High resolution wind fields over the Black Sea derived from Envisat ASAR data using an advanced wind retrieval algorithm

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In this investigation we apply a new wind retrieval algorithm developed by Mouche et al. 2012 to wind fields over the Black Sea.

Mouche, A., K.-F. Dagestad, F. Collard, G. Guitton, B. Chapron, J. Johannessen, V. Kerbaol, and M. W. Hansen, 2012: On the use of Doppler shift for sea surface wind retrieval from SAR, IEEE Trans. Geosci. Remote Sens., in press.

It uses three sources of information on wind direction:

1) Model winds

2) Normalized radar cross section

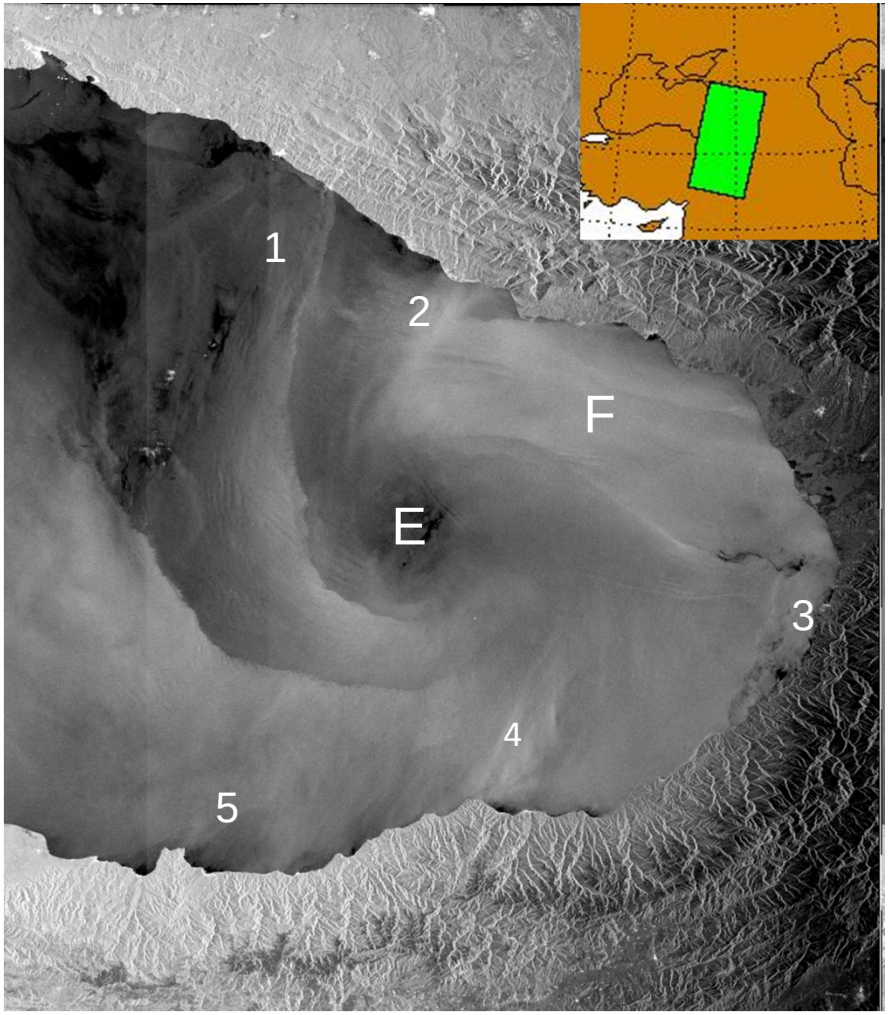
3) Doppler shifts extracted from SAR data

All three sources of Information are combined using the Bayesian method

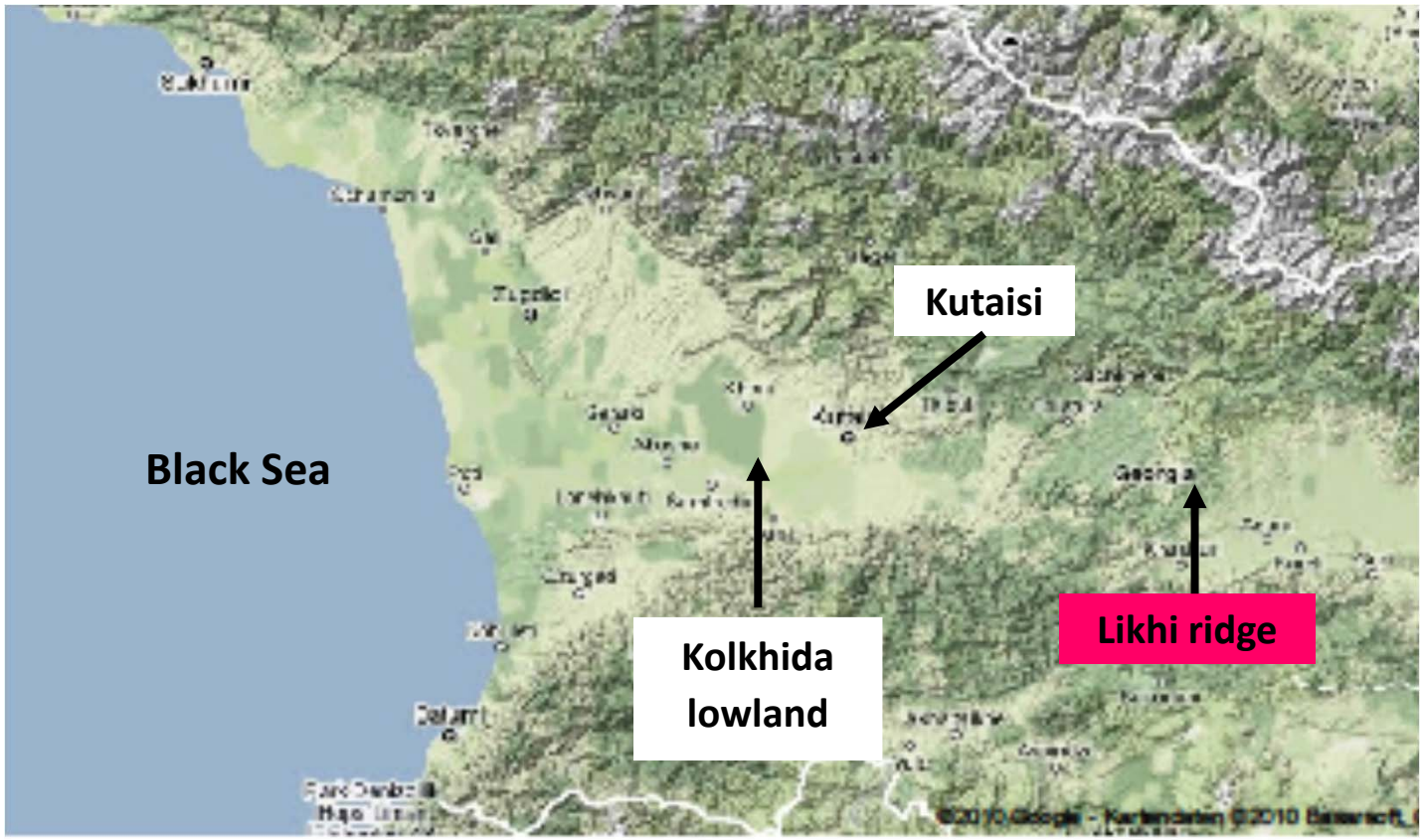
The Black Sea has a complex coastal topography giving rise to various local winds, like foehn winds, bora winds, gap winds, and katabatic winds interacting with synoptic-scale winds.

Thus the Black Sea is an ideal area to test algorithms to retrieve sea surface winds from SAR data.

