



Interplay between current information derived from ground-based HF radars and from satellite sensors

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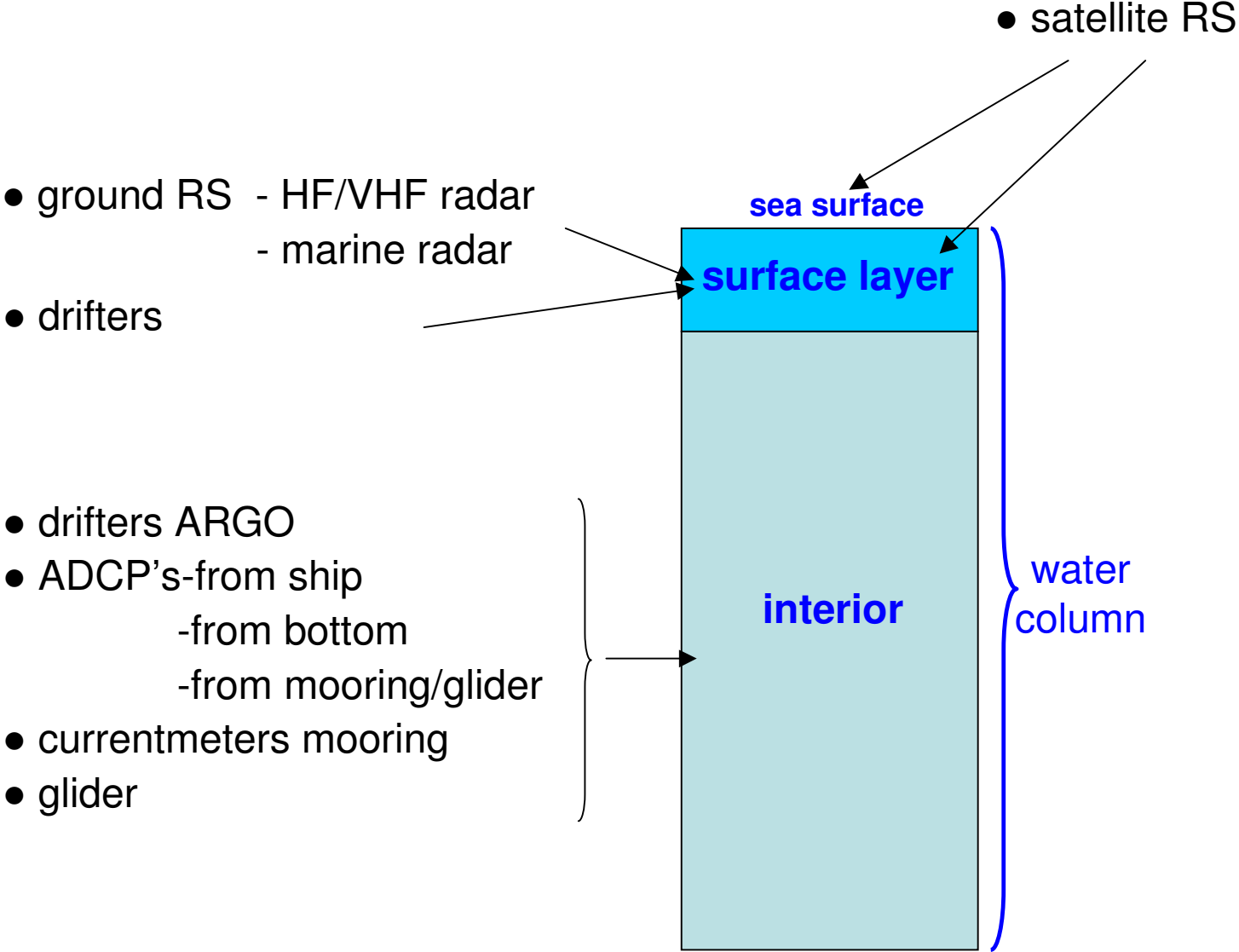
Toulon-La Garde , France



Issues: contribution to answer these questions

- what bring HF current measurements to current information from space
- what bring current data from space to surface current maps derived from HF data
- what brings both (twin) techniques to dynamical coastal oceanography

Measuring ocean currents



Satellite RS of ocean currents

Two kinds of measurements

- QUANTITATIVE currents (or component) in m/s

- + direct : ➤ interferometry

- SAR through Doppler

res=200 m

- + indirect : ➤ altimetry (SS topography)

res=10 km

- CURRENT FEATURES

- +direct : ➤ SAR (roughness)

res=50 m

- fronts - gyres - IW surface expression

- +indirect :

