Assessment of wave-current interactions on the Mediterranean Sea dynamics

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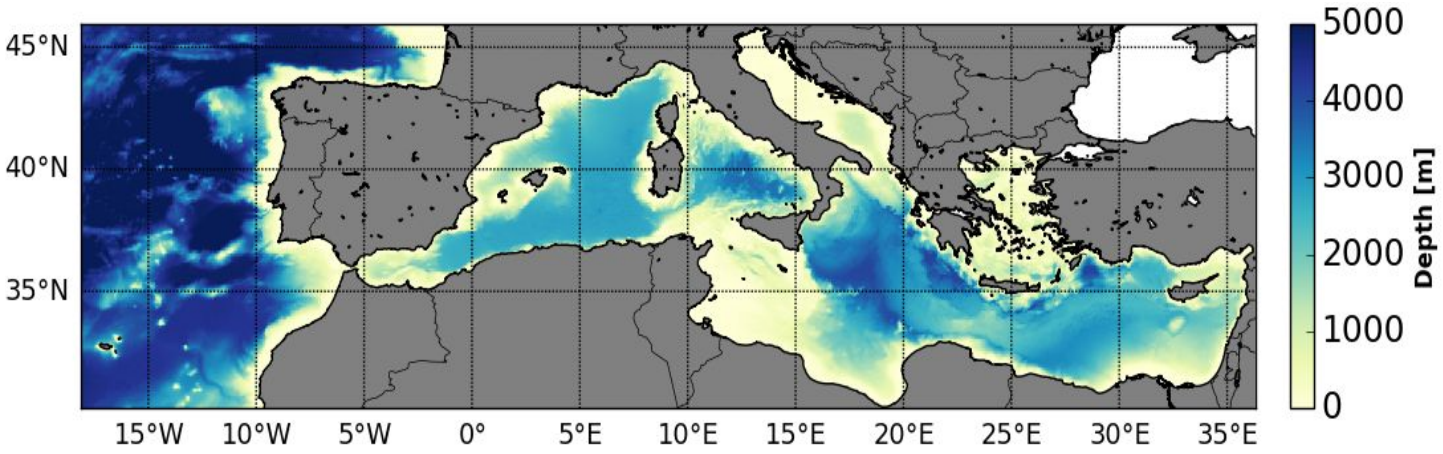

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IMPROVING OCEAN MODELS FOR THE COPERNICUS PROGRAMME

EGU General Assembly 2022

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CONTEXT

- A good description of the **sea state** is crucial in order to have an accurate representation of air-sea interactions and the ocean dynamics

- Waves impact the ocean dynamics in three major ways: the momentum transfer, the turbulent energy injection and the generation of mass transport

- **NEMO v4.2** has been updated in order to improve **the coupling with wave model** and **the wave-current interaction processes**

What is the impact of those new developments, especially the effect of the wave-induced mixing in the Mediterranean sea dynamics?

CONFIGURATION & SET-UP

NEMO v4.2 RC

141 vertical levels, **key_qco**

➢ **Variable parameterizations:**
(Couvelard et al, 2020)

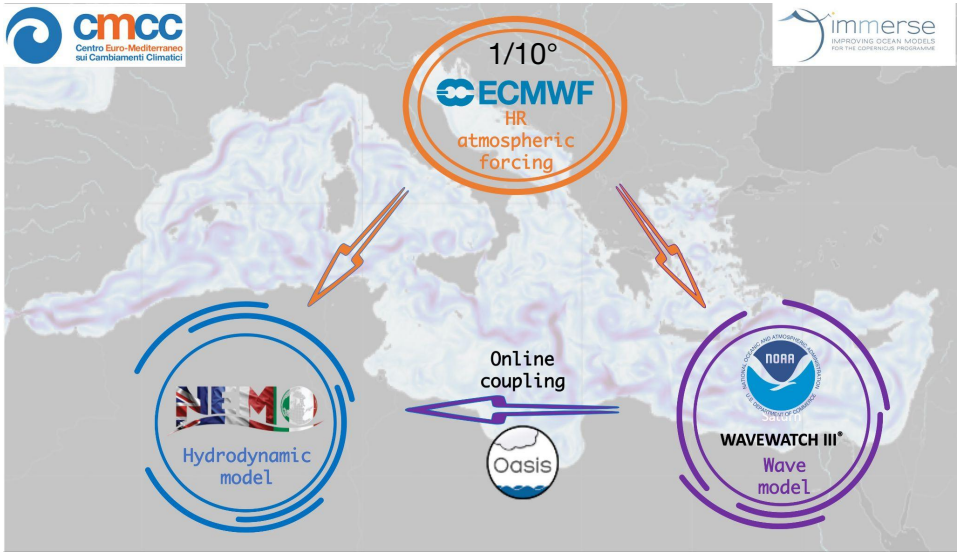
- Stokes drift parameterization
(Breivik et al, 2016)

