An inter-comparison between algorithms for wet path delay retrieval in the coastal regions

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Outline

- Review of methods for retrieving the path delay for coastal altimetry
  - Land Proportion Algorithm (LPA)
  - Mixed-Pixel Algorithm (MPA)
  - GNSS-Derived Path Delay (GPD)
  - Composite Correction (from AVISO)
- Inter-comparison of the methods
  - SLA statistics function of the distance to coast
  - SLA variance

Mixed-Pixel Algorithm (MPA)

Method

- Parameterizes log-linear coefficients as a function of the18.7-GHz land fraction using a database of modelled coastal land TBs (Shannon Brown, 2010).
- Based on existing open-ocean algorithm for TMR/JMR/AMR, but extends to ocean and coastal TBs

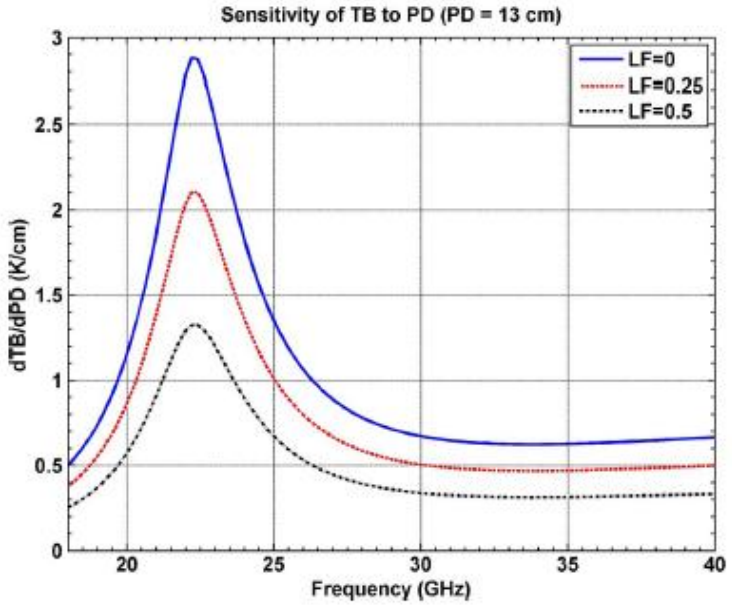


Fig. 1. Sensitivity of T_B to PD versus frequency for several land fractions.

Data requirements

- MWR measured TBs
- Accurate land-sea mask
- Database of modelled coastal land TBs (pre-processing)

Accuracy (AMR)

- 0.8 cm > 15 km from land
- 1.0 cm > 10 km
- 1.2 cm > 5 km
- 1.5 cm up to the coast

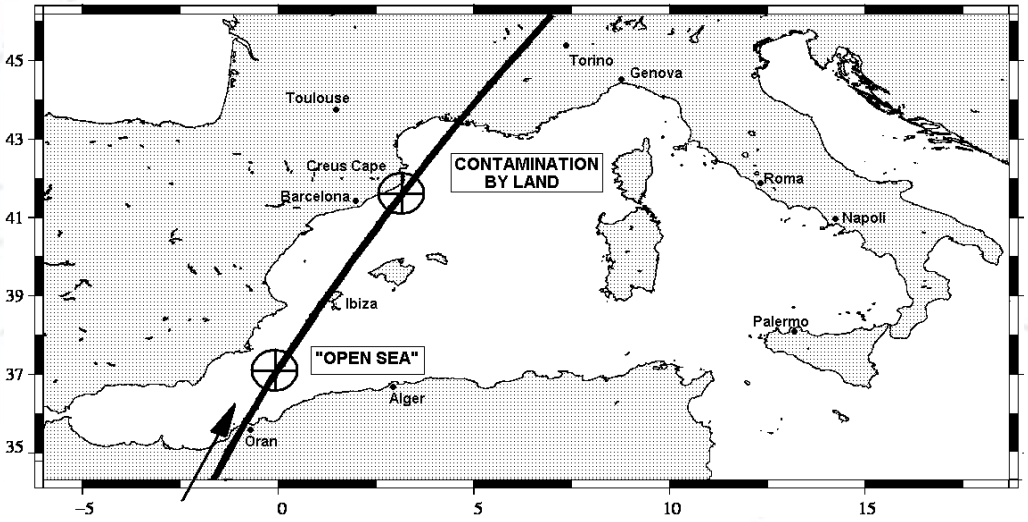
Local / Global

Global (open-ocean and coastal)

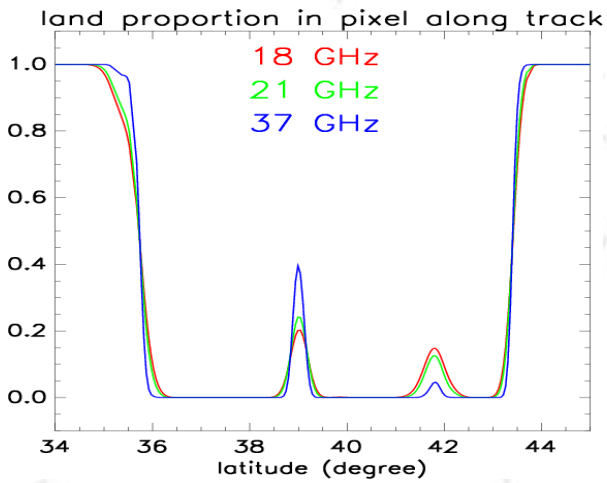
Sensors

- Applied to Jason-1 and Jason-2
- Applicable to any radiometer (antenna pattern may impact performance)

Land Proportion Algorithm (PISTACH)



(Top) TOPEX track number 187, 16 March around 12:00 (cycle 202) or 15 April around 06:00 (cycle 205). [Obligis et al. 2011]



(Bottom) Land proportion in the footprint along the top figure track [Obligis et al. 2011]

Method

- Corrects MWR measured TBs from land proportion in the MWR footprint, (Bennartz,1999), (Desportes et al., 2007)
- Applies existing TMR/AMR open-ocean PD algorithm to corrected TBs

Data requirements

- MWR measured TBs
- Accurate land-sea mask

Accuracy (TMR)

2 – 3 cm in the coastal zone

Local / Global

subject to land TB data availability

Sensors

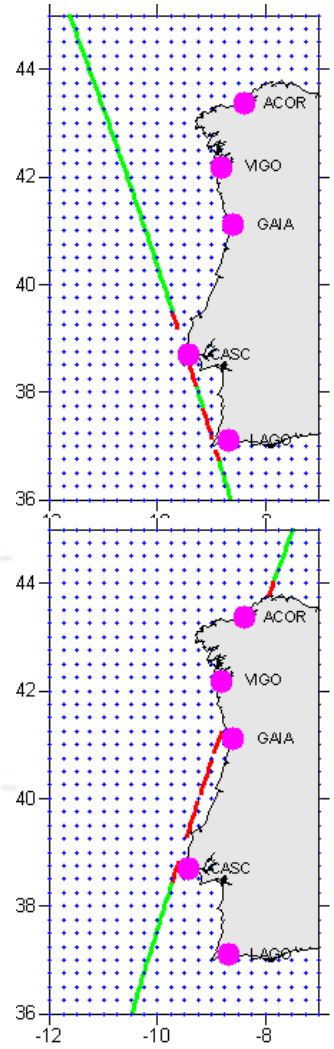
- Applied to TMR and AMR (PISTACH)
- Applicable to any MWR

GPD - Summary of the method

GPD (GNSS-derived Path Delay)

Combines the following data sets (objective analysis):

- GNSS-derived Zenith Total Delays (ZTD) at coastal GNSS stations
- Valid MWR measurements
- ZWD from a Numerical Weather Model:
  - ECMWF operational (0.25° × 0.25°, every 6h)
  - ERA Interim (0.75° × 0.75°, every 6h)



