Naval Oceanographic and Atmospheric Research Laboratory

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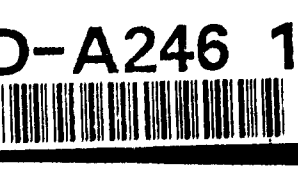

Monthly Mean Sea Ice Data from the Polar Ice Prediction System, the Regional Polar Ice Prediction System - Barents Sea, and the Regional Polar Ice Prediction System - Greenland Sea

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These working papers were prepared for the timely dissemination of information; this document does not represent the official position of NOARL.

ABSTRACT

The Polar Ice Prediction System (PIPS), the Regional Polar Ice Prediction System - Barents (RPIPS-B) and the Regional Polar Ice Prediction System - Greenland (RPIPS-G) are all operational sea ice forecasting systems that have been run daily at the Fleet Numerical Oceanography Center (FNOC) since September 1987, June 1989 and October 1991, respectively. The basis for all three models is the Hibler ice model (Hibler, 1979; 1980). The ice models are driven by monthly mean ocean currents and deep ocean heat fluxes derived from the Hibler and Bryan (1987) coupled ice-ocean model. They are also driven by atmospheric forcing from the Navy Operational Global Atmospheric Prediction System (NOGAPS) (Rosmond, 1981; Hogan et al., 1990). Each day a 24-hour forecast of PIPS, RPIPS-B and RPIPS-G is submitted and archived by Naval Oceanographic and Atmospheric Research Laboratory (NOARL). This technical note contains monthly mean values of geostrophic winds, ice drift, ice thickness and ice concentration derived from the PIPS and RPIPS-B 24-hour forecast from 1990 and 1991; and 24-hour forecast from RPIPS-G from 1991.

ACKNOWLEDGMENTS

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MONTHLY MEAN SEA ICE DATA FROM THE POLAR ICE PREDICTION SYSTEM (PIPS), THE REGIONAL POLAR ICE PREDICTION SYSTEM - BARENTS SEA (RPIPS-B) AND THE REGIONAL POLAR ICE PREDICTION SYSTEM - GREENLAND SEA (RPIPS-G)

The Polar Ice Prediction System (PIPS), the Regional Polar Ice Prediction System - Barents Sea (RPIPS-B) and the Regional Polar Ice Prediction System - Greenland Sea (RPIPS-G) are all operational sea ice forecasting systems which have been run daily at the Fleet Numerical Oceanography Center (FNOC) since September 1987, June 1989 and October 1991, respectively. The basis for all three models is the Hibler ice model (Hibler, 1979; 1980). The Hibler ice model calculates ice drift, ice thickness, ice concentration (ice edge) and the growth/decay of ice based on both dynamic and thermodynamic effects. The ice models are driven by monthly mean ocean currents and deep ocean heat fluxes derived from the Hibler and Bryan (1987) coupled ice-ocean model. They are also driven by atmospheric forcing from the Navy Operational Global Atmospheric Prediction System (NOGAPS) (Rosmond, 1981; Hogan et al., 1990).

PIPS forecasts over the entire Arctic basin, the Barents Sea and the Greenland/Norwegian Sea using a grid resolution of 127 km (Fig. 1). RPIPS-B, a higher resolution version of PIPS, forecasts over the Barents Sea and the western part of the Kara Sea using a grid resolution of 25 km (Fig. 2). RPIPS-G, another higher resolution version of PIPS, forecasts over the region adjacent to the East Greenland coast using a grid resolution of 20 km (Fig. 3). The timestep used by all three models is 6 hours. The length of the daily PIPS, RPIPS-B, and RPIPS-G forecast, 120 hours, is based on the length of the NOGAPS forecast. Each model is restarted daily using its own 24-hour forecast. Once per week, the PIPS, RPIPS-B and RPIPS-G ice concentration is reinitialized (updated) by the digitized hand analysis of ice concentration from the Naval Polar Oceanography Center (NPOC). If these restart fields are not available, each model initializes from a model derived climatology. To create these climatological data bases, each model was run for 3 years, using the 1986 NOGAPS forcing for each year until a "cyclic" equilibrium was reached. A detailed description of PIPS may be found in Preller and Posey (1989a) and Preller (1985). A detailed description of RPIPS-B may be found in Preller et al. (1989). A preliminary study of RPIPS-G may be found in Preller et al. (1990).

The following report, the third in a series (Preller and Posey, 1989c; Posey and Preller, 1990), contains monthly mean values of geostrophic wind, ice drift, ice thickness and ice concentration derived from PIPS and RPIPS-B 24-hour forecast from 1990 and 1991 and the 24-hour forecast from the RPIPS-G from 1991.

The scale factor for the geostrophic wind velocities, located in the lower right-hand corner of each figure is 20 m/sec for the PIPS results, 30 m/sec for the RPIPS-B and RPIPS-G results. The scale factor for all the model's ice drift velocities, located in the lower right-hand corner, is 30 cm/sec. RPIPS-B ice drift values are plotted at every other, RPIPS-G at every 4th point and PIPS at every point. The ice thickness contours for PIPS begins at 0.5 m and are incremented by 0.5 m. The ice thickness contours for RPIPS-B begin at 0.1 m and are incremented by 0.1 m. The ice thickness contours for RPIPS-G have two contour intervals, the first begins at 0.1 m and incremented by 0.1 m until the 0.4 m is reached; the second begins at 0.5 m and is incremented by 0.5 m. The ice concentration contours for PIPS and RPIPS-G begin at 0.2 (20%) and are incremented by 0.05 (5%). For the RPIPS-B ice concentration results, the contours begin at 0.2 (20%) and are incremented by 0.1 (10%).

SPECIFIC COMMENTS ON EACH YEAR

PIPS 1990 RESULTS

The PIPS 1990 results, a continuation of our last report, begin with October 1990. The 1990 PIPS monthly means were calculated from the 24-hour forecasts. Each day a 24-hour PIPS forecast is submitted by NOARL to run on the FNOC computer. The output from this forecast is brought back to NOARL and archived. In the past several years, PIPS has often forecasted excessive ice growth in the marginal ice zones during the winter season. During 1990, both corrections to NOGAPS and the ice model code resulted in more realistic ice concentration and ice thickness in the PIPS forecasts. Also during this period, NPOC, with the assistance of FNOC, incorporated a more fully automated technique of transmitting and quality controlling the ice concentration update to FNOC. As a direct result, the PIPS model's ice concentration was updated more frequently, 11 out of 13 weeks.

PIPS 1991 RESULTS

The 1991 PIPS monthly means were also calculated from the 24-hour forecast fields in the same way as the 1990 results. As seen before, the "Odden", a formation of very thin ice that protrudes east from the Greenland coast, appeared from February through April.

In May, 1990, the NOGAPS atmospheric model was upgraded by doubling the resolution. The new version of NOGAPS also included new products. One of these products is a surface wind stress field. The operational PIPS uses a constant drag coefficient (0.8×10^{-3}) and turning angle (23°) to determine surface stress while the NOGAPS surface stress is derived from variable planetary boundary layer conditions (Hogan et al., 1990). A statistical comparison to Arctic buoy data was performed to determine which surface stress field resulted in the most accurate ice drift. PIPS driven by high resolution NOGAPS stresses was shown to provide more accurate forecasts of ice drift. As a result of these tests, PIPS was upgraded during July 1991, to use the high resolution stresses from the NOGAPS model. To remain consistent, we have only plotted the geostrophic wind calculated from the NOGAPS surface pressures even though the surface stresses were used to calculate the ice drift.

Geostrophic winds and the resultant PIPS ice drift show the Arctic to be dominated by a clockwise circulation in the Beaufort and Chukchi Sea region for most of the year. This pattern begins to decay and reverses to a counter clockwise circulation in the summer. This reversal of the dominant anticyclonic gyre, usually occurring in August or September, appears to be due to an increase in the number of low pressure systems in this region during the late summer (Preller and Posey, 1989b). A return to the normal clockwise circulation usually begins in October. During 1991, the reversal of this circulation began in July. In August, a somewhat disorganized cyclonic circulation dominated the region north of the Canadian Archipelago and the region near the North Pole. The ice motion reverted back to the clockwise circulation in the Beaufort and Chukchi Sea regions in September.

During January through September of 1991, the PIPS model was updated by the NPOC ice concentration 37 out of 39 weeks.

RPIPS-B 1990 RESULTS

RPIPS-B was designed, at higher resolution than PIPS, in order to predict a more accurate location of the ice edge, obtain better resolution of straits, and to better define land and island boundaries. Similar to PIPS, the RPIPS-B results are a continuation from our previous report. Along with PIPS, each day a 24-hour RPIPS-B forecast was submitted by NOARL to run on the FNOC computer. The output from this forecast was brought back and archived. All of the RPIPS-B results shown were calculated from the 24-hour forecast field. Similar to PIPS, RPIPS-B was updated each week with ice concentration data from NPOC.

As in the PIPS results, RPIPS-B during this time compared well with observed ice concentrations as a direct result of the regular weekly updating of the ice concentration (11 out of 13 weeks).

RPIPS-B was restarted from climatology on November 25 and again on December 2. These restarts were due to a computer systems problem that caused the destruction of the area in which the model's daily restart fields were stored.

RPIPS-B 1991 RESULTS

January through September, RPIPS-B was updated regularly each week with the NPOC analysis, which assisted in the realistic forecasts in the Barents region.

During May 1991, RPIPS-B, like PIPS, was upgraded to use the high resolution surface stresses from the NOGAPS model. A validation study was performed in order to justify an upgrade to use the new product from NOGAPS. As with the PIPS results, the RPIPS-B ice drift results were improved by using the higher resolution surface stresses.

RPIPS-G 1991 RESULTS

RPIPS-G was designed also, at higher resolution than PIPS, in order to predict a more accurate location of the ice edge, obtain better resolution of the Fram Strait and to better define land and island boundaries. Included here are results from RPIPS-G that were archived during the model's OPTEST, from March 1991 through June 1991. RPIPS-G was declared operational in October 1991. Along with PIPS and RPIPS-B, each day a 24-hour RPIPS-G forecast is submitted by NOARL to run on the FNOC computer. The output from this forecast is brought back and archived. All of the RPIPS-G results shown were calculated from the 24-hour forecast field. Similar to both PIPS and RPIPS-B, RPIPS-G is updated each week with ice concentration data from NPOC. This includes a correction to the ice thickness field as well. If the data indicated that no ice actually existed in a grid cell that contained ice, the ice was removed and heat was added to the mixed layer to keep ice from immediately growing back. If the data indicated that ice actually existed in a grid cell that contained only open water, ice was added to the cell according to the following equation:

If $A > 0.5$	$H = 0.4$ m
If $A < 0.5$	$H = 0.2$ m

where A is the ice concentration (0.5 = 50%) and H is the ice thickness.

As seen in the PIPS model, the "Odden" appeared in RPIPS-G but with greater detail than PIPS. The feature started to occur in late March, peaking during April then slowly disappearing in May.

On May 21, RPIPS-G was reinitialized from the model climatology because of computer problems at FNOC.

During the melting period, July through September, RPIPS-G compared well with the weekly ice concentration maps from NPOC. Also during this time, the model was updated 15 out of 17 weeks, which assisted the model in producing realistic results.

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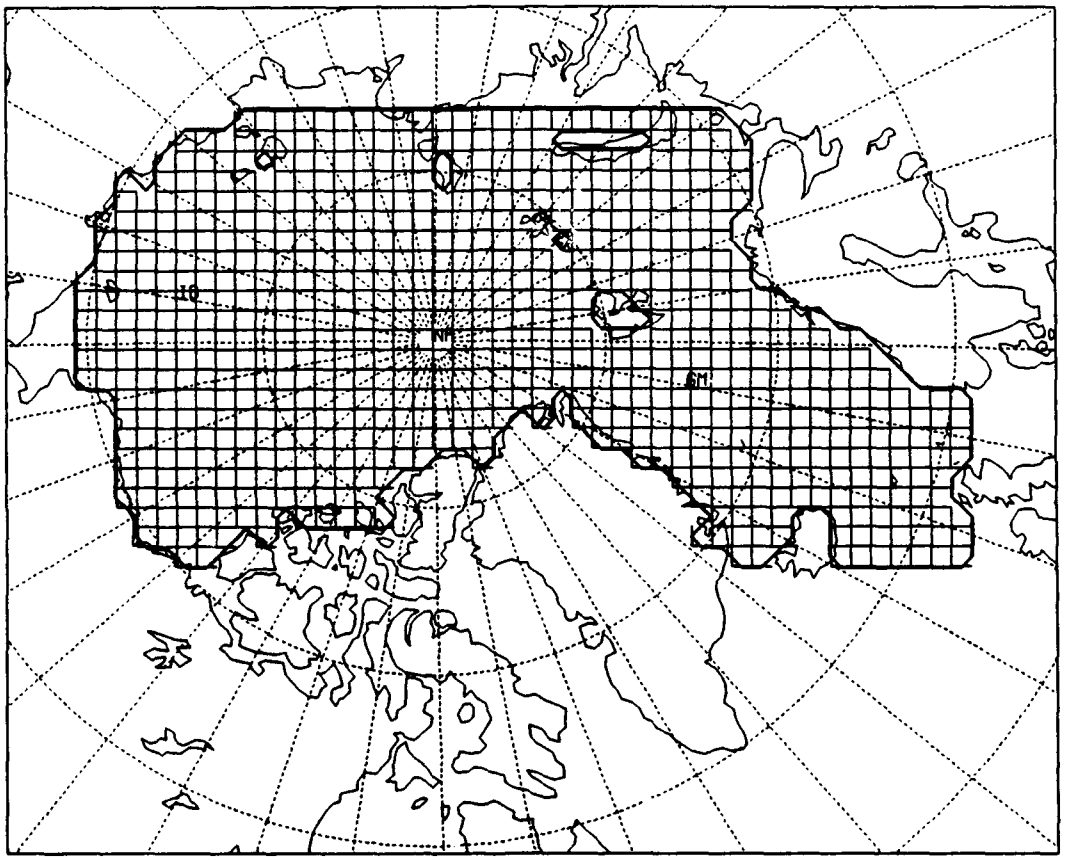

Figure 1. PIPS domain with the 127 km resolution grid overlaid.

PIPS 1990

MONTHLY MEANS

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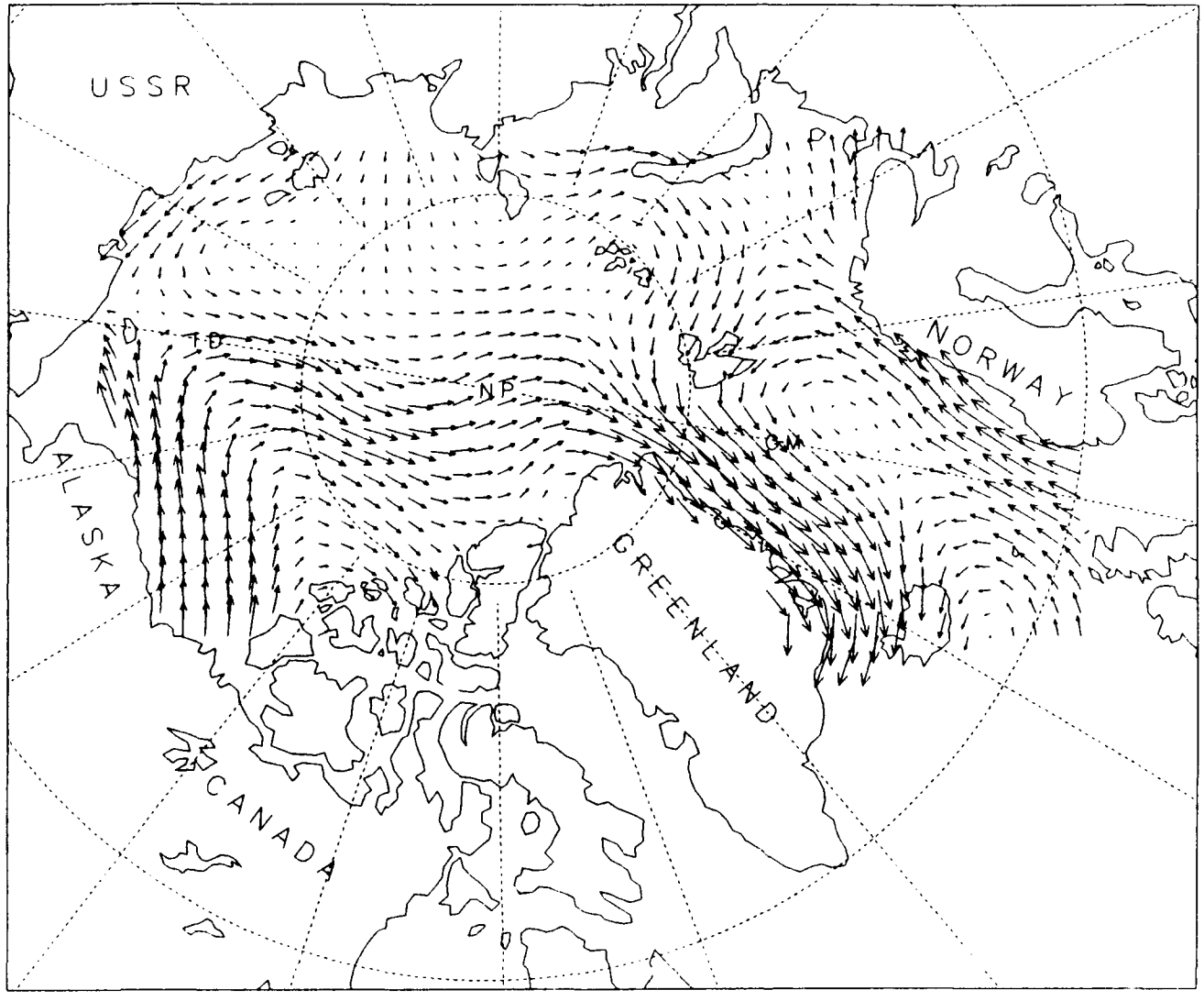

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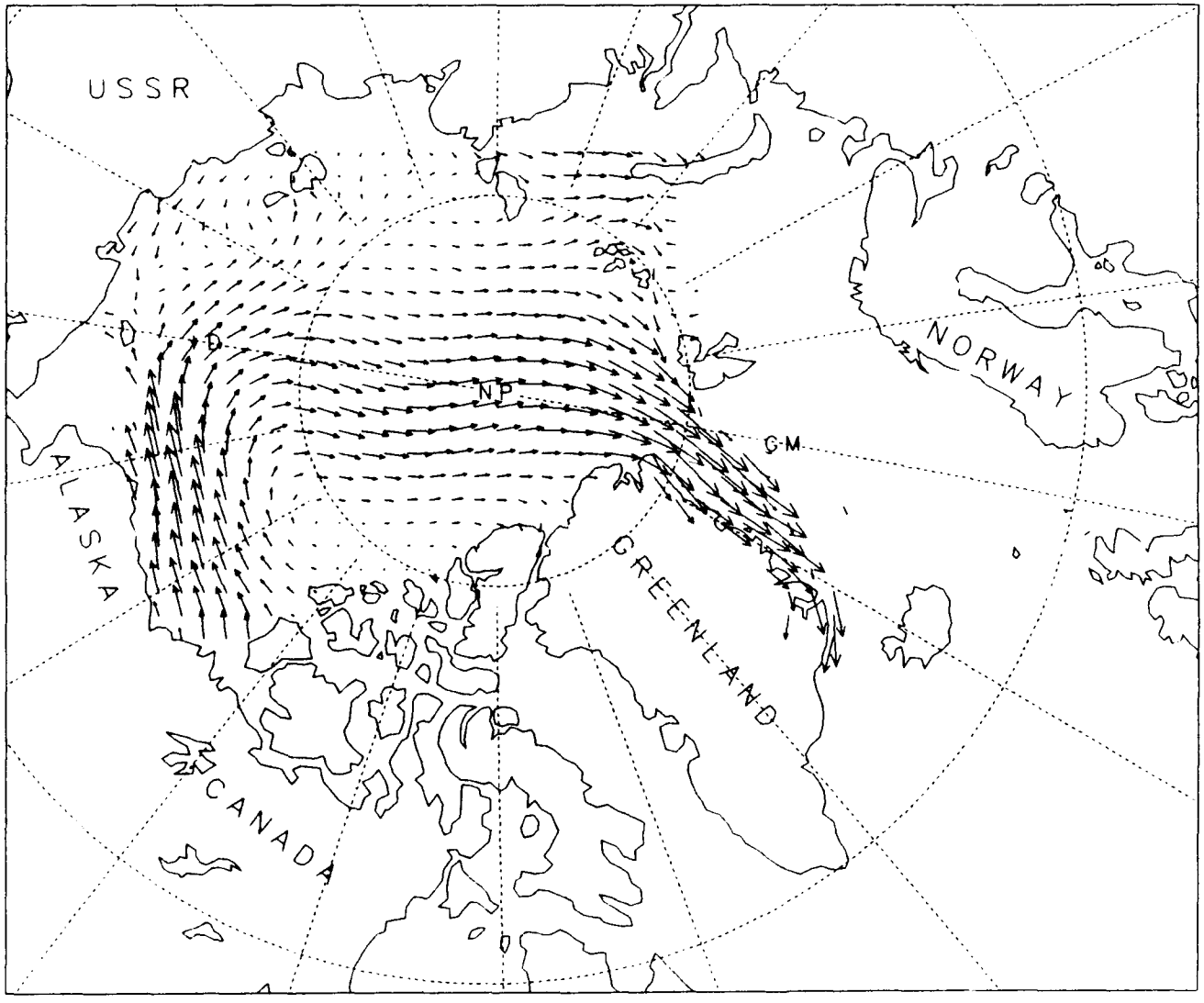

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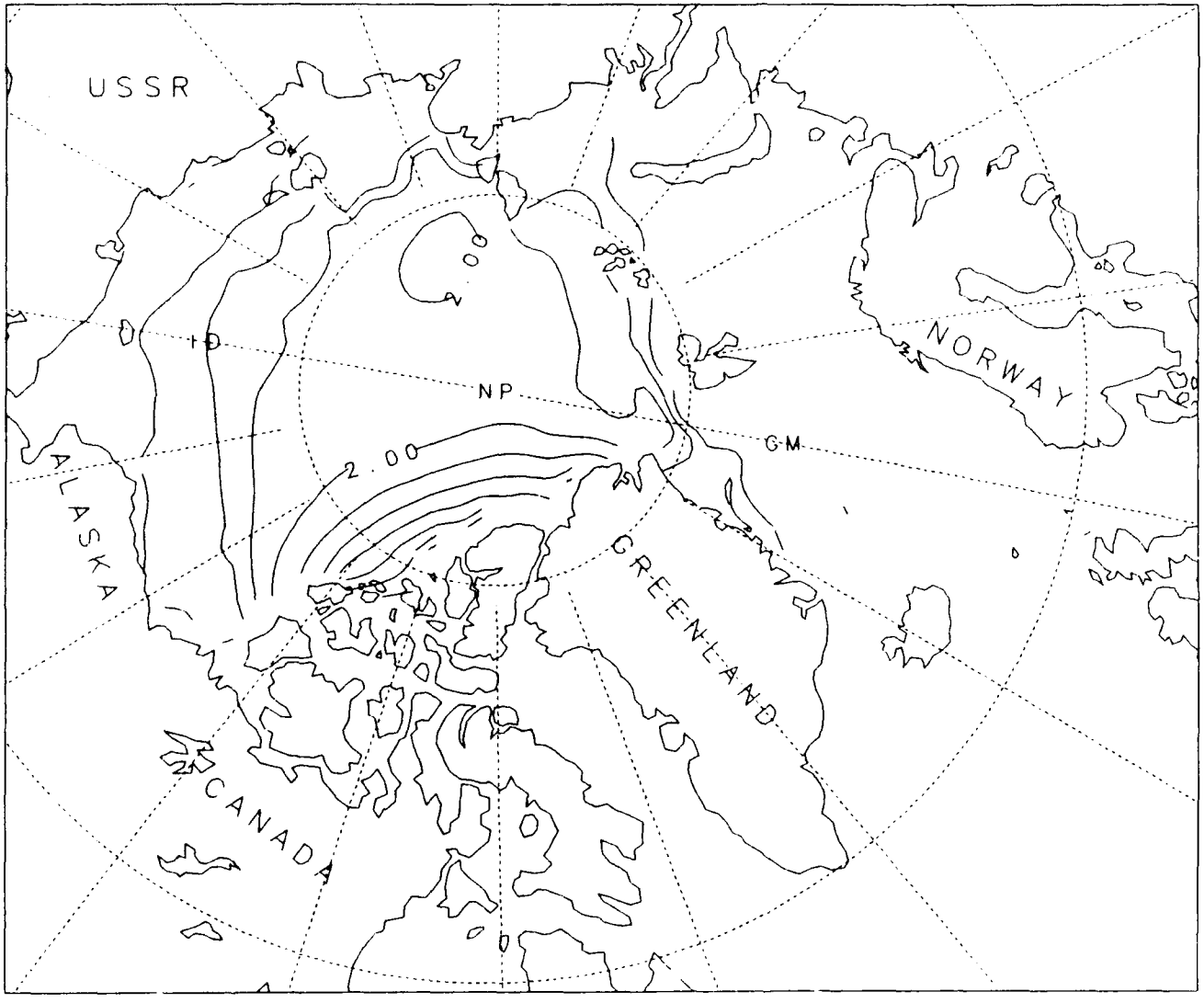

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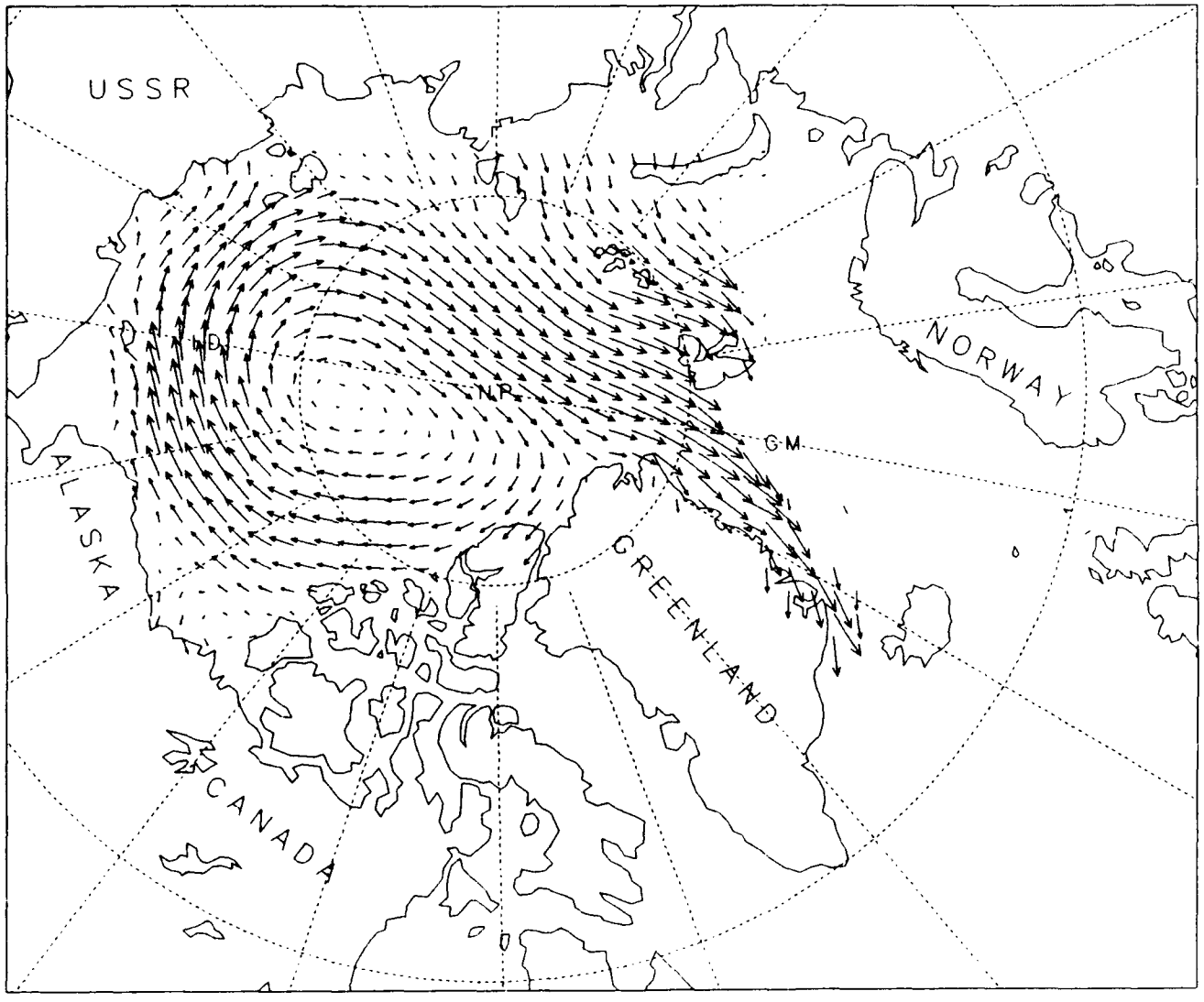

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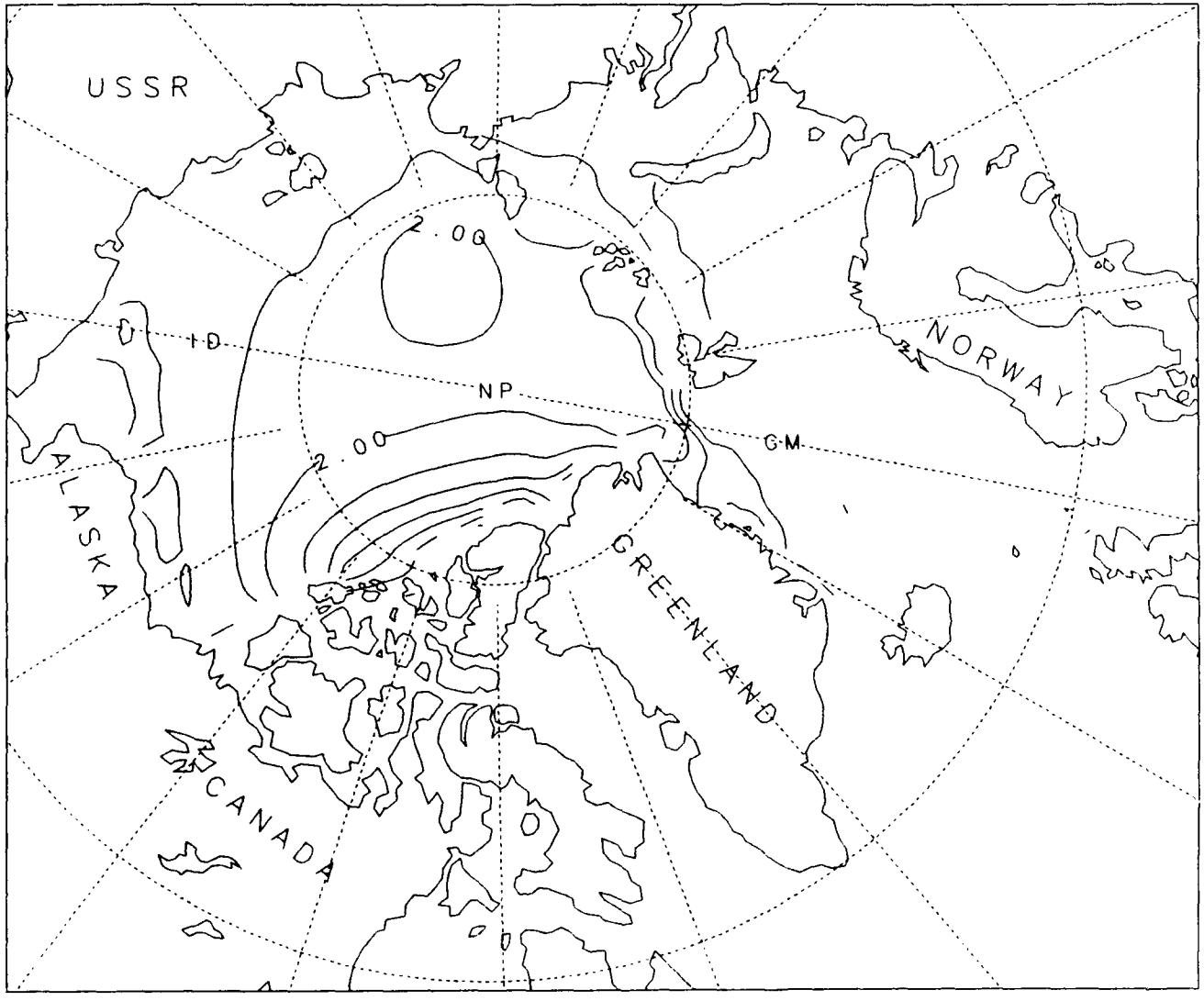

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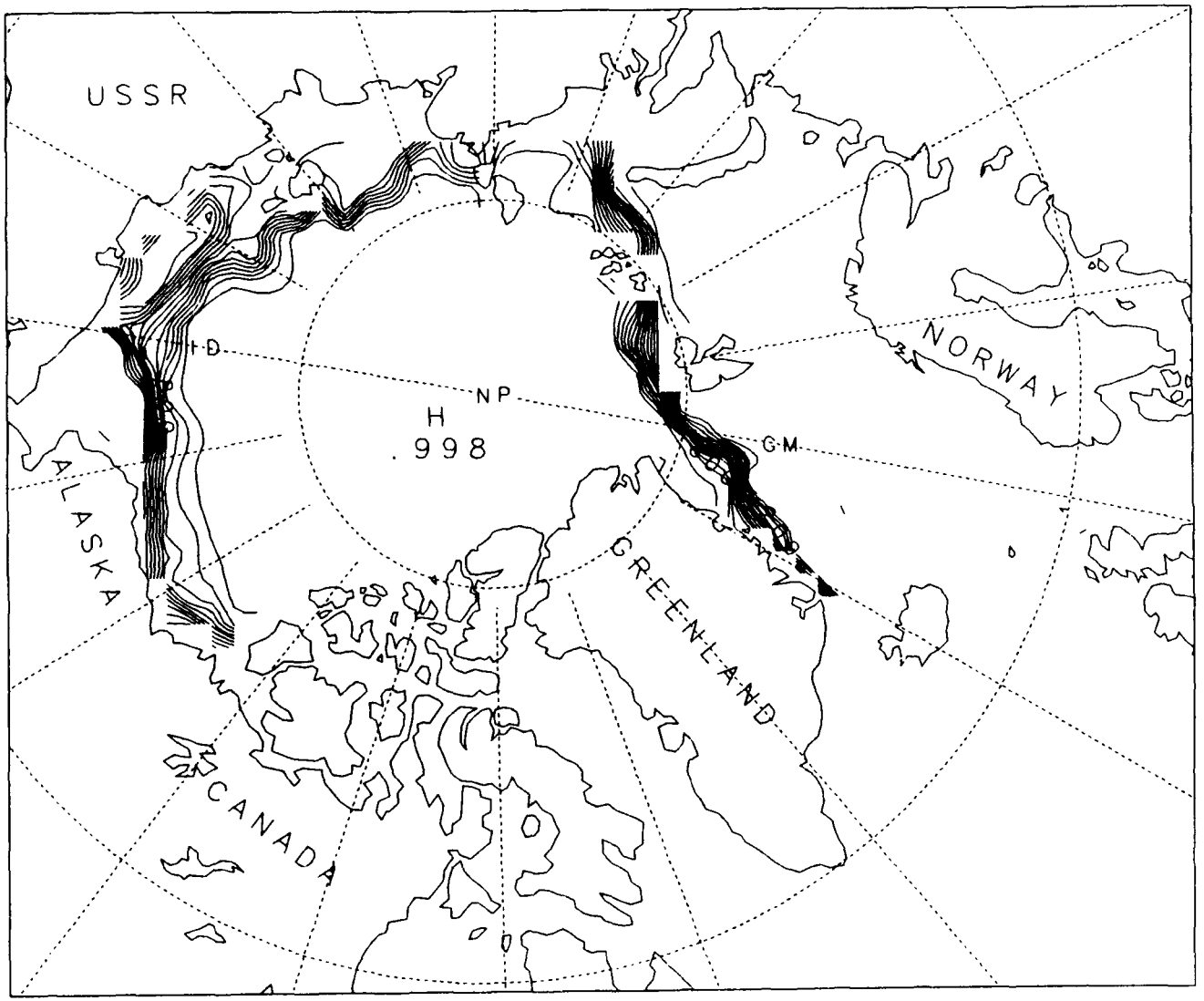

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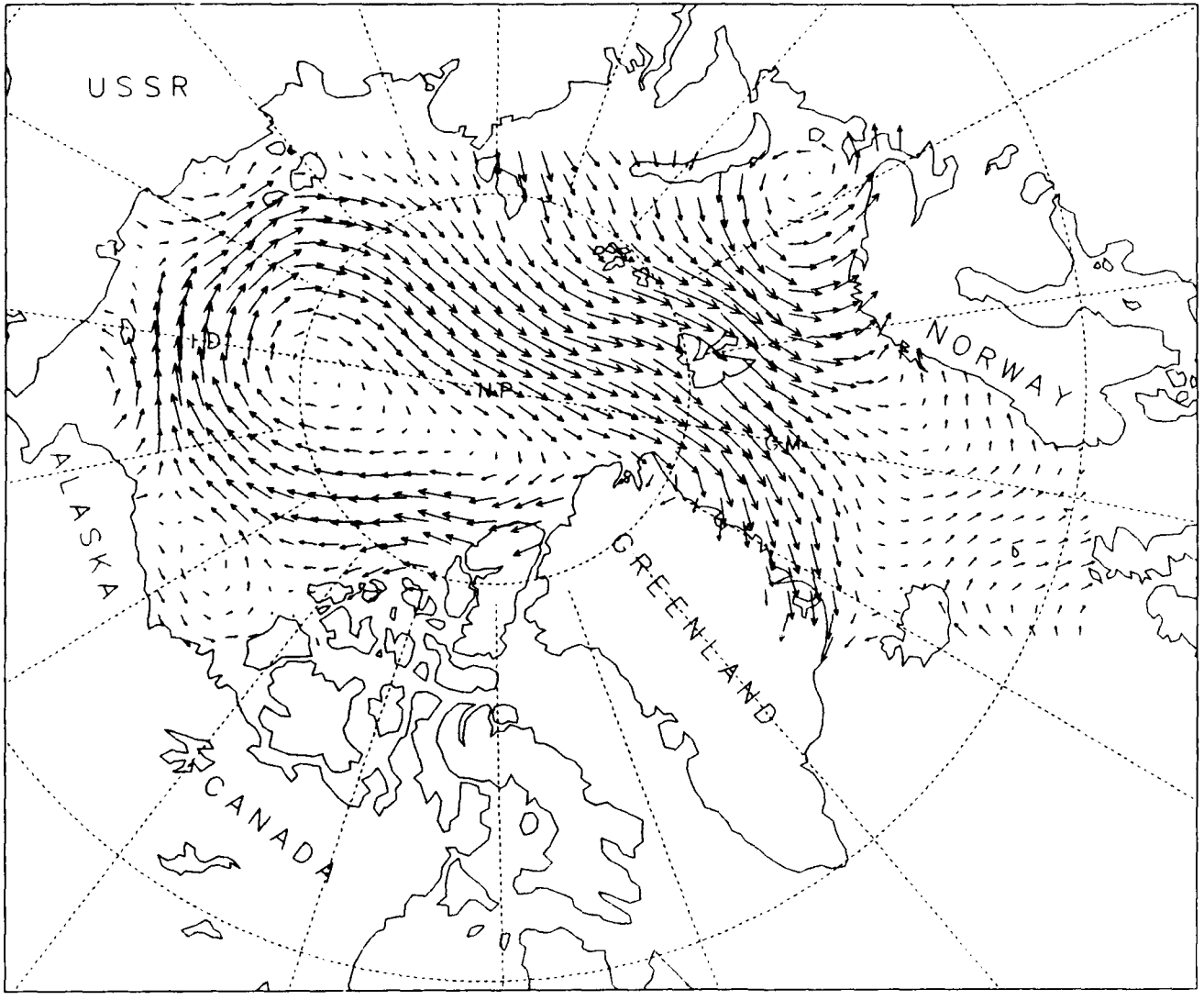

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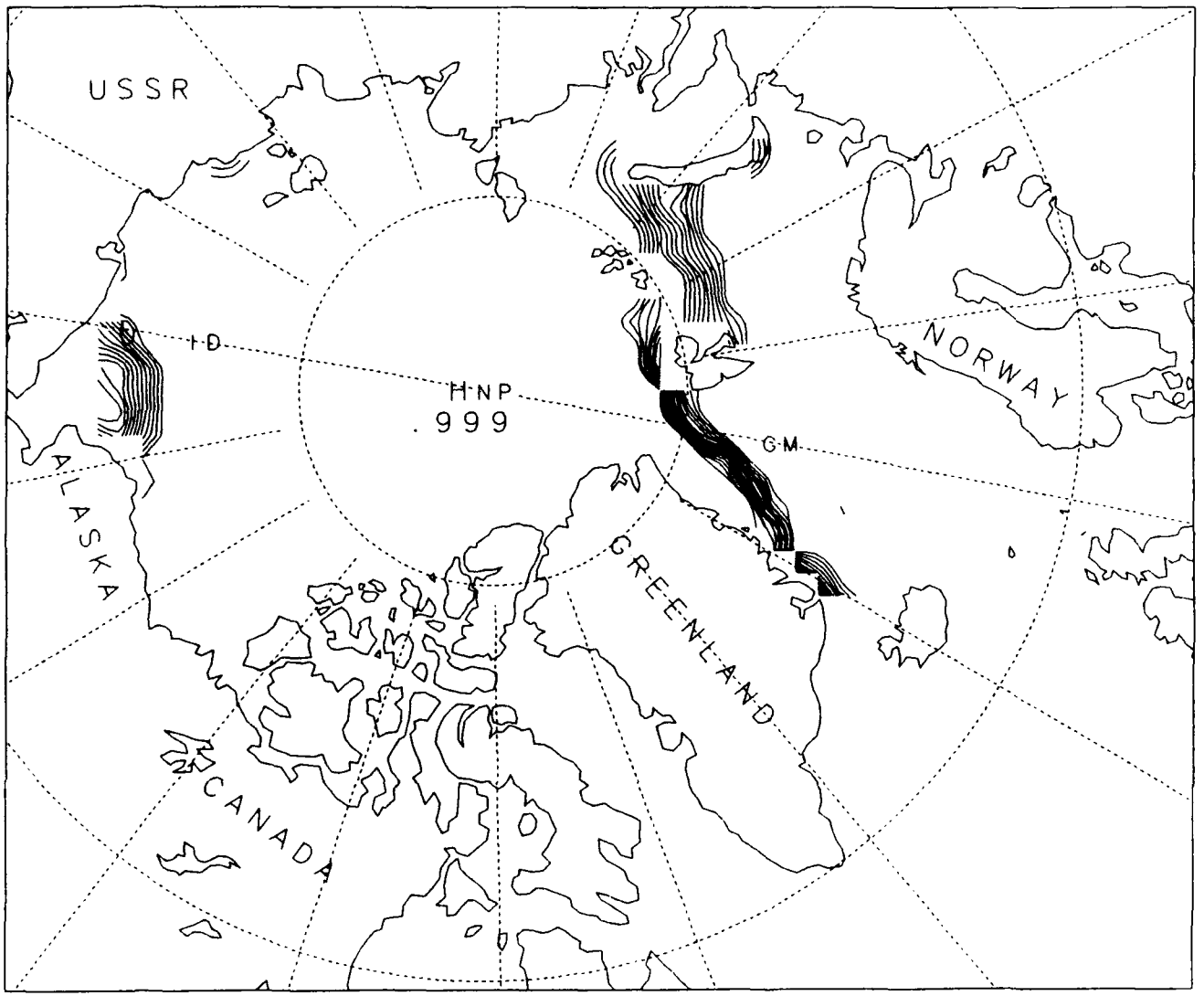

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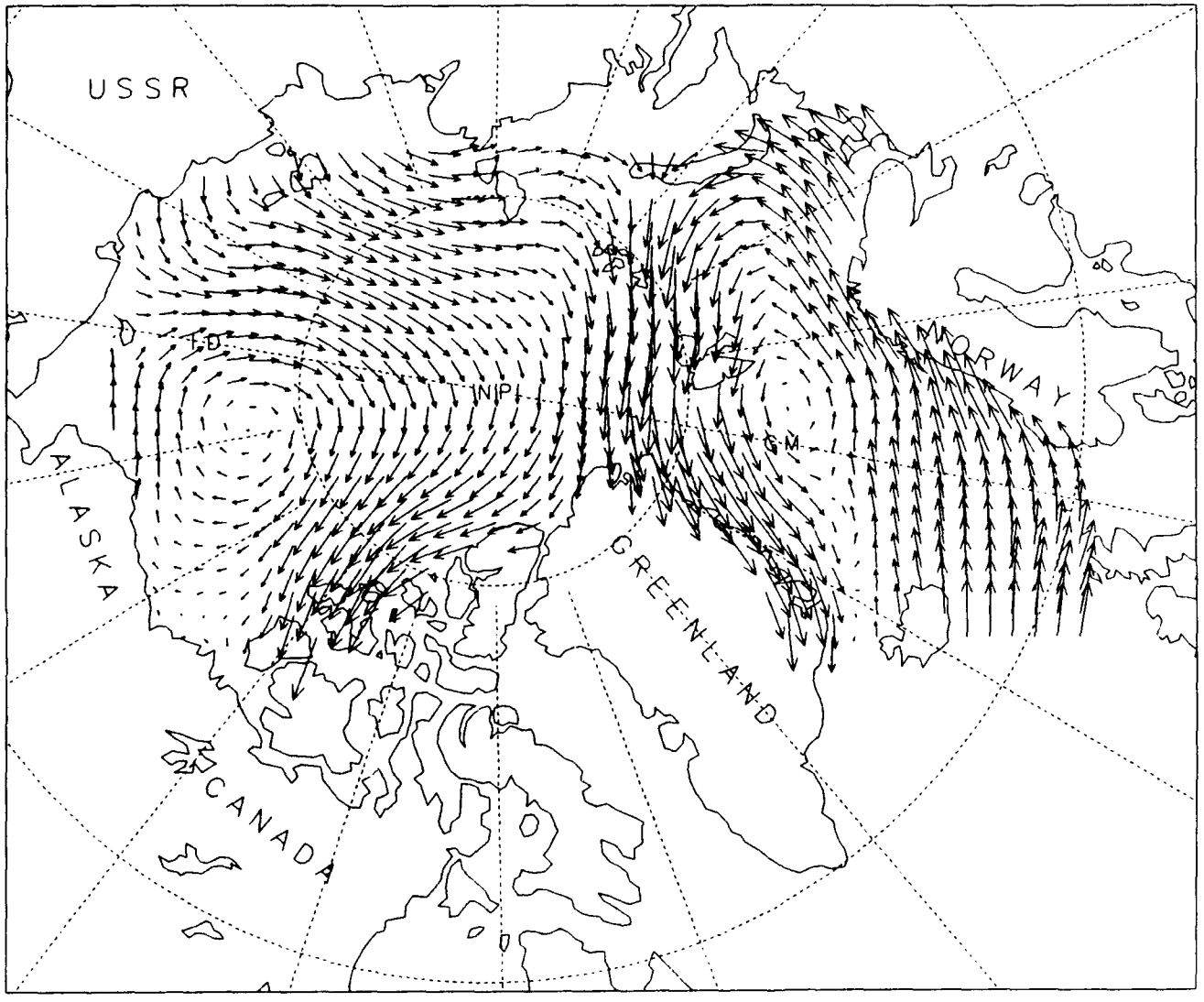

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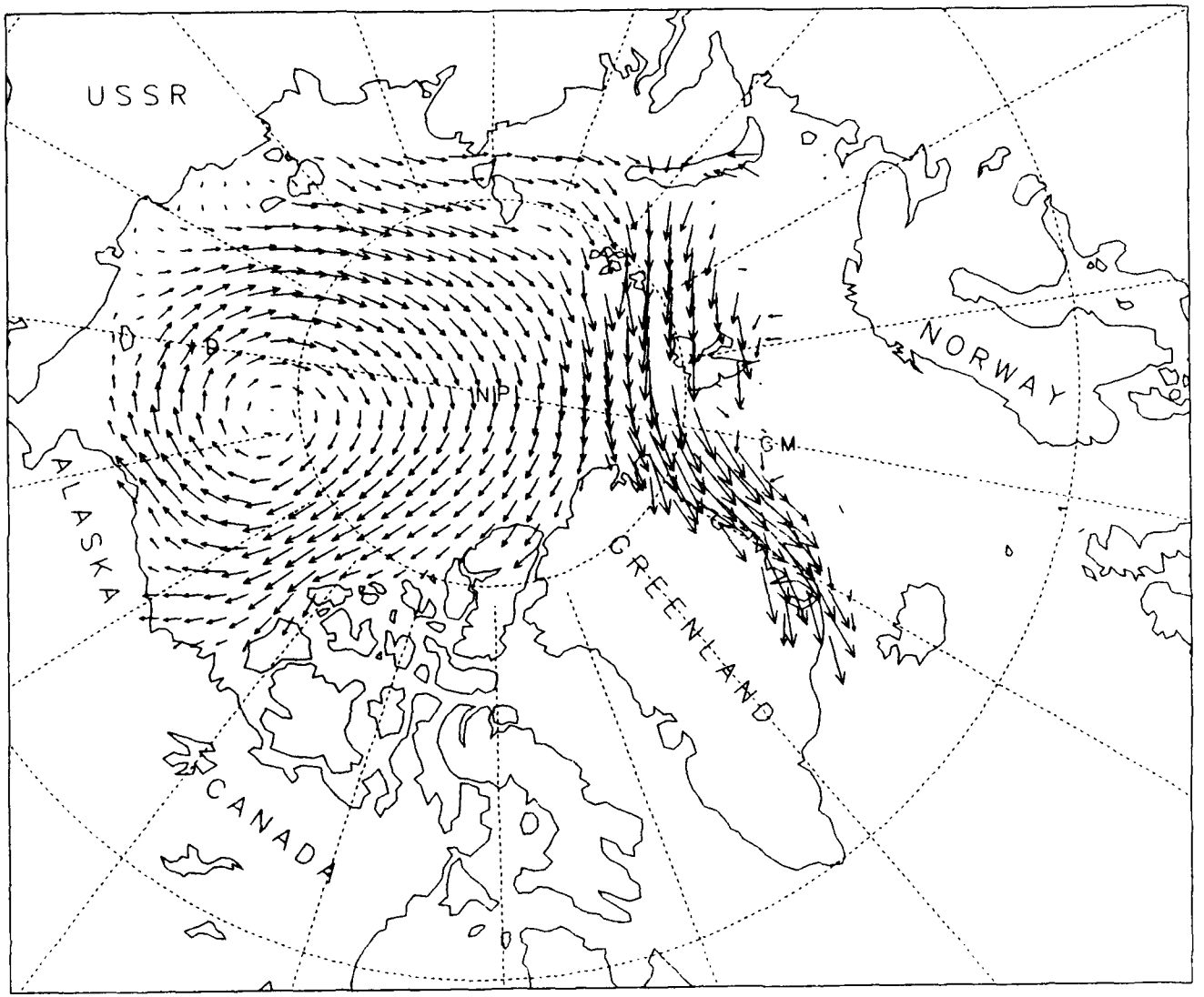

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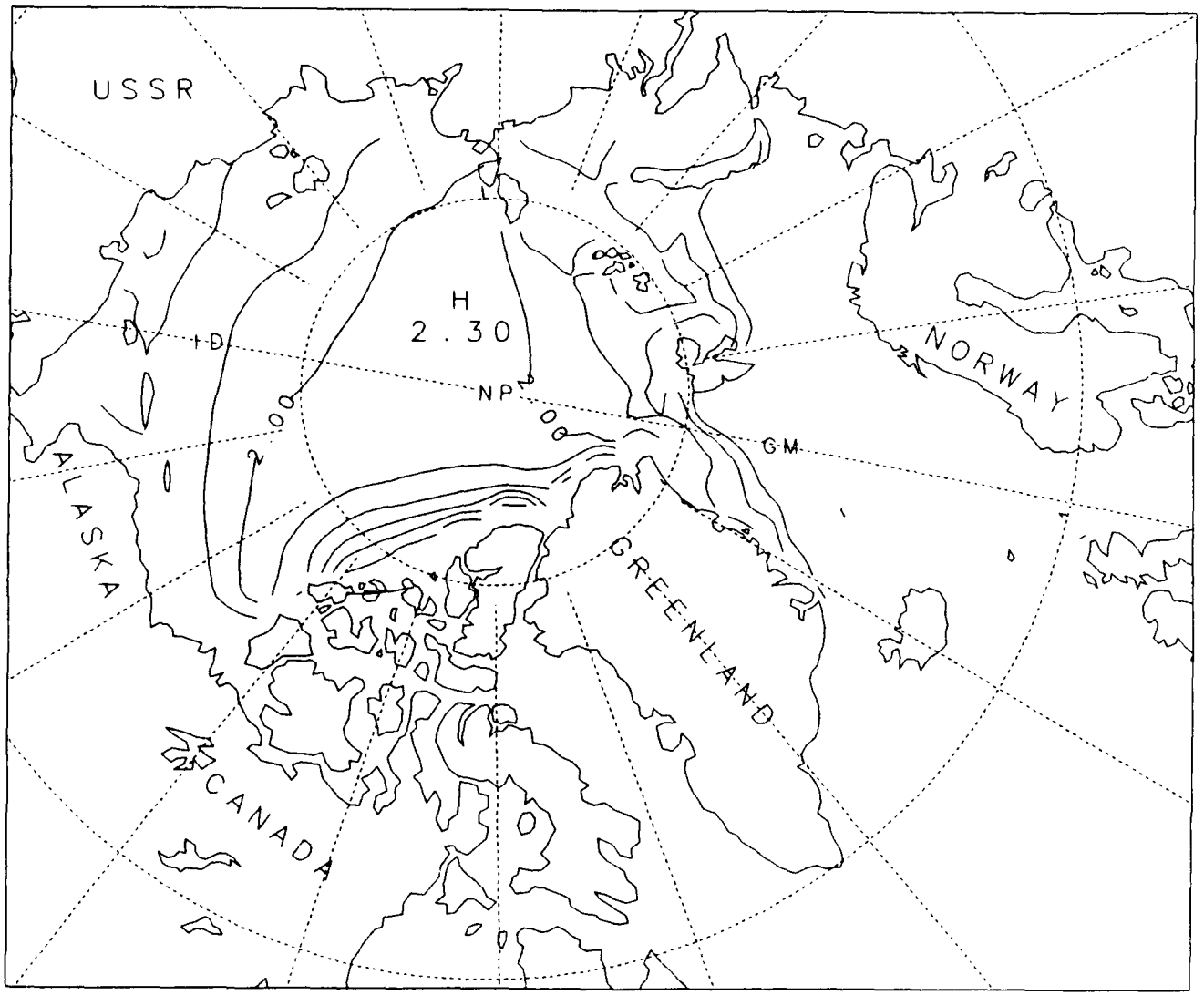

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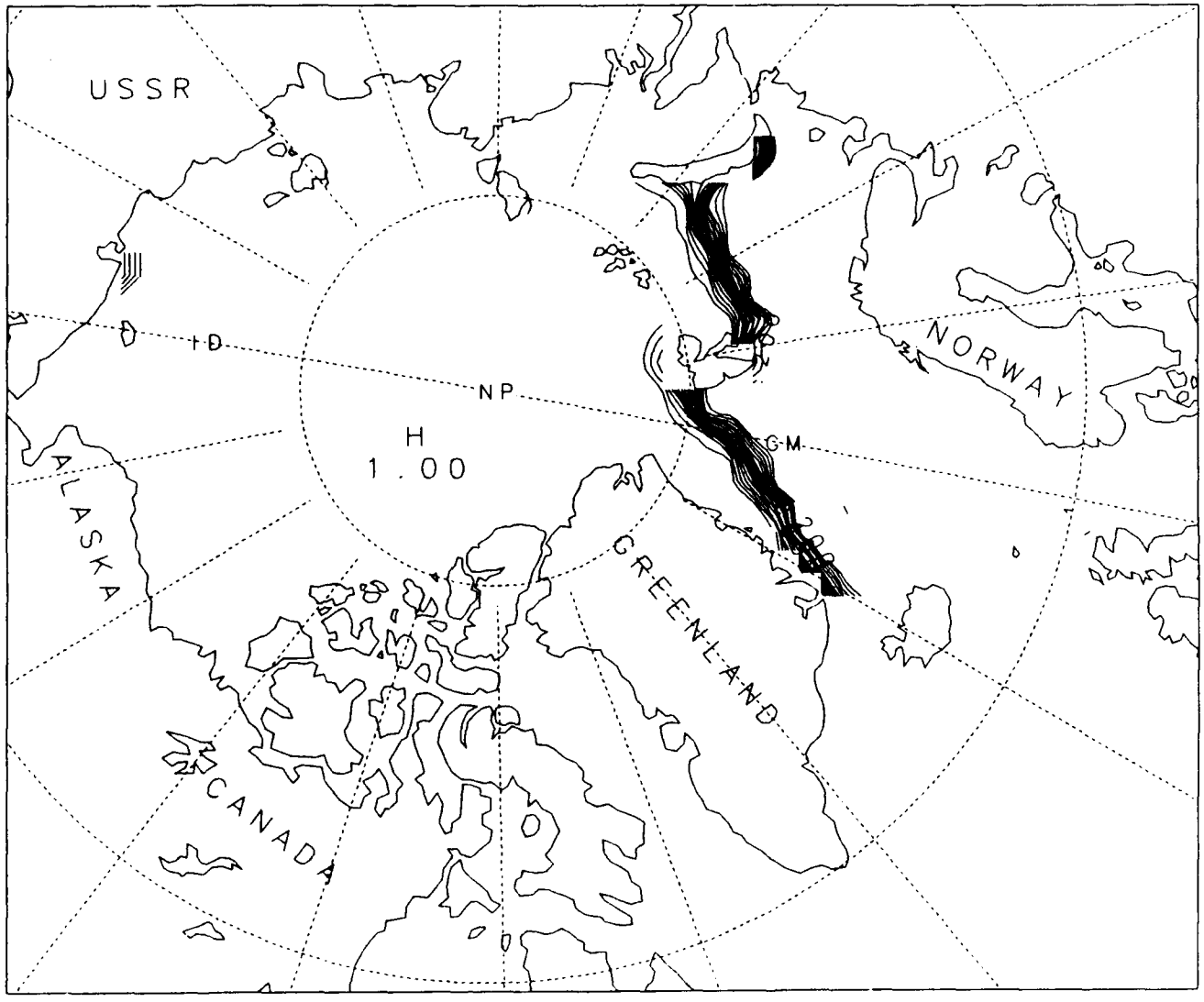

