Imperial College London

14th AMS Conference on Satellite Meteorology and Oceanography, Atlanta, GA, 30 Jan – 2 Feb 2006

AEROSOL RETRIEVALS FROM MSG SEVIRI OVER OCEAN USING AVHRR-LIKE ALGORITHM

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ABSTRACT

The current operational algorithm used to retrieve aerosol optical depth (AOD) and Ångström exponent (AE) over ocean from the solar reflectance bands of the Advanced Very High Resolution Radiometer (AVHRR) flown onboard NOAA polar orbiting satellites was adapted to the corresponding channels of the Spinning Enhanced Visible and Infra-Red Imager (SEVIRI) on the Meteosat Second Generation (MSG) geostationary platform. The algorithm was applied to a large Saharan dust event which occurred through 3-5 March 2004 and a detailed description of the dust loading through the diurnal cycle was obtained. Snapshot comparisons with spatially resolved retrievals from the MODerate resolution Imaging Spectrometer (MODIS) instruments flown on the *Terra* and *Aqua* polar platforms show qualitative agreement with the SEVIRI retrievals. In addition to the generic aerosol model used in the NOAA/NESDIS algorithm, tuned to optimize retrievals over global ocean, three microphysical models, specifically proposed for desert dust, have also been tested. However, comparison of the diurnal variation seen in these SEVIRI retrievals with available ground based Aerosol Robotic Network (AERONET) observations from the Cape Verde coastal station suggests that the phase functions associated with two of these dust representations, obtained under the assumption of particle sphericity, result in unrealistic time dependent behaviour. This tendency is removed when either the generic aerosol representation used in the NOAA/NESDIS algorithm is employed, or a more physically based non-spherical dust representation is used.

RETRIEVAL METHODOLOGY

Acquire SEVIRI images for 0.6, 0.8, 1.6, 7.3, 8.7, 9.7, 10.8 and 12 μm channels along with corresponding geometry and cloud flag information

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Convert visible and near-ir channels to reflectances, mid-ir channels to brightness temperatures and spatially average to 3 x 3 SEVIRI pixels (~ 10 x 10 km^2)

↓

Perform mid-ir dust detection[1] and estimate 0.55 μm optical depth

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Add dusty points to nominally clear points identified by MPEF cloud flag[2]

↓

Identify regions of sun-glint and points with solar zenith angles > 60° within 'clear' points and remove

↓

Retrieve 3 monochromatic AODs (at 0.63, 0.83, 1.61 μm) from 3 SEVIRI reflectances for given solar/view geometry using pre-defined, aerosol specific look up tables (LUTs). Derive AEs from AODs. Scale retrieved AODs to other wavelengths as required (e.g. for comparisons with AERONET, MODIS).

AEROSOL MODELS

LUT Label	Aerosol model employed
3gen	Monomodal, log-normal size distribution, purely scattering aerosol[3] Used as standard in 3rd generation AVHRR aerosol retrievals
Opac	OPAC desert model at 0 % relative humidity[4]
Des	'Desert-like' aerosol model[5]
Nonspher	Optical properties derived using AERONET retrieval of desert dust size distribution and refractive indices[6] and assuming particles to be randomly orientated spheroids[7]

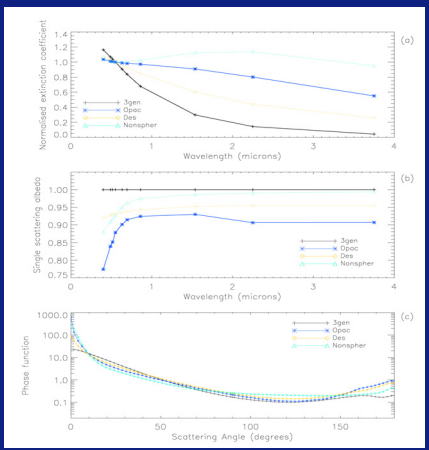

FIGURE 1

Optical properties associated with the aerosol models tested here:

(a) Spectral dependence of normalized extinction coefficient for 3gen, Opac, Des and Nonspher aerosol models.

(b) As (a) for the single-scattering albedo.

(c) Dependence of phase function (normalised at 2π) on scattering angle at a wavelength of 0.63 μm for the four aerosol models.

