DComb wet tropospheric correction for CryoSat-2 over open and coastal ocean

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Outline

- ❑ **Scope and objectives**
- ❑ **The DComb wet tropospheric correction**
  - Data sets used
  - Implementation
- ❑ **Application to Jason-2**
- ❑ **Application to CryoSat-2**

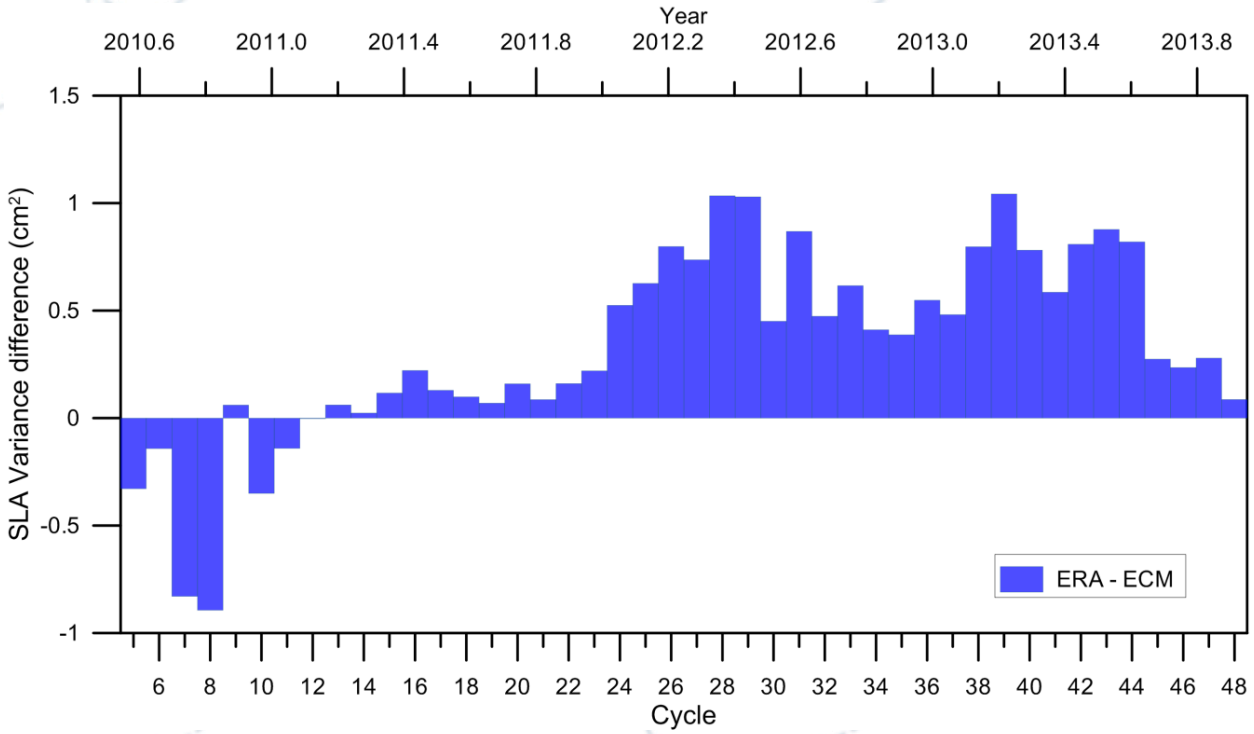
Scope and objectives

- **Study performed in the scope of the CP4O project.**
- **Computation of an improved WTC for CryoSat-2 by data combination (DComb), through objective analysis, of two datasets:**
  - SI-MWR (Scanning Imaging MWR) on board RS missions;
  - GNSS data from coastal inland and island stations.
- **In the absence of observations, ECMWF Operational model values are used.**

Data sets used - model

⇨ ERA Interim vs ECMWF Operational

• For most of the period of the CS-2 mission (since 2011) ECMWF Op provides better results than ERA Interim (ECMWF Op has better spatial resolution than ERA, 0.125˚ vs. 0.75˚).



SLA variance difference (cm²) for each CS-2 sub/cycle: ERA Interim - ECMWF Operational

Data sets used – SI-MWR sensors

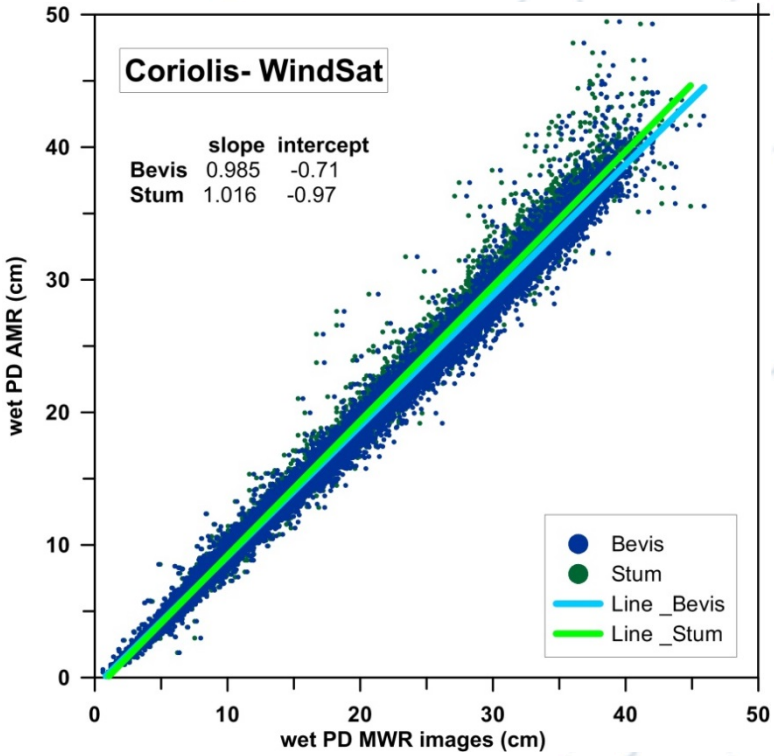
⇨ **Mean data availability for CS-2 period:**

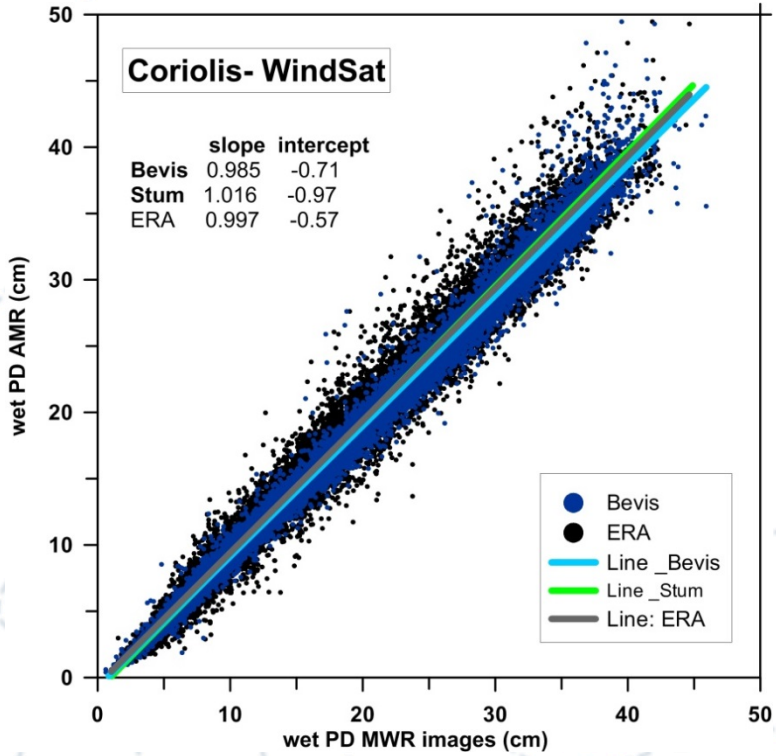
- 11 satellites: 10 sun-synchronous; 1 non sun-synchronous;
- 6 different sensors; pixel size: 10 – 50 km (centre of pixel);
- Two types of products: swath and gridded.

⇨ **CS-2 coverage within 110 minutes:** 70%-100%.

