AERONET-based Estimates of Clear-sky Direct Solar Radiative Effect

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Goals

- **Derive efficiency of aerosol direct radiative effect (ADRE) for key aerosol types**
- **Generate a database for evaluating satellite/model-based ADRE assessments**

ADRE Calculations – aerosol data

- **AERONET aerosol**
  - **τ, ω, g (λ=440, 670, 870, 1020 nm)**
  - **total, fine-mode**
  - **monthly (climatology, 2000, 2001, 2002)**

- **Assumptions & uncertainties**
  - ***α (λ >1020nm) = α (870-1020nm)***

    a factor of 2 change of α (λ >1020nm), < ±4%

  - ***ω (λ >1020nm) = ω (λ=1020nm)***

    if ω (λ >1900nm)= 0.2, 3~8%(TOA), 2~4% (SFC)

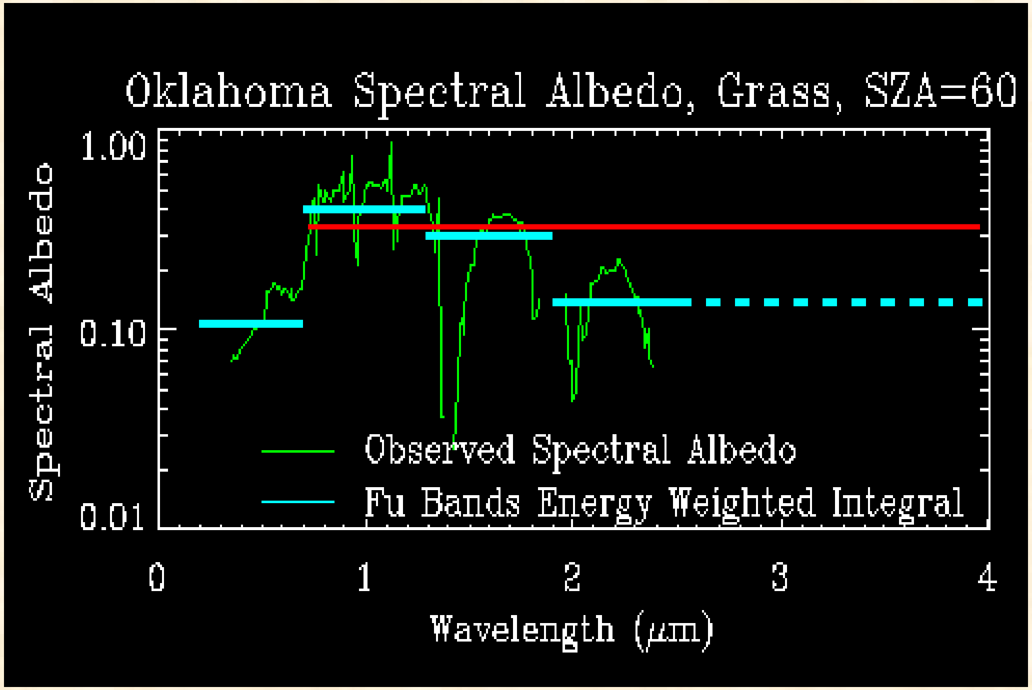
***** if use properties at 550 nm only***

Overestimate TOA forcing by 20%, surface forcing by 10%.

ADRE Calculations – surface albedo

*** MODIS broadband land albedo**

- **0.3~0.7 μm**
- **0.7~5.0 μm**

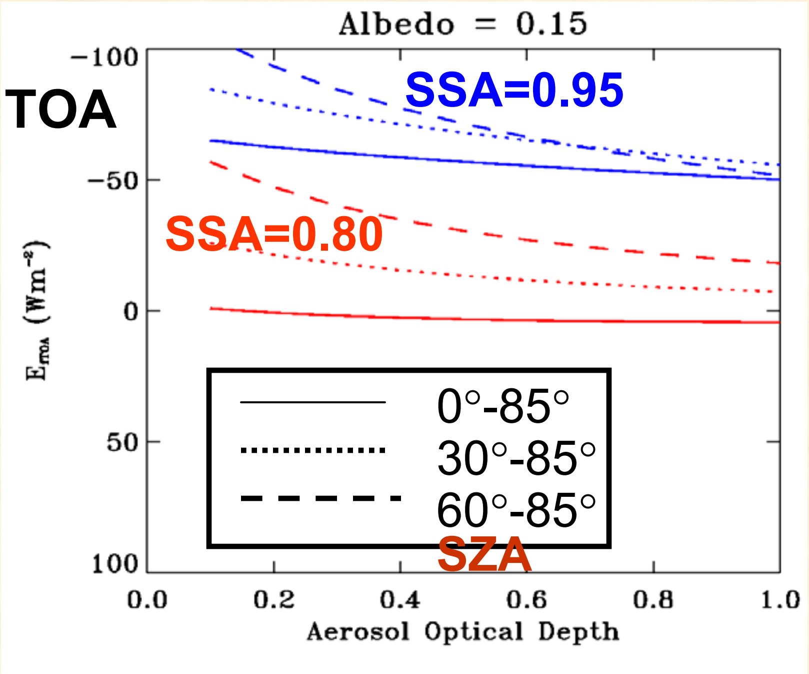


10% underestimate of vegetation albedo at 0.7-1.3 μm

⇒ <7% overestimate of forcing

ADRE Efficiency for Key Aerosol Types

- **ADRE Efficiency (E)**
  - $E = \Delta(F\downarrow - F\uparrow) / \tau_{550}$ (TOA & surface)
- **Dependence on optical depth, latitude, season**



