Biomass Burning In The Amazon: Links Between Burning, SCIAMACHY Trace Gases, And Aerosol And Surface Properties From The ORAC-AATSR Retrieval

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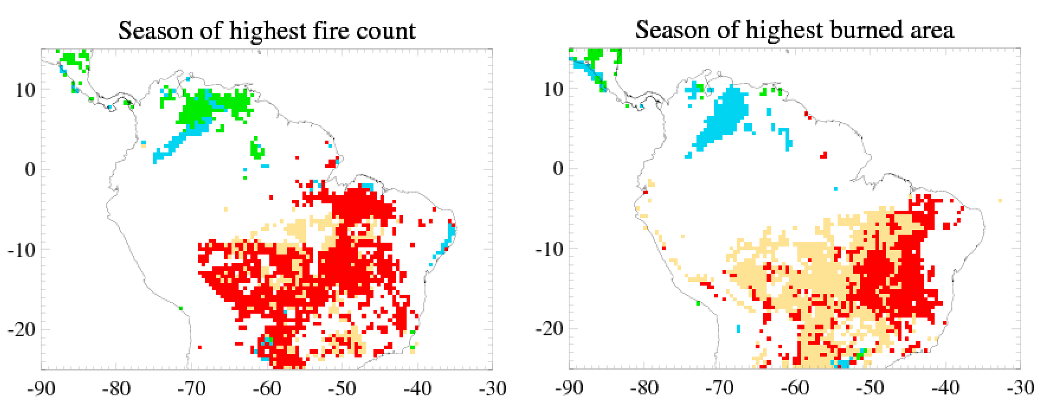
Introduction

The aerosol component of the Oxford-RAL Aerosol and Clouds (ORAC) algorithm has recently been improved and applied to six and a half years of AATSR data over the Amazon. This poster presents some of the scientific highlights. Seasonality of atmospherically-corrected normalised difference vegetation index (NDVI) derived from the ORAC data is examined and linked with proportional burned area from MODIS. Retrieved aerosol fields reveal strong seasonality in aerosol optical depth (AOD) and effective radius, linked to biomass burning through detected fires. Use of complementary SCIAMACHY glyoxal (CHOCHO) and formaldehyde (HCHO) data reveals that glyoxal in this region is proportional to the AOD for both biomass-burning and background biogenic aerosol, while formaldehyde shows an increase with AOD only in biomass-burning regions. The ratio between these two gases may be used to distinguish between biomass burning and biogenic aerosol air masses in this region.

Seasonality Of Burning

Biomass burning in the Amazon shows strong seasonal variability, peaking early in the year in the northern part of the region and later in the southern part. Fire counts are generally highest up to 3 months after the burning of ground.

On the right is the season of most frequent active fire detection from the ESA ATSR World Fire Atlas (left) and the season of highest proportional burned area from the MODIS product MCD43A1 (right). Blue indicates the peak occurs in DJF, green in MAM, orange in JJA and red in SON.

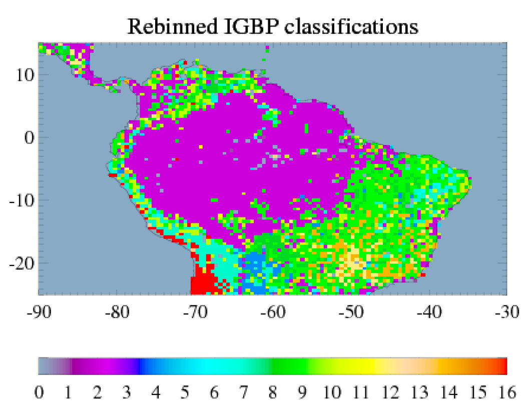


Derived Vegetation Index

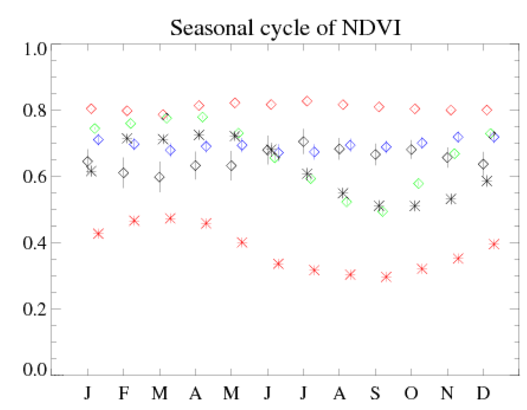
The NDVI may be derived from the ORAC retrieved surface albedo. Although a simple metric of vegetation cover, the full atmospheric correction improves its sensitivity as compared to older NDVI datasets.

