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GLACIOLOGICAL DATA

WORKSHOP ON SNOW COVER AND SEA ICE DATA

World Data Center A
for
Glaciology
[Snow and Ice]

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Inadequacies in Archived Sea Ice Data

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Introduction

Needs are increasing rapidly today for sea ice data to support shipping, under ice operations, oil rig structures and terminal design, studies of air and water pollution impact and control, and to determine the effects of sea ice in climatic prediction and modification.

Since ice predictions were initially provided by U.S. Navy activities in support of surface shipping, several factors have operated to make difficult the establishment of a coherent body of quality data. Firstly, only since 1953 has the United States conducted regular reconnaissance and a forecasting service. Hence, codes, definitions, and nomenclature have developed slowly since that time and have not been altogether suitable for numerical, exactly defined, components of a data base. For example, ice thickness data have been based on differently defined categories and groupings. The same applies to floe size distribution; concentration, amount of ice, or stages of development types versus the amount of open water available; ridging or roughness -- both surface and subsurface, etc. Secondly, development for both airborne and satellite technology in remote sensors and sea ice interpretation spurred in NASA's vigorous programs has resulted in a constantly increasing sophistication in terms of spatial, thermal, and other types of resolution in defining key ice features and processes with a constantly greater degree of exactitude. Thus since 1962, the user of ice data and information has had to deal with combining his traditional, largely estimated, visual observations with the electromagnetic and optical (laser data on ice topography) data in formulating data bases for real-time extrapolation or forecasting and for development of "normal" concepts of ice features, conditions, and distribution and their time-space variation.

In the following discussion, however, what are primarily emphasized are not so much the largely insurmountable problems, but the correctable inadequacies existent in today's processing and use of data.

The following examples are not the only errors or omissions in published accounts of historical sea ice data, and are presented simply as examples: mistakes in plotting data, ineptness in the interpretation of satellite imagery, failure to incorporate other data, and a failure to maintain continuity and a constant watch on changing conditions. In the cases presented, an understanding of sea ice distribution and the meteorological/oceanographic influences, combined with a constant watch, the use of all possible data sources, and the exercise of quality control could have prevented the inadequacies.

1. One of the most dramatic short-term changes in the extent of sea ice occurred in the Bering Sea during the period from 4 March to 8 March 1970. During that period, the Bering Sea ice pack expanded some 330 km southward over a 72-hour period. This expansion was a result of freezing (formation of new ice) and ice drift. The formation of new ice accounted for over 75 percent of the expansion. On 4 March, the air circulation was generally east to west, which would tend to maintain the pack edge in position with only limited new ice formation south of the thicker ice. On 5 March, the airflow had backed to the north, and much colder air moved from the Arctic with associated strong winds. Just south of the pack, the water temperatures were very near the temperatures necessary for new ice formation, and the advection of the much colder air caused almost immediate freezing at an accelerated rate. In 24 hours, about 110 km of the open water south of the existent ice edge froze to a thickness that enabled the satellite (ESSA series) to make detection. Within the new ice formation were belts of thicker ice, and these belts were tracked to determine the drift rate of the ice. Winds were strong and off the pack just about perpendicular to the edge. Strong winds hamper the formation and solidification of new ice by agitating the water and producing mechanically induced convection or mixing, but the air temperatures were much lower and the ice itself formed a narrow lee with relatively smooth water. This lee froze

and in turn produced another lee, which froze and formed another lee, etc. On 7 March, the strong circulation began breaking down, and by 8 March, the winds had subsided and the Bering Sea was coming under the influence of a different air mass which was not nearly as cold. During the period of the most rapid expansion (72 hours), the ice edge expanded at a rate of approximately 4.6 km per hour or 110 km per day. Rapidly changing conditions like those described above could have been dangerous for the fishing fleet or offshore drilling. The documentation of short-term changes is important to ice forecasters, providing evidence that rapid growth and expansion can take place. It is also important to other activities involved in heat budget studies, marine navigation and offshore exploration. This short-term change was not documented, although it could have and should have been.

2. During April and May of 1970, nearly 550 km of existing ice east of Greenland was not documented. As a matter of fact, existing documents provide an ice edge which is in error. One document places the ice edge nearly 550 km too far to the west. The failure to record this ice was a matter of lack of understanding of sea ice distribution, ineptness in interpreting satellite imagery, a failure to maintain a watch on the ice edge, and a failure to incorporate foreign data. Granted, the ice was partially obscured by clouds and not easily detected, but by daily evaluation the ice could have been viewed. Further, if data from Icelandic or Danish sources had been incorporated, these data would have provided other clues that more ice existed.

3. Data from aerial ice reconnaissance conducted during early October 1959 were plotted in error and accepted by ice forecasters. Within the ice message, an ice edge was provided with ice conditions north of the edge off Point Barrow, Alaska. The edge was plotted correctly, but the conditions north of the edge were plotted to the south instead of to the north, thereby indicating that the ice was hard against the coast. It may seem virtually impossible that this error could go undetected, but it did. Contributing factors to this error were a lack of "quality control" and knowledge of ice distribution, and a tendency to make assumptions when having difficulty in plotting messages. In any event, published data closed the coast to navigation about 10 days prior to the time it actually closed. These erroneous data were included in tables of closing dates and navigation dates.

In an attempt to rectify some of the errors and omissions, Sea Ice Consultants has conducted a data collection project since 1973. In the Alaskan area, for example, the actual reconnaissance messages since 1953 have been replotted, and ship and coastal station reports added. A project of this magnitude was undertaken as a result of the many mistakes encountered within existing publications when attempting to provide industry with historical ice conditions. This is not to say that other data sources do not exist and that our ice charts are completely accurate, but that they are more accurate and do provide a better insight into historical conditions than any other existing publication. In addition, but only for the Alaskan area, we have been maintaining our own record of sea ice conditions. Our charts are for periods of five days or less, depending on sea ice changes and data availability.

Conclusion

Archived sea ice data serve many purposes and various disciplines. They can be used for feasibility studies applicable to marine navigation and offshore exploration. They can also be used for studies of the global heat budget and climate, and can be used to assist in determinations pertaining to pollution control. Further, they are extremely valuable to the sea ice forecaster for "normals", drift patterns, and maximum and minimum sea ice extent.

Personnel involved in compiling historical sea ice data should understand sea ice distribution and the influencing meteorological/oceanographic parameters, use all possible data sources, and exercise quality control.