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A PROPOSED SCHEME FOR COLOR ENHANCEMENT OF WATER VAPOR IMAGERY ON SWIS

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Water vapor (WV) imagery from the 6.7μ channel on GOES is becoming an increasingly valuable tool for synoptic and even mesoscale analysis of the mid and upper troposphere (Beckman, 1987). Operational use of this tool can be increased by using the animation and color enhancement capabilities of the Satellite Weather Information System (SWIS). Some enhancement techniques have previously been developed at the WSFOs (e.g., Morris and Field, 1988). This note describes another scheme which highlights some of the most important features: (1) dry zones associated with jet streaks, shortwave troughs and upper level anticyclones, (2) areas of transition in upper level moisture, (3) cirrus clouds and (4) very cold clouds (thunderstorms or very deep multilayered cloud systems).

The enhancement employs a simple color scheme involving three colors: yellow to show dry zones, green for cirrus clouds and red for very cold cloud tops. A gray to white enhancement shows the transition from the dry, yellow to moist, green cirrus regions. Within each color, a range of color intensities shows variations of conditions. For example, yellows become darker to correspond to drier air aloft. Table 1 shows the input gray scale values and output color counts for each enhancement level.

The current gray scale enhancement on the WV images is referred to as the "ZA curve." It is really an alteration of the gray shades produced within the data processing stream before the image data reaches the sectorizers. The ZA enhancement is designed to simulate the "ZD curve" used on images produced prior to the "Mode AAA" conversion in the summer of 1987. With the ZA curve, dry regions are often extremely dark, too dark for the eye to easily perceive any significant changes. The color enhancement described here will highlight subtle drying (darkening) trends which would otherwise go undetected.

The color enhancement was designed on the McIDAS (Man computer Interactive Data Analysis System) at Camp Springs, Maryland. The enhancement was then entered on the SWIS at the Washington, D. C. WSFO, after a conversion to account for a larger number of gray shades and different color choices available with the SWIS.

The green color threshold was selected to match the cirrus coverage at mid latitudes. This was done by toggling back and forth between the IR and corresponding WV image. The green color level, however, overestimates the cirrus area coverage at high latitudes due to absorption of radiation at the oblique viewing angle. Conversely, some underestimate of cirrus has been observed at low latitudes. Some small adjustments to the green threshold may be made to correct for these biases, depending on the user's area of interest. Mottled green areas seem to correspond to thin, patchy cirrus while solid green indicates more widespread cloud cover.

The red color threshold corresponds approximately to the -55°C temperature on the infrared images (dark grey on the MB enhancement curve). With the presence of thick, cold clouds, very little radiation is reaching the satellite from subcloud regions in either the WV or IR channels, thus they have similar brightness values.

Some characteristics of the upper level moisture conditions for each color range have been noted. The yellow regions correspond to deep, dry layers aloft with temperature-dew pont spreads ($T-T_d$) of 30°C or more. Darker yellows usually indicate some subtle differences such as a somewhat deeper dry layer and/or slightly warmer temperatures at high levels. The gray-to-white transition zone may relate to a large number of possible conditions. In general, moisture is increasing aloft as the image becomes whiter; $T-T_d$ decreases from, say, 20-30°C for dark gray to 5-10°C in the white regions. Thin cirrus not detectable in IR could be present in the white zone. Although temperature certainly has an effect on the observed brightness, the height and thickness of the moist layer are more important (Weldon and Steinmetz, 1983). Finally, green and red zones relate to nearly saturated conditions ($T-T_d \leq 5$°C), with lighter greens and reds indicating thicker (or higher) clouds.

Figure 1 shows the black and white version of the color-enhanced water vapor image at 1100 UTC, 10 November, 1988. A line of weakening showers or thunderstorms (green and red) has a western terminus in east Texas, surrounded by a dry zone (yellow) at the southern end. Radiosondes for Midland, TX (MAF), Oklahoma City (OKC) and Jackson, MS (JAN) are shown in Figure 2. Very dry conditions aloft are seen at MAF, which is located in the dry band. This dry zone probably corresponds to the subtropical jet stream which can be seen in the 200 mb winds at MAF. A shallow moist layer is evident at OKC where the image is light gray. At JAN, a deeper moist layer is present at 400 mb and up, which is apparently anvil debris associated with the line of convection.

