Data of Project on Atmospheric Circulation and Material Cycle in the Antarctic, Part 2. NOAA AVHRR Images received at Syowa Station, Antarctica in 1997

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1. Introduction

Since 1997, a project on "Atmospheric Circulation and Material Cycle in the Antarctic" has been carried out by the 38th Japanese Antarctic Research Expedition (JARE-38) and subsequent expeditions. The project aims to clarify the transport and transfer of atmospheric minor constituents related to the atmospheric circulation. During the wintering in 1997, extended observations with rawinsondes, shortwave and longwave radiometers, lidar, aerosol sondes, ozone sondes, and sampler and counter of aerosols at the surface were made at Dome Fuji Station (77°19'S, 39°42'E, 3810 m a.s.l.). Observations of atmospheric phenomena at Dome Fuji Station in JARE-38 are described by Yamanouchi *et al.* (1999a,b), Hirasawa (1999) and Hayashi (1999). The first report (Part 1) of this series has dealt with the aerological data with rawinsondes at Dome Fuji Station (Hirasawa *et al.*, 1999).

Recently, various satellite data sets are being used in studies of the polar regions, not only as pioneer work but also as one of basic information. Syowa Station has been receiving several satellite data by now. As one of those, the polar orbital satellite NOAA data has been received for 1980 to 1991 to examine mainly cloud detection and radiational characteristics in the Antarctic (*e.g.*, Yamanouchi and Seko, 1992). Collection of these data was re-started to receive the NOAA data at Syowa Station on March 7, 1997 (JARE-38). In the present report, we will indicate daily images on channel 1 (visible channel) and 4 (infrared channel) of the Advanced Very High

Resolution Radiometer (AVHRR), covering the Antarctic continent from 0° E to 90° E and the ocean area.

2. Sensors

The specifications of AVHRR are listed in Table 1. Channels 1 and 2 correspond to the range of visible wave length and channels 3, 4 and 5 infrared wave length. Yamanouchi *et al.* (1987) demonstrated cloud detection in the Antarctic by use of the multi-channel radiometer. They took channels 1 and 3 together to detect clouds over sea ice and continental ice areas in summertime (or for the duration of the sunshine). On the other hand, detection of clouds in wintertime (in the Polar Night) is still difficult. They tried to distinguish thin clouds from thick clouds or ice surface areas by using channels 4 and 5.

Table 1. Specifications of the AVHRR.

Channels	Wave length	Resolution	Width
1	0.52~0.68 μ m	1.1 km	2700 km
2	0.725~1.1 μ m	1.1 km	2700 km
3	3.55~3.93 μ m	1.1 km	2700 km
4	10.3~11.3 μ m	1.1 km	2700 km
5	11.5~12.5 μ m	1.1 km	2700 km

The TIROS Operational Sounder (TOVS) is another sensor, which is also available from the data received at Syowa Station. TOVS is useful to obtain atmospheric circulation fields (*e.g.*, of geopotential height, geostrophic wind, etc.). However, for the data around Syowa Station, an examination of accuracy of such atmospheric circulation fields that are derived from TOVS is a future issue. Thus, no results of TOVS are indicated in the present report.

3. Observation

NOAA-12 and -14 were received during JARE-38. Table 2 shows total number of passes received in each month. Approximately ten passes were received a day.

Table 2. Monthly total number of passes received.

Month	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	total
Num.	247	318	335	275	312	366	269	288	242	248	3162

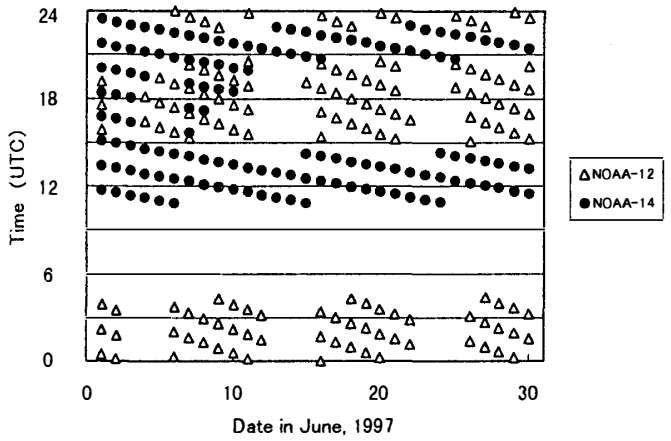

Fig. 1. Distribution of receiving time in days in June 1997 for NOAA-12 (△) and -14 (●).

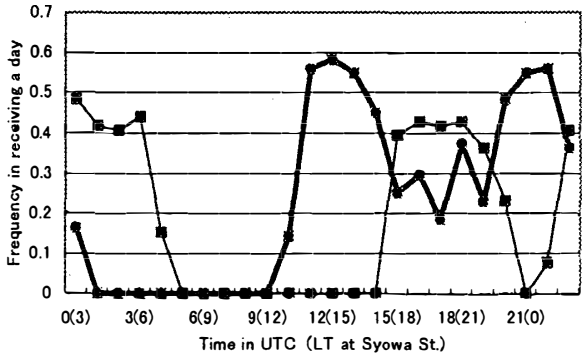

Fig. 2. Histograms of the frequency in number of passes received for the hourly zone for NOAA-12 (solid line) and -14 (bold line) for June of 1997.

Figure 1 shows the distribution of receiving time per day in June 1997 for NOAA-12 and -14. We gave priority to NOAA-14 over NOAA-12, so marks of NOAA-14 are more frequent than NOAA-12. Figure 2 shows histograms of the frequency in number of passes received by hour of day for NOAA-12 and

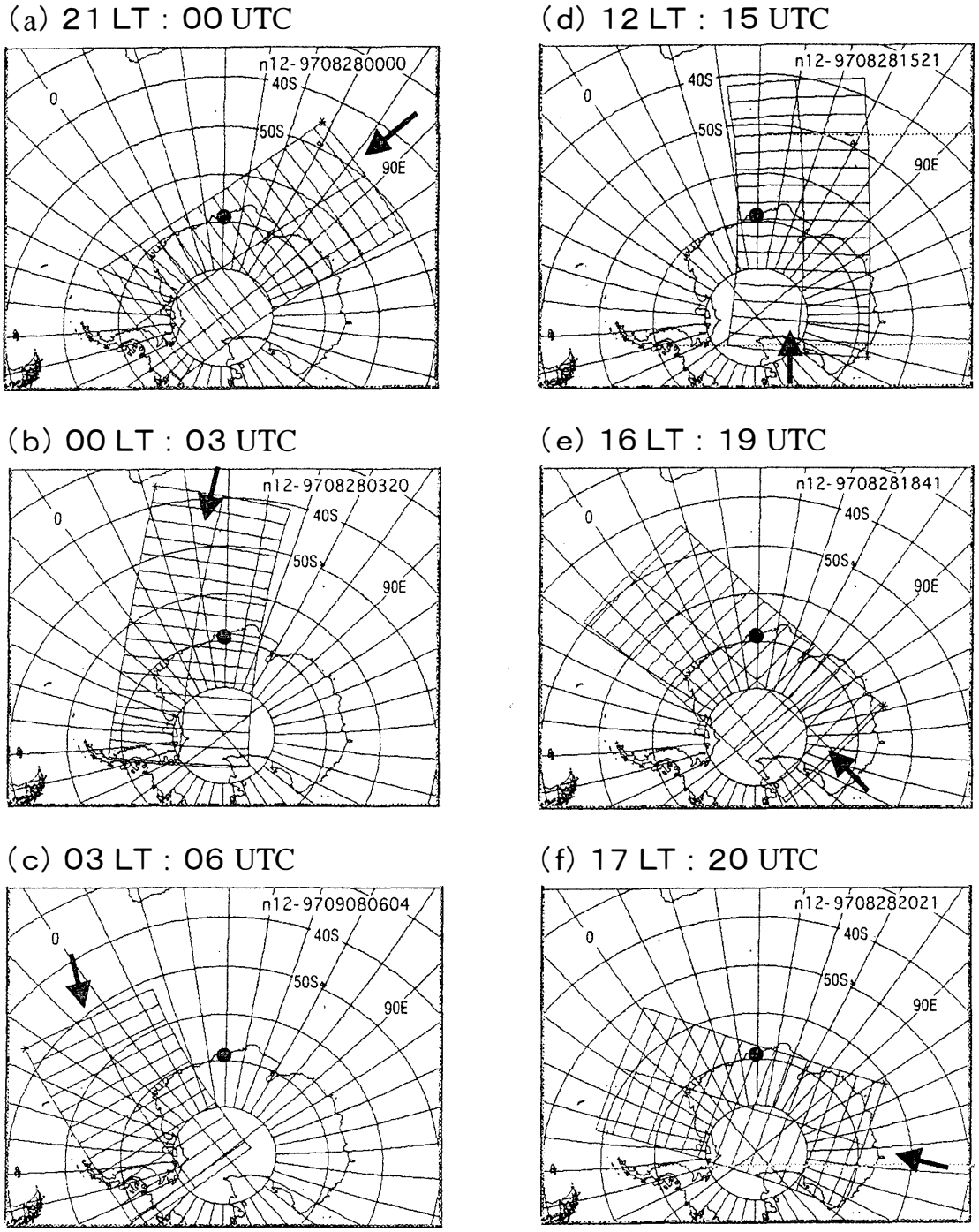

Fig. 3. Daily variation of the orbit and data area of NOAA-12.

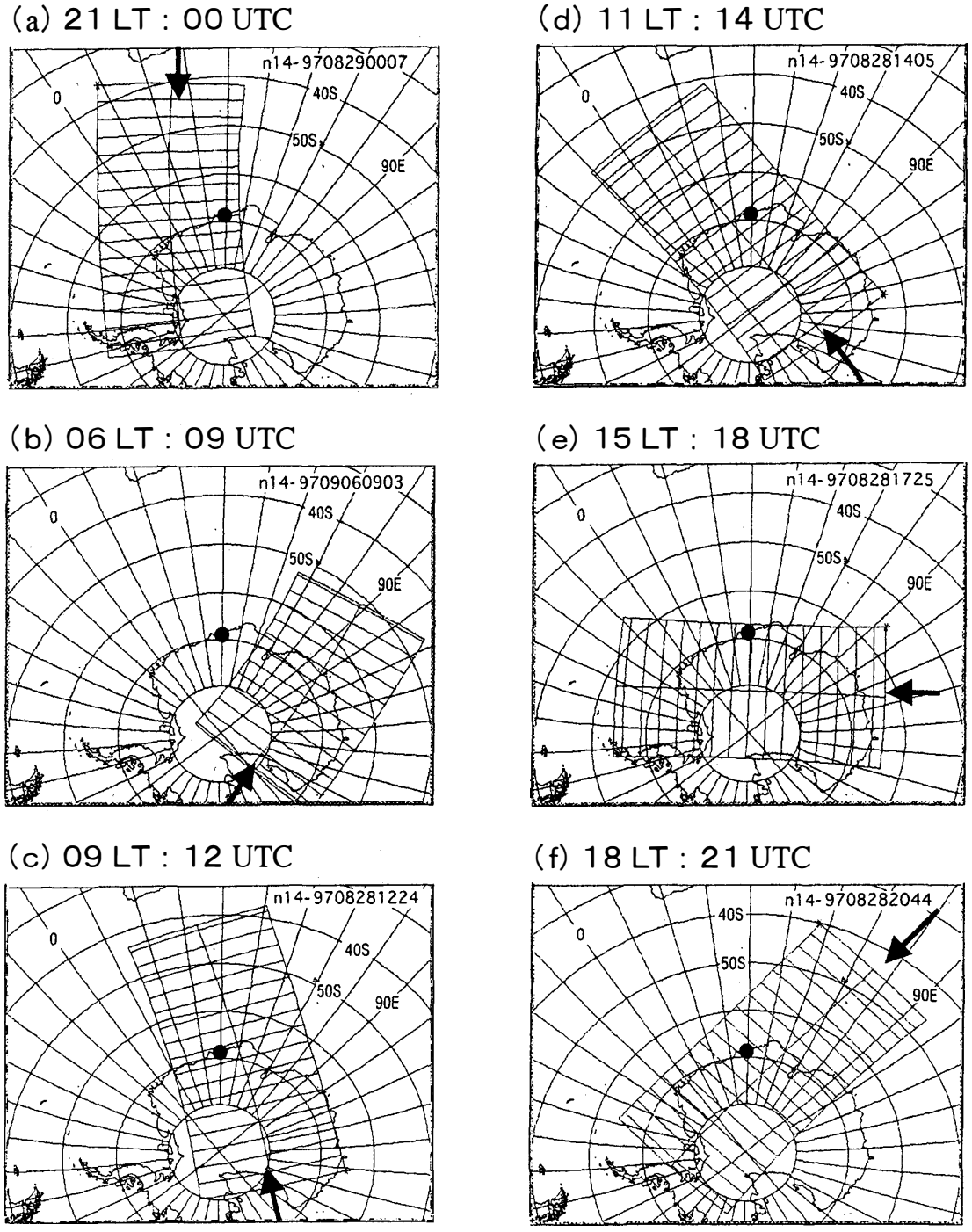

Fig. 4. Daily variation of the orbit and data area of NOAA-14.

14 for June of 1997 as an example. The peak values in frequency of NOAA-14 appear in two time zones around 11-14 UTC and 21-23 UTC. Those of NOAA-12 appear also in two time zones around 00-04 UTC and 15-19 UTC. The time zones of peaks in frequency correspond to those of the maximum elevation angle of the satellite. Figures 3 and 4 show examples of the daily variation of the orbit and data area of NOAA-12 and 14, respectively.

4. Description of images on the following pages

In the present report, one pass was selected up every day for presentation from the time zone for 1200 UTC to 1415 UTC when a peak of frequency in receiving of NOAA-14 appeared, as shown in Fig. 2. In the cases of no passes received in the time zone, images at other times are shown as long as possible. However, there are several days without images mainly due to trouble with the receiving system.

On a page, images of channel 1 (the upper panel) and 4 (the lower panel) of one day are shown. On the other hand, in wintertime between April 6 and September 14, images of only channel 4 are shown because of little sunshine in that period.

The date, time (UTC), satellite number and channel are indicated in the upper left part of each image. Longitudinal and latitudinal lines are drawn every 10 degrees. The projection is polar stereo centered at the South Pole. Both radiance in channel 1 and temperature in channel 4 vary with the season and thus, a peculiar gray-scale was adopted in each season in order to enhance the contrast in those distributions. Here, the radiance in channel 1 was standardized with the solar constant value to convert in the range of 0 to 100%. The range of gray-scale in each period is shown in Table 3 and the outline of steps in the range are indicated in each panel.

Table 3. Range of gray-scale in each period.

Period	Channel 1	Channel 4
Jan.1～Feb.19	0～70 %	10～ -60 ℃
Feb.20～Mar.4	0～70 %	0～ -70 ℃
Mar.5～Apr.5	0～50 %	0～ -70 ℃
Apr.6～Sep.14	Not shown	0～ -90 ℃
Sep.15～Oct.15	0～50 %	0～ -70 ℃
Oct.16～Oct.31	0～70 %	0～ -70 ℃
Nov.1～Dec.1	0～70 %	10～ -60 ℃

Acknowledgments

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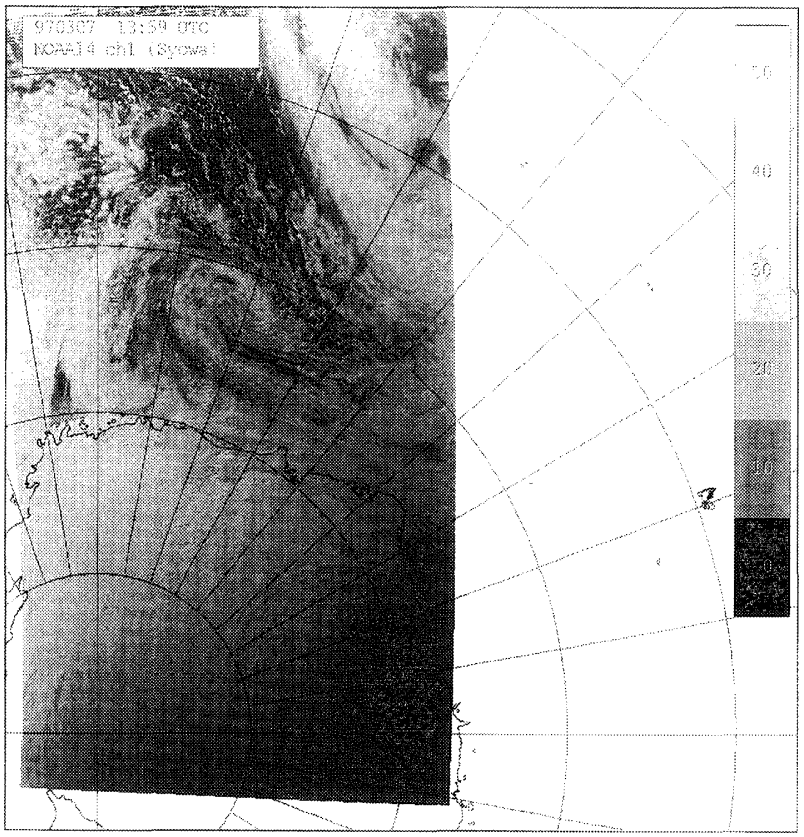
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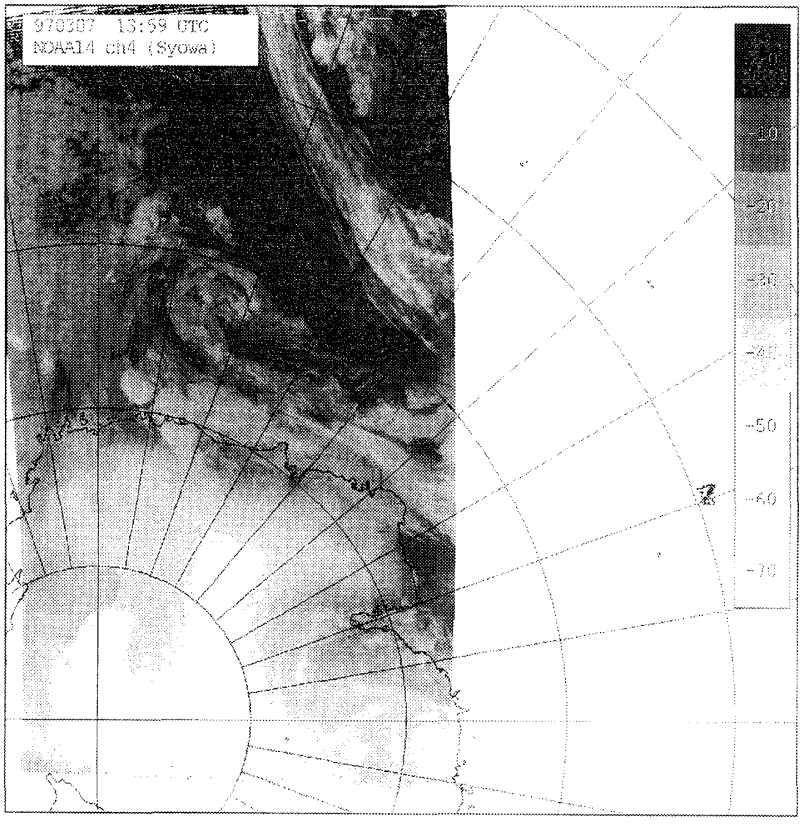
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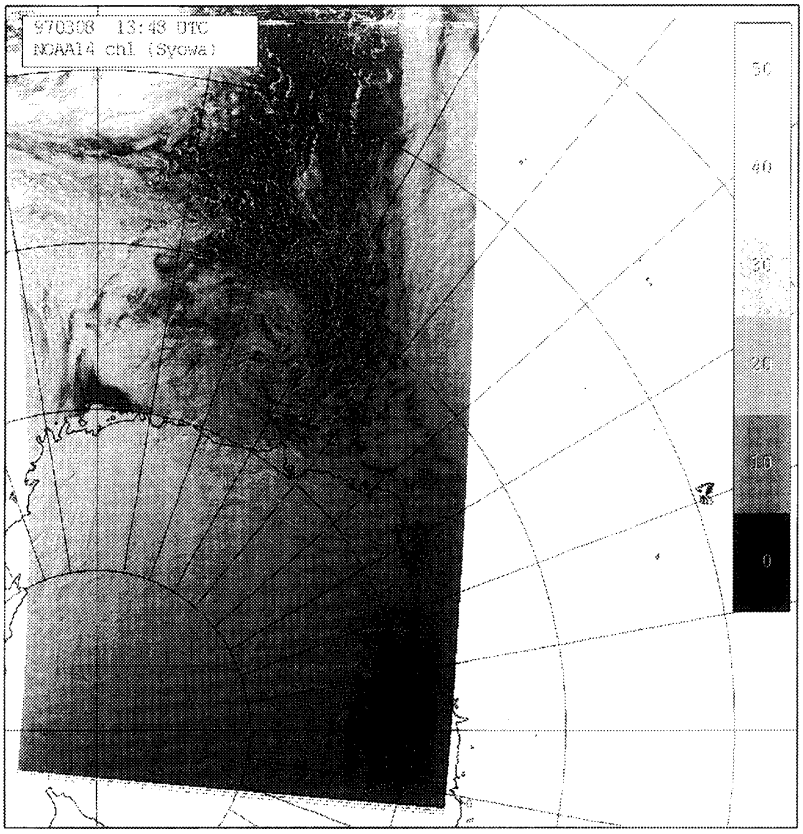
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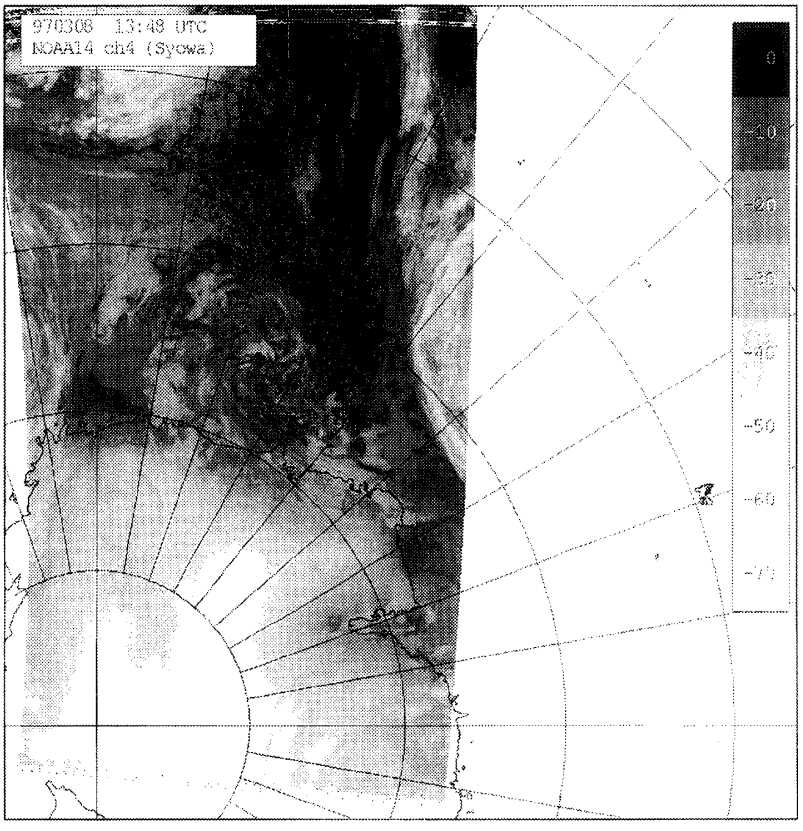
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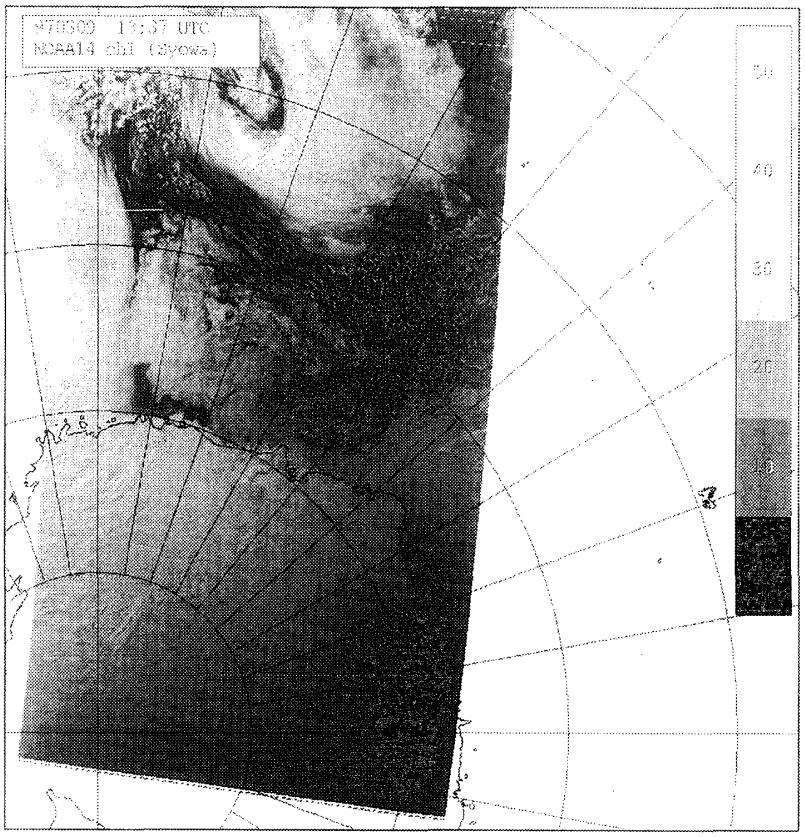
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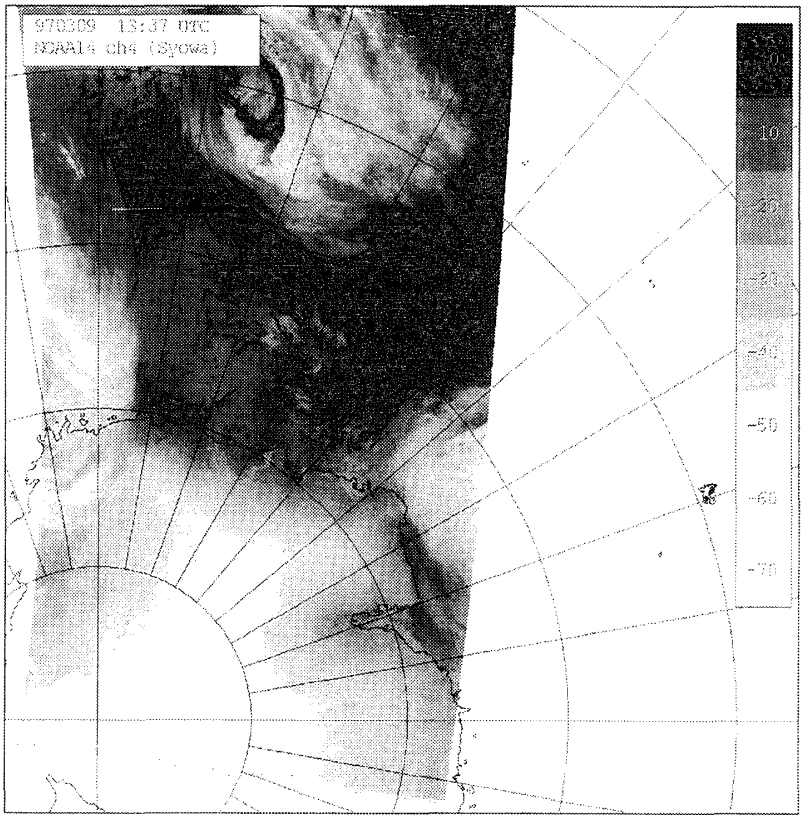
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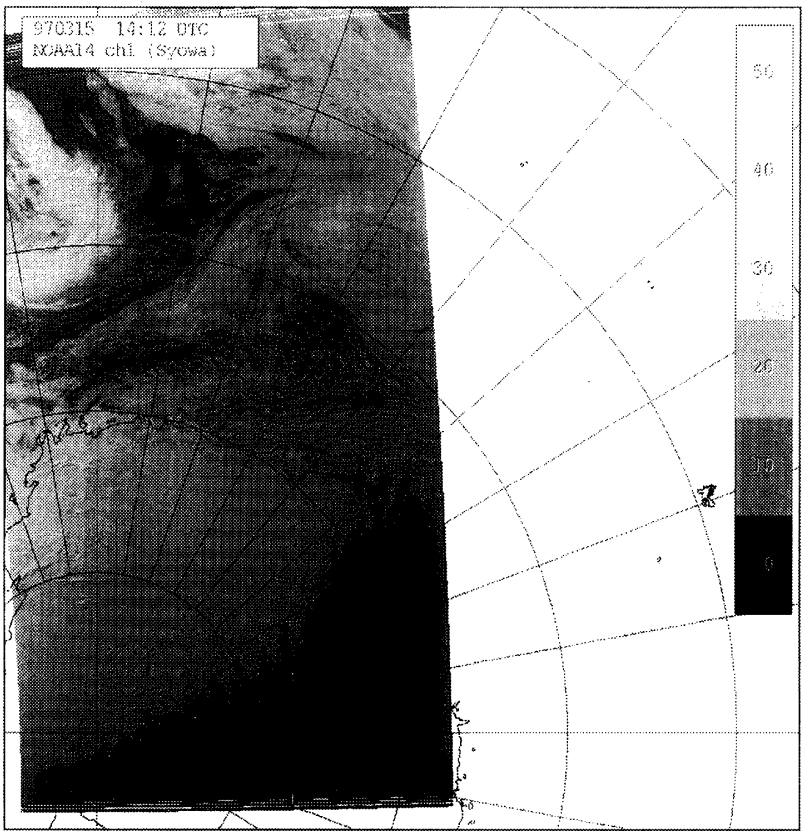
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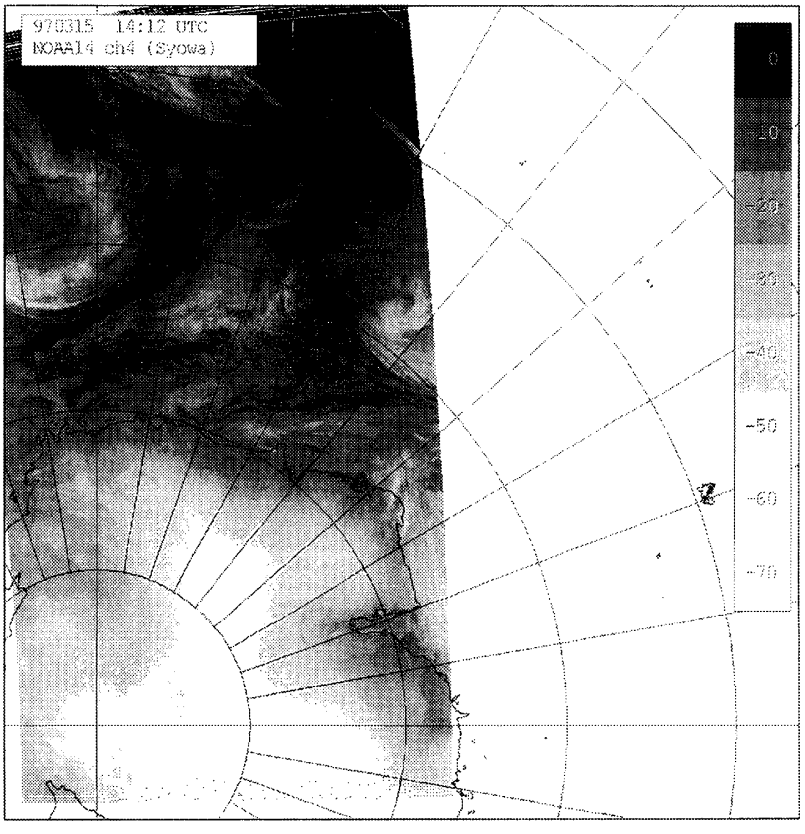
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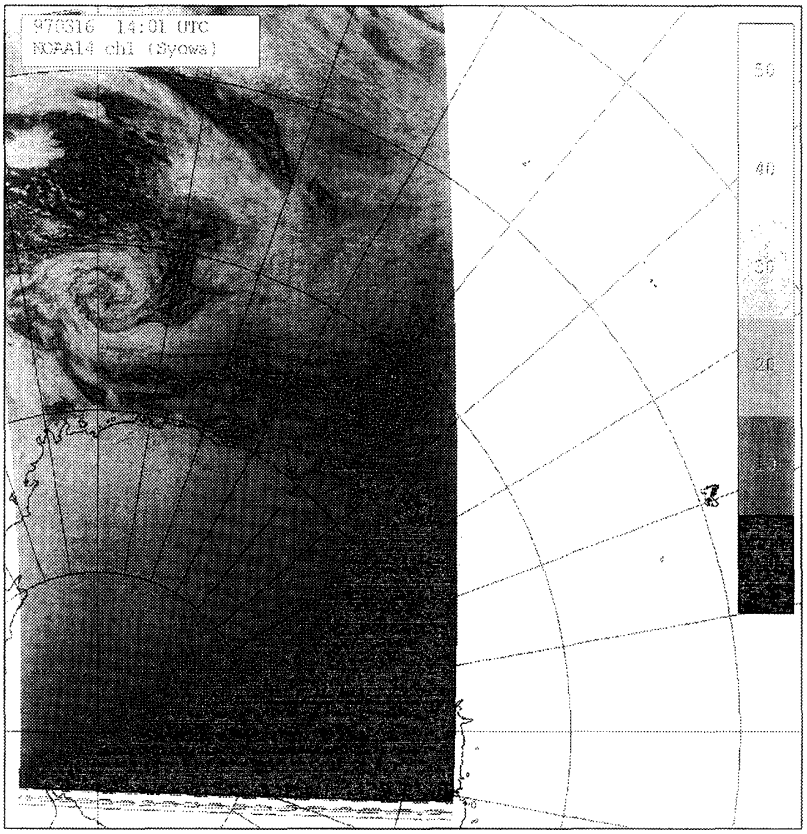
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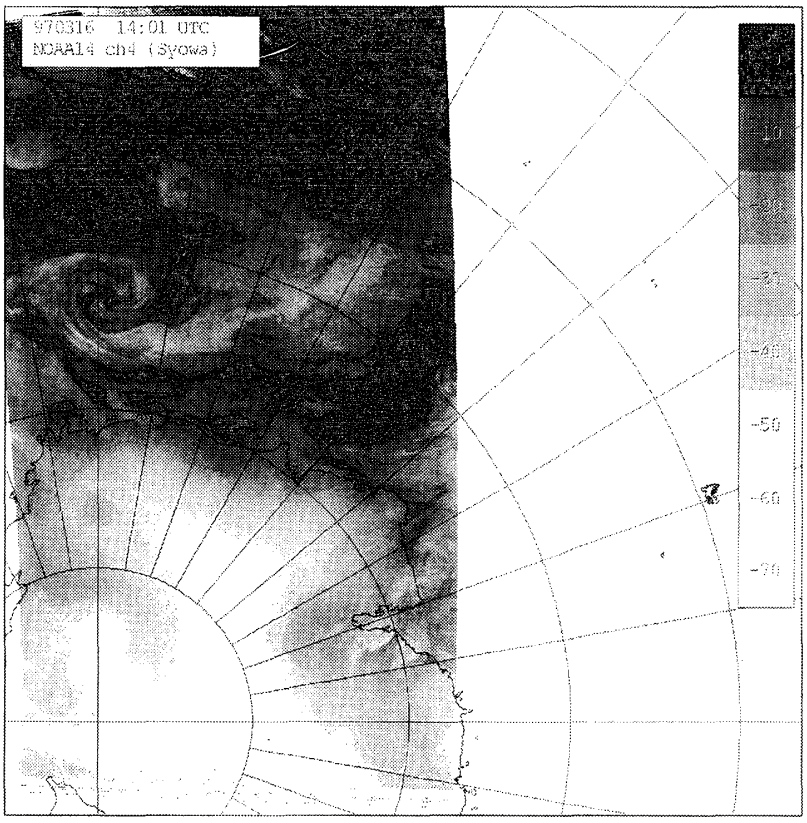
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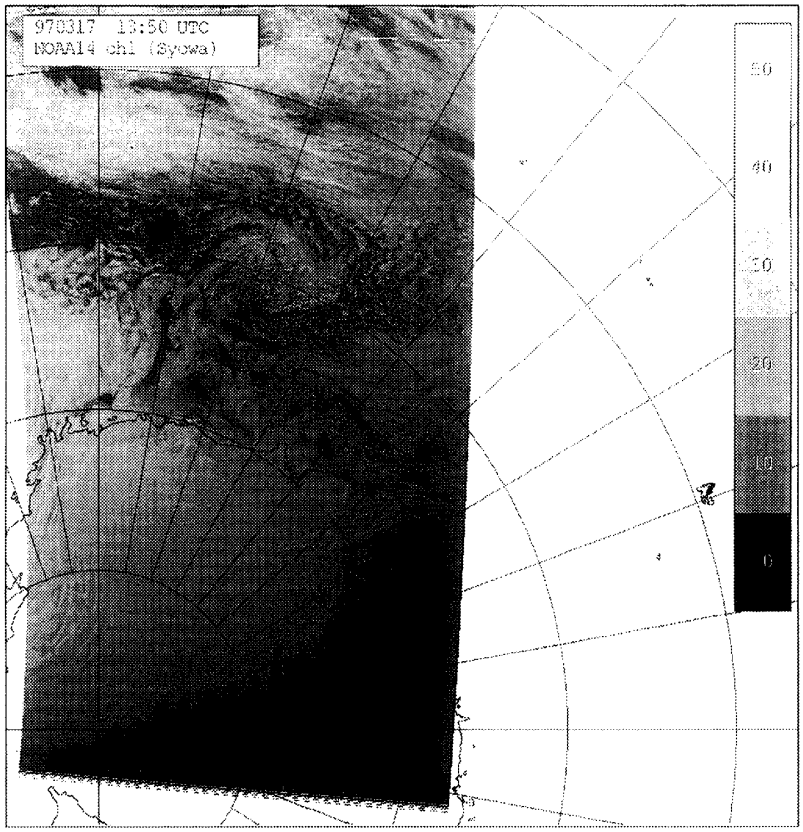
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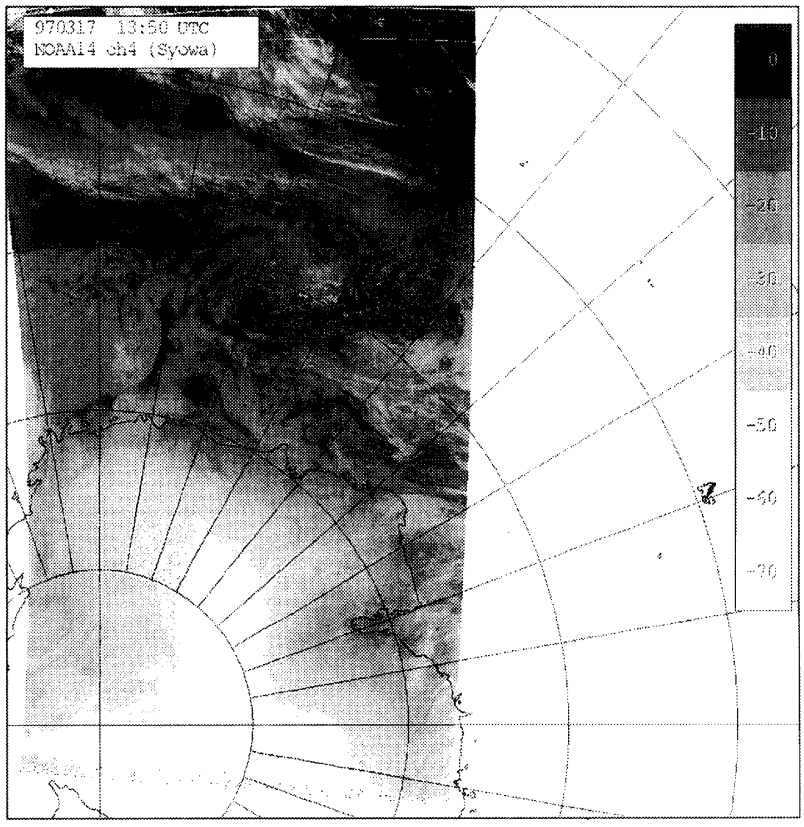
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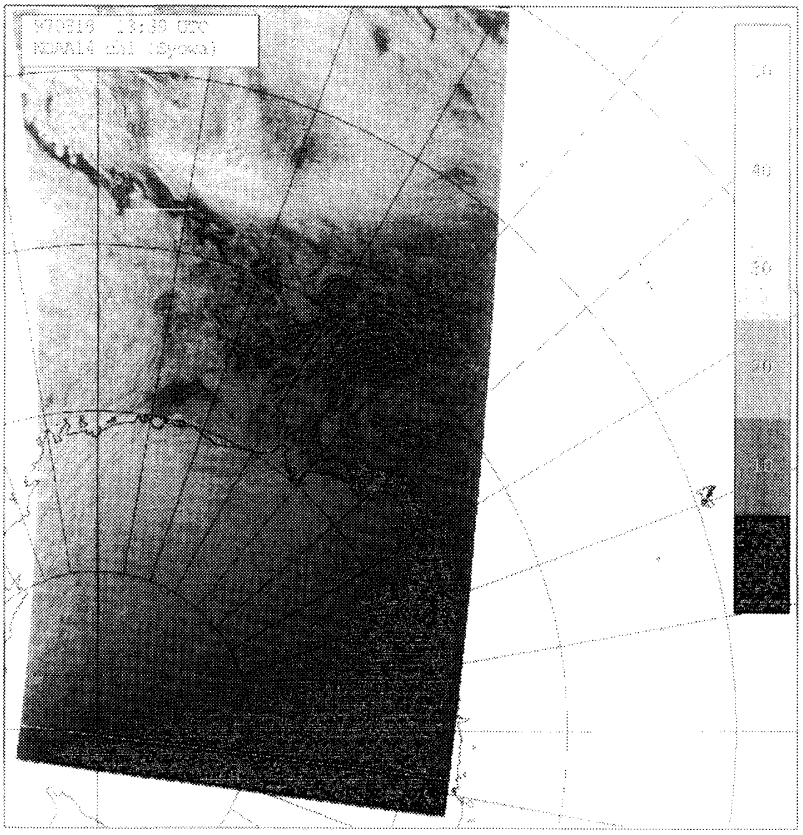