- Vortex Force +
Stokes-Coriolis +
Bernoulli Head Pressure

- **Enhanced mixing by waves**
in TKE vertical mixing

- Wind stress calculating from
the neutral drag coefficient

Spatial resolution: 1/24°



OASIS3 MCT v4

1 way-coupling

Significant wave height
Surface Stokes Drift (SD)
Transport associated to SD
TKE surface flux
Neutral drag coefficient
Bernoulli head pressure

WW3 v6.07

➢ **Spectral discretization**

- 30 frequencies (log)
- 15° in direction

➢ **Physical option**

Source Term 4
(Ardhuin et al, 2010)

EXPERIMENTS

EXP. NAME	Cpp Key	WAVE COUPLING				
		wave model CD	Stokes Drift	Vortex-Force Stokes-Coriolis Bernouilli Head Pressure	Mixing	Langmuir Param
TKE_v42RC	key qco	NO	NO	NO	NO	0.15
TKE_CO_FORCE _MIX_LC015	key qco	**YES**	**YES**	**YES**	**YES**	0.15

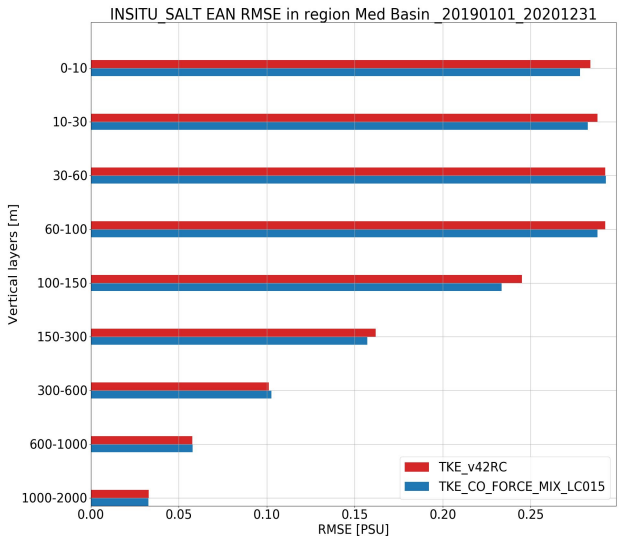
- Enhanced mixing by waves in TKE vertical mixing:
  - Surface boundary condition (dissipation of the wave field)
  - Stokes drift shear
  - Langmuir turbulence coefficient

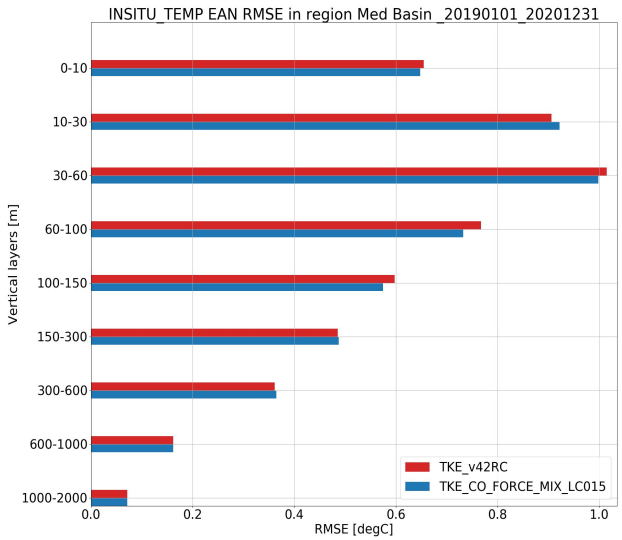
Salinity and Temperature: comparison with *insitu* data (2019-2020)

