

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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*Presenting for MIRA Steering Committee

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

From the MIRA Charter...

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 with clear goals
- Projects are often characterized by requests for additional observational and/or modeled data

Why?

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

How does MIRA differ from other projects?

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

How does MIRA work?



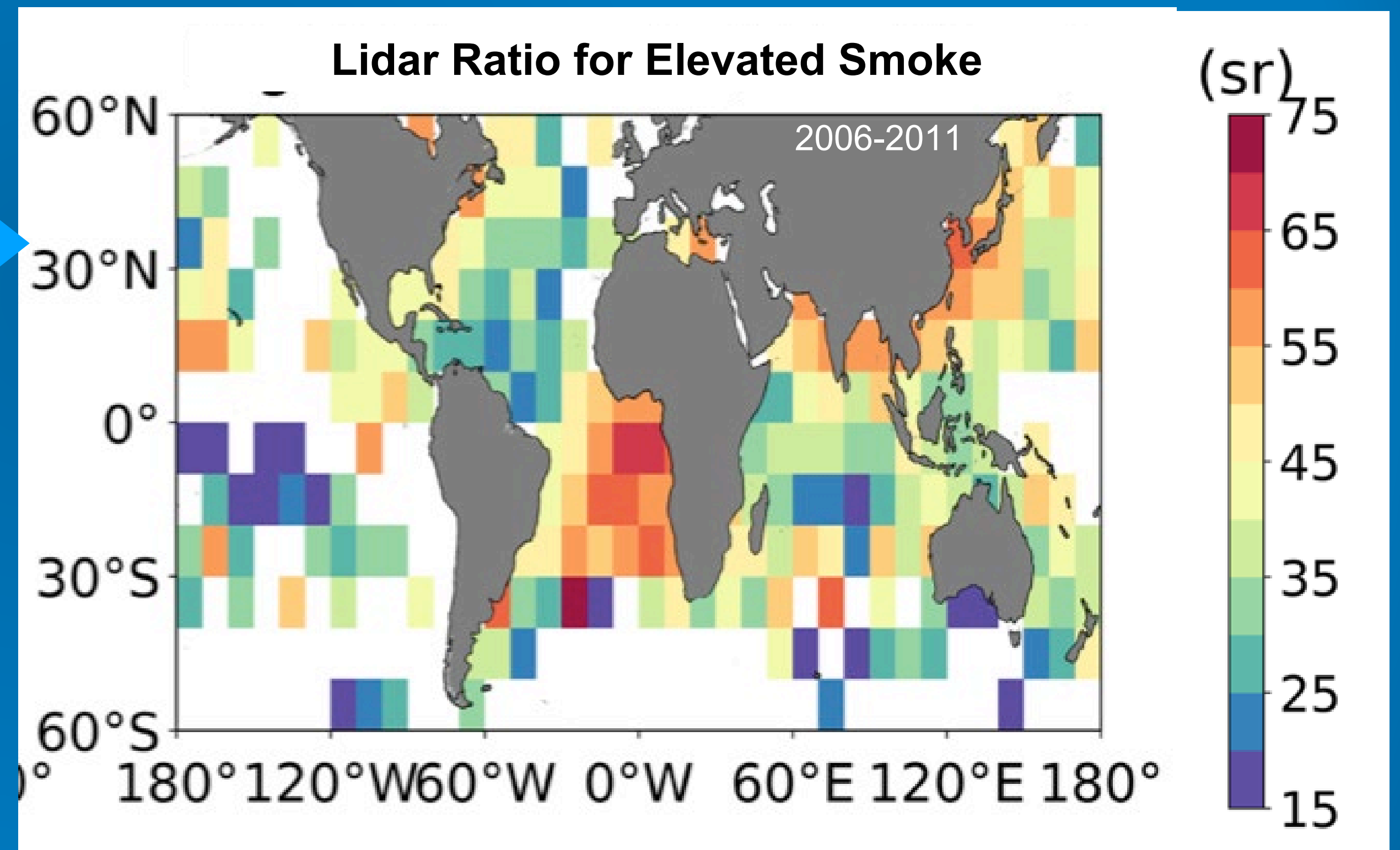
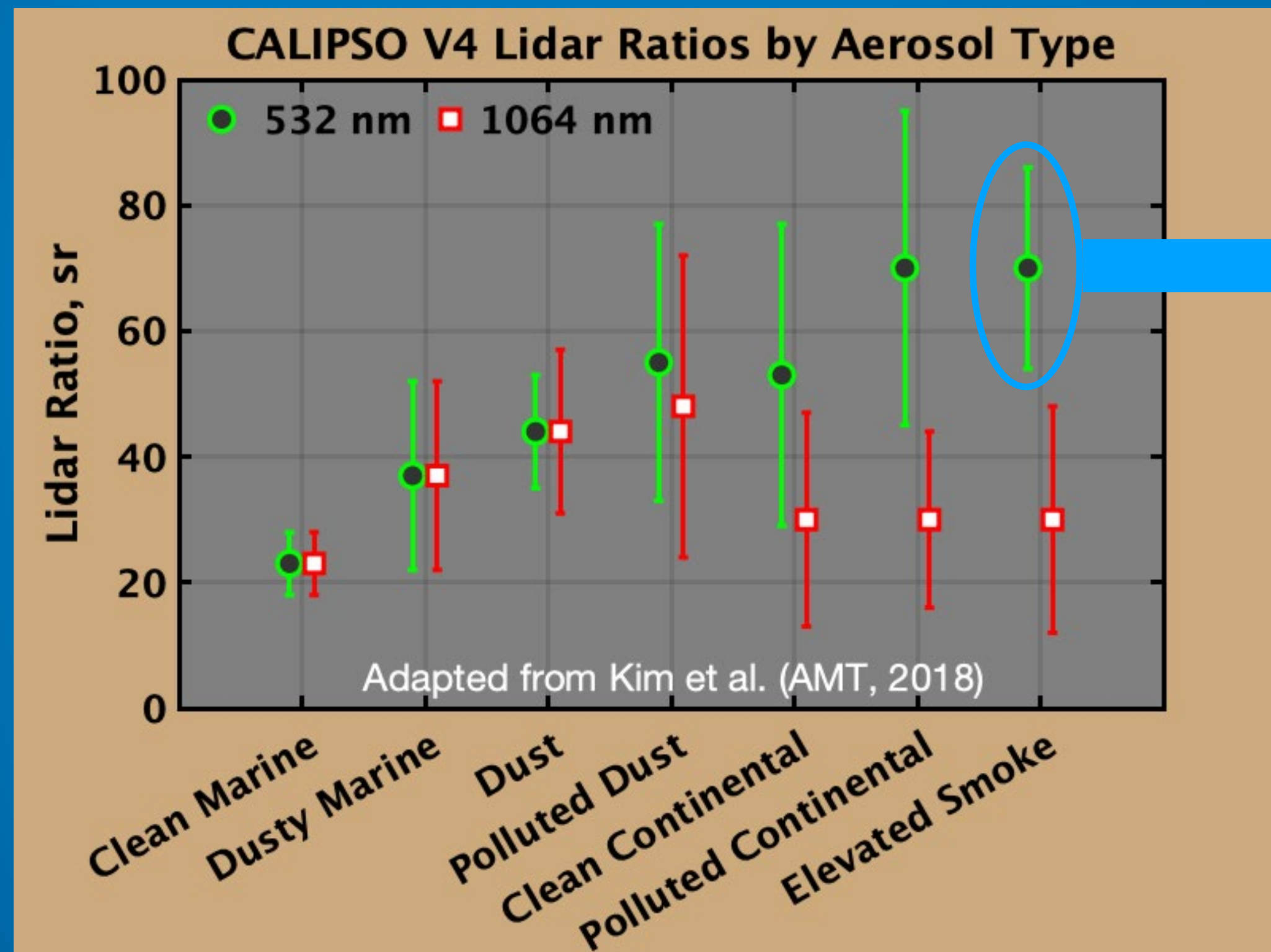
- Define a multi-disciplinary project that requires data from at least 2 of the 3 MIRA disciplines (i.e., models, in situ, and remote sensing).
- Identify an *Ask*, which is generally additional data from one of the disciplines.
- Submit the project description and the *Ask* to the MIRA Steering Committee.
- The MIRA Steering Committee advertises the project 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.



