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

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Outline

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- RegESM Design
- Model Domain & Configuration
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- Conclusions

Motivation

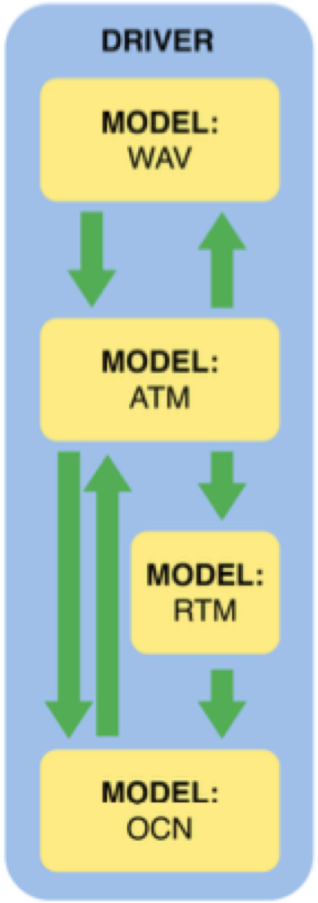
- The aim of this study is investigating the adding value of the air-sea interaction produced by atmosphere-ocean-wave coupling in climate simulations.

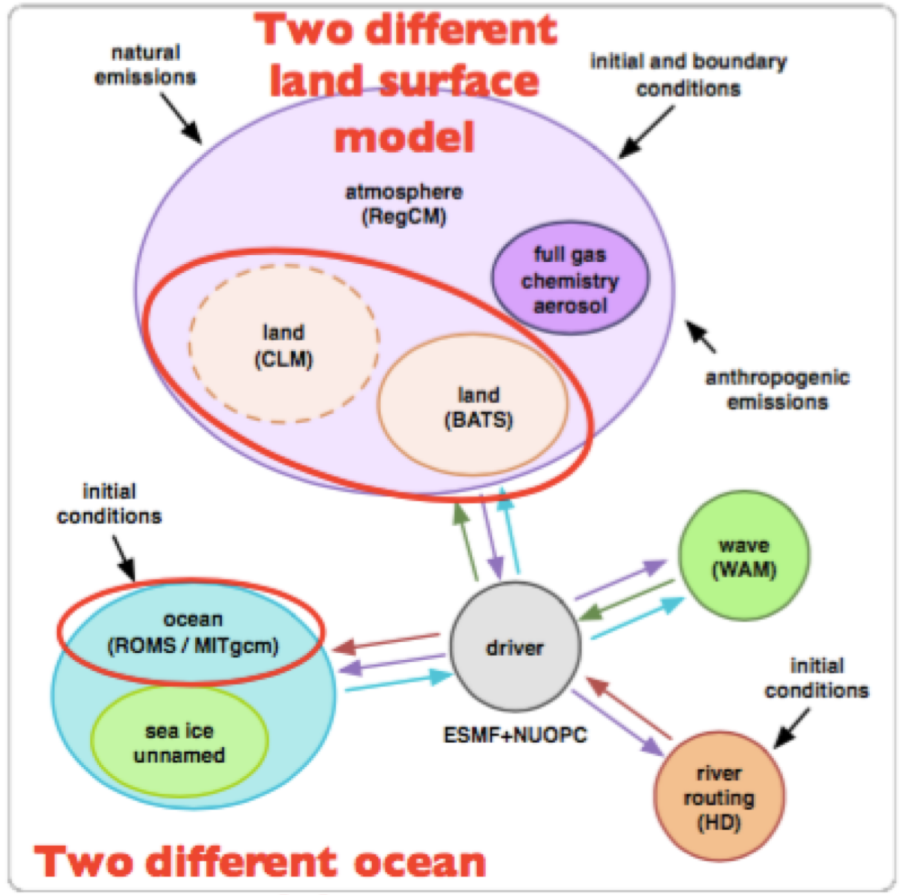
- To investigate the ability of the coupled and uncoupled models to reproduce the characteristics of the observed medicanes and to investigate the role of air-sea interaction in the simulation of key processes that govern medicane occurrences over the study area.

