

CHARACTERIZING THE COASTAL CIRCULATION IN THE NW MEDITERRANEAN SEA USING DEDICATED HIGH RESOLUTION COASTAL ALTIMETRY



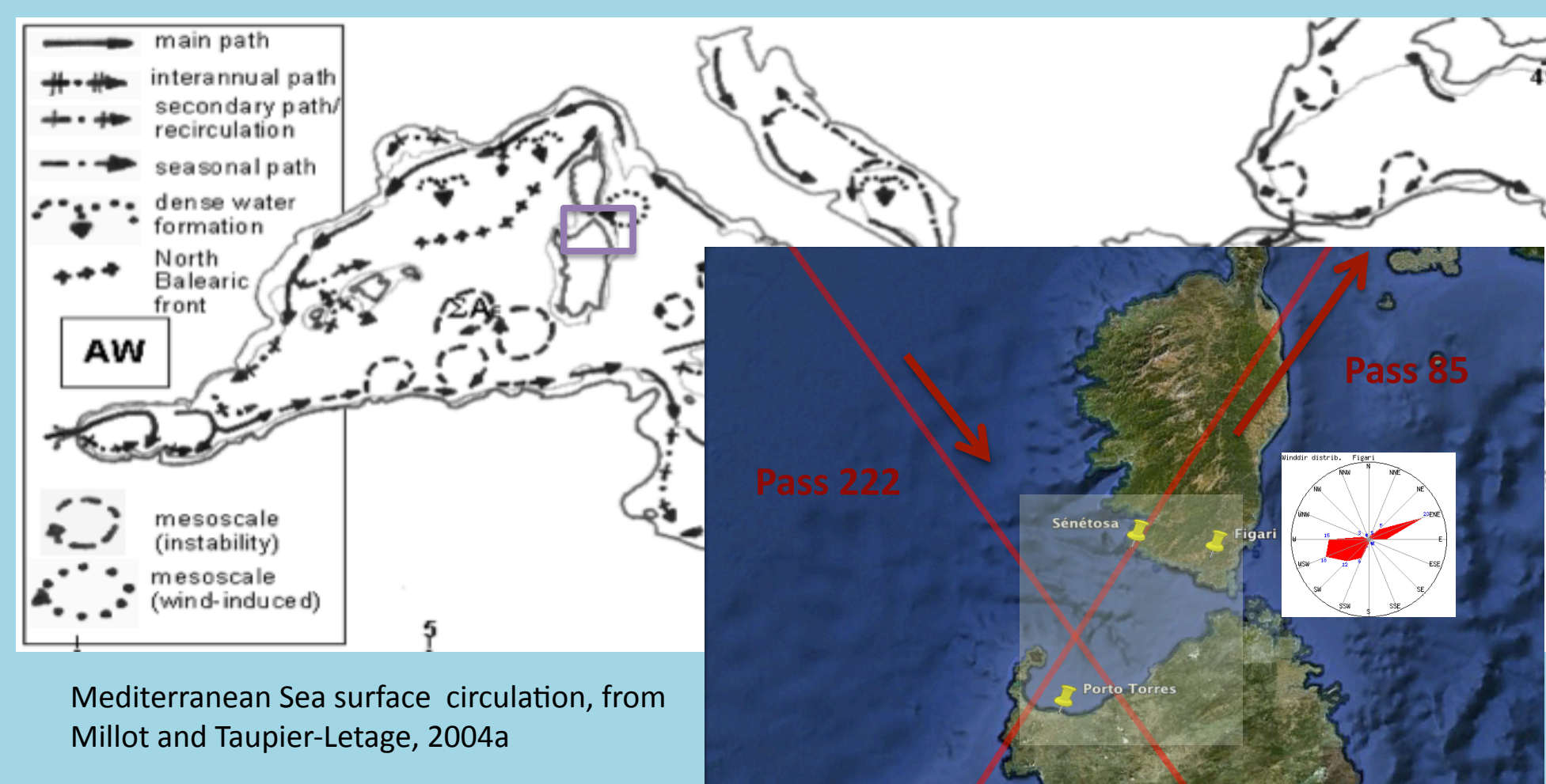
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Abstract

