Validation of CERES Unfiltering Algorithm

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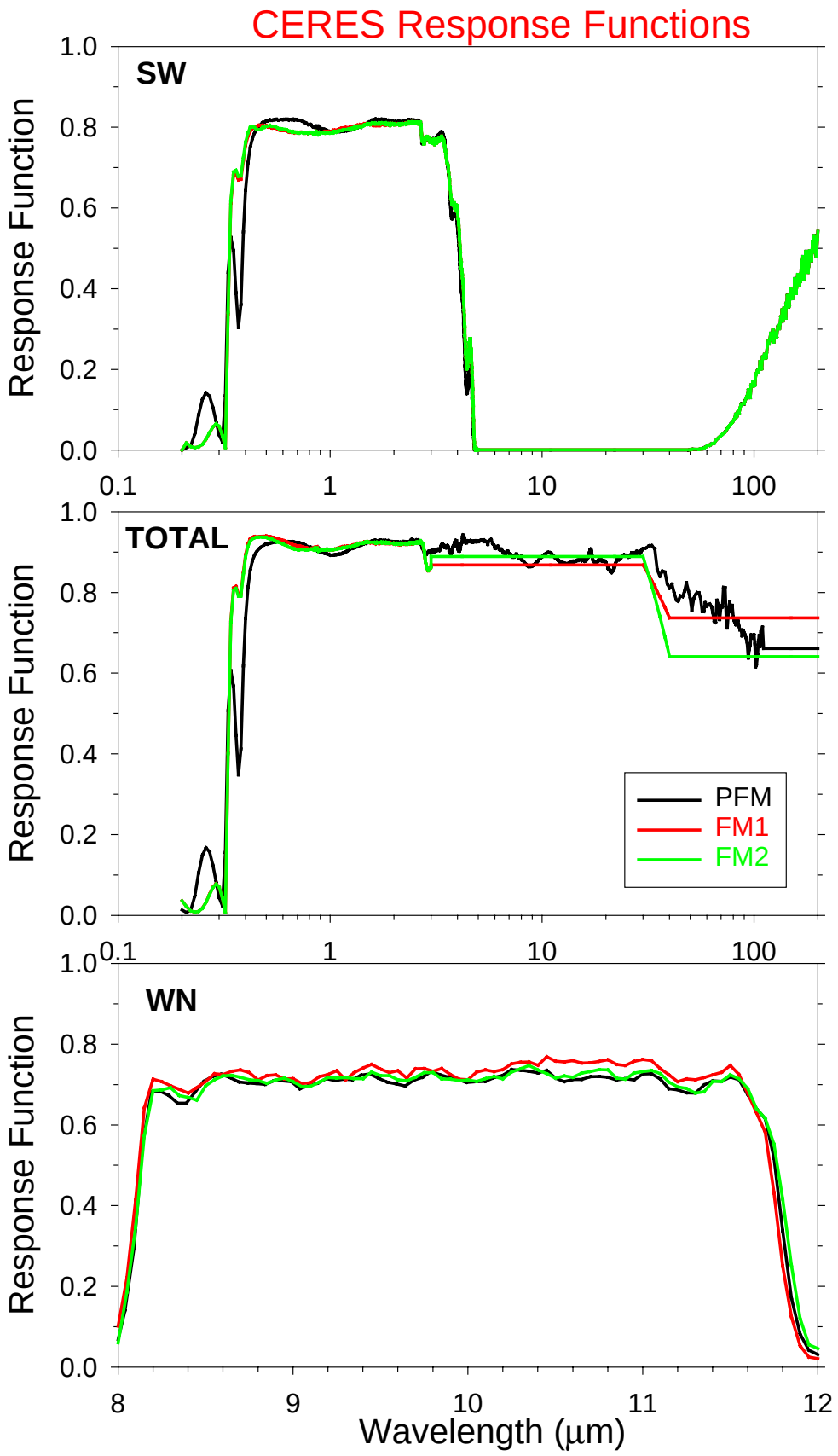
Approach

1. Determine uncertainties in SW, LW and WN radiances for PFM (TRMM), FM1 and FM2 (Terra) using theoretical test cases (MODTRAN).

