

Aerosol retrievals over oceans from MSG/SEVIRI for the use in GERB radiation budget analyses

(Manuscript in preparation for *Remote Sensing of Environment*)

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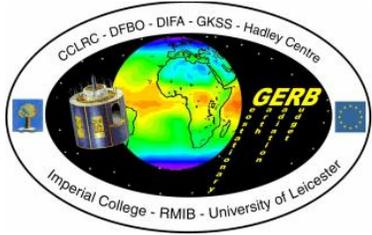
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Alessandro Ipe (GERB & RMIB)

Acknowledgement:

Yury Kihai, NOAA/NESDIS and QSS Inc



Aerosol Product from SEVIRI in RMIB GERB Processing (RGP)

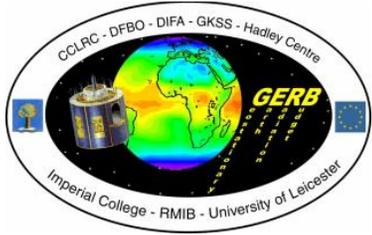


Meteosat-8 launched 28 Aug 2002

- GERB: Sister-instrument to CERES
- RMIB GERB Processing (RGP) operational at RMIB
- Aerosol product on GERB datasets needed for aerosol forcing studies

AVHRR-like Aerosol product from SEVIRI: Incorporated in RGP

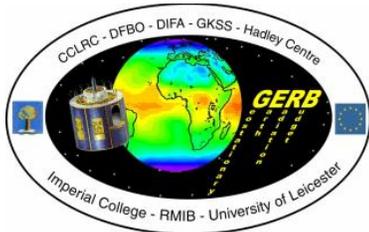
- SEVIRI: AVHRR-like imager (Aerosol bands 0.63, 0.83, 1.61 μm)
- AVHRR-like aerosol product
 - 3 AODs independently derived in 3 bands using single-channel algorithm
 - Angstrom exponent estimated from spectral AODs
 - Extensively tested with AVHRR and MODIS; Reported on TRMM (primary) and Terra and Aqua CERES SSFs (back-up product)
 - Tested with SEVIRI for dust cases (Brindley and Ignatov 2006)



Outline of talk



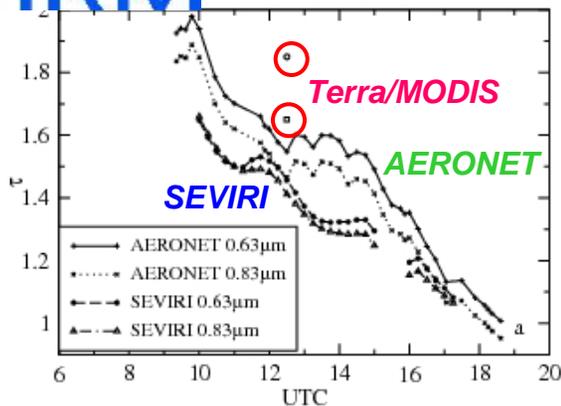
1. Validation of AVHRR-like Aerosol Product from SEVIRI against AERONET in confidently clear-sky conditions
2. RMIB Cloud Mask & Comparison with MPEF & SAFNWC CMs
3. Examples of RGP SEVIRI aerosol products
4. Comparisons with Terra/Aqua MODIS
5. Conclusion and future work



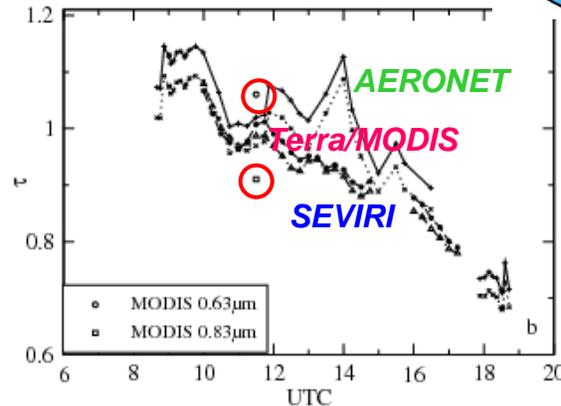
Validation of SEVIRI AOD1 and AOD2 against AERONET (confidently clear conditions)



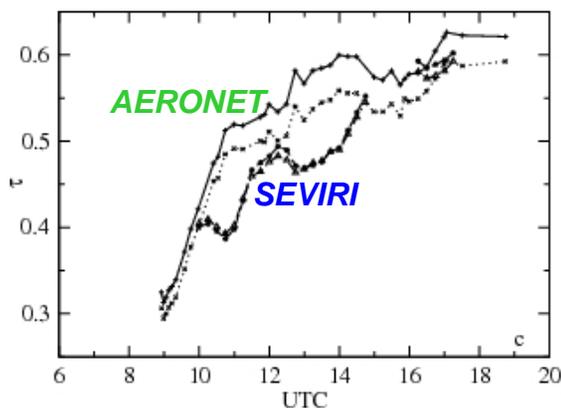
Cape Verde,
5 March 2004



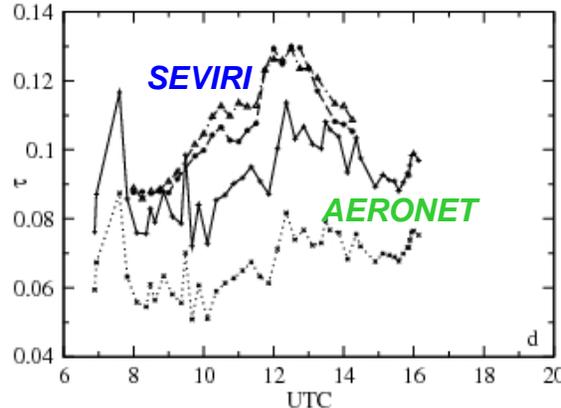
Cape Verde,
6 March 2004



Cape Verde,
7 March 2004

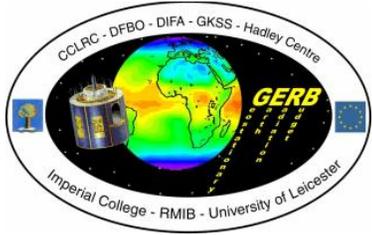


Lampedusa,
12 March 2004



Case studies comparisons with AERONET/MODIS: SEVIRI Aerosol reasonable. However:

- Dust (Cape Verde): Low bias. Insufficient aerosol absorption (Brindley Ignatov 2006)
- Low Aerosol (Lampedusa): High bias (SEVIRI calibration?)
- Spectral dependence in SEVIRI product suppressed (SEVIRI cal? Aerosol model?)



