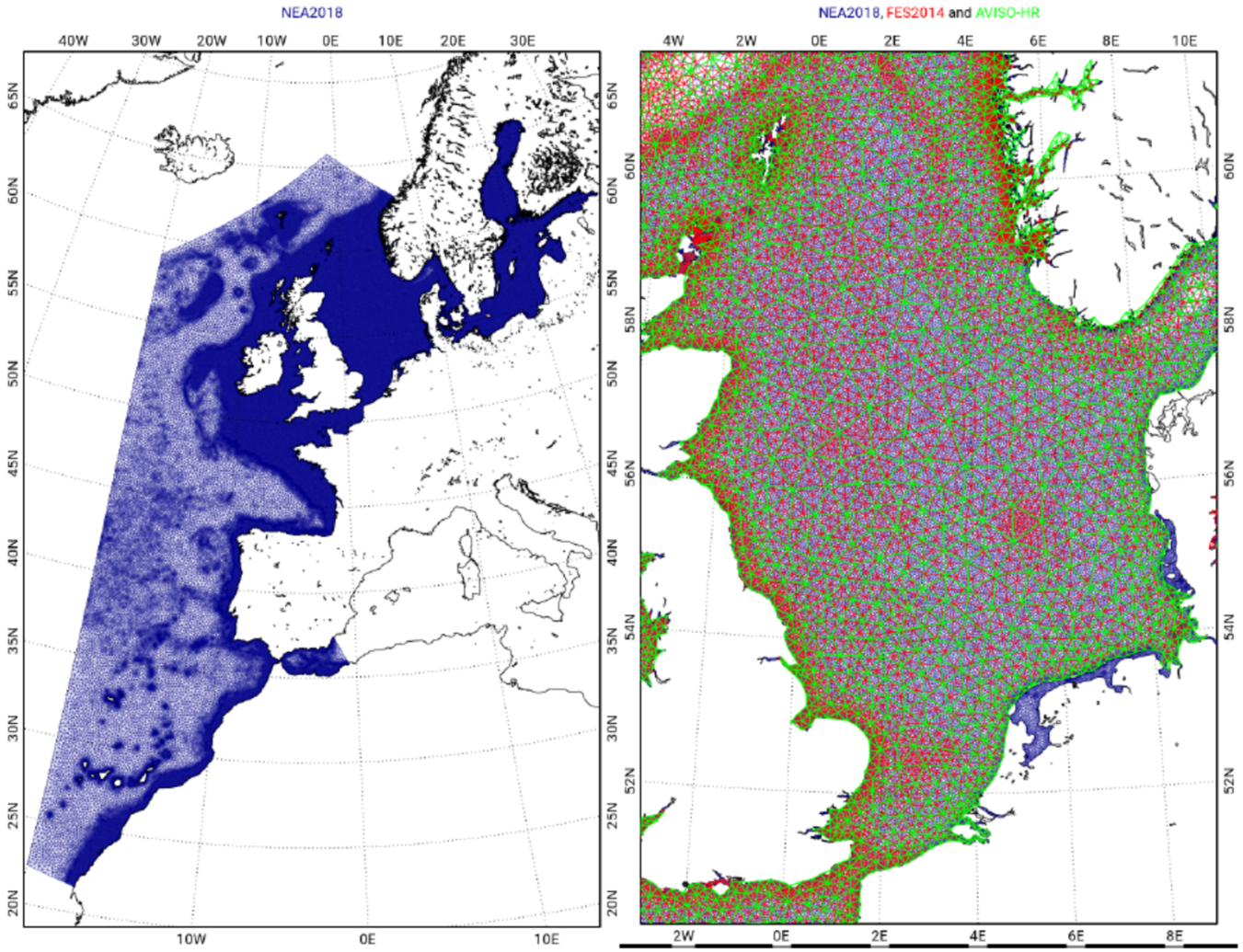


=> Need to work on spatial filtering of 2D fields and on temporal filtering …

Challenges of coastal ocean

- Coastal ocean = insufficient resolution, higher error budget
- Need to improve data coverage :
    - Toward 1km resolution at coasts (SWOT & HR missions)
    - Take care of transitions areas : estuaries, continuity between coastal-deep ocean correction …
- Need more accurate bathymetry fields (cf M. Cancet presentation)
- Need to take into account more complex process like effects of waves on storm surges (cf. L. Pineau-Guillou presentation)
- Narrow the gap in accuracy between open and coastal ocean

