Improved wet tropospheric correction for CryoSat-2 over ocean

CP4O Open Meeting
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Outline

- Scope and objectives
- Datasets used
- DComb implementation (update)
- Computation of the WTC for Jason-2 and CryoSat-2
- WTC validation: comparison with AMR and SLA variance analysis

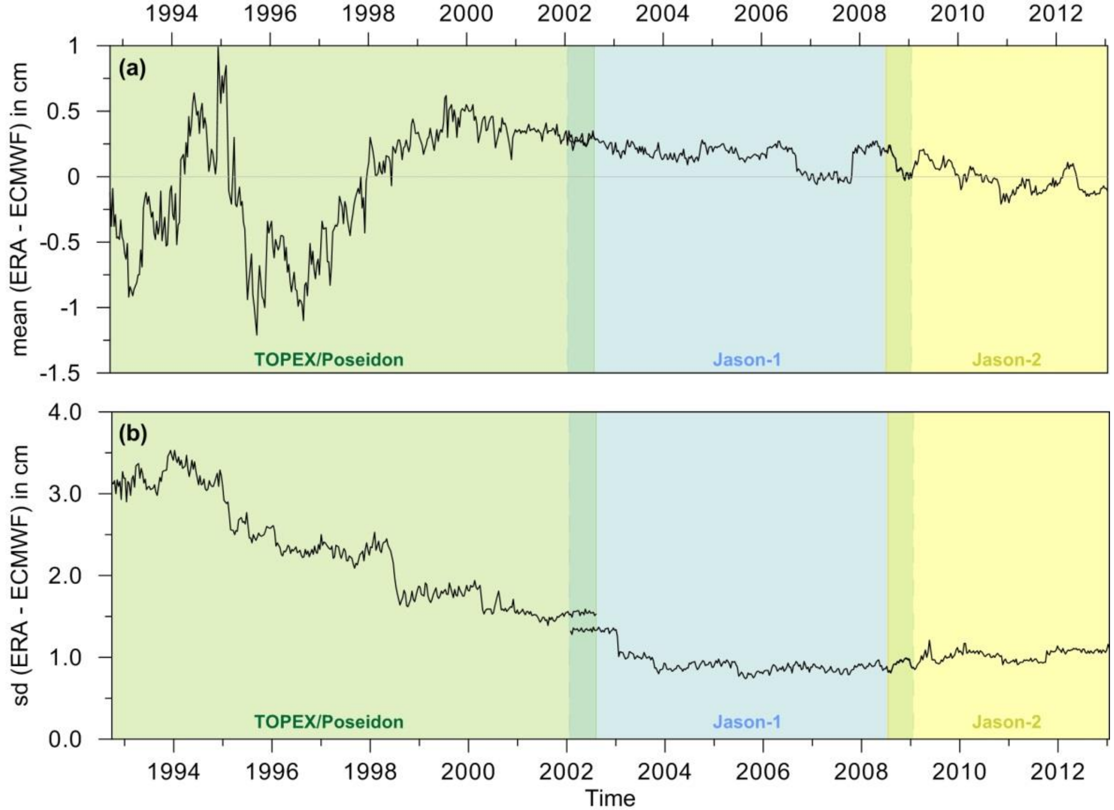
Scope and objectives

Computation of an improved WTC for CryoSat-2 by data combination (DComb), through objective analysis, of three datasets:

- SI-MWR (Scanning imaging MWR) on board RS missions
- GNSS data from coastal inland and island stations
- ECMWF operational model

ERA Interim vs ECMWF Operational

Considering the whole time span of the main altimetric missions, ERA Interim provides a more precise and homogeneous WTC than ECMWF Operational model



Mean and standard deviation of the differences between the WTC computed from ERA Interim and the ECMWF operational model (in cm) for each cycle of T/P, J1 and J2.

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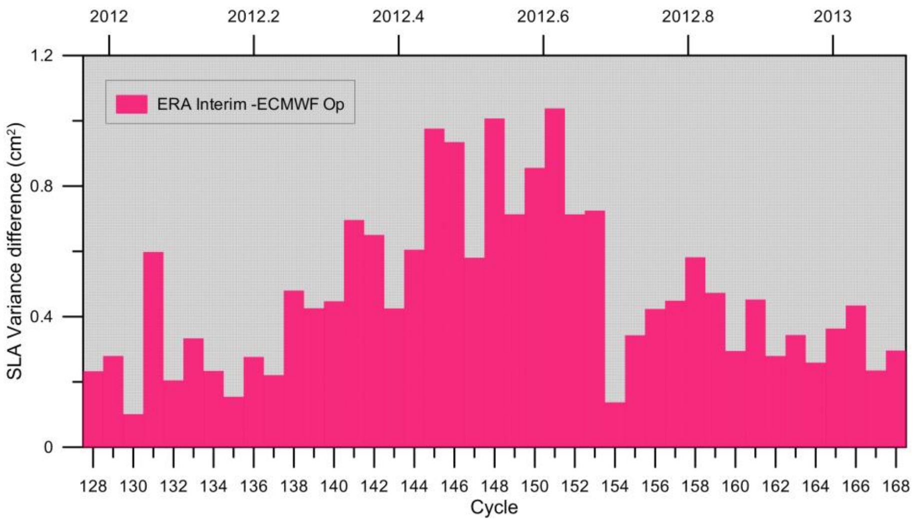
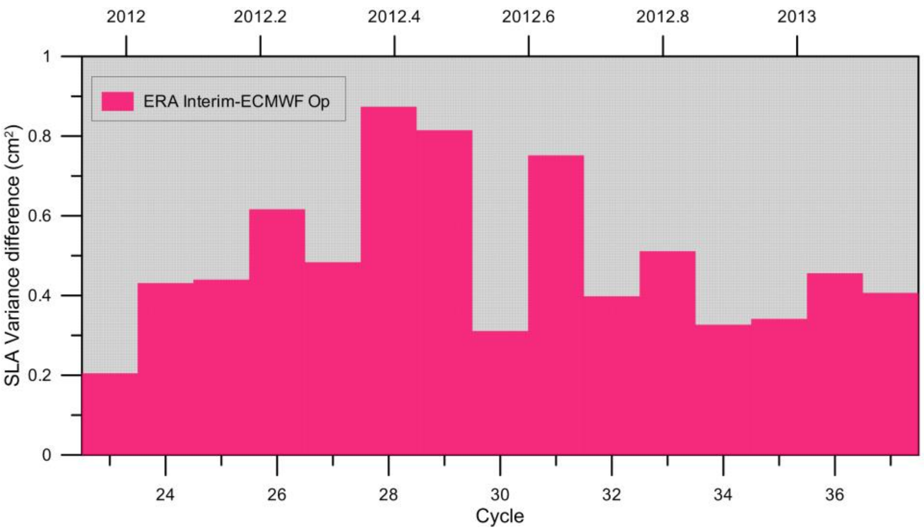
ERA Interim vs ECMWF Operational

It was found that for the period of the CS-2 mission ECMWF operational model provides better results than ERA Interim. The two models should be very similar but ECMWF operational has better spatial resolution than ERA-Interim (0.125˚ vs. 0.75˚).





SLA variance difference (cm^2) for each J2 (left) and CS-2 (right) cycles: ERA Interim - ECMWF Operational

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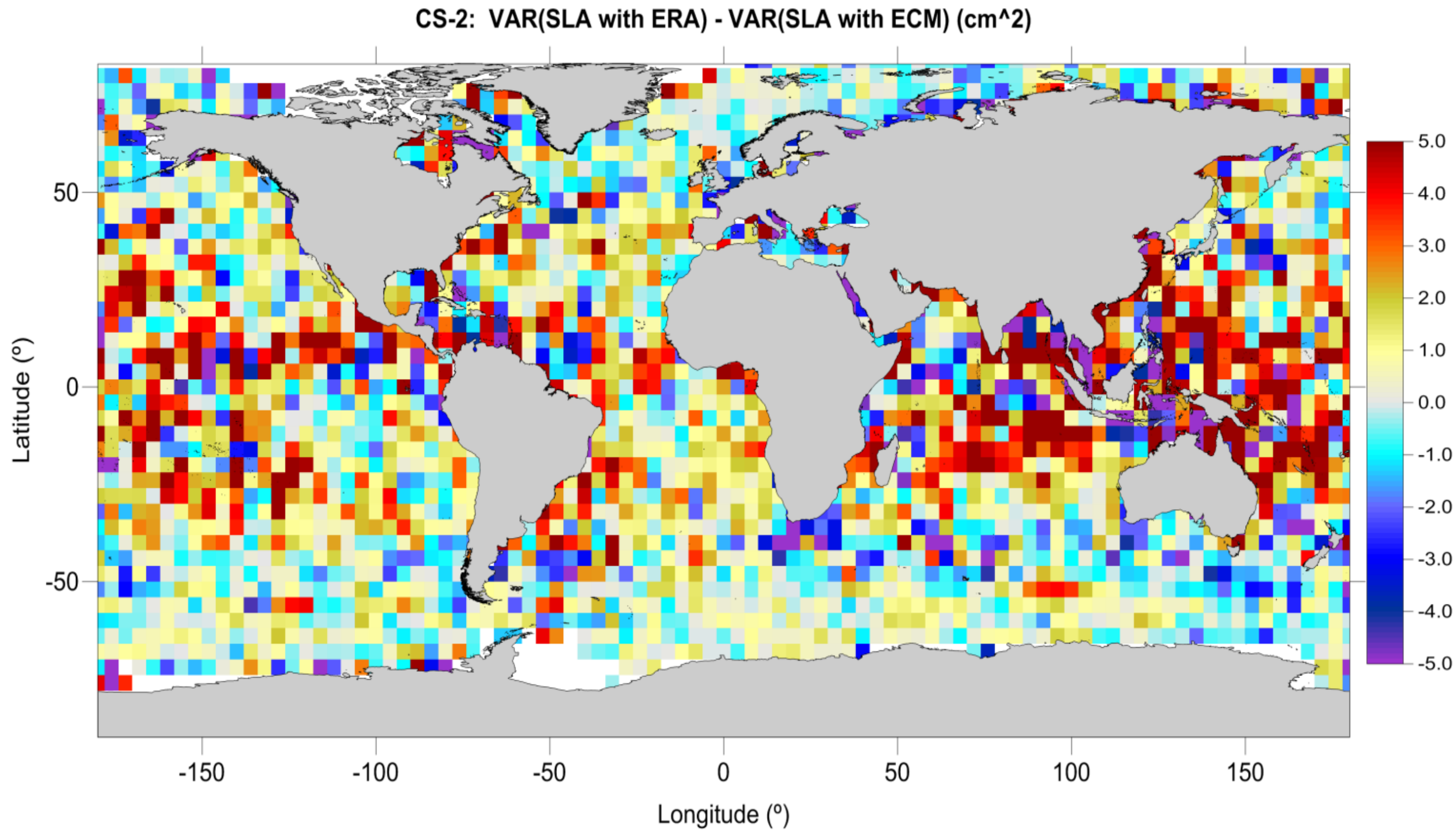
ERA Interim vs ECMWF Operational



SLA variance difference at CS-2 crossovers (cm^2) between ERA Interim and ECMWF Operational models.