- SST

res=1 km

- water color

res=1 km

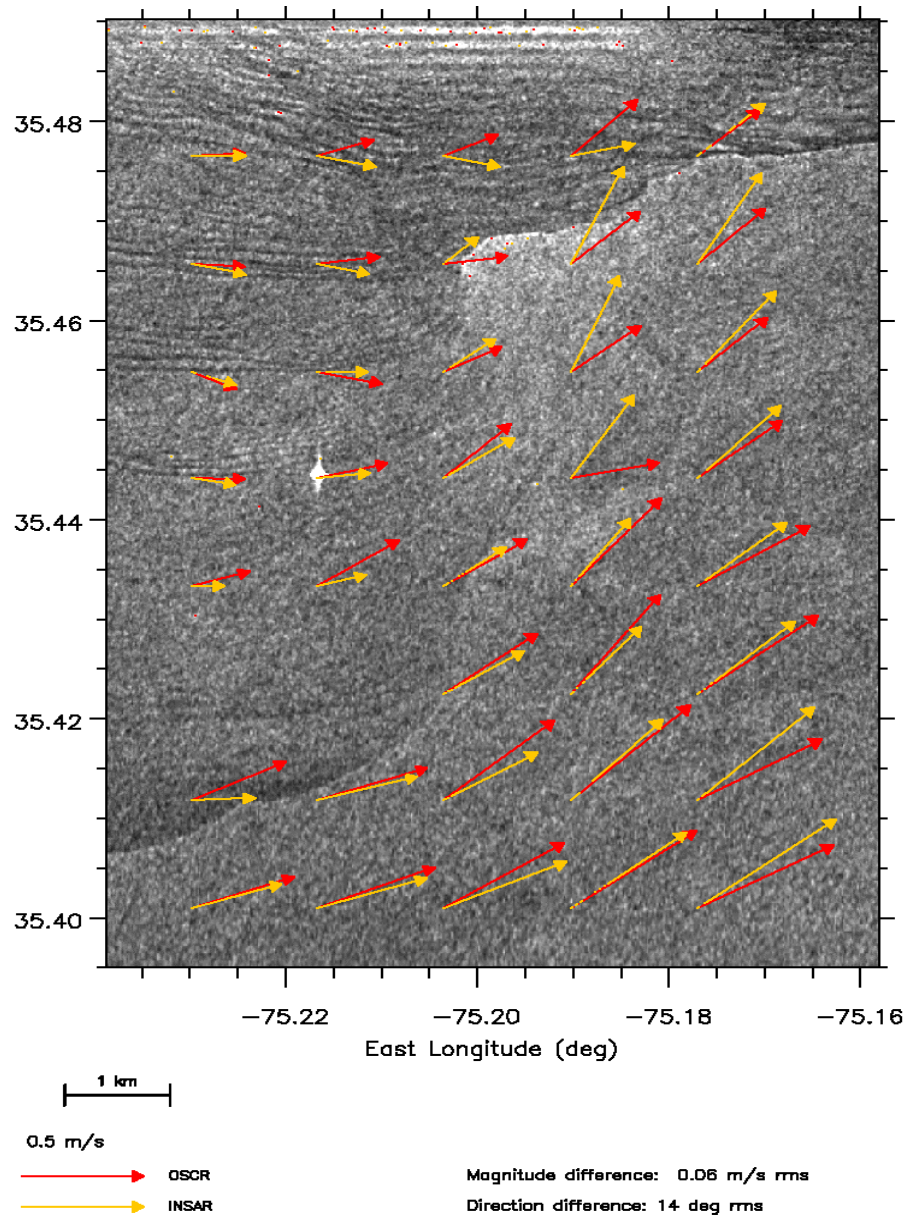
- high-res optical imagery

res=10 m

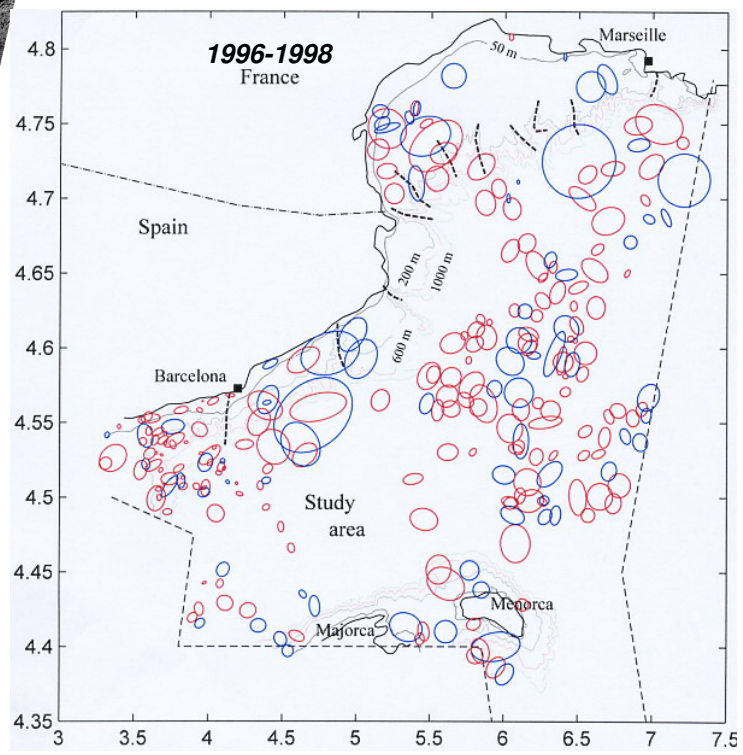
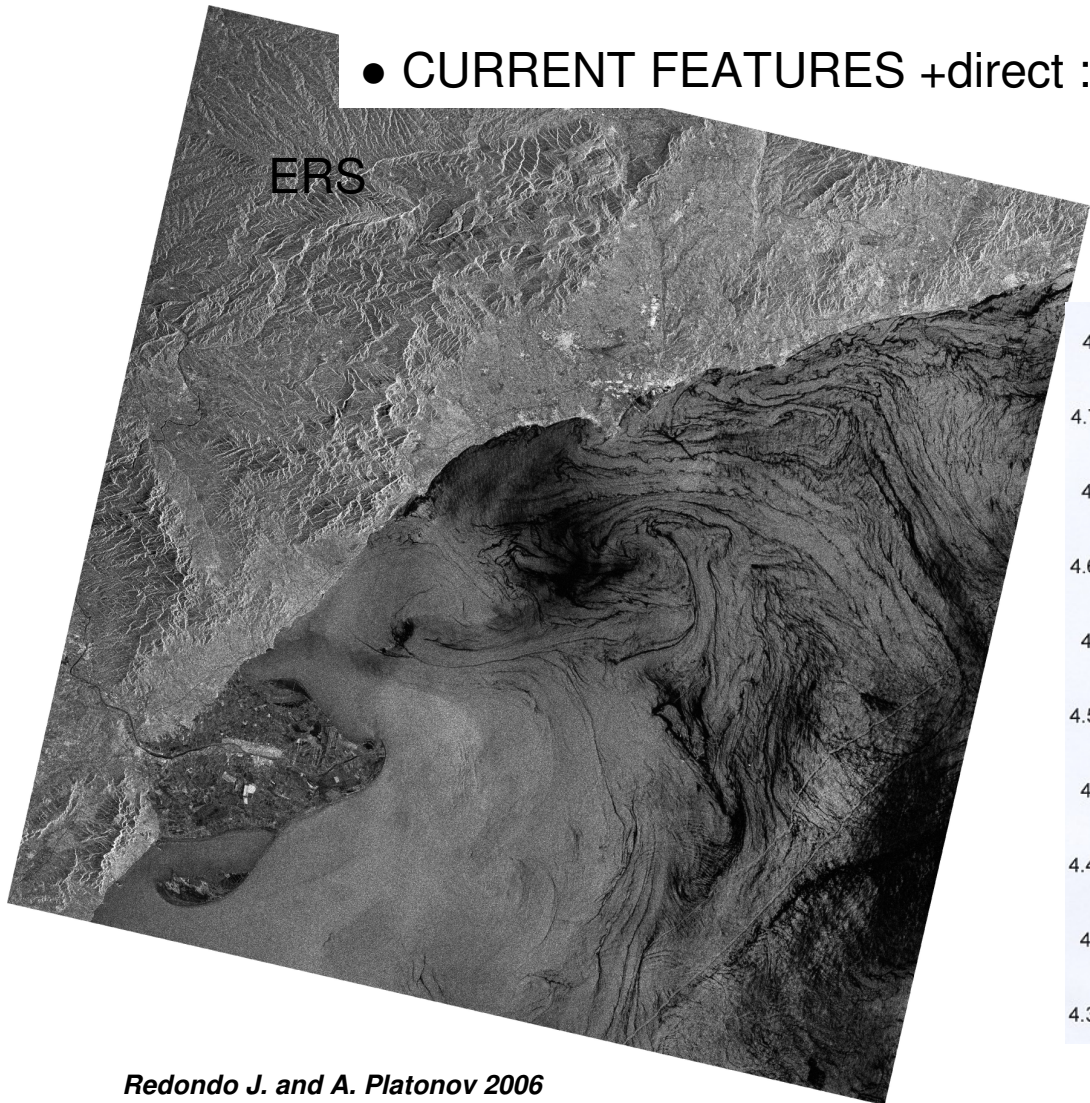
- QUANTITATIVE + direct :  interferometry

