U.S.ARMY

Overview of Dust Emission and Forecasting Research

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US Army Corps of Engineers.

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Motivation

Dust Effects on Operations

Mission planning

- Intelligence Preparation of the Battlefield (IPB):
  - Route/landing zone planning
  - Abrasion/Engine Intake hazard assessment
- Atmospheric corrections for satellite imagery/retrievals

Force protection

- Enemy or covert operation activity masked by major dust events

Essential US DoD dust simulation/forecasting applications

- Scene simulation for acquisition testing applications
- Soldier health (poor air quality; disease/pathogen transport)
- Accurate decisions about aircraft asset downtime
- Land management decisions on dryland installation environments
- Sensor data interpretation

ERDC Geomorphic (ERDC-Geo) Surface Erodibility Parameterization

Mathematically **links geomorphic landscape traits (landforms)** to soil erodibility and **dust emission potential**

Incorporates the effects of **sediment supply** on dust emission into dust models

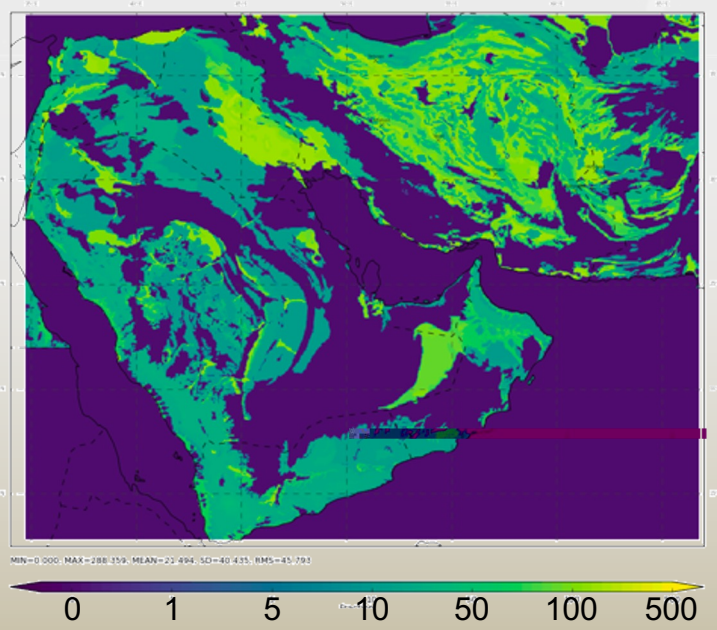
Spatially-varying dust emission flux multiplier designed to work with most physics-based dust emission models

TEAM

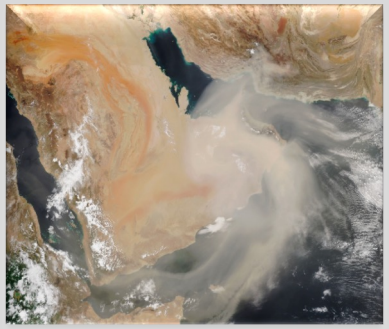
US Army Engineer Research and Development Center (ERDC),
UK Met Office, UK Ministry of Defence,
US Air Force Life Cycle Management Center (AFLCMC),
US Air Force 557th Weather Wing, US Dept. of Agriculture,
Desert Research Institute, Uni. of California Los Angeles, New Mexico State University

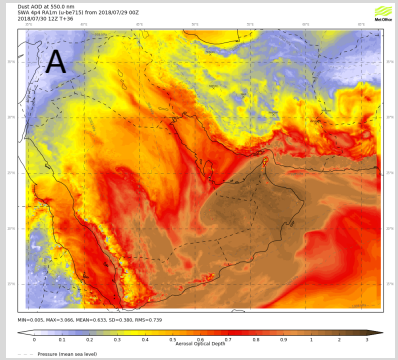
Method is simple to apply and portable across dust models

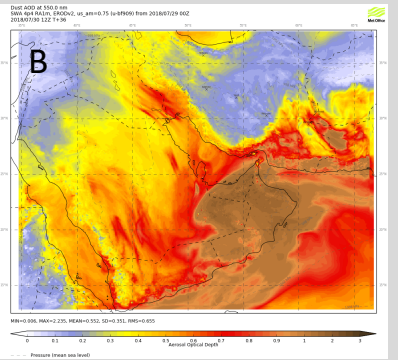
ERDC Geomorphic (ERDC-Geo) Surface Erodibility Parameterization



Dust emission scaling factor for 4.4 km Southwest Asia produced for Unified Model domain/dust emission module. Note, this field does not represent dust source strength.