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SI-MWR sensors

Sensor	Pixel size (km)	Swath width (km)	N. of (Lines,pixels)	Name of product	Scale factor	Data type
AMSR-E	9 km	1625	(variable,243)	Med_res_vapor	0.01	SWATH
AMSU-A	50 km (***)	2200	(variable,30)	TPW	0.1	SWATH
TMI	10 km	878	(variable,104)	Columnar_water_vapor	0.01	SWATH
SSM/I	25 km	1420	(variable,64)	TPW	0.1	SWATH
SSM/I, SSMIS	0.25°	1790 - 1850	(720,1440)	VAPOR	0.3	GRID
WindSat	0.25°	1400	(720,1440)	VAPOR	0.3	GRID

- Mean data availability for CS-2 period:
    - 11 satellites: 10 sun-synchronous; 1 non sun-synchronous
    - 6 different sensors; pixel size: 10 – 50 km (centre of pixel)
    - Two types of products: swath and gridded
- CS-2 coverage within 110 minutes: 70%-100%

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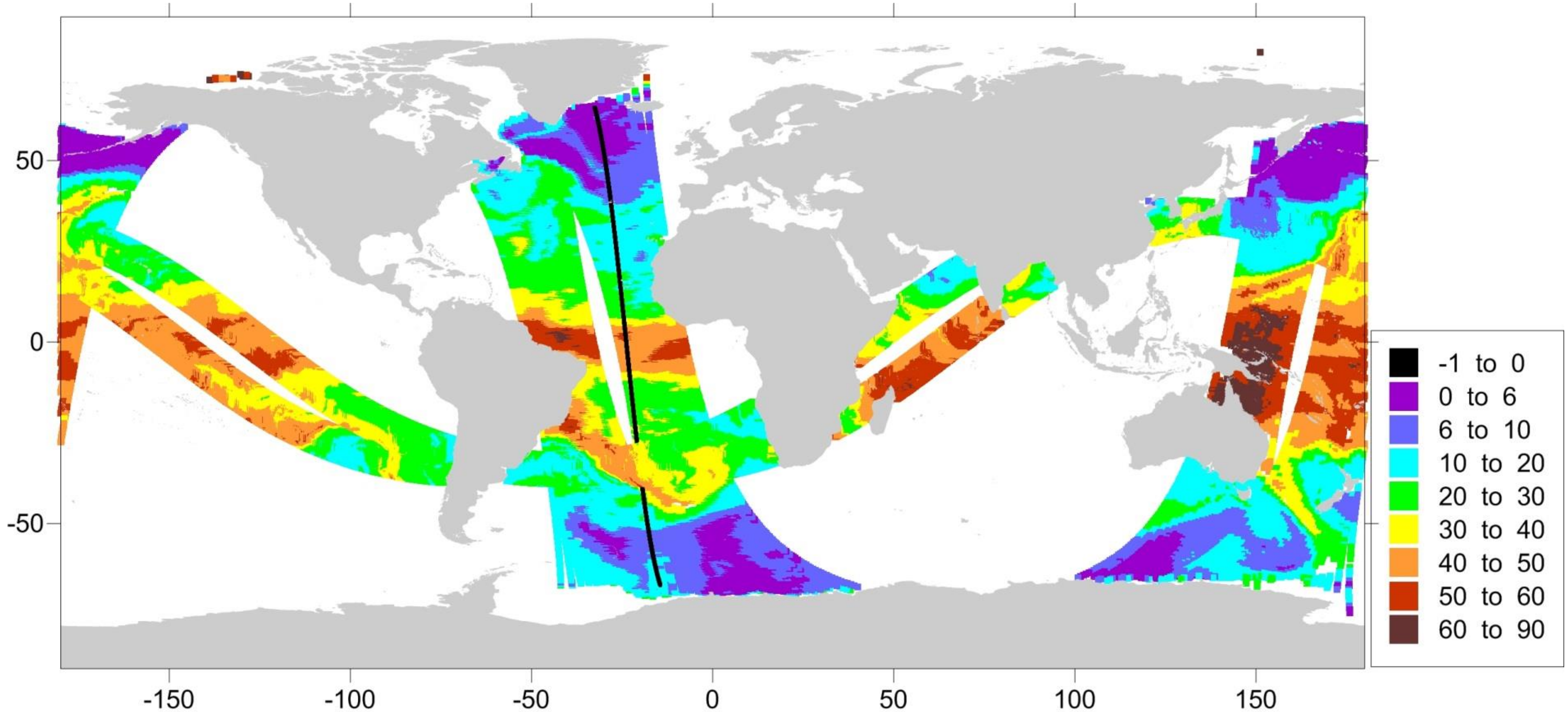
Example of swath TCWV products



NOAA-17/AMSU-A and TRMM/TMI images closest in time to CS-2 ascending pass 3 (in black), sub-cycle 26 (March 16, 2012). Colour scale is TCWV (Total Column Water Vapour) in mm.

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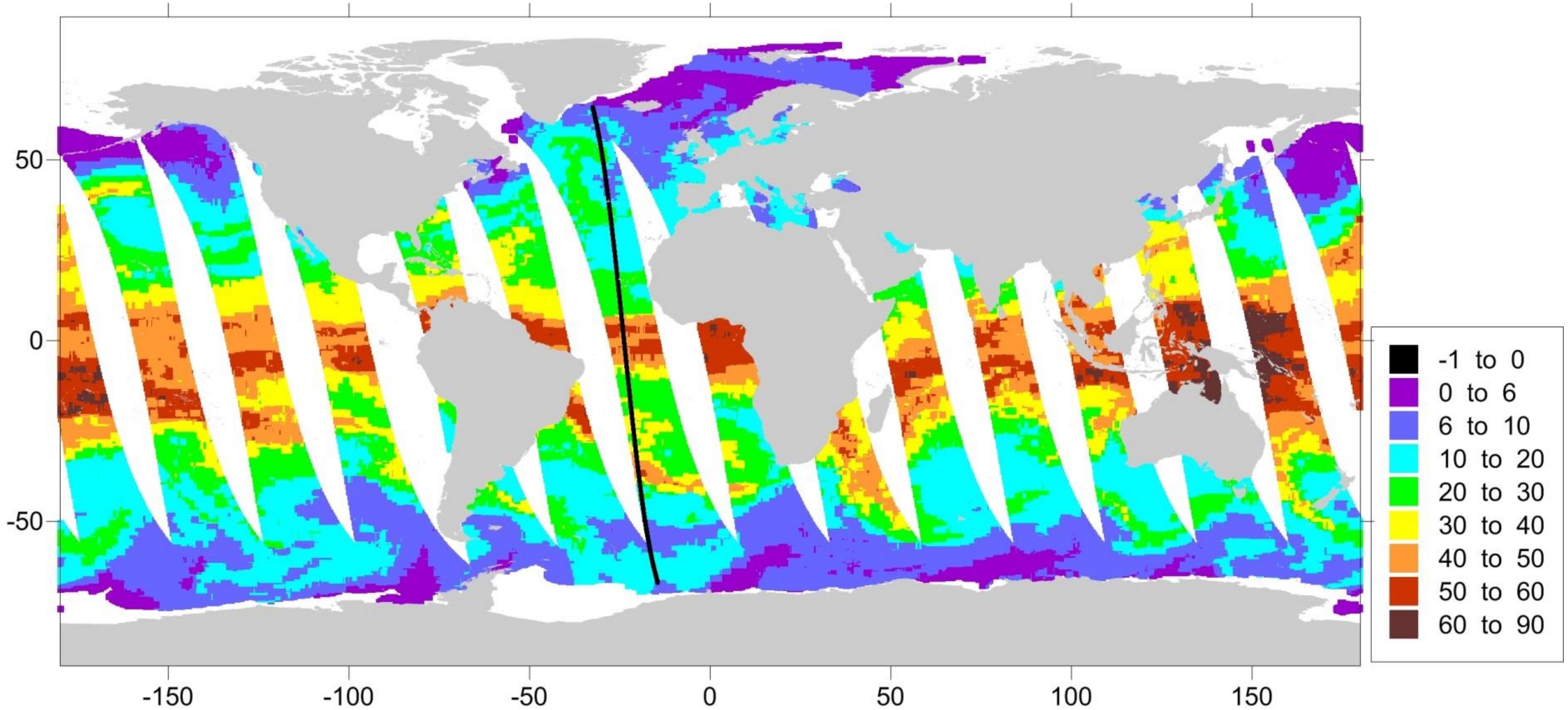
Example of GRID TCWV products



Coriolis (WindSat) ascending images for the same day of CS-2 ascending pass 3 (in black), sub-cycle 26 (16 March 2012). Colour scale is TCWV (Total Column Water Vapour) in mm.

