# CE 597E Water Resources Engineering Seminar Series

## Observing, Understanding and Modeling Precipitation Processes in Complex Terrain - Lessons Learned in the Himalaya

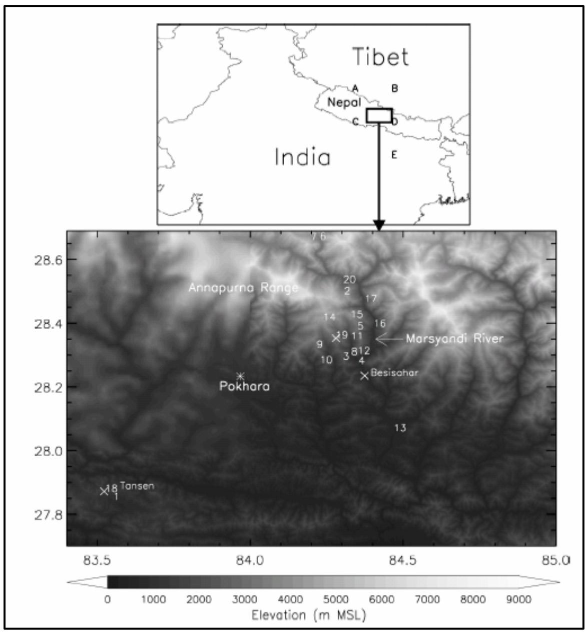


FIG. 1. Topographic map of the Marsyandi River basin, showing locations of the meteorological stations in the network (numbers; Table 1) as well as the MOHPREX radiosonde launch locations and the Telbrung micrometeorological tower (Xs). Also shown are various landmarks in the region, including the city of Pokhara. The large-scale map shows the location of the network relative to southern Asia, as well as the locations of the grid points used in the NCEP–NCAR reanalysis comparison (letters; Table 3).


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**12-1.30pm**
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**ABSTRACT.** Through diagnostic studies combining space-time scaling analysis of ground-based hydrometeorological observations, radiosonde profiles, METEOSAT and TRMM satellite data, as well as simulations using a Cloud Resolving Model, we were able to identify and characterize the dominant weather systems and associated precipitation processes in the Central Himalayas: a) monsoon depressions; b) wintertime storms; c) stationary orographic gravity waves; and d) ridge-locked convection. Our analysis shows that while the first two regimes are associated mainly with large-scale circulations, and exhibit strong inter-annual variability in frequency, intensity and spatial track; the second

two regimes modulate the diurnal cycle during the monsoon and the spatial distribution of precipitation year round.  A synthesis of Himalayan hydrometeorology is proposed that relies on three principal modes of space-time variability: 1) an inter-seasonal mode linked to large-scale dynamics that explains infrequent events producing significant amounts of precipitation over one-three day periods (wintertime storms and monsoon depressions); 2) a regional mode linked to ocean-land-atmosphere interactions over Northern-India and the Bay of Bengal at time-scales of days to weeks consistent with the succession of rainy and dry episodes during the break and active phases of the monsoon; and 3) an orographic mode that explains the spatial variability of the diurnal cycle on the Himalayan range during the monsoon.  One especially remarkable feature of the later is the ubiquity of congruent precipitation, landform and vegetation patterns which provide evidence for the hypothesis that landform, land-cover patterns, soil moisture, clouds and precipitation are dynamically interconnected on steep altitudinal gradients, and that evapotranspiration plays a key role in the spatial organization of precipitation at the ridge-valley scale, even in the presence of strong monsoon forcing.  This hypothesis has profound implications for our understanding of orographic precipitation processes, and for elucidating the role of land-atmosphere interactions in the hydroclimatology of tropical mountainous regions and elsewhere.