**28th CERES SCIENCE MEET, NORFOLK, VA.**

**6-8 May, 2003**

# ADM working group

## *LONGWAVE ANISOTROPY*

## A SOLAR ZENITH ANGLE PERSPECTIVE


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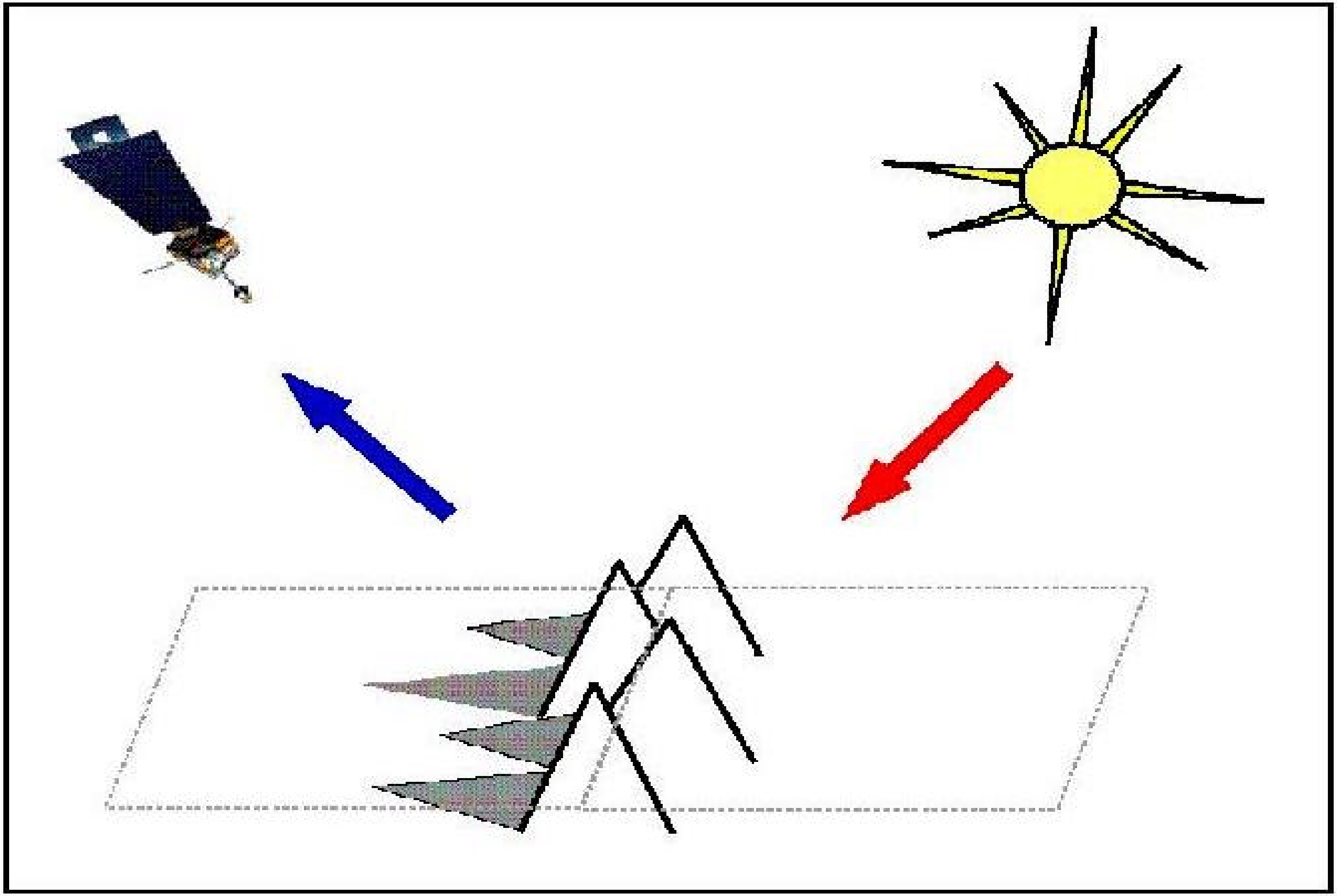
# PLAN

1. Theme of study
2. Progress
3. Data and Binning
4. SZA Vs LCT bins
5. New binning method
6. Model and validation
7. Future

# THEME OF STUDY



Forward scatter
Colder temperature measured

Back scatter
Warmer temperature measured

# PROGRESS SINCE LAST CERES SCIENCE MEET

1. **Using the SZA bins instead of Local Time Bins**

2. **Terra results based on 8 months of Ed 1A instead of 4 months beta Ed**

3. **Validation of model now based on 8 months of Data instead of single month**

# DATA and BINNING

**SSF data from CERES TRMM and Terra**

**Wavelengths:** LW (**5-100 μm**) & WN (**8-12 μm**)

**Time periods**

**TRMM- Jan- Aug 1998 (10 km nadir) - Ed 2B (69 days)**

**TERRA- Jan- Aug 2001 (20 km nadir) - Ed 1A (179 days)**

**Bin averaging**

**9 RAA** bins (every 20°) **7 VZA** bins (every 10°)

**4 *SOLAR ZENITH ANGLE* bins** :

**1) $0 – 41.41^0$ 2) $41.41 – 60^0$**

**3) $60 – 75.52^0$ 4) $75.52 – 90^0$**

**Clear sky definition: 0-5% Cloud**

# Topo and Geo data

**Geo types**: **5 scene types** defined by regrouping **IGBP**

**Forests, Shrub lands, Savannas, Croplands, and Deserts**

**ETOP05 5´resolution (~10 km) elevation database**

**(NOAA National Geophysical Data Center/World Data Center for Marine Geology and Geophysics)**

**Surface topo Variability (SV)** = SD of adjacent 3x3 pixels

**4 bins** ***using histogram of global*** SV data:

**1) Min (lowest 50%) 2) Low med (50-70%)**

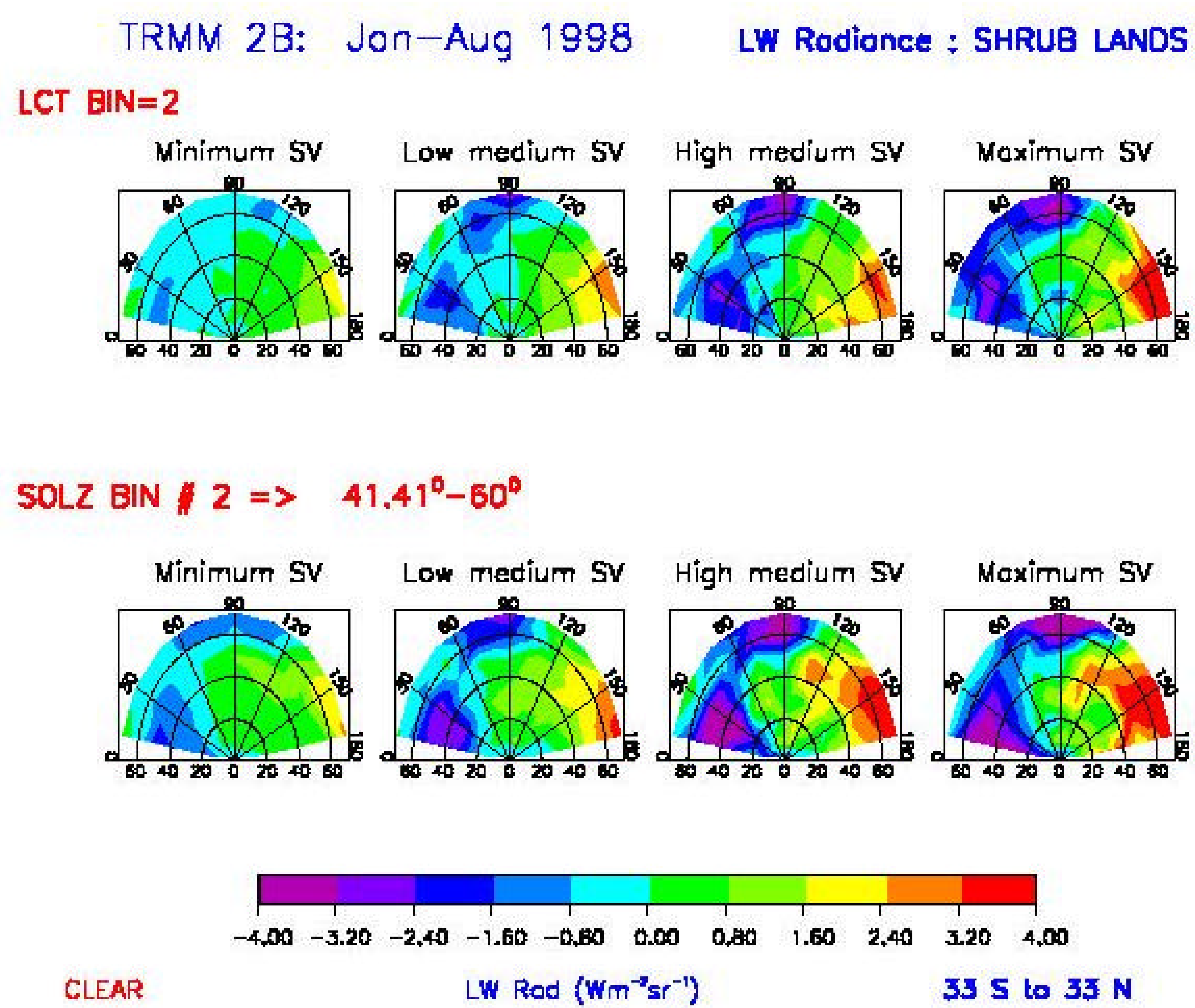
**3) High med (70-90%) 4) Max (90-100%)**

