Comments on "Comparison of Northern Hemisphere Snow Cover Datasets"

DAVID A. ROBINSON AND GEORGE KUKLA

Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York

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Scialdone and Robock (1987, hereafter SR) are to be commended for continuing and expanding earlier work comparing continental and hemispheric operational snow cover products (Kukla and Robinson, 1979, 1981a,b; Ropelewski, 1984). Snow cover is an important variable of the climate system and may be useful as an indicator of climate change. Therefore, it is important that snow datasets be carefully evaluated and their strengths and limitations well defined prior to utilizing them in climate studies.

Given the transitory nature of snow cover and the wide variety of techniques employed in charting snow, it is not surprising that SR found notable differences between the various operational products they compared. Scialdone and Robock decided to use one of the products, the NOAA/NESDIS (formerly NOAA/NESS) Weekly Snow and Ice Charts as their standard. They concluded that any other product is inaccurate when it fails to agree with the NOAA/NESDIS chart, but provided no independent analysis supporting this assumption.

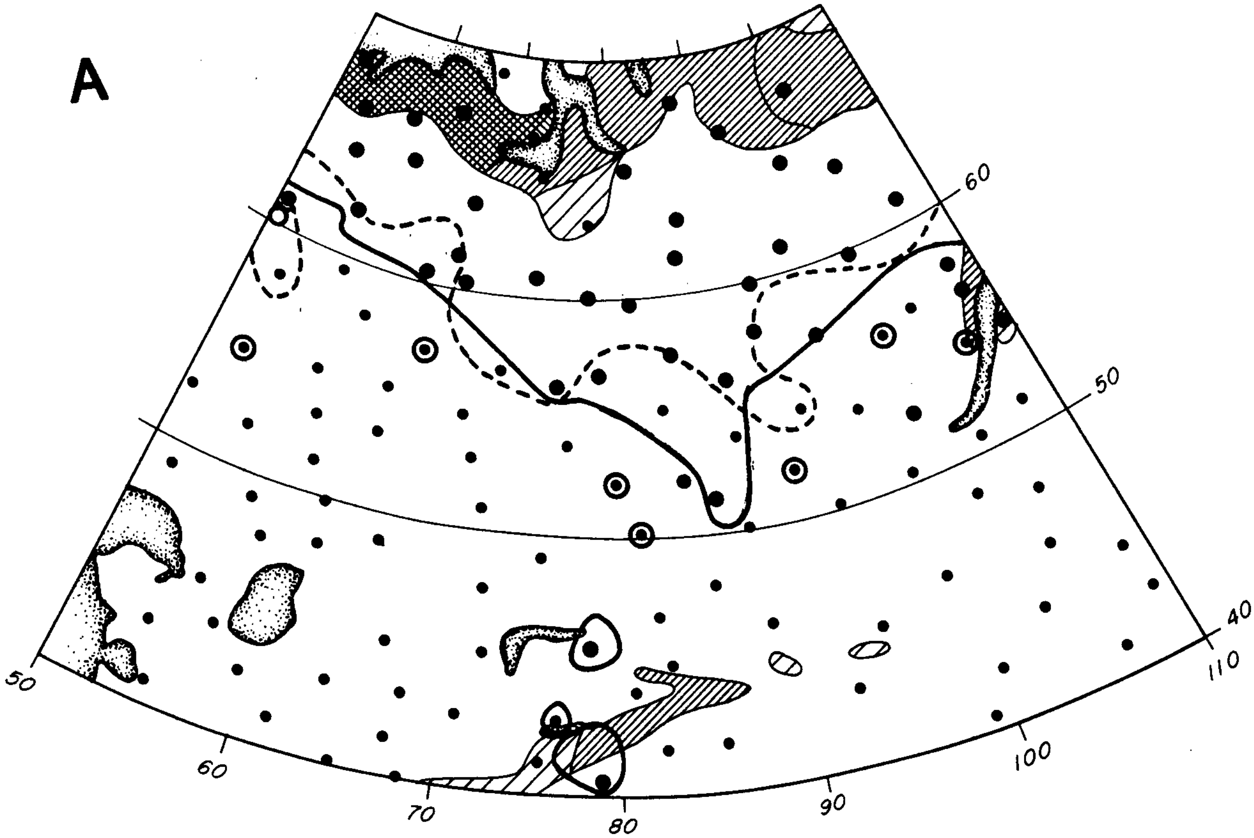
It is not the intention of this comment to judge which product is most accurate. Rather, several examples will be used to help illustrate the positive and negative aspects of two of the operational chart series, the NOAA/NESDIS and Air Force operational charts. The NOAA/NESDIS charts are produced by a manual analysis of visible satellite imagery. The Air Force charts rely primarily on station data as input into a numerical model which employs sophisticated extrapolation procedures and climatology to create charts with global coverage. In two of the examples below, the charts will be compared with retrospective charts derived manually at Lamont from the Defense Meteorological Satellite Program imagery or the NOAA Very High Resolution Radiometer imagery. Synoptic data from NOAA 0000 Northern Hemisphere charts are used in a third example.