RMIB Cloud Mask: Comparison with MPEF and SAFNWC CMs

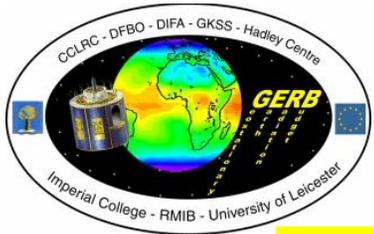


RMIB Cloud Mask over oceans

- Threshold Cloud Optical Depth @ $0.83 \mu\text{m}$ ~ 0.6 (Ipe et al., 2004)
- Use dust tests to restore “cloud” to “clear” (Brindley Russell 2006)
(NB: No restoral tests for other aerosol categories with high AOD, such as smoke)
- Use 11-12 μm brightness temperature difference to identify cirrus

MPEF (Meteorological Product Extraction Facility; Lutz 1999) and **SAFNWC** (Satellite Application Facility in support of NOWcasting and very short forecasting; Derrien and Legleau 2005)

- Threshold solar reflectances and their inter-band differences
- Threshold brightness temperature and their inter-band difference (including using RTM to set up thresholds, dynamically)
- Spatial uniformity tests
- Test for sun-glint and snow



6 March 2004 12:00 UTC

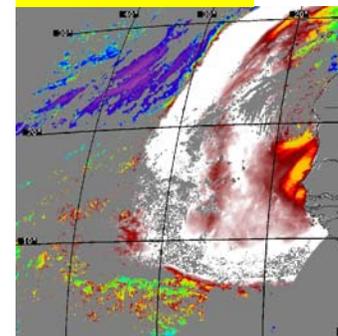
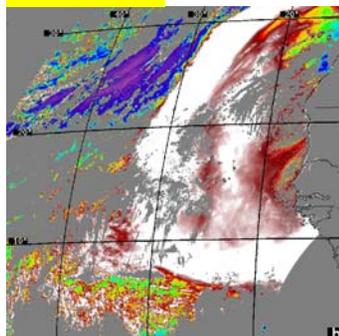
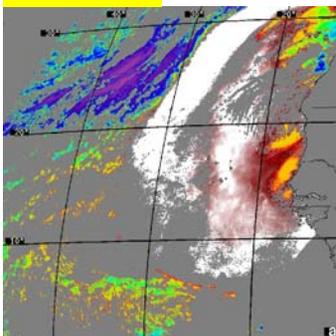


RMIB

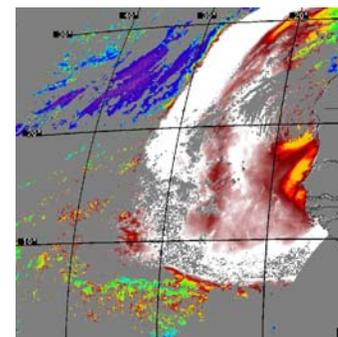
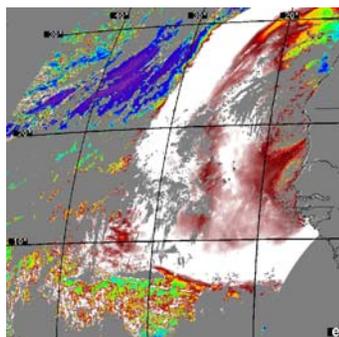
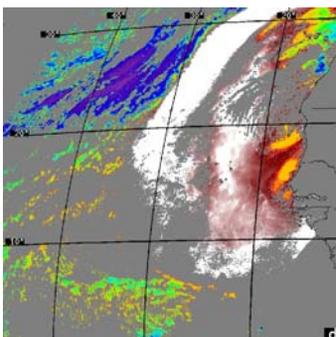
MPEF

SAFNWC

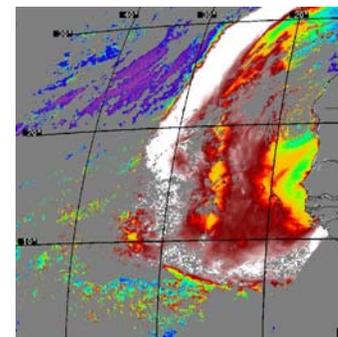
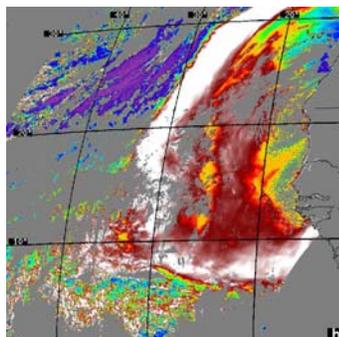
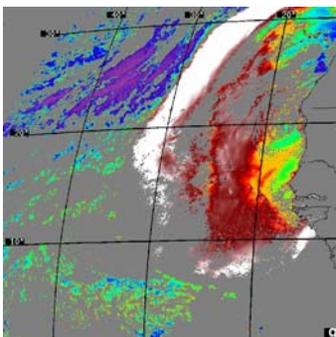
AOD1
(0.63 μm)



AOD2
(0.83 μm)



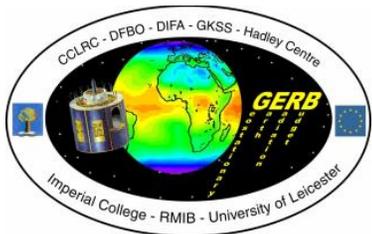
AOD3
(1.61 μm)



