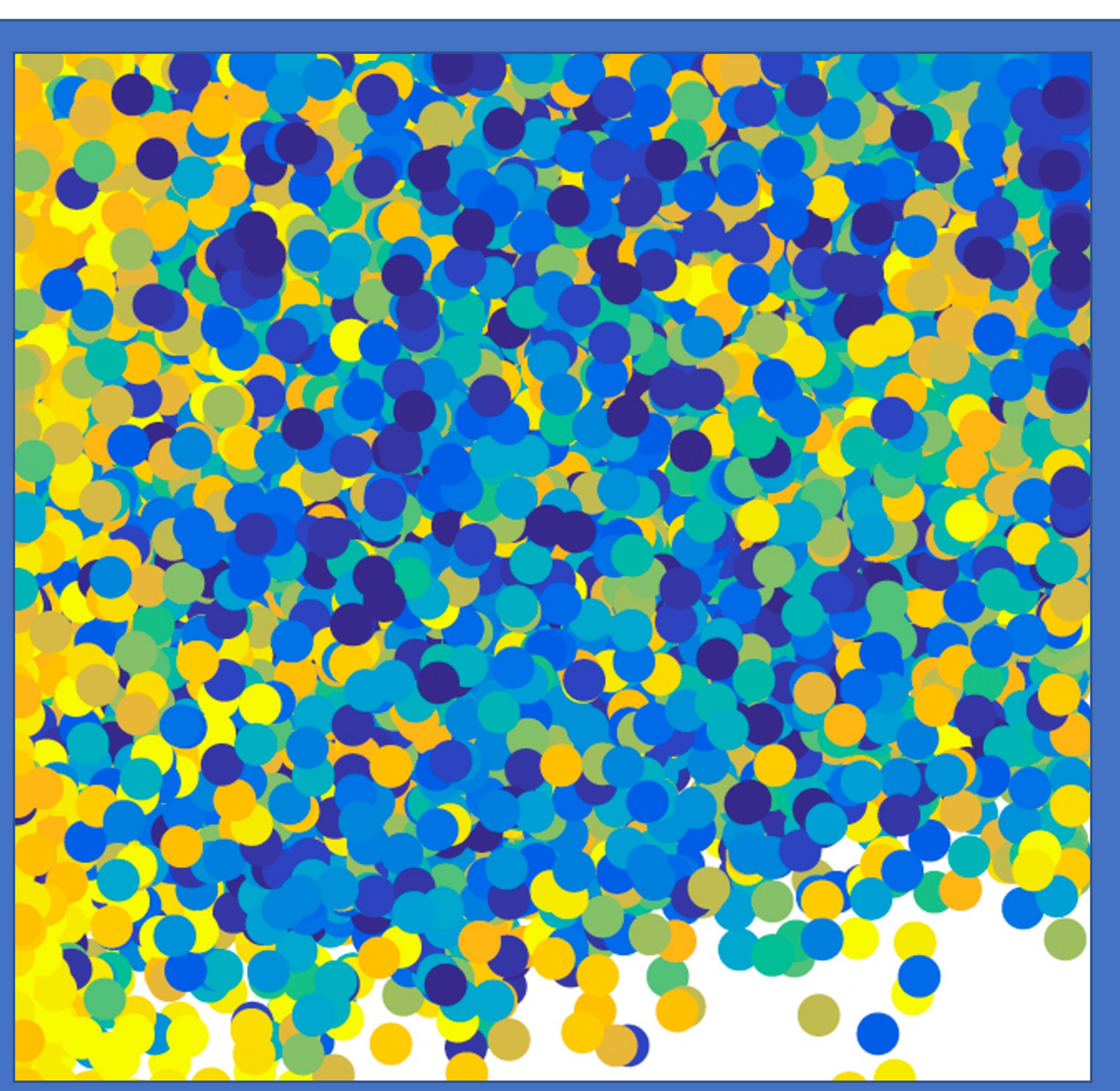

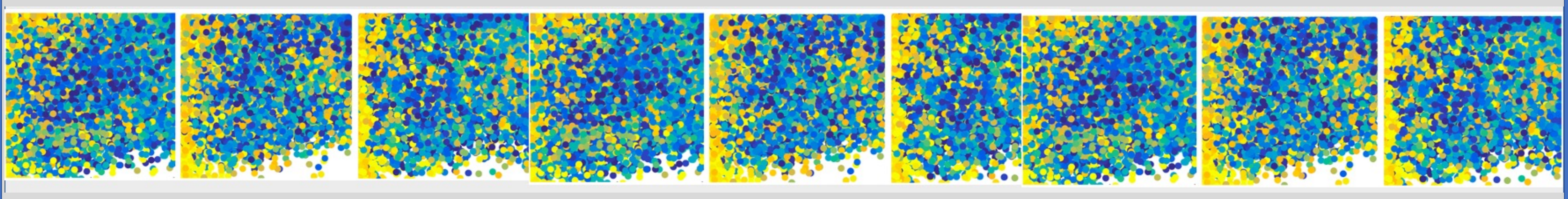

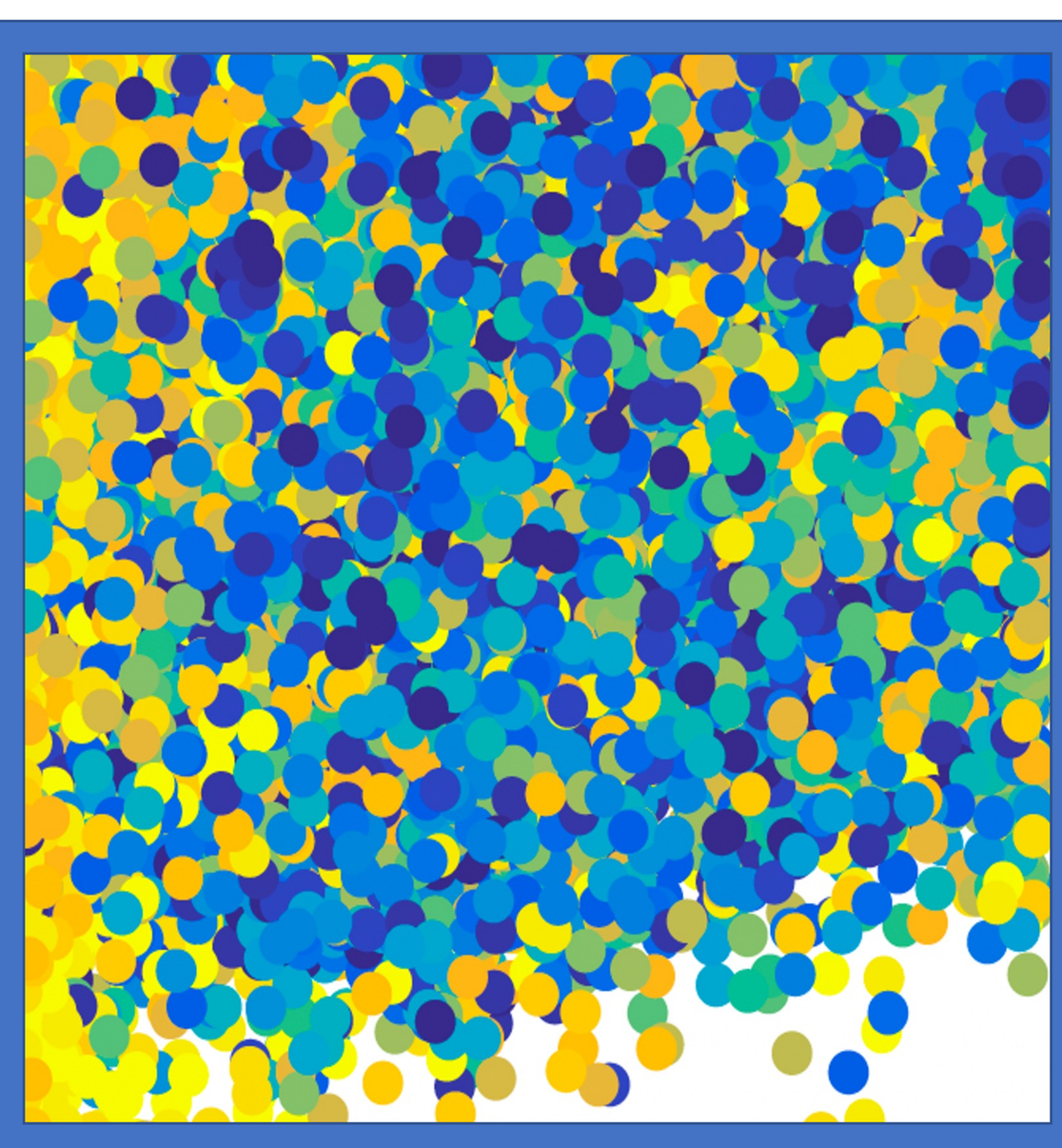

Simulations and Experiments using Satellite-retrieved Carbon Monoxide (CO) as a Speciated Proxy of Smoke Aerosol Layered Aerosol Optical Depth (AOD) for Radiative Transfer (RT) Model Studies

