Geostrophic current speed : From gridded products to high resolution along-track

J. Tournadre,

IFREMER, Laboratoire d'Océanographie Spatiale, Brest, France

M. Rouault

CSIR – NRE, Research Group : Earth Observation

Rosebank South Africa

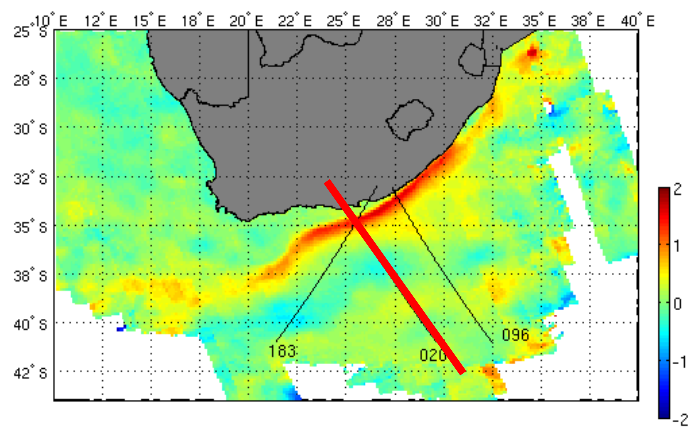
- The availability of precise MDT such as the Rio 2009 one allows estimating the absolute dynamic topography and thus the determination of absolute geostrophic velocity.
- Several products are now routinely available to compute Vg
  - MADT gridded mean absolute dynamic topography (interpolate absolute DT and geostrophic speed) from AVISO
  - DT along track, 1hz along track Delay Time sea surface height
  - GDR, geophysical data record along track 1Hz and 20hz
- How do thess products compare for velocity?
- What is the impact of averaging and gridding, especially when considering strong narrow surface current?

Can we quantify the differences between the current speed estimates ?

Test on Topex/Jason pass 020 which intersects the Agulhas current near Port Elizabeth.

Advantages :

- strong permanent current
- Track almost perpendicular to the current (i.e. Good estimation of across-track speed)
- Good Mean Dynamic Topography Rio and from SAR data



GDR 1Hz and 20Hz current estimate

Estimation of the absolute geostrophic velocity from sea surface height

First flag SSH data for rain and sigma0 bloom

Then compute the mean sea surface MSS

ADT=SSH- MSS+MDT

MDT mean dynamic topography (Rio or SAR)

Across-track current velocity

$$V_g = \frac{g}{f}\frac{d\,ADT}{dx}$$

Problem: because of differentiation V_g is very noisy especially at 20Hz

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Filtering

Filtering should preserve the strong gradient of ADT associated to the strongest current.

Lee filters (Lee, 1981) developed to reduce SAR image speckle noise are based on local statistics (mean, variance) and can be adapted to filter ADT.

The local mean and variance are estimate over 10 -20Hz samples and the samples departing by more than 1.5 std are replaced by the mean and the process is iterated until convergence.

