NWS-CR-TA 90-10

CRH SSD
MARCH 1990

CENTRAL REGION TECHNICAL ATTACHMENT 90-10

A COMPARISON OF AFTERNOON/MAXIMUM TEMPERATURES OVER SNOW COVER: FOREST AREAS VS. OPEN COUNTRY

James P. Richardson
National Weather Service Forecast Office
Minneapolis, Minnesota

1. Introduction

In many cases the coverage and depth of snow cover are key variables in wintertime temperature forecasting. The usual decision is to forecast lower temperatures over snow covered areas than over bare ground. However, this may not be the case if one considers a snow covered forest area primarily composed of coniferous trees. A surface temperature analysis, snow cover chart, and a visible satellite picture are used to examine the apparent effects of a forest on the afternoon temperature of a snow covered region.

2. Synoptic Situation and Discussion

On December 5, 1988 the Upper Midwest was under clear skies and in a relatively barotropic air mass of Pacific origin. The 850 mb temperature analyses for 12Z and 00Z for December 5 and 6 (Figs. 1 and 2) indicated that Minnesota and Wisconsin were in a warm sector with moderate westerly flow. No significant change in temperature was implied through the day. The 00Z December 6 soundings for International Falls (INL) and St. Cloud (STC) (Figs. 3 and 4) showed very similar temperature and wind profiles.

Clear skies prevailed over the Northern Plains and the Upper Mississippi Valley on the afternoon of December 5 with the exception of extreme northeast Wisconsin and central upper Michigan. Station circles on the surface plot for 1900Z December 5 (Fig. 5) showed clear skies over the Dakotas and Minnesota. There was some thin cirrus over central Wisconsin.

A visible satellite photo from 1831Z on December 5 (Fig. 6) indicated snow cover over northern Iowa, portions of southern and central Minnesota, and central Wisconsin. There was a small portion of southwest Minnesota that was snow free.

A snow cover plot for December 5 (Fig. 7) confirmed the snow area on the satellite imagery. However, the extensive snow cover of 6-12 inches over