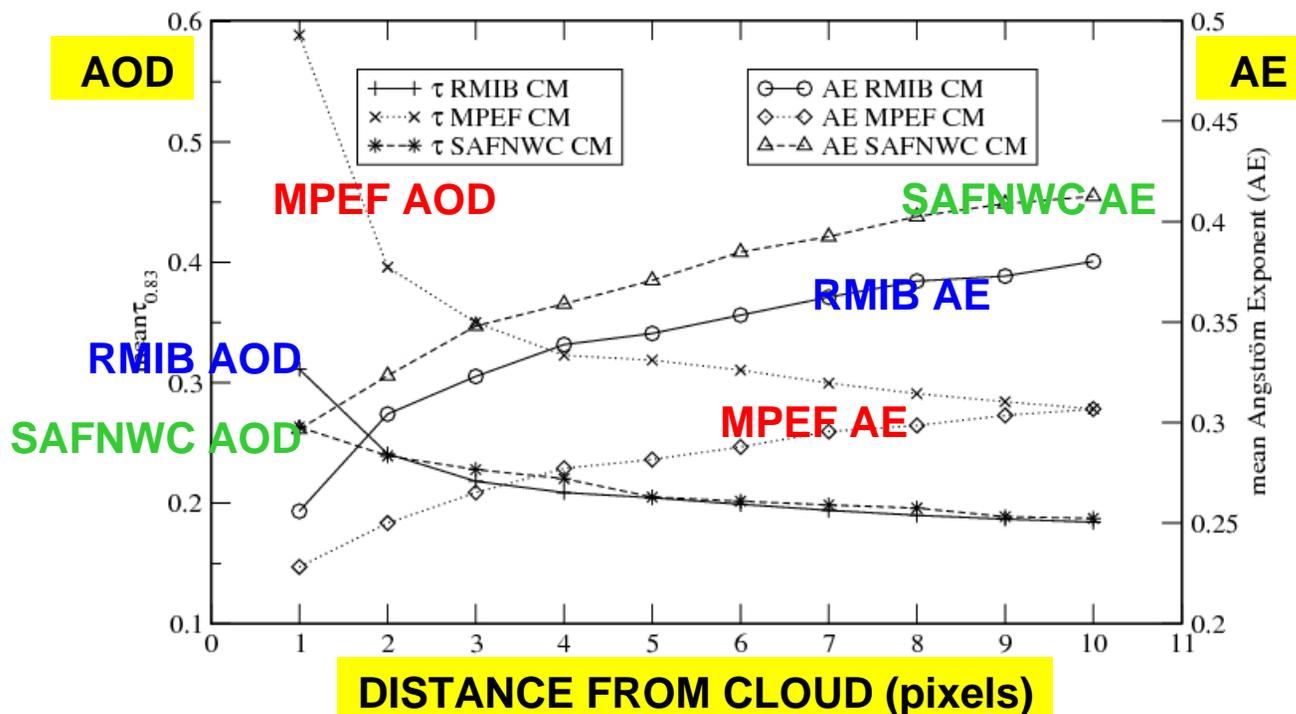
04/26/2007

CERES2 STM-7 24-26 April 2007



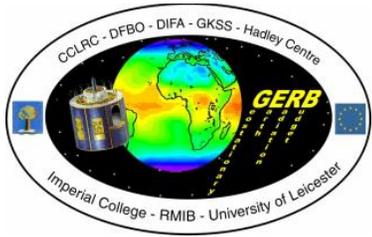


Effect of proximity to cloud on AOD and Angstrom Exponent



RMIB CM was selected for operational GERB Processing because it:

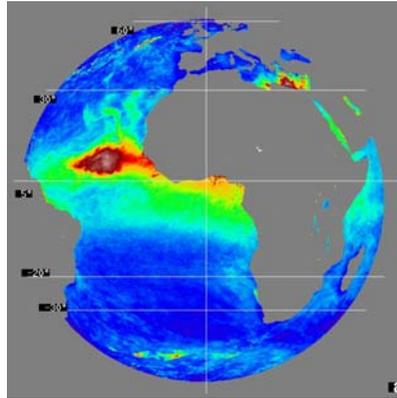
- Compares well with SAFNWC & Outperforms MPEF CM
- Simple, robust, computationally efficient, easy to maintain/improve



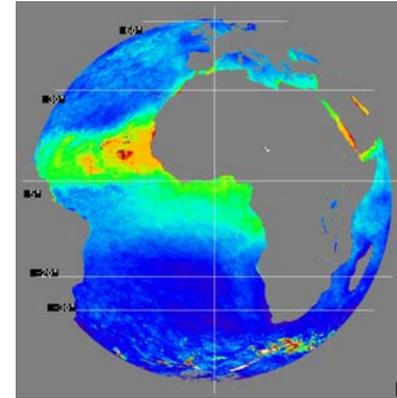
Seasonal maps of AOD2 from 21 Dec 2005 – 20 Dec 2006



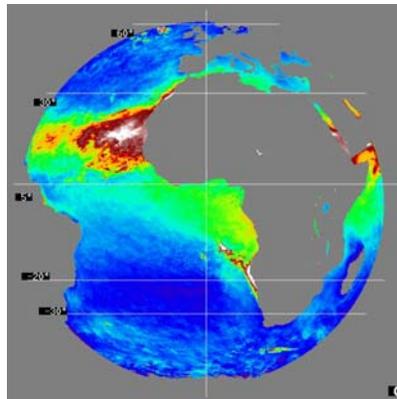
Winter



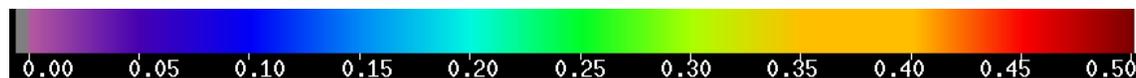
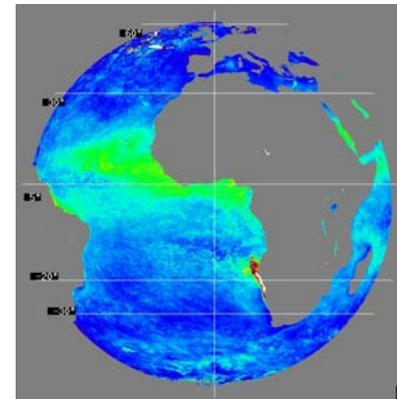
Spring