Monitoring currents in marginal seas and flows through sea straits is of importance, not only for shipping safety and military uses, but also for the basic scientific purpose of understanding how the circulation depends on the various physical drivers. From an observational standpoint, continuous in situ measurements have been sparse in the whole NW Mediterranean Sea, so the coastal circulation is not routinely monitored. Satellite altimetry can be a unique system to provide long-term observations of the surface dynamics of this area. Unfortunately, standard maps of Sea Level Anomaly (SLA) derived from multiple satellite radar altimeters measurements are not well adapted to measure the fine-scale and rapid coastal processes, whereas standard along track SLA data suffer various biases and noise when approaching the coast. To overcome those difficulties, optimized and coastally-tuned altimeter SLA estimates are needed. The MARINA OSTST research program is intended to pursue two central objectives: 1) to enhance the satellite altimetry coverage and quality in the marginal ocean by using a multi-satellite approach; 2) to exploit the improved coastal altimetry in combination with regional hydrodynamic modelling of shelves and coastal circulation, focussing on several areas in the NW Mediterranean Sea.

In this study, we assess the potential of high resolution altimetry-derived surface geostrophic velocity anomalies (SGCA) time series to observe the surface flow features at the entrance of the Strait of Bonifacio.

The Strait of Bonifacio lies between the islands of Corsica and Sardinia and is only a 14km-wide for a 21km-long. This shallow strait connects the Ligurian-Provençal Sea, west of the strait, and the Tyrrhenian Sea, east of the strait, and is a frequently used shipping corridor, and also hosts marine national parks. Understanding the flow conditions here is critical for maritime safety and marine resource management. In the Mediterranean Sea, the first baroclinic radius of deformation is typically about 10-15km so the Strait of Bonifacio is narrow enough to impose restrictions for surface flows. The Strait of Bonifacio plays a negligible role for water mass exchange and in the large scale motions circulation, as most of the volume transport passes through the Corsica Channel, in the north of the Ligurian Sea. However, it is dominated by strong westerly winds and the presence of Corsica and Sardinia mountains induces enhanced atmospheric turbulence in the shadow of the islands, inducing oceanic turbulence.



Data processing

High-resolution coastal altimetry:

- combined along-track dataset from TOPEX/Poseidon + Jason-1 high rate measurements
- CTOH M-GDR processed with the X-TRACK processor
- local tidal correction and dynamical atmospheric correction from a barotropic regional model (T-UGOm 2D)
- local high resolution along-track mean sea surface
- > SLA time series every 600m

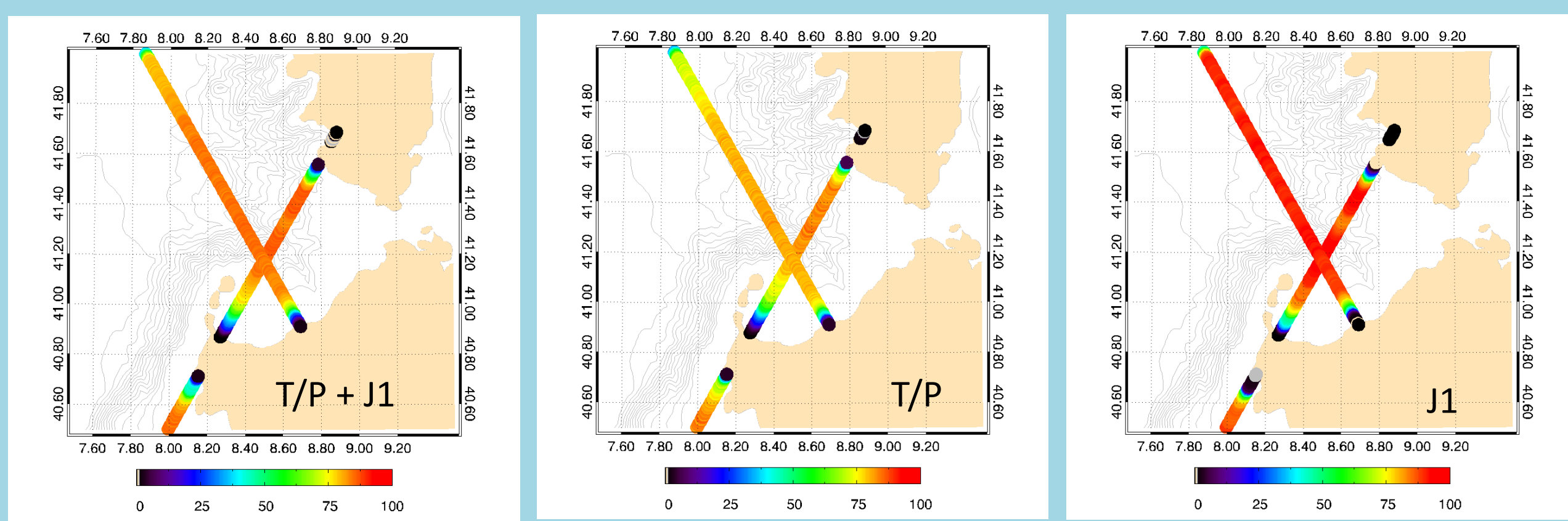
Sea surface temperature:

- AVHRR weekly composite images from DLR EOWEB since 1998

Tide gauges:

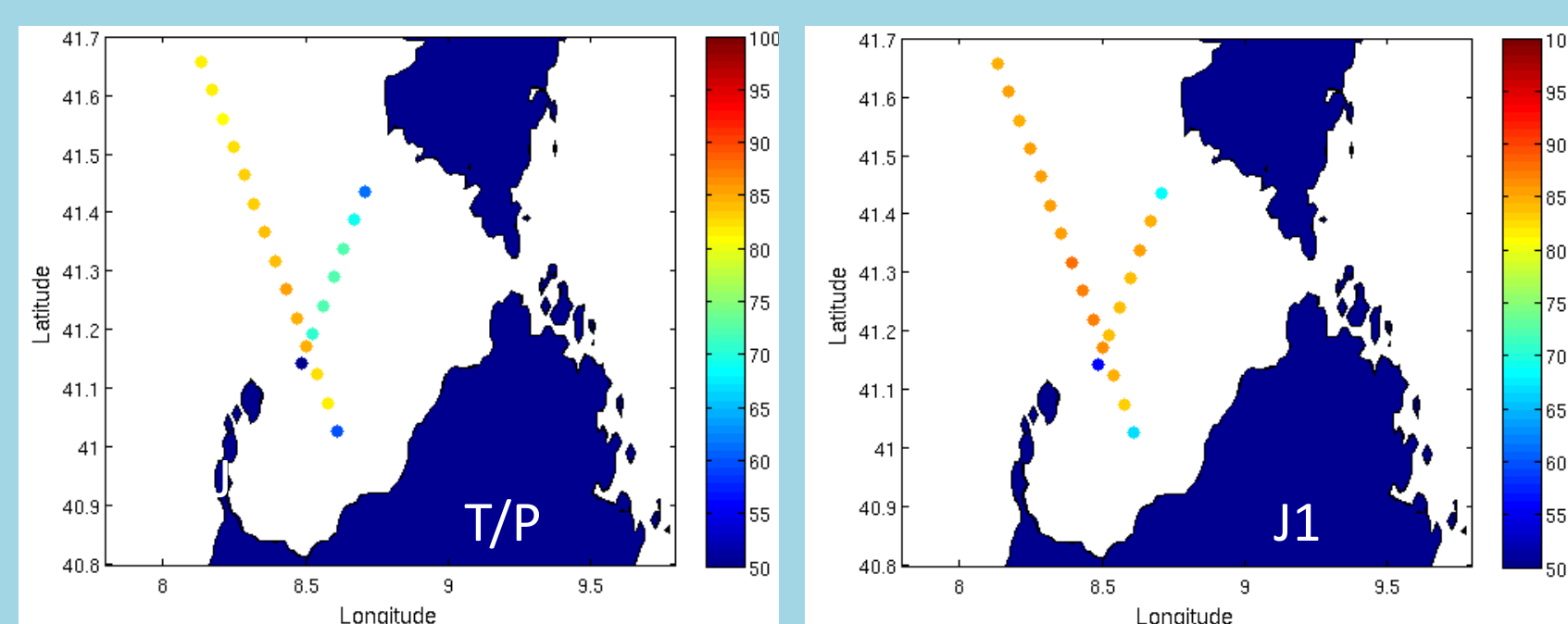
- S n tosa (France) since 12/05/1998, courtesy of CNES/NOVELTIS/GEMINI
- Porto Torres (Italy) since 01/01/2000, operated by APAT and made available by ESA
- High frequency tides are removed by harmonic analysis and low frequency tides are removed using FES2004 atlas
- dynamic atmospheric effects are corrected using the same regional model as altimetry

High resolution SLA data availability



Percentage of valid SLA estimates for the combined SLA CTOH product (left), and when separating TOPEX/Poseidon (centre) and Jason-1 (right).

