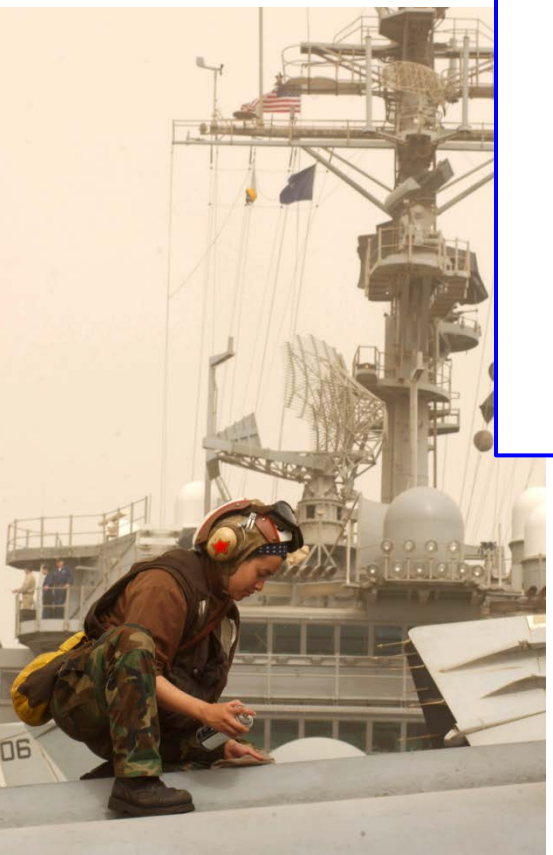
The Naval Research Laboratory's Marine Meteorology Division Dust Forecasting Capabilities

Annette Walker

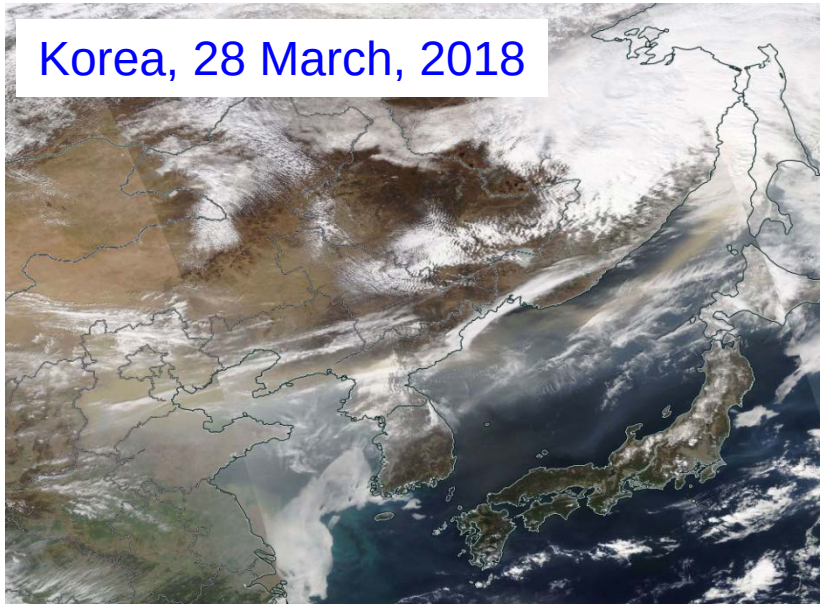
Arizona Dust Storm Workshop
March 5, 2019

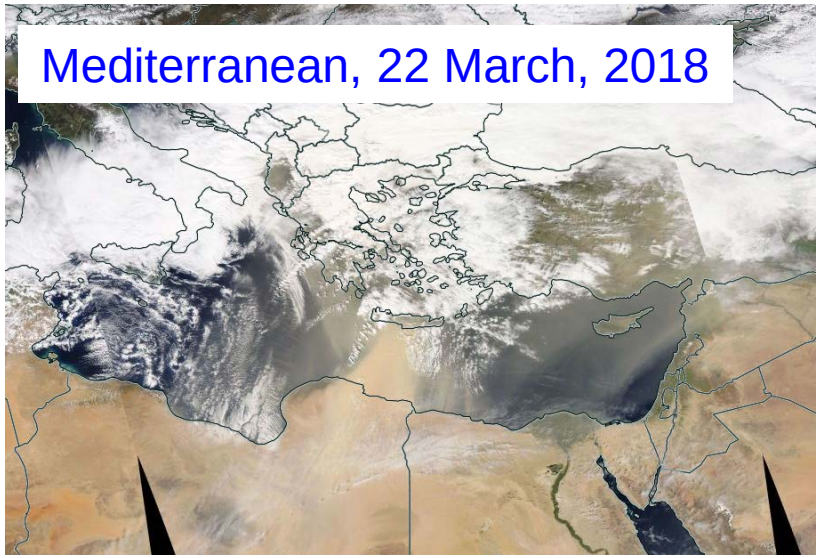


Navy Aerosol and Visibility Forecast Needs:

- Tactical and strategic planning
- Target Acquisition
- Port Navigation
- Carrier landings
- Ship defense