SALINITY

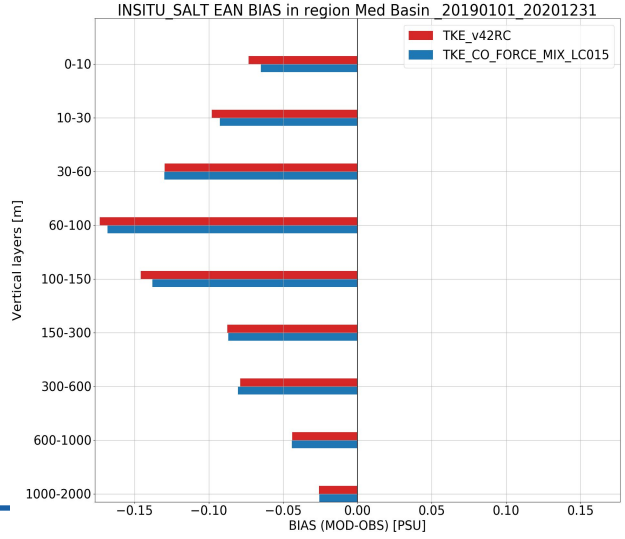
TEMPERATURE

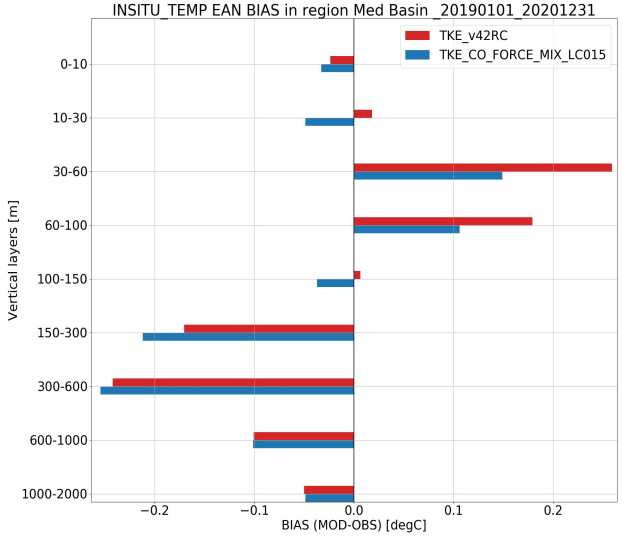
RMSD





BIAS





NEMO (uncoupled)

NEMO-WW3 (CD+VF+SC+BHD+ MIX+LC=0.15)

- Basin averaged salinity:

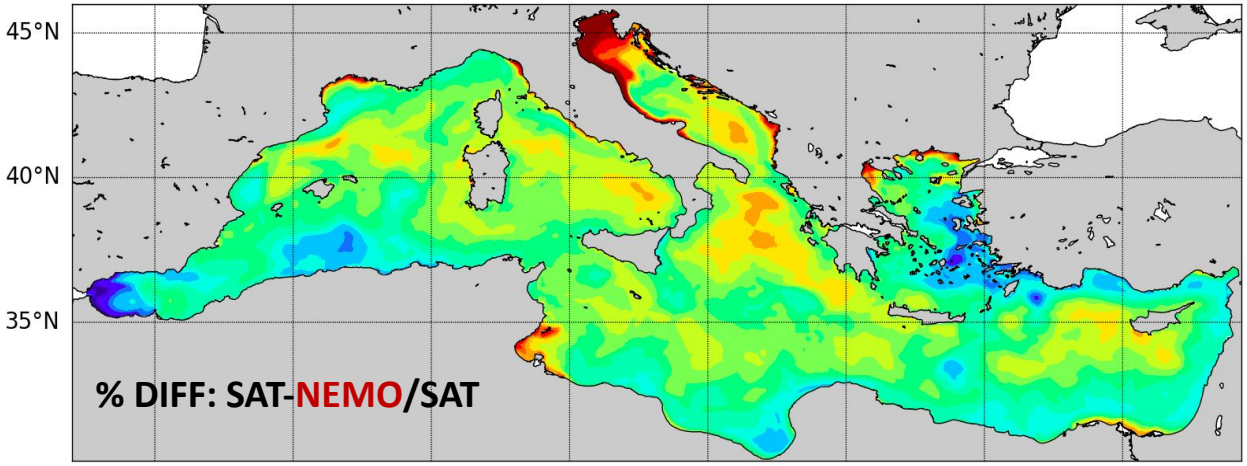
  RMSE and BIAS are slightly decreased over the whole column for the coupled experiment

