13th International TOVS Study Conference

ATOVS Operational Cloud Products from HIRS/3 and AMSU-A

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http:/poes.nesdis.noaa.gov/

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- Improvements to the accuracy and coverage of the ATOVS Cloud Products has been built on the efforts of many researchers and programmers over the last 30 years. In recognition of the hard work and contributions made by the following persons:

S. Manuabe; D.J. McCleese; L.S. Wilson; M.T. Chahine; W.P. Menzel; W.L. Smith; T.R. Stewart; A. Heidinger; C.G. Wellemeyer; P.H. Wang; P.K. Bhartia; T.F. Eck; L.L. Stowe; S.M. Read; C.C. Long; J.D. Susskind; S. Zhou; A. Nappi; S.K. Yang; H. Woolf; A. Swaroop; L. McMillin; F. Tilley; B. Baril; K. Campanna; A. Allegrino; L. Wilson

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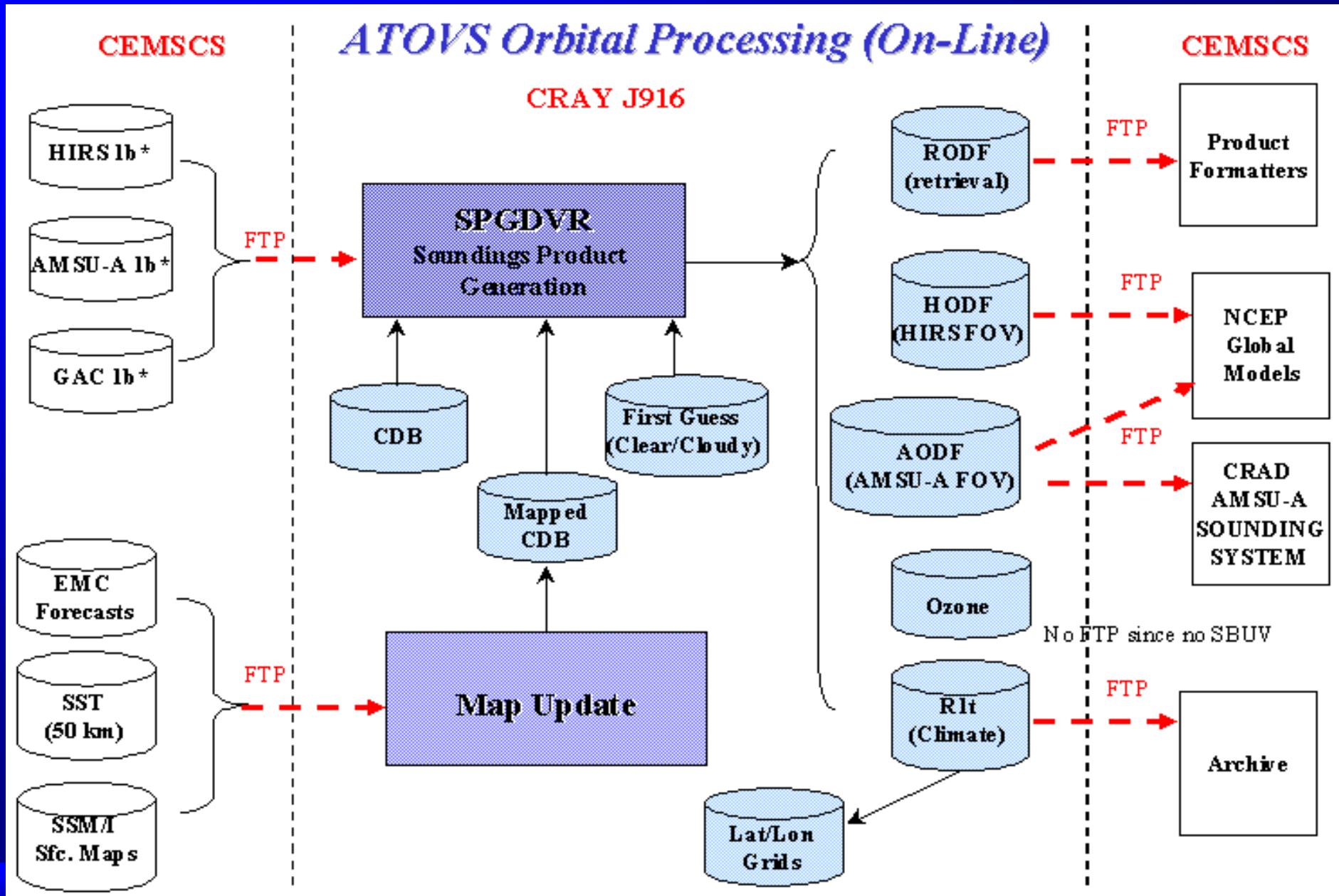

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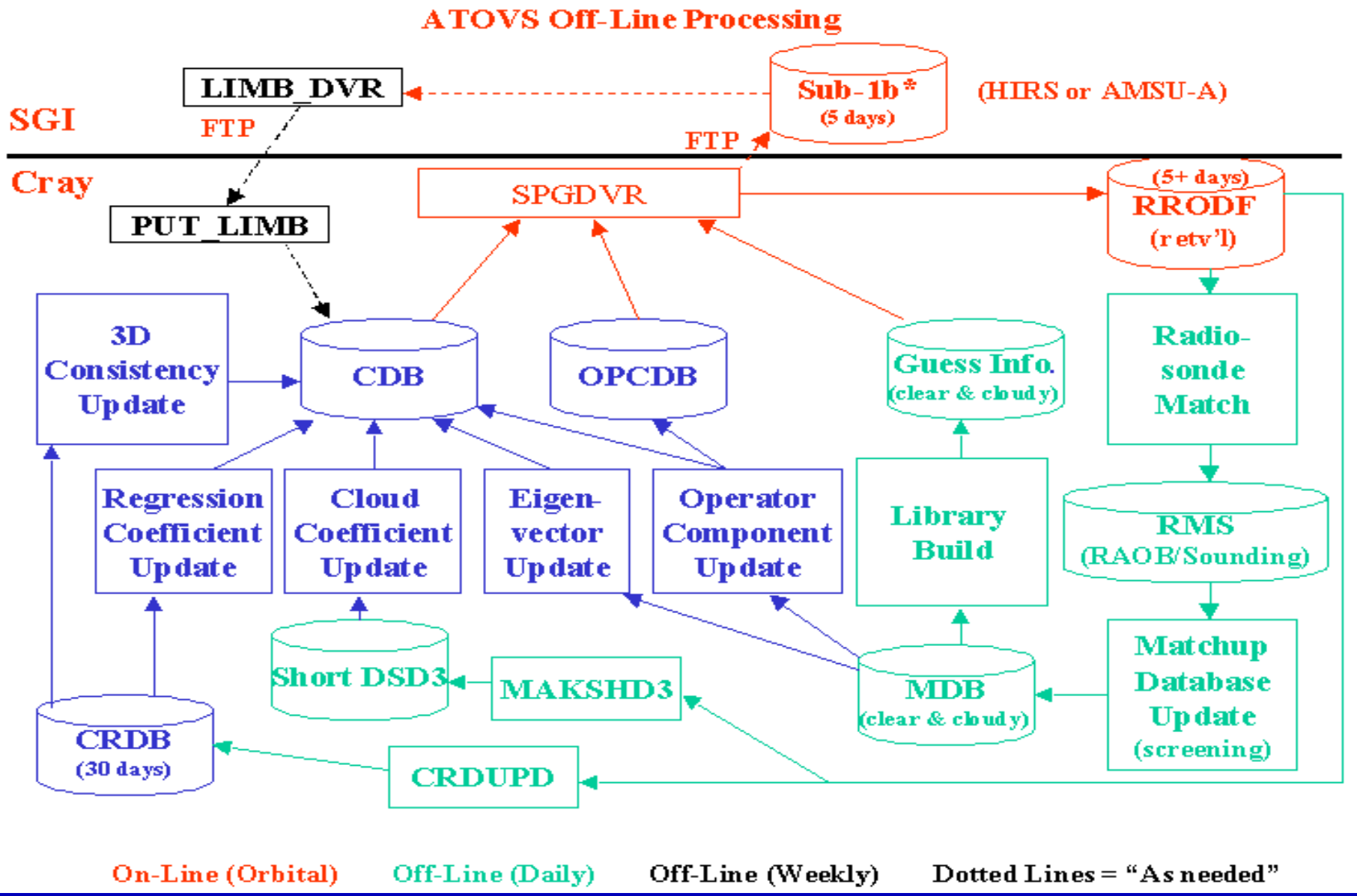
This graphic illustrates the ATOVS off-line sub-systems with the daily, weekly and periodic update sub-networks



