MEMORANDUM FOR: SAF/PAS
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Washington DC 20330-1690

JUN 14 2002

FROM: Francis G. Hinnant, Col, USAF
Associate Director of Acquisition
NPOESS Integrated Program Office
8455 Colesville Rd, Suite 1450
Silver Spring, MD 20910

SUBJECT: Paper approval for: The NPOESS VIIRS Sea Surface Temperature Retrieval Algorithm

Enclosed are the required ten (10) copies of the subject papers. This paper will be released at the IGARSS02 conference in June 2002. It was written by, and will be presented by employees of Raytheon Electronic Systems.

The program office has reviewed the information in the attached papers and found it appropriate for public disclosure without change.

Point of contact on this matter is Capt. Ken Speidel, NPOESS IPO/ADA at 301-427-2084 (Ext. 208).

Attachment: Presentation—10 copies

INT1_B29_11

The NPOESS VIIRS Sea Surface Temperature Retrieval Algorithm

Richard J. Sikorski
Information Technology and Scientific Services
Raytheon

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phone (301)794-5105, fax (301) 794 5247
email Richard_J_Sikorski@Raytheon.com

Visible/Infrared Imager Radiometer Suite (VIIRS) MWIR/LWIR Spectral Responses

Band Name	Center λ(nm)	Bandwidth(nm)	IR Region
M12	3700	180	MWIR
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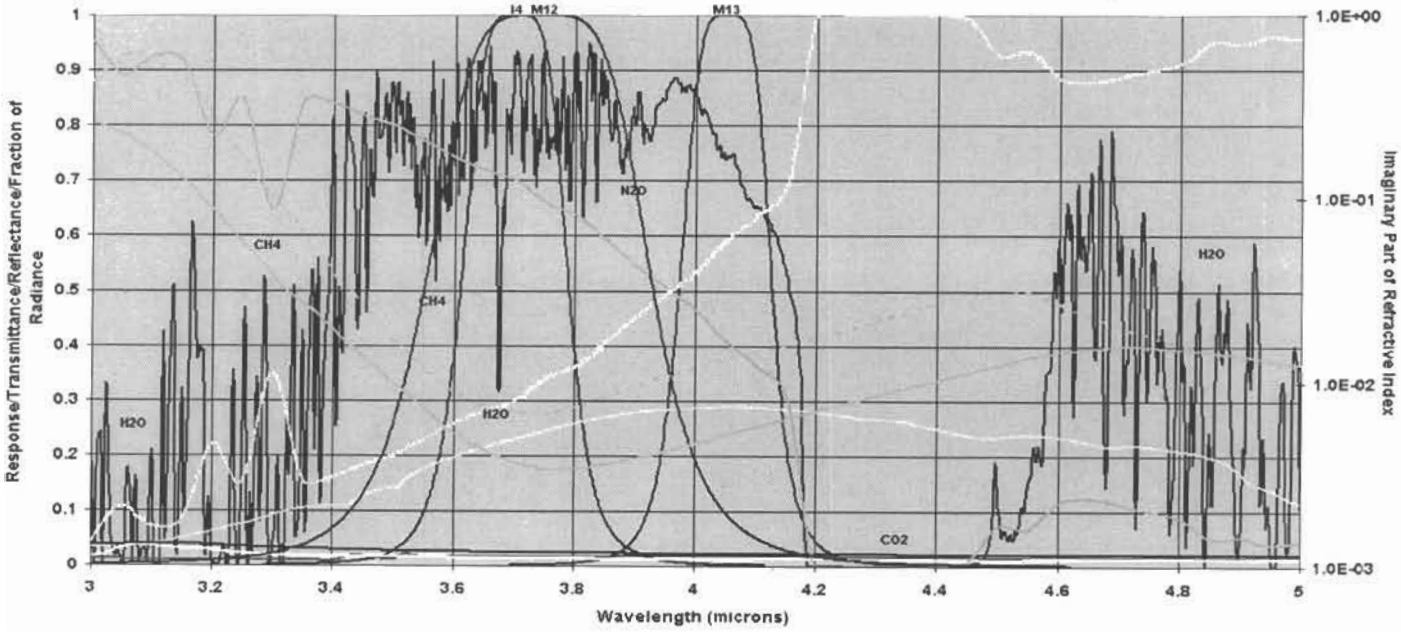
Spectral Band Response, Atmospheric Transmittance, Surface Reflectance, Solar/Emissive Radiance Fraction for Cloud, and Imaginary Part of Refractive Index for Water and Ice, Mid Wave Infrared (MWIR)



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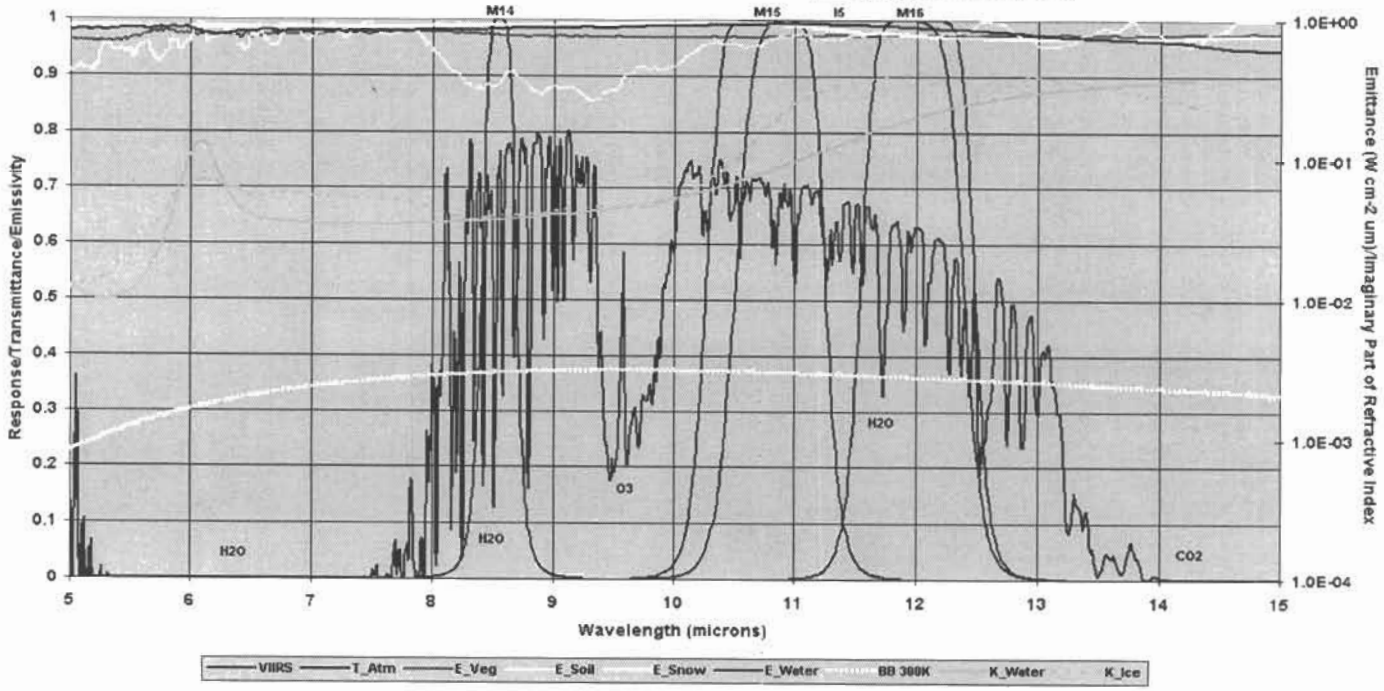

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➢ Dual split window daytime algorithm:

$$SST = a_0 + a_1 T_{11} + a_2 T_{12} + a_3(\sec(z) - 1) + a_4 T_{3.7} + a_5 T_{4.0} + a_6 T_{3.7}\cos(zs) + a_7 T_{4.0}\cos(zs) + a_8 (T_{11} - T_{12})^2$$

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- The basic algorithm is enhanced by deriving day and night coefficient sets for three airmass classifications: Cool atmosphere, Warm dry atmosphere, and Warm moist atmosphere. Interpolation applied between these airmass classifications.

- The basic coefficient set may be derived from radiometric measurements (e.g. M-AERI) for skin SST retrievals, and may be derived from buoy measurements for bulk SST retrievals.

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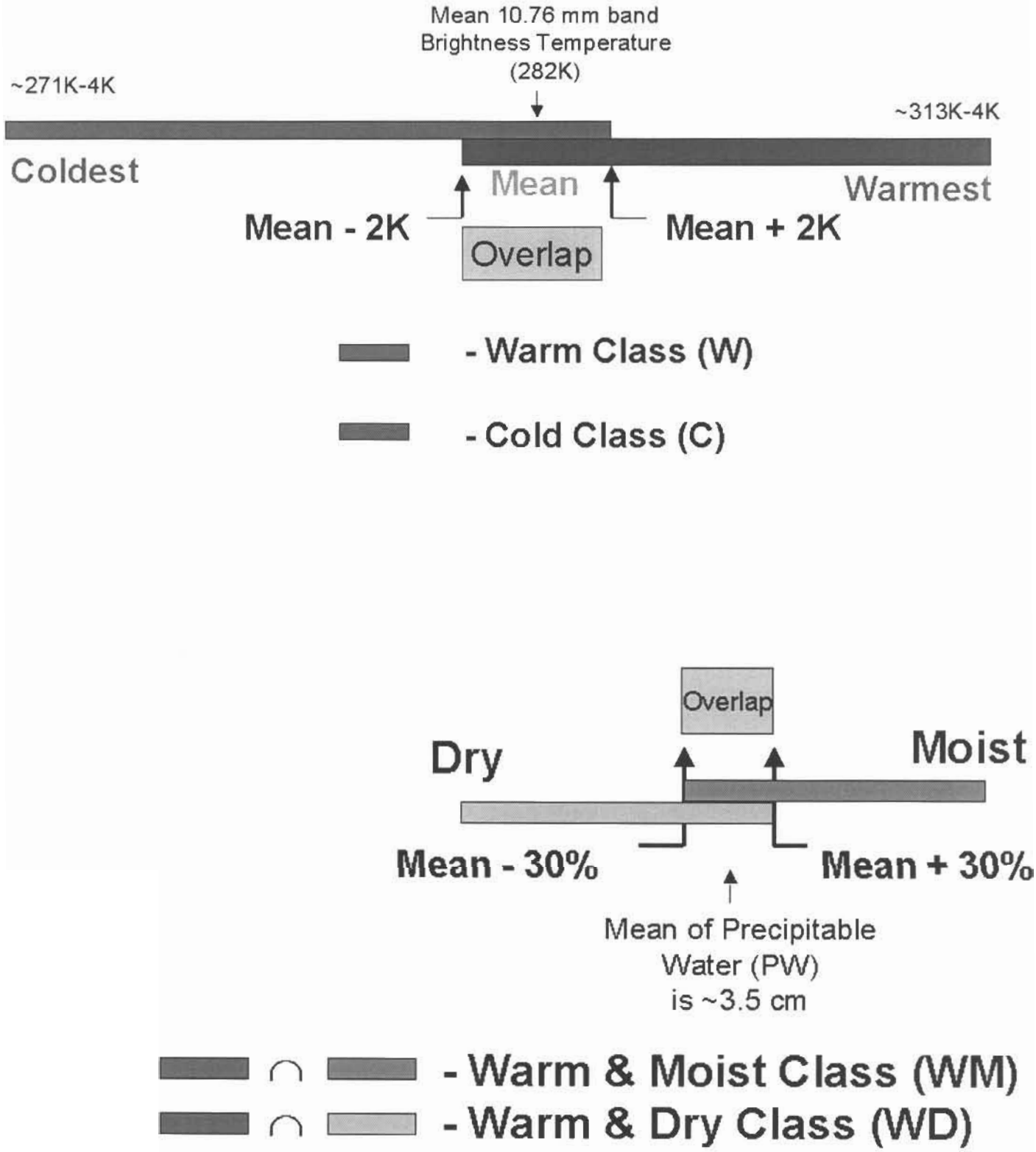
Warm/Cold, Moist/Dry



