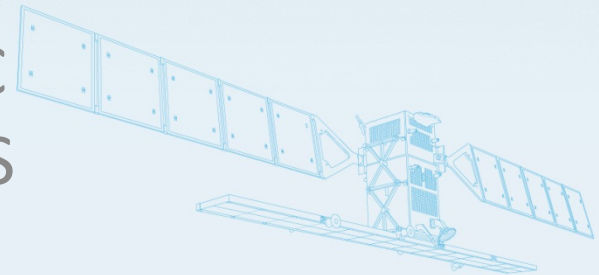


→ SEASAR 2012

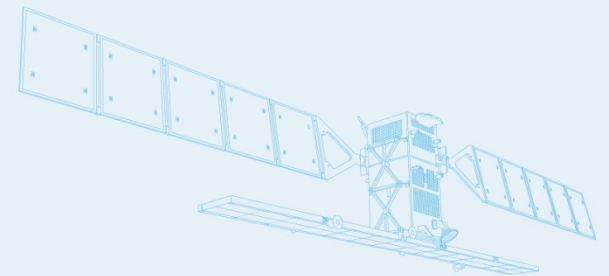
The 4<sup>th</sup> International Workshop on Advances in SAR Oceanography

# Towards consistent inversion of wind, waves and surface current from SAR

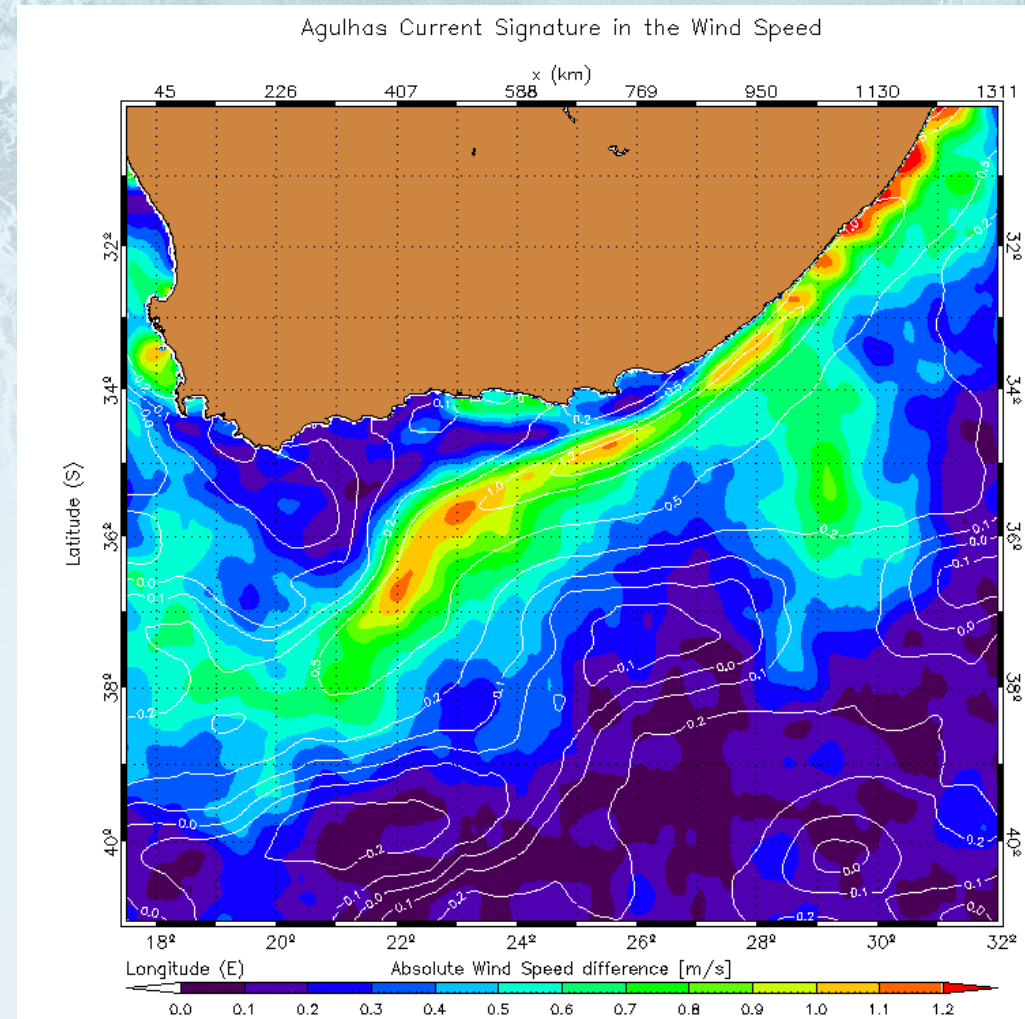
Chapron, IFREMER  
Kudryavtsev, NIERSC  
Johannessen, NERSC  
Collard, Mouche, CLS



