Lessons from coherent uncertainty analysis of aerosol observations from multiple satellite sensors and implications for model evaluation

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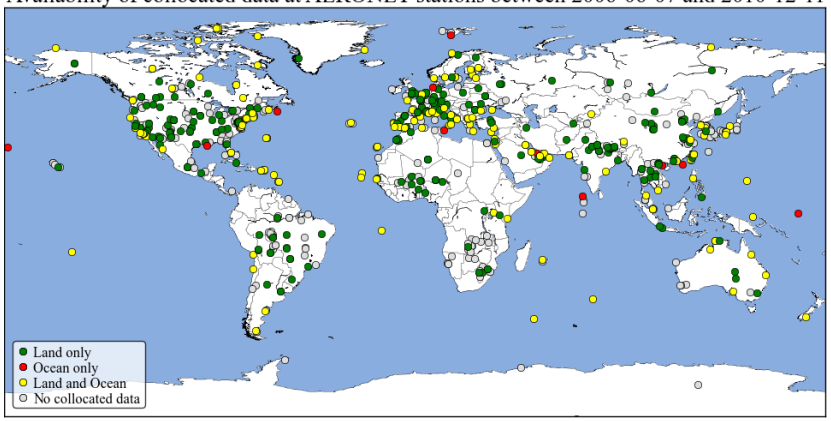
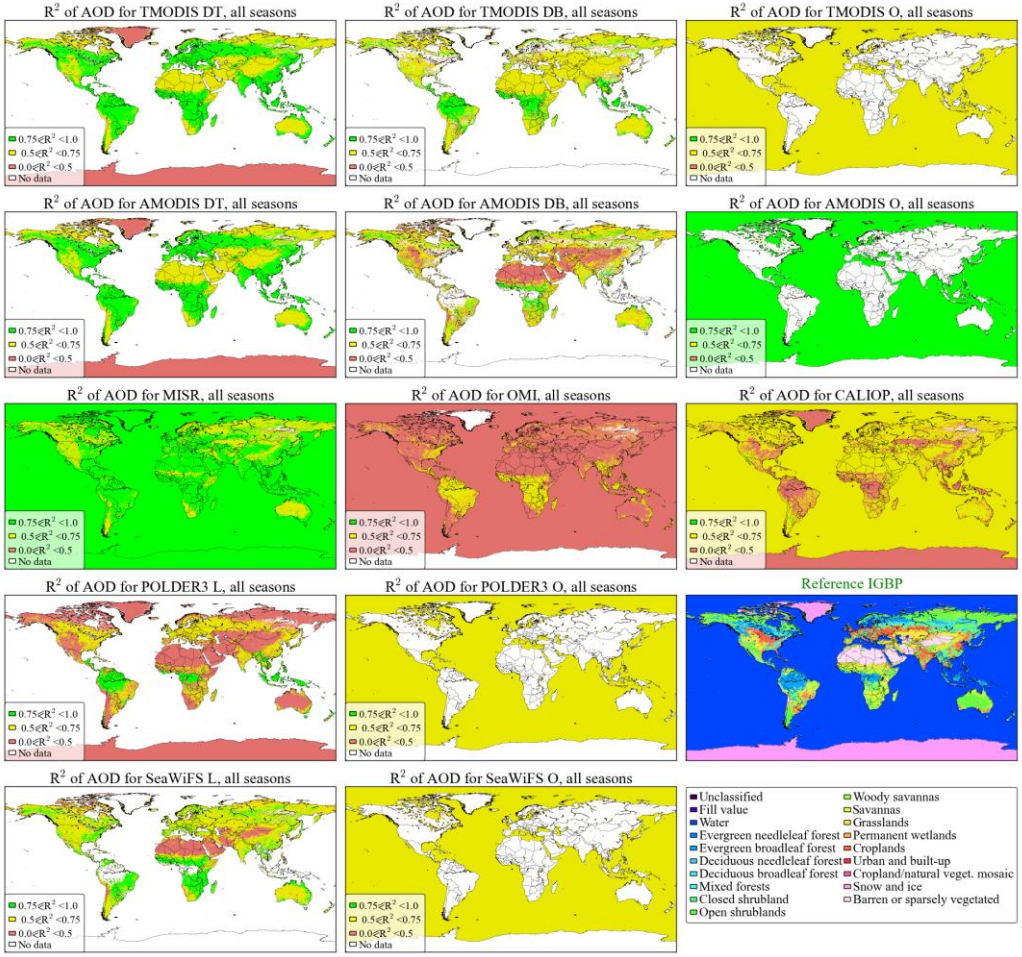
Analysis Framework

- Data from multiple sensors sampled within 55-km diameter circles centered over AERONET stations
- AERONET data sampled within ±30 minutes of each overpass of the satellites
- AOD error computed based on the difference between spaceborne and ground-based observations of AOD, grouped by IGBP land cover type (region)

Availability of collocated data at AERONET stations between 2006-06-07 and 2010-12-11



Measures of accuracy (e.g. R^2) by Land-cover Type



Reference: Petrenko, M. and Ichoku, C.: Coherent uncertainty analysis of aerosol measurements from multiple satellite sensors, Atmos. Chem. Phys., 13, 6777-6805, doi:10.5194/acp-13-6777-2013, 2013.

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Results

IGBP land cover type	Most adapted products
Water	MODIS, MISR, and SeaWiFS
Evergreen needleleaf forest	MODIS and MISR
Evergreen broadleaf forest	POLDER, MISR, and MODIS
Deciduous broadleaf forest	MODIS and MISR
Mixed forests	MODIS and MISR
Closed shrubland	MISR, CALIOP, MODIS Deep Blue
Open shrublands	All sensors have $R^2<0.7$
Woody savannas	MODIS Dark Target, MODIS Deep Blue, MISR, SeaWiFS
Savannas	MODIS, SeaWiFS, MISR, POLDER
Grasslands	All sensors have $R^2<0.7$
Permanent wetlands	MODIS and MISR
Croplands	MODIS and MISR
Urban and built-up	MISR
Cropland / natural veget. mosaic	MODIS, MISR, and SeaWiFS
Snow and ice	MISR
Barren or sparsely vegetated	MISR

- Product accuracy varies with the region (land-cover type), but no product is accurate across all regions
- Each product has unique features that make it advantageous in certain regions, e.g., multi-angle (MISR) over barren land and snow, polarization (POLDER) over biomass burning regions in Brazil
- Certain land-cover types are problematic for all products, e.g., open shrublands and grasslands

Models?

Questions for Satellite-Model aerosol comparison, interaction, and synergy:

- How do models compare to observations over specific regions?
- Can models benefit from the success of the satellite products over their 'best' regions, e.g., by incorporating the features that make these products especially suitable and accurate?
- Can models be used to complement or supplement retrieval algorithms to reduce uncertainty of satellite aerosol retrievals over problematic regions?