Plinius Conference Abstracts,
Vol. 11, Plinius11-30, 2009
11th Plinius Conference on Mediterranean Storms

Hydrologic response of the Beqa watershed to spatial and temporal characteristics of convective rain cells

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In semi-arid regions, the rain is characterized in great variability in time and space. Location of the convective rain cells, their intensity and movement direction and speed impact the watershed hydrological response.
Meteorological radar data provide detailed information of the rain structure with high spatial and temporal resolution that allow us to get a better understanding of the rain cells characteristics. In this research the rain cells were modeled and used as an input to a hydrological model
The research is focused on the Beqa watershed, a sub watershed of the Besor, located close to Be'er-Sheva, and on a flash flooding rainstorm from December 23rd, 1993. A former research done in the Northern Negev area found that the rain cells in this area are usually elliptical, the rain intensity decays from the cell center to the cell margins. To describe the spatial structure of the rain cells a combination of two functions has been used: a Gaussian function to describe the high rain intensity core of the rain cell and an exponential function for the surrounding lower rain intensity area. A threshold value was used, above it the Gaussian function was used and below it the exponential one. The model was fitted to the radar data to find the parameters that describe each rain cell: Gaussian function maximum (Rg), exponential function maximum (Re) and the threshold value (R1). The rain cells were manually tracked to find the direction and speed of cells. 56 rain cells for the analyzed storm were modeled in the process described above.
The hydrological model is a 2-parameter infiltration model, which assumes a rainfall depth threshold and a constant infiltration rate. The flow over the hillslopes and in the channel of each sub-basin is modeled with the kinematic flow equation. Constant channel infiltration rate is assumed. The watershed is divided into 17 sub-basins, each composed of 2 slopes and a channel.
The modeled rain cells were used as an input for the hydrological model, in order to test the watershed sensitivity to the rain spatial and temporal characteristics. One major cell was identified to be the most important in generating the flash-flood. Few of the cell's characteristics were changed: location, direction and speed, and the resulted runoff was examined. The results show that the watershed is sensitive mainly to the cell's location and speed. A cell that moves closer to the outlet produces more runoff than a cell that is located upstream. Also, a cell that moves slower produces more runoff.