- ✓ More than 80% overall availability for the CTOH high resolution combined demo product T/P + J1
- ✓ Lower but homogeneous availability for T/P
- ✓ Quasi-full availability for J1
- ✓ Availability very close to both coasts



Percentage of valid SLA estimates for the AVISO regional MERSEA DT-SLA-EXT dataset (1Hz) for TOPEX/Poseidon product (left) and Jason-1 product (right).

Consistency with tide gauges:

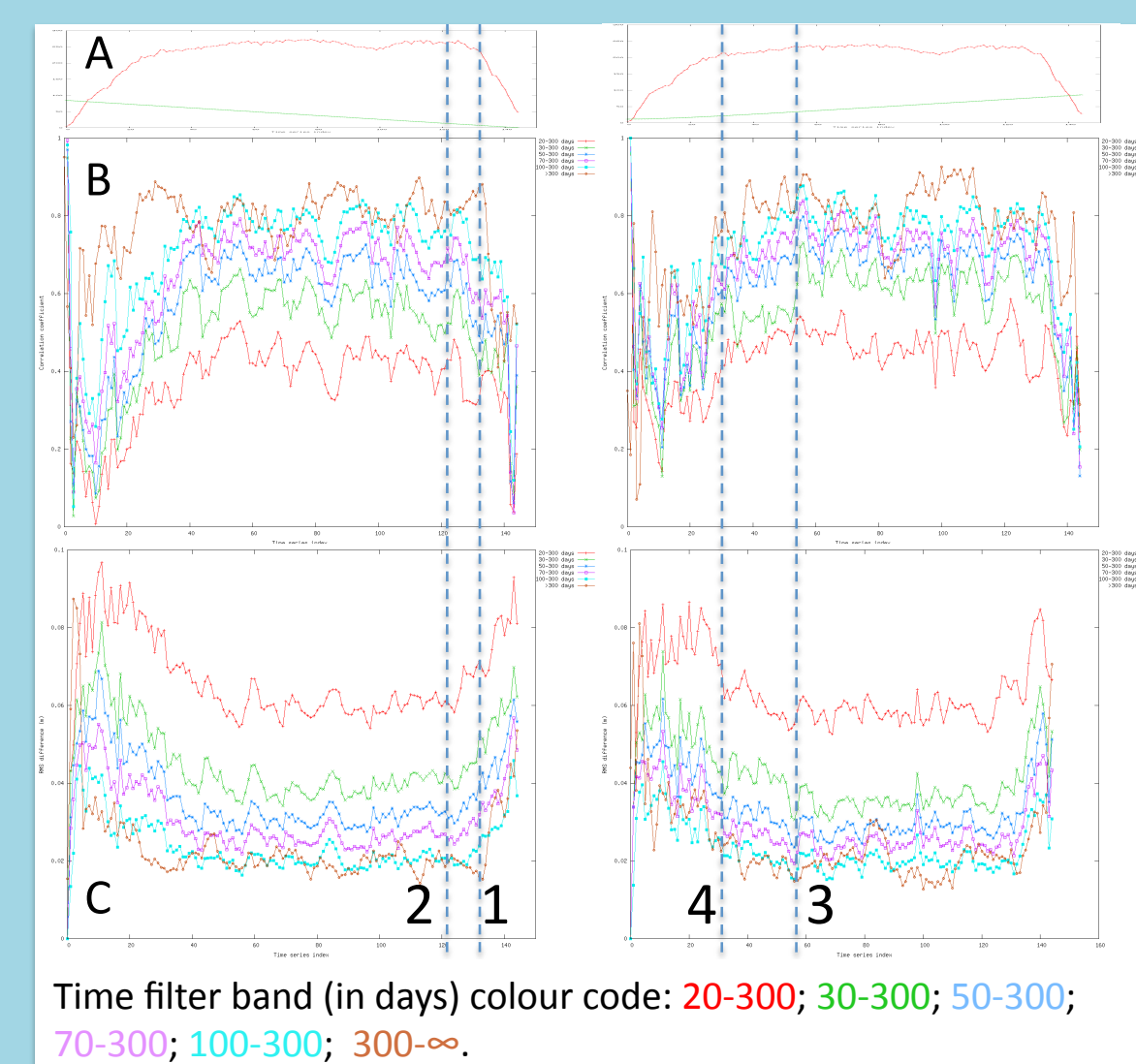
which space/time scales... and which quality?