Example 1: Foehn wind (F) encounters an atmospheric eddy (E)

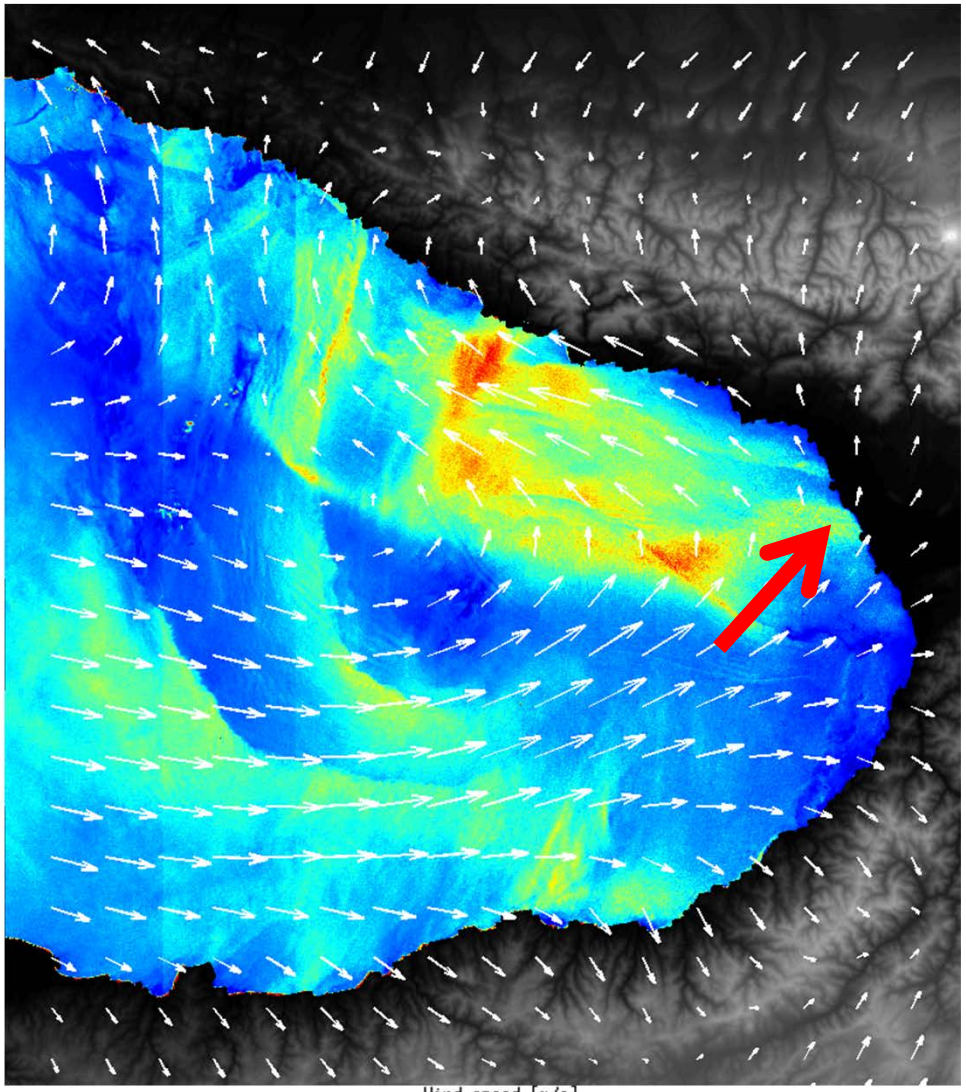


SAR image acquired by the ASAR onboard the Envisat satellite in the Wide Swath mode (VV polarization) at 0732 UTC 13 September 2010 over the eastern section of the Black Sea. The imaged area is 400 km x 480 km. The inset shows the location of the SAR scene. The letter E denotes the center of the atmospheric cyclonic eddy and F the wind band associated with the foehn. The other features marked by numbers are explained in the text. © ESA



Topography of the Kolkhida lowland (Rioni River Basin) . © Google maps

SAR-derived wind field using the wind direction from the NCEP model



NERSC

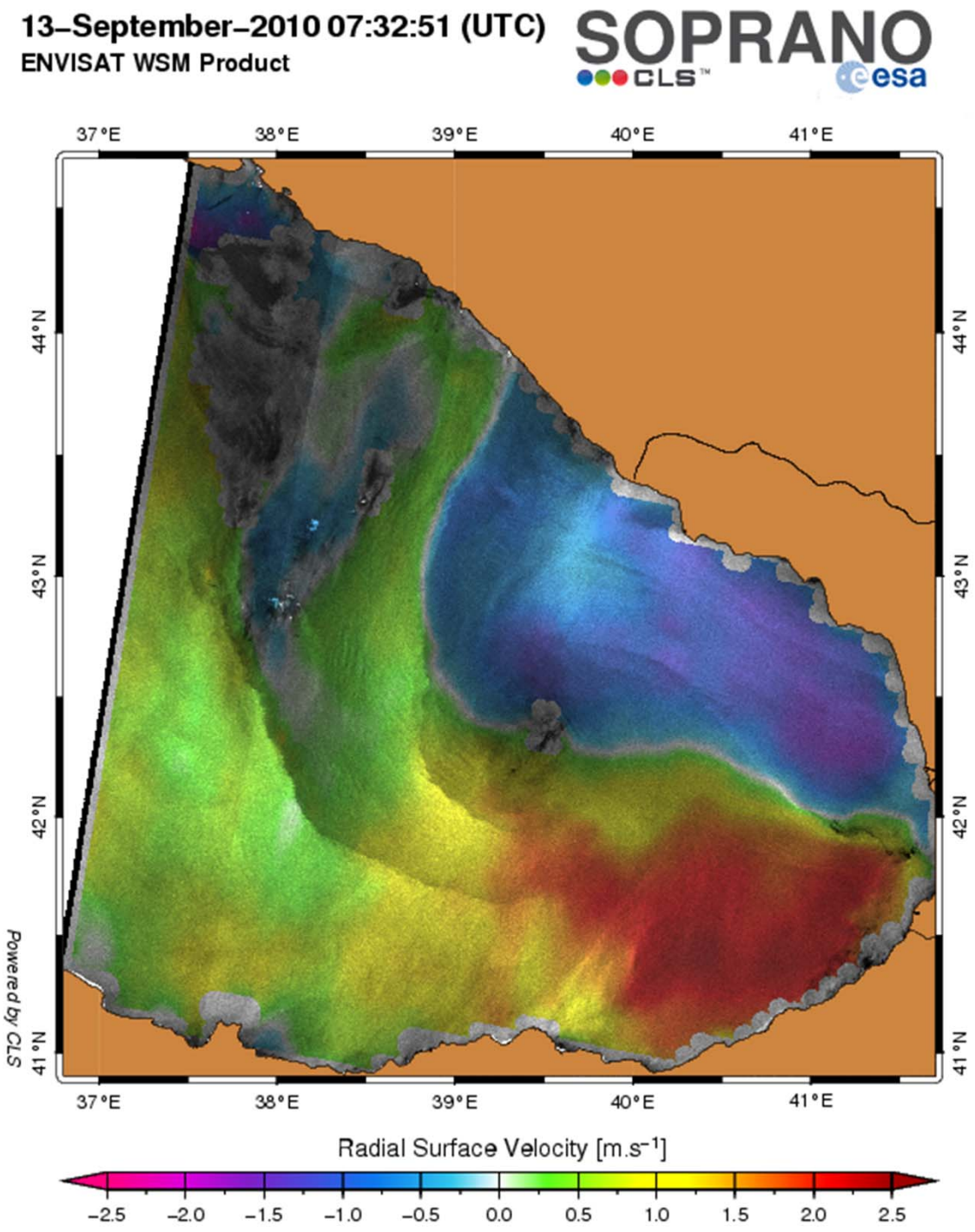
Envisat ASAR Wind Speed 13-Sep-2010 07:31:50
Wind dir: NCEP GFS 0.5 deg (+01:28) - Algorithm: cmod4

esa

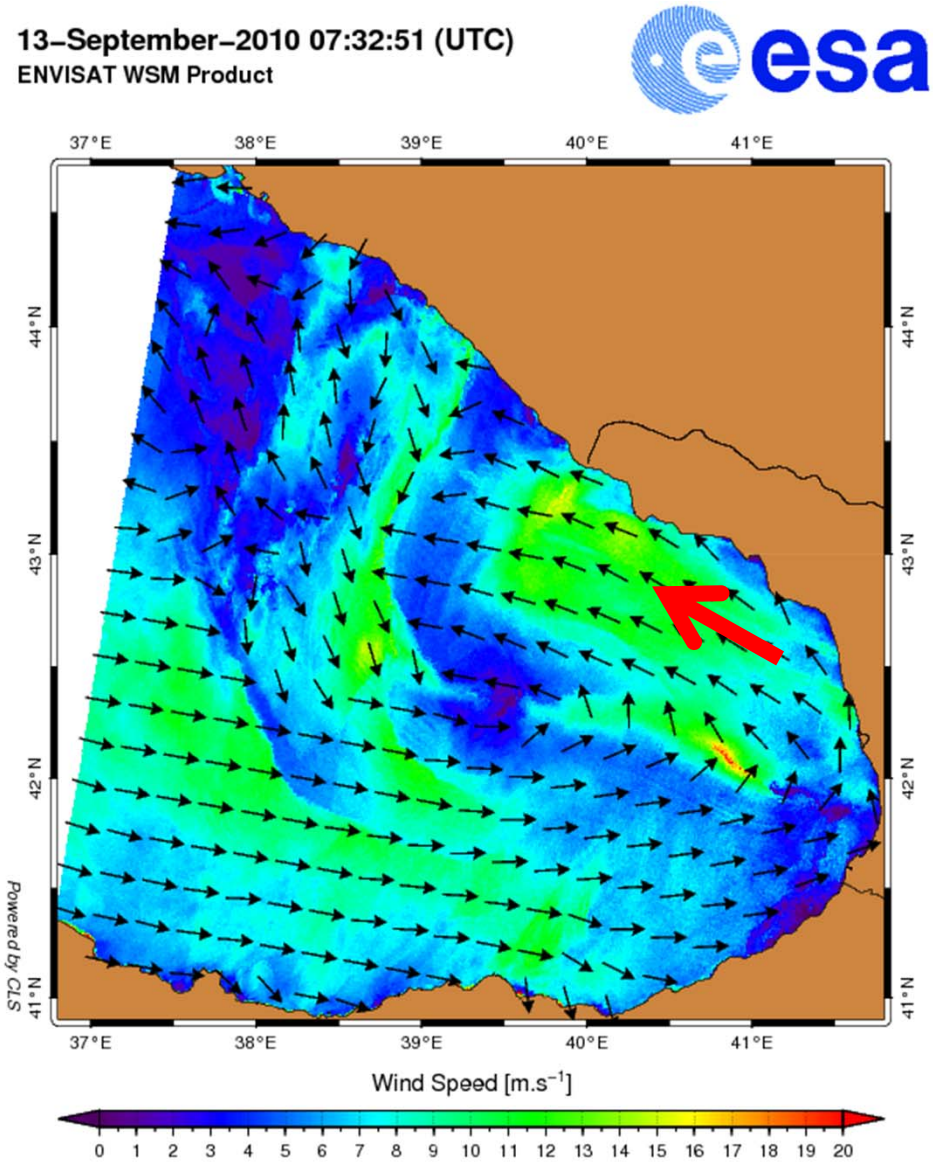
Doppler velocity retrieved from the SAR data

Green-Yellow-Red colors: Wind blows to the right (in an easterly direction).

