WESTERN REGION TECHNICAL ATTACHMENT
NO. 86-21
July 8, 1986

VERTICAL VELOCITIES IN THE NGM

The technical attachment for this week is a response to a question by one of our Seattle forecasters, John Jannuzzi, regarding vertical motion predicted by the NGM. It is interesting and enlightening with regard to how the regional models function. Most important, it points out a difference between the LFM and NGM vertical motion output. The LFM vertical motion consists of a two-hour average, whereas the NGM field is an instantaneous value.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE

National Meteorological Center
W/NMC2x2, WWB, Room 204
Washington, DC 20233

June 30, 1986 W/NMC2x2:NAP

MEMORANDUM FOR: J. Jannuzzi
Lead Forecaster, Seattle WSFO

THRU: R. Hutcheon
Area Manager, Washington State

FROM: N. Phillips
Principal Scientist, NMC

REF: Letter from Jannuzzi on vertical velocities at 12 hours in the NGM forecast from 00Z May 25.

This case is an interesting one to examine by comparing the NGM and LFM results, including the initial analyses. I am able to come up with one fact that is clear-cut(item I),but it will only explain part of the large value of 15 microbars in the northeastern corner of Washington. (The LFM had a value of at most 3 microbars (See figs. 1a and 1c). I can also come up with a very crude hand-waving argument(item II) that would explain part of the difference as arising from analysis differences, but unfortunately the data is too sparse to test this argument.

I. Time-smoothing of the output vertical velocities

The NGM output of vertical velocity is an instantaneous value, whereas the LFM averages its vertical velocity over a two-hour interval before it is put into the forecast output file. I believe that this averaging was instituted in the early days of the LFM to cut down on the numerical noise that was introduced into the LFM forecast by the treatment of its lateral boundaries. I am embarrassed to find that I omitted to mention this difference in either TPB 350 or 351. I would guess that if the NGM value were averaged in time, it might in this case be reduced to about 10-11, which is still larger than one is accustomed to seeing from the LFM.

A similar effect, but common to both models in the early stages of a forecast (e.g. 0 to 12 hours), is that the pattern of vertical velocity is not completely established at the start of the forecast. Some time is necessary to establish the magnitude of vertical velocity that is in close agreement with the vertical velocity demanded (so to speak) by the initial patterns of vorticity and temperature advection, even when special efforts are made to initialize the vertical velocity at t=0. This "adjustment process" can involve some overshoot of the correct vertical velocity. Part of the large NGM vertical velocity may reflect this overshoot; the +15 value has greatly weakened to +8 by 24 hours (not shown).

The NGM atmosphere was saturated in the vicinity of the +15 center, and the lapse rate was only slightly stable (+4 for the NGM lifted index) This would also contribute to a large vertical velocity value.

II. Velocity details

Figures 2c and 3c show the two 12-hour vorticity forecasts at 500 mbs. The NGM has a pronounced ridge of vorticity extending up the western boundary of Idaho. This is absent in the LFM. At the north end of the NGM vorticity ridge, on the Canadian border, there is a small region of strong advection of vorticity. This is located very close to the +15 center of vertical velocity, verifying that (as said in the referenced letter) the center was "appropriately placed".

Was this vorticity tongue correct? If so, there should have been a moderately strong southerly jet located just to the right of the vorticity tongue (i.e. near Lewiston, Idaho). Figure 4a is the NGM 500-mb velocity forecast for 12Z, while Figures 4b and 4c show the observations at the initial and verifying time. Unfortunately the observed 12Z winds at Boise, Great Falls, Spokane, and Calgary only hint that there might be a jet streak located between Spokane and Great Falls, as was forecast by the NGM. The data at the initial time (00Z) are more explicit about a southerly jet with speeds in excess of 50 knots located in central Washington to the east of the coastal trough, but by 12Z the jet could have weakened more than was forecast by the NGM. Thus I am unable to say whether the LFM or NGM 12-hour vorticities were more accurate, and therefore, am unable to say which of the 12-hour forecast vorticity advection patterns was more correct, and therefore, which of the vertical velocity patterns was more correct.

The NGM forecast a larger precipitation maximum (Fig. 1b) in the first 12 hours than the LFM did (Figure 1c). The latter was more wide-spread, however. Some observed 24-hour precipitation amounts are shown in Fig. 5. The largest values agree more with the NGM, while the areal spread agrees more with the LFM. This evidence is therefore inconclusive, also.

