A Coupled Atmosphere-Ocean modelling system to investigate the exceptional Winter 2012 conditions in the Northern Adriatic Sea

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1 – WINTER 2012 IN THE ADRIATIC REGION

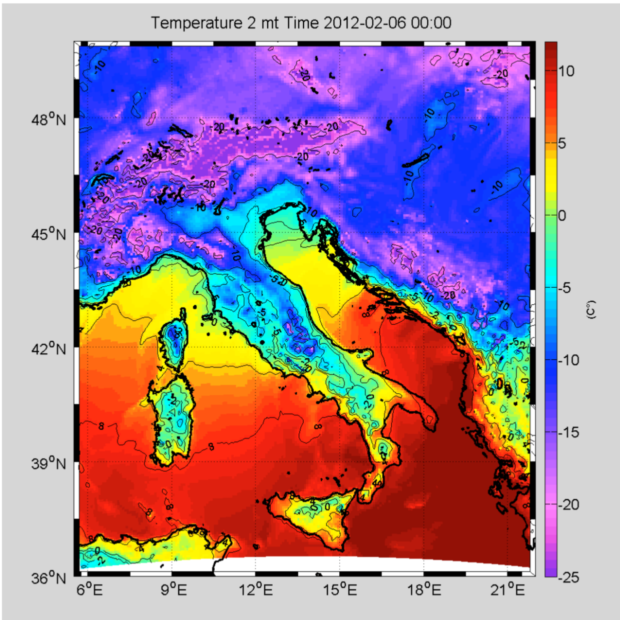

Fig. 1- Air Temperature 2 mt 6 February 2012 at 00:00 UTC

During late January and early **February 2012**, the eastern Mediterranean area was characterized by a persistent cyclonic circulation associated with an exceptional **cold anomaly**.

This atmospheric pattern was responsible for large **heat energy losses** in the shallow northern **Adriatic Sea**, mostly due to cold and extremely strong Bora winds (from NE) that induced a drop in sea water **temperatures** to about 6°C and the partial icing of the Venice lagoon.

The Coupled Ocean-Atmosphere-Wave- Sediment Transport System **(COAWST)** is used to model air-sea interaction and circulation processes. The atmospheric component, the **Weather Forecast Research (WRF)** model, is utilized with different surface boundary conditions.

COAWST includes feedback scenarios between the atmosphere model **WRF**, the ocean model Regional Ocean Modeling System (**ROMS**) and the Simulating WAves Nearshore (**SWAN**) model.

2 - NUMERICAL RUNS PERFORMED

The following runs have been performed:

WRF STAND ALONE RUNS
(WRF: 239x214 pts, 7 km res.)

NO SST: initial SST is derived from the skin temperature of the global model . No update during the integration.

STATIC: initial SST derived from NOAA/NCEP radiometer 8.3 km, then maintained constant. No update.

OML: initial SST as in STATIC, then evolving according the 1-D OML built-in WRF

DYNAMIC: as in STATIC, then SST updated every 6 hours

COAWST RUNS
(ROMS and SWAN: 1 km res)

COAWST AO: WRF <-> ROMS
COAWST AOW: WRF <-> ROMS <-> SWAN

Coupling among models every 1200 s

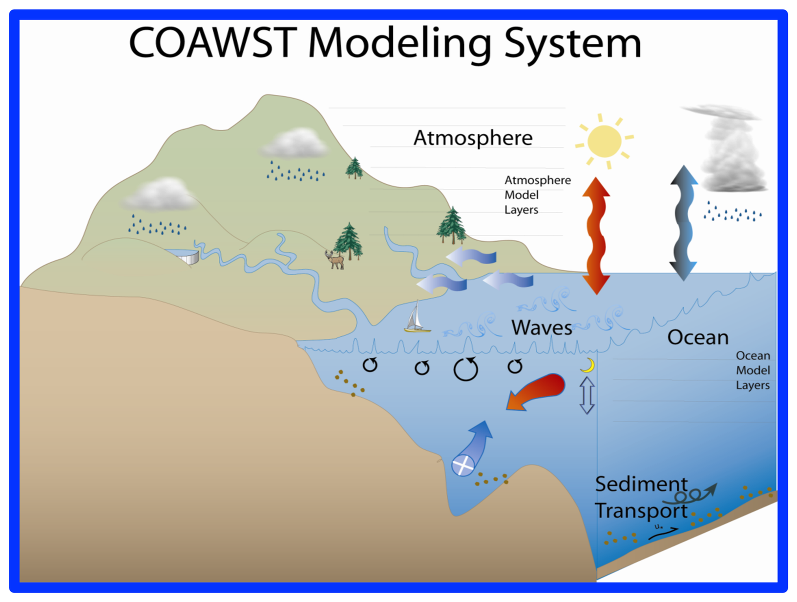

Fig. 2- sketch of the COAWST system

Fig. 3- CNR "Acqua Alta" tower

3 - AIR AND SEA TEMPERATURE

Results have been compared against measurements available at "Acqua Alta" CNR tower and "Paloma Buoy".

