What is the benefit of high-resolution sea level anomaly datasets?
A case study in the Bay of Biscay and New Caledonia regions based on Jason2-3, Saral/AltiKA and Sentinel3.

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Motivation

In the prospect of the SWOT mission, this study focuses on high resolution (HR) datasets from the recent satellite missions including Jason-2/3, SARAL/AltiKa, and Sentinel-3. In this poster we review different methods and options in the data processing to get HR-SLA. The ability of the different datasets and processing to provide information on the dynamics is illustrated in two contrasted regions: the Bay of Biscay and the subtropical region south of New Caledonia.

HR Data set

The different characteristics of the altimetric mission are recalled on the table. The primary HR dataset comes from the L2 GDR but environmental and geophysical corrections are only available at 1 Hz so HR SSH have been computed by interpolating at 20/40 Hz the L2P 1Hz correction. The CNES-CLS-2015 MSS is subtracted to get HR SLA. A threshold editing procedure is applied based on the standard validation flag parameter provided in the L2P Aviso HandBook (SLA-HR). At HR, some outliers still exist and a supplementary post processing based on a nonlinear iterative editing filter (Dibarboure et al., 2014) is applied (SLA-HR-EDIT) (Fig. 1).

Mission	Jason-2 (J2)	SARAL/AltiKa (SRL)	Sentinel-3A (S3A)
Radar characteristics	LRM / ku band	LRM / ka band	SAR
High Resolution (HR)	20 Hz	40 Hz	20 Hz
Along-track Sampling	~ 294 m	~ 175 m	~ 330 m
Repetitiveness	10 days	35 days	27 days
Period	2008 - 2016	2013 – 2016	2016 - 2021
Number of cycles	303	35	76

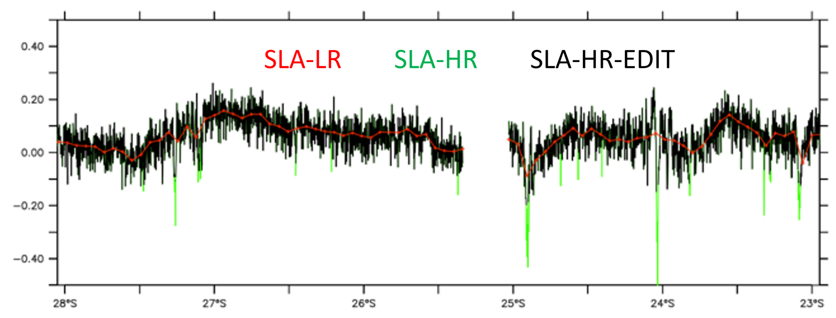


Fig. 1: Example of SLA editing based on S3A. SLA-LR: 1Hz resolution, SLA-HR/SLAHR-EDIT: 20Hz resolution

New Caledonia (South-West Pacific)

South of New Caledonia is a place of transiting mesoscale eddies, instabilities of the South Tropical CounterCurrent (STCC)/ South Caledonia Jet (NCJ) and complex bathymetric features. All these elements are at the origin of huge meso/submesoscale activity and strong baroclinic tides (Fig. 2). Its SWOT swath overlay during the Phase Sampling Phase makes it a key region for understanding the observability of the SWOT SSH. Here, we first focus on the SSH HR data of the nadir altimetric missions.