Corresponding author address: Dr. David A. Robinson, Lamont-Doherty Geological Observatory, Columbia University, Palisades, NY 10964.

Figure 1 shows the large difference of snow coverage as plotted in central Asia by NOAA/NESDIS and the Air Force in mid-October 1979. It also shows a closer agreement between the Air Force chart and British Meteorology Office charts constructed from WMO station reports than between the British and NOAA charts. Snowfall occurred over much of central Asia on the last two days covered by the NOAA analysis (Fig. 2) (snow also fell there earlier in the week). The falling snow was accumulating, as morning temperatures were below freezing on both days. In this case, persistent clouds prohibited the assessment of ground conditions from satellites. Thus, the Air Force chart provided the most accurate information. This is a common situation near the snow boundary, particularly in autumn.

Snow cover over the southwestern United States in mid-March 1978 as charted by NOAA/NESDIS, the Air Force, and Lamont is shown in Fig. 3. While neither operational chart shows the detail of the Lamont chart, the NOAA coverage more closely resembles the retrospective product. The Air Force inaccuracies appear to stem from an insufficient number of stations or unrepresentative stations in this mountainous region which has a highly variable terrain.

The two operational products were also compared to Lamont charts over northern Canada in April 1984. Reasonably good agreement was found between the charts (Fig. 4), particularly when the areas classified as patchy snow by NOAA and Lamont and having less than two inches of snow by the Air Force were eliminated. The largest differences between the three charts occurred at midmonth (Fig. 4a), where the NOAA chart showed a large area of patchy cover in an area reported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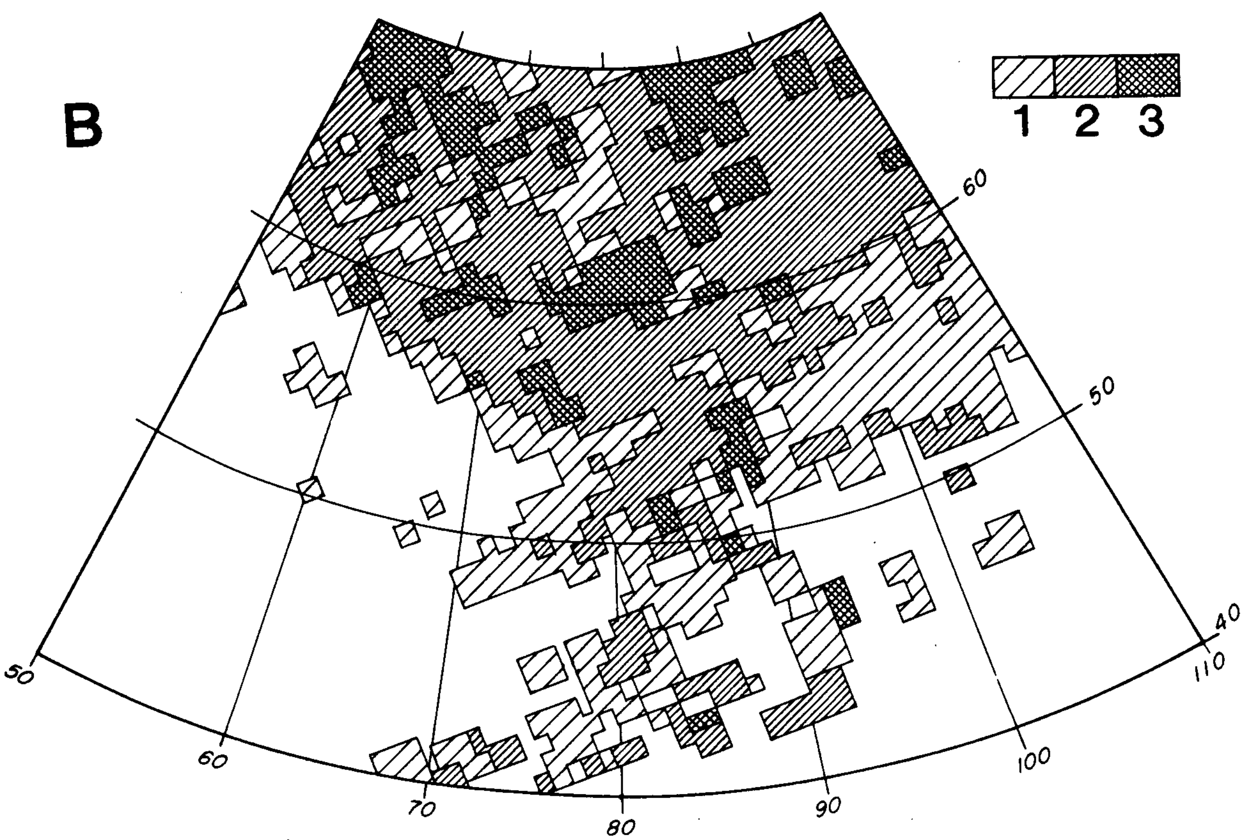
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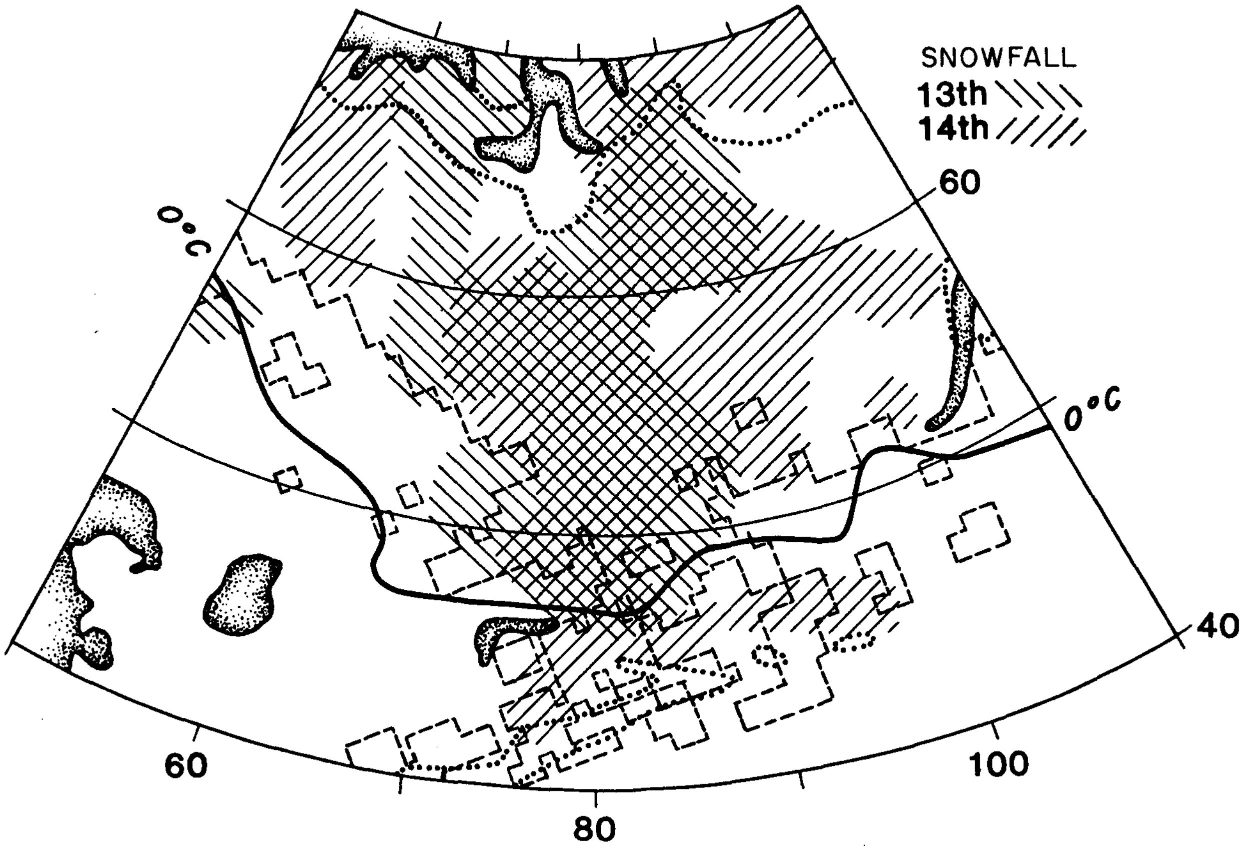

