Plans for Terra ADM Development: ADM Parameter Studies

Nitchie Manalo-Smith
Analytical Services & Materials,Inc.

Norman G. Loeb
Hampton University

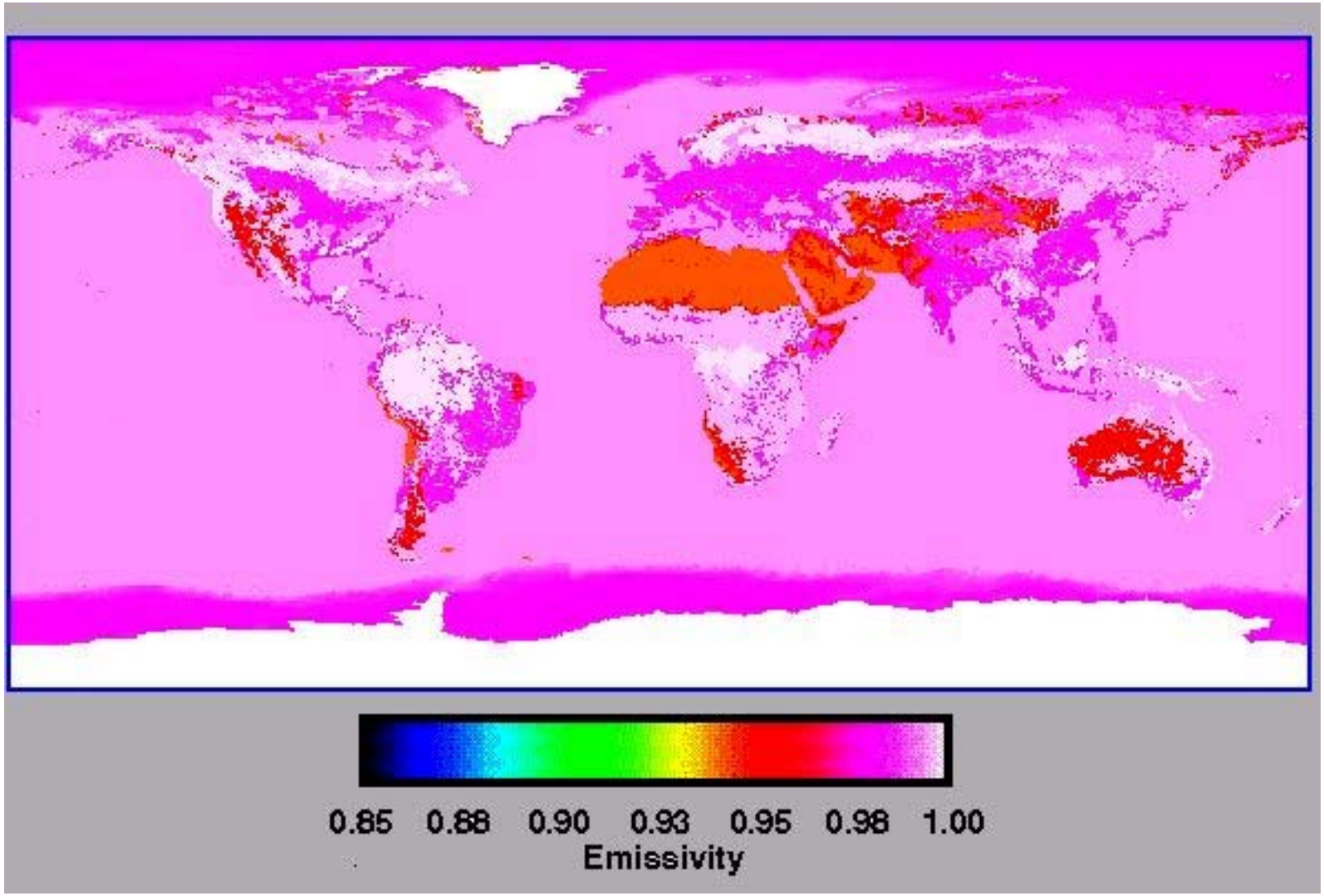
OVERVIEW

- Selection of Terra ADM scene type parameters
- Preliminary Terra ADMs for clear and overcast scenes
- Clear sky ADMs using MODTRAN radiances to estimate radiances in unsampled VZA bins

