

NOAA SATELLITE MONITORING OF SNOW COVER IN THE NORTHERN
HEMISPHERE DURING THE WINTER OF 1977

Donald R. Wiesnet, Michael Matson, and David F. McGinnis

National Oceanic and Atmospheric Administration
National Environmental Satellite Service
Washington, D.C. 20233

Northern Hemisphere snowcover has been monitored by NOAA/NESS since 1966. Weekly snow and ice charts (Fig. 1) have been used to prepare mean monthly data on snowcover for both North America and Eurasia. These data were then utilized to prepare simple regressions of antecedent snowcover vs. January, February, February and January-through-March snow-cover figures, demonstrating a number of statistically significant relationships for Eurasia and the Northern Hemisphere (land surface only). These relationships, despite the limited data sample (i.e., 10 years of record), indicate that higher-than-average December snowcover tends to presage a winter of more-than-average snowcover.

Certainly, widespread snow raises the albedo of the Earth's surface and decreases the net amount of long-wave radiation absorbed by that surface. The snowcover also tends to cool the adjacent atmosphere, thereby inducing snow rather than rain in peripheral snow-free areas.

It has been suggested that these simple regressions might be used to forecast continental and hemispheric snowcover 30, 60, and 90 days in advance. On January 2, 1977, advance estimates of snowcover (Table 1) were prepared to test and evaluate this Antecedent Snow Cover Technique for the winter of 1977.

December 1976 snowcover was 36.5 million km² in the Northern Hemisphere (1.4% above the December 1975 figure). Eurasian snowcover made up 22.4 million km² of this total, and was 4.2% higher than in 1975. On the other hand, North American snowcover measured only 14.1 million km² or 2.8% lower than December 1976.

The mean monthly snowcover in January 1977 for North America was 15.8 million km², the greatest mean monthly figure recorded in the 10-year satellite record. Approximately 65% of the North American continent was snow-covered during January.

Eurasia was likewise well covered by extensive snows in January. In fact; 26.5 million km² were covered by snow, making it the highest mean monthly snowcover for any January of the 10-year satellite record. Thus, the Northern Hemisphere mean monthly snowcover for January became the highest figure recorded for any month: 42.3 million km².

February was rather different. The Northern Hemisphere total fell to 40.0 million km² of which North America recorded 14.4 million km², a drop of 0.7% from February 1976, and Eurasia accounted for the remaining 25.6 million km², a gain of 5.4% over the February 1976 snowcover.

Northern Hemisphere March snowcover was only 32.1 million km², a drop from March 1976 of 9.7%. Snowcover in both Eurasia and North America dropped; Eurasia dropped 12.7% and North America dropped 4.5% from the March 1976 figures.

The regression equations continue to be reasonably valid with regard to Eurasia and the

Northern Hemisphere. Indeed, January 1977 advance estimates of above-average snowcover winter in Eurasia (+4.4% above 1976) correctly indicated the winter trend. The actual snowcover was 1.9% above the 1976 figure. Advance estimates of Northern Hemisphere winter snowcover also correctly indicated the trend. The estimate was for an increase (+1.9% over 1976). The actual snowcover was 1.5% above the 1976 figure. The estimate for North America, which called for a decrease of 2.8%, correctly indicated the trend as the actual 1977 figure was 0.5% less than the 1977 figure.

Snowcover during the winter of 1977, while severe locally, was the result of localized climatic variations caused by meteorological conditions. For example, in North America, January snowcover set a record, yet December 1976, February 1977, and March 1977 had less snowcover than in the preceding year. For Eurasia, it clearly was a high snowcover year, all months exceeding those of the preceding winter except for March which was greatly reduced.

Long-range predictions of severe global climatic change cannot be substantiated on the basis of satellite snowcover data during the winter of 1977. Nevertheless, over the 10-year period of record, snowcover does show a tendency to be increasing slightly. Continued satellite monitoring of this important climatic variable is clearly warranted.

BIBLIOGRAPHY

- Matson, M. and Wiesnet, D.R., 1976: "Winter Snow Cover Patterns in North America and Eurasia, 1975-76," Proceedings of the NOAA Climate Diagnostics Workshop, Washington, D.C., pp. 6-1 to 6-15.
- Matson, M., 1977: "Winter Snow Cover Maps of North America and Eurasia from Satellite Records, 1966-1976," NOAA Tech. Memo. NESS 84, Dept. of Commerce, Washington, D.C., 28 pp.
- Wiesnet, D.R. and Matson, M., 1975: "Monthly Winter Snowline Variation in the Northern Hemisphere from Satellite Records, 1966-75," NOAA Tech. Memo. NESS 74, Dept. of Commerce, Washington, D.C., 21 pp.
- Wiesnet, D.R. and Matson, M., 1976: "A Possible Forecasting Technique for Winter Snowcover in the Northern Hemisphere and Eurasia," Monthly Weather Review. Vol. 104, No. 7, pp. 828-835.
- Wiesnet, D.R. and Matson, M., 1976: "Satellite Record of Winter Snowcover in North America and Eurasia, 1966-1975," Proceedings of the Eastern Snow Conference, Glen Falls, New York, pp. 129-144.

TABLE 1. SNOWCOVER ADVANCE ESTIMATES, MEASURED SNOWCOVER, AND THE DIFFERENCES BETWEEN THE TWO FOR THE WINTER OF 1976-77

1976-1977

SNOW COVER ADVANCE ESTIMATES TEST AND EVALUATION FORM

<u>Period of Snowcover</u>	<u>Advance Estimate (x 10⁶km²)</u>	<u>Estimate Change from Prior Year (%)</u>	<u>Measured (x 10⁶km²)</u>	<u>Actual Change from Prior Year (%)</u>	<u>Difference (Estimate vs. Measured)</u>
<u>NORTHERN HEMISPHERE</u>					
December	NONE	---	36.5	+1.4%	---
January	39.6	+2.6%	42.3	+9.6%	-7.0%
February	41.8	+7.7%	40.0	+3.1%	+4.6%
March	30.7	-13.0%	32.1	-9.7%	-3.3%
Jan-March (Running total)	114.8	+1.9%	114.4	+1.5%	+0.4%
<u>EURASIA</u>					
December	NONE	---	22.4	+4.2%	---
January	25.1	+5.9%	26.5	+11.8%	-5.9%
February	27.5	+13.2%	25.6	+5.4%	+7.8%
March	19.2	-13.1%	19.3	-12.7%	-0.4%
Jan-March (Running total)	73.2	+4.4%	71.4	+1.9%	+2.5%
<u>NORTH AMERICA</u>					
December	NONE	---	14.1	-2.8%	---
January	14.5	-2.7%	15.8	+6.0%	-8.7%
February	14.3	-1.4%	14.4	- .7%	- .7%
March	11.5	-14.2%	12.8	-4.5%	-9.7%
Jan-March (Running total)	41.6	-2.8%	43.0	-0.5%	-2.3%

TABLE 2. NINE AND TEN-YEAR AVERAGES OF MONTHLY WINTER CONTINENTAL SNOWCOVER AND COMPARISON WITH 1976-77 WINTER SNOWCOVER

Continent	Month	Number of Data Points	Average ($\times 10^6$ km ²)	Standard Deviation ($\times 10^6$ km ²)	1976-77 Snowcover ($\times 10^6$ km ²)
Eurasia	December	9	20.0	1.9	22.4
Eurasia	January	9	23.0	2.0	26.5
Eurasia	February	10	23.7	3.0	25.6
Eurasia	March	10	19.8	2.3	19.3
North America	December	9	13.7	1.0	14.1
North America	January	9	14.8	.5	15.8
North America	February	10	14.4	.5	14.4
North America	March	10	13.1	1.0	12.8