RegESM Design

https://github.com/uturuncoglu/RegESM

- Model components merged with ESMF/NUOPC





ATM:
ICTP's RegCM 4.4 / 4.5

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

WAV:
ECMWF's WAM
4.5.3 MPI

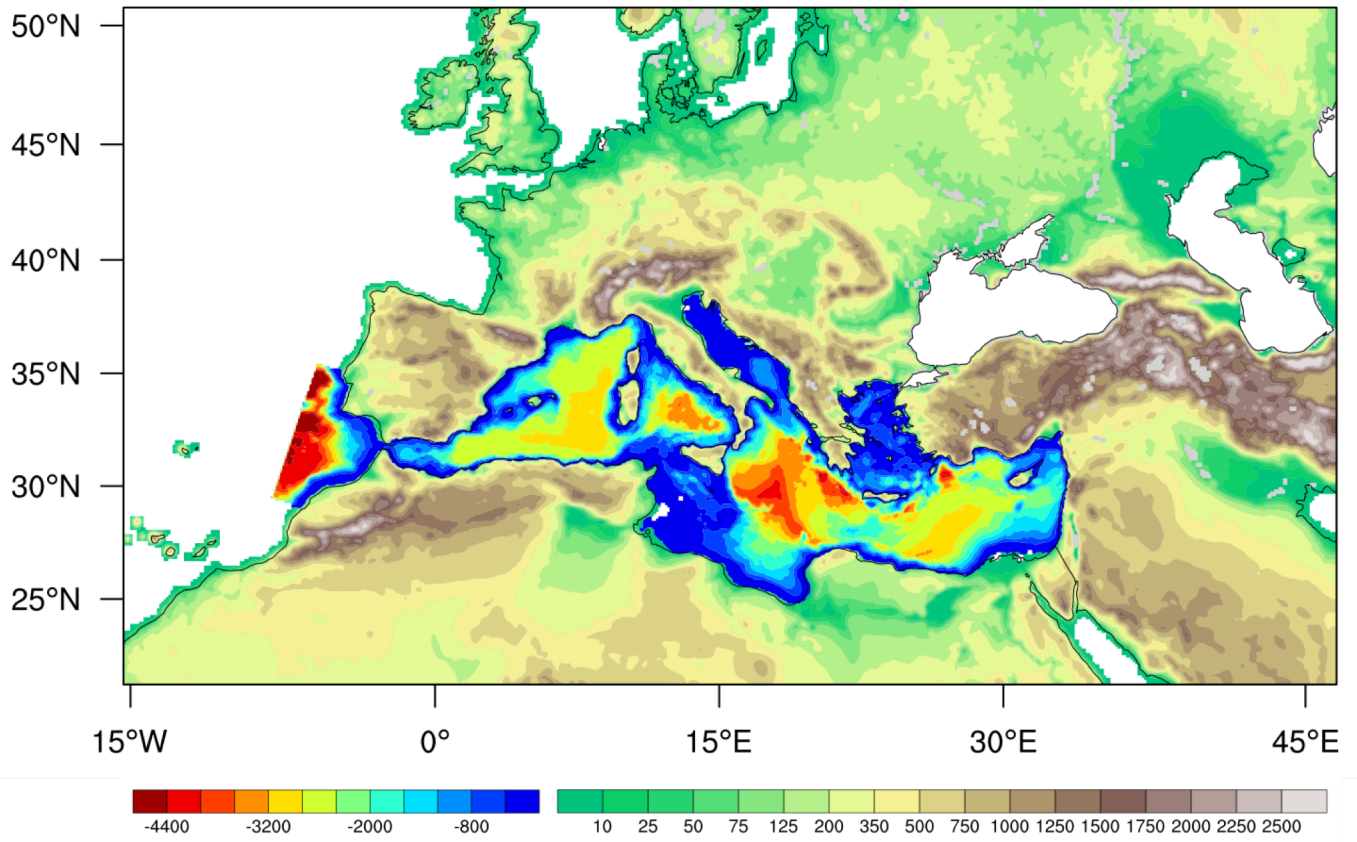
RTM:
Max Planck's HD
(1.0.2 modified)
Special thanks to
Prof. Stefan Hagemann

