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Analysis of the environmental conditions favoring the development of deep pyroconvection in Southern Europe

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Deep pyroconvection can strongly modify surface weather conditions, especially when a firestorm develops, completely altering fire spread and making it more difficult to predict and control. However, the limited number of observations constrains our understanding of this type of events, so the environmental controls on deep pyroconvection are not entirely clear and, in particular, there are still uncertainties about the atmospheric conditions conducive to the development of this phenomenon. We conduct idealised numerical simulations with the fire-atmosphere coupled model WRF-Fire initialised with selected real-case atmospheric profiles of wind, temperature and moisture, obtained from the ERA5 database, corresponding to the 100 days of highest fire risk per year during the 2010-2019 period at six different European fire-prone locations. For each of these atmospheric profiles, we perform a suite of paired experiments of an ideal fire spreading through five different fuel categories. Each pair consists of a control run with interaction between fire and atmosphere and a simulation in which the sensible and latent heat fluxes from the fire are turned off (uncoupled simulation). This experiment allows us to make a significant statistical study of pyroconvection events and thus analyse which environmental factors favour its development. We found that a high fuel load, a large vertical temperature lapse rate between the 850 hPa and the 500 hPa levels and a high moisture content in the lower layers of the atmosphere are some of the main factors in the development of firestorms.