# ADV retrieval algorithm for AATSR

Pekka Kolmonen[1], Larisa Sogacheva[1],
Edith Rodriguez[1], Anu-Maija Sundström[2],
Timo Virtanen[1], Gerrit de Leeuw[1,2]

[1]Climate Change Unit, Finnish Meteorological Institute
[2]Department of Physics, University of Helsinki

# 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, 55º 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
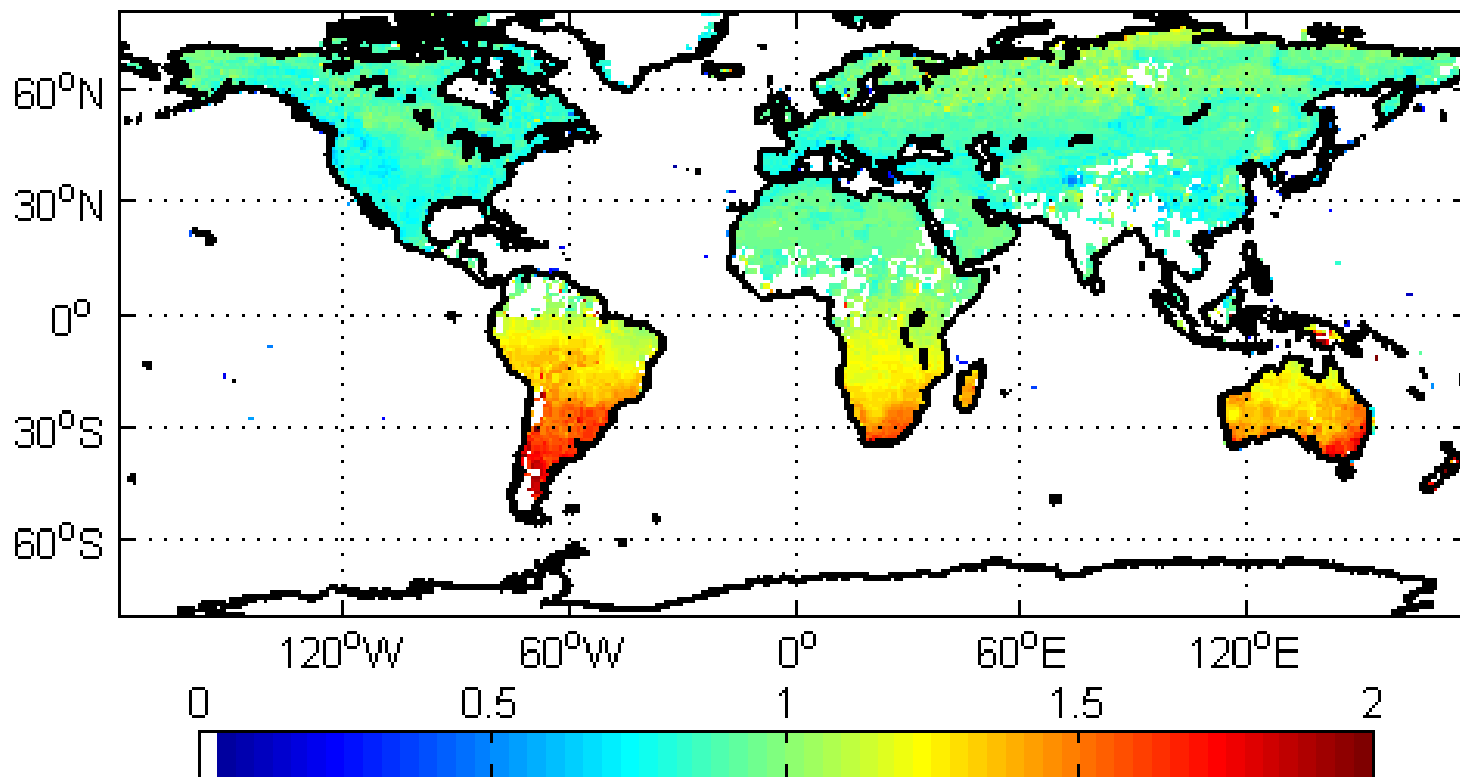
# ADV Aerosol Retrieval