Hourly tide gauges measurements are interpolated at the satellite measuring times over their common recording period.

Several statistical comparisons to tide gauges measurements are computed for each altimeter time series, i.e every 600m along pass 85. Several time cut-offs are tested to study the impact of Nyquist period (raw data), residual aliasing of tides and meteo effects on the data quality.

To get rid of the large energy amplitude due to the steric signal surface signature, SLA time series are also 300-days high-pass-filtered.

Effects of sub-sampling on estimations have been also checked.

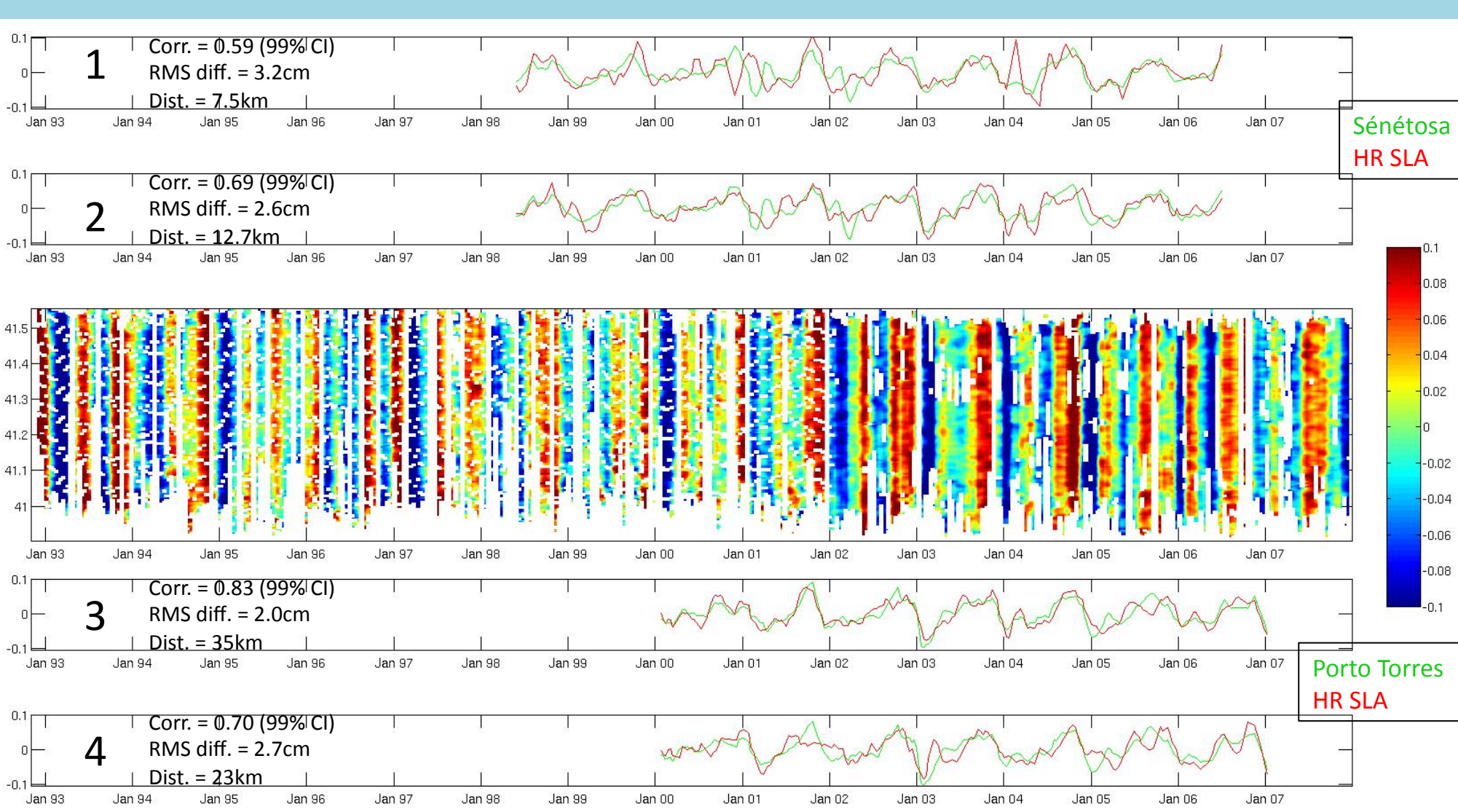


Time filter band (in days) colour code: 20-300; 30-300; 50-300; 70-300; 100-300; 300-∞.

