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Medicane Zorbas: Origin and effects of an uncertain upper-level PV streamer

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On 29 September 2018 an intense Mediterranean cyclone called "Zorbas" hit Greece with strong winds, storm surges, heavy rainfall and flash floods. It caused severe damages and with its characteristics of a tropical cyclone it has been considered as a "Medicane" (Mediterranean hurricane). However, until two days in advance, the formation of "Zorbas" was very uncertain, including its location and eventual intensity – partly because the upper-level steering flow remained uncertain. Medicanes often form when an upper-level positive potential vorticity anomaly (i.e. a potential vorticity cut-off or streamer) moves over very warm sea surface temperatures in the Mediterranean, induces cyclonic rotation and triggers convection, that then becomes self-organized similar to a tropical cyclone. In our study, we use the operational analysis and the 50 members ensemble forecast from the European Centre for Medium Range Weather Forecasts (ECMWF) to investigate diverging scenarios of upper-level and low-level development and point out the main large-scale atmospheric ingredients that allowed these scenarios to emerge. We find that the uncertainty can be traced back to initial condition uncertainties at the tropopause over Newfoundland that propagate across the North Atlantic where they amplify as quasi-geostrophic forcing in the vicinity increases. This finally results in large uncertainties in the position of a potential vorticity streamer over the Mediterranean three days after forecast initialization. We identify three different scenarios: In the first one, the potential vortictiy streamer is at the same location as in the analysis, in the second and third it is shifted to the west and to the east, respectively. These scenarios then result in shifted cyclogenesis and different characteristics and origin of low-level moist and warm air masses close to the cyclone centre. This study contributes to a better understanding of the large-scale conditions under which a Medicane can form and highlights origin, amplification processes, and effects of forecast uncertainties for a high impact weather event.