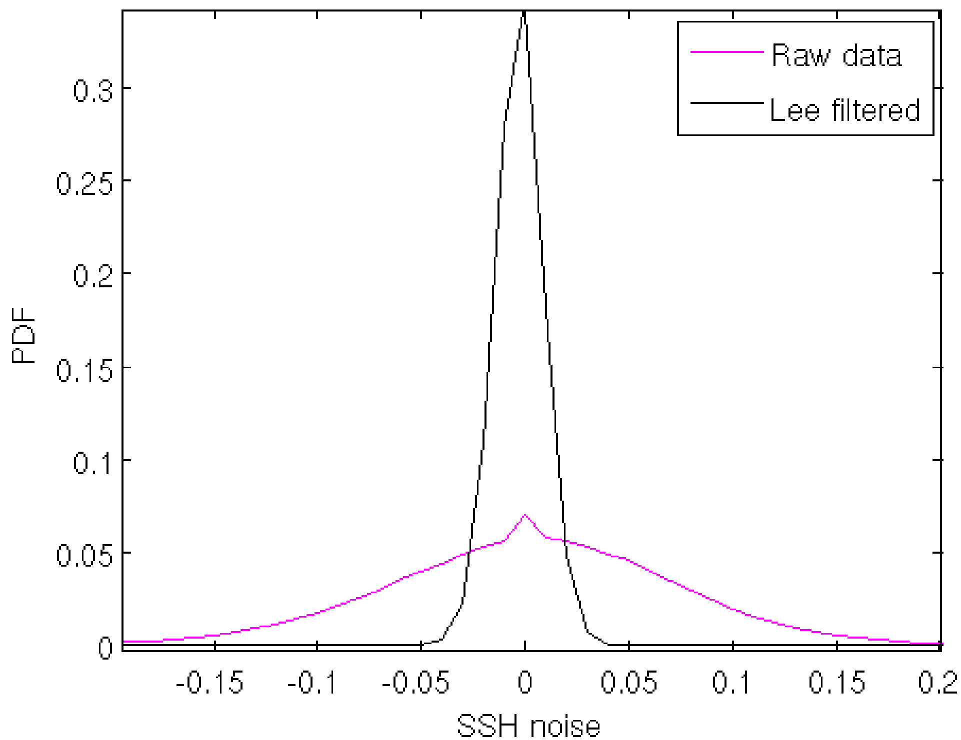
Test of the filter

245 cycles of smoothed along track current

Integration of velocity to compute “true” dynamic topographic

Add noise estimated from real SSH data

Filtering of noisy ADT and comparison with true ADT

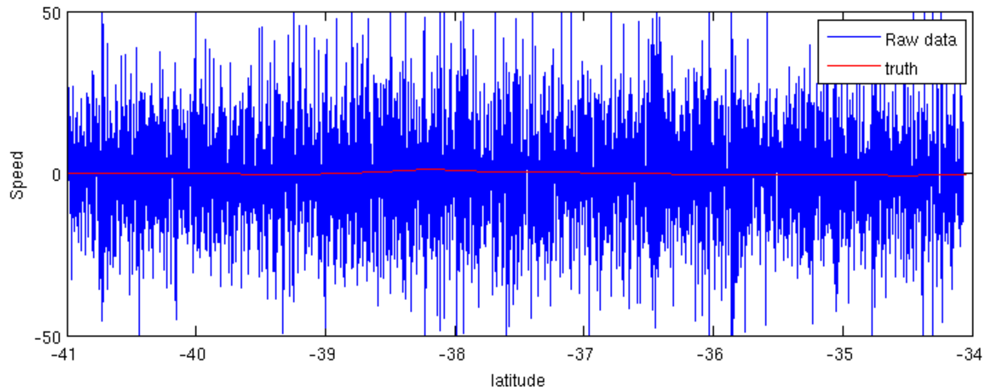


Reduce Std from 0.07 to 0.01

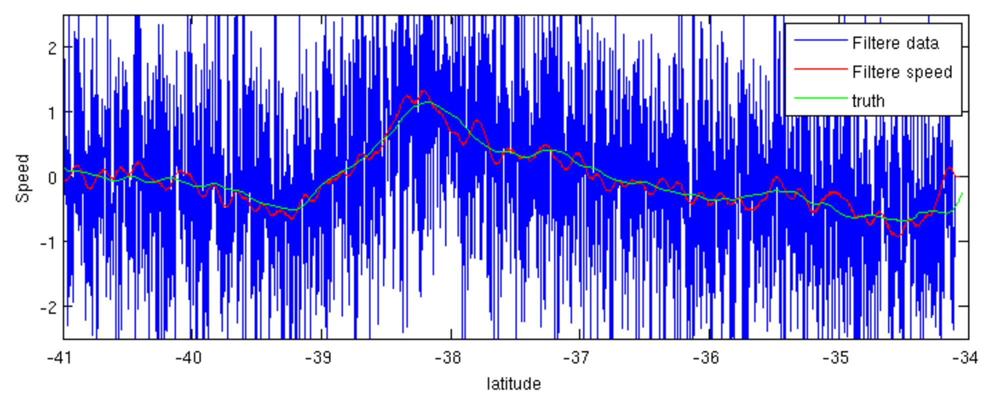
Velocity estimates

Compute velocity from noisy and filtered ADT

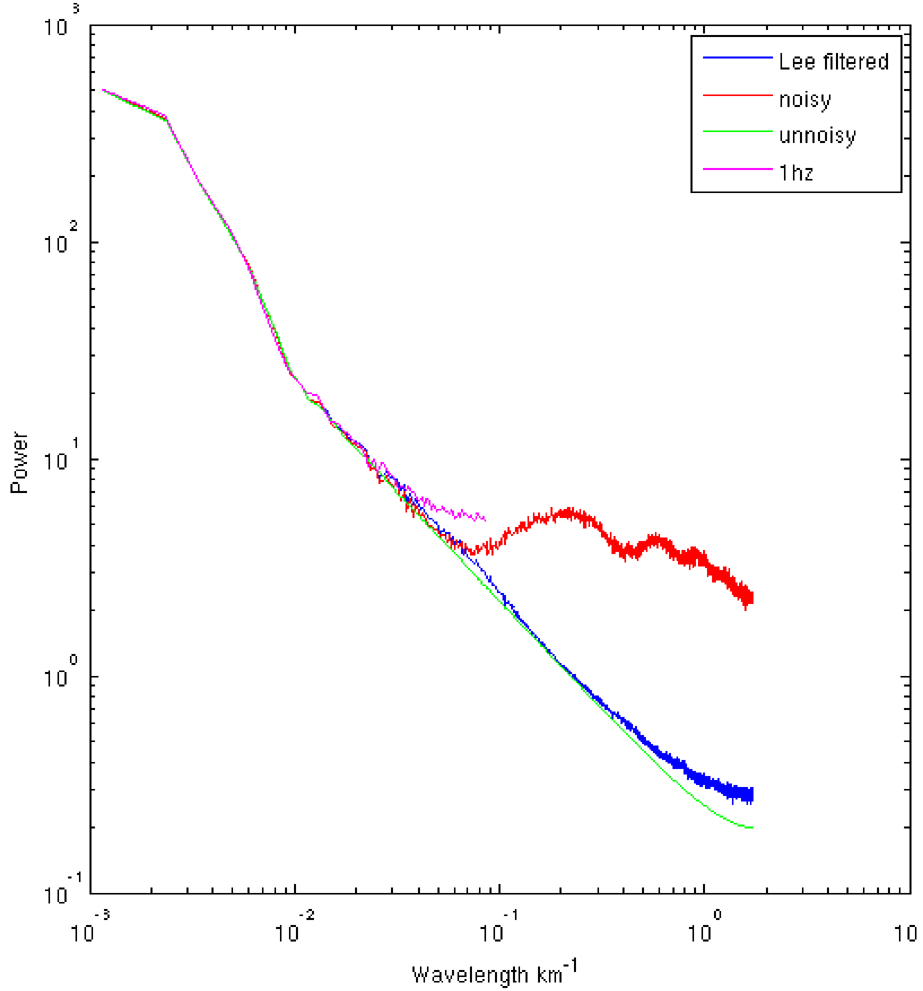
Filter velocity using lee filter and comparison with true velocity



