Dust, Smoke, and Sea Salt Concentrations Simulated during CRYSTAL-FACE with MATCH/CARMA

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Motivation

- Simulate dust, sea salt, and smoke aerosol concentrations during CRYSTAL-FACE
- Lend context to aerosol observations made during the experiment
- Assist in interpretation of radiation measurements
MATCH/CARMA

- 3D aerosol transport model
- Driven by NCEP reanalyses (~ 2° x 2°, 28 vertical layers)
- Physics are from NCAR MATCH model
- Fields are subsetted to a region of interest and fed into CARMA
- CARMA does sources, transport, and removal
- Resolve 8 size bins from 0.1 – 10 µm radius

**Sources**
- Dust: Ginoux et al. [2001]
- Sea Salt: Monahan et al. [1986]
- Smoke: *not yet!*

**Removal**
- Sedimentation
- Dry Deposition
- Wet Removal
Smoke: June 29, 2002
TOMS: July 1, 2002

EP-TOMS AI

Aerosol Index

0.4  0.8  1.2  1.6  2.0  2.4  2.8  3.2  3.6  4.0
MPL at eastern ground site

July 3, 2002

Altitude [km]

Extinction [km^{-1}]

Optical Depth

Fraction AOD

Angstrom

0.580

0.561

0.529

0.902

Time

1157

1200

1211

1355
Back trajectories: July 3, 2002

$\Theta = 330 \text{ K}$
Sea Salt

Sea salt fluxes are wind speed dependent.

![Graph showing sea salt concentration over July 2002.](image-url)
Dust Sources

- Dust sources are located preferentially in topographic lows
- Sources are wind speed, soil moisture dependent

**EP-TOMS Monthly Average AI**

**July 2002**

**CARMA Dust Emissions**

**July 2002**
AOD near Sources
AOD far from Sources
Surface dust masses

Model Dust Surface Mass Concentration [µg m⁻³]

July 2002

Mass Concentration [µg m⁻³]
July 29, 2002
Both the model and the MPL see an elevated dust layer between 2 and 4 km
Comparison to aircraft profile
Volume profile

Key West

Altitude [km]

Aerosol Volume [$\mu$m$^3$ cm$^{-3}$]

02072918

- Red: Model
- Dashed: Model: $r > 1$ $\mu$m
Dust/Sea Salt Size Distribution

AERONET Size Distribution

July 29, 2002

AERONET
Model Dust X 3
Model Sea Salt

Eastern
Ground-site

\( \frac{dV}{d(\ln R)} \left[ \mu m^3 \ cm^{-2} \right] \)

radius [\( \mu m \)]
Sensitivity Tests

MPL Vertical Profile

July 29, 2002

- MPL
- Baseline
- No Wet
- South
- East

Altitude [km]

Extinction [km$^{-1}$]
Back trajectories

$\Theta = 310 \text{ K}$
Sensitivity Test: Add a Coastal Source
Vertical Profile with Coastal Source

MPL Vertical Profile

July 29, 2002

Altitude [km]

Extinction [km⁻¹]
Mass with Coastal Source

- No wet simulations put too much dust at the surface
- The added coastal source elevates the surface concentration

![Graph showing model dust surface mass concentration](image-url)
Size Distribution with Coastal Source

AERONET Size Distribution

July 29, 2002

\( \frac{dV}{d(ln R)} \) [\( \mu m^3 \ cm^{-2} \)]

radius [\( \mu m \)]

- AERONET
- Model Dust
- Coastal Source
- Model Sea Salt
Is this source in MODIS-Terra?
Is this source in MODIS-Aqua?

MYD021KM.A2002202.1455.003.2002205035054.hdf
Conclusions

- Evidence for long-range transport of smoke over Florida

- The dust model shows dust at the right altitude on July 29
  - Not enough dust to match the lidar extinction
  - Surface concentrations are too low

- Turning off wet removal makes the rest of the simulation look worse

- Increasing the source or adding a coastal source can help, but what’s the evidence for this?

- Possibly the wind fields are not right..?
Future Directions

- Further evaluation of the sea salt source
- Include smoke aerosol in the simulation for the CF time frame
- Try another wind source for the dust emissions transport
- Further investigate the removal mechanisms at play here

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