NWS-CR-TA-88-22

CRH SSD
MAY 1988

CENTRAL REGION TECHNICAL ATTACHMENT 88-22

WHERE'S THE JET MAX: A DRY BAND COLOR ENHANCEMENT TECHNIQUE

Todd R. Morris and Glenn A. Field
National Weather Service Forecast Office
Milwaukee, Wisconsin

1. Introduction

"Where's the jet max?" In trying to assess the answer to this question, forecasters often analyze isotachs on upper air data charts, look at radiosonde information, or view modeled wind maxima. In recent years, forecasters have also learned how to use satellite imagery (VAS Moisture Channel imagery in particular) to infer the location of jet maxima. A color enhancement curve has been devised for SWIS which highlights dry bands in the Moisture Channel imagery. When one uses simplistic four-quadrant jet core theory and applies this dry band enhancement curve to a sequence of water vapor images on SWIS, the jet maxima often can be easily identified. In the few short weeks since the installation of SWIS, numerous cases have occurred in which jet maxima were identified and there was a good correlation with surface precipitation or pressure patterns. Thus, the dry band enhancement curve can be a valuable forecasting tool. Without it, this information might go unnoticed.

2. Color Enhancement Curve for Water Vapor Imagery

The type of moisture imagery available on SWIS is the 6.7 micron VAS water vapor channel. The 6.7 micron wave length receives its peak contribution from the water vapor in the air at 450 mb. However, depending on the distribution of atmospheric moisture, the total contribution can range from as low as 800 mb to as high as 250 mb. "Observing a 6.7 micron image is similar to looking into fog -- the less dense the fog...the more we see into it" (Weldon, 1985). Thus, a dry middle and high troposphere means that the satellite can sense things from a lower (warmer) level. Conversely, for moist middle and upper layers, the satellite senses from a higher (colder) level.

The standard enhancement curve applied to water vapor imagery is the "ZA curve," which varies from black (dry) to white (moist). However, the human eye can distinguish different colors more easily than it can between similar shades of gray. The enhancement curve presented in this paper (see Table 1) makes dry bands very noticeable by enhancing them with colors ranging from red (very dry) to magenta (dry) to turquoise (somewhat dry). Moisture is indicated by a dark green enhancement (somewhat moist) which becomes lighter and then white (very moist). A gray region, which varies from dark to light, separates the dry and moist bands. It should be noted that often what is important to the forecaster

TABLE 1
Gray Scale and Color Count Values that Define the Dry Band Enhancement Curve

GRAY SCALE (BRIGHTNESS TEMP.) COUNT VALUE	COLOR COUNT VALUE
1 - 43	58 (Red)
44 - 70	8 (Purple)
71 - 93	24 (Lavender/Magenta)
94 - 111	152 (Light Turquoise)
112 - 130	132 (Dark Turquoise)
131 - 138	225 (Dark Gray)
139 - 145	227 .
146 - 152	228 .
153 - 158	230 .
159 - 168	232 .
169 - 176	234 .
177 - 181	236 .
182 - 189	238 (Light Gray)
190 - 204	103 (Dark Green)
205 - 231	125 (Light Green)
232 - 255	255 (White)

is moisture tendencies and not the actual magnitude of the moisture. Thus, an area does not have to dry out so much that it becomes enhanced with turquoise, magenta, or red in order to be considered important. Sometimes even a subtle change from green to gray could indicate significant drying.

3. Two Examples

The first case in which this color enhancement curve was used in conjunction with simplistic jet core theory to identify jet maxima in real time occurred on December 30, 1987. A weak 500 mb short wave trough coupled with a weak surface low (1003 mb) was moving across the central Rockies into an upper level ridge along 90° West. At 12Z, the 300 mb plot showed the polar jet stretching from southern California to Lake Superior with the strongest winds, 115 kts, located over South Dakota. By 18Z, the surface low had deepened to 998 mb over eastern South Dakota. Four to six mb pressure falls were reported across southern Minnesota and northern Iowa. As expected, the precipitation shield associated with the low had enlarged dramatically.

A 6.7 micron water vapor imagery loop for that morning, with the above enhancement curve applied, showed a distinct moist (green)/dry (turquoise) couplet moving through the upper flow. Although unable to show colors here, Figure 1 depicts this couplet. The location of this feature coincides with the front left and front right quadrants of the observed jet maxima. Upwind of this couplet, there also were two areas that were becoming more moist (right rear quadrant) and drier (left rear quadrant) with time. Although they were not as distinct as their downwind counterparts, they were identifiable by noticing subtle color changes with time.