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

SI-MWR sensor calibration wrt AMR



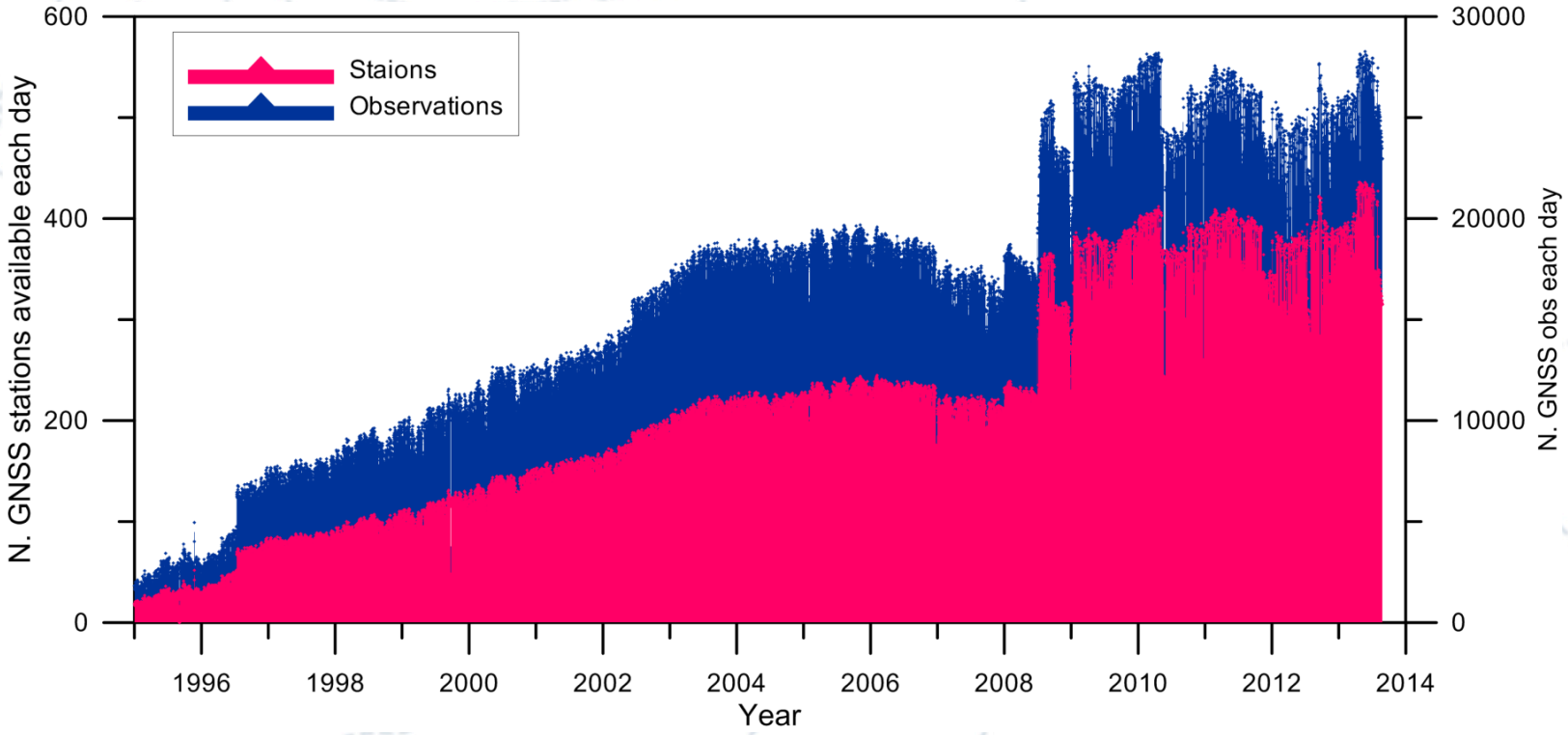


Wet PD model	Scale	Offset (cm)	RMS bef. (cm)	RMS aft. (cm)
Bevis	0.985	-0.71	1.33	0.88
Stum	1.016	-0.97	1.11	0.86

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

Data sets used – GNSS

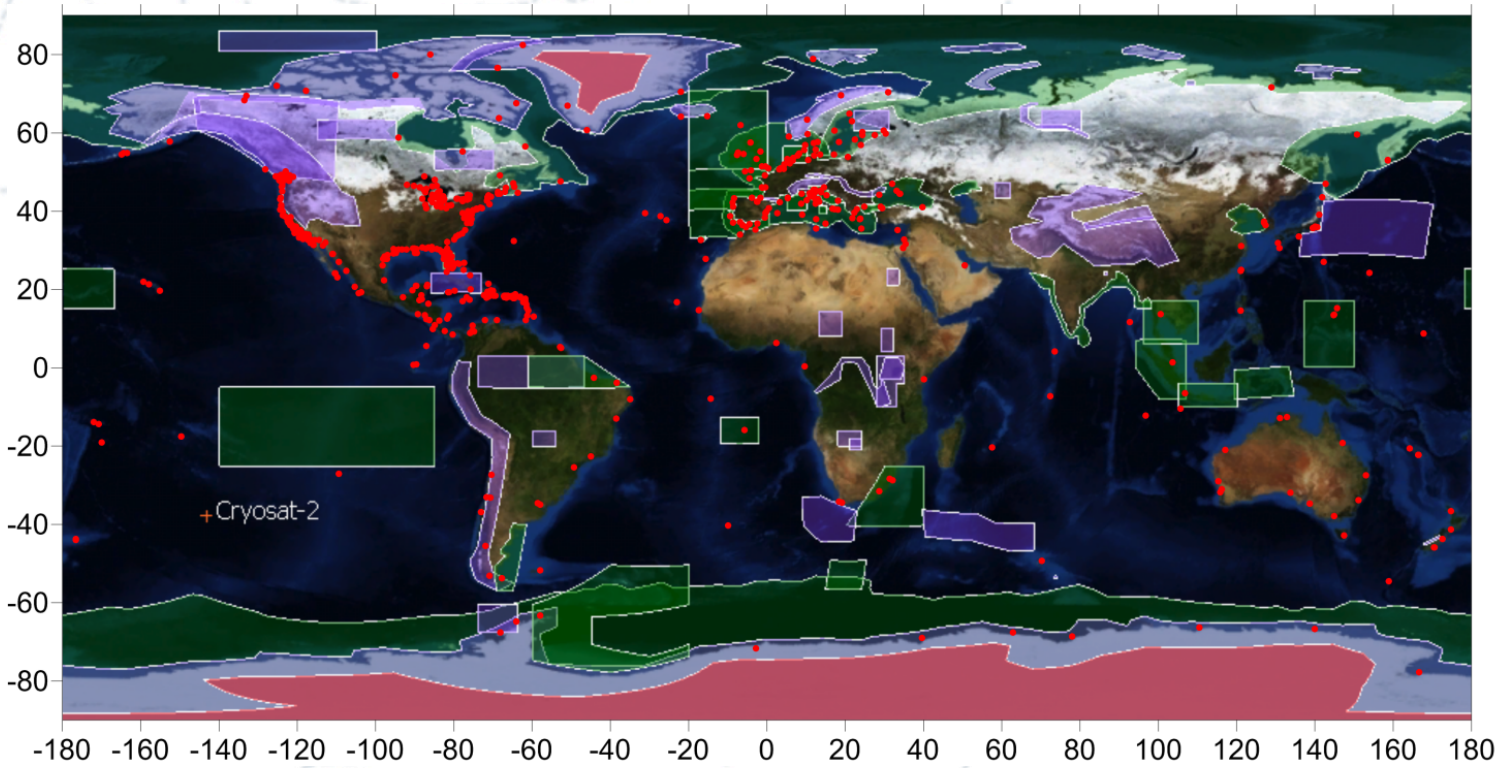
⇨ Mean number of ~400 GNSS stations available each day for the CS-2 mission period.