# METHODOLOGY

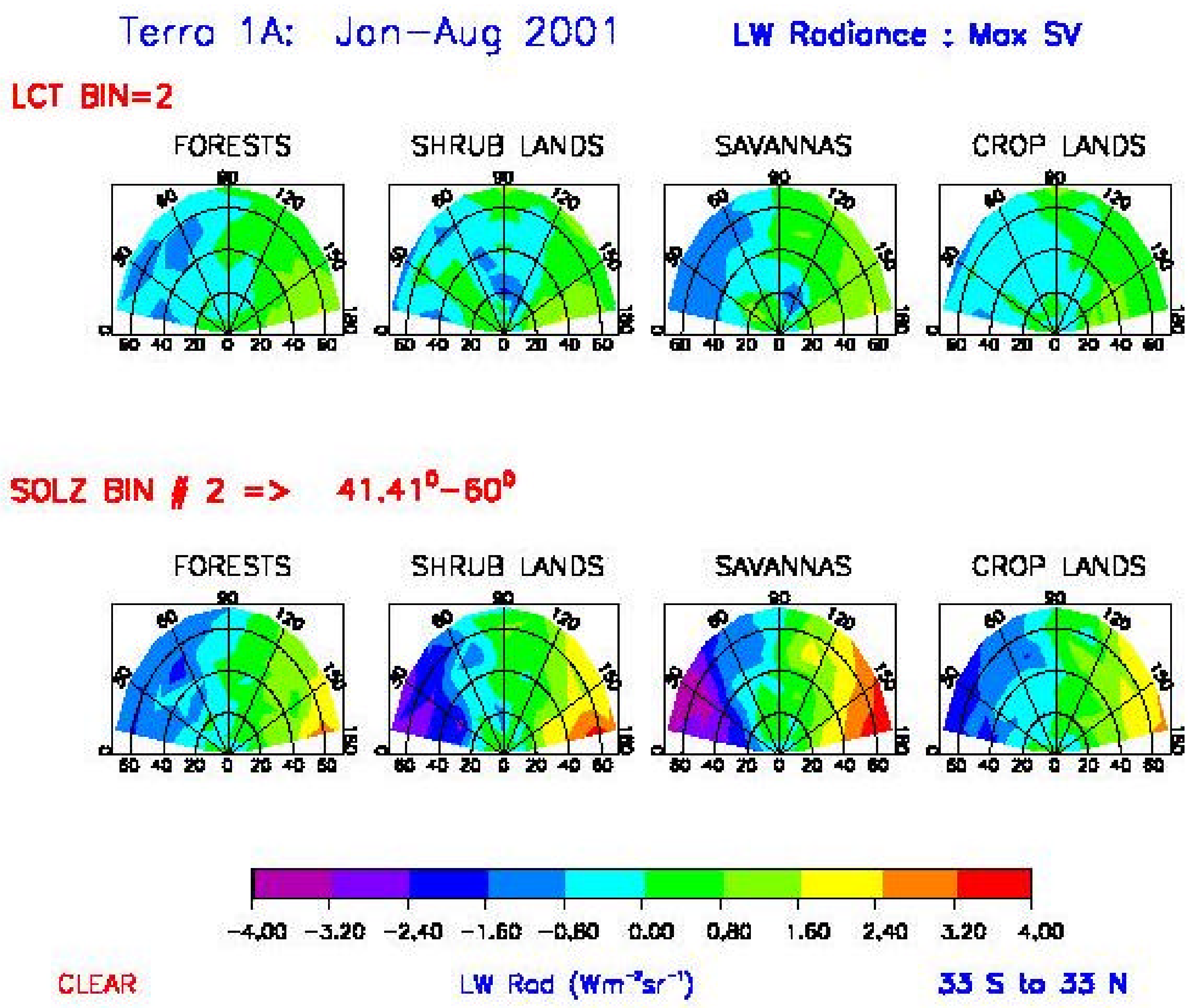
The VZA means are subtracted from bin mean of each RAA bin in a given VZA bin to remove limb darkening effect

These differences are plotted as a function of VZA and RAA

# LW ANISOTROPY : SZA BINS VERSUS LCT BINS (TRMM)



# LW ANISOTROPY: SZA BINS VERSUS LCT BINS (TERRA)

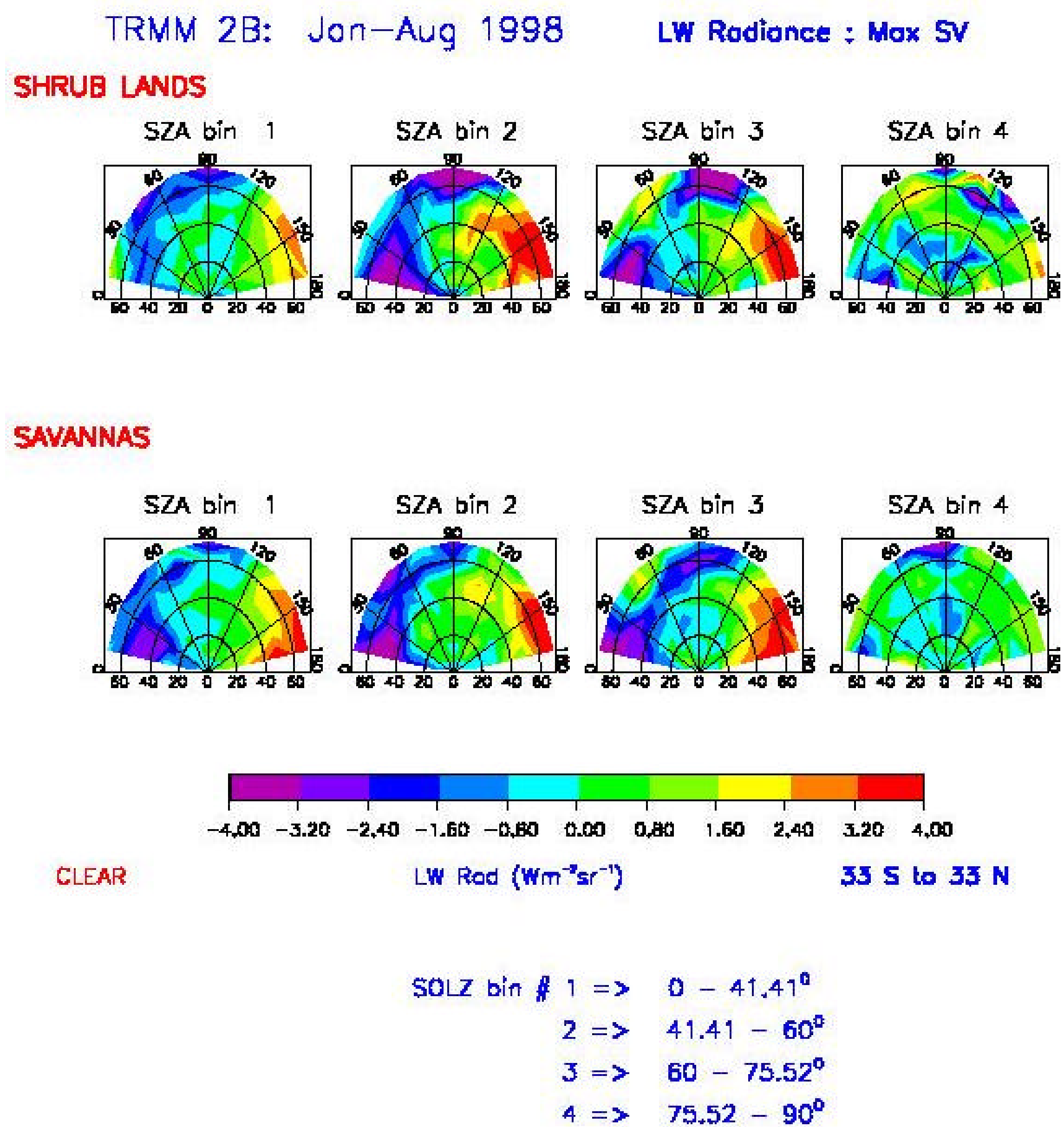


# Inferences

1. For both TRMM and Terra azimuthal signal is more conspicuous when binning is done based on SZA instead of LCT.

2. For shrub lands, savannas and Croplands azimuthal signature is more important

# COMPARISON OF LW ANISOTROPY FOR 4 SZA BINS



# Inferences

Azimuthal signal is strong in SZA bins 2 & 3.