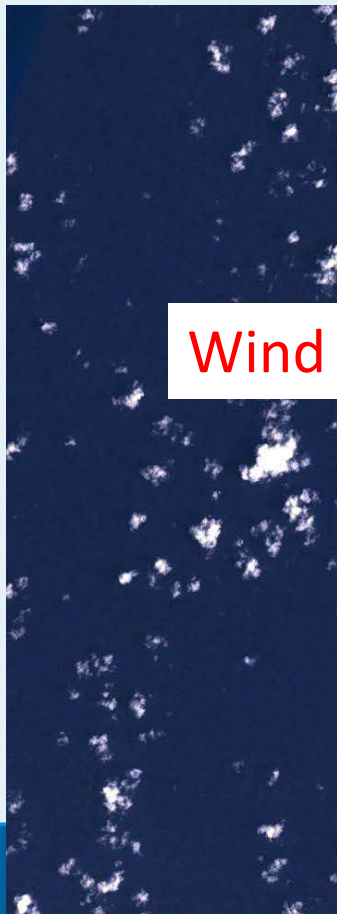
Today wind, waves and current  
are retrieved separately, causing  
errors on the retrieved individual  
fields



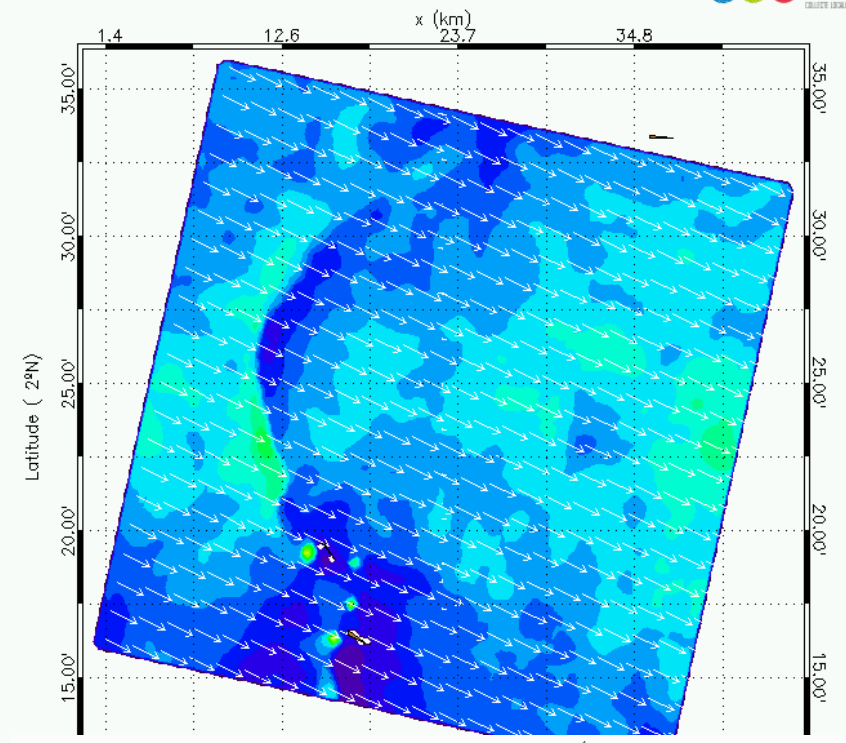
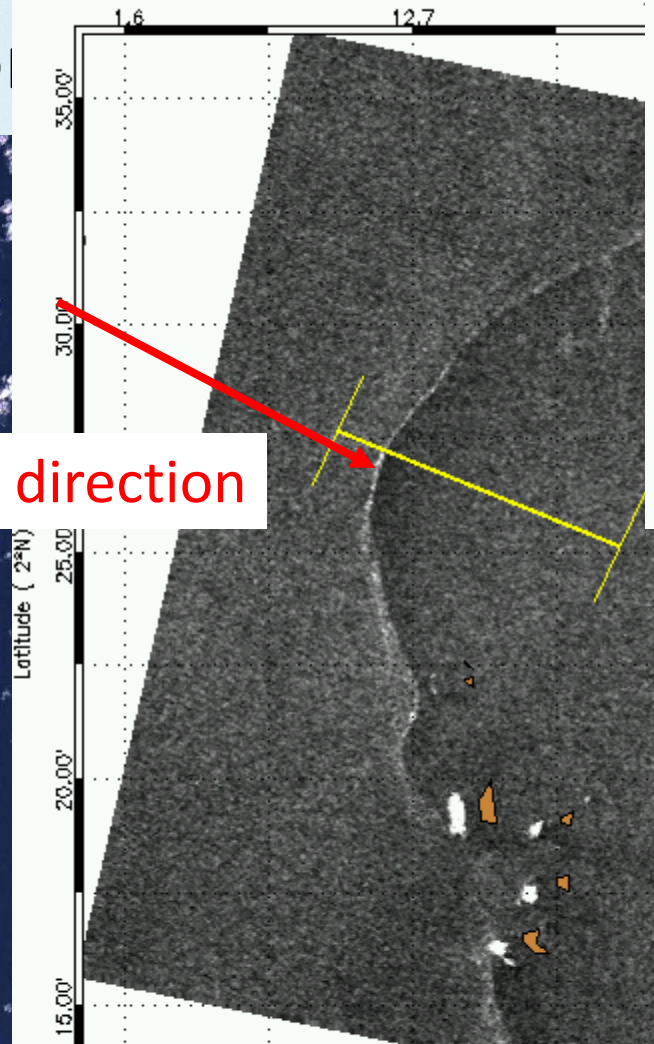
Wind field anomalies  
(SAR wind-ECMWF)  
contains surface  
current information  
(cross section modified  
in the presence of  
surface current)



