Remote sensing of the relative concentrations of carbonaceous aerosols and dust

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Volume concentrations shown here -- see Mikko Pitkänen's poster for radiative effects.

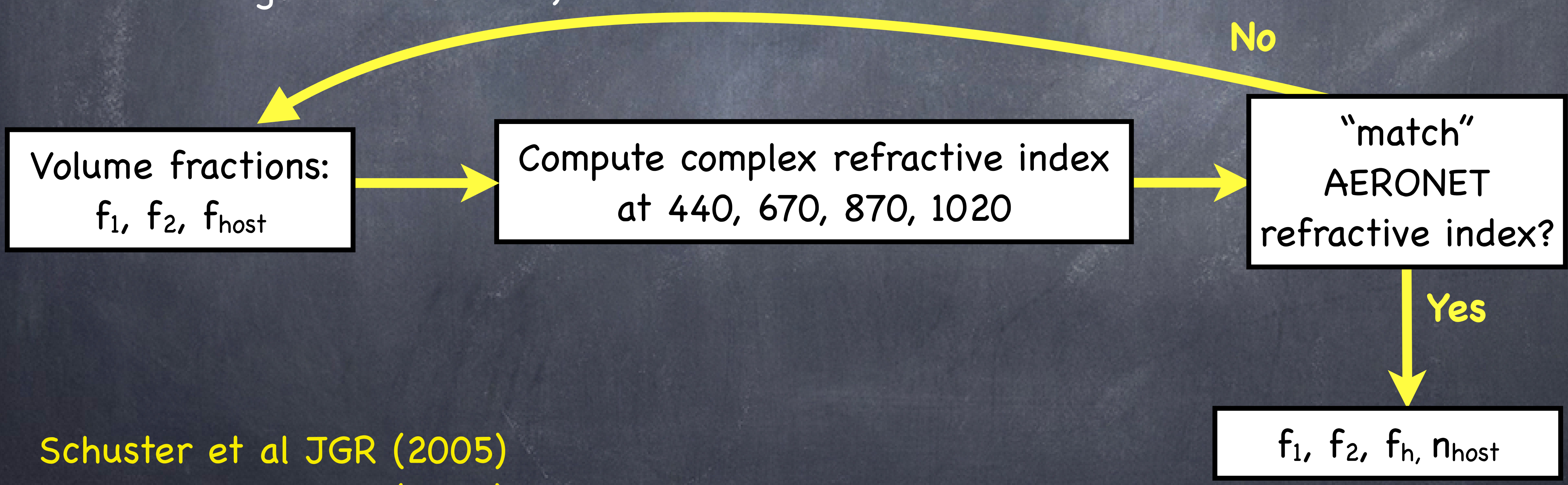
Acknowledgements
This work was supported by NASA's Science Mission Directorate, Earth Science Division, Glory Science Team. We appreciate the efforts of the AERONET and PHOTONS (Service d'Observation from LOA/USTL/CNRS) principal investigators and the entire AERONET/PHOTONS teams.

Outline

- Description of retrieval from AERONET Lev 2.0 almucantar data
- Absorption Angstrom Exponent (AAE)
- Usage comments about AERONET products

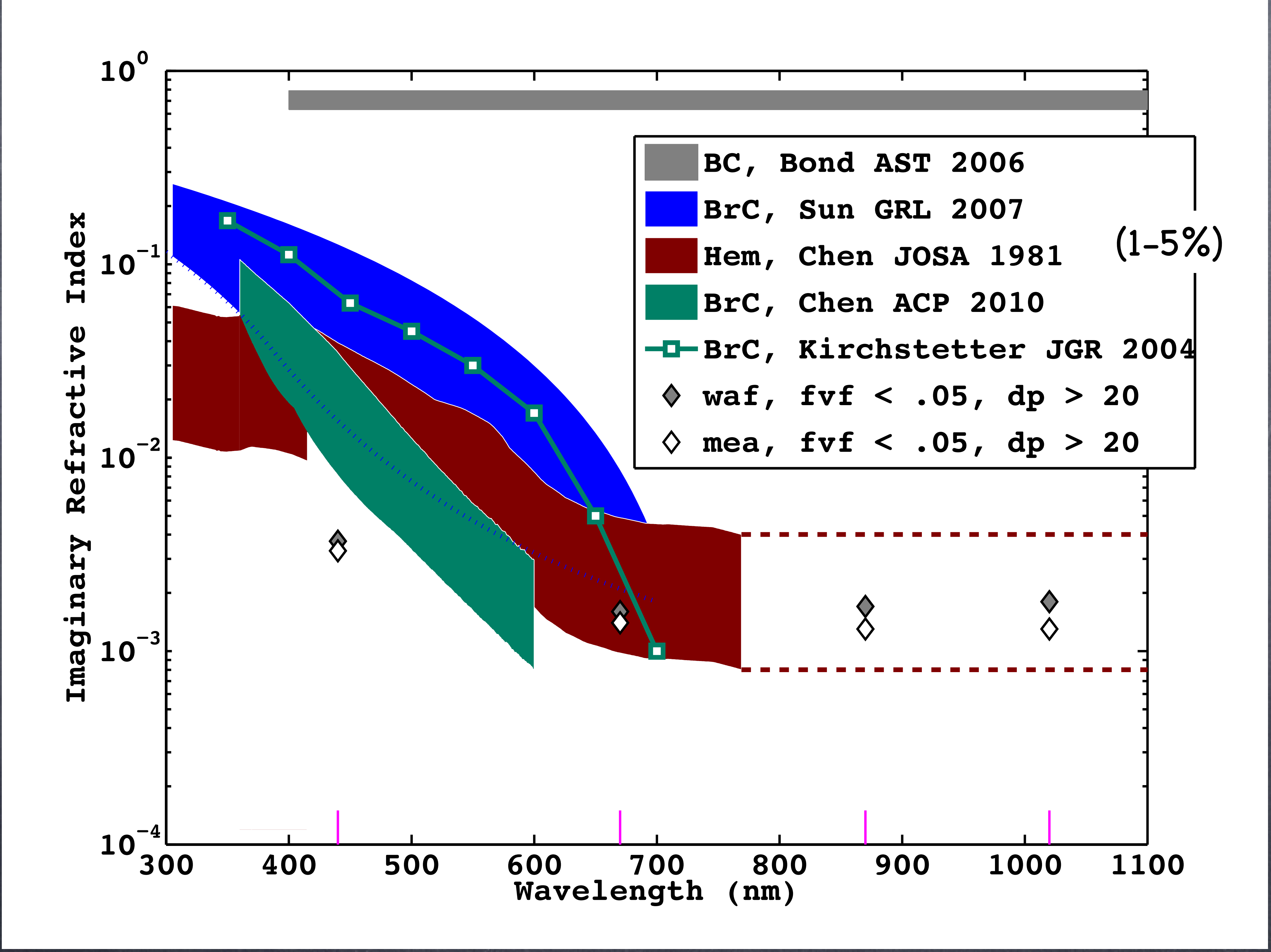
Motivation

- There has been recent interest in separating the absorption contributions of dust, black carbon and organic carbon (Bond 2013, Chung 2012, Bahadur 2012).
- AERONET provides imaginary refractive index (i.e., absorption) at 4 wavelengths (440, 675, 870, 1020 nm) and the aerosol volume.
- These refractive indices can be used to infer the volume fraction of one spectrally flat absorbing species and one colored species in a non-absorbing host (i.e., BC and OC for carbonaceous aerosols, hematite and goethite for dust).



Schuster et al JGR (2005)
Schuster et al GRL (2009)

Imaginary refractive indices of the four common absorbing aerosol species



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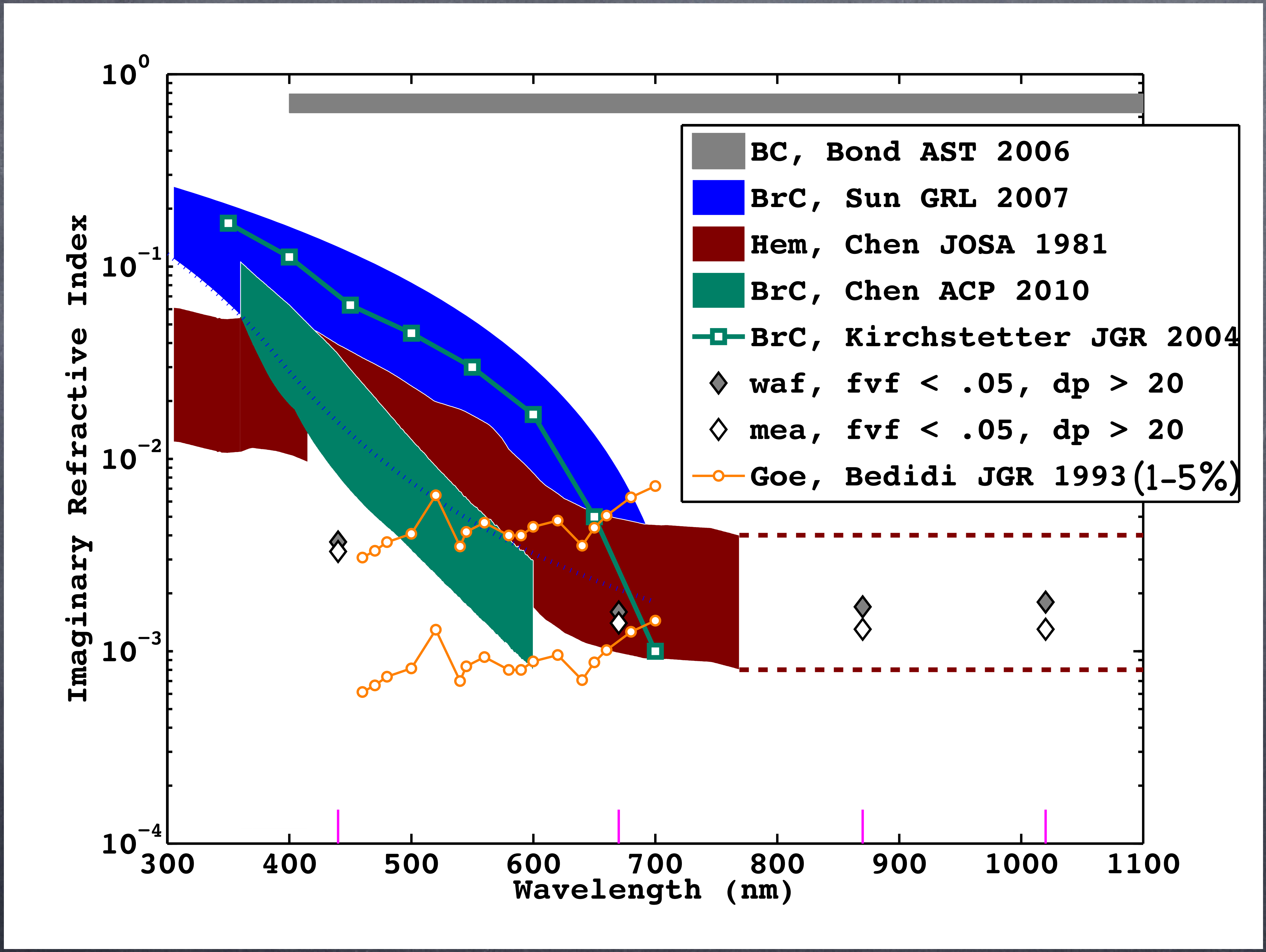
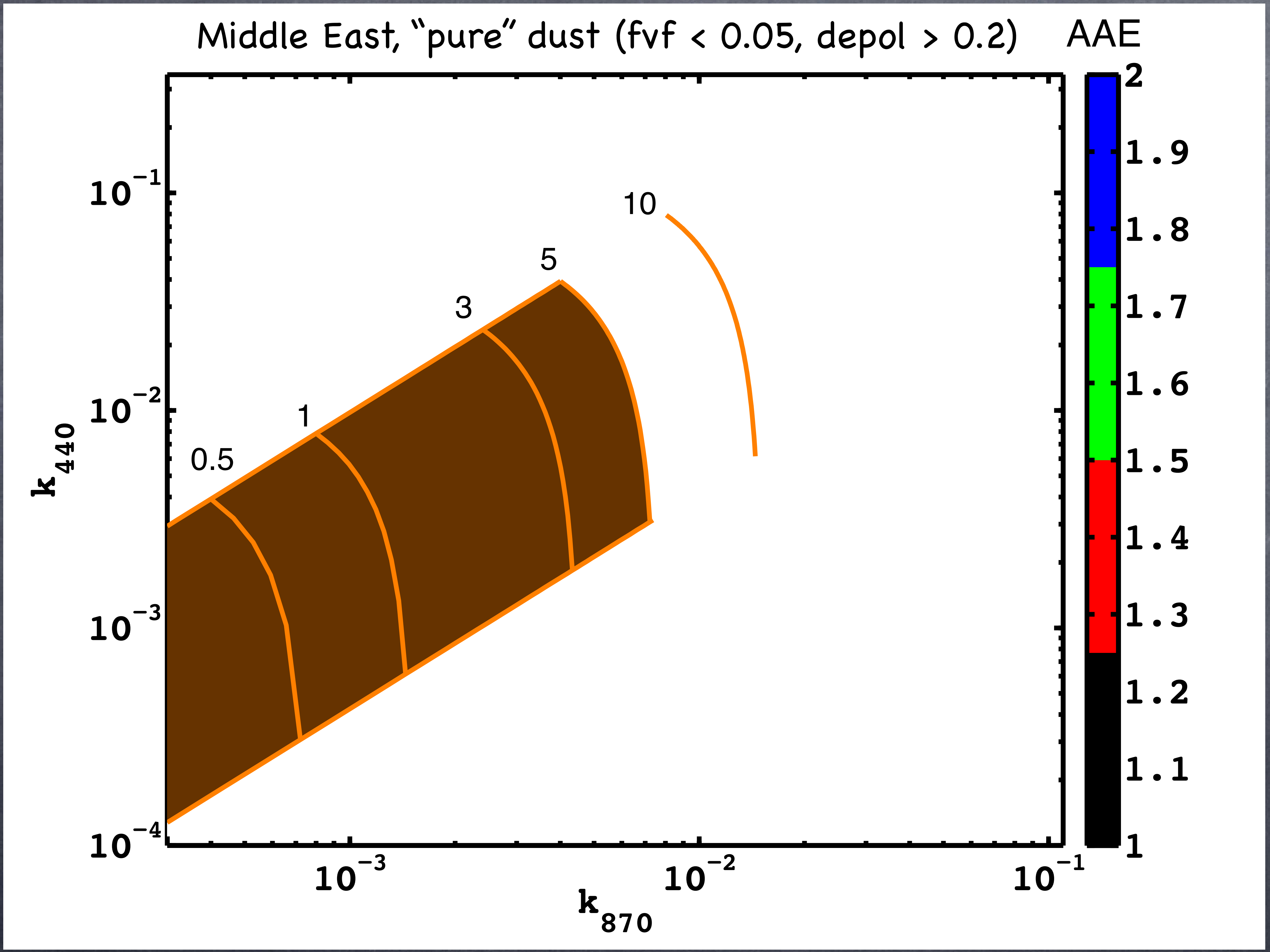