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.



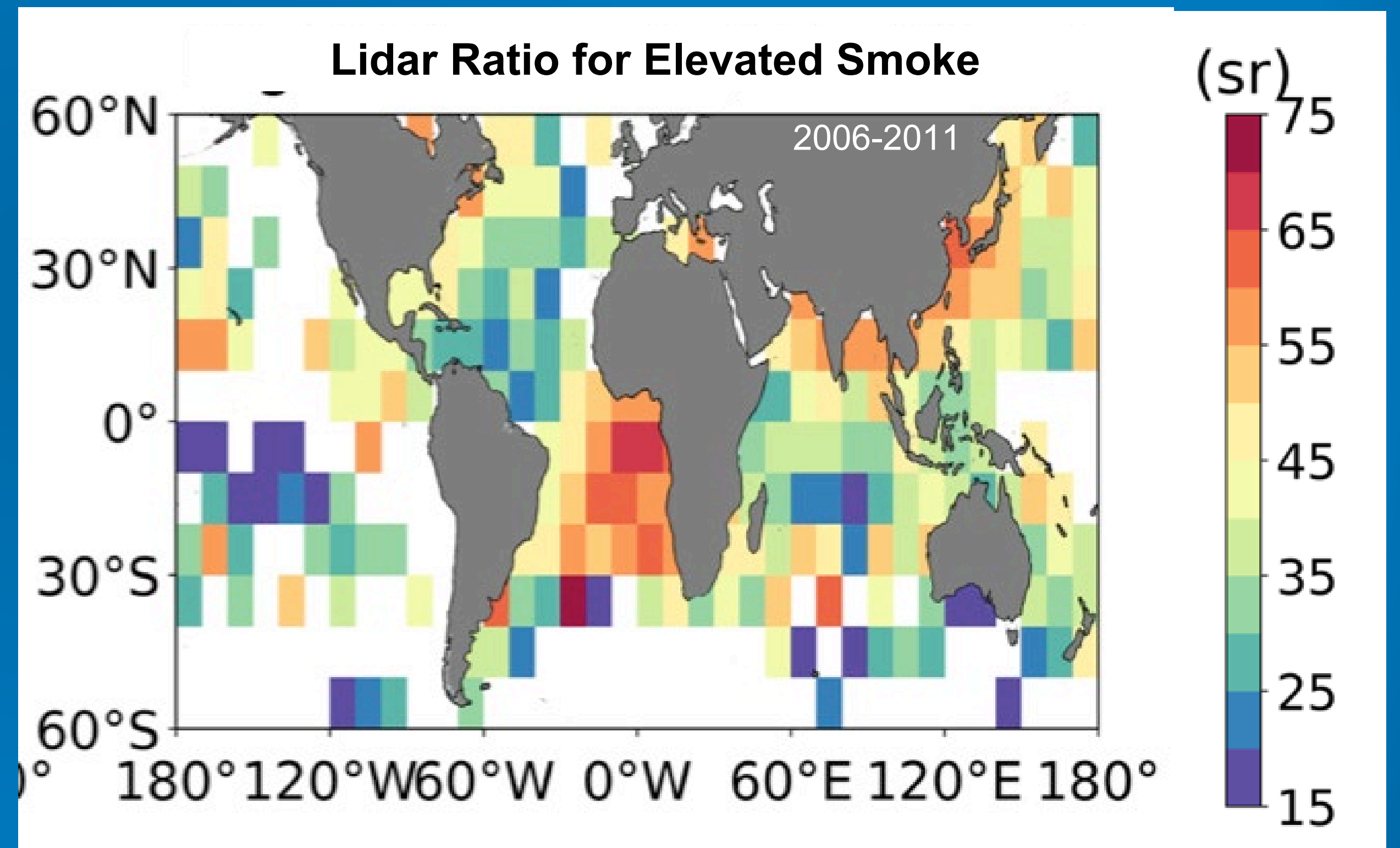
Example: Lidar ratio map for nighttime elevated smoke, based upon CALIPSO backscatter profiles constrained by SODA-CPR optical depths. From Z. Li, AMT 2022.