Figs 2a and 3a are the initial vorticity analyses from the RAFS analysis and the Cressman LFM analysis. The overall patterns are similar, but there is some difference in detail. In the critical region at and west of the northern boundary of California, the RAFS (NGM) has a stronger vorticity pattern. If one examines the orientation of the vorticity and height lines on the NGM analysis, it is easy to see how a tongue of large vorticity (+16) could be advected northward up the western boundary of Idaho, as was done by the NGM. Both vorticity analyses appear to be consistent with the data on Fig. 4b.

I arrive thus at only a hypothesis about the reason for the NGM-LFM difference in vertical velocity. This is that the initial wind analyses are different in important details, without violating the observations. A test of this would be to run the NGM model from the LFM analysis (to the extent that this is meaningful in light of the vertical model differences) or to run the LFM model from the NGM analysis. If this can be done, I will let you know the results.

The RAFS optimum interpolation method and the LFM Cressman method both assume a symmetric region of influence for each observation to correct the errors in the "first guess". This is probably a poor approximation in the vicinity of fronts and jets, where the errors are likely to have an elongated pattern. This may lead to vorticity advection patterns in the analysis that are unrealistic in their small-scale features.

It somehow seems unlikely to me that the real atmosphere would engage in such strenuous deformation of the vorticity lines as was done by the NGM in the first 12 hours, or, that the RAFS analysis was accurate enough to correctly map out the subtle aspects of the vorticity field that must have BRIEFLY existed for the real atmosphere to do this deformation.

cc: W/OM
Regional SSD's
NMC: Copy 1. J. Hoke, J. Tuccillo, G. Dimego, R. Petersen, A. Lorenc.
Copy 2. R. McPherson, J. Brown, H. Saylor, W. Bonner

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE

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'86 JUN 6 AM 7:50

Date: May 27, 1986

To: W/WR3 Glenn Rasch, NWSWR Salt Lake City NWSWR SLC UTAH

Thru: Richard J. Hutcheon, Area Manager, Washington State

Thomas G. Swift, DMIC, WSFO Seattle

From: John Jannuzzi, Lead Forecaster, WSFO Seattle

Subject: Small Scale Strong Vertical Motions in the NGM

There have been a number of occasions this year where the NGM has forecast small areas of very high upwards vertical motions. They seem to be appropriately placed (where upwards motion would be expected), but the magnitudes seem extreme.

I have enclosed a recent case, which is also the highest value I have yet seen the NGM forecast. I have included other NGM forecast fields, at the same time period, to show that nothing extraordinary seems to occur in any other forecast parameters.

I would appreciate hearing any comments that you might have regarding this phenomenom. Perhaps NMC would like to take a look at this also.