The reason:

Azimuthal signal is based on contrast of shadow which itself depends upon

1. Strength of radiation field
2. Sun's position => Maximum asymmetry in radiation field

SZA bin 1: Radiation field is strong but asymmetry is low

SZA bin 2 & 3 : Radiation field is good; asymmetry is high

SZA bin 4: Radiation field is weak; asymmetry is strong

## MODEL

Bin mean  assumed to be represent the value at centre location.

Use of linear interpolation.

R  (Anisotropic Factor )  =  Pi*L / M where

L = Radiance (W / $m^2$ / sr)

M = Flux  (W / $m^2$ )

Fluxes are calculated by extrapolating radiances as

VZA for CERES SSF data  range 0-70 $^0$

## INPUT TO MODEL:

Latitude, Longitude, VZA, RAA, SZA, Cloudiness fraction

# VALIDATION of WN Azimuthal model

**Match within 15´ coincident VIRS and Geostationary 10.7 µm in $1^0$ gridded radiances**

**- VIRS from SFC data set**

**- Geostationary from GGEO data set, Meteosat, GMS, GOES-8 (Jan-Aug 1998)**

**- clear-sky (cloudiness < 5%) based on VIRS analysis**

**Compare Azimuthal model to limb darkening model**

Azimuthal model R = F (VZA, RAA, SZA, geo, topo)

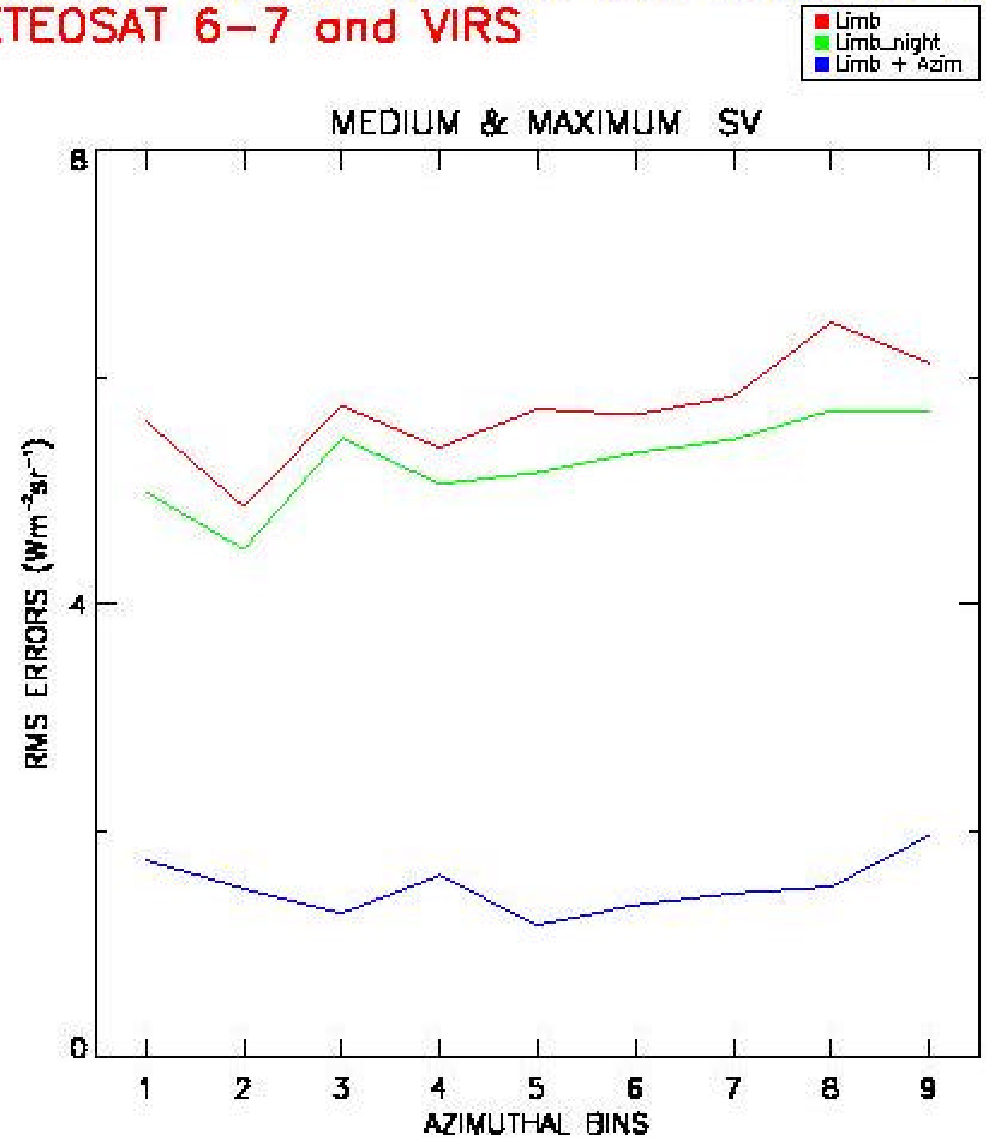
Limbmodel   R´= F (VZA, geo)

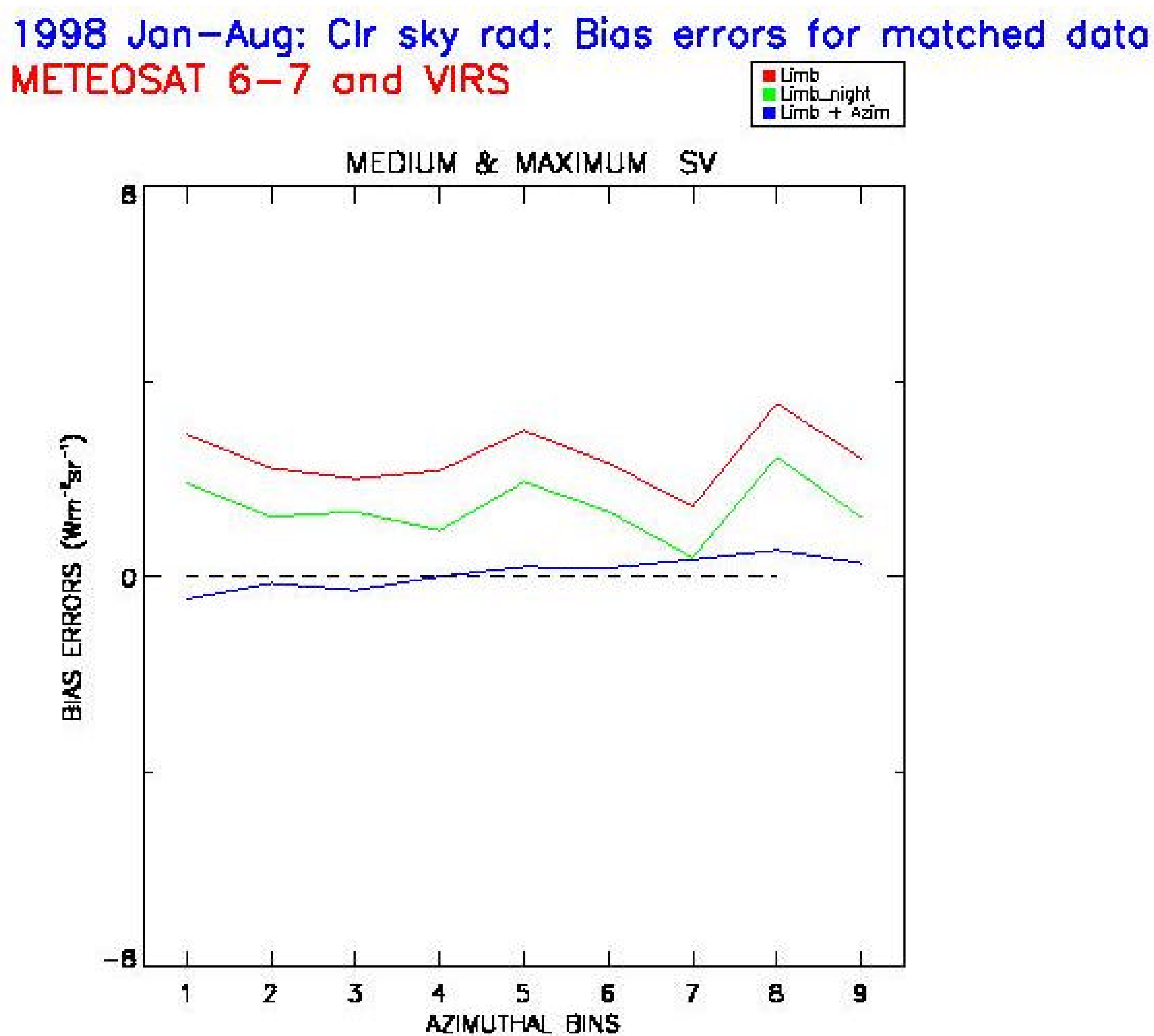
$error_{az} = GGEO_{rad} - VIRS_{rad} \quad R_{GGEO}/R_{VIRS}$