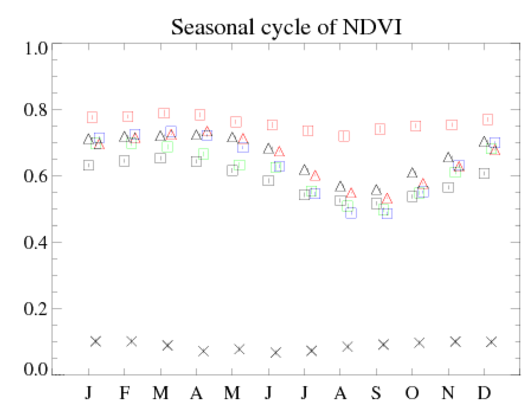
Seasonal Cycles

The International Geosphere-Biosphere (IGBP) land cover classification map is shown to the right resampled to a 0.5º grid. Below this are the annual cycles of NDVI observed for each type. The middle plot shows classes 1-7 and the lowest 8-16. A key to these figures is below. In all cases, the error bars indicate the standard error on the data. Decreases from June onwards are consistent with the onset of the dry season and the beginning of burning.



Class	Surface type	Symbol in cycle plots
0	Water	-
1	Evergreen needleleaf forest	Black diamonds
2	Evergreen broadleaf forest	Red diamonds
3	Deciduous needleleaf forest	-
4	Deciduous broadleaf forest	Green Diamonds
5	Mixed forests	Blue diamonds
6	Closed shrublands	Black asterisks
7	Open shrublands	Red asterisks
8	Woody savannas	Black triangles
9	Savannas	Red triangles
10	Grasslands	Black squares
11	Permanent wetlands	Red squares
12	Croplands	Green squares
13	Urban and built-up	-
14	Crops/natural vegetation mosaic	Blue squares
15	Snow or ice	-
16	Barren or sparse vegetation	Black crosses

