Recent SMART-COMMIT Observations of Smoke and Dust Aerosols

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#http://climate.gsfc.nasa.gov; Image of the week, June archive
@Special thanks to U.S. Air Force Reserve for FREE C-5 contributions
($22 K/hr \times 16 hr = $352 K)

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… “Sal” means salt in Portuguese. Apparently, this island produces nothing but salt – even the basic two elements, air and water, for humankind are imported. The air breezes mainly from the African continent this time of the year, especially the SAL (Saharan Air Layers) with airborne dust particles. The fresh water is bottled and shipped predominantly from Portugal.
• **Saharan Air Layer:**
  – occurs during the late spring through early fall
  – convergence induced by heat lows over the Sahara
  – hot, dry, dust laden of well mixed layer up to 500mb, westward propagation with African Easterly Waves

• **SAL-Tropical Cyclogenesis:**
  – may stabilize the lower atmosphere due to *solar absorption* by dust particles;
  – may regulate the *strength* and *structure* of Mid-Level Easterly Jet (MLEJ);
  – impact remains *inconclusive!* (e.g., Karyampudi & Pierce, MWR, 2002)


- **Earth Observing Satellites:** Terra, A-Train, etc. (e.g., Deep-Blue)
- **DC-8 high-altitude research aircraft** (based at Sal)
- **NPOL polarimetric weather research radar** (based at Dakar)
- **TOGA C-band Doppler weather radar** (based at Praia)
- **SMART-COMMIT ground-based mobile observatory** (based at Sal)

SMART-COMMIT Deployment at Sal, CV

05:15 02 Sept. 2006

08:30 02 Sept. 2006

8:37 PM local time

SAL

Cirrus

local solar noon
SMART-COMMIT Goals for NAMMA

• **Remote sensing:**
  – detecting/retrieving *Dust* (in SAL) and *Cirrus* (aloft) properties from atmospheric emitted, as well as transmitted, radiance fields.

• **In-situ:**
  – measuring surface *aerosol* (*& precursor*) properties and *boundary-layer atmospheric parameters* for mixing/transport modeling.

• **Surface energetics:**
  – developing *radiative forcing* approximations for measurements of coexisting *aerosol-cloud*.
Simulated nadir up-looking spectral brightness temperatures at the surface as a function of wavenumber for different dust loadings ($\tau = 0.5, 1.0, \text{ and } 3.0; 0-5 \text{ km}$), in conjunction with effective particle radius of $2.0 \ \mu m$. The cirrus cloud, located at $10 \ \text{km}$, has an effective particle size of $15 \ \mu m$ and an optical thickness $\tau = 0.5$. 

\[ \partial I/\partial \lambda, \ \text{contrasting each other} \]
**Retrievals of Dust Properties**
- forward radiative transfer calculations of dust models as function of *wavelength, size, shape, and composition*;
- $\chi^2$ statistical optimization;

**Comparisons**
- collocated *AERONET*
- wavelength scaling factor as *extinction coefficient ratio*;
- good results depending on choice of *dust compositions*. 
Tropospheric Aerosols:

• Originate by activities at/near Surface
  – Dust, Smoke, Air Pollution, Sea Salt, etc.
  – Chemical, Physical, & Optical properties measurable

• Evolve in Planetary Boundary Layer
  – Diffusing, Mixing, Transport, etc. Processes
  – Chemical, Dynamical & Physical models available

• Signify within Free Troposphere
  – Diabatic Heating/Cooling, Microstructure Effects, etc.
  – Satellite, Surface/Aircraft, Modeling synergy
Si-Chee Tsay, Deputy EOS/Terra Project Scientist

September 2006

DC-8 & SMART-COMMIT Open House

SMART-COMMIT 4 Packing Days

3A. Nephelometer

Scattering Coefficient (km$^{-1}$)

9. Angstrom Exponent

Black Carbon Concentration (µg.m$^{-3}$)

Dust

Dust+Smoke

Sea Salt

7A. Aethalometer

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**Aerosol Types:**

- Angstrom Exponent
- Filter Color
- Size Distribution
- Hygroscopicity
- Others
Aerosol Direct Radiative Forcing

\[ F_{ARF} = F_{Asl} - F_{Cln} \quad \text{or} \quad \frac{\Delta T}{\Delta t} = -\frac{1}{C_p \rho} \frac{\Delta F}{\Delta z} \propto \frac{\Delta F}{\Delta \tau} \]

- Hypothetical, not co-existed
- Surrogate:
  - Monthly mean, e.g., ERBE (Ramanathan et al., 1989)
  - Reference min., e.g., INDOEX (Conant, 2000)
  - Hybrid approach
- Water vapor interactions
- Langley-like approach

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