Project: **987**

Project title: **The role of the South Atlantic Anticyclone in the Tropical Atlantic climate variability**

Principal investigator: **Dmitry Sein**

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During the year, our attention was focused on four topics:

1. In ref. 1 we explore the ability of ROM to simulate the Canary current upwelling system (CCUS). The CCUS is one of the major eastern boundary coastal upwelling systems in the world, bearing a high productive ecosystem and commercially important fisheries. has a large latitudinal extension, usually divided into upwelling zones with different characteristics in which ocean-atmospheric feedbacks play a relevant role. Also, eddies, filaments and other mesoscale processes are known to have an impact in the upwelling productivity, thus for a proper representation of the CCUS the coupling and high horizontal oceanic and atmospheric resolution are required. ROM's performance over the CCUS is assessed against relevant reanalysis data sets and compared with an ensemble of global climate models (GCMs) and an ensemble of atmosphere-only regional climate models (RCMs) to assess the role of the horizontal resolution and coupling. ROM improves the GCMs outputs, reproducing the larger scale pattern of the CCUS and its latitudinal and seasonal variability over the coastal band. Also, ROM shows a performance comparable to the ensemble of RCMs in the representation of the coastal wind stress and near-surface air temperature fields. The oceanic mesoscale structures (such as the upwelling filaments events off Cape Ghir), which are not well represented in most of GCMs, are properly reproduced by ROM. Thus, our results stress the ability of ROM to reproduce the larger scale as well as mesoscale processes over the CCUS.

2. In ref. 2, which is a follow up of ref. 5, we continue to explore the question of whether the representation of the oceanic influence and the role of air-sea coupling is adequately represented in regional models used for downscaling the European climate as the usually include a relatively small area of the Atlantic Ocean and are uncoupled, with the SST used as lower boundary conditions much coarser than the mesh of the regional atmospheric model. In this case, the impact of atmosphere–ocean coupling on the climate change signal over the Iberian Peninsula (IP) is studied. We find that under the RCP8.5 scenario, the generalized 2-m air temperature (T2M) increase by the end of the twenty-first century (2070–2099) in the atmospheric-only simulation is tempered by the coupling. The impact of coupling is specially seen in summer when the warming is stronger. Precipitation shows regionally-dependent changes in winter, whilst a drier climate is found in summer. The coupling generally reduces the magnitude of the changes. Differences in T2M and

precipitation between the coupled and uncoupled simulations are caused by changes in the Atlantic large-scale circulation and in the Mediterranean Sea. Additionally, the differences in projected changes of T2M and precipitation with the RAOCM under the RCP8.5 and RCP4.5 scenarios are tackled. Results show that in winter and summer T2M increases less and precipitation changes are of a smaller magnitude with the RCP4.5. Whilst in summer changes present a similar regional distribution in both runs, in winter there are some differences in the NW of the IP due to differences in the North Atlantic circulation. The differences in the climate change signal from the RAOCM and the driving Global Coupled Model show that regionalization has an effect in terms of higher resolution over the land and ocean.

3. In ref. 3 we study the fate of the deep water formation (DWF) in the North Western Mediterranean (NWMed) in the RCP8.5 simulation with REMO. The DWF is a key feature of Mediterranean overturning circulation and changes in DWF under global warming may have an impact on the regional and even on the global climate. The MPIOM setup used in the simulation analysed has a high horizontal resolution enough to represent the DWF. We find that under the RCP8.5 scenario the deep convection in the Gulf of Lions (GoL) collapses by 2040-2050, leading to almost a 90% shoaling in the winter mixed layer depth by the end of the century. Surface heat fluxes change little, thus the collapse is mainly related to changes in sea water temperature and salinity of Modified Atlantic Waters (MAW) and Levantine Intermediate Waters (LIW) that strengthen the vertical stratification in the GoL. The stratification changes also alter the Mediterranean overturning circulation and the water, heat and salinity exchange with the Atlantic.
4. In ref. 4 we explore the ability of ROM to represent the oceanic mesoscale structures and the impact of climate change under climate change. This study is carried out in the Tyrrhenian Sea. This sea presents a marked, seasonally-dependent surface circulation enriched in dynamical mesoscale structures. Also, the water that exits the Tyrrhenian via the Corsica Channel has been found to have an influence on deep water formation in the Gulf of Lions. Therefore, the Tyrrhenian Sea can be regarded as a challenging location to study future changes in its ocean circulation and its consequences in adjacent areas. We found that our model correctly reproduces the main features of the Tyrrhenian basin present-day circulation. Towards the end of the century the winter cyclonic, along-slope stream around the Tyrrhenian basin becomes weaker. In the future, the northward water transport across the Corsica Channel towards the Liguro-Provençal basin becomes smaller than today and the flow through this channel presents a stronger stratification because of a generalized warming with a saltening of intermediate waters. A detailed analysis of these results suggest that a higher ocean resolution would help to improve the simulation of the

climate variability.

References:

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6-