ATSR-2, AATSR, GOME, SCIAMACHY, OMI

TNO Physics and Electronics Laboratory

Gerrit de Leeuw
with contributions from Thomas Holzer Popp and others
Aerosol retrieval

- Cloud detection
- Separate surface contributions
- Separate Rayleigh contributions
- Choice of aerosol type and distinction between aerosol types
  - Particle size distribution
  - Complex refractive index
  - Mixture: external or internal
- Minimizing error function to determine optimum mixture
- Provides:
  - Aerosol Optical Depth (AOD)
  - Angstrom coefficient
  - Aerosol type mixing ratio
  - Aerosol index (AI)
Aerosol retrieval algorithms

- **Single view:**
  - Nadir
  - Forward
  - Dark surfaces
  - Over water:
    - Correction for whitecap cover \( f(u) \), chlorophyll
    - Sunglint
    - Fresnel reflection

- **Dual view**
  - Eliminates land surface contributions
ATSR-2

- AOD retrieval over Europe from ATSR-2
- Evaluation with Sunphotometer data (AERONET, PHOTONS)

September 1997

**Ångström Parameter**

- Aerosol Optical Depth:
- \( AOD (\lambda) = \lambda^{-\alpha} \)
  - \( \lambda \) wavelength
  - \( \alpha \) Ångström parameter

Particle size distribution:
\( dN/dD = D^{-\nu} \)
- \( \nu \) Junge exponent
- \( \nu = \alpha + 3 \)

Ångström Parameter is **not** independent of wavelength.
ATSR-2: INDOEX

- Mixture of continentally influenced and sea salt aerosol
- Minimizing error function to determine optimum mixture
- Provides:
  - AOD
  - Angstrom coefficient
  - Mixture
- Over the ocean the mixture gradually changes from continental to sea salt

Robles Gonzalez et al., 2003
ATSR-2: SAFARI
August 2000

September 2000

Robles Gonzalez et al., 2003
TEMIS activities

• Conversion scientific to operational algorithm
  Integration of different routines in a single algo:
  ATSR-2, AATSR

• Application on regional scale (Europe and European seas)
  • Testing for 2000 over Europe
  • Evaluation with AERONET data
  • Presentation on TEMIS website
  • Implementation DV&SV algos at KNMI:
    • AOD over Europe, end 1995-early 2001
Global Ozone Monitoring Experiment

- Spectrometer on ERS-2
- Wavelength range 0.240 to 0.790 µm
- Spectral resolution 0.2 to 0.4 nm
- Pixel size 320x40 km², in validation phase 80x40 km²

Retrieval:

- Five wavelength bands between 0.340 and 0.400 µm, width 1 nm
- Albedo of land surfaces is low
- Assumptions are made on surface albedo
- Bi-modal aerosol model
GOME August 1997
Comparison of retrieval methods

(a) GOME vs. ATSR-2

AEROSOL OPTICAL DEPTH vs. WAVEL ENGTH (µm)

(b) De Bilt vs. Lille
Synergetic aerosol retrieval

Dr. Thomas Holzer-Popp
and Marion Schroedter

German Aerospace Center (DLR)
German Remote Sensing Data Center (DFD)
Climate and Atmosphere Products
Phone: +49-8153-28-1382
Email: thomas.holzer-popp@dlr.de

AEROCOM meeting

June 2003
- SYNAER uses GOME/ATSR-2 or SCIAMACHY/AATSR
- SYNAER delivers AOT and type over land and ocean
- spatial resolution: 80x40 km$^2$ / 60x30 km$^2$
- temporal resolution: weekly coverage (ENVISAT), only 3 days per month from ERS-2
- data acquisition through ESA AO projects (operational from 2004)
- to be negotiated with ESA: “3 day” climatology for 2000
- regular global monitoring planned from 2004
- backprocessing of ENVISAT data is possible up to mid 2002
Based on SYNAER evaluation of GOME / ATSR-2 data
July 1997 – March 1998 (3 days per month), extension to Aug 1998
5 x 5 degree grid