Impact of Dust Aerosols on DoD Activities



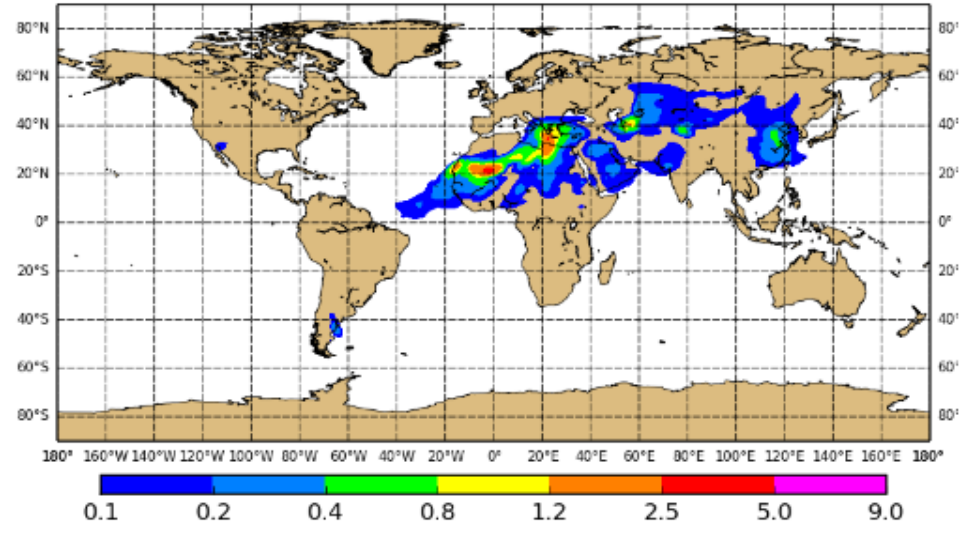


Global and Mesoscale Aerosol Models

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

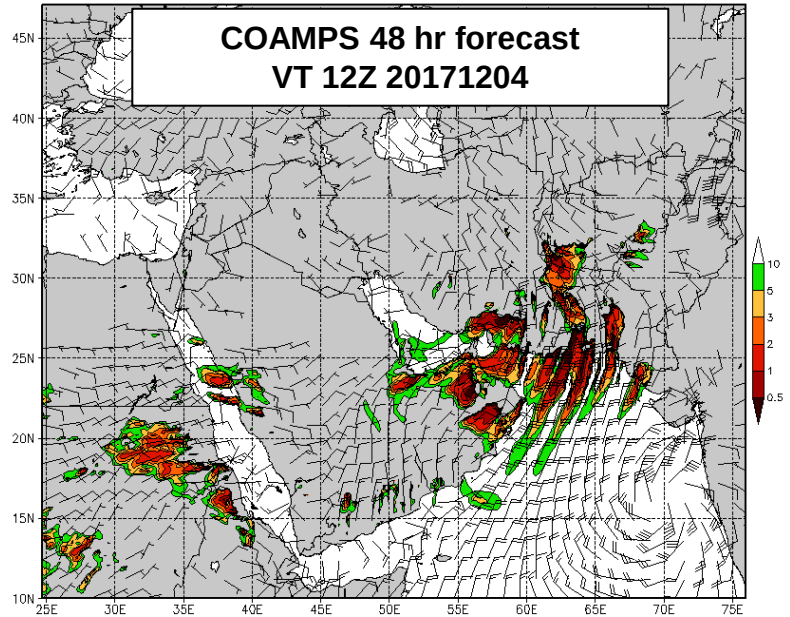
NAAPS Analysis 00Z 20180322
Dust Aerosol Optical Depth



Plots Generated Friday 23 March 2018 11UTC NRL/Monterey Aerosol Modeling

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



VT: Mon 12Z 04 DEC 17
FNMOC 15km COAMPS (U): Dust Surface Visibility [nm] Winds [kts] 048 HR FCST
Run: 2017120212Z Tau: 48

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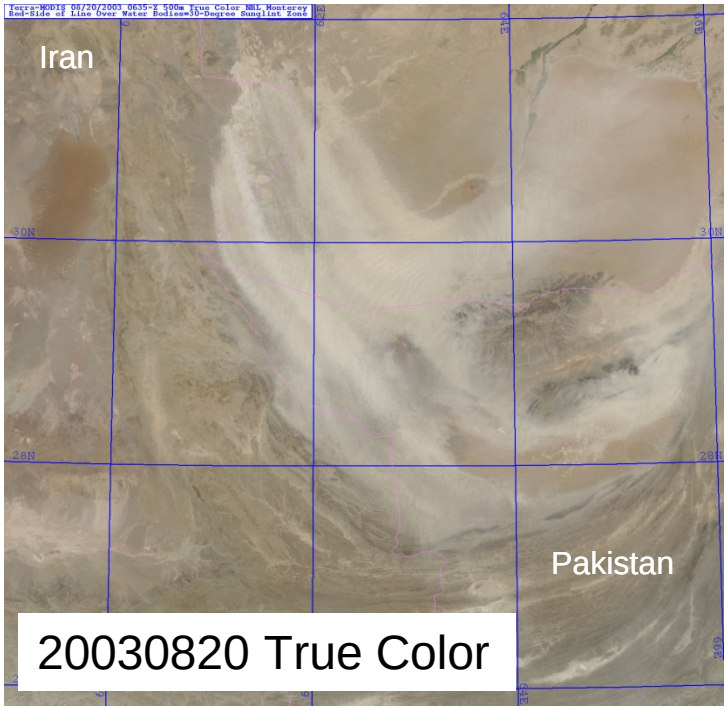
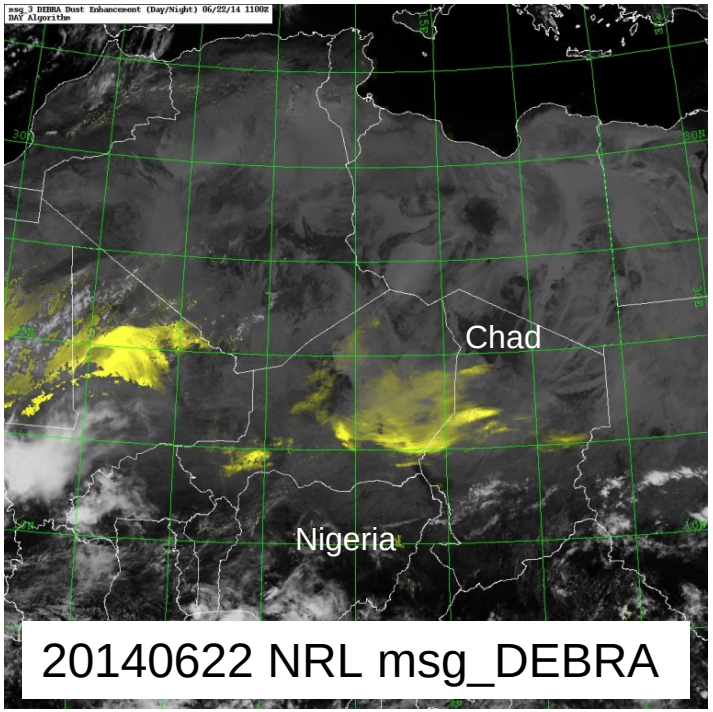
High-resolution Dust Source Database



