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A Technique for Directly Comparing Radiances From Two Satellites

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The SBUV instrument on Nimbus 7 and the SBUV-2 instrument on NOAA-9 are almost identical, each measuring the ultraviolet atmospheric albedo at wavelengths from 2500-3400 Å to infer total ozone and ozone profiles. While derived ozone has been compared for the two instruments, understanding the calibration differences between the two instruments requires that the measured radiances be compared. The problem is that SBUV is in a noon sun synchronous orbit while SBUV-2 is in an afternoon orbit (Figure 1). Radiances cannot be compared directly because the solar zenith angles of the observations are different (Figure 2).

Comparison of ozone values avoids this problem because solar zenith angle effects are implicitly taken into account in the retrieval algorithm. Figure 3 is a plot of the weekly average differences between SBUV and SBUV-2 of total ozone and of Umkehr layer ozone amounts. Initial biases between the two instruments, 5% in total ozone in March of 1985, are probably due to degradation of the SBUV diffuser plate, which had been in use for six years when NOAA-9 was launched. The relative change between 1985 and 1987 was significant for total ozone but was especially striking for ozone in the upper stratosphere, layers 7-10. This change was likely due to SBUV-2 orbit drift since SBUV degradation was fairly well known and much less rapid. In order to understand this change in ozone, it would be very useful to know the changes in the radiances.

A technique to compare radiances has been developed in which the measured albedo at each wavelength is put onto a common solar zenith angle scale. A forward calculation for each wavelength is done using the derived ozone profile, then repeated for the common solar zenith angle to predict what each instrument would have measured had it been at the standard solar zenith angle. This technique is accurate provided neither the zenith angle nor the zenith angle correction is large. Direct comparisons of the instrument measurements (Q values) are then possible. The Q value is the ratio of the backscattered radiance to the extraterrestrial solar irradiance scaled by the Rayleigh scattering phase function.