AT-INSAR and HF Current Estimates

Thompson et al. 1997



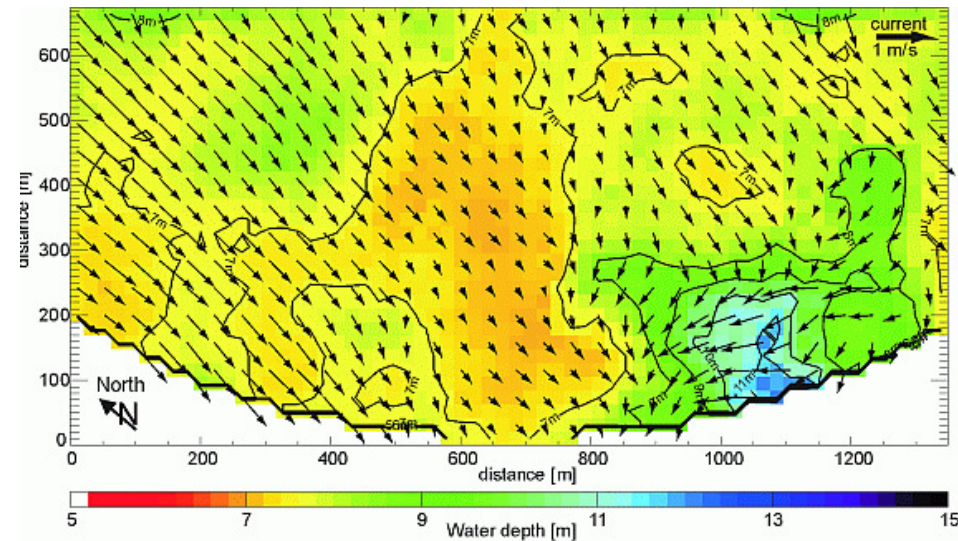
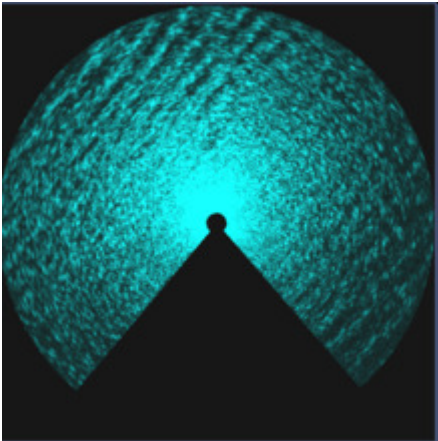
- CURRENT FEATURES +direct : ● SAR (roughness)



Redondo J. and A. Platonov 2006

Ground/airborne RS of ocean currents

- marine radars (X-band - eg WAMOS)
 - airborne – radar or optical
- } estimation of the 3D wave spectrum:
current estimates from the
dispersion relationship



