S6VT

Sentinel-6 Validation Team Meeting

Virtual meeting,
26-28 September 2021
14:30-18:30 UTC

Benefits of using fast fully focused SAR processing over different surfaces and potential applications

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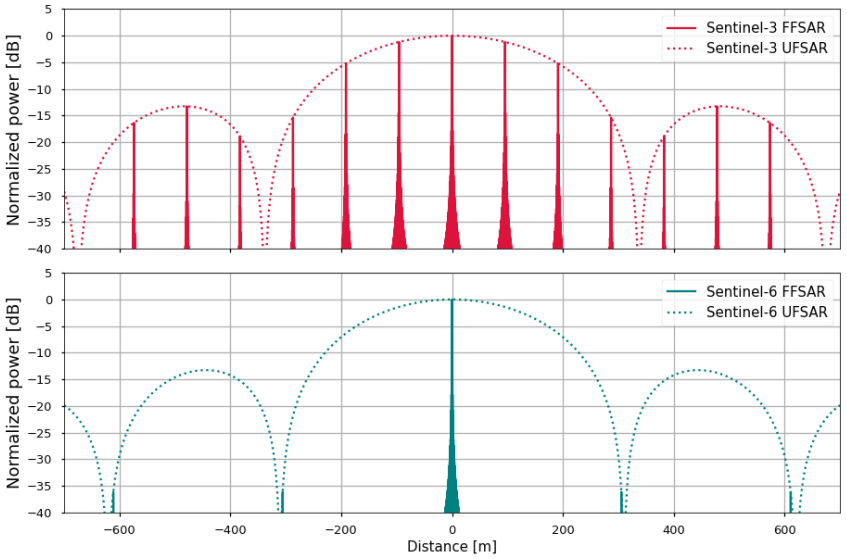
(1) CLS (Collecte Localisation Satellites), France, (2); Geosciences Environnement Toulouse, France; (3) CNES, France; (4) Aresys Srl, Italy; (5) ESA/ESTEC, Netherlands; (6) University of Porto, Portugal

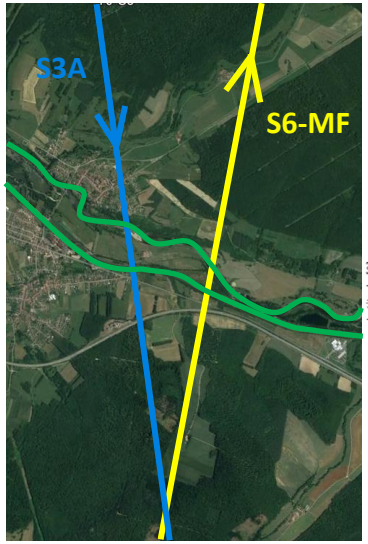
General benefits of FFSAR for S6-MF

- **Almost continuous emission-reception of pulses between bursts, only 2 missing pulses creates replicas at the zeros of UFSAR PTR envelop**
- **Match-filtering : no RVP phase to correct exactly (in back-projection) or approximately (in omega-kappa) thanks to Poseidon-4 digital altimeter**
- **A good signal-to-noise ratio**

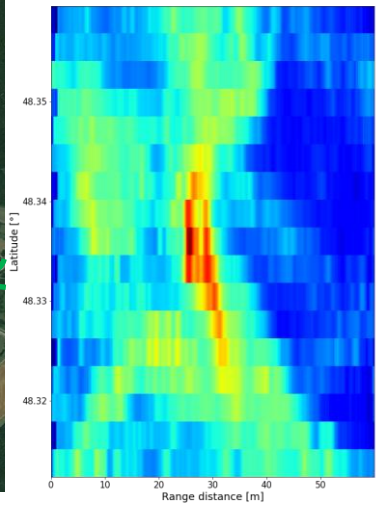


Theoretical along-track impulse response of S3 (red) and S6 (blue).