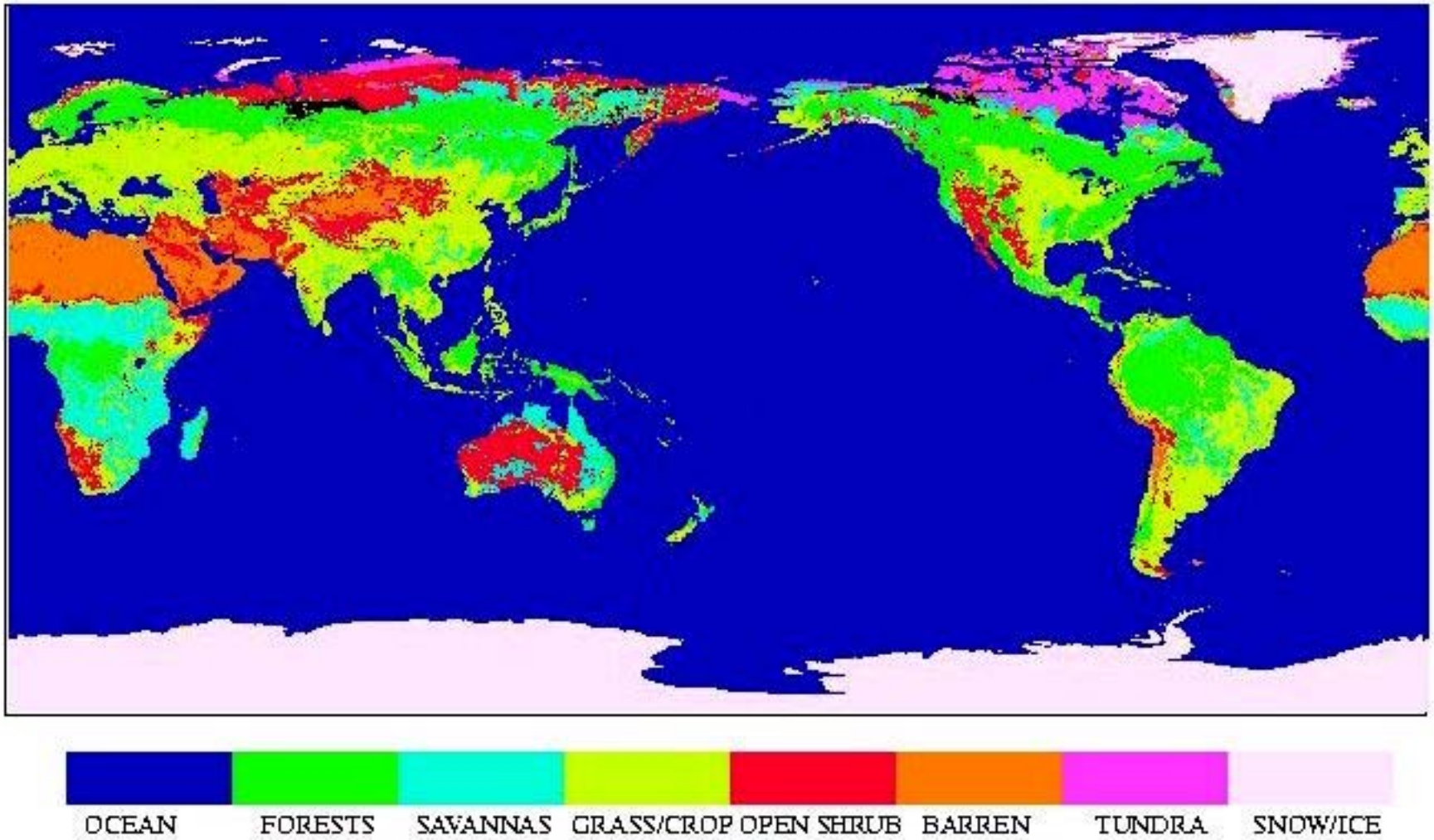
LONGWAVE AND WINDOW ADM SCENE TYPES FOR CLEAR SCENES

SCENE TYPE PARAMETERS	TRMM	TERRA (Preliminary)
SURFACE TYPE	Ocean Land Desert	Ocean Forest, Cropland/Grass, Savanna Open Shrub, Barren Desert Tundra, Snow
PRECIPITABLE WATER	Intervals (Percentile): ≤ 33 33 - 66 ≥ 66	Intervals (cm) < 1 1 -3 3 -5 > 5
VERTICAL TEMPERATURE CHANGE	Intervals (Percentile) Inversion ($\Delta T_s < 0$) 0 - 25 25 - 50 50 - 75 > 75	Intervals (°C) < 15 15 -30 30 - 45 > 45
SKIN TEMPERATURE		Intervals (K) < 270 270 - 290 290 - 310 310 - 330 > 330

