DOPSCAT

Feasibility Investigation of Global Ocean Surface Current Mapping using ERS, MetOp and QuikScat Wind Scatterometer

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DOPSCAT OBJECTIVES

DOPSCAT aims at assessing the potential of scatterometer instruments for sea surface current retrieval.

The objectives are twofold:

- To obtain some preliminary new results from existing scatterometer data capitalizing on new signal processing techniques;
- To propose an optimized scatterometer concept maintaining the good directional NRCS detection performances and coverage for wind vector retrieval but, at the same time, allowing Doppler shift estimation with sufficient accuracy for surface current measurement.

Scope

We will consider a dynamic range of surface currents spanning from:

-0.05 m/s to 4 m/s
-        with a retrieval accuracy of ~ 0.10 m/s
-        at a spatial resolution of approximately 10 km
-        and at a temporal resolution of 12-24 hours.

Note that better accuracy (cm/s) is needed over longer integration time.

The requirements for tidal and near coastal currents in terms of resolution and time variability are very demanding. They are better suited to be covered by coastal HF/VHF radars and therefore not considered further in this Doppler scatterometer study.

Doppler shift

- ENVISAT/ASAR provides the Doppler shift (or centroid anomaly) since 2007

$$f_{Dca} \equiv f_{Dc} - f_{Dp}$$

- f_{Dc} is the measured Doppler centroid defined as the radar return frequency shift at the antenna beam center
- f_{Dp} is the predicted Doppler shift arising from the relative velocity of the satellite and rotating Earth (Hansen et al, IEEE 2011).

θ

V_{radial}

V_{horiz}

Sea surface velocity
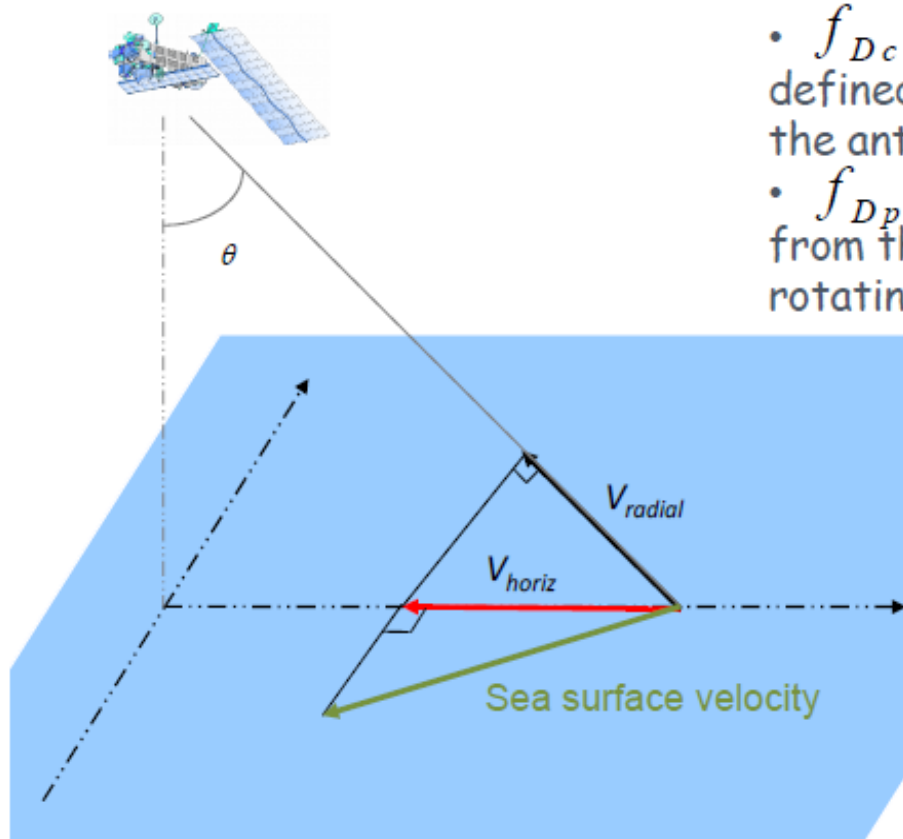
$$\Delta f = \frac{2 \cdot V_{radial}}{\lambda}$$

⇒ Only the radial component of the sea surface displacements contributes to the geophysical Doppler shift

• **Third order**: interactions between
Advanced physically based models are
modification of wind-wave spectrum by
Hypotesis: At relatively low resolution
km), the averaged interactions between current and wind are negligible in
the measured Doppler anomaly. Effect Neglected.
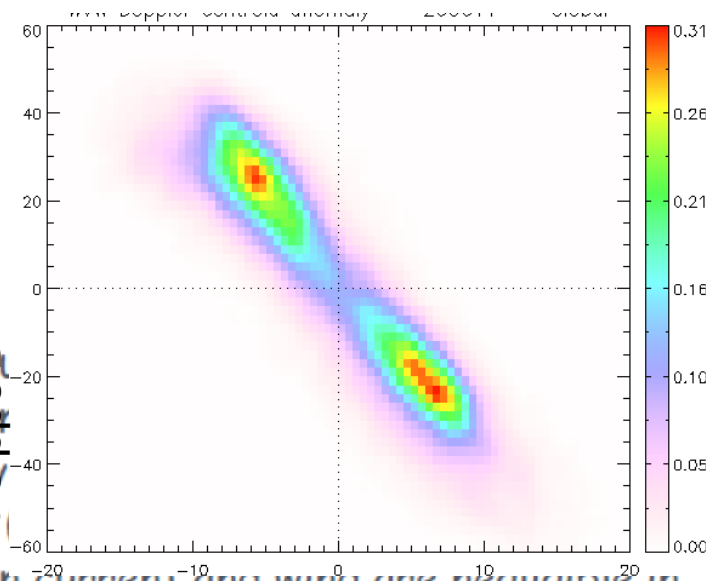
Doppler

Radial wind

Chapron et al., JGR 2005

Doppler shift

Observed Doppler velocities = background sea state + underlying current + sea state perturbated by surface current.

