Models, In situ, and Remote sensing of Aerosols (MIRA): Formation of an International Working Group

Presented by the MIRA Steering Committee

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https://science.larc.nasa.gov/mira-wg/

What is MIRA?

- A new forum that fosters international collaborations among aerosol Modeling, In situ, and Remote Sensing specialties
- A collection of interdisciplinary of independently funded projects or focus areas with clear goals
- Grassroots organization associated with the International Global Atmospheric Chemistry community

Why?

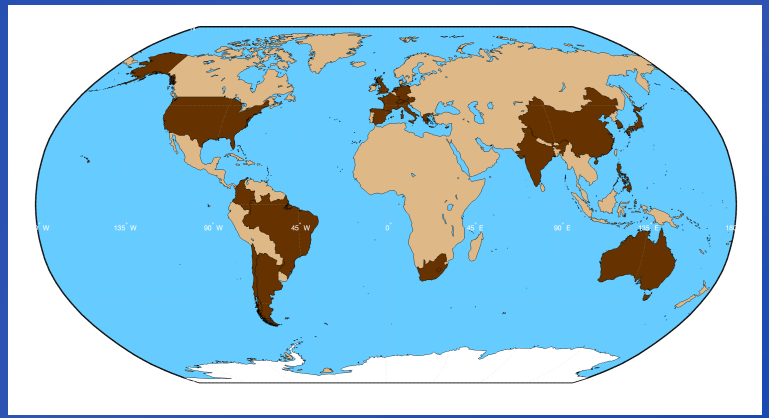
- Improve access and knowledge of observations and model results through the encouragement of holistic projects and collaborations

How does MIRA differ from other focus working groups?

- Focus on interdisciplinarity to improve the *utility* and *interpretation* of measurements and simulations
- Complements the activities of other groups (e.g., AEROCOM, AEROSAT, ARM/ASR, ICAP)
- Bridges ground-based, airborne and satellite observational networks with modeling communities

Growing International Participation

- More than 200 members in 23 countries
- Website to advertise and coordinate topics
- Quarterly newsletter
- News billboard
- Regular webinars on multidiscipline topics
- MIRA sessions and presentations at major conferences and meetings (e.g., AGU, AMS, AOGS, IGAC)



List of Participant Countries

USA
India
Japan
Columbia
Greece
Germany
Brazil
Chile
Argentina
Netherlands
Spain
Italy
Sri Lanka
Phillipines
Austria
France
China
South Africa
South Korea
Australia
Cyprus
United Kingdom
Switzerland

How does MIRA work?

https://publicdomainvectors.org/

- Define a multi-disciplinary project that requires data from at least 2 of the 3 MIRA disciplines (i.e., models, in situ, and remote sensing)
- Identify an *Ask*, which is generally additional data from one of the disciplines
- Submit the project description and the *Ask* to the MIRA Steering Committee
- The MIRA Steering Committee advertises the project/focus area and the *Ask* through the MIRA webpage and email distribution
- Lead investigator is responsible for organizing and coordination of the research effort
- Publications should respect contributions