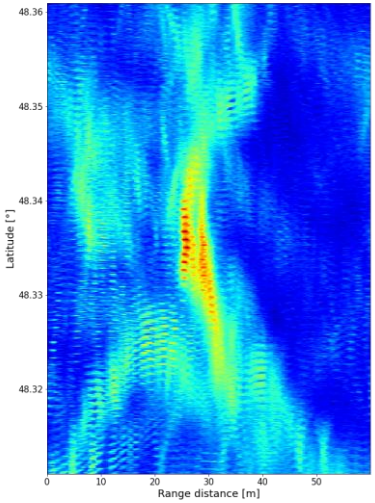
Benefits of FFSAR for rivers



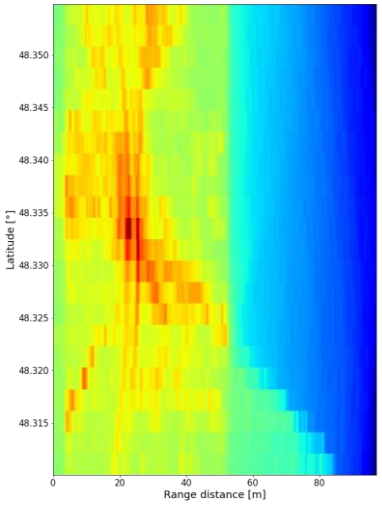
S3 20Hz UFSAR



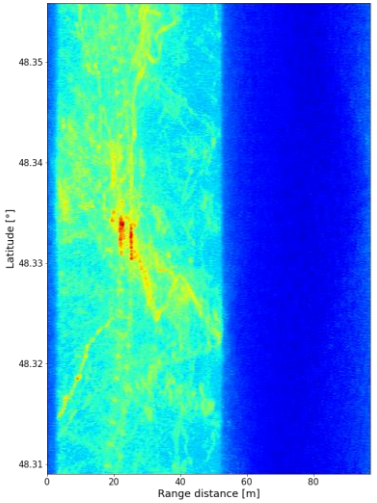
S3 754Hz FFSAR



S6 20Hz UFSAR

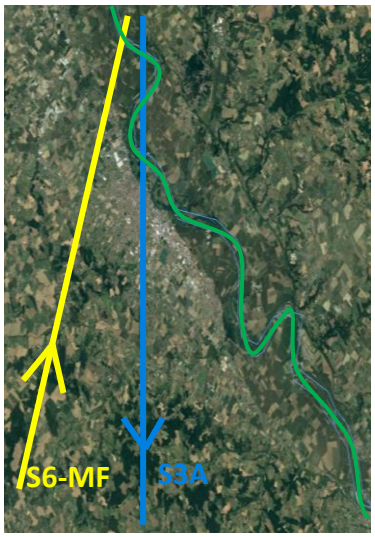


S6 697Hz FFSAR

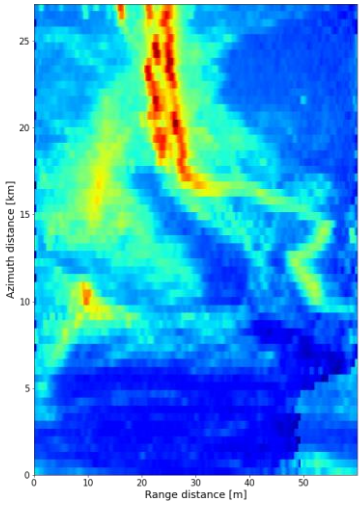


*Radargrams over Moselle river (France) at crossing point of S3A (*cycle 66 pass 122*) and S6-MF (*cycle 4, pass 111*).*