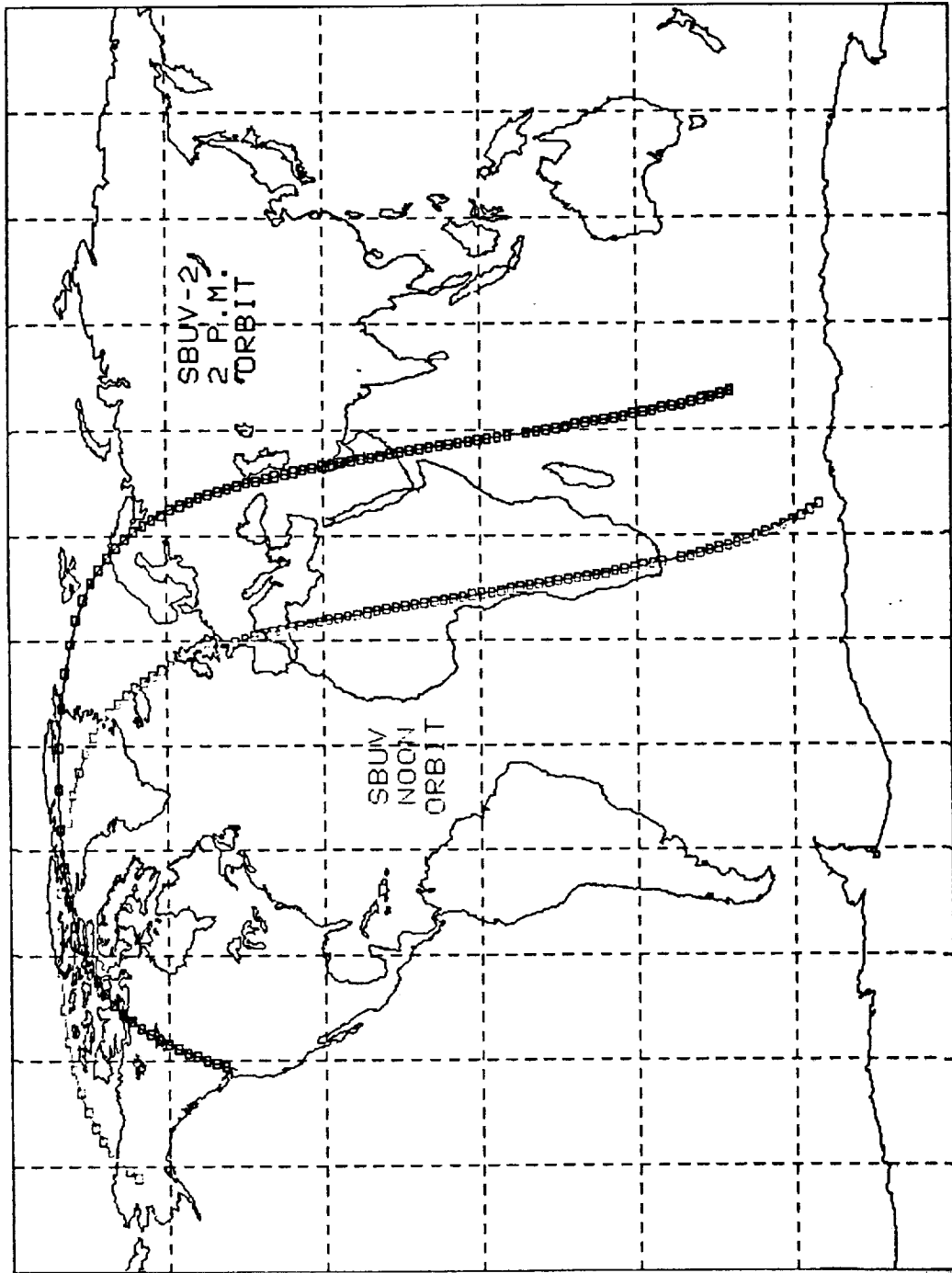
Such radiance comparisons for March of 1986 are shown in Figures 4 and 5. Differences traceable to calibration should be independent of latitude; ie., the difference curves should be flat. Significant deviations occur at large solar zenith angles (high latitudes) and at wavelengths for which multiple scattering is important (2975-3058 Å), indicating the limits for the

technique.

The time dependence of the relative change between the two instruments is shown in Figure 6, normalized to day 1. Between March 1985 and August 1987 there was almost a 14% relative change at 2975 Å, the longest wavelength shown, and a 20% relative change at the shortest wavelength, 2735 Å. During this period the SBUV-2 orbit drifted from 2 PM local time to approximately 5 PM local time. The increasing incidence angle on the diffuser plate during solar flux measurements is being examined as the possible cause of the apparent SBUV-2 calibration change. To first order, such goniometric errors would be expected to be wavelength independent.

The explicit wavelength dependence is shown in Figure 7. The most striking conclusion is that the differences between SBUV and SBUV-2 are almost wavelength independent for wavelengths 2735 Å through 2922 Å. The results for wavelengths 2975-3058 Å are less reliable because multiple scattering is important for these wavelengths but was not included in the forward calculation. But the fact that total ozone changes relative to the Dobson network are observed indicates that there is some wavelength dependent error for wavelengths greater than 3000 Å. The wavelength dependence that is seen at the shorter wavelengths is consistent with the long term degradation of the SBUV diffuser plate, which is known to be greater at shorter wavelengths.