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

Data sets used – GNSS

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

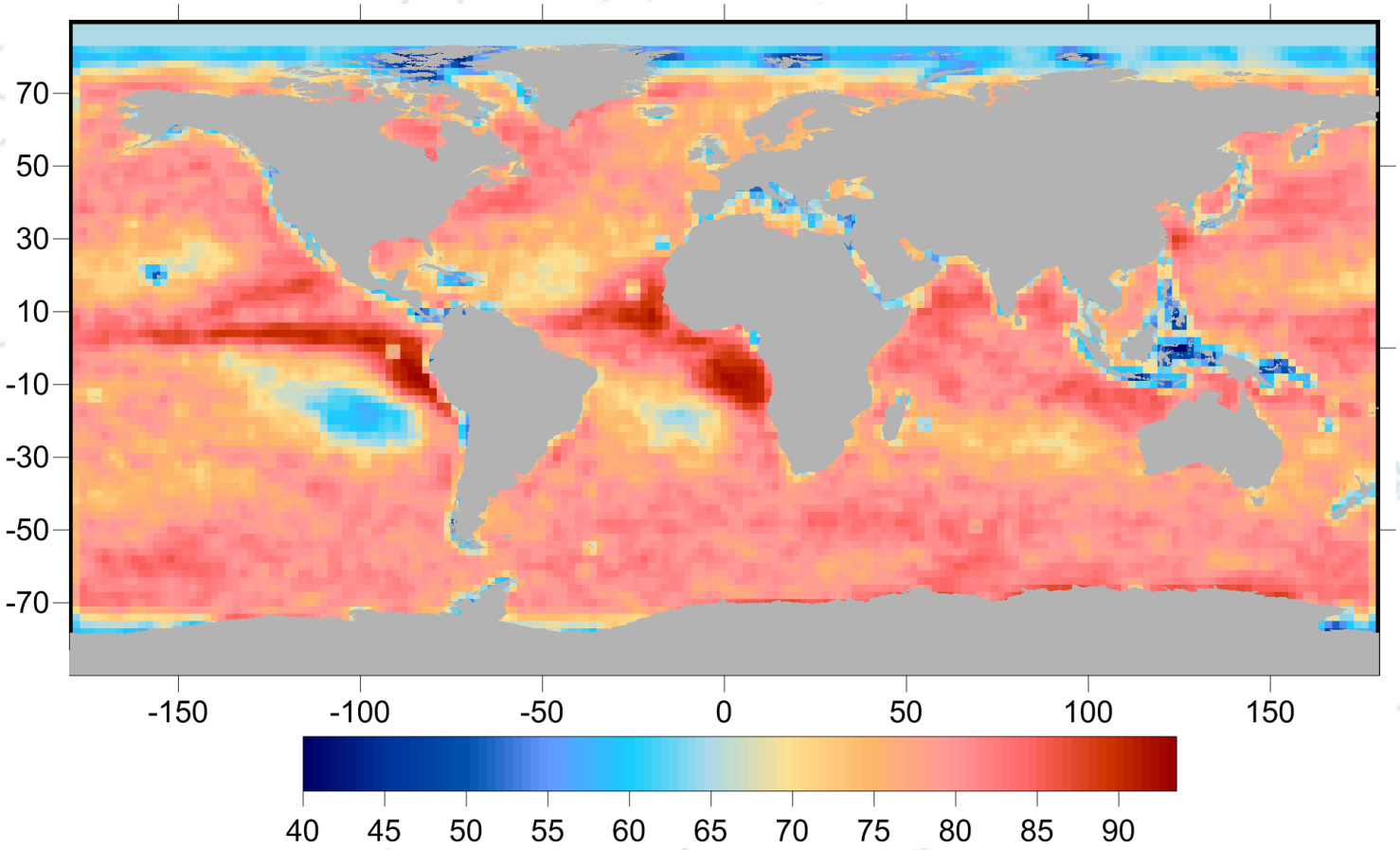


Location of the whole set of coastal GNSS stations overlaid on CS-2 mode mask 3.4.

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 Op 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 scales determined from ECMWF Op grids; temporal correlation scale: 100 min.

DComb spatial correlation scales



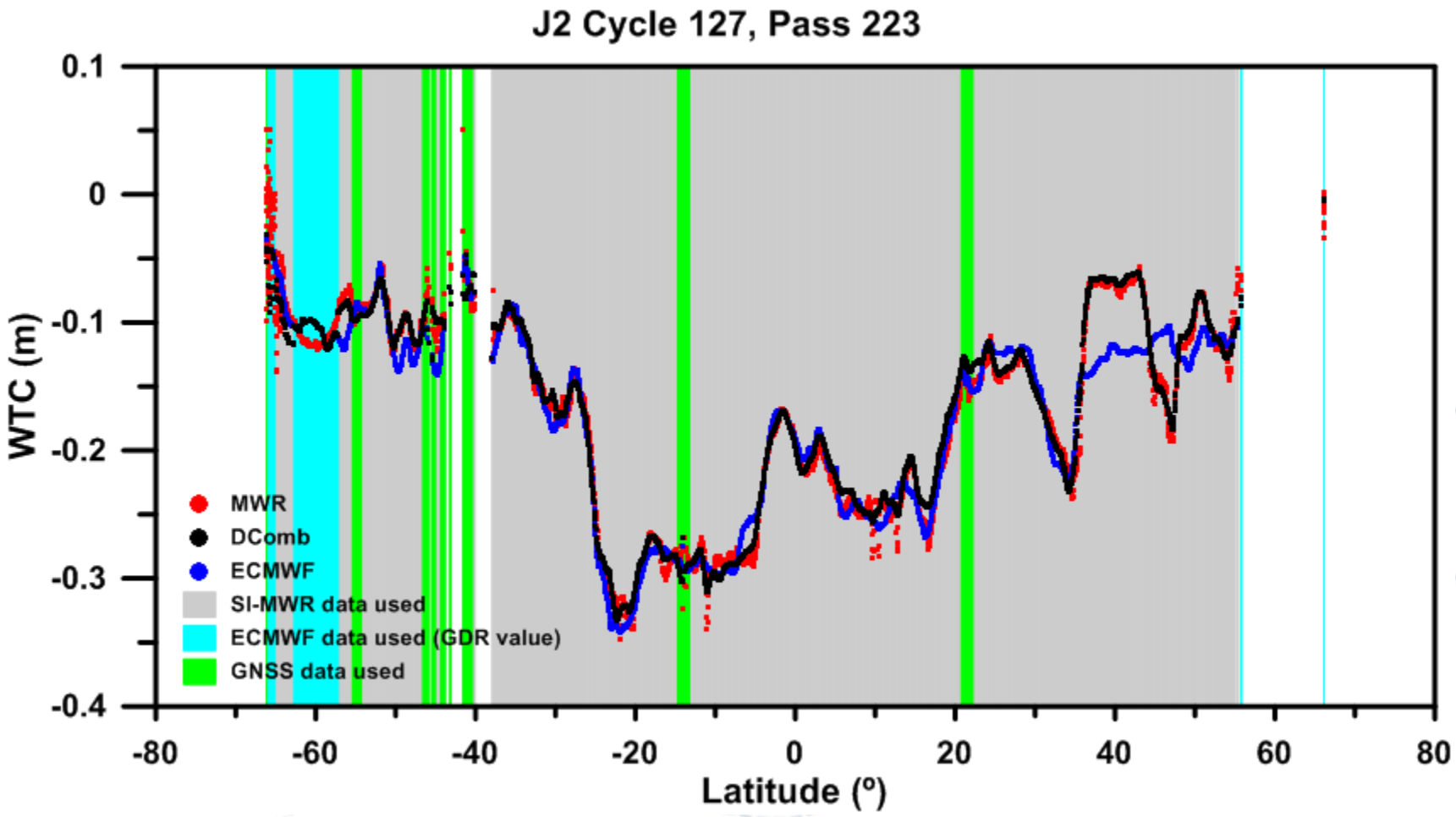
Spatial correlation scales (in km) for the WTC as determined from a set of ECMWF Op grids at 0.125˚ well distributed over the year 2013.

Computation of the WTC for J2

⇨ Correction was computed for J2:

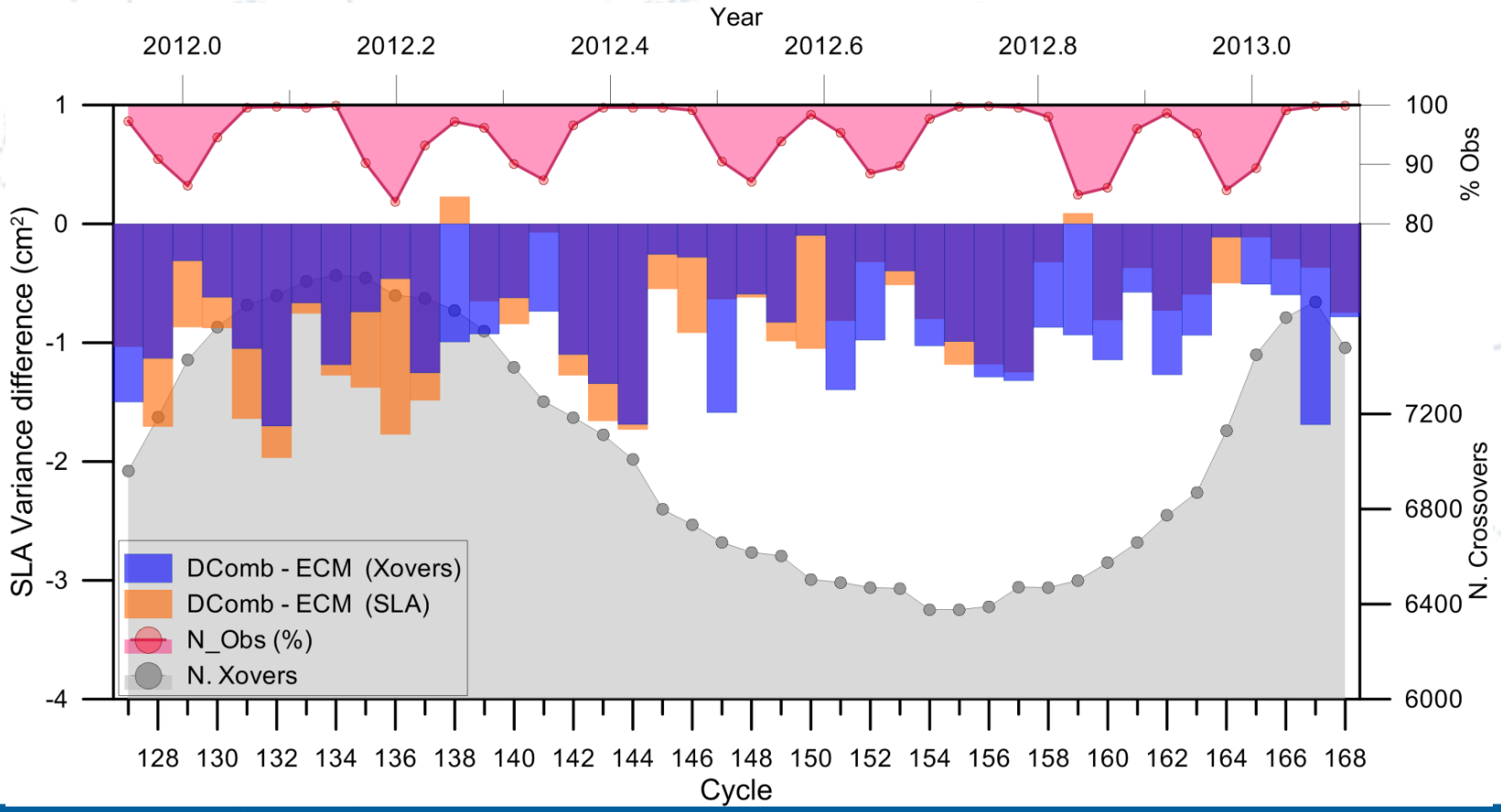
- ❑ Sub-cycles 127-168
- ❑ January 2012 – January 2013

