ADV retrieval algorithm for AATSR

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Contents

• (Too) short retrieval method description
• Main product in highlight
• Strech retrieval to its limits - Additional aerosol retrieval results
• Cloud retrieval introduced
• Future plans
ADV/ASV Basics

• Retrieval of aerosol properties using the AATSR/ATSR2 instruments
  • ADV – AATSR Dual View algorithm for over land retrieval
  • ASV – AATSR Single View algorithm for over ocean retrieval
• ADV uses both AATSR views (near nadir, 55° forward) to uncouple atmospheric and surface reflectance
• ASV uses only one of the views together with an ocean surface reflectance model
• The 555, 659 and 1610 nm wavelengths are used in ADV. ASV includes also the 865 nm wavelength
ADV Aerosol Retrieval

- Handling of surface reflectance
- **Main assumption**: the ratio of forward and nadir surface reflectance (k-ratio) is wavelength independent
- The ratio is determined using the 1610 nm measured reflectance
- The ratio, together with a formal connection of nadir and forward TOA reflectance models, enables to use both AATSR views during retrieval. No prior information about surface reflectance is needed
- Limitations: Does no work properly for bright surface (sand deserts, snow, ice), 865 nm wavelength no usable
ADV: k-ratio ($R_{\text{forward}}/R_{\text{nadir}}$ at 1610 nm)
ADV/ASV Aerosol Retrieval

- Four aerosol components from ESA CCI project: 1 - non-absorbing fine particles, 2 - absorbing fine particles, 3 - coarse sea salt, and 4 - coarse dust
- In retrieval two mixtures between the components are determined
- \[ x = m_f[m_{na}x_1(L) + (1 - m_{na})x_2(L)] + (1 - m_f)[(1 - m_d)x_3(L) + m_dx_4(L)], \]
  where \( m_f \) denotes fine/coarse mix, \( m_{na} \) non-absorbing/absorbing fine mix, and \( m_d \) dust fraction. For all \( m; m = \{0,1\} \), \( L \) is aerosol loading related parameter. Dust mixture \( m_d \) comes from AEROCOM/AERONET climatology.
ADV/ASV Aerosol Retrieval

- $x$ can be any aerosol property that has been determined for the individual aerosol components.
- In ADV/ASV $x$ is usually **aerosol optical depth (AOD)**.
- Possible values in the aerosol look-up-tables for $x$: AOD, TOA reflectance, transmittance (direct, diffuse), SSA, asymmetry parameter etc.
ADV/ASV AOD validation

- External validation done within the ESA Aerosol-CCI project
- Example: Level 3 (1º x 1º grid) for 2008 from AEROCOM
AOD uncertainty

- Uncertainty of AOD (555, 659 and 1610 nm) is based on the propagation of measurement error through the retrieval process
- Under work: uncertainties from modeling errors (wrong aerosol model, sea surface modeling errors, etc).

Ensemble & sensitivity studies
Other retrieval results: fine particle SSA

- By using \( x = m_{na}x_1 + (1 - m_{na})x_2 \), where \( x \) is SSA, and ignoring coarse particles an effective fine particle SSA can be determined.

Illustration of the spectral difference of non-absorbing (blue) and absorbing (red) fine particle reflectance.

Wavelengths:
- star – 555 nm
- circle – 659 nm
- cross – 865 nm
- square – 1610 nm
Fine particle AOD and SSA

MODIS fire rapid response, 9th – 18th Sep. 2010
(L. Giglio, J. Descloitres)
Surface reflectance

- As only weak assumption about surface is made in aerosol retrieval (k-ratio), the derived surface reflectance is considered to be an independent retrieval result
- Validation with AERONET based ASVRN product
Instantaneous small particle direct radiative effect (DRE)

- With AOD, SSA, surface reflectance, and asymmetry parameter retrieved (a priori vertical aerosol distribution), radiative effect can be computed by applying radiative transfer.

Instantaneous fine particle DRE (W/m²) at 555 nm, September 2010
Retrieval of cloud properties

- Cloud module “Sacura” (Kokhanovsky et al., JGR, 2003) has been implemented to ADV
- For nadir observations using 865 nm and 1600 nm wavelengths with SZA below 30 deg
- See poster by L. Sogacheva
- Output
  - Cloud optical thickness
  - Effective radius
  - Liquid water path
  - Cloud albedo
  - Cloud top height by using stereoview (nadir-forward)
ADV/ASV further development

• Bright surface retrievals, k-ratio issues
• Enhanced uncertainty determination
• Retrieval over snow and ice (Finnish emphasis: black carbon studies in Arctic regions)
• Full ATSR2/AATSR 17 year aerosol dataset
• Upcoming SLSTR instrument (NRT retrieval)
• Aerosol-cloud interaction studies