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Asks

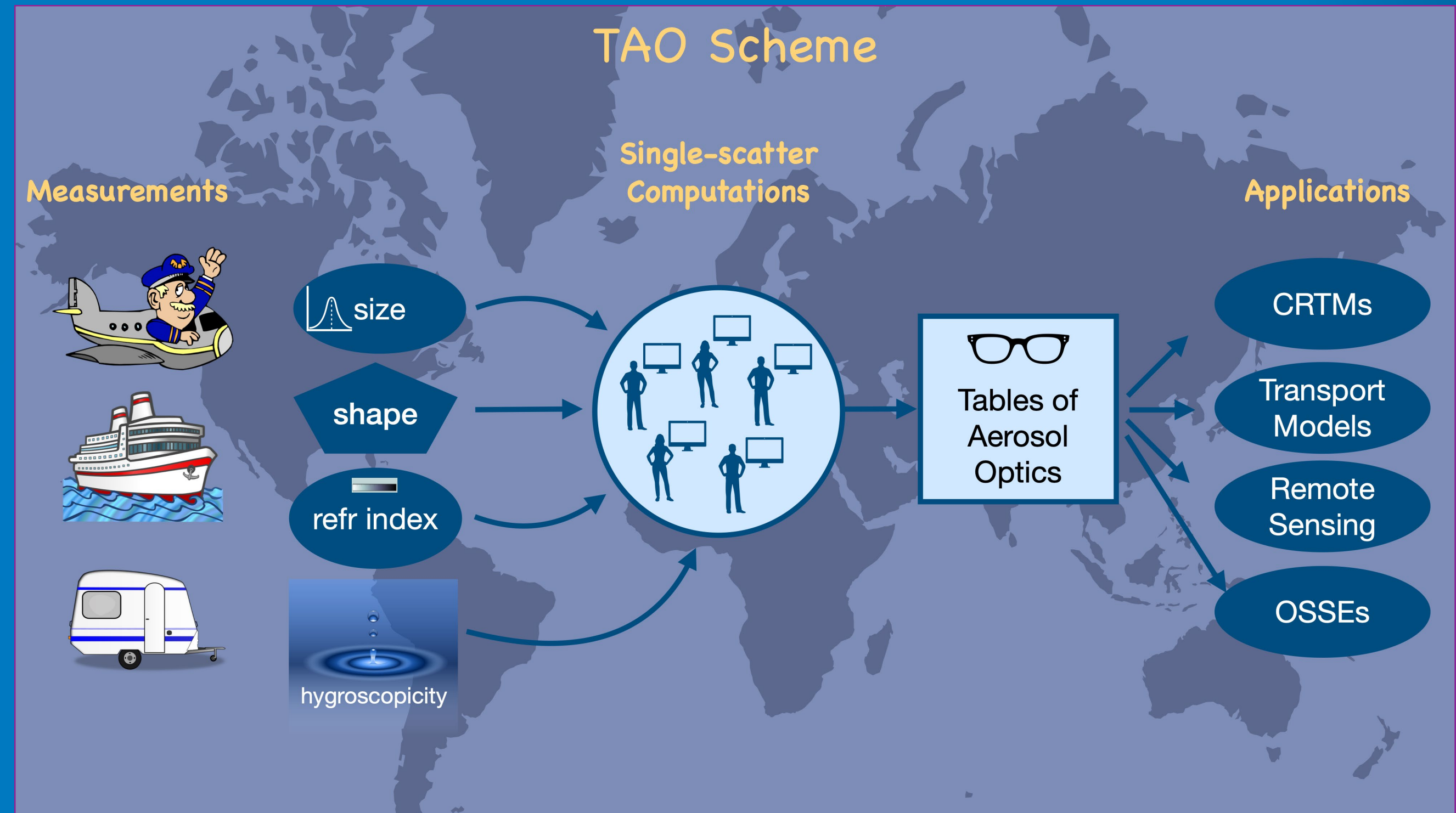
- Climatological lidar ratios from longtime surface lidars for verification.
- Aerosol load from global aerosol models sorted by aerosol type (optical).
- Dust aerosol loads from global models, separated by source region.