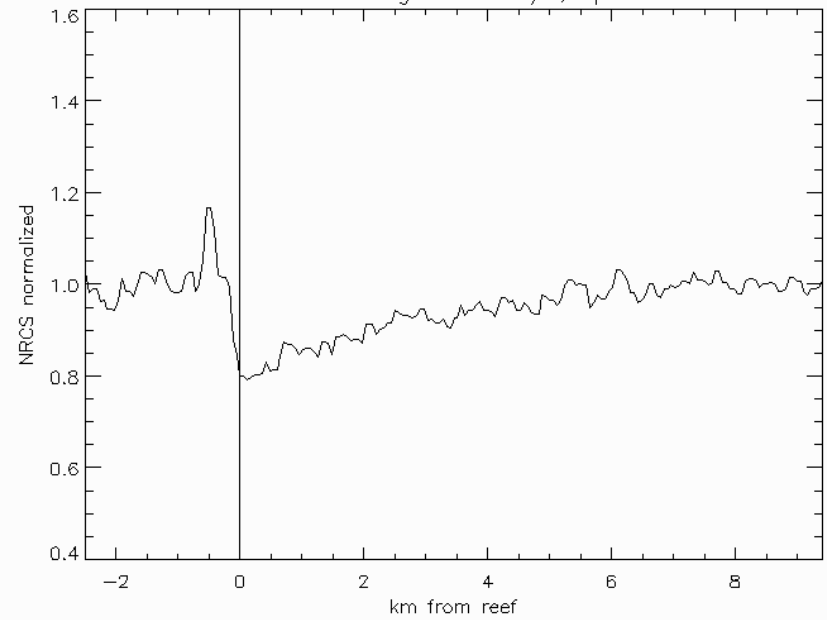
cross section also depe  
developp  
(reductio



