EGU24-5991, updated on 08 Mar 2024
https://doi.org/10.5194/egusphere-egu24-5991
EGU General Assembly 2024

Towards a better understanding of pyroconvective clouds using Meso-NH/ForeFire coupled model

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In 2017, Portugal was affected by several mega-fire episodes, which led the convective clouds formation, i.e., pyroCumulus (pyroCu) or pyroCumulonimbus (pyroCb). The pyroCb plays a crucial role in the fire front evolution through feedback processes between the atmosphere and the fire, including increased burn and spread rates by surface wind speed and direction variations. In order to investigate the pyro-convective activity during mega-fire events, numerical simulations were performed with the Meso-NH atmospheric model coupled to the ForeFire fire propagation model. The present study considers the mega-fires occurred in Pedrógão Grande and Góis on June 17, 2017, and in Quiaios on October 15, 2017. The experiments were configured into three nested domains with horizontal resolution of 2000 m (600 km × 600 km), 400 m (120 km × 120 km) and 80 m (24 km × 24 km) for the innermost model. The vertical resolution is the same for all the nested domains, with 50 levels and a first level above the ground at 30 m height. Initial and lateral boundary conditions for the outer domain were provided by ECMWF analysis, with updates every 6 h. Heat and water vapour were emitted into the atmosphere using the ForeFire model. In this case, the fire front evolution is directly imposed from a pre-defined time of arrival map (one-way coupling) and obtained from official reports. The results from the simulation of 80 m horizontal resolution showed that in the Pedrógão Grande mega-fire, the violent fire-driven convection manifested as a pyroCb cloud. The convective column penetrated the upper troposphere, and an intense outflow originated from the pyroCb cloud. In Quiaios mega-fire, the simulation also well represented the pyro-convection phenomenon, characterised by a northward-oriented smoke plume and the development of a pyroCu cloud. This study has provided important insights into the numerical modelling of pyroconvective clouds using Meso-NH/ForeFire simulations. This study was funded by national funds through FCT-Foundation for Science and Technology, I.P. under the PyroC.pt project (Ref. PCIF/MPG/0175/2019).

How to cite: Couto, F. T., Campos, C., Filippi, J.-B., Baggio, R., Purificação, C., Santos, F. L. M., and Salgado, R.: Towards a better understanding of pyroconvective clouds using Meso-NH/ForeFire coupled model, EGU General Assembly 2024, Vienna, Austria, 14–19 Apr 2024, EGU24-5991, https://doi.org/10.5194/egusphere-egu24-5991, 2024.