ATOVS HIRS Based Atmospheric Products

- Temperature / Moisture Soundings & Total Ozone are operational along with 20 secondary products
- ATOVS Cloud and Radiation Products have been available to selected users, for product evaluation since 1994
- New Operational Product Suites (as of Jan. ’04) Include:
  - Cloud Products – Cloud Top Pressure; Cloud Amount; and Cloud Top Temperature
  - Radiation Products – ALL_SKY OLR; CLEAR_SKY OLR; CLEAR_SKY Layer Cooling Rates

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The CO2 Slicing Technique used by both GOES and ATOVS

1) Calculate Cloud Top Temperature iteratively using the Newton-Ralphson method (using HIRS 7 & 8 as pilot pair).

2) Obtain the Cloud Top Pressure from the ATOVS Temp. Sounding then correct the channels for attenuation above the cloud tops and repeat steps 1 & 2.

3) Select a channel pair which straddles the cloud top pressure, correct for attenuation above the cloud top and re-compute Cloud Top Temp. and obtain Cloud Top Pressure.

4) Compute the CLEAR HIRS ch # 8 temperature and correct this and the skin temperature for attenuation above the cloud top, convert to radiance and finally compute CA.

$$T_{c(n+1)} = T_{c(n)} - (f(T_{c(n)} - m) / (f(T_{c(n)}) - f(T_{c(n)} - d)) \quad (1)$$

where $T_c = f(I(v_2)m)$

and $f(T_c) = (I(v_2)c - I(v_2)o) / (I(v_1)c - I(v_1)o)$ (2)

where, n = iteration number

d = increment temperature

T_c = Cloud Top Temperature

m = slope of the line formed by the ratio of the paired channel radiance differences

$m = (I(v_2)c - I(v_2)m) / (I(v_1)c - I(v_1)m)$ (3)

$I(v_1)c$, & $I(v_2)c$ = clear radiances for paired channels 1 & 2

$I(v_1)m$, & $I(v_2)m$ = measured radiances for paired channels 1 & 2

$I(v_1)o$, & $I(v_2)o$ = overcast radiances for paired channels 1 & 2

$$A_c = 1 - (I(v_2)m - I(v)o) / (I(v_2)c - I(v)o) \quad (4)$$

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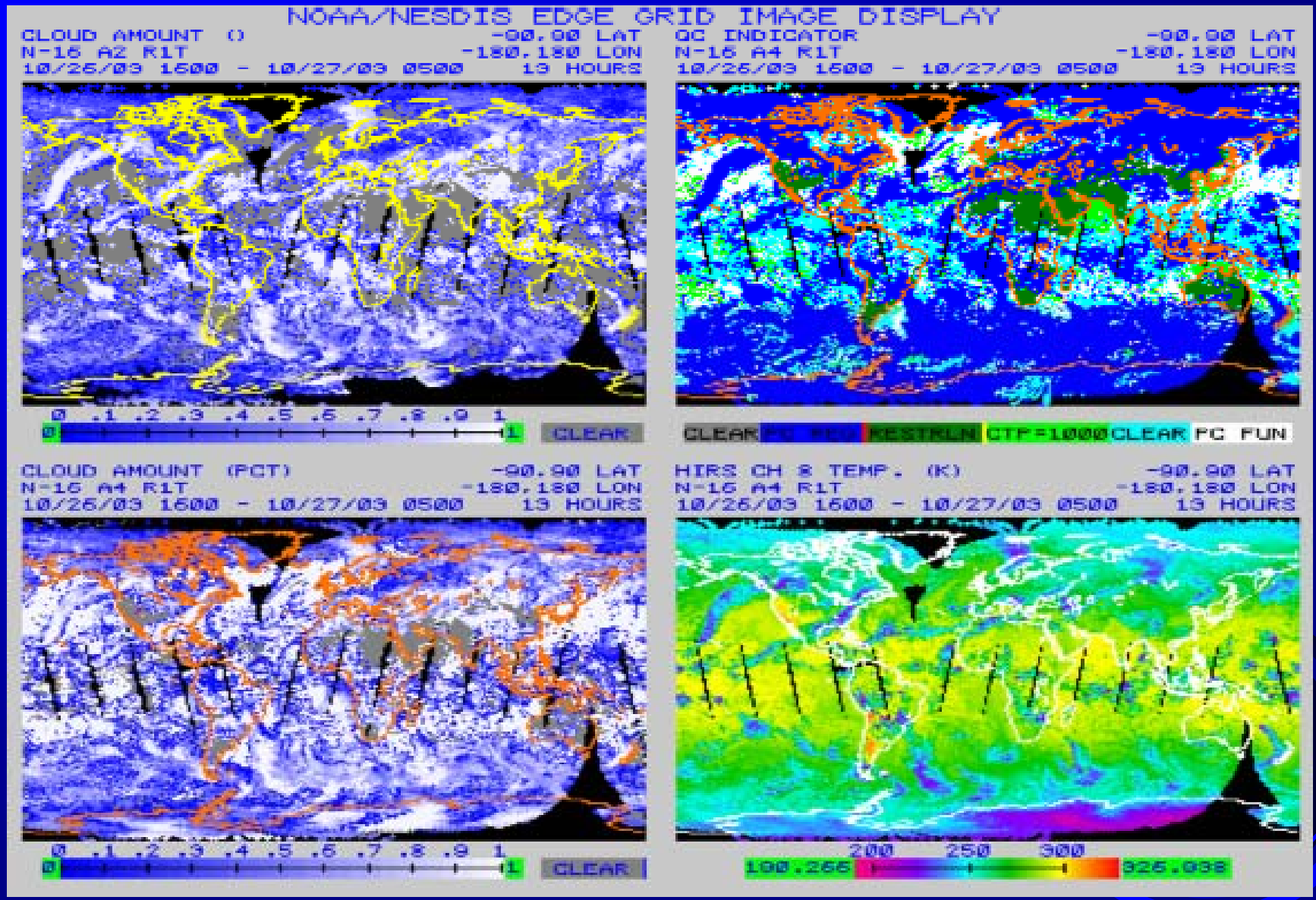