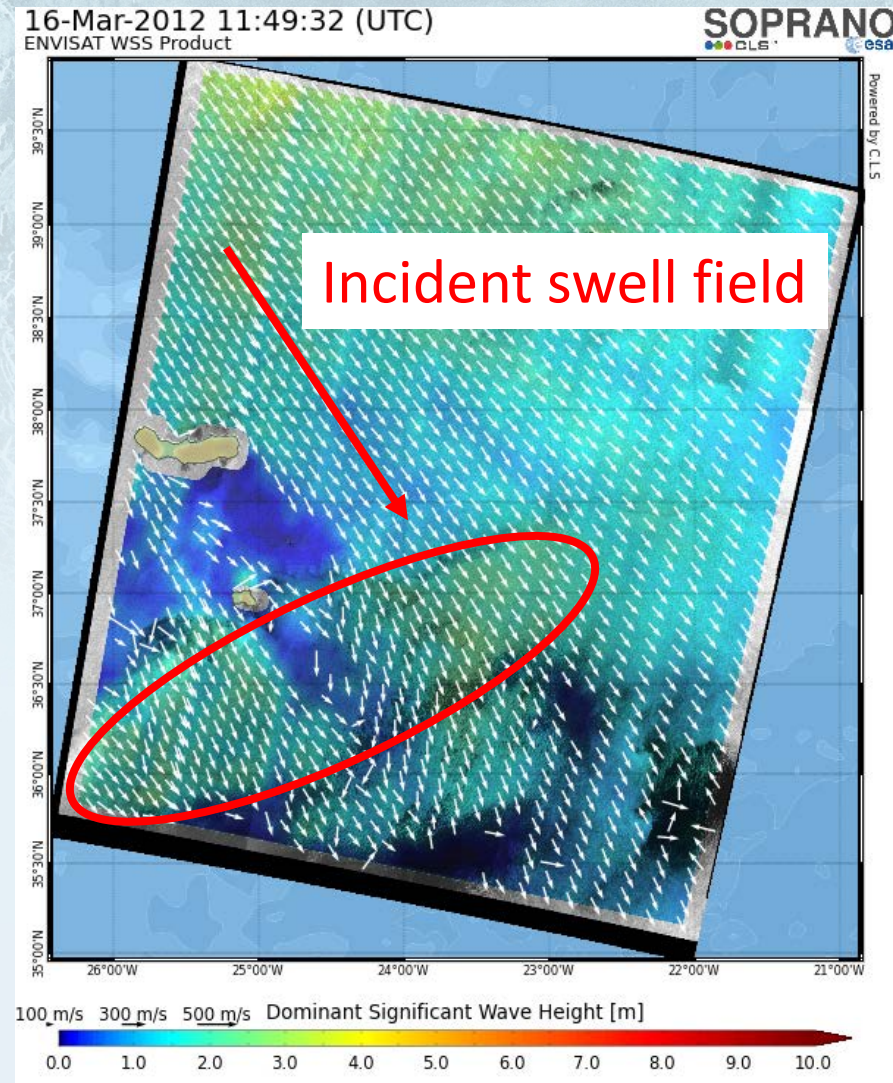
Wind direction



HH inc 32deg. wind 5m/s, upwind



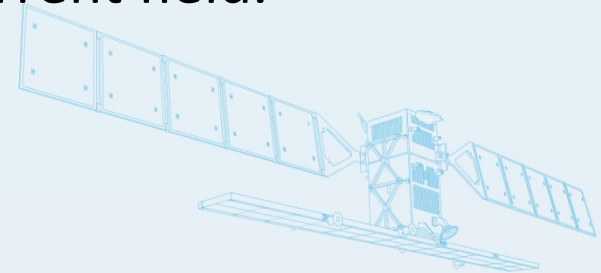
Wave field retrieval depends on wind speed : Backscatter modulation by long waves is increased at low wind (WSS)



# SAR Surface current field depends heavily on sea state correction (today using ancillary ECMWF Wind)

Spatial resolution of ECMWF wind is not consistent with Doppler grid  
-> Small scale wind variations transferred into surface current errors.

Time of ECMWF wind is not consistent with SAR acquisition time  
-> rapidly evolving atmospheric phenomena such as fronts will be mislocated and induce large errors in surface current field.