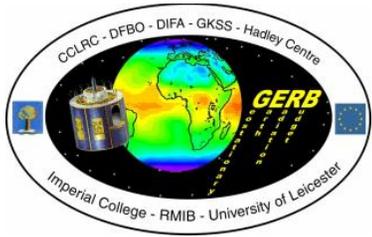


Summer



Fall

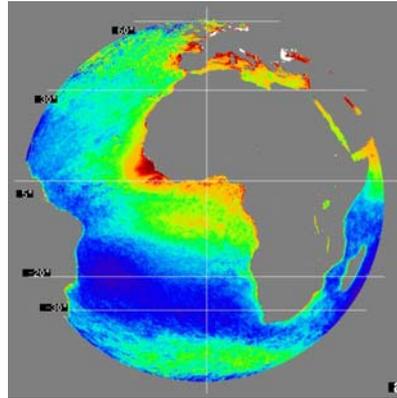




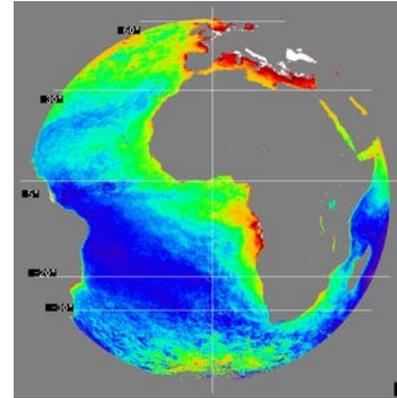
Seasonal maps of AE23 from 21 Dec 2005 – 20 Dec 2006



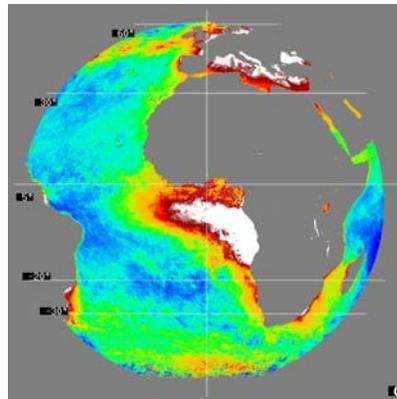
Winter



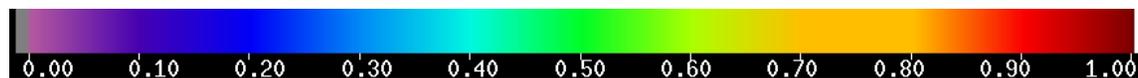
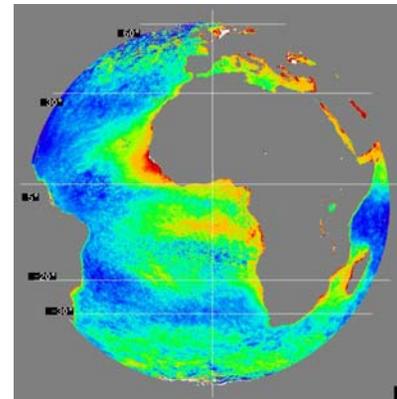
Spring

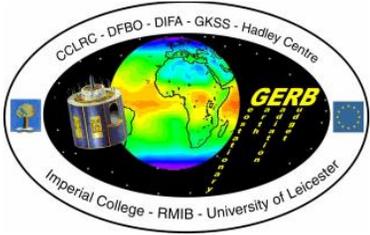


Summer



Fall



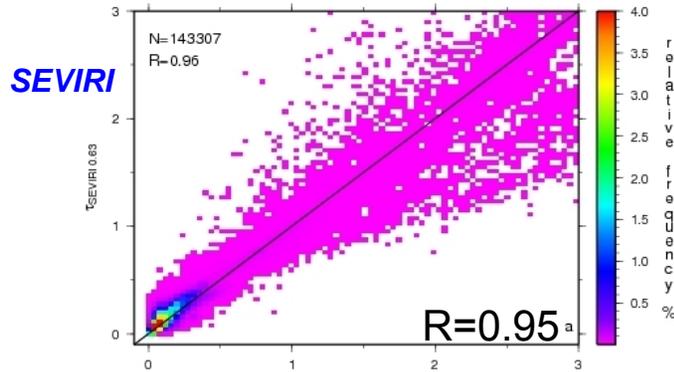


SEVIRI versus MODIS (10km)

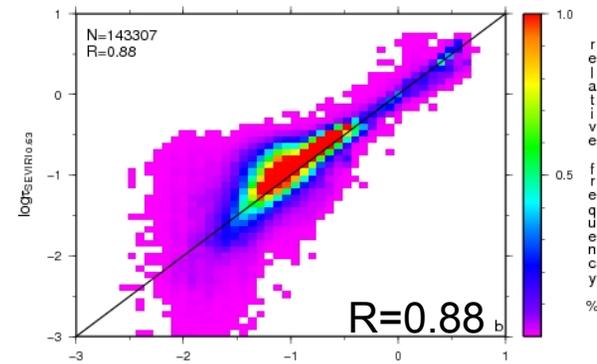
28 Feb – 12 Mar 2004, AOD1 (0.63 μm)



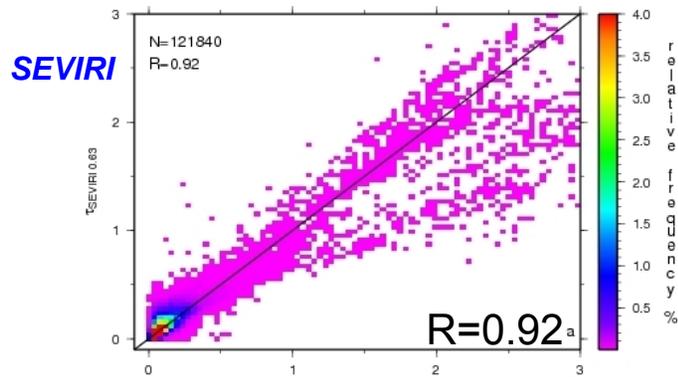
Comparisons done in “double-rectified” conditions (cloud-free pixels in both products.) May not tell a complete story.