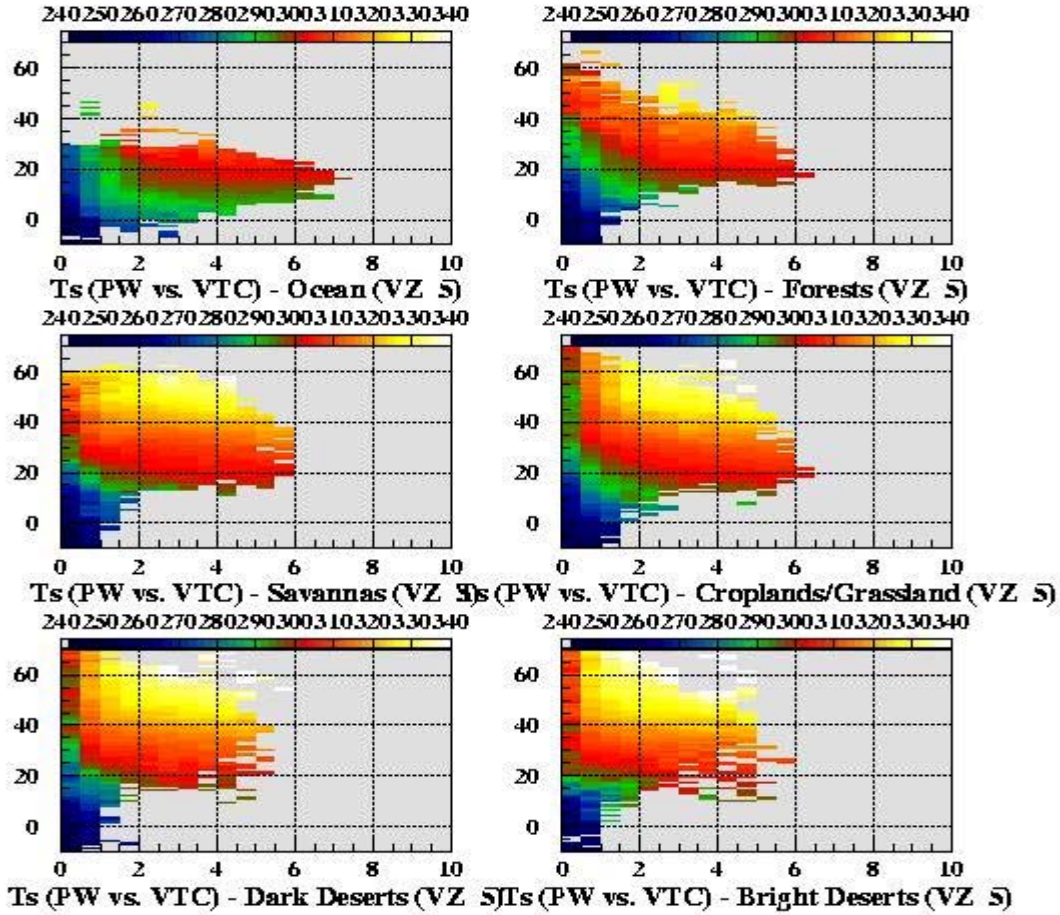
BROADBAND SURFACE EMISSIVITY



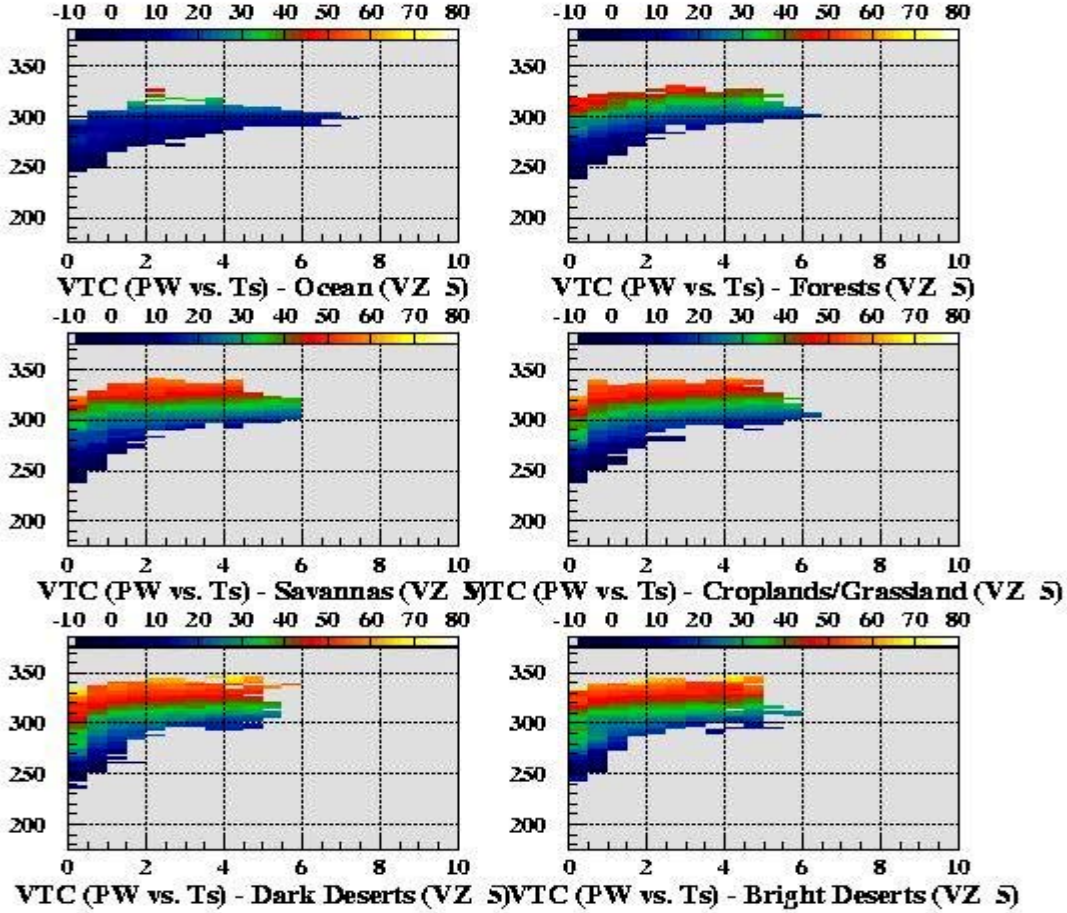
Longwave ADM Scene Surface Types



Mean Skin T (PW,VTC) for Clear Scenes

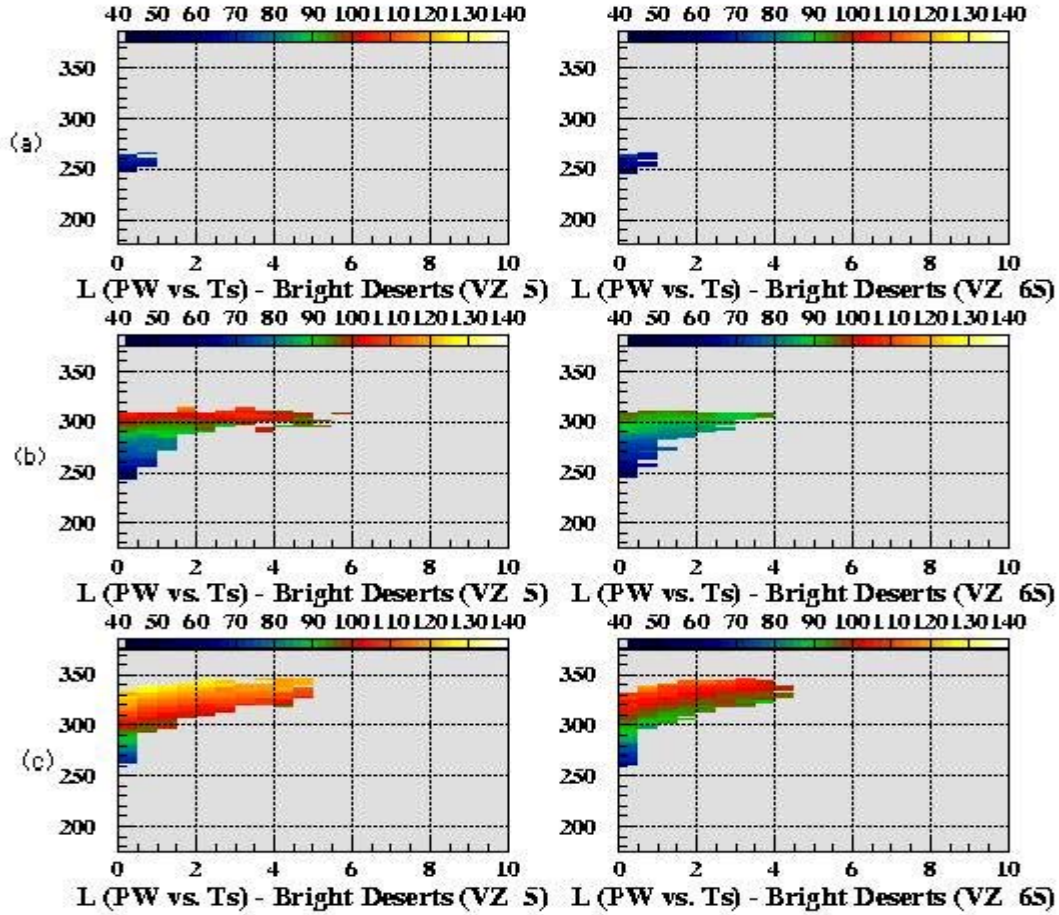


Mean Vertical Temperature Change (PW,Ts) for Clear Scenes