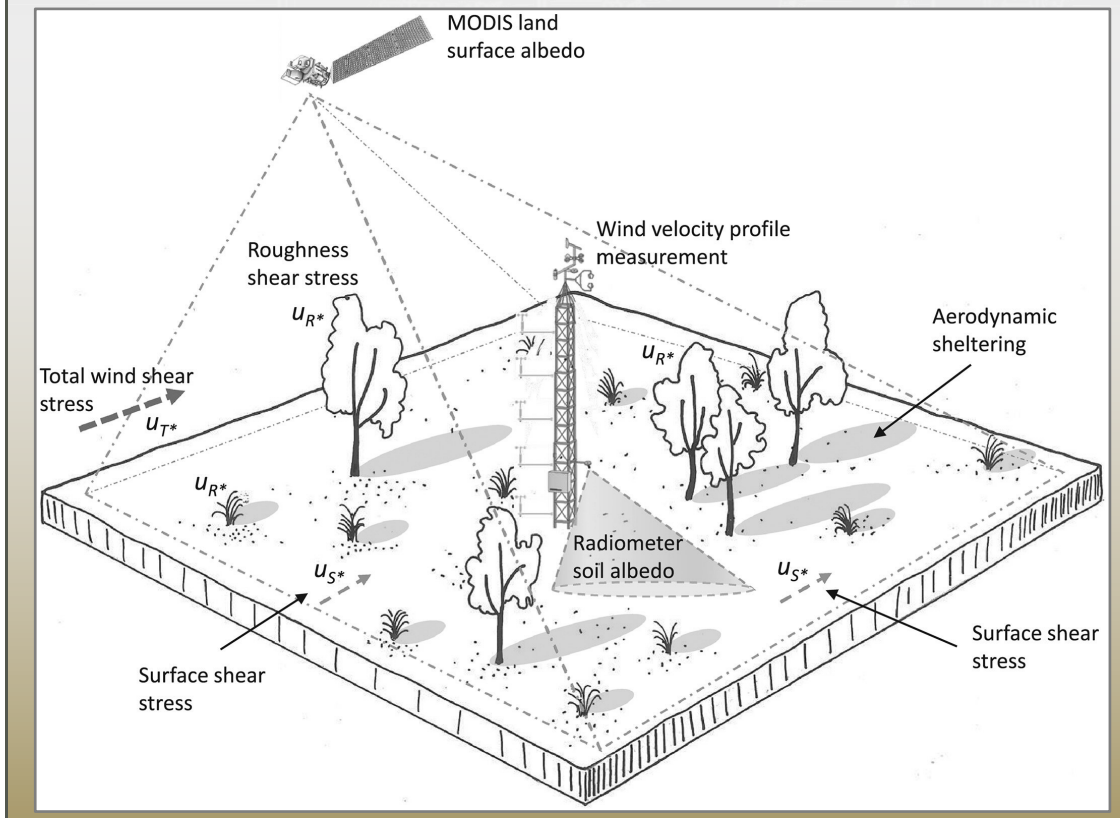
July 30, 2018 dust event satellite imagery and 36 hour 550nm AOD forecasts produced by the A) original Unified Model configuration and B) Unified Model with ERDC-Geo.