Helgoland WaMoS II www.oceanwaves.org/

- ground radars: HF/VHF systems

res=5 km / 300 m

scene size: 100 km / 20 km

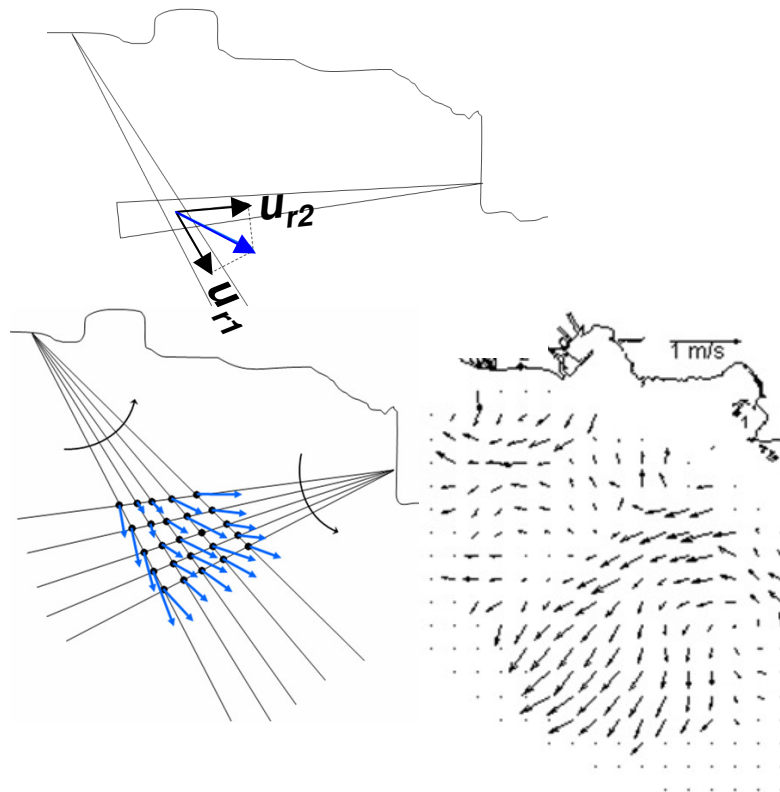
HF/VHF RS of ocean currents

integration depth = $\lambda/8\pi$ VHF : 0.3 m

HF : 1 m

surface layer

principle in brief



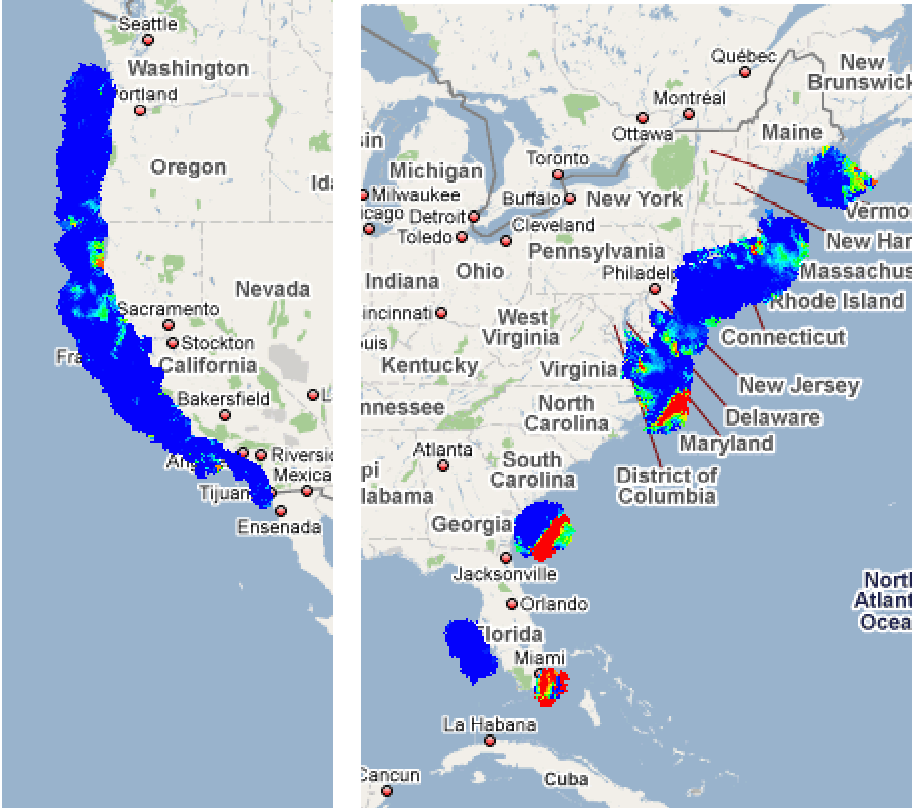
HF systems nowadays

- SeaSonde (CODAR) ≈ 150 over the world
- WERA (Heltzel Co.) ≈ 20
- Others (labs - private - military)

Countries (CODAR) : Argentina - Brazil - Australia - Canada - Chile - China - Croatia - Egypt - France - Greece - Germany - India >10 - Israel - Italy >5 - Japan >10 - Jordan - Korea >10 - Mexico - Norway >100 - Portugal - Spain >5 - Taiwan >100 - Thailand >5 - Spain - Russia - US >100

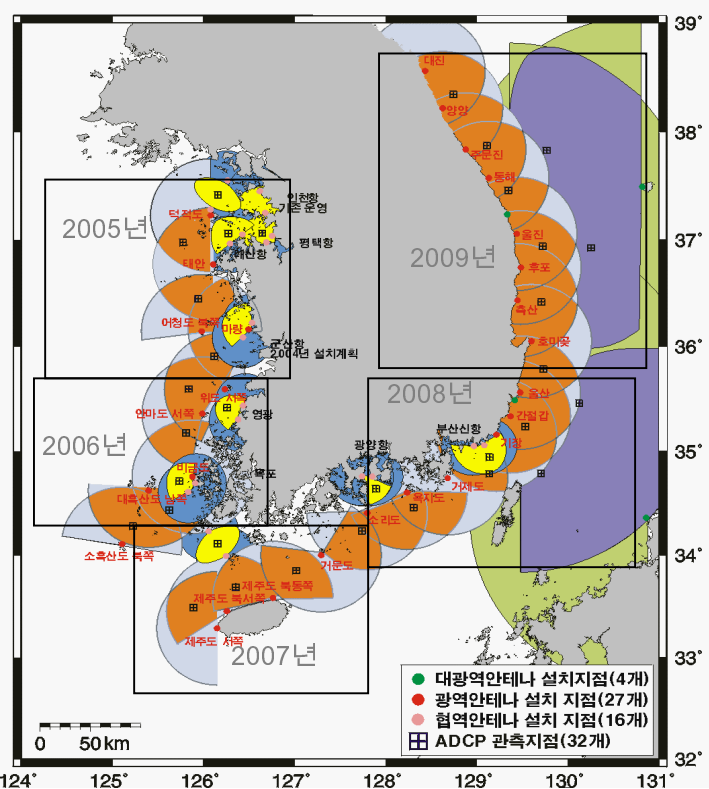
Examples of networks

Seasonde's in US



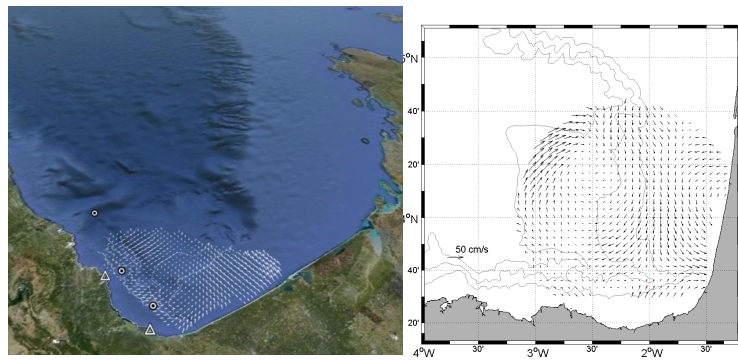
U.S. Integrated Ocean Observing System (IOOS®) High Frequency Radar Network (leader Jack Harlan)

