Observations of Arctic Environmental Change

S. V. Nghiem

Jet Propulsion Laboratory, California Institute of Technology
MS 300-235, 4800 Oak Grove Drive, Pasadena, CA 91109
Phone: 818-354-2982, Fax: 818-393-3077
E-mail: Son.V.Nghiem@jpl.nasa.gov

Abstract- **This overview paper presents recent observations of anomalous change in Arctic environment using satellite scatterometer data together with in-situ and field measurements over land, snow, sea ice, and Greenland ice sheet.**

I. Introduction

Significant change in the Arctic environment has been observed in the past decade. The change, some was drastic, occurs on land, lakes, ocean, and atmosphere as recently reported in the first Study of Environmental Arctic CHange (SEARCH) Open Science meeting (Seattle, 2003). This paper presents an overview of anomalous change observed by satellite scatterometer together with in-situ and field measurements over the Arctic.

II. Arctic Change Observations

Although new compared to other satellite datasets, global backscatter data have been collected by the SeaWinds scatterometer on the QuikSCAT Satellite about half of a decade since its launch in 1999. Nevertheless, this dataset is timely because various anomalies have occurred in the Arctic environment in the past few years [1-3].

In 2002 and again 2003, sea ice extent shows a record minimum. The diminishing ice condition coincided with prolonged summertime preceding the ice seasons. Observations at Chuckchi Station and at C-ICE Station (Parry Channel) consistently reveal the longest melting season in 2002 followed by the shortest freezing season since the beginning of the QuikSCAT dataset. Furthermore, the summertime in 2003 was even longer there. We also present the ice extent observation for summer 2004 from the latest data to assess the impact of the prolonged summertime. Sea ice mapping products obtained from scatterometer data over the Arctic indicate a significant reduction of multi-year sea ice in Beaufort Sea at freeze-up time in 2002 and 2003, and reduction of first-year ice in East Arctic during winter 2002 and 2003. Surface-melt area over the Greenland ice sheet set a record maximum in 2002 and melt duration was excessively prolonged in 2003 even in northern regions of Greenland. At the GC-Net NASA-SE Station, both in-situ and satellite scatterometer data record reveal an anomalous snow accumulation that was doubled compared to that of previous years. Snow accumulation mapping with QuikSCAT data in the percolation zone of the Greenland ice sheet shows an extensive surface area in southeastern Greenland where snow accumulation was doubled in the 2002-2003 season compared to other years.

Decadal meteorological data sets indicate an increase in the amount of precipitation in winter season, increase in spring air temperature, and adverse shifting of snowmelt onset dates. Long-term river-monitoring data reveal an increase in the annual discharge of fresh water from the six largest Eurasian rivers to the Arctic Ocean. In particular, the Lena River region, a very important region for Russian diamond mining industry, suffered catastrophic floods in recent years (1998, 1999, and 2001), and the 2001 flood was the worst in 100 years. Snowmelt days derived from scatterometer data show the anomalously rapid melt in 2001 leading to the Lena Flood of the Century. With interannual results, our analysis shows a distinctive relationship between the number of snowmelt days and flood severity. Furthermore, areal percentage reduction in daily snow coverage during the snowmelt process indicates that such data can potentially be used to predict flooding conditions. This is because changes in snow reduction or snowmelt rate can be observed, thanks to the pan-Arctic coverage with the high temporal resolution of the satellite scatterometer, in advance of subsequent flood events caused by snowmelt.

At higher latitude, scatterometer data records show recent anomalous change in the timing of snow season and exposed-land duration. For example, scatterometer data together with in-situ temperature measurements at the Atlas Station in Ivotuk, Alaska, show that the 2002 summertime was about a month longer and followed by a significantly shorter snow season. However, this change was not observed at the Olenek Station in Siberia. These different conditions indicate that the Arctic environment has suffers recent drastic changes that are complex and varied over various regions. Observing such Arctic environmental change demands continuous satellite observations over large scales.

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References

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