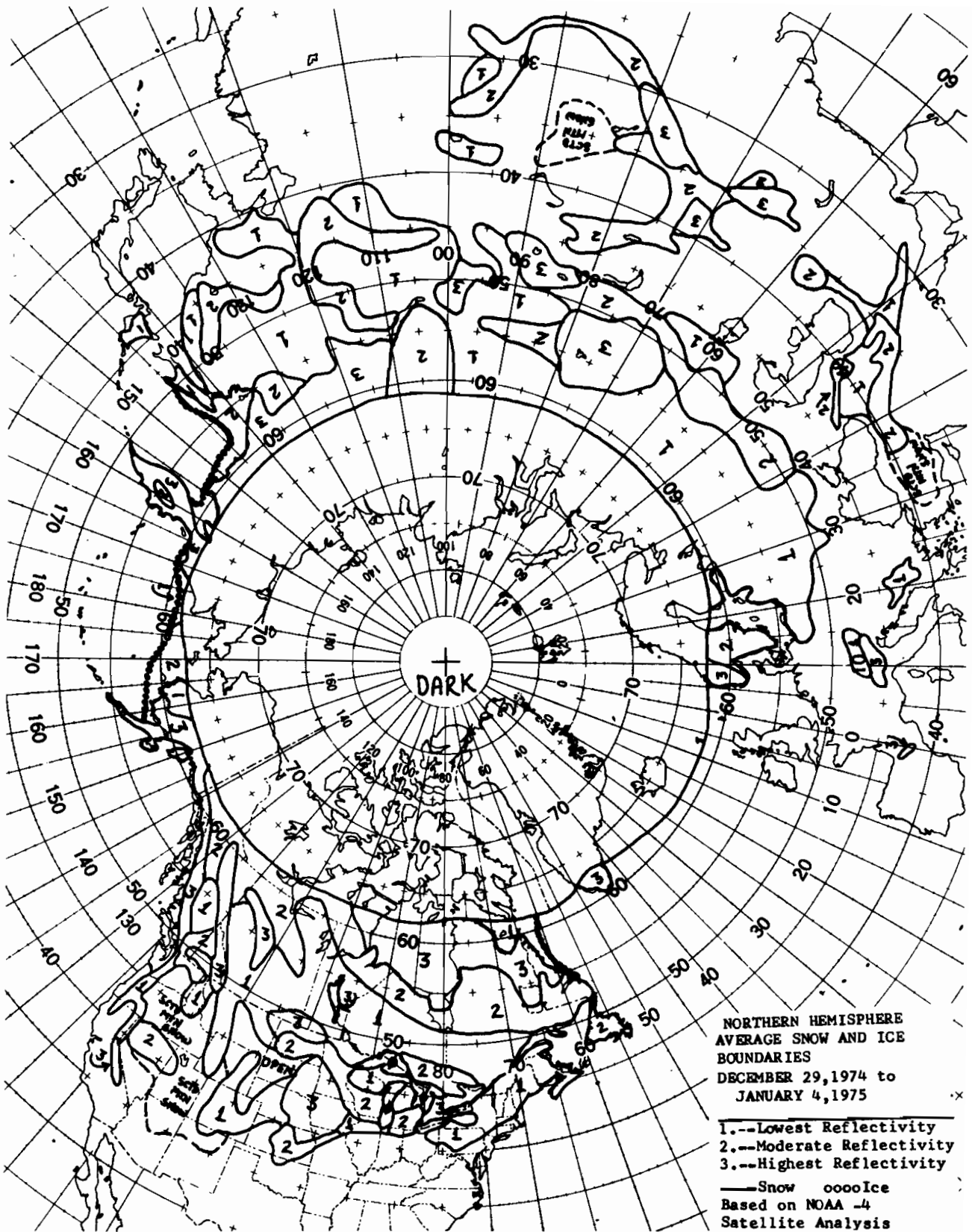


Fig. 1. Weekly Snow and Ice Cover chart of the Northern Hemisphere for the 7-day period December 29, 1974 through January 4, 1975 (scale: 1:50,000,000), prepared by Analysis Branch, NOAA/NESS. Note the various reflectivities and the areas of scattered mountain snow. Also note the "dark" area where visible data cannot be collected during the polar winter.

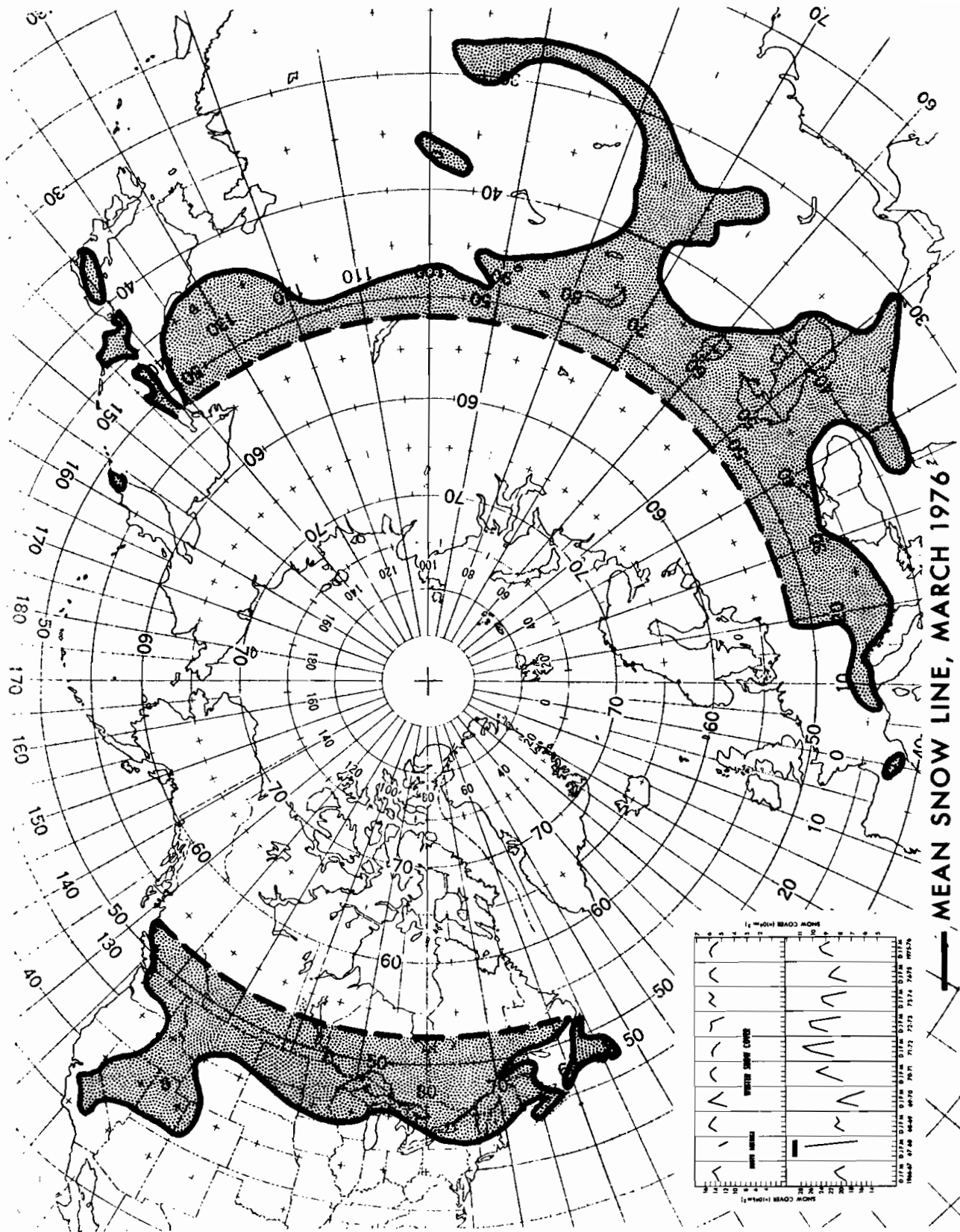


Fig. 2. Monthly mean snow cover chart of the Northern Hemisphere for March 1976 on a stereopolar projection at a 1:50,000,000 scale. This chart was prepared from the weekly charts.

