BETA4 TSI/SYNI Status

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8th CERES-II Science Team Meeting

8:30am Thursday 15th November
Fairmont Empress Hotel
Victoria, British Columbia, Canada
Nov 14-16 2007

Outline

- TSI Changes for Beta4
  - Ed3 like daytime TOA LW correction
- SYNI Changes for Beta4
  - Sfc Albedo History revised maps
  - Sea Ice Surface Albedo perturbation method
  - Snow Grain size retrieval
- Validation
  - PAR {SeaWifs Comparison}
  - UVA, UVB {USDA Sfc Obs}
  - SYNI @ CERES times compared to FSW
  - Model Vs Observed TOA Flux
    - Geo vs Ceres Times

SYNI Product *What is it?*

- Global 1x1deg Grid Hourly
- Fu-Liou radiative transfer broadband SW and LW TOA, surface and atmosphere

TSI Input product for SYNI

- CERES& MODIS (~twice a day)
- 3 hourly Geostationary
  - Normalized to CERES for TOA Fluxes
  - Geostationary radiances calibrated to MODIS for Cloud Properties (tau, height, phase, particle size)

Other major input products for SYNI

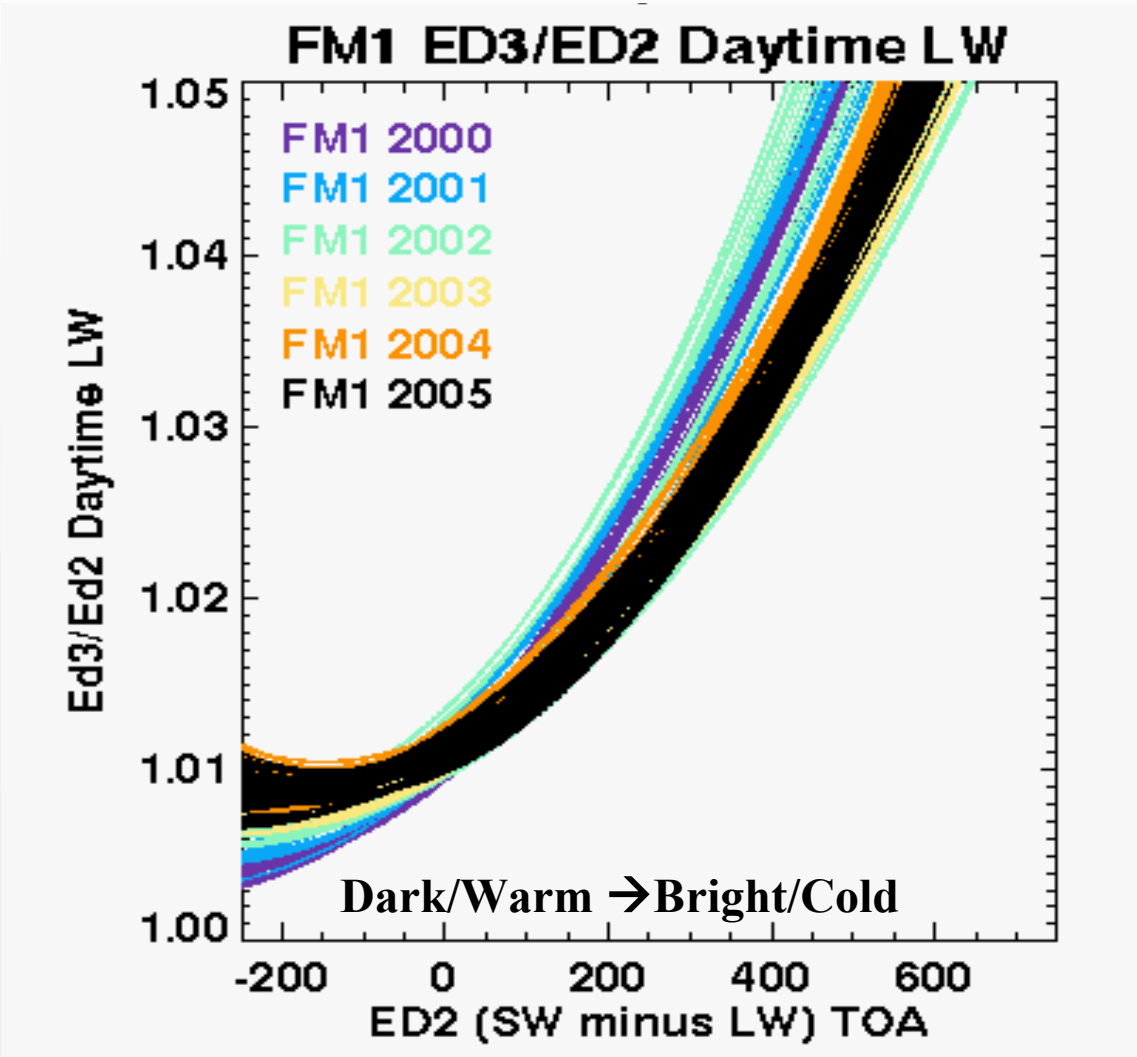
- GEOS4 Temperature & Humidity
- SMOBA Ozone
- Modis and Match AOTs , Match constituents
- Microwave daily Snow & Ice

TSI Changes For BETA4

- Produce grid-hour <u>integrated</u> sun angle!
  - 1 Hour in <u>Time</u>
    - Beta4 center on **bottom** of hour :Was centered@Top of the hour in Beta3
  - 1x1 degree Grid Box in <u>Space</u>.
- Rev1 SW correction applied
- Ed3*like* Daytime Longwave Correction (~ +1%)
- <u>No</u> interpolation of MODIS Aerosol during cloudy non-retrieval periods. (SYNI reverts to MATCH AOTs)
    - Reduce cloud contamination
    - MODIS AOTs *as is*, **not** filtered by CERES FOV Cloud mask
- Fixed occasional cloud top > cloud base pressure problem
- Supply clear sky TOA albedo even when overcast
  - If clear sky present at some time in month

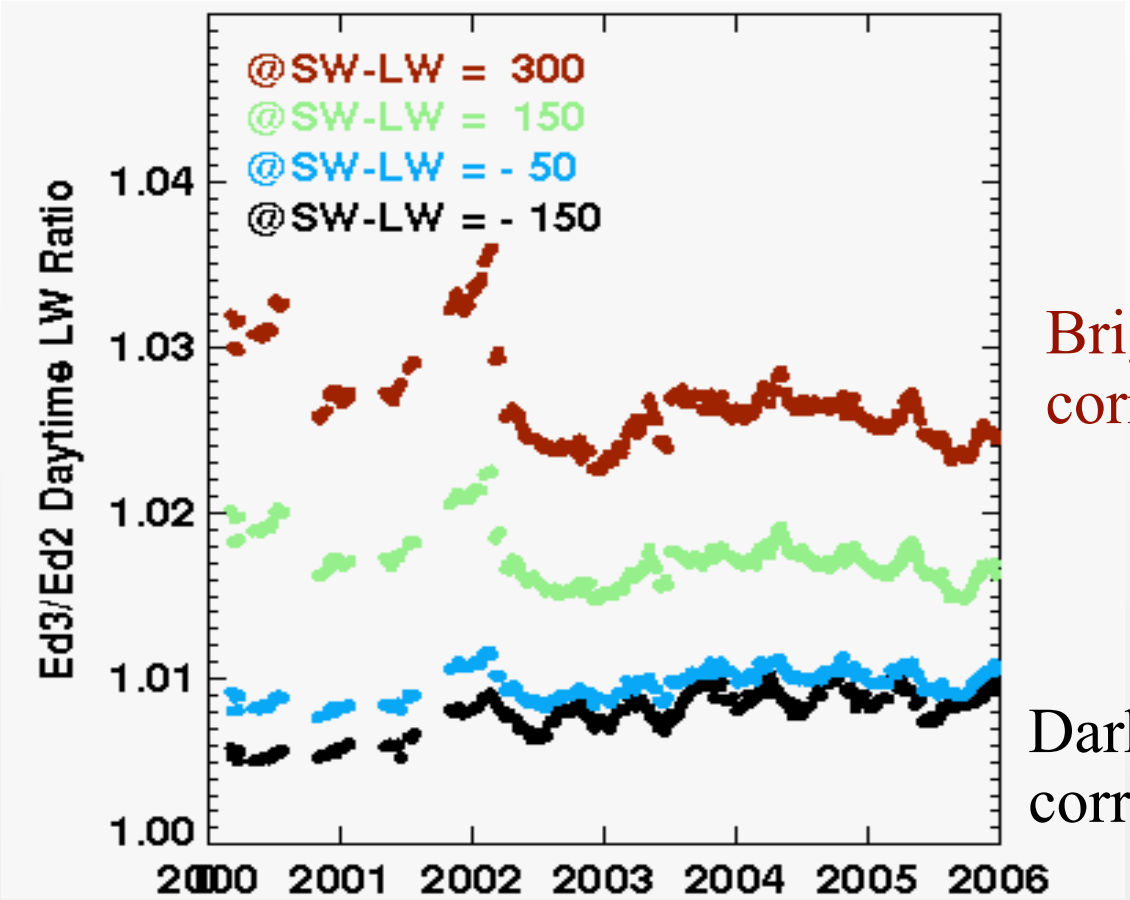
Ed3-*like* Daytime Longwave Correction

- Monthly Parameterization to *Ed2* (SW *minus* LW) Toa Flux
- Based on Loeb processing of daily data *Edition 3 Beta7*