Inter-comparison of various WTC

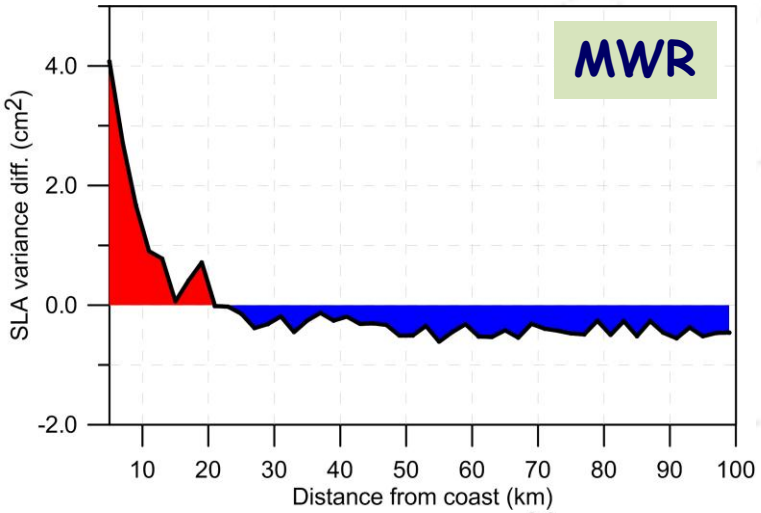
- For Envisat
- For Jason-2

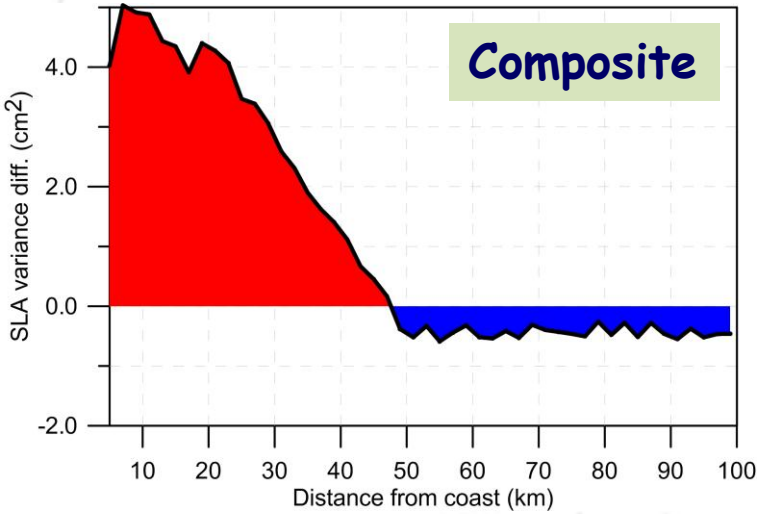
Comparisons for Envisat data

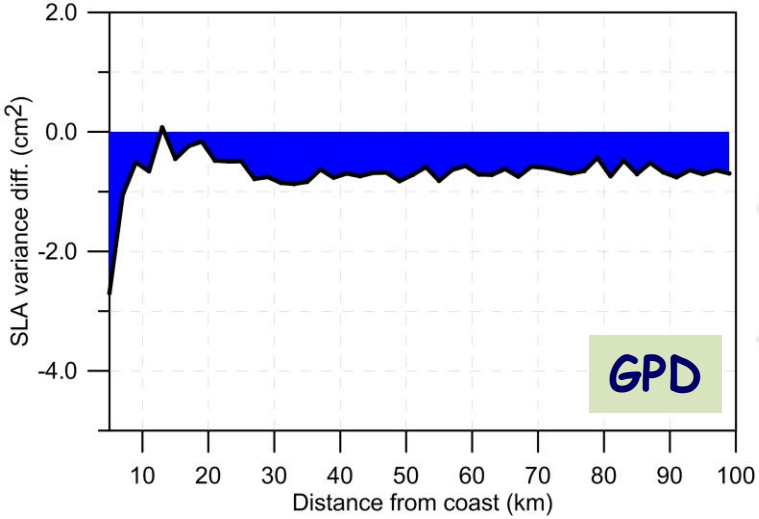
- Data from ESA Sea Level CCI project, cycles 9 - 93

- Available Corrections
  - GNSS-Derived Path Delay (GPD)
  - Composite Correction (from AVISO)
  - Microwave Radiometer (MWR)
  - ECMWF

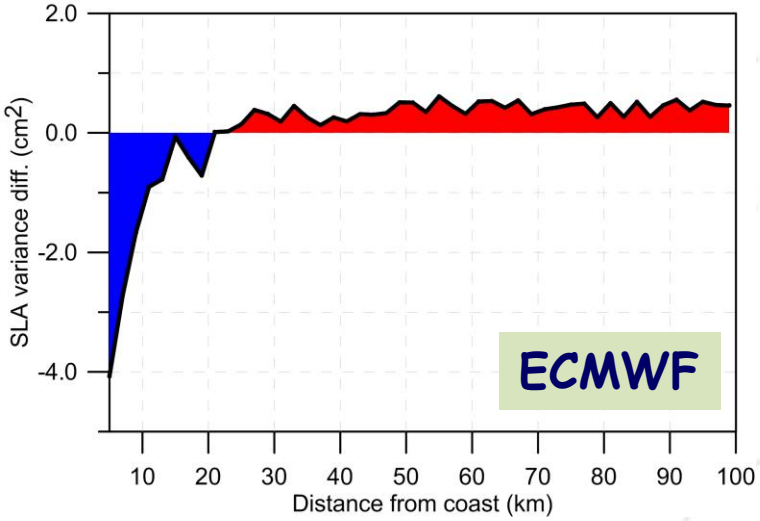
Envisat SLA variance differences wrt ECMWF

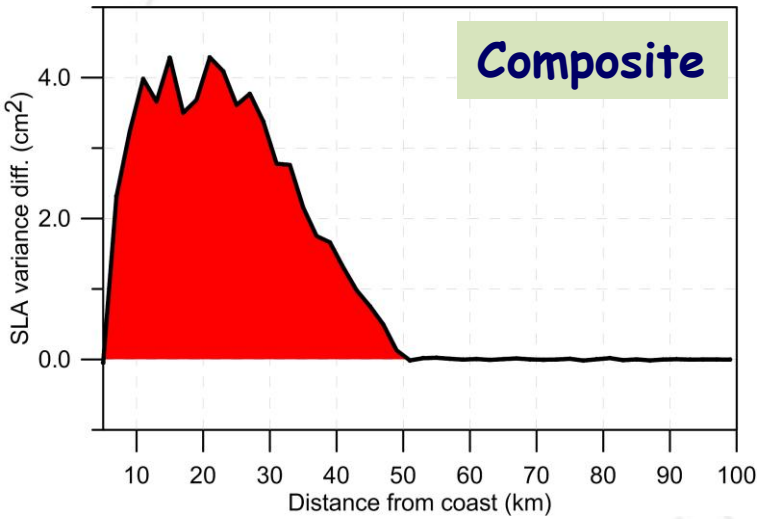


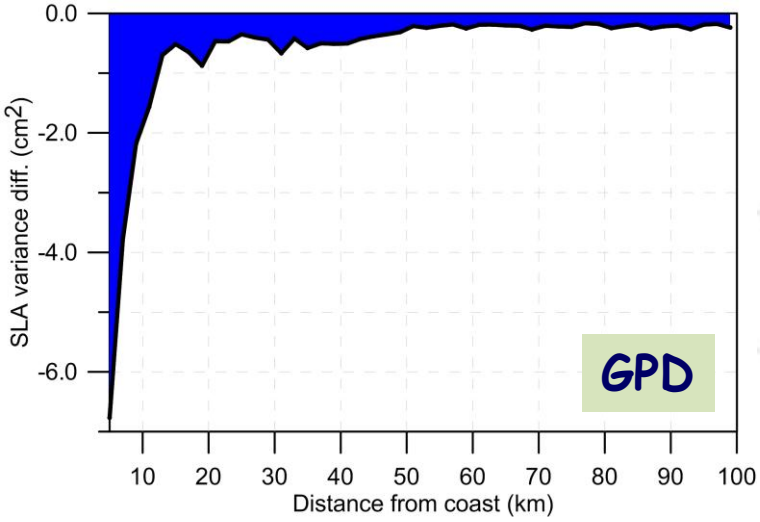




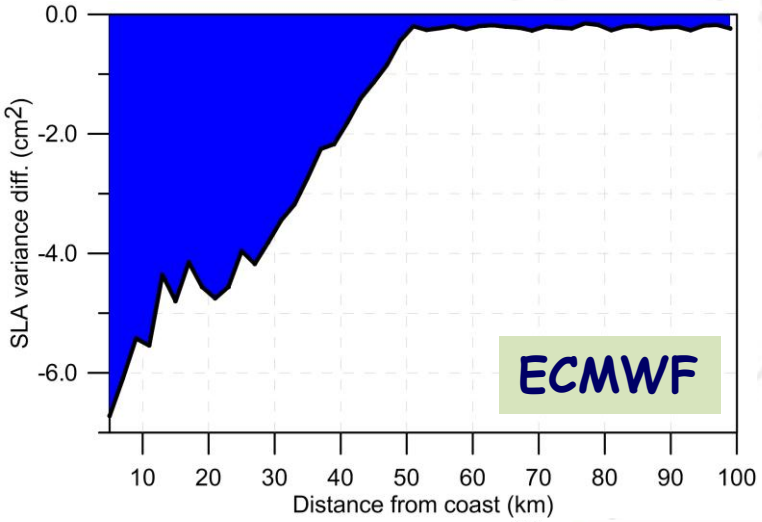
Envisat SLA variance differences wrt MWR