 # 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

Model Domain & Configuration

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)

- 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 1hour 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

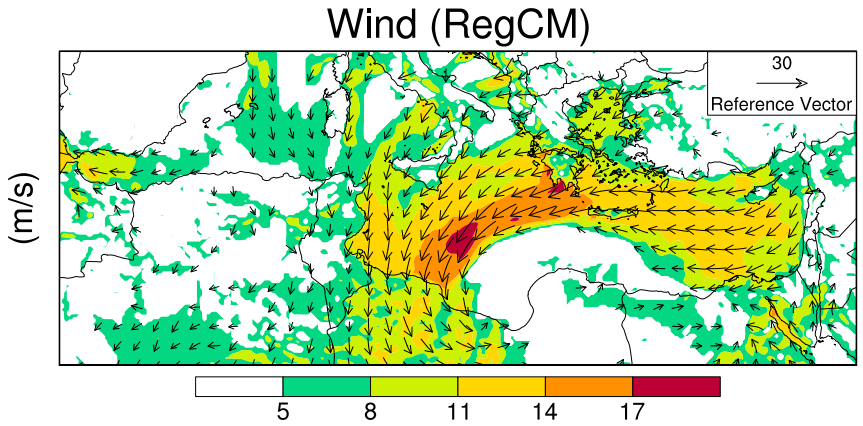


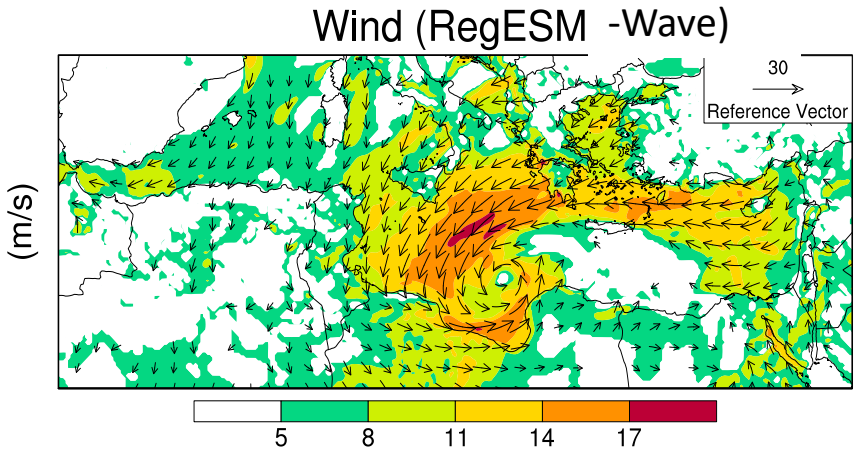
Model Domain: Med-CORDEX

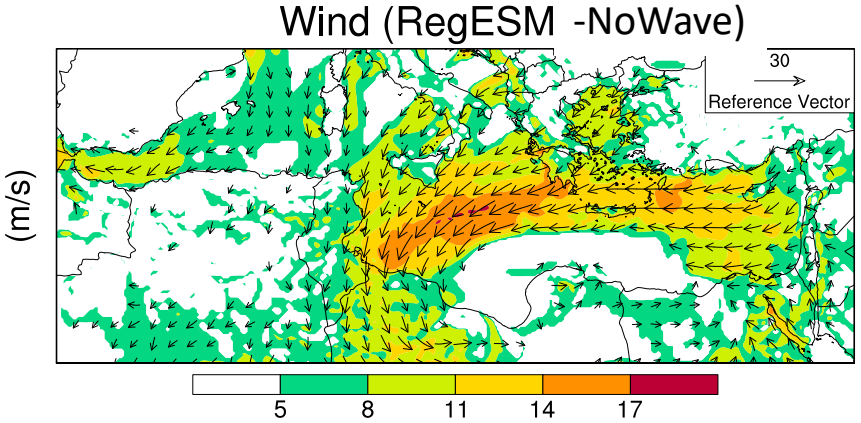
List of Simulations

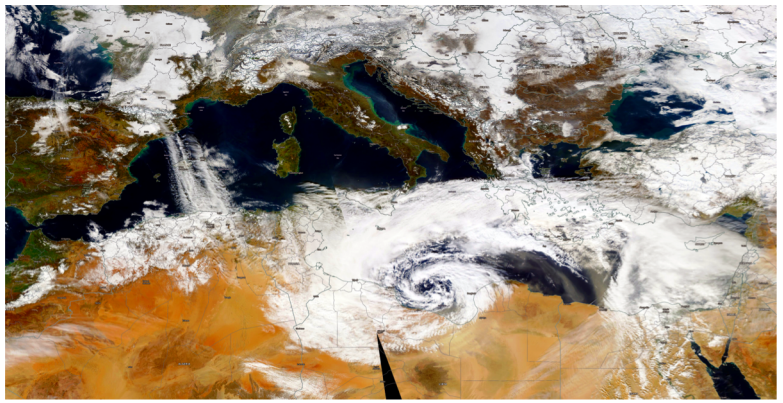
Run Id	Resolution	ICBC	Active Models	Details
WAV14	WAM, (0.125º ~14km)	STD12 wind field	WAM Cycle-4 (4.5.3-MPI)	Standalone
R12E	ATM (12km)	ERA-Interim ERSST	ATM (RegCM4)	Standalone
C12E	ATM (12km), OCN (1/12° active only Med. Sea), WAV (0.125º ~14km)	ERA-Interim ERSST	ATM (RegCM4) OCN (ROMS revision 809), WAM Cycle-4 (4.5.3-MPI)	Exchange heat, freshwater fluxes, short wave radiation, surface pressure, wind components and SST, roughness length
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)