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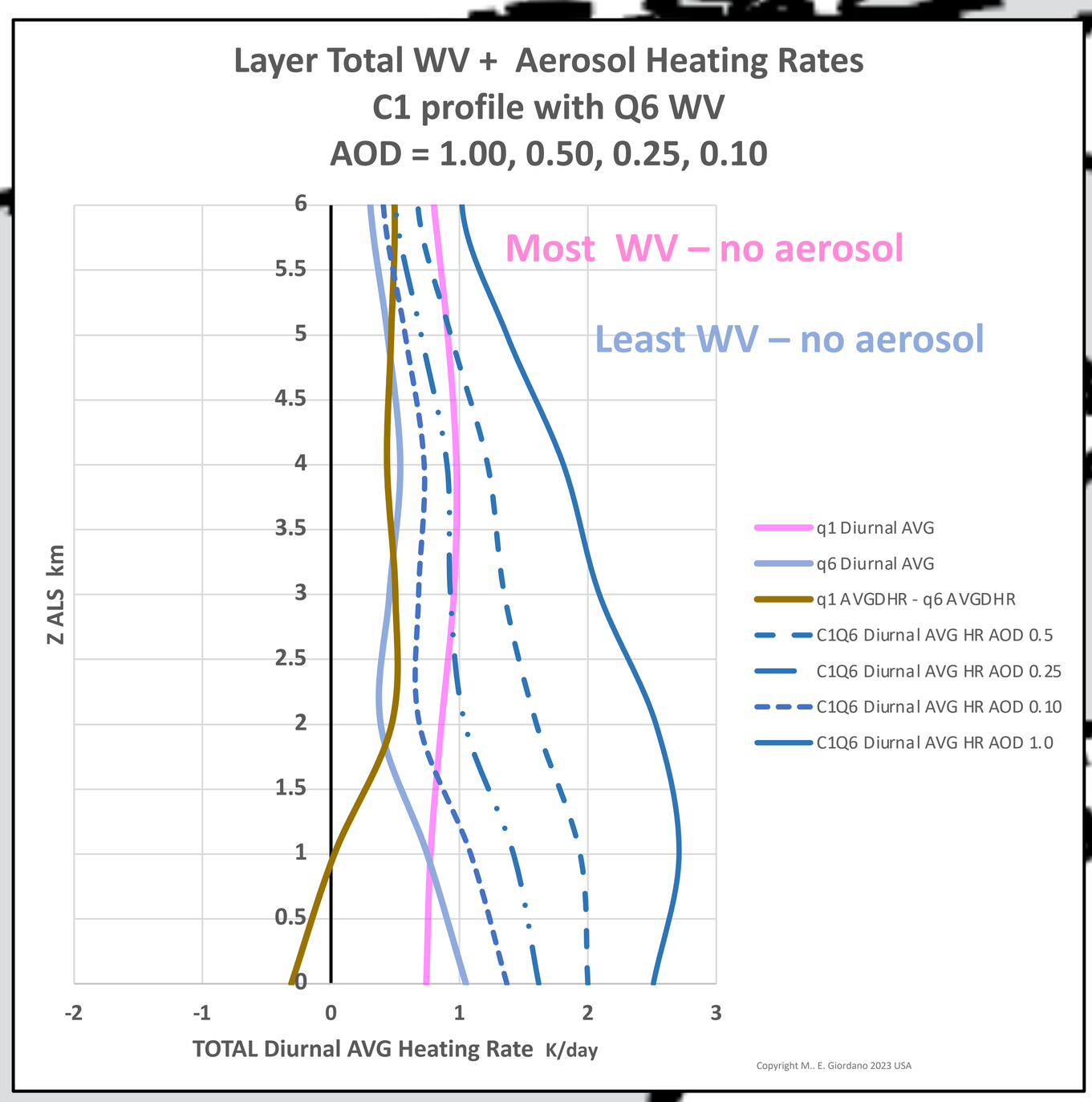
Introduction: We are attempting to elucidate the interplay of enhanced water vapor WV and elevated Aerosol Optical Depth (AOD) from Seasonal Biomass Burning events upon vertical profiles of atmospheric heating rates (HRs). AREA of Interest: Southeast Atlantic (SEA) – ORACLES region 2016-2018. ◸