2. Examine coincident FM1 and FM2 Terra data by scene type.

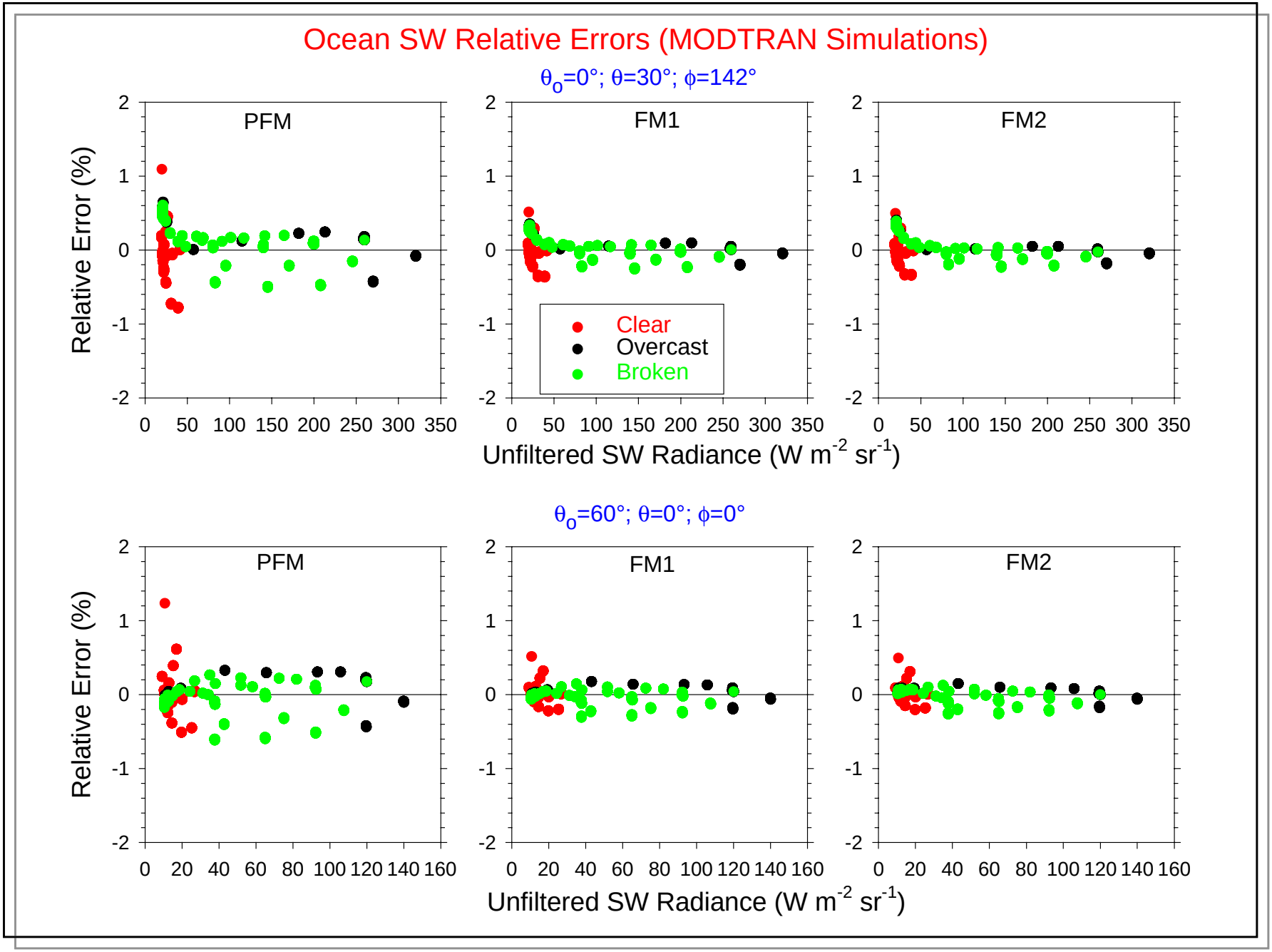

CERES Response Functions
SW
TOTAL
WN
Response Function
Wavelength (µm)
PFM
FM1
FM2
1.0
0.8
0.6
0.4
0.2
0.0
0.1
1
10
100
8
9
10
11
12