• **First order** : background sea state.
<u>Hypothesis:</u> The background sea state can be described by the surface wind vector information. The relatively small scales in the sea state are the the major contributors to the Doppler and also happen to be generally in equilibrium with the surface wind.

• **Second order**: underlying current
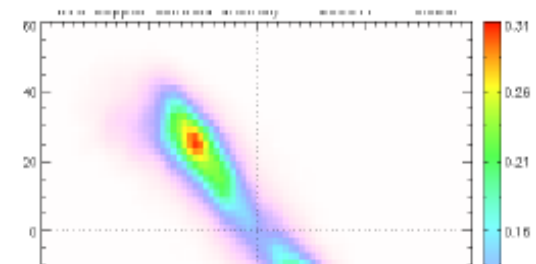
• **Third order**: interactions between current and wind, swell…
Advanced physically based models are needed to take into account modification of wind-wave spectrum by surface current gradients.
<u>Hypotesis:</u> At relatively low resolution (typically greater than 10 km by 5 km), the averaged interactions between current and wind are negligible in the measured Doppler anomaly. Effect Neglected.

Chapron et al., JGR 2005

Doppler-Wind GMF

- Good correlation of Doppler and wind vector

- Good sensitivities in both speed and

W_wind9   2481 upwind (black)   2830 downwind (red)
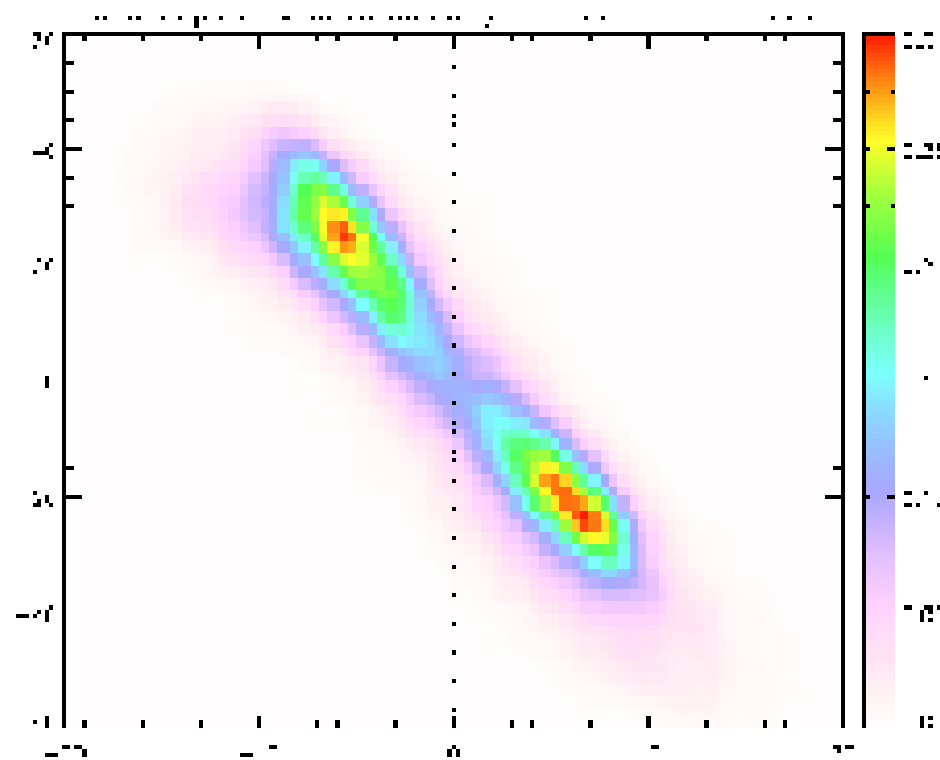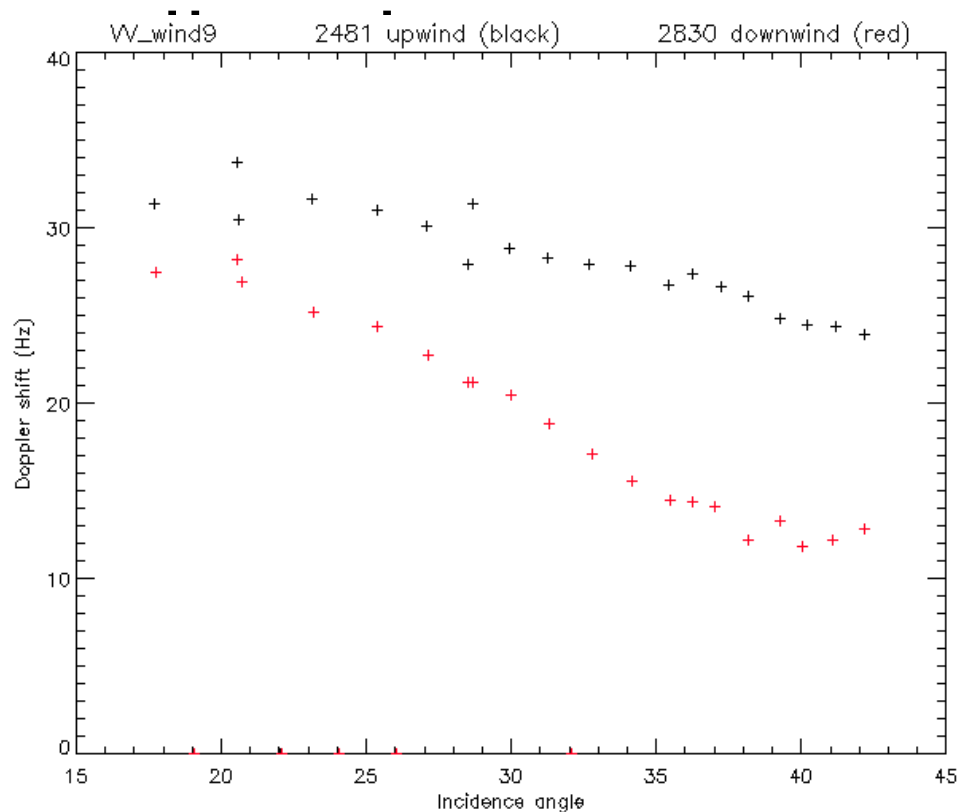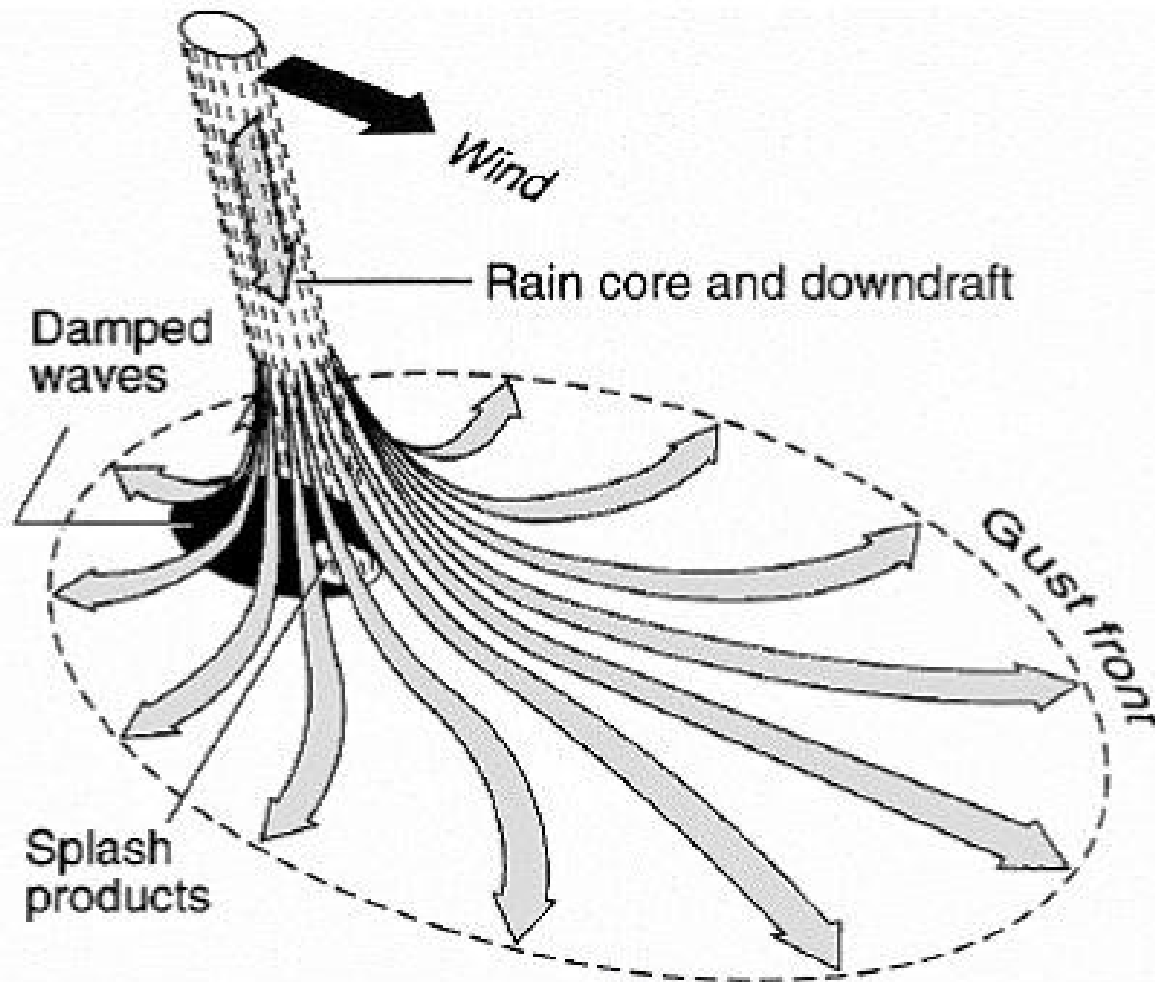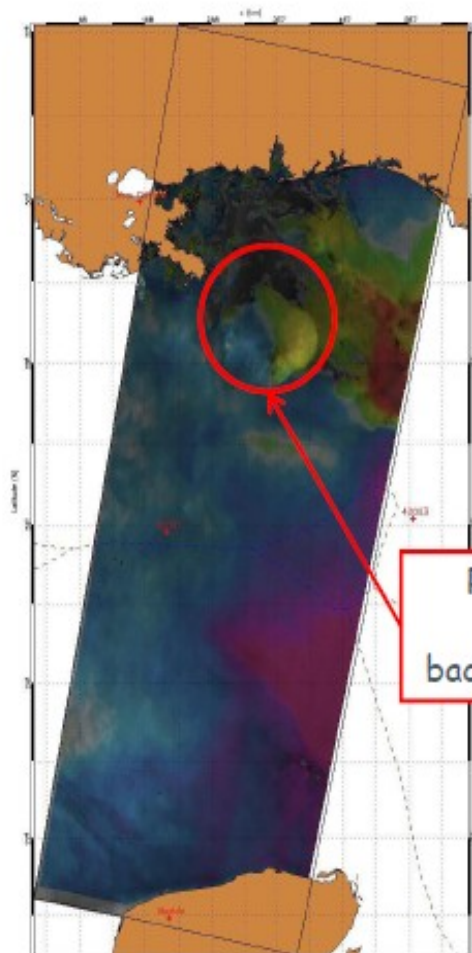
Example: rain cell