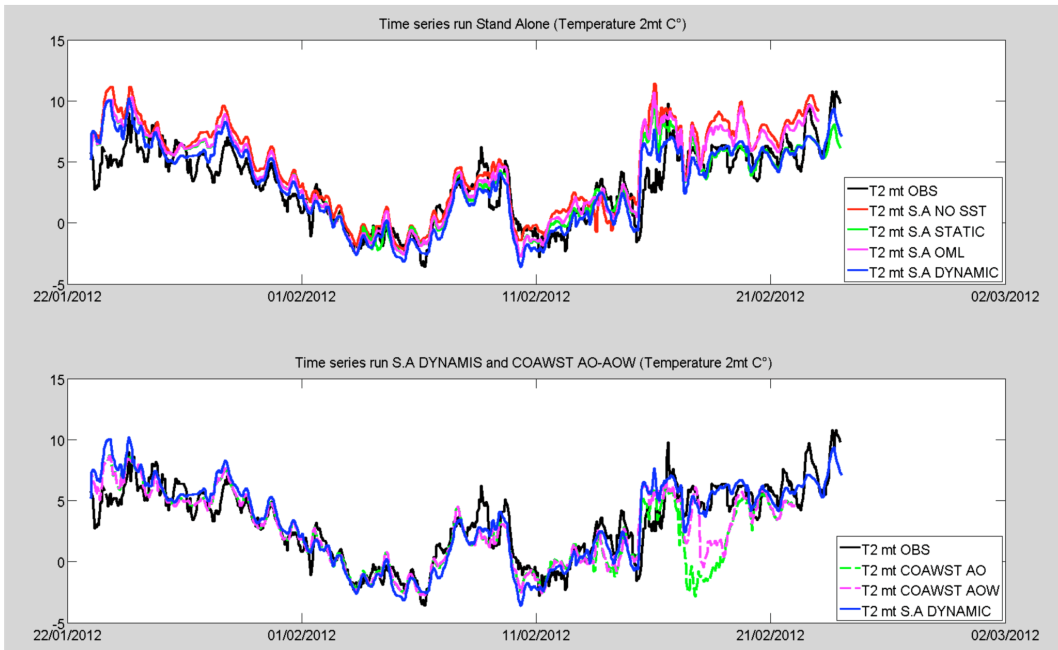

Fig. 4- Time series of 2m air temperature (°C) at *"Acqua Alta" tower* as resulting from different runs. (a) WRF cases. (b) including also COAWST cases