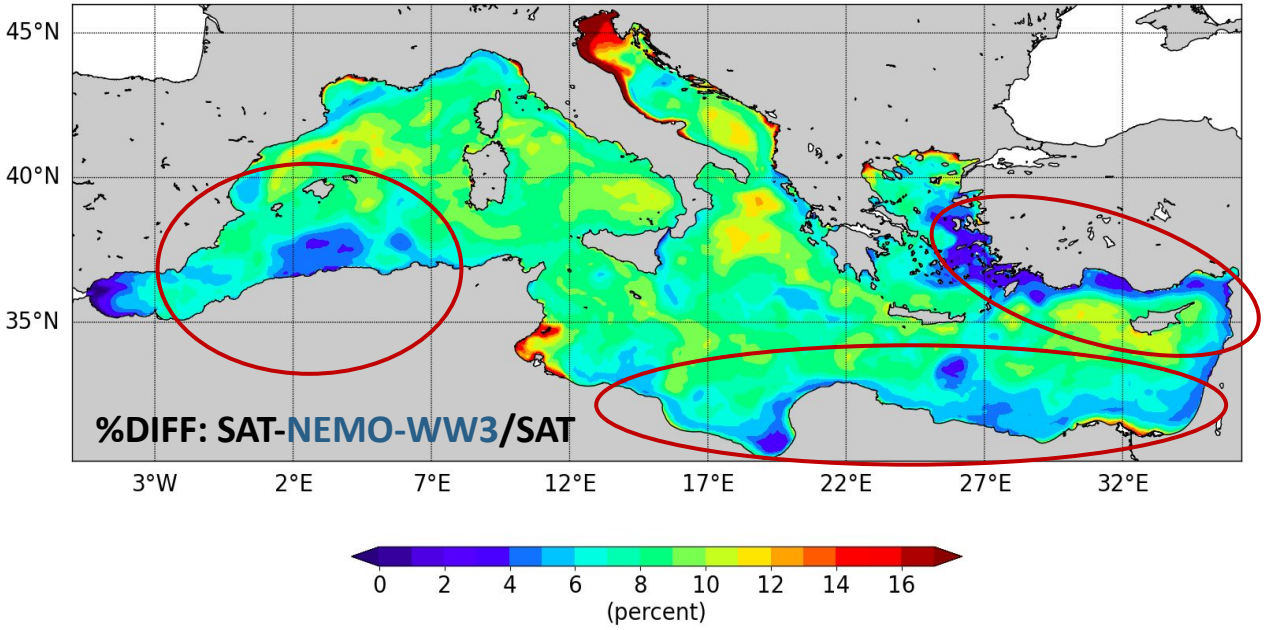
- Basin averaged temperature :

  RMSE slightly decreased

  BIAS clearly decreases between 30 and 150 meters whereas the layer from 10 to 30m presents some deterioration

SST time mean maps : comparison with SST L4 satellite data





- Both uncoupled and coupled simulations are, on average, cooler than the observations over the whole Mediterranean

- The coupled simulation shows a lower BIAS than the uncoupled experiment, especially in the Aegean sea, Levantine sea, the western part of the Mediterranean sea and the coastal area.

CONCLUSION

- The new physical processes related to wave-current interaction included in NEMO 4.2 *(Couvelard et al, 2020)* lead to an improvement of the Mediterranean sea dynamics

- Fully coupled experiment provides on average the best skill reducing salinity and temperature RMSE in comparison with CMEMS *insitu* and satellite observational datasets

- SST is on averaged improved close to the coast and in the western Mediterranean sea in the coupling system