Hematite-goethite mixtures in imaginary index space



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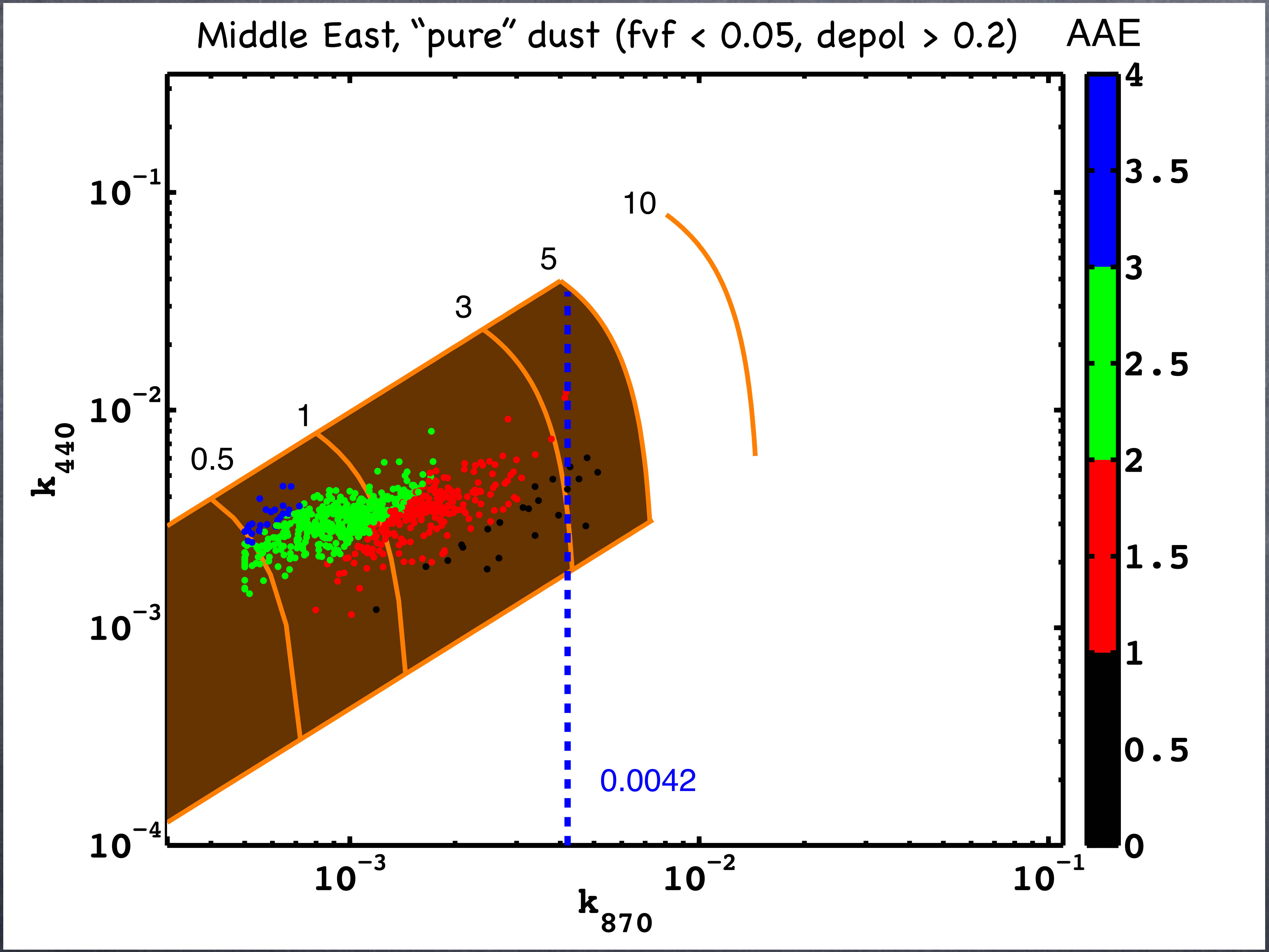
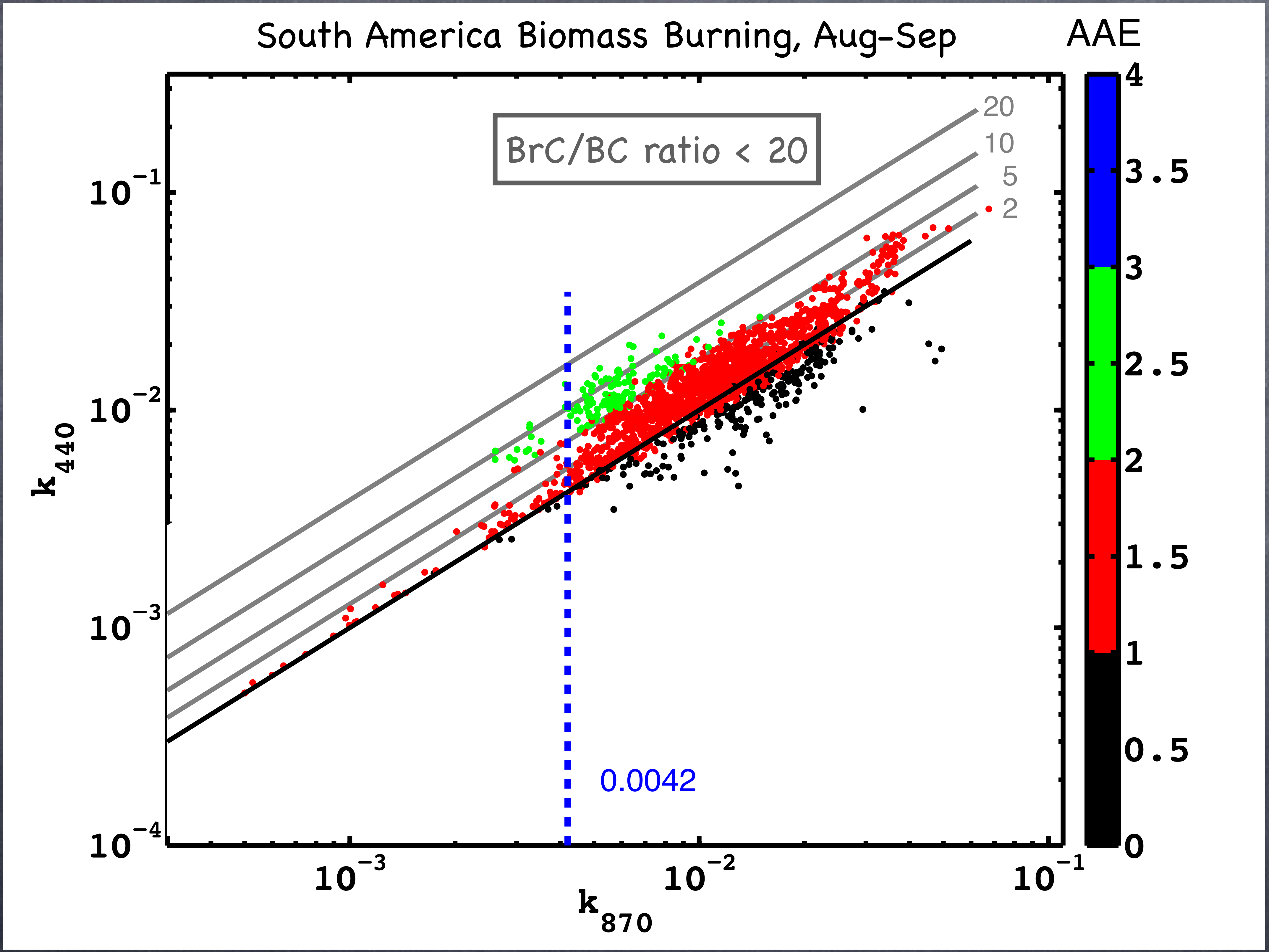
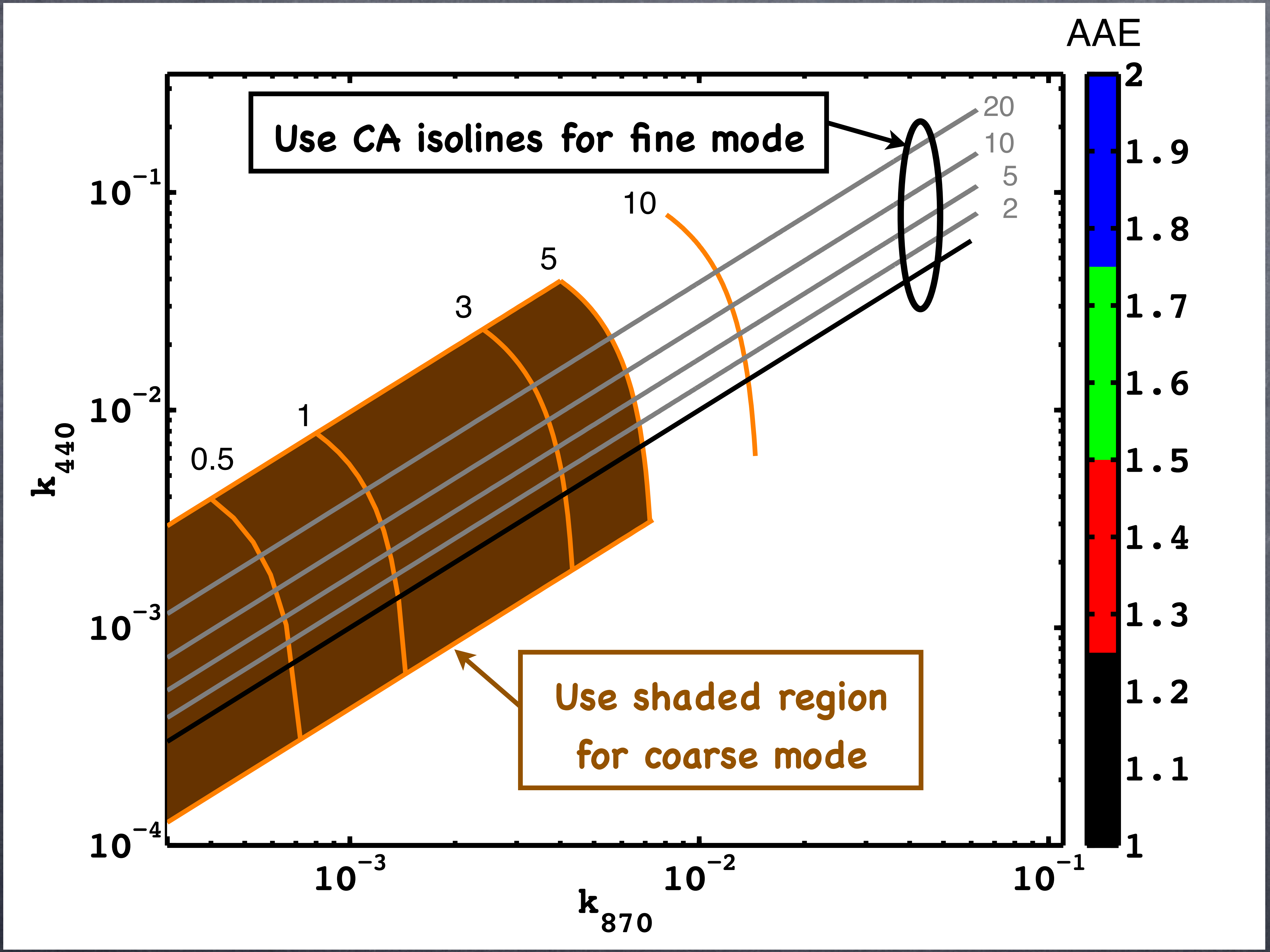