20030820 True Color

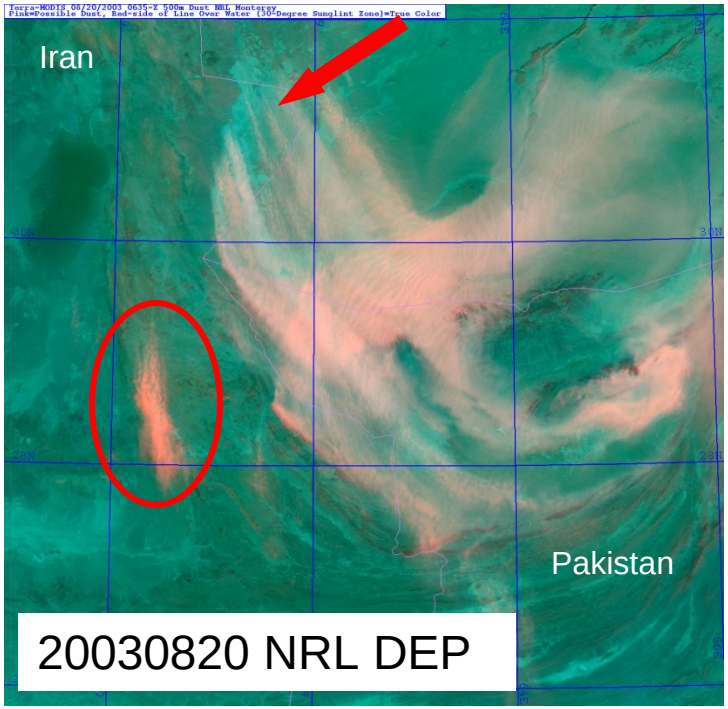


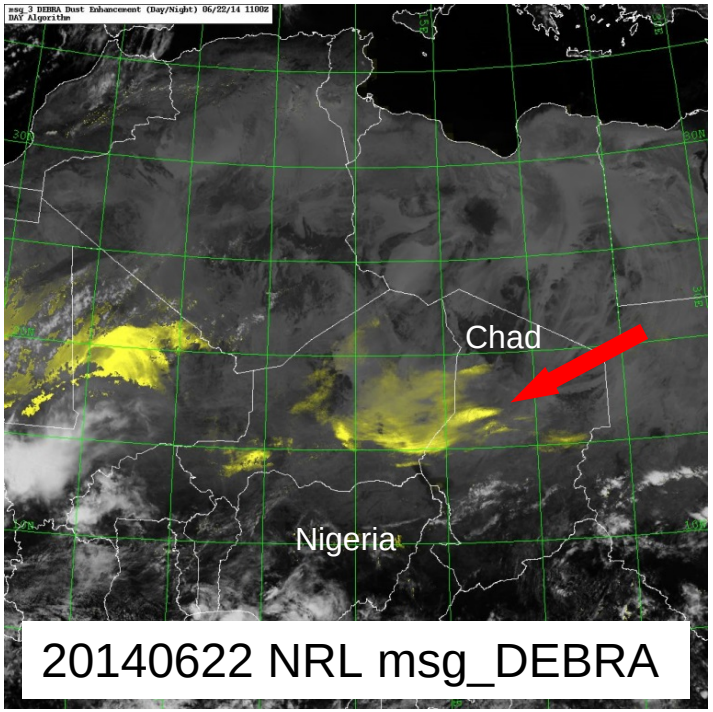
20140622 NRL msg_DEBRA

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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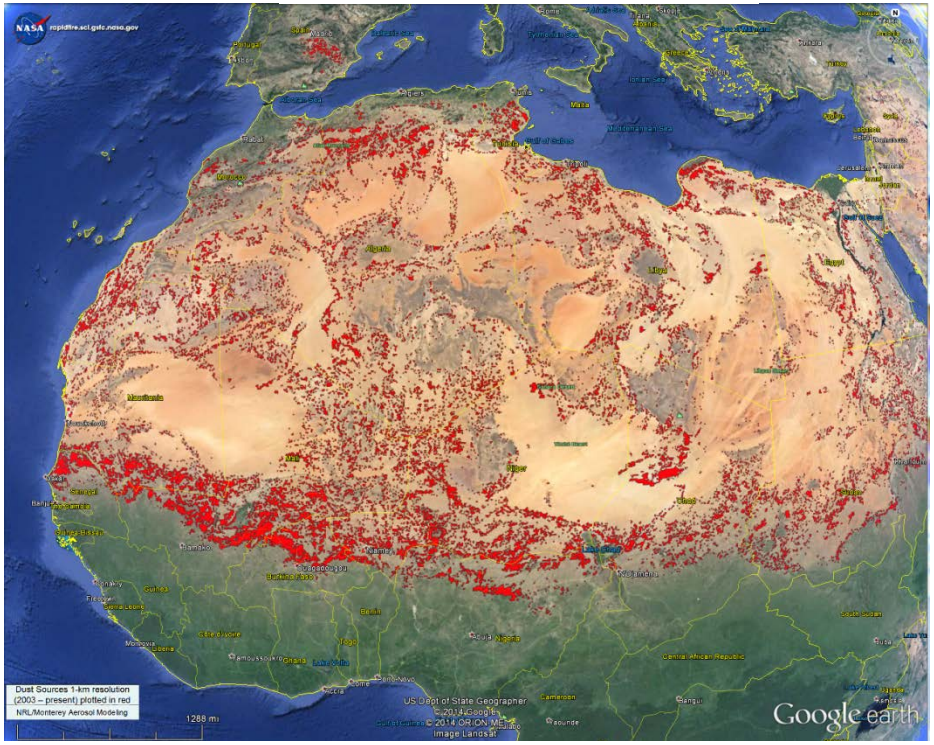
High-resolution Dust Source Database