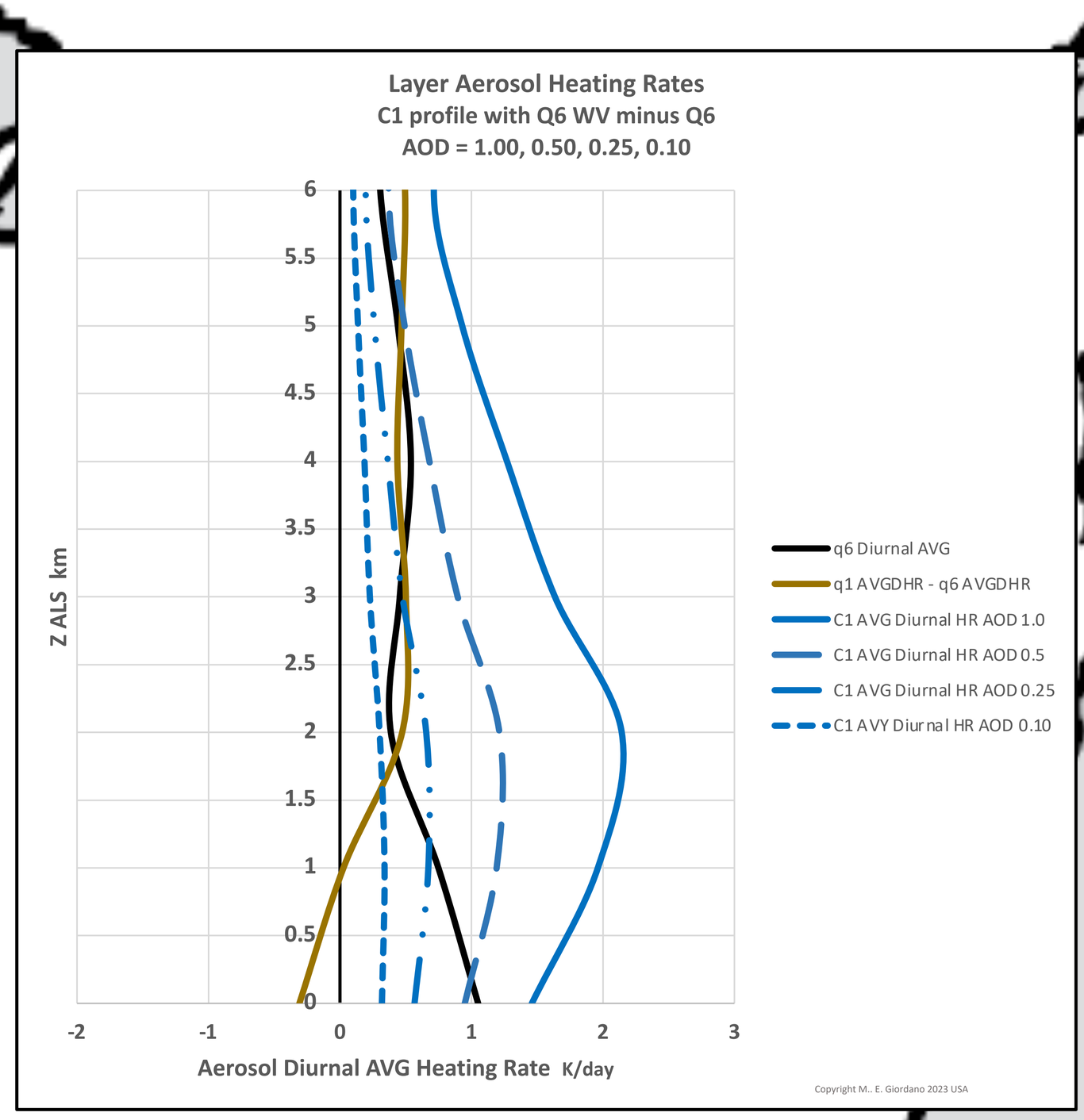
Methodology:
- We construct seasonal [2014-2019 AUG SEP OCT] profiles of enhanced WV from ERA5 by k-means clustering and Carbon Monoxide (CO) profiles clustered from CAMS, to be Canonical Representations of those atmospheric constituents
- We assert the CO concentration is directly proportional to the amount of Bulk Column Aerosol (BCA) expressed as AOD and distributed similarly
- We construct the BCA aerosol AOD profiles by fractional values at Z layer levels to be shape preserving for any summative value of AOD desired
- We invoke the OPAC aerosol optical properties associated with 4STAR retrievals using a mixture of smoke, polluted dust, and maritime aerosol
- Radiative Transfer is modeled using *LibRadtran* ™ running a version of the *Disort* Radiative Transfer Equation (RTE) solver from 250 – 3000nm ◸