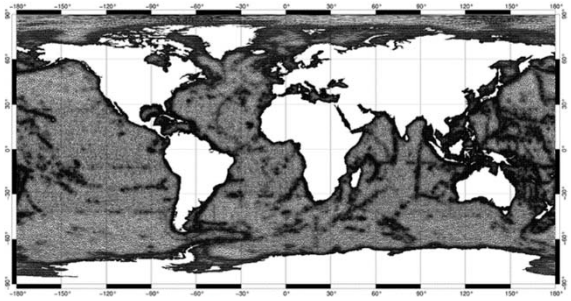
Challe



esa
European Space Agency

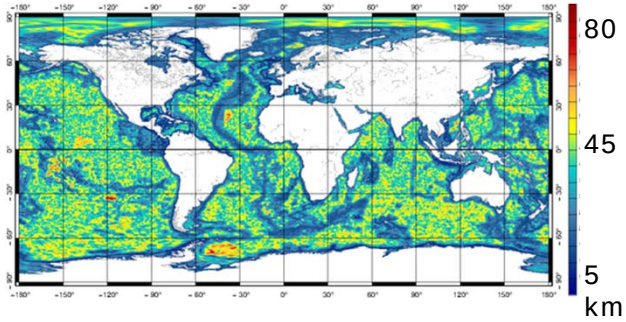
es Archipelago, Portugal

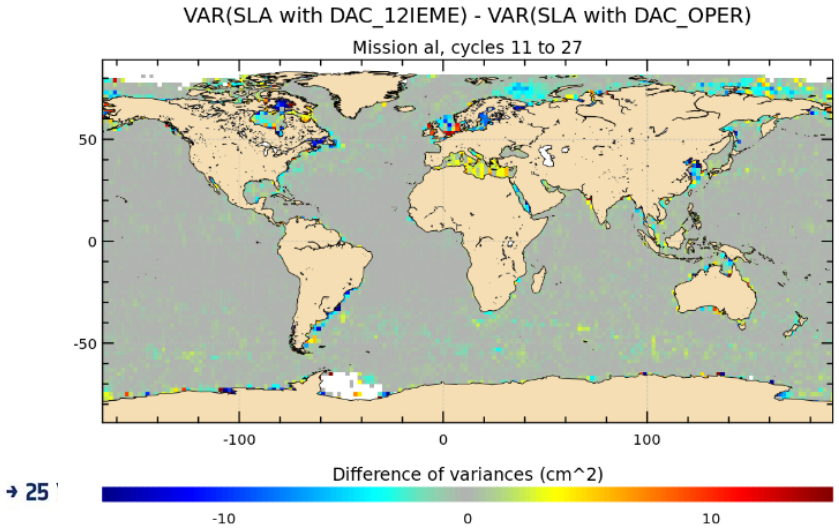
Using FES2014 mesh

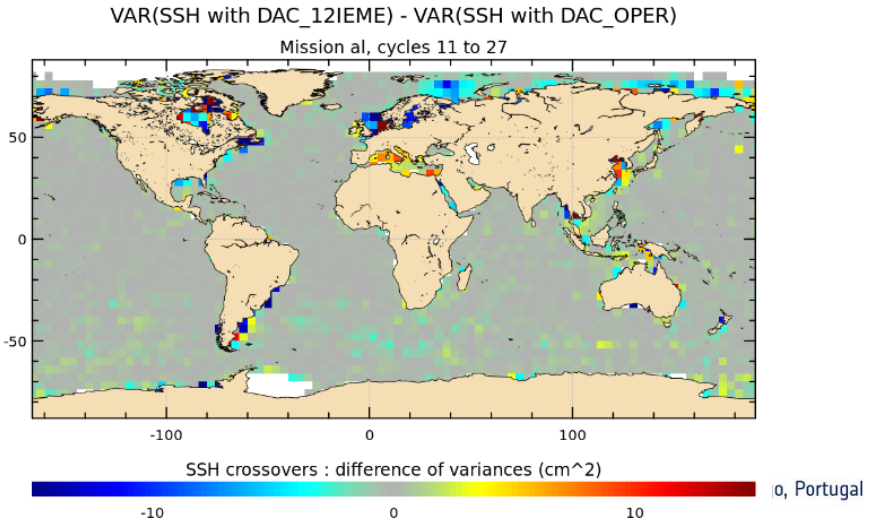


AVISO-HR
- 250 000 nodes

FES2014
- 750 000 for LGP1 - surge



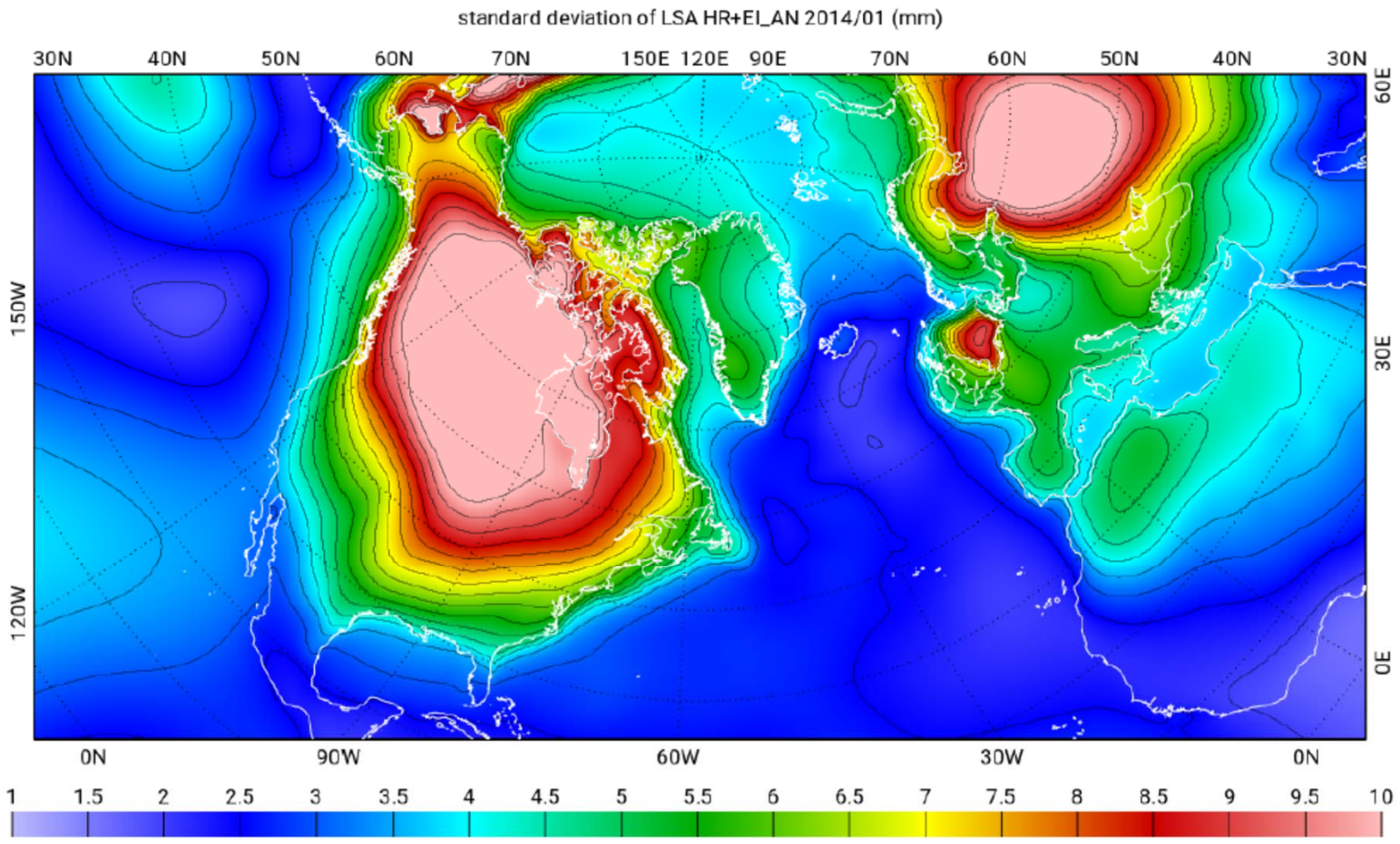




Still some challenges for global ocean

- DAC-MOG2D has a good budget error in deep ocean
- Some improvements are envisioned:
  - Increase resolution at global scale – FES2014 mesh