FIG. 2. Areas of snowfall reported by WMO stations at 0000 on 13 and 14 October 1979 are hatched (cf. Fig. 1 for stations used in the analysis). Stations north of the 0°C isotherm had below freezing surface air temperatures on both mornings. The NOAA snow line is dotted, the AF dashed. Lakes are stippled. (From Kukla and Robinson, 1981a).

to have deep snow by the Air Force and having nearly complete snow cover on the Lamont chart. Much of this area was classified as full cover on the subsequent NOAA chart (Fig. 4b). Also during the midmonth interval (Fig. 4a), the Air Force reported snow over 2 inches deep in the southeast portion of the study zone where Lamont and NOAA reported patchy cover. However, in the south central area Lamont and NOAA showed patchy cover where Air Force reported snow-free conditions.

To date, no product is available which accurately monitors the extent (or other characteristics) of snow cover for climate studies on regional scales. This holds true for both the NOAA and Air Force products. There are no grounds at present which justify one as being the best.

What is needed is a global set incorporating all available satellite and ground station information. The necessary input has been available since the late 1960s but the global scale analysis has yet to be done. The incorporation of microwave-derived snow cover products beginning in the late 1970s would further increase the accuracy of the set. However, the microwave data cannot completely substitute for the other data sources,

FIG. 1. Snow cover in central Asia for mid-October 1979 as reported by (a) *NOAA*/NESS and (b) the *Air Force*. NOAA results for the week ending on the 14th show snow field reflectivities from low (class 1) to high (class 3). Air Force results for the 15th show snow depth of <2 inches (class 1), 2 to <6 inches (class 2), and 6 inches or more (class 3). WMO stations reporting snow cover on the 17th are shown with large dots, those reporting no snow on the ground are shown with open circles. The area with snow cover of >2 cm on 12 October is north of the dashed line, on the 17th north of the solid line (from British Meteorological Office charts). These and the remaining WMO stations (small dots) provided data used in Fig. 2 (from Kukla and Robinson, 1981a).