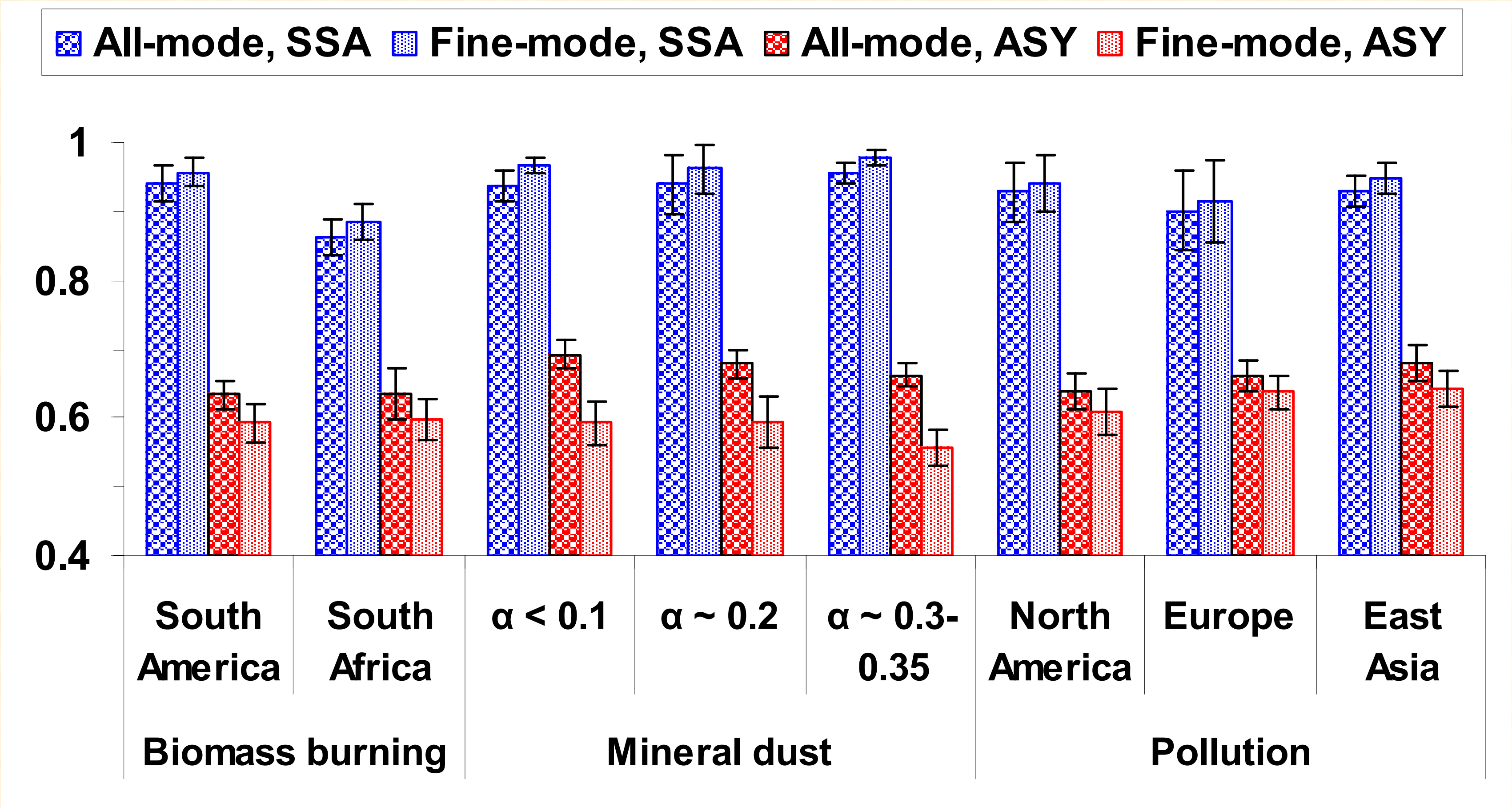
E decreases with increasing AOD;