Ratio of physically-modeled to analog-based dust emission potential used to generate a **spatially varying dust emission flux multiplier** field

Preliminary research suggests that ERDC-Geo will greatly improve the spatial accuracy of Unified Model dust products

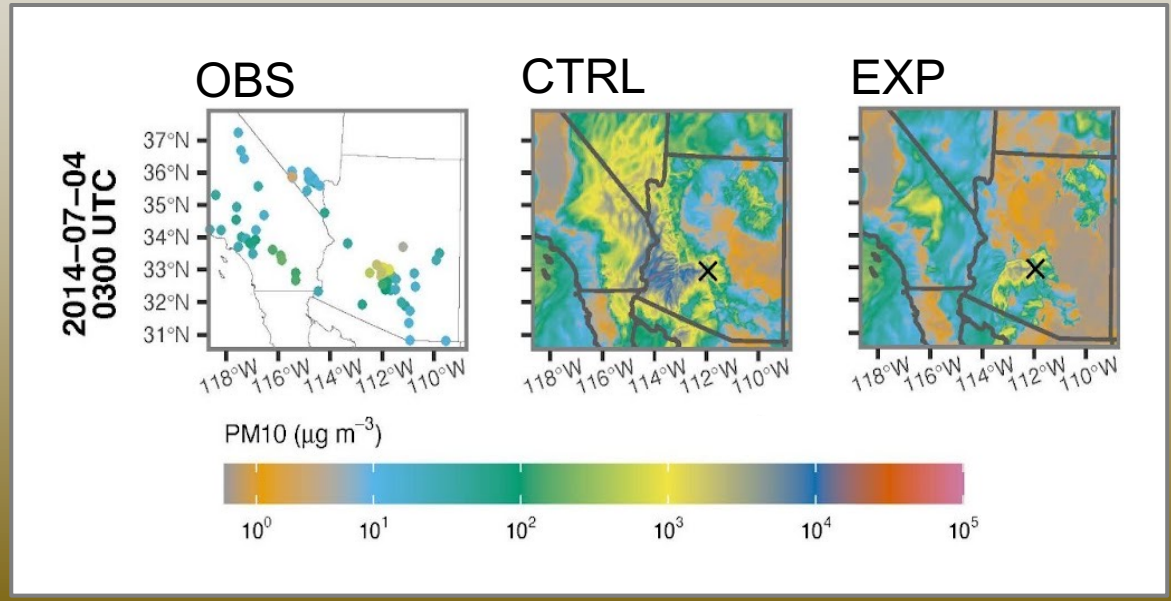
Sediment Mobilization Processes – Vegetation Effects

Shadow-based Method for Incorporating Vegetation Effects into Model



Shadow-based drag partition concept (figure from Ziegler et al. 2020; JGR)

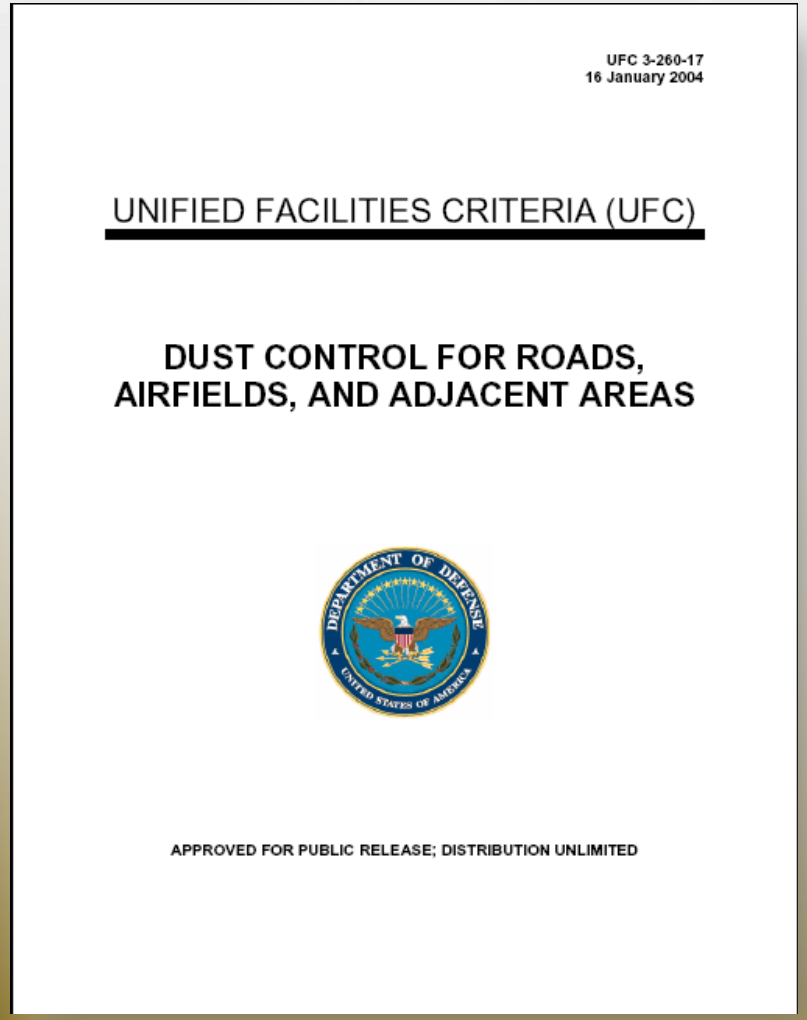
Code and Implementation Instructions:
Michaels et al. (2022): *Implementation of an albedo-based drag partition into the WRF-Chem v4.1 AFWA dust emission module.* ERDC Tech Report TR-22-2 (available via Google Scholar)