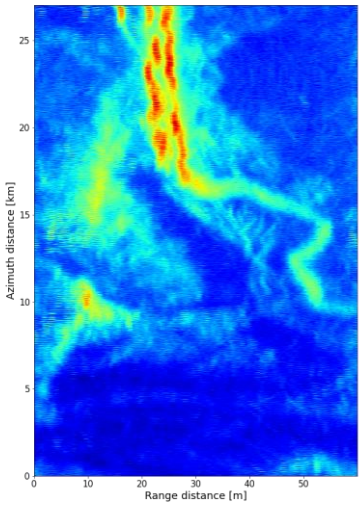
Benefits of FFSAR for rivers



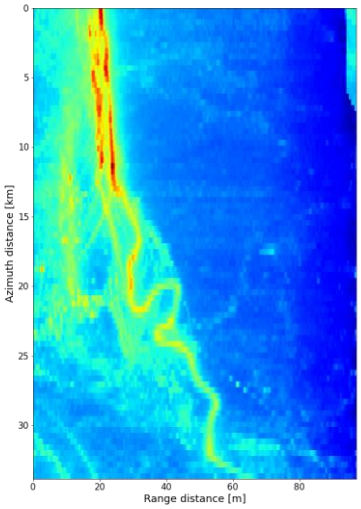
S3 20Hz UFSAR



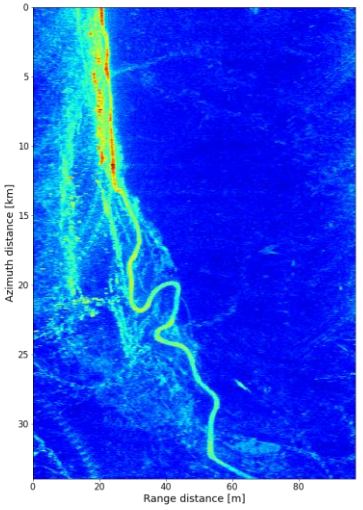
S3 754Hz FFSAR



S6 20Hz UFSAR

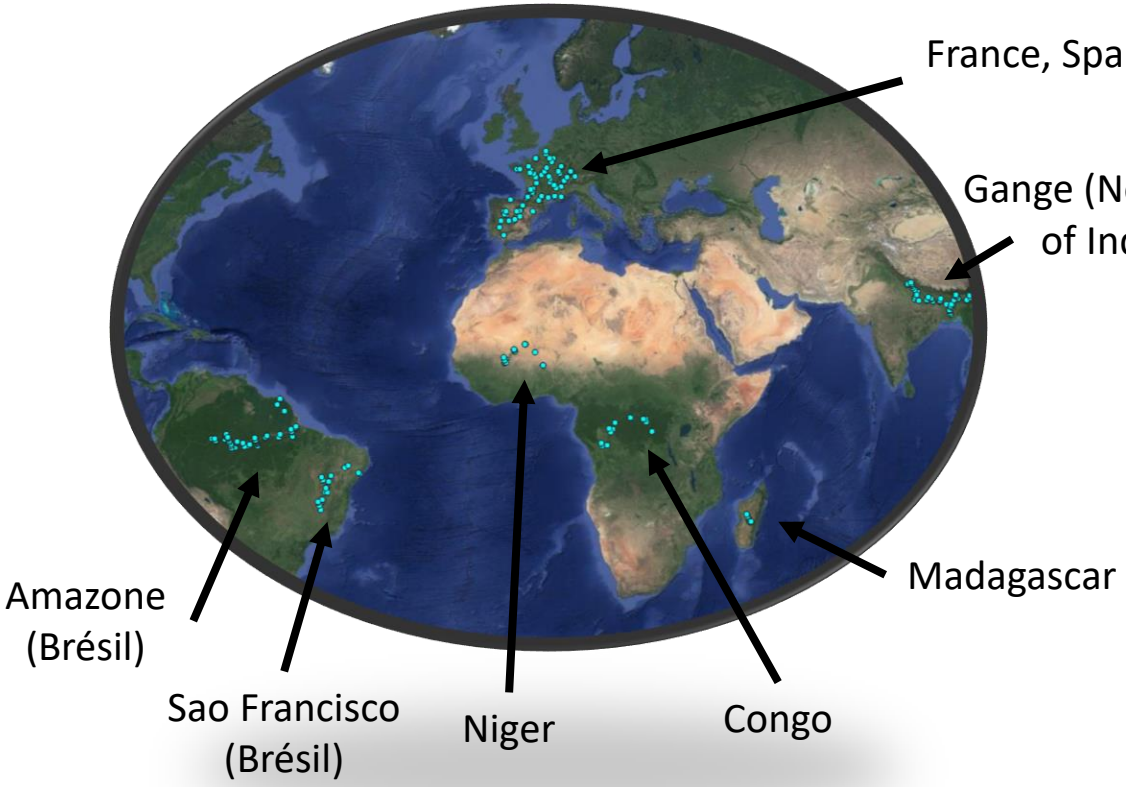


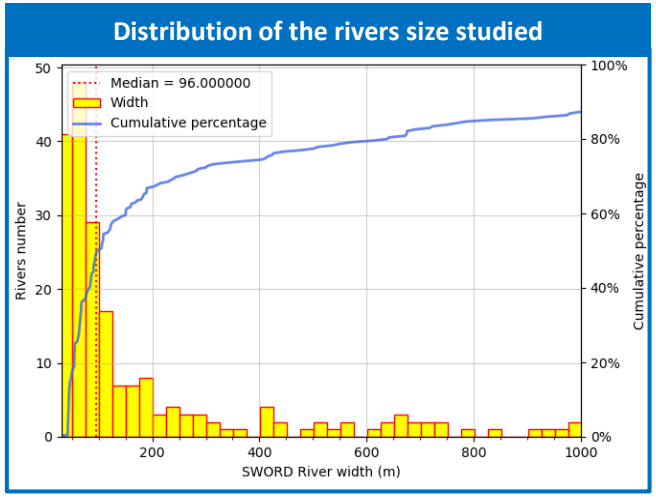
S6 697Hz FFSAR



*Radargrams over Garonna river (France) at crossing point of S3A (*cycle 10 pass 70*) and S6-MF (*cycle 68, pass 299*).*

Benefits of FFSAR for global treatment in hydrology (with F. Girard and M. Vayre)



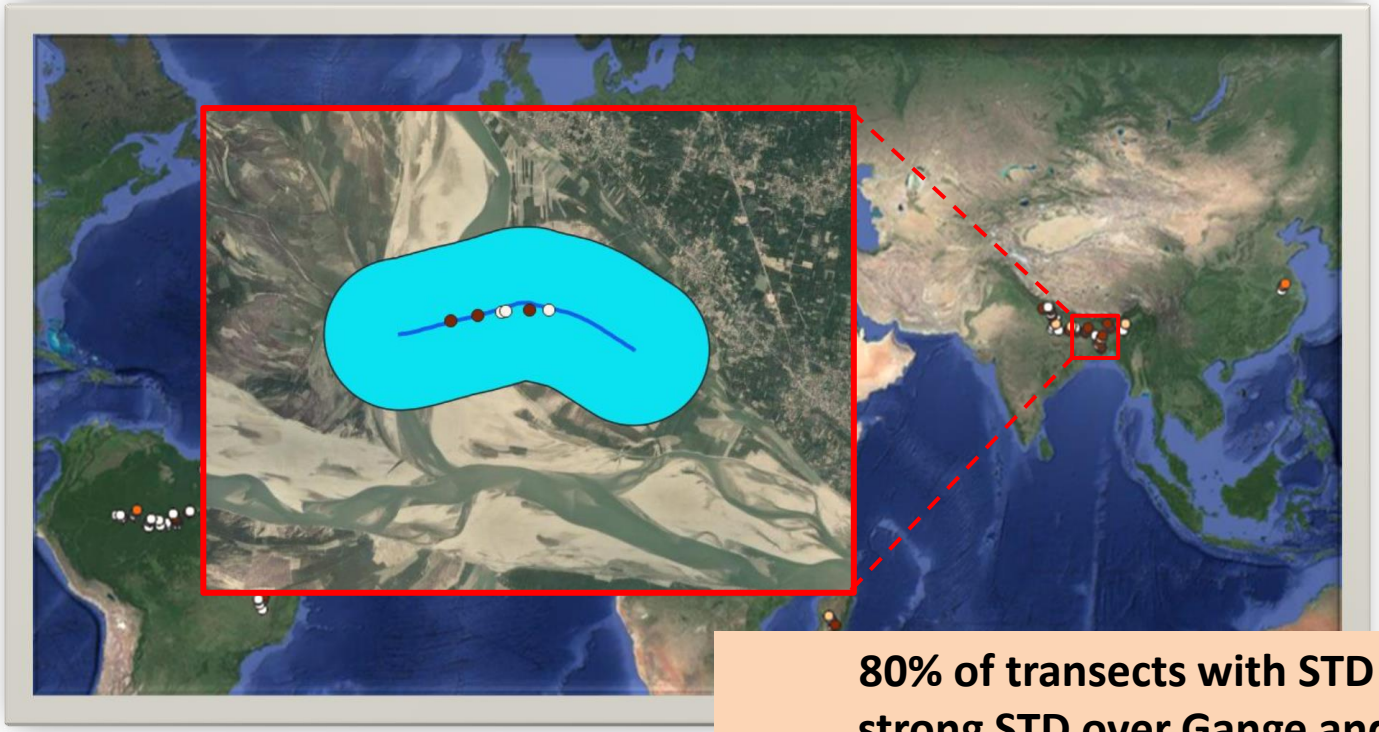


Distribution in location (left) and size (right) of the ensemble of rivers to be globally treated with FFSAR omega-kappa.

Benefits of FFSAR for global treatment in hydrology (with F. Girard and M. Vayre)

Cartography of precision values obtained with FFSAR omega-kappa.

Benefits of FFSAR for global treatment in hydrology (with F. Girard and M. Vayre)