  - Take into account LSA effects
  - Use higher frequency forcing (3h or 1h) and revisit the S1S2 processing
  - Improve the wind stress forcing
  - Sea-ice effects
  - Improve dissipation in the simulations while forcing with atmosphere and tides at the same time
  - Model evolution - MOG2D/TUGO

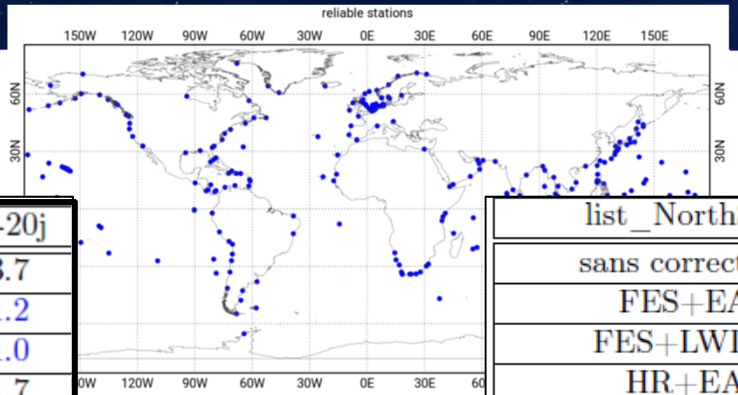
LSA e

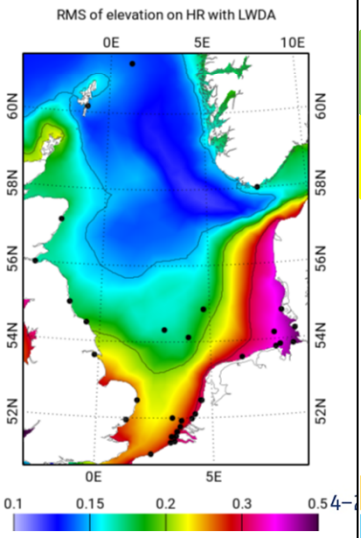

standard deviation of LSA HR+EI_AN 2014/01 (mm)
30N
40N
50N
60N
70N
150E
120E
90E
70N
60N
50N
40N
30N
150W
120W
60E
30E
0E
0N
90W
60W
30W
0N
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10

Some tests with TUGO model

RMS at TG - mm

list_global	0-∞	0-20j	0.5-20j
sans correction	135.5	113.7	83.7
FES+EA	86.1	44.4	31.2
FES+LWDA	85.9	42.9	31.0
HR+EA	85.6	45.1	31.7
HR+LWDA	85.6	44.2	31.6
HR+EA+tides	86.9	45.1	33.1
HR+LWDA+tides	87.1	45.1	33.3
HR+EA2h	86.6	44.2	31.6
HR+EA3h	86.6	44.0	31.6
HR+EA4h	86.6	44.1	31.7
HR+EA6h	86.8	44.4	31.9
HR+EI_AN	86.0	45.9	33.8
HR+EI_AN+tides	88.4	48.9	36.3
HR+EI_AN+FC	86.2	46.2	33.4
HR+EI_AN+FC+tides	87.3	46.7	35.0
HR+CLS	87.5	44.5	32.0
HR+CLSf	87.5	44.6	32.1
SLEV_DAC_OPER/	88.4	47.8	36.8