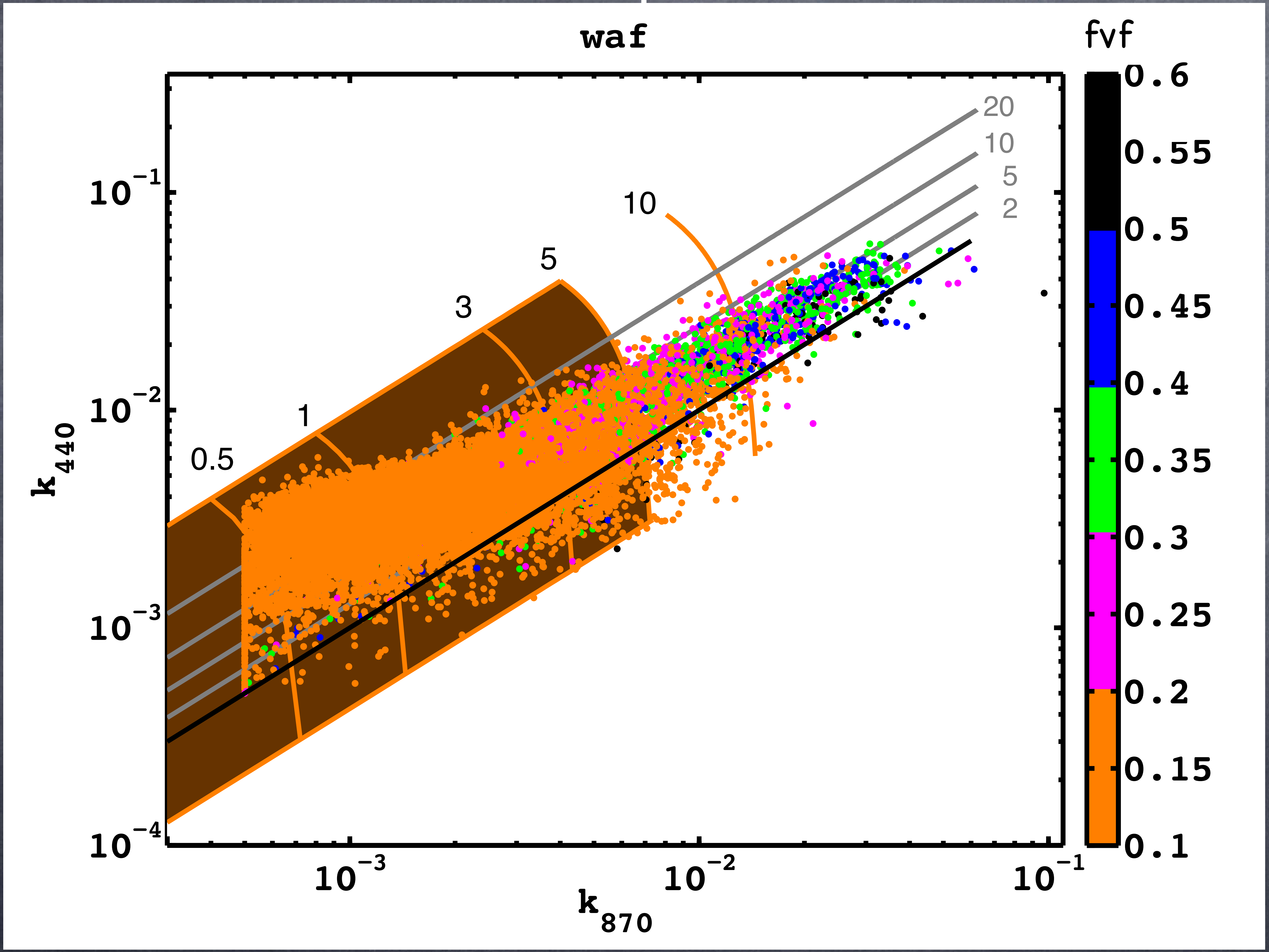
BrC-BC mixtures in imaginary index space



First thought: Assume all fine mode absorption is caused by BC, and all coarse mode absorption is caused by dust.



Problem: Refractive indices fall outside of known range for dust in West Africa, despite coarse-mode dominance



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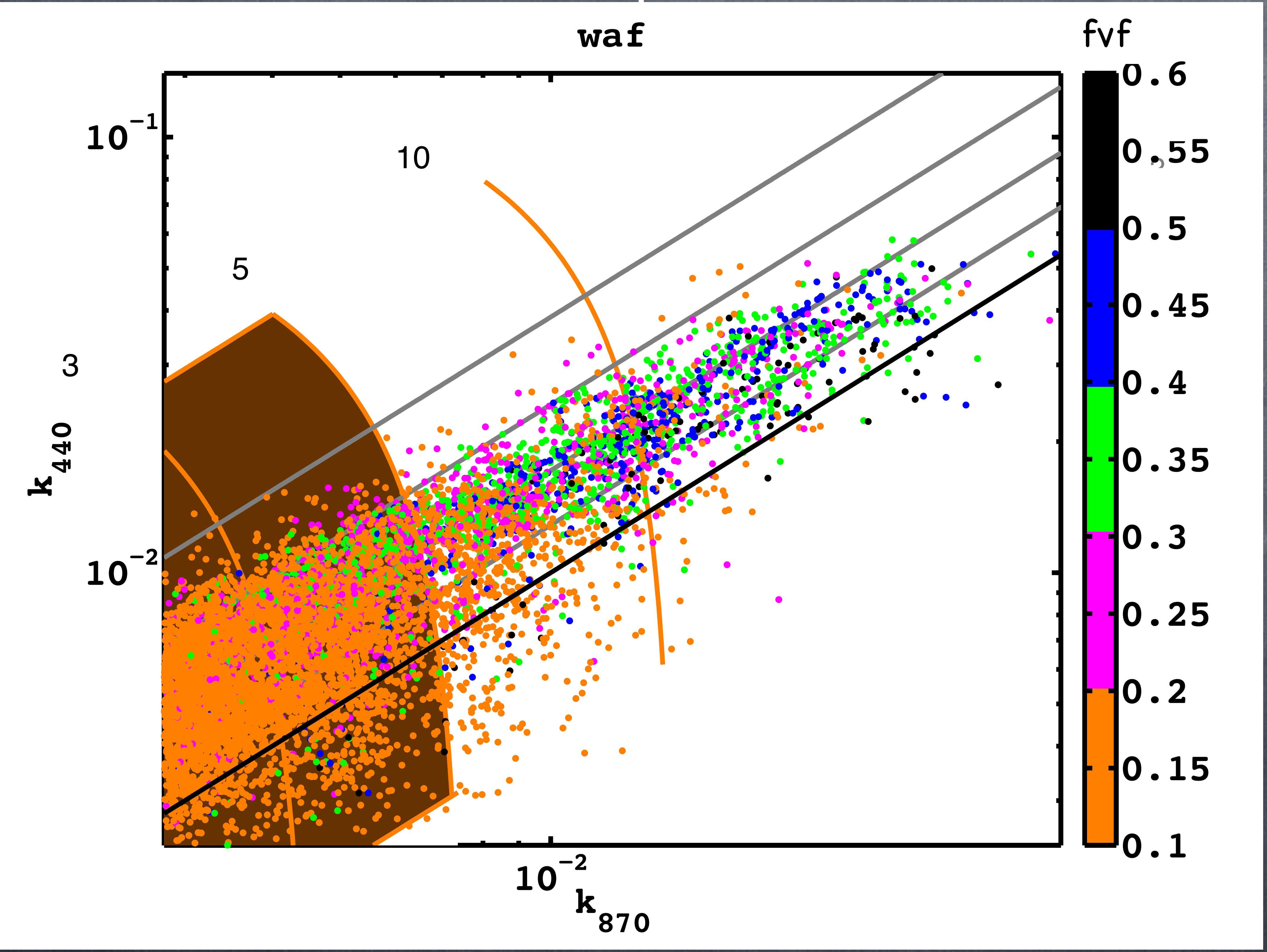
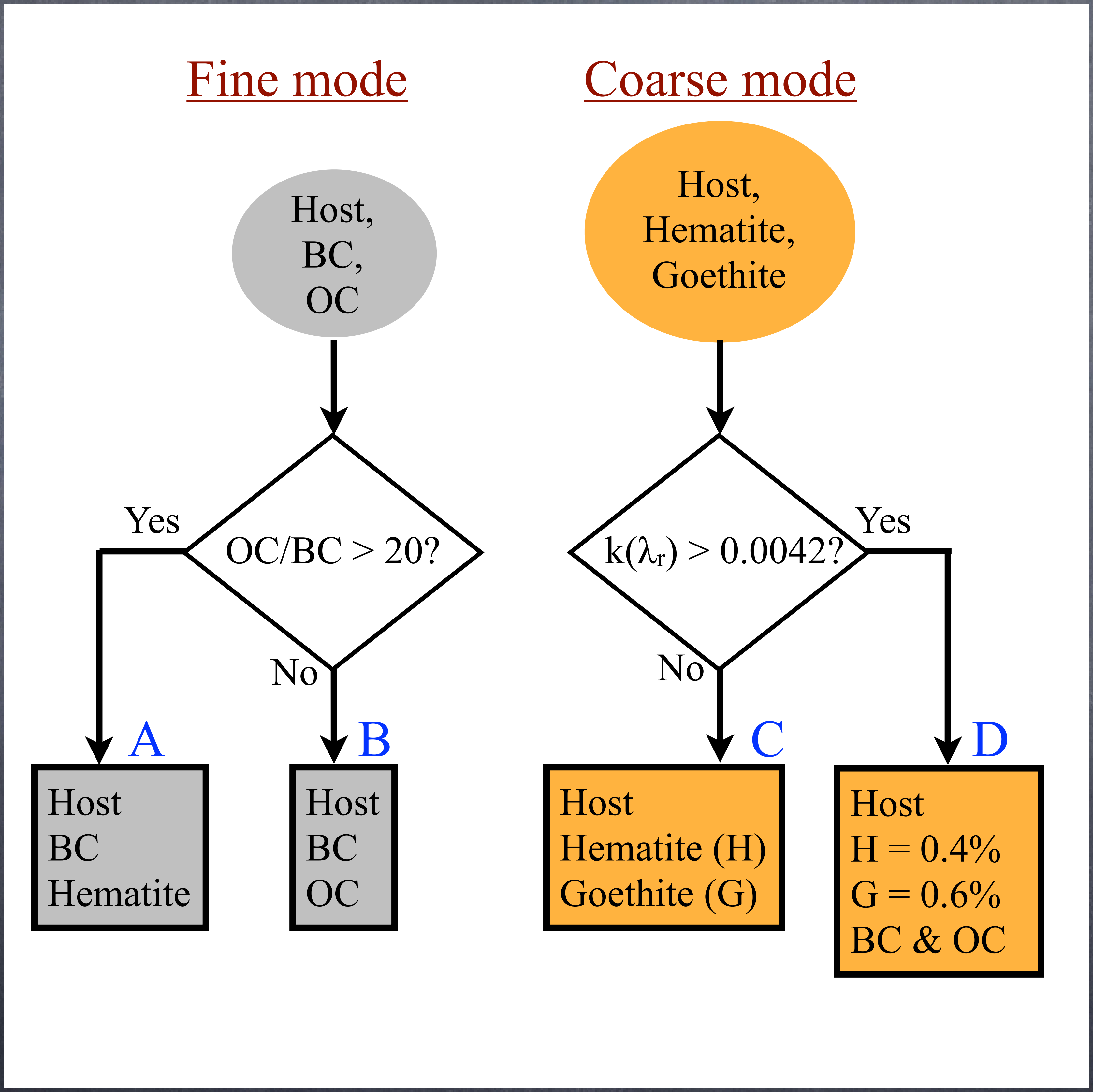
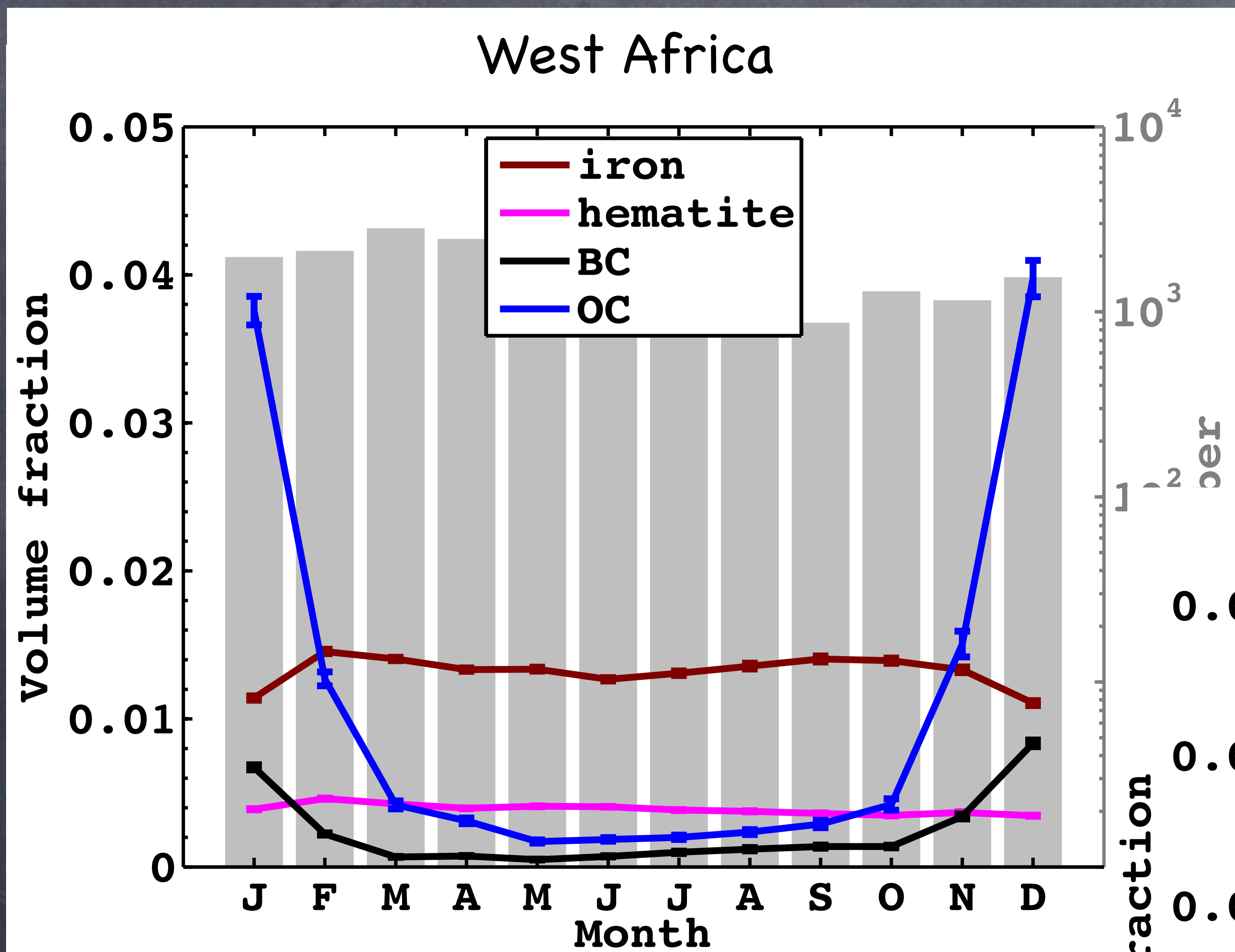