- 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 ($R_{forward}/R_{nadir}$ at 1610 nm)



k-ratio, August 2010

# 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
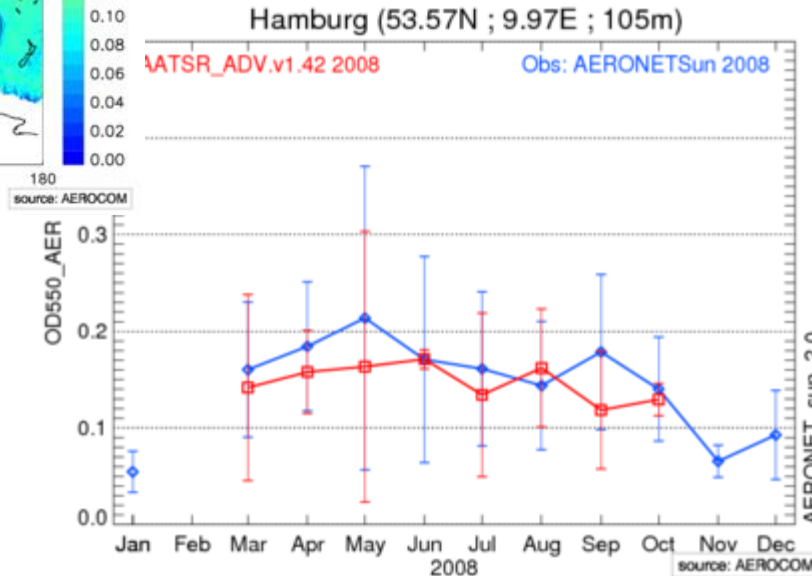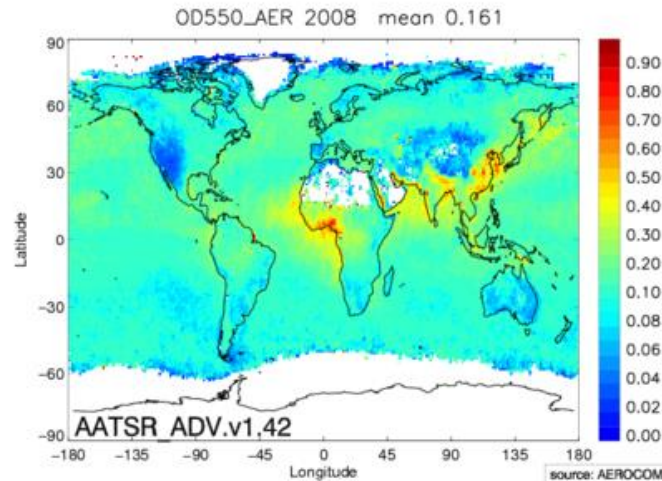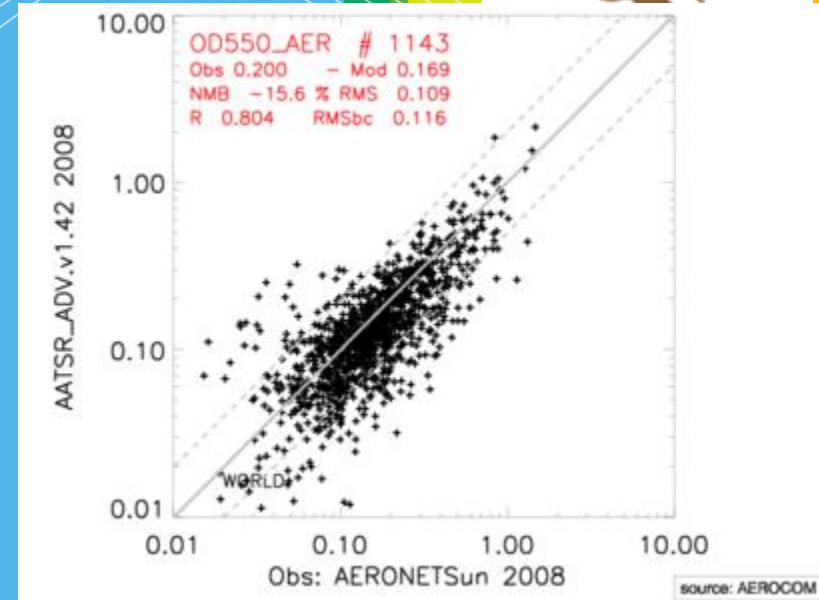
# AOD uncertainty