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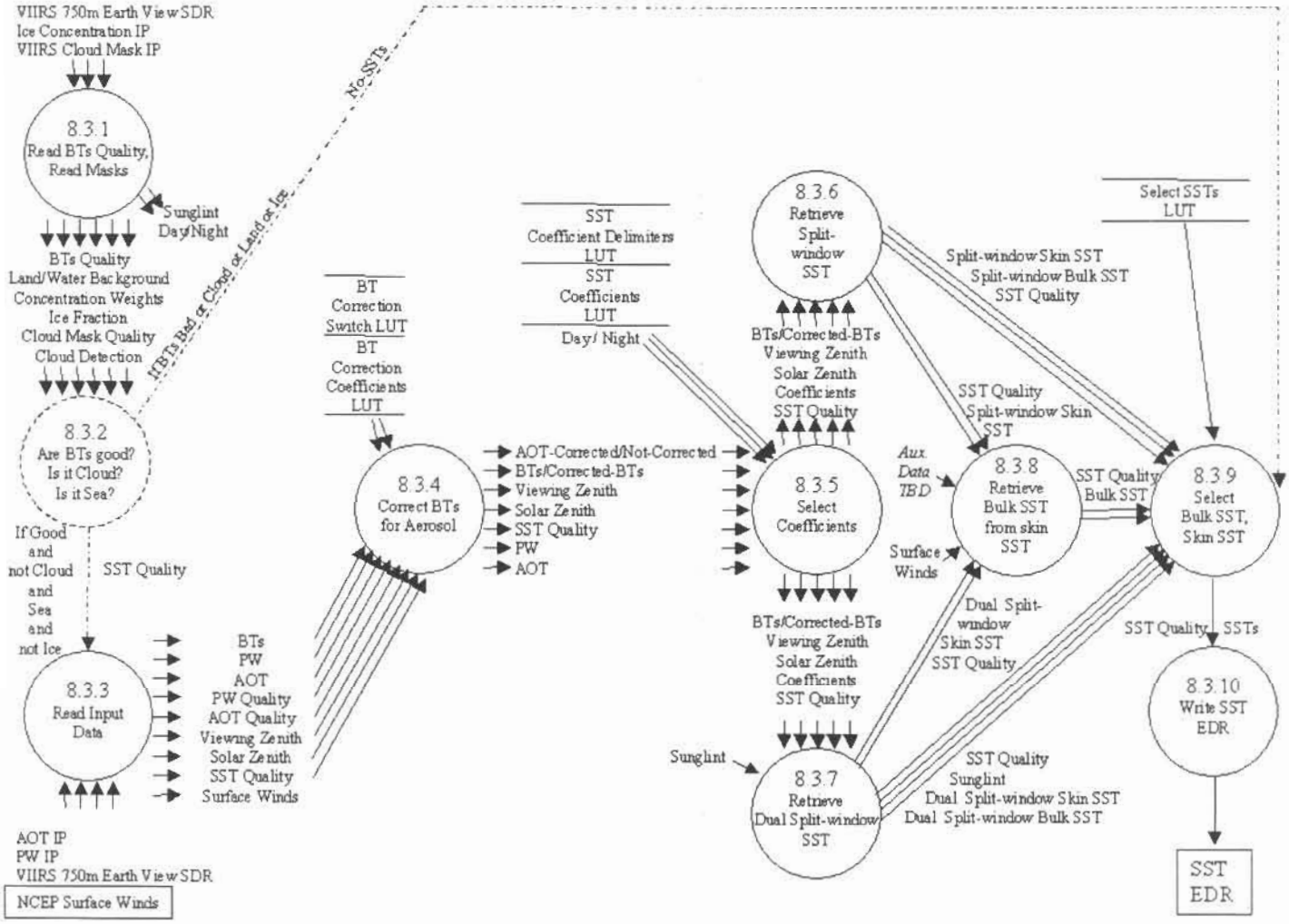

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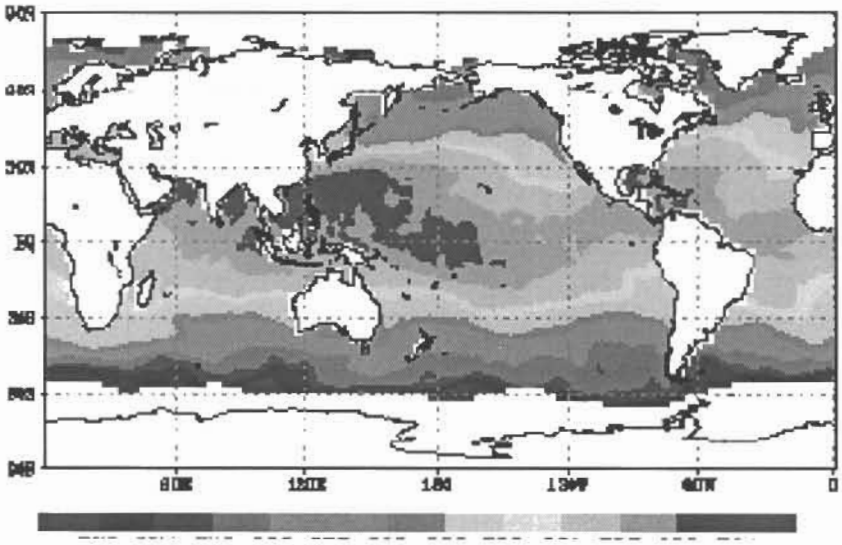

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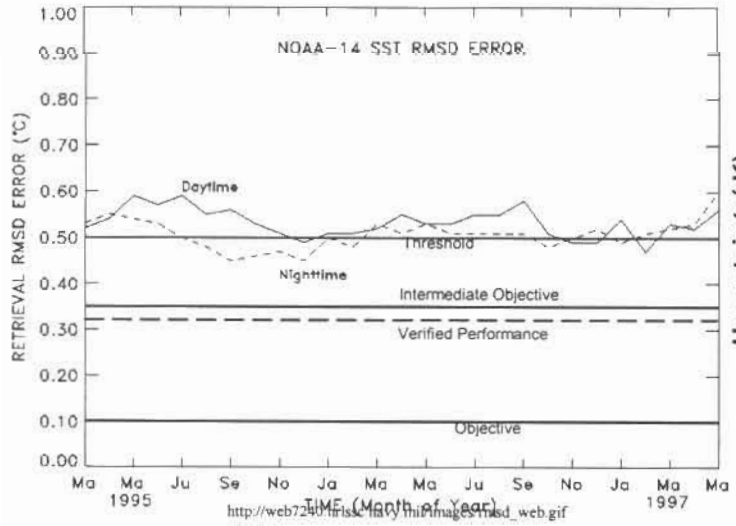

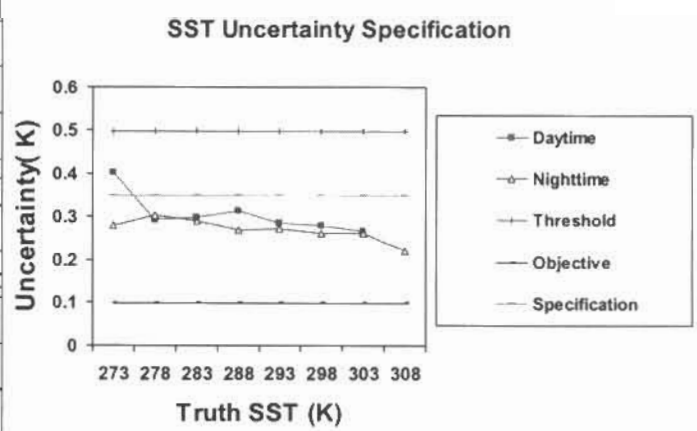

SST Retrievals

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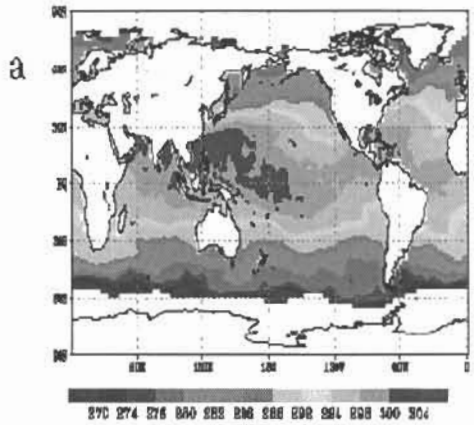

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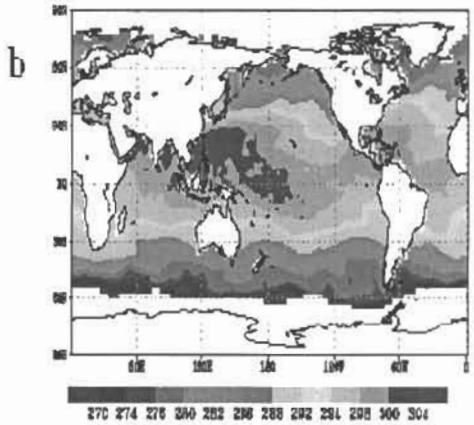

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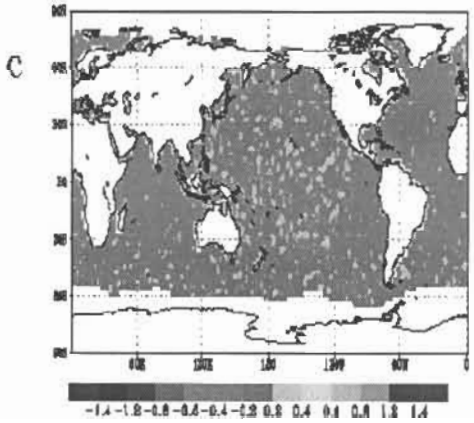