- ✓ Due to a low signal/noise ratio, high rate SLA must be time-filtered to study local dynamics
- ✓ 70 day cut-off is a good trade-off between correlation and rms difference
- ✓ Evidence of statistically-consistent, higher variability close to both coast

SLA variability

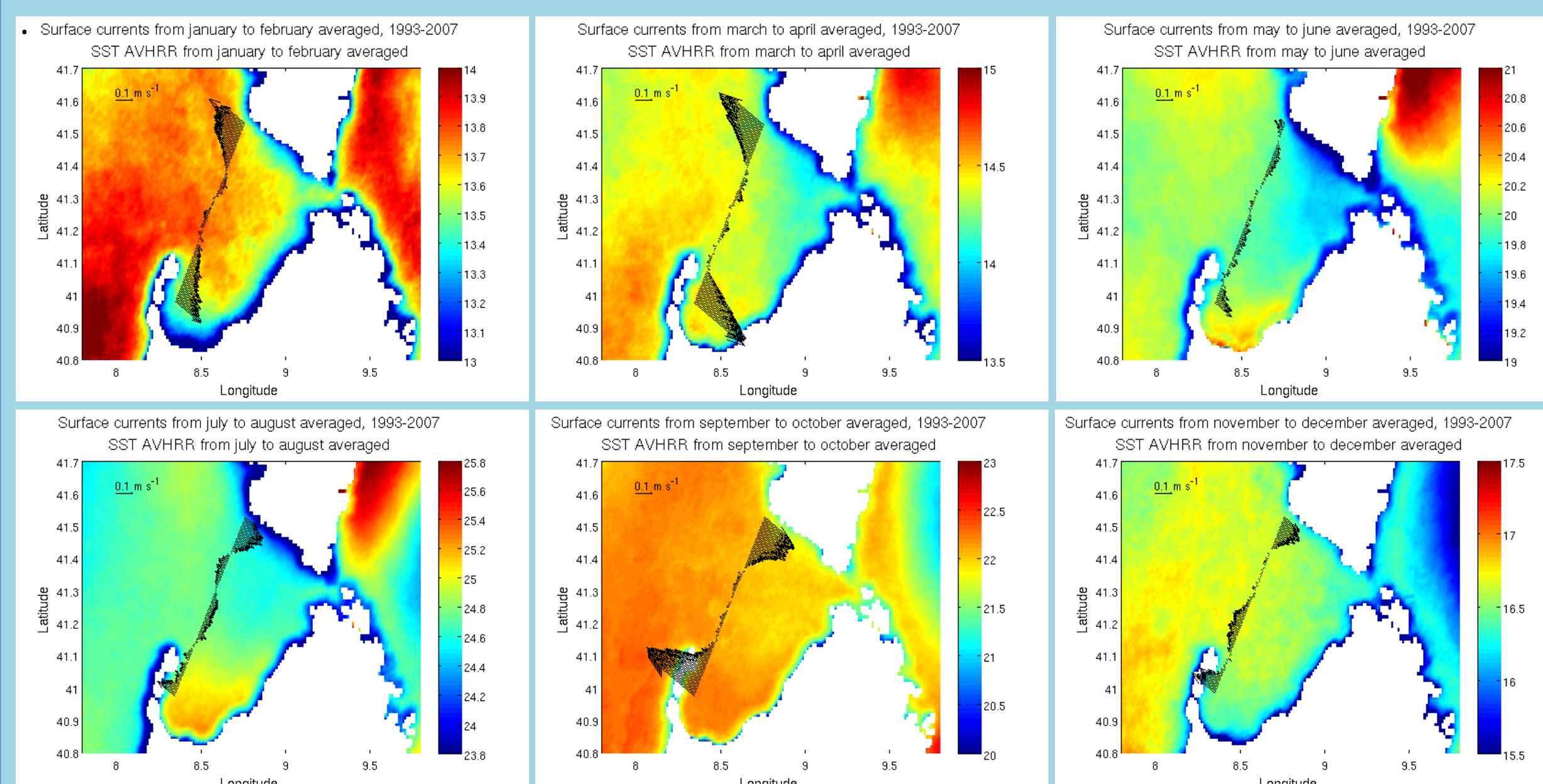
4 altimeter time series are compared to tide gauges in the [70-300 days] band. Points 1 and 4 are the closest statistically-reliable time series; points 2 and 3 are located outside coastal variability area.