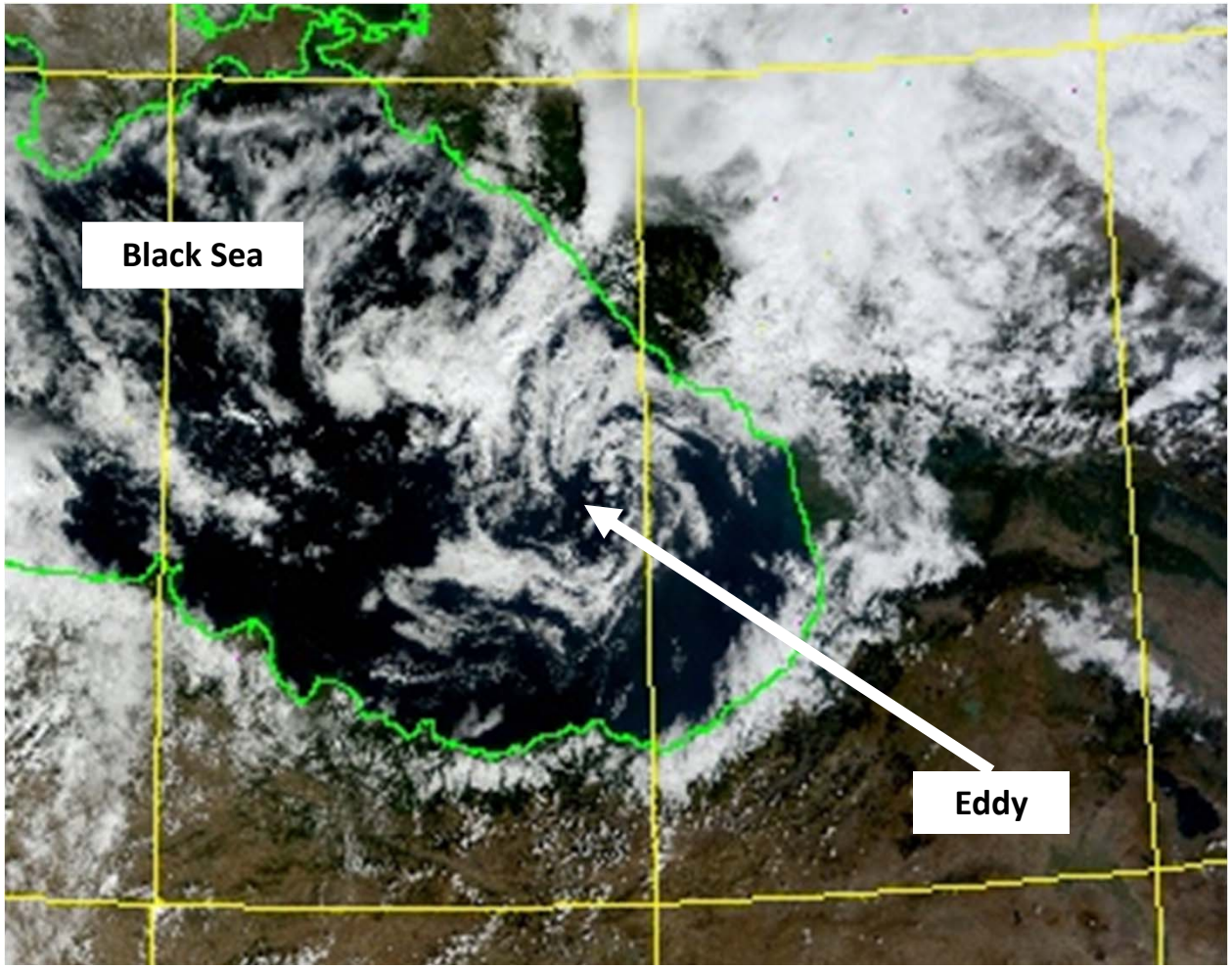
Blue-purple colors: Wind blows to the left (in a westerly direction).

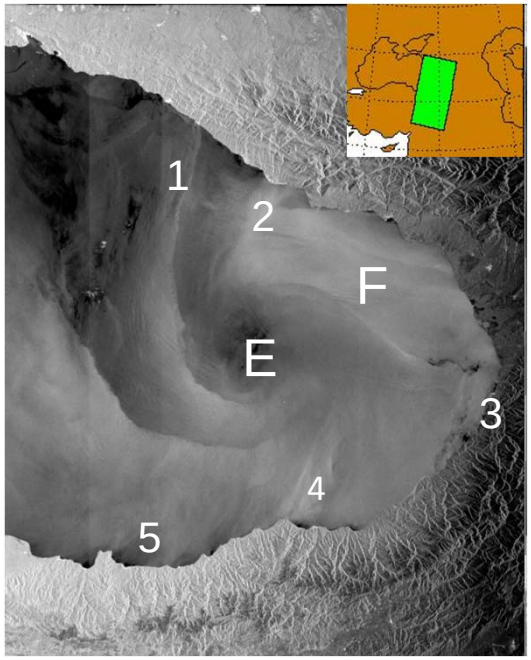


SAR-derived wind field by including Doppler



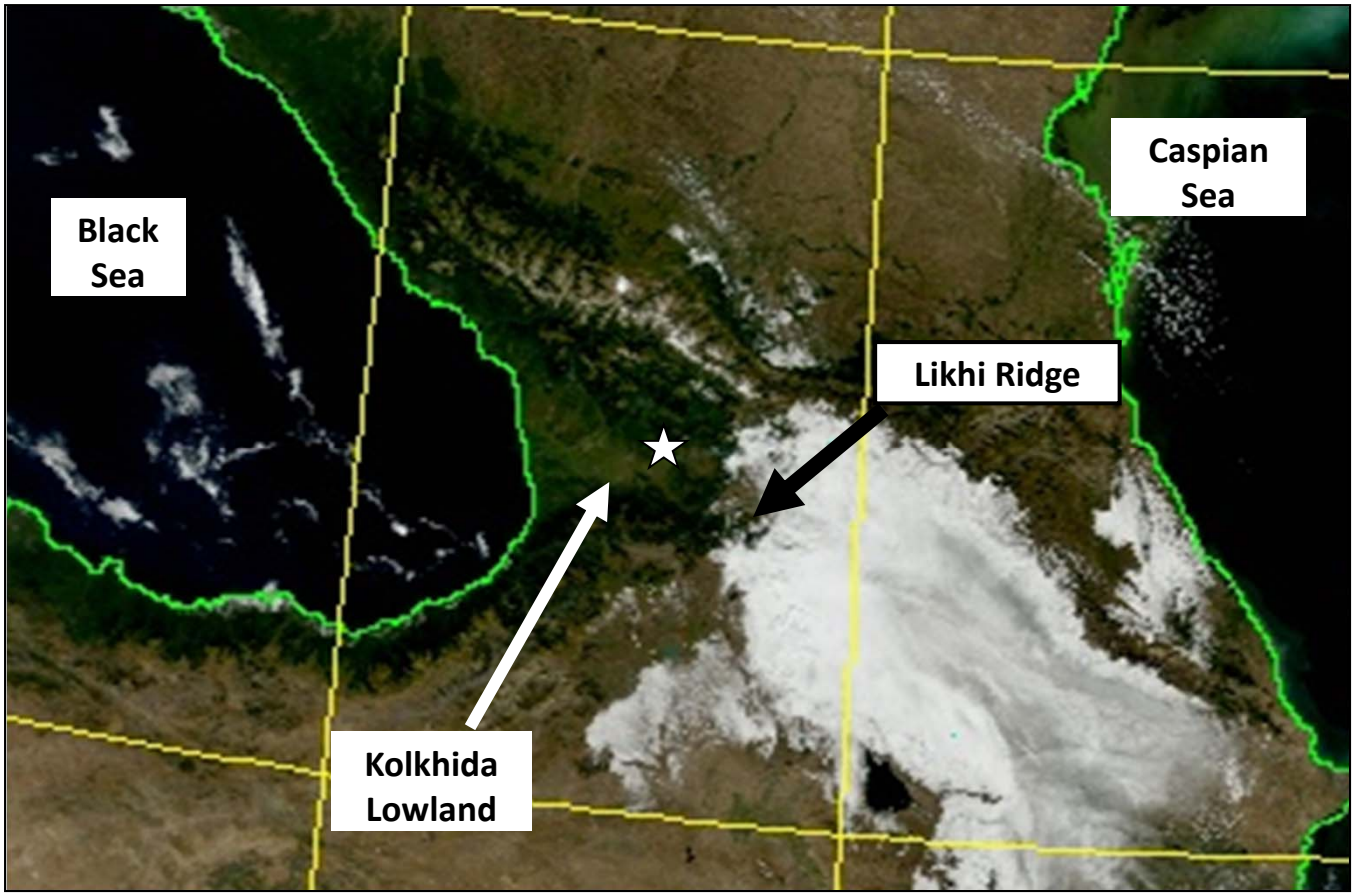
Good!