PIPS 1991

MONTHLY MEANS

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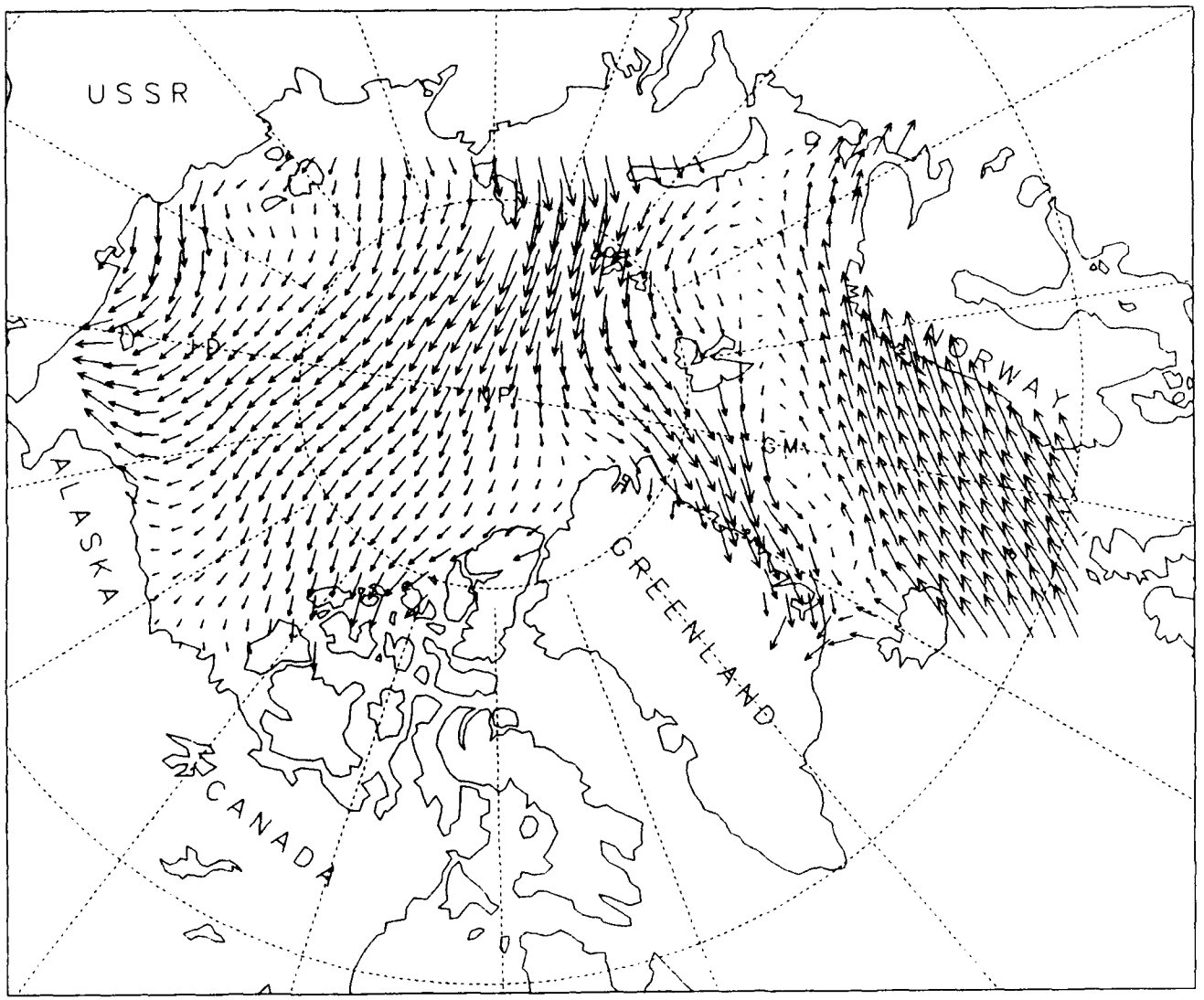

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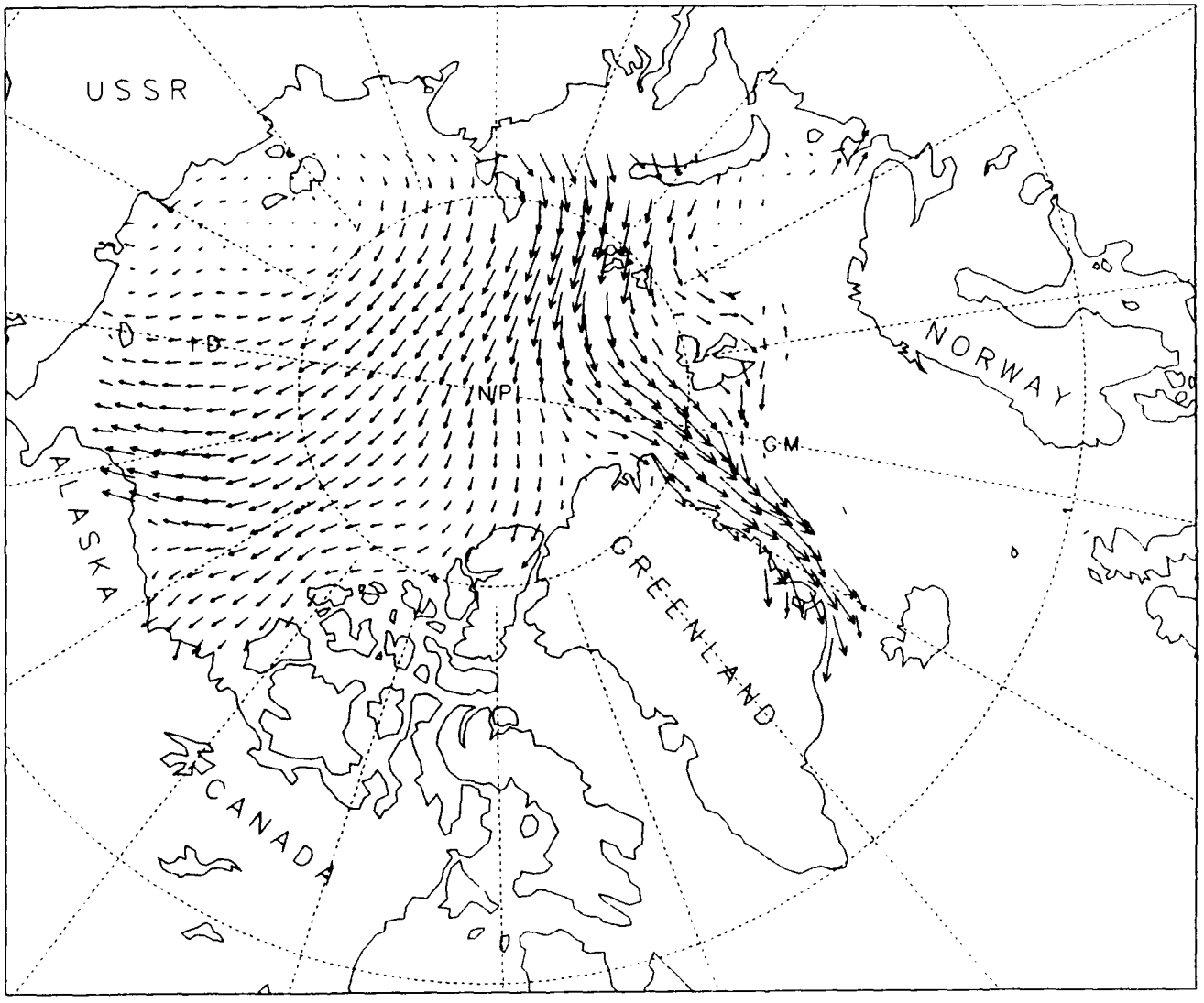

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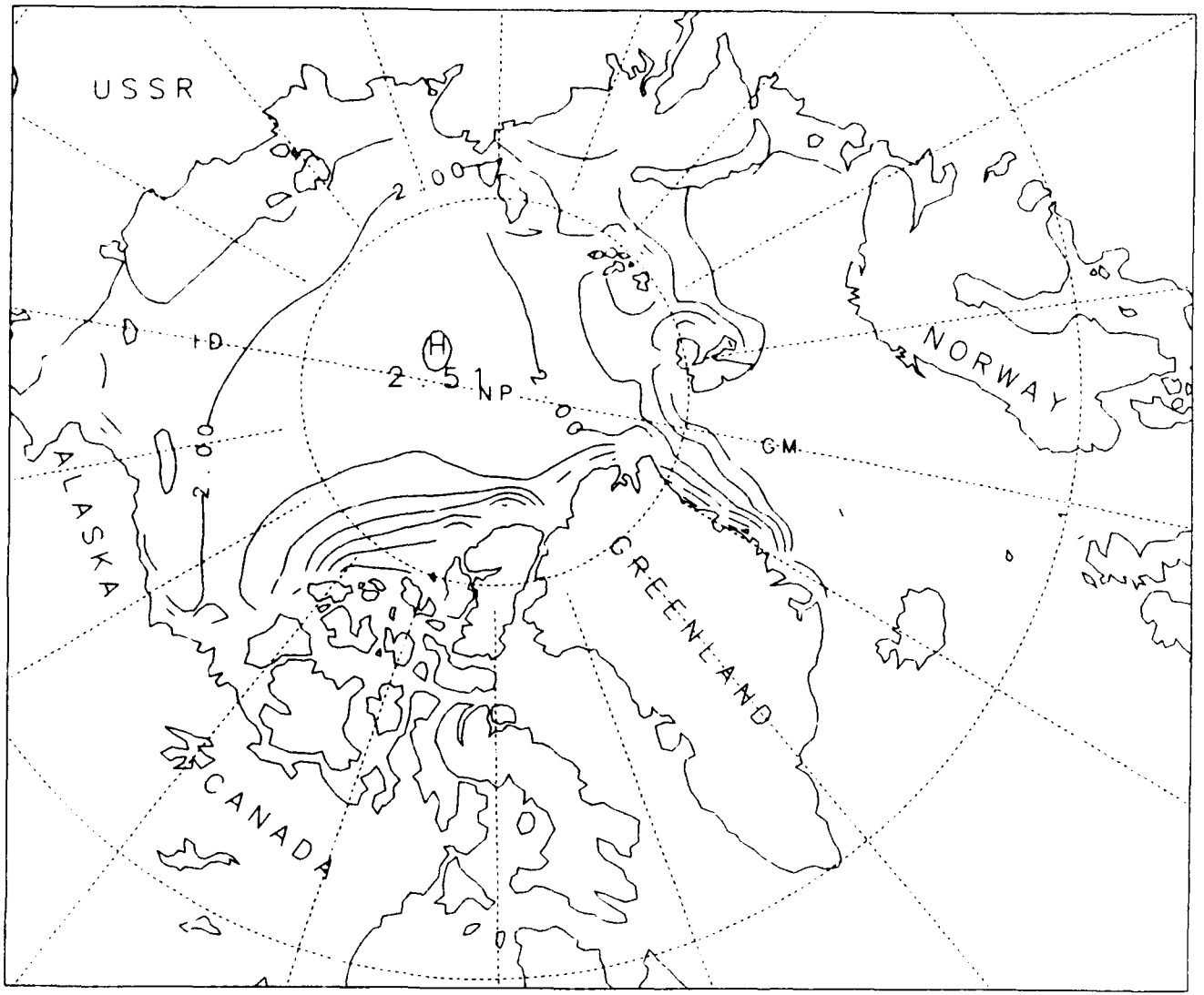

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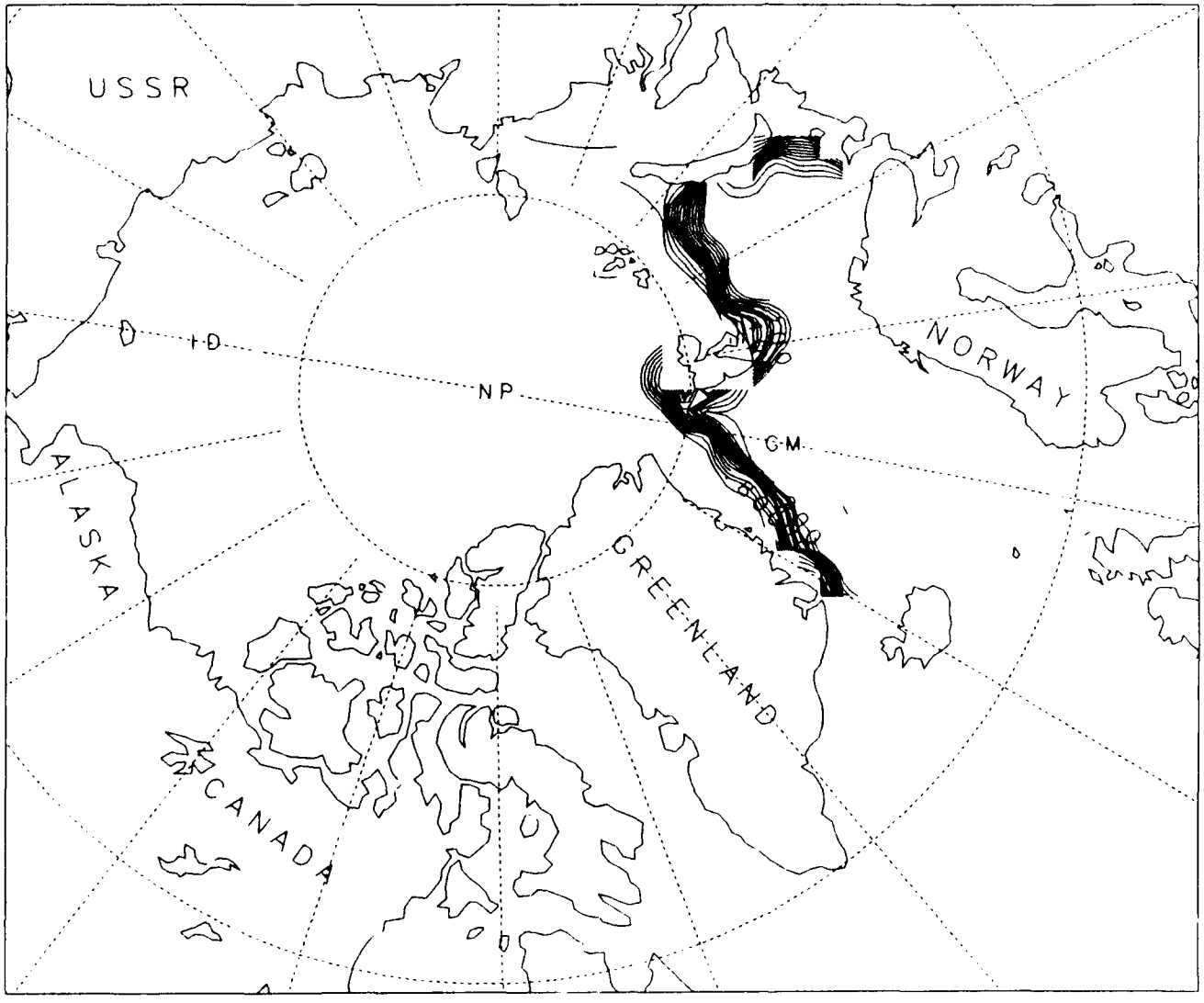

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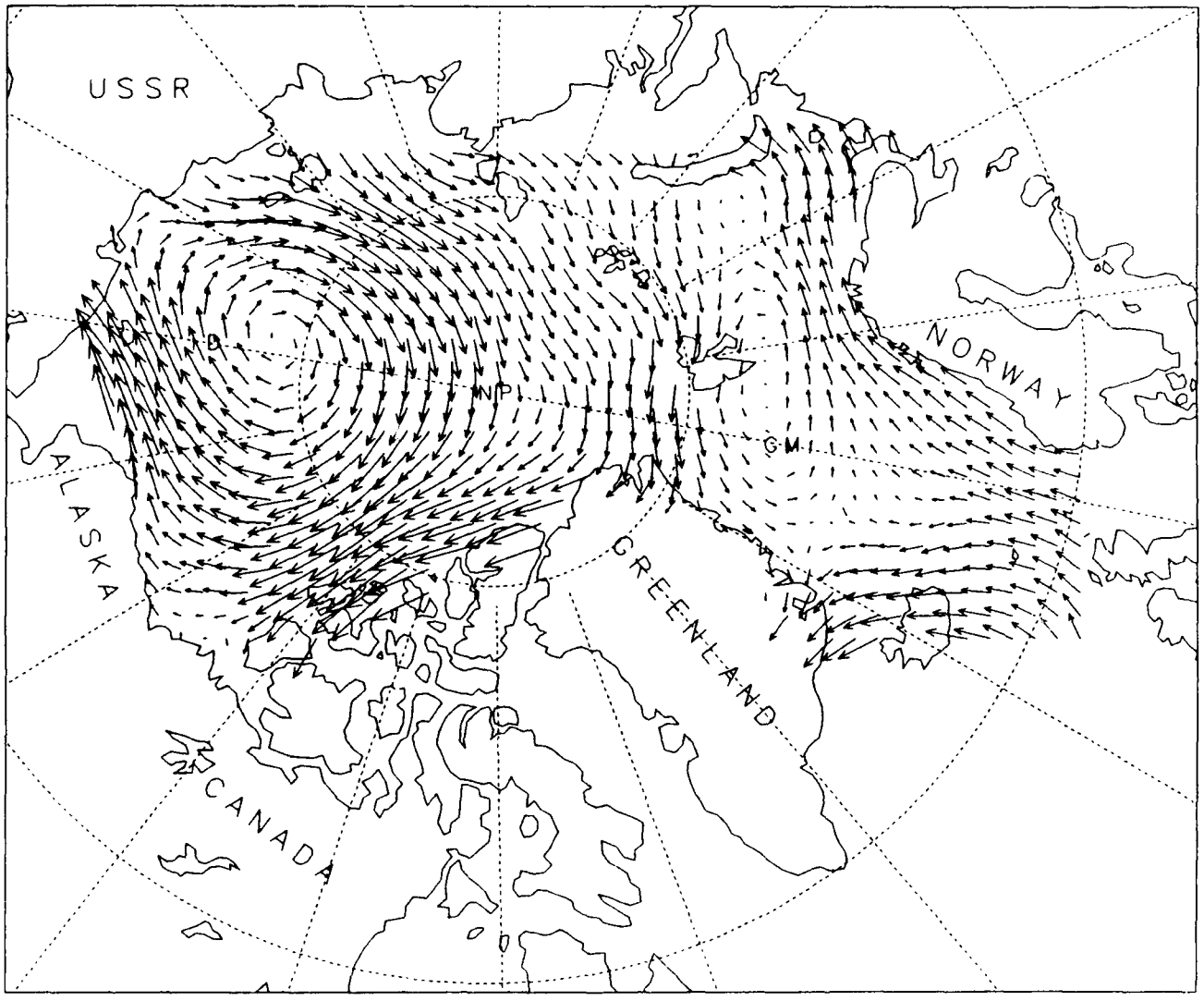

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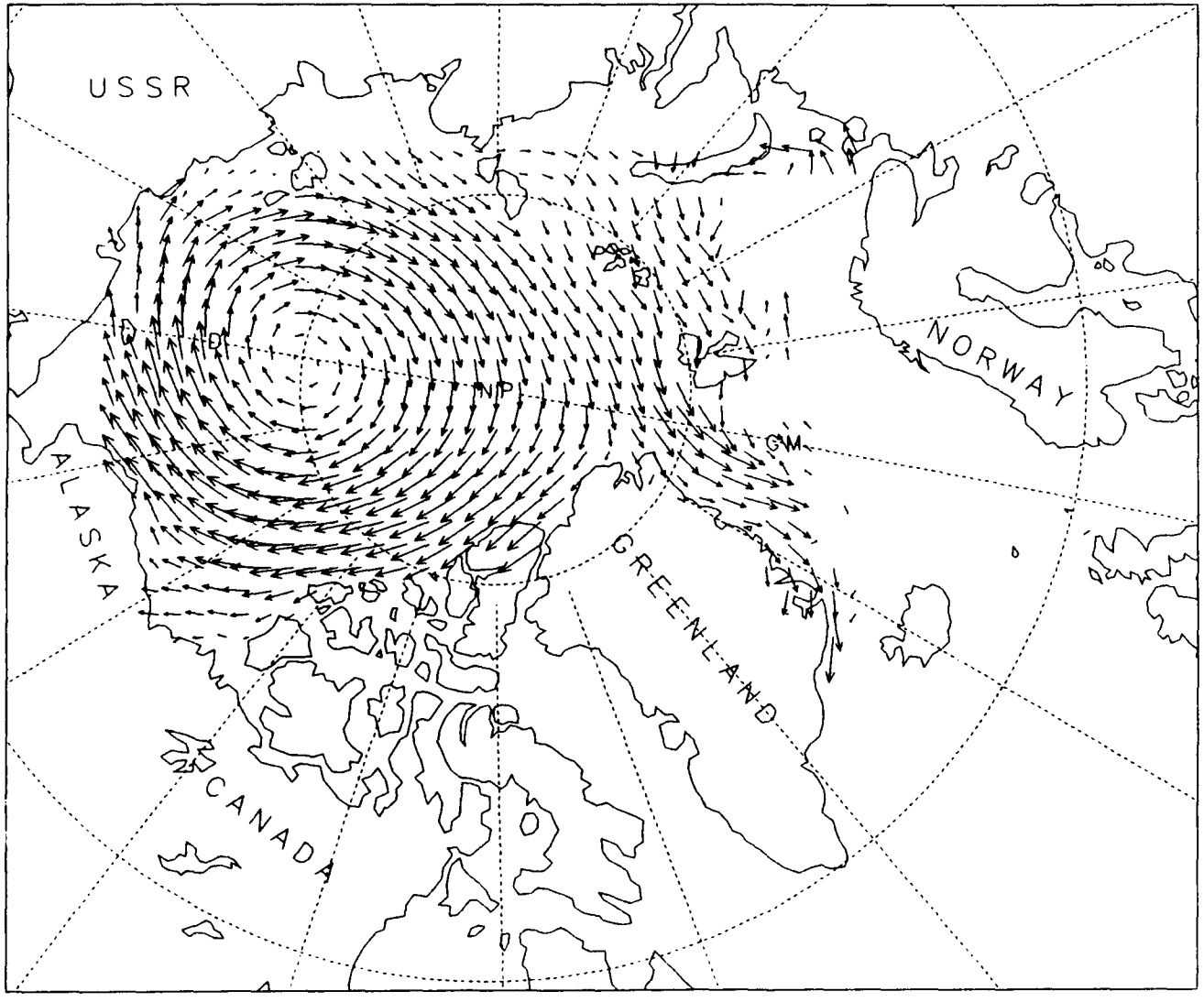

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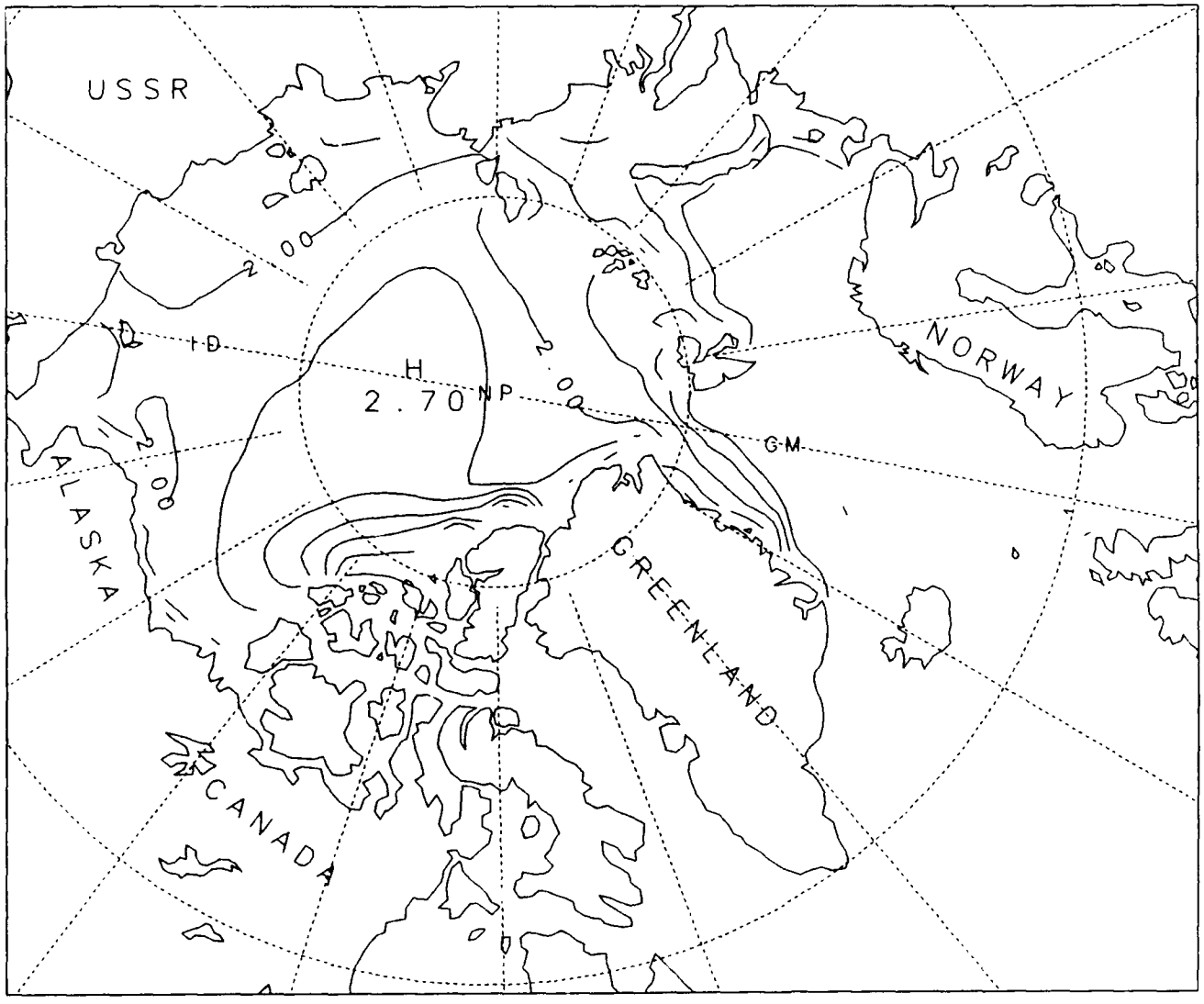

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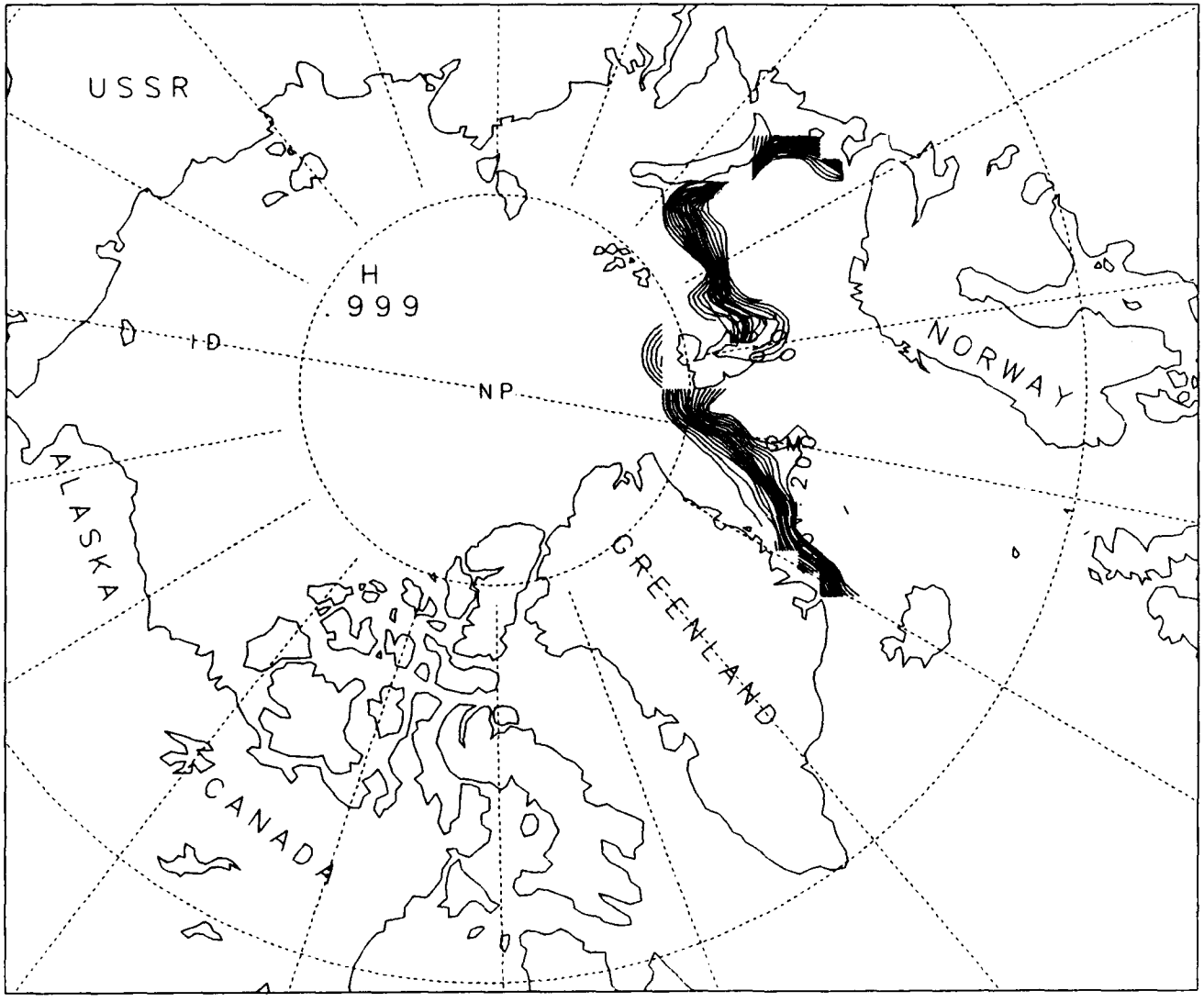

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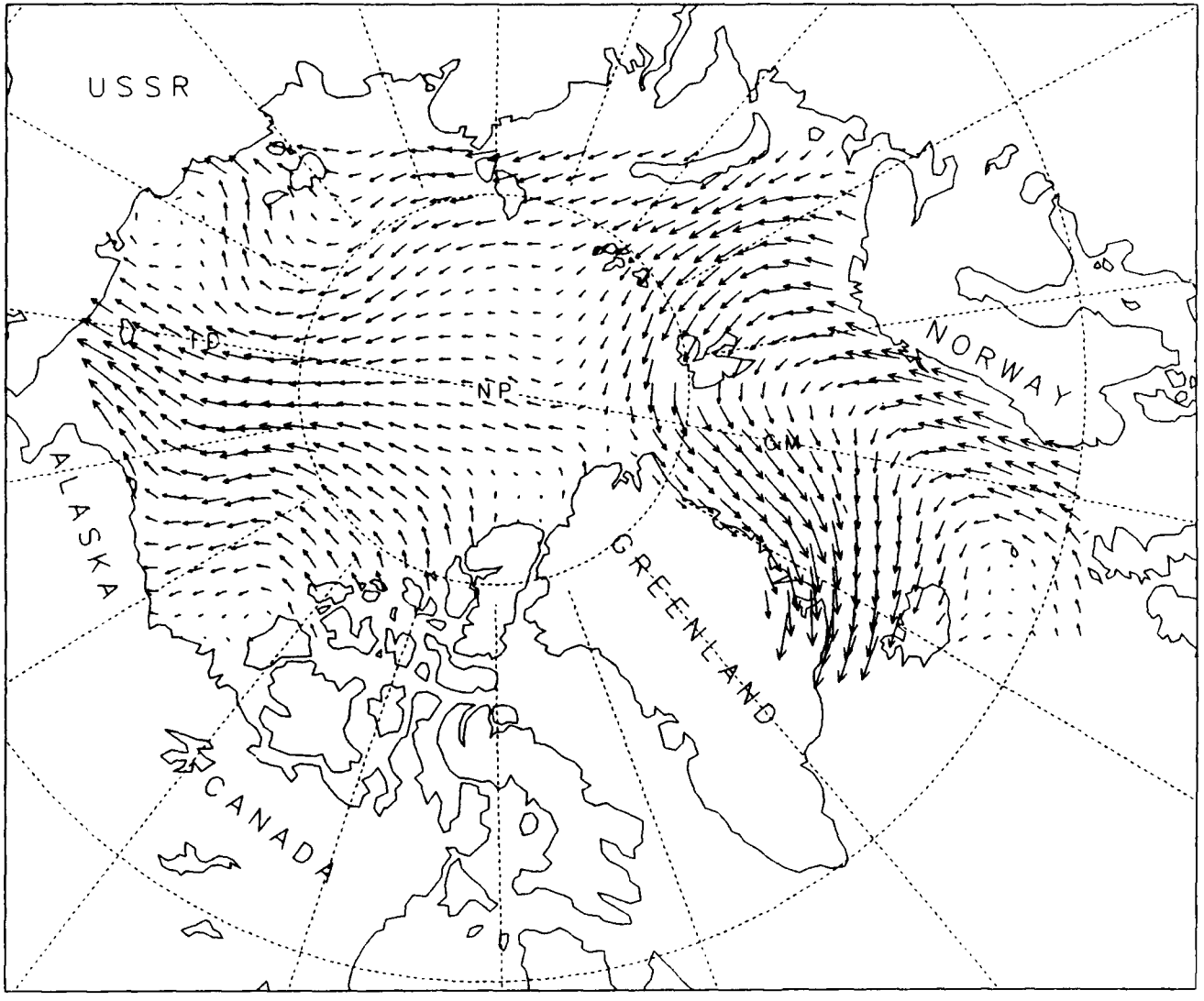

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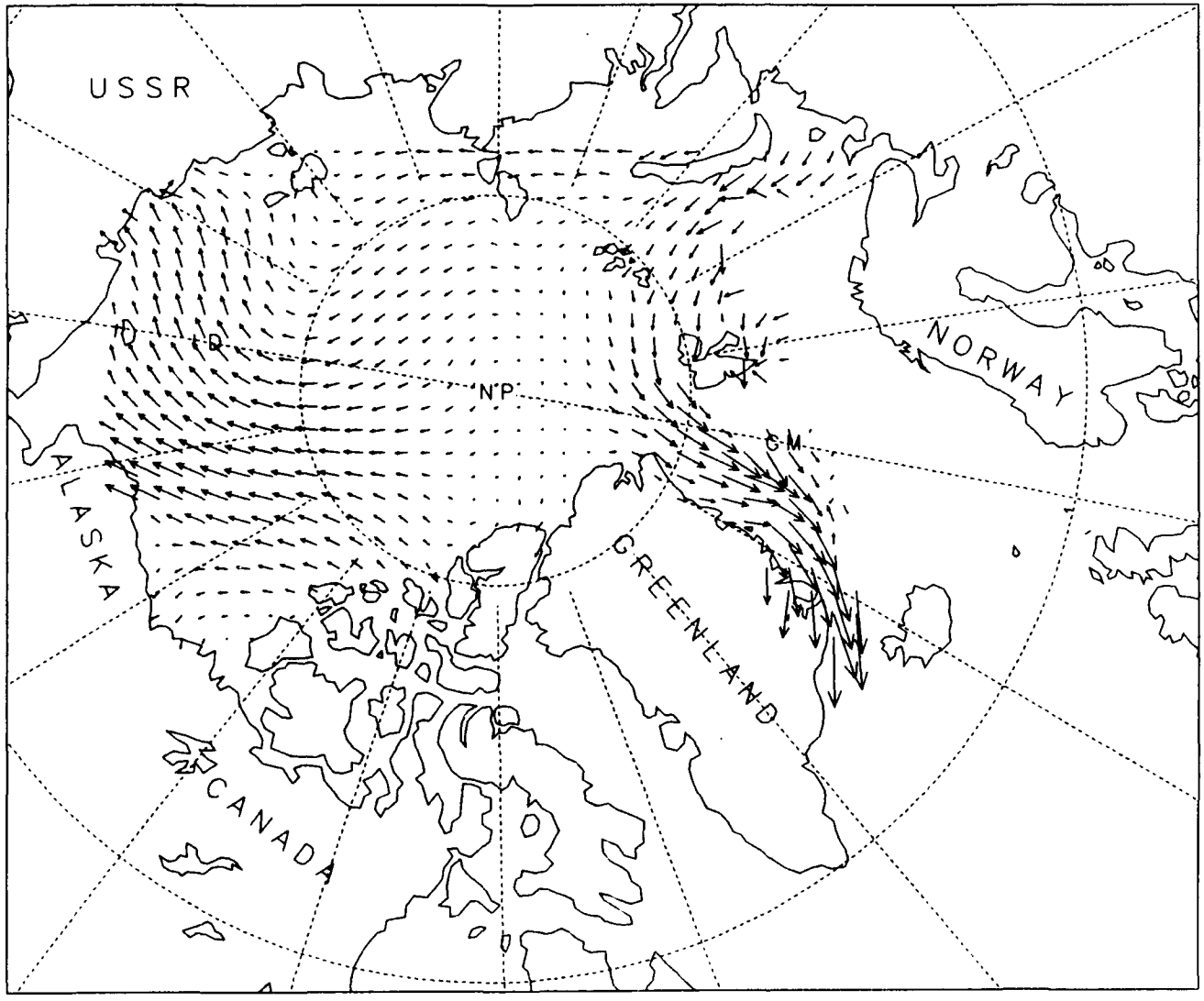

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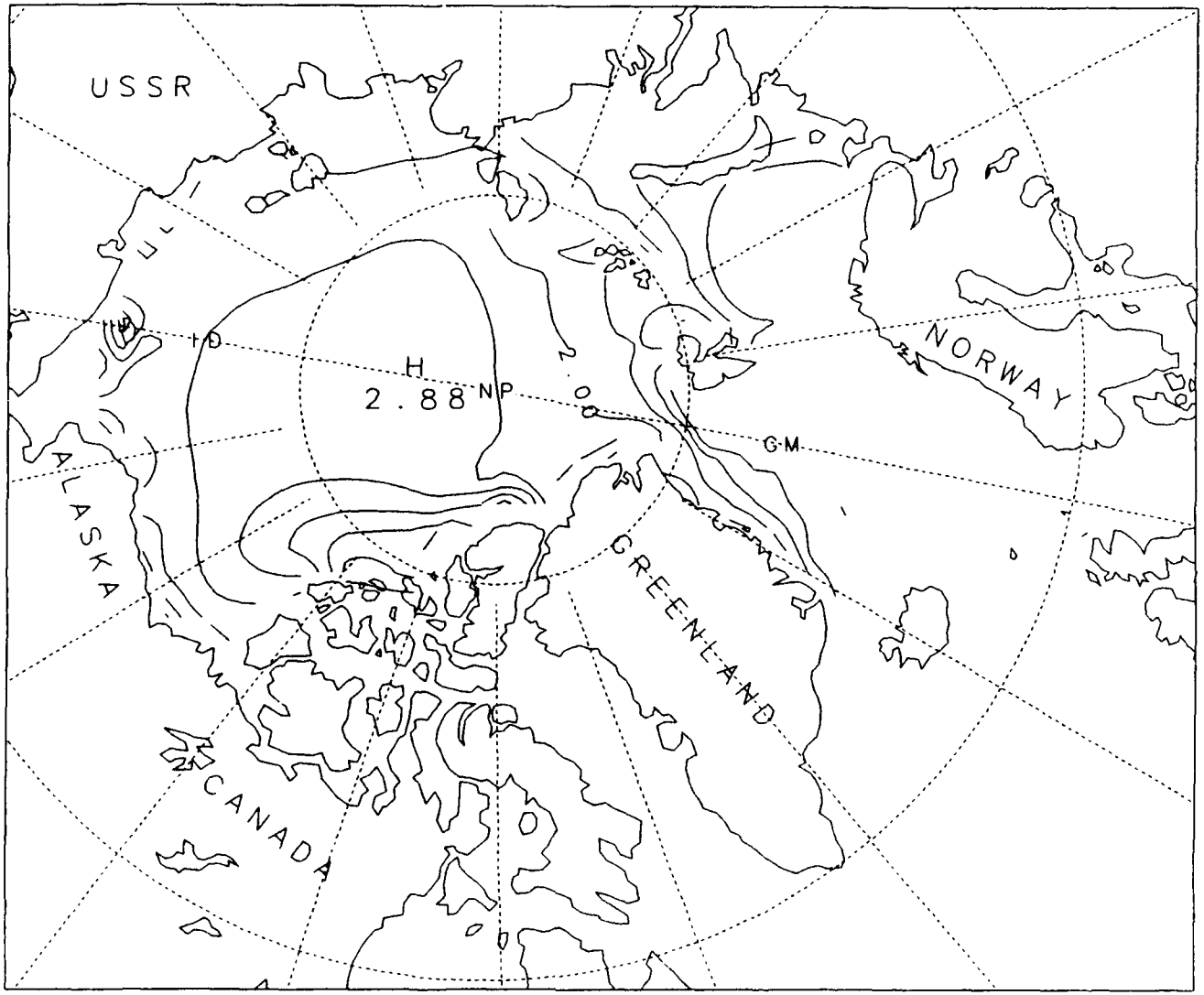

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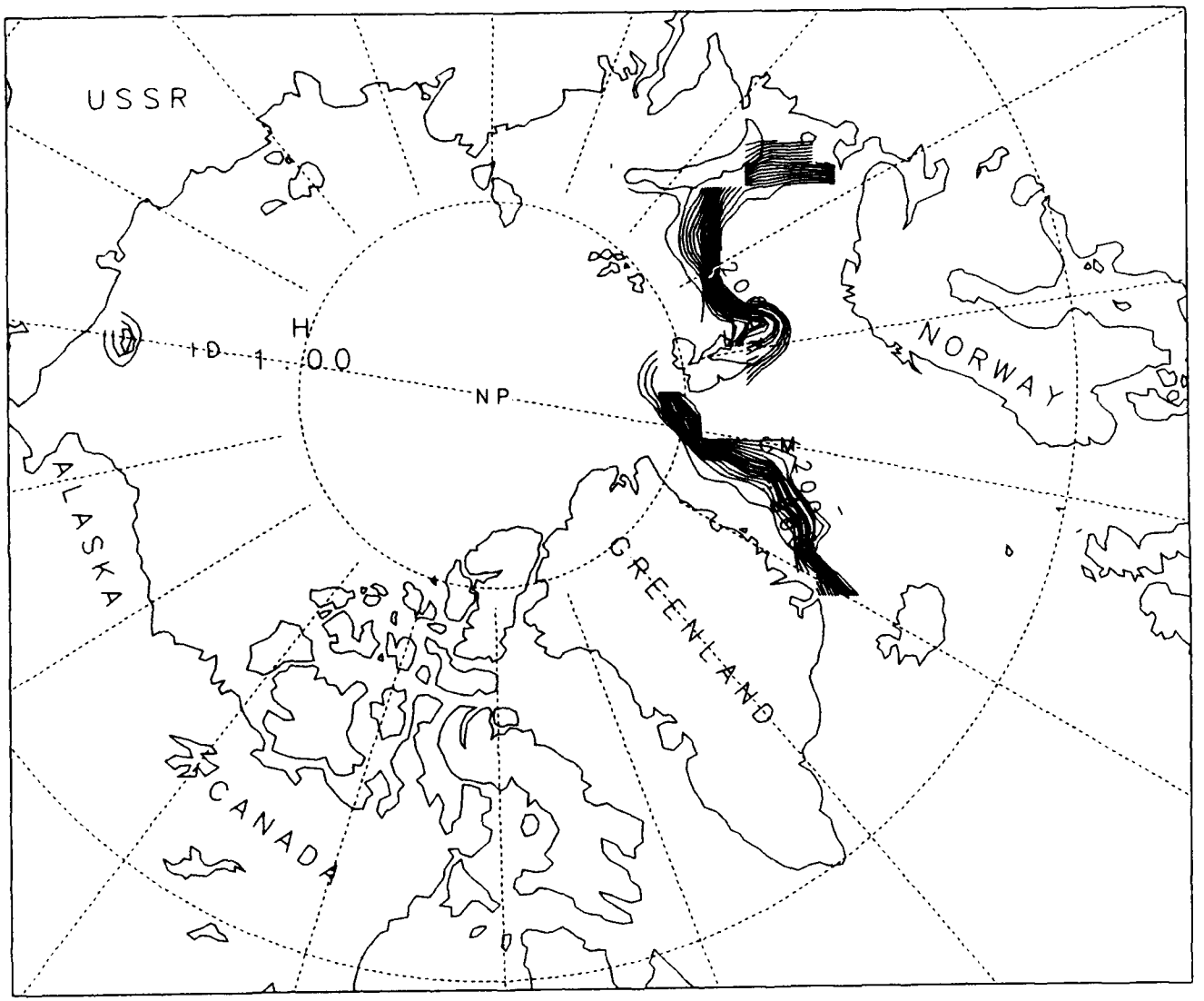

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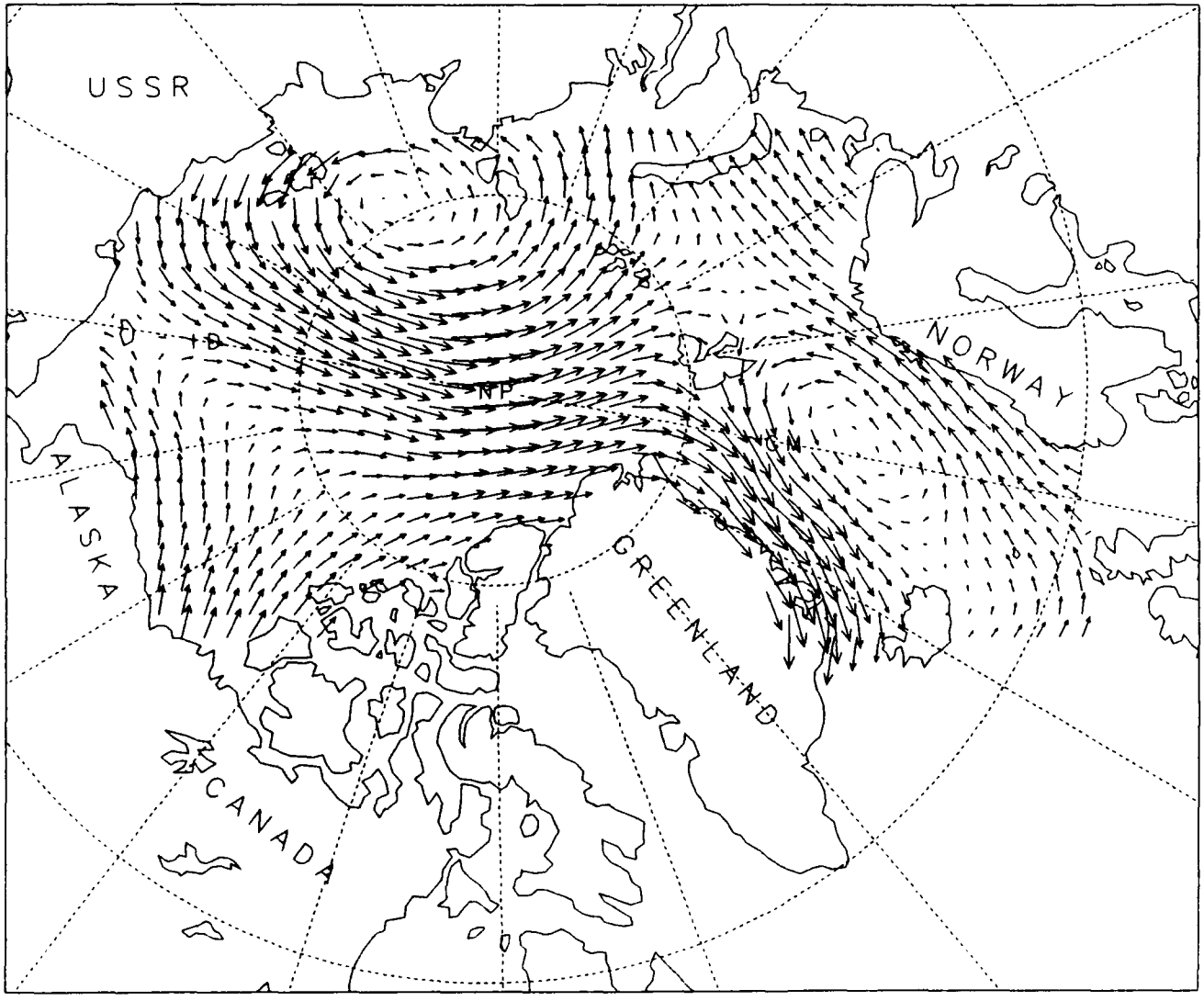

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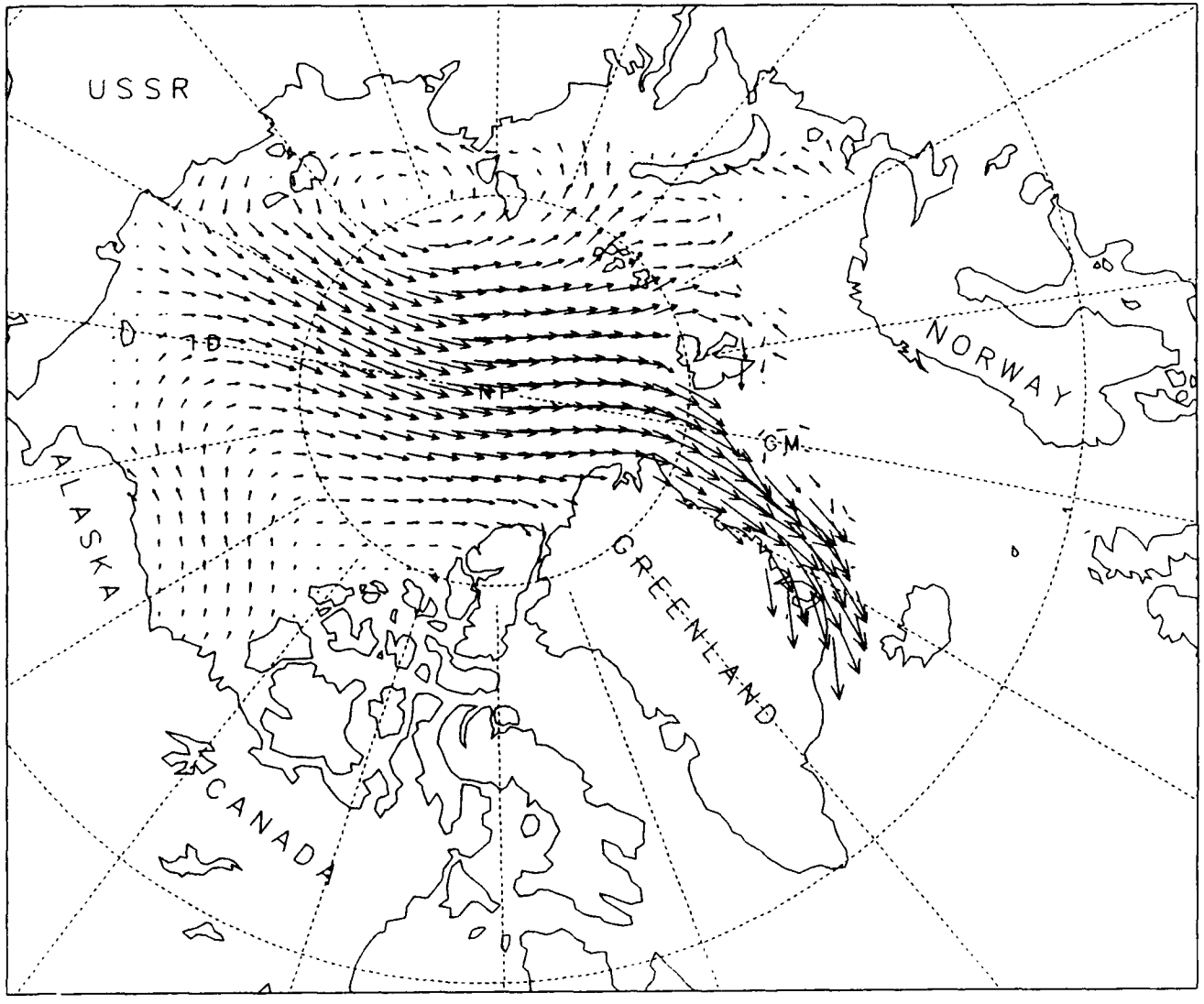

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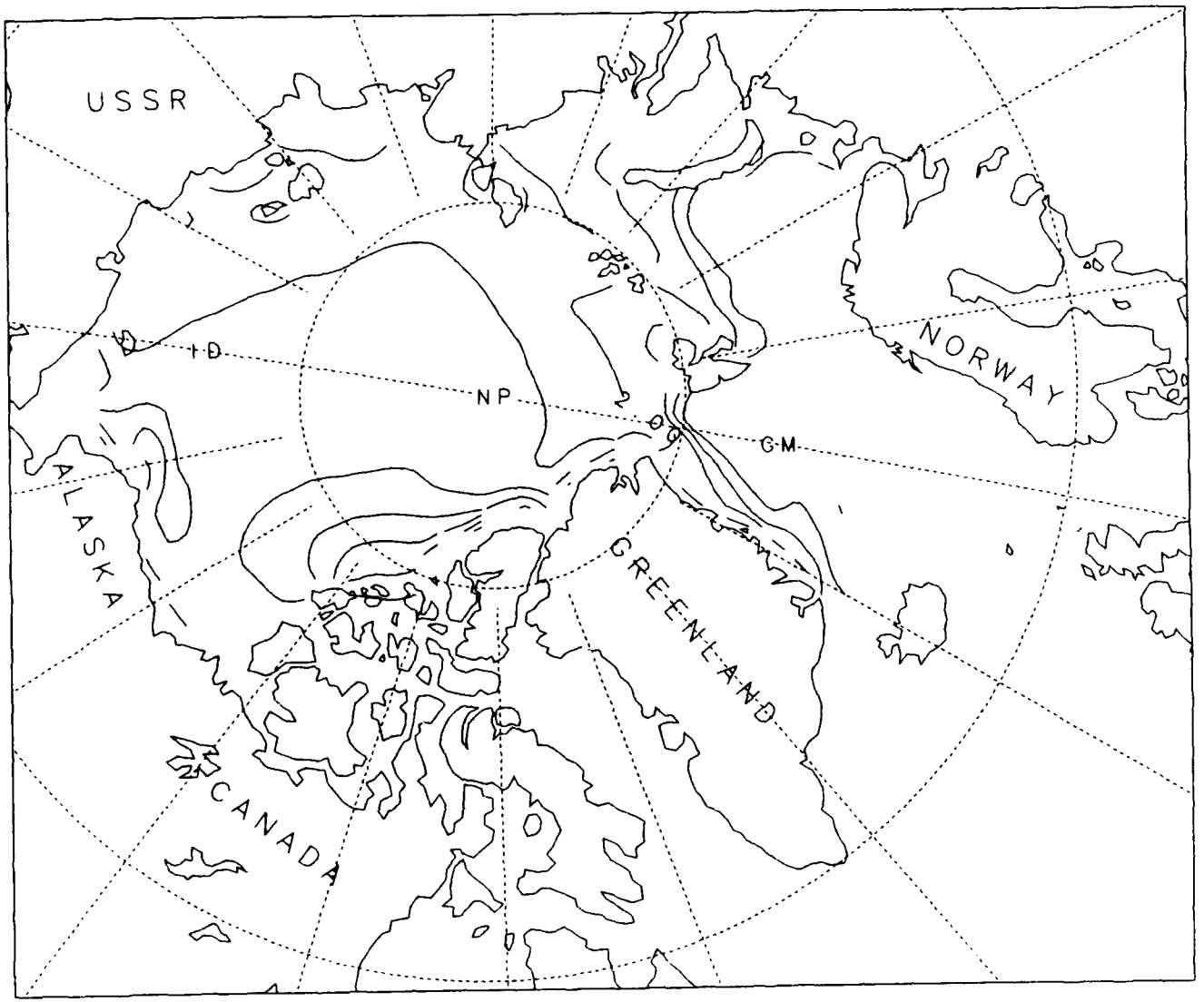

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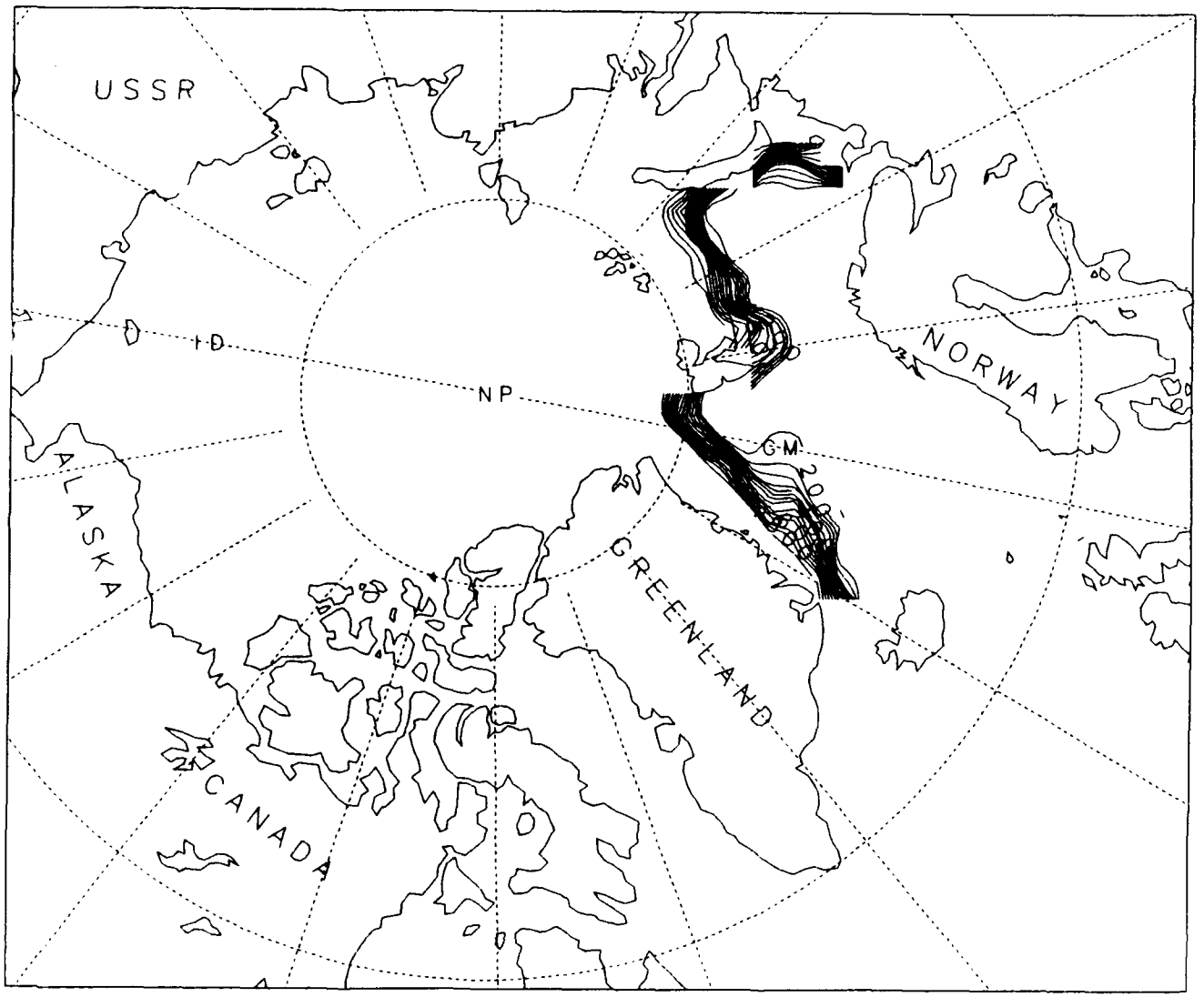