Ed3-*like* Daytime Longwave Correction

FM1 Trends as function of SW *minus* LW value



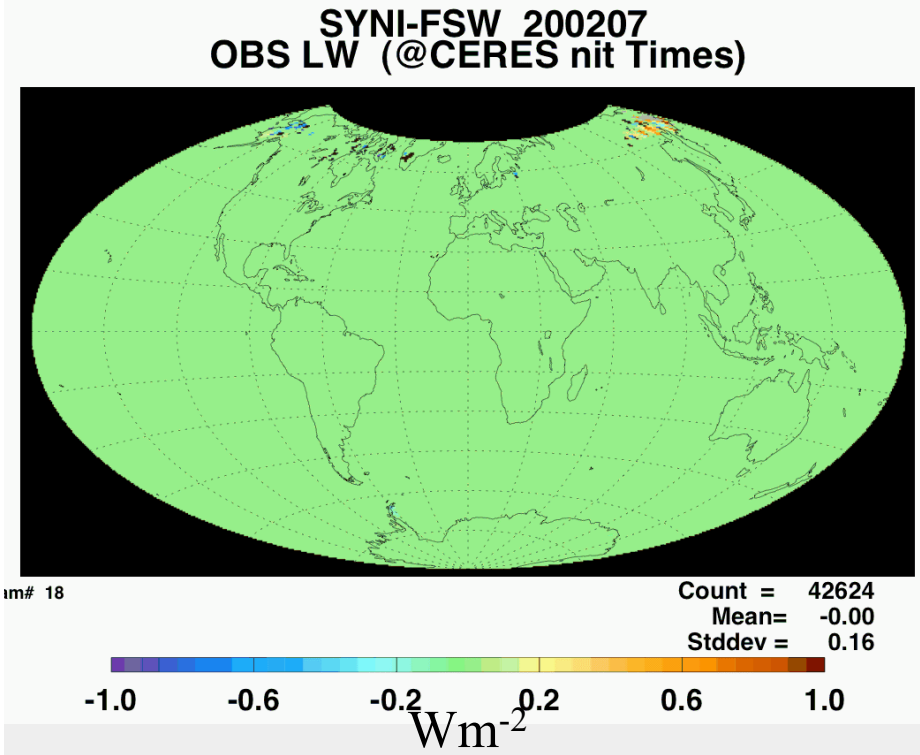
Bright/Cold scenes correction <u>decreases</u>

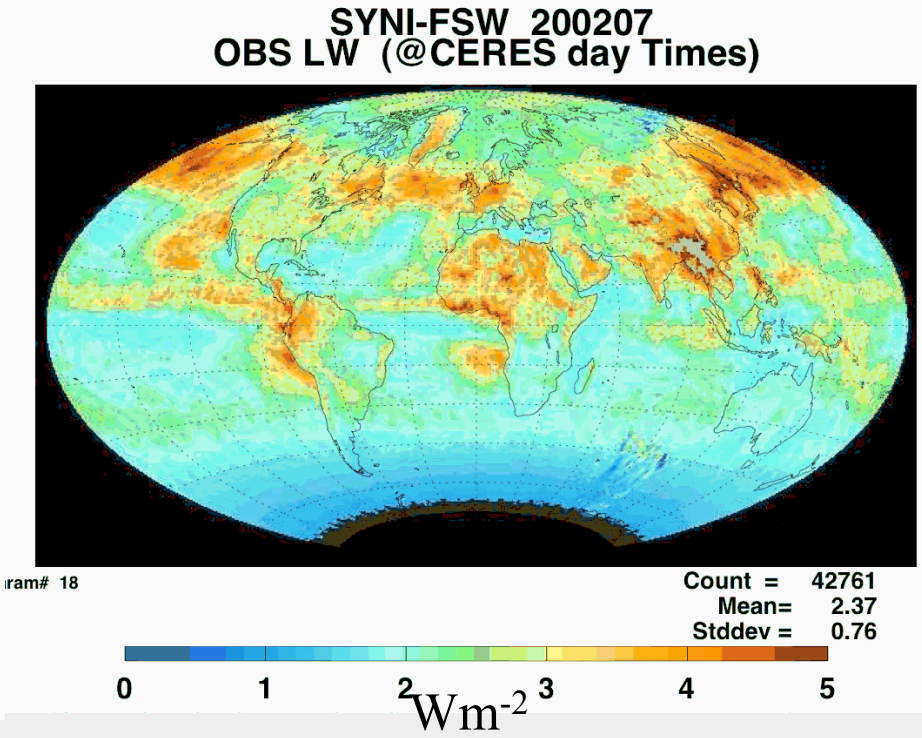
Dark/Warm scenes correction <u>increases</u>

TIME (Year)

SYNI vs FSW CERES OBSERVED LW

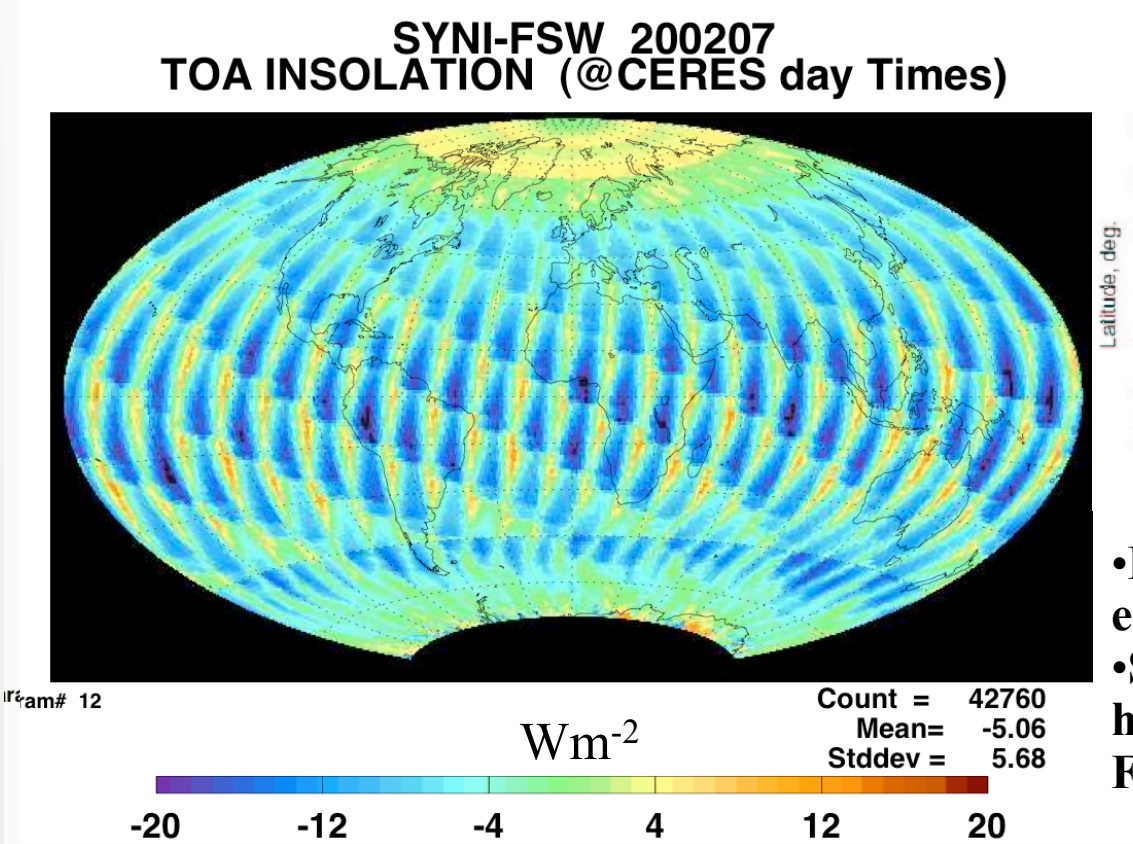
Ed3-like daytime OLR correction

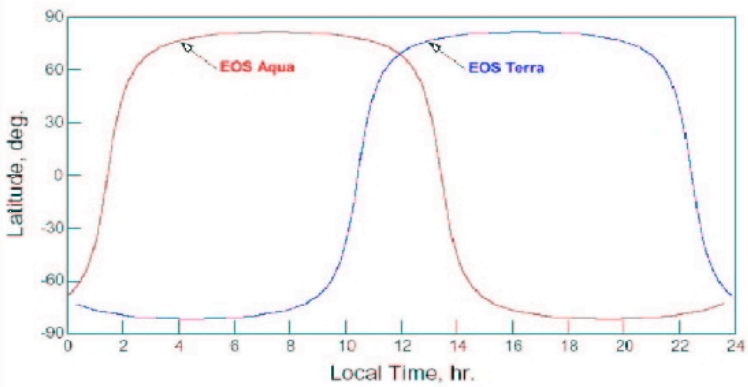




SYNI vs FSW CERES Observed SW Reflected Flux and TOA Insolation

- FSW average whatever FOVs fall into 1x1deg x 1hr hourbox
- SYNI spatial temporal integration over hourbox
- Rev1 Correction applied to Obs TOA SW in TSI/SYNI





•Differences follow Terra orbit equator crossing time
•Solar Declination computed hourly in TSI, only daily in FSW/CRS

SYNI uses Fu-Liou Code

- Gamma weighted 2-Stream (SW) , 2/4 Stream (LW) pristine multi-stream correction to COART
  - Treats sub-computational scale Inhomogeneous clouds (S.Kato)
- Correlated k : 29 Bands : 15 SW, 14 LW , 3 of 14 LW in WN
  - Enhanced output of PAR and UVA,UVB (W.Su)
- Shortwave: (0.17 - 4.0 or *inf*)μ [2500-57000 cm-1]
  - HITRAN 2000 (H_20) w/(O_2,CO_2,CH_4)@Fixed concentration
  - JPL(1994) O_3 uv , WMO(1985) O_3 vis
- Longwave (0-2850cm-1) (3.5μ – Infinity)
  - H_20 ,CO_2 ,O_3 ,N_20 ,CH_4 ,CFCs, H20 continuum)
- Optical Properties: spectral (β, ω , g)
  - Water Cloud (Y.Hu)
  - Ice Cloud (Q.Fu 1996 ,Dge)
  - Aerosol Optical Properties (OPAC, Tegin&Lacis, d'Almedia)
- Major Revisions
  - 10 visible SW bands reworked for O_3 and rayleigh in 1995
  - Near-Ir 0.7-1.3μ subdivided into 4 bands in 2005
- Online Version http://www-cave.larc.nasa.gov/cave

Beta4 SYNI CHANGES

- Use Daily MATCH aerosol assimilation when no MODIS
  - Cloudy sky aerosol retrieval contamination issue
- Revise Monthly Surface Albedo History(SAH) maps to include Ocean Sea Ice domain and monthly average snow &/or sea ice fraction field.
- Simple Snow Grain size retrieval using CERESonly Broadband
  - Spectral surface albedo at non-ceres times assume constant snow grain size
- Separate Clear &Cloudy Sky Colorization of Spectral Sfc AlbedoLUT
- Zhuo Wang two coef. diurnal models for surface albedo(igbp 1-10&12)
- Add outputs field to SYNI
  - MATCH AOT
  - SAH surface albedo values (consistency check)
  - UVB Total Sky Upward Flux
  - Retrieved snow grain size
- Fix known bugs ::
    - Omission of high thin clouds T<235K &Tau < 0.2
    - Insure pristine sky toa correction is output on product
    - Cloudy Sky albedo not at diffuse angle for partly cloudy grid boxes
    - Allow model computation even if no SW Toa flux given in TSI

SYNI Surface Optics

- **Scene Id**:
  - IGBP
  - Daily Snow Ice maps (NSIDC microwave)
    - Where No microwave data
      - Threshold of Cloud WG Daily 0.63μ & 1.6μ overhead sun albedo
- **Emissivity**
  - Cloud WG seasonal maps (3 window bands)
  - SOFA (IGBP based for remaning LW bands)
- **Broadband Surface Albedo:**
  - Multiple methods :: apriori and retrievals
  - More explanation to follow…..