A second case occurred on January 14, 1988. This time, the polar jet, at 12Z, stretched from an upper level ridge building along the west coast of the U.S. to the mid-Mississippi Valley. Very weak impulses were moving through the strong upper flow. The only significant surface feature was a weak warm front that stretched from northern Montana to eastern Nebraska.

By around 14Z that morning, the color enhanced water vapor satellite imagery once again began showing a distinct moist/dry couplet. It was decided that this represented the front left and front right quadrants, respectively, of a jet max, since the 12Z 300 mb plot showed 100 kts at Rapid City with only 50-85 kts at surrounding RAOB sites (see Figure 2). Two hours later, a narrow heavy snow band developed over south central and southeast Minnesota. The ceiling and visibility at Mankato (MKT) suddenly deteriorated from 8,000 ft-10 mi to 500 ft-1/8 mi (see Figure 3).

It is worth noting that this second case was similar to the first in that the front quadrants had a strong water vapor signature. However, the rear quadrants were not noticeable in the second case.

4. Summary

It has been shown that jet maxima can become readily identifiable when the dry band color enhancement curve is applied to a sequence of water vapor images on SWIS. However, they are not always obvious unless one is thinking about

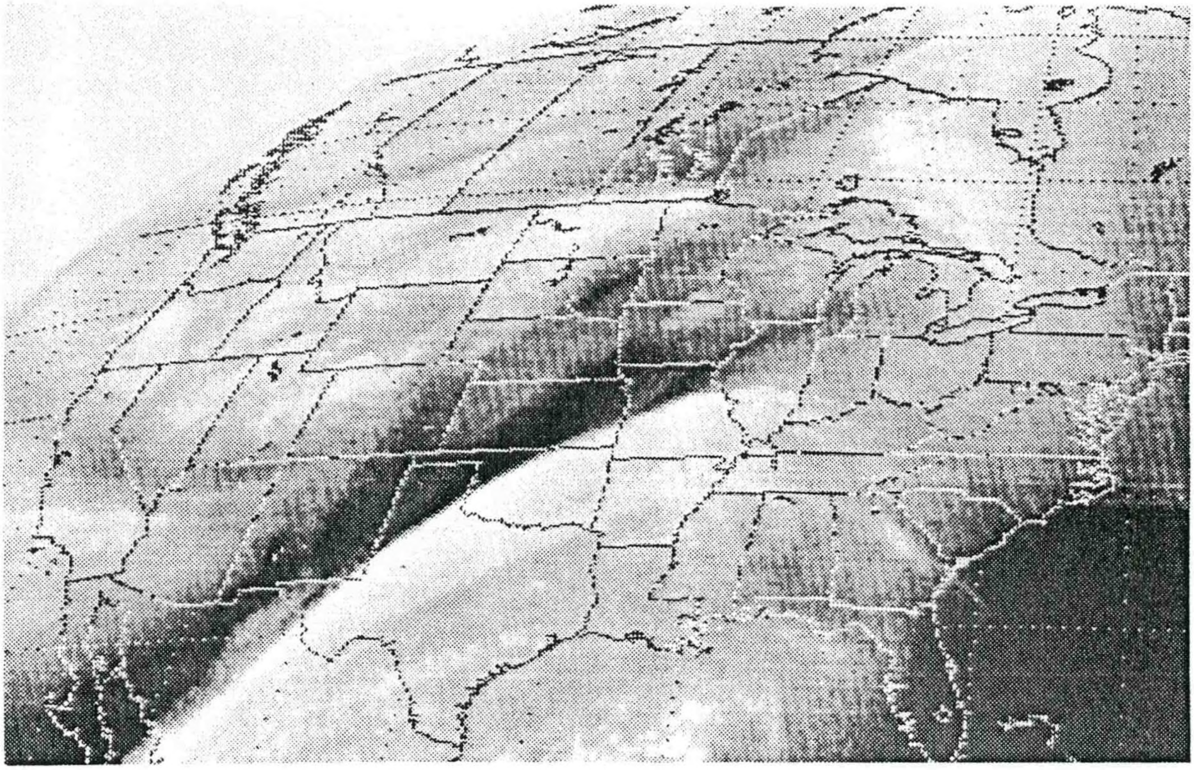

Fig. 1. 6.7 Micron water vapor image from 17Z on December 30, 1987, showing moist/dry couplet over the Dakotas.