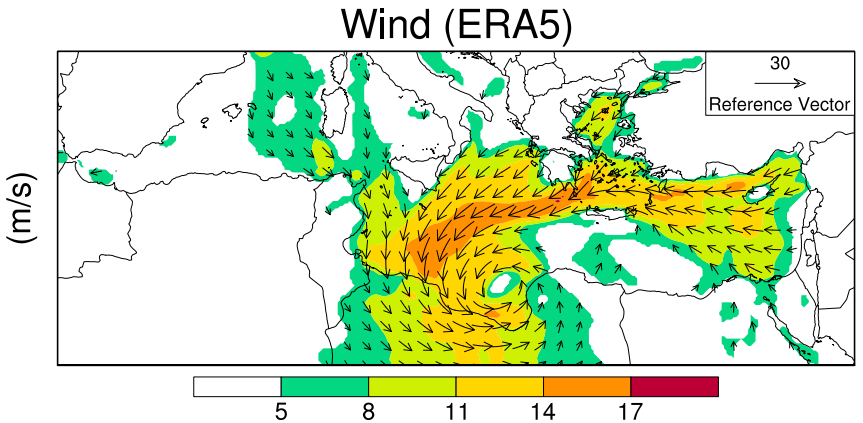






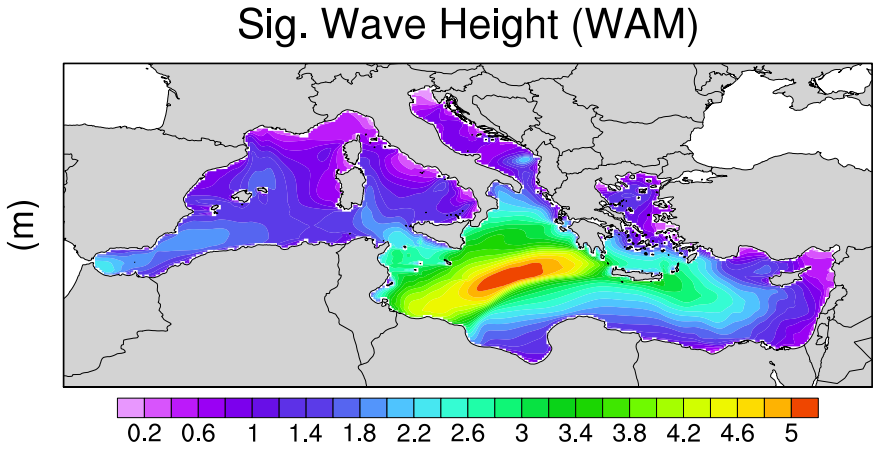


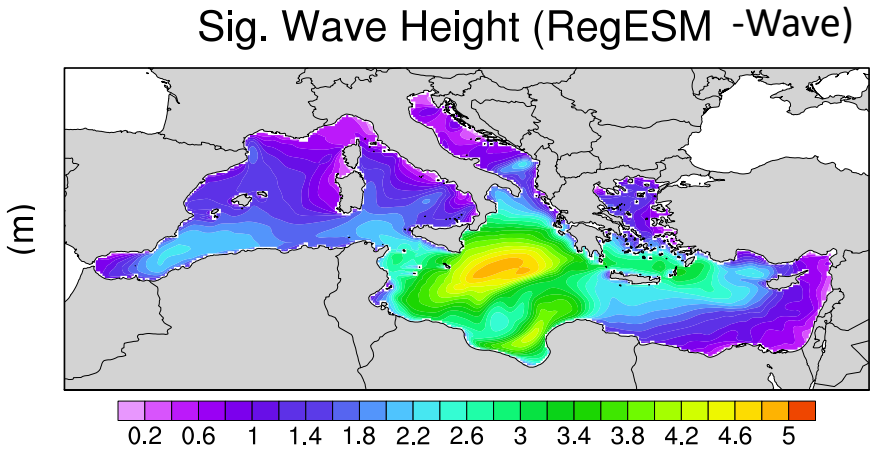
Satellite image from https://worldview.earthdata.nasa.gov

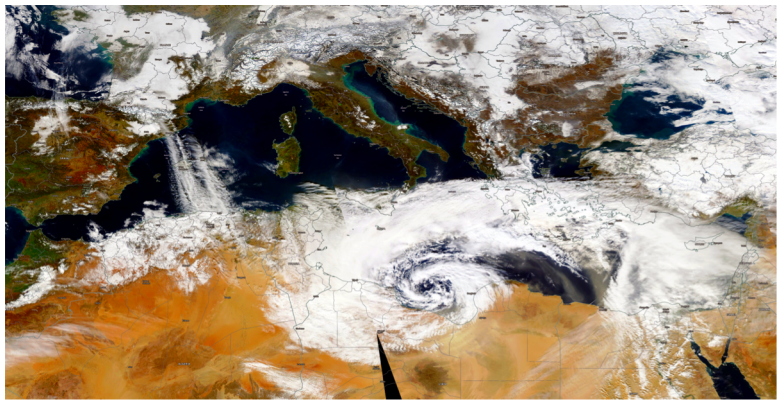


- Storm symmetry, wind speed and direction are well captured and better represented by RegESM compare to RegCM and RegESM-NoWave.

A snapshot of a medicane event on 1st February 2006 to test the capturing ability of the coupled model (RegESM)