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.



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

Tables of Aerosol Optics (TAO)

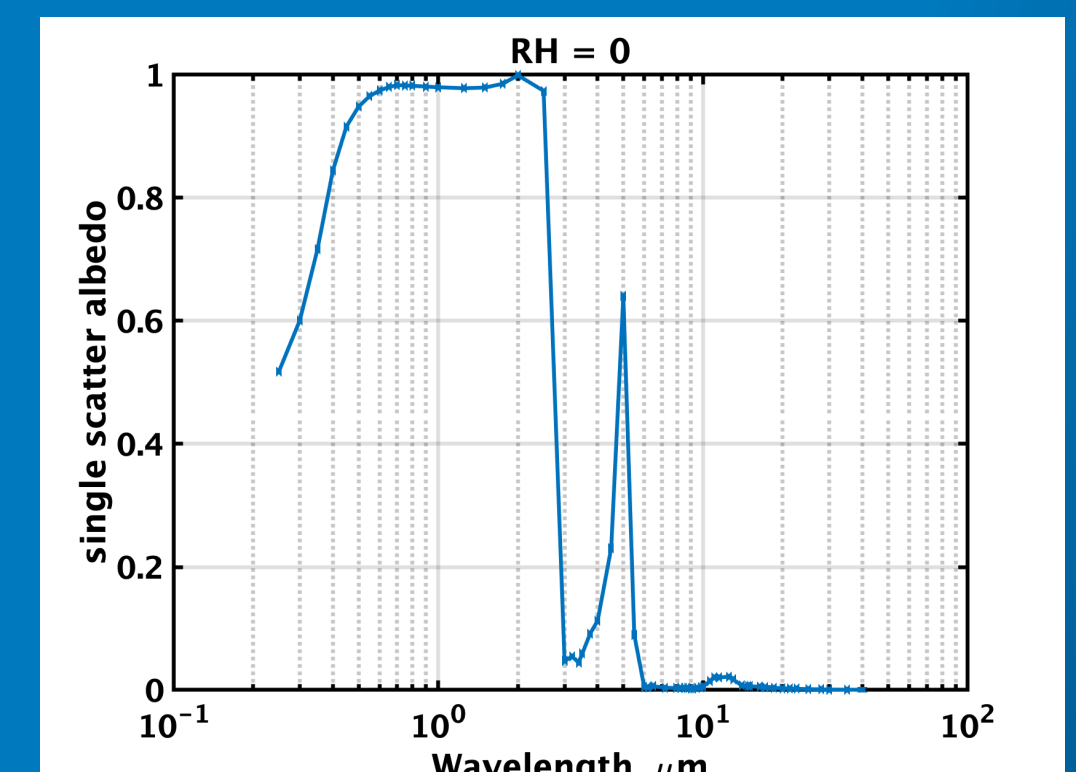
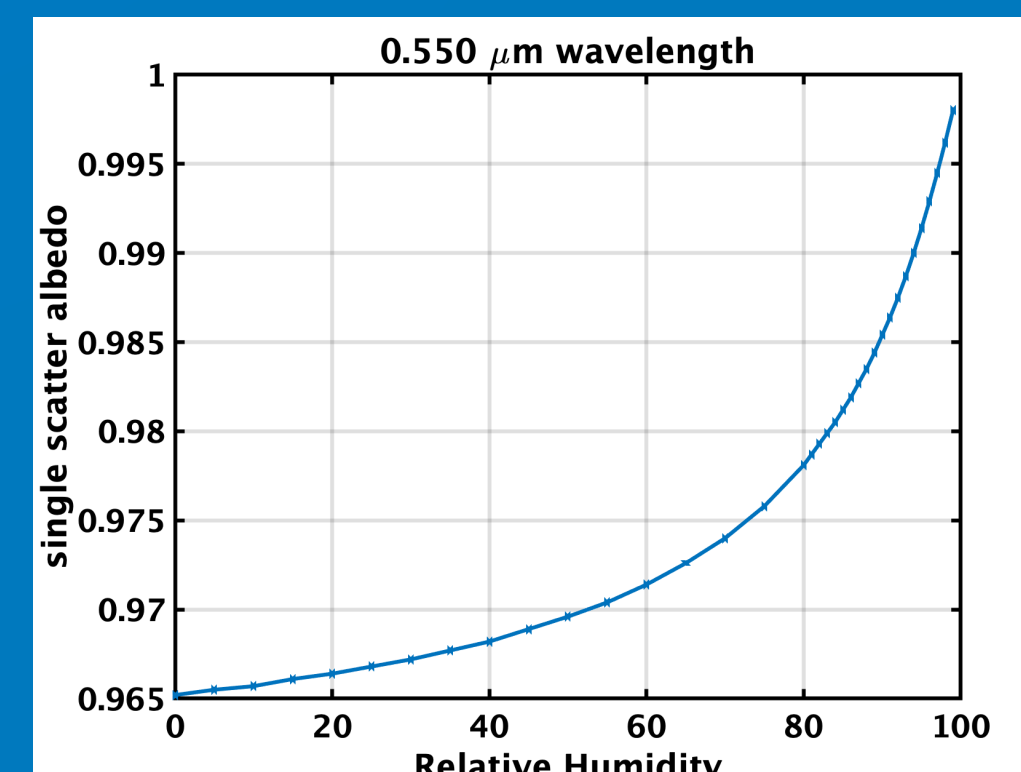
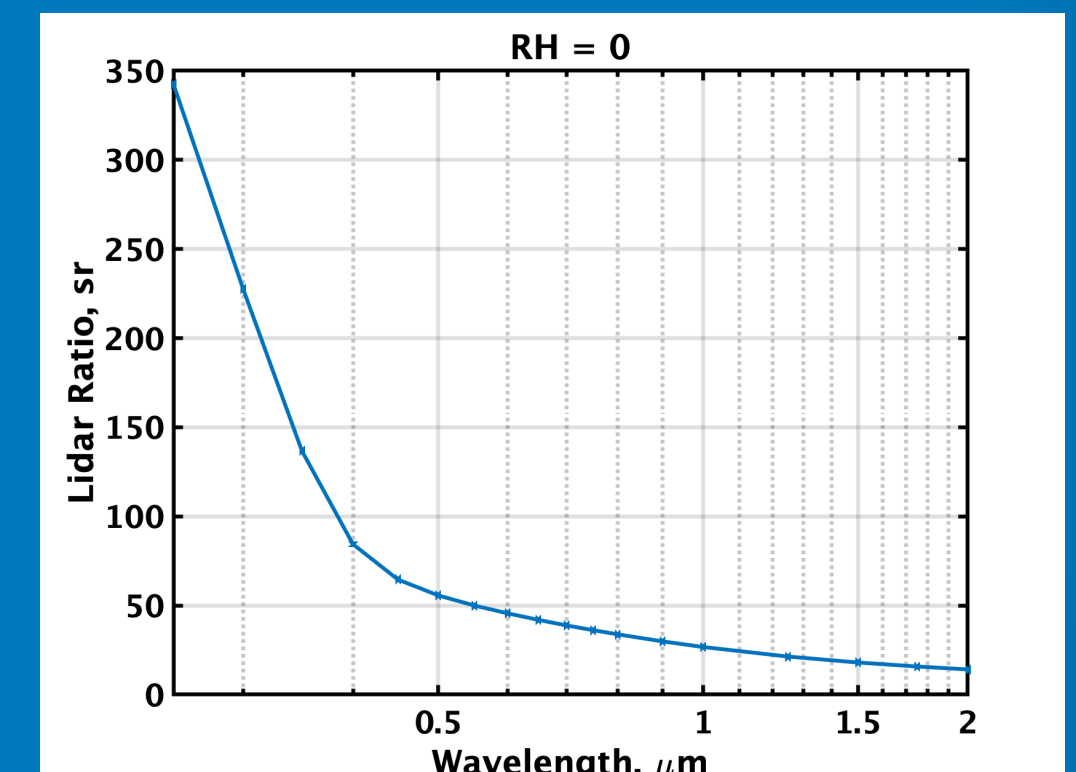
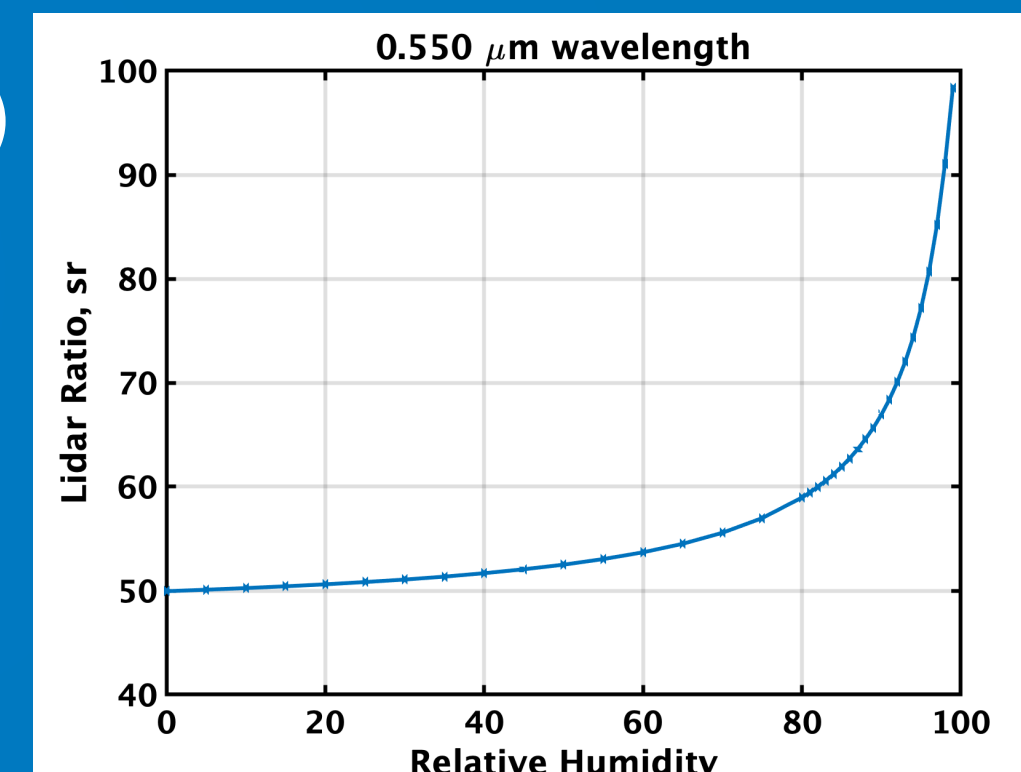