# Exemple over Agulhas current

## Radial current    sea surface roughness    wind

09-Feb-2012 21:20:12 (UTC)  
ENVISAT WSM Product

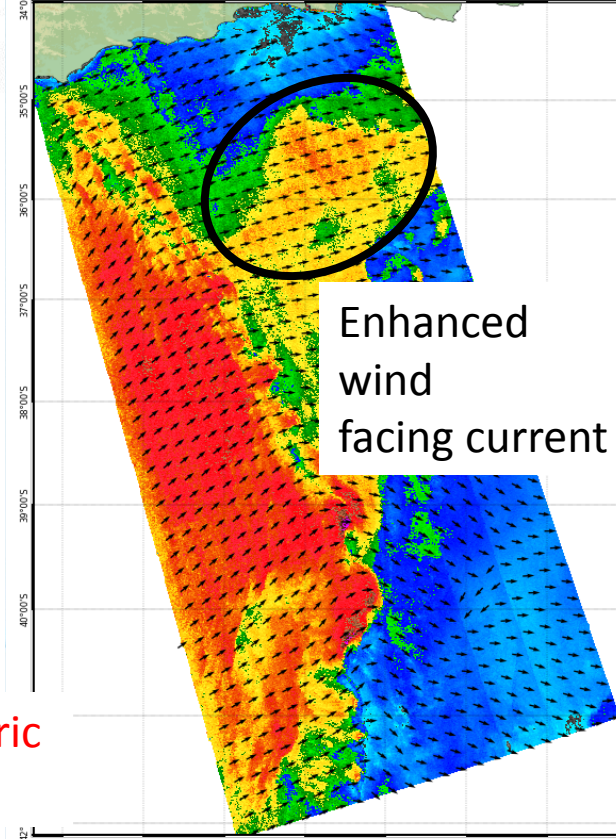
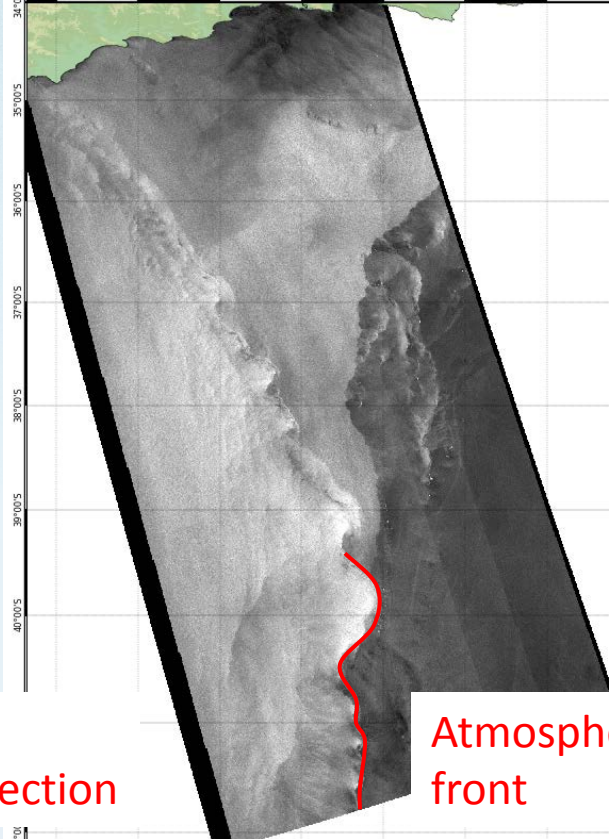
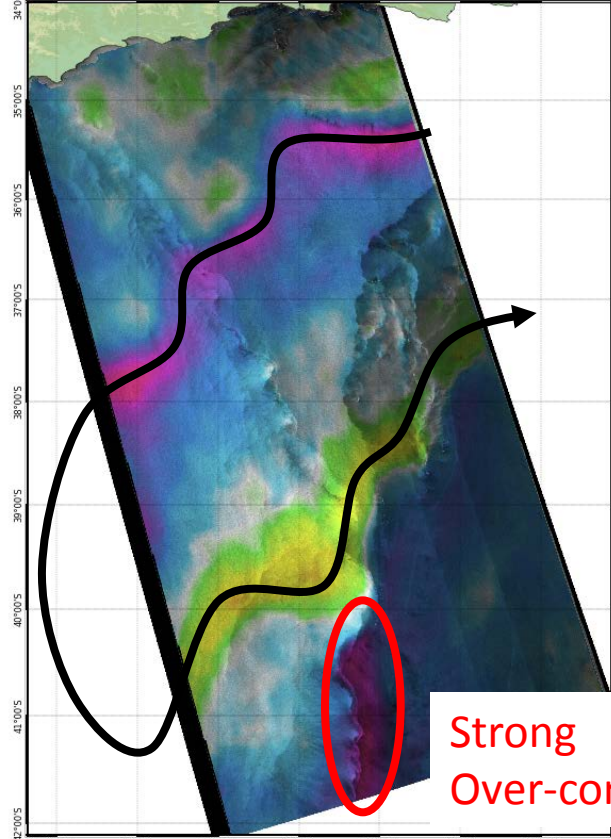
SOPRANO  
Powered by CLS