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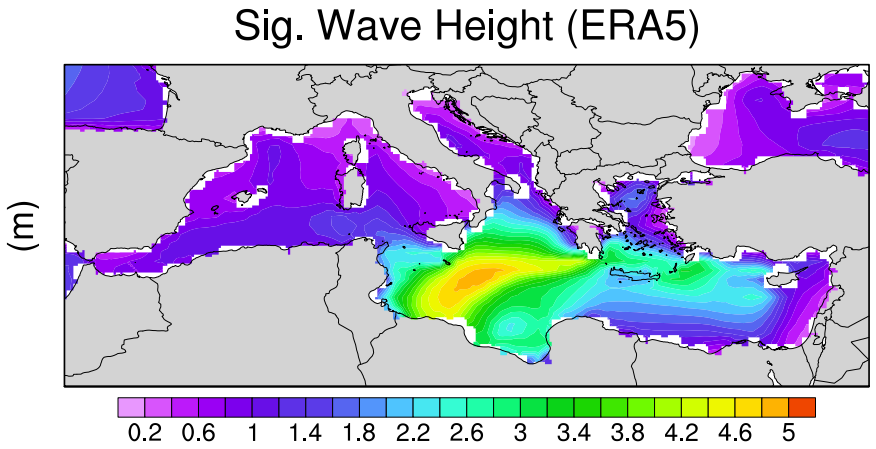
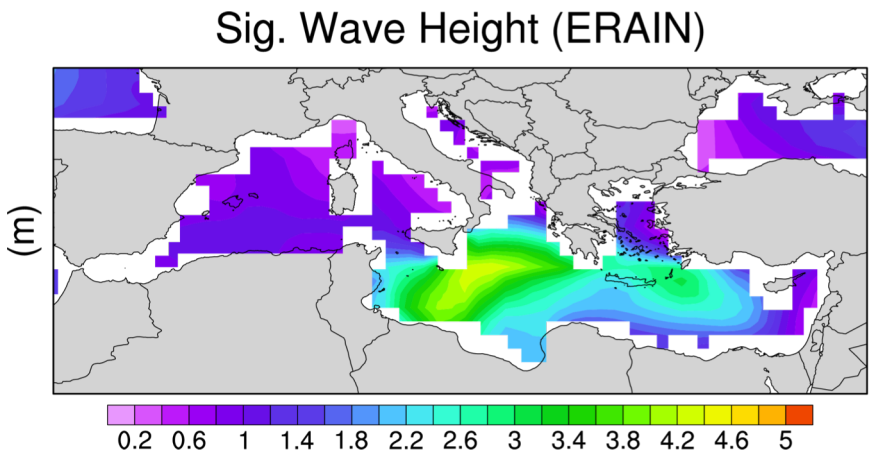
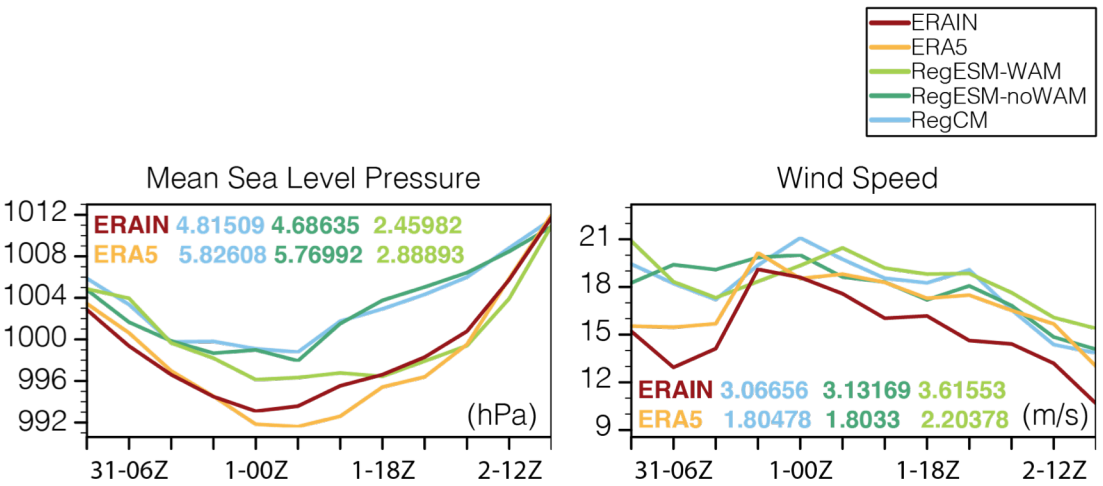