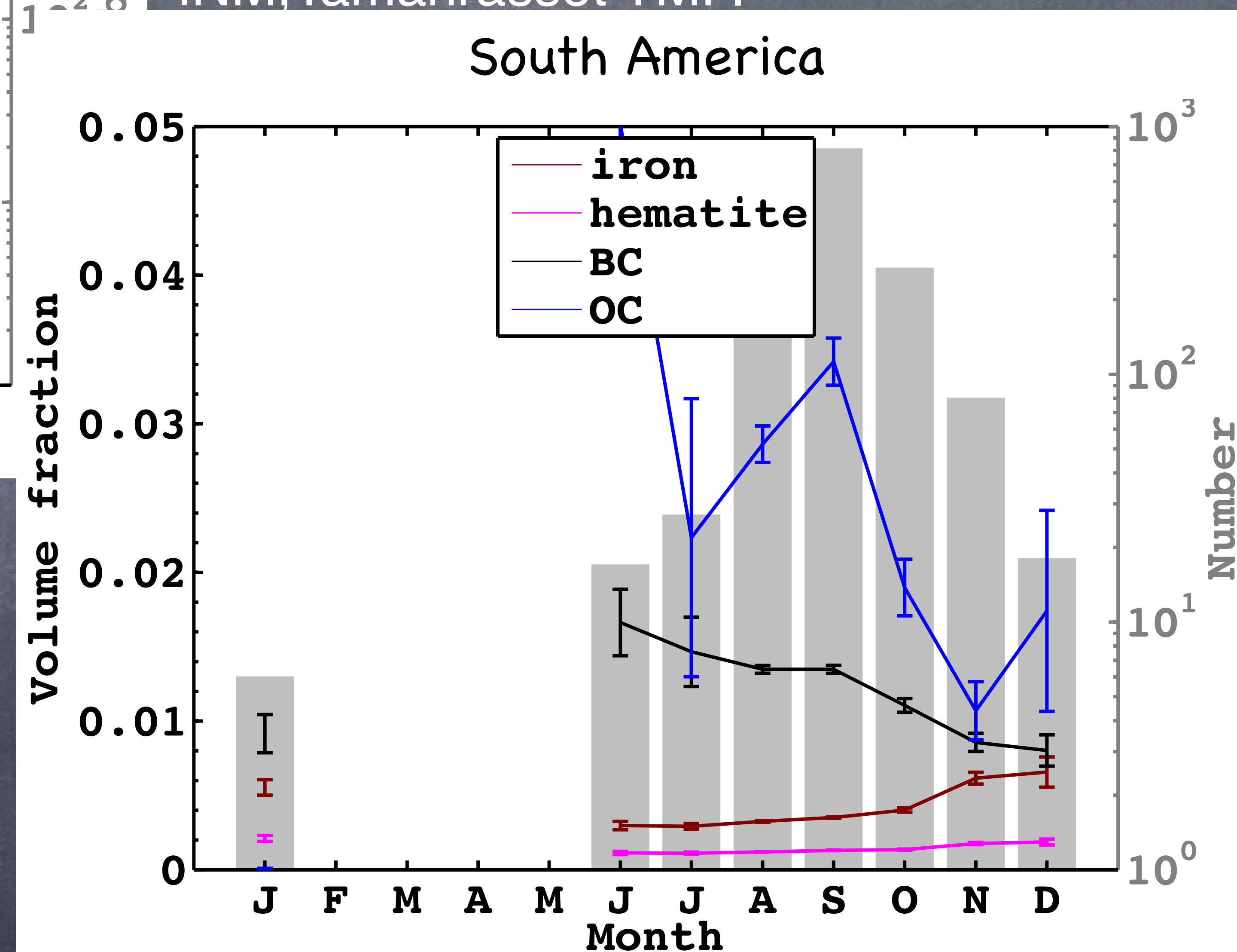
Next thought: Use thresholds determined from imaginary index space to constrain absorbing species concentrations



Volume fraction

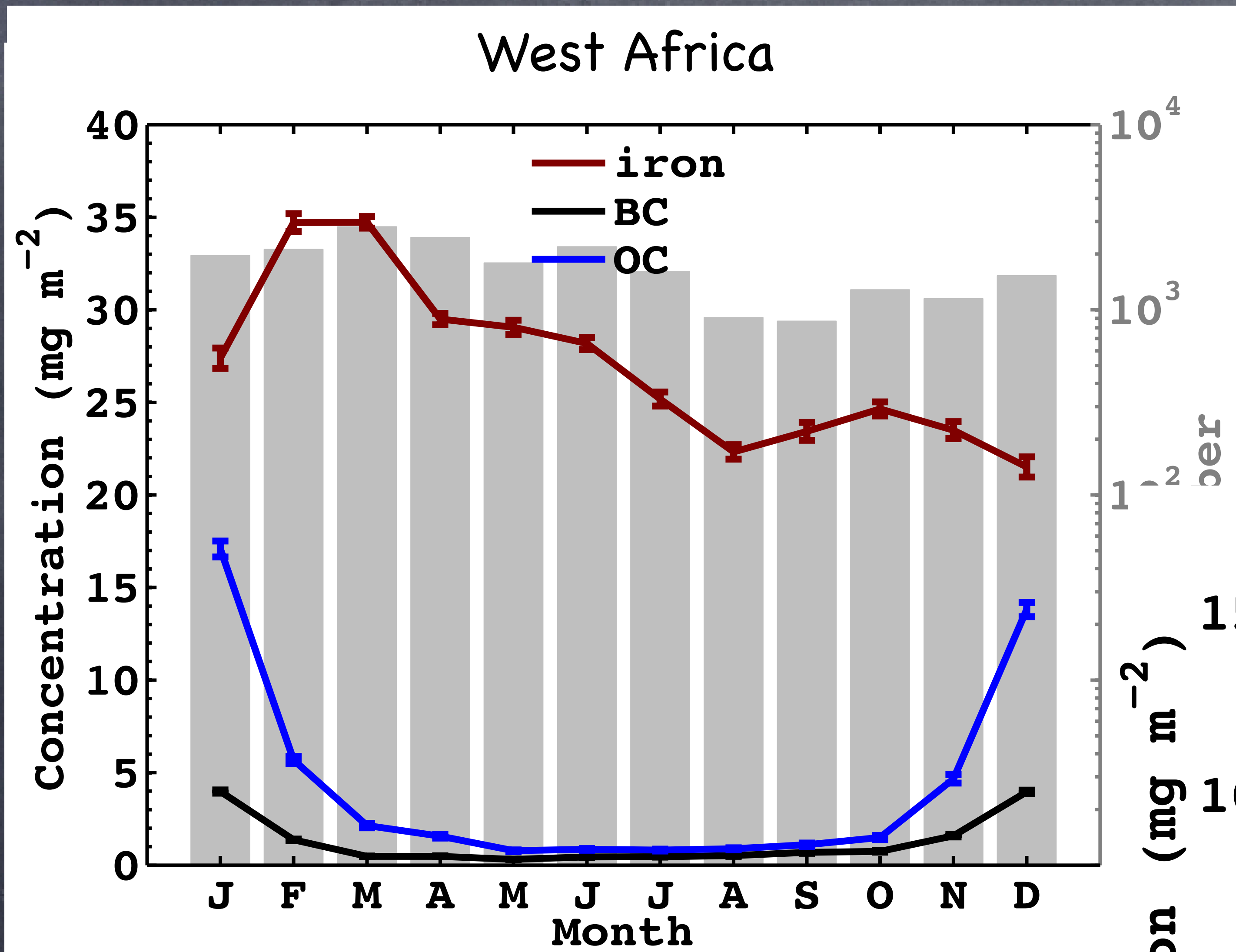


West Africa (waf):
Agoufou, Banizoumbou, IER Cinzana, DMN Maine Soroa,Ouagadougou, Djougou, Saada, Capo Verde, Dahkla, Dakar,Ilorin, Quarzazate, Santa Cruz Tenerife, Tamanrasset INM,Tamanrasset TMP.