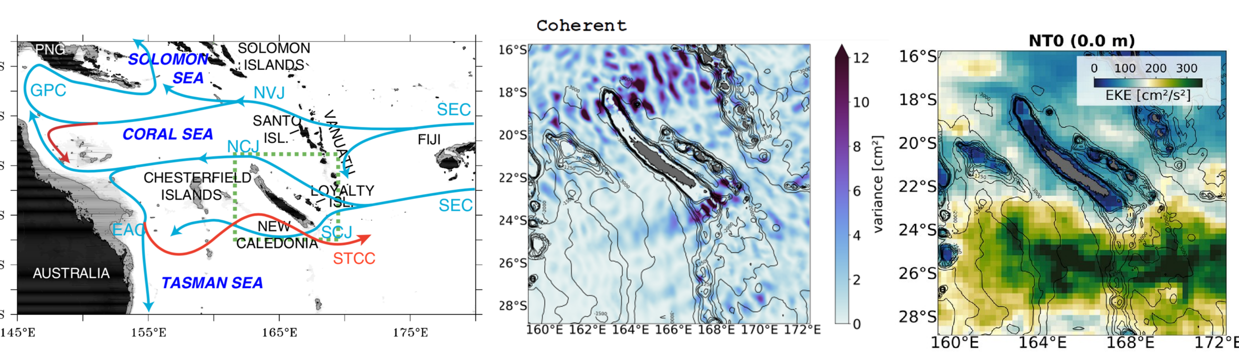
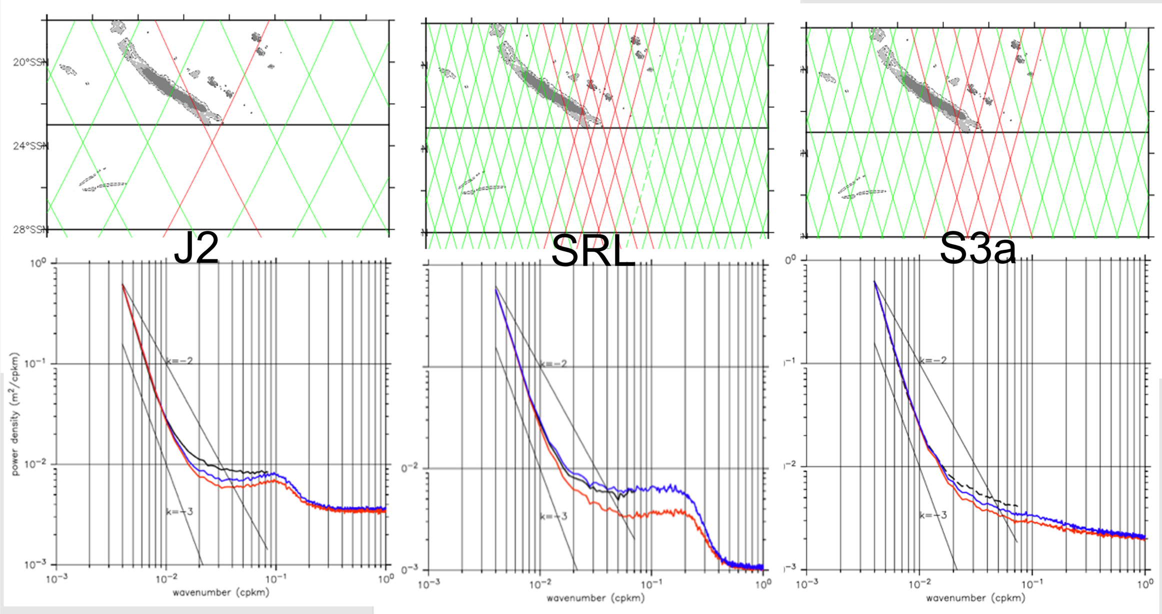


Fig. 2: a) a schematic description of the South tropical Pacific circulation with a zoom on New Caledoniato highlight b) M2 coherent baroclinic tides and c) meso/submesoscale Eddy Kinetic Energy level (courtesy of A. Bendinger)

A. SLA-LR, SLA-HR/SLA-HR-EDIT Spectra



The tracks are limited to 500 km segments between 23°-28°S covering longitudes 160°E-175°E (Fig. 3). The red tracks focus on the area of interest for SWOT.

The corresponding spectra (Fig. 3) show:

1. SLA-HR better accuracy of the mesoscale range up to 70 km compared to SLA-LR
2. SLA-HR-EDIT particularly efficient for SRL

Fig. 3: J2 (a), SRL (b) and S3a (c) tracks used for spectra calculation. The corresponding spectra (d,e,f) function of the different SLA datat set

B. Comparison J2/S3a/al SLA-HR-EDIT spectra

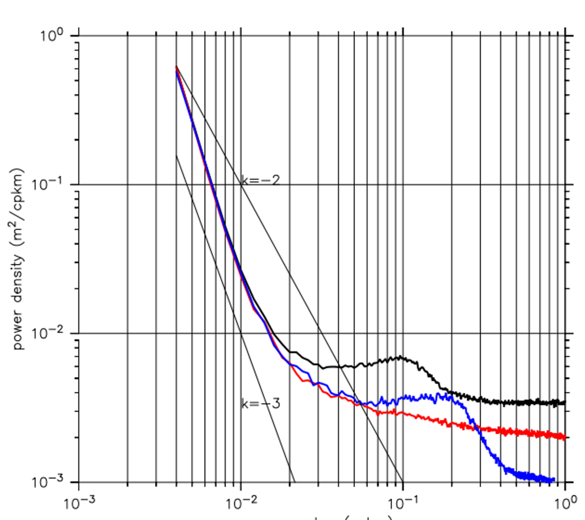


*Fig. 4: SLA-HR-EDIT spectra for **J2**, SRL and S3a datasets*

The comparison of spectra for the different missions (Fig. 4) show:

1. SRL and S3a better than J2 for wavelengths up to 80 km
2. SRL and S3a similar shape for wavelengths down to 15 km

Compared to LR, HR have improved mesoscale resolution (see table)

	J2	SRL	S3a
	HR/LR	HR/LR	HR/LR
Slope (70-250 km)	-3.6/-3.6	-3.4/-3.4	-3.5/-3.7
Mesoscale resolution (km)	55/71	40/66	56/82

C. Regional and temporal sensibility

The motivation here is to illustrate the sensitivity of such spectra to seasonal variability and to local dynamics by comparing spectra for the red tracks in Fig.1 and for the full domain (Fig.5).

The region just South of New Caledonia, full of internal tides and meso/submesoscle features are more energetic in the 45-125 km wavelength range compared to the full region (Fig 5a).
This is particularly true during the winter austral season (Fig.5b) when submesoscale activity is particularly active (Fig.5c)

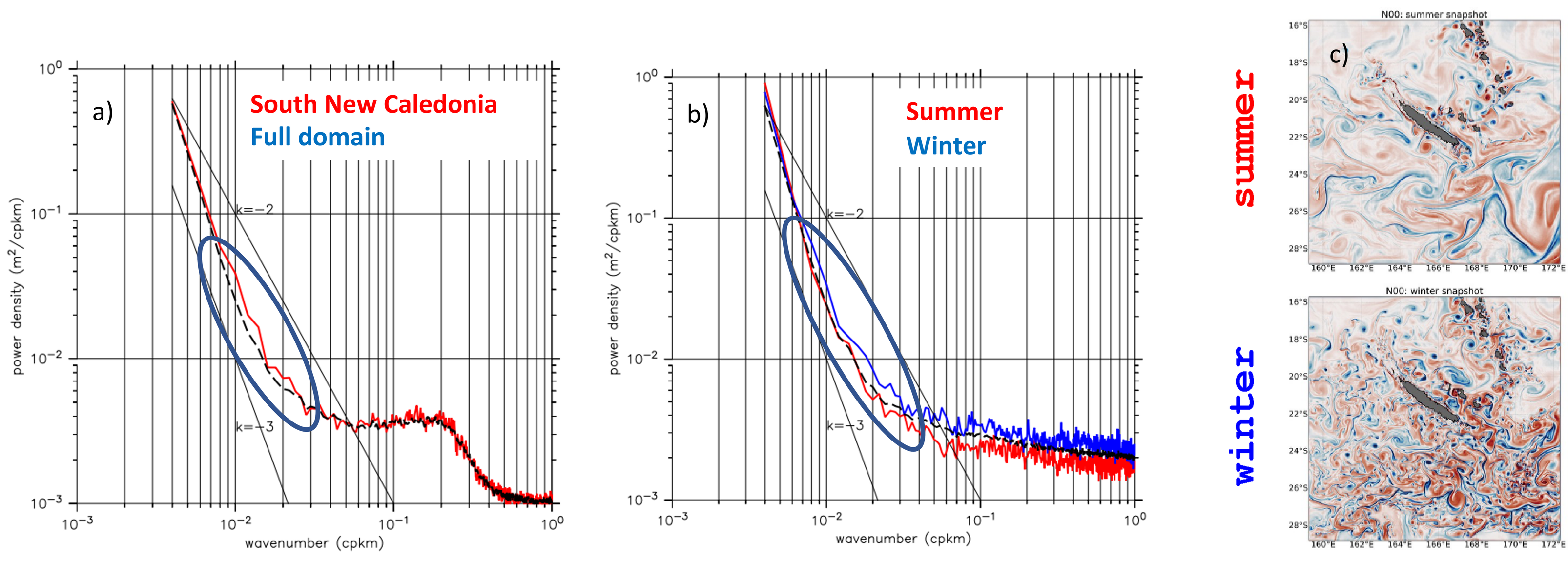