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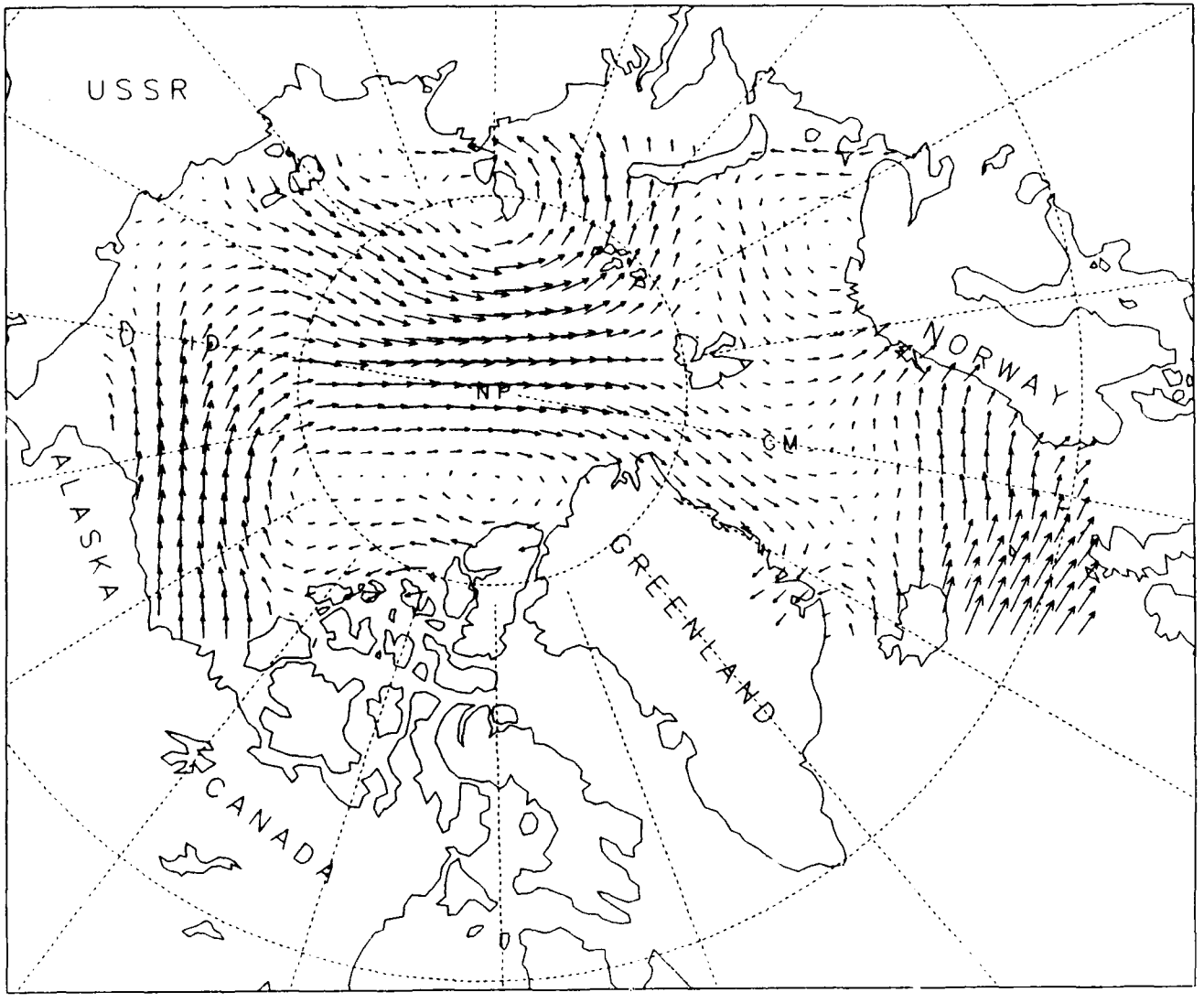
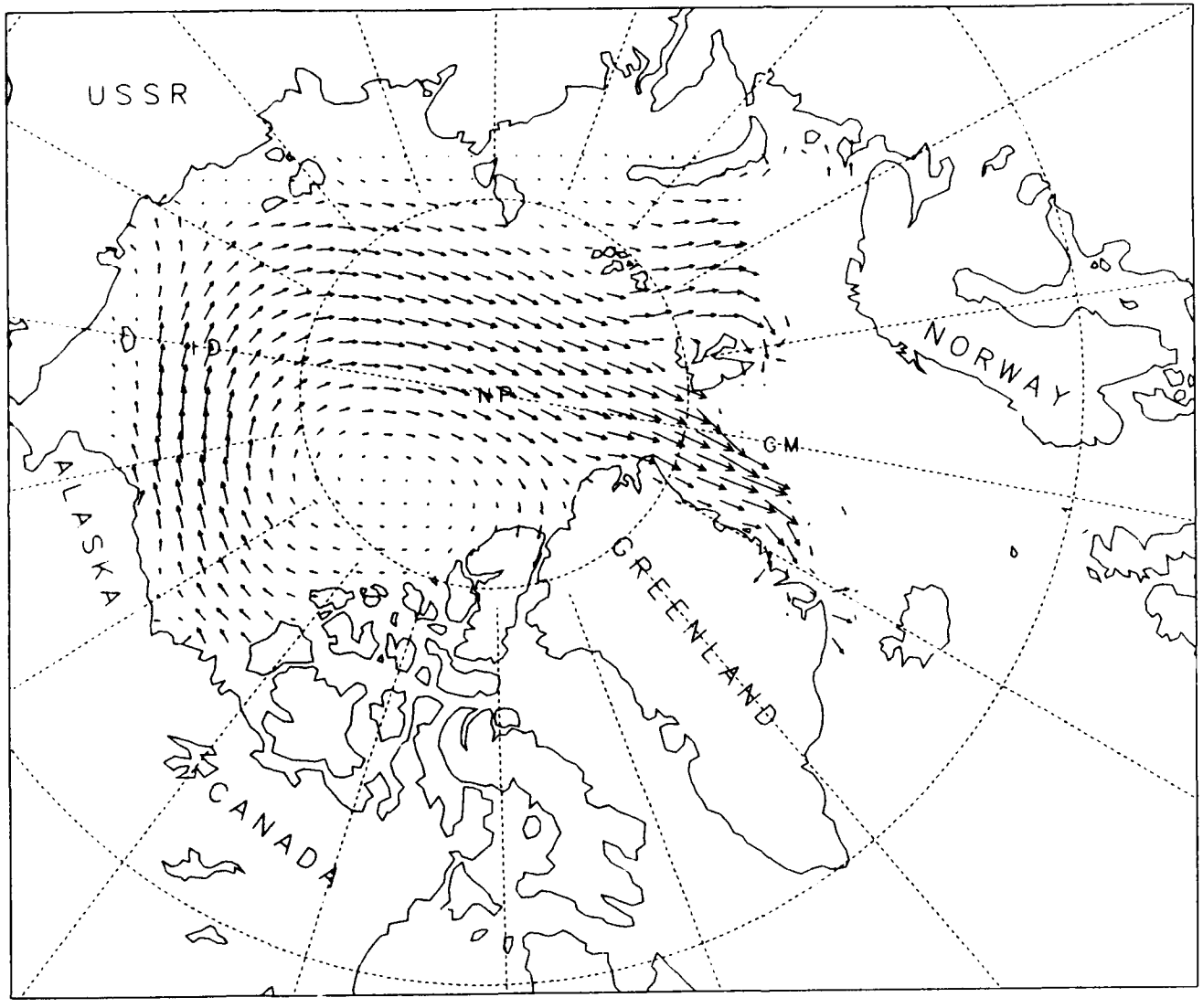
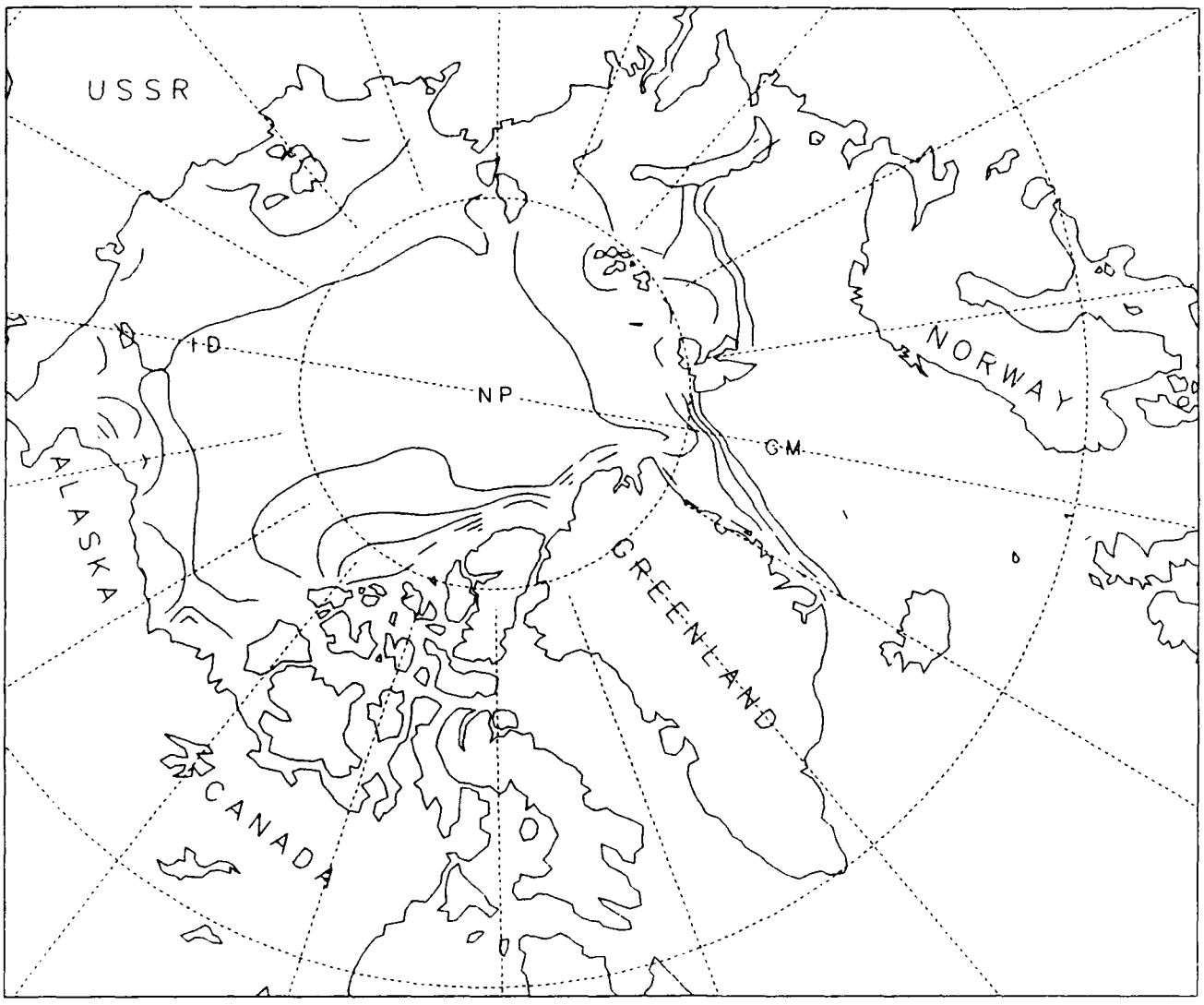