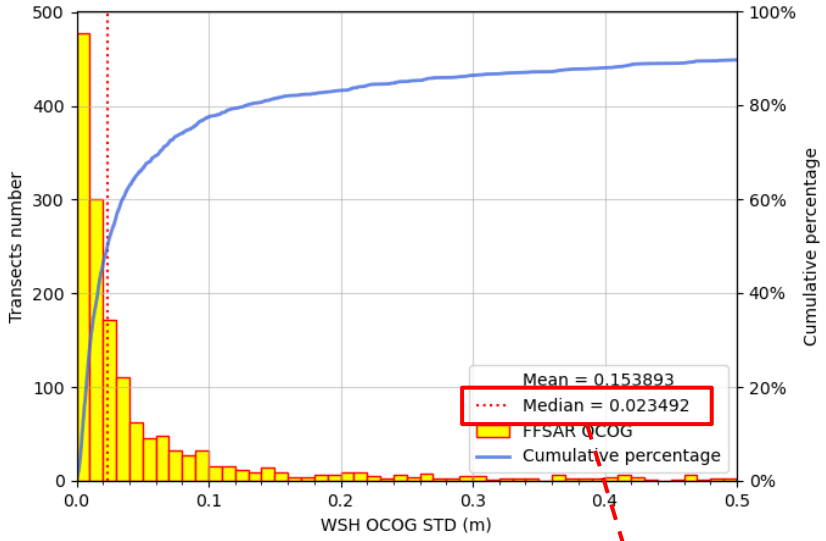


80% of transects with STD < 10cm
strong STD over Gange and Congo

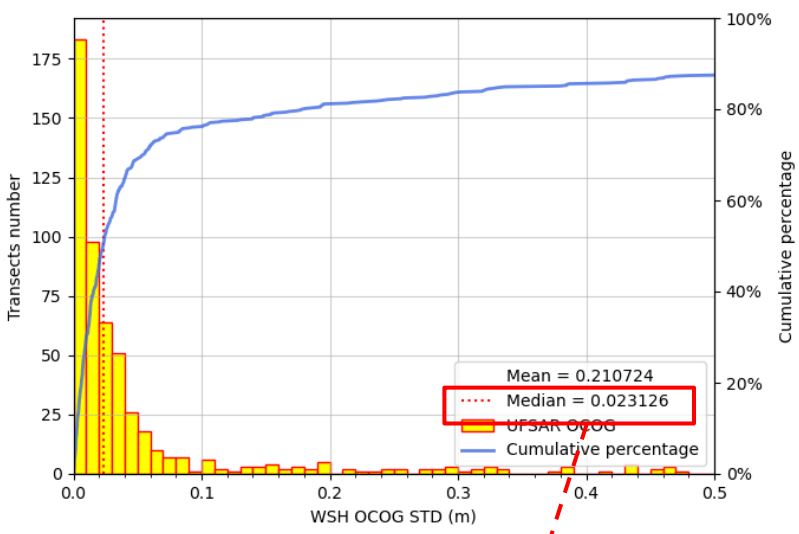
Cartography of precision values obtained with FFSAR omega-kappa.

Benefits of FFSAR for global treatment in hydrology (with F. Girard and M. Vayre)

FFSAR



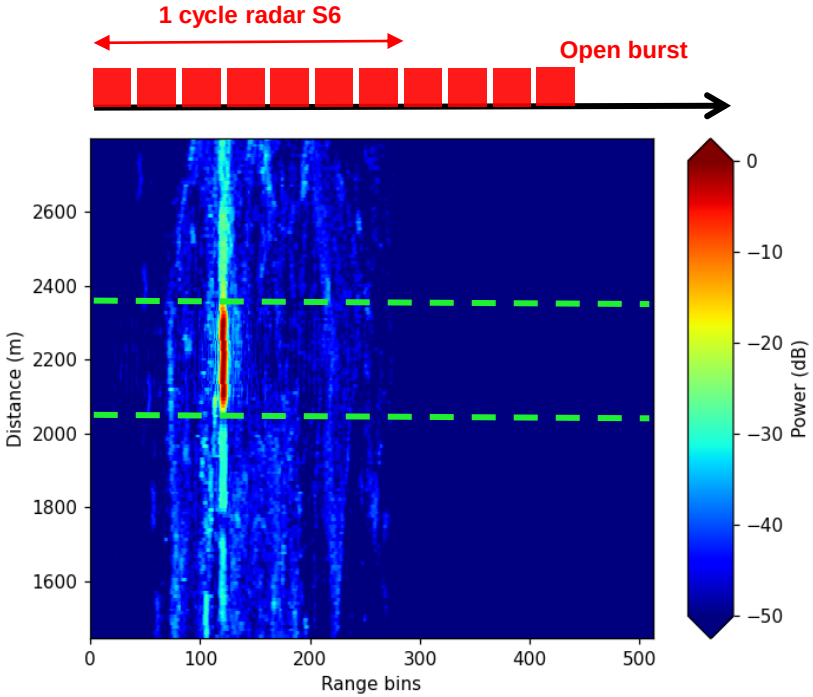
UFSAR



Precison on the range is the same for FFSAR and UFSAR (median of 2.3cm), acuracy must be studied to determine if FFSAR is more accurate !

Precision values w.r.t. transect number obtained with FFSAR omega-kappa and UFSAR after OCOG retracking.

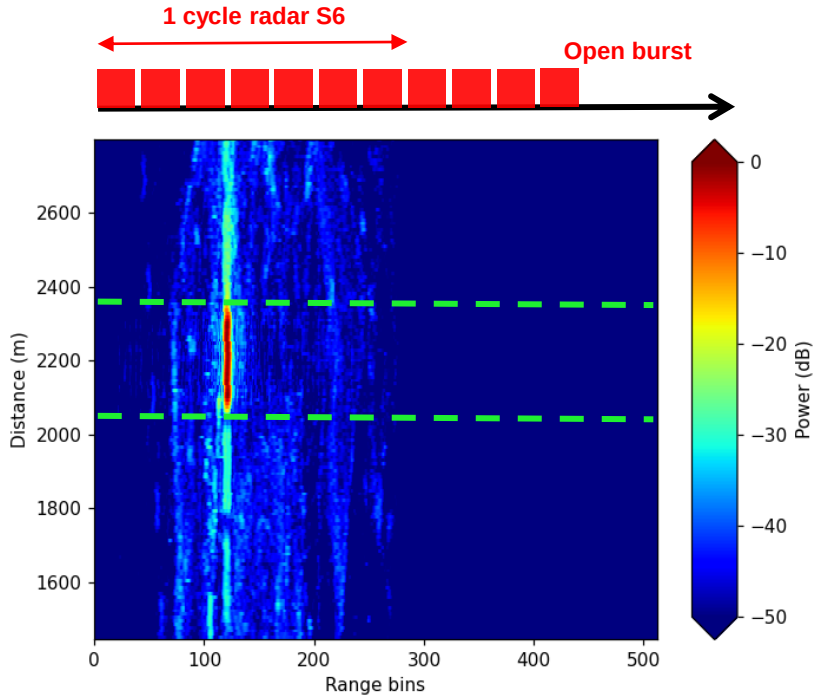
Benefits of FFSAR for global treatment in hydrology (with F. Girard and M. Vayre)