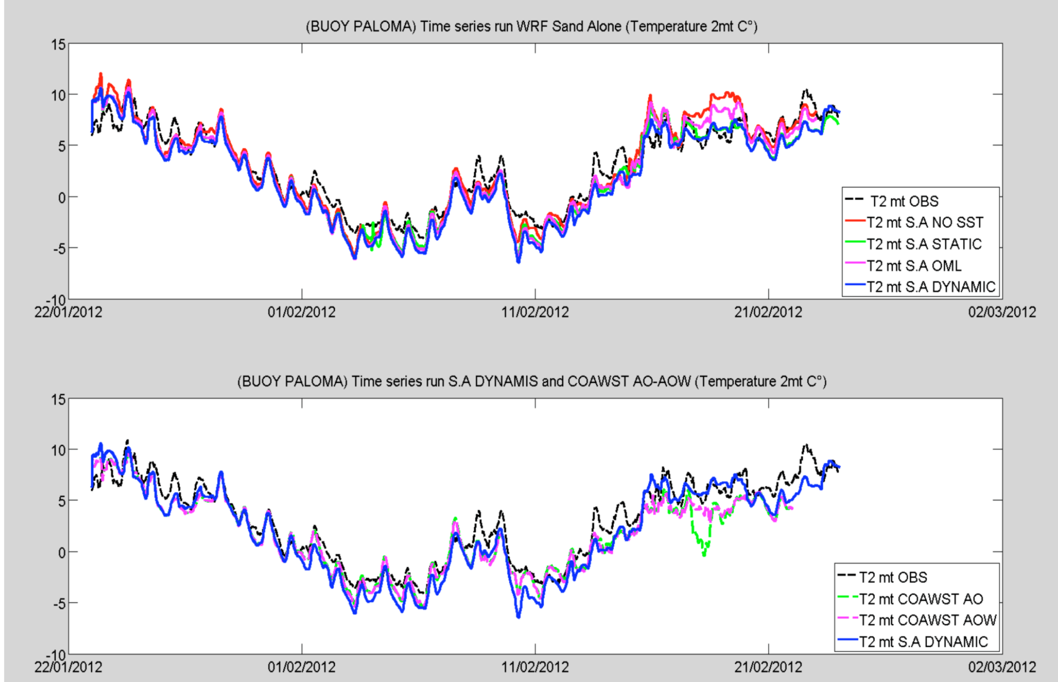

Fig. 5- Time series of 2m air temperature (°C) at *"Paloma Buoy"* as resulting from different runs. (a) WRF cases. (b) including also COAWST cases

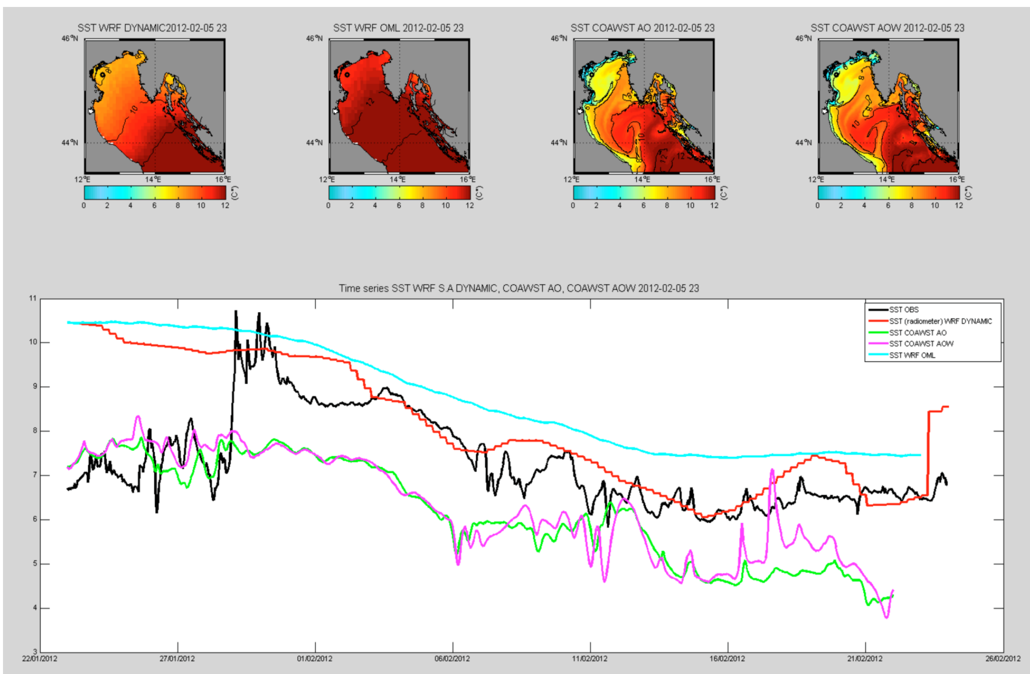

Fig. 6- Sea Surface Temperature (°C) (a) 2D as resulting from different runs; (b) time series at *"Acqua Alta" tower.*

COAWST runs start from a colder initial condition than that identified by the radiometer