attachment

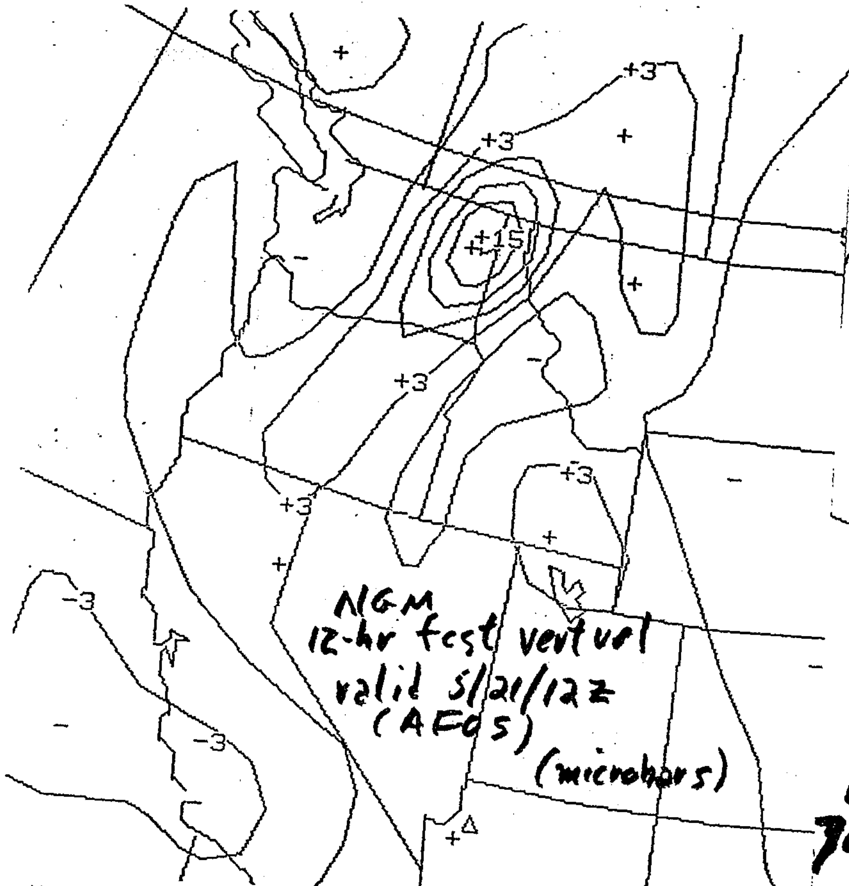

FIGURE 1a. NGM 12-hr forecast vertical velocity, valid 12Z May 21, 1986.

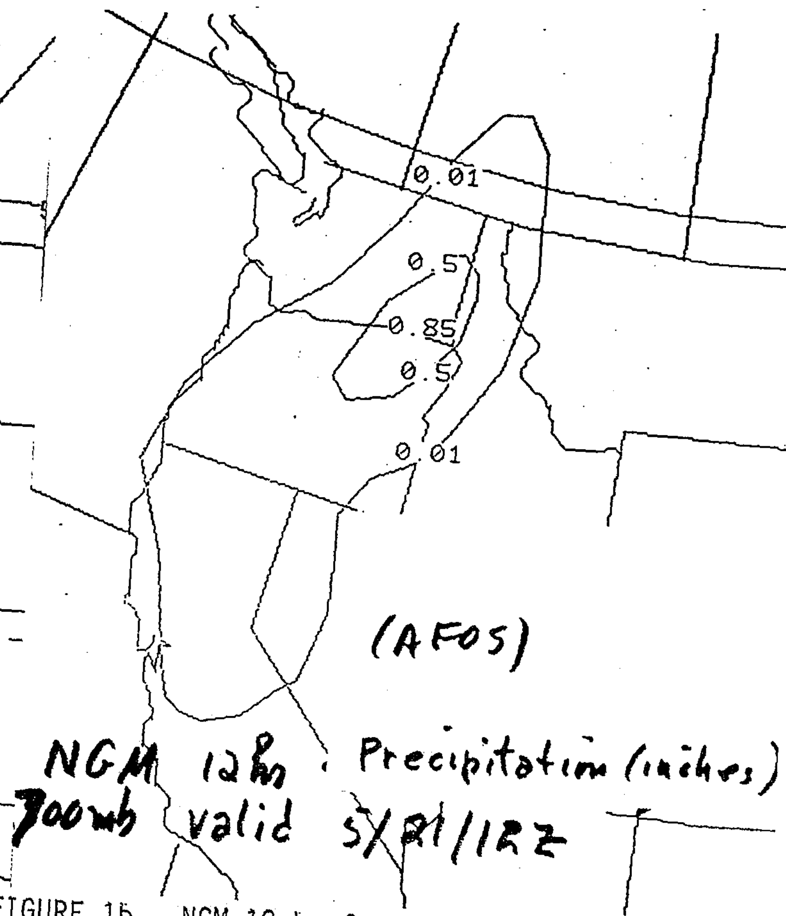

FIGURE 1b. NGM 12-hr forecast precipitation, ending 12Z May 21, 1986.

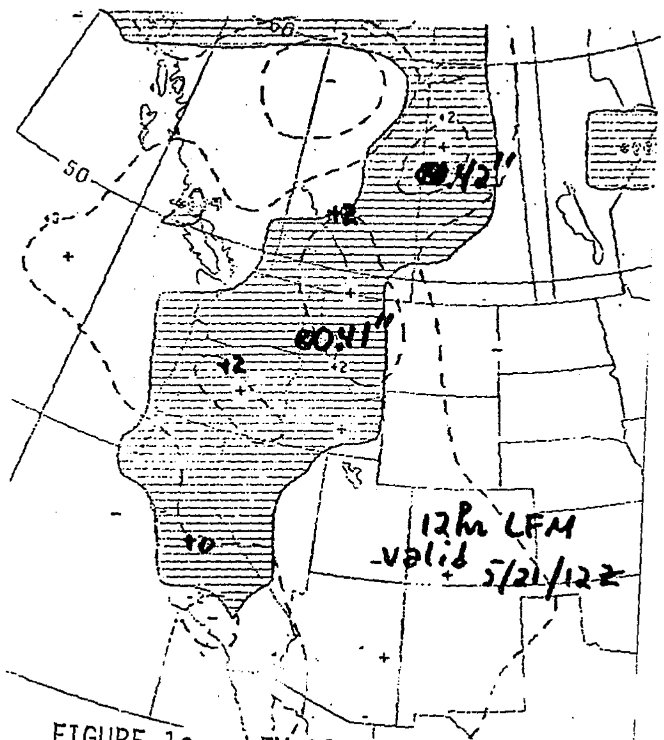

FIGURE 1c. LFM 12-hr forecast precipitation and vertical velocity, valid 12Z May 21, 1986