in Korea



O. Jeong 2010

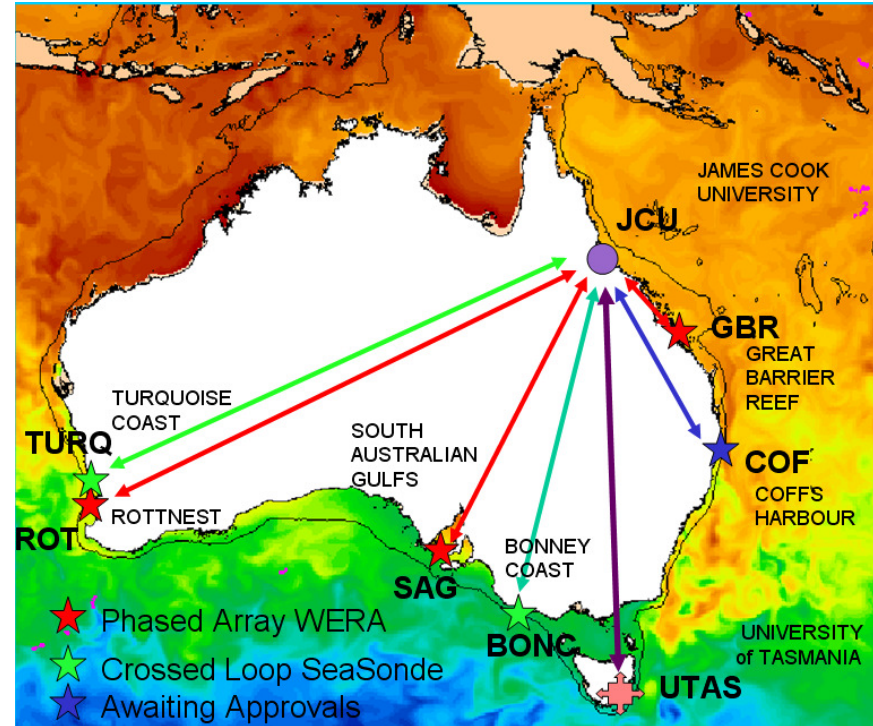
in Spain



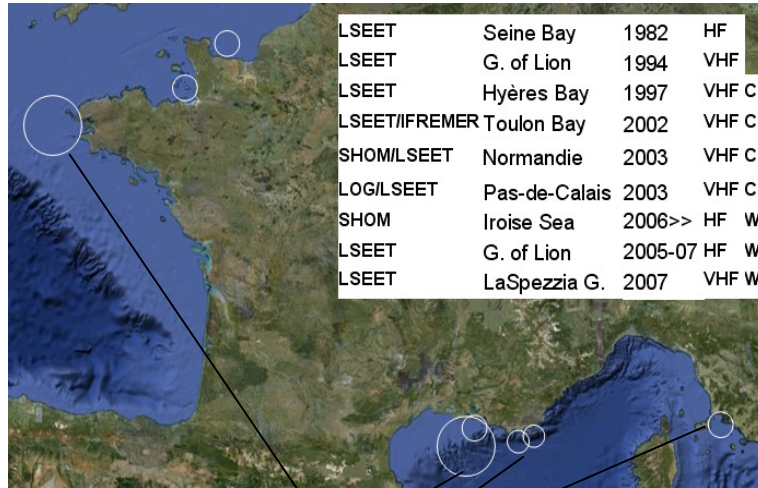
Julien Mader, et al 2011

Anna Rubio et al. 2010

Australian network ACORN

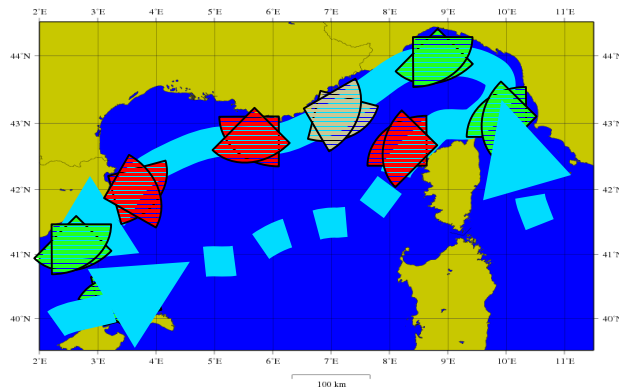


HF/VHF campaigns in France



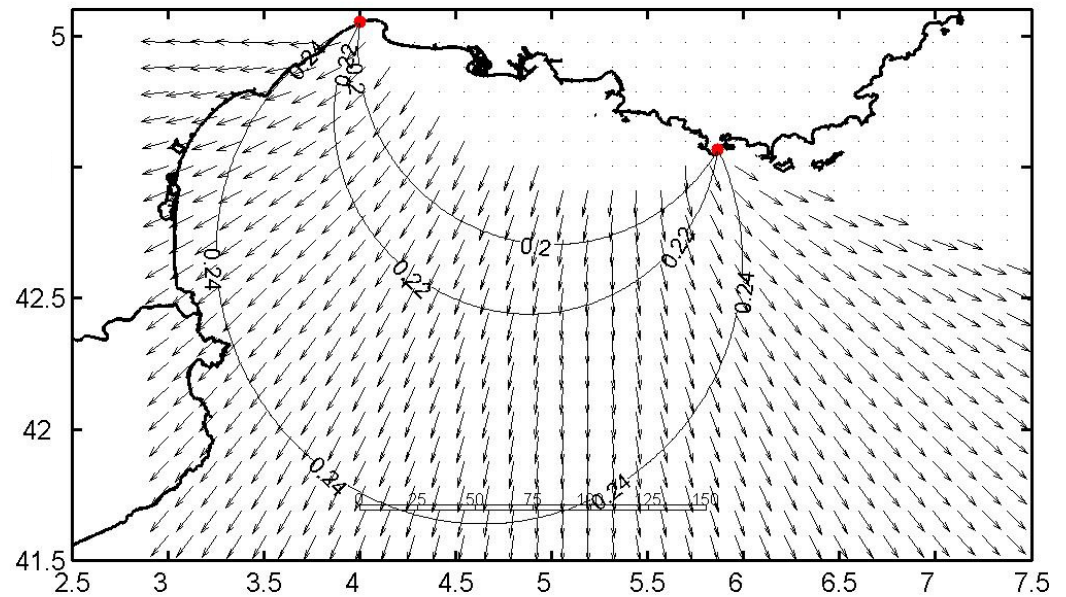
WERA

Concept of a NW-Med radar network



STRADIVARIUS

2011 – industrial project) concept of HF long range (4.5/9 MHz)-bistatic – radar with constant resolution for target detection and environment application
TDF, DIGINEXT, LSEET, ACTIMAR, ANTHEOP



HF/VHF radars : what for

Main: monitoring of coastal circulation at relevant scales of time (long term) and space (long range)

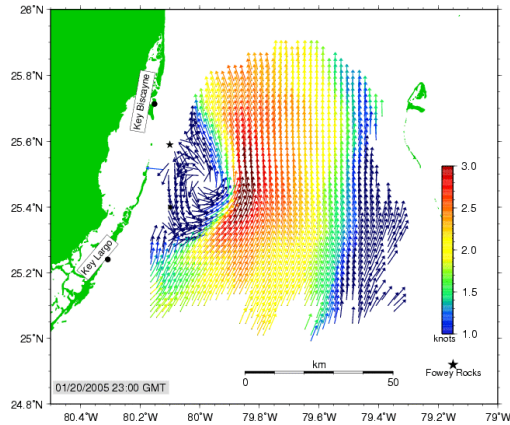
- support to process study in ocean dynamics
- support to ocean modelling: assessment, surface condition, model downscaling, assimilation
- support to ecological studies
- support to measurements at sea

Special:

- environment : fate & transport of pollutants (esp. oil spill pollution)
- search and rescue
- risk (floods, tsunamis)
- maritime operation