MODIS Terra color composite image acquired at 0830 UTC 13 September 2010 showing in the eastern section of the Black Sea a cyclonic eddy in the cloud pattern. The inserted latitude and longitude lines have a grid spacing of 5^0 x 5^0 . © NASA GSFC.

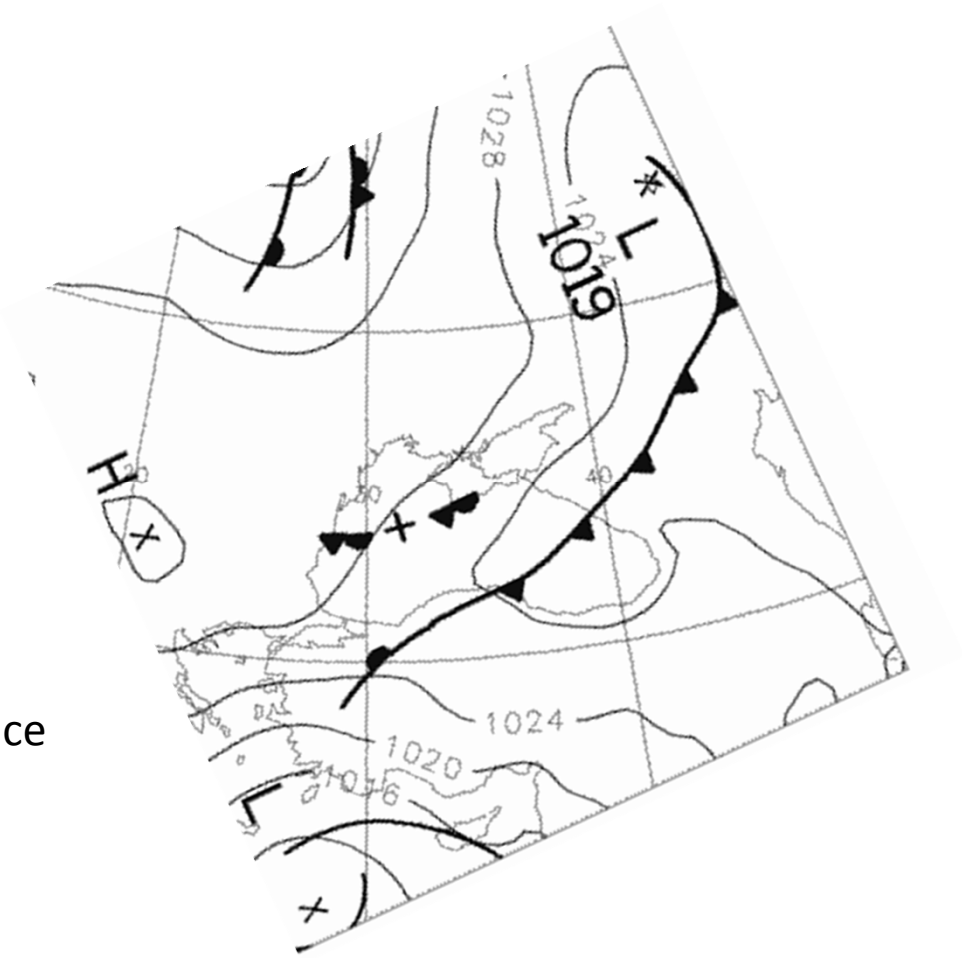
Characteristic foehn feature: Cloud-free area on the lee side of the mountain ridge



MODIS Terra color composite image acquired at 0745 UTC 12 September 2010, approximately 24 hours before the SAR data acquisition, showing the eastern section of the Black Sea, the Caucasus area with the Kolkhida Lowland, and the western section of the Caspian Sea. The star denotes the location of the Kutaisi weather station. Note the blocking of the low-level clouds by the Likhi Ridge. © NASA GSFC.

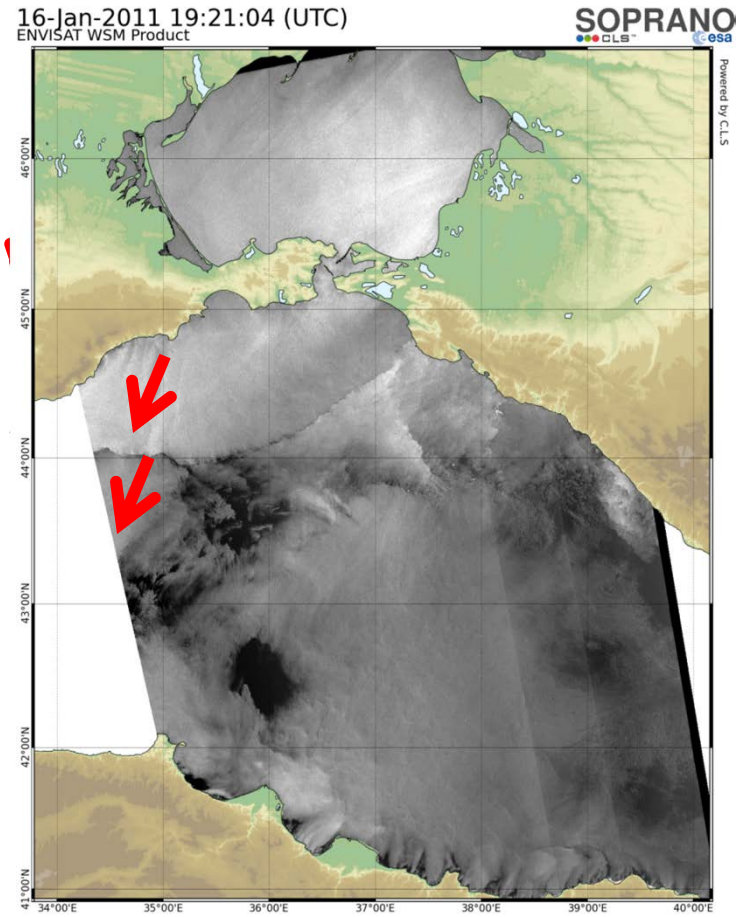
Example 2:
16 January 2011, 1910 UTC, event

