

NSCAT Observation of Spring Thaw in Alaskan Boreal Forest

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Research Summary

The focus of this effort is the assessment of spaceborne scatterometer observations for monitoring landscape freeze/thaw transitions in the boreal forest thereby providing a means for estimating growing season duration. Ground-based temperature measurements have been compared with NSCAT observations at selected sites along a north-south transect through the Alaskan boreal forest. We have measured vegetation tissue temperatures, soil temperature profiles, and micrometeorological parameters *in situ* at eight monitoring stations extending from the Brooks Range at the northern extreme, through Alaska's central interior, across the Alaska Range, and to the Kenai Peninsula at the southern extreme. At each station, vegetation and soil temperature is monitored at sites selected as representative of vegetation types found along this transect. NSCAT data obtained during winter and spring 1997 have been assembled for correlation with the *in situ* temperature measurements.

Fig. 1 shows backscatter *vs.* incidence angle as measured by NSCAT's aft antenna from Day of Year (DOY) 92 through 119, 1997. Each data point corresponds to backscatter measured during one NSCAT pass over our ground station located in the southern Dietrich Valley, near Coldfoot, Alaska, and represents average backscatter computed within a 75 km diameter circle centered at that station.

Fig. 2 shows a sample of *in situ* temperature measurements recorded at the Coldfoot ground station for DOY 90 through 120. Temperature was monitored every five minutes with thermistors implanted in the trees' trunks and in the soil. Measurements were averaged to two hour ensembles and data stored on a data logger. These plots show: (top) temperature in the trunk at breast height and at ground level for two black spruce (*Picea mariana*) trees in a flat boggy area, (second from top) similar temperature measurements for two black spruce trees growing on a north-facing slope, (third from top) similar temperature measurements for two white spruce (*Picea glauca*) trees growing on a south-facing slope, (second from bottom) a temperature profile measured at depths of 5, 25, 50 and 90 cm in the soil and at 10 cm above

the soil surface (corresponding to snow temperature) in the black spruce bog, and (bottom) temperature at 2 meters height in the black spruce bog and in a nearby stream (1) (1).

The response of the NSCAT backscatter to landscape thaw is readily apparent in these figures. Fig. 2 shows that a short thaw period began around DOY 96. This is followed by a freeze-up beginning around DOY 103. The final springtime thaw transition begins around DOY 113. The breast height trunk temperatures in all trees indicate thawed conditions between DOY 96 and 103. The near-surface trunk temperature remained consistently below 0 degrees during that time. The soil does not begin to thaw until about DOY 115. However, the snow temperature reaches zero between DOY 96 and 103 indicating that some snow melt may be underway during that time.

During the winter months, backscatter exhibits a linear decrease with increasing incidence angle. Backscatter response from DOY 92 through 97 reflects frozen landscape conditions and is identical to the response observed throughout the preceding winter months. On DOY 98, backscatter falls 2 to 3 dB below the wintertime response curve. The timing of this decrease corresponds to the onset of the initial thaw shown in Fig. 2. The chart second from the top of Fig. 1 shows that backscatter varies considerably between DOY 99 and 105 reflecting the transitional conditions occurring until the landscape again freezes between DOY 102 and 103. The chart second from the bottom shows a similar response to wintertime frozen conditions, indicating frozen conditions. After DOY 113 (bottom chart) backscatter again decreases, reflecting the onset of the final thaw transition.

Figure 3 shows backscatter response for three weeks as observed over regions surrounding ground stations near Coldfoot, the Bonanza Creek Experimental Forest (BCEF), and Denali National Park and Preserve. The three weeks for which data are graphed correspond to (1) winter frozen conditions (DOY 85 - 92), (2) the freeze-up period after the initial brief thaw (DOY 106-113) and (3) the week of the final spring thaw transition (DOY 113-120). Response during the periods of landscape freeze is similar for all three sites. During the thaw transition, there is a 3 to 5 dB decrease in backscatter over all three regions with the Coldfoot area having the largest change. The backscatter response to landscape thaw allows differentiation between frozen and thaw states over all three regions. The high temporal density of data acquired by NSCAT during its operation provides more than one observation a day of the northernmost sites. During some days, up to four observations have been acquired for the Dietrich Valley alone, thus allowing for daily assessment of the landscape freeze-thaw state.