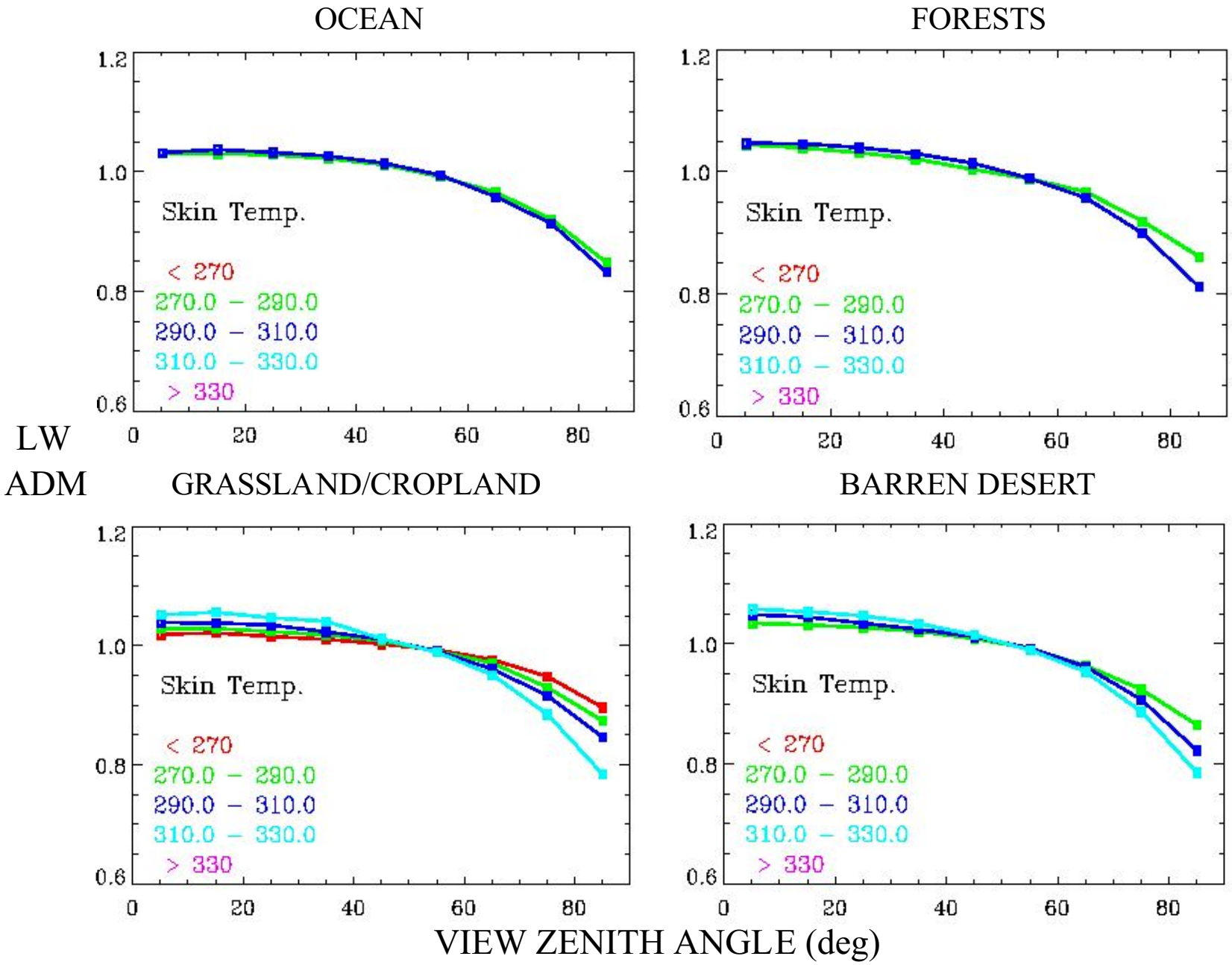


Mean Radiance (PW,Ts) for 3 VTC Intervals for Bright Deserts

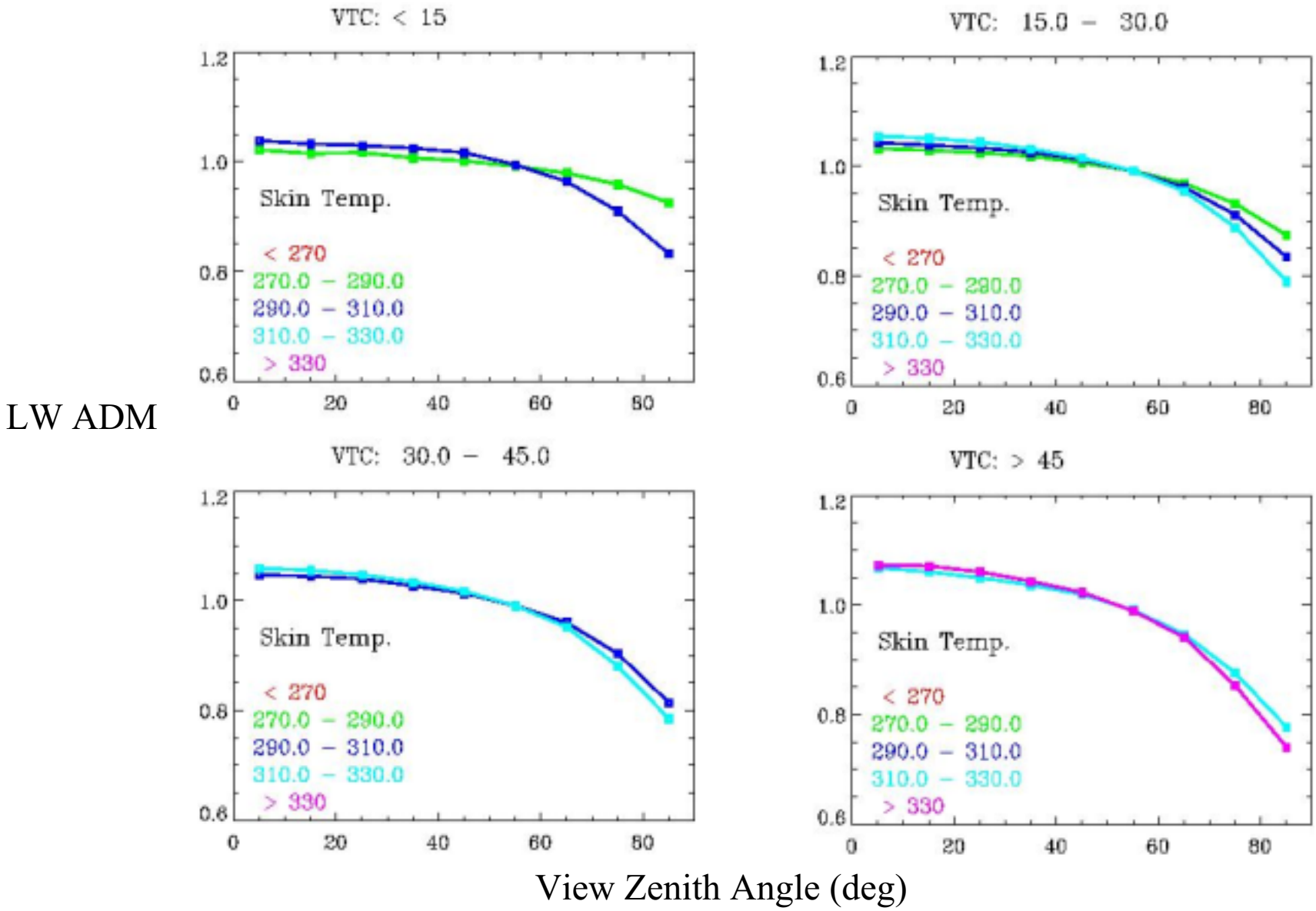
VTC: (a) < 10 deg (b) 0-25th pctil (c) > 75th pctil



VARIATION OF LW ADM WITH SKIN TEMPERATURE (PW:0-1 cm,VTC:15-30 deg C)