Surface Albedo History(SAH) Global Monthly Weighted Mean Maps

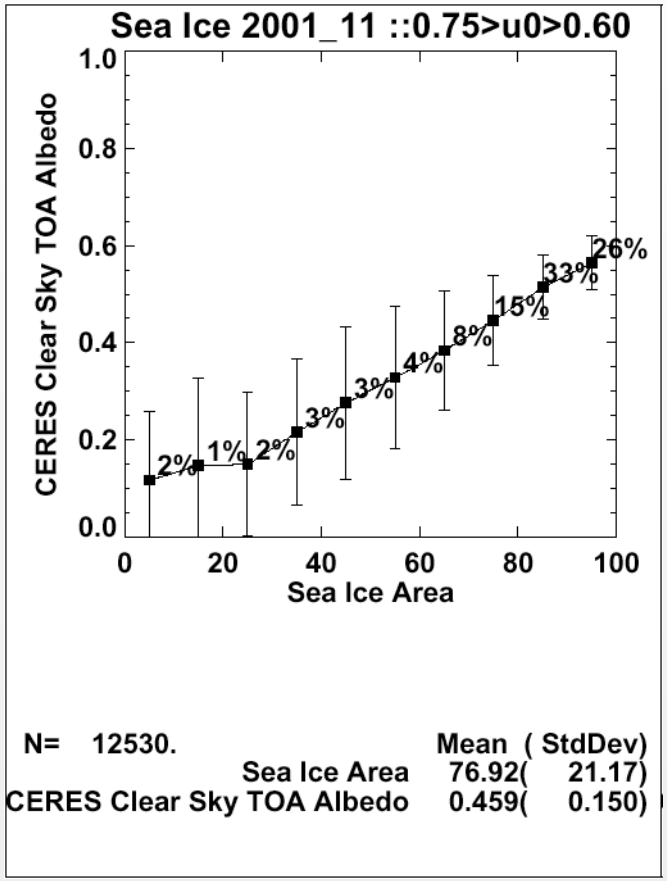
- 10’ grid (2160x1080) ~18x18km
- Clear Sky Toa based Surface Albedo Retrieval
  - SfcAlb = f (ToaAlb, SZA, PW, O_3, TauAer, SSAAer, Elevation, IGBP)
- Monthly Weighted Mean ::
  - SfcAlbedo@overheadsun , CosSZA, Cryosphere%
- Weight = u0 * v0 * f(Sa2-Sa1)
  - u0 :Cosine Solar Zenith Angle (0-1) *u0<0.3 allowed*
    - Less atmosphere correction at high sun
  - v0: Cosine View Zenith Angle (0-1)
    - Spatial resolution better near nadir, 10’ map is filled
    - Oblique views fill multiple 10’ grids @ low weight
  - f(Sa2-Sa1): Aerosol Forcing to Retrieved Surface Albedo
    - Match Aerosol AOT and Constituents

Surface Albedo History Composite Creation

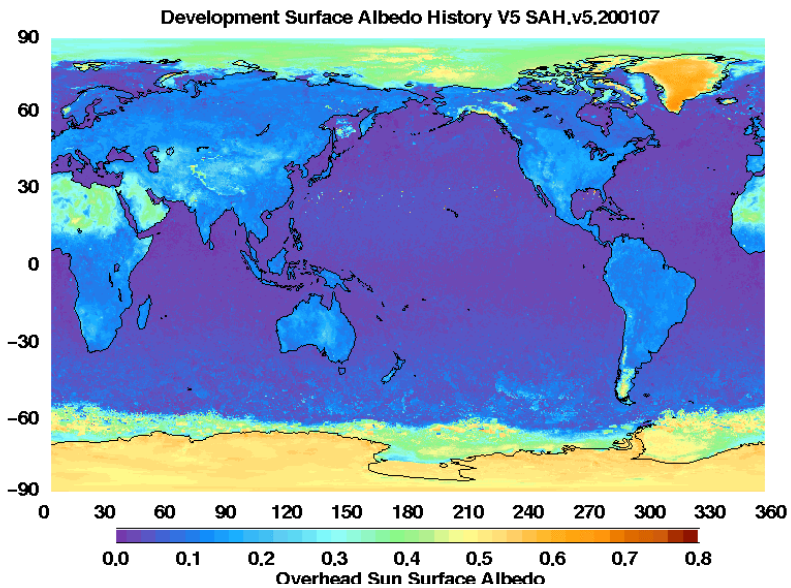
- Monthly maps generated seperately for FM1 & FM2
  - Rev1 correction applied before retrieval
- Individual instrument maps composited to fill spatial gaps (c*louds)*
- Remaining gaps filled according to hierarchy
  - 1) Canonical Season Month
  - 2) Epoch Average (Mar2000-Dec2005)
  - 3) IGBP default.

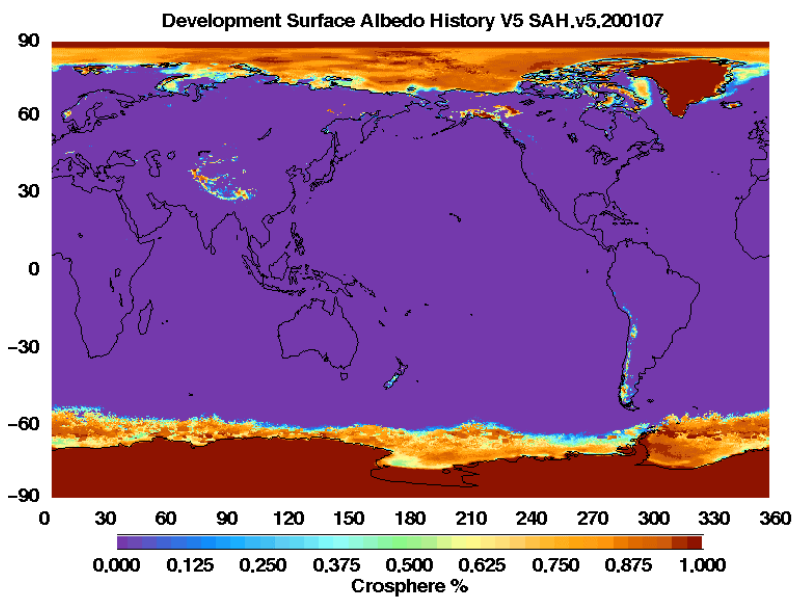
Surface Albedo History perturbation by daily sea ice data

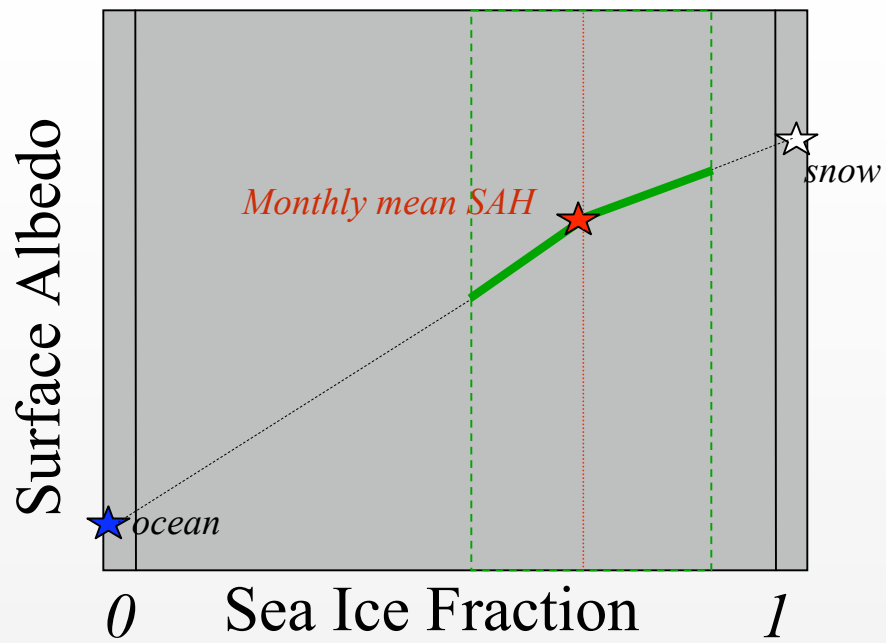
- Can we use daily microwave Sea Ice variability to *perturb* monthly surface albedo ?
- YES ! A Correlation to CERES Clear sky TOA albedo is present
  - One month of CERES and Microwave SeaIce
  - Cos Sol 0.75 – 0.60

