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Maximum Snow Area Density Digital Product

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ABSTRACT

Maximum snow area density (SAD) of stable snow cover in six classes is shown for the Northern Hemisphere. Data are available in digitized form in the NMC grid.

The surface albedo (understood here as a reflective property) of land surfaces with stabilized winter snow cover differs according to: 1) the type, density, and distribution of the vegetational cover; 2) the relief roughness and attitude; and 3) the proportion of water bodies.

It has been shown that the surface brightness of a region covered by about 10 in (25 cm) of snow changes relatively little by additional snow deposition (McGinnis et al., 1975; Petzold, 1977). Time dependent variations in the surface albedo of such a snowfield are largely due to the changing directional and spectral distribution of the incoming radiation (Kukla, 1981), and to the occasional deposition of wet snow or icings in the shrubs and tree canopies. Except for forests in high latitudes or altitudes, such deposits are not frequent. In practice, any given area with a sufficiently deep snow cover will attain, in winter and spring, a characteristic surface albedo which will vary relatively little with time and with meteorologic conditions, as long as the surface air temperatures remain low. We refer to such an albedo as the maximum stabilized snow cover albedo (MASCAL).

Closely related to the maximum albedo is the maximum snow area density (MASAD), measured as the percentage of visible snow within the total analyzed area observed from nadir (see Kukla et al., p. 87 this volume).

The regional MASAD in autumn differs significantly from that in the spring. This is because water bodies freeze over late in the season and are mostly ice free and dark in autumn. On the contrary, they would stay ice and snow covered late in spring even when the snow on surrounding land has dissipated.

Our MASAD reconstruction refers to late winter conditions with all the water bodies frozen and covered by snow. Snow depth is considered to be 10 in (25 cm) or more and the scene is observed about two days after the last snowfall. Snow on ground is partially obscured by vegetation or occasionally absent on steep sloping rock surfaces.

NOAA-VHRR, AVHRR, NOAA-GOES, and DMSP imagery were used in the analysis. An example of a DMSP satellite scene with full winter snow cover is in figure 1. In the few regions where snow depth specifications were not met, we reconstructed the maximum SAD by examining satellite imagery with a thin or missing snow cover, and vegetation atlases. Figure 2 shows the MASAD in the Northern Hemisphere in six classes.

Table 1 gives the median SAD and the estimated mean surface albedo for each charted class. We made a first order estimate of the mean surface reflectivity for each of the six SAD classes by assuming the average reflectivity of snow-free areas as 15 percent and fully snow-covered areas on land as 70 percent. The only exception is class 6 where a reflectivity of 80 percent is assumed over all snow-covered ice surfaces and 75 percent over arctic tundra. The 70 percent value for classes 1-5 takes into account the fact that areas appearing to be 100 percent snow covered actually contain subpixel-size dark objects, such as patches of tall vegetation or protruding rock and soil surfaces.