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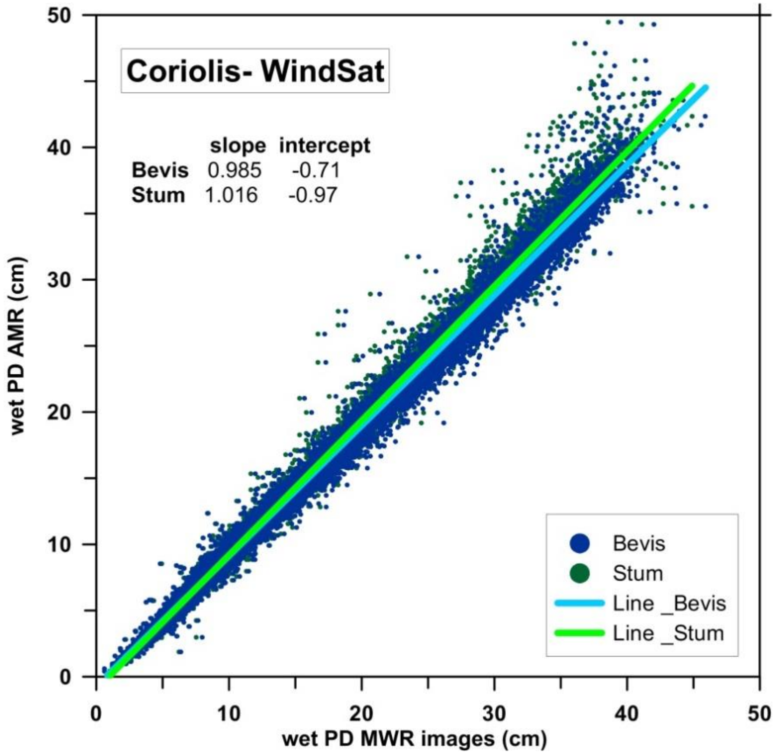
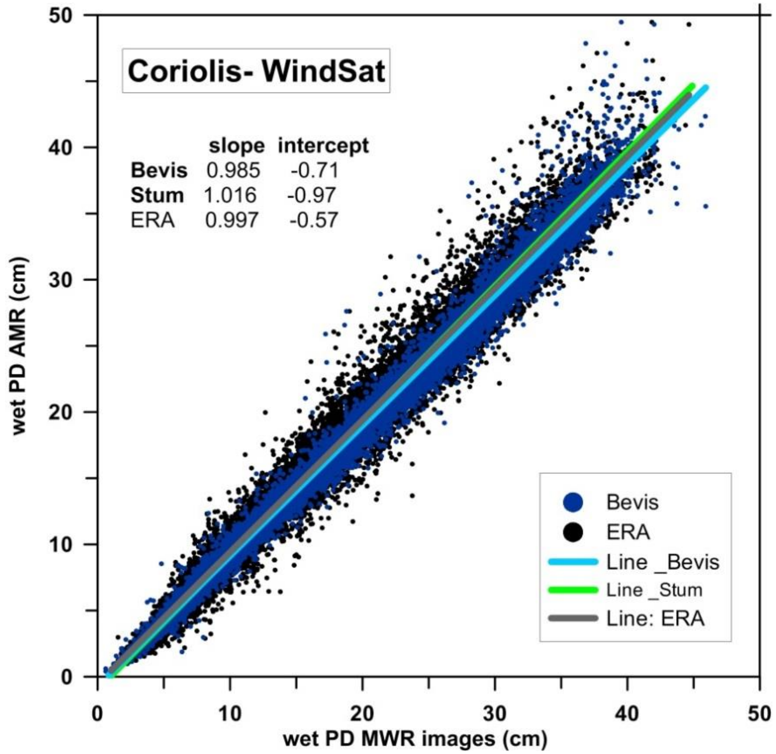
SI-MWR sensor calibration wrt AMR





Wet PD model	Scale	Offset (cm)	RMS bef. (cm)	RMS aft. (cm)
Bevis	0.985	-0.71	1.33	0.88
Stum	1.016	-0.97	1.11	0.86

Calibration parameters were determined for all sensors using two different approaches. After calibration, WTC_Bevis and WTC_Stum agree within ±2 mm (1 σ).

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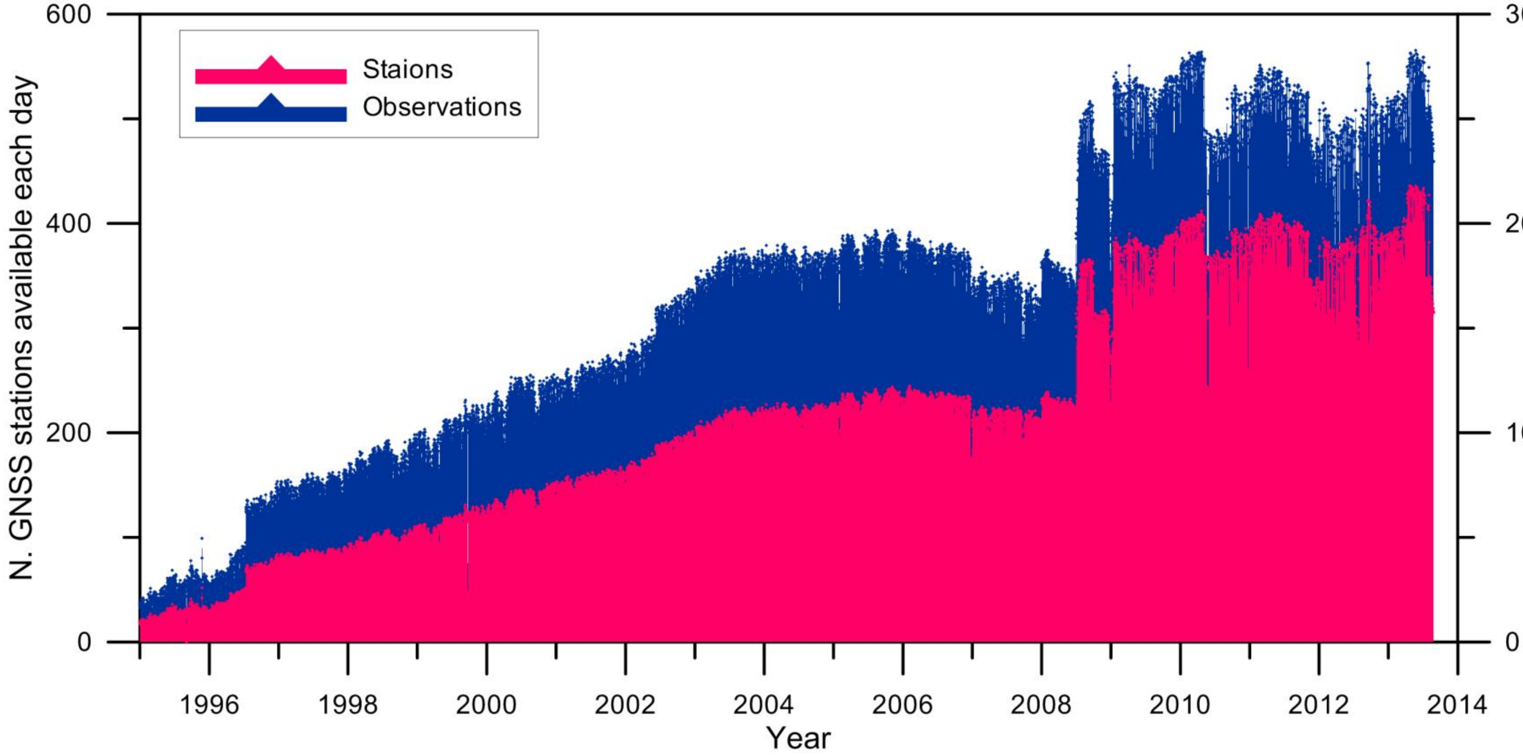
GNSS data

Mean number of ~400 GNSS stations available each day for the CS-2 mission period.



Number of GNSS stations and observations per day, since 1995.

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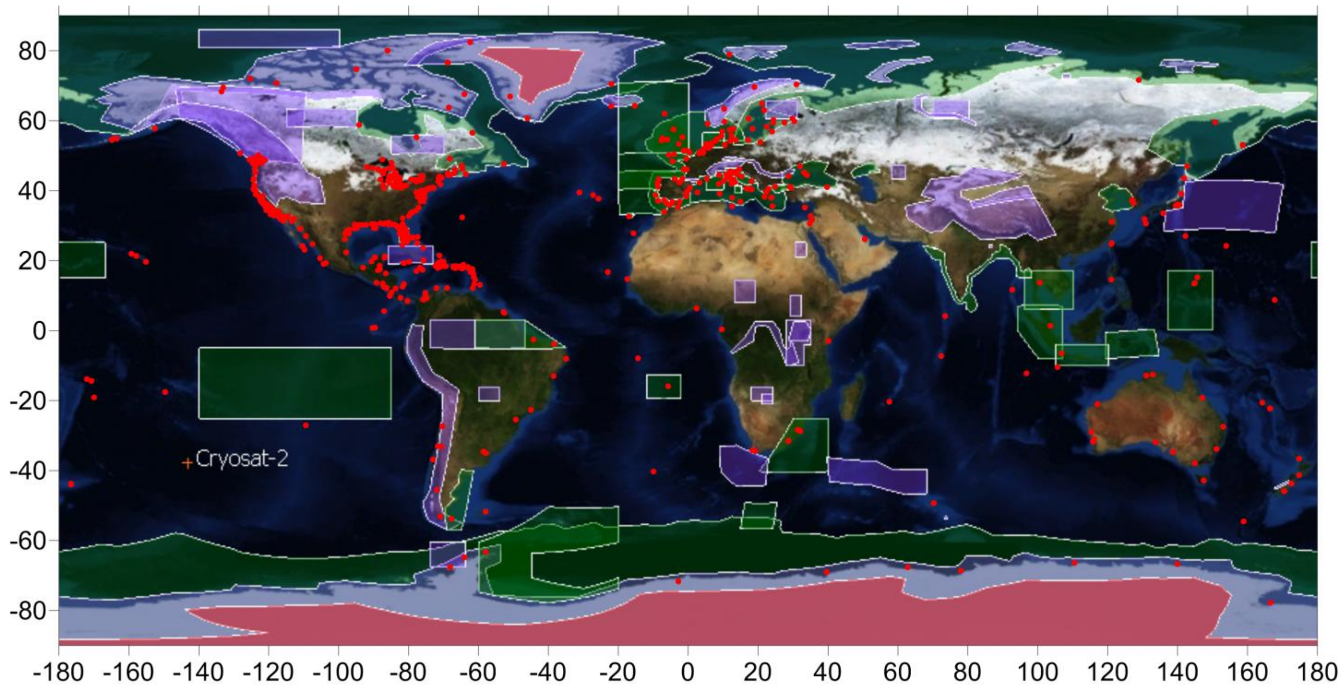
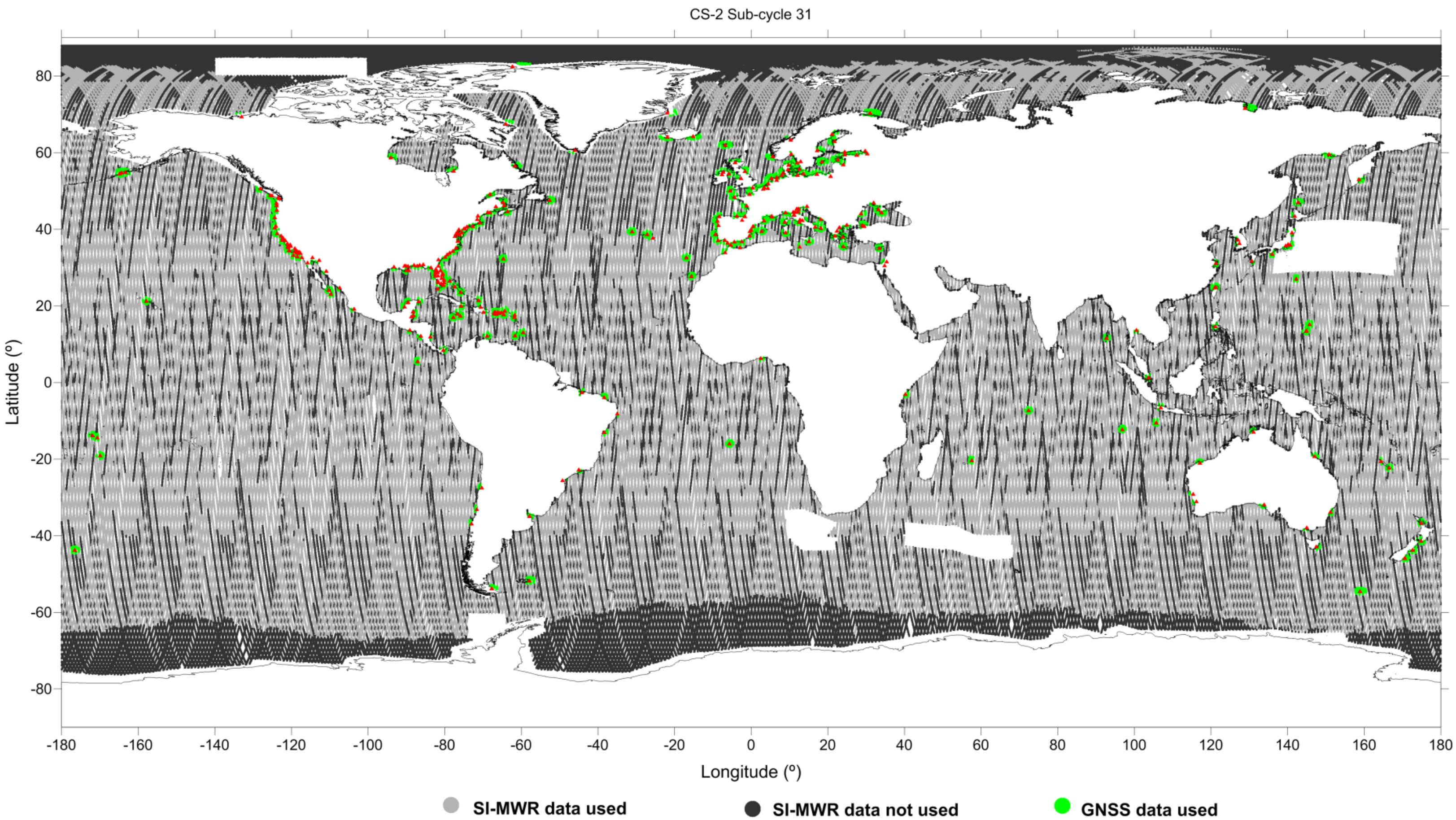
GNSS data