• 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



AERONET comparison with uncertainties, 2008 winter
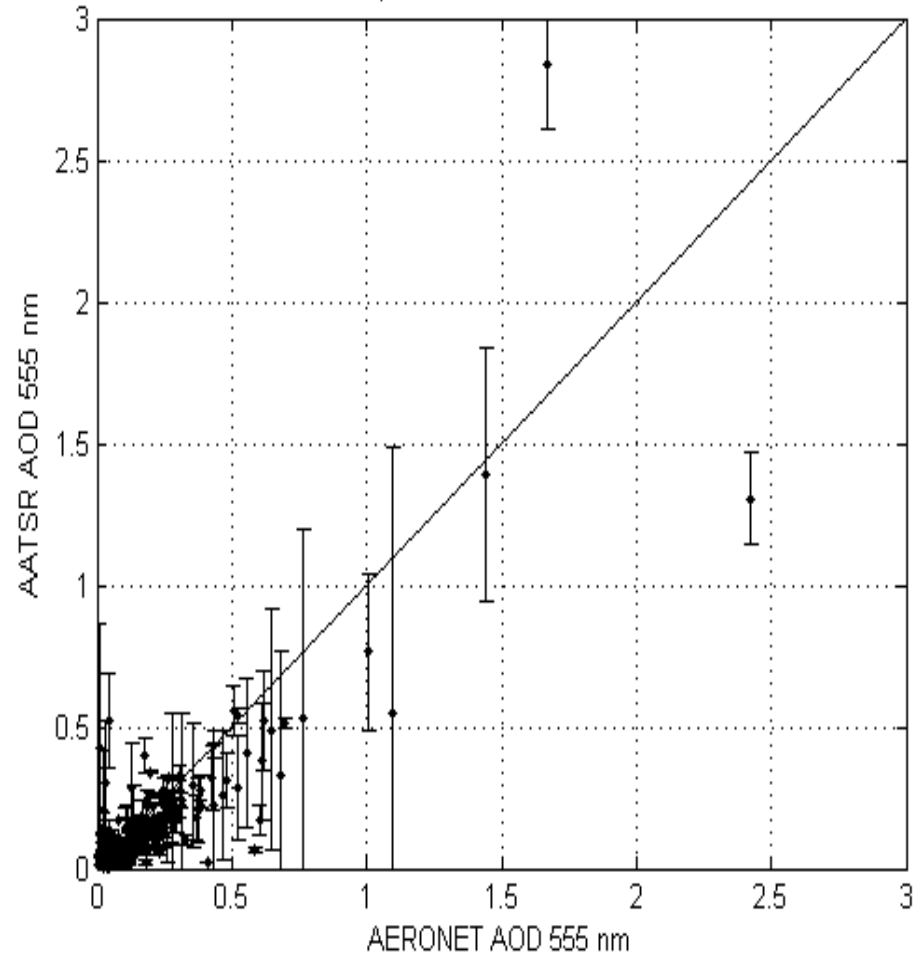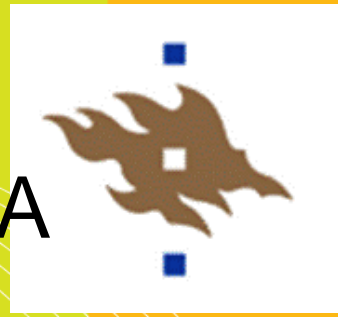
# Other retrieval results: fine particle SSA