This image shows improvement to the ATOVS Cloud Procuct coverage

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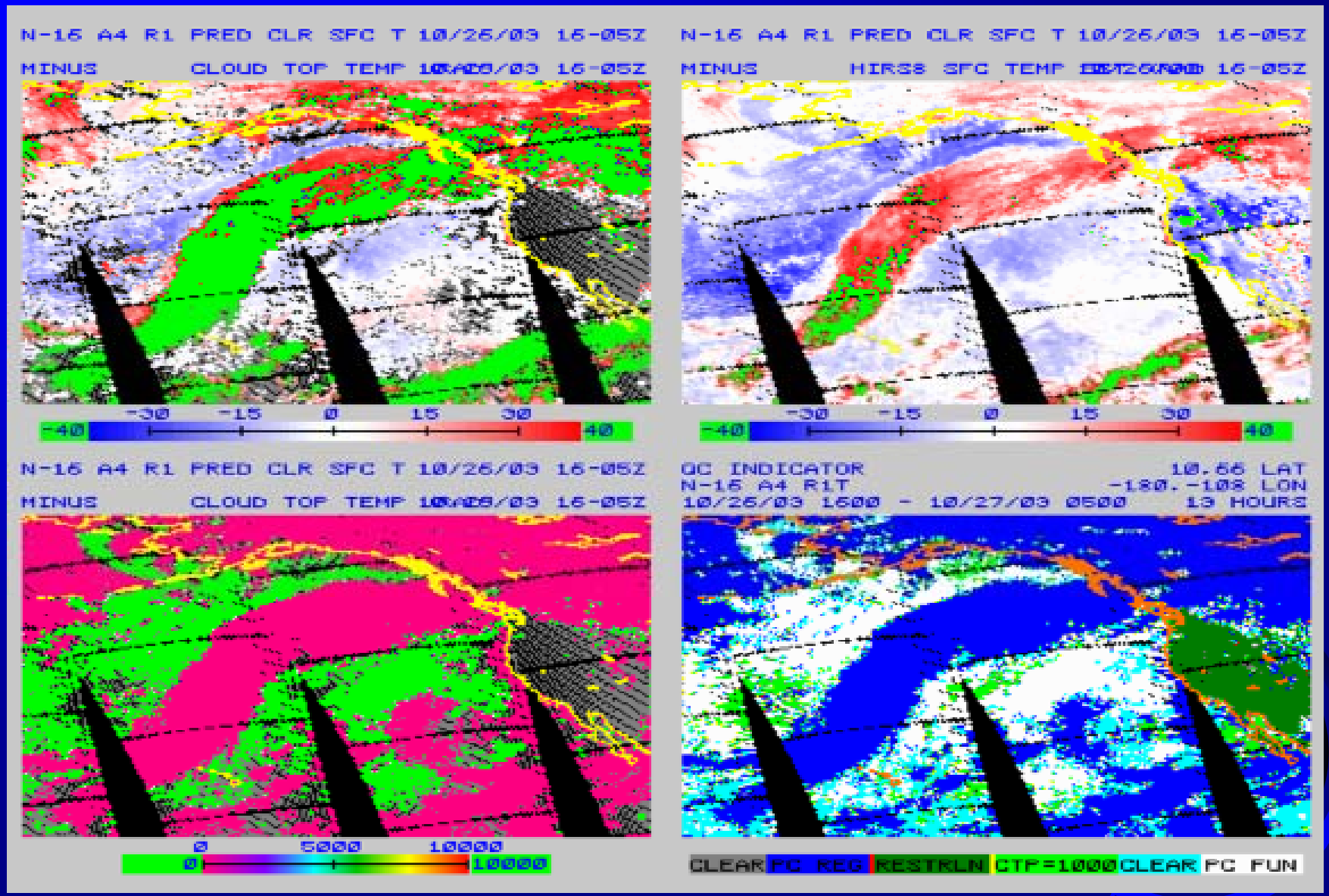

(PC – CTT) left; (PC – STE) top right, with Q/C Flag bottom right

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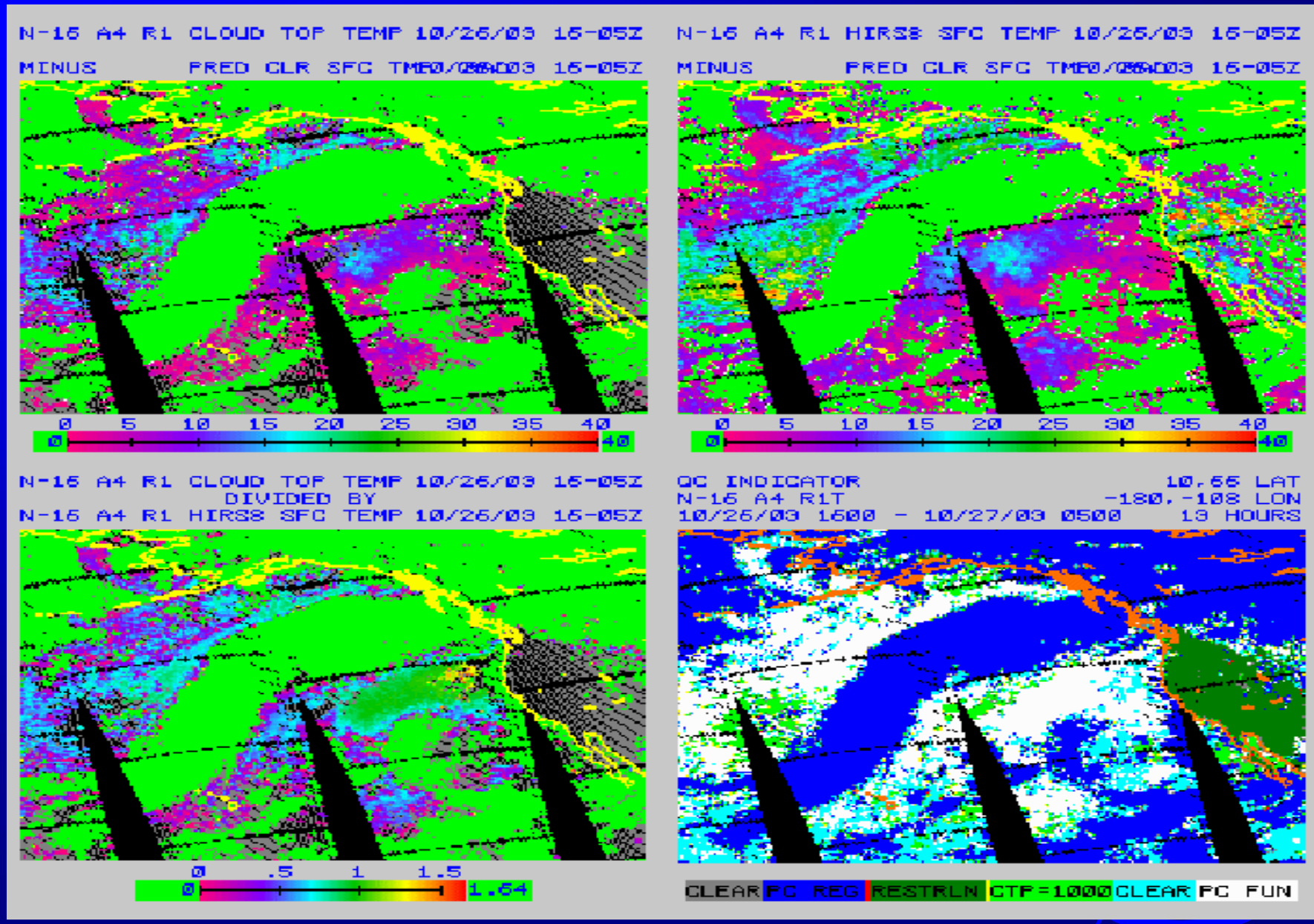