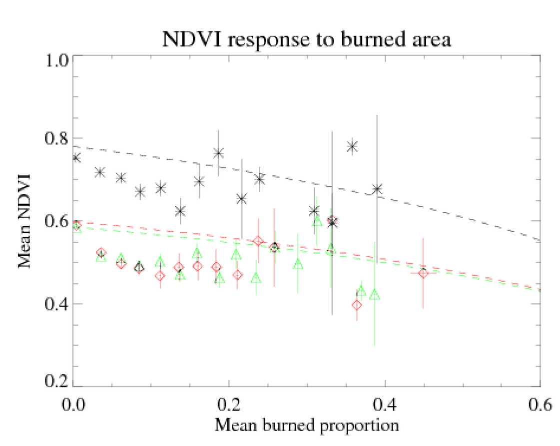




Response To Burning

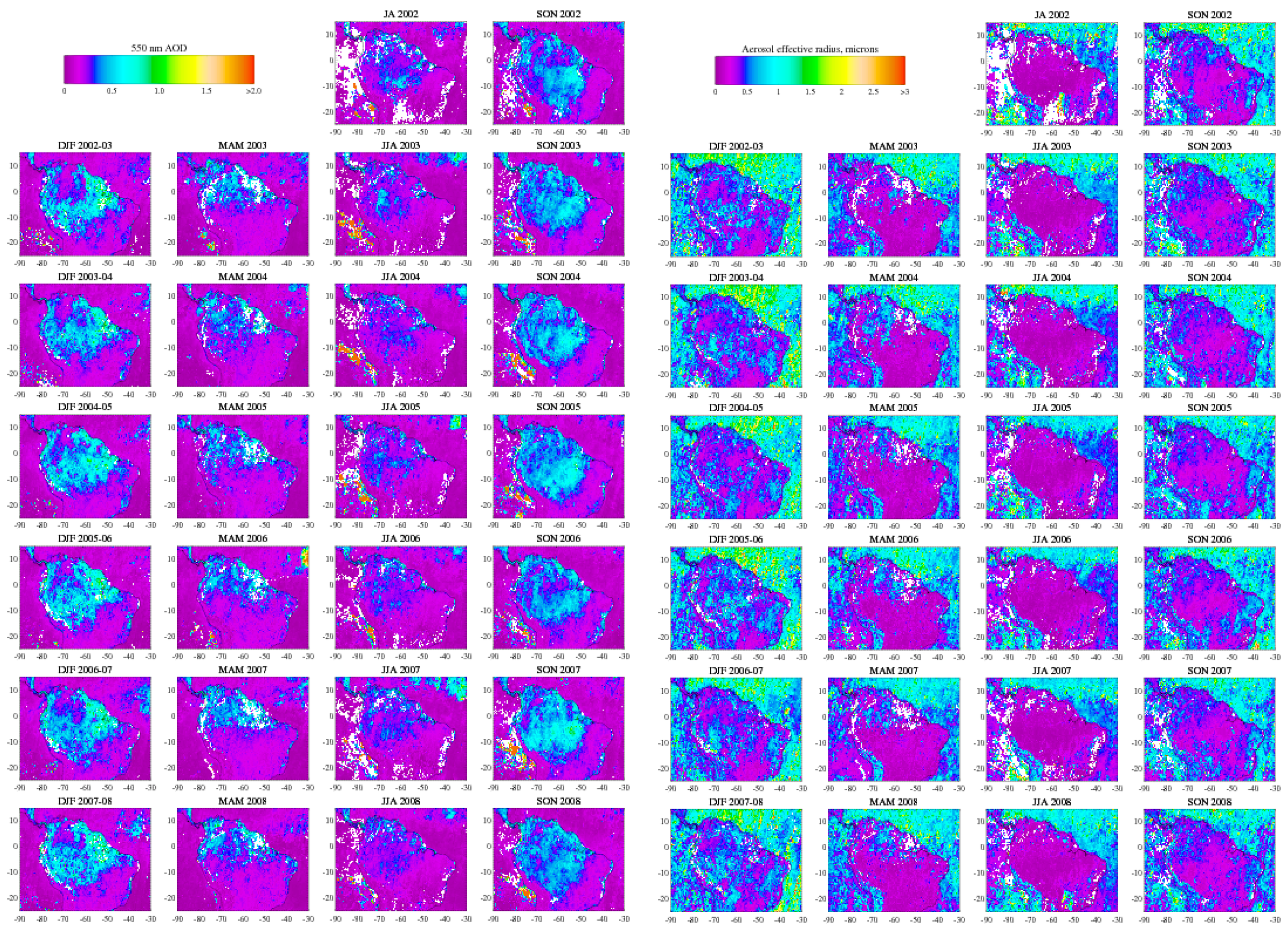
A model has been developed to examine the response of NDVI to fractional burned area; NDVI should decrease nonlinearly with an increase in burning, with the rate dependent on the reflectance of the unburned ground. The model has been tested with monthly composite NDVI and burned area data, below to the right.

Dashed lines indicate the model and symbols the observed response, with error bars the standard error. Black asterisks indicate results for the evergreen broadleaf forest ecosystem type, red diamonds woody savannas, and green triangles savannas. These are the ecosystems in which most burning occurs. There is reasonable agreement although the results suggest that other factors, such as, for example, moisture, should be taken into account to explain the observed NDVI response. Sampling is also a problem.



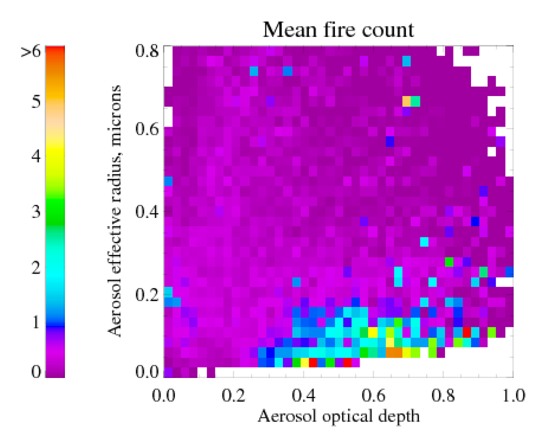
Aerosol And Gas Properties

Retrieved AOD (right) and aerosol effective radius (far right) show strong seasonal cycles, with a high level of interannual consistency. Data are shown from 2002 – 2008 (top-bottom) and DJF – SON (left-right) on a 0.5º grid.



