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Meteorological Forcing of the Abrupt Springtime Temperature Rise at the Greenland Crest

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EXTENDED ABSTRACT

Air temperature records from automatic weather stations (AWS) at the Greenland crest revealed a rise of up to 23°C during a 24–48 hour period in May. A composite for six years of AWS data (1987–1993) suggests typical increases of 15°C and subsequent persistence at typical summertime values (Fig. 1). The associated barometric pressure rise suggests a plausible link to changing synoptic conditions of the atmosphere. This project examines the meteorological processes driving the abrupt spring temperature rise (ASTR) over the Greenland ice sheet.

The spatial and temporal characteristics of the ASTR phenomenon were investigated through a superposed epoch analysis of three hourly AWS temperature and pressure records, twice daily temperatures and pressures from World Meteorological Organization stations in the region, and 5° by 5° degree gridded sea-level pressure and 500 hPa geopotential height charts.

Results of this project suggest that a sequence of four weather patterns was responsible for ASTR events. Seven days prior (not shown) to the date of maximum temperature rise (zero date), a deep trough and zonal circulation south of Greenland; two days prior (Fig. 2), a short wave ridge developing west of Greenland and prominent ridge over northern Europe; on the date of maximum temperature rise (Fig. 3), northward circulation develops in response to a strong blocking high pressure system southeast of Greenland; finally, seven days following (Fig. 4), the high pressure over the ice sheet persists. Simulation results from an energy balance model suggest that nocturnal irradiance from low-level clouds and boundary layer mixing strongly enhanced the downward heat flux to the snow surface during ASTR events. Further details are forthcoming in a future issue of Hydrological Processes, pending scientific review.

The abrupt warming and persistence of air temperature over Greenland may be connected to depth hoar formation and other metamorphic processes, thereby altering the thermal and radiative properties of the snow surface. Interpretation of remote sensing images, analysis of data from the Greenland Climate Network AWS, and measurements of snowpack properties would increase understanding and facilitate verification/validation and improvement of the energy balance model.

Keywords: meteorology, Greenland, energy balance, air temperature, clouds

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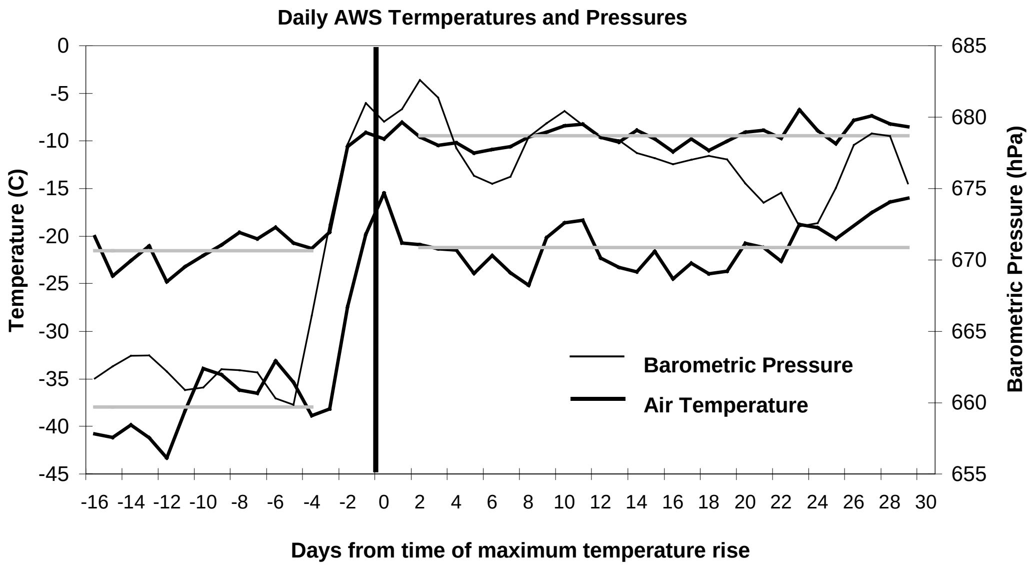

Figure 1. Composite of 6 years of AWS daily maximum and minimum air temperatures and daily mean barometric pressure for a period 15 days prior to and 30 days following the date of abrupt springtime temperature rise (ASTR).