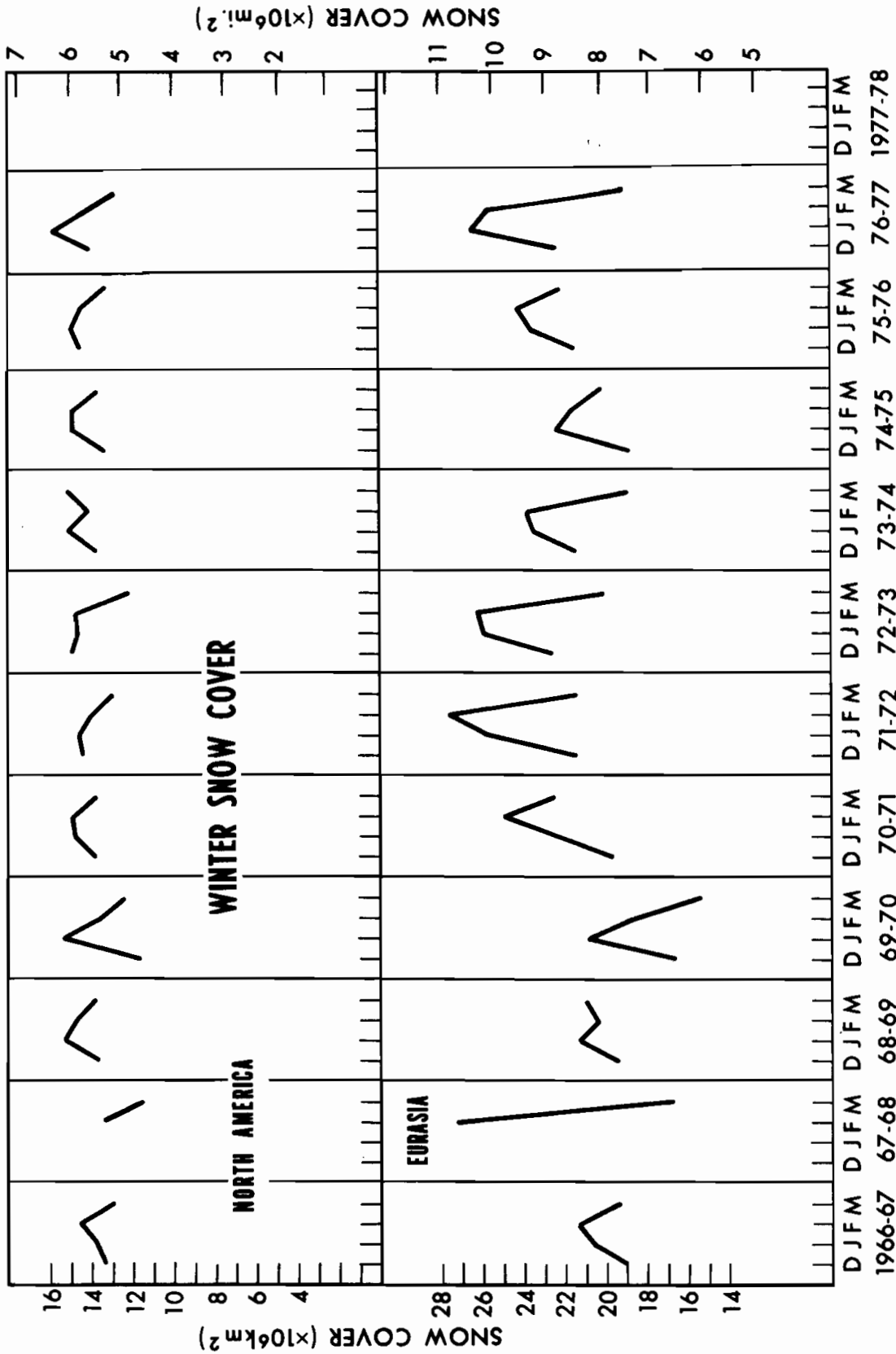


Fig. 3. Graph of monthly mean winter snow cover of North America and Eurasia for the period 1966-1977.

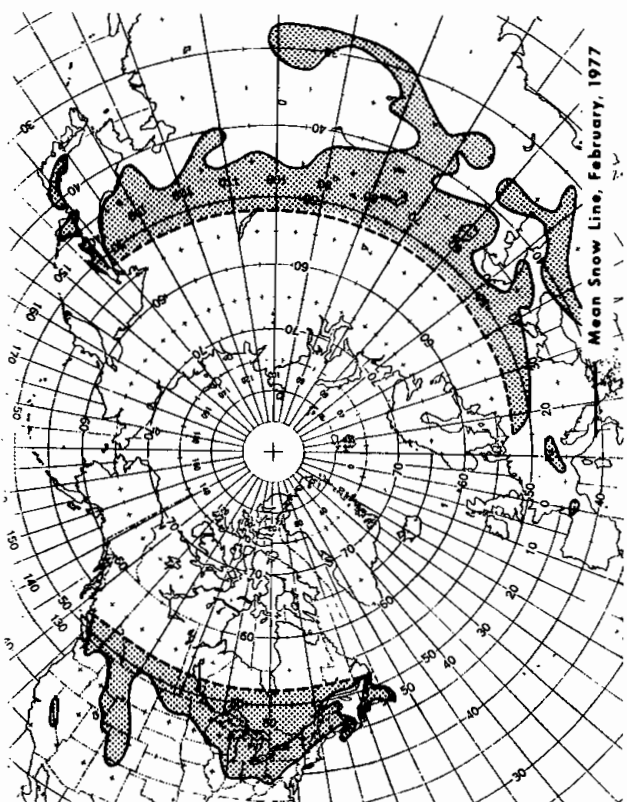
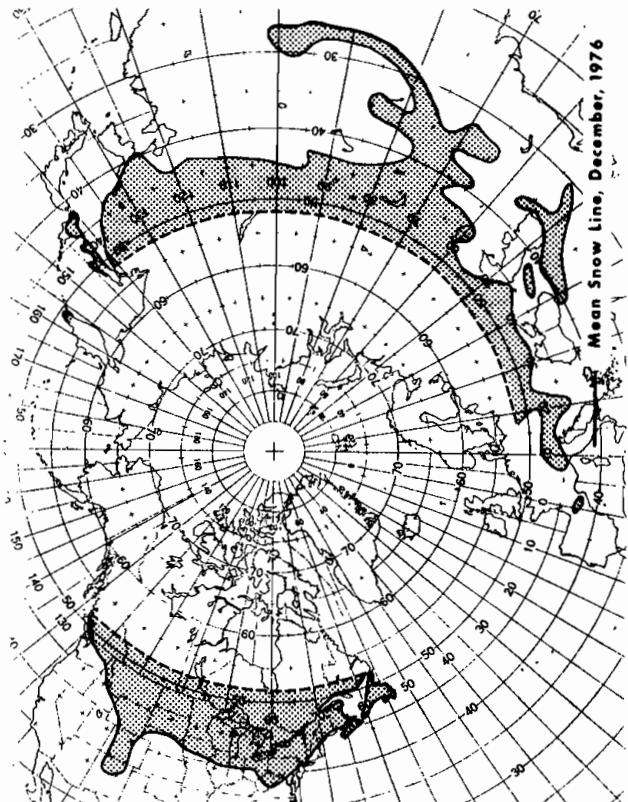
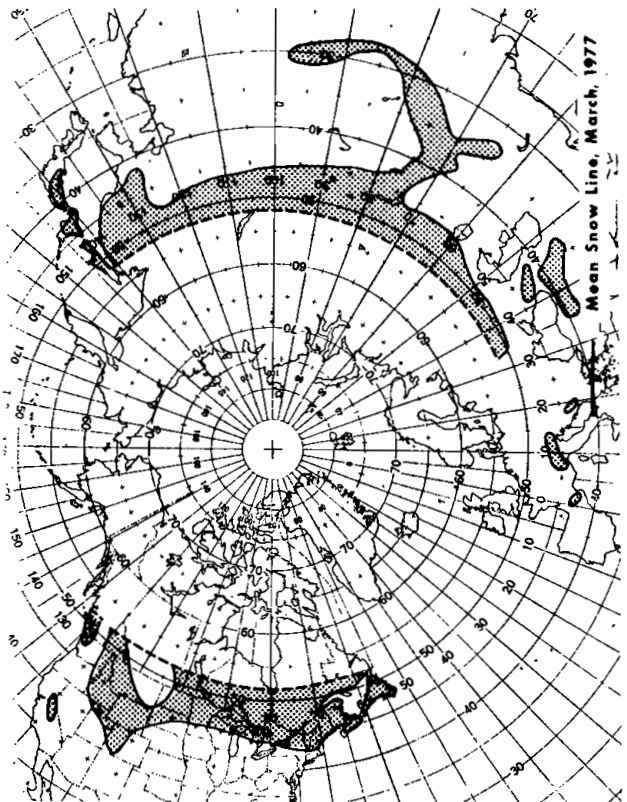
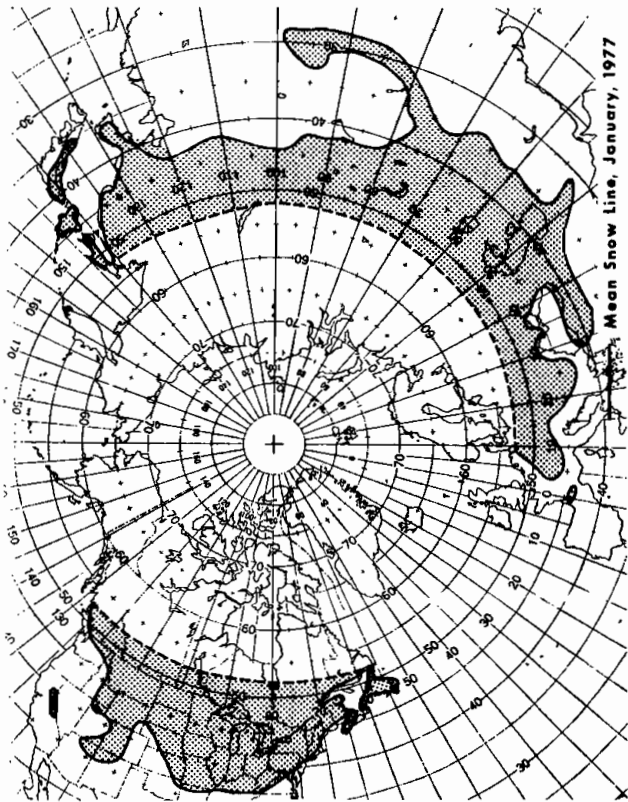