Reduce std from 1,2 m/s to 0.12 m/s



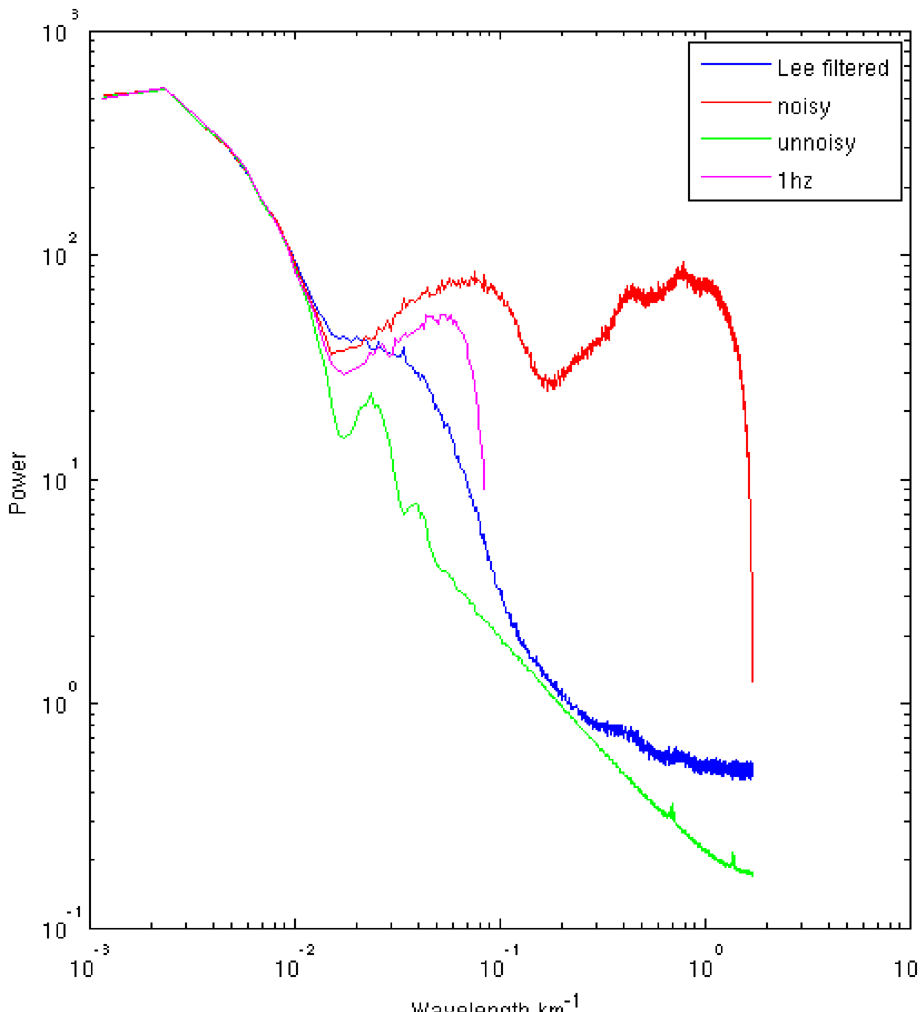
Comparison of spectral behavior ADT



For shh

Lee Filter filters most of the high freq noise in the region not covered by the 1 Hz data