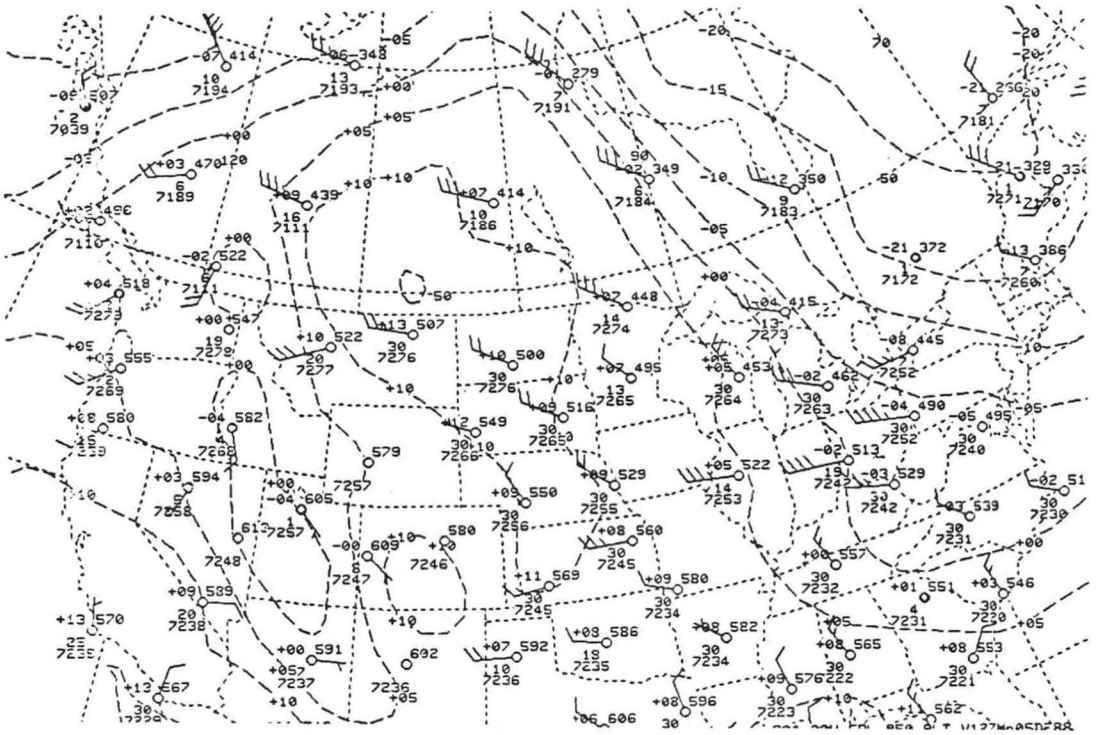

FIG. 1 850 MB TEMP ANALYSIS 12Z 05 DEC 1988

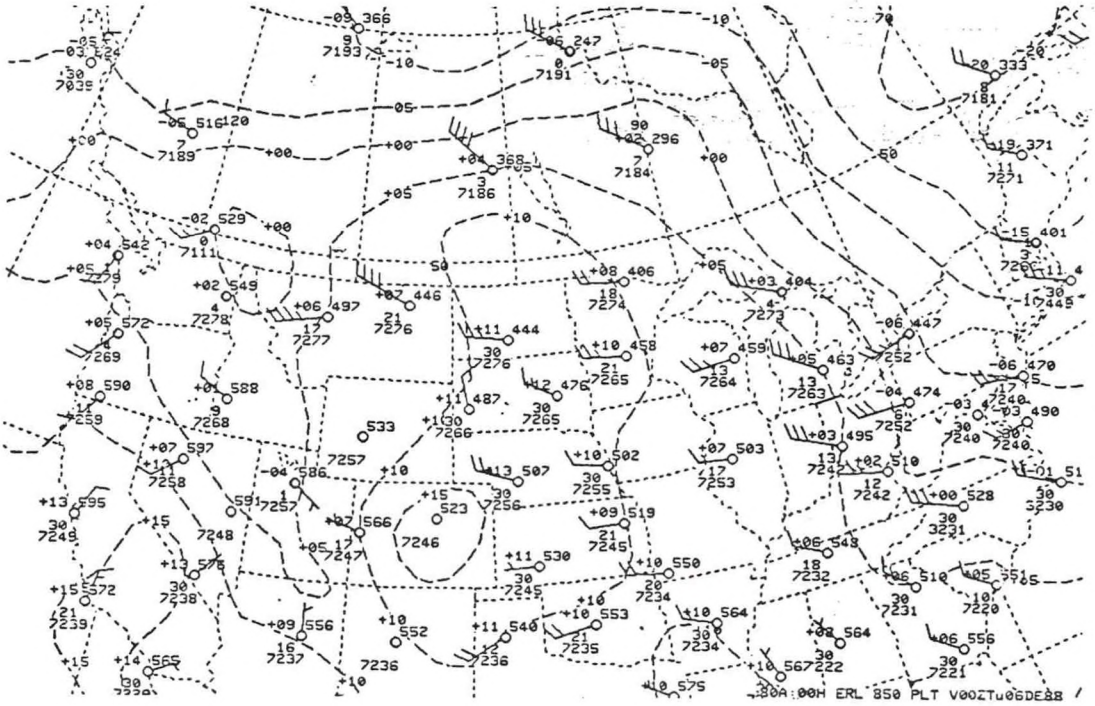

FIG. 2 850 MB TEMP ANALYSIS 00Z 06 DEC 1988

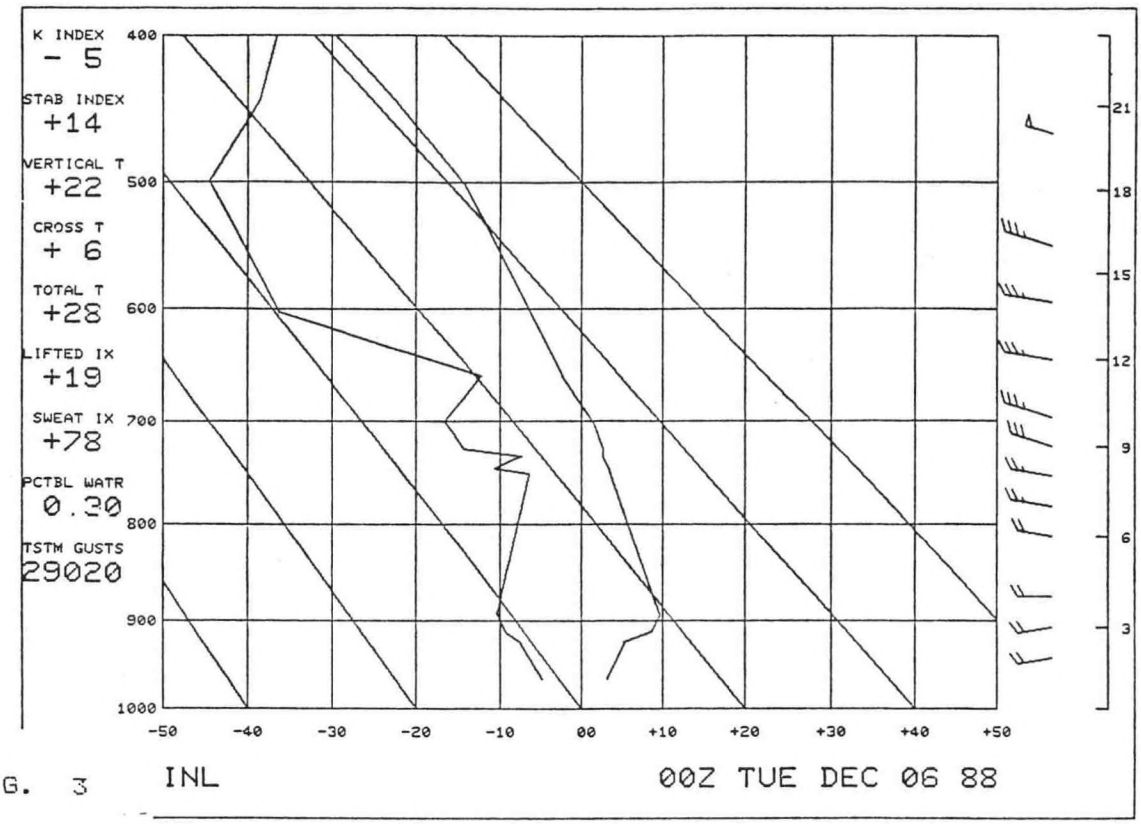
K INDEX
- 5
STAB INDEX
+14
