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# Technical Procedures Bulletin

**Subject: Automated Ice Concentration Analysis**

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This bulletin, prepared by Dr. R. W. Grumbine of the Ocean Modeling Branch, Environmental Modeling Center, National Centers for Environmental Prediction, describes automated sea ice concentration analysis which is derived from passive microwave satellite observations and is provided in digital form. These analysis fields were implemented for use by the NCEP models (weather, wave, and sea ice), the National Ice Center, and Arctic weather service offices.

The automated ice concentration fields have been produced experimentally since April 1994. The data input are derived from the Special Sensor Microwave Imager (SSMI) instrument on Defense Meteorological Satellite Program (DMSP) satellites (F-11 originally, changed to F-13 in May, 1995). The ice concentrations are derived from the observations by using the NASA Team algorithm (Cavalieri, 1992) with brightness temperatures adjusted according to Abdalati et al. (1995). Weather contamination is filtered from the ice concentrations by application of the Cavalieri weather filter (1992) as extended in Grumbine (1996). The result is two hemispheric grids designed for use by ice analysts and a global grid designed for use by numerical models. The automated ice concentration analysis will be implemented as soon as the current moratorium on implementations is lifted.

This is the first Technical Procedures Bulletin on the Subject.

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# Automated Ice Concentration Analysis

by R. W. Grumbine

## 1. INTRODUCTION

An automated ice concentration processing scheme, which has been run in a developmental mode daily since May 1, 1994, has been approved for operations. Two types of fields are produced, analysis fields, and the global fields. The analysis fields are suitable for further manual operational ice concentration analysis, and have been used for the purpose by the National Ice Center since February, 1995. These fields are also used for starting the sea ice forecast model. The global fields are also used to create global grids for making ice/no ice determinations in weather models, and have been used for that purpose by the NCEP/NCAR Climate Reanalysis Project.

## 2. METHOD

The ice concentrations are derived from passive microwave observations from the DMSP F-13 SSMI instrument. The NASA Team algorithm (Cavalieri, 1992) is used to make the derivation. This algorithm is based on the contrast in the microwave between open water (cold) and ice (warm), with three frequencies used to allow for differences in the microwave between old and young ice. Heavy rain and high seas can deceive the algorithm into believing that there is ice even in places that have none. North Atlantic storms routinely appear as false patches of ice. To overcome this problem, a weather filter [Gloersen and Cavalieri, 1986] is applied in an extended mode [Grumbine, 1996]. The extended mode weather filter clears most of the false ice reports, but not all. Since fairly extreme conditions are required for the algorithm to report weather as being ice, analysts should be able to identify these errors by considering the current weather situation.

The global grid for models cannot apply this intelligence to the false ice reports, so a different method is used to generate the final product. Ice concentrations are averaged from the native polar stereographic grids on to a half-degree latitude-longitude grid. Then if the sea surface temperature on the OI SST analysis nearest the given point is greater than 2 C, the ice concentration is forced to zero. This clears false reports fairly effectively.

## 3. DEVELOPMENT AND DEFINITIONS

Sea ice concentration is taken to be the fraction of the area of a pixel (25.4 km by 25.4 km on the analysis grid) that is covered by ice. The satellite does not detect ice less than 5-10 cm thick, so satellite ice concentration is the concentration of ice thicker than this.

## 4. ANALYSIS CONTENT AND DISSEMINATION

Sea ice concentrations are computed to a precision of 1% coverage. The accuracy is 3-5%. Flags are used for special cases in the analysis grid: weather is flagged at 1.77, bad data is 1.66, no data is 2.24. The ice concentrations from the algorithm may exceed 1.00 (100% coverage). There is some thought that there is information present in the over 100% coverage points, so the algorithm does not adjust these high values. Analyst commentary is invited! The global grid for models does

not use these flags as bad, missing, or weather points are filled in with the last good observation. It seldom requires more than three days to get another good point on the ice pack. Samples, in black and white, of the two hemispheric (analysis) and the global (model) grid are given in figures 1, 2 and 3. The data are far easier to view and use in color, as they are displayed on the OMB web page at http://polar.wwb.noaa.gov/seaice/Analyses.html (capitalization is important). The automated analysis fields are disseminated daily in GRIB format, via ftp to various machines at NCEP.