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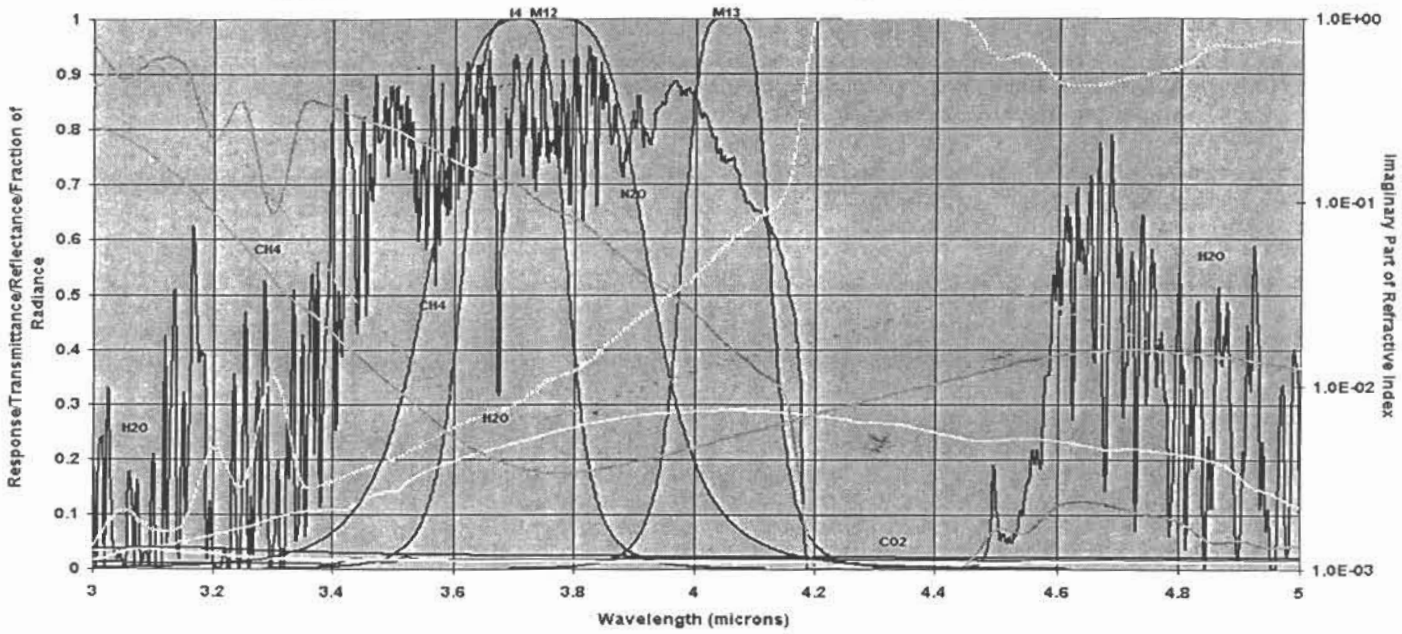

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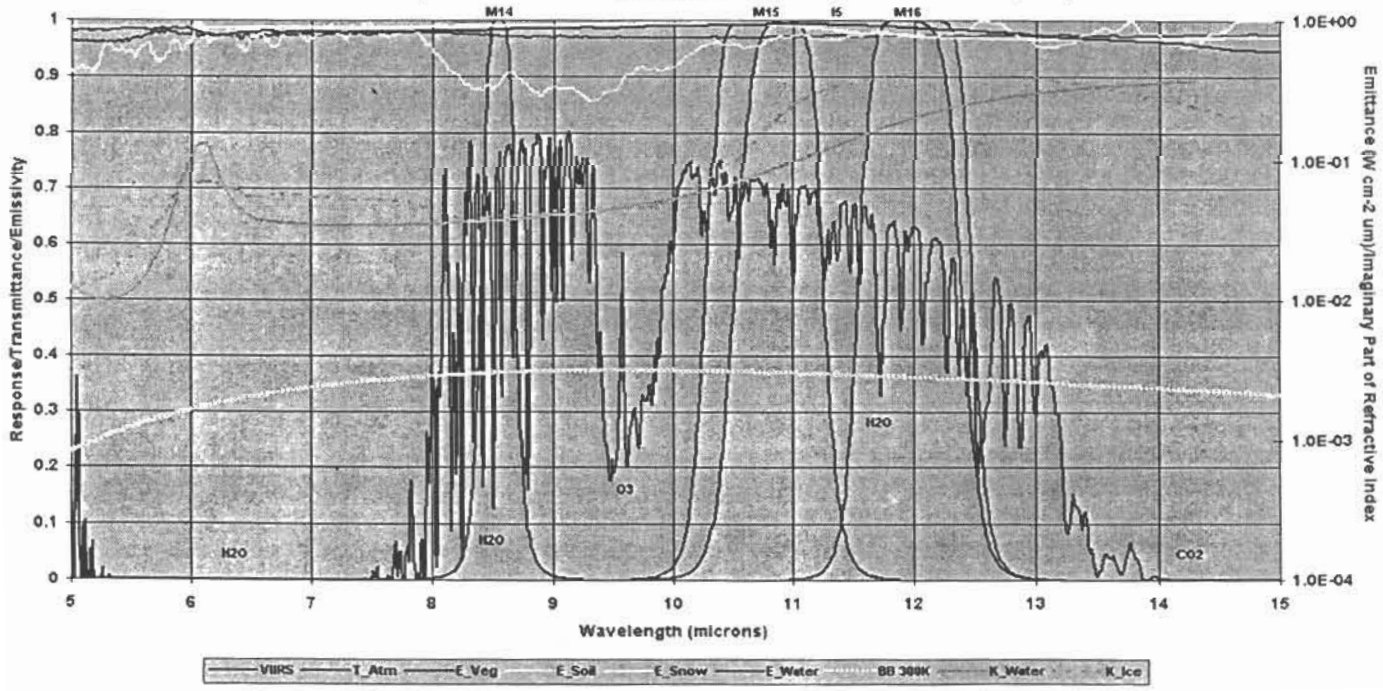

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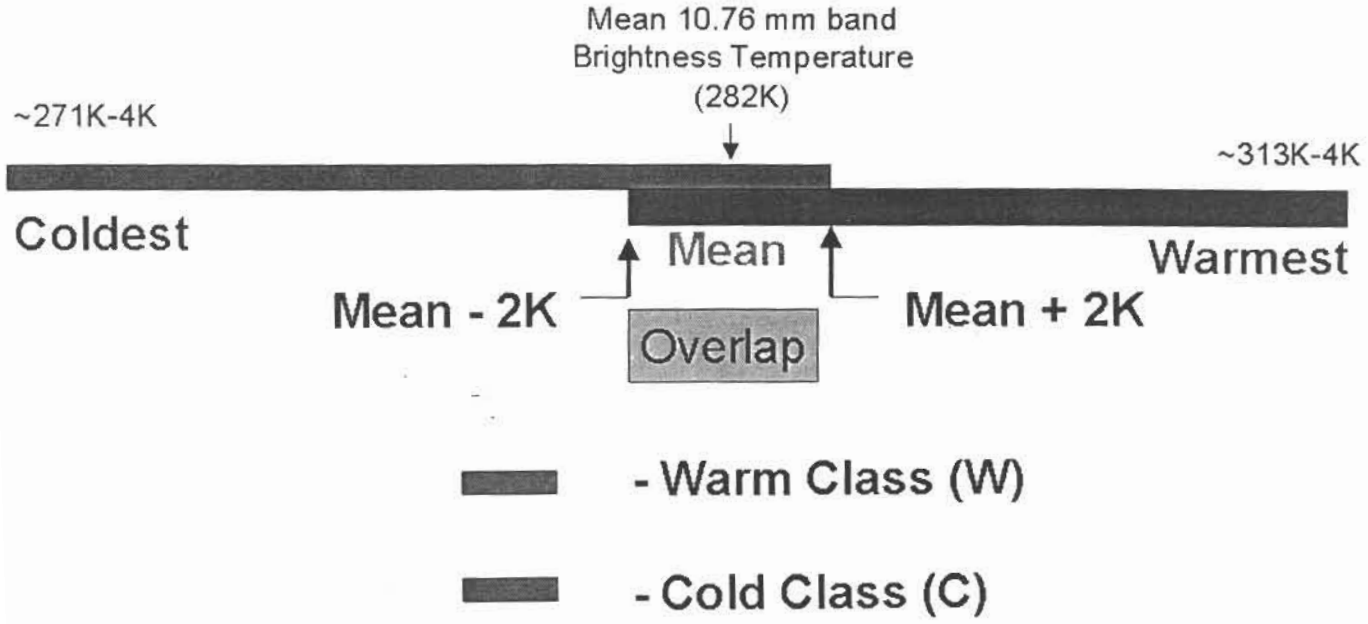