(CTT – PC) & (STE – PC) top; Cloud Amount & Q/C Flag bottom

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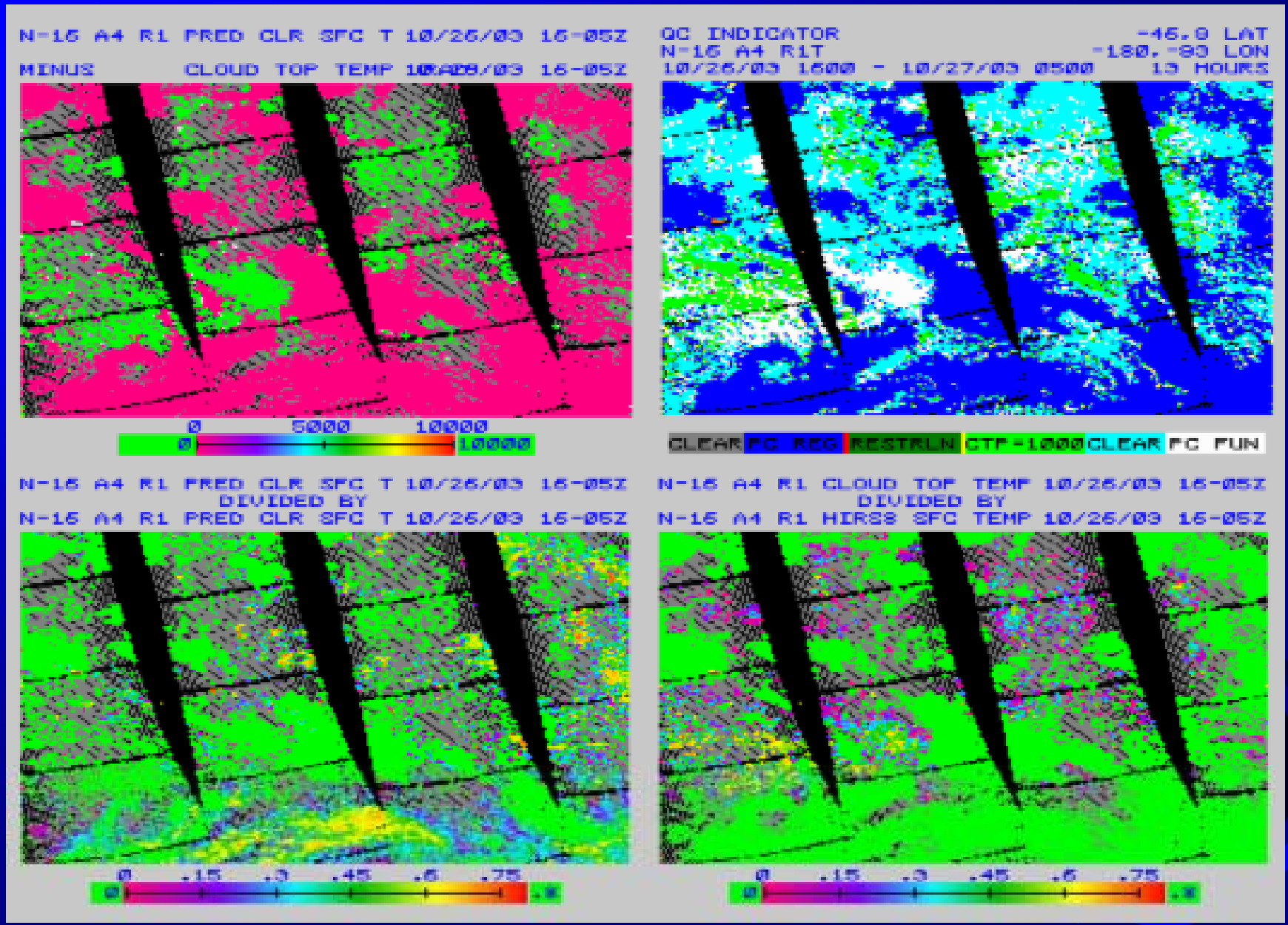


(PC - CTT) discriminator top; Cloud Amount of marine stratus for regular & inverted

$I(\nu_1)c$, & $I(\nu_2)c$ = clear radiances for paired channels 1 & 2

$I(\nu_1)m$, & $I(\nu_2)m$ = measured radiances for paired channels 1 & 2

$I(\nu_1)o$, & $I(\nu_2)o$ = overcast radiances for paired channels 1 & 2

$$A_c = 1 - (I(\nu_2)m - I(\nu)o) / (I(\nu_2)c - I(\nu)o) \quad (5)$$

or

$$A_c = (I(\nu_2)c - I(\nu_2)m) / (I(\nu_2)c - I(\nu)o) \quad (6)$$

This covers:

~58% of HIRS/3 FOVs retrieved as CLOUDY and,

~6% of HIRS/3 FOVs are flagged as Restralen (LAND) as CLEAR

~6% of HIRS/3 FOVs are computed with CTP = 1000 hPa are CLEAR

The problem is in areas where $(I(\nu_2)c - I(\nu)o)$ **.LE. 0.0**

~22% of HIRS/3 FOVs show **CTT > Predicted CLEAR Temp.**

~8% of HIRS/3 FOVs show mixed mode

The solution is **(NOT YET AUTHORIZED FOR OPERATIONS)**

1) Invert the equation for A_c when $(I(\nu_2)c - I(\nu)o)$ **.LE. 0.0** and use the absolute value, for this difference.