### a. NCEP Computers and File Names

Table 2 gives the NCEP computer or workstation and data set name for the experimental global ice drift point forecasts and the Alaska subset of these data.
Currently, the only way to receive these data will be from the Cray machines or by ftp (file

**Table 1.** List of NCEP computers/workstations and associated file names for automated sea ice concentration analyses.

| NCEP Computer/Workstation | File Name |
|---|---|
| Northern Hemisphere Concentration field | |
| cray3 | /ombptmp/ice/analy/fifteenth/northpsg.yymmdd[2] |
| cray4 | /marine/ice/ice.analy/northpsg.yymmdd[2] |
| polar.wwb.noaa.gov[1] | pub/ice/northpsg.yymmdd[2] |
| Southern Hemisphere Concentration field | |
| cray3 | /ombptmp/ice/analy/fifteenth/southpsg.yymmdd[2] |
| cray4 | /marine/ice/ice.analy/southpsg.yymmdd[2] |
| polar.wwb.noaa.gov[1] | pub/ice/southpsg.yymmdd[2] |
| Global Ice Concentration Field | |
| cray3 | /ombptmp/ice/analy/eng.yymmdd[2] |
| cray4 | /marine/ice/driftfore/eng.yymmdd[2] |
| polar.wwb.noaa.gov[1] | pub/cdas/eng.yymmdd[2] |

[1]Use this address to ftp sea ice drift file on Internet.
[2]yymmdd is the date in 6 digit format

transfer protocol) to the address given in Table 1 over the Internet.

## 5. EVALUATION

The NASA Team algorithm has been subject to objective analysis for several years [c.f. Cavalieri, 1992]. Subjective analysis at the National Ice Center [D. Helms, personal communication 1995, M. Sullivan, 1996] also supports this algorithm as the preferred.

## 6. REFERENCES


Abdalati, W., K. Steffen, C. Otto and K. C. Jezek 1995: Comparison of brightness temperatures from SSMI instruments on the DMSP F8 and F11 satellites for Antarctica and the Greenland ice sheet, Int J. Rem. Sensing, 16, 1223-1229.

Cavalieri, D. J. 1992: Sea ice algorithm in NASA Sea ice Validation Program for the Defense Meteorological Satellite Program Special Sensor Microwave Imager: Final Report NASA Technical Memorandum 104559, pp. 25-32.

Gloersen, P. And D. J. Cavalieri 1986: Reduction of weather effects in the calculation of sea ice concentration from microwave radiances J. Geophys. Res., 91, 3913-3919.

Grumbine, R. W. 1996: Automated Passive Microwave Sea Ice Concentration Analysis at NCEP, DOC/NOAA/NWS/NCEP/EMC/OMB Technical Note 120, 13 pp.

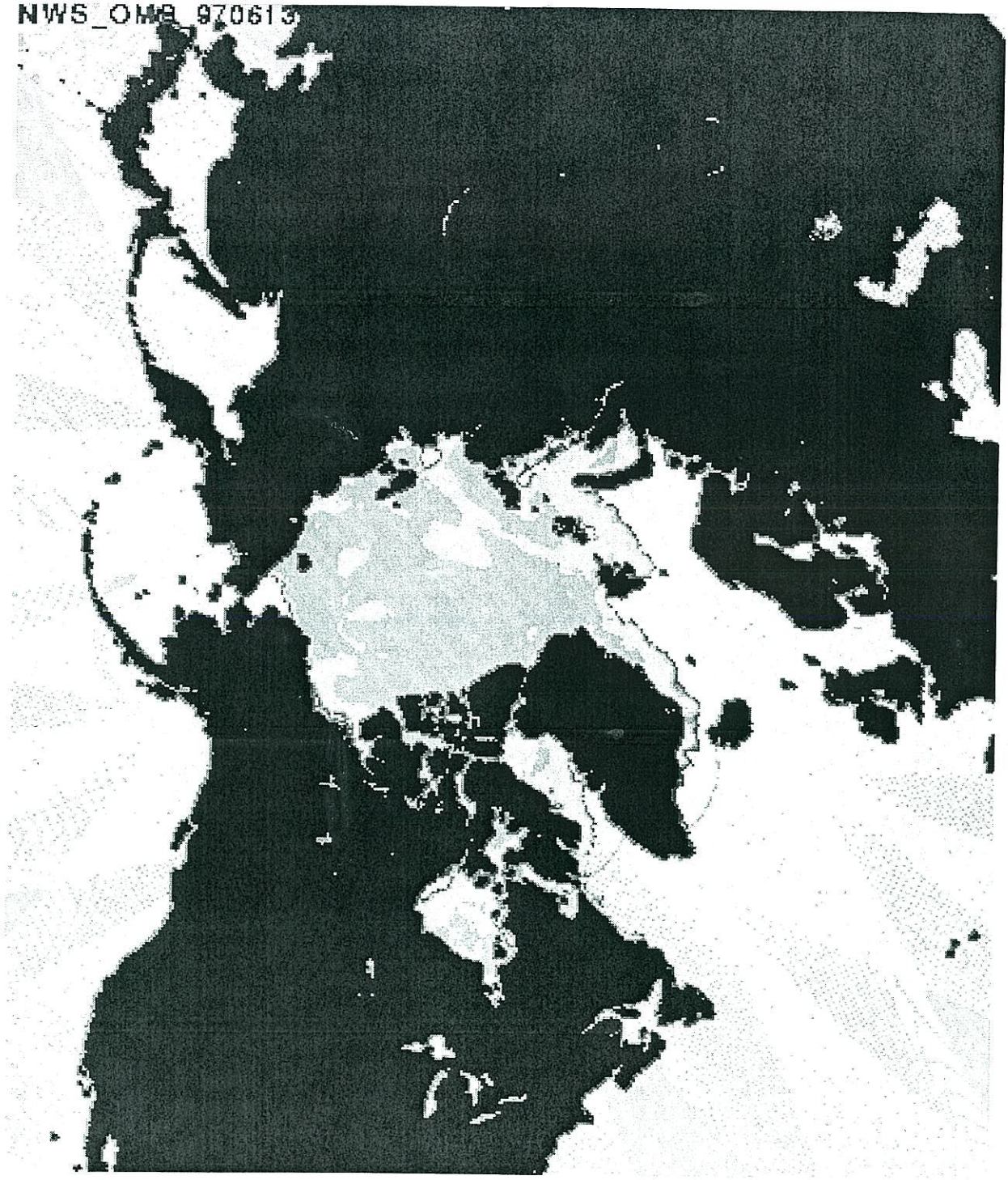


Figure 1: Northern Hemisphere ice concentration analysis as produced by the automated algorithm for 9 August 1996.

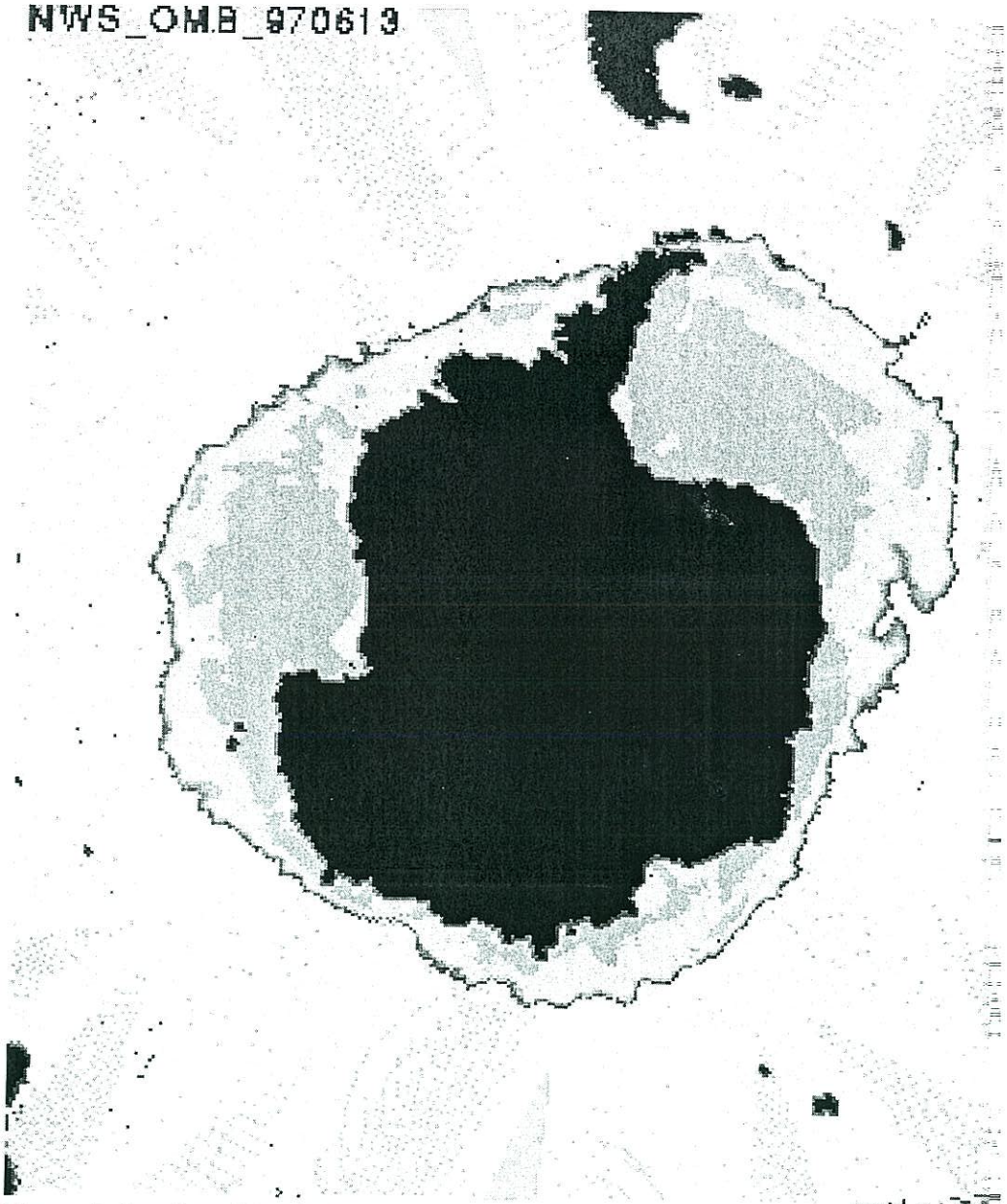


Figure 2: Southern Hemisphere ice concentration analysis as produced by the autc
algorithm for 9 August 1996