ICE VELOCITIES 1991 MAY

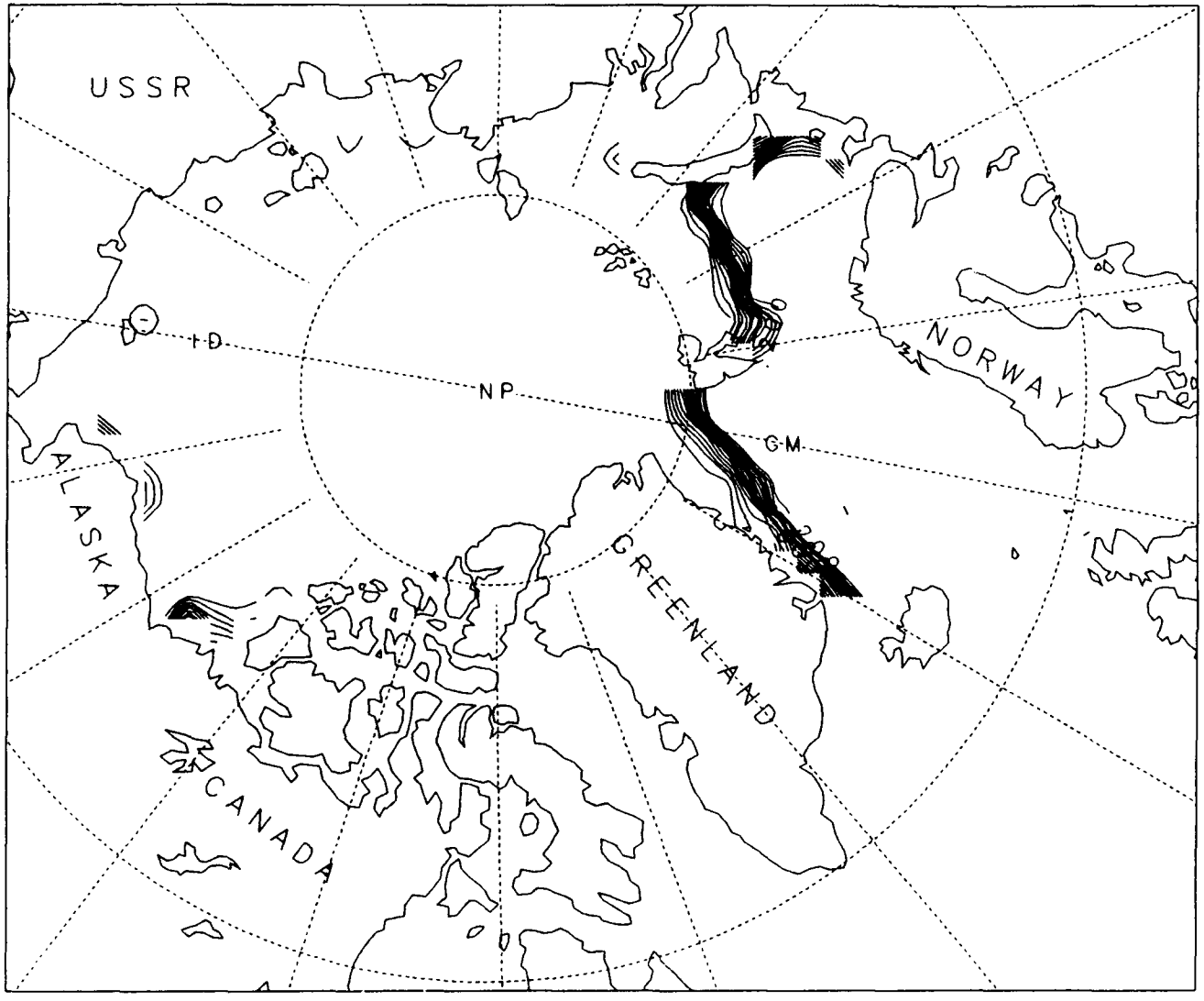


0.300E+00
MAXIMUM VECTOR

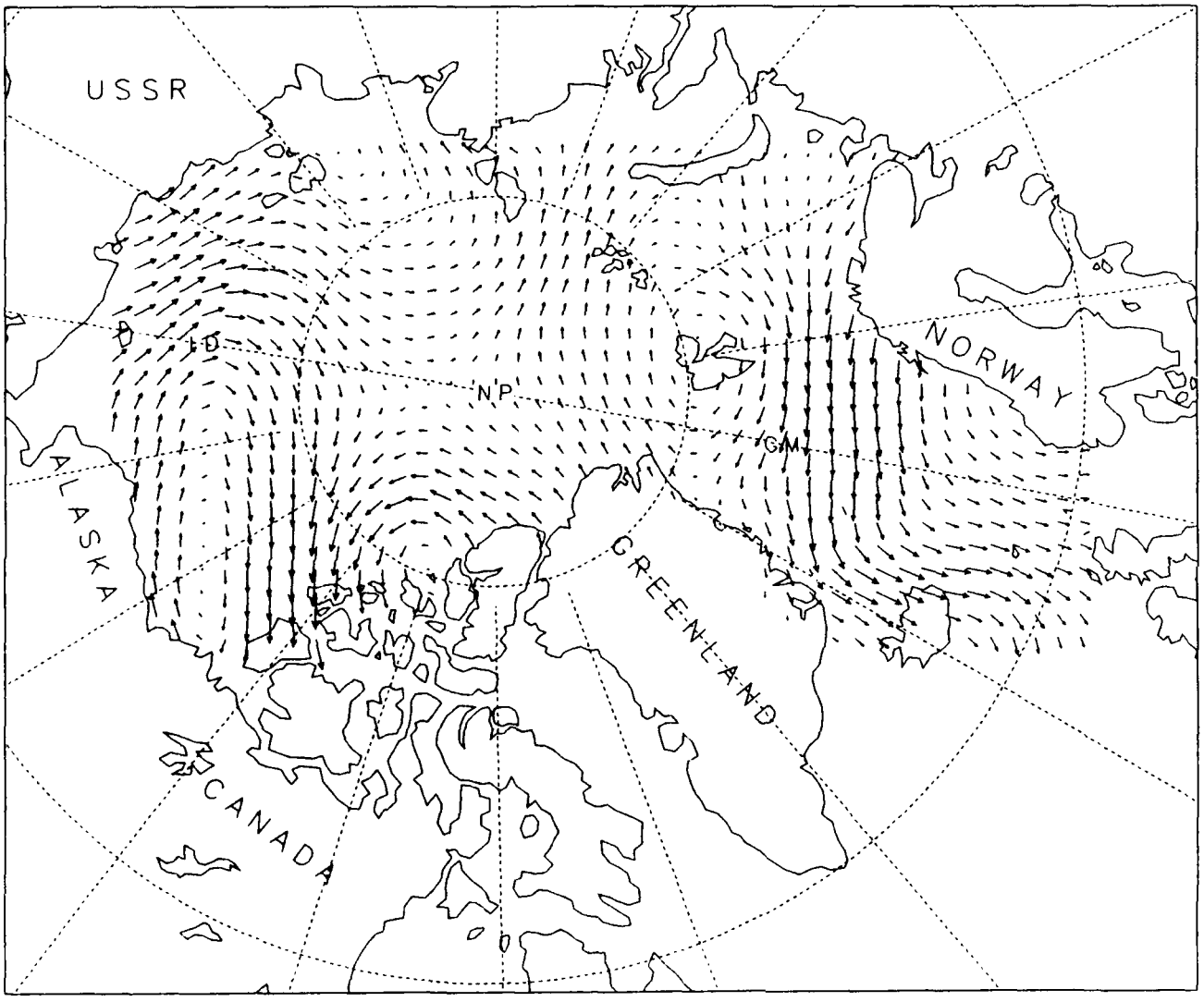
ICE THICKNESS 1991 MAY



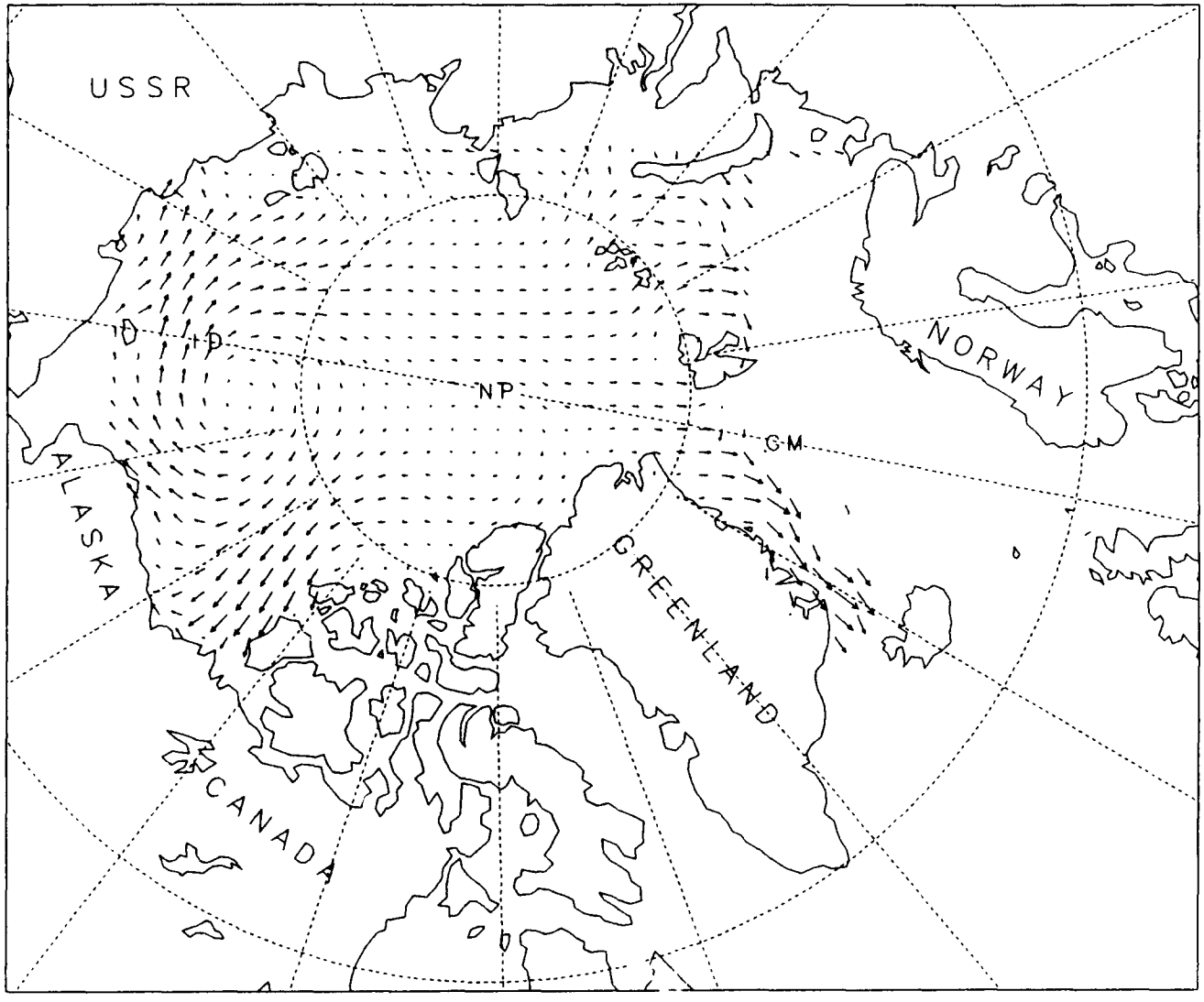
ICE CONCENTRATION 1991 MAY



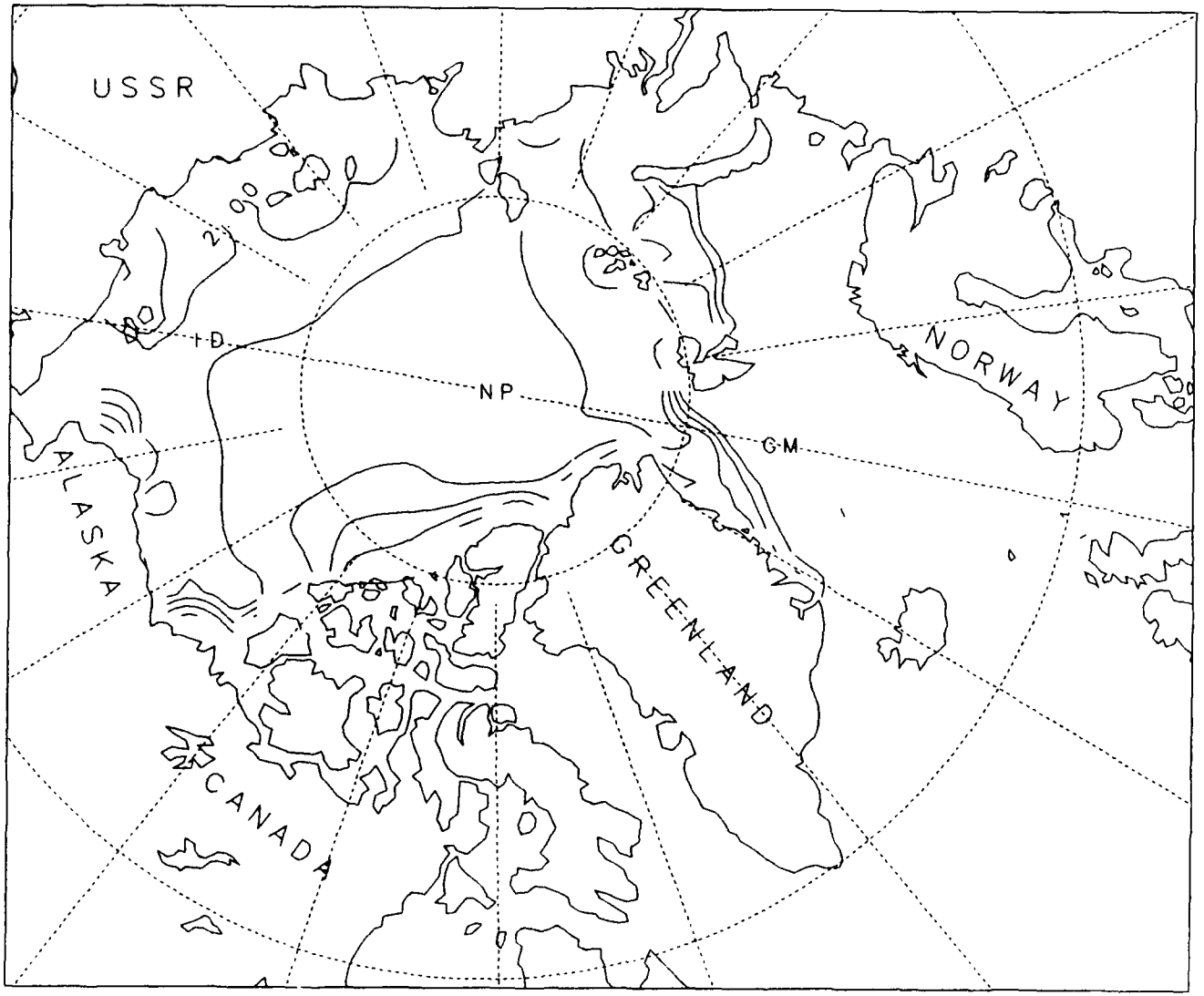
WIND VELOCITIES 1991 JUNE



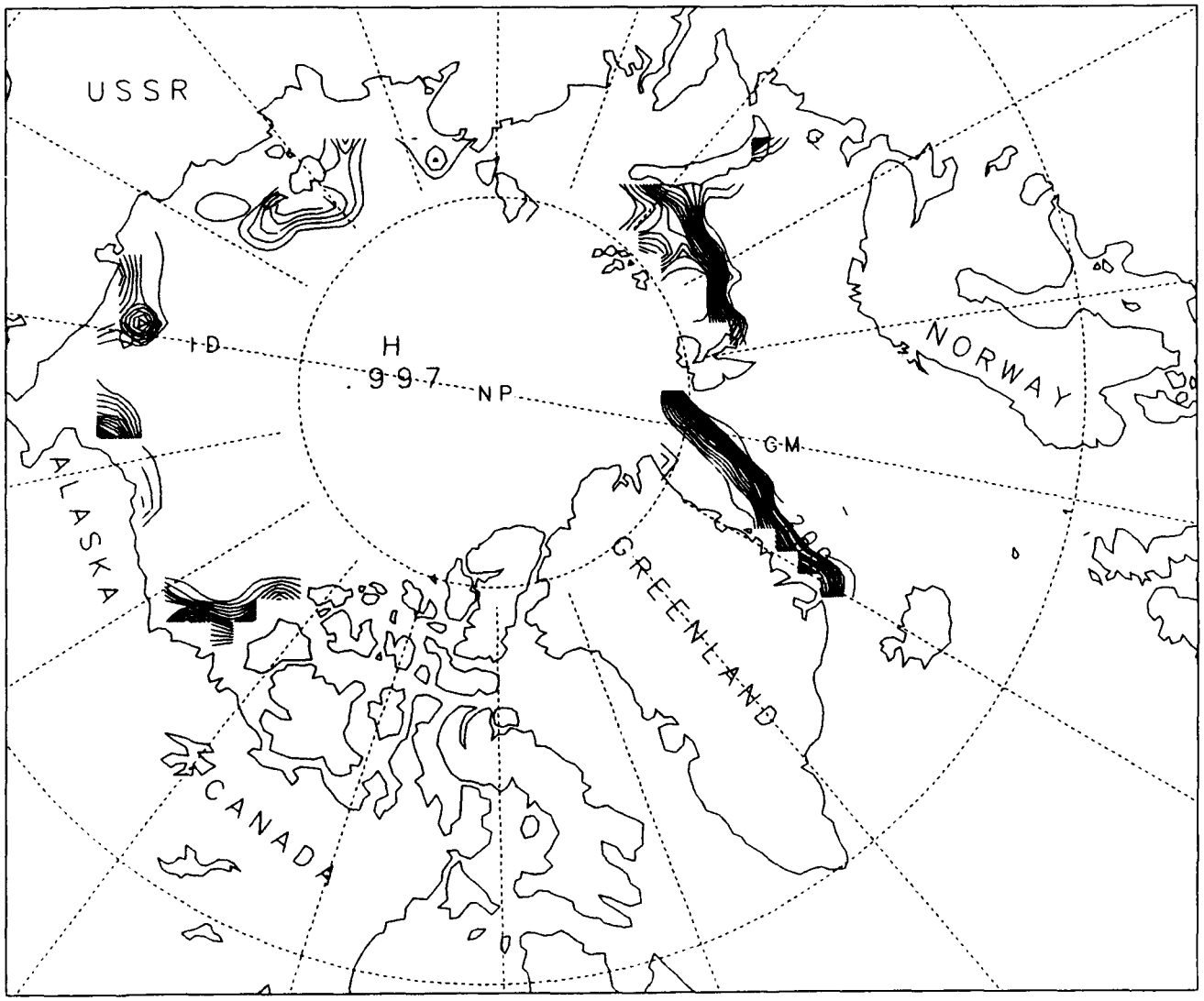
ICE VELOCITIES 1991 JUNE



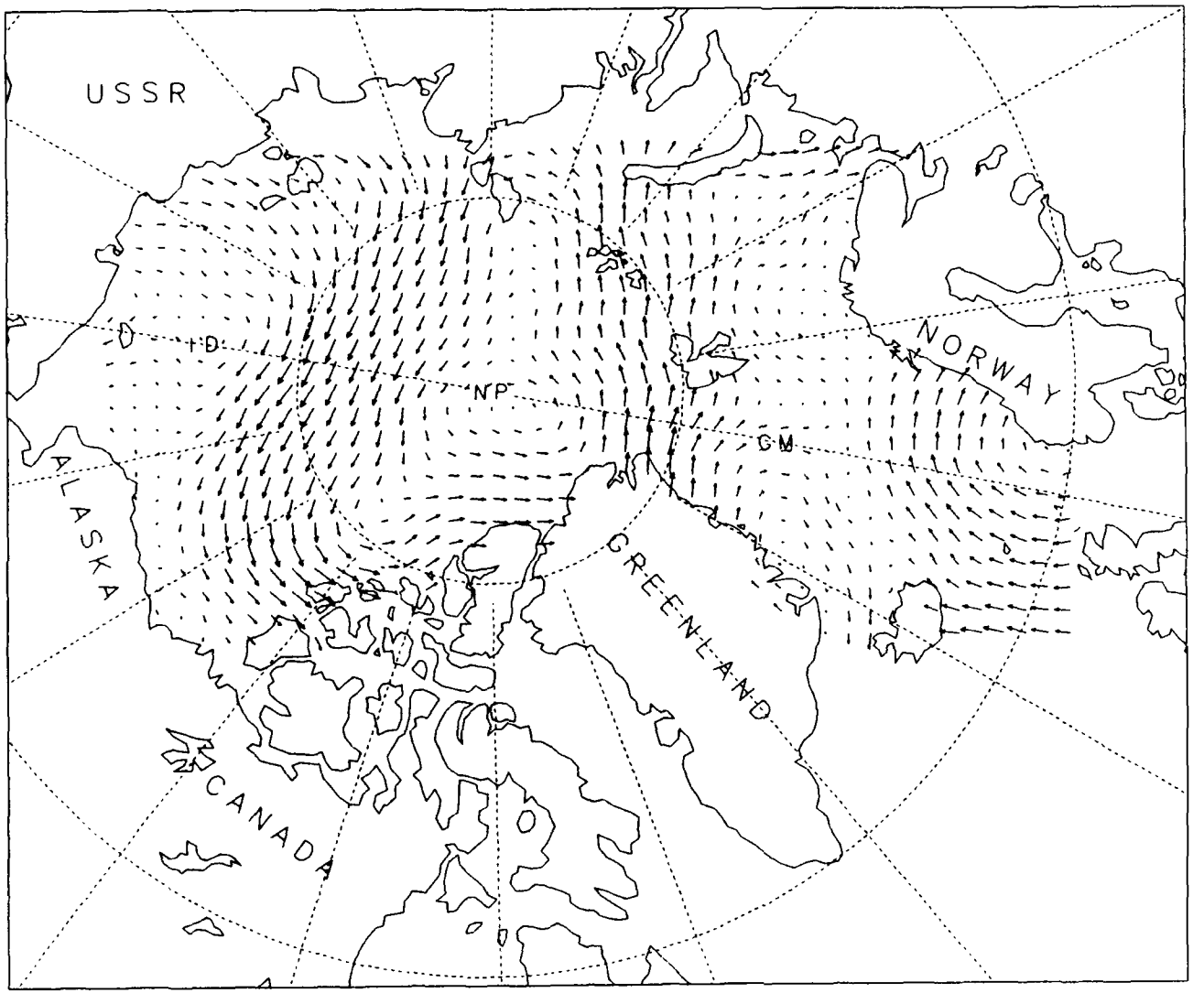
ICE THICKNESS 1991 JUNE



ICE CONCENTRATION 1991 JUNE

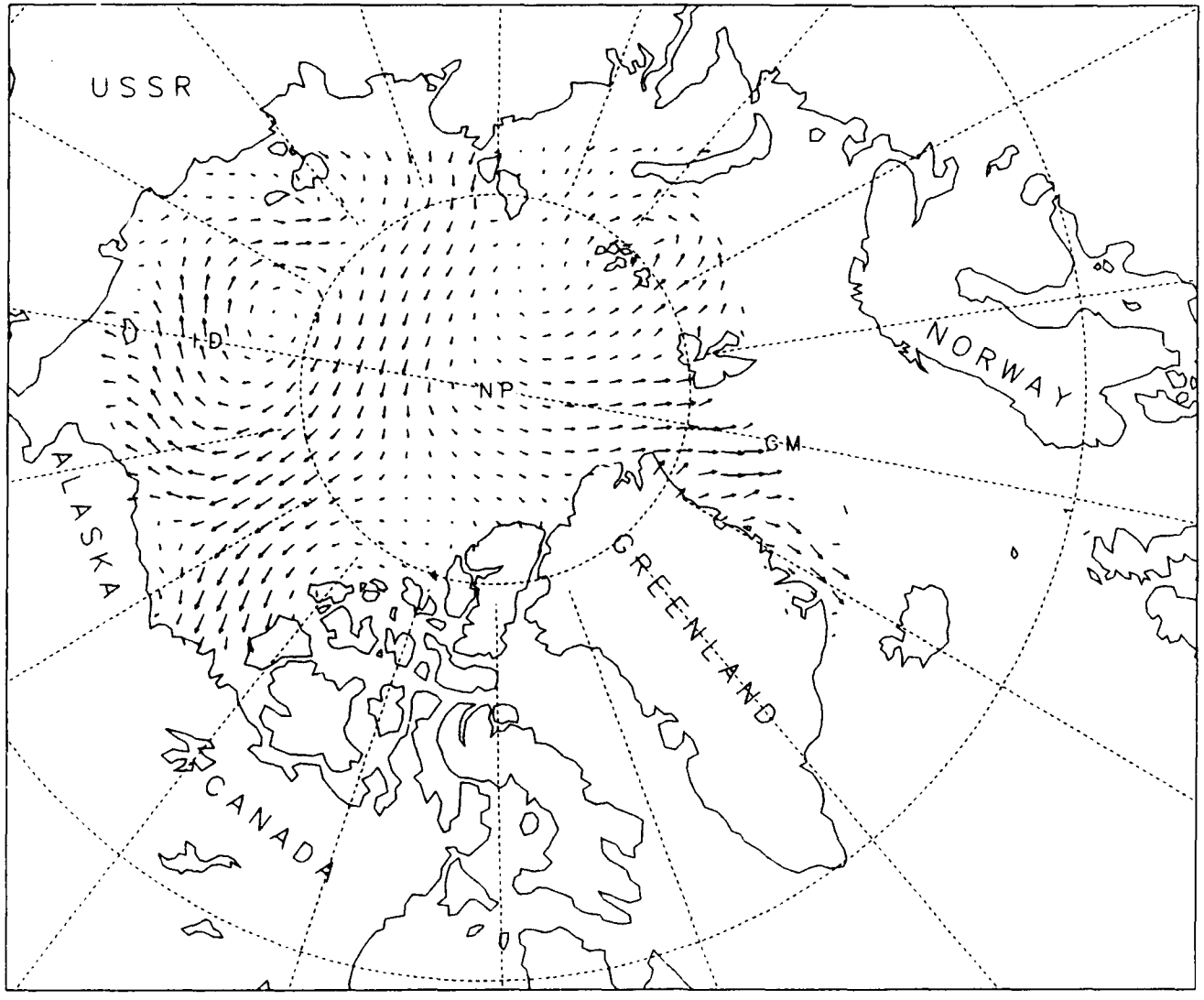


WIND VELOCITIES 1991 JULY



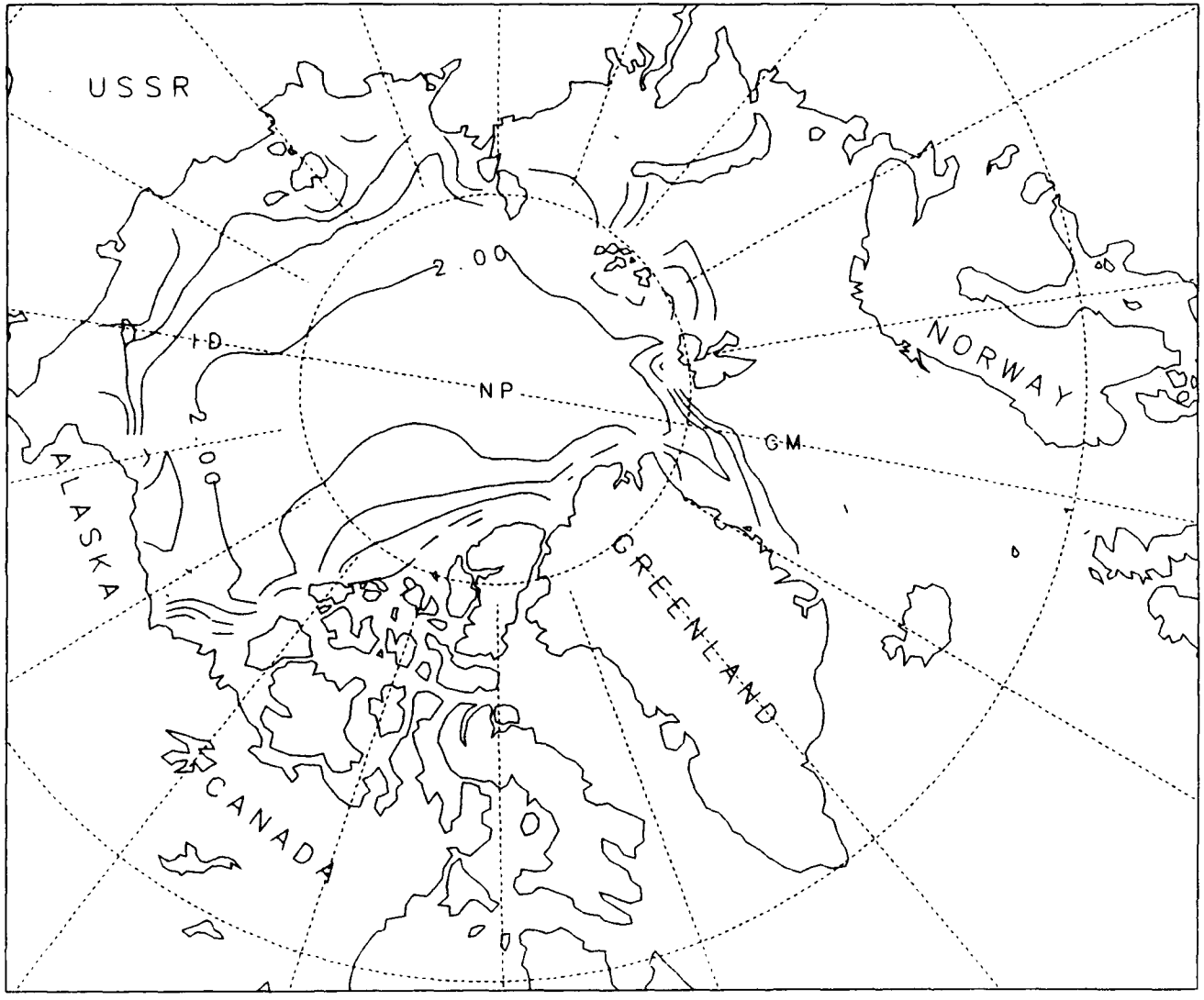
0.200E+02
MAXIMUM VECTOR

ICE VELOCITIES 1991 JULY

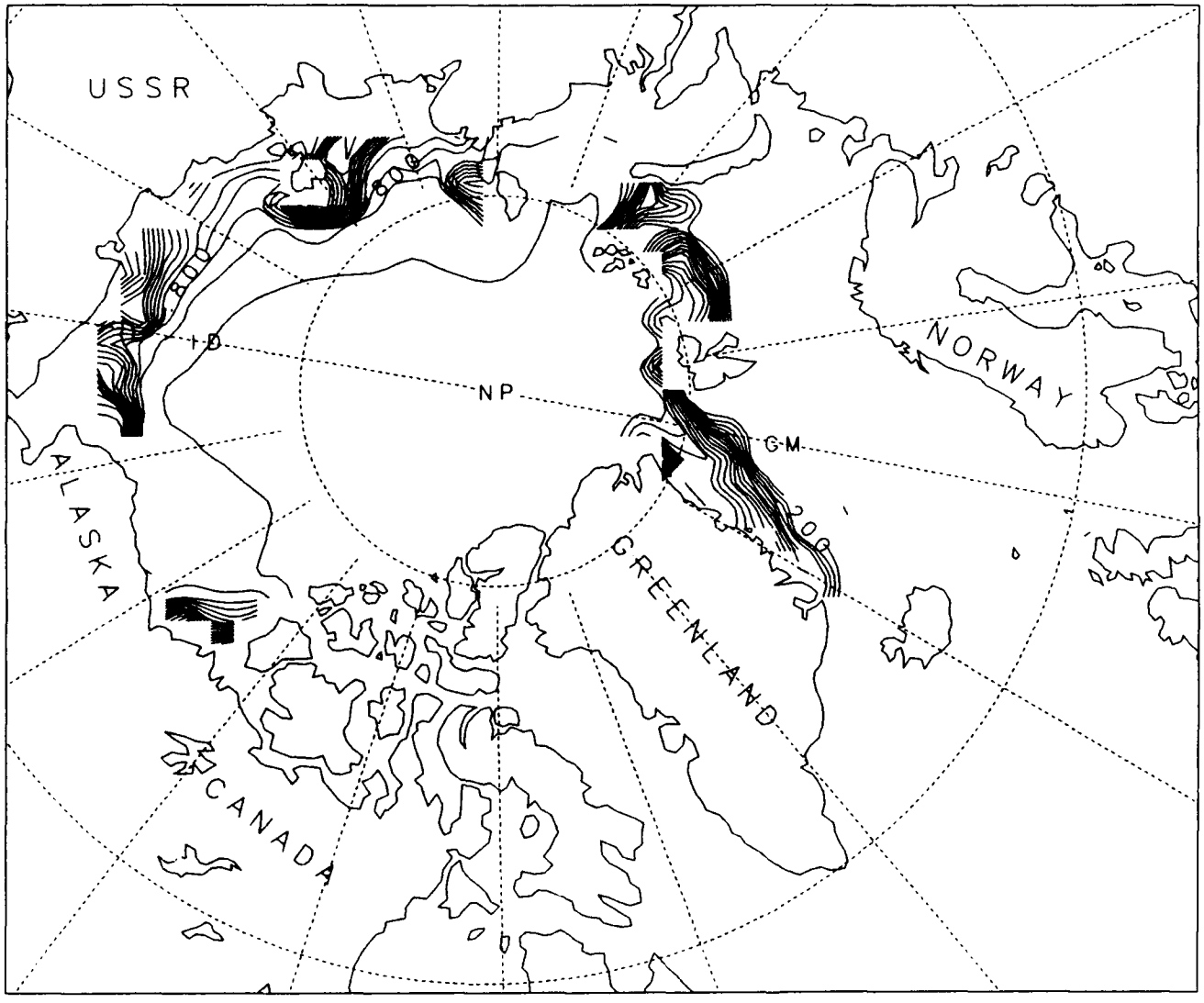


0.300E+00
MAXIMUM VECTOR

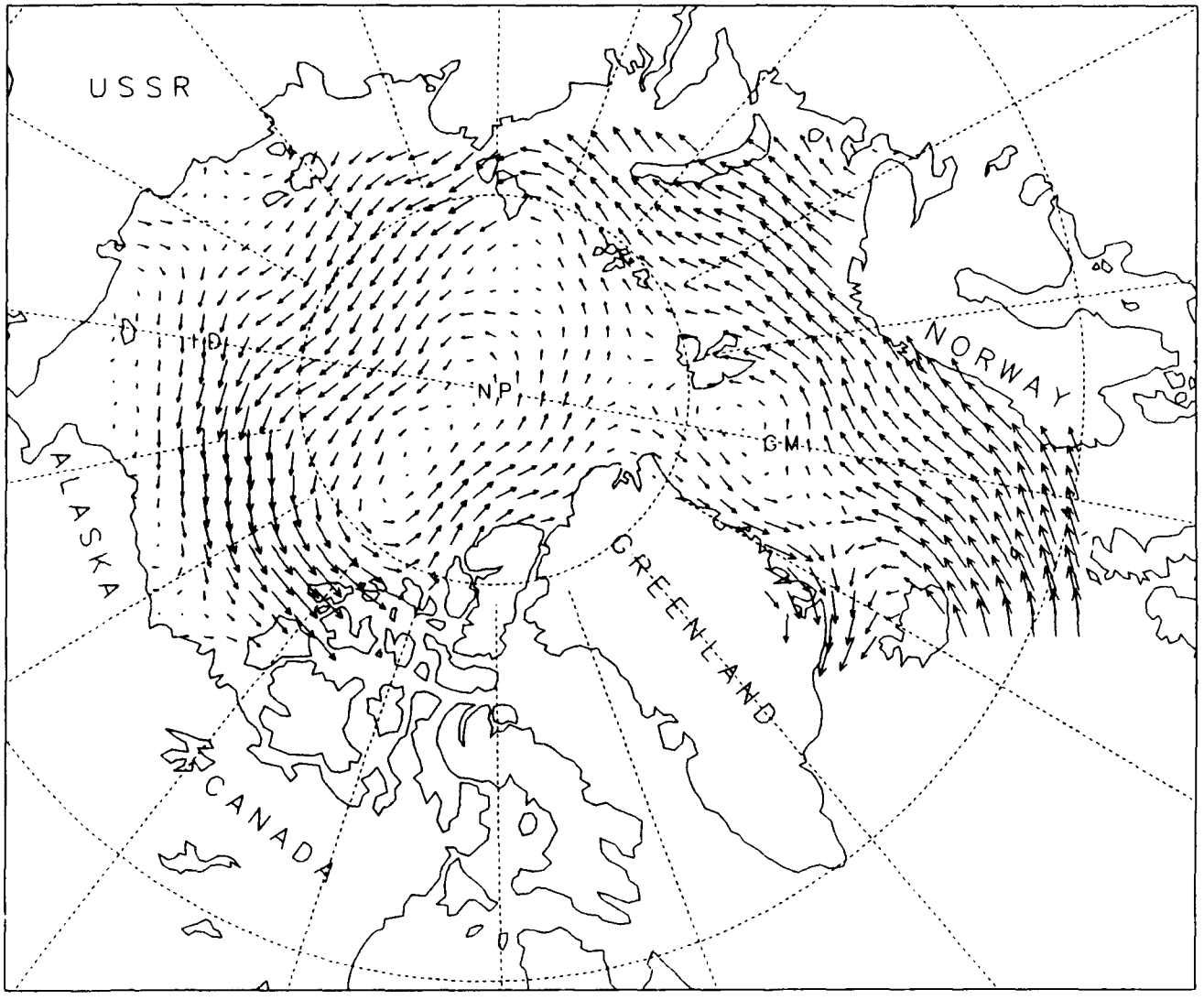
ICE THICKNESS 1991 JULY



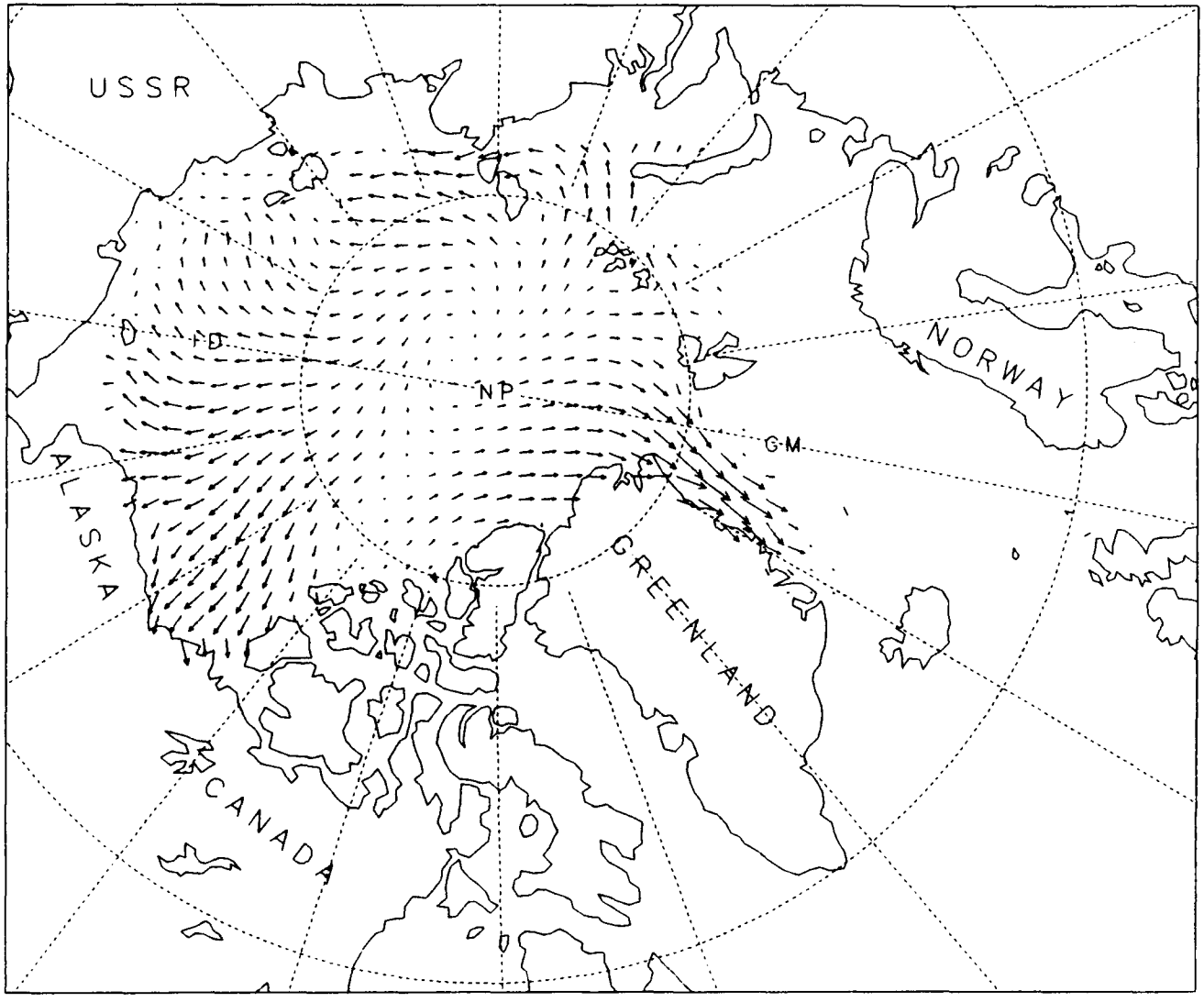
ICE CONCENTRATION 1991 JULY



WIND VELOCITIES 1991 AUGUST

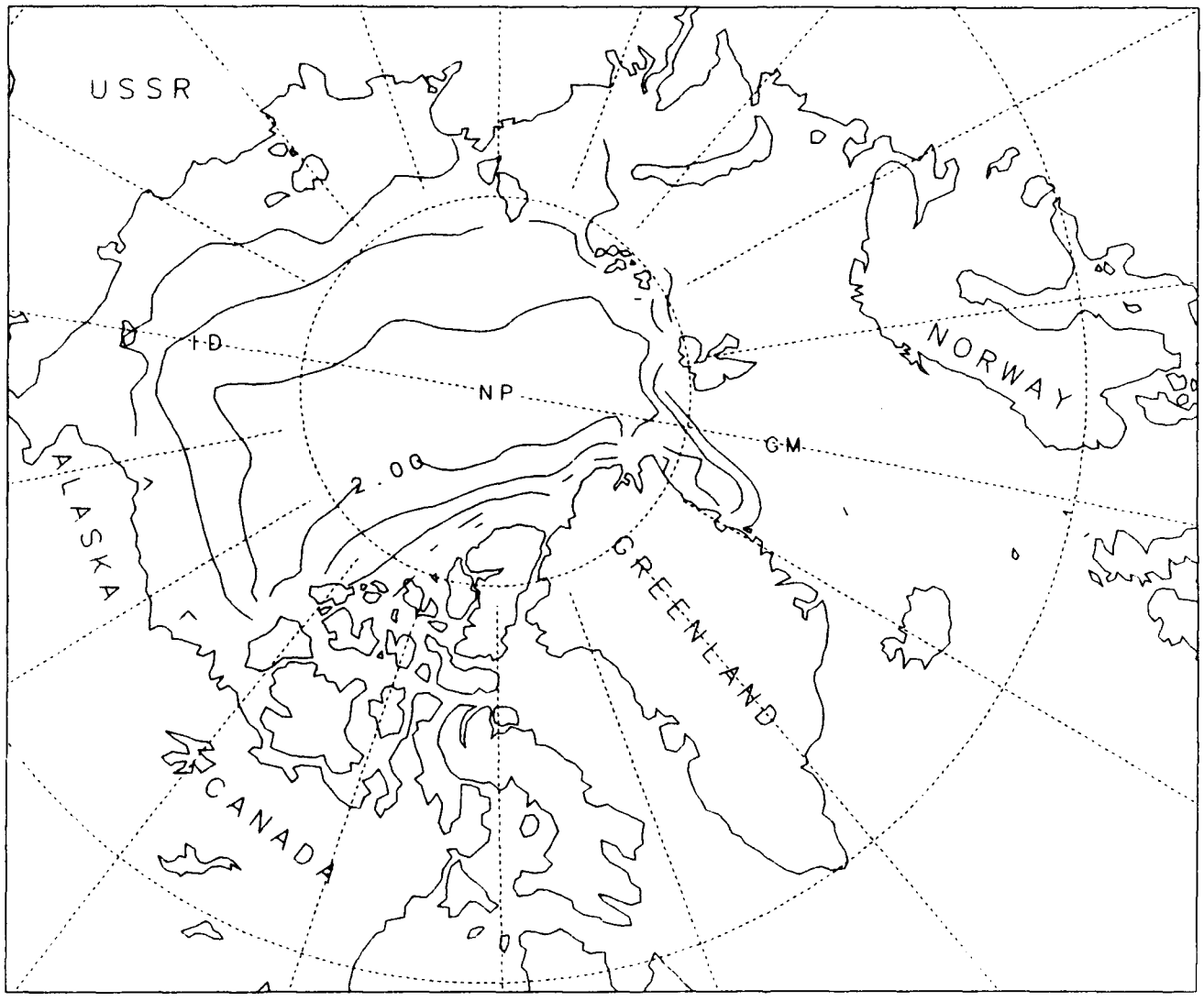


ICE VELOCITIES 1991 AUGUST

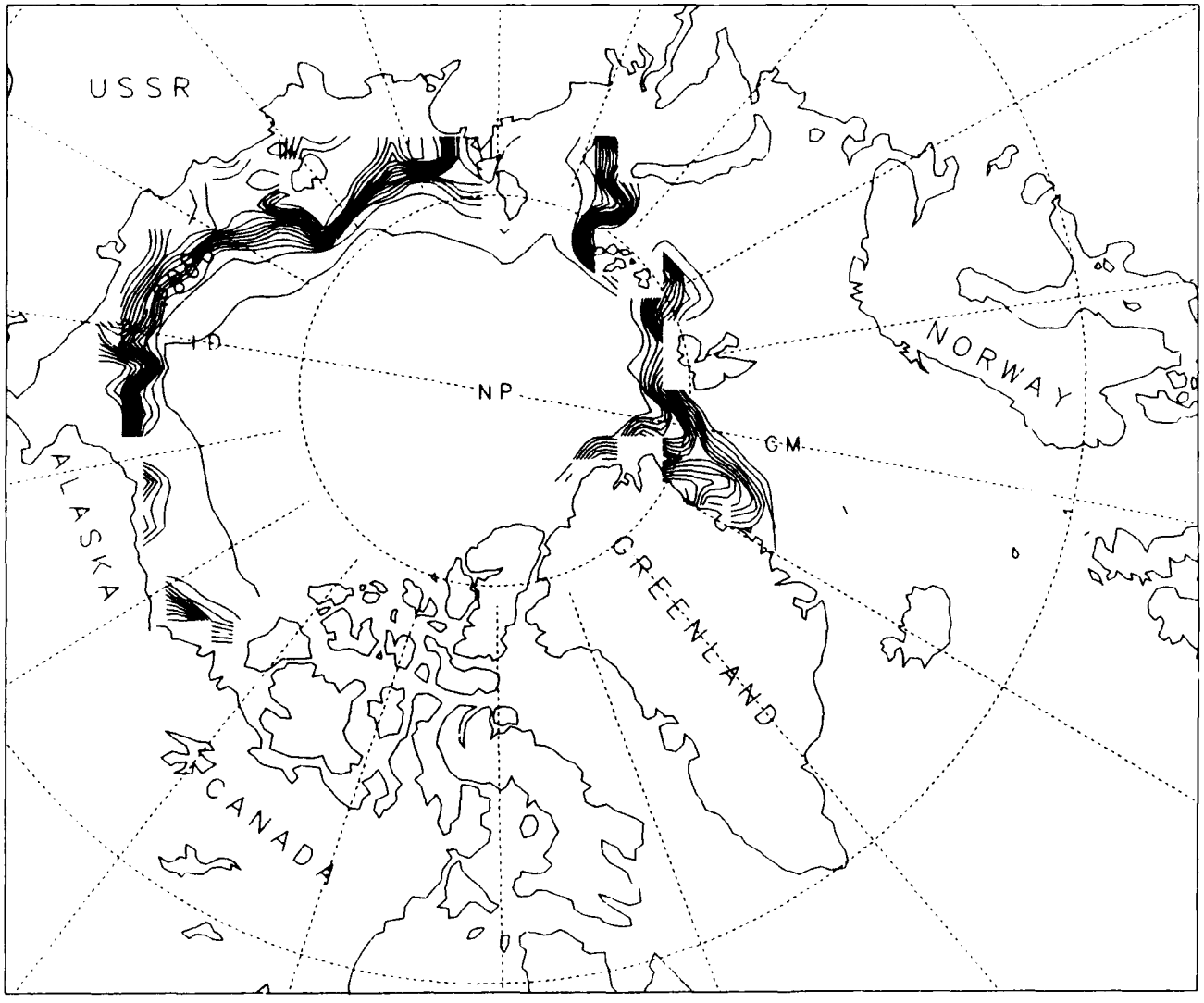


0.300E+00
MAXIMUM VECTOR

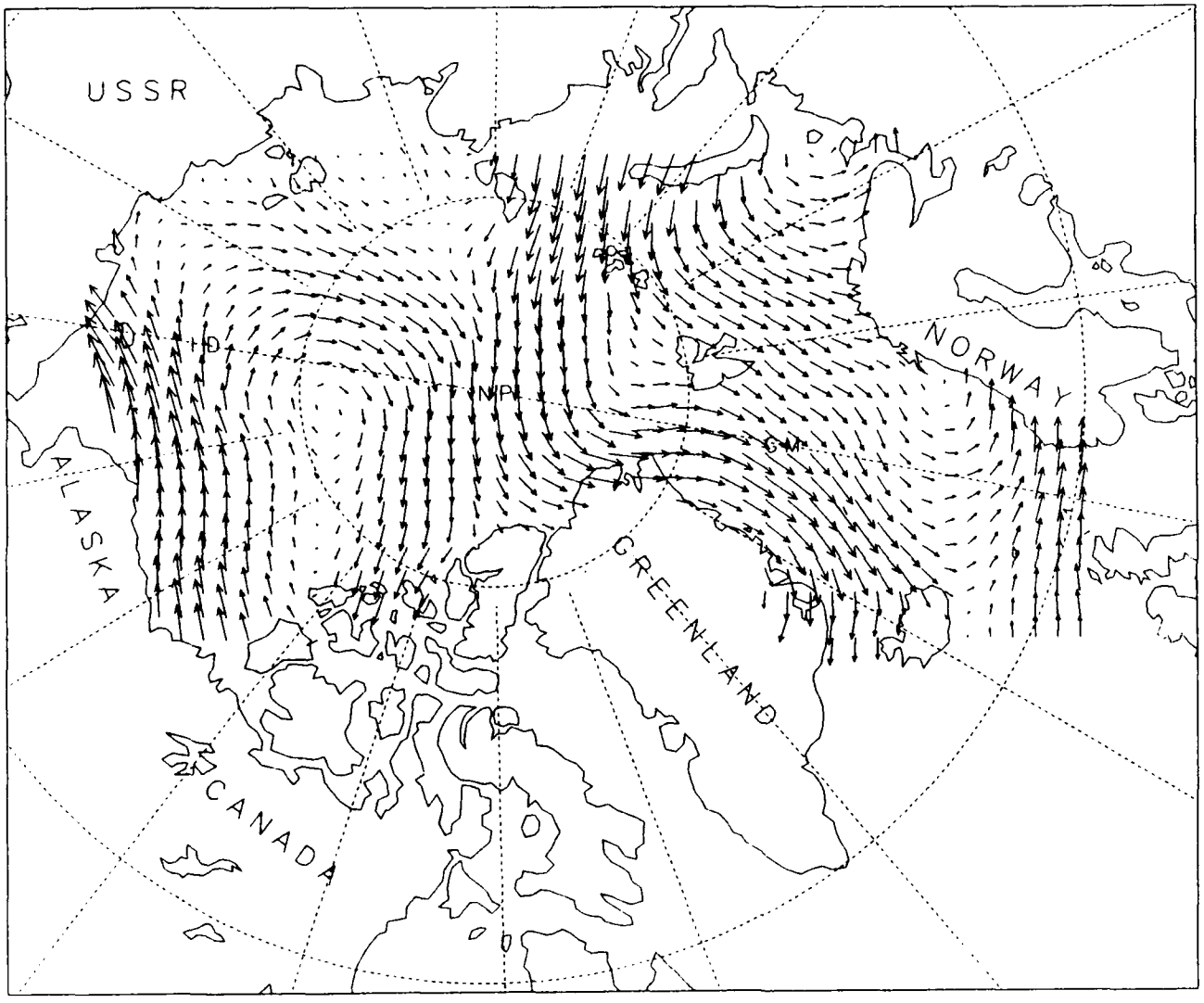
ICE THICKNESS 1991 AUGUST



ICE CONCENTRATION 1991 AUGUST

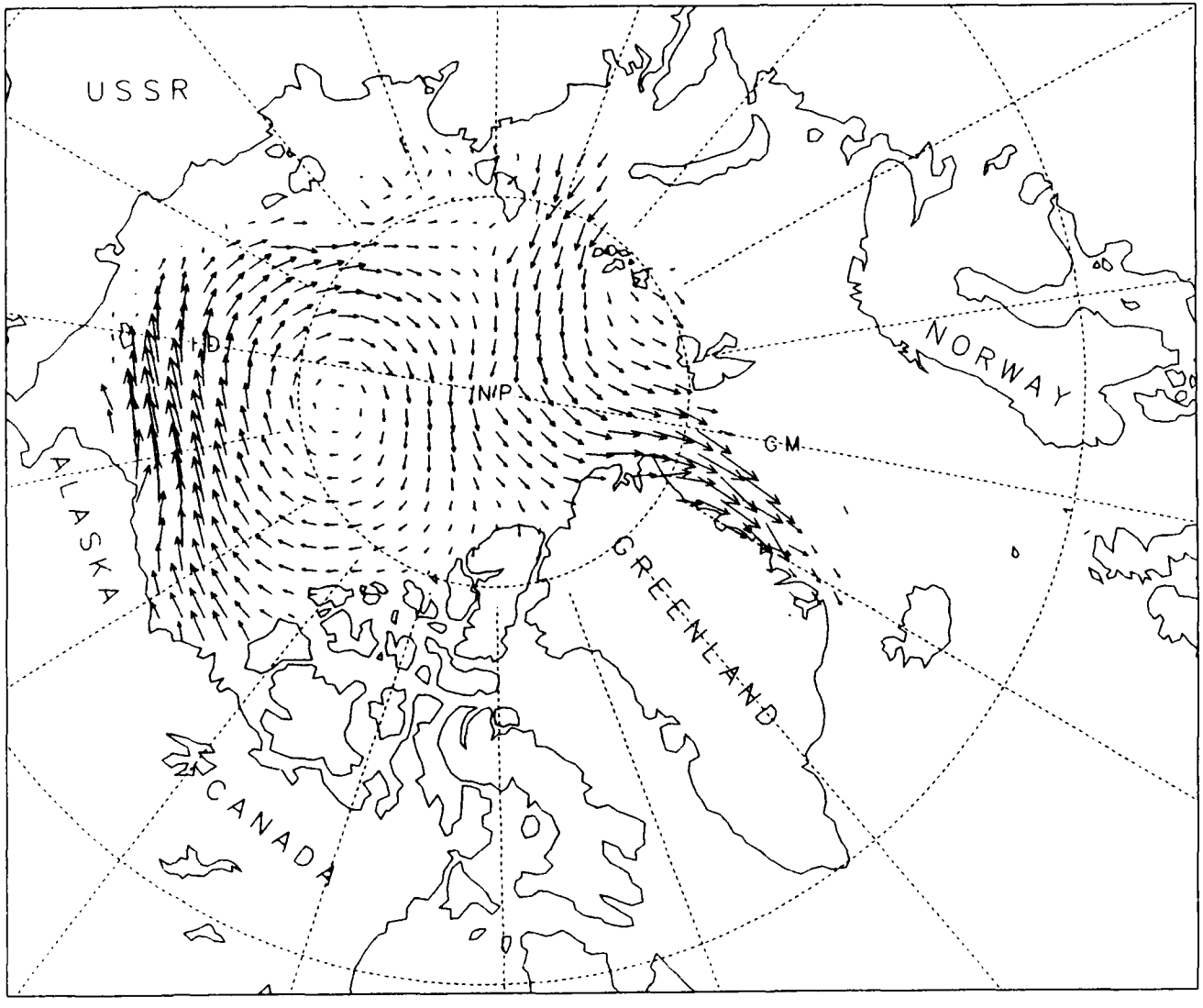


WIND VELOCITIES 1991 SEPTEMBER

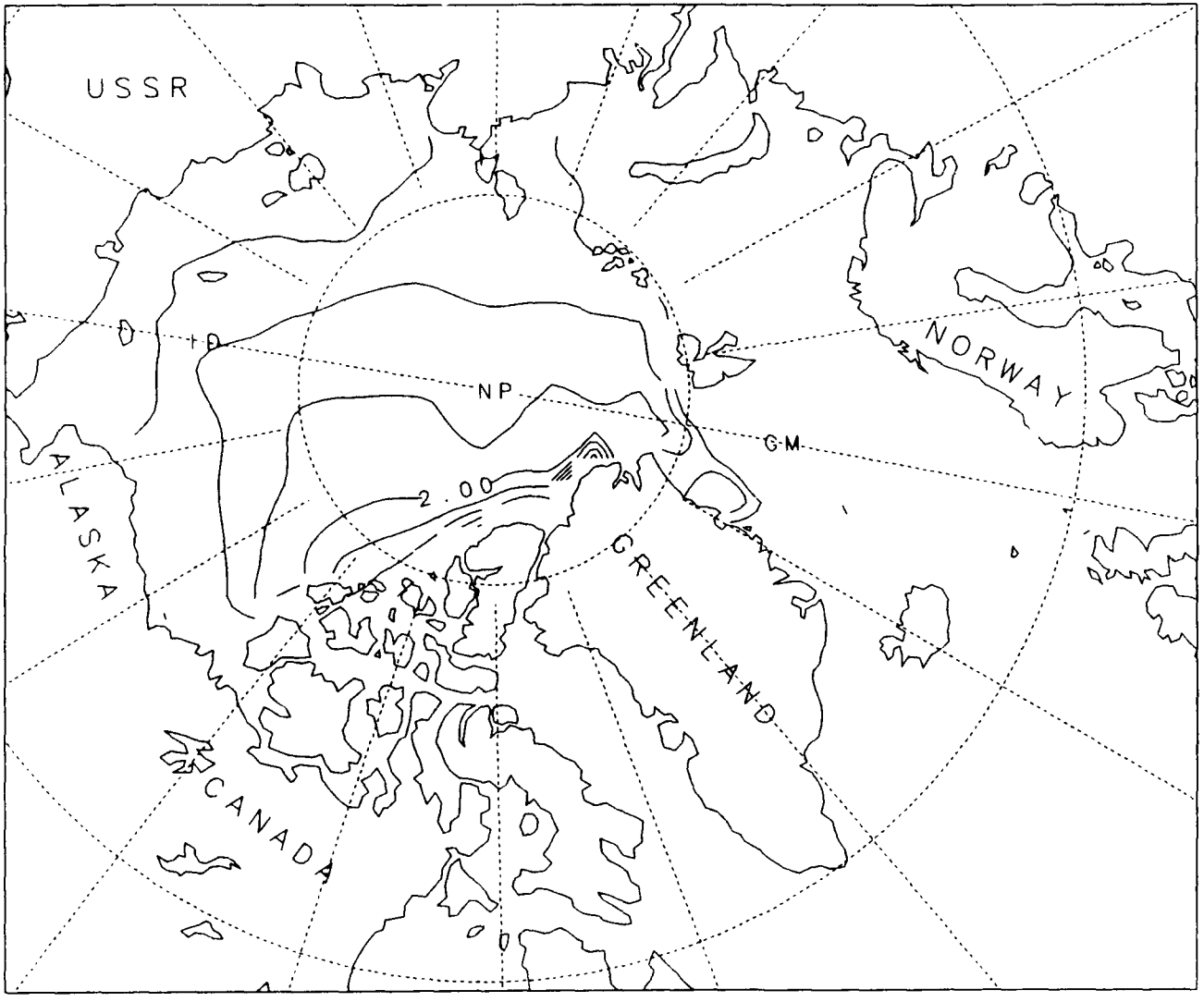


0.200E+02
MAXIMUM VECTOR

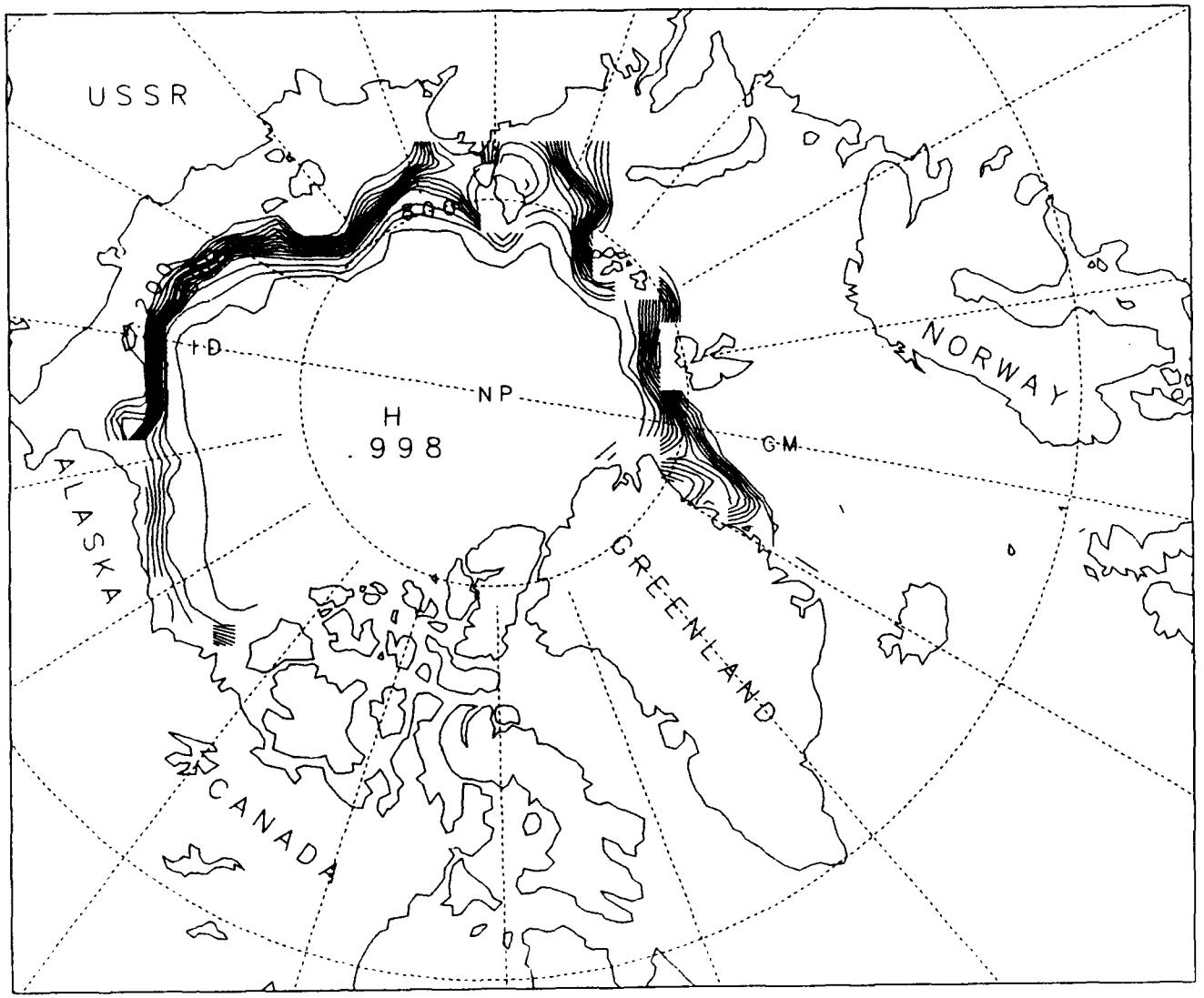
ICE VELOCITIES 1991 SEPTEMBER



ICE THICKNESS 1991 SEPTEMBER



ICE CONCENTRATION 1991 SEPTEMBER



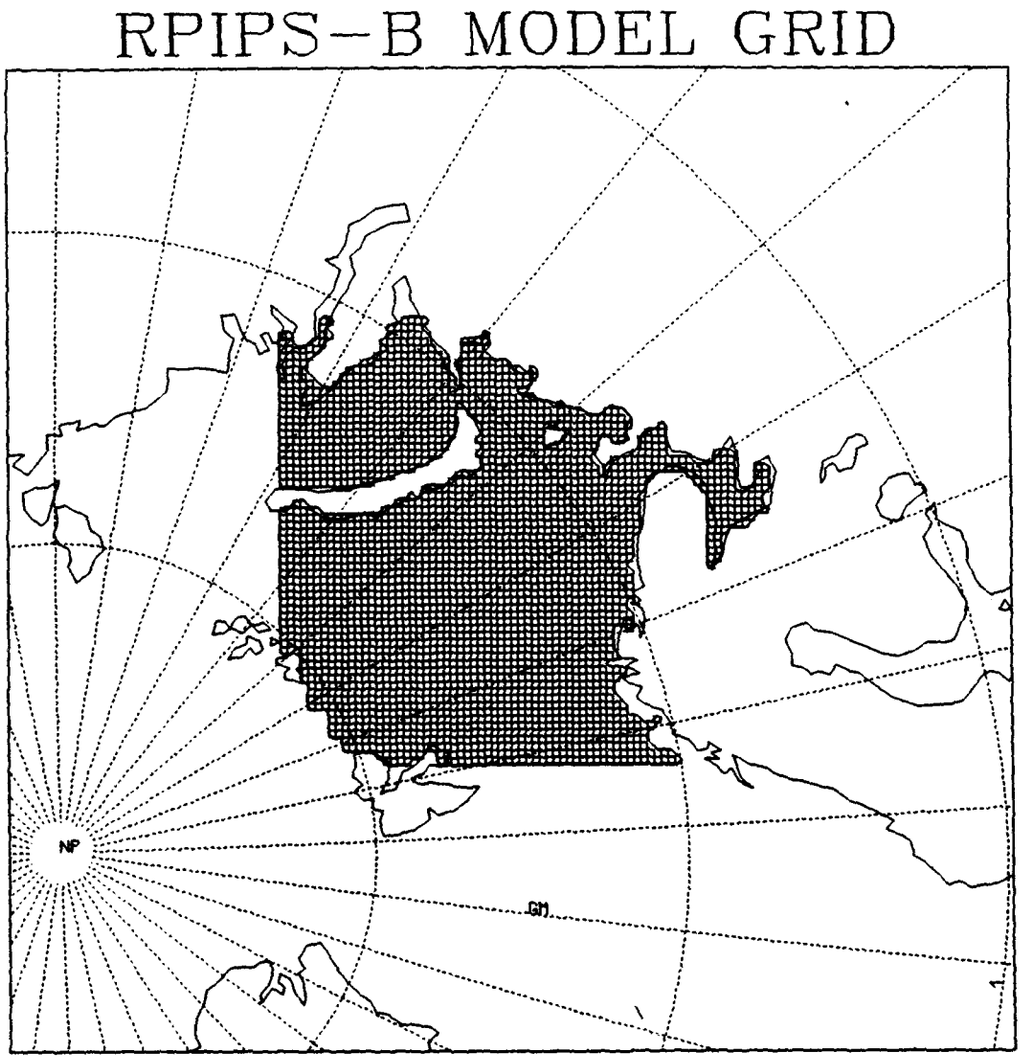
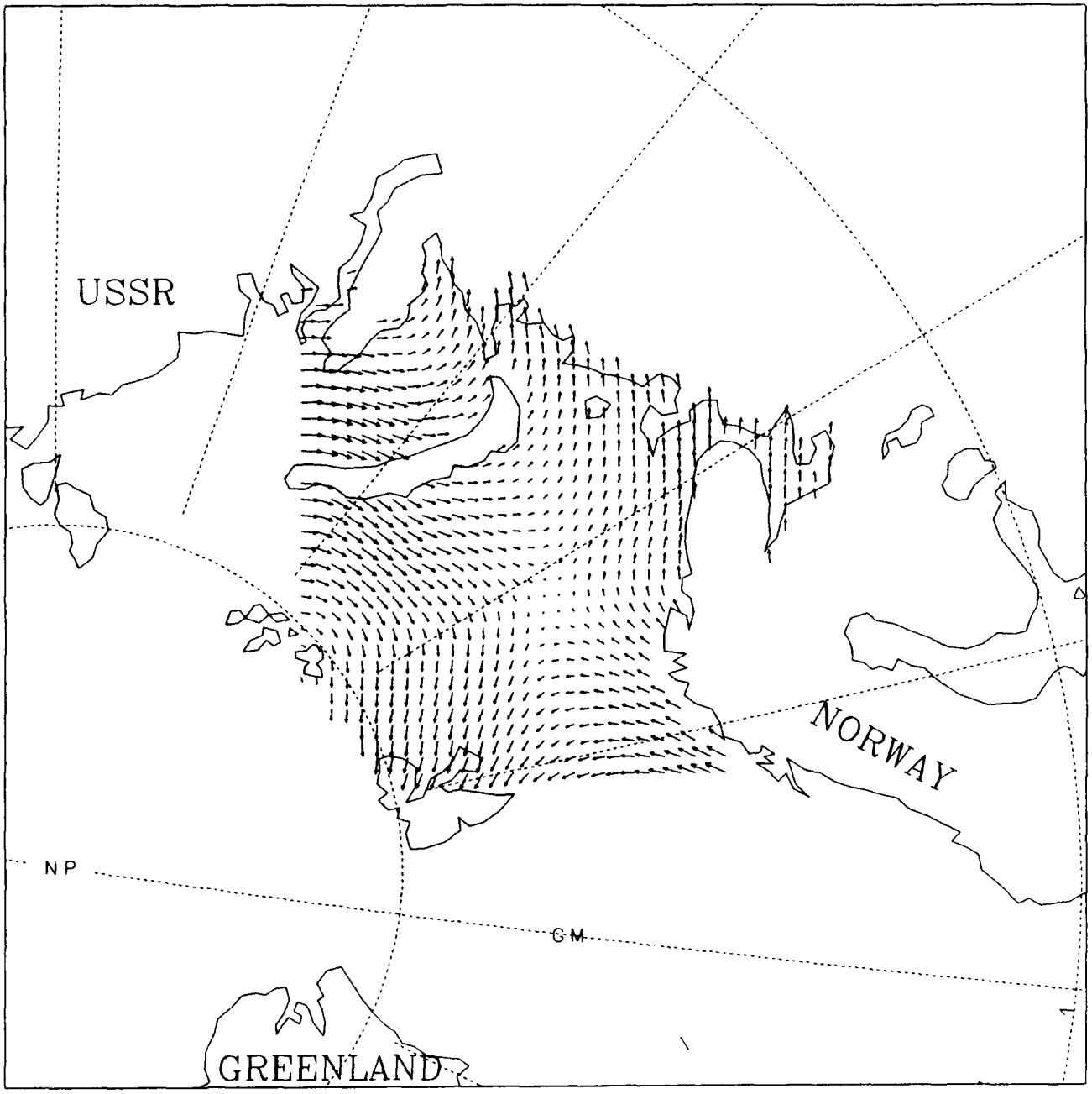


Figure 2. RPIPS-B domain with the 25 km resolution grid overlaid.