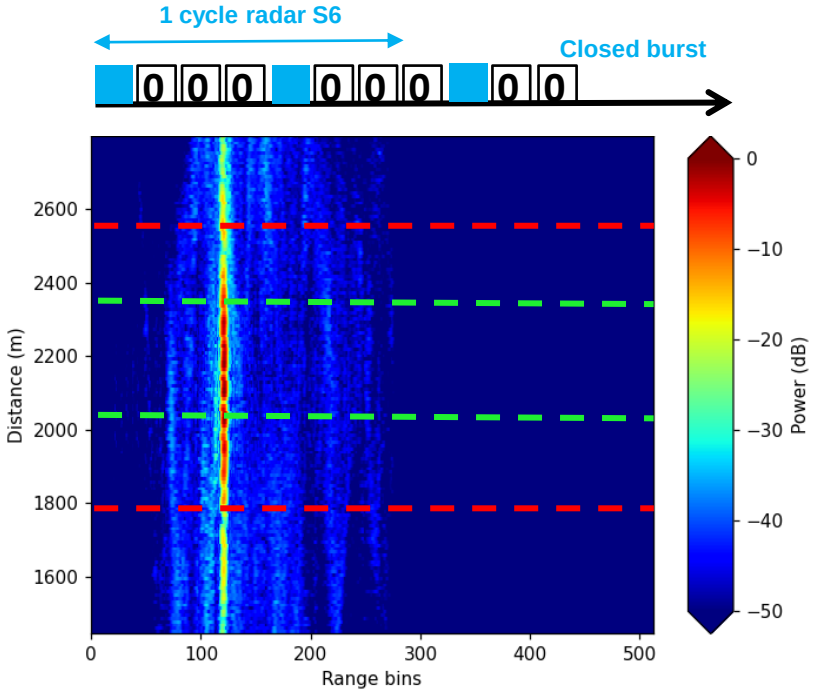
Original S6 (Open-Burst)

Radargram of open-burst mode with FFSAR over Guadalquivir river.

Benefits of FFSAR for global treatment in hydrology (with F. Girard and M. Vayre)



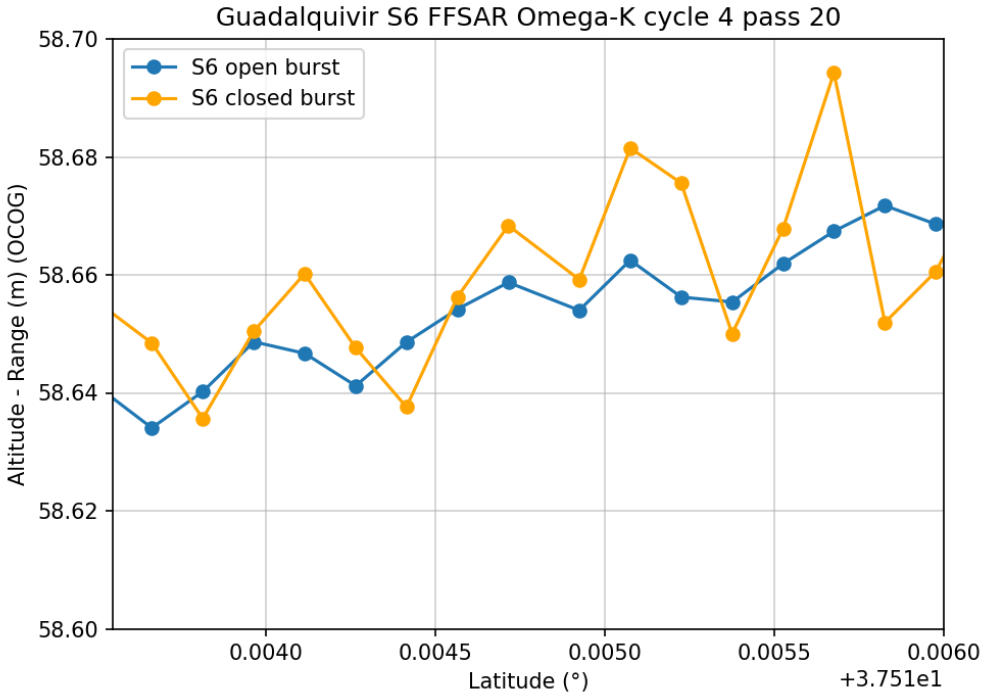
Original S6 (Open-Burst)



Degraded S6 (Closed-Burst)

Comparison of radargrams in closed-burst and open-burst mode with FFSAR over Guadalquivir river.

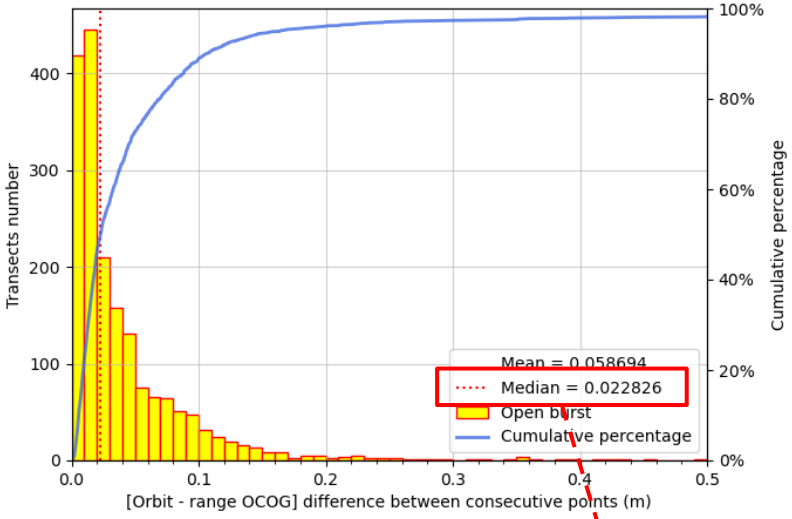
Benefits of FFSAR for global treatment in hydrology (with F. Girard and M. Vayre)