Fig. 4. Monthly mean snow cover maps of North America and Eurasia for December 1976, January 1977, February 1977, and March 1977. Note the large area of snow cover in North America and Eurasia for January 1977.



**NORTH AMERICA
SNOW COVER
JAN. 14, 1976**



**NORTH AMERICA
SNOW COVER
JAN. 31, 1977**

Fig. 5. GOES-1 satellite images comparing snow cover in North America for January 14, 1976 and January 31, 1977. The snowline is 500 to 600 km farther south in the 1977 image than in the 1976 image. Note the snowcover stretching from Texas to South Carolina in the 1977 image.

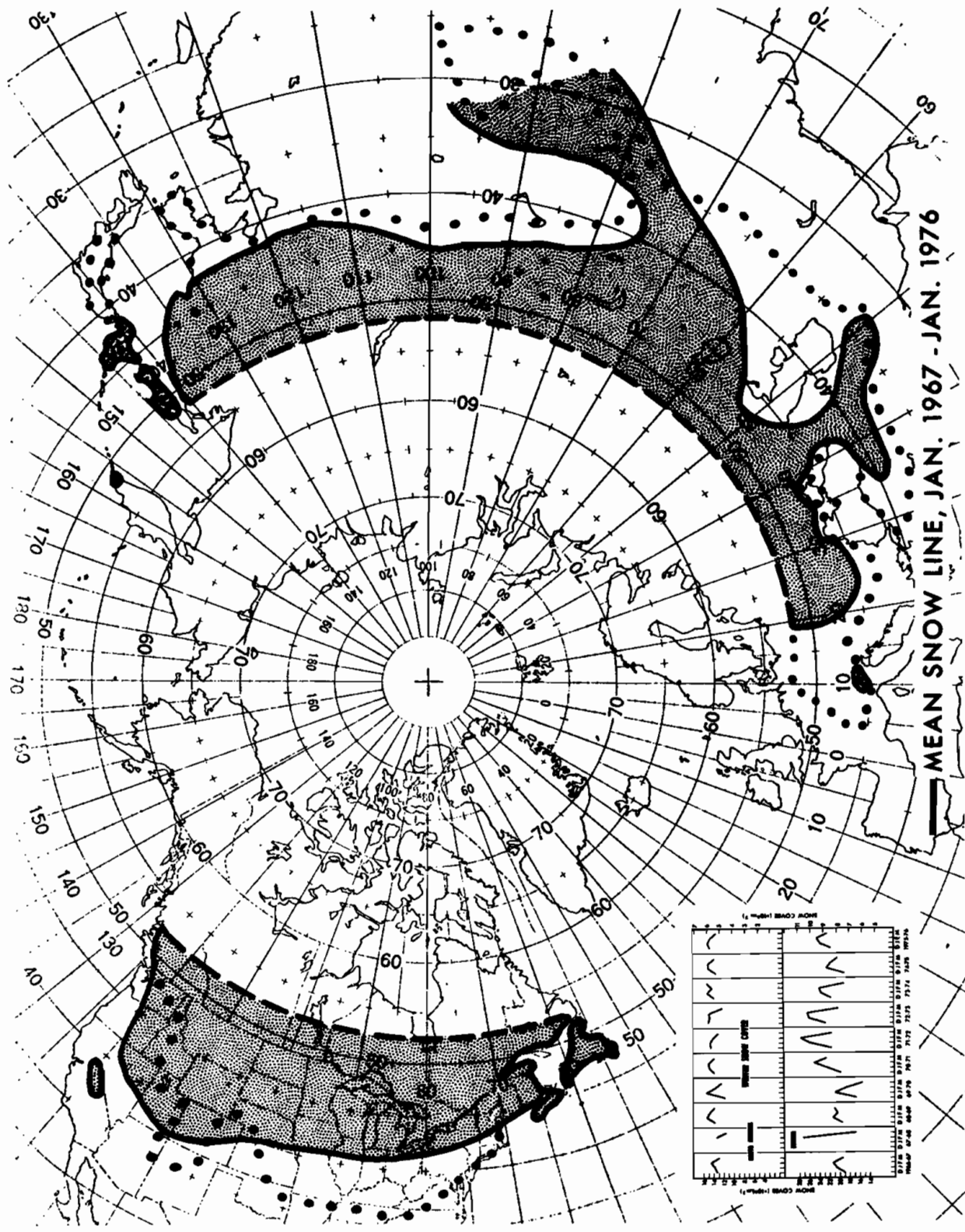


Fig. 6. Comparison of the satellite-derived mean snowline for January 1977 and the 10-year satellite-derived mean snowline.