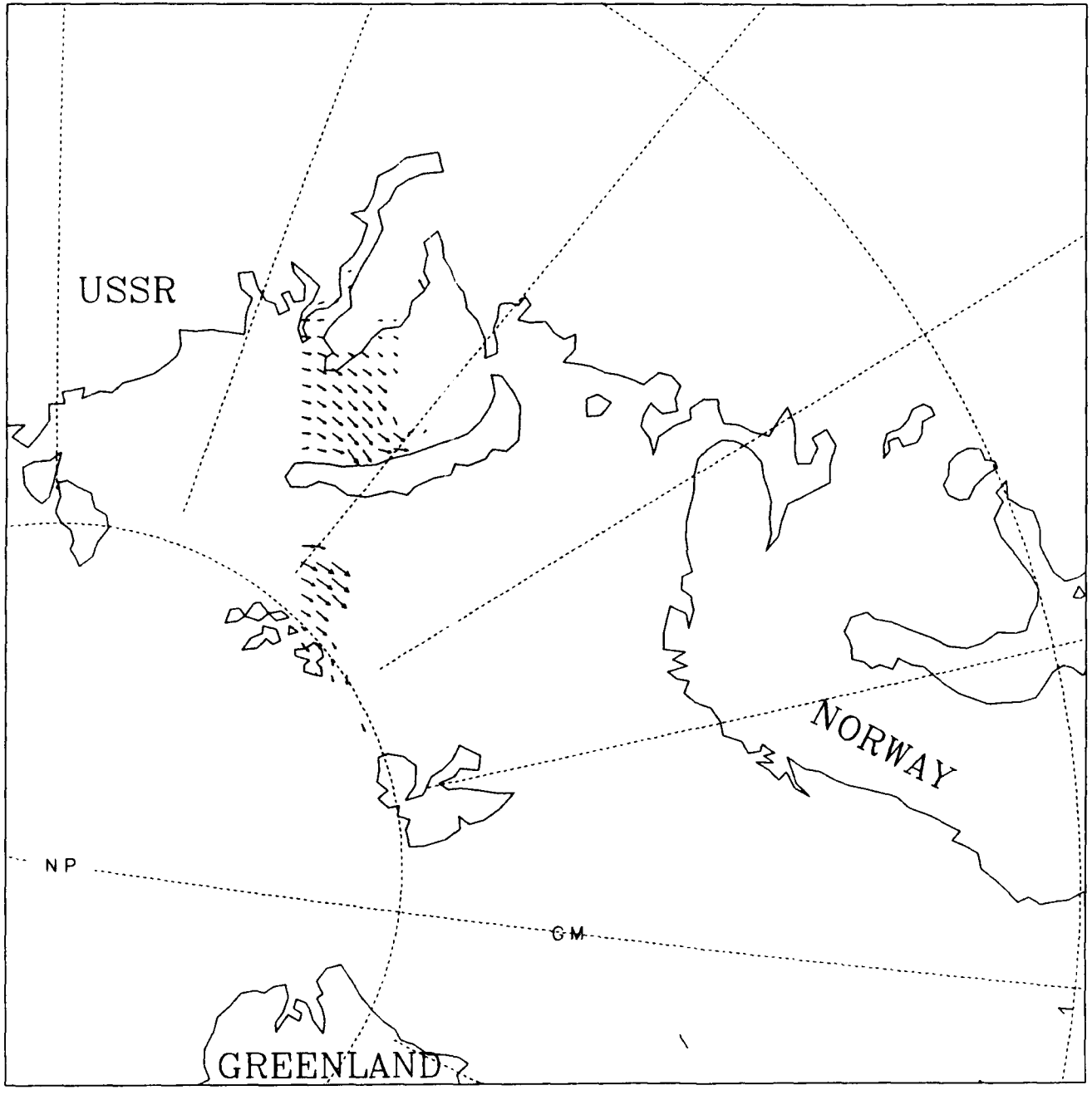
R PIPS-B 1990

MONTHLY MEANS

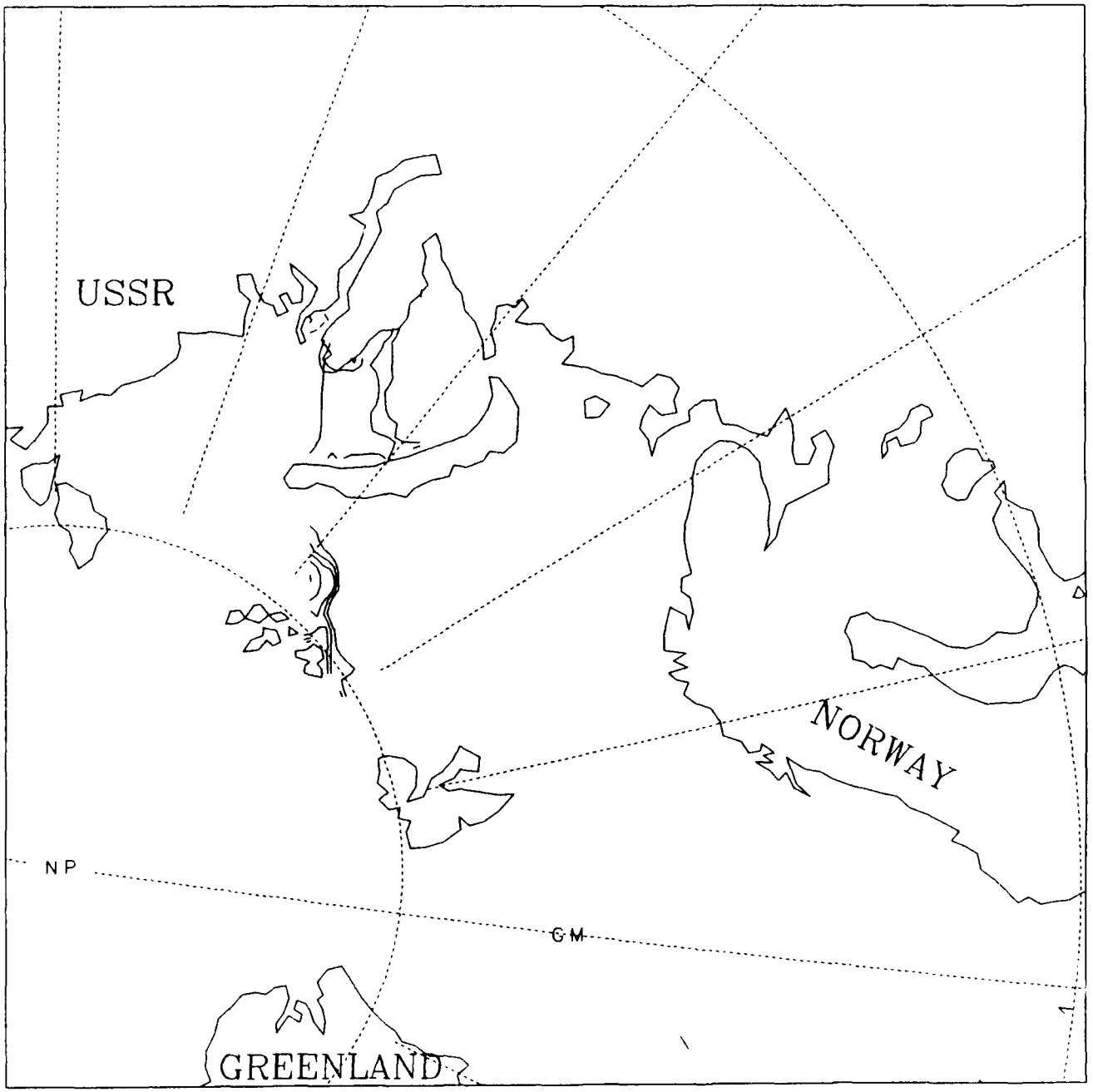
WIND VELOCITIES 1990 OCTOBER



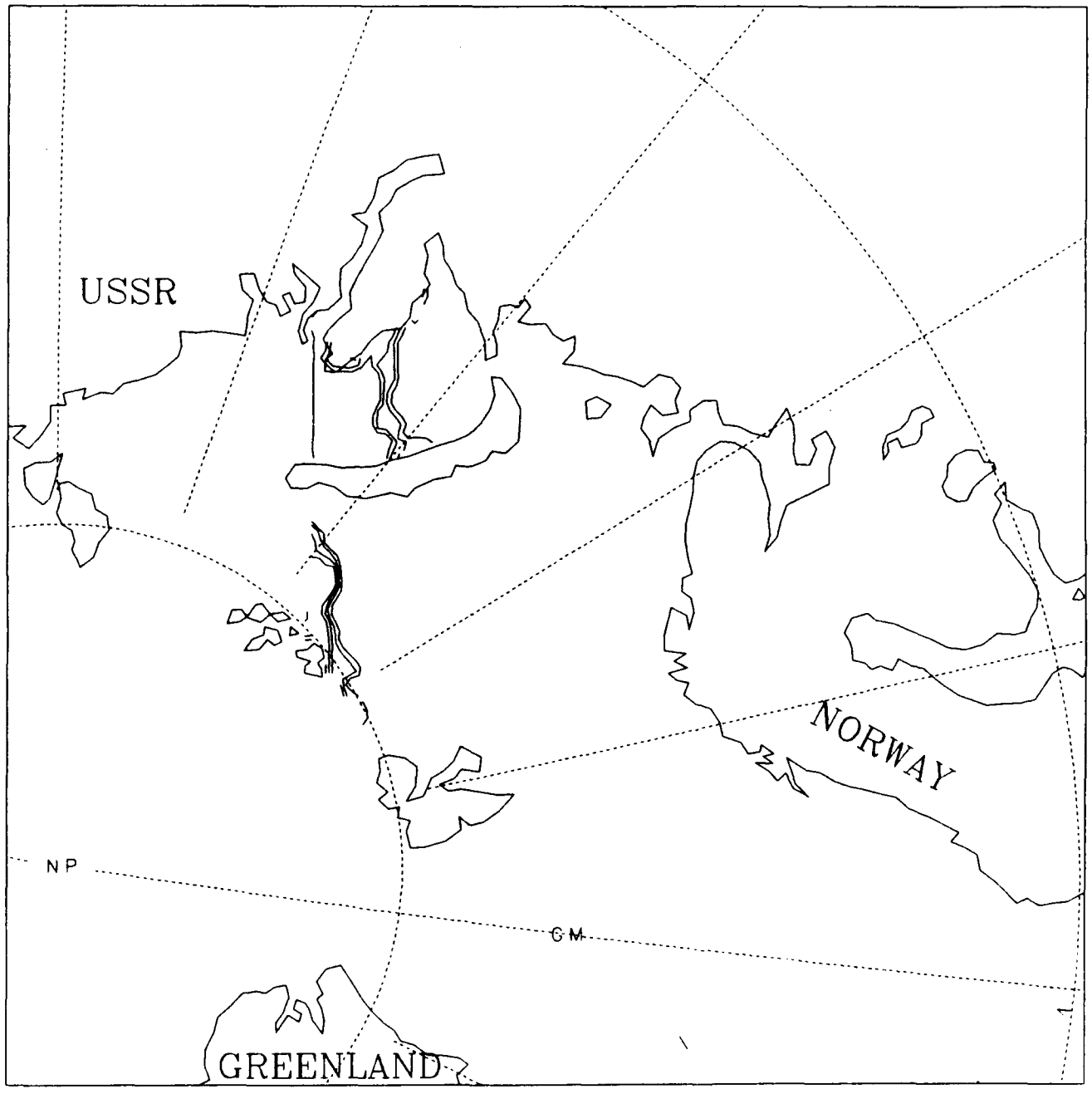
ICE VELOCITIES 1990 OCTOBER



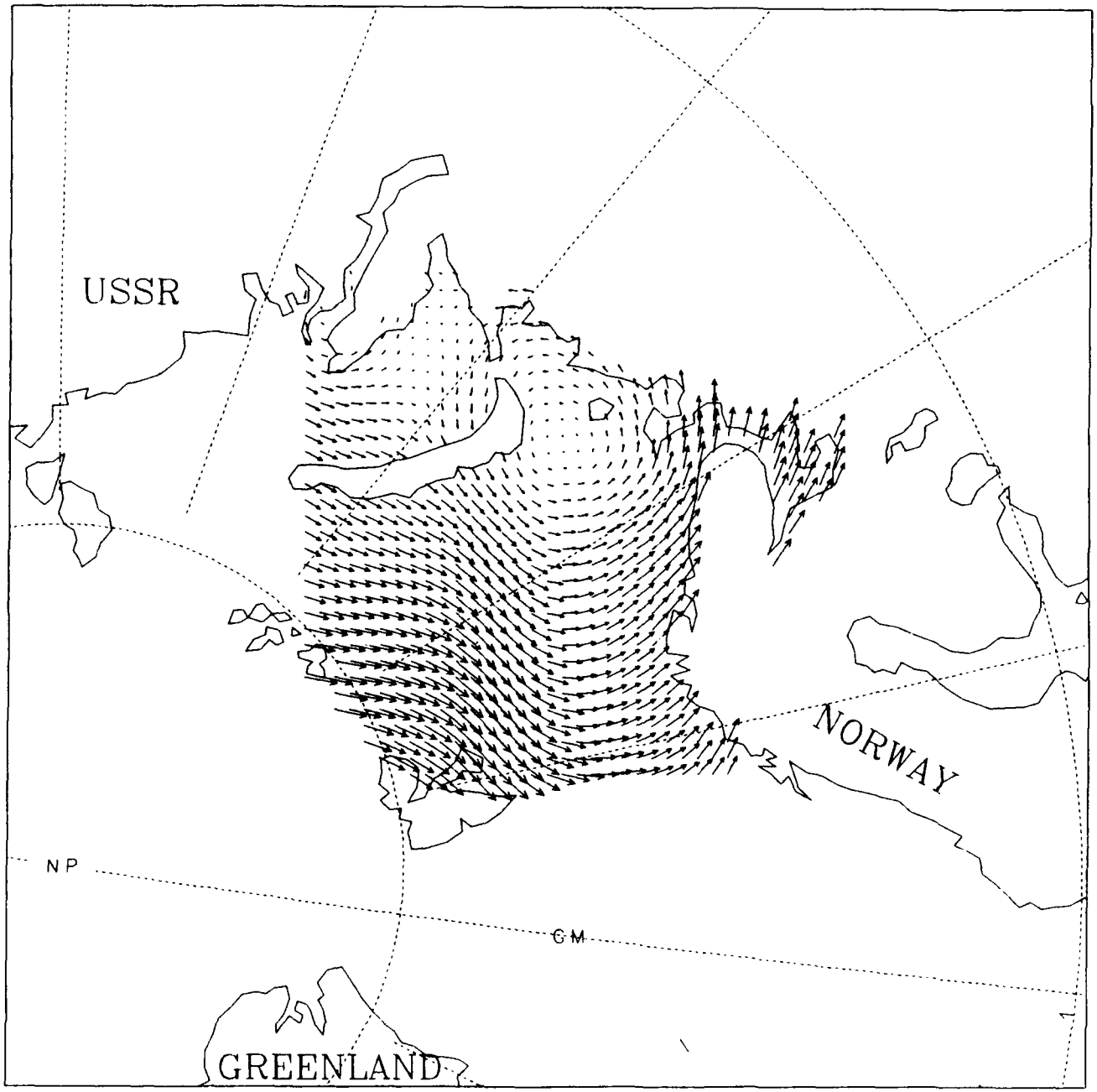
ICE THICKNESS 1990 OCTOBER



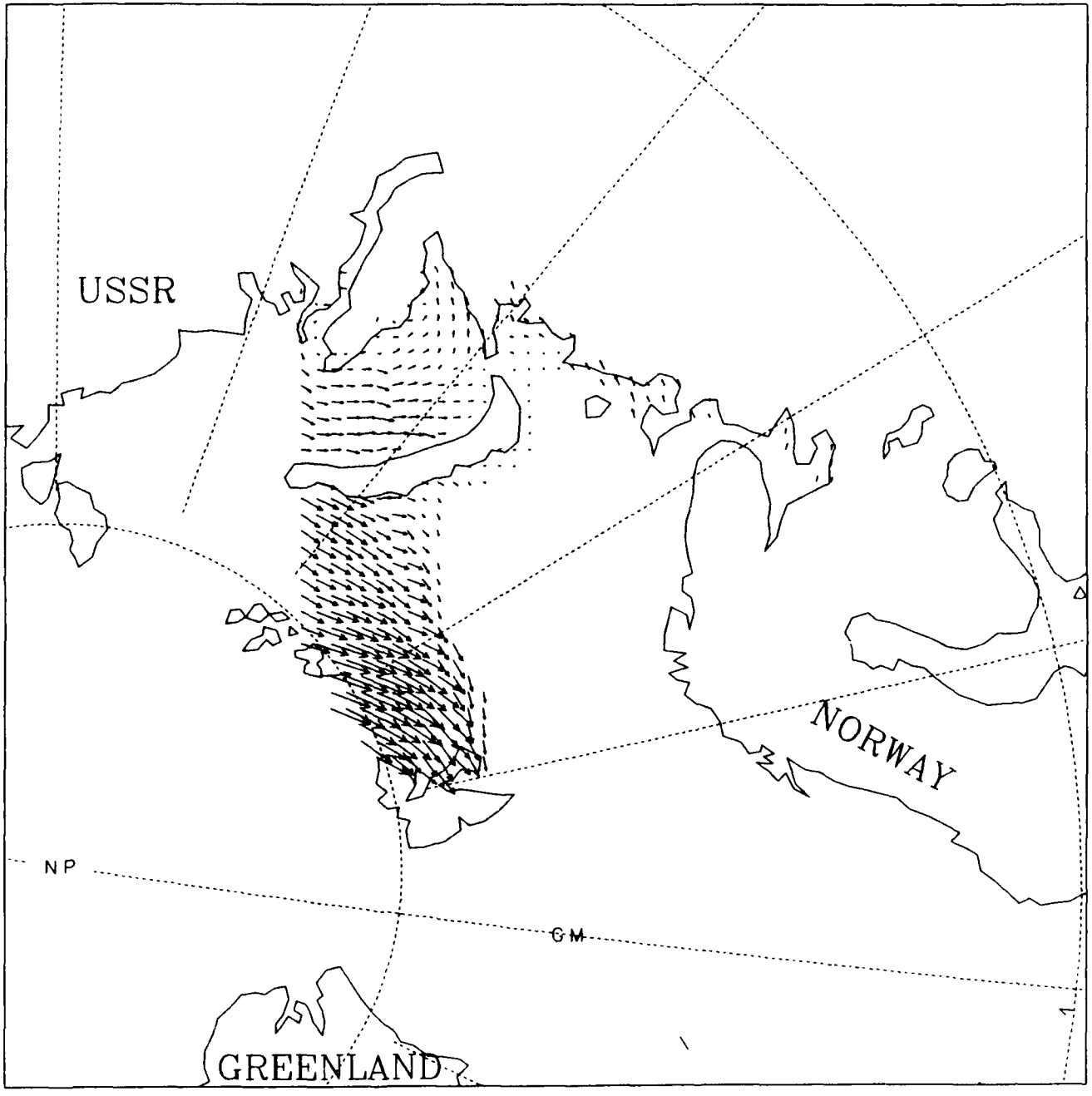
ICE CONCENTRATION 1990 OCTOBER



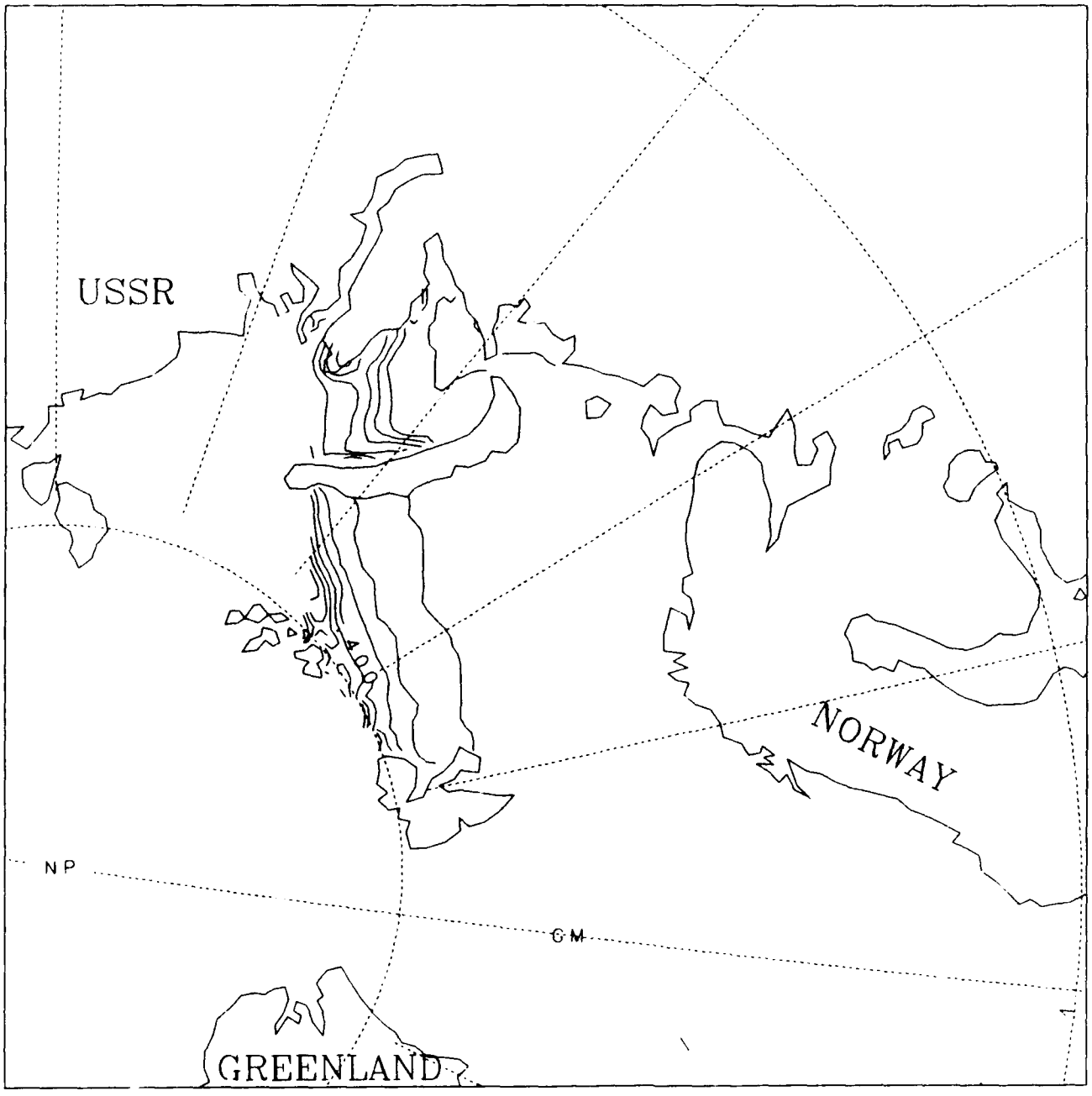
WIND VELOCITIES 1990 NOVEMBER



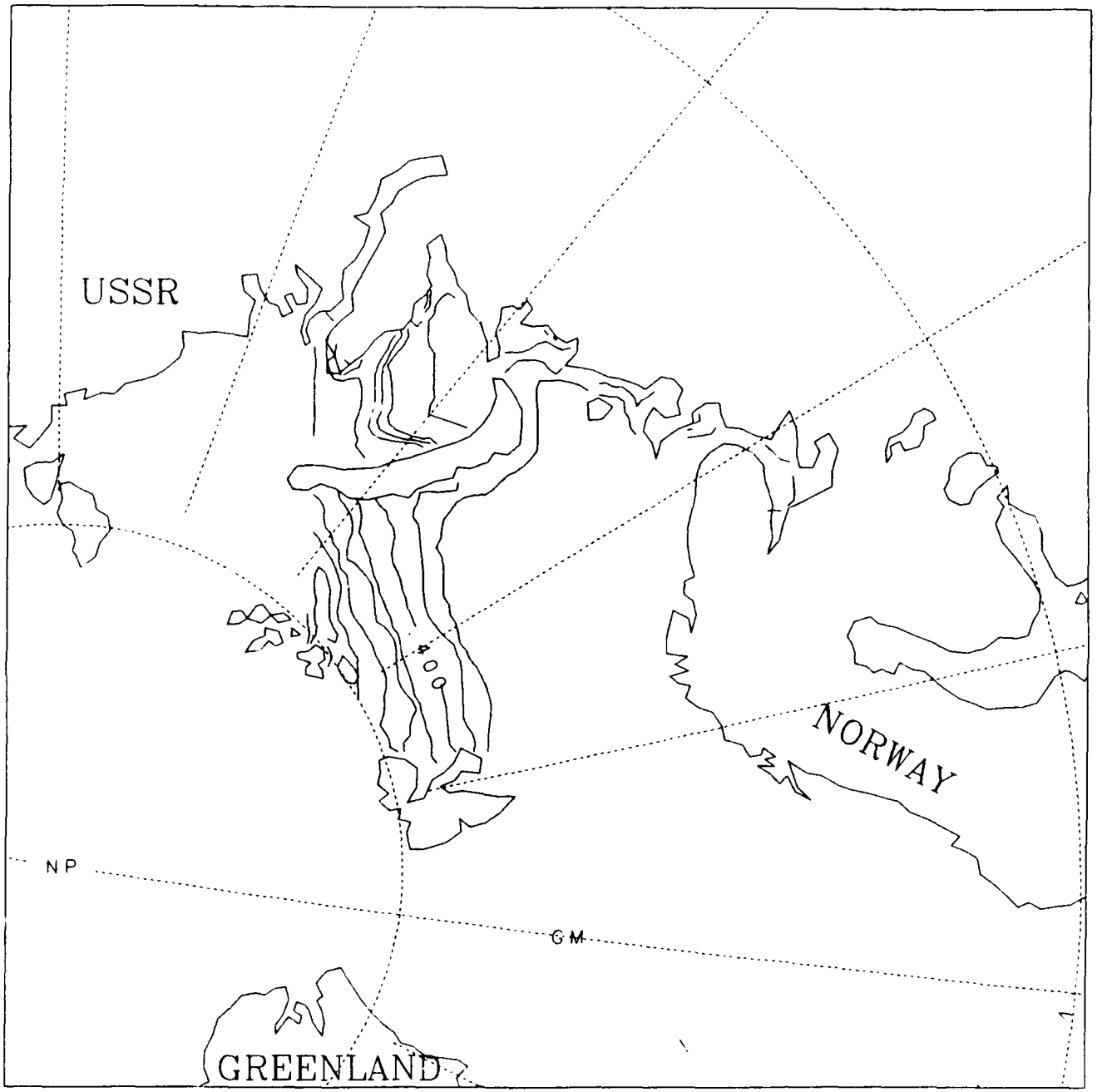
ICE VELOCITIES 1990 NOVEMBER



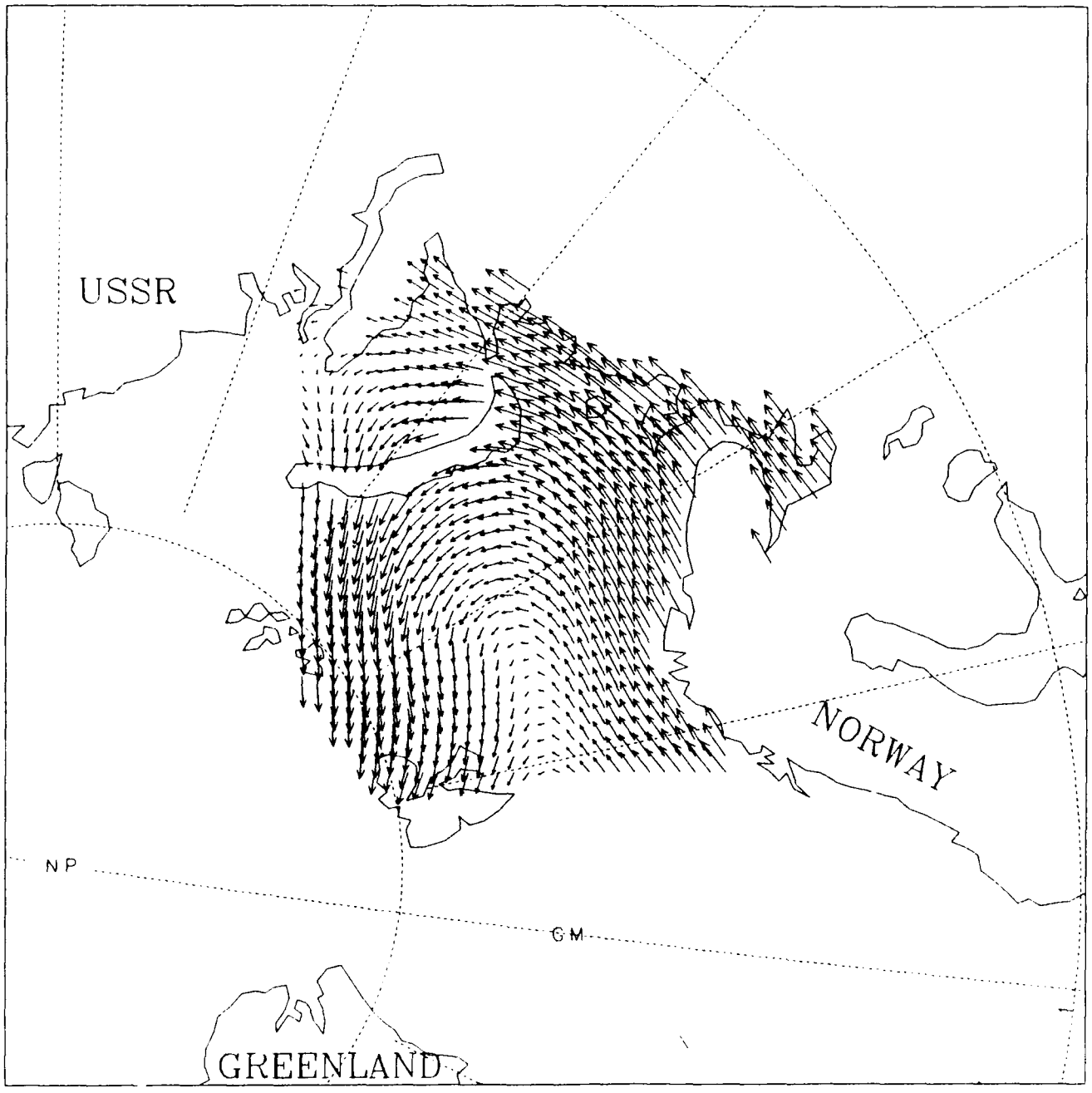
ICE THICKNESS 1990 NOVEMBER



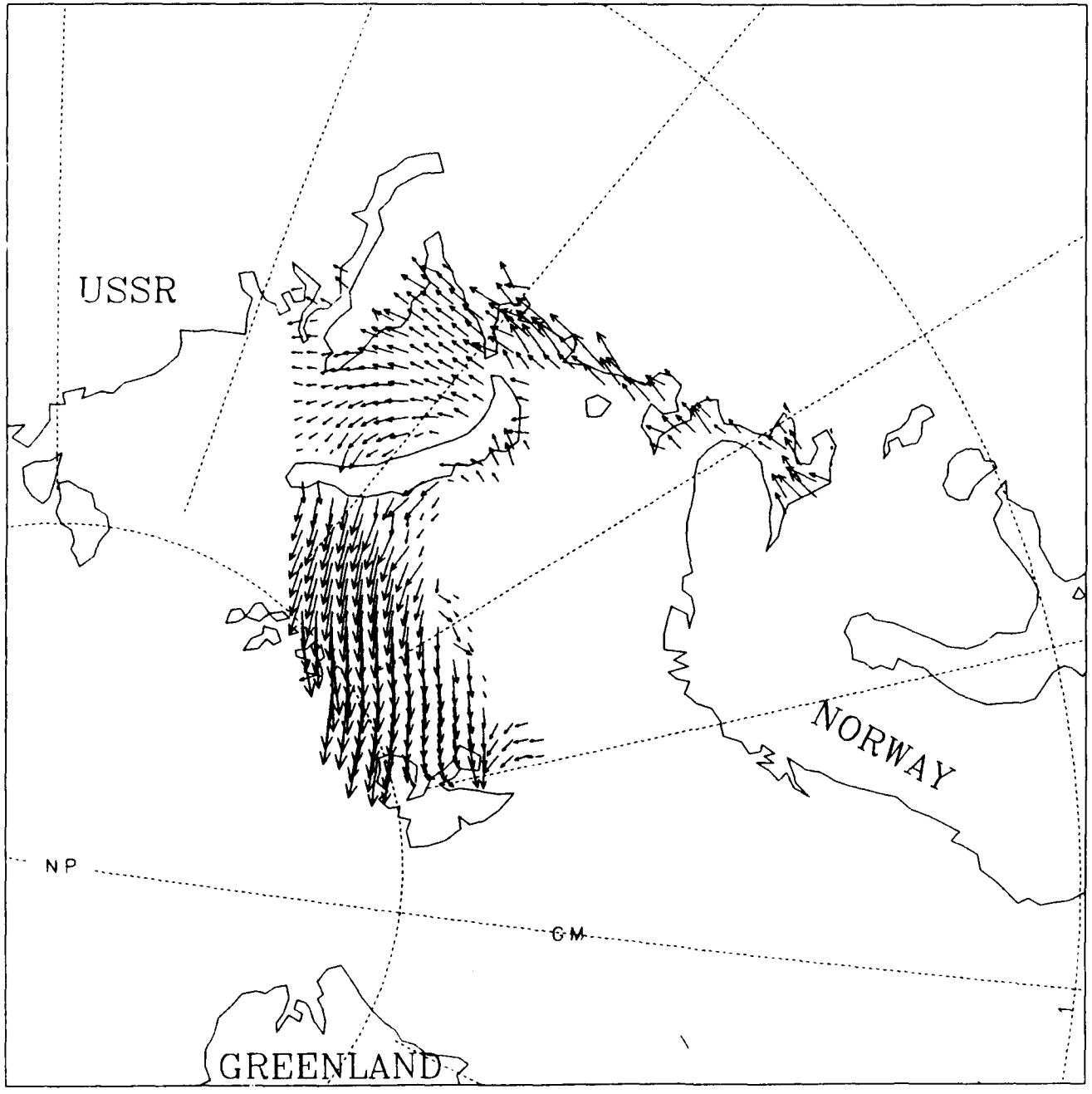
ICE CONCENTRATION 1990 NOVEMBER



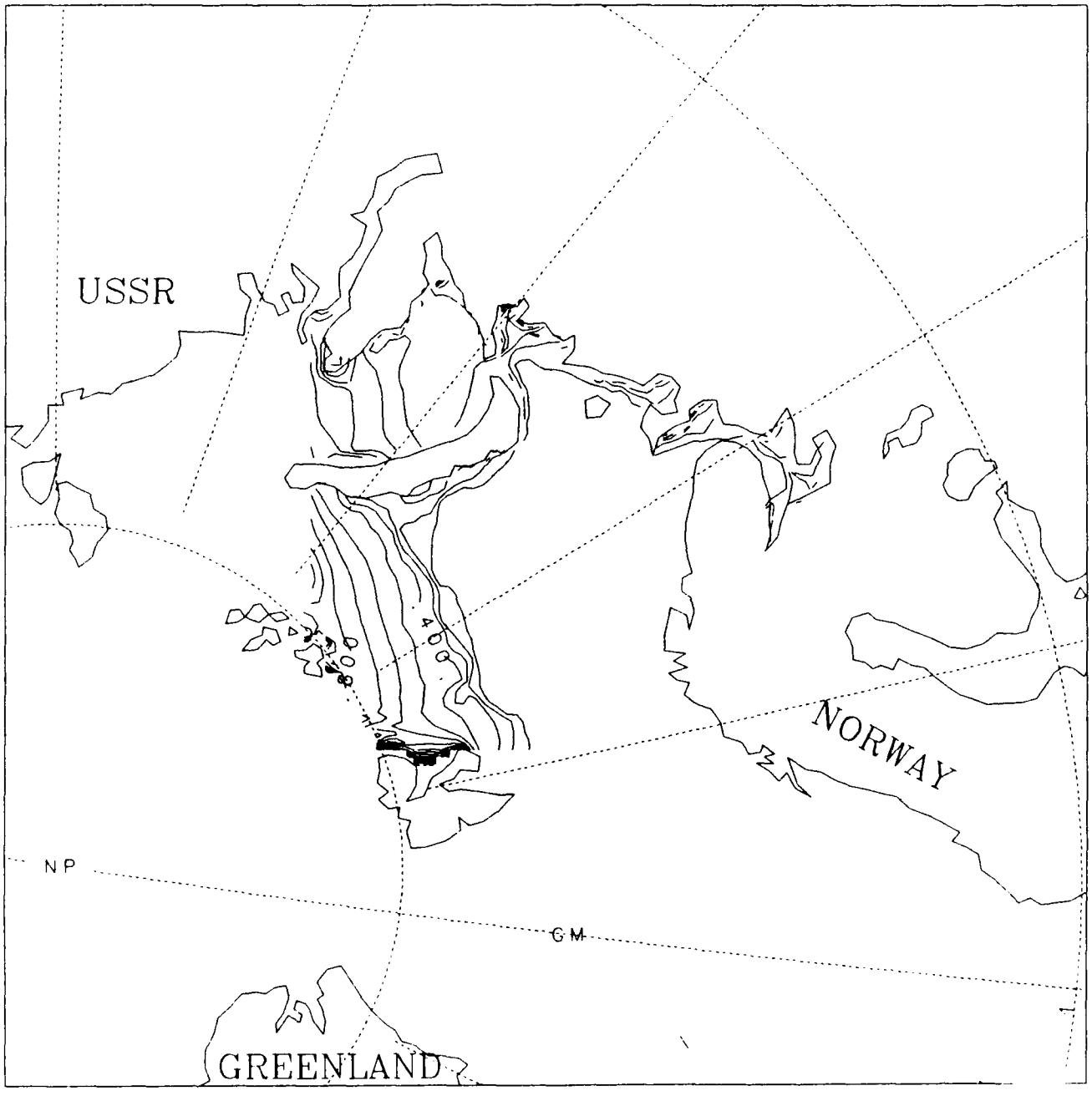
WIND VELOCITIES 1990 DECEMBER



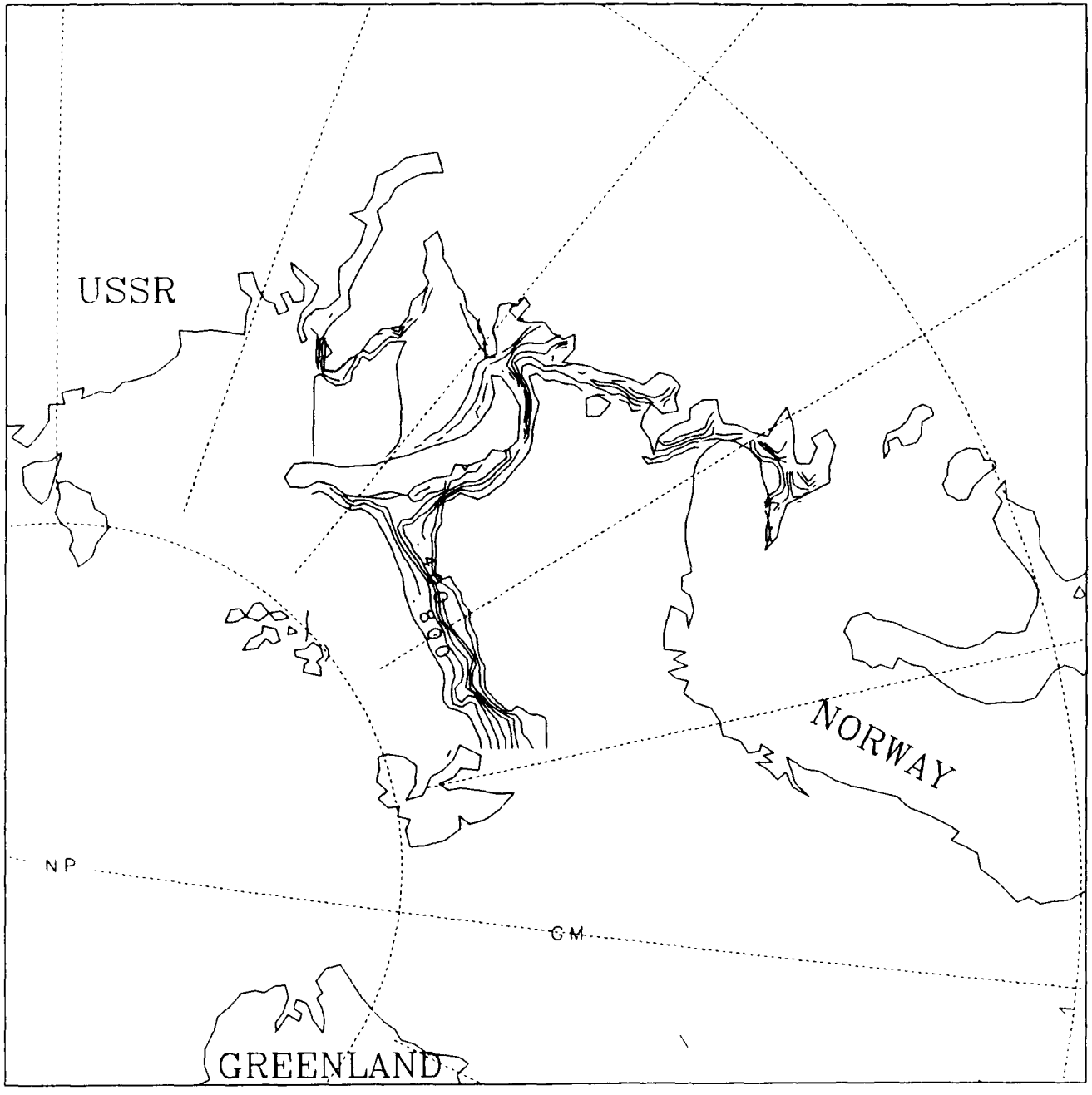
ICE VELOCITIES 1990 DECEMBER



ICE THICKNESS 1990 DECEMBER



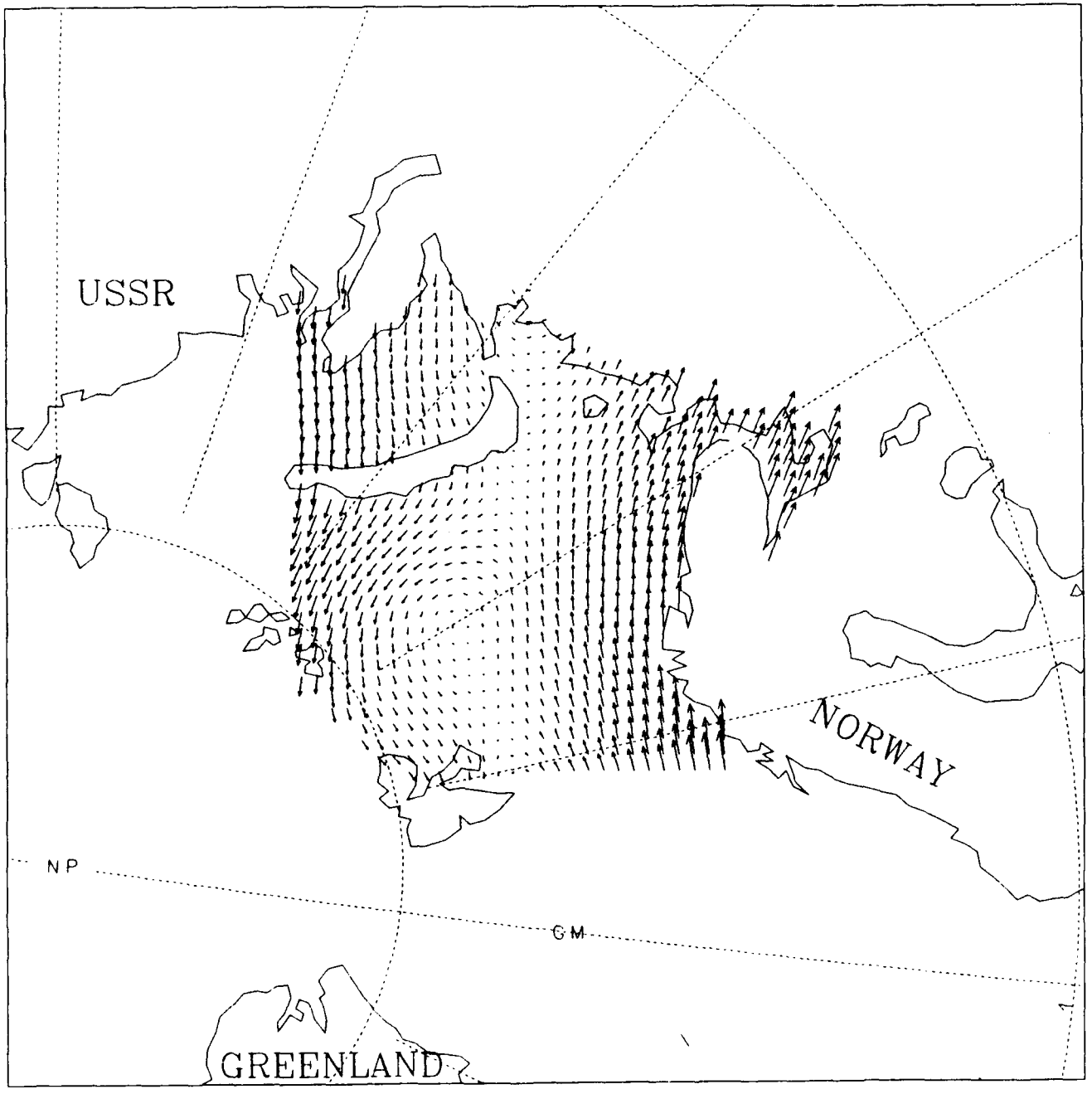
ICE CONCENTRATION 1990 DECEMBER



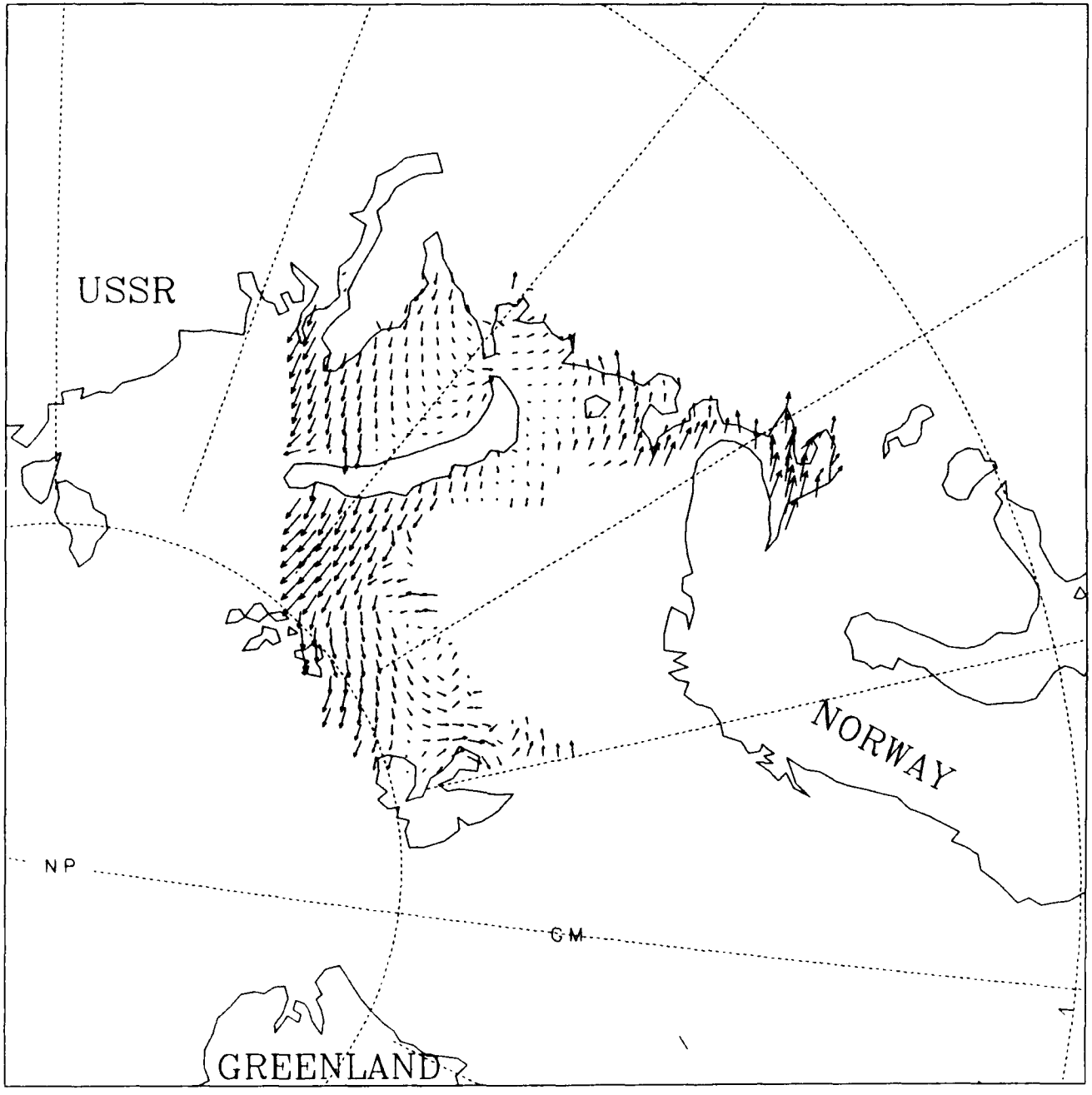
R PIPS-B 1991

MONTHLY MEANS

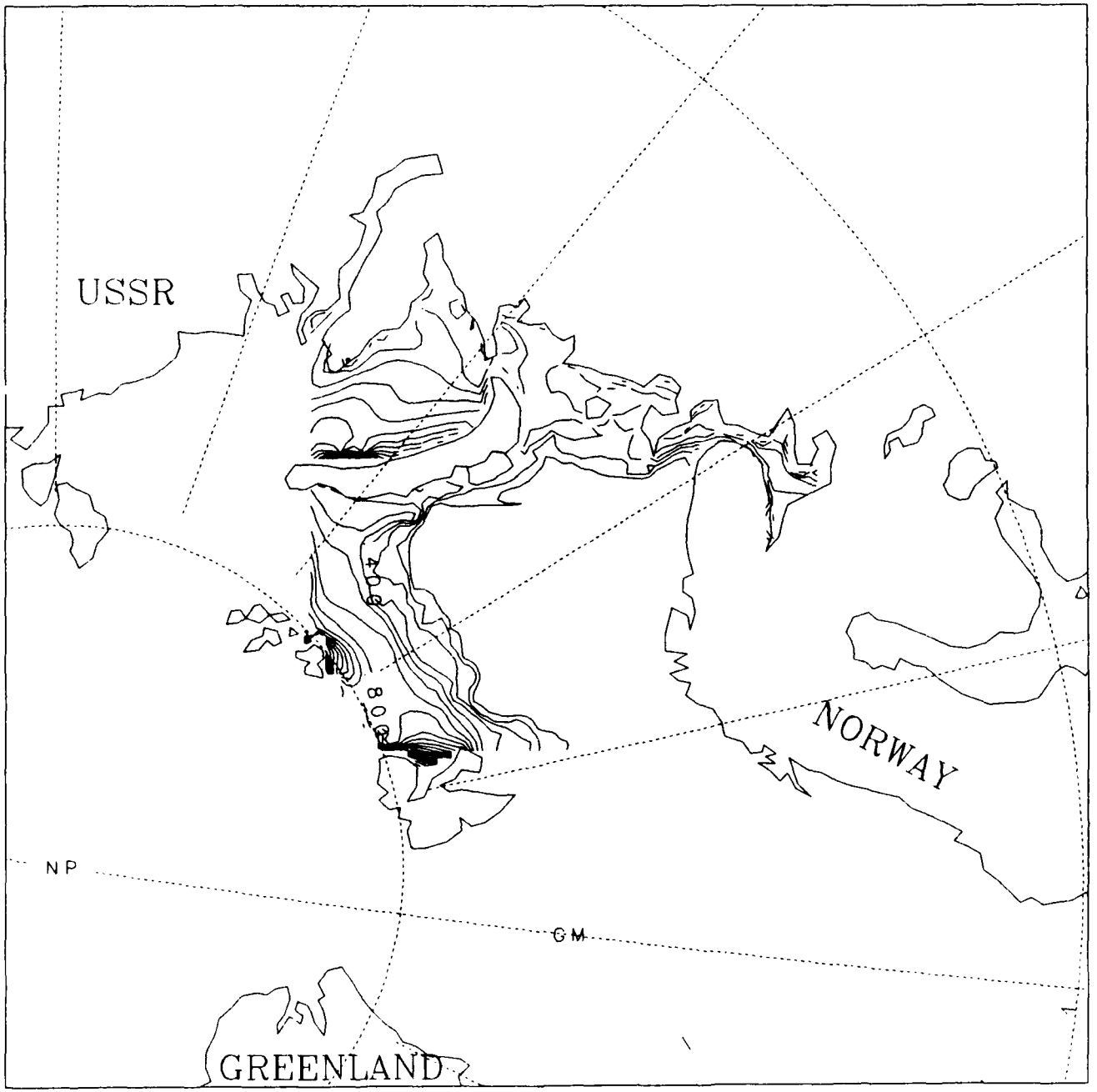
WIND VELOCITIES 1991 JANUARY



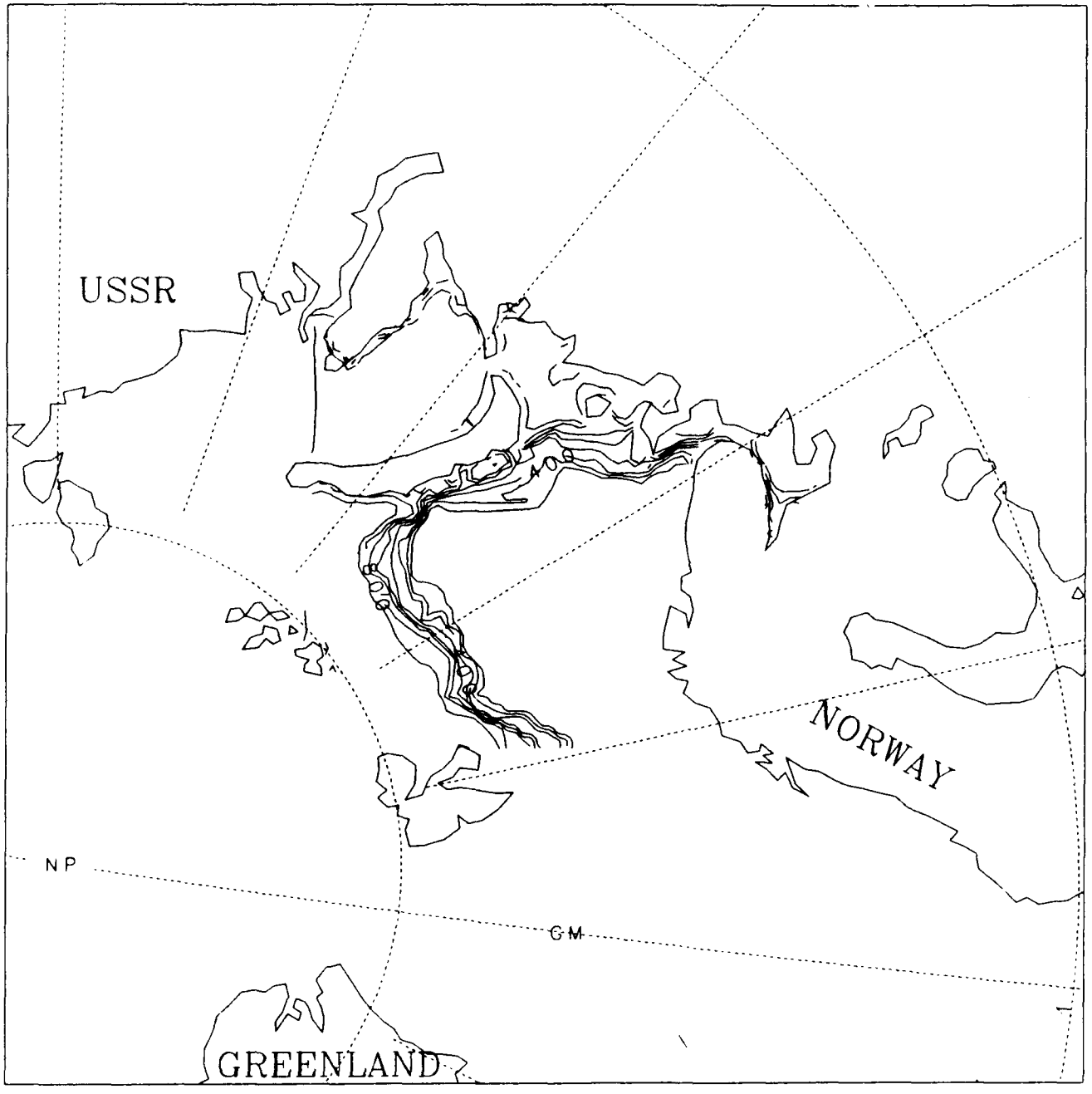
ICE VELOCITIES 1991 JANUARY



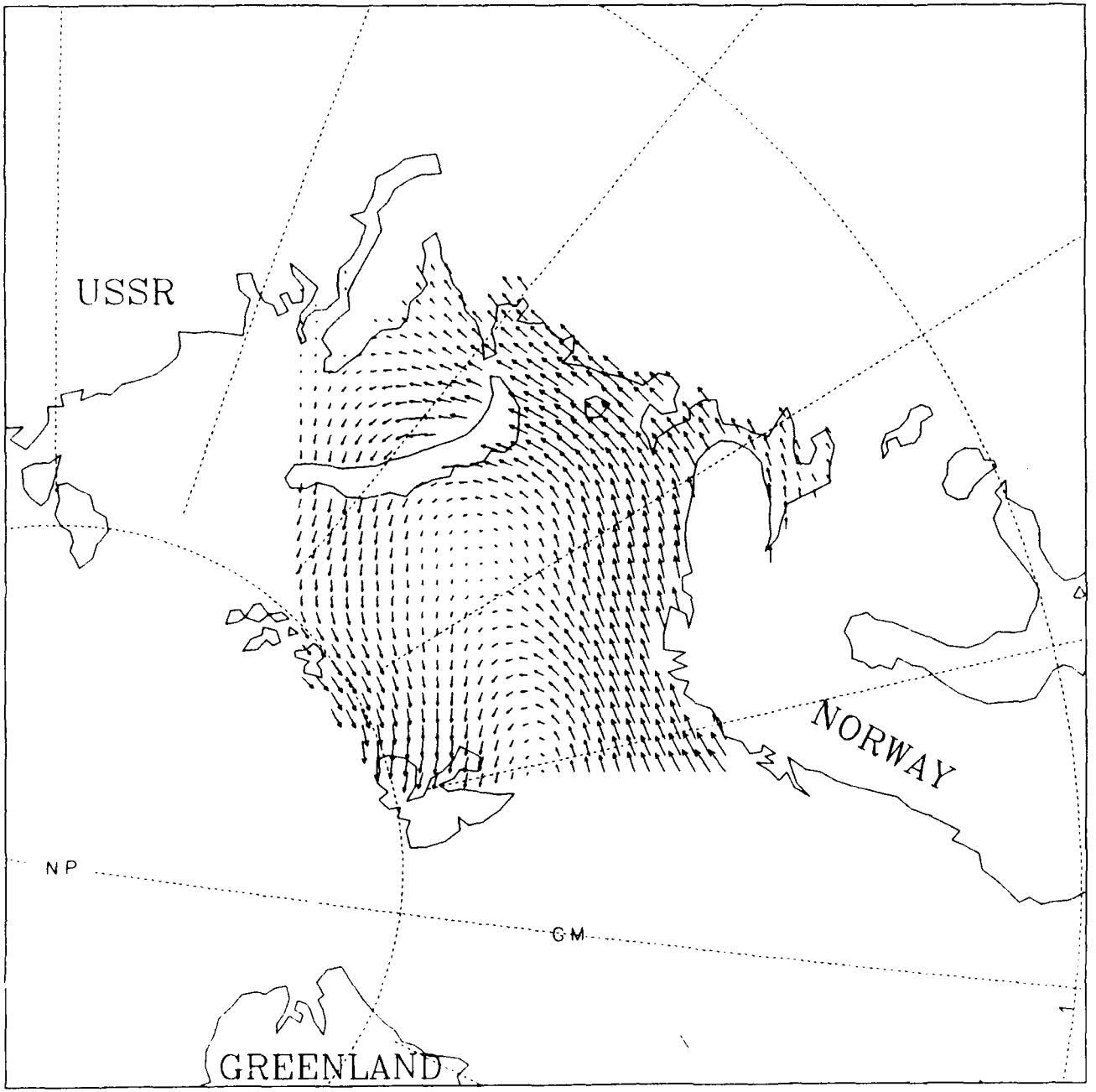
ICE THICKNESS 1991 JANUARY



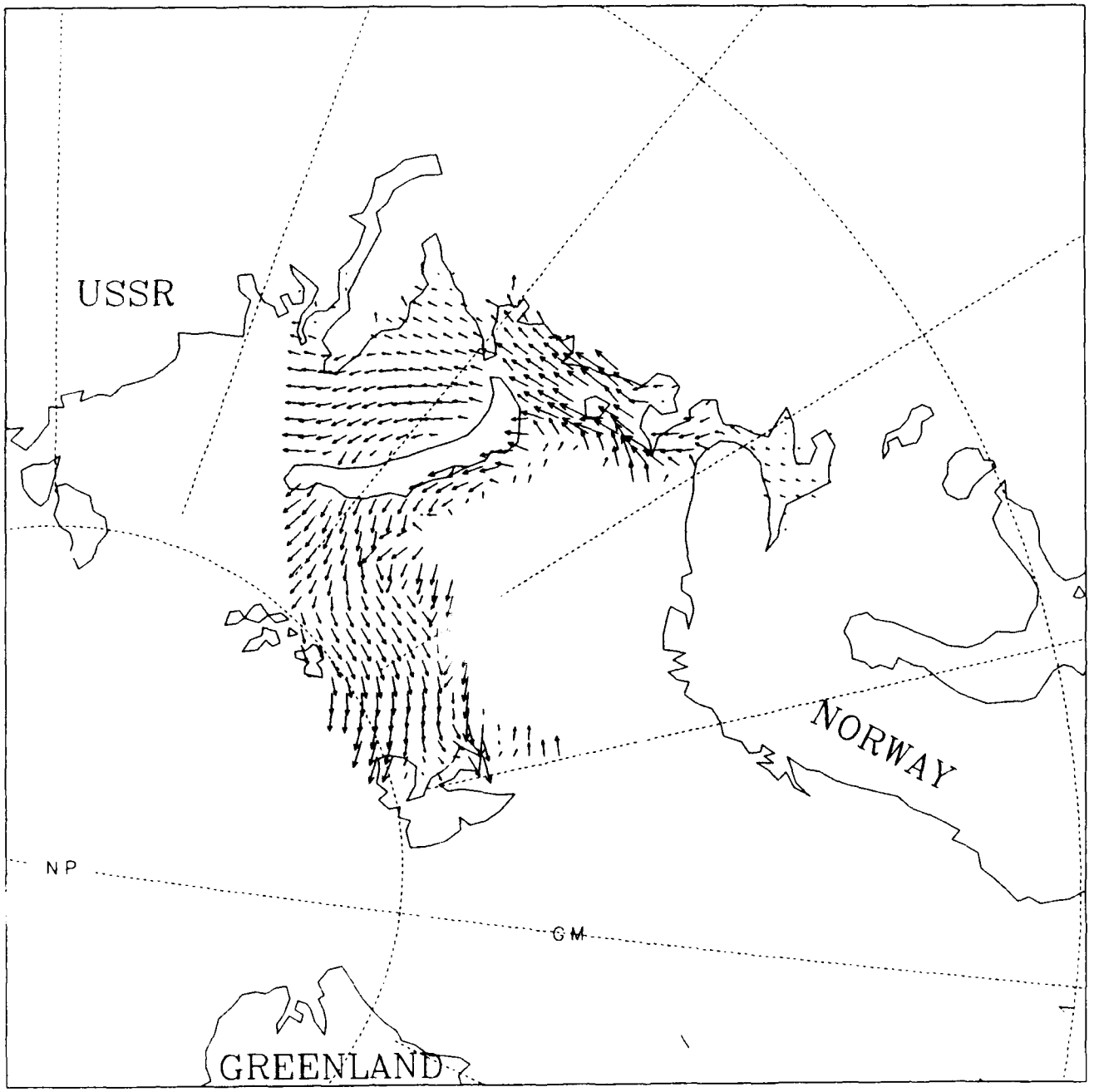
ICE CONCENTRATION 1991 JANUARY



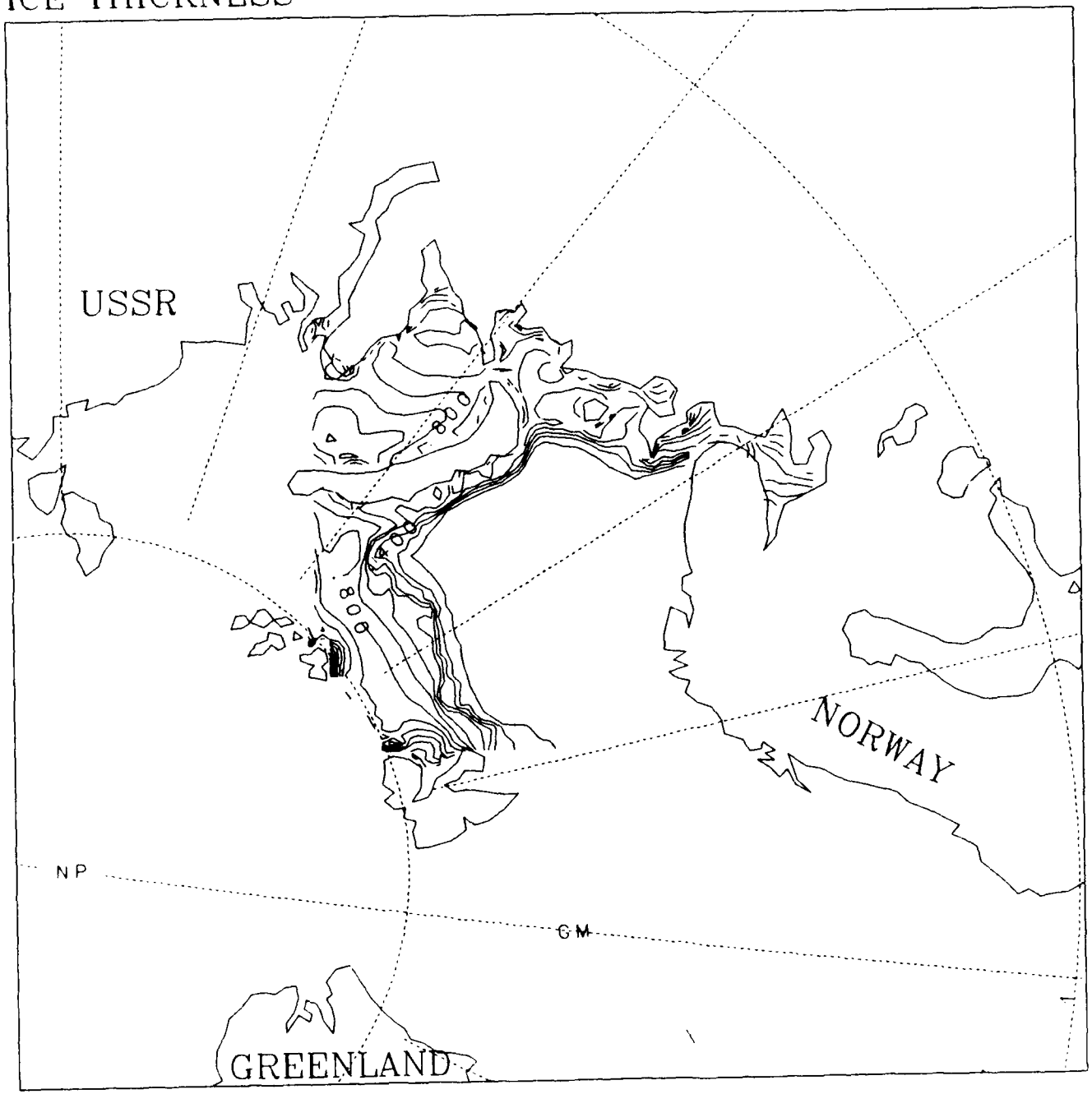
WIND VELOCITIES 1991 FEBRUARY



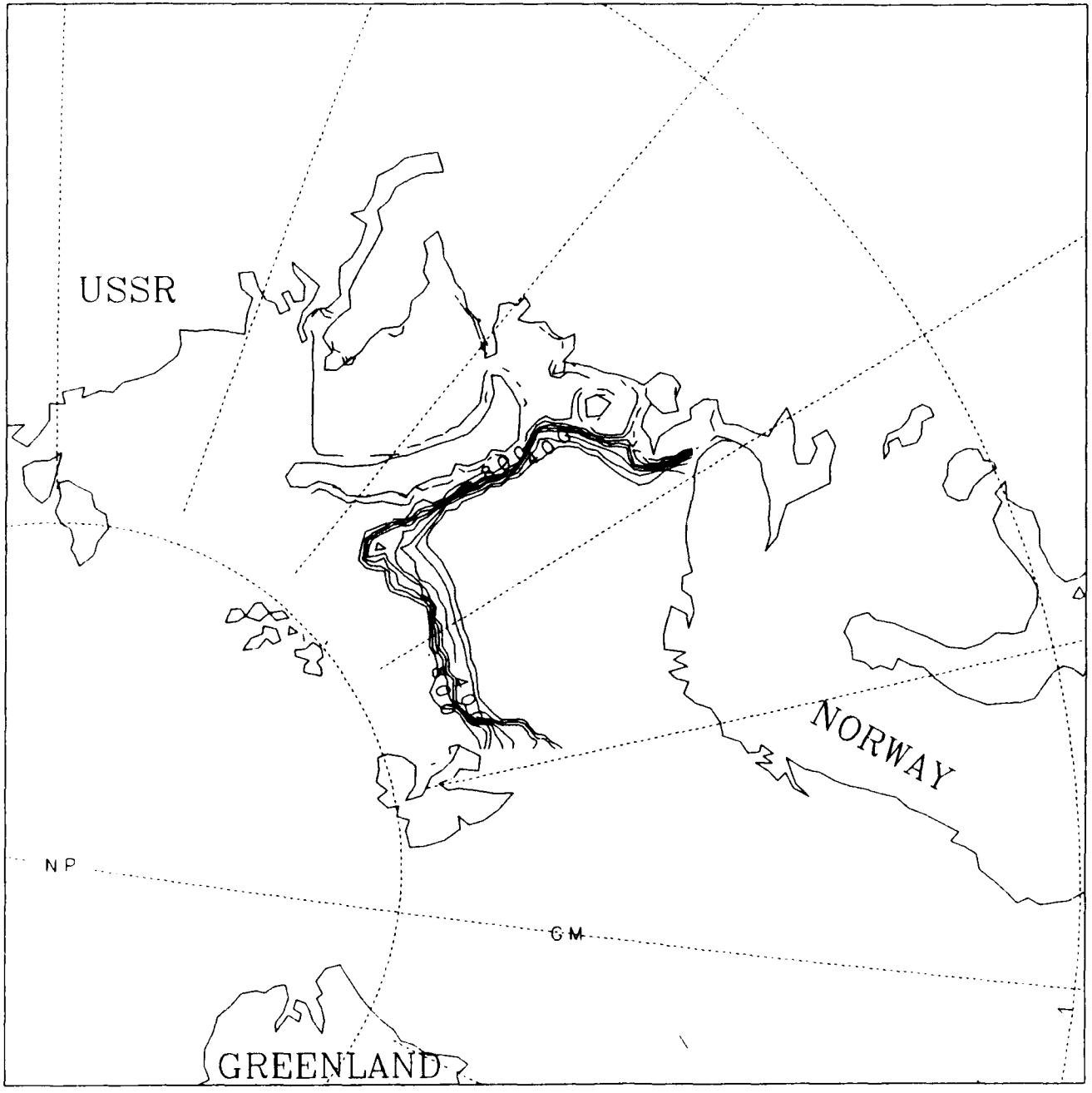
ICE VELOCITIES 1991 FEBRUARY



ICE THICKNESS 1991 FEBRUARY

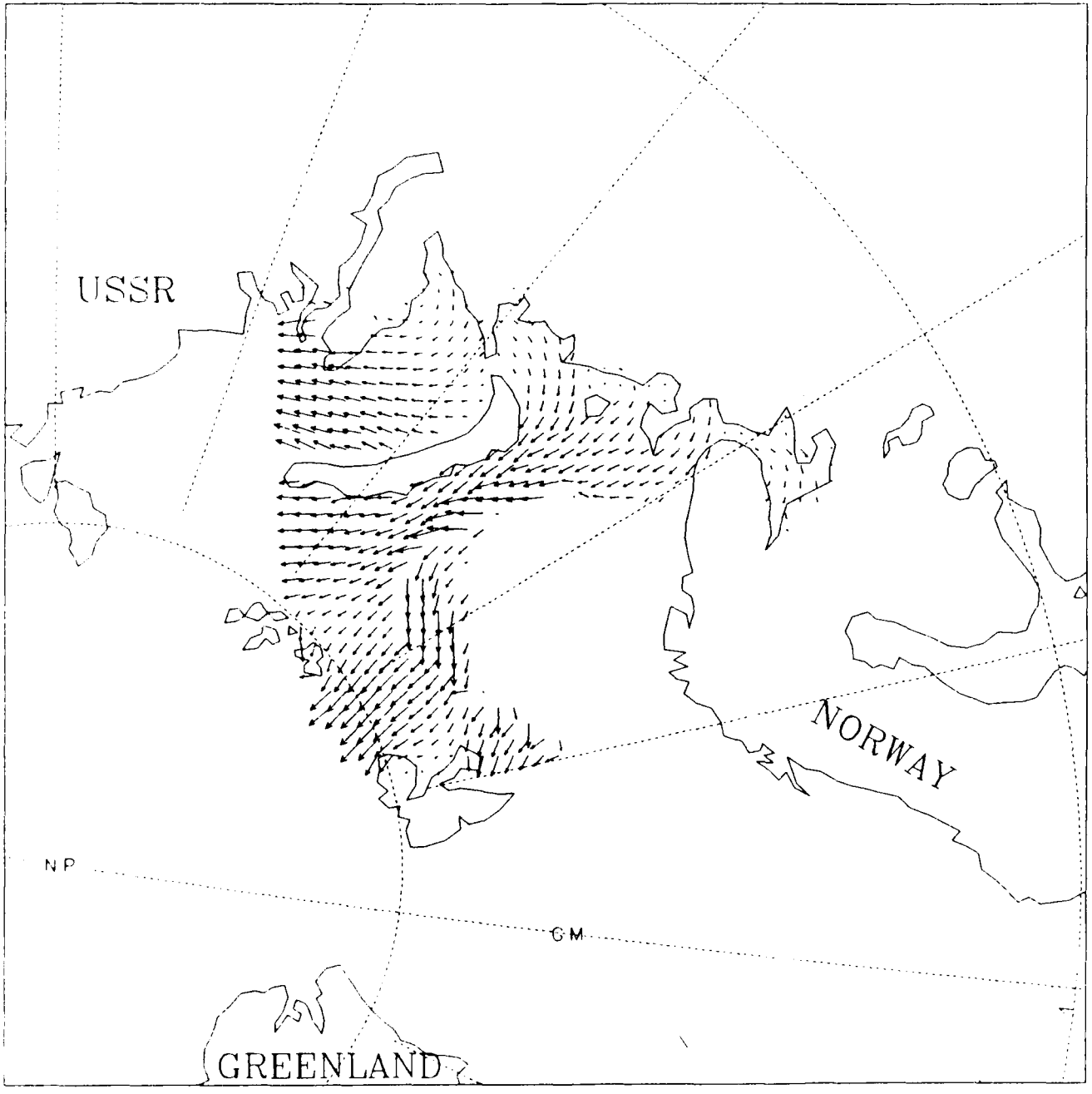


ICE CONCENTRATION 1991 FEBRUARY

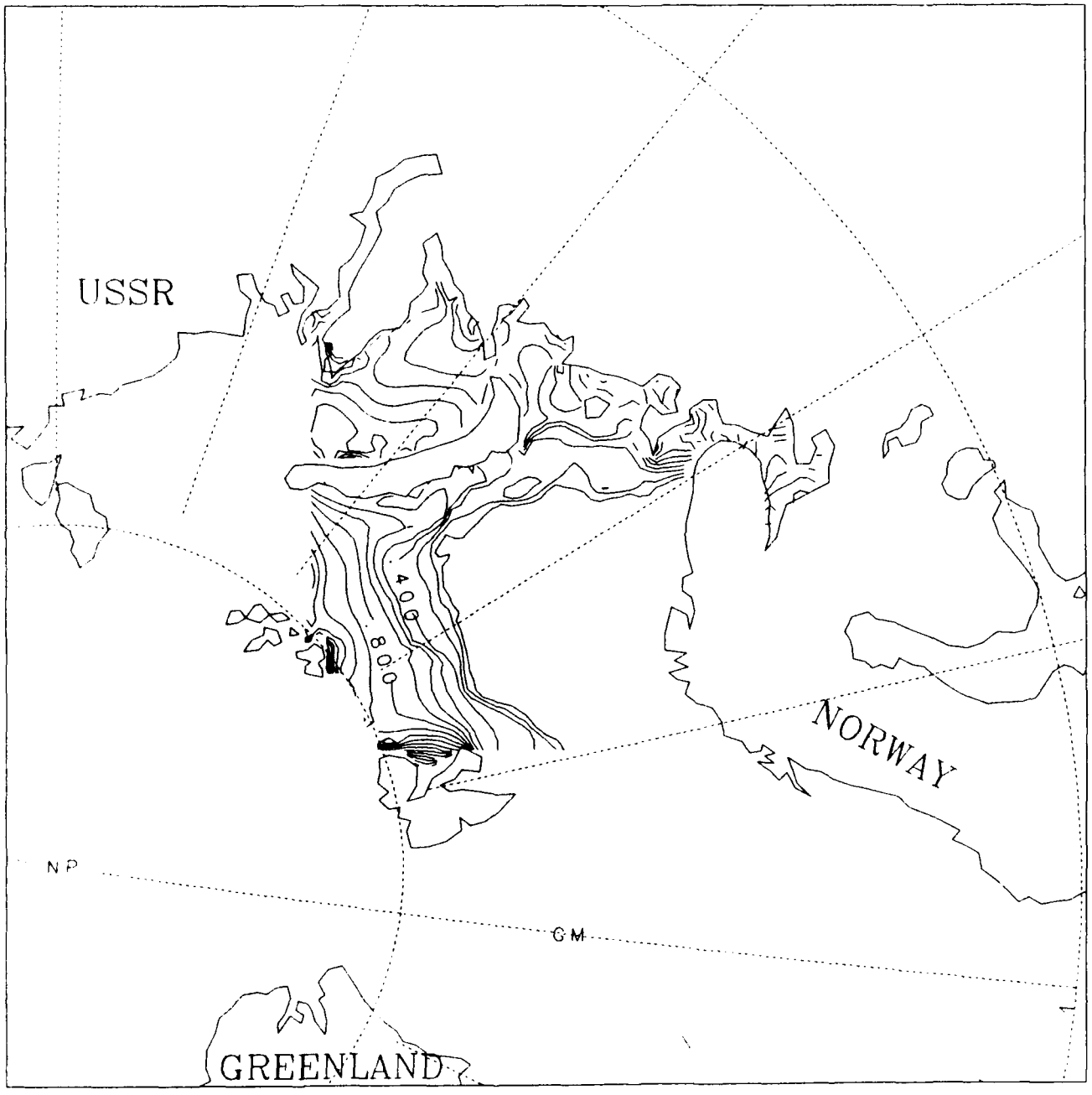


WIND VELOCITIES 1991 MARCH

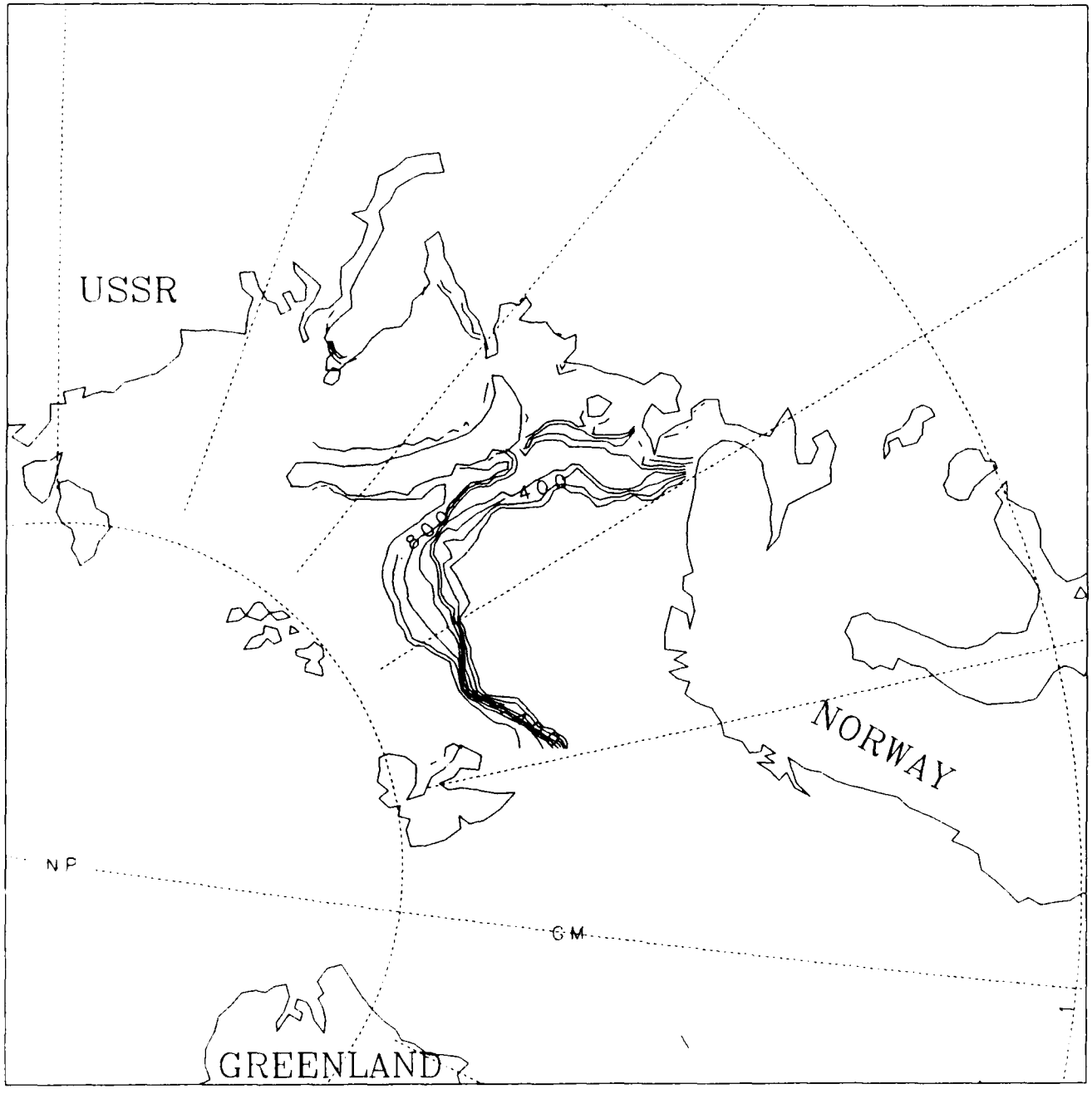