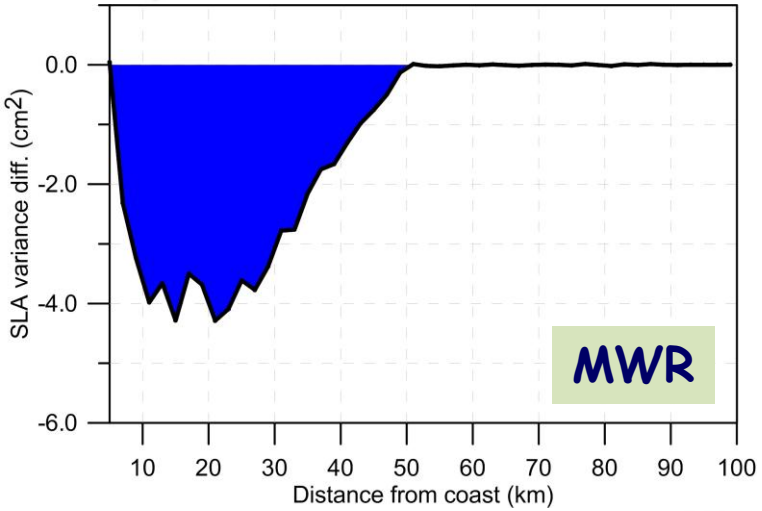


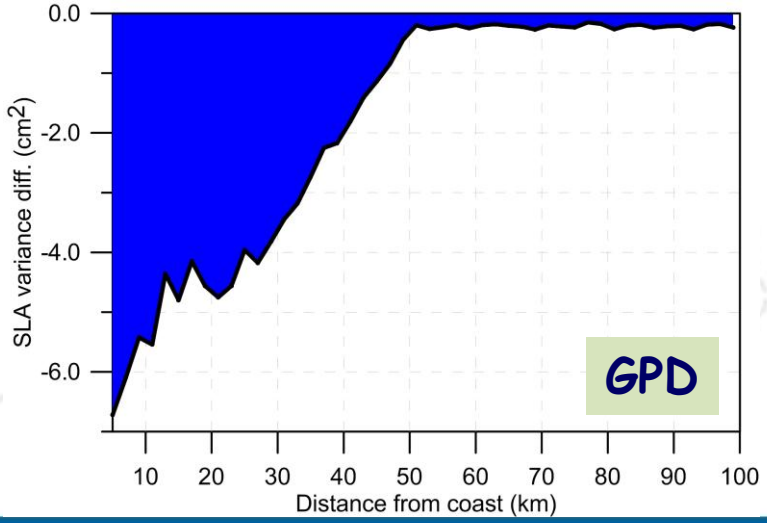




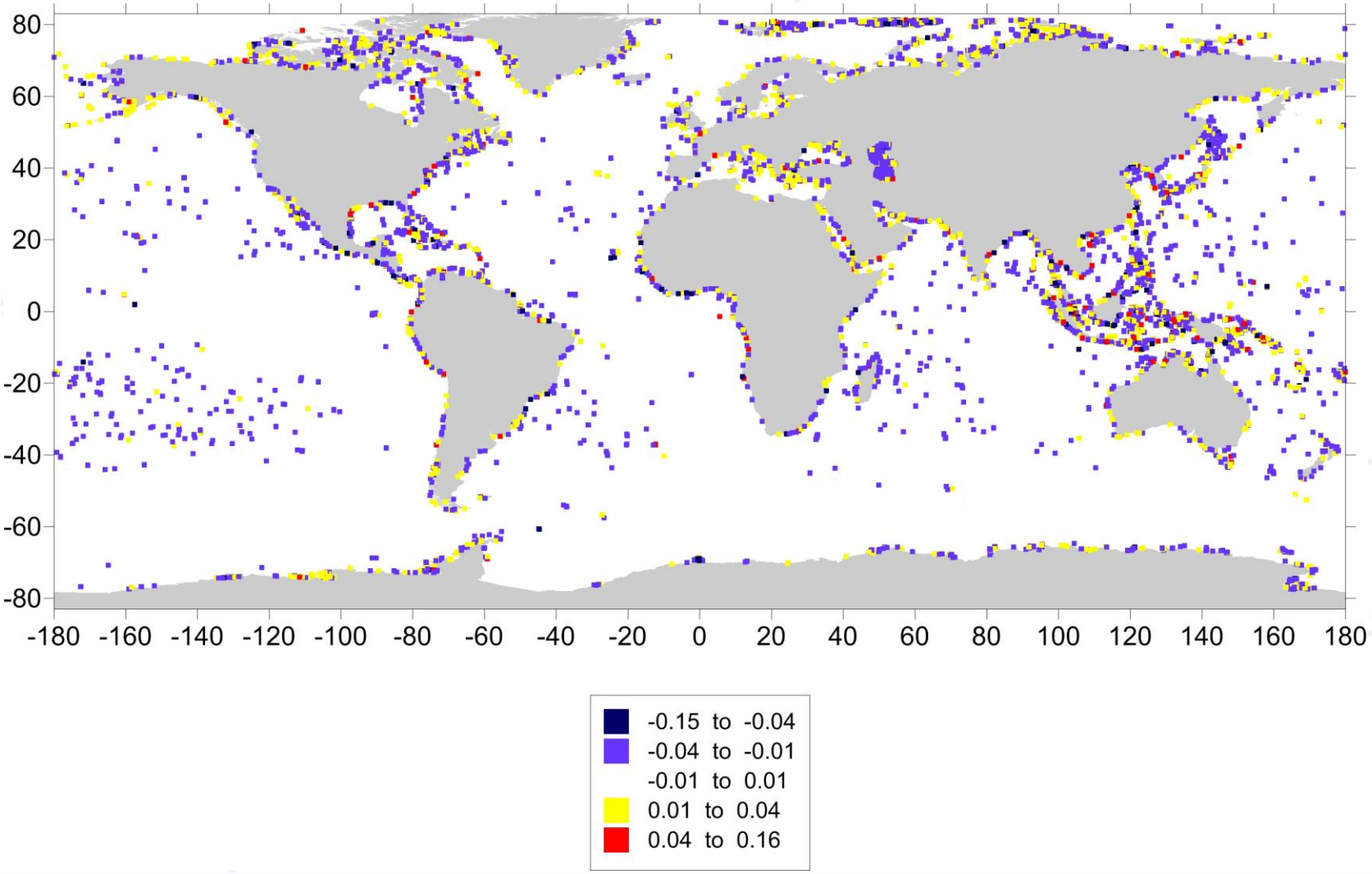
Envisat SLA variance diff. wrt Composite Corr.