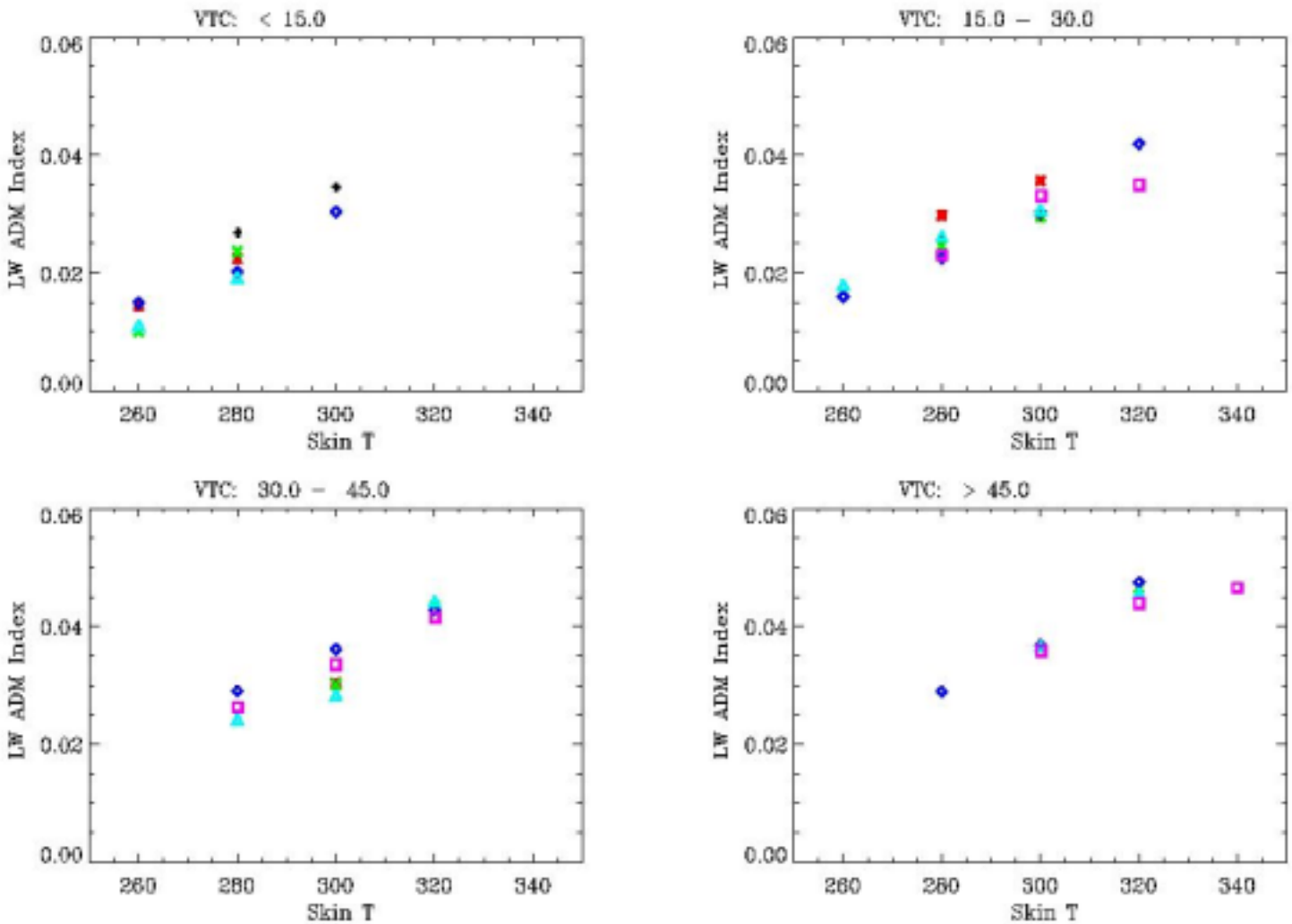
VARIATION OF LW ADM WITH SKIN TEMP AND VTC FOR GRASSLANDS/CROPLANDS (PW: 1-3 cm)