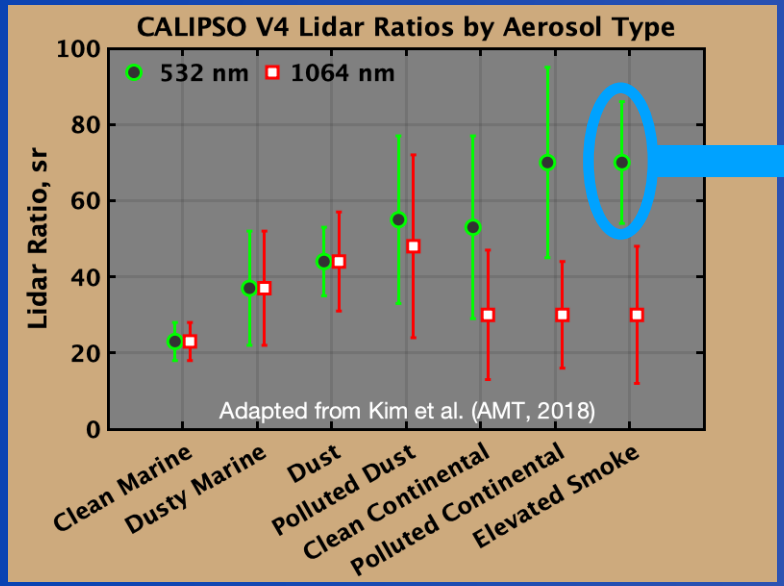
Ask

Atmospheric Aerosol/Cloud Spacebased Lidar Missions

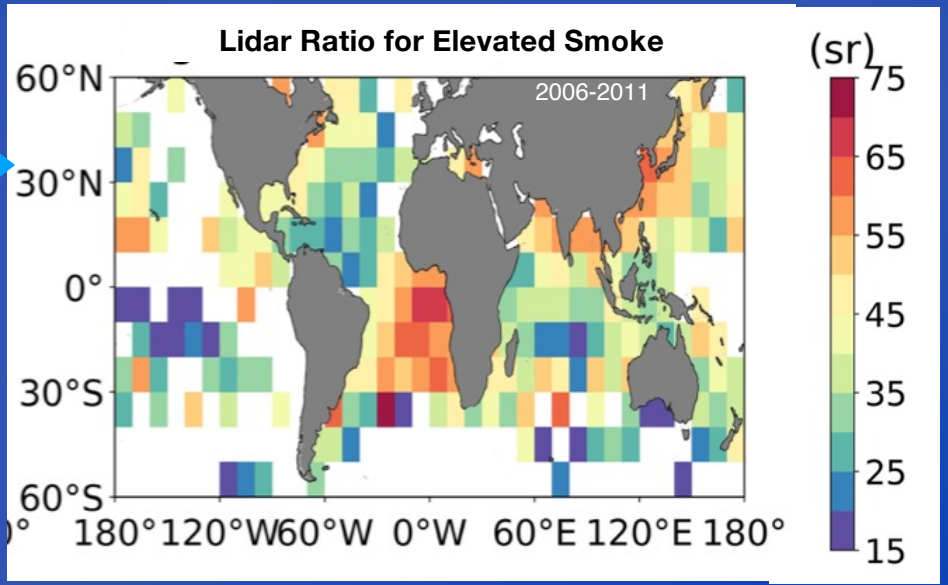
- NASA/CNES CALIPSO mission officially ends its science mission on 01 August 2023 after 17 years of operations
- Chinese Aerosol Cloud High Spectral Resolution Lidar launched (ACHSRL) April 2022
- ESA EarthCare mission scheduled for launch in 2024
- NASA Atmospheric Observatory Sciences mission lidar for launch ~2030

Mapping Aerosol Lidar Ratios for CALIPSO (MAC)

There is a large range of lidar ratio variability for all of the CALIPSO subtypes.



MAC is building climatological maps of the lidar ratio to capture the regional and seasonal variability of the 7 CALIPSO aerosol types.



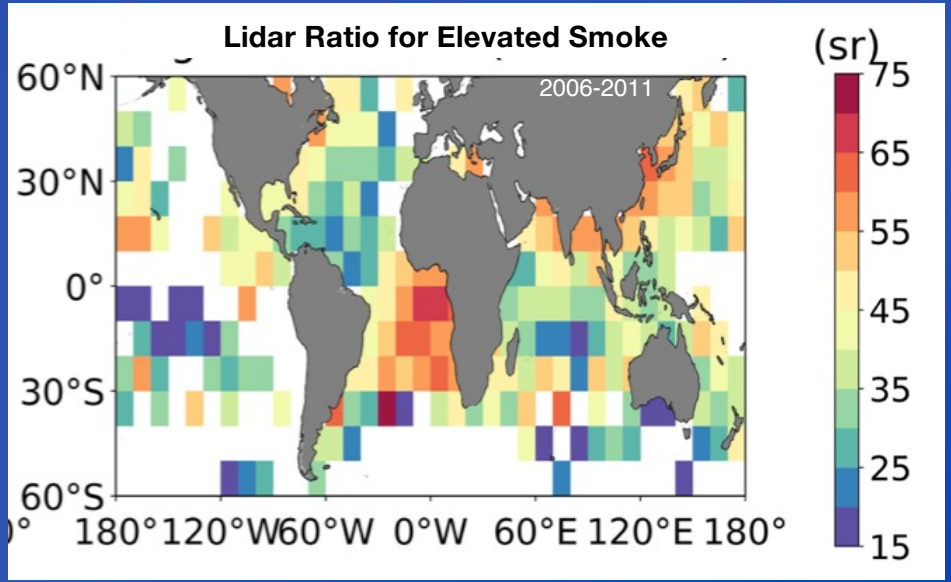
Example: Lidar ratio map for nighttime elevated smoke, based upon CALIPSO backscatter profiles constrained by SODA-CPR optical depths. From Z. Li, AMT 2022.

