Session: C4 Poster: TH224A

HyMeX - Model of the Regional Coupled Earth system (MORCE): application to process and climate studies in the Mediterranean region

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The vulnerability of human populations and natural systems and their ability to adapt to extreme events and climate change varies between geographic regions and populations. Until now, a number of regional climate model (RCM) systems have been developed during the last two decades in order to downscale the output from large scale global climate model (GCM) simulations and produce fine scale regional climate change information useful for impact assessment and adaptation studies. To date most RCMs have been composed by an atmospheric component coupled to a land surface scheme and driven over ocean areas by prescribed sea surface temperature. Although such a RCM can be sufficient for many applications, there are cases in which the fine scale feedbacks associated with air-sea interactions can substantially influence the spatial and temporal structure of regional climates. This is the case for the Mediterranean region where the morphological complexity of the basin leads to the formation of intense weather phenomena, such as strong winds, topographically-induced intense cyclogenesis, heavy precipitation. Such physical processes have two critical characteristics: first, they derive from strong air-sea coupling and, second, they occur at fine spatial scales. To improve the representation of these events in regional climate modelling, atmosphere-ocean regional climate models (AORCM) have been developed and employed in the mid 2000's. However, the Earth system is the physical, chemical, biological, and social components, processes, and interactions that together determine the state and dynamics of Earth, including its biota and human occupants. Developing regional Earth system models has two primary motivations: (i) with respect to climate science, to improve modelling capabilities and better understand coupled processes at regional scales and (ii) to support stakeholders who aim to use climate information for regionally-specific impact assessment and adaptation planning. The Institut Pierre Simon Laplace (IPSL) in collaboration with ENSTA-ParisTech, LOPB, and CERFACS developed the MORCE (Model of the Regional Coupled Earth system) plateform for process and climate studies of the regional Earth system. The original aspects of the MORCE plateform are (1) the integration of a large number of coupled compartments and processes (physical and biochemical processes in the ocean, atmosphere and continent), (2) the transferability of the numerical plateform to different locations in the world, (3) the use of a non-hydrostatic model for the atmospheric module which allows numerical simulations at kilometer scale horizontal resolution. The present study shows results obtained in the Mediterranean region in the context of HyMeX and MED-CORDEX (sub-project of the CORDEX international program) on (1) coupled processes between vegetation and atmospheric composition, vegetation and droughts and heat waves, and ocean and atmospheric extremes and (2) on the Mediterranean Sea water budget.