- ✓ Statistical agreement for infra-seasonal time scales
- ✓ Agreement closer at Northern End; phase shifts between altimeter and tide gauge during winter 2001 and 2002 (to be investigated)
- ✓ Agreement offshore at Southern End; phase shifts between altimeter and tide gauge during winter 2003 and 2005 (to be investigated)

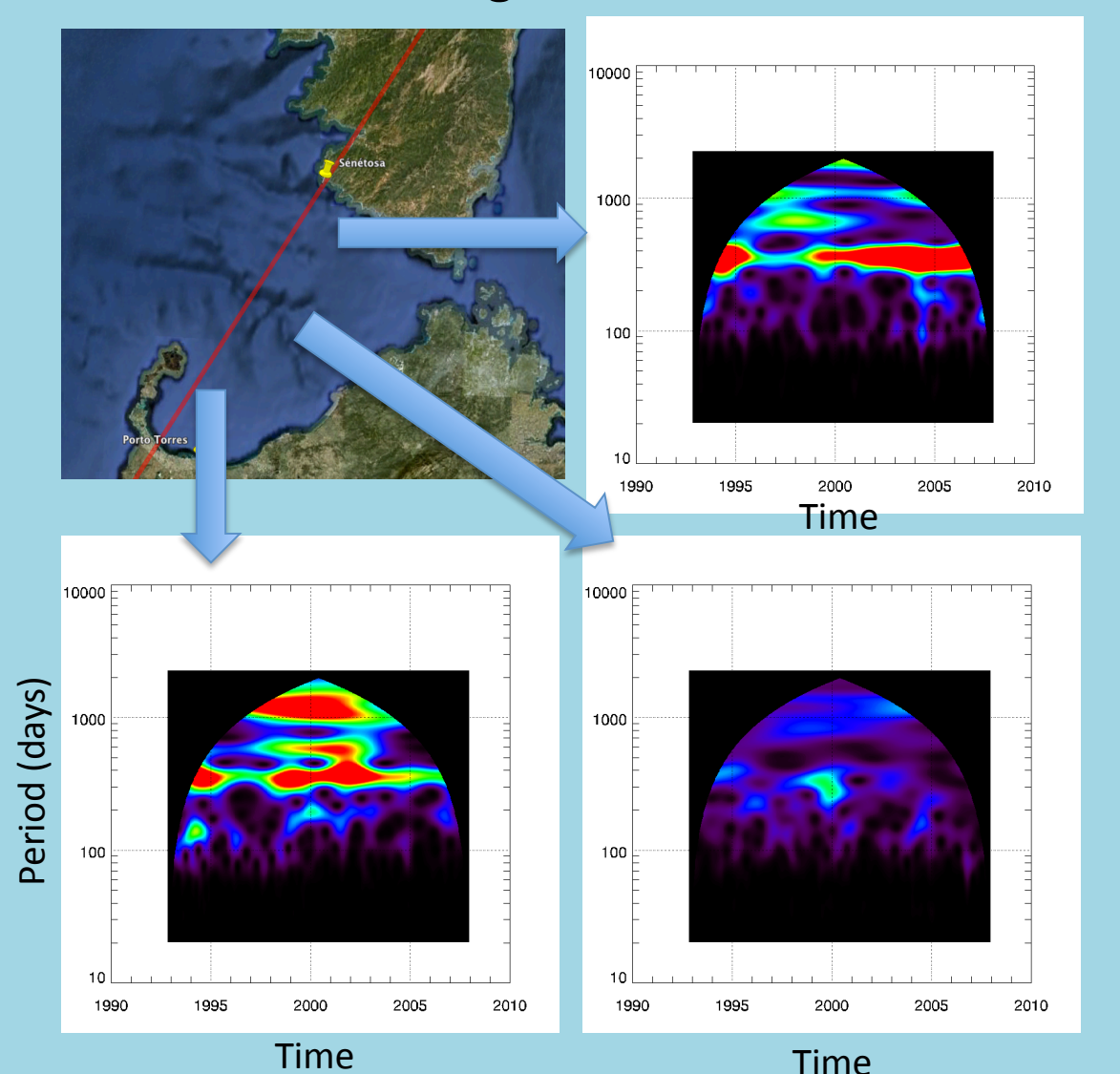
Surface geostrophic current anomalies (SGCA) variability

Along-track SLA slope is smoothed with a Powell & Leben filter (JAOT, 2004) with a cut-off of 20km; resulting SGCA are 70days filtered. 2-month climatologies are compared with SST equivalent climatologies computed over 1998-2007.