Cold front over the Black Sea

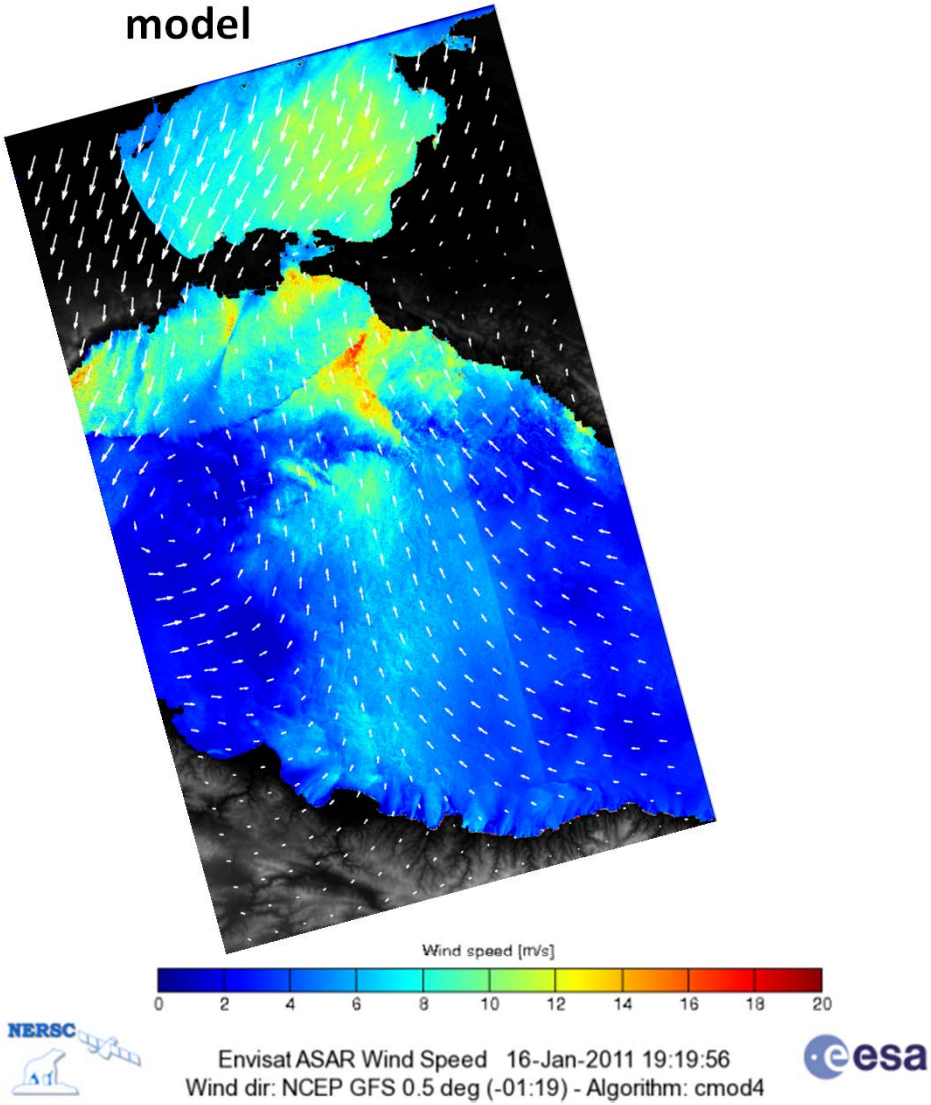


Ground weather map, UK Met Office
17 June 2011, 00 UTC

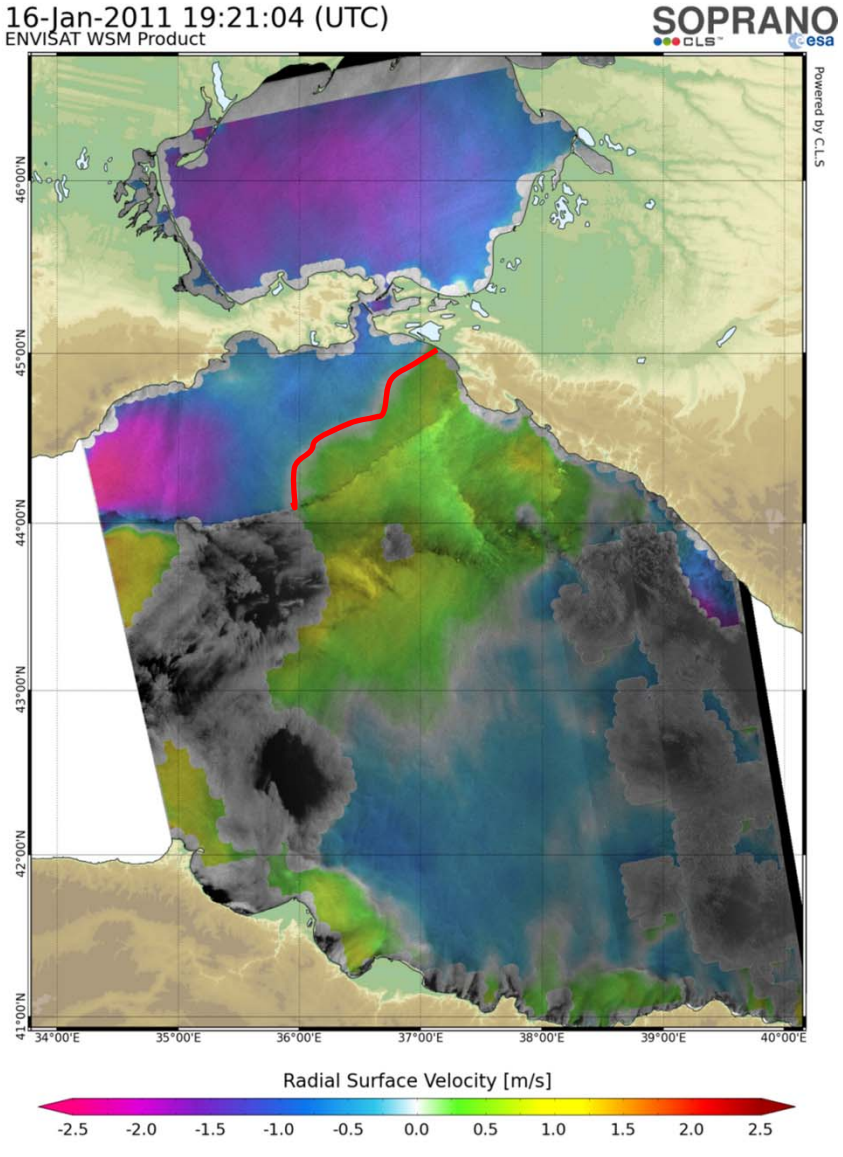
SAR image



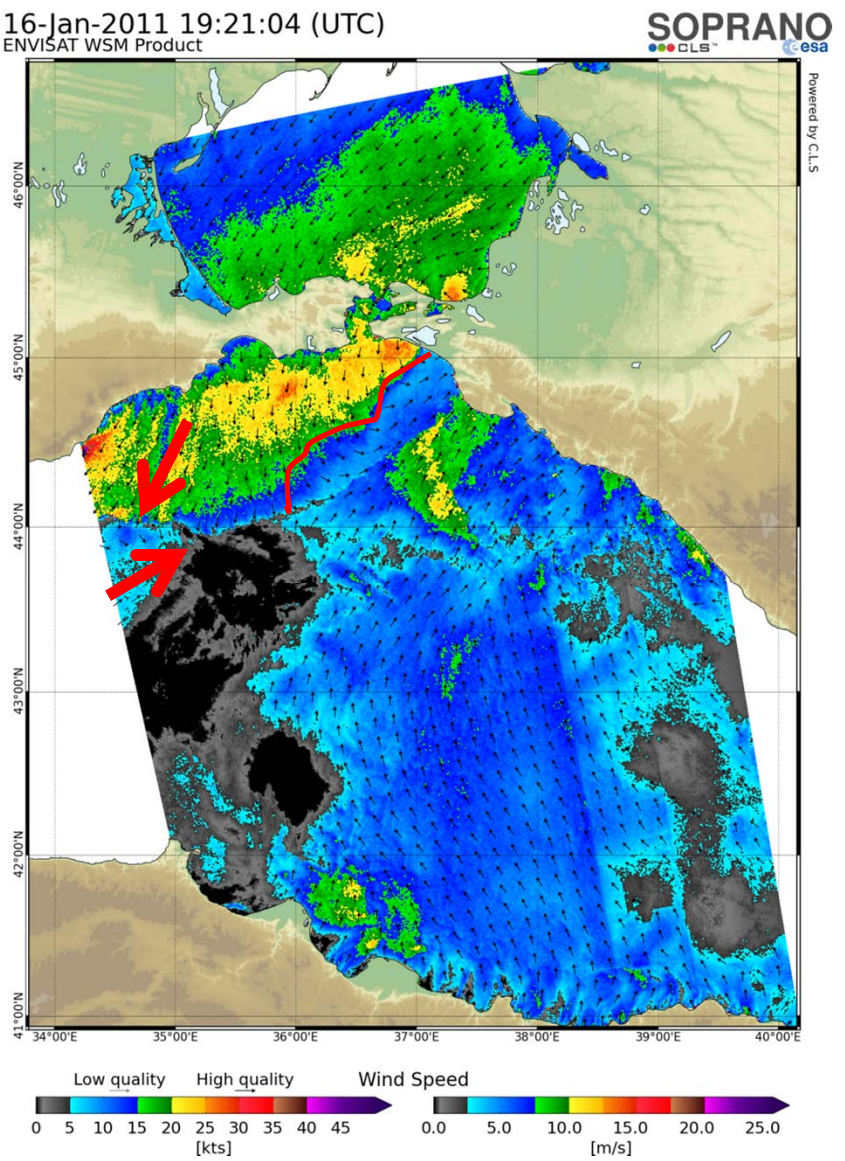
SAR-derived wind field using the wind direction from the NCEP model