- 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
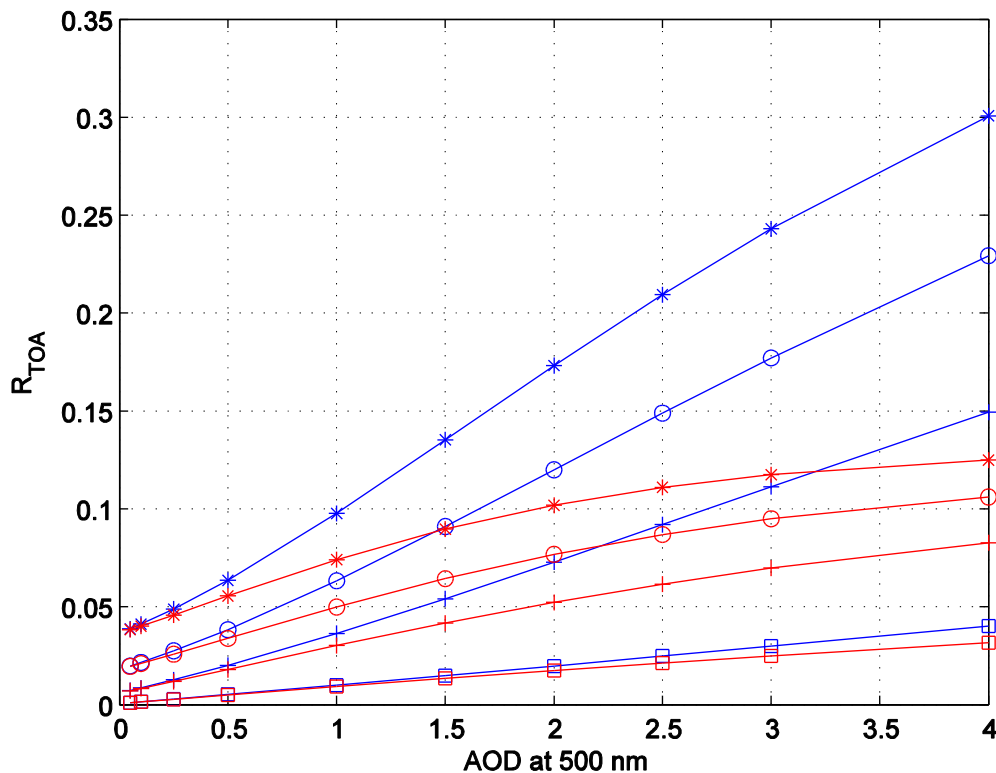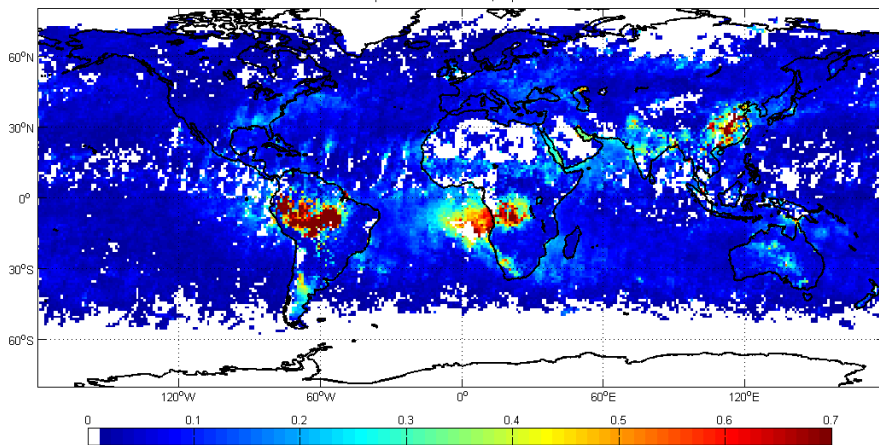