South America (sam):
Alta Floresta, Cuiaba, CUIABA-MIRANDA, Abracos Hill, Balbina, Belterra, SANTA CRUZ.

Concentration



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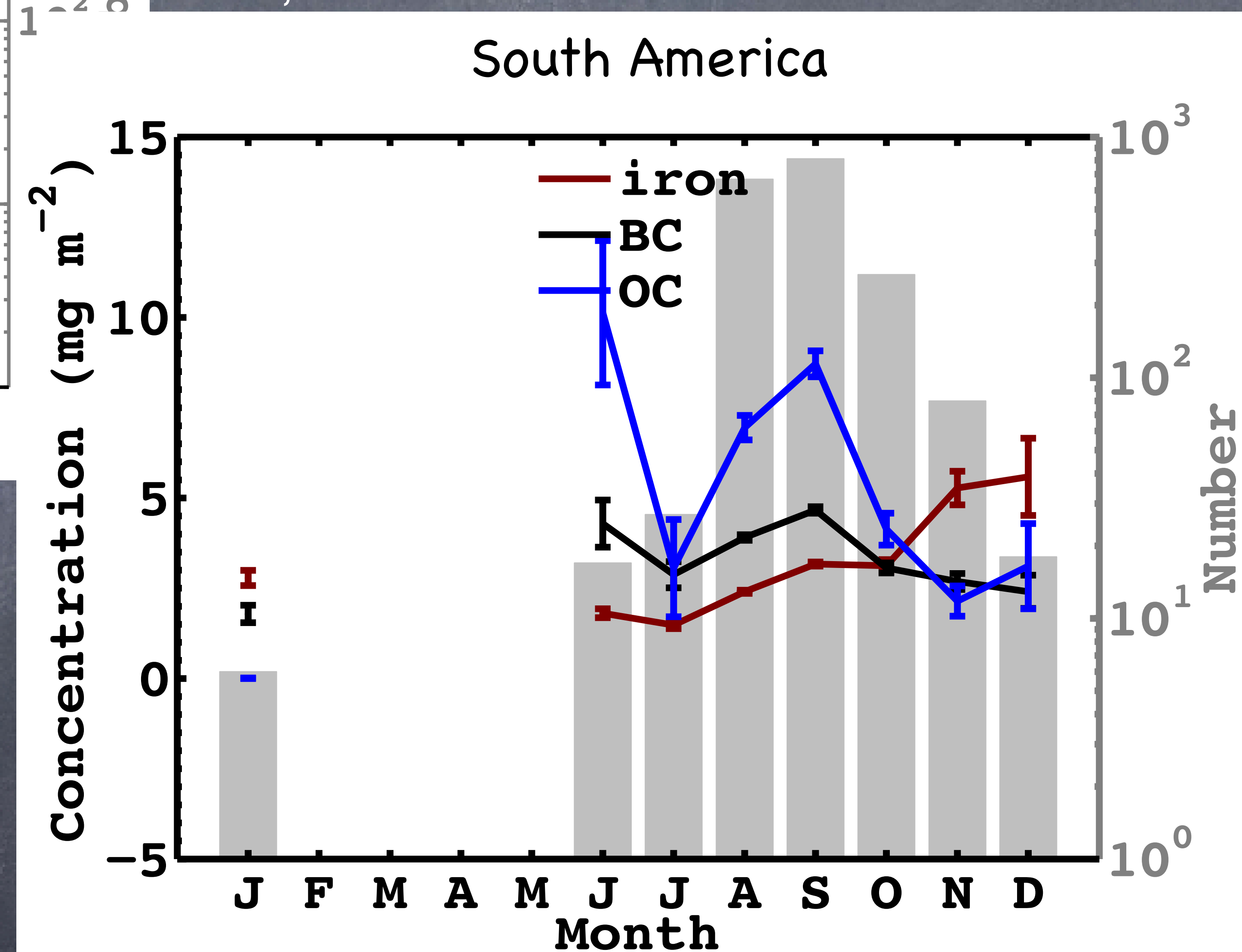

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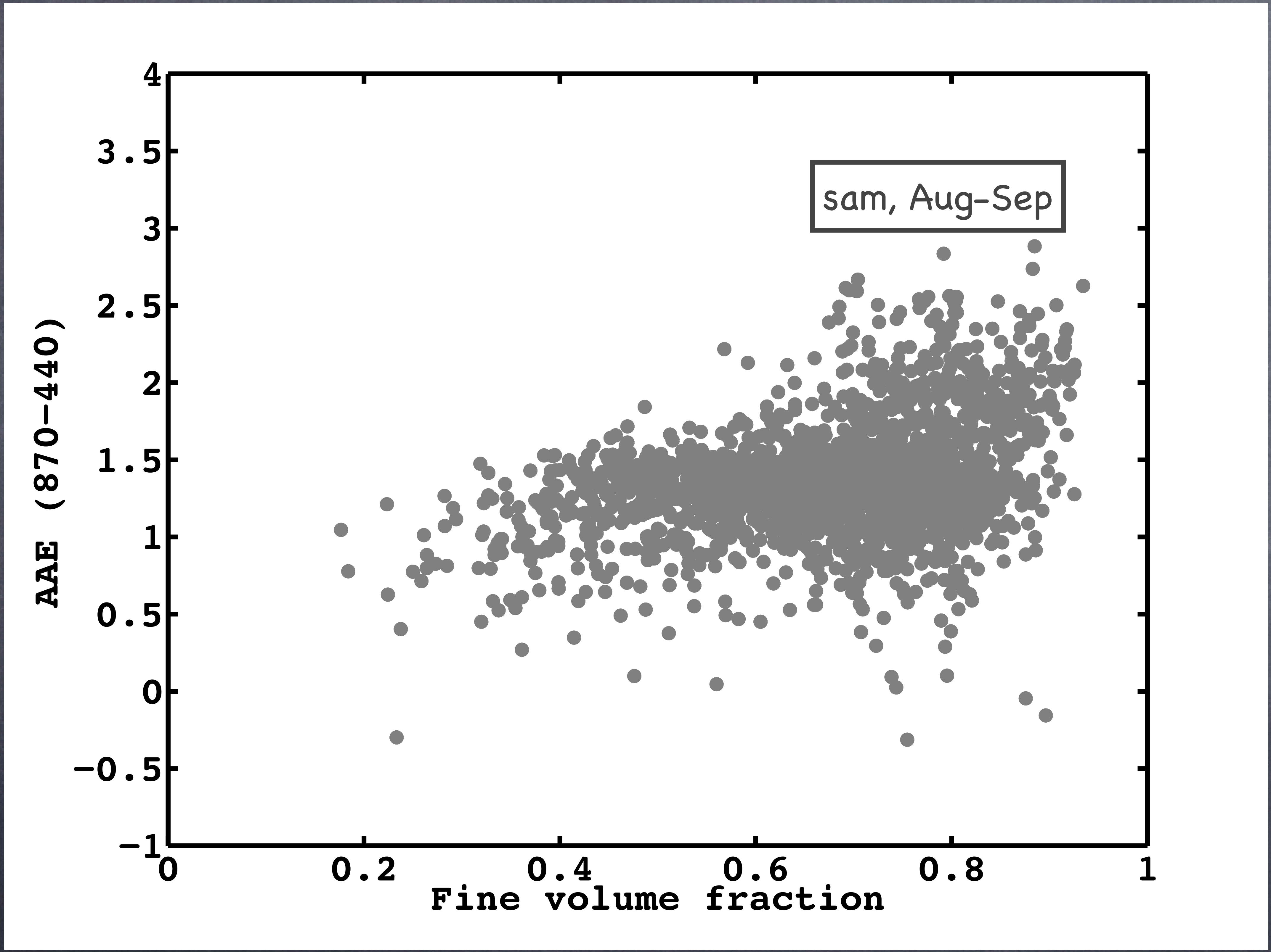
AAE Approach for separating aerosol absorption

(Arola ACP 2011, Chung PNAS 2012, Bahadur, PNAS 2012)



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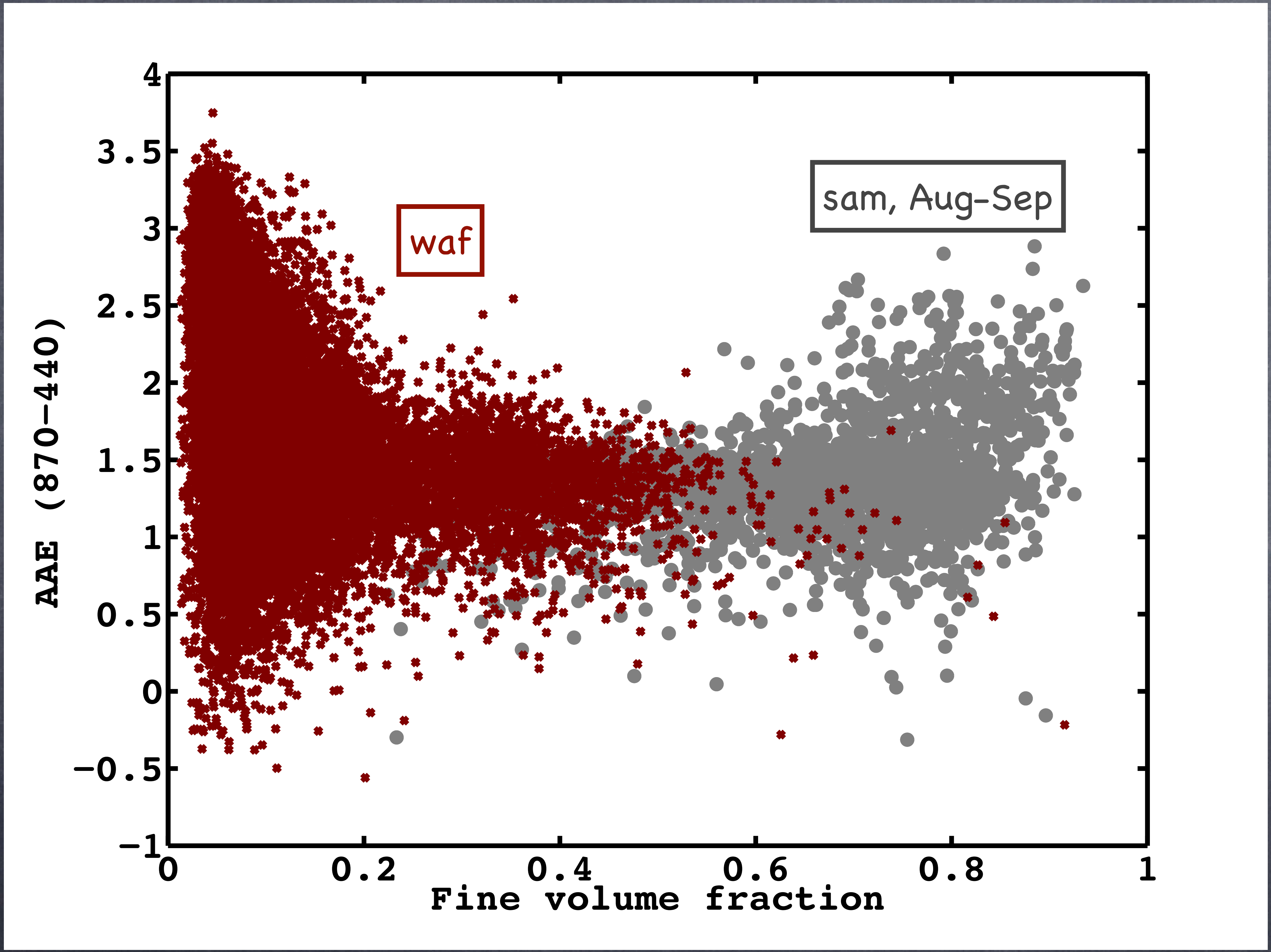

