Identification and Mapping of Intense Rain Events

The algorithm for identifying intense rain events uses a rain estimation technique referred as Hydro-Estimator (H-E). The H-E technique originally developed by NOAA/STAR for GOES is modified and calibrated for Kalpana/INSAT satellite observations. The H-E method uses Kalpana/INSAT VHRR thermal infrared (TIR) observations and Numerical Weather Prediction (NWP) model based environmental parameters to make a quantitative assessment of the precipitation at each TIR pixel (~ 4km x 4 km for INSAT-3D/3R) in every acquisition of the satellite measurement (presently, 30 minutes for Kalpana/INSAT). In H-E method, the rain at a pixel is determined by the cloud growth with respect to the surrounding pixels. The H-E method ensures heavier rain for growing clouds and at the upwind portion with overshooting tops of the storm. The rain at a pixel is the combination of rain from convective (core) and stratiform (non-core) portions of the clouds, which is determined by the vertical growth of the clouds at the pixel under consideration with respect to surrounding pixels. The relationship between rain rate from core portion and brightness temperature is exponential in nature with coefficients depend upon the available total columnar precipitable water (TPW). Thus these coefficients are determined dynamically at each pixel for the given TPW from NWP model. The correction due to orography resulting in enhancement/reduction of rain; and the detection and enhancement of rain from warm clouds are also applied to H-E rain. The orographic correction is carried out by determining average slope in the direction of the prevailing 850 mb winds, whereas correction for the warm clouds is determined by locating the level of neutral buoyancy (LNB) in the atmosphere. Further correction for the evaporation of the rain drops below the cloud base using relative humidity from the NWP model fields is applied. The H-E algorithm is found to show very low rain over high terrains, especially over the Himalayas. A thorough study of the H-E rain over Himalayas showed missing LNB computation (because of non-convergence) and inconsistent calculation of orographic gradients, especially when surface pressure is below 850 mb. It is also noticed that NCEP model derived TPW and RH have strong dry bias over Himalayas that resulted in drying of rain over such regions. In the modified algorithm, the TPW and RH over Himalayas are adjusted using histograms of these parameters over Indian planes using histogram equalization technique. For a given value of TPW/RH, the histogram equalization provided same probability for rain over plane and hilly terrains, which, however, is further modified by orographic and warm-cloud correction. In the modified algorithm, the 850 mb wind is replaced by winds above the given surface pressure level at each steps of the computation of orographic correction. The LNB calculation is also modified by considering given surface pressure as reference level for the computation (unlike 1000 mb level as the standard practice earlier). With these modifications, it is found that measurement of rain using H-E method improved significantly, especially over hilly terrains.

The intense rain events (> 10 mm/h) from the H-E derived rain rates are identified and their area extent and central coordinates are determined and provided in the tabular and pictorial form. Also the districts which experience more than 5 mm/h rain are identified; their name and corresponding met-subdivision are provided in another table. The H-E rain over the land as well as over the oceans are available from MOSDAC in HDF5 format. However, the intense rain events shown here are provided only over the Indian landmass. The H-E method depends upon brightness temperature in satellite thermal infrared observations and NWP model fields. The thermal infrared observations sense only the cloud top and hence their use for rain measurement is essentially indirect in nature. Also the infrared based methods have well known weakness for warm and orographic rain. Though H-E offers corrections for orographic and warm rain, the accuracy of the method still depends upon the accuracy of the input dataset, especially the NWP fields.

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