1. INTRODUCTION

Prominent topography in the path of a wind field play an important role in rainfall generation by altering the atmospheric flow. Rain systems often depend critically on the presence of mountain topography (example: fig. 1). Although there have been numerous modeling studies on the dynamics of the problem (See Pathirana et al. 2003 for a review.), majority of these have been ‘dry’ simulations, ignoring the moisture effects. In this paper the results of a modeling study on the mountain flow problem including the moisture considerations and the microphysics, are presented.

2. MODELING SYSTEM

Pennsylvania State University’s MM5 modeling system (Grell et al. 1996) is a 3-dimensional mesoscale model with fully compressible non-hydrostatic dynamics, widely used for limited-area atmospheric simulations for operational and research purposes. Since the original model is geared towards the simulation of actual atmospheric situations, using the model for an idealized simulation is not a straightforward task. Several researchers have modified the modeling system to perform idealized ‘dry’ simulations in the past. For the present research we have modified the system (MM5 version 3) to incorporate general (idealized) topographic conditions and ‘wet’ dynamical forcings. This modified system can run simulations with arbitrary topographic/landuse conditions and wind, temperature (by means of Brunt-väisälä frequency, N) and moisture conditions specified at each pressure level.

3. SIMULATIONS

In this paper the results of a class of simulations performed on a system with a single mountain ridge with horizontal wind of constant speed normal to it, are presented. Fig. 2 shows the parameters used for the simulations. Due to the possibility of cloud formation at relatively high altitudes the model top was selected at 70mb (about 16km). It should be noted that most of the model parameters were selected so that the idealized simulations are comparable with the typical summer monsoon situation in Sri Lanka. Results of three case studies with ridge height, \( h = 500\, \text{m}, 1000\, \text{m}, \) and \( 2000\, \text{m} \) are presented. All three scenarios were simulated for a period of 24h (at 6s time-steps) and the results were sampled at 10min intervals.

4. RESULTS AND DISCUSSION

After several minutes of model start, the clouds first start to appear above the wind-side slope of the mountain. These clouds are of very low altitude (only several hundred meters above mountain surface) During the next several 10min periods, the clouds develop rapidly in height, and stats to grow towards the lee-side (e.g. fig. 3). When the topography is higher, this growths takes place faster (within 2h in 2000m whereas 500m takes about 4hours).
significant amount of rainfall starts to appear only after this cloud escalation. The rain starts towards the peak and then spreads towards the lee-side slope as the clouds spread that way.

At a given instance, it is not clear whether the mountain or the lee-side plain is getting higher rainfall. However, once the rainfall is accumulated over 24h (fig. 4), it becomes clear that the rainfall amount received by the mountain area is much larger than the plain. This indicates that the mountain rainfall has a higher degree of persistence. Although the instantaneous (10min) maximum value ratios between mountain and lee-plain are very close to unity, the accumulated (24h) ratios are much larger (Table 1).

In case of dry atmosphere (Pathirana et al. 2003) with steady boundary conditions, reach a state where the output also is stable, once the initial shock of the abrupt start of the model die-down. However, in case of the present (wet) simulation, the rainfall output never reached stability even after running the simulation for a several days. Typical monsoon weather results in large amount of rainfall on mountains and in the wind side plains. However, in the present simulation, it is the mountaintop and the lee side plains that received almost all rainfall. It appears that the present simulation could not capture the essential properties of the monsoon rainfall mechanism.

**REFERENCES**


**KEYWORDS:** rainfall simulation, atmospheric model, mountain flow

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**Table 1** Some statistics of rainfall distribution along the cross-section. (plain: lee-side plain, mt: area around mountain top)

<table>
<thead>
<tr>
<th></th>
<th>500 m Mt.</th>
<th>1000m Mt.</th>
<th>2000m Mt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. mm/10min</td>
<td>3.0</td>
<td>3.5</td>
<td>2.9</td>
</tr>
<tr>
<td>Avg. mm/24h</td>
<td>8</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Max. mm/24h</td>
<td>56</td>
<td>59</td>
<td>70</td>
</tr>
<tr>
<td>Avg. mm/24h</td>
<td>77</td>
<td>92</td>
<td>108</td>
</tr>
<tr>
<td>Max. mm/24h</td>
<td>77</td>
<td>92</td>
<td>108</td>
</tr>
</tbody>
</table>

**Fig. 3** Top: Development of clouds (200min after start). Bottom: Corresponding rainfall.

**Fig. 4** Cumulative rainfall in 24h. (a) 2000m mountain. (b) 500m mountain.

Topography is also shown below each plot.