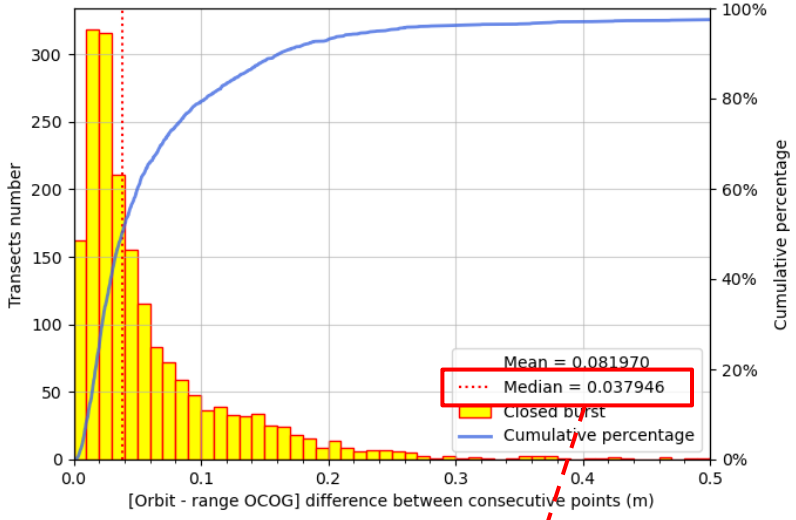
Orbit-Range OCOG comparison between closed-burst and open-burst mode with FFSAR over Guadalquivir river.

Benefits of FFSAR for global treatment in hydrology (with F. Girard and M. Vayre)

Open burst



Closed burst

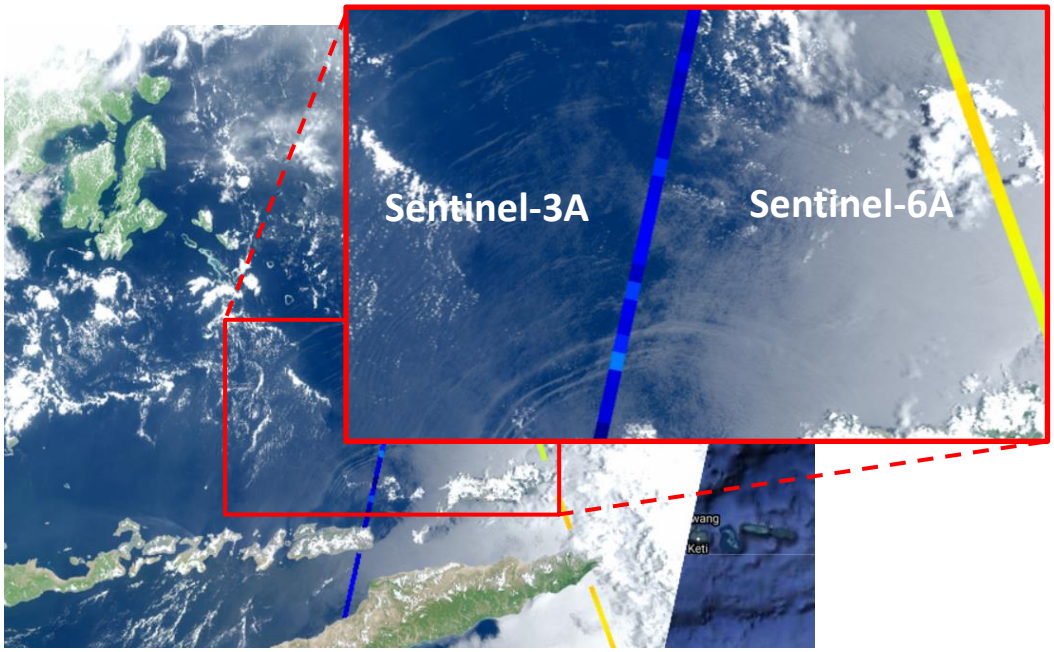


Increasing of the high frequency noise due to the closed burst mode (3.7cm) compared the open burst mode (2.3cm)

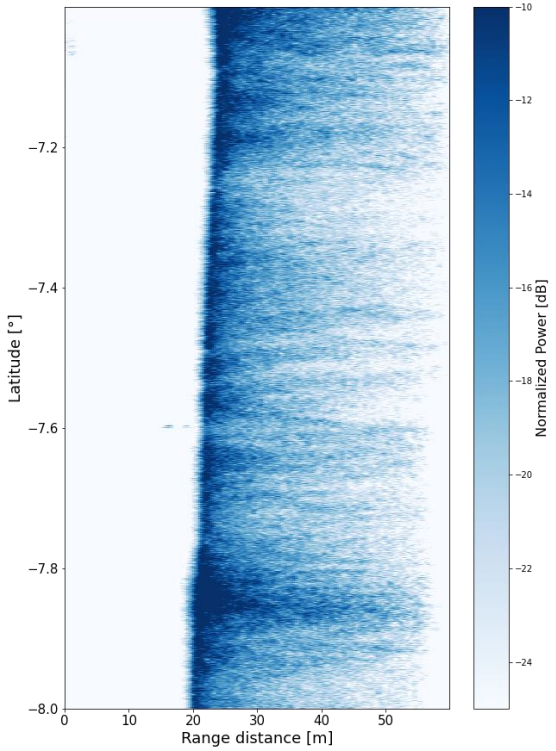
High frequency noise values of open and closed burst mode with FFSAR after OCOG retracking.

Benefits of FFSAR for solitary waves (with J. Da Silva, A. Dos Santos Ferreira)