ICE VELOCITIES 1991 MARCH



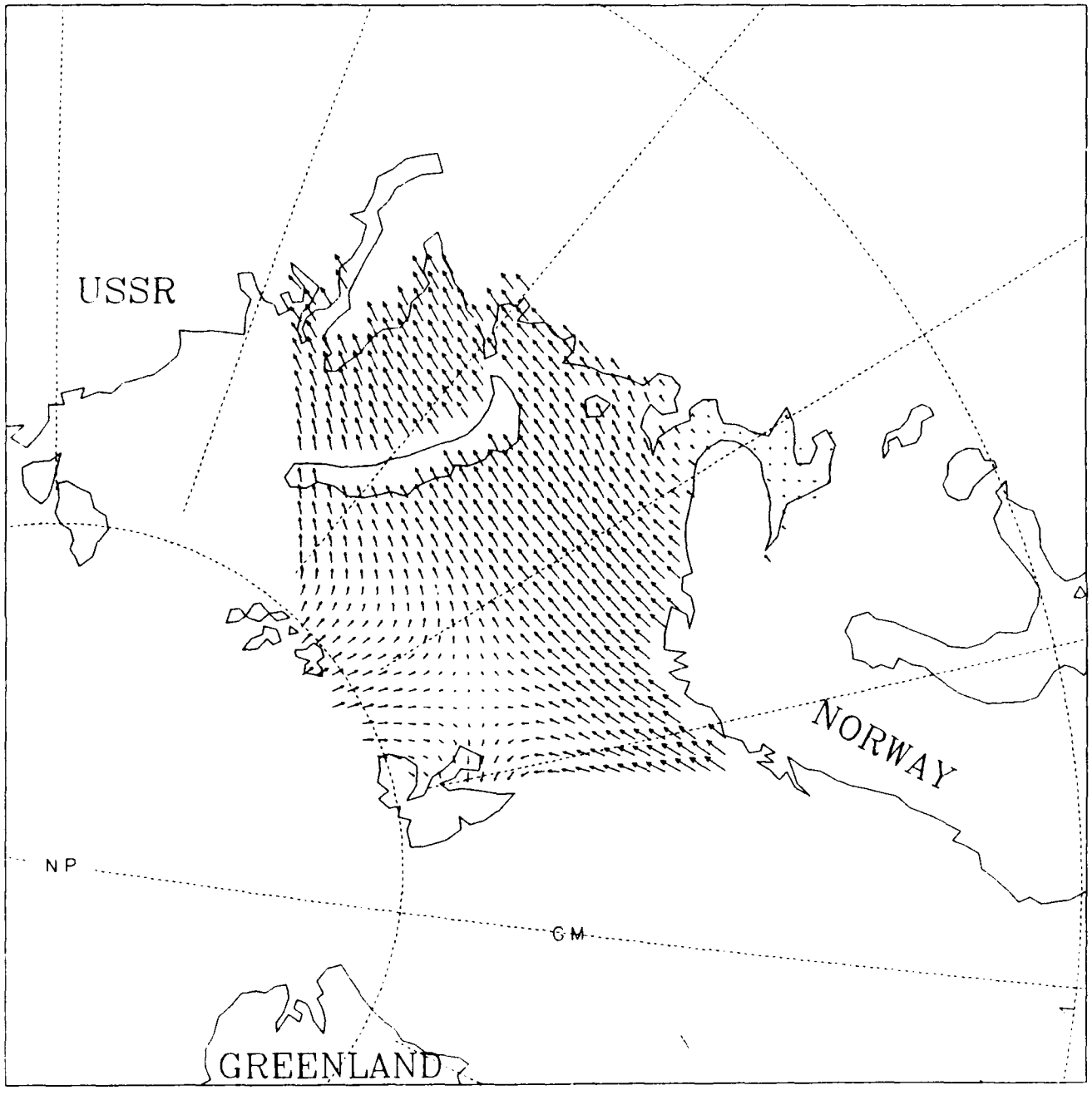
ICE THICKNESS 1991 MARCH



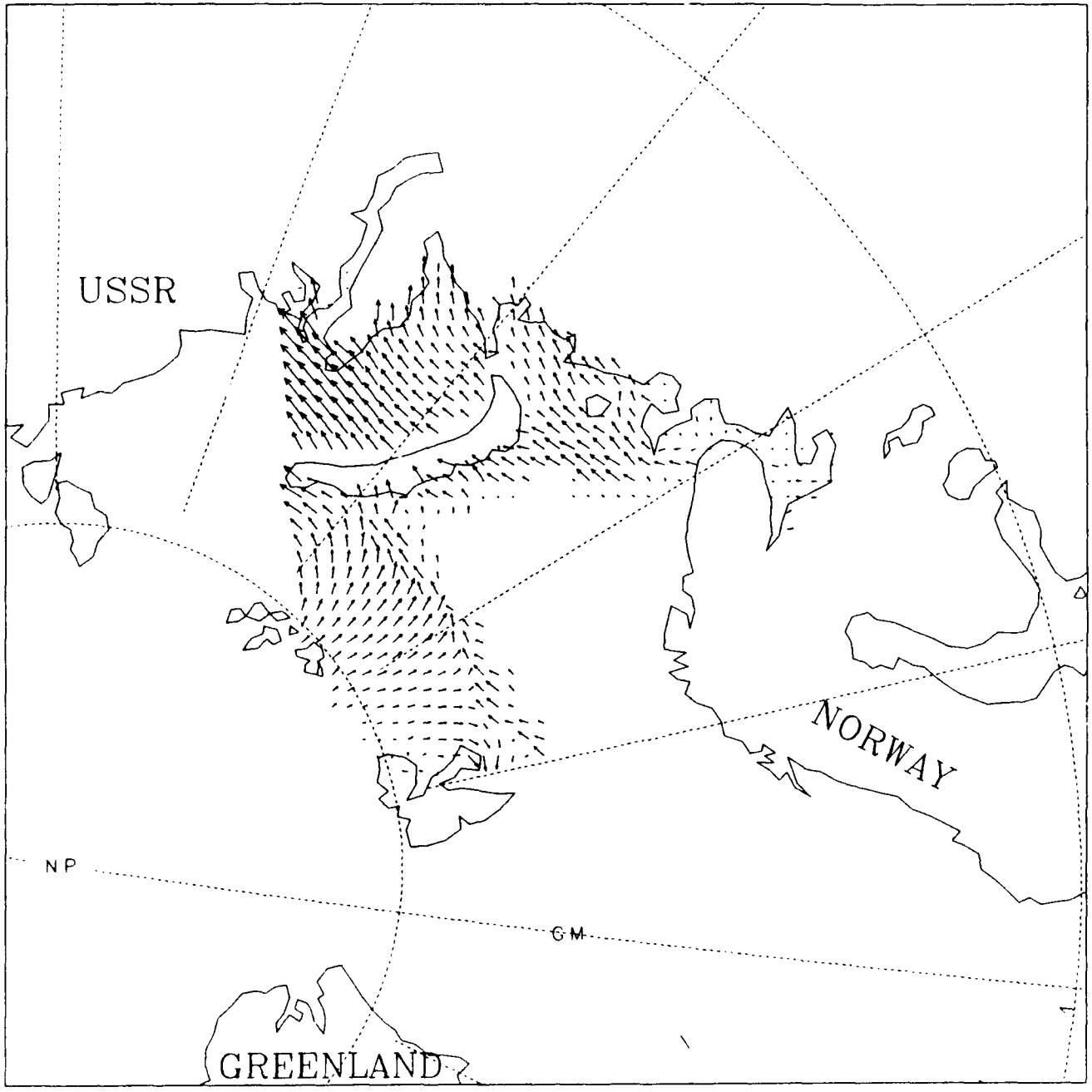
ICE CONCENTRATION 1991 MARCH



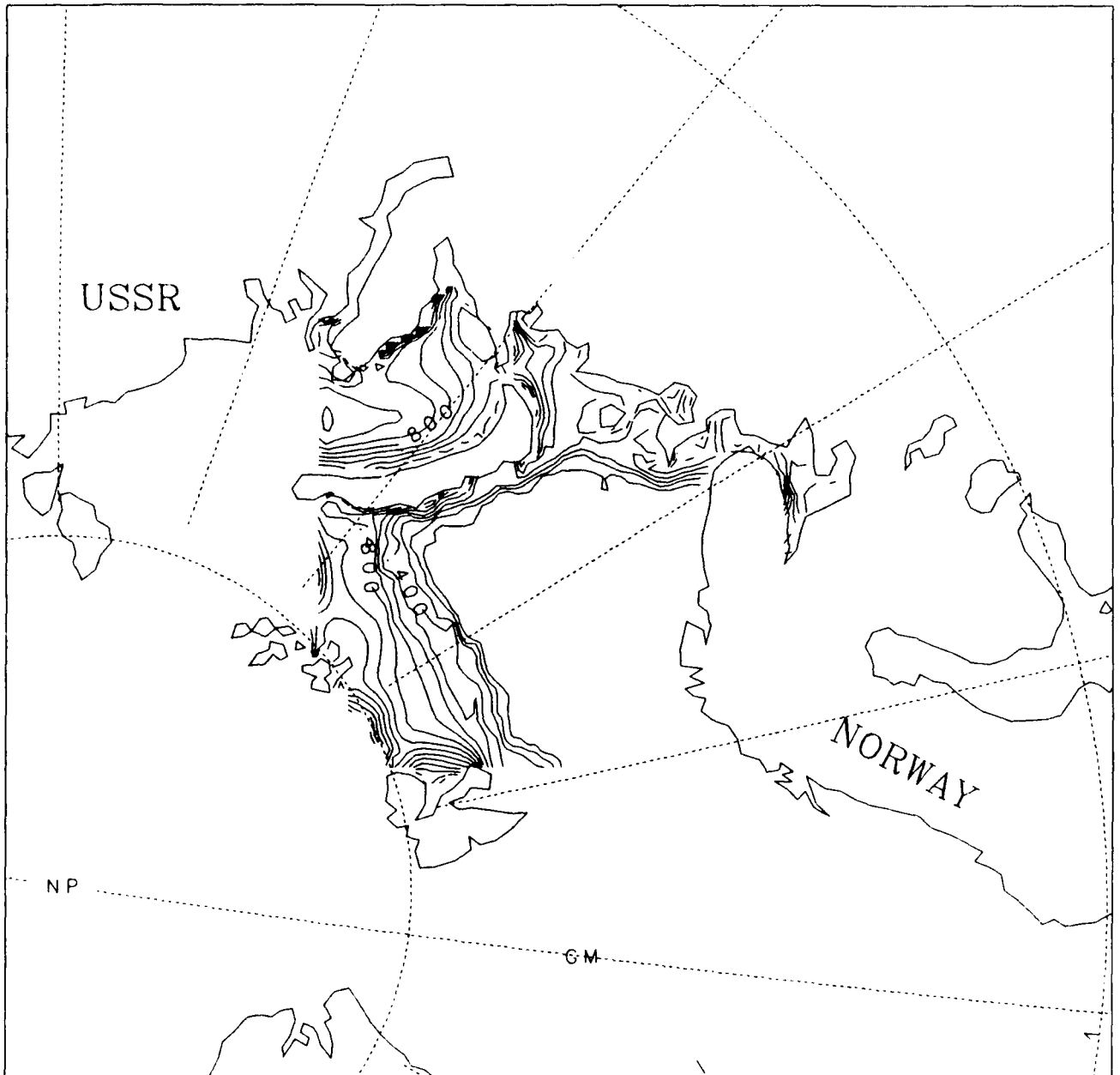
WIND VELOCITIES 1991 APRIL



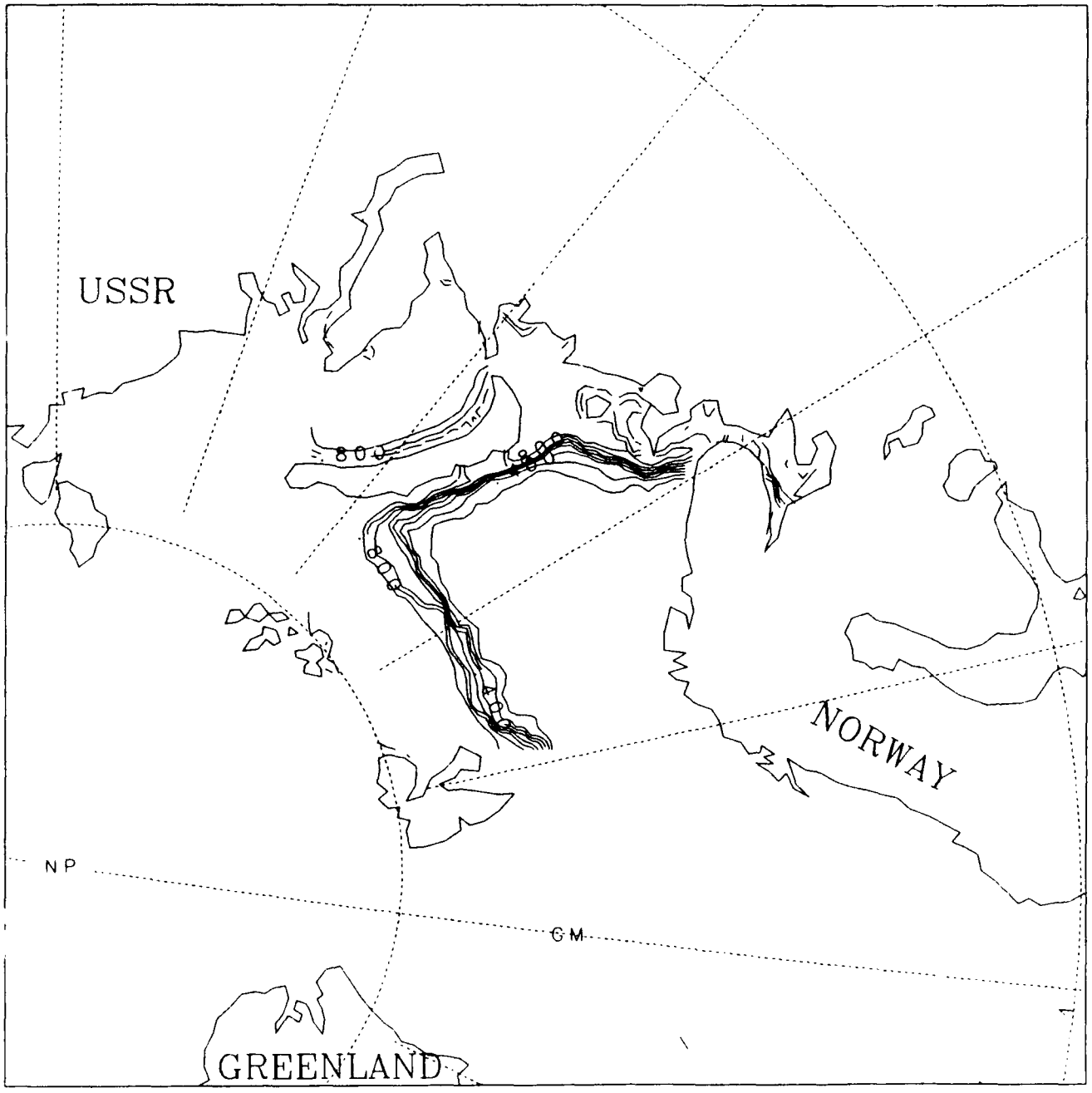
ICE VELOCITIES 1991 APRIL



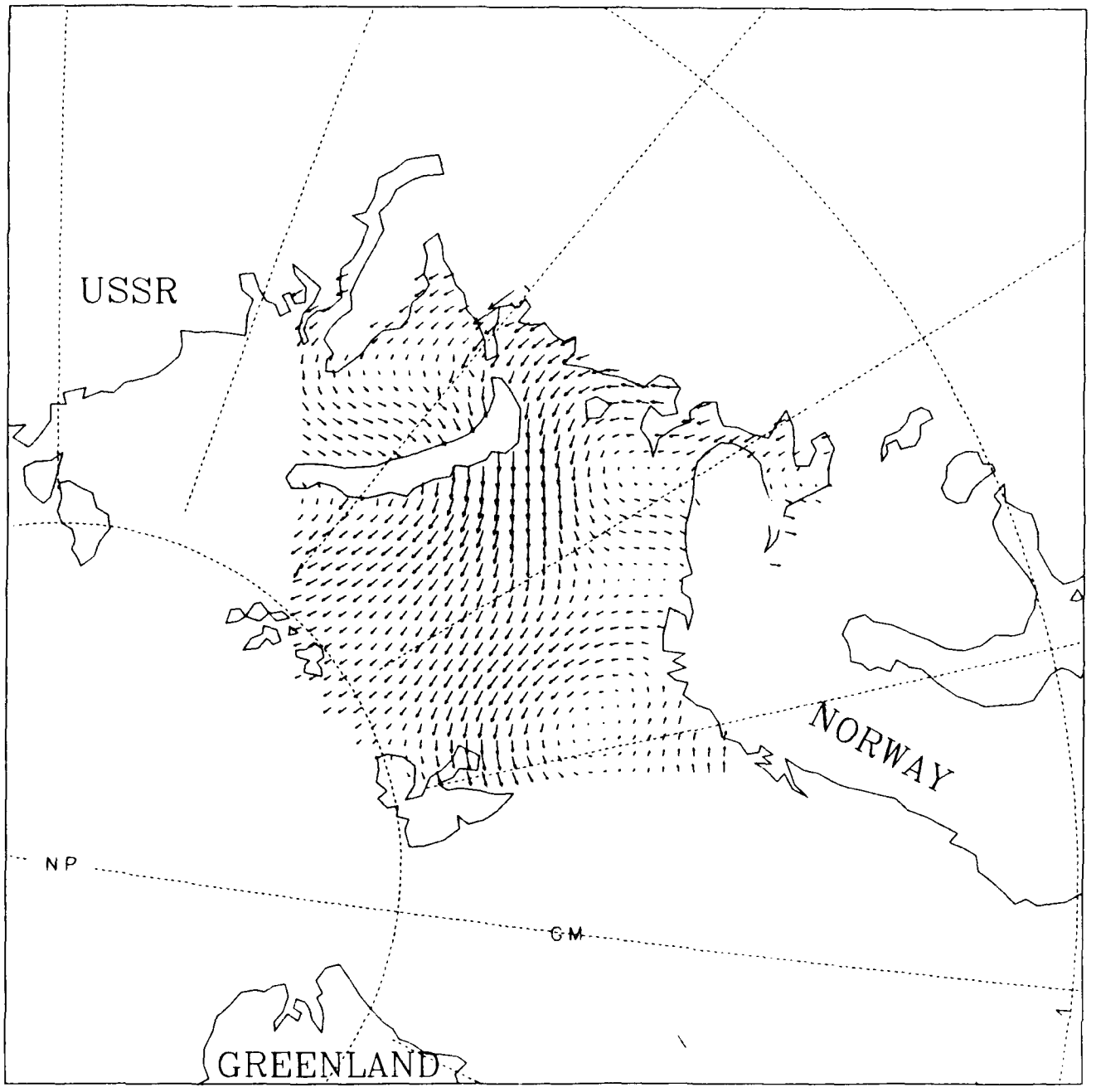
ICE THICKNESS 1991 APRIL



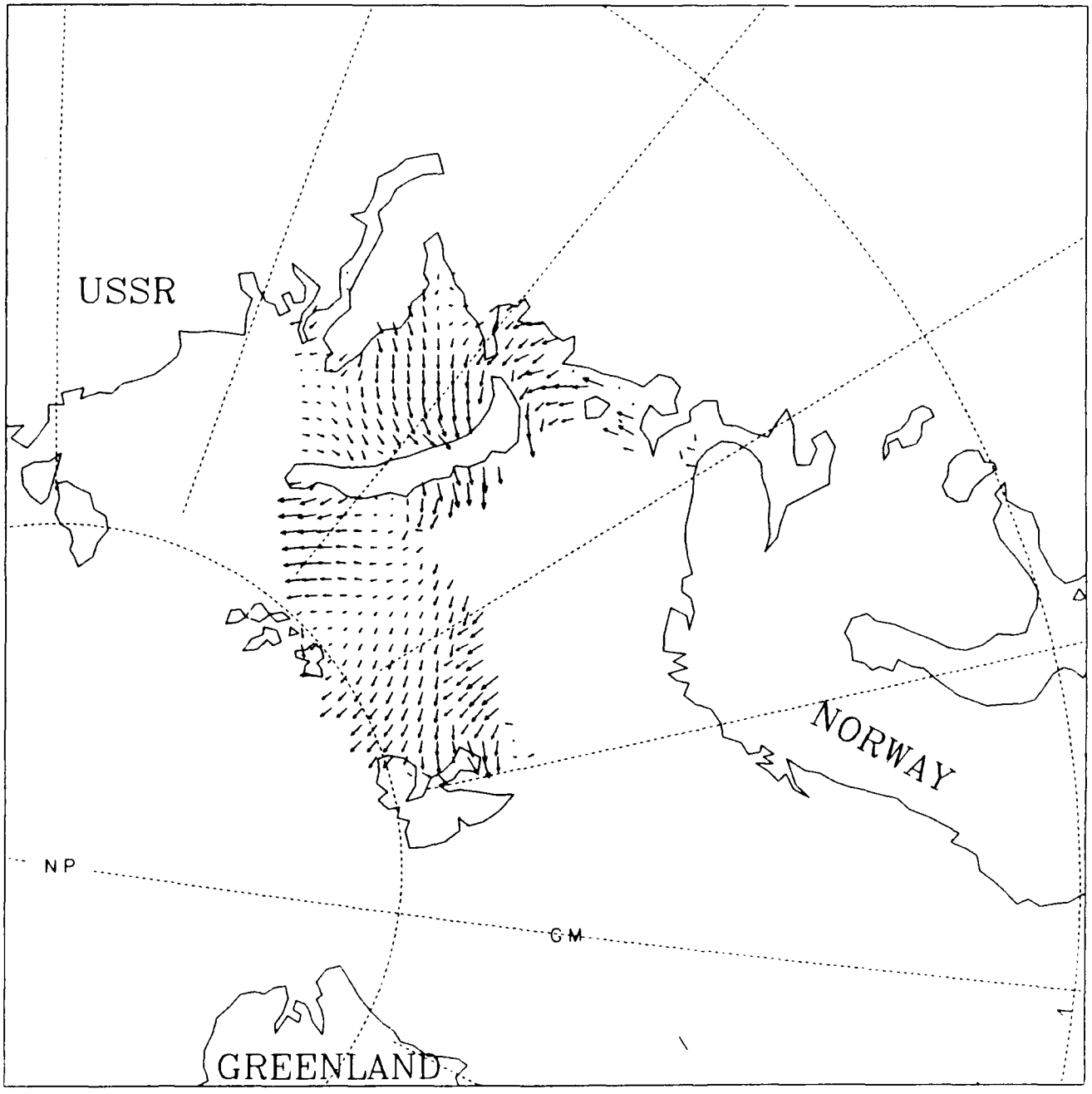
ICE CONCENTRATION 1991 APRIL



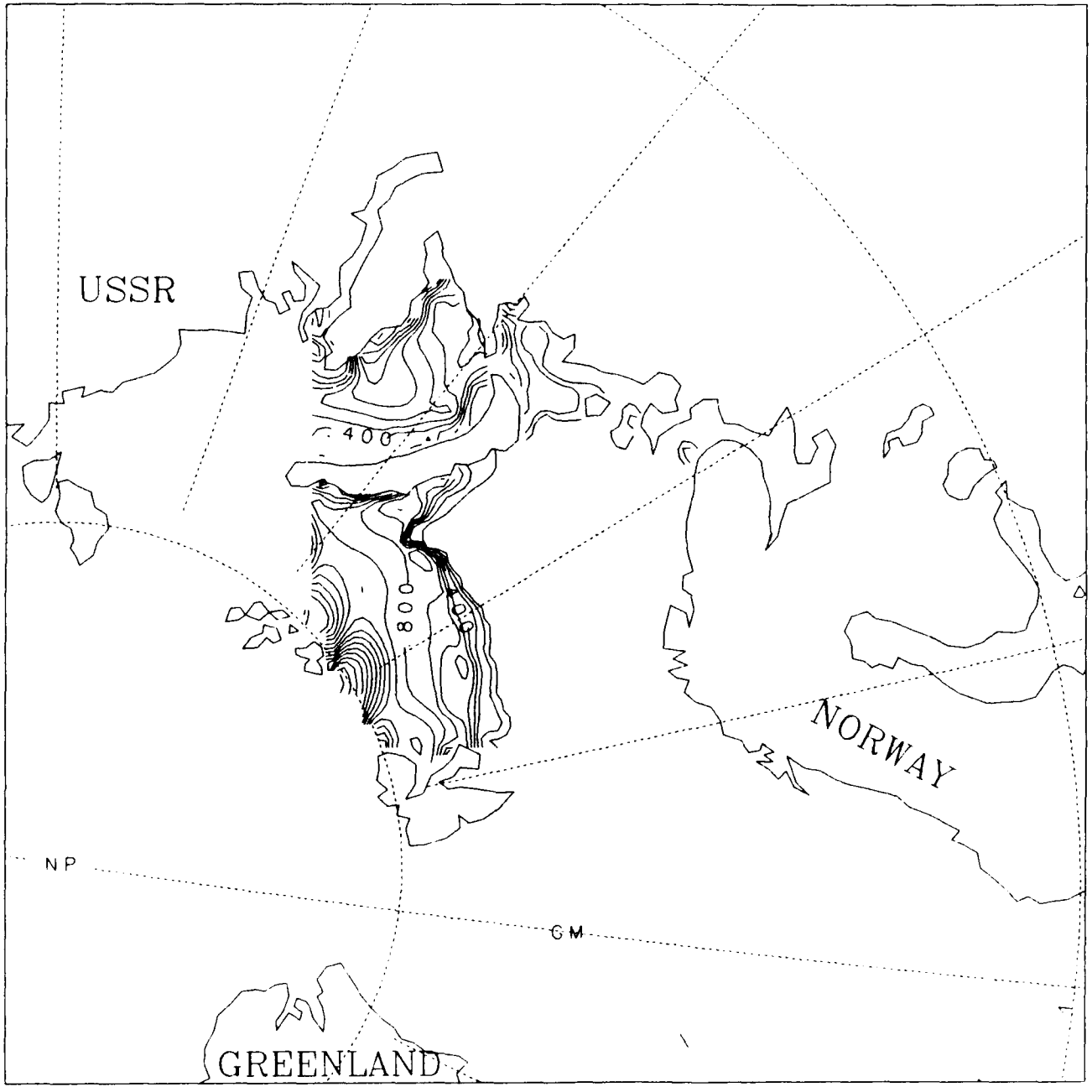
WIND VELOCITIES 1991 MAY



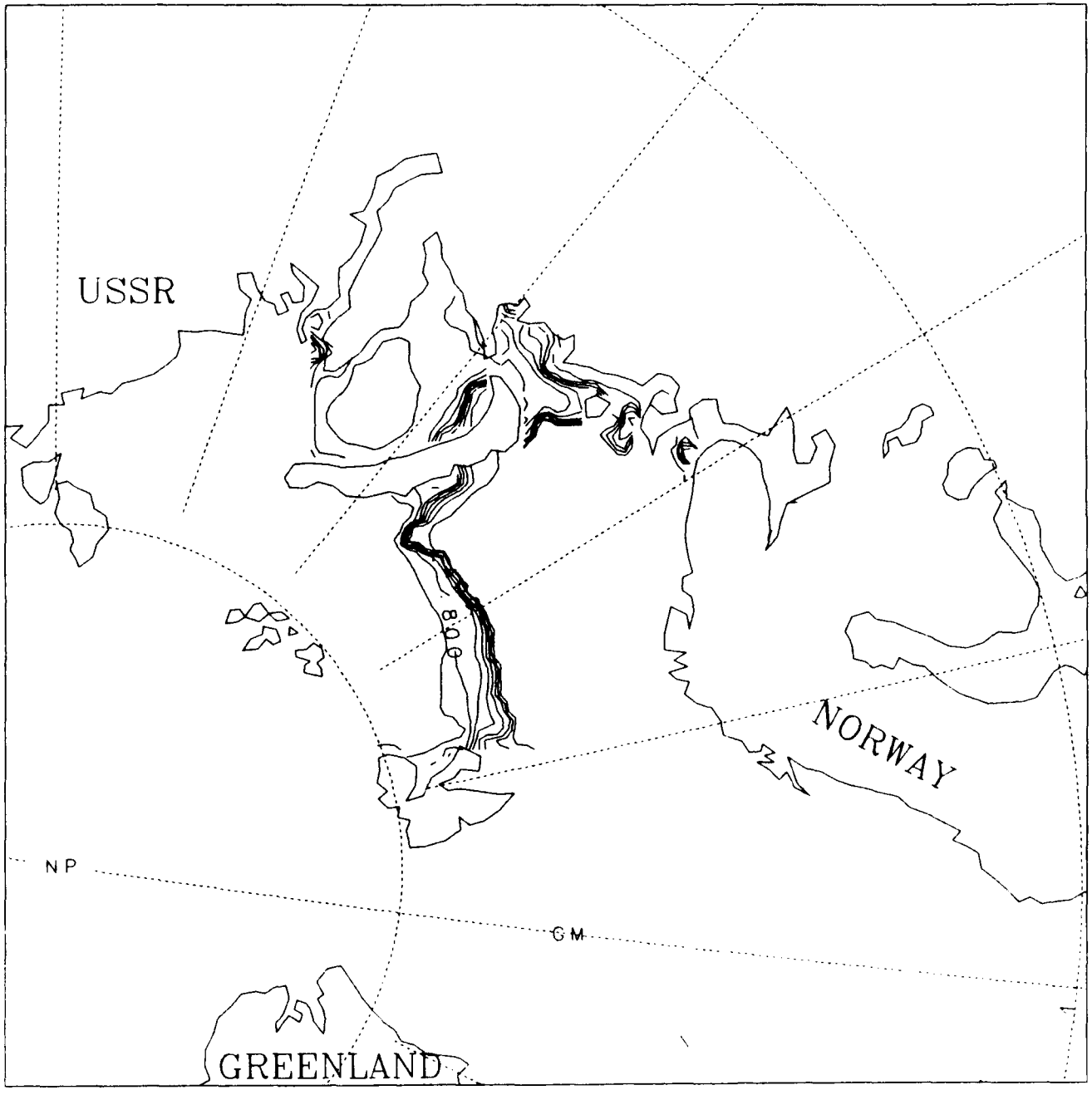
ICE VELOCITIES 1991 MAY



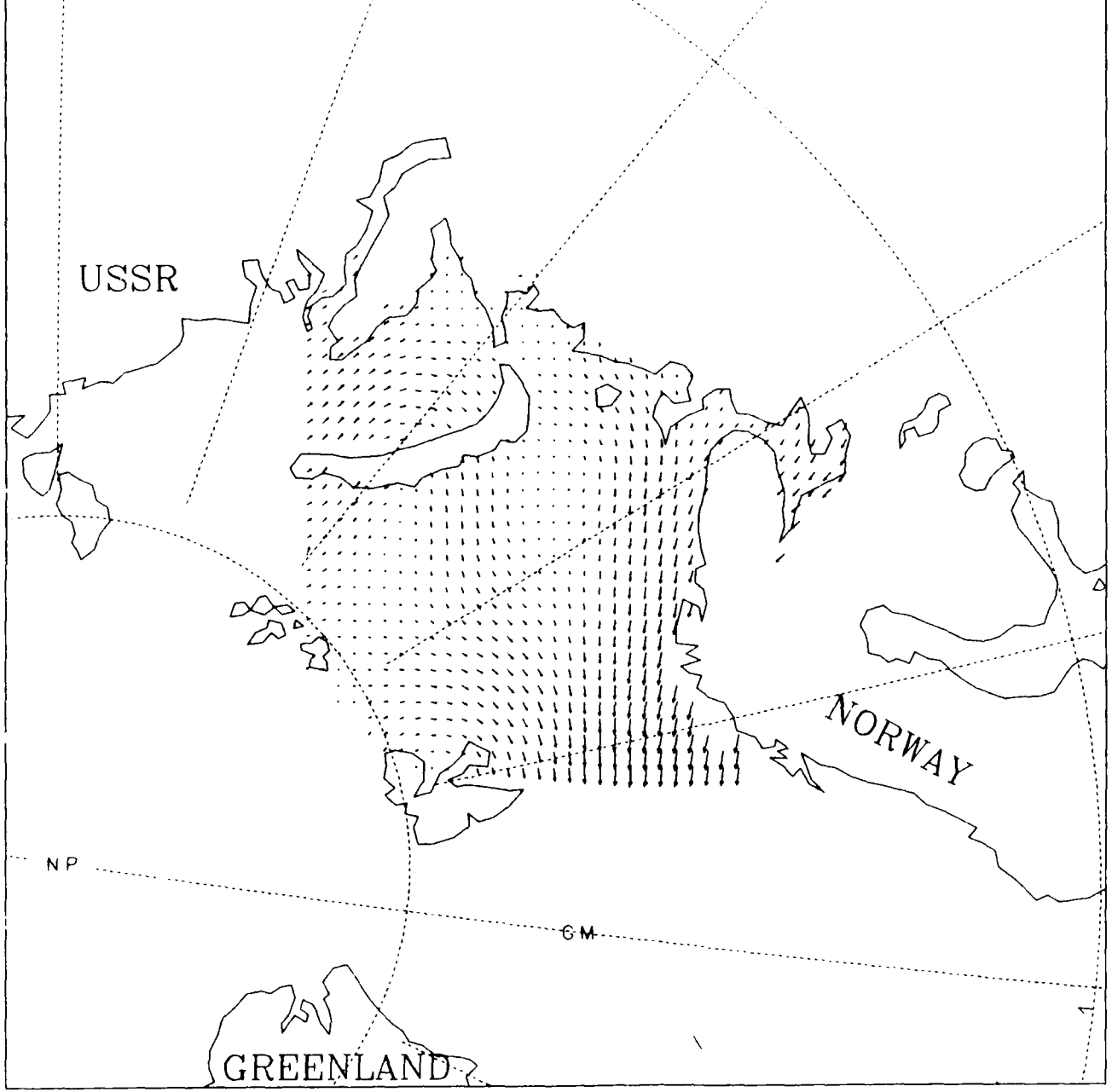
ICE THICKNESS 1991 MAY



ICE CONCENTRATION 1991 MAY

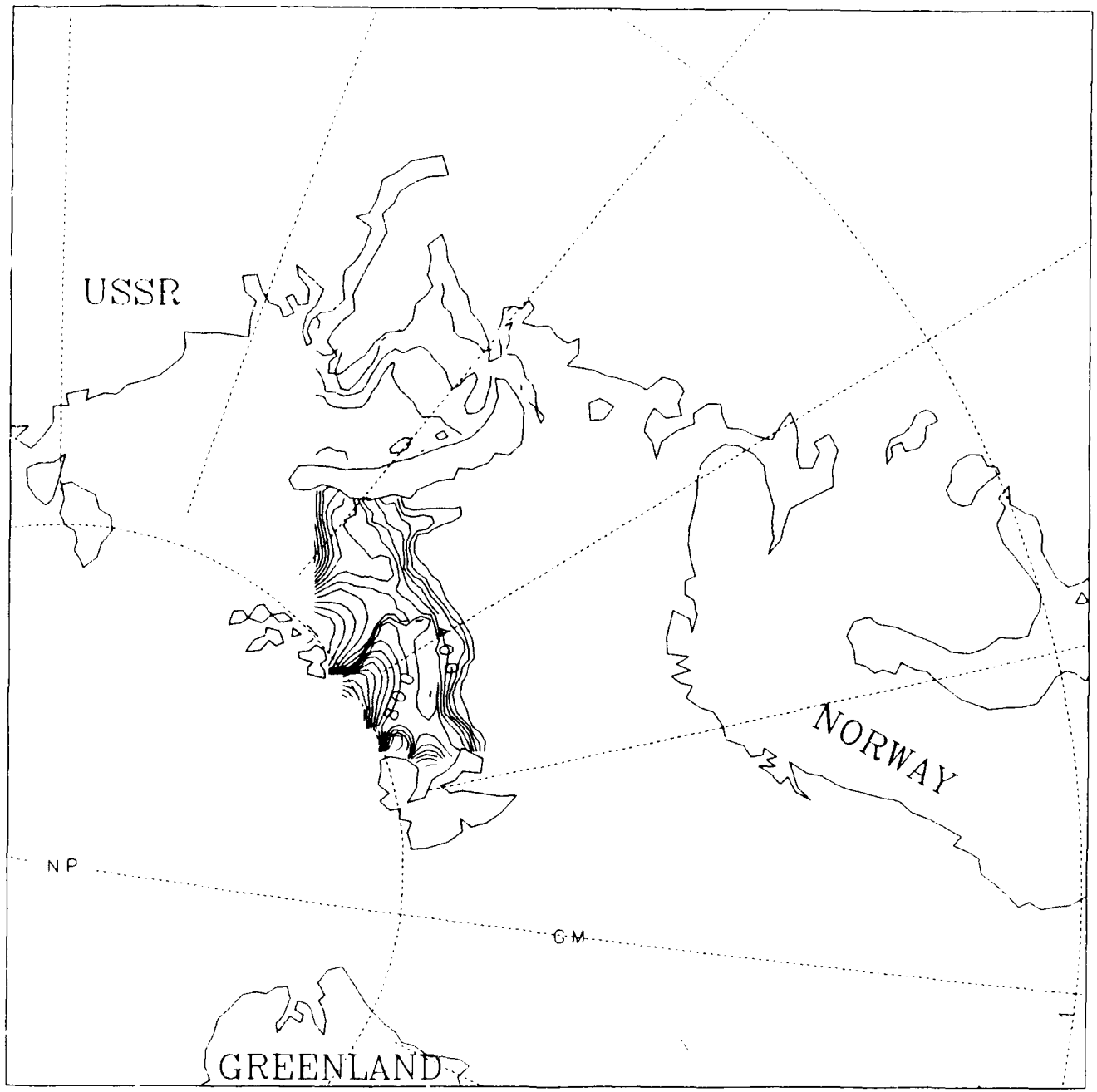


WIND VELOCITIES 1991 JUNE



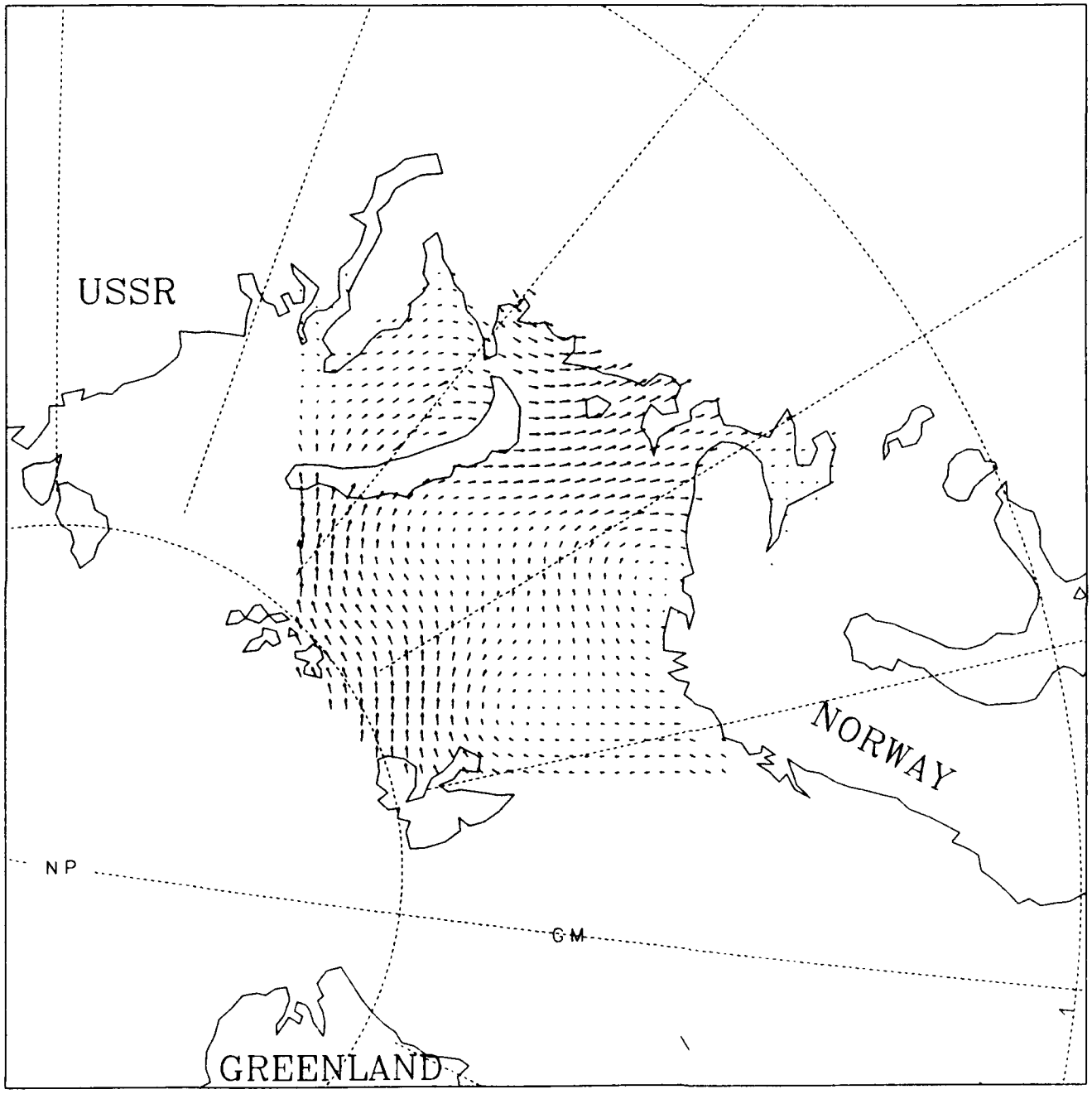
ICE VELOCITIES 1991 JUNE

ICE THICKNESS 1991 JUNE

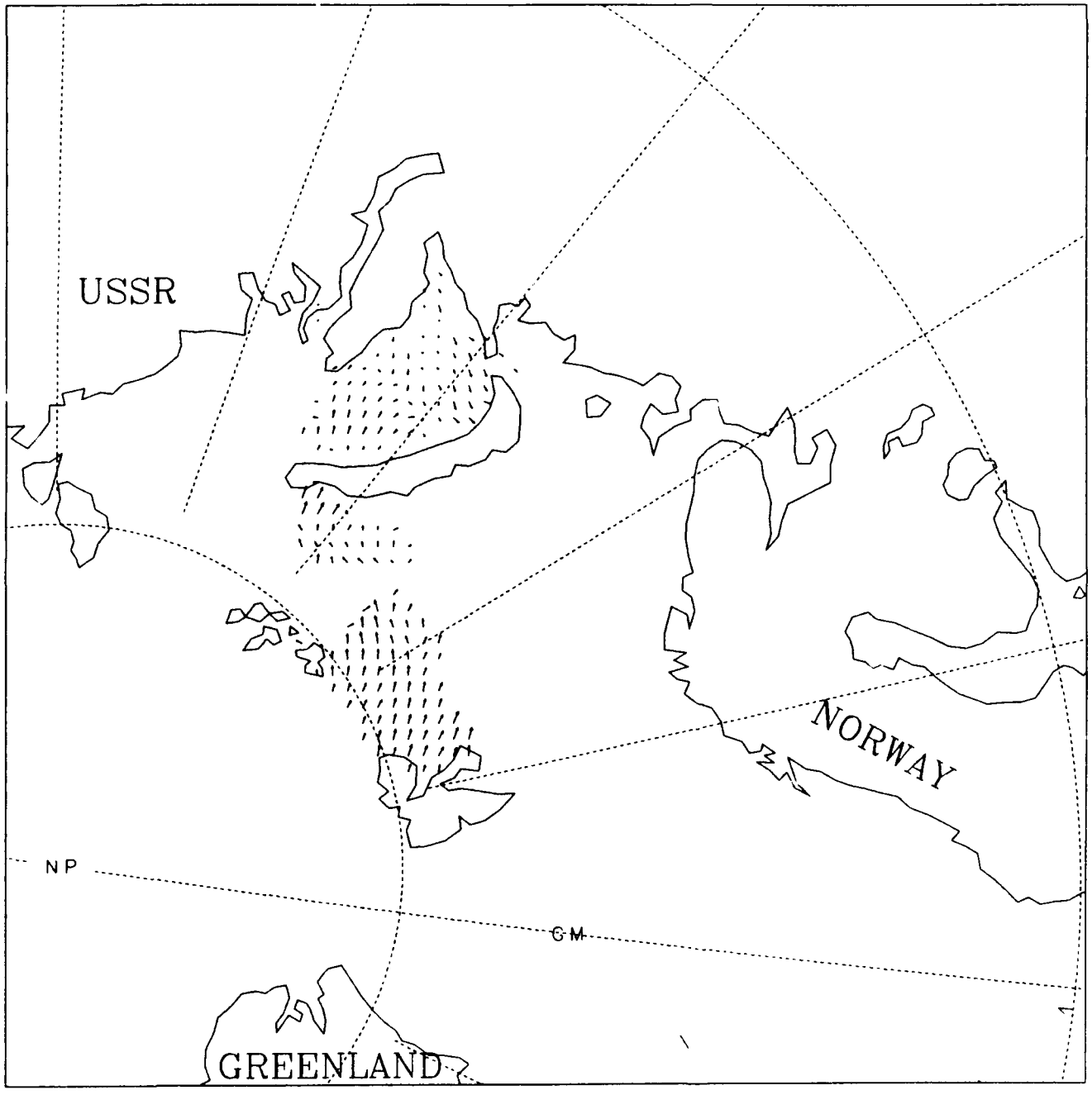


ICE CONCENTRATION 1991 JUNE

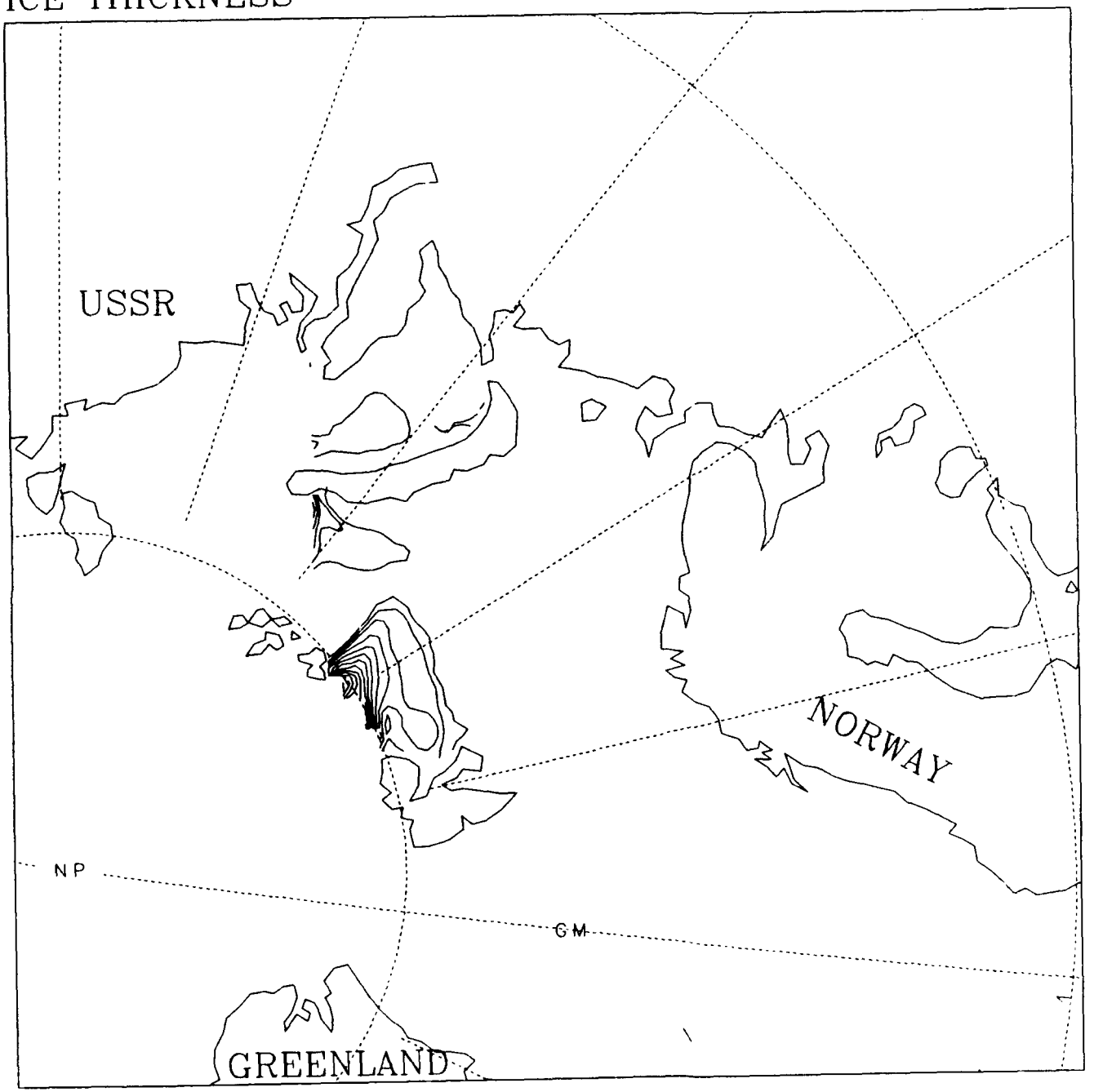
WIND VELOCITIES 1991 JULY



ICE VELOCITIES 1991 JULY



ICE THICKNESS 1991 JULY



ICE CONCENTRATION 1991 JULY

WIND VELOCITIES 1991 AUGUST

0.300E+02
MAXIMUM VECTOR

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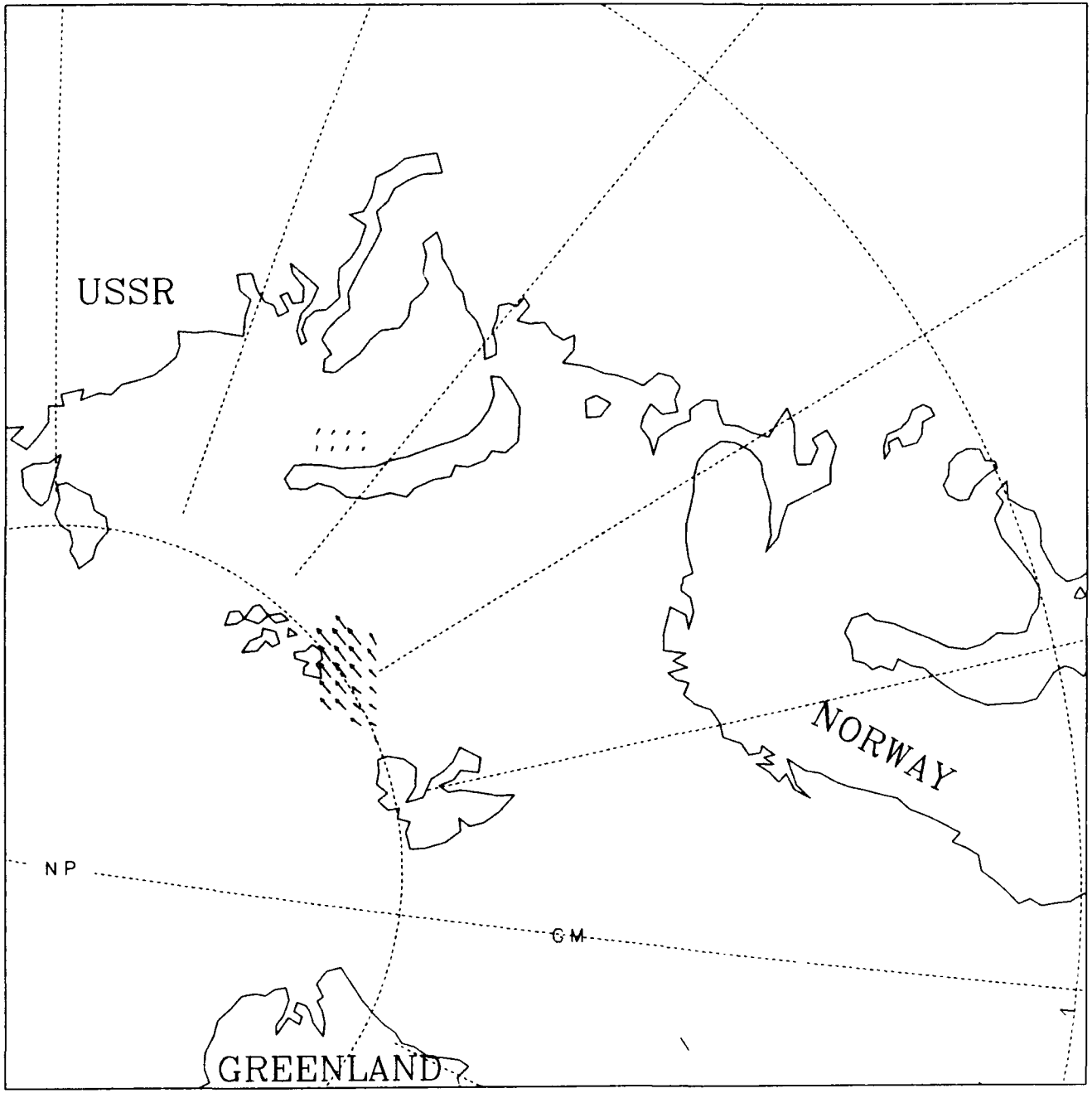

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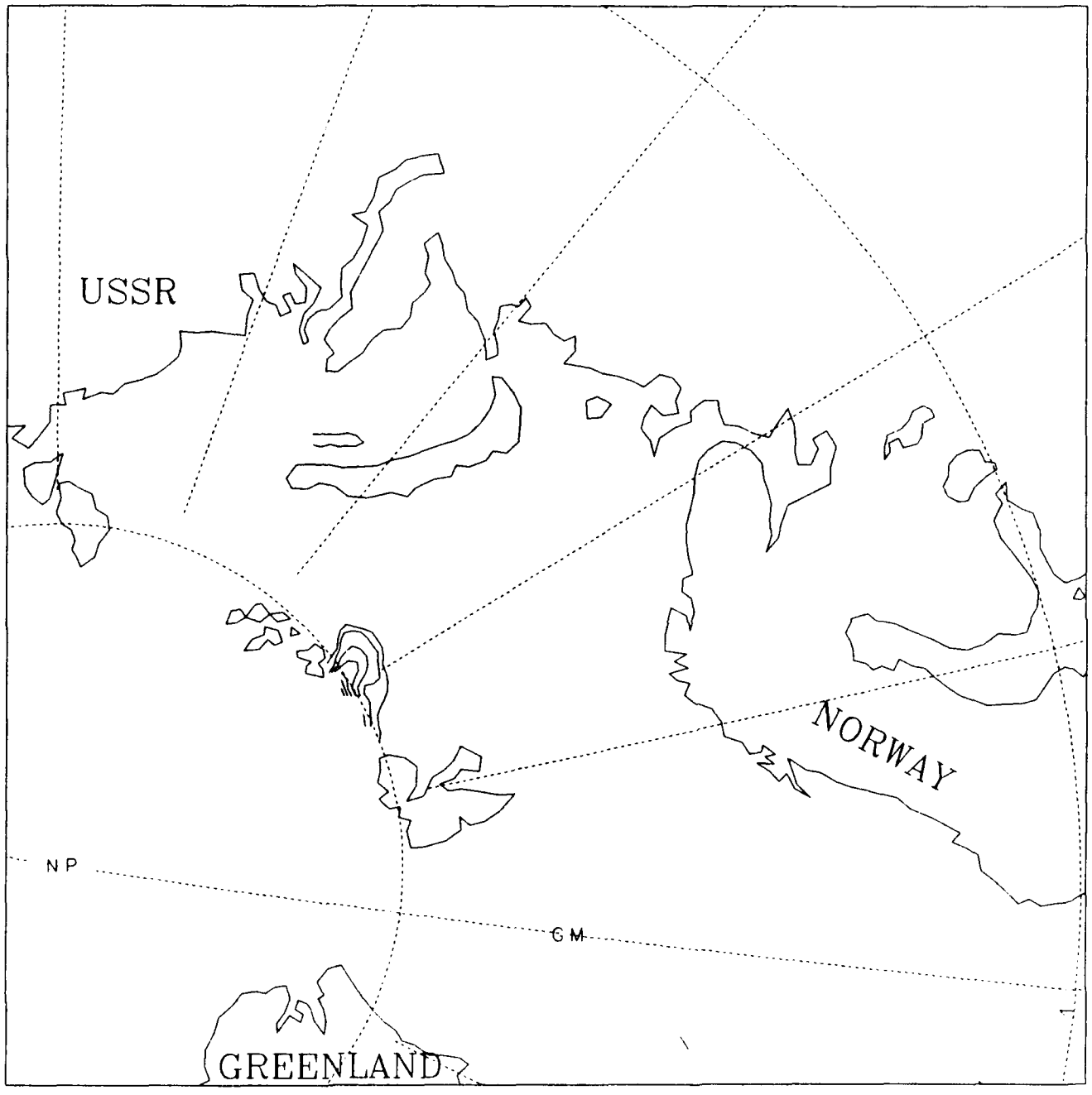

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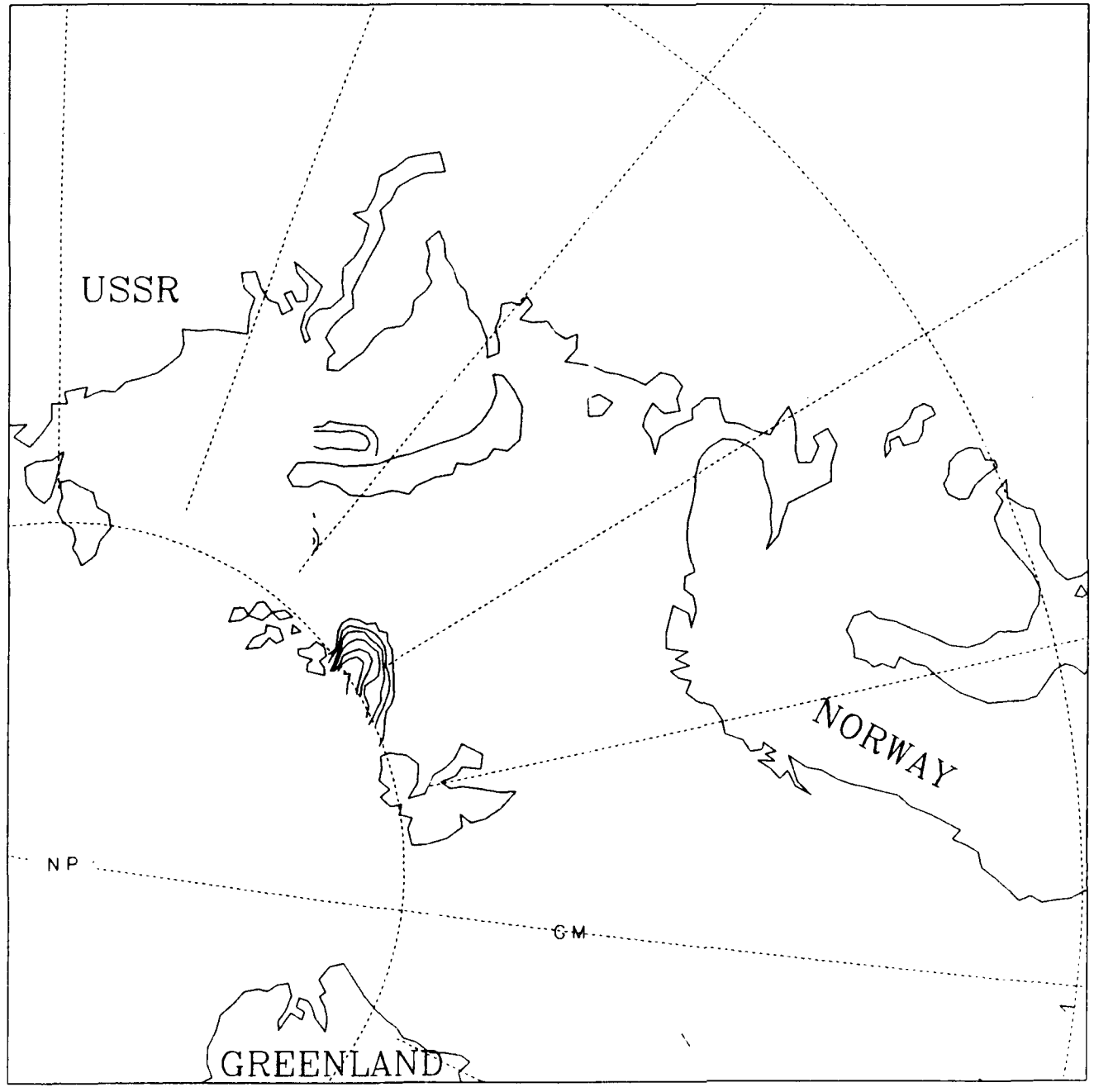

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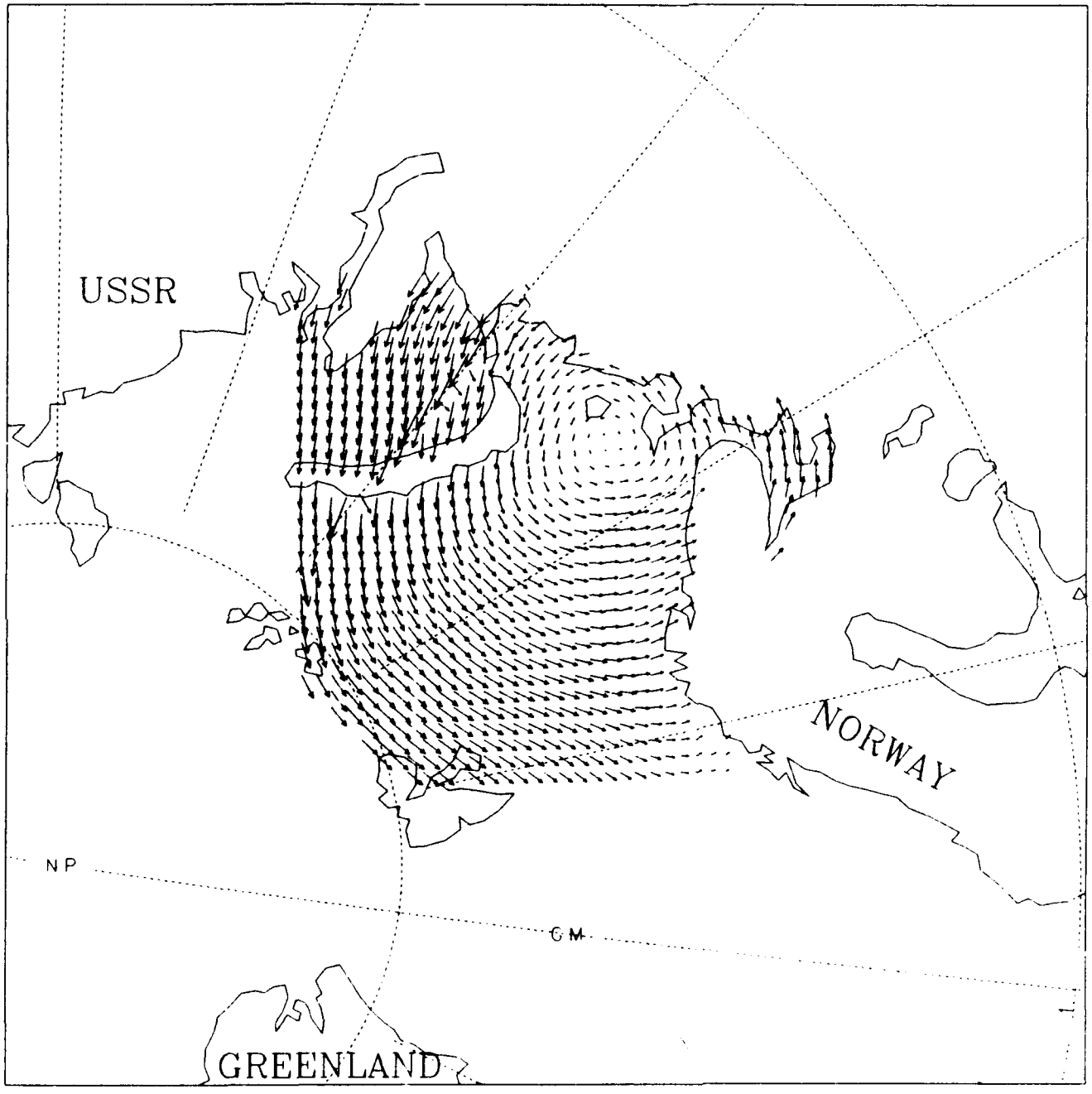

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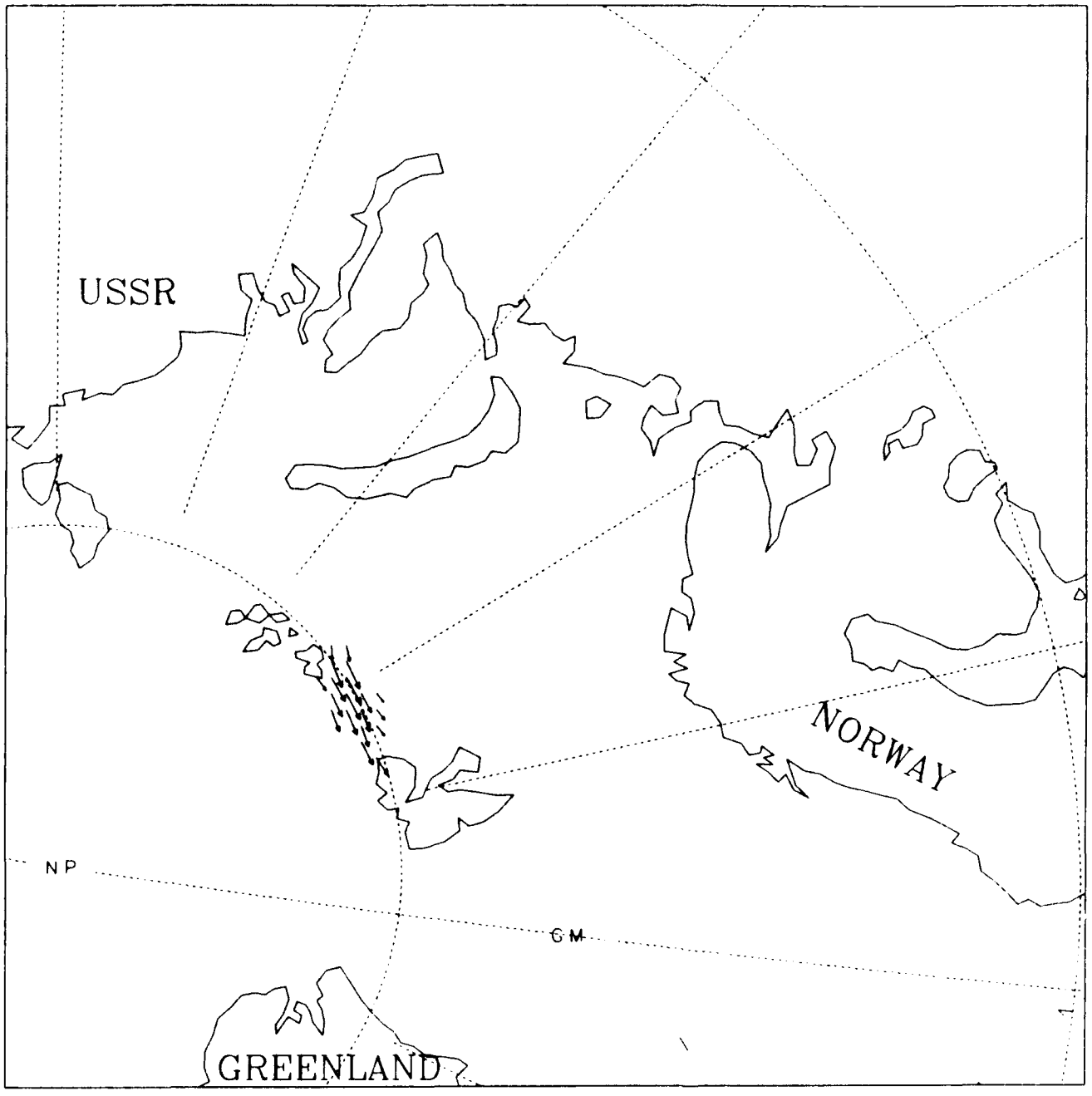