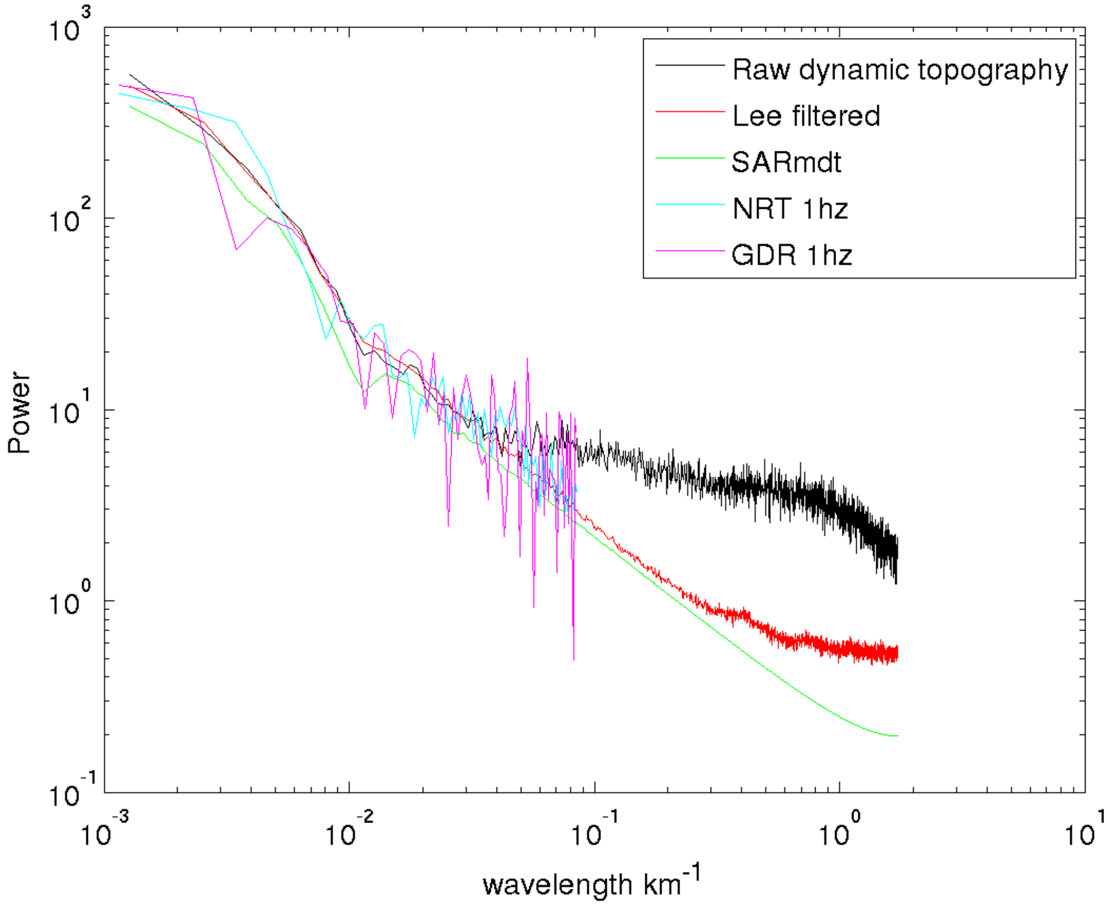
Comparison of spectral behavior Vg



For speed
Still noise for wavelength <10km

Analysis of velocity from the different products