greater in high latitudes and winter than in low latitudes, and summer

Site Selection: full annual cycle of aerosol climatology

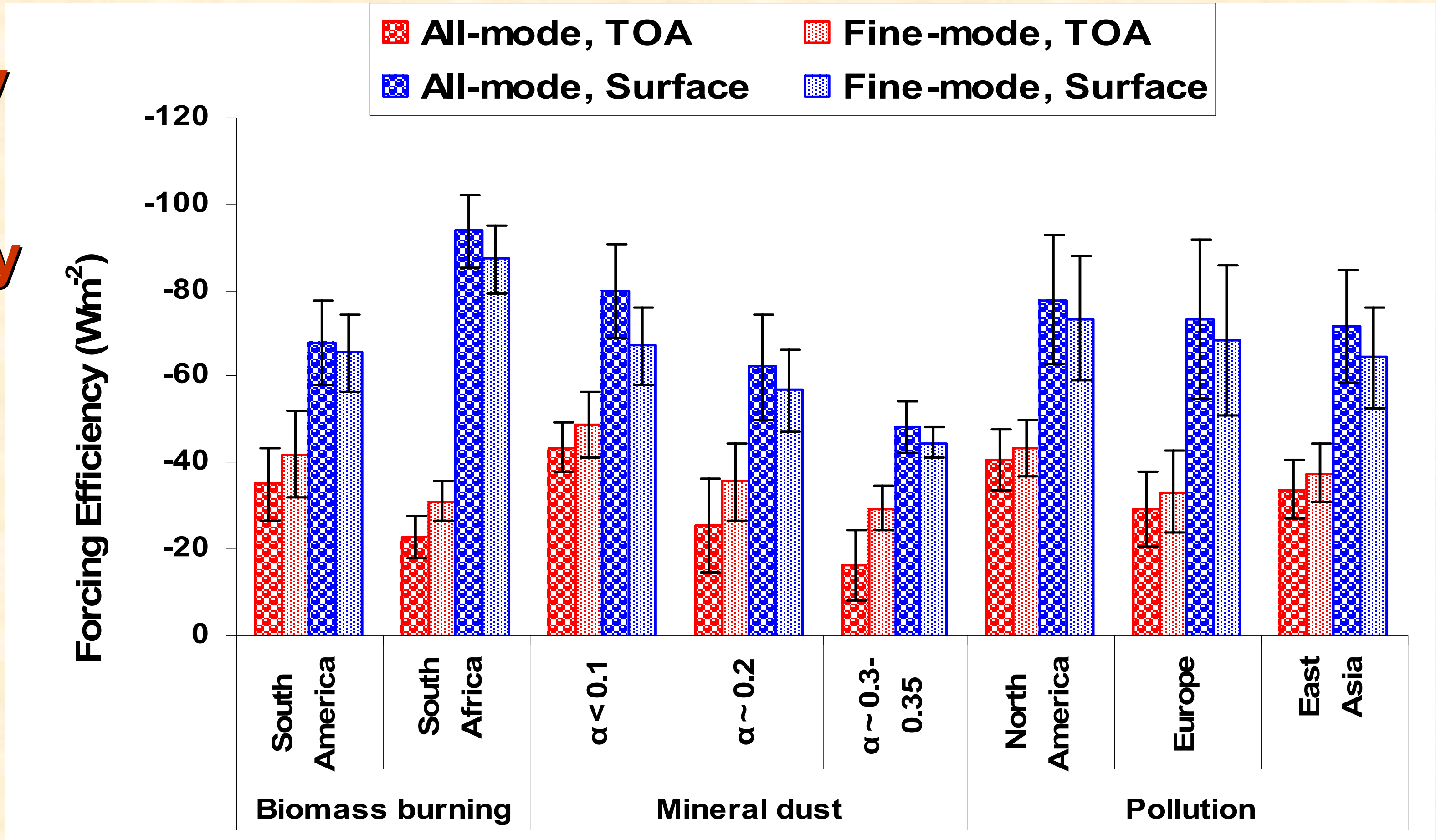
Aerosol Type	Region	AERONET Stations
Biomass Burning	S. America	Alta_Floresta
	S. Africa	Mongu, Skukuza
Mineral Dust	albedo~0.1	Capo_verde, Baharain
	albedo~0.2	Ilorin, Nes_Ziona
	albedo:0.3~0.35	Banizoumbou, SEDE_BOKER, Solar_Village
Pollution	N. America	COVE, GSFC, Oyster, MD_Science_Center, SERC, Stennis, Wallops
	W. Europe	Ispra, Lille, Moldova, Venise
	E. Asia	Anmyon, NCU_Taiwan, Shirahama

Fine-mode vs All-mode



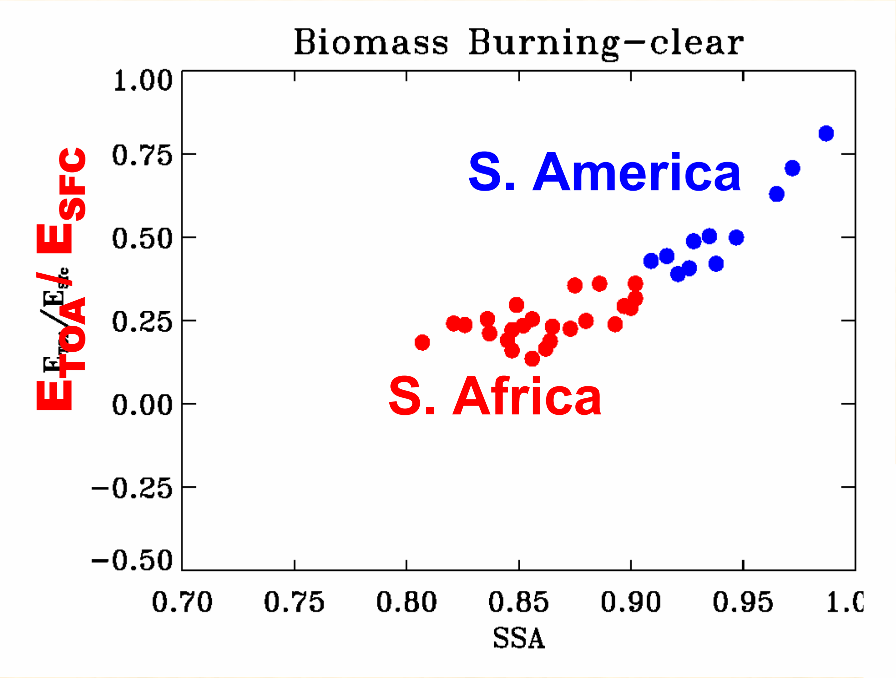
- Fine mode has a larger single-scattering albedo (SSA), smaller asymmetry factor (ASY)