- 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)

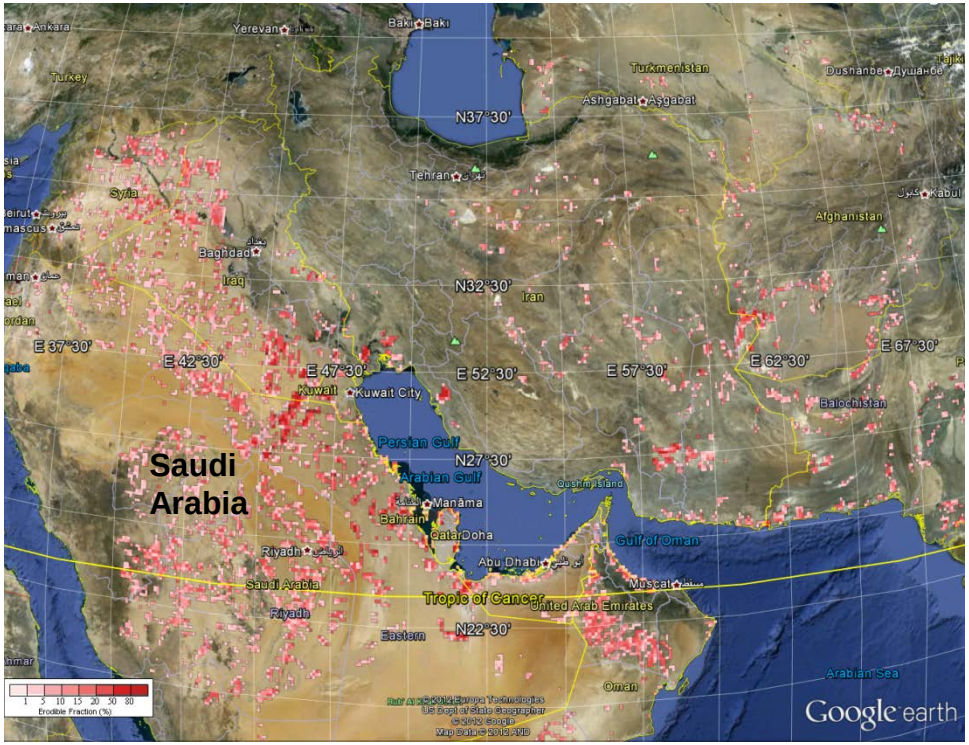
$$\text{Flux}_{\text{dust}} \; \alpha \; \text{Erodible Fraction} * u_*^4$$