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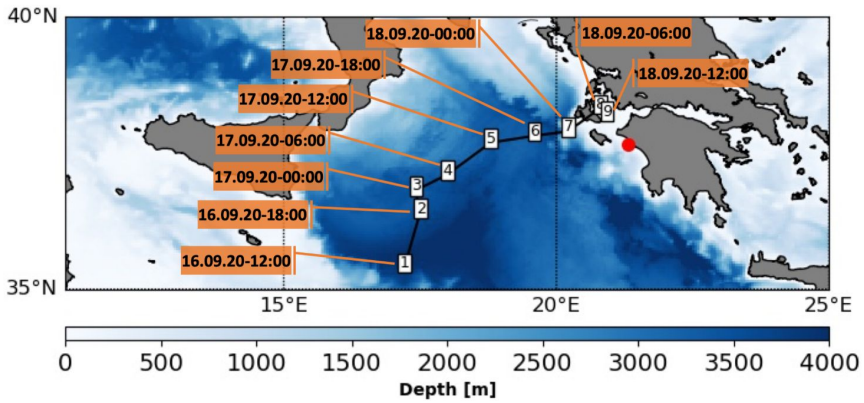
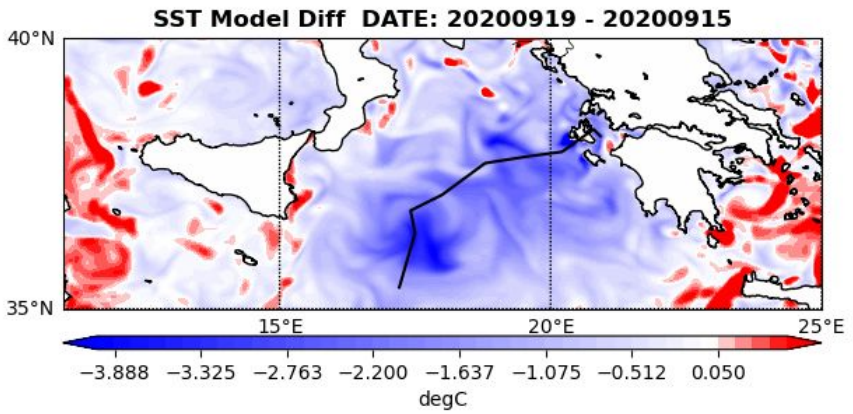
SST anomaly for the extreme event IANOS

15th September 2020 = before Ianos

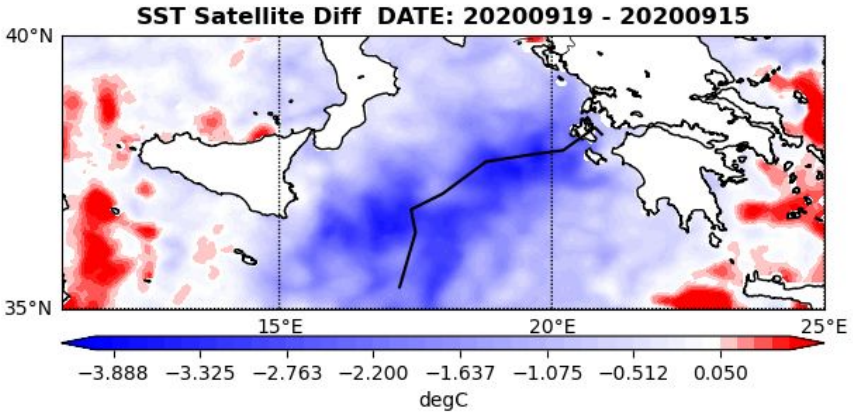
19th September 2020 = after Ianos



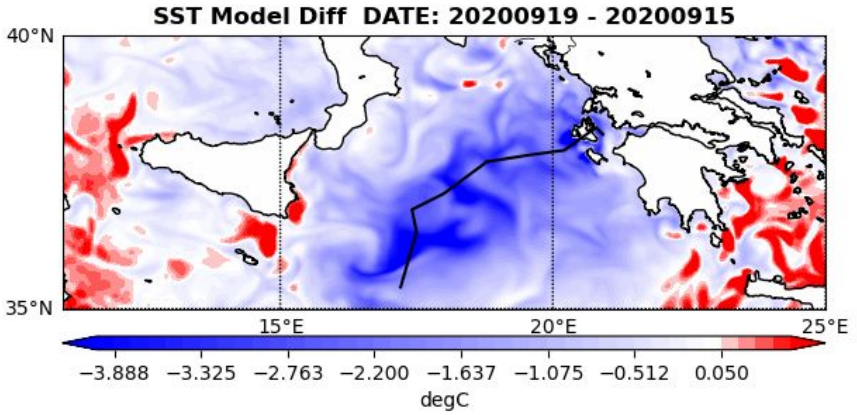
NEMO



OBSERVATION



NEMO-WW3



⇒ Temperature difference closer to observation with the coupled system