Atmospheric Aerosol In The Amazon: Results From The ORAC Retrieval Algorithm Using AATSR

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Introduction

The Amazon is a region of great importance for the world's water and carbon cycles; however, the future of the rainforest is threatened by deforestation and climate change. We present the results of a retrieval of aerosol and surface properties from seven years of visible and near-infrared measurements from the Advanced Along Track Scanning Radiometer (AATSR), interpreted in the context of the region.

Instrumental Details

AATSR, aboard Envisat, measures top-of-atmosphere reflectance or brightness temperature at seven wavelengths in the visible and infrared. Data are available from July 2002 onwards. The instrument measures near-simultaneously at two geometries: a nadir view at zenith angles of 0°-22° and a forward-view at zenith angles of 53°-55°. Measurements from 4 of these channels (bands centred at 550 nm, 660 nm, 870 nm and 1600 nm) and both geometries are used in the ORAC retrieval. The swath consists of approximately 500 1 km by 1 km pixels; the retrieval is typically performed averaged to a 10 km 'superpixel' sinusoidal grid.

Retrieval Algorithm And Output

The aerosol retrieval belongs to the **O**xford-**R**AL **A**erosol and **C**louds (ORAC) family, also used in the GRAPE cloud project. ORAC is an optimal estimation retrieval. The rigorous statistical basis of optimal estimation provides the following advantages:

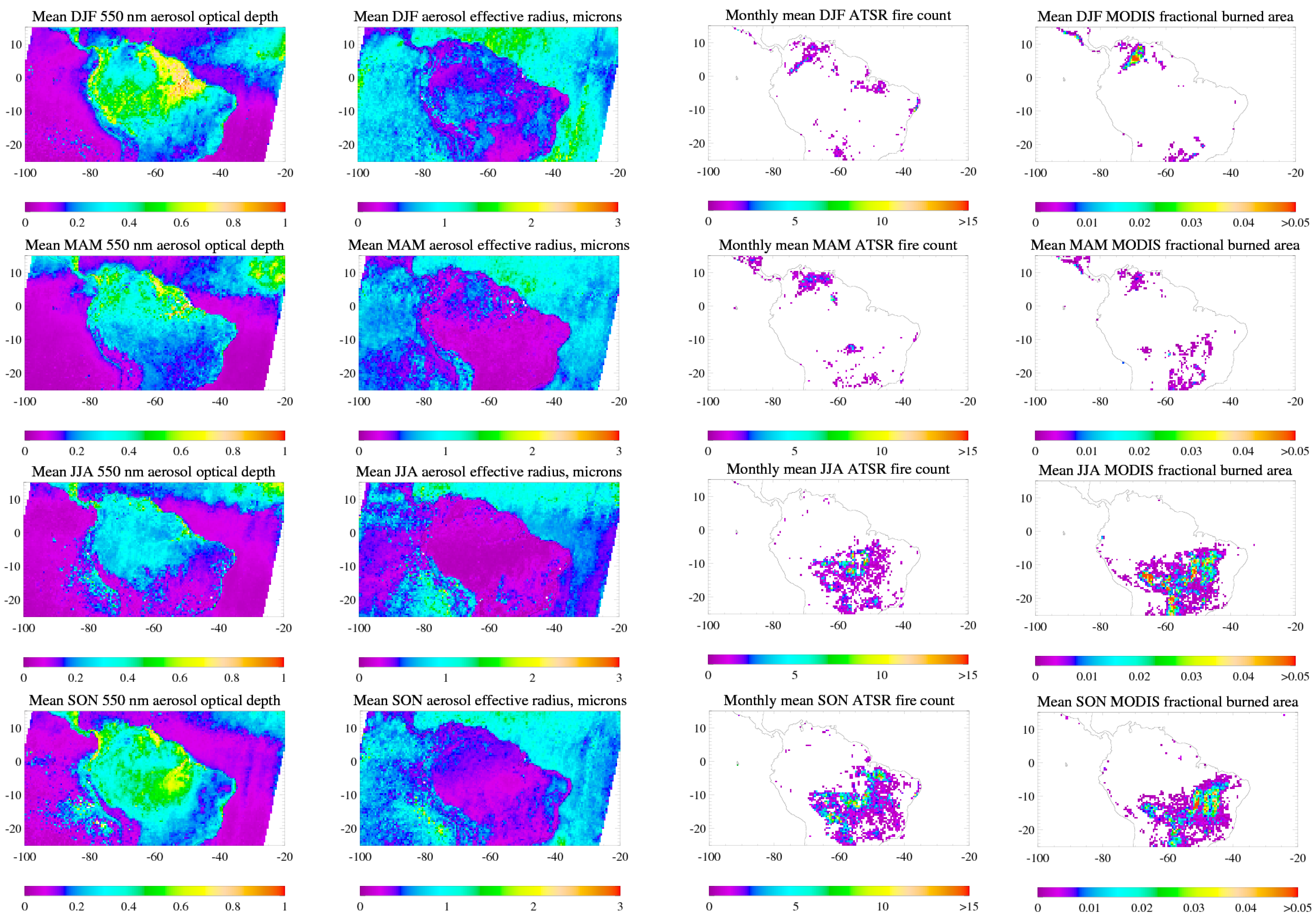
1. Estimates of the uncertainty on retrieved parameters.
2. Quality control check of the goodness-of-fit on the solution (retrieval 'cost').
3. Ability to incorporate *a priori* information on the surface and atmospheric state. Here, MODIS BRDF model parameters (over land) and ESA-DUE GlobColour data and ECMWF 10 m winds (over ocean) are used as model inputs for the surface albedo.