<u>References</u>

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

Morris, T. R. and G. A. Field, 1988: Where's the jet max?: A dry band color enhancement technique. NWS Central Region Technical Attachment 88-22, May, 1988, 6 pp.

Weldon, R., and S. S. Steinmetz, 1983: Characteristics of water vapor imagery. Satellite Applications Laboratory (NESDIS), 23 pp.

TABLE 1.

Water Vapor Enhancement Table

Input Gray Level	Output Color Count	Color Range
0-16	66	Dark Yellow
17-32	69	.
33-48	72	.
49-64	75	.
65-80	78	.
81-96	81	.
97-112	84	Bright Yellow
113-120	214	Dark Gray
121-128	219	.
129-136	224	.
137-144	229	.
145-152	234	.
153-160	239	White
161-176	100	Dark Green
177-192	108	.
193-208	116	.
209-224	124	Bright Green
225-240	44	Dark Red
241-256	55	Bright Red

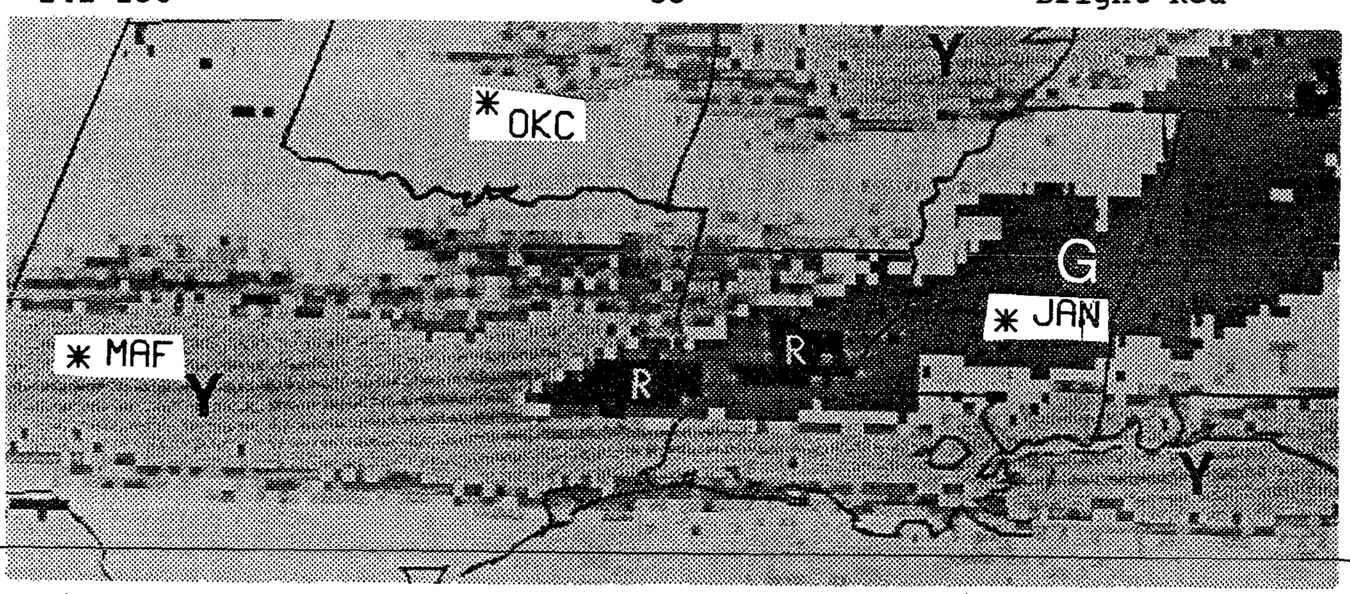

Figure 1. A segment of the enhanced water vapor image at 1100 UTC, 10 November, 1988, as seen on the McIDAS display. Letters are color codes, R for red, Y for yellow and G for green.