09-Feb-2012 21:20:12 (UTC)  
ENVISAT WSM Product

SOPRANO  
Powered by CLS

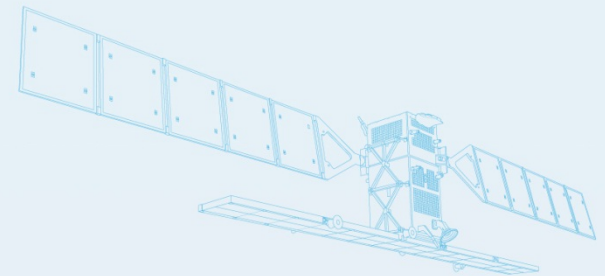
09-Feb-2012 21:20:12 (UTC)  
ENVISAT WSM Product

SOPRANO  
Powered by CLS



## Existing sigma0 physical model, empirical model

- Sigma0 = RIM or CMOD(wind-current, Mean Square Slope long waves, current, fetch, stability) + local wave breaking + local damping (surfactant)
- Sigma0 VV and Sigma0 HH = RIM(wind, wave, current)
- Sigma0 HV and VH = f(high wind)

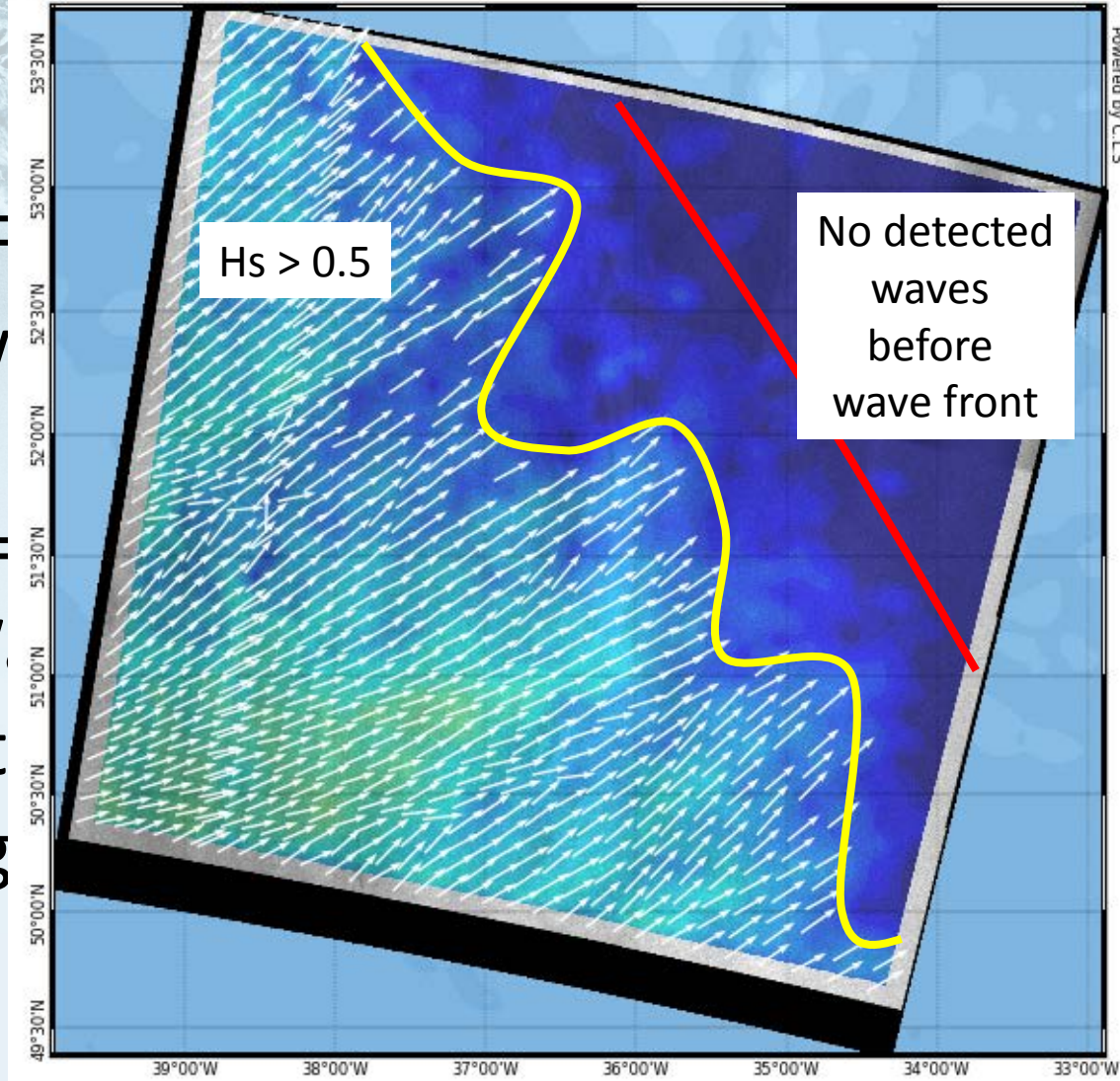




## Existing Sigma0

05-Apr-2012 12:52:25 (UTC)  
ENVISAT WSS Product

Powered by CLS

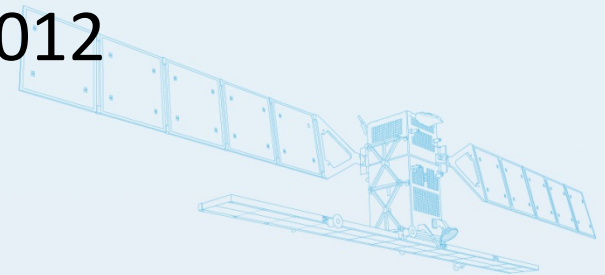


- SAR spectrum = MTF
- Azimuth cutoff =  $f(w)$  (interaction)
- Wave ray curvature : Spatial variation of  $W$  wave-current interaction happen when passing

Existing Doppler physical model, **empirical model**

- Doppler = current + DOPRIM/CDOP\*(wind, wave, **wave-current-interaction**)
- Doppler VV-Doppler HH = CDOP VV-CDOP HH

\*CDOP : Mouche & al , On the use of Doppler shift for sea surface wind retrieval from SAR, TGRS 2012

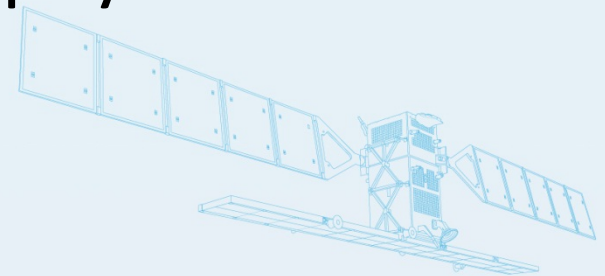


Combined wind wave current inversion requires  
consistent models across parameters

Need to derive consistent empirical models

How to better use semi-empirical models?

Can we develop a fully consistent physical model ?



Combined inversion at which resolution ?

Sigma0 at 1km or less

Wave spectra at 2 to 5 km

Doppler shift at 5 to 10km

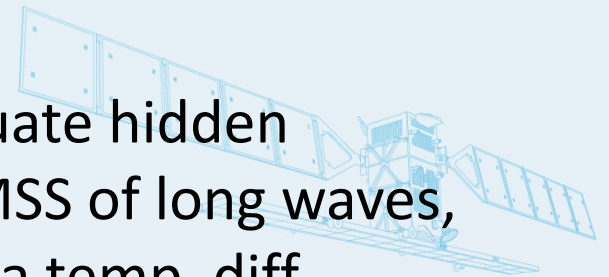