GNSS data have been processed using procedures developed in the scope of previous projects (COASTALT and Sea Level CCI)



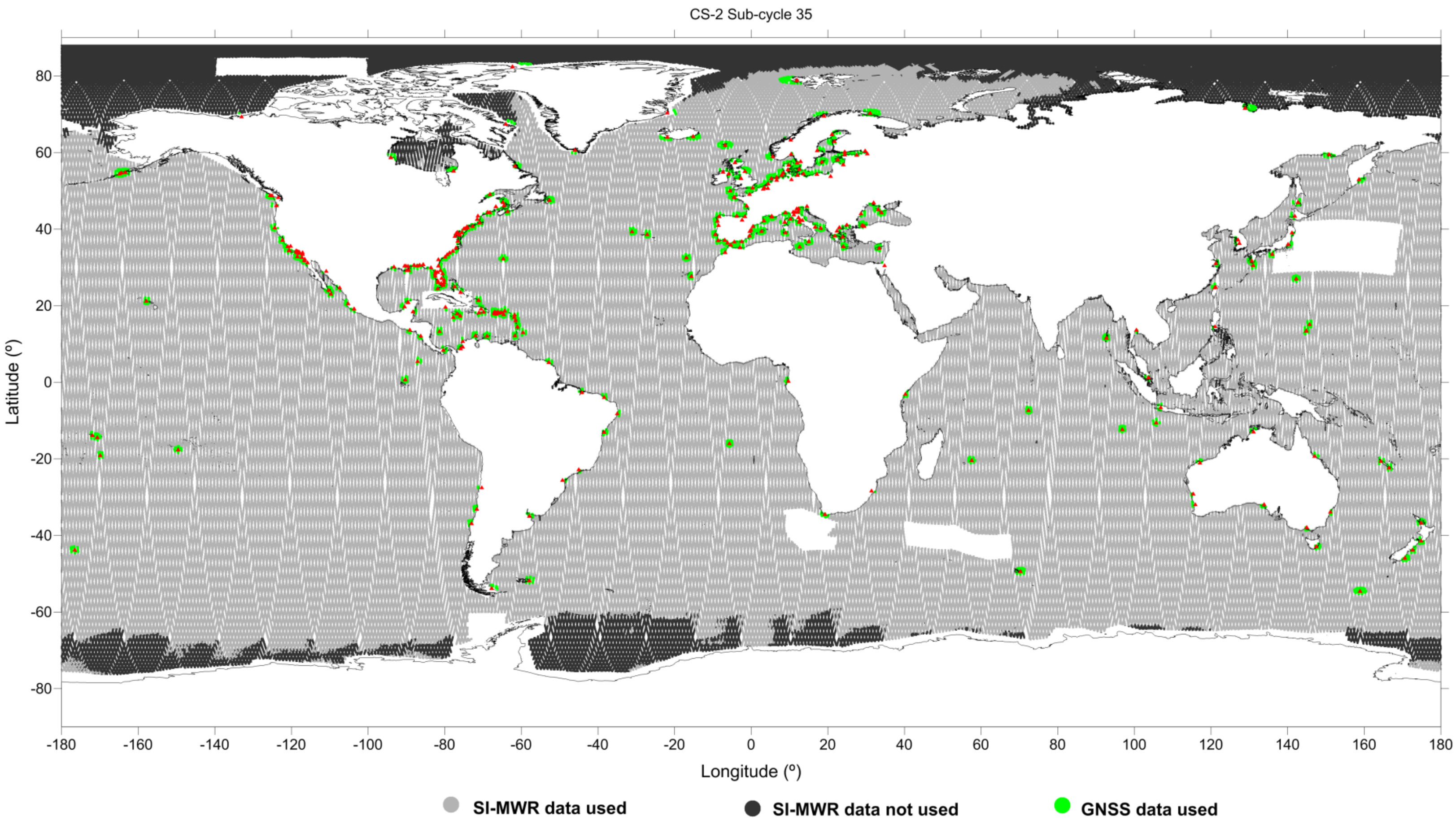
Location of the whole set of coastal GNSS stations overlaid on CS-2 mode mask 3.4.

Spatial data coverage for CS-2 sub-cycle 31



Spatial coverage of the various datasets for CS-2 sub-cycle 31. Red triangles represent the location of the GNSS stations.

Spatial data coverage for CS-2 sub-cycle 35



Spatial coverage of the various datasets for CS-2 sub-cycle 35. Red triangles represent the location of the GNSS stations.

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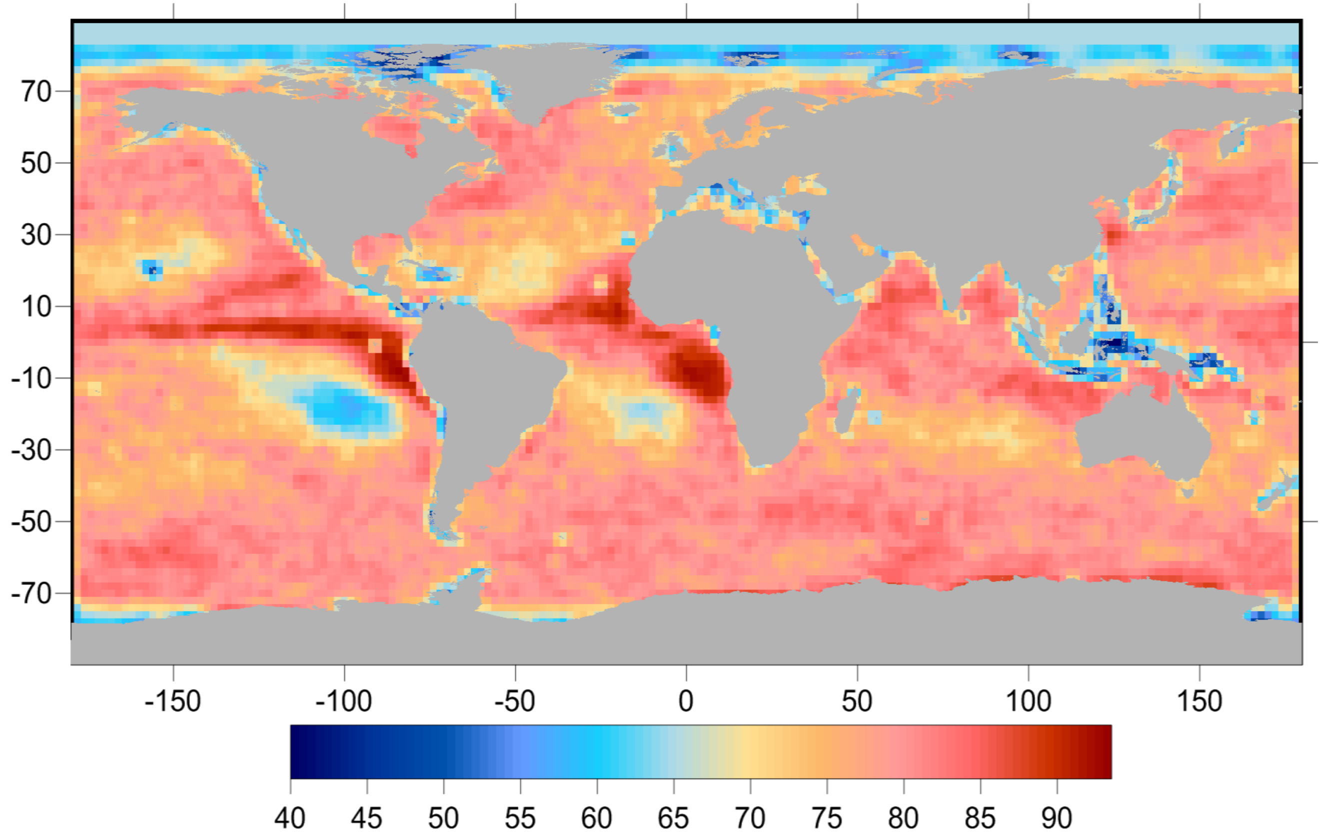
DComb implementation

Present DComb implementation:

- **First Guess**: weighted average of all selected WTC values within the space and time search radii
- **Signal variance** determined from 2 years of ECMWF Operatinal model grids
- **white noise associated to each data type**: GNSS: 0.5 cm; SI-MWR: from 0.81 to1.22 cm, depending on sensor, ECMWF operational model: 1.5 cm.