For each retrieval superpixel, the AATSR cloud flag is checked to determine whether the scene is cloudy or not. Cloud-free radiances are then averaged, and the following parameters (and associated uncertainties) are retrieved:

1. Aerosol optical depth, referenced to 550 nm.
2. Aerosol particle distribution effective radius. From this, the optical depth, and knowledge of the aerosol model used, the Angstrom exponent and optical depth at 870 nm are also derived.
3. The white-sky albedo of the surface at 550 nm, 660 nm, 870 nm and 1.6 µm. White-sky albedo is retrieved separately at each wavelength.
4. An indication of the best-fitting aerosol type. A selection of models, drawn from mixtures of components from the literature, are used:
   - Continental clean (from the OPAC database)
   - Desert dust (separate spherical, from OPAC, and non-spherical models)
   - Maritime clean (from OPAC)
   - Urban (from OPAC)
   - Biomass burning (from Dubovik *et al.*, 2002)
   - Volcanic ash (from Volz, 1973)

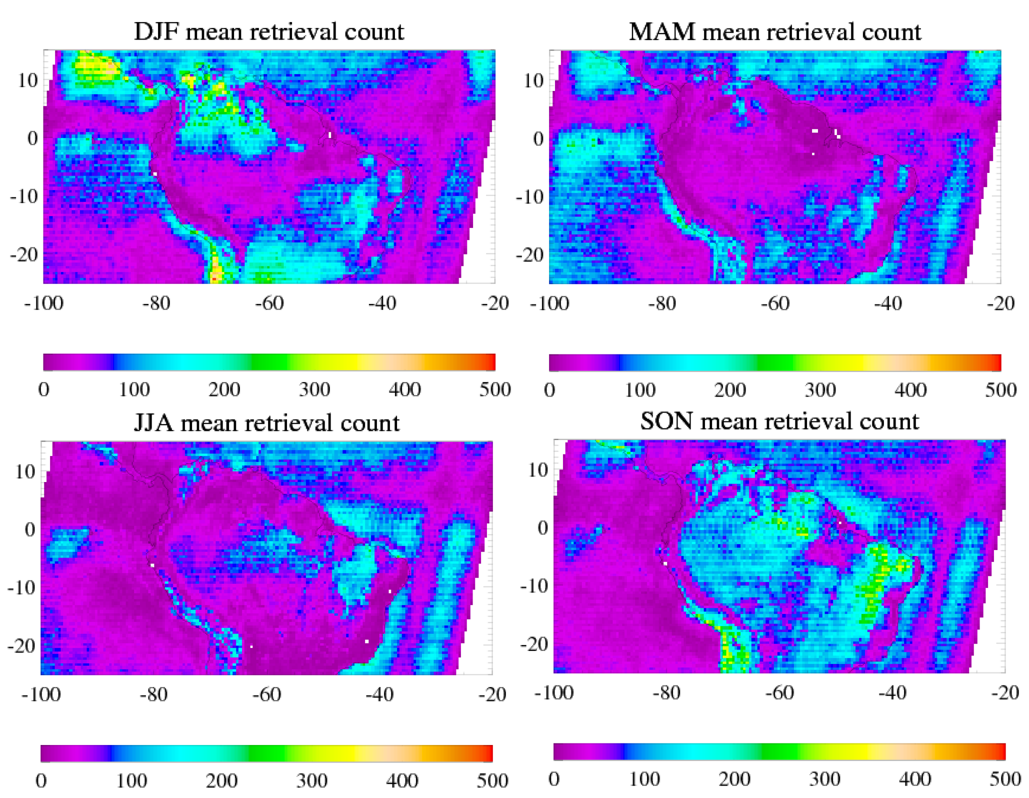
AATSR Data Processed

AATSR data from July 2002 – November 2008 have been processed with the ORAC retrieval algorithm; these have then been averaged on a monthly basis on a 0.5° grid. The results show strong seasonality but limited interannual variability. As a result, seasonal composites of the data are presented. Additionally, seasonal mean composites at the same resolution of monthly mean fire counts from the ESA-ATSR World Fire Atlas, and the fractional burned area from MODIS (derived from the MCD54A1 product), are shown.