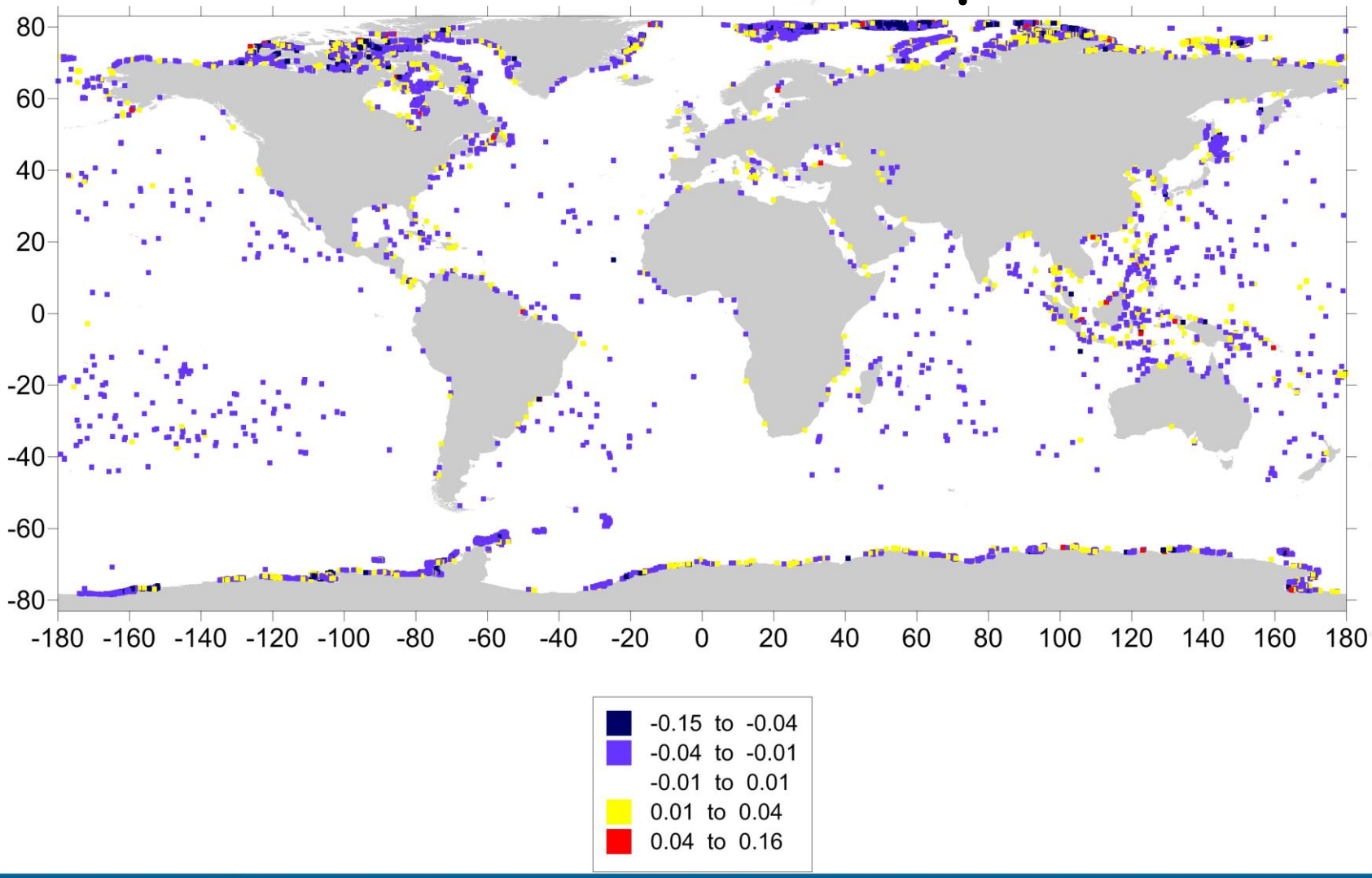




SLA std difference GPD-MWR



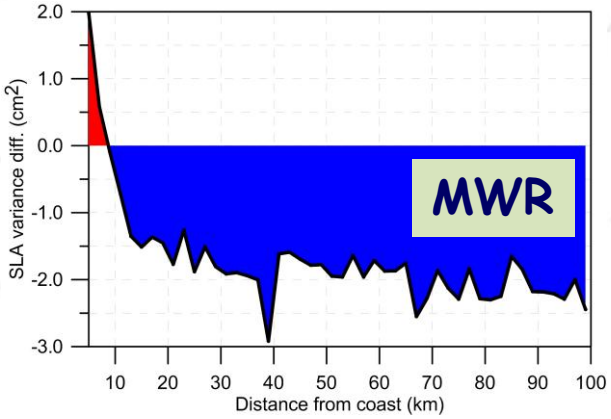
SLA std difference GPD-Composite Corr.

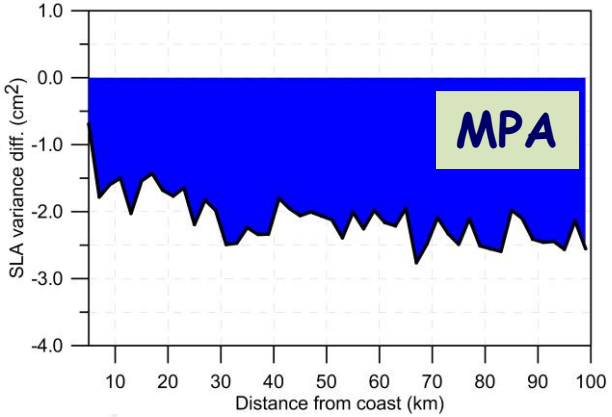


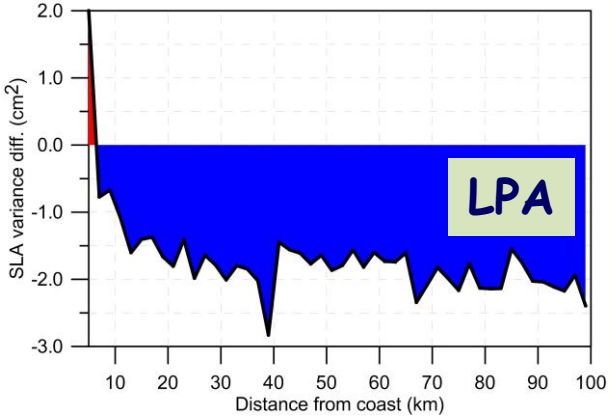
Comparisons with Jason-2 data

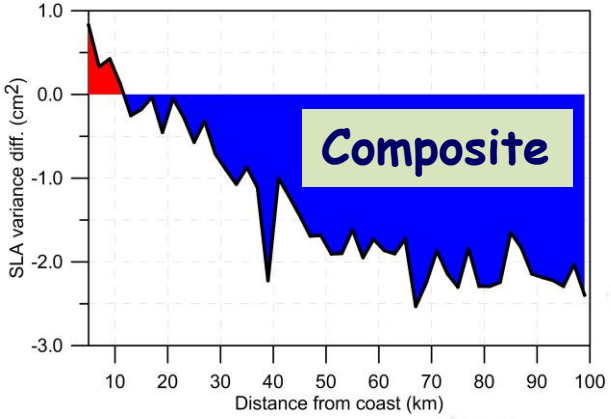
- Data span: cycles 1 - 128
- Available Wet Tropospheric Corrections from RADS:
  - Enhanced Microwave Radiometer (MPA)
  - ECMWF operational
  - ERA Interim
- Available Corrections from PISTACH:
  - Land Proportion Algorithm (LPA)
  - Composite Correction (from AVISO)
  - Microwave Radiometer (MWR)
  - ECMWF
- GPD ??

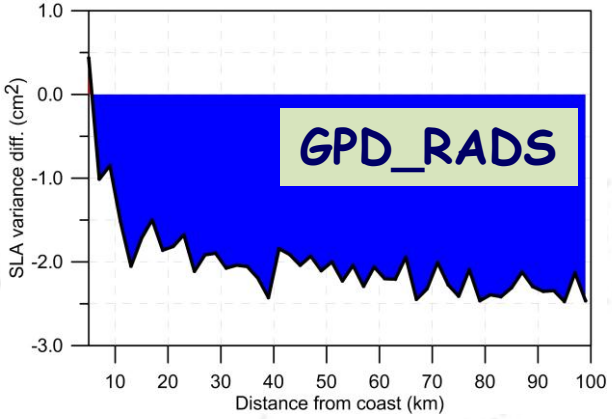
Jason-2 SLA variance differences wrt ERA Interim