Figure 17.1. Schematic sketch of the downdraft associated with a rain cell. The downdraft spreads over the sea surface, causing and enhanced roughening of the sea surface and, thus, an increase in the backscattered radar power [After *Atlas*, 1994b].
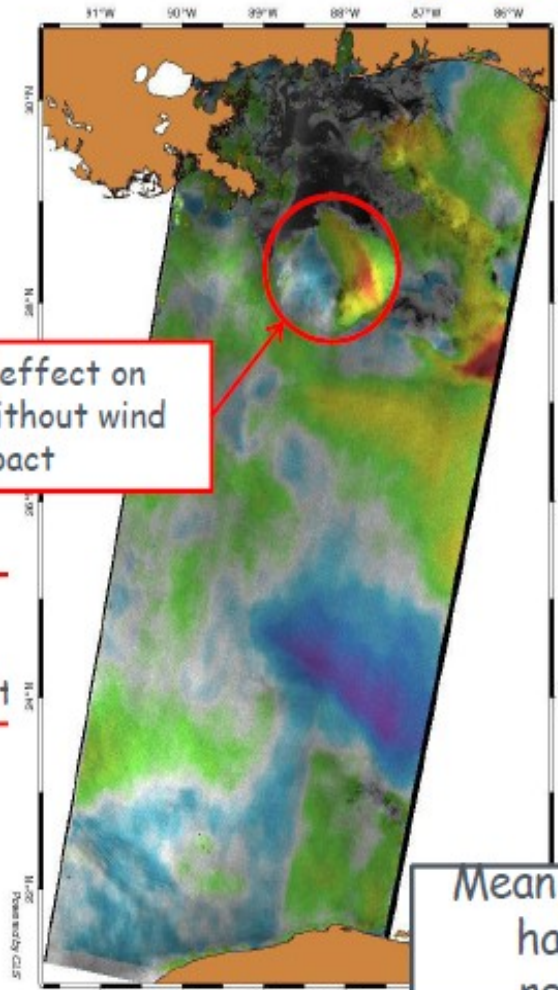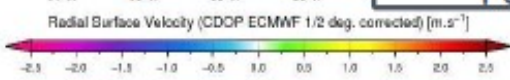
Doppler & Rain cells

Rain cell effect on Doppler without wind impact

Rain cell effect on Doppler with background wind impact

Doppler with all geophysical contributions

Mean wind flow has been removed

02–July–2010 15:54:15 (UTC)
ENVISAT WSM Product

Radial Surface Velocity (CDOP ECMWF 1/2 deg. corrected) [m.s⁻¹]

Doppler & Rain cells

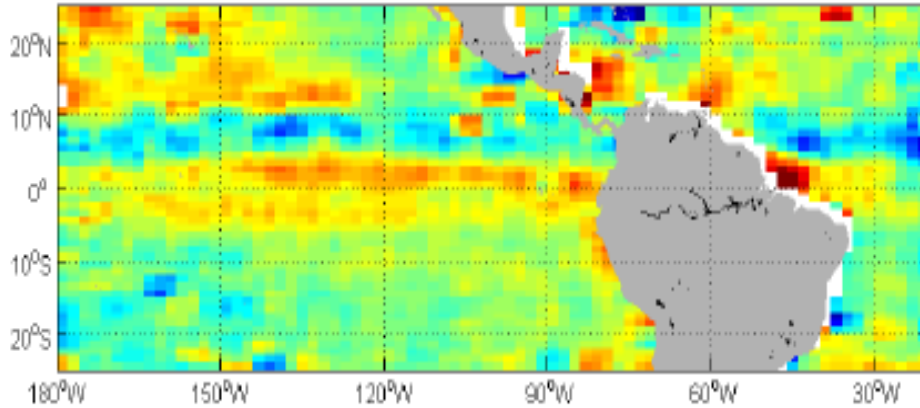Wind inversion only performed where no strong current is detected
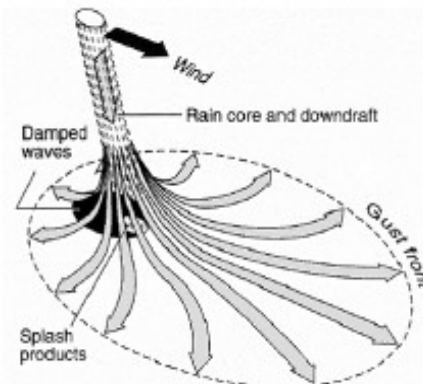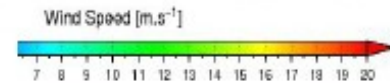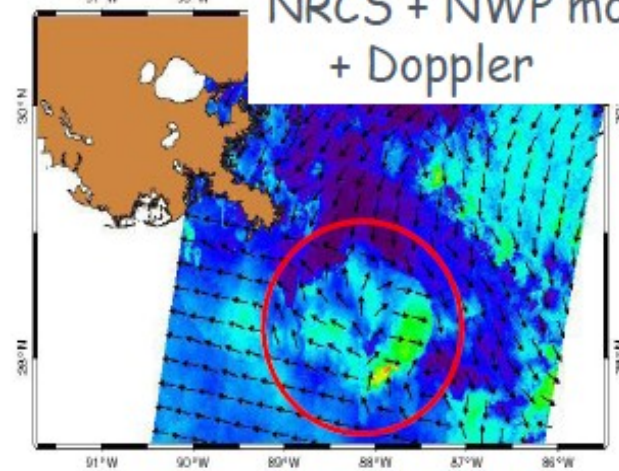
ENVISAT Doppler currents

