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Experimental investigation of the relationship between HF radar measurements of currents and the dynamical properties of the upper ocean

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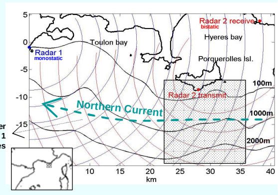
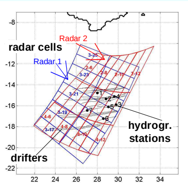
Overview **Surface currents measured by HF radar in the NW Mediterranean Sea were analysed in the light of dynamical properties of the surface ocean. In situ measurements consisted in high resolution current profiling by ADCP, microprofiling of temperature/salinity by SCAMP and drifted buoy trajectories. Current profiling by ADCP was performed along the radar beam directions. These first results concern the 3D structure of the horizontal current and the stratification in presence of weak wind.** ***Work suported by INSU-CNRS, program LEFE 2013-14.***

Experimental set up

The MIO radar network in Provence

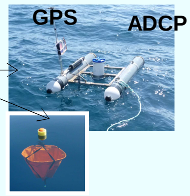
- HF radars 16 MHz (WEllen RAdar technology)
- monostatic and bistatic HF radars
- direction finding processing by MUSIC
- 3 radial current maps per hour
- dates of the experiment: Sept. 3 & 4, 2013





In situ measurements

- towed and drifting ADCP
- surface drifters
- Self Contained Autonomous MicroProfiler (SCAMP)
- on board wind station



Comparison HF radar – in situ measurements

ADCP vs radar

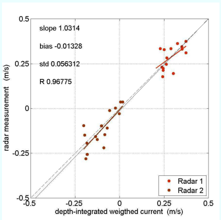
Stewart-Joy 1974

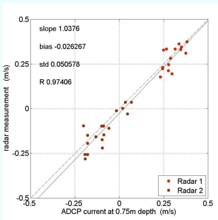
$$U_{radar} = 2k\int U(z)\exp -2kz\,dz$$

practical

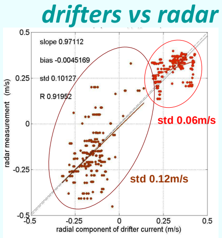
$$U_{radar} = U(z = \lambda / 8\pi)$$

here $\lambda / 8\pi = 0.74\ m$



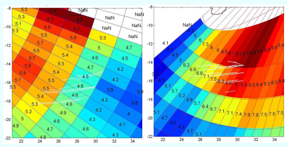


drifters vs radar



measurement (intrinsic) noise of radar currents

Estimated from a long period record (2 years). The measurement noise corresponds to an essentially white noise spectral signature of radar records in the high frequency range (~<5 h).



Corresponding std values

synthetic results

	s.t.d. in m/s		Intrinsic noise		
	U_{ADCP}-U_{radar}	$U_{drifter}$ - U_{radar}	from DF	from Doppler resol.	total
Radar 1	0.054	0.039	0.051	0.010	0.052
Radar 2	0.056	0.105	0.078	0.010	0.079

U_{ADCP} : depth-integrated

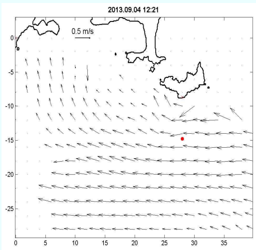
main results

- Good agreement in the limits of intrinsic radar measurement accuracy
- Best fit obtained with vertically weighted ADCP current
- The standard approximation $U_{radar}=U(\lambda/8\pi)$ works well
- Higher intrinsic radar noise in bistatic & short range than in monostatic
- Remaining outliers in radar measurements

Northern Current (NC)

The NC is a permanent current in the NW Mediterranean roughly following the ~ 1000 m isobath in the region.

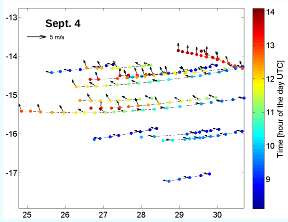
Intensity: 20-45 cm/s during the experiment



Typical radar map of surface current
Boat located by the red dot

Circulation in the upper layer

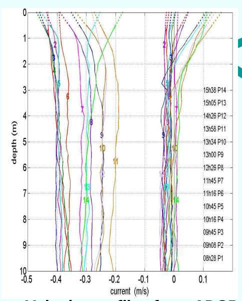
Drifters follow the surface current. Trajectories reflect the mean westward transport due to the NC, wind-induced perturbations and other eventual spatial (small scale) variability of circulation.



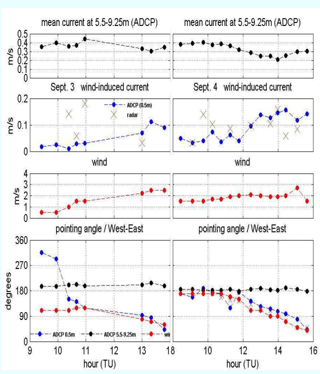
Drifters trajectories. Sept. 4. Dark arrows: wind. Time in color.

Wind-induced perturbation

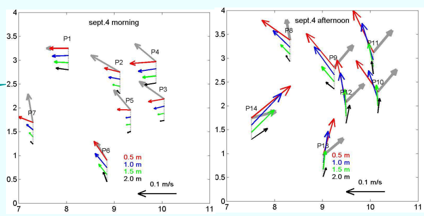
Wind-induced velocity is obtained by substracting from ADCP and radar velocities an average velocity recorded by ADCP in the subsurface layer (5 to 9 m).



Velocity profiles from ADCP (example of Sept. 4)

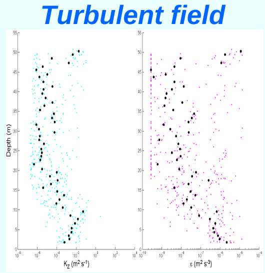


Time variation of wind and currents



Wind-induced velocity in the surface layer 2 m depth. Left: morning, right: afternoon. Sept. 4.

Turbulent field



SCAMP-derived vertical diffusivity and dissipation. Sept. 3. Median values: black dots.

main results

- Noticeable variability of the NC
- Well identified wind-induced surface circulation (Uw). Intensity ~3.5% of the neutral 10m-wind speed.
- Fast response of Uw in speed, direction and Ekman layer deepening to wind variations
- For present weak wind conditions, Uw variations remain within the radar intrinsic accuracy
- Turbulent field vertical profiles provide information on background flow structure