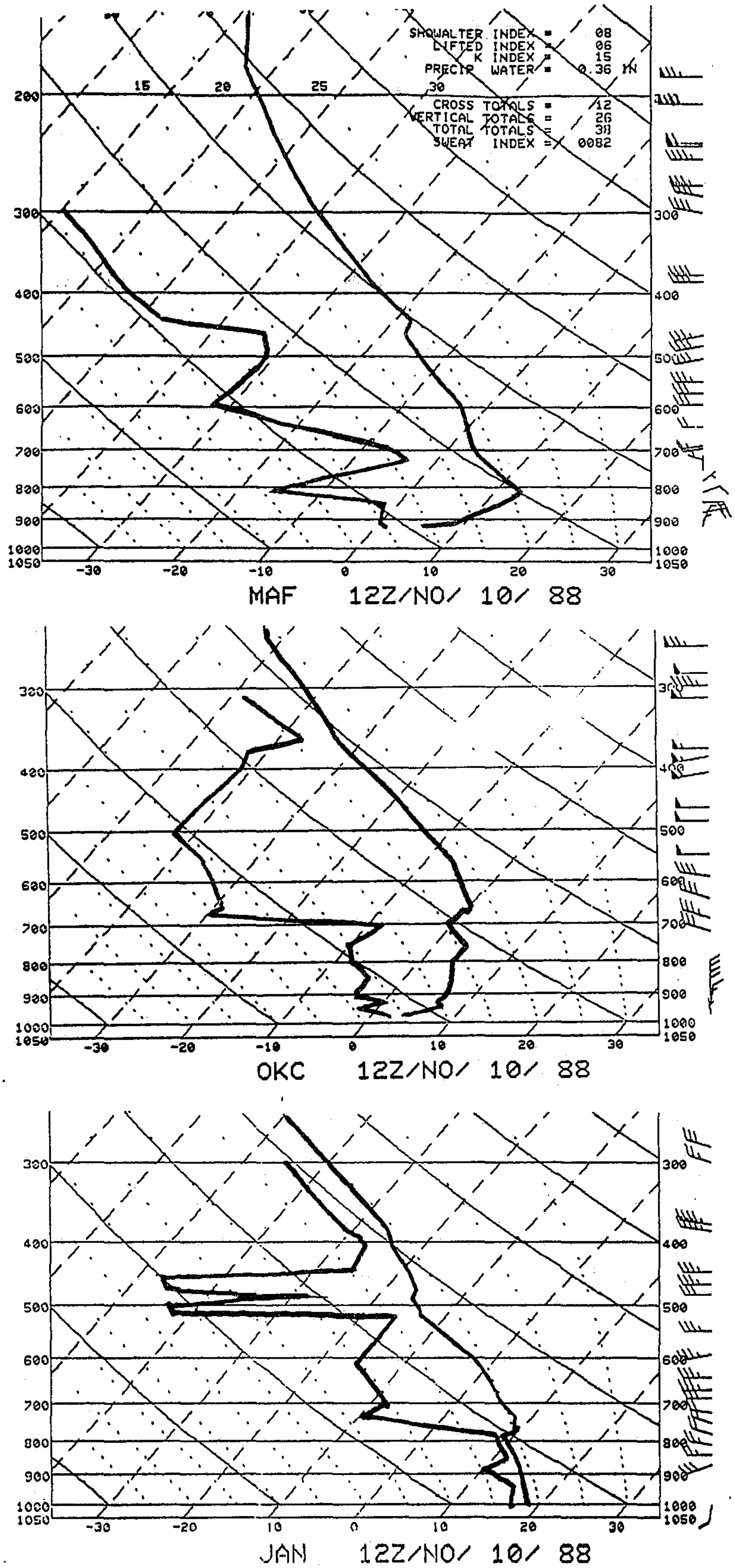

Figure 2. Radiosonde plots for 1200 UTC, 10 November 1988 for Midland, TX (MAF) (top), Oklahoma City (OKC) (middle), and Jackson, MS (JAN) (bottom).