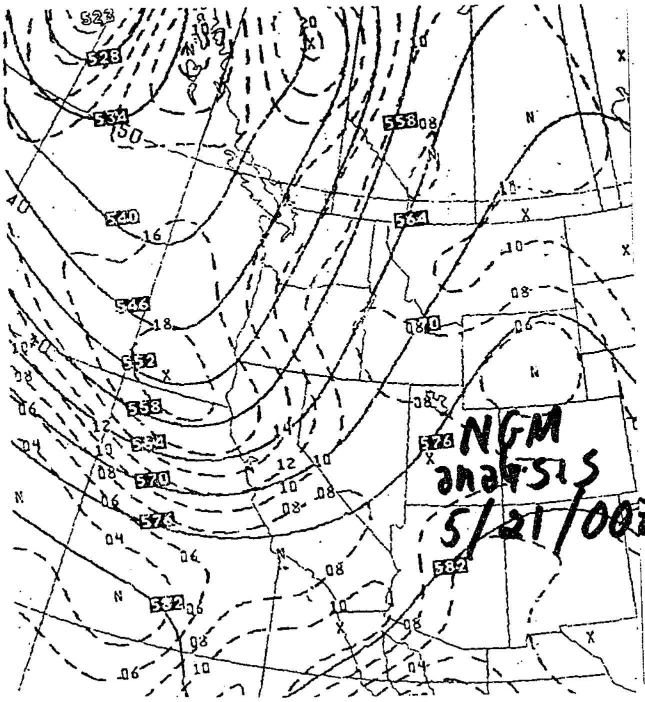

FIGURE 2a. NGM 500-mb analysis, 00Z May 21, 1986.

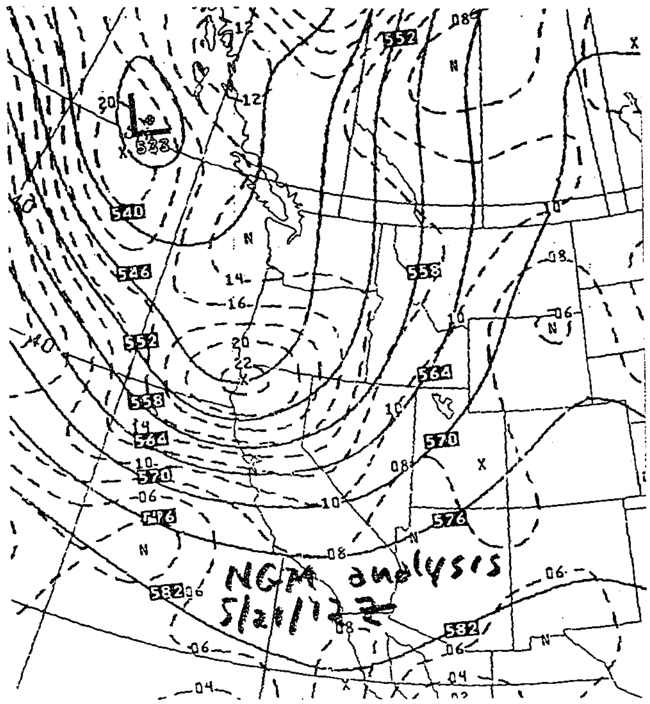

FIGURE 2b. NGM 500-mb analysis, 12Z May 21, 1986.

