<u>REALISTIC NUMERICAL SIMULATIONS OF UPWELLING AND</u> <u>DOWNWELLING IN THE MIDDLE ADRIATIC:</u> THE MAY 2017 EPISODE

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ROMS (Regional Ocean Modeling System) model setup

Regional Ocean Modeling System (ROMS) is used to reproduce and analyse upwelling detected in the middle Adriatic Sea during May 2017.

☆ The ROMS domain covers the entire Adriatic, with a rectangular grid having horizontal resolution of 2.5 km and 22 unequally spaced 's' levels along the vertical.

✤ Baseline ROMS simulation is run for the period from 1 August 2016 to 31 December 2018.



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ROMS model forcings

*Atmospheric forcing (Fairall et al., 1996)

✓ Wind stress

✓ Heat fluxes

✓ Water fluxes (E-P)

Three-hour surface fields from ALADIN-HR prognostic model (8 km for scalar fields, 2 km for wind fields) and instantanious SST calculated by ROMS

*Rivers

 \checkmark 41 rivers along the Adriatic coasts with climatological discharges (Raicich, 1994)

* Tides

✓ (7 seven tidal harmonics - M2, S2, N2, K2, K1, O1, P1)

*Open boundary condition:

✓ Warer mass exchange trought the Strait of Otranto using AREG MODEL (Oddo et al., 2006) results. For the barotropic part, a modified Flather scheme is used (Flather, 1976), while for baroclinic velocity and tracers (temperature and salinity) a combination of Orlanski-type radiation boundary conditions with nudging is applied (Marchesiello et al., 2001).



10-m ALADIN-HR wind fields before field experiment: 24-27 May 2017.

10-m ALADIN-HR wind fields during and after field experiment: 28-31 May 2017. Red circle on 28 May plot denotes variable NNW wind above the area of measurements.

ATMOSPHERIC FORCING

Numerical experiments focus on May 2017 when upwelling induced by prevailing **NNW wind** was recorded in middle Adriatic 15-20 km off the eastern coast by yo-yo CTD profiler.





* Baseline ROMS experiment (Exp.1) reproduced basin-wide cyclonic circulation.



Mean monthly currents at 1 and 10 m depth in May 2017. Vectors are plotted at every fifth grid point.





ROMS model results are assessed with available CTD and HF radar measurements, satellite sea surface temperatures (SST) and data collected during May 2017 and June 2018 cruises by the yo-yo CTD profiler and shipborne ADCP.



0.6637

12

0.0195





Daily mean surface temperature, salinity, density and current fields for 28 (up) and 29 (down) May 2017 obtained in ROMS baseline experiment. ROMS results are analysed along crossbasin transects (white dashed lines - A, B, C). CTD data were collected along red part of transect B.

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Exp.1 Daily mean surface temperature, salinity, density and current fields for 28 (a), 29 (b), 30 (c) i 31 (d) May 2017 obtained in ROMS baseline experiment. ROMS results are analysed along cross-basin transects (white dashed lines - A, B, C). CTD data were collected along red part of transect B.

Satellite SST from 28 to 31 May 2017. Upwelling area is marked with red rectangle on the Adriatic map (up) and satellite image for 28 May (down).

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ROMS baseline and sensitivity experiments:

Baseline experiment qualitatively reproduces the upwelling but several sensitivity experiments are needed to increase agreement between model and measurements. Various intensities of horizontal viscosity and diffusivity and drag coefficient are tested in sensitivity studies. Moreover, a third order upwind advection scheme is tested as is the behaviour of solar shortwave radiation along the water column.

2017.	TNU2	VISC2	CD	Hor.adv.	solar source
Exp.1	20	200	1	TS_MPDATA	+
Exp.2	0	5	1	TS_MPDATA	+
Exp.3	20	1	1	TS_MPDATA	+
Exp.4	20	5	1	TS_MPDATA	+
Exp.5	10	15	1	TS_MPDATA	+
Exp.6	10	5	1	TS_MPDATA	+
Exp.7	20	5	2	TS_MPDATA	+
Exp.8	20	5	2	TS_U3HADVECTION TS_C4VADVECTION	+
Exp.9	20	5	2	TS_U3HADVECTION TS_C4VADVECTION	-
Exp.10	20	5	2	MP_DATA	-











CONCLUSIONS

- Significant improvement in the upwelling simulations is obtained using increased drag coefficient.
- * ROMS reproduced development of dense water dome recorded in May 2017 in the middle Adriatic 15-20 km off the eastern shore and cyclonic surface circulation around it.
- * Circulation pattern recorded by shipborne ADCP with inflowing currents in the first 10 km from the eastern middle Adriatic coast and wind-controlled two-layer flow further offshore is also reproduced by the ROMS model.
- * Next step will be simulations with increased horizontal resolution.

