CNRM, UMR 3589

# SOUTENANCE DE THESE CNRM

***vendredi 24 mars 2023 à 10h***

# Multi-scale modelling of the Strait of Gibraltar and its role as a regulator of the Mediterranean climate

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**en salle Joël Noilhan**

Lien BJ: https://bluejeans.com/754160326/9665

Résumé en anglais :

The Strait of Gibraltar (SoG) is a narrow and shallow channel that forms the primary connection between the Mediterranean Sea and the global Ocean. This oceanic pathway is home to tremendous exchanges of water masses, closing the Mediterranean thermohaline and biogeochemical balances. Despite the broad impacts of these exchanges on the Mediterranean Sea, various mechanisms at play within the SoG and their influence on the Mediterranean climate remain, so far, unclear. This PhD investigates tidal and fine-scale processes at the SoG, their relevance to the Mediterranean climate, and their representation in numerical models. To do so, we rely on two numerical models of the Mediterranean region, providing different perspectives on the SoG and its large-scale influence. The first one is an ocean model, used in stand alone mode and characterized by high-resolution at the SoG, allowing us to investigate fine-scale and non-linear mechanisms within the strait. The second one, developed in the scope of this PhD, is a fully-coupled regional model of the Mediterranean region, with refinement capacity at the SoG and explicit or parameterized tides. It allows us to build a hierarchy of numerical simulations that aims at isolating the respective and combined influences of tidal and fine-scale processes at the strait on the Mediterranean Sea and overlying atmosphere. We first focus on understanding the mechanisms driving tide-induced water mass transformations across the SoG, so-called tidal mixing. We show that tidal mixing relies on fine-scale dynamics, forced by the interaction of tidal currents with the abrupt topography of the strait. More specifically, the mixing is driven by a periodic enhancement of vertical shear near the seafloor and a weakening vertical stratification in the vicinity of topographic obstacles, where tidal convergence and divergence patterns feed recirculation cells. Then, we show that tidal and fine-scale processes within the strait significantly influence Mediterranean hydrography, particularly for salinity, ultimately modulating the Mediterranean deep convection. In this way, local processes at the SoG indirectly affect the hydrography of intermediate and deep water masses as well as long-term

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hydrographic trends over deep layers. For the first time to our knowledge, we reveal that these processes also impact on the atmosphere. Specifically, in the summertime, tidal mixing at the SoG moderately cools and dries the near-surface atmosphere. Ultimately, this drives a moderate decrease in cloudiness over the Sea and coastal areas and a decrease in precipitation over the western Mediterranean region. Finally, we investigate a tidal mixing parameterization for coarse-resolution non-tidal models of the Mediterranean Sea. We show that the parameterization reproduces remarkably well the main characteristics of the water mass transformations across the strait, but further developments are needed to parameterize tidal advection mechanisms. Overall, these results highlight that both explicit tides and kilometric resolution at the SoG should be included in numerical models of the Mediterranean Sea for use over decadal time-scales. When this is not possible, parameterizations should be used. This works provides a first step in this direction.

*Membres du jury :*

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*M. Achim WIRTH, Rapporteur*
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*M. Casimir DE LAVERGNE, Examinateur*
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