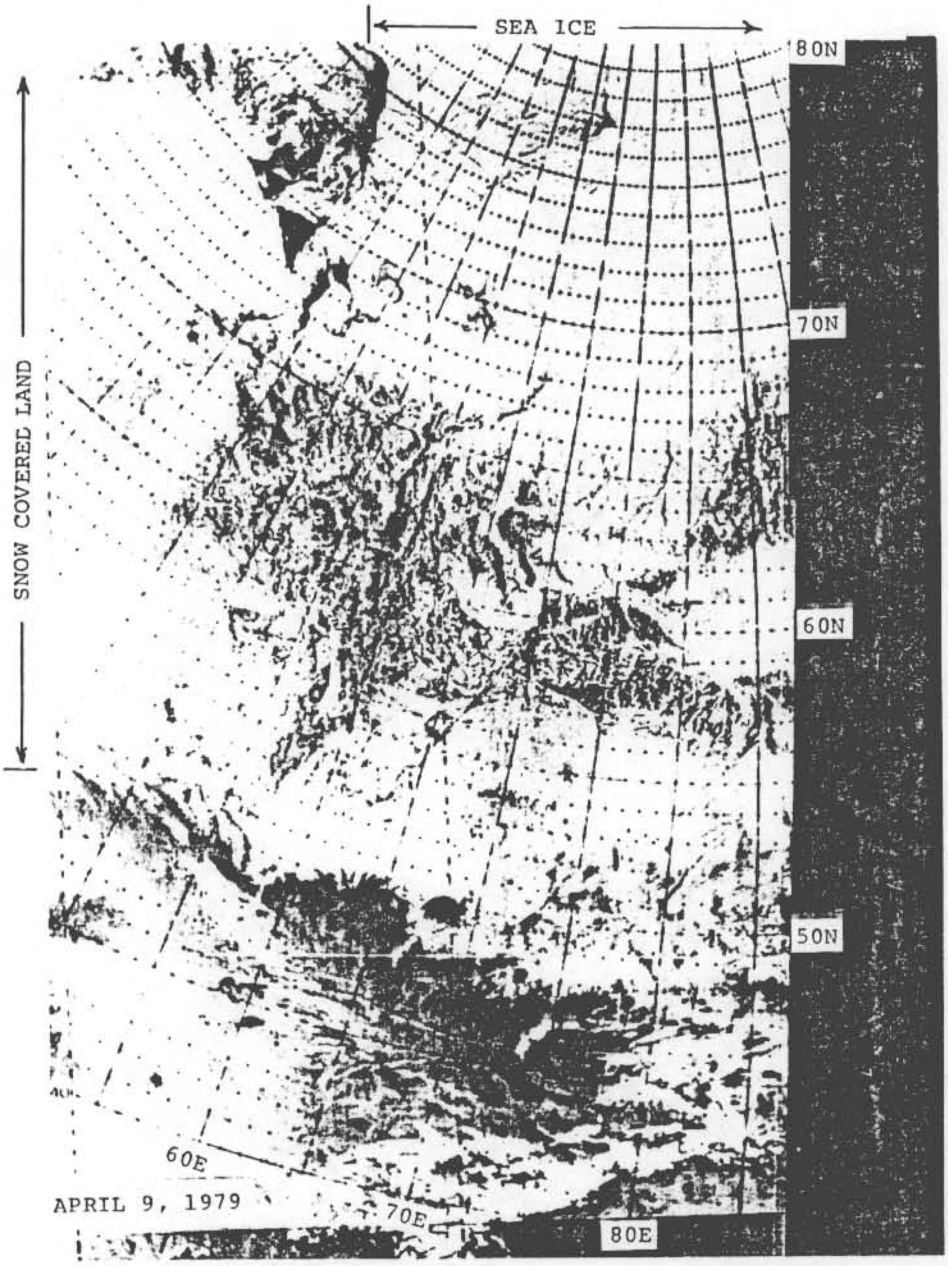

Figure 1. Snow covered section of Eurasia on 9 April 1979 as viewed by the DMSP (Defense Meteorological Satellite Program) satellite. Observe the low albedo of forested zones in the center of the picture.