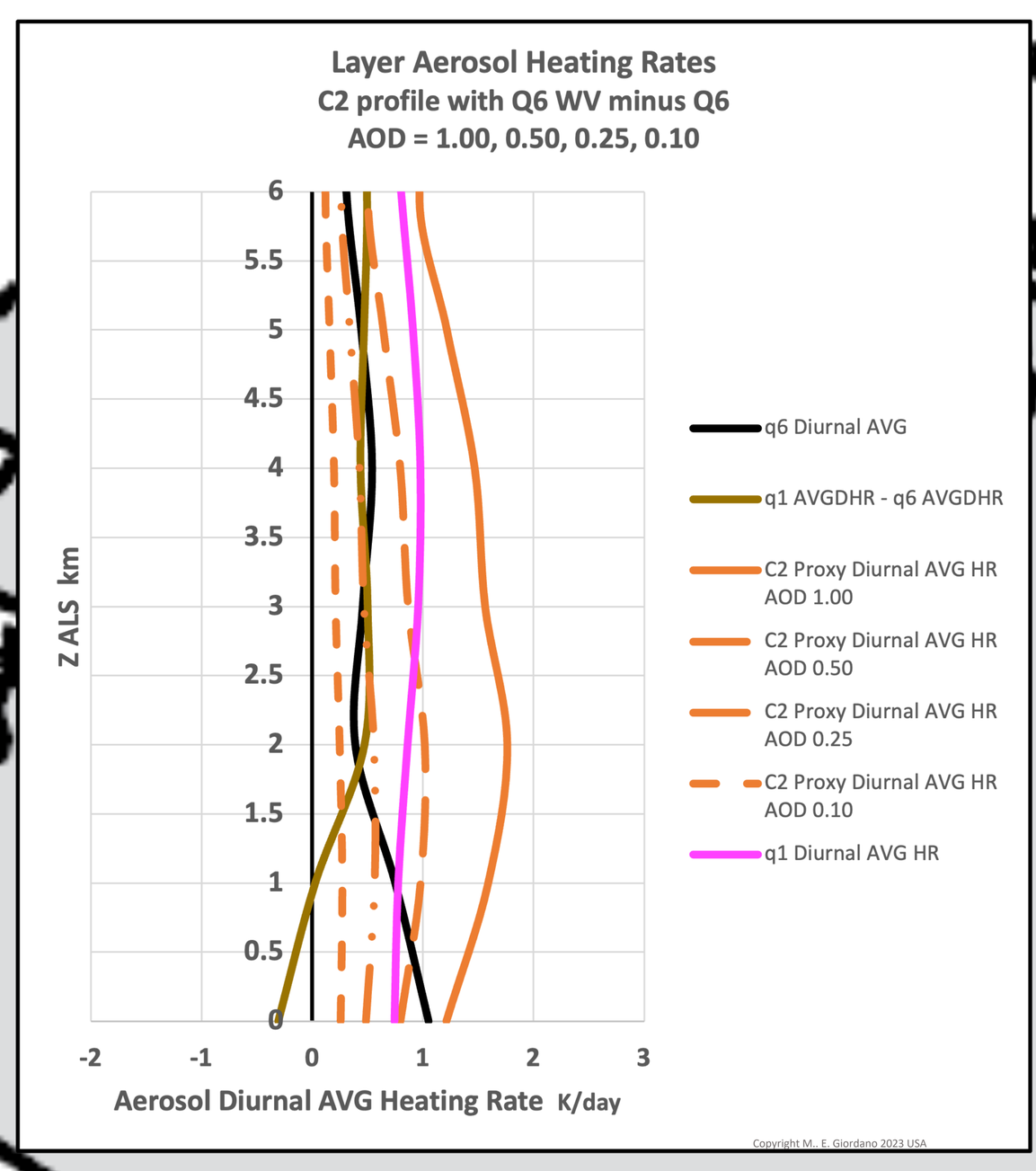


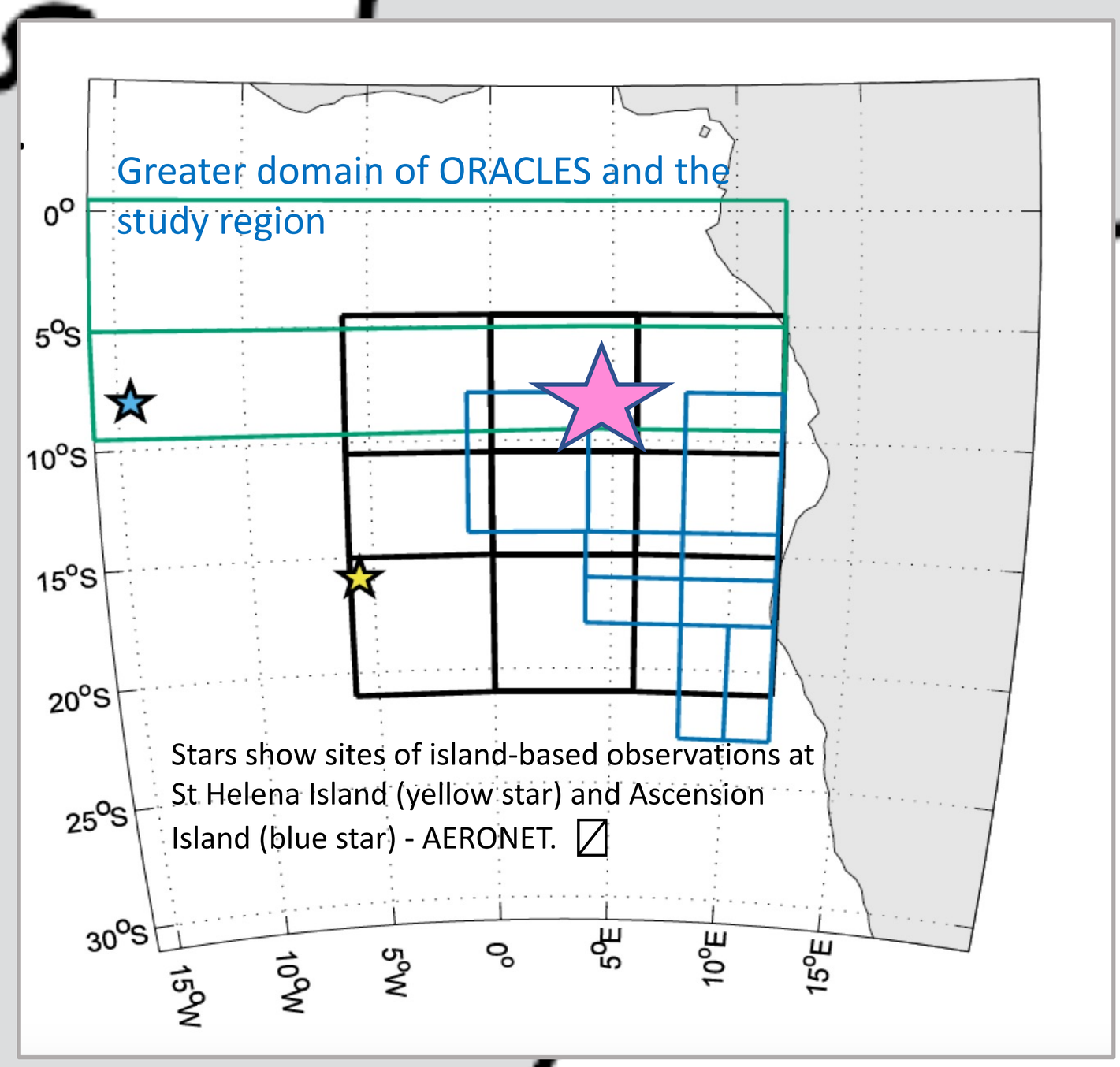
Key Objectives:

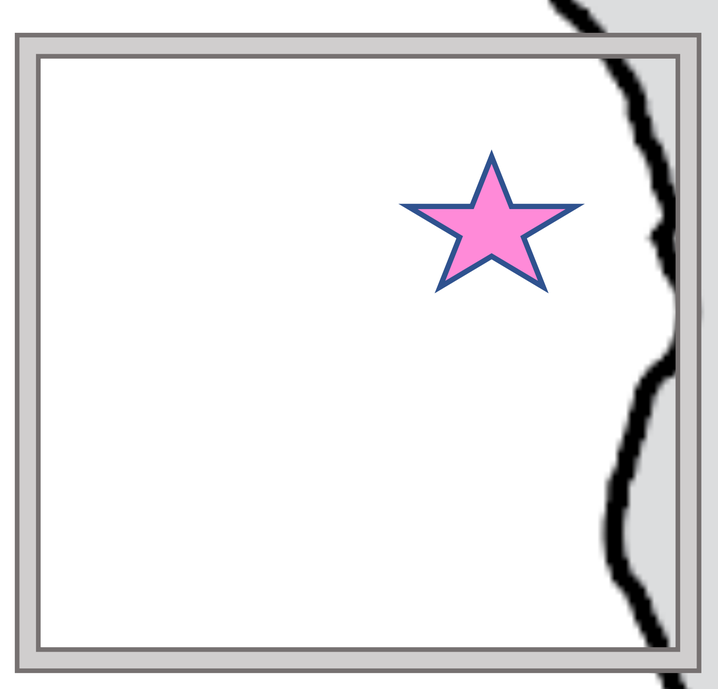
•Compare the magnitudes of daytime radiative heating of the atmosphere due to black carbon aerosol variations to that of water vapor variations.

•Characterize heating rates when humid air coincides with smoke aerosols.



