Using upper-air conditions to estimate South Cascade Glacier (U.S.A.) summer balance

L. A. RASMUSSEN, H. CONWAY

Department of Earth and Space Sciences, University of Washington Seattle, Washington, U.S.A.

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ABSTRACT. A simple model uses once-daily upper-air conditions from the NCEP-NCAR Reanalysis database to estimate summer balance of South Cascade Glacier each year over 1959-99. The rms error, 0.30 m water equivalent $(r^2 = 0.71)$ is comparable to measurement error. The model relates summer balance linearly to temperature T > 0 °C at 2000 m and to snow flux at 1650 m, the altitudes in recent years of the equilibrium line and terminus. The snow flux is the product of the humidity and westerly wind component at 850 hPa when temperature $T < +2 \,^{\circ}\text{C}$ at 1650 m. Temperatures are interpolated linearly between the 850 and 700-hPa levels. Both the positive 2000-m temperature and the snow flux are summed April 26 to October 4. When the summer estimates are combined with those from a winter balance model using the same database, the rms error in estimating net balance is 0.40 m ($r^2 = 0.81$). The indicated sensitivities of balance to warming of $1 \,^{\circ}\text{C}$ are -0.51 m for summer, and -0.24 m for winter. On the assumption that the total $-0.75 \text{ m}^{\circ}\text{C}^{-1}$ sensitivity exists at all altitudes, a warming of only 0.7 °C would be sufficient to overcome the 1986-98 average net balance +0.5 m at the top of the glacier.