Numerical study of the 3-5 December 2001 intensive cyclone in Israel and eastern Mediterranean region

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Unusually intensive rains characterized weather conditions over Israel during December 3-5, 2001. The rains were associated with a cold-core cyclone approaching the area from the west. The cyclone started its development over the Mediterranean Sea area several days prior to the period. Heavy rains were observed in Zichron Yaakov, of about 250 mm during the Dec.3 00:00 UTC – Dec. 5 00:00 UTC time period (192 mm per 6 hrs between Dec 04 06:00 LT and Dec 04 12:00 LT). At Maor station the precipitation amount was of about 70 mm per the 48 hours time period. The rainfall peak here was during 12:00-18:00 LT of December 4 with the rain intensity of about 20 mm per 6 hours. The weather developments were simulated with the MM5 mesoscale system adapted at Tel Aviv University NWP Unit for twice-daily real-time numerical weather prediction using two nested domains with 60 and 20 km resolution and 36 levels in vertical. The model runs are initiated by the NCEP and UKMO objective analysis and forecast data. The daily model predictions are available on website http://earth.nasa.proj.ac.il/mm5/current/.

The model quite accurately predicted the precipitation in Israel although the model predicted values were somewhat lower than the observed maxima (Fig. 1). The simulated rain intensity was higher in the higher resolution model runs. Most of the model-produced rains (Fig. 2) were of non-convective form. Convective precipitation was found mainly along the coastline. According to the NCAR/NCEP Reanalysis Project data on the Best Lifted stability Index, an area with high negative values of the index already existed over the Eastern Mediterranean (EM) to 00:00 UTC on Dec. 3, i.e. prior to the cyclone rapid intensification. This indicated a high level of instability of the air mass in the lower troposphere. The zone shifted eastward together with the cyclone. The model simulation of the period demonstrated rapid intensification of the cyclone occurring after southward displacement of a mid-tropospheric low characterized by a narrow zone of relatively mild stratospheric PV intrusion on Dec. 5 00:00 (Fig. 3). The potential vorticity (PV) pattern on the 350 K (about 200 hPa) isentropic surface also demonstrates occurrence of intrusion of the cold air masses from the extratropical stratosphere into the upper troposphere over the Mediterranean region (Fig. 4). The process evidently played an important role in the cyclone

intensification over the EM. Analysis of the modeling results suggested important additional role, played by the local topography of the EM region, which resulted in the intensification of the low level flow in the narrow costal zone with the approach of the cyclone. The effect evidently caused a faster eastward propagation of the low-tropospheric system in advance of the more slowly moving upper-level trough.

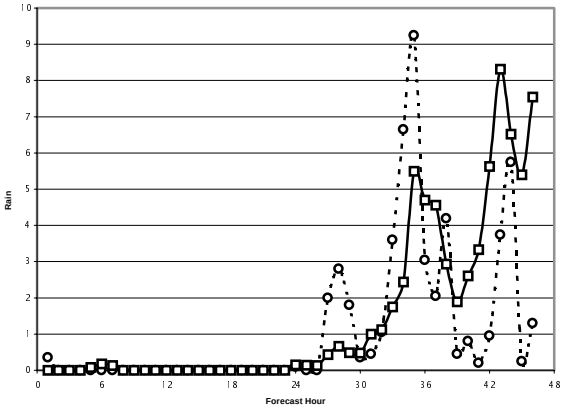

Fig. 1. Mean model produced (solid) and Observed (dashed) precipitation in northern Israel

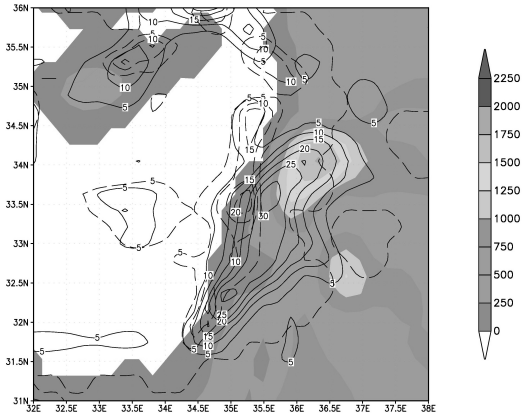

Fig. 2. Model terrain (shaded), convective (dashed) and non-convective (solid) precipitation at 00:00 UTC 05 Dec

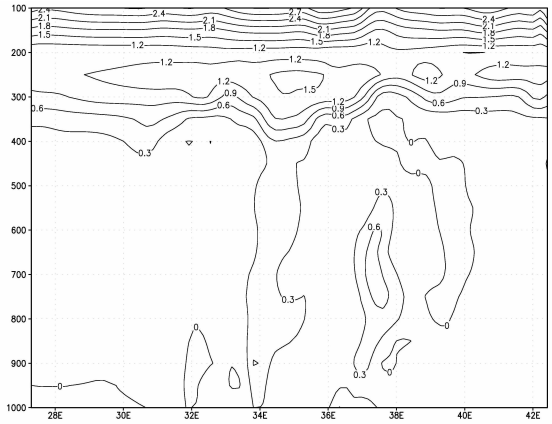

Fig. 3. PV cross-section along 35N at 00:00 UTC 5 Dec

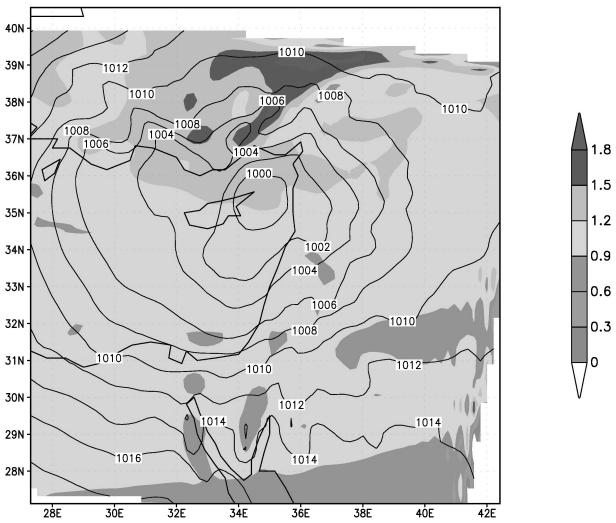

Fig. 4. IPV on 350K at 00:00 UTC 5 Dec 2001