Illustration of the spectral difference of non-absorbing (blue) and absorbing (red) fine particle reflectance
Wavelengths:
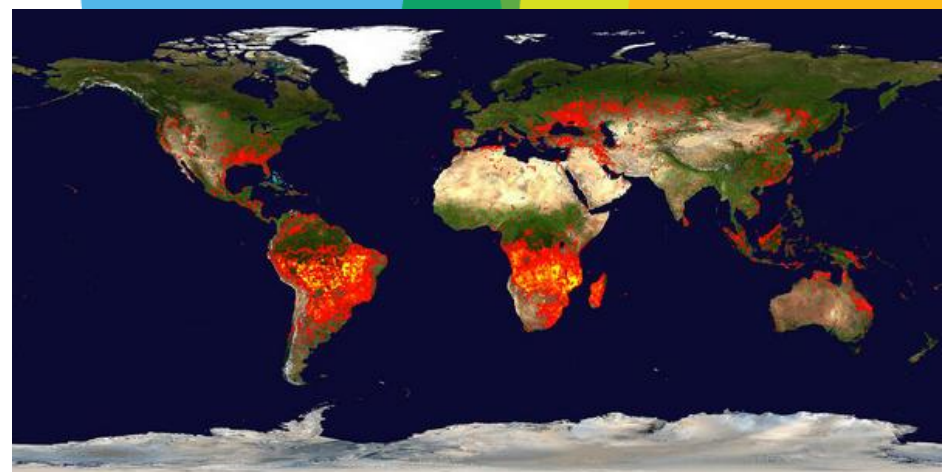star – 555 nm
circle – 659 nm
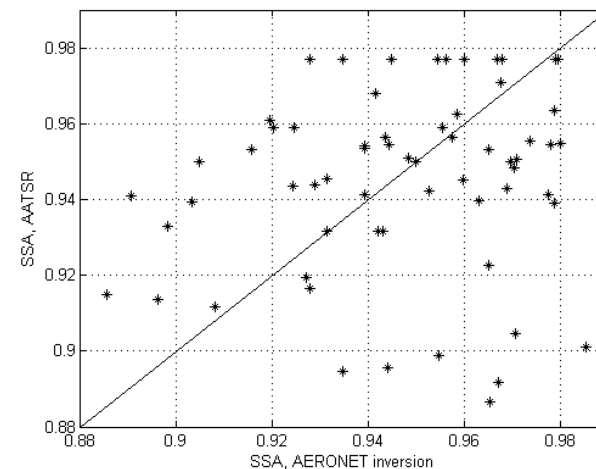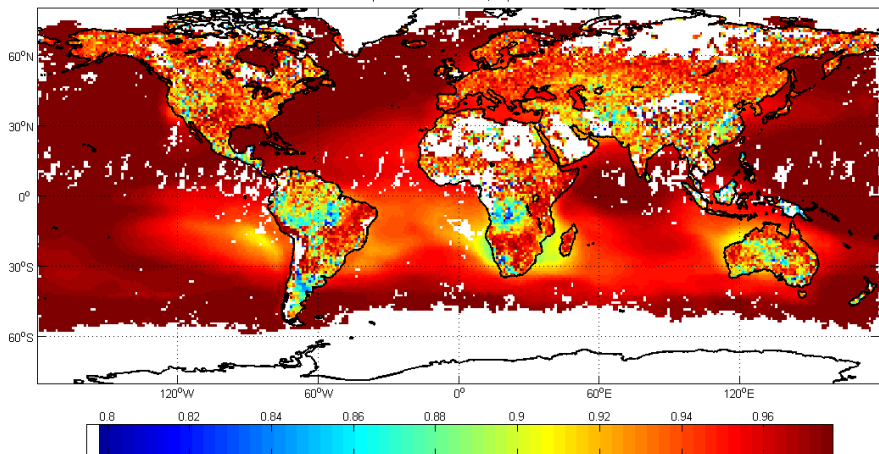cross – 865 nm
square – 1610 nm

# Fine particle AOD and SSA



Small particle AOD at 555 nm, September 2010



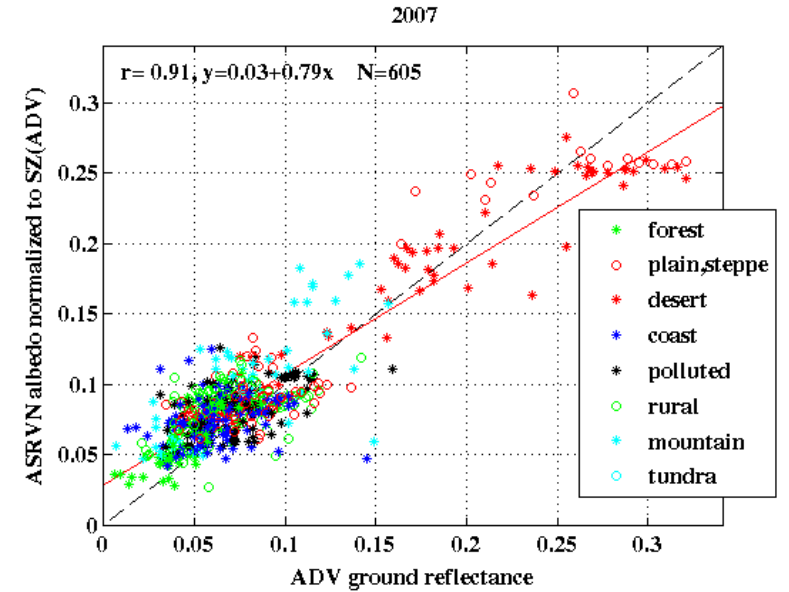Small particle SSA at 555 nm, September 2010





