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6A.7 TRANSITION FROM NOAA WEEKLY TO DAILY HEMISPHERIC SNOW CHARTS

David A. Robinson*
Rutgers University, Piscataway, New Jersey

J. Dan Tarpley and Bruce H. Ramsay
NOAA/NESDIS, Camp Springs, Maryland

1. INTRODUCTION

In 1997, the National Environmental Satellite, Data, and Information Service (NESDIS) of the National Oceanic and Atmospheric Administration (NOAA) began production of a daily Interactive Multisensor Snow and Ice Mapping System (IMS). This product is being implemented to provide a daily Northern Hemisphere snowmap for use in specifying the surface boundary conditions in numerical weather forecast models run by the National Weather Service's National Center for Environmental Prediction (NCEP). In May 1999 the daily IMS snowmaps will replace a weekly snowmap that NESDIS has been producing since 1966. Both the old weekly snow cover maps and the new IMS product are produced manually, but the IMS makes use of a wider variety of satellite data and uses different mapping technology. The climate community has expressed concern that the new multisensor product will cause a discontinuity in the long-term record. It is critical that NESDIS produce both the weekly and daily snowmaps simultaneously for some interval and that a detailed validation of both products be done. It is also very important that a comparison between the two snowmaps be undertaken to determine what differences occur between the products and why and under what circumstances the discrepancies occur.

NESDIS management agreed to generate both the weekly and daily snowmaps for two complete Northern Hemisphere snow seasons (1997/98 and 1998/99). Funding for a validation effort is being provided to the authors through the NASA/NOAA Enhanced Data Sets for Analysis and Applications Program. Here we report on both the weekly and daily products and initial results of the validation effort for the 1997/98 snow season.

*Corresponding author address: David A. Robinson, Rutgers University, Department of Geography, Piscataway, NJ 08854; e-mail: drobins@rci.rutgers.edu

2. SNOW CHARTS

Trained meteorologists produce the weekly NESDIS snow product from visual analyses of visible satellite imagery. It is the longest satellite-derived environmental data set available and plays an important role in the monitoring of climate variability and change (Matson and Wiesnet, 1981; Matson et al., 1986; Robinson et al., 1993). The primary data source is visible imagery acquired from NOAA-n polar orbiting satellites and is stored in hardcopy. Secondary data sources include online GOES, GMS, and METEOSAT imagery. Snow cover identification is made by the manual inspection of hardcopy imagery and graphics products, online imagery loops, and the previous week's analysis. Map quality is predicated on the availability of clear sky visible imagery and the meteorologist's experience. After all snow boundaries have been identified and placed on a hardcopy map an electronic version is made through the digitization of a 89 x 89 cell acetate overlay of the polar stereographic map.

The IMS product is generated from a UNIX-based workstation application that provides the analyst the ability to visually inspect imagery and mapped data from various sources to determine the presence of snow over Northern Hemisphere lands. Daily snow maps are produced from a variety of visible satellite imagery, estimates of snow extent derived from microwave satellite data, and station mapped products. These maps went into routine production in February 1997 and this product was declared operational in November 1997. NCEP evaluated the daily snowmap and began using it operationally in the NCEP ETA model in June 1998.

The IMS methodology continued to evolve during the first comparative season, with the incorporation of station and microwave data not

complete throughout the entire season. This will eventually be addressed when comparing first and second season results. Separate analysts prepared the weekly and daily maps independently; thus much can still be learned from a comparison of the two products produced during the first year of this investigation. Also, it is important to note that weekly charts are produced by starting with a blank map and working backward in time, filling in regional conditions (snow or no snow) where clear skies are found. Daily charts build forward; adjusting yesterday's chart based on an evaluation of data received on the chart day.

3. IMS VERSUS WEEKLY COMPARISONS

The basic IMS snow cover map is produced as a 1024 x 1024 cell polar stereographic map with a resolution of approximately 18 kilometers at 60°N. To compare the snow cover in the IMS maps with the NESDIS weekly product, the IMS maps were reduced in resolution by methods that closely approximate the digitization procedure in the weekly maps. The 89 x 89 weekly maps and the 1024 x 1024 daily maps are both oriented such that the principal meridian is 80°W and that each cell in the 89 x 89 map is exactly coincident with an 8 x 8 cell array of the 1024 IMS map. Then IMS maps are aggregated to match the 89 x 89 grid using the same rules that the snow analysts use to digitize the handdrawn weekly maps: if 50% or more of the 64 cells in the part of the IMS map that corresponds to a single cell in the 89 x 89 map show snow, then the reduced resolution cell in the aggregated IMS map is called snow covered. This reduced resolution IMS product is the basis of comparison with the NESDIS weekly snow cover map.

