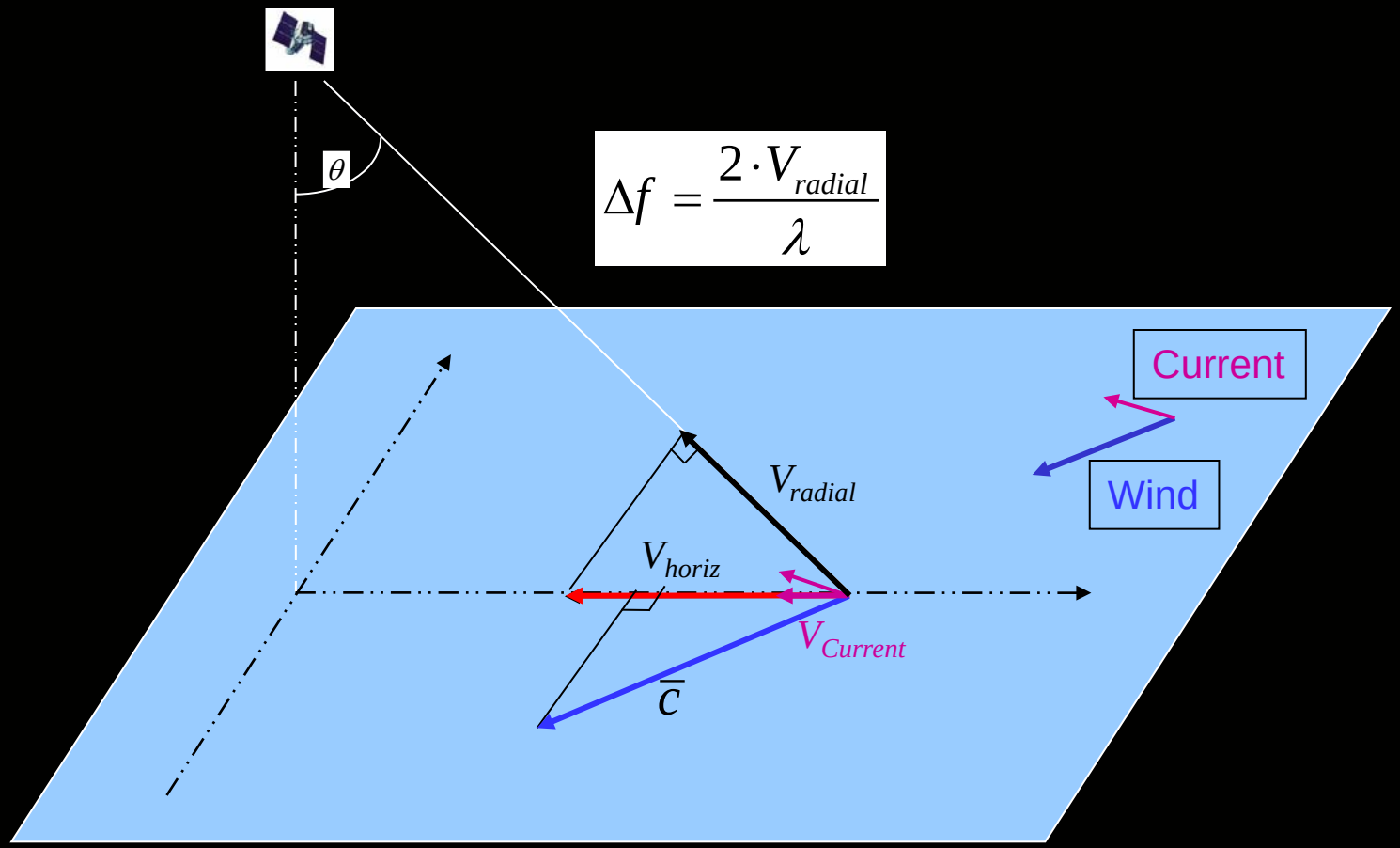
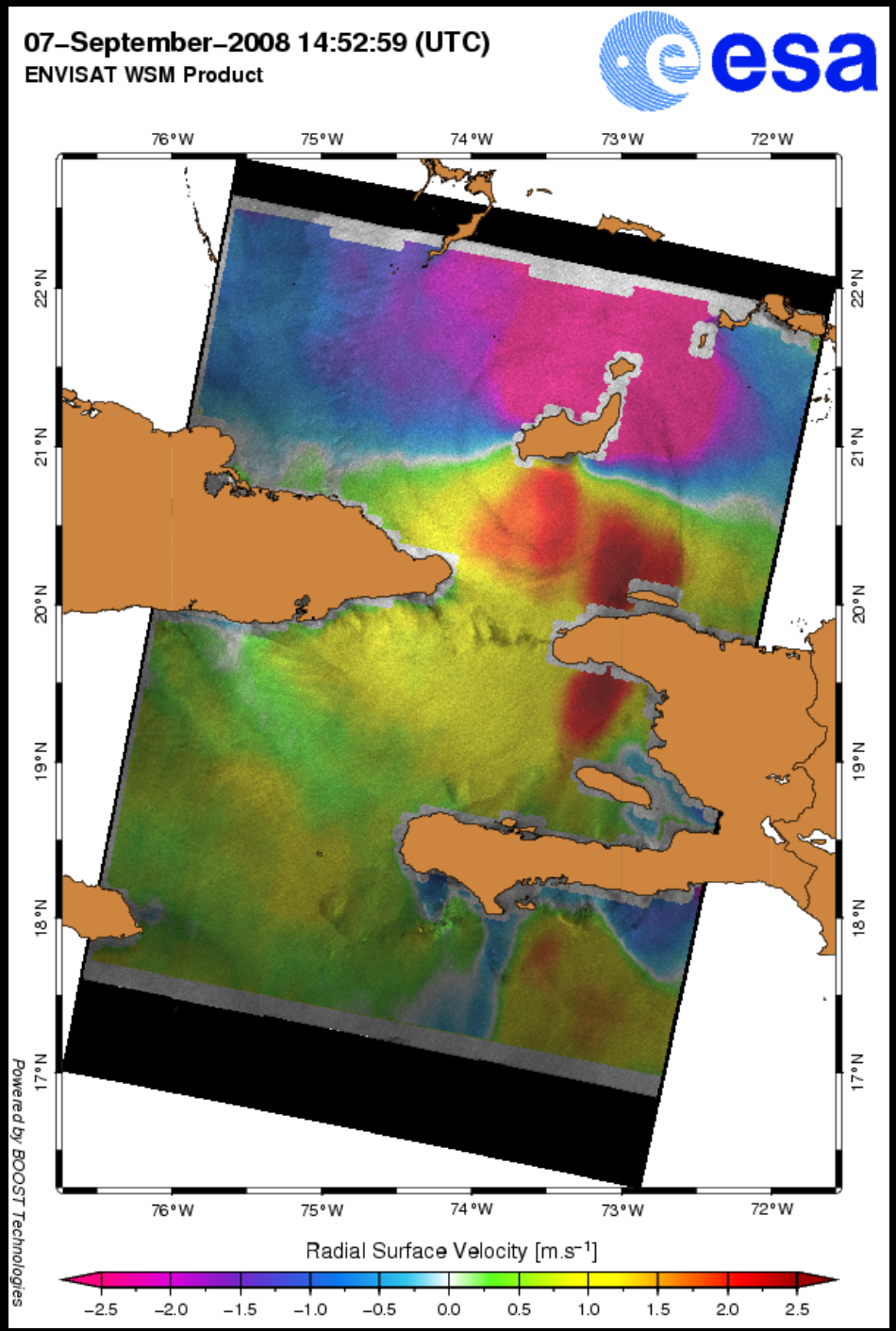
On the use of Doppler shift for SAR wind retrieval

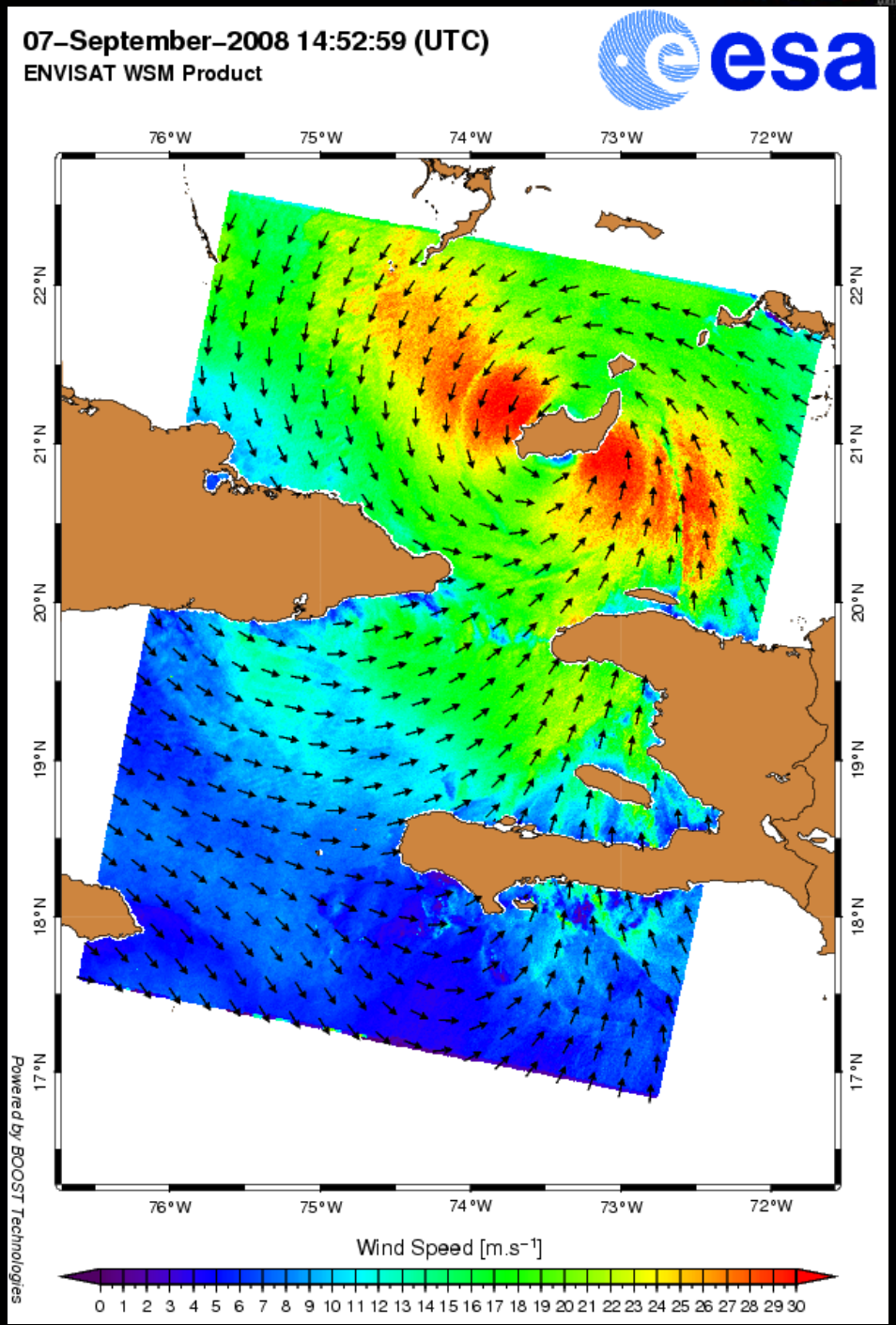
F. COLLARD, A. MOUCHE, B. CHAPRON
CLS/IFREMER Brest, FRANCE