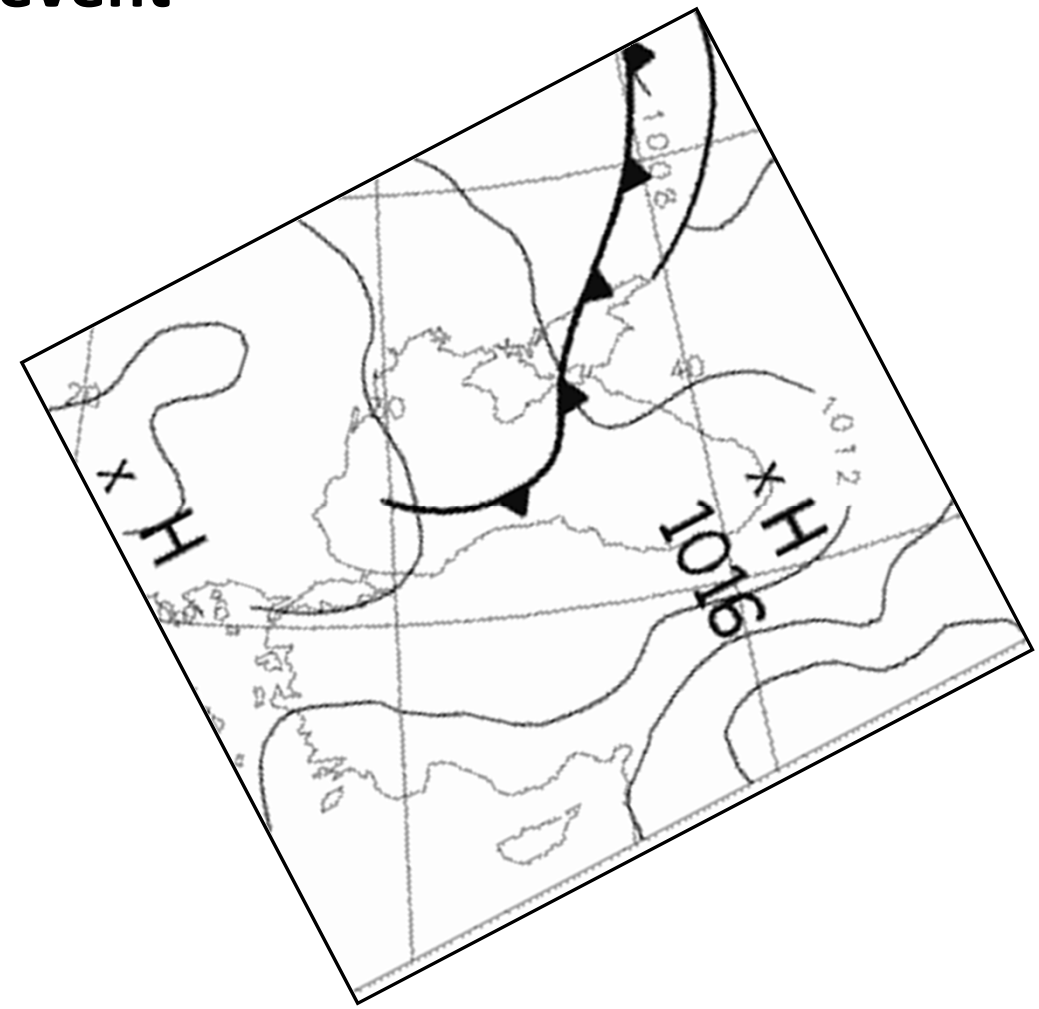
Radial surface velocity



SAR-derived wind field by including Doppler



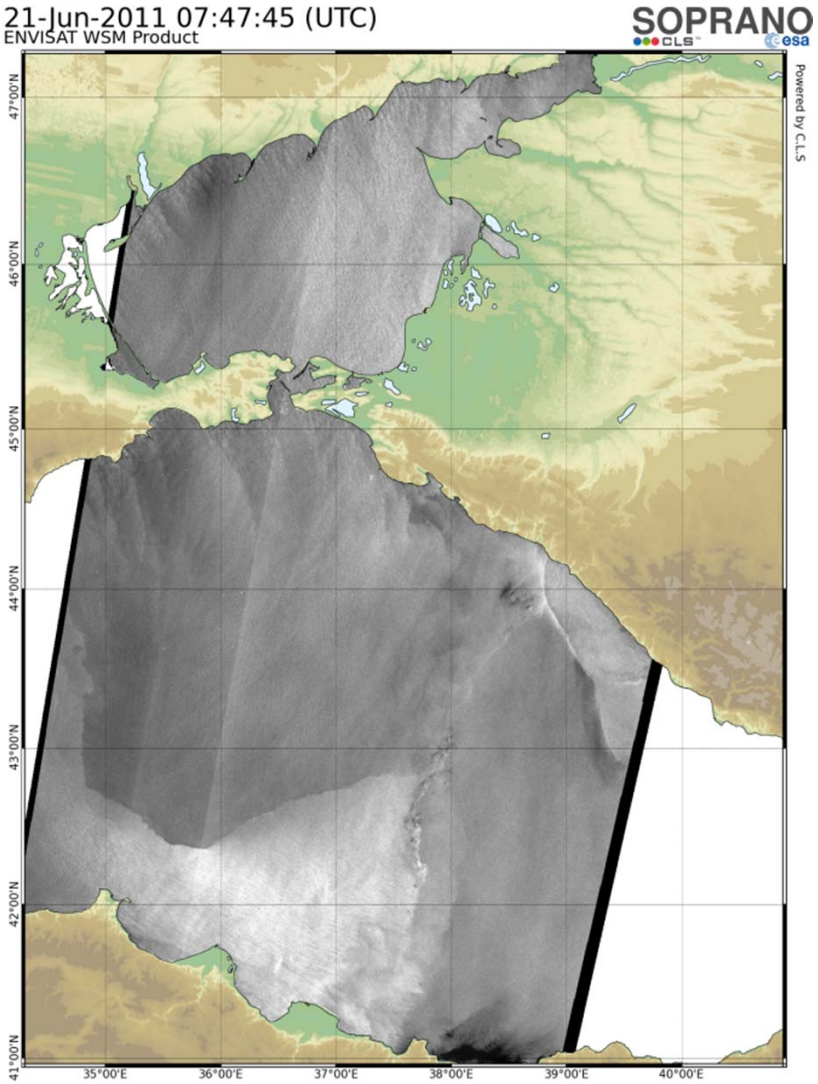
Example 3:
21 June 2011, 0747 UTC, event