Mapping Aerosol Lidar Ratios for CALIPSO (MAC)

Asks

- Climatological lidar ratios from longtime surface lidars for verification.
- Aerosol load from global aerosol models sorted by aerosol type (optical).
- Dust aerosol loads from global models, separated by source region.

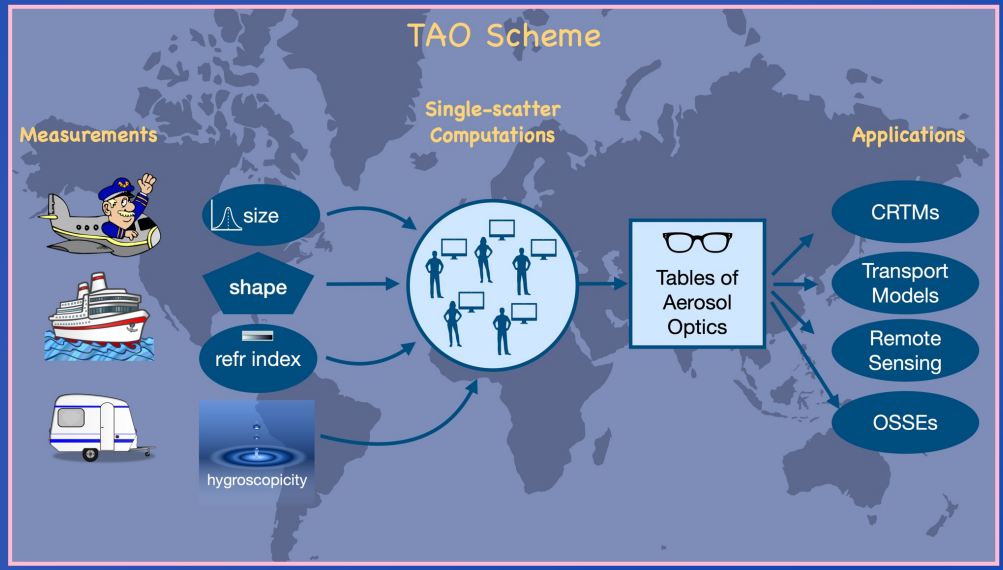
MAC is building climatological maps of the lidar ratio to capture the regional and seasonal variability of the 7 CALIPSO aerosol types.



Example: Lidar ratio map for nighttime elevated smoke, based upon CALIPSO backscatter profiles constrained by SODA-CPR optical depths. From Z. Li, AMT 2022.

Tables of Aerosol Optics (TAO)

- The TAO is a dynamic community repository of optics computations that are useful for models and remote sensing (mass extinction coeffs, mass absorption coeffs, SSA, Lidar Ratio, etc).
- TAO updates historical efforts (Shettle and Fenn, d'Almeida, GADS, OPAC, etc) with recent measurements and new computational techniques for non-spherical particles.
- TAO will accept computations for aerosol 'type' as well as computations for traditional aerosol species (amm sulfate, sea salt, etc.)
- Presently, TAO is highly fluid and located on a NASA google drive and will move to GitHub within about a year.

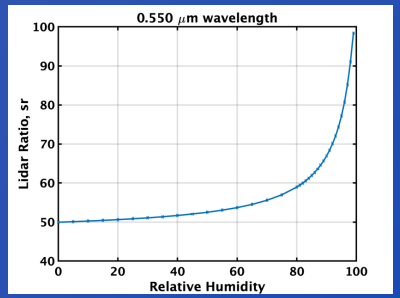


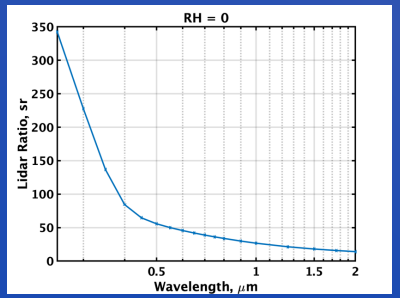
Tables of Aerosol Optics (TAO)

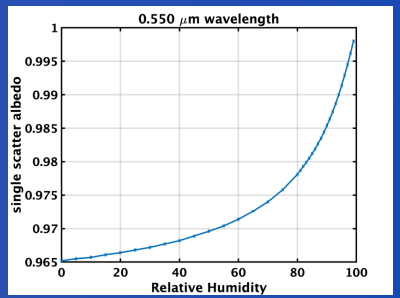
What TAO has now, and how you can get it