Dust Abatement - Methods and Testing

ERDC-Geo

Dust Abatement – Field Guides and Handbooks


UFC 3-260-17
16 January 2004

UNIFIED FACILITIES CRITERIA (UFC)

DUST CONTROL FOR ROADS, AIRFIELDS, AND ADJACENT AREAS

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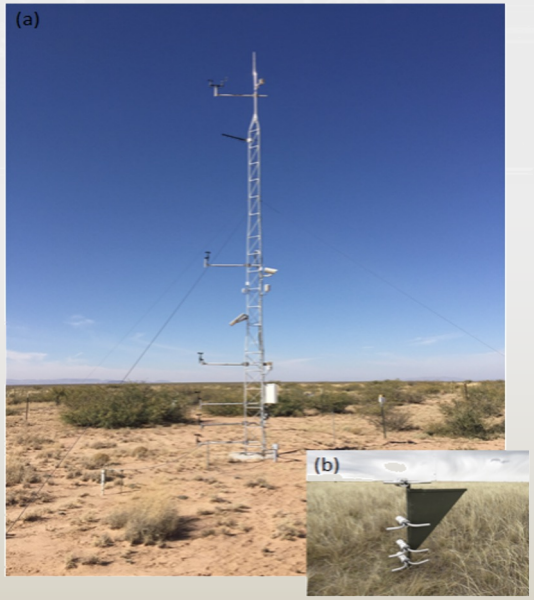
ERDC-Geo

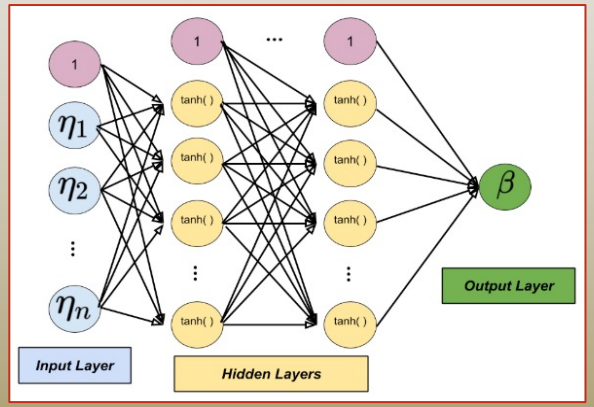
Dust - Basic Research

Field Experimentation



Wind Tunnel Experimentation

Data-driven Discovery



Mathematical Modeling

$$\frac{\partial U_i}{\partial t} + U_j \frac{\partial U_i}{\partial x_j} = -\frac{\partial P}{\partial x_i} - \frac{\partial \left\langle \overline{u_i' u_j'} \right\rangle}{\partial x_j} - \frac{\partial \left\langle \overline{u_i'' u_j''} \right\rangle}{\partial x_j} + \left\langle \frac{\partial \bar{p}''}{\partial x_i} \right\rangle + \nu \left\langle \frac{\partial^2 \bar{u}_i''}{\partial x_j \partial x_j} \right\rangle$$

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