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Effects on the atmospheric boundary layer of a solar eclipse in the Arctic

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On 1 August 2008, a total solar eclipse took place in the Arctic and in Longyearbyen, the main settlement in the High Arctic archipelago of Svalbard (78° 13′ N, 15° 37′ E), the maximum solar coverage was 93%. The eclipse had a large impact on the atmospheric boundary layer and the local weather in general around Longyearbyen triggering a fog that lasted for three days. This fog grounded all air traffic to and from Svalbard and so in addition to the change in local weather, the eclipse also had economic and social consequences.

Approximately 60% of Svalbard is covered with permanent ice and snow. Permafrost underlies most of the surface. In Longyearbyen, the midnight sun is present between 19 April and 23 August and so on the day of the eclipse the sun was about 30 degrees above the horizon at noon and 6 degrees above at midnight. A rare opportunity therefore occurred to study what happens when the sunlight is suddenly decreased after several months with no dark night. The maximum solar coverage at Longyearbyen took place at 10.41 Local Standard Time. The incoming shortwave radiation had then decreased from approximately 300 W m-2 before the start of the eclipse to 20 W m-2, i.e. less radiation than during a normal cloud free night at the same location at the same time of the year.

Observations of turbulence and mean meteorological parameters were taken both over land and over a large fjord in the vicinity of Longyearbyen. In addition, cloud observations were recorded. Data have been analysed in detail from 31 July to 2 August, i.e., from one day before to one day after the eclipse.

The simultaneous observations over land and over water showed that the atmospheric response was much faster and stronger over land than over water. Over land, the air temperature sank by 0.3-1.5°C, wind speed decreased, turbulent fluctuations were significantly reduced and the atmospheric stability changed from unstable to stable. Over the fjord, no clear minima in these parameters could be found and the response was delayed.

The cooling over land was sufficient to trigger downslope winds in the valleys surrounding the large fjord. When the air from land and adjacent glaciers reached the water, it continued to cool, thereby increasing the relative humidity. A few hours after the eclipse, Stratus clouds appeared over the fjord. These clouds continued to grow and they were later advected in over land, where they developed into a fog that covered Longyearbyen. Low wind speeds prevented the fog from dissipating for three whole days, although the vertical extent was limited.