VERTICAL T
+22
CROSS T
+ 6
TOTAL T
+28
LIFTED IX
+19
SWEAT IX
+78
PCTBL WATR
0.30
TSTM GUSTS
29020
400
500
600
700
800
900
1000
-50
-40
-30
-20
-10
00
+10
+20
+30
+40
+50
21
18
15
12
9
6
3
INL
00Z TUE DEC 06 88

FIG. 3

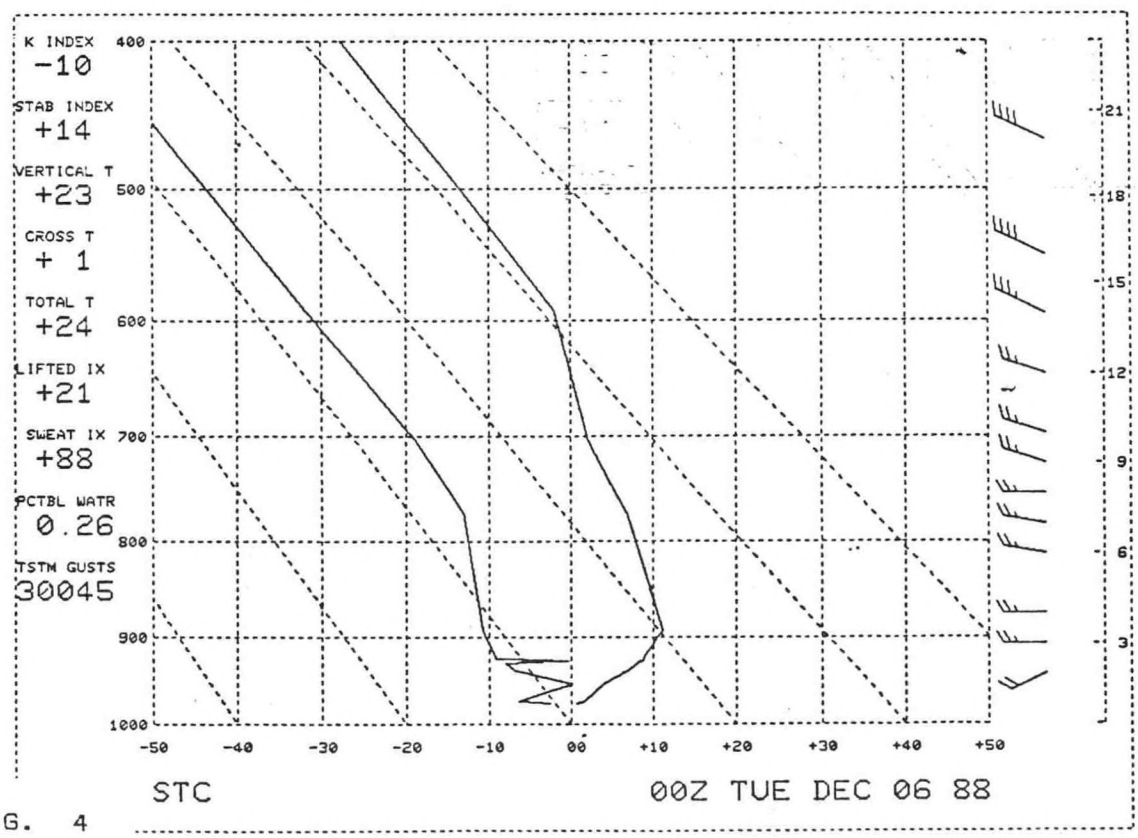
K INDEX
-10
STAB INDEX
+14
VERTICAL T
+23
CROSS T
+ 1
TOTAL T
+24
LIFTED IX
+21
SWEAT IX
+88
PCTBL WATR
0.26
TSTM GUSTS
30045
400
500
600
700
800
900
1000
-50
-40
-30
-20
-10
00
+10
+20
+30
+40
+50
21
18
15
12
9
6
3
STC
00Z TUE DEC 06 88