**Limitation:**
3 days per month only
Cloudiness
Bright surface albedo

**Quality check / ambiguity test:**
Surface albedo 670 nm less than 0.07 (0.015) over land (ocean)
Cloud fraction in GOME pixel less than 50%
Fit error GOME spectrum less than 0.025
Number of contributing orbits per box 2 or more (mean: 4)
Number of contributing GOME pixels per box 5 or more (mean: 19)
Component analysis only for AOT > 0.1
SYNAER aerosol retrieval

ATSR delivers aerosol optical depth and surface albedo but needs aerosol type.

GOME delivers aerosol type, but needs aerosol optical depth and surface albedo first.

-> combined retrieval

Holzer-Popp, et al.
JGR 107, D21 (2002)
T. Holzer-Popp and M. Schroedter, DLR-DFD
Method and case study validation published in: JGR 107 (2002), D21 and D24

Europe 1-3 September 1995
full resolution OT map (right)
component map (below)

IN=insoluble, WA=watersoluble, SO=soot, SA=sea salt accumulation mode, SC=sea salt coarse mode, MT=mineral transported

AOT AERONET

Case study validation against AERONET sun photometers from 340 to 870 nm indicates to selecting the right aerosol OT and mixture
Αβσορβίνη αεροσόλ ινδεξ (ααι) ρετριεσάλ φρομ Σχιαμαχηψ ανδ ΓΟΜΕ
Μαρτιν δε Γκααφ ανδ Πιετ Σταμμεσ, KNMI

\[ AAI = -100(\log(P335/P380)_μεασ - \log(P335/P380)_Ραψ) \]
Αεροσολ χλιματολογυς οφ Σαηαρα δεσερτ δυστ φρομ ΓΟΜΕ δατα. Ήερε τηε ασεραγε παλυε οφ δεσερτ δυστ ισ ρεπορτεδ φορ θυνε 1997. Τηε ψελλοω-ρεδ ρανγε ινδιχατες τηε πρεσενχε οφ δεσερτ δυστ εσεντς εμβεδδεδ ιντο α μαριτιµε αεροσολ ανδ ρεσιδουαλ χλουδς (λιγη βλυε). (P. Γυζζι)
SCIAMACHY: Approach over land

Scheme tested with GOME data

1. Reflectances at TOA measured by SCIAMACHY
   - Cloud screening
   - Gas absorption correction

2. Surface correction
   - GOME surface reflectances database
   - + EOF method for a given region

3. Rayleigh correction → Aerosol reflectance

4. LUT of aerosol reflectances for a given satellite and solar geometry

5. The best fit with aerosol model

6. AOD

Jolanta Kusmierczyk-Michulec
OMI (EOS Aura, Jan 2004)

INPUT

Compute Aerosol indices

OMI / MODIS cloud product

CLoud/GLINT screening

Select Aerosol Models

Correction for surface albedo

Geographical Distribution database

Near-UV Method

Multi-Wavelength Method

Compute Output

LUT

Surface Reflectance Database

Torres, Decae, Veefkind & De Leeuw, OMI ATBD, 2002
Summary

- Satellite aerosol retrieval products (AOD, type, Angstrom coefficient, AI) are becoming available:
  - ATSR-2/AATSR (1x1 km²)
    - 5 months available
    - ATSR-2 for 2000 over Europe (with hopes for 1995-2001)
    - Other areas feasible
    - ATSR-2 series continued with AATSR
    - Available on TEMIS web site
  - GOME
    - GOME over water product (Guzzi) on TEMIS web site
  - SYNAER
    - SYNAER (GOME/ATSR-2) climatology (Holzer Popp)
    - Continued with SYNAER (SCIAMACHY/AATSR)
  - SCIAMACHY global product
  - OMI global product
  - Synergistic use of satellites
  - Needs validation/evaluation
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