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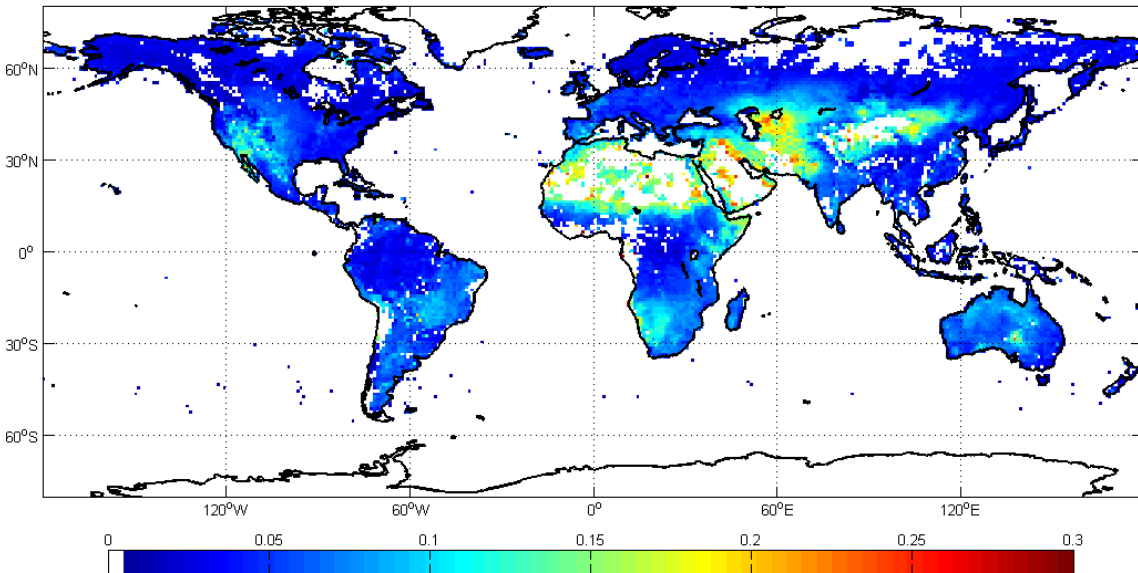(L. Giglio, J. Descloitres)