$error_{limb} = GGEO_{rad} - VIRS_{rad} \quad R'_{GGEO}/R'_{VIRS}$

1998 Jan–Aug: Clr sky rad: RMS errors for matched data

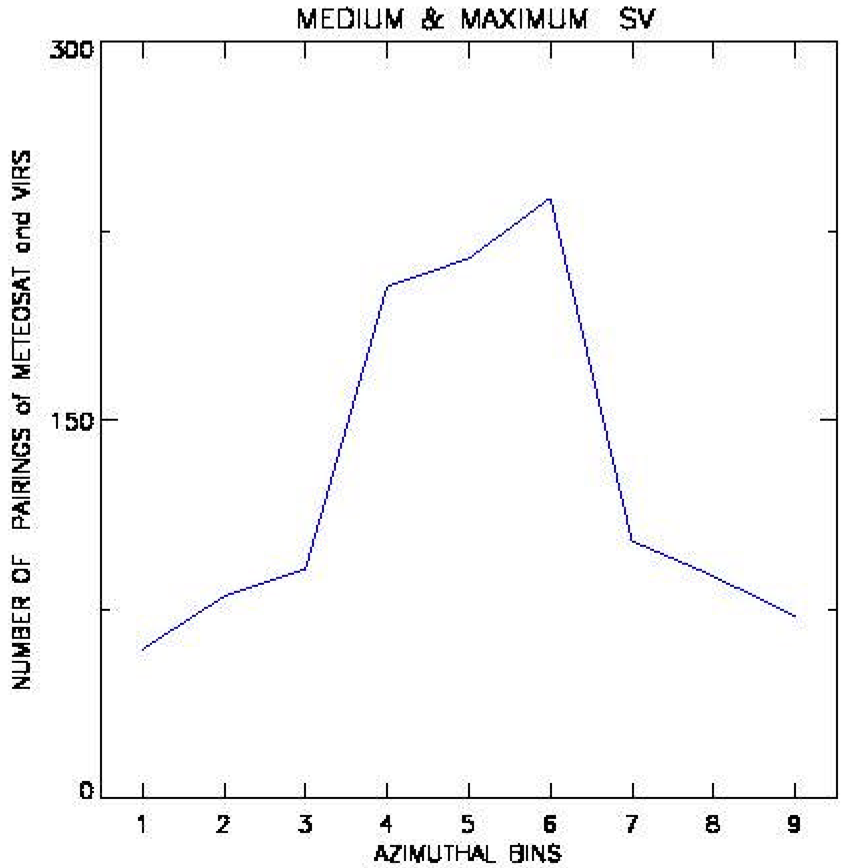
METEOSAT 6–7 and VIRS




1998 Jan-Aug: Clr sky rad: Bias errors for matched data
METEOSAT 6-7 and VIRS
Limb
Limb_night
Limb + Azim
MEDIUM & MAXIMUM SV
BIAS ERRORS ($Wm^{-2}sr^{-1}$)
AZIMUTHAL BINS
8
0
-8
1
2
3
4
5
6
7
8
9