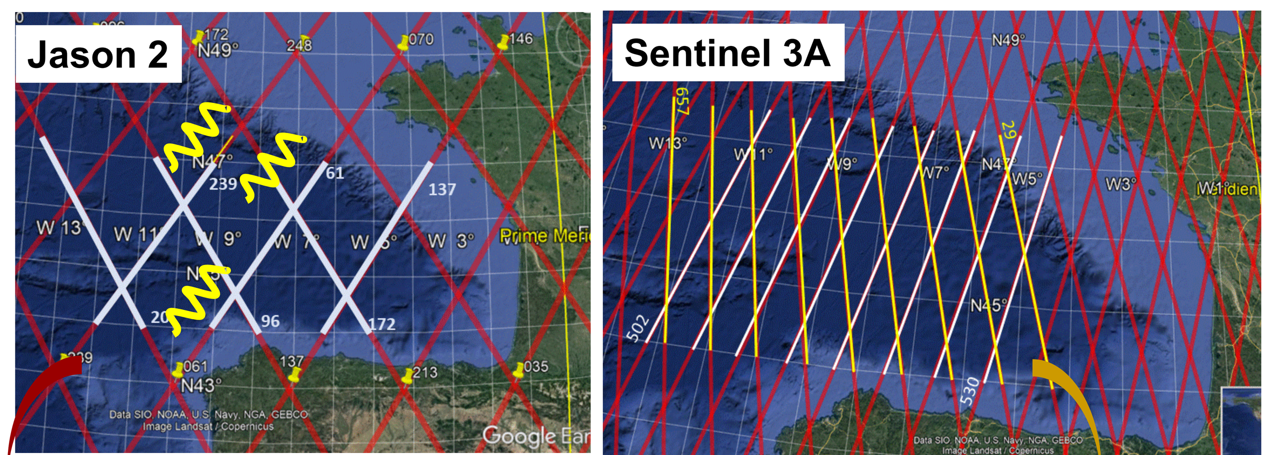
*Fig. 5: a) Srl spectra for the South New Caledonia region and the **full domain**. b) S3a seasonal spectra for the South New Caledonia region. c) seasonal modulation of meso/submesoscale activity (Ro from CALEDO60 simulations, courtesy A. Bendinger)*

Bay of Biscay (North-East Atlantic)

Ocean circulation in the Bay of Biscay (BoB): strongly constrained by a wide continental shelf and a steep slope at the shelf break

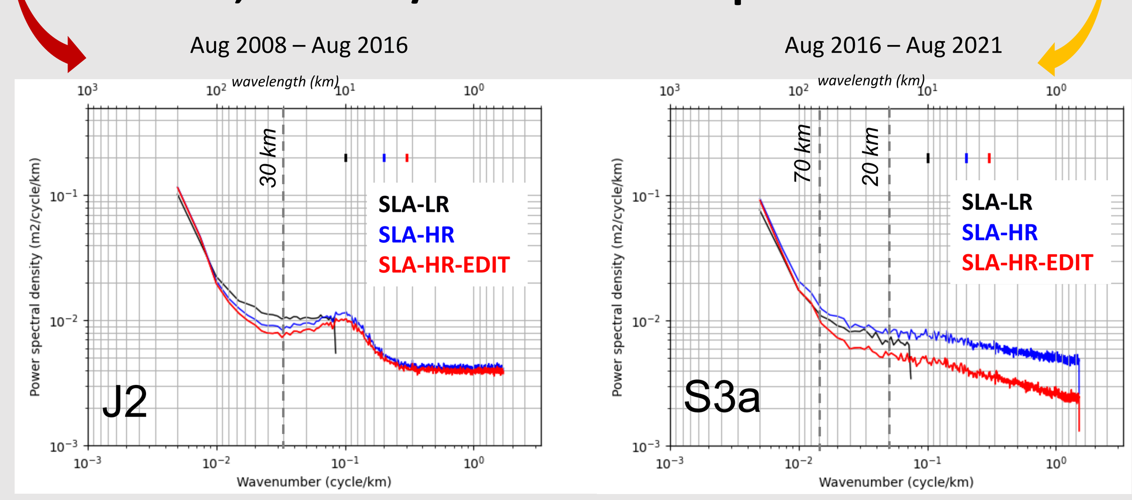
- in the abyssal plain, **general surface circulation is weak** (1-2 cm/s), with seasonal variability;
- **Eddies** over the abyssal plain with diameters between 45-100 km at surface;
- **M2 internal tides** generation along the slope (yellow waves on the map below);

➡ Do 20 Hz data improve observability of the mesoscale variability and of internal tides ?