Acknowledgment

This work was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under contract to the National Aeronautics and Space Administration.

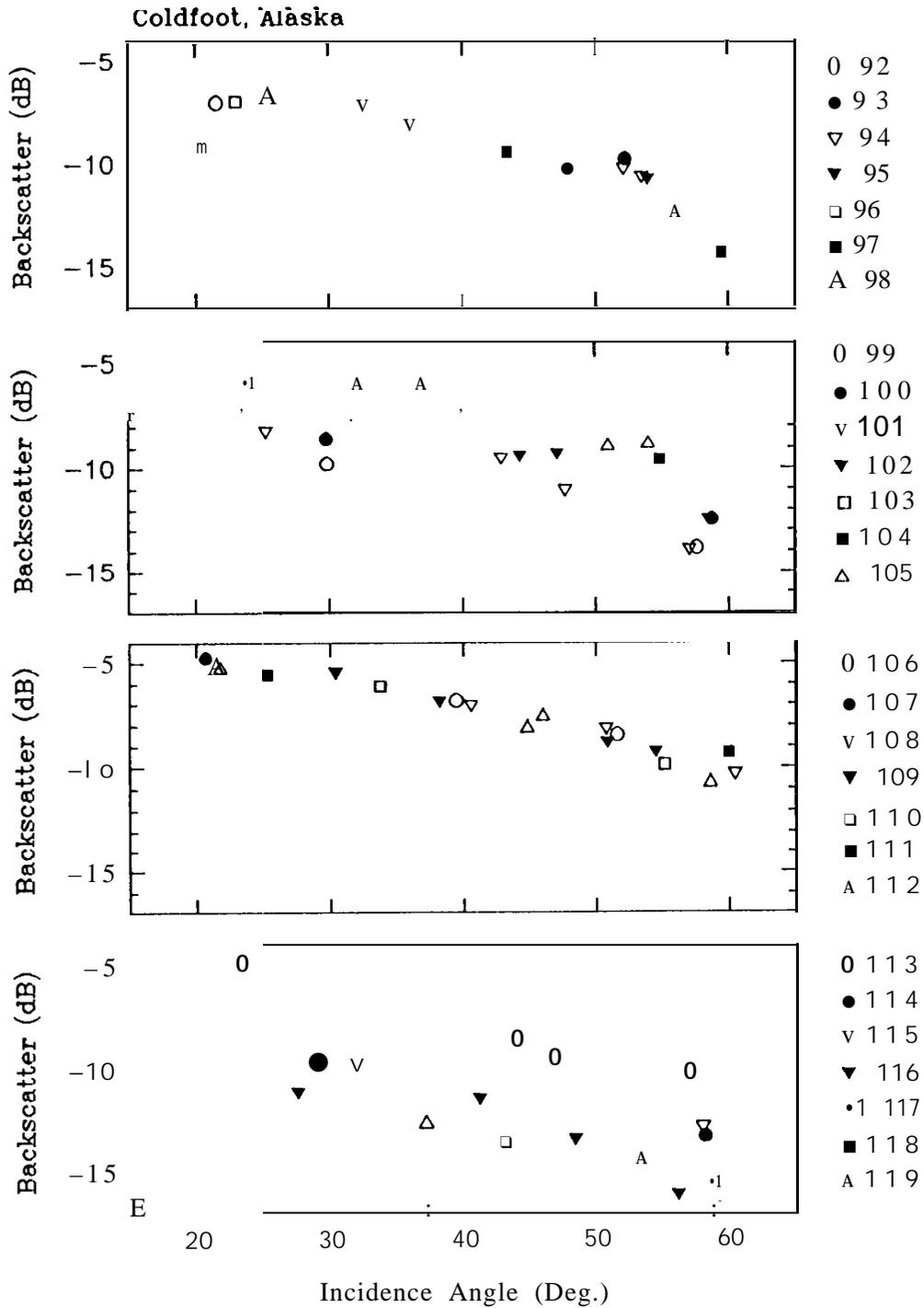


Figure 1: Backscatter vs. incidence angle as observed in the Dietrich Valley during spring thaw.