SBUV ORBITS JUNE 87

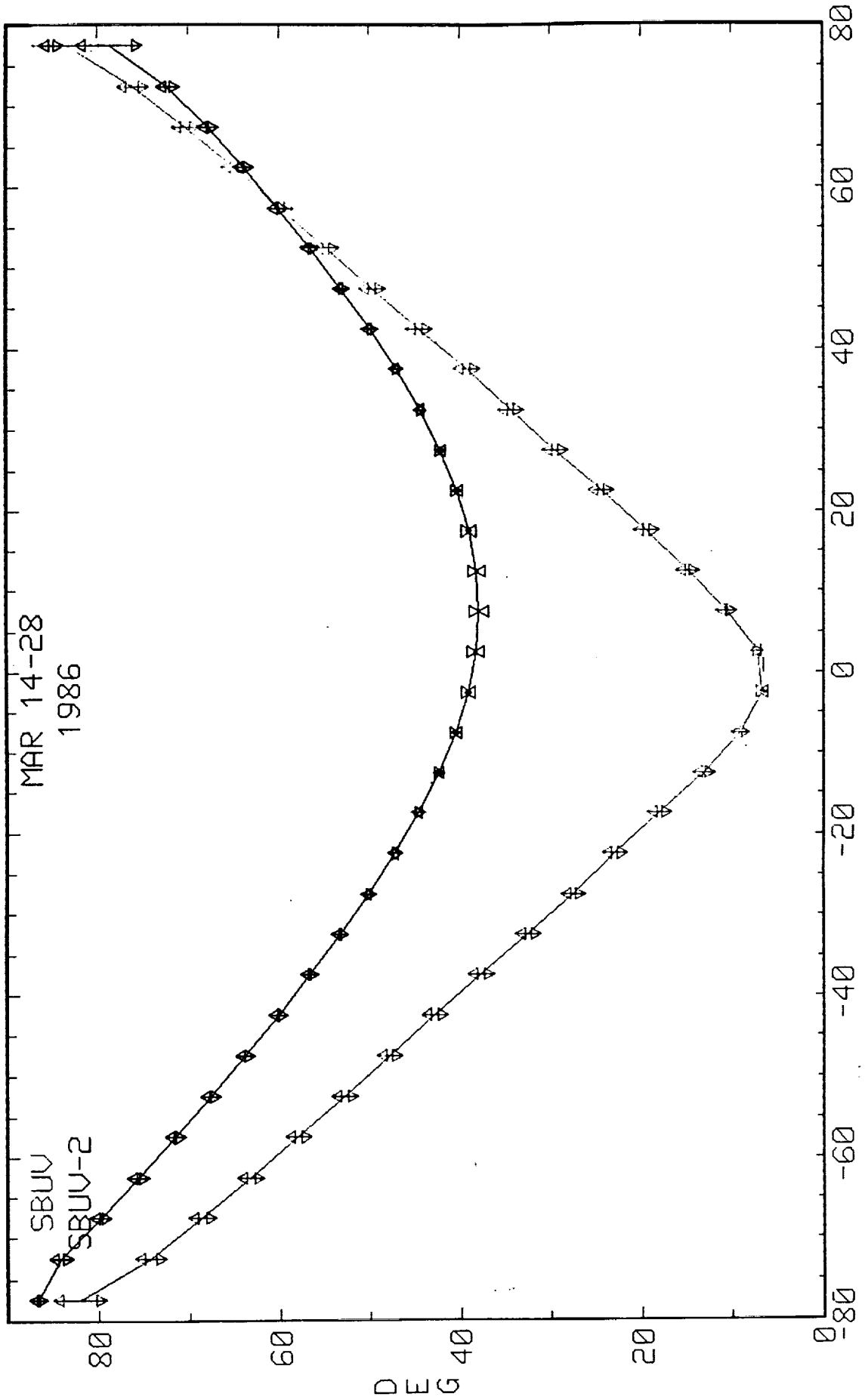


SBUV & SBUV-2 ZA