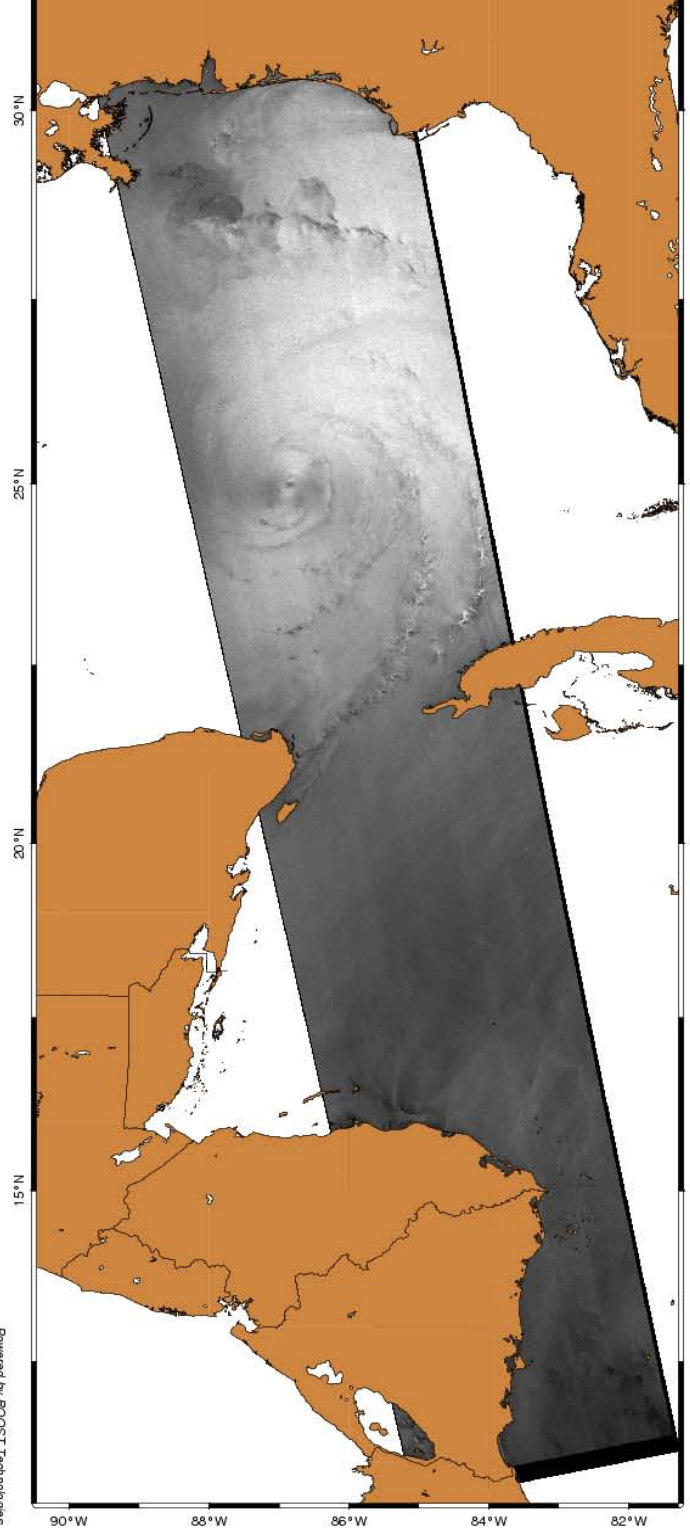
From Doppler shift to Doppler velocities