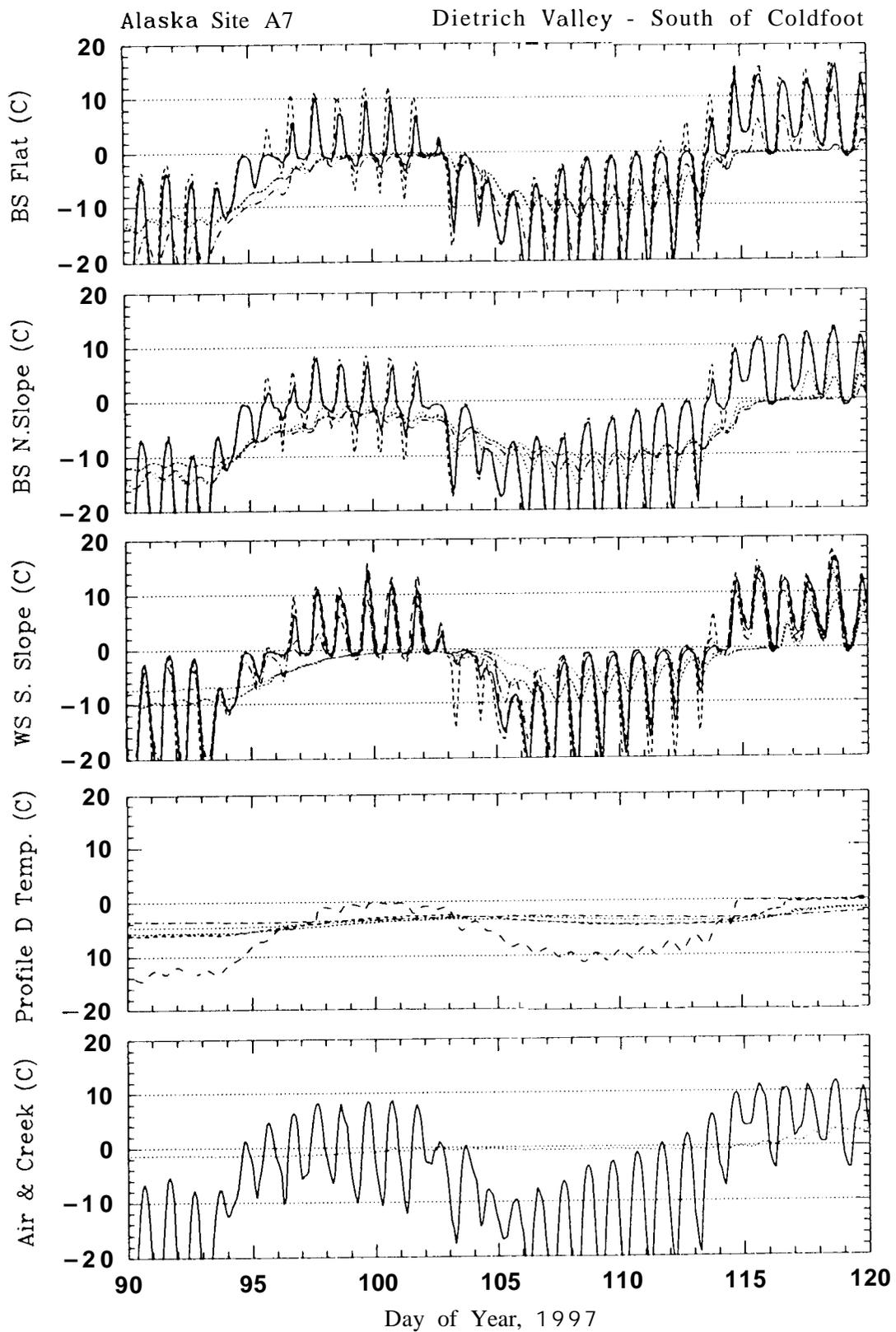


Figure '2: Component temperatures as observed at the Coldfoot ground station in the southern Dietrich Valley during spring thaw.