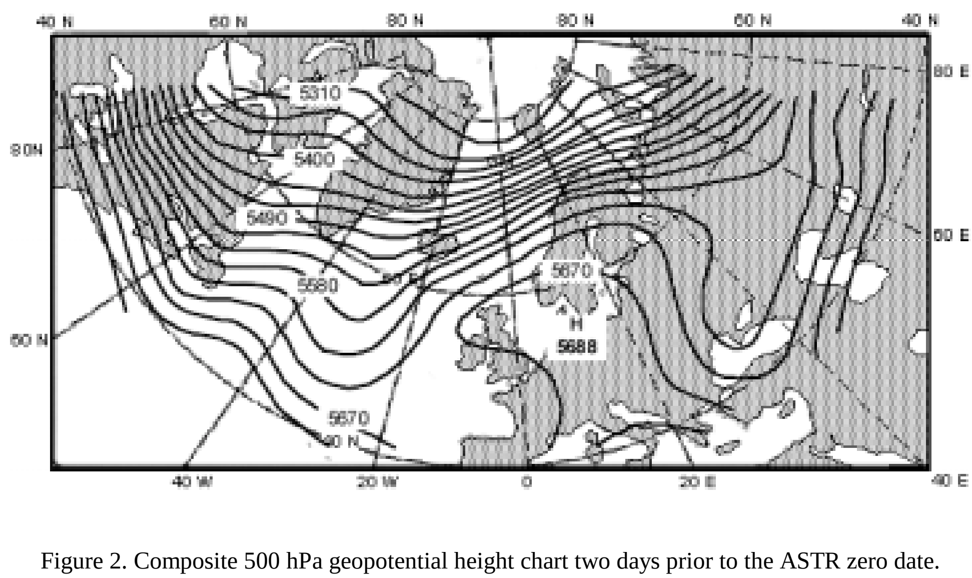

Figure 2. Composite 500 hPa geopotential height chart two days prior to the ASTR zero date.

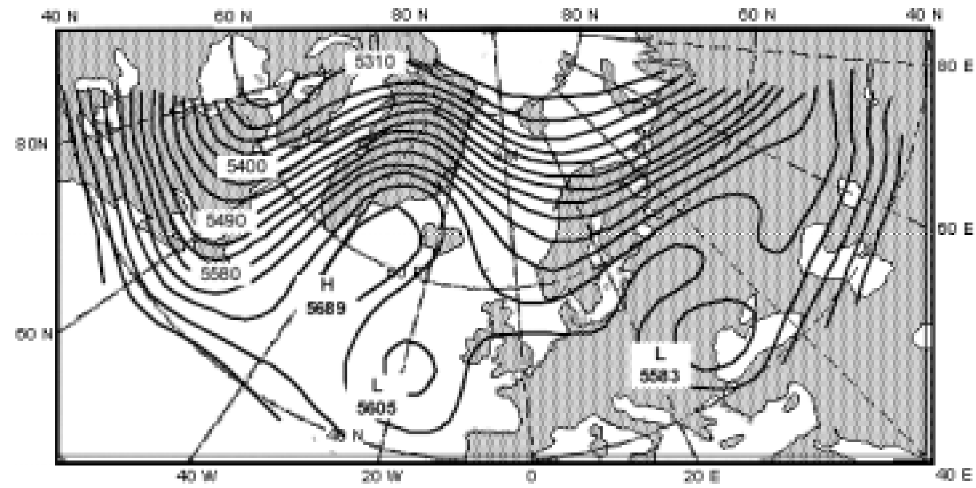

Figure 3. Composite 500 hPa geopotential height chart on ASTR zero date.

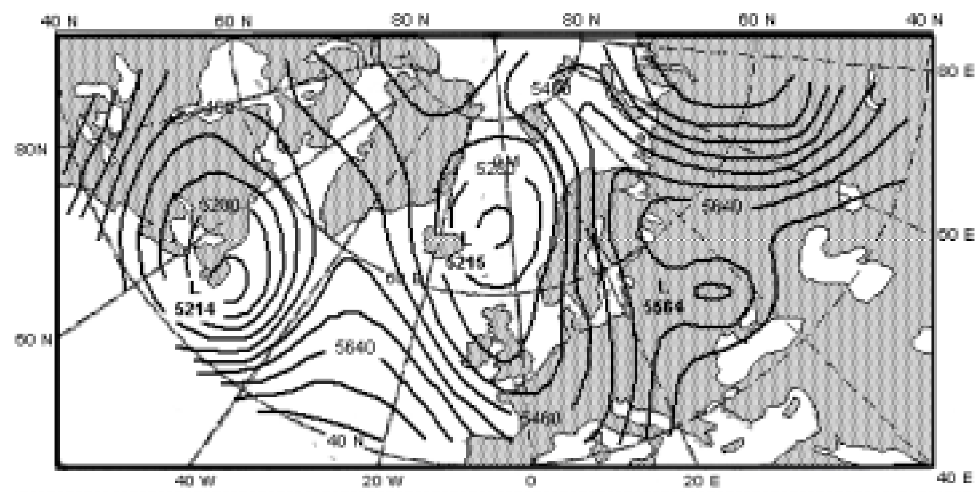

Figure 4. Composite 500 hPa geopotential height chart seven days following the ASTR zero date.