FIG. 4

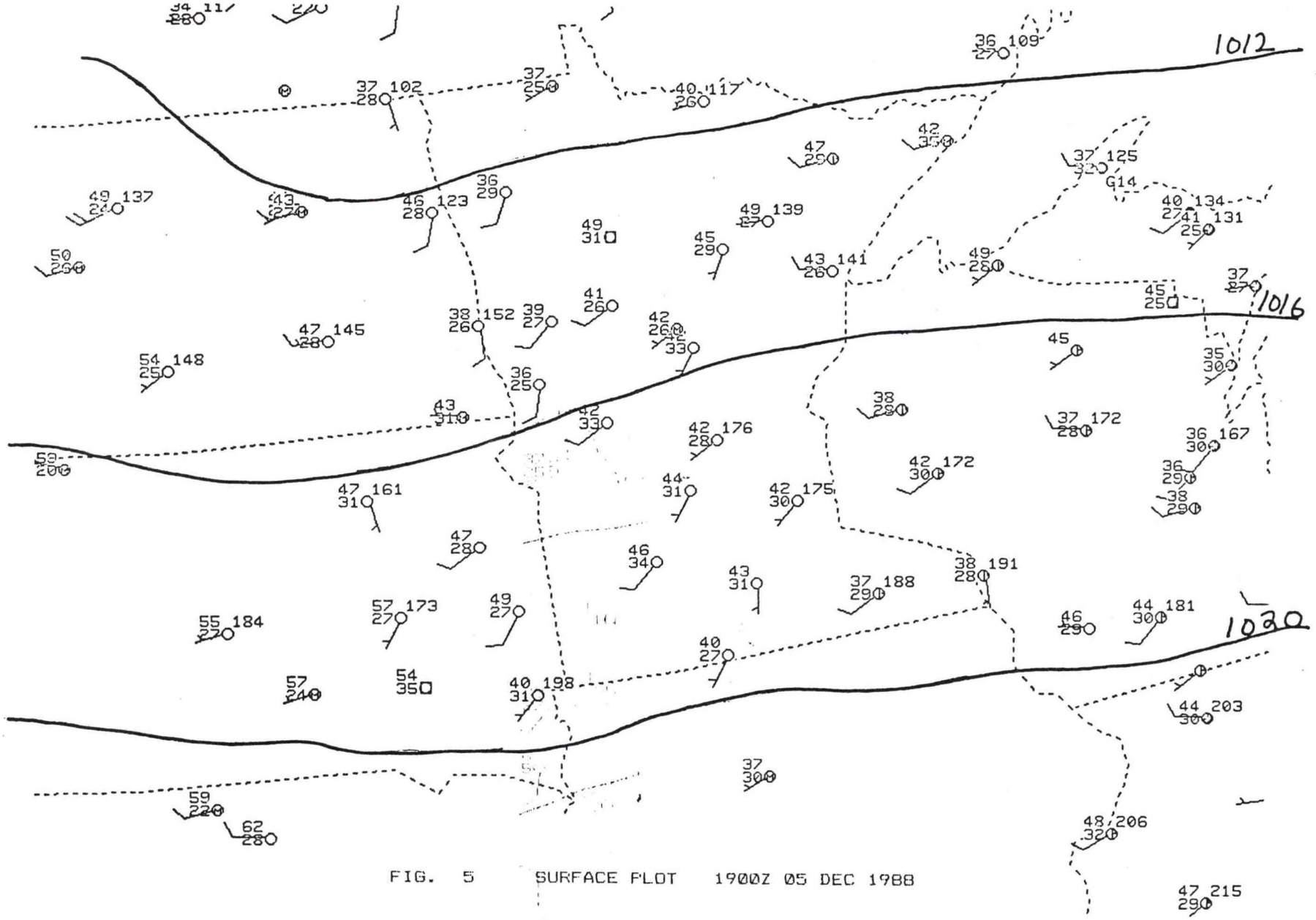

FIG. 5 SURFACE PLOT 1900Z 05 DEC 1988

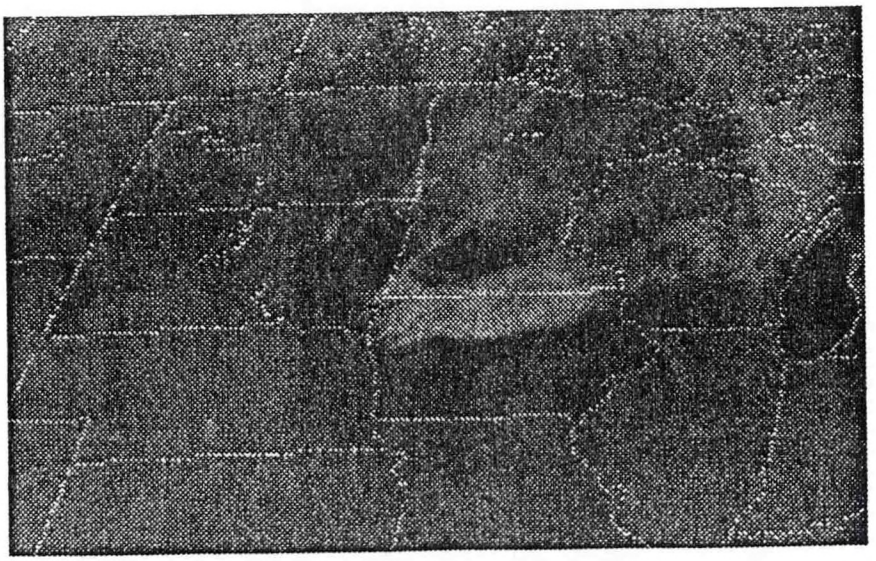

Figure 6. Visible satellite imagery, 1831Z, December 5, 1988.

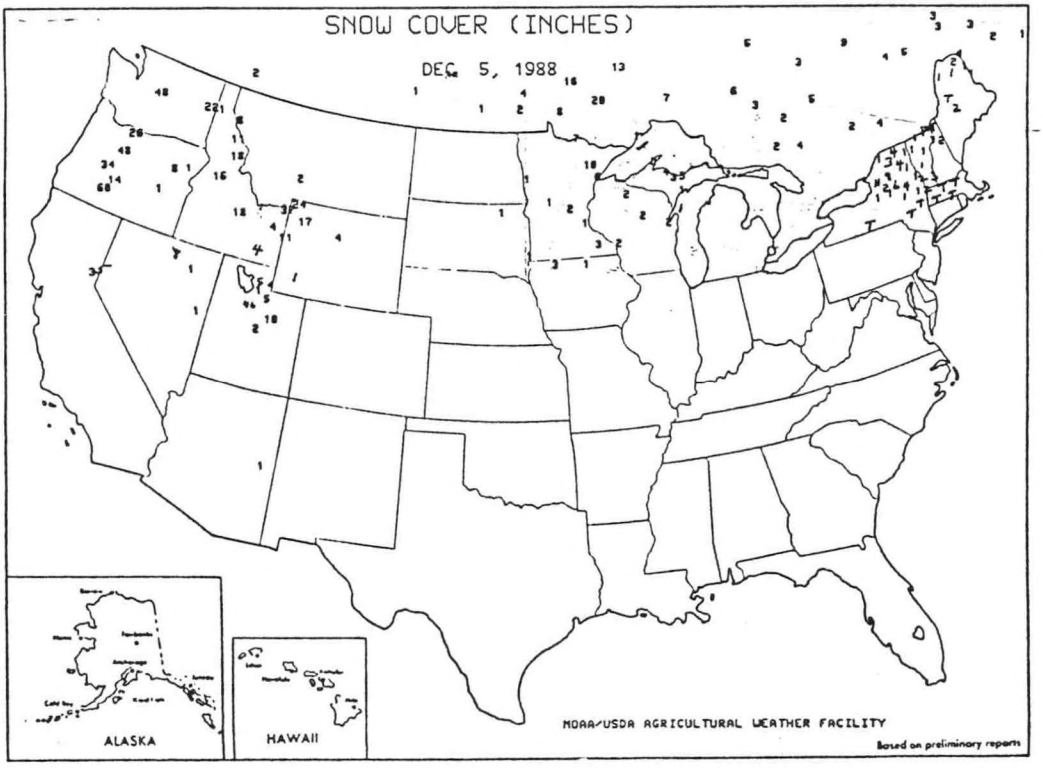

FIG. 7

northeast Minnesota (Fig. 8) was not obvious on the satellite imagery because of the "dark" forest area. Several inches of snow also covered the forested areas of northern Wisconsin, a situation not evident from looking at visible satellite imagery.