4 examples

1 - coastal currents : gyres

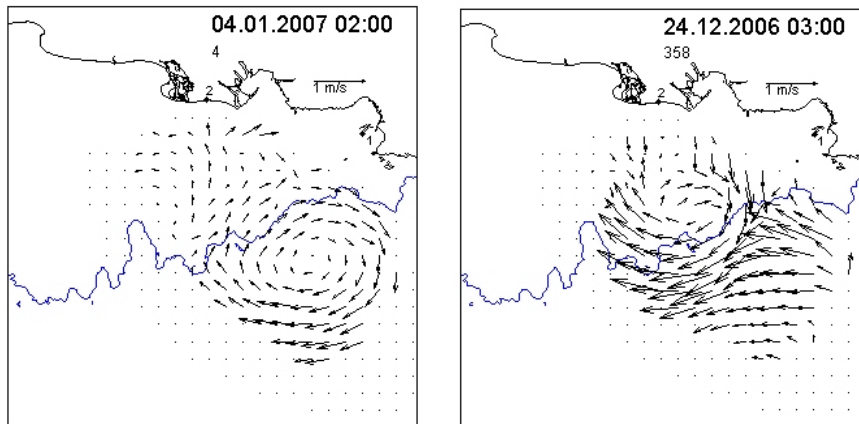


North Carolina - Duck

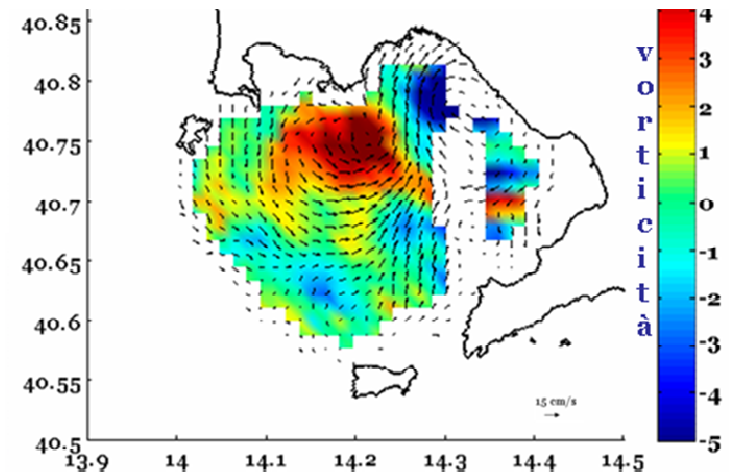
Shay et al. 1998

Gulf of Naples

Gulf of Lions



Schaeffer Forget 2010

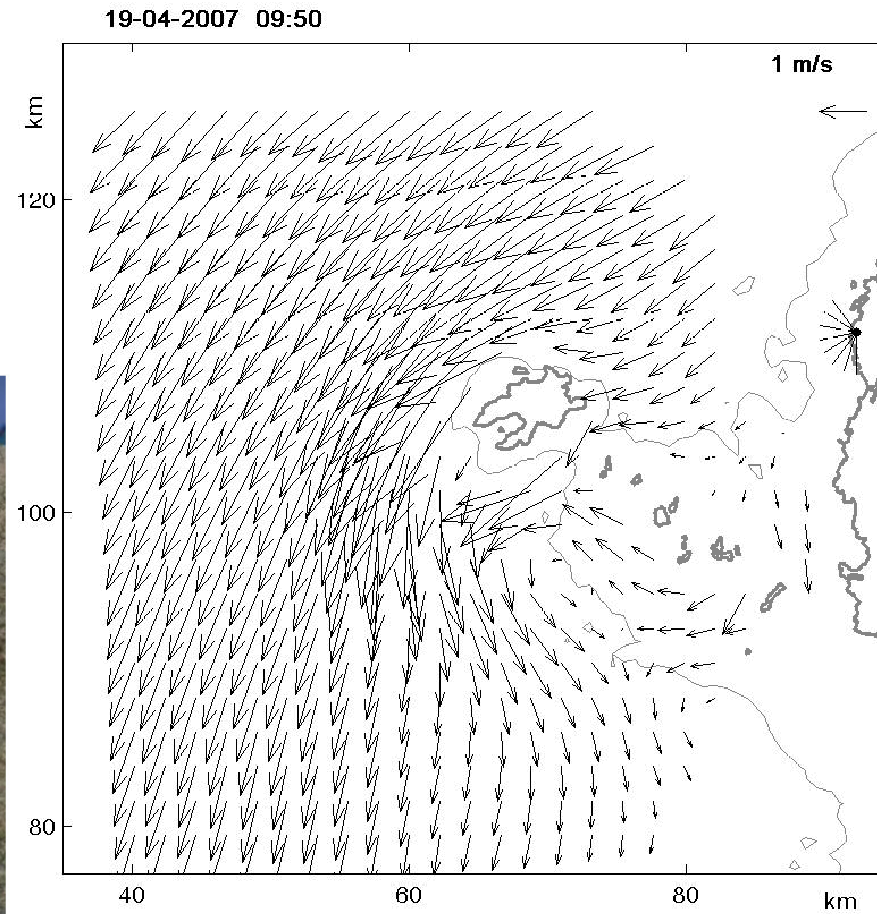
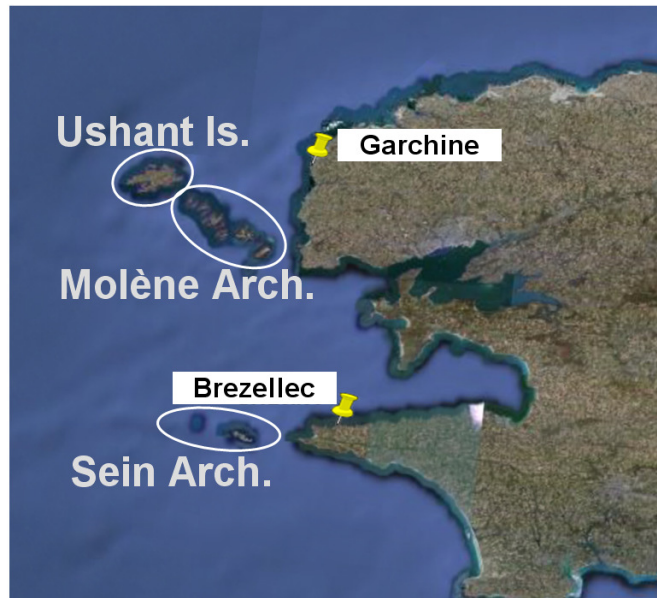


Enrico Zambianchi 2010

2 - coastal currents : tidal flows

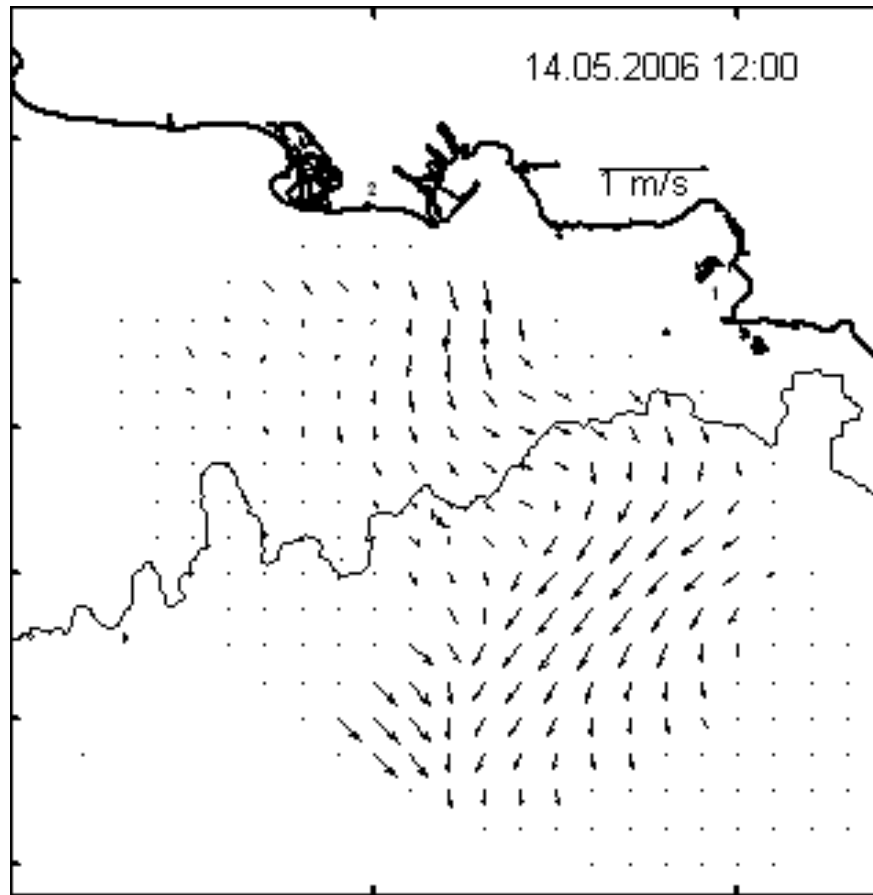
Iroise radars

- 12 MHz
- long time series (from 2006 to date)
- time resolution: 1/3 h
- resolution: 1.5 km along beam
- 2° in azimuth

