An Examination of the 3-4 December 2002 Fort Peck Lake Effect Snow Event for the Weather Event Simulator (WES)

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December 9, 2003

Introduction

A lake effect snow event occurred over Fort Peck Lake in the overnight hours from 3-4 December 2002. Snow developed along the north shore of Fort Peck Lake during the evening, spread eastward overnight, before ending in the late morning hours over the eastern end of the lake. The town of Fort Peck received 4 to 6 inches of snowfall during the event.

Background

Fort Peck Lake is a long narrow lake formed by the building a dam on the Missouri River south of Glasgow. The widest portion of the lake is above the dam where Big Dry Creek and Bear Creek join the Missouri river. The highest terrain is around Signal Hill, east of the dam (Fig 1). Lake effect clouds are observed frequently over the lake in the winter, when the lake is not frozen, and lake effect snow occurs several times during the season. The lack of observations around the lake and the sub-model grid scale of the area, makes forecasting the onset and duration of these lake effect snow event a challenge for the Glasgow WFO staff. This WES scenario was used to investigate the synoptic and mesoscale conditions prior to a lake effect snow event and to observe the development and evolution of the snow bands on radar and relate them to changing mesoscale conditions.

Synoptic and Mesoscale Features

A broad upper trough was over central Canada and the northern Plains and Great Lakes with ridging over the Pacific coast. At 500mb, a shortwave trough was moving south from Saskatchewan. At the surface, a cold arctic high was also moving from Saskatchewan into North Dakota (Fig 2). The result was clear skies and light wind over northeast Montana with deep cold inversion. As the high pressure moved south across North Dakota during the night, the low level winds veered from north during the evening of 3 December to southwest by dawn on 4 December.

Discussion

Lake effect snow needs three ingredients to develop. The first ingredient, a warm body of water, is provided in this case by Fort Peck Lake. Surface water temperatures of the lake were around 40F (4C). The second ingredient, cold air, was brought south by the arctic high pressure. The 850mb temperature on the 4 December 00z sounding from GGW was around -18C with an unstable mixed layer below this level (Fig 3). The depth (~1 km) and degree (> 20C) of the instability, combined with the low temperatures, allowed for very efficient snow production, resulting in snow amounts of 4 to 6 inches.

The third ingredient for lake effect snow is wind to determine where the snow bands will occur. Because of the small size of Fort Peck Lake and the general shallowness of the mixed layer, winds must remain light so as to not shear apart the convective clouds before they can produce snow. For this reason, Fort Peck Lake effect snow tends to develop as shore parallel bands within 5 miles of the lee shore of the lake.

As mentioned earlier, low level winds veered from north to southwest through the course of the event. As the wind veered, the location of the snow band changed as the convective cells were nudged toward the lee shore. By 02z December 4 the boundary level winds were from the east with the snow band along the western side of the lake (Fig 4). At 08z December 4 the winds had continued to veer and were now from the southeast. The snow band had shifted toward the north of the lake with the strongest radar reflectivity over the town of Fort Peck (Fig 5). This was the peak of the event.

The 4 December 12z sounding from GGW (Fig 6) indicated the 850mb temperature had risen to -12C. The top of the cold mixed layer would continue to lower through the morning with instability weakening. At 17z on 4 December, the snow had tapered to flurries and the band of radar reflectivity was oriented over the center of the lake and onshore over the high terrain south of Signal Hill (Fig 7). The forcing provided by this higher terrain allowed the snow to persist longer in this area even as the instability diminished. Observations from Signal Hill suggest the cloud layer was thinning and dissipating (Fig 8) and would continue to decrease as air temperatures rose.

While this scenario was a long lived, intense case of lake effect snow on Fort Peck Lake, it provided good training for forecasters on observing the development and evolution of lake effect snow as well as the synoptic and mesoscale features leading to the onset and dissipation of the event.

