Aerosol Direct Forcing PI Product

Direct Aerosol Forcing: Calculation from Observables and Sensitivities to Inputs

Allison McComiskey
Stephen Schwartz
Beat Schmid
Hong Guan
Ernie Lewis
Paul Ricchiazzi
John Ogren

Approach

- aerosol direct radiative forcing at TOA and SRF
- variation with τ, ω, g, *and α*
- sensitivity $S_i = \frac{\partial F}{\partial p_i}$
- uncertainty $\Delta F_i = S_i \Delta p_i$ $\quad \Delta F = \left[\left(\frac{\partial F}{\partial \tau} \Delta \tau \right)^2 + \left(\frac{\partial F}{\partial \omega} \Delta \omega \right)^2 + \left(\frac{\partial F}{\partial g} \Delta g \right)^2 + \left(\frac{\partial F}{\partial \alpha_{UVV}} \Delta \alpha_s \right)^2 \right]^{1/2}$
- two models: SBDART and RRTM

Approach

3 Quantities:

$\overline{F_S}$: spectrally averaged, diurnally averaged

$\overline{F_{0.55}}$: 0.55 μm, diurnally averaged

$F_S(\theta)$: spectrally averaged, θ=30˚ (TWP), 45˚ (SGP), 70˚ (TWP)

Approach

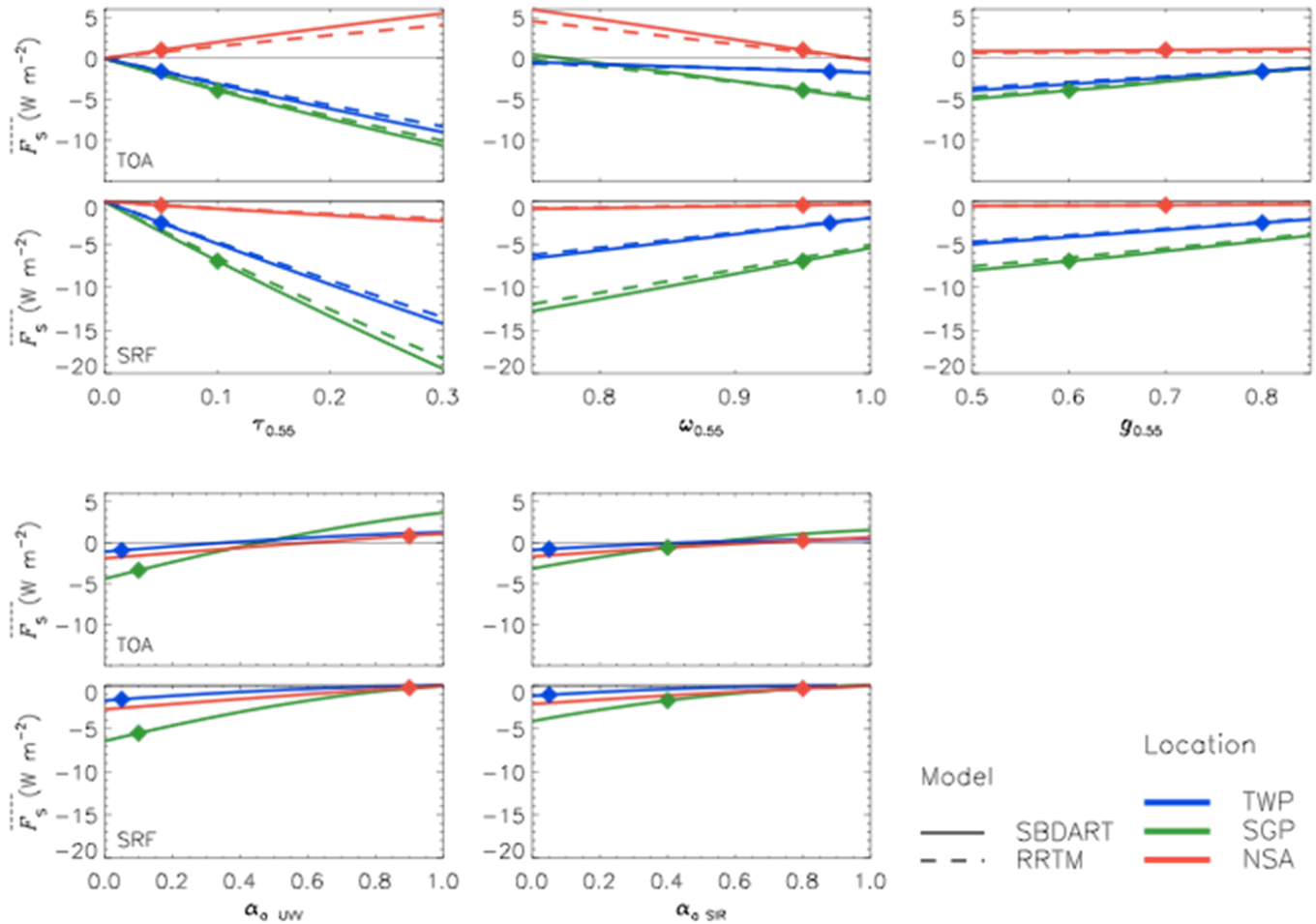
3 Sites:

	TWP	SGP	NSA
Latitude	0.52˚N	36.61˚N	71.32˚N
$\tau(0.55)$	0.05	0.1	0.05
$\omega(0.55)$	0.97	0.95	0.95
$g(0.55)$	0.8	0.6	0.7
$å_{sp}$	0.52˚N	1.0	1.5
$å_{ap}$	1.0	1.0	1.0
α_{UVV}	0.05	0.1	0.9
α_{SIR}	0.05	0.4	0.8
λ_g (μm)	5.0	5.0	5.0
θ	30˚	45˚	70˚

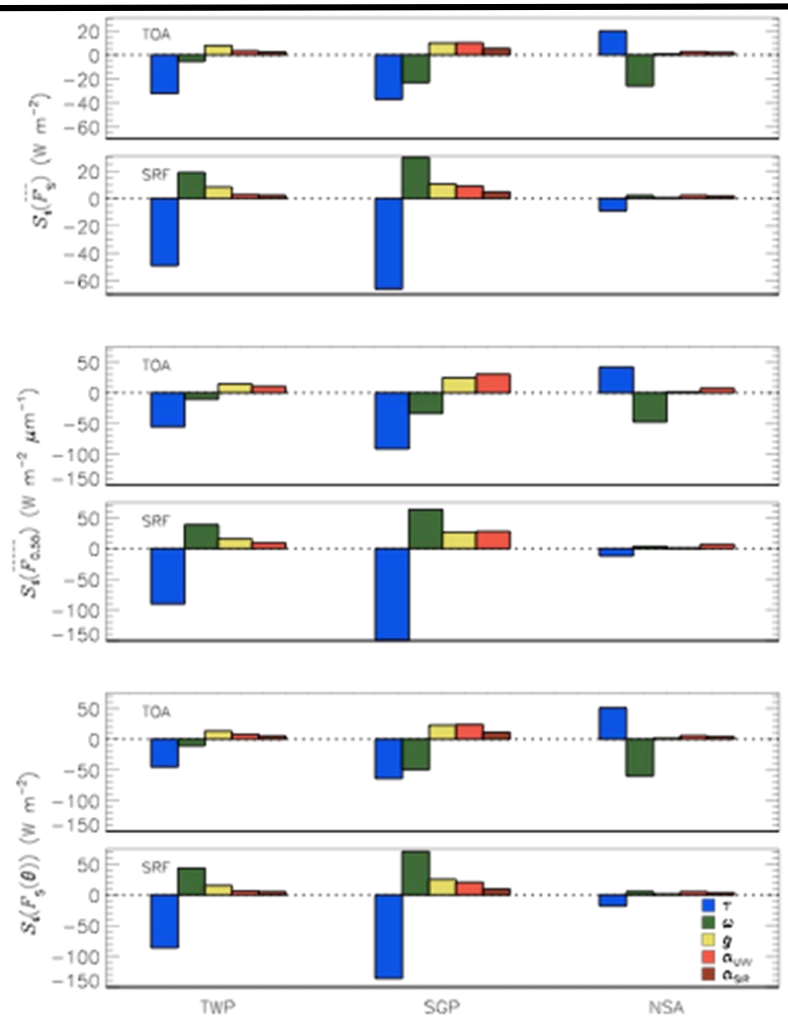
Measurement Uncertainties

Property p_i	Range	Uncertainty Δp_i
$\tau(0.55)$	0.0 - 0.3	0.01
$\omega(0.55)$	0.75 - 1.0	0.03
$g(0..55)$	0.50 - 0.75	0.05
α_{UVV}	0.0 - 1.0	0.05
α_{SIR}	0.0 - 1.0	0.05

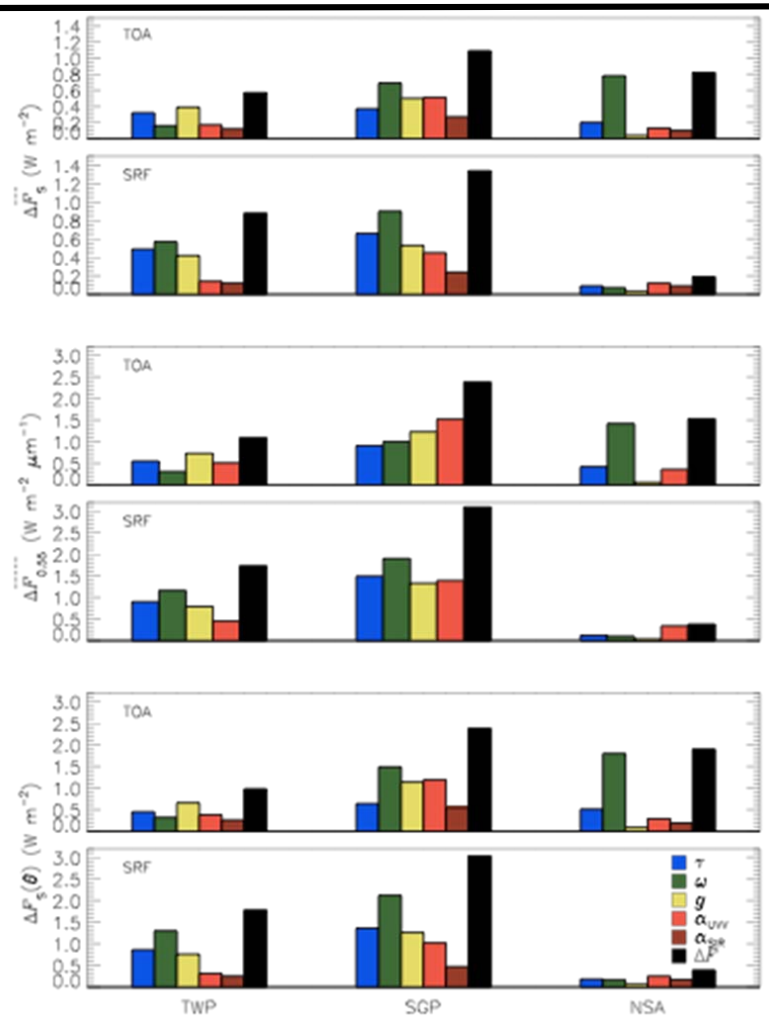
Direct Radiative Forcing (Quantity 1)



Sensitivity



Uncertainty



Summary of Base Cases

➢ Absolute and fractional uncertainties at TOA and SRF for 3 quantities at 3 sites

absolute: 0.2 - 3.1 W m^{-2}

fractional: 20 - 80 %

➢ Absolute and fractional model differences (SBDART-RRTM)

absolute: 0.0 - 6.3 W m^{-2}

fractional: 0.0 - 33.0 %

PI Product

- ➢ radiative forcing for full range of aerosol/surface properties

- ➢ DRF uncertainty for specific measurement uncertainties

- ➢ radiative forcing efficiency