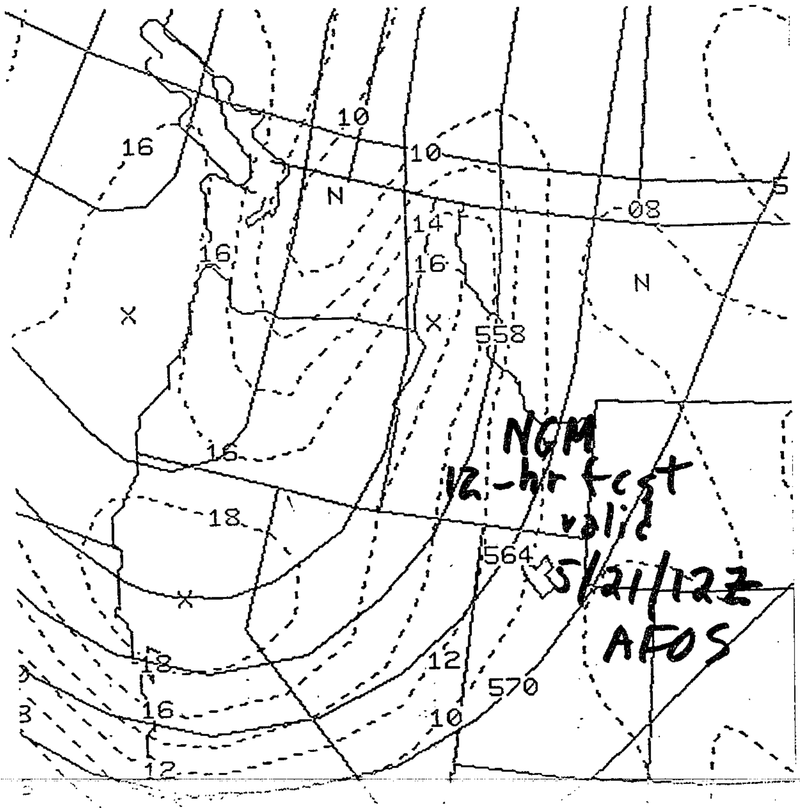

FIGURE 2c. NGM 12-hr 500-mb forecast, valid 12Z May 21, 1986.

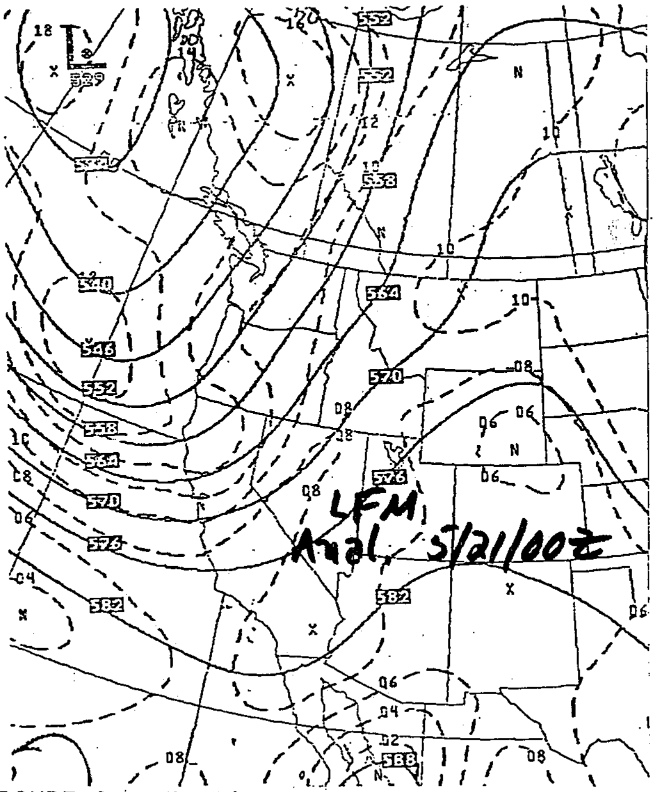

FIGURE 3a. LFM 500-mb analysis, 00Z May 21, 1986.