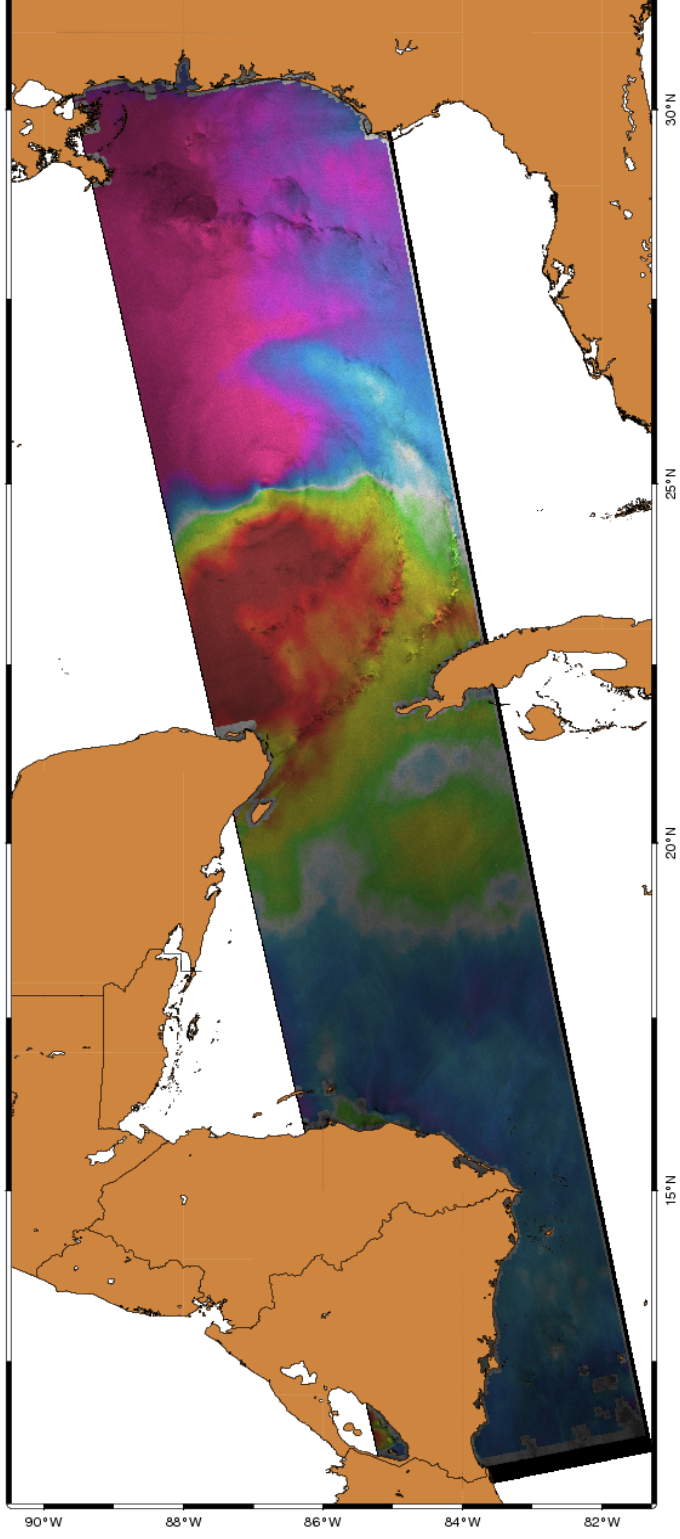


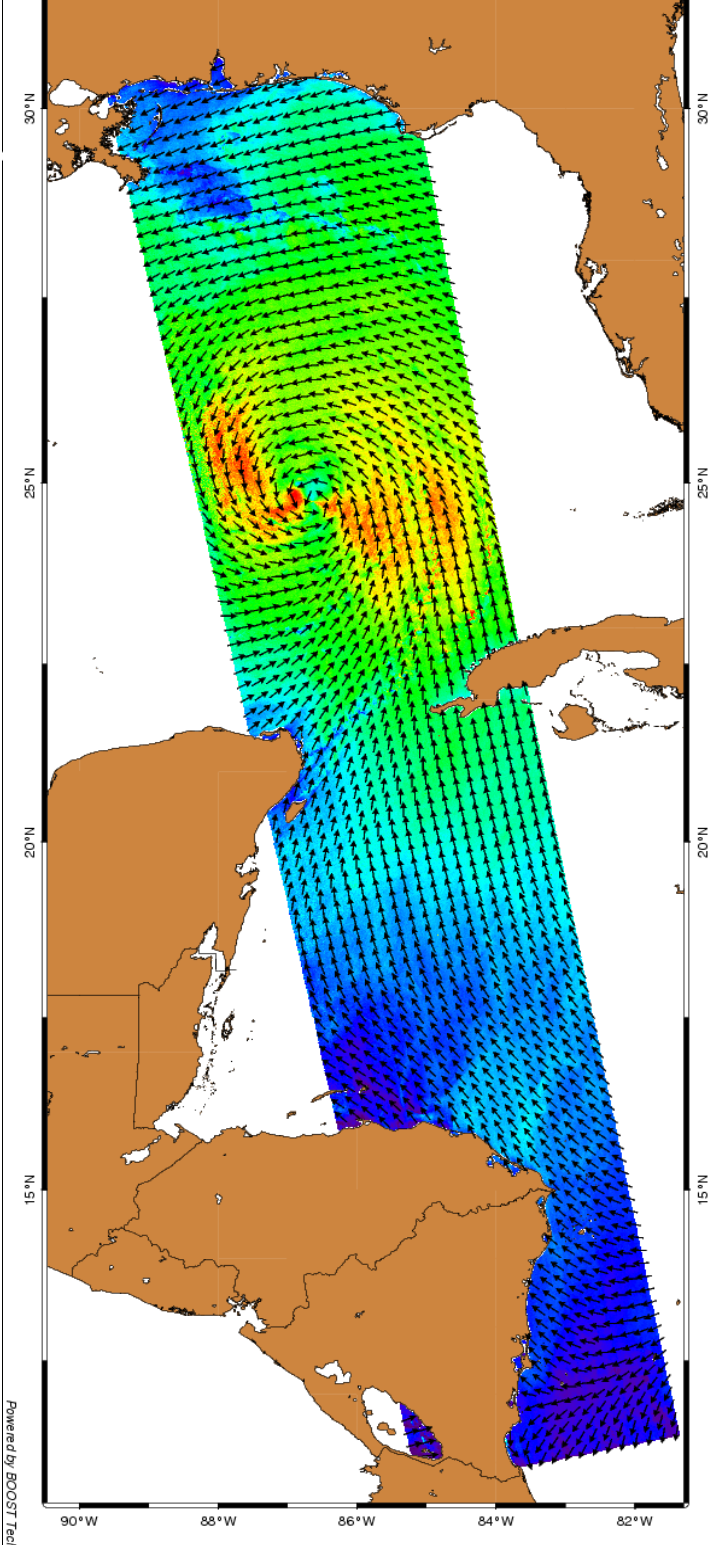
Doppler velocities vs SAR wind






30°N
25°N
20°N
15°N
90°W
88°W
86°W
84°W
82°W

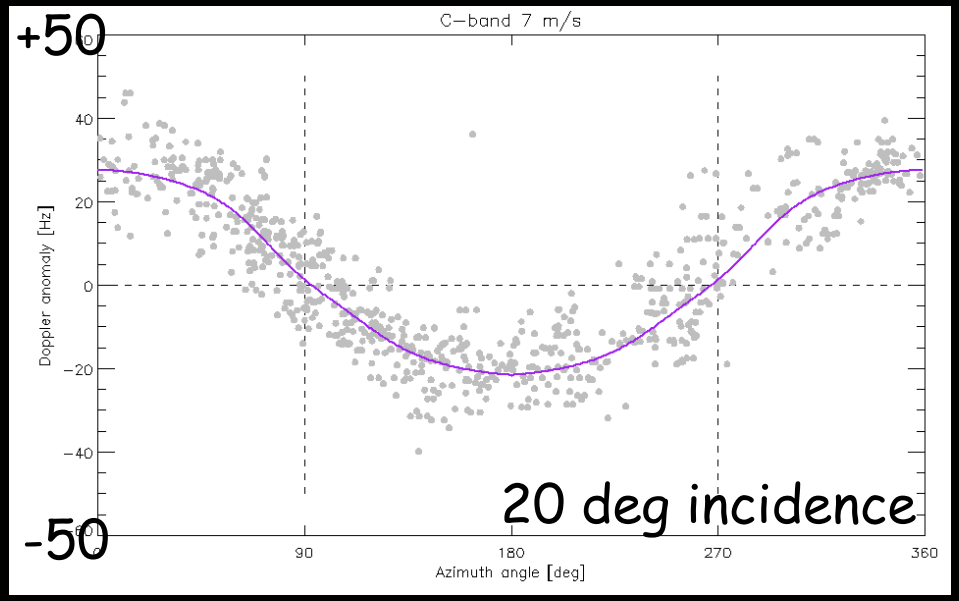

30°N
25°N
20°N
15°N
90°W
88°W
86°W
84°W
82°W
Radial Surface Velocity [m.s⁻¹]


30°N
25°N
20°N
15°N
90°W
88°W
86°W
84°W
82°W
Wind Speed [m.s⁻¹]
Powered by BOOST Technologies

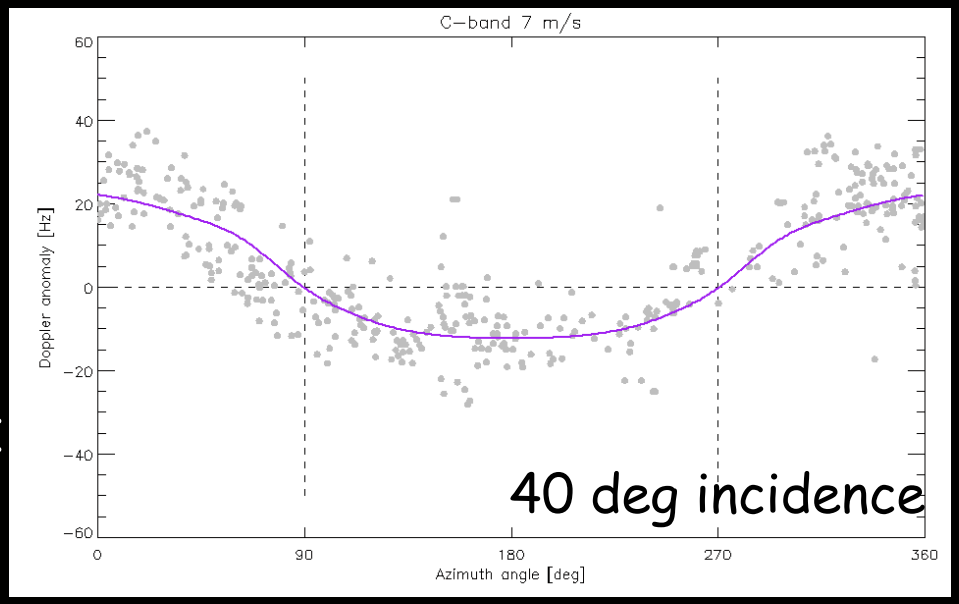
C band VV polarization Doppler shift

CDOP : Cband VV pol Doppler GMF based on ASAR/ASCAT collocation

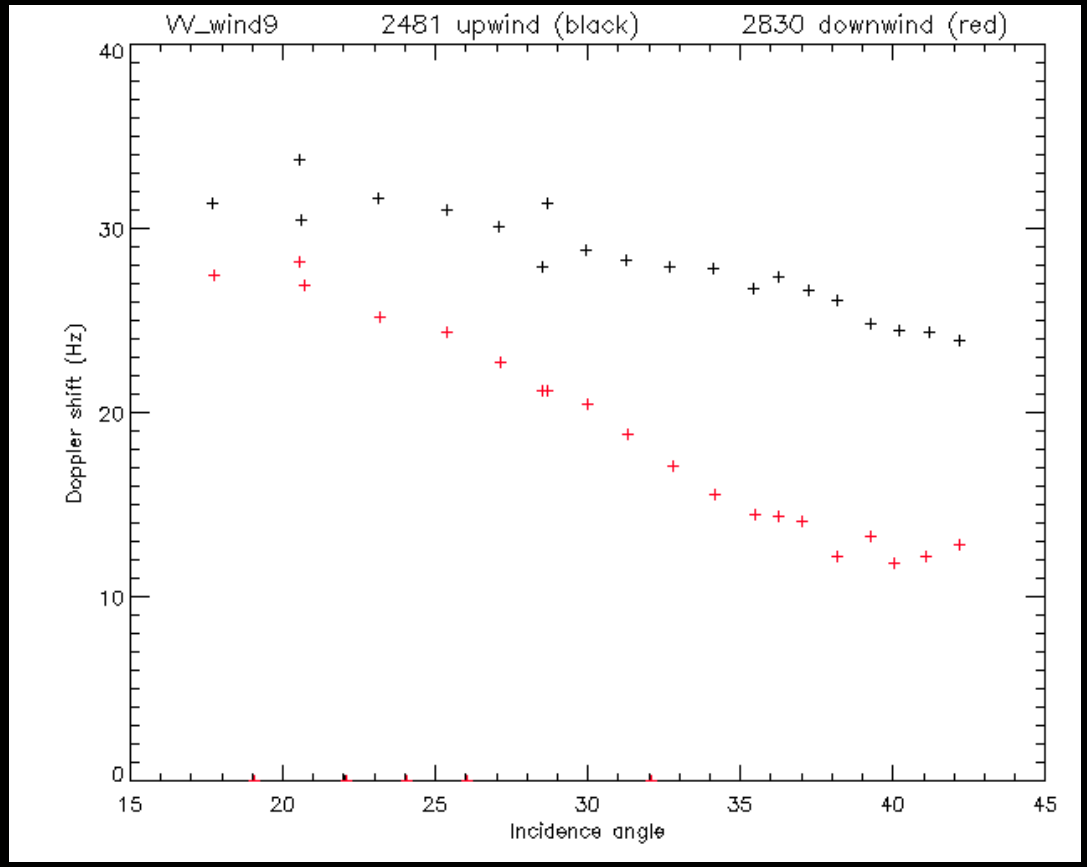
Doppler shift (Hz)



Doppler shift (Hz)

