Monitoring & Predicting the Intensity of the Saharan Air Layer (SAL) Events Over the Caribbean using Remote Sensing & Dust Model Ensemble

Arunas Kuciauskas¹, Peng Lynch¹, Edward Hyer¹, James Campbell¹, Luis Rosa², Joseph Prospero³, Steve Miller⁴, Jeremy Solbrig¹, and Mindy Surratt¹

1. Naval Research Laboratory, Monterey, CA
2. National Weather Service, San Juan, Puerto Rico
3. U. of Miami, Rosenstiel School of Marine & Atmospheric Science
4. Cooperative Institute for Research in the Atmosphere, Ft Collins, CO

photo courtesy: NOAA
Motivation

• Large dust events coming from Sahara (Saharan Air Layer or SAL) pose major health & wildfire problems over the Caribbean
  – high concentrations of P10 and P2.5 particles
  – low humidity = high fire potential

• NWS, San Juan is responsible for issuing alerts to greater Caribbean community when such conditions occur

• Resources they request from NRL-MRY
  – remote sensing products NRT (especially VIIRS & MODIS)
  – request: dust model that predicts large dust events 3+ days in advance
Saharan Air Layer (SAL)

- Part of global Saharan dust transport across the Atlantic
  - $1000 \times 10^{12}$ g per yr
    (Prospero and Mayol-Bracero, JGR 2010)

- Hot/dry elevated thick dust layer forming over Saharan desert
  - 3 – 5 km layer above W Africa
  - 2 – 3 km layer above Caribbean

- Most frequent over Caribbean & eastern US during late spring through early fall

Canary Islands

Barbados

San Juan, Puerto Rico
Overview
Path of SAL during Boreal Summer
Tracking the SAL Events
VIIRS True Color

Targeted areas: Puerto Rico (PR) & Ragged Point, Barbados (RP)
Monitoring SAL Episode

MSG-Dust Enhanced Background Reduction Algorithm (DEBRA)

Animation:
23 – 27 June, 2014

Leading SAL edge
Ragged Pt: 06/25
Puerto Rico: 06/26
Environment Depicting SAL Propagation Across Atlantic Basin

- unstable
- warm
- dry

- stable
- colder
- moist

Puerto Rico

Caribbean

70W 10W
Virtual Potential Temp. Plots during SAL

Model initial times: 00:00Z

70W 10W 70W 10W

850 mb

700 mb

06/23

06/24

06/25

06/26

Puerto Rico

West Africa

Puerto Rico

West Africa

Puerto Rico

West Africa

Puerto Rico

West Africa

850 mb

700 mb

850 mb

700 mb
SAL Monitoring
TPW and Puerto Rico Soundings

06/27

12Z

courtesy: Jason Dunion, HRD-CIMAS
International Cooperative for Aerosol Prediction Multi-Model Ensemble (ICAP-MME)

*Sessions, et al., 2015, Atmospheric Chemistry & Physics (final revision)*

- 7 quasi-operational aerosol/dust models
  - provided at NRL-MRY and FNMOC
- Plotted on 1 X 1 degree grid every 6 hours, 1 day latency
- Provides skillful depictions of SAL dust intensity
- Validated with AERONET measurements
- Potentially valuable resource for air quality & fire hazard prediction throughout Caribbean
Individual Dust Models

Initial: 06/23 00Z, Forecast valid 06/24 18Z, tau = 42

NRL/NAAPS

ECMWF/MACC

NASA/GEOS-5

JMA/MASINGAR

NCEP/NGAC

BSC/NMMB BSC-CTM

UKMO/MetUM

ICAP-MME
Animation of ICAP-MME

Monday 23 June 2014 00UTC ICAP Forecast t+108
Friday 27 June 2014 12UTC Valid Time
DUST Aerosol Optical Depth at 550nm (nMEM = 7)

Plots Generated Thursday 26 June 2014 12UTC NRL/Monterey Aerosol Modeling
Monitoring SAL Passage

06/25

ICAP valid 18Z

Puerto Rico

Ragged Point

06/26

ICAP valid 18Z

Puerto Rico

Ragged Point

CALIPSO-CALIOP Backscatter
ICAP-MME Validation

Bi-seasonal comparisons of +4 day model 550nm AOT RMSE with 21 core AERONET verification sites.

Individual model validations are in colored circles, large blue circles are ICAP-MME means.

Sessions, et al., 2015, Atmospheric Chemistry & Physics
Summary

• Qualitative overview of predicting SAL using in-situ, satellite and model resources
• ICAP-MME performs well in predicting dust across the Atlantic basin
  - 3+ days in advance, fits operational needs
  - future: more models will become part of the system => more robust
• Plans to implement ICAP-MME and VIIRS in support of Puerto Rico/Caribbean weather agencies
  - possible nighttime monitoring of dust