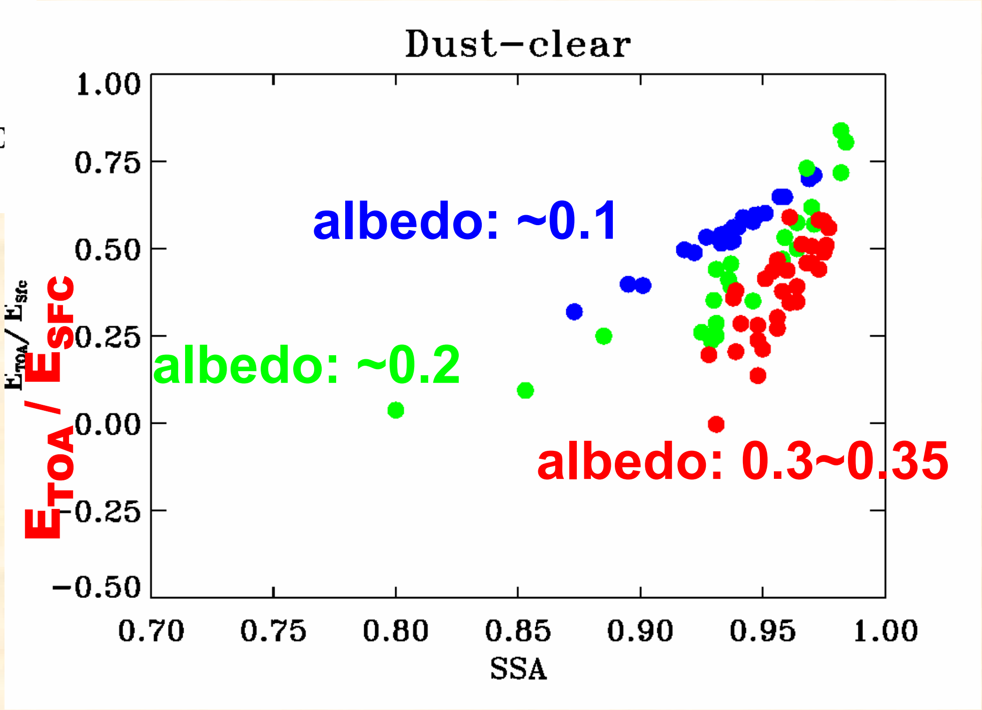
Clear-sky ADRE Efficiency



- A large range of ADRE efficiency:
  - TOA = -15 ~ -50W/m2; SFC = -45 ~ -90W/m2
- Fine mode aerosol has a more negative forcing at TOA, a less negative forcing at surface (larger SSA & smaller asy. factor)

E_{TOA}/E_{SFC} vs. SSA





For dust, surface albedo is another factor: SSA-dependence much stronger for bright desert than for dark ocean.

Evaluate Satellite/Model-based Aerosol Direct Effect

- ***CCSP project: "A review of measurement based assessment of aerosol radiative forcing and aerosol sources."***
  - **Coordinators: Yoram Kaufman & Mian Chin *(NASA GSFC)*, Graham Feingold *(NOAA ETL)***

- **Goals:**
  - Assessments of the aerosol distribution & direct radiative effects using satellites supplemented by chemical transport models.
  - Assessment of the anthropogenic component, using satellite data and models.
  - Evaluation of the assessments against surface network data and field experiments. Comparison of the assessments to model estimates.