Spectral behavior



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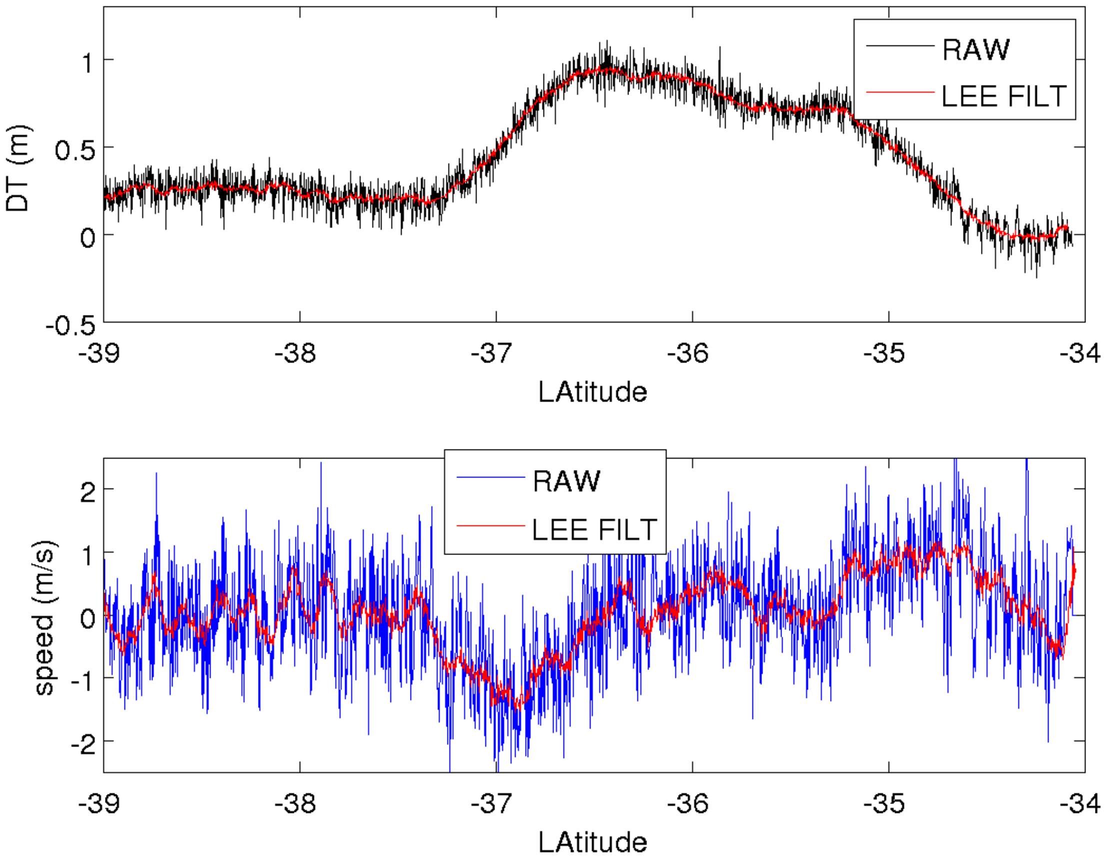
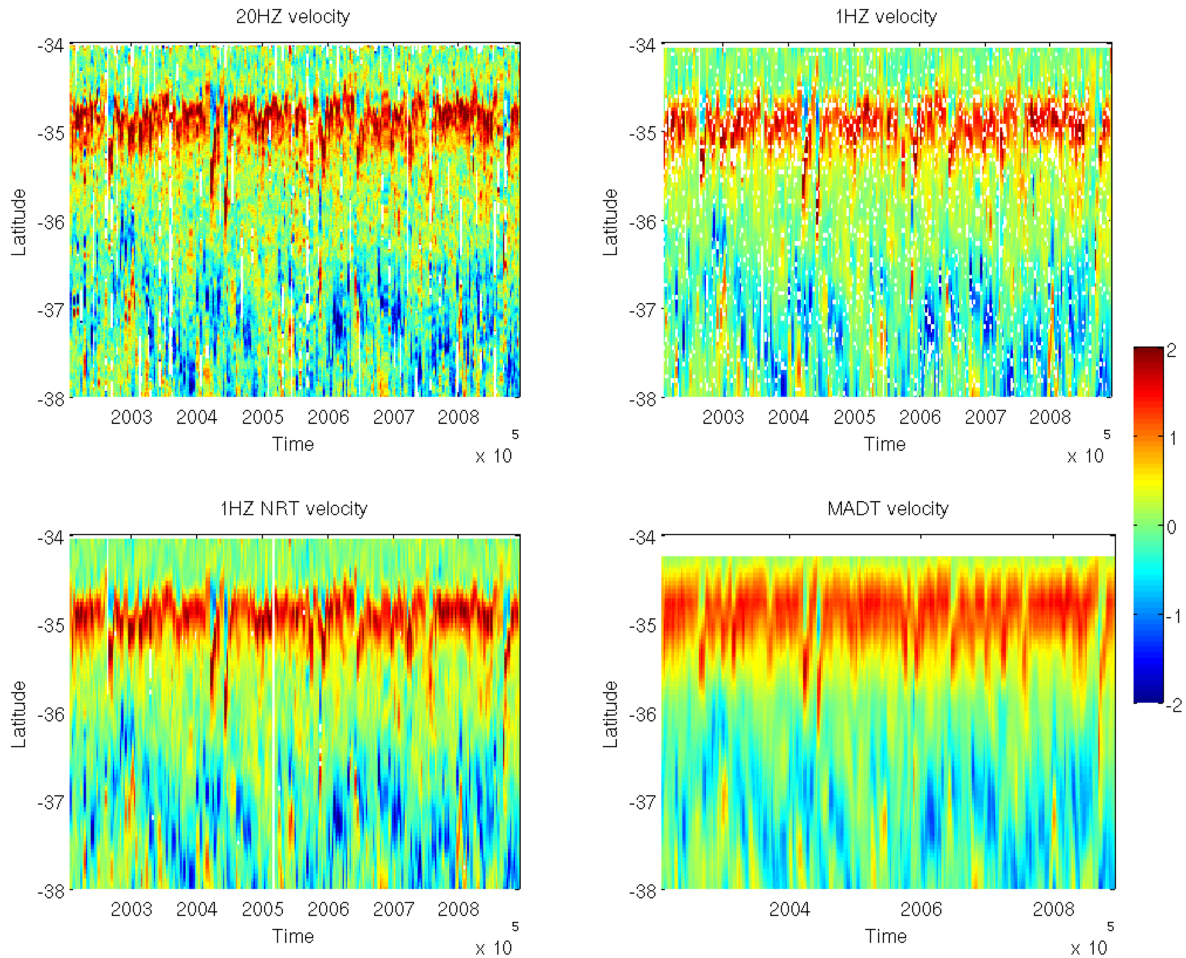
Example of lee filtering of ADT