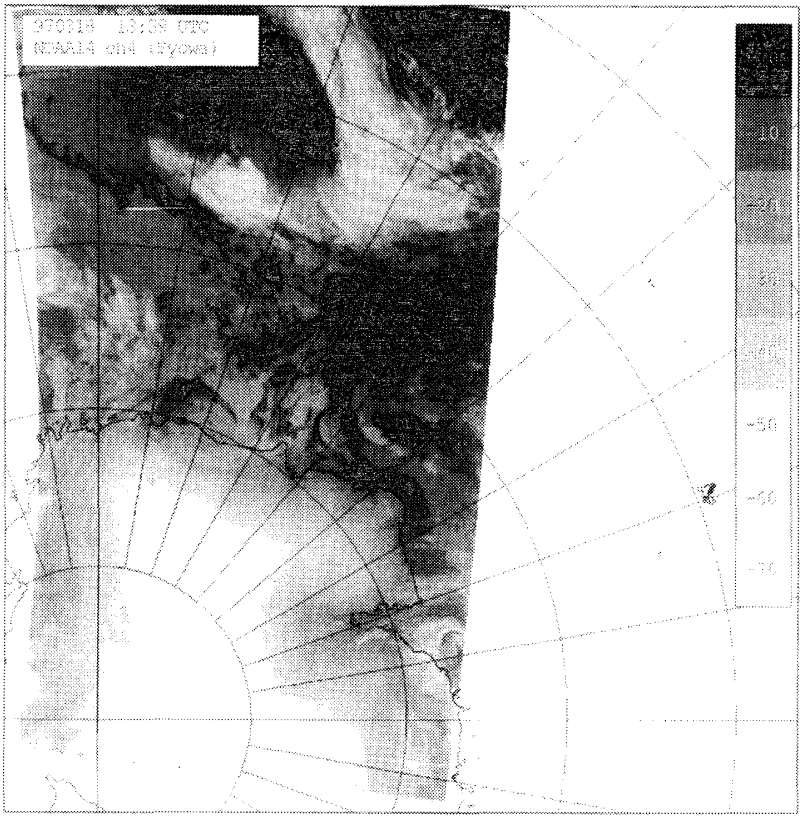

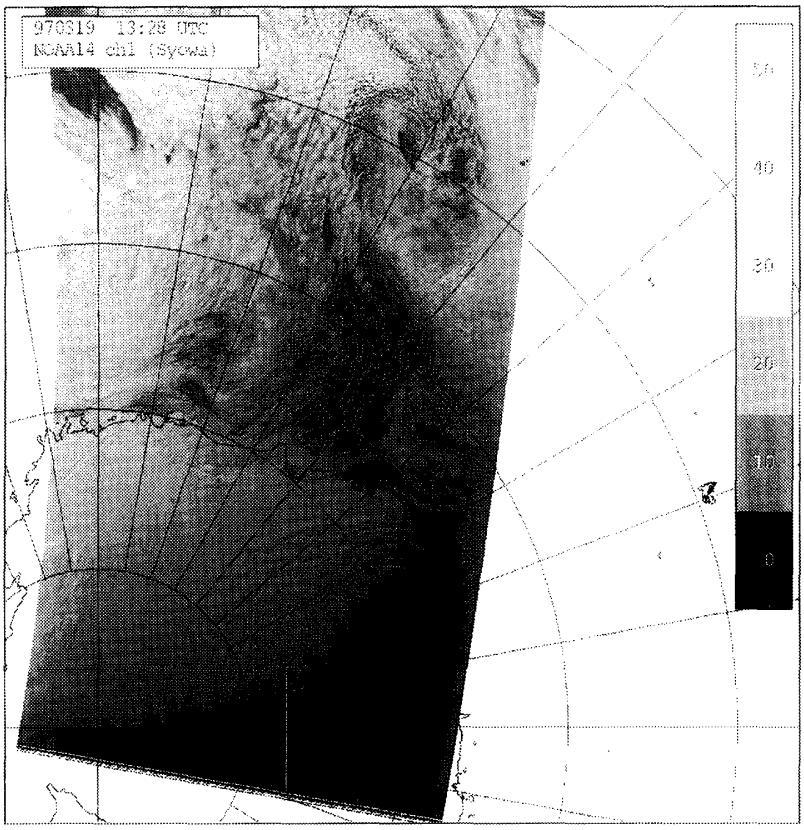
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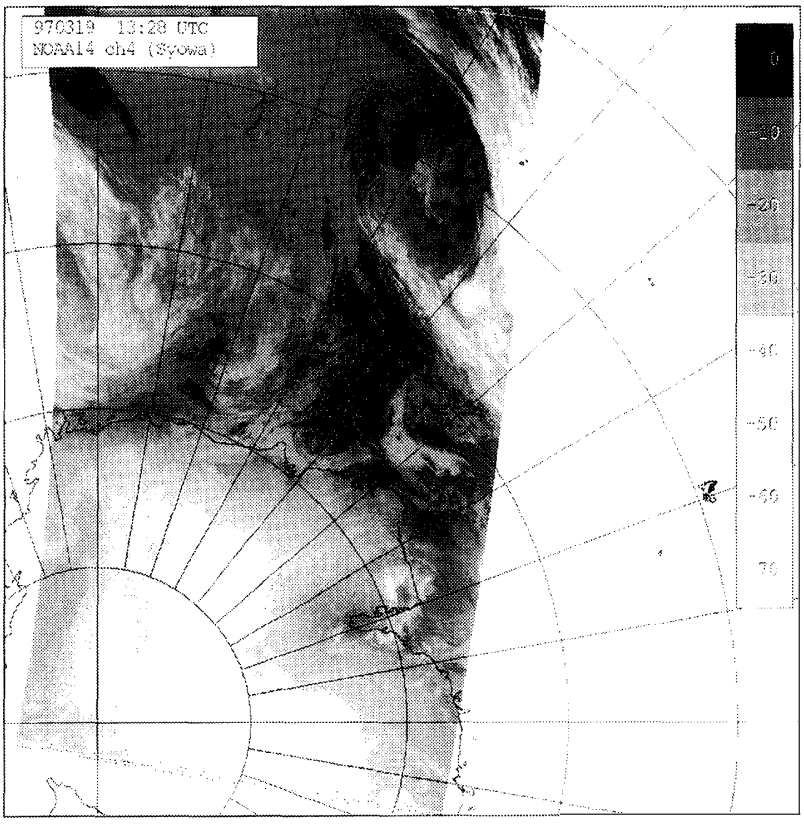
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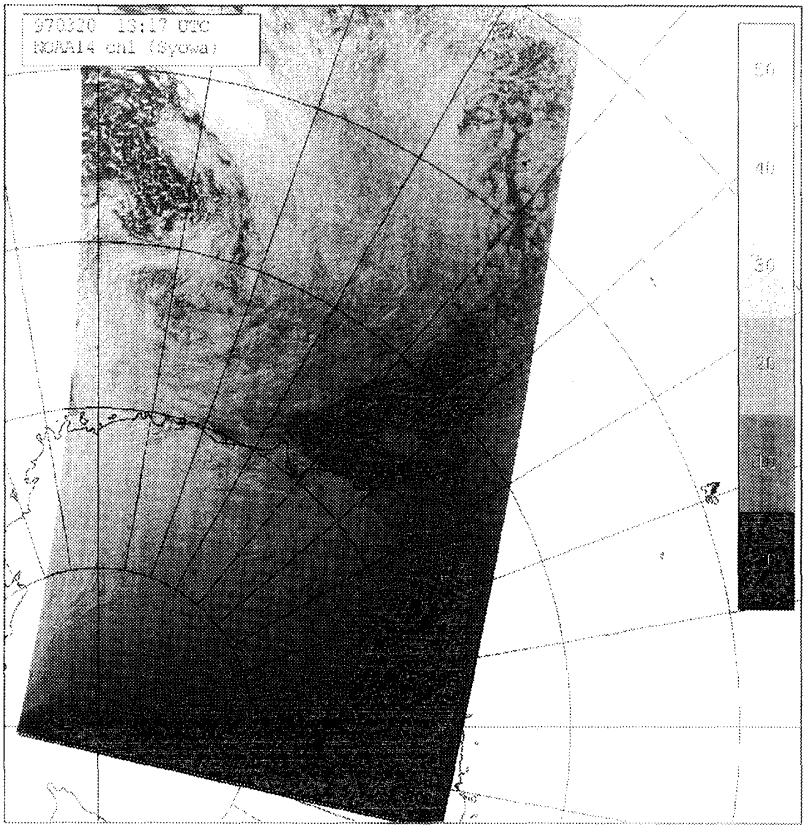
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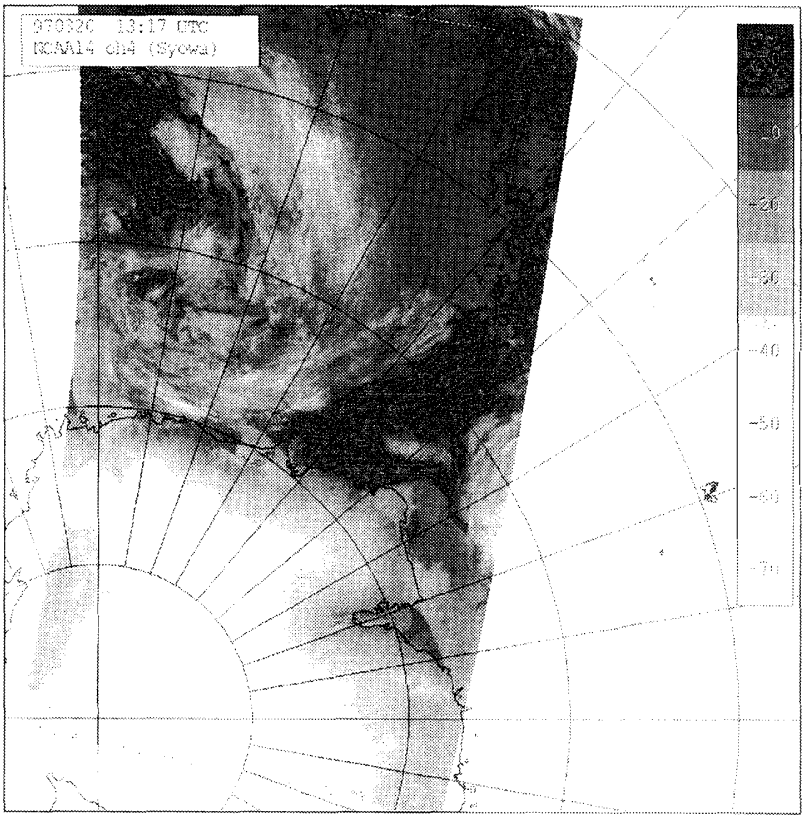
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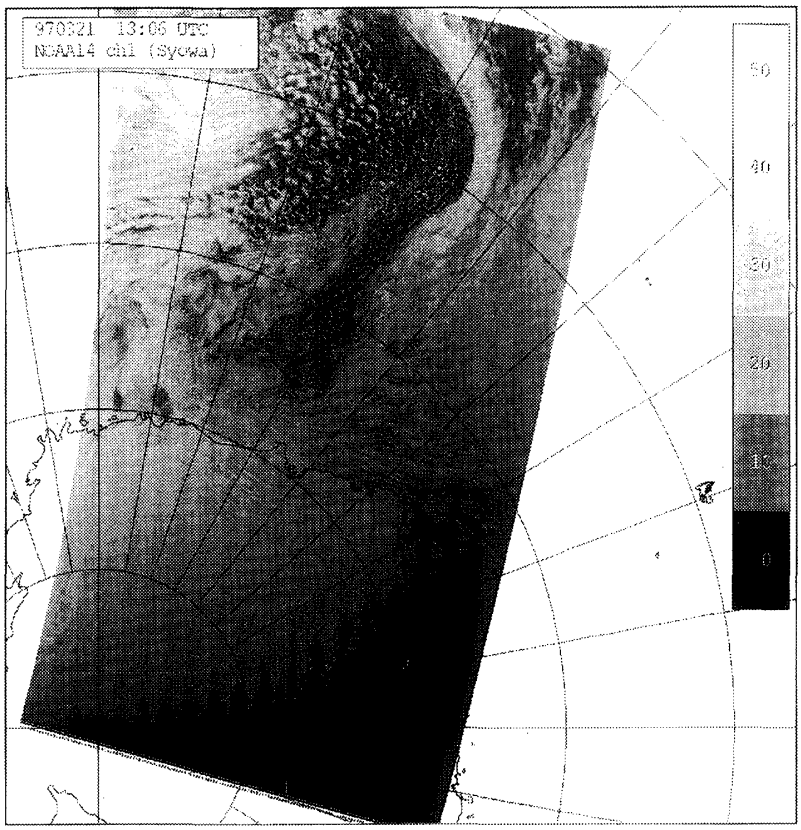
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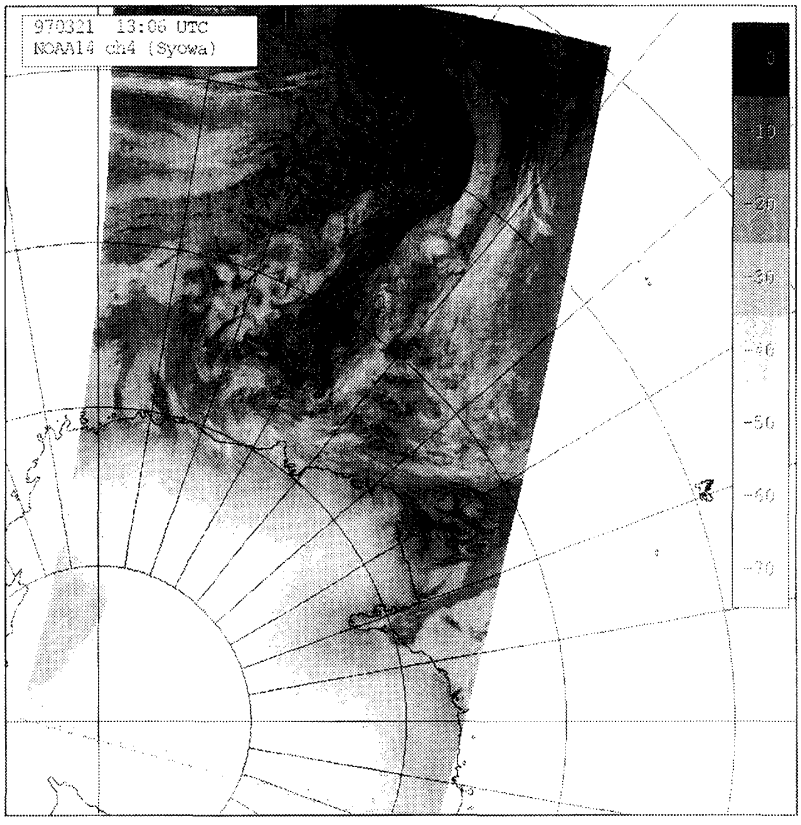
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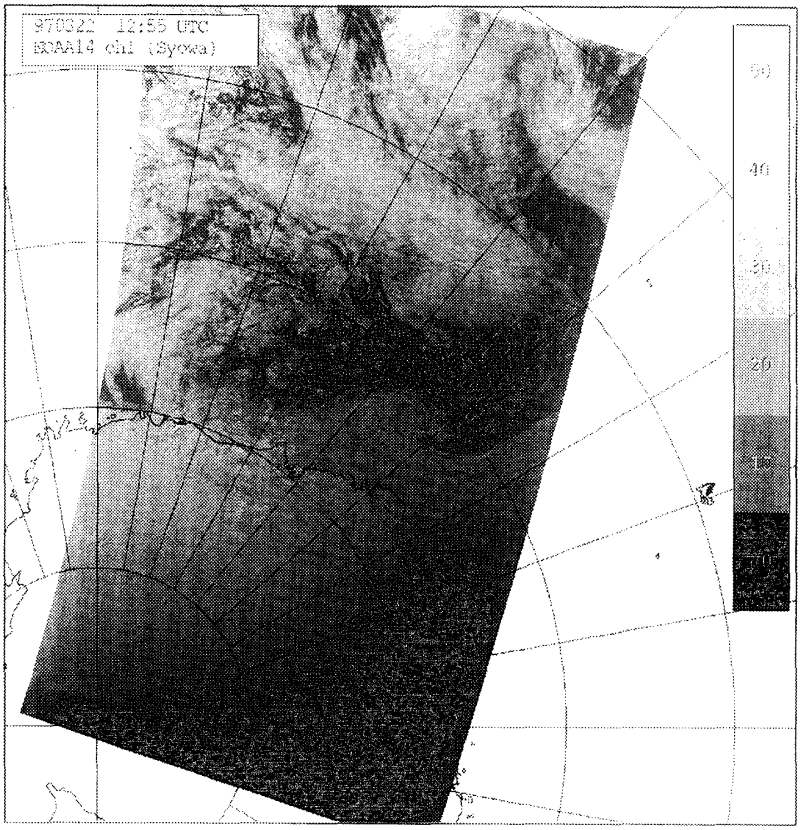
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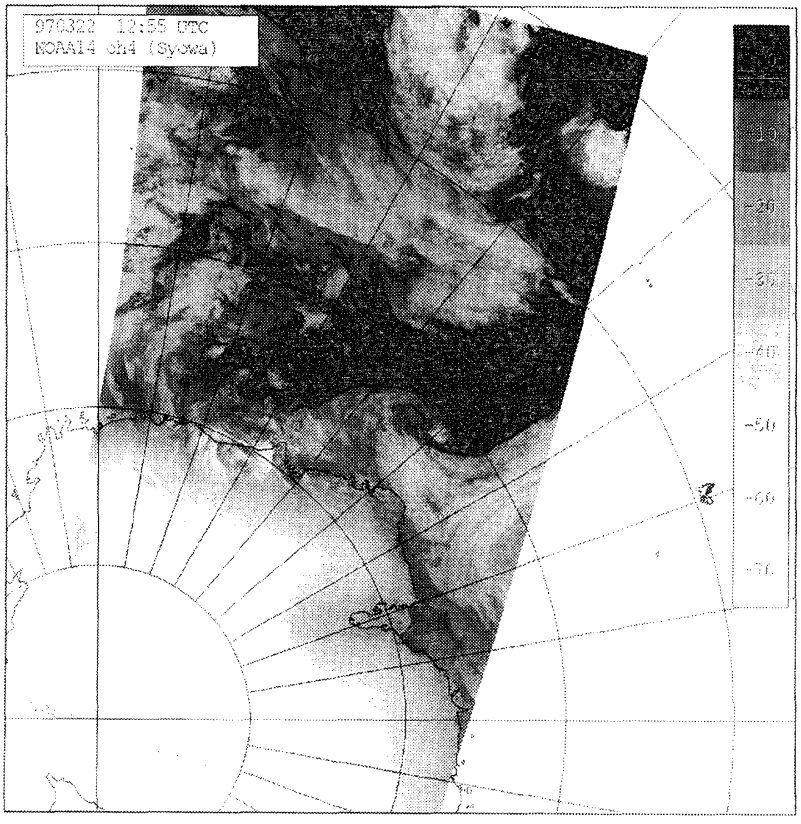
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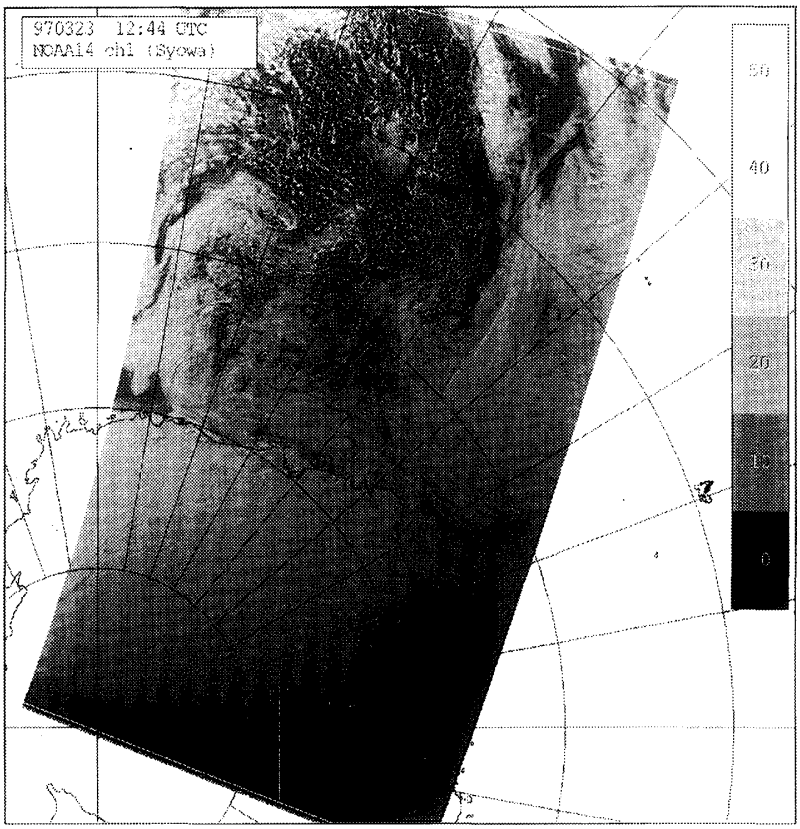
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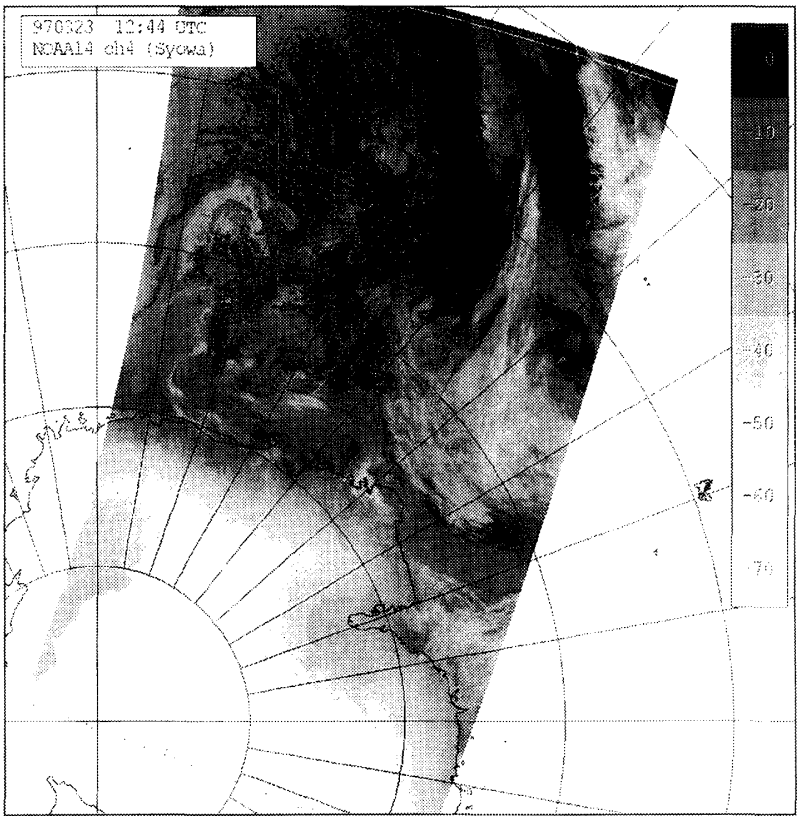
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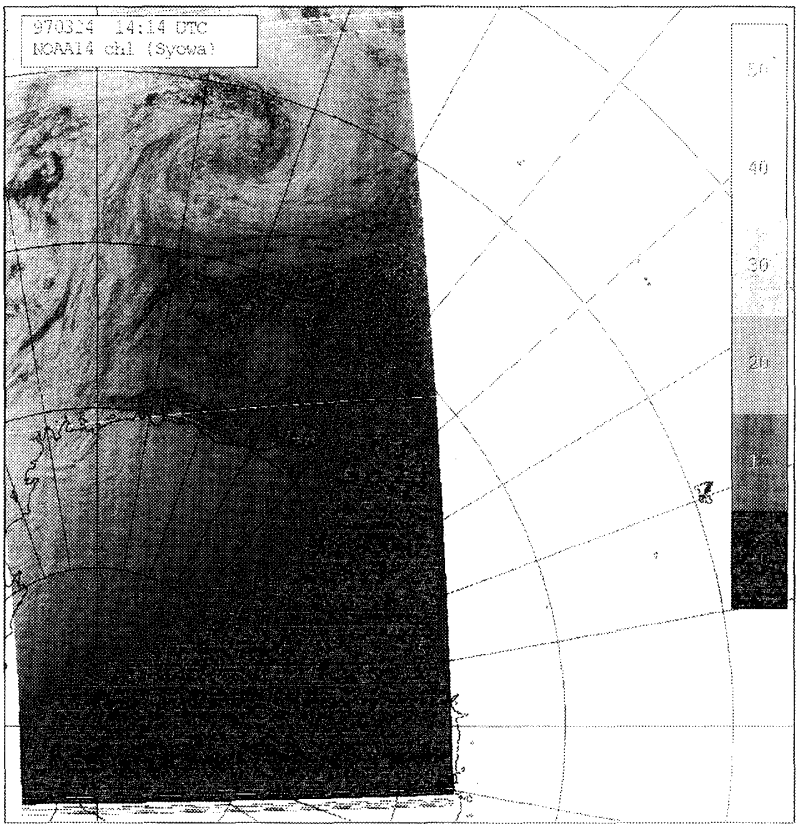
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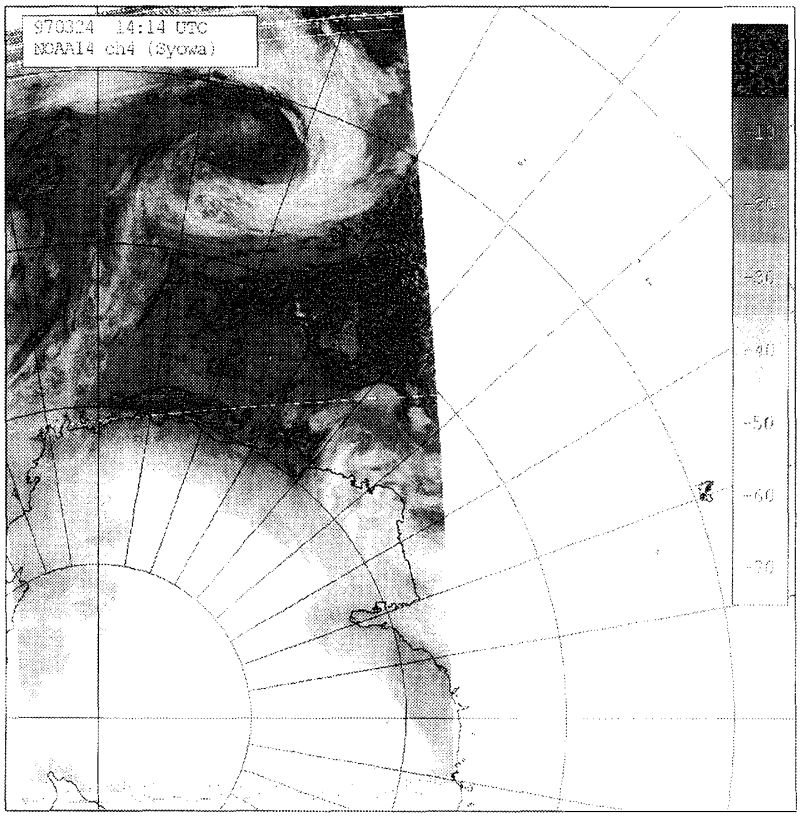
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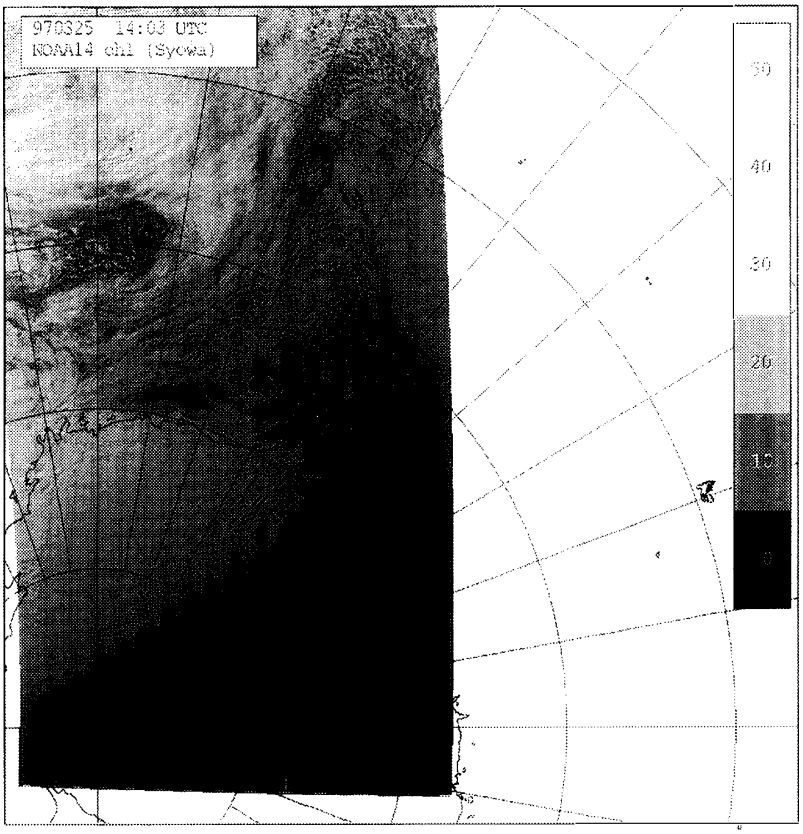
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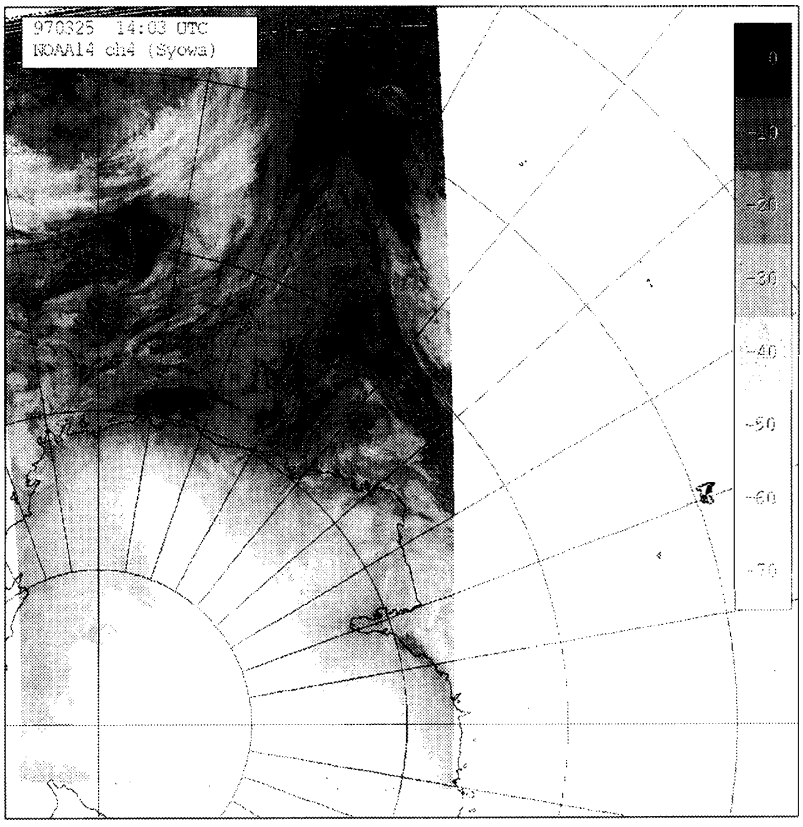
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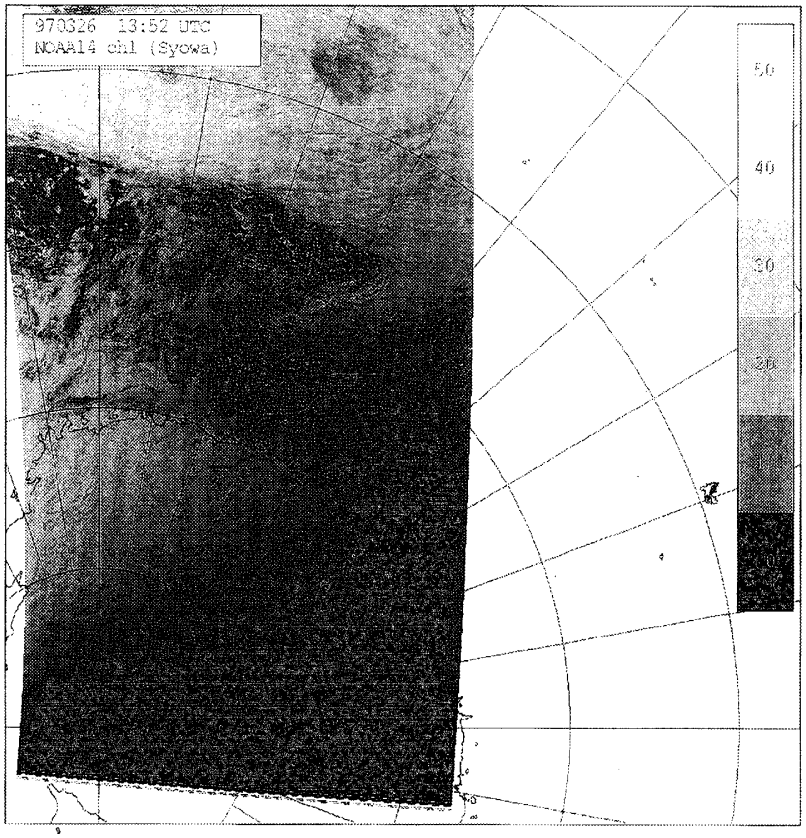
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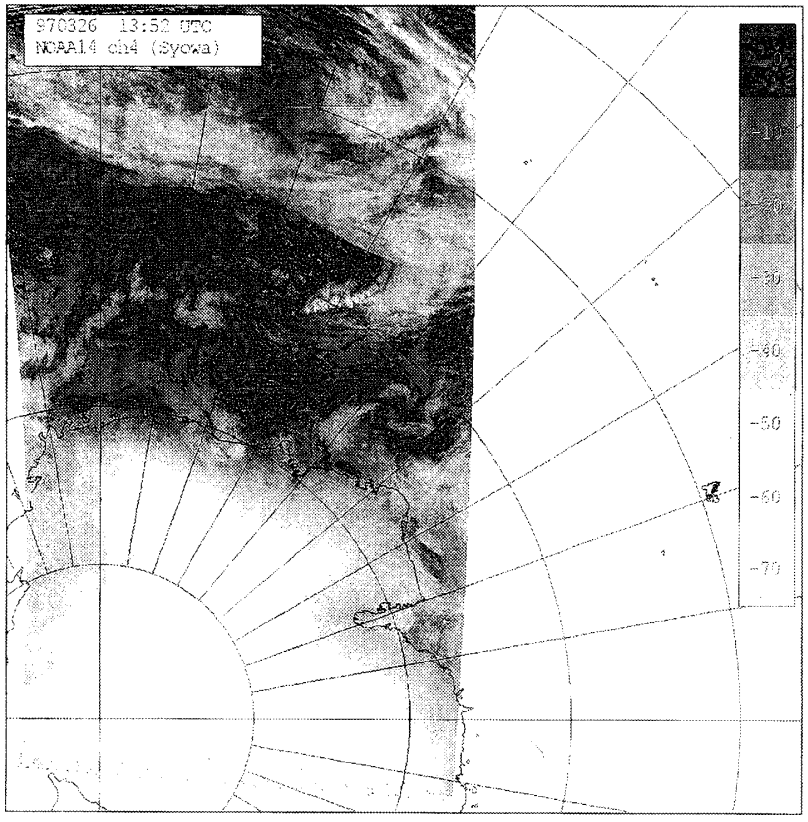
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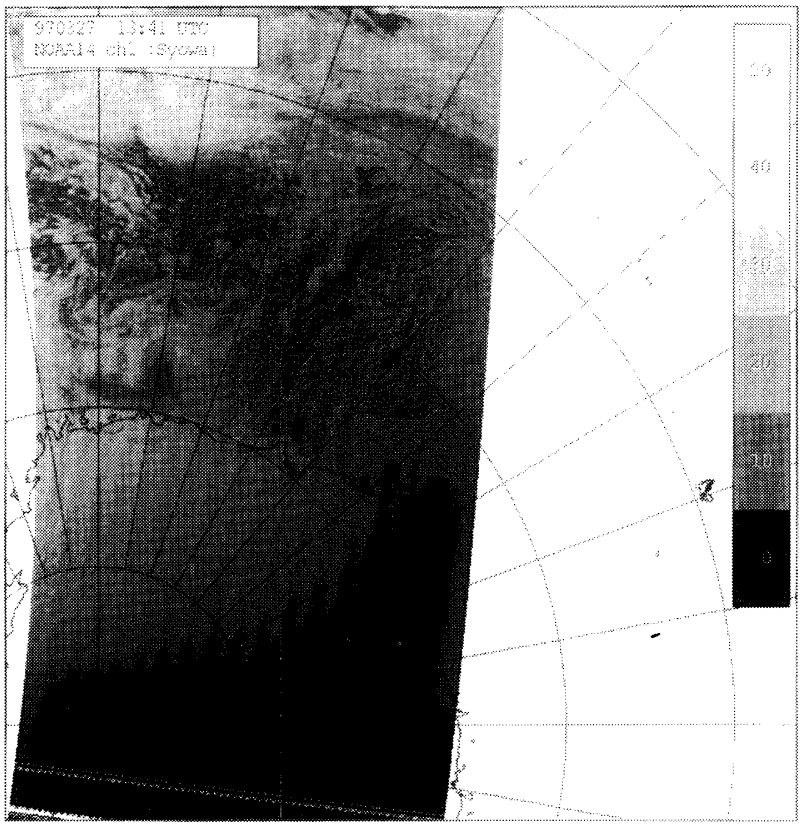
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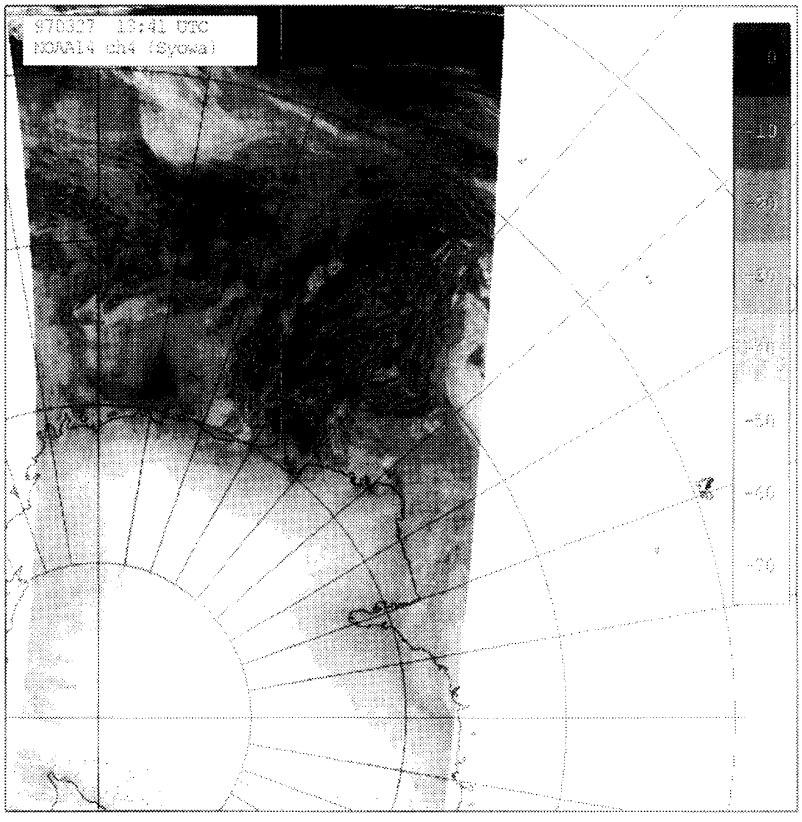
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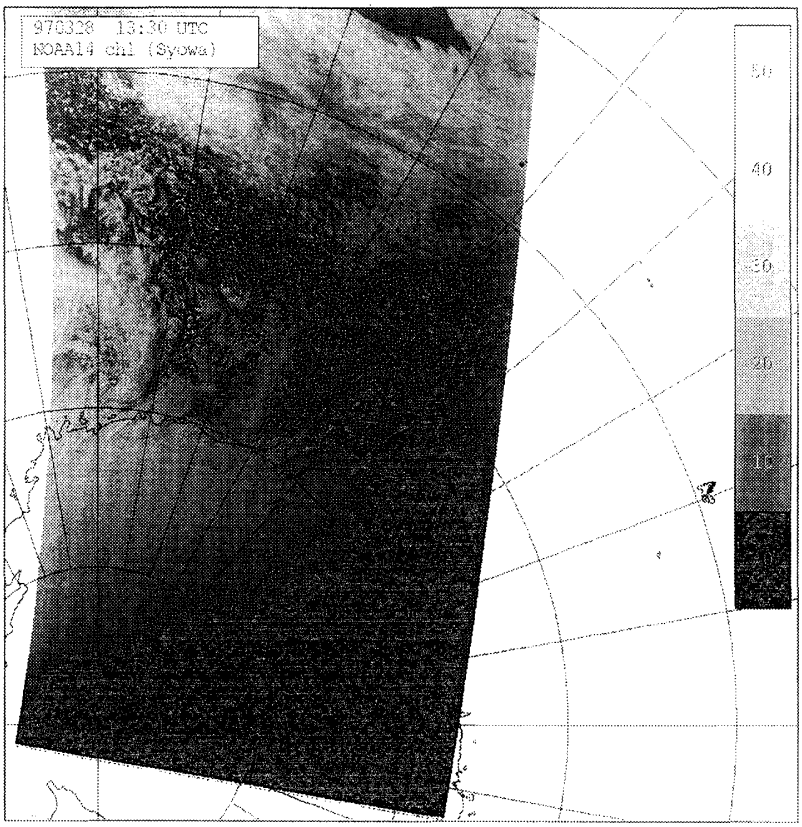
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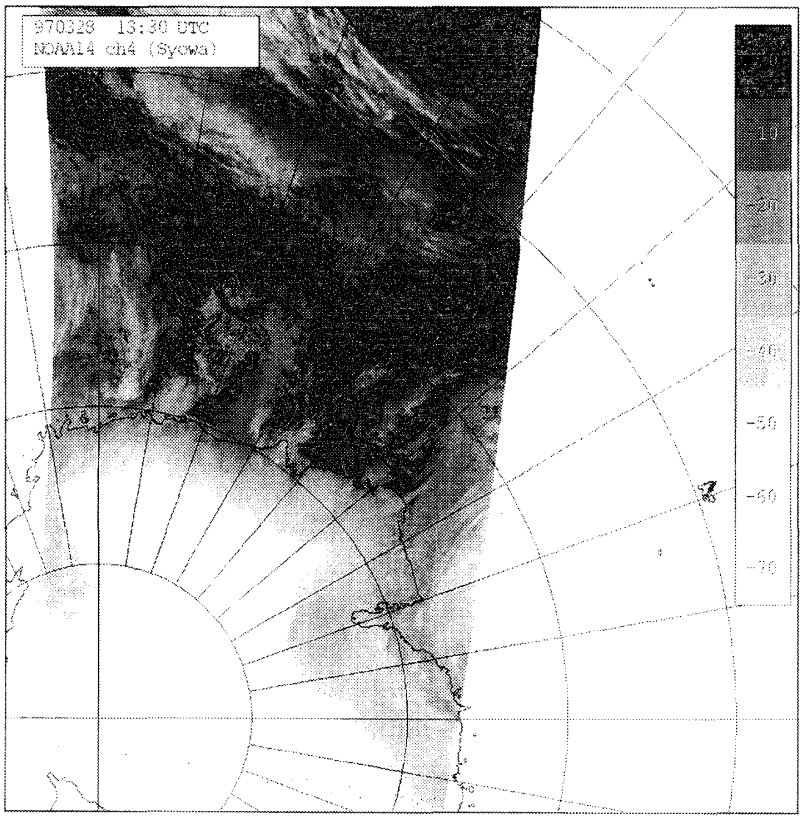
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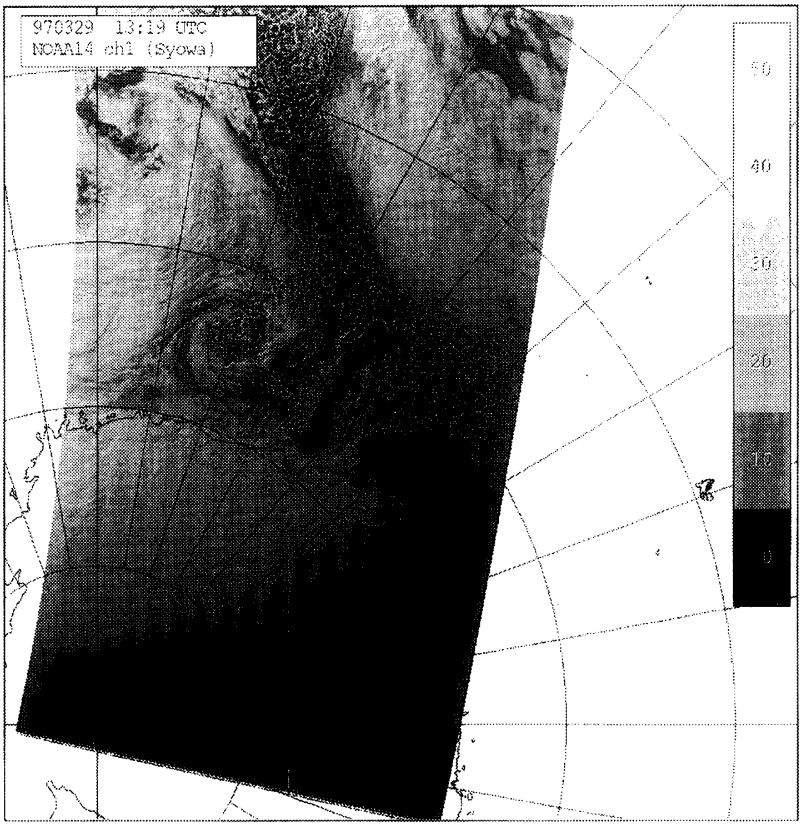
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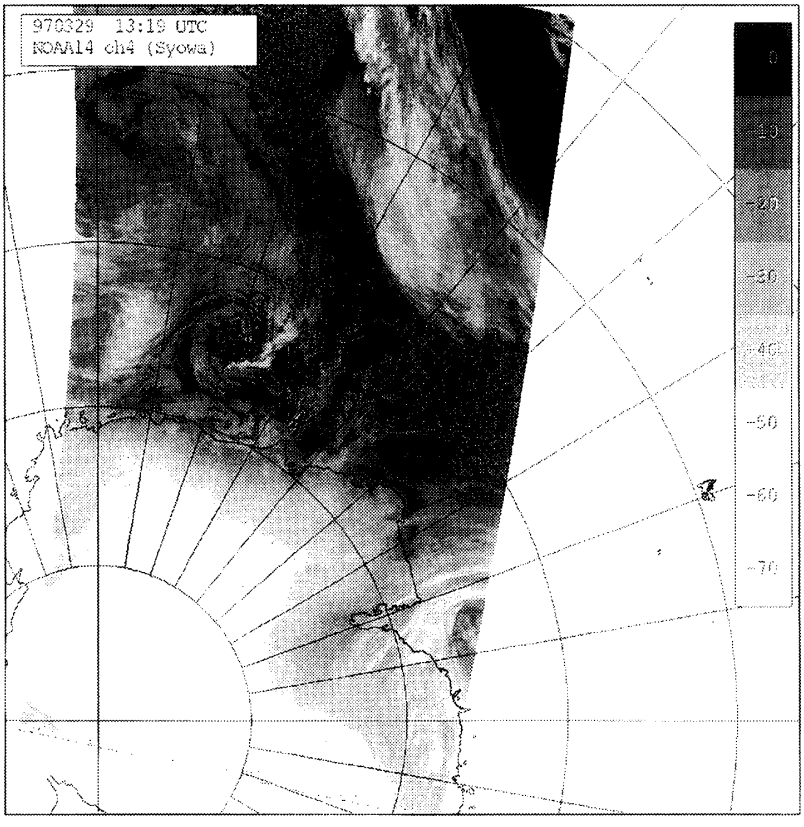
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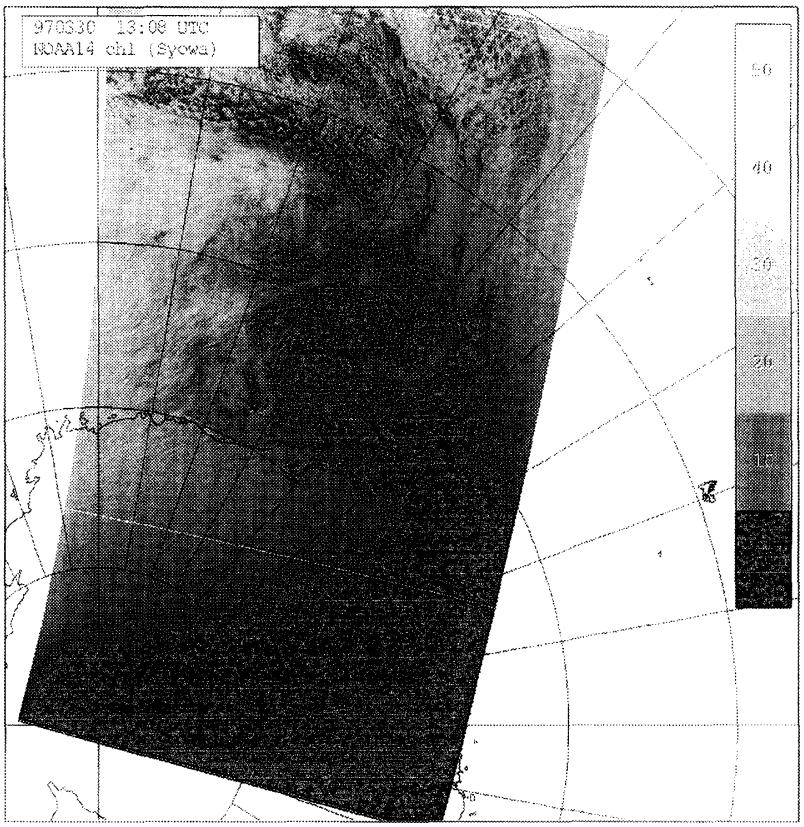
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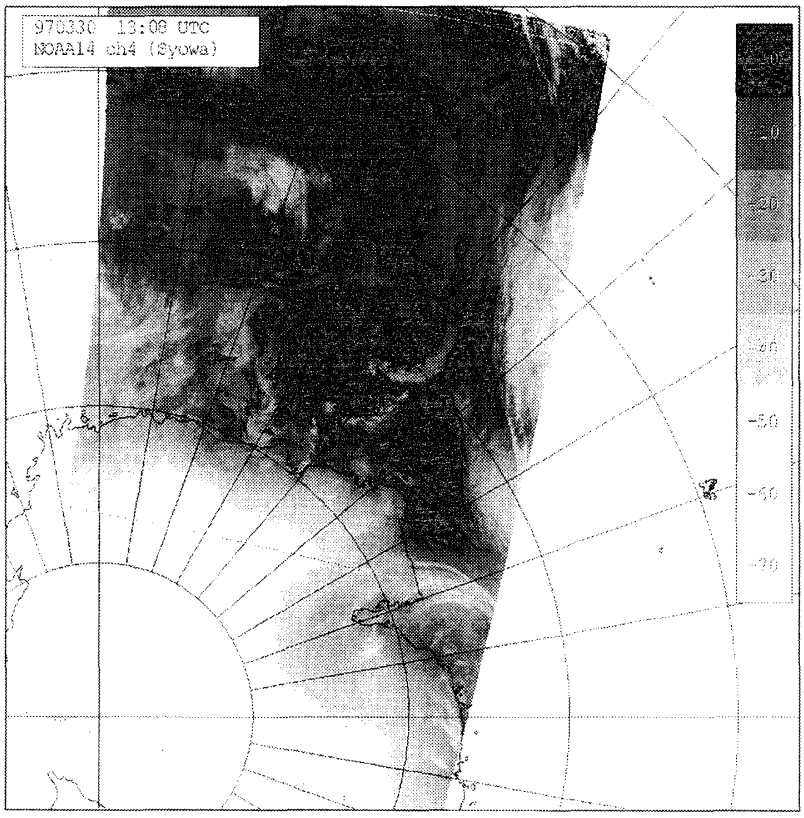
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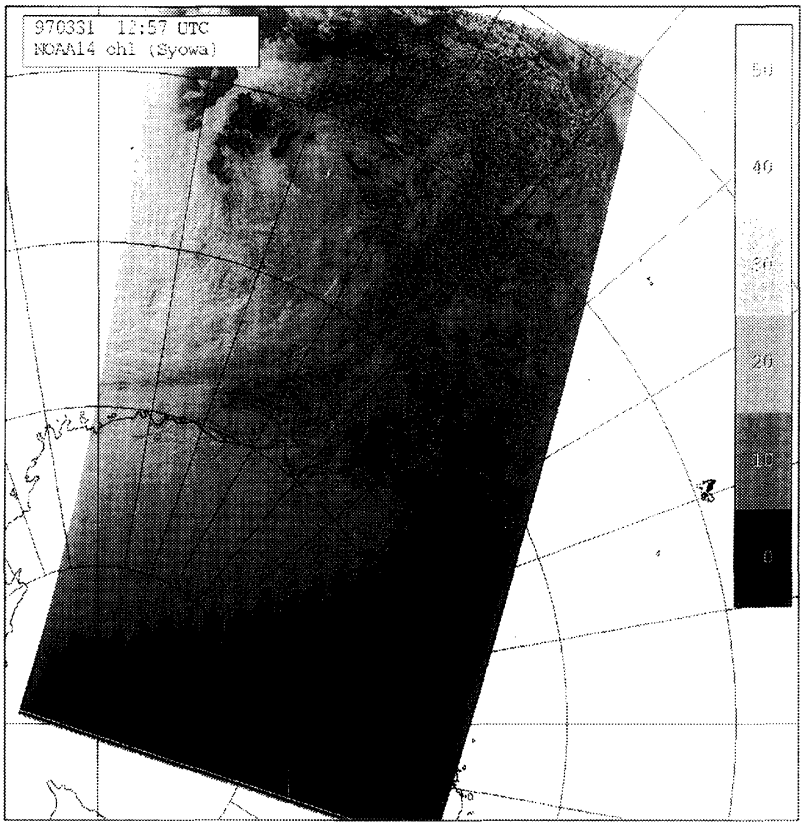
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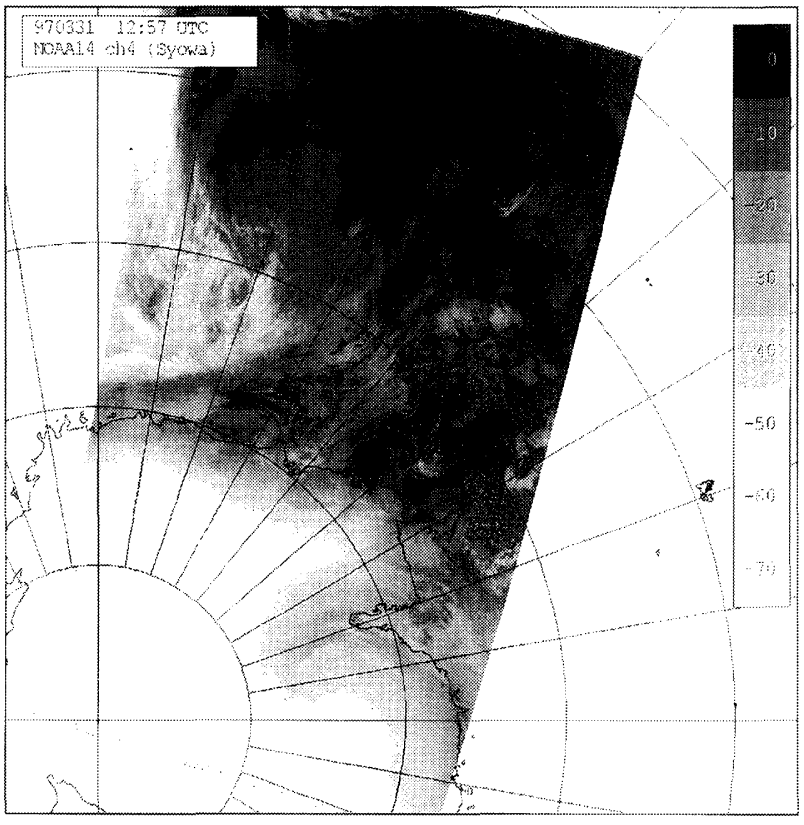
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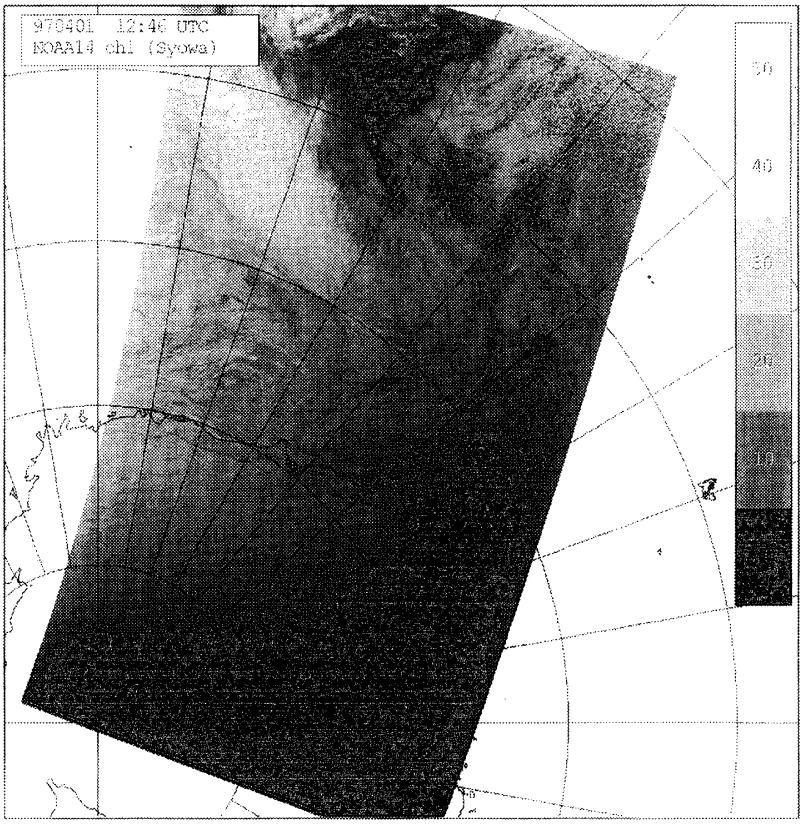
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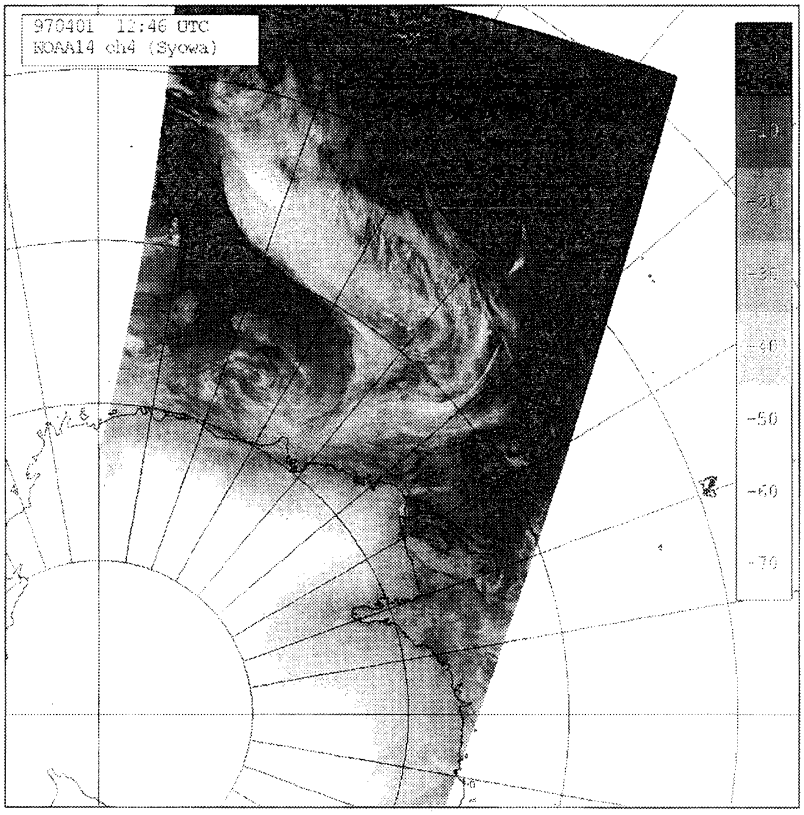
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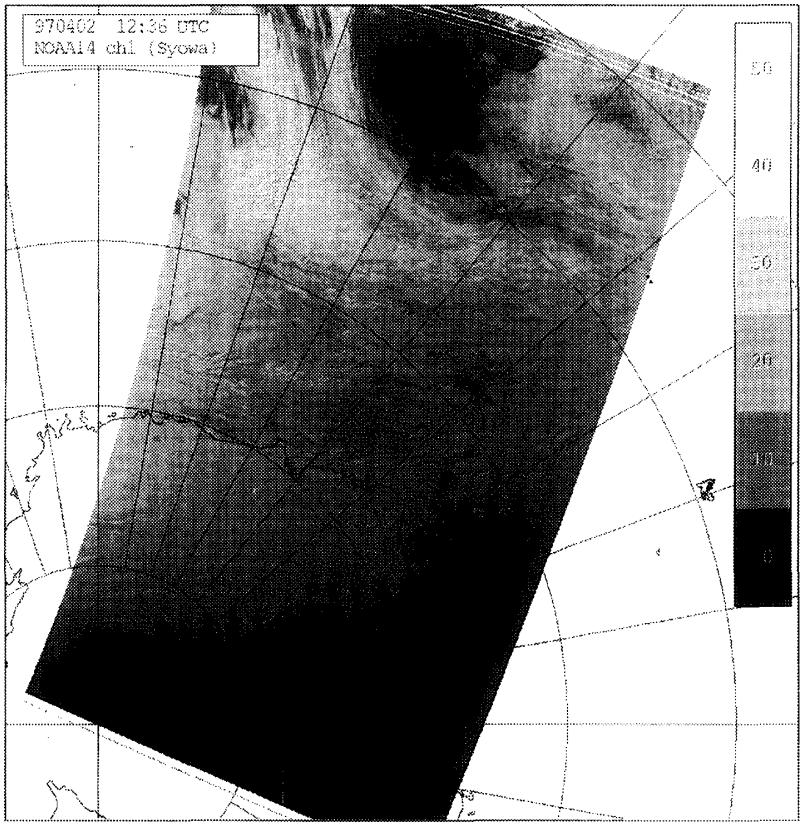
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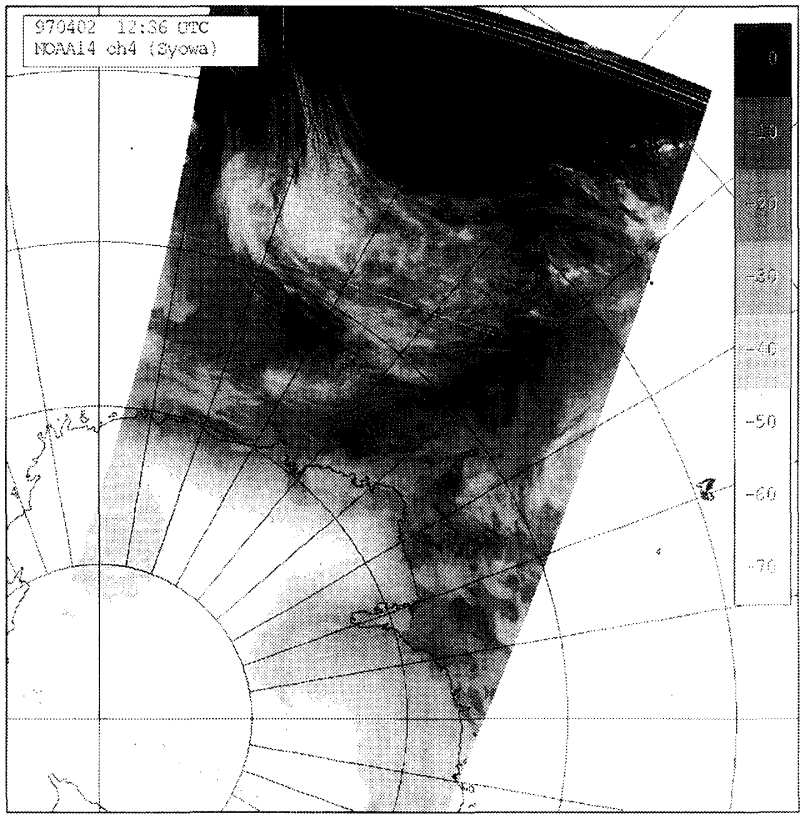
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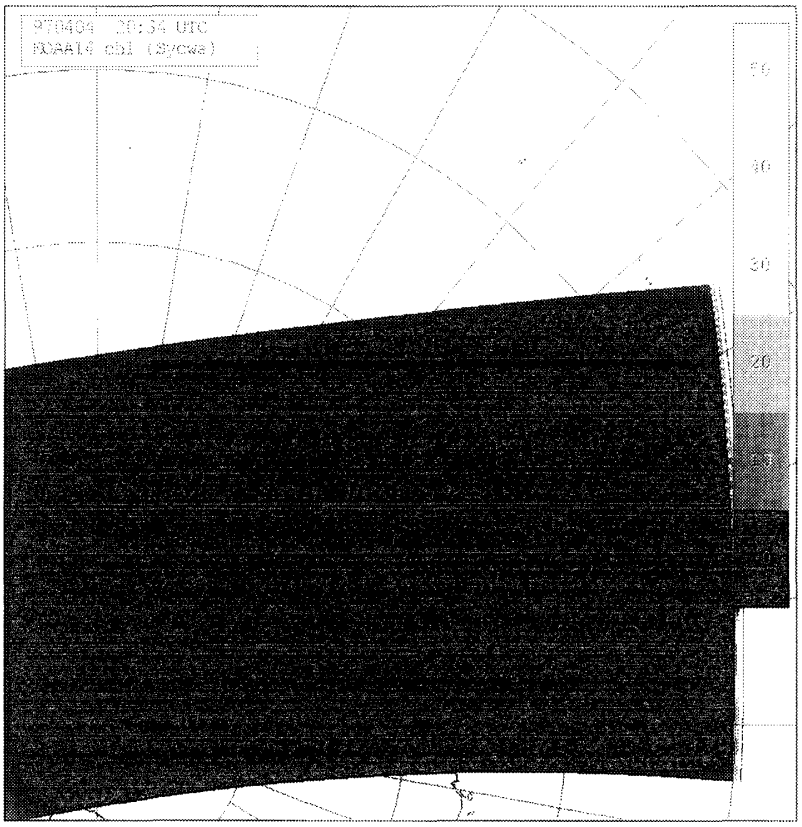
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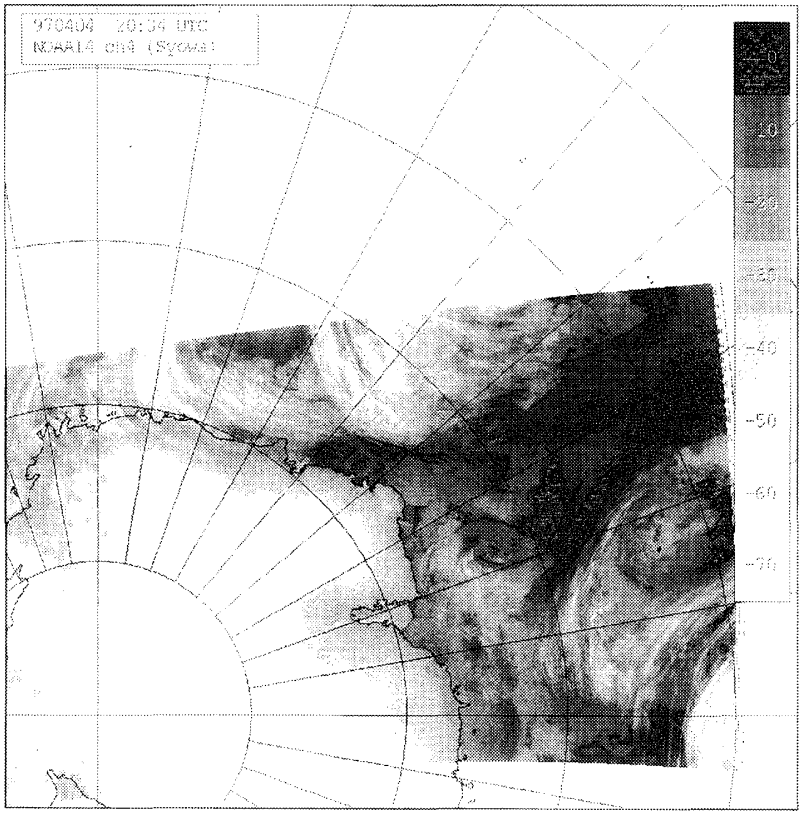
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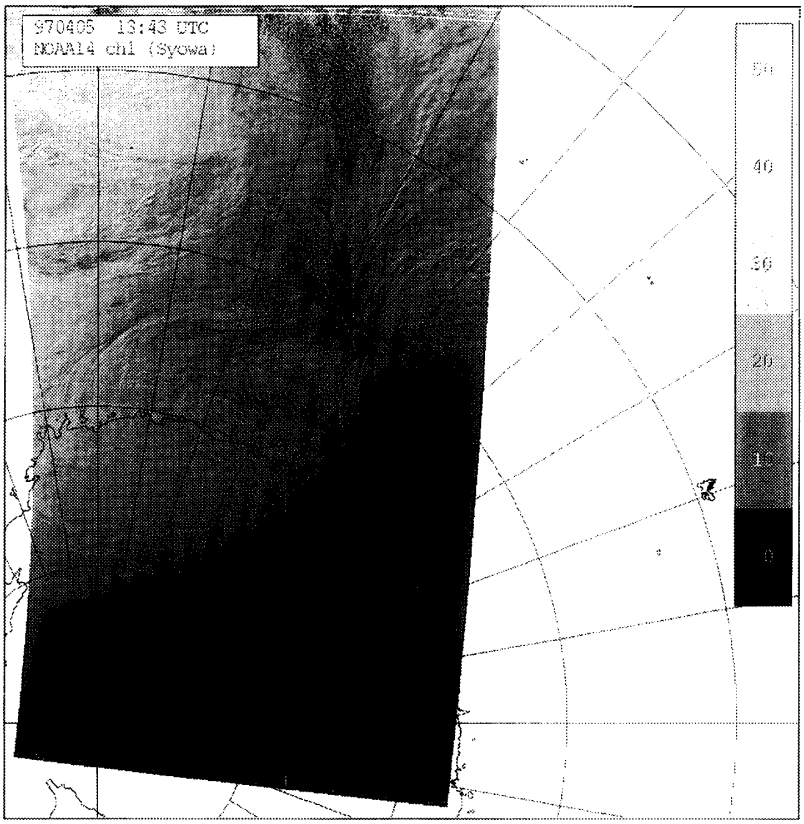
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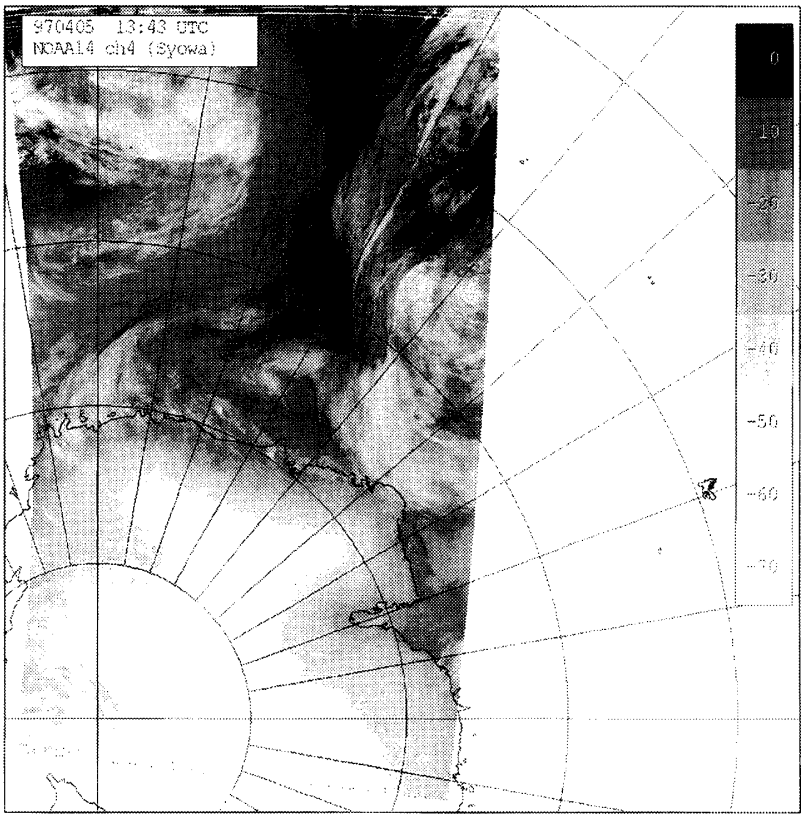
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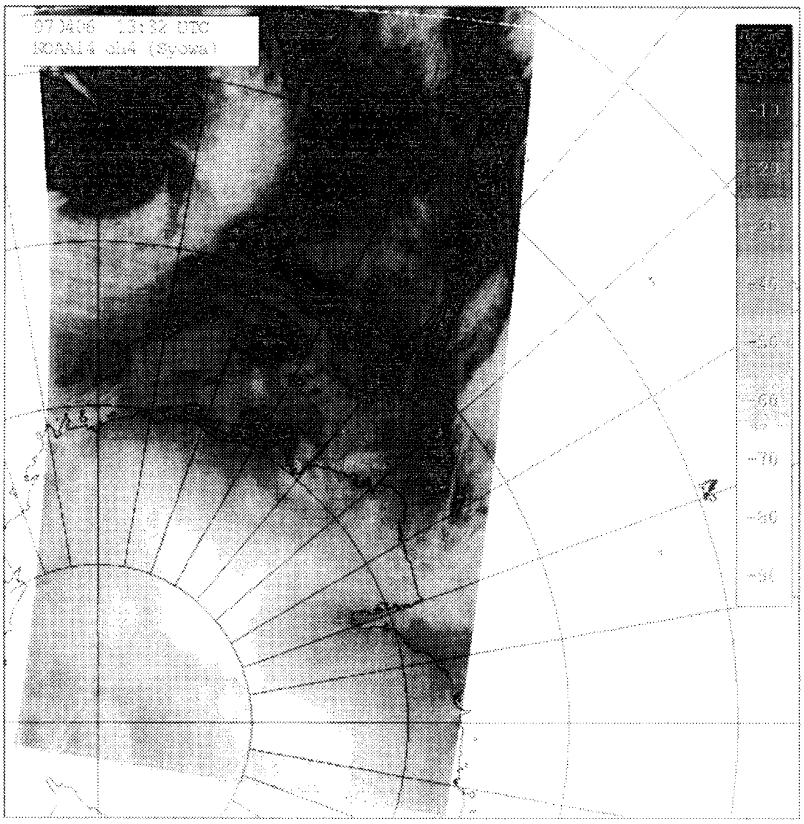
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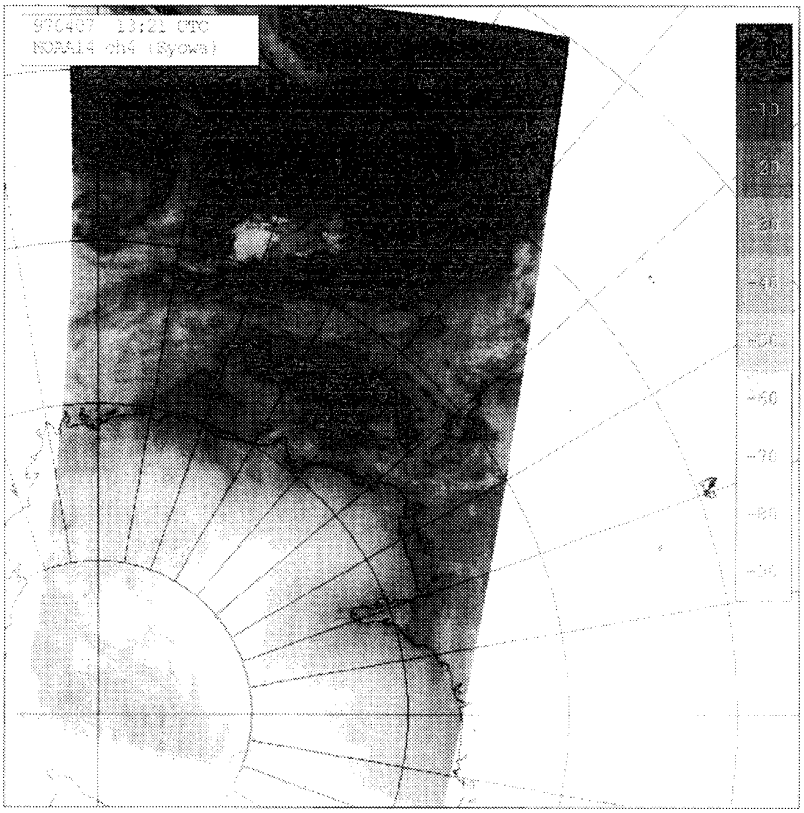
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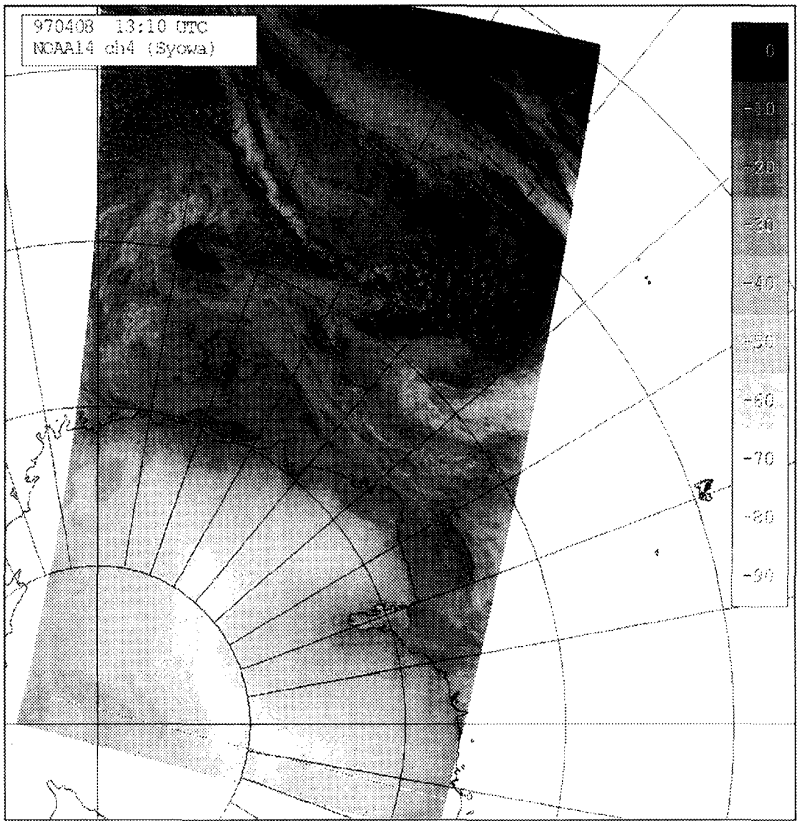
970408 13:10 UTC
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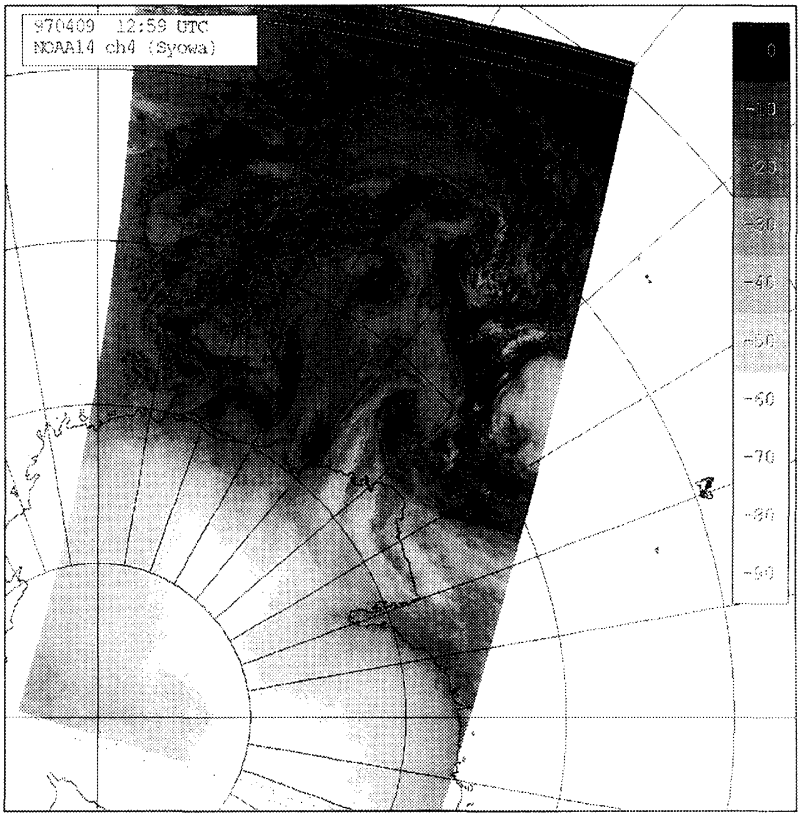
970409 12:59 UTC
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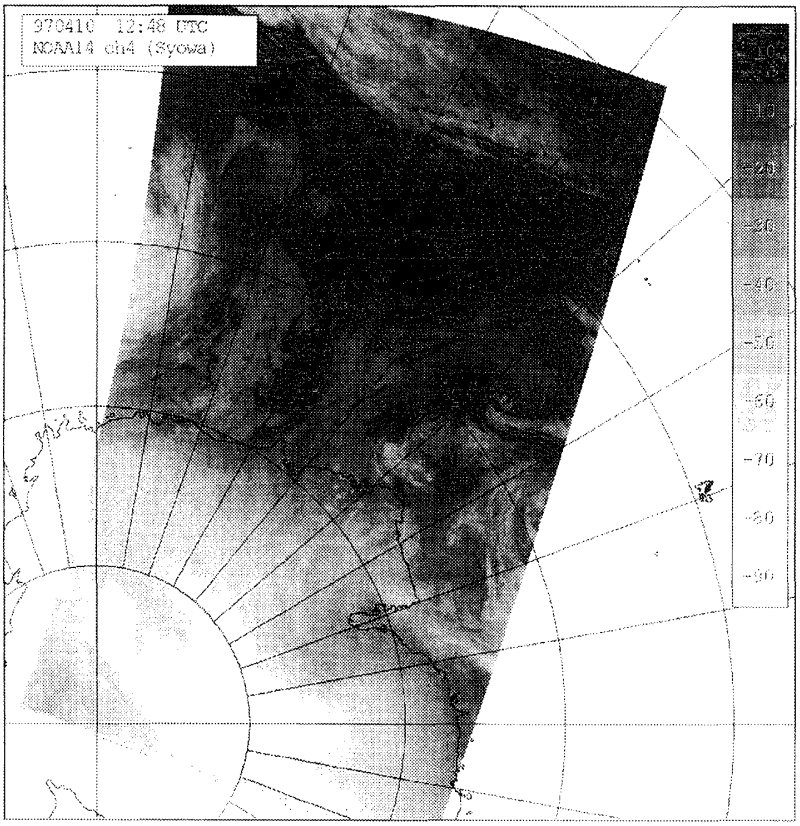
970410 12:48 UTC
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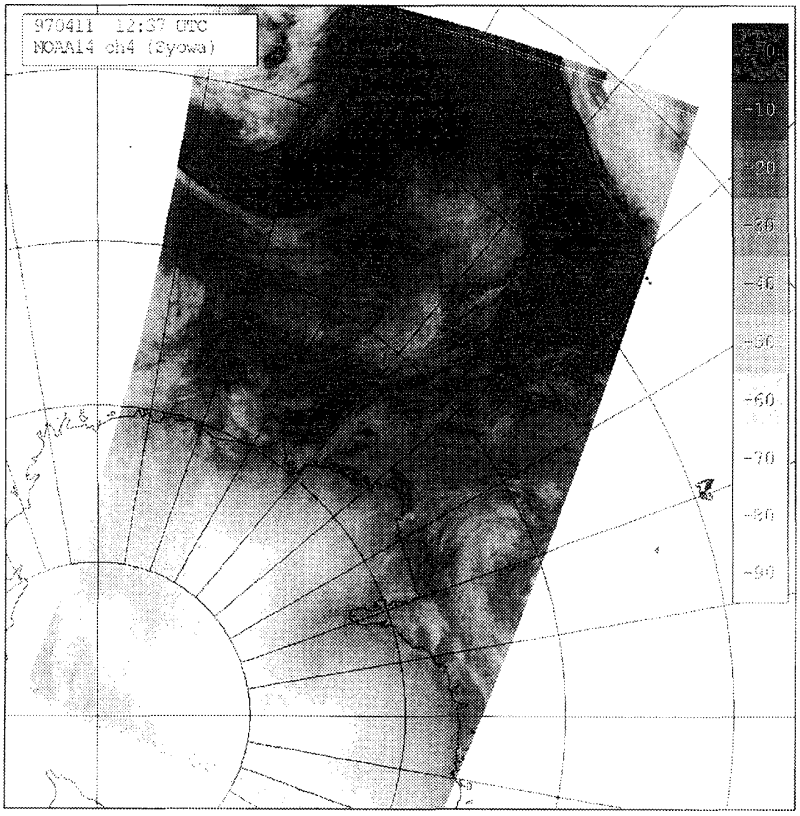
970411 12:37 UTC
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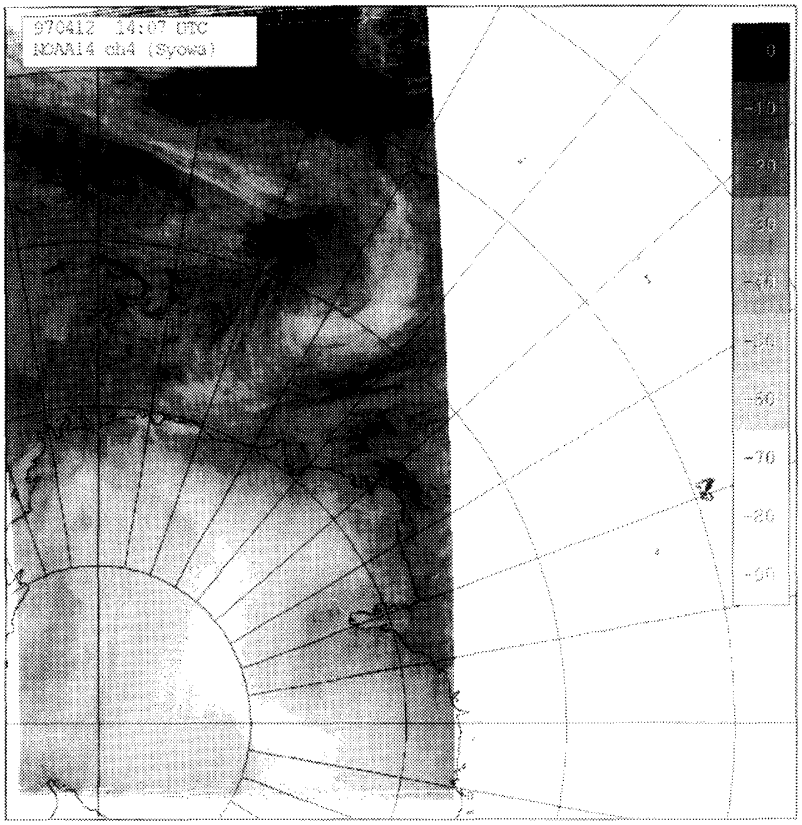
970412 14:07 UTC
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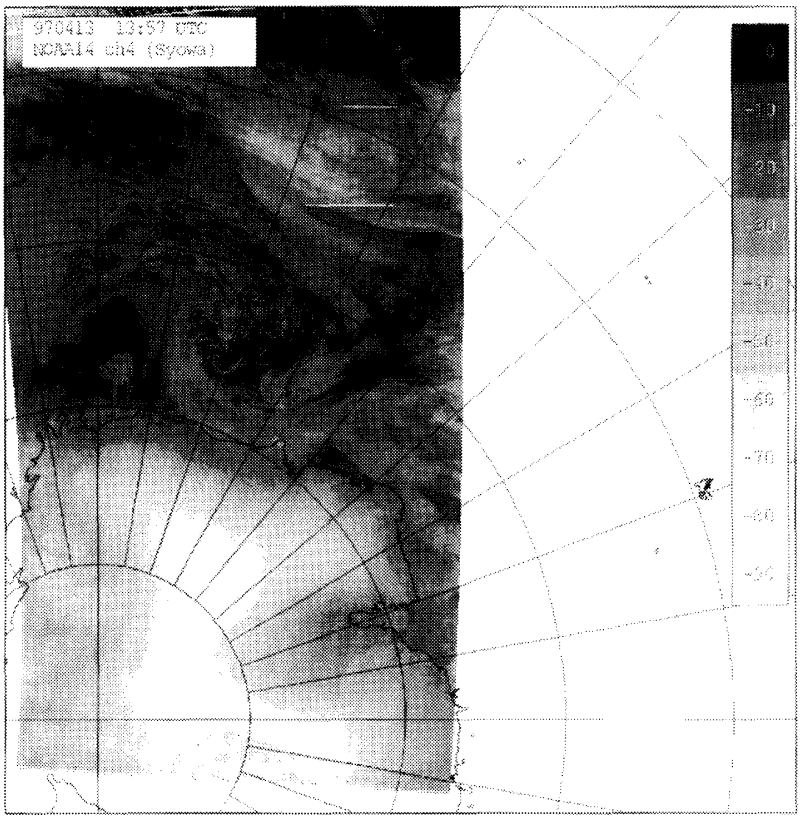
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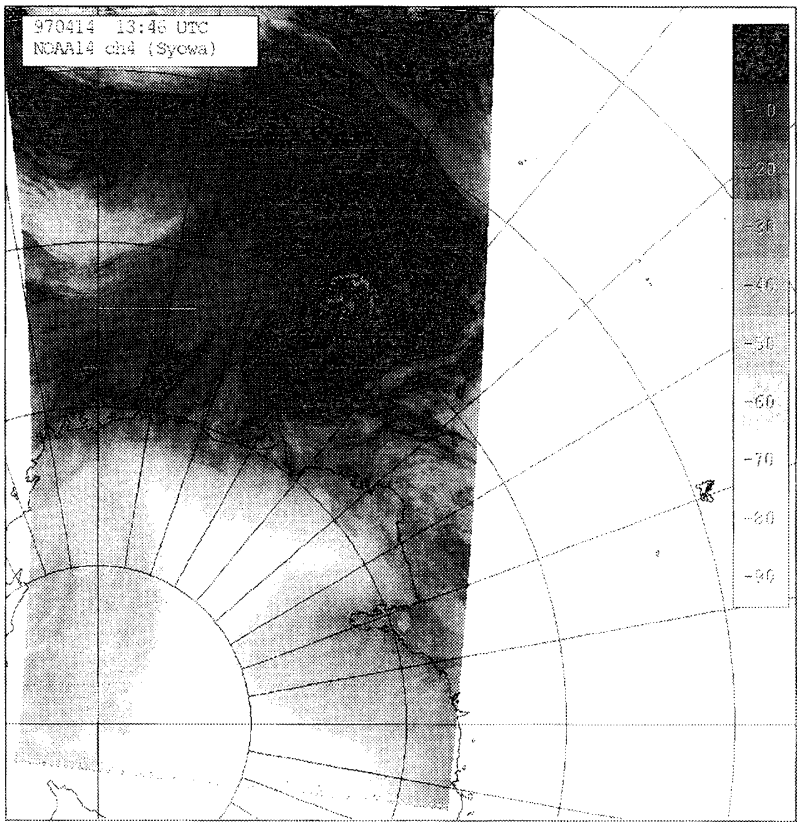
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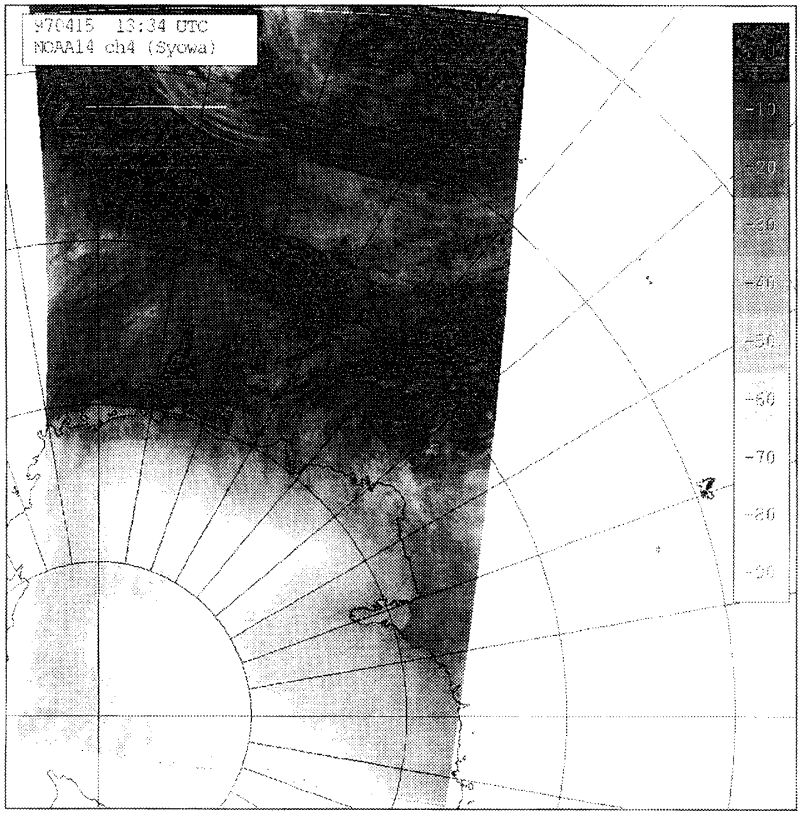
970415 13:34 UTC
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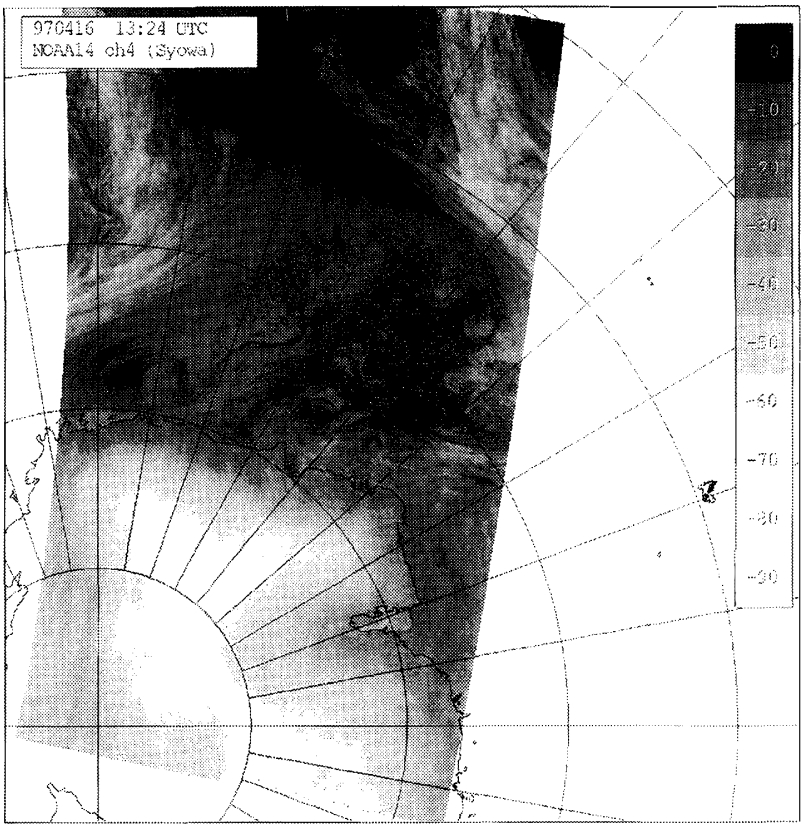
970416 13:24 UTC
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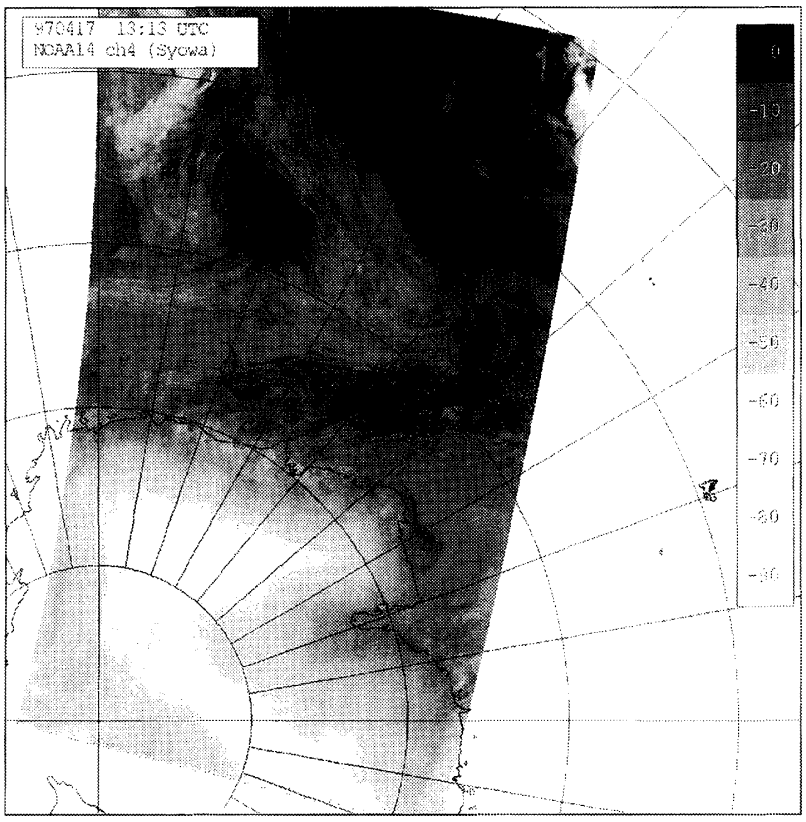
970417 13:13 UTC
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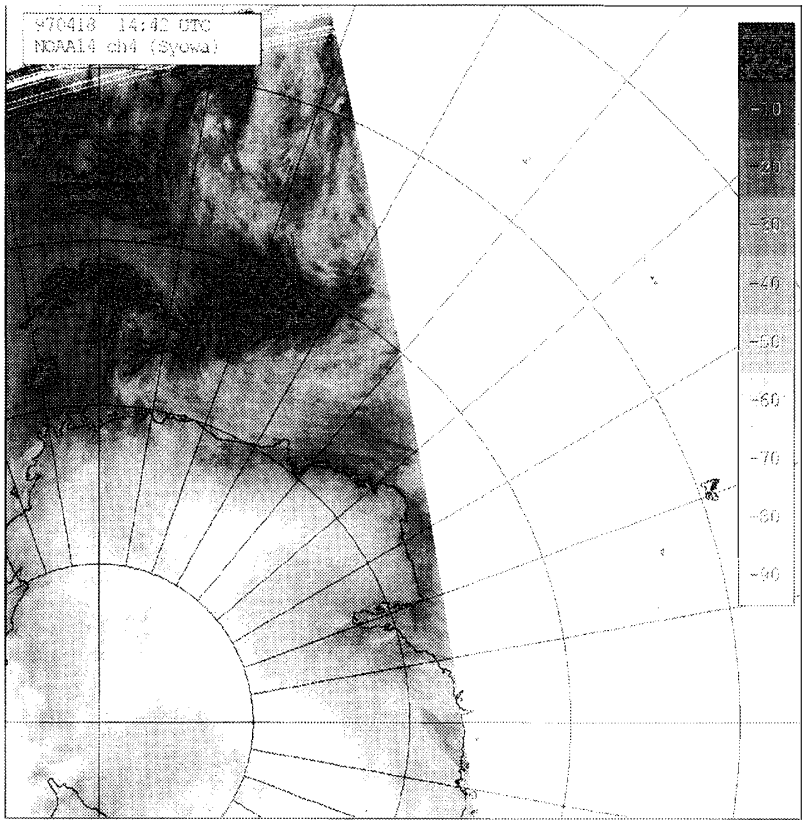
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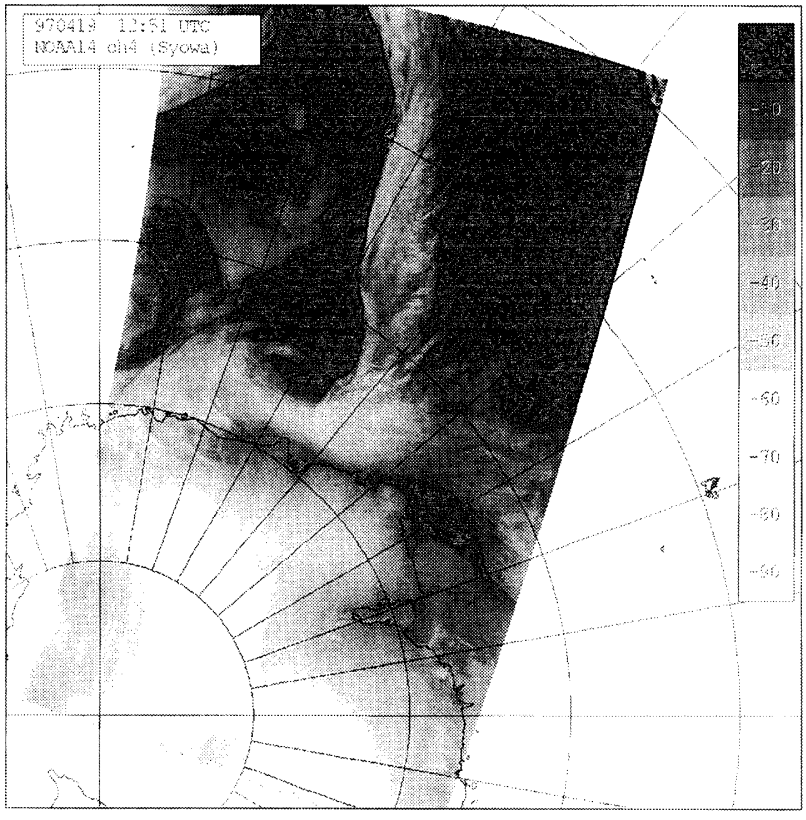
970418 13:51 UTC
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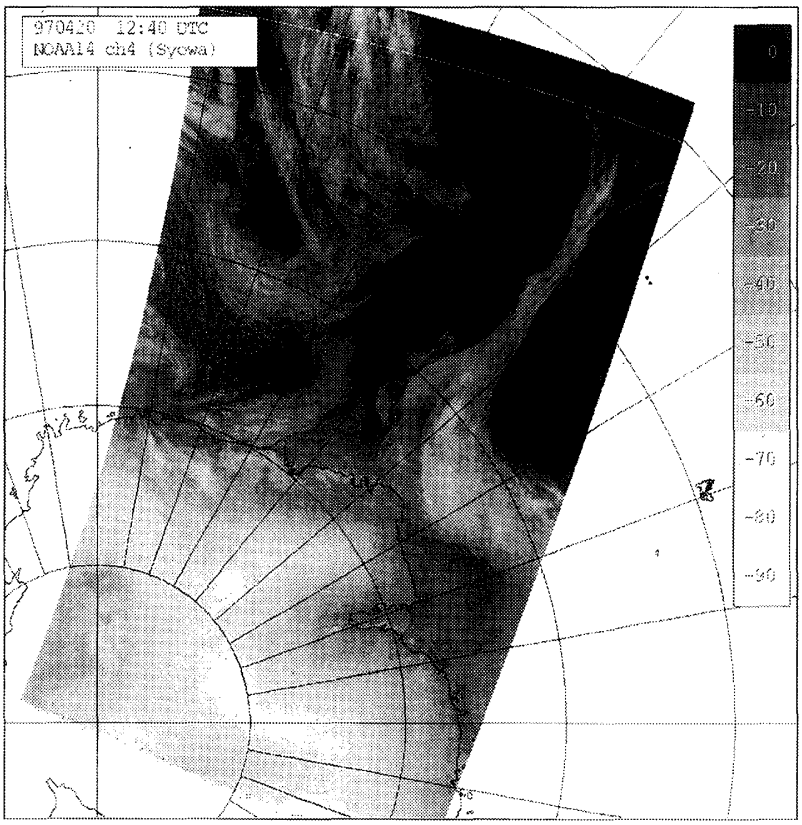
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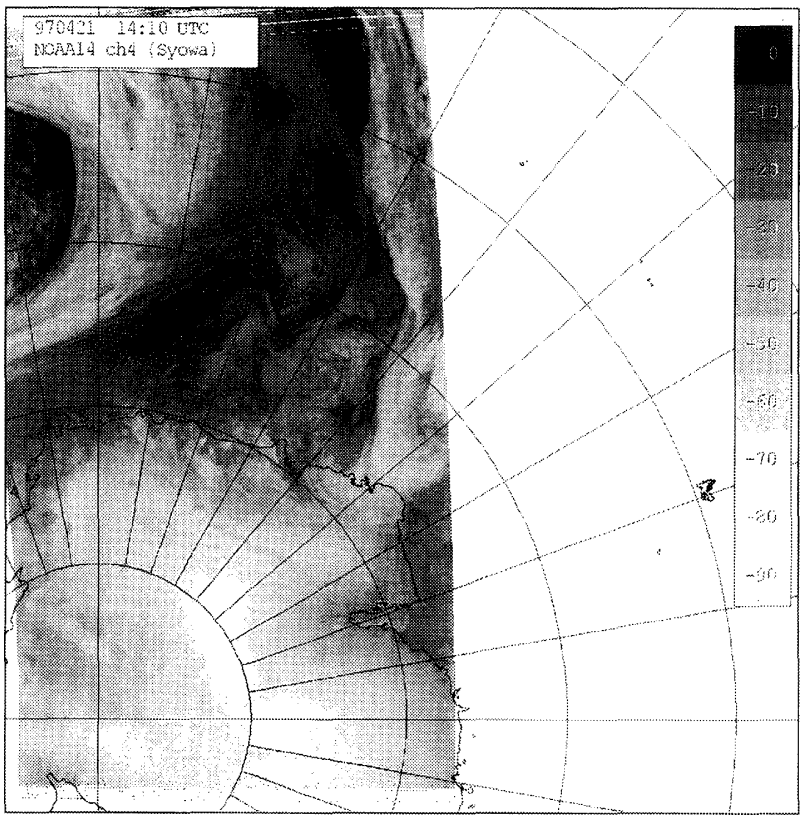
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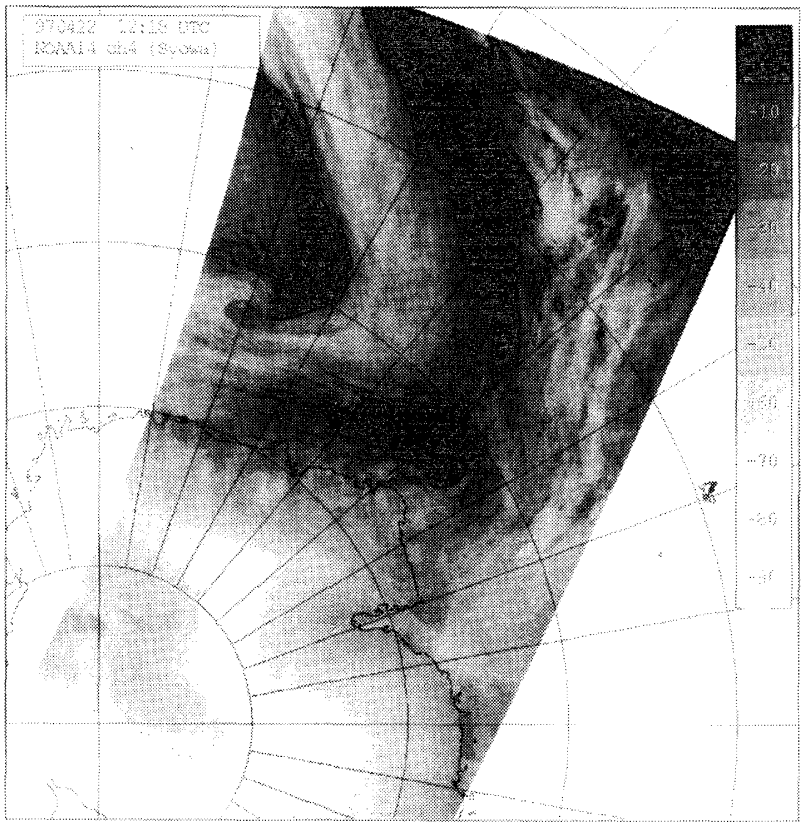
970422 22:25 UTC
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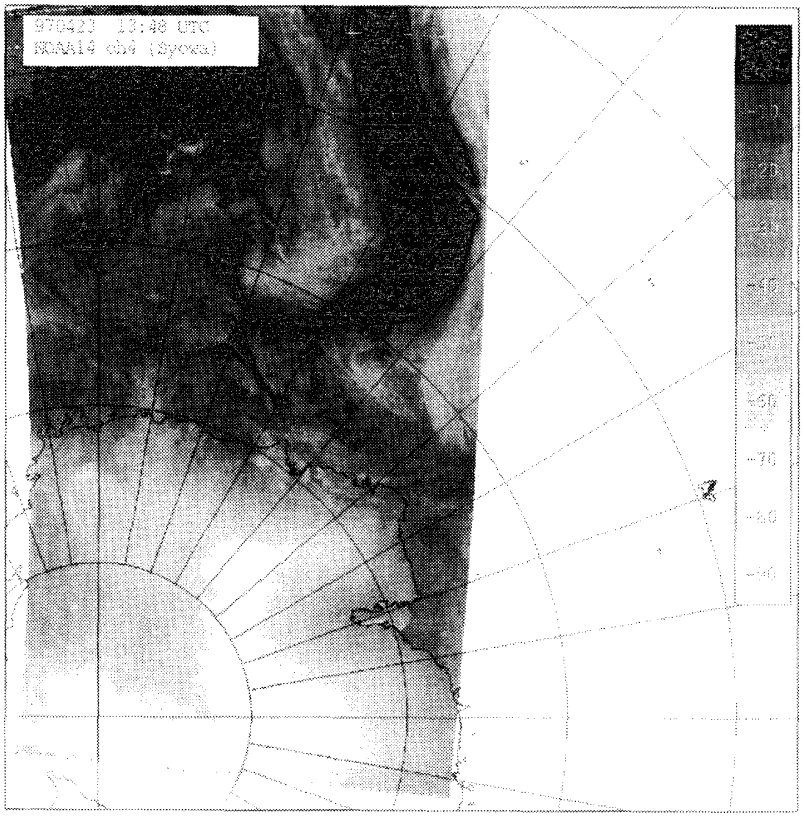
970423 13:48 UTC
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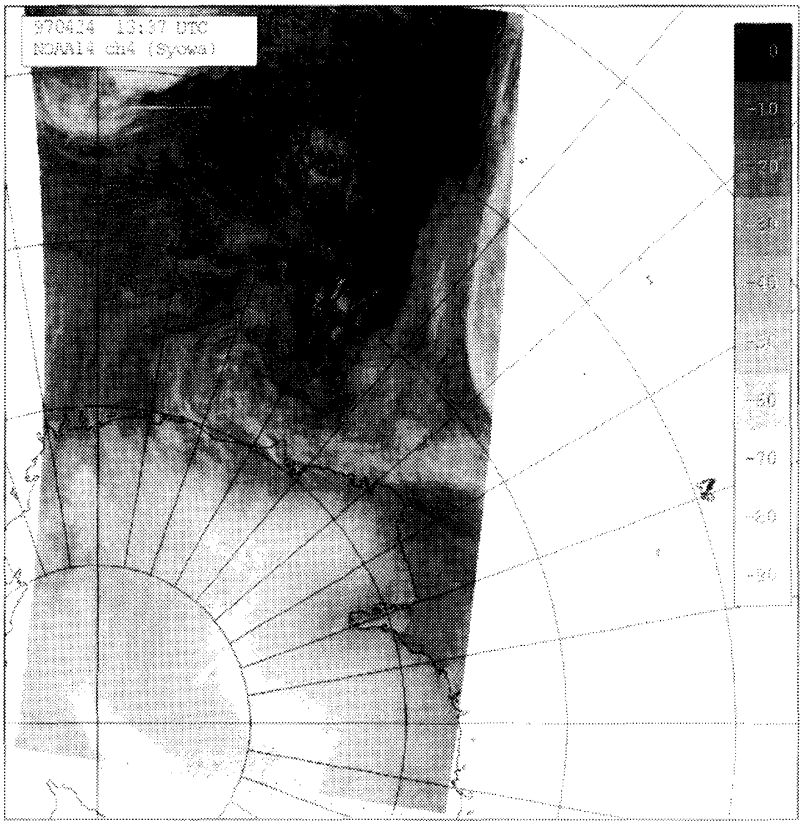
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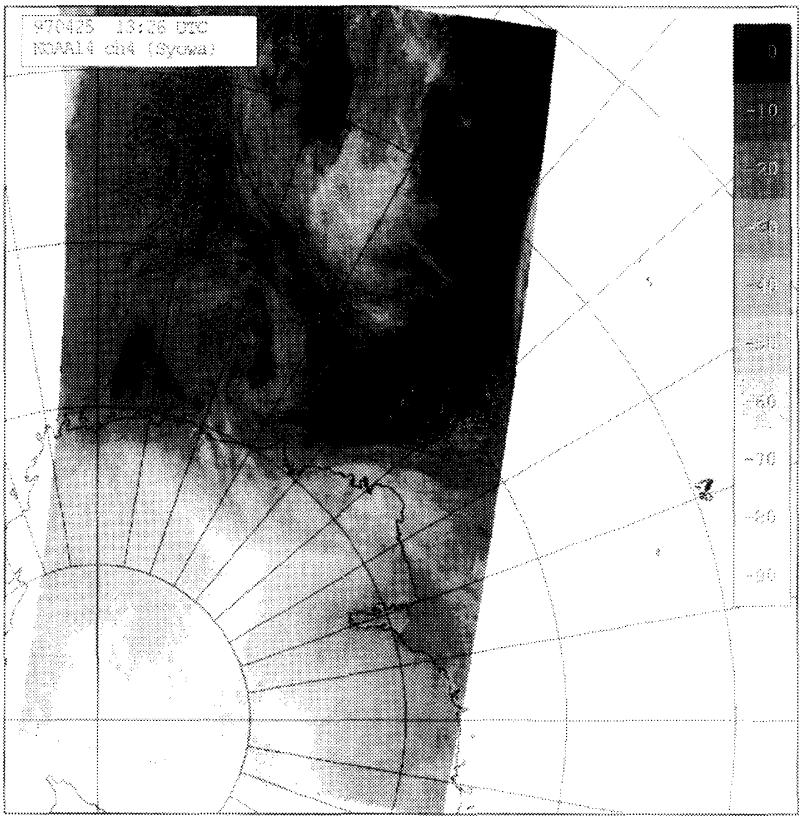
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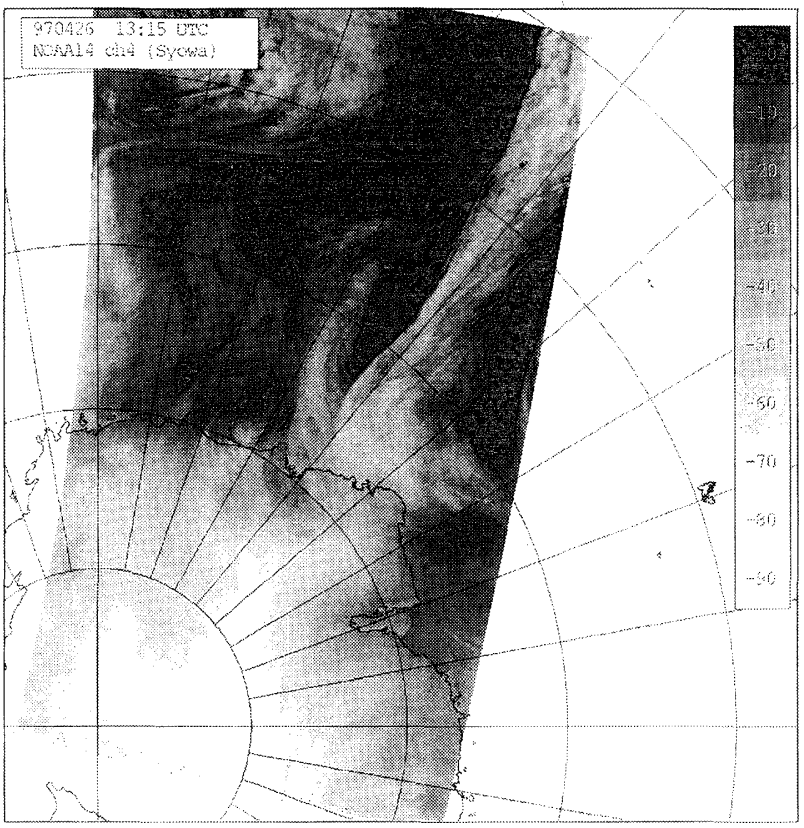
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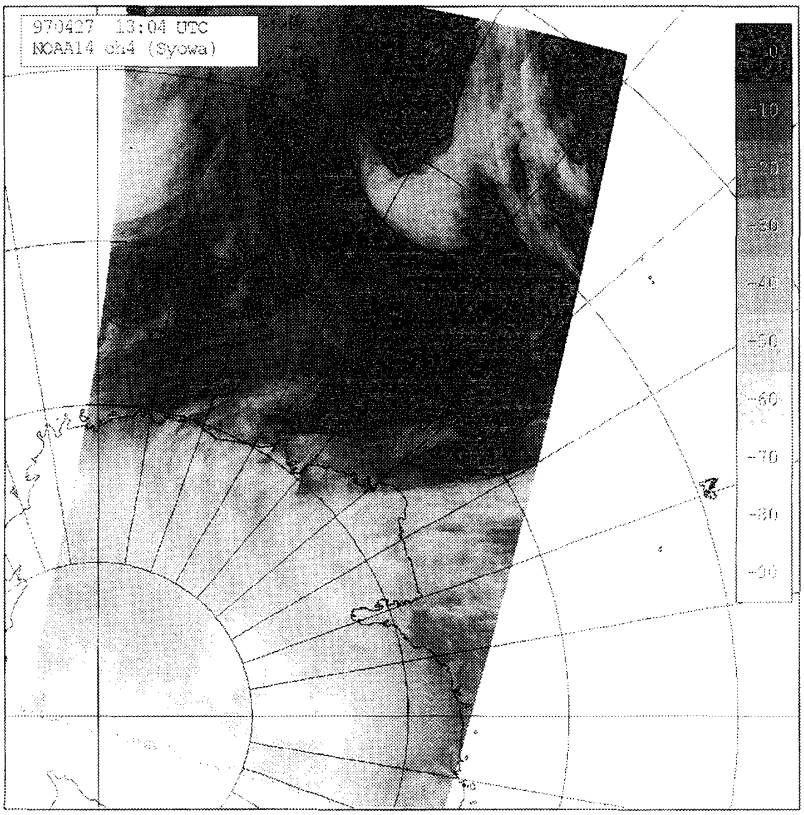
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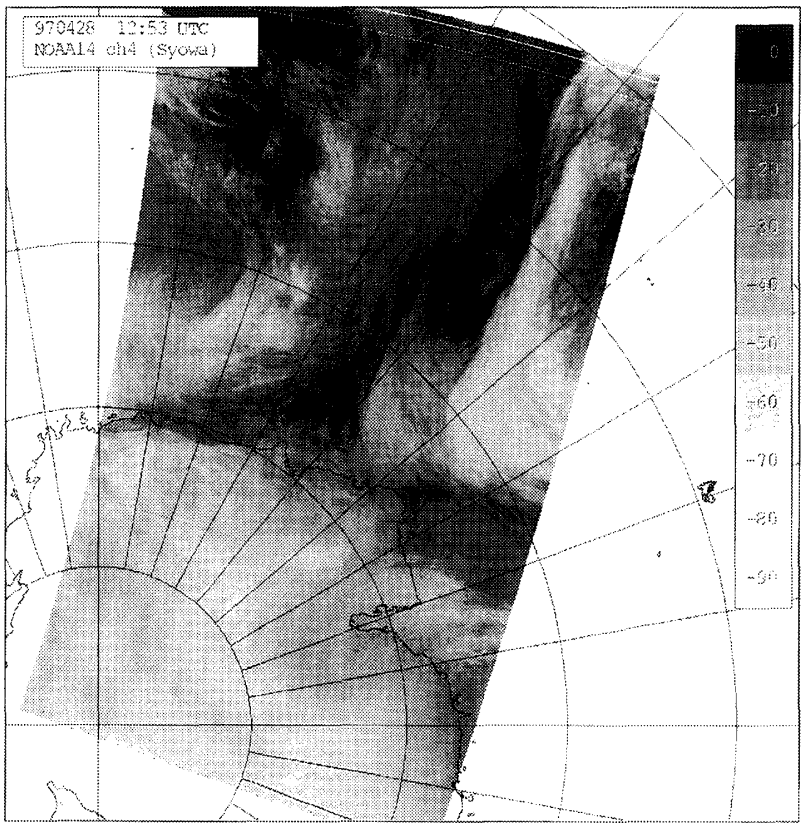
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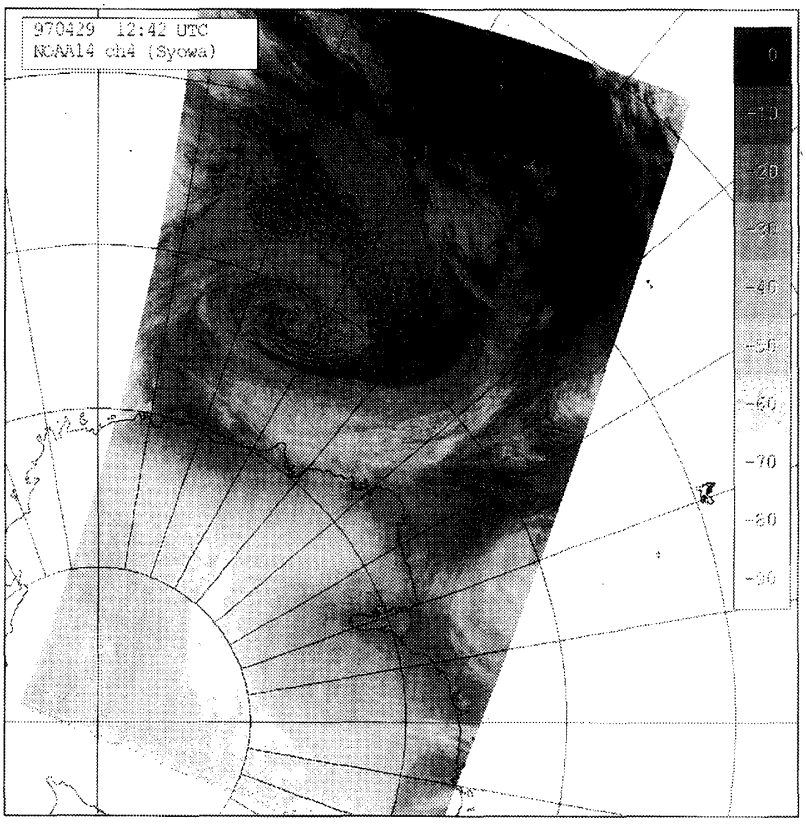
970429 12:42 UTC
NOAA14 ch4 (Syowa)