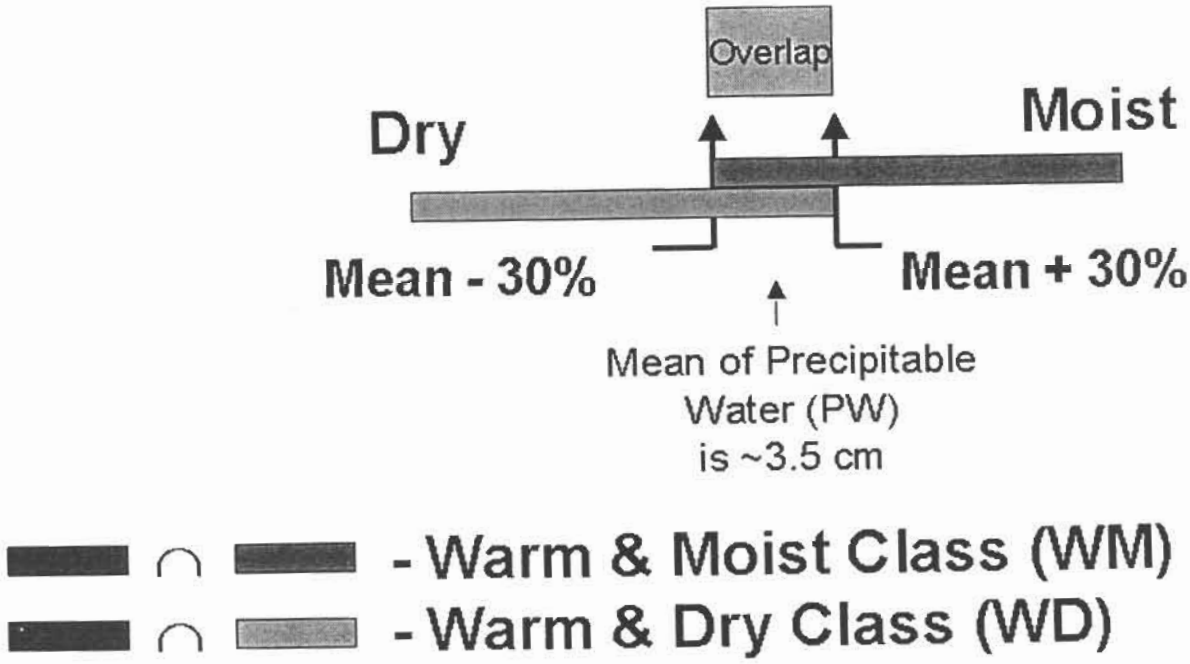

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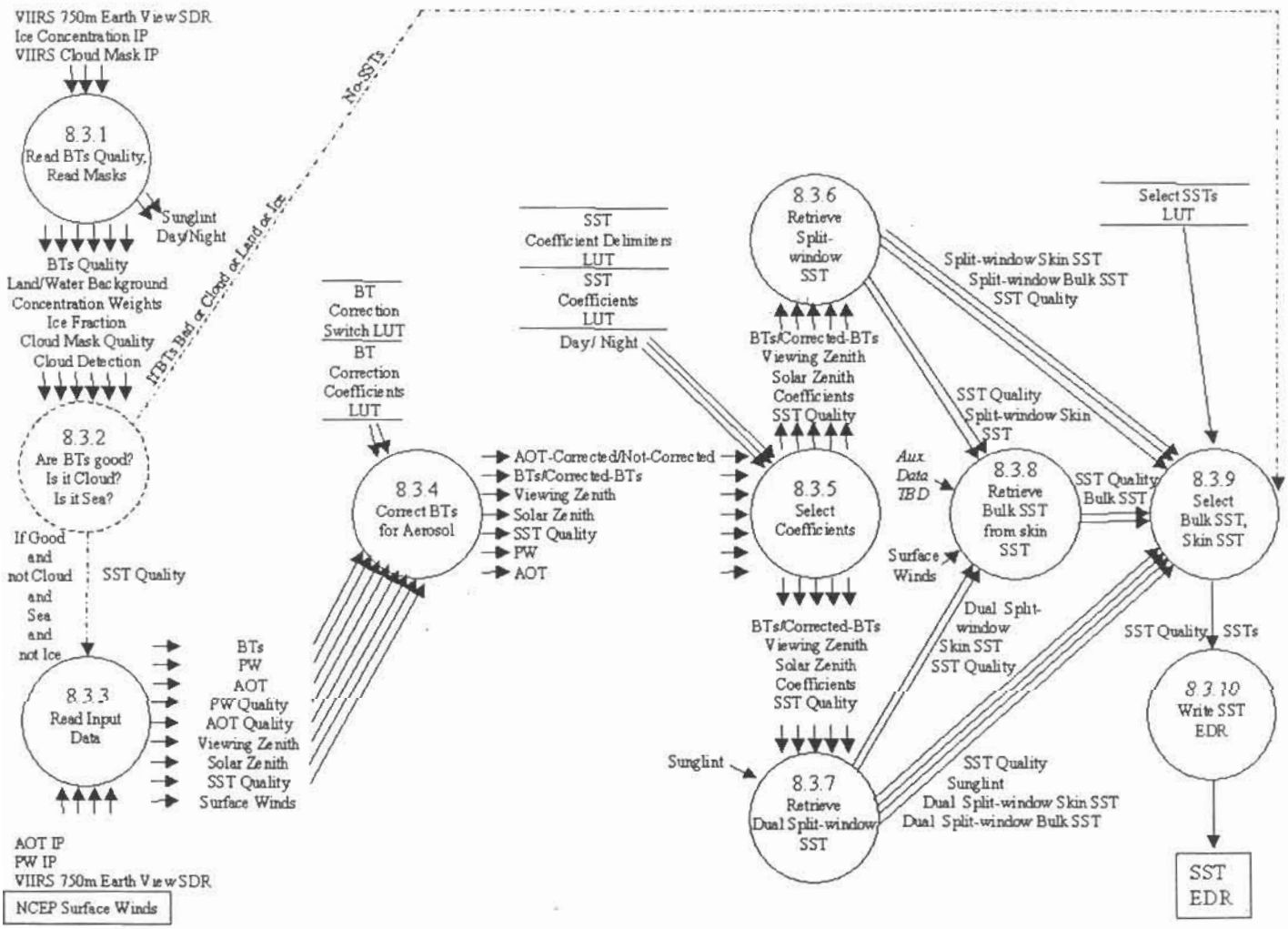

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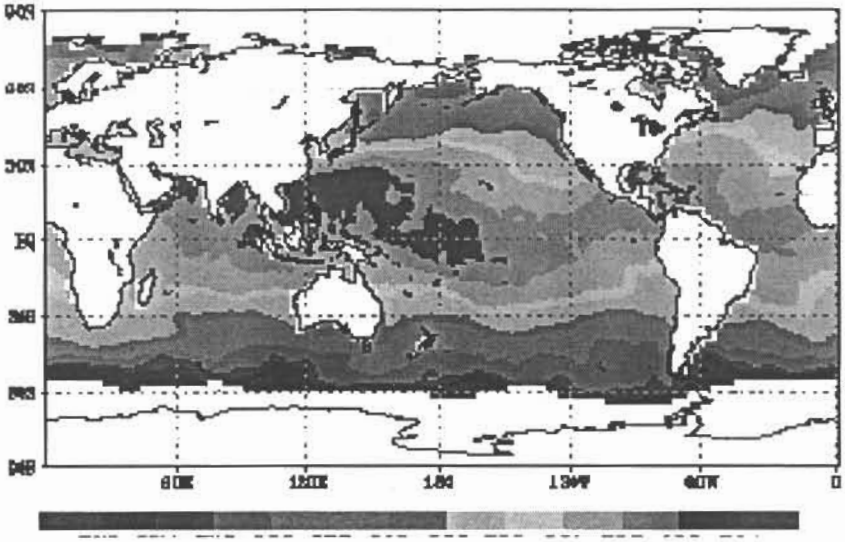

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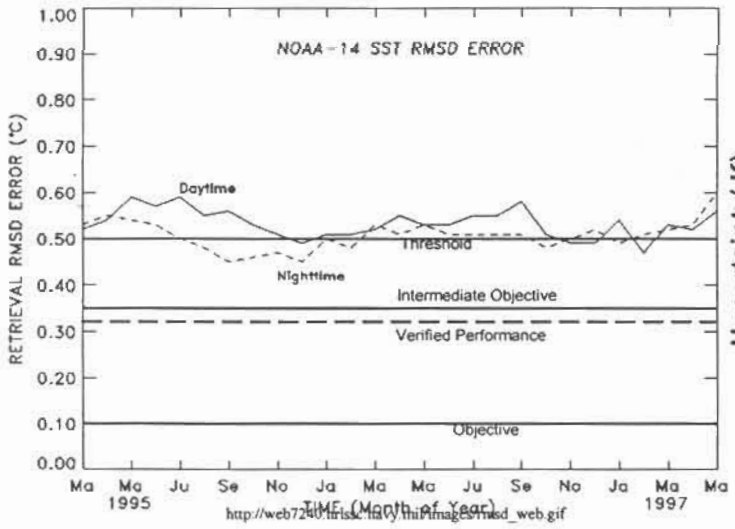

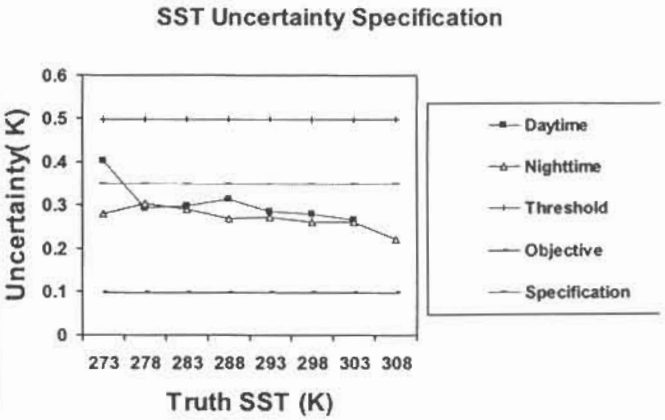

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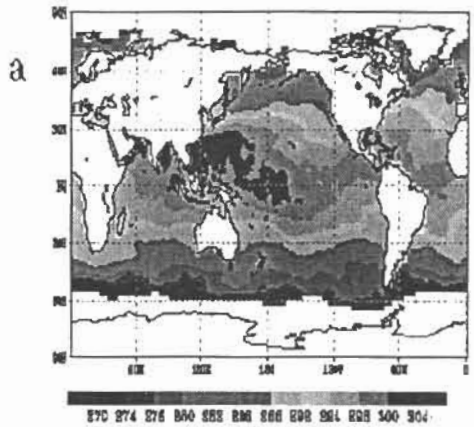

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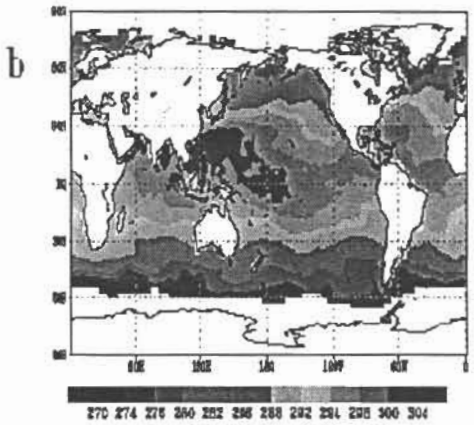

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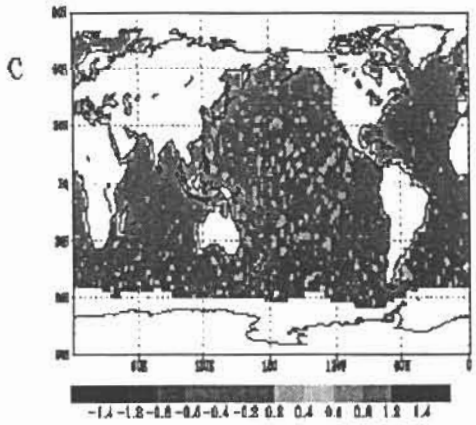

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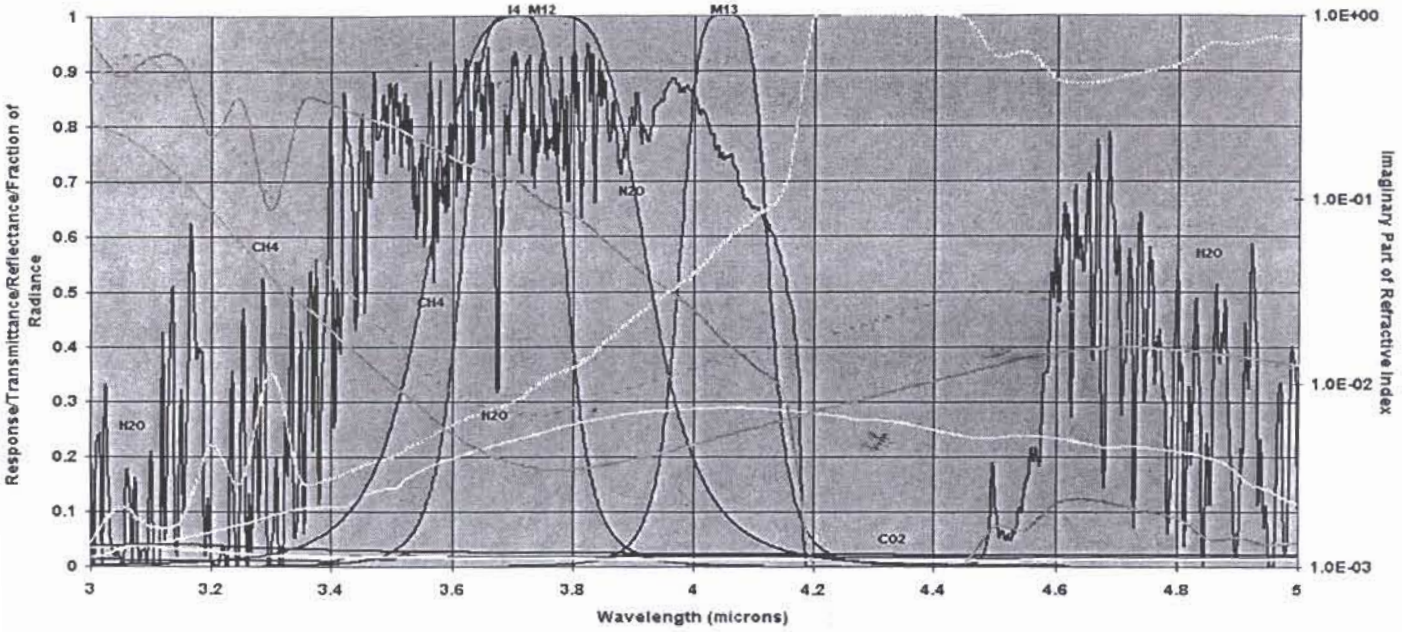