-> consistent retrieval at 5km resolution ?

Higher resolution will also involve further synergetic HR variables (SST, MSS from optical glitter, SAR altimeters...)

## Consistent iterative retrieval scheme

- 1) Relative Wind retrieval -> Wave retrieval -> Current retrieval
- 2) True Wind retrieval with presence of current using both corrected NRCS and sea state Doppler residual-> Wave retrieval in presence of current -> current retrieval using true SAR wind for sea state correction.
- 3) ...

Use of cost function residual value to evaluate hidden variables not easily accessible such as MSS of long waves, other synergetic variables such as air-sea temp. diff.



# Conclusion 1

Separate retrieval algorithms for wind wave and current have reached a stage where future significant progress can only be done going towards combined retrieval.

Still a lot remains to be done before attempting combined retrieval of wind wave and current : Consistent semi-empirical models have to be derived based on ENVISAT archive building from pieces of existing physical (RIM,DOPRIM, ...) or empirical models (CMOD,CDOP,...)



## Conclusion 2

Sentinel1 SAR L2 OCN products will provide all required parameters for combined retrieval (sigma0, Doppler shift, modulation spectra, azimuth cutoff,...) but consistent models for some of these parameters are still missing.

**There is a urgent need to support such further scientific developpments. This will also require dedicated field campains**