Figure 1

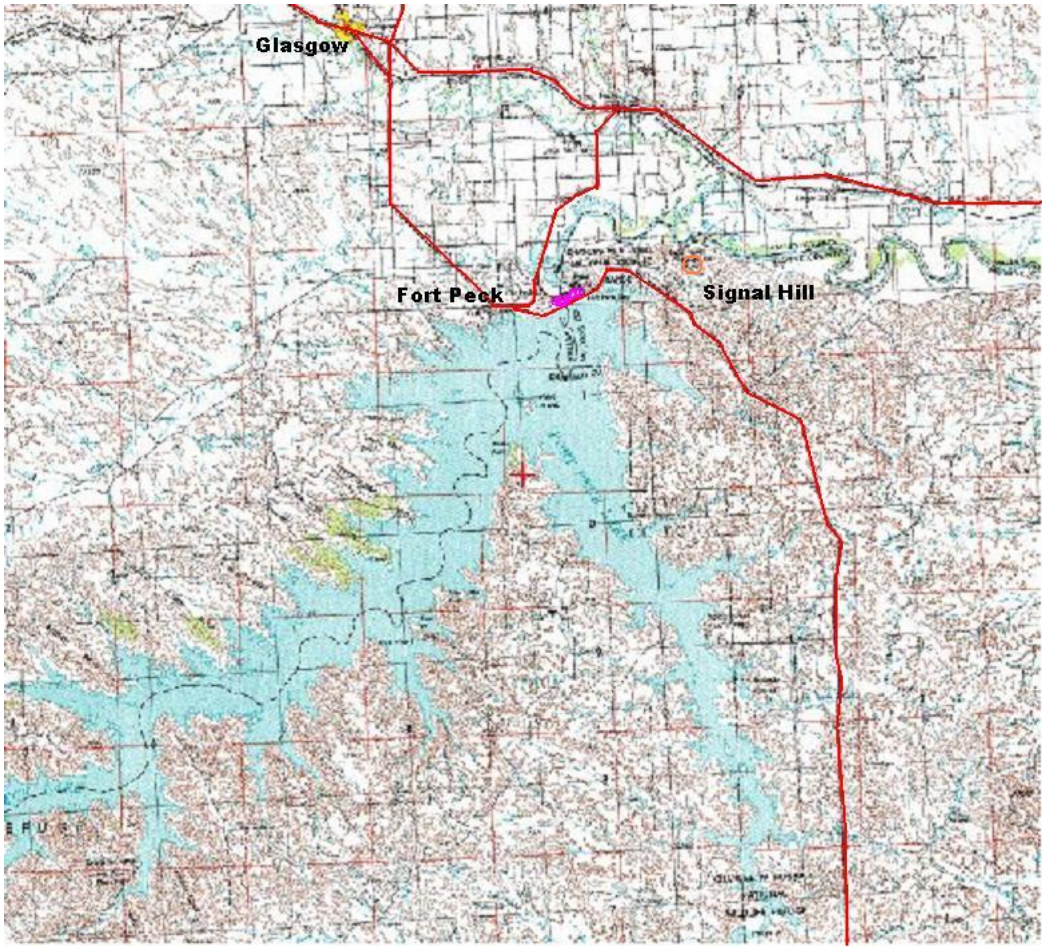


Figure 2