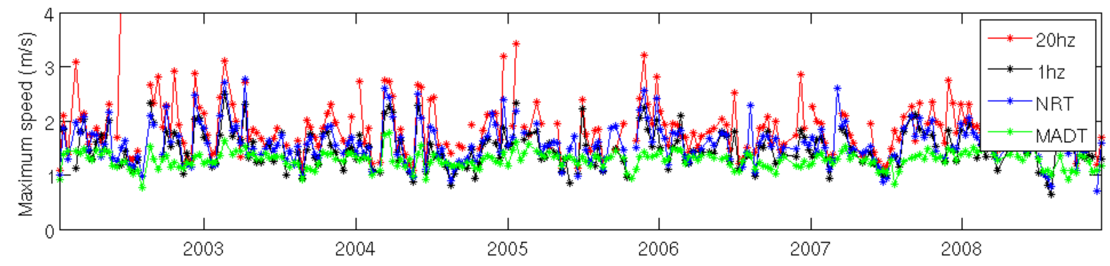


Velocity estimate for 255 cycles of Jason-1 PASS 020

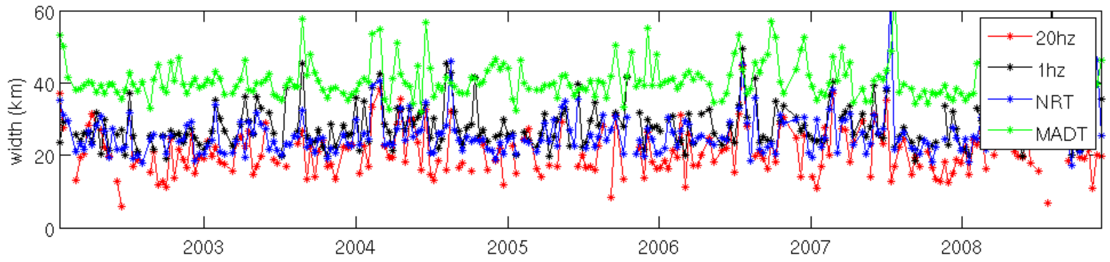


Comparison of the Agulhas current

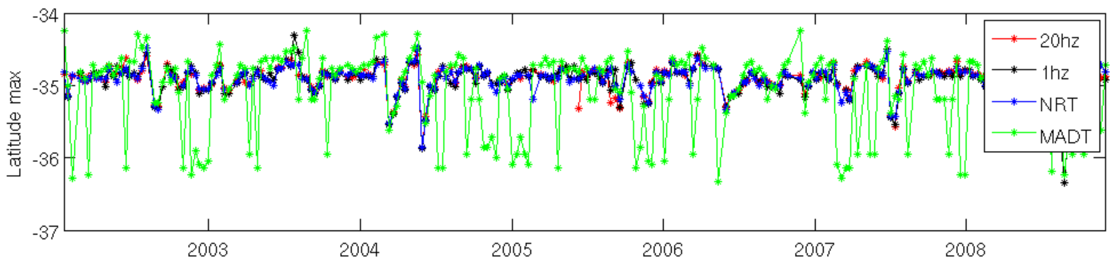
How do these different products represent the Agulhas current?
We used a Gaussian fit of the current for a better comparison



Max vel



Width



Lat max

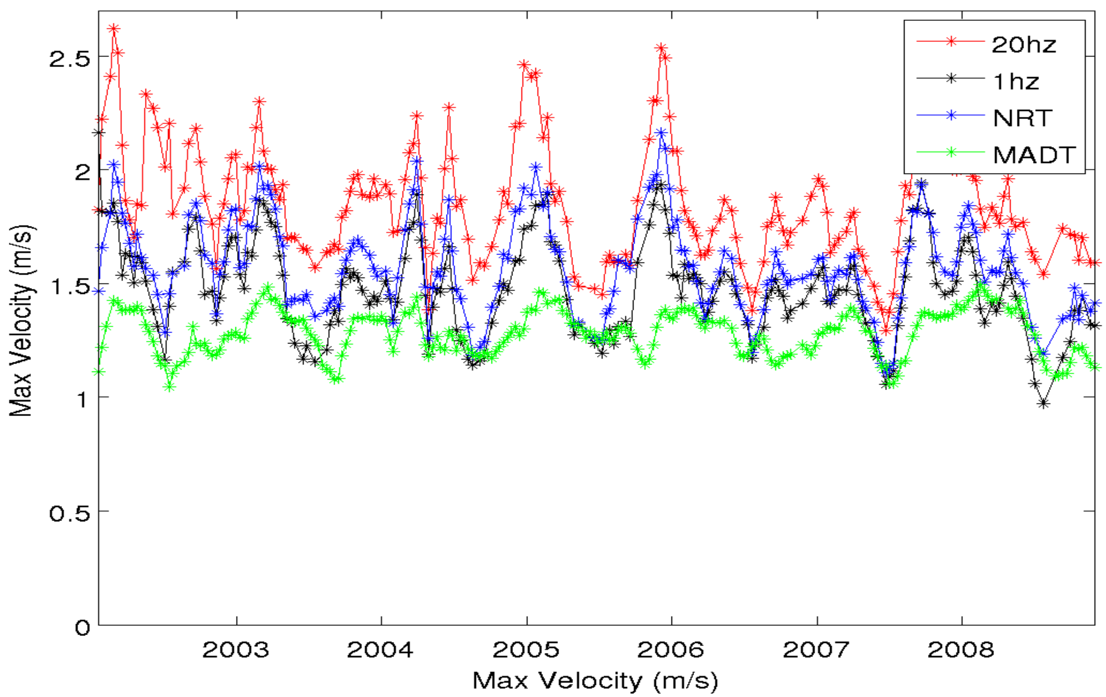
Comparison of Gaussian fit of the Agulhas current

How do these different products represent the Agulhas current.