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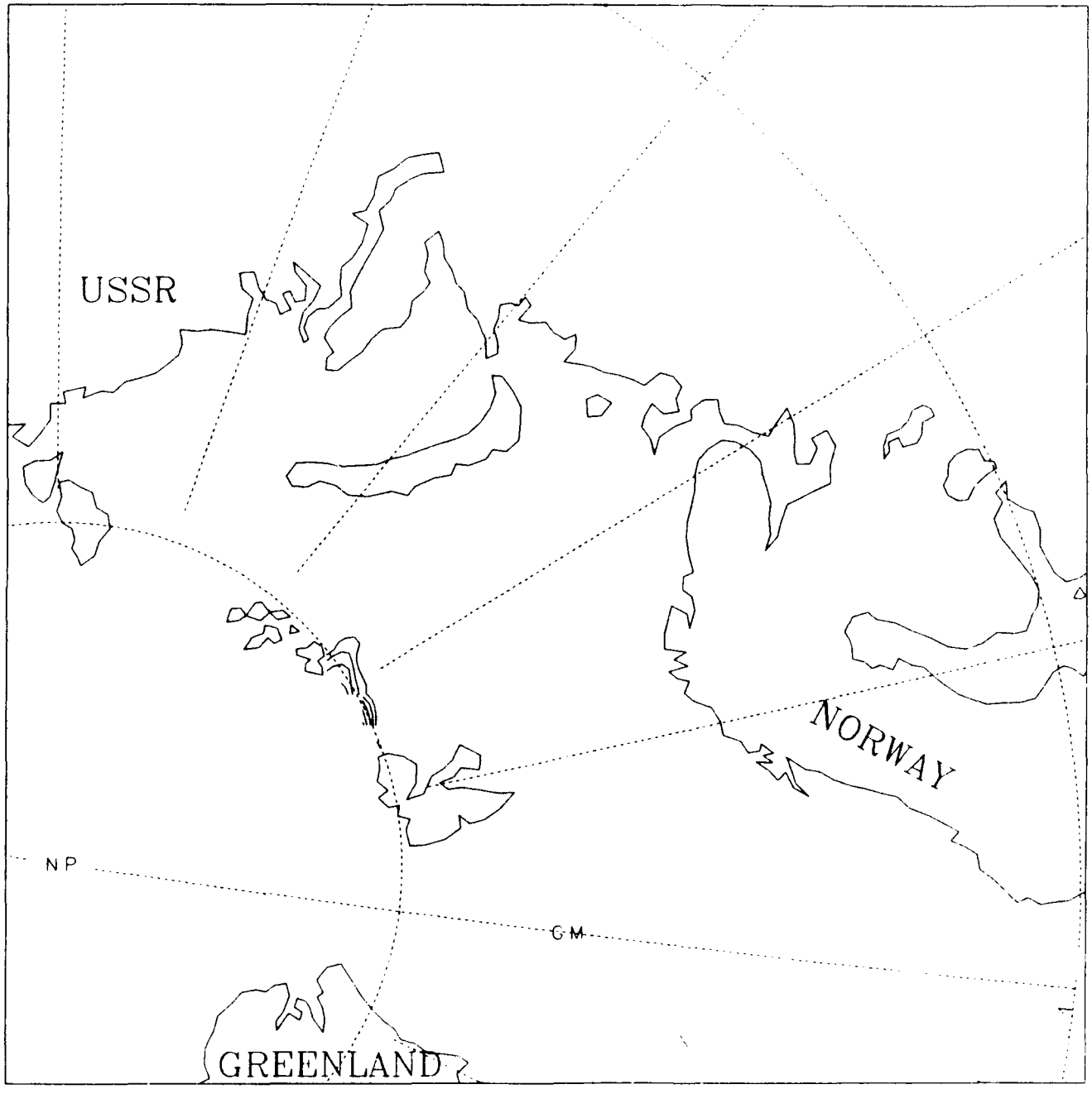

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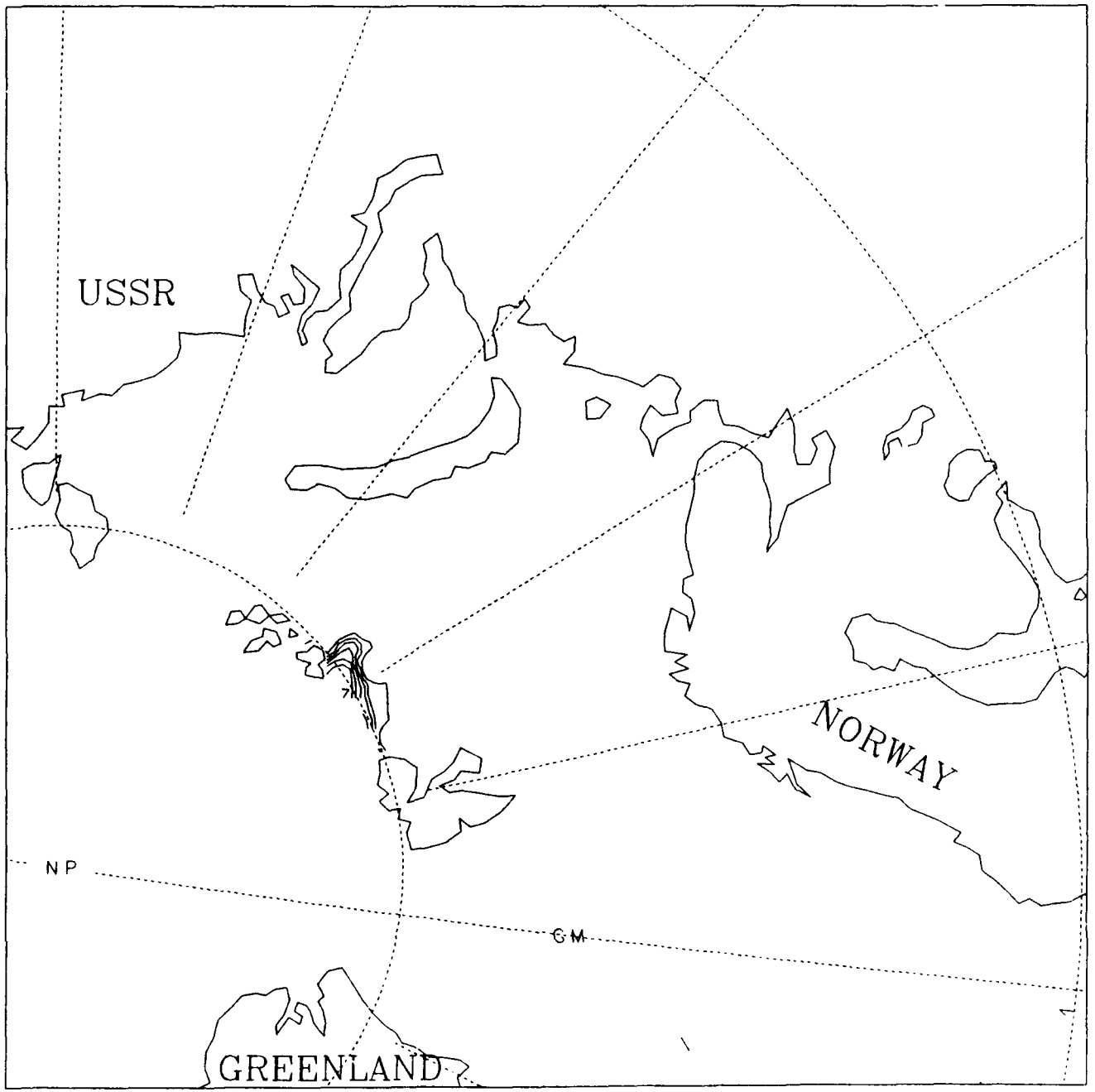


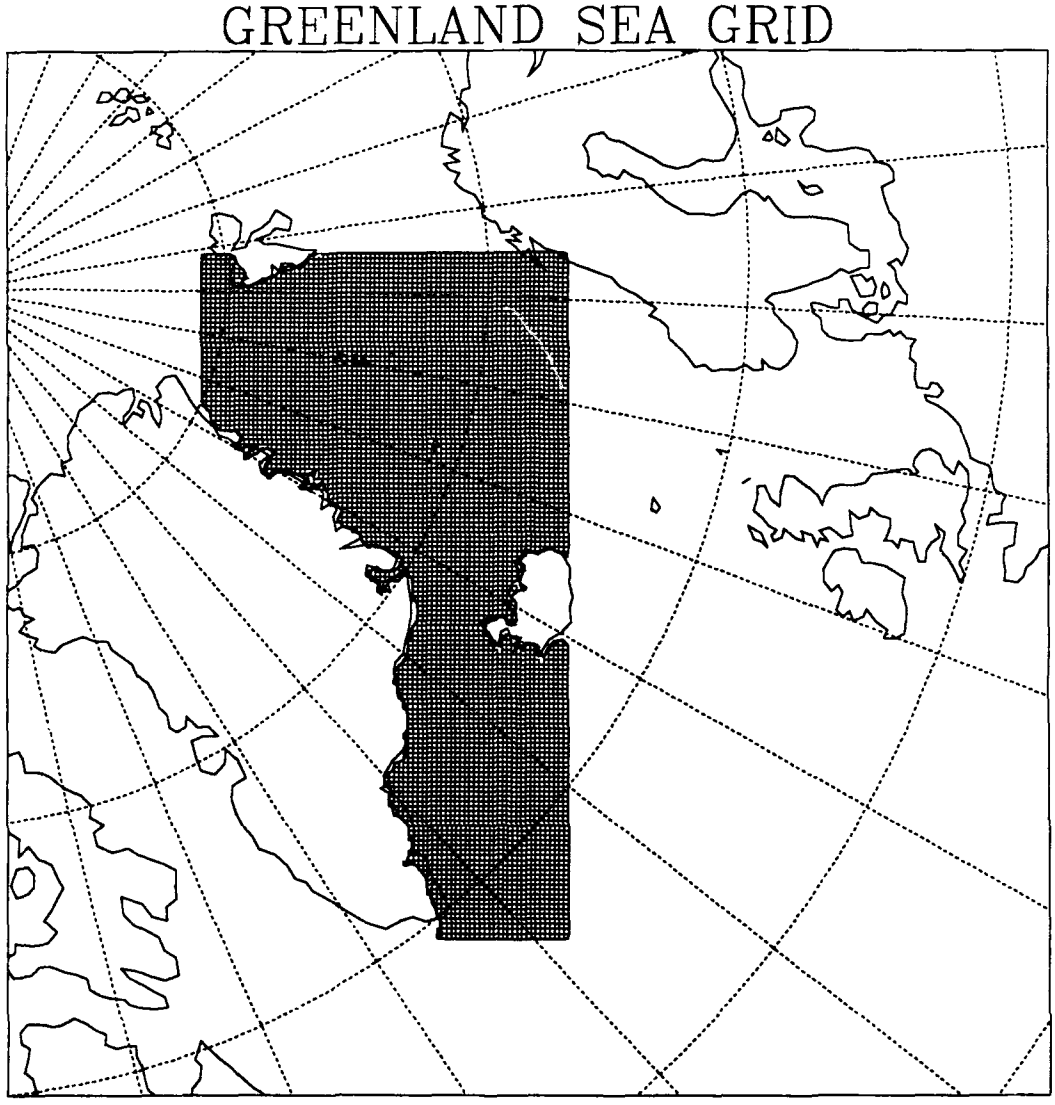
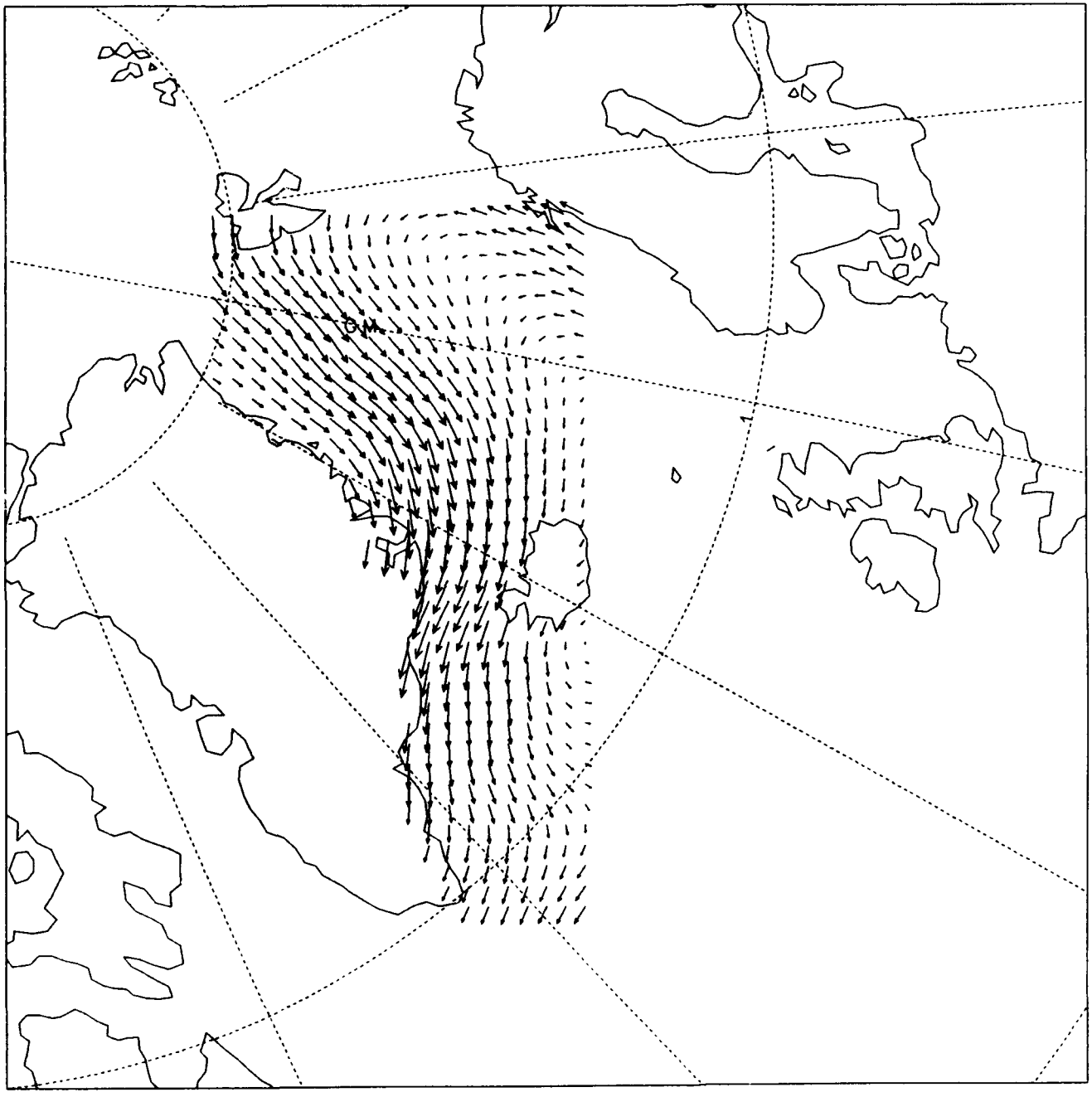


Figure 3. RPIPS-G domain with the 20 km resolution grid overlaid.

R PIPS-G 1991

MONTHLY MEANS

WIND VELOCITIES 1991 MARCH



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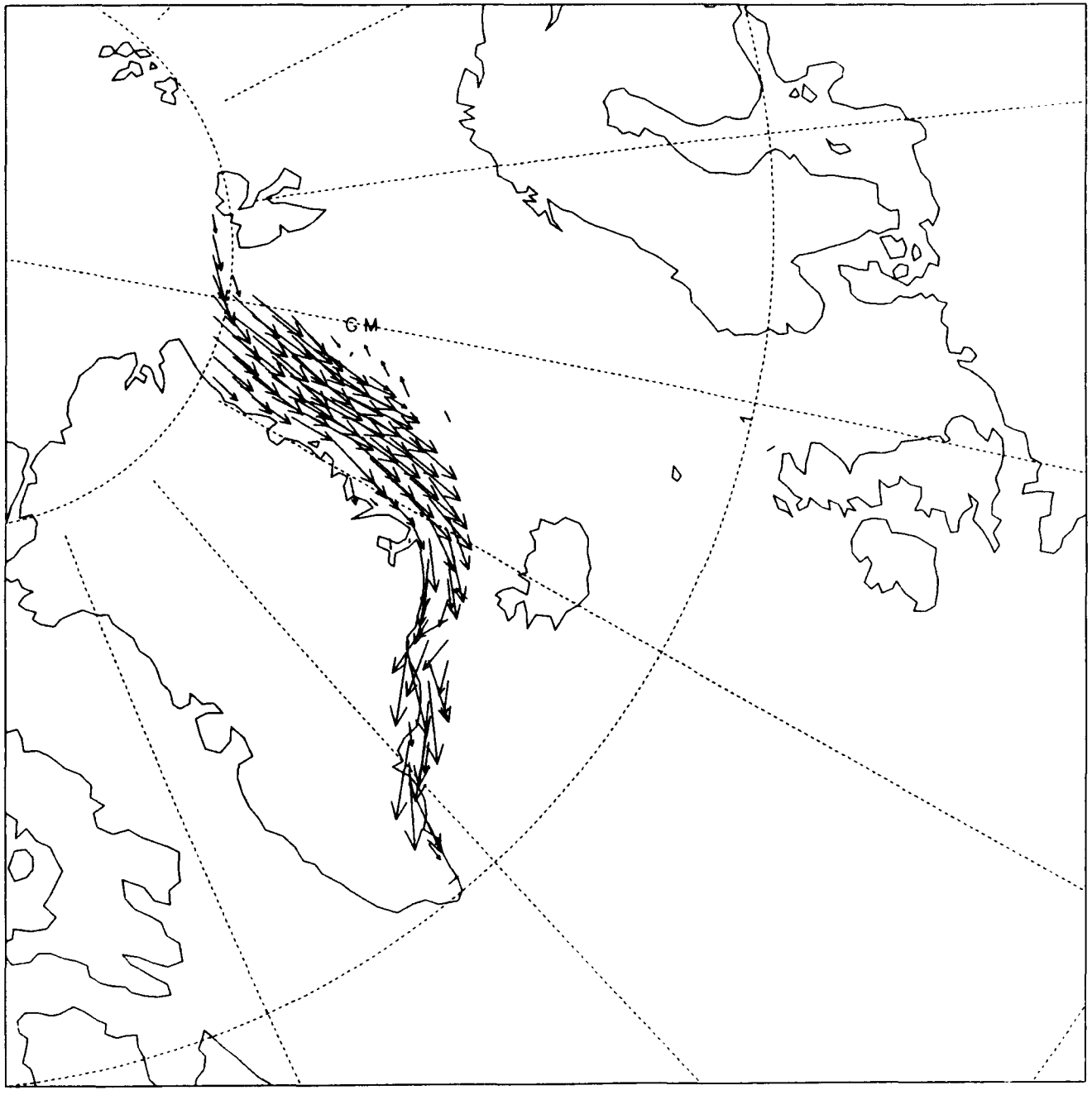

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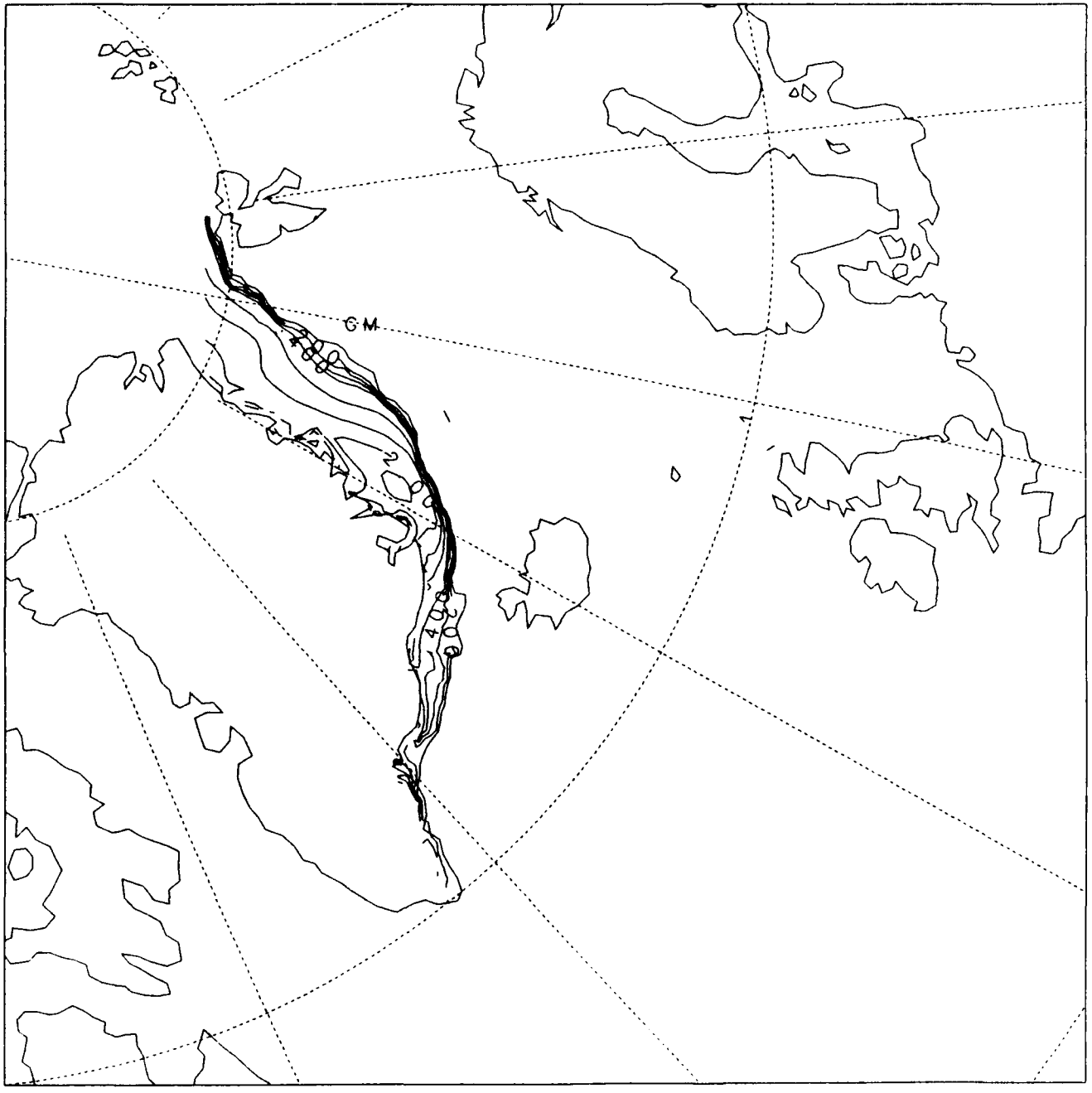

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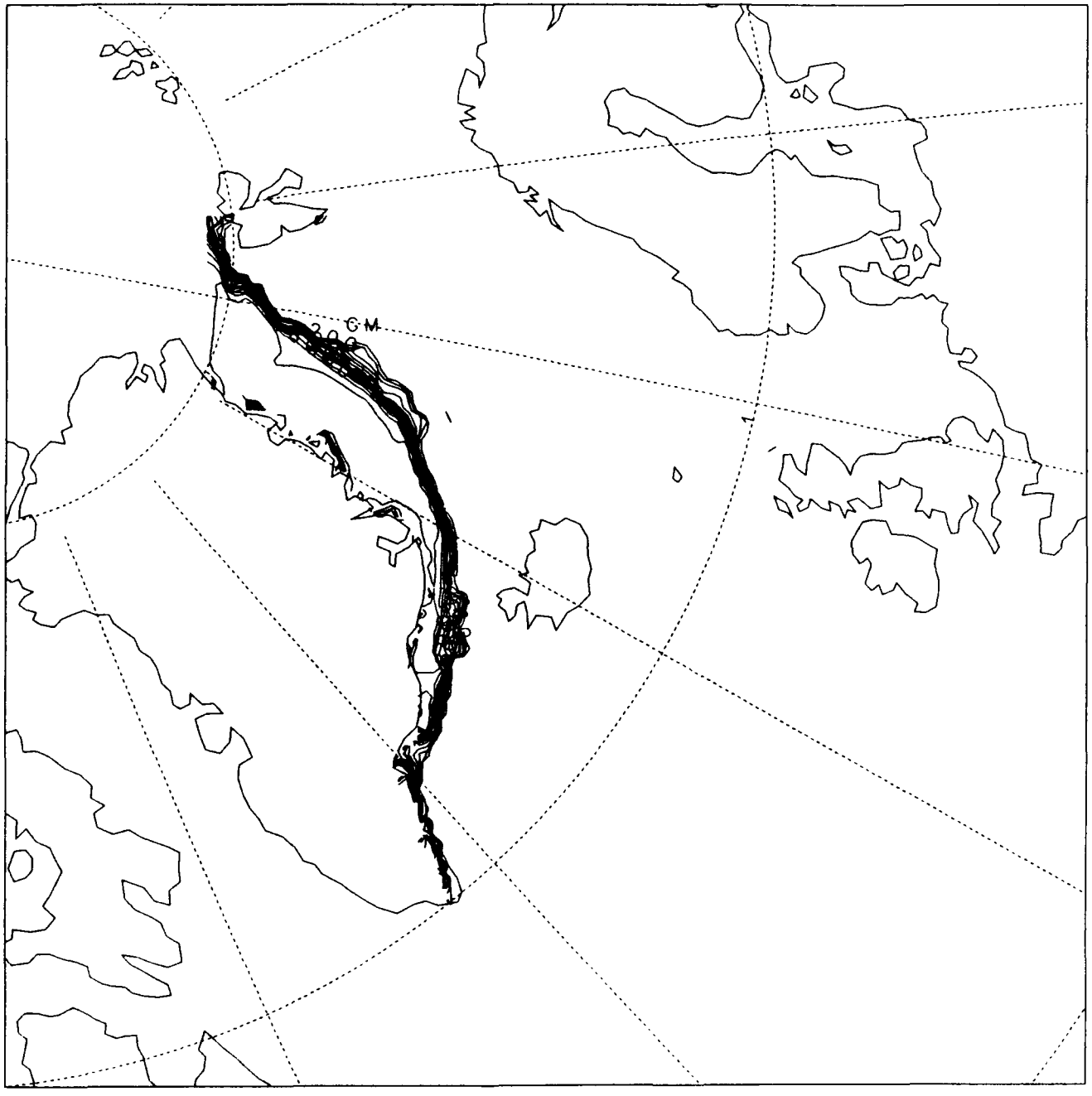

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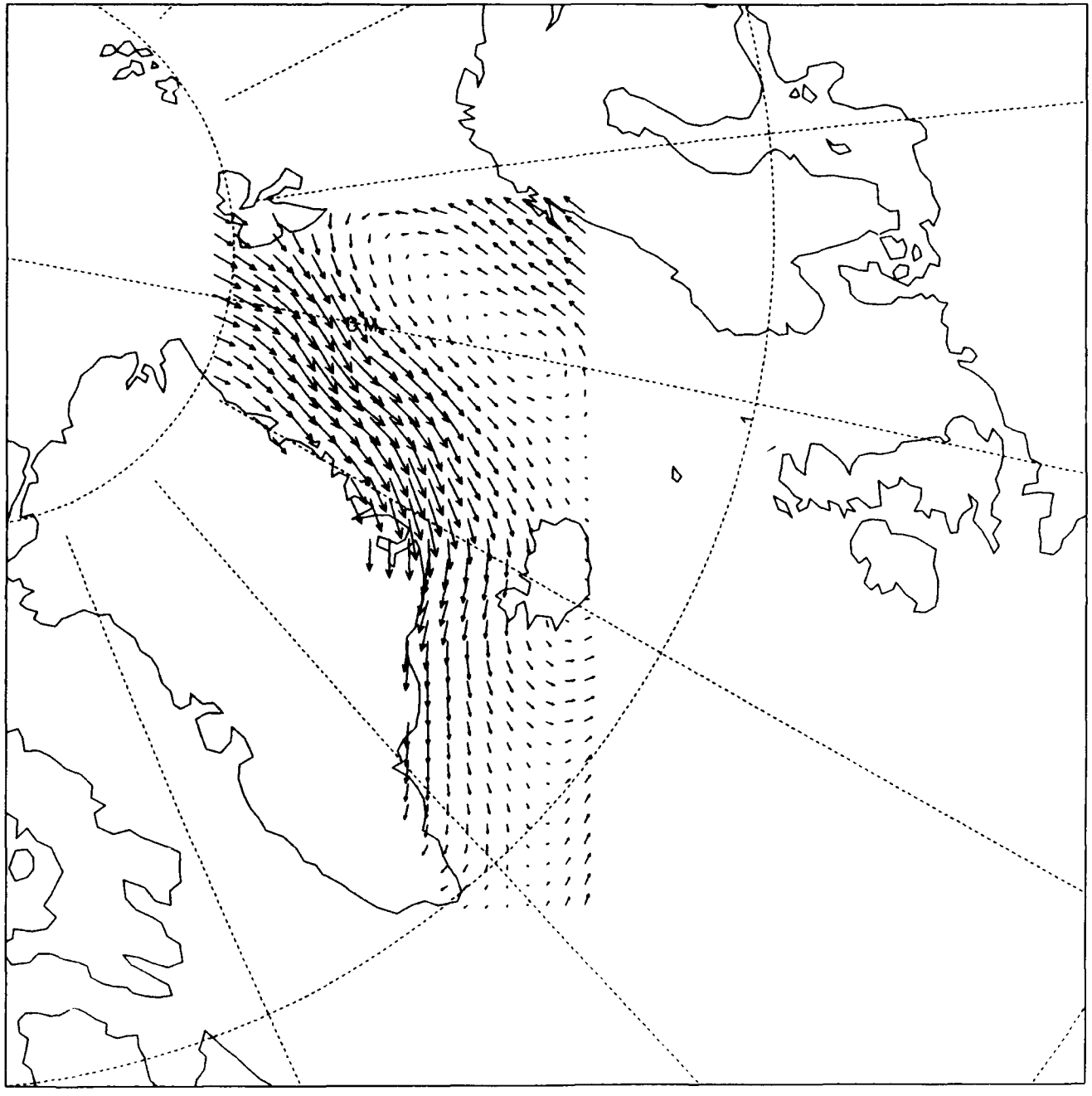

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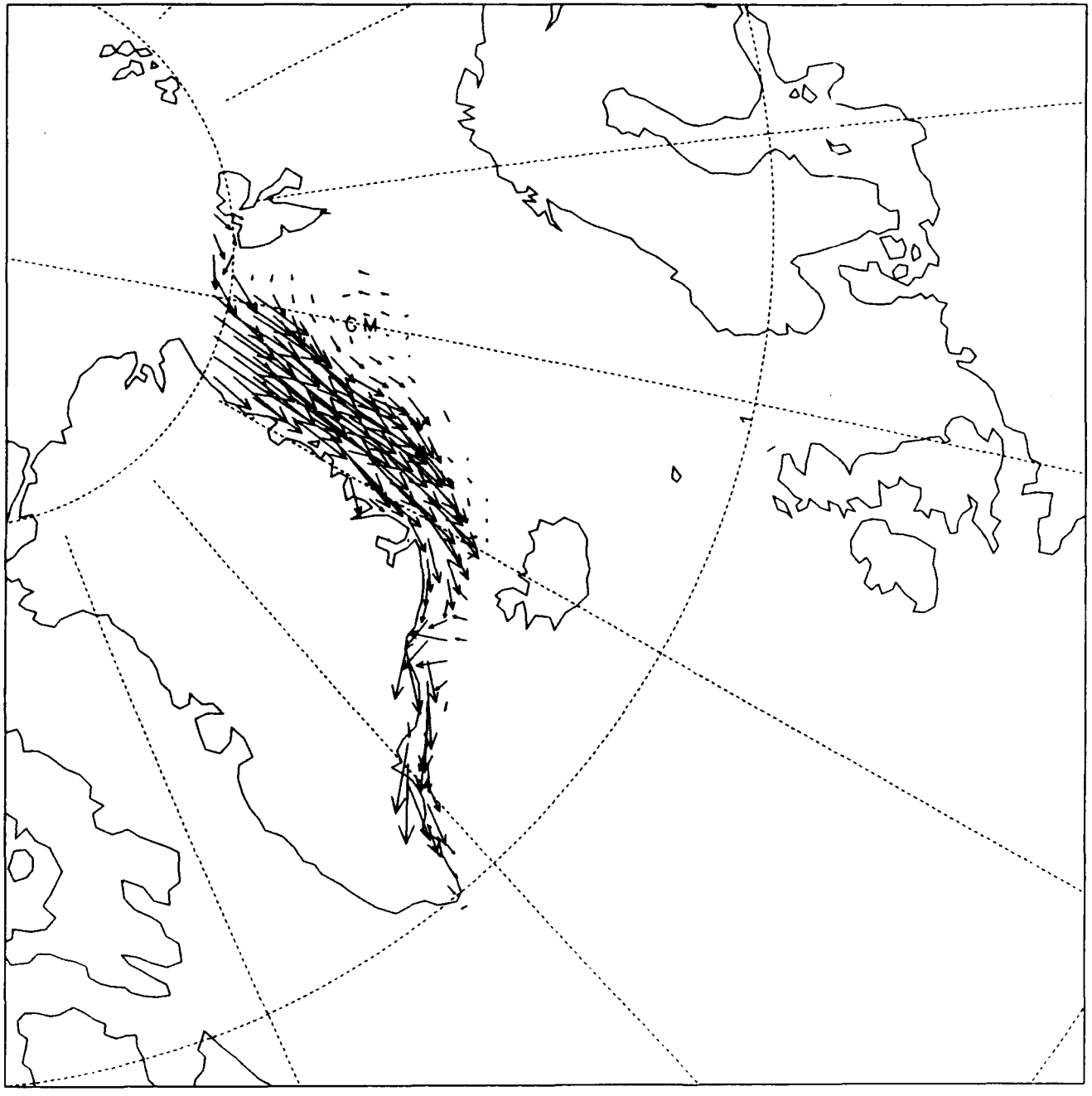

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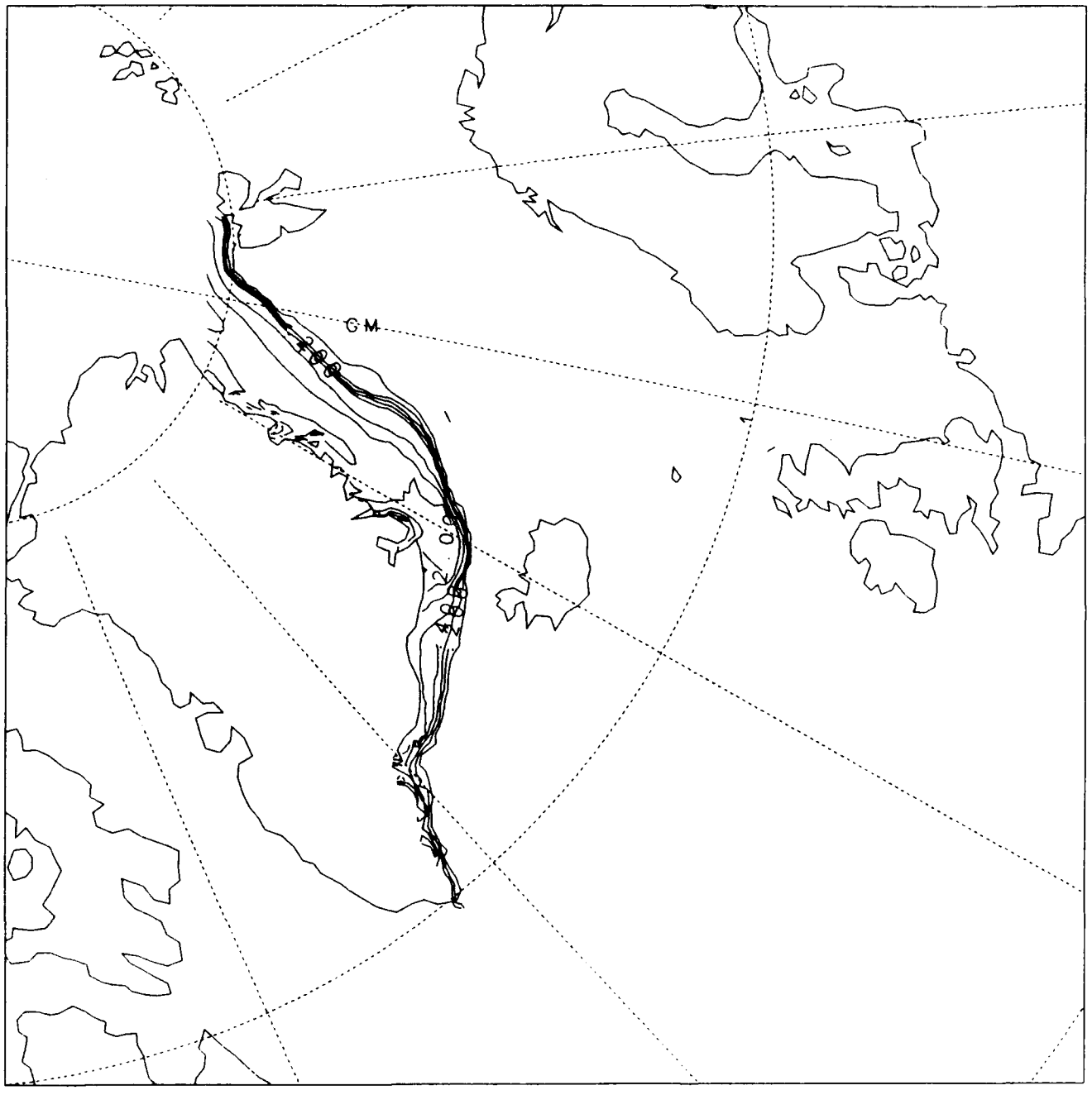

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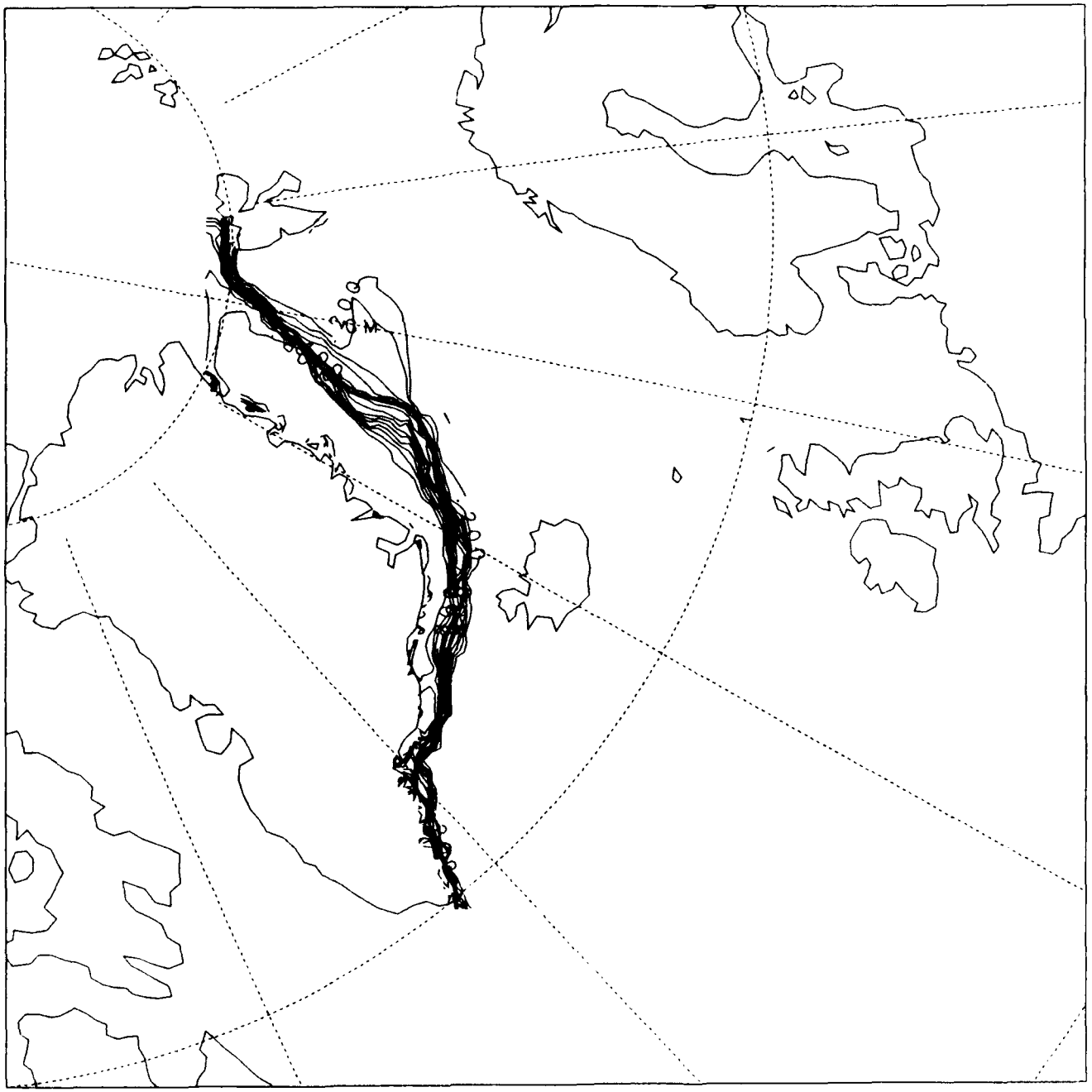

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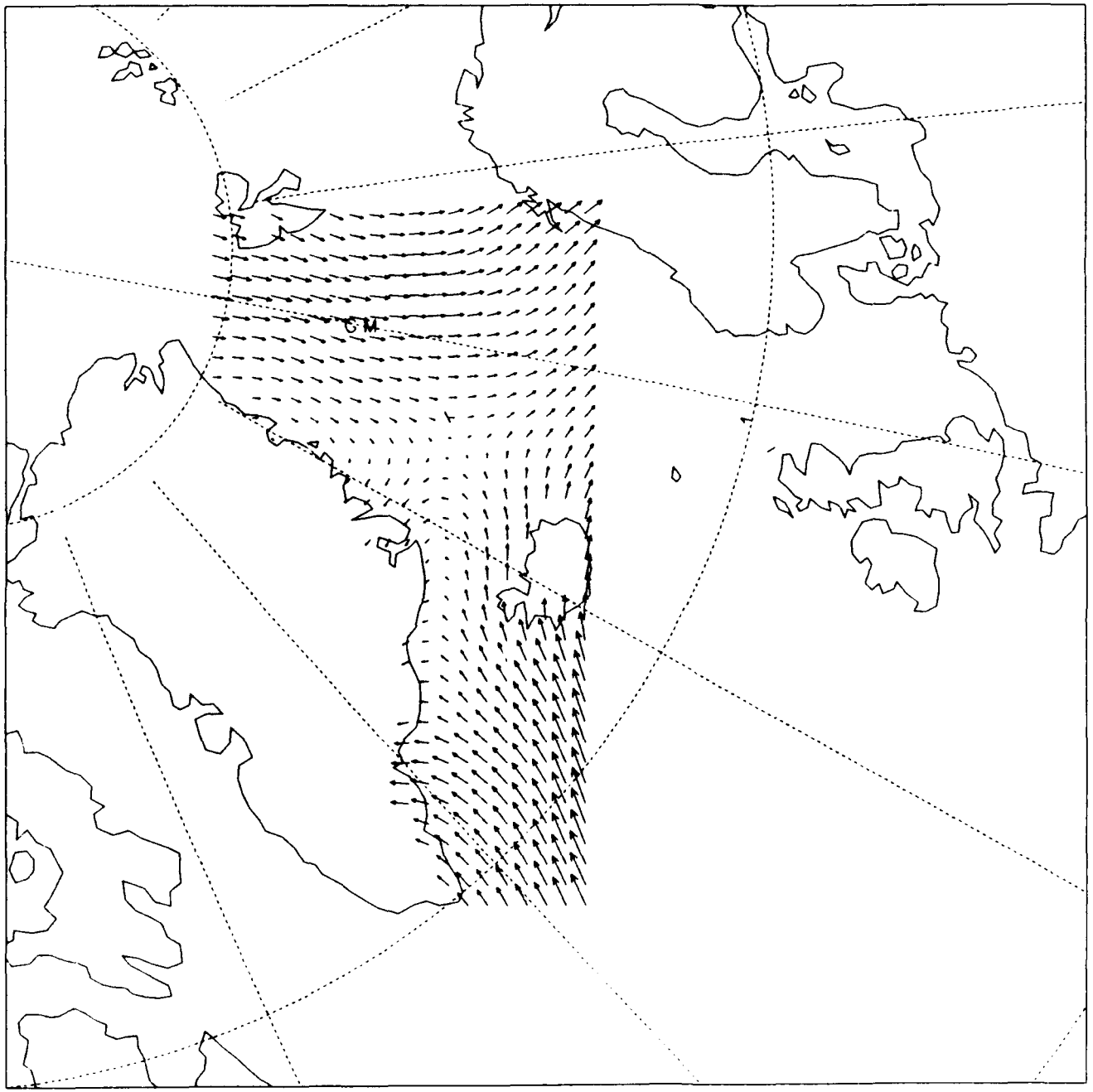

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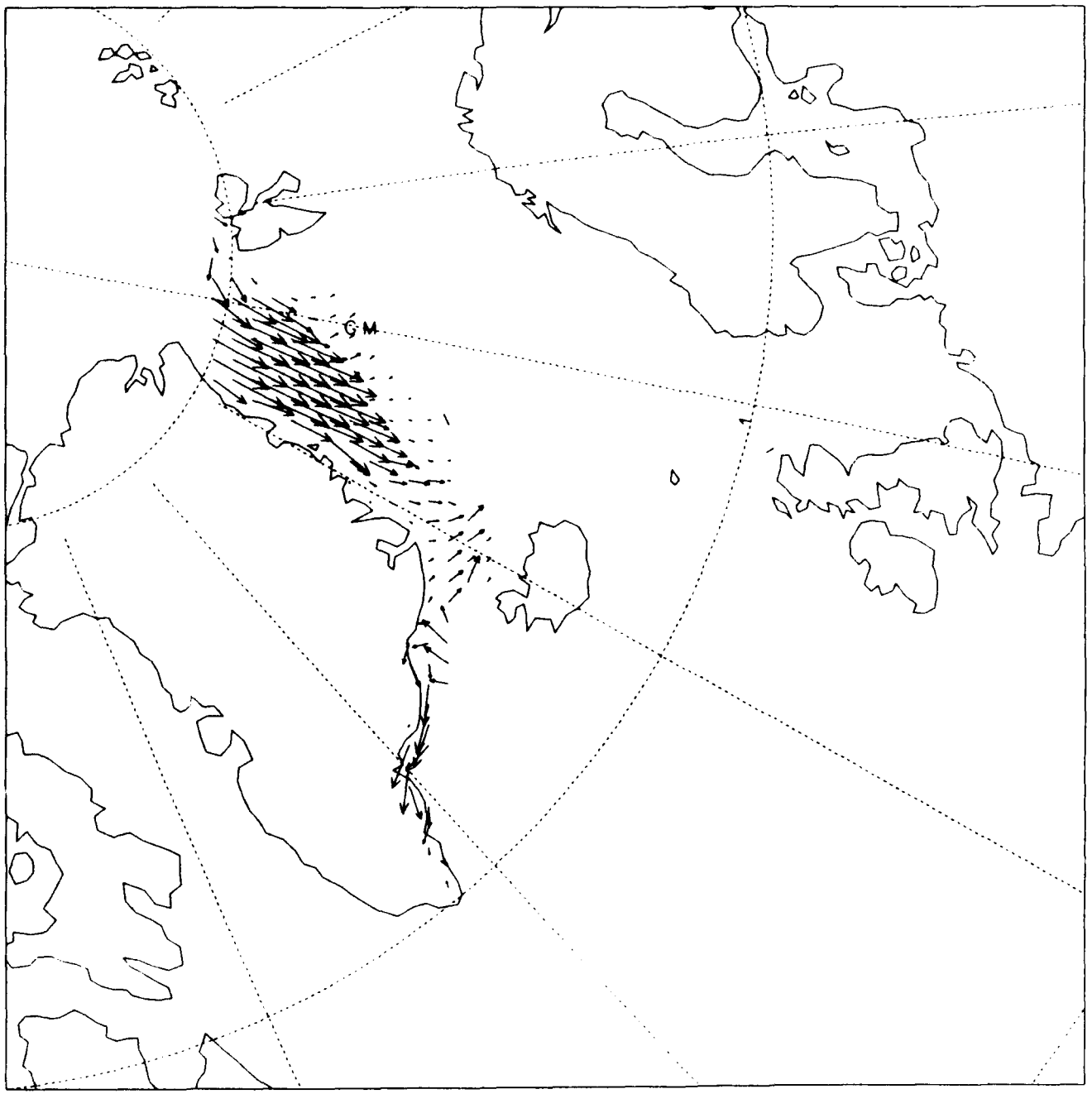

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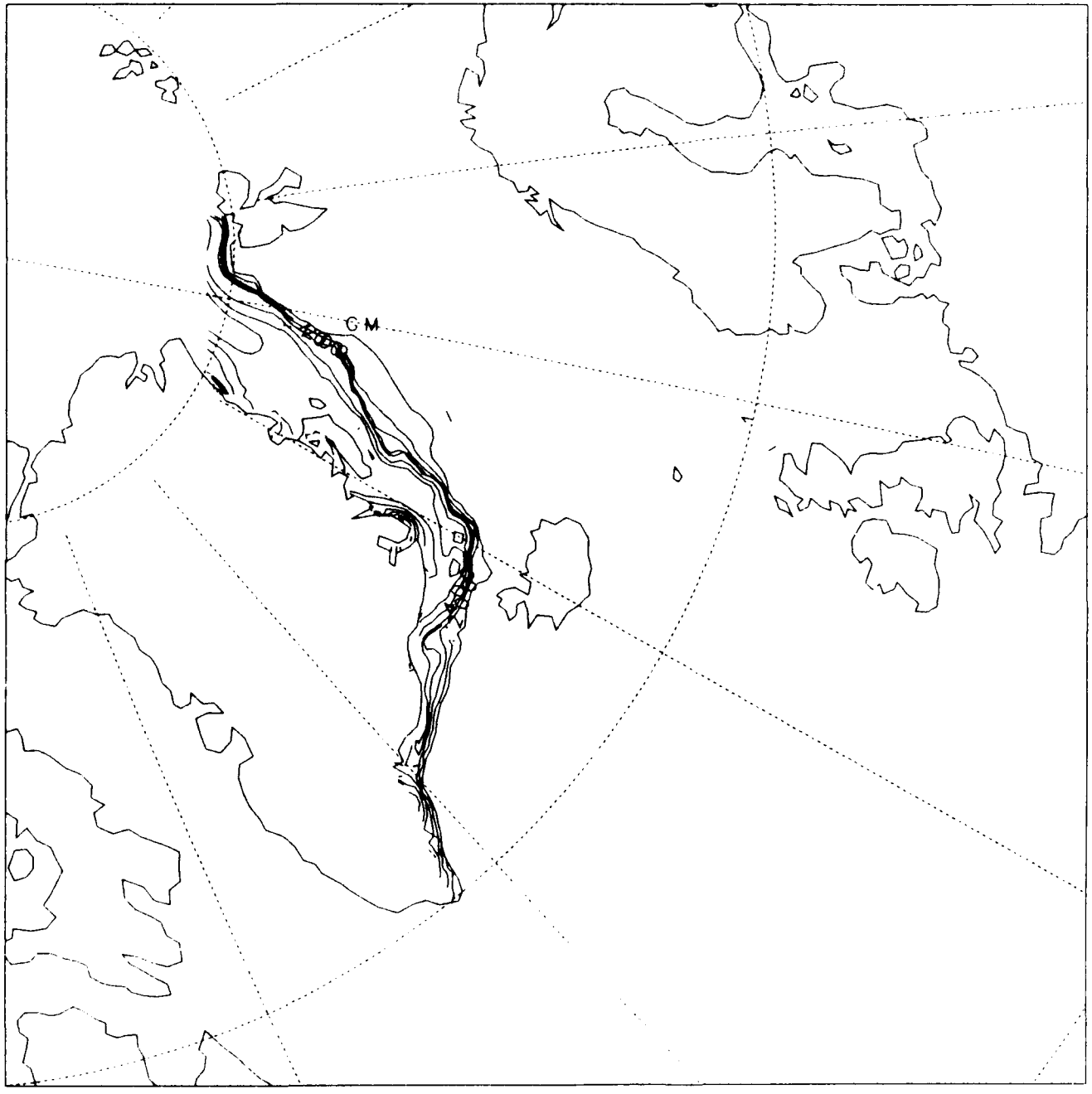

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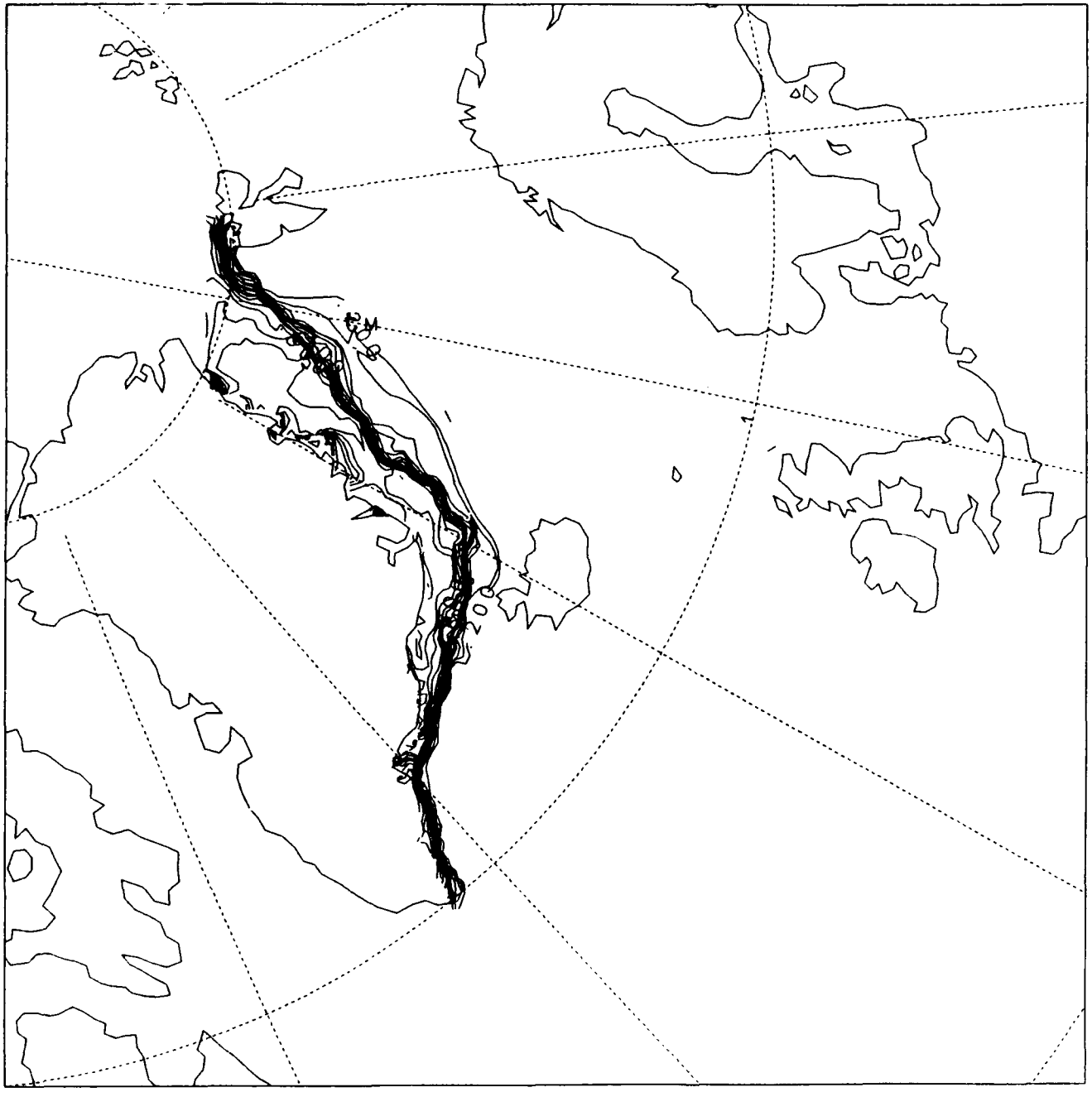

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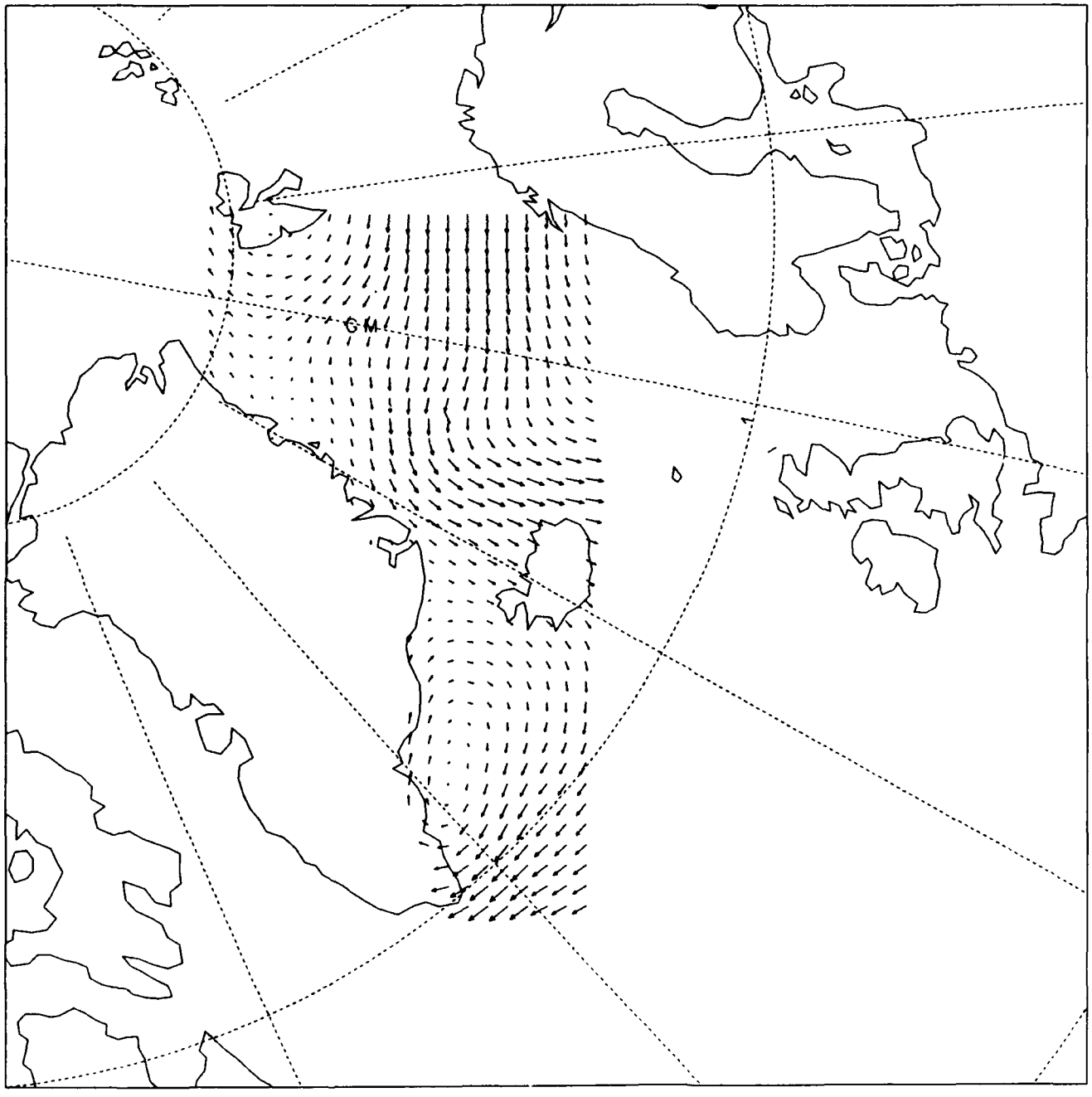