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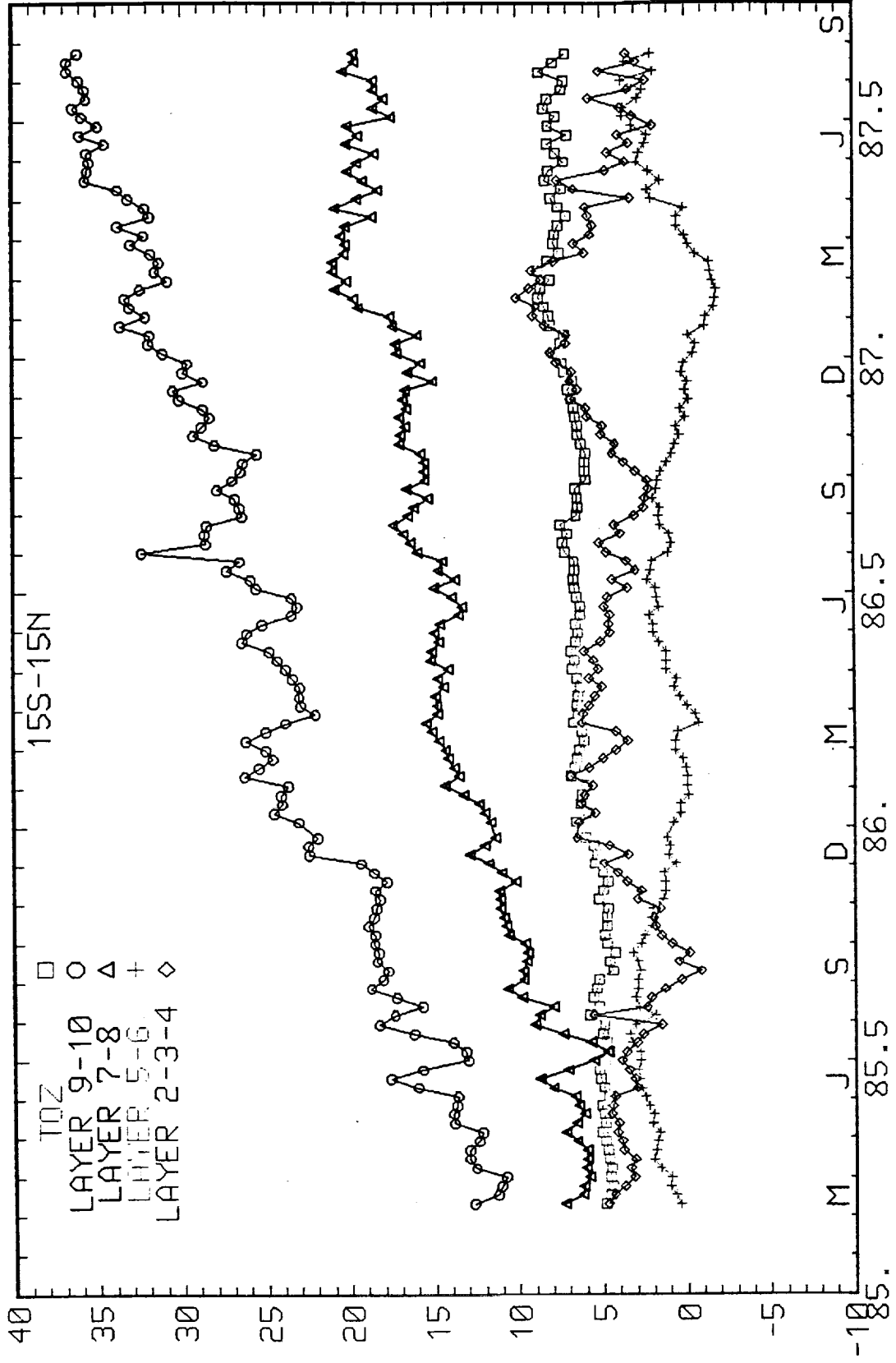
MAR 14-28
1986