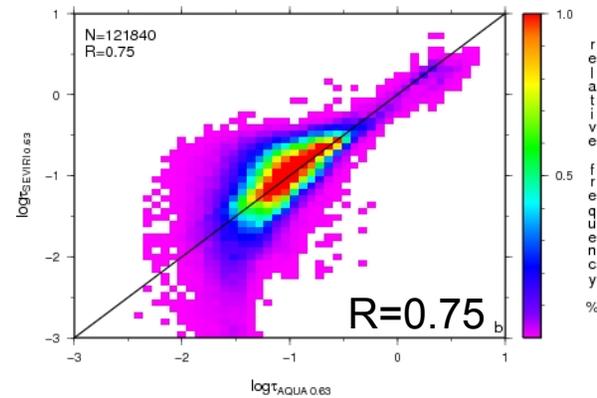
Terra/MODIS



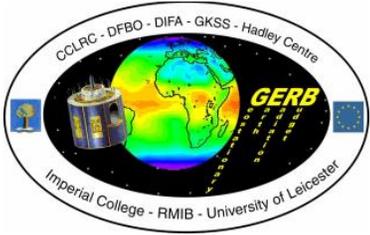
.. in a log-log scale



Aqua/MODIS



- Globally, SEVIRI agrees well with MODIS
- SEVIRI AOD is noisier than MODIS

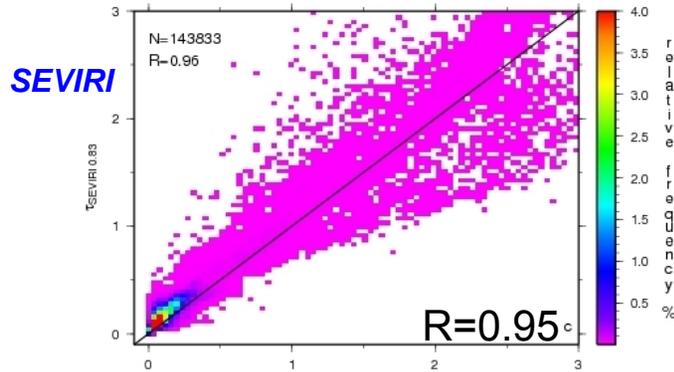


SEVIRI versus MODIS (10km)

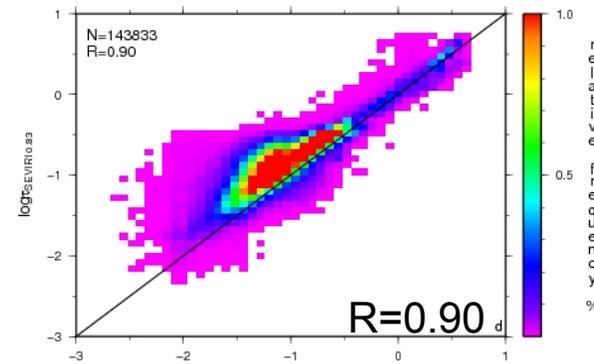
28 Feb – 12 Mar 2004, AOD2 (0.83 μm)



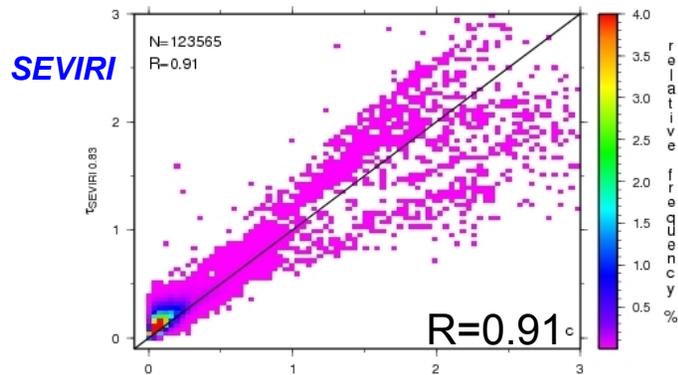
Comparisons done in "double-rectified" conditions (cloud-free pixels in both products.) May not tell a complete story



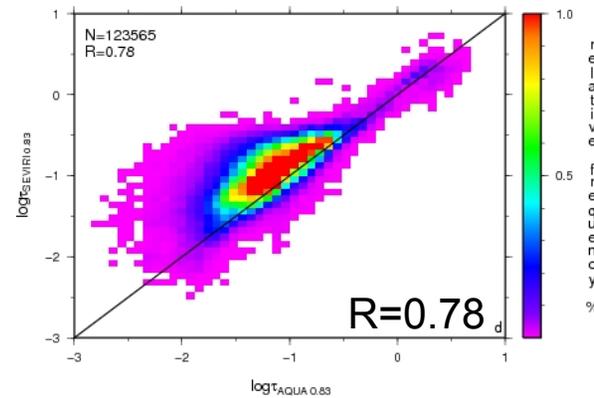
Terra/MODIS



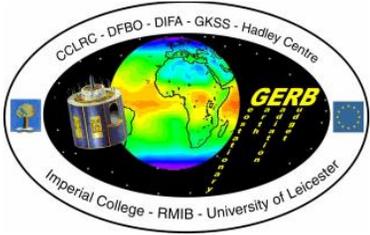
.. in a log-log scale



Aqua/MODIS



- Globally, SEVIRI agrees well with MODIS
- SEVIRI AOD is noisier than MODIS
- SEVIRI Band 2: Cal biased high w/rt to Terra/Aqua?