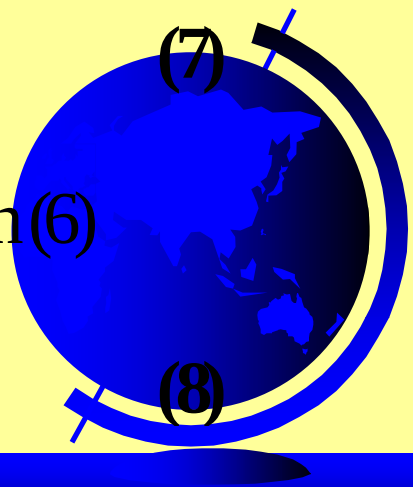
2) The mixed mode must be handled, for either case, by insuring that $(I(\nu_2)c - I(\nu_2)m)$ **.GT. 0.0** and use the absolute value, for this difference.

Therefore, the retrieval of Cloud Amount for the regular mode equation (6) becomes:

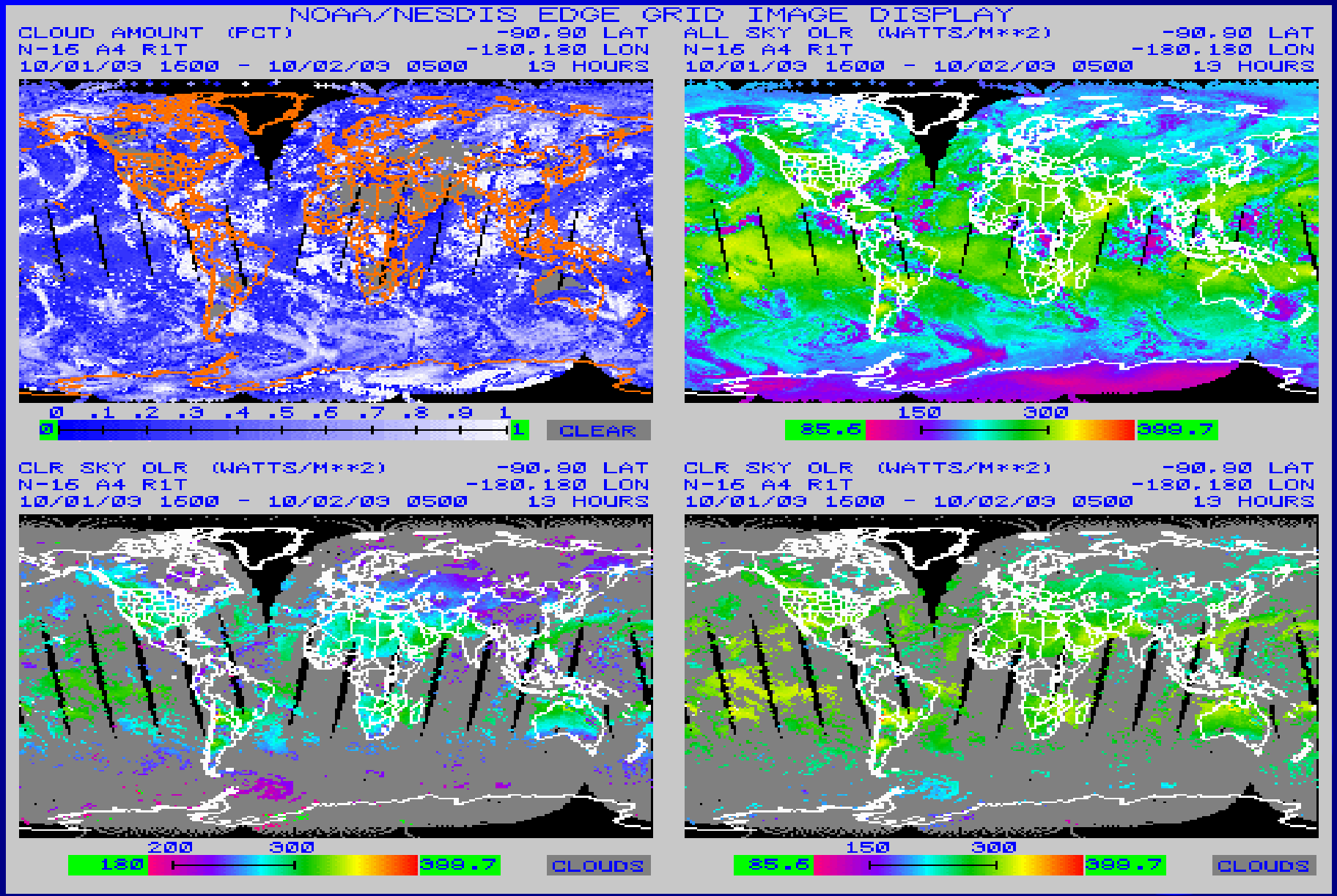
$$A_c = |(I(\nu_2)c - I(\nu_2)m)| / |(I(\nu_2)c - I(\nu)o)| \qquad (7)$$

For the retrieval of Cloud Amount in the inversion mode equation (6) becomes:

$$A_c = |(I(\nu_2)c - I(\nu)o)| / |(I(\nu_2)c - I(\nu_2)m)| \qquad (8)$$

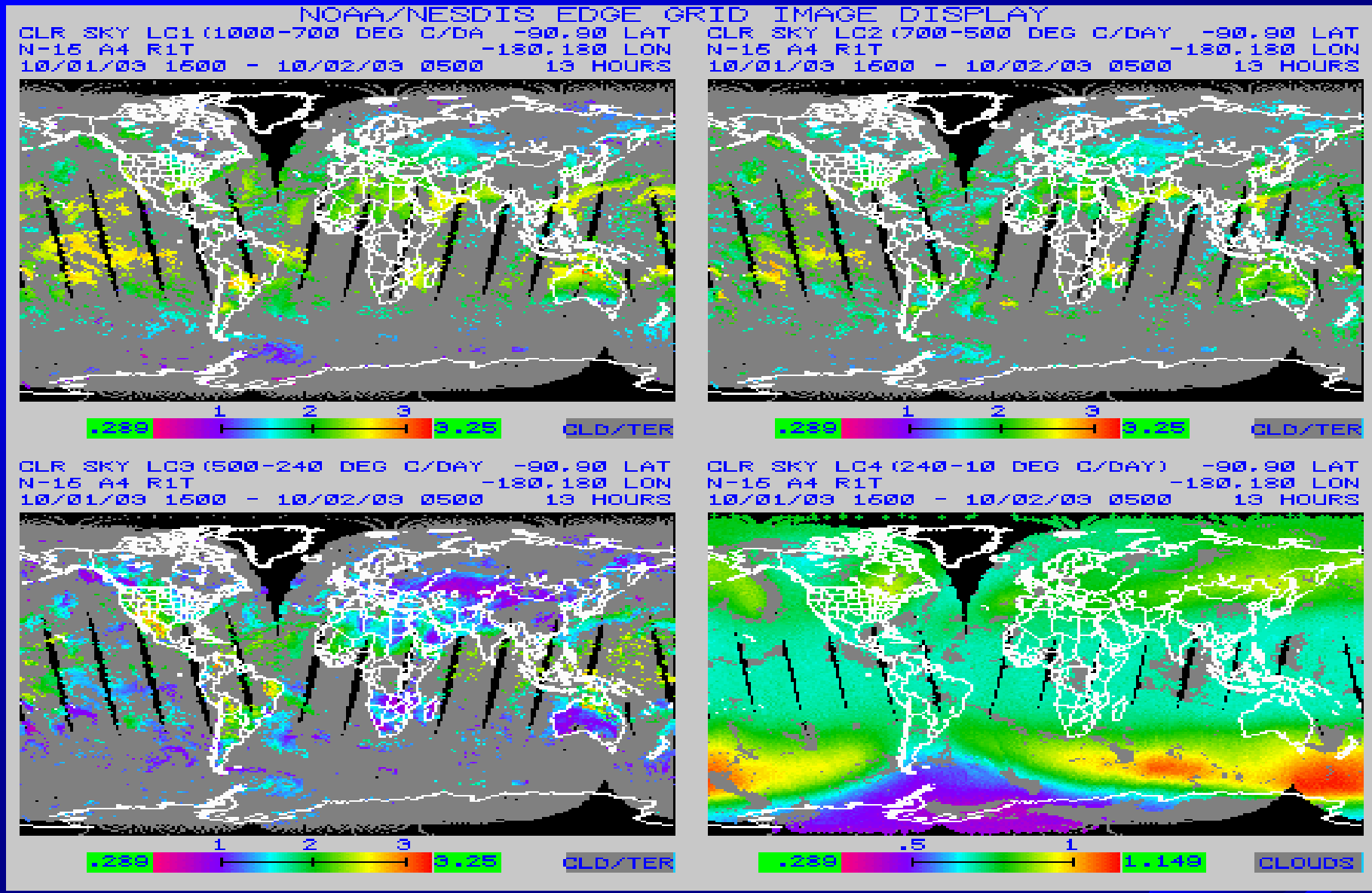


ATOVS Cloud/Radiation Products



Cloud Amount; ALL_SKY OLR; and CLEAR_SKY OLR with two scales (bottom)

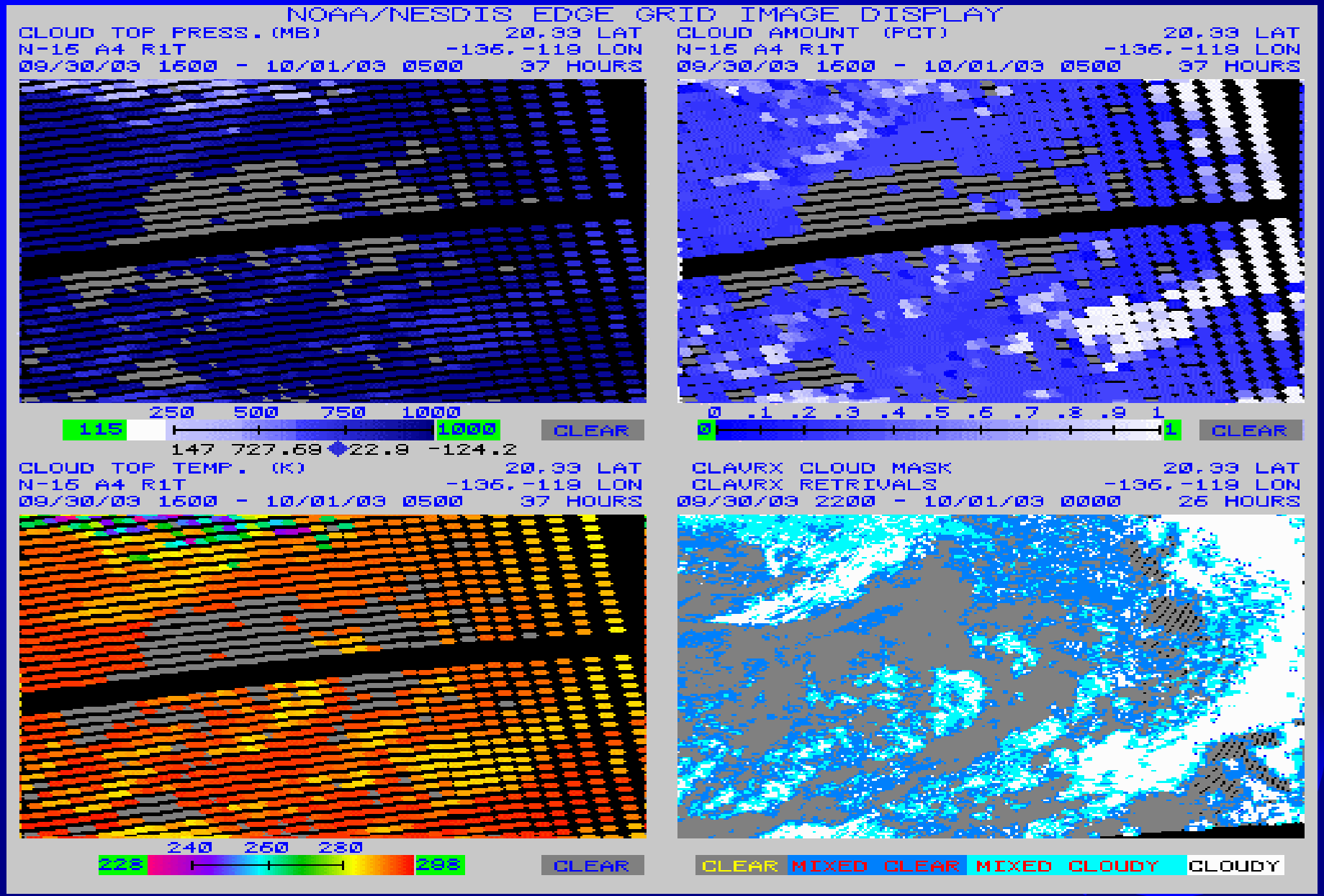
ATOVS Cloud/Radiation Products



CLEAR_SKY Layer Cooling Rates (filtered for Clouds and Terrain)

CLEAR_SKY LCR4 (filtered only for High Clouds and at a different scale)

ATOVS Cloud/Radiation Products



Cloud Top Pressure; Cloud Amount; Cloud Top Temperature; CLAVR-x Cloud Mask

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ATOVS Cloud & Radiation Product Formats

- Current distribution of ATOVS Cloud products is via AWIPS to NWS Field Forecast Offices with the Soundings, at 1 out of 4 HIRS/3 FOVs

- Operational distribution and archive of ATOVS Cloud & Radiation product suites shall be at each HIRS/3 FOV, from the DSDR1T file

- ATOVS Cloud & Radiation product suites shall also be archived and distributed in 1 x 1 degree gridded fields

The averaged grid cell Fractional Cloud Amount, of Type j, is computed

$$A_j = \sum_{i=1}^{I} A_{ij} / I \qquad (9)$$

The averaged grid cell Cloud Top Pressure, of Type j, is computed by

$$P_j = \sum_{i=1}^{I} A_{ij} * P_{ij} / \sum_{i=1}^{I} A_{ij} \qquad (10)$$

and the corresponding Cloud Top Temperature by

$$T_j = \sum_{i=1}^{I} A_{ij} * T_{ij} / \sum_{i=1}^{I} A_{ij} \qquad (11)$$

where,

j = Cloud Height Type Index, (1 = LOW; 2 = MEDIUM; 3 = HIGH)