Jason 2 and Sentinel 3A tracks over the BoB bathymetry (Google Earth image). The 400 km long segments used to compute the spectra over the plain are shown in white (J2, S3A) and yellow (S3A).

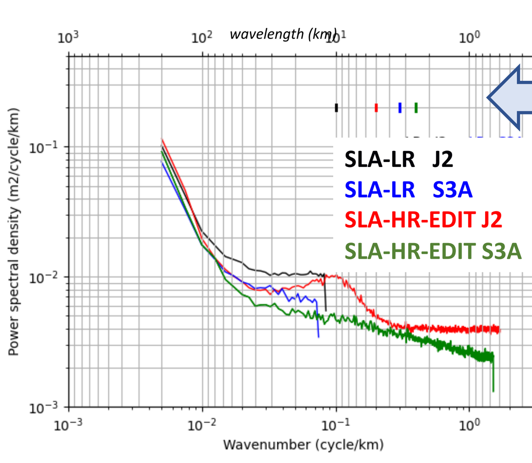
A. SLA-LR, SLA-HR/SLA-HR-EDIT Spectra



SLA-HR-EDIT → lower noise than SLA-LR :
between 30-100 km for J2
between 20-70 km for S3A

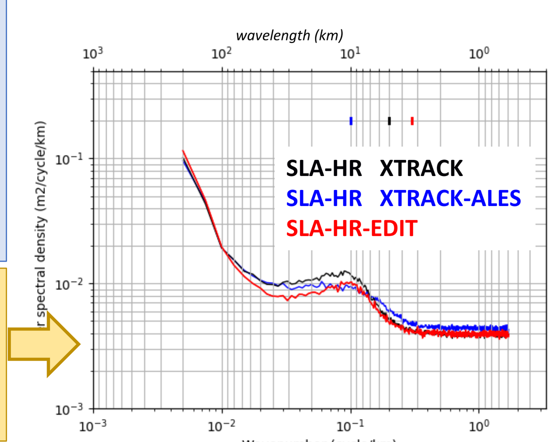
-filtering: efficient to reduce the instrumental noise on S3A data but limited efficiency on J2

B. Comparison J2/S3a SLA-HR-EDIT and J2 XTRACK* spectra

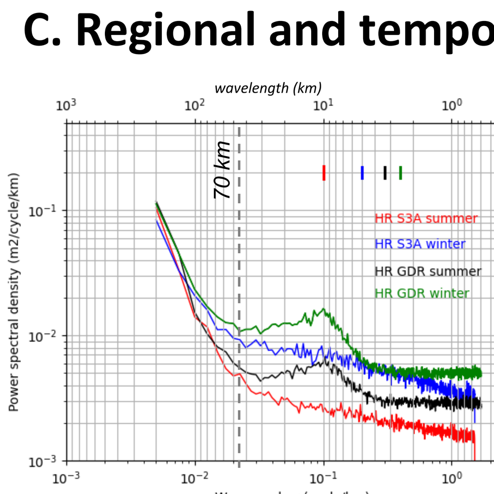


-similar spectra for J2 and S3A for scales > 70 km
-slope estimated between k=-2 and k=-3 but no robust estimate of the slope

GDR: gridded MSS; Xtrack: Mean along track profile:
→ consistent spectra GDR/ XTRACK