Clear Sky ADM Index for PW < 1

$$AI = \sqrt{\frac{\Sigma_{i=1}^{n}(R_{ji} - R_{Lamb})^2}{n}}$$

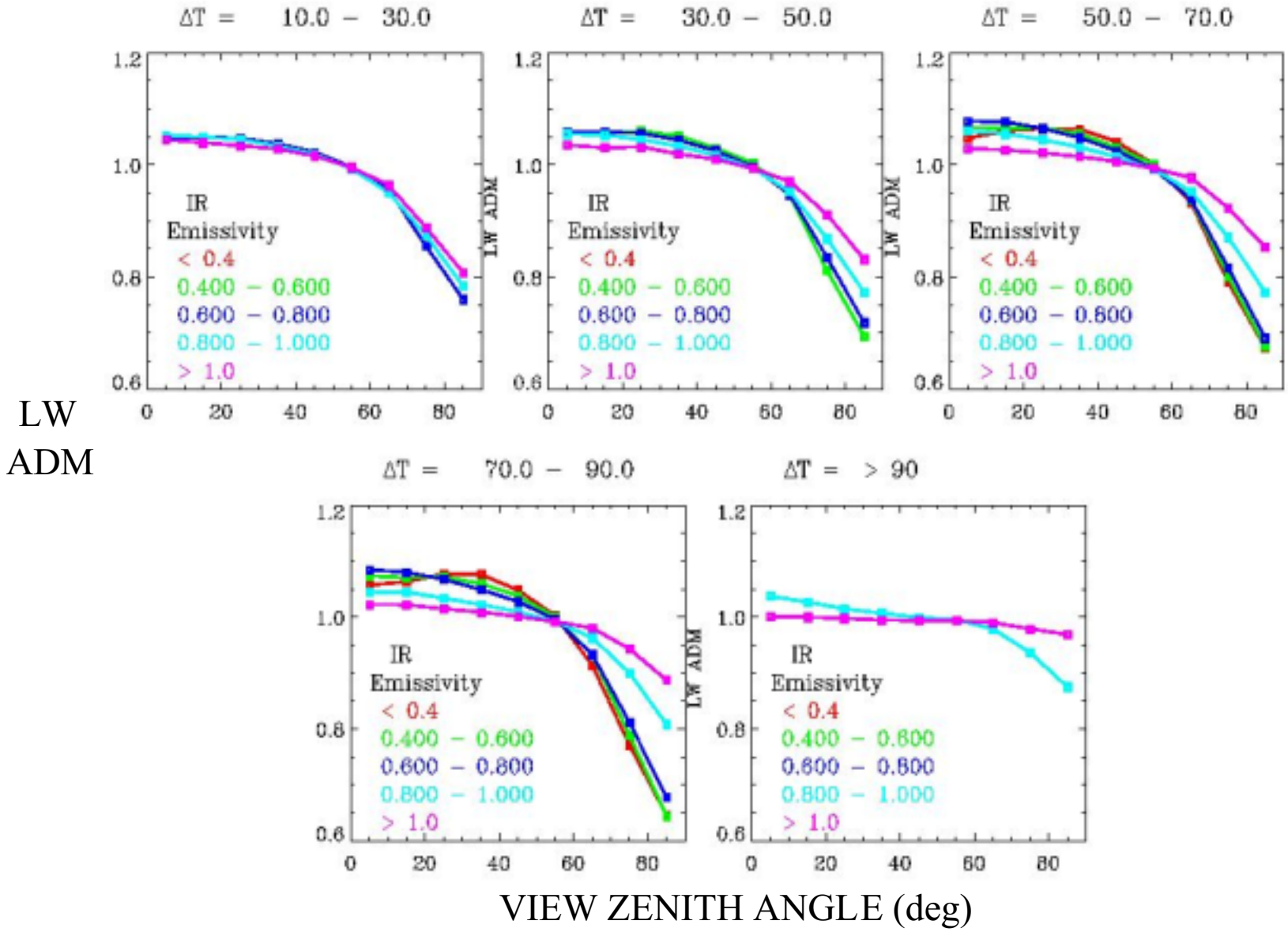
OCEAN FORESTS SAVANNAS GRASSLAND/CROPLAND OPEN SHRUBLAND BARREN/DESERT



LONGWAVE AND WINDOW ADM SCENE TYPES FOR CLOUDY SCENES

CLOUD FRACTION (%)	SCENE TYPE PARAMETERS	TRMM	TERRA (Preliminary)
BROKEN CLOUD FIELD 0.1 - 25 25 - 50 50 - 75 75 - 99.9 OVERCAST ≥ 99.9	SURFACE TYPE	BCF: Ocean Land Desert OVERCAST: ALL	Ocean Forest, Cropland/Grass, Savanna Open Shrub, Barren Desert Tundra, Snow
	PRECIPTABLE WATER	Intervals (Percentile): ≤ 33 33 - 66 ≥ 66	Intervals (cm) < 1 , 1 -3, 3 -5, > 5
	ΔT (SFC - CLOUD T)	$\Delta T_c < 0$ °C, Percentile: 0 - 20, 20 - 40, 40 - 60, 60 - 80, > 80 -> BCF $\Delta T_c < 0$ °C, Percentile:0 - 20, 20 - 40, 40 - 60, 60 - 80, 80 - 90, > 90 -> OVC	Intervals (°C) < 10, 10 - 30, 30 - 50, 50 - 70, 70 - 90, > 90
	IR EMISSIVITY	Percentile: 0 - 25, 25 - 50, 50 - 75, > 75 -> BCF Percentile: 0 - 5, 5-10, 10-25, 25 - 50, 50 - 75, > 75 -> OVC	< 0.4 0.4 - 0.6 0.6 - 0.8 0.8 - 1.0 > 1.0

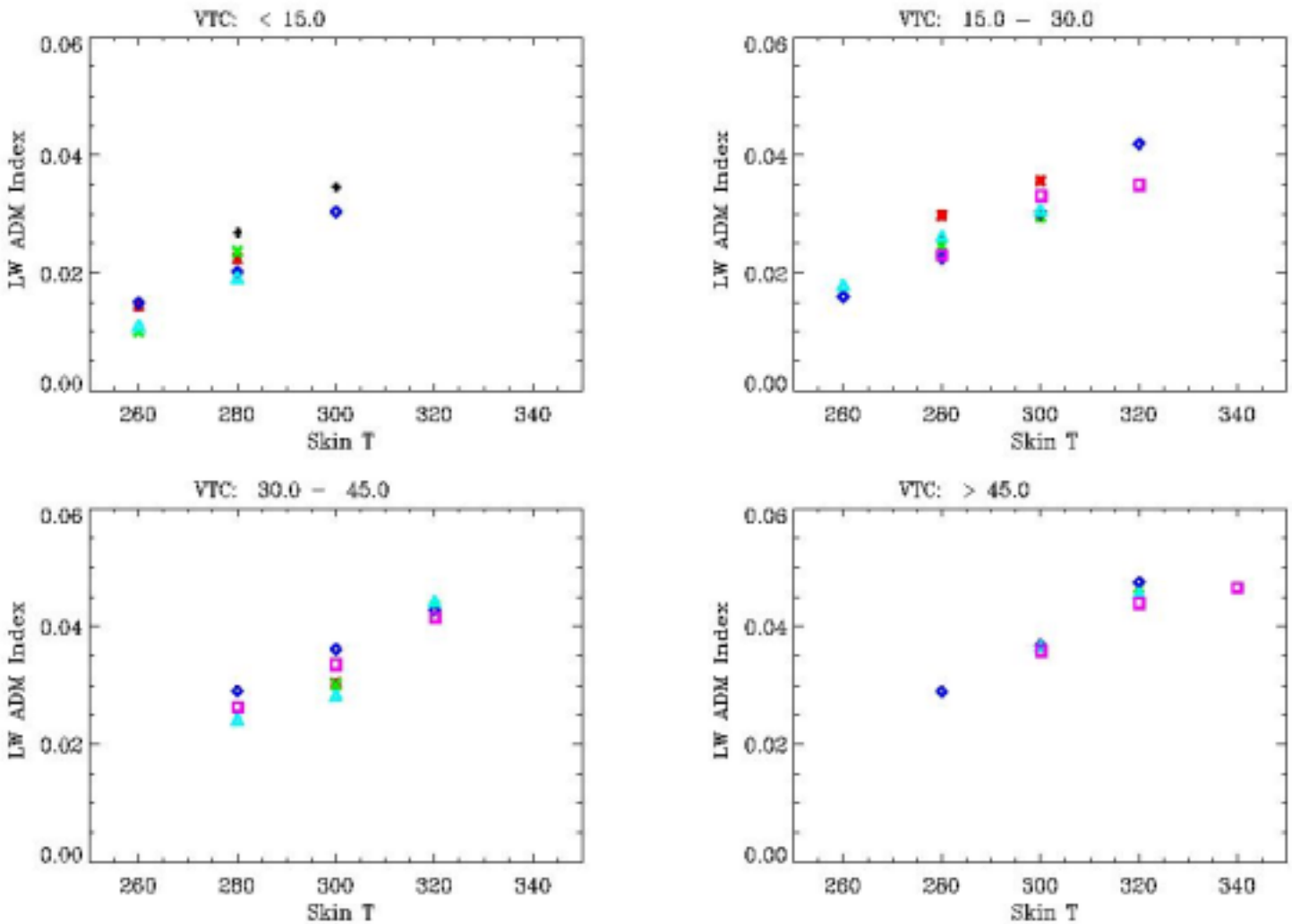
VARIATION OF LW ADM WITH ΔT AND IR EMISSIVITY (PW>5 cm) FOR OVERCAST/OCEAN SCENE