An isotherm analysis at 1900Z on December 5 (Fig. 9) clearly showed the cooler temperatures over the snow covered areas extending from northwest Iowa into central Wisconsin. A second area of cooler temperatures was seen over extreme northwest and west central Minnesota. However, the more interesting part of the analysis was the warm pocket over northeast Minnesota, extreme northern Wisconsin, and the western upper peninsula of Michigan. This area was about 6 to 10 degrees warmer than the open country unforested region to the southwest.

The warmer temperatures in the forest areas are explained by the much lower albedo of the forest compared to the snow. Figures 10 and 11 show that forests have one of the lowest albedos of natural materials. This low albedo suggests that incoming short wave radiation is absorbed by the forest canopy making it a heat source for the surrounding area.

3. Conclusions

If one looks at a visible satellite picture of a snow covered area in terms of albedo, a quick evaluation of the afternoon temperature would be that the forest area will have higher temperatures than the open country. The forest area appears much darker. Much more solar radiation is reflected back into space over areas where the snow is "visible." Secondly, if the open country has bare ground but the forests still have snow cover, one may not want to forecast lower maximum temperatures in the forest area. For obvious reasons, this method of temperature evaluation would only be applicable if the region has clear skies, is in a quasi-barotropic air mass, and the topography is relatively uniform.

4. References

NOAA, 1988: Weekly Weather and Crop Bulletin, December, Volume 75, Washington, D.C.

Oke, T. R., 1978: Boundary Layer Climates. Methuen & Co. Ltd, London.

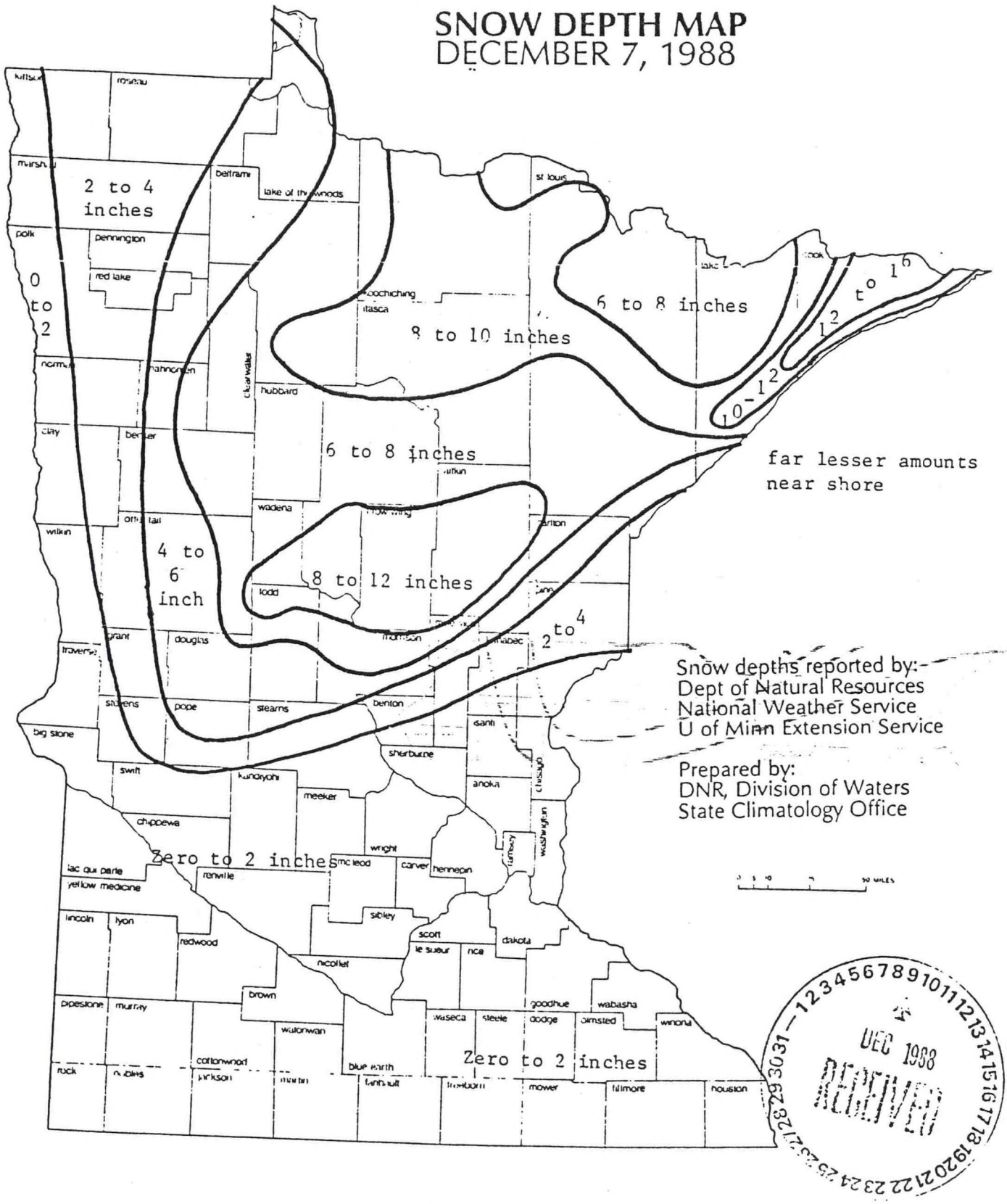
SNOW DEPTH MAP
DECEMBER 7, 1988
2 to 4 inches
0 to 2
6 to 8 inches
8 to 10 inches
6 to 8 inches
4 to 6 inch
8 to 12 inches
2 to 4
Zero to 2 inches
Zero to 2 inches
far lesser amounts near shore
Snow depths reported by:
Dept of Natural Resources
National Weather Service
U of Minn Extension Service
Prepared by:
DNR, Division of Waters
State Climatology Office
beltrami
lake of the woods
st louis
pennington
red lake
polk
hubbard
clay
becker
wadena
todd
douglas
grant
stevens
pope
stearns
benton
sherburne
anoka
chisago
meeker
kandiyohi
swift
chippewa
big stone
wright
mcleod
carver
hennepin
lac qui parle
yellow medicine
renville
sibley
lincoln
lyon
redwood
brown
nicollet
scott
le sueur
rice
dakota
goodhue
wabasha
winona
olmsted
dodge
waseca
steele
pipestone
murray
cottonwood
jackson
watonwan
blue earth
faribault
freeborn
mower
fillmore
houston
rock
nobles
martin
UEC 1988
RECEIVED