4 - TURBULENT HEAT FLUXES TIME SERIES

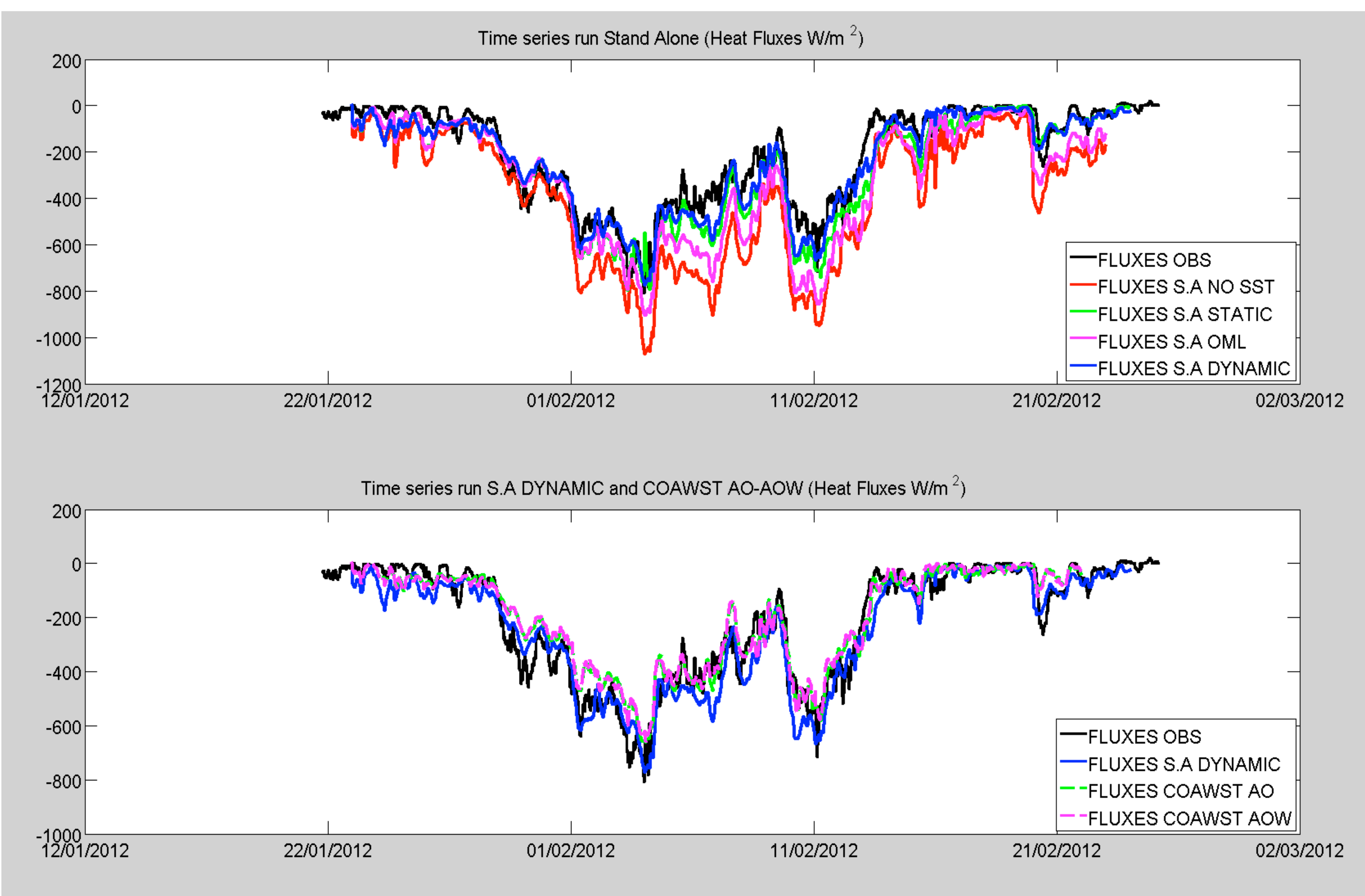

Fig. 7- Time series of turbulent heat fluxes (W/m^2)