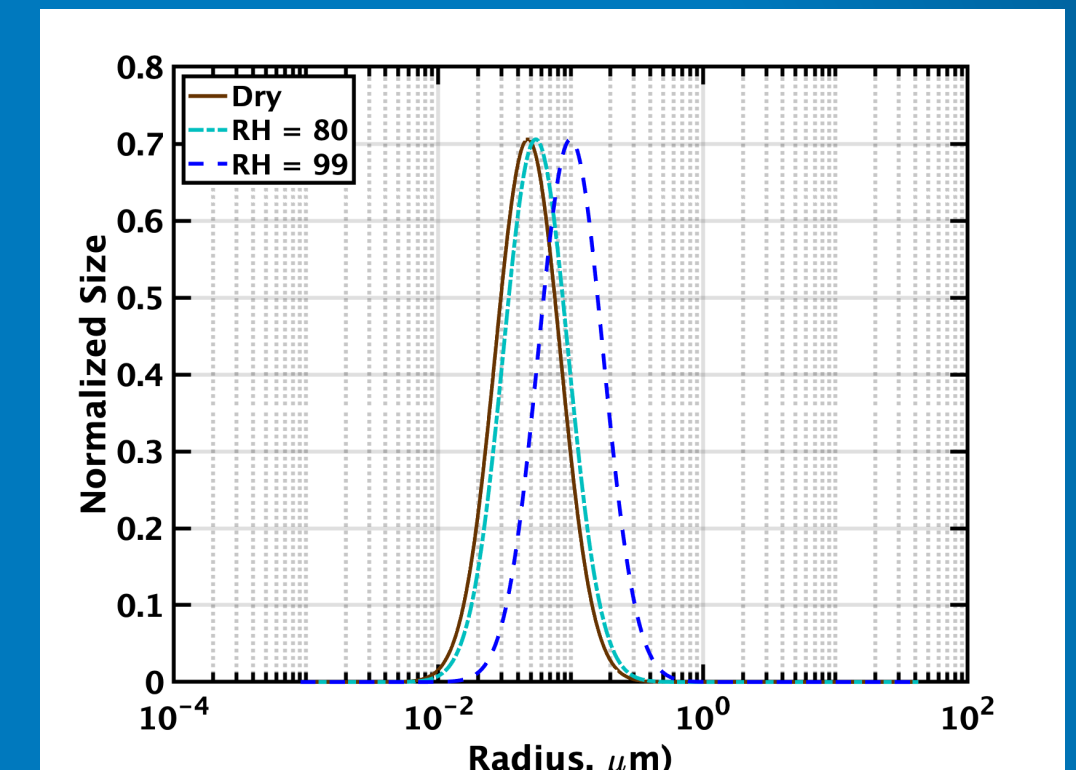
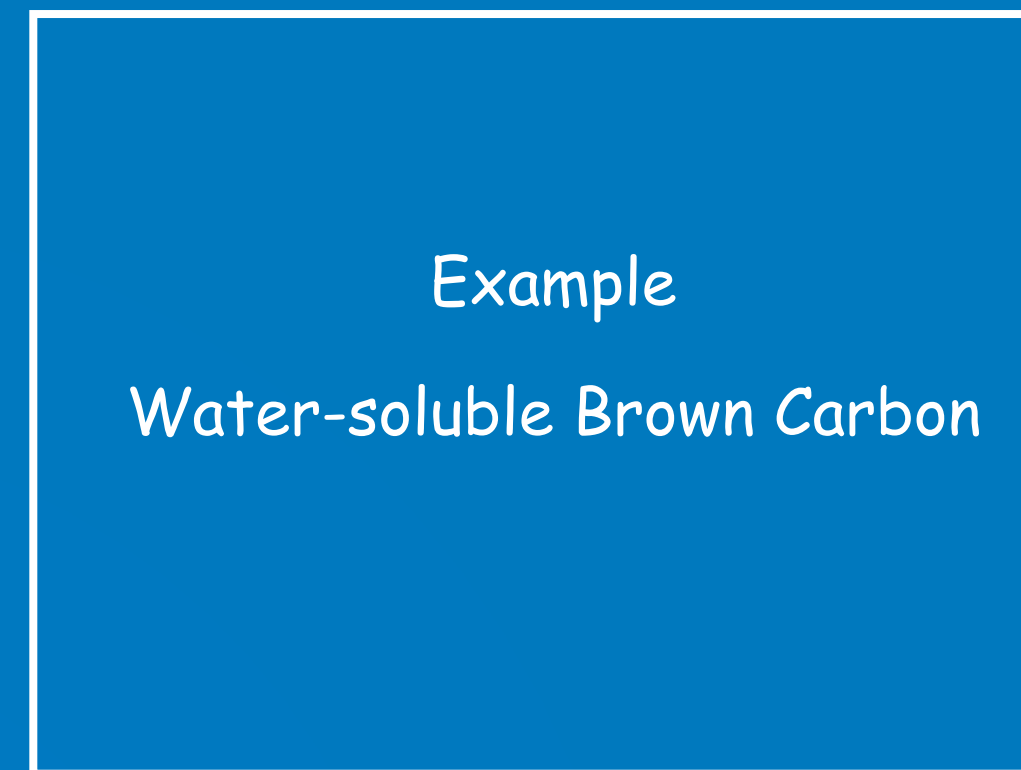
Example: processed 52 aerosol size distributions lognormals so far:

- We have created aerosol optical tables that include mass extinction, absorption, and backscatter coefficients, single-scatter albedos, etc.,
 - ✓ Water-insoluble Brown Carbon
 - ✓ Water-soluble Brown Carbon
 - ✓ Water-insoluble “White” Carbon
 - ✓ Water-soluble “White” Carbon
- Externally-mixed Black Carbon
- Internally-mixed Black Carbon
- Multi-mineral dust mixtures (non-spheres) Saito (JAS, 2021), Chin (Ann Geophys, 2009)
- Sulfates
- Nitrates
- Sea salt



36 SDs, CRIs, & kappas
Amazon (Rissler, ACP, 2006)

Brock (ACP, 2021)



(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.”

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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:

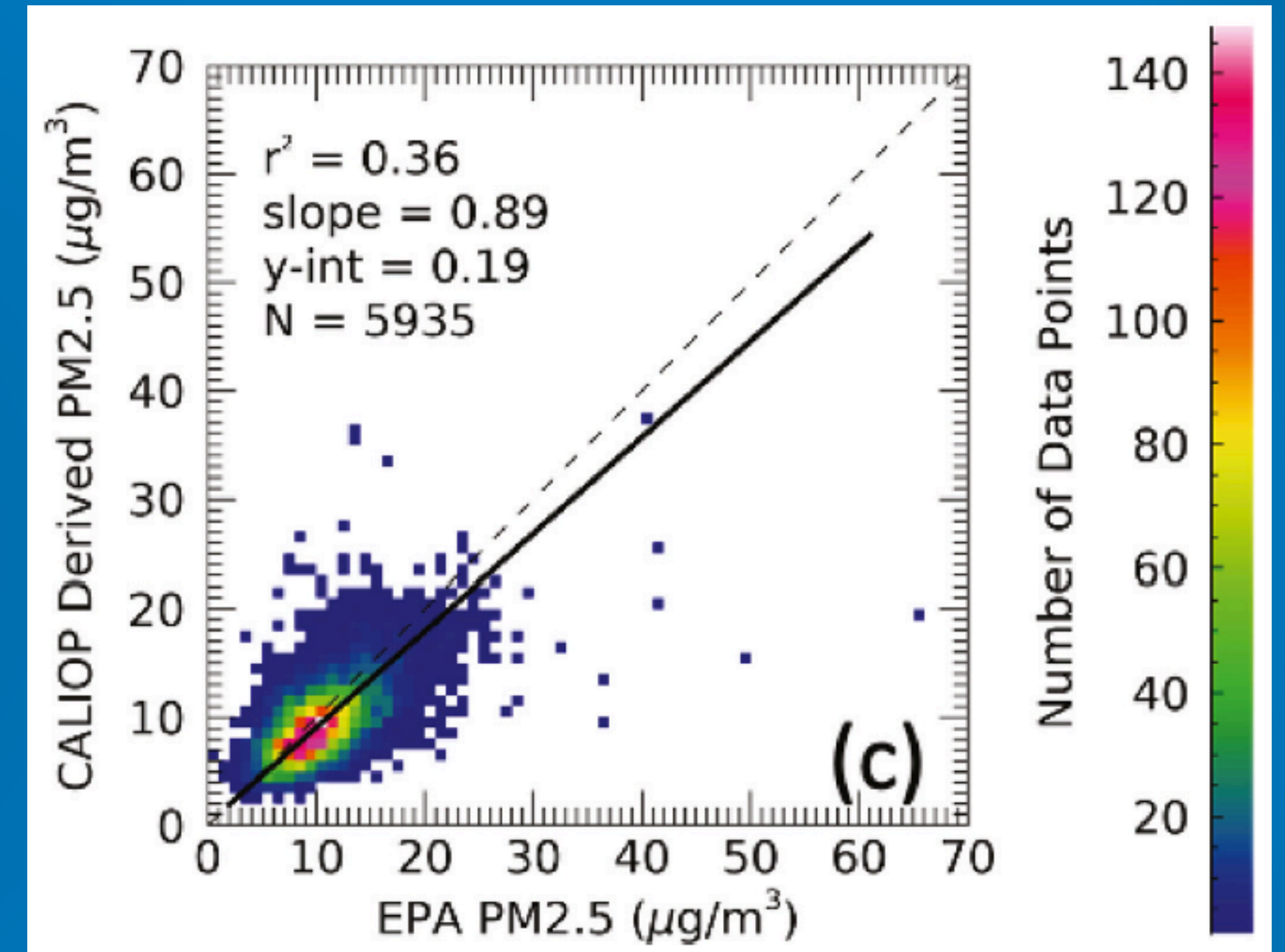
- Develop strategy to compare aerosols species with RS aerosol type
- Configure RS observations for assimilation by climate models
- Design climate model output of aerosol species as constraint for RS retrievals