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

North Africa DSD



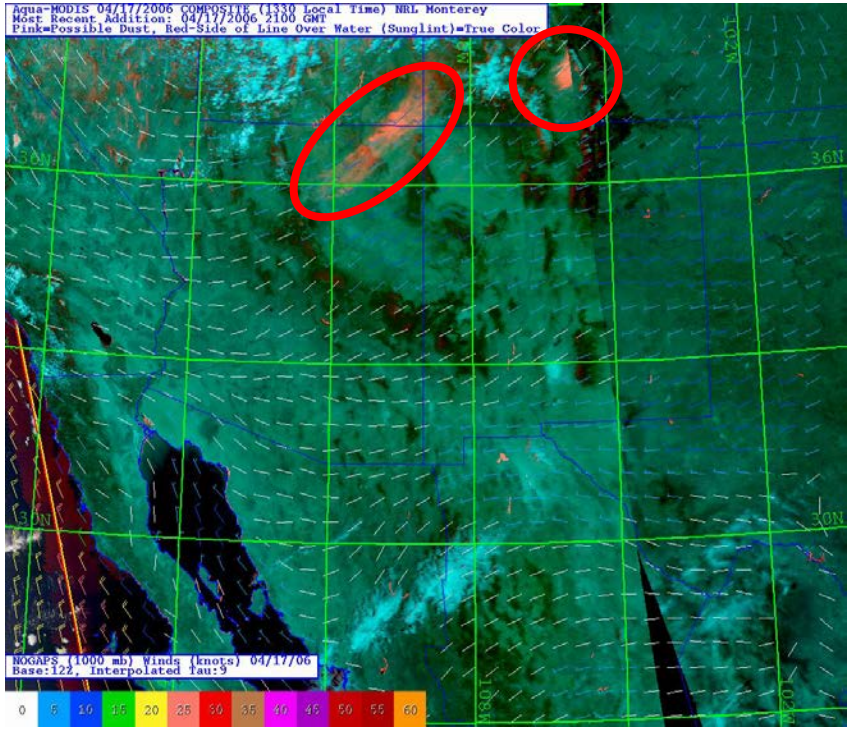
SW Asia DSD

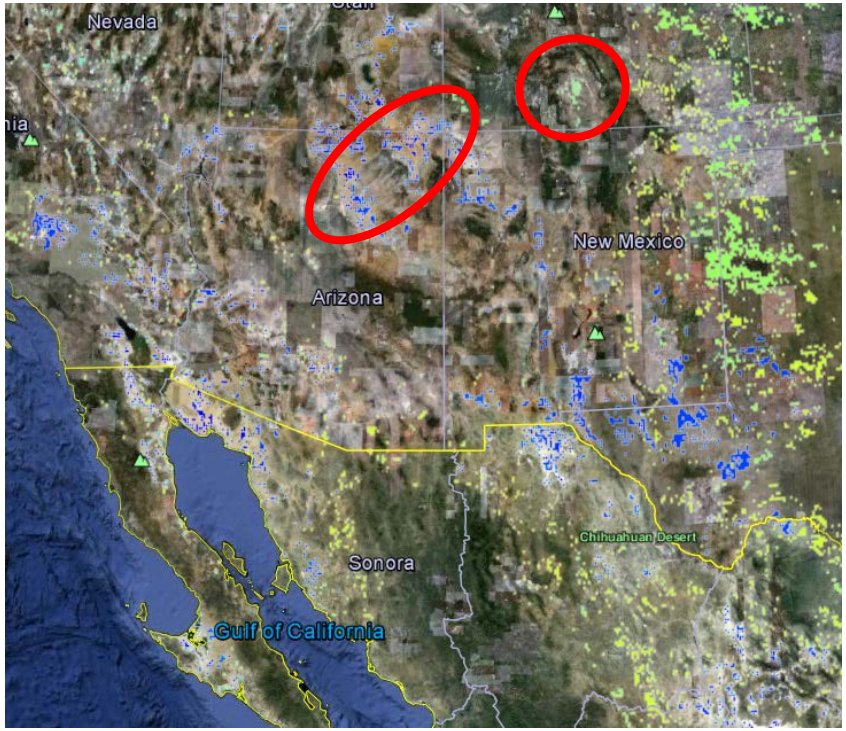


North America High-resolution DSD

- 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)





