Progress report to the Climate Change Data and Detection Element's Applied Research Center, National Oceanic and Atmospheric Administration

CONTINUED MONITORING OF GLOBAL SNOW COVER EXTENT AND DEPTH

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Recent activities

The Rutgers University Global Snow Lab (GSL) remains actively involved in developing databases of snow extent and depth, and distributing snow products to customers in public, academic and private research and applied communities. Monthly and annually, we also contribute analyses of hemispheric snow extent to national and international assessments. To serve all interested parties, GSL activities include the acquisition, quality control, archiving and dissemination of snow coverage on regional to continental scales. The ongoing focus is on maintaining the long-term daily (formerly weekly) NOAA Interactive Multisensor Snow and Ice Mapping System (IMS) data set of snow maps produced by NOAA. In addition, microwave maps of snow cover extent and depth, and station snow depth observations from US and Canadian sources continue to be developed and updated. In association with this ARC effort, and several GSL endeavors funded by NOAA and NASA, we continue to develop climate data records of continental snow, in addition to snow melt atop Arctic sea ice and the Greenland ice sheet.

We are pleased to report that following multiple years of effort, in part under NOAA ARC support, we have completed a reanalysis of the NOAA satellite-derived snow cover extent product that dates back to late 1966. This product has long been used in international assessments of climate variability and change, and in investigations regarding the role of snow cover in the climate system. Despite their proven climate utility, meteorological forecasting has been the driving force behind producing these maps. As such, changes (documented and undocumented) in mapping methodologies have occurred over time without a focus on their climatological continuity. Members of our team have kept a watchful eye on changes in this satellite environmental data record (EDR). From this EDR, we have developed a satellite snow cover extent (SCE) climate data record (CDR).

Among the mapping changes that had to be accounted for, with adjustments made when necessary, was a category called “patchy” cover, which was often charted during the 1970s and early 1980s. We determined that such areas had insufficient snow cover to be digitized as such, thus these cells were eliminated from the weekly maps. Another major

change occurred in the late 1990s, when following a two-year test overlap period, the coarse weekly product was officially replaced with the daily IMS 24 km resolution product. Comparing the 1966-99 climatology and 1999-08 IMS climatology found mismatched cells in each month. So, too, were mismatched cells found during a weekly and proto-IMS dual mapping period from 1997-1999. Where such cells were found for both tests, they were removed or added from weekly maps from the 1966-99 era, to agree with IMS era mapping. The resultant "fine tuning" of SCE primarily addressed the IMS conversion to weekly and inconsistencies in mountainous regions (such as the Himalayas) during specific months of the year. More information and publications regarding these changes are forthcoming. Figure 1 shows a comparison of annual snow extent means between the former EDR and new CDR products. The latter depicts less snow extent. This is a function of the removal of earlier patchy cells and especially the reduction of extents over mountainous areas, where clearly the early, coarser product depicted too much cover. To only a small extent do these adjustments influence previously published assessments of continental snow extent variability and change (figure 2).

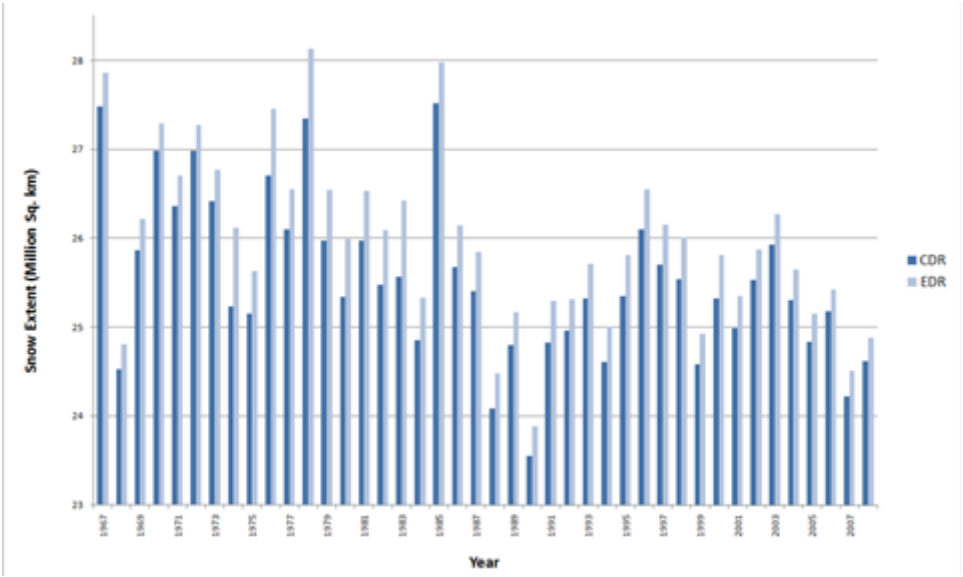

Figure 1. Annual Northern Hemisphere snow extent generated from the NOAA weekly environmental data record and the new NOAA weekly climate data record.