Particulate Matter from Lidars in Space (PMLS)

- 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
- The RS 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

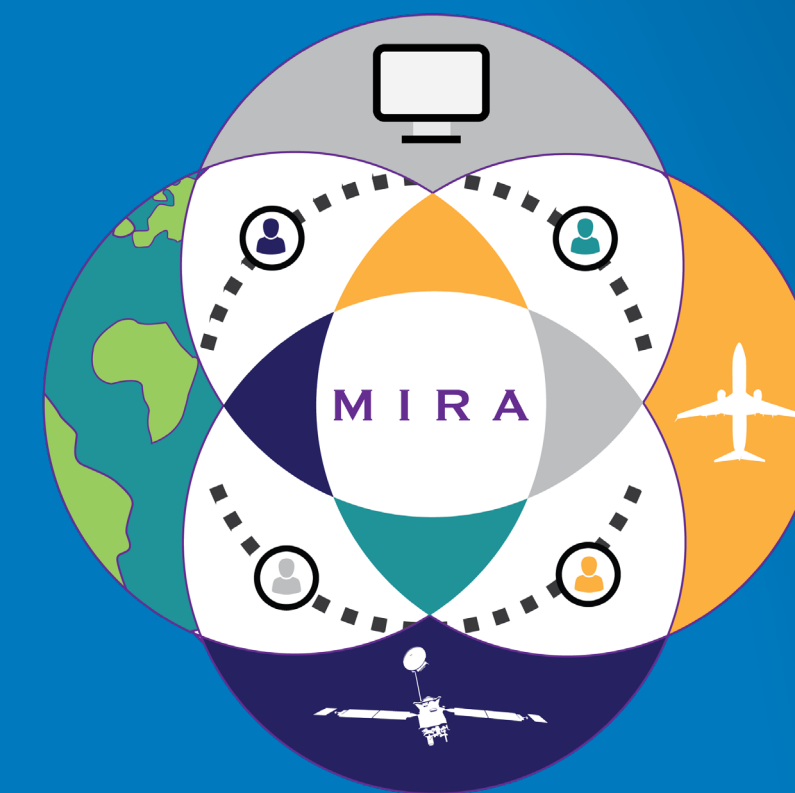


Toth et al (Atmos Env, 2022)

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

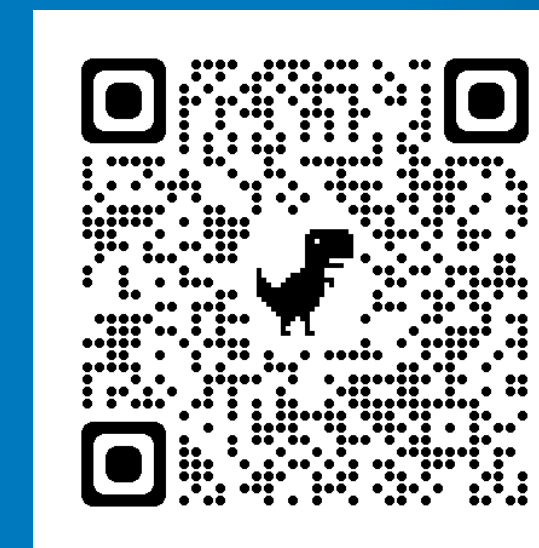
Summary

- MIRA is a new international working group with ~200 members
- MIRA is a collection of projects; 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 seek more projects. If you have a multi-disciplinary project and you seek additional data, consider contacting the MIRA steering committee at <https://science.larc.nasa.gov/mira-wg/contacts/>
- The benefit of adding your project to MIRA is that MIRA provides a forum for reaching out to like-minded collaborators



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

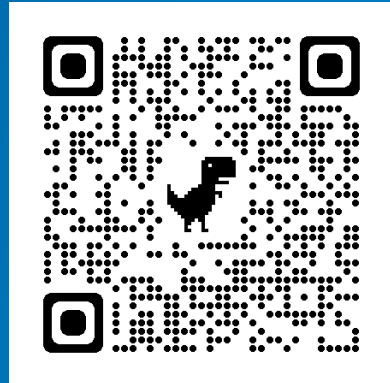
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Summary of Current MIRA Projects



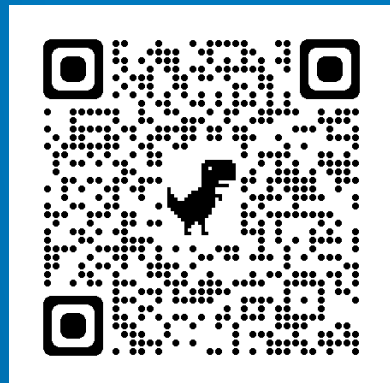
• MAC: Mapping Aerosol lidar ratios for CALIPSO (Greg Schuster)

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.



• 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.



• PMLS: Particulate Matter from Lidars in Space (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.