Percent of Eurasia and North America Covered by Annual Winter Snow

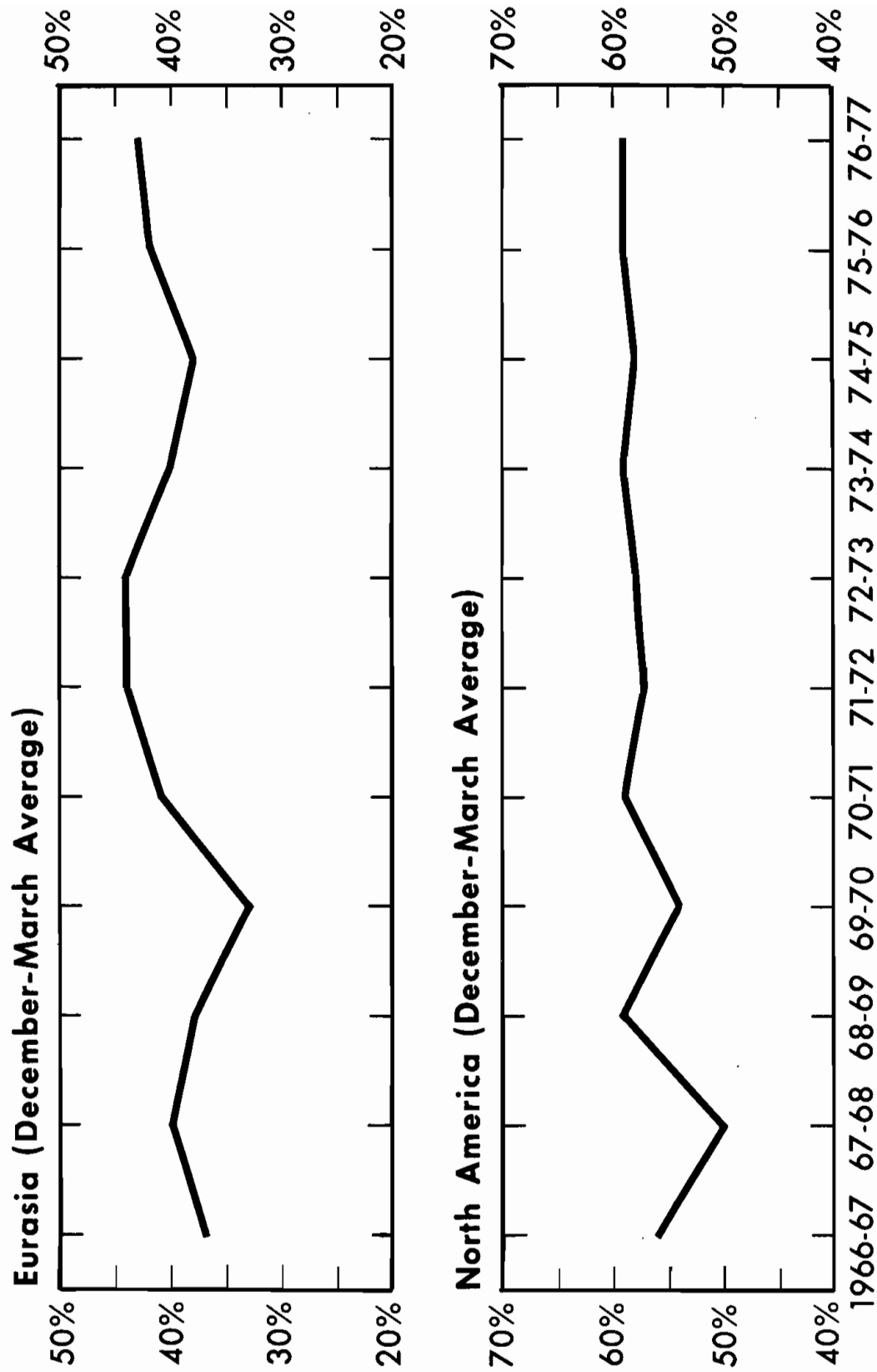


Fig. 7. Graph showing the percentage of North America and Eurasia covered by average winter snow cover for the period 1966-1977.

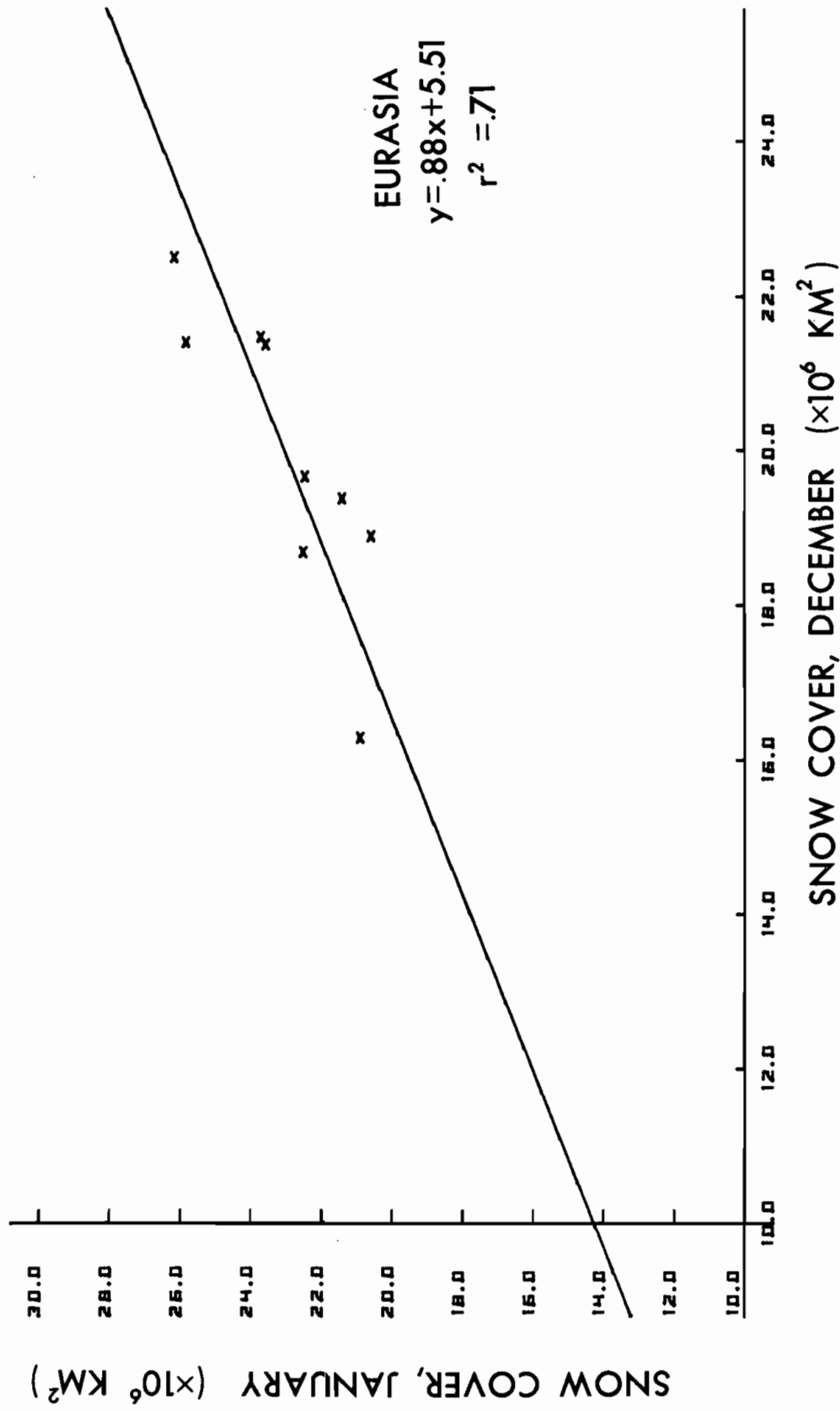


Fig. 8. Regression analysis of Eurasian January snow cover vs. Eurasian December snow cover.