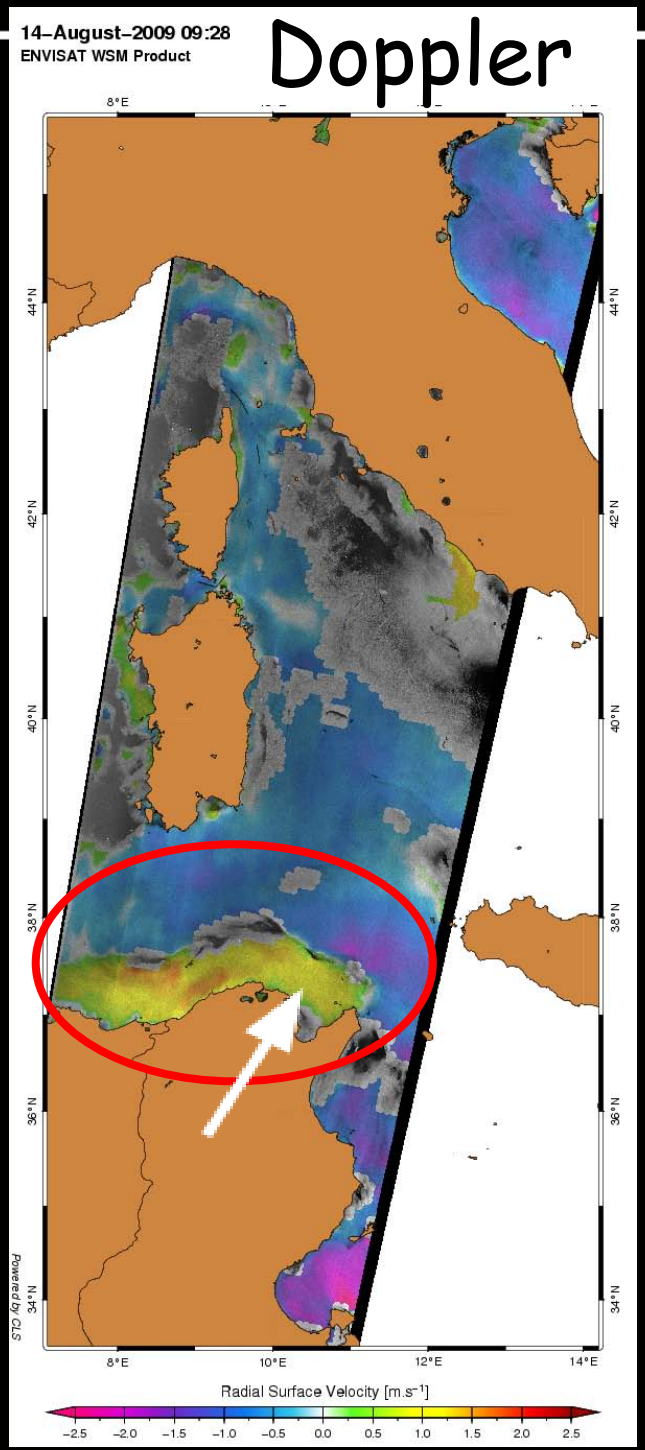


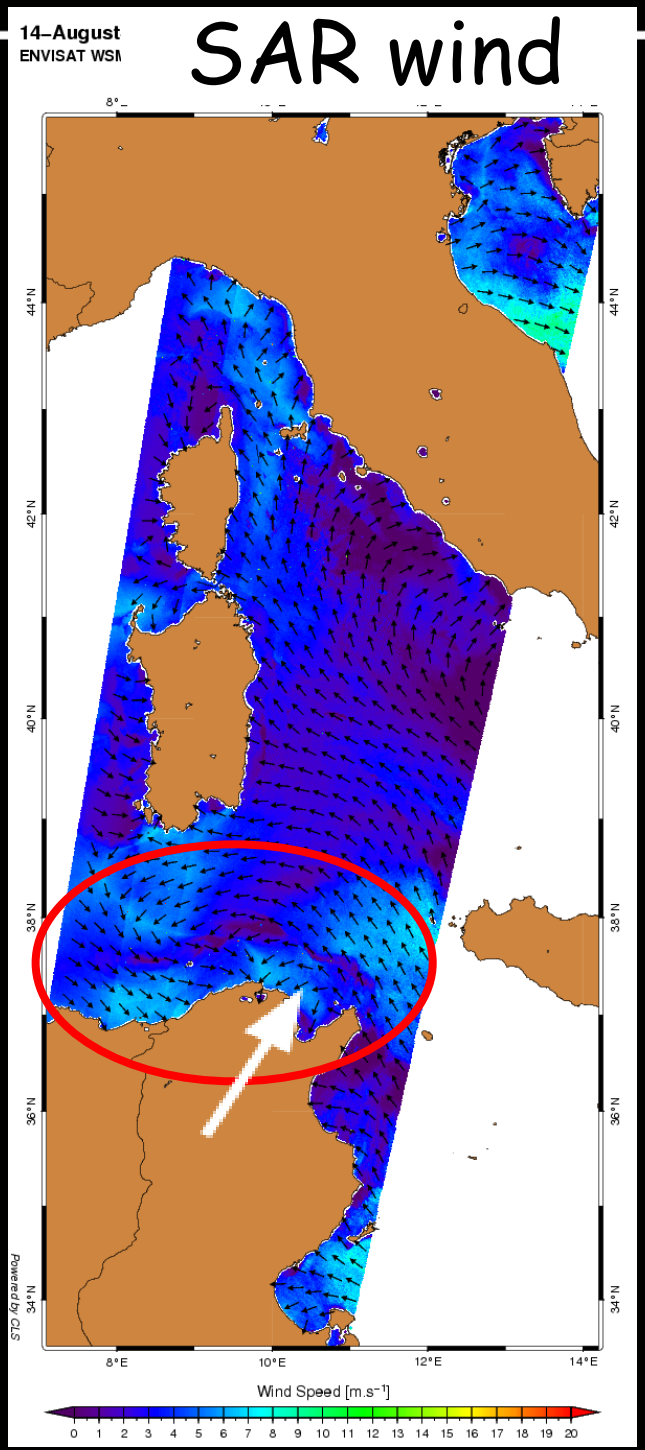
Azimuth angle



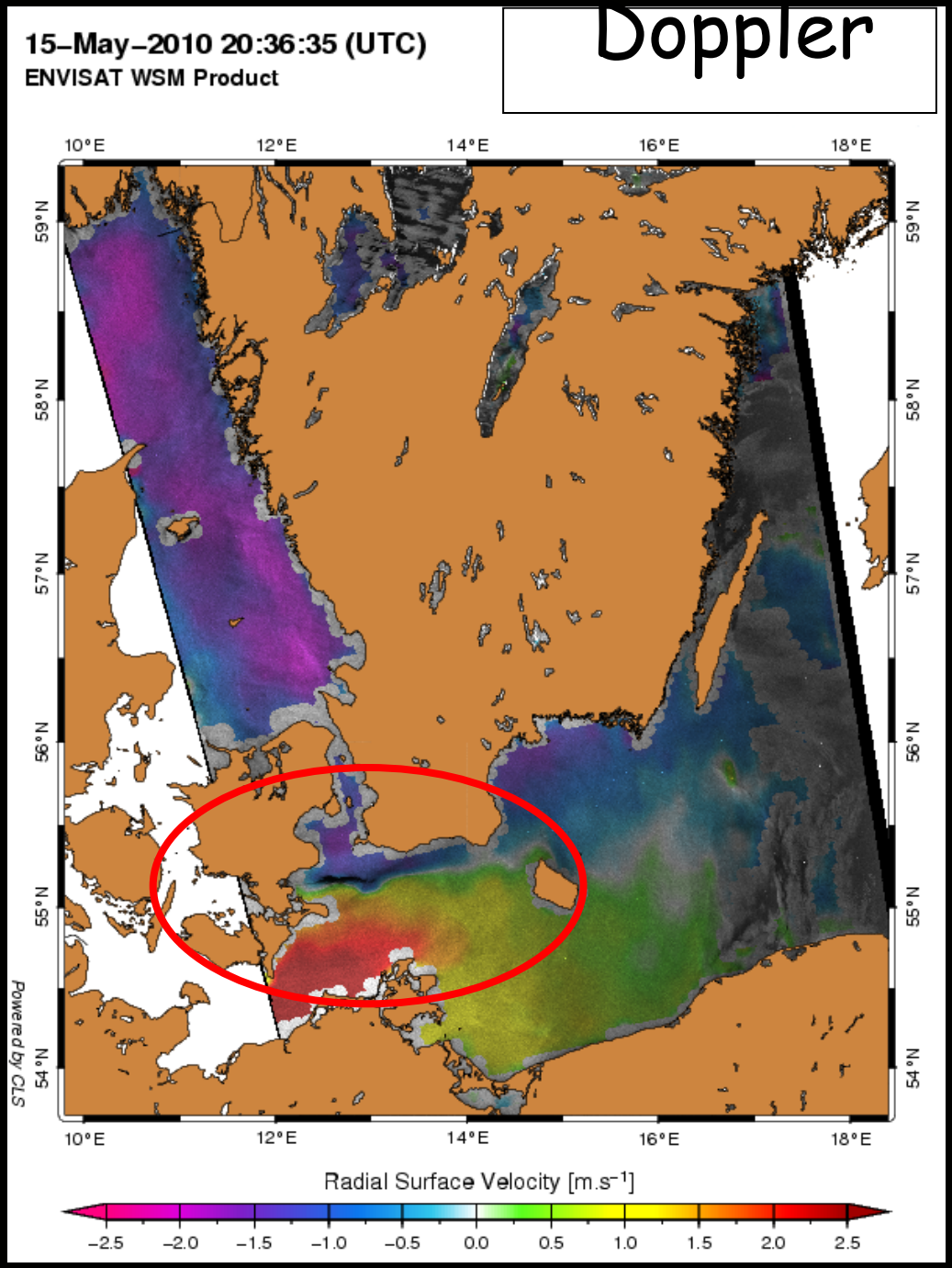
Incidence angle

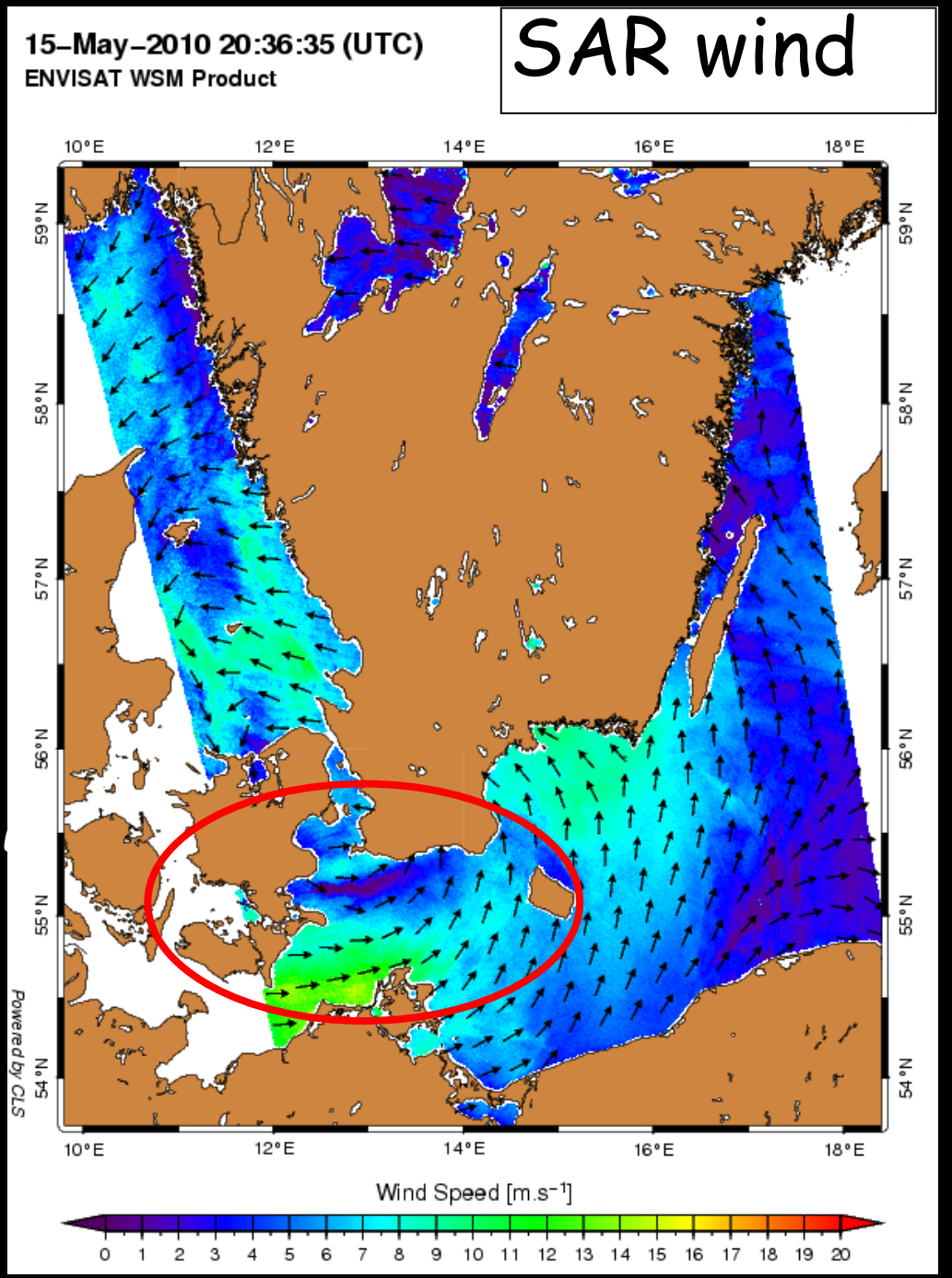
Doppler velocities vs SAR wind



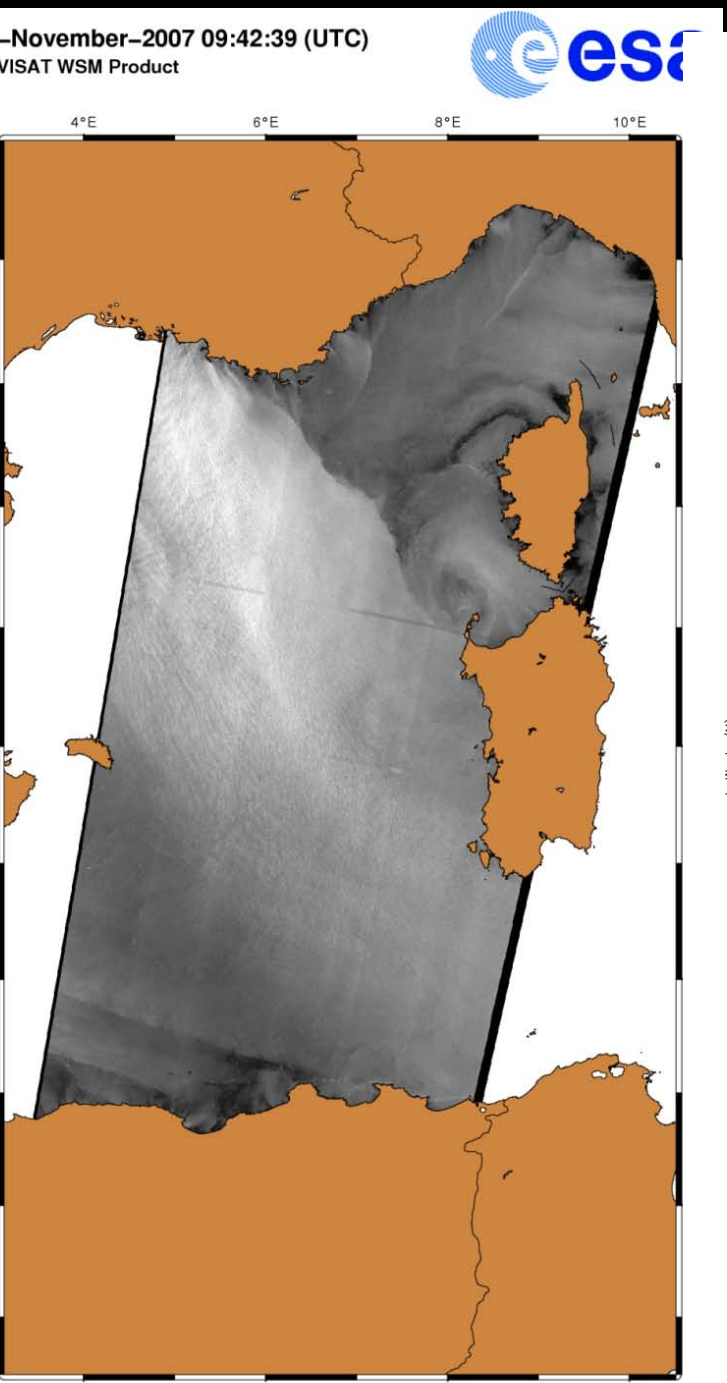


Doppler velocities vs SAR wind

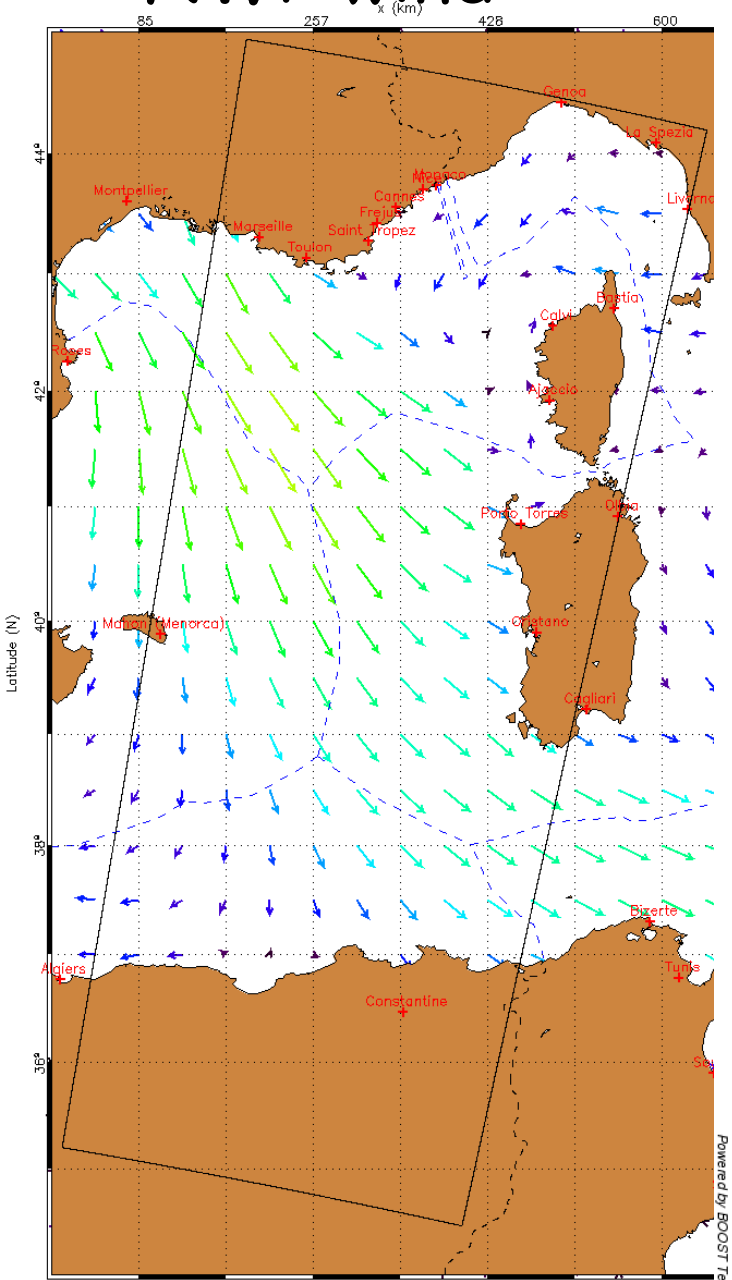