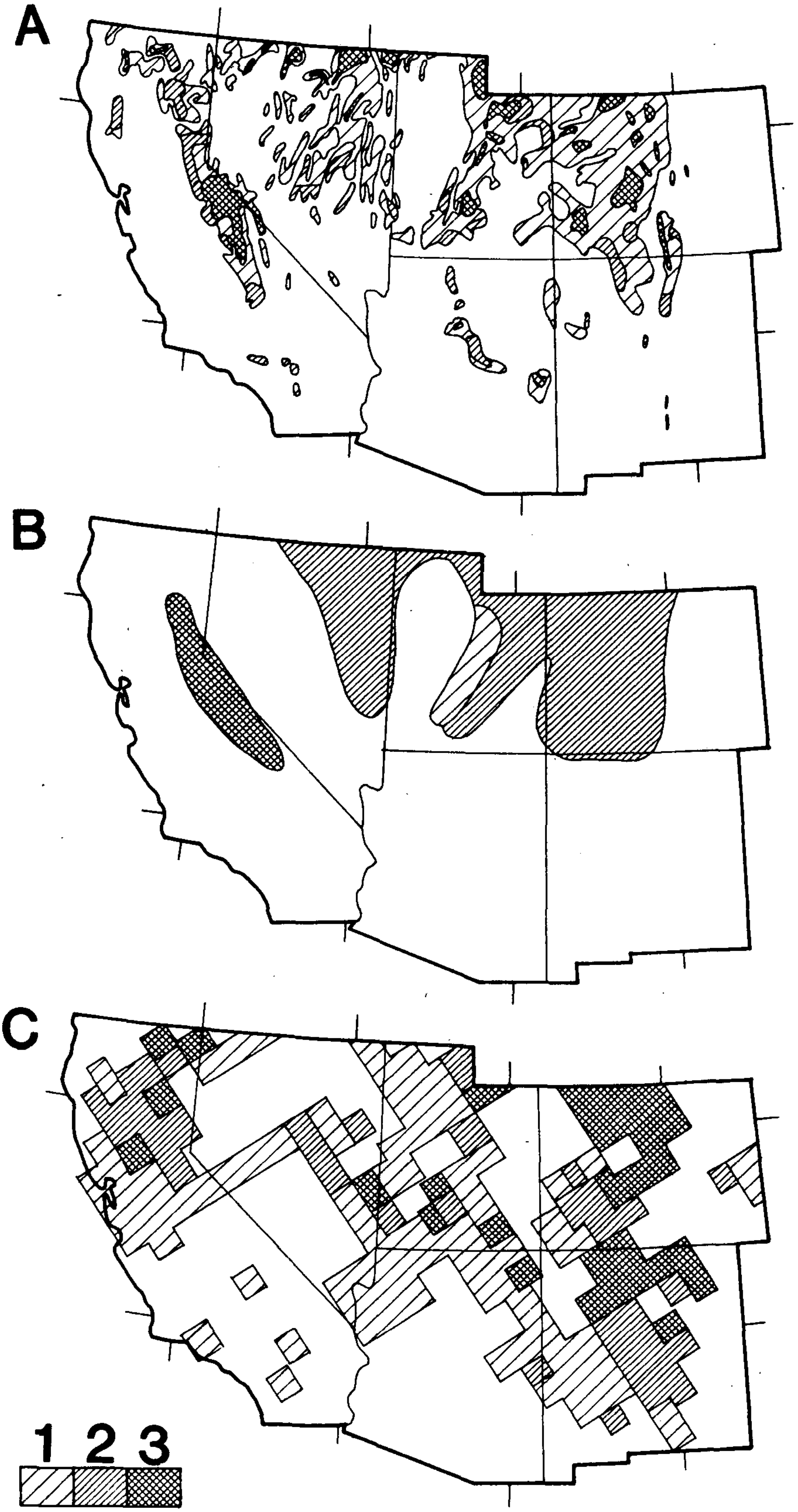

FIG. 3. Snow cover in the southwest United States in mid-March 1978 as charted (a) on the 16th by *Lam*ont, (b) for the week of the 13th to 19th by NOAA, and (c) on the 20th by AF. Reflectivity and depth classes are the same as in Fig. 1 for the operational products and the same as NOAA for the Lam product (after Kukla and Robinson, 1981a).