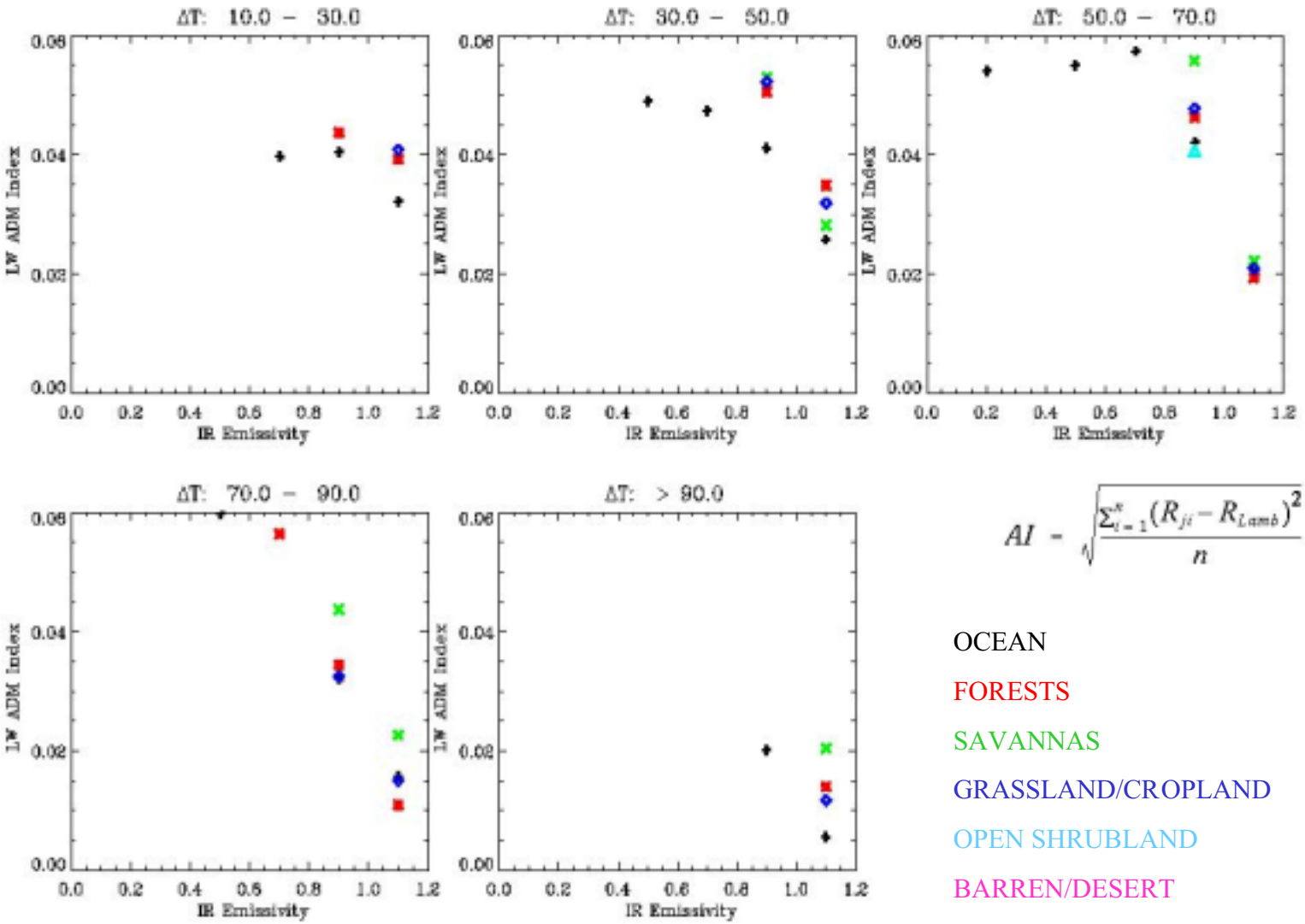
Clear Sky ADM Index for PW < 1

$$AI = \sqrt{\frac{\Sigma_{i=1}^{n}(R_{ji} - R_{Lamb})^2}{n}}$$

OCEAN FORESTS SAVANNAS GRASSLAND/CROPLAND OPEN SHRUBLAND BARREN/DESERT



Overcast ADM Index for PW > 5



$$AI = \sqrt{\frac{\sum_{i=1}^{n}(R_{ji} - R_{Lamb})^2}{n}}$$

OCEAN

FORESTS

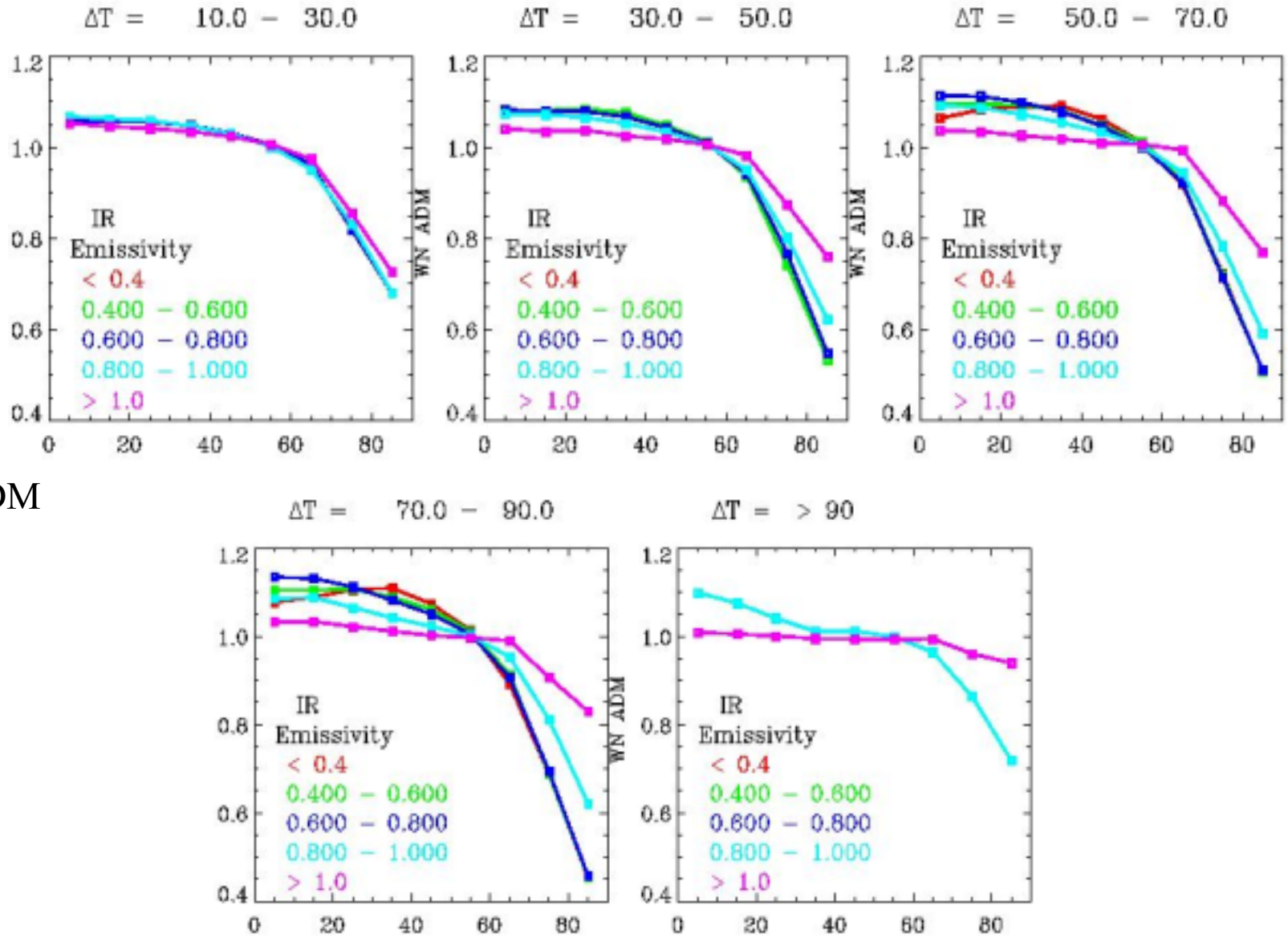
SAVANNAS

GRASSLAND/CROPLAND

OPEN SHRUBLAND

BARREN/DESERT

VARIATION OF WN ADM WITH ΔT AND IR EMISSIVITY (PW>5 cm) FOR OVERCAST/OCEAN SCENE



LW ADM

VIEW ZENITH ANGLE (deg

Modtran Calculations

- Broaband radiances from MODTRAN4
- 19 viewing zenith angles (5 deg resolution). Angles defined at surface reference level.
- CO_2 Concentration 360 ppmv for all cases.

I. clr.outbb
---
6 Atm Models x 6 PW x 17 Surface Temperatures = 612 cases

Atm Models
1. Tropical (15N Annual Average)
2. Midlat Summer (45N July)
3. Midlat Winter (45N January)
4. Subarctic Summer (60N July)
5. Subarctic Winter (60N January)
6. U.S. Standard Atmosphere (1976)

PW (cm)
4.12 (Tropical)
2.89 (Midlat Summer)
0.796 (Midlat Winter)
2.03 (Subarctic Summer)
0.382 (Subarctic Winter)
1.37 (U.S. Standard Atmosphere)

Sfc Temps (K)
250, 255, 260, 265, 270, 275, 280, 285, 290,
