The Naval Research Laboratory’s Marine Meteorology Division Dust Forecasting Capabilities

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Arizona Dust Storm Workshop
March 5, 2019
Navy Aerosol and Visibility Forecast Needs:

- Tactical and strategic planning
- Target Acquisition
- Port Navigation
- Carrier landings
- Ship defense
Impact of Dust Aerosols on DoD Activities

Korea, 28 March, 2018

Southwest Asia, 04 December, 2017

Mediterranean, 22 March, 2018
Global and Mesoscale Aerosol Models

Navy Aerosol Analysis and Predication System (NAAPS)

- World's first operational global aerosol model (at 1/3 degree resolution)
- 6-day forecasts dust, smoke, pollution, and sea salt aerosols (run 4x/day)
- Utilizes world's first operational aerosol data assimilation & fire data streams

Coupled Ocean Atmosphere Mesoscale Prediction System (COAMPS)

- Operational dust forecasts at FNMOC since 2001 (currently 1.6 and 15 km resolution, run 2x/day; 72 hr forecasts)
- Accurately forecasts the onset/cessation of low visibility conditions, and individual dust plumes
- Uses the NRL high-resolution dust source database
High-resolution Dust Source Database

**Approach and Methodology**

- **NRL Dust Enhancement Products**
- Used 17 years of NRL DEP + 8 years of DEBRA msg_RGB to locate/update dust plume sources
- Dust source area entered into database (cursor location tool = 1km precision)

- COAMPS 10 m wind overlays (plume head vs tail)
- Surface weather maps (showing dust storms, reduced visibility)
- Cross-correlate land and water features (using maps, atlases, GE)
High-resolution Dust Source Database

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High-resolution Dust Source Database

- Solid red shapes identify dust source areas located using DEP and msg_DEBRA
- DSD used in COAMPS (1 km sources gridded to 1.6, 5, 15, and 45 km resolution)

$$\text{Flux}_{\text{dust}} \propto \text{Erodible Fraction} \times u^4$$

- GE kml used on the watch floors at the FWC and OWS

North Africa DSD

SW Asia DSD

Saudi Arabia
North America High-resolution DSD

- Same approach taken with North America (added machine learning component)
- Used NASA/USGS MODIS global land surface and albedo datasets
- Formed self-organizing map (SOM) containing 1,000 classes

**Arizona and Colorado: April 17, 2006 21Z**
Plumes originate in Painted Desert and San Luis Valley

**Corresponding SOM- Classes:**
- 218, 228, 229, 249, 258, 260 (blue)
- 513, 521, 525, 526 (yellow green)
April 15, 2016 1955Z
Two Active Regions: California/Arizona and northern Mexico

Point Sources
• Danby (dry) Lake, Mojave Desert
• Agricultural sources along CA/AZ border
• Hydrologic sources (seasonal streams/Casas Grandes) by Los Trios
North America High-resolution DSD

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Navy Aerosol Analysis Activities

- Basic research
- Parameterizations
- Air and ground based measurements
- Models
- Forecasting and Verification
- Ensemble modeling
- Data assimilation
- Operational satellites
- Field Campaigns (NASA, NCAR, NOAA)
- Parameterizations

Models
Forecasting and Verification

Ensemble modeling

Data assimilation
Operational satellites
Cold Pools

Dry
- Dry Microburst

Wet
- Wet Microburst

Convective Dust Storm (Haboob)

Gust Front (Moist Outflow)

Secondary Development

Aqua MODIS, 9/7/15 1035Z

South China Sea
NRL Dust Forecasting Capabilities

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