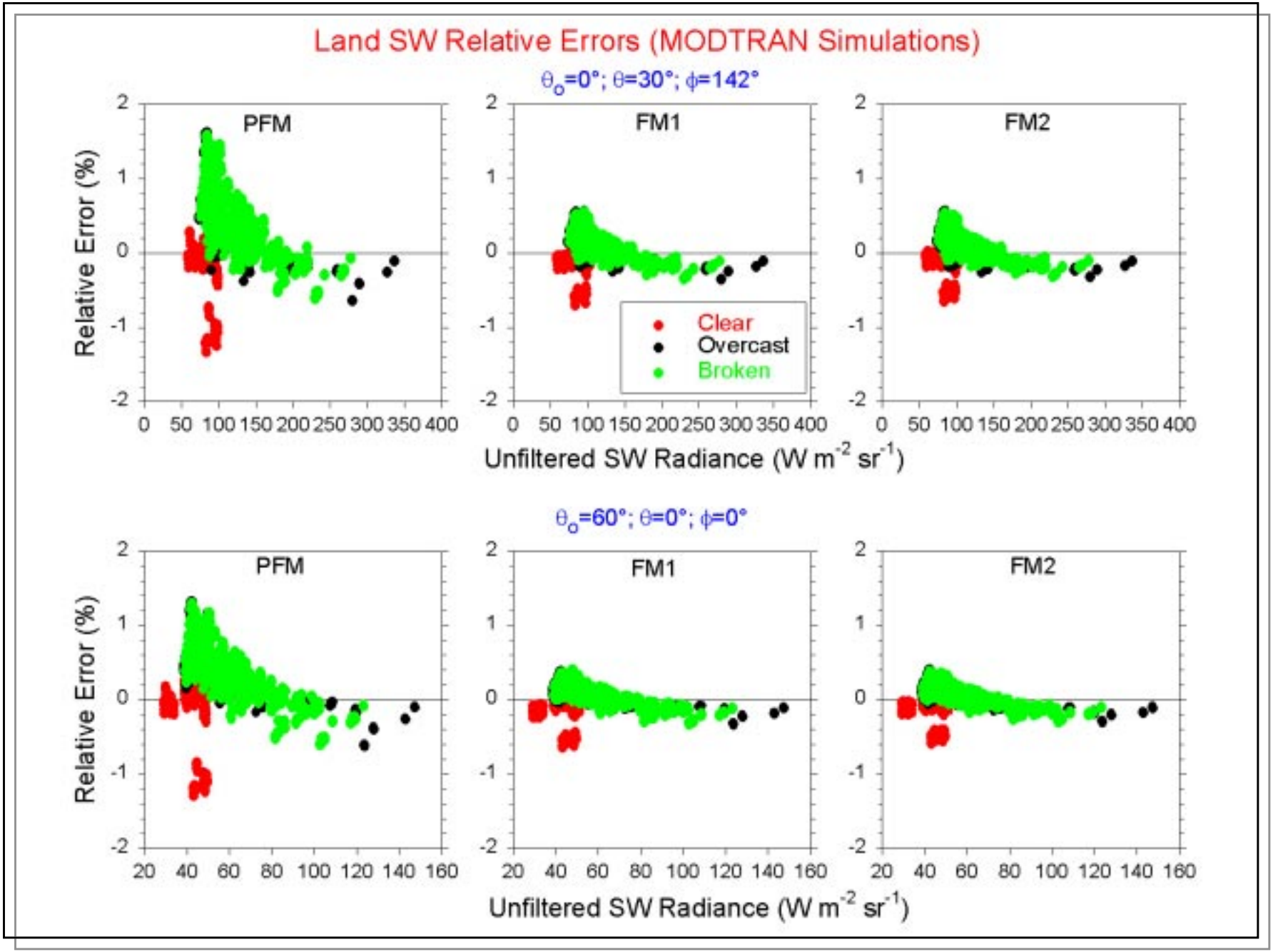
Ocean Test Cases

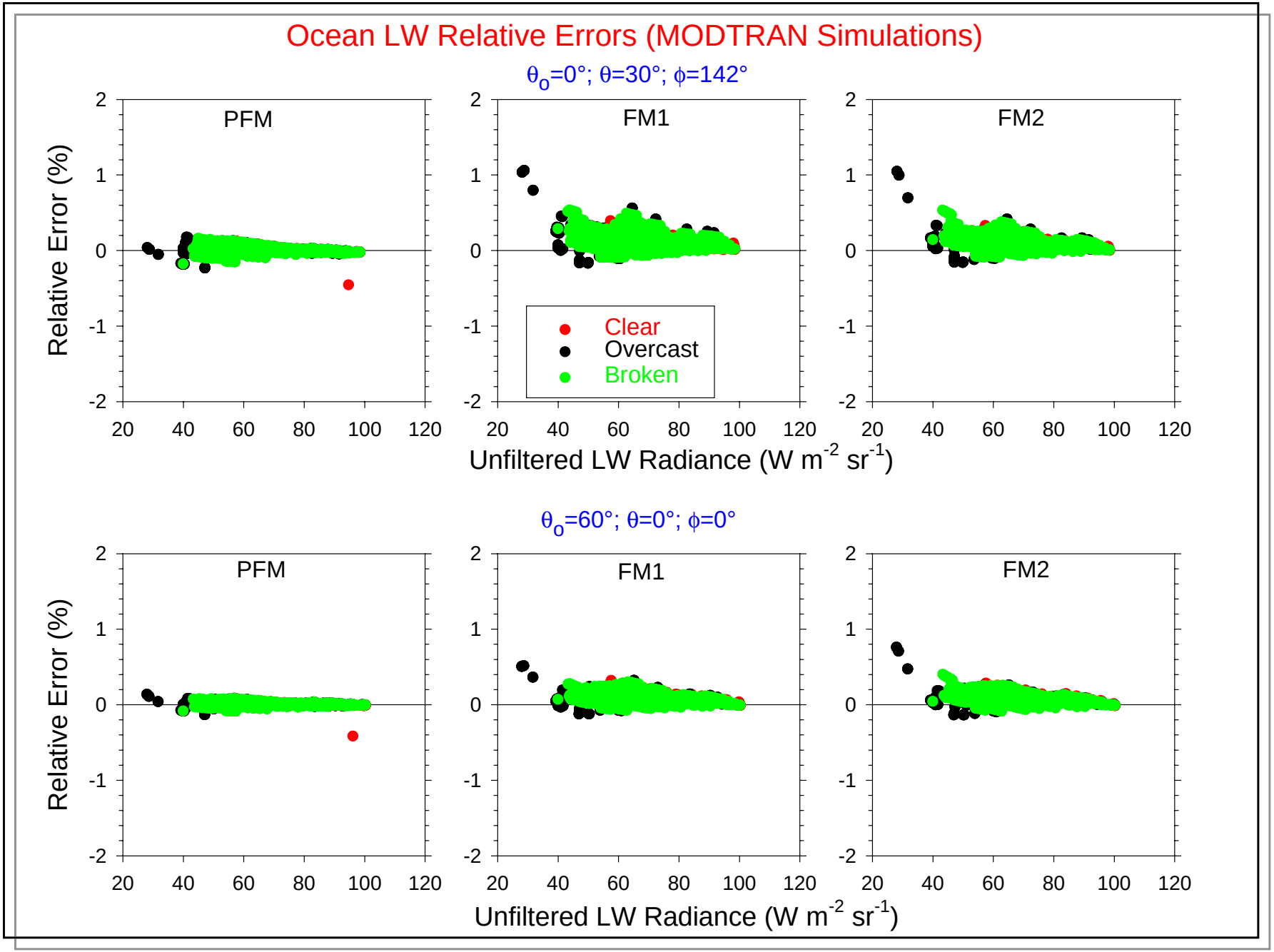
Atmospheric Profile (Boundary Temperature (K))	Aerosol Type (0.55 μm Optical Depth)	Cloud Type (0.55 μm Optical Depth; Cld Top Height (km))
Tropical (T_b=280 – 310)	None	Cumulus (τ=217; z_t=3)
Midlatitude Summer (T_b=270 – 300)	Maritime (τ=0.02 - 1.0)	Stratus (τ=38; z_t=1)
Midlatitude Winter (T_b=250 – 280)	Rural (τ=0.02 - 1.0)	Cirrus (τ=0.05 - 30; z_t=7 – 13)
Subarctic Summer (T_b=260 – 290)	Urban (τ=0.02 - 1.0)	Subvisual Cirrus (τ=0.01 – 0.05; z_t=12)
Subarctic Winter (T_b=240 – 270)	Desert (τ=0.02 - 1.0)	Deep Convection (τ=217; z_t=15 - 17)
	INDOEX (τ=0.13)	