Example of the Dcomb WTC for J2



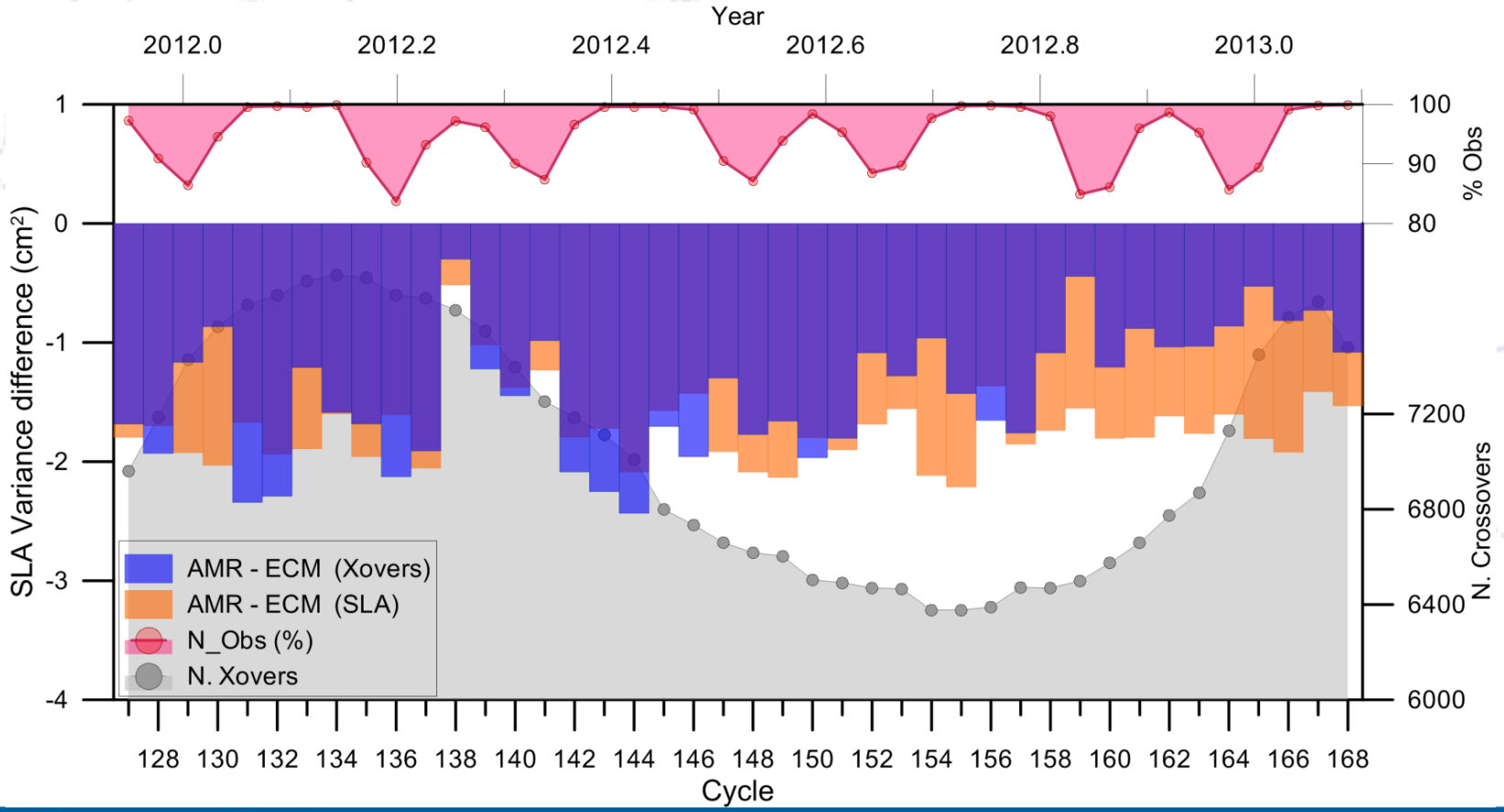
SLA and Xovers variance difference: DComb-ECMWF

Along-track SLA variance difference (**blue**) and SLA variance difference at crossovers (**orange**) (cm^2), for each J2 cycle, between **DComb** and **ECMWF Operational model.**



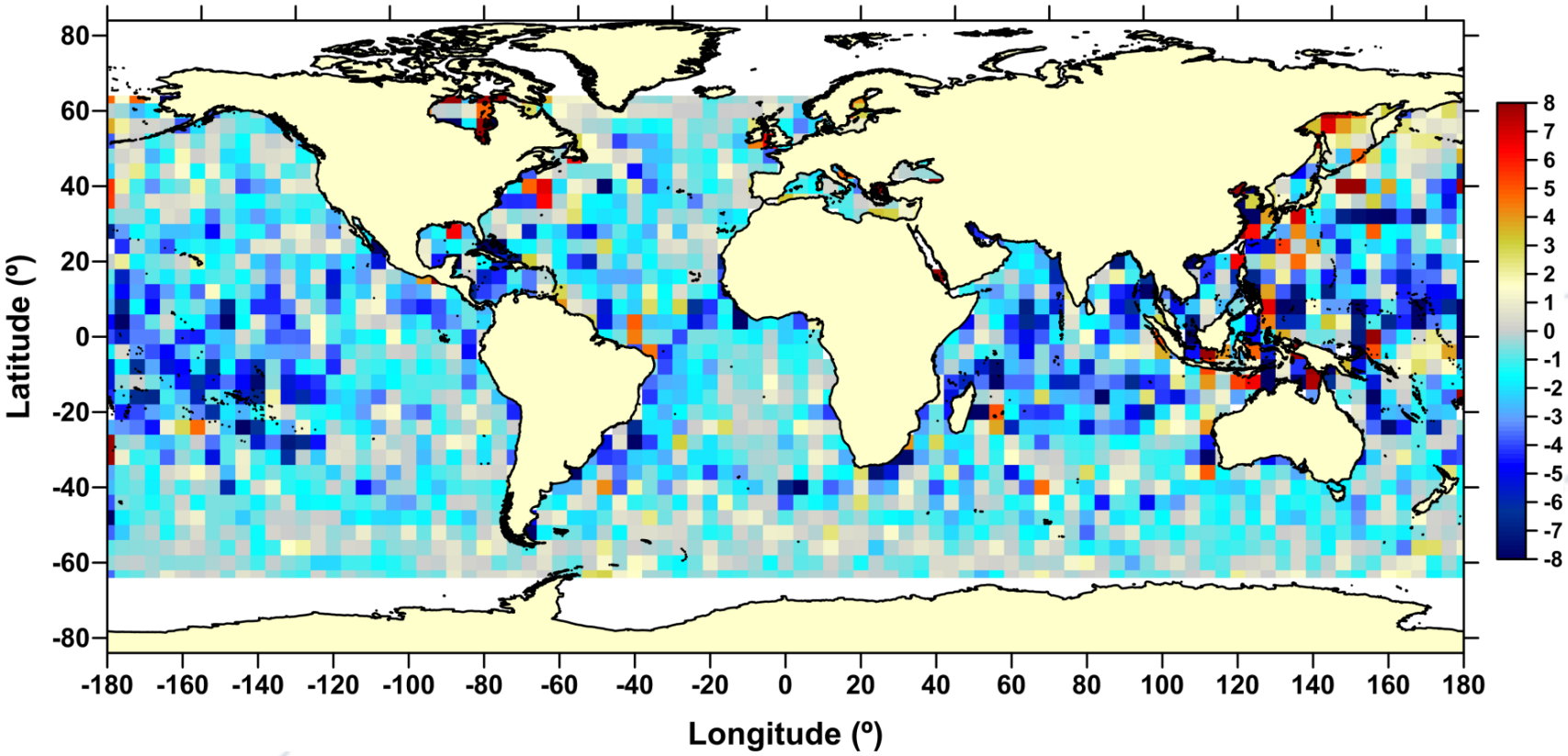
SLA and Xovers variance difference: AMR-ECMWF