- Residual provides current in ASAR line of sight

Doppler Anomaly/Velocity
(ASAR WM)

Radial Wind Speed
(ECMWF)

CDOP

Doppler Anomaly/Velocity
predicted (NNT)

−

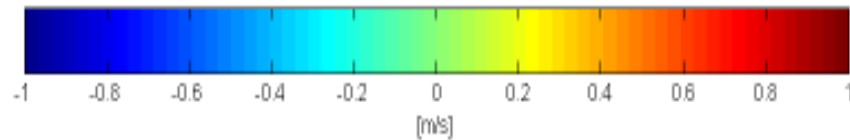Residual Doppler Anomaly
(current)
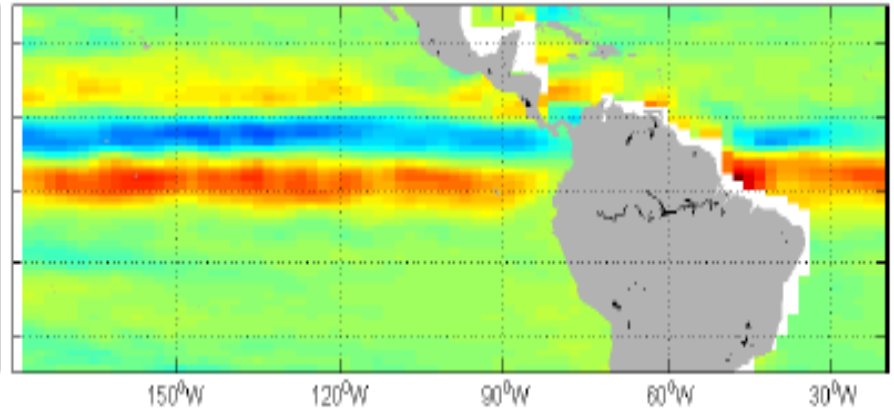
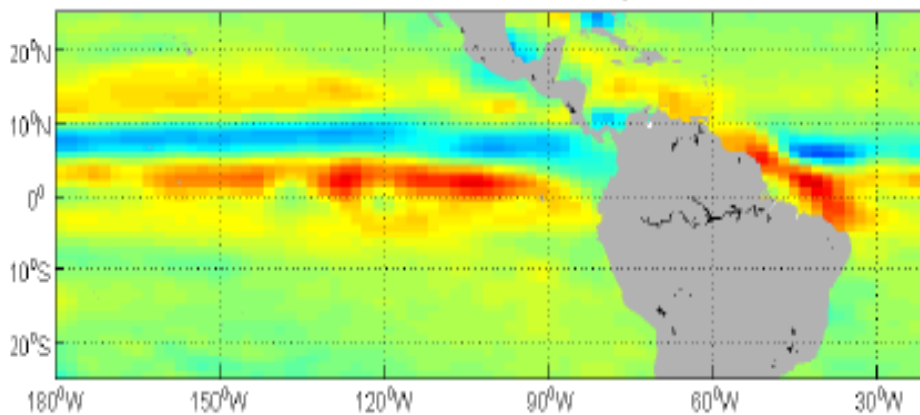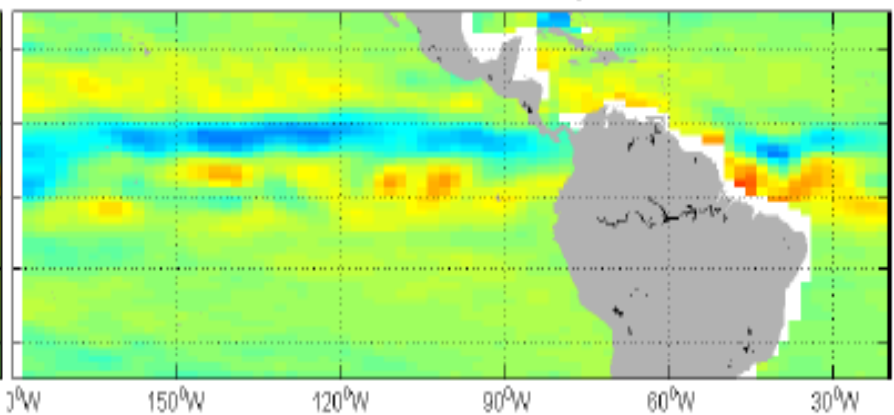Collard al., SEASAR 2008
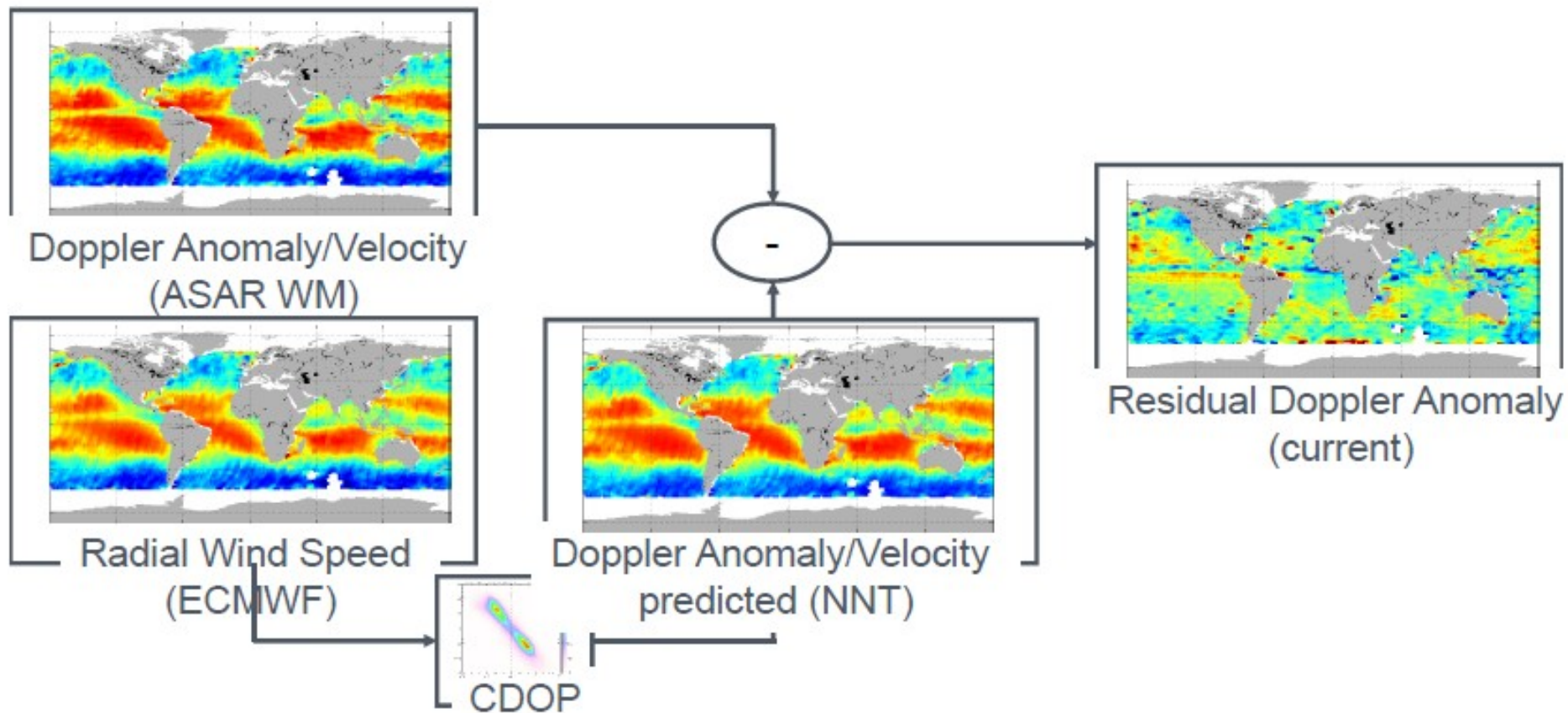
Near the equator