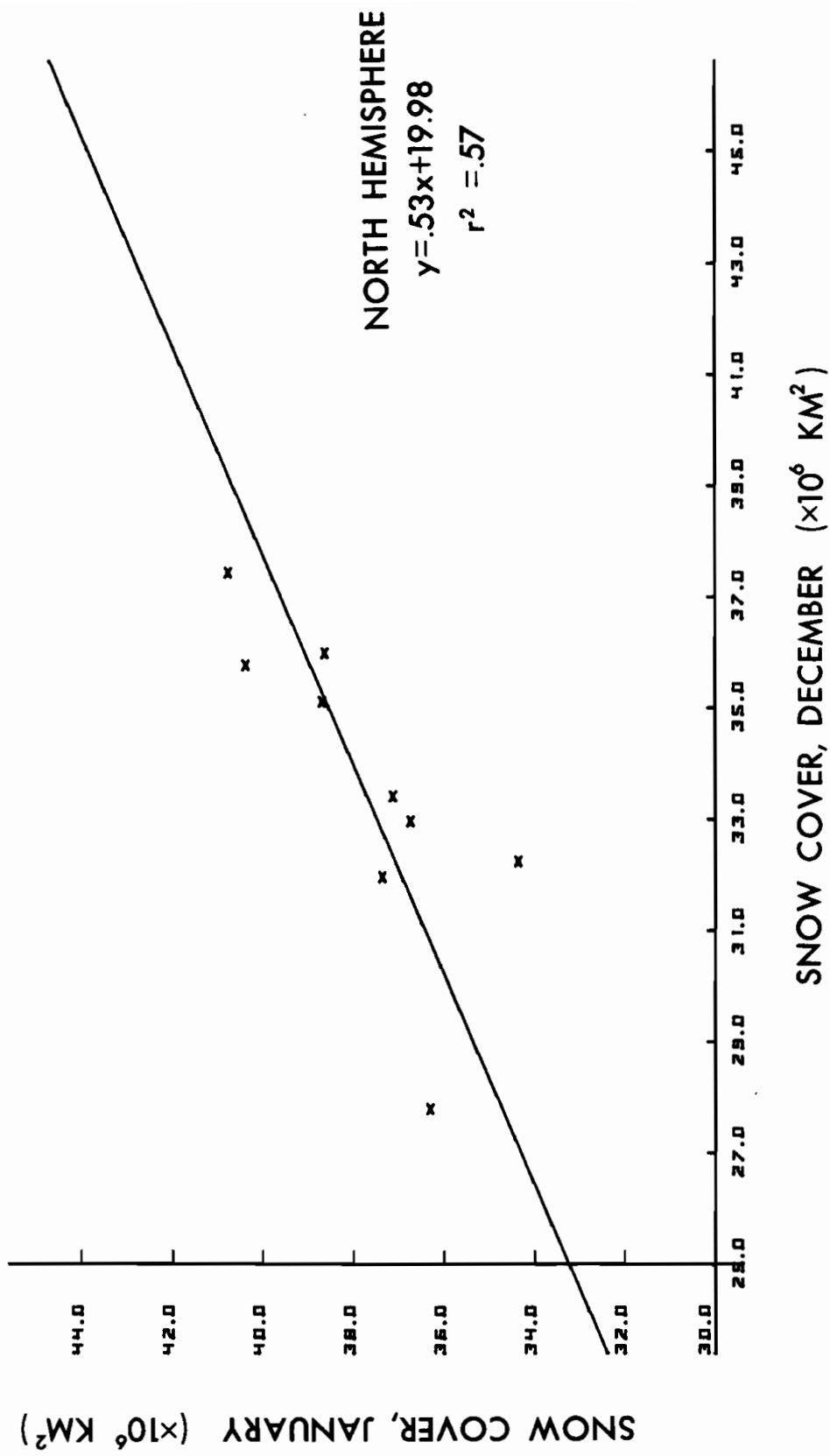


Fig. 9. Regression analysis of Northern Hemisphere January snow cover vs. Northern Hemisphere December snow cover.

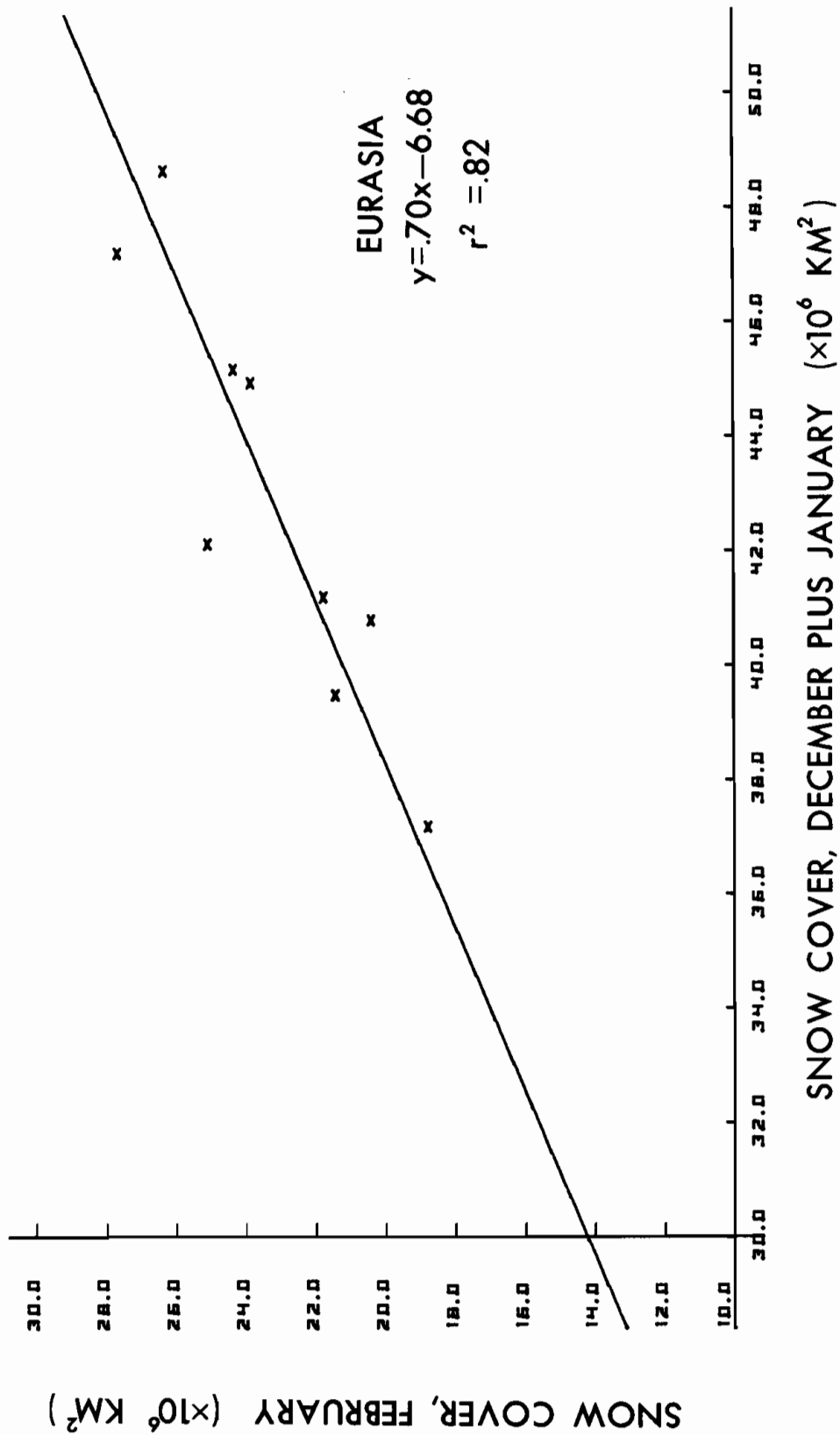
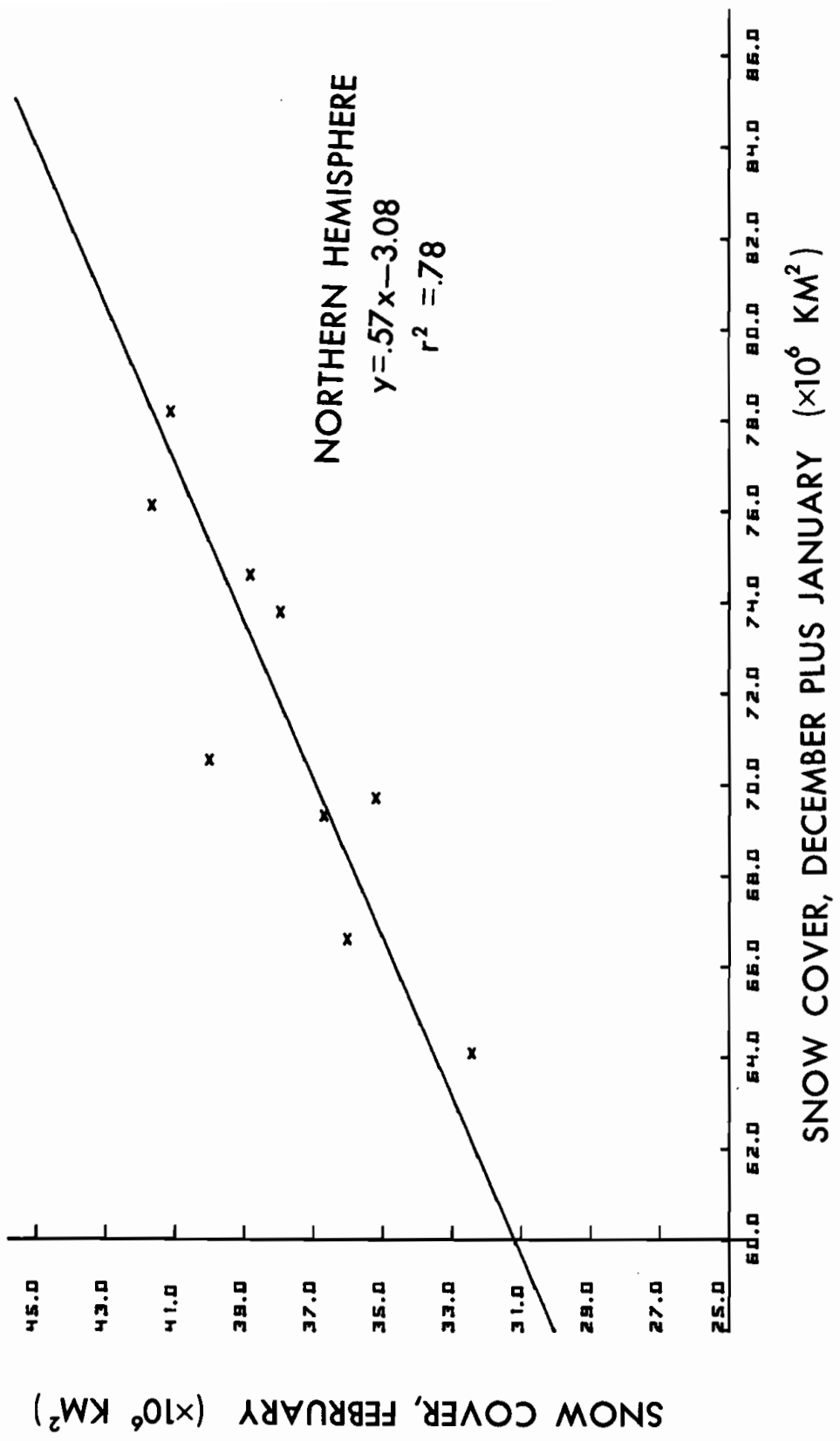