5z surface chart

4 Dec 2002

Northeast Montana

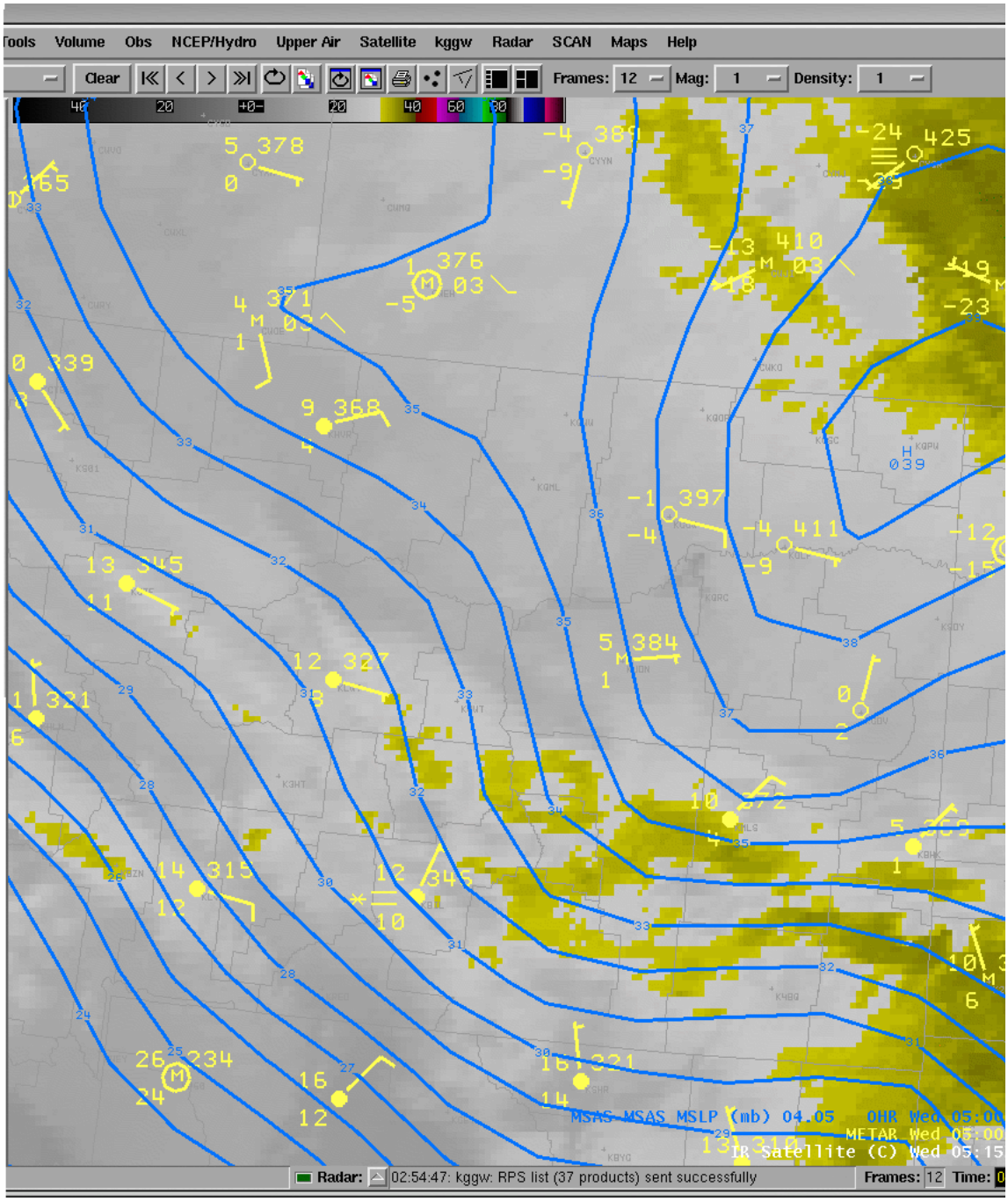
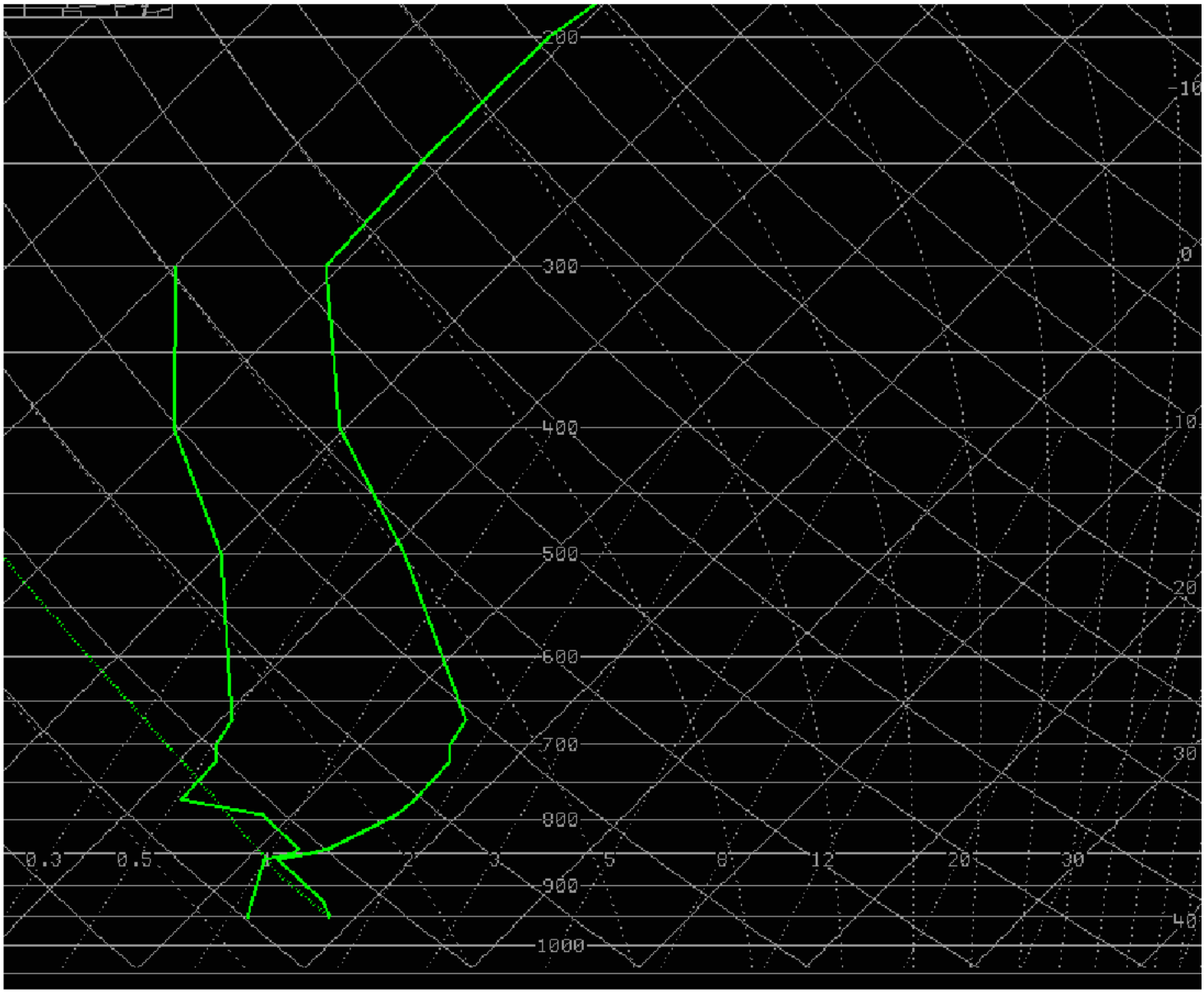