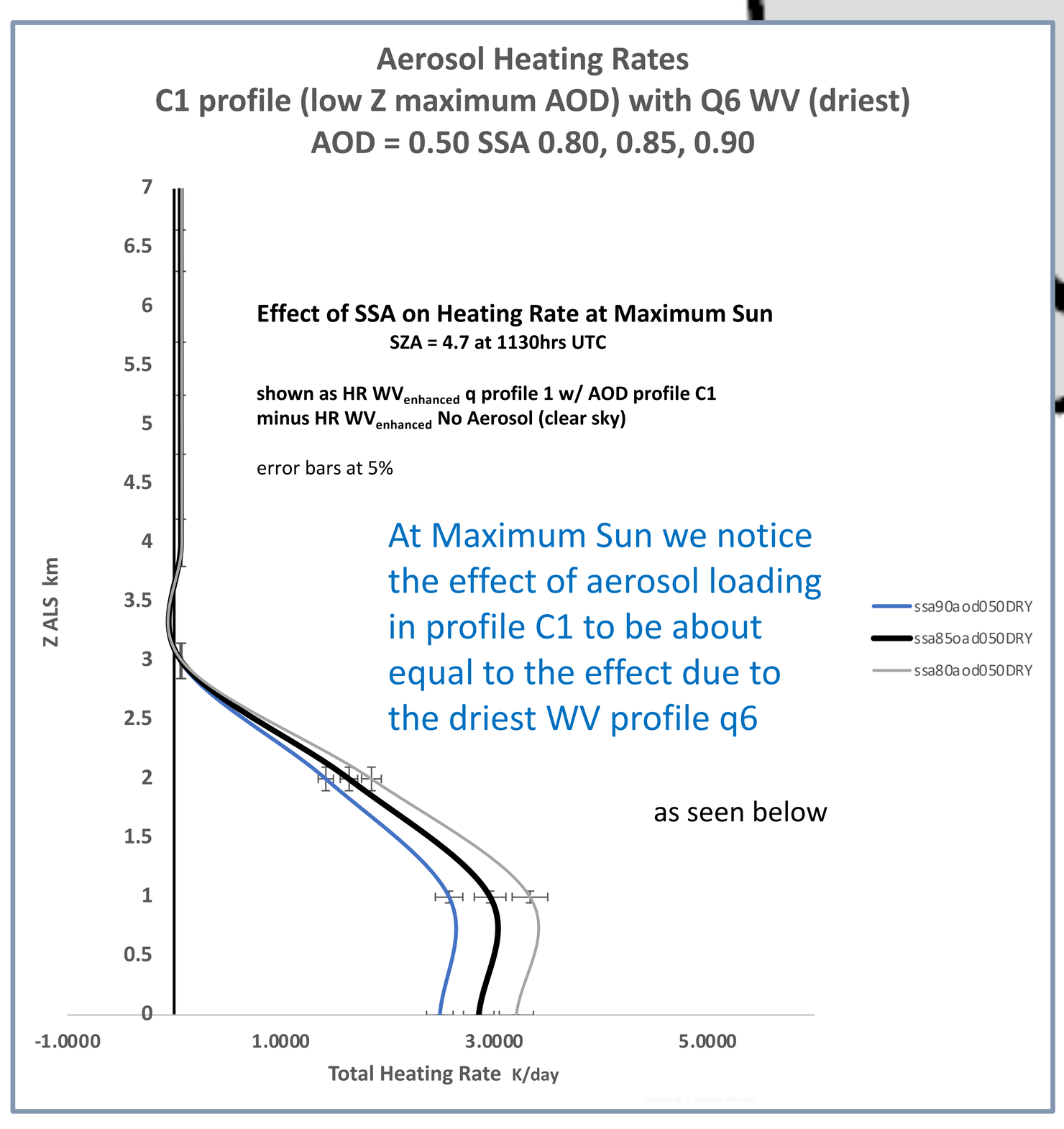


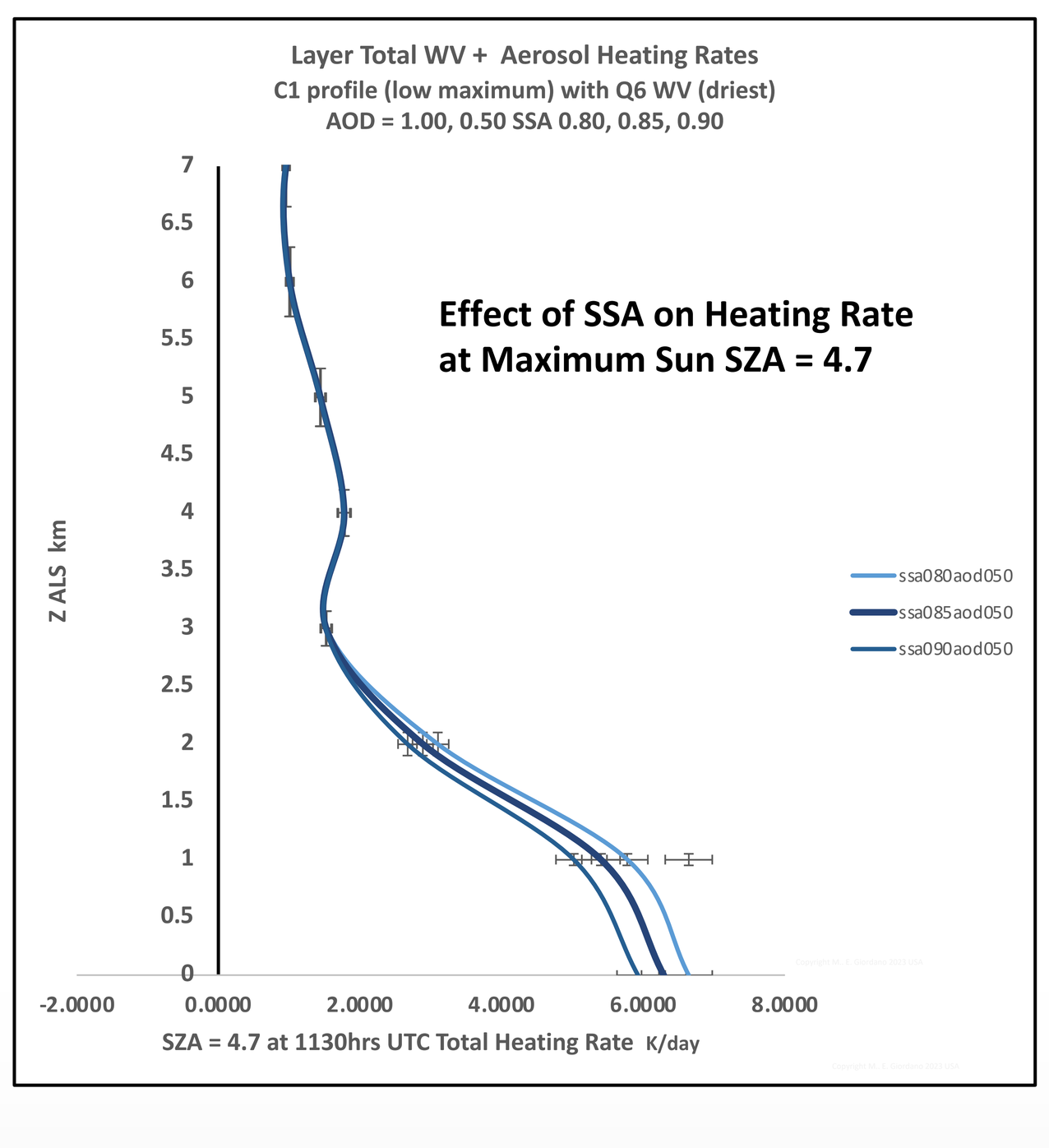




AMAZONIA

The SSA values are greater for this type of Biomass Burning. ◺ ◯ ⊙ but CO can still serve as AOD proxy





Heating Rate Profile Sensitivity to Single Scattering Albedo SSA

We simulate over 250nm – 300nm but scale the spectral dependence upon SSA 550nm for all wavelengths and altitudes for study relevance.

We set the BCA AOD at 550nm so that the RT model scales tau to the spectral dependence accordingly. ◸

Regional/seasonal SSA values range from ~0.80 to ~0.94 +/- 0.03-0.05 for SEA Biomass Burning Events.

We observe similar effects of *aerosol only* changes in the Diurnal Average Heating Rate with changes in SSA as shown in the maximum sun case.

Diurnal average HRs can reflect dominance of AOD over WV in some combinations of canonical Water Vapor and aerosol concentration profiles.

Discussion and Further Considerations:

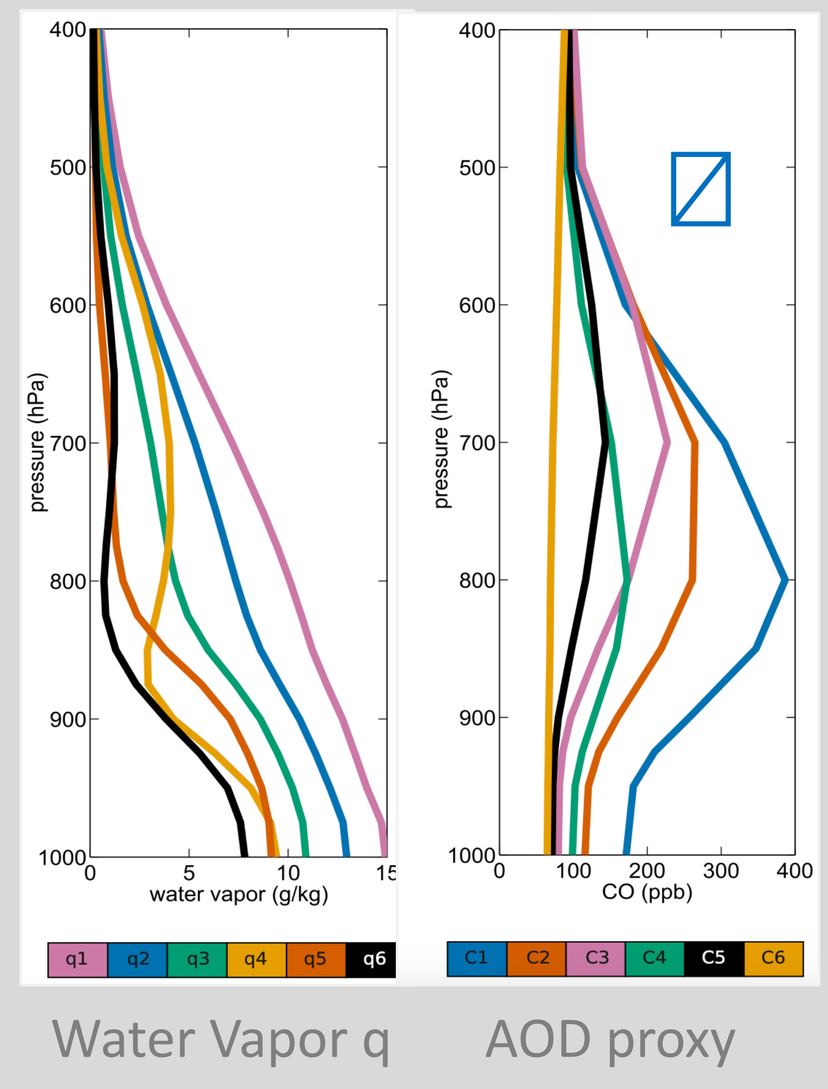
Use the sub-grided seasonal q vs CO to determine most frequent combinations for elevated Heating Rate Profiles

RT model all the extreme combinations of WV and AOD

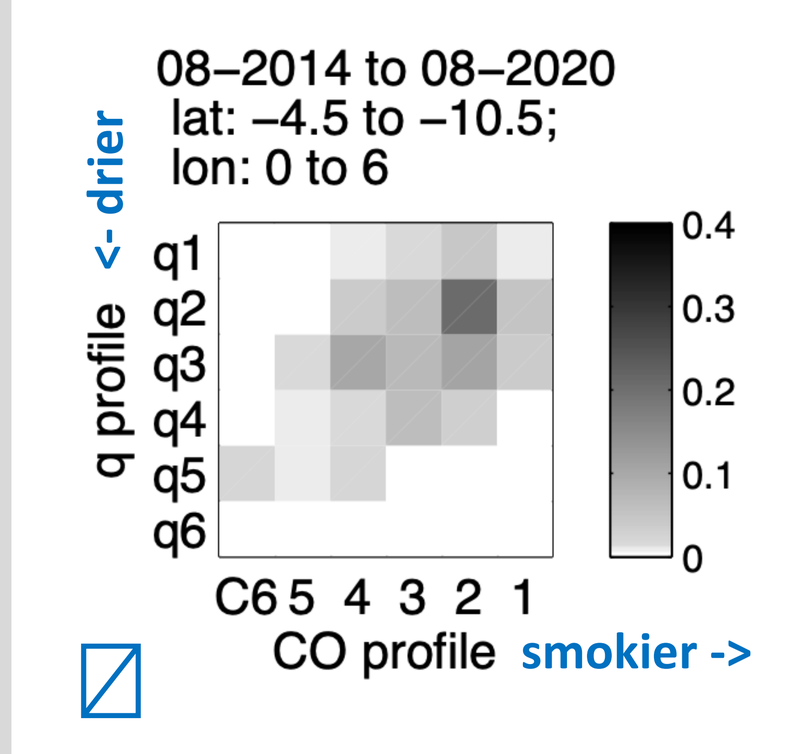
Properly consider the Aerosol and Water Vapor radiative effects in "cloudy conditions"
Q: How best to make use of retrieved Cloud Fraction C_f as model input?

Examine the relative occurrence of canonical Water Vapor and CO aerosol proxy profiles in the remaining 8 sectors of the greater study area, to study the relative distribution of radiative heating.