C. Regional and temporal sensitivity of SLA-HR-EDIT spectra J2/S3A



Similar spectra for both satellites for scales > 70 km

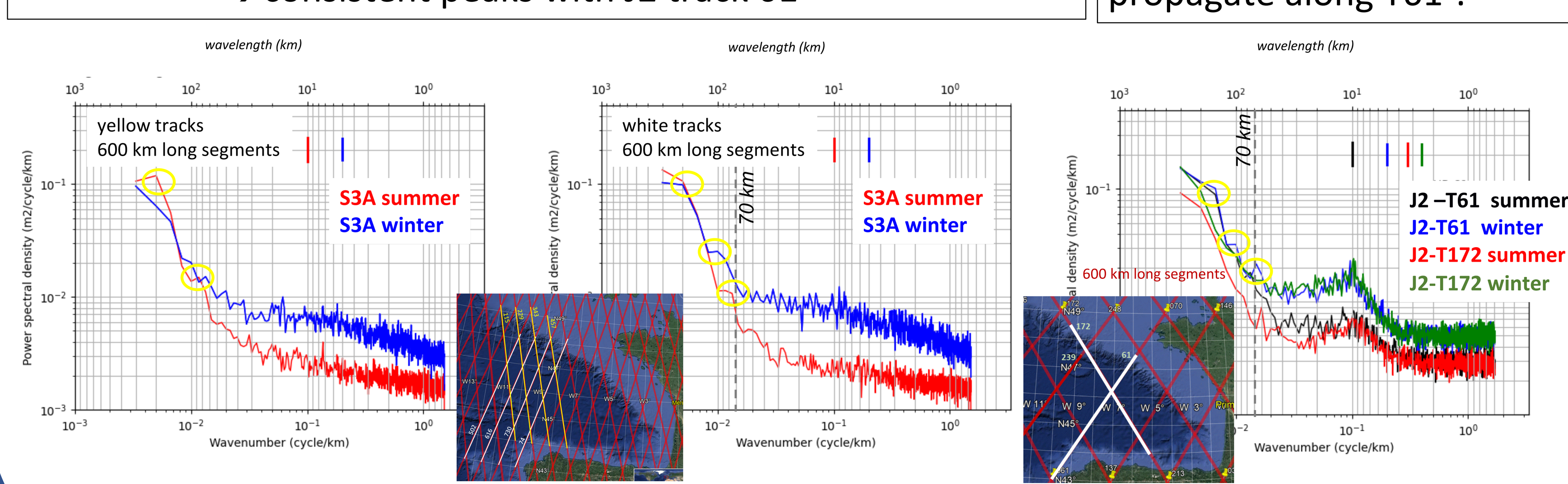
Large seasonal variability at scales < 100 km

In winter: more energetic circulation with the poleward slope current (Birol et al., 2017), mesoscale eddies generated as slope current instabilities and submesoscale activity due to a deep mixed-layer, larger instrumental errors due to stronger swell and sea state (Dufau et al., 2016)

Spectra represent a 'mix' of several dynamics → large changes from one track to the other

S3A ascending (yellow) and descending (white) tracks:
asc. tracks → capture IT generated in summer at the Galician shelf break ?
desc. tracks → capture IT generated at the northern shelf break
→consistent peaks with J2 track 61

J2 tracks 61 & 172:
more energy in summer along T61 than T172
→ due to internal tides that propagate along T61 ?



**20 Hz XTRACK coastal datasets are produced by CTOH/LEGOS and by the Climate Change Coastal sea level team for the ESA Sea Level Climate Change Initiative. XTRACK-ALES DOI: 10.5270/esa-sl_cci-xtrack_ales_sla-200206_201805-v1.1-202005*
No use of a gridded MSS but of a mean along track profile

CONCLUSION

- thanks to the nonlinear iterative editing filter : **HR data spectra less contaminated by errors than LR data spectra for wavelengths up to 70km**.
- **improved mesoscale resolution** capability therefore achieved: ~40km for Saral-HR and ~55 km for Jason2 and S3A.
- HR edited data for the 3 missions → **consistent spectra in the mesoscale range and similar seasonal behavior**.

The subtropical region are characterized by a -3.6 mesoscale spectral slope (70-250km) typica of SQG dynamics. HR spectra provide information on finest scales with a South New Caledonia region more energetic than the surrounding area in the 45-125 km wavelength range, especially in winter when submesoscale activity is fully developed.

In the Bay of Biscay: J2 HR data editing lead to consistent spectral characteristics with XTRACK-ALES data. The use of J2 and S3A HR data is expected to complement previous analysis of mesoscale and slope circulation in the abyssal plain. The spectral characteristics are very sensitive to the choice of tracks making difficult the interpretation of spectra in particular for internal waves dynamics.

The spectra computed in both regions will serve as **reference for SWOT data spectra for scales > 50km**.