We used a Gaussian fit of the current for a better comparison

Correlation 20hz-1hz 0.73 20hz-NRT 0.83 20hz-MADT 0.47 1hz-NRT 0.90 1hz-MADT 0.65

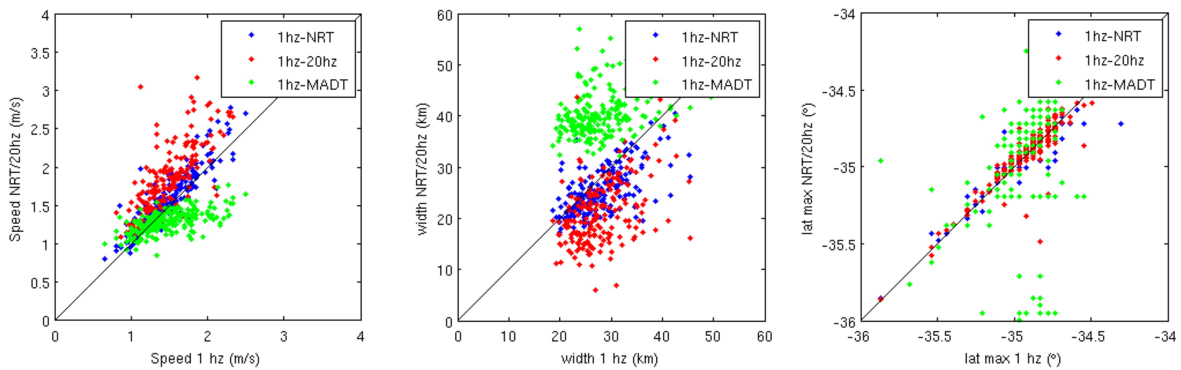
Bias & std 20hz-1hz 0.38+- 0.35 m/s 20hz-NRT 0.29 +- 0.28 m/s 20hz-MADT 0.79+-0.53 m/s NRT-MADT 0.29+-0.30m/s



Max vel
50 days
Running mean

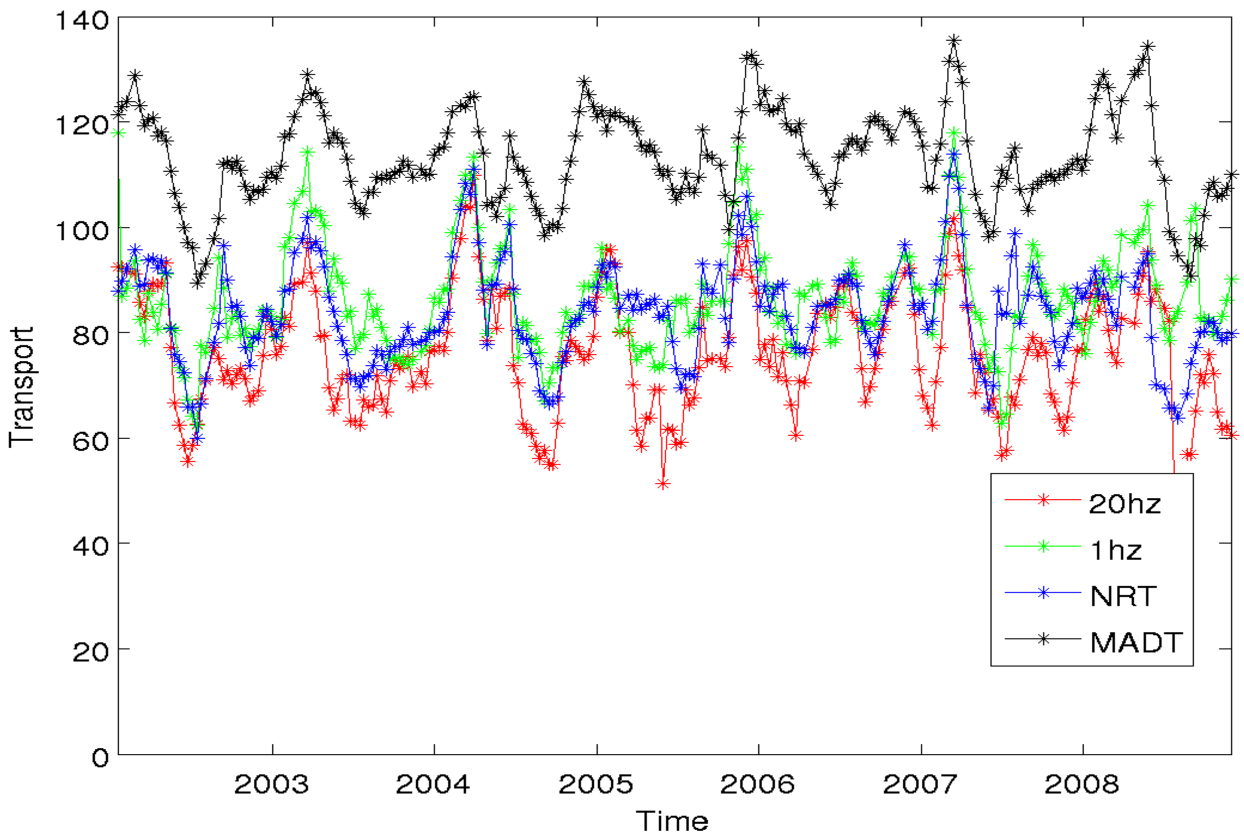
Comparison of Current parameters

- Bias & std 20hz-1hz -7+-4 km 20hz-NRT -4.8+-6.2 km 20hz-MADT -20+-6.8km NRT-MADT -15+-6.2 km
- The position of the current max is almost identical between20hz, 1hz and NRT (corr>.9). For MADT OI smoothed the filed too strongly.
- 20hz gives a narrower and stronger current.