Correlation scales



- ❑ Spatial correlation scales (in km) for the WTC as determined from a set of ECMWF Operational Model grids at 0.125 ˚ well distributed over the year 2013
- ❑ Adopted temporal correlation scale: 100 min

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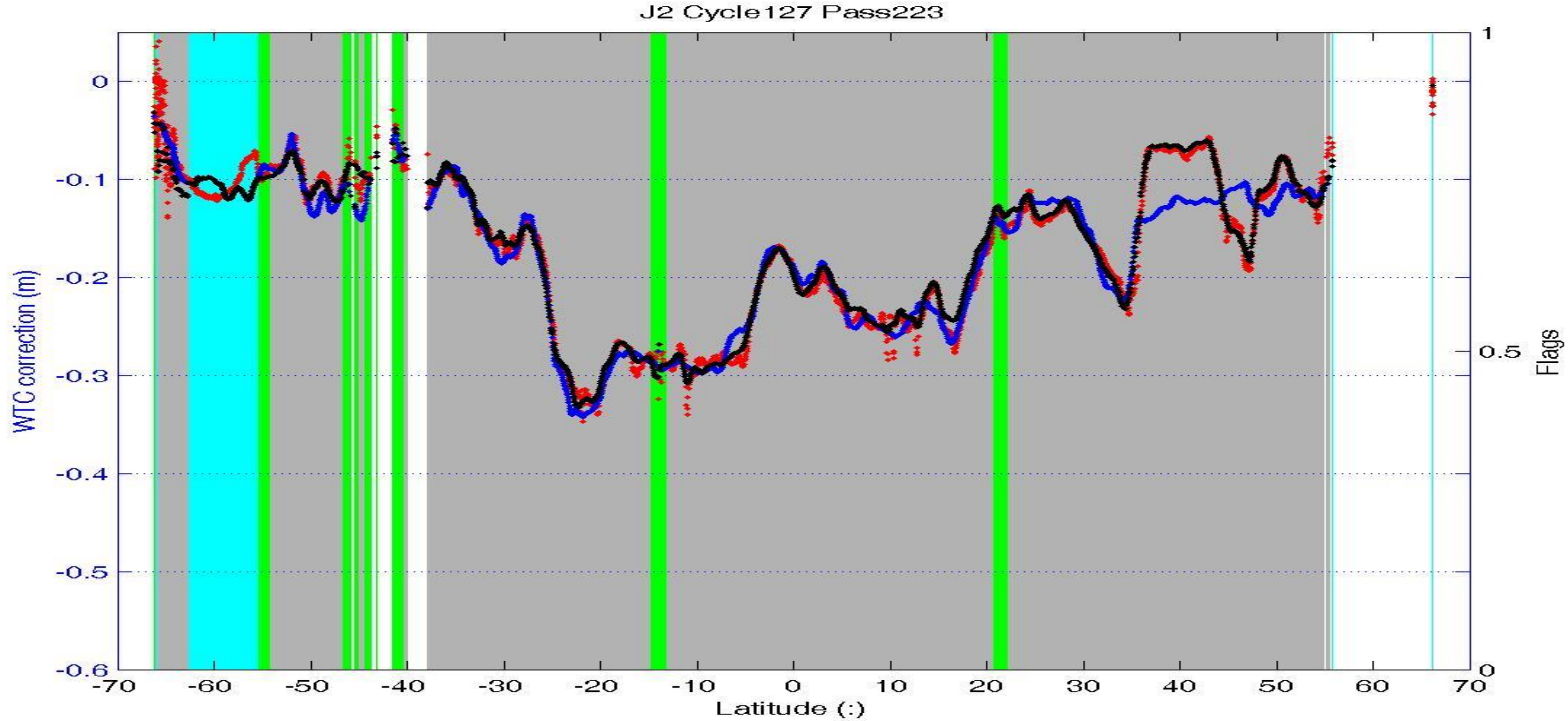
Results for J2

Correction was computed for J2:

- Cycles 128-168
- January 2012 – January 2013

Computation of the WTC for J2

Example of various WTC for J2 cycle 127 pass 223



WTC for J2 cycle 127 pass 223: **ECMWF operational model (blue)**, **AMR (red)** and **DComb (black)**. The shaded areas represent regions for which SI-MWR observations (grey), GNSS (green) or model only (blue) are available.

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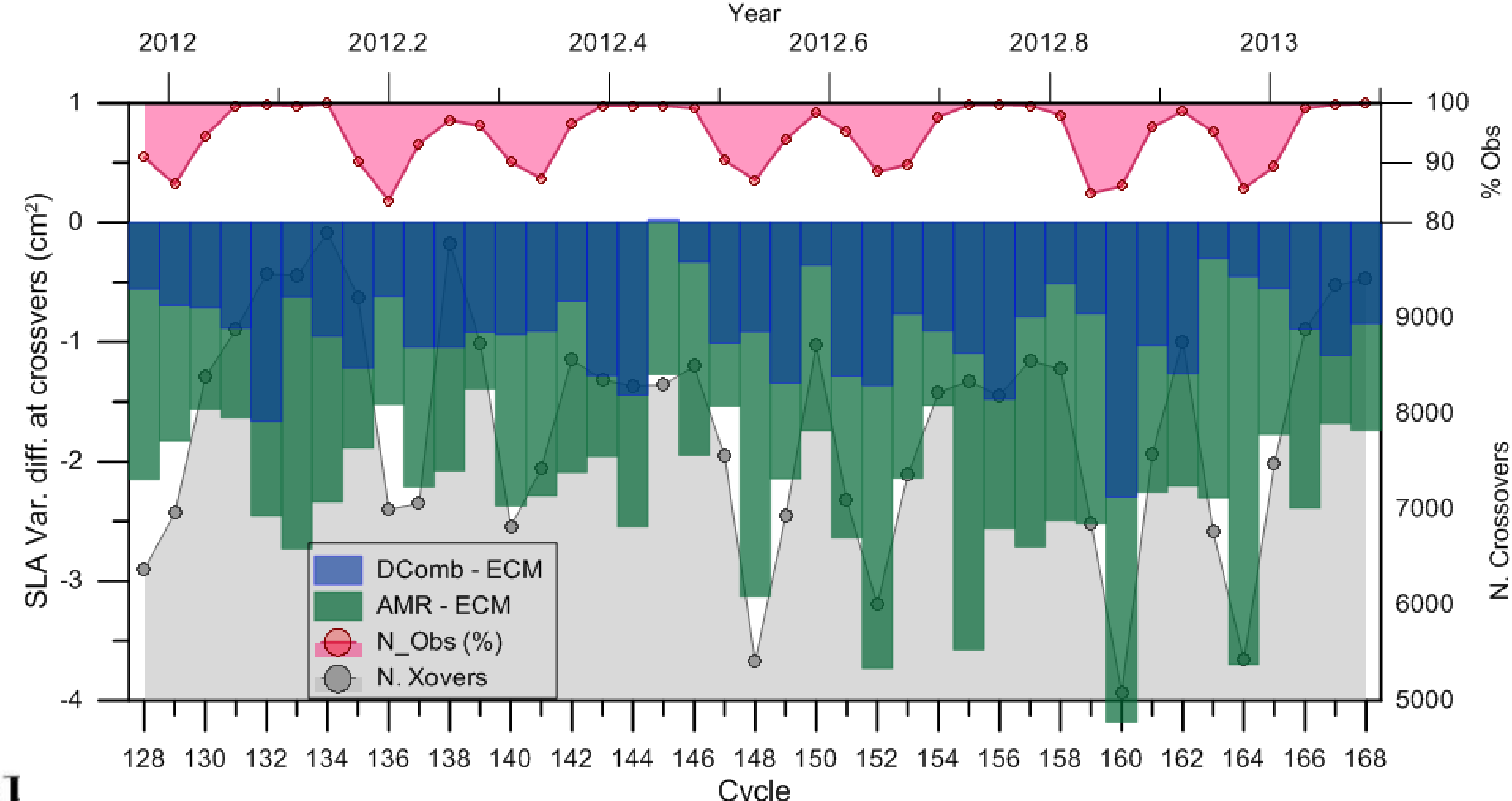
Computation of the WTC for J2

SLA variance difference at crossovers (cm^2), for each J2 cycle, between DComb and ECMWF Operational model (blue) and between AMR and ECMWF Operational model (green).