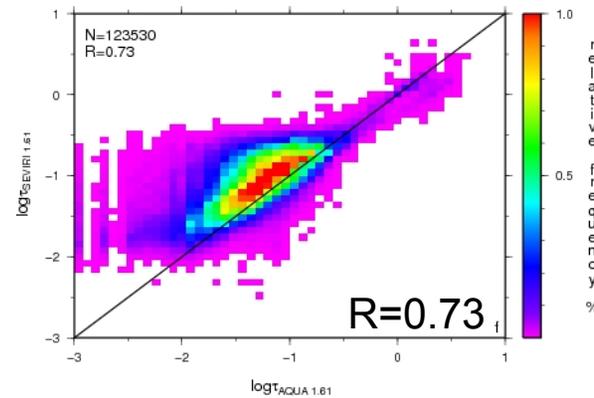
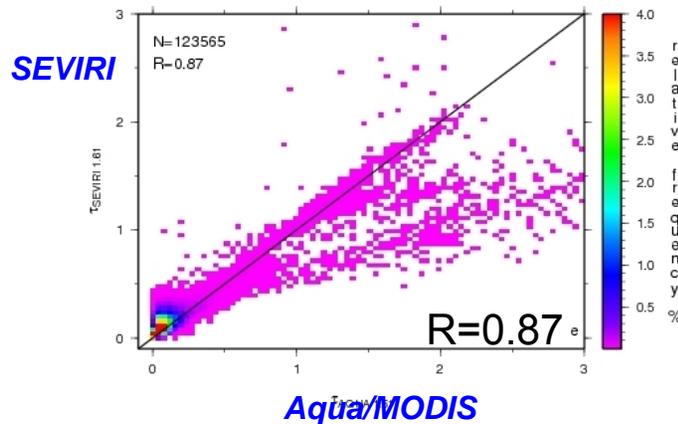
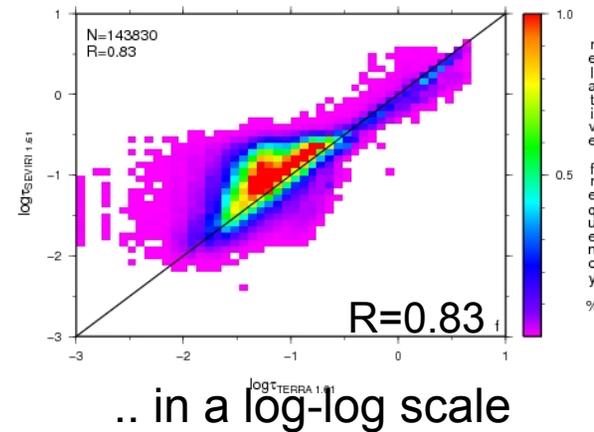
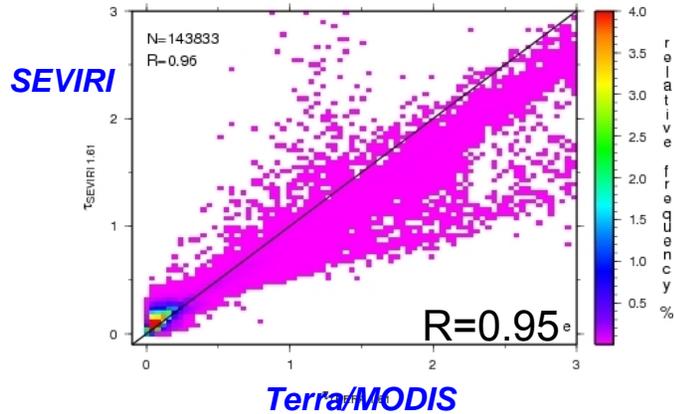


SEVIRI versus MODIS (10km)

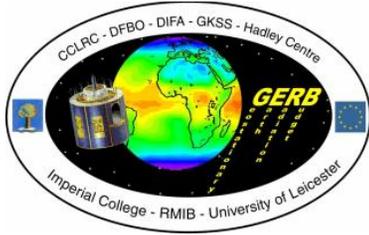
28 Feb – 12 Mar 2004, AOD3 (1.61 μm)



Comparisons done in "double-rectified" conditions (cloud-free pixels in both products.) May not tell a complete story



- Globally, SEVIRI agrees well with MODIS
- SEVIRI AOD is noisier than MODIS
- SEVIRI Band 3: Cal biased high w/rt to Terra/Aqua?



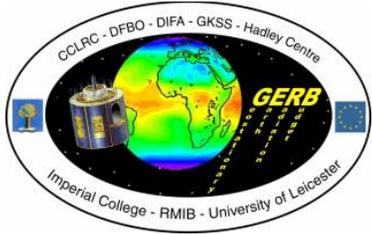
Conclusion



- ❑ End-to-end SEVIRI Aerosol product integrated in RMIB GERB Processing
 - ✓ It is based on RMIB Cloud Mask; and
 - ✓ NESDIS 3rd gen AVHRR-like Aerosol Algorithm
 - ✓ Better suited to start looking into direct aerosol forcing (indirect forcing limited)

- ❑ High spatial and temporal GEO resolution & Spectral AOD and AE
 - ✓ Resolves fine structure and dynamic of aerosol concentration and size
 - ✓ Helps suppress noise (particularly important for Angstrom Exponent)

- ❑ Comparison with AERONET & MODIS
 - ✓ SEVIRI Aerosol product looks reasonable
 - ✓ Possible improvements
 - Cloud Mask: Better handle of non-dust high-AOD cases
 - SEVIRI Calibration (Bands 2-3 high with respect to MODIS)
 - Aerosol model (dust AOD underestimated)



Future work



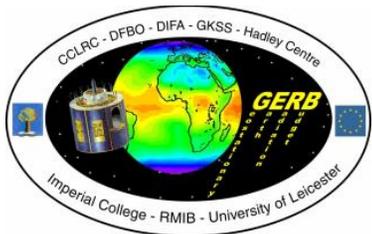
- Cloud Mask for SST/Aerosol for GOES-R/ABI
 - ✓ Use MSG/SEVIRI as prototype for GOES-R/ABI
 - ✓ Explore CLAVR-x based AVHRR Clear-Sky Processor for Oceans (ACSPO)
 - ✓ Explore Pat Minnis's group Cloud Mask for SEVIRI

- Calibration in SEVIRI Aerosol bands
 - ✓ Use AVHRR-like AOD from SEVIRI for diagnostic
 - ✓ Explore Angstrom Exponent which is very sensitive to Cal errors

