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.