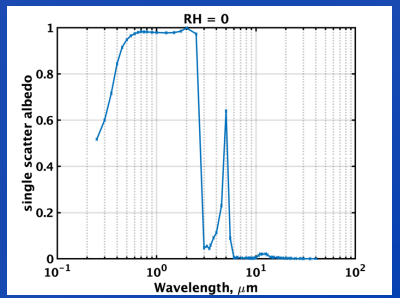
- Computations at 61 OPAC wavelengths from 0.25 to 40 μm and 12 common remote sensing wavelengths.
- We will eventually make recommendations about how to proportion species for the different aerosol types (e.g., Black Carbon / Brown Carbon ratios for biomass burning).
- TAO is located on a NASA google drive while we get started. Contact mira_crew@lists.nasa.gov for access.

TAO Aerosol Species	Aerosol Type				
	Bio Burn	Urban	Dust	Marine	Bckgrnd
Externally-mixed Black Carbon	√	√			√
Internally-mixed Black Carbon	√	√			√
Water-insoluble Brown Carbon	√				√
Water-insoluble White Carbon	√	√		×	√
Water-soluble Brown Carbon	√				√
Water-soluble White Carbon	√	√		×	√
Sulfates		×		×	×
Nitrates		×			×
Sodium Chloride				×	×
Internal mix of clays + FeO_x			√		









Asks

What we seek from the community

- Existing tables that people are using
- Measurements (firsthand or from the literature)
- Additional single-scatter computations (spheres, irregular dust, fractal BC, internal mixtures, etc.).
- Customers and "Special orders."

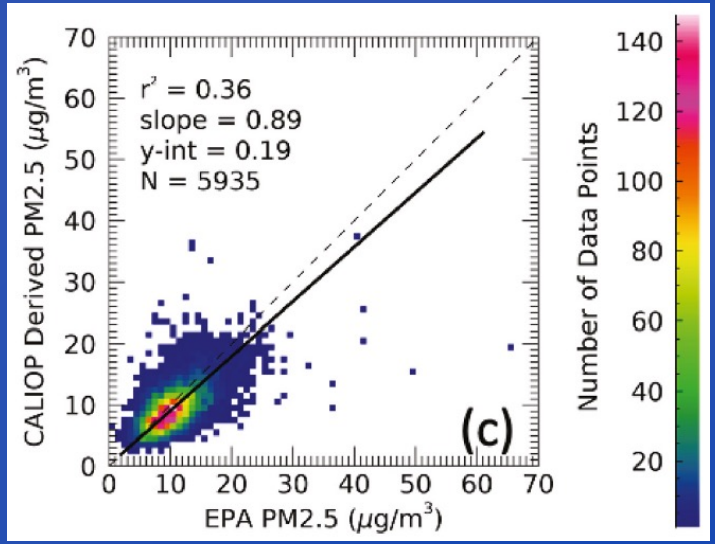
Send email to aerosol-optics-join@lists.nasa.gov with the word 'subscribe' in the subject line to join TAO and receive email updates.

Satellite-Assisted Particulate Matter (SAPM)

- $PM_{2.5}$ provides an important indicator of air quality and its impact on human health
- Remote sensing retrievals seek to augment the ground-based sensor network that can greatly extend coverage over data sparse regions
- Lidar $PM_{2.5}$ observations are relatively new and require validation and complementary information to assess their quality and utility

Asks

- In situ mass scattering/absorption coefficient and aerosol hygroscopic property datasets for various aerosol species and locations worldwide
- Air quality forecasts to compare with $PM_{2.5}$ observation network



Toth et al (Atmos Env, 2022)

https://doi.org/10.1016/j.atmosenv.2022.118979

Harmonization of aerosol Assimilation Models and Retrievals (HAMR)