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SBUV2-SBUV PERCENT DIFF

03/08/89



YEAR

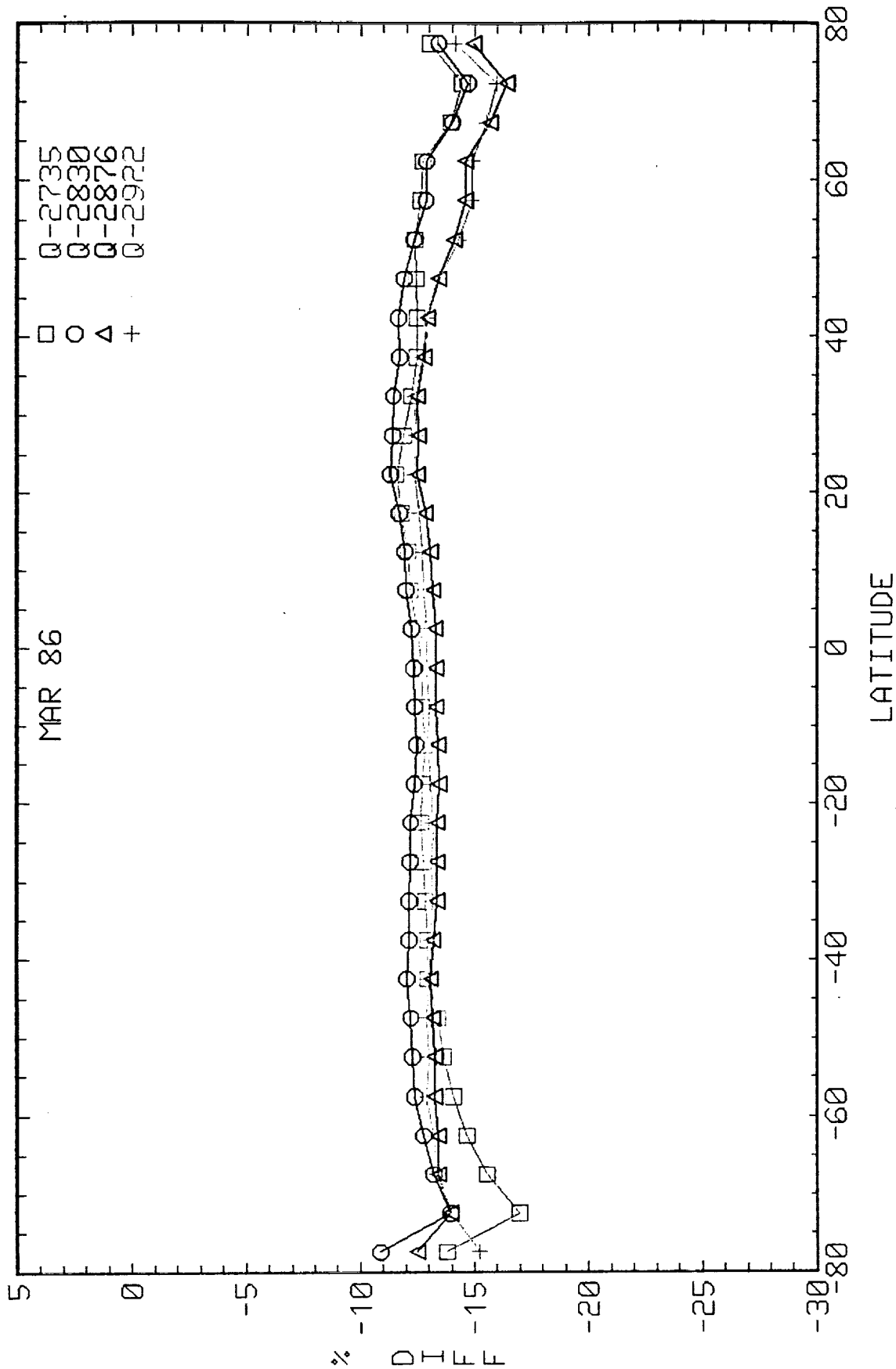
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SBUV2 - SBUV PERCENT DIFF