# 1998 Jan–Aug: Clr sky rad: # of Pairings for matched data

## METEOSAT 6–7 and VIRS



# New Binning Method

**To reduce noise in individual azimuthal bins, make courser stratification**

**3 *SOLAR ZENITH ANGLE* bins** :

**1) 0 – 48$^0$ 2) 48 – 70.1$^0$ 3) 70.1 – 90$^0$**

**3 bins *using histogram of global*** SV data:

**1) Min (lowest 50%) 2) Med (50-80%)**

**3) Max (90-100%)**

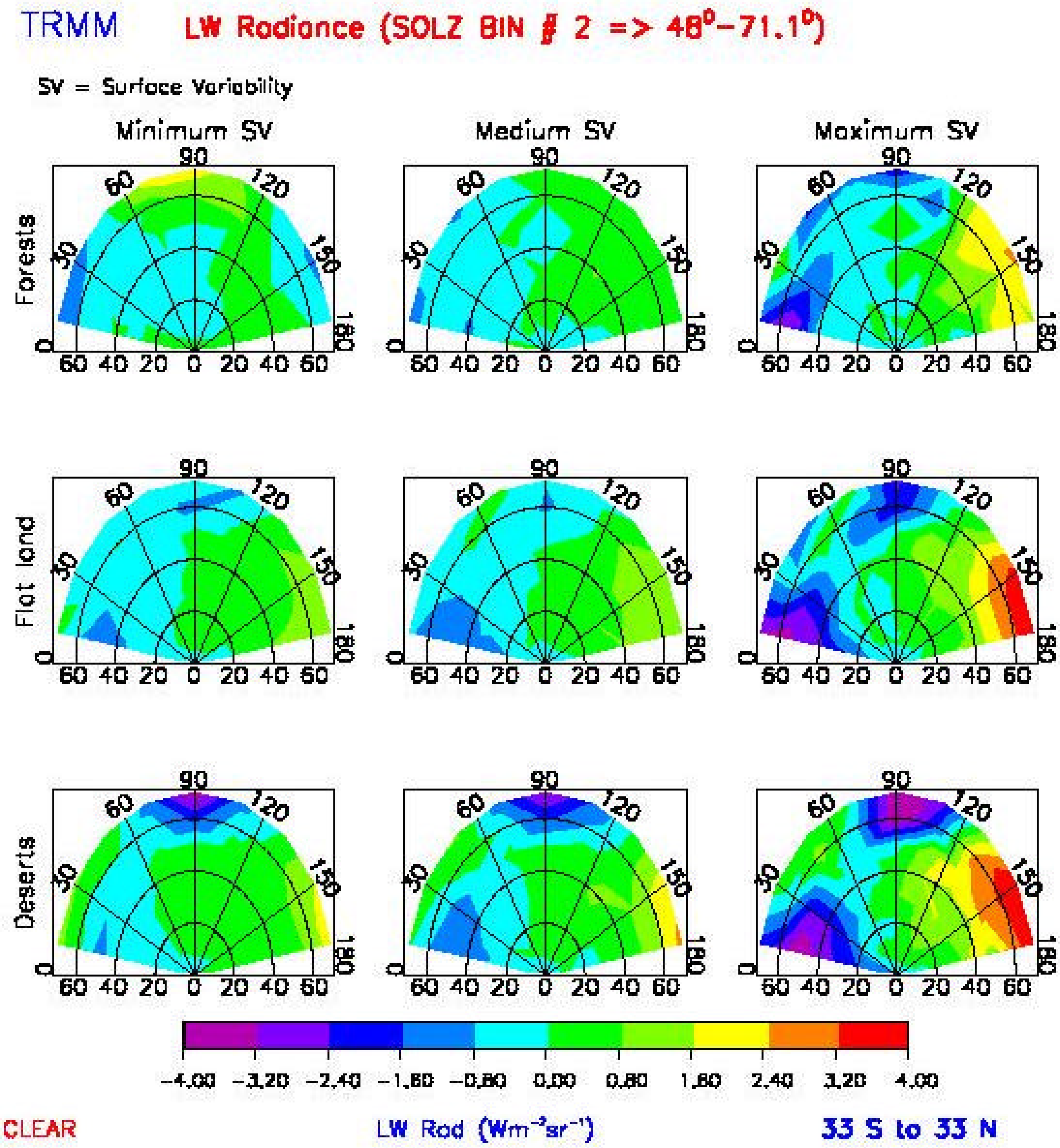
