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Published on *EOSDIS - Earth Data Website* (https://earthdata.nasa.gov)

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Snowlines over Kathmandu [1]

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Published in 1996

Scientists are investigating the relationship between Eurasian snow cover and monsoon intensity.

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Weak Indian summer monsoons often follow winters of heavy Eurasian snowfall, while less snow cover frequently leads to more intense monsoons. Scientists first recognized this inverse relationship between Eurasian snow cover and monsoon intensity more than a century ago. Now, with the help of satellite data, scientists are probing the roots of the relationship, hoping to better understand regional climate dynamics while also looking for indications of global climate change.

The snow cover-monsoon relationship is rooted in interactions of land and ocean. Essentially, the monsoon circulation is set up by enhanced heating of the Eurasian continent, which results in a land/sea temperature contrast that draws moist air off the Indian Ocean and onto the Himalayas.

Greater snow cover affects the degree and timing of continental warming in two ways. First, more winter and spring snow takes longer to melt, thereby reducing the amount of time that bare ground is exposed to the sun and effectively diminishing its seasonal heat storage. Also, a heavier snow pack inhibits continental warming even after the snow has melted. By increasing soil moisture, greater snow cover means more solar energy is used to evaporate soil moisture than to warm the land.

By inhibiting continental heating in these ways, a heavier snow pack diminishes the land-ocean temperature differential and thus delays the onset of the monsoon. Likewise, lighter snow cover leads to stronger monsoons. In this region, where the planet's largest land mass meets the Indian Ocean, the effects of differential heating are intense.

Recent years have produced a flurry of publications describing the interaction of Eurasian snow cover with the Indian monsoon and the regional climate. Against this backdrop, Chris Duncan, a post-doctoral scientist at the Cornell Theory Center, is studying snow lines that rise and fall seasonally on the steep flanks of Himalayan mountains.

Duncan and collaborator Bryan Isacks, Principal Investigator for Cornell's EOS investigation of climate in high mountain systems, generate snow lines as additional climate indicators. Duncan and Isacks drape snow cover data over a digital elevation data set. Where the edge of the snow cover data intersects the elevation data, the snow lines appear. Duncan and Isacks plan to establish spatial and temporal patterns for the Himalayan snow lines over several years.

Delineation of the spatial distribution of the snow lines could provide a benchmark for paleoclimate studies, Duncan said. Temporal distribution of the snow lines might shed light on the regional sources of snow, which include monsoons to the south and Eurasian sources to the north and west. And, comparison of Himalayan snow lines, which register clearly in this high relief area, with those found elsewhere in the world may provide insight about global climate.

Duncan and others hope to detect hidden climate signatures in this complex physical system. "The monsoon is a seasonal phenomenon and the winter storms are seasonal phenomena. They dump different amounts of snow from different sources at different levels at different times," said Duncan. "We don't know what such a signature might be, but by looking at snow lines and starting to get a fix on both their means and their variability from those means, we might actually find a climate change signal."

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