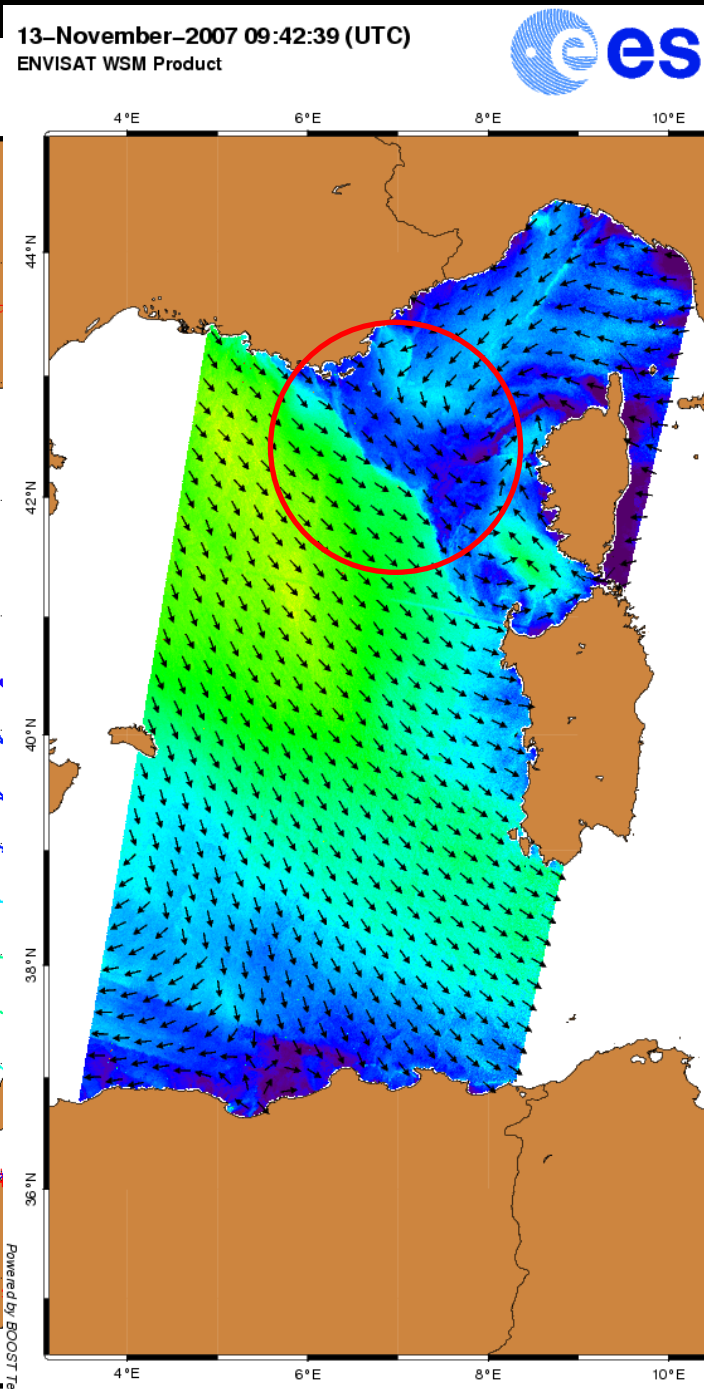


Case analysis : atmospheric front in the med sea



NWP wind

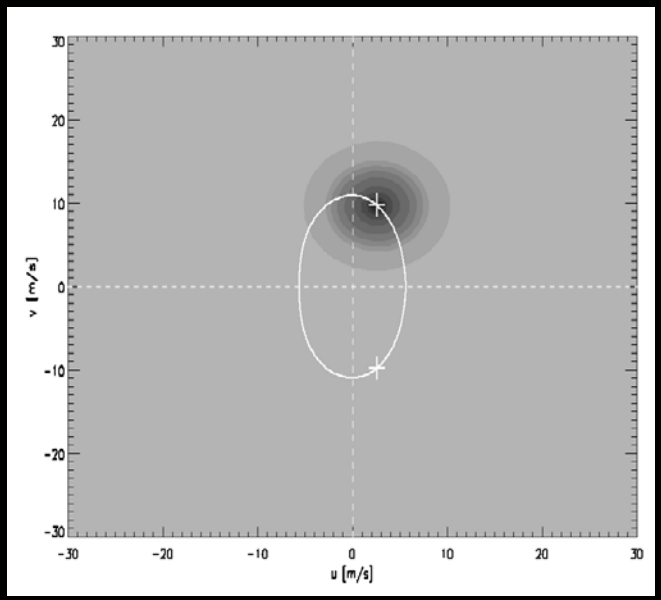




Bayesian Wind inversion scheme using Doppler

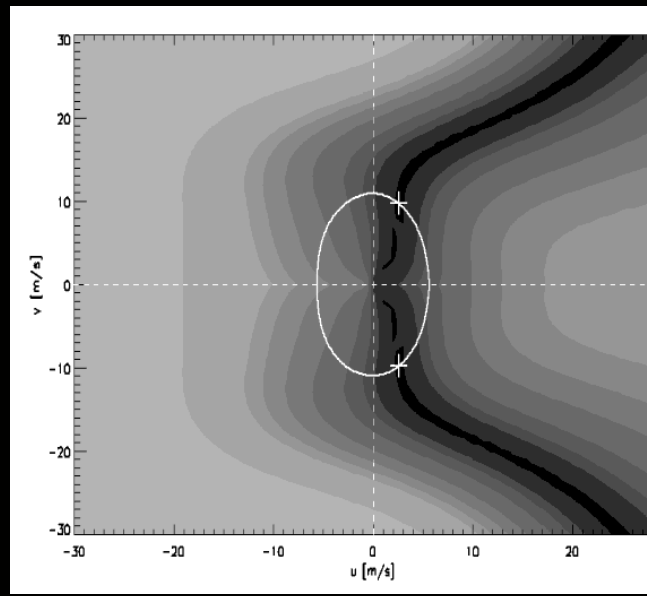
Bayesian scheme to combine SAR observation(s) with a priori ancillary information and its associated uncertainties.