**Geo types**: **3 scene types**

**1) Forests 2) Savannas + Croplands**

**3) Deserts + Shrub lands**

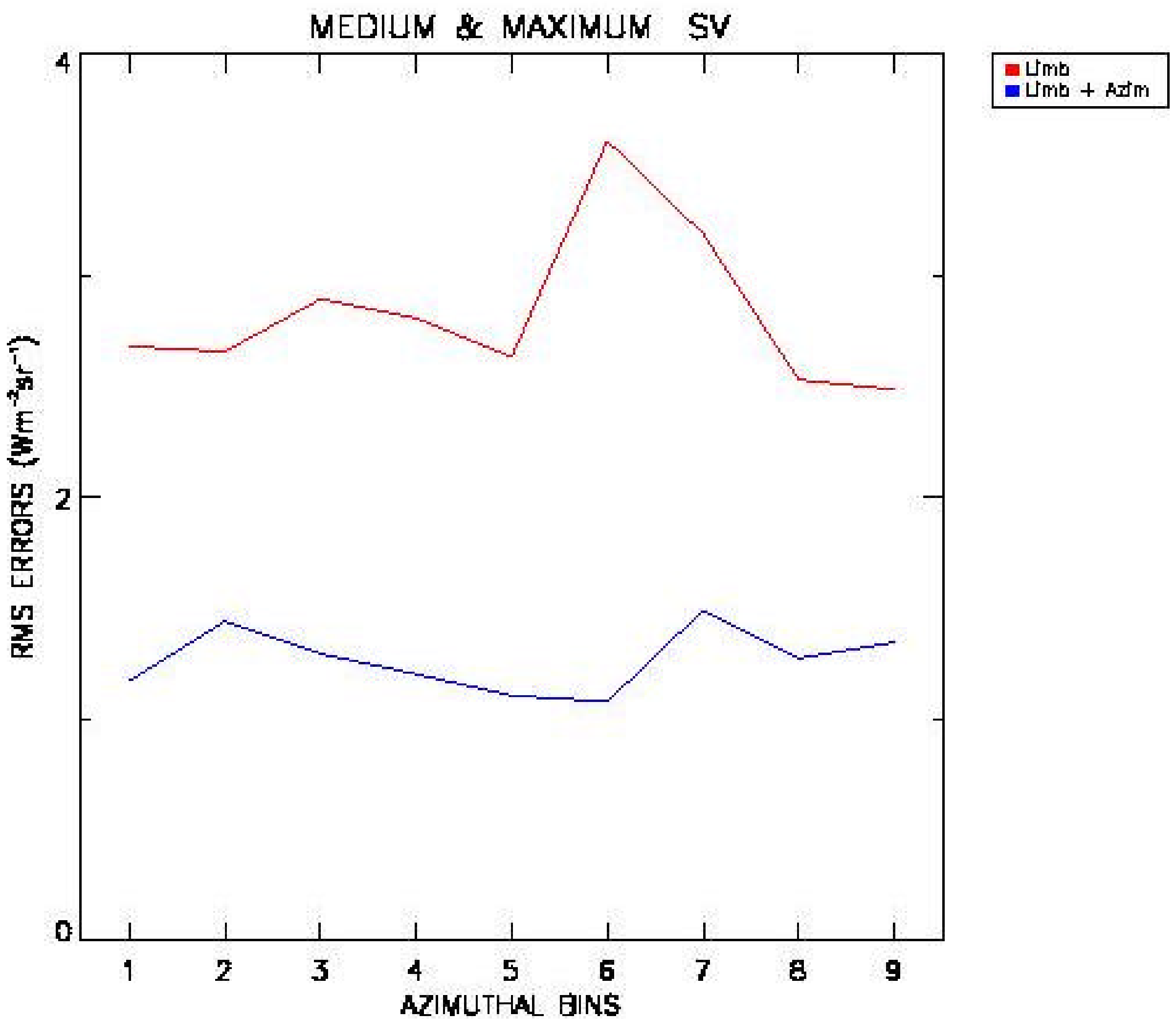
**Clear conditions : 0-5% clouds**

# New binning: 3 SZA, 3 Scenes and 3 SD bins

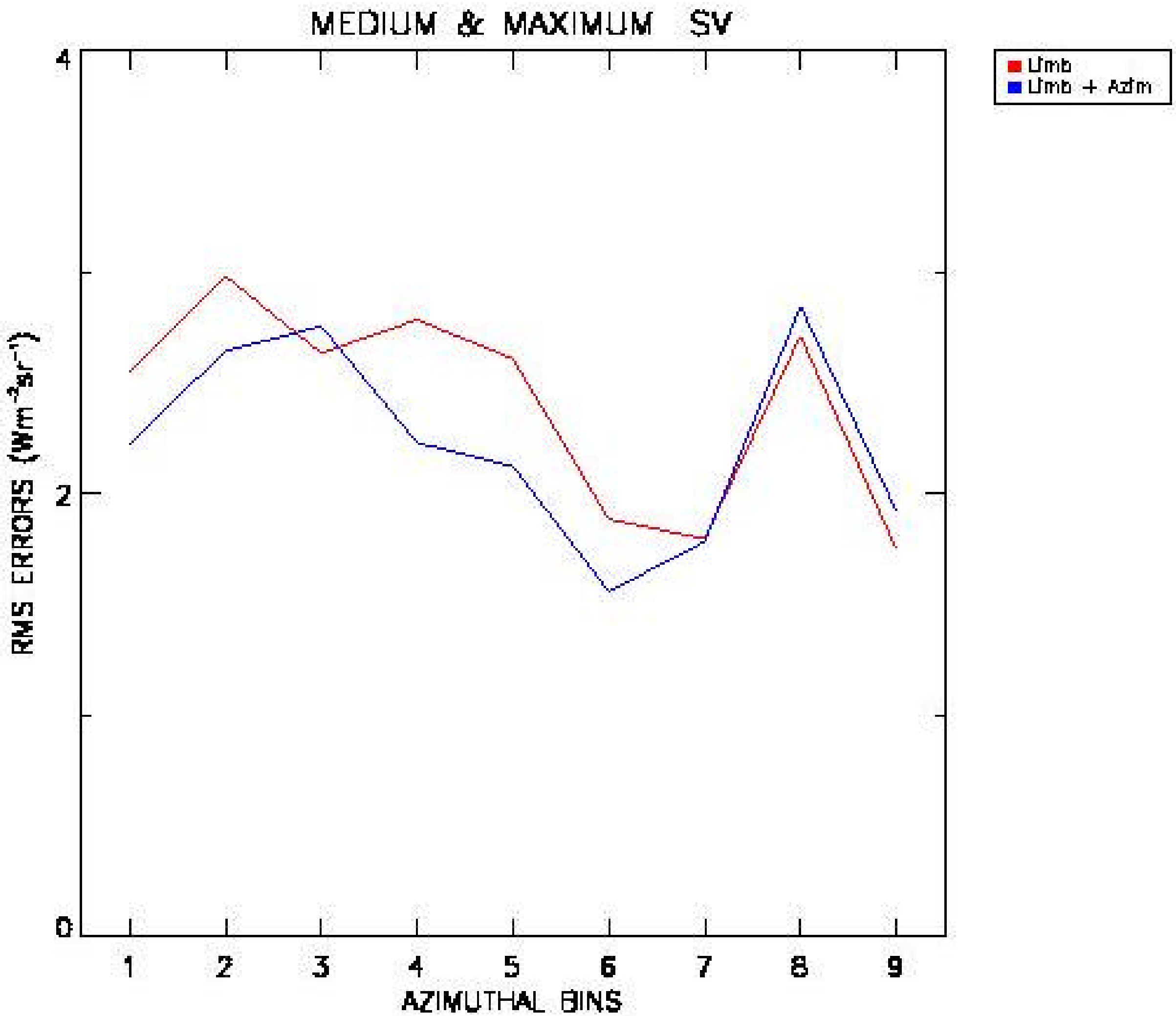


1998 Jan-Aug: Clr sky rad: RMS errors for matched data

METEOSAT 6-7 and VIRS

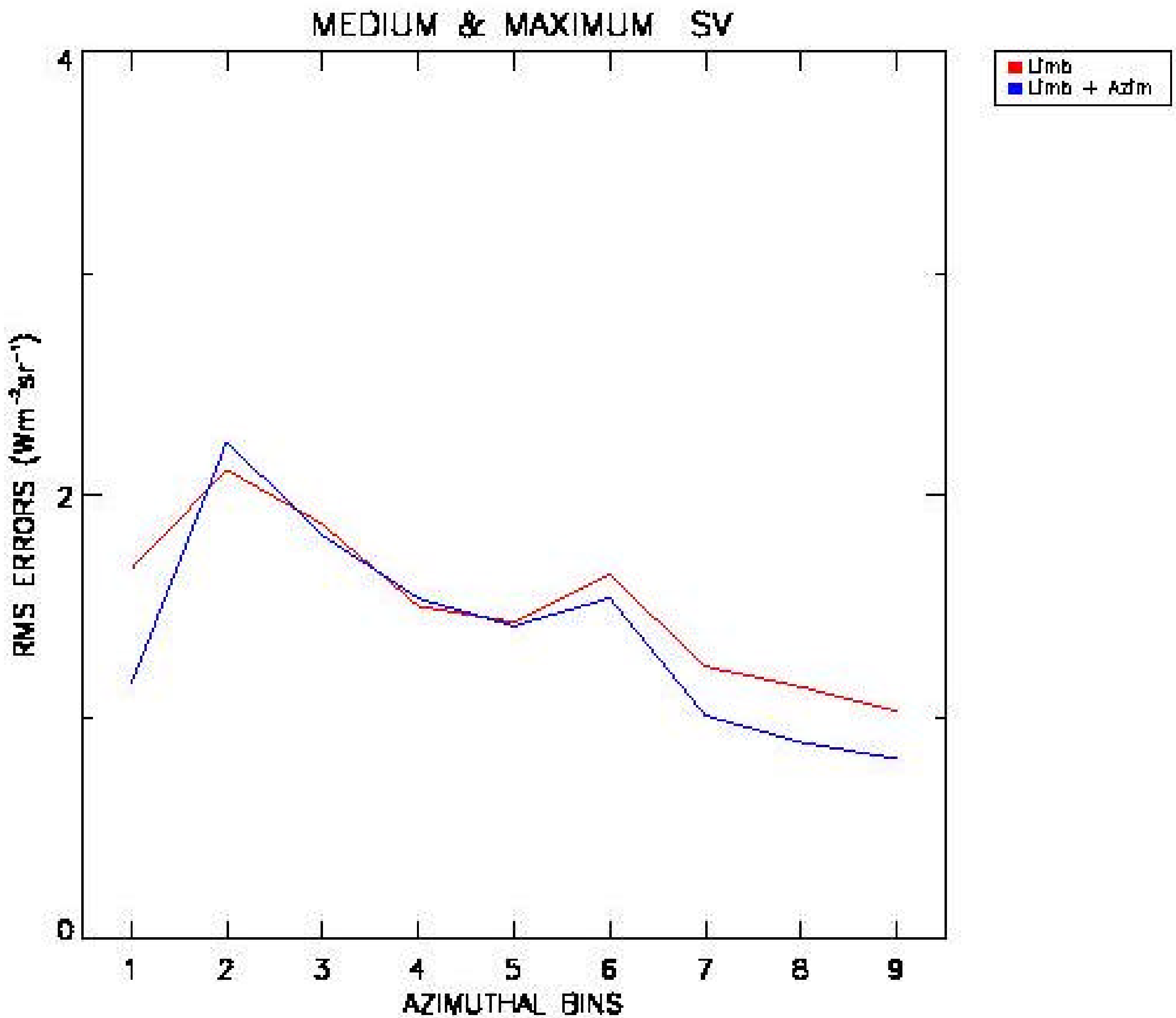


# 1998 Jan–Aug: Clr sky rad: RMS errors for matched data
## GMS and VIRS



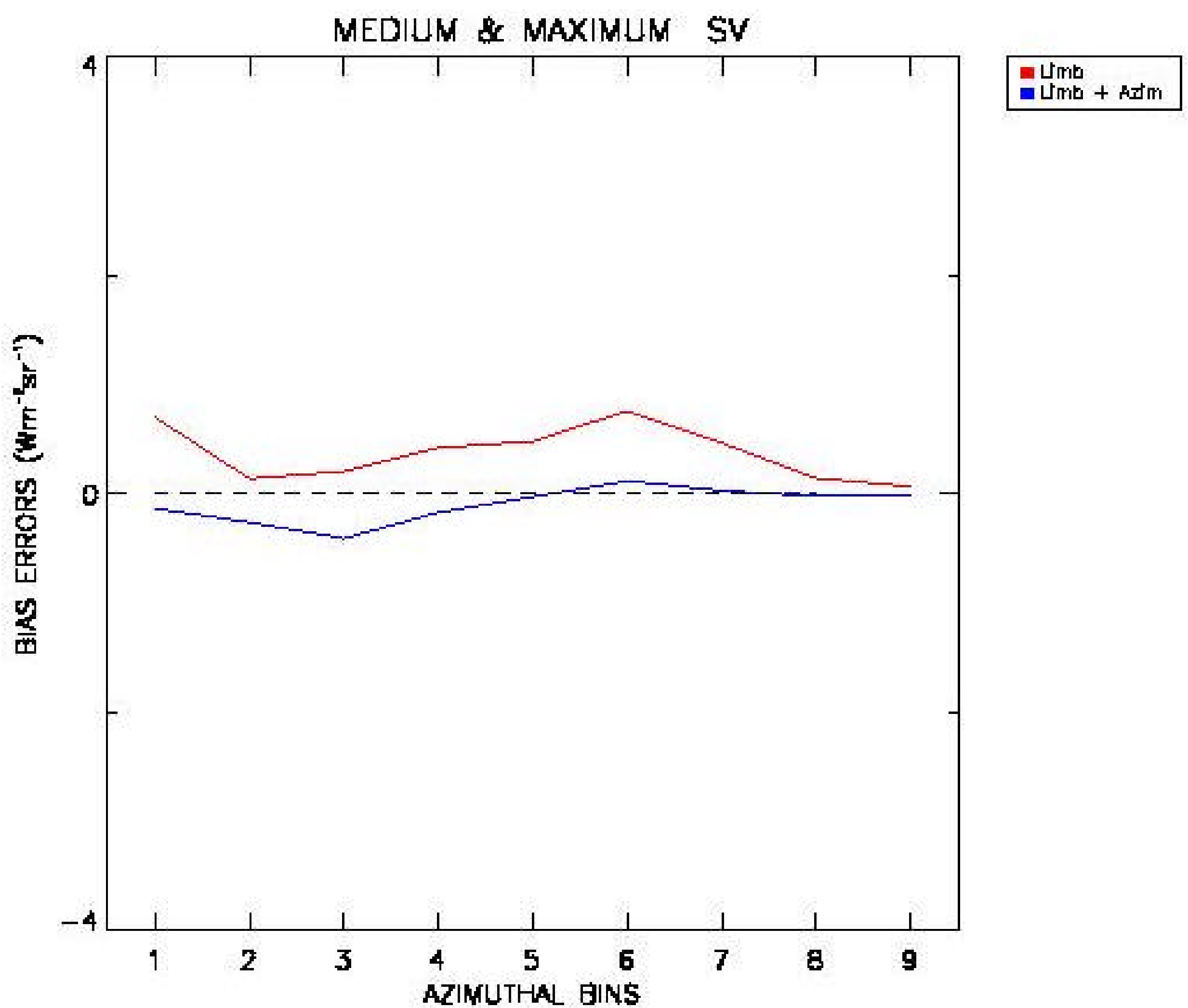
1998 Jan–Aug: Clr sky rad: RMS errors for matched data