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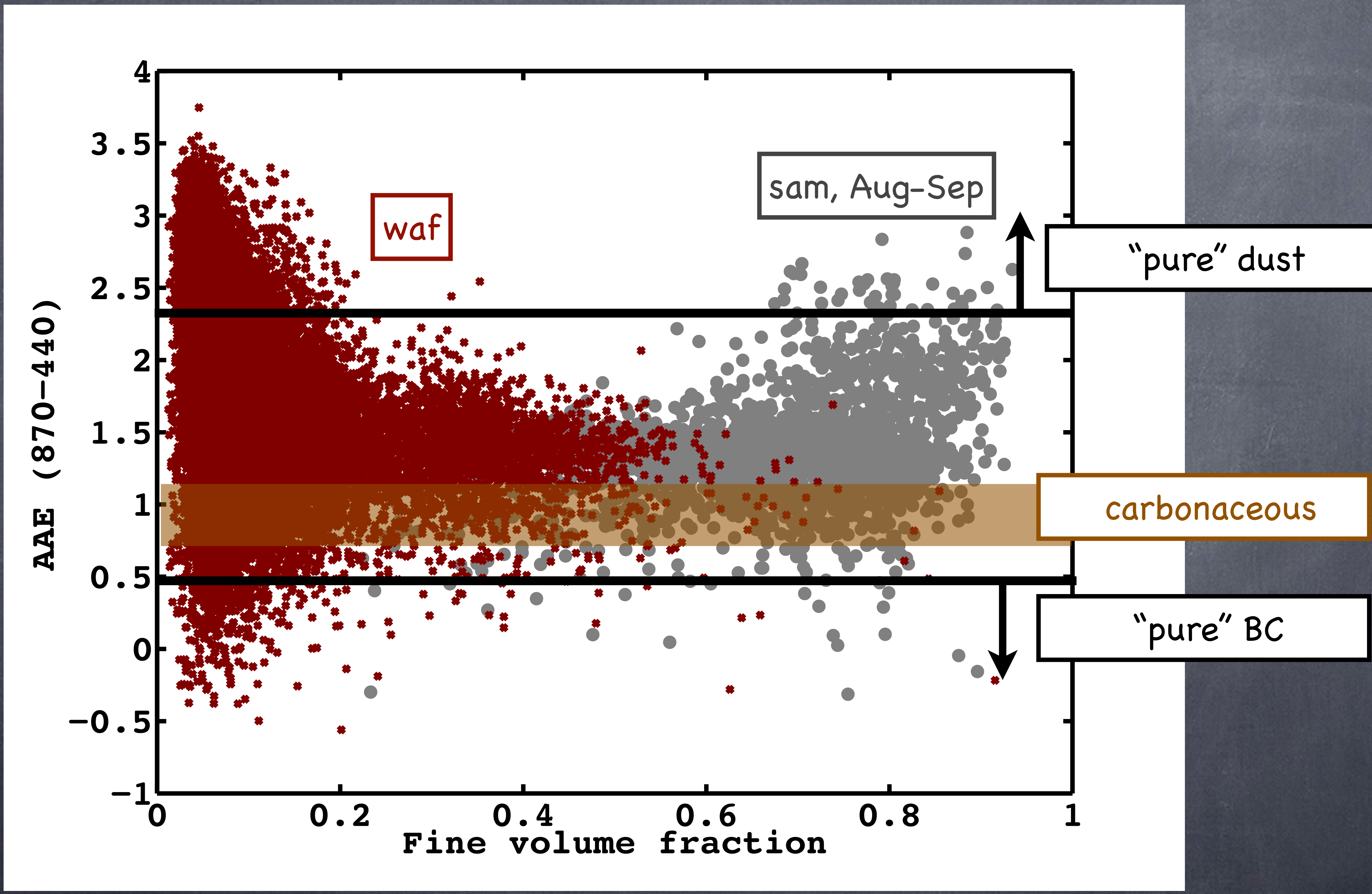

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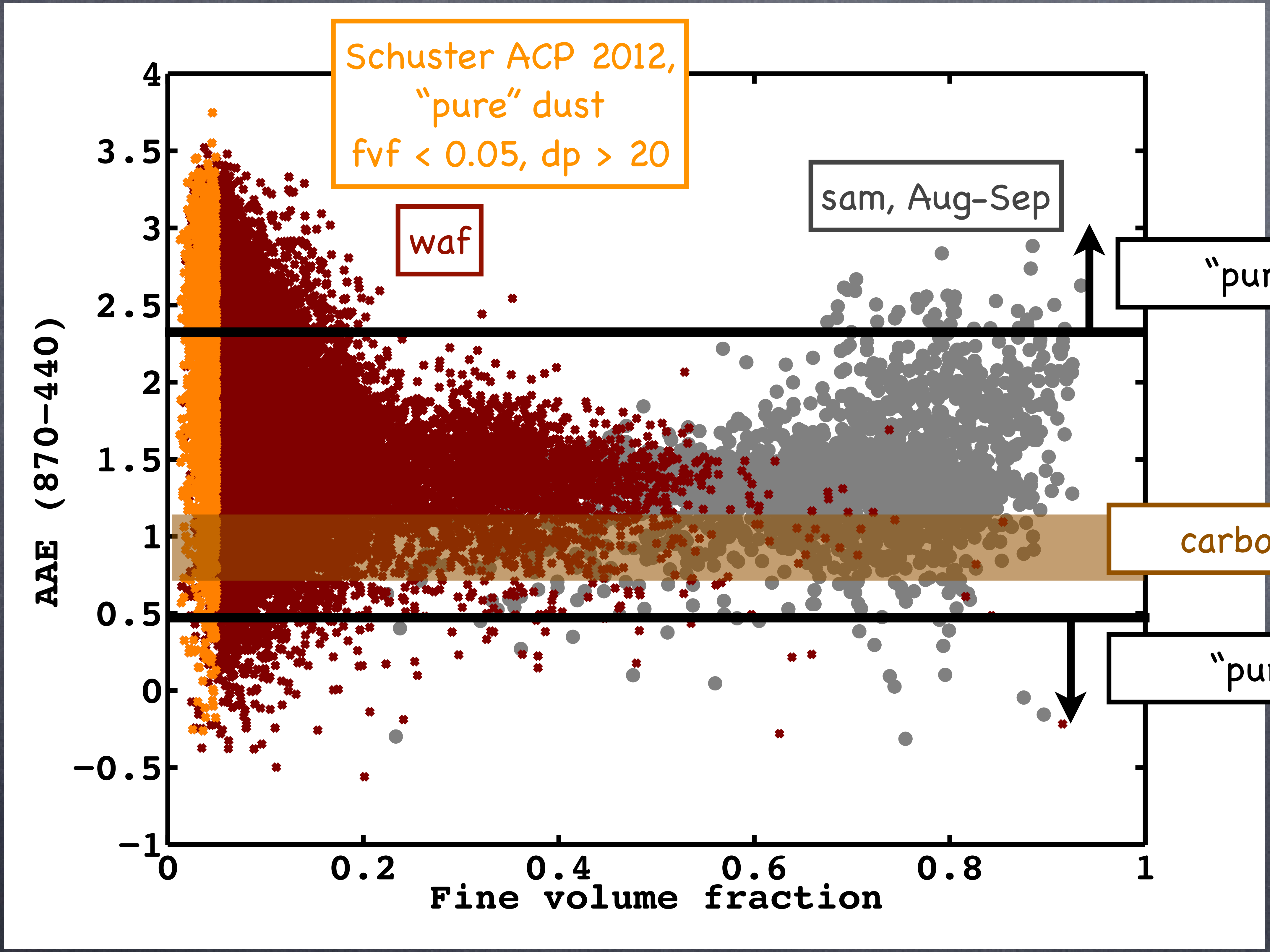

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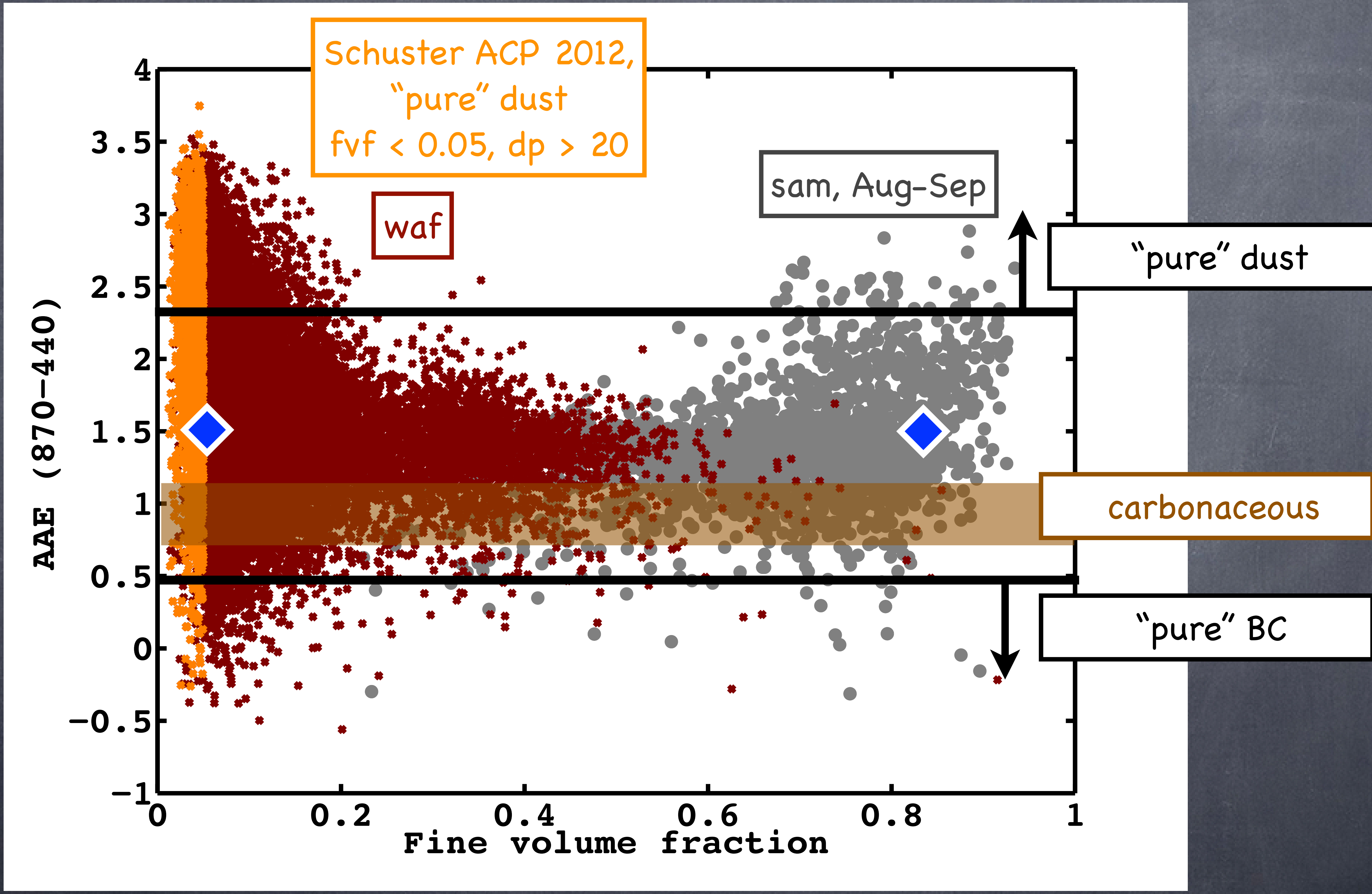
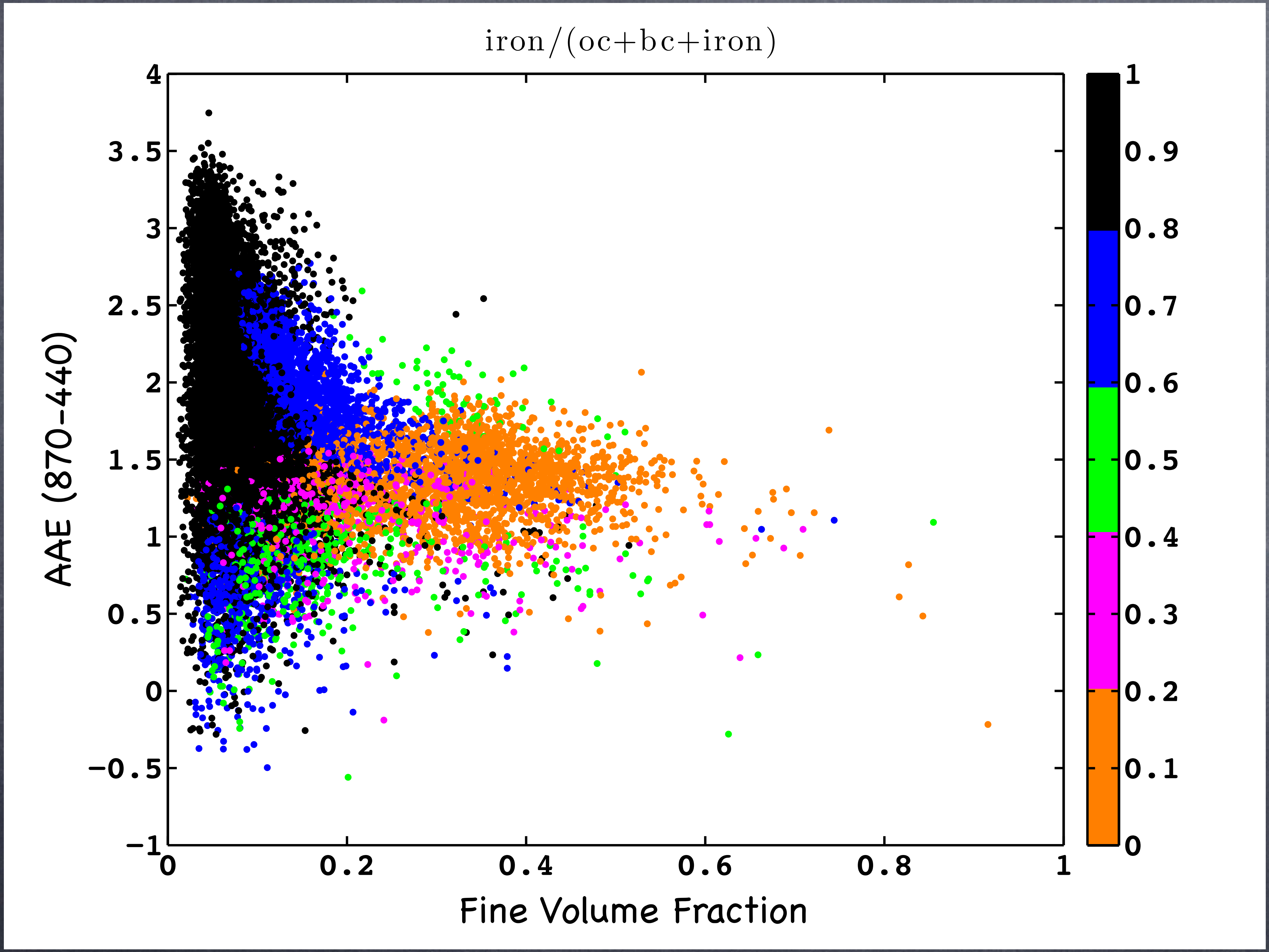
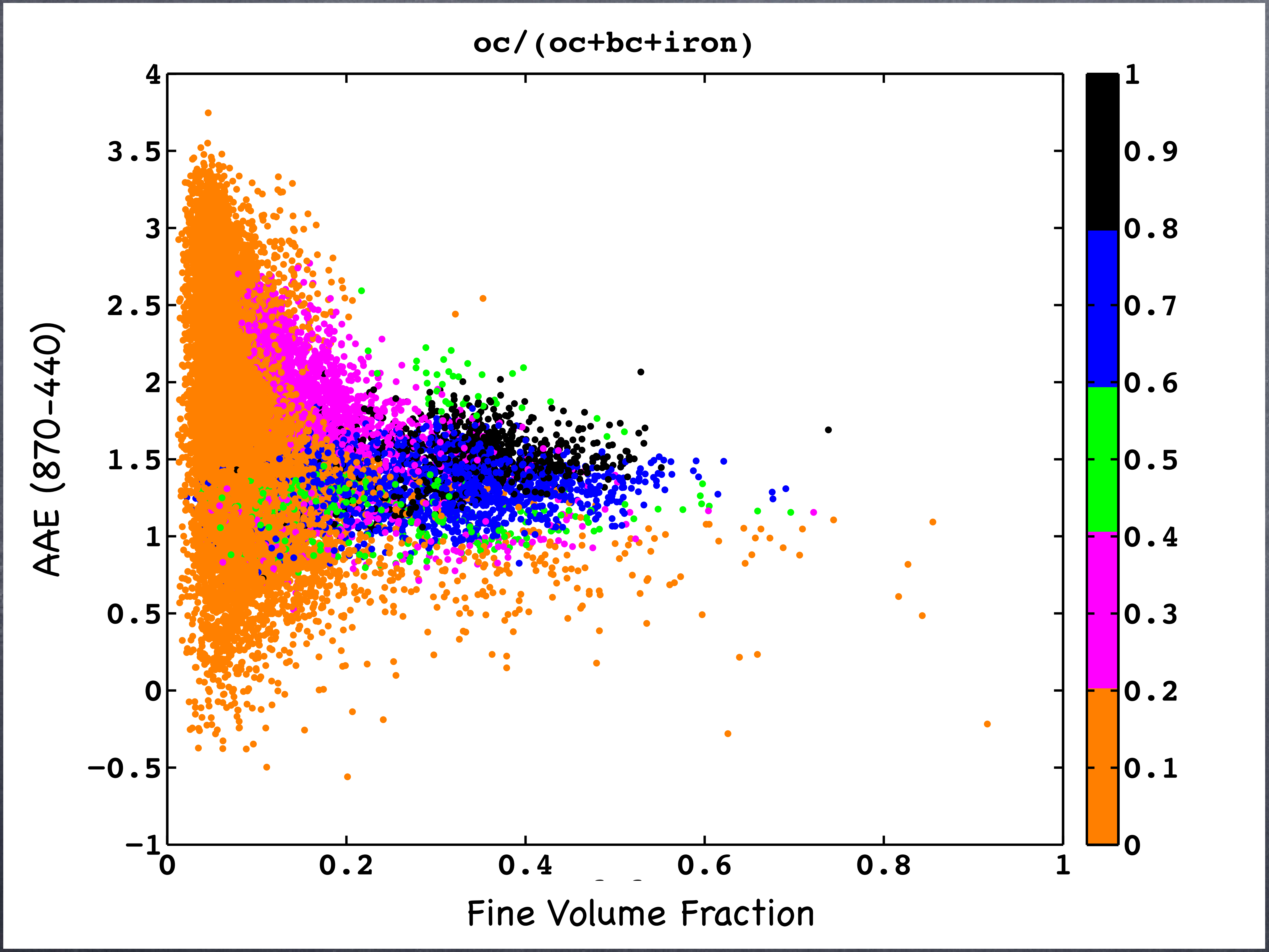


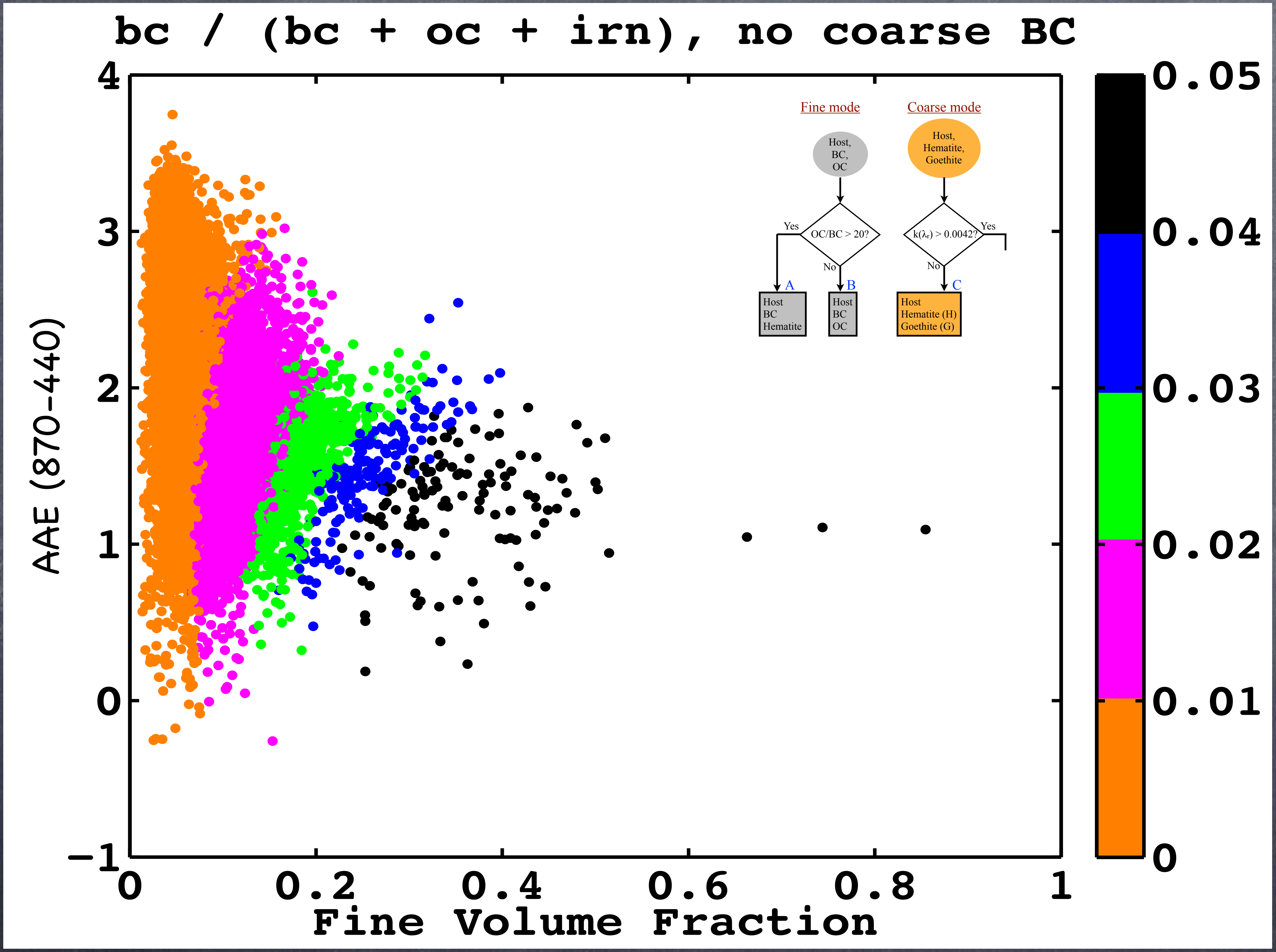
Iron fraction wrt all absorbers, W. Africa



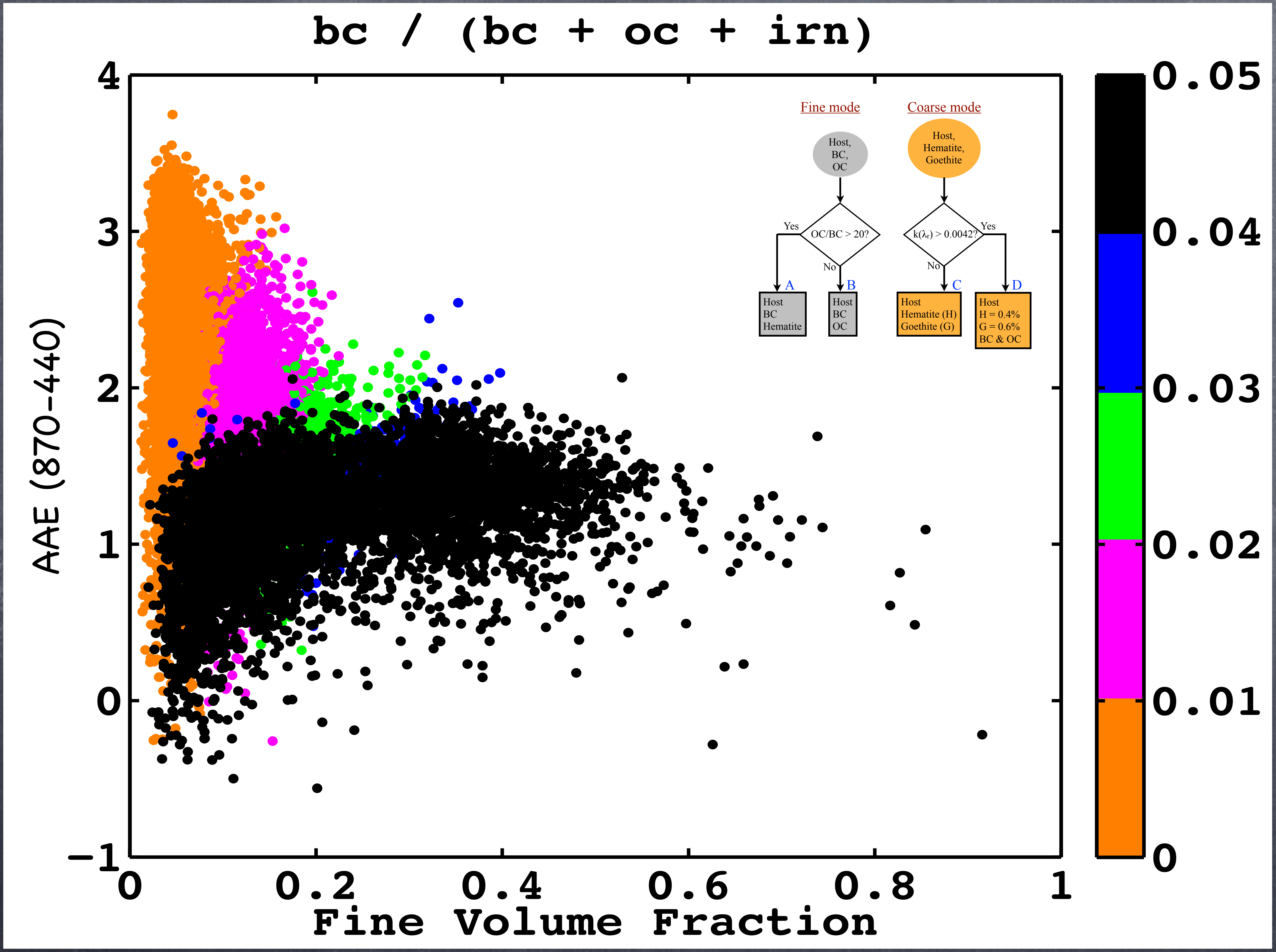
OC fraction wrt all absorbers, W. Africa



BC fraction wrt all absorbers, W. Africa



BC fraction wrt all absorbers, W. Africa



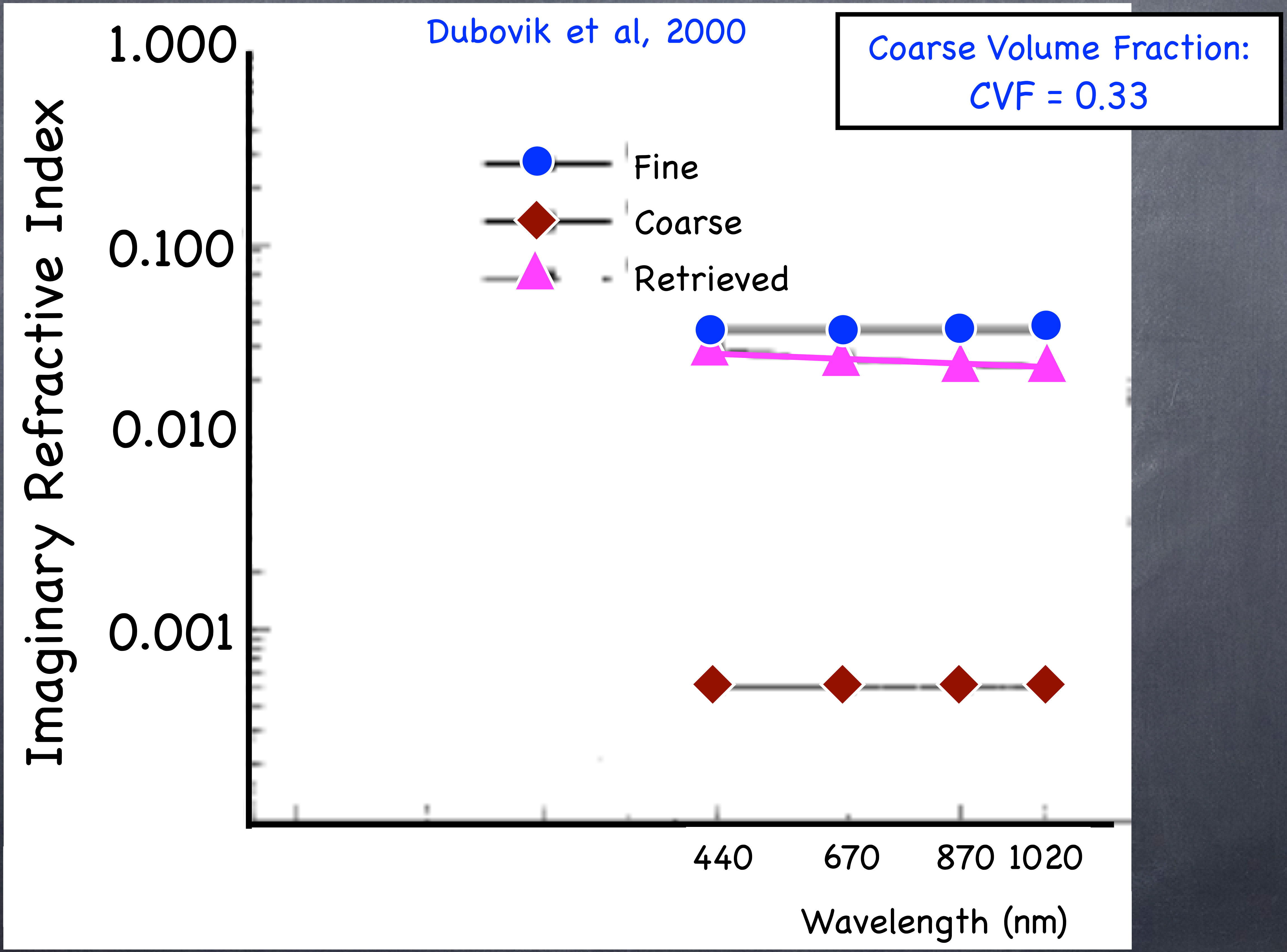
Some thoughts on the use of AERONET retrievals

- AERONET's "coincident" AOD is a separate product from "all" AOD that modelers should check before using the other advanced products. The coincident AOD is always > 0.4 at 440 nm.

- How to handle AAOD at low AOD... Robustness of Lev 1.5 data for climatologies is still questionable (come see my poster!). Modelers should consider subsampling results with AOD > 0.4 to validate/constrain with advanced Lev 2 AERONET products.

- A single refractive index for all particles means that AERONET assumes internal mixing for all particles.

AERONET retrievals sometimes attribute fine mode absorption to the coarse mode



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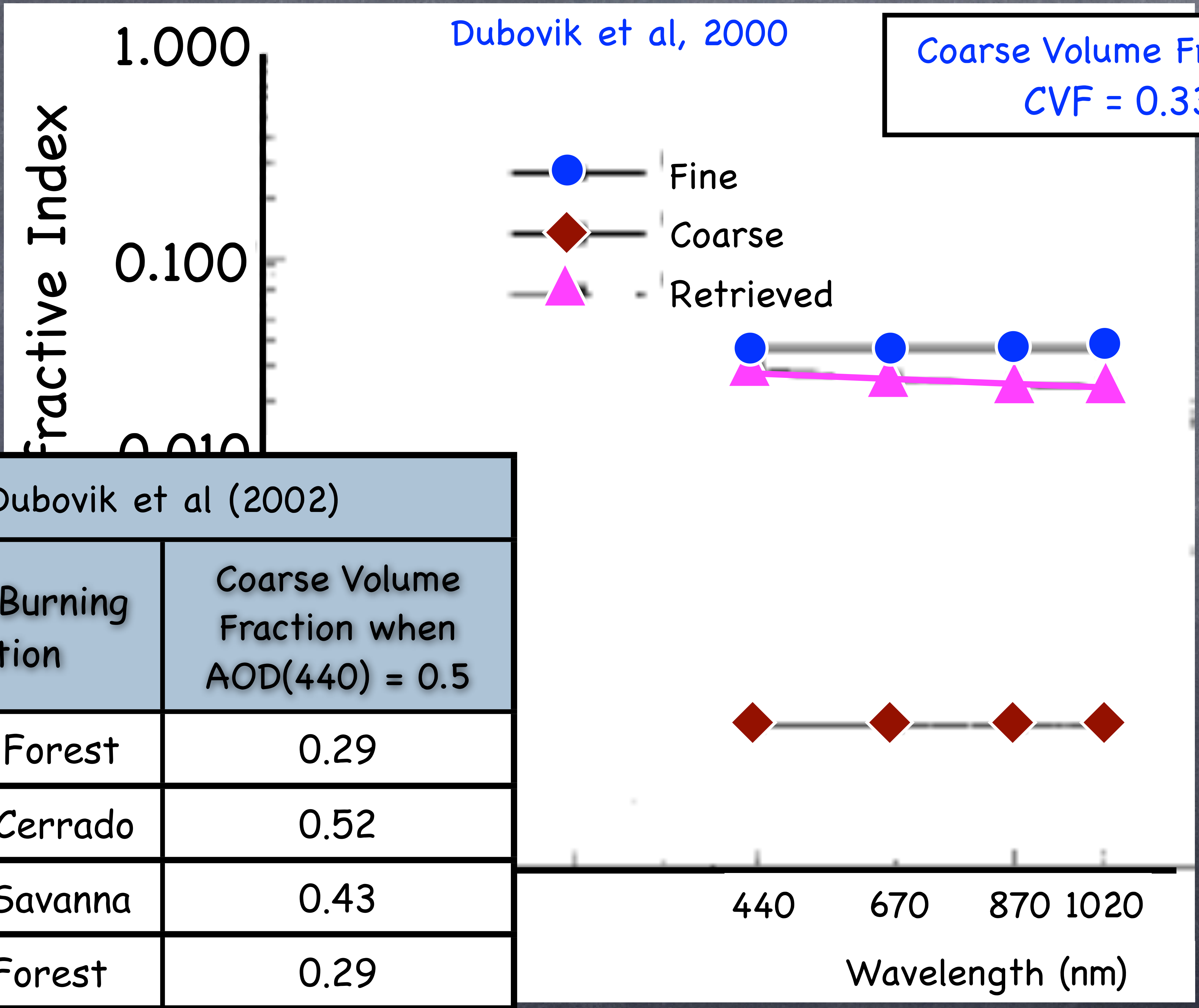

Dubovik et al (2002)	
Biomass Burning Location	Coarse Volume Fraction when AOD(440) = 0.5
Amazon Forest	0.29
S. Amer Cerrado	0.52
African Savanna	0.43
Boreal Forest	0.29

Conclusions

- Retrieval initially deduces two absorbing components in each aerosol mode (BrC/BC in fine mode, hematite/goethite in coarse mode)
- Retrieval makes adjustments to both modes if thresholds are exceeded (BrC/BC > 20 for fine mode, $k > 0.0042$ for coarse mode).
- Seasonal results at West Africa and South America are consistent with expectations.
- Discussed results in context of AAE.