# 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



2007

r= 0.91, y=0.03+0.79x   N=605

forest
plain,steppe
desert
coast
polluted
rural
mountain
tundra

ASRVN albedo normalized to SZ(ADV)
ADV ground reflectance



Surface reflectance at 555 nm, September 2010

# 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



Direct radiative effect at 555 nm, small particles
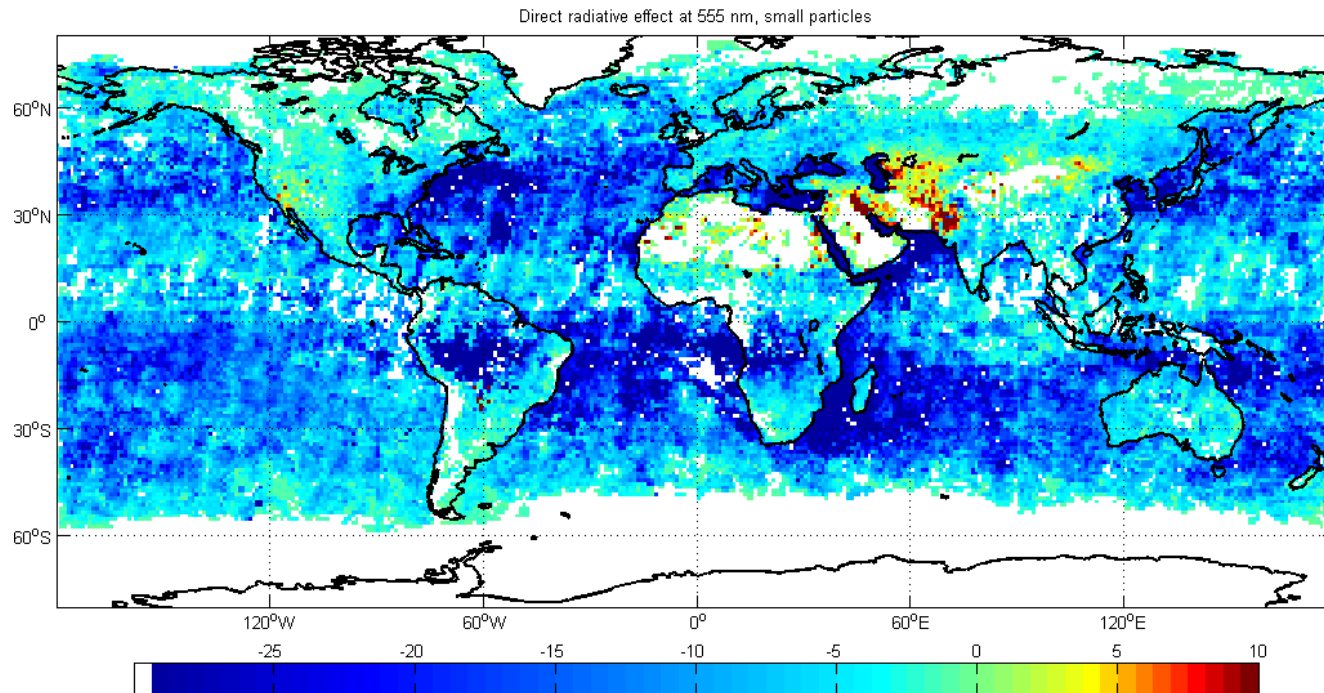
Instantaneous fine particle DRE (W/m$^2$) at 555 nm, September 2010