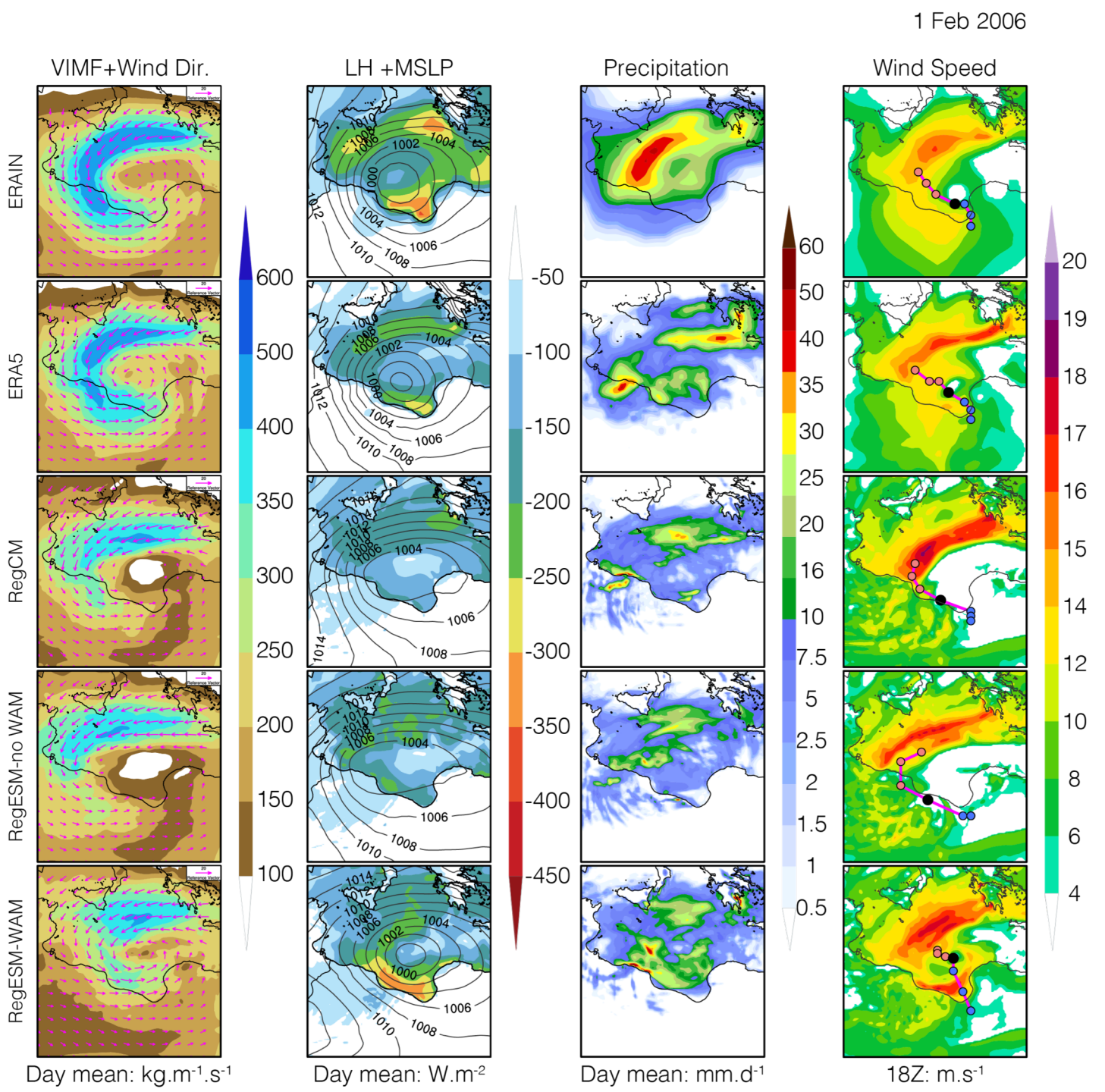


- Standalone WAM overestimates the significant wave height and doesn't capture the symmetry of the cyclone as well as RegESM.
- Significant Wave Height is well represented with RegESM.