$\{u,v\} = GMF^{-1}(NRCS,\varphi)$, where $\varphi \in [0,360]$ °



NRCS with NWP MODEL

NRCS with DOPPLER



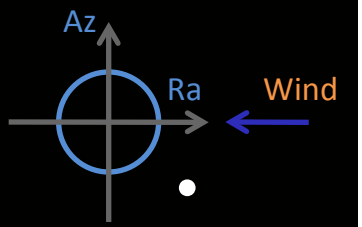
$$J = \left(\frac{u_b - v}{\Delta u}\right)^2 + \left(\frac{v_b - v}{\Delta v}\right)^2\Big|_{\{u,v\}\in\mathcal{G}_{SAR}}$$

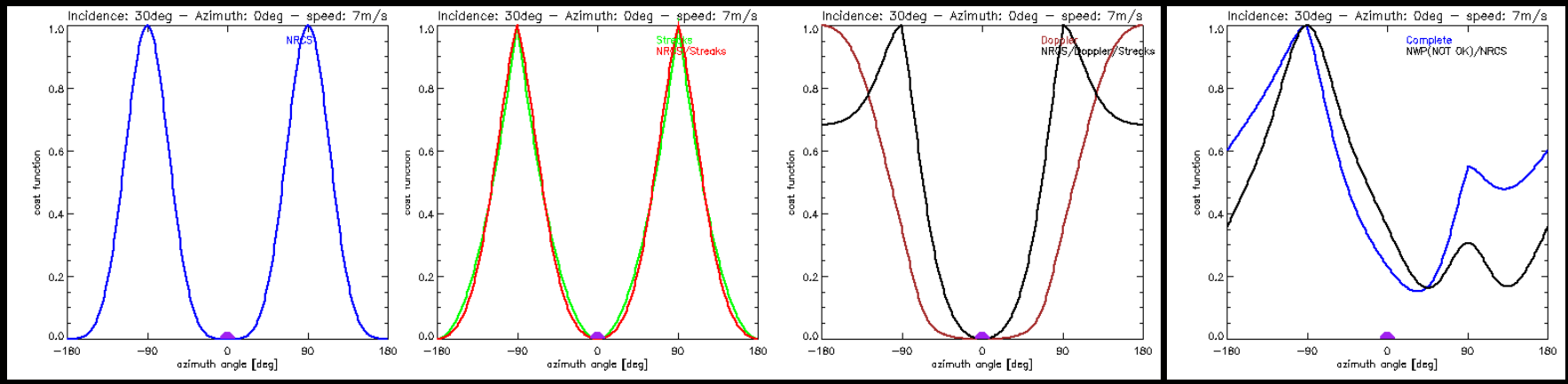
$$J = \left(\frac{f_{CDOP}^{D_{ca}}(\theta,\phi) - f^{D_{ca}}(\theta,\phi(u,v))}{\Delta f^{D_{ca}}}\right)^2\Big|_{\{u,v\}\in\mathcal{G}_{SAR}}$$

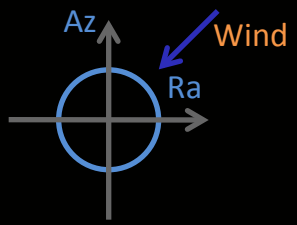
Cost Function:

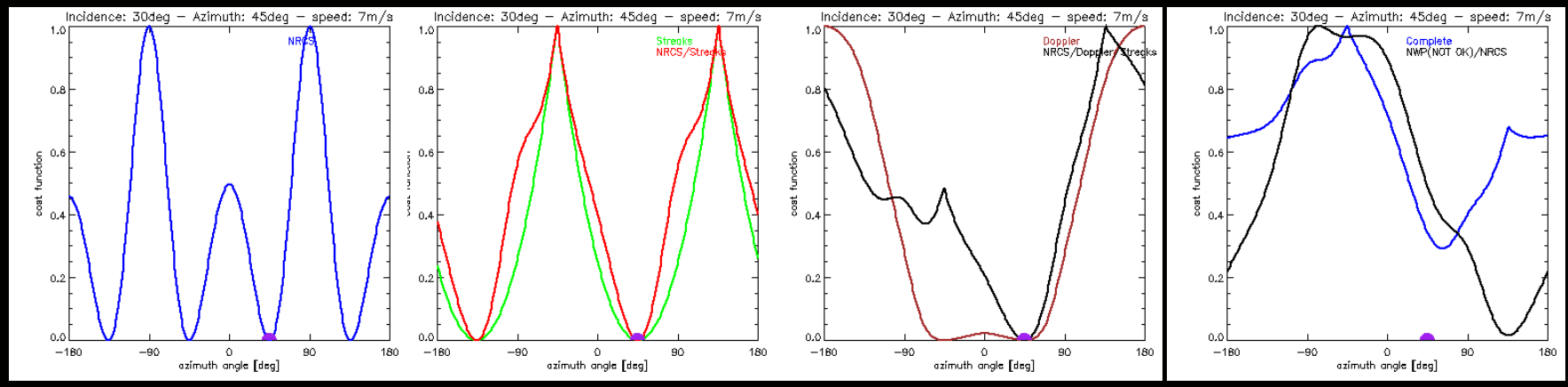
$$\left(\frac{\hat{\sigma}_0-\bar{\sigma}_0}{\Delta\sigma_0}\right)^2+\left(\frac{\hat{\phi}-\phi}{\Delta\phi}\right)^2+\left(\frac{\hat{f}_{ca}-\bar{f}_{ca}}{\Delta f_{ca}}\right)^2+\left(\frac{u_{NWP}-u}{\Delta u_{NWP}}\right)^2+\left(\frac{v_{NWP}-v}{\Delta v_{NWP}}\right)^2$$

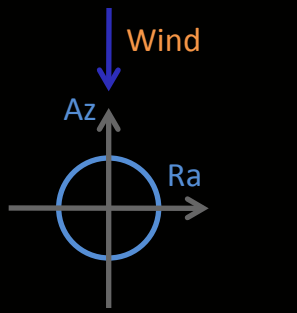
NRCS | Wind Streaks | Doppler | NWP Model