05/08/89

MAR 86

□ 0-2735
○ 0-2830
△ 0-2876
+ 0-2922



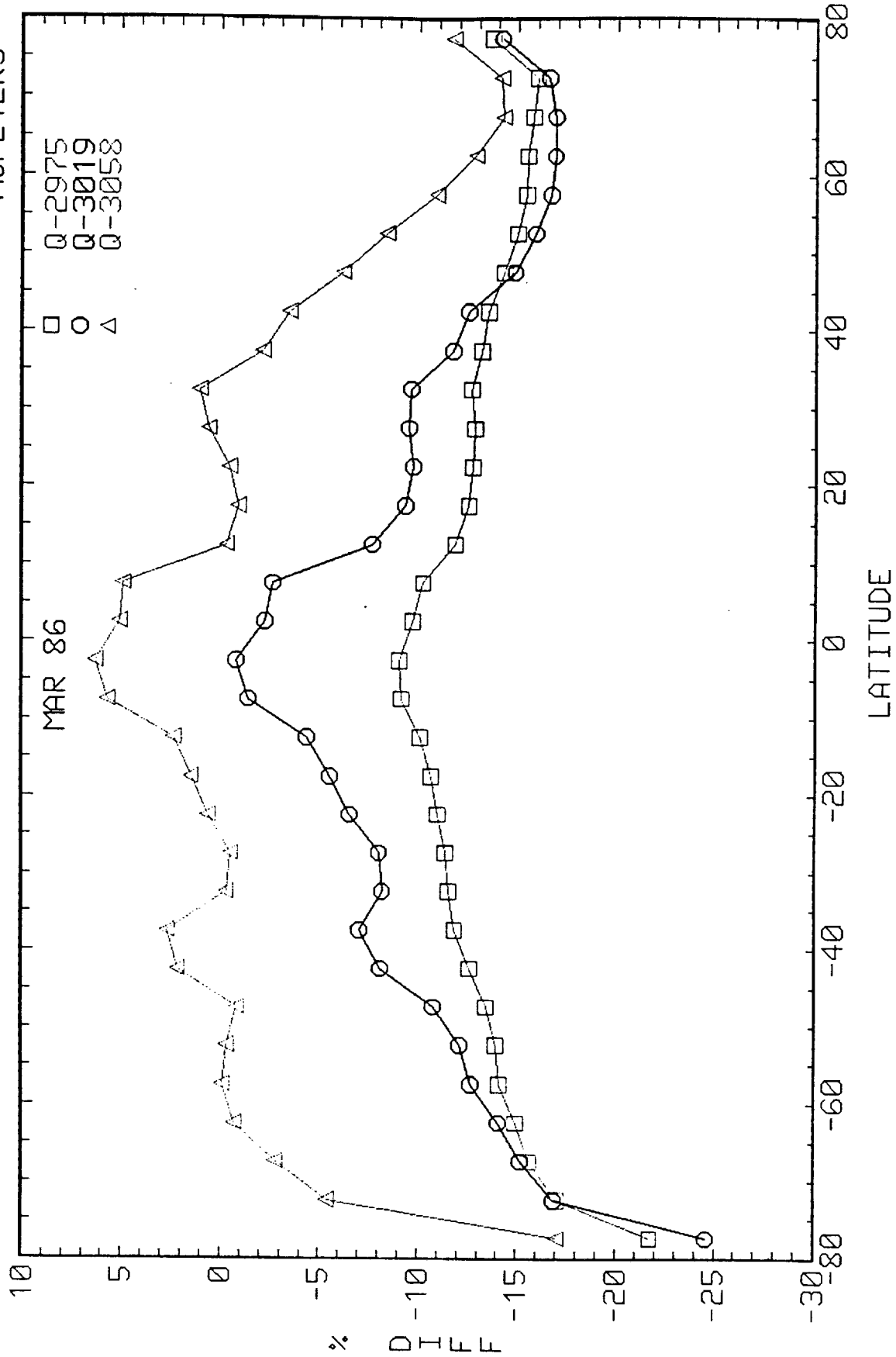
SBUV2 - SBUV PERCENT DIFF

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MAR 86

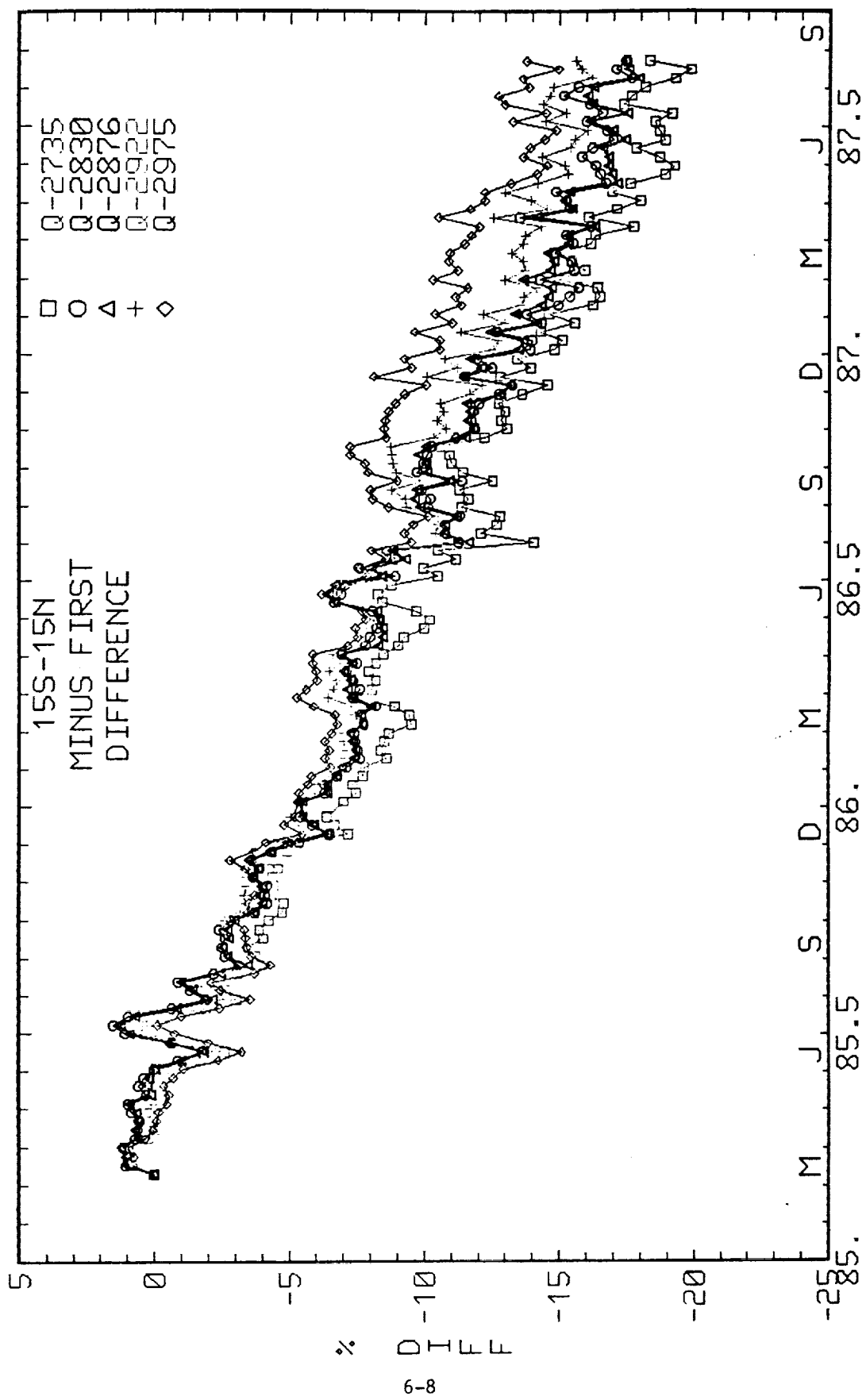