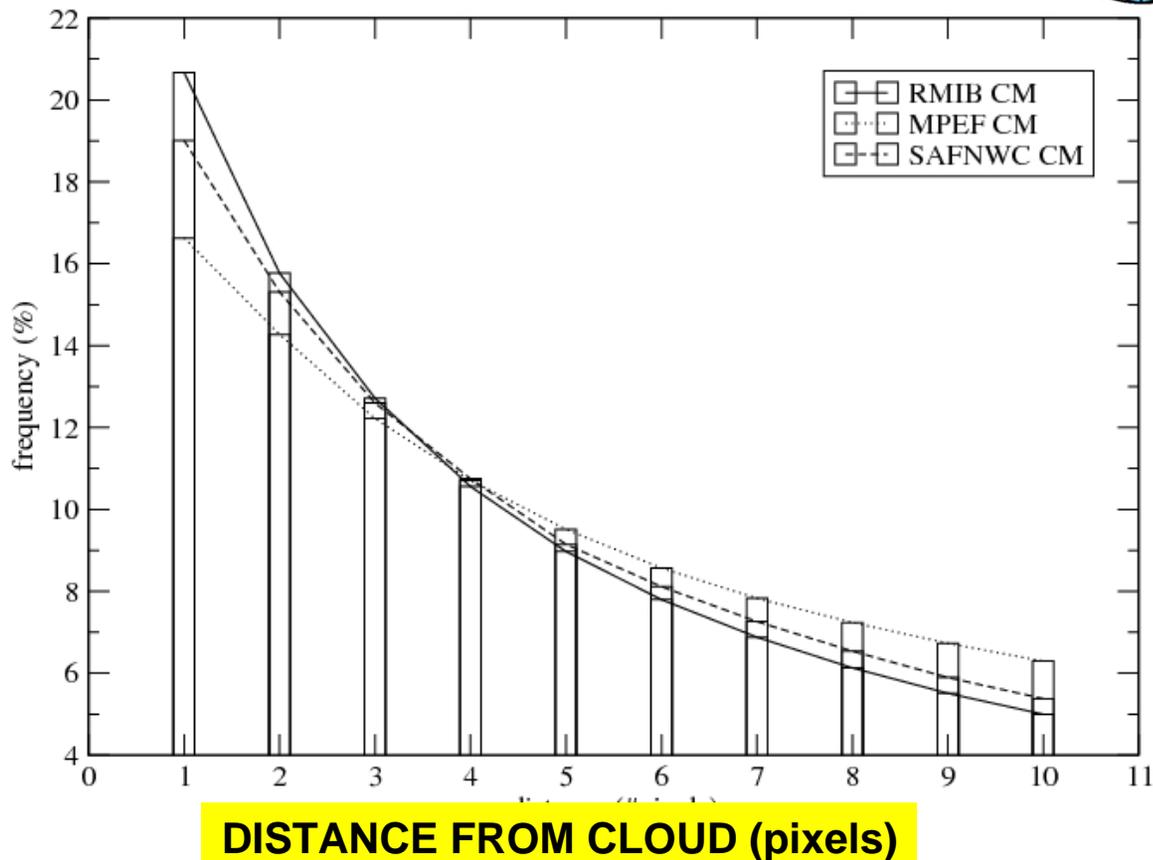
- Fine-tune AVHRR 3rd gen aerosol model
 - ✓ Explore non-spherical model of Dubovik (cf. Brindley and Ignatov 2006)

- Communicate/Sync new developments with RMIB/GERB and EUMETSAT colleagues

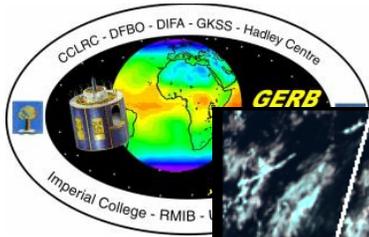
Back-Up slides



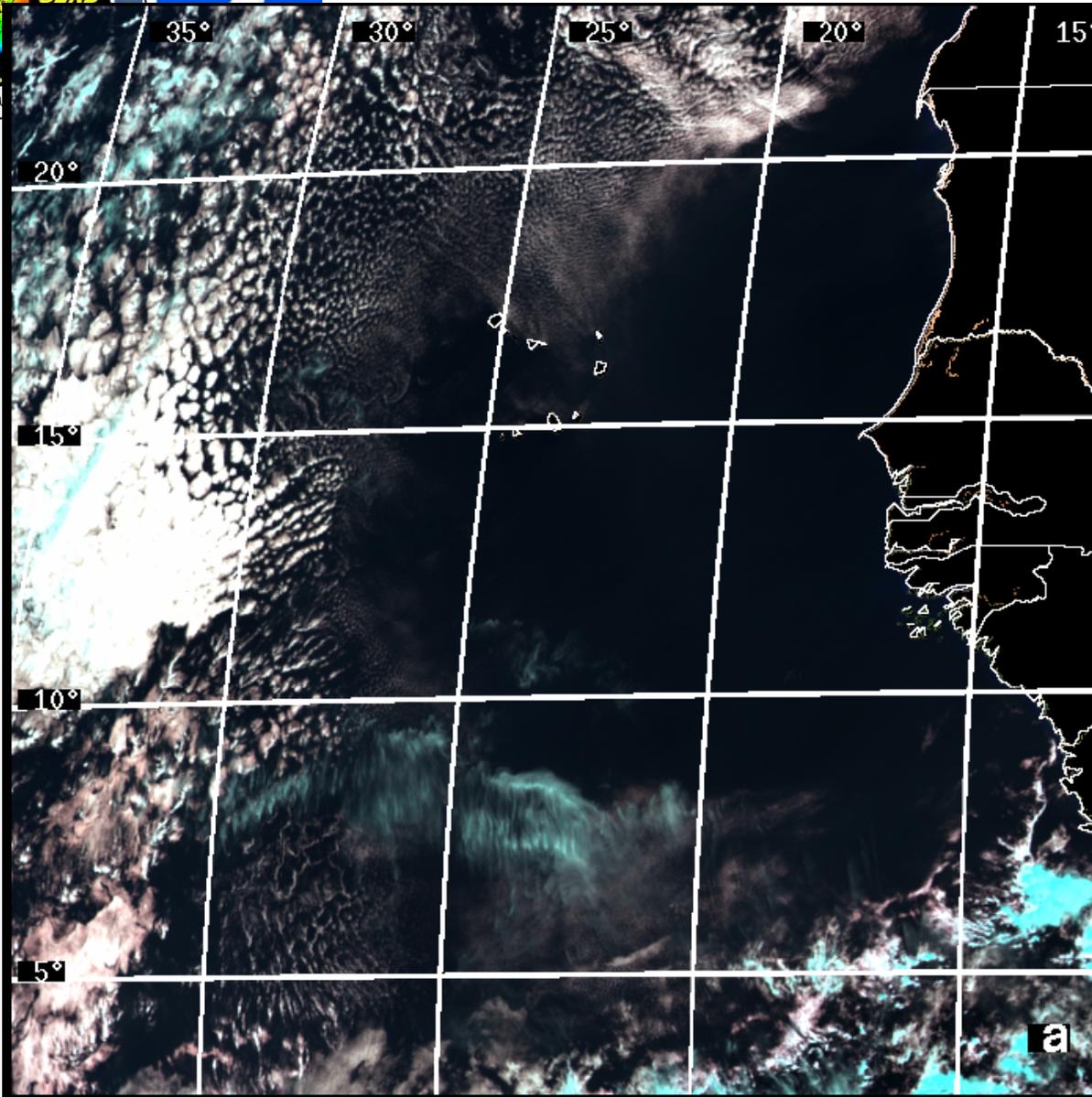
PDF of proximity to cloud for 3 cloud masks