2006/11- Residual Radial Velocity
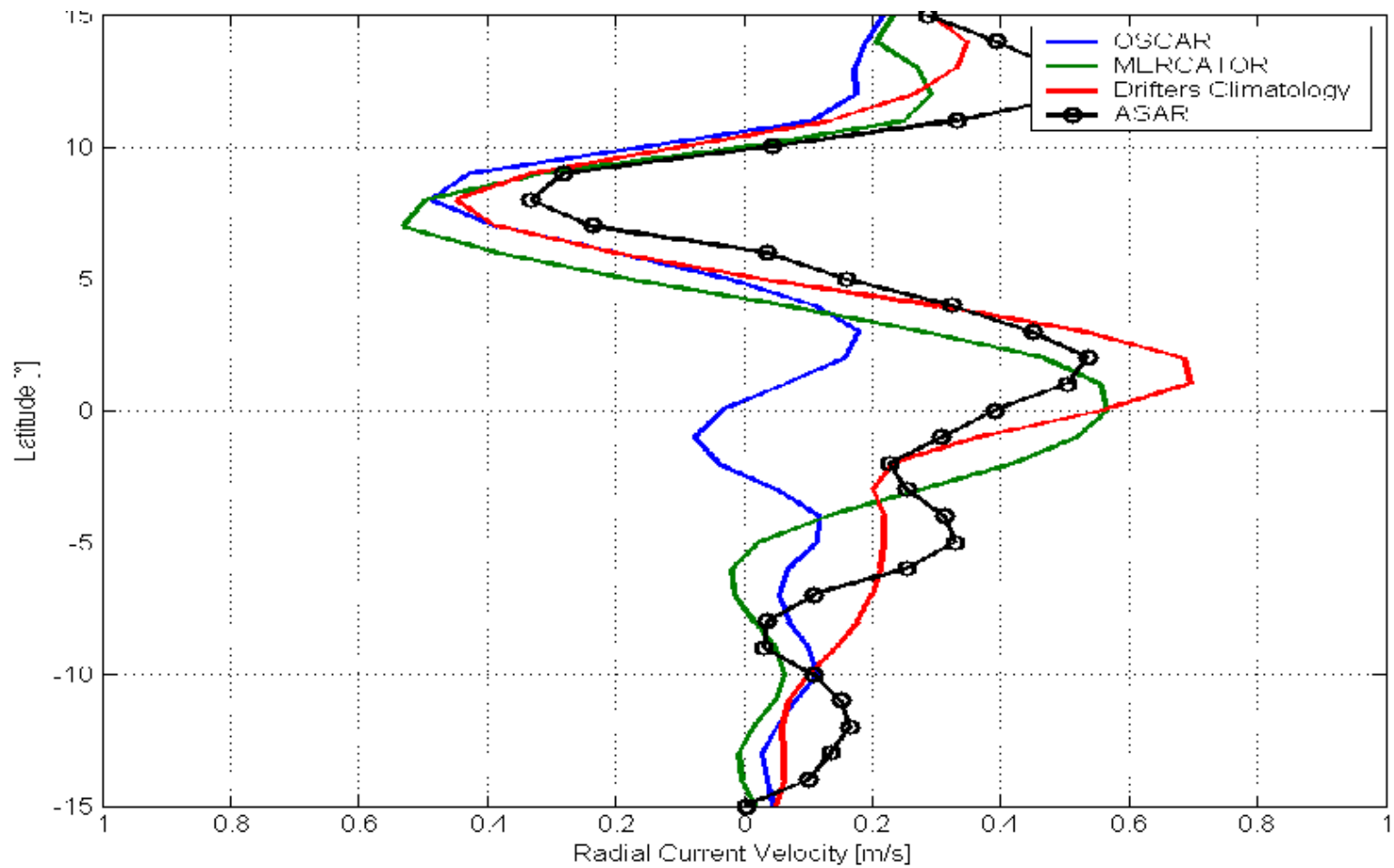
2006/11- MERCATOR Radial Velocity
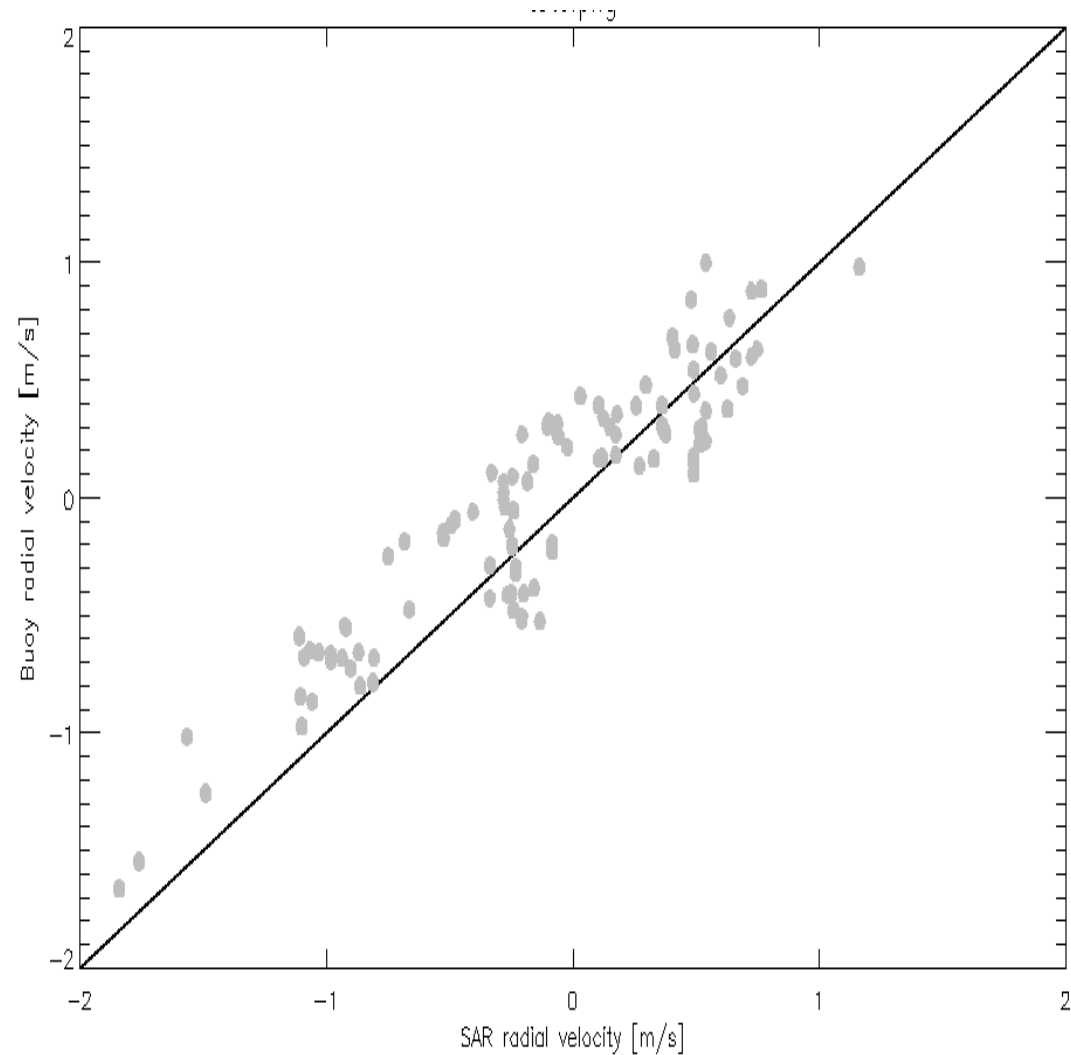
[m/s]