□ 0-2975
○ 0-3019
△ 0-3058



SBUV2-SBUV PERCENT DIFF

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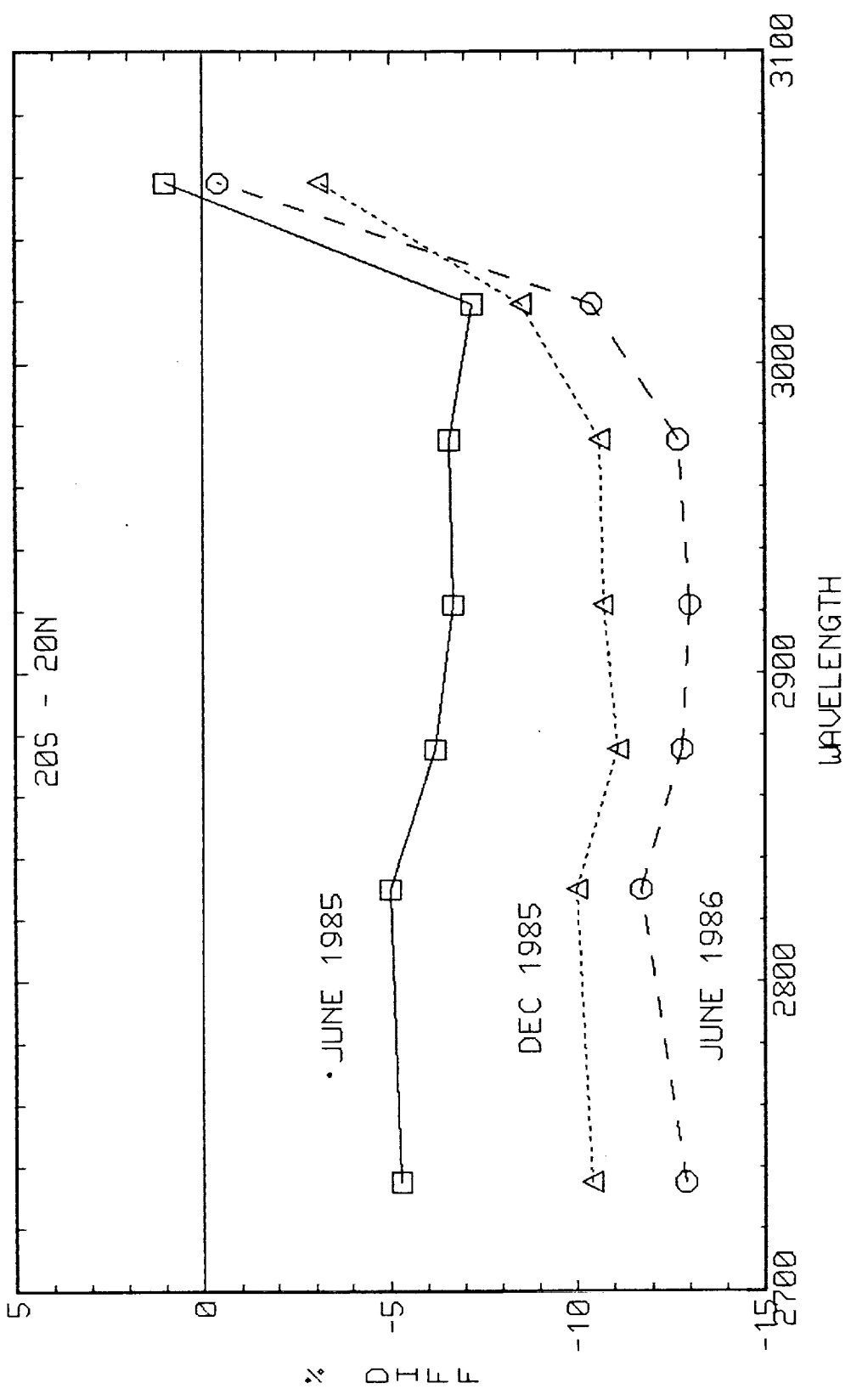
% DIFF

YEAR

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SBUV2 - SBUV DIFFERENCE

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Attachment 7
SBUV/2 Comparisons
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NOAA/NWS-CAC