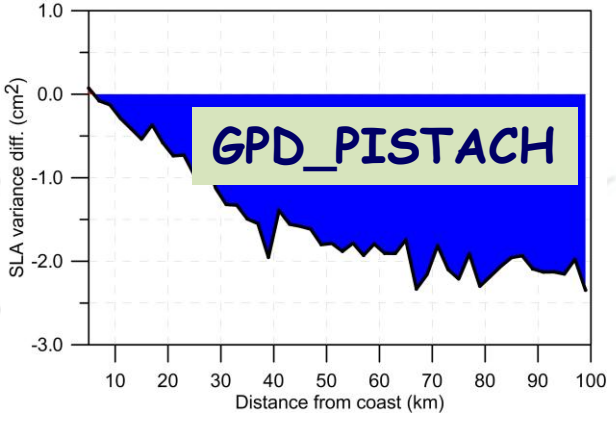




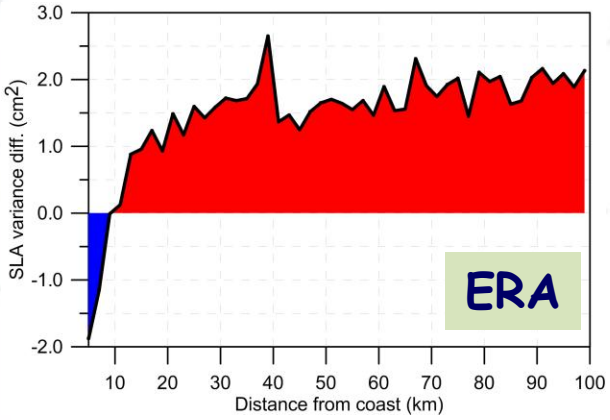


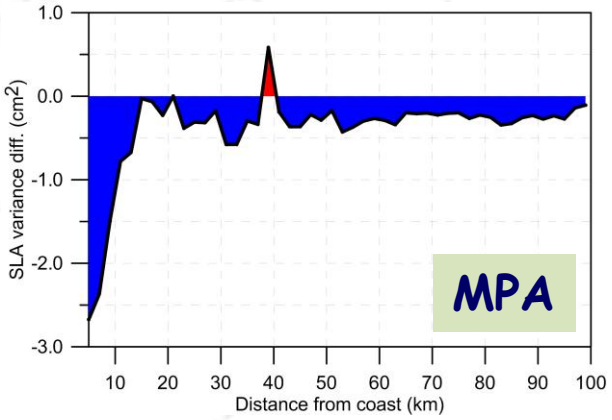


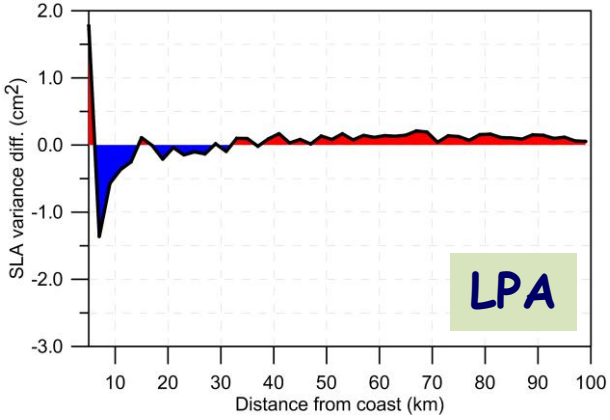


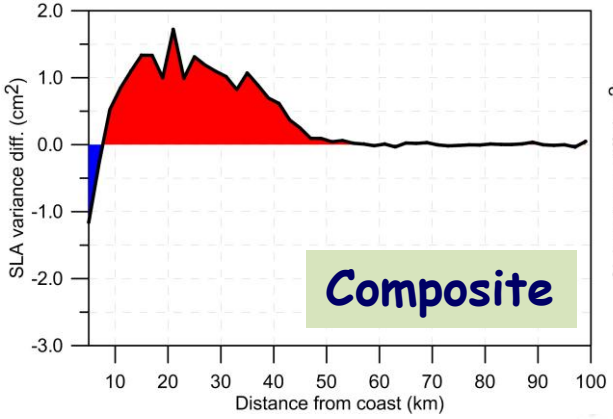


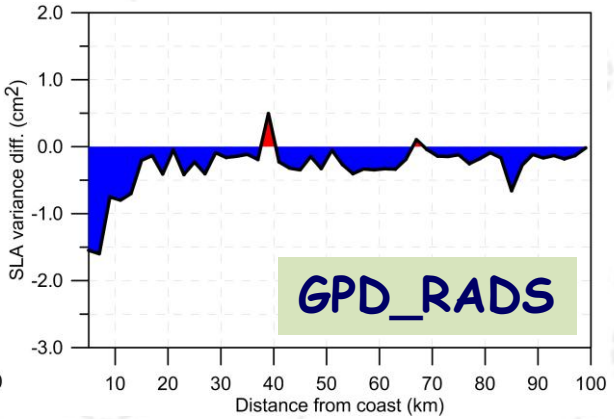
Jason-2 SLA variance differences wrt MWR