Along-track SLA variance difference (**blue**) and SLA variance difference at crossovers (**orange**) (cm^2), for each J2 cycle, between **AMR** and **ECMWF Operational model.**



Variance difference at Xovers: DComb-ECMWF

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



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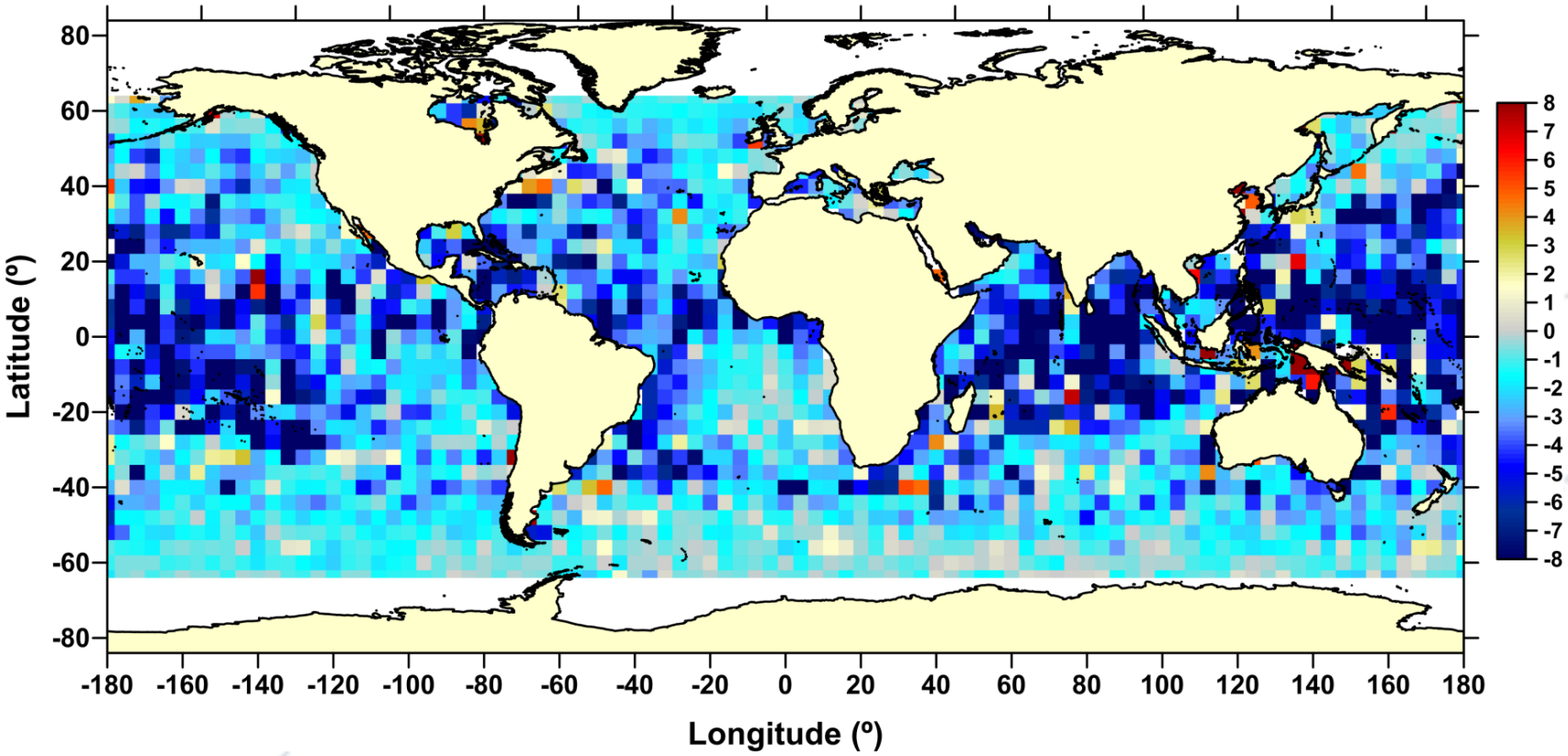
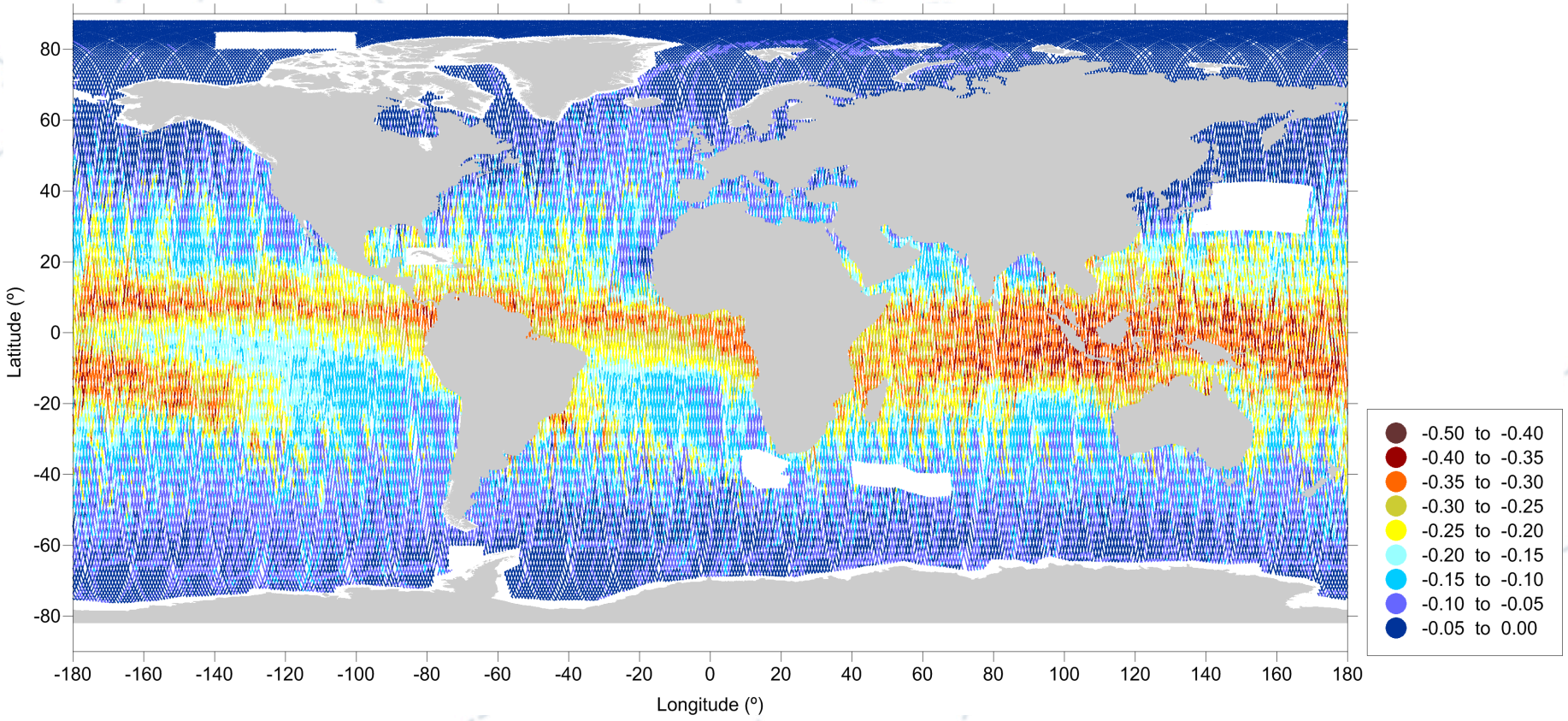


Computation of the WTC for CS-2

⇨ Correction was computed for CS-2:

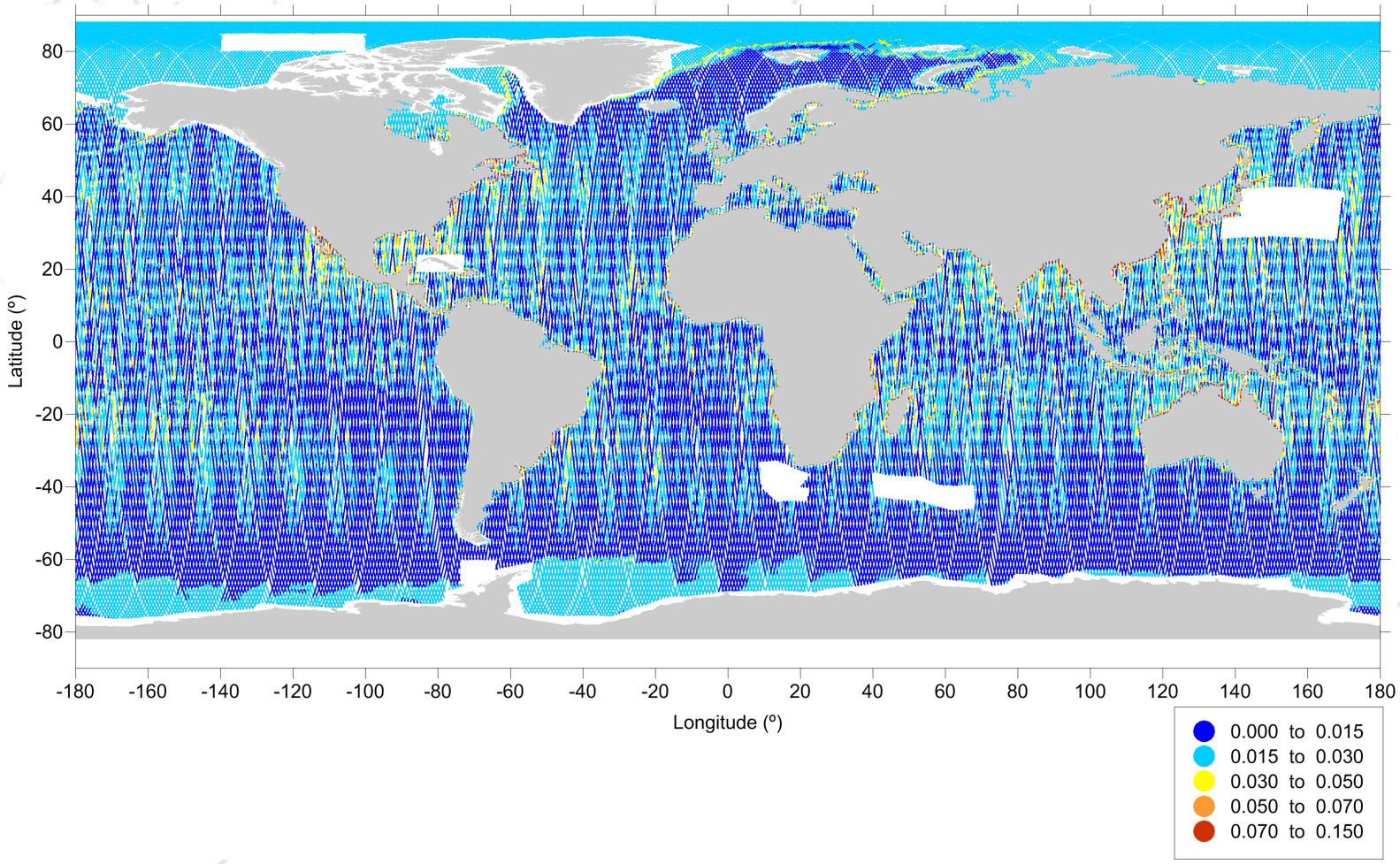
- ❑ Sub-cycles 05-48
- ❑ July 2010 – December 2013

DComb WTC for CS-2 sub-cycle 35

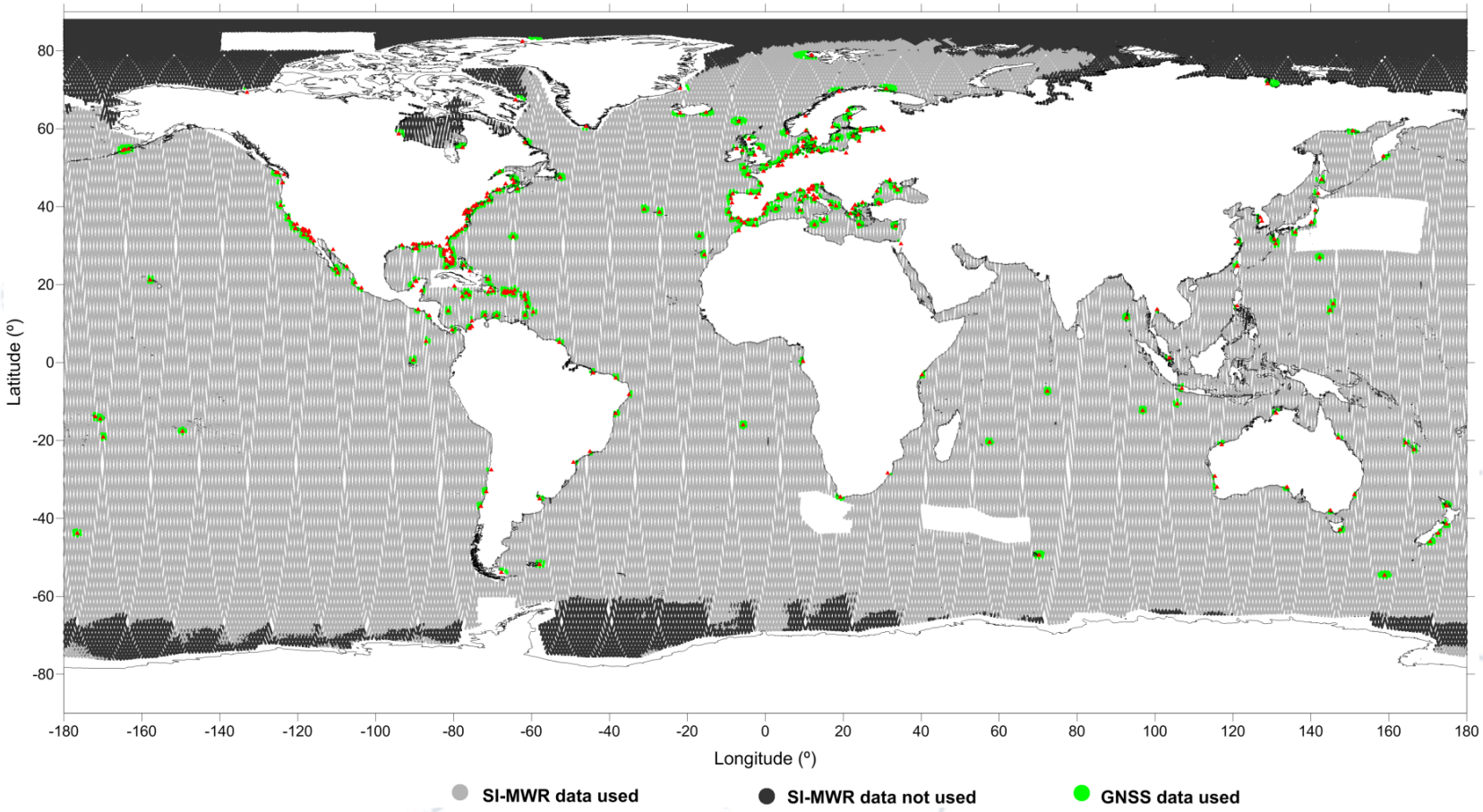


DComb WTC for CS-2 sub-cycle 35 (m)

