Supporting the NWS in San Juan, Puerto Rico with VIIRS-derived Products

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Improvements in Predicting Saharan Air Layer (SAL) Events over the Greater Caribbean using Modeling and Satellite Resources

1. Project description & recent activities
   • What is SAL?
   • Milestones during 2017

2. Customer interaction
   • NWS San Juan, Puerto Rico site visit
   • SAL event: a) operational perspective b) NRL resources

3. Current and planned activities
   • Modeling
   • Satellite products
   • JPSS instruments
Defining SAL

3D cutout

Karyampudi and Carlson, J. Atmos. Sci., 1988

Isentropic diagram

Kuciauskas et al., BAMS, 2017 (accepted for publication)
Product suite

Satellite Imagery:
- Visible
- IR
- True & Natural and GEO Color
- Nocturnal Low Clouds
- Dust (Bluelight, DEBRA, AOD, RGB)
- TPW (NRL, NESDIS/CIRA, MIMIC)
- Water Vapor

Lidar Instruments: * currently unavailable
- CALIPSO/CALIOP *
- MPLNET *

Ground-based instruments:
- AQ (PM$_{2.5}$, PM$_{10}$, pollution level measurements)
- AERONET

Modeling (dust):
- NAAPS MODIS + VIIRS AOD
- Navy NWP Model wind overlays
- CIMH (WRF-Chem), ICAP, NGAC
Project Recent Activities

- **R&D: SAL chemistry, thermodynamics, predictability, public impacts**
  - Satellite-based product development (focus: VIIRS)
  - Model-based forecast products (focus: VIIRS AOD as Data Assimilation)
  - In-situ measurements that are not readily available
  - Hosted (near real time) and maintained on NRL website (SAL-WEB)
  - BAMS Publication: project summary

- **Conducted NWS site visit (31 July – 03 August)**
  - Overview of forecast operations: weather impacts, social interaction
  - Product feedback
  - SAL impacts
  - Forecaster needs outside of AWIPS-II
  - Future collaboration, including other Caribbean agencies

- **Blend environment with health aspects**
  - Puerto Rico/West Indies: among the world’s worst asthma conditions
  - Participated with various environment/health agencies throughout Greater Caribbean
    - Caribbean Institute for Meteorology and Hydrology, Barbados (CIMH)
    - Caribbean Aerosol and Health Network (CAHN)
    - University of Puerto Rico
Customer Interaction: NWS Site Visit
San Juan, Puerto Rico
Highlights of Site Visit

- **Overall, very positive feedback**
  - SAL-WEB applied as resource of daily analysis
  - Growing interest/concern during SAL events, mainly during summertime

- **AQ/Dust Aerosol Modeling**
  - No aerosol model in AWIPS-2
  - NWS, San Juan unaware of NGAC dust model
  - NWS has been reliant on NAAPS and GEOS-5
  - NAAPS will be 1st to incorporate Enterprise VIIRS AOD into data assimilation (DA)

- **Surface observations**
  - Greater access to site containing AQ measurements in NRT
  - Lidar (MPLNET): *currently unavailable*
    - Backup in Key Biscayne

- **Public Awareness/Social media**
  - SAL has gained notoriety, but concepts are distorted
    - Need better definition
    - NWS is evolving toward Facebook, Twitter, media interaction

- **Environment & Health impacts of SAL**
  - Dr. Olga Mayol-Bracero, Professor at U of P.R.
    - Widely known as expert in Caribbean environment
    - Lidar installation in Capo San Juan (northeast P.R.)
    - Wealth of instruments throughout P.R.
  - Dr. Bolaños, Professor at U of P.R. 13 year study
    - Little correlation between African dust events and respiratory ailments
    - Spore production within rain forests major asthma contributor during fall/winter & nighttime conditions
    - African dust can act as an irritant for the respiratory system

- **Future support**
  - Satellite needs: Atmospheric profiling
    - GOES-16 products
    - JPSS-1 launch
    - Ozone (pollution) research: OMPS
    - CrIS sensing
  - Training: “Just-in-time” as SAL events occur
SAL Case Study: An Operational Perspective

29 July – 04 August
Showcase NRL resources
Case Study: 29 July – 04 August 2017

VIIRS true color

MODIS AOD
SAL impacts: AERONET

Puerto Rico

Key Biscayne, FL

AERONET AOT, La Parguera, lvl 1.5

AERONET AOT, Key Biscayne, lvl 1.5

SAL event

SAL events

AERONET courtesy: Brent Holben
Model Perspective

NAAPS dust aerosol optical depth at 550nm
20170804 0000 UTC - 086

Dust AOD difference [NGAC - NAAPS]
20170804 00Z tau = 558

dust aerosol optical depth at 550nm - dust aerosol optical depth at 550nm

Surface Dust Concentration (µg/m³) Valid 00Z 30/07/2017

11
Case Study: Lidar sensing
Key Biscayne, FL

31 July – 04 August

MPLNET Key_Biscayne 2017-07-31...2017-08-04 (V3, MPL44110, 532.00 nm): vol_depol_ratio

Altitude (km)
0 1 2 3 4 5

Date / Time
2017-07-31 2017-08-01 2017-08-02 2017-08-03 2017-08-04 2017-08-05

Percent
0 1 10

No dead time calibration. No after pulse calibration. No pol calibration.
No dark count calibration. No overlap calibration.
Evolving SAL Over Miami

20170802
Developing SAL

20170803
Developing SAL

20170804
Mature SAL
Split Window SAL Views

Better spectral/spatial resolution
NAAPS Vertical Profile Forecasts during SAL
Florida EPA AirNow Sites (PM$_{2.5}$)

NAAPS (red) vs sfc TEOM sites (black)

NAAPS profile: total PM mass concentration from dust, smoke, sea salt, and anthropogenic aerosol tracers
Summary

1. Coordination with NWS:
   a) Evolve SAL into higher impact status -> forecast discussions, social media
      i. Better understanding of SAL
      ii. Training => forecasters/public/gov. agencies: weather & health impacts
      iii. Beyond VIIRS: acquire additional resources from NEXGEN sensors
          • GOES-16 fusing with polar orbiters, models, in-situ measurements

2. Improve Navy dust model:
   a) Incorporate Enterprise VIIRS AOD into NAAPS
   b) Integrate international dust models (ICAP)

3. Leverage Navy funding: R&D toward Caribbean dust/pollution/health:
   a) SAL dust vs localized pollutants characterization
      i. Ozone studies related to detecting/discriminating pollution from dust
      ii. Apply OMPS retrievals
   b) Visibility aspects related toward trafficability
Summary

US Navy Requirements Related to the Tropical Atlantic Environment

Support tactical and operational environment

- Trafficability
- Helicopter operations
- UAV operations
- Search and Rescue
- Reconnaissance
- Weapons systems

Improve tactical prediction of near-surface weather

- Boundary Layer Clouds
- Fog
- Aerosol Loading
- Visibility

“We must advance our technological expertise to predict how electromagnetic waves will move through the physical battlespace.”

~ RDML Tim Gallaudet, USN

Clouds affect, or are indicators of, tropospheric boundary layer conditions and EM/EO propagation.