S2 image over Banda Sea solitary waves

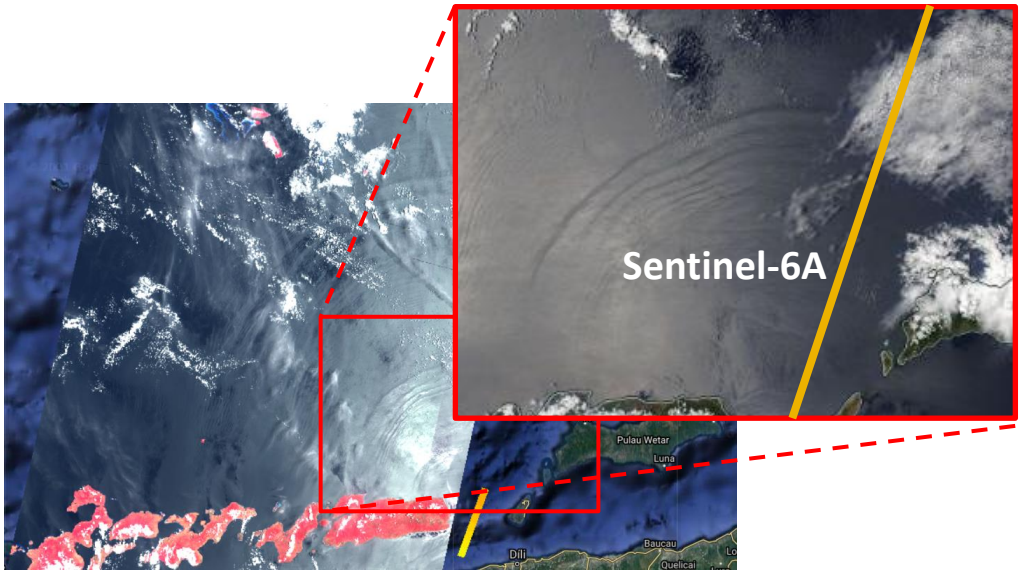


S3 348Hz FFSAR radargram over Banda sea solitary waves (cycle 77, pass 188)

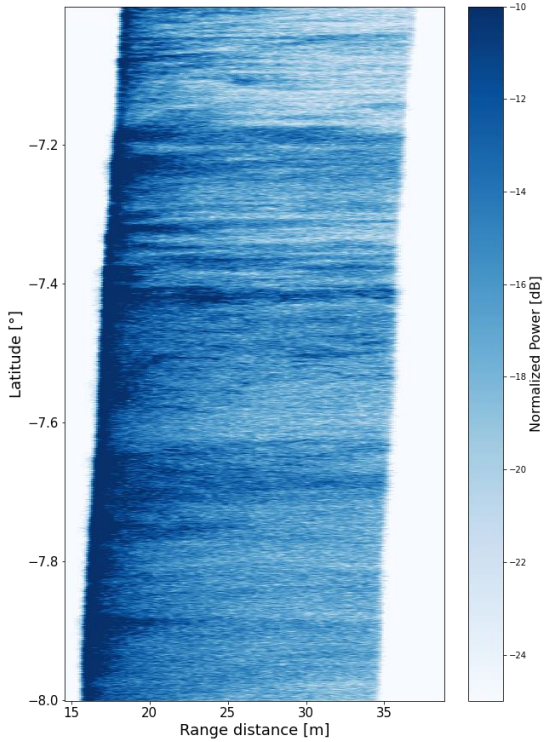


Benefits of FFSAR for solitary waves (with J. Da Silva, A. Dos Santos Ferreira)

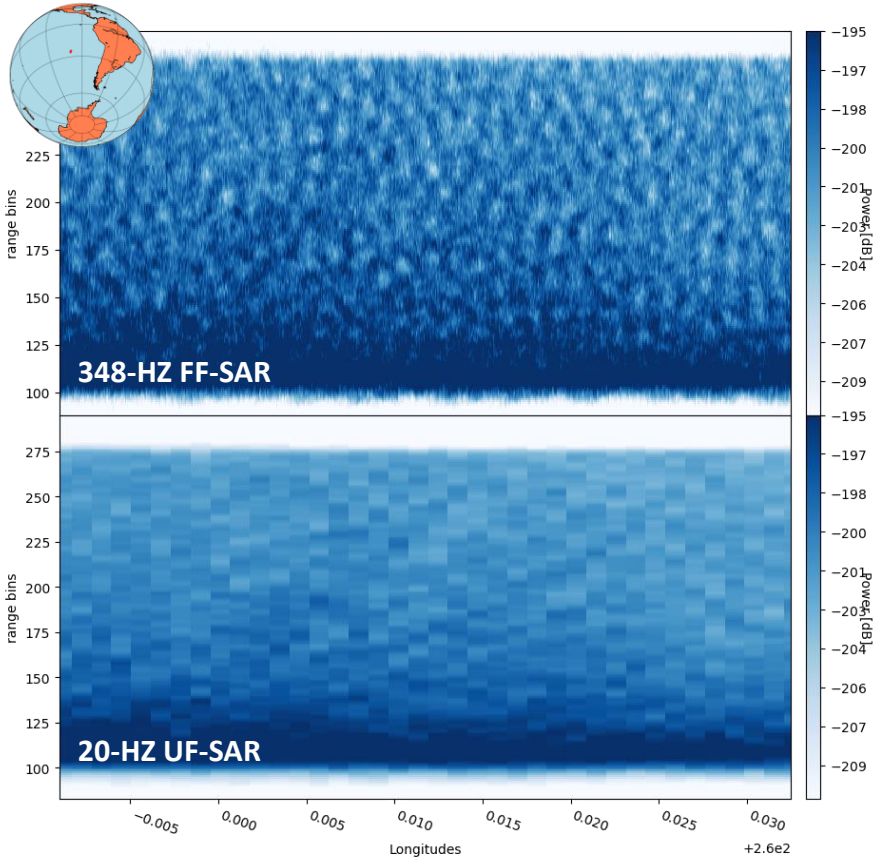
S2 image over Banda Sea solitary waves

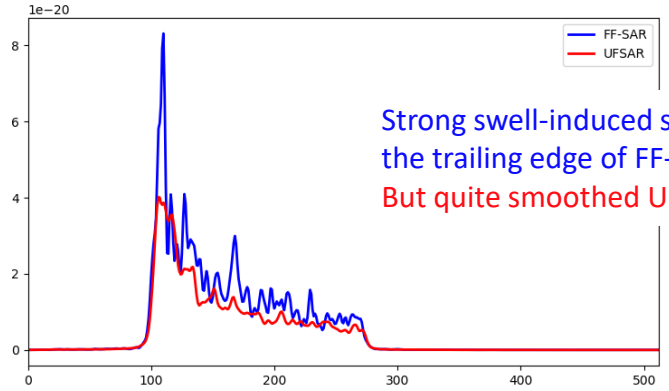


S6 348Hz FFSAR radargram over Banda sea solitary waves (cycle 33, pass 253)