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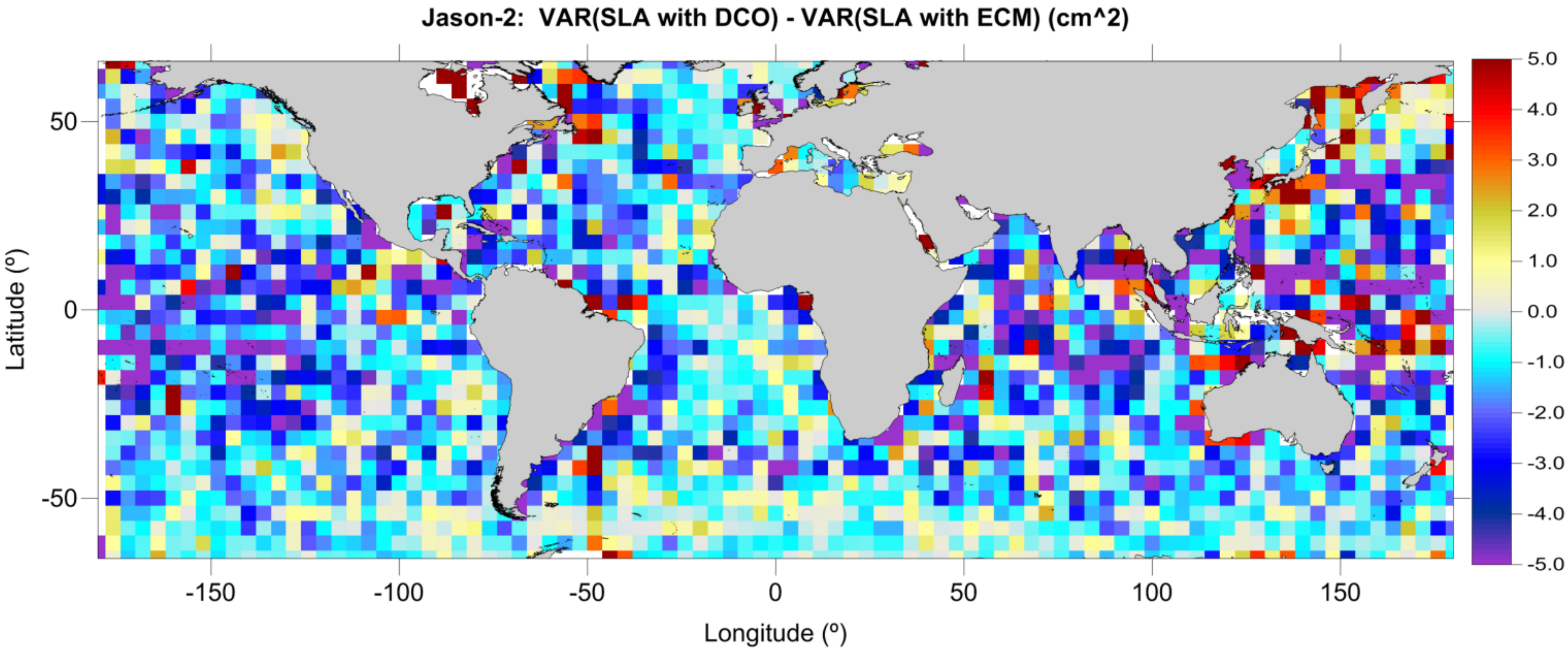
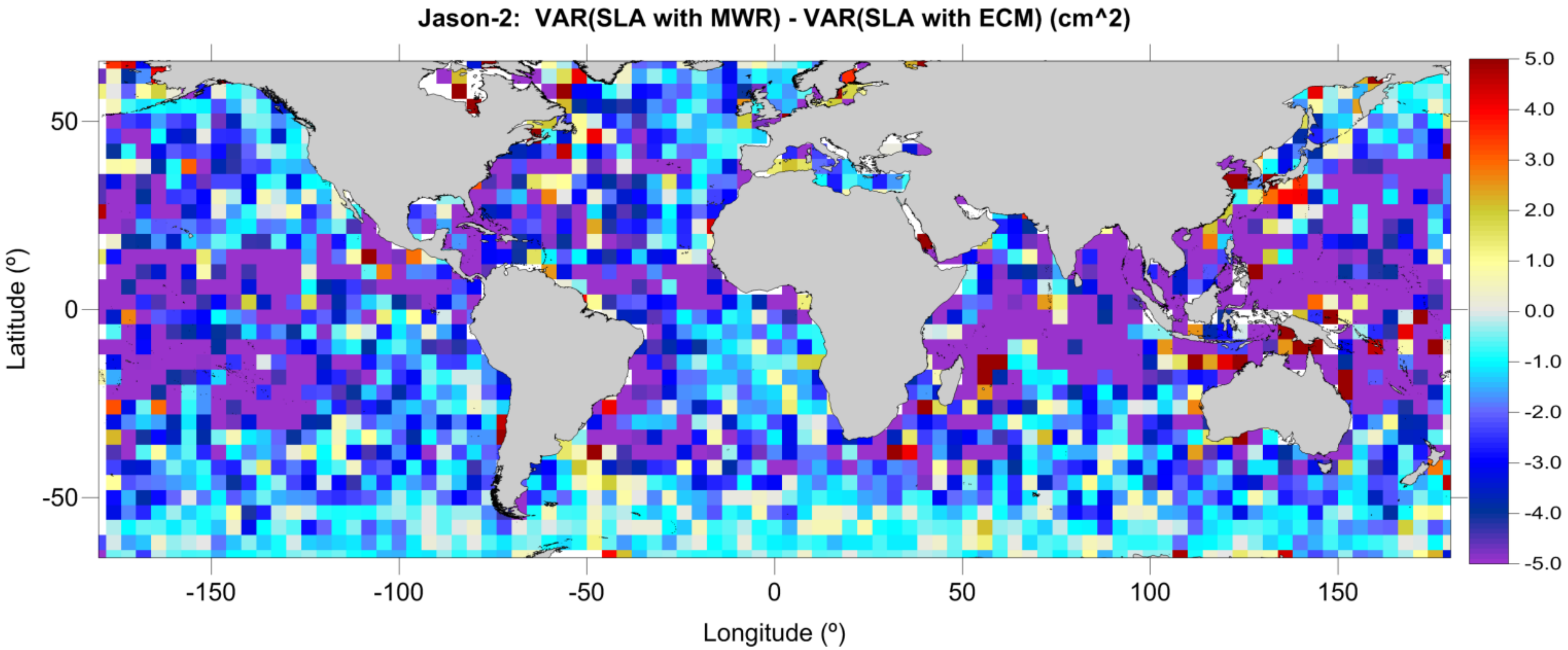
Computation of the WTC for J2

SLA variance difference at crossovers (cm^2) between DComb and ECMWF Operational Model



Computation of the WTC for J2

SLA variance difference at crossovers (cm^2) between AMR and ECMWF Operational Model



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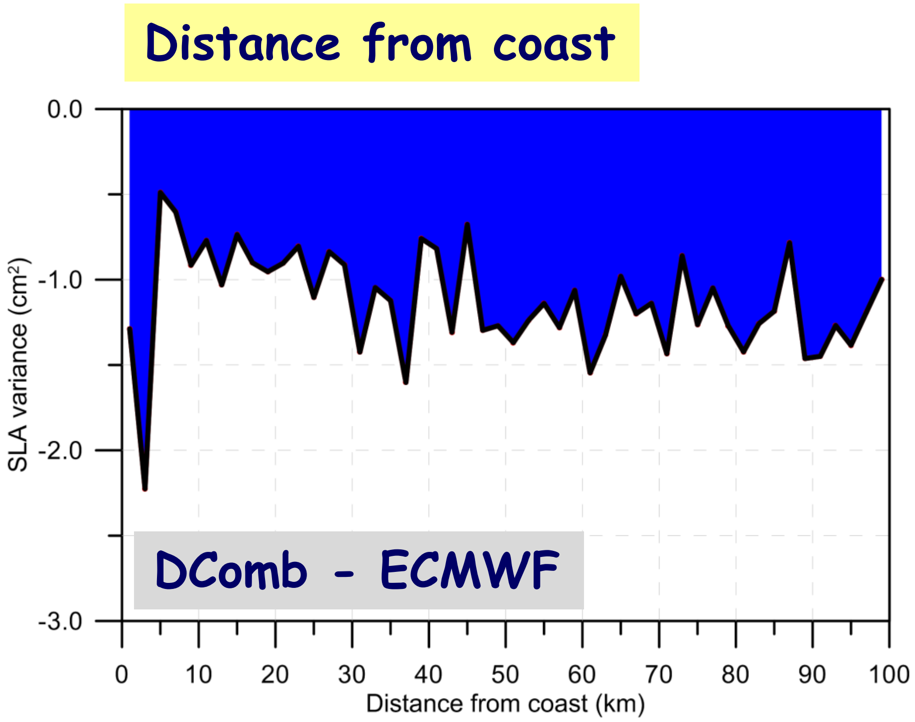
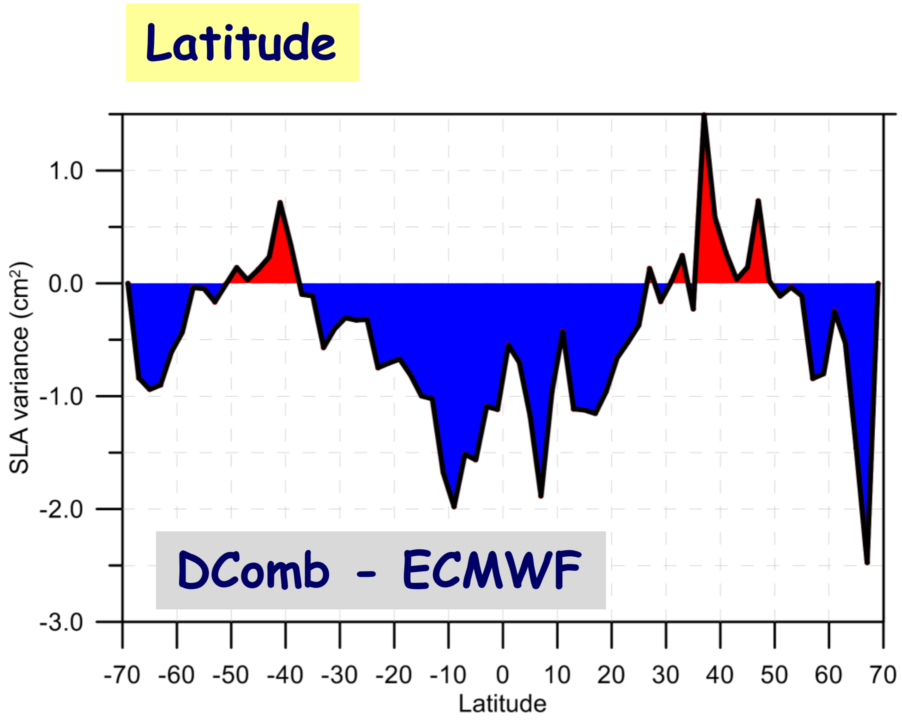
Computation of the WTC for J2

J2 SLA variance difference function of:





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Computation of the WTC for CryoSat-2

Results for CS-2

Correction was computed for CS-2:

- Sub-cycles 23-37
- January 2012 – January 2013

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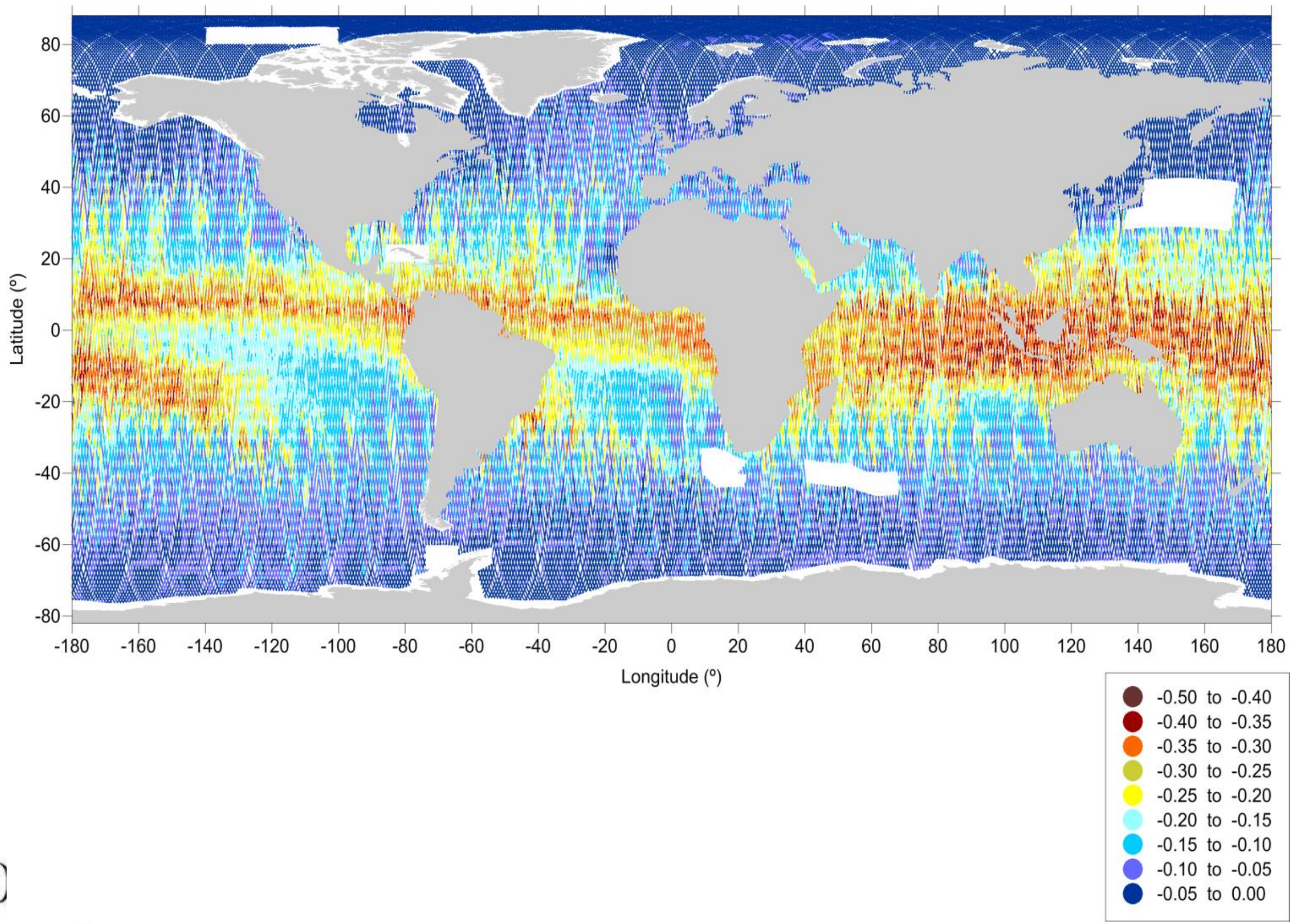
DComb WTC for CS-2 sub-cycle 35