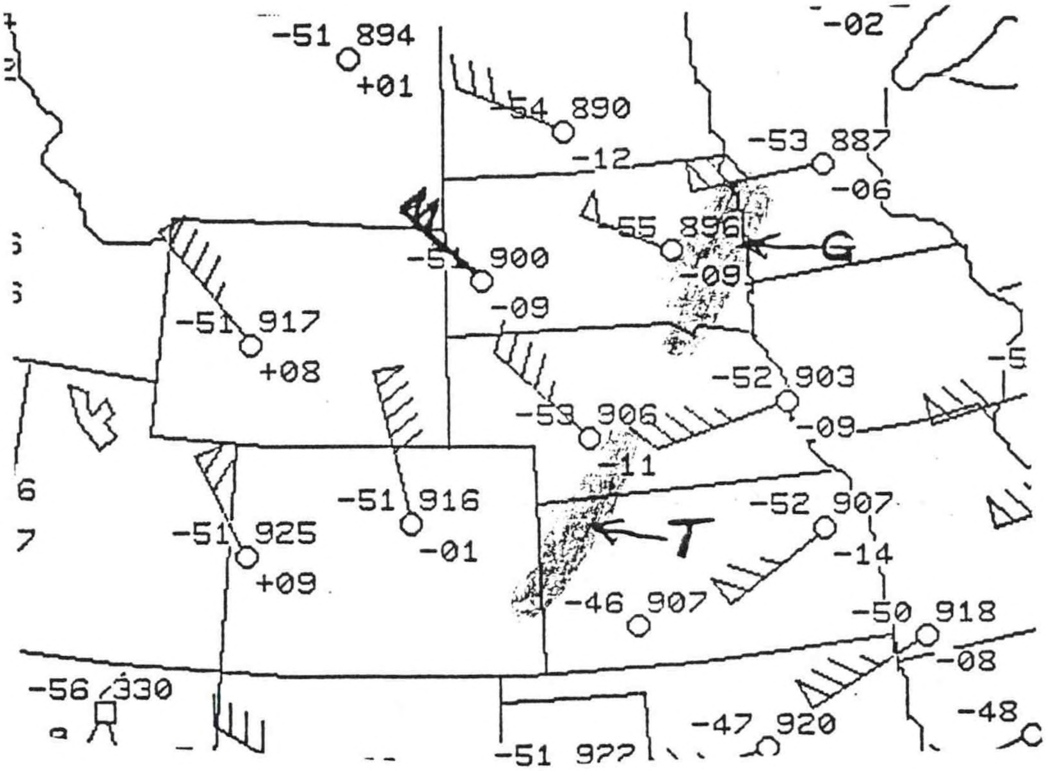

Fig. 2. 300 mb plot from 12Z, January 14, 1988 showing 100 kt jet max at Rapid City and corresponding downwind color satellite enhancements. Moist region is indicated by green (G) and dry region by turquoise (T).

```
MSPSAOMKT
SAUS90 KWBC 141606
 MKT SA 1553 W5 X 1/8V S+BS 10/7/1417/027/VSBY1/16V1/4
MSPSAOMKT
SAUS90 KWBC 141503
 MKT SA 1451 E80 OVC 10 8/4/1210/030
MSPSAOMKT
SAUS90 KWBC 141411
 MKT SA 1352 E100 OVC 10 7/3/1116/030
MSPSAOMKT
SAUS90 KWBC 141202
 MKT SA 1145 E150 OVC 10 5/2/1212/036
```

Fig. 3. Five hour trace of weather observations at Mankato, Minnesota on January 14, 1988.

basic jet core theory and looking for dry/moist couplets. While this technique does not necessarily apply in every case, it can be a valuable aid to forecasting.

Since the curve was developed in the winter, it may need to be adjusted somewhat for summer use. It is anticipated that this curve also will be helpful in detecting mid-level dry air intrusions, often associated with the development of severe thunderstorms (Beckman, 1987). Other possible applications include identifying: (1) the filling of surface lows (Weldon, 1985), (2) the development of upper low centers (Beckman, 1987), and (3) regions of turbulence (Ellrod, 1986).

5. References

Beckman, S. K., 1987: Operational use of water vapor imagery. NOAA Technical Memorandum NWS CR-87, National Weather Service Central Region, Scientific Services Division, Kansas City, MO, 15 pp.

Ellrod, G. 1986: Uses of satellite imagery in turbulence detection. Proceedings, 24th Aerospace Sciences Meeting of the American Institute of Aeronautics and Astronautics (Reno, NV), 7 pp.

Weldon, R., 1985: Water vapor imagery interpretation. Notes presented at the National Weather Service Flash Flood Course, National Weather Service Training Center, Kansas City, MO, December 1986. This was excerpted from a NOAA Technical Memorandum to be published in 1988.