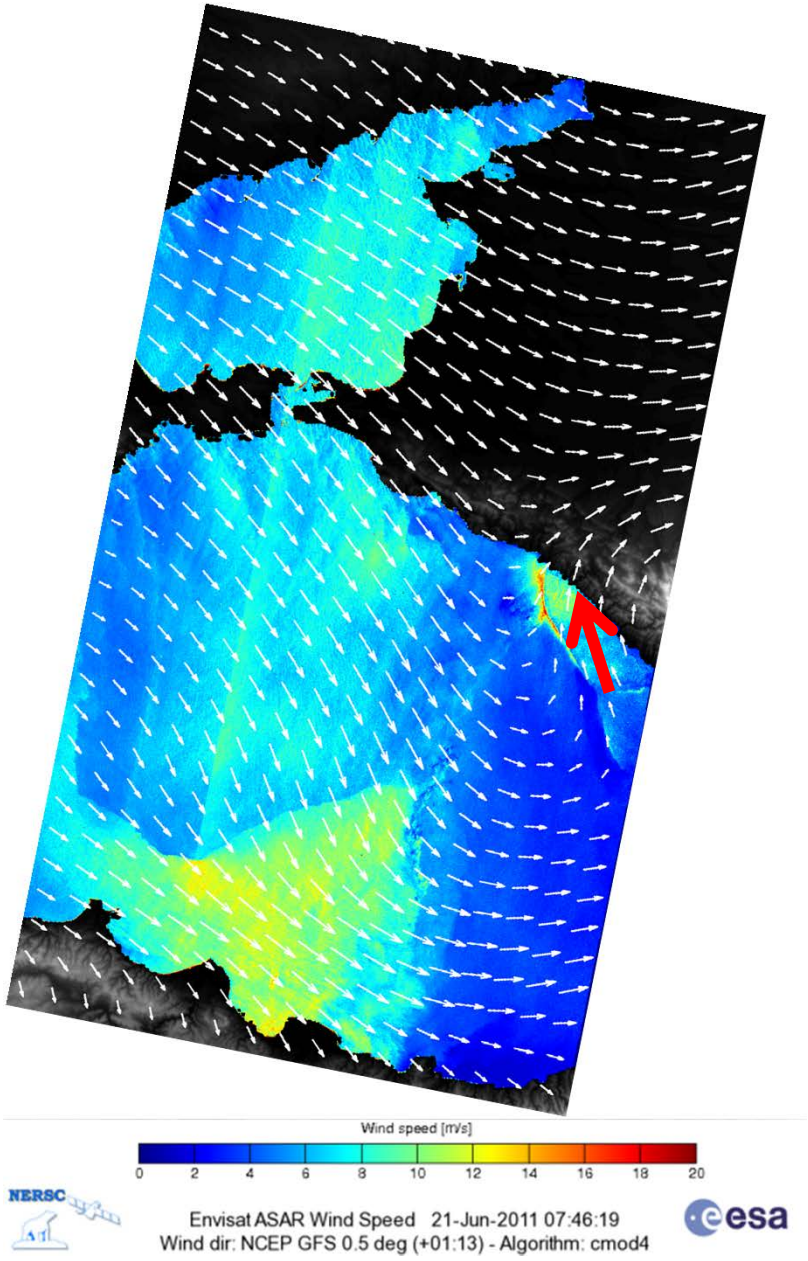
Cold front over the Black Sea

Ground weather map, UK Met Office
21 June 2011, 00 UTC

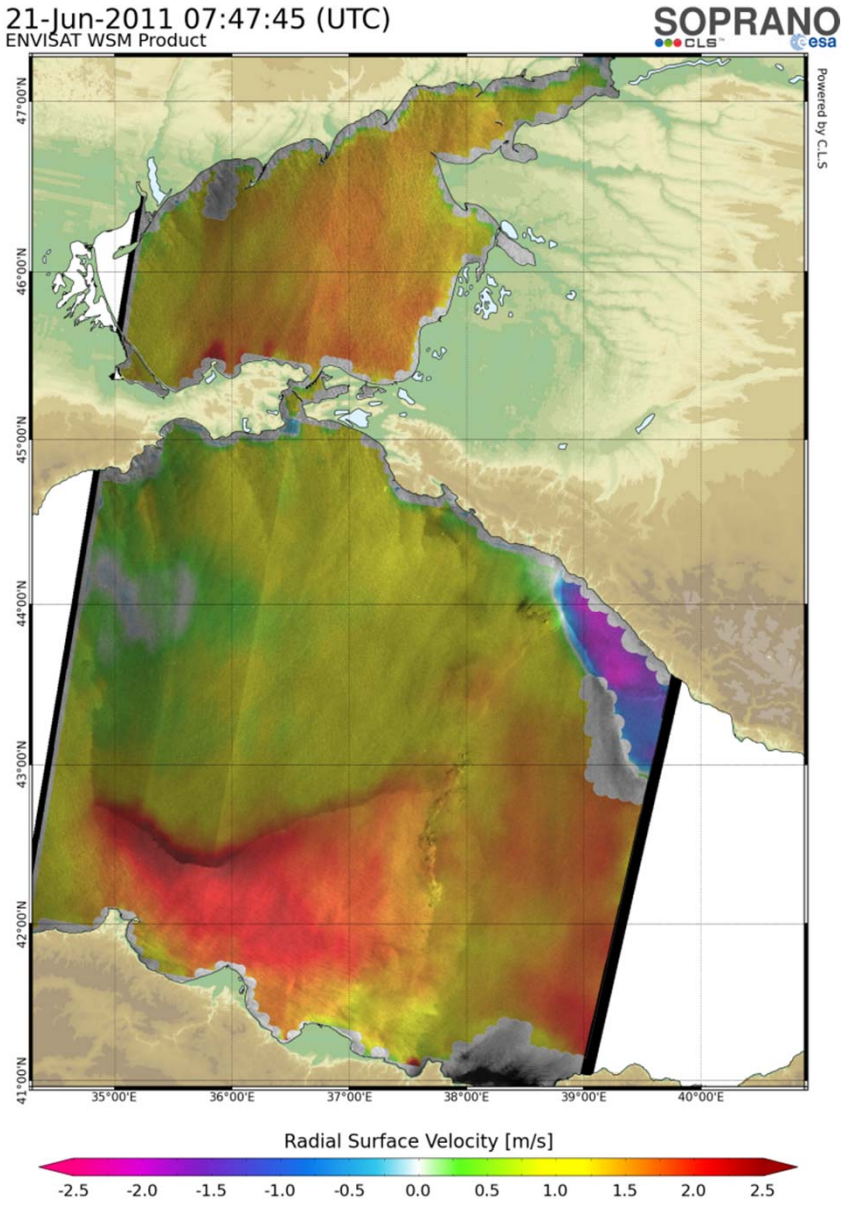
SAR image



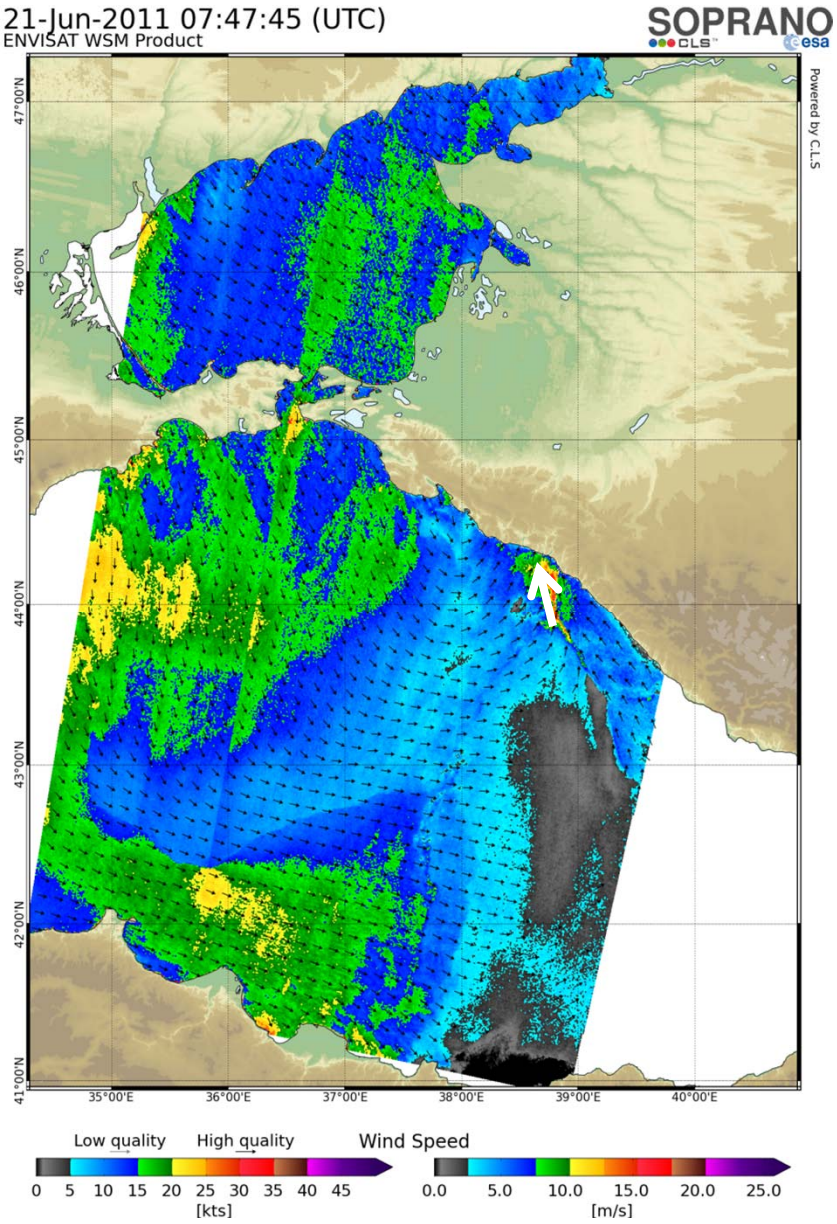
SAR-derived wind field using the wind direction from the NCEP model