GOES-8 and VIRS

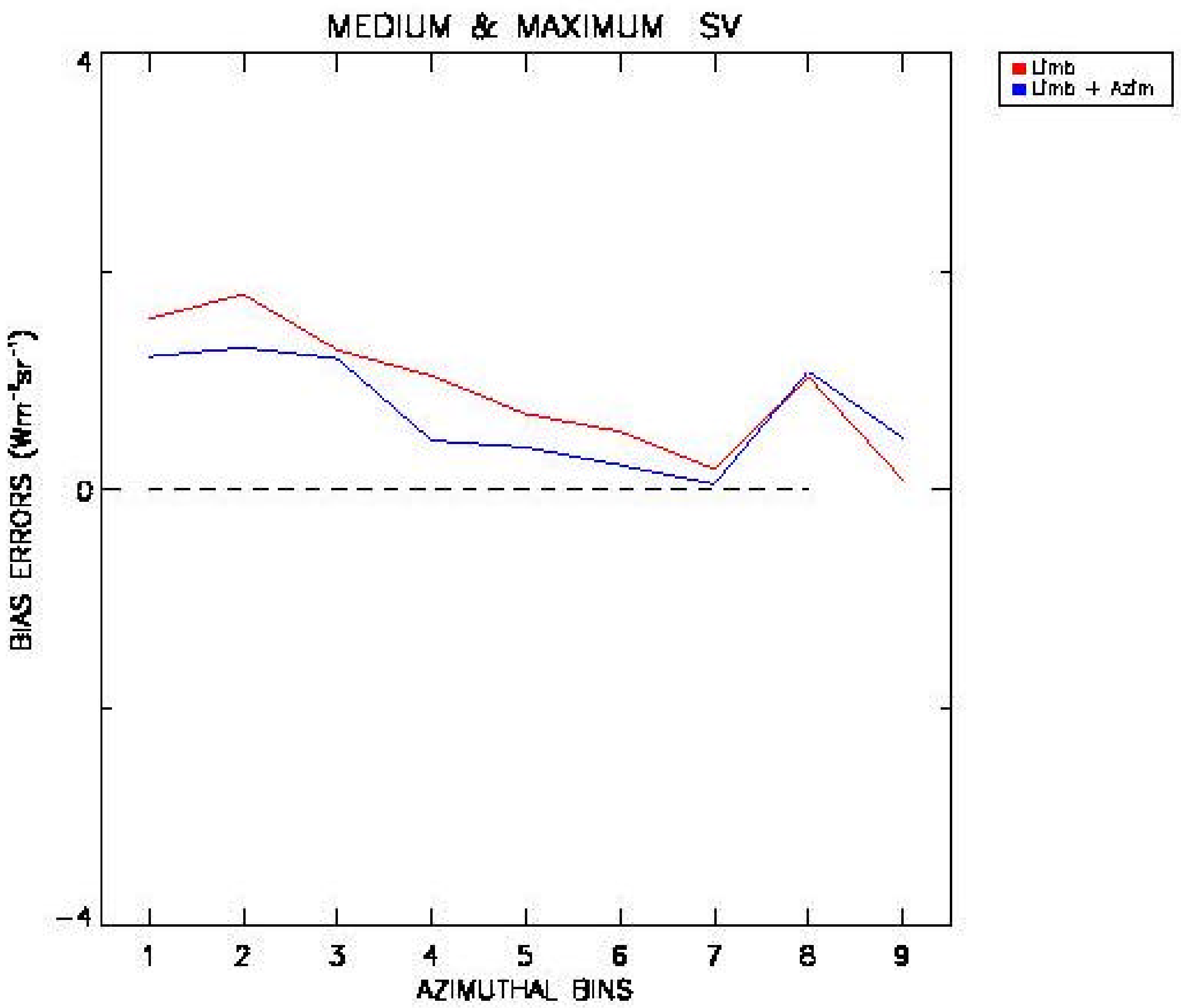


1998 Jan–Aug: Clr sky rad: Bias errors for matched data

METEOSAT 6–7 and VIRS

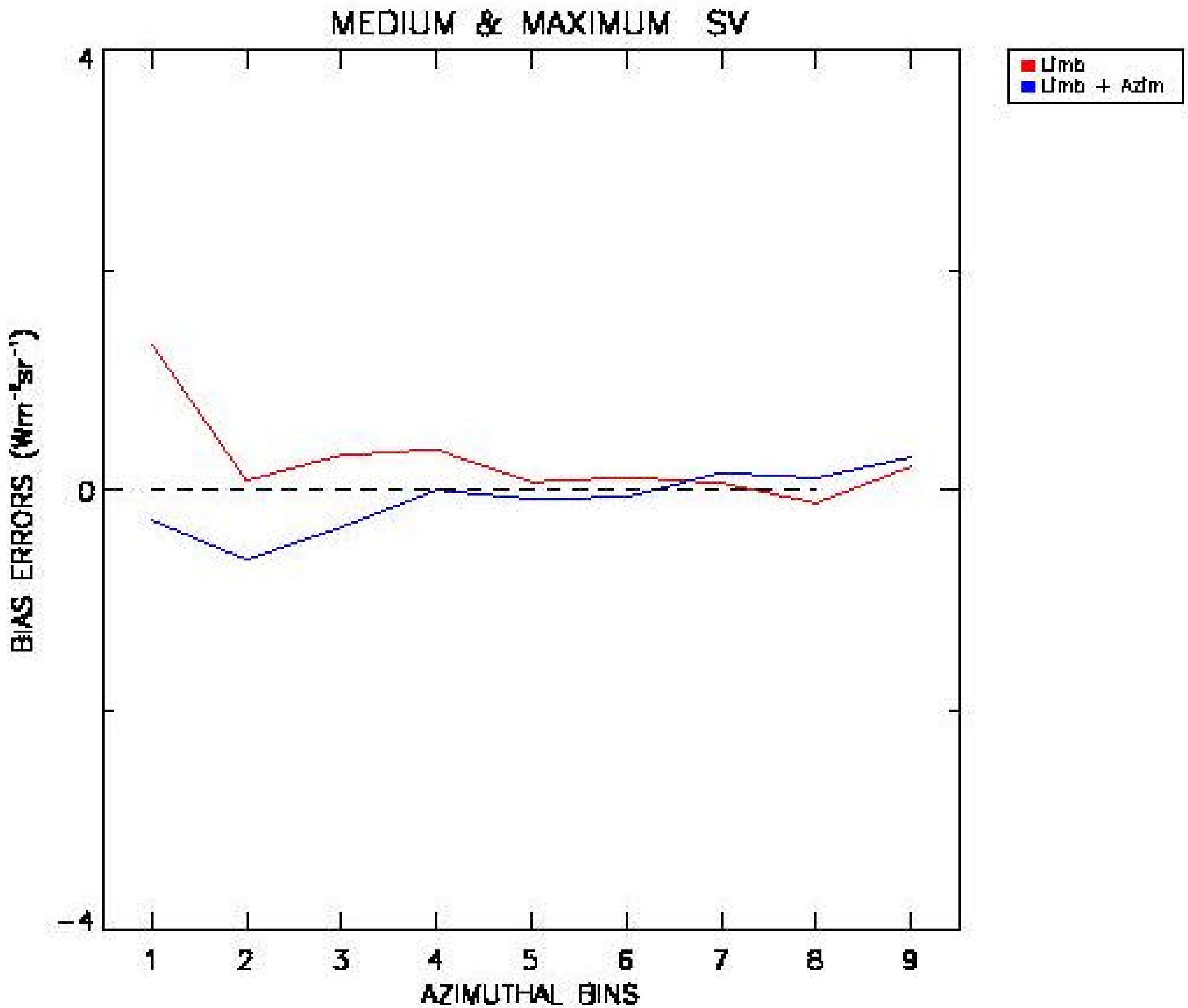


# 1998 Jan-Aug: Clr sky rad: Bias errors for matched data
GMS and VIRS



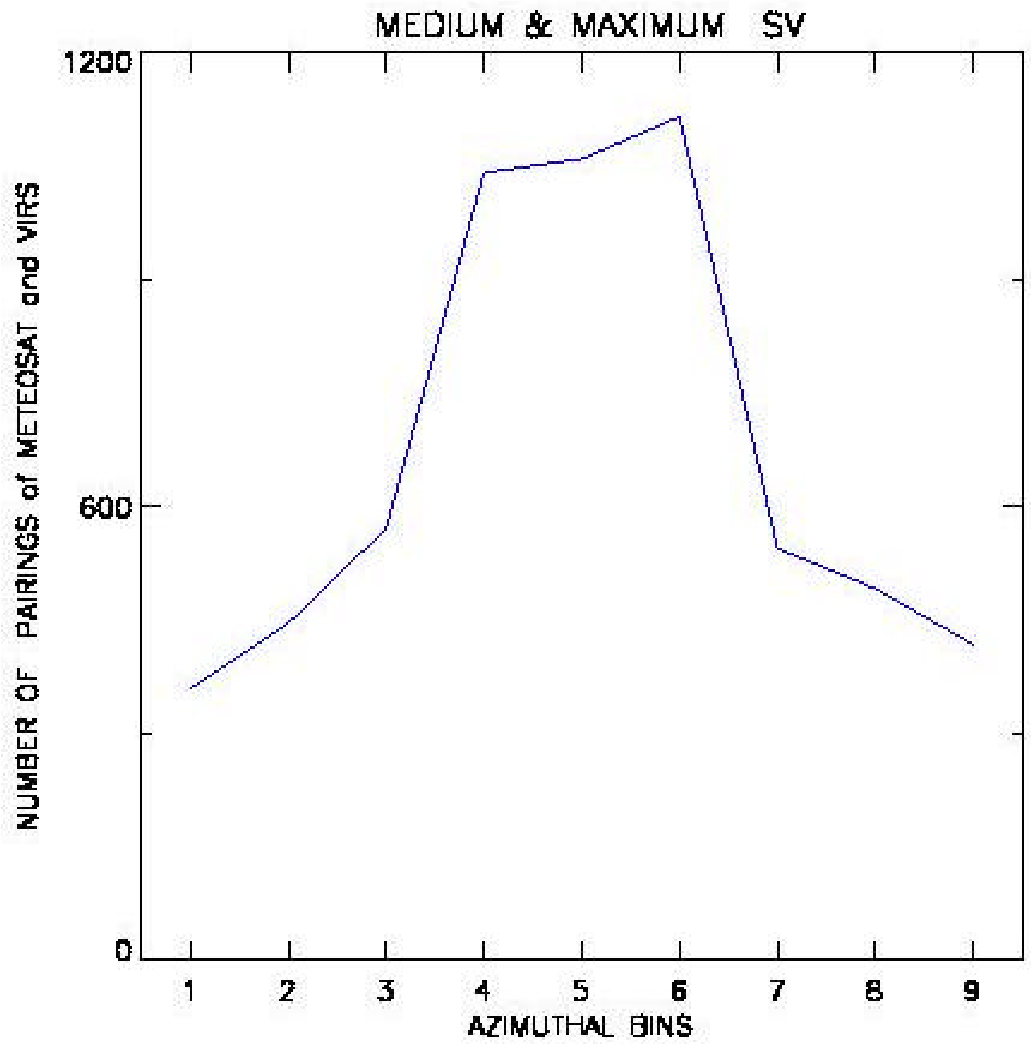
1998 Jan-Aug: Clr sky rad: Bias errors for matched data