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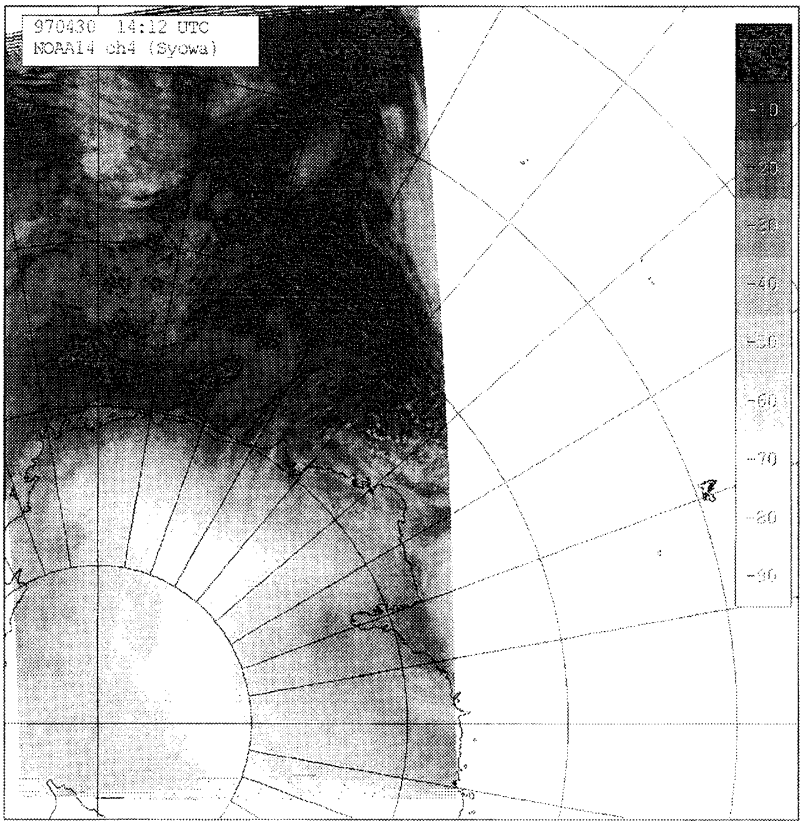
970430 14:12 UTC
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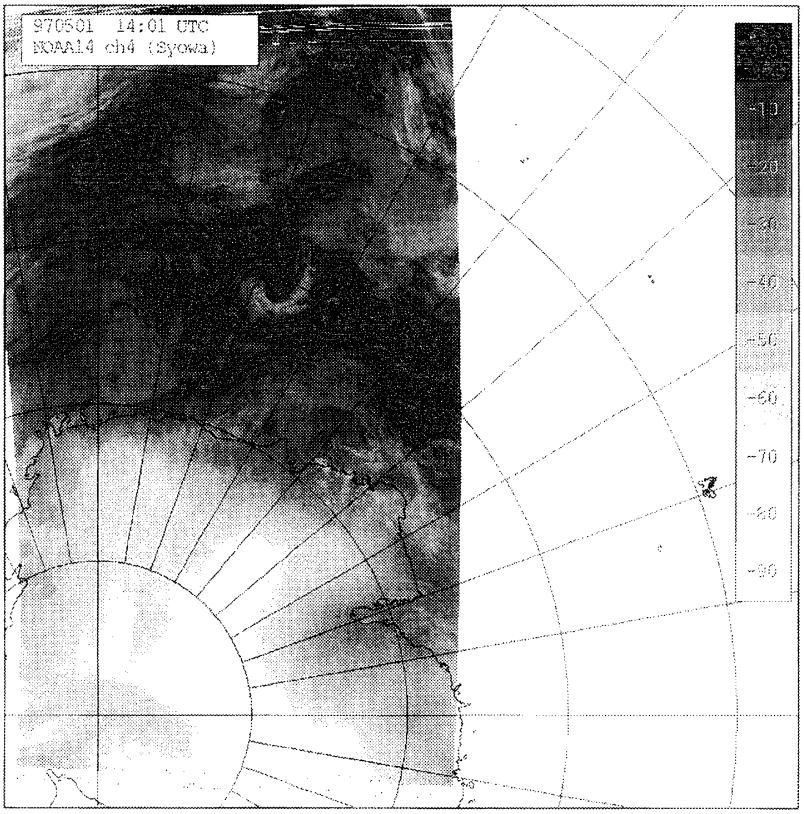
970501 14:01 UTC
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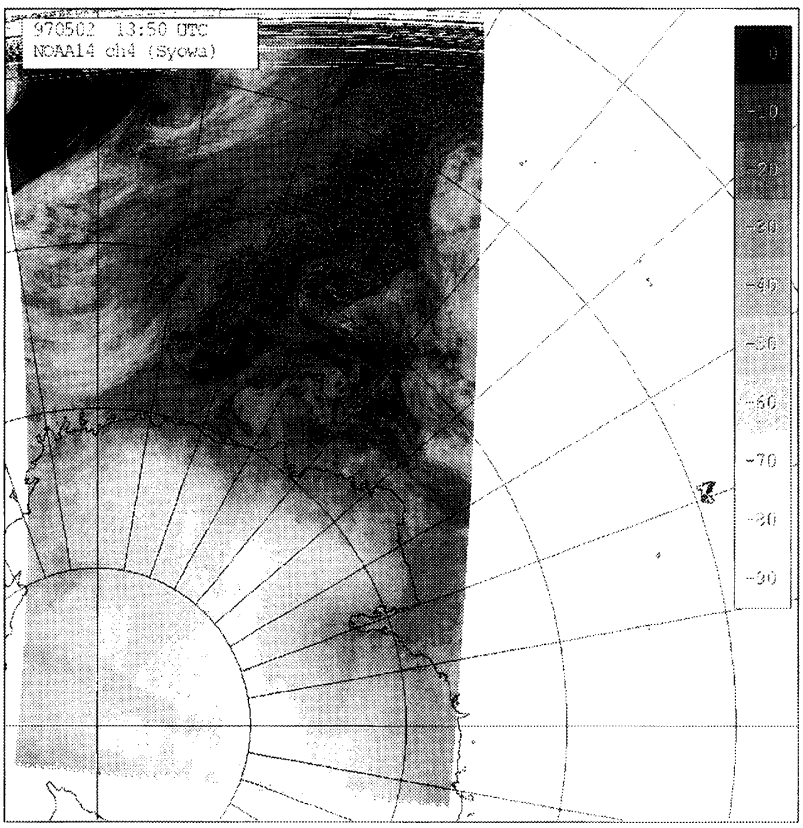
970502 13:50 UTC
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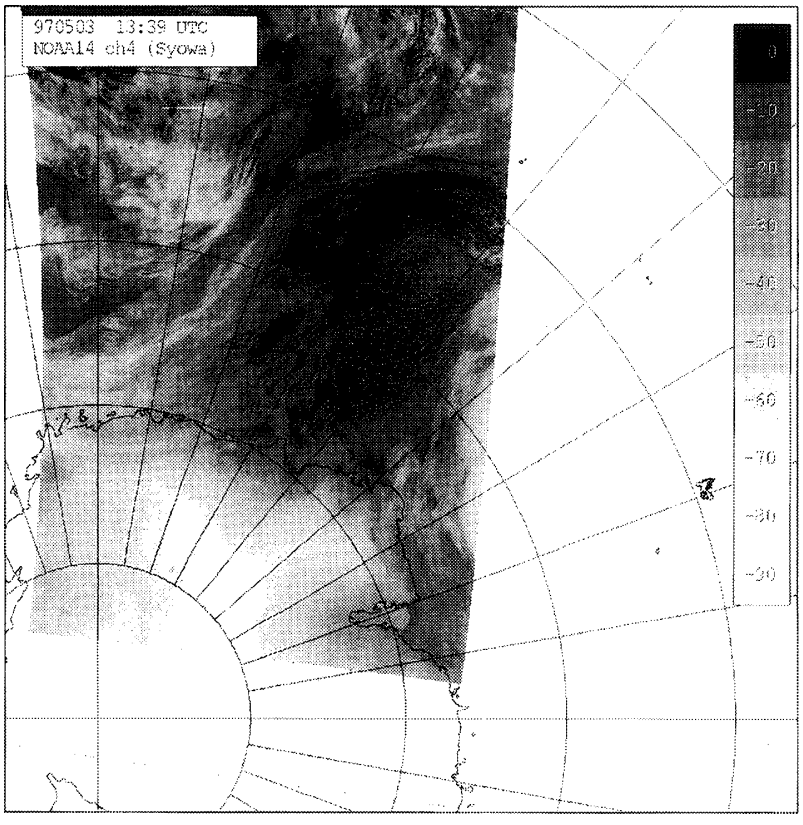
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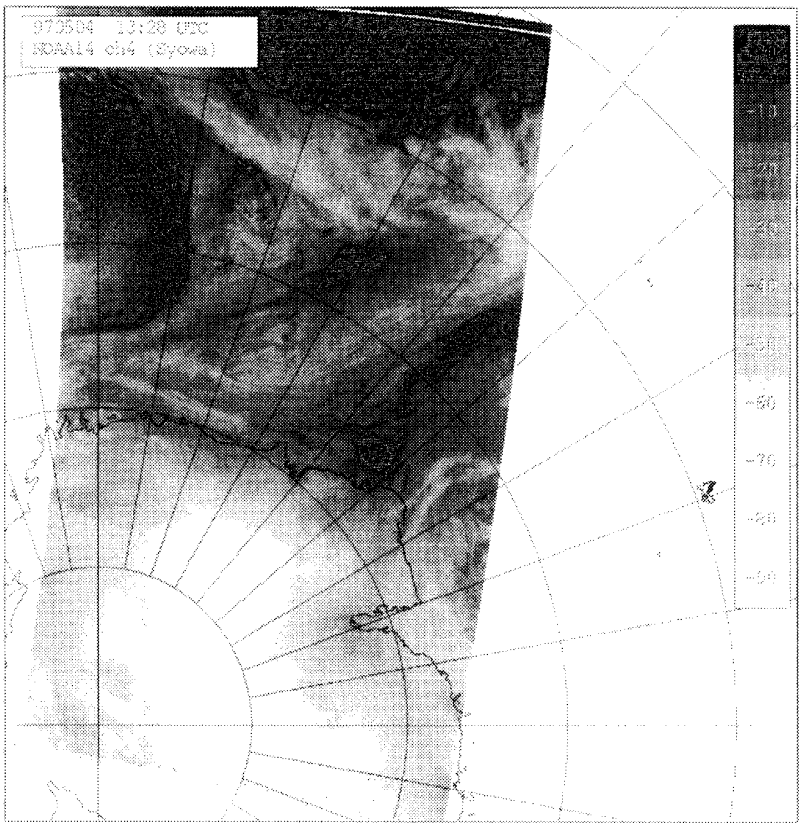
970504 13:28 UTC
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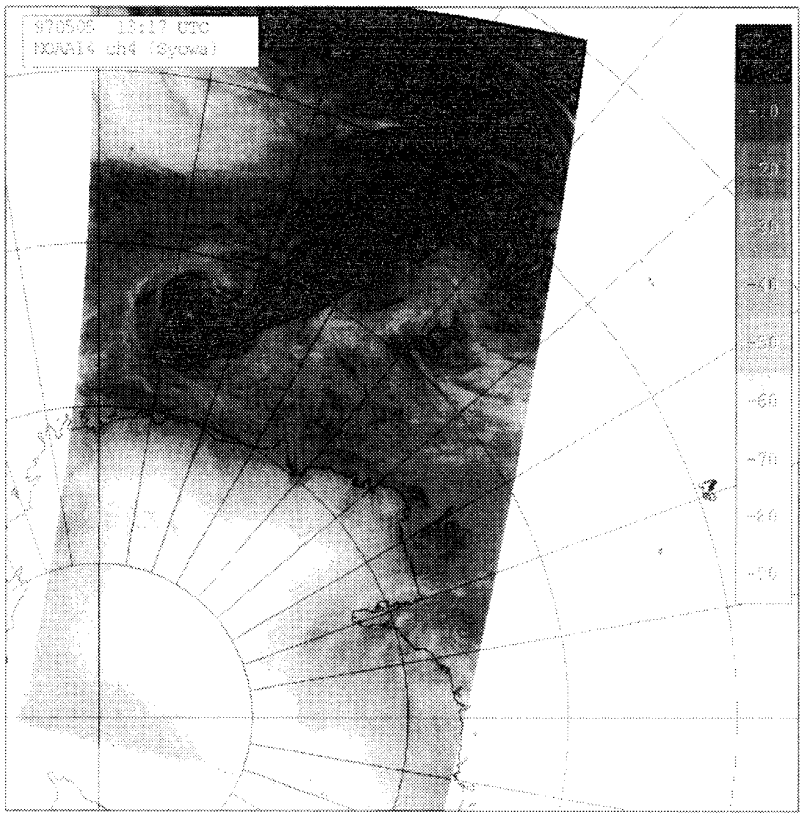
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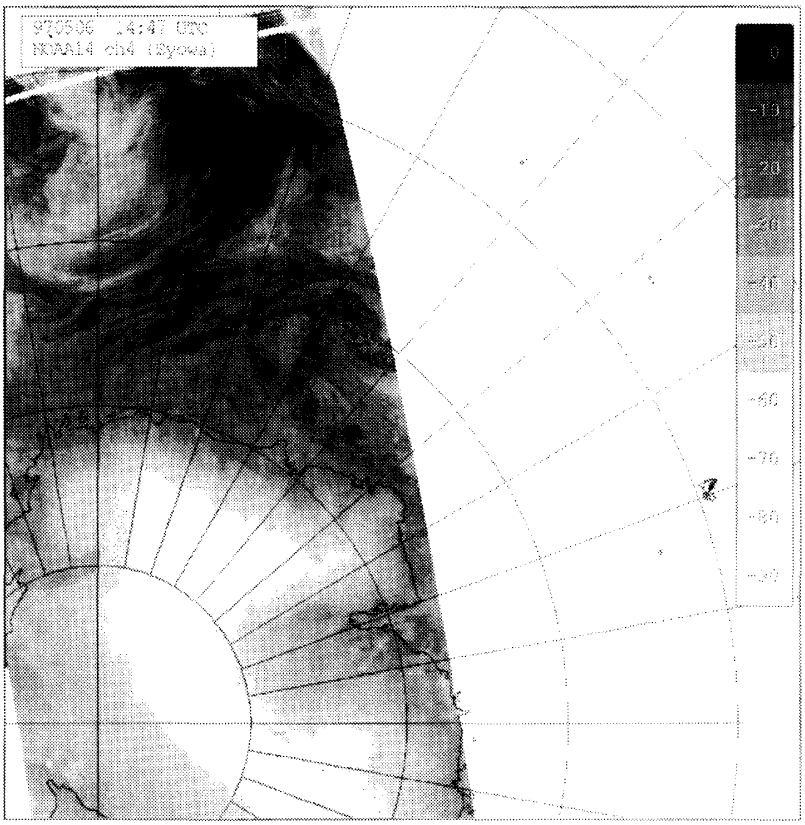
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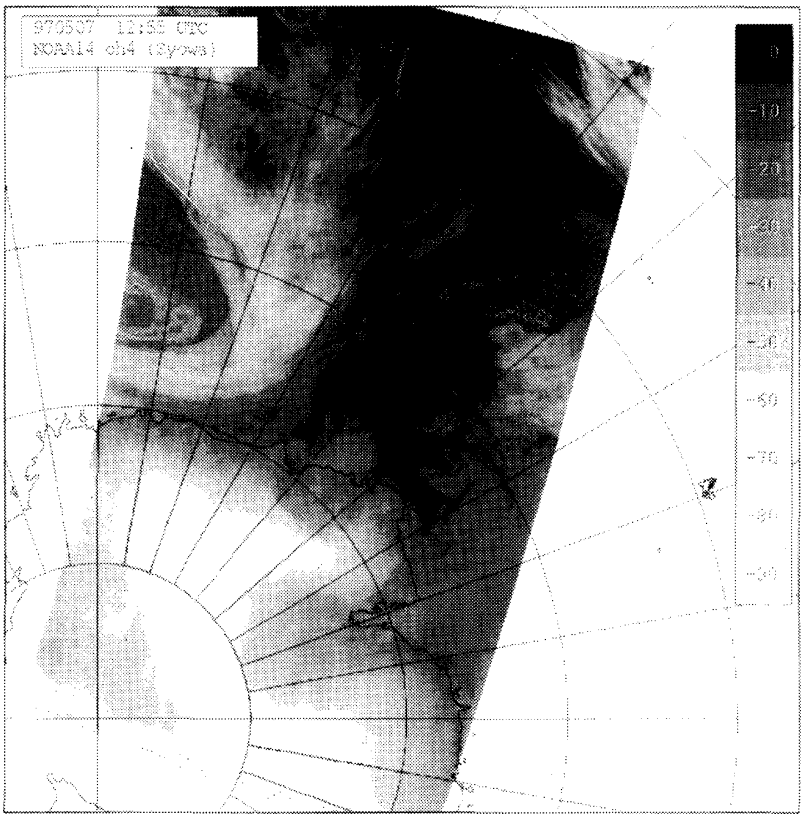
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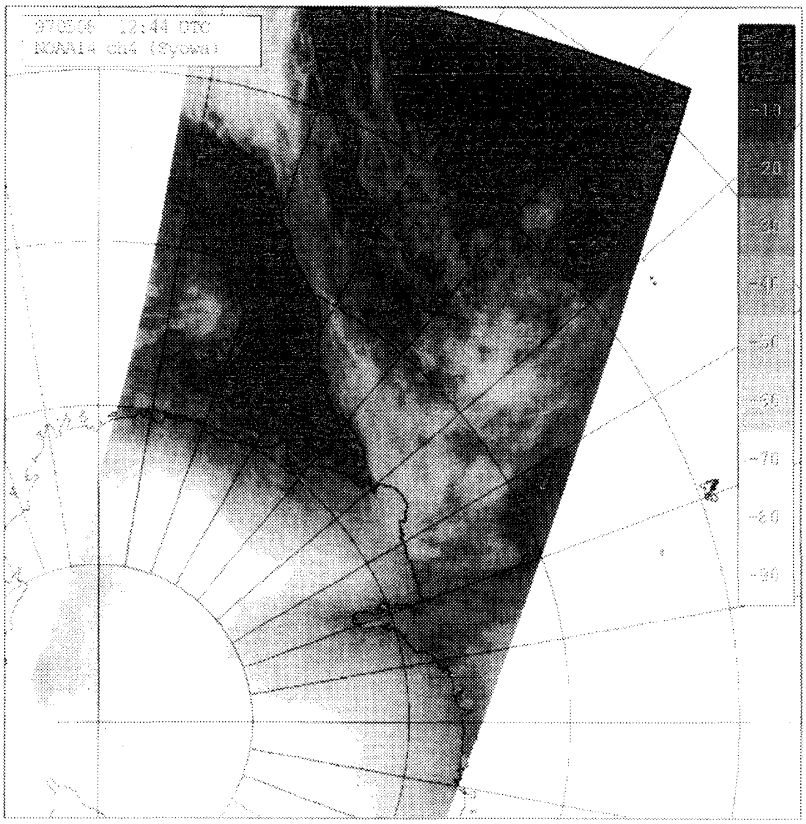
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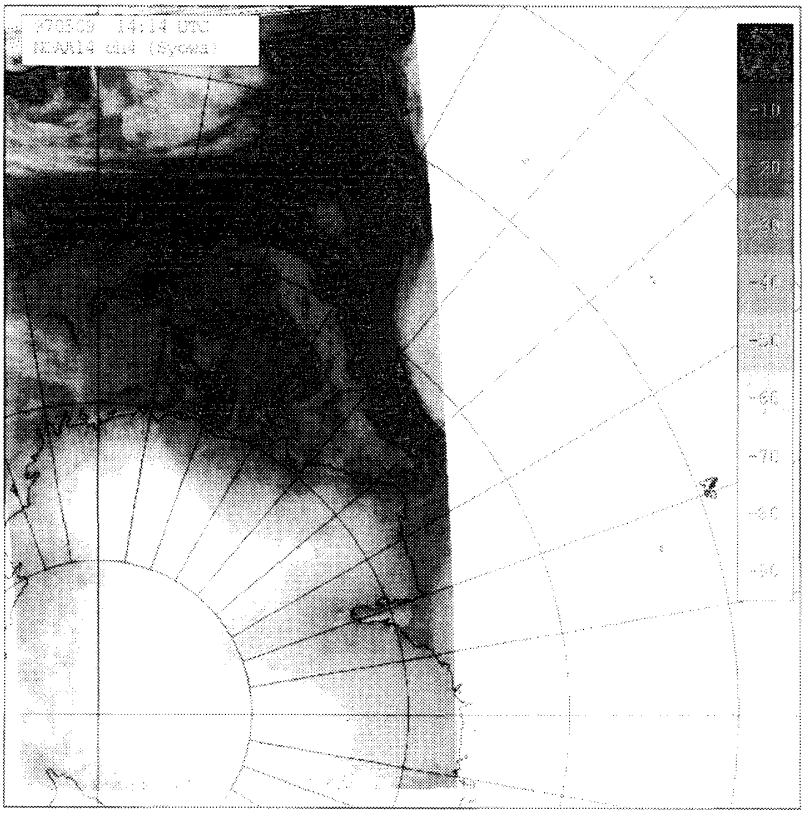
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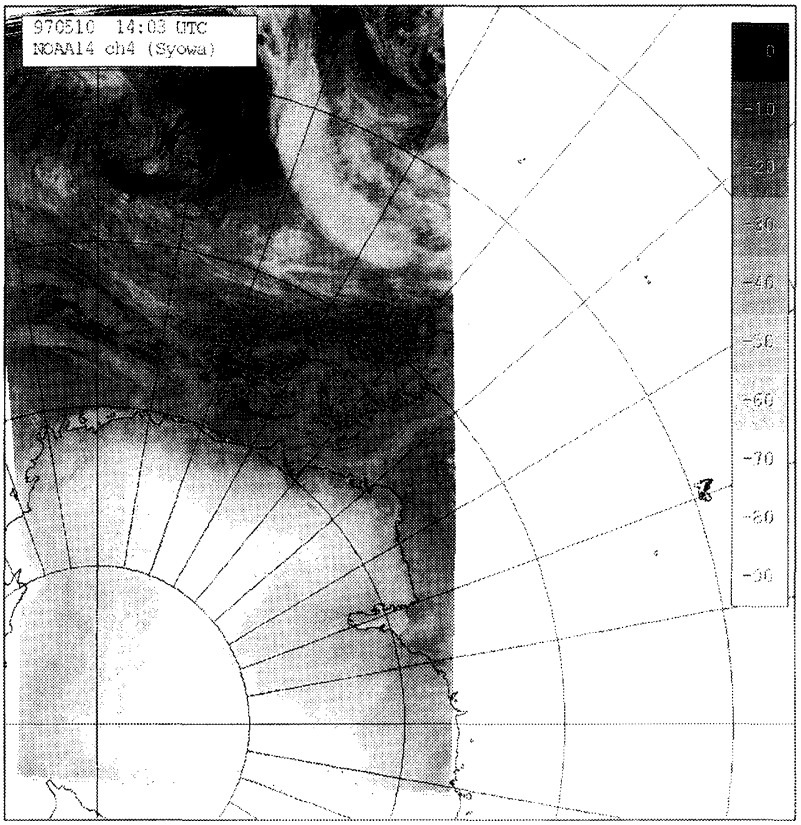
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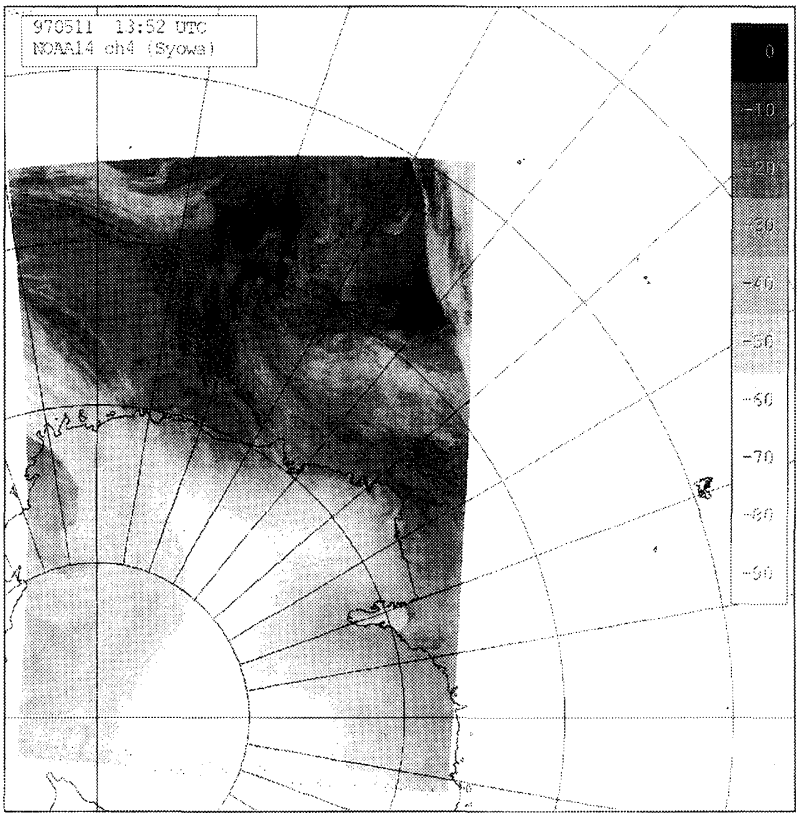
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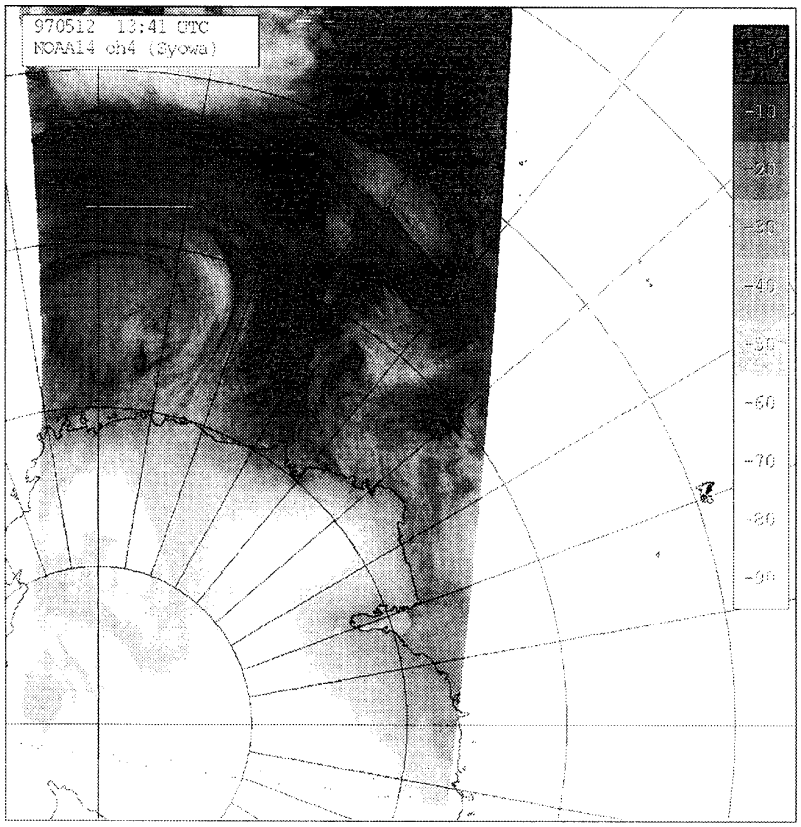
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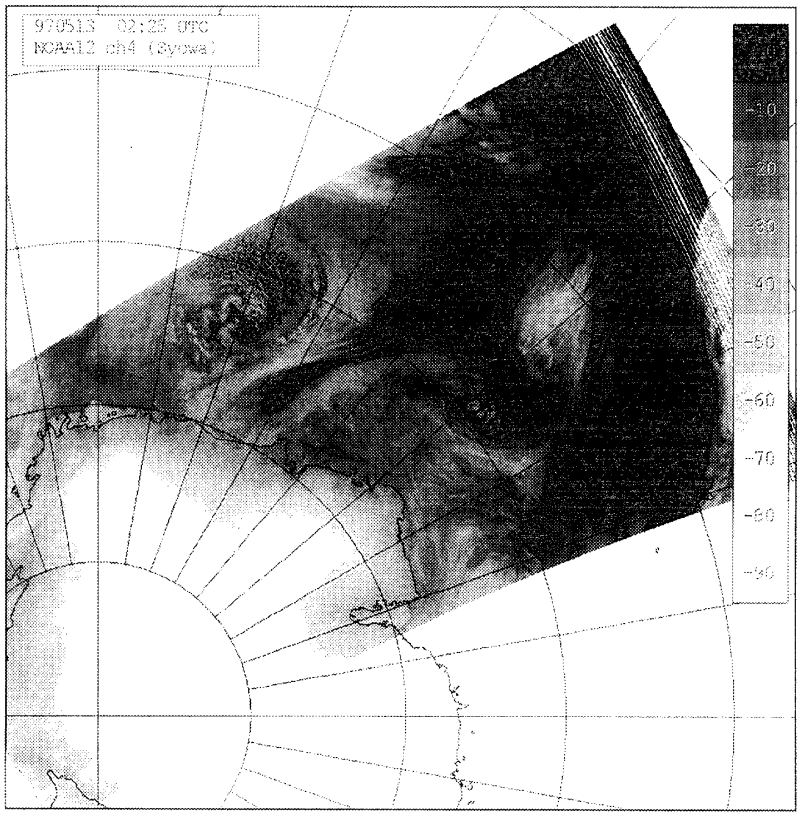
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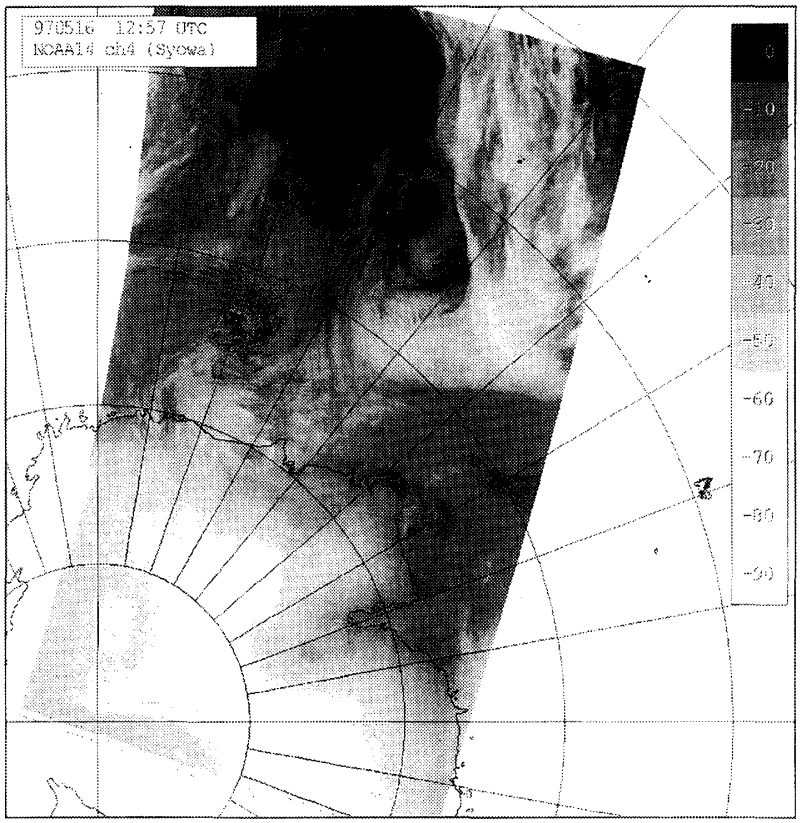
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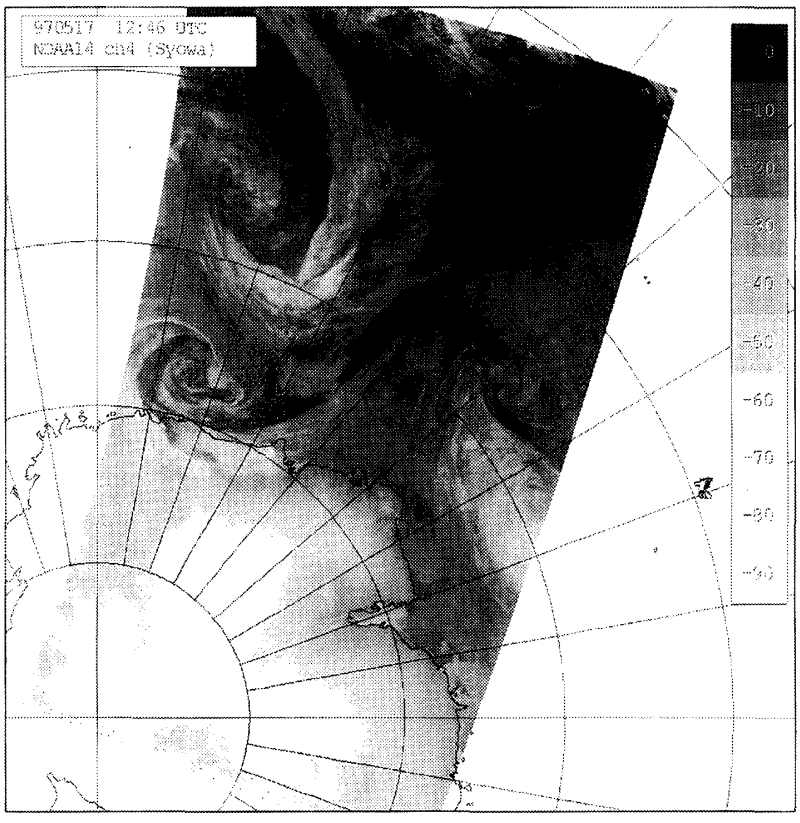
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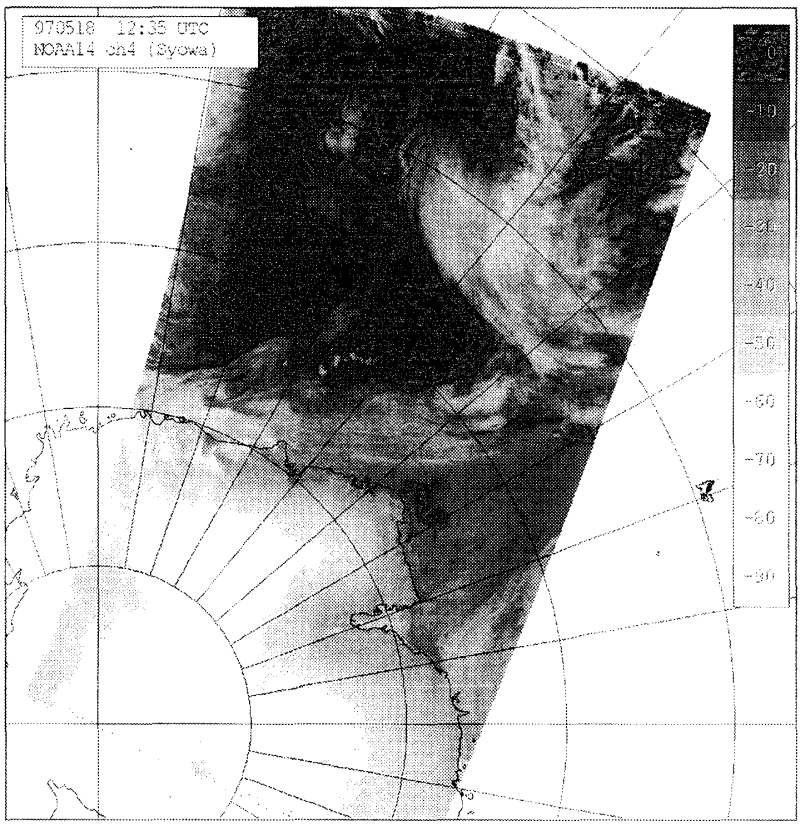
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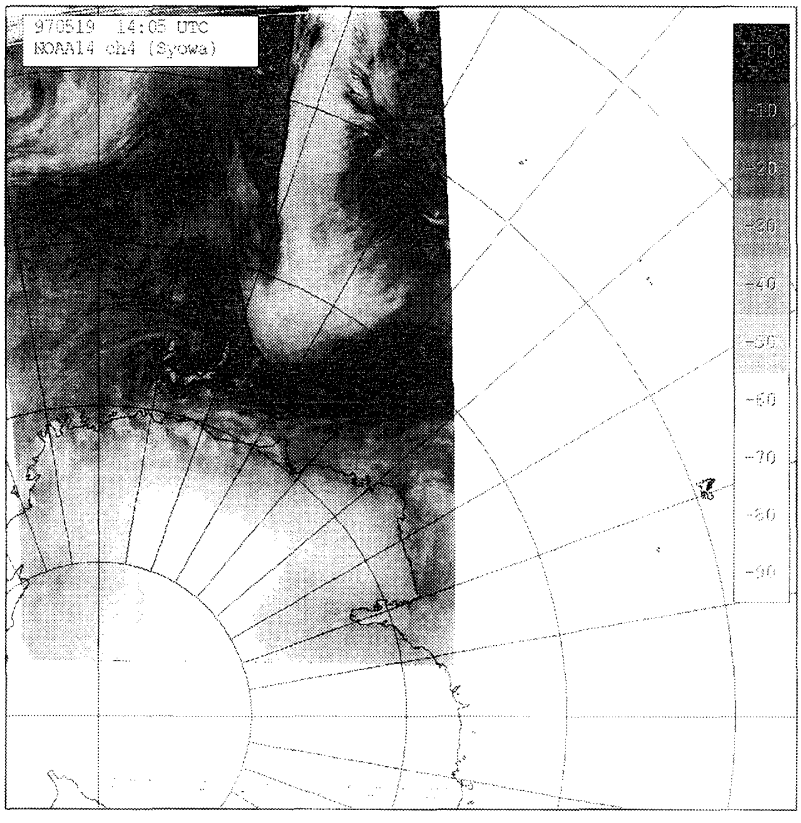
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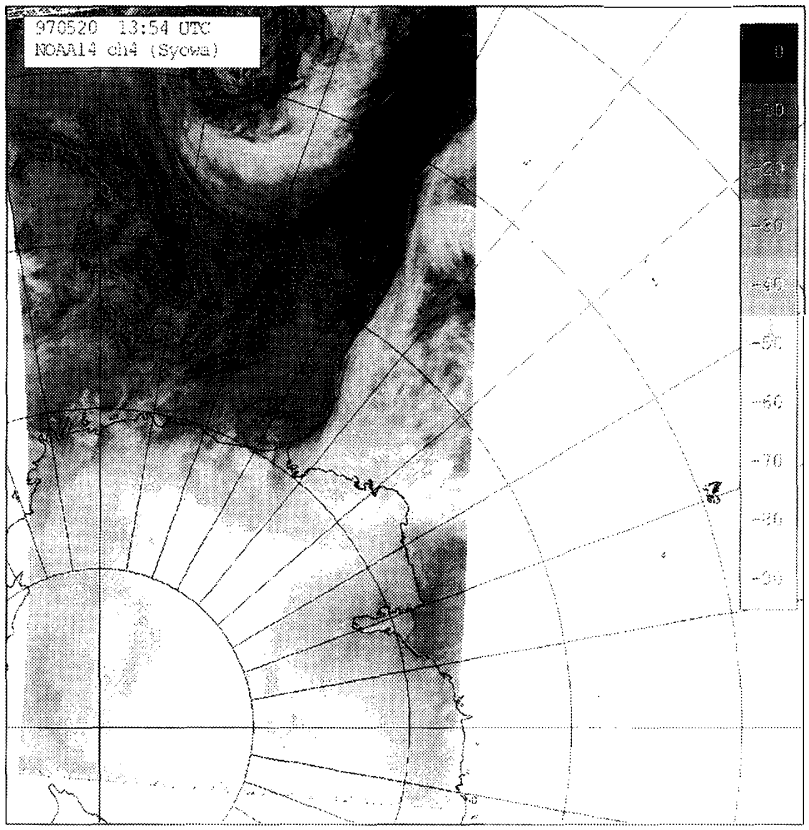
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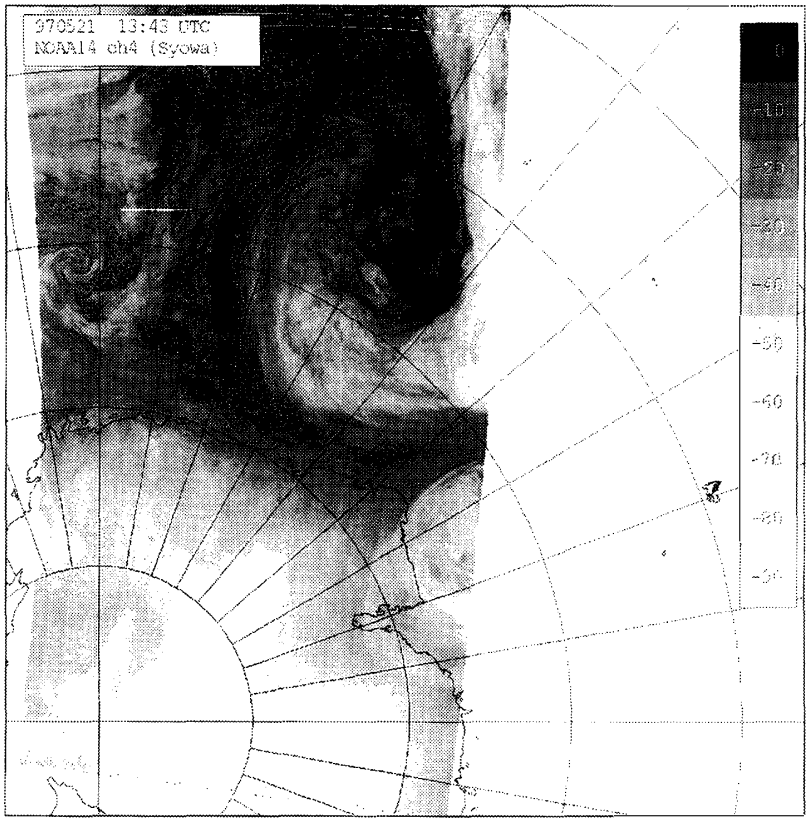
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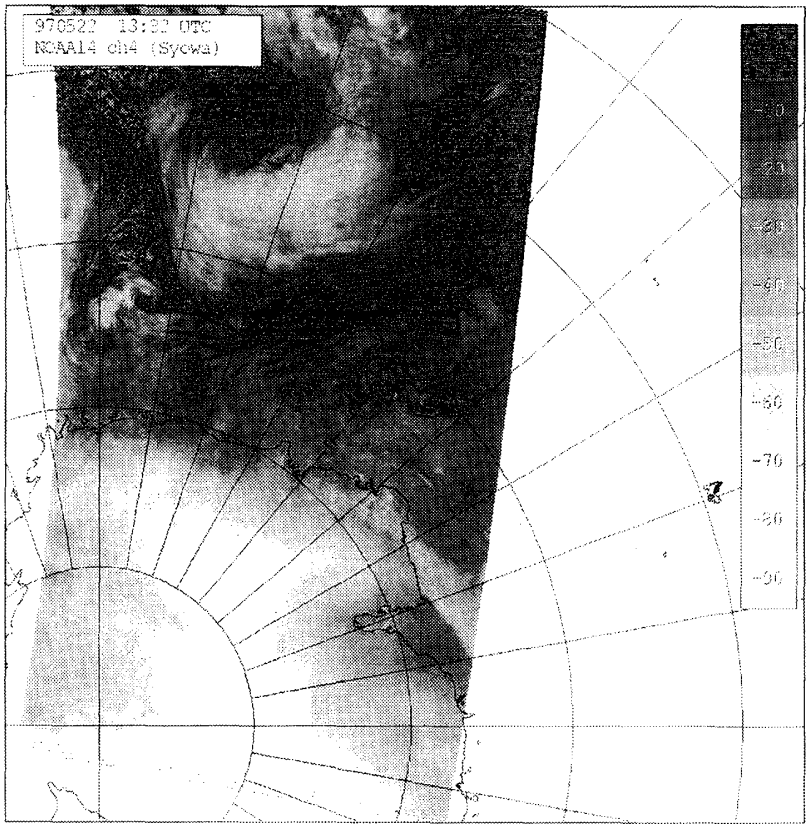
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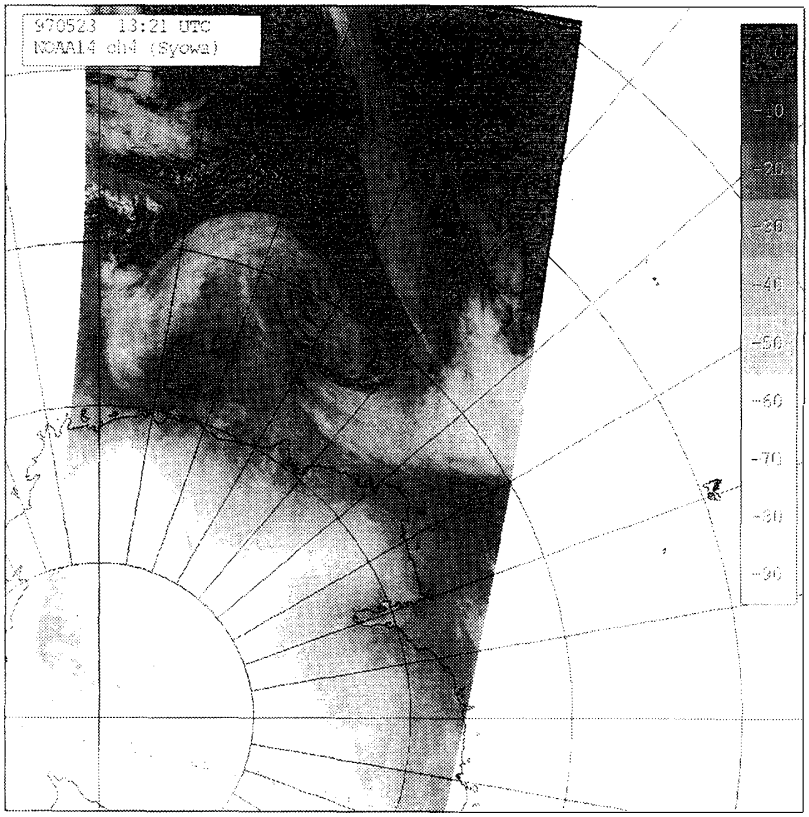
970523 13:21 UTC
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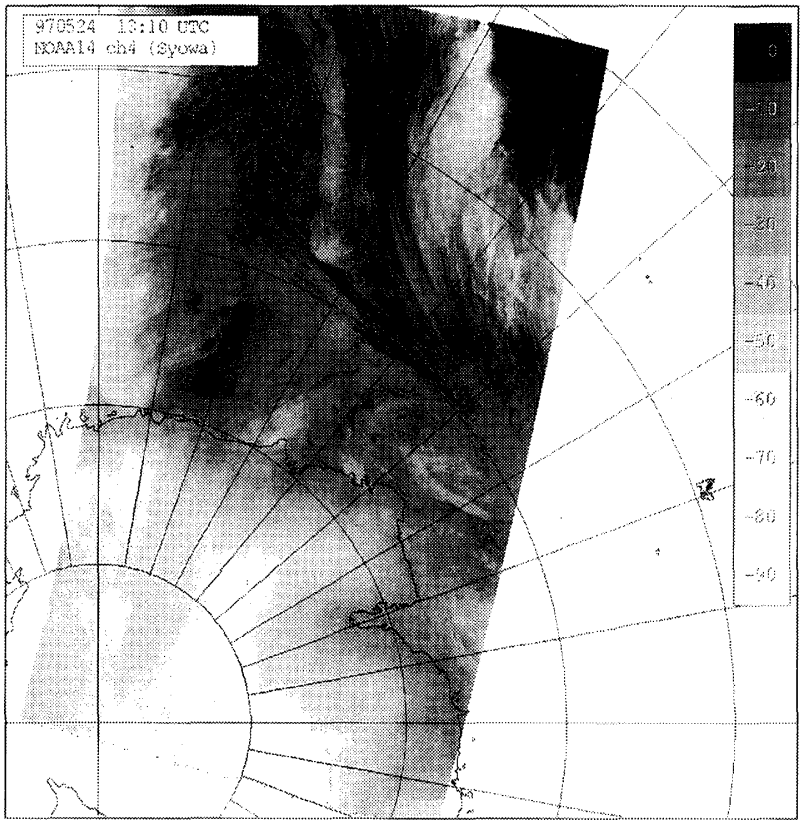
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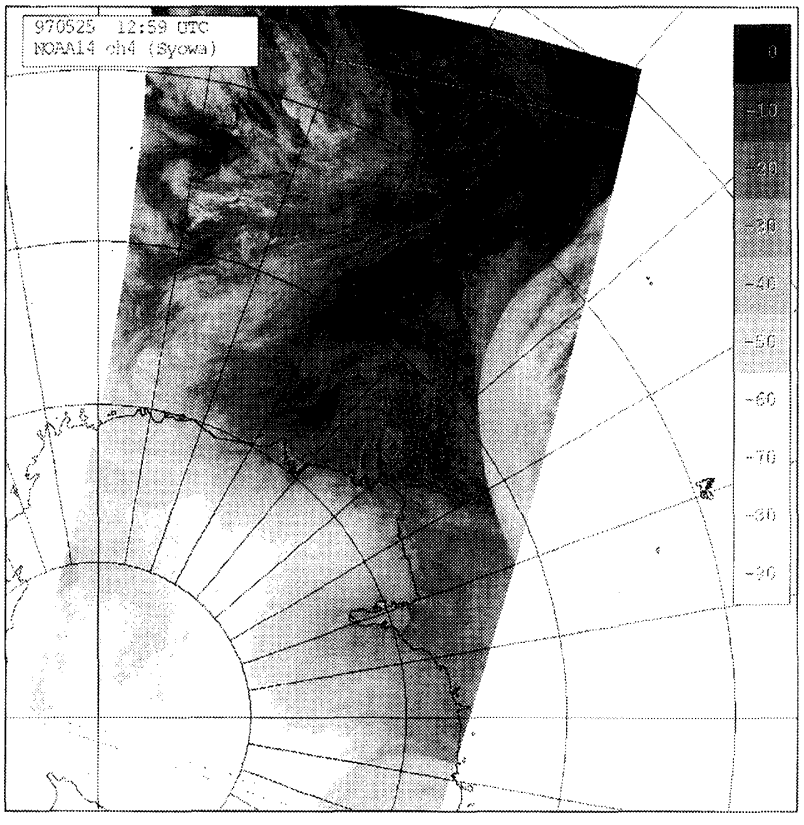
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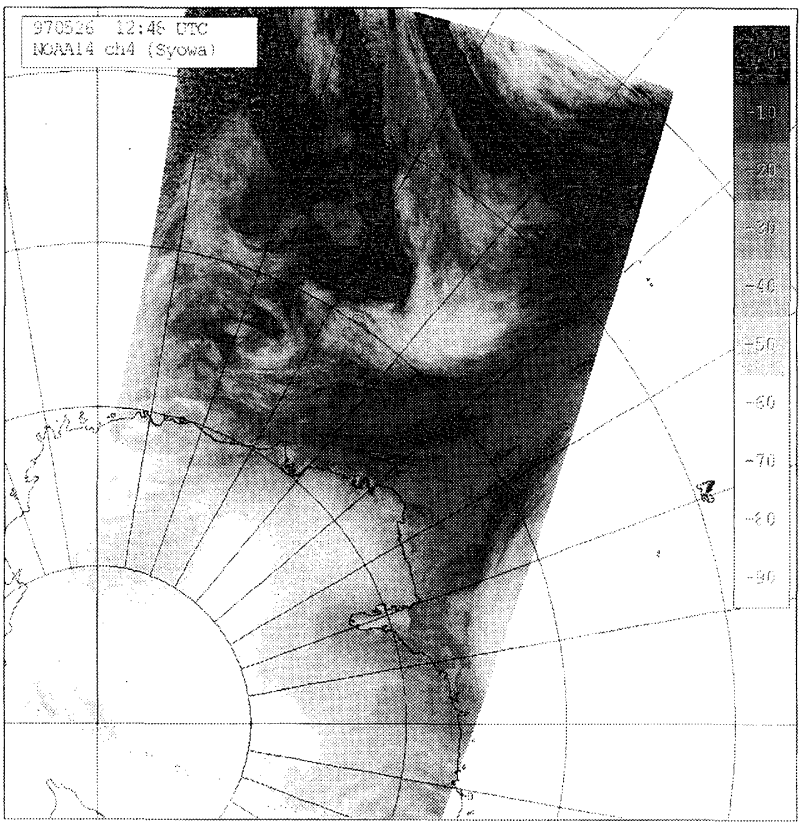
970526 12:46 UTC
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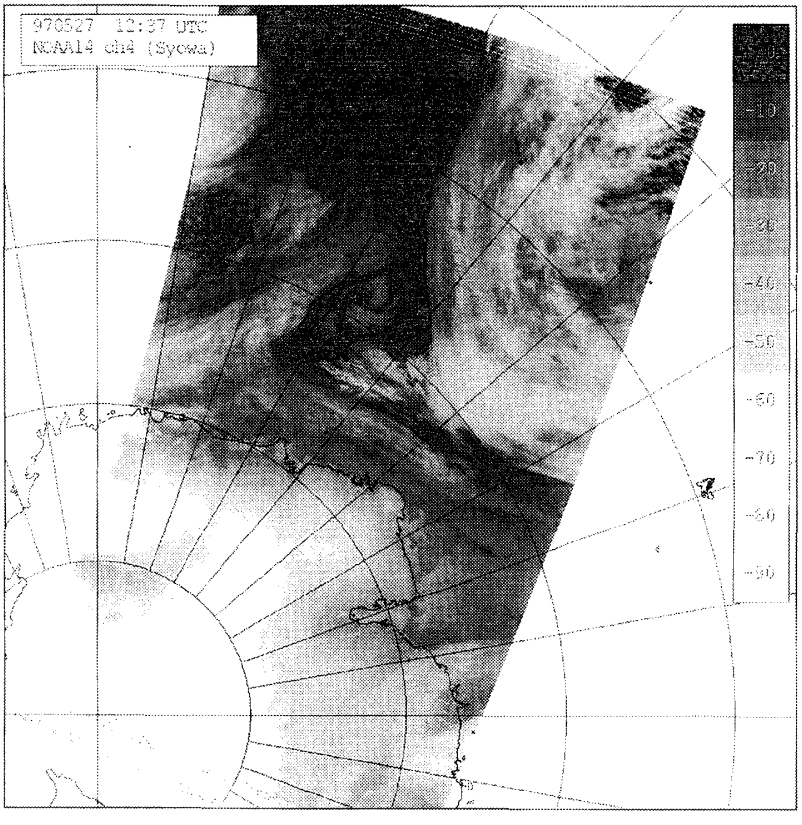
970527 12:37 UTC
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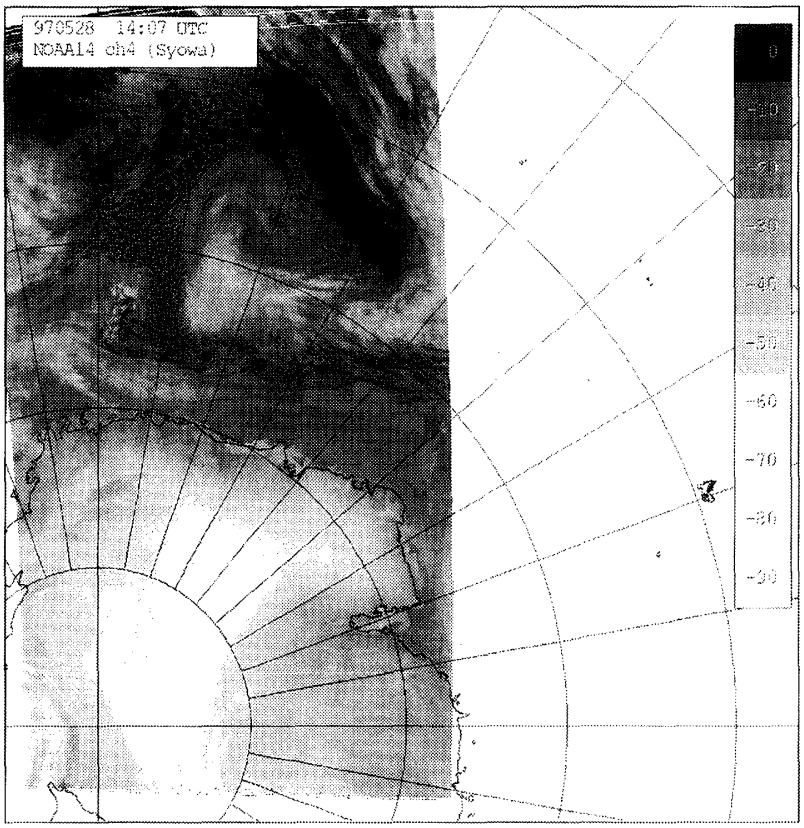
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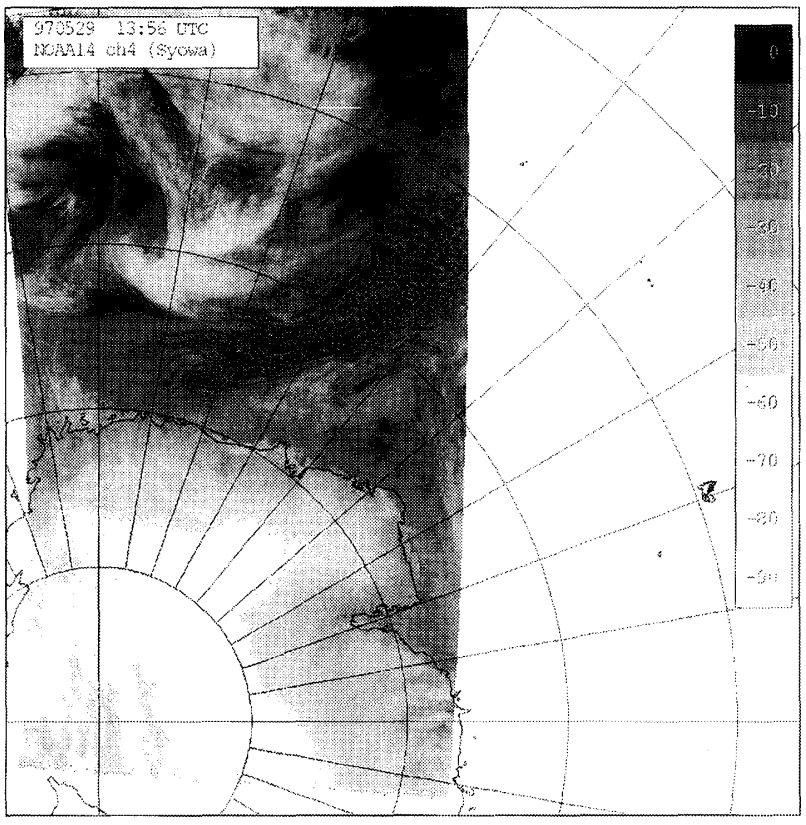
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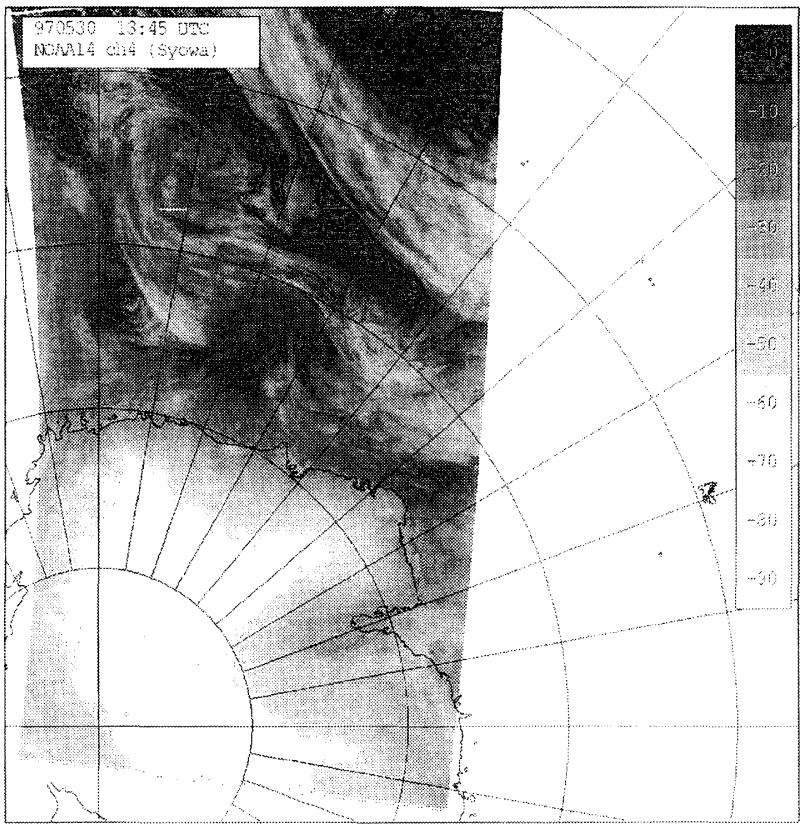
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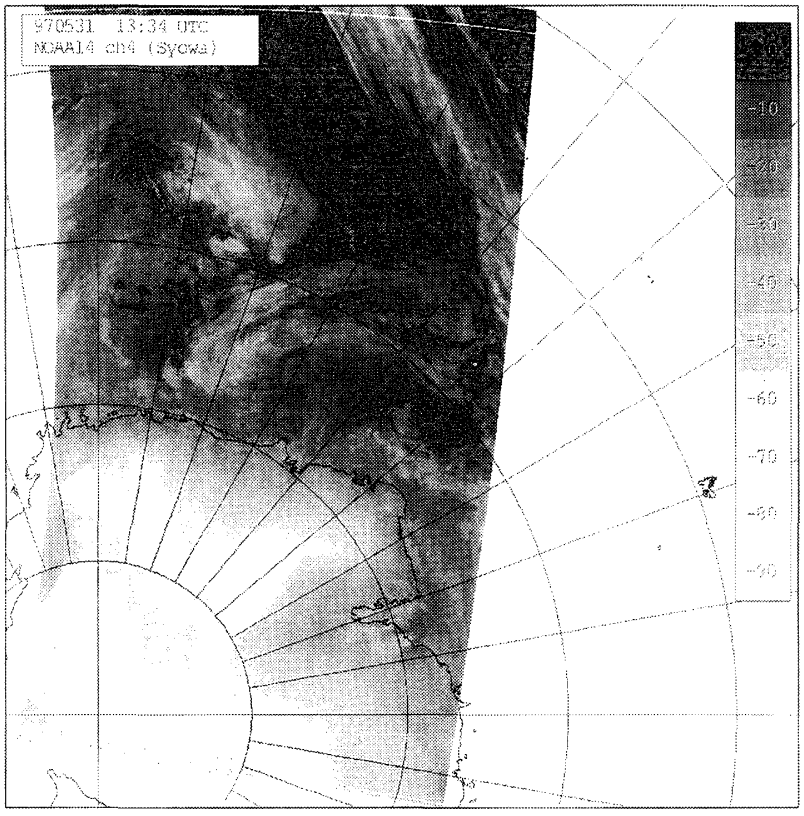
970531 13:34 UTC
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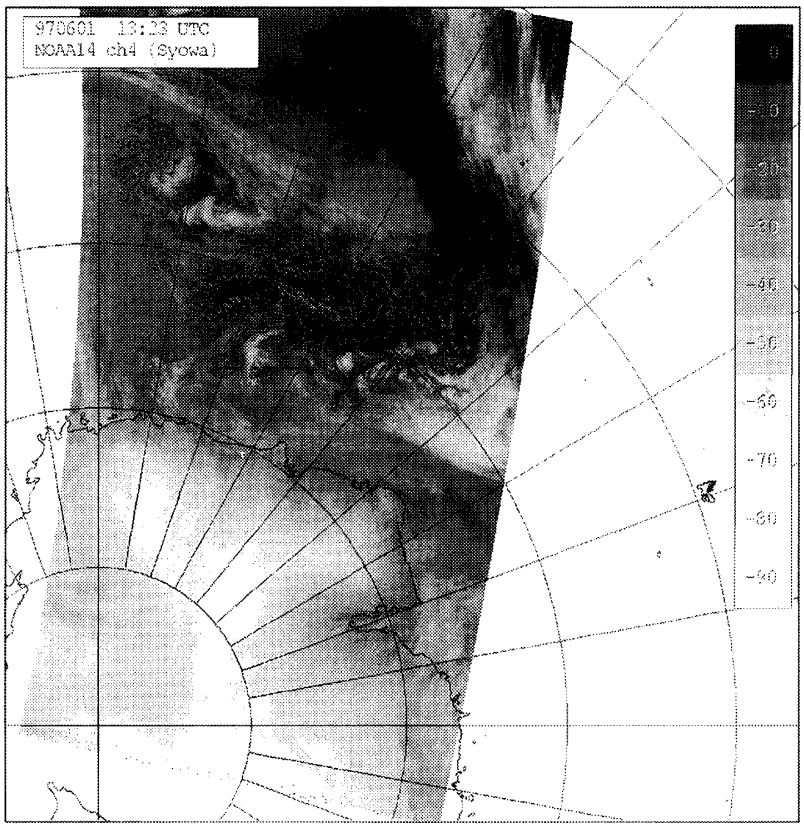
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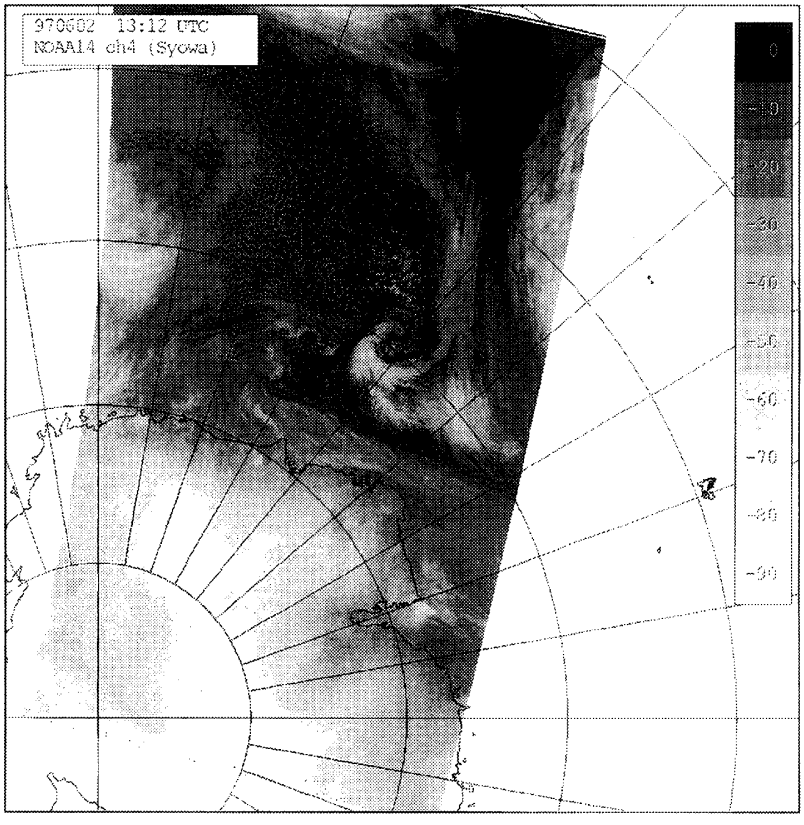
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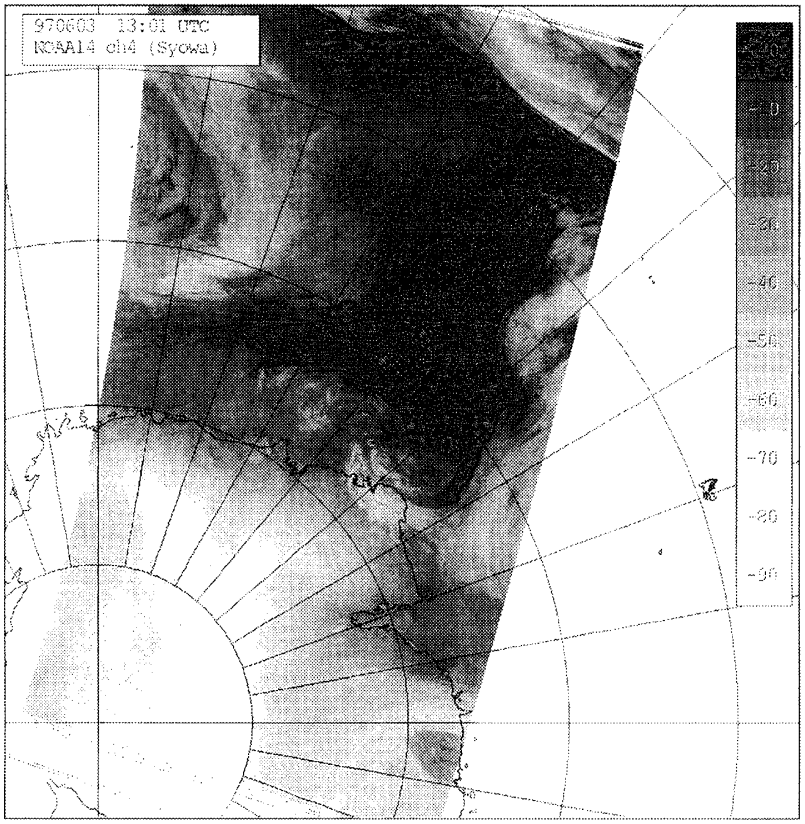
970603 13:01 UTC
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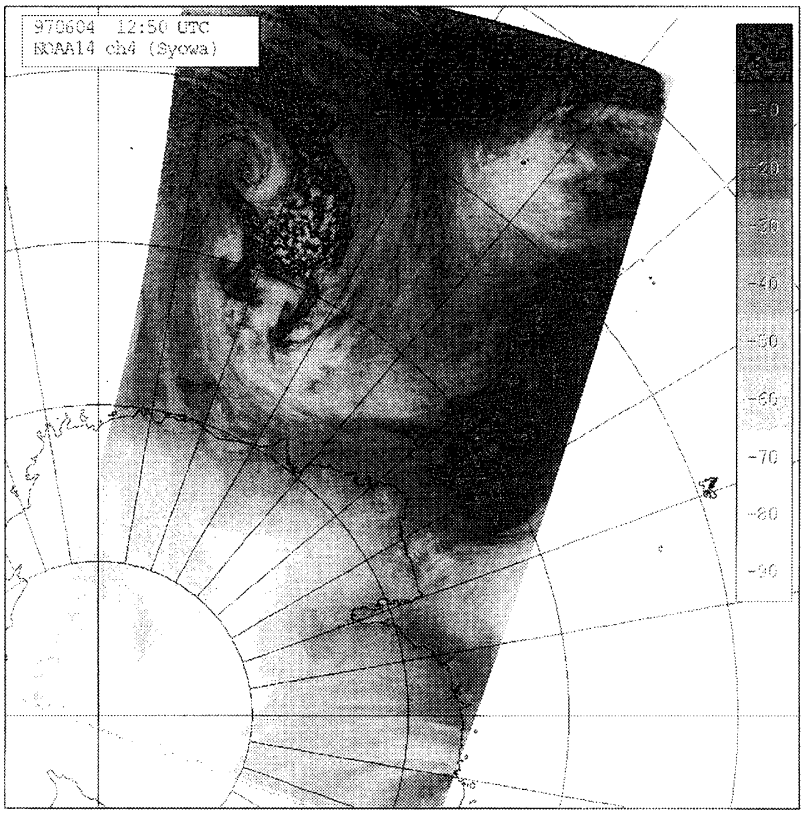
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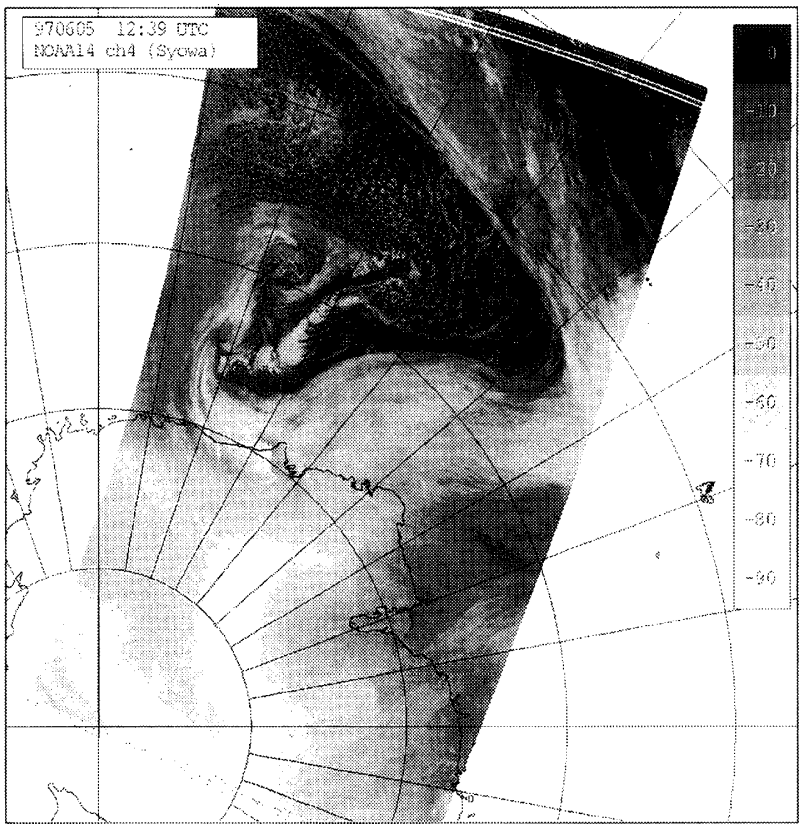
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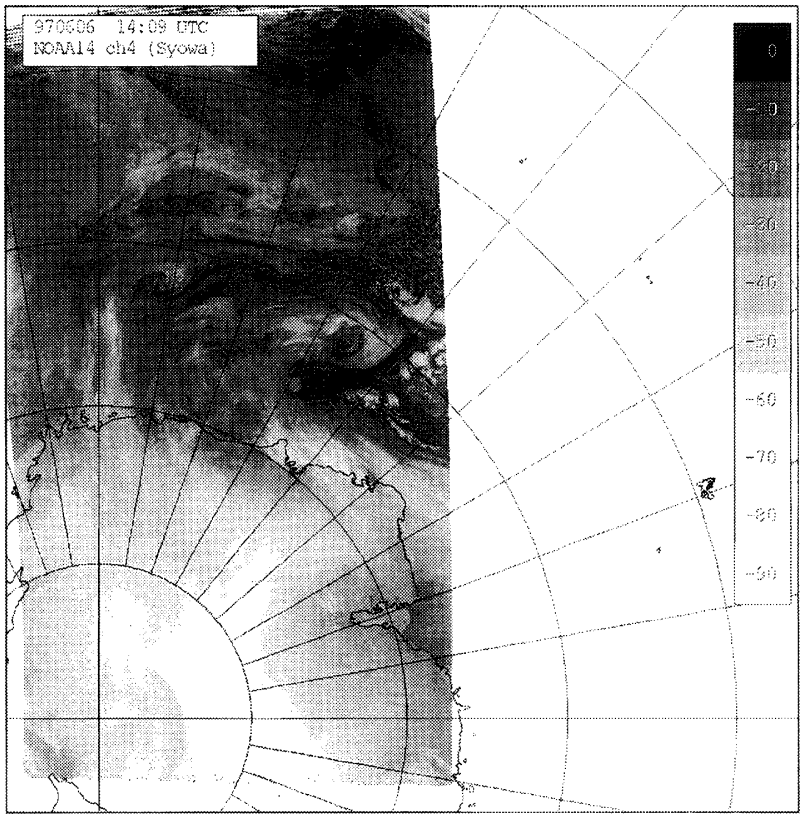
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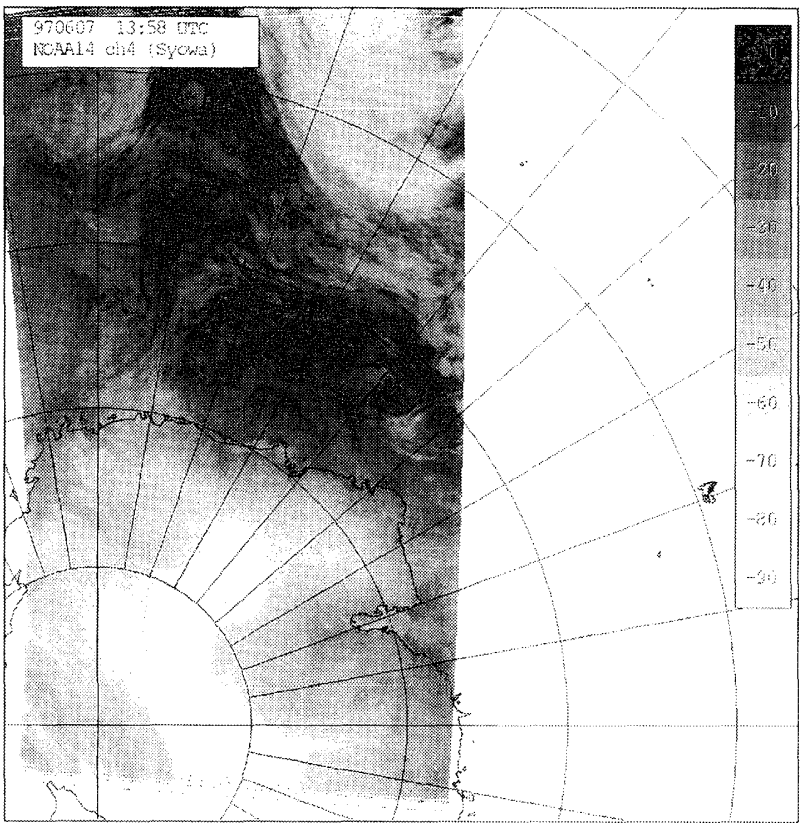
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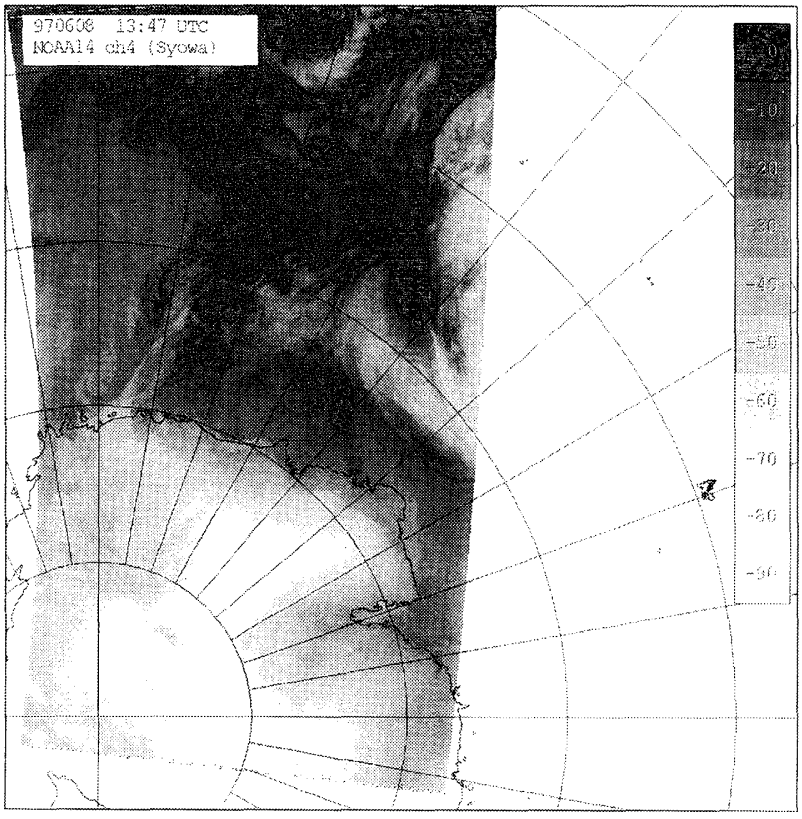
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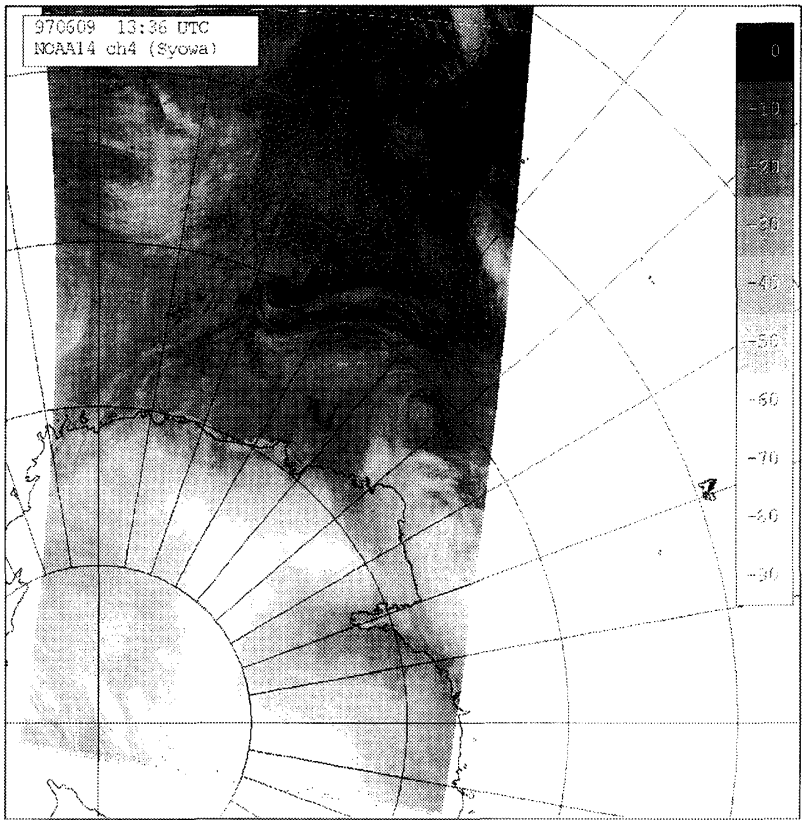
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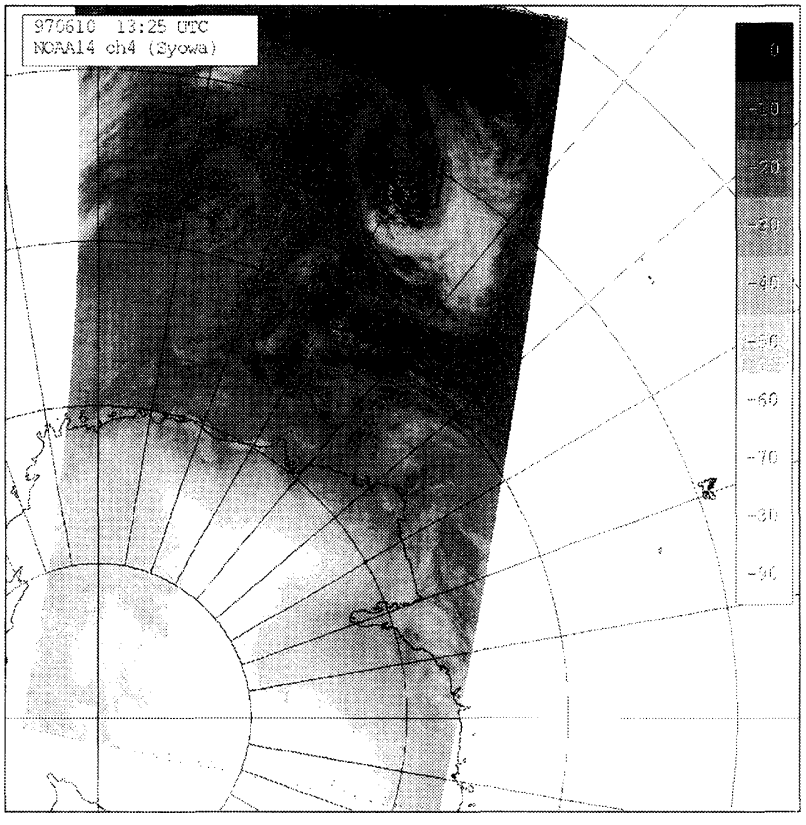
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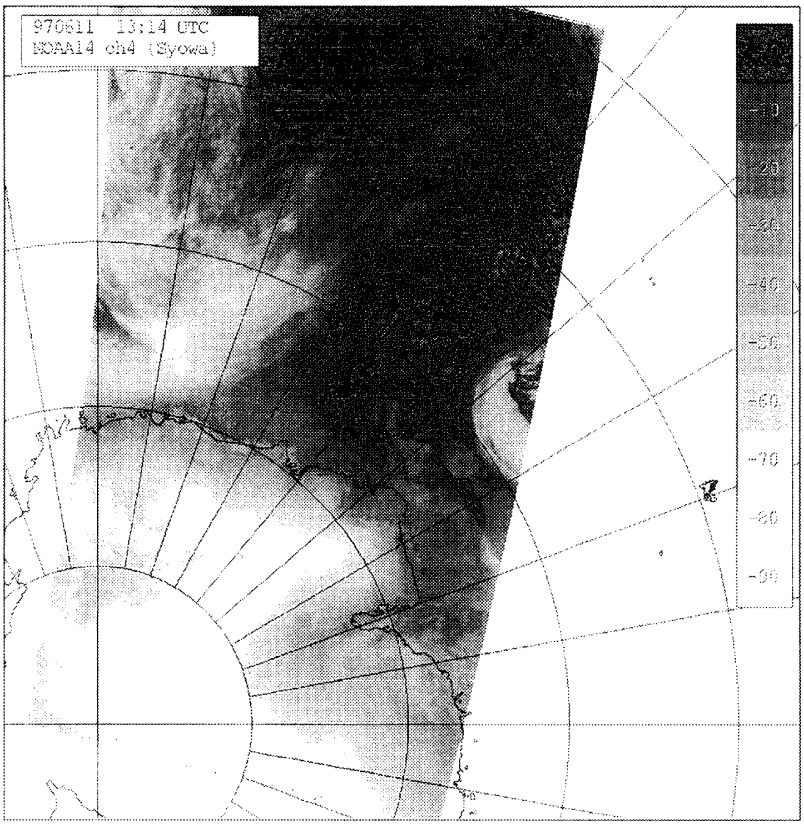
970811 13:14 UTC
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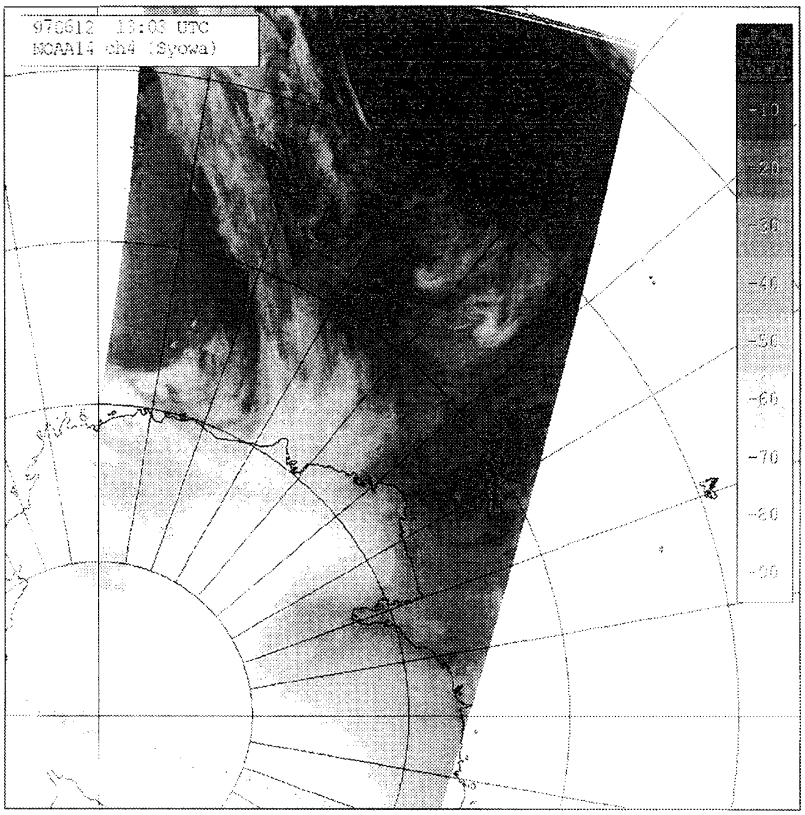
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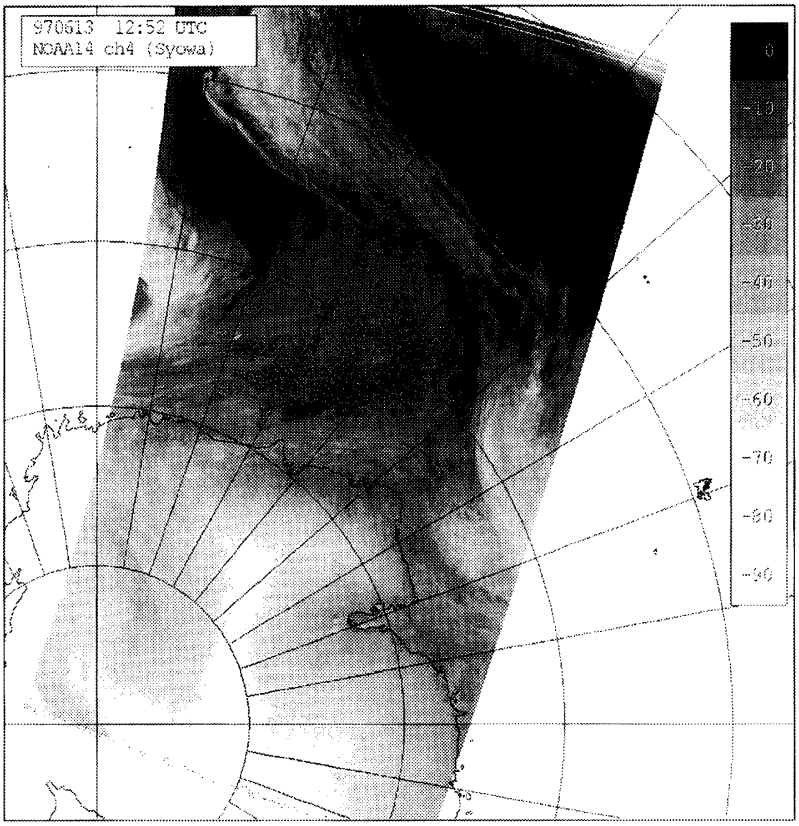
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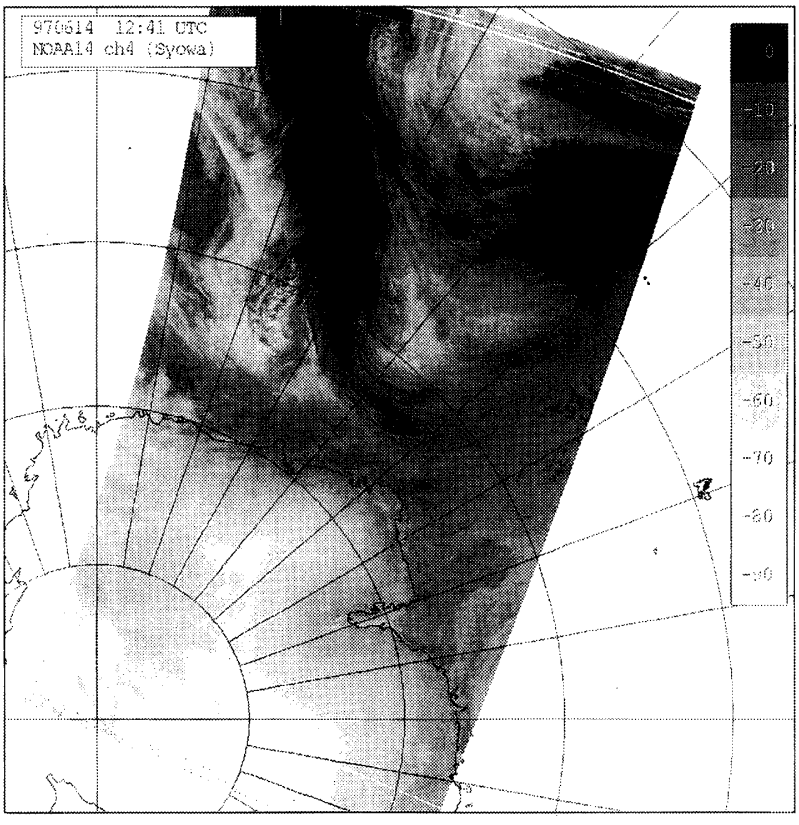
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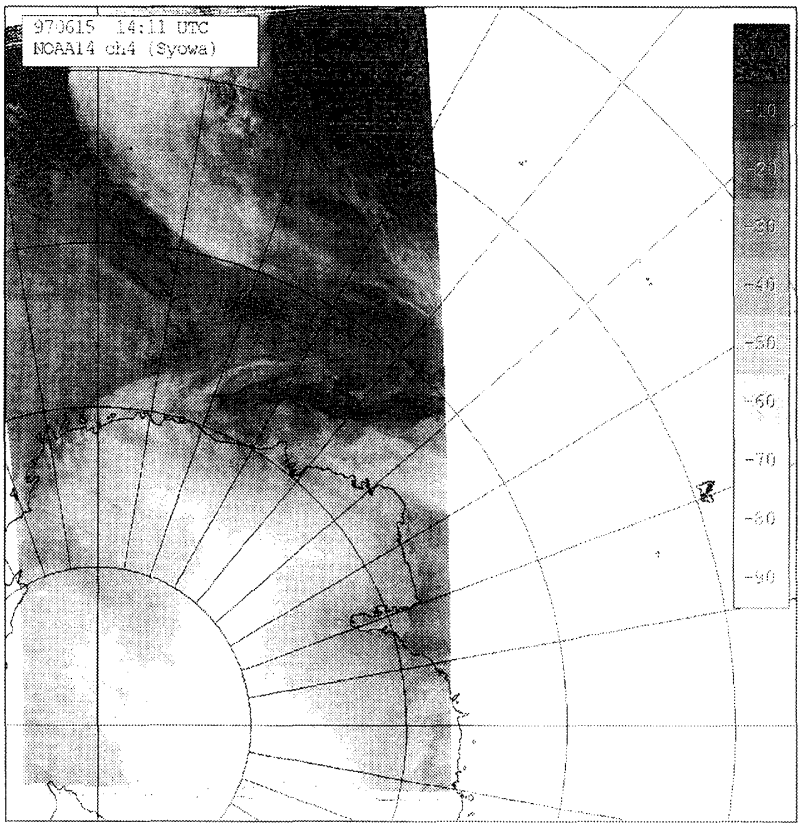
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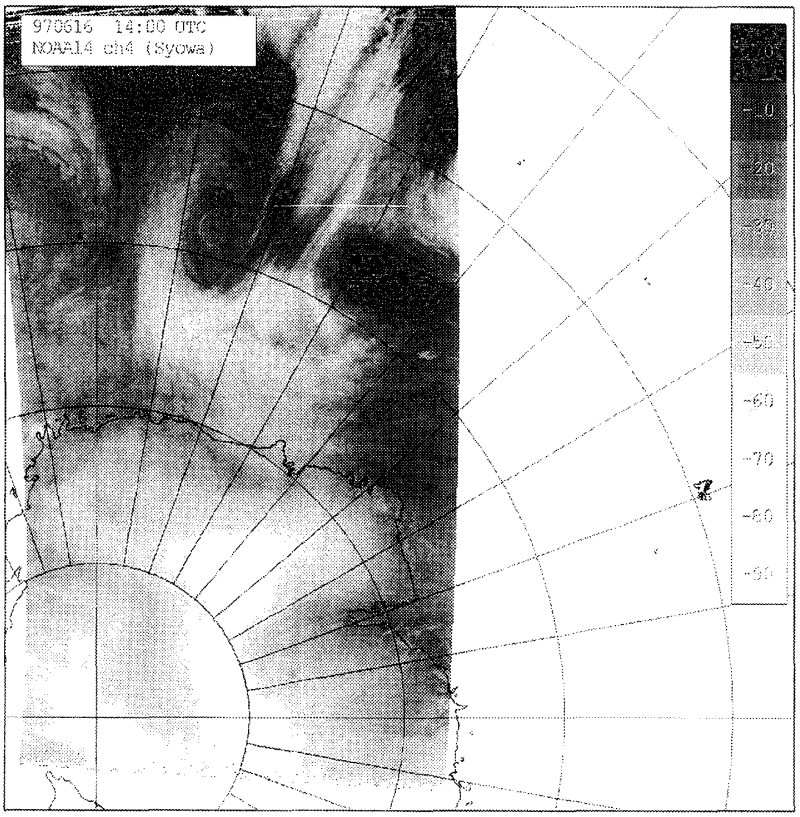
970616 14:00 UTC
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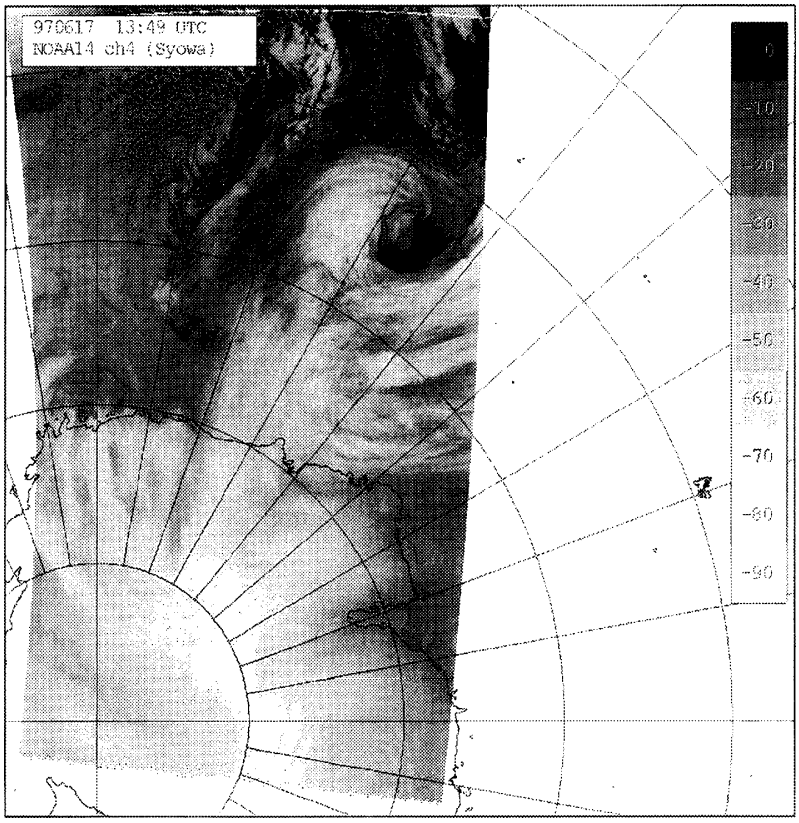
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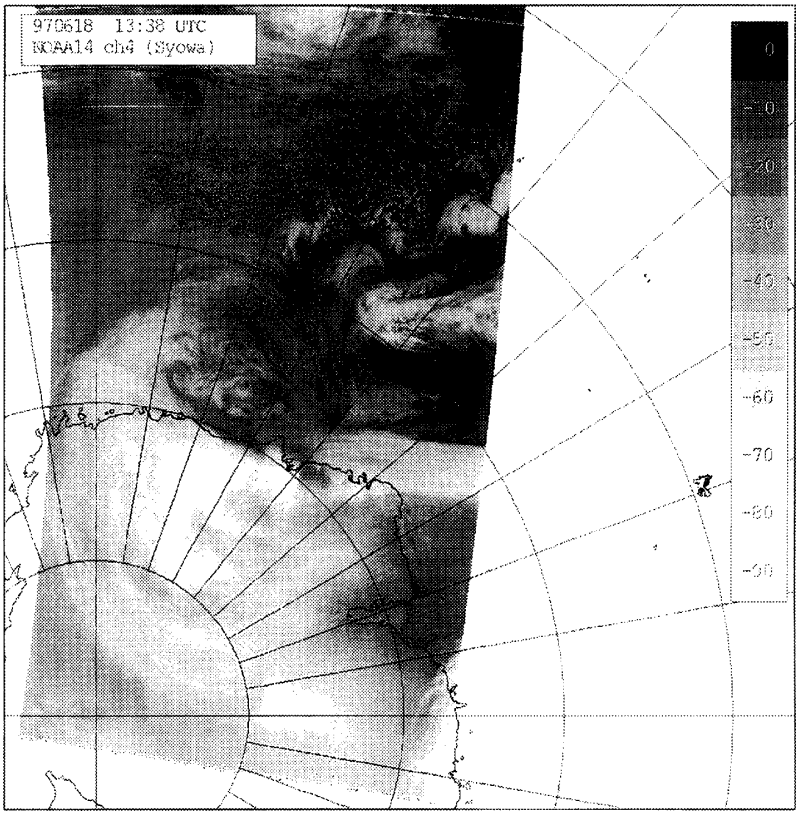
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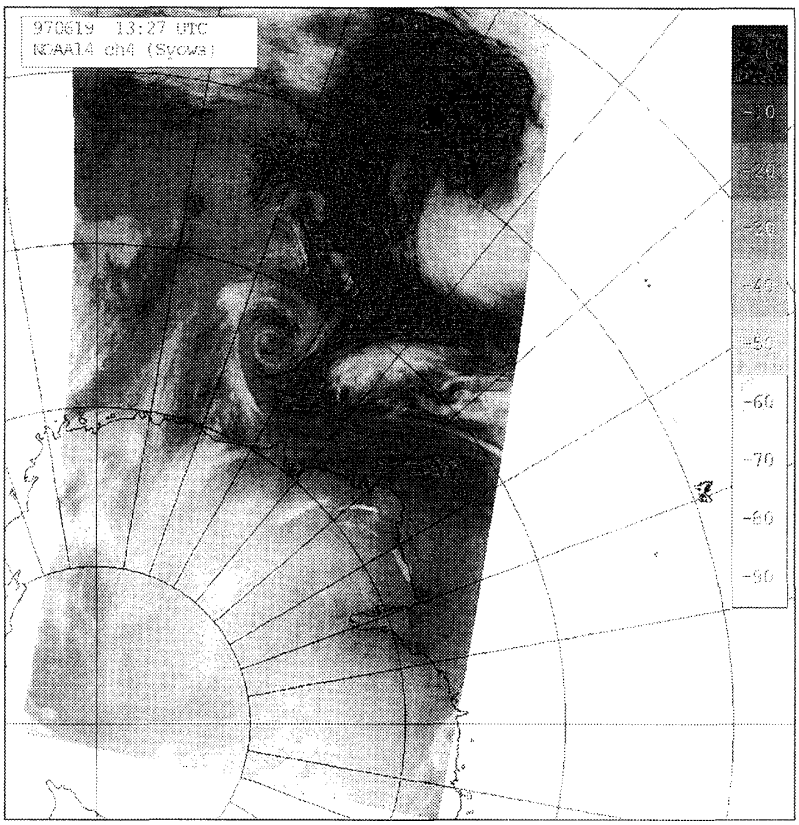
970619 13:27 UTC
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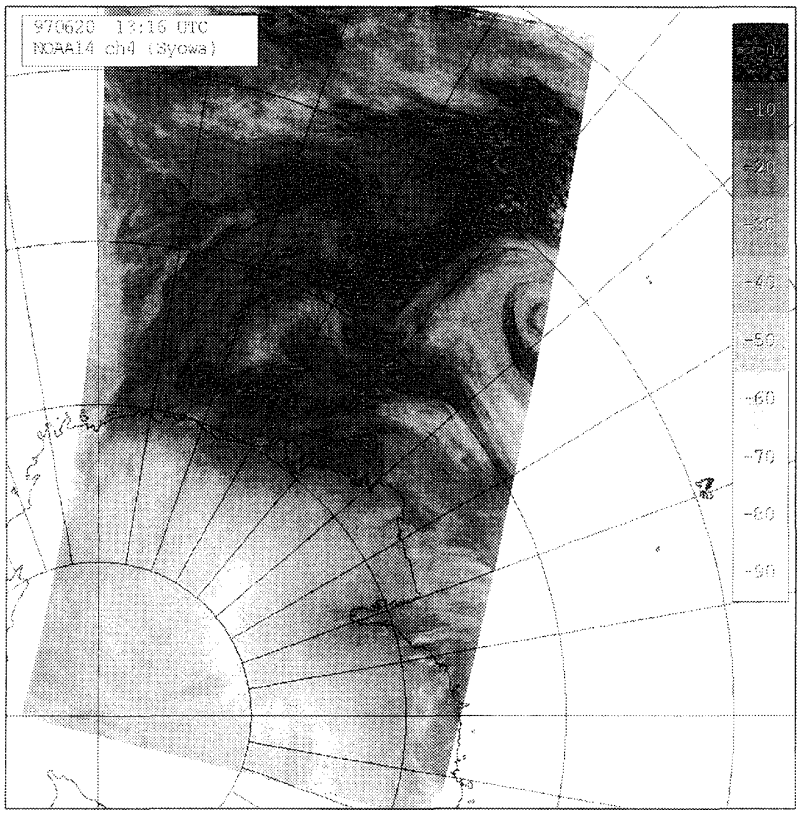
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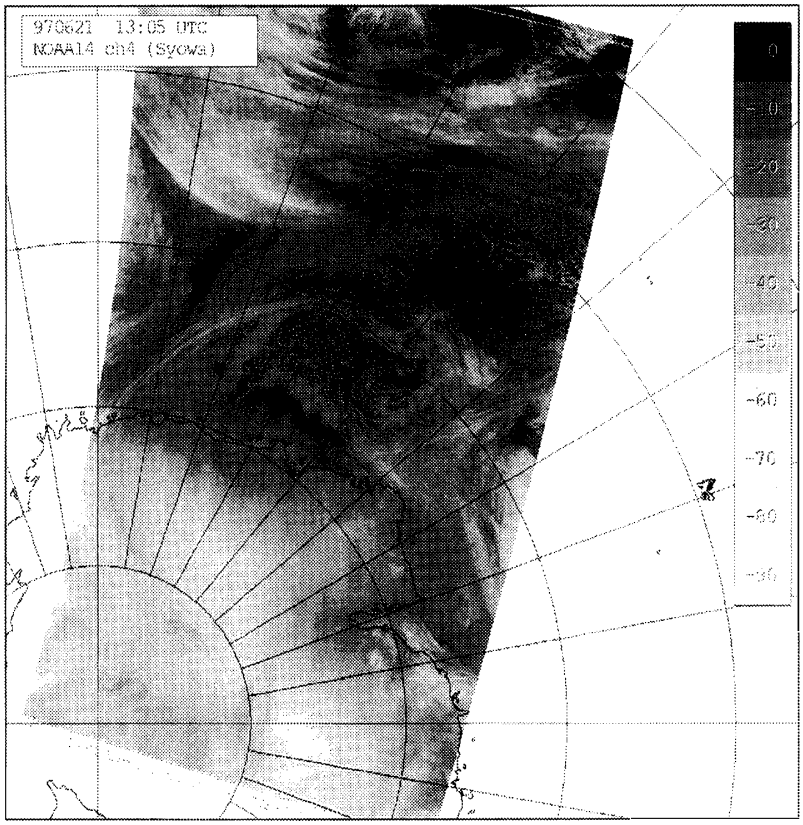
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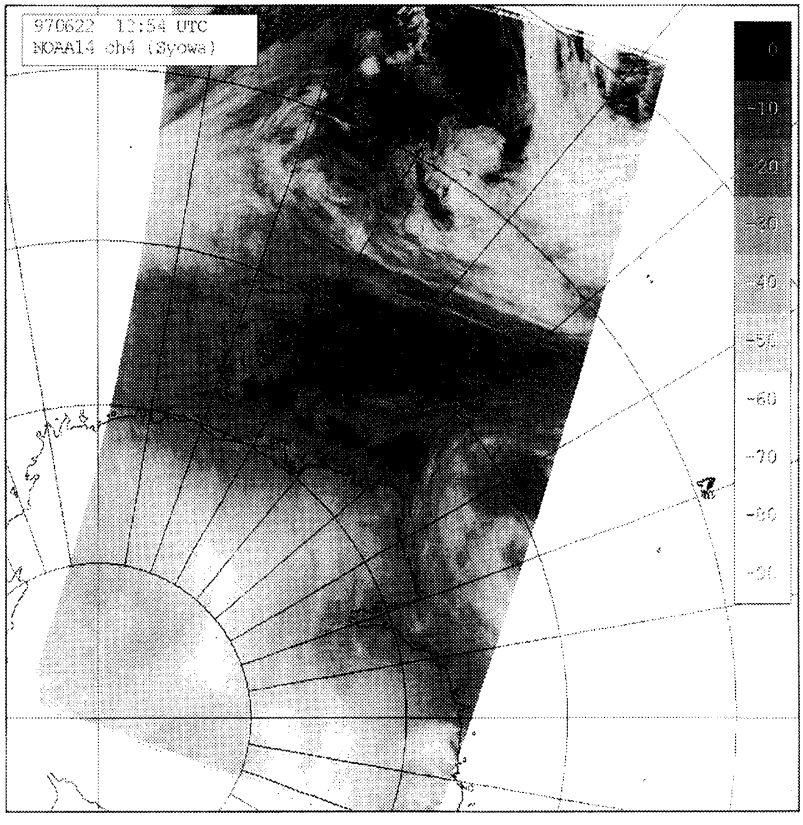
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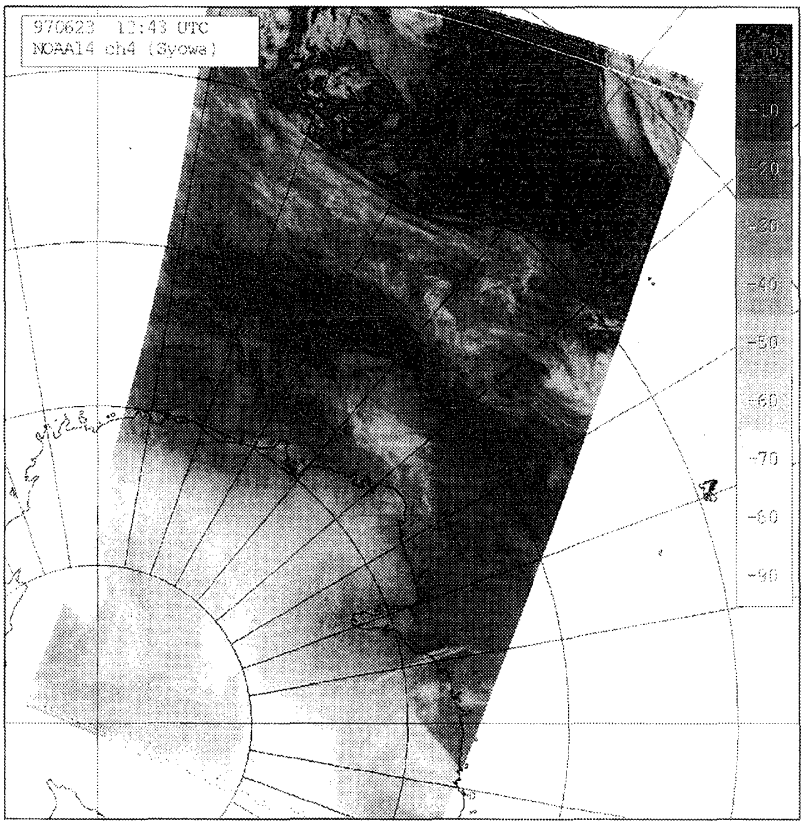
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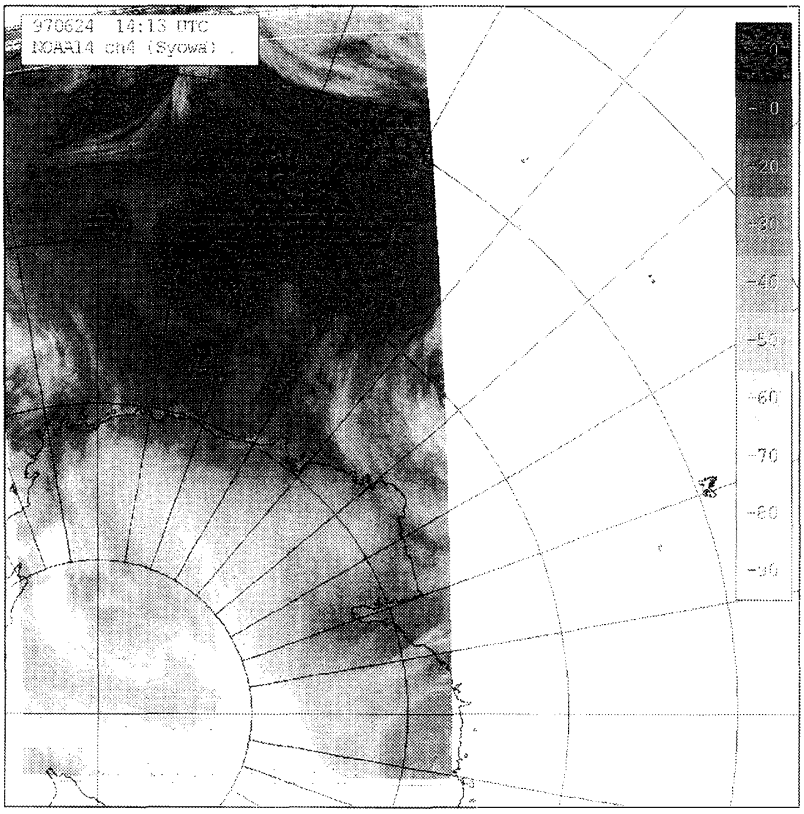
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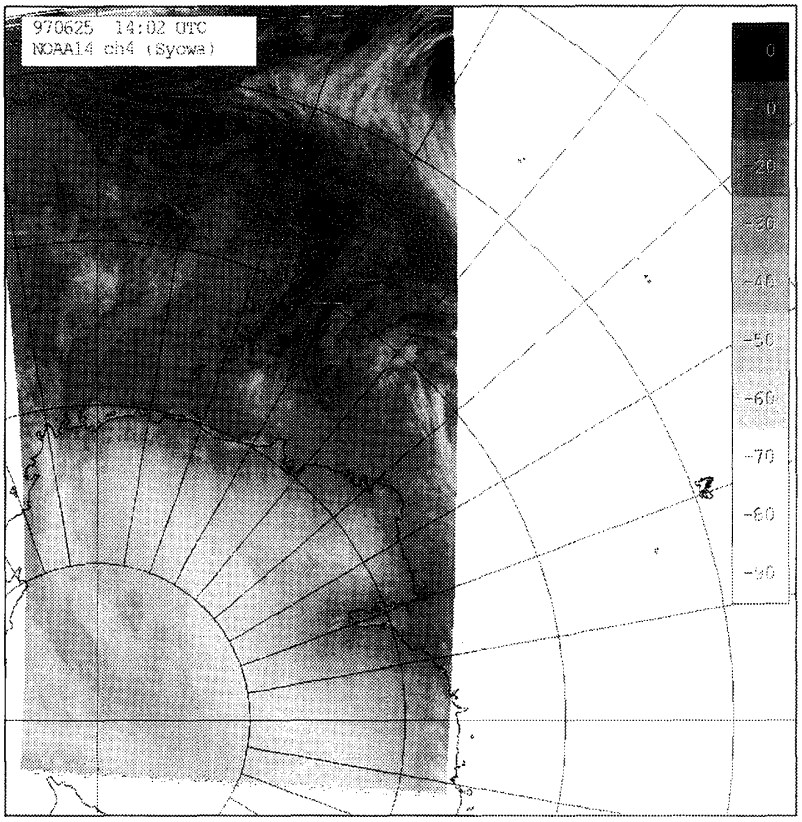
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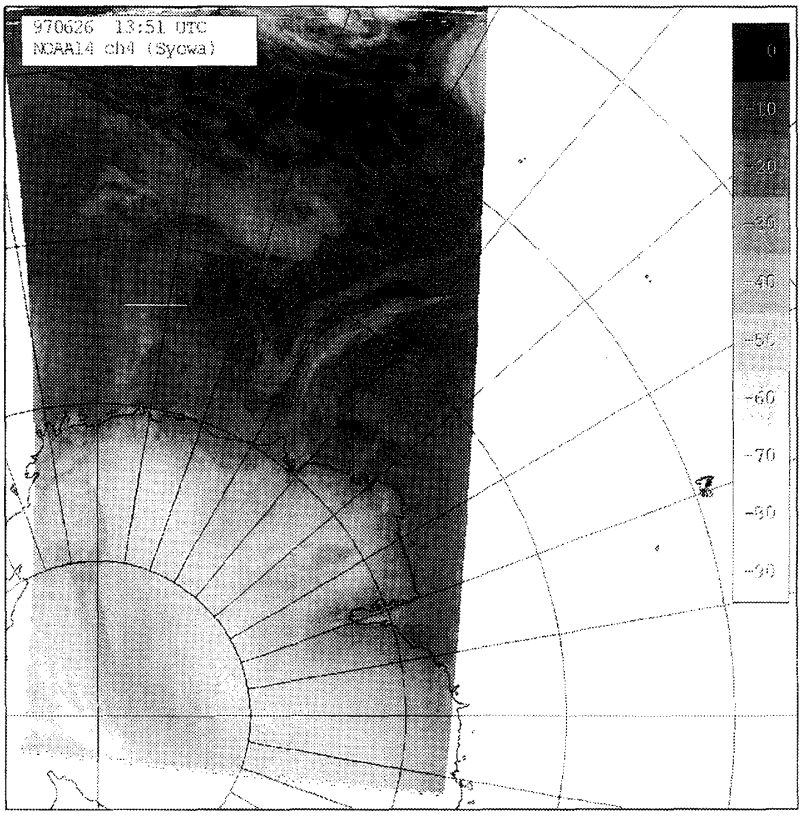
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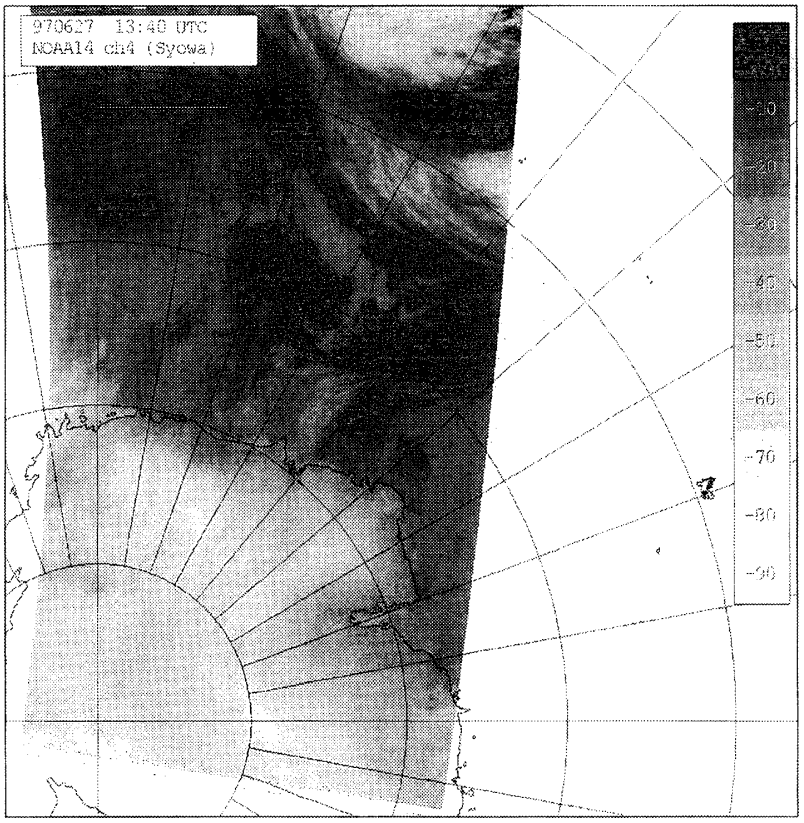
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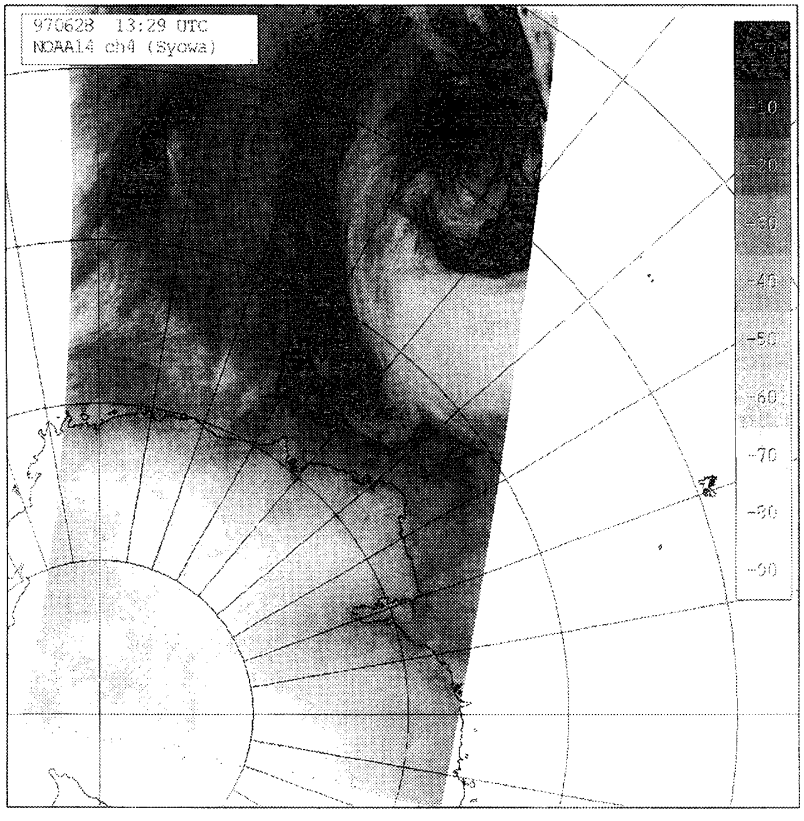
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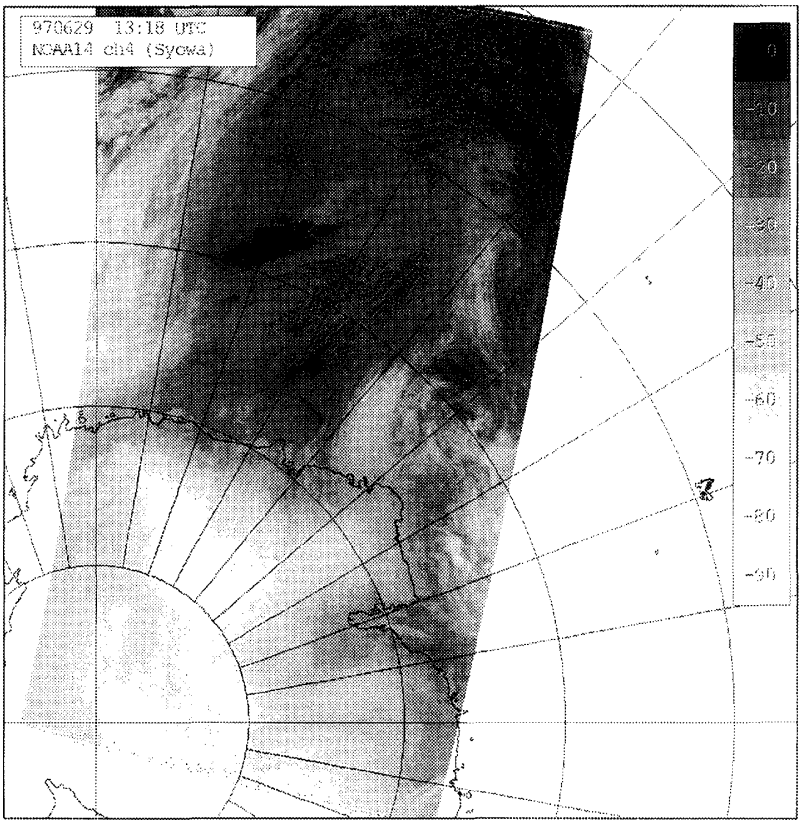
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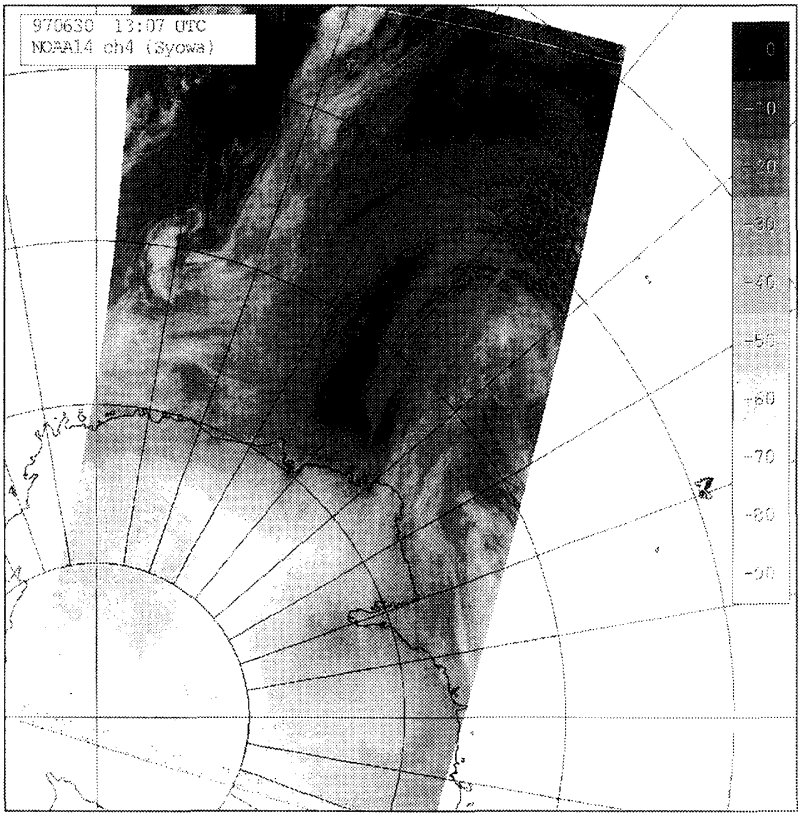
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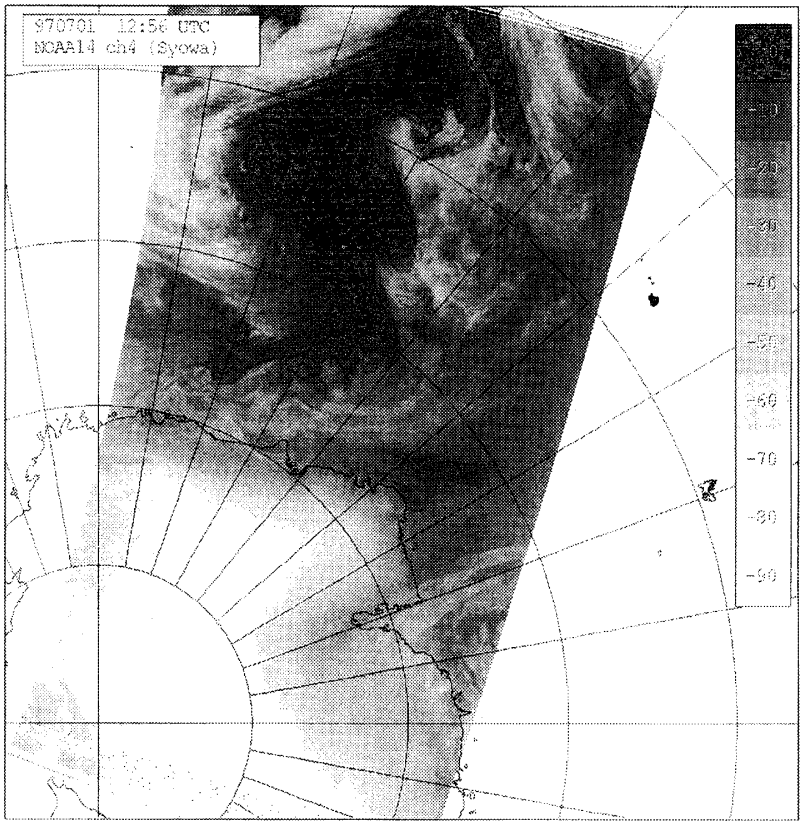
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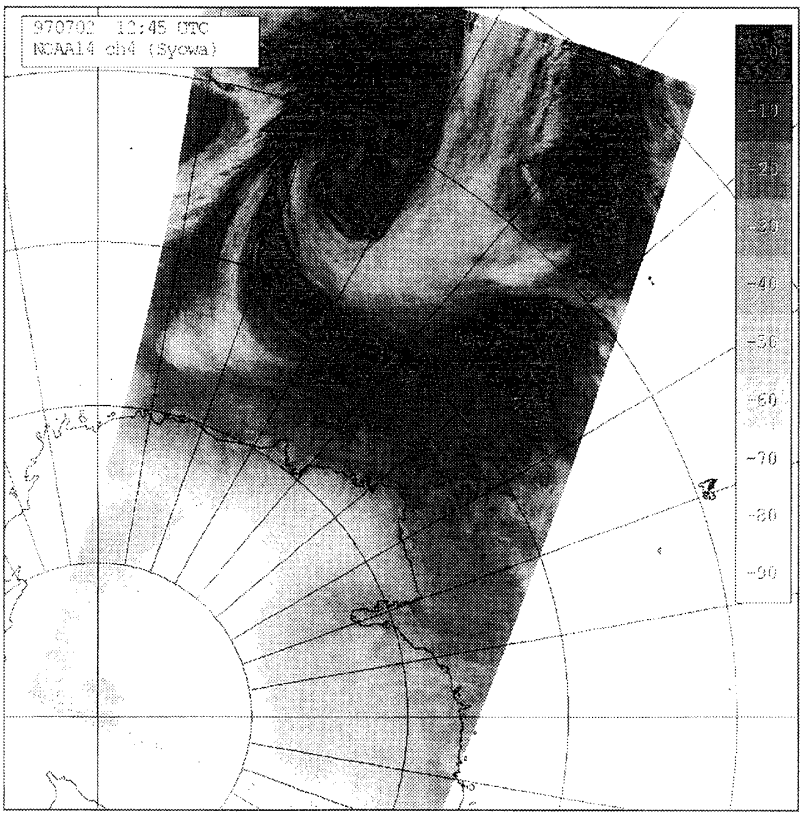
970702 12:45 UTC
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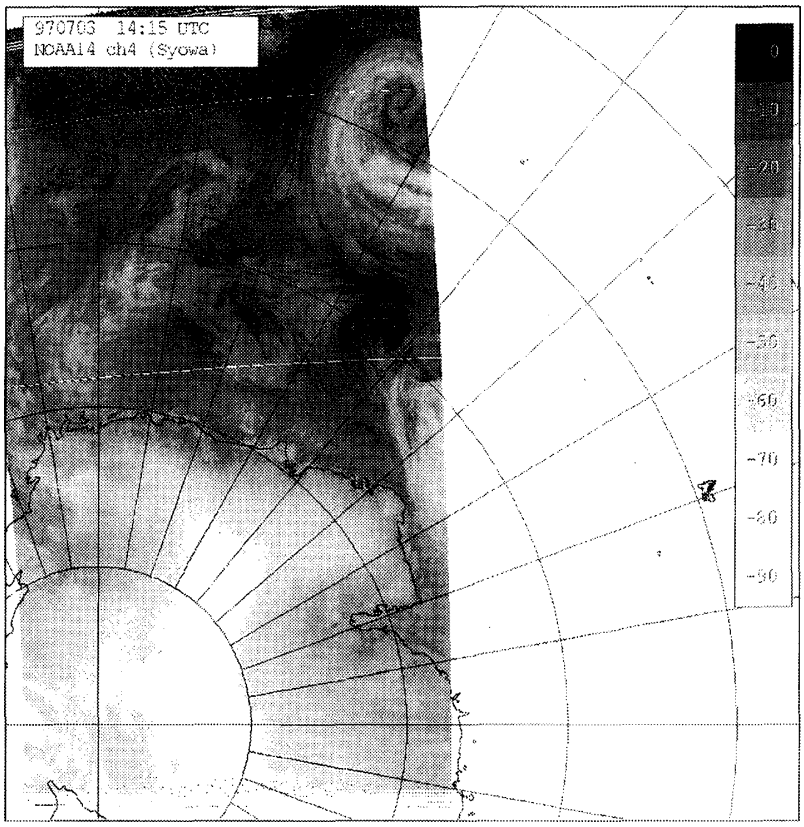
970703 14:15 UTC
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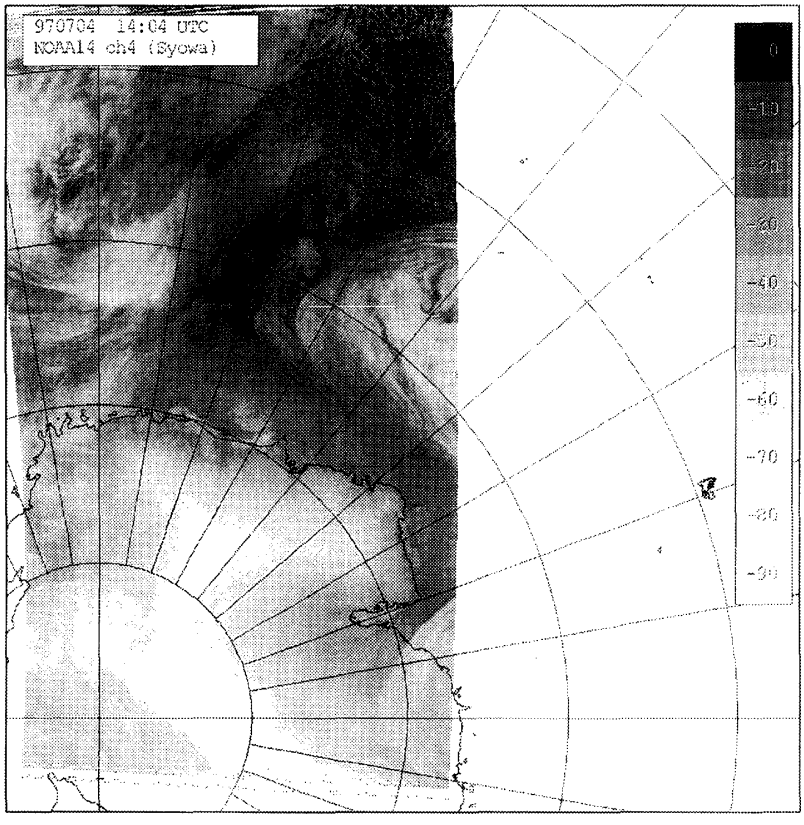
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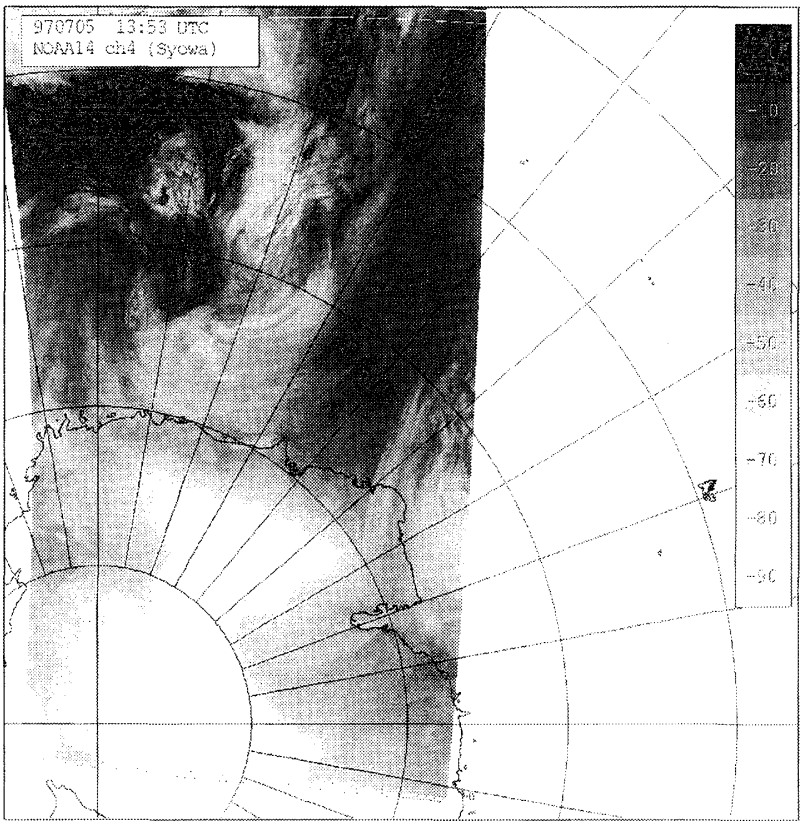
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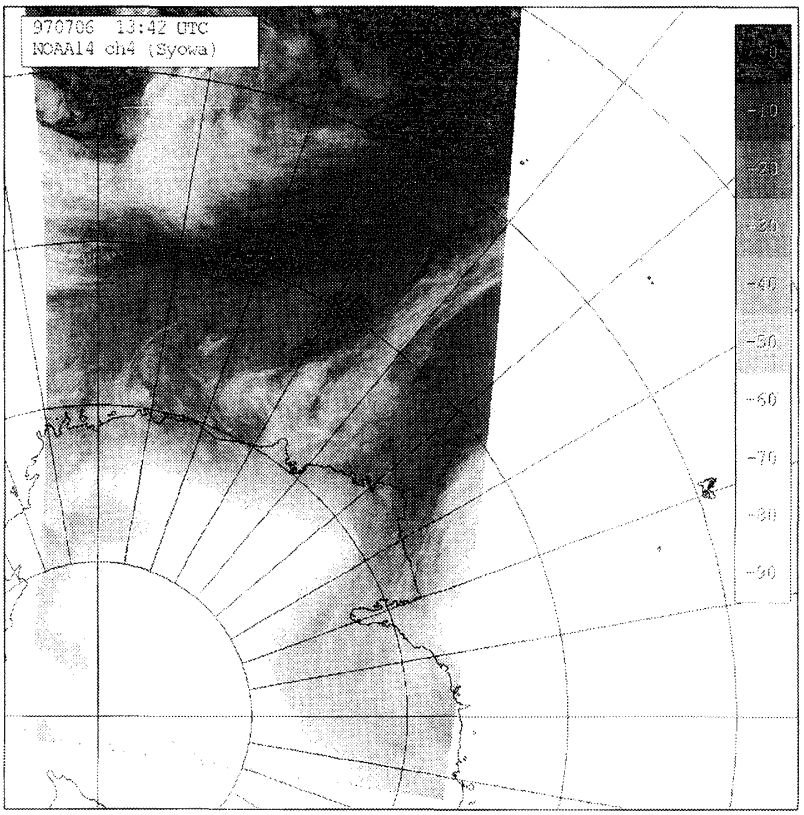
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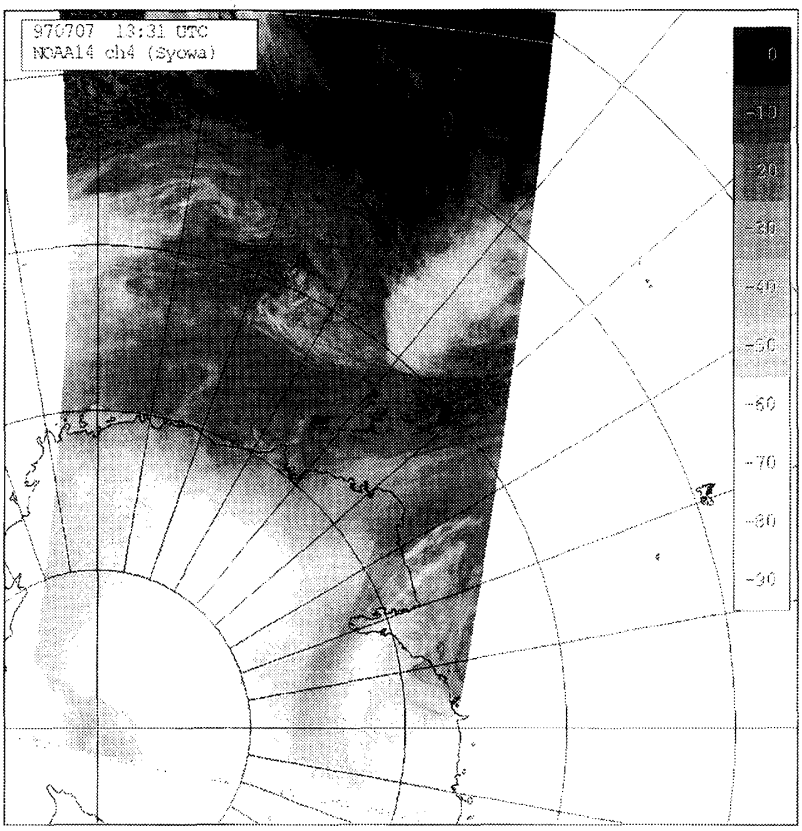
970707 13:31 UTC
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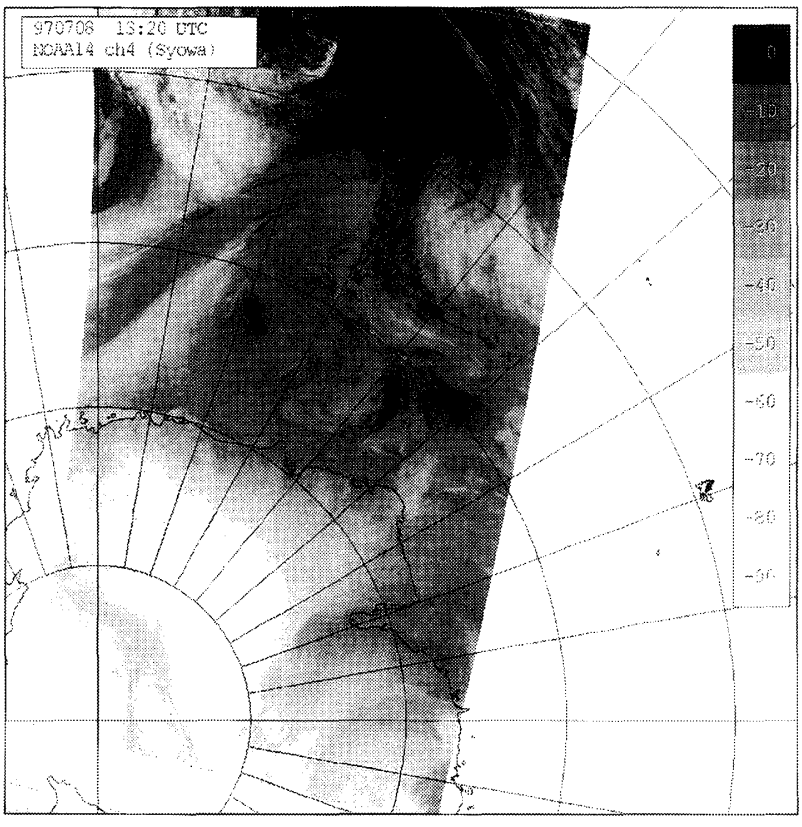
970708 13:20 UTC
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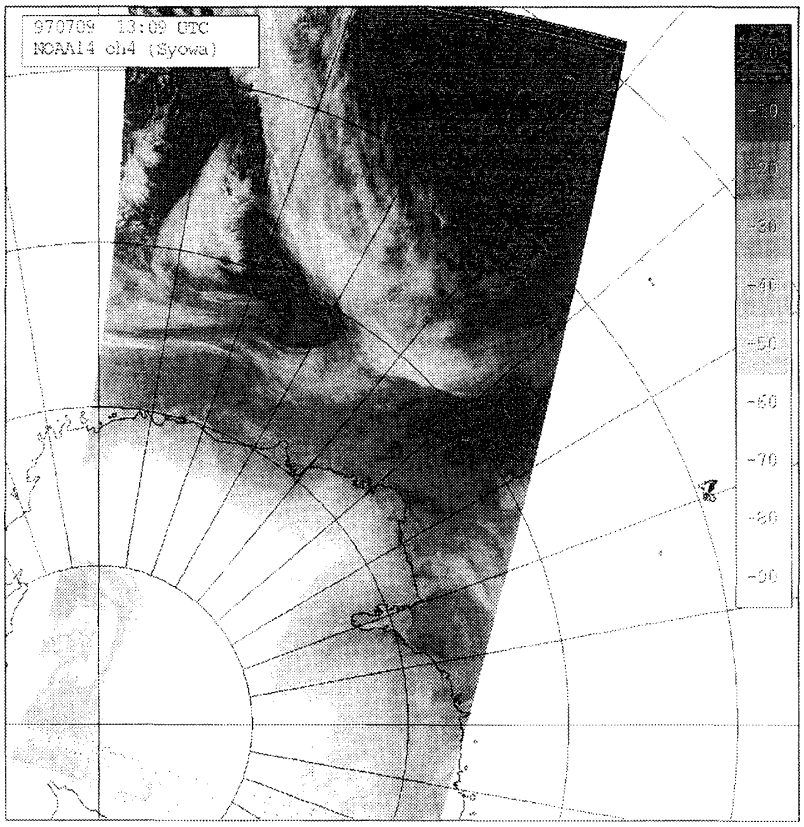
970709 13:09 UTC
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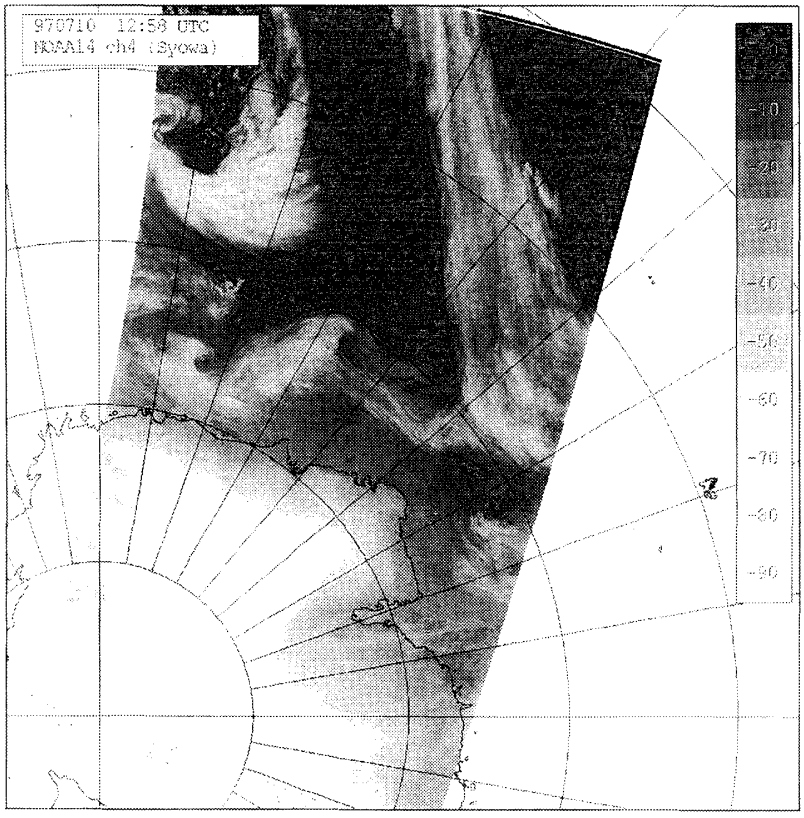
970710 12:58 UTC
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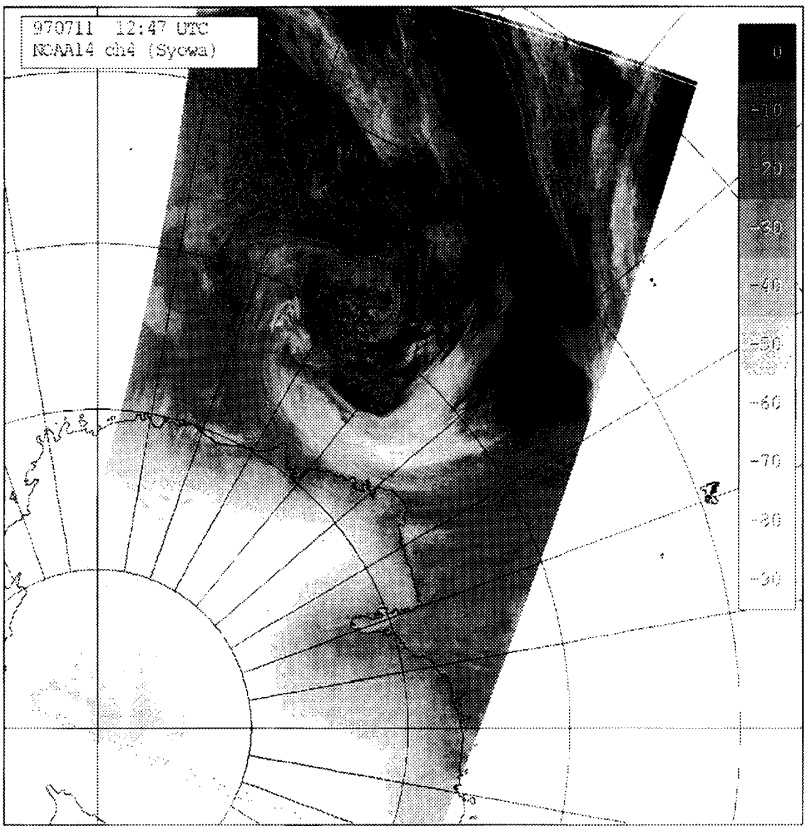
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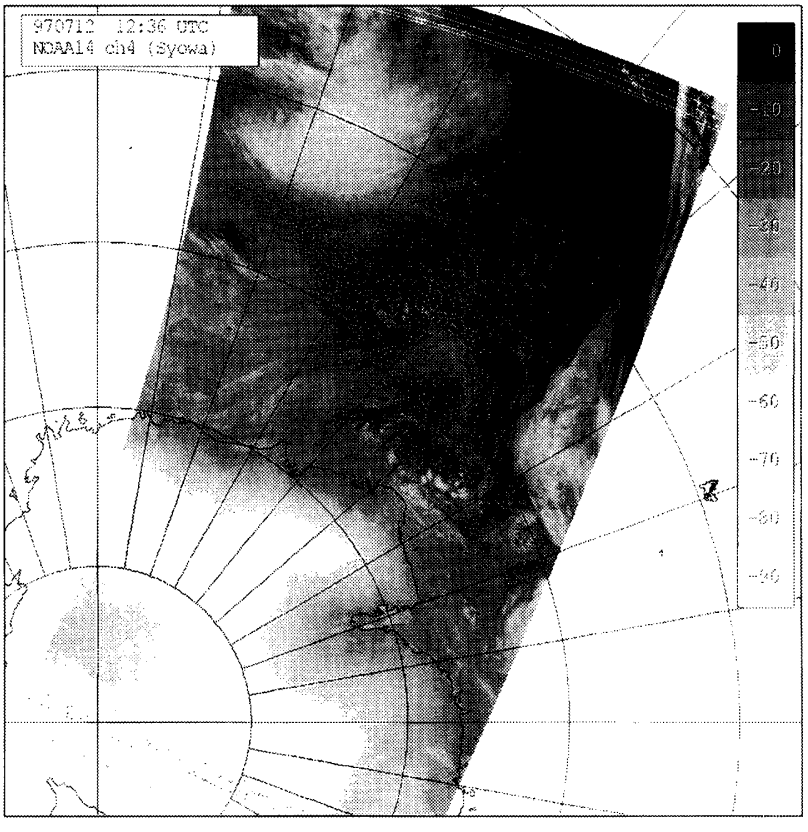
970712 12:36 UTC
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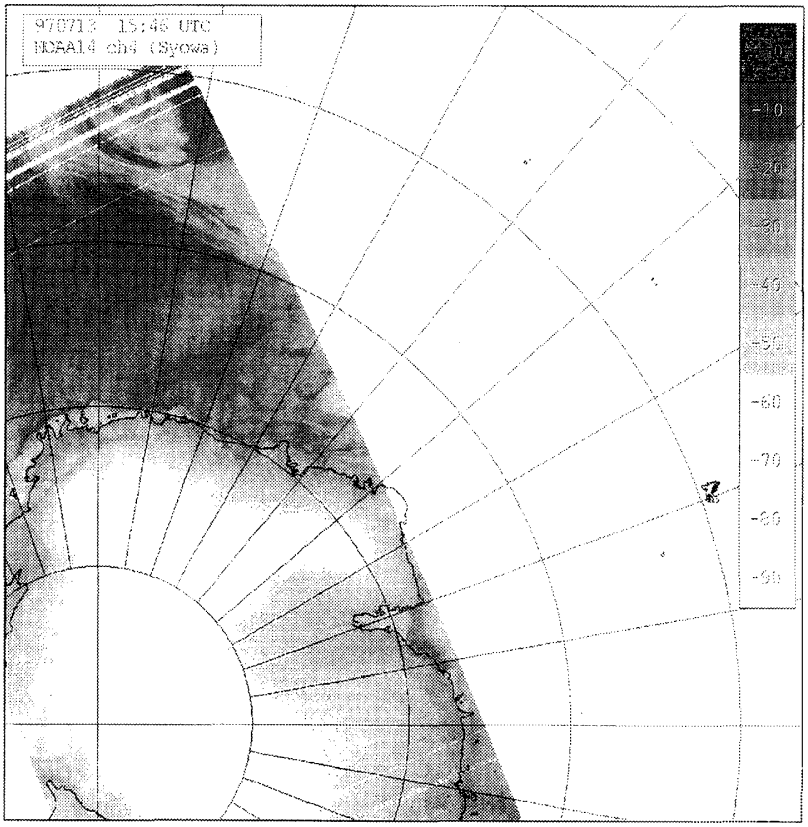
970713 15:46 UTC
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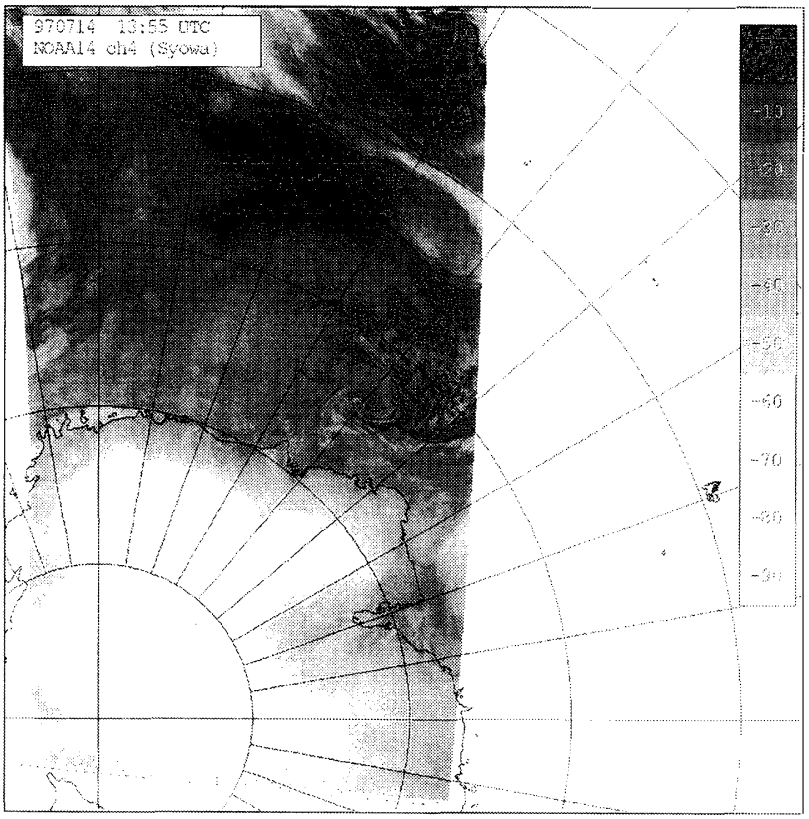
970714 13:55 UTC
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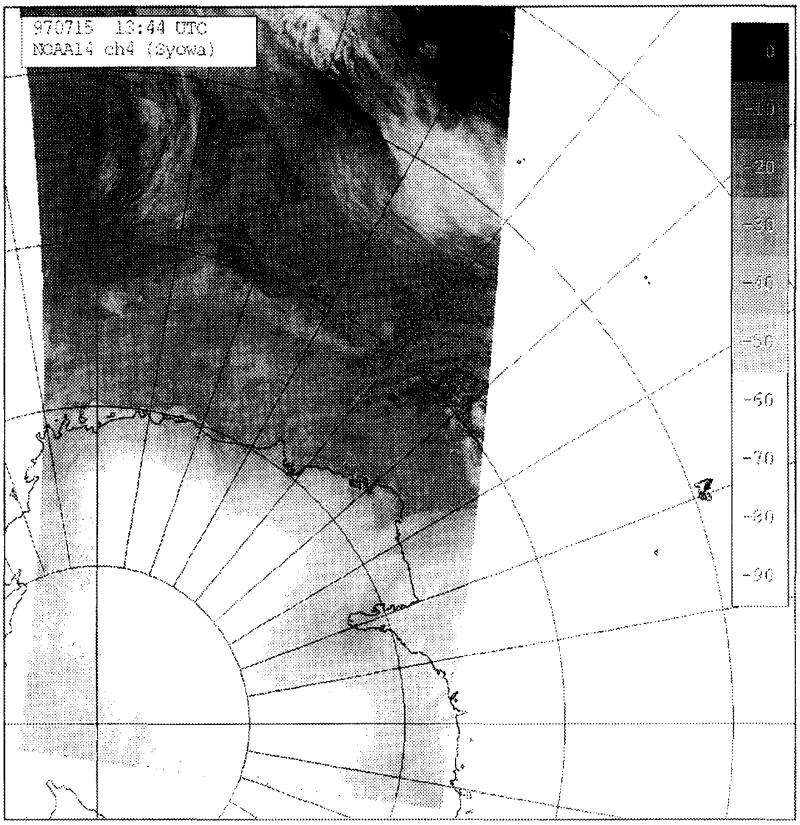
970715 13:44 UTC
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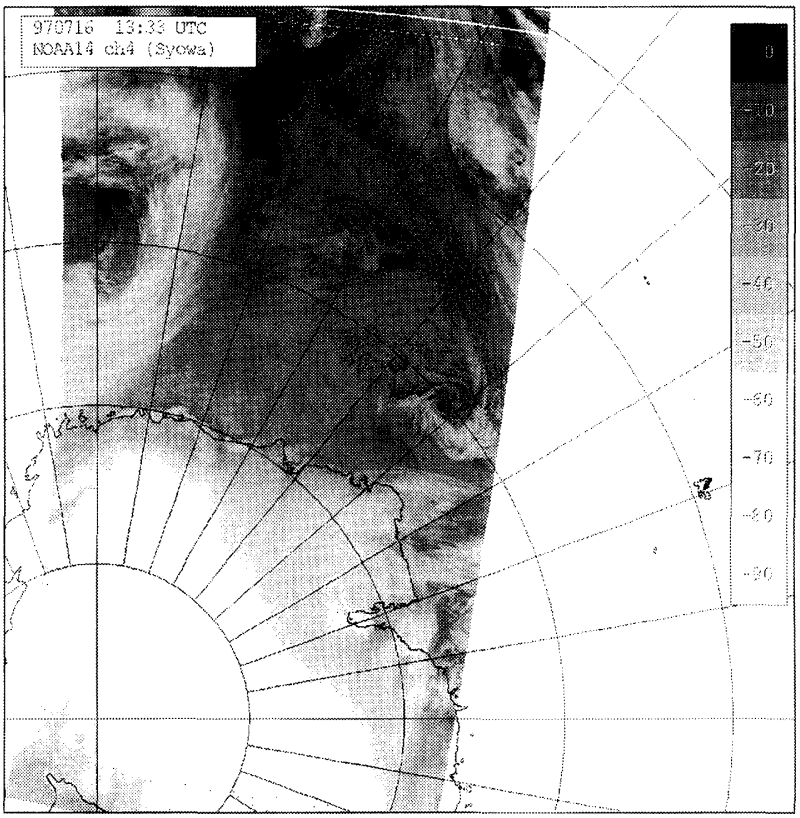
970716 13:33 UTC
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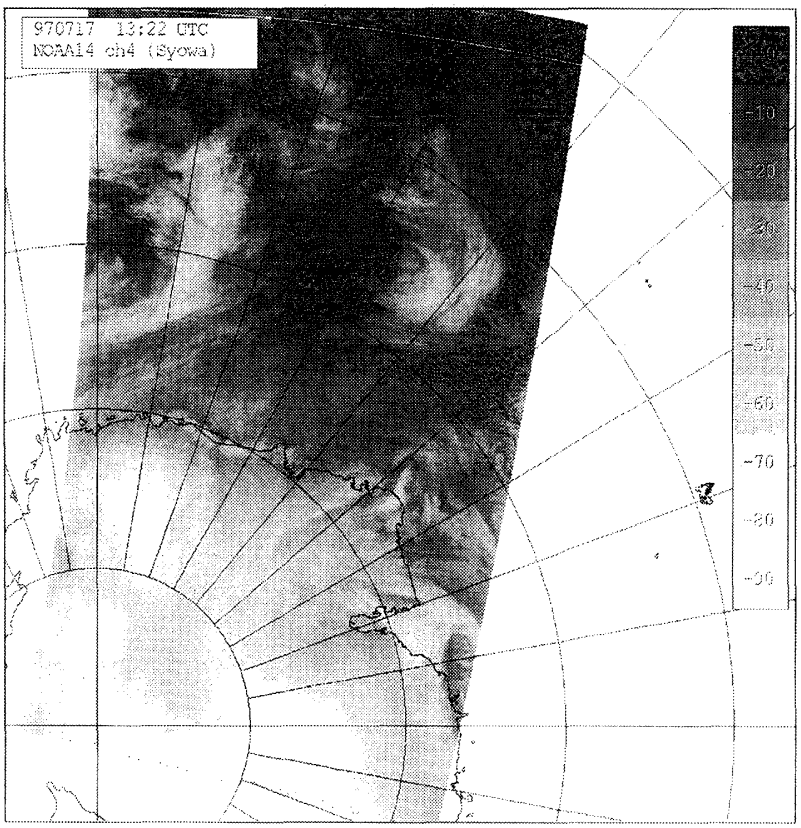
970717 13:22 UTC
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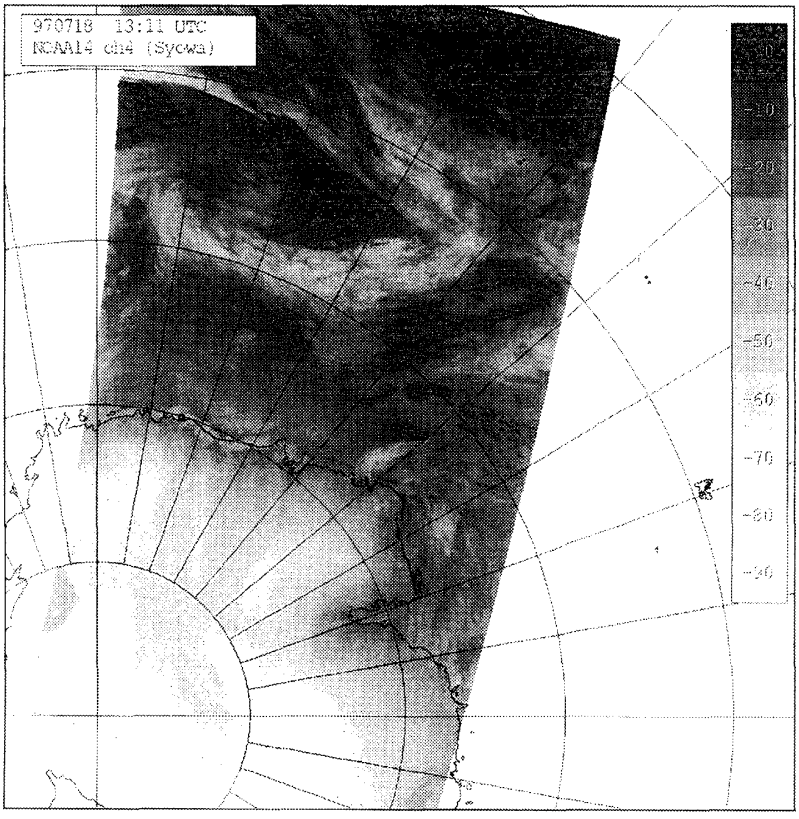
970718 13:11 UTC
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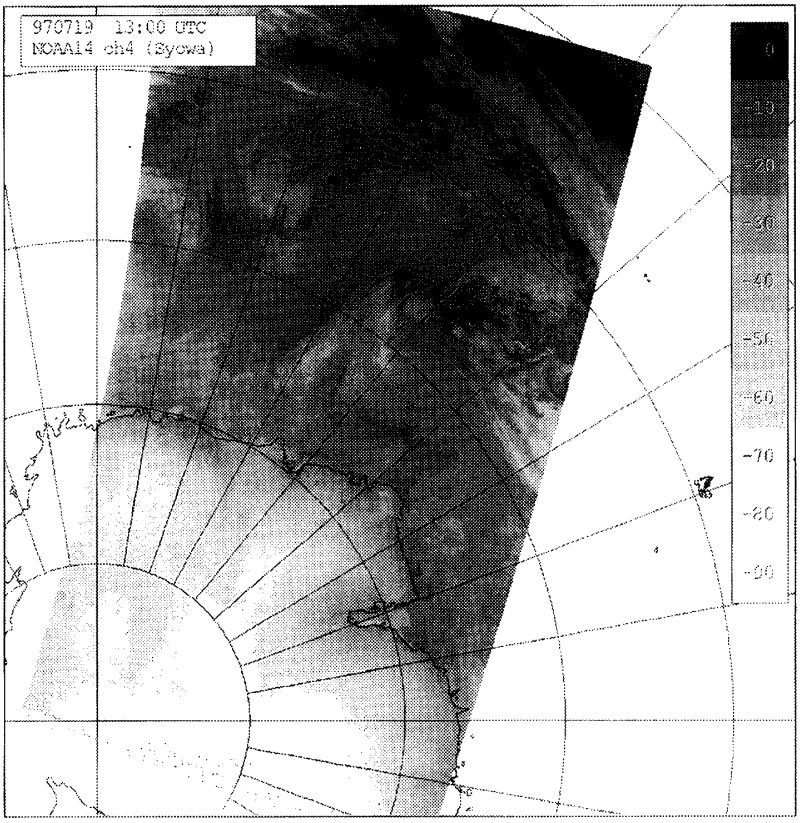
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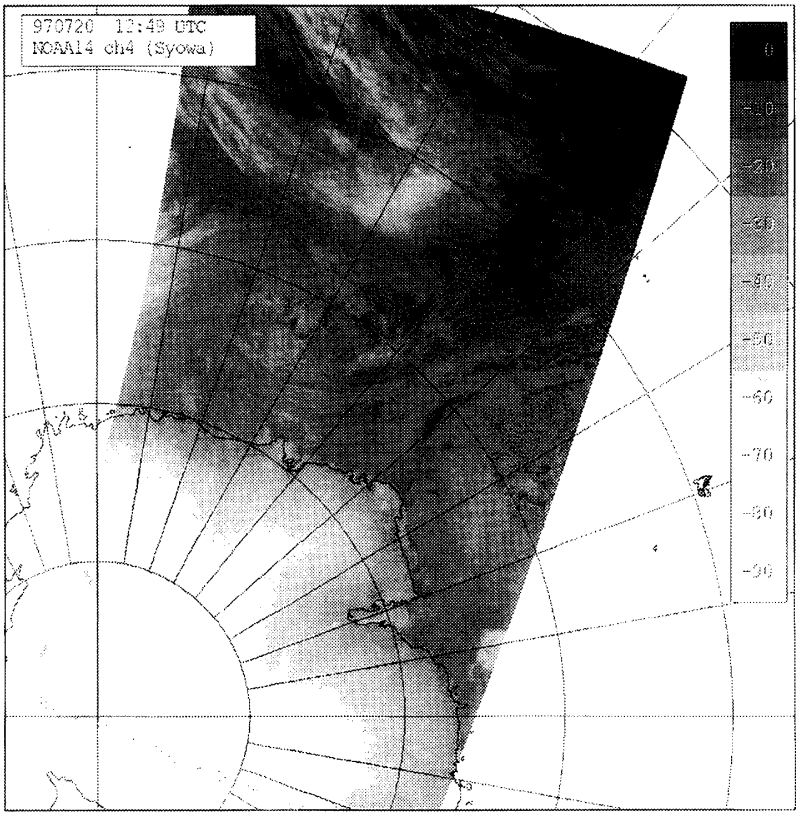
970720 12:49 UTC
NOAA14 ch4 (Syowa)
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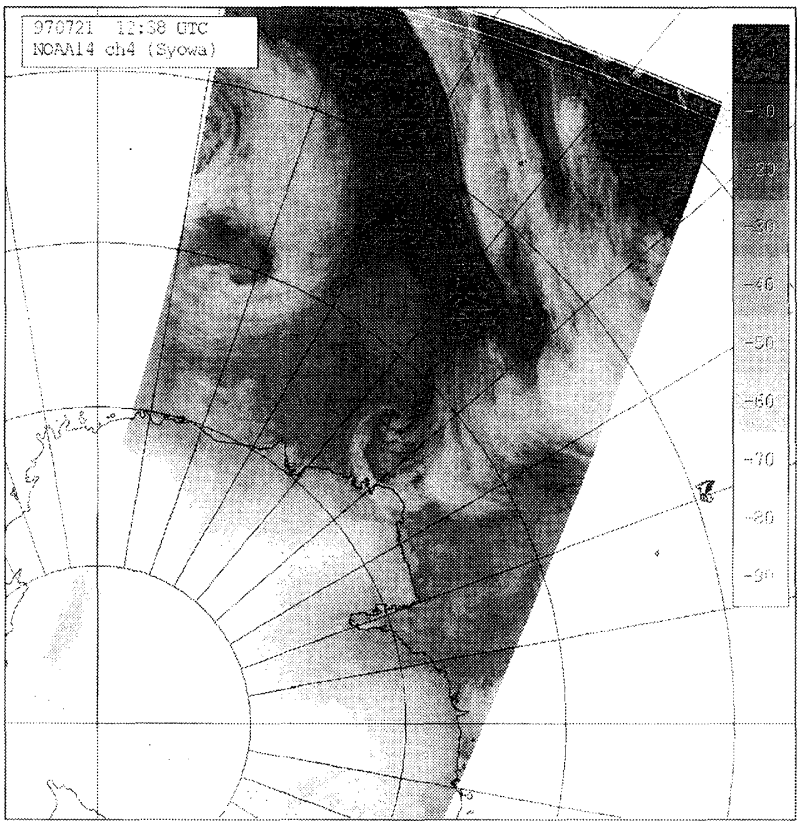
970721 12:58 UTC
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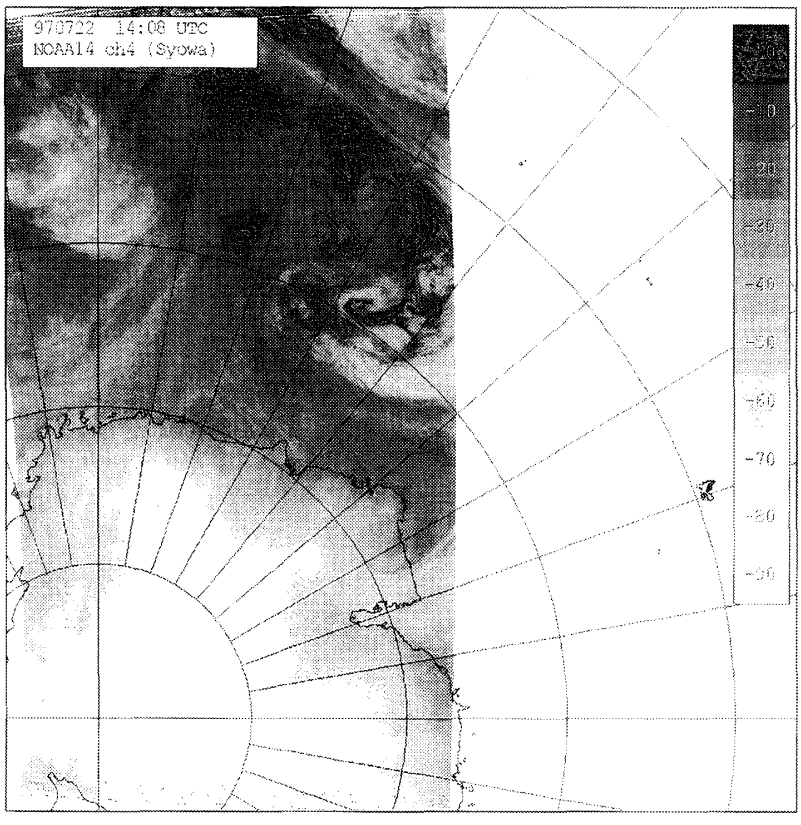
970722 14:00 UTC
NOAA14 ch4 (Syowa)
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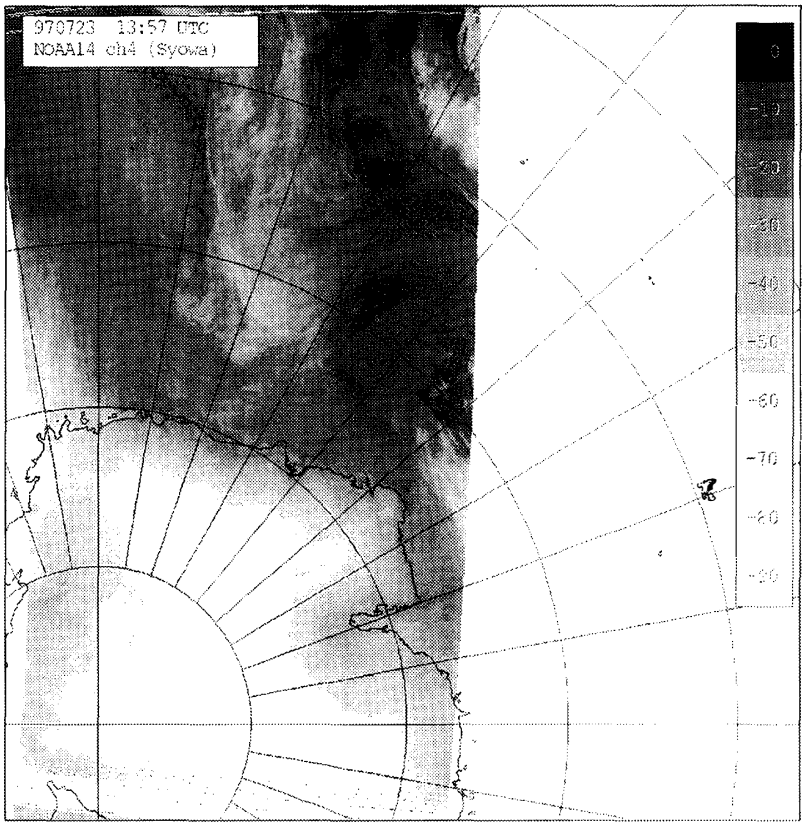
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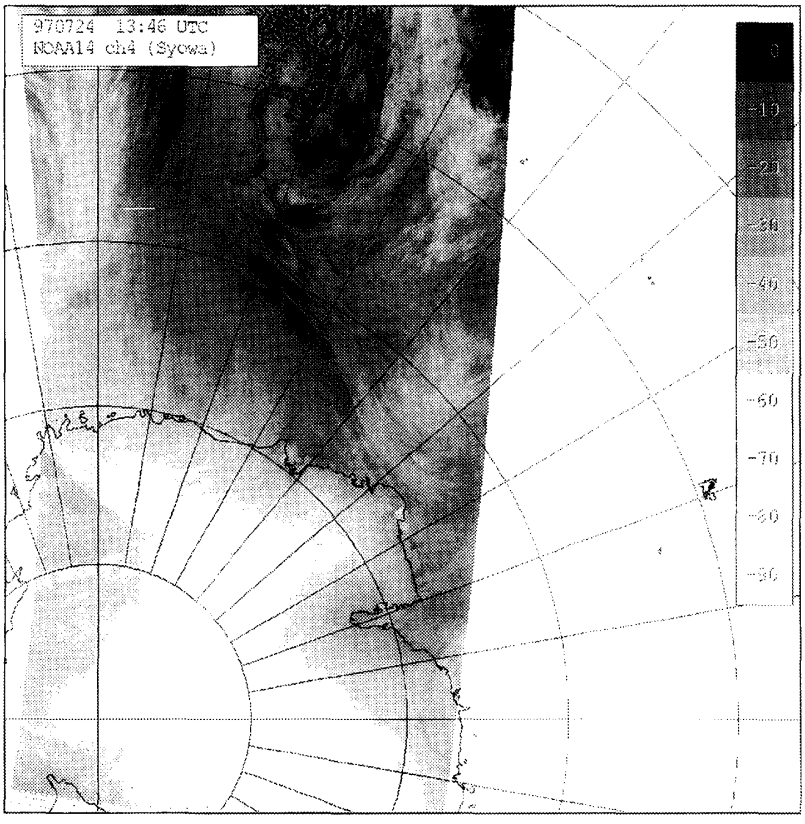
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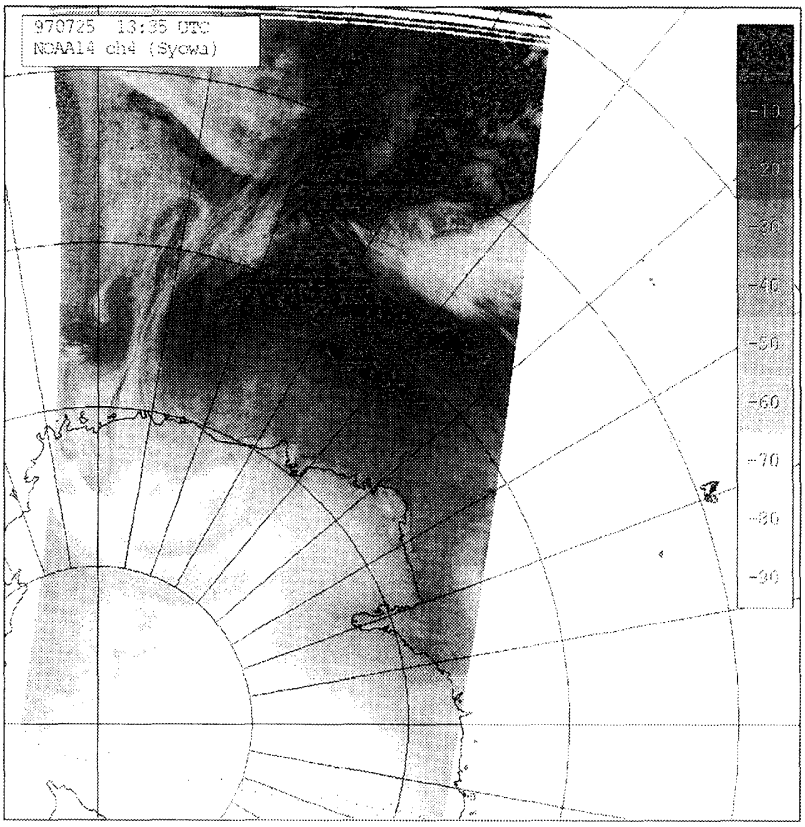
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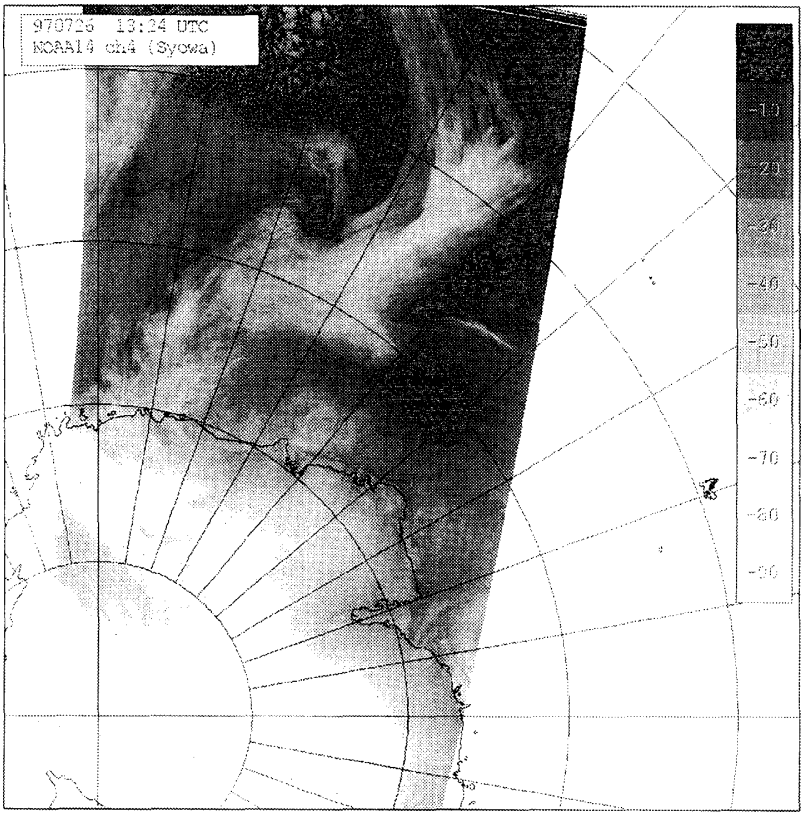
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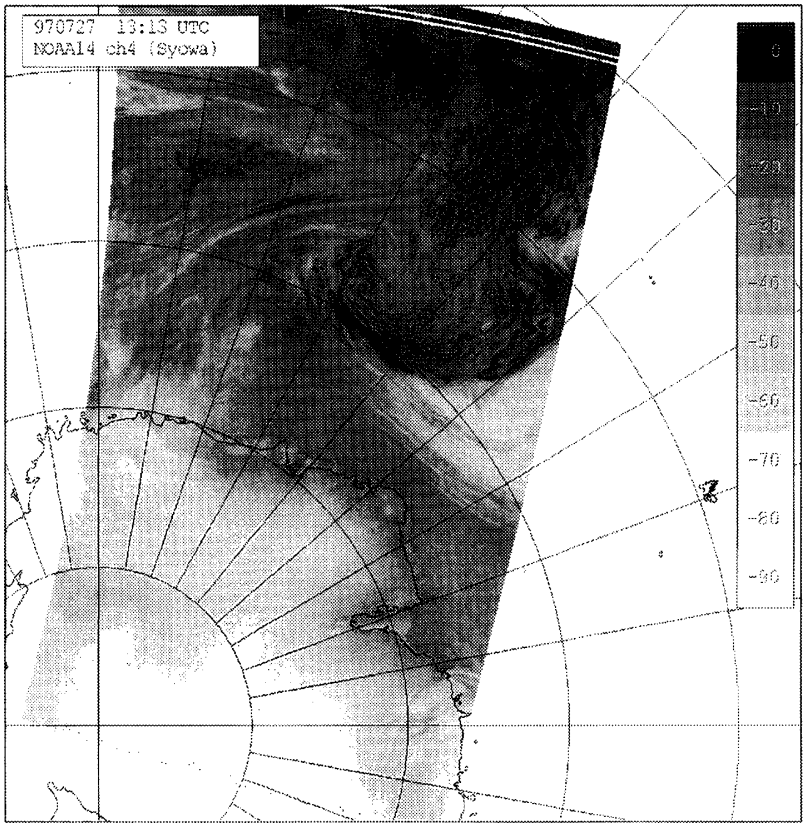
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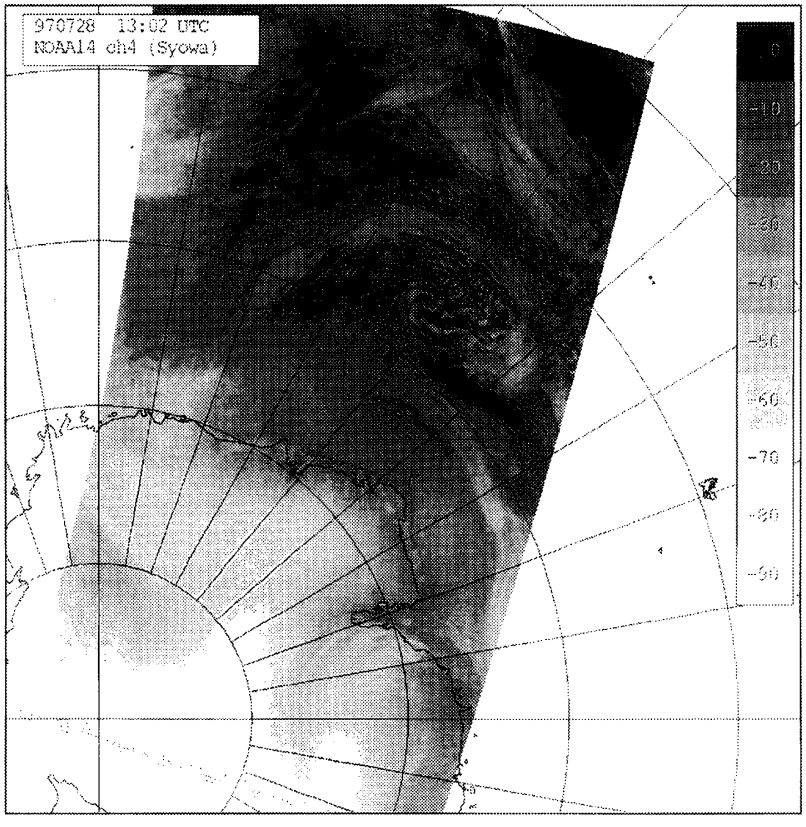
970728 13:02 UTC
NOAA14 ch4 (Syowa)
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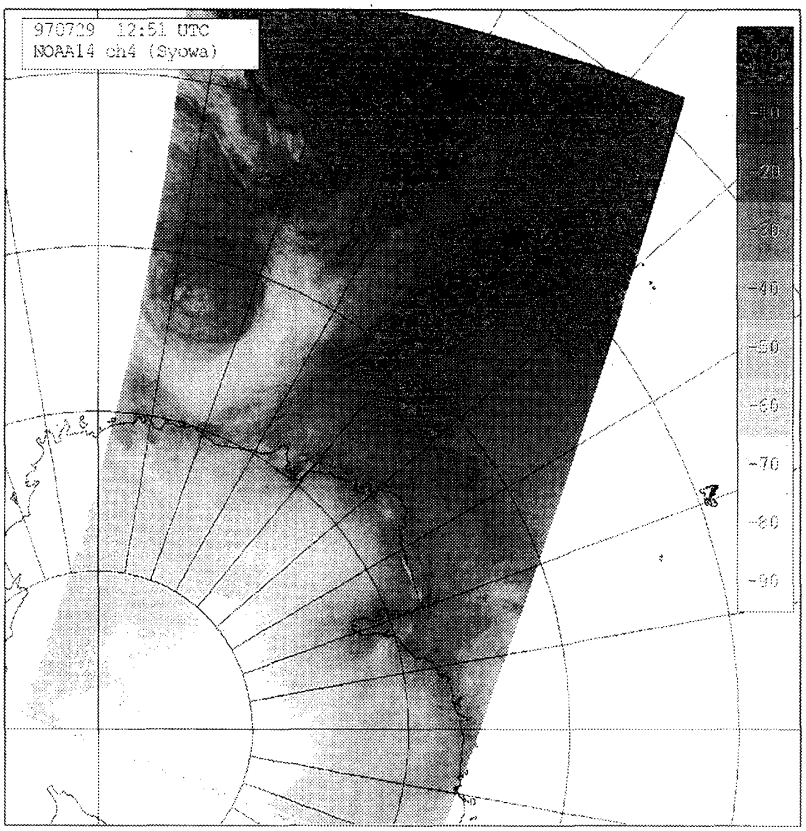
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NOAA14 ch4 (Syowa)
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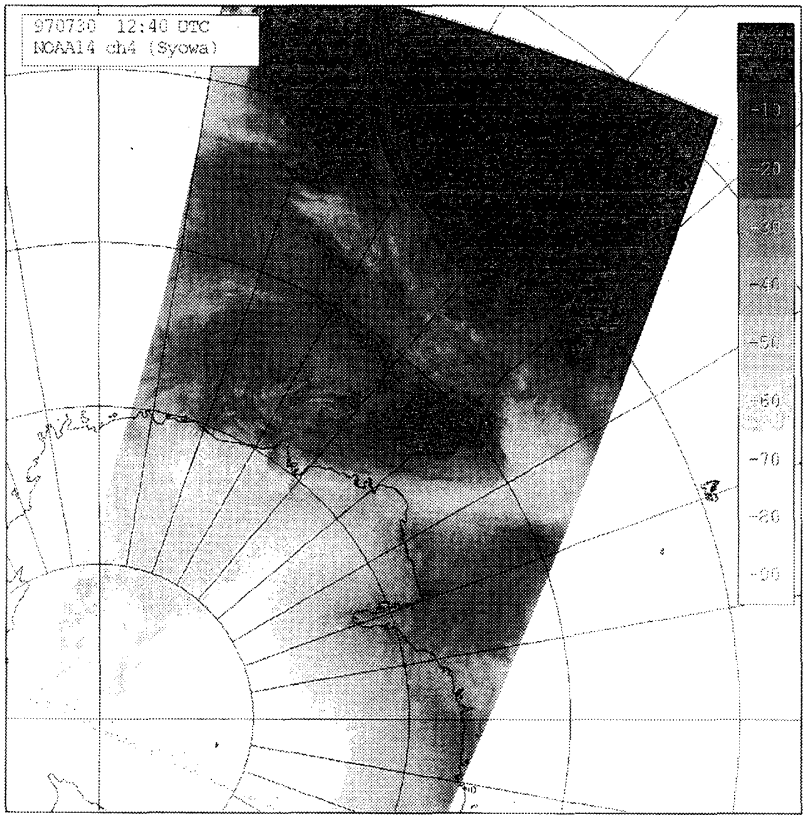
970730 12:40 UTC
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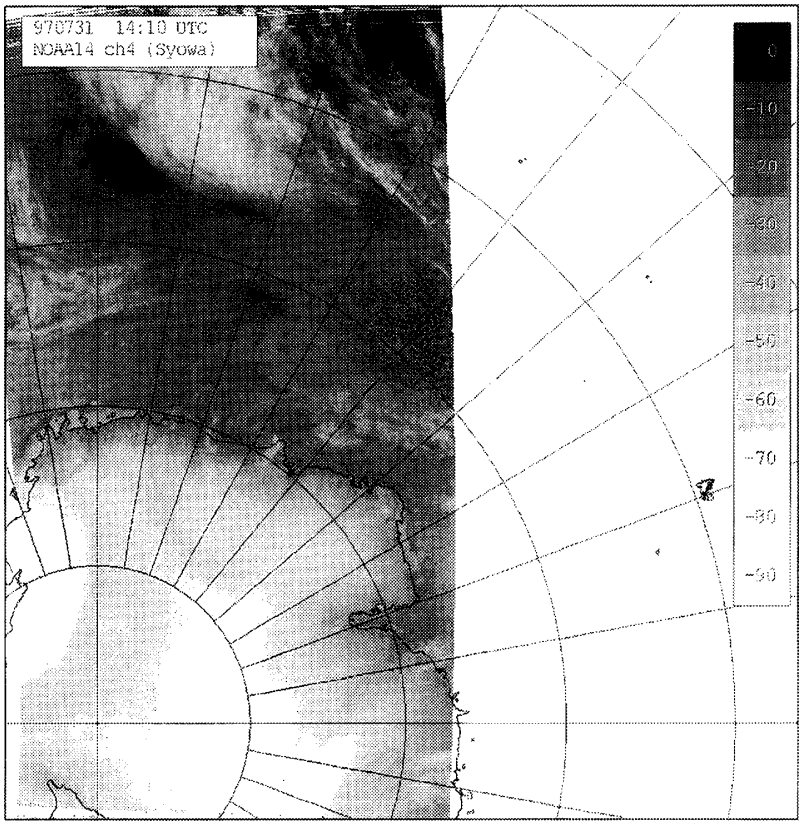
970731 14:10 UTC
NOAA14 ch4 (Syowa)
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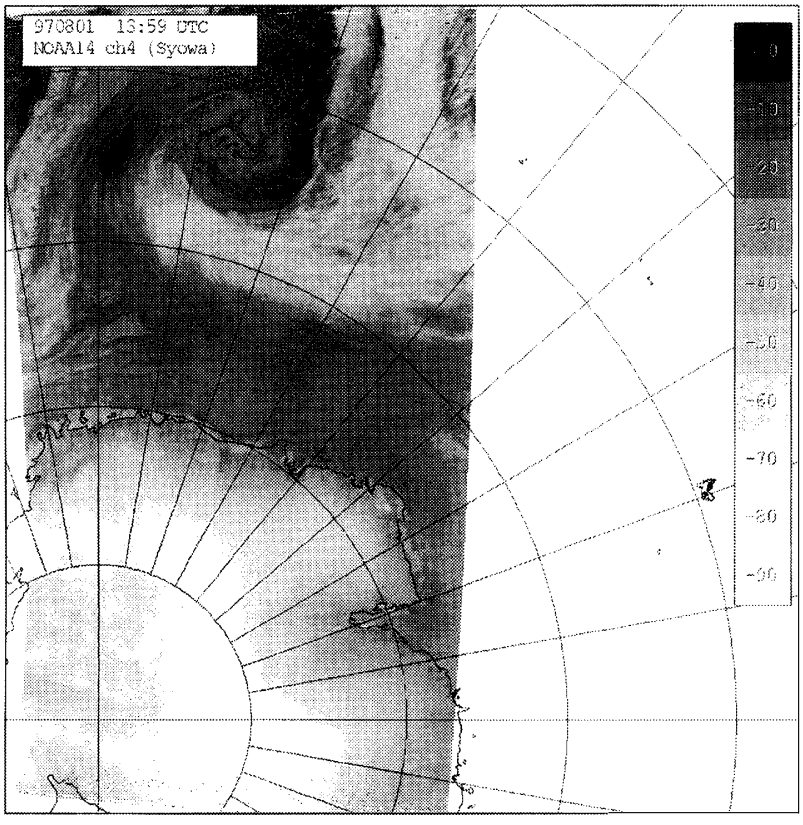
970801 13:59 UTC
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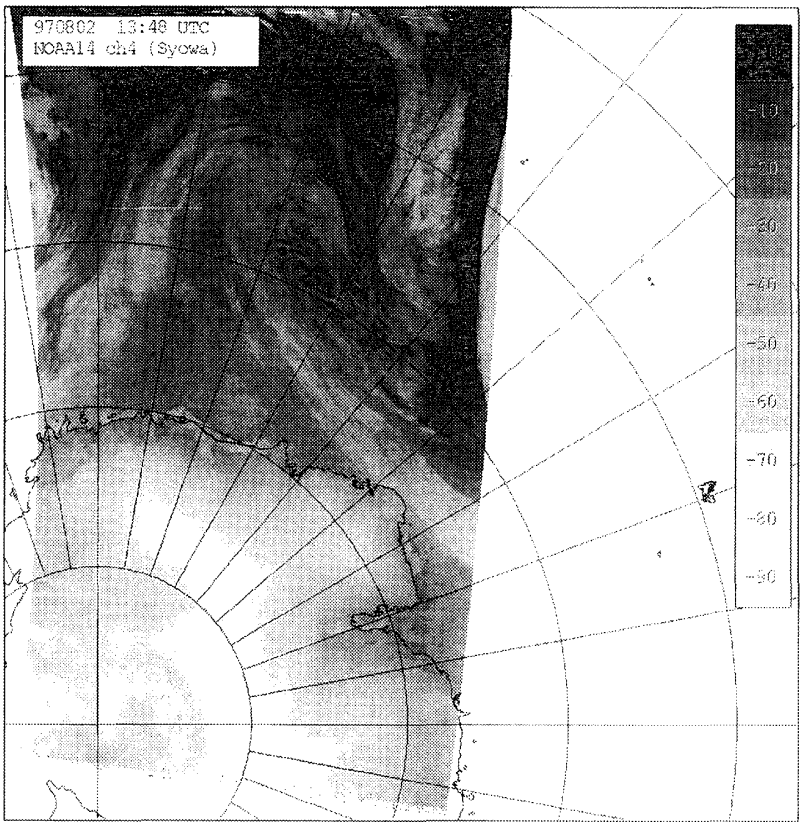
970802 13:40 UTC
NOAA14 ch4 (Syowa)
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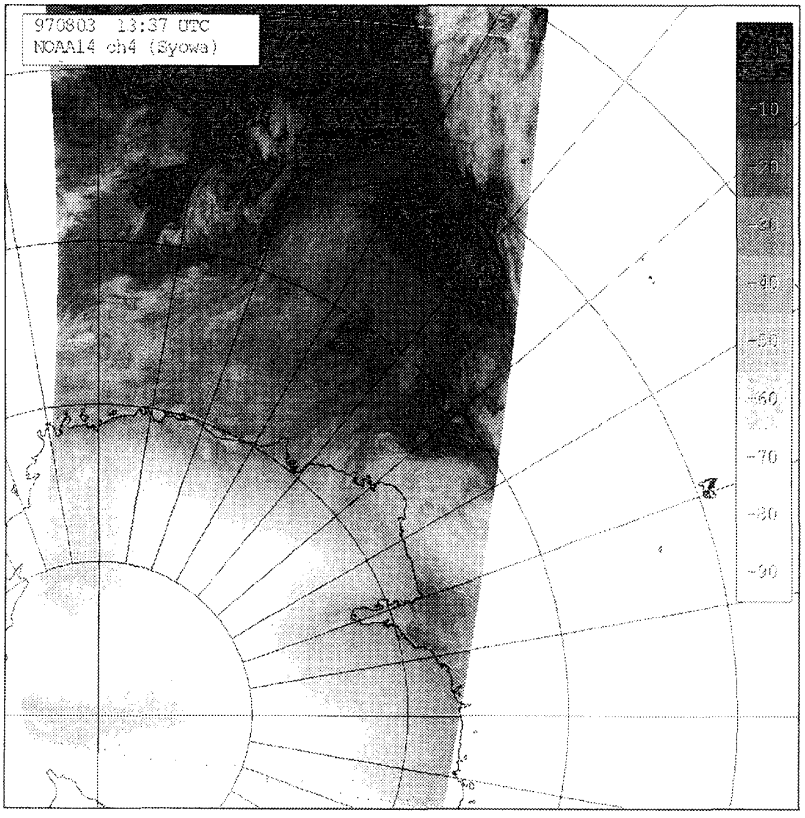
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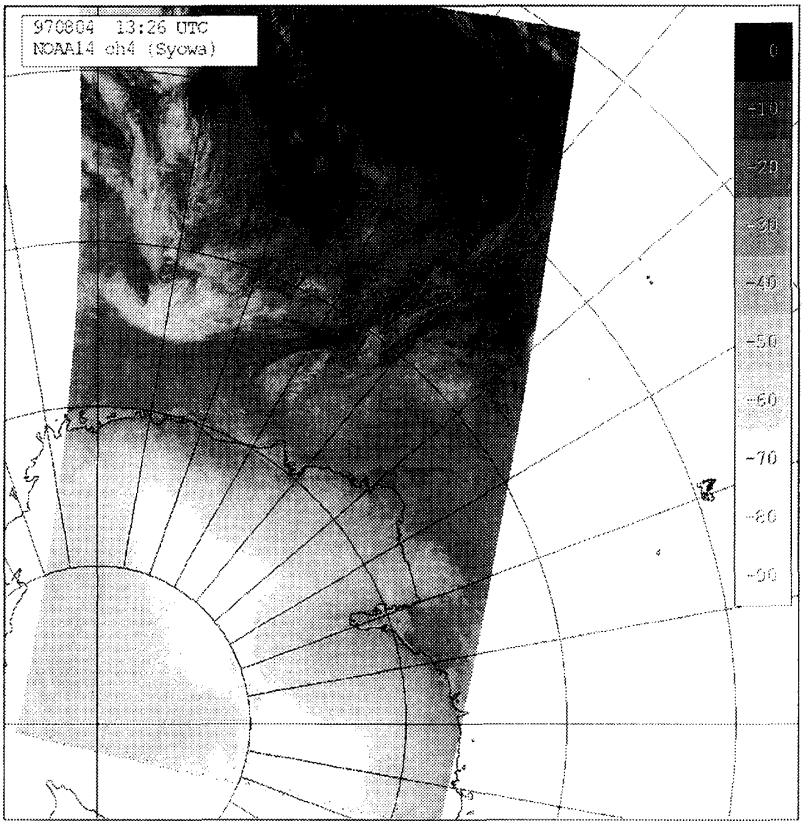
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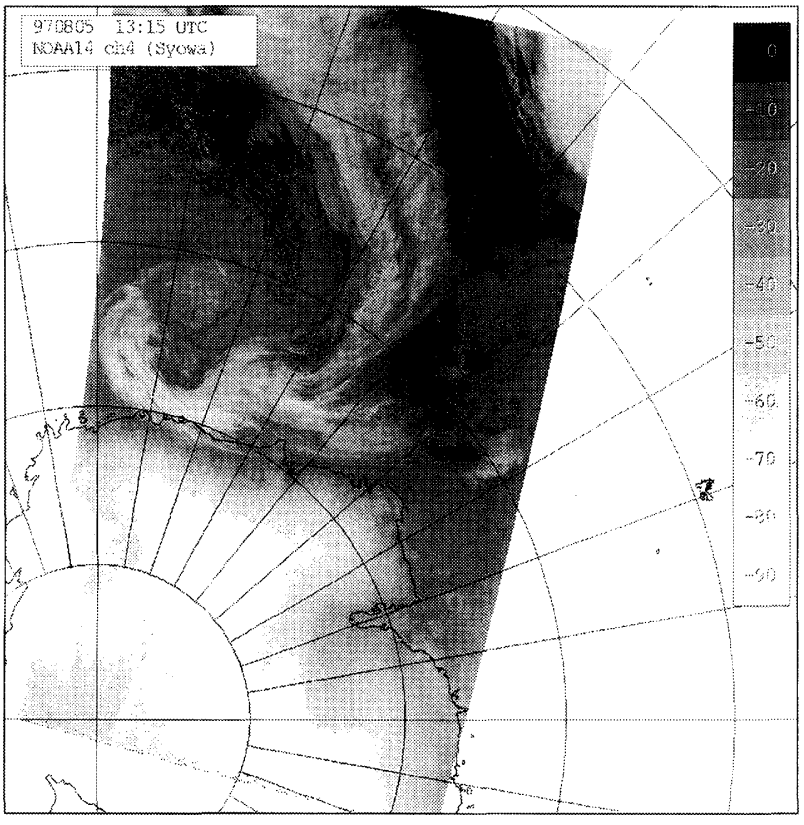
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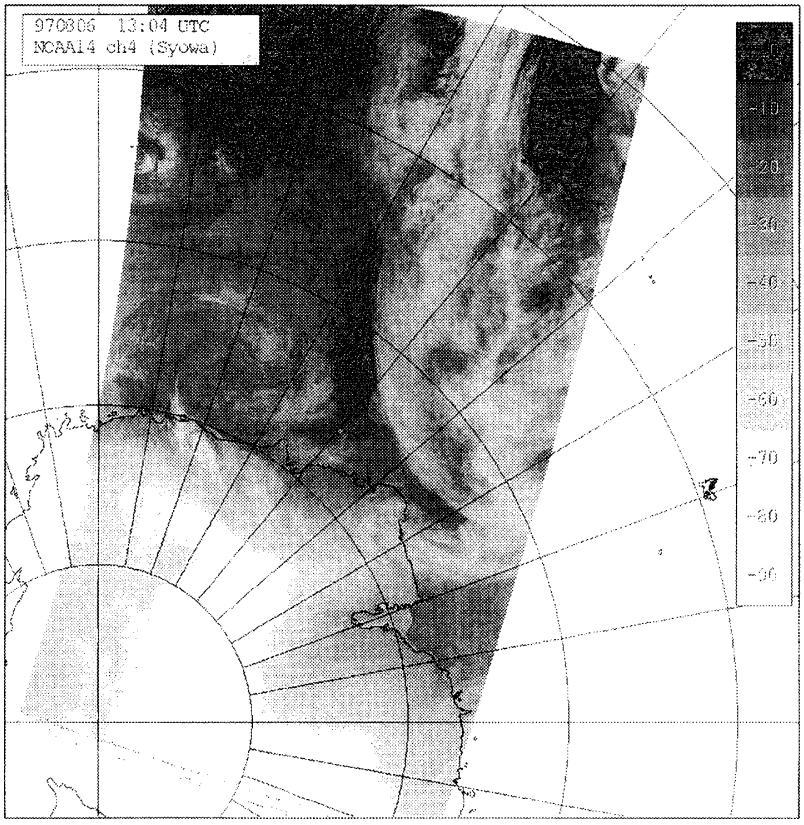
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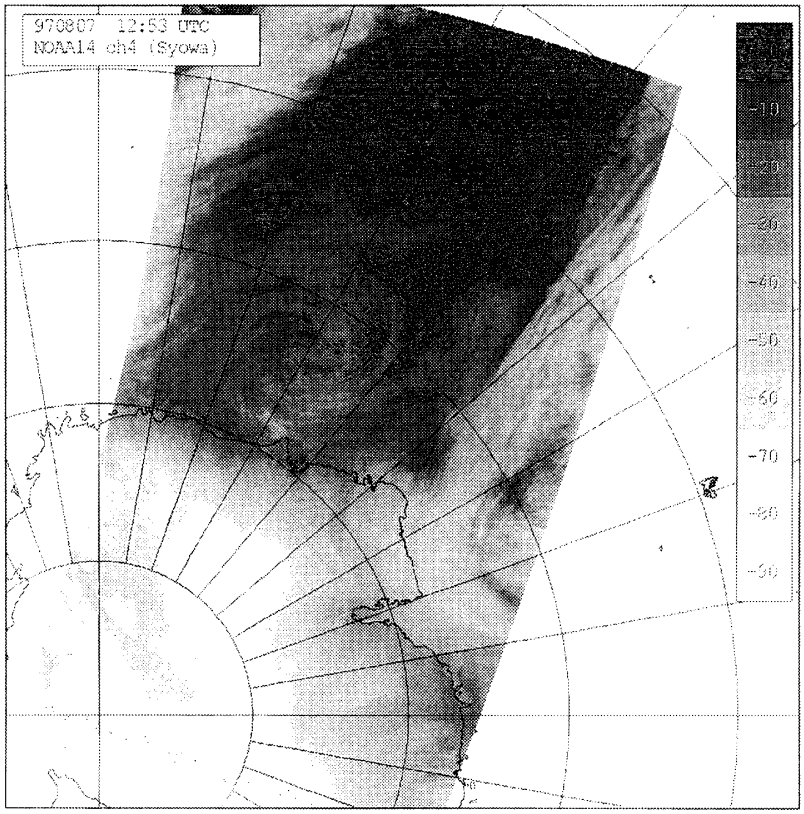
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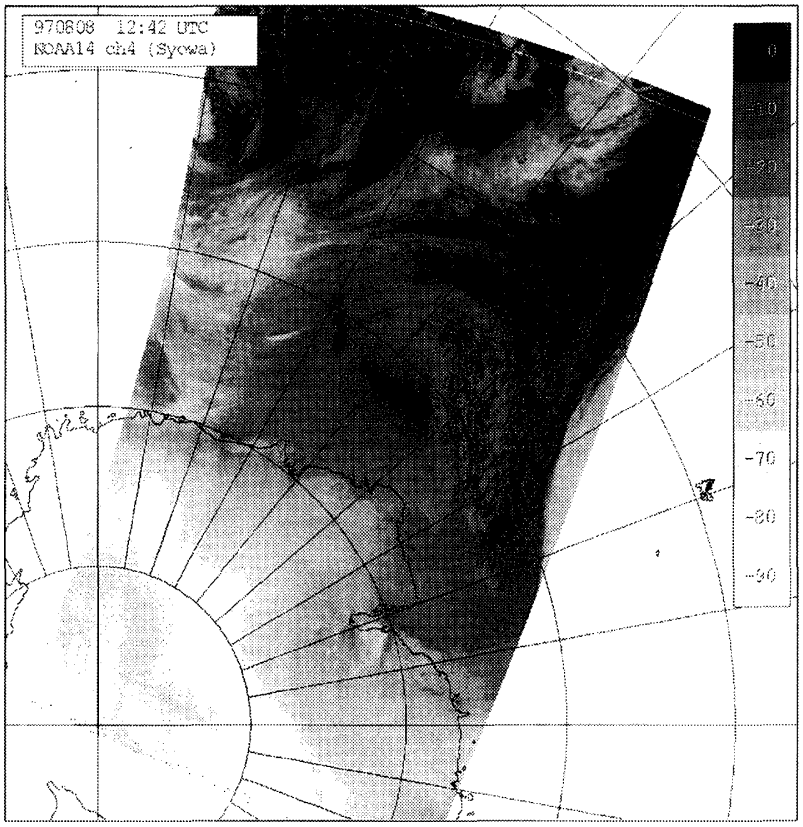
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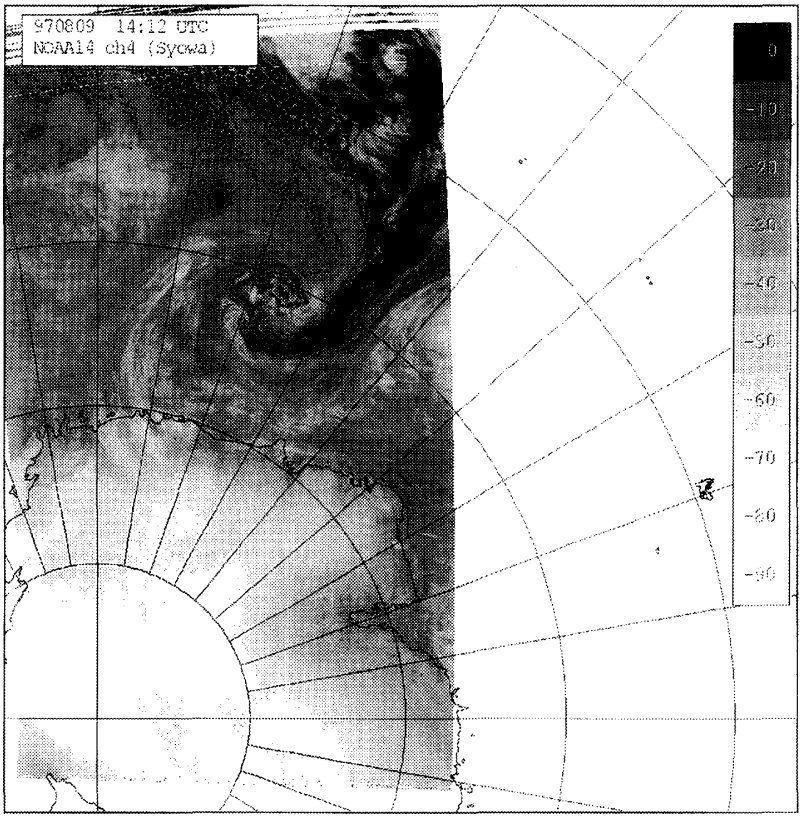
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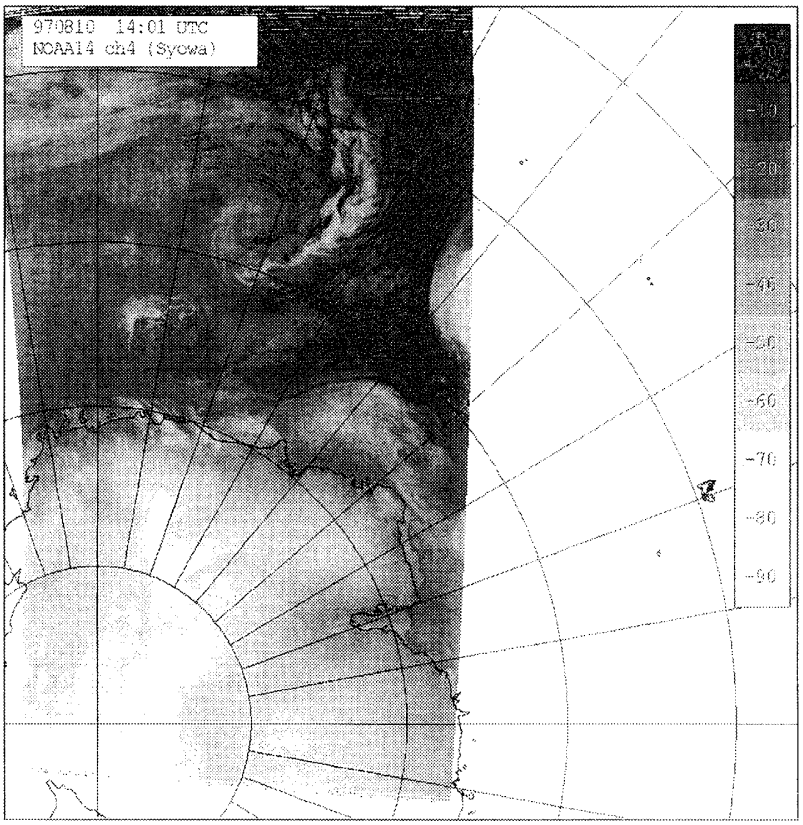
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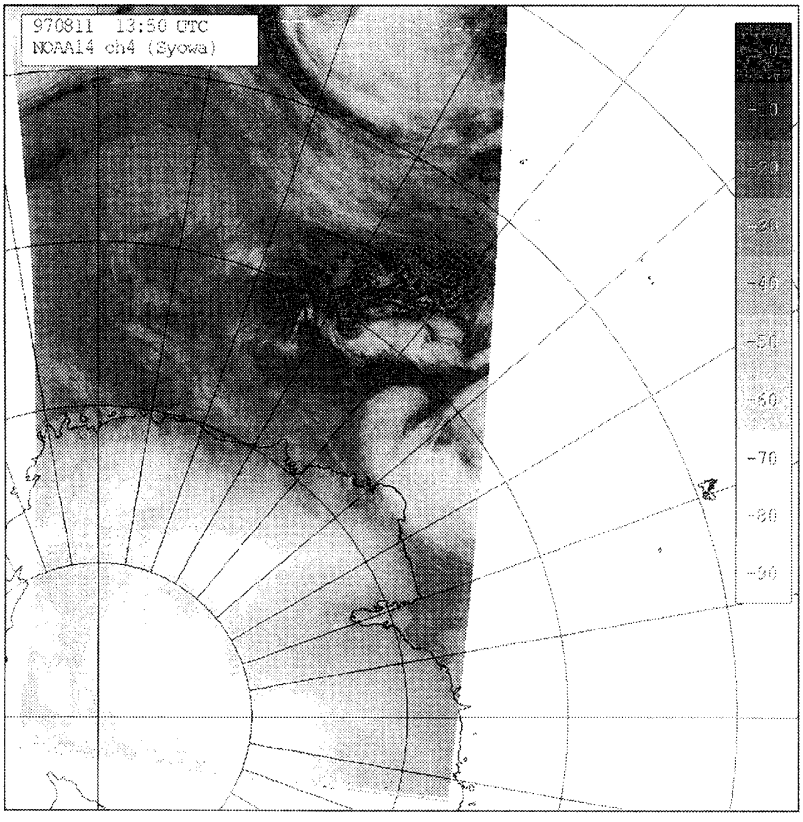
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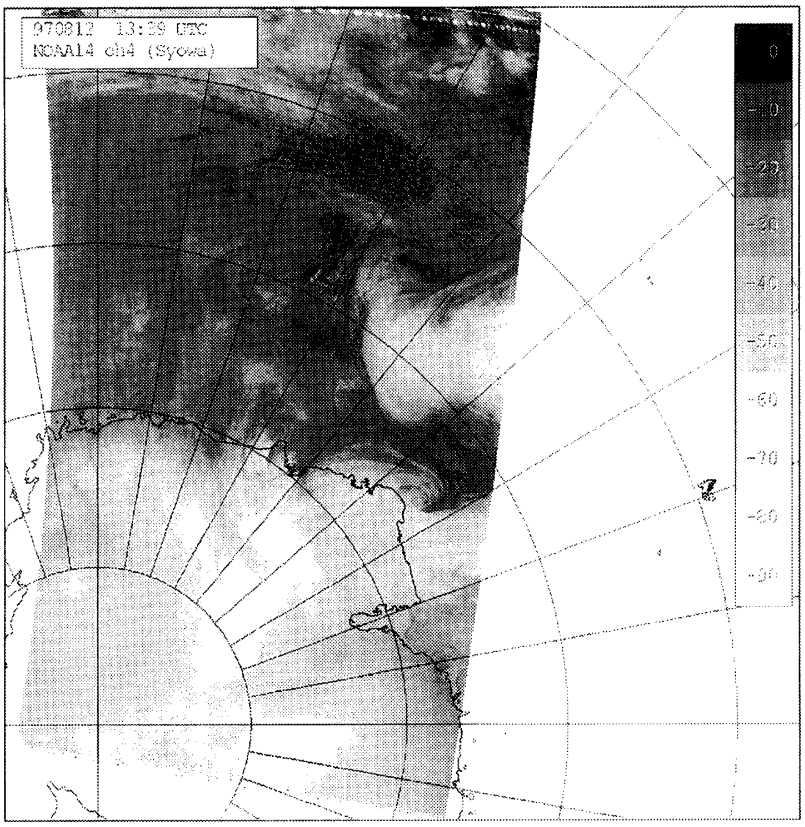
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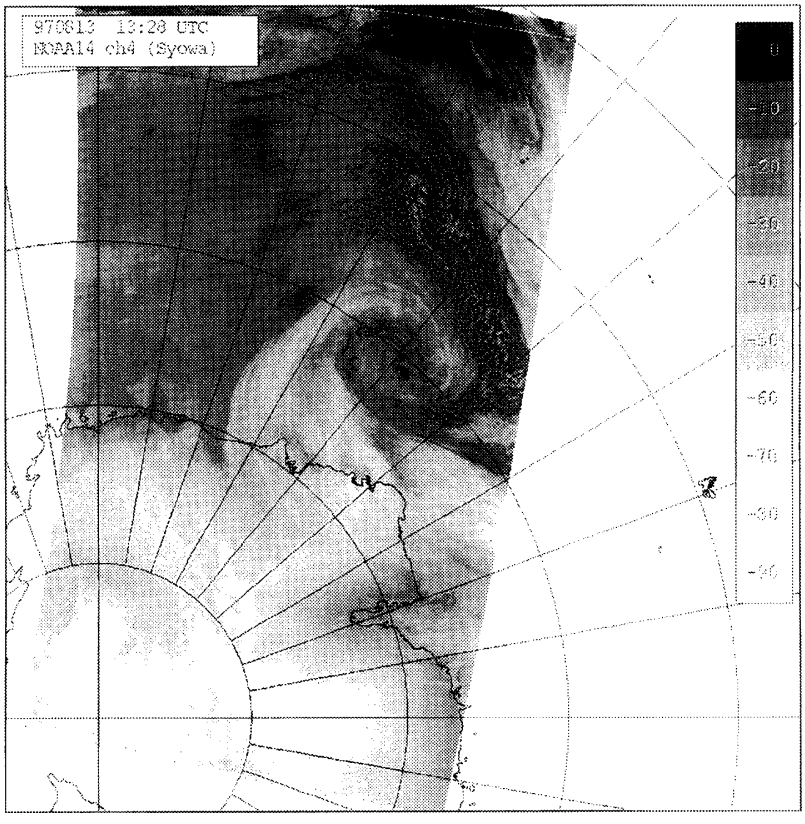
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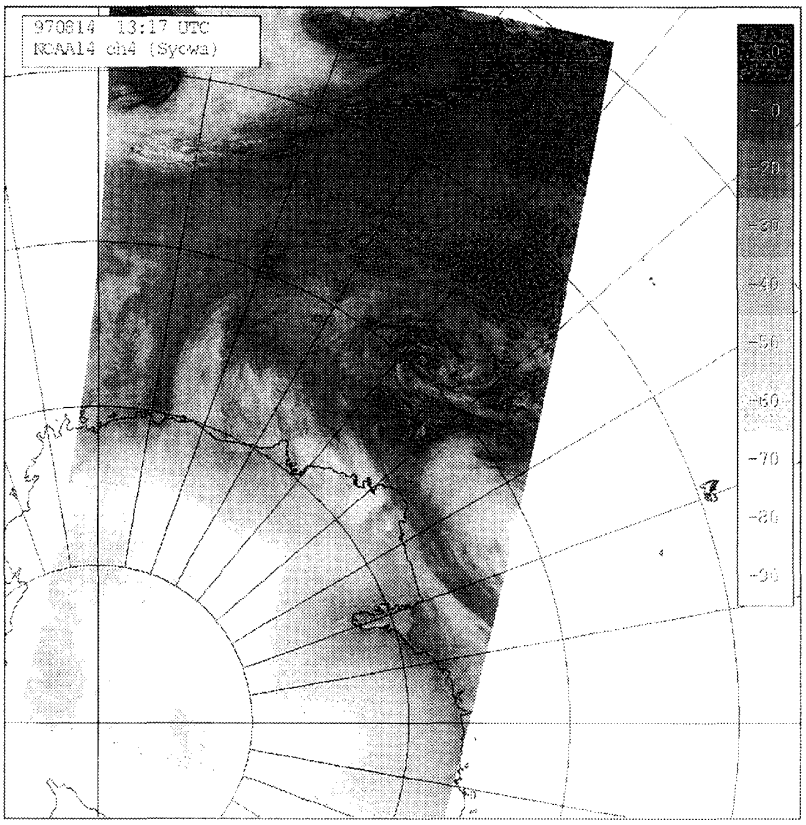
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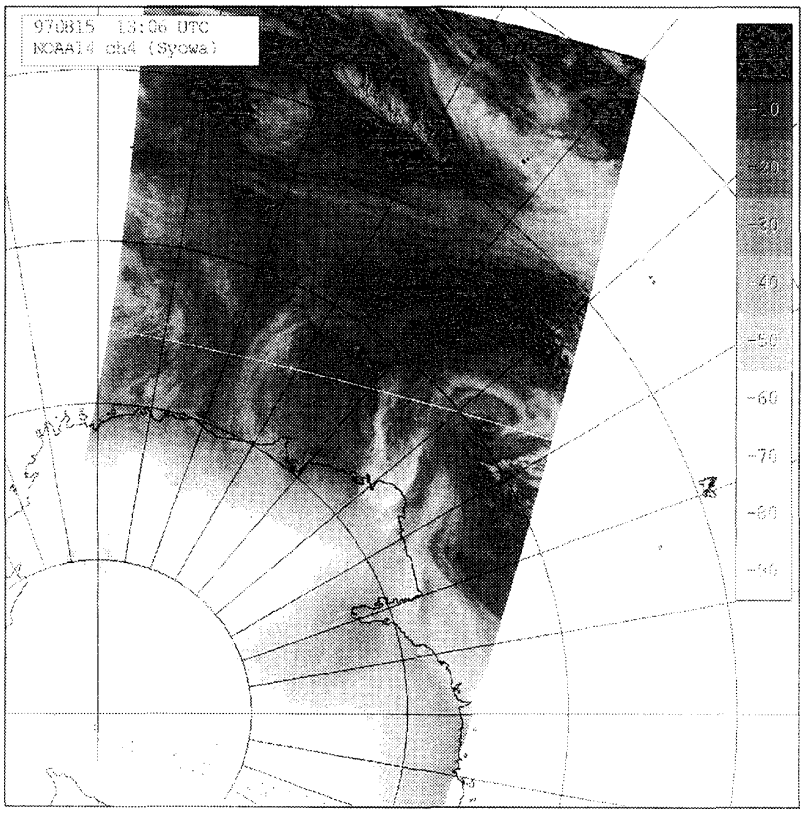
970815 13:06 UTC
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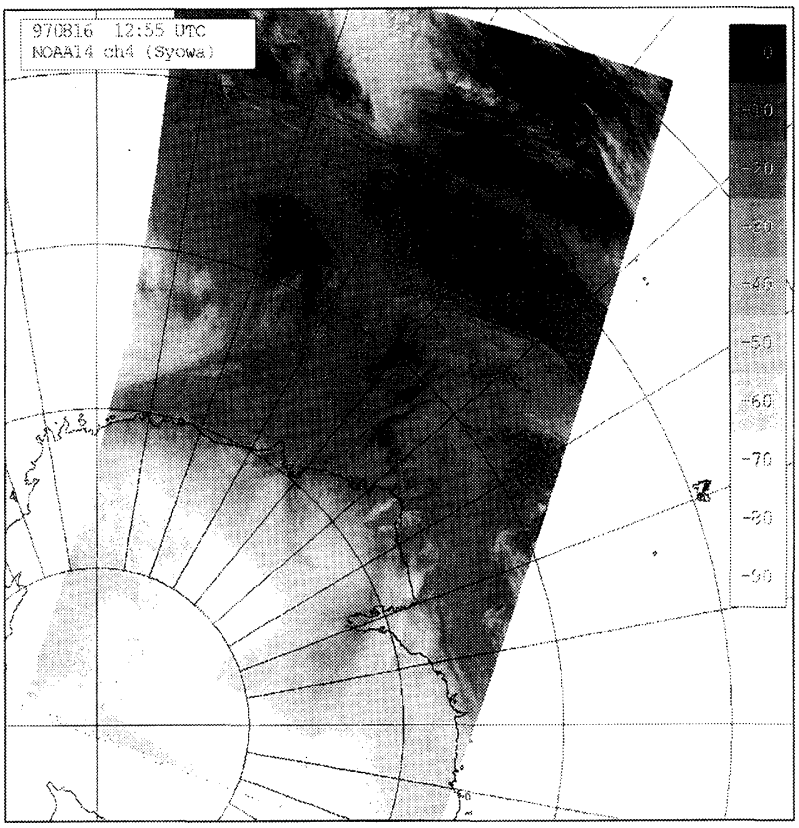
970816 12:55 UTC
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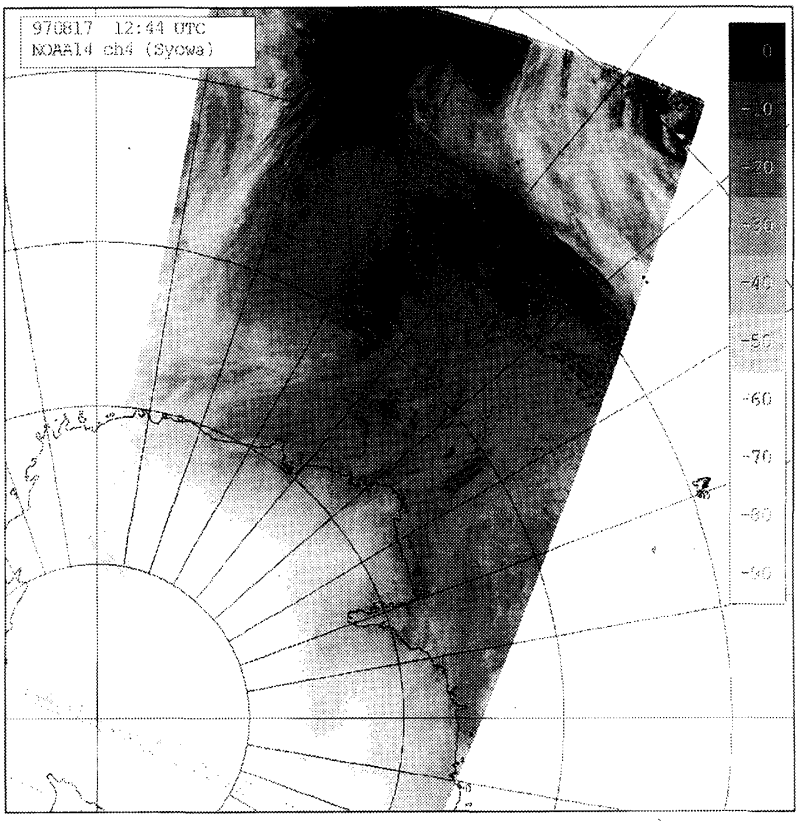
970817 12:44 UTC
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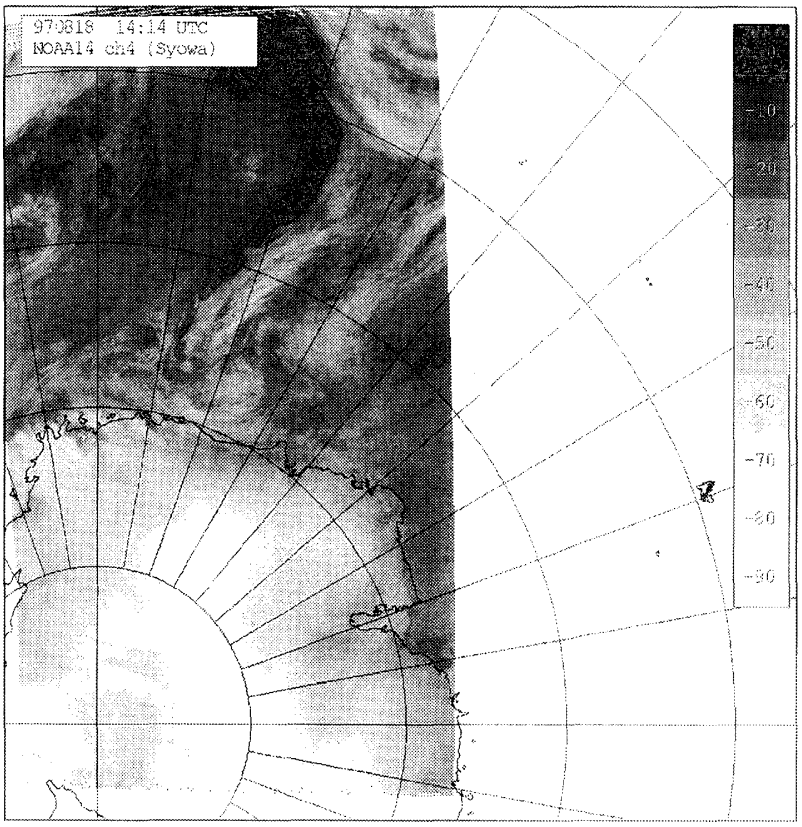
970818 14:14 UTC
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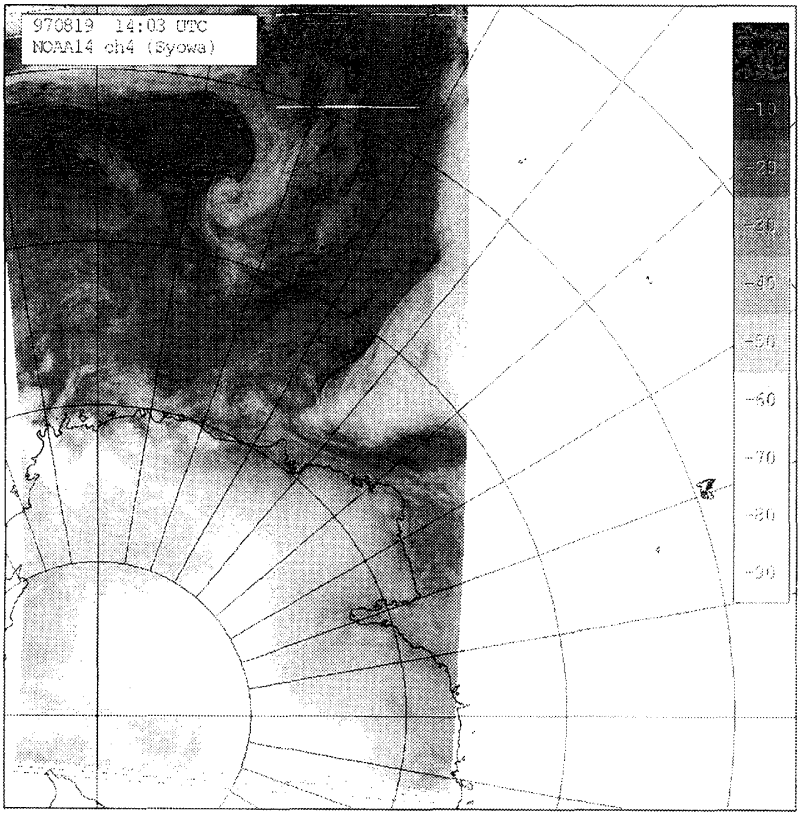
970819 14:03 UTC
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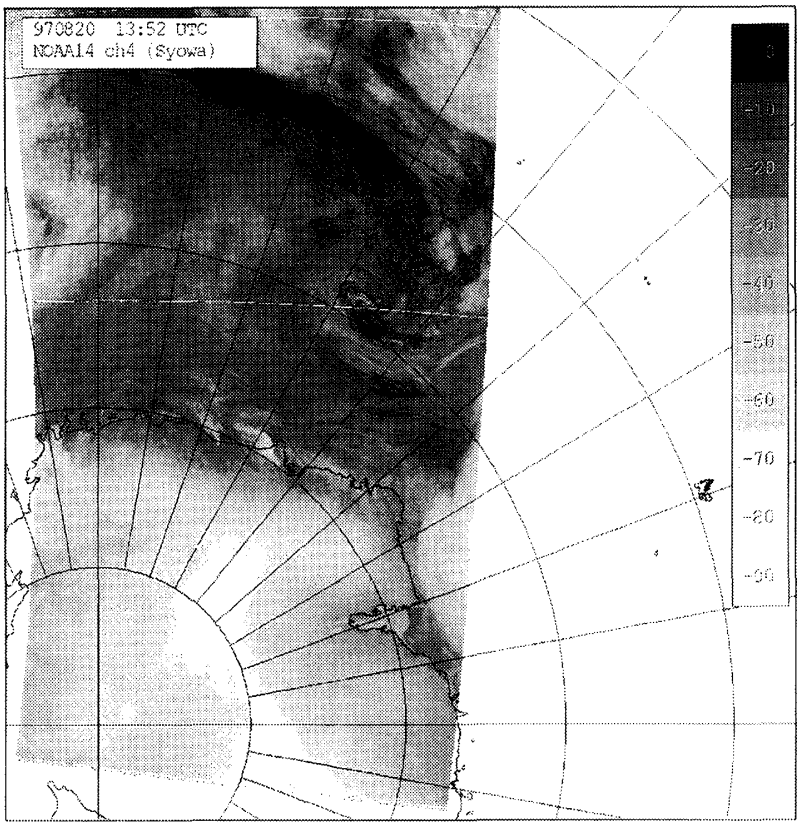
970820 13:52 UTC
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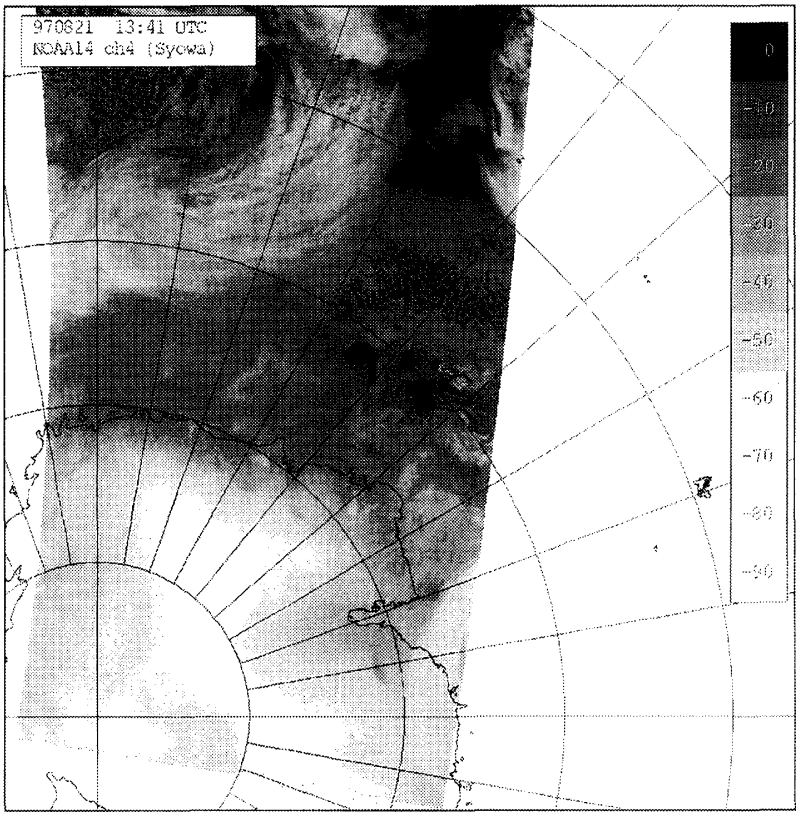
970821 13:41 UTC
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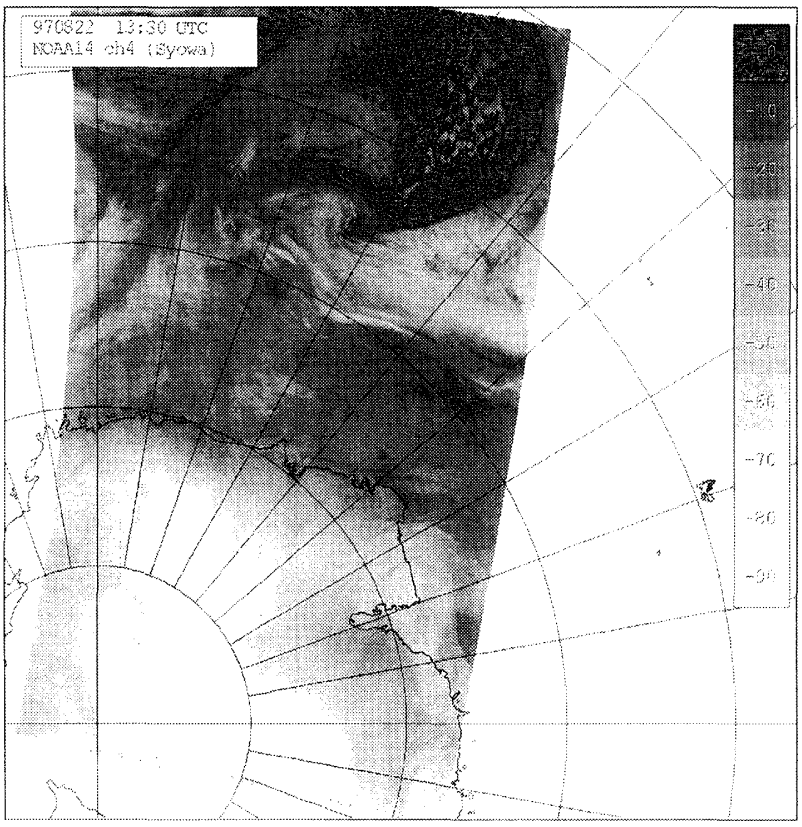
970822 13:30 UTC
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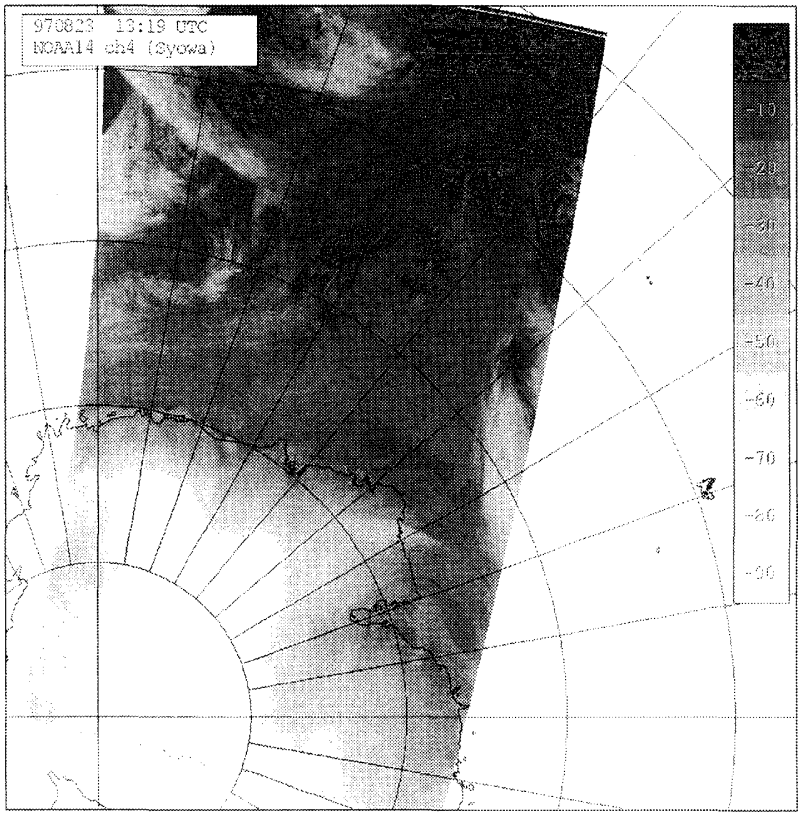
970823 13:19 UTC
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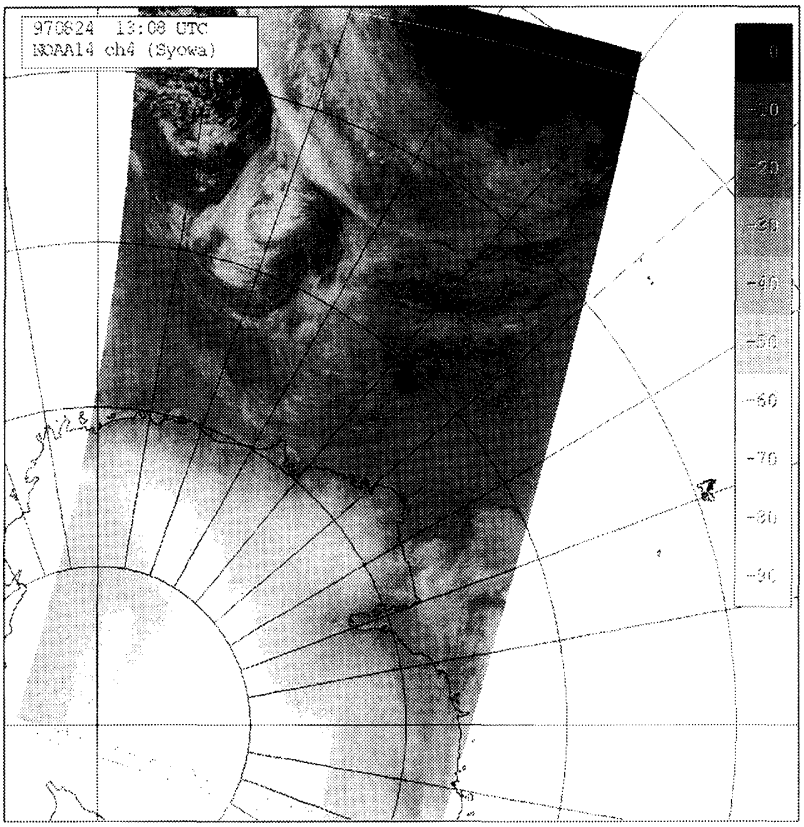
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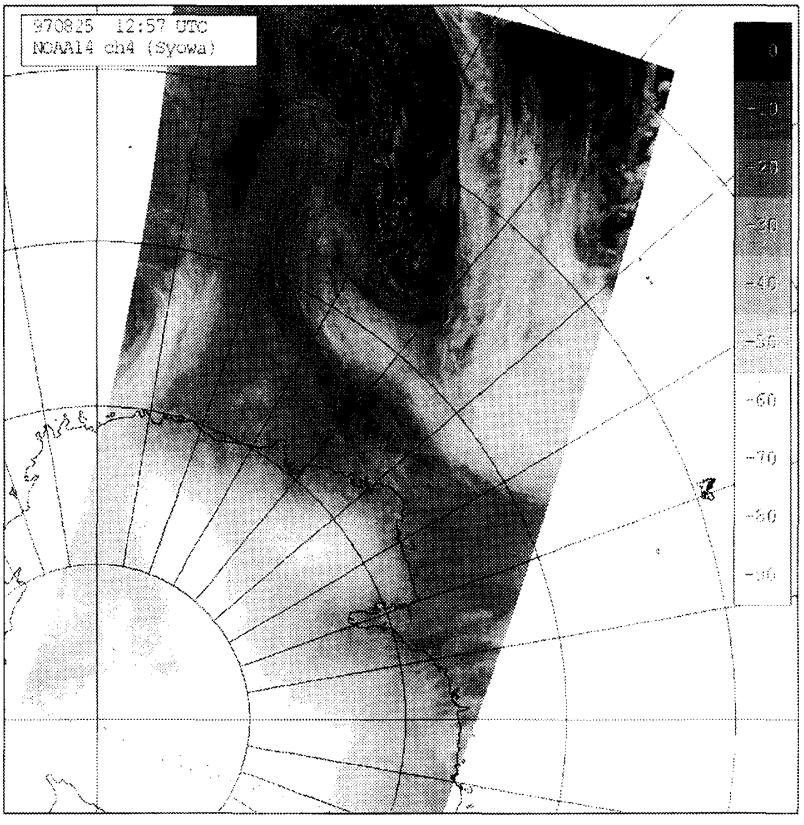
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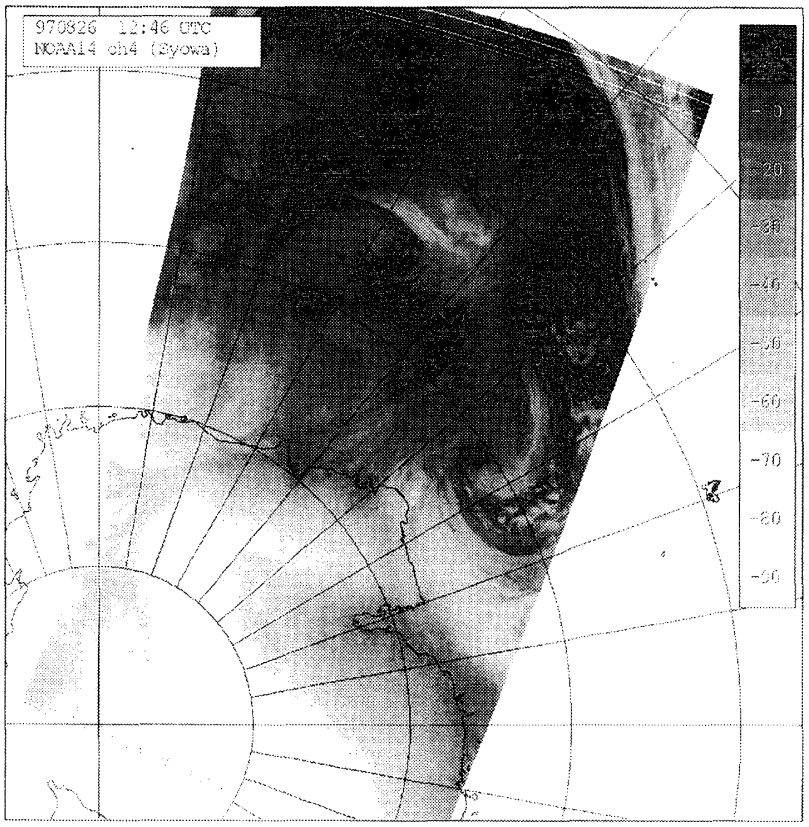
970826 12:46 UTC
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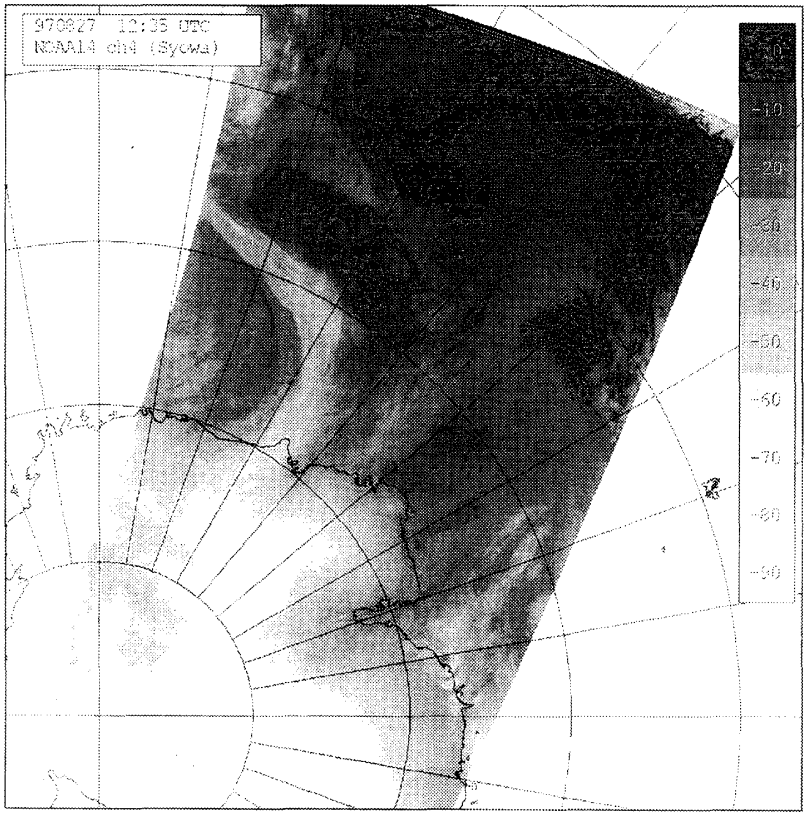
970827 12:35 UTC
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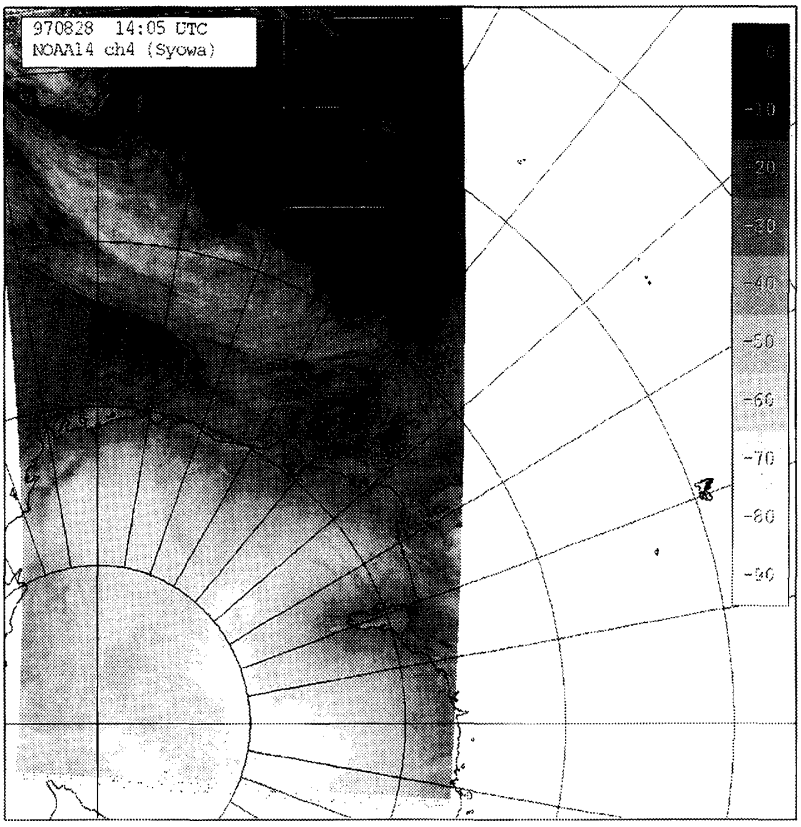
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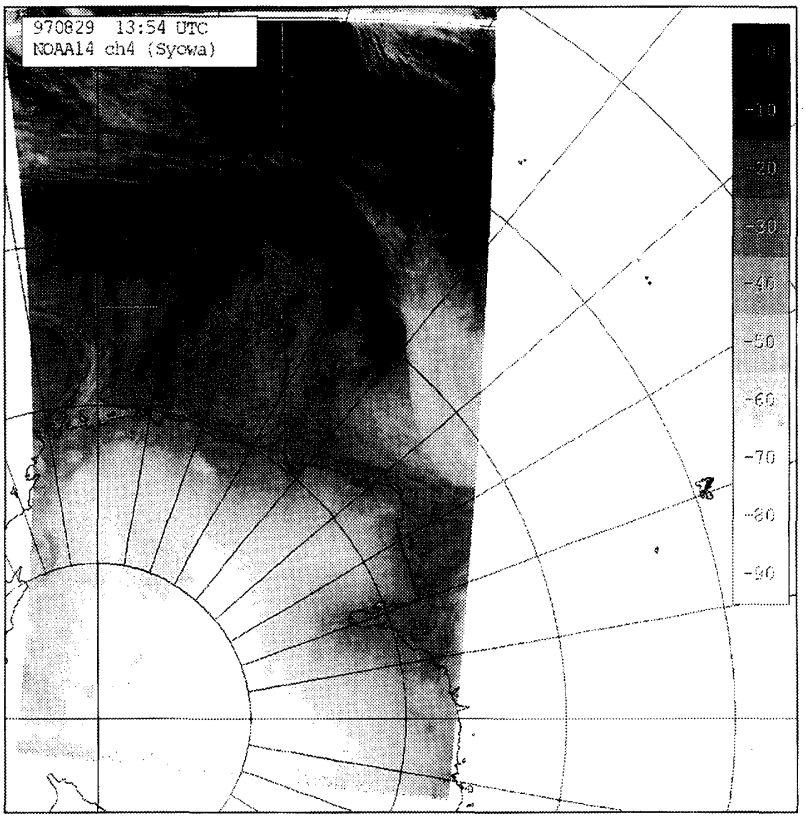
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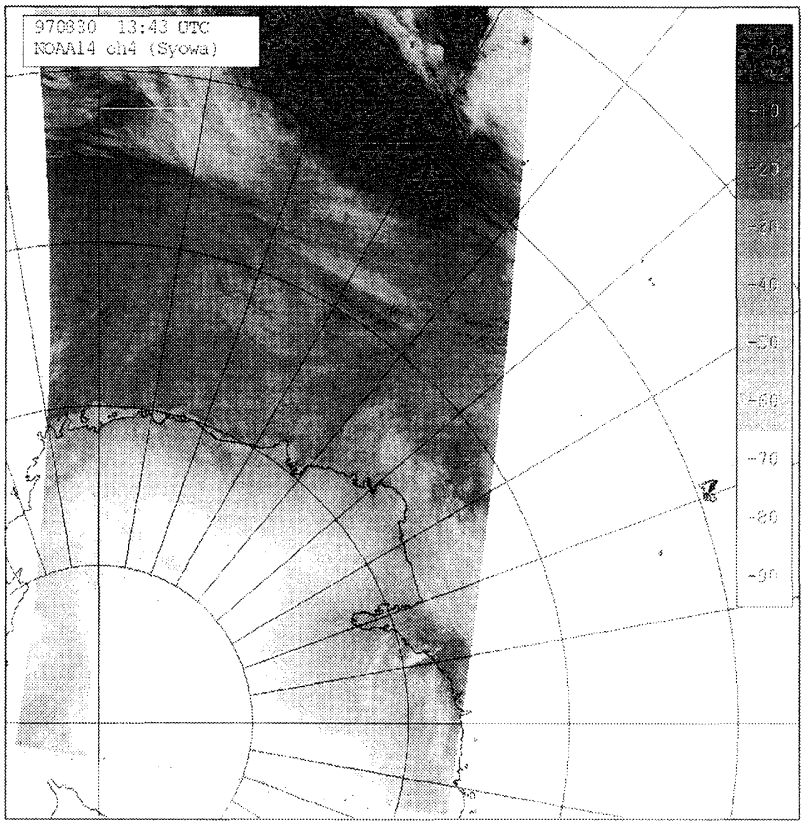
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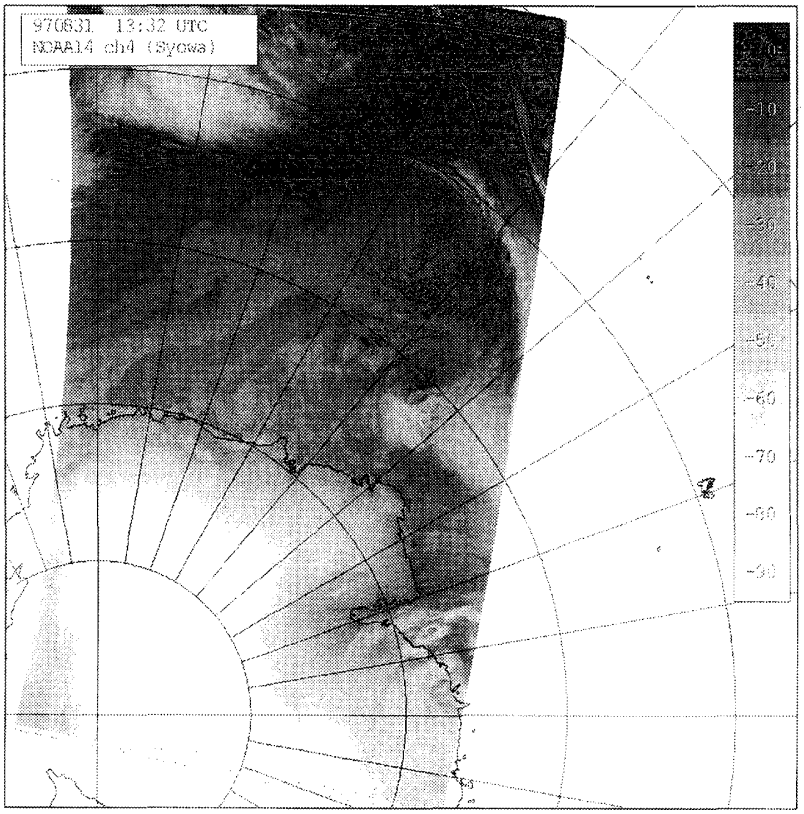
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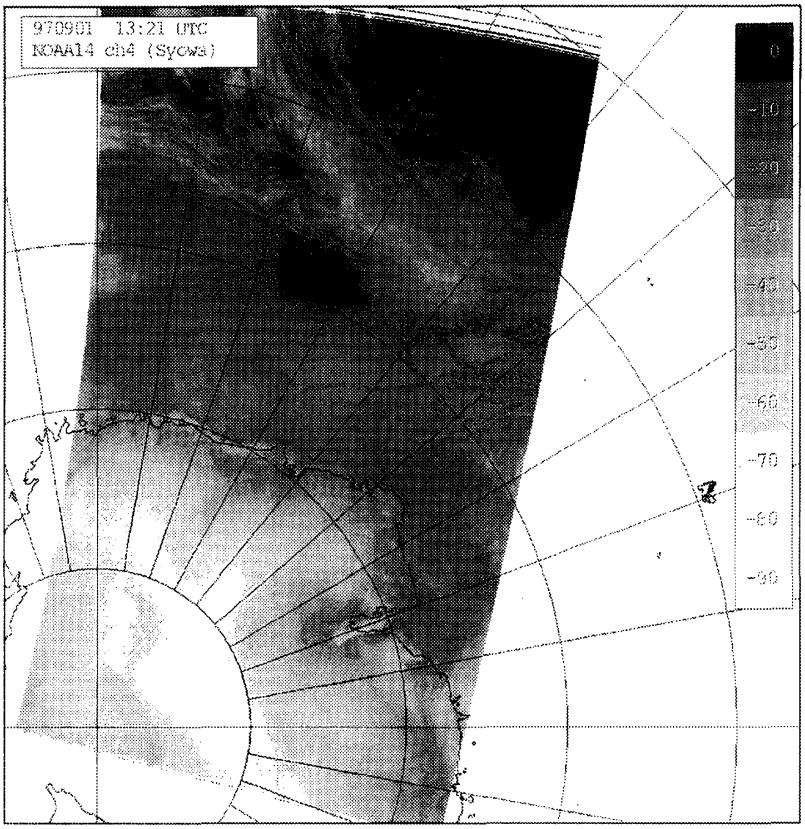
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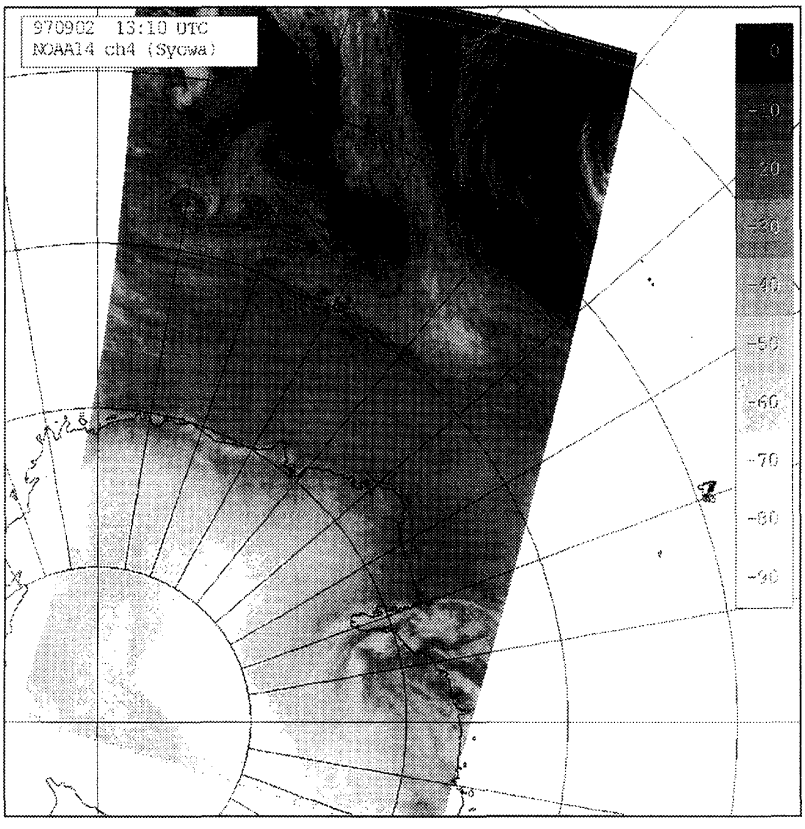
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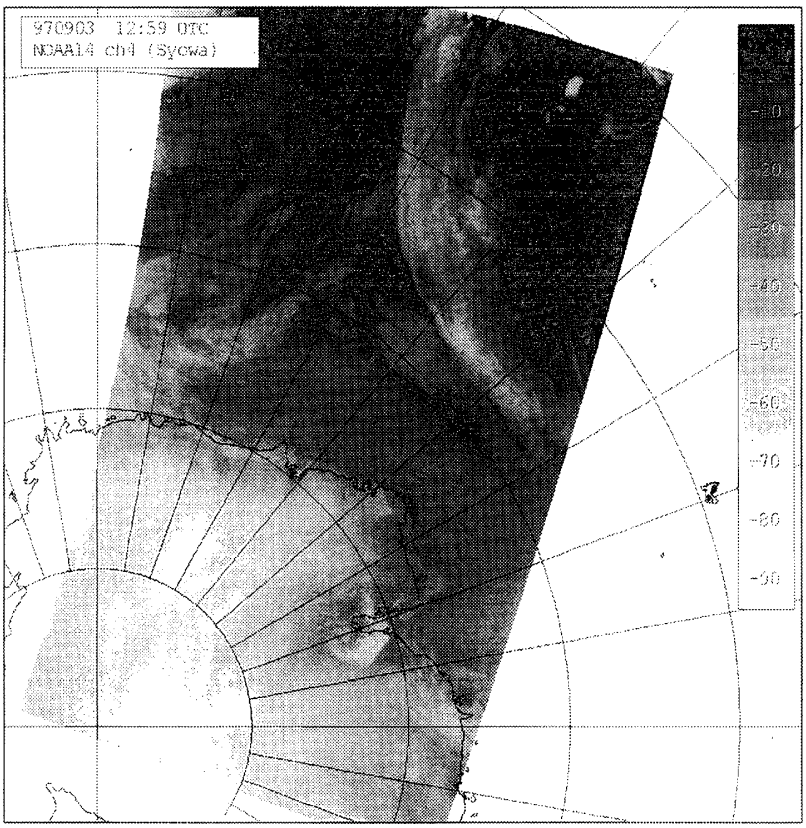
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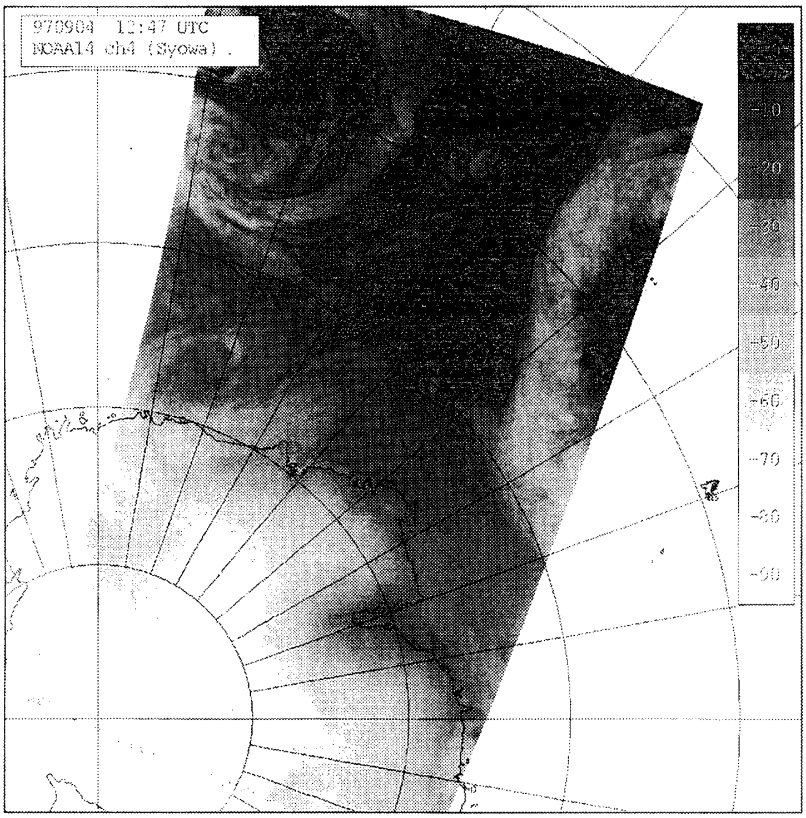
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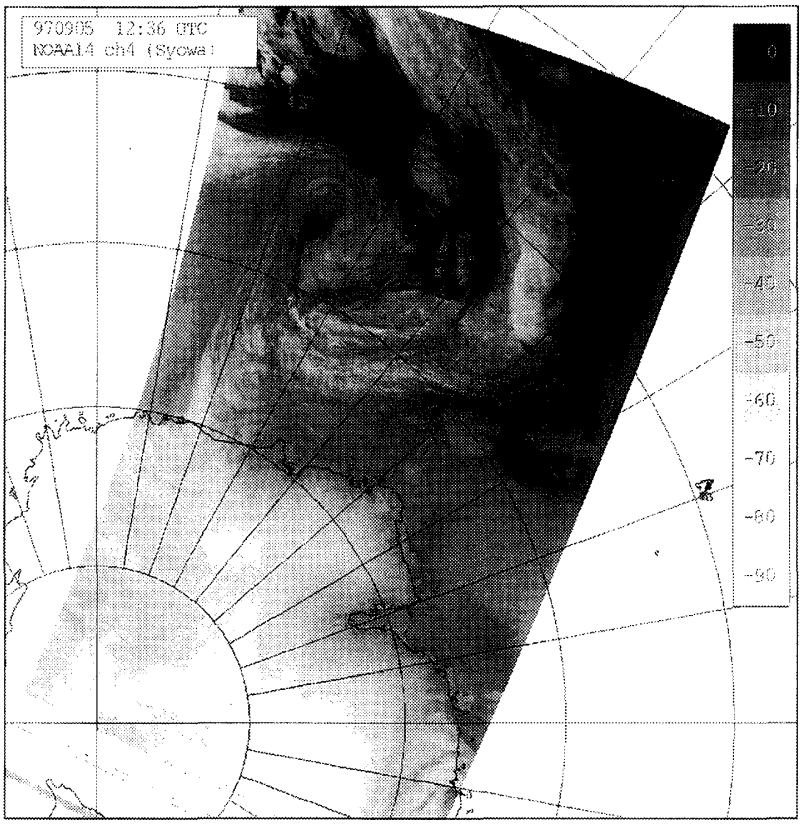
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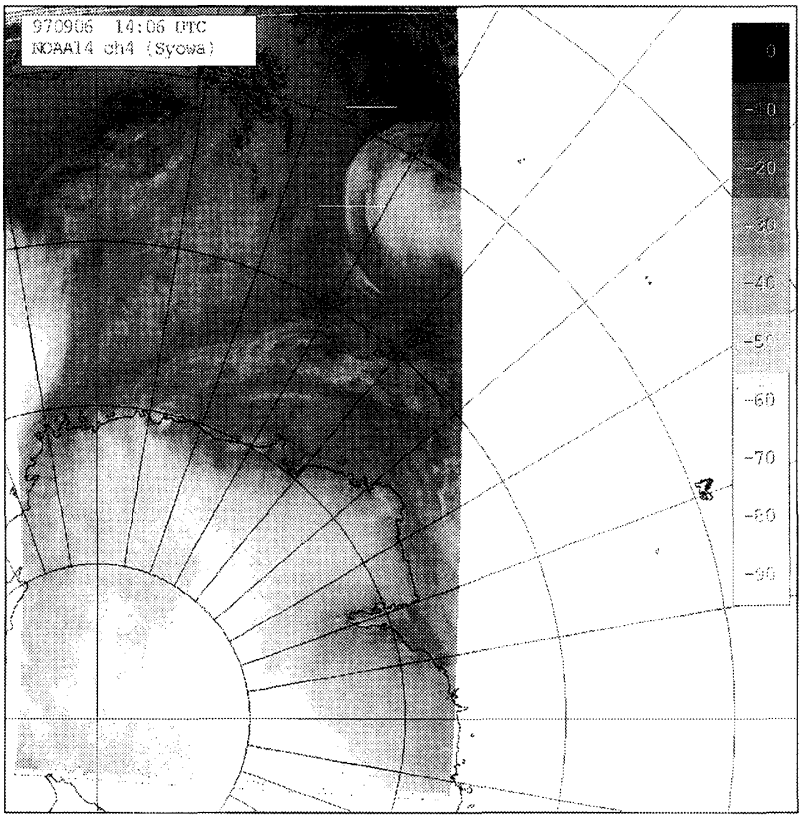
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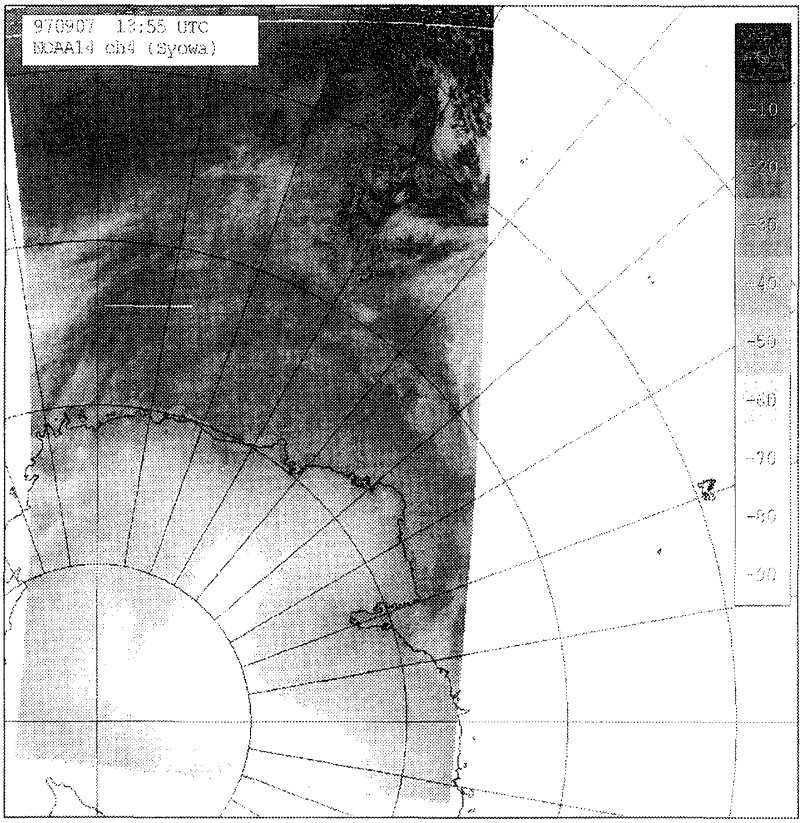
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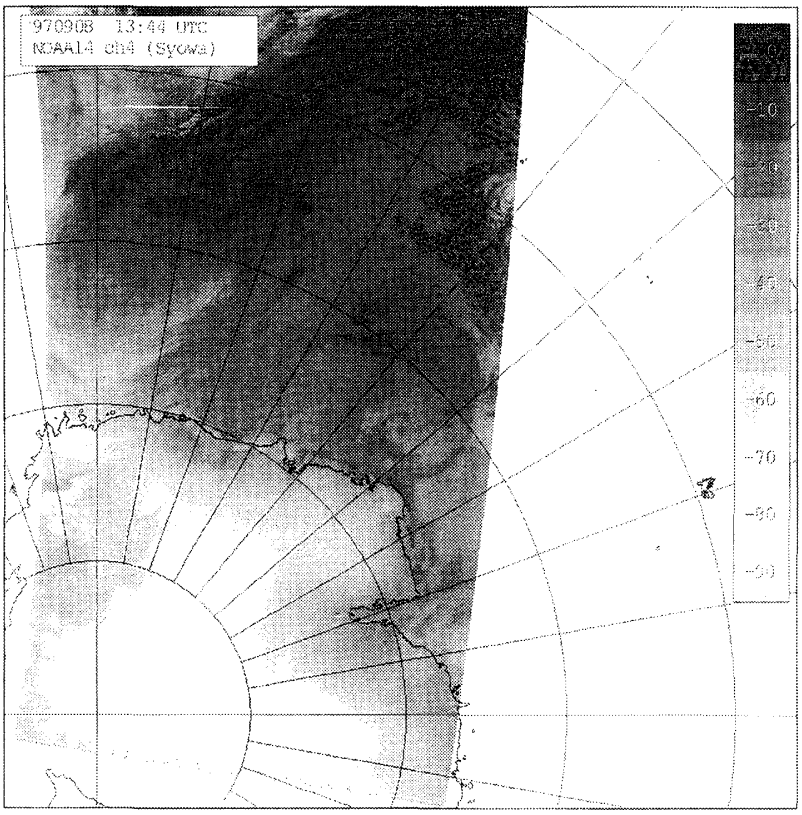
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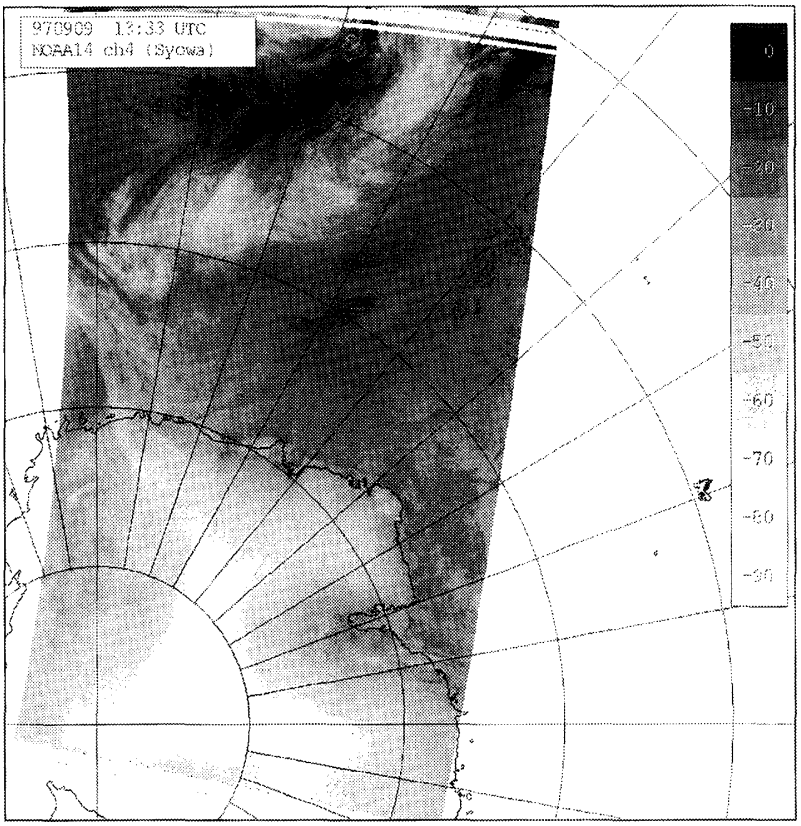
970909 13:33 UTC
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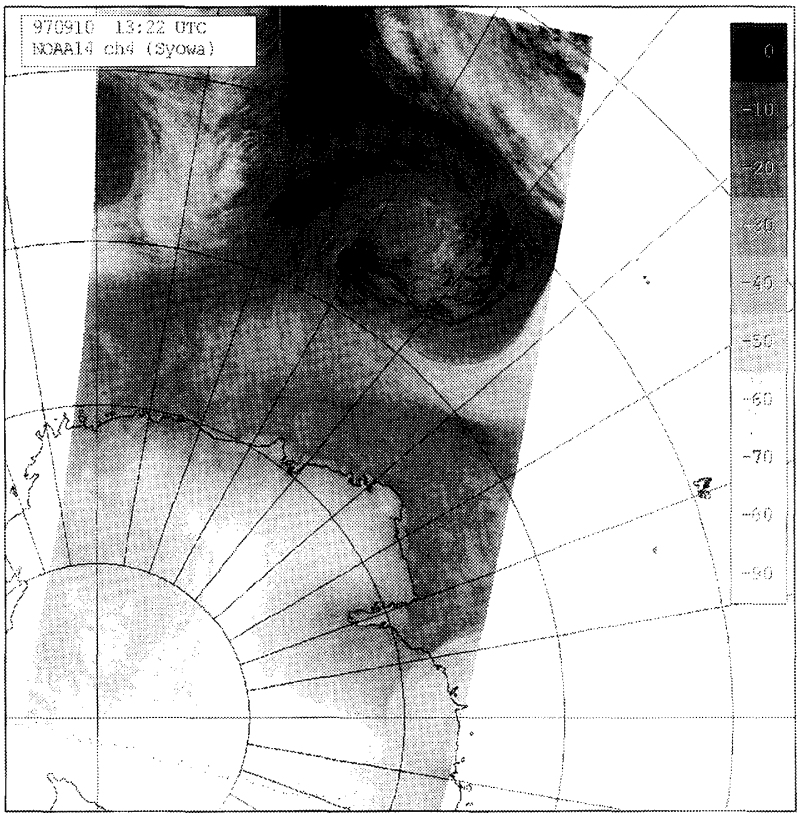
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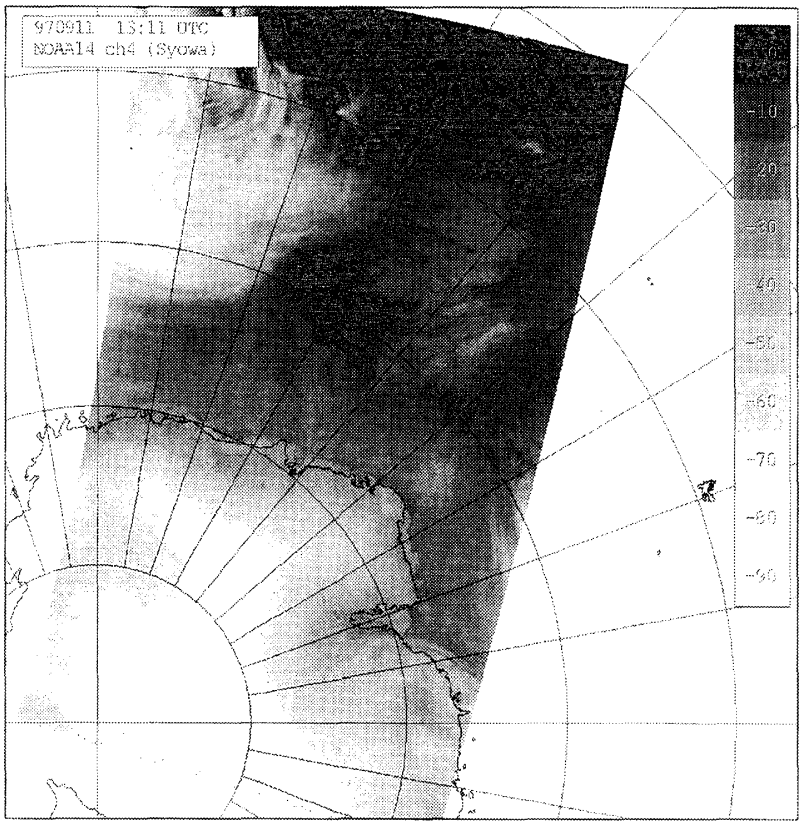
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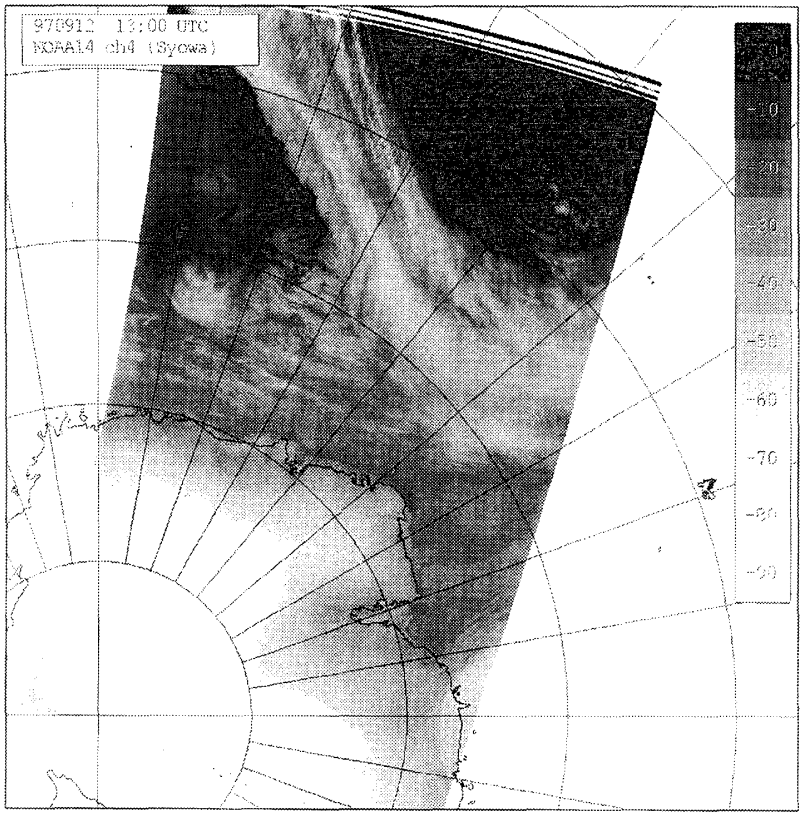
970912 13:00 UTC
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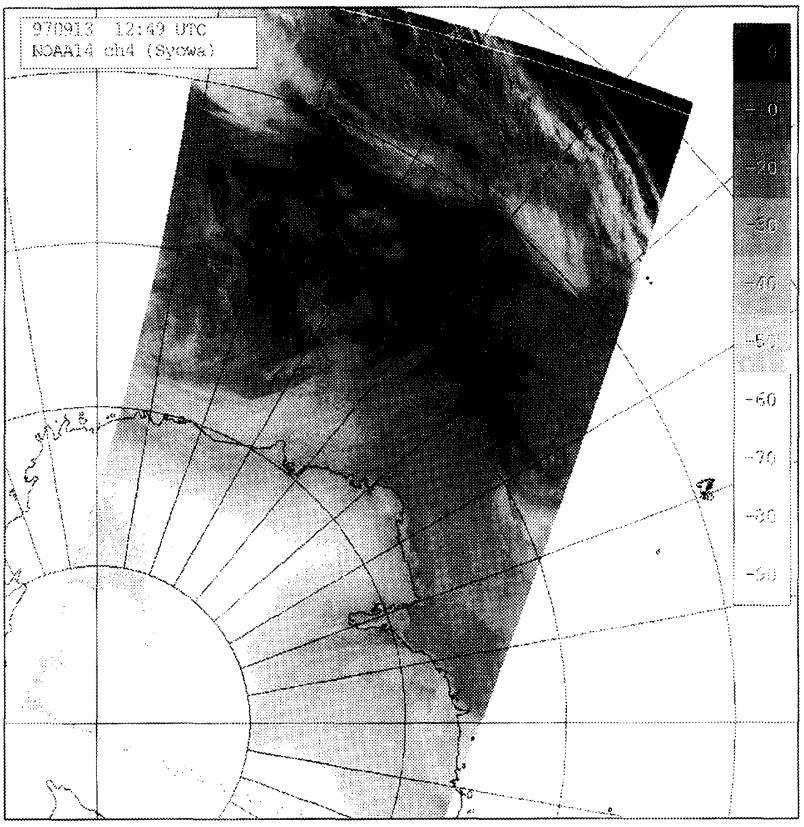
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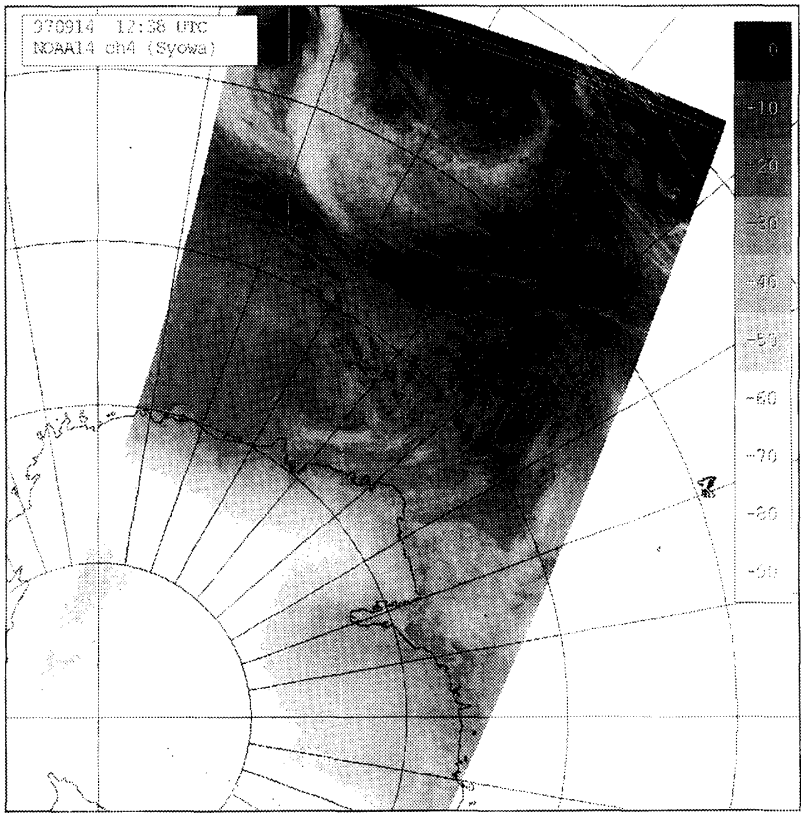
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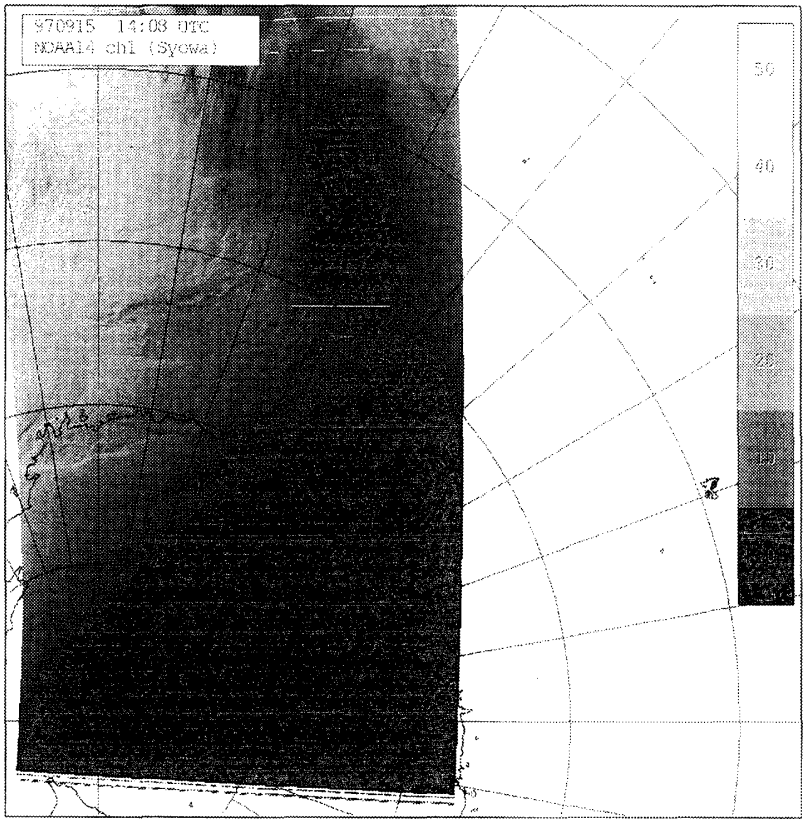
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NOAA14 ch1 (Syowa)
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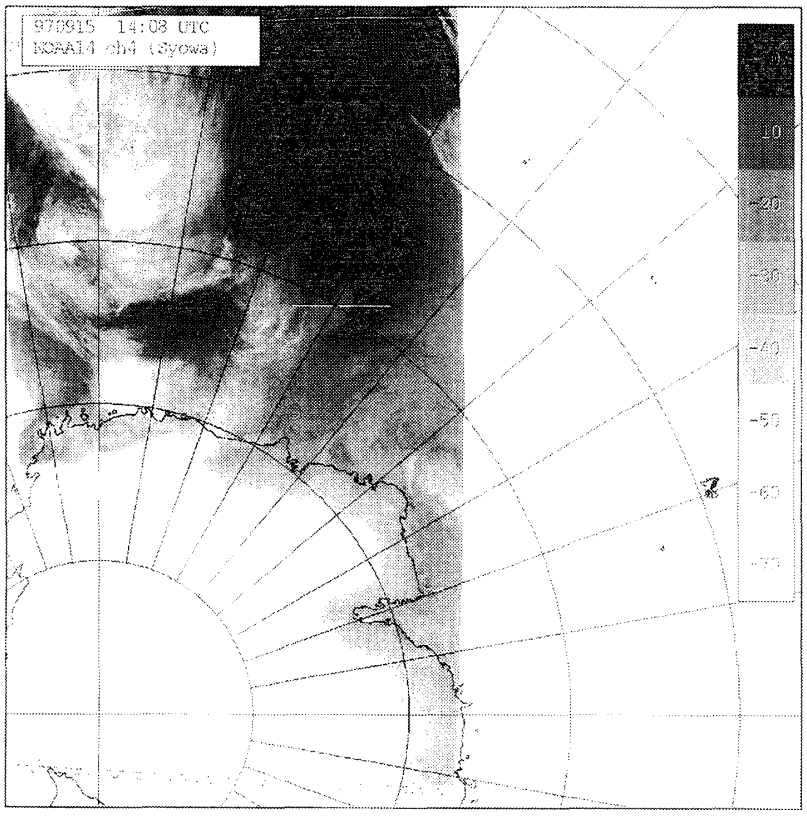
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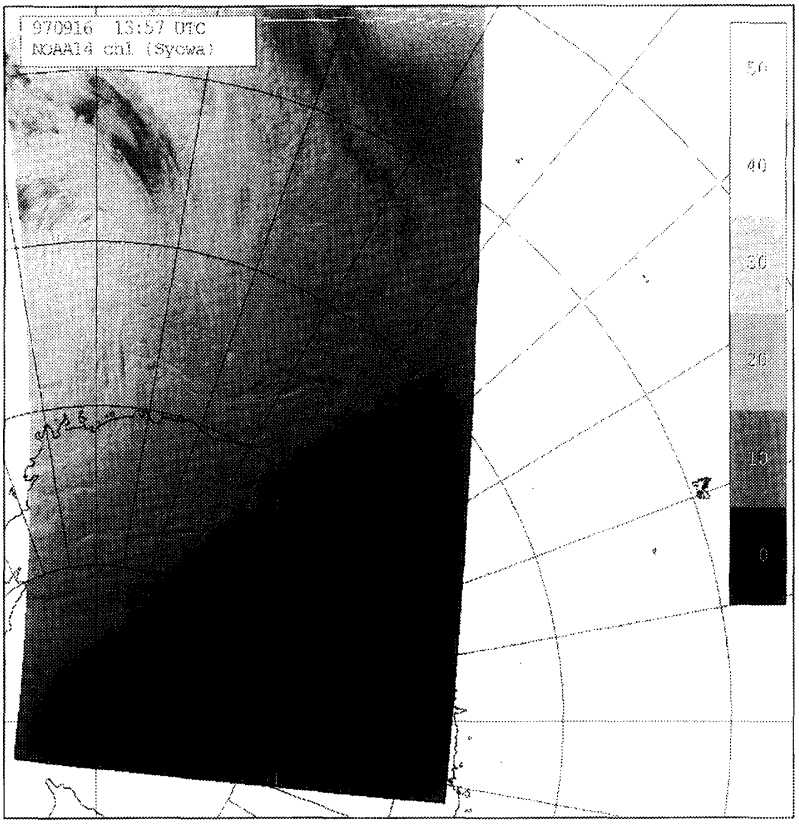
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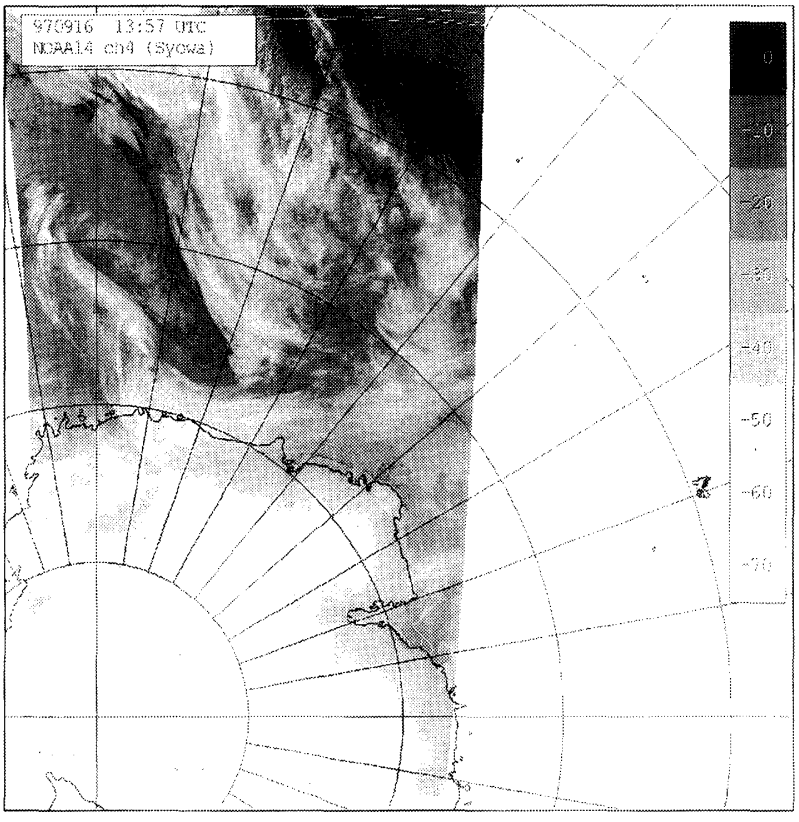
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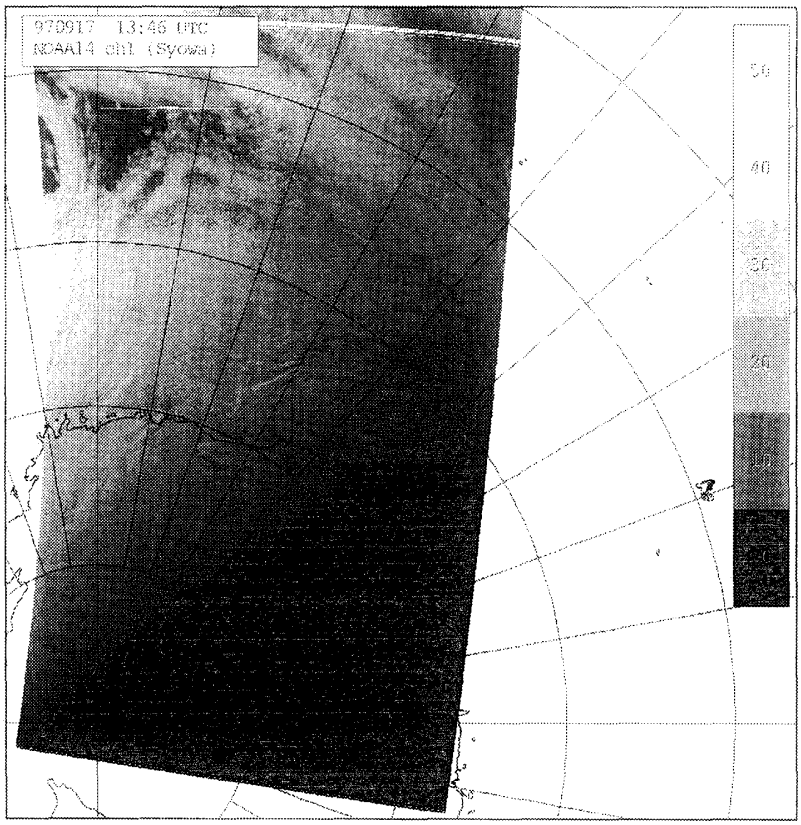
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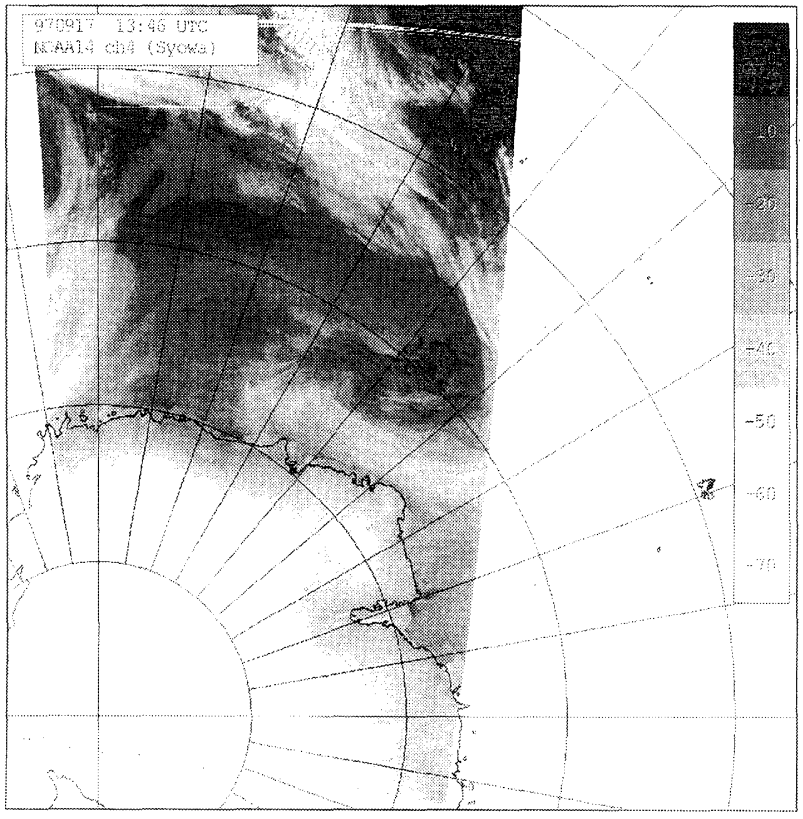
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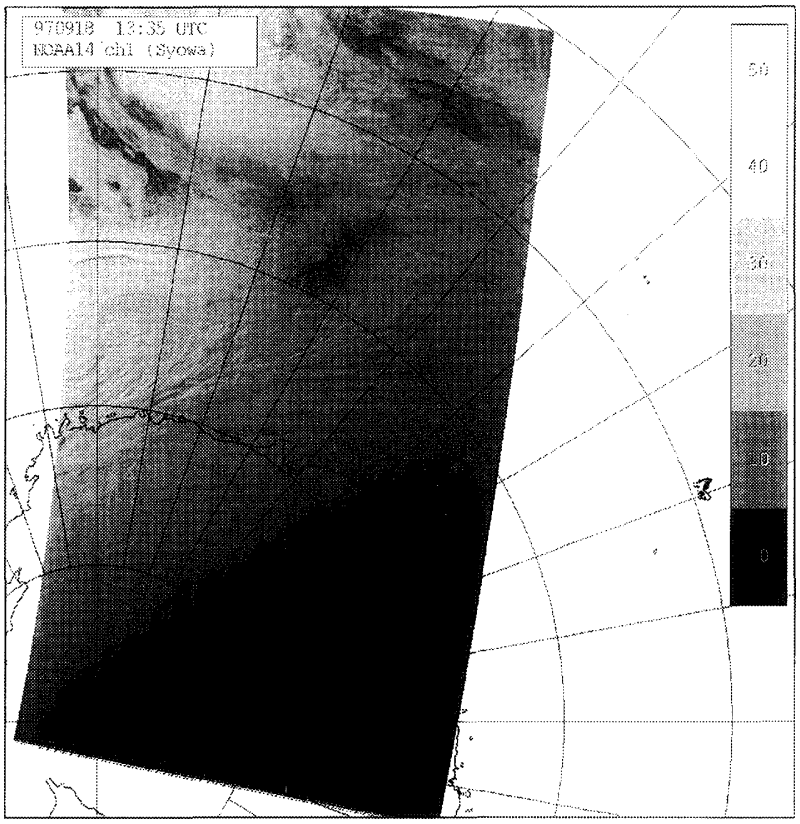
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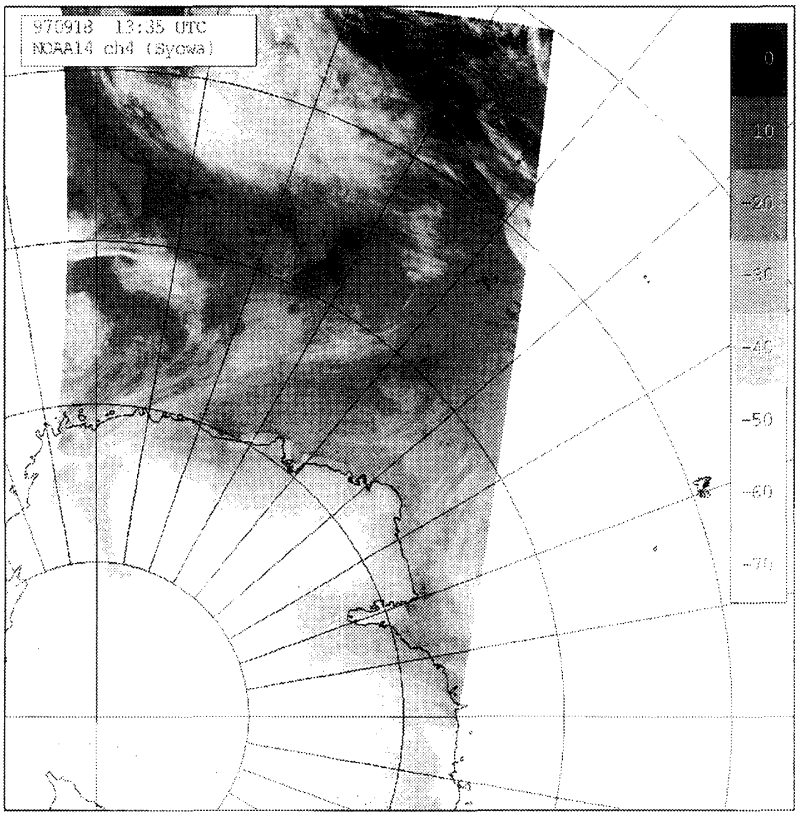
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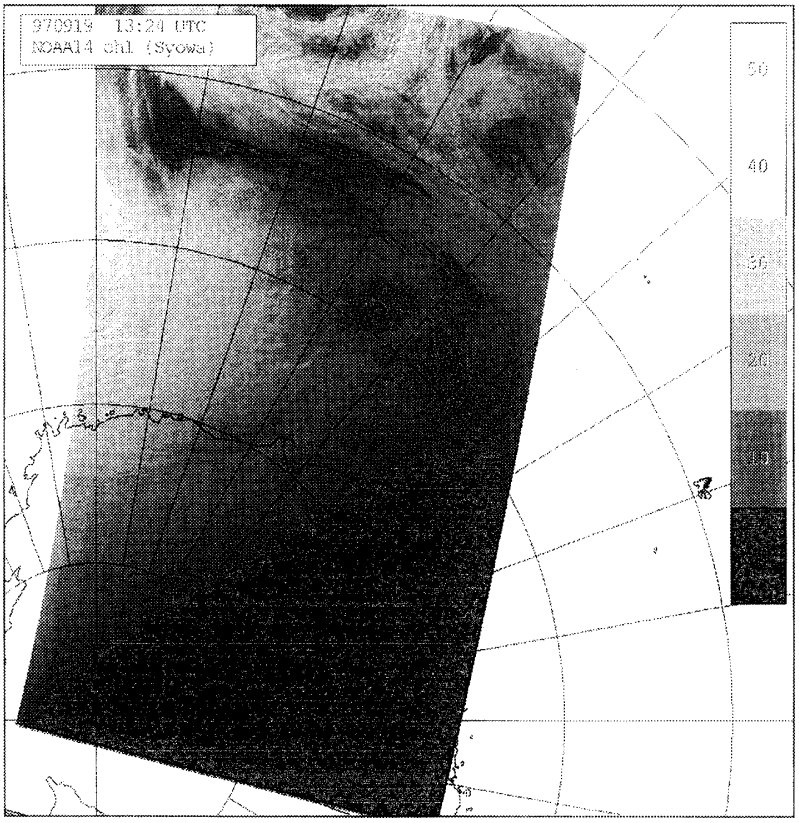
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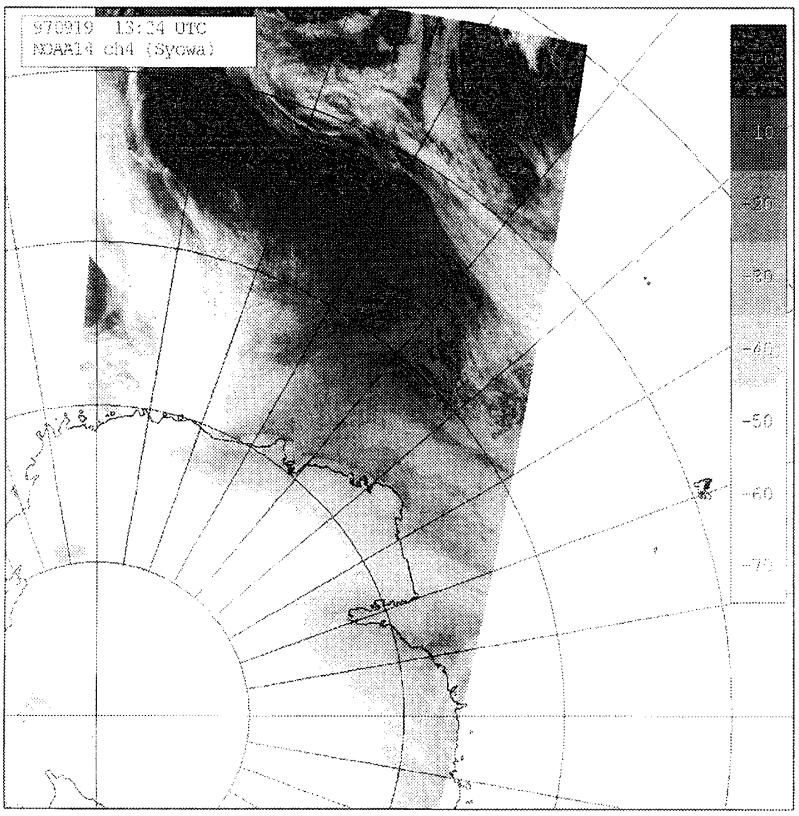
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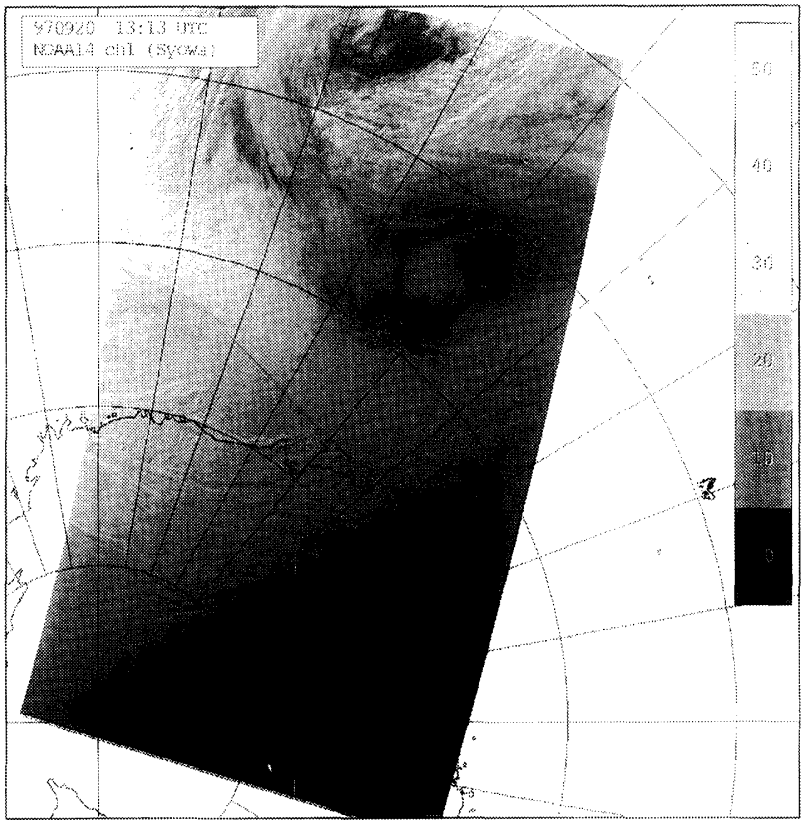
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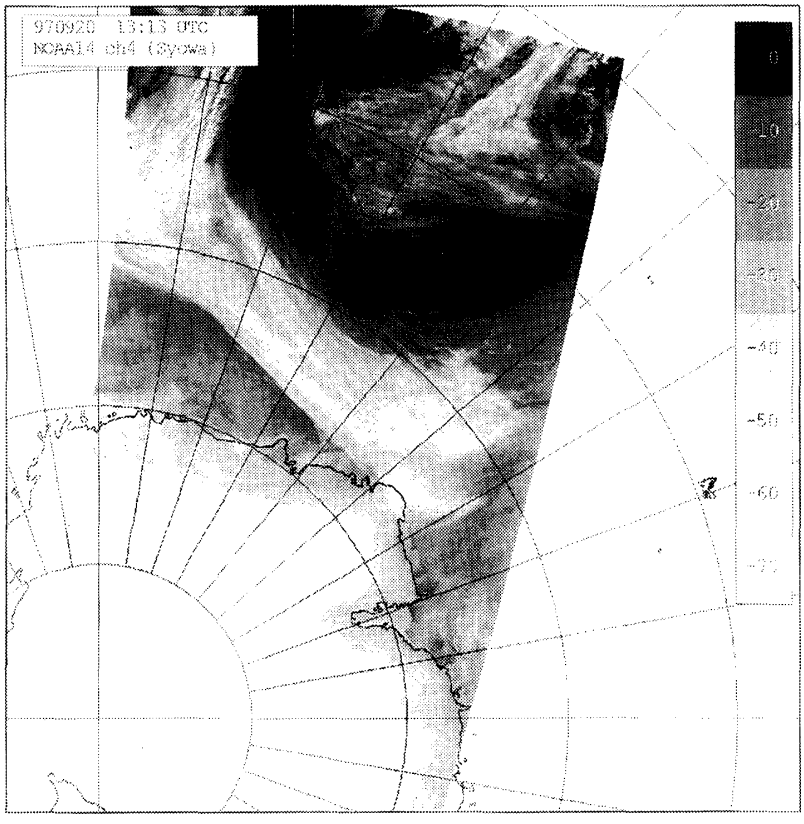
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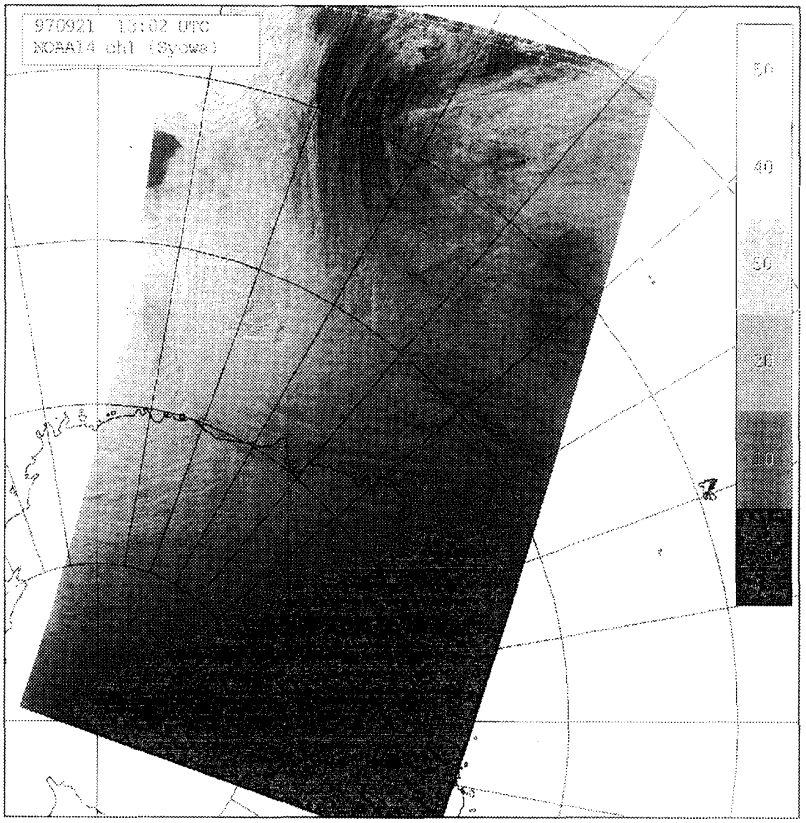
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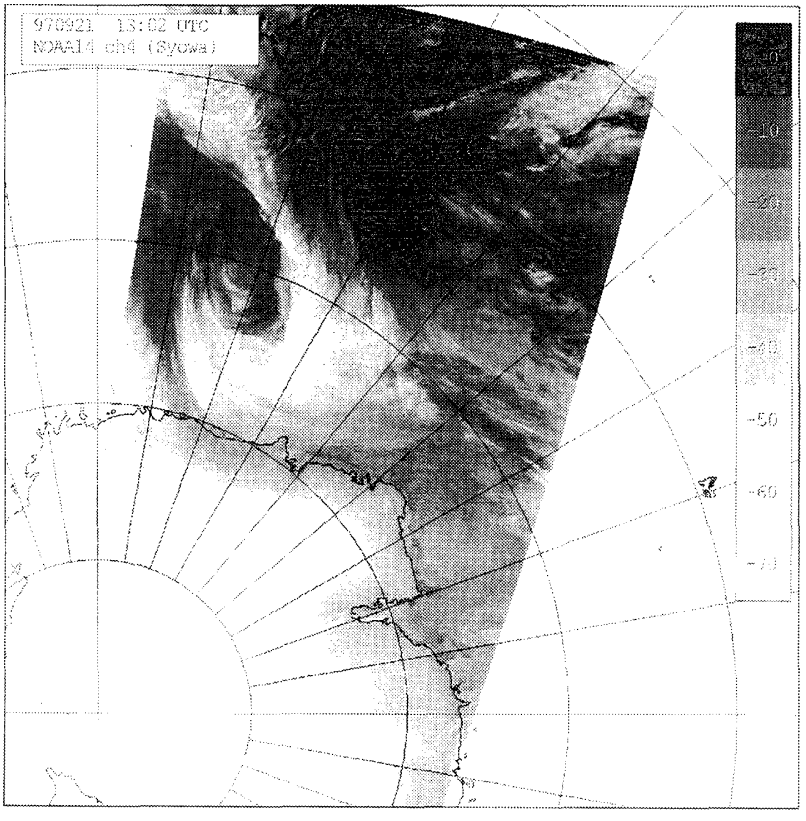
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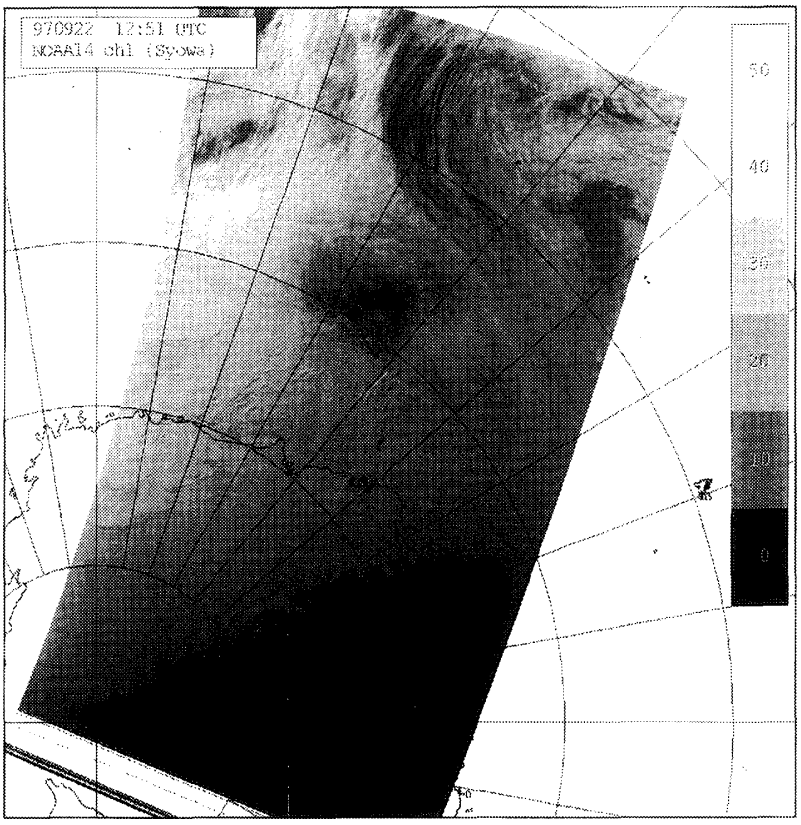
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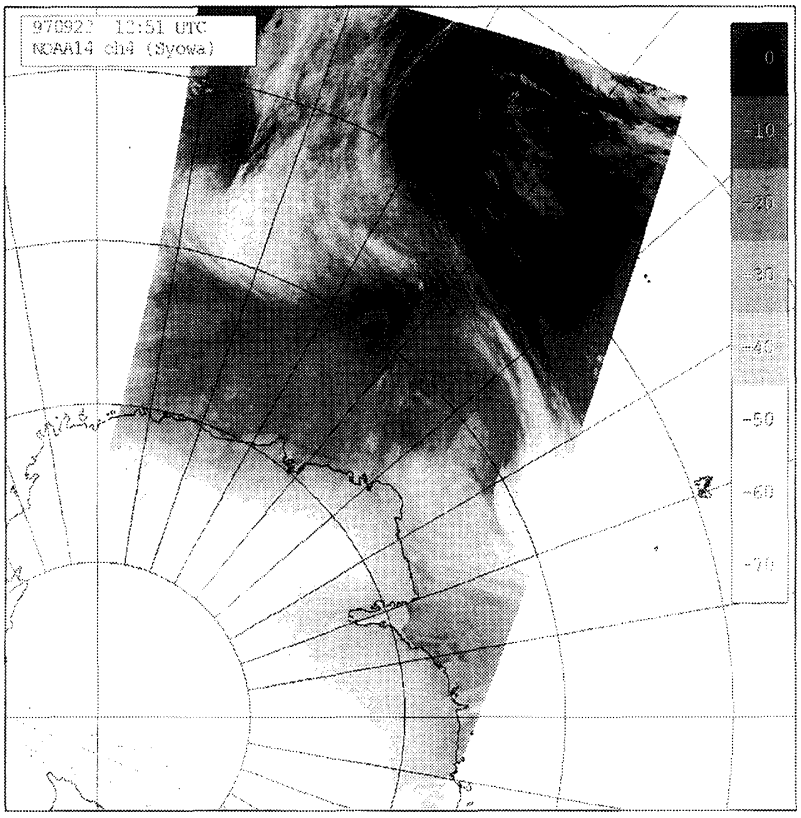
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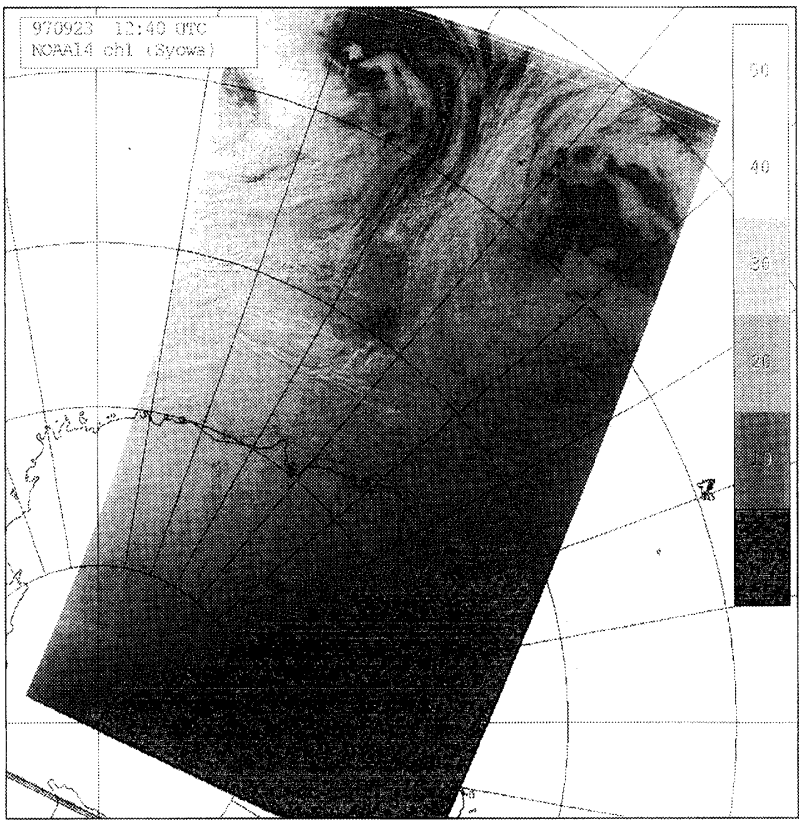
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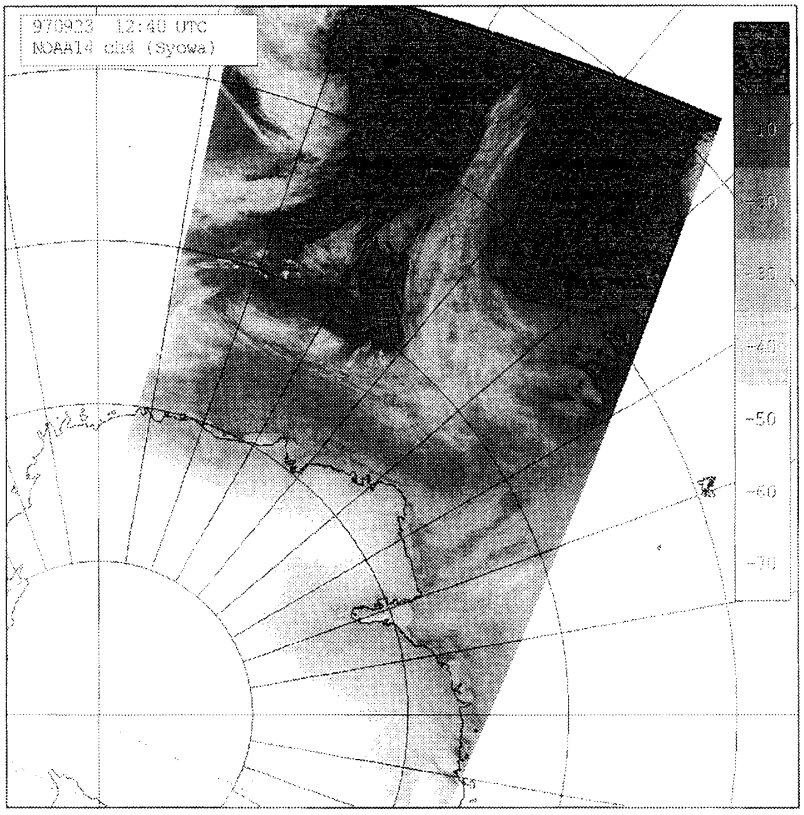
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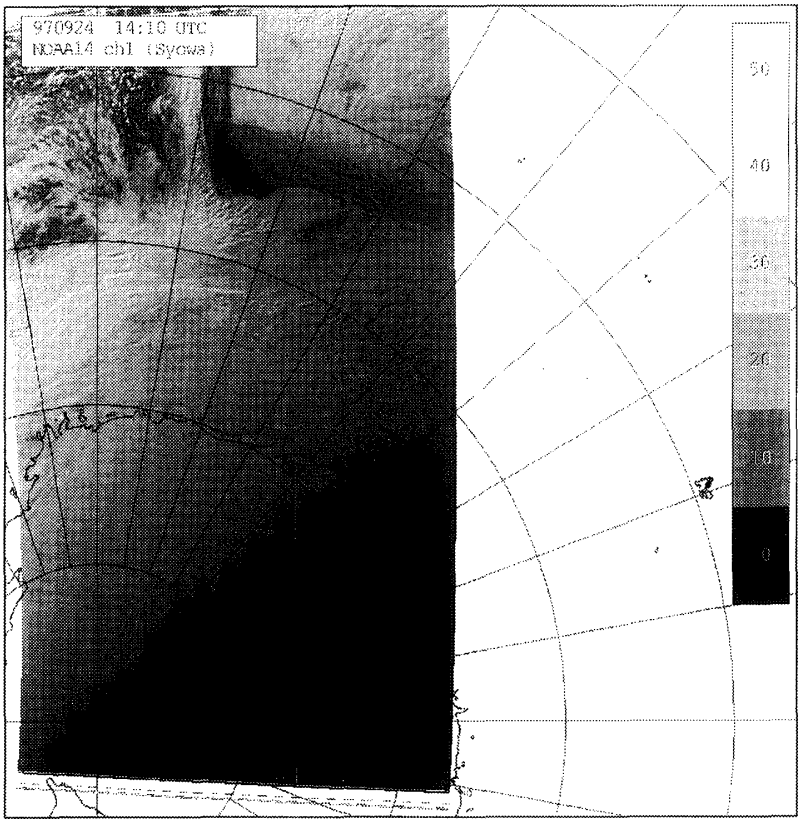
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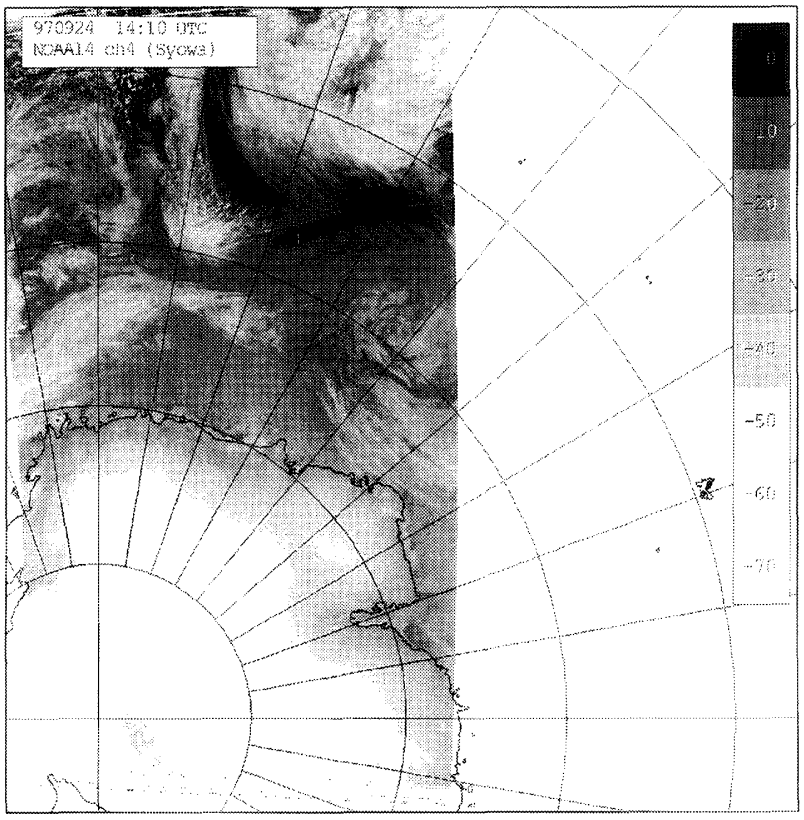
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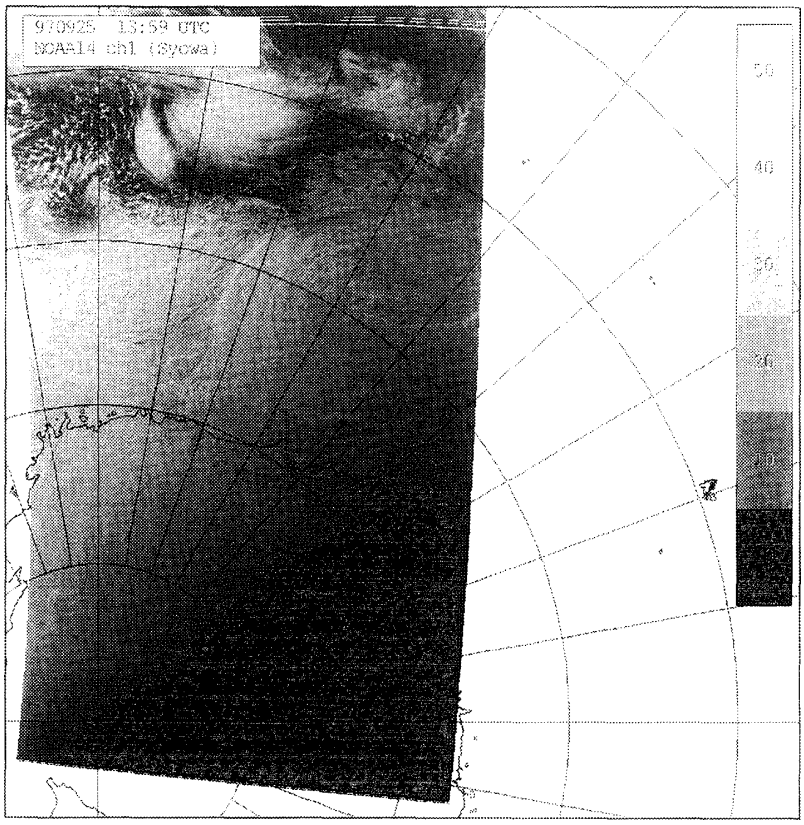
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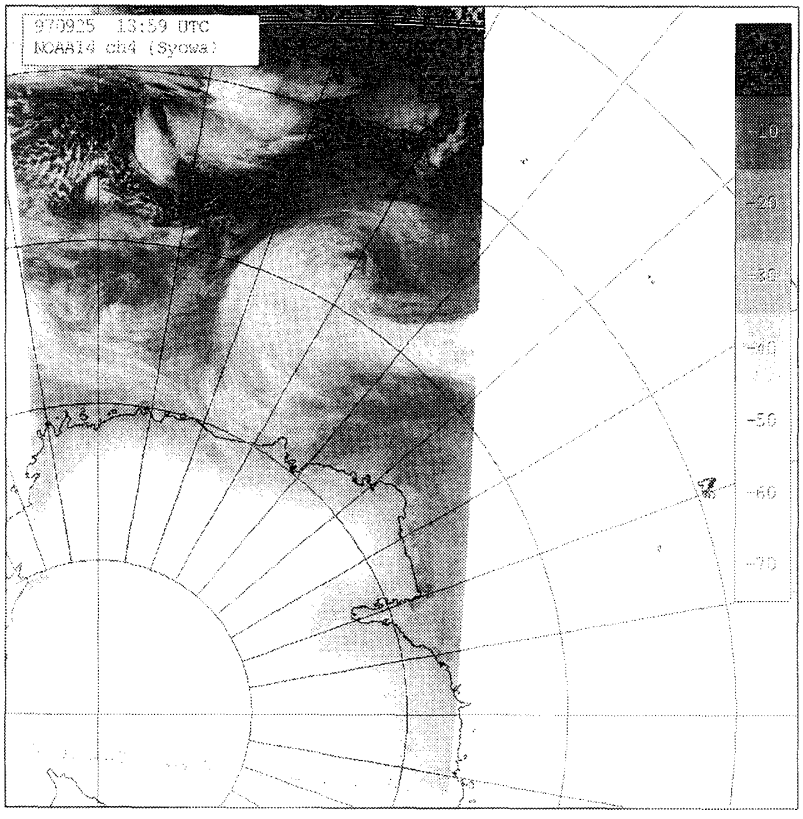
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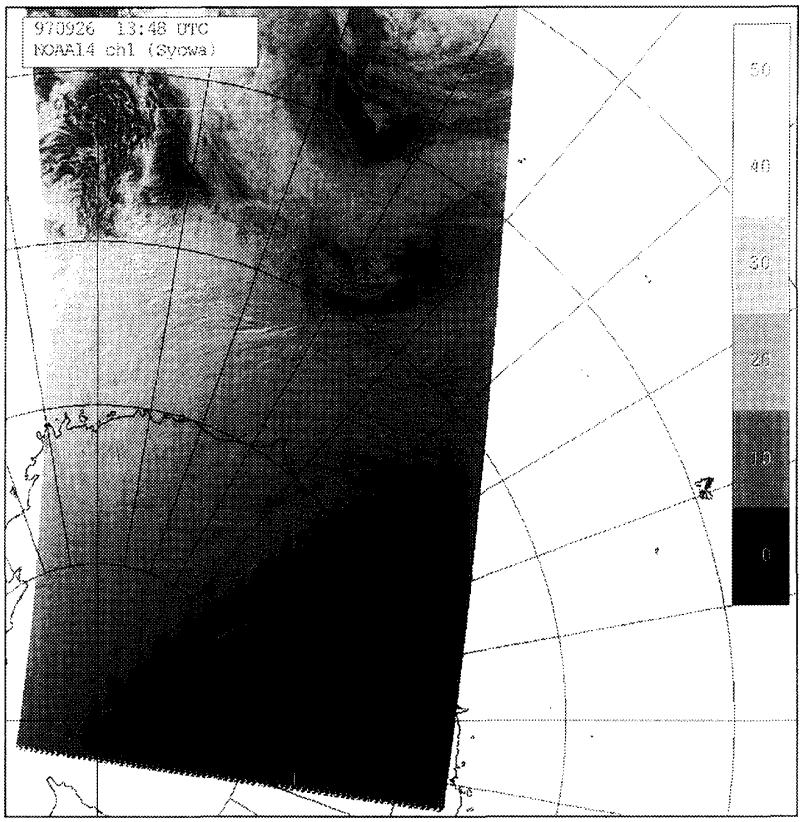
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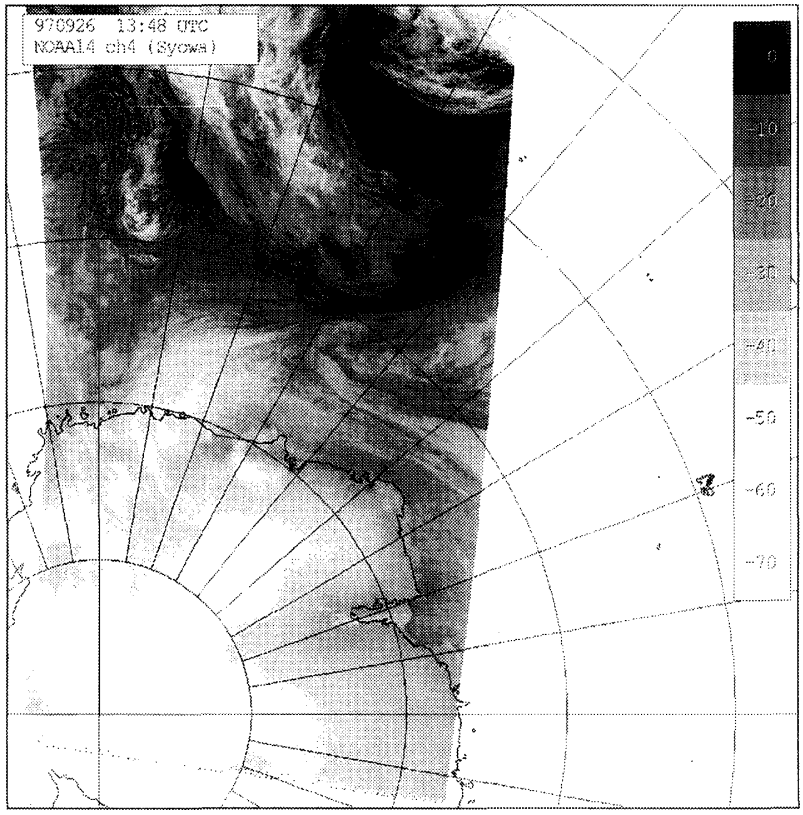
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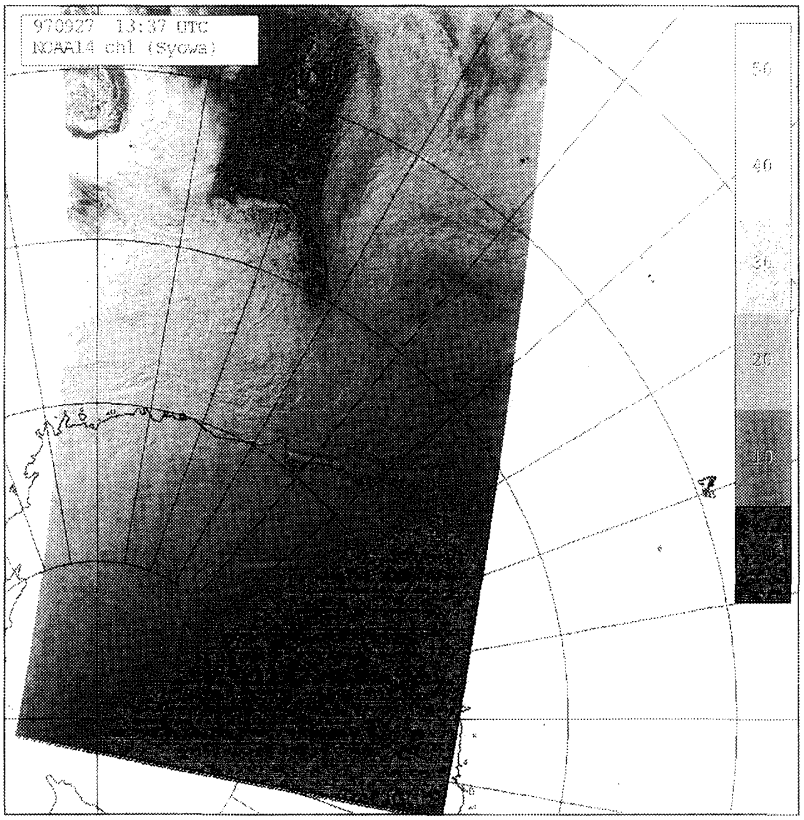
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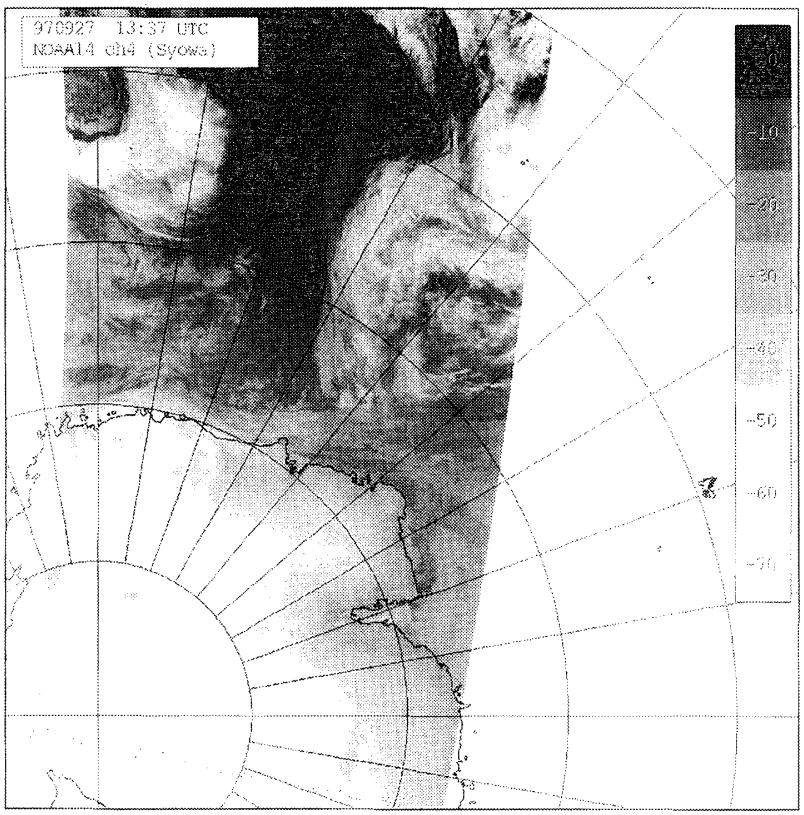
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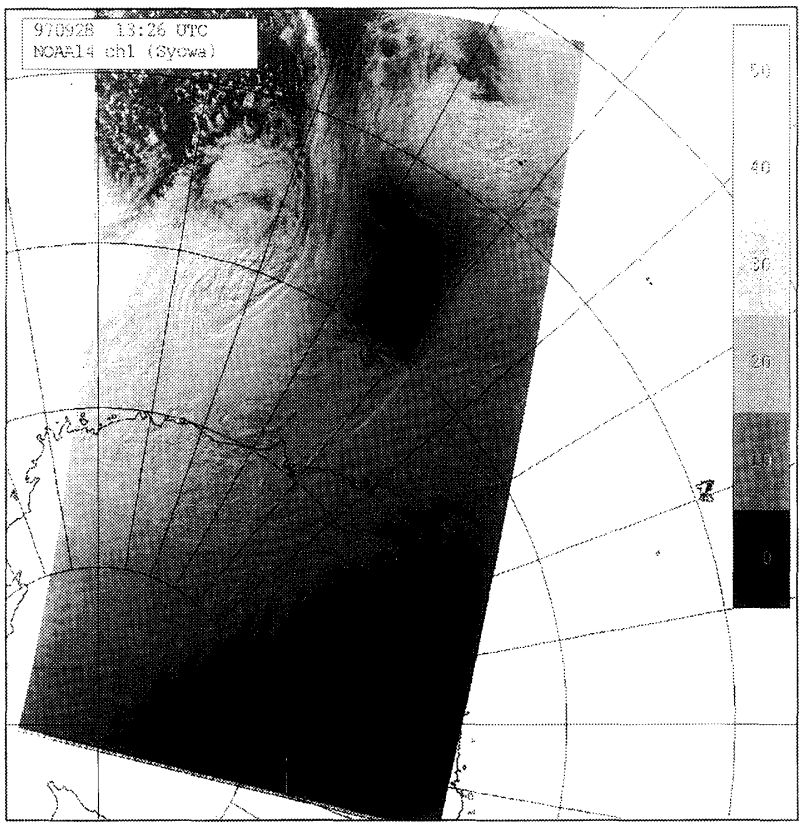
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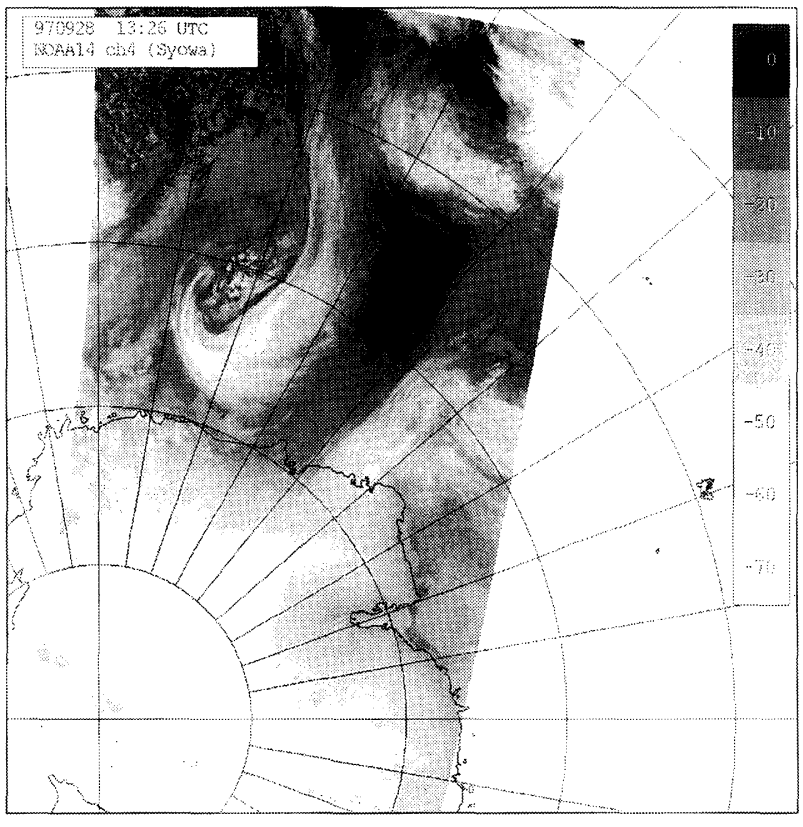
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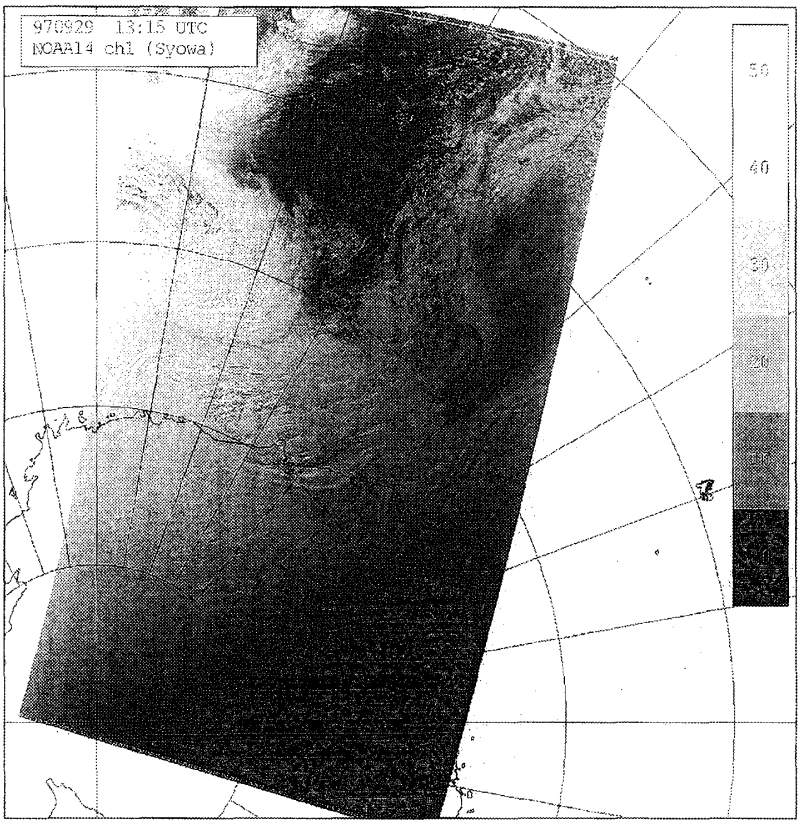
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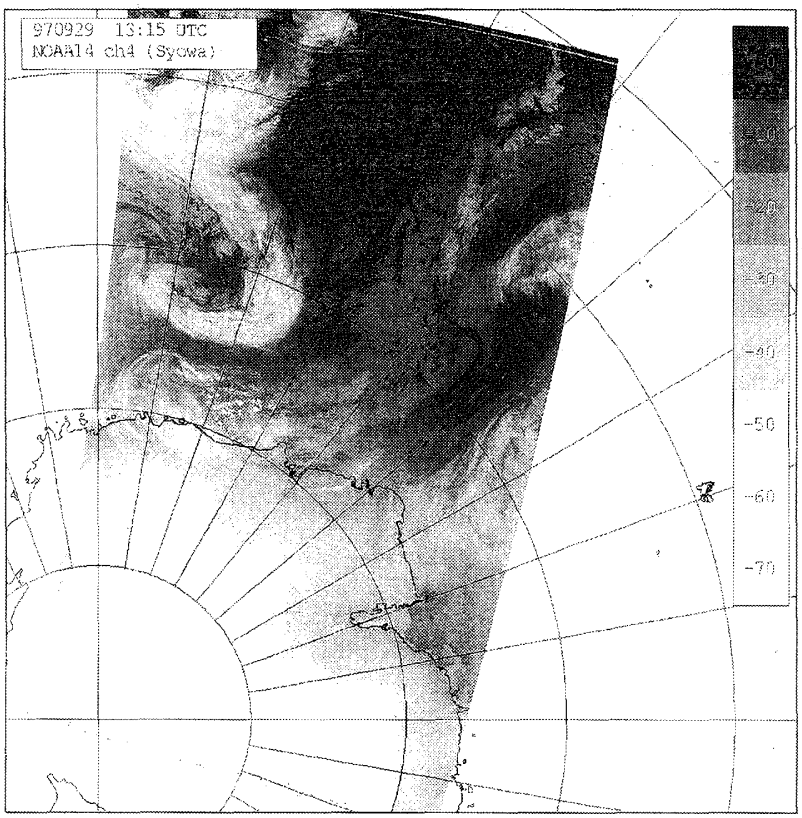
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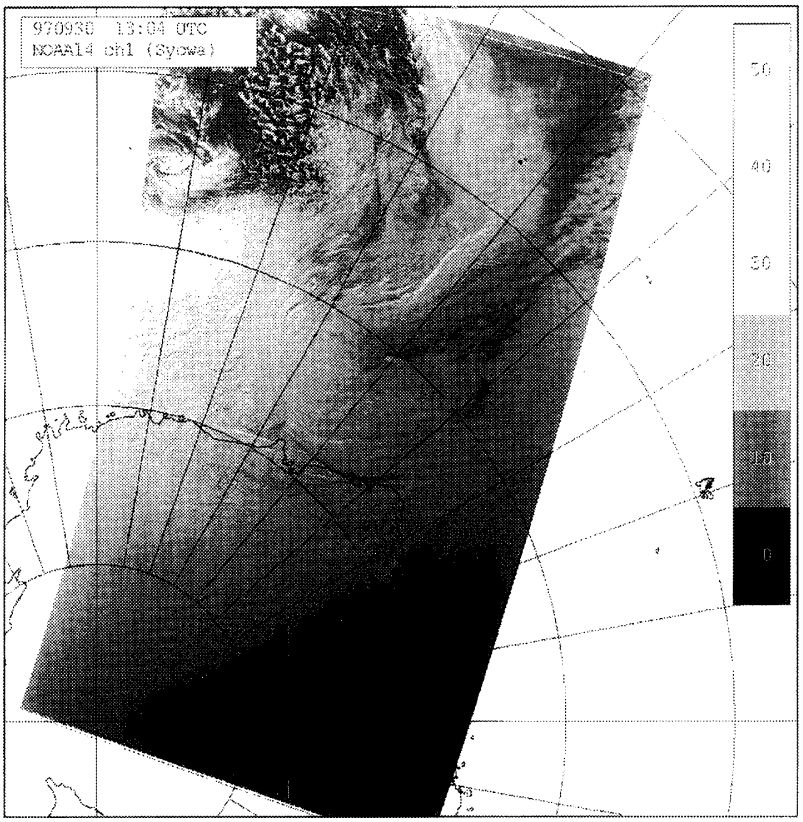
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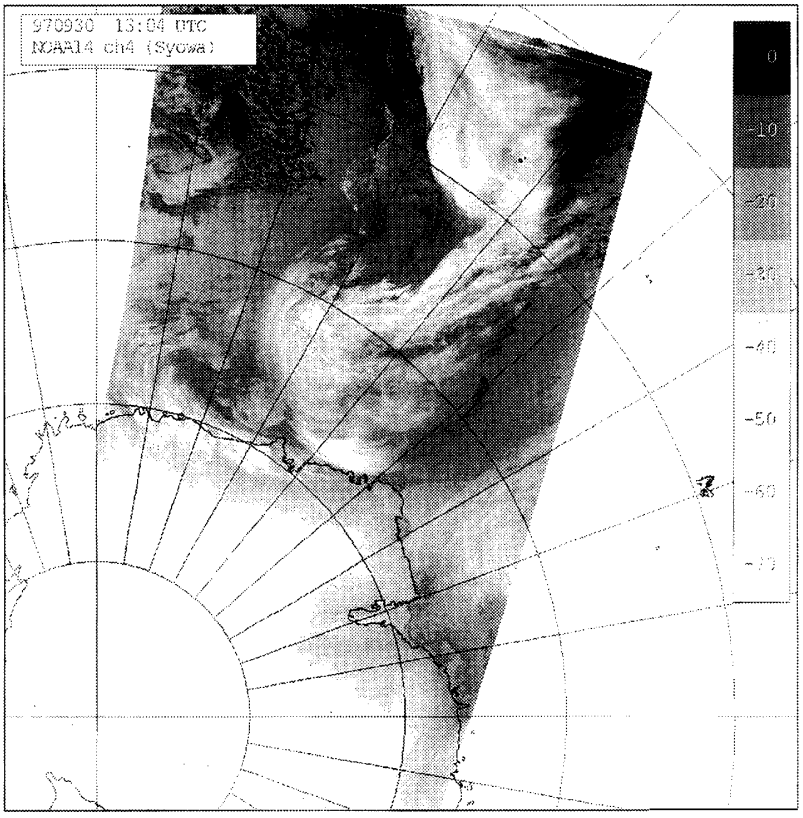
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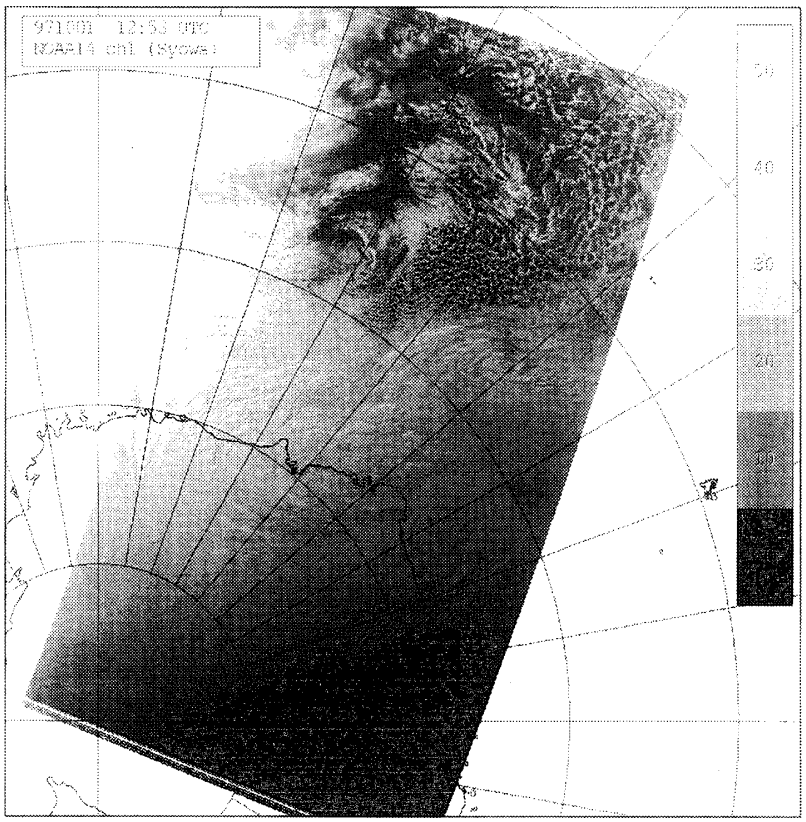
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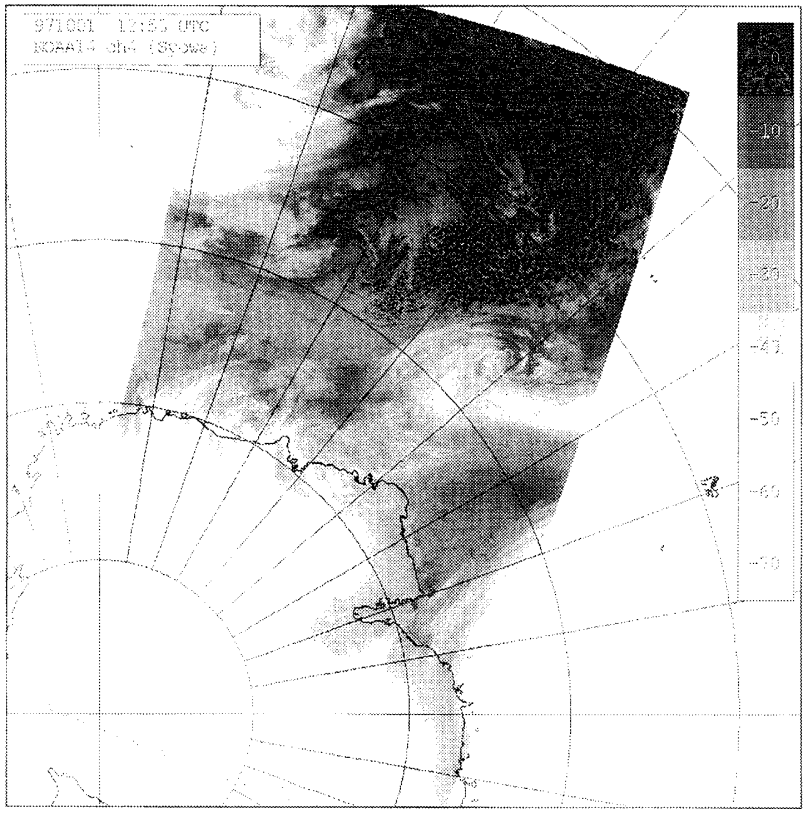
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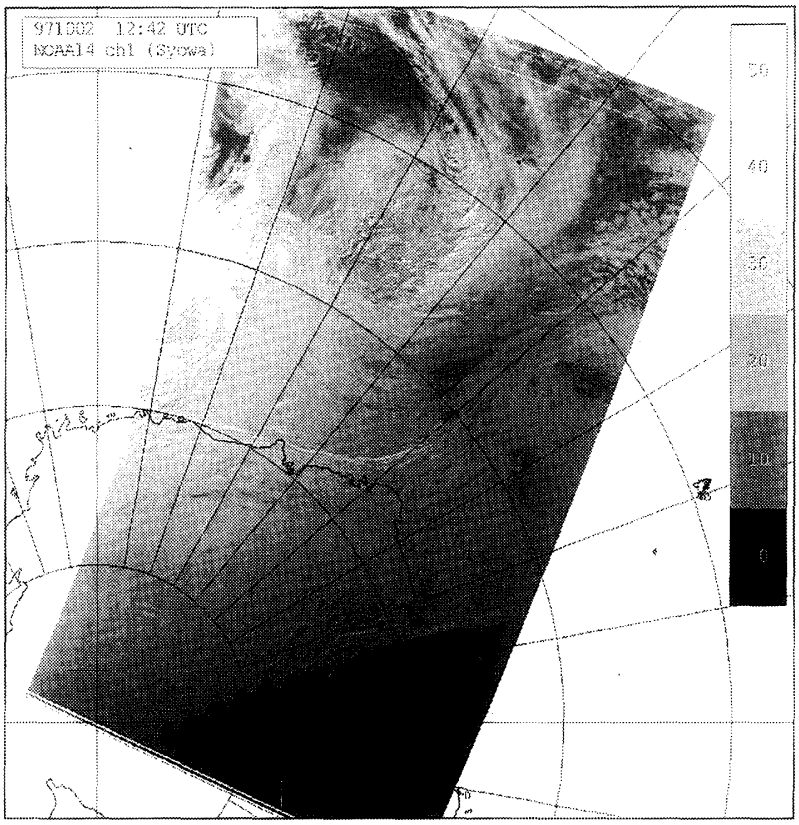
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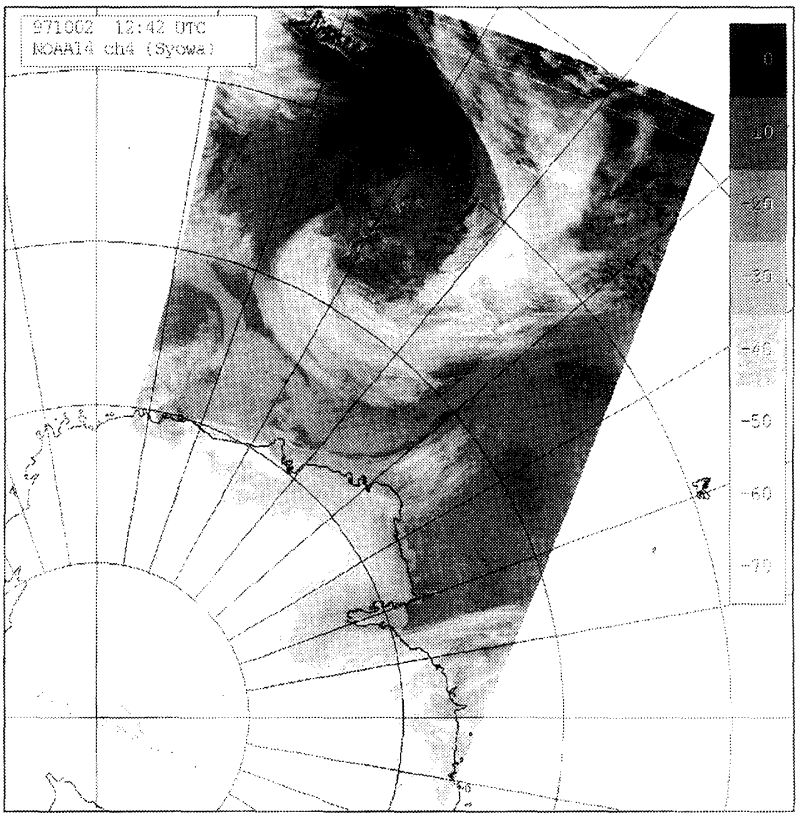
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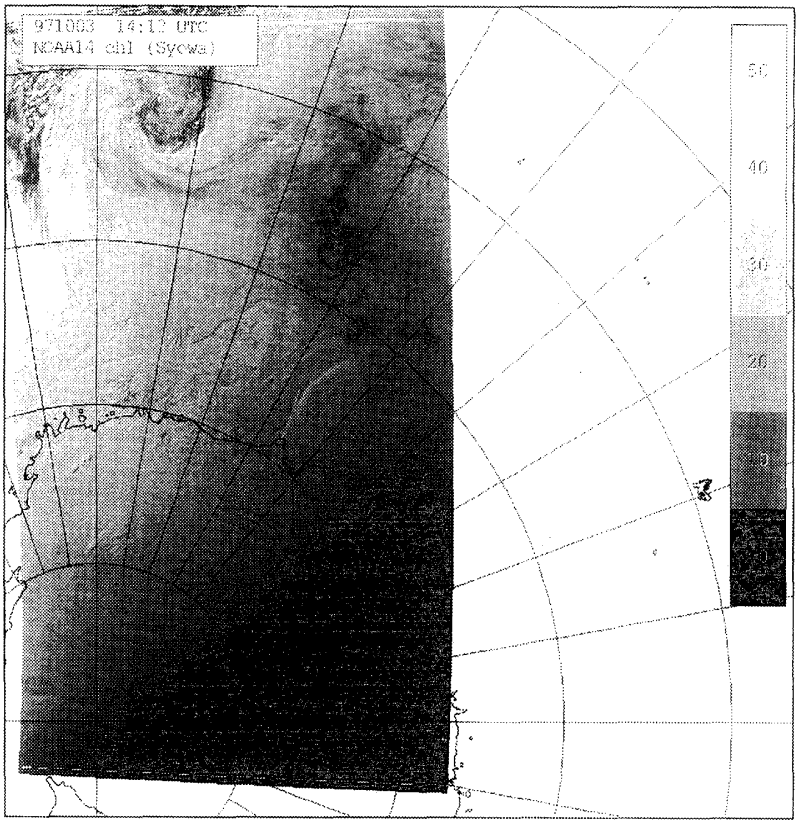
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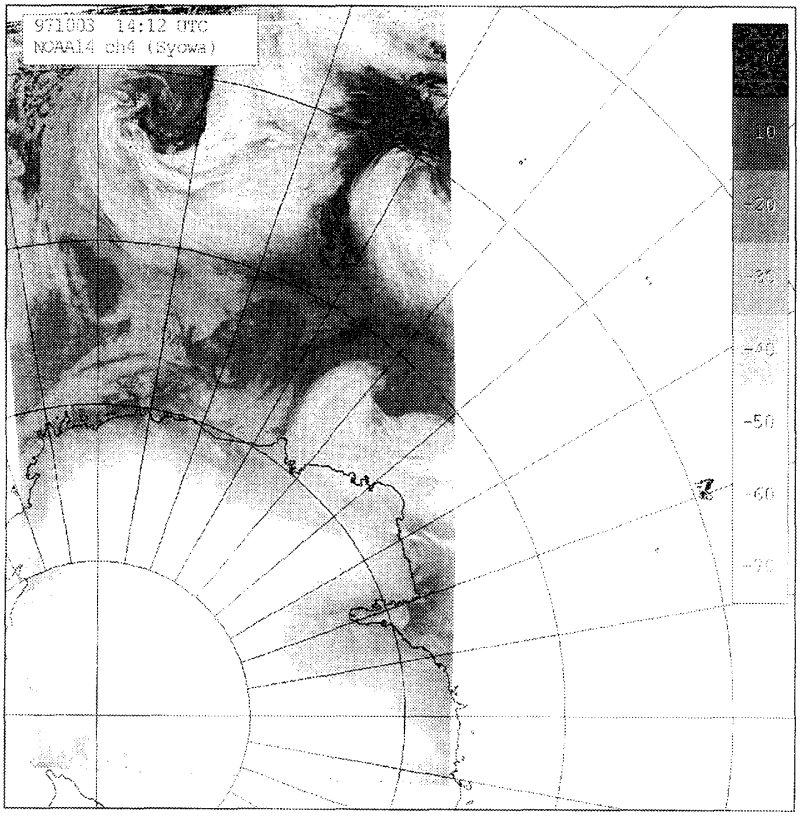
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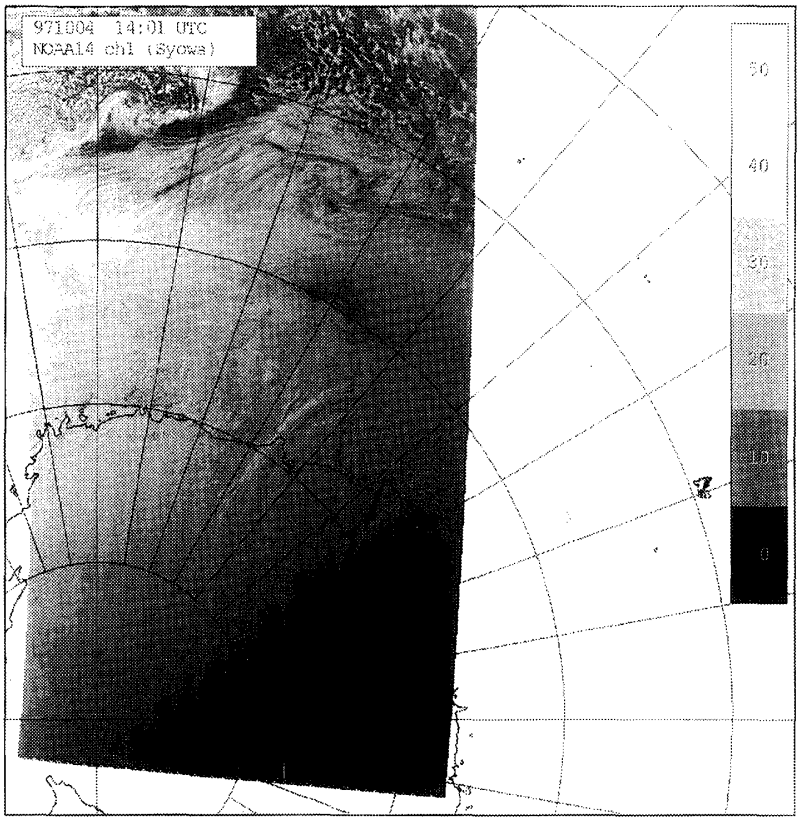
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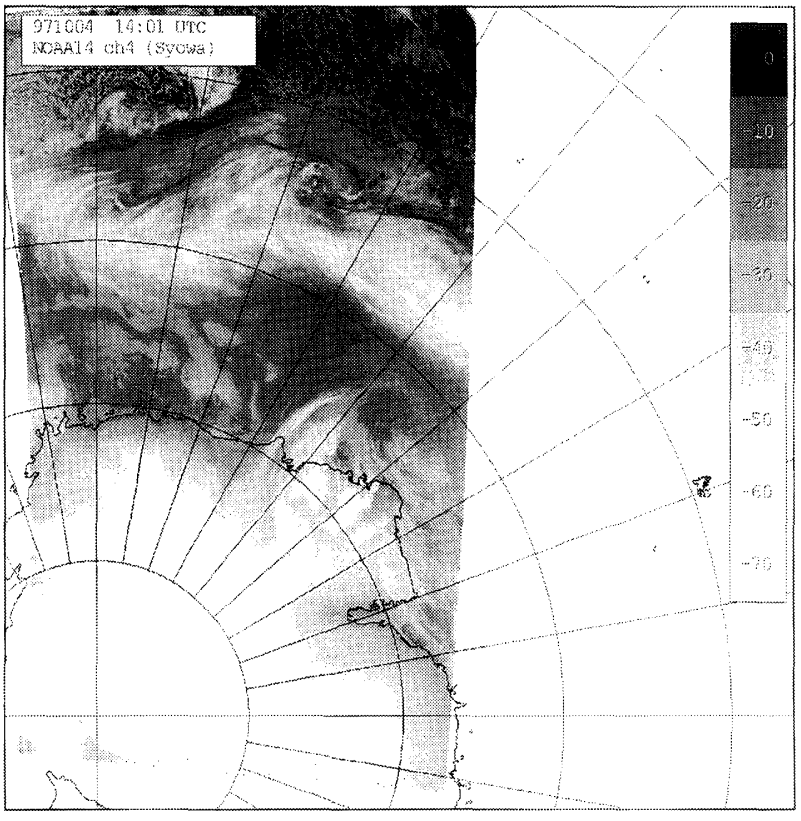
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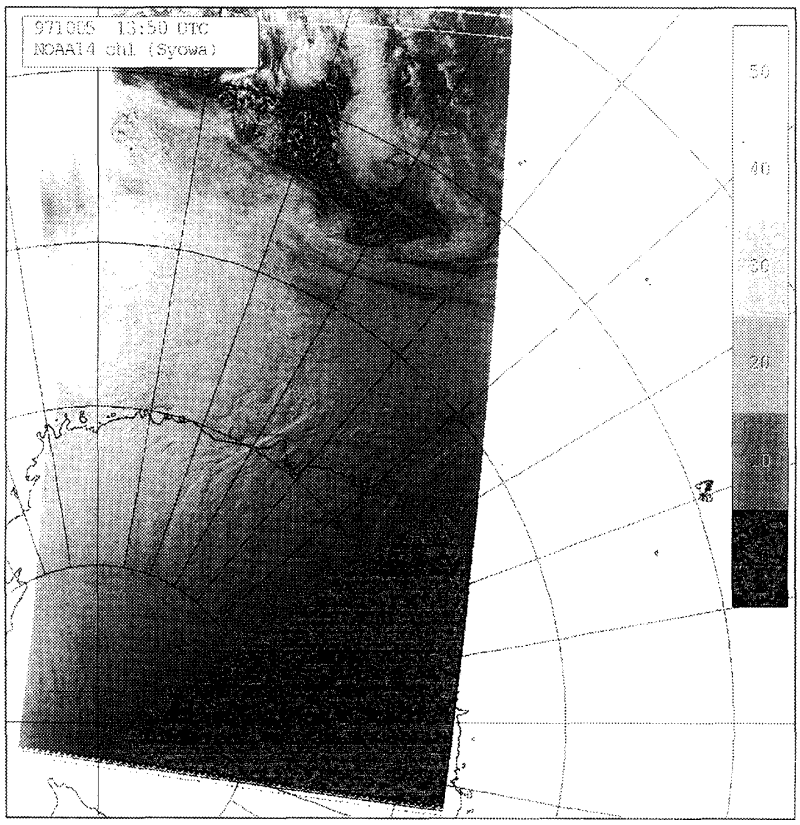
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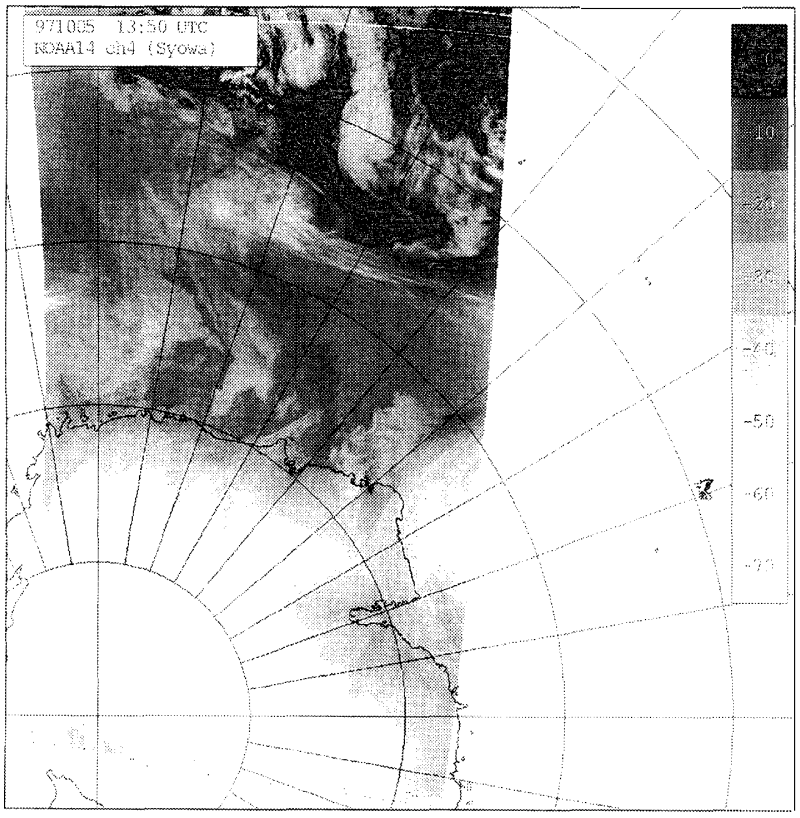
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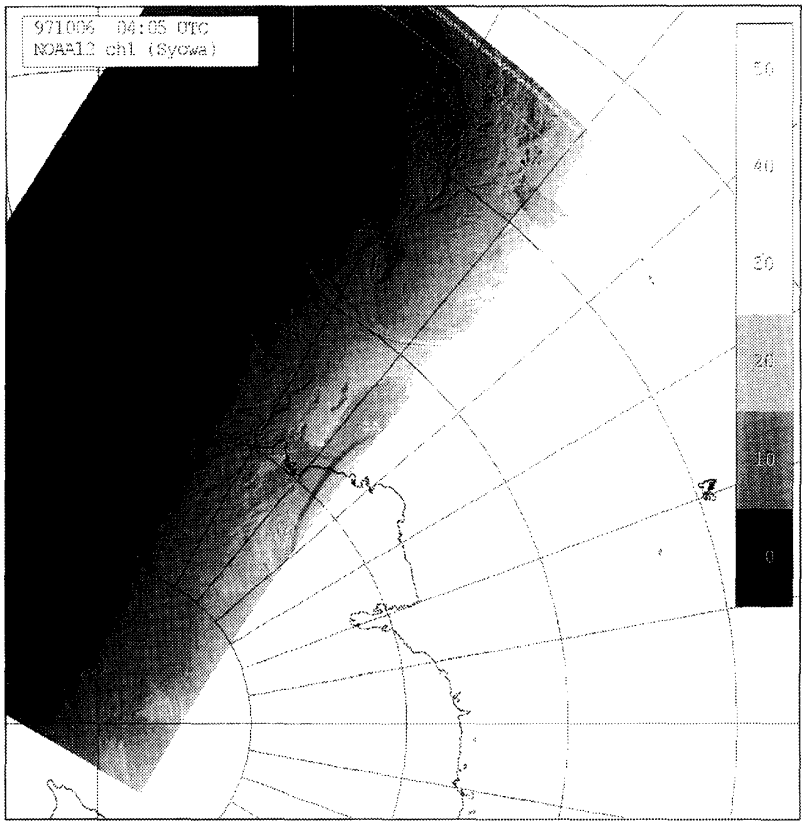
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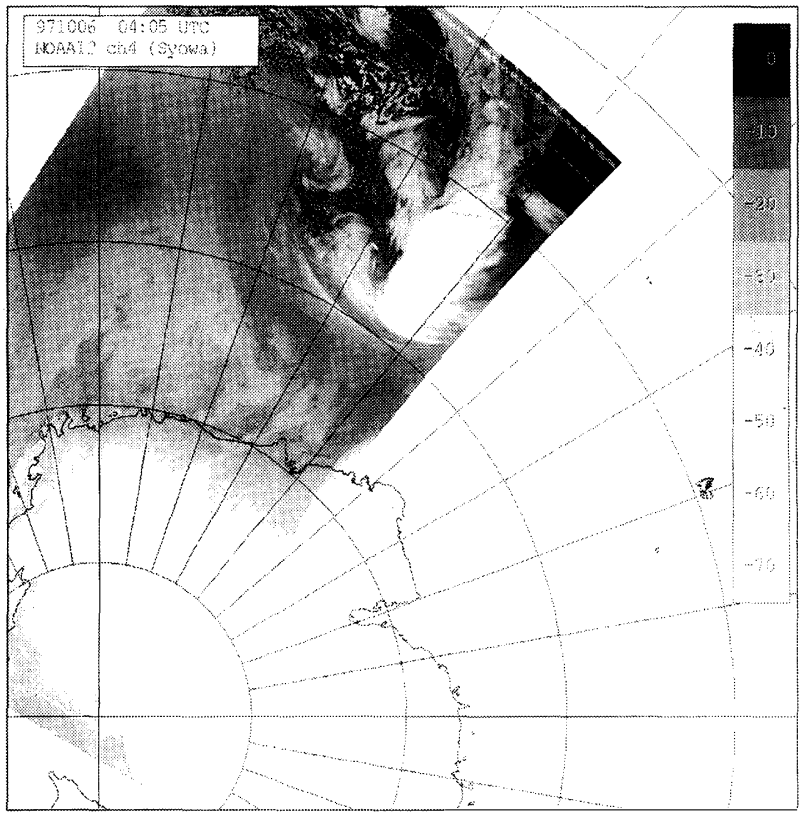
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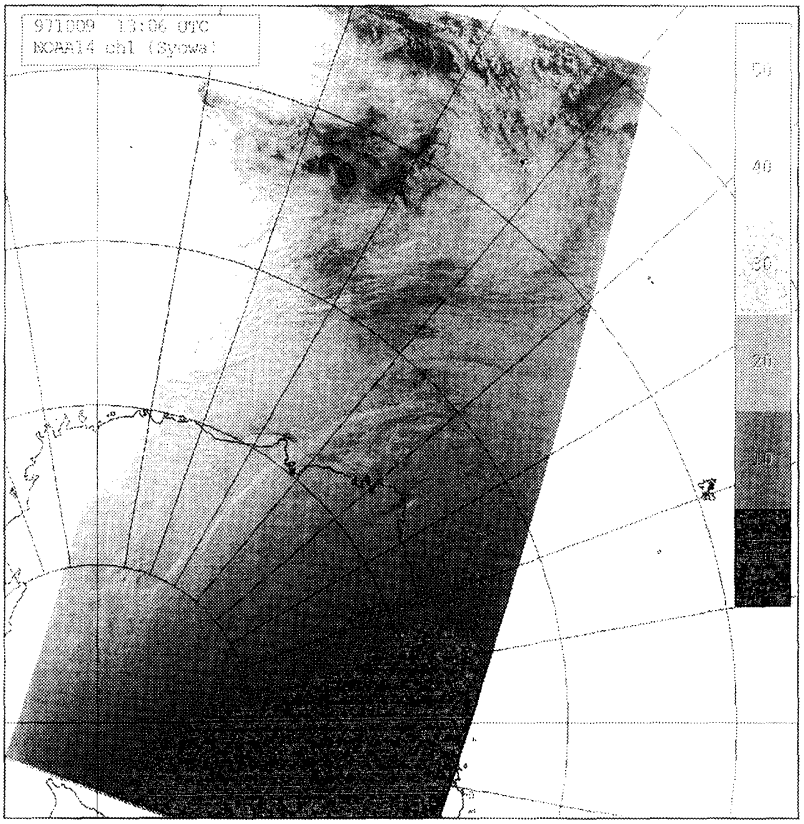
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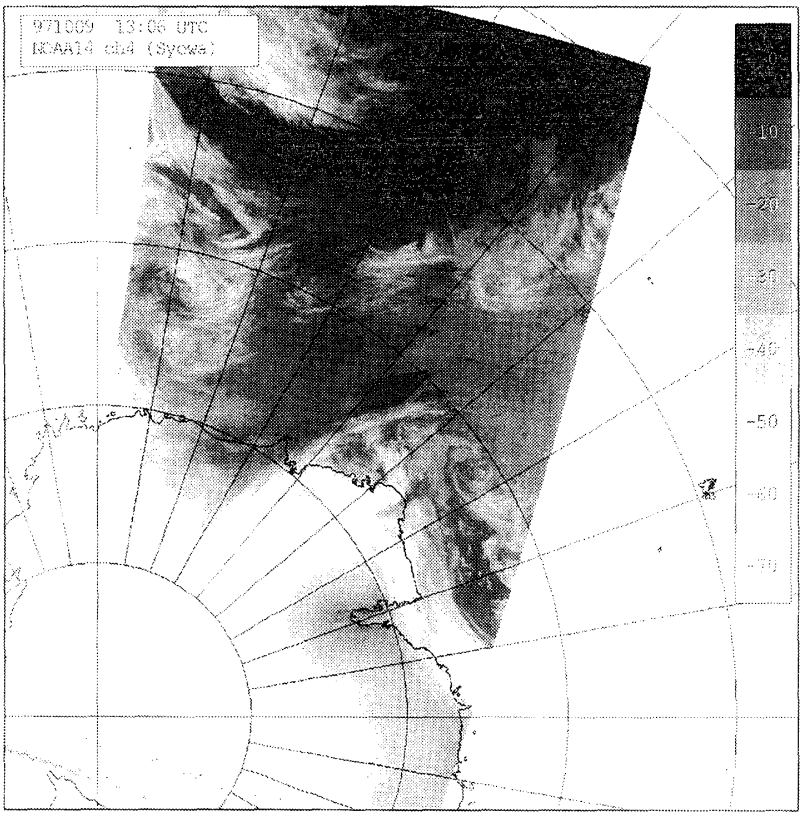
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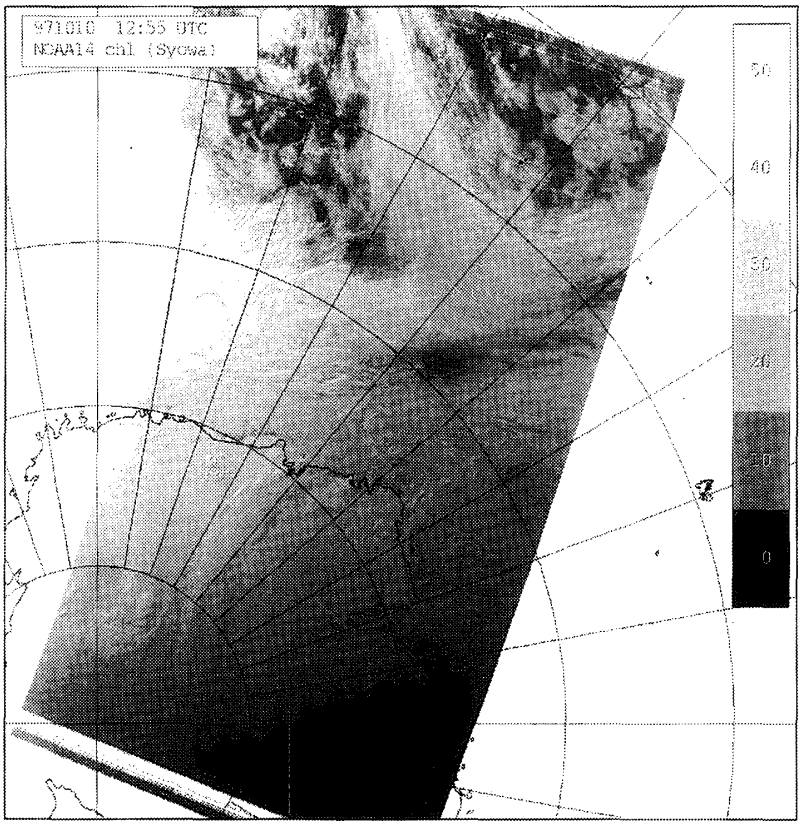
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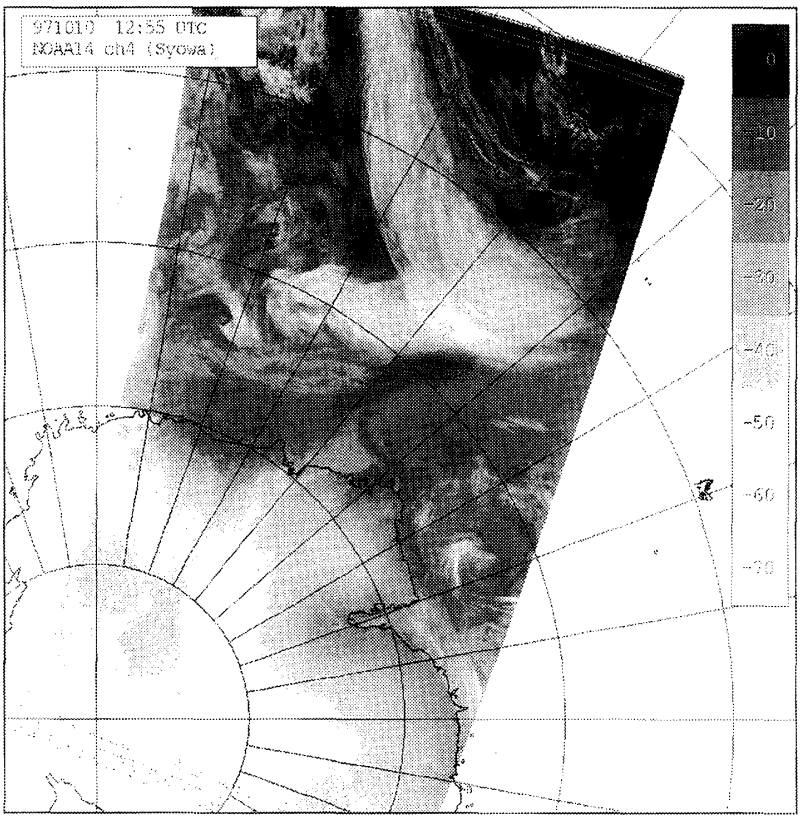
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NOAA14 ch4 (Syowa)
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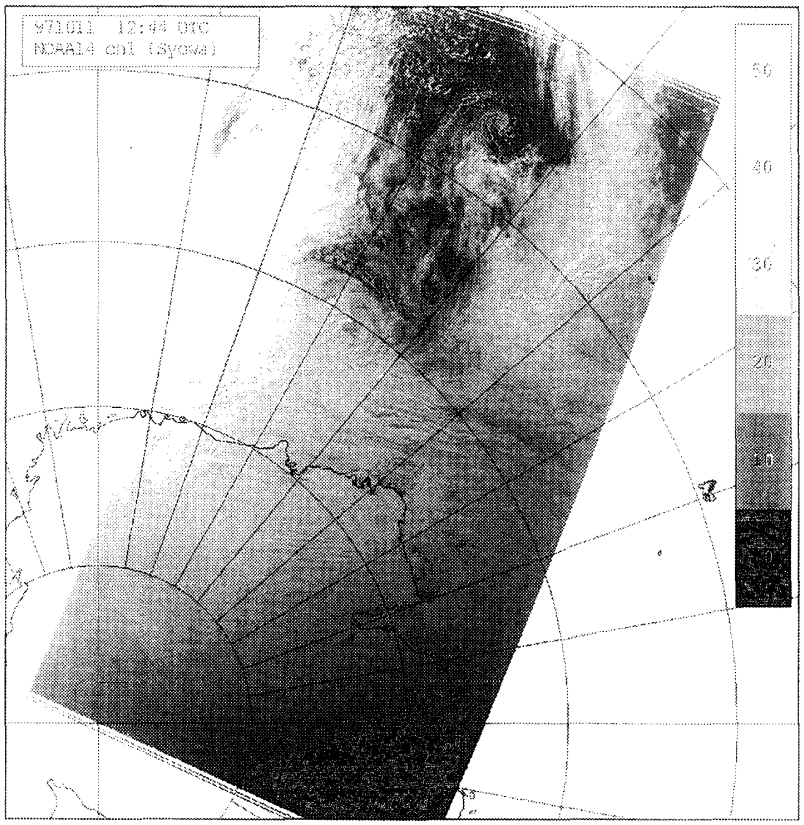
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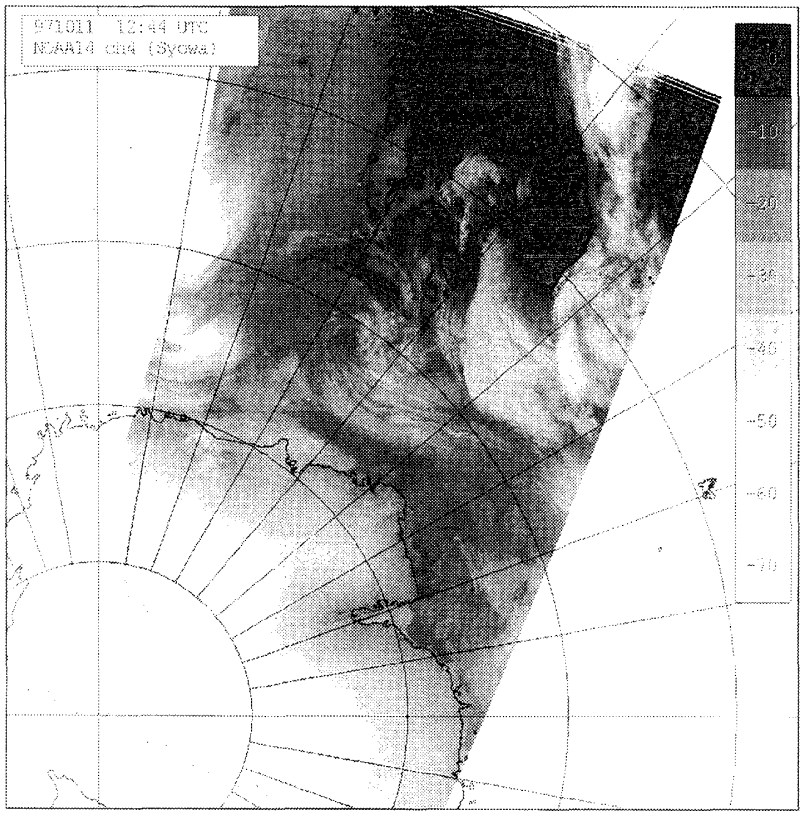
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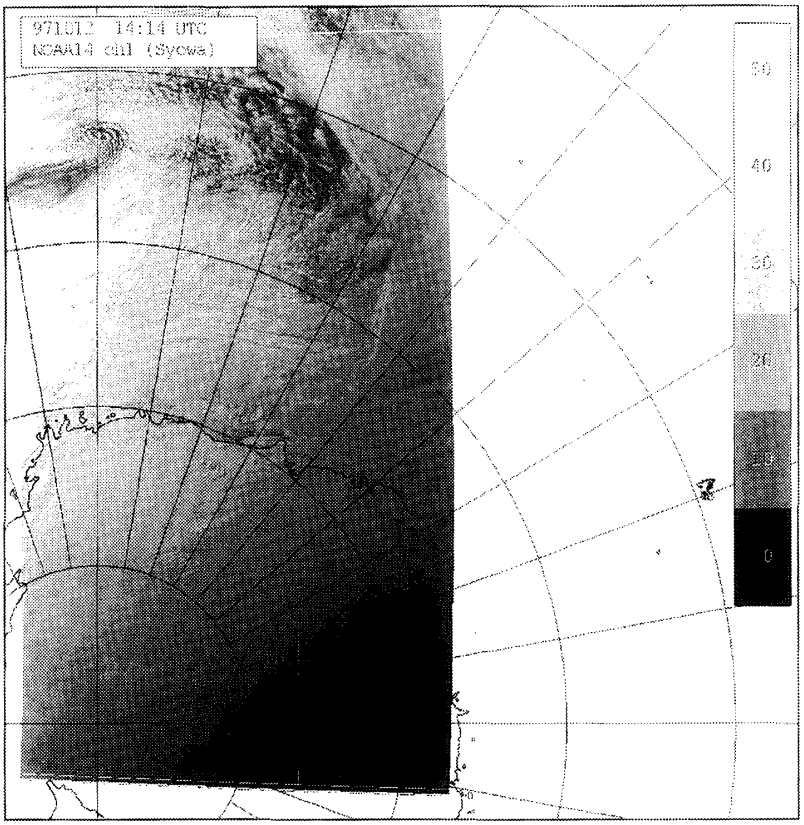
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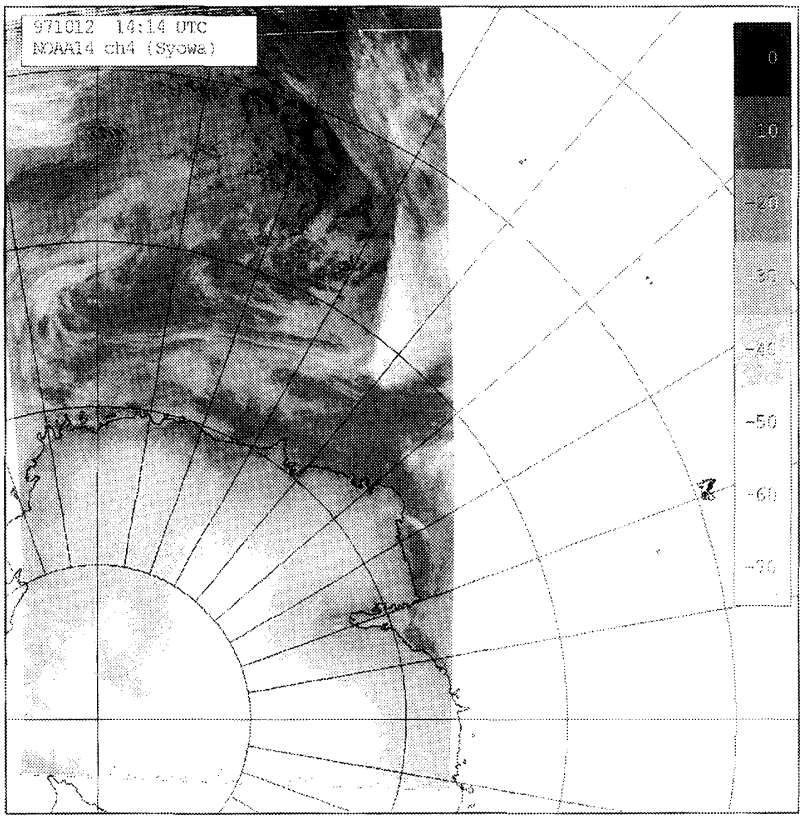
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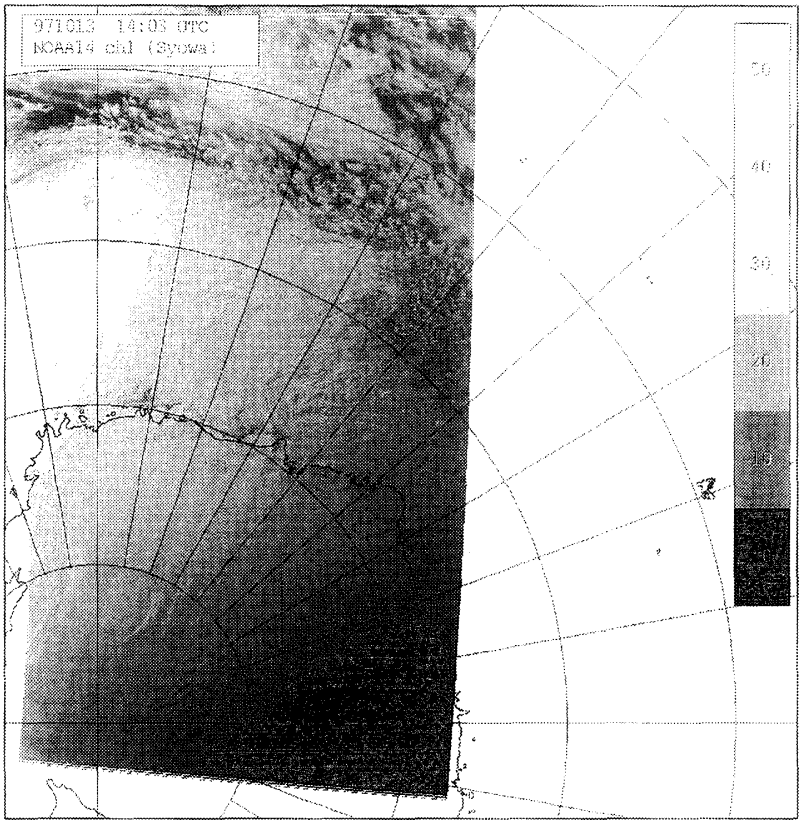
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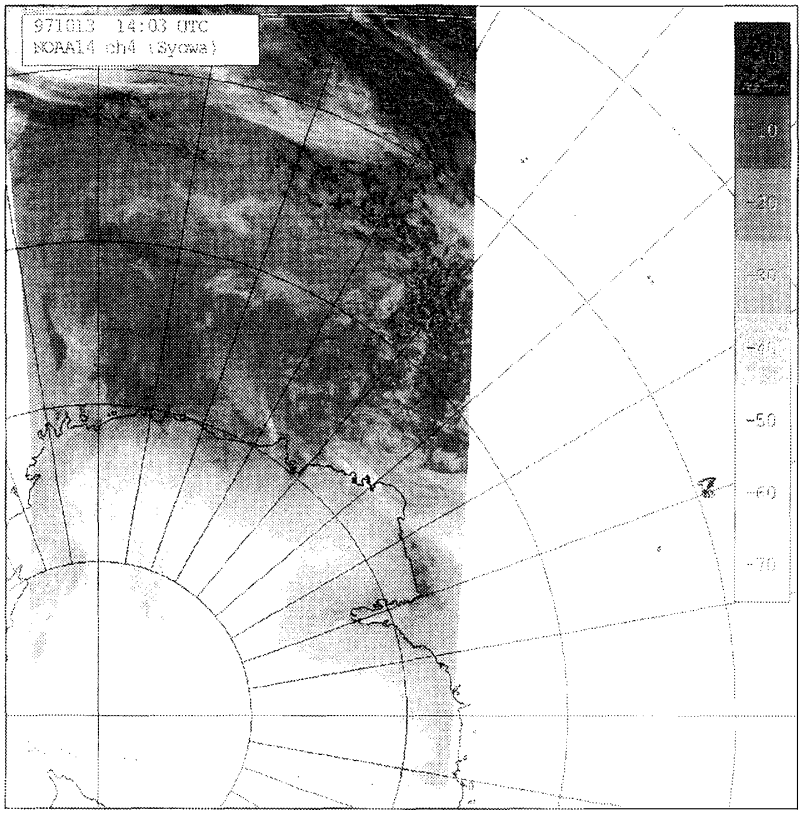
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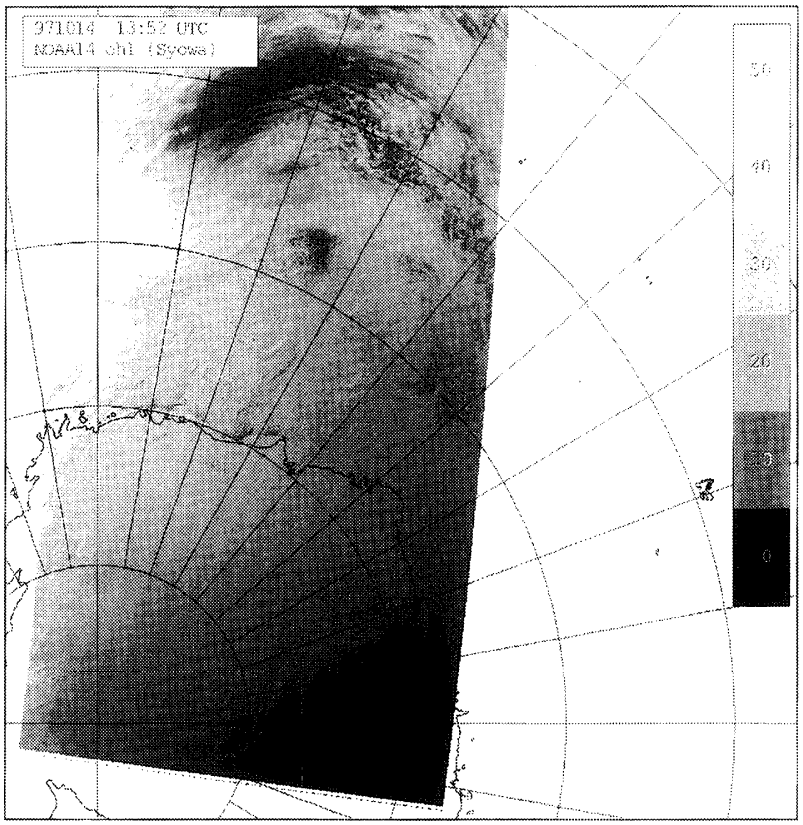
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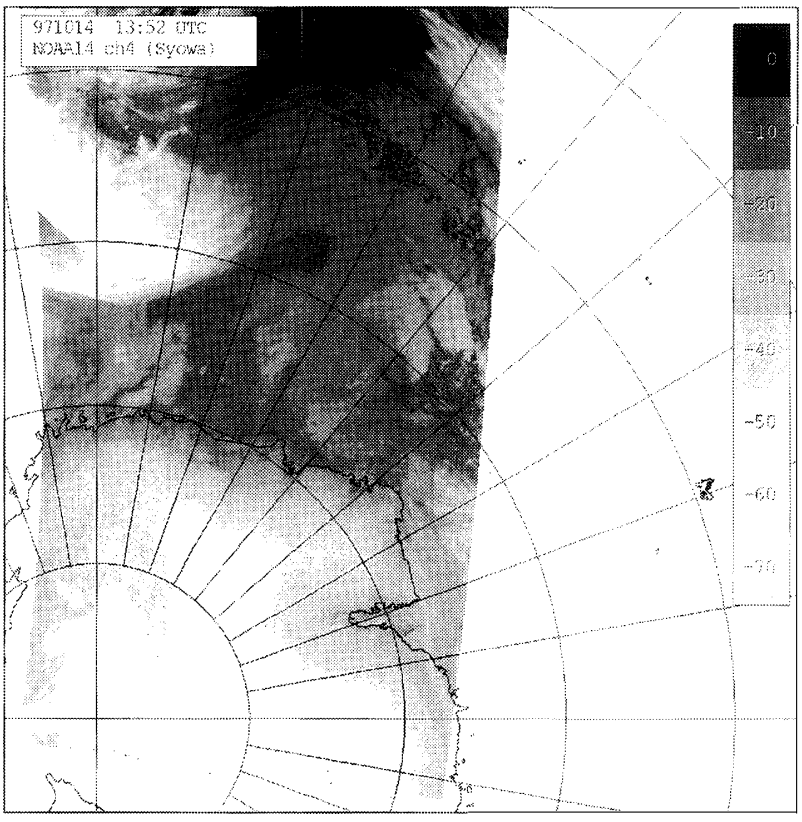
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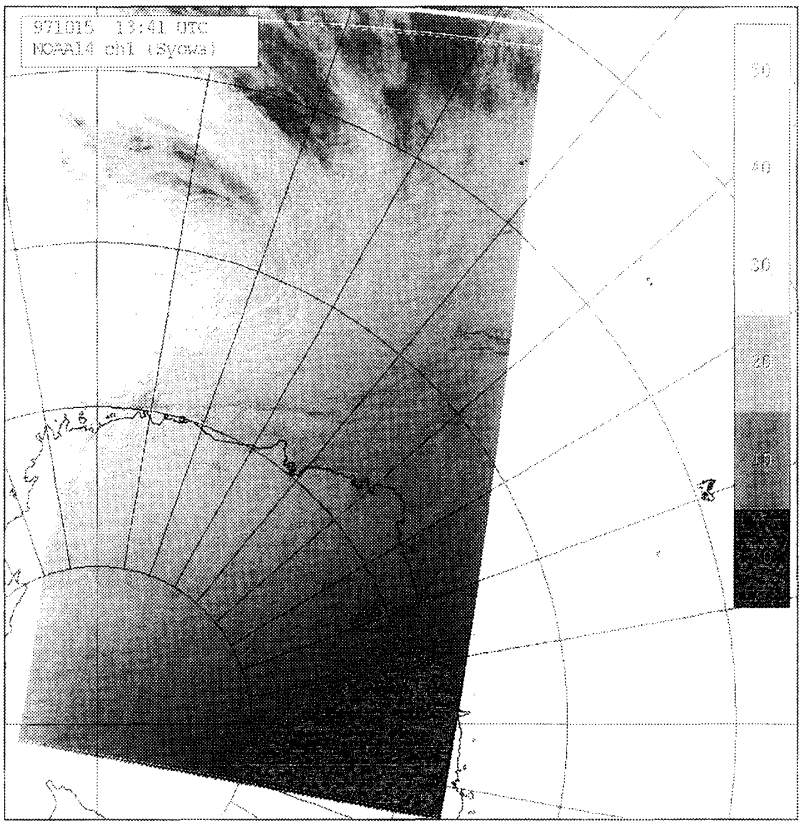
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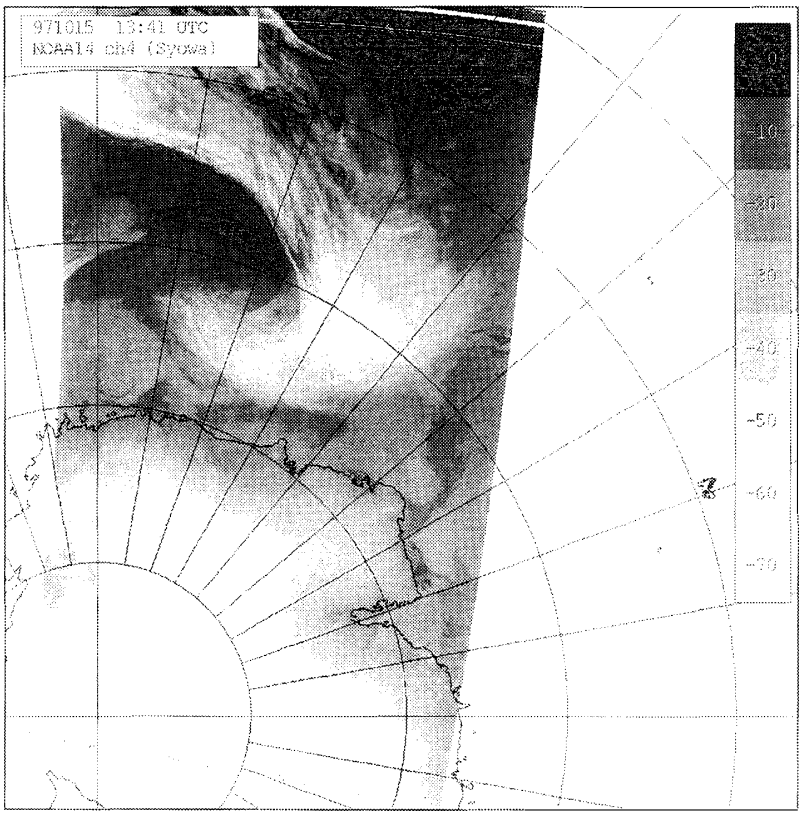
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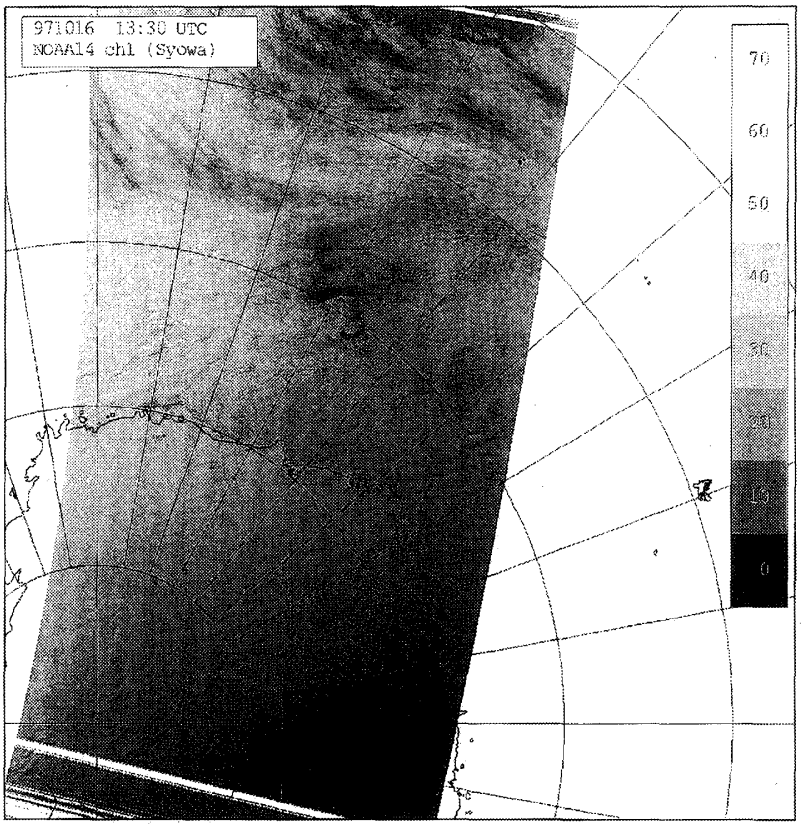
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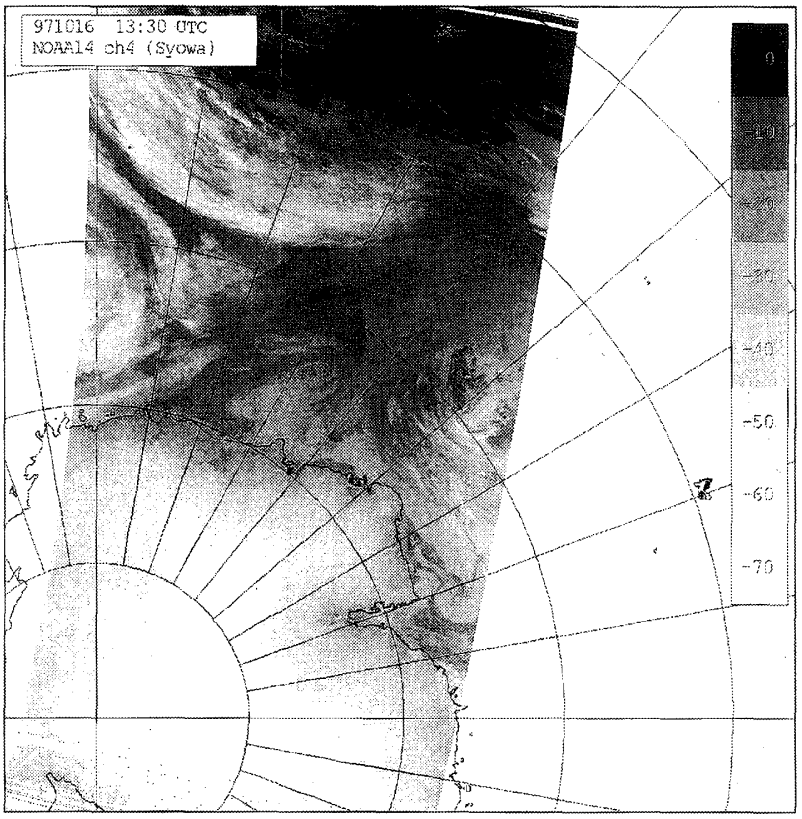
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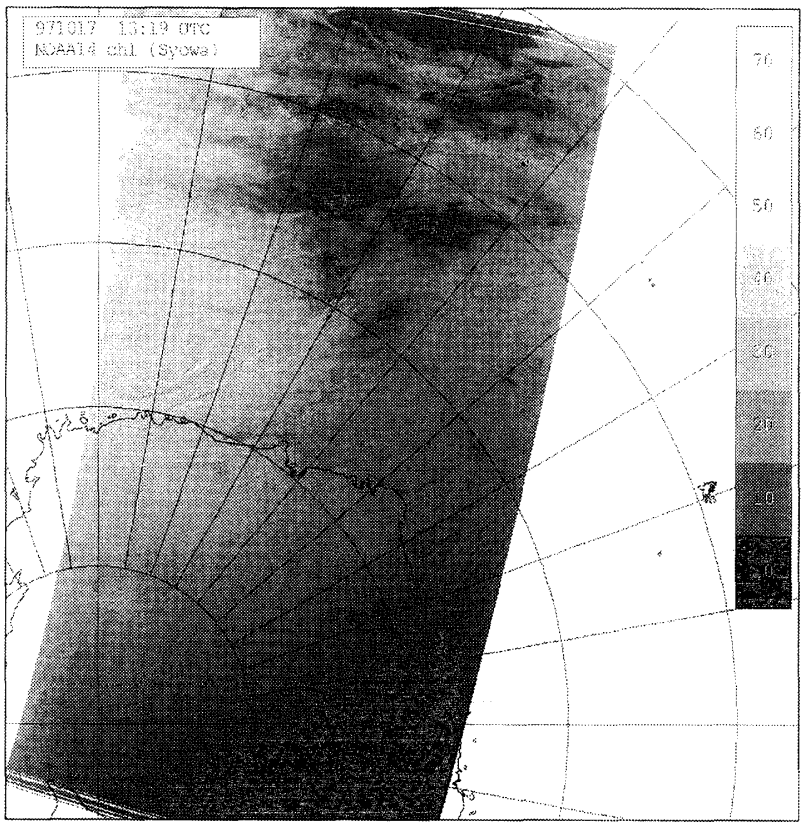
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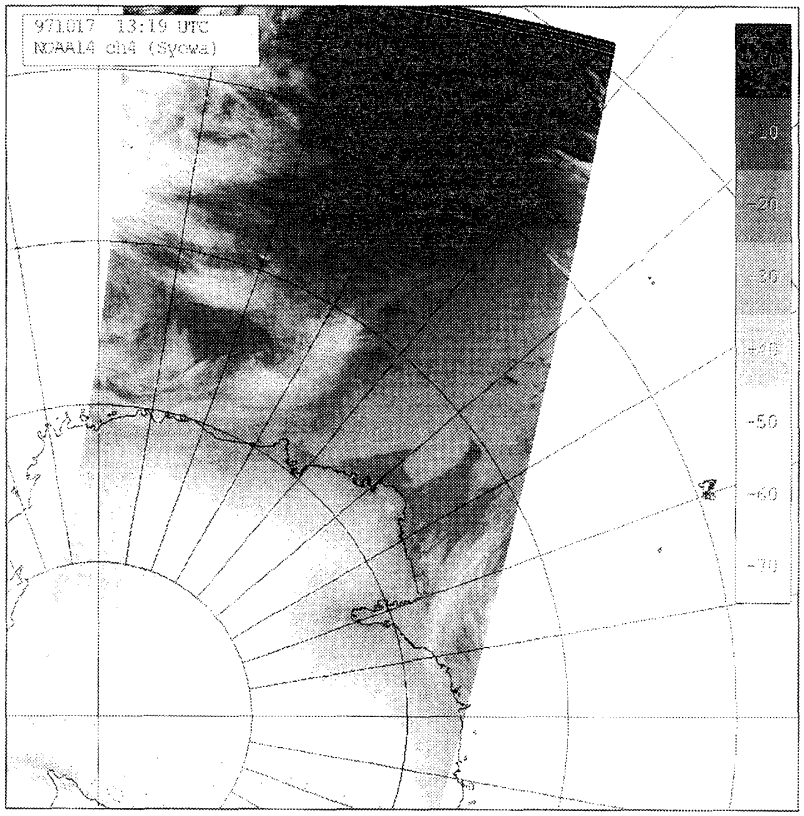
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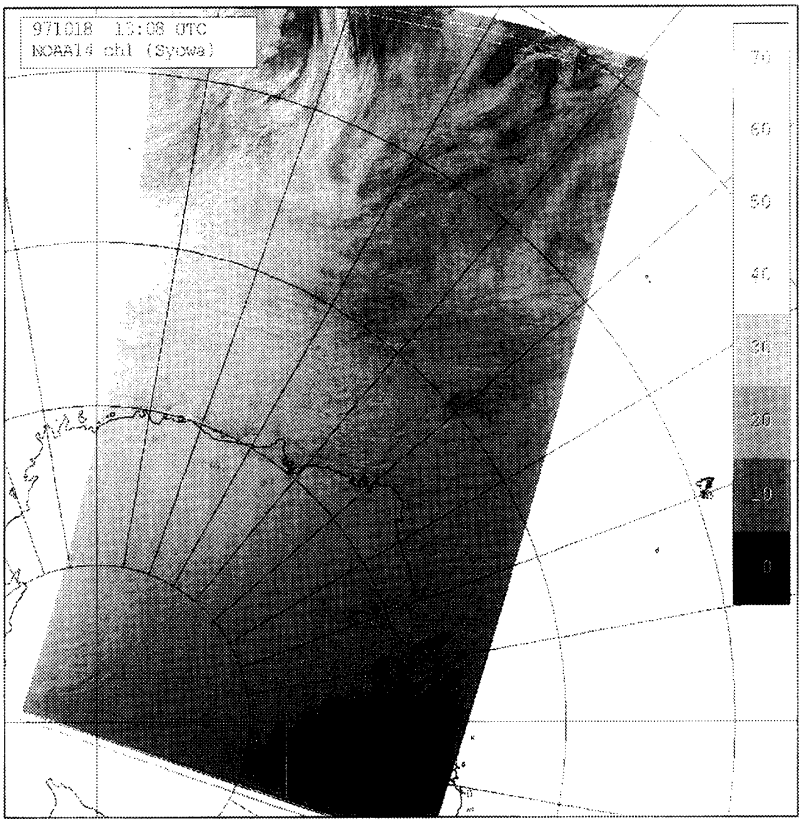
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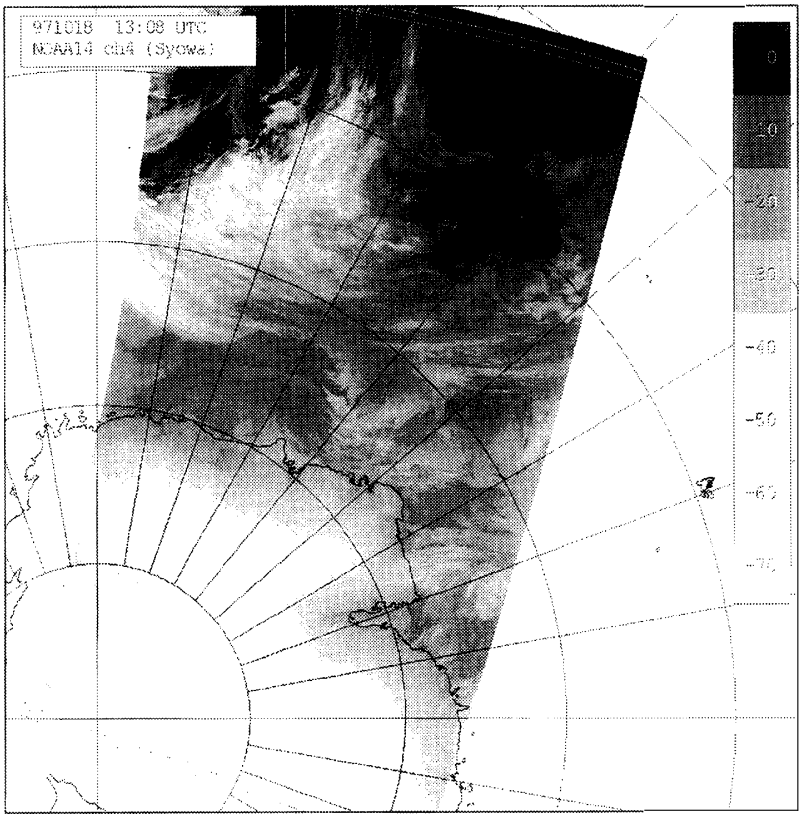
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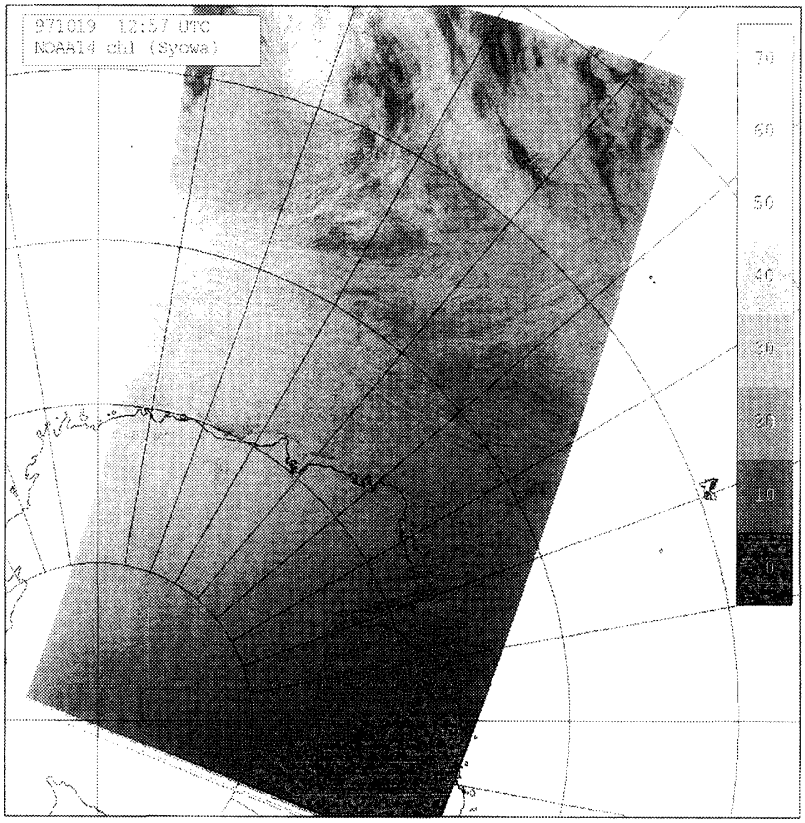
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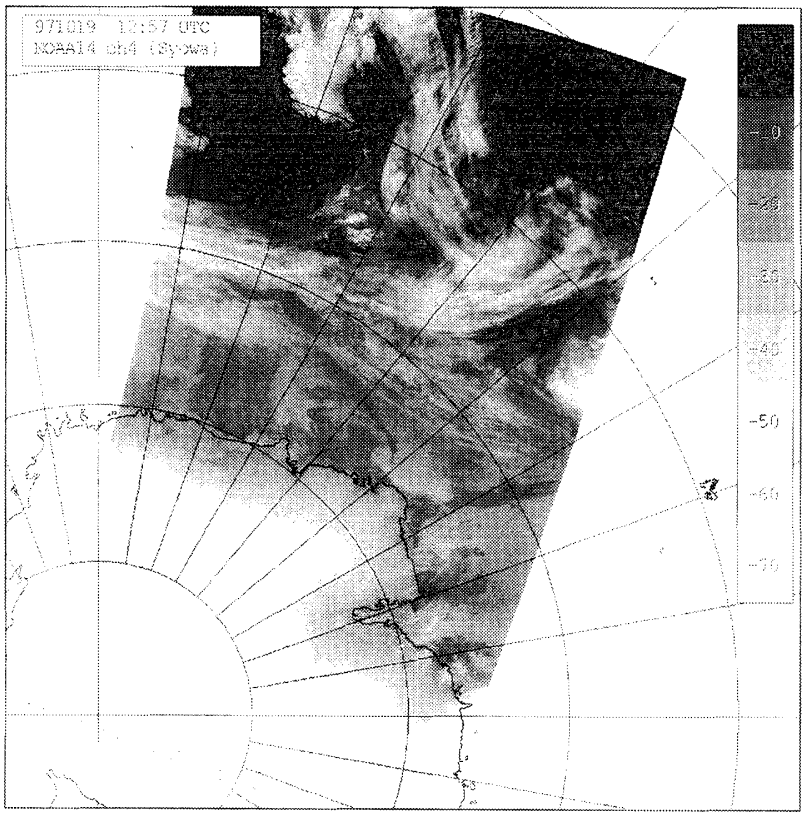
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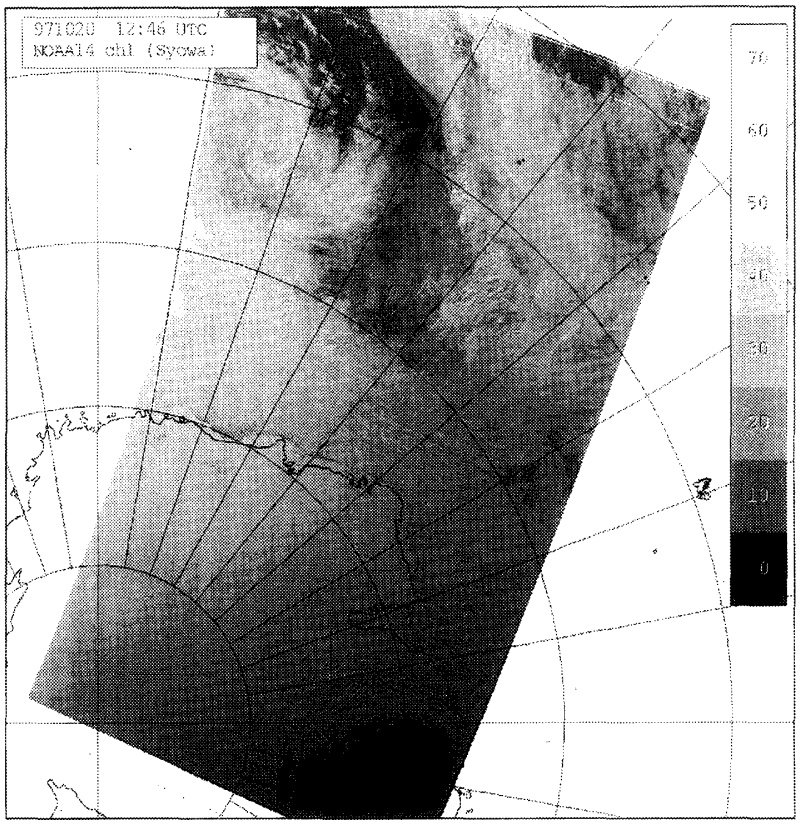
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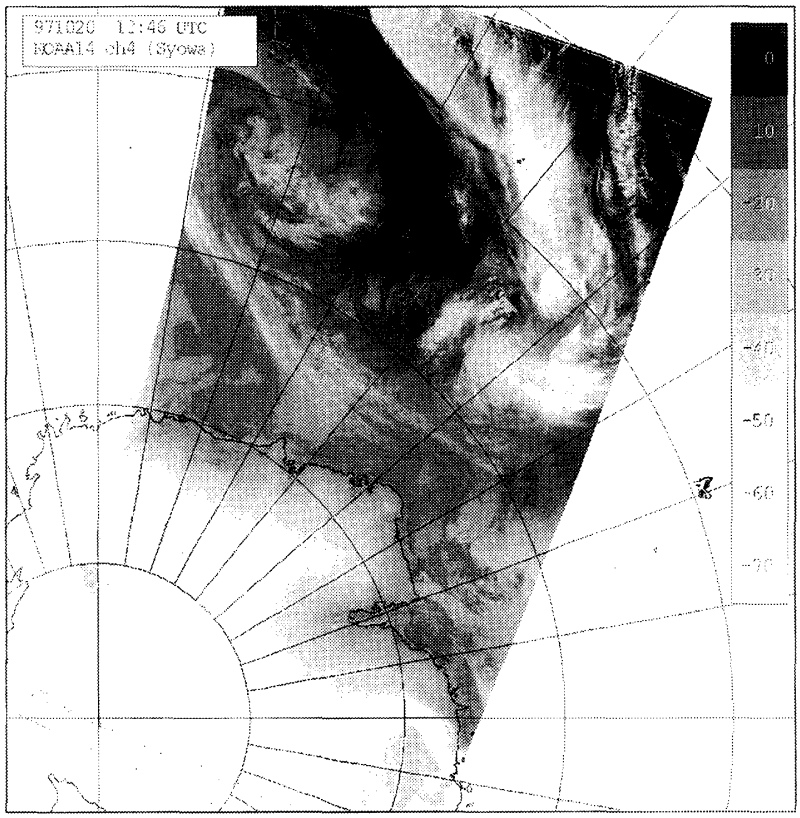
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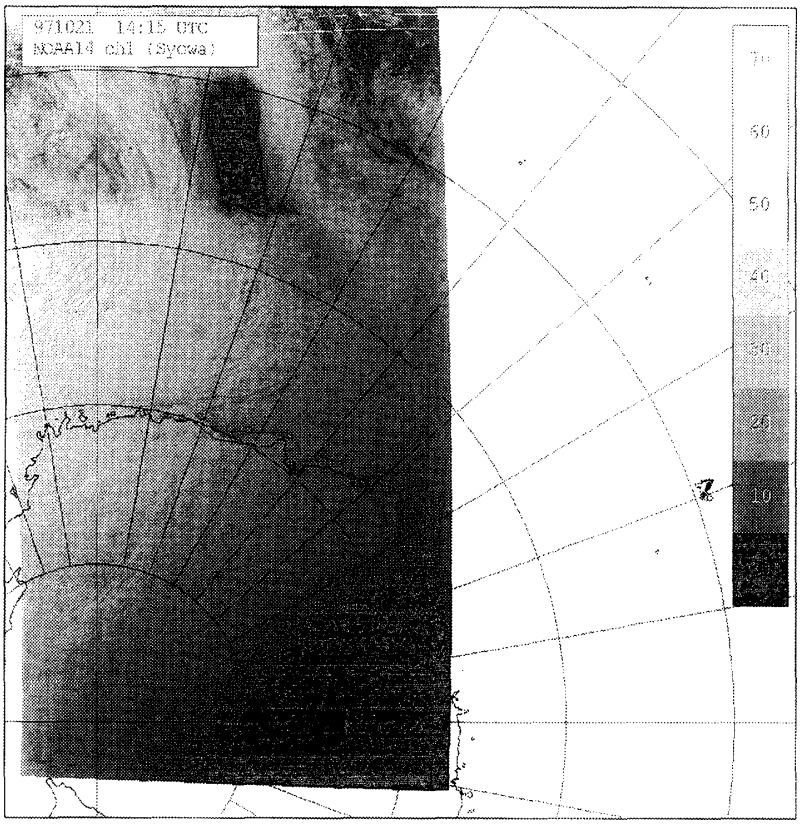
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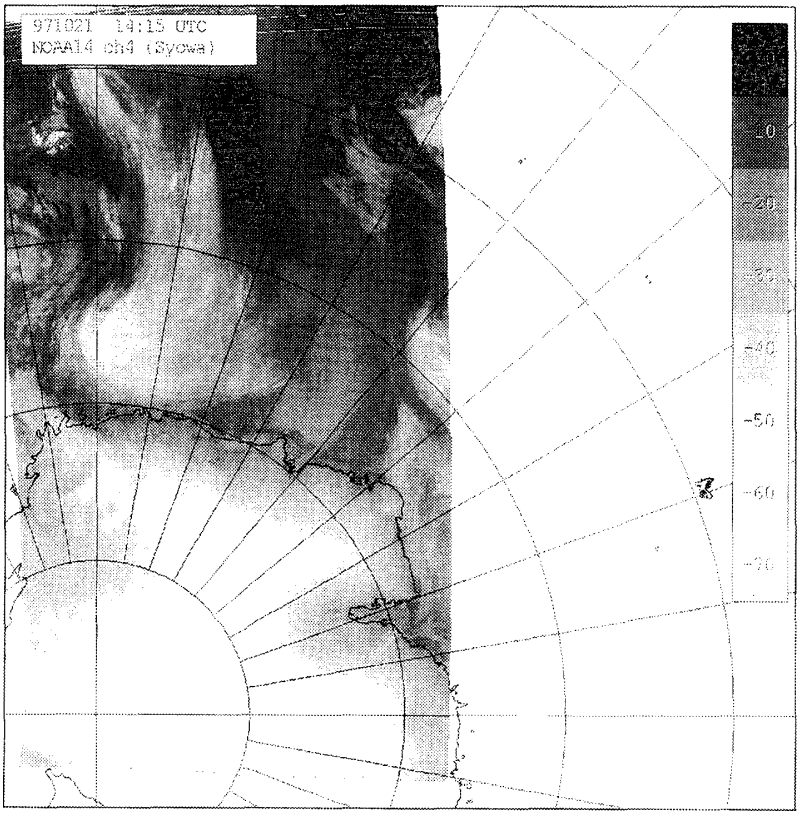
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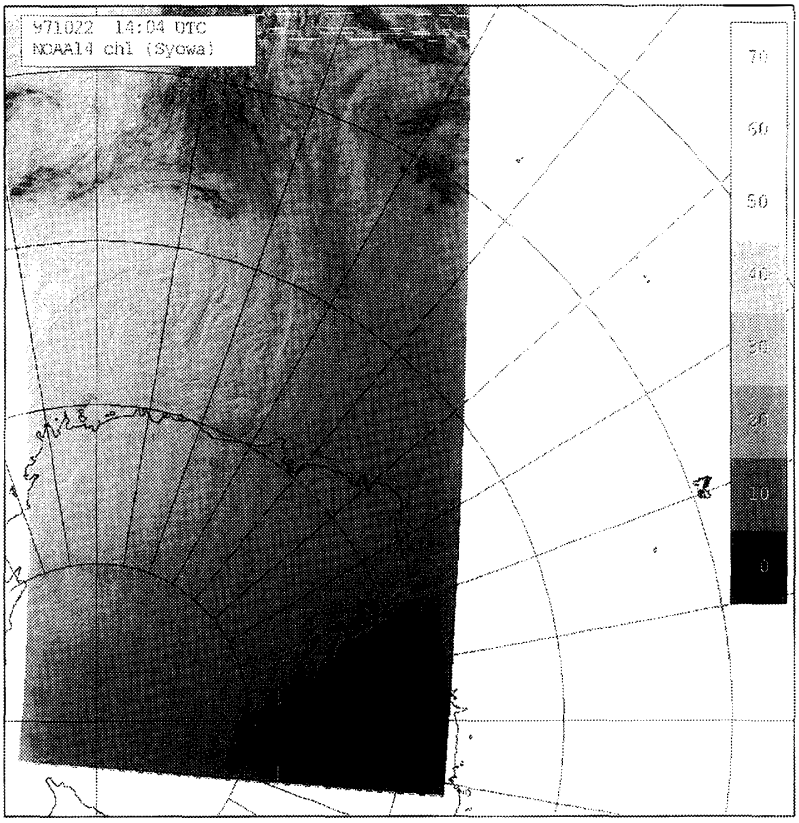
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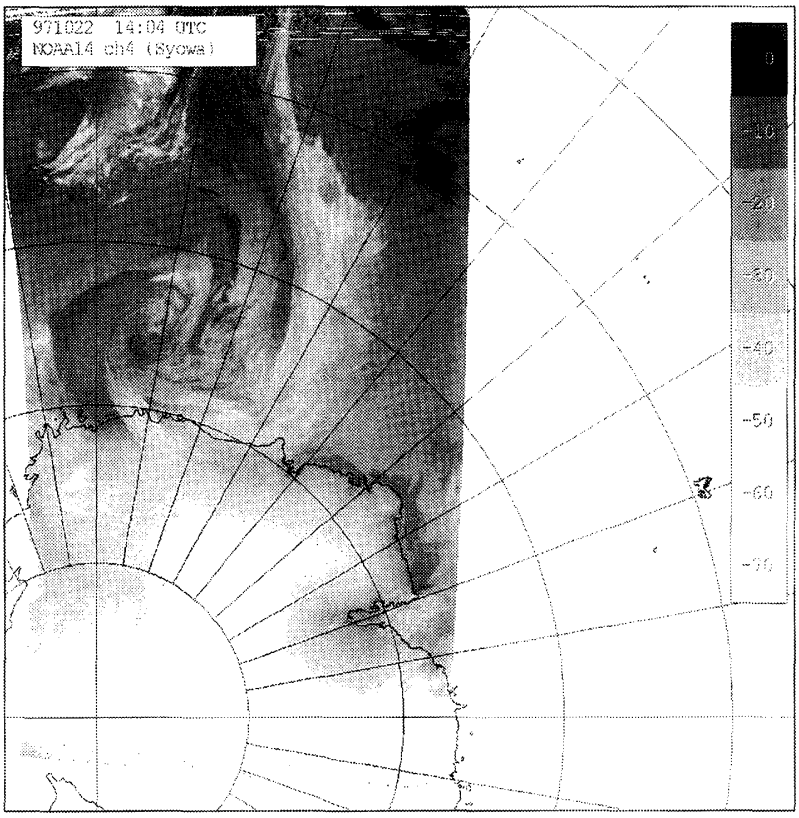
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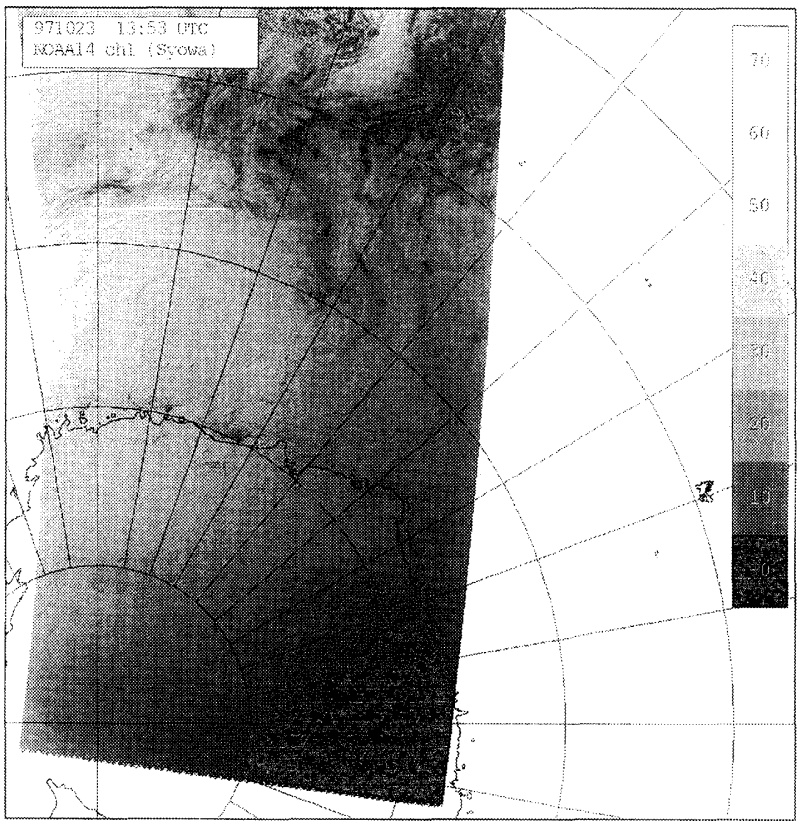
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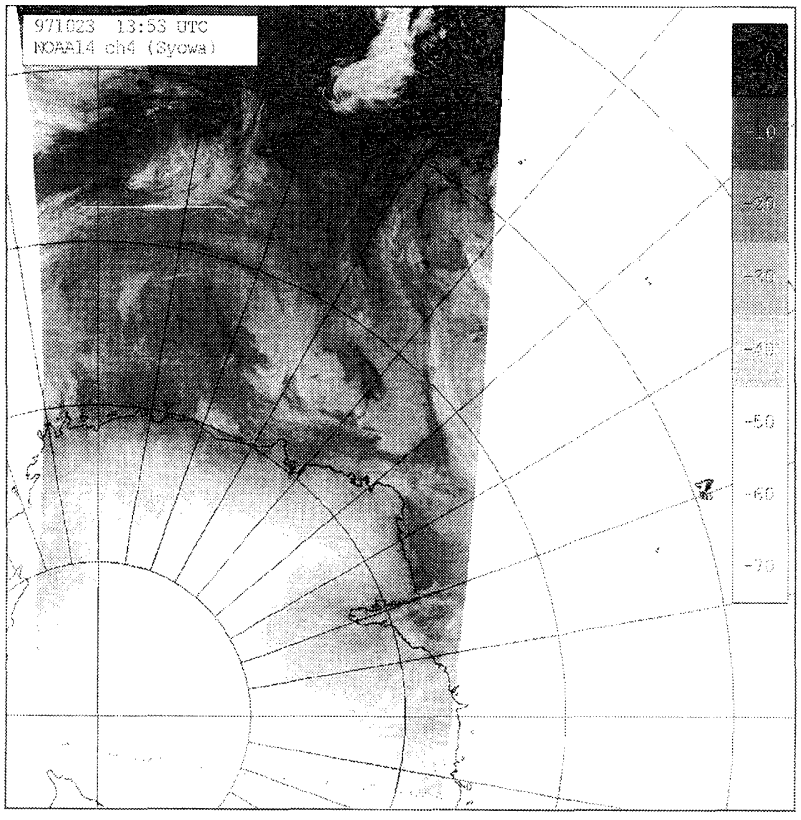
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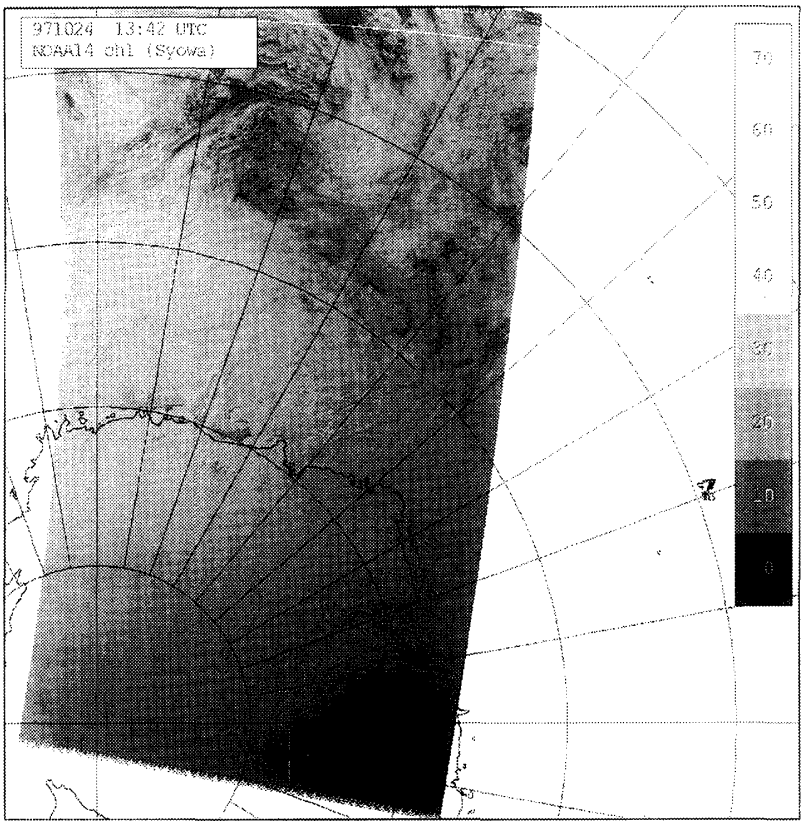
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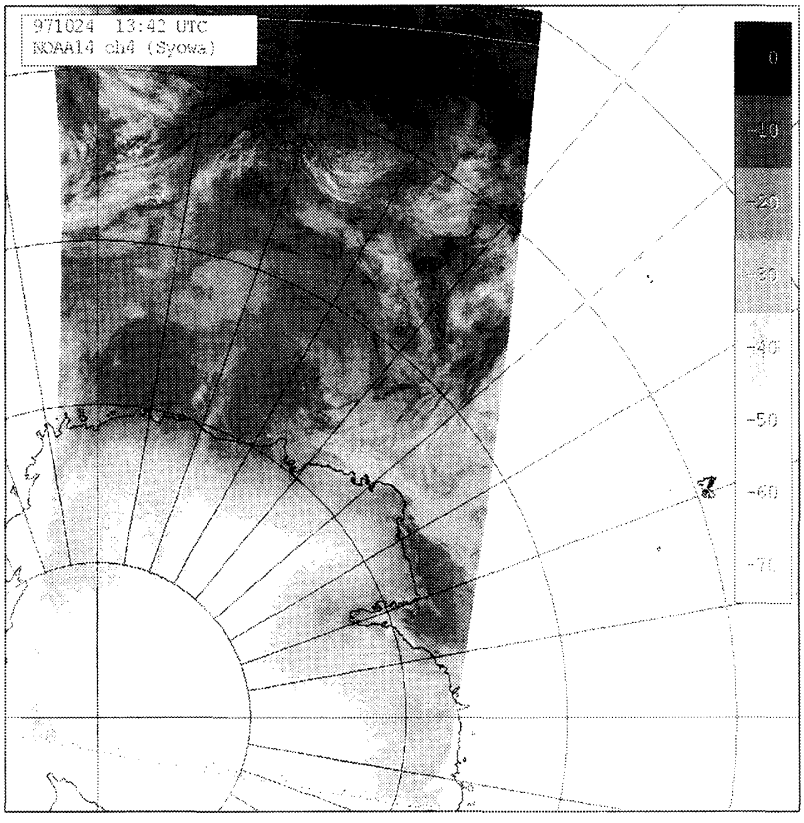
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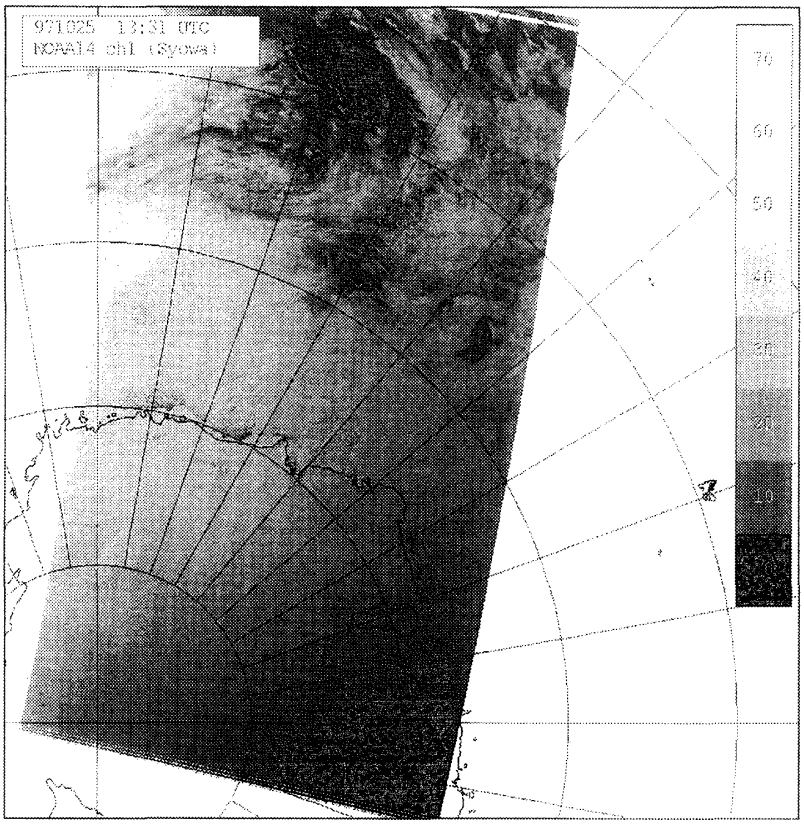
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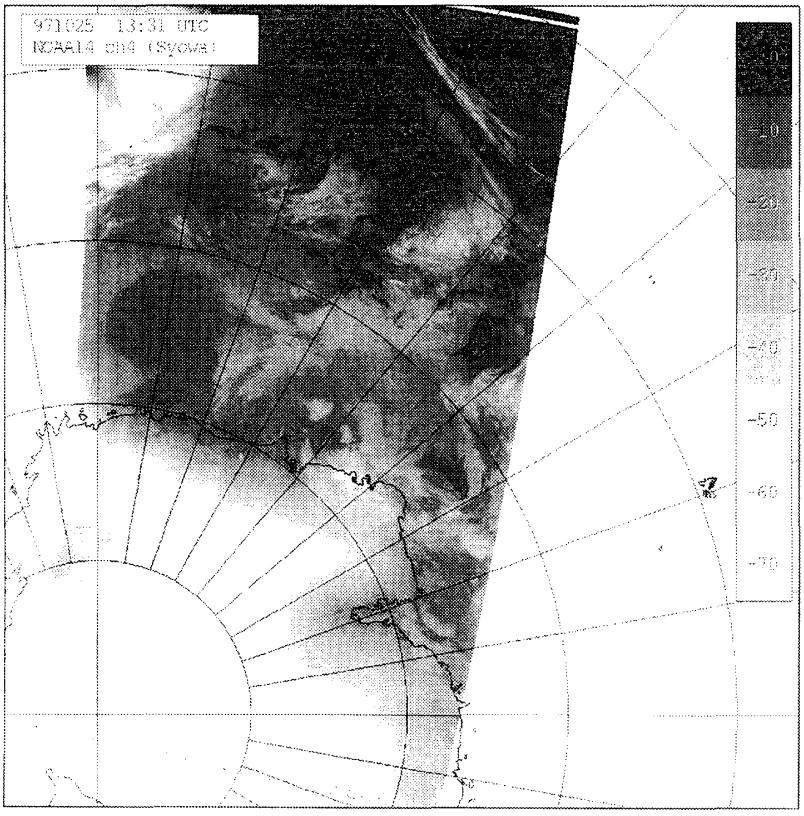
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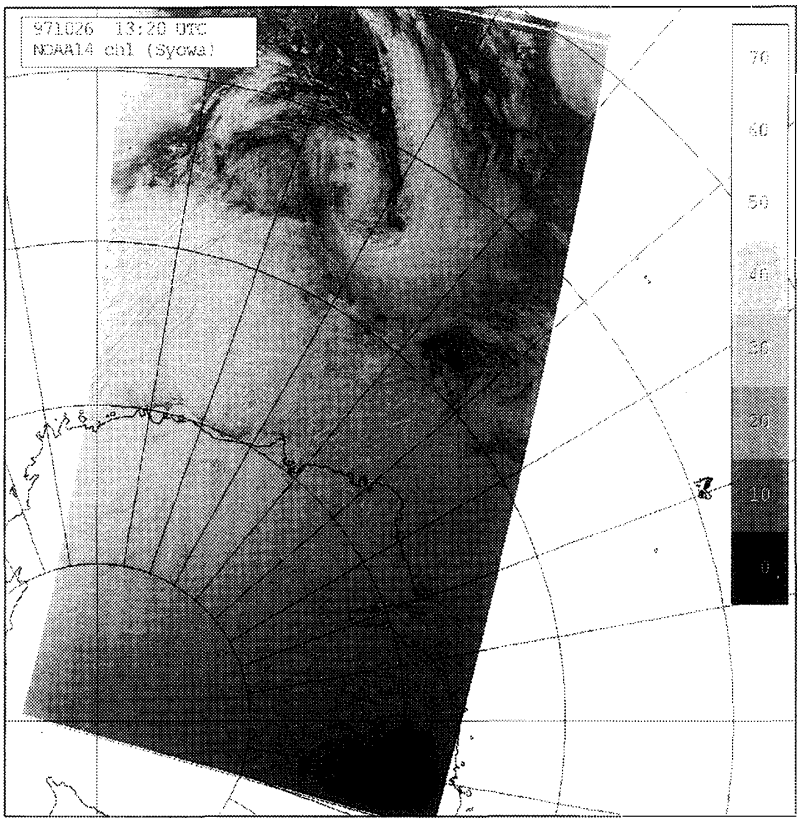
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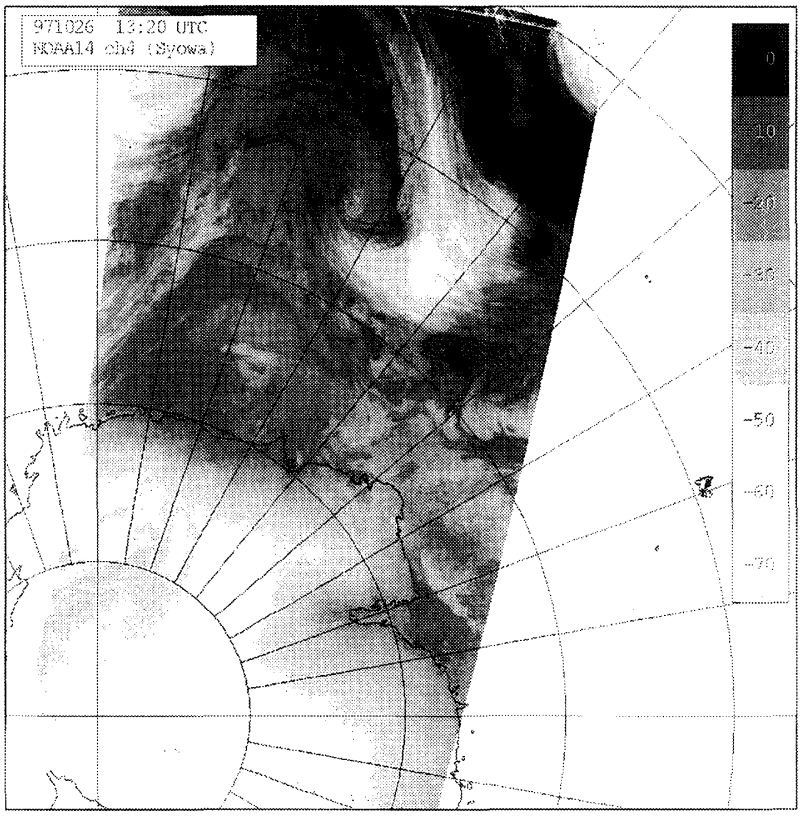
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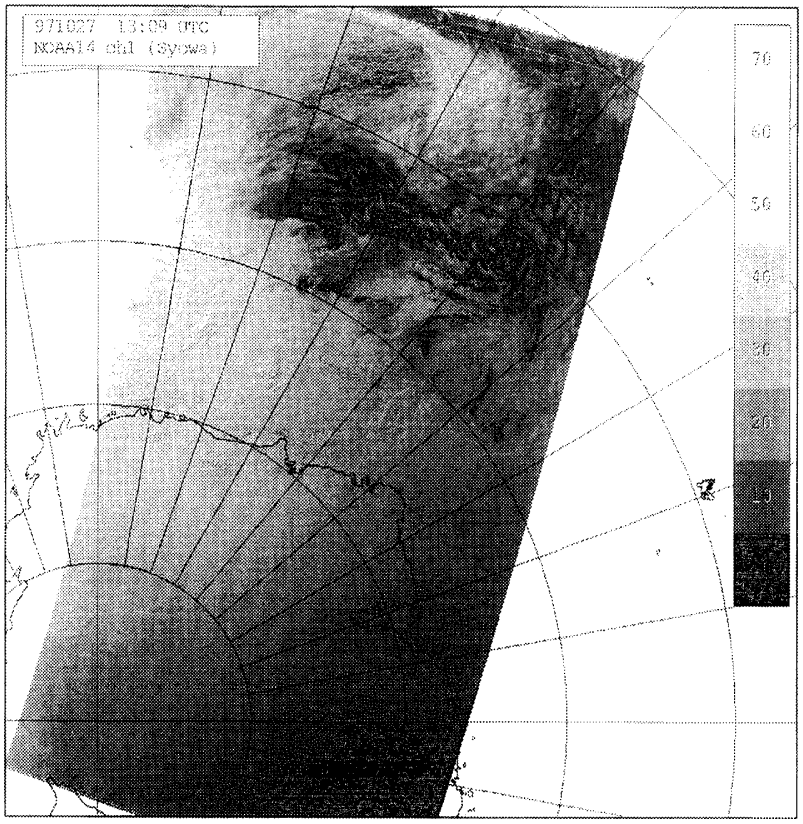
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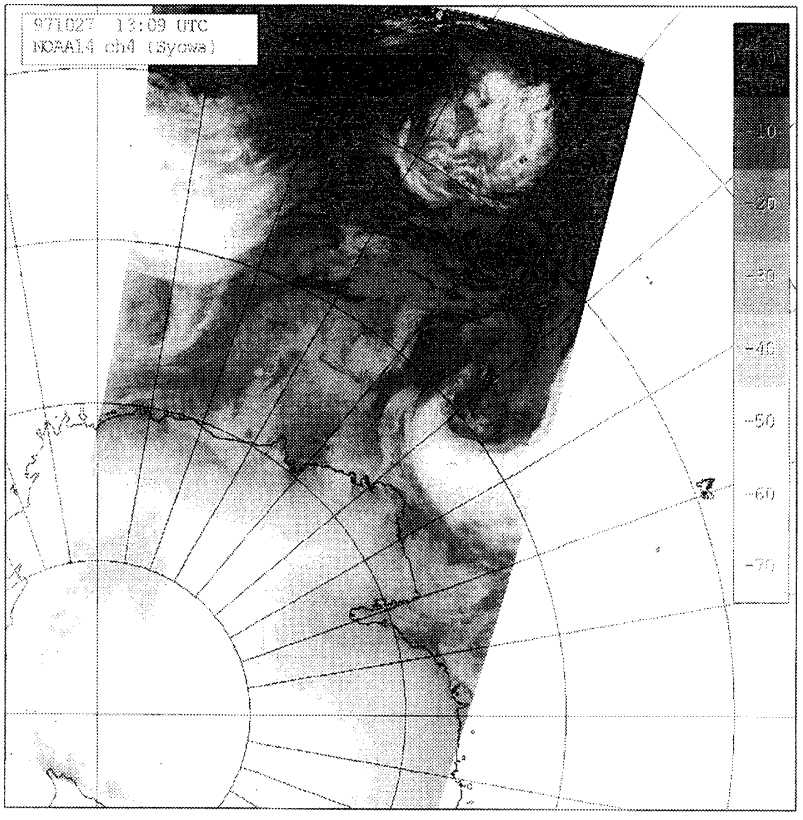
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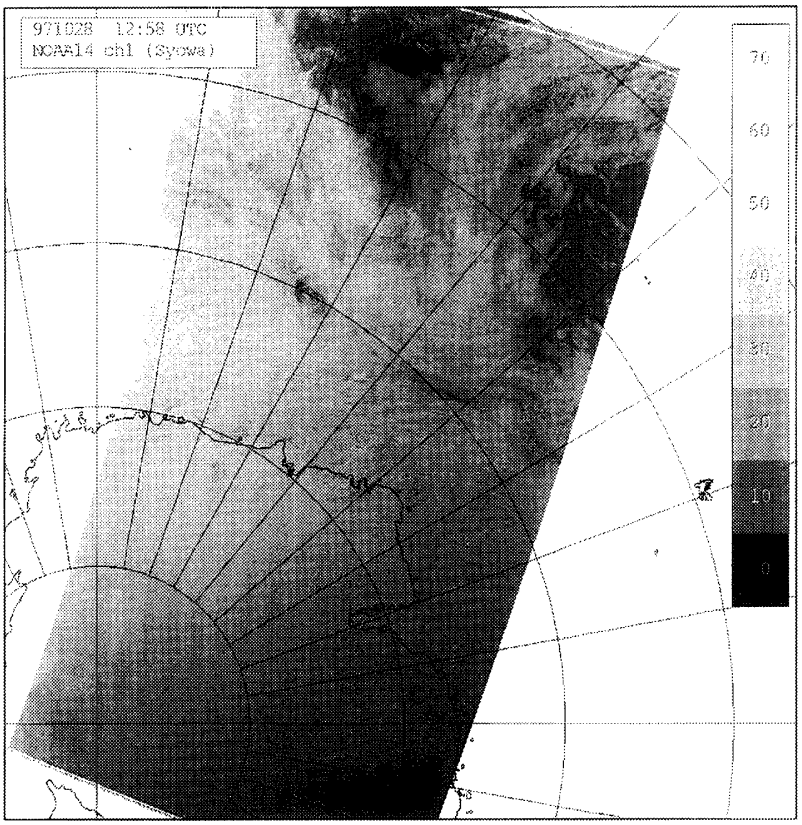
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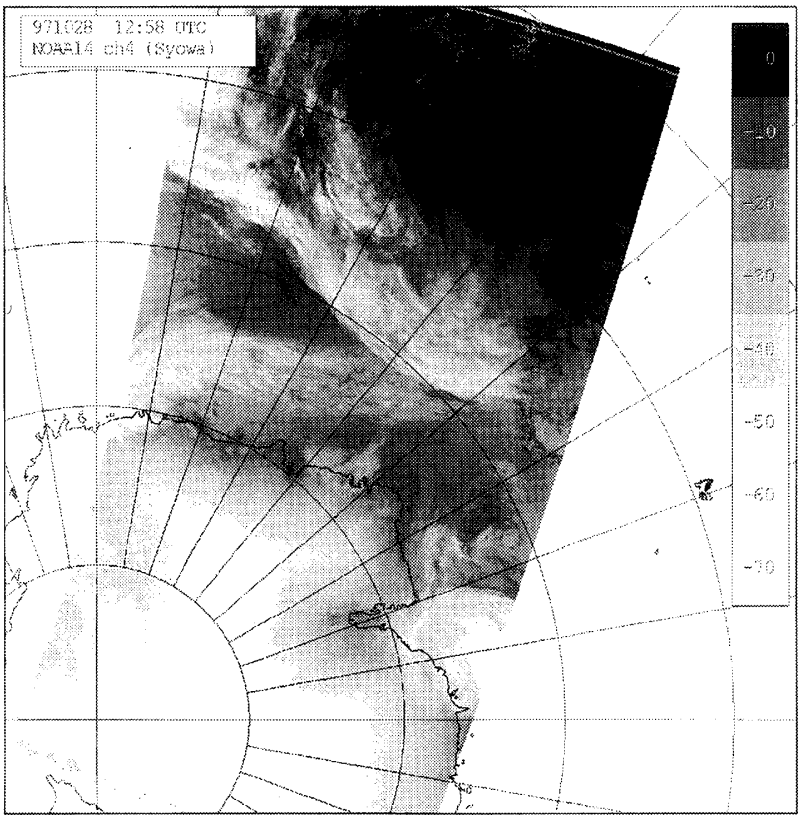
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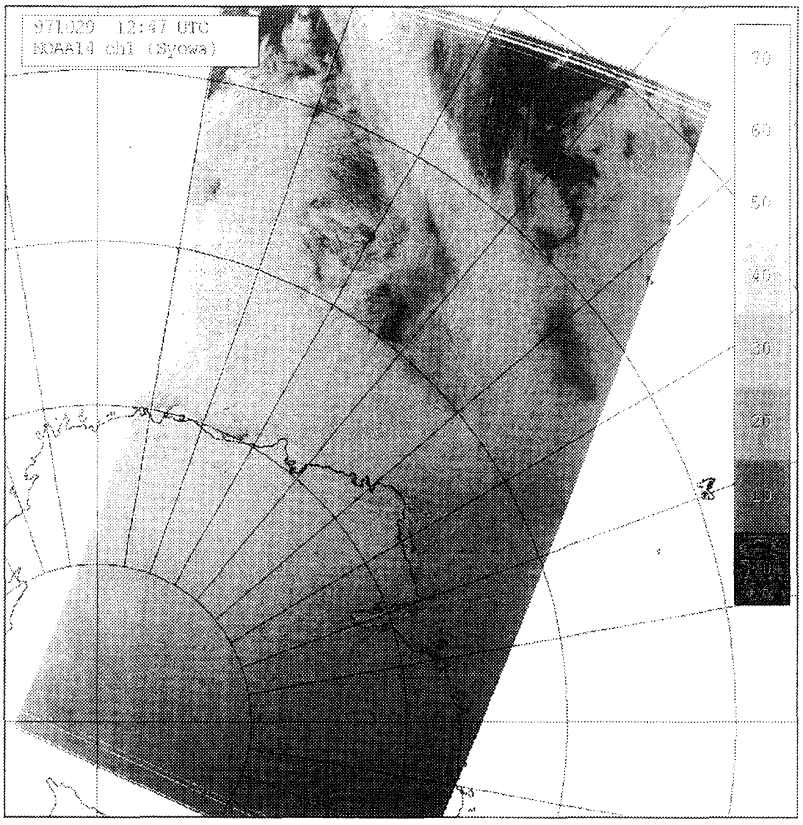
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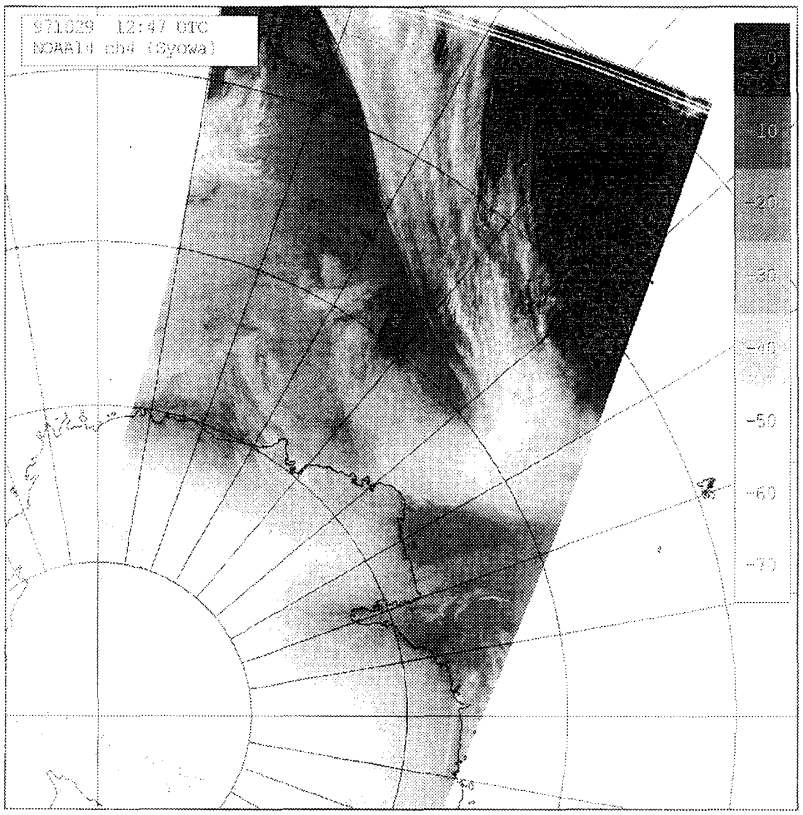
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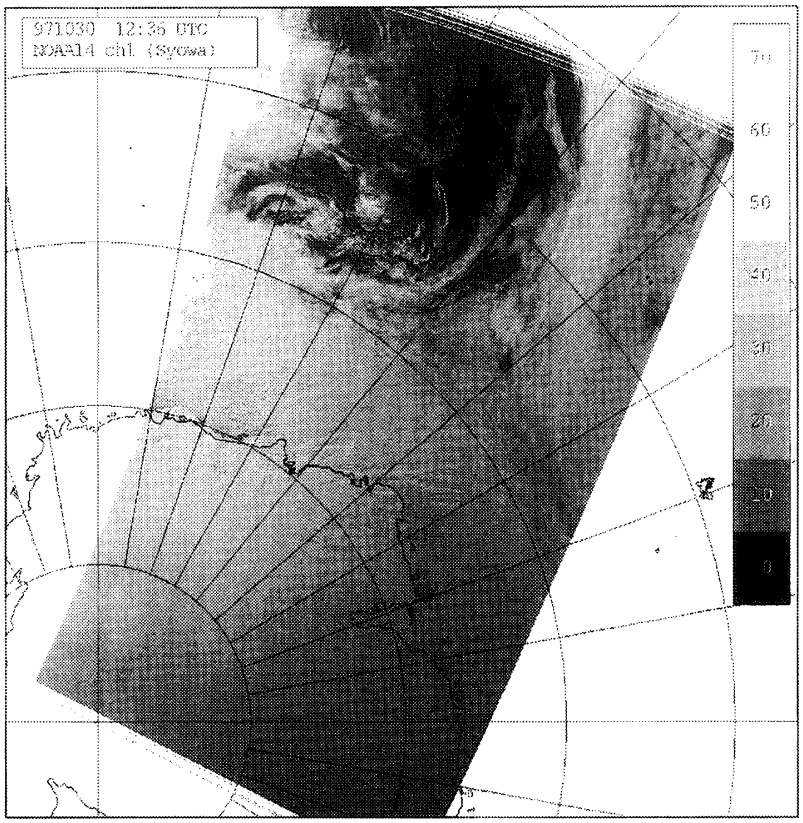
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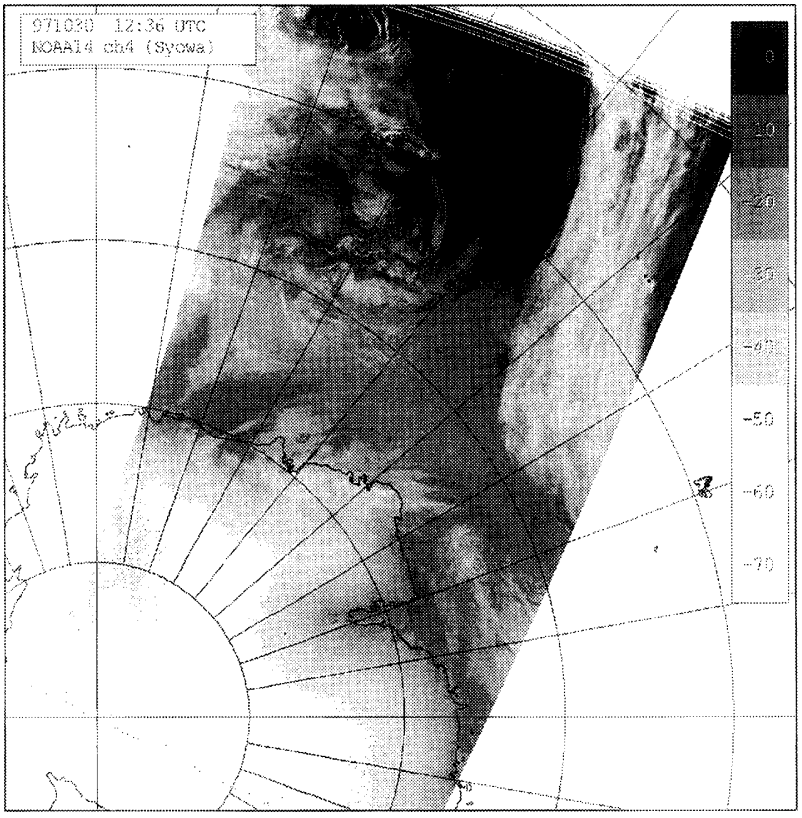
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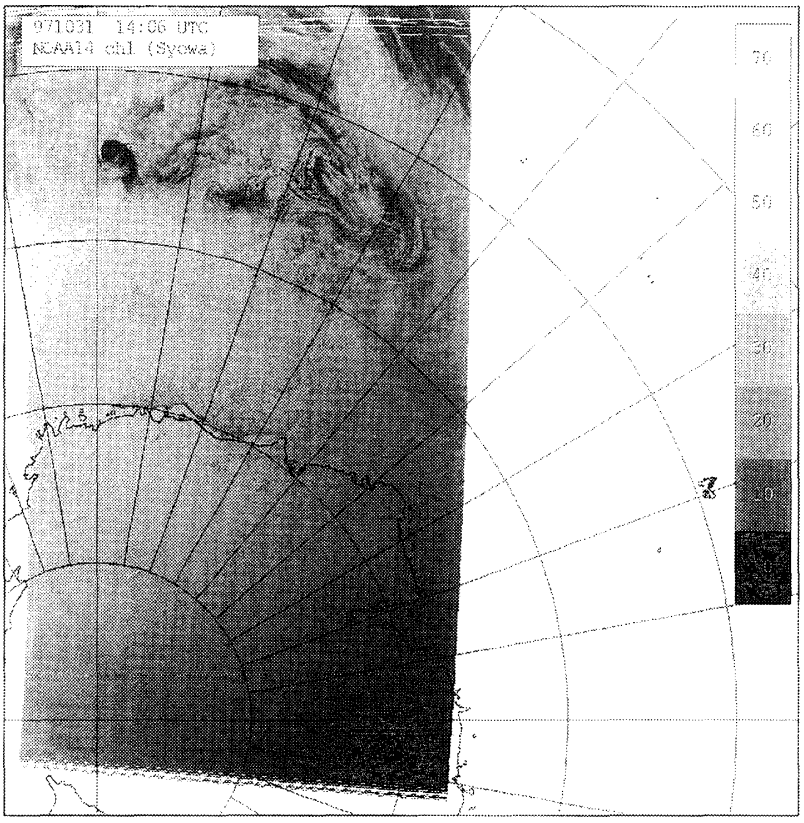
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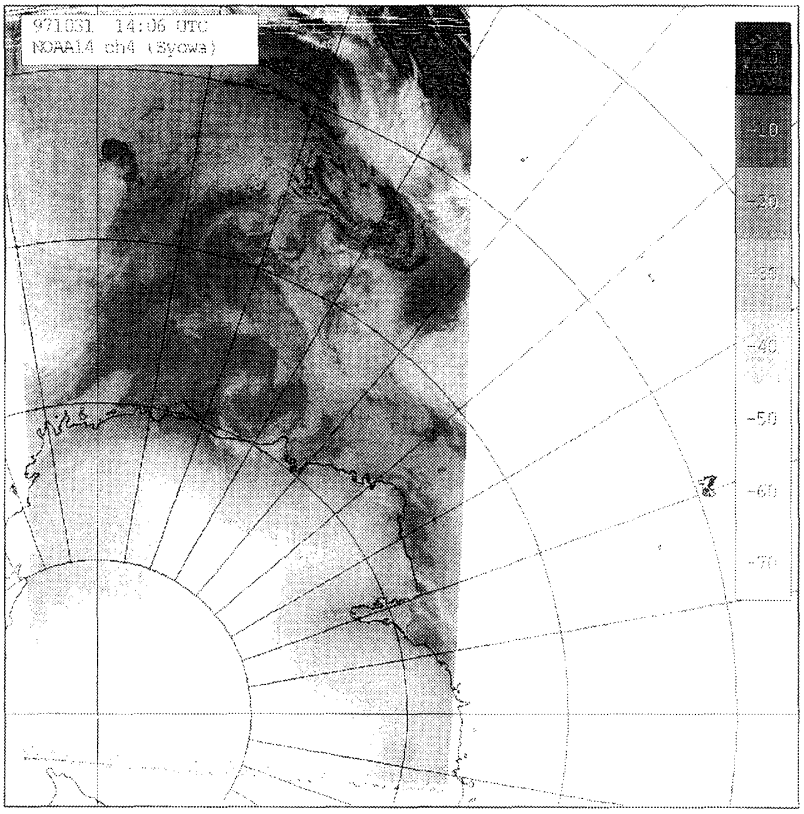
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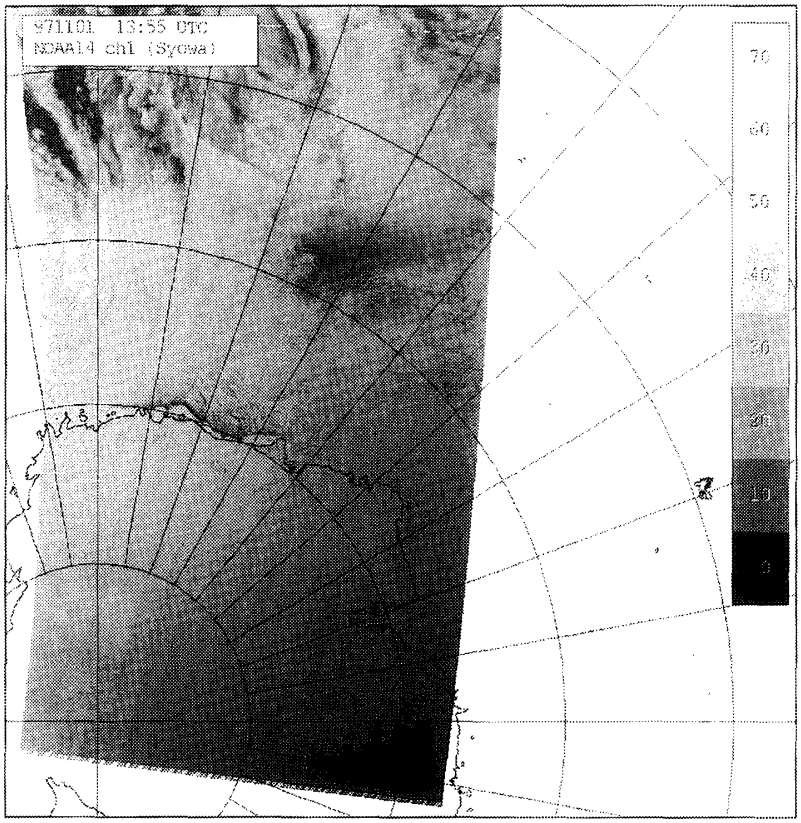
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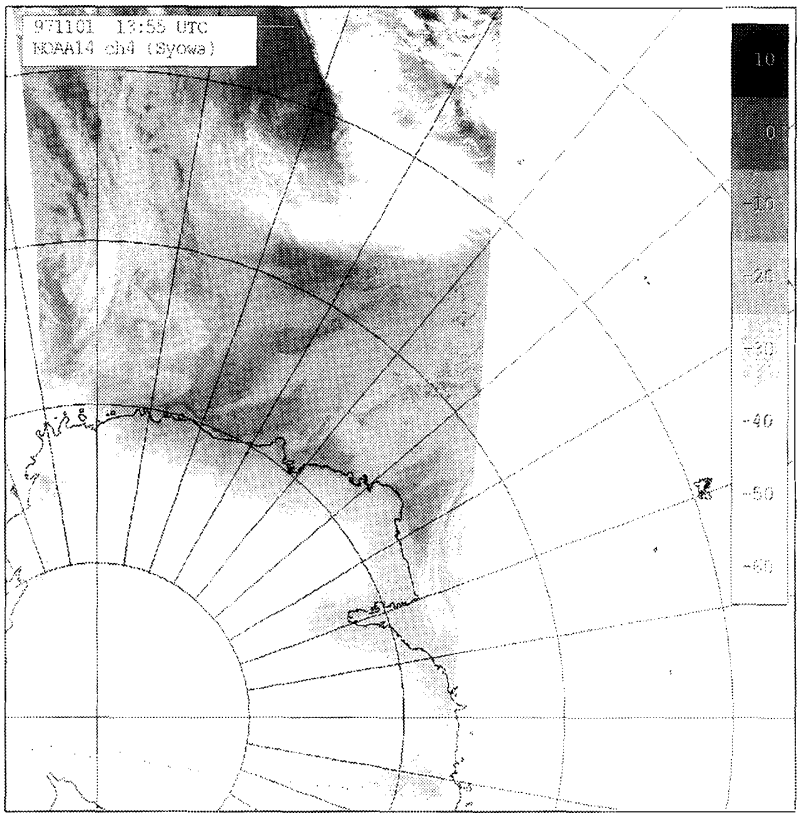
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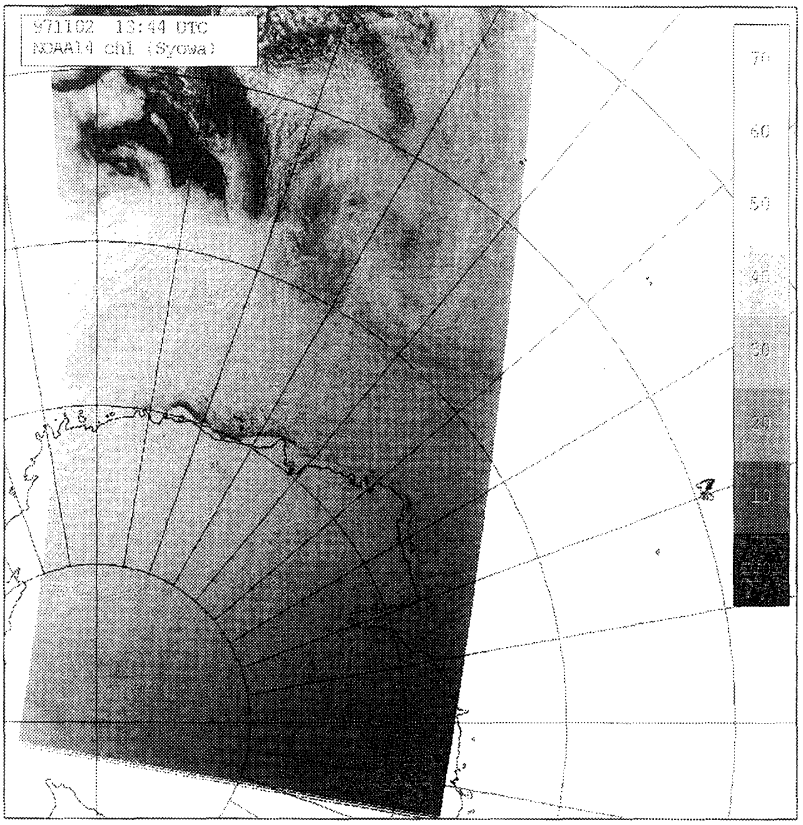
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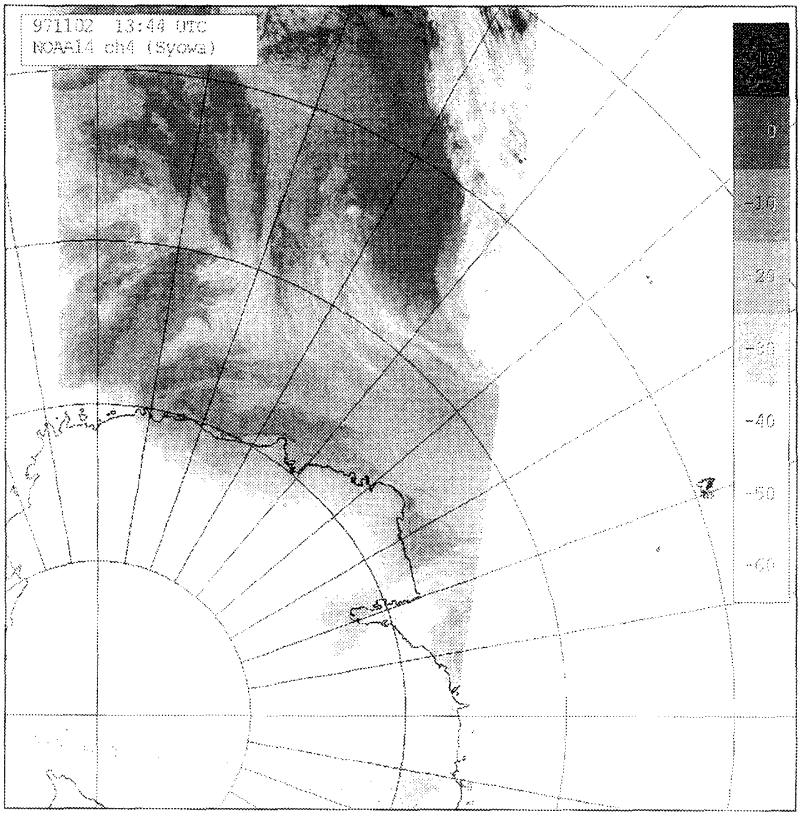
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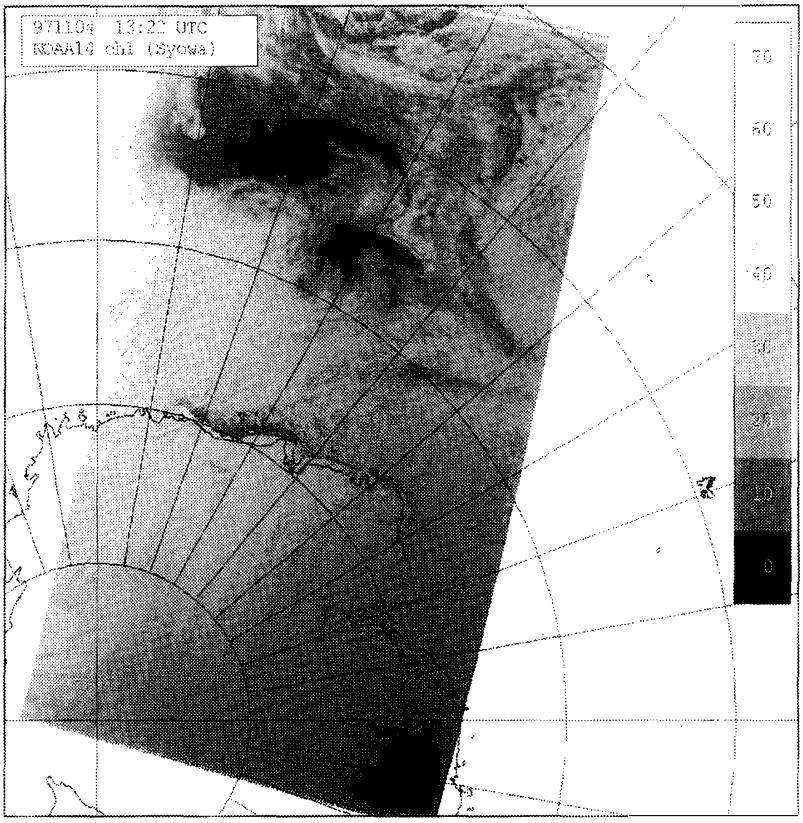
971104 13:22 UTC
NOAA14 ch1 (Syowa)
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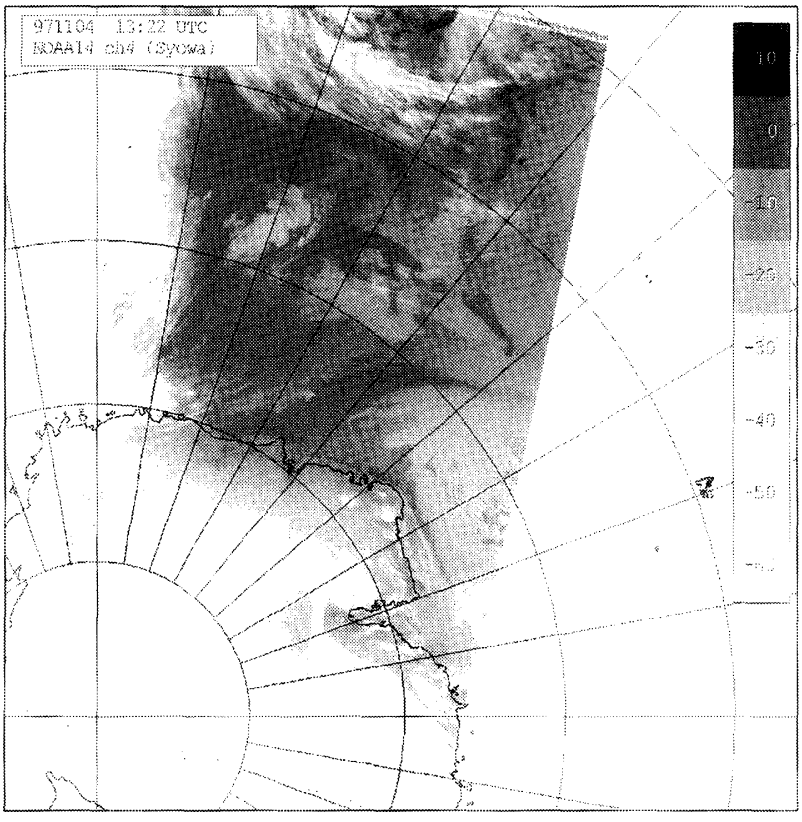
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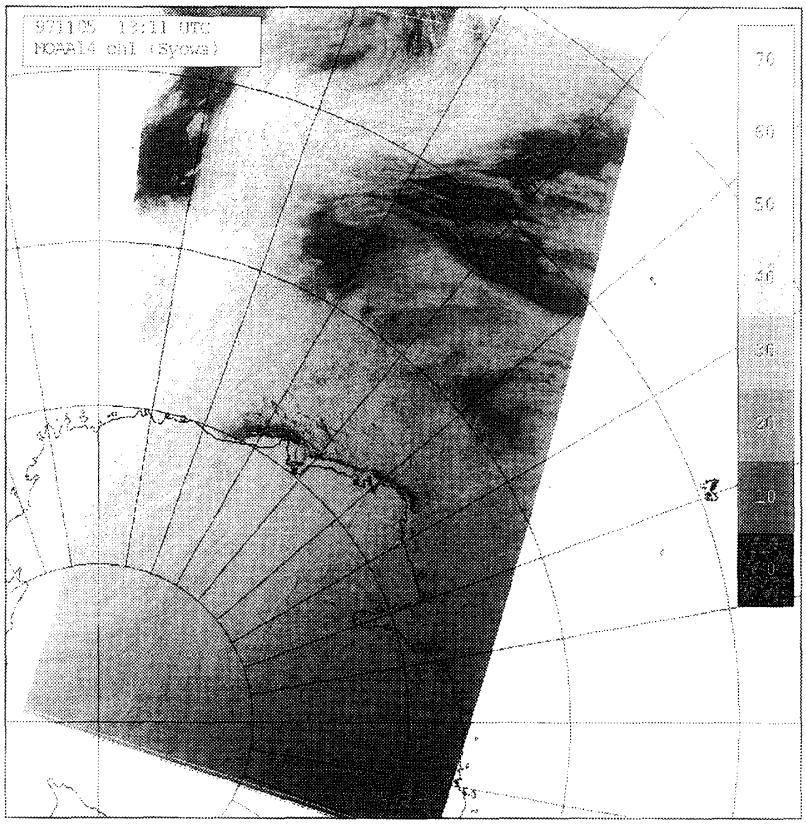
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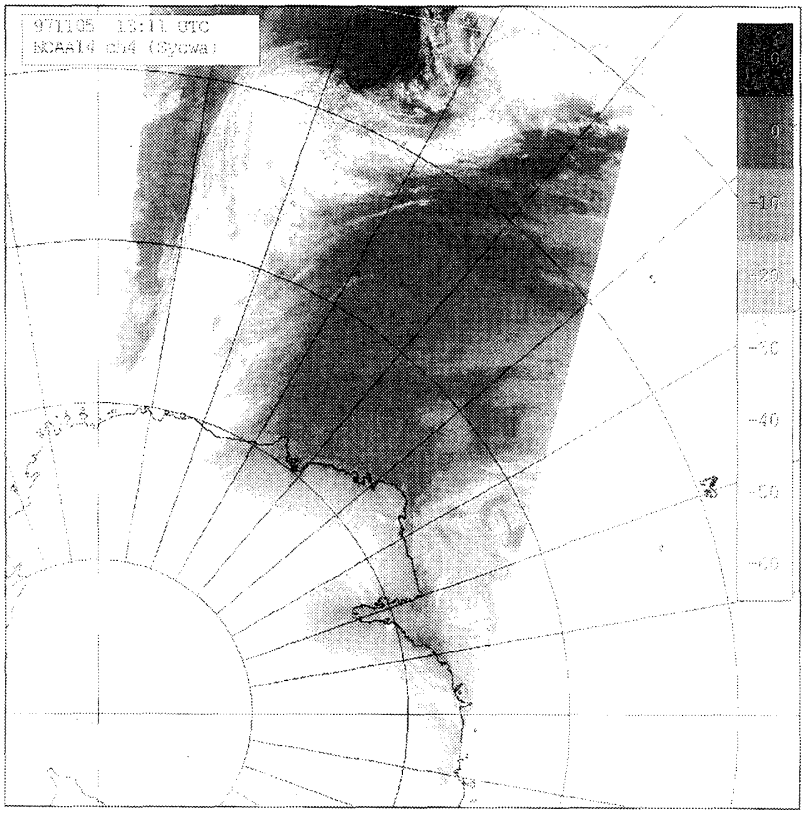
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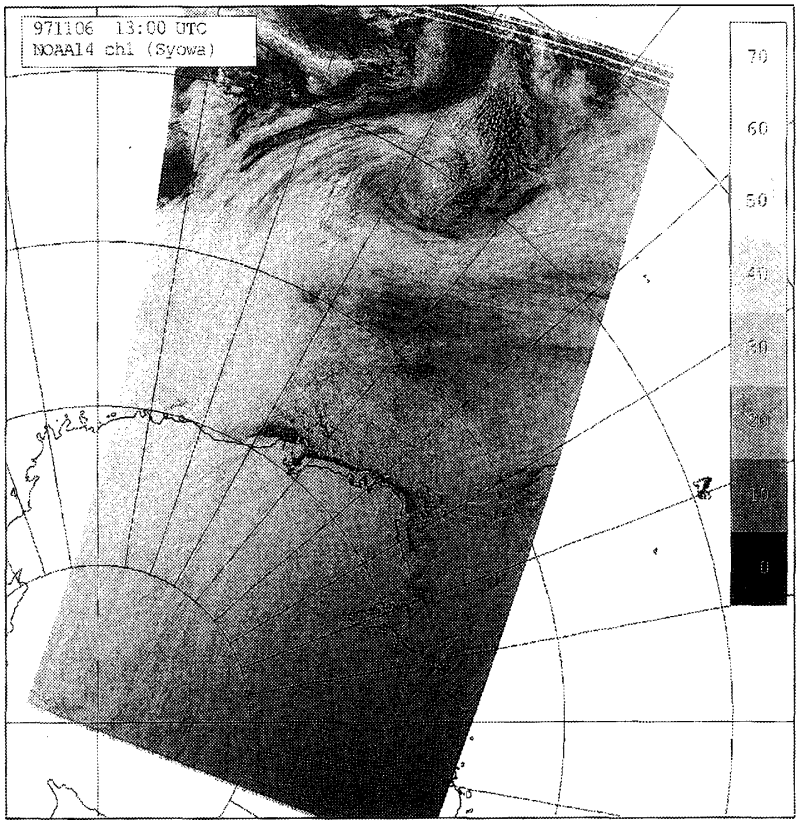
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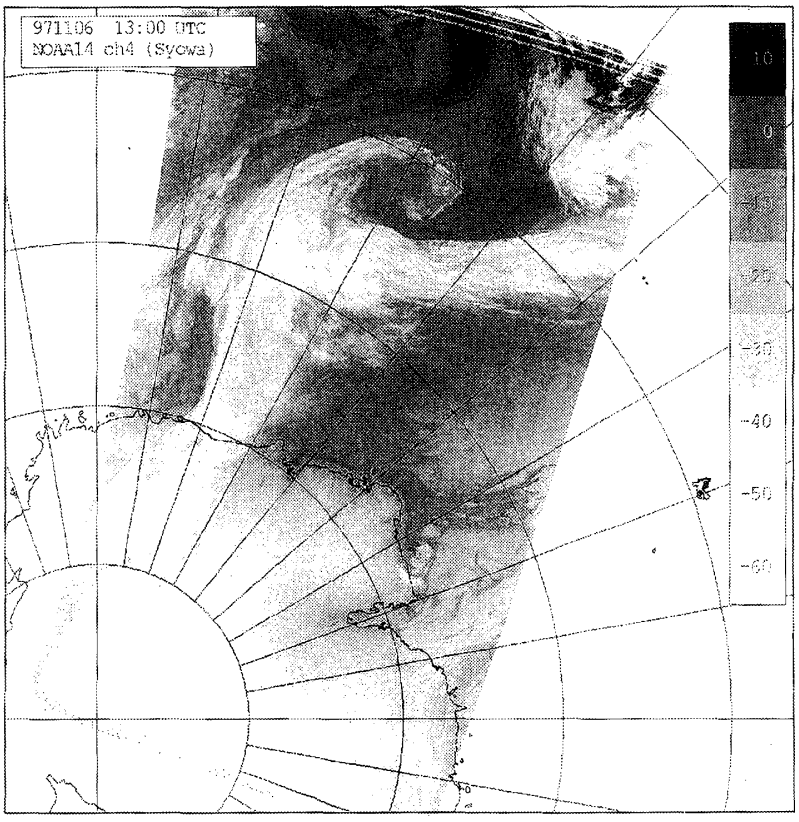
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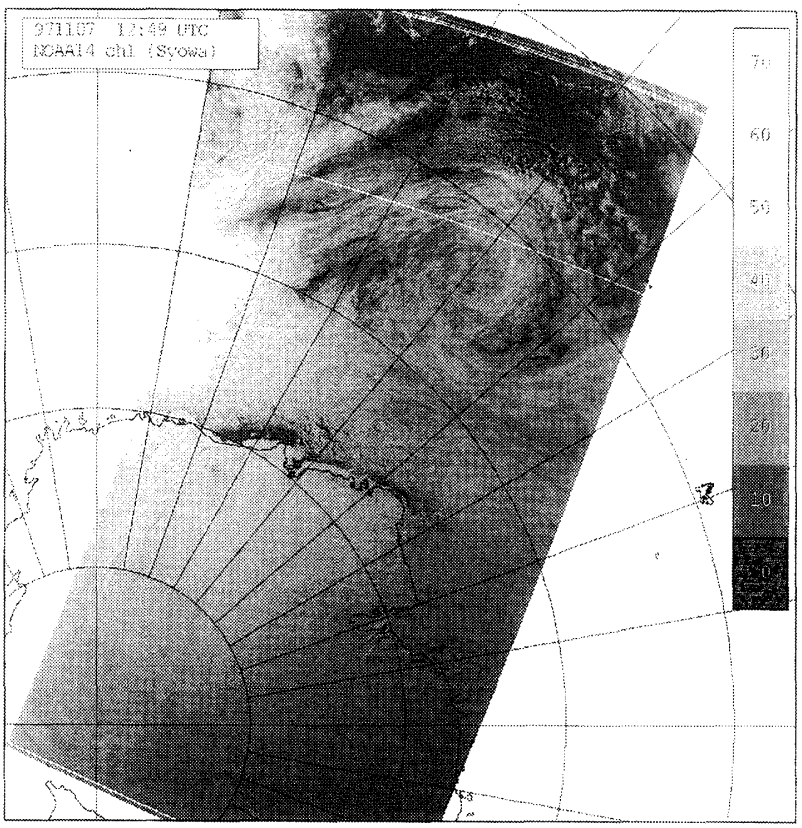
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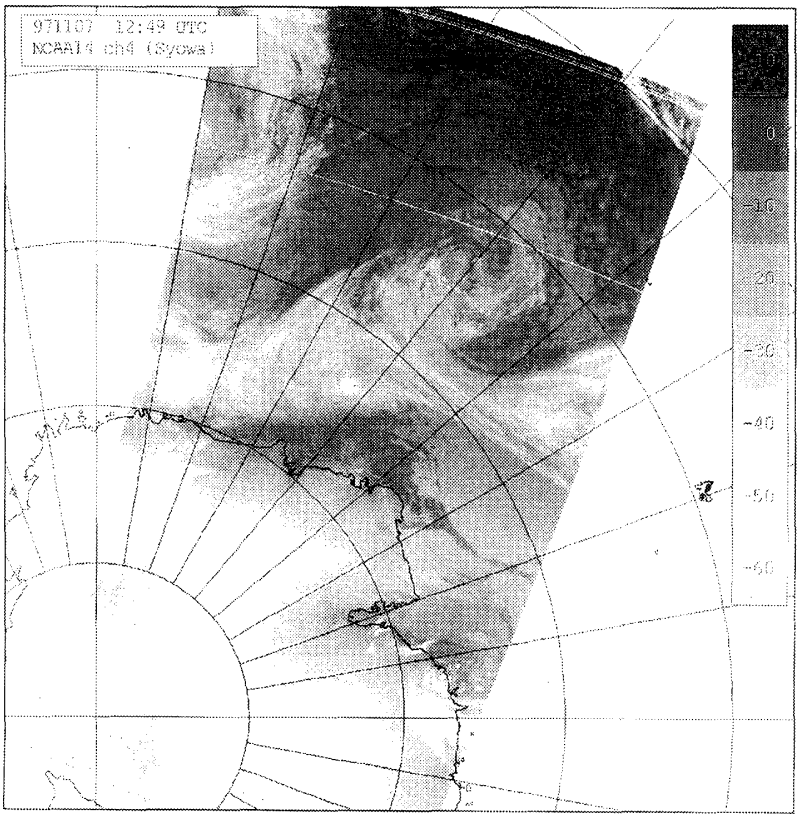
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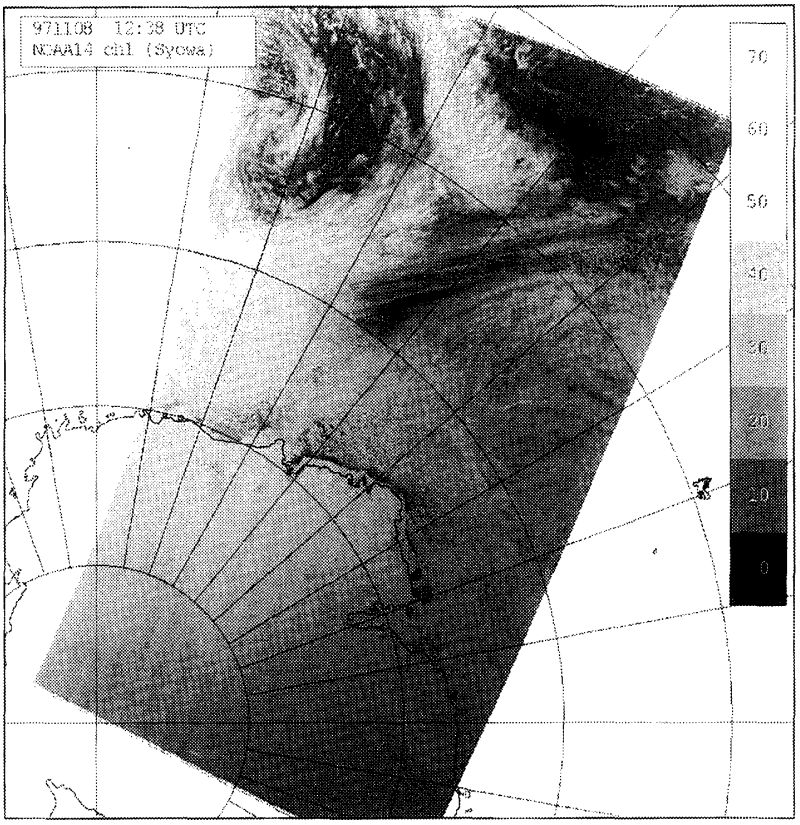
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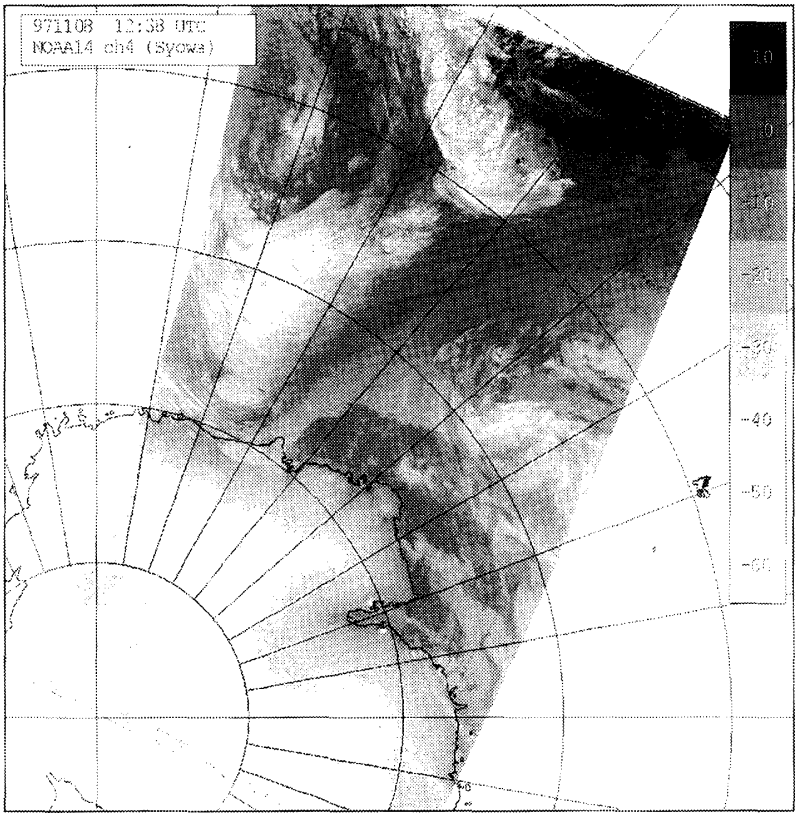
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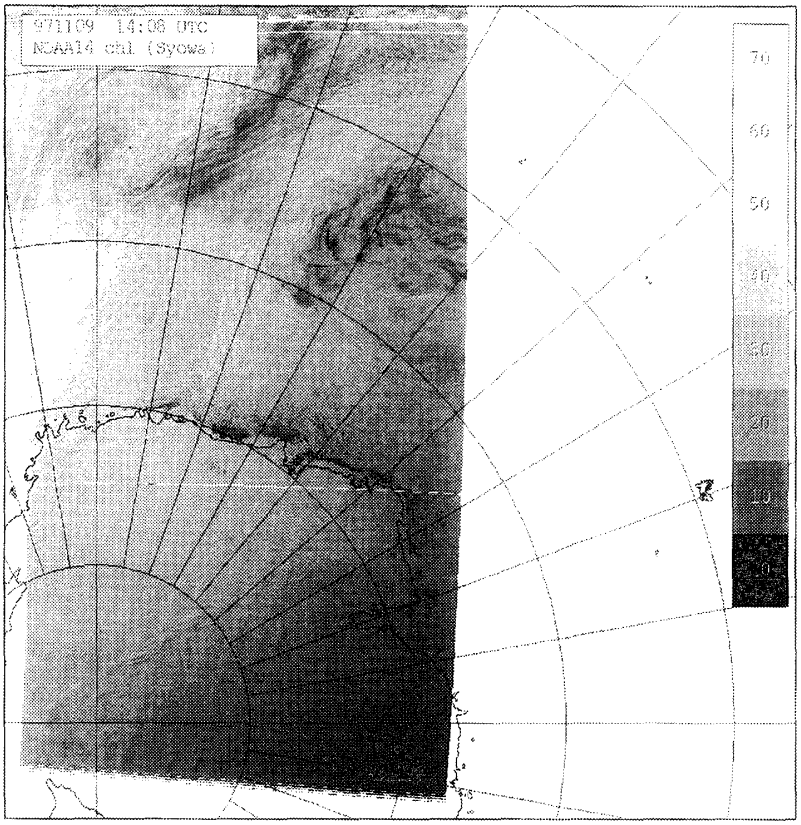
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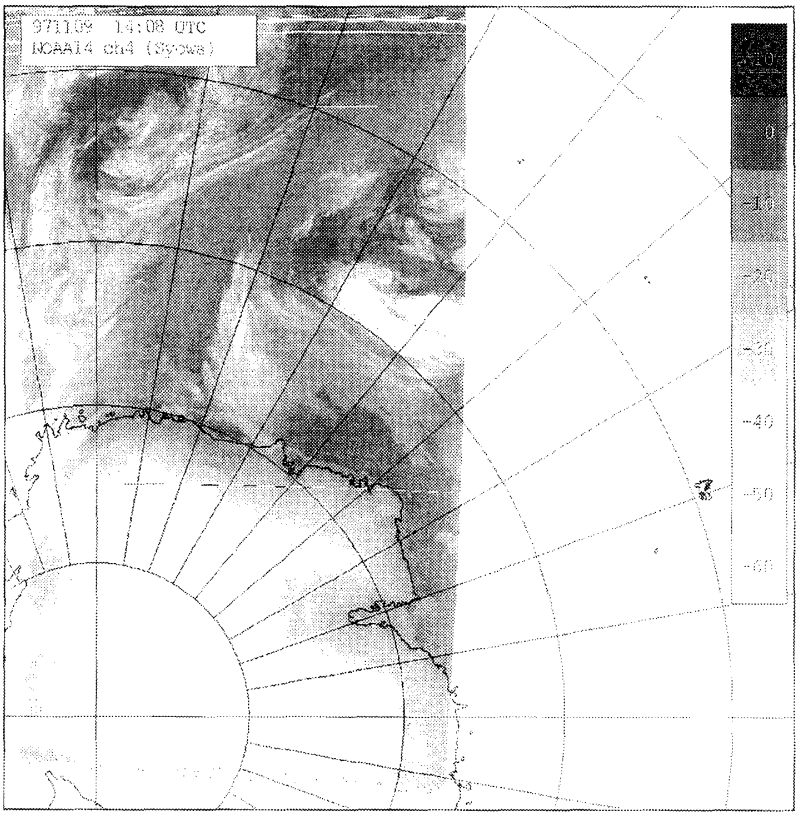
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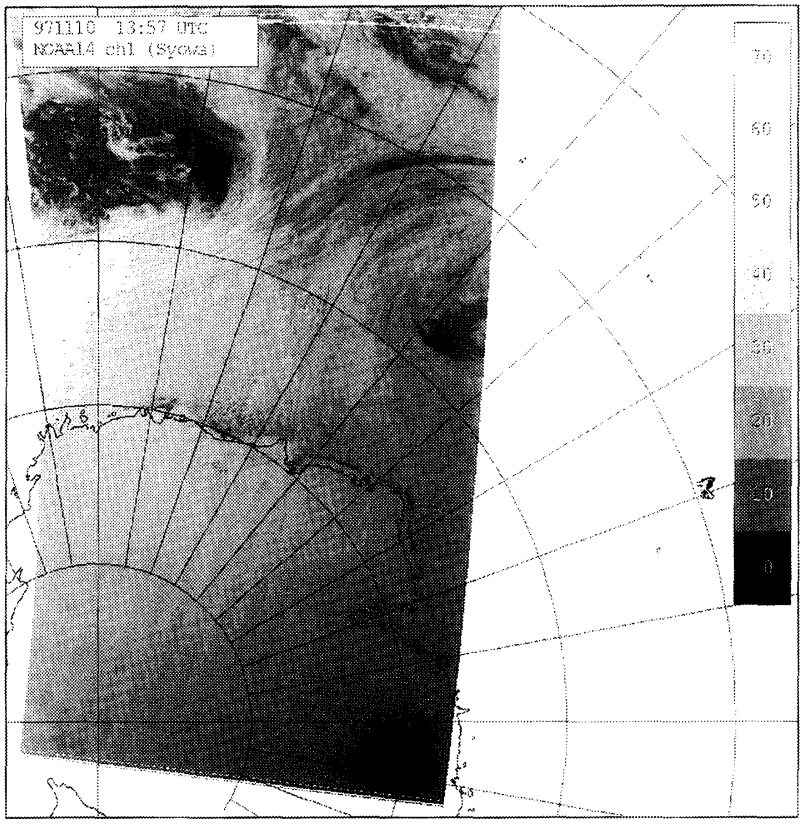
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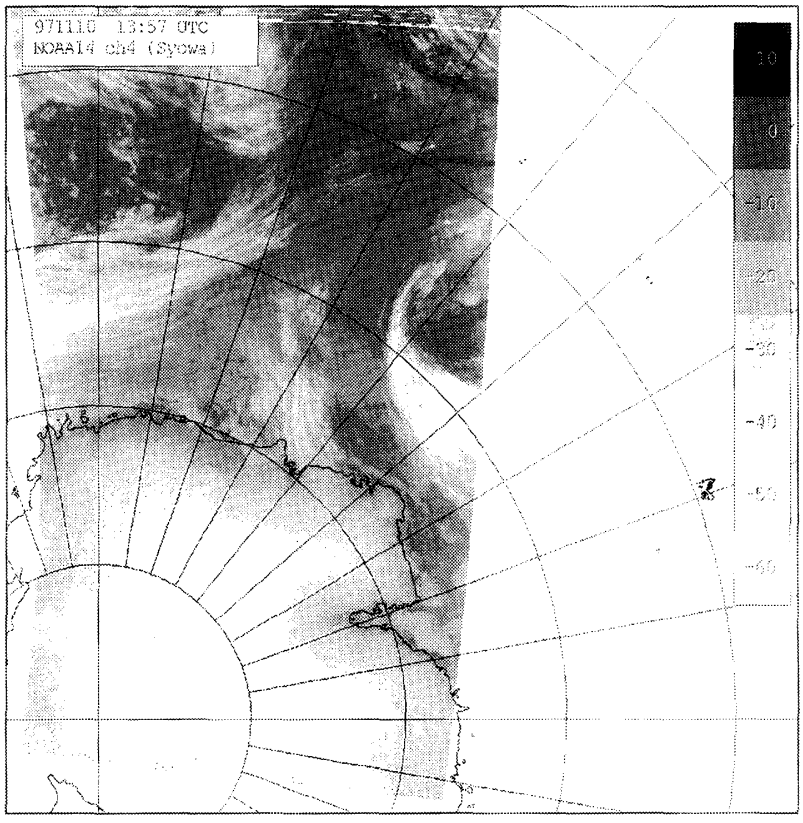
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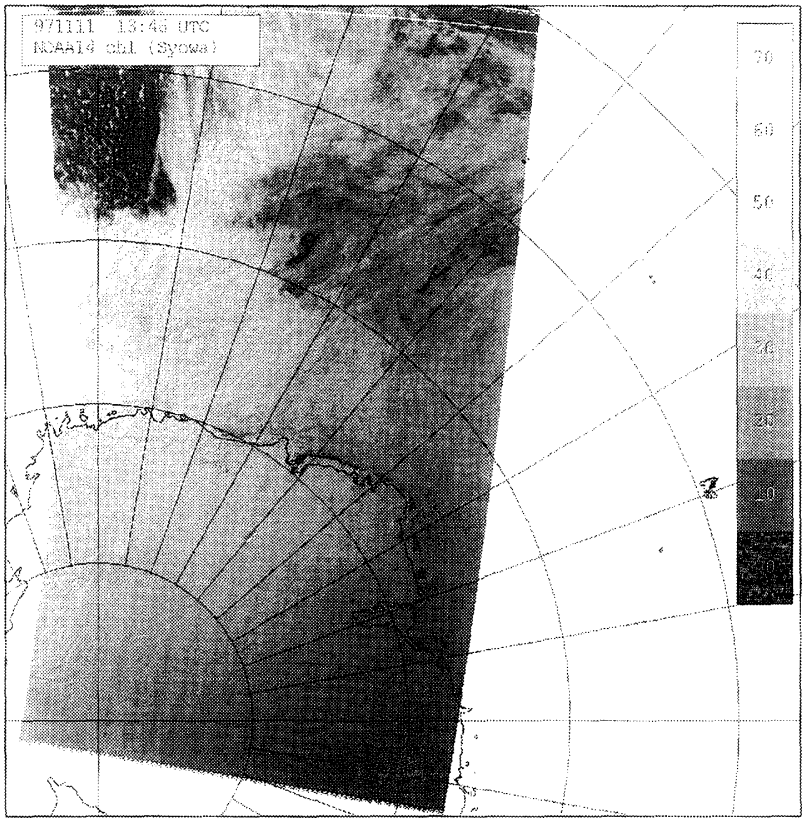
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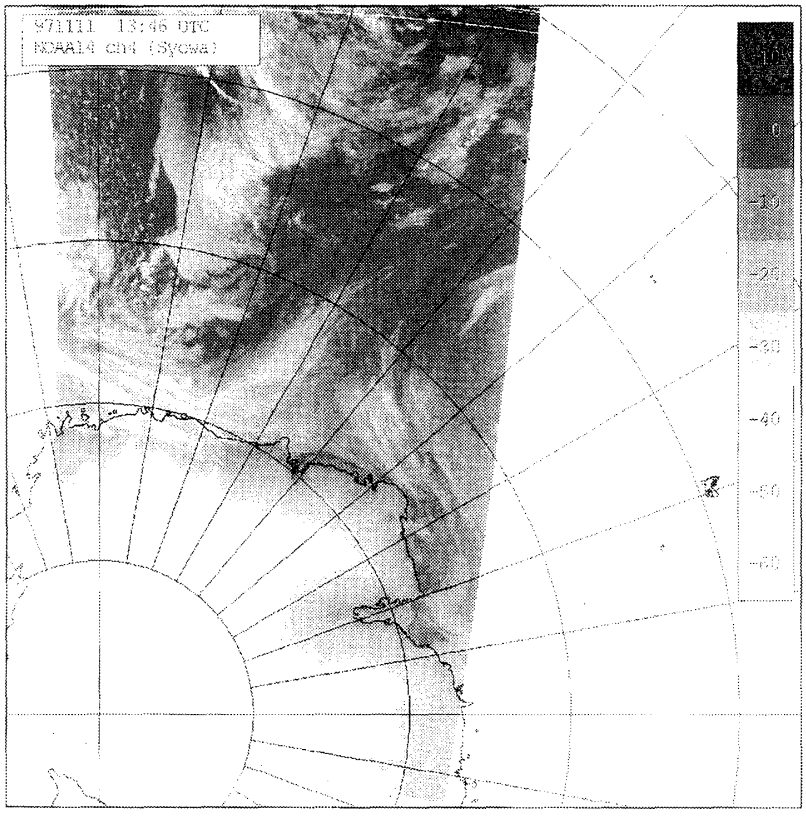
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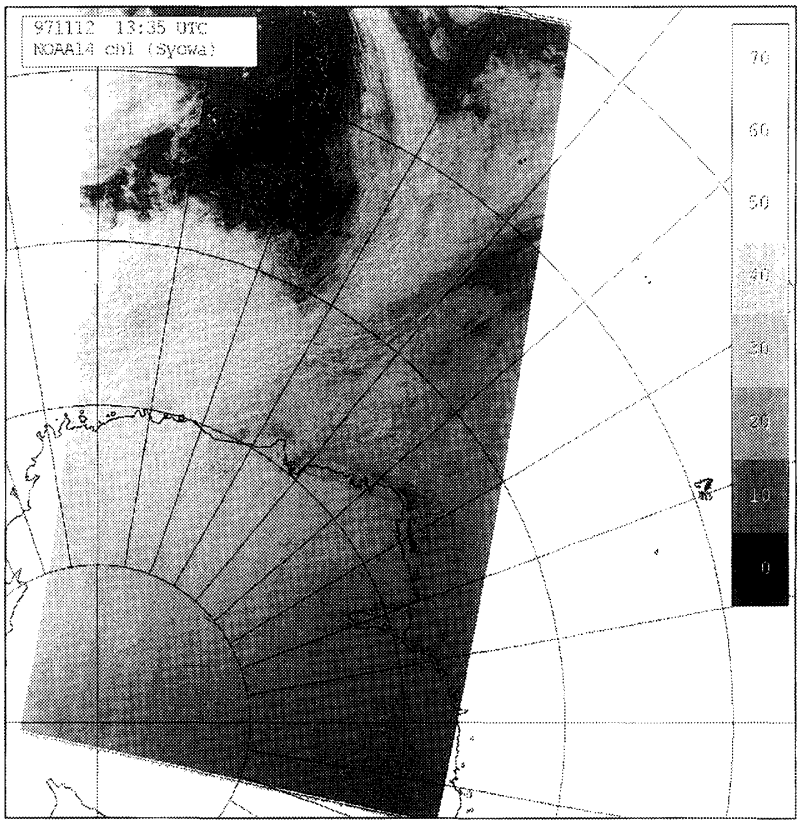
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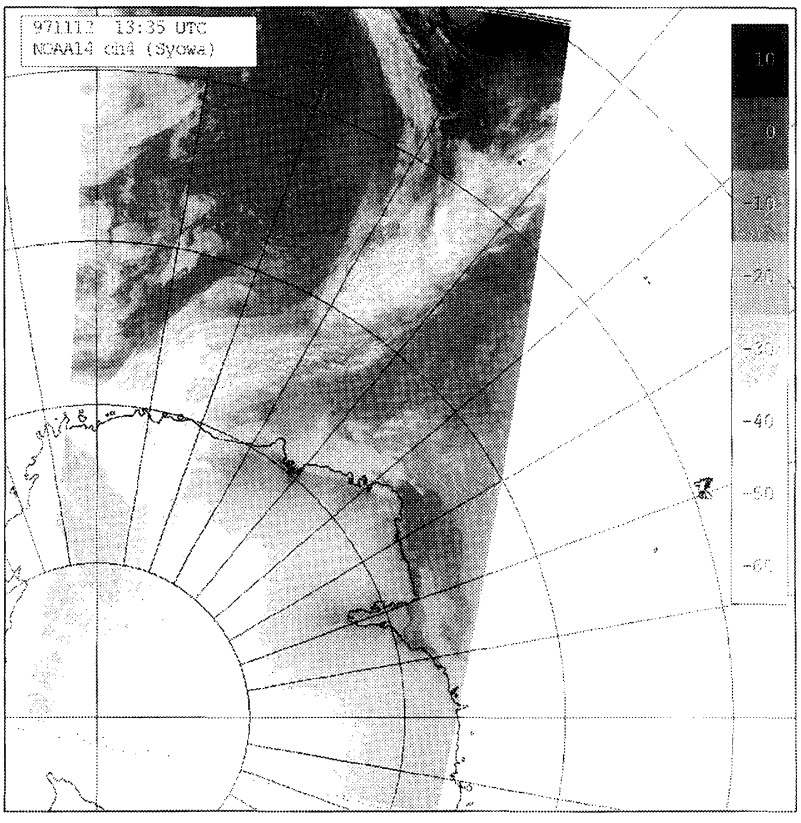
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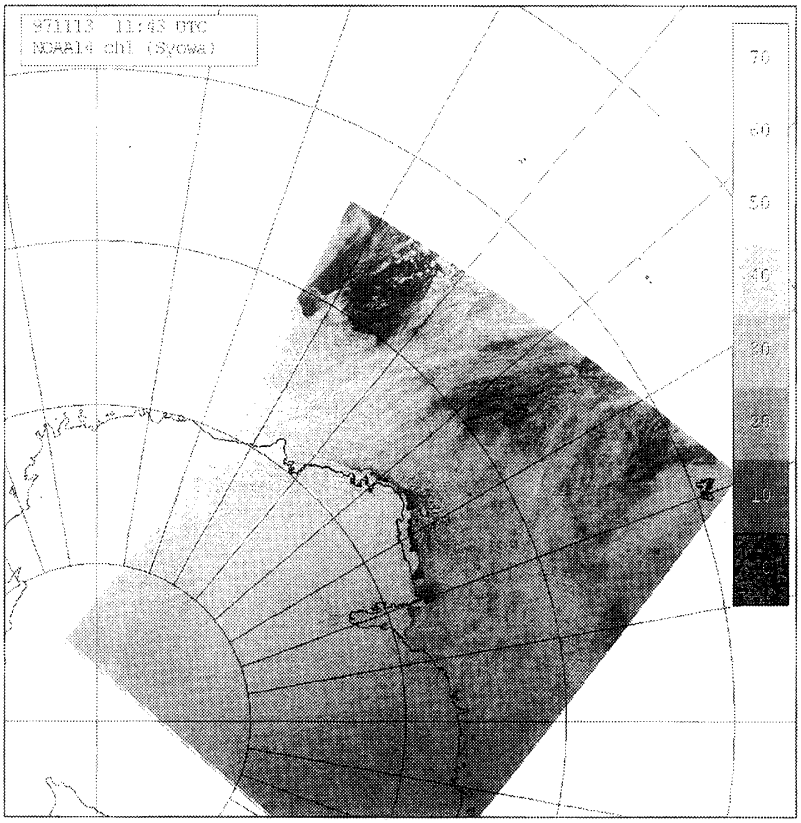
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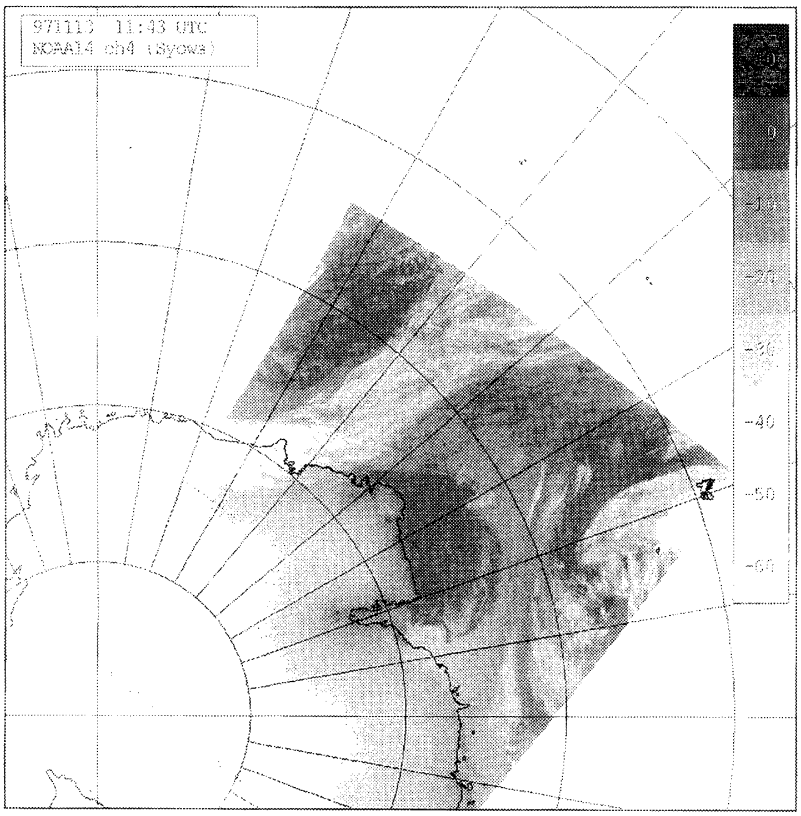
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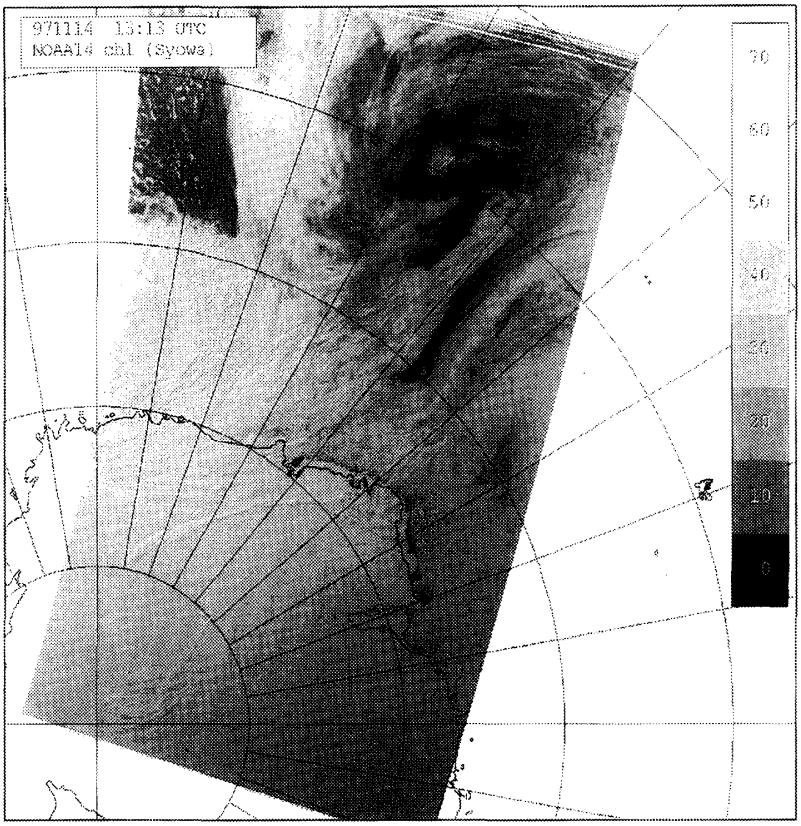
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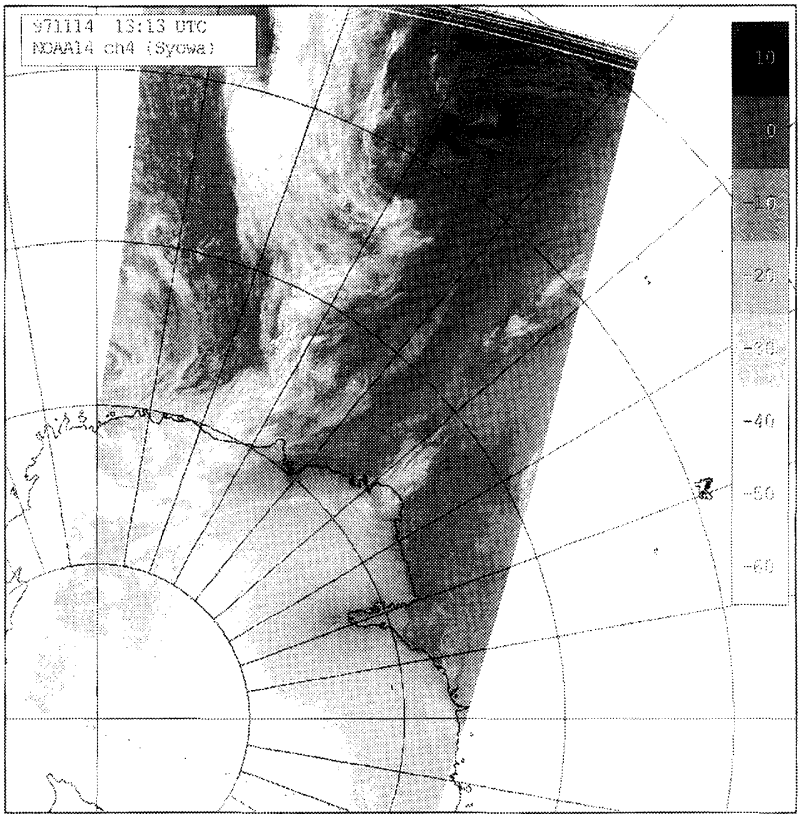
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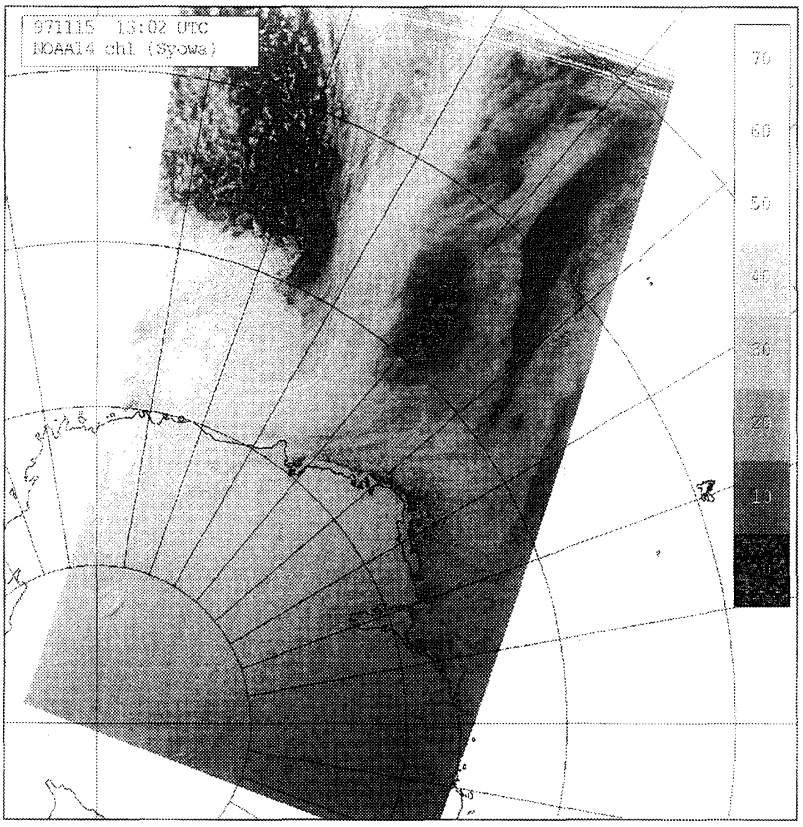
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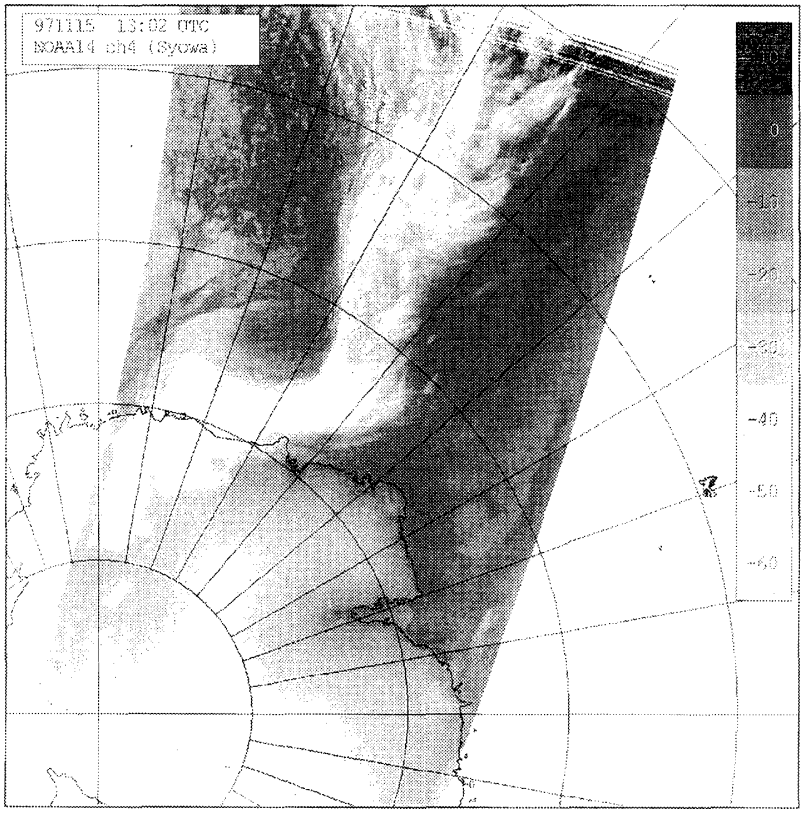
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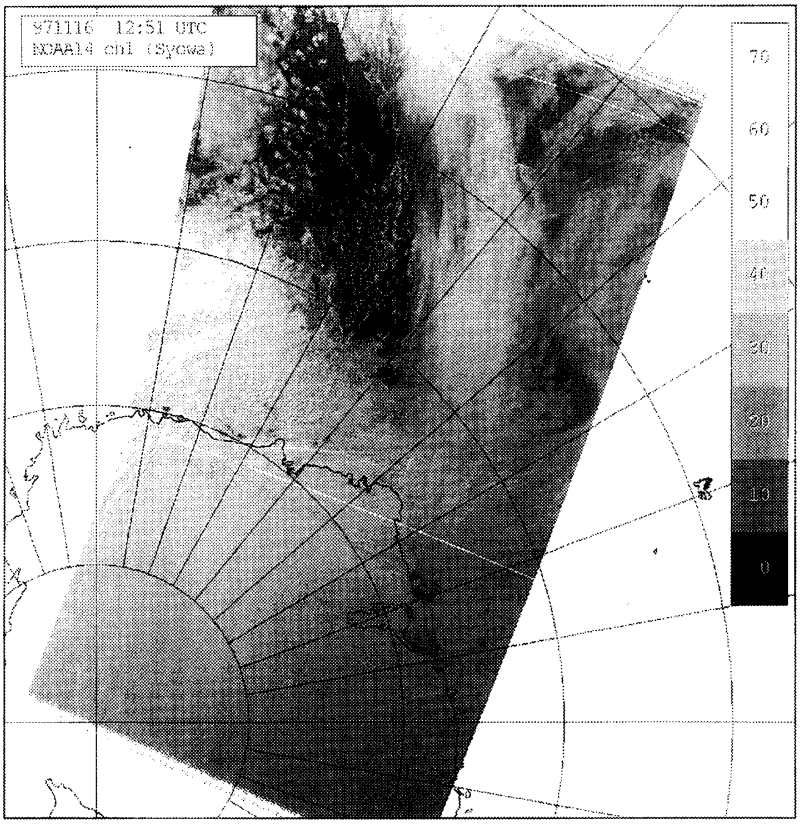
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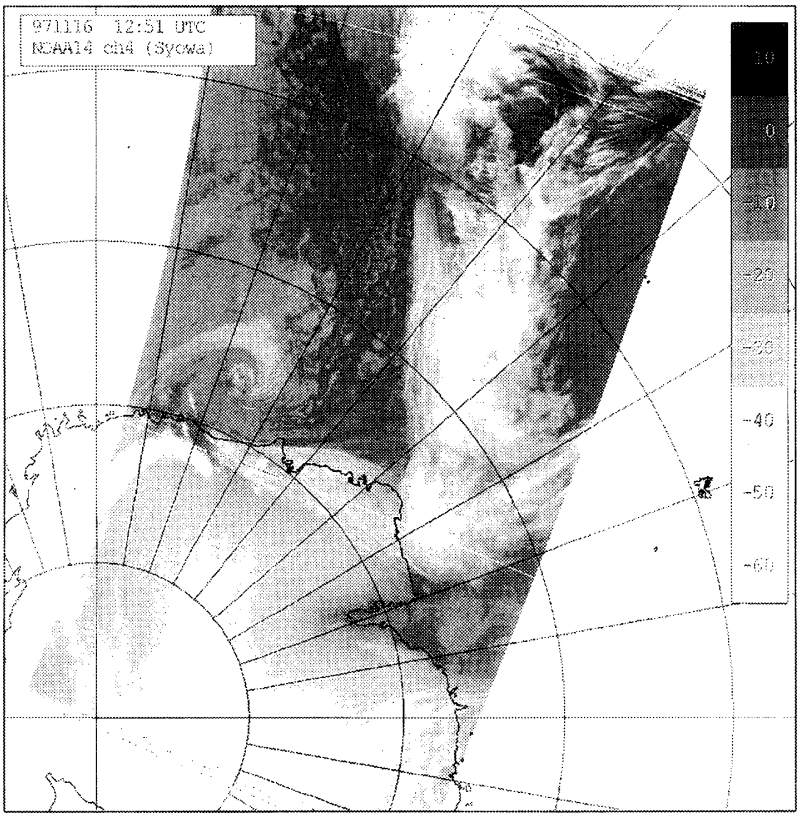
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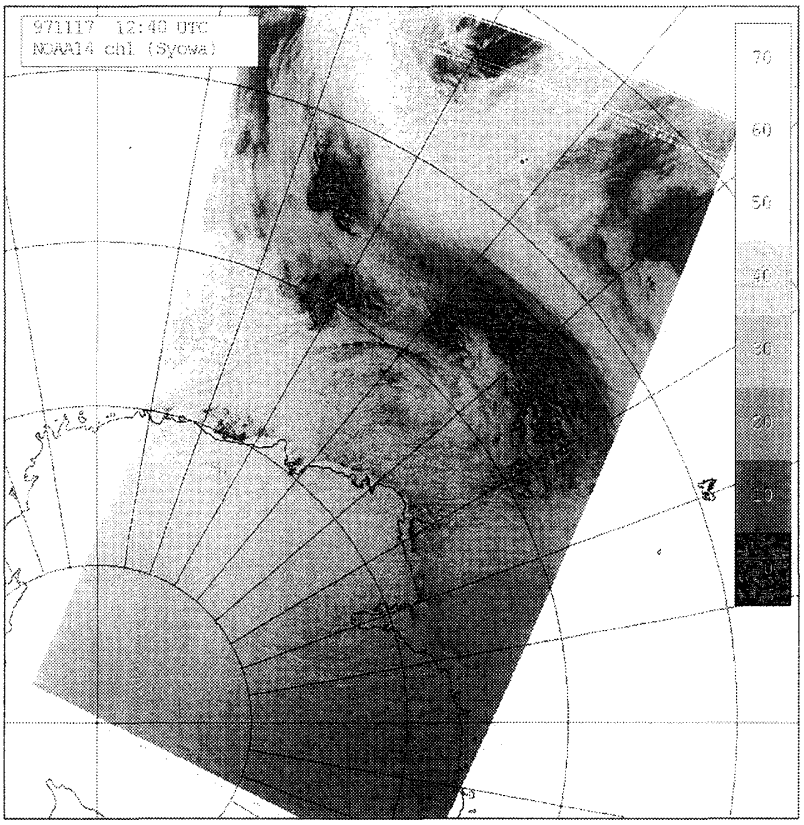
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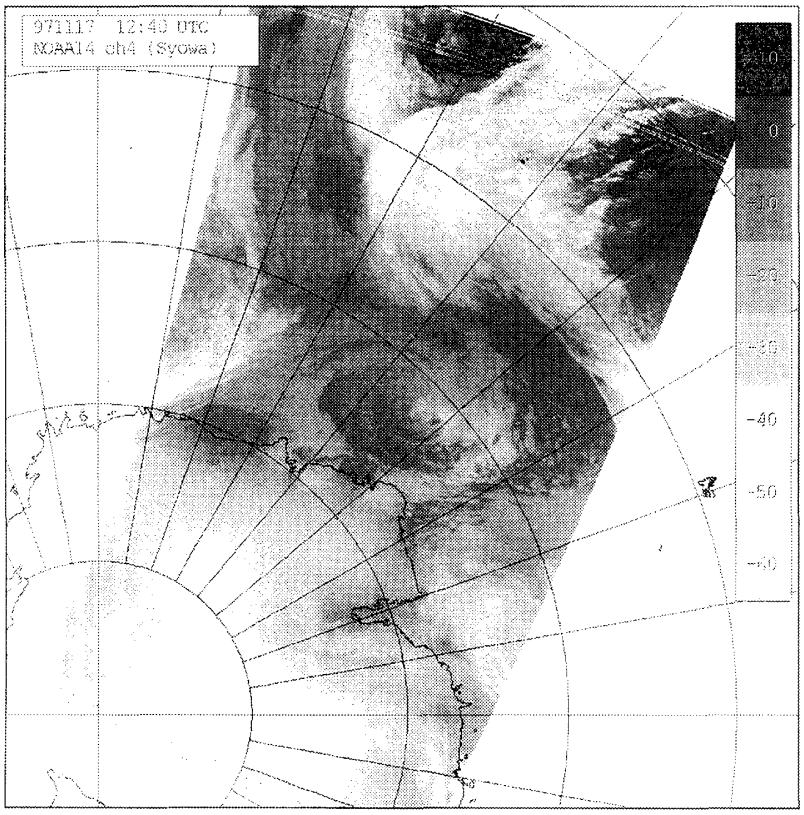
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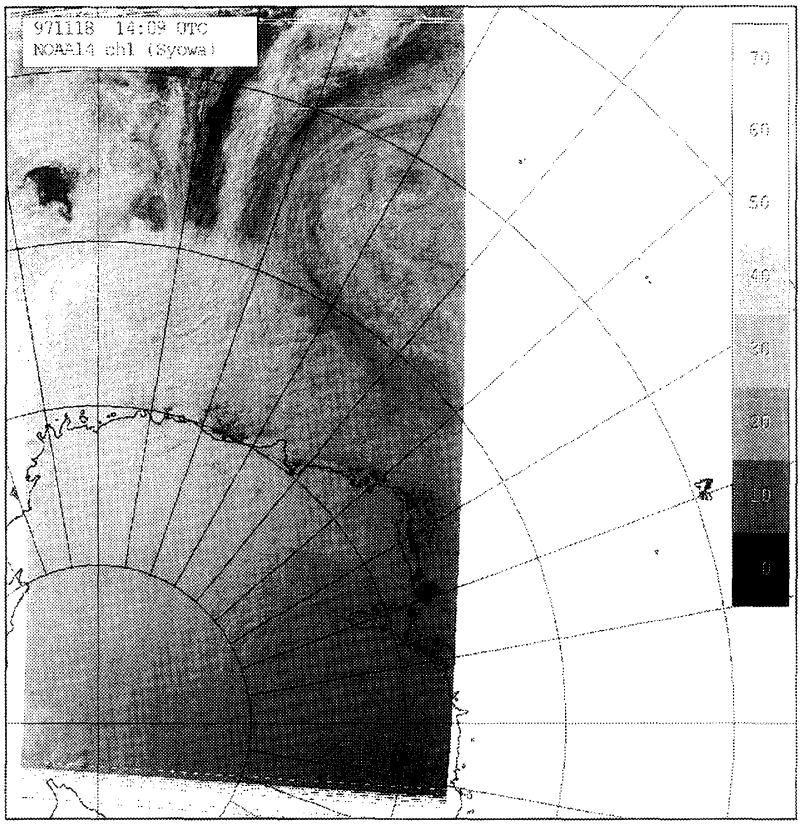
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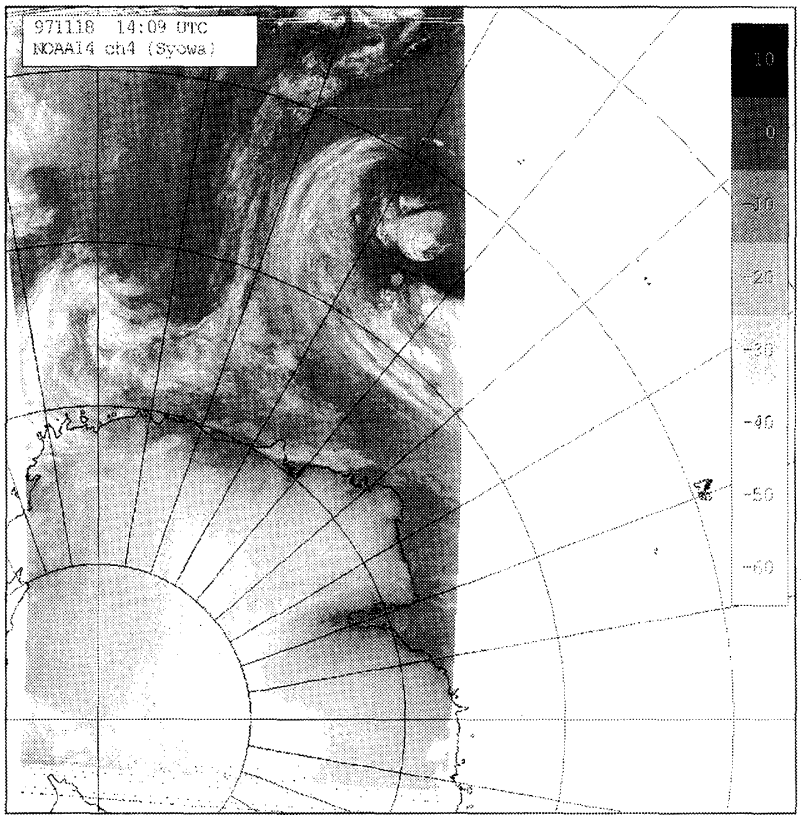
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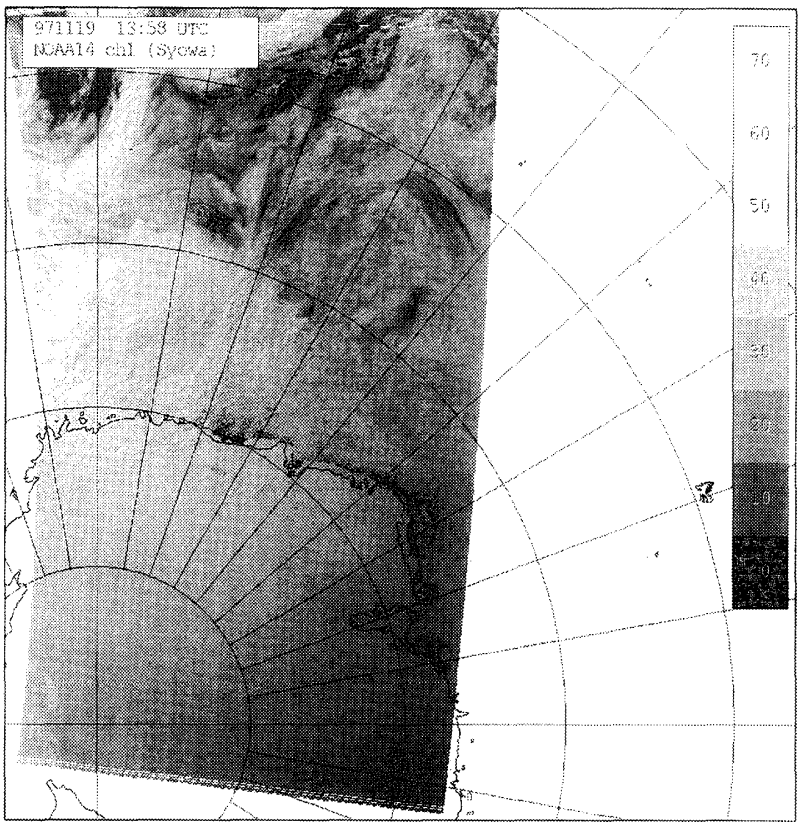
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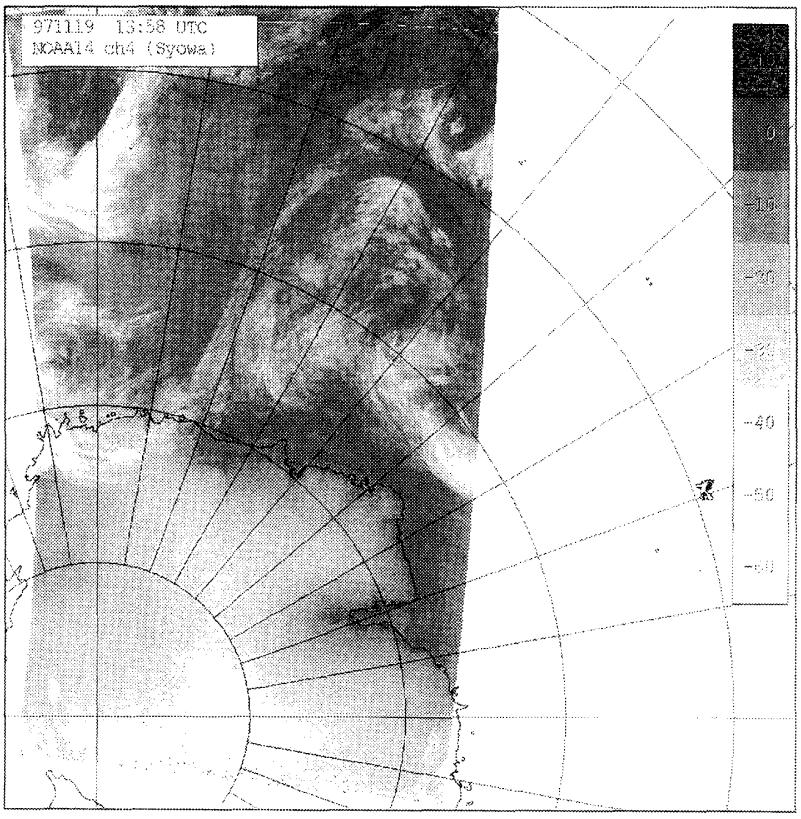
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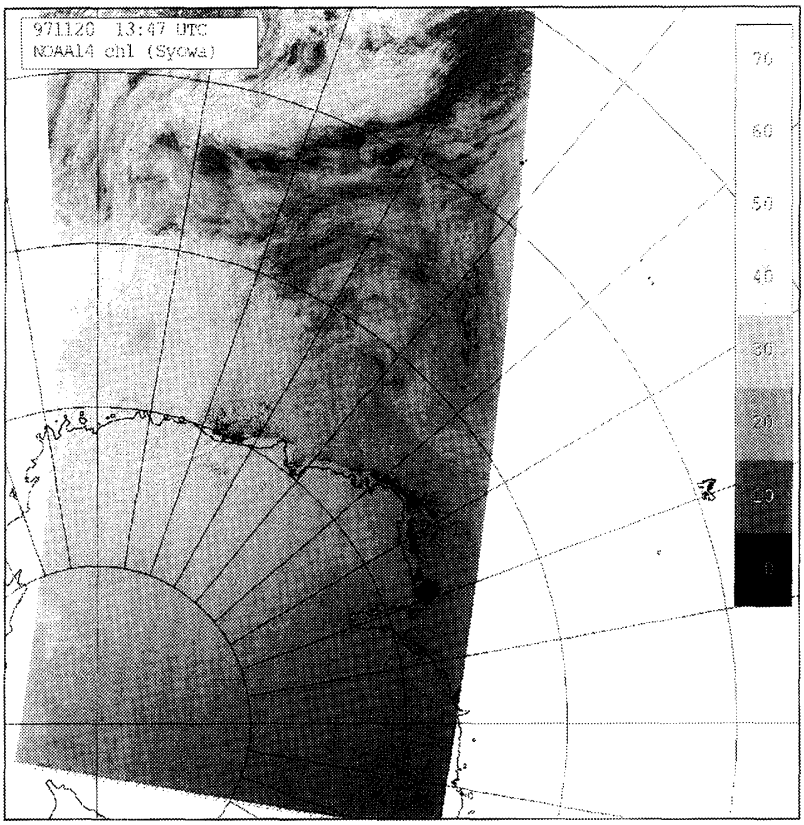
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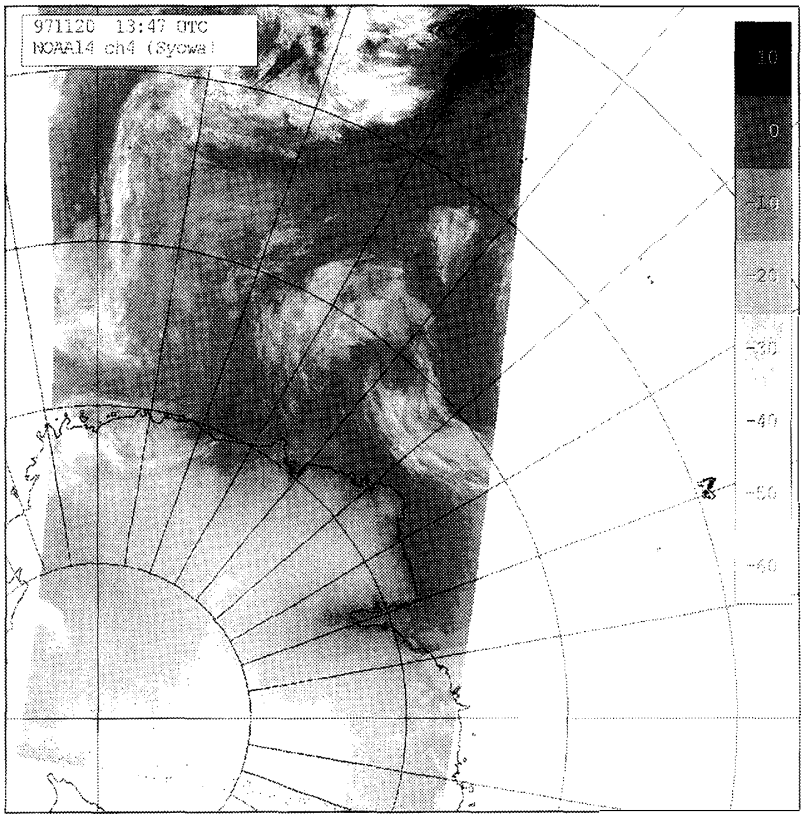
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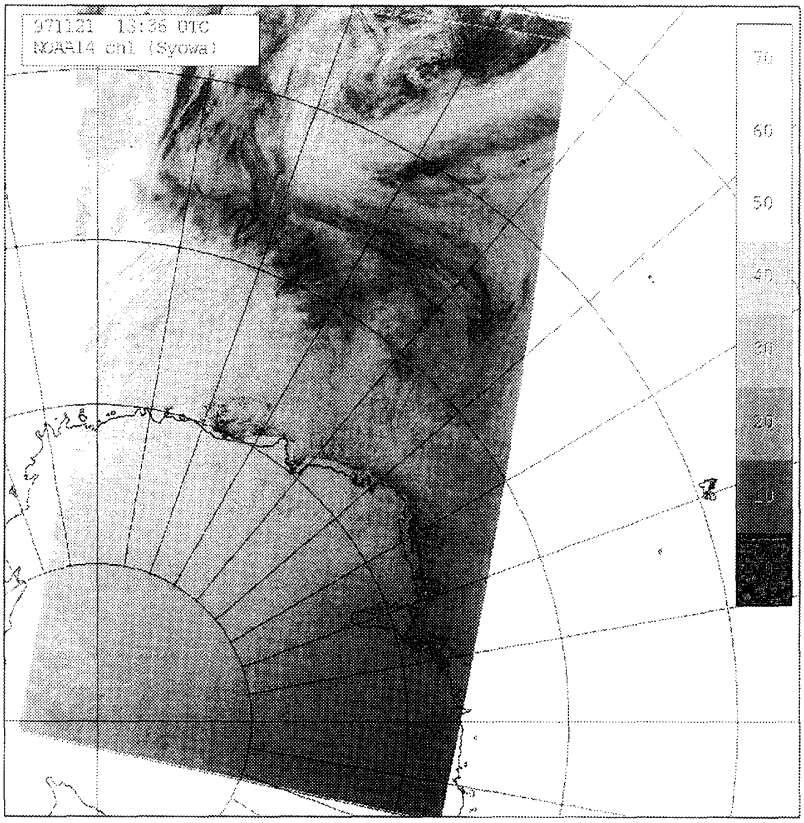
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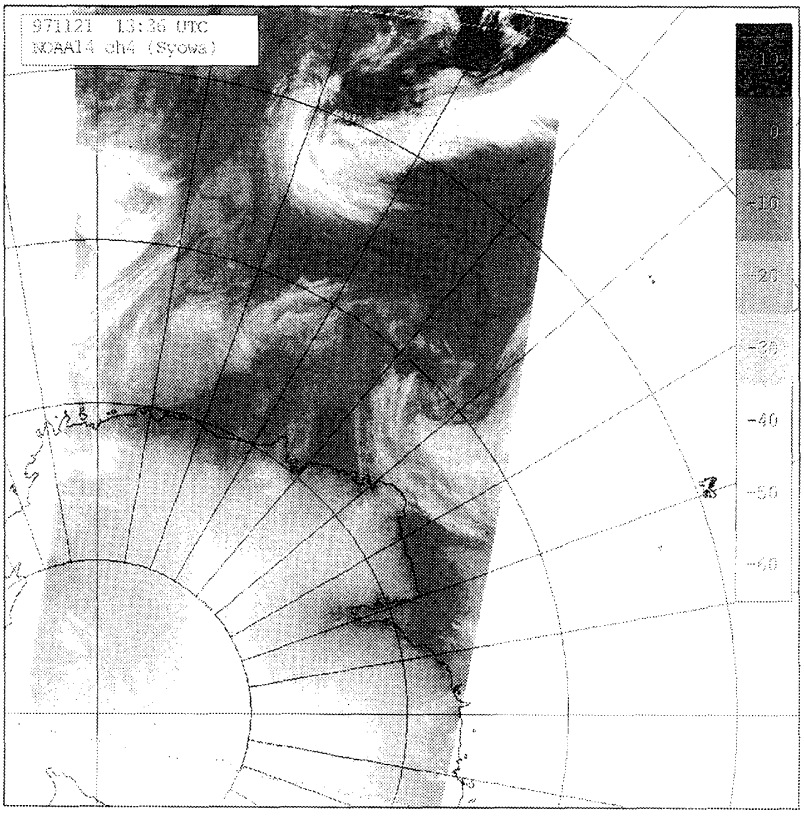
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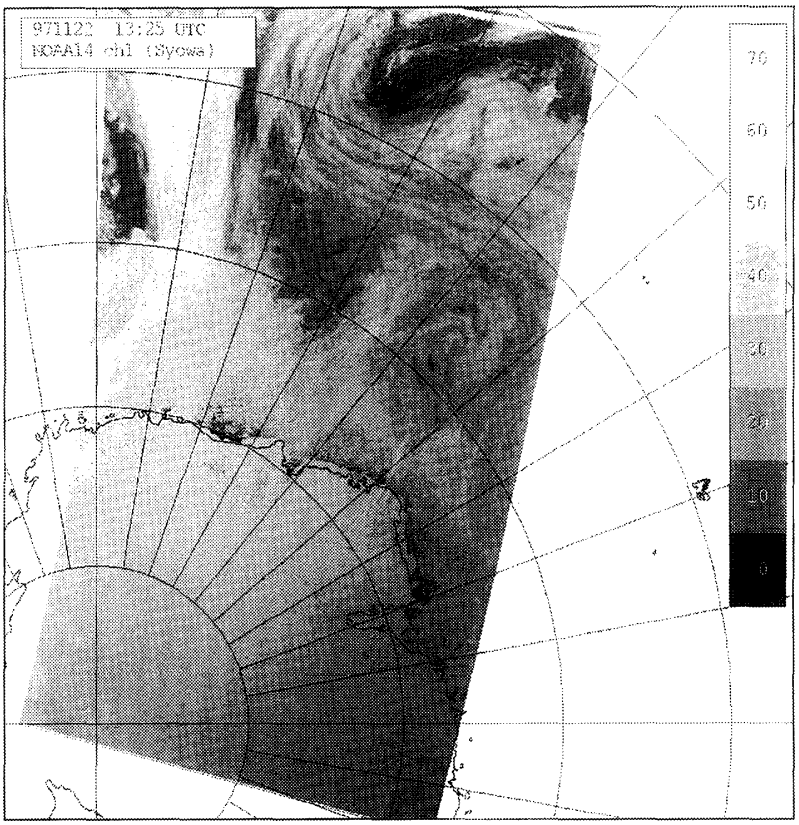
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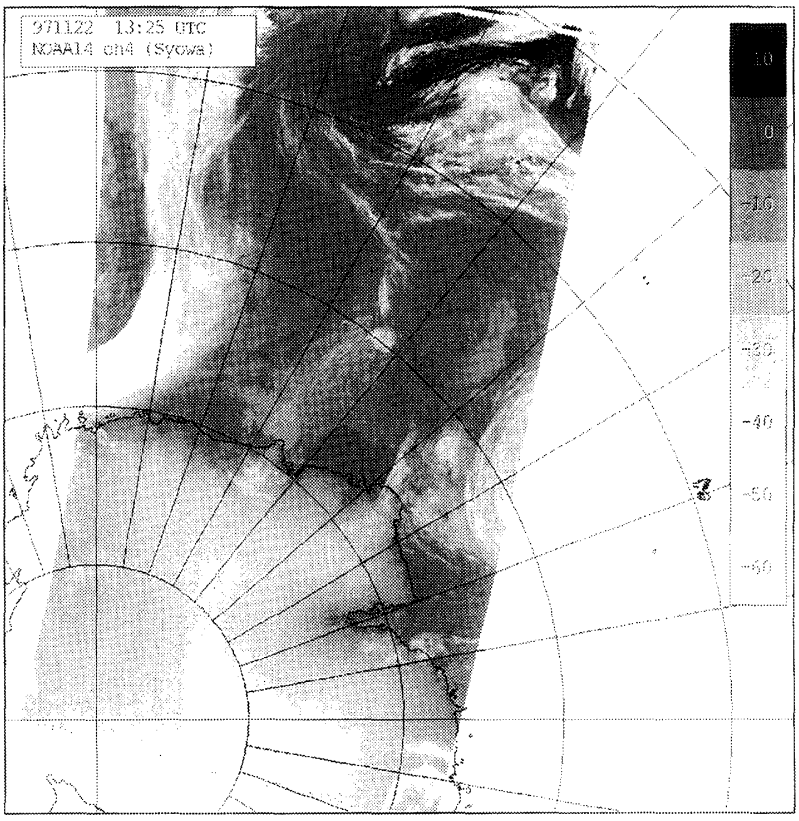
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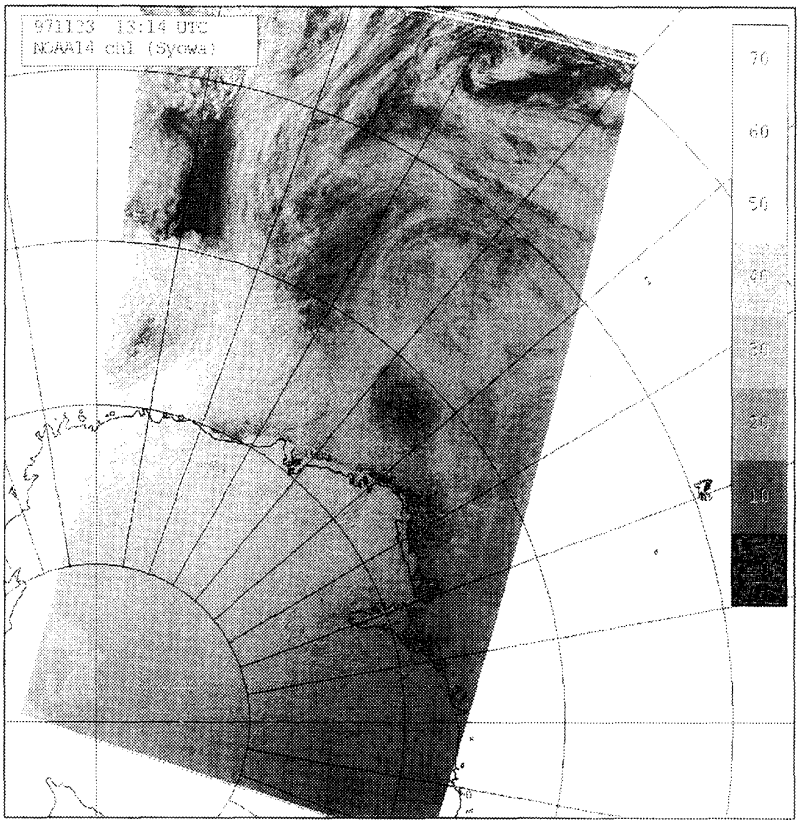
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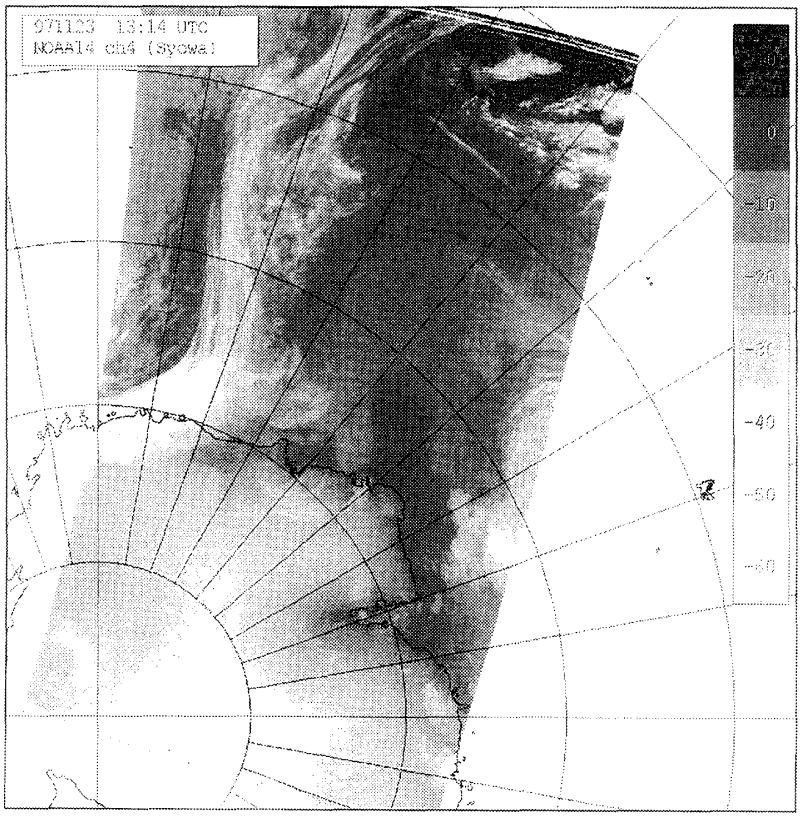
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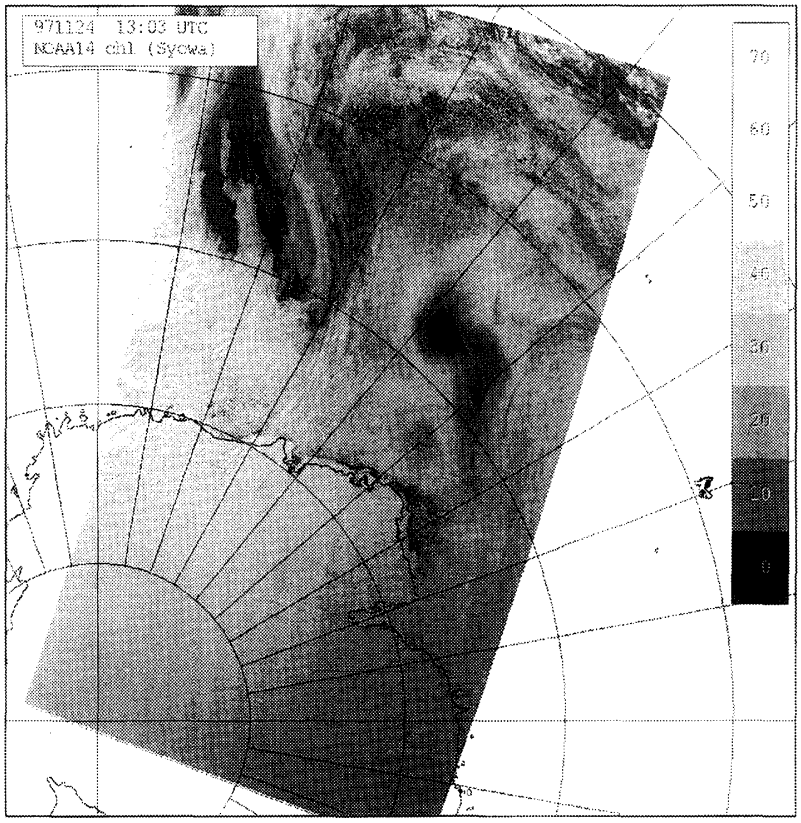
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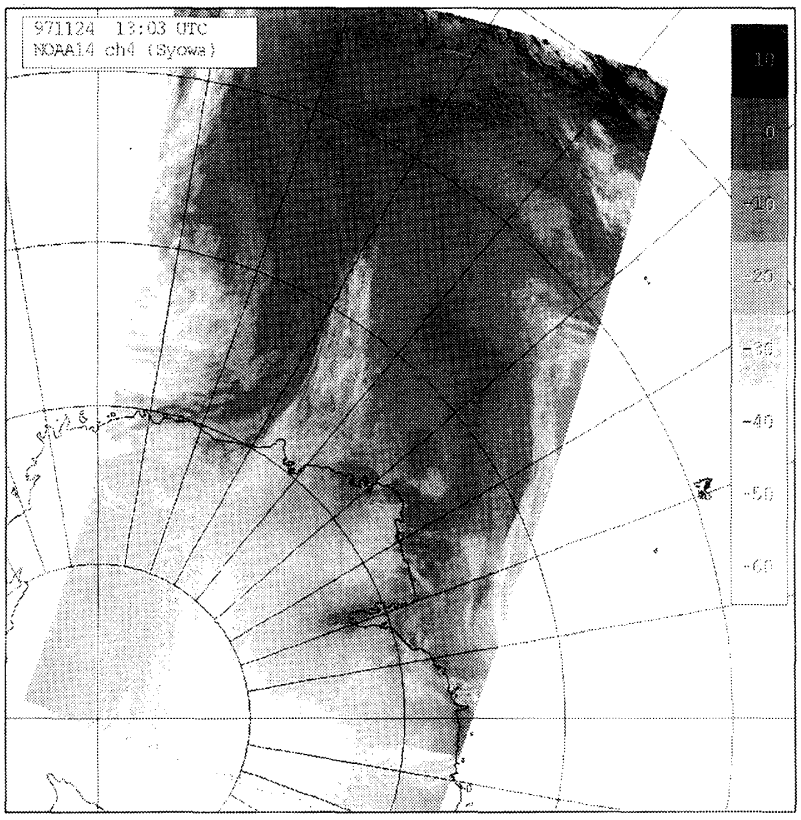
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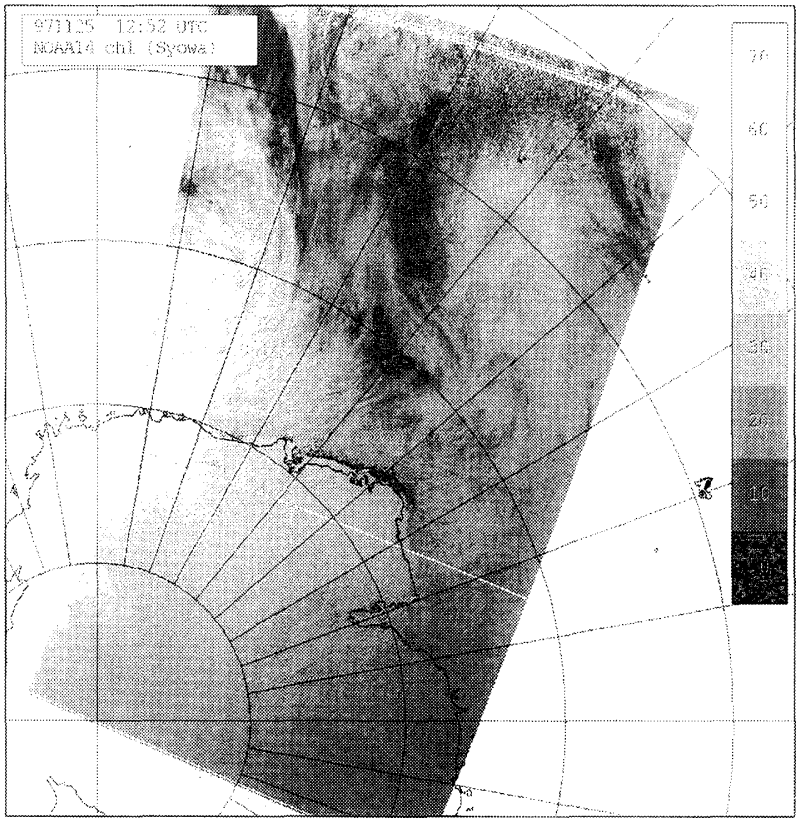
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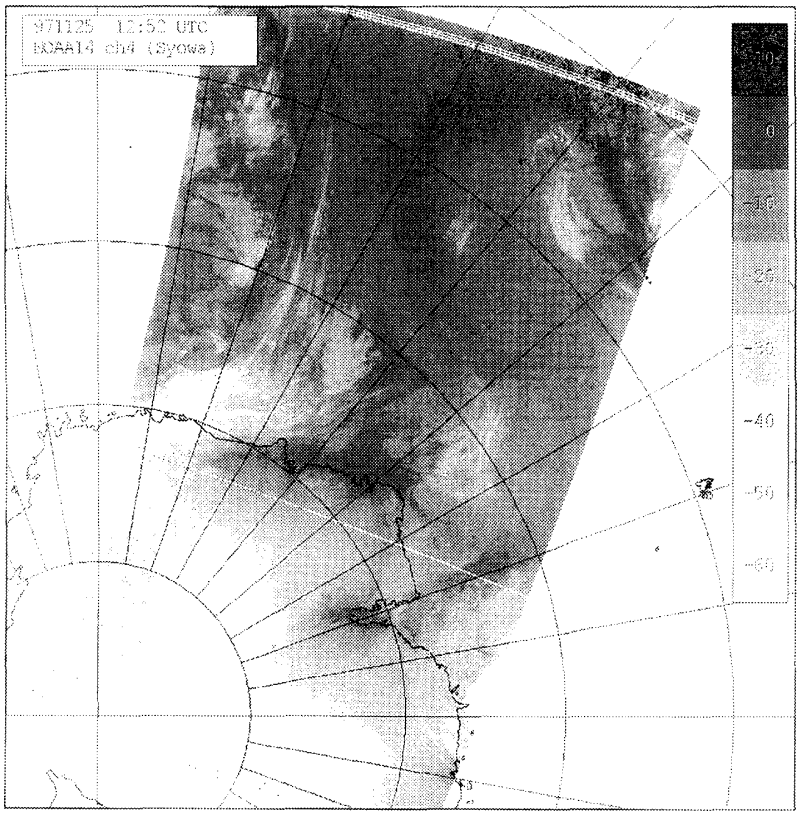
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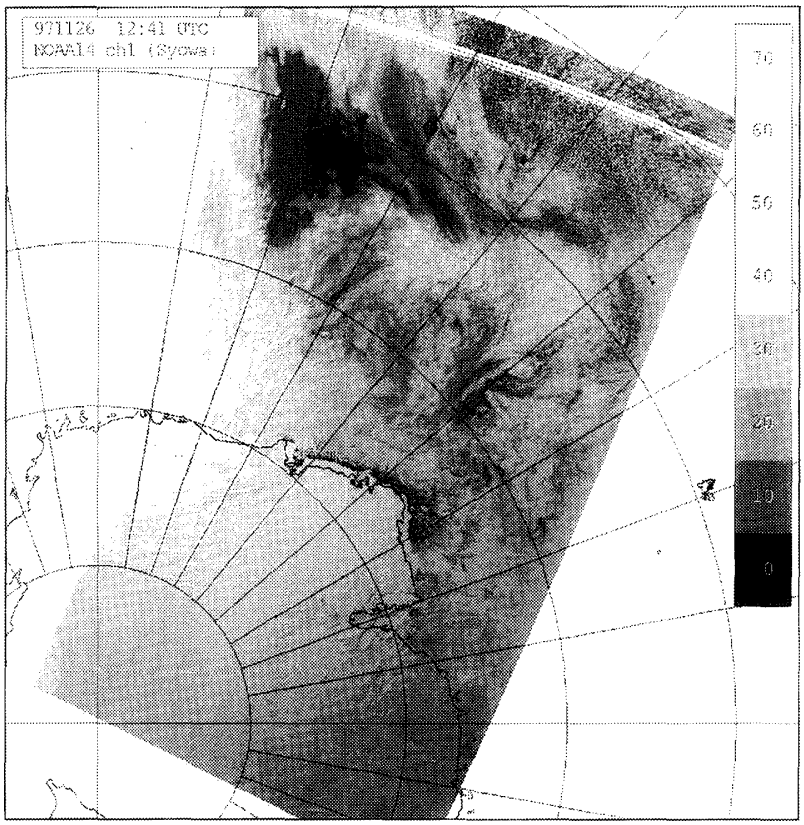
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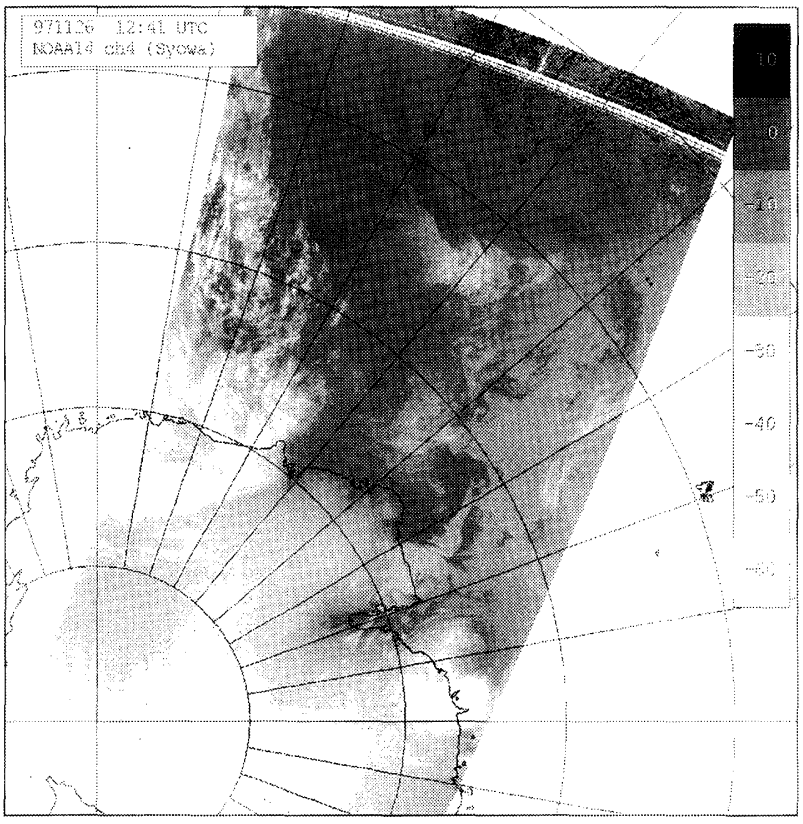
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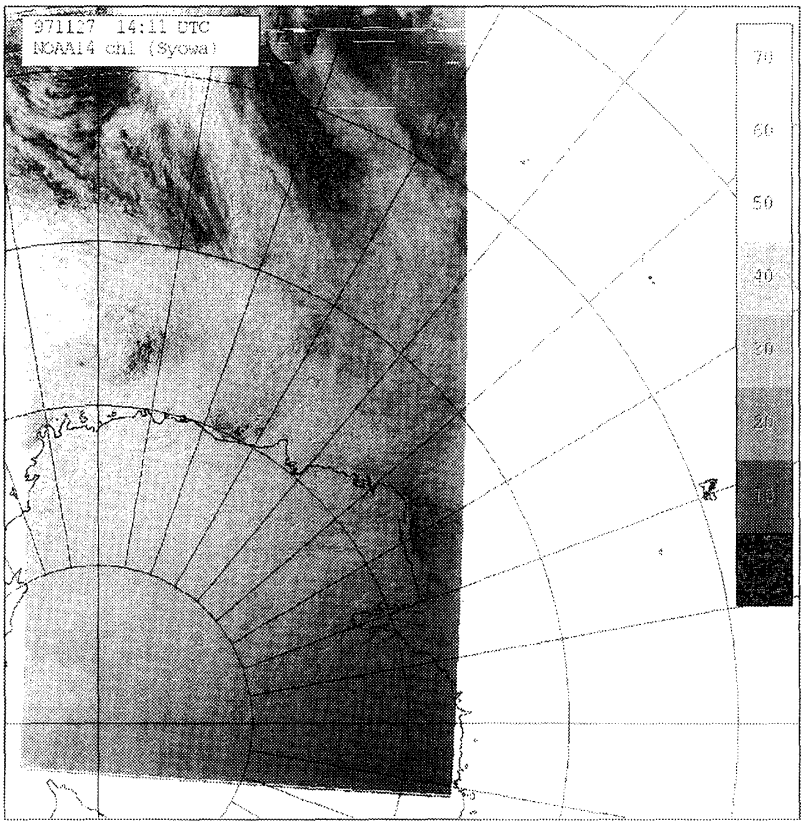
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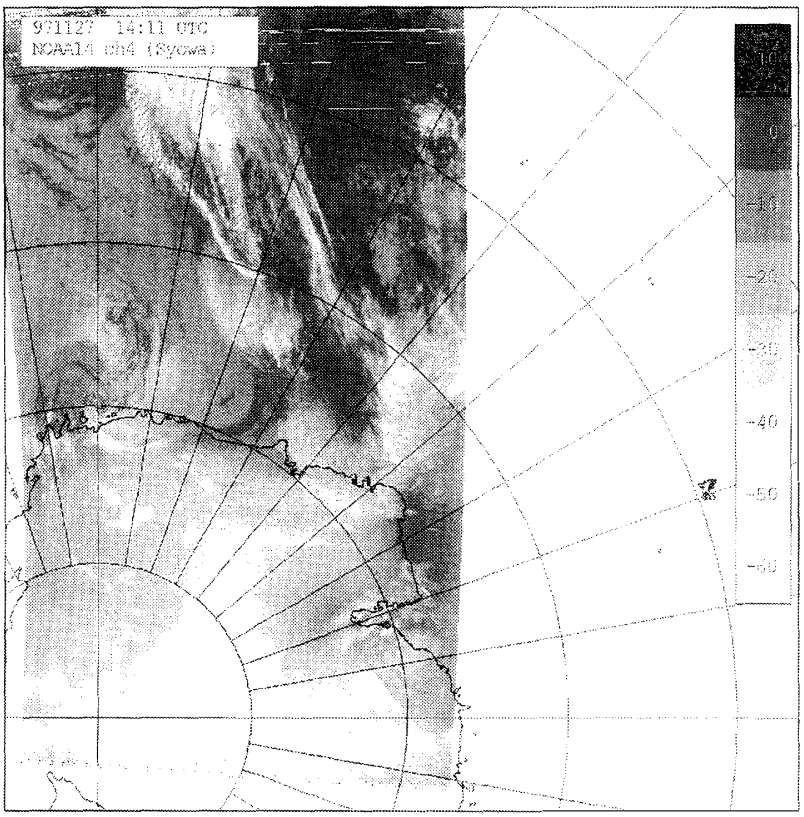
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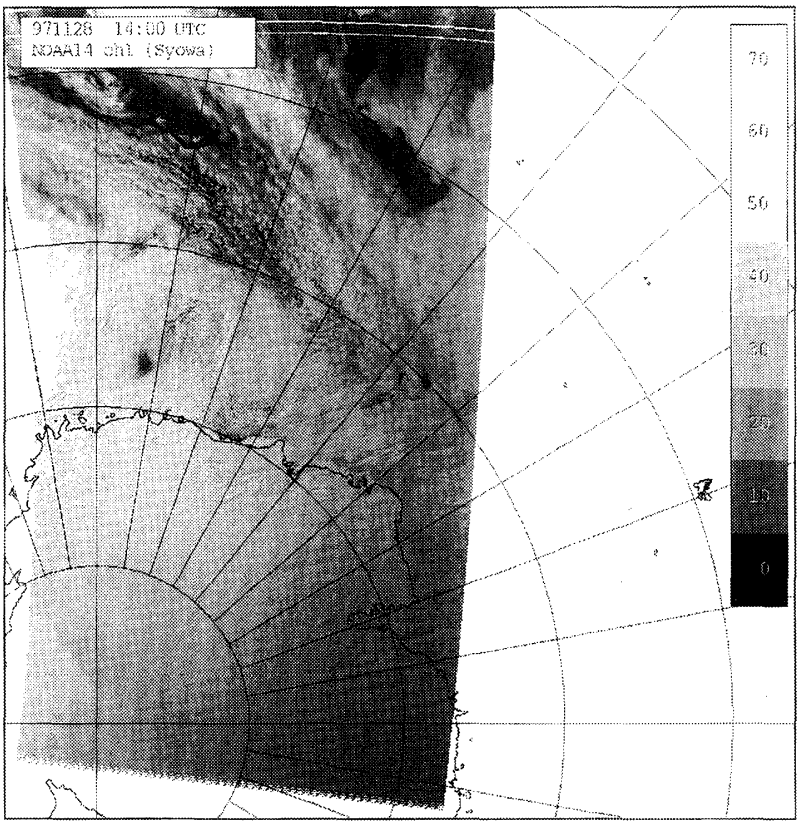
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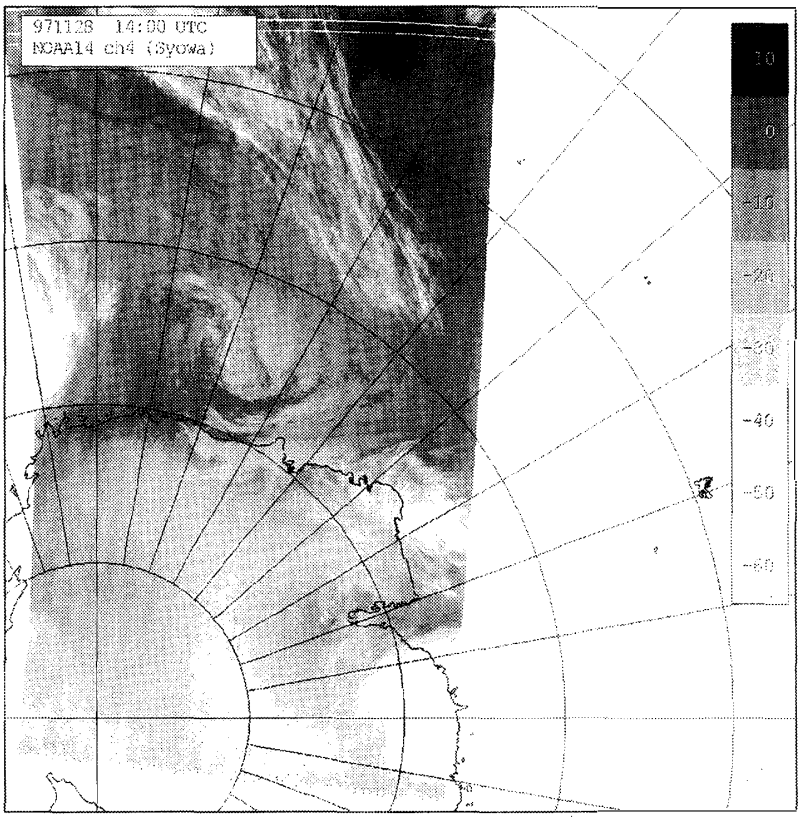
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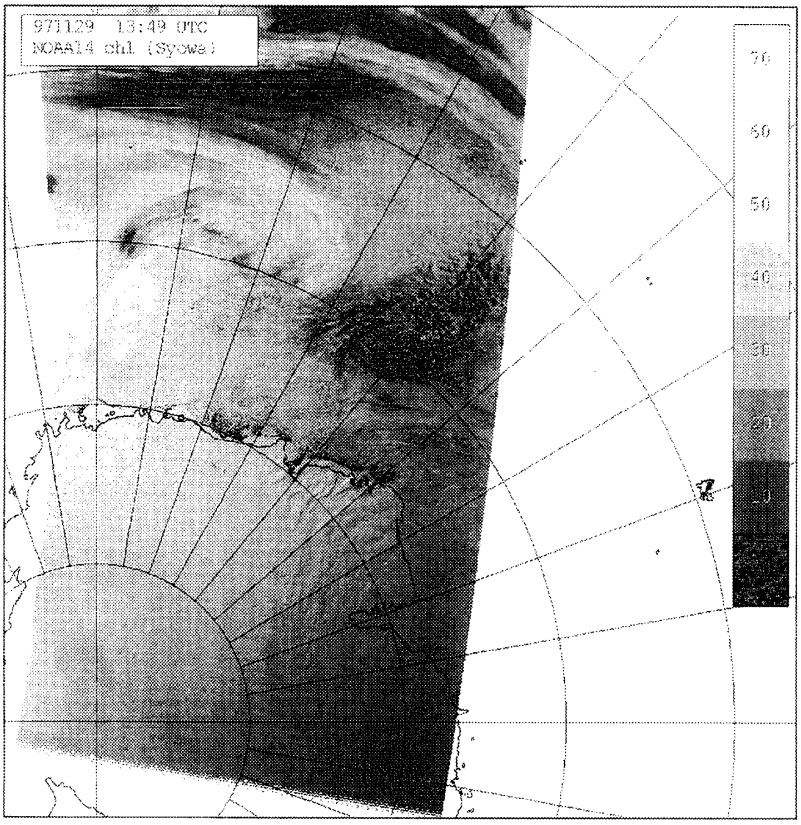
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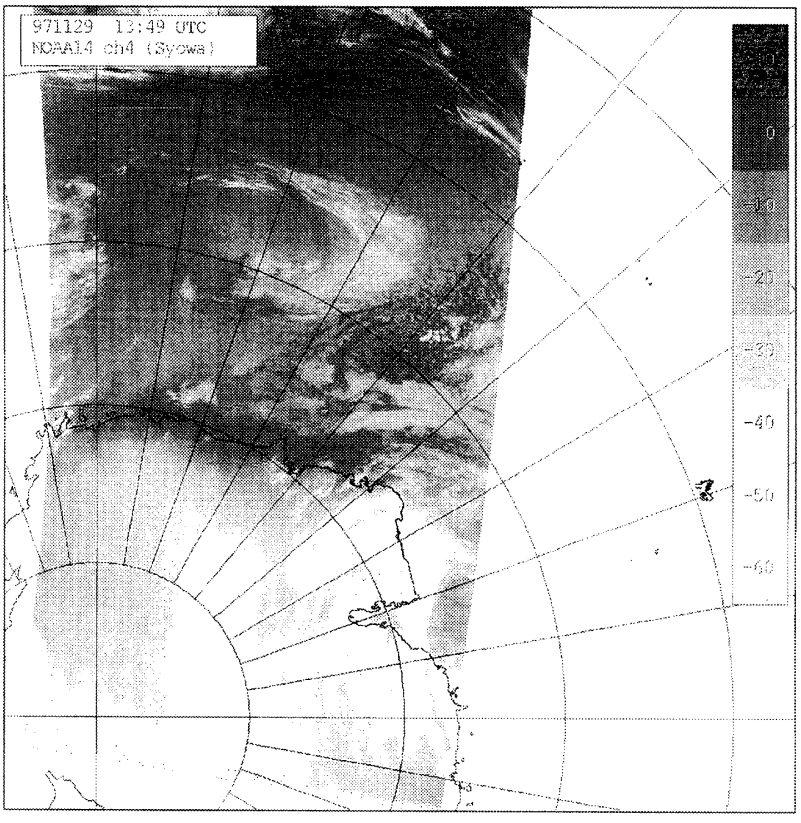
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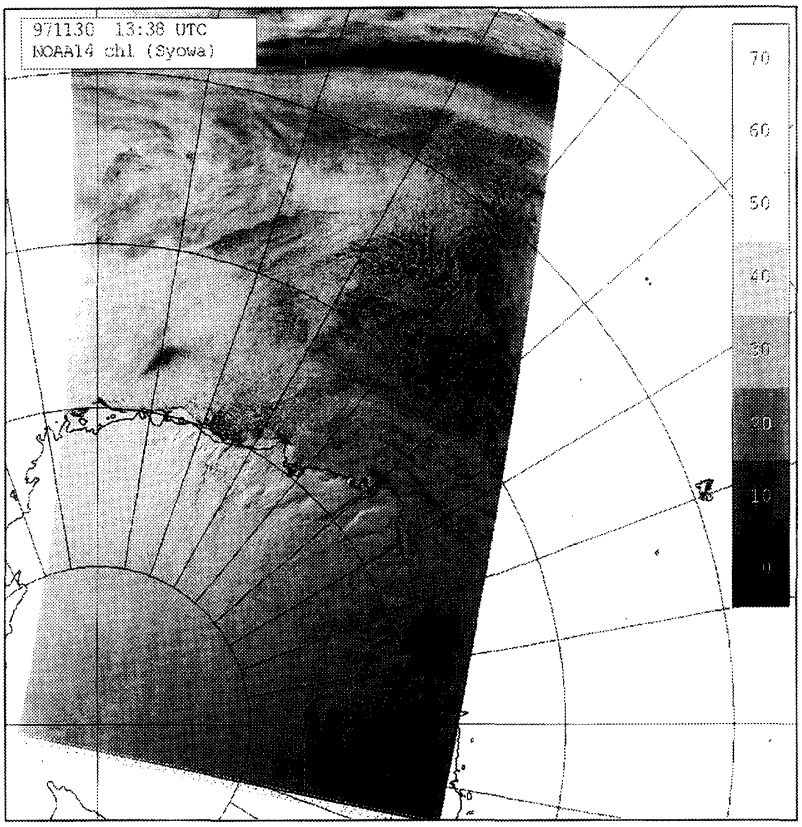
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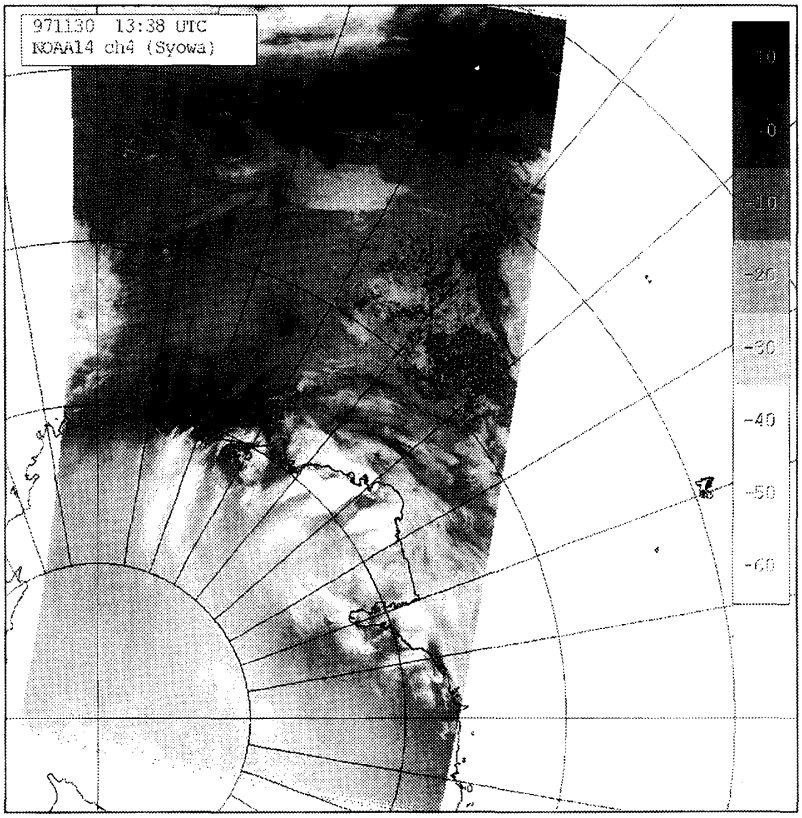
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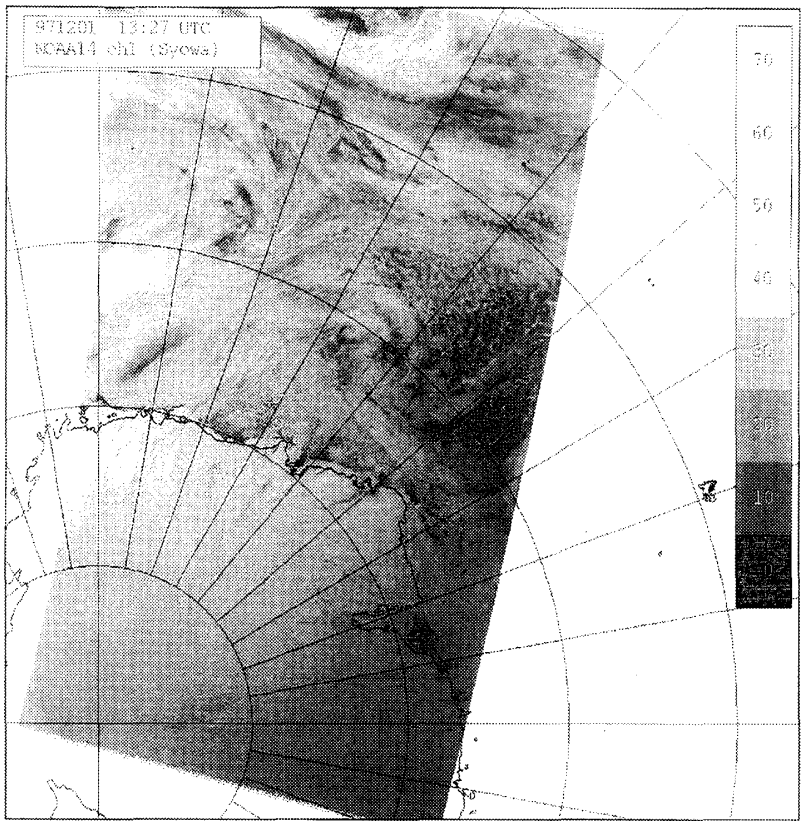
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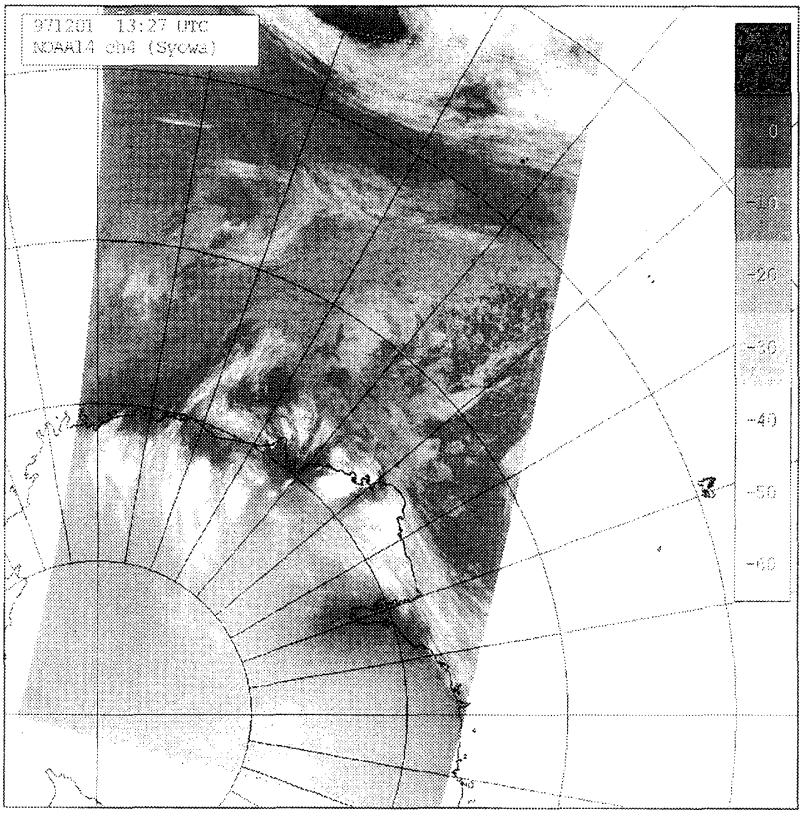
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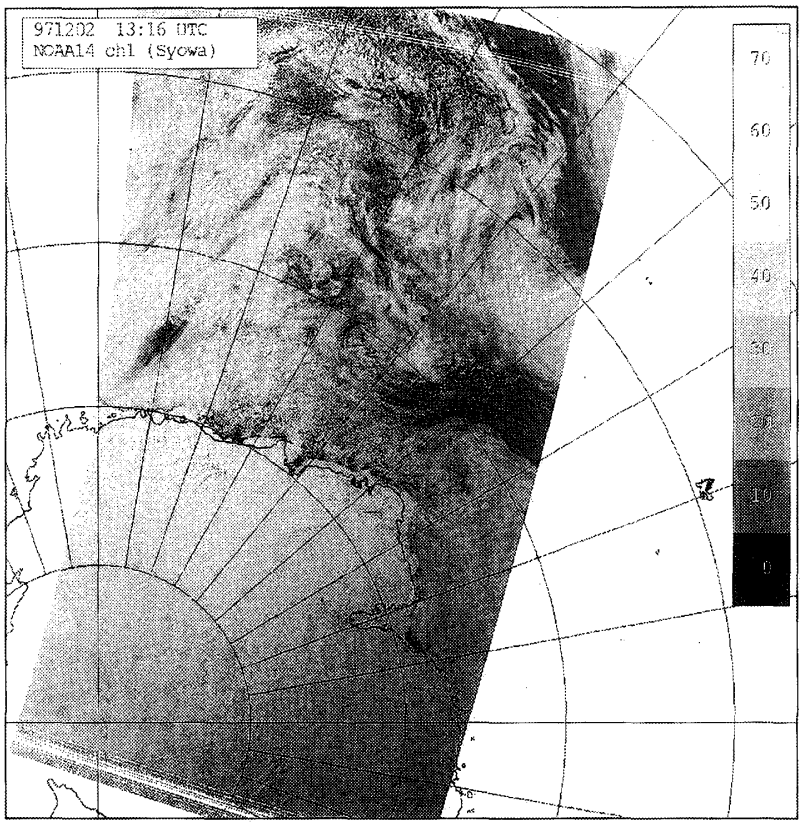
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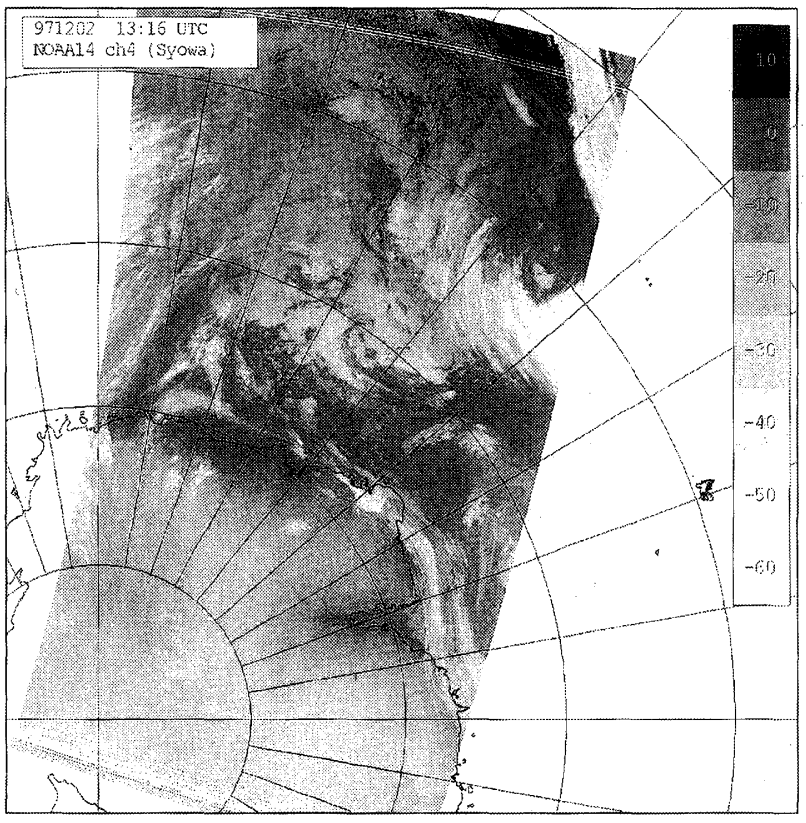
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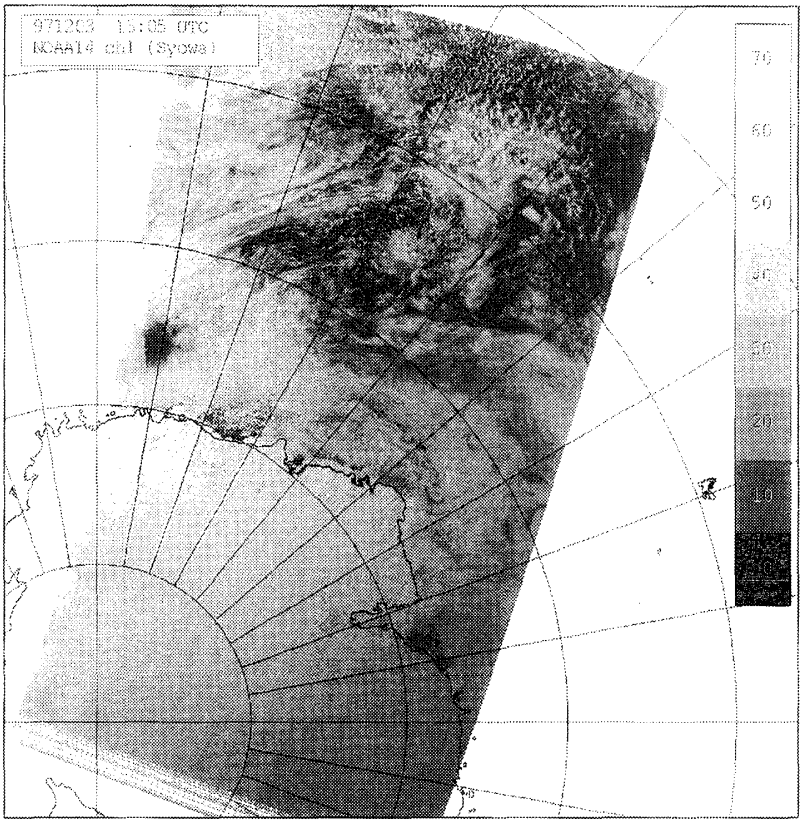
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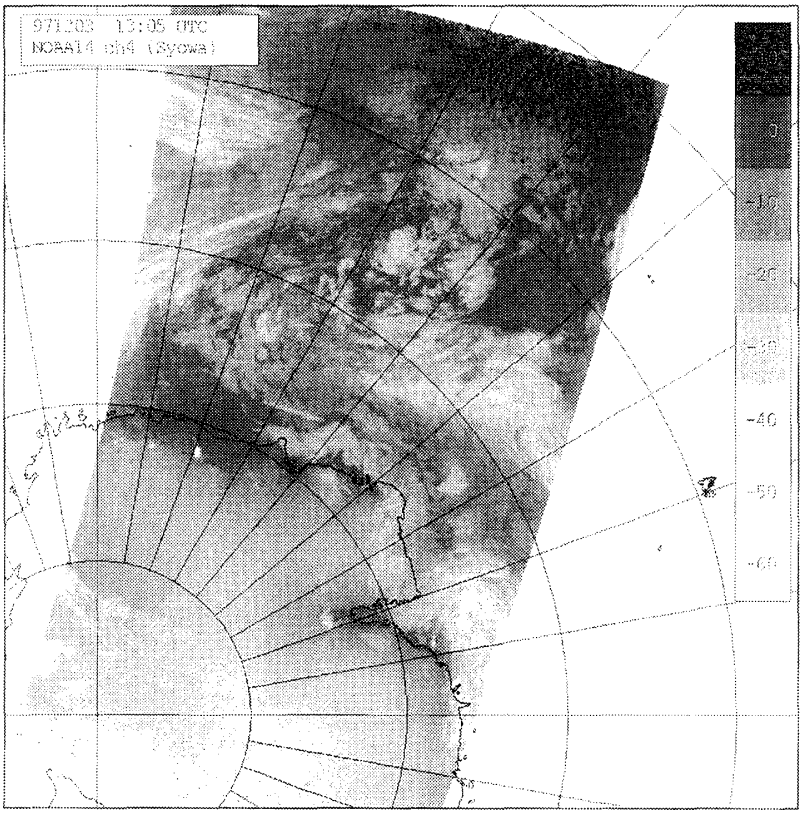
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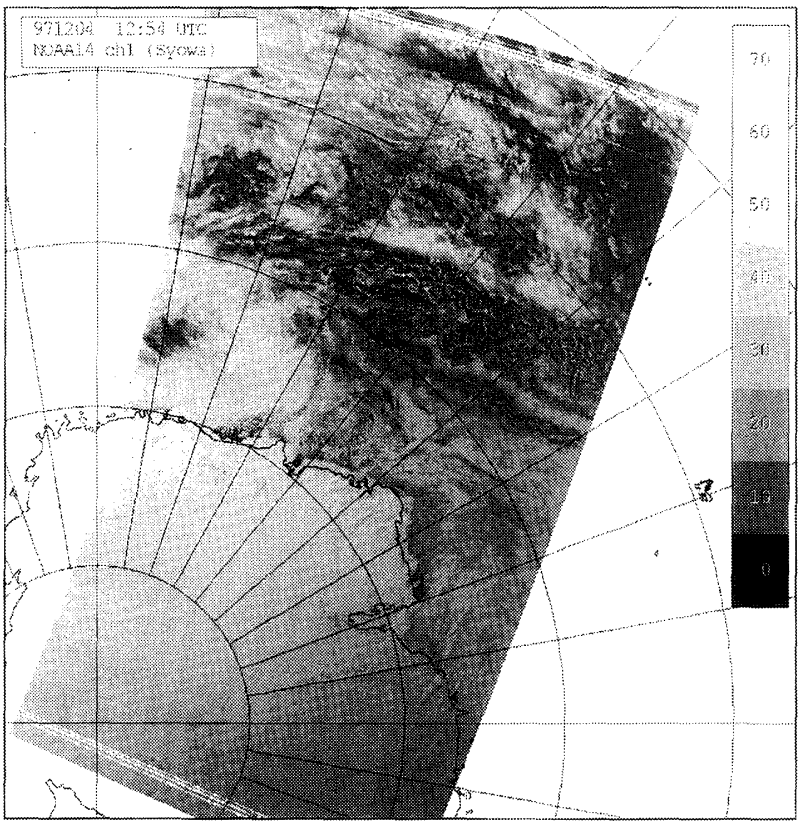