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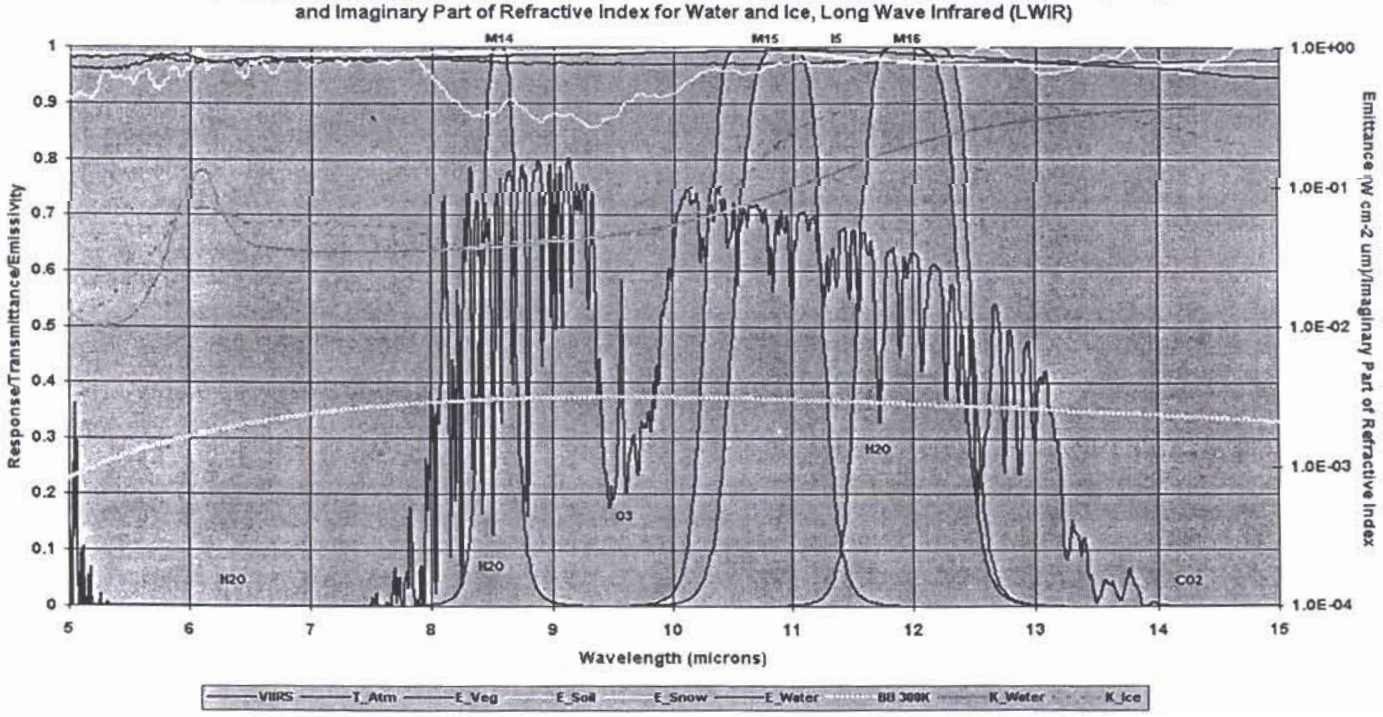

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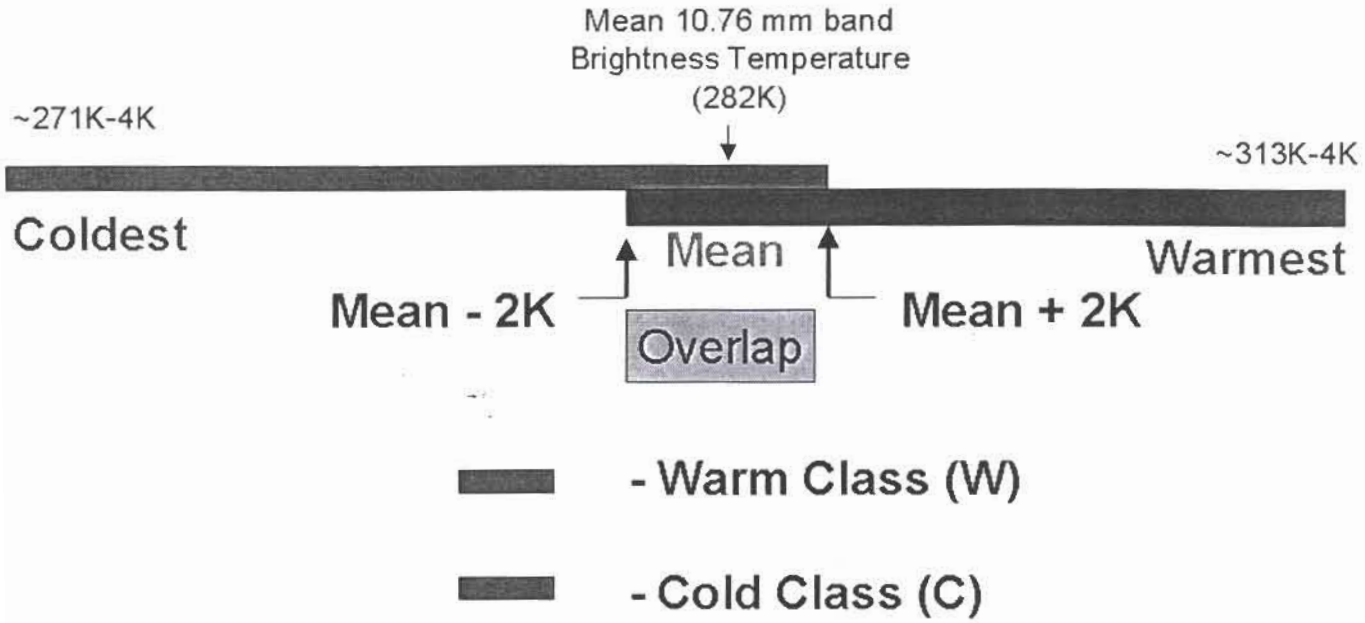