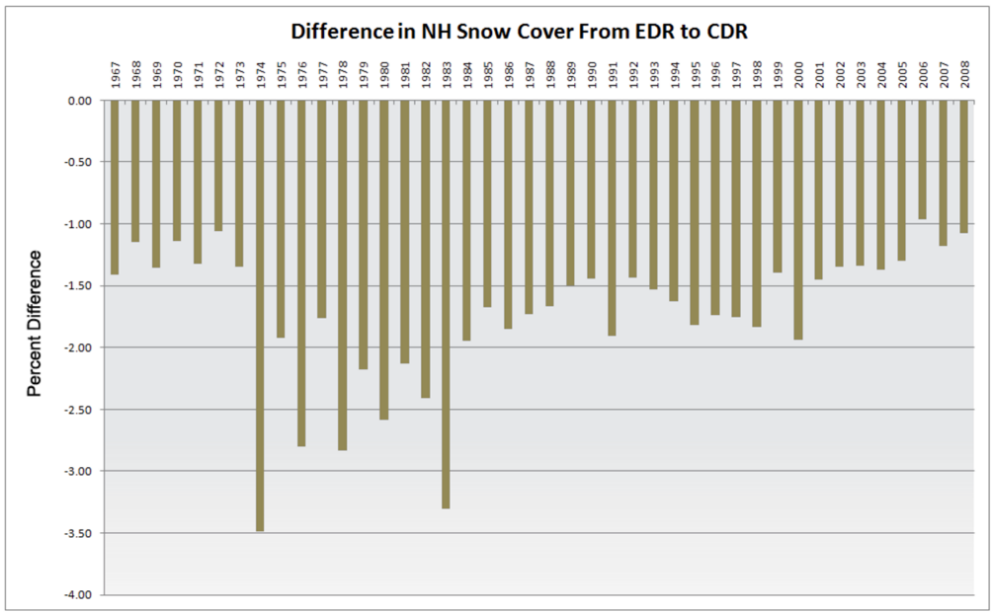

Figure 2. Annual differences in Northern Hemisphere snow extent generated from the NOAA weekly environmental data record and the new NOAA weekly climate data record. Negative values indicate the CDR depicting less SCE than the EDR.

Customers

An international array of individuals maintains an interest in GSL databases and derived information. For the vast majority, a visit to our website (http://climate.rutgers.edu/snowcover) suffices to meet their needs. The site includes daily, monthly, seasonal and annual information on snow extent and departures in map and tabular formats. With the exception of the daily anomaly maps, all web site information has been recomputed using the new CDR. The daily project will be completely shortly.

We are pleased to report that in 2009, 23,594 individuals visited the site at least once (2008 saw 15,595 visits). Visitors clearly found the site useful, as there were 14,128 returning visitors over the course of the year (11,791 in 2008). January 2009 saw a 92% increase in visits over 2008, while December 2009 was second with a 71% increase over 2008. As also seen in 2008, visits in 2009 came from 102 countries, with the top ten from greatest to least including the U.S., Russia, United Kingdom, Netherlands, Italy, Sweden, Canada, France, Spain, Germany (same as in 2008). 51% of the visitors came directly to the site, 36% arrived from a referring site, indicating a number of other websites contain a link to our site. The remaining 14% found the site through search engines.

For those seeking further information concerning the data or wishing to obtain all or portions of the gridded databases, individual consultations occur via phone or email and data. Most often these involve making all or portions of a database, including metadata,

available for the customer to download. Follow up interactions often occur. In 2009, the GSL provided data to 39 entities (compared to 27 in 2008), which in addition to encompassing groups at US and international universities and federal research labs included such interesting entities as the Office of the Chief Economist of the US Department of Commerce, USA Today and National Geographic. All of these special data requests were in addition to data supplied regularly to the National Snow and Ice Data Center (NSIDC). NSIDC fills numerous requests for the Rutgers GSL-enhanced NOAA product and data products. It is also worth noting that quite often we are contacted for snow products that either aren't available or are inappropriate for the potential user's needs. For instance, the NOAA gridded database is not of a sufficiently high resolution or consistency for time series studies of individual mountain ranges.

Finally, we have had another successful year of providing timely monthly reports to NCDC colleagues. This includes information on recent conditions and placing them in historic perspective for use in NCDC monthly assessments.