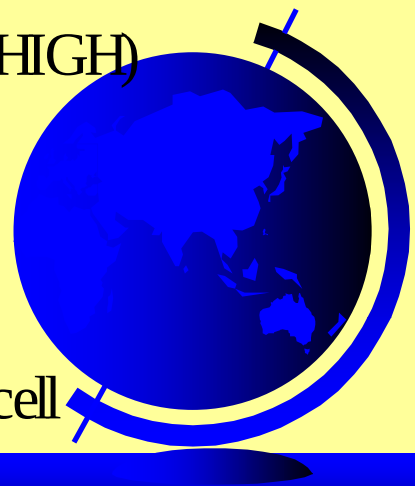
i = HIRS/3 FOV Index within the grid cell

A_{ij} = Fractional Cloud Amount of Type j, FOV i (0<=A<=1)

P_{ij} = Cloud Top Pressure of Type j, FOV i

T_{ij} = Cloud Top Temperature of Type j, FOV i

I = total number of CLEAR and CLOUDY FOVs in each grid cell



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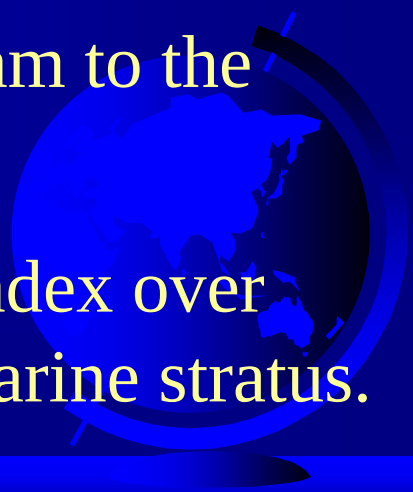
Future Plans for ATOVS Cloud Products

- Upgrade the computation of the Predicted CLEAR Temperature, by increasing the sampling and reducing the time period from 30 to 7 days.
- Continue comparisons of ATOVS Cloud Products with CLAVR-x, GOES and RTNEPH and include MODIS and AIRS
- Upgrade the OPTRAN transmittance program to the most recent version.
- Use visible AVHRR channels and Vegie Index over oceanic areas to confirm the presence of marine stratus.



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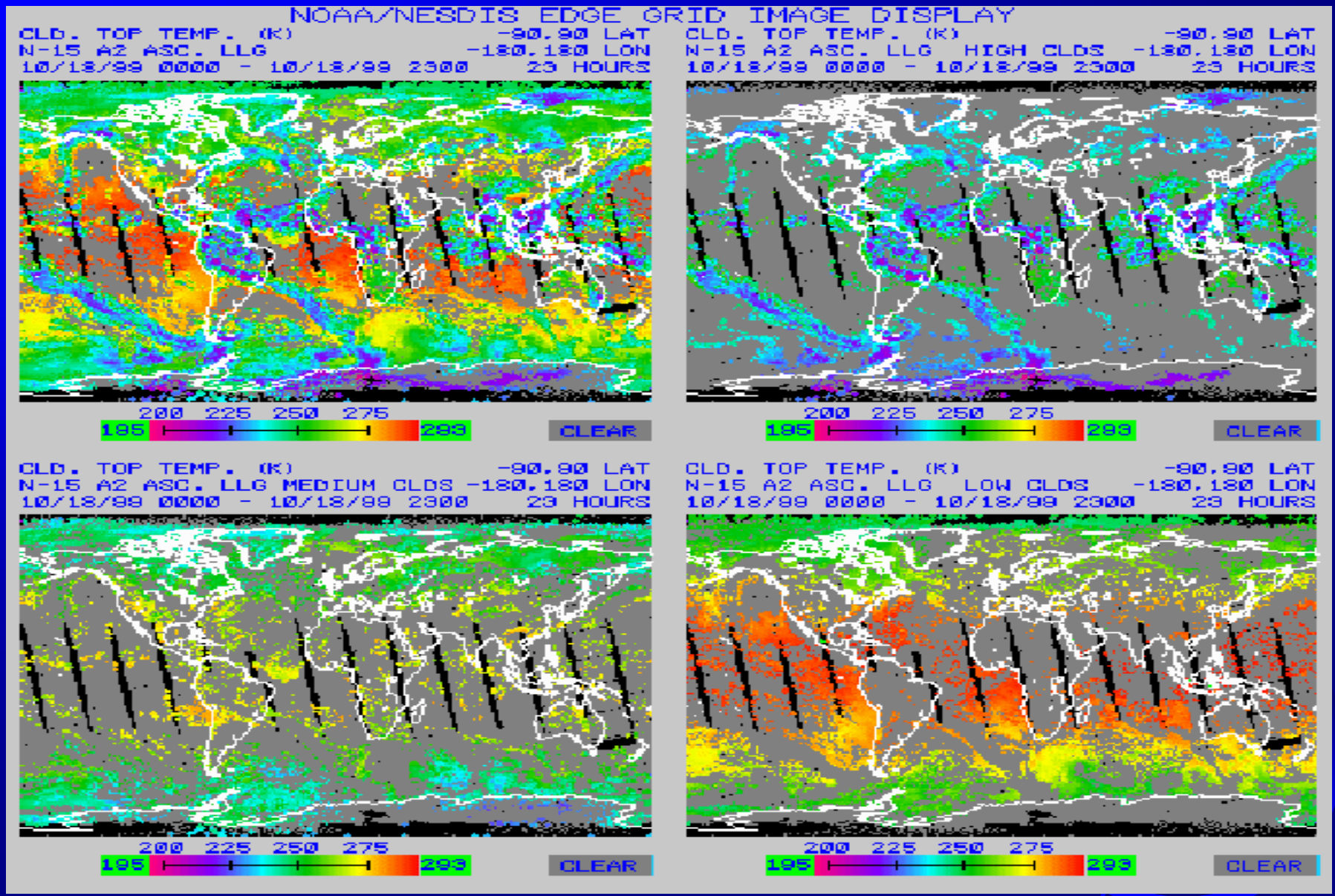