Further details on 1st February 2006 Medicane

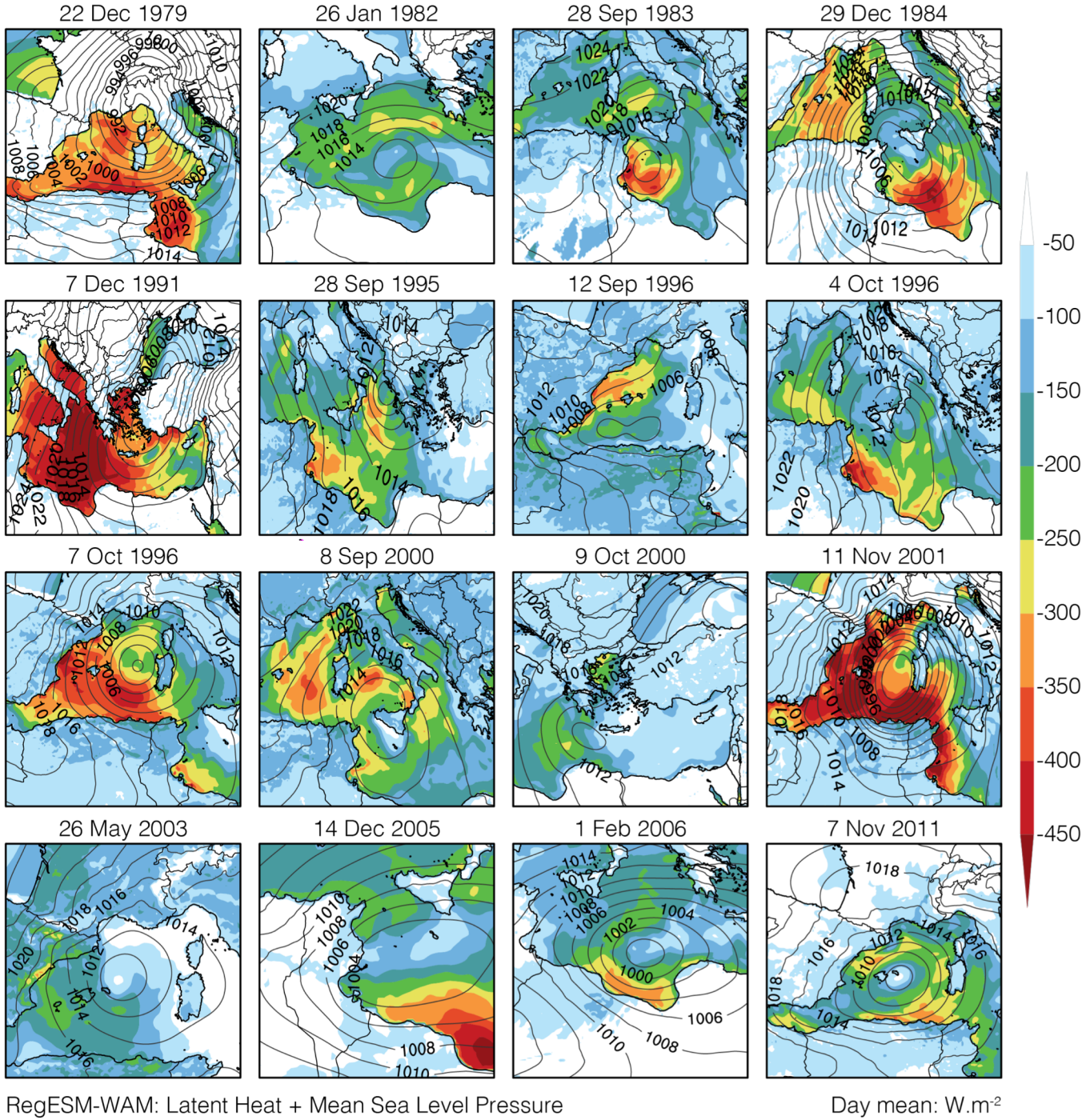
- Vectically integrated moisture flux + Wind Direction
- Latent Heat Flux + Mean Sea Level Pressure
- Precipitation
- Wind Speed + Motion of the Medicane





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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