Transition prospects

With the completion of the CDR upgrade, the door now opens to further advance the development of a more automated method of generating monthly, seasonal, annual and longer temporal products. Currently we gather the daily IMS product, post it in a resolution similar to the historic weekly maps and generate a daily anomaly map. A recent anomaly map shows quite a low SCE April over North America, but certainly not in east Asia.

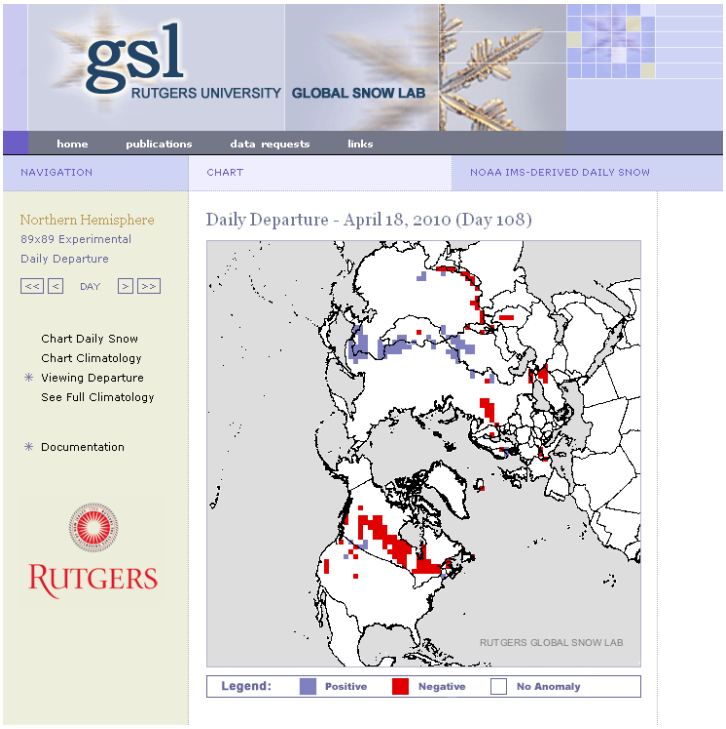

Figure 3. Daily departure of SCE on April 18, 2010.

The next year will bring substantial progress as we begin to generate the longer-term automated products. There will be a number of steps to this process, but this certainly can be accomplished. We would like to give this system the flexibility to generate a running monthly analysis of sorts, or at least be able to on demand generate a monthly analysis before the "standard" map arrives at the end of each month. Our method for generating monthly maps and statistics requires the first Monday IMS map following the end of the previous month (this to keep the monthly product in line with pre-IMS (pre-1999) analyses). So for instance for the March 2010 map we needed to wait until the Monday April 5 map arrived to generate the March figures. However, knowing how late this would be for NCDC's monthly assessment, we took a day the previous week and "made" it the April 5 map. These results were sent to NCDC on April 1. The updated analysis was sent on the 6th.

We will also develop means of accessing all or portions of the gridded satellite and station databases. This will involve upgrading the metadata files, as we are concerned that fully-automated access to the gridded data may result in it being misused unless the customer is well versed in database details, including limitations. The GSL-processed NOAA product continues to be provided to the National Snow and Ice Data Center in Boulder, CO. We plan to eventually make the daily gridded station-derived US-Canadian database available to NSIDC. This includes 1°x1° data of snowfall, snow on ground, maximum and minimum temperatures and precipitation in "drop in the bucket" and interpolated formats.

Proposed funding

Requested ARC funding for the Rutgers Global Snow Lab over the next funding year is approximately that of the current year, or just under $50,000. One half of a summer salary month is requested for PI Robinson. Research associate Thomas Estilow will spend approximately four months on the project. Tom has a master's degree in Geography, is the GSL's webmaster, possesses ArcGIS knowledge, and is familiar with the station databases. Travel to ARC team meetings and/or professional conferences is also included.

Ancillary thoughts

Unlike the previous year, our 2010 funding did not include a supplement for our snow storm ranking efforts that have been underway with NCDC for the past several years. This did not interfere with the GSL continuing to cooperate on this effort, as we had some funds remaining from the previous year and our effort was not as substantial as it had been earlier. However, it would be appreciated if ongoing renewals of ARC support consider some level of support for the snow ranking efforts as support for our snow cover extent efforts diminishes due to increased automation. We hope that future efforts with the storm ranking will involve the GSL with operational quality control of snow observations and/or with an end-of-season reanalysis effort. Finally, with the onset of the operational snow storm effort, there is strong potential of not only extracting daily snowfall observations from operational daily feeds but also, snow depth reports. This would permit us to produce daily, weekly, monthly and seasonal evaluations of snow

depth to compliment our SCE and storm ranking efforts. Focus would be on the United States, however there would be some potential to expand this to Canada and Eurasia.