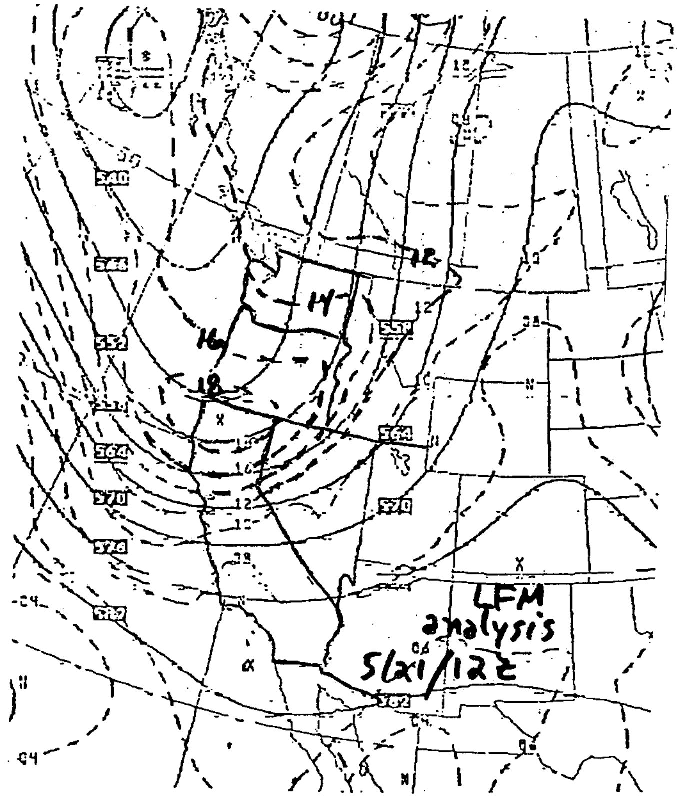

FIGURE 3b. LFM 500-mb analysis, 12Z May 21, 1986.

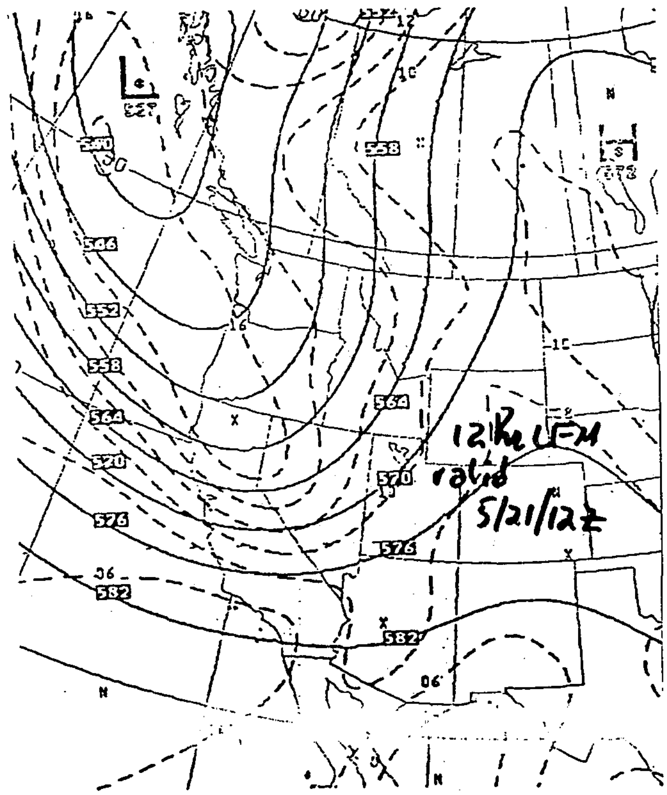

FIGURE 3c. LFM 12-hr 500-mb forecast, valid 12Z May 21, 1986.

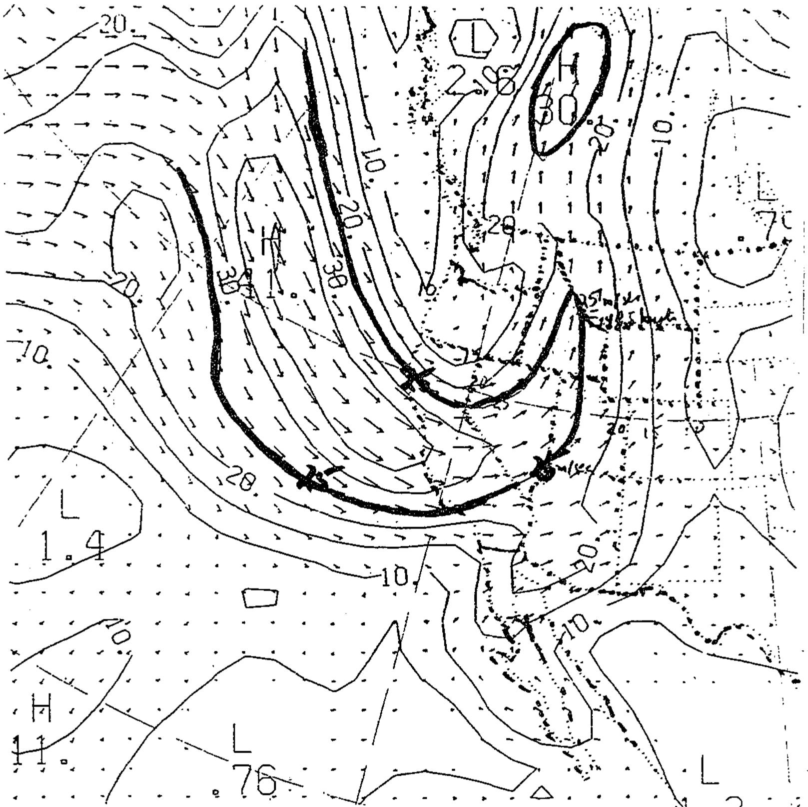

FIGURE 4a. NGM 12-hr 500-mb wind forecast (m/sec), valid 12Z May 21, 1986.