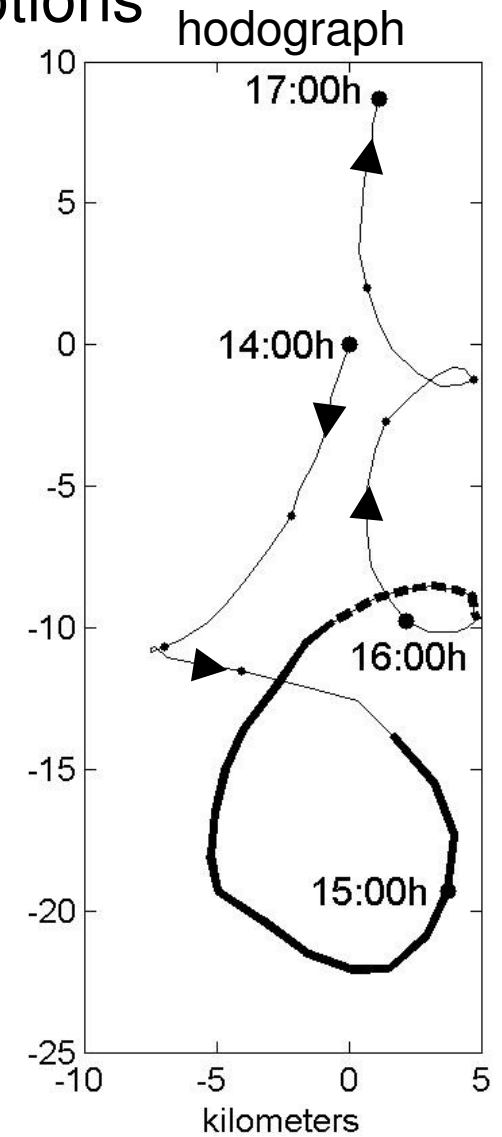


Sentchev Forget 2011

3 - coastal currents : inertial motions

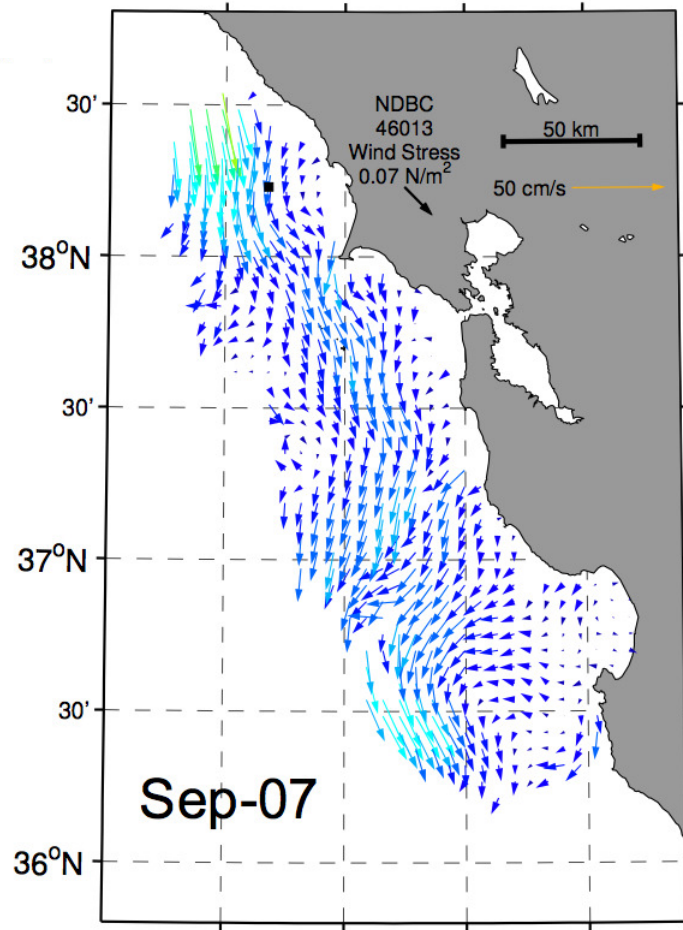


Wera : 2006-05-14 12h 05-17 00h



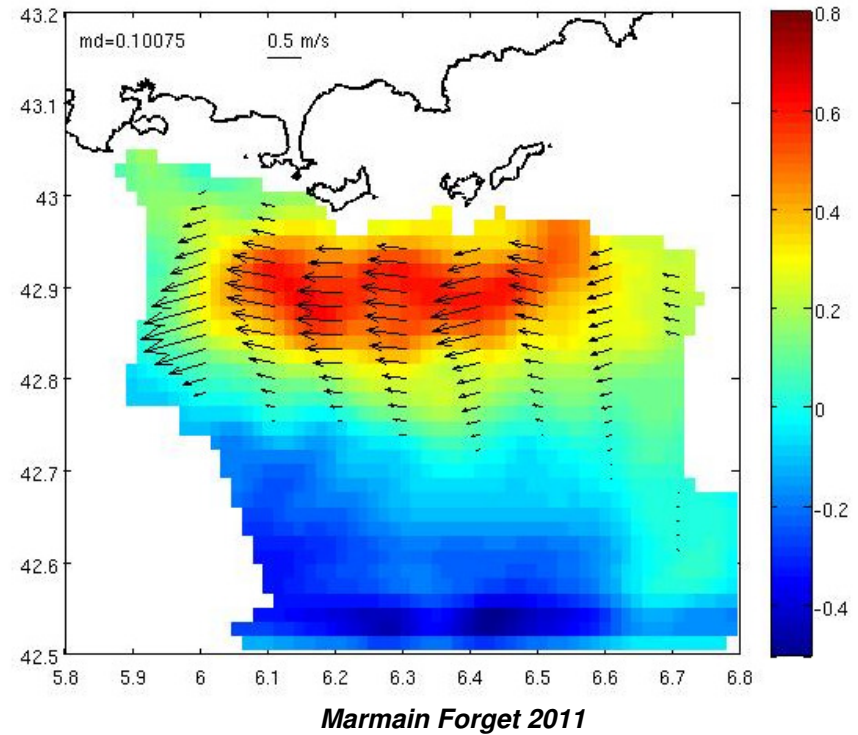
4 - boarder current

Californian current



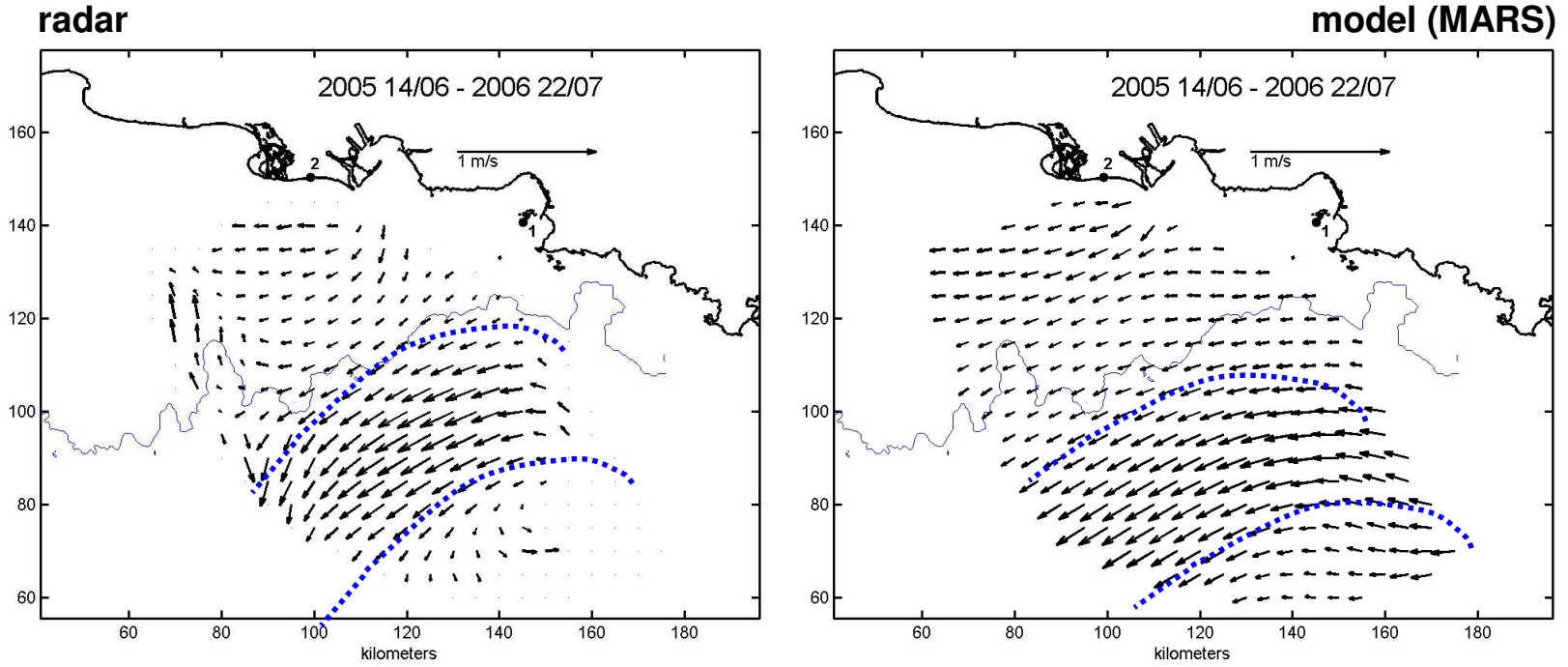
Paduan Kaplan 2009

North current (NW-Med) estimate from 1 radar station



4 – model assessment

Average current – 1 year



Answers to the questions

what brings HF current measurements
to current information from space

☺ Nice current product for assessment/validation of a satellite sensor

+ **current vector field**

+ **quite large coverage**. Satellite estimates can be projected on to a significant piece of ocean surface.

+ **continuous functioning** (1 map/1 h). Satellite currents can be regularly compared/checked over a large period.

☹ Limitations

+ **resolution** (SAR's case). Can be insufficient to resolve small structure (fronts, IW). OK for altimeters.

+ **synchronicity** between orbit and radar field of view. Ideally, radars location should be designed to operate within the swath of a given mission.

+ **range** of radar systems => coastal zones.

What brings current data from space to HF derived surface current data

😊 **high resolution** (SAR's case) which enables to describe subresolution structures within the radar cell

😊 **large coverage** (SAR and, especially, altimeter) which is useful to understand/characterize the « environment » of the radar area coverage (e.g. forcing by boarder current, boudary conditions)

Limitation: **revisit time** (days) ☹️ >>> radar acquisition rate (hour)

>>> time scale of coastal currents

☹️ \geq time scale of (boarder) forcing currents

What brings both (twin) techniques to dynamic coastal oceanography

☺ Both are useful within the paradigm of operational oceanography

