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Dynamic processes associated with the eastern Mediterranean 'bomb' of 2004

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The meteorological "bomb" of the 21st and 22nd of January 2004, that affected the eastern Aegean Sea with very strong winds reaching 80 kts, excessive rain and even snow, with accumulations of at least one (1) meter on Limnos island and mean sea-level pressure at the record level of 972 hPa on Ikaria island, is studied from the synoptic and mostly dynamic concept. Lagouvardos and co-authors have already proved that the upper tropospheric PV anomaly was a necessary ingredient of the explosive cyclogenesis and the latter was attributed to the merger of troughs coming from North Africa and Europe.
The present study is mainly concerned with the dynamic processes that led to the explosive cyclogenesis of 21 – 22 January 2004. Relying upon the use of the original ECMWF data information, a serious attempt is made to investigate, verify and justify the space and time of the "bomb explosion", the accompanied characteristics and the reasons causing the cyclolysis. Upper and lower tropospheric level forcing mechanisms are identified and monitored and a quantitative dynamical picture is provided for the explosively (pre) cyclogenetic period.
The explosive cyclogenesis begins in Gabes Sea, just off the Libyan coast, the low forming on a frontogenetically active occlusion of a Saharan depression, when a tropopause fold/upper level front system crosses aloft. The occlusion is traced back to the Sahara desert, as a low level convergence/frontal zone, along which Qs vectors indicate an anticyclonic rotation of the warm part of the front. Dynamic tropopause maps show significant cold air advection just upstream the area of surface cyclogenesis on the 21st of January 2004. Consequently, an upper level vortex forms, which perturbs the thermal field, maximizing Q vector convergence above the bomb. Gradually the role of the tropopause decreases, as the upper level front system weakens. During these initial stages, when the low level vortex of the bomb is not yet well defined, the tropical front plays a key role in the explosive cyclogenesis. The warm conveyor belt of a tropical Saharan depression to the south of the bomb, travelling eastward parallel to the latter, advects warm air northwards. High Θe air is channeled into the trough of warm air aloft (TROWAL) of the initial Saharan depression, contributing to large-scale moist ascent above the bomb area. The associated deep diabatic heating, calculated as a residual from the thermodynamic equation, enhances cyclogenesis. The vorticity budget shows that vortex stretching, due to upper level forcing (initial stages) and low level frontogenesis (mainly final stages), plays a key role in the explosively cyclogenetic process.
Soon the bomb turns into a frontogenetically active frontal depression. As the polar front approaches the Aegean, low level frontogenesis speeds up. The latter maximizes when frontal merger takes place. However, low Θe cold continental air, ingested into the bomb updraft through the polar front zone, contributes to a more stable profile, checking cyclogenesis. What actually stops cyclogenesis, is that tropical air masses do not any more ascend into the bomb vortex, as the tropical front moves southeast, away from the bomb, at these final stages of cyclogenesis.