295, 300, 305, 310, 315, 320, 330, 340

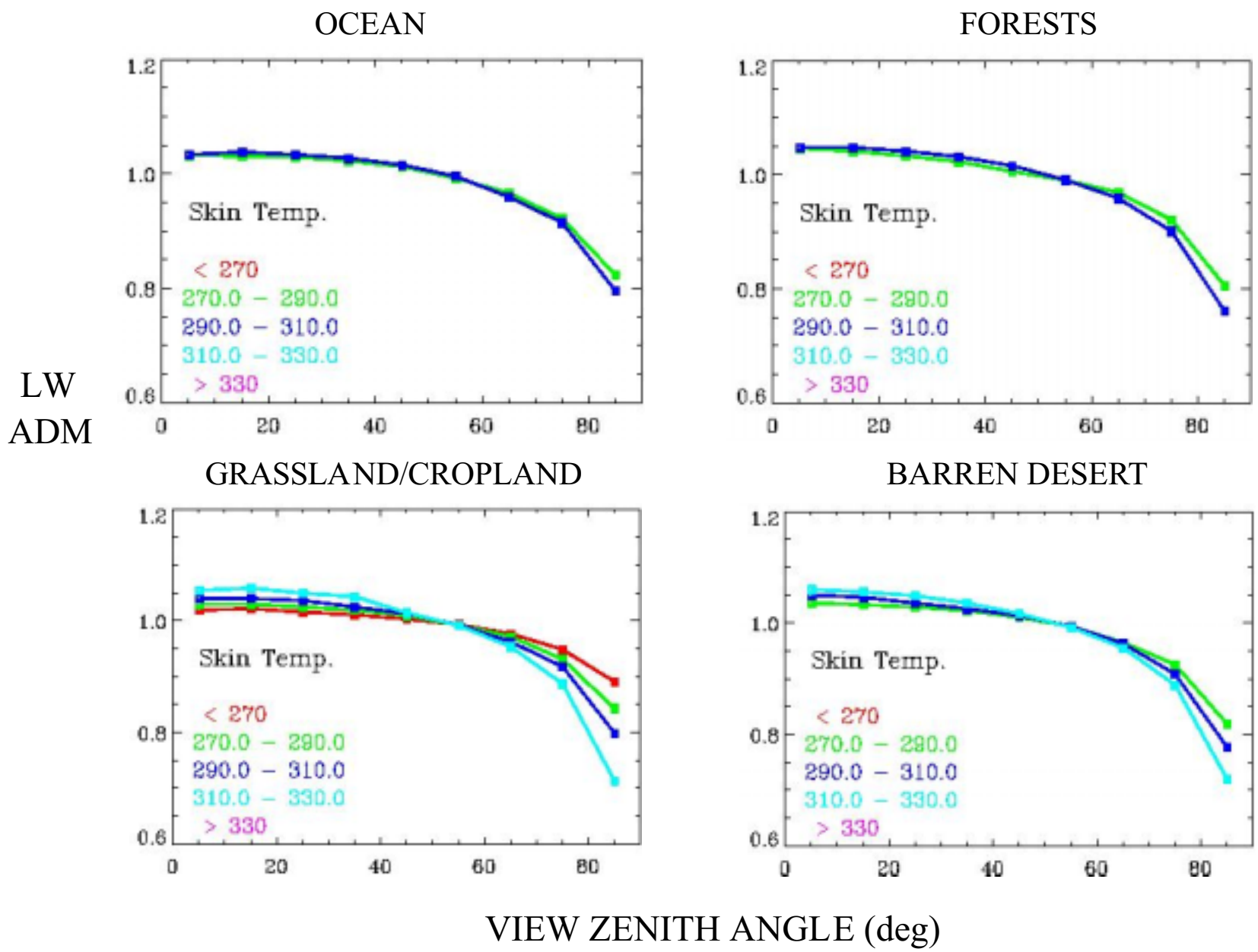
II. clr2.outbb
---
1 Atm Models x 2 PW x 10 Surface Temperatures = 20 cases

Atm Model
Subarctic Winter (60N January)

PW (cm)
2.03 (Subarctic Summer)
0.382 (Subarctic Winter)

Sfc Temp (K)
200, 205, 210, 215, 220, 225, 230, 235, 240, 245

VARIATION OF LW ADM WITH SKIN TEMPERATURE (MODTRAN Radiances)



SUMMARY

- Scene type parameters are stratified into discrete intervals rather than percentile intervals for Terra.
- IGBP surface types are grouped into surface emissivity to determine Terra surface types.
- Clear sky ADMs exhibit the largest dependence upon skin temperature. Anisotropy increases as skin temperature and vertical temperature increase.
- Overcast ADMs are most sensitive to cloud emissivity. Anisotropy increases as emissivity increases.
- Clear sky scenes using MODTRAN radiances to estimate unsampled VZA bins are more anisotropic than when Gupta theoretical radiances are applied.
- WN ADMs show the same dependence on scene parameters but are generally more anisotropic.
- FUTURE WORK: Cloudy ADMs using MODTRAN radiances.
  Azimuthal dependence of ADMs (?)
  Validation of Terra R1/Ed1