UK RESEARCH INTERESTS

HUGH COE

• Africa is the largest source of biomass burning on the planet.

• Aging of biomass aerosol is poorly represented in global aerosol models.

• The single scattering albedo of biomass burning aerosol is critical in the radiative forcing.

• The single scattering albedo of aged aerosol remains difficult to determine.
UK RESEARCH INTERESTS

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- Transformation of BB aerosol and changes in optical properties during transport
- Characterisation of aerosol and cloud across the region
- Interaction between BB and cloud
- Semi-direct effects
- transition from stratocumulus to trade wind cumulus
- Effects on NWP resulting from absorbing aerosol
Organic Mass in biomass burning plumes shows no increase over time but chemical composition changes, O:C increases

Aging of biomass burning aerosols over West Africa: Aircraft measurements of chemical composition, microphysical properties, and emission ratios

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\[ \text{Intercept} = 4.72 \times 10^{-6} \pm 1.1 \times 10^{-6} \]
\[ \text{Slope} = 1.62 \times 10^{-6} \pm 8.2 \times 10^{-8} \]

Behaviour dissimilar to previous studies of BB ageing

ACPD
9, 767–836, 2009

Emissions from biomass burning in the Yucatan
R. Yokelson et al.
20-South Rationale during VOCALS

- Statistically representative cloud, thermodynamic and composition dataset for modellers.
- UK BAe-146, US DoE-G1, US NSF-C130 and Ron Brown used.
- 35 flights = 230 hours sampling time.
- 70 - 90 W, from 0-7 km, over 24 days.
- Composition statistics as a function of longitude interpreted for airmass history.
- Allen et al, 2010, ACPD, in press
- Links to Bretherton et al., 2010, ACP
• MBL well mixed
• Often enhancements in the FT – discrete layers.
• Evidence of entrainment and mixing in the cloud layer
A selection of vertical profiles over the ocean

(Haywood et al., 2004)

Figure 2. The aerosol scattering coefficient at 0.55 μm, $b_{0.55}^{sc}$, measured by the nephelometer on the C-130 aircraft. Each profile is shown by a separate colour, and in the interests of clarity a maximum of two profiles are shown for each flight. (a) Biomass burning aerosol measured during SAFARI 2000, for eight transit flights as indicated above each frame; (b) Saharan dust aerosol measured during SHADE for six flights. The absolute error in $b_{0.55}^{sc}$ is estimated as $\pm 0.3 \times 10^{-4}$ m$^{-1}$ for biomass burning aerosol (Haywood and Osborne 2000), but $\pm 0.5 \times 10^{-4}$ m$^{-1}$ for Saharan dust owing to super-micron sampling losses (Haywood et al. 2003c). See text for details.
Vertical profiles over the Sea

Profiles near Ascension Island

Profile #1

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Semi Direct Effects

LES model simulations of idealised aerosol and marine StCu (Johnson et al, 2004, QJRMS)

Indoex properties for aerosol in BL. dotted line is SSA=0.88, solid line is control.
Diurnal mean direct, semi-direct and total radiative forcing for low altitude BC

But altitude is important.....

<table>
<thead>
<tr>
<th>TABLE 3. SUMMARY OF EXPERIMENT 2</th>
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<tbody>
<tr>
<td>Experiment</td>
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The 2-day mean semi-direct, direct and total aerosol radiative forcings (W m$^{-2}$) for different aerosol layers. $Z_{inv}$ is the height of the inversion, which varies between 600 and 650 m. Absorbing aerosol has $\omega = 0.88$ (at 0.55 $\mu$m) and scattering aerosol has $\omega = 1.00$. The aerosol mass mixing ratio is $3 \times 10^{-8}$ kg kg$^{-1}$ in the aerosol layer.
‘Geoengineering’ simulations reveal interesting impacts for NWP when Namibian Sc is artificially brightened.

The Namibian Sc is brightened in HADGEM2.

The response is a drying in Brazil.
An interesting aside for NWP:

*Milton and Earnshaw (2007)*: investigated the precipitation anomaly by comparing against detailed rain-gauge data over land areas.
An interesting aside for NWP:

When we invoke an indirect effect in SA we:-

1) Enhance the cloud reflectivity
2) Reduce the SST
3) Get an El-Nino type drying response (particularly in S. America)

SINERGEE (GERB vs UM) project:-

For 2002/2003, “the reflectivity of low-level cloud, including stratocumulus, appears too high in the model” - Richard Allan
### POSSIBLE INTERESTED PARTIES

#### UK VOCALS Community:
Manchester, Leeds, Reading, Met Office
interests in:
- Sc clouds
- aerosol-cloud interaction
- clouds and dynamics
- improving BL processes in NWP
- high resolution climate modelling

#### UK AMMA Community:
Leeds, UEA, York, Leicester, Manchester, Reading, Centre for Ecology and Hydrology, Met Office, interests in:
- land-surface interactions
- monsoon development and dynamics
- gas phase chemistry in clean sub tropics
- aerosol formation and transformation
- interaction between dust and BB aerosol.
- assessment of radiative effects dust and BB.
A strawman field program

• Designed to observe key aspects of clouds and elevated biomass burning aerosols

• Also provides key measurements of stratocumulus to cumulus transition in clouds over increasing SST