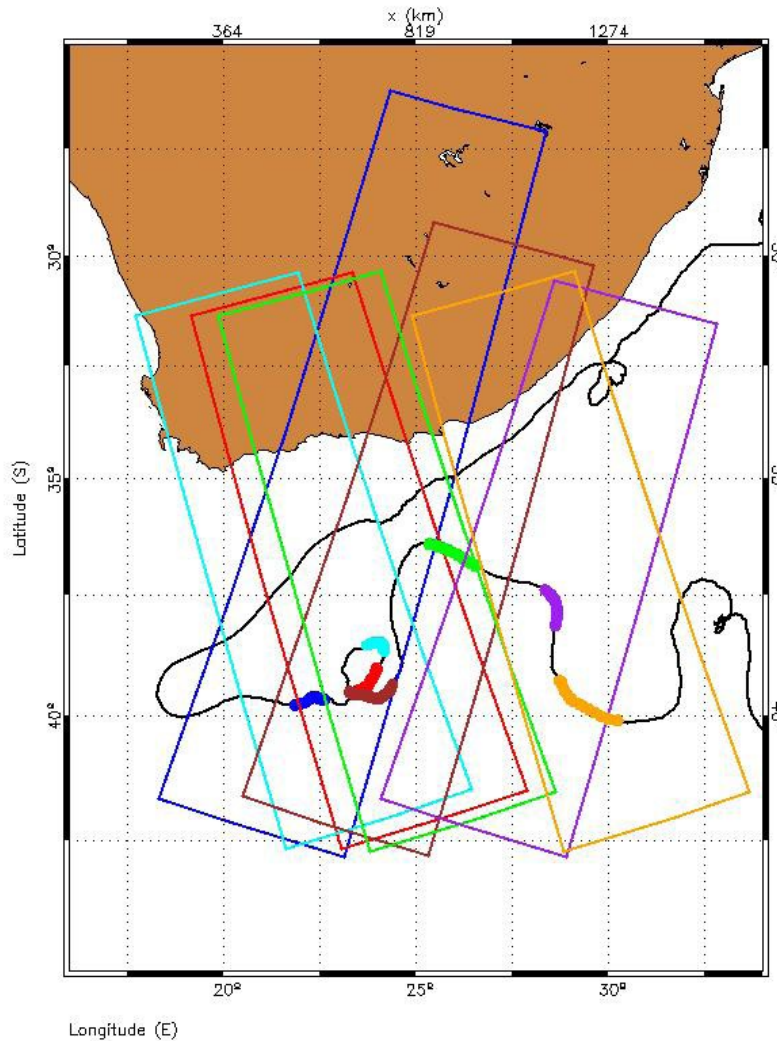November - Drifter Radial Velocity
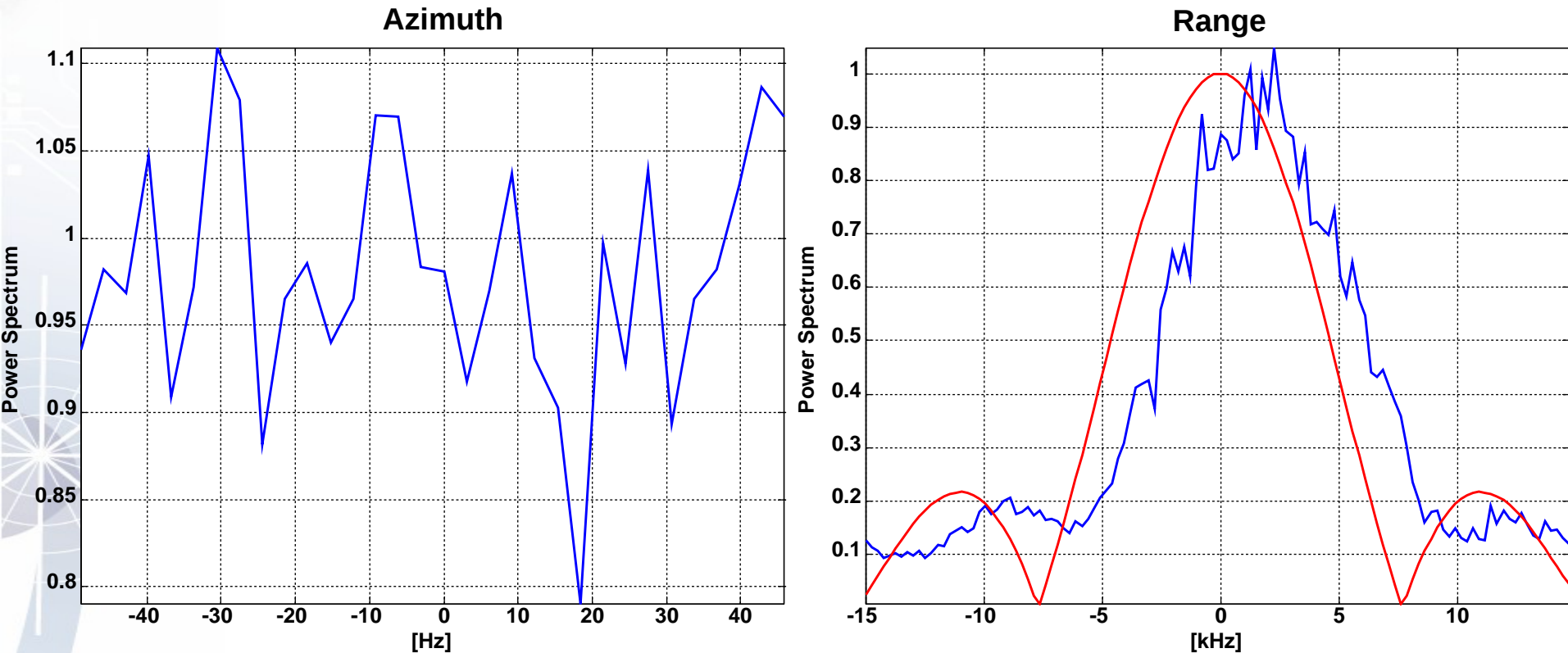
2006/11- OSCAR Radial Velocity

@ 128 W

Agulhas verification

ERS-2 scatterometer data spectral analysis (EWIC)

➤ Just a brief analysis on the spectral content of the EWIC data was performed until now

➤ DC estimation from EWIC data is critical due to very low sampling frequencies

Summary

- Ocean current information is a needed complement to scatterometer winds
- Doppler is only related to the sea in absence of current
- Doppler can be used for wind inversion
- In areas with strong and large currents, relative wind (NRCS) and current (Doppler) vector measurements are needed for interpretation/application
- A combined inversion scheme should enable to do both wind and current vector retrieval
- Apply SAR knowledge for design of a wind and current scatterometer
- Principles being tested for static fan-beam ERS-2 scatterometer