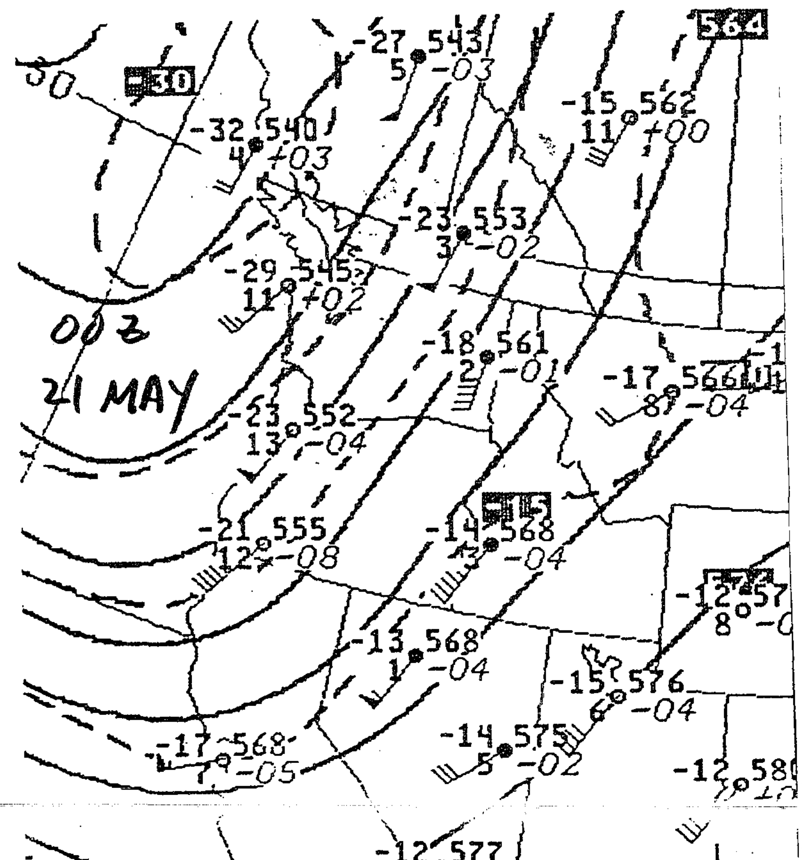

FIGURE 4b. 500-mb analysis, 00Z May 21, 1986.

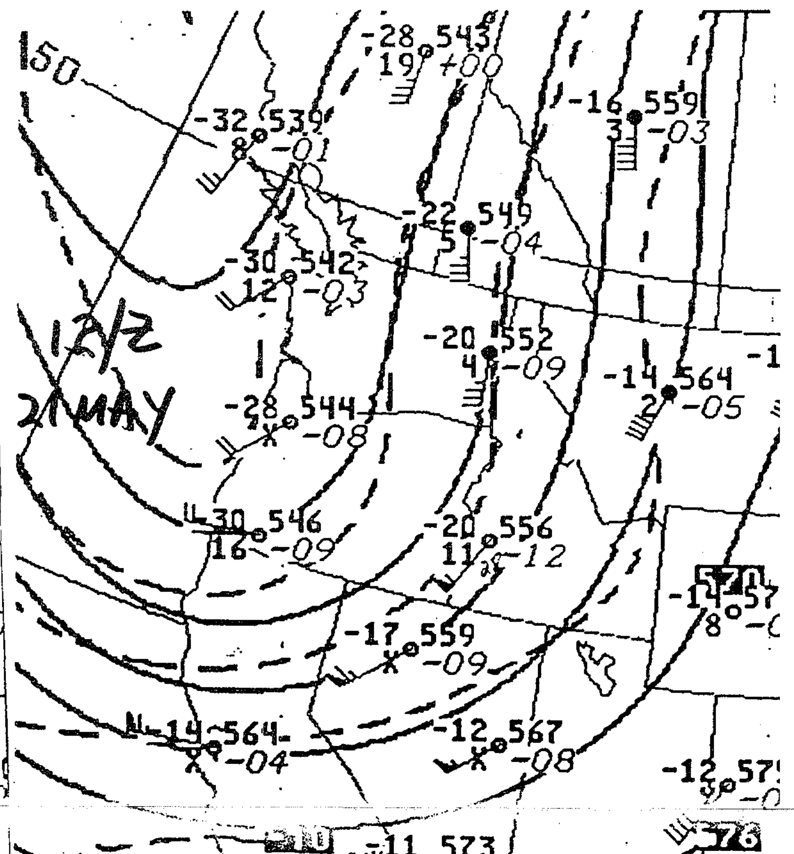

FIGURE 4c. 500-mb analysis, 12Z May 21, 1986.

