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Is Snowmelt Independent of Elevation?

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Average Conditions and Traditional Theory

Basic meteorology describes a decrease in temperatures of 6.5°C per 1000 ft in elevation. April and May 1998 had no appreciable day change in the start of the snowmelt season for each 100 ft in distance to altitude. Common experience and intuition suggest the cover at any elevation is snow.

Synoptic Patterns Overwhelm Elevation: Spring 1998

In the Sierra, during a spring snow, such as 1998 (left), a short period of warm weather is followed by a cold spell and additional snow storms. During this early warm period, snow starts to melt and streams start to rise. In the spring, however, cold climates that first as winter returns. A second time, spring returns with a vengeance, and the average temperatures rise over 12°C in a matter of days (a, top left). This rapid warming is insufficient to initiate snowmelt at all elevations. Snow falls at all elevations (b, middle left) and a shift from accumulation to melt conditions, and streams range from high altitude cirques (Emerald and Topaz) to large-scale basins (Merced) the simultaneity.

What is Typical?

How common are sudden snowmelt compared to gradual ones? 85 years of Yosemite Valley and Merced River discharge data suggest that spring snowmelt "comes in like a lion." Averaging the temperatures (below) before and after the day the river starts rising reveals that minimum temperatures are about 8°C and maximum temperatures are about 16°C during the weeks surrounding the spring runoff. Of 85 years, only 8 years, including 1998 (right), had rapid increases that were not accompanied by a steady temperature rise. In 1993 temperatures rose more gradually (top, a), and snow began melting at lower elevations first (middle, b). Flow increased gradually as more and more elevations joined in to contribute.

Case Study: Yosemite National Park, 2002

In Spring 2002, ten pressure sensors measured the onset of spring runoff in sub-basins of the Tuolumne River in Yosemite National Park, California. Sub-basin areas ranged from a few to 775 km², and measurement elevations ranged from 2400 m (8000 ft) at Glyph Creek in 2001 to 3000 m (10,000 ft) at Glyph Creek. Some were north-facing and some were south-facing. Despite these differences, streamflow was simultaneous, (Sanftner et al. 2005, at pages right).

In 2002, two pressure sensors measured the onset of spring runoff in sub-basins of the Tuolumne River in Yosemite National Park, California. Sub-basin areas ranged from a few to 775 km², and measurement elevations ranged from 2400 m (8000 ft) at Glyph Creek in 2001 to 3000 m (10,000 ft) at Glyph Creek. Some were north-facing and some were south-facing. Despite these differences, streamflow was simultaneous, (Sanftner et al. 2005, at pages right).