# 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
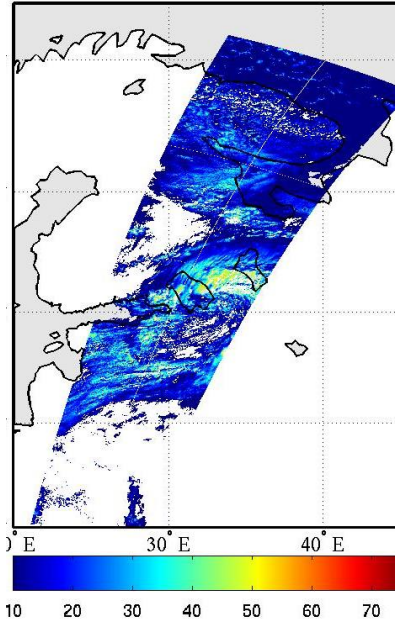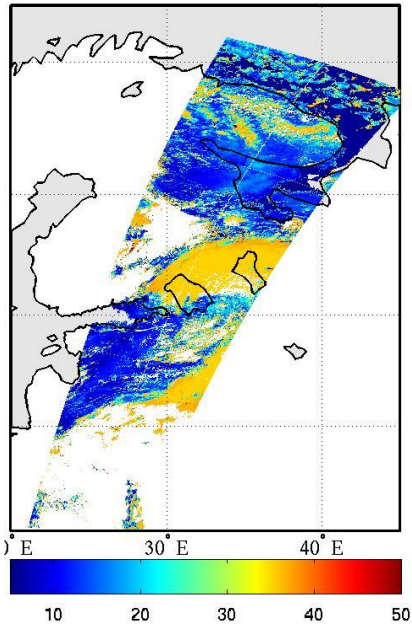  - Cloud top height by using stereoview (nadir-forward)
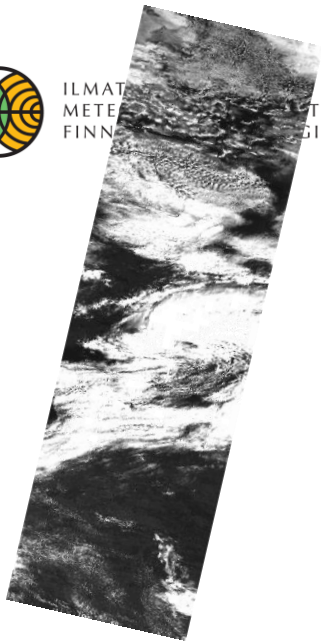
ADV AOD 555nm   28-06-2009
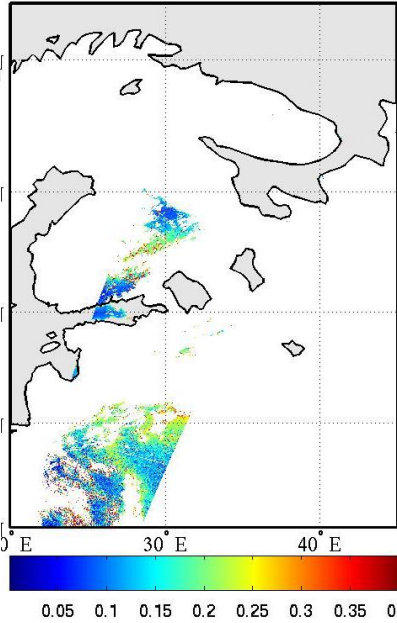
ADV COT   28-06-2009
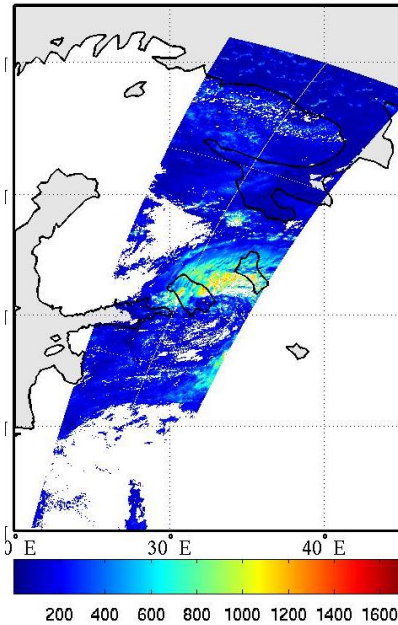
ADV CTH   28-06-2009
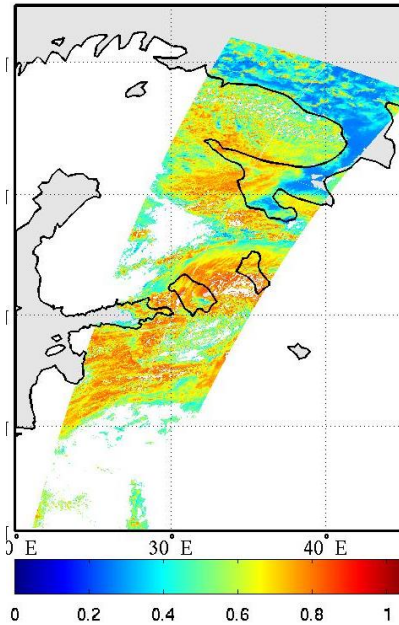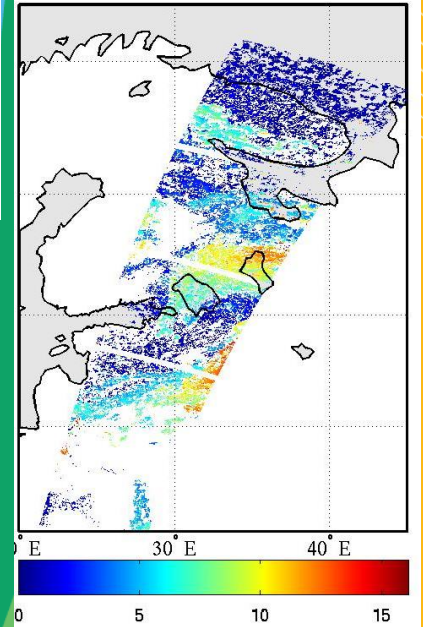
ADV Reff   28-06-2009

ADV LWP   28-06-2009

ADV albedo   28-06-2009

# 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