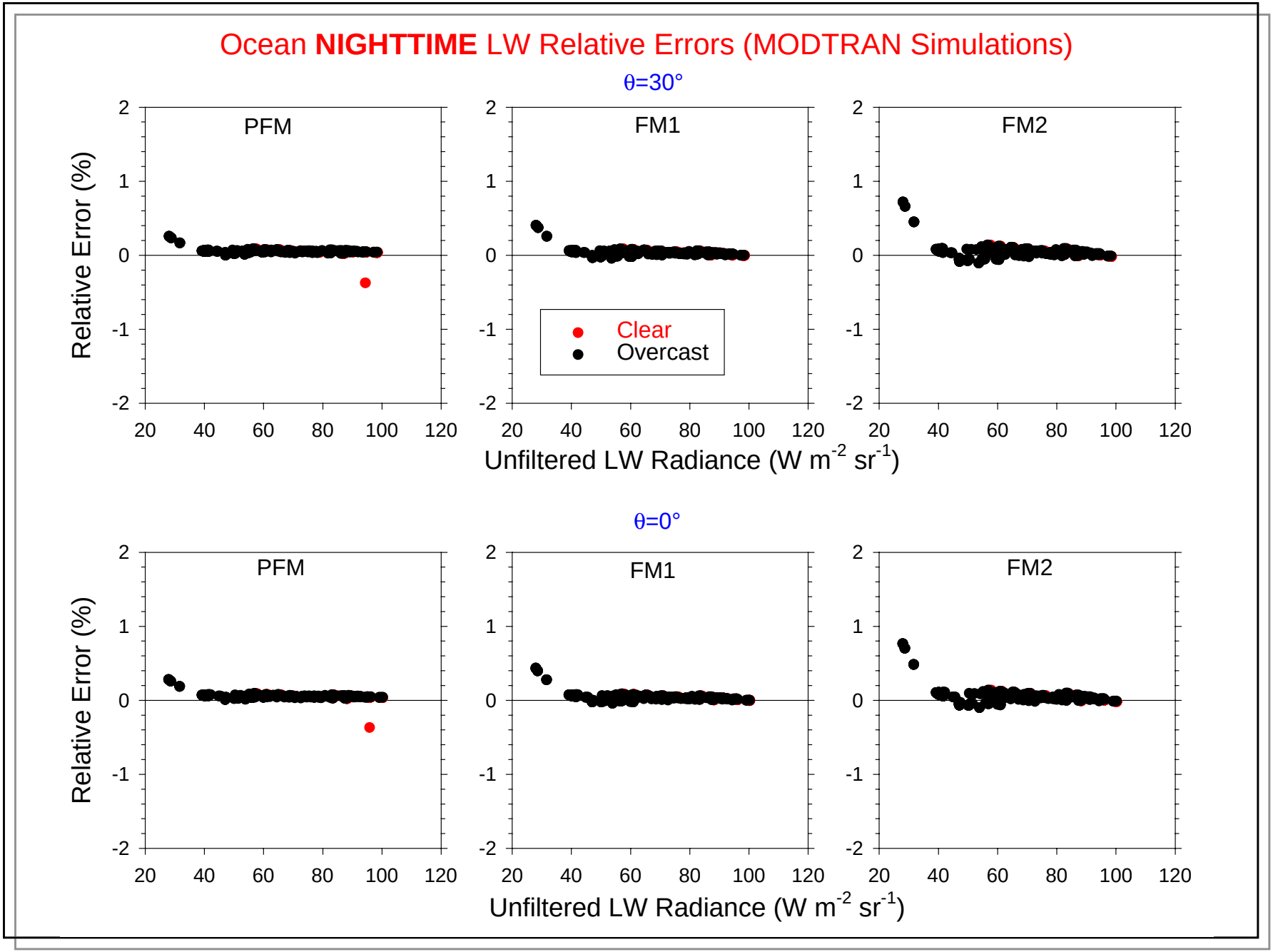
Land Test Cases

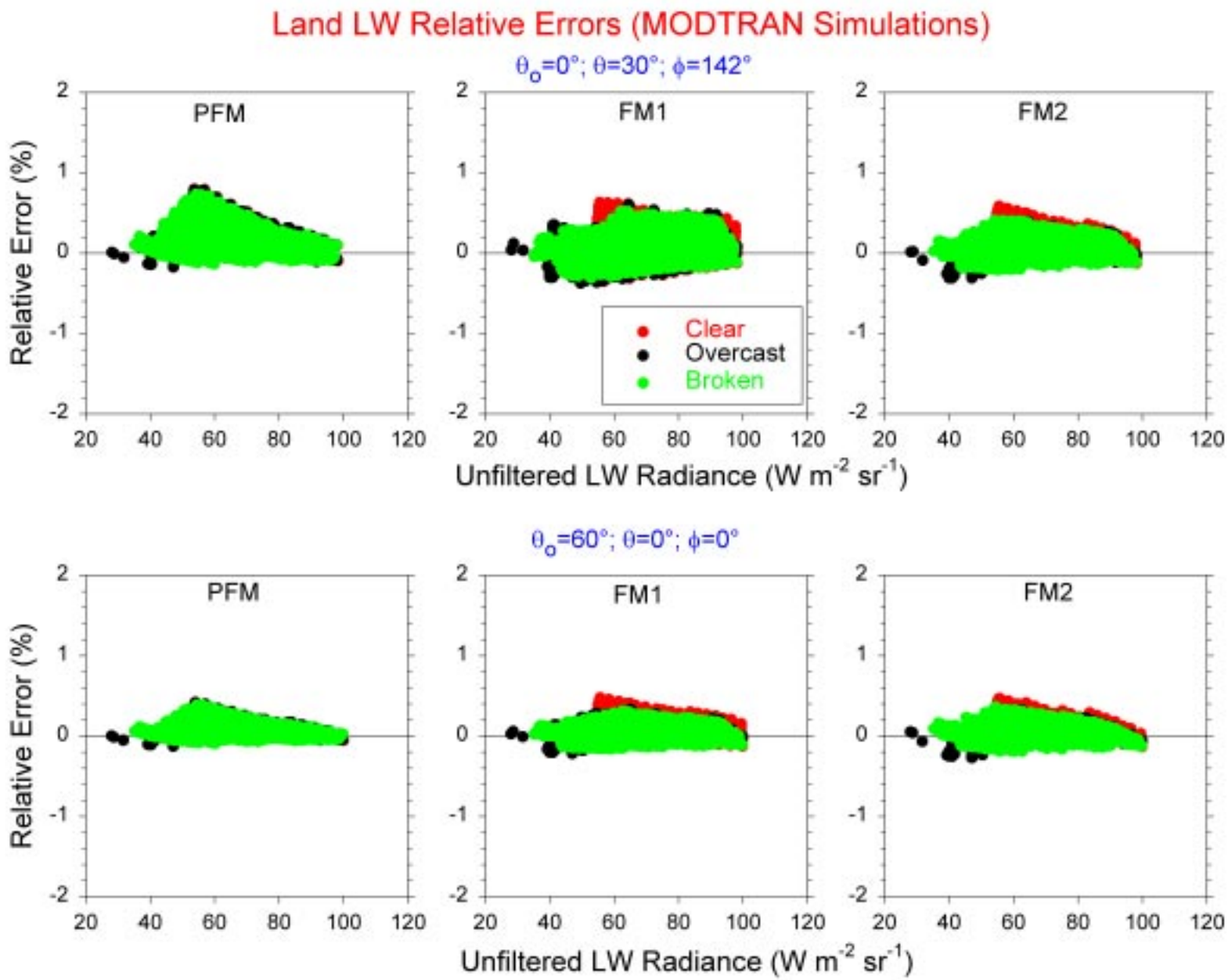
Surface	Aerosol Type	Aerosol Optical Depths (at 0.55 μm)
Dry sand (Bowker, 1985)	Desert	0.0, 0.15
Dry meadows grass (Tarnopolskiy, 1978)	Rural, Urban	0.0, 0.16, 1.2
Conifers (JPL, 1998)	Rural, Urban	0.0, 0.16, 1.2
Deciduous (JPL, 1998)	Rural, Urban	0.0, 0.16, 1.2
Grass (JPL, 1998)	Rural, Urban	0.0, 0.16, 1.2
Brown silty loam (JPL, 1998)	Rural, Urban	0.0, 0.16, 1.2
Dark reddish brown loam (JPL, 1998)	Rural, Urban	0.0, 0.16, 1.2
Reddish brown loam (JPL, 1998)	Rural, Urban	0.0, 0.16, 1.2
Dark reddish brown silty loam (JPL, 1998)	Rural, Urban	0.0, 0.16, 1.2