From 17-21% aerosol pixels are within one pixel of cloud boundary; from 14-16% are within 2 pixels, etc



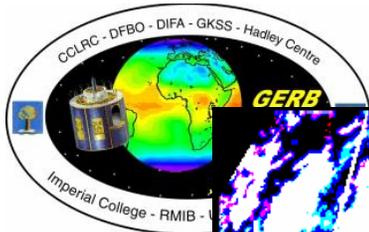
3 March 2004 11:00 UTC



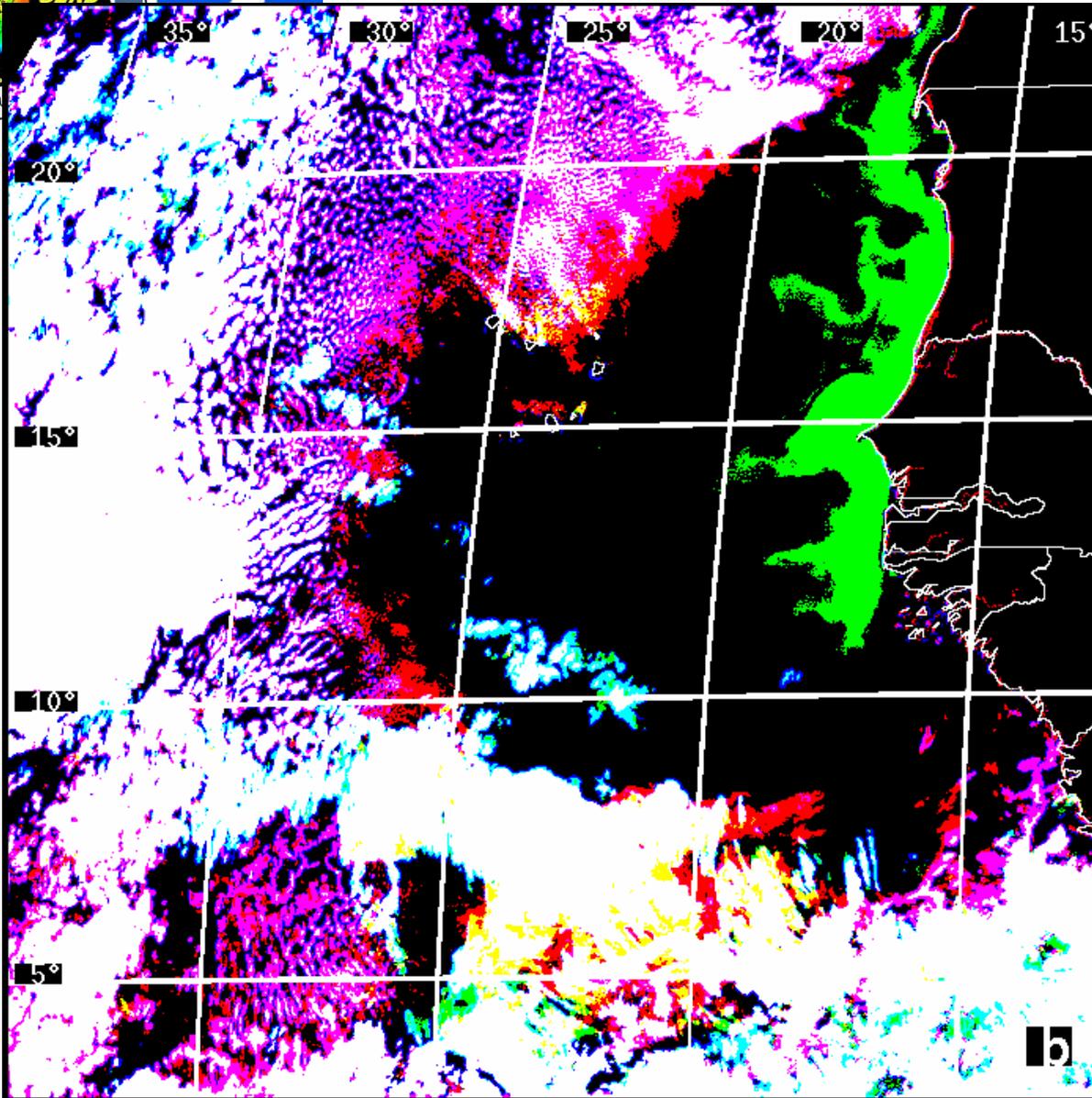
04/26/2007

CERES2 STM-7, 24-26 April 2007
Newport News, VA

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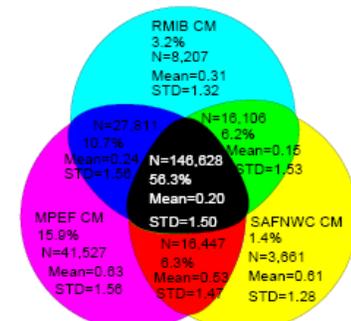
3 March 2004 11:00 UTC



Red: RGB(256,0,0)
 RMIB says "cloud"
 MPEF/SAFNWC
 both say "clear"

Green: RGB(0,256,0)
 MPEF says "cloud"
 RMIB/SAFNWC
 both say "clear"

Blue: RGB(0,0,256)
 SAFNWC says cloud
 RMIB/MPEF
 both say "clear"



04/26/2007

CERES2 STM-7, 24-26 April 2007
 Newport News, VA