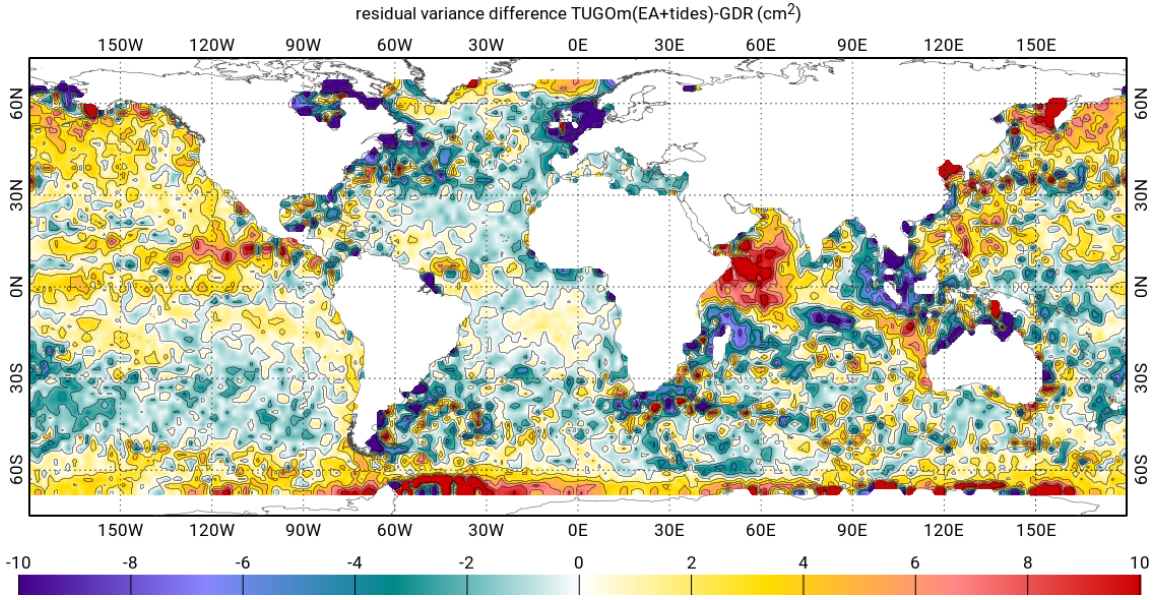




RMS at TG - mm

list_NorthSea	0-∞	0-20j	0.5-20j
sans correction	240.2	206.0	188.9
FES+EA	123.2	106.0	80.3
FES+LWDA	123.6	106.7	81.2
HR+EA	119.5	102.3	75.2
HR+LWDA	119.7	102.4	75.6
HR+EA+tides	106.8	90.4	60.3
HR+LWDA+tides	106.1	90.5	59.7
HR+EA2h	119.7	102.3	75.5
HR+EA3h	120.0	102.2	75.9
HR+EA4h	120.4	102.6	76.5
HR+EA6h	122.0	104.0	77.8
HR+EI_AN	125.2	106.9	80.9
HR+EI_AN+tides	111.3	94.8	64.0
HR+EI_AN+FC	122.9	104.7	77.9
HR+EI_AN+FC+tides	108.7	91.5	60.7
HR+CLS	121.9	103.8	77.6
HR+CLSf	122.7	104.2	78.7
SLEV_DAC_OPER	148.7	104.6	78.6

Some tests with TUGO model



- TUGO with FES2014 bathymetry improved in North sea, tides and ERA-5 forcing
- Preliminary analysis against altimetry data

⇒ Improvement in shallow waters

⇒ Complementary analysis needed

Conclusion-perspectives

- DAC is still mandatory for satellite measurements due to aliasing of HF
- Several studies are being performed with 2 main objectives:
    - Keep improving the correction at regional and global scale
    - Fulfill the users needs for the different applications of altimetry
- Some improvements can be envisioned shortly/medium term:
    - improve resolution and bathymetry at global scale – FES2014 mesh
    - Improve the wind stress forcing
    - Improve dissipation in the simulations while forcing with atmosphere and tides at the same time
    - MOG2D-TUGO transition if operationality and improvement is confirmed

Conclusion-perspectives

- Longer term evolutions:
  - LSA effects
  - Use higher frequency forcing (3h or 1h) and revisit the S1S2 processing when operational meteo forcing will provide 1h analysis
  - Very high resolution mesh (FES20XX), regional models and even coupling global-regional models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