- ✓ Qualitative agreement of current velocity anomalies wrt SST
- ✓ Marked coastal variability during spring and fall with transient regime in summer and winter
- ✓ Interannual variability in the coastal band
- ✓ Seasonal signal enhanced at Northern end after 1998, stronger between 1997-2004

Periodograms of SGCA time series have been computed over 0.1° boxes along pass 085 using Morlet wavelet transform of degree 6.



Acknowledgements

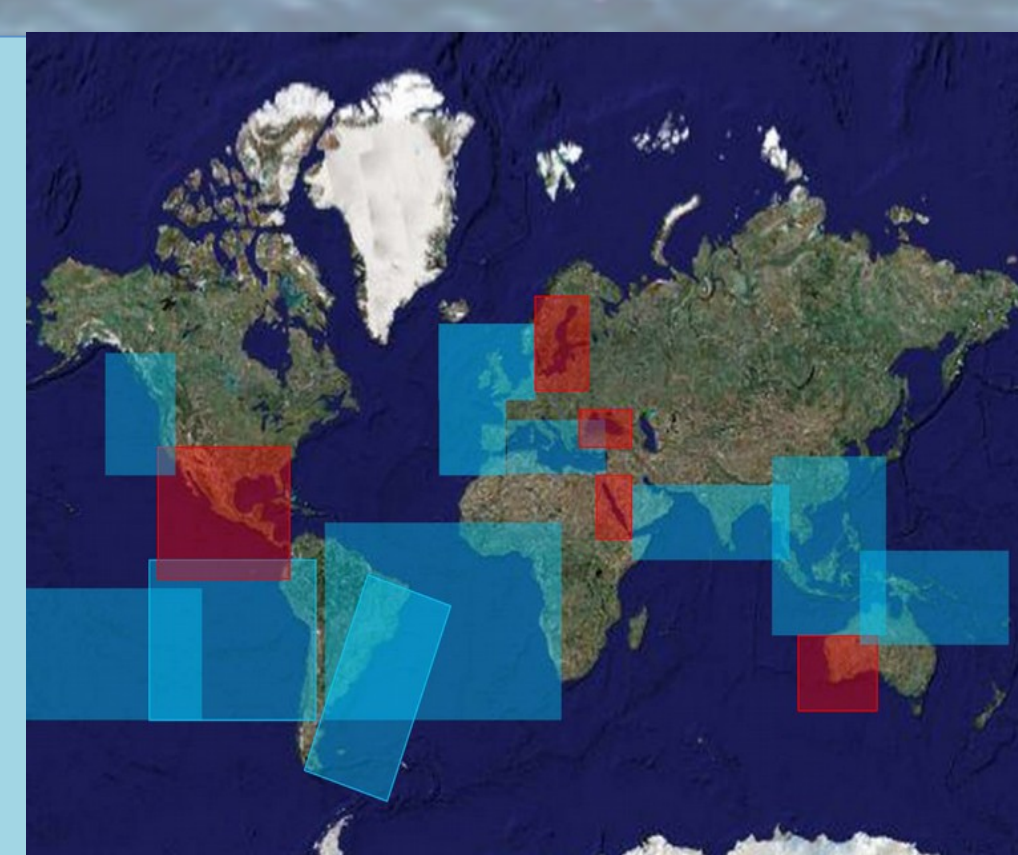
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Data request

LEGOS/CTOH group is currently distributing 1Hz SLA for many coastal regions.

Visit our website: <http://ctoh.legos.obs-mip.fr/> or send us an email to: ctoh_products@legos.obs-mip.fr

New products coming soon (see talk by Birol et al)



Conclusions

- ✓ Monitoring the local dynamics on the western shelf of the Strait of Bonifacio is possible with improved, high resolution altimetry (CTOH/LEGOS SLA and SGCA demo products based on X-TRACK processor and 10Hz/20Hz data)
- ✓ Local high resolution SLA dataset agrees well with tide gauges records, from infra-seasonal to interannual time scales
- ✓ Altimetry-derived surface geostrophic current anomalies exhibit marked seasonal variability along the coasts, with interannual variability
- ✓ Qualitative agreement with AVHRR SST climatologies
- ✓ Ongoing investigations of the drivers of seasonal and interannual variability