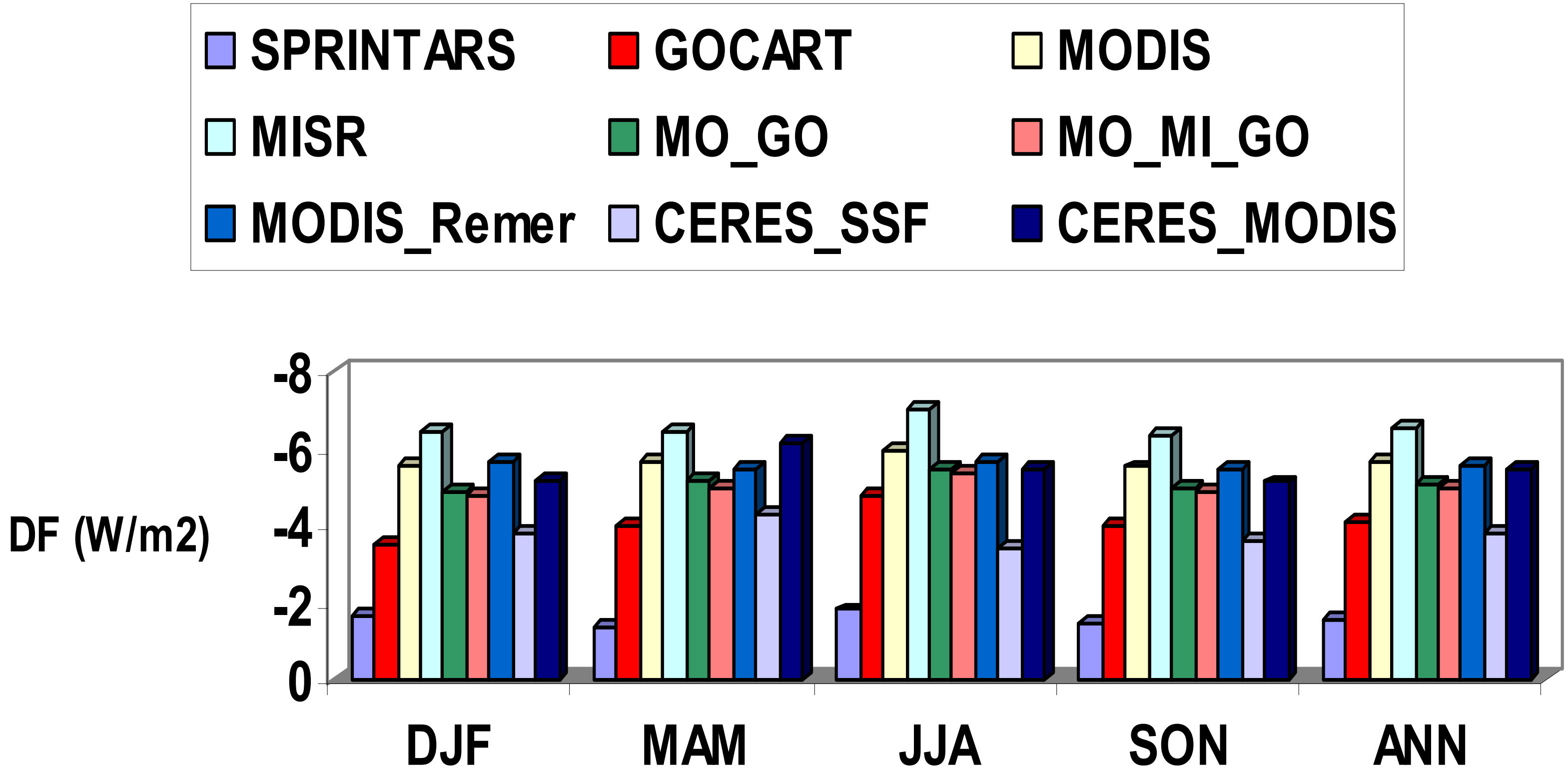
Global & Regional ADRE Comparisons

- Clear-sky, solar, monthly average for 2001. Using different aerosol optical depths:
  - GOCART: GOCART alone
  - MODIS: only gaps filled with GOCART
  - MISR: only gaps filled with GOCART (if any)
  - MO_GO: MODIS + GOCART integration (Kalman filter)
  - MO_MI_GO: MODIS (O) +MISR (L) +GOCART integration

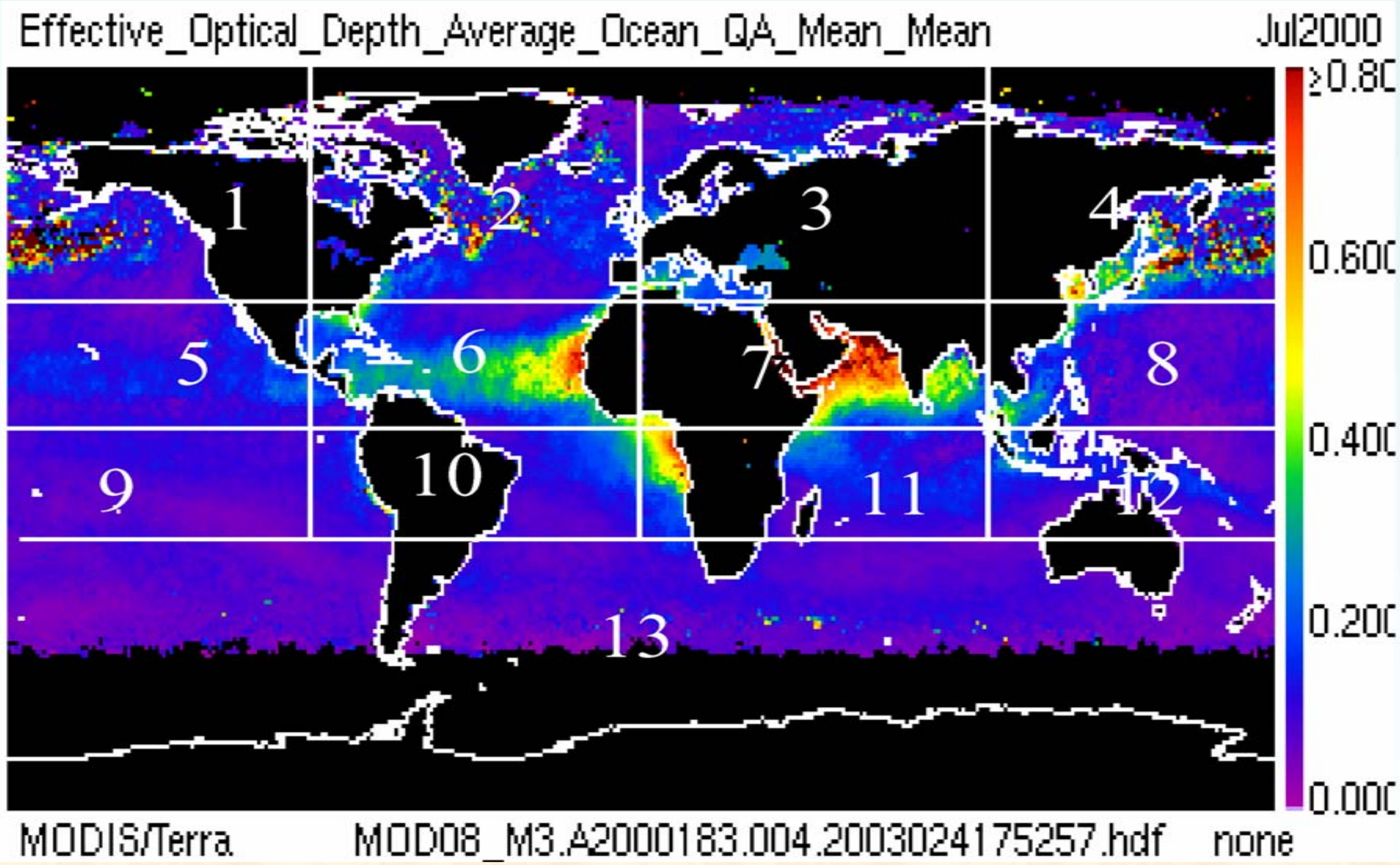
  ** Other aerosol parameters from GOCART; land albedo from MODIS, ocean albedo from Jin et al., 2004.