Often an increased aerosol optical depth and decreased effective radius are found over land near regions of strong biomass burning as indicated by fire counts or burned area. A lower effective radius indicates a higher proportion of fine-mode aerosol, as is typical for biomass burning events. Burning peaks early in the year in the north of the region and later in the south. High aerosol optical depths are also found over unburnt Amazonian forest, due to the high productivity of the dense growing vegetation. The Atlantic region shows evidence of transport of mineral dust and biomass burning aerosol from Africa. Future work will attempt to link the variations in aerosol properties with that of trace gases from other instruments, such as SCIAMACHY.

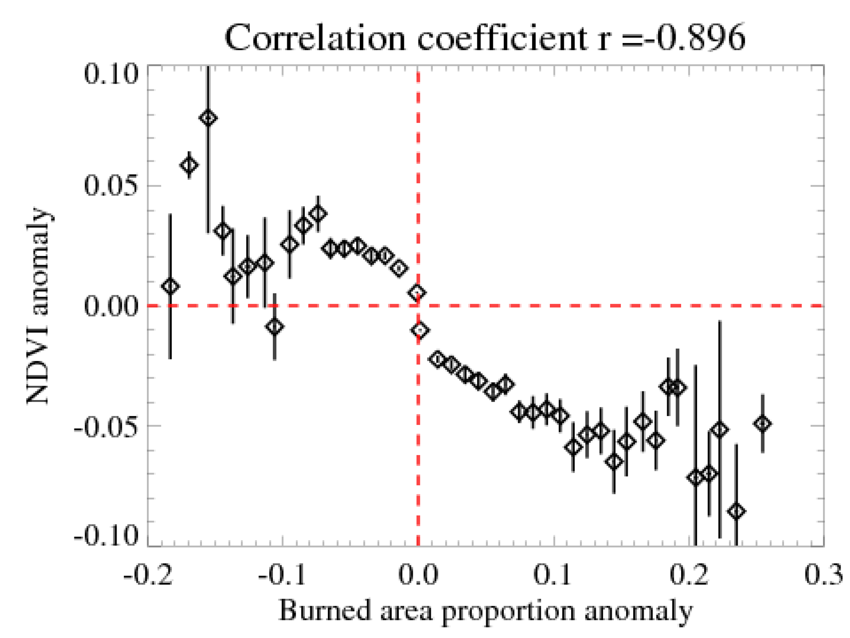
Does Cloud Flagging Remove Biomass Burning Events?



The above figures show the mean number of successful aerosol retrievals per month for each season during the 2002-2008 period processed.

High cloud cover leads to sampling problems in the Amazon. However, a low retrieval count (due to pixels being flagged as cloudy) is often found in regions with the highest fire count, particularly during the JJA season. Selected months are being reprocessed without use of the ESA-AATSR cloud flag to investigate whether strong biomass burning events are being misidentified as cloud.

Comparison Of NDVI Anomaly And MODIS Burned Area



The MODIS monthly proportional burned area data has been de-seasonalised to create a time series of burned area proportion anomaly. A similar dataset has been obtained from the retrieved atmospherically-corrected NDVI. The burned area data have been sorted in bins of 0.01 and the mean NDVI anomaly calculated. This is shown above; error bars indicate the standard errors on the data.

There is a strong negative correlation between NDVI anomaly and burned area anomaly, although the relationship does not appear to be linear, with the NDVI anomaly levelling-off for large anomalies in burned area. The relationship does, however, appear to be symmetric about zero.

See Also

- GlobAerosol project website: *http://www.globaerosol.info* - A twelve-year (1995-2007) aerosol dataset from ATSR-2, AATSR, SEVIRI and MERIS
- ORAC project website: *http://www.atm.ox.ac.uk/project/ORAC/* - More information about the ORAC retrieval scheme
- GRAPE project website: *http://www.atm.ox.ac.uk/project/grape/* - The ORAC retrieval scheme applied to derive cloud and aerosol properties from ATSR-2
- GRAPE dataset on the BADC: *http://badc.nerc.ac.uk/data/grape/* - Free download of the GRAPE cloud and aerosol dataset from June 1995 – January 2001; no registration required

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