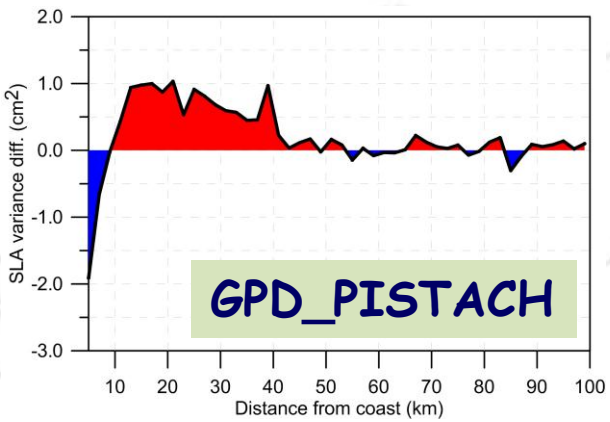




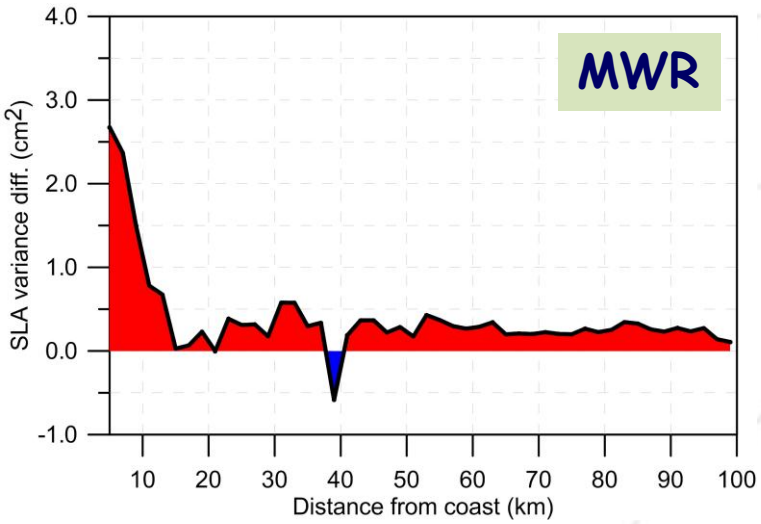


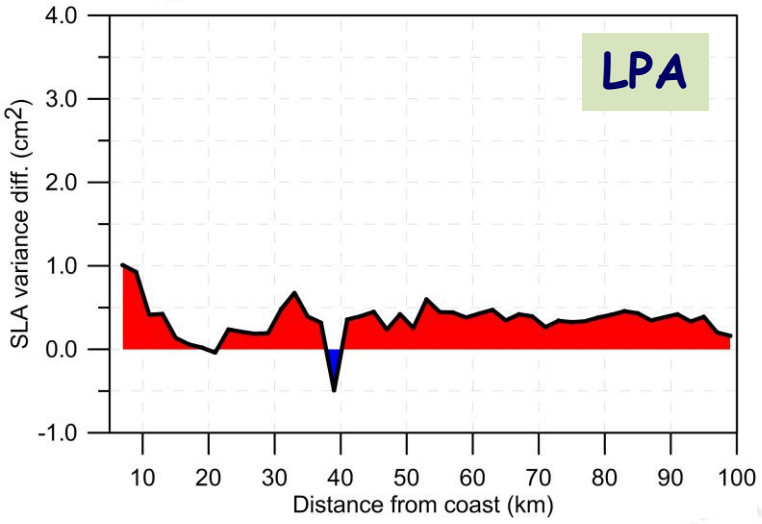


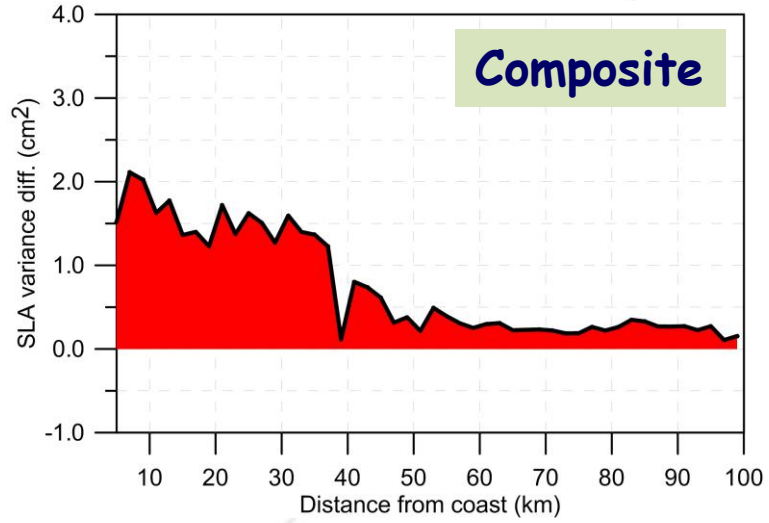


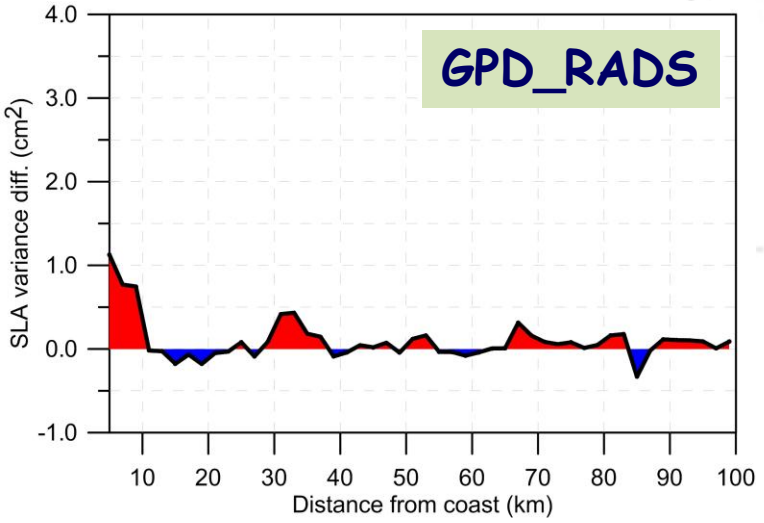


Jason-2 SLA variance differences wrt MPA



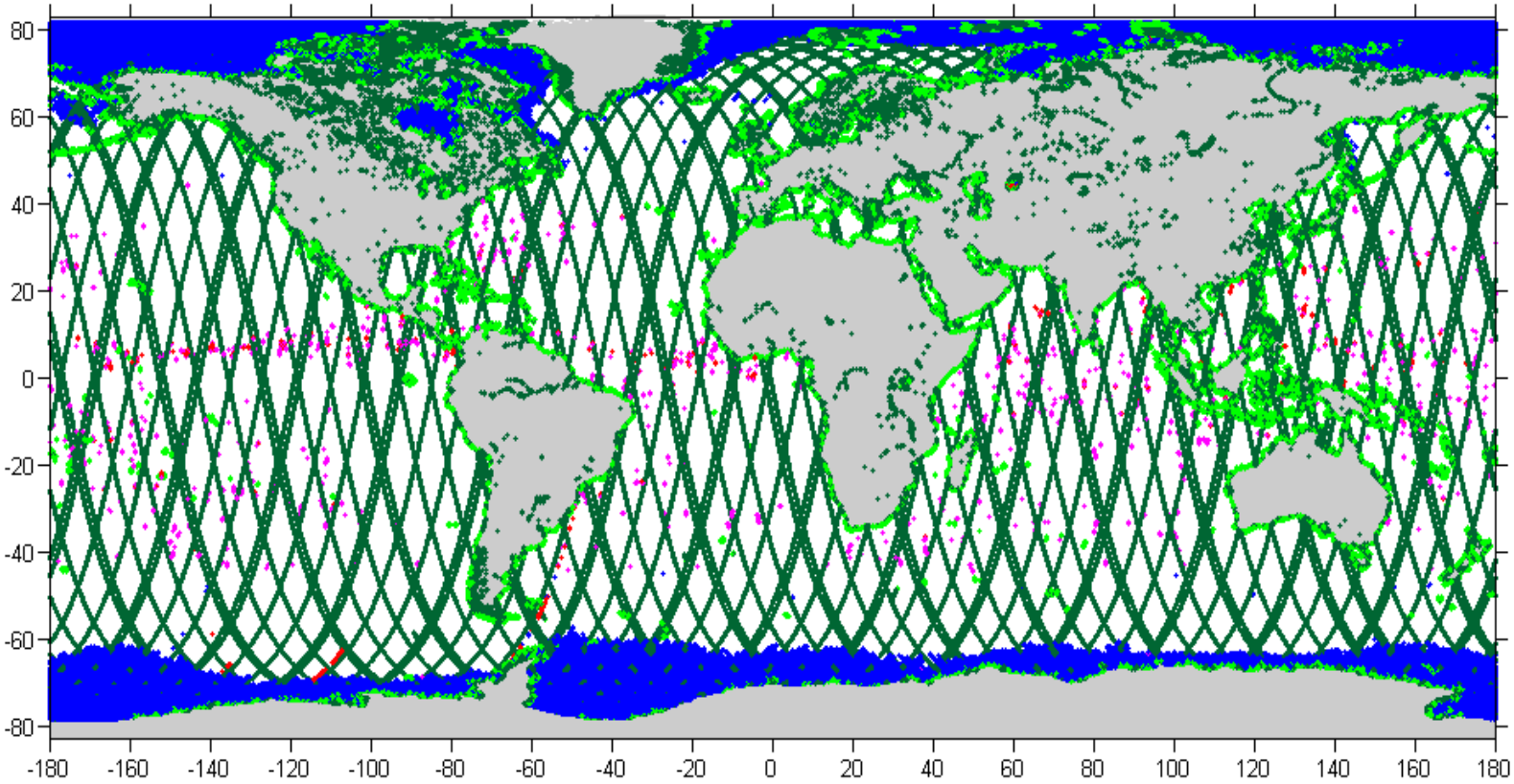






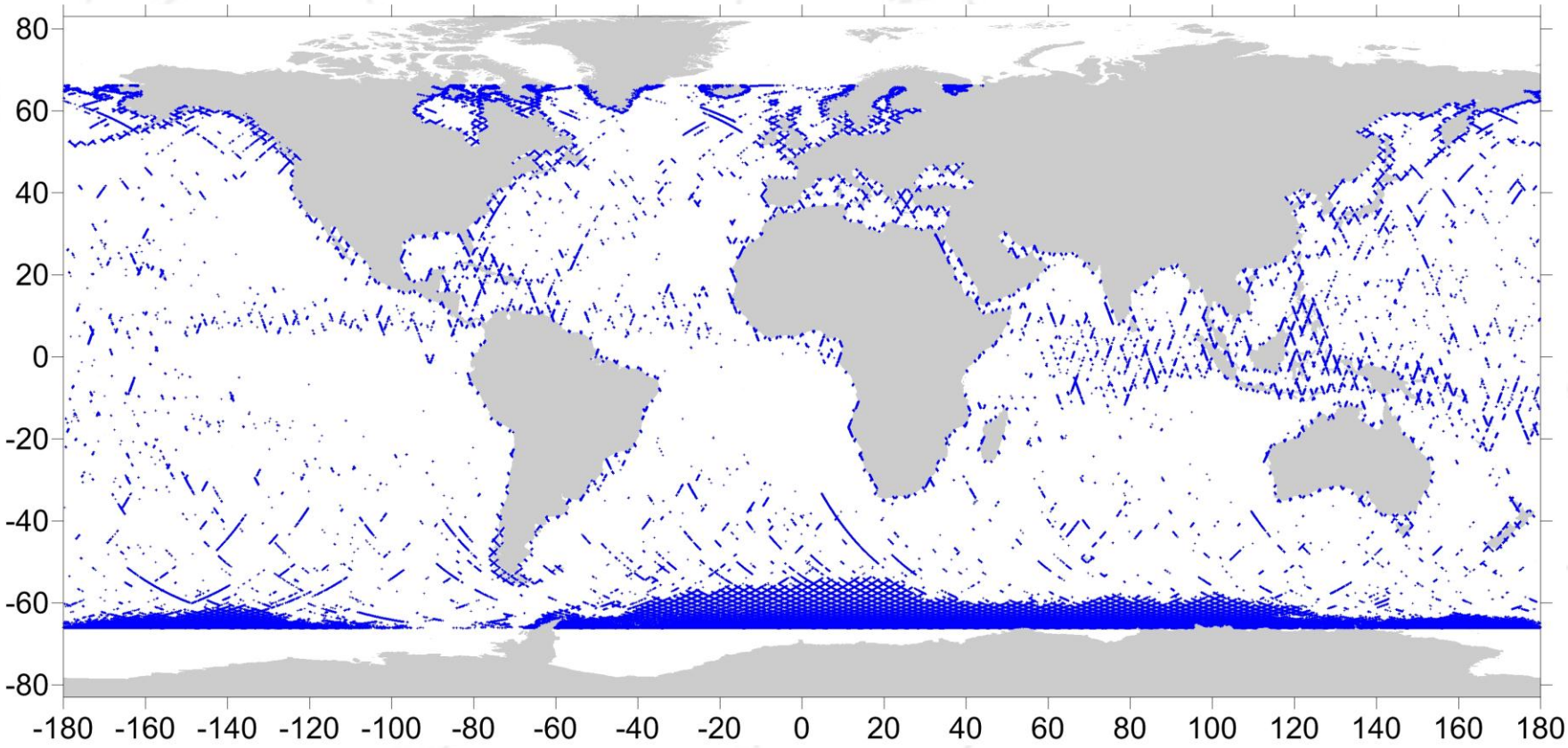
GPD for Envisat - points for the estimation