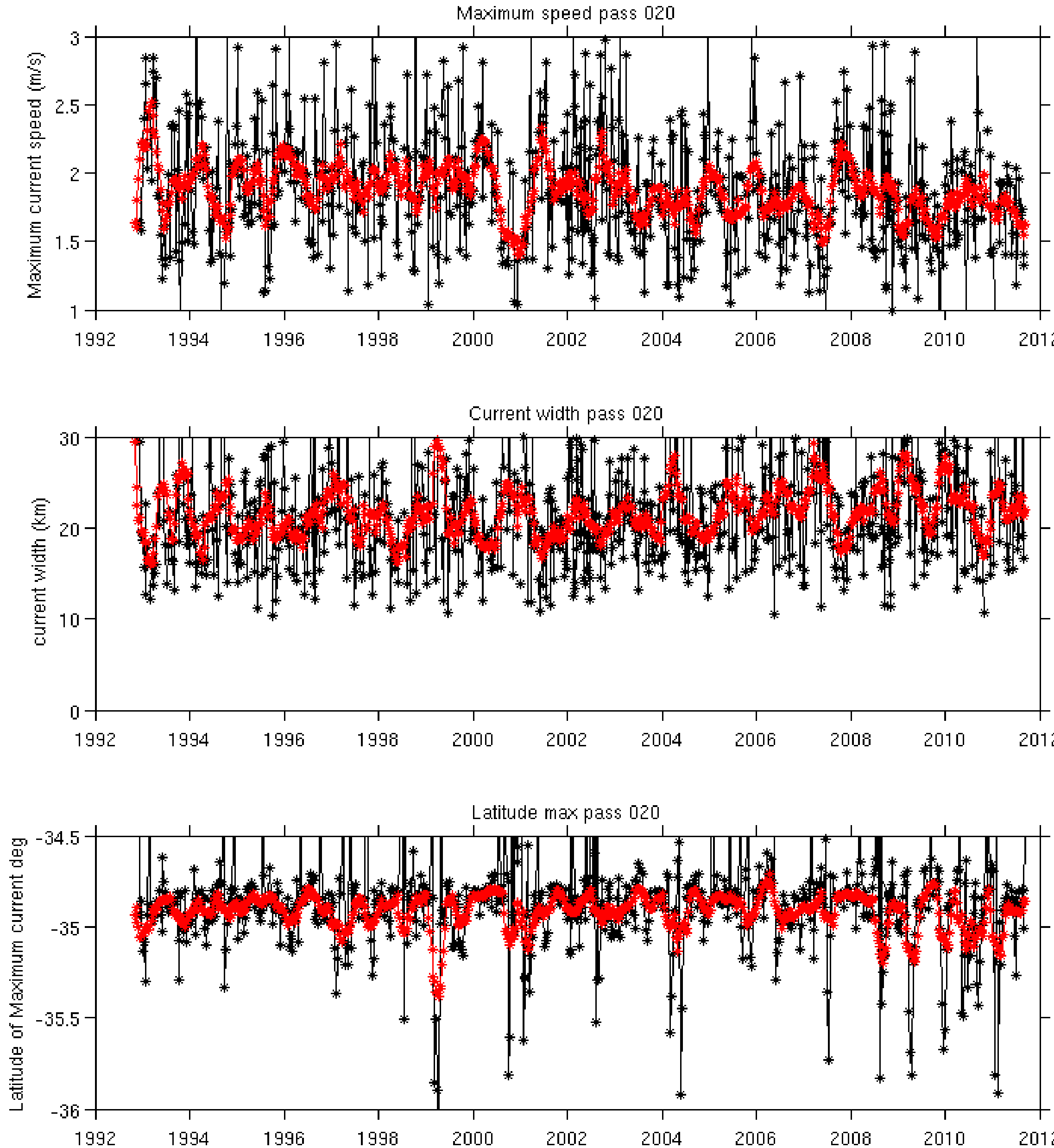
Comparison of "transport"

- Integration of velocity over the width of the current
- NRT, GDR 1Hz in very good agreement
- Some discrepancies between1hz and 20 hz with higher variability for 20 hz
- Transport overestimated by MADT and low frequency variability well reproduced



Conclusion

- Estimation of velocity from 20hz possible and pertinent with specific filtering
- The comparison between 20 and 1hz estimate shows a good agreement and shows that the smoothing introduced by 1hz averaging leads to an underestimation of velocity and a widening of the current.
- 20 hz are certainly essential to study mesoscale structure or coastal currents
- OI velocity fields gives a very smoothed picture of the reality with reduced temporal and spatial variability. The velocity are underestimated by ~50%.


Maximum speed pass 020
Maximum current speed (m/s)
3
2.5
2
1.5
1
1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012
Current width pass 020
current width (km)
30
20
10
0
1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012
Latitude max pass 020
Latitude of Maximum current deg
-34.5
-35
-35.5
-36
1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012