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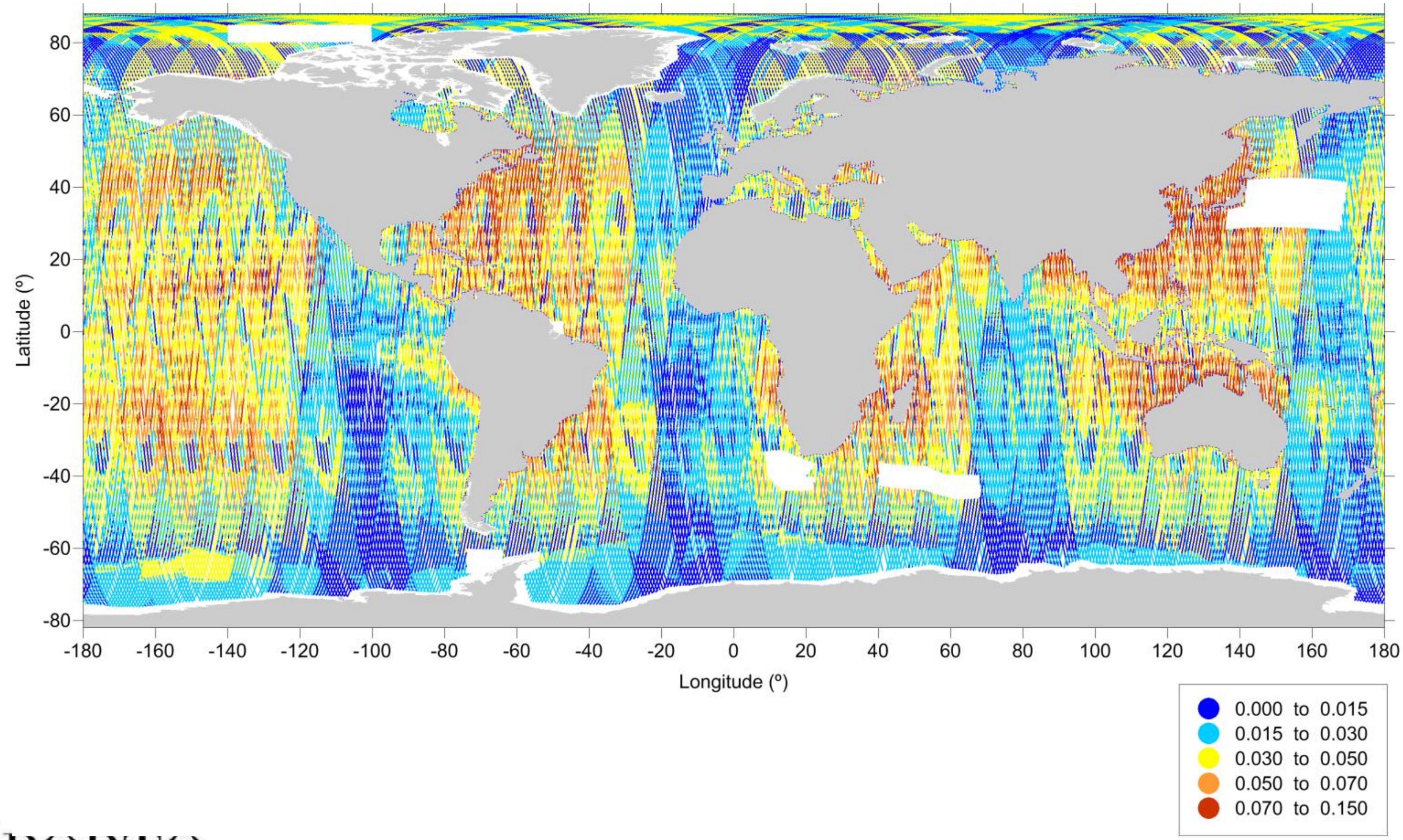
WTC error for CS-2 sub-cycle 31



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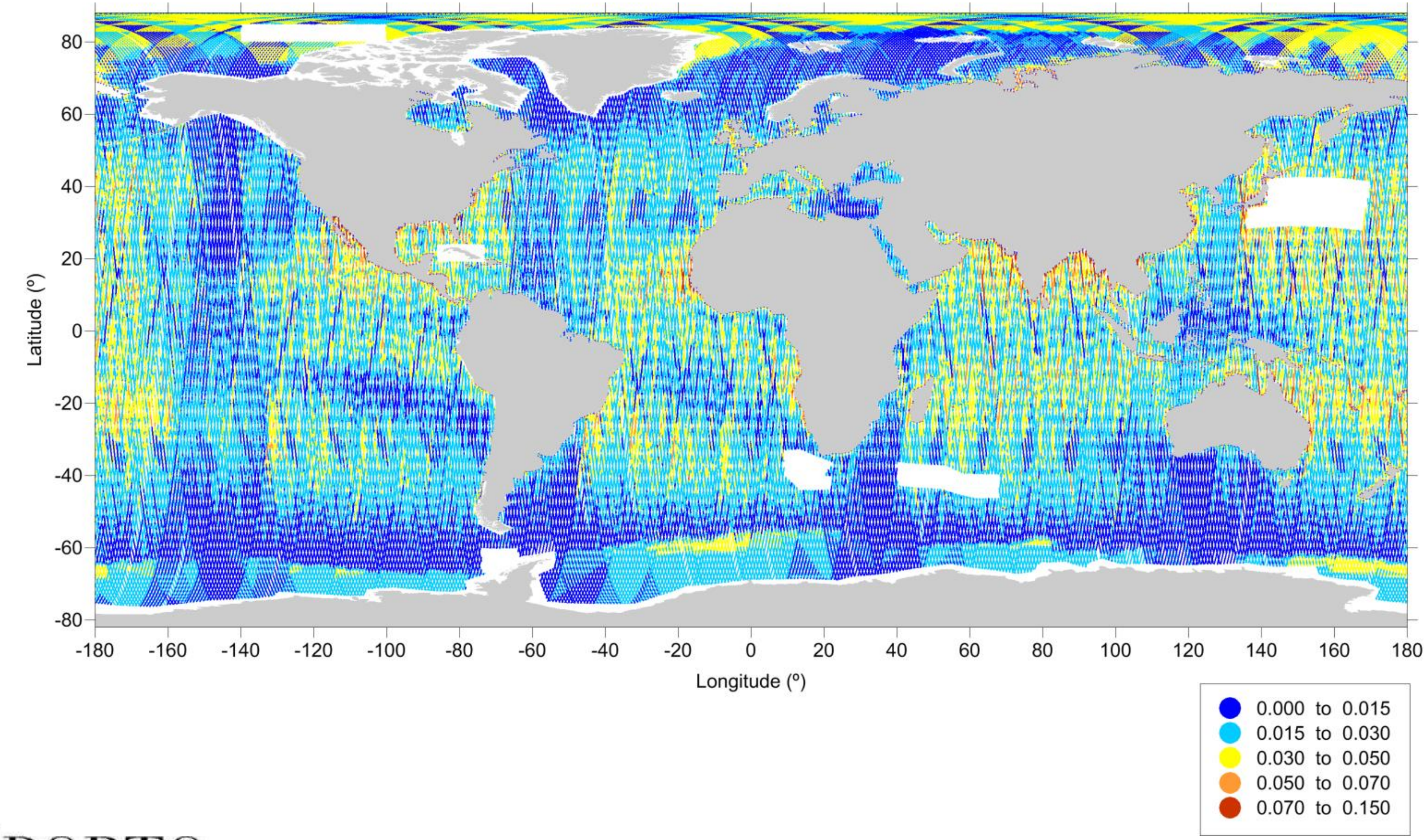
WTC error for CS-2 sub-cycle 35