GPD rejection flag



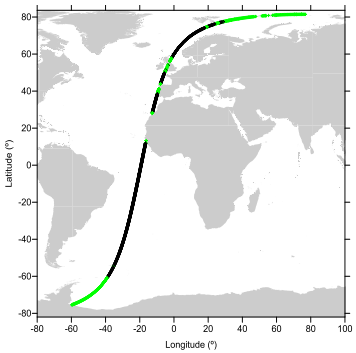
Location of Envisat cycle 58 points selected for the GPD computation. Only points with invalid MWR data (MWR_REJ ≠ 0) are shown. **Dark green**: points with MWR_REJ = 1; **Light green**: points with MWR_REJ = 2; **Blue**: points with MWR_REJ = 3; **Red**: points with MWR_REJ = 4; **Pink**: points with MWR_REJ = 5

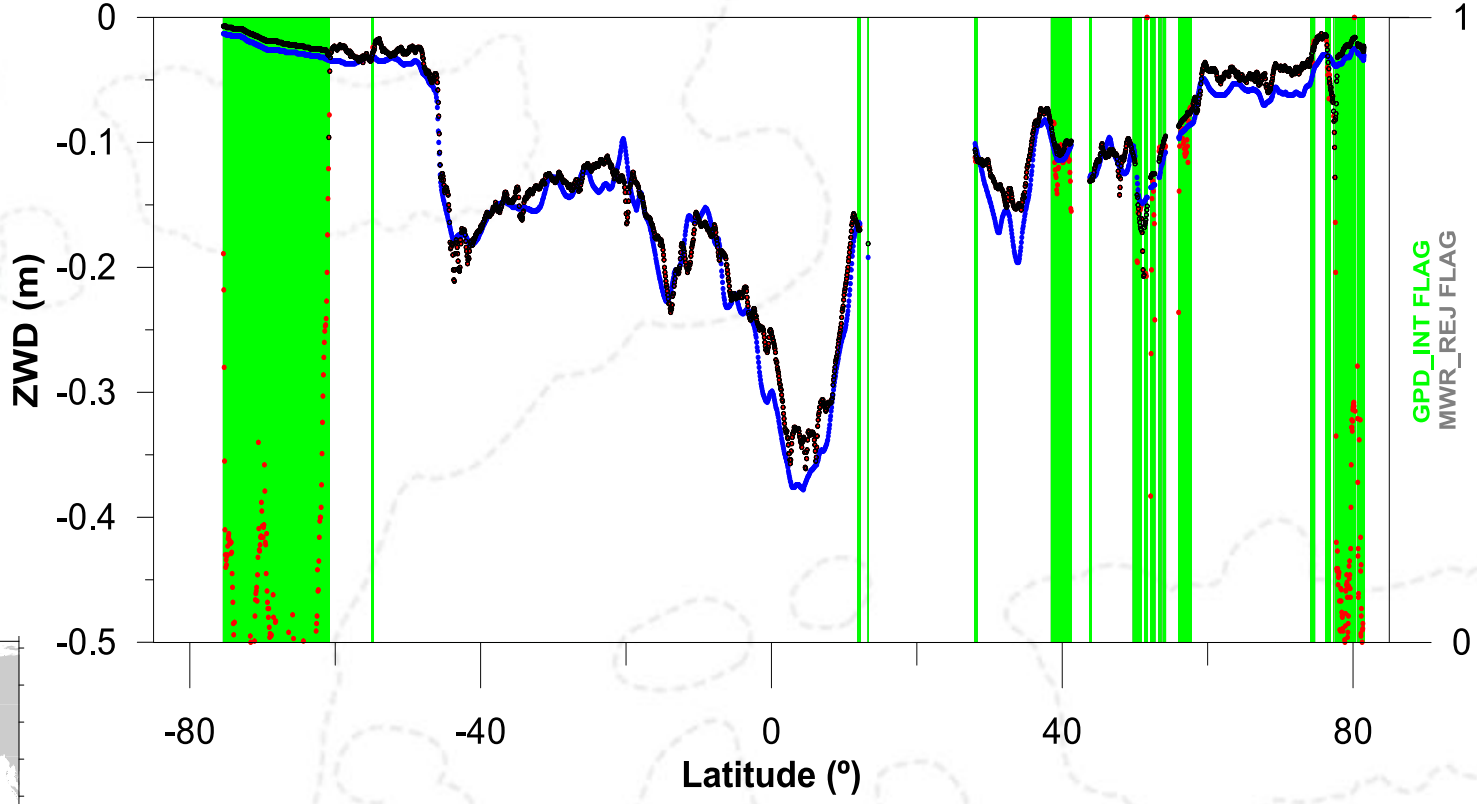
Problems with the flags: RADS MWR ice flag for Jason-2



WTC Envisat cycle 58 pass 0160

- GPD
- MWR
- ECMWF (GDR)

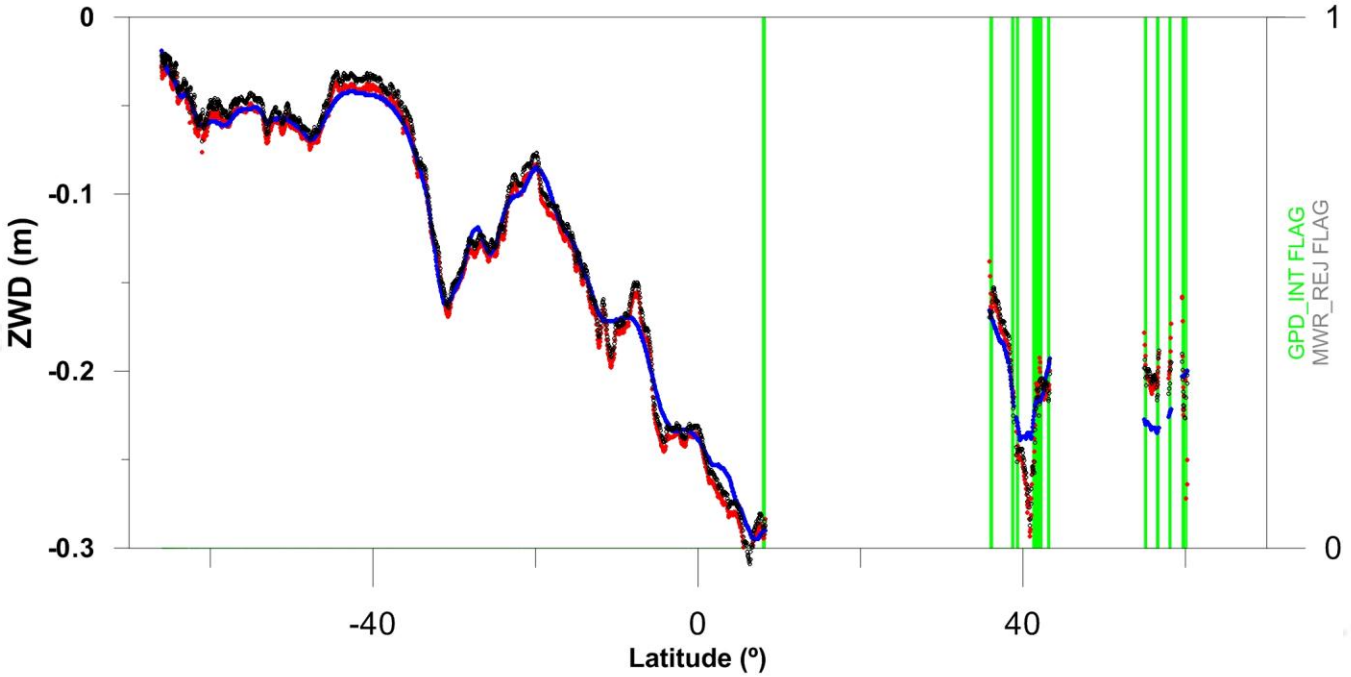




Wet tropospheric correction from three data sets (in metes). The shaded green areas indicate regions where the GPD_INT Flag was set