Figure 3



0z sounding - 4 December 2002 - Glasgow MT

Figure 4

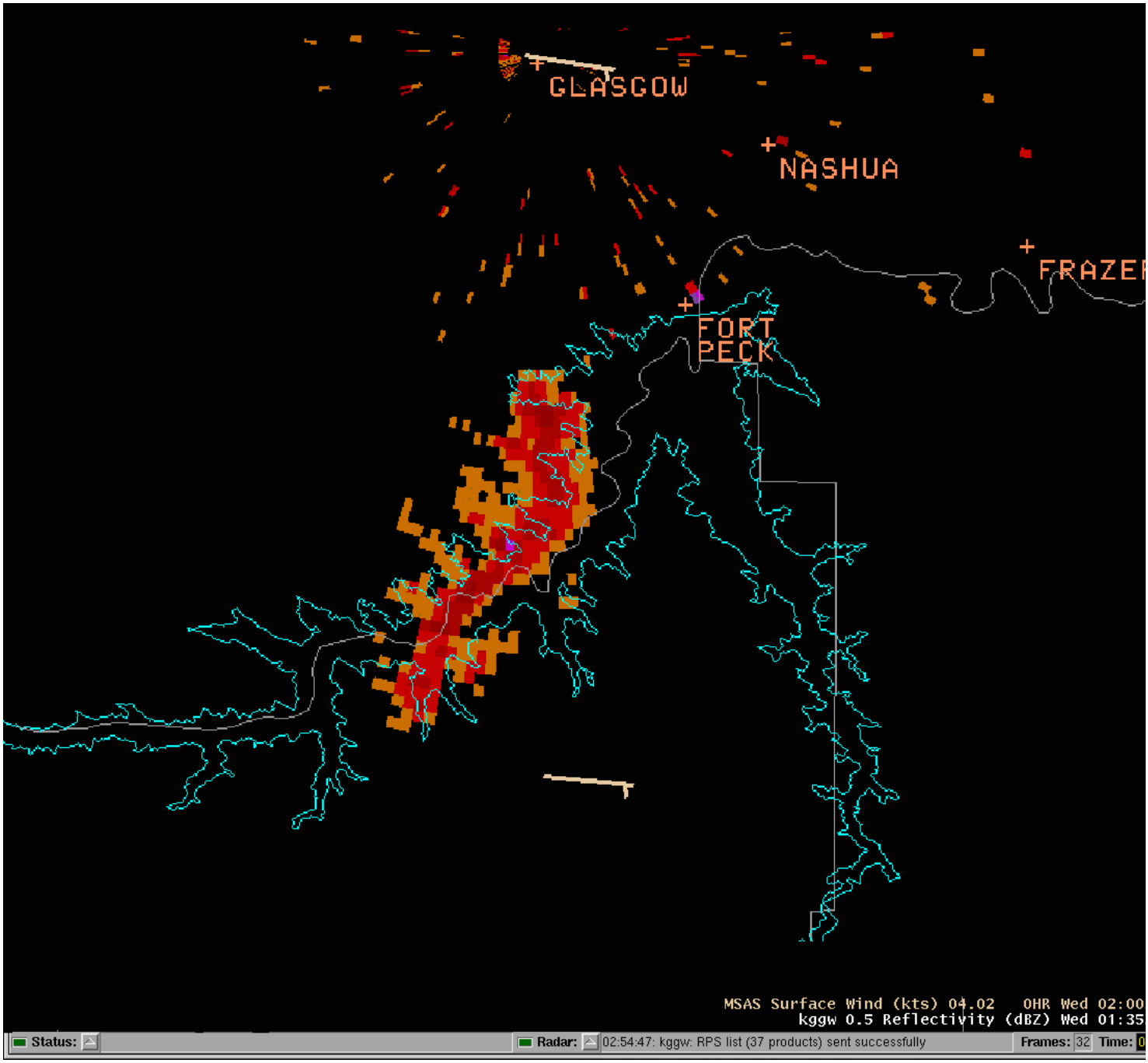

GLASGOW
NASHUA
FRAZER
FORT
PECK
MSAS Surface Wind (kts) 04.02 0HR Wed 02:00
kggw 0.5 Reflectivity (dBZ) Wed 01:35
Status:
Radar:
02:54:47: kggw: RPS list (37 products) sent successfully
Frames: 32
Time:

Figure 5

08z
.5 degree
base Radar
Reflectivity

4 Dec 2002

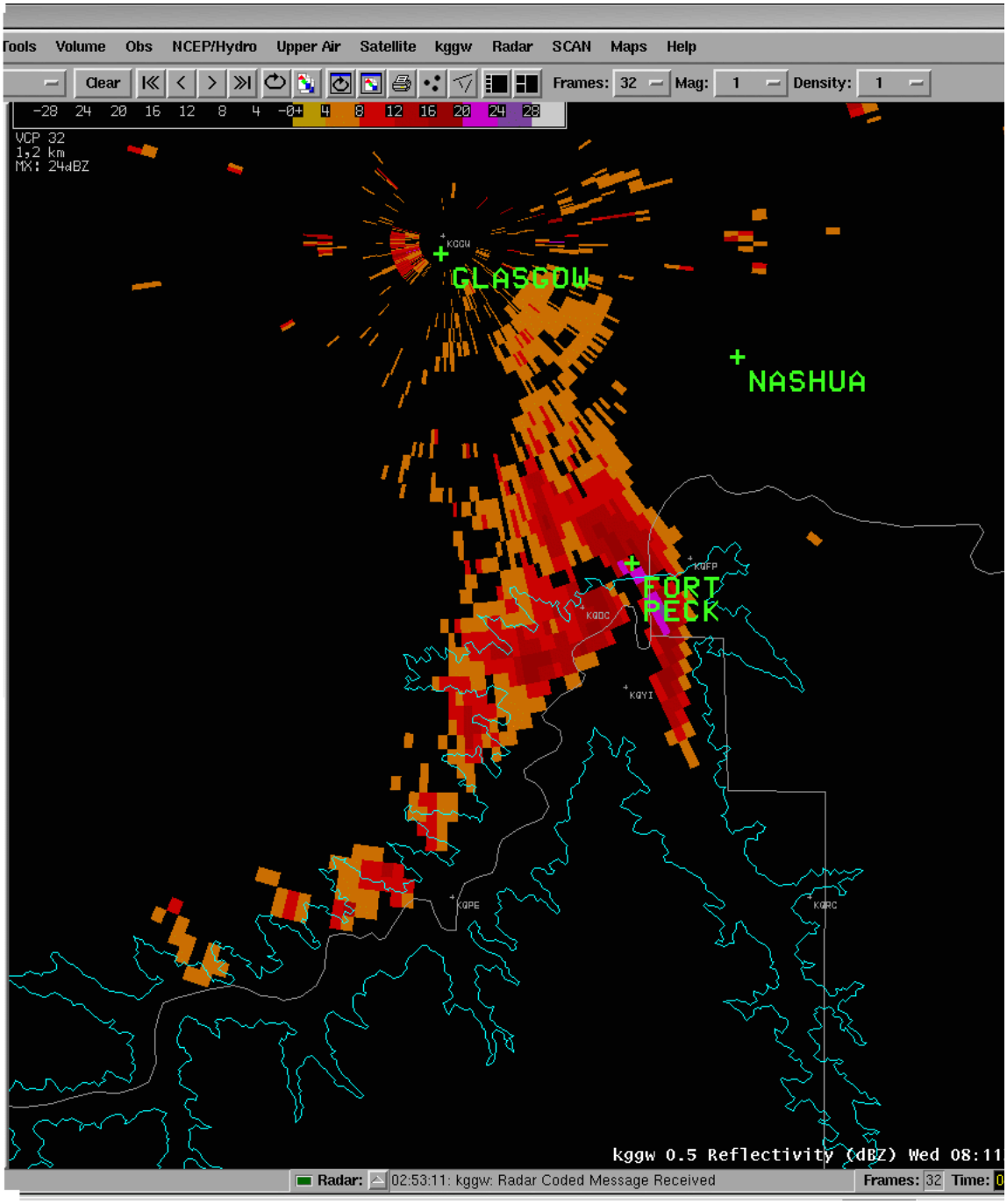
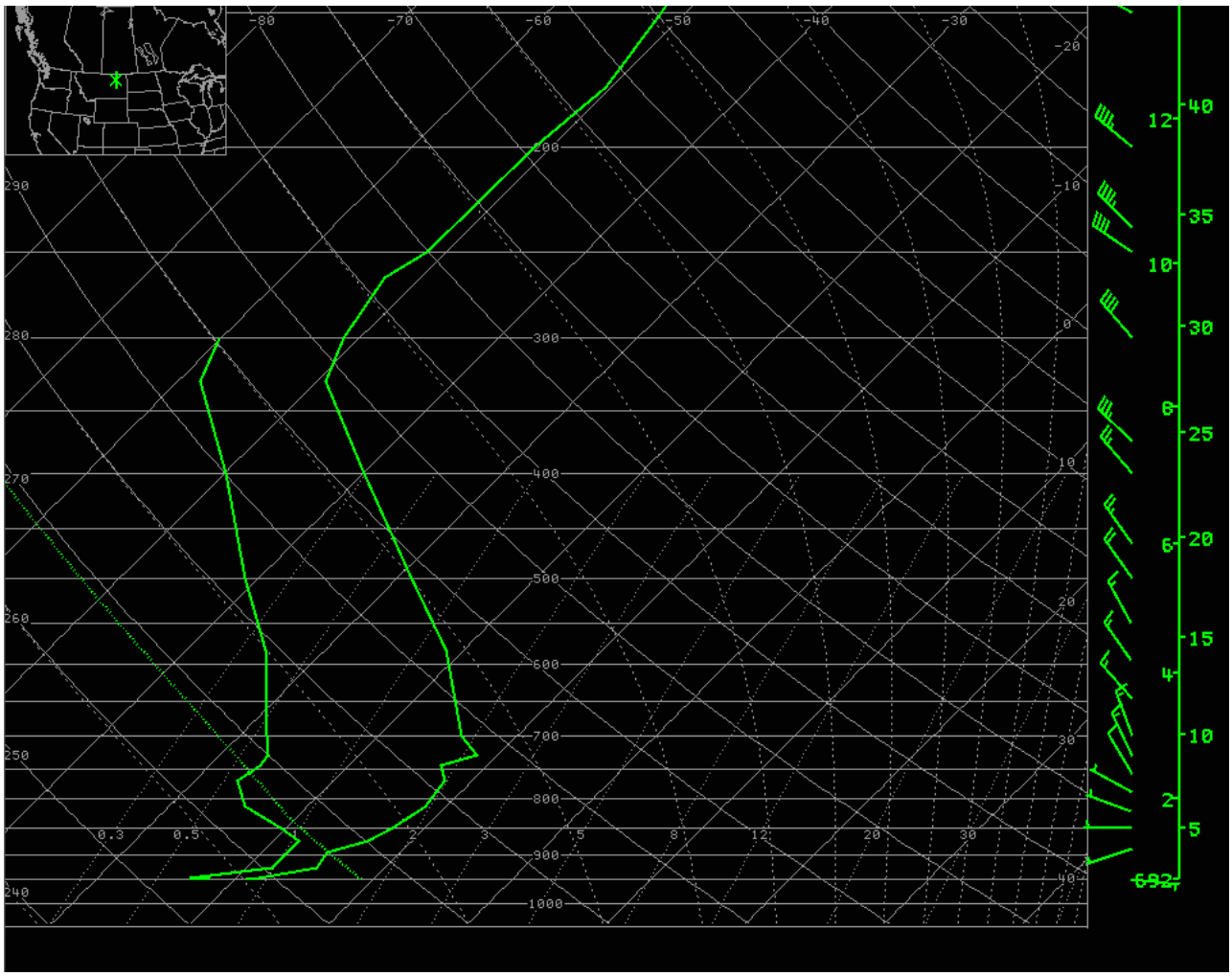