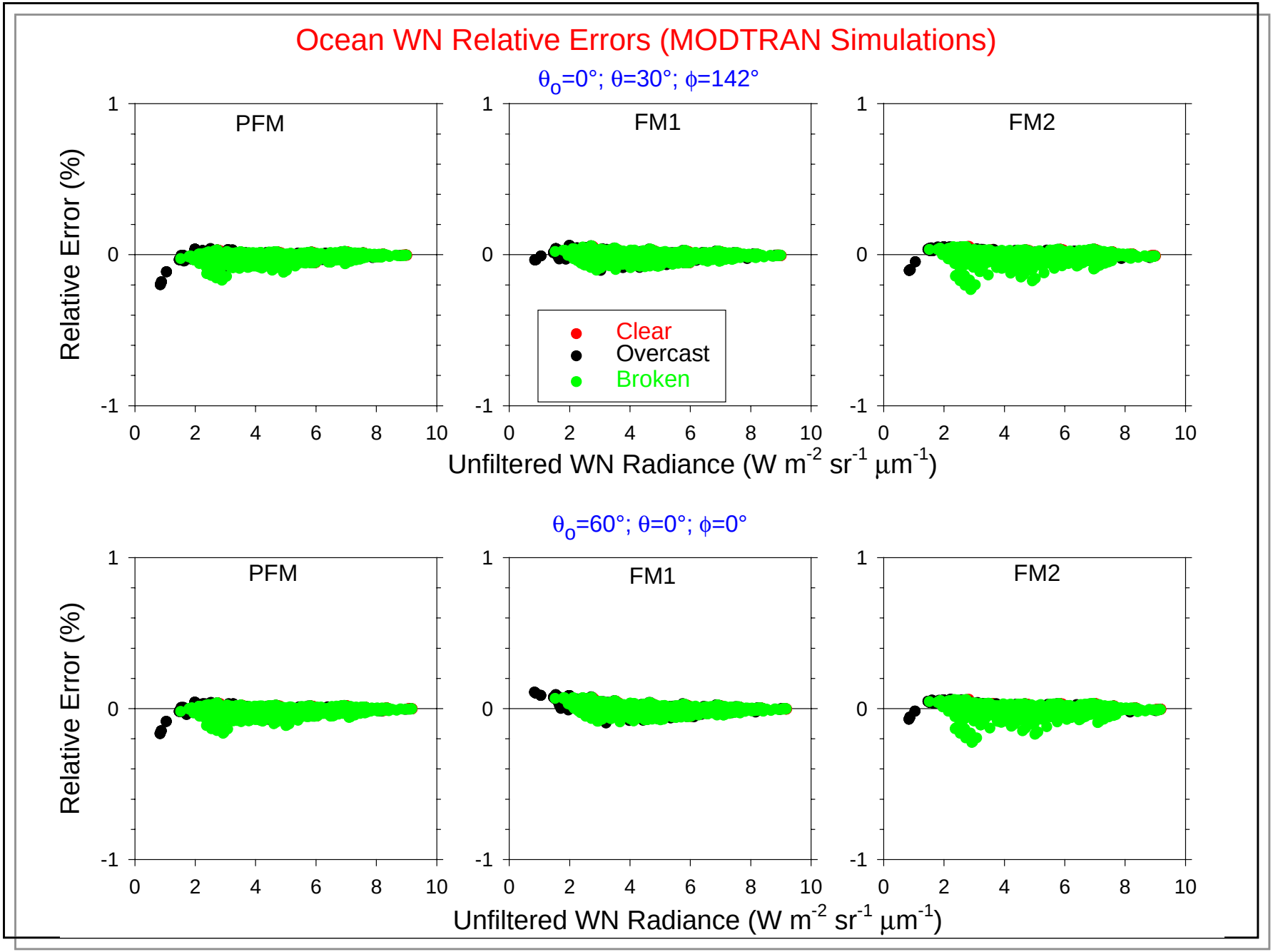

Ocean SW Relative Errors (MODTRAN Simulations)
θo=0°; θ=30°; ϕ=142°
PFM
FM1
FM2
Relative Error (%)
Clear
Overcast
Broken
Unfiltered SW Radiance (W m-2 sr-1)
θo=60°; θ=0°; ϕ=0°
PFM
FM1
FM2
Relative Error (%)
Unfiltered SW Radiance (W m-2 sr-1)


Land SW Relative Errors (MODTRAN Simulations)
θo=0°; θ=30°; ϕ=142°
PFM
FM1
FM2
Relative Error (%)
Clear
Overcast
Broken
Unfiltered SW Radiance (W m-2 sr-1)
θo=60°; θ=0°; ϕ=0°
PFM
FM1
FM2
Relative Error (%)
Unfiltered SW Radiance (W m-2 sr-1)