Gridded 1 x 1 Cloud Top Temperatures for TOTAL, HIGH, MEDIUM and LOW

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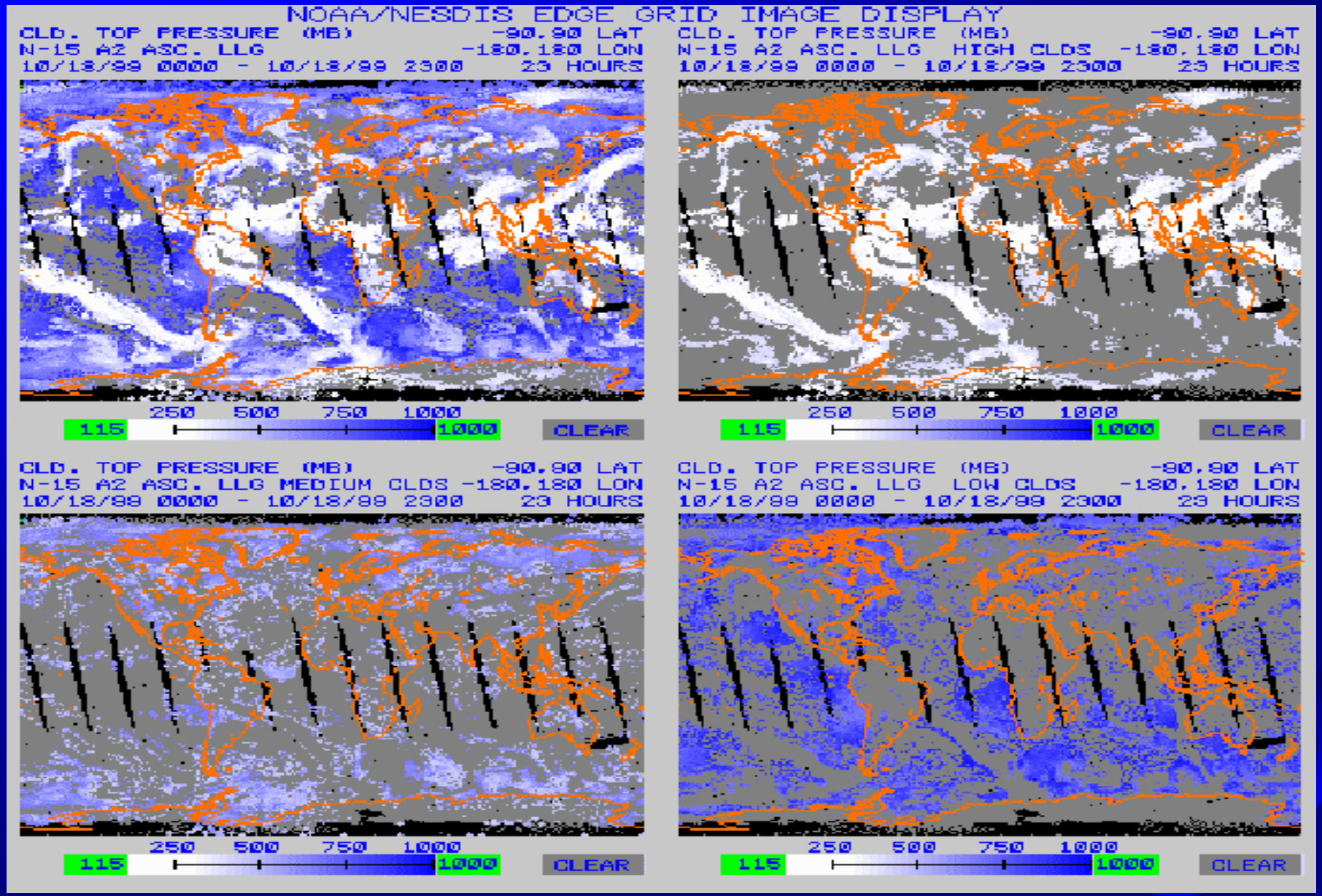

Gridded 1 x 1 Cloud Top Pressure for TOTAL, HIGH, Medium and LOW

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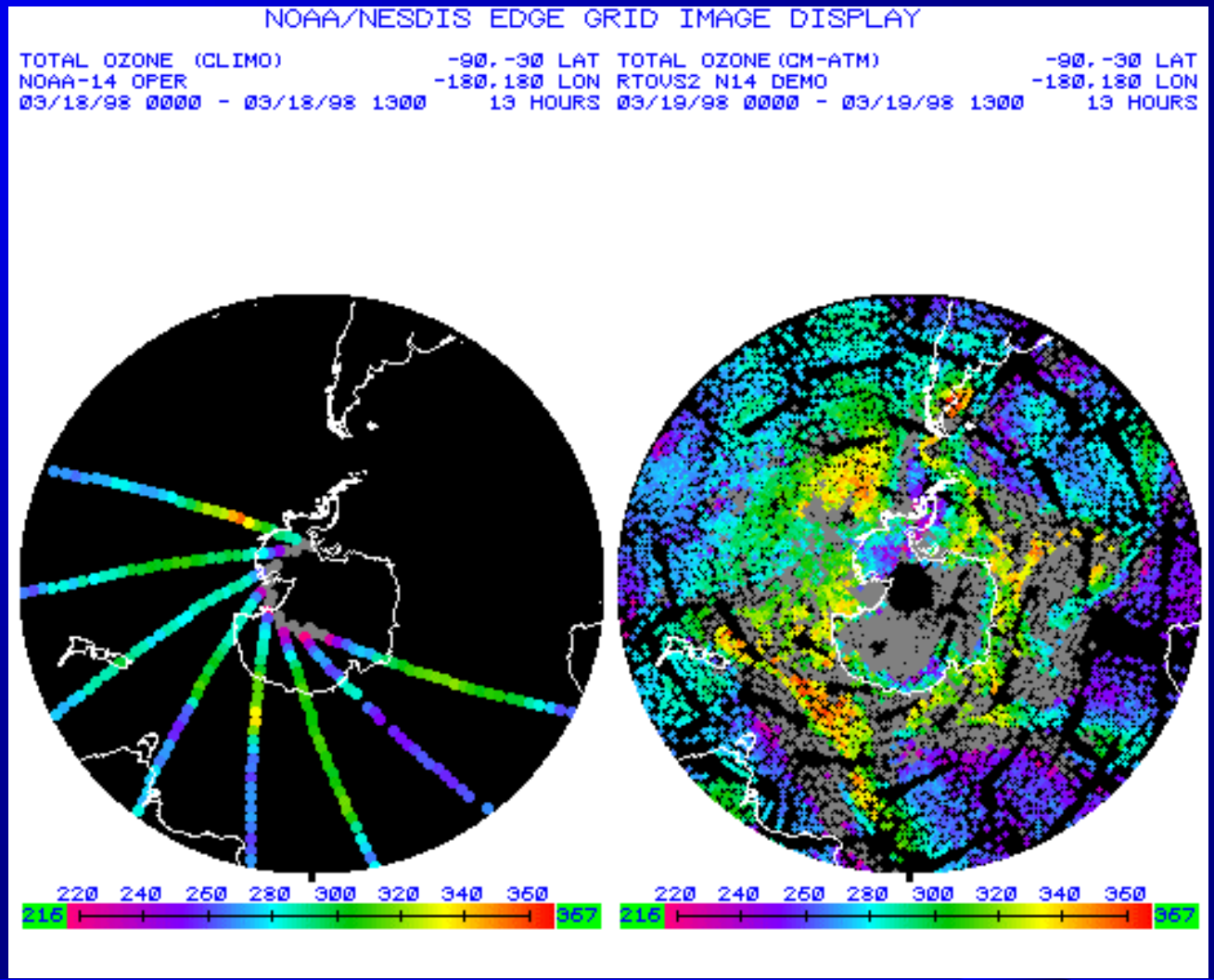
This image illustrates the a half day of Total Ozone coverage from SBUV/2 and HIRS/2I

- The coincident Total Ozone from SBUV/2 (left) and HIRS/2I (right) shows improved coverage for the HIRS/2I product, however, it has some seasonal bias compared with TOMS.



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This image illustrates the coincident coverage of Cloud Top Pressure from GOES-8 & 9 versus NOAA-14