Figure 6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-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
290
280
270
260
250
240
200
300
400
500
600
700
800
900
1000
0.3
0.5
2
3
5
8
12
20
30
40
12
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35
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30
8
25
6
20
15
4
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2
5
692

Figure 7

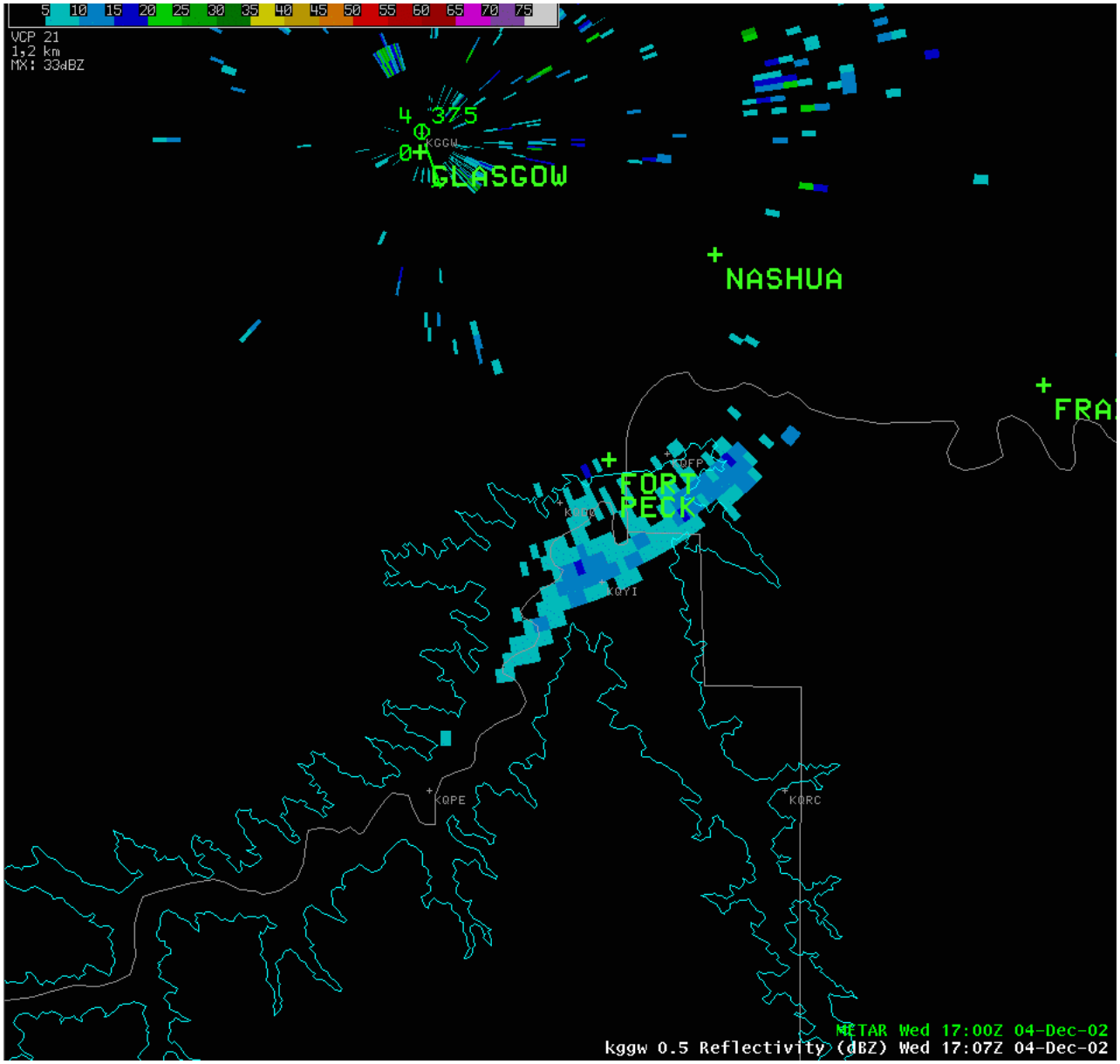
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
VCP 21
1.2 km
MX: 33dBZ
4 375
0
KGGW
GLASGOW
NASHUA
FRA
FORT PECK
KQPE
KQRC
METAR Wed 17:00Z 04-Dec-02
kggw 0.5 Reflectivity (dBZ) Wed 17:07Z 04-Dec-02

Figure 8