Ocean LW Relative Errors (MODTRAN Simulations)
θo=0°; θ=30°; ϕ=142°
PFM
FM1
FM2
Relative Error (%)
Clear
Overcast
Broken
Unfiltered LW Radiance (W m-2 sr-1)
θo=60°; θ=0°; ϕ=0°
PFM
FM1
FM2
Relative Error (%)
Unfiltered LW Radiance (W m-2 sr-1)

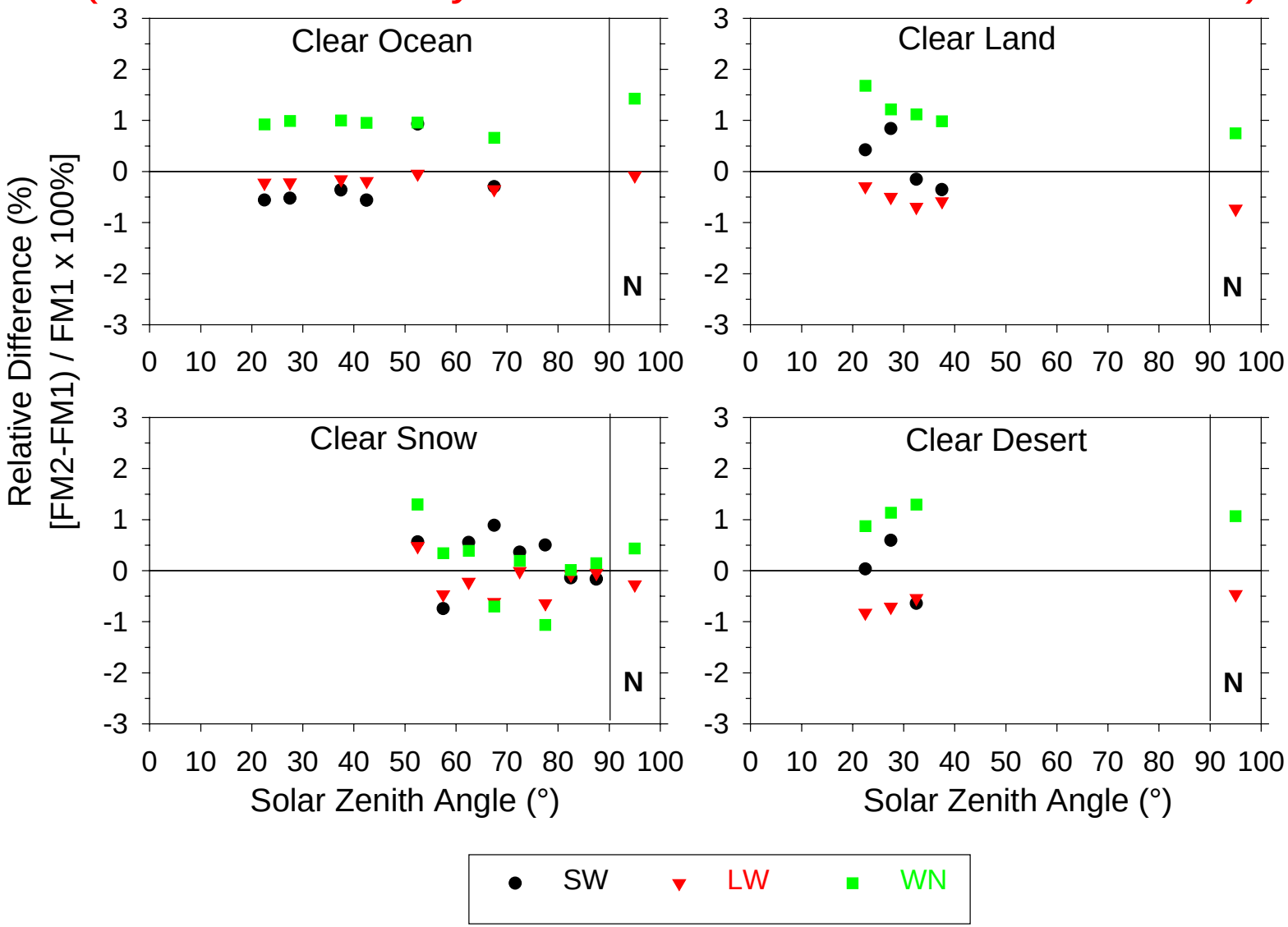

Ocean NIGHTTIME LW Relative Errors (MODTRAN Simulations)
θ=30°
PFM
FM1
FM2
Relative Error (%)
Clear
Overcast
Unfiltered LW Radiance (W m-2 sr-1)
θ=0°
PFM
FM1
FM2
Relative Error (%)
Unfiltered LW Radiance (W m-2 sr-1)


Land LW Relative Errors (MODTRAN Simulations)
θo=0°; θ=30°; ϕ=142°
PFM
FM1
FM2
Relative Error (%)
Clear
Overcast
Broken
Unfiltered LW Radiance (W m-2 sr-1)
θo=60°; θ=0°; ϕ=0°
PFM
FM1
FM2
Relative Error (%)
Unfiltered LW Radiance (W m-2 sr-1)