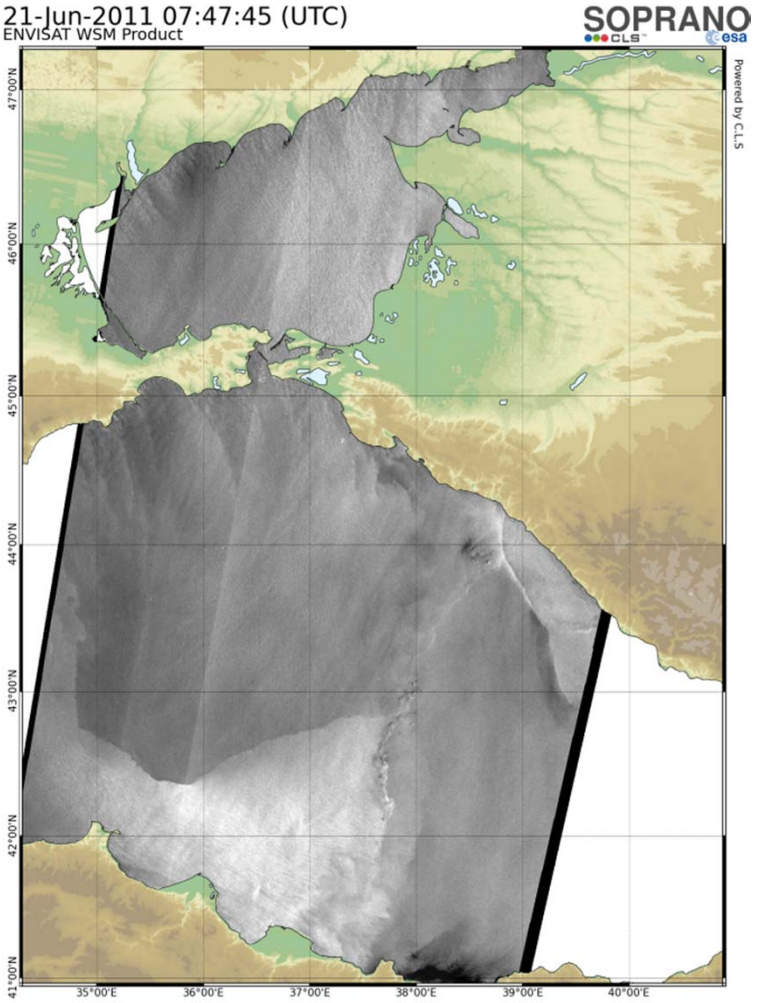
Radial surface velocity

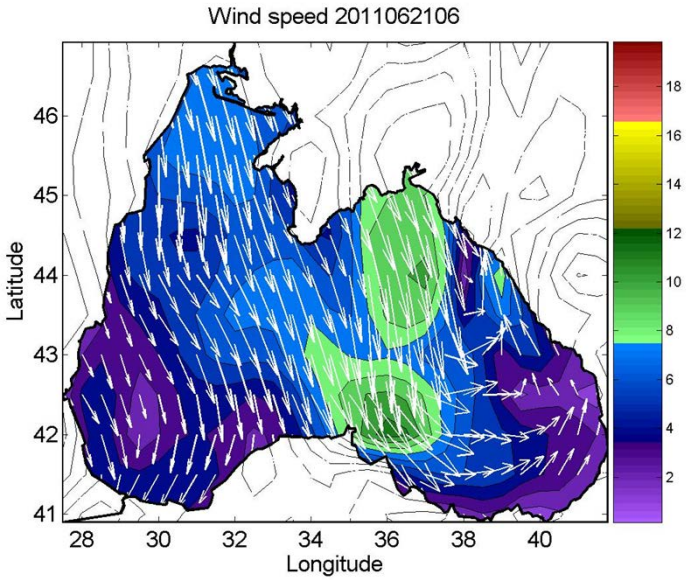


SAR-derived wind field by including Doppler

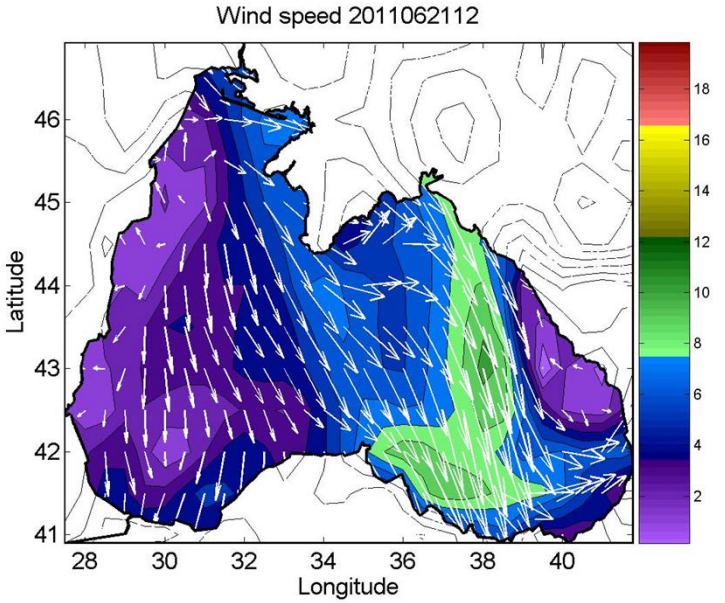


Wind direction is a matter of debate!





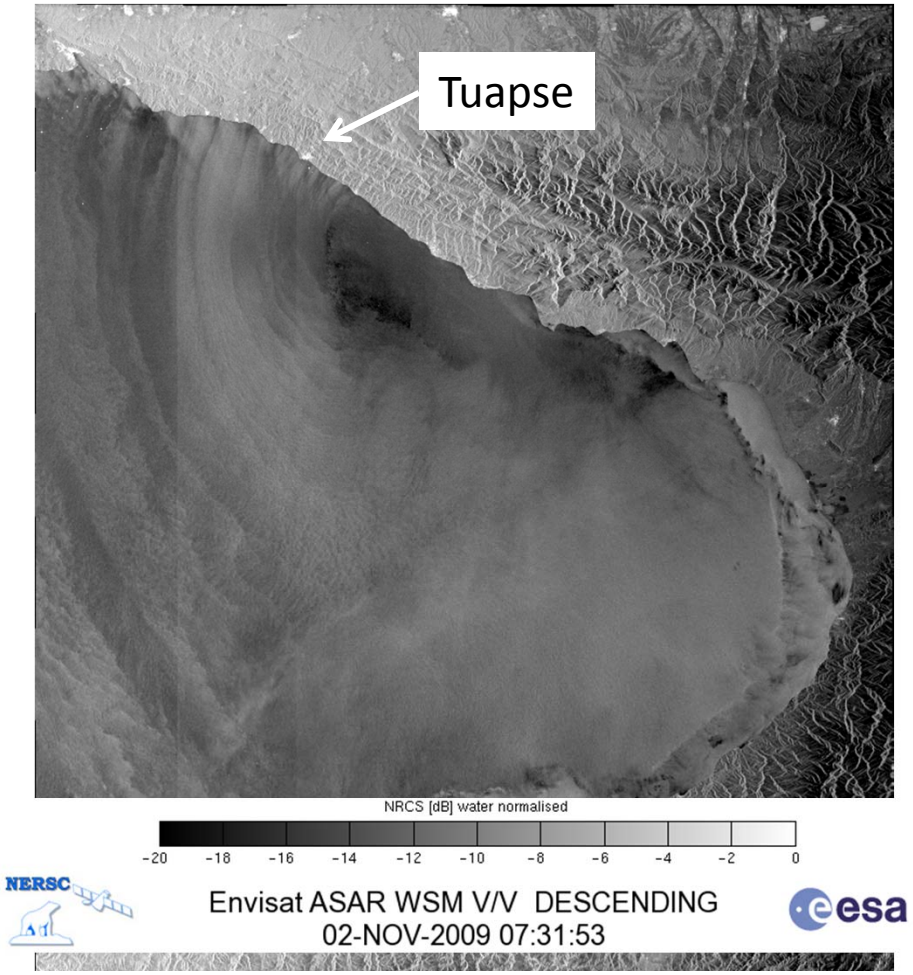
00 UTC

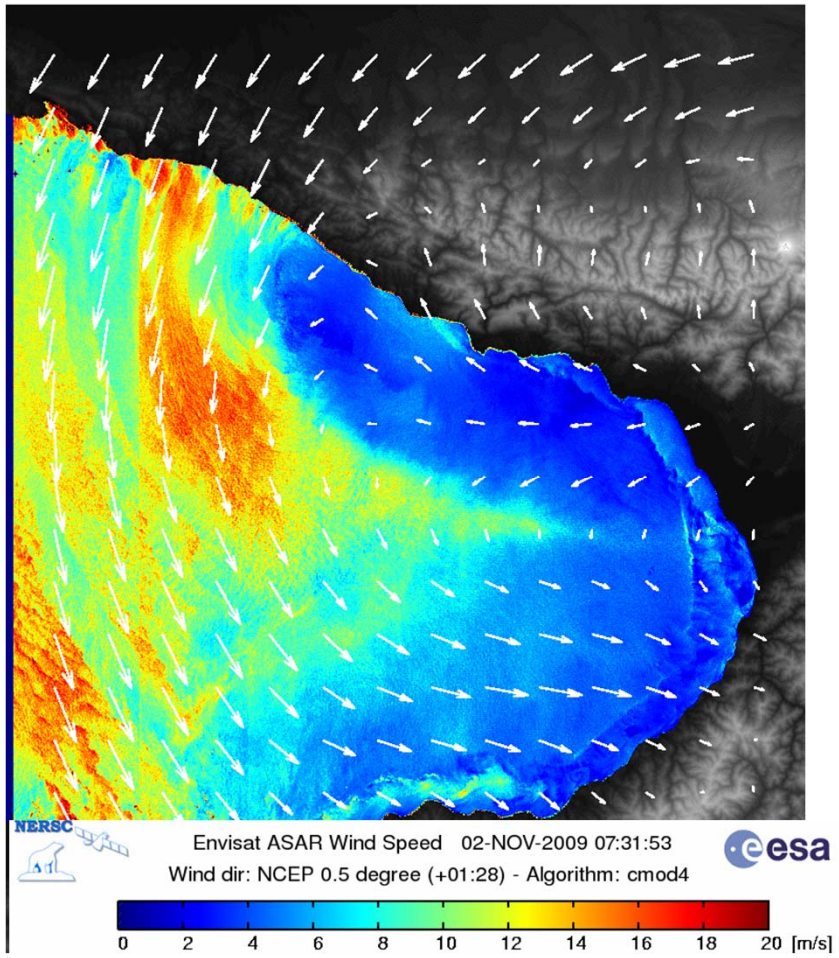


12 UTC

web-site of Marine Hydrophysical Institute in Sevastopol(Ukraine)

Typical wind jet linked to the coastal topography





Conclusions

- The new SAR wind retrieval algorithm including Doppler information (Mouche et al., 2012) gives, in general, better results than the algorithms using only model winds or linear features visible on SAR images.

- However, sometimes human intervention is needed in this automatic wind retrieval algorithms to obtain correct wind fields.

Thank you for your attention