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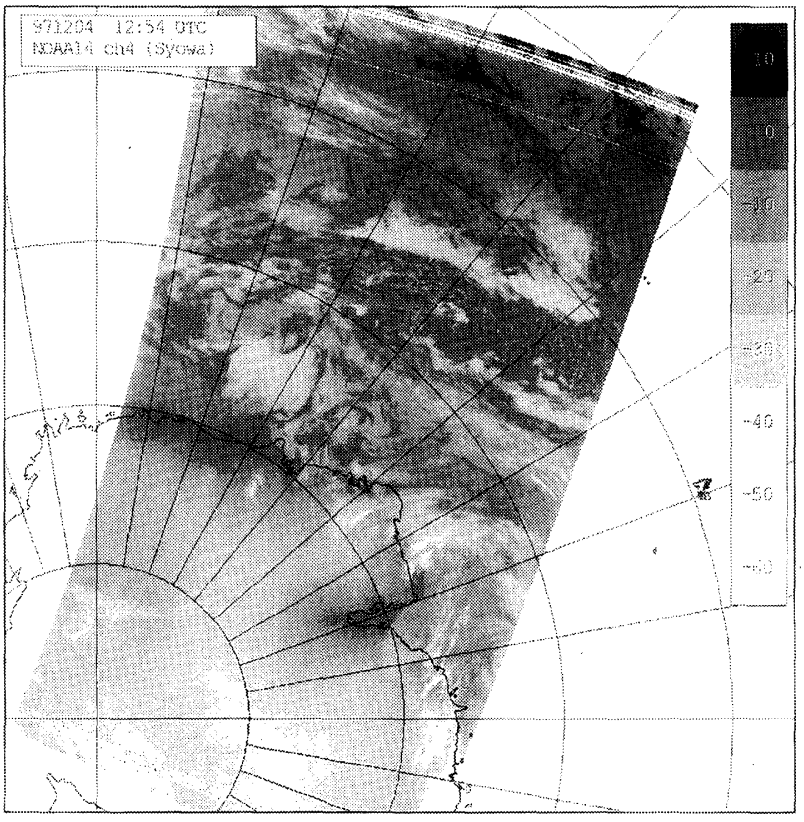
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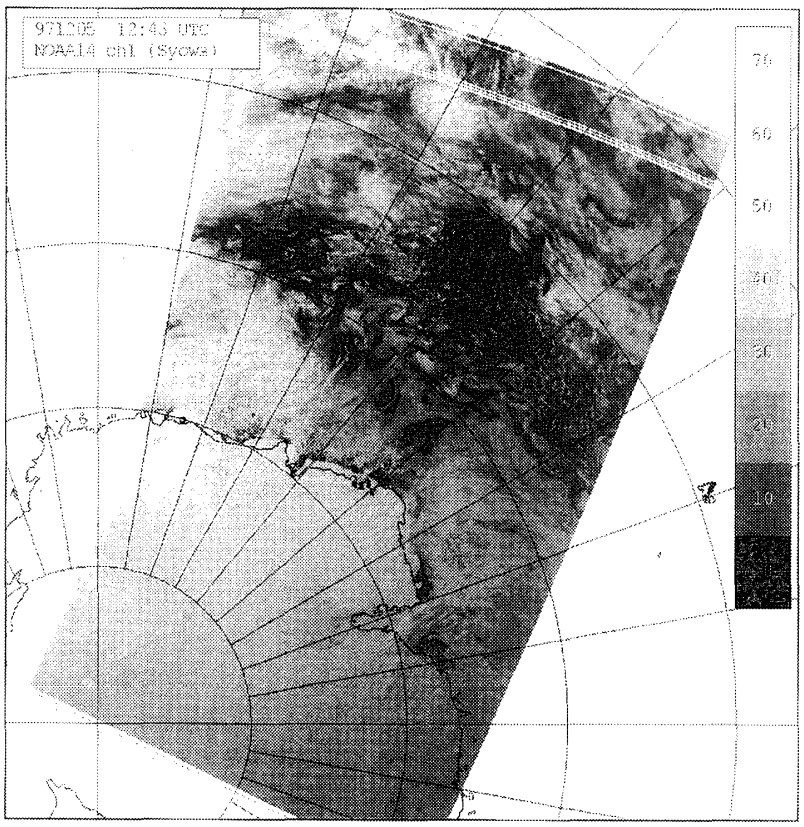
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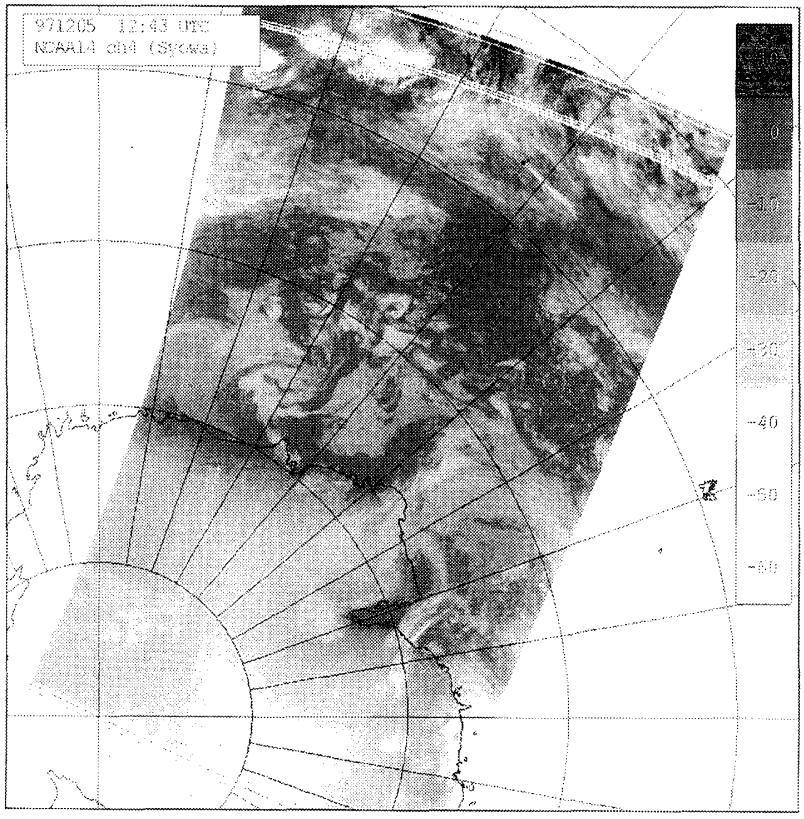
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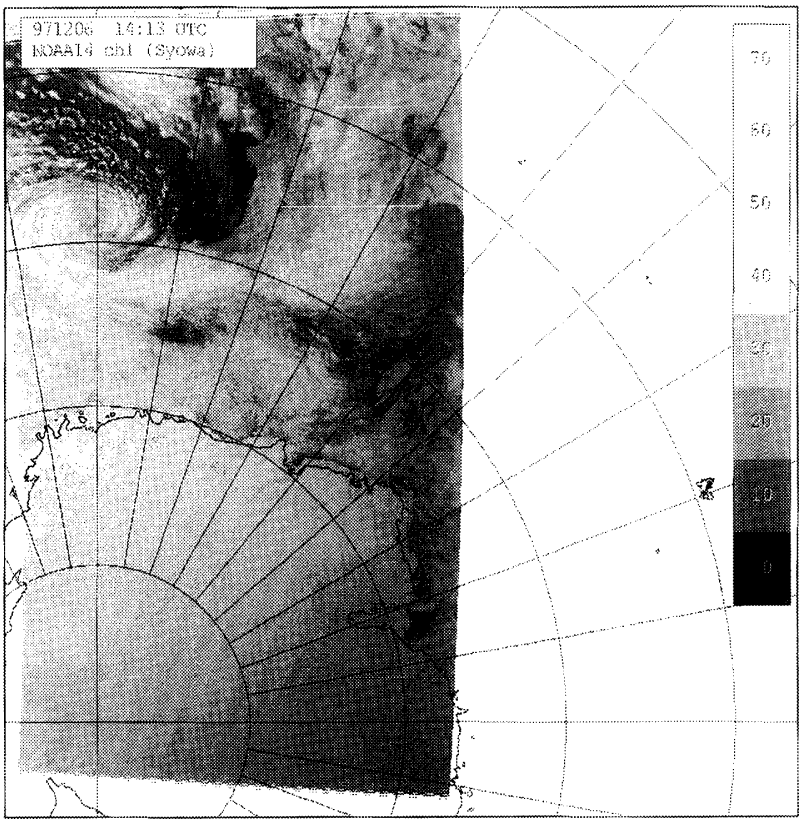
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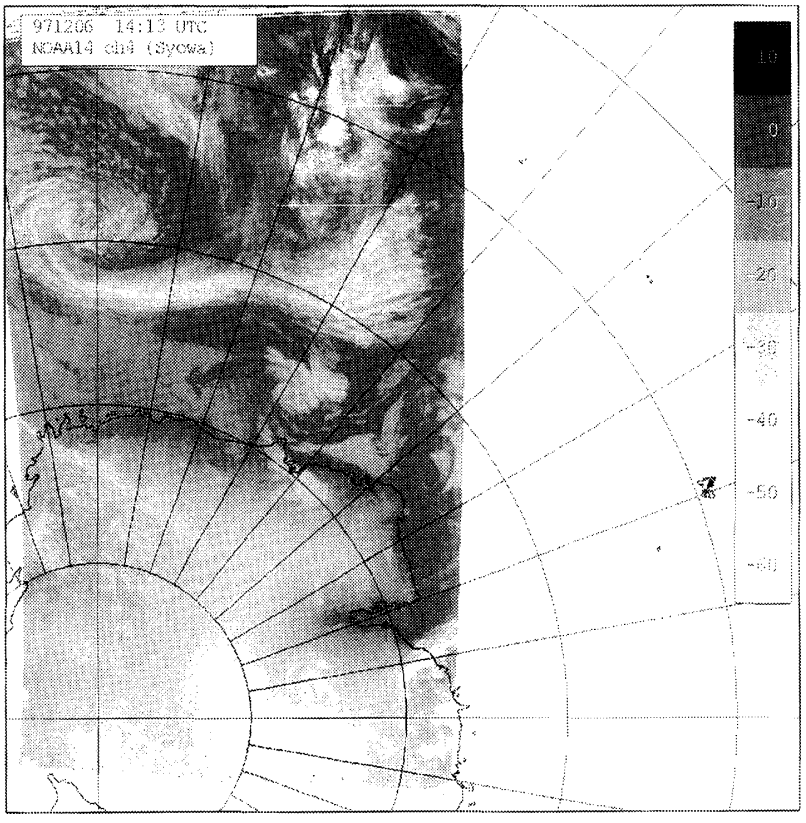
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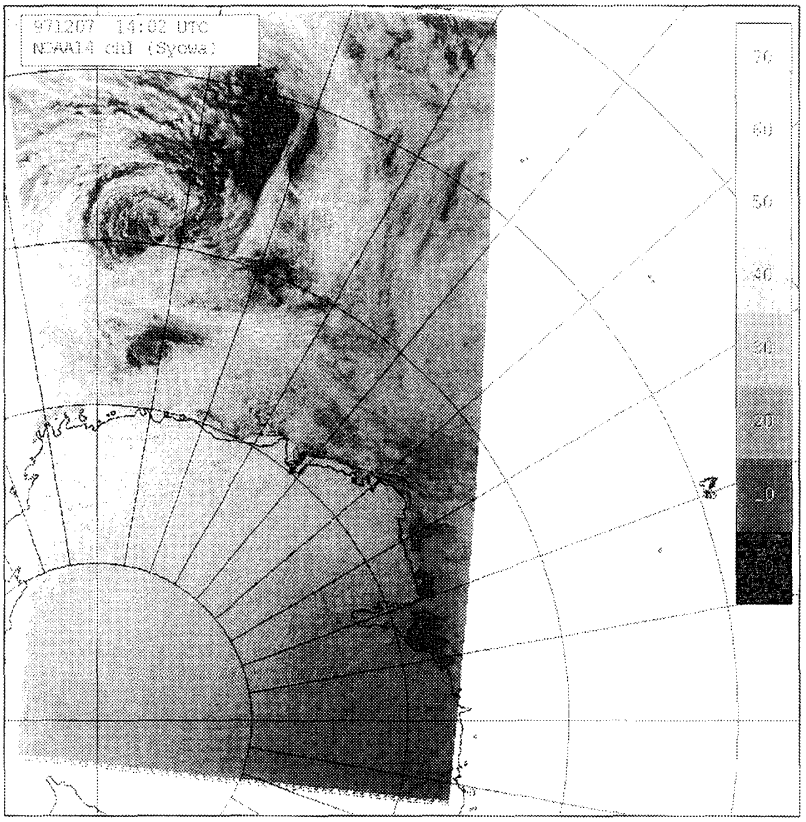
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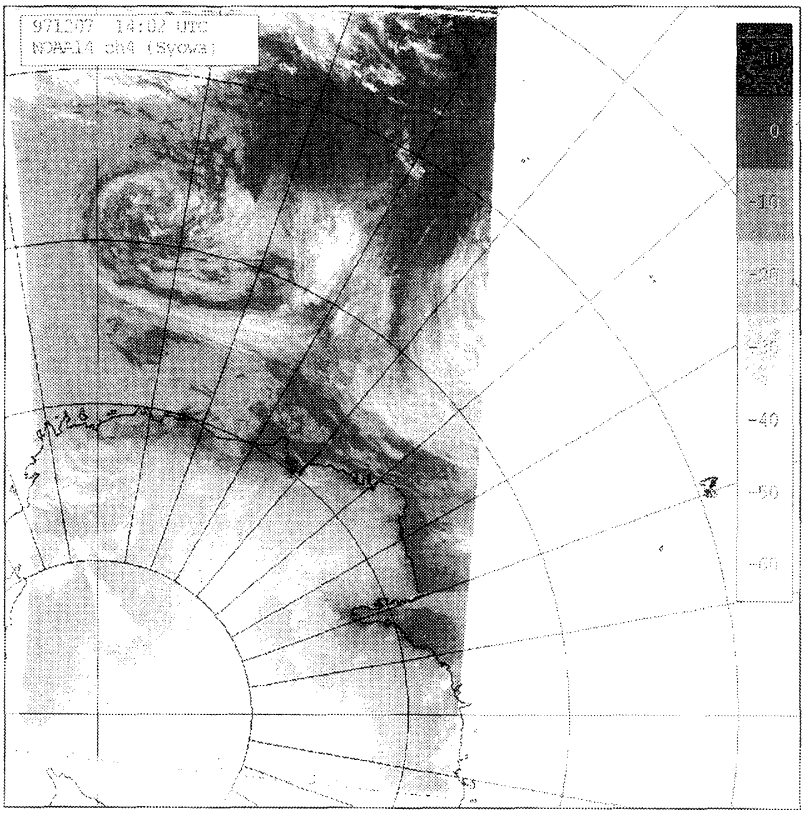
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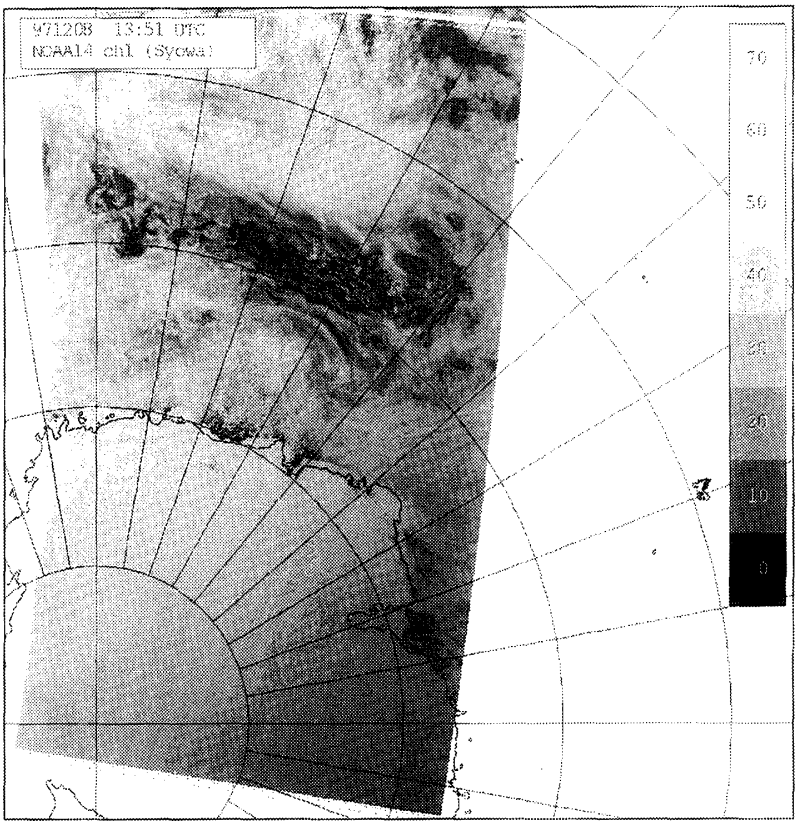
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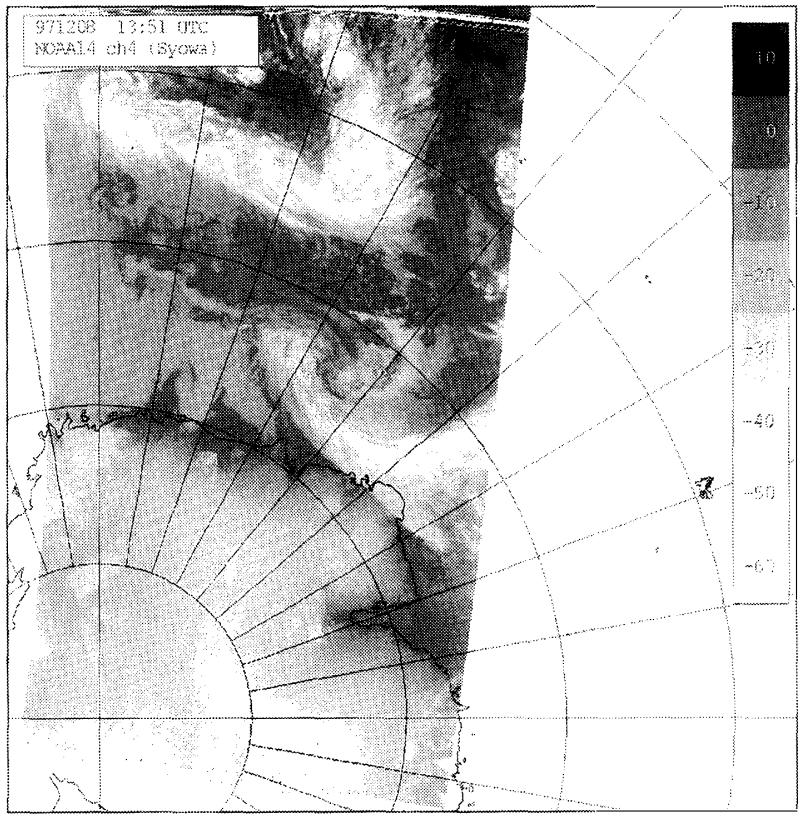
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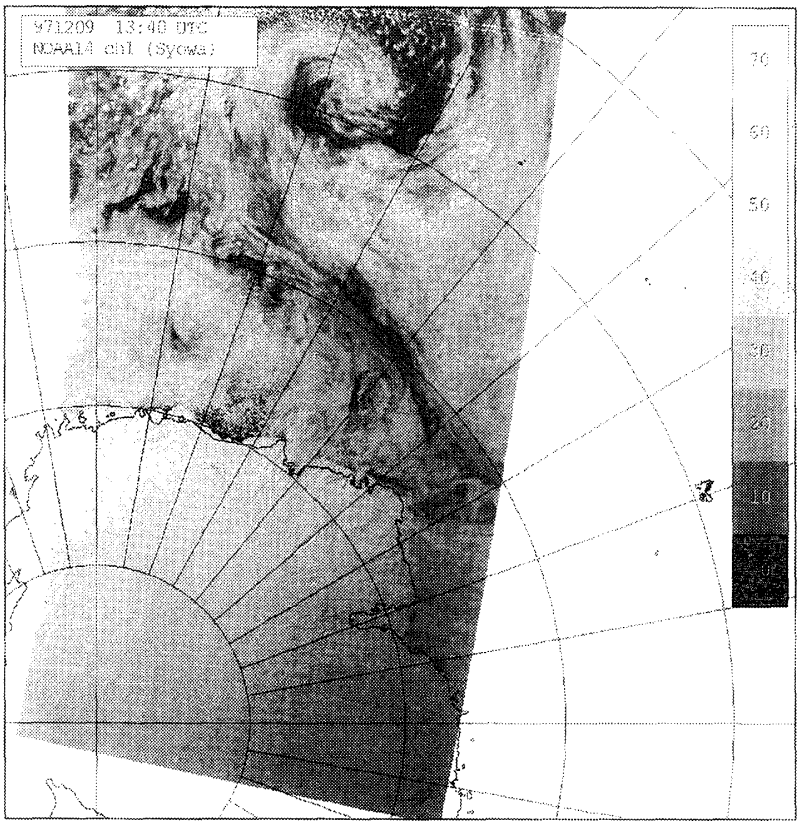
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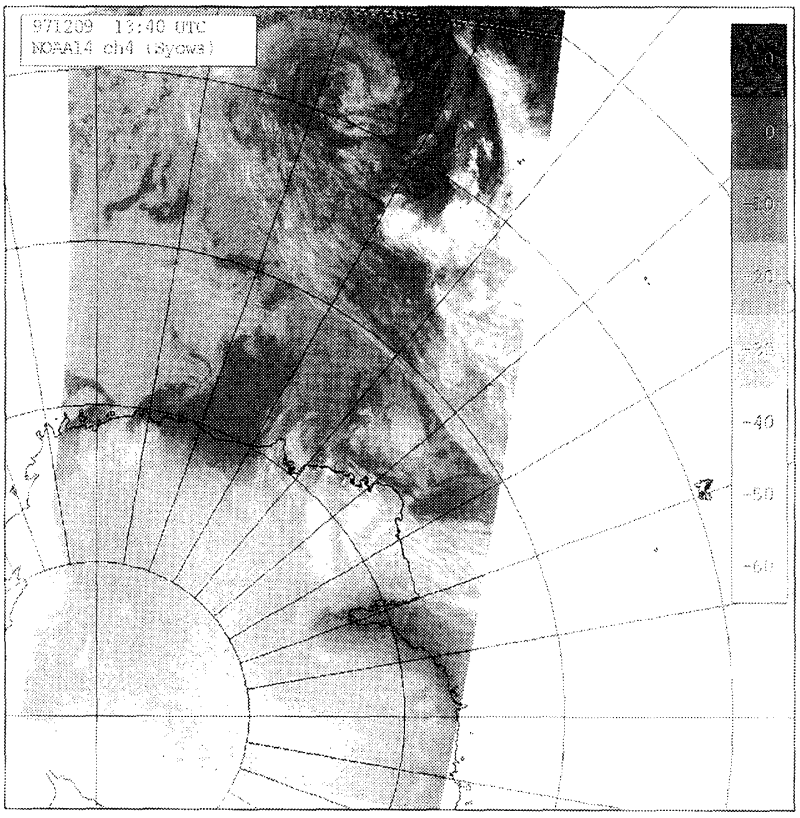
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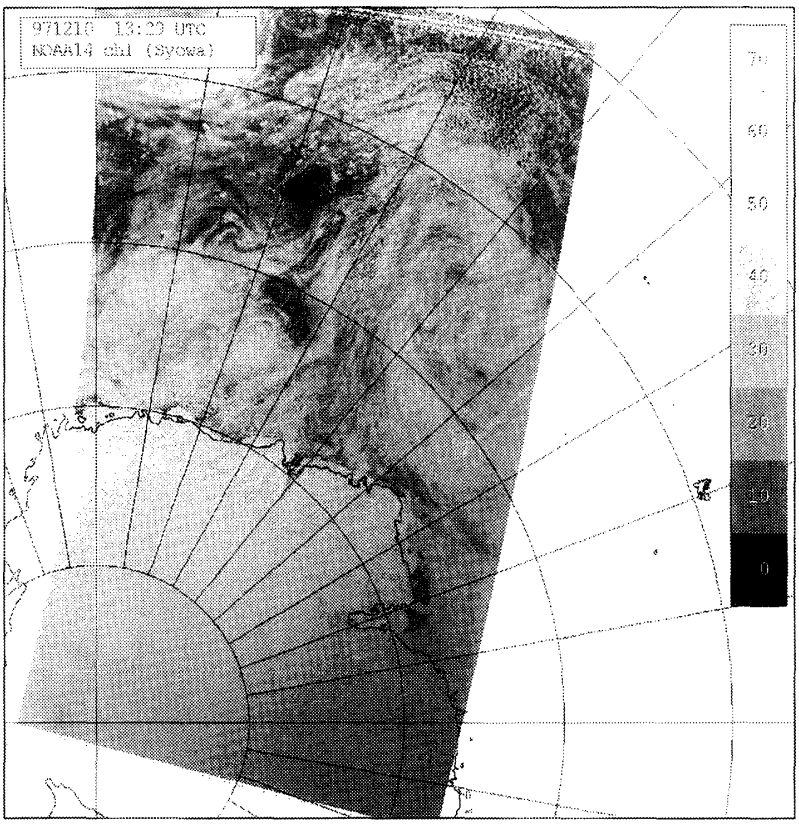
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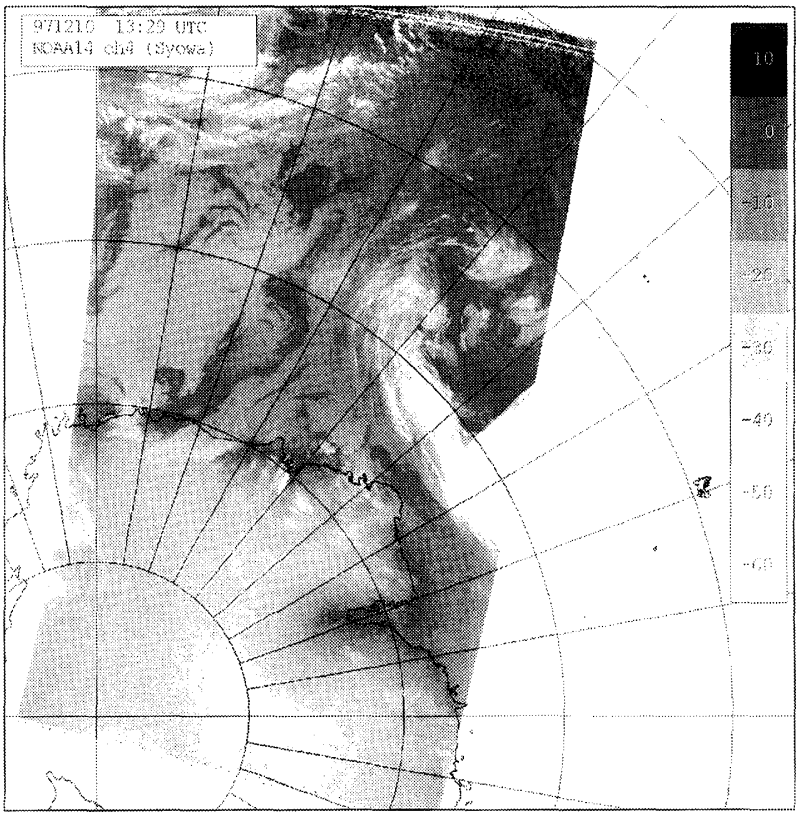
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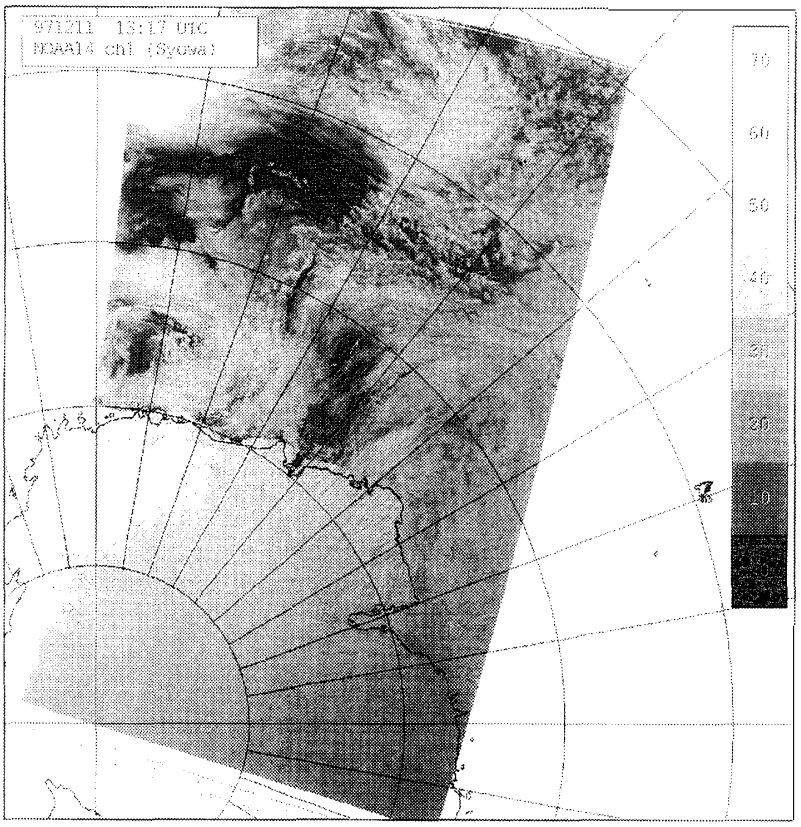
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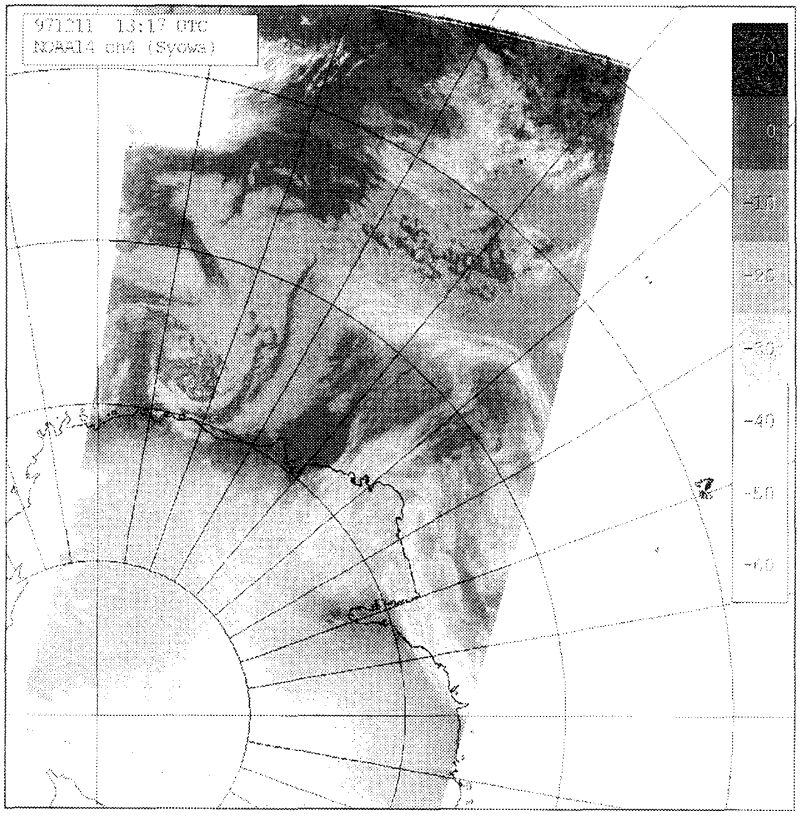
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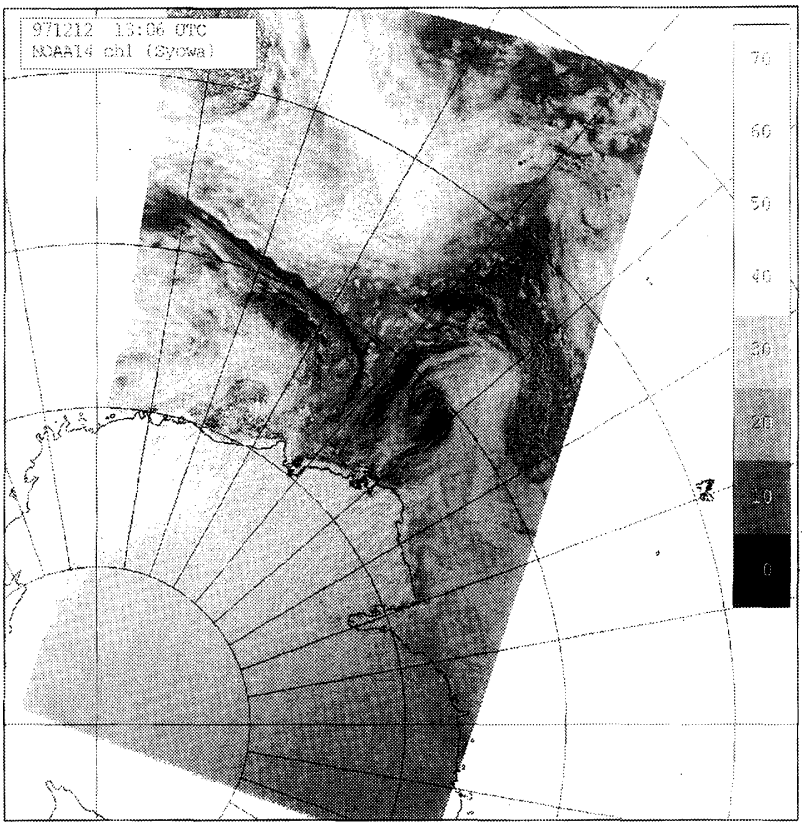
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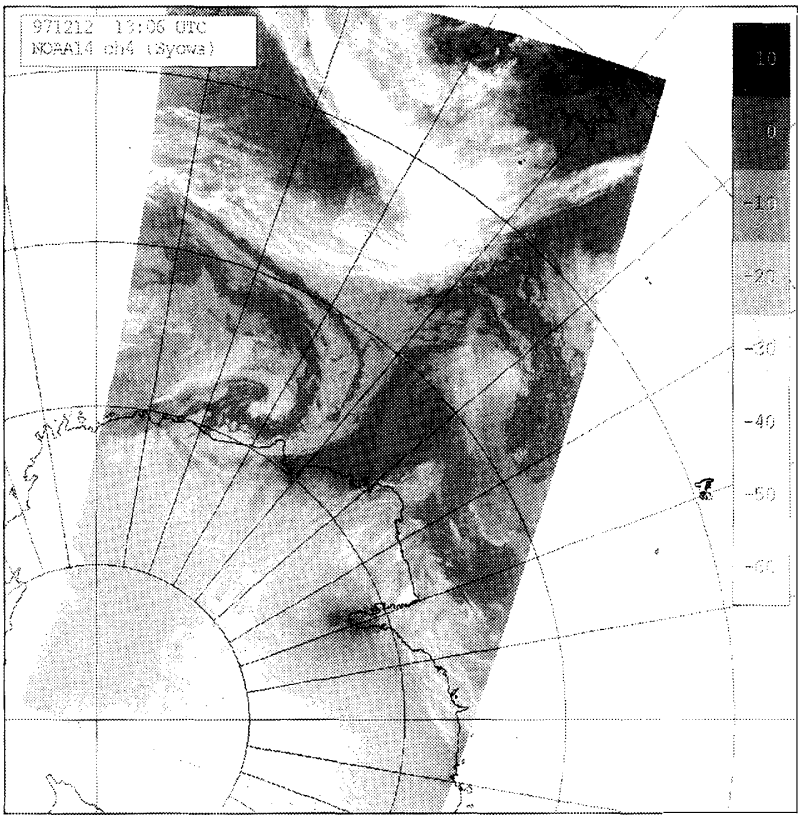
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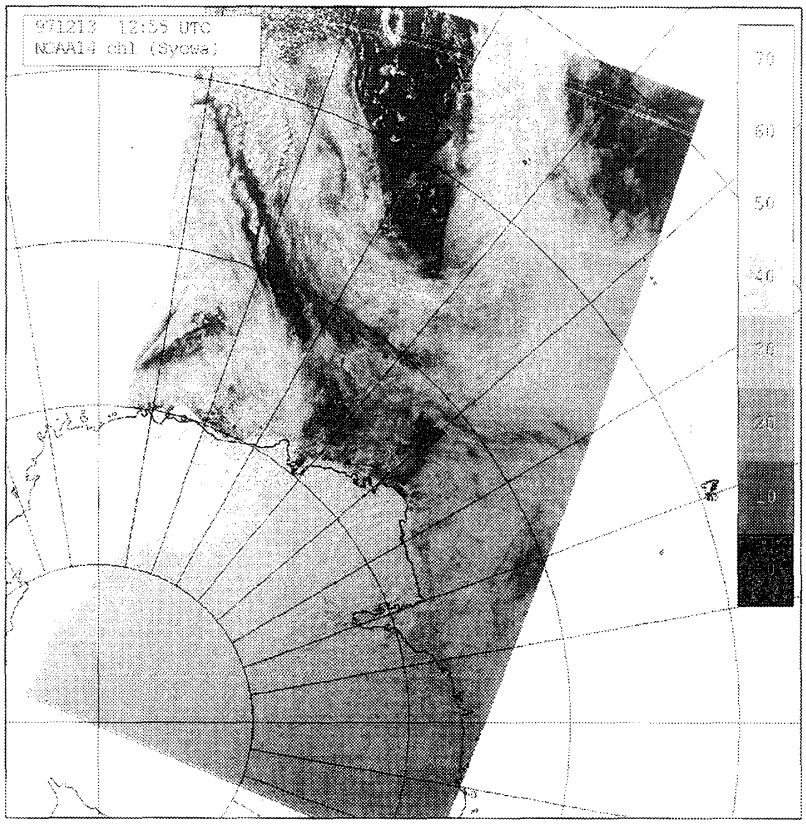
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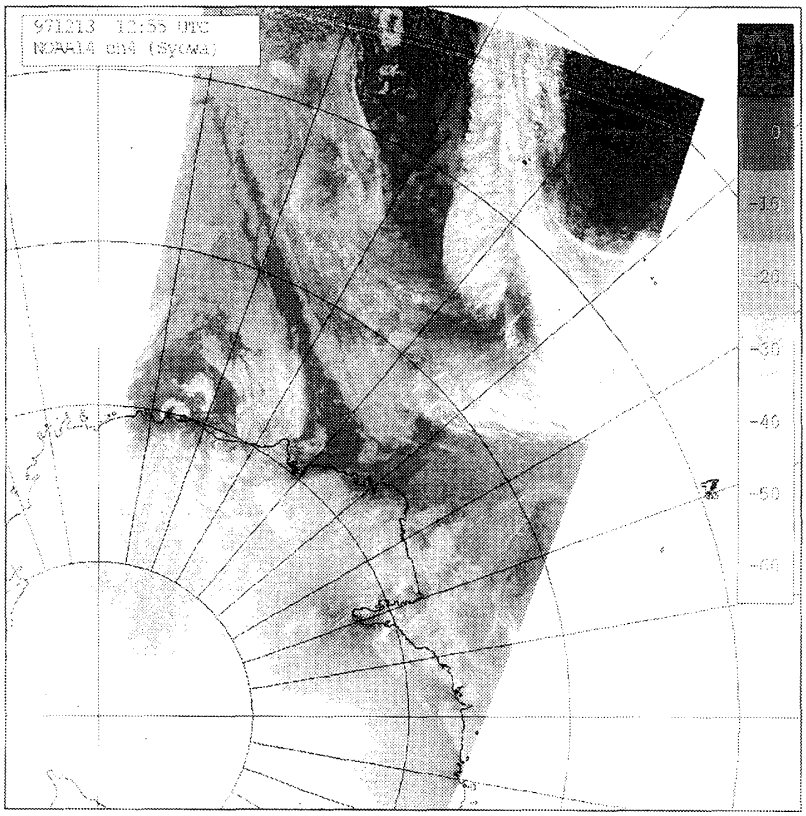
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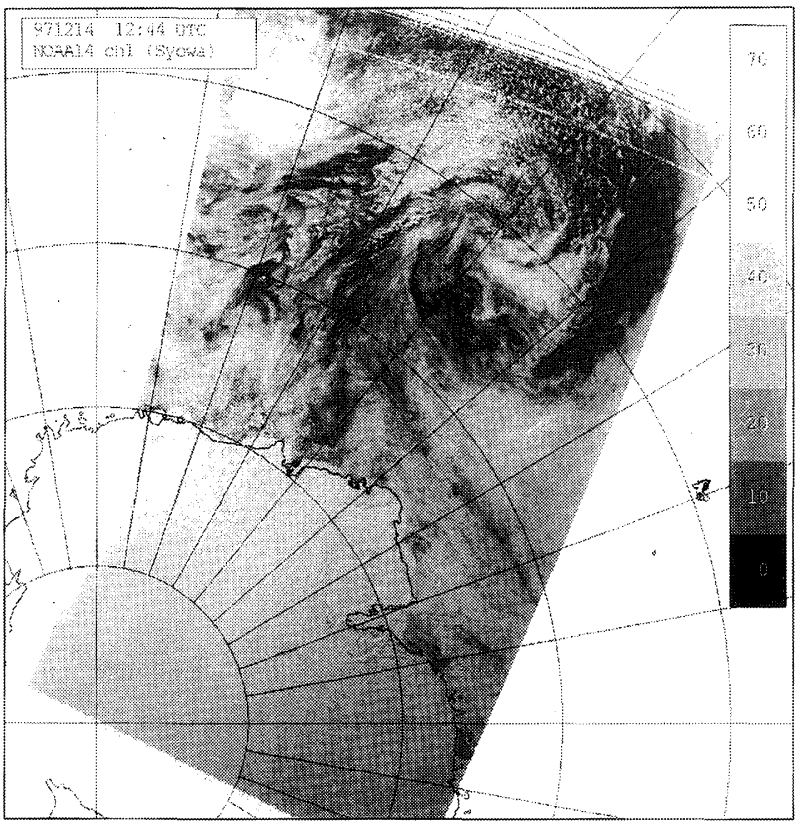
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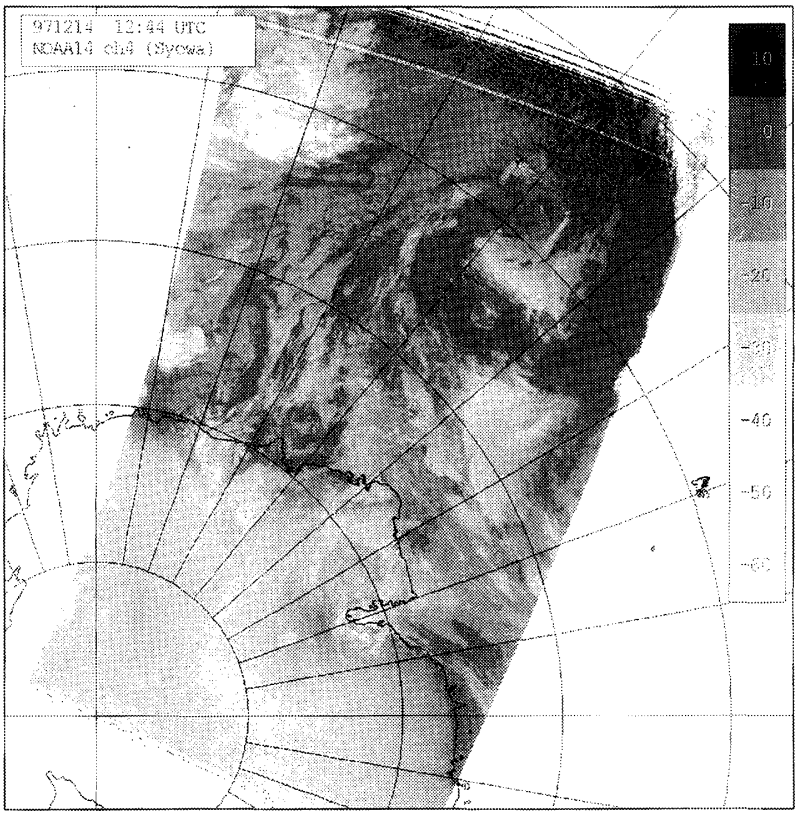
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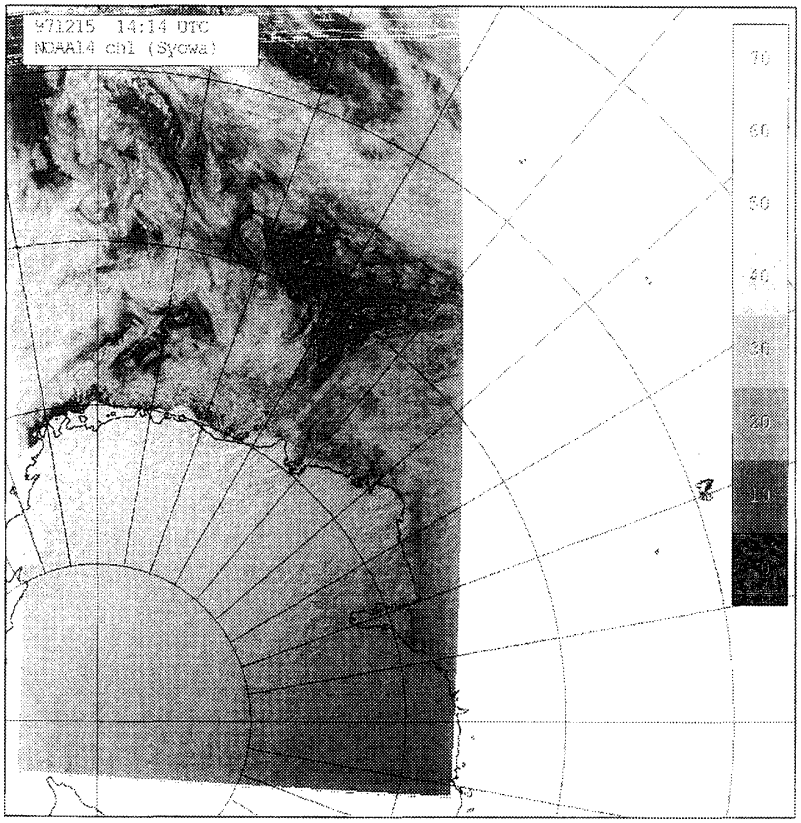
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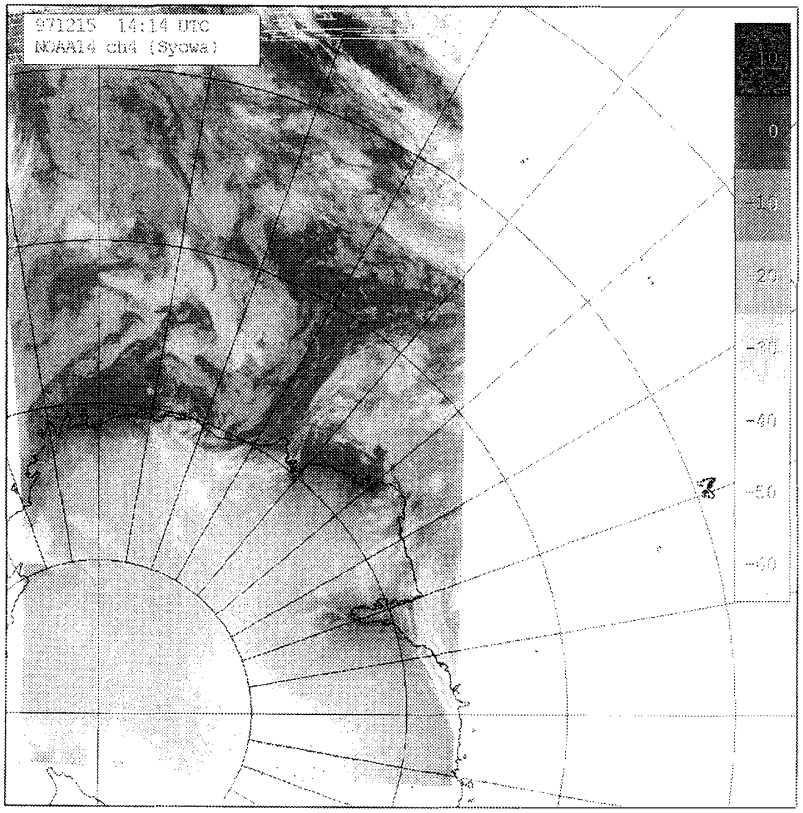
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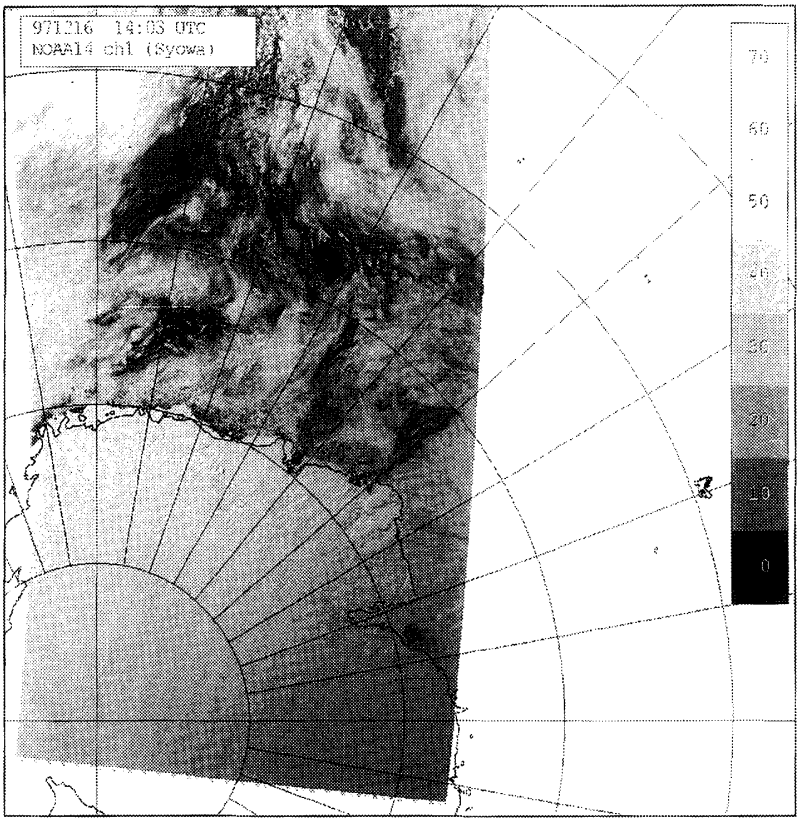
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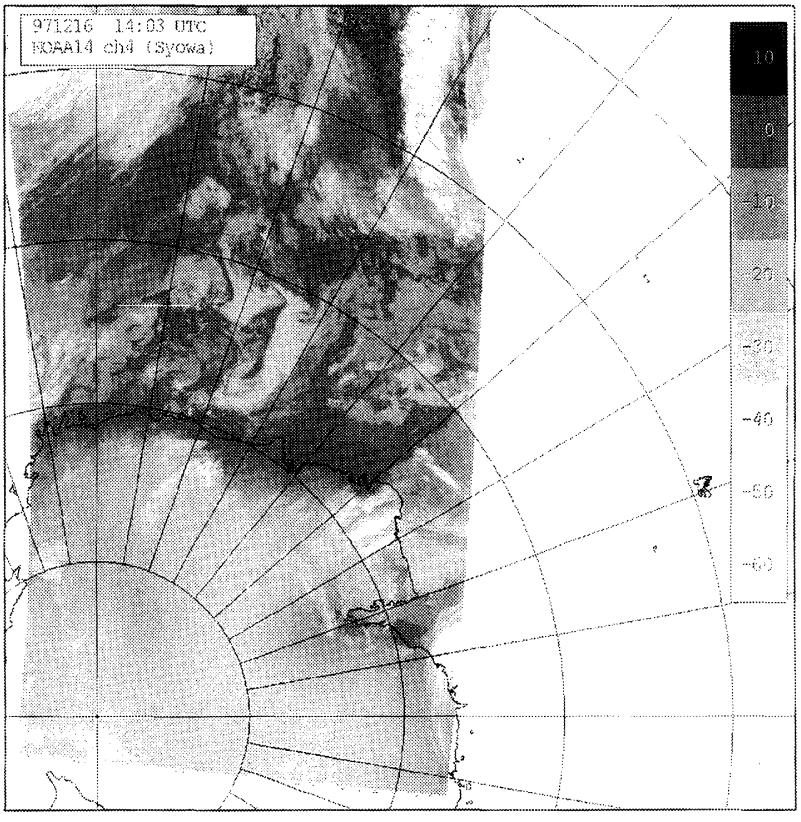
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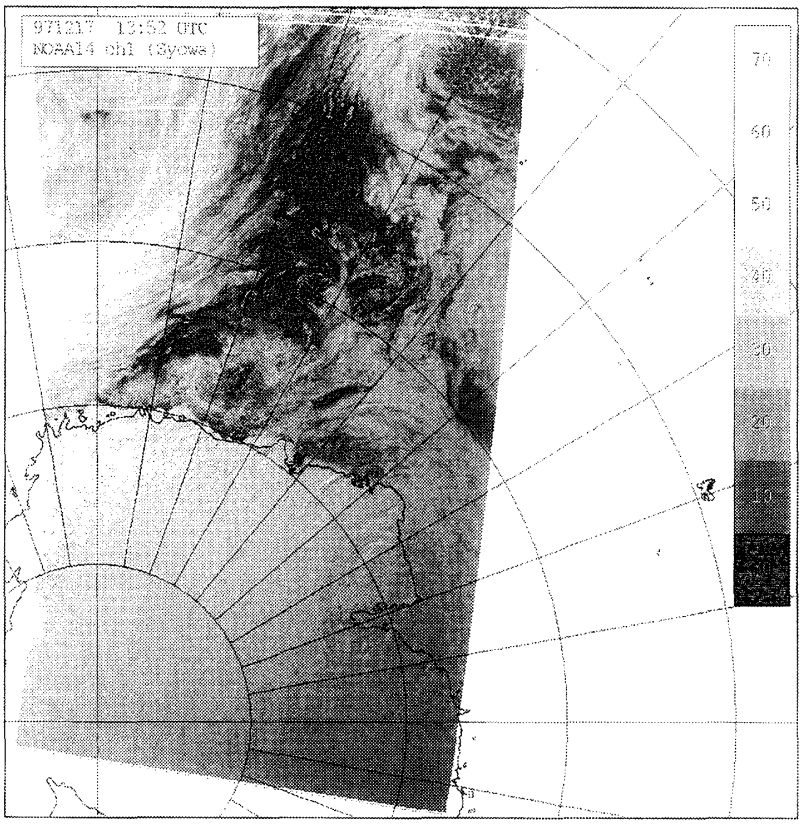
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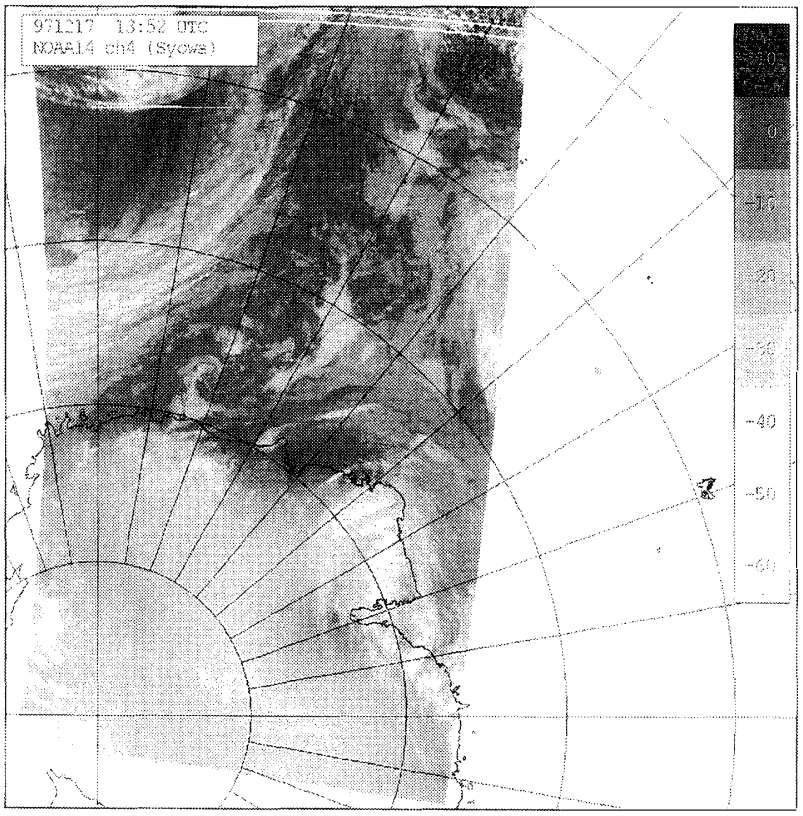
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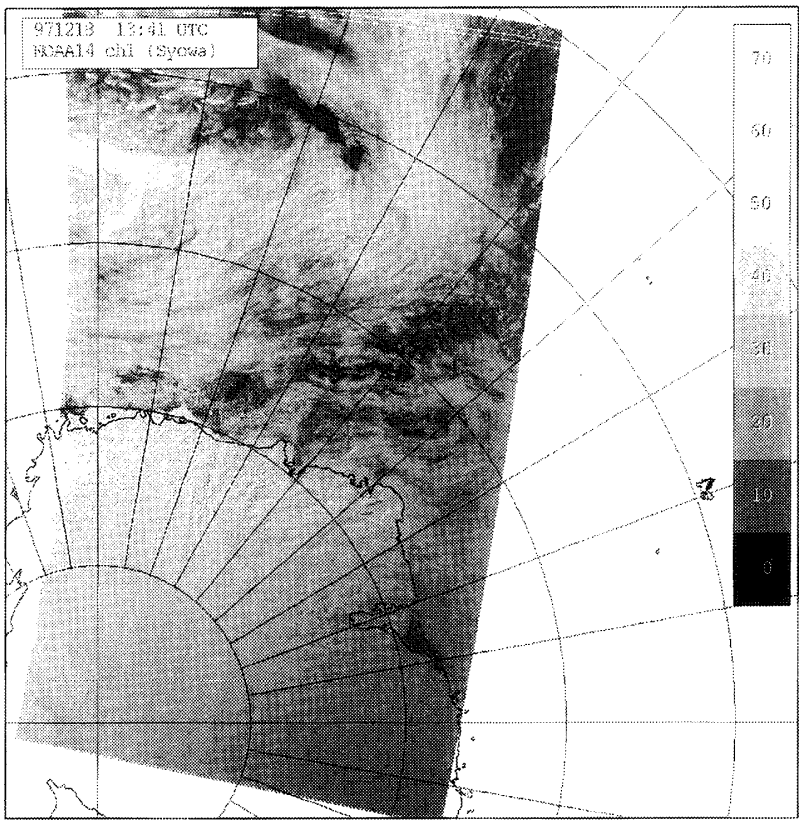
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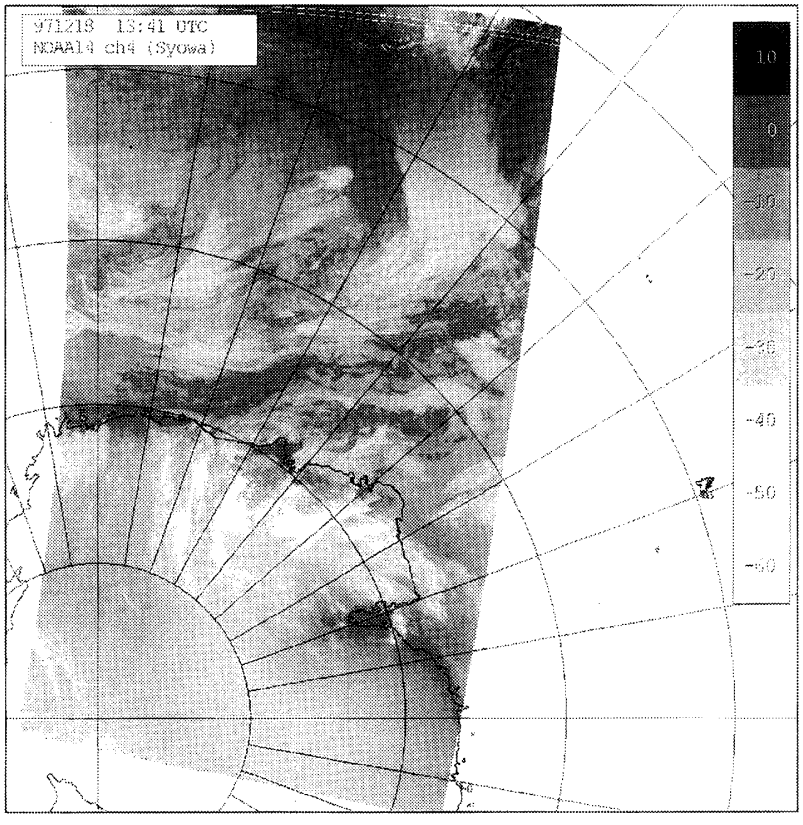
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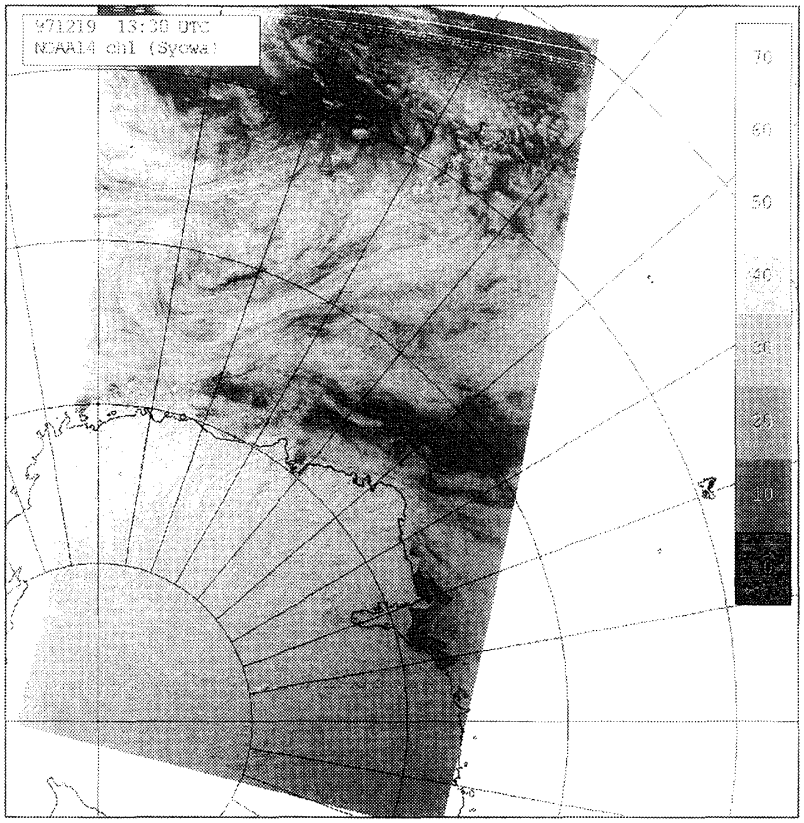
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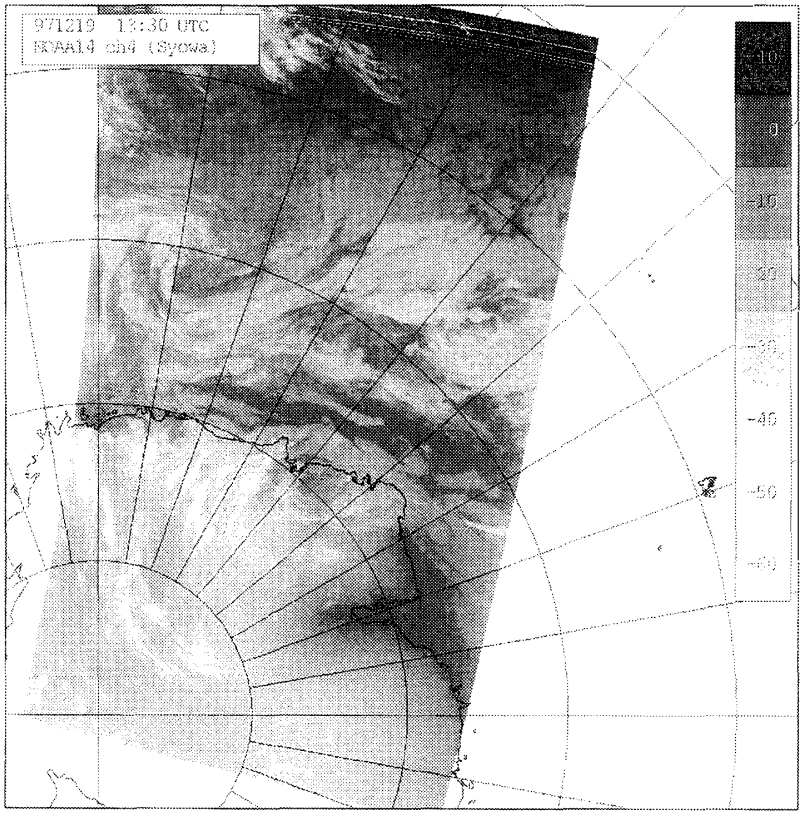
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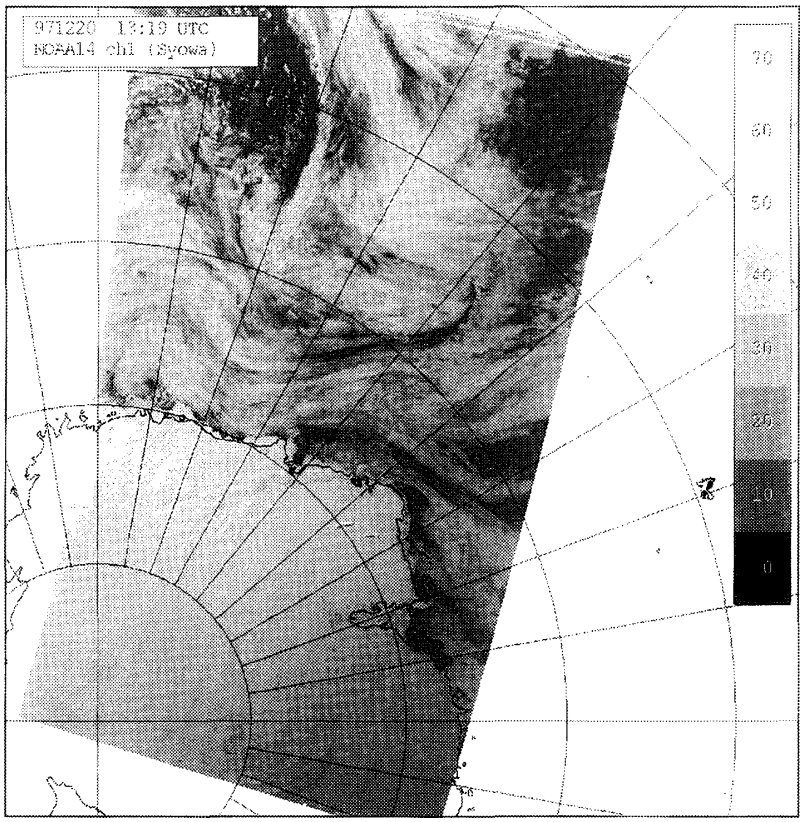
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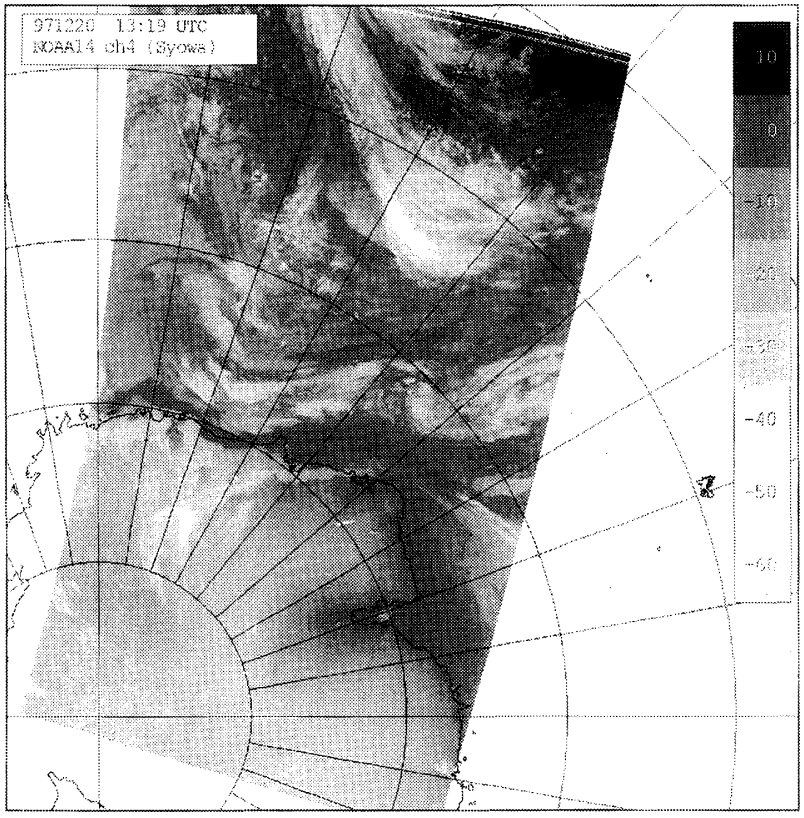
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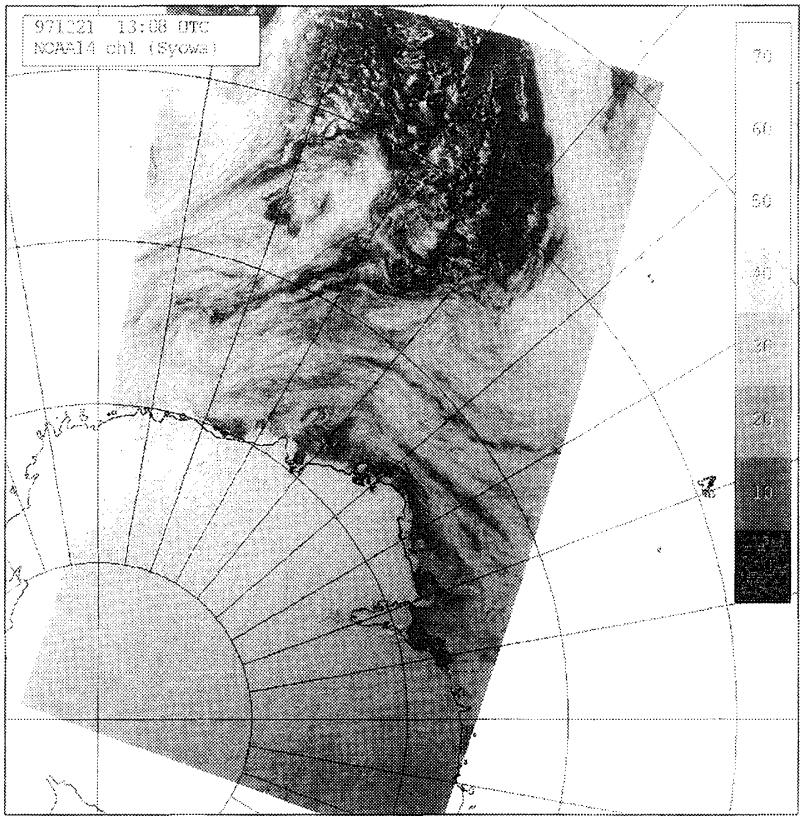
971221 13:08 UTC
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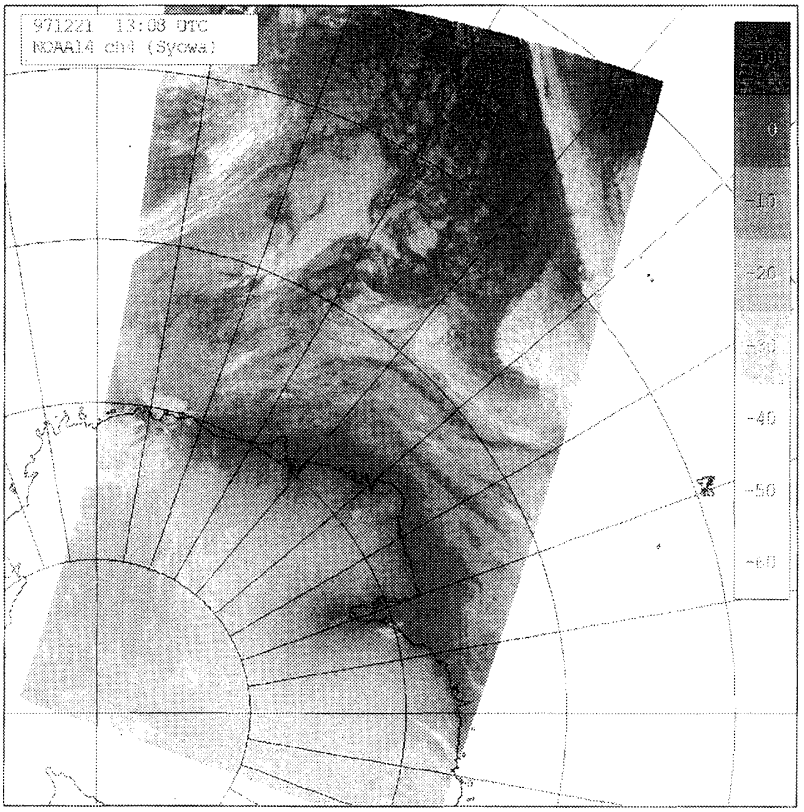
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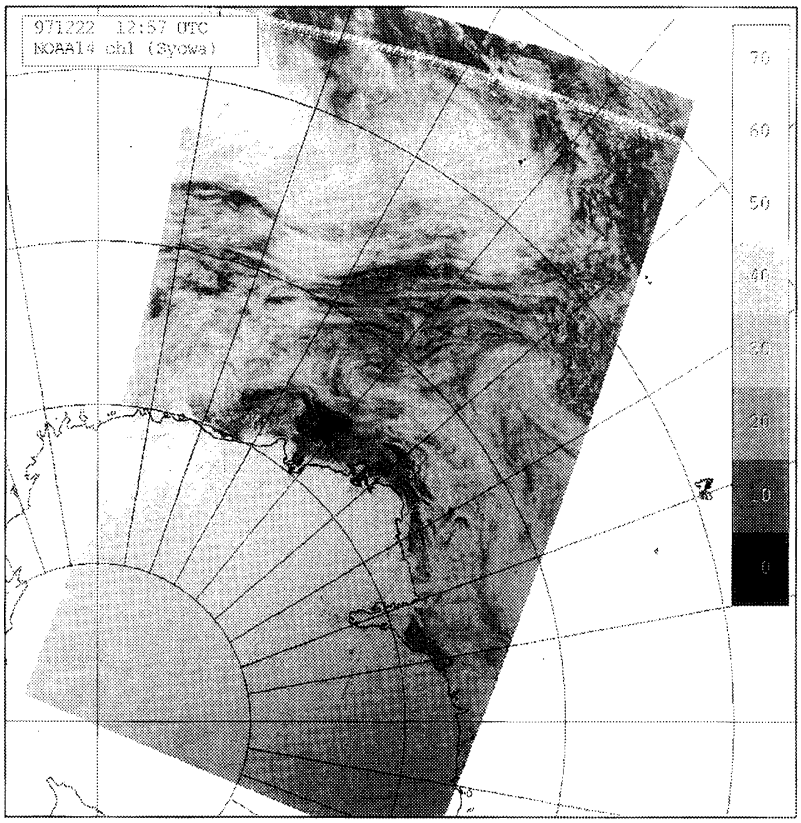
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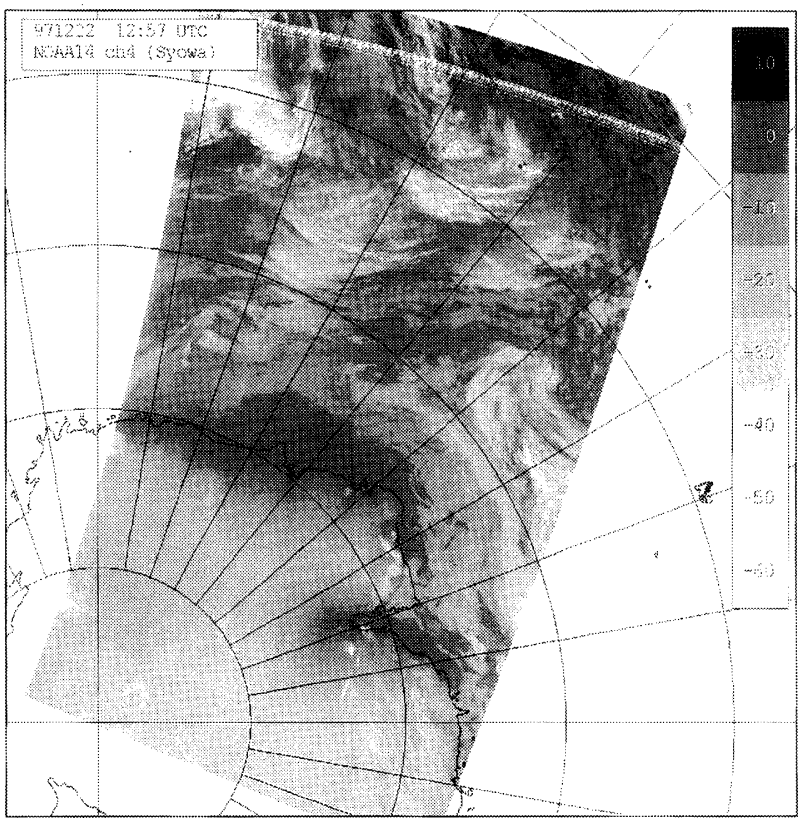
971222 12:57 UTC
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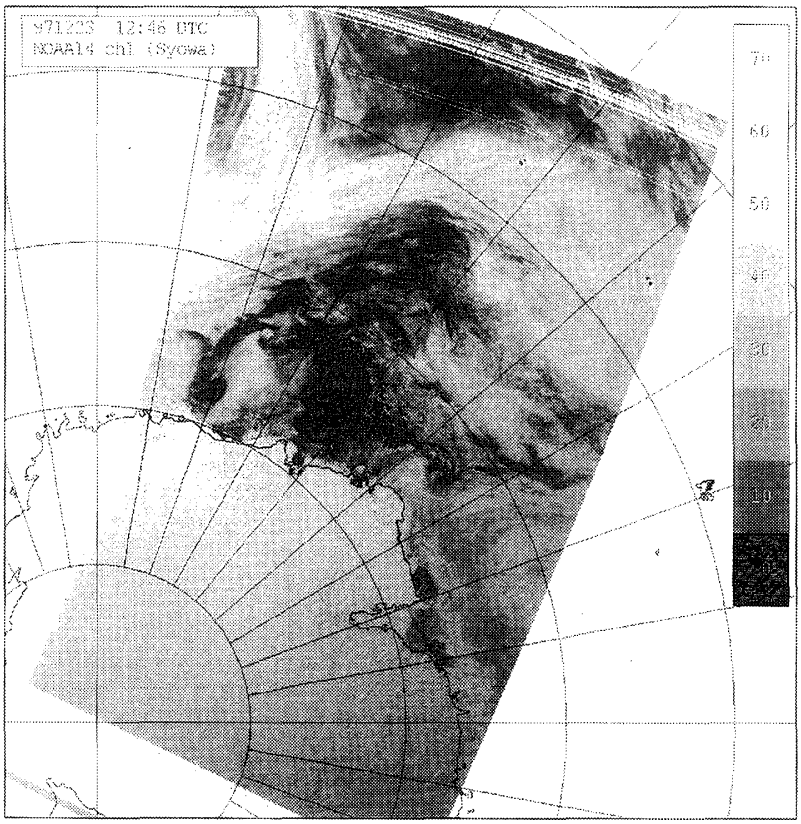
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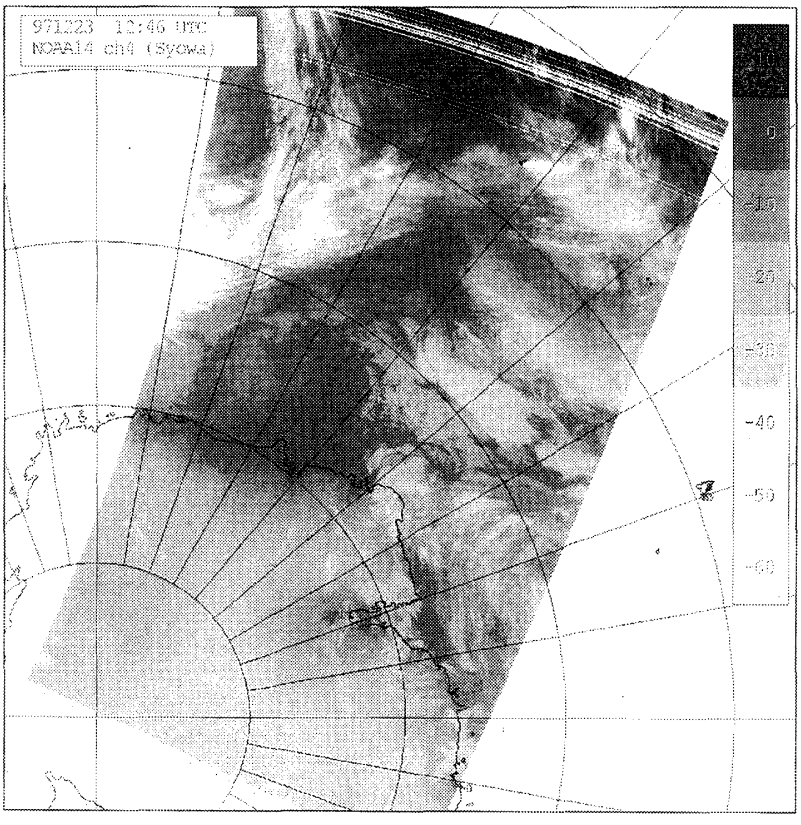
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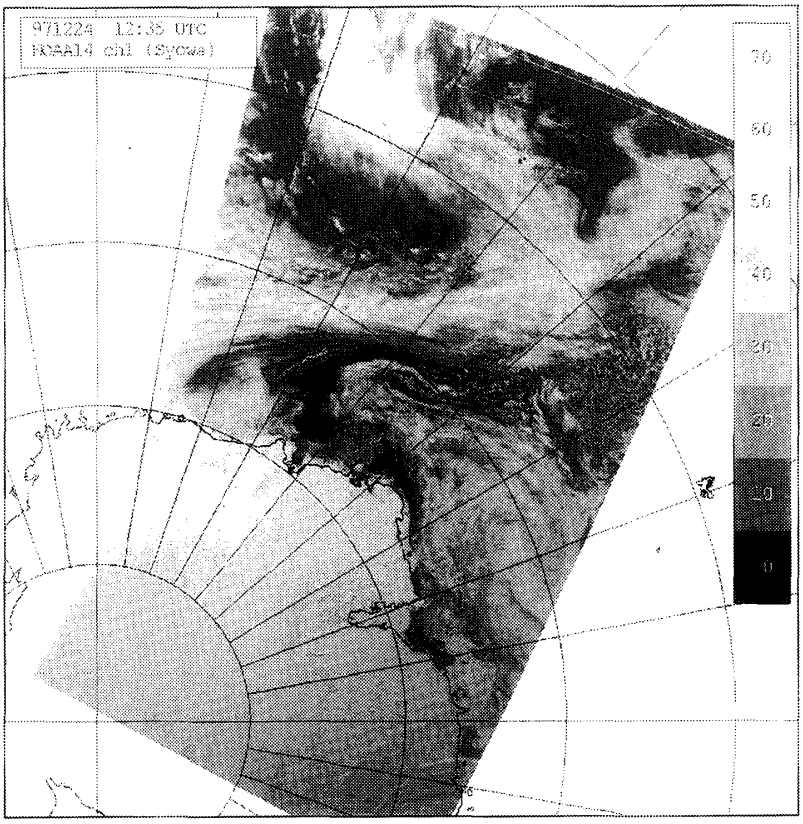
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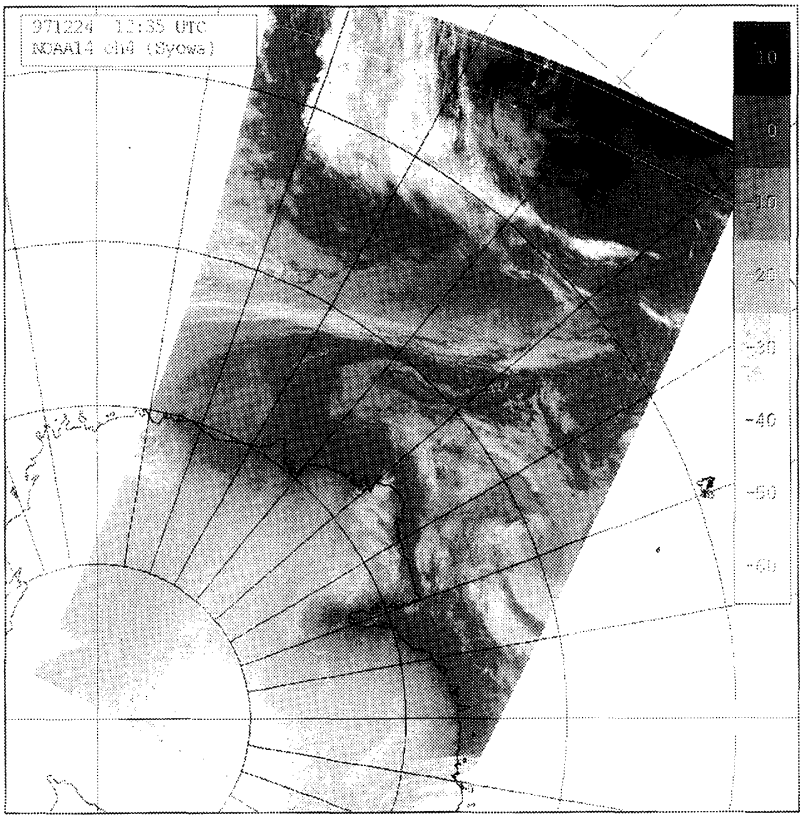
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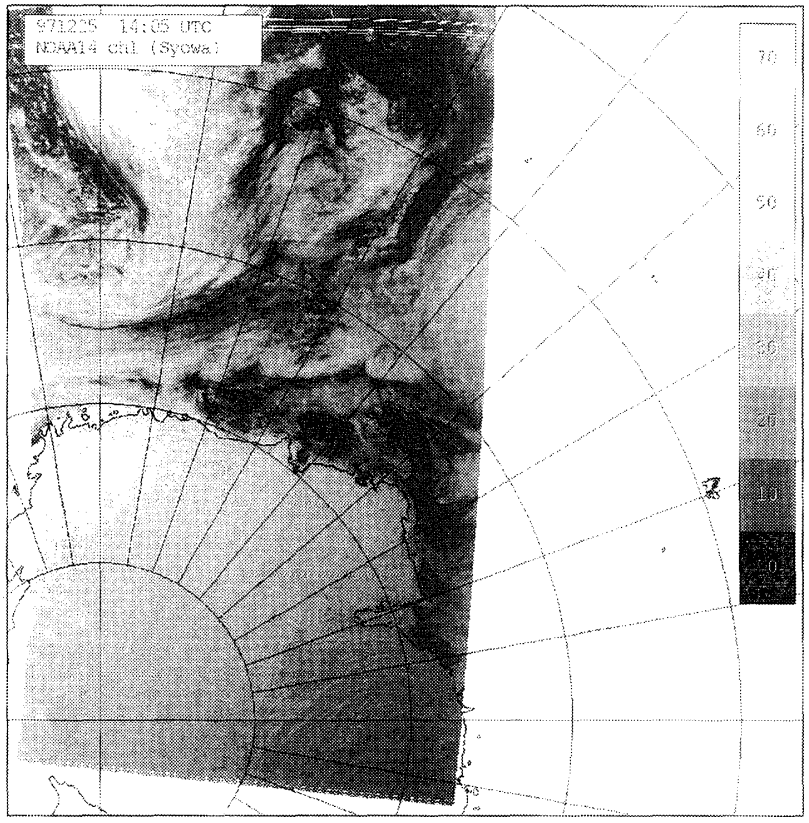
971225 14:05 UTC
NOAA14 ch1 (Syowa)
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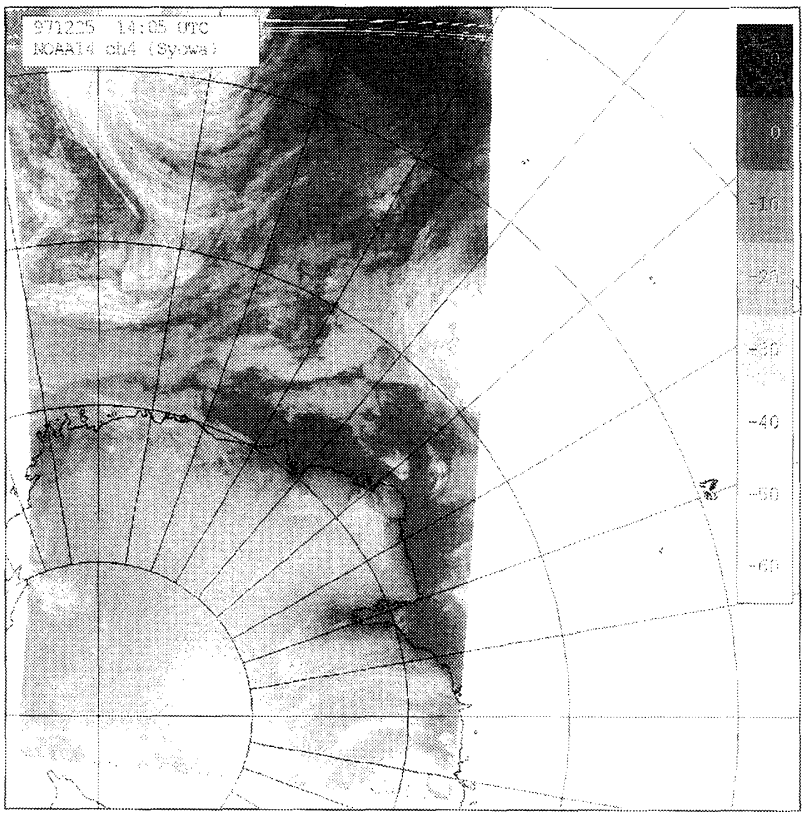
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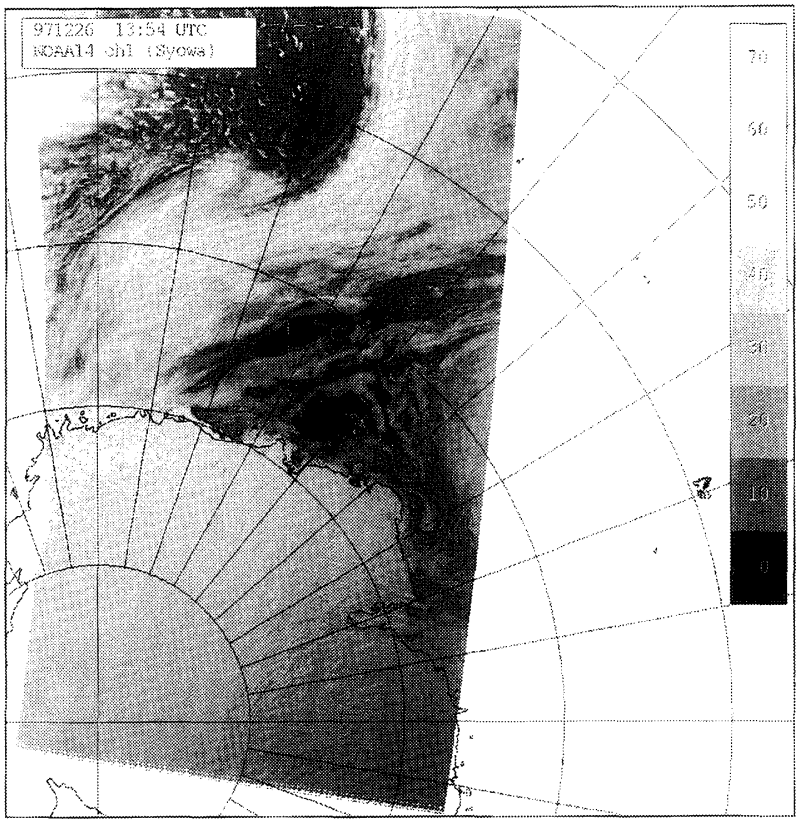
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NOAA14 ch1 (Syowa)
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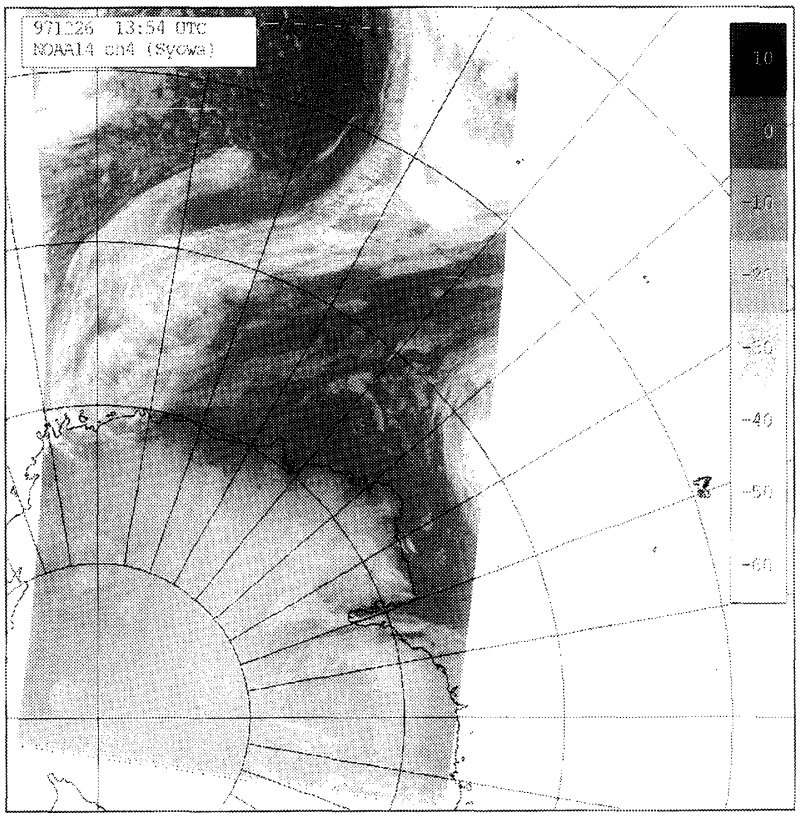
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NOAA14 ch4 (Syowa)
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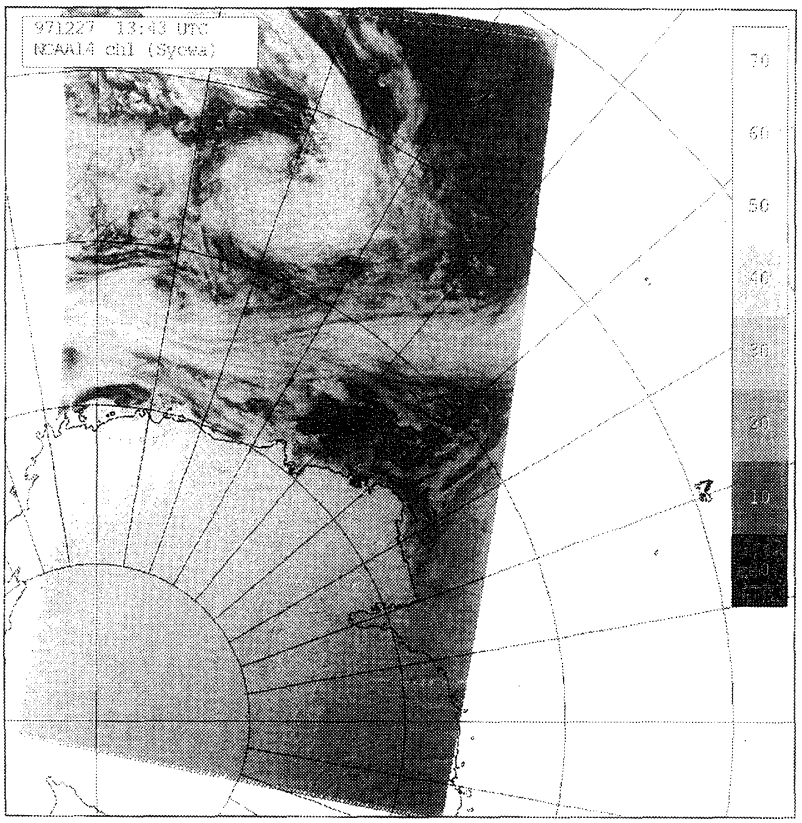
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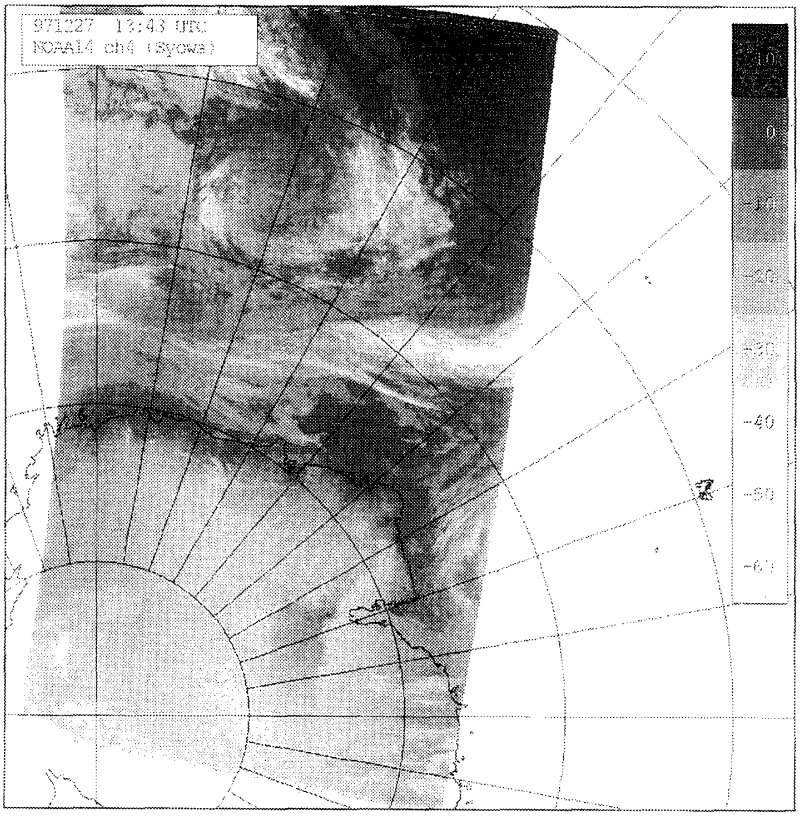
971227 13:43 UTC
NOAA14 ch4 (Syowa)
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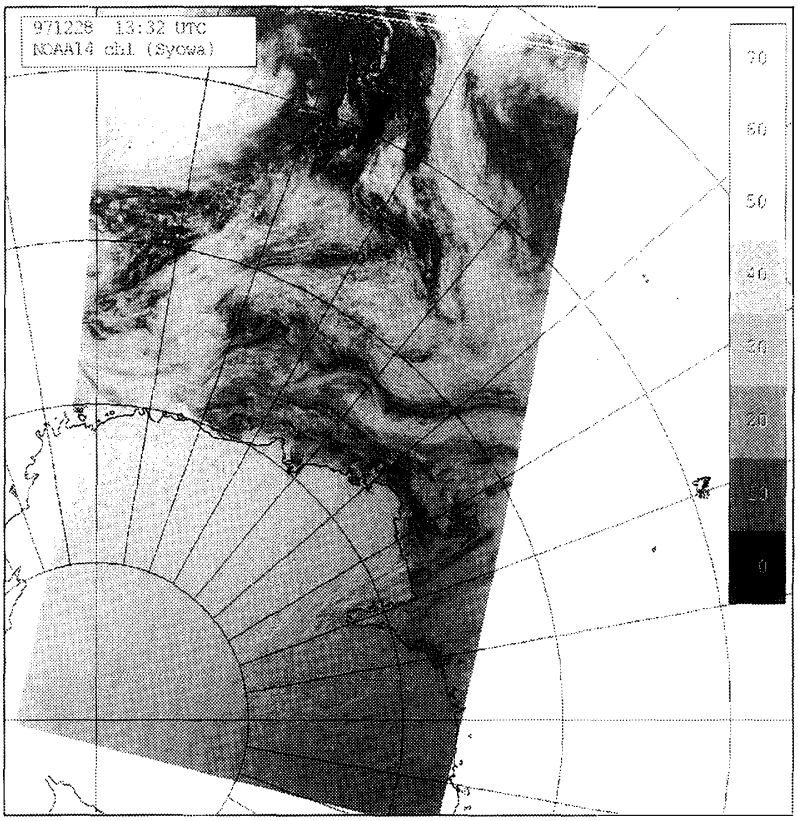
971228 13:32 UTC
NOAA14 ch1 (Syowa)
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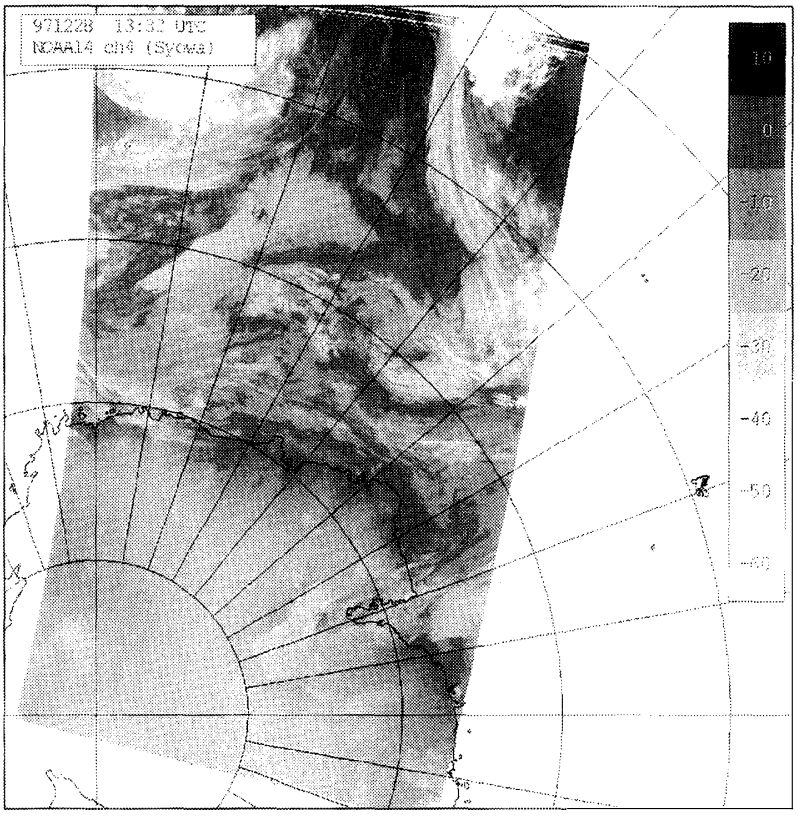
971228 13:32 UTC
NOAA14 ch4 (Syowa)
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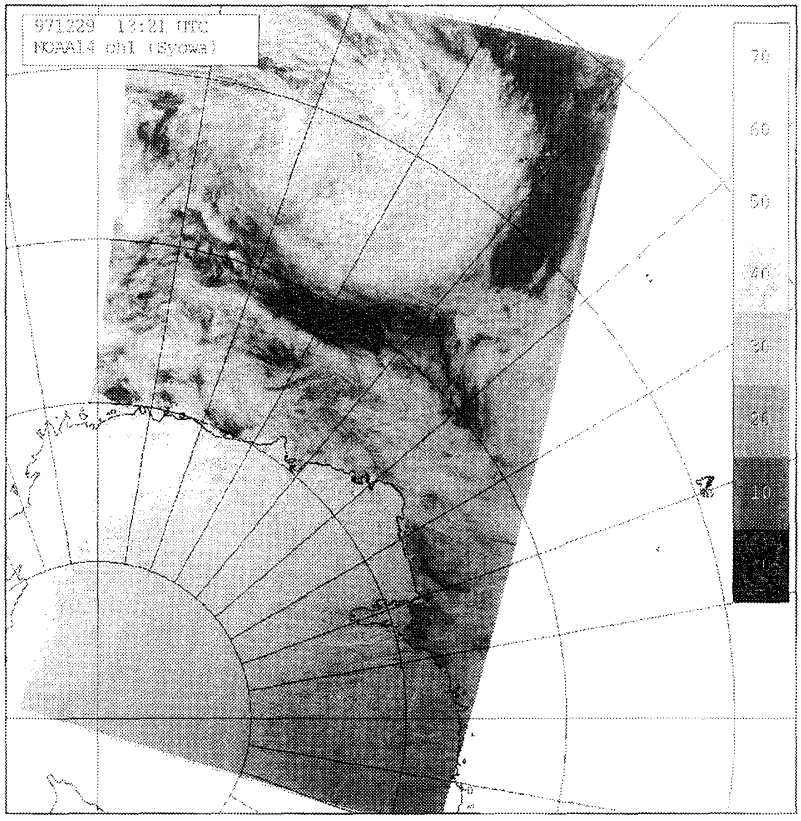
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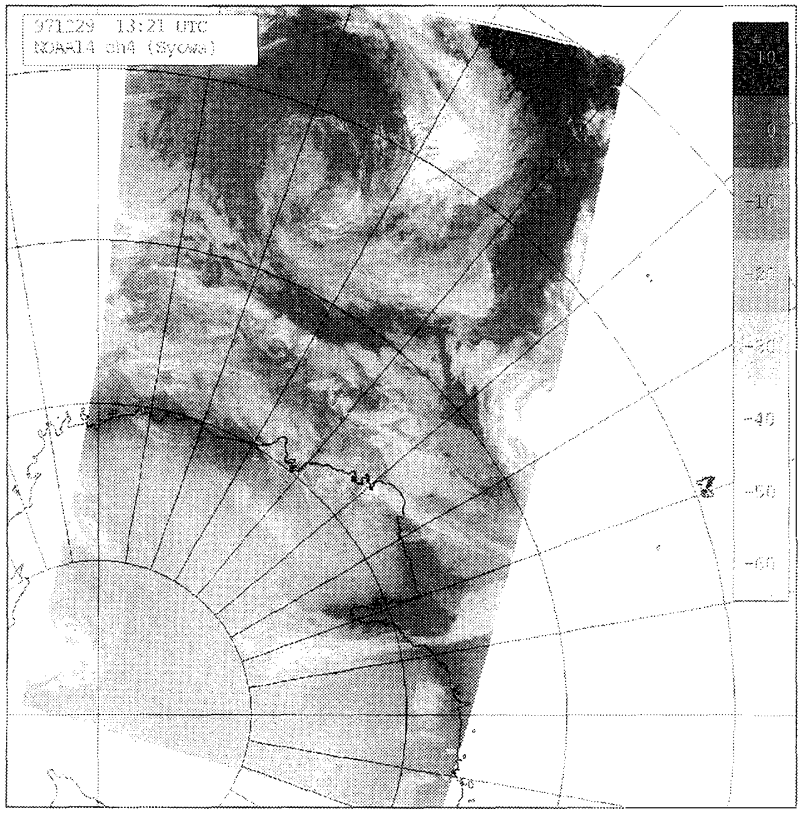
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NOAA14 ch4 (Syowa)
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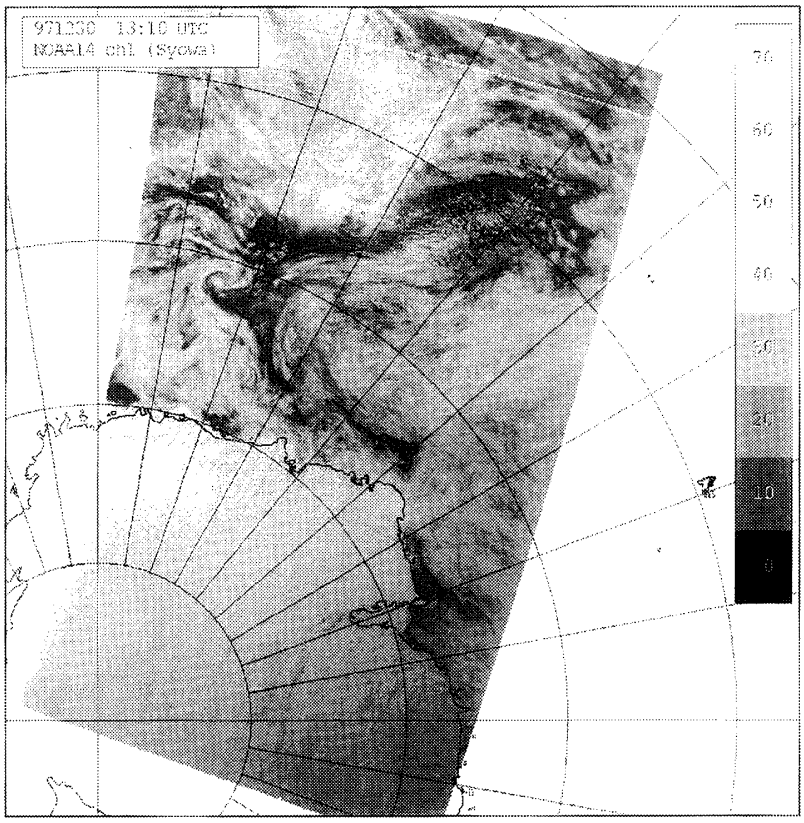
971230 13:10 UTC
NOAA14 ch1 (Syowa)
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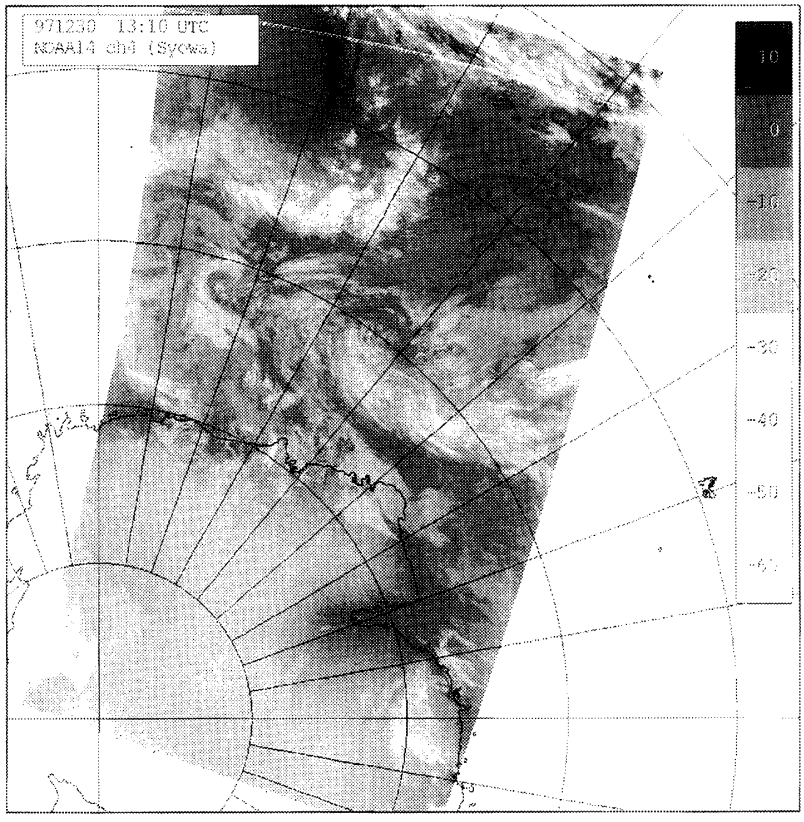
971230 13:10 UTC
NOAA14 ch4 (Syowa)
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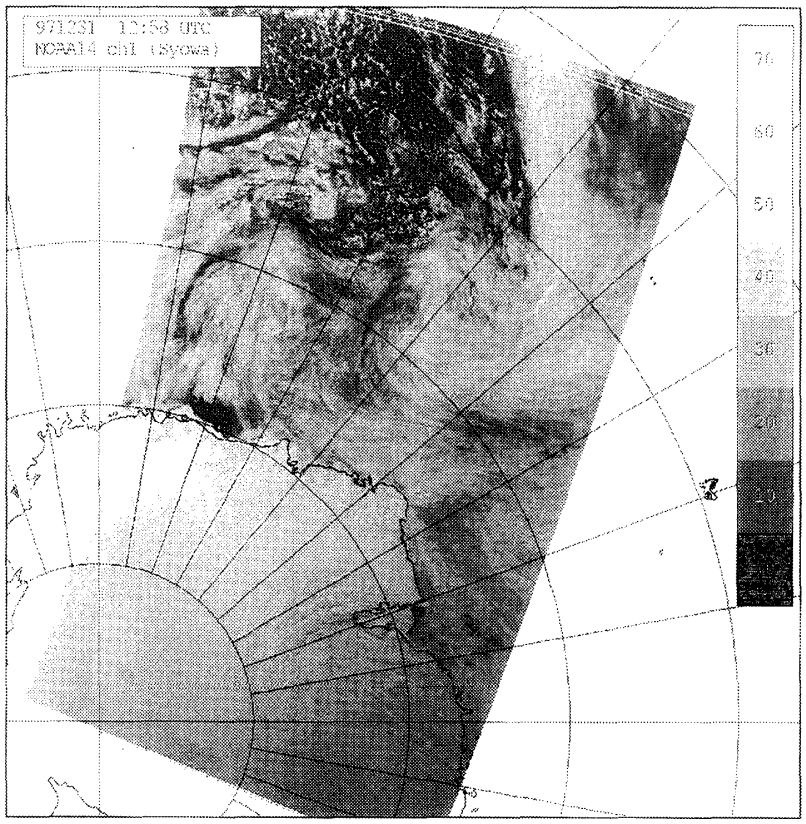
971231 12:58 UTC
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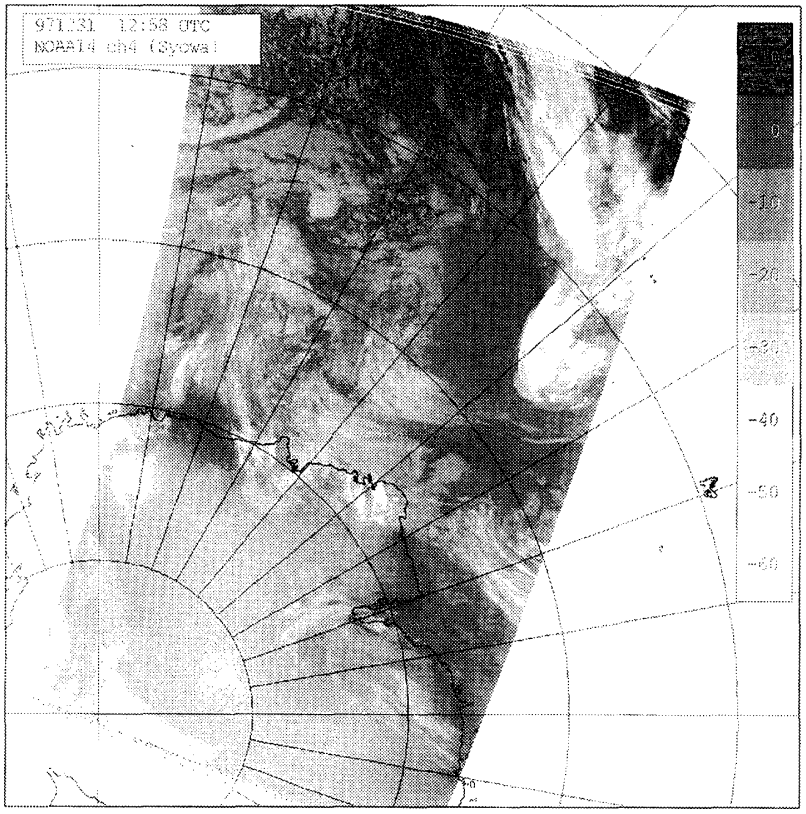
971231 12:58 UTC
NOAA14 ch4 (Syowa)
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