Constraining dust sources with the MODIS and MISR observations

Xiaoguang Xu, Jun Wang, and Yi Wang

ARROMA, University of Nebraska-Lincoln, Lincoln, NE

Motivation & Research Goal
- Large uncertainties prevail in dust emission estimates due to limited understanding of dust uplifting mechanism.
- Whereas efforts have been made to improve the dust emission estimates with satellite aerosol measurements\[1-3\], no study has been done to constrain the parameterization of dust emission scheme from multi-sensor observations combined with dust transport model.
- This work aims to improve dust emission parameterization constrained by satellite AOD measurements through the GEOS-Chem adjoint.

Dust Mobilization Scheme\[4-5\] & Selection of Parameters to Optimize

While dust emissions are influenced by many soil and meteorological parameters, we choose to optimize the most influential and uncertain ones:
- + 100% in dust emission
- + 13% U
- + 15% M\text{clay}
- + 100% S
- - 31% u\text{t} threshold

Clay fraction is one of the most influential parameters; it is assumed to be 0.2 globally in GEOS-Chem.

Observation Constraints
- State vector a: Parameters in dust mobilization scheme to be constrained.
- Optimal state x: GEOS-Chem forward model emission/transport/convection/deposition.
- Receptor flux f: simulated aerosol concentration/AOD.
- Observation y: AOD from multiple satellite sensors.
- Optimal adjoint product y\text{adj} is together with Receptor flux f.
- Numerical optimization approach.

Feasibility of Inversion & Pseudo Observation Experiment

Figure below: Relationships between the emitted dust fluxes at u\text{t} = 0.20 and u\text{t} = 0.35 m$^2$s$^{-1}$ for various values of the emission coefficient (S\text{t}) and the threshold friction velocity (u\text{t}).

Fittings of MODIS-DB DOD (June 2008)

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MODIS-DB DOD:
- Derived from Aqua/MODIS Deep Blue aerosol products with approach of [3]
- Assumed error 30%
- Over bright surface only
- Local overpass time ~ 1:30 PM
- Daily global coverage

MISR DOD:
- AOD \times Non-spherical Fraction from the level-2 Terra/MISR aerosol products
- Only over-ocean data is used
- Assumed error 20%
- Local overpass time ~ 10:30 AM
- 9-day global coverage

References: