Connection between water vapor budget components and rainfall in the eastern Mediterranean

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Rainfall over a rectangular region with an area of 3.04 x 10^5 km^2 over the Eastern Mediterranean Basin is studied by the use of a NASA GOES -1 reanalysis gridded (2.5^0 longitude by 2^0 latitude) data set, for a period of eight rainy seasons (October - April) of the years 1985-1993 (total, 56 months, or 1698 days). The NASA data set has been used to obtain 3 hourly mean water vapor budget components. Another data file had 4 times daily synoptic data at 18 pressure surfaces, that we have used for generating composite synoptic charts and water vapor fluxes. All days over the study period have been sub-divided into 6 groups of days, based on rainfall amount. The first group contains 145 days with zero precipitation. The next five groups contain, about 310 days each, with precipitation ranges of 0.01-0.15, 0.15-0.4, 0.4-0.9, 0.9-2.2 and over 2.2 mm/day. The water vapor budget components have been averaged for each of the six rainfall groups.

We found that the mean annual (October - April) precipitation over the study region was, about, 260 mm. The highest rainfall category (over 2.2 mm/day), contributed 63% to the total rainfall in October - April.. Composite synoptic analysis was employed to study the synoptic differences among the above six rainfall groups. We found that the two highest precipitation categories (0.9-2.2, and over 2.2 mm/day) contributing 85% of the total rainfall, were accompanied by deep upper troughs extending from the Black Sea to Crete with an MSL cyclone located near Cyprus. For the rest of the rainfall categories the upper air flow was nearly zonal and with no clear MSL cyclonic activity in the study area.

We found that generally, the Outflow–Inflow is balancing the independently calculated evaporation minus precipitation minus the time change of precipitable water to within 1.5 mm/day. The correlation coefficient between the daily Outflow-Inflow and E-P-dPW was 0.82. These results lend high credibility to the WVB calculations based on the reanalysis data. Our results have many features in common with earlier, mostly land based, water vapor budget analyses but there are also some special, new features noted. An important result is the relatively high correlation (+0.36) between daily P and E and a much higher correlation (+0.64) for the monthly averaged P and E data. Both these results are in agreement with the hypothesis that EM precipitation is fed by moisture evaporating from the Mediterranean Sea. The correlation of P with both inflow and outflow is also high (+0.45) and there exists an extremely high (+0.90)

positive correlation between inflow and outflow. However, in contrast to findings in water vapor budget studies for the Midwestern US in summer – our study shows no significant correlation between P and outflow - inflow (= Moisture flux divergence). This is in contrast with summer rain in the Midwest where intense convection develops in the warm sector (near the maximum MFD).

The recycling ratio R.R, expresses the ratio of locally evaporated water to water vapor imported from outside the region – in the falling precipitation. The mean value found for R.R for the study region is 14% - 18%. R.R generally being higher for smaller precipitation amounts. These values are considerably lower than those for the US Midwest (15% - 30%), but these higher values may be explained by the research region in the Midwest being considerably larger than that in the EM. Since the moisture inflow to the region may originate from other parts of the Mediterranean Sea, R.R may not be the best parameter for this problem. Nevertheless, the level of R.R is low and it is in contrast to common knowledge among meteorologists that rainfall over the EM and Israel originates mostly in humidity evaporating from the EM.