FIG. 8

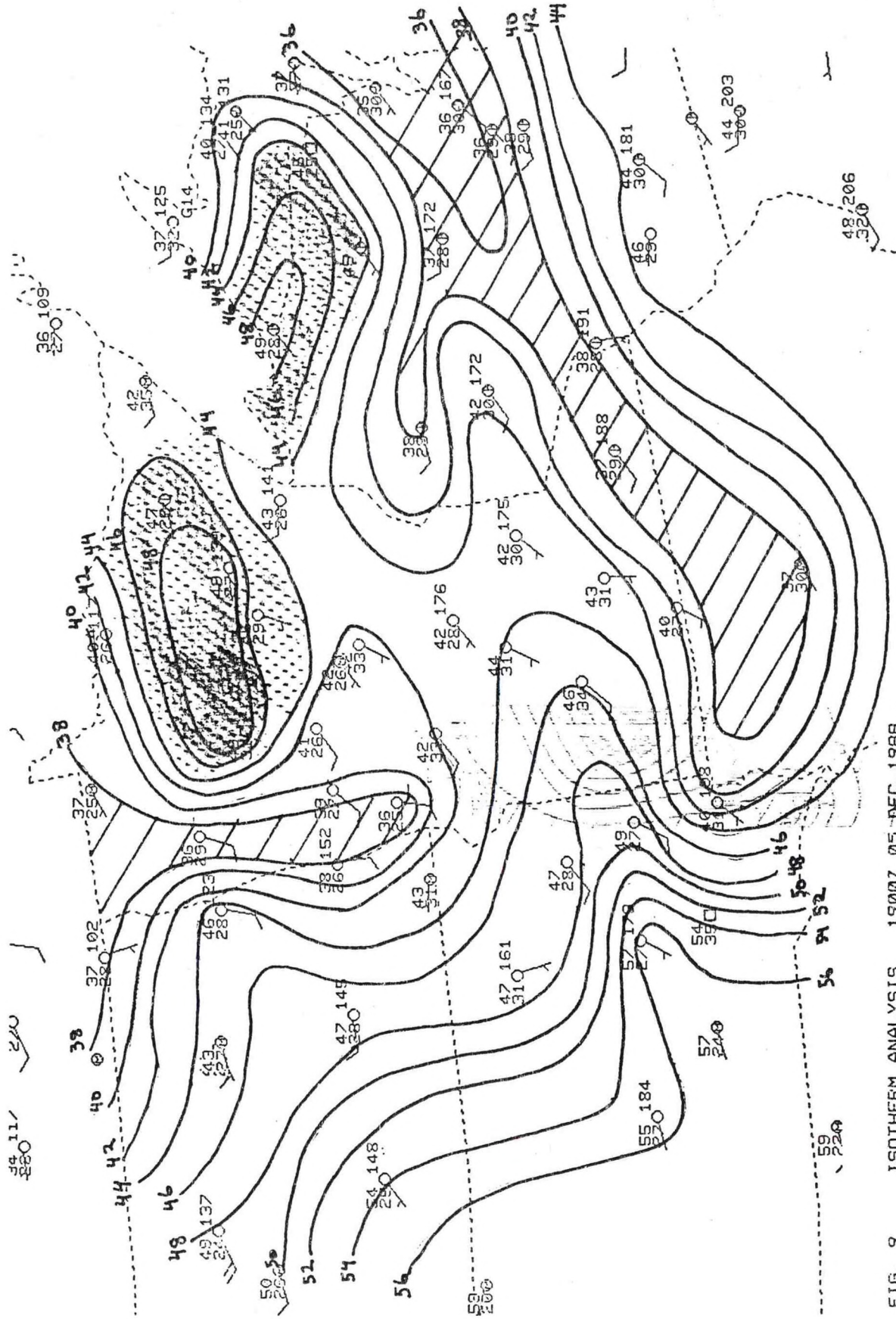

FIG. 9 ISOTHERM ANALYSIS 1900Z 05 DEC 1988

Fig. 10 Radiative properties of natural materials.

Surface	Remarks	Albedo α	Emissivity ε
Soils	Dark, wet Light, dry	0·05–0·40	0·90–0·98
Desert		0·20–0·45	0·84–0·91
Grass	Long (1·0 m) Short (0·02 m)	0·16– 0·26	0·90– 0·95
Agricultural crops, tundra		0·18–0·25	0·90–0·99
Orchards		0·15–0·20	
Forests			
Deciduous	Bare Leaved	0·15– 0·20	0·97– 0·98
Coniferous		0·05–0·15	0·97–0·99
Water	Small zenith angle	0·03–0·10	0·92–0·97
	Large zenith angle	0·10–1·00	0·92–0·97
Snow	Old Fresh	0·40– 0·95	0·82– 0·99
Ice	Sea	0·30–0·45	0·92–0·97
	Glacier	0·20–0·40	

Sources: Sellers (1965), List (1966), Paterson (1969) and Monteith (1973).

From Oke, T.R., 1978

Climates of vegetated surfaces

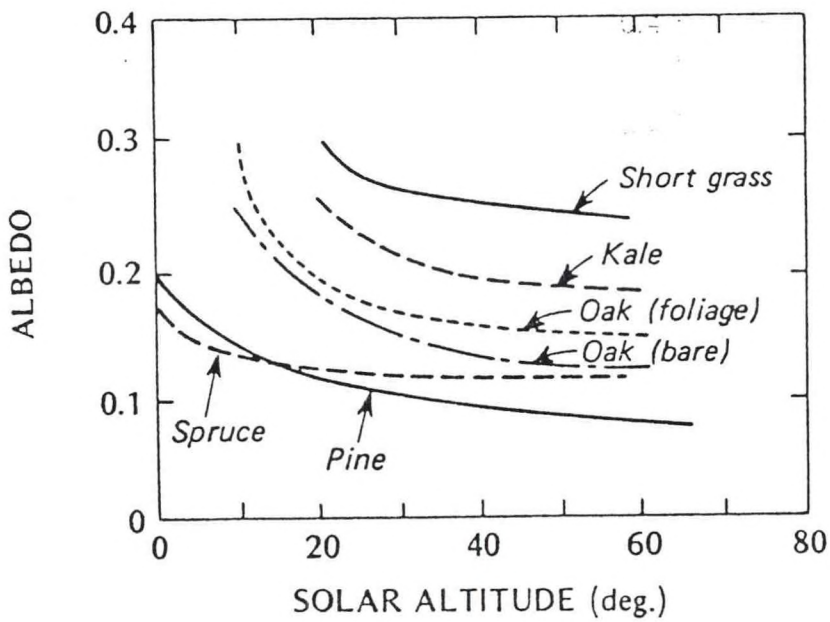

Figure 11 Relation between the albedo of vegetation and solar altitude on sunny days. Grass and kale (Monteith and Szeicz, 1961); oak forest (Rauner, 1976); spruce forest (Jarvis *et al.*, 1976); and Scots pine forest (Stewart, 1971).

From Oke,T.R. 1978