Fig. 10. Regression analysis of Eurasian February snow cover vs. Eurasian December plus January snow cover.



SNOW COVER, DECEMBER PLUS JANUARY ($\times 10^6$ KM²)

Fig. 11. Regression analysis of Northern Hemisphere February snow cover vs. Northern Hemisphere December plus January snow cover.

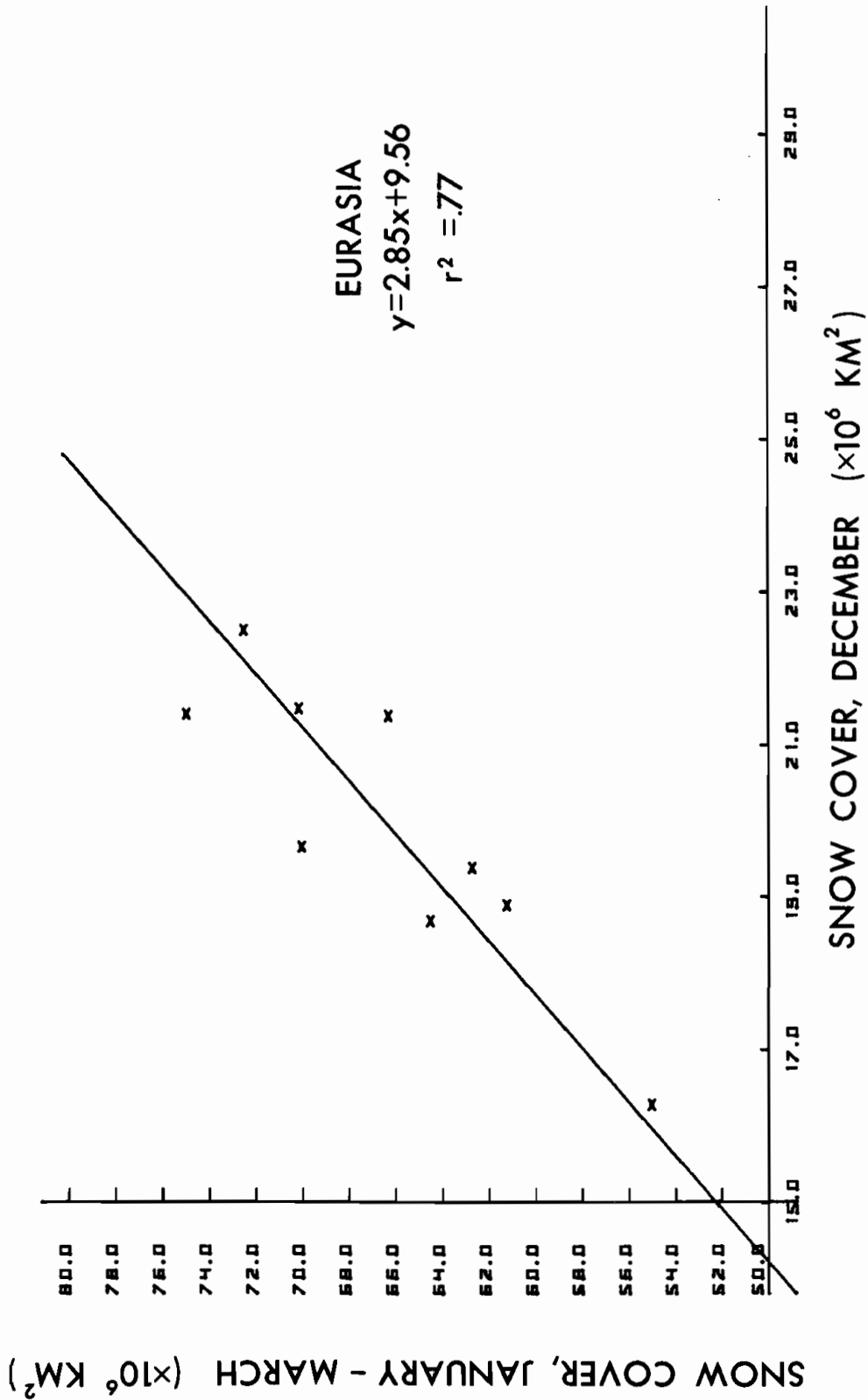


Fig. 12. Regression analysis of Eurasian January through March snow cover vs. Eurasian December snow cover.

