Hindcast Simulation of Medicanes with an Atmosphere-Ocean-Wave Coupled Modelling System

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Outline

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Motivation

• The aim of this study is investigating the adding value of the air-sea interaction produced by atmosphere-ocean-wave coupling in climate simulations.

• To investigate the ability of the coupled and uncoupled models to reproduce the characteristics of the observed medicanes and to investigate the role of air-sea interaction in the simulation of key processes that govern medicane occurrences over the study area.
RegESM Design

- Model components merged with ESMF/NUOPC

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**ATM:**
ICTP's RegCM 4.4 / 4.5

**OCN:**
Rutgers Univ.
ROMS (r737)
MITgcm (63s / 64s)

**WAV:**
ECMWF's WAM
4.5.3 MPI

**RTM:**
Max Planck's HD
(1.0.2 modified)
Special thanks to
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# Following combination of model components can be used:
2 component: ATM-OCN, ATM-WAV,
3 component: ATM-OCN-RTM, 4 component: ATM-OCN-WAV-RTM

https://github.com/uturuncoglu/RegESM
Model Domain & Configuration

- Closed boundary in Atlantic used as a bufferzone
- Model has been forced with ERA-Interim reanalysis for the 1979-2012 period.
- The coupling timestep is 1 hour and exchanged variables among the models are:
  - ATM-OCN: windstress, surface air pressure, short wave radiation, net heat and fresh water flux (E-P)
  - OCN-ATM: sea surface temperature
  - ATM-WAV: wind
  - WAV-ATM: roughness length

Atmosphere: RegCM 4.6.0 (12 km)
Ocean: ROMS revision 809 (1/12º ~9km)
Wave: WAM Cycle-4 (4.5.3-MPI) (0.125º ~14km)
### List of Simulations

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<td>Exchange heat, freshwater fluxes, short wave radiation, surface pressure, wind components and SST, roughness length</td>
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</table>

The river discharge of major rivers are prescribed using GRDC dataset. The coupling time step is set as 1 hours
A snapshot of a medicane event on 1st February 2006 (18Z) to test the capturing ability of the coupled model (RegESM)

- Storm symmetry, wind speed and direction are well captured and better represented by RegESM compared to RegCM and RegESM-NoWave.
A snapshot of a medicane event on 1st February 2006 to test the capturing ability of the coupled model (RegESM)

- Standalone WAM overestimates the significant wave height and doesn’t capture the symmetry of the cyclone as well as RegESM.

- Significant Wave Height is well represented with RegESM.
Further details on 1st February 2006 Medicane

- Vectically integrated moisture flux + Wind Direction
- Latent Heat Flux + Mean Sea Level Pressure
- Precipitation
- Wind Speed + Motion of the Medicane
16 Medicane events across the Mediterranean

- Latent Heat Flux + Mean Sea Level Pressure of 16 different medicane events.
- Investigations related with their location, structure and amplitude is ongoing.
Conclusions

• Using RegESM improves on some standalone model limitations.
• Compare to standalone WAM simulations, RegESM represents significant wave heights more accurately in terms of magnitude and distribution.
• RegESM improves wind speed and direction representation.
• The cyclonic distribution of wind and rainfall caused by medicane is captured well with RegESM.
• RegESM incorporates atmosphere, ocean and wave components and thereby is better capable to improve the understanding of the mechanisms driving medicanes.
Questions!

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