DComb WTC error for CS-2 sub-cycle 35

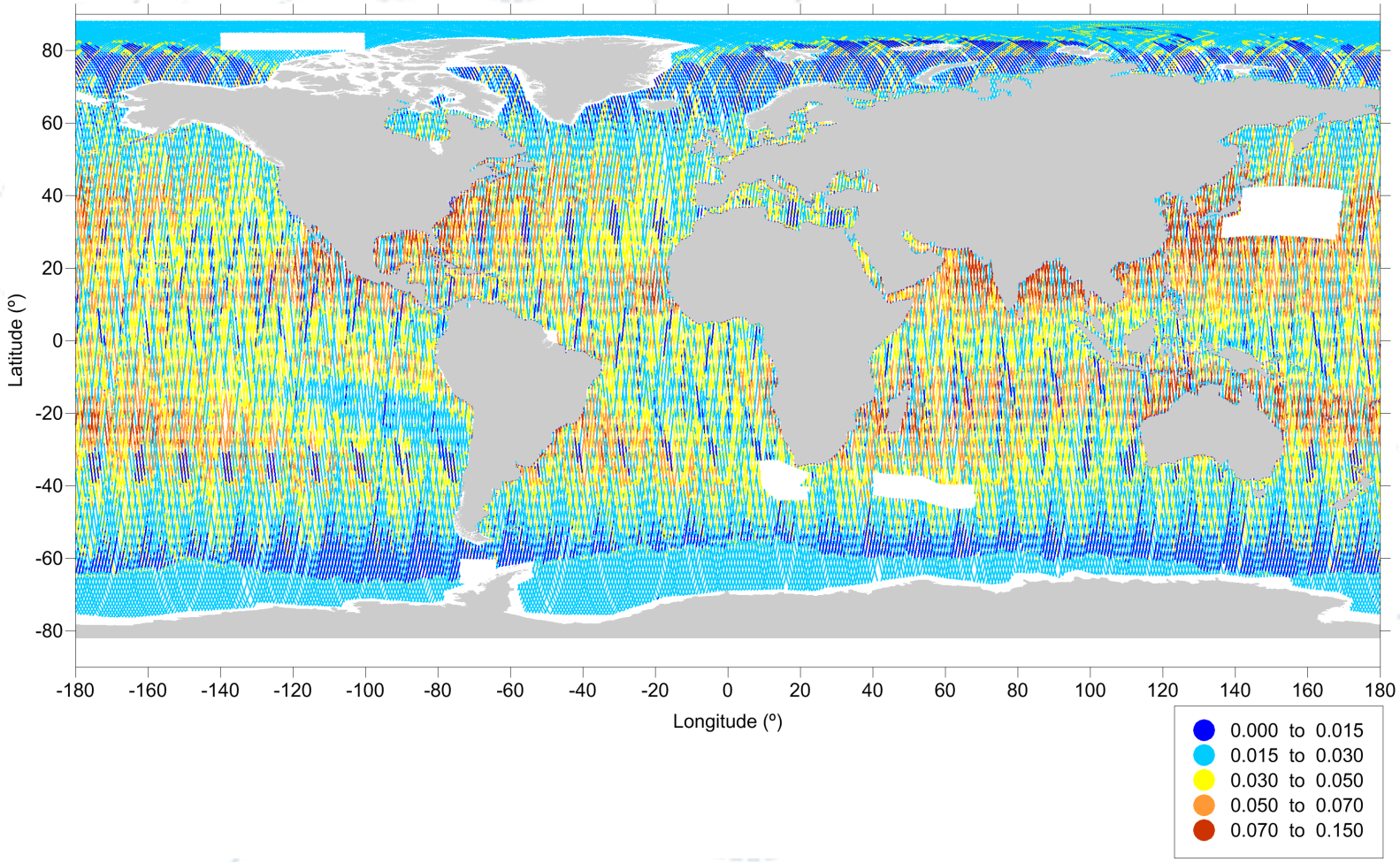


Spatial data coverage for CS-2 sub-cycle 35

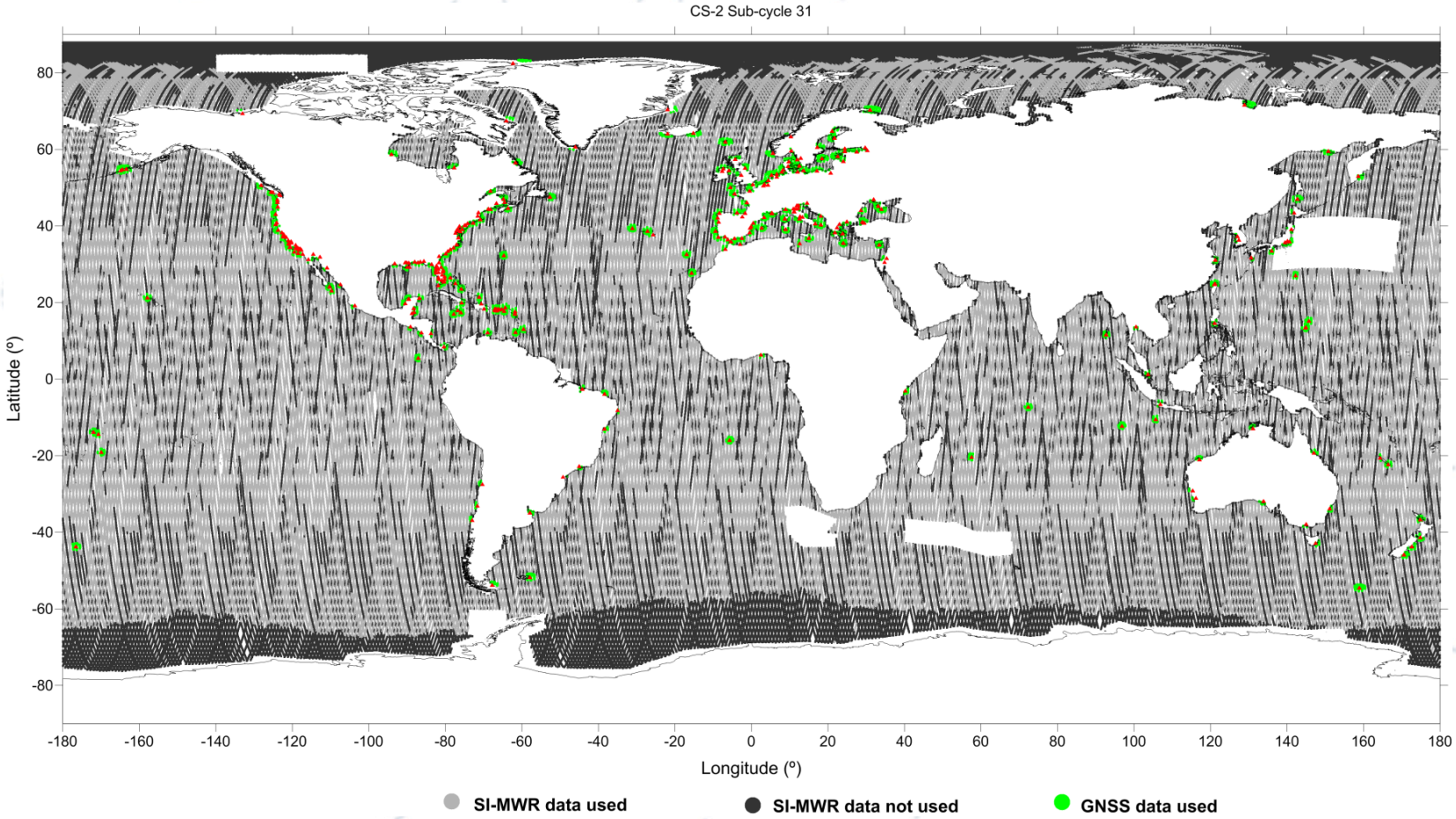


Spatial coverage of the various datasets for CS-2 sub-cycle 35. Red triangles represent the location of the GNSS stations.

DComb WTC error for CS-2 sub-cycle 31



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.