North America High-resolution DSD

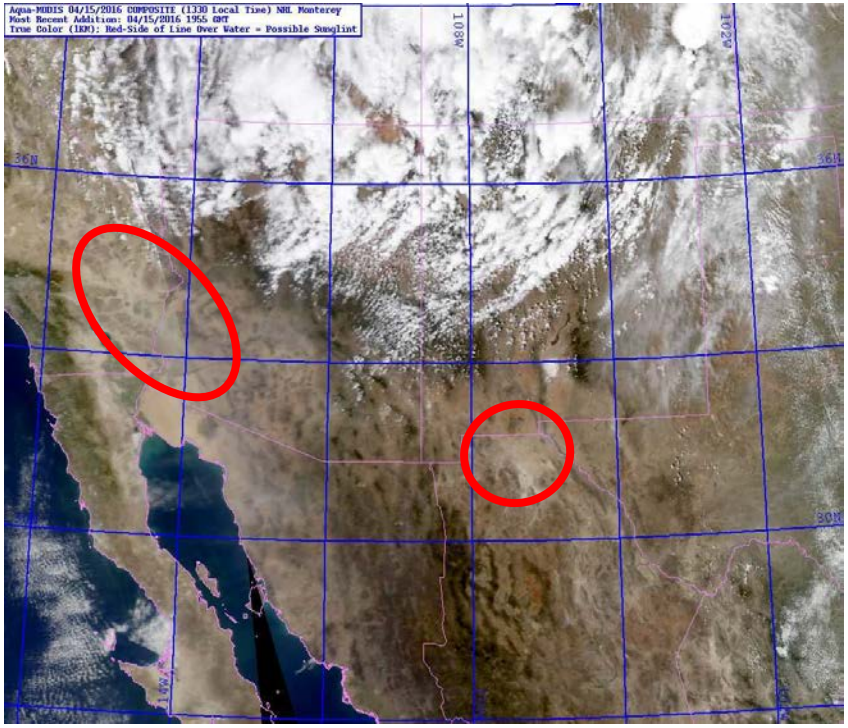
April 15, 2016 1955Z

Two Active Regions: California/Arizona and northern Mexico

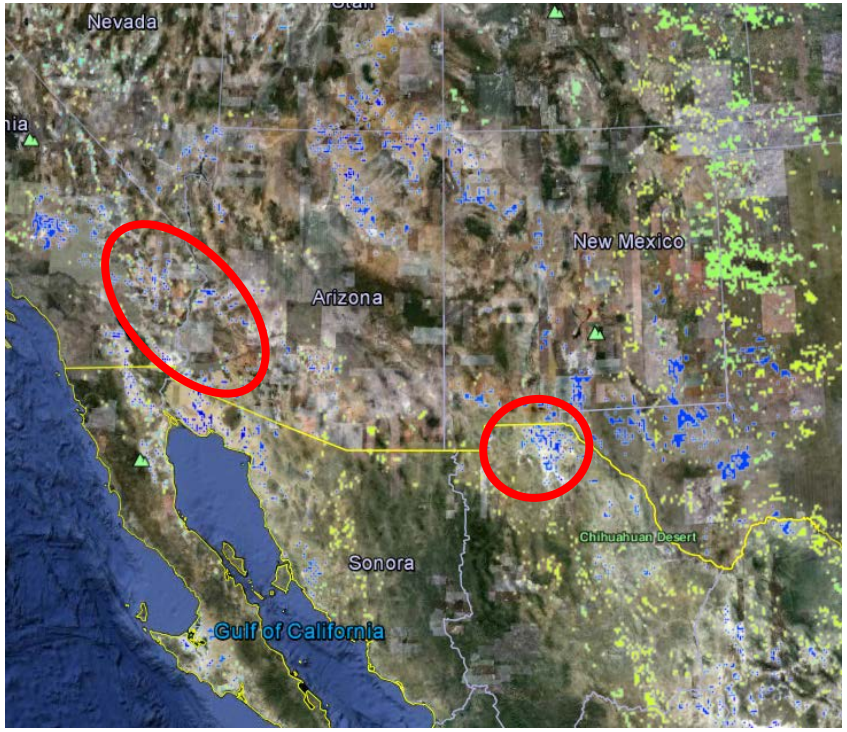
Point Sources

- Danby (dry) Lake, Mojave Desert
- Agricultural sources along CA/AZ border
- Hydrologic sources (seasonal streams/Casas Grandes) by Los Trios

MODIS Aqua True Color



NRL DSD



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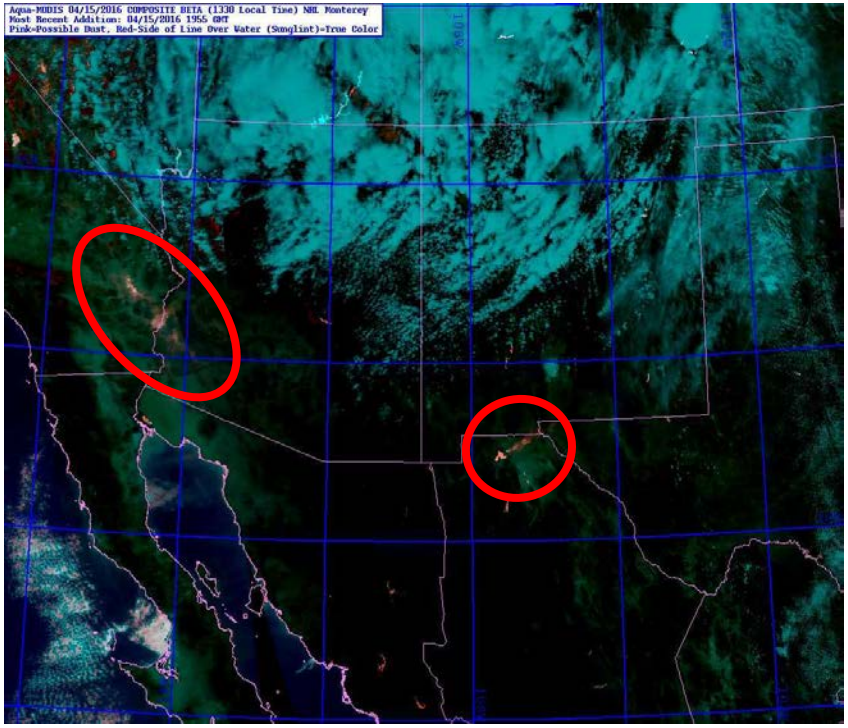
MODIS Aqua NRL DEP



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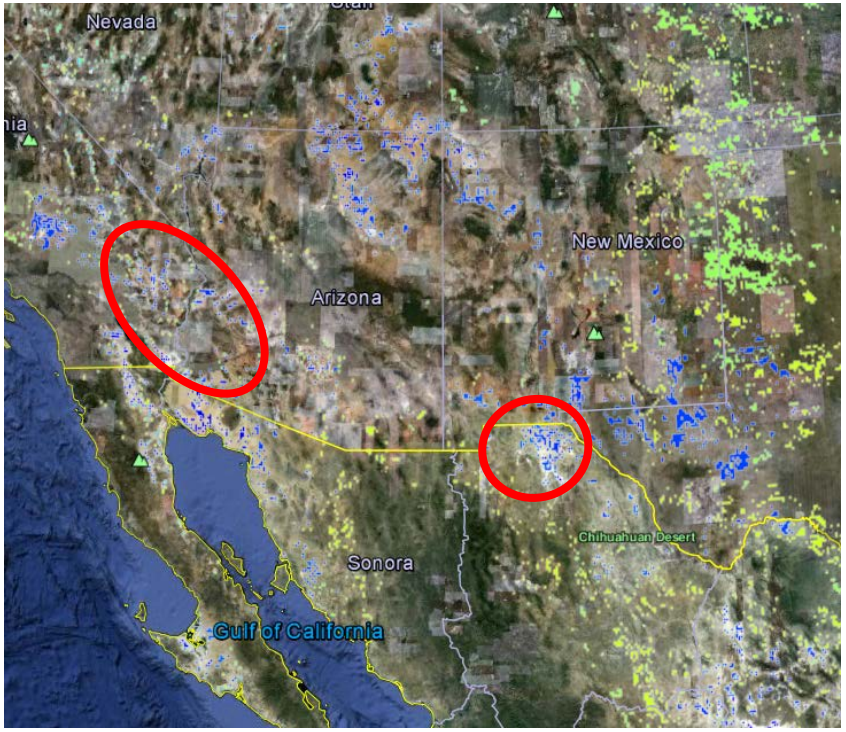