5 –FLUXES and AIR TEMPERATURE VARIABILITY

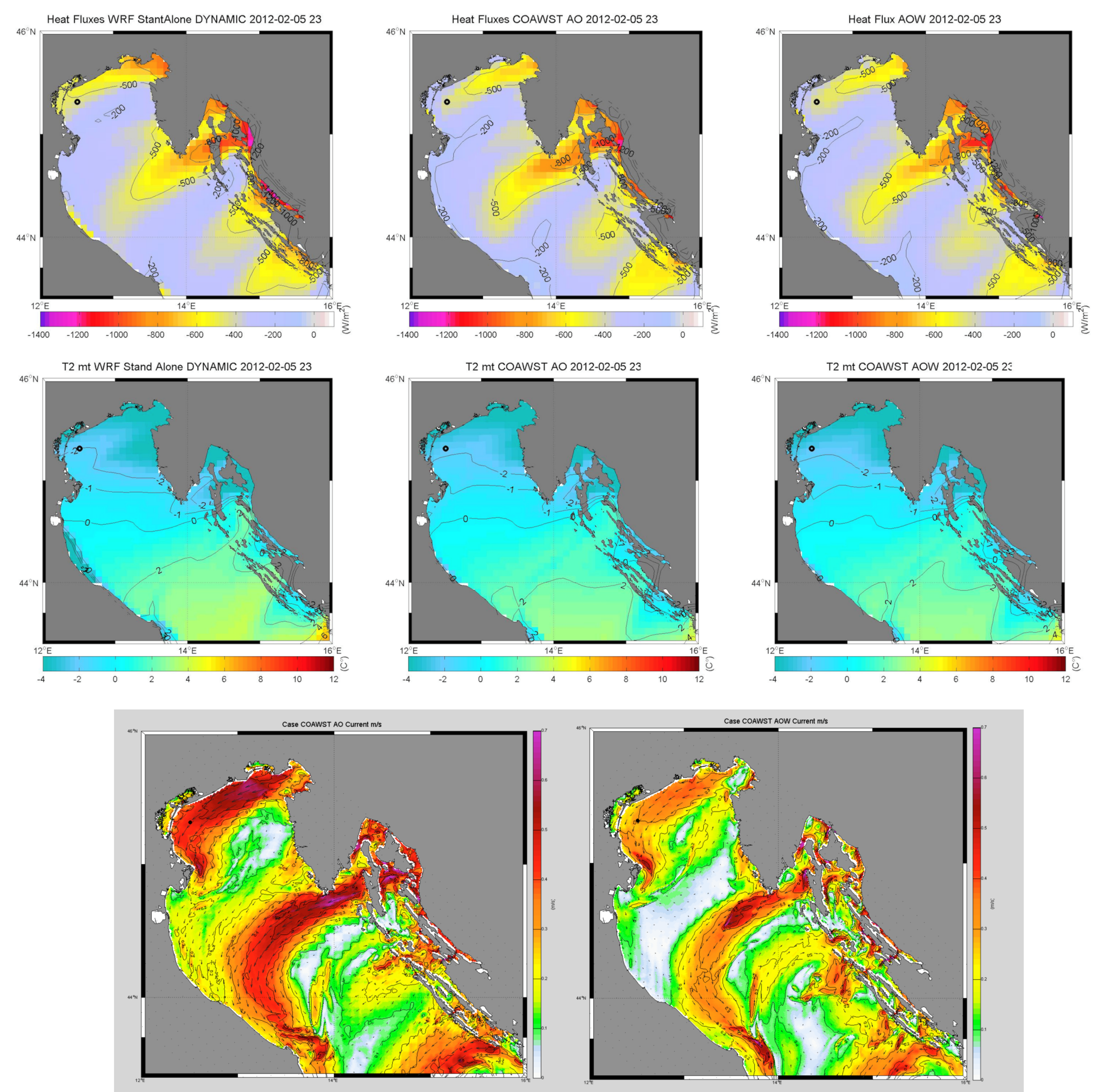

Fig. 8- (a) Fluxes, (b) air temperature and (c) surface current

6 – CONSIDERATIONS

We examined different surface boundary conditions of WRF atmospheric model. By adopting the COAWST system, an assessment of ocean-atmosphere interactions during an intense winter in a semi-enclosed basin is provided. The relevance of the ocean presence when applying an atmospheric model has been highlighted. We utilize an exceptional cold event to focus on the improvement that a series of more complex models can provide. Albeit limited by a lack of in situ measurements, we demosntrate through the use of *Acqua Alta* tower and *Paloma buoy* data:

Not surprisingly, SST at the tower is followed rather well by the radiometer (see WRF S.A. DYNAMIC) after the cloudy period (Fig. 6b). However, for the same runs, the air temperature (Fig. 4b) is warmer w.r.t. data.

A better agreement in the SST (and in the heat fluxes) is obtained with WRF-ROMS (atmosphere-ocean coupling); however, the best agreement in the turbulent fluxes (Fig. 7) is reached with WRF-ROMS-SWAN (atmosphere-ocean-wave coupling). The presence of a relatively cold basin in this coupling needs to be more careful assessed (Fig. 6b), particularly with reference to the atmospheric model resolution.

ROMS model seems to play a significant role in getting a "correct" coupled atmosphere", but it is pivotal when employed in conjuction with the wave models. AOW run provides a larger roughness and shows a greater impact on the air temperature (Fig. 8).

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