WTC
Jason-2
cycle 6
pass 187

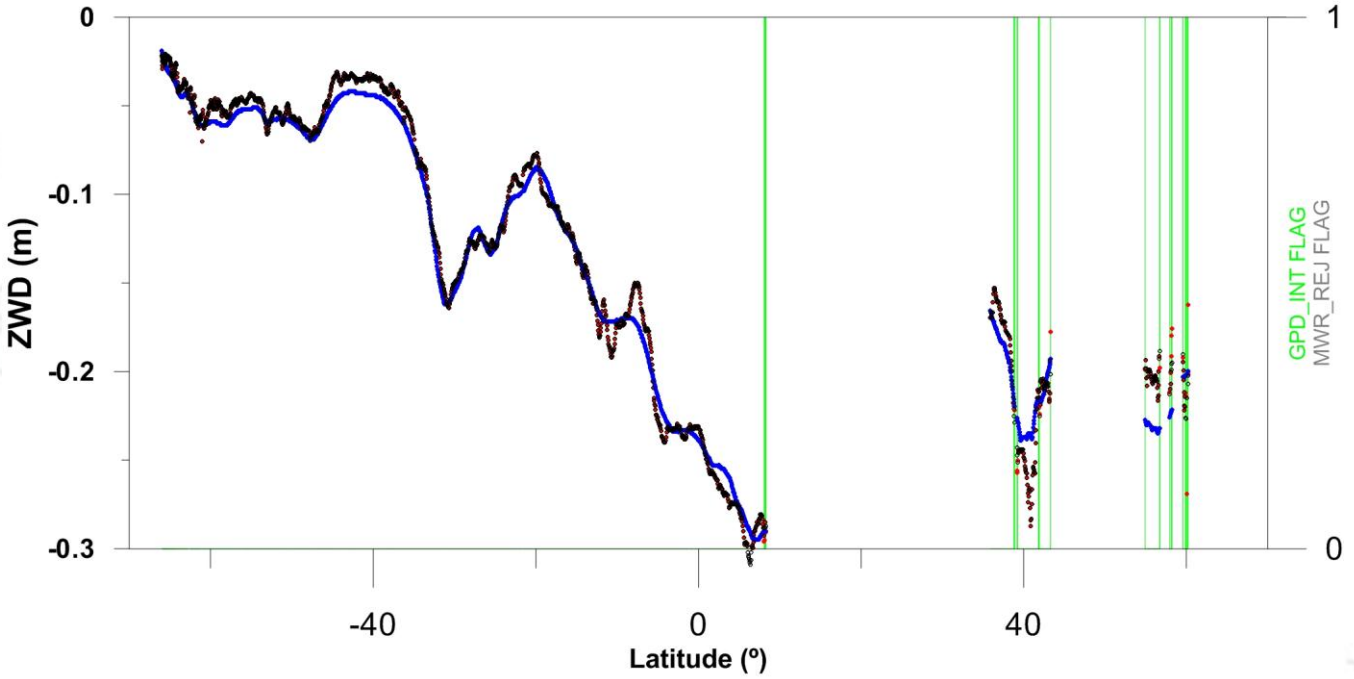
- GPD_PISTACH
- MWR
- ERA



Wet tropospheric correction from three data sets (in metes). The shaded green areas indicate regions where the GPD_INT Flag was set

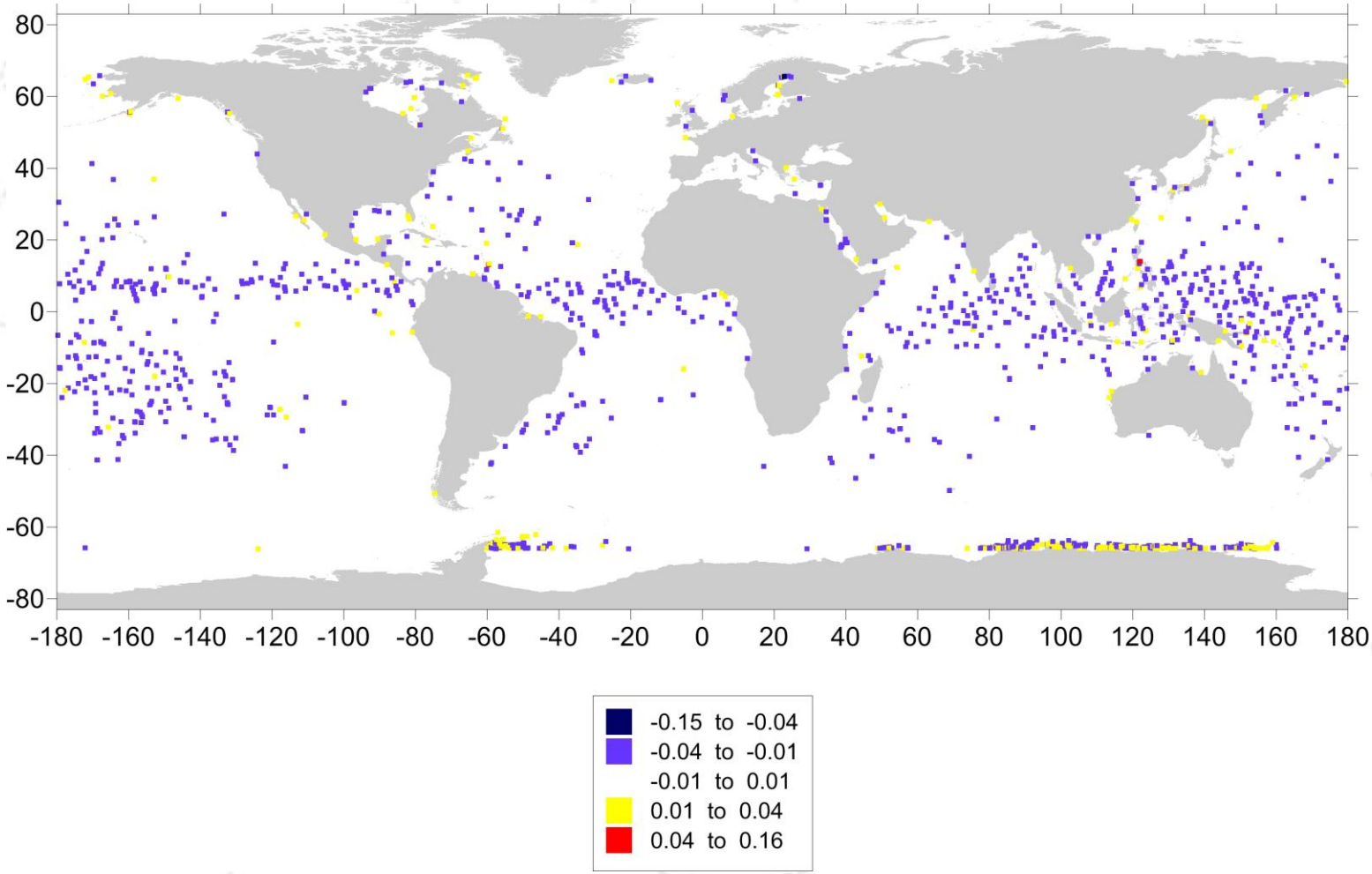
WTC Jason-2 cycle 6 pass 187

- GPD_RADS
- MPA
- ERA



Wet tropospheric correction from three data sets (in metes). The shaded green areas indicate regions where the GPD_INT Flag was set

SLA std difference MPA - ERA



Conclusions

- Difficult to inter-compare various methods if they rely on different MWR versions
- LPA improves the MWR data for distances up to 30 km; improved version is being developed for Envisat
- MPA performs well for Jason-2
- GPD performs well for Envisat
- GPD for other satellites:
  - Identification of valid/invalid MWR measurements is a key issue
  - For satellites for which MPA is available, GPD should be run over MPA
  - A GPD type of approach is being developed for CryoSat-2 (CP4O)
- All MWR based WTC still better than ECMWF/ERA

Acknowledgments

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