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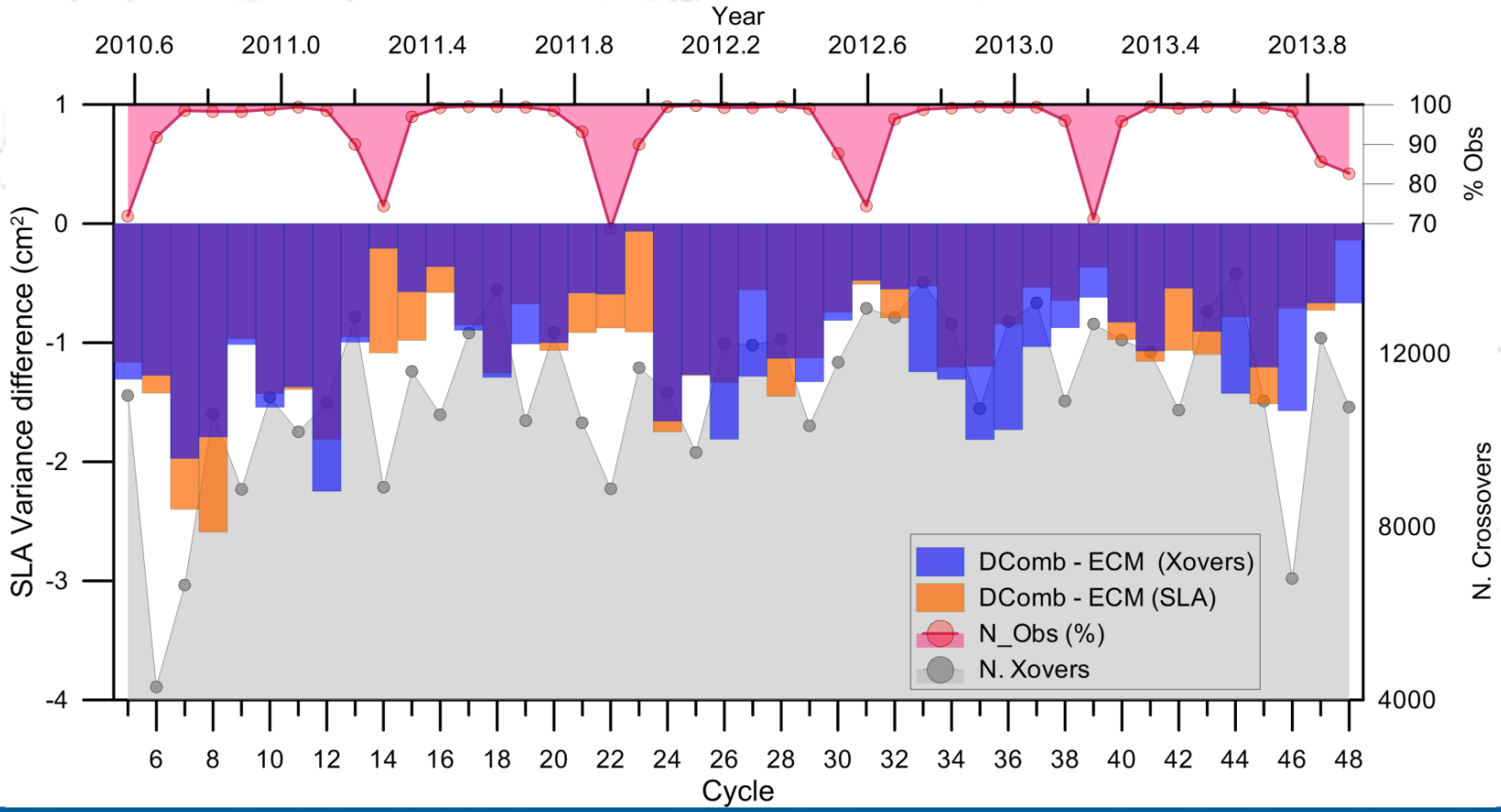
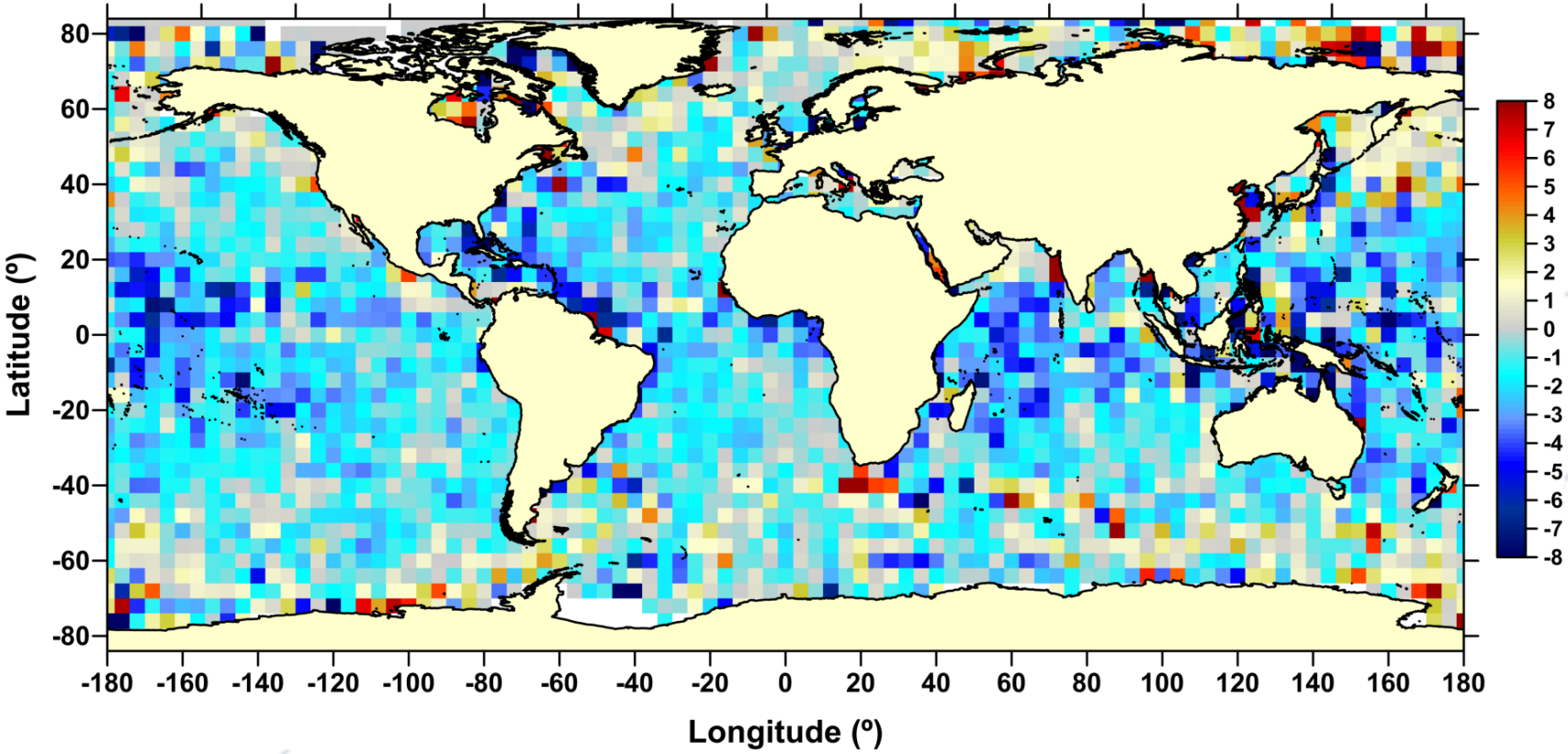


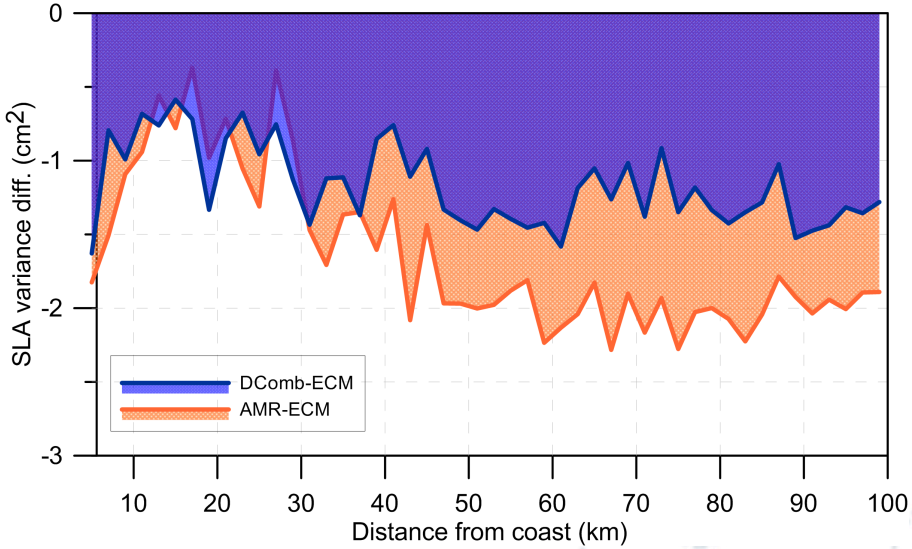
Variance difference at Xovers: DComb-ECMWF

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

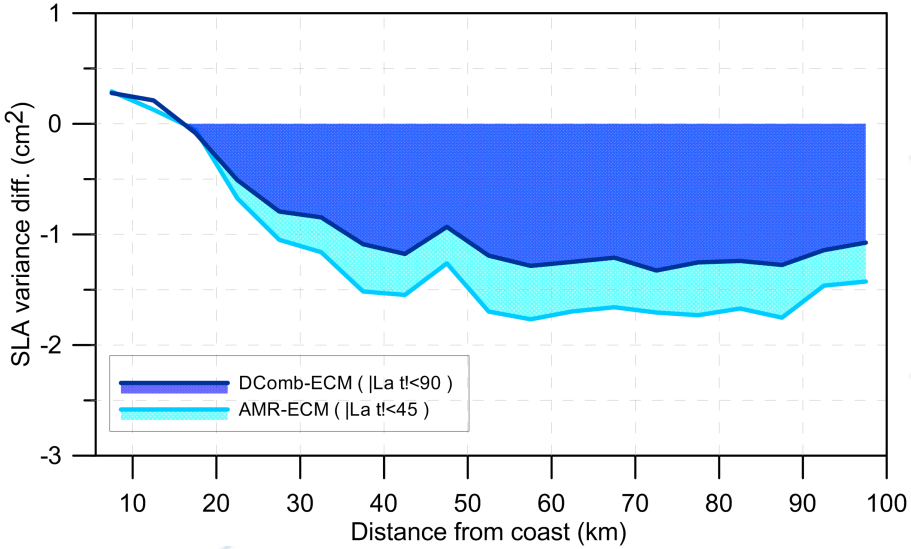


SLA Variance difference function of distance from coast

⇨ J2 SLA variance difference (DComb-ECMWF and AMR-ECMWF)



⇨ CS-2 SLA variance difference (DComb-ECMWF)



Summary

- Correction is continuous and applicable to any mission
- Reduces the variance wrt ECMWF Operational model from 1-4 cm^2
- Accuracy depends on data coverage
- In the coastal regions Dcomb improves the model up 30 km
- Next (CCI-SL project): improve the correction in the coastal and polar regions