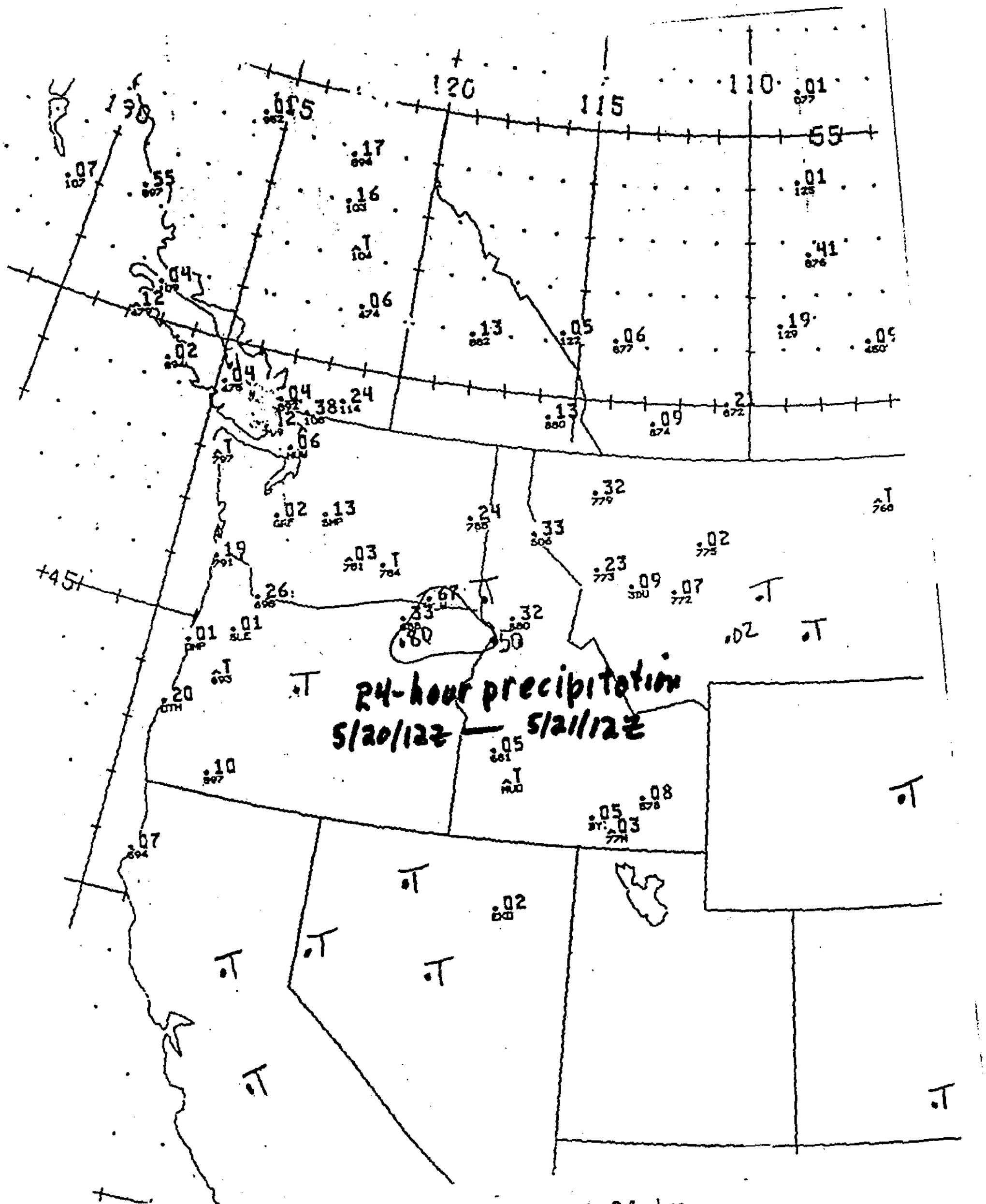

FIGURE 5. Observed 24-hr precipitation, ending 12Z May 21, 1986.