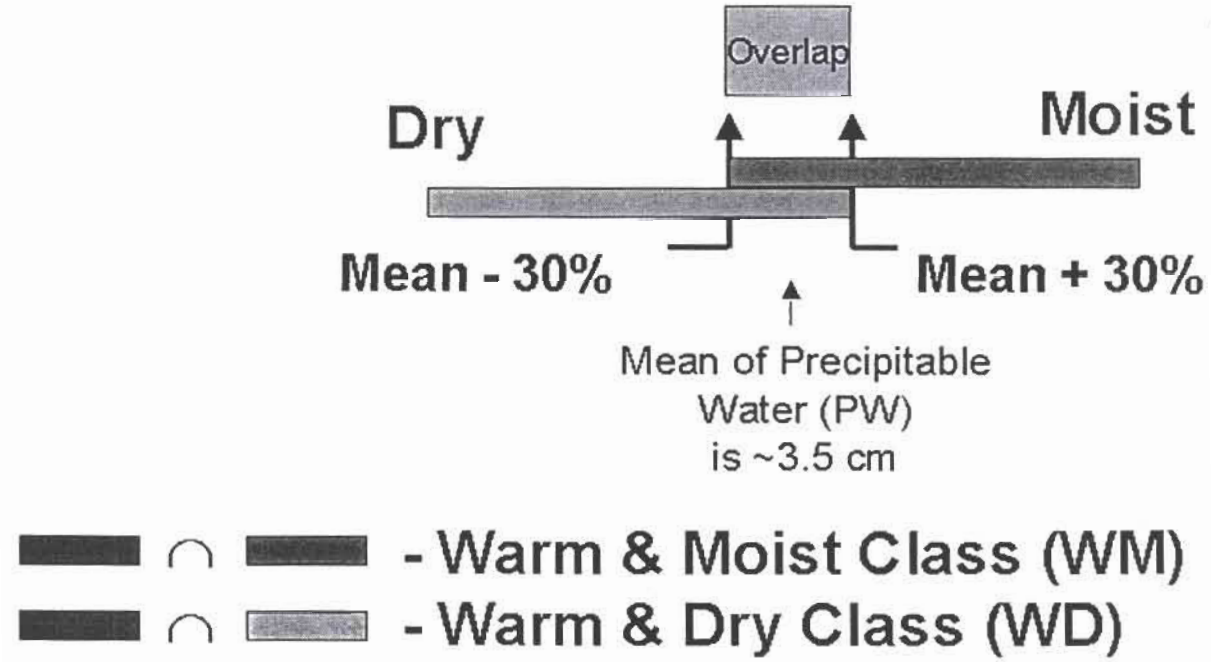

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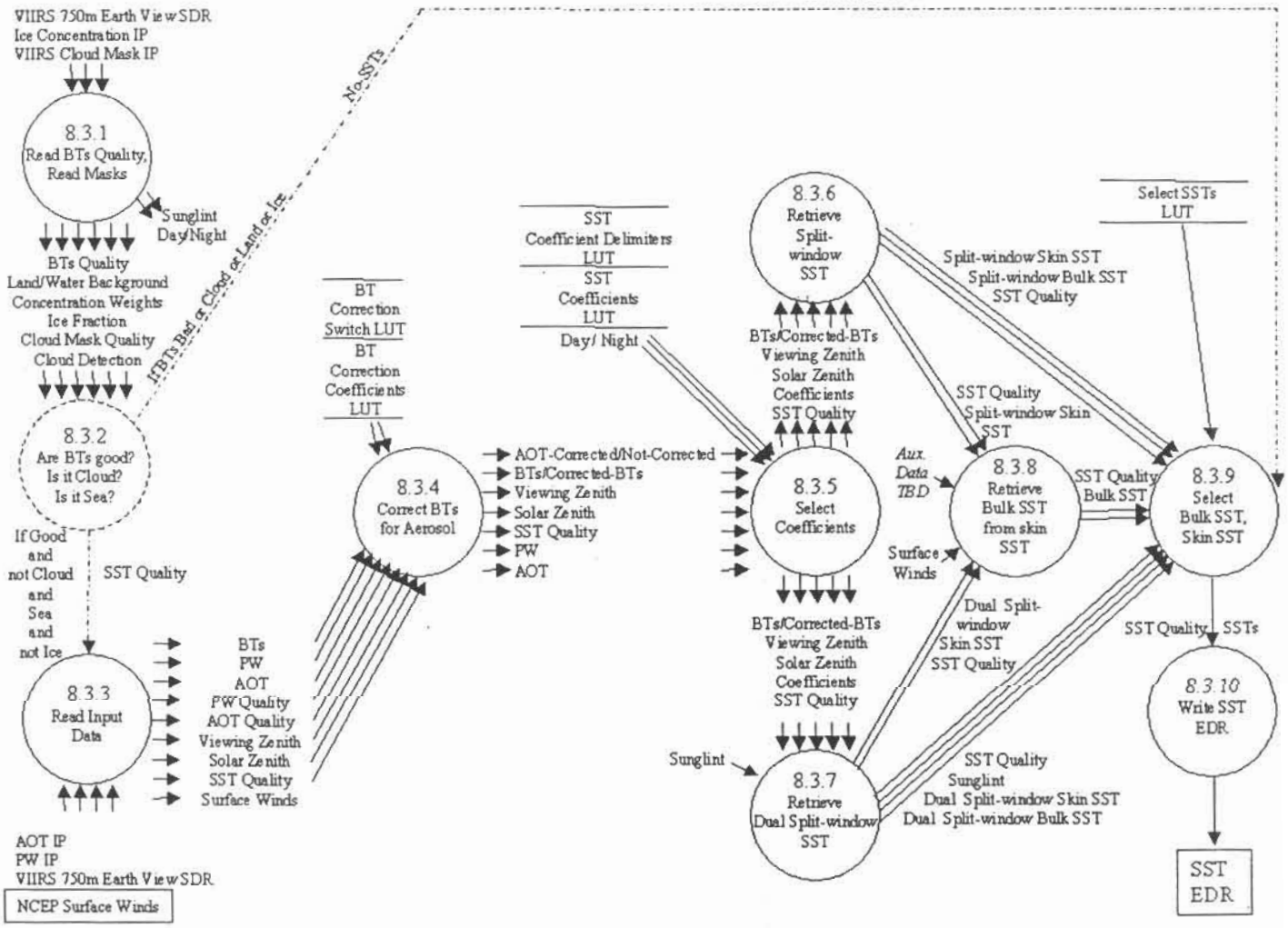

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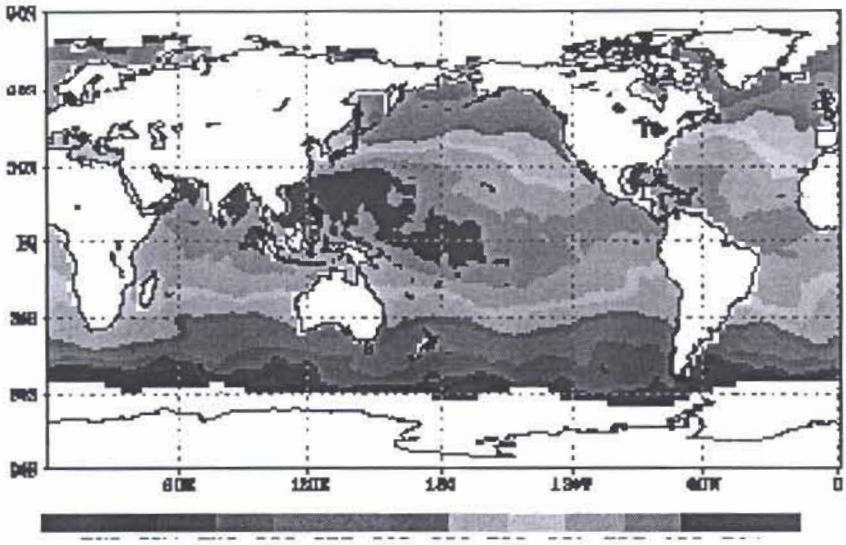

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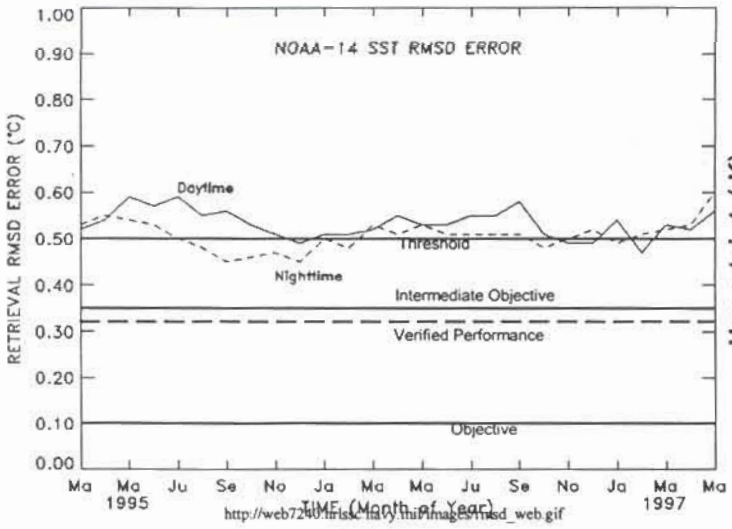

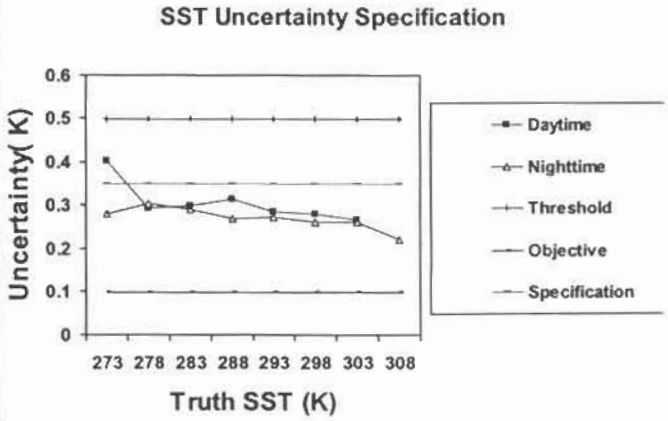

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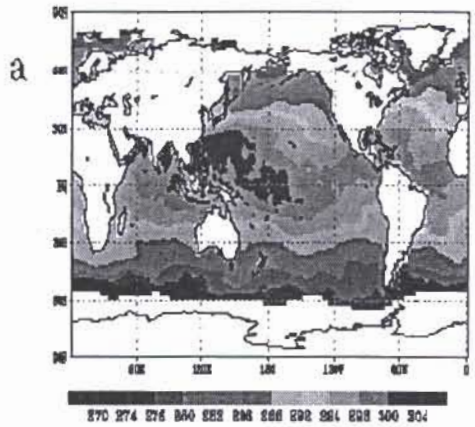

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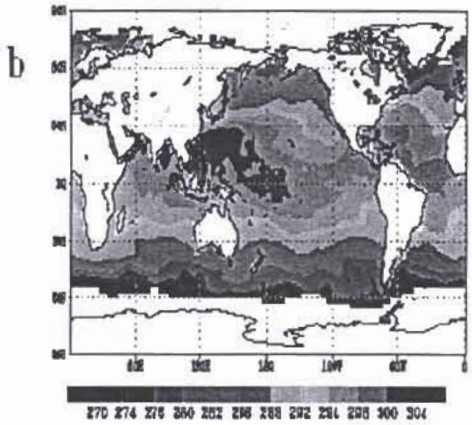

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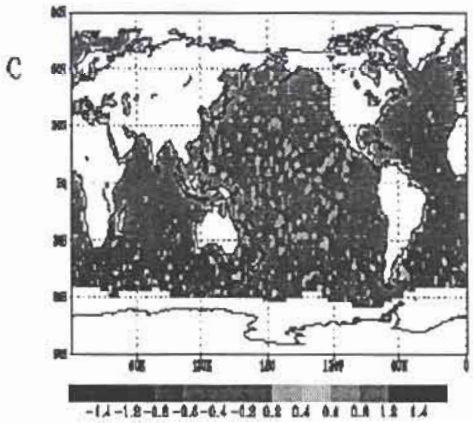

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The NPOESS VIIRS Sea Surface Temperature Retrieval Algorithm

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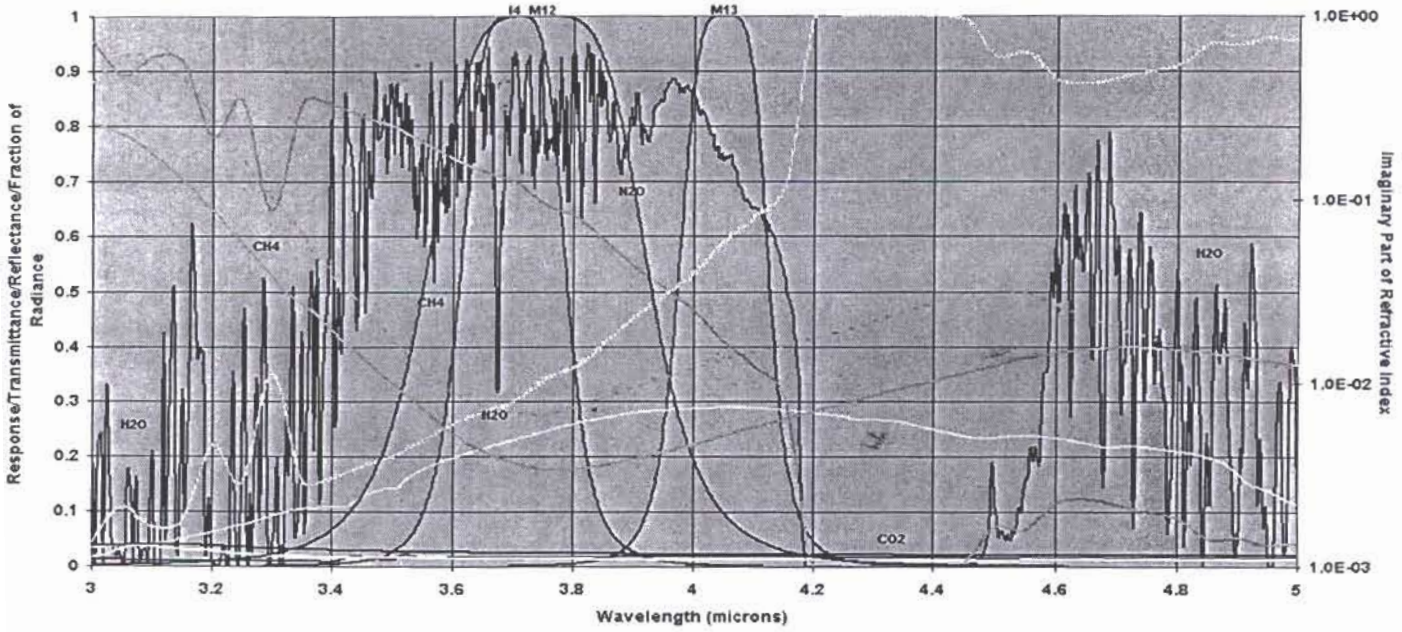
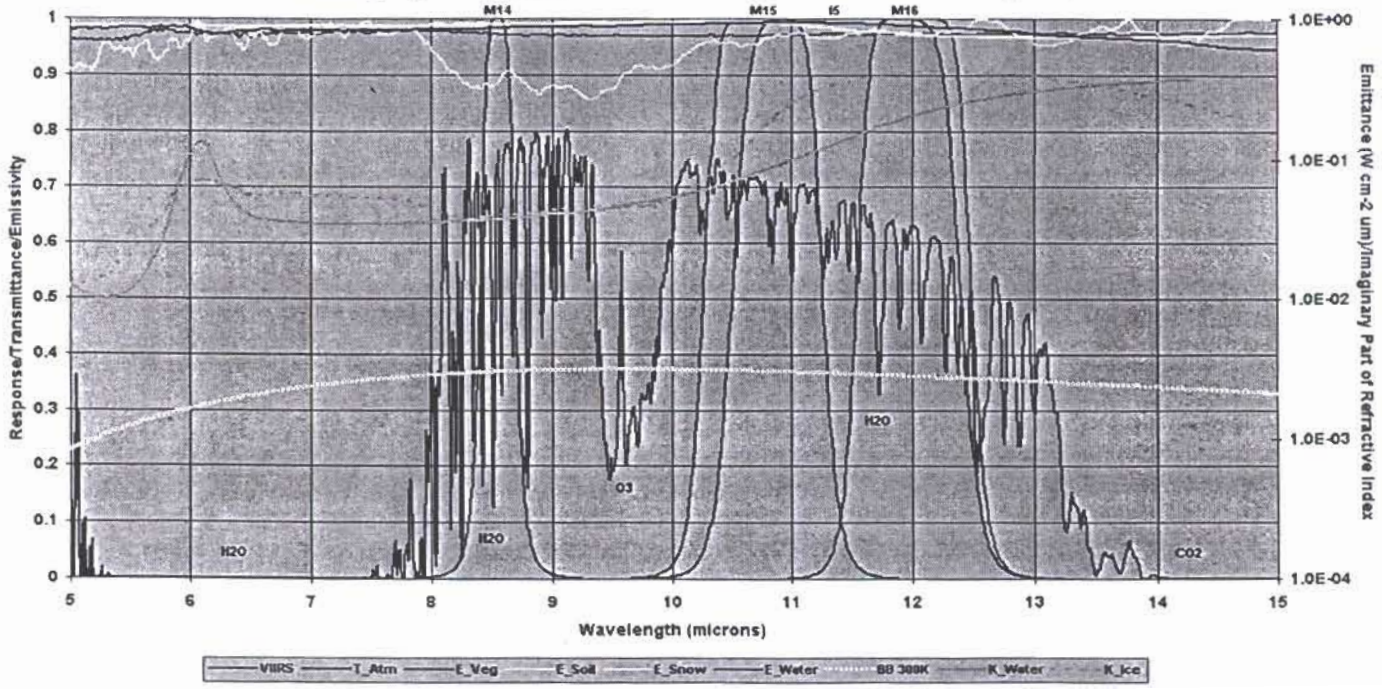
Visible/Infrared Imager Radiometer Suite (VIIRS) MWIR/LWIR Spectral Responses

Band Name	Center λ(nm)	Bandwidth(nm)	IR Region
M12	3700	180	MWIR
M13	4050	155	MWIR
M15	10763	1000	LWIR
M16	12013	950	LWIR

Spectral Band Response, Atmospheric Transmittance, Surface Reflectance, Solar/Emissive Radiance Fraction for Cloud, and Imaginary Part of Refractive Index for Water and Ice, Mid Wave Infrared (MWIR)



Spectral Band Response, Atmospheric Transmittance, Surface Emissivity, Blackbody Emittance (300 K), and Imaginary Part of Refractive Index for Water and Ice, Long Wave Infrared (LWIR)



SST Retrieval Strategy

- The VIIRS Sea Surface Temperature EDR is a 1km Cat I/A product retrieved using a Dual Split-Window algorithm adapted from extensive MODIS/AVHRR heritage. MWIR is corrected by the VIIRS baseline dual split-window algorithm for solar reflectance. Pixels that are contaminated by sun glint are not processed in MWIR. The VIIRS fallback LWIR split-window algorithm is applied to those pixels.

➢ Dual split window daytime algorithm:

$$SST = a_0 + a_1 T_{11} + a_2 T_{12} + a_3(\sec(z) - 1) + a_4 T_{3.7} + a_5 T_{4.0} + a_6 T_{3.7} \cos(zs) + a_7 T_{4.0} \cos(zs) + a_8 (T_{11} - T_{12})^2$$

➢ Dual split window nighttime algorithm:

$$SST = a_0 + a_1 T_{11} + a_2 T_{12} + a_3(\sec(z) - 1) + a_4 T_{3.7} + a_5 T_{4.0} + a_6 T_{3.7}{}^2 + a_7 T_{4.0}{}^2 + a_8 (T_{11} - T_{12})^2$$

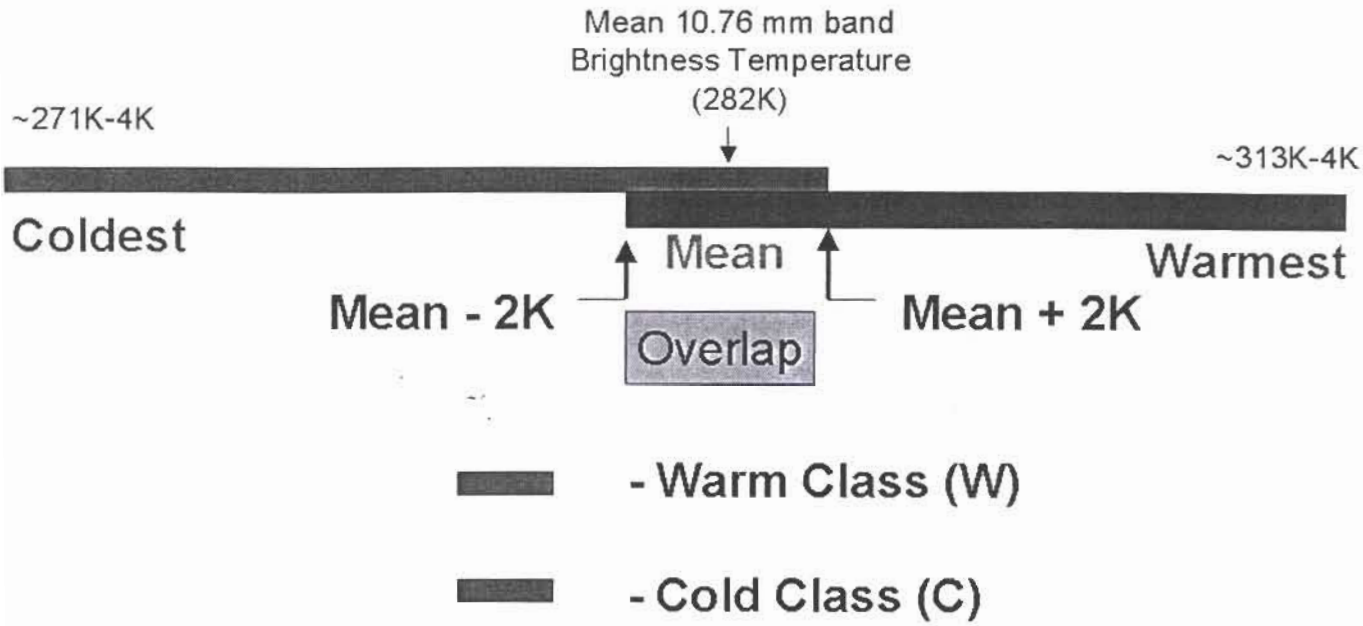
➢ Split window nonlinear algorithm :

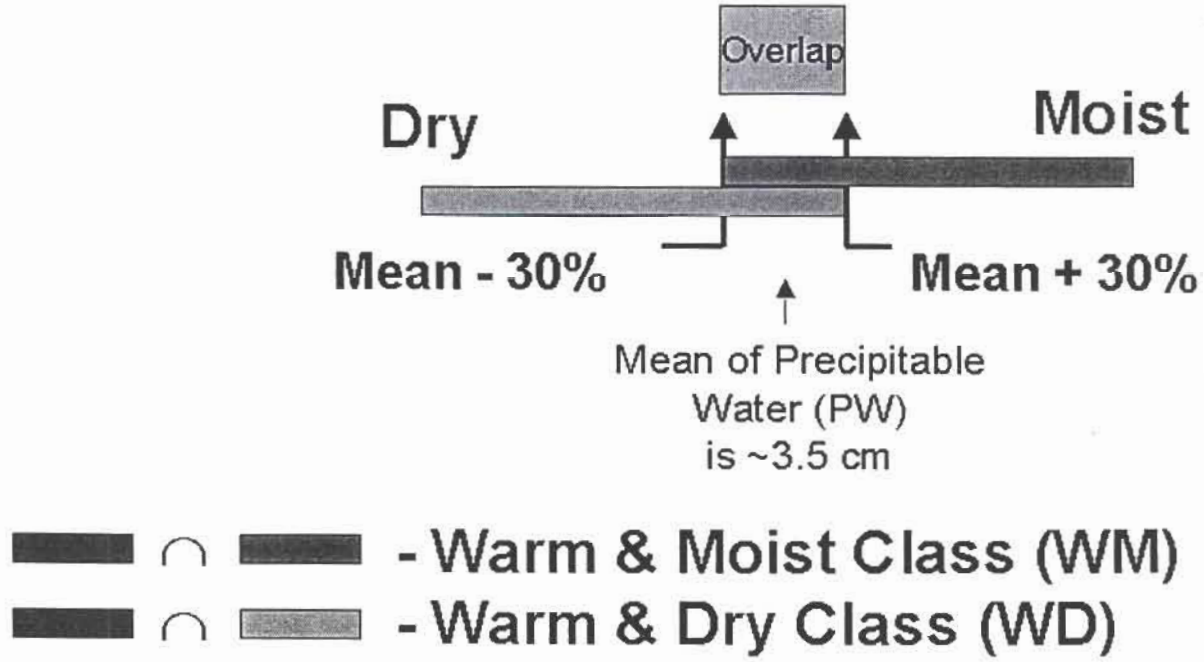
$$SST = a_0 + a_1 T_{11} + a_2 (T_{11} - T_{12}) + a_3(\sec(z) - 1) + a_4 (T_{11} - T_{12})^2$$

- The basic algorithm is enhanced by deriving day and night coefficient sets for three airmass classifications: Cool atmosphere, Warm dry atmosphere, and Warm moist atmosphere. Interpolation applied between these airmass classifications.