RESULTS I: SPATIAL CONSISTENCY WITH MODIS

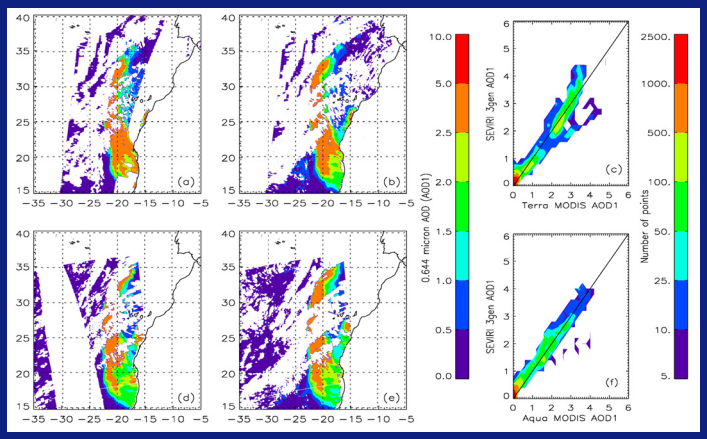

FIGURE 2

Top Row: (a) Aerosol optical depth at 0.644 μm (AOD1) retrieved from 11:50 and 11:55 UTC MODIS (*Terra*) granules on 4th March 2004. (b) AOD1 retrieved from 12:00 UTC SEVIRI observations using 3gen aerosol model. (c) 2-D histogram of the two AOD1 distributions. One-to-one line is shown for comparison.

Bottom Row: As top row, but comparing MODIS (*Aqua*) AOD1 with matched SEVIRI retrievals between 14:50 and 15:00 UTC on 4th March 2004.

RESULTS II: DIURNAL CONSISTENCY WITH AERONET

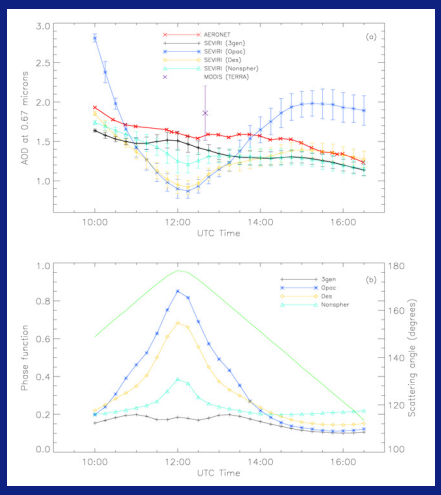

FIGURE 3

(a) Comparison of the temporal evolution of AOD seen at Cape Verde during March 5th 2004 between ground based AERONET measurements and retrievals from SEVIRI using the four aerosol models. Best agreement with the AERONET measurements is seen when either the 3gen or Nonspher dust model is employed. MODIS (Terra) value is also shown for completeness. Error bars indicate the spatial variability in the satellite retrievals.

(b) Dependence of the scattering angle of SEVIRI observations with time (green line). Values of the phase function at the given scattering angle are also shown. The AOD retrievals essentially mirror the phase function behaviour and suggest that the dependence of the phase function on scattering angle in the back-scatter region is too pronounced in the dust specific spherical models.

CONCLUSIONS

- 'AVHRR-like' aerosol retrieval algorithm is in place for routine use on SEVIRI visible and near-ir channel observations, and is planned for inclusion in the products available from the Geostationary Earth Radiation Budget (GERB) project on a test basis.
- Tests on specific dust case studies show the impact of the assumed aerosol model on the retrieval quality. Of the four models considered here, both the 3rd generation AVHRR aerosol representation, and the more physically based non-spherical dust model provide a good match to independent observations of the AOD from AERONET and MODIS.
- For the 3gen model, snapshot comparisons with MODIS retrievals show a mean agreement in AOD of ~ 0.1 at 0.644 μm, although the spatially resolved differences can be > |2.0| in optically thick regions (AOD > 4.0).
- Analysis of the time evolution of the SEVIRI AOD over coastal AERONET sites shows close agreement between the temporal behavior of SEVIRI & AERONET. Absolute AOD values are also in good agreement although the satellite AODs show a low bias relative to the AERONET (may be due to insufficient absorption in retrieval aerosol model).
- The dedicated desert-like spherical dust models tested here do not capture the temporal behavior of the AERONET AOD, principally due to the strong dependence of their Mie-calculated phase functions on scattering angle in the back-scatter region.

ACKNOWLEDGEMENTS

Thanks to colleagues at the Royal Meteorological Institute of Belgium for supplying the SEVIRI and GERB-like data, to NASA for providing access to the MODIS observations, and to Didier Tanré for his effort in establishing and maintaining the Cape Verde AERONET site. Special thanks to Oleg Dubovik for providing the non-spherical aerosol model. HB is funded by the Natural Environment Research Council, UK under grant NER/I/S/2002/00698 and AI is funded under the NOAA EOS/CERES (NASA contract L-90987C). The views, opinions, and findings contained in this report are those of the authors and should not be construed as an official NOAA or U.S. Government position, policy, or decision.

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