GOES-8 and VIRS

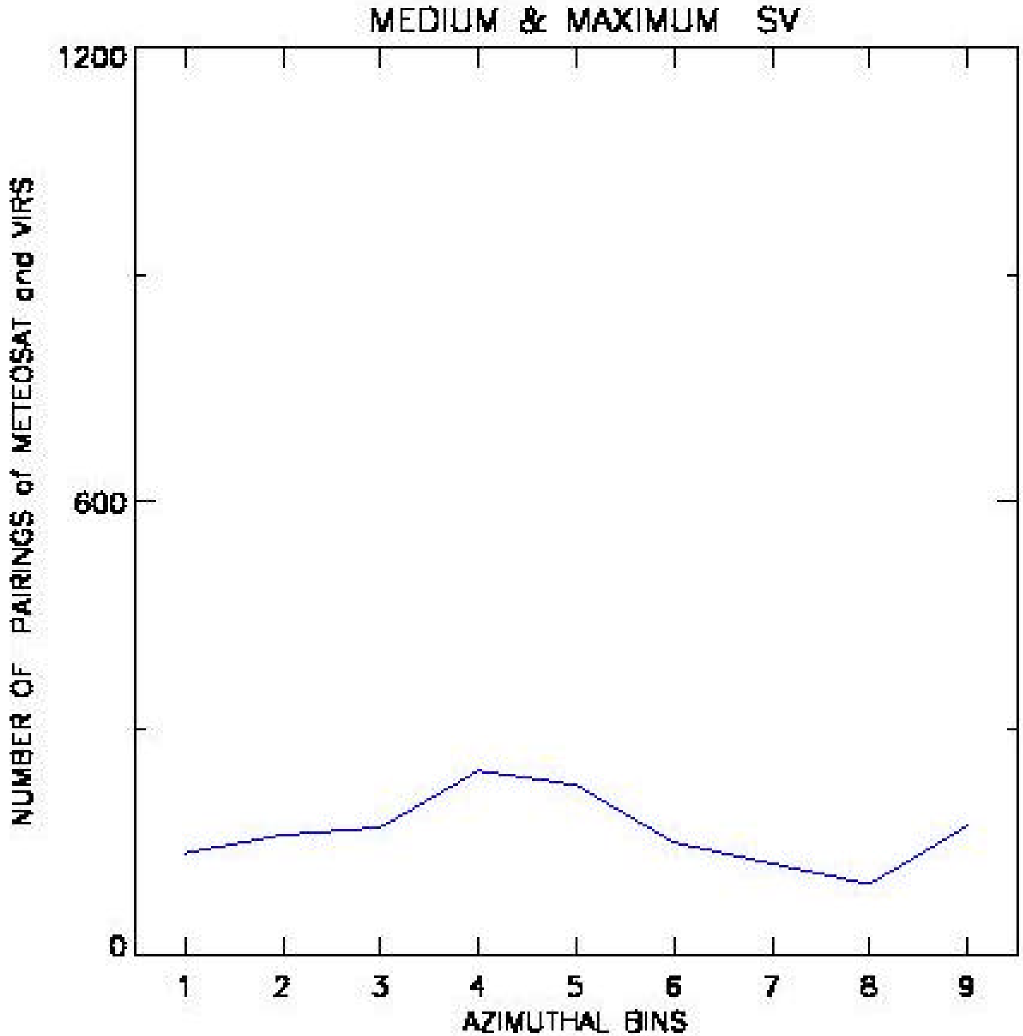


1998 Jan-Aug: Clr sky rad: # of Pairings for matched data

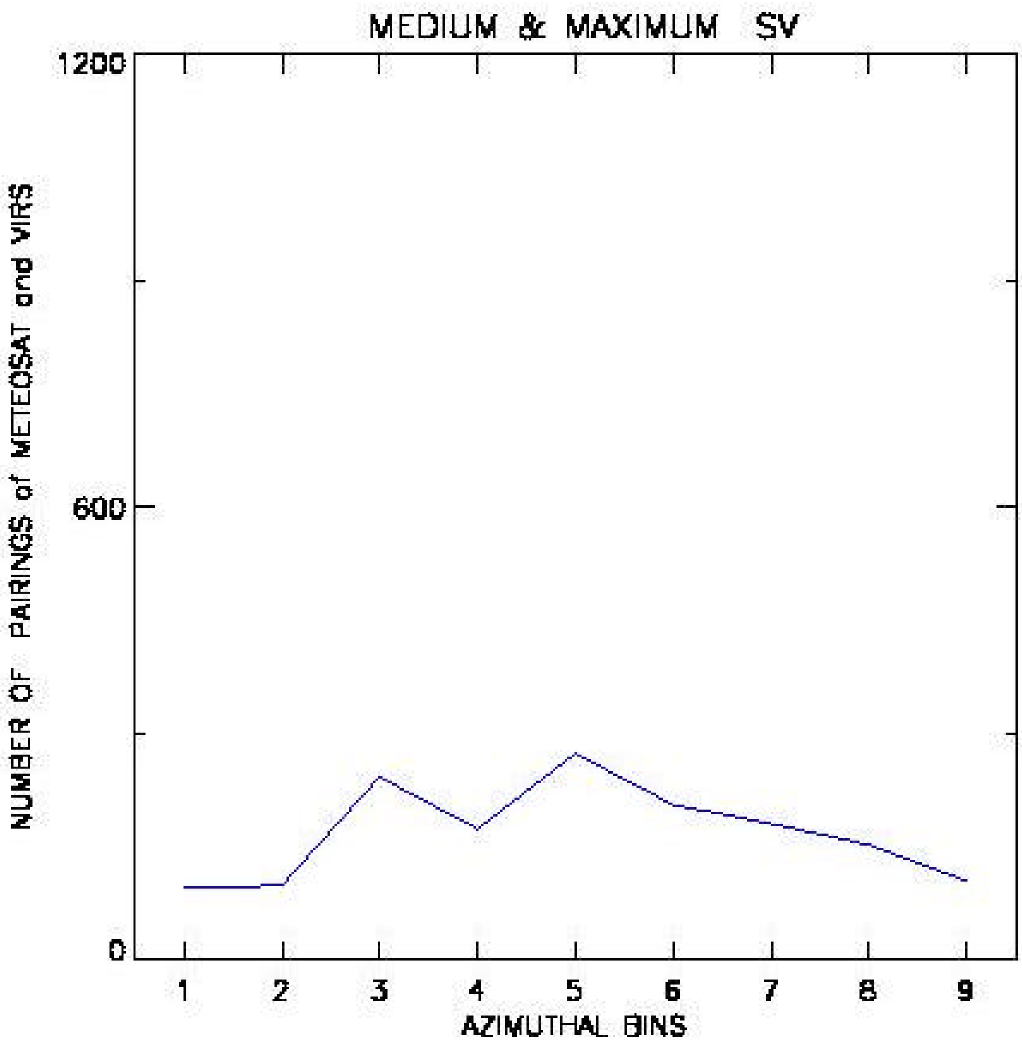
METEOSAT 6-7 and VIRS



1998 Jan-Aug: Clr sky rad: # of Pairings for matched data
GMS and VIRS



1998 Jan-Aug: Clr sky rad: # of Pairings for matched data
GOES-8 and VIRS



# Conclusions

1. Binning by SZA demarcates azimuthal signal better

2. Validation for 8 months data of VIRS and GGEO shows that azimuthal correction is indeed needed for high SV and possibly for medium SV bins

# FUTURE

1. Revalidate the results with some other data set possibly.
2. Inclusion of azimuthal model in LW ADM for high SV.