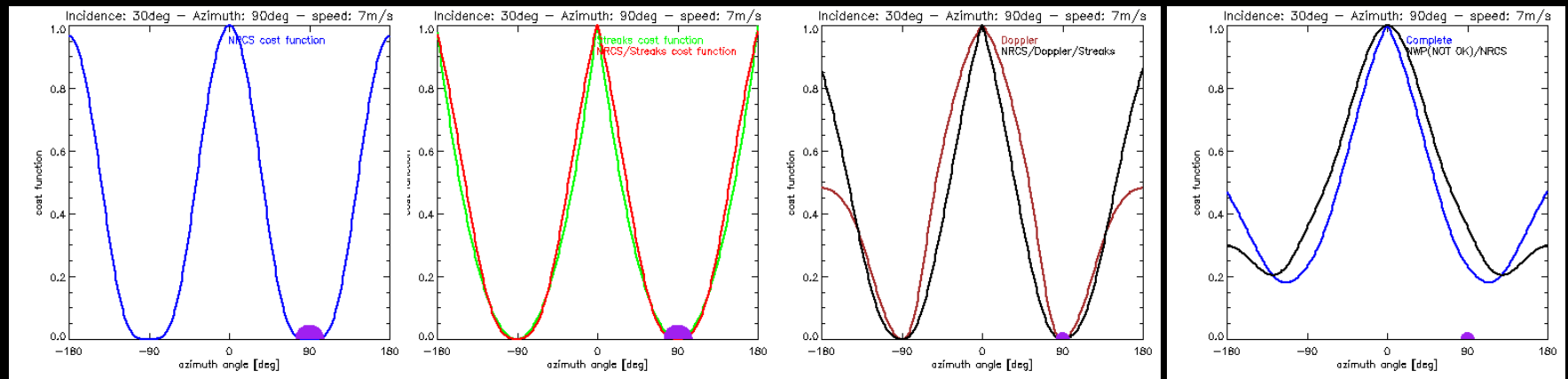




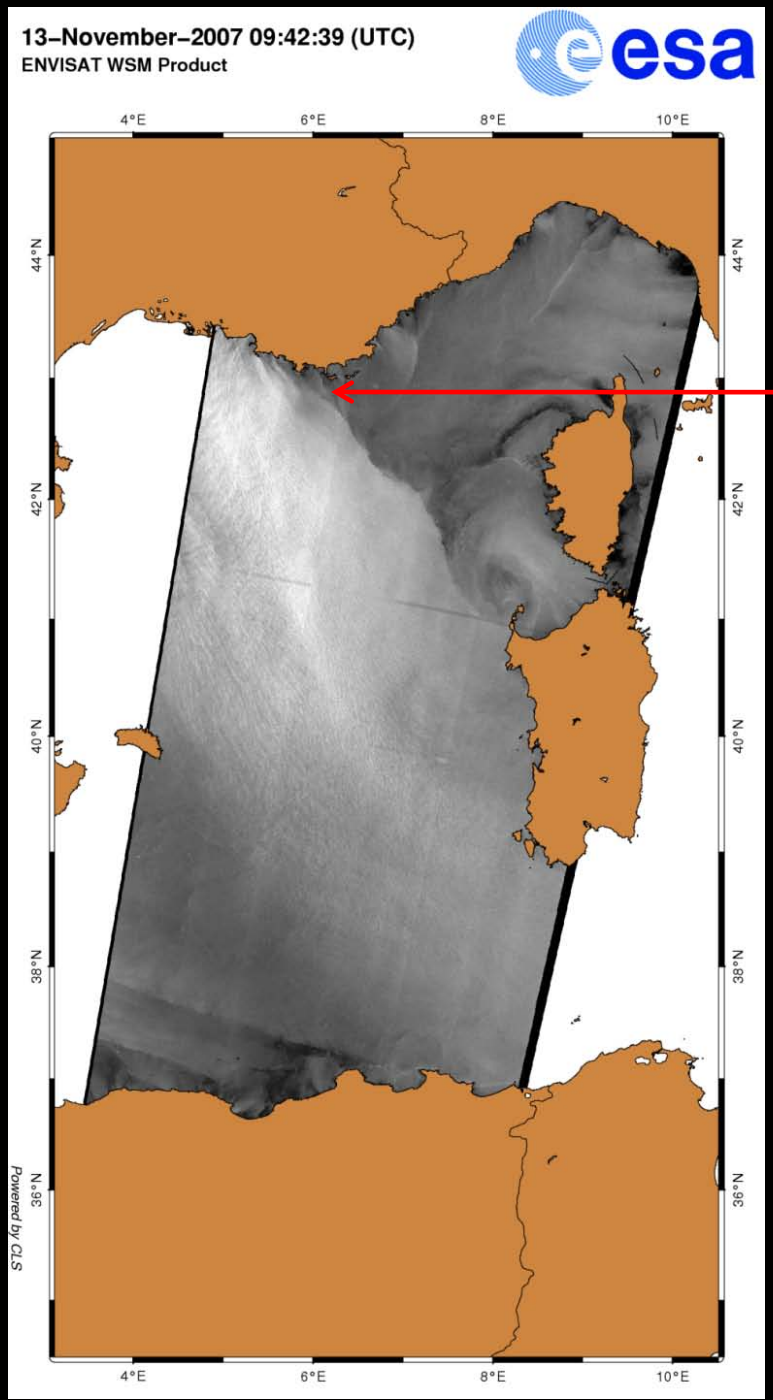


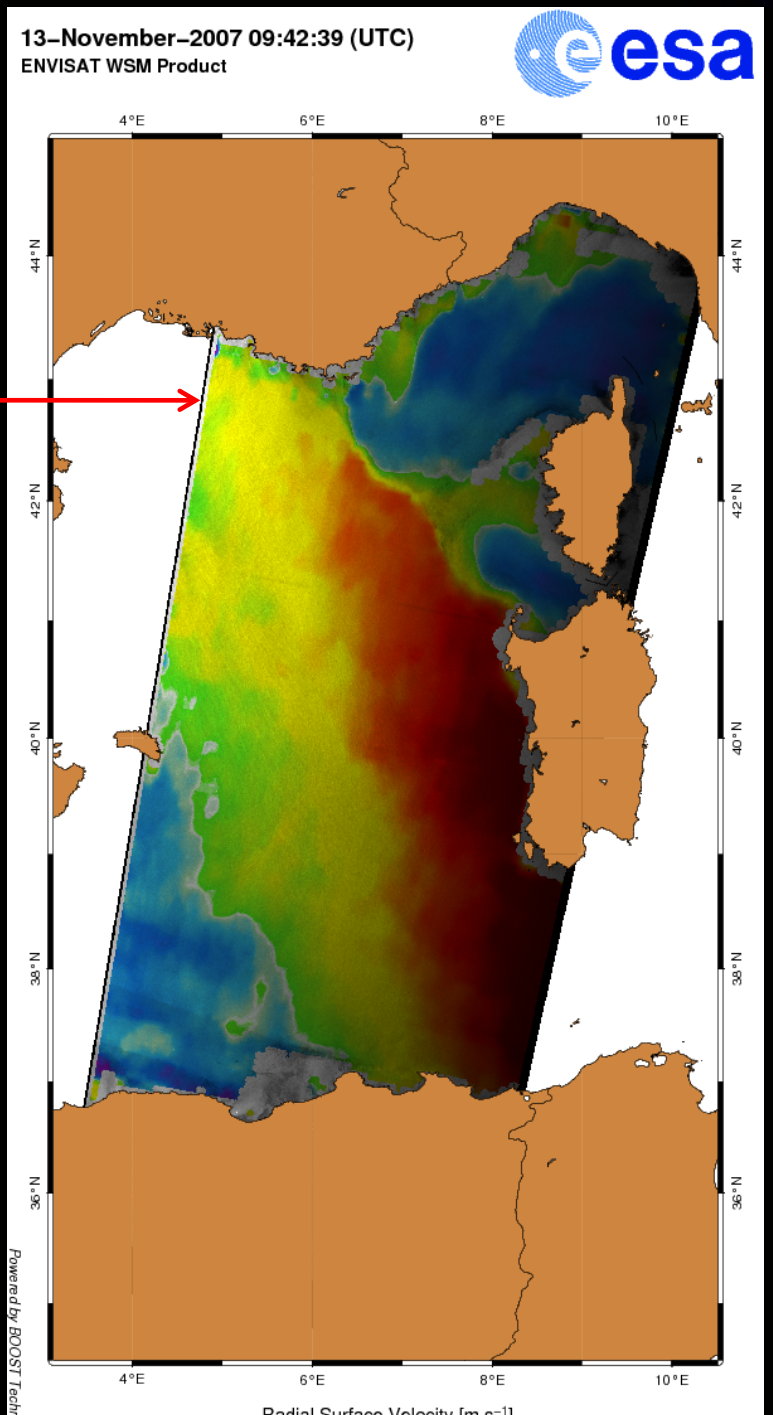


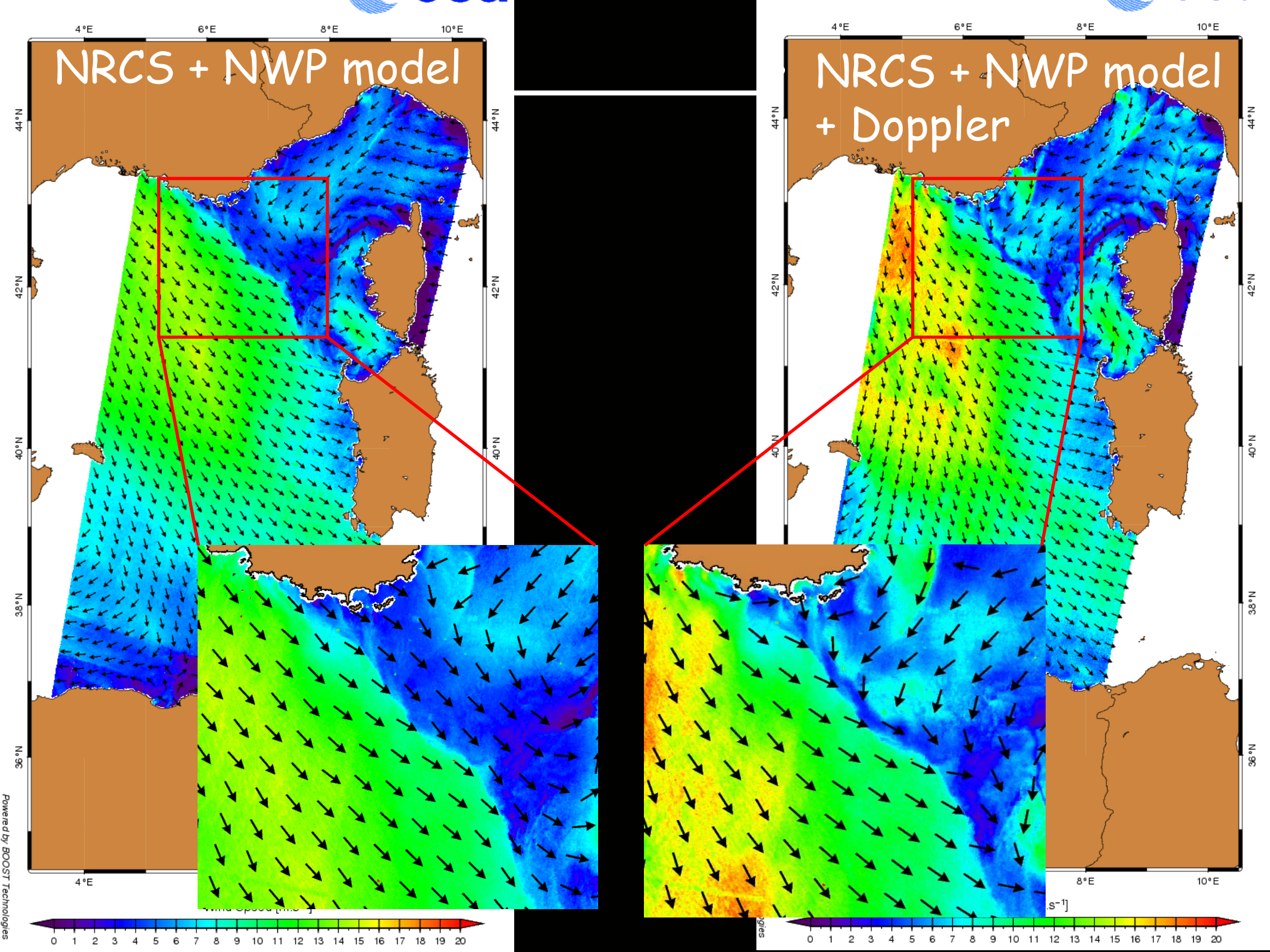




Can Doppler help ?