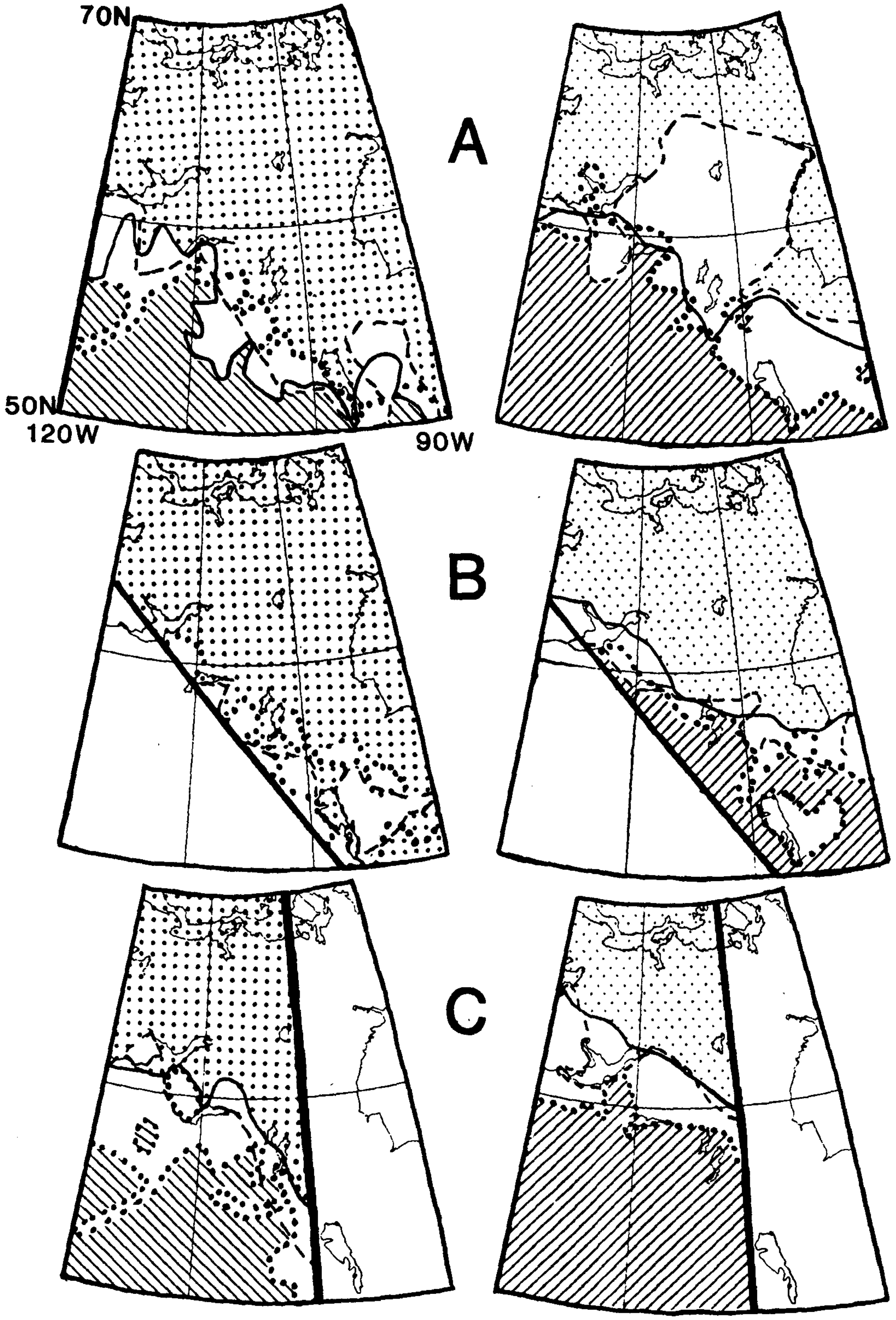

FIG. 4. Snow boundaries over central Canada in April 1984 according to Lam (solid line), NOAA (dashed line) and AF (dotted line) products. Charts on the left show the boundaries between full or patchy snow cover and snow-free ground according to NOAA and Lam and between areas with a trace or more cover and snow-free ground according to AF. Charts on the right show the boundaries between full snow cover and patchy or no snow cover according to NOAA and Lam and between areas with 2 inches or more snow cover and those with less than 2 inches or no snow cover according to AF. Stippled areas on the charts to the left show where all products agree that snow cover is present, whether it be full or patchy, and hatched areas show where all agree the surface is snow free. Stippled areas on the charts to the right show where all products agree that full snow cover is present and hatched areas show where all agree full snow cover is not present. Charts at the top (a) are for 14–16 April (Lam), 9–15 (NOAA), 16 (AF); (b) for 22–24 (Lam), 16–22 (NOAA), 23 (AF); (c) for 28–30 (Lam), 23–29 (NOAA), 30 (AF).

particularly where snow cover is in a transitional state (Robinson et al., 1984). As suggested by SR, such a methodology should be followed in charting snow cover in years to come.

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