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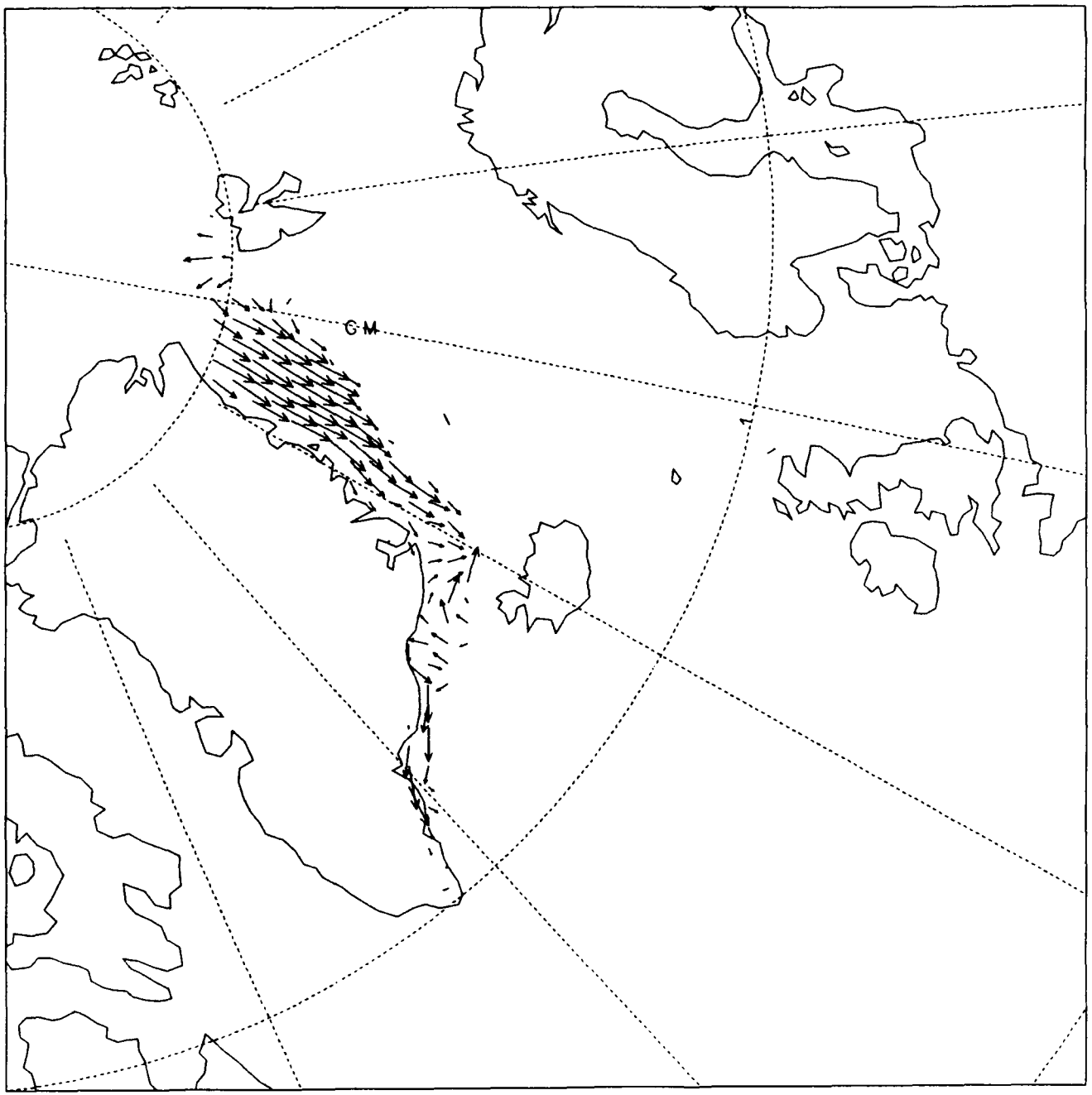

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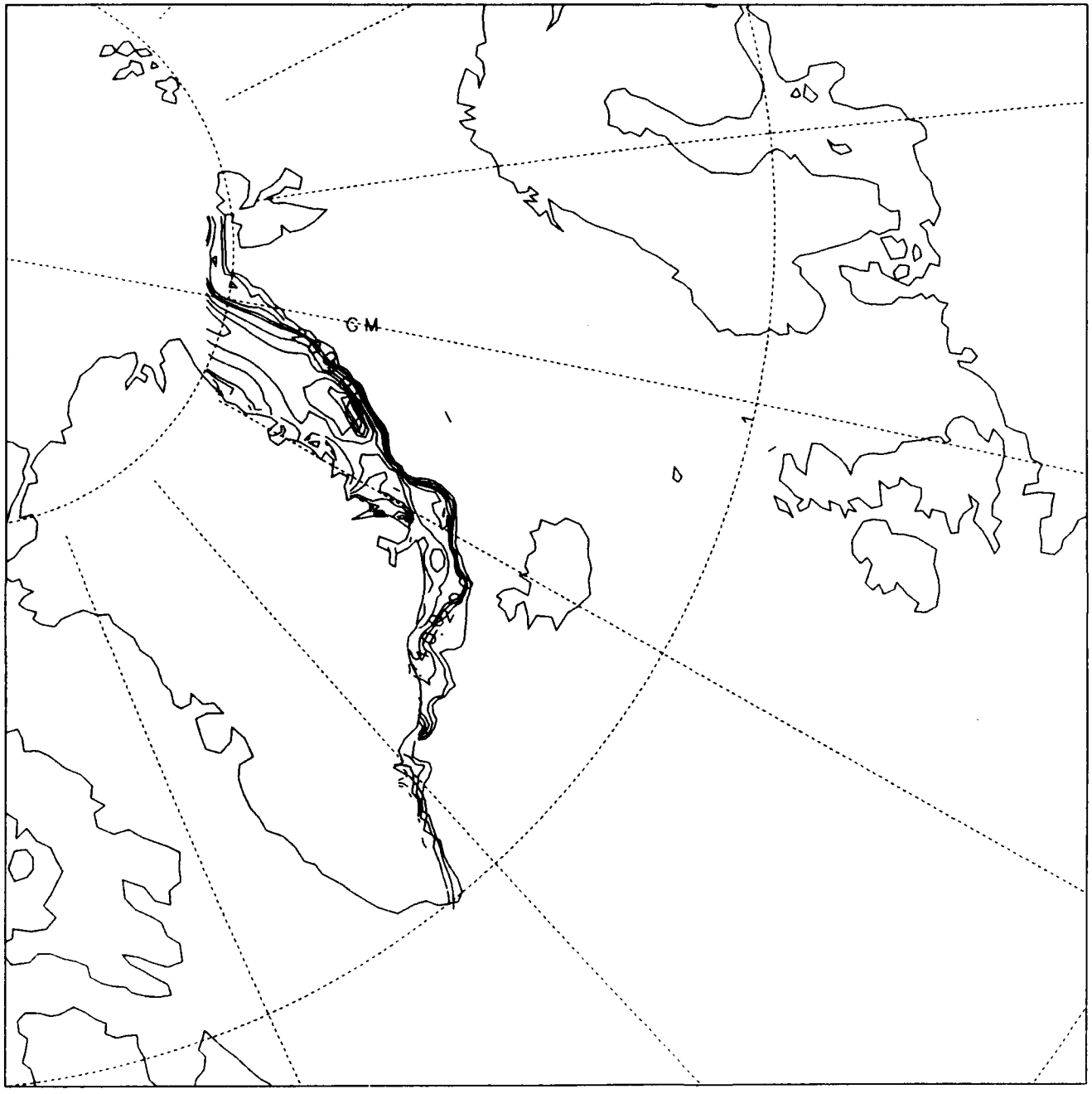

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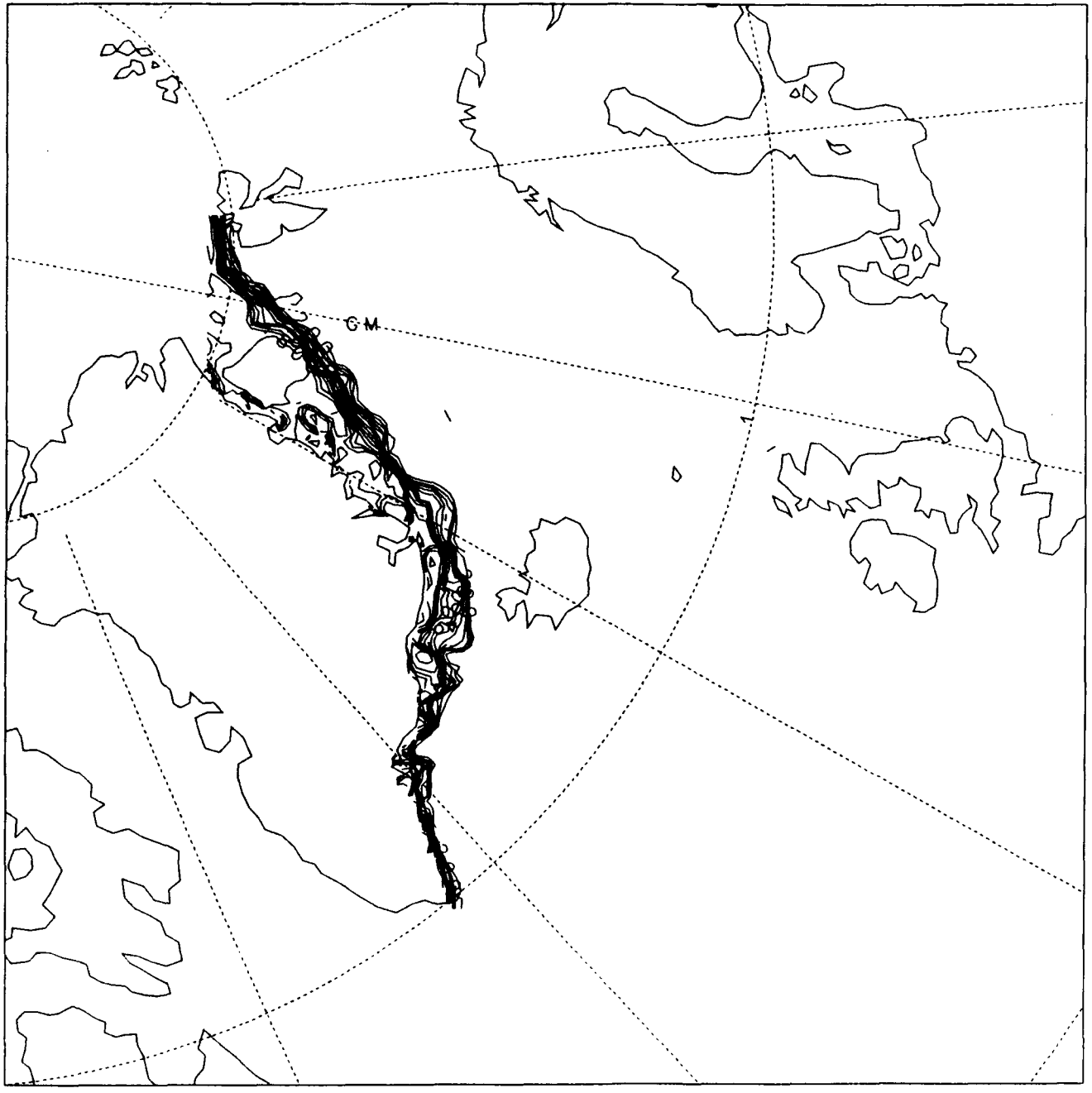

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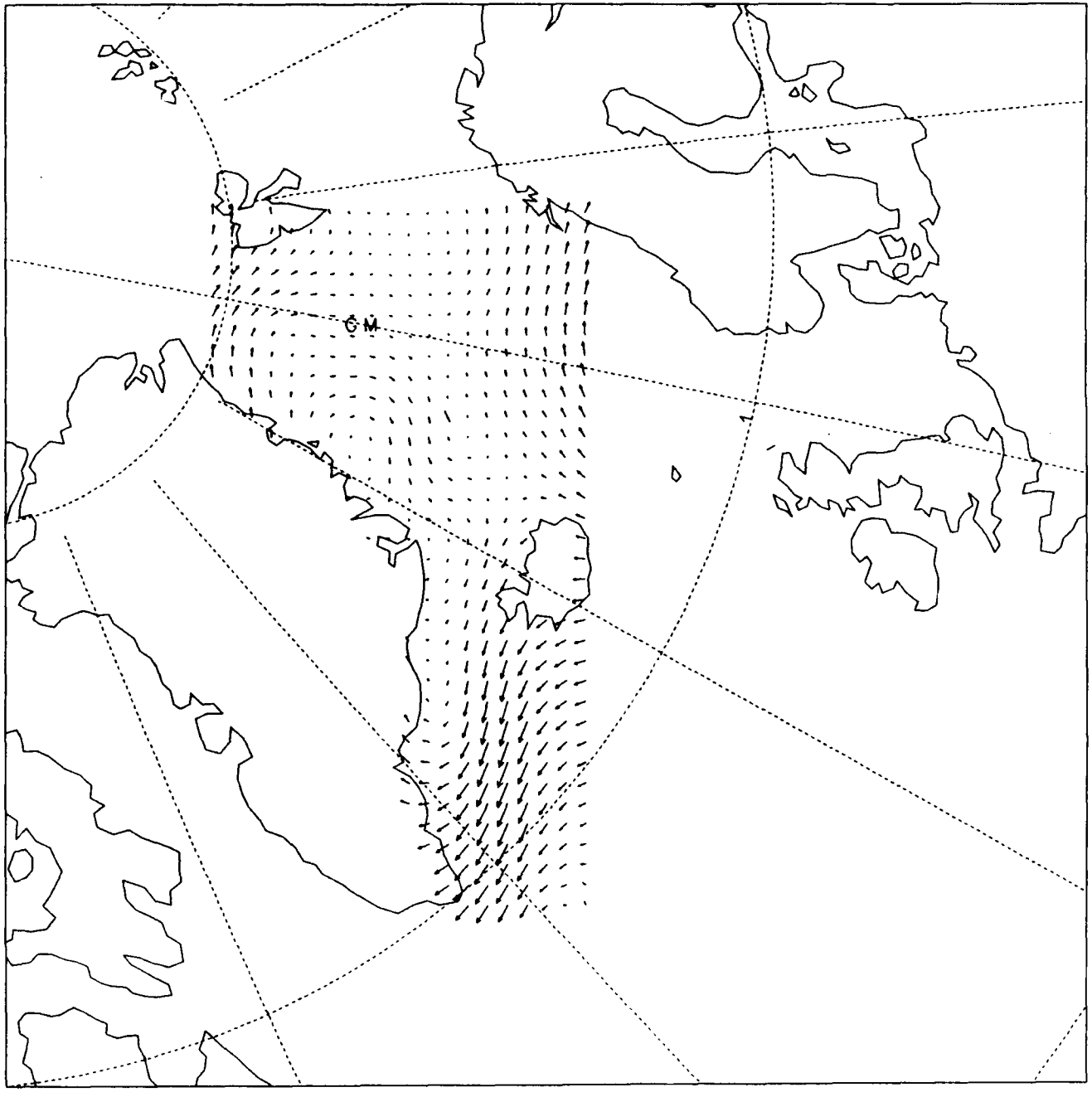

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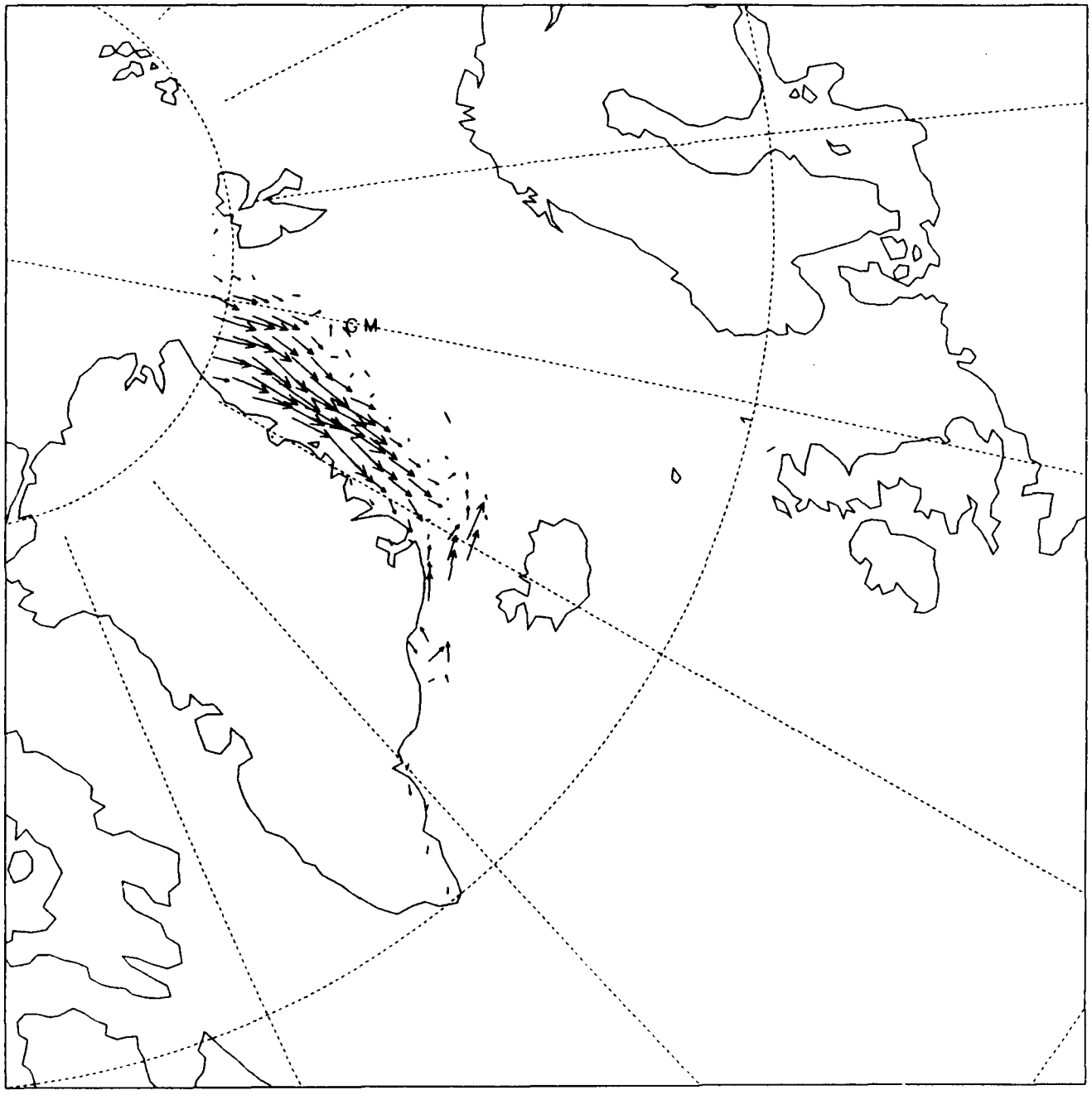

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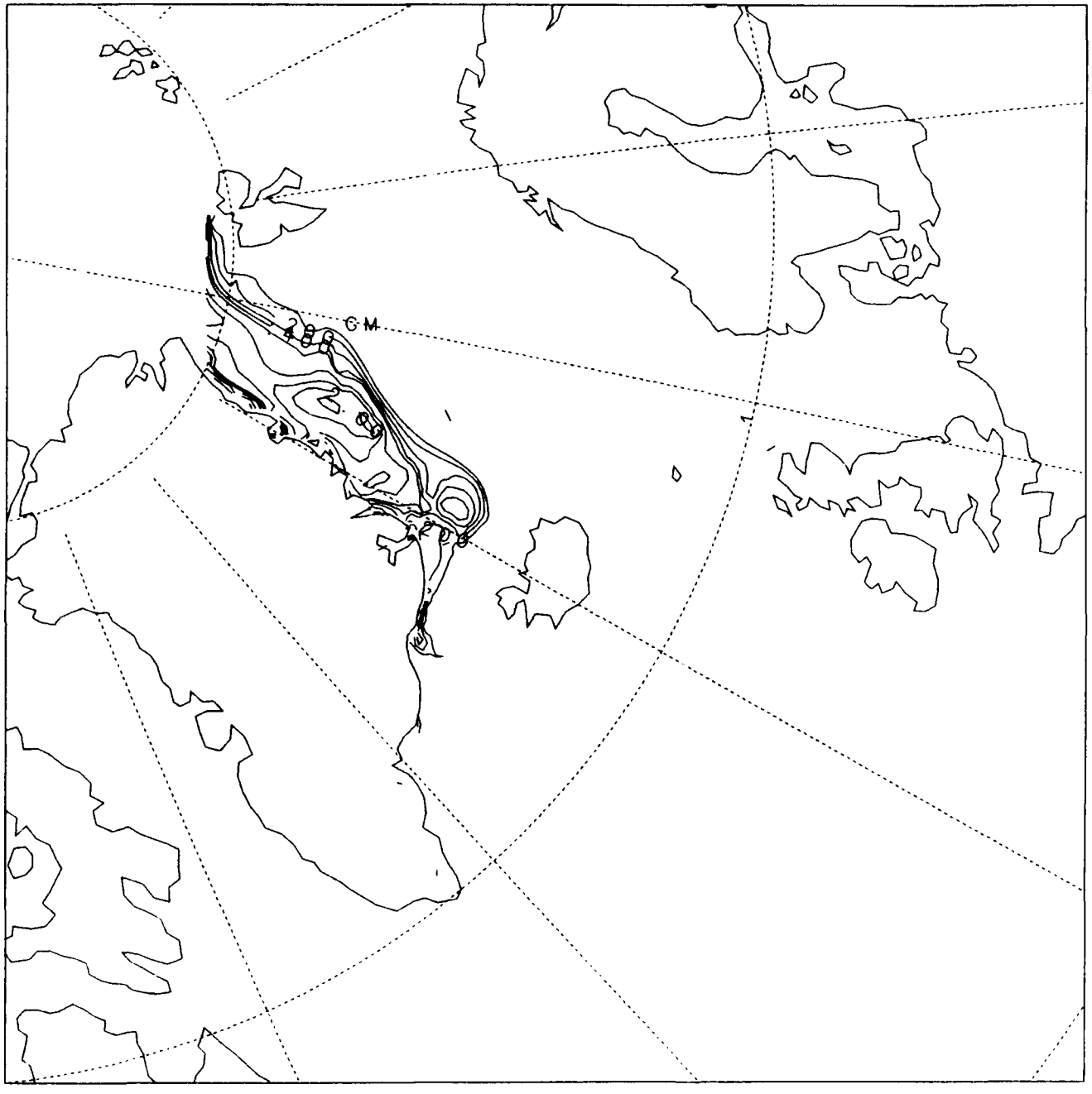

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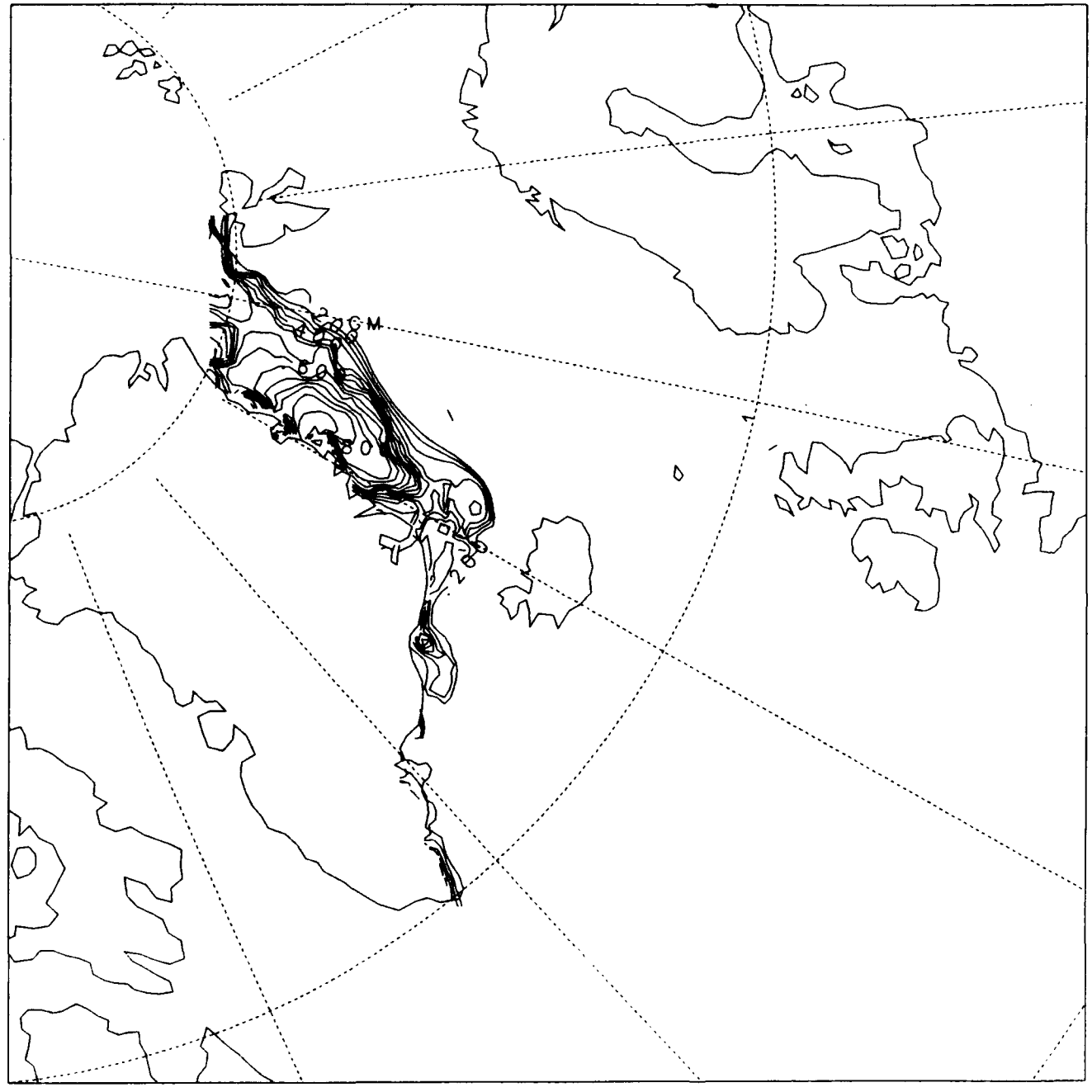

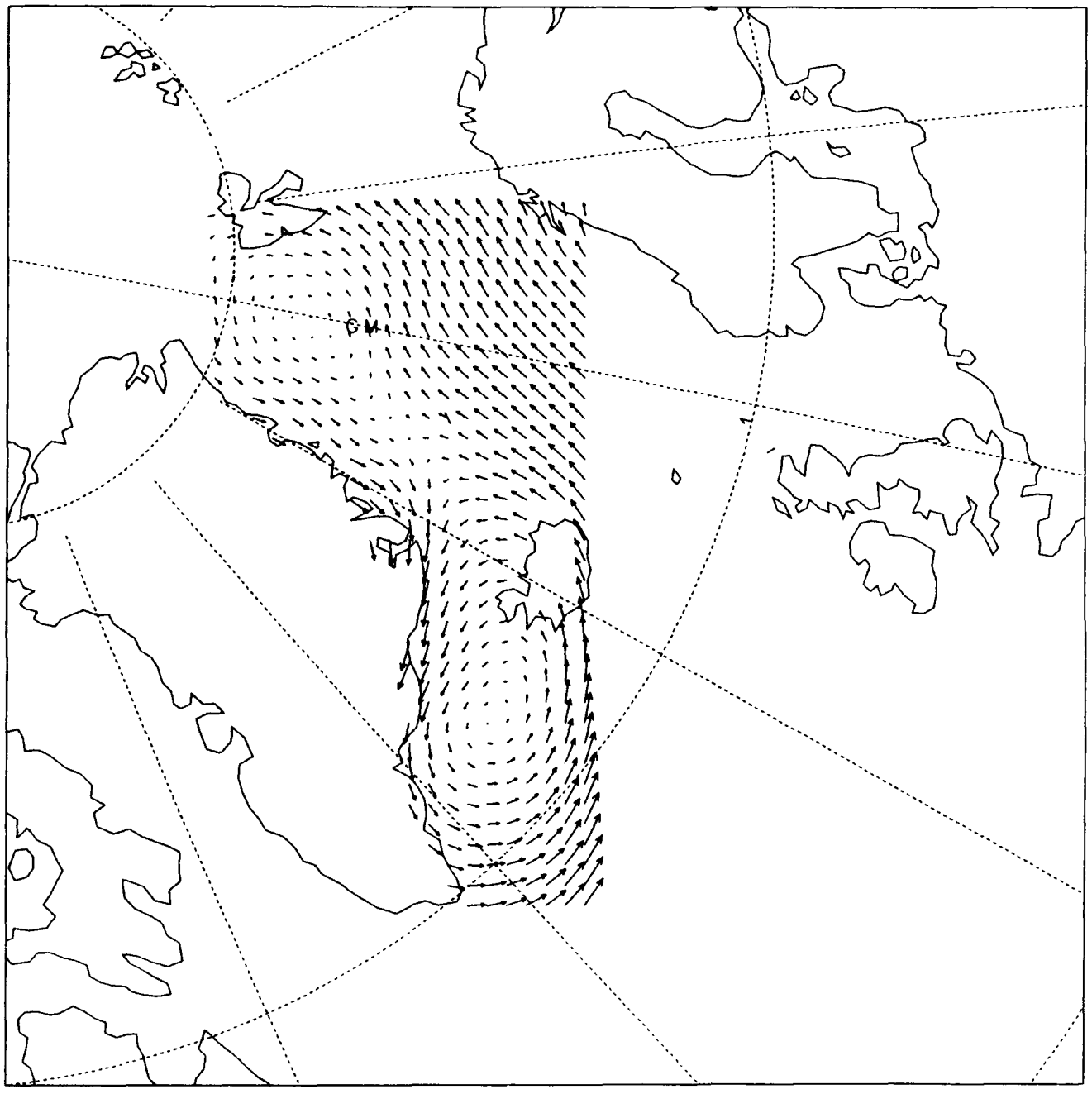
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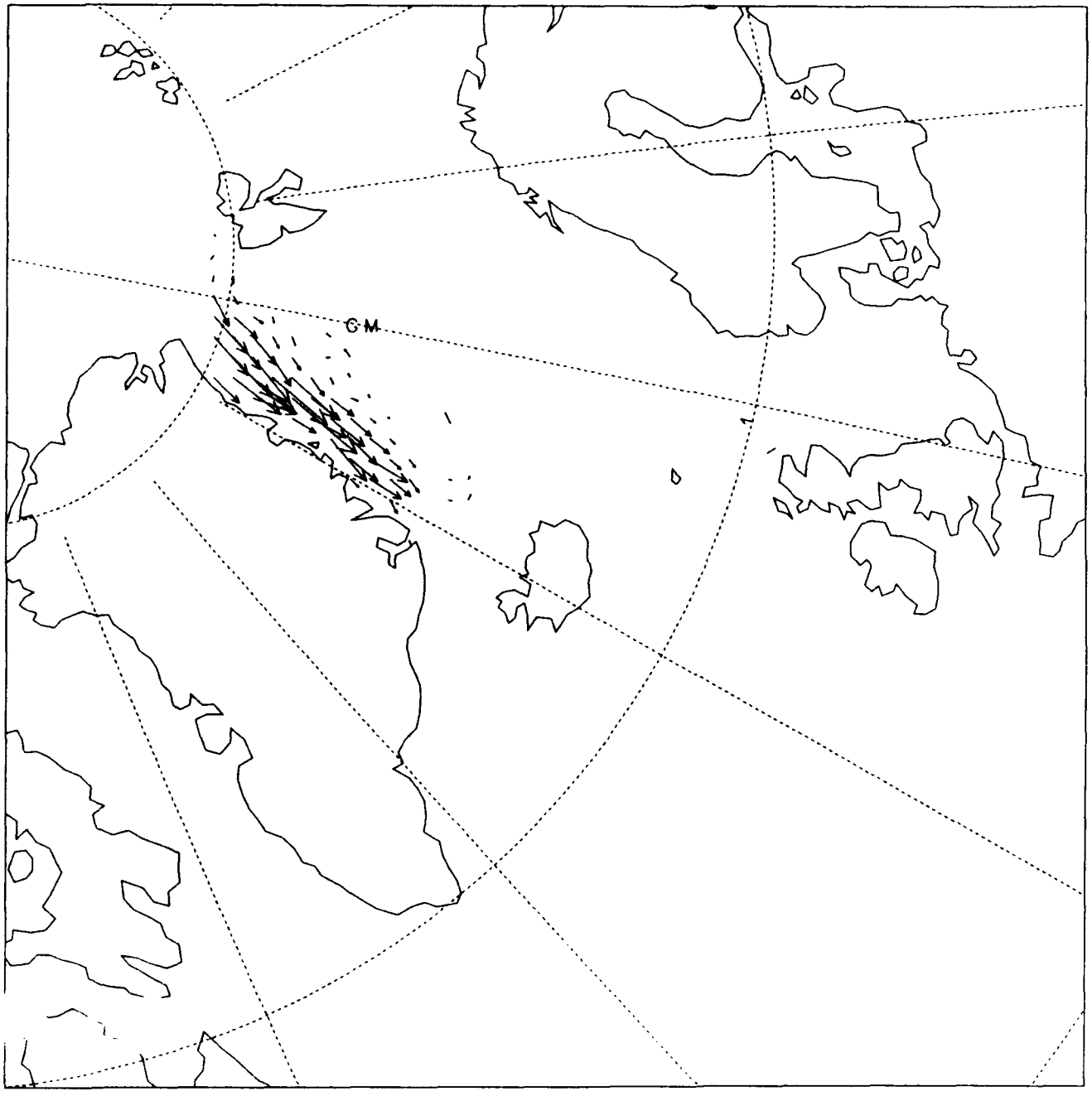

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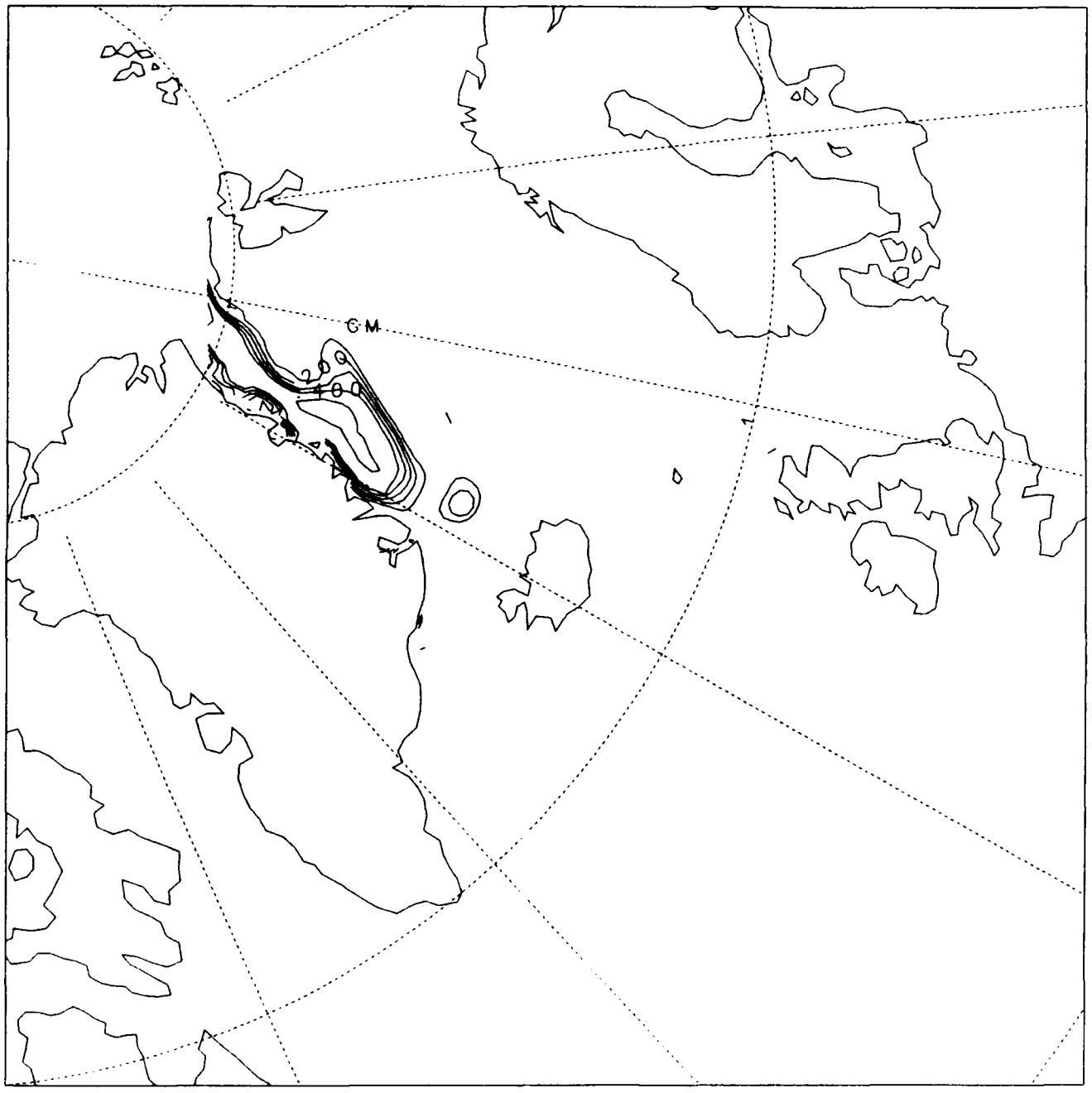
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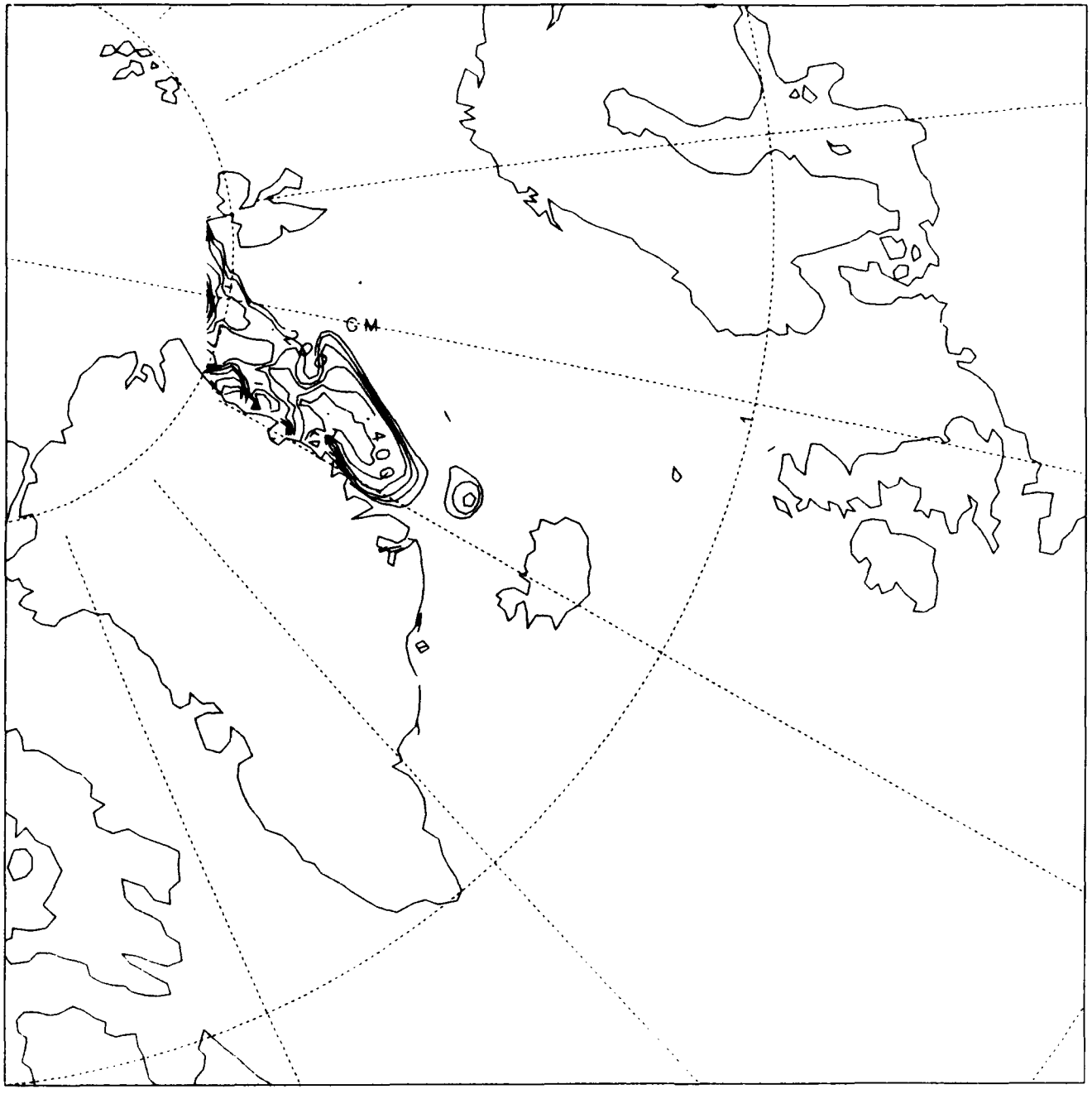

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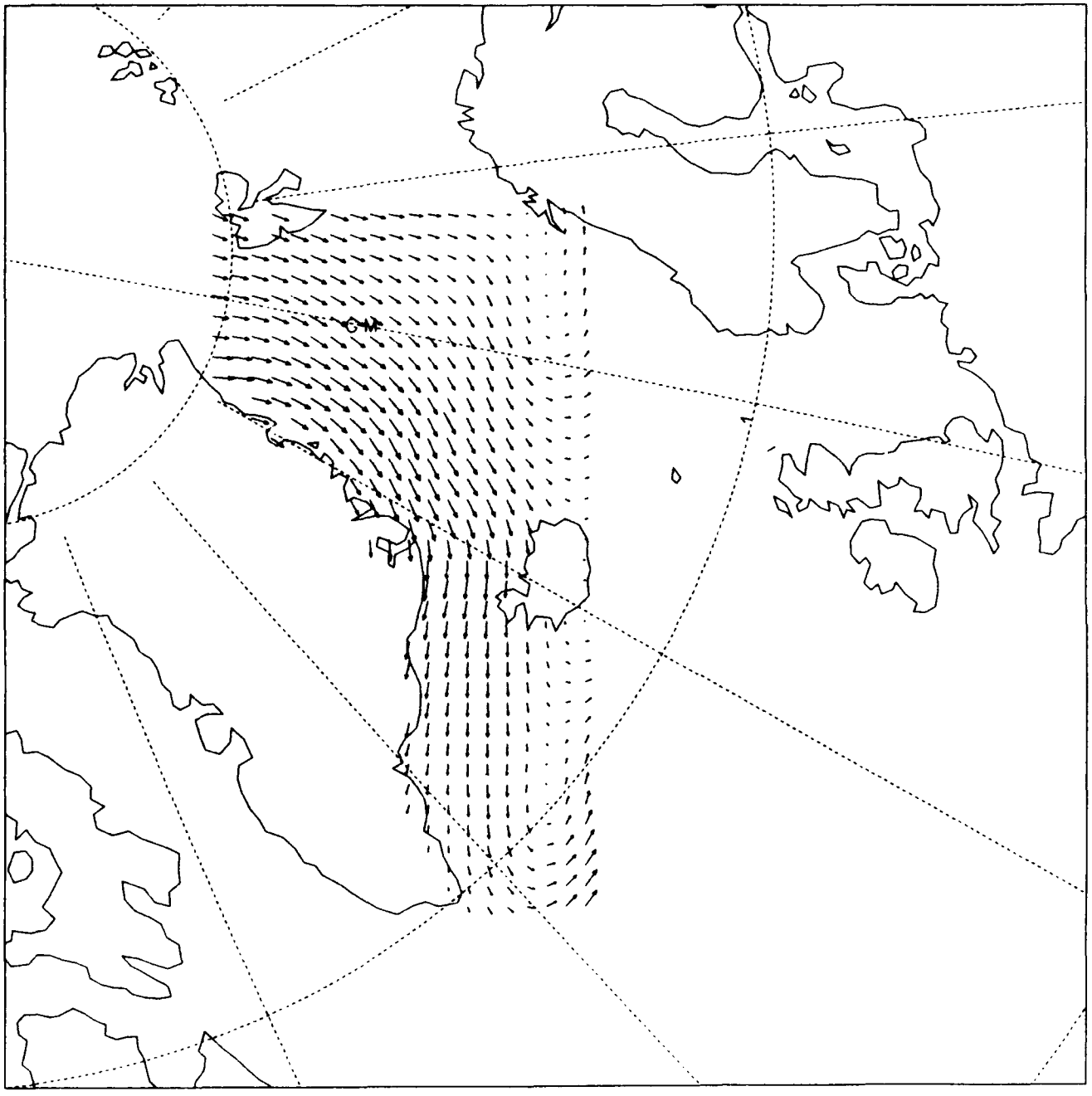

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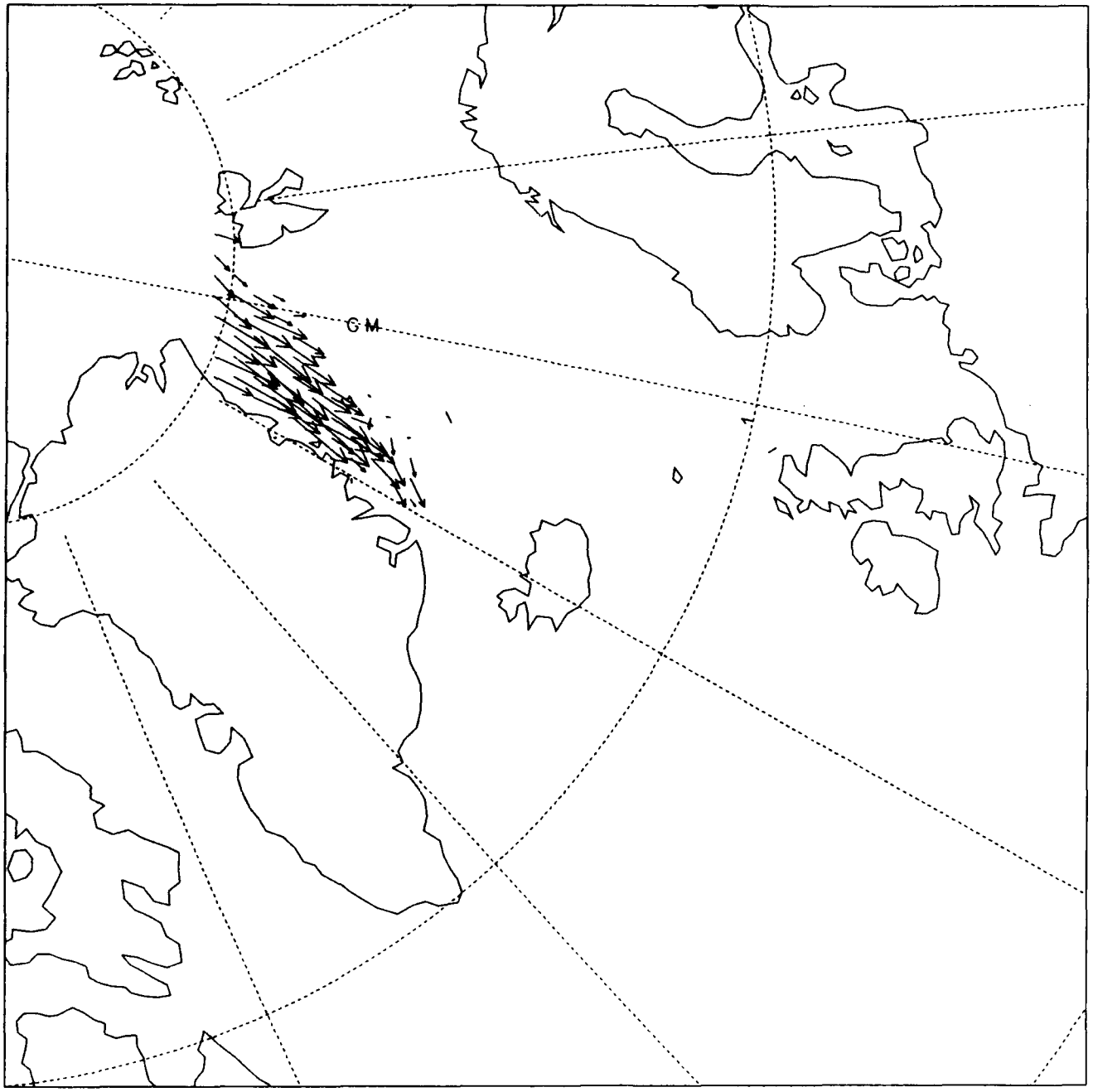

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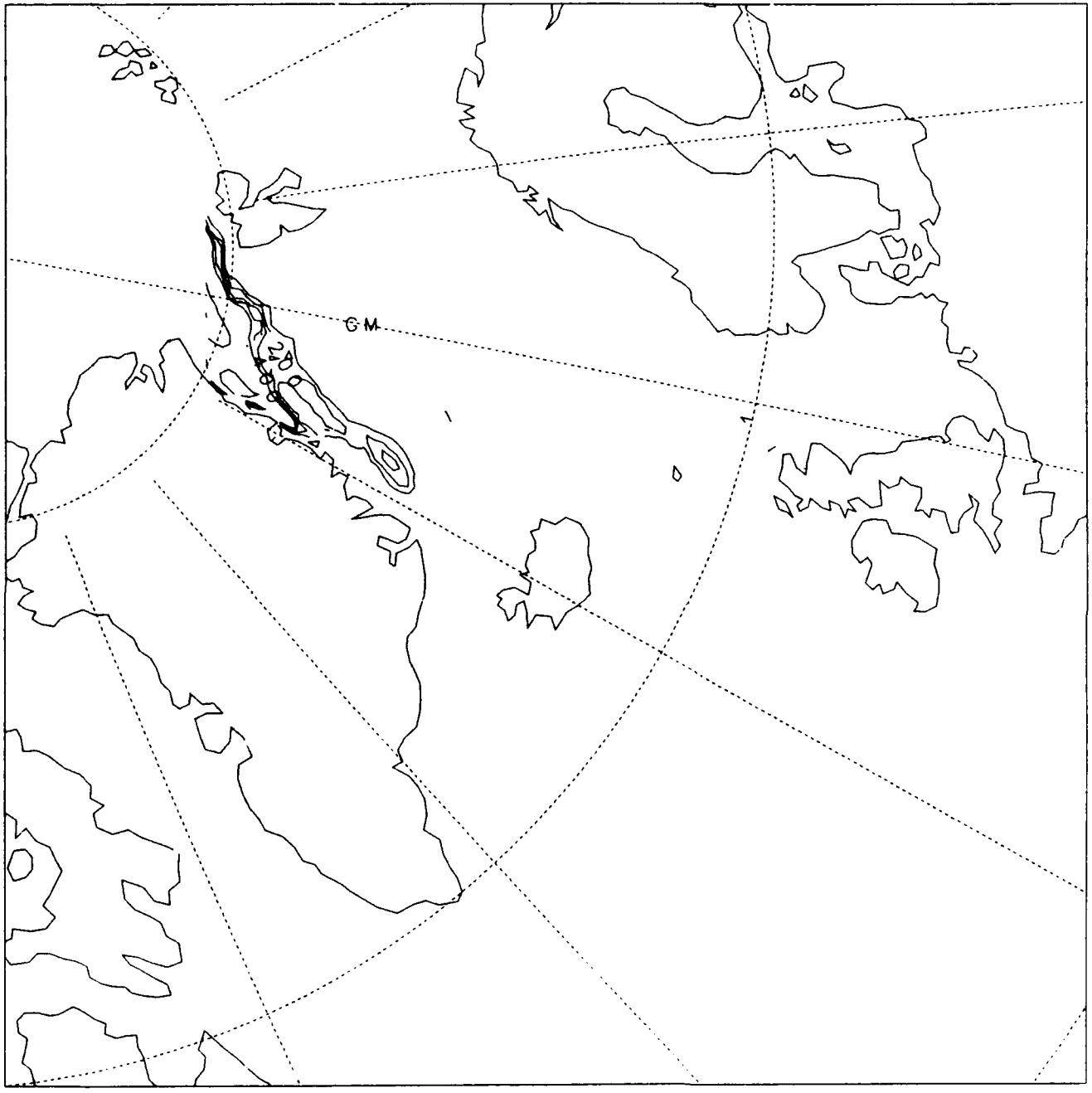

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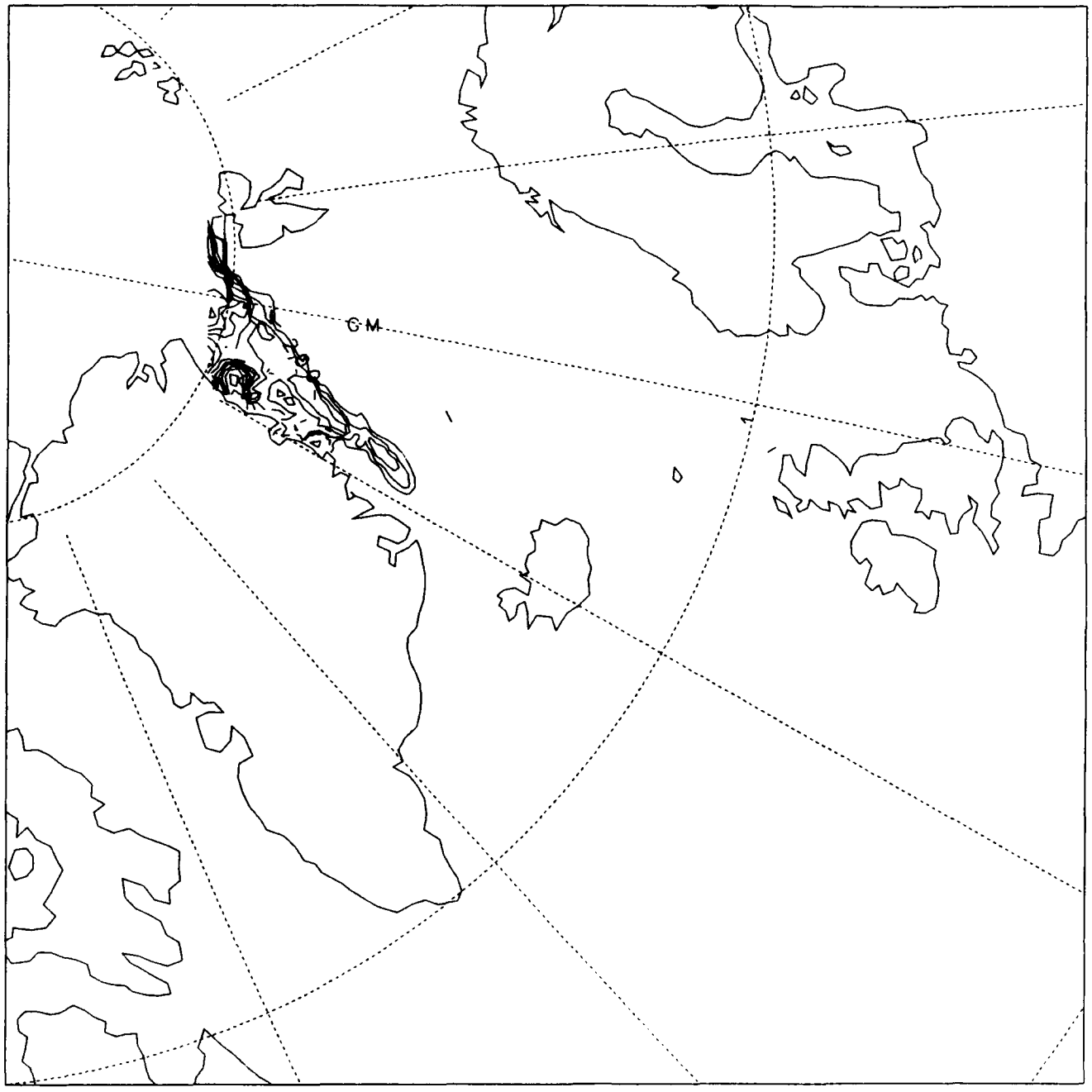

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13. Abstract *(Maximum 200 words).*

The Polar Ice Prediction System (PIPS), the Regional Polar Ice Prediction System - Barents (RPIPS-B) and the Regional Polar Ice Prediction System - Greenland (RPIPS-G) are all operational sea ice forecasting systems that have been run daily at the Fleet Numerical Oceanography Center (FNOC) since September 1987, June 1989 and October 1991, respectively. The basis for all three models is the Hibler ice model (Hibler, 1979; 1980). The ice models are driven by monthly mean ocean currents and deep ocean heat fluxes derived from the Hibler and Bryan (1987) coupled ice-ocean model. They are also driven by atmospheric forcing from the Navy Operational Global Atmospheric Prediction System (NOGAPS) (Rosmond, 1981; Hogan et al., 1990). Each day a 24-hour forecast of PIPS, RPIPS-B and RPIPS-G is submitted and archived by Naval Oceanographic and Atmospheric Research Laboratory (NOARL). This technical note contains monthly mean values of geostrophic winds, ice drift, ice thickness and ice concentration derived from the PIPS and RPIPS-B 24-hour forecast from 1990 and 1991; and 24-hour forecast from RPIPS-G from 1991.

14. Subject Terms.
Sea Ice Forecasting, Sea Ice Models, Sea Ice Analysis

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