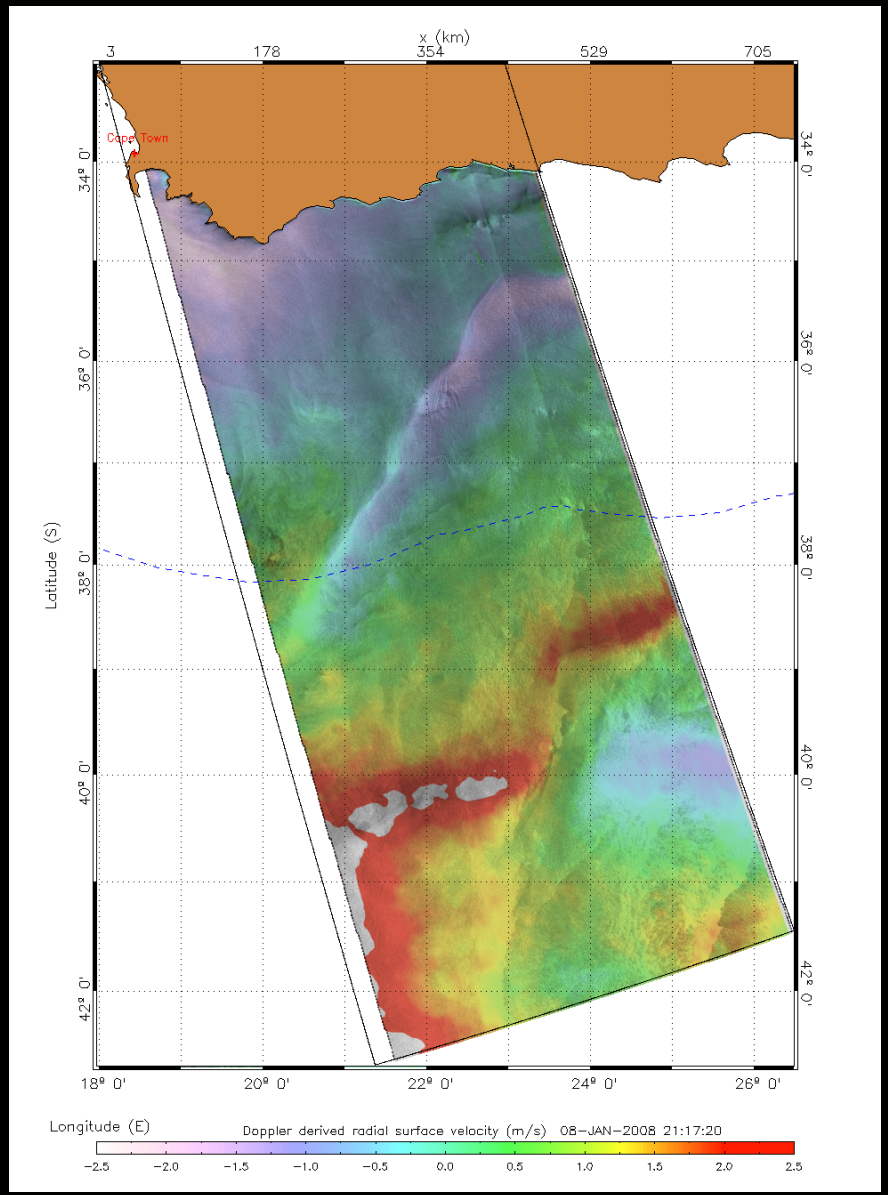




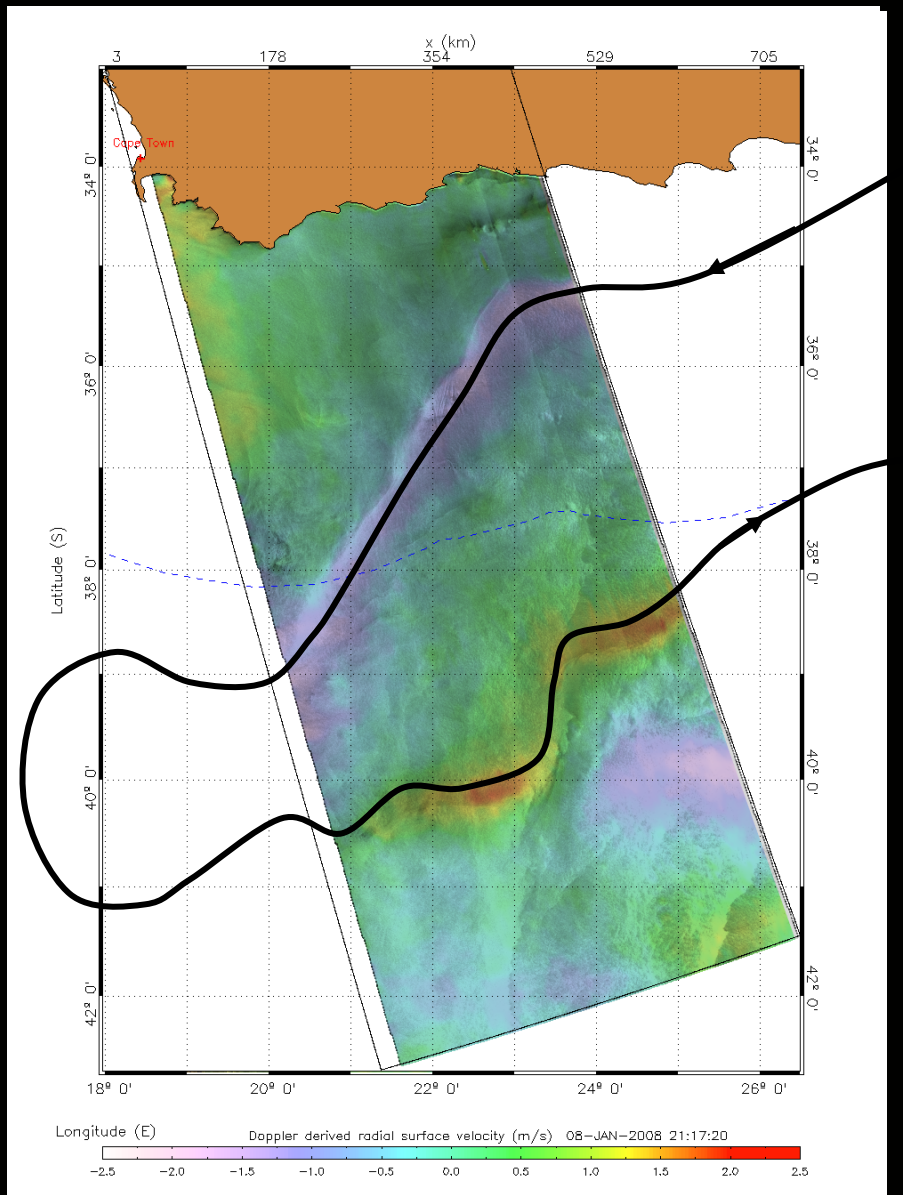

NRCS + NWP model
NRCS + NWP model + Doppler
4°E
6°E
8°E
10°E
44°N
42°N
40°N
38°N
36°N
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Powered by BOOST Technologies

Combined retrieval of Winds and Surface Currents

- Doppler velocities



- Residual velocities



Combined retrieval of Winds and Surface Currents

Wave breaking modulation by wind/current interaction is not linear and therefore, surface current can enhance cross section several times more than just the relative wind increase can.

$$\sigma_0 = \sigma_{0R}(1-q) + \sigma_{0b}q$$

q : breaking coverage

Combined retrieval of Winds and Surface Currents

Wave breaking modulation by wind/current interaction is not linear and therefore, surface current can enhance cross section several times more than just the relative wind increase can.

$$\sigma_0 = \sigma_{0R}(1-q) + \sigma_{0B}q$$

q : breaking coverage

To retrieve surface current, total Doppler shift should be corrected from actual scatterer velocities that are closely related to surface winds that SCAT is actually measuring.

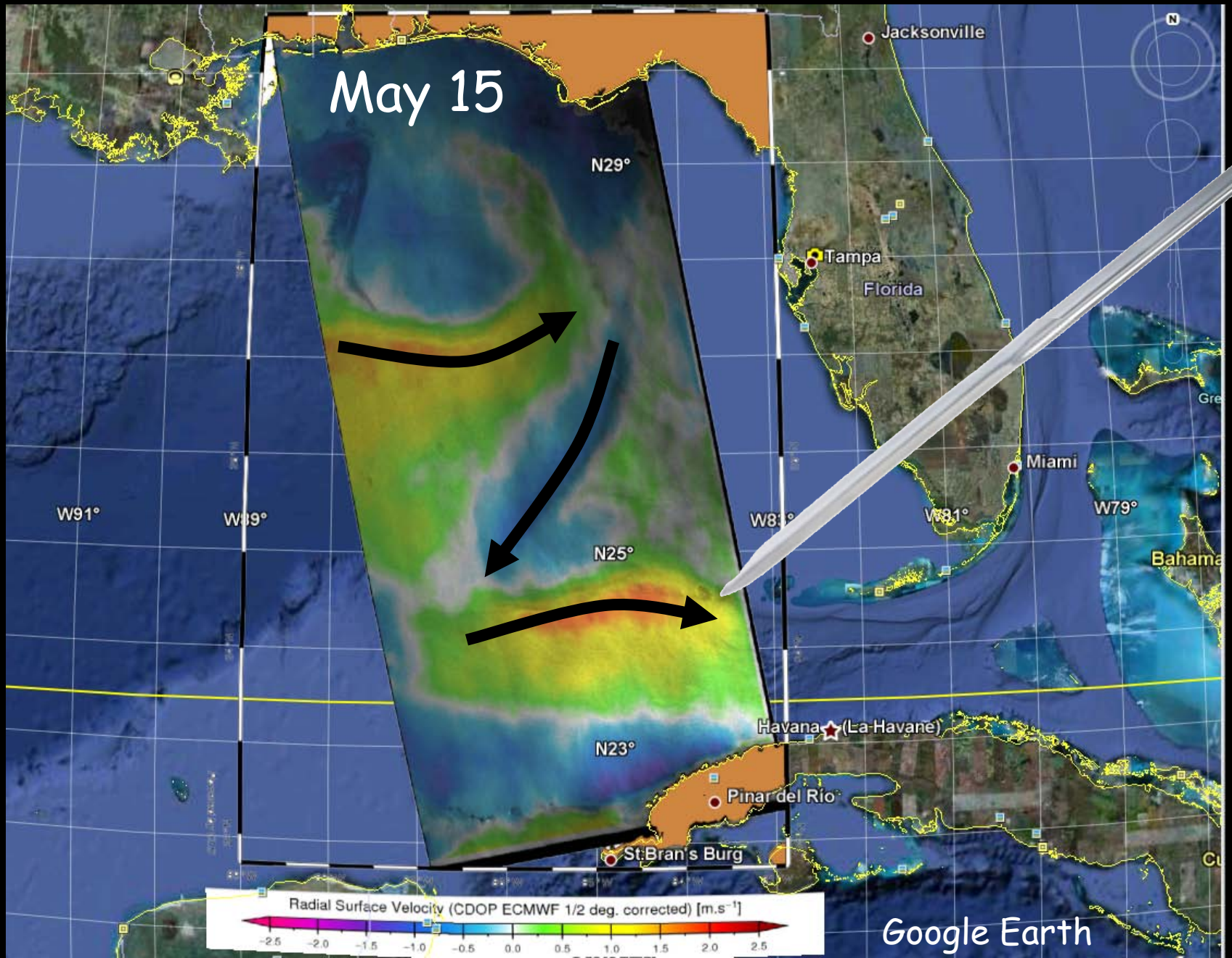
$$V_D = \frac{1}{2\tan\theta_I}\left(\alpha_i \|U_s\| - U_{sx}\frac{1}{\sigma_0}\frac{\partial\sigma_0}{\partial\theta_I}\right) + \alpha_r\frac{U_{sx}}{2} + U_{cx} + \frac{U_{sx}}{2} + O\left(\varepsilon^3\right)$$

$$V_{D,\mathrm{mod}} = \frac{1}{2\tan\theta_I}\left(-0.024\left[1.-0.5*\left|\tanh\left(\frac{U}{10}\right)\right|\right]U\frac{1}{\sigma_0}\frac{\partial\sigma_0}{\partial\theta_I}\right)$$

parallel estimation of wind and current vector looks a promising option . . .

S W O R D

SWath Ocean Radar Doppler



S W O R D

SWath Ocean Radar Doppler