- Other clear-sky ADRE estimates for intercomparison
  - MODIS_Remer: AOD + aerosol models used *(2001-2004, Remer)*
  - CERES_SSF: NOAA NESDIS radiance *(2000, Loeb)*
  - CERES_MODIS: MODIS radiance *(2000, Loeb)*
  - *Sundar Christopher's estimate: CERES+MODIS*
  - SPRINTARS: clear-sky simulations *(2001, Takemura)*

60°S ~ 60°N Ocean TOA Forcing Clear-sky



Divisions of 13 Regions



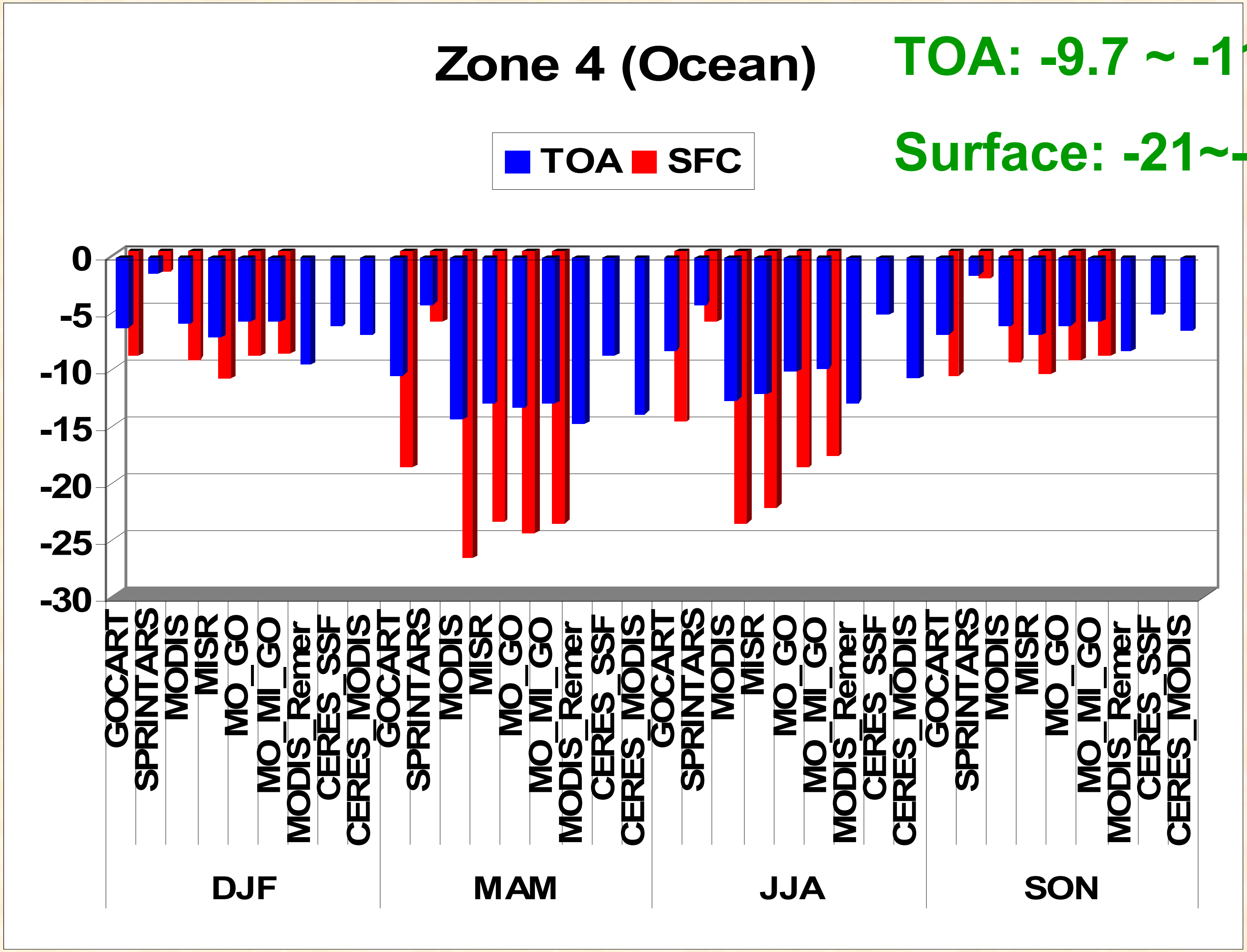
Land / Ocean separately, seasonal average

*** comparisons for "plumes" (easy to connect with intensive field experiments)**

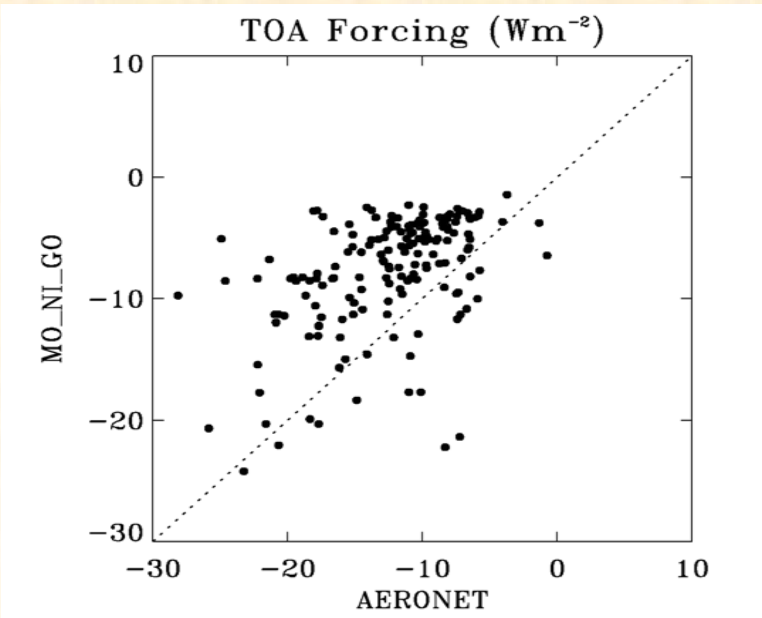
ACE-Asia (20-50N, 100-150E, April 5-15, 2001) [Seinfeld et al.,BAMS, 2004]:

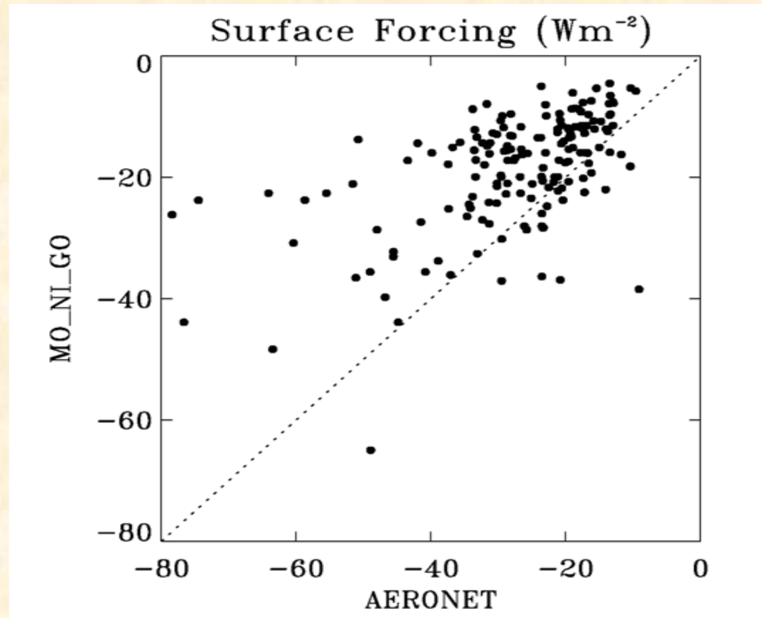
TOA: -9.7 ~ -11 W/m2

Surface: -21~-23.5 W/m2



Evaluation of Satellite/Model-based Forcing Estimates

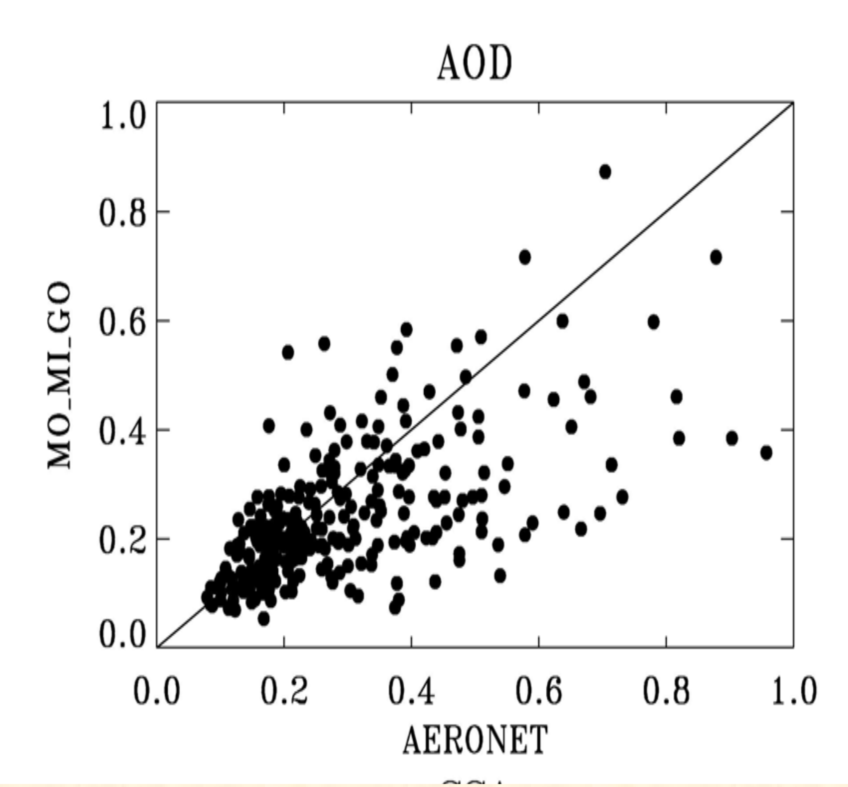


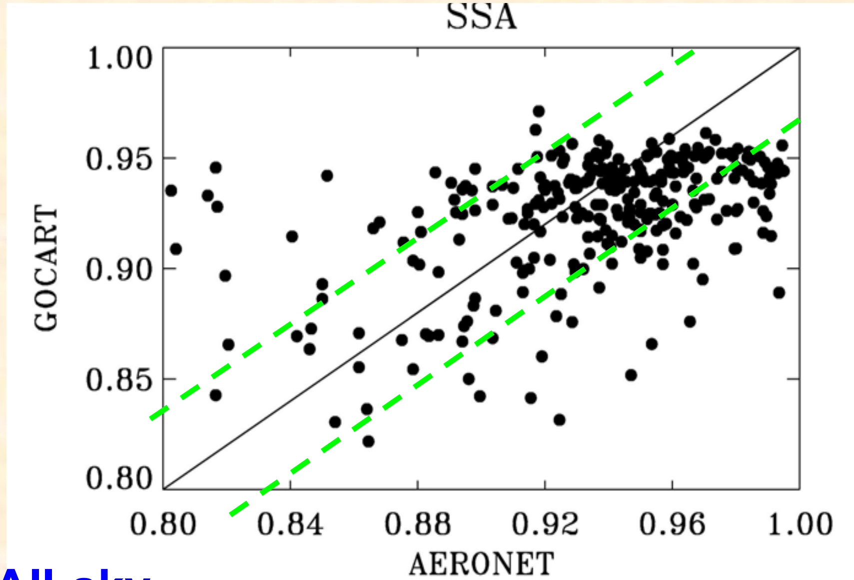


2001, AERONET AOD > 0.2

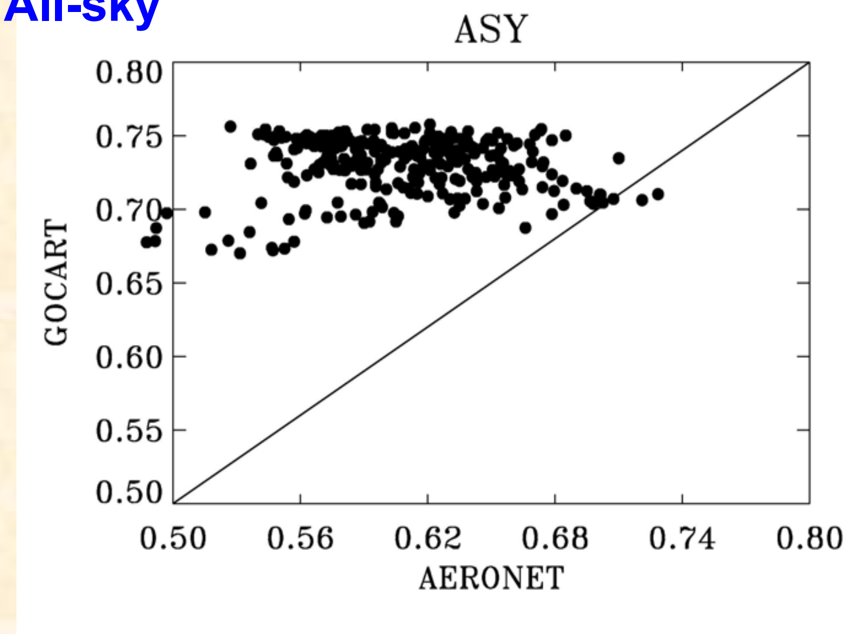
MO_MI_GO: MODIS (ocean) + MISR (land) + GOCART integration

What Cause Differences?





All-sky



Need to extract clear-sky asymmetry factor

END

THANKS!