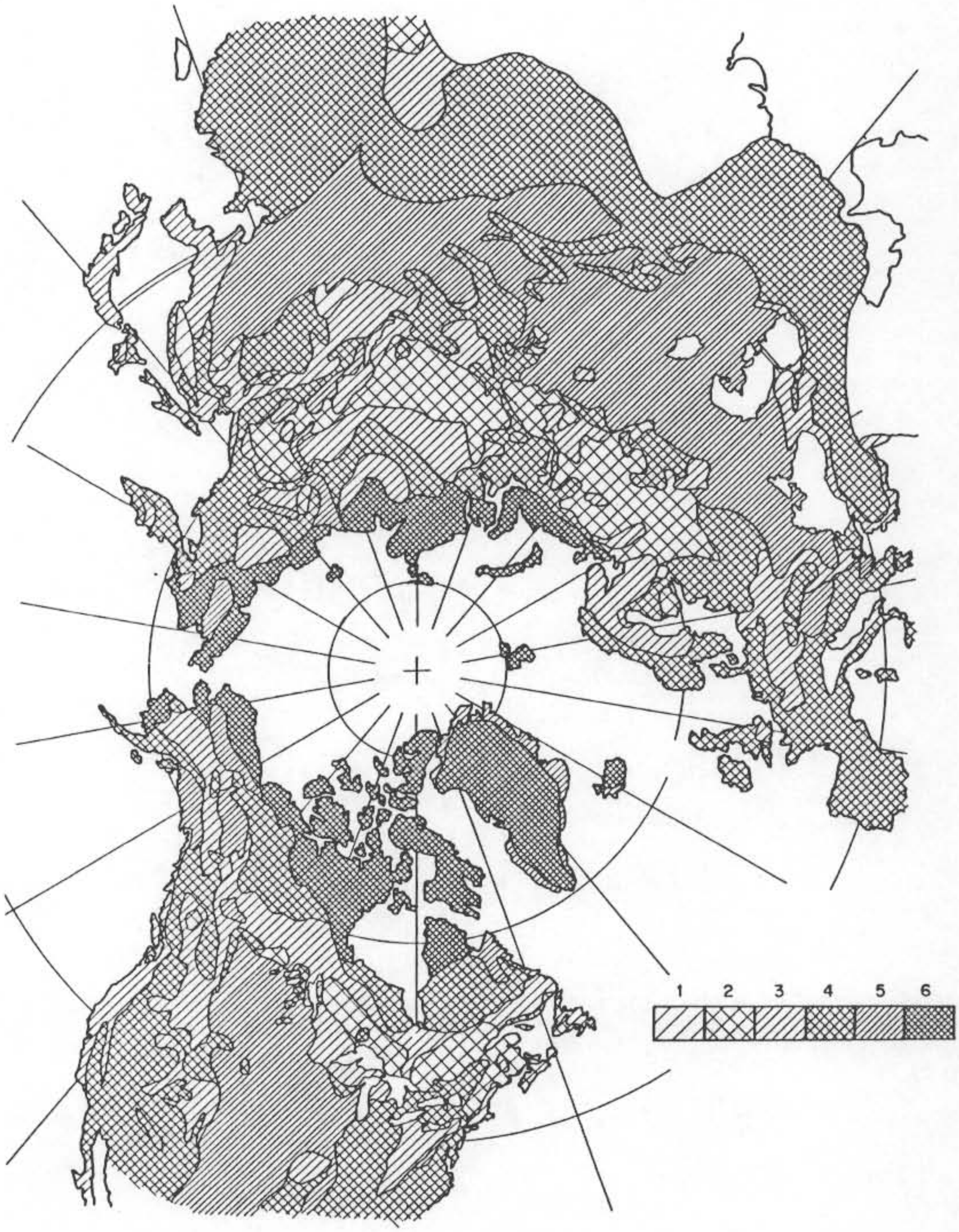

Figure 2. Maximum SAD (Snow Area Density) for portions of the Northern Hemisphere where snow cover can form. Classes are explained in table 1.

The SAD is a relatively objective and reproducible measure. With our newly acquired image processor, we plan to improve the estimates and provide a more accurate correlation with actual surface albedo values.

The digital tables, available at Lamont, present SAD class values for each grid box of a WMO 1/2 mesh grid, the same as used by Matson and Varnadore (p.123 this volume) and Dewey (p.129 this volume). The value for each grid box was determined from figure 2 by visually choosing the dominant class. This was done twice independently, and conflicting results were checked a third time.

At present our chart and tables represent the most complete and realistic assignment of maximum winter surface reflectivity of a mature snow cover on a hemispheric scale. Digitized data can be obtained from the author and can be used in combination with the digital product of Matson and Varnadore (see p.123, this volume) and of Dewey (see p.129, this volume), to assess the impact of the week-to-week variation of the snow cover extent on surface albedo. They also show which parts of the land exhibit the largest albedo change under the snow cover and have therefore, the highest sensitivity to the snow modulation.

Table 1. Maximum snow cover properties.

Class	Snow Area Density (SAD) (Percent)	Estimated Average Reflectivity (Percent)
1	10	21
2	30	32
3	50	43
4	70	54
5	90	65
6	100	80*

*75 over Arctic tundra in high latitudes.

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