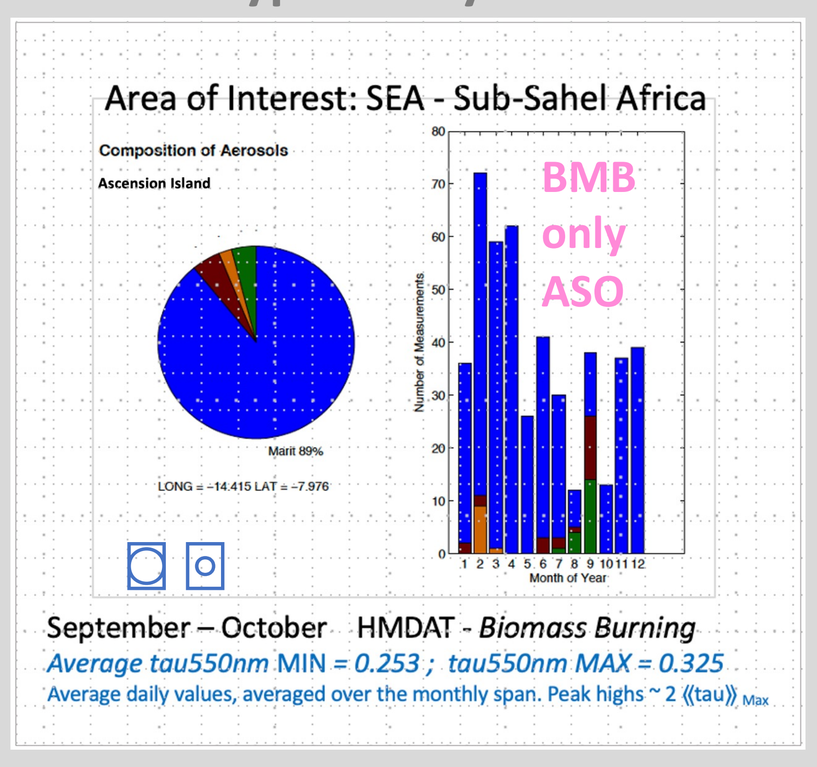
Canonical Profiles ASO



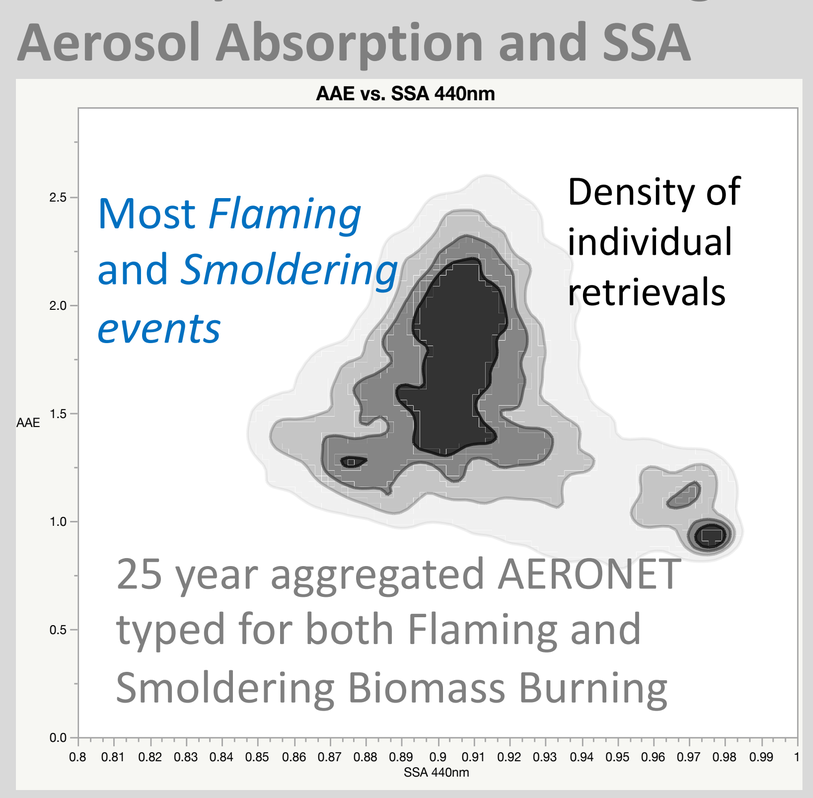
Example: Fractional Incidence



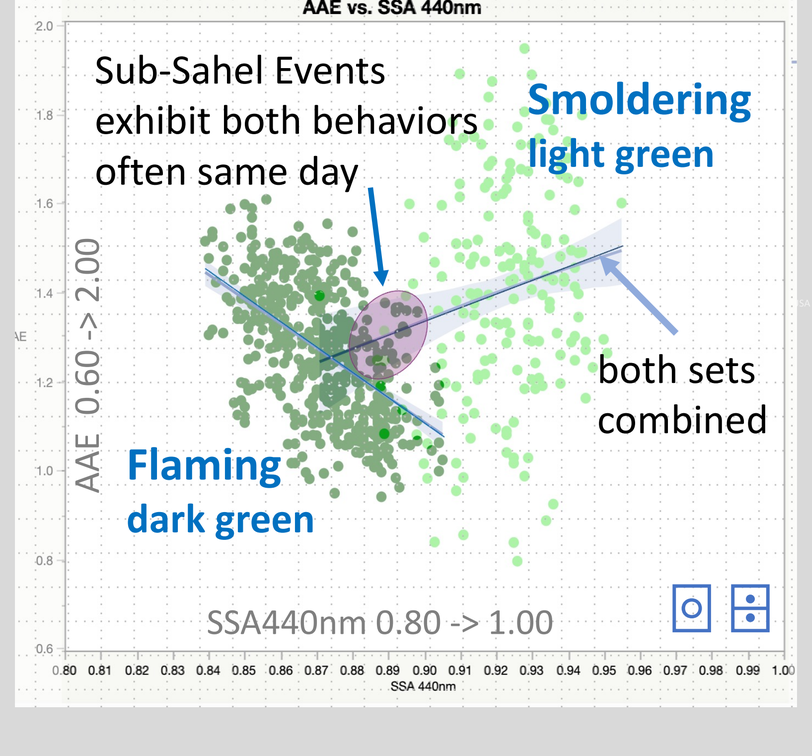
Historic Seasonal Dominant Aerosol Type – 25 yr AERONET



Modality of Biomass Burning Aerosol Absorption and SSA



Intervariable Correlation Analysis Biomass Burning AAE with SSA



BM Smoldering is the only aerosol type in an 8-aerosol typology that has a **positive** correlation coefficient between AAE and SSA. ⊡

Both sets of points combined show a positive correlation trend

NO PHOTOS

◸ Pistone, K., Wilcox, E. M., Zuidema, P., Giordano, M., Podolske, J., LeBlanc, S. E., Kacenelenbogen, M., Howell, S. G., and Freitag, S.: EGUsphere [preprint], https://doi.org/10.5194/egusphere-2023-2412, 2023.
◺ Wilcox, E. M. 2010: Stratocumulus Cloud thickening beneath layers of absorbing smoke. Atmos. Chem, Phys., 10, 11769-11777, 2010 www.atmos-chem-phys.net/10/11769/2010/ doi: 10.5196/acp-10-11769-2010
◸ LibRadtran ™ C. Emde, et al. (2016) The libradtran software package for radiative transfer calculations (version 2.0.1). *Geoscientific Model Development*, 9(5):1647-1672, 2016
◯ Giordano, M., 2019: On Interactions of Matter and Energy: Light and Particles in a Terrestrial Atmosphere Progress on Opto-Physical Recognition and Classification of Aerosols. Ph.D. Dissertation, 294 p., University of Nevada: Reno, NV
⊙ Giordano, Marco E. (2022). A historic global ground-based monthly seasonal aerosol climatology based in AERONET data: a database 1993-2013 [Dataset]. Dryad. https://doi.org/10.5061/dryad.0vt4b8h0d
⊡ Giordano, Marco E. (2023). Centroid values of aerosol optical properties for 8 sub-types based in AERONET inversion data (1993–2018) [Dataset]. Dryad. https://doi.org/10.5061/dryad.sxksn036z