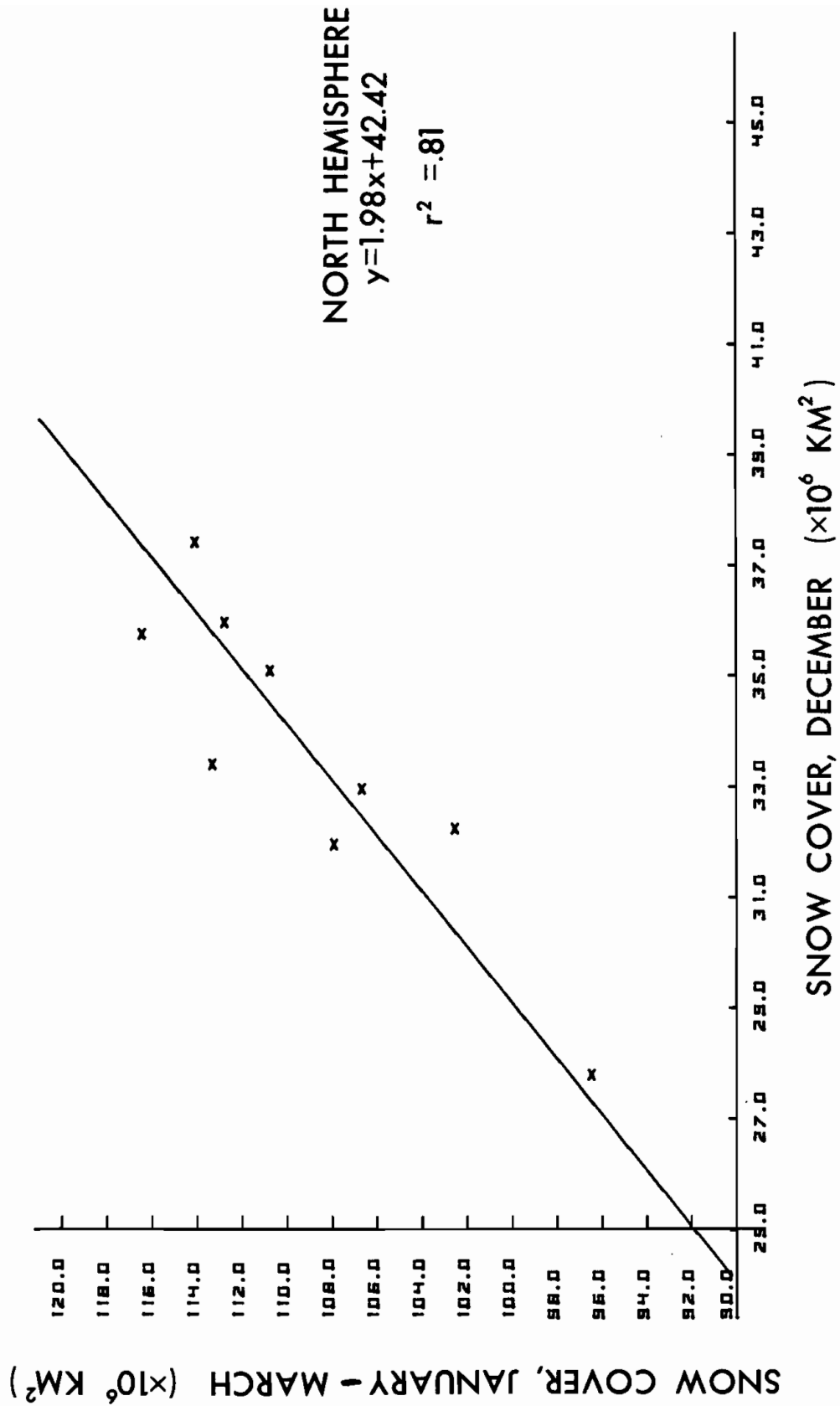
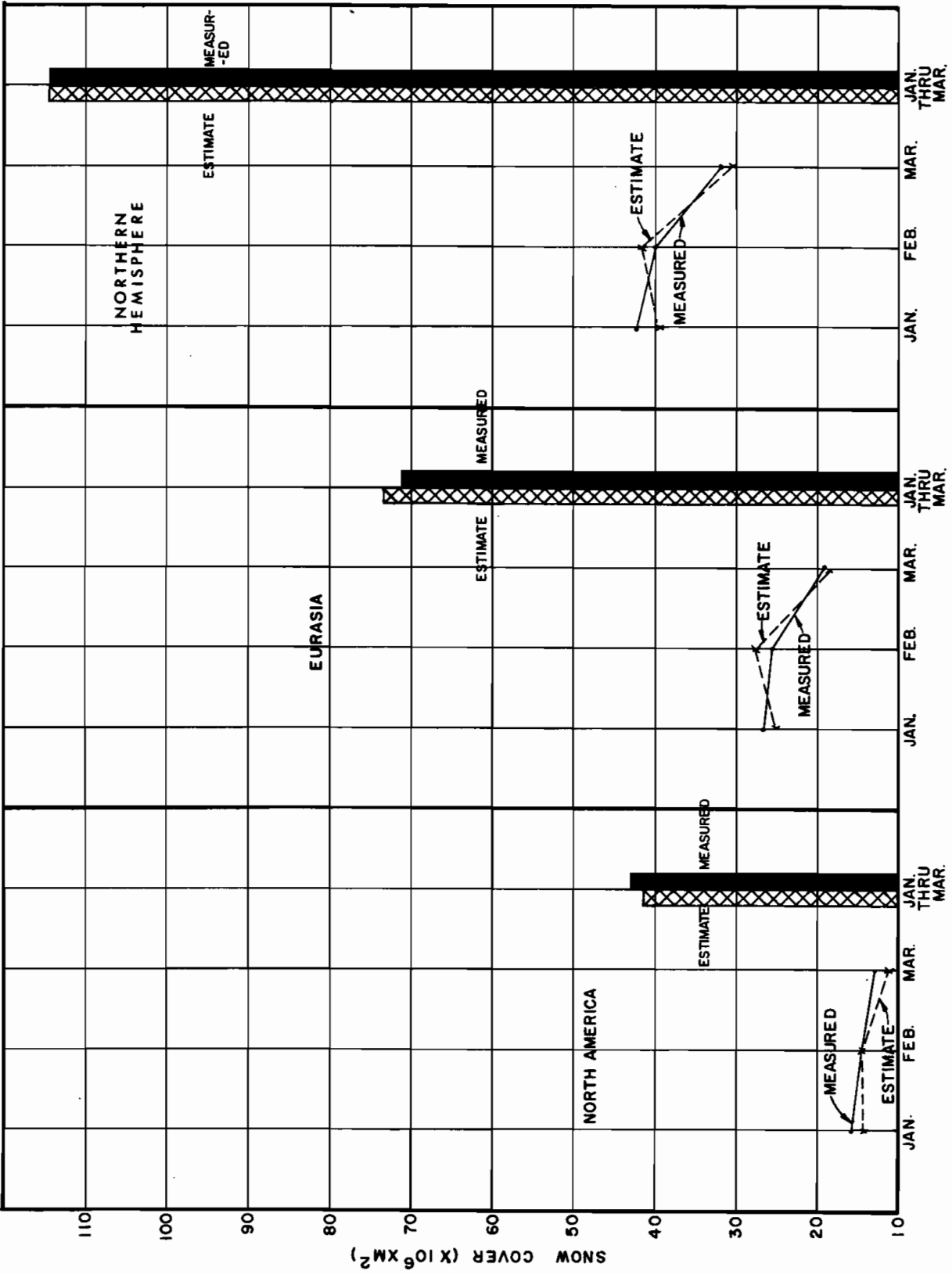


Fig. 13. Regression analysis of Northern Hemisphere January through March snow cover vs. Northern Hemisphere December snow cover.

COMPARISON OF WINTER 1977 SNOW COVER ESTIMATES vs. WINTER 1977 SNOW COVER MEASUREMENTS NORTHERN HEMISPHERE



1977 1977 1977
 Fig. 14. Graph comparing winter 1977 snow cover estimates vs. winter 1977 snow cover measurements.