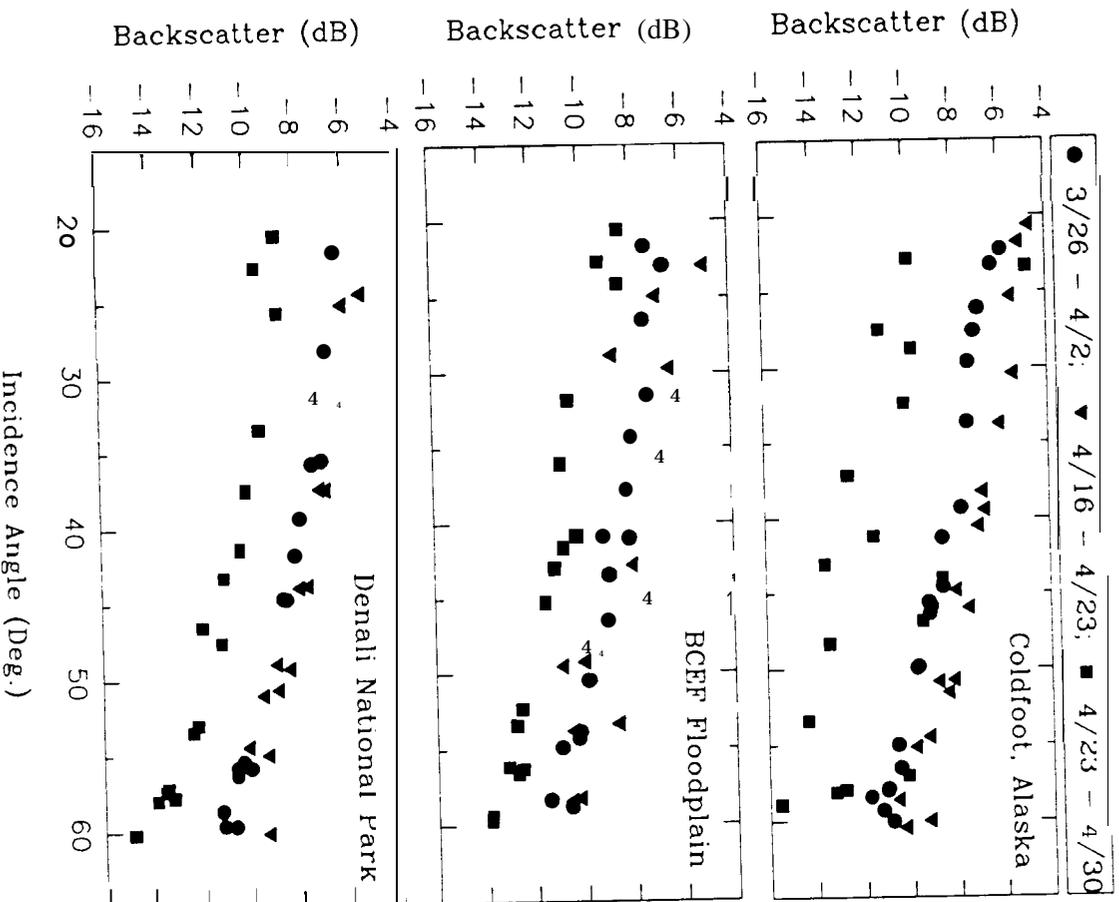


Figure 3: Backscatter vs. incidence angle as observed from March 26 - April 2 (DOY 85 - 92), April 16 - 23 (DOY 106 - 113), and April 23 - 30 (DOY 113 - 120) for (top) the Coldfoot/Dietrich Valley region, (middle) the Bonanza Creek Experimental Forest region, and (bottom) the Denali National Park and Preserve region.