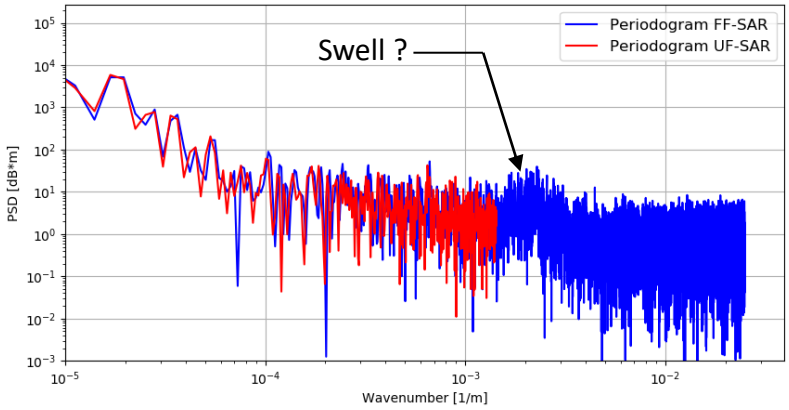


Benefits in oceanography for long ocean waves detection



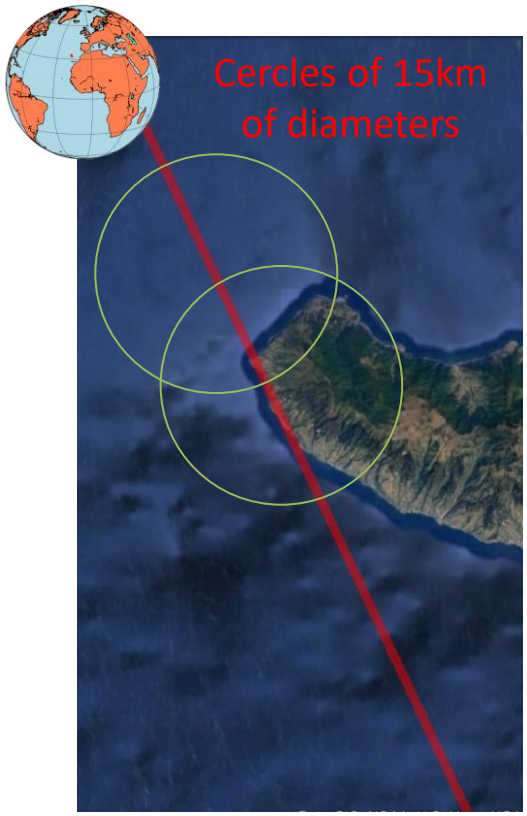


Strong swell-induced signal on the trailing edge of FF-SAR echo
But quite smoothed UF-SAR echo

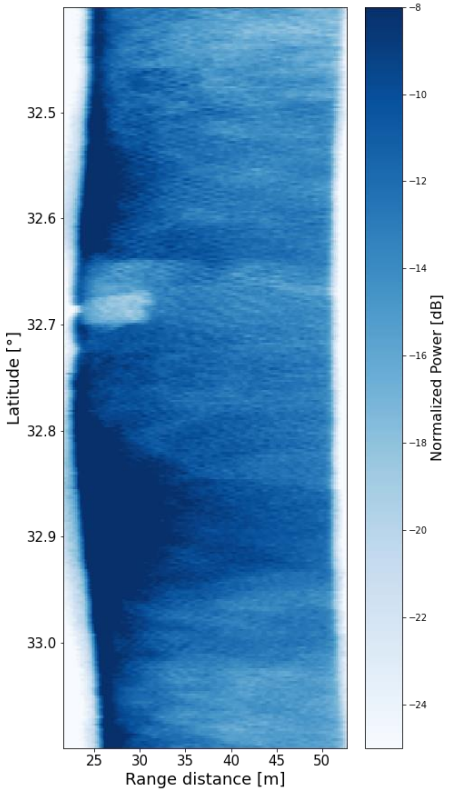


Benefits on coastal regions (with F. Boy, C. Maraldi)

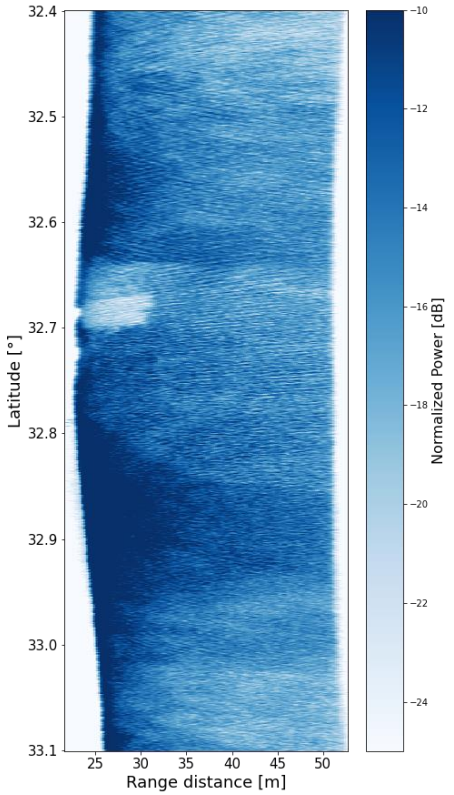
Sentinel-6 (cycle 32, pass 148) over Madeire Island coasts showing a loss of power at the coasts and waves.



S6 20Hz UFSAR



S6 174Hz FFSAR



Conclusions

- **FFSAR omega-kappa [Guccione, at al, 2018] is a fast time computing processing, only 17% longer than UFSAR in term of CPU time, that has been successfully tested for global treatment.**
- **For hydrology : FFSAR is particularly suited for specular non-dynamical targets, like narrow rivers. Compared to UFSAR, FFSAR significantly enhances the along-track resolution of the point targets, and FFSAR with Sentinel-6 does not contain replicas unlike Sentinel-3 with its lacunary pulse chronogram.**
- **For ocean : FFSAR mode can be used to detect long period waves (as solitary waves) but FFSAR is very valuable for capturing small period waves like swell (preferably when the wave propagation is parallel to the satellite track).**
- **A FF-SAR processing prototype (SMAP) is on a public git repository for those interested in getting a better insight of this new processing:** http://doi.org/10.5270/esa-cnes.sentinel-3.smap