Overview of Dust Emission and Forecasting Research

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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

Method is simple to apply and portable across dust 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
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)
Dust Abatement - Methods and Testing
Dust Abatement – Field Guides and Handbooks

Dust Abatement Handbook
Standard Practices for Mitigating Dust on Helipads, Roads, Airfields, and Base Camps

U.S. Marine Corps Systems Command

Dust Control Field Handbook
Standard Practices for Mitigating Dust on Helipads, Lines of Communication, Airfields, and Base Camps

UNIFIED FACILITIES CRITERIA (UFC)

DUST CONTROL FOR ROADS, AIRFIELDS, AND ADJACENT AREAS

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Dust - Basic Research

Field Experimentation

Wind Tunnel Experimentation

Data-driven Discovery

Mathematical Modeling

\[
\frac{\partial U_i}{\partial t} + U_j \frac{\partial U_i}{\partial x_j} = - \frac{\partial P}{\partial x_i} - \frac{\partial \langle u'_i u'_j \rangle}{\partial x_j} - \frac{\partial \langle u''_i u''_j \rangle}{\partial x_j} + \frac{\partial \langle \bar{p}'' \rangle}{\partial x_i} + \nu \left( \frac{\partial^2 \bar{u}''}{\partial x_j \partial x_j} \right)
\]
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