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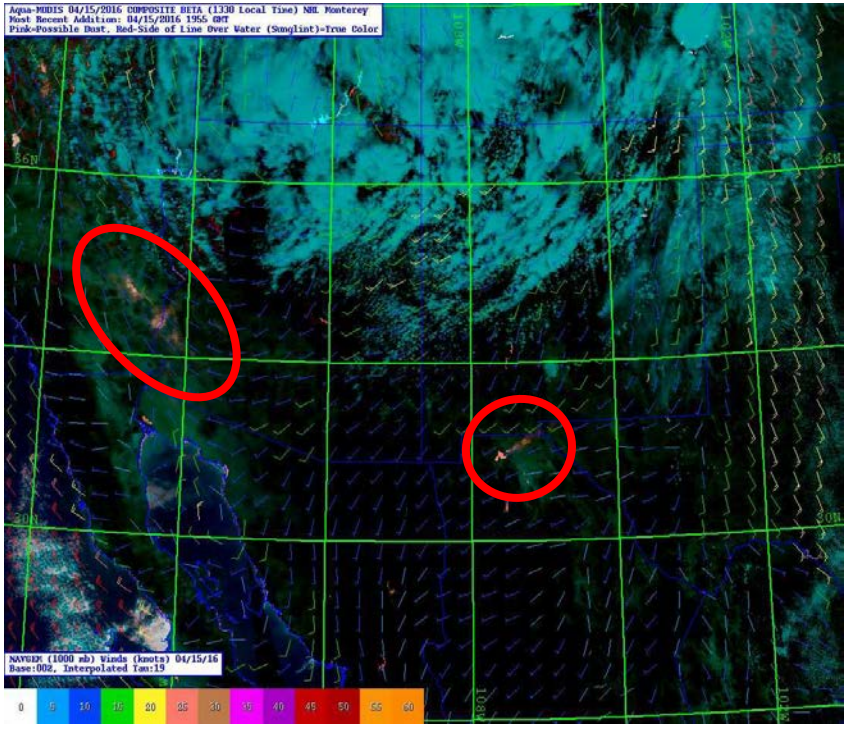

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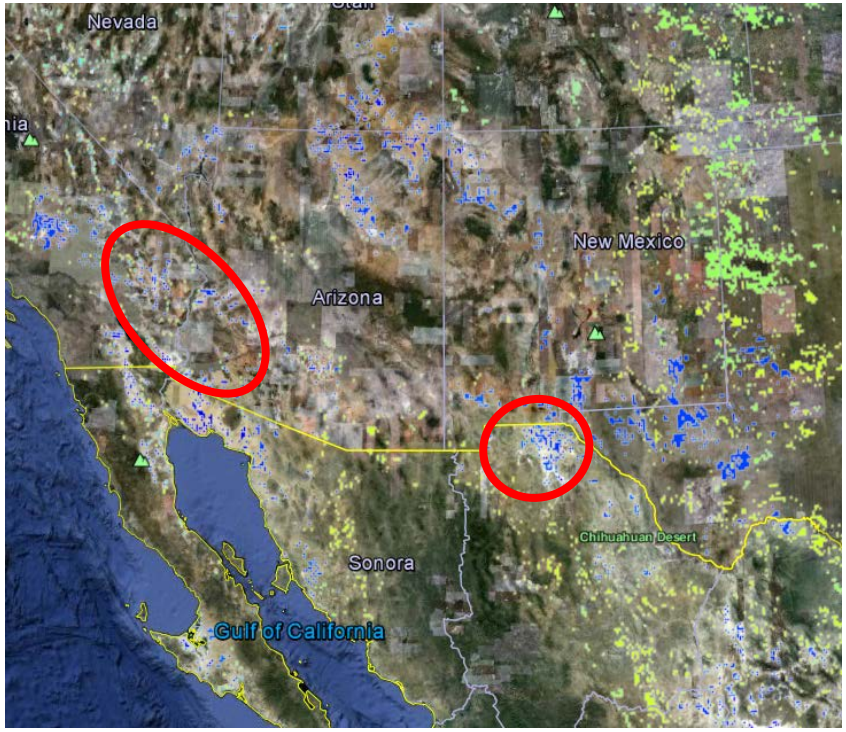
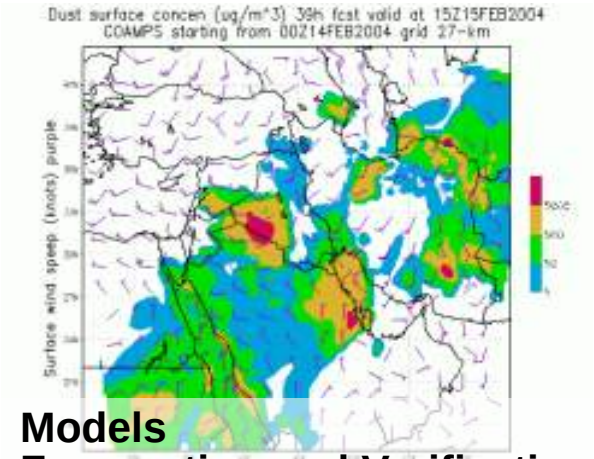
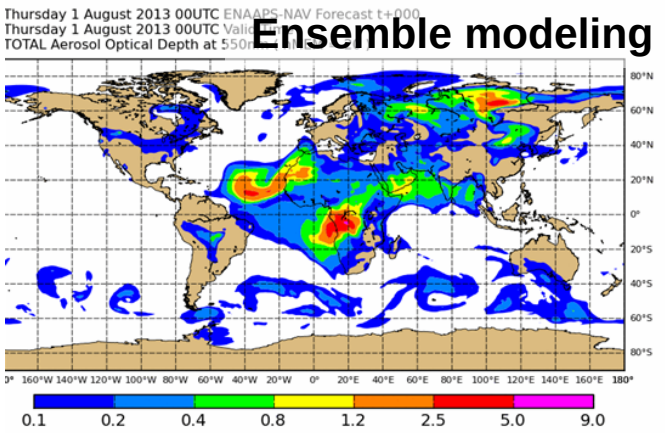