Aerosol Properties And Fire

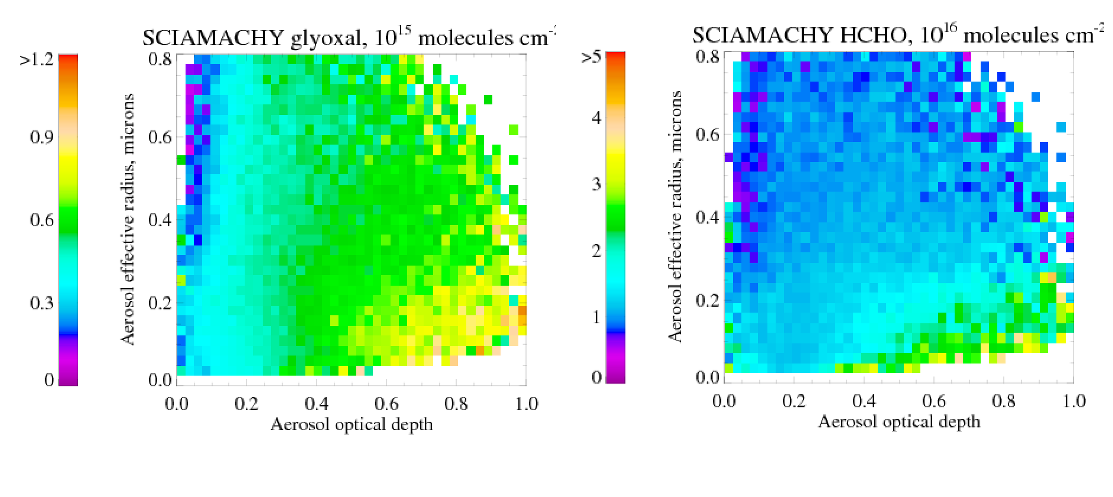
For each month and each grid cell, the monthly mean AOD, effective radius and fire count are calculated. The mean fire count is shown as a function of aerosol properties to the right. Fires are most often found in moderate to high AOD conditions with effective radii <0.2 µm. This is consistent with expected characteristics of biomass burning aerosol. Sampling problems due to cloud cover and the narrow AATSR swath limit both datasets (aerosol is retrieved from only daytime orbits, and fires detected only at night).



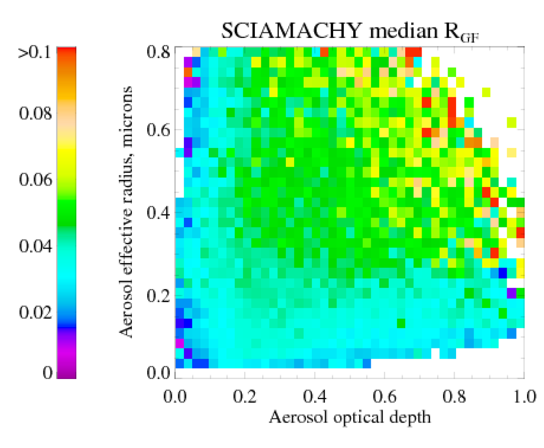
Linking Aerosol Properties And Gas Abundance

SCIAMACHY provides measurements of trace gases from the same orbits which AATSR derives aerosol and surface properties. Of particular interest are the short-lived species glyoxal (CHOCHO) and formaldehyde (HCHO), which are indicators of intense photochemical activity.

Analagous to the above figure involving fire counts, to the right are the median CHOCHO and (far right) HCHO vertical column densities (VCDs) as a function of AOD and effective radius. Both increase with AOD in biomass burning regimes; for larger biogenic aerosol (>0.2 µm) CHOCHO is also enhanced for high AOD, while HCHO is not.



As well as the VCDs, the ratio CHOCHO:HCHO (denoted R_{GF}) is of interest. This is shown to the right. Biomass burning regimes are associated with a lower R_{GF} (< 0.04) than regions dominated by biogenic aerosol. This does not hold for the low AOD, effective radius > 0.2 µm regions which are predominantly in the Andes mountains. Future research may enable the use of trace gas data to inform the choice of aerosol model for aerosol retrievals.



See Also

- ORAC website: *http://www.atm.ox.ac.uk/project/ORAC/*
- GlobAerosol website (ORAC ATSR-2, AATSR and SEVIRI aerosol from 1995-2007): *http://www.globaerosol.info/*
- SCIAMACHY at the University of Bremen: *http://www.iup.uni-bremen.de/sciamachy/*
- ESA (A)ATSR World Fire Atlas: *http://dup.esrin.esa.it/ionia/wfa/index.asp*
- MODIS Fire and Thermal Anomalies at the University of Maryland: *http://modis-fire.umd.edu/index.asp*

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