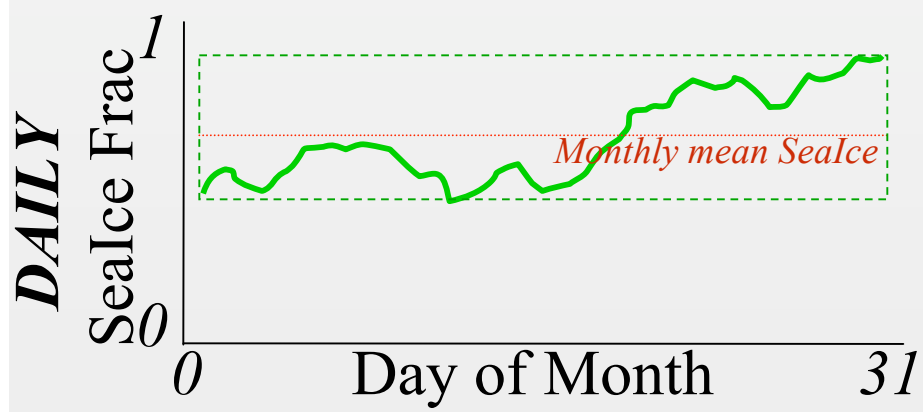


Cloudy Sky Sea Ice SAH perturbation method

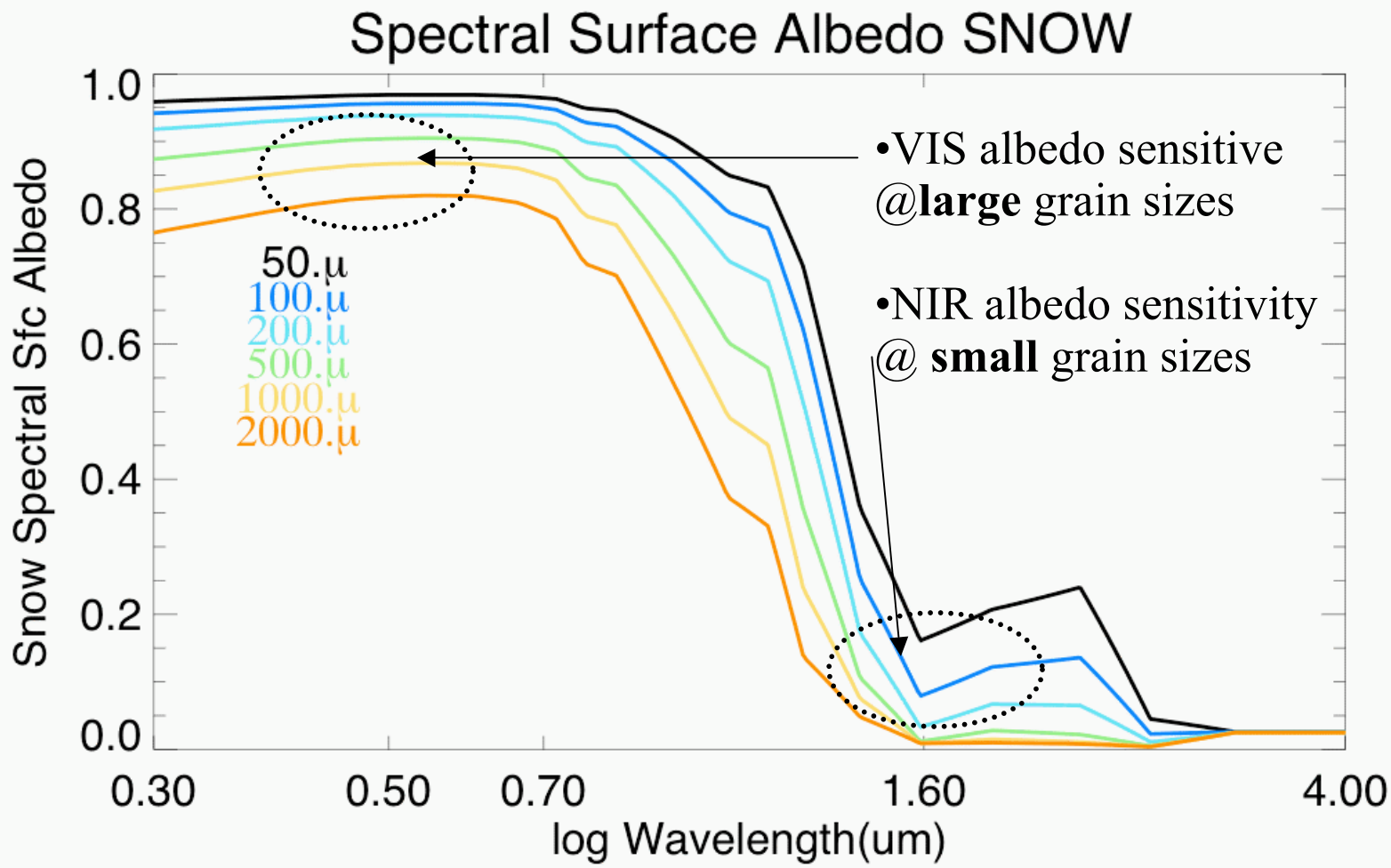








Spectral Albedo and Snow Grain Size
COART model example



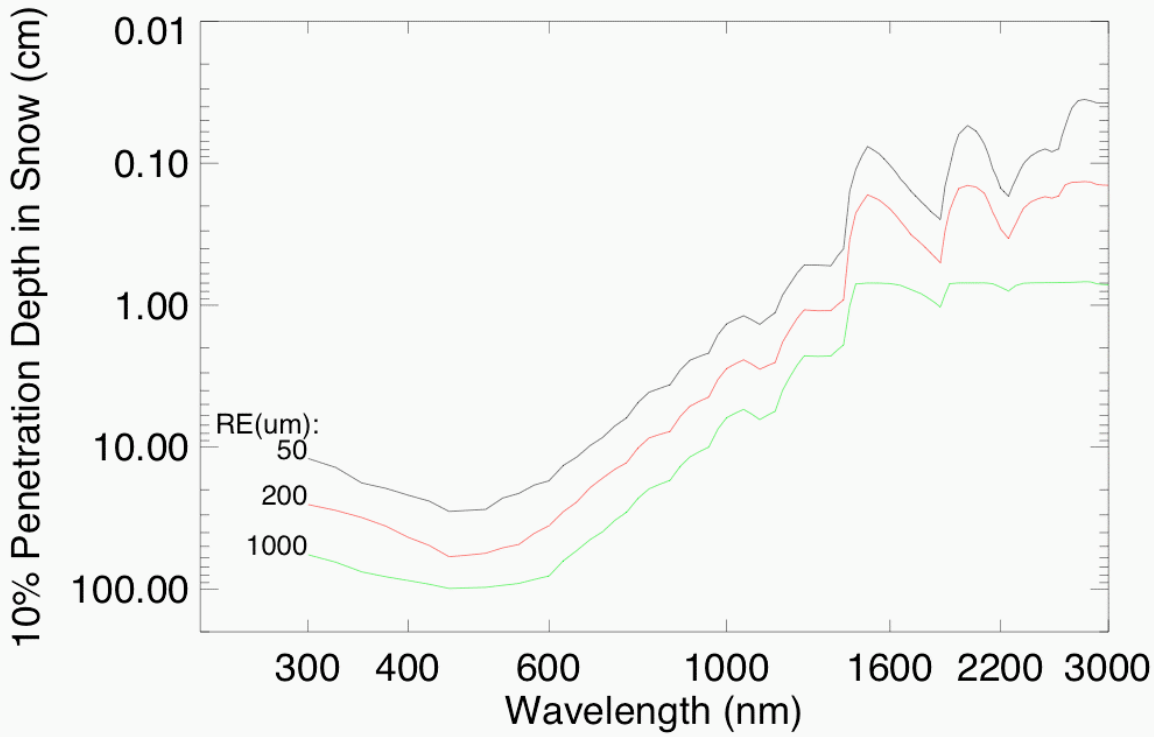
Snow Grain Retrieval Background

- NIR senses only top 1cm or less
- Visible penetrates snowpack

~From COART (Zhonghi Jin)

- Small grain size near top
- Larger sizes with depth

~From Aoki 2000



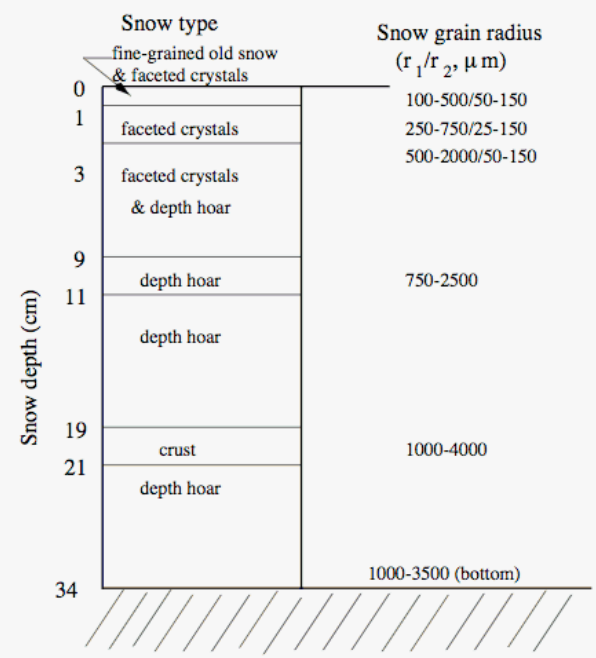
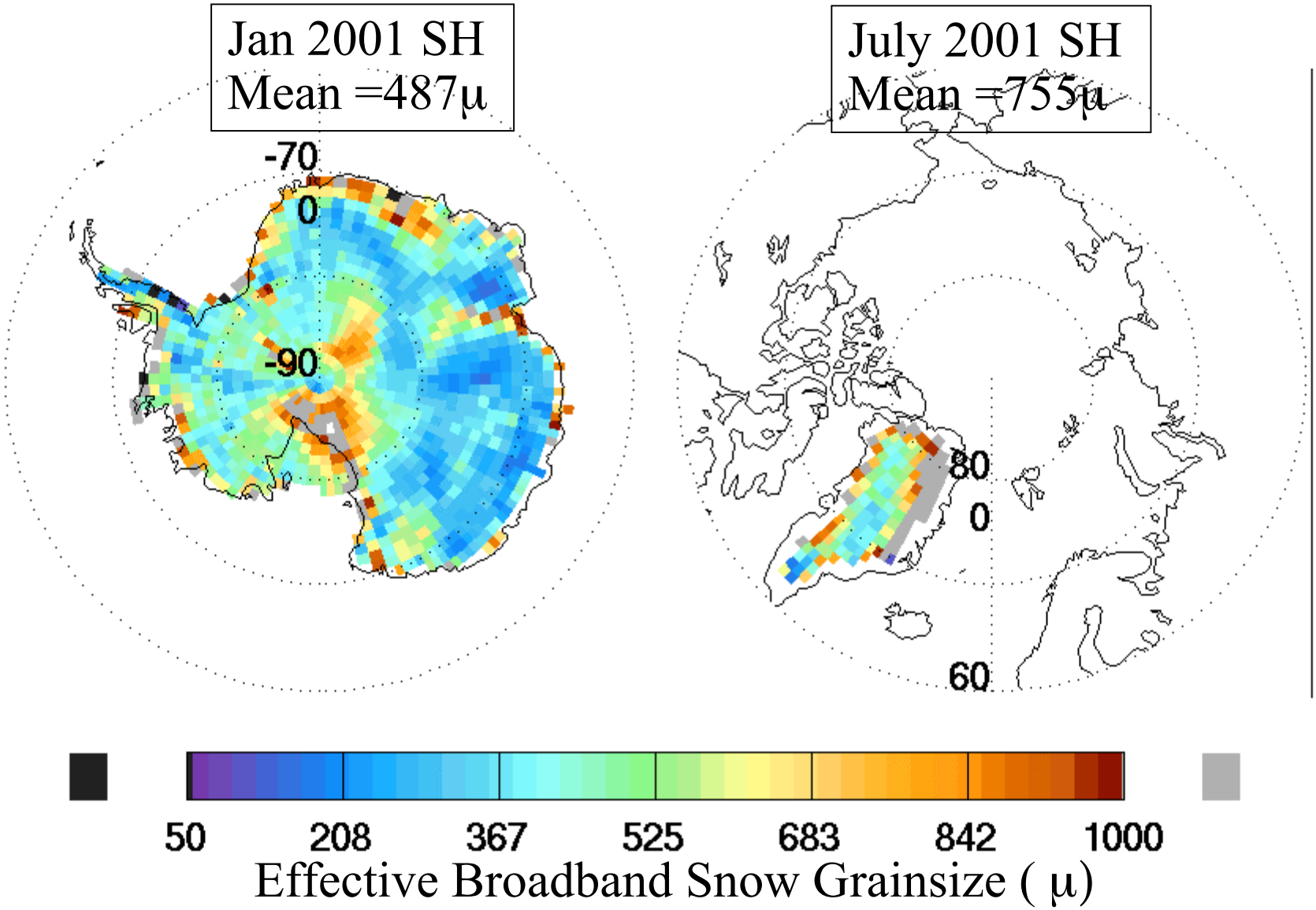


Figure 1. Vertical profile of snow grain size in eastern Hokkaido, Japan from *Aoki et al.*, [2000]. r_1 is one-half the length of the major axis of crystals or dendrites, and r_2 is one-half the branch width of dendrites or one-half the dimension of the narrower portion of broken crystals.

Snow Grain Size Retrieval

- Limited to >90% snow cover in grid box according to microwave snow map
- COART(Z.Jin) spectral surface albedo LUT for SNOW
  - Sfcalb(λ) = f(CosSZA, Aot , soot, grain size, λ)
- Fu Liou calculations using snow spectral albedo for multiple (CosSZA, PW, Aot, O_3 ,GrainSize) to generate 2nd LUT of SW broadband TOA albedo as function of snow grain size
- PRIMARY PURPOSE: **retrieval finds a <u>depth and wavelength integrated effective snow grain size</u> consistent with broadband CERES TOA albedo and other LUT inputs that has realistic surface albedo spectral shape for snow!**

SYNI Effective Snow Grain Retrievals Beta4@SCF



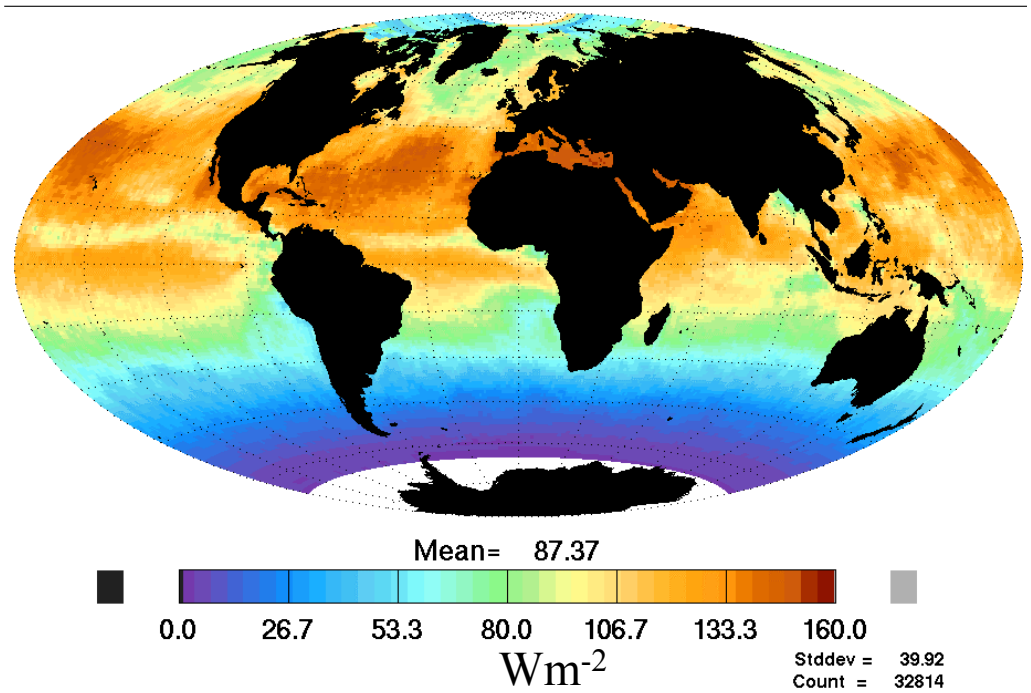
Surface Albedo Mode Summary Table

	Clear *high sun* u0 > 0.3	Clear *low sun* u0 < 0.3	Cloudy
Ocean	Z. Jin COART LUT	Z. Jin COART LUT	Z. Jin COART LUT
Land	TOA Retrieval	Monthly SAH map moved to u0 by Wang(b1,b2)	Monthly SAH map moved to u0**diffuse** by Wang(b1,b2)
SeaIce	TOA Retrieval	Ice Perturbed Monthly SAH moved diurnally to u_0 by Dickenson(d)	Ice Perturbed Monthly SAH moved to u_0**diffuse** by Dickenson(d)
Snow	Snow Grain retrieval ONLY @CERES Times SAH as needed	Snow Spectral albedo using last SGR @u0 SAH as needed	Snow Spectral albedo using last SGR@u0**diffuse** SAH as needed

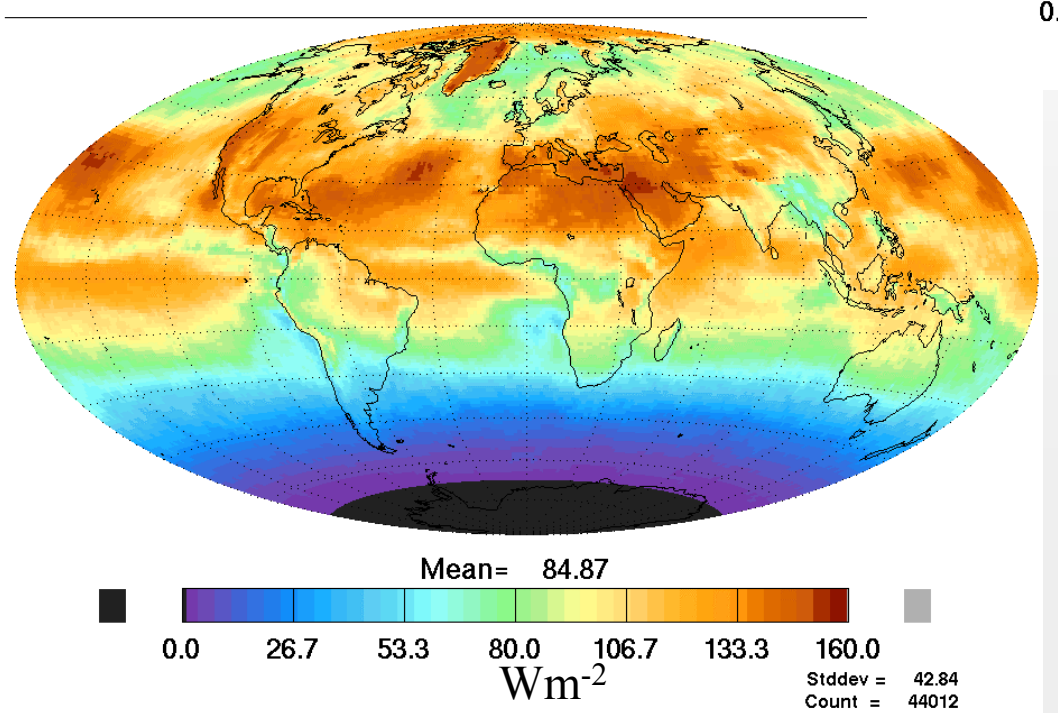
Selected Validation Efforts

Comparison of
Beta4 SYNI and SEAWIFS
Photo synthetically Active
Radiation (PAR)
products for July 2002

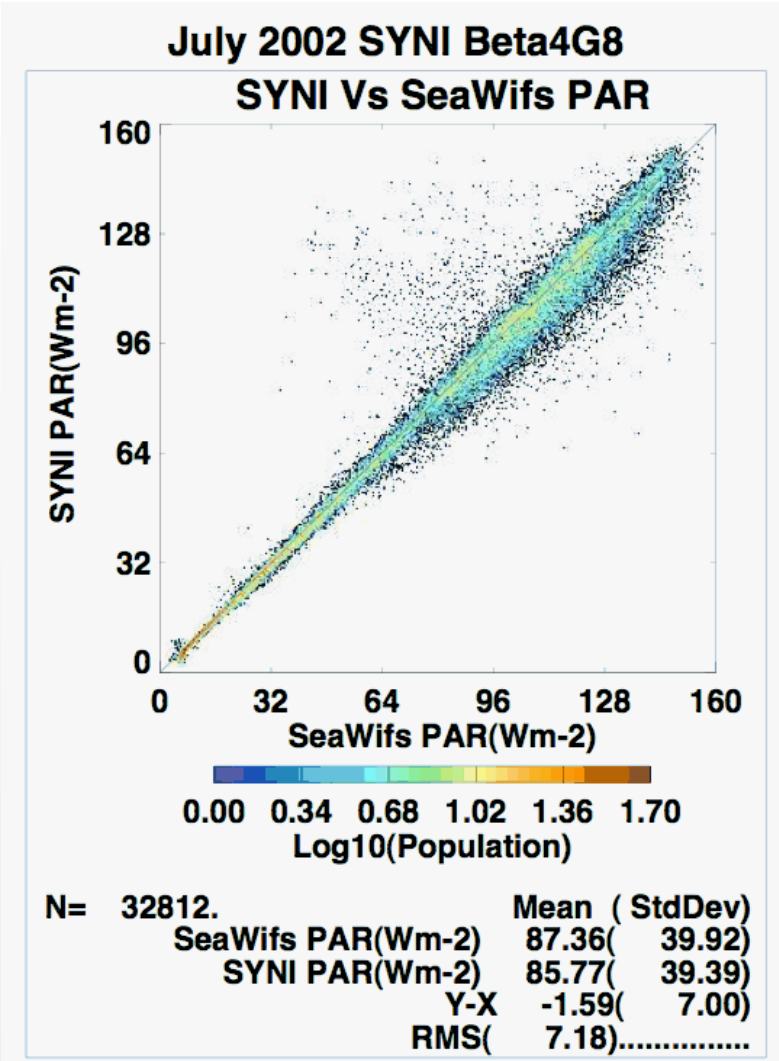
SEAWIFS PAR



SYNI PAR

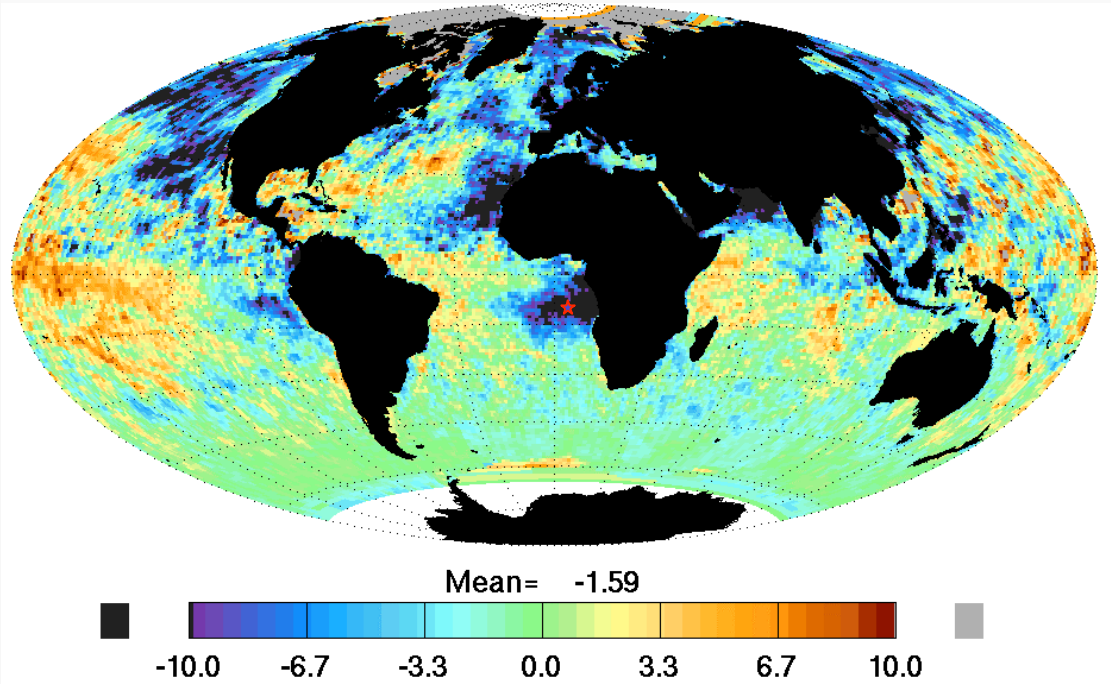


Comparison of SYNI and SeaWiFS PAR



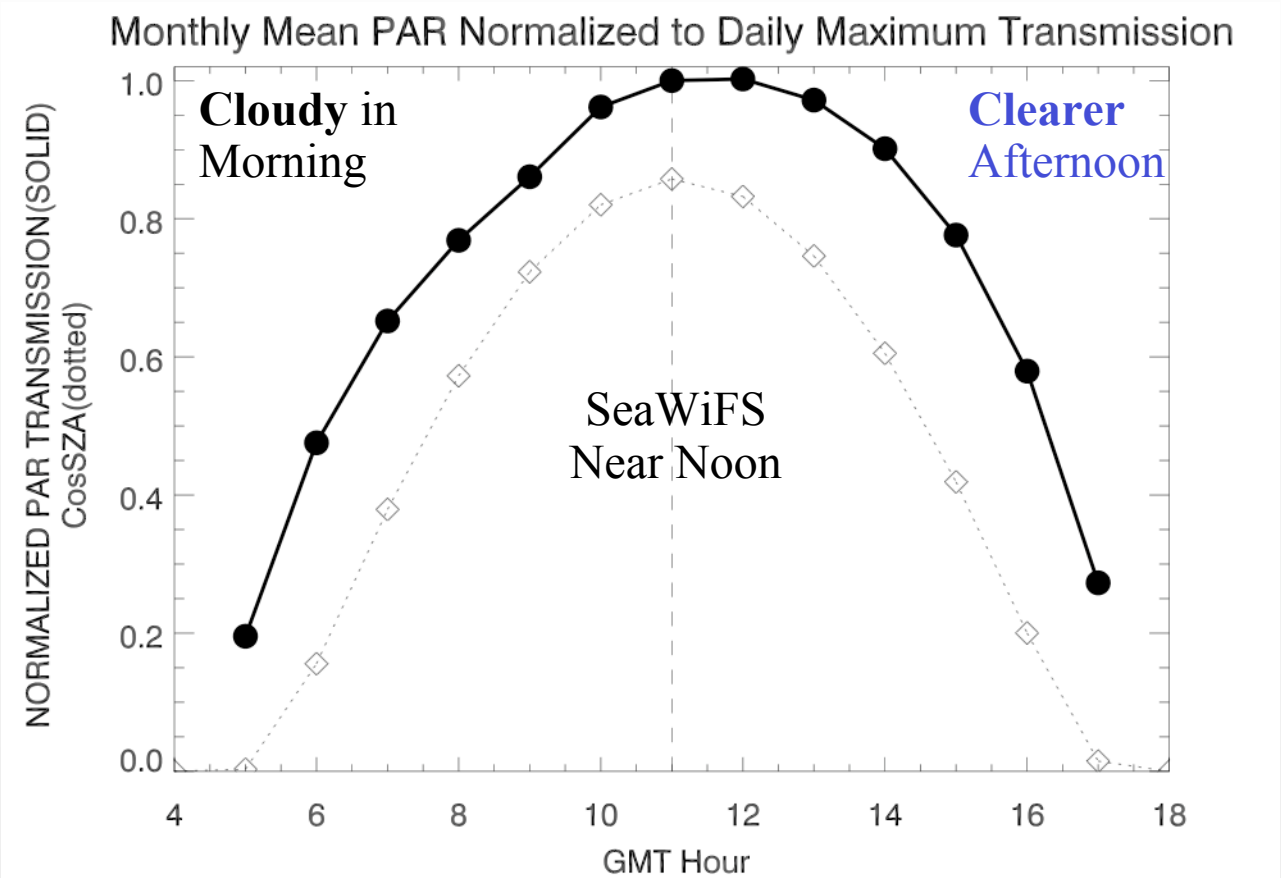
- SeaWiFS noon orbit w/diurnal model
- SYNI (captures full diurnal cycle)
  - Terra CERES/MODIS (10:30)
  - 3-hourly Geostationary

SYNI *minus* SeaWiFS PAR



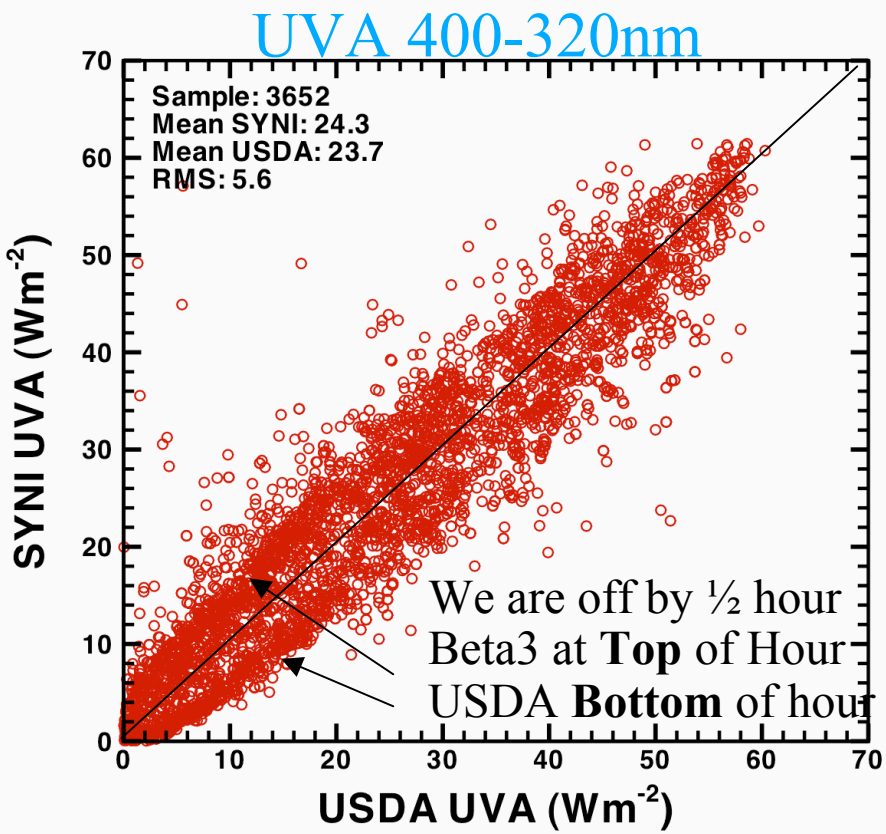
PAR Difference (Wm^{-2})

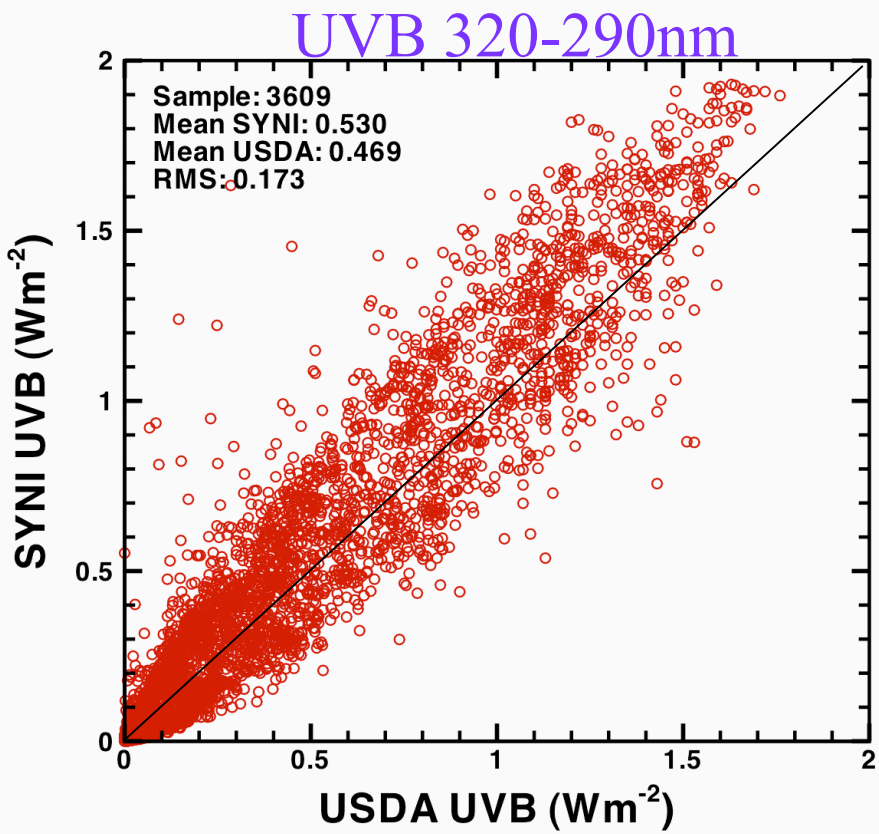
SYNI Diurnal Cycle of PAR off coast of Angola July 2007



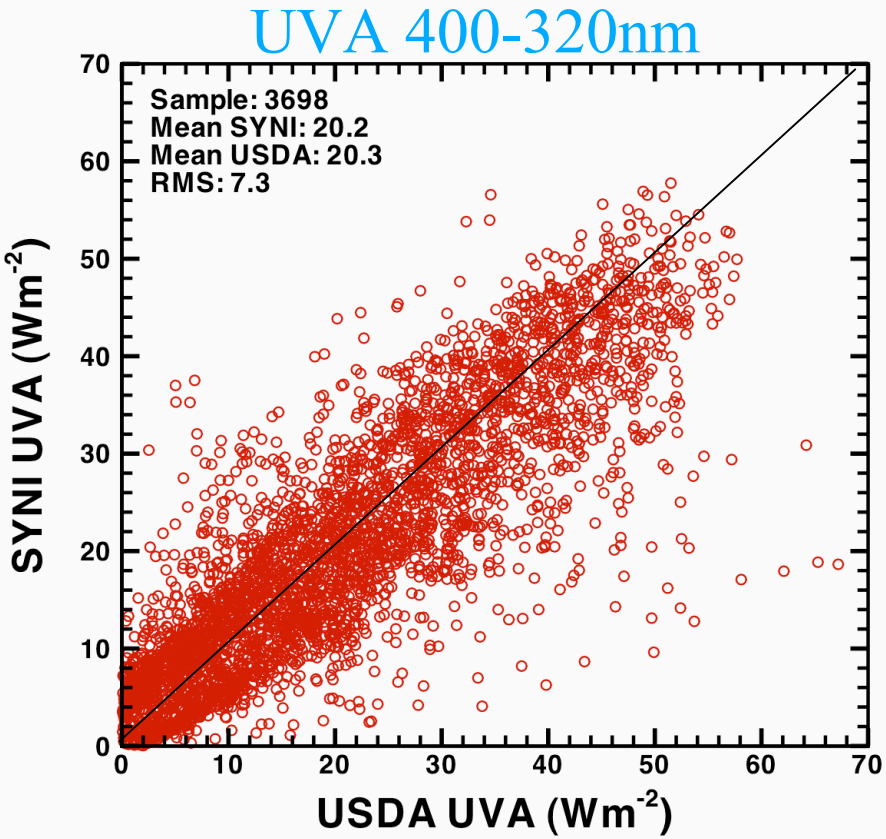
SGP UV Validation 2002

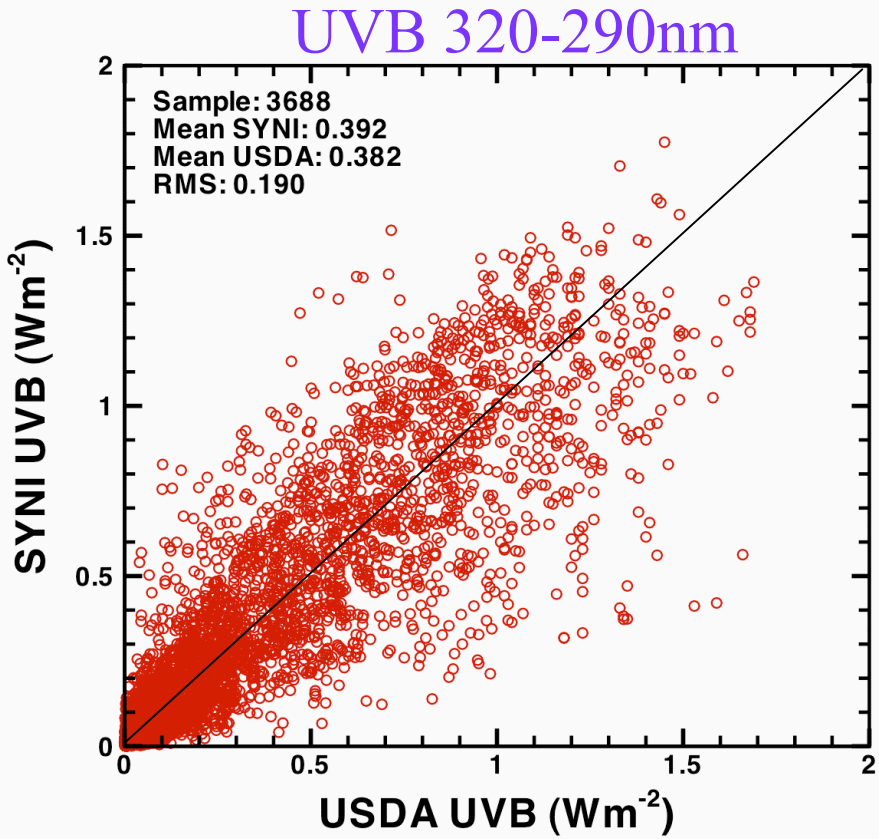
- Beta3 SYNI for entire year of 2002
- Validation analysis by Wenying Su



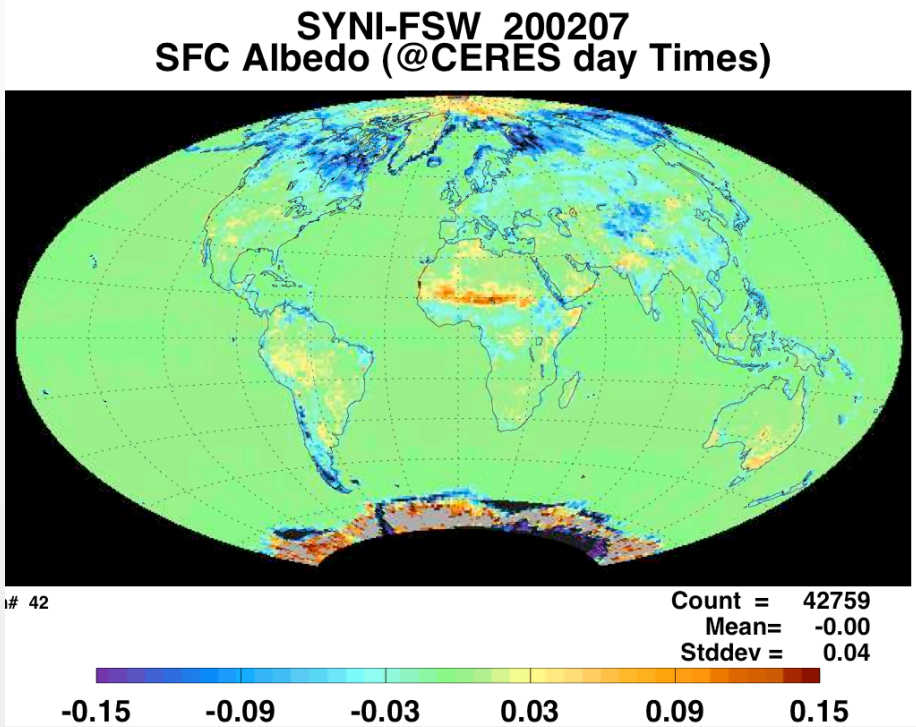


Bondville
UV Validation

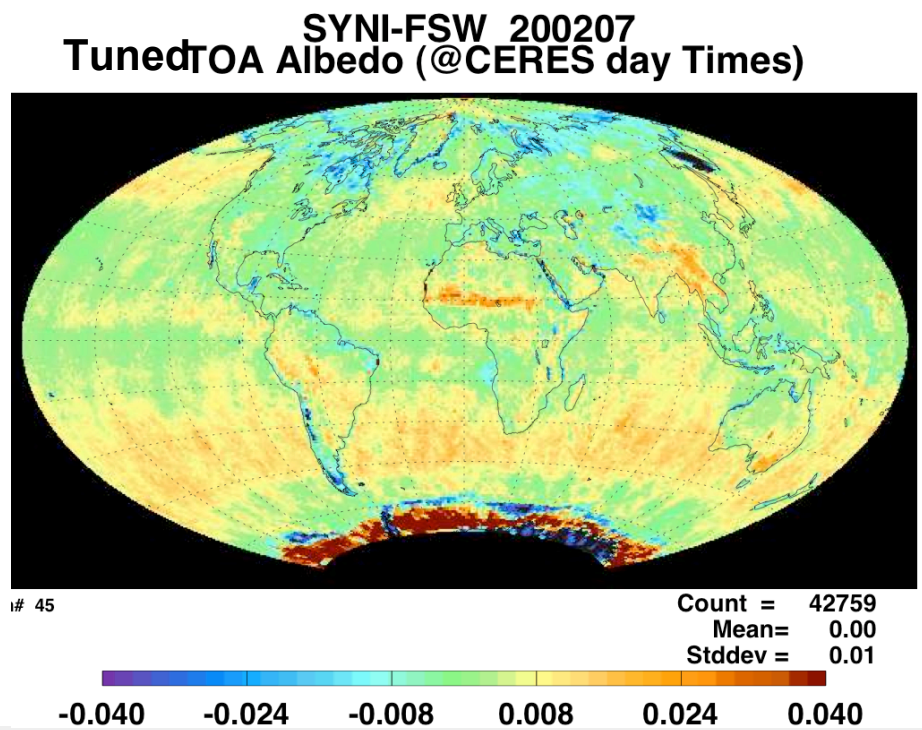




SYNI vs FSW
Surface and TOA Model Albedo



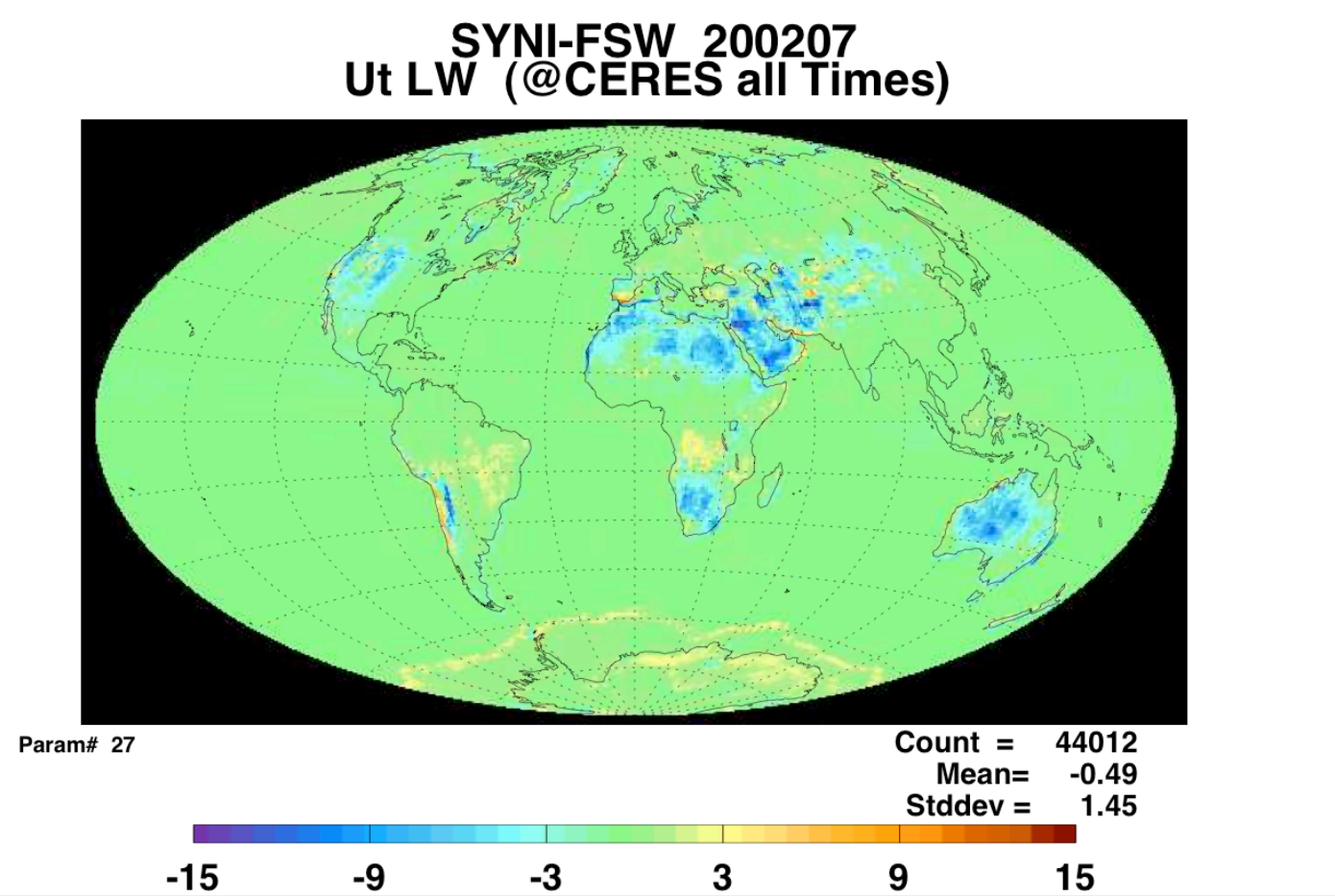
Sfc Albedo Difference



TOA Albedo Difference

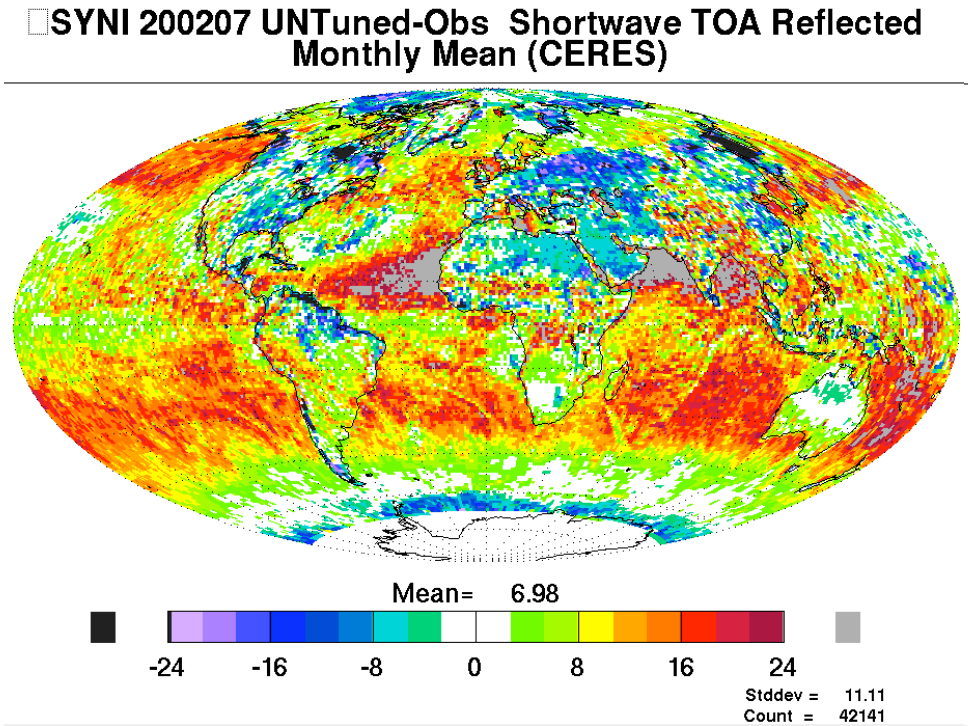
SYNI vs FSW Model OLR

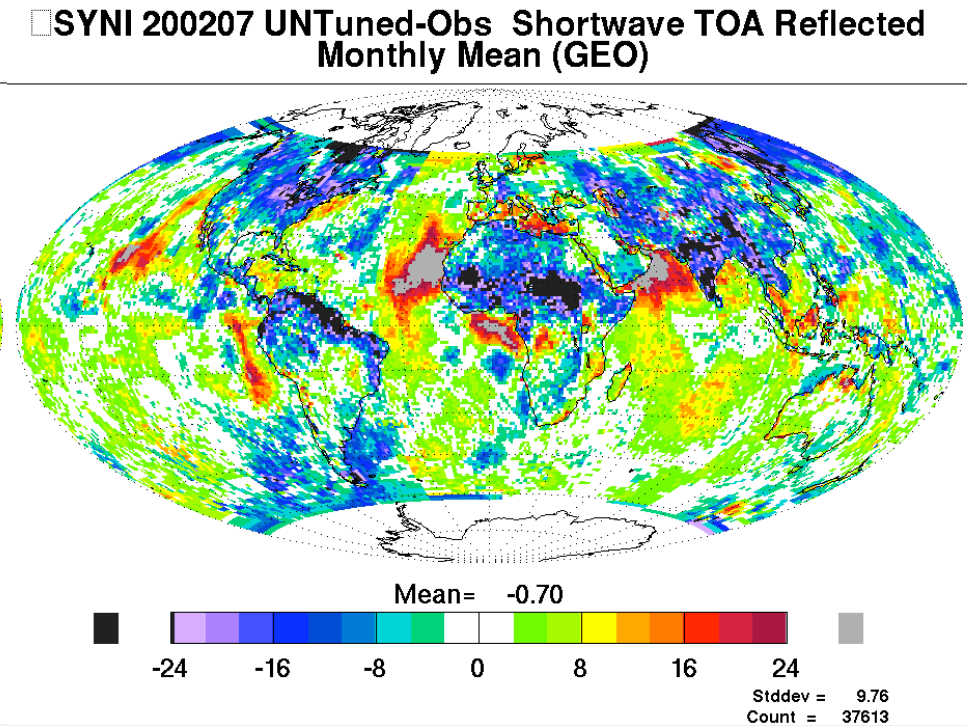
- SYNI uses solely GEOS4 Skin Temperatures
- FSW used Clear sky MODIS Skin temperatures



Difference Wm^{-2}

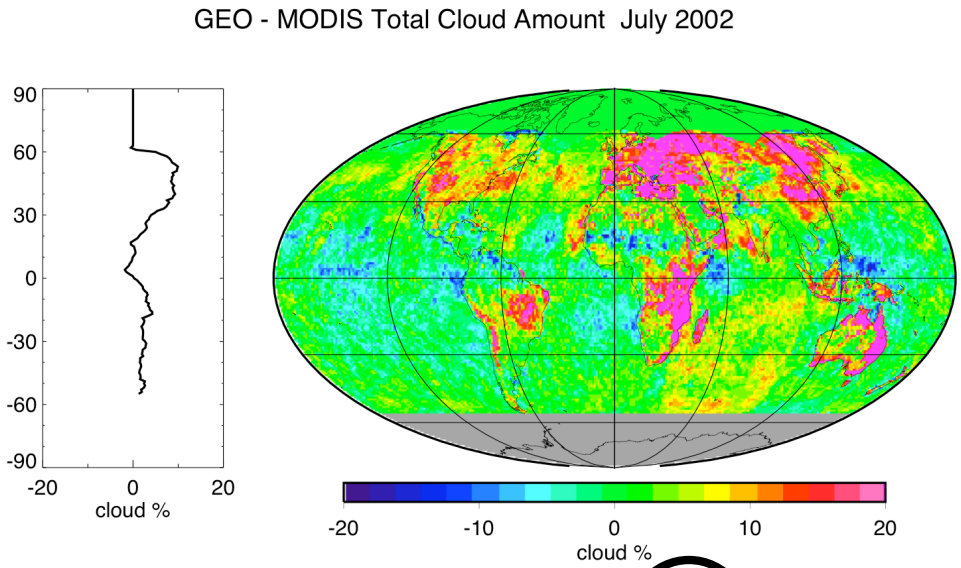
TOA SW Bias
@CERES/MODIS Vs GEO Times