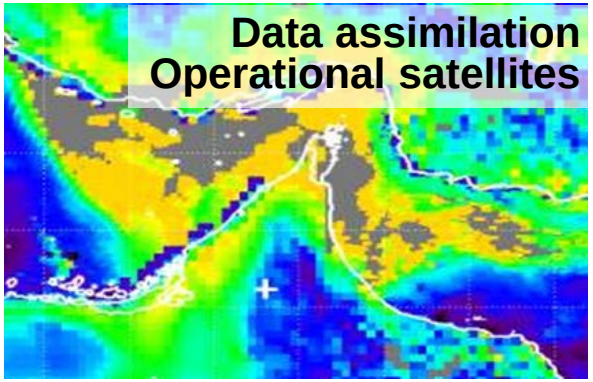
Navy Aerosol Analysis Activities



Models
Forecasting and Verification



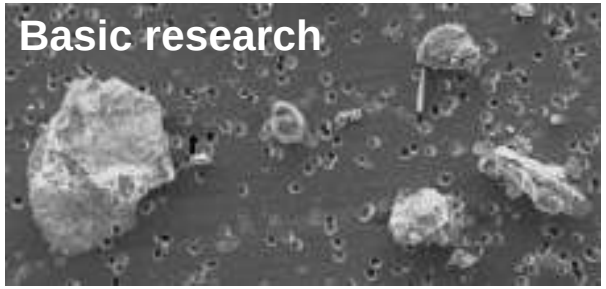
Ensemble modeling



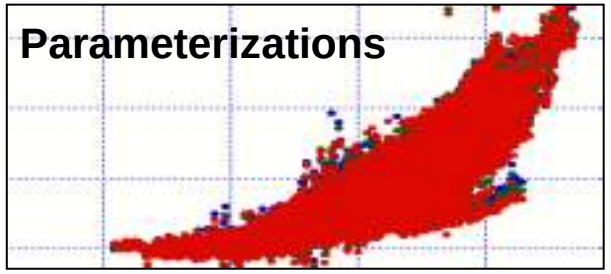
Data assimilation
Operational satellites

Air and ground based measurements

Field Campaigns
(NASA, NCAR, NOAA)



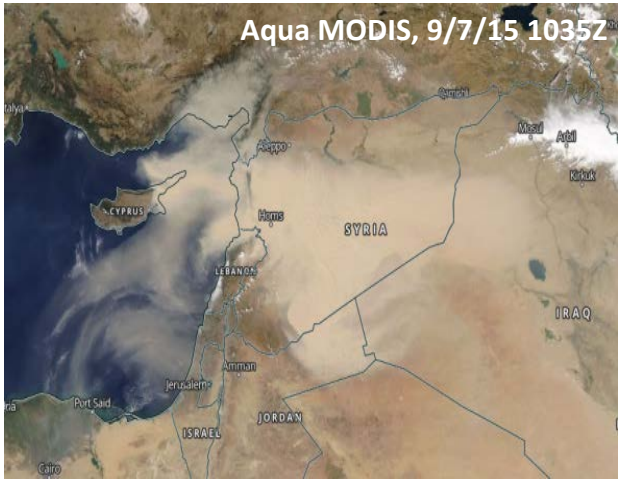
Basic research



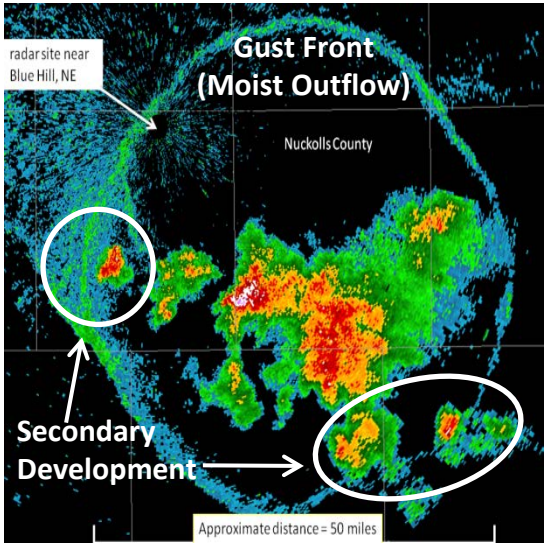
Parameterizations

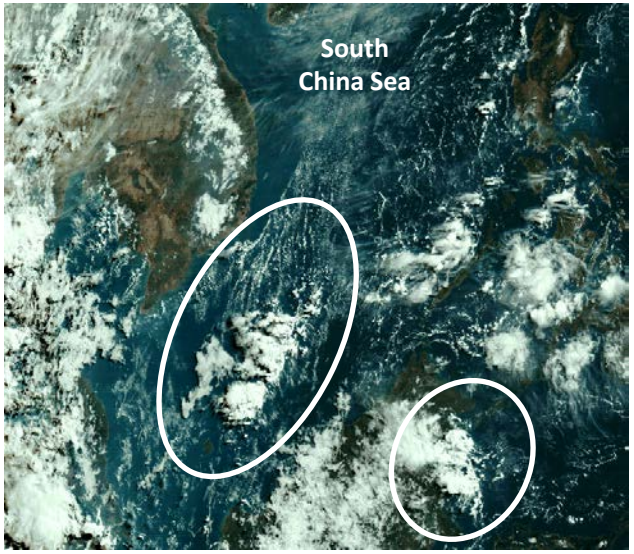
Cold Pools

Dry



Wet





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Annette.Walker@nrlmry.navy.mil

Marine Meteorology Division
Naval Research Laboratory
7 Grace Hopper Ave., Stop 2
Monterey, CA 93943-5502
(831) 656-4722

Group Members:

Anthony Bucholtz
Rich Bankert
Chris Camacho
James Campbell
Edward Hyer
Chris Johnson
Arunas Kuciauskas
Dave Peterson
Jeffery Reid
Betsy Reid
Mindy Surratt
Peng Xian