- The basic coefficient set may be derived from radiometric measurements (e.g. M-AERI) for skin SST retrievals, and may be derived from buoy measurements for bulk SST retrievals.

Air Mass Classification
Warm/Cold, Moist/Dry





SST Unit Processes under Several Cloud Conditions

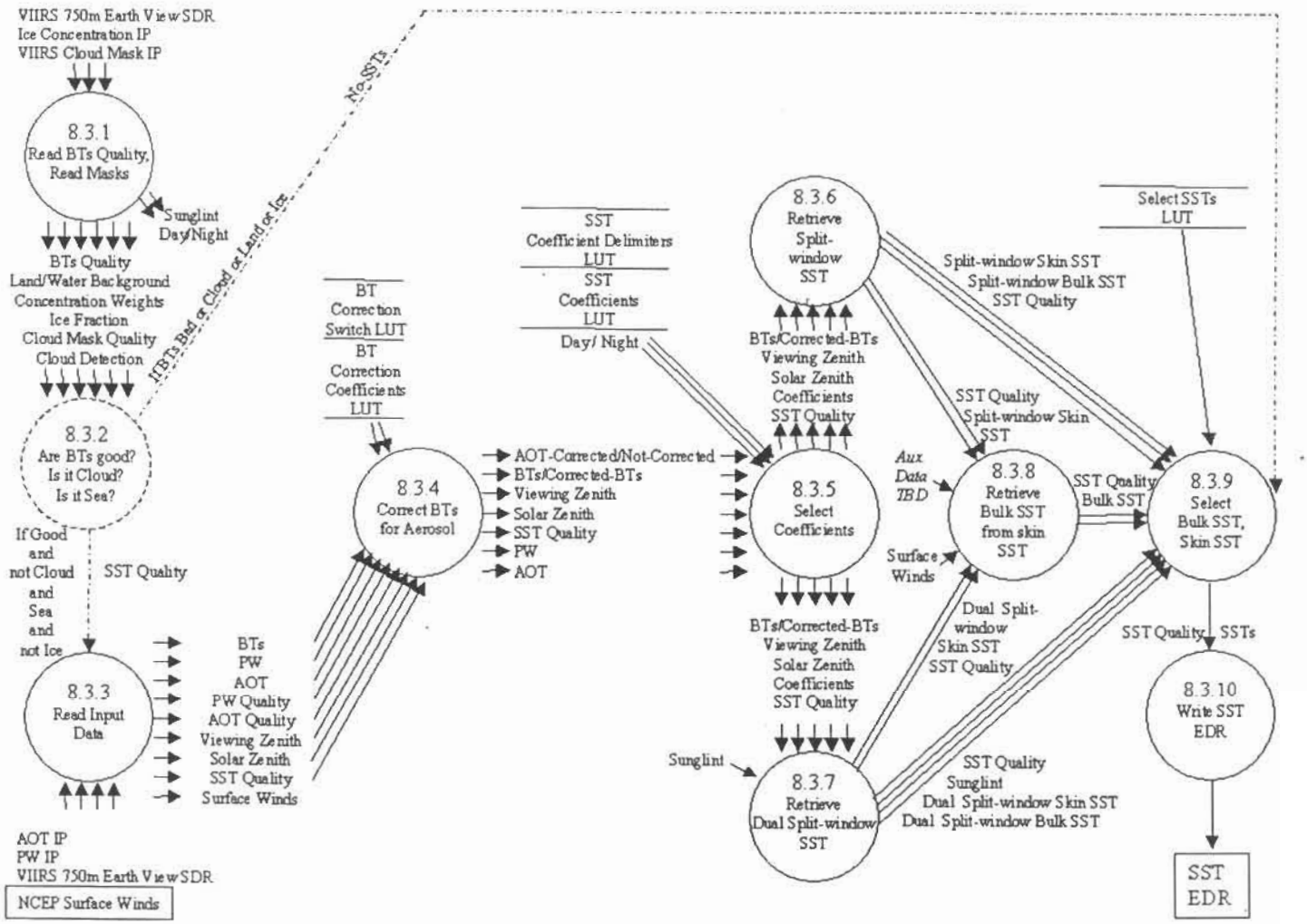
- The software architecture is designed for operational efficiency and minimal dependencies on other products.

- SST can be derived within specifications using only the VIIRS 750m Earth View SDR Brightness Temperatures and the VIIRS Cloud Mask.

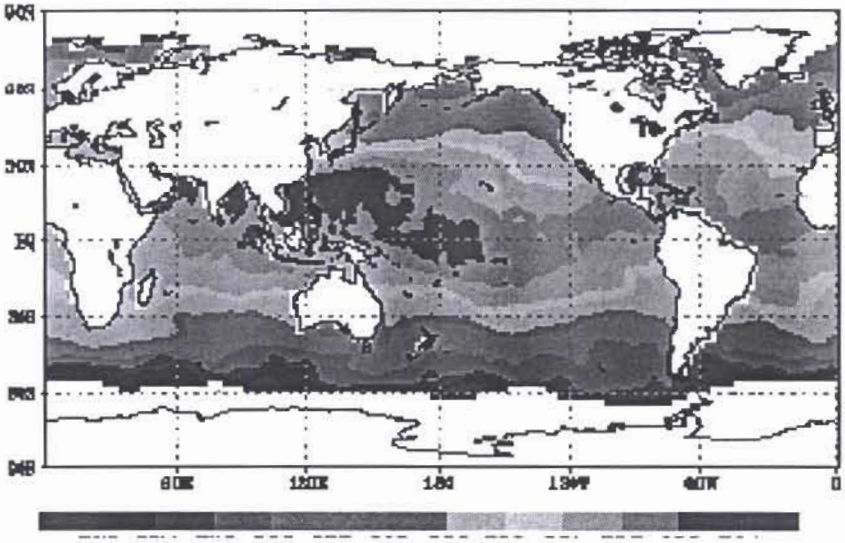
- VIIRS Cloud Mask delivers Threshold, Difference, and Ratio cloud tests.
  - "Confident clear" SST processed.
  - "Probably clear" and "Probably cloudy" flagged, and SST processed.
  - Thin cirrus and Non-cloud obstruction flagged, and SST processed.
  - "Confident cloudy" flagged. SST not processed.

- Same-pixel VIIRS Ice Concentration EDR, VIIRS Precipitable Water EDR, VIIRS Aerosol Optical Thickness EDR available to enhance APU performance.

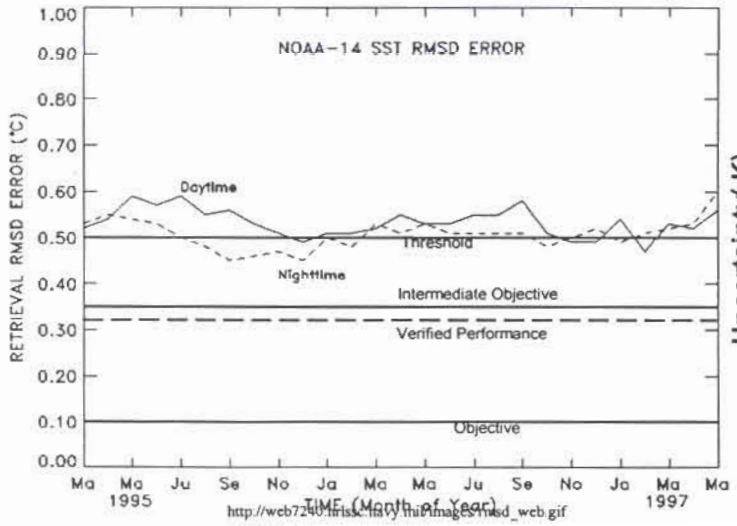
SST S/W Architecture
Unit-level design details I/O, processes, dependencies, & dataflows

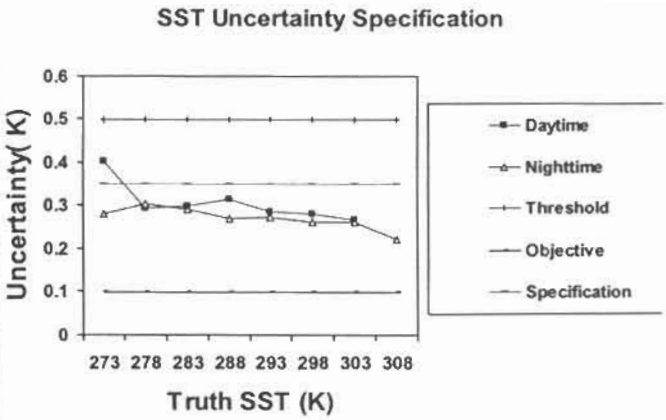


VIIRS SST Performance



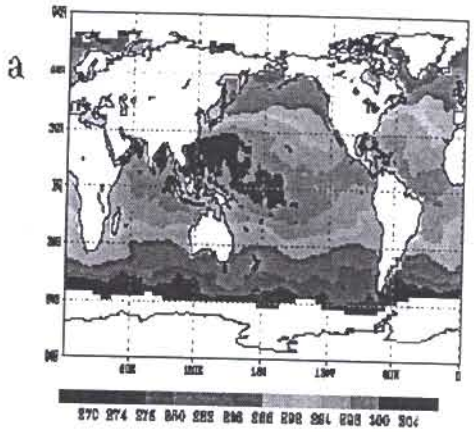
- VIIRS SST Algorithm achieves specified performance with margin,
- at fine resolution, day and night,
- for all temperature and zenith angle stratifications.



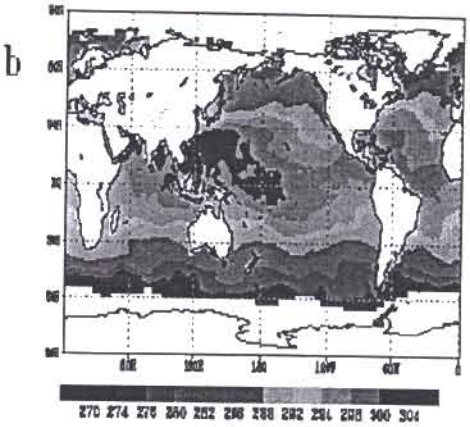


SST Retrievals

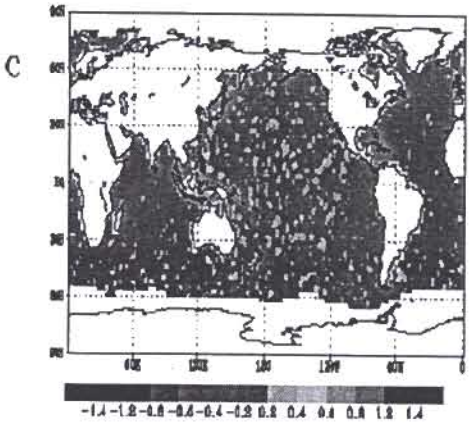
a) Global NCEP SST



b) VIIRS SST Retrieval



c) dSST < 0.3K globally



References and Acknowledgements

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For more details, refer to the Sea Surface Temperature Visible/Infrared Imager/Radiometer Suite Algorithm Theoretical Basis Document #Y-2386.