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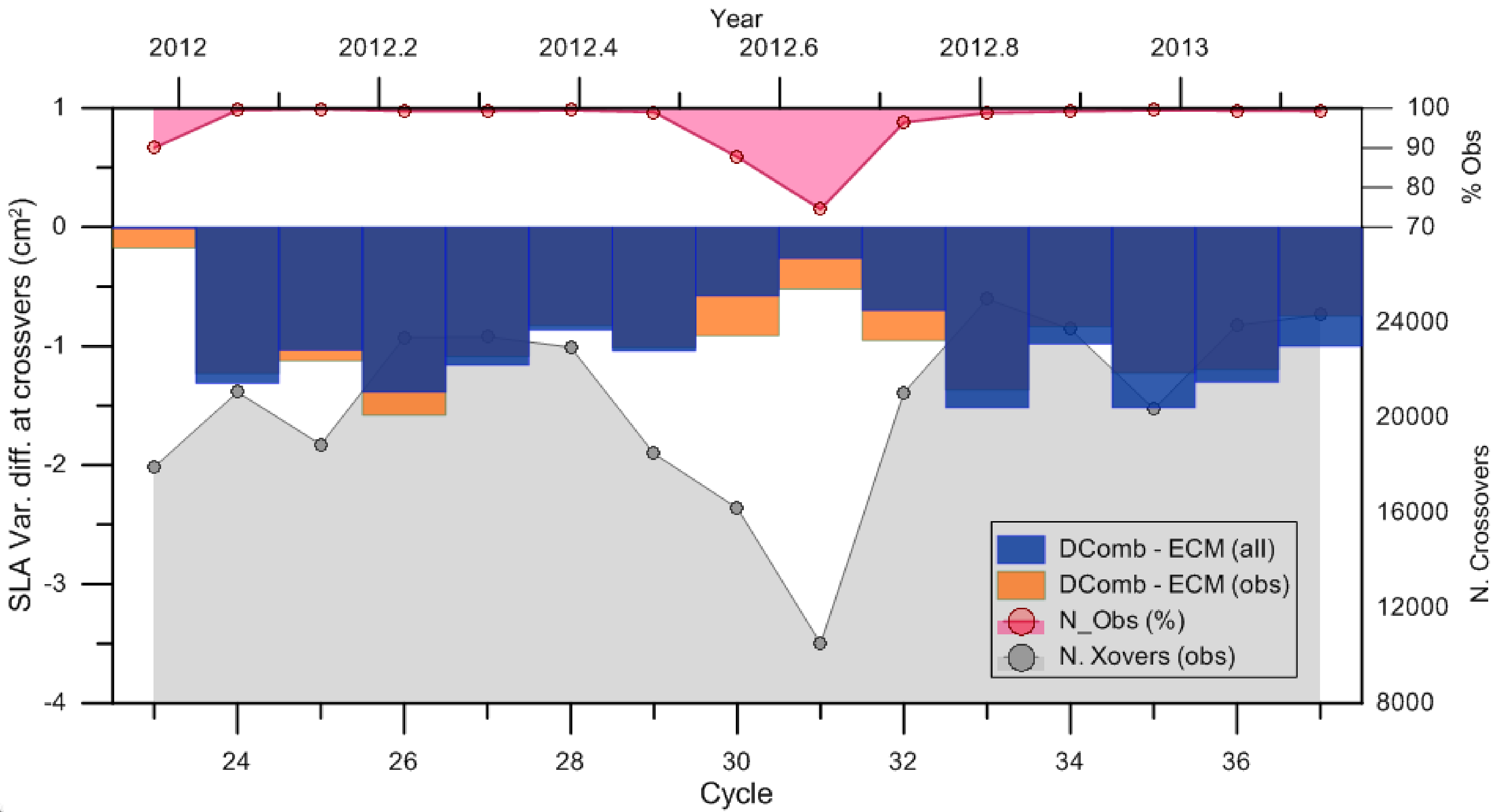
Computation of the WTC for CS-2

SLA variance difference at crossovers (cm^2) for each CS-2 cycle, between DComb and ECMWF Operational Model



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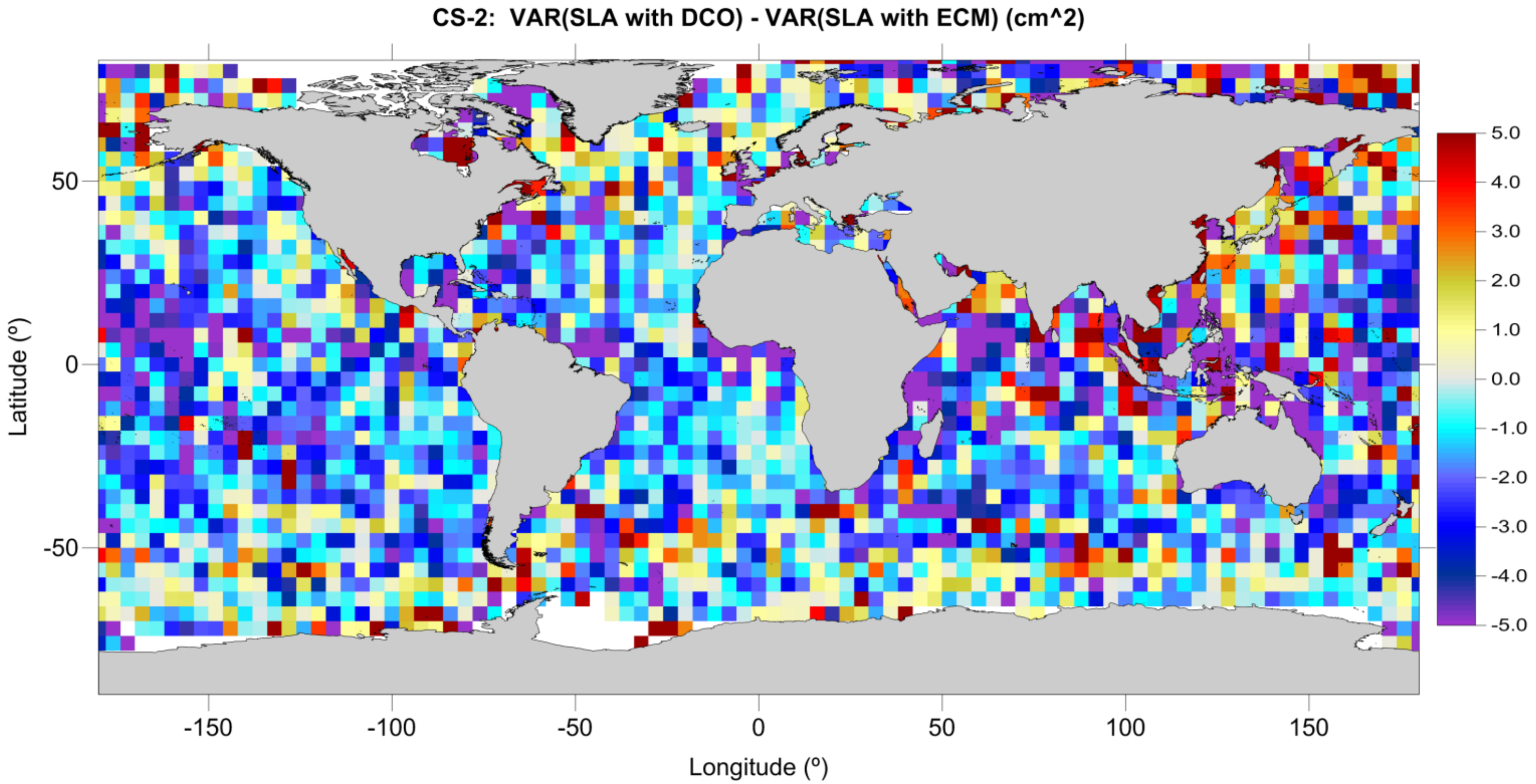
Computation of the WTC for CS-2

SLA variance difference at crossovers (cm^2) between DComb and ECMWF Operational Model



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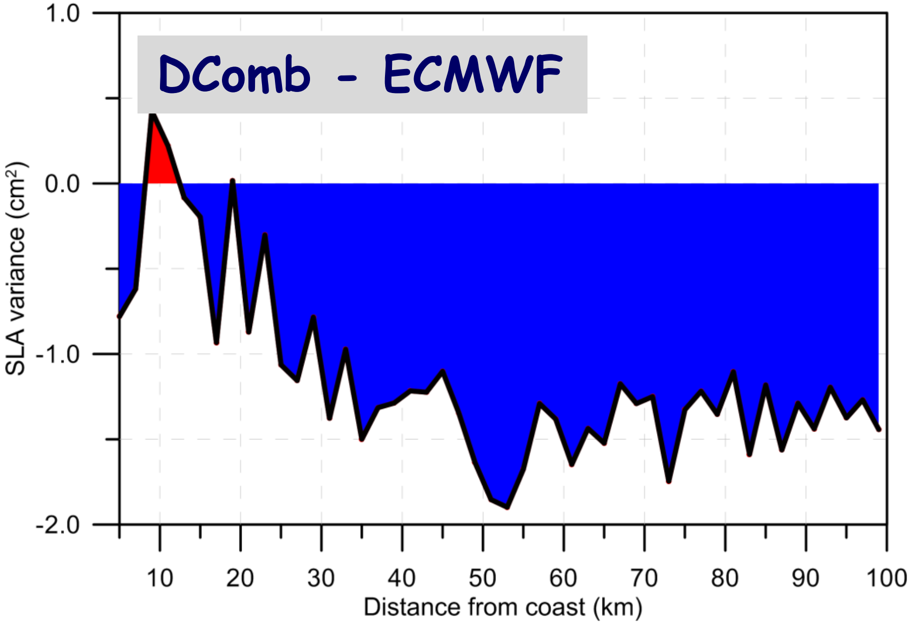
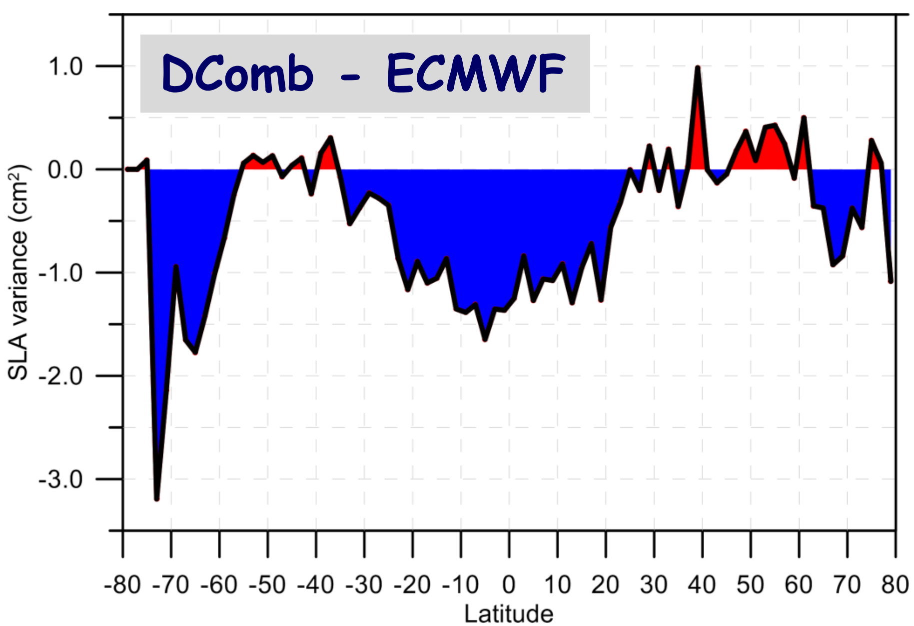
Computation of the WTC for CS-2

CS-2 SLA variance difference function of:

Distance from coast



Latitude



Computation of the WTC for CS-2

SLA variance difference (cm^2) for each CS-2 cycle, between DComb and ECMWF Operational Model