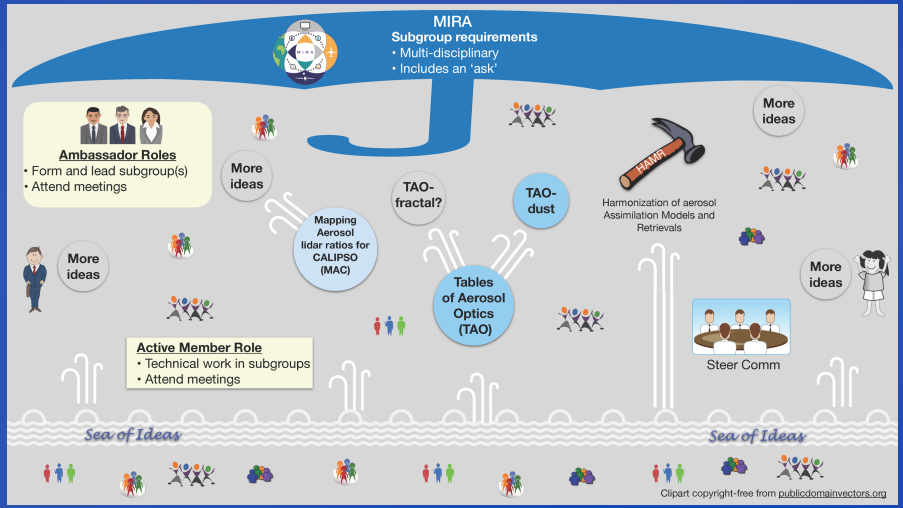
- Climate Models (CM) simulate physical and chemical processes in the atmosphere in an effort to accurately quantify aerosol mass, but such models generally use rather simple radiative transfer modules.
- Remote Sensing (RS) models utilize accurate radiative transfer codes to infer aerosol optical and microphysical properties, but detailed aerosol speciation is beyond the reach of present-day remote sensing.
- HAMR will provide the following benefits:
  - Applying remote sensing techniques to the optics modules in climate models will improve the accuracy of the CM optics modules.
  - An improved CM/RS interface will improve the efficiency of aerosol assimilation models.
  - Improved efficiency of Remote Sensing approaches that use Climate Model data as *a priori* constraints.

Asks - Community Involvement to organize HAMR:

- Develop strategy to compare aerosols species with RS aerosol type
- Configure RS observations for assimilation by climate models
- Design climate model output pf aerosol species as constraint for RS retrievals

Overarching Questions for MIRA Working Group

- How to determine sampling compatibility between measurement sensors and modeling grids?
- How to employ Earth System models to interpret measurement records?
- What measurements are most influential to Earth System models?
- Is there consistency between measurement records and are they compatible with modeling capabilities?



Organization of MIRA is being accomplished under IGAC with plans to hold a working group meeting at the next IGAC Conference in 2024. Discussions will include plans to petition IGAC for consideration as an officially sponsored activity.

Summary

- MIRA is a new international working group with ~200 members in 23 countries and growing!
- MIRA is a collection of focus areas of interest; presently we have four:
  - MAC: Mapping Aerosol lidar ratios for CALIPSO
  - TAO: Tables of Aerosol Optics
  - HAMR: Harmonization of aerosol Assimilation Models and Retrievals
  - PMLS: Particulate Matter from Lidars in Space
- We are seeking more participation and leadership
- The benefit of adding your topic to MIRA is that MIRA provides a forum for reaching out to like-minded collaborators

MIRA Website

https://science.larc.nasa.gov/mira-wg

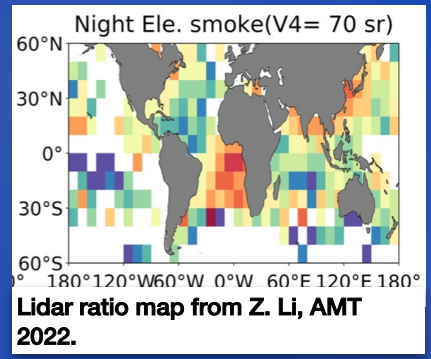
Subscribe to the MIRA email list

https://espo.nasa.gov/lists/listinfo/mira

Summary of Current MIRA Projects

MAC: Mapping Aerosol lidar ratios for CALIPSO (Greg Schuster)

The MAC sub-group uses lidar ratio retrievals and measurements with aerosol types provided by global aerosol models to build global lidar ratio maps that can vary by season; these maps will be pertinent to the CALIPSO Version 5 extinction profile products.



Lidar ratio map from Z. Li, AMT 2022.

HAMR: Harmonization of aerosol Assimilation Models and Retrievals (Oleg Dubovik)

The HAMR sub-group strives to improve consistency in aerosol assumptions and optimize the output of retrievals for the needs of aerosol assimilation.

SAPM: Satellite-Assisted Particulate Matter (Travis Toth)

We seek international mass scattering/absorption coefficient and aerosol hygroscopic property datasets for various aerosol species in order to develop more robust $PM_{2.5}$ retrievals from lidar measurements.

TAO: Tables of Aerosol Optics (Greg Schuster)

The purpose of TAO is to provide a community database of optical tables for various aerosol species and types.