NESDIS weekly and IMS daily maps for mid March 1998 are shown in figure 1. The IMS map is shown at its full 1024 x 1024 resolution. Both maps were produced on March 23, however the long-standing convention has been to label the weekly map for the previous seven days (March 16-22), as imagery used to construct these maps comes mainly from this period, although map-day imagery processed by analysis time is used. The IMS map is dated for the day it is produced, although imagery from approximately the past 36 hours is examined. Ground station input is from 1200Z observations on the 23rd, making it early morning on this date for Western Hemisphere sites.

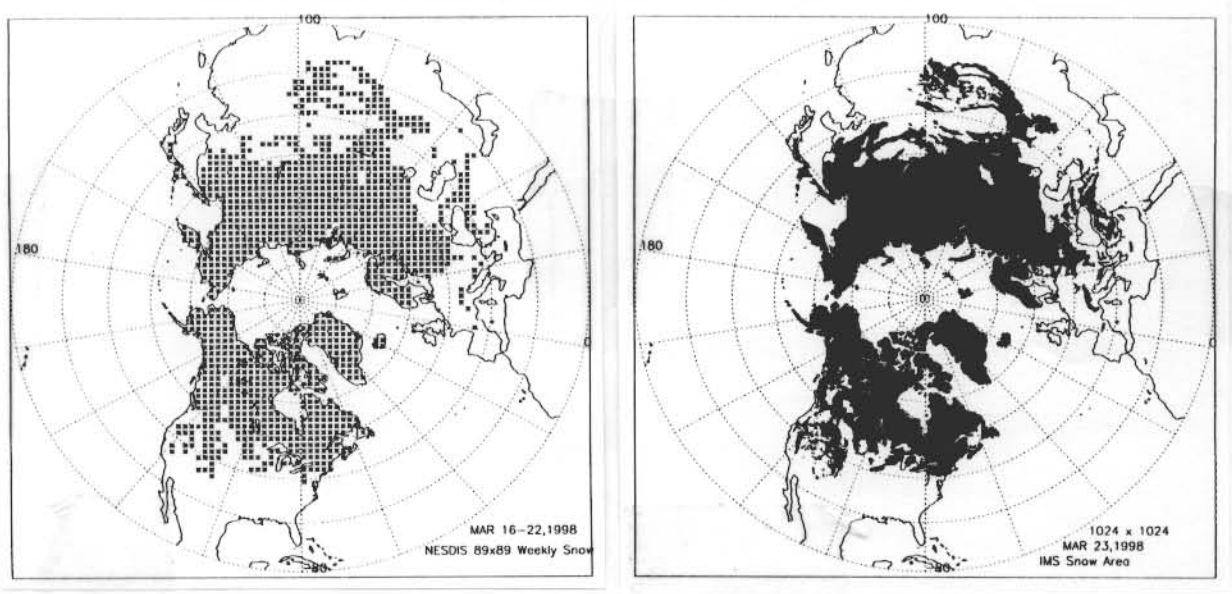

Figure 1. Weekly Snowmap for March 16-22, 1998 (left), and IMS Daily Snowmap for March 23, 1998 (right).

The spatial distribution of snow is similar on both March maps in figure 1. The weekly product indicates a hemispheric coverage of 41.4 million square kilometers and the IMS map (calculated using the reduced resolution procedure described previously) shows 39.7 million sq. km. of cover. Visual inspection of the two charts reveals little difference between them; yet the approximately 4% difference in cover needs to be understood if a successful merging of the two temporal series is to be achieved.

Throughout the first study season, comparisons between the two products were encouraging (figure 2). Note that only one daily map per week, the one falling on the day in which the weekly map is constructed is used in the comparisons. According to the IMS maps, the average snow extent for the 38-week season was 19.0 million sq. km. over Eurasia, only 0.2 million sq. km. less than the average of the weekly maps. IMS seasonally-averaged North American cover of 12.6 million sq. km. was 0.1 million sq. km. less than the weekly product. Over North America, the IMS tended to show more snow than the weekly maps through mid winter (14 of the first 16 weeks). For the remainder of the season the weekly maps consistently showed more snow than the IMS (20 of 22 weeks). The reason for this remains uncertain, but will be examined closely once adequate station data are available. Such was not the case over Eurasia, where 12 IMS maps showing more snow than the weekly ones were scattered throughout the season. Compared to the long-term mean, departures for each product had the same sign in all but 7 of the 38 weeks.

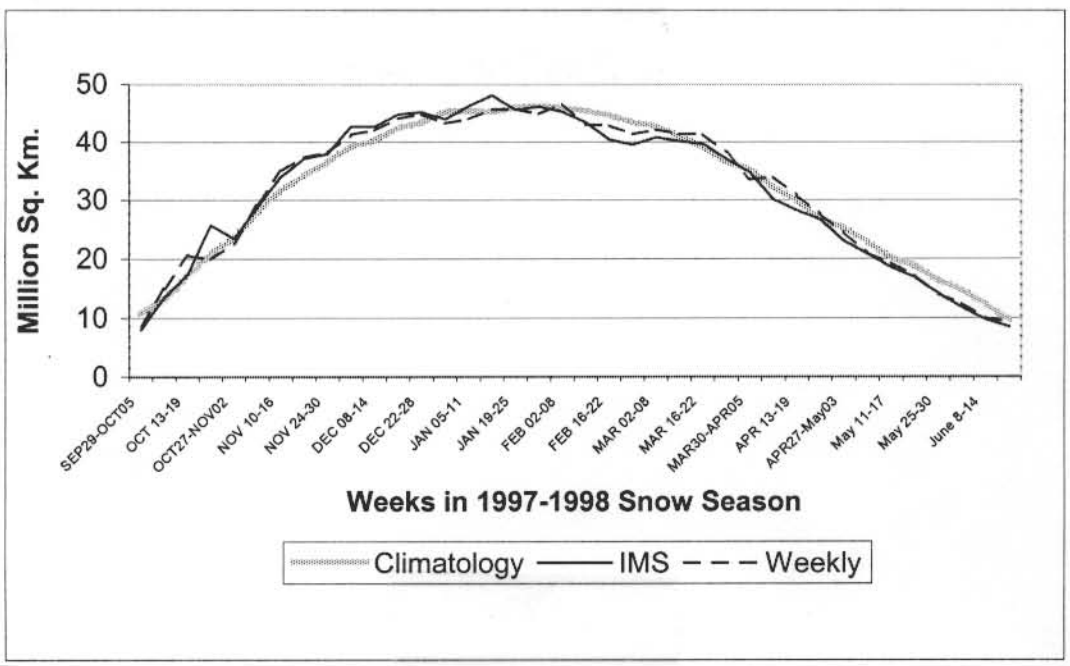

Figure 2. Extent of Northern Hemisphere snow cover according to NESDIS Weekly and IMS snowmaps for the 1997-1998 snow season. The weekly climatology for 1973 through 1996 is also plotted.

4. ONGOING COMPARISONS

Throughout the 1997/98 snow season, daily data from approximately 1500 stations in Eurasia, primarily in Russia, were acquired from the Russian Hydrometeorological Service (Roshydromet) for comparison with the IMS and weekly maps. The large majority of these stations are not part of the Global Telecommunications System (GTS) network (GTS stations are used in the generation of the IMS charts), thus are an independent source of information for comparative

investigations. A preliminary analysis shows a strong agreement between these station observations and both snow products. Data from Canadian and U.S. networks are also being gathered, which will permit an analysis of the early-late season difference in extent. In addition to using independent station observations, differences between the IMS and weekly maps will be investigated using information on land cover type, elevation, and other land characteristics that may influence the products.

5. CONCLUSIONS

Initial results comparing the NESDIS Weekly and daily IMS snow maps suggest that a transition from the former to latter product will not lead to a major artificial step change in the estimate of snow extent over Northern Hemisphere lands. However, more rigorous statistical analyses remain to be performed, both on the first year's coincident maps discussed in this manuscript and those being produced during the 1998/99 snow season. With the completion of these efforts, we anticipate that any differences between the two products will be well understood, thus permitting confident interpretation of future characteristics of the multi-decadal hemispheric snow time series.

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