Ocean WN Relative Errors (MODTRAN Simulations)
θo=0°; θ=30°; ϕ=142°
PFM
FM1
FM2
Relative Error (%)
Clear
Overcast
Broken
Unfiltered WN Radiance (W m-2 sr-1 μm-1)
θo=60°; θ=0°; ϕ=0°
PFM
FM1
FM2
Relative Error (%)
Unfiltered WN Radiance (W m-2 sr-1 μm-1)

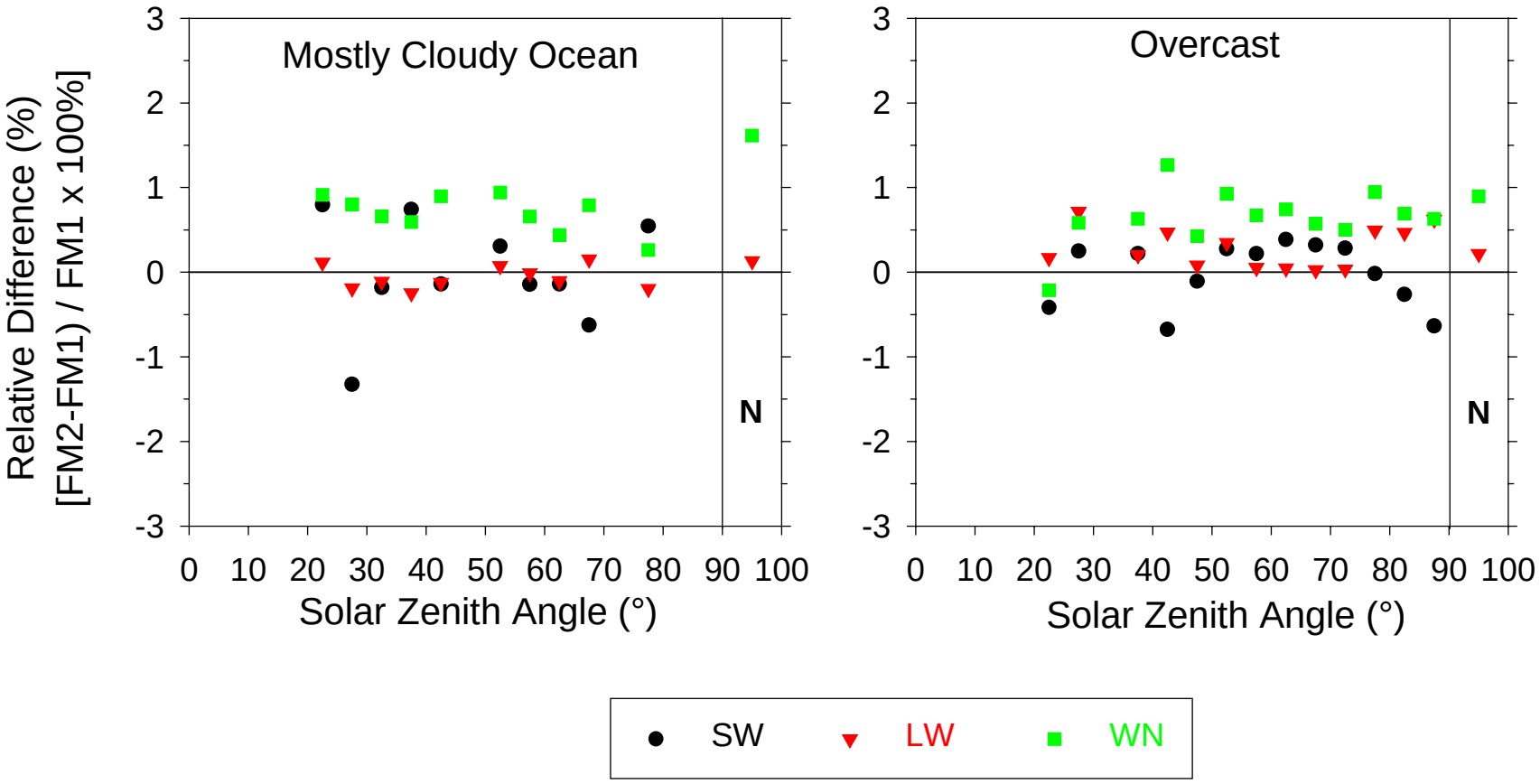
FM2-FM1 Unfiltered Radiance Relative Differences

(4 Coincident Days in March 2000; Near-nadir; Global)



FM2-FM1 Unfiltered Radiance Relative Differences

(4 Coincident Days in March 2000; Near-nadir; Global)



Summary

- Theoretical tests of CERES unfiltered radiances show:
  - Reduction in error in SW region for FM1 and FM2 compared to PFM.
  - Larger relative errors (≈1%) in unfiltered LW radiances from deep convective clouds for FM1 and FM2.
- Unfiltered SW and LW radiance differences between FM1 and FM2 are small (< 0.5%) and show no evidence for any systematic dependence on scene type or solar zenith angle.
- FM2-FM1 unfiltered WN radiances differ by ~1% due to WN channel calibration error.