

The effects of sudden insolation change on the air temperature during a total solar eclipse over Dome Fuji, Antarctica

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The Moon cast a long shadow over Antarctica on 23 November 2003 in a total solar eclipse. The eclipse was observed at Dome Fuji Station, located at the highest point of East Dronning Maud Land, Antarctica, and lasted 1 h 41 min 37 s in a cloudless condition, during which the Sun was completely obscured for 1 min 43 s. This was the first total solar eclipse to be observed in the Antarctic ice sheet. During the eclipse at Dome Fuji, the air temperature at 1.5 m above the snow surface and the subsurface snow temperature decreased by 3.0 K and 1.8 K, respectively. Estimated surface snow temperatures decreased by 4.6 K. Atmospheric pressure and wind direction did not change, but the wind speed possibly decreased by 0.3 m/s with decreasing air temperature; natural variations in wind speed before and after the eclipse made it difficult to identify a true effect of the solar eclipse. Variations of energy components (net shortwave and longwave radiations, sensible and latent heat fluxes, and geothermal heat) during the eclipse were investigated. The total loss of global solar radiation during the eclipse was 0.60 MJ m⁻², equaling 1.6% of the total daily global solar radiation. Regional effects of the eclipse due to a reduction of global solar radiation for air temperature and snow temperature ranged from 0.015 to 0.020 K (W m⁻²)⁻¹. We additionally examined the relation between eclipse obscuration (the fraction of the Sun's surface area occulted by the Moon) and the reduction of global solar radiation from the first to second contacts. The eclipse was also observed from space by the Moderate Resolution Imaging Spectroradiometer (MODIS) sensors onboard NASA's Terra and Aqua satellites. The observational results of this study will contribute to detailed model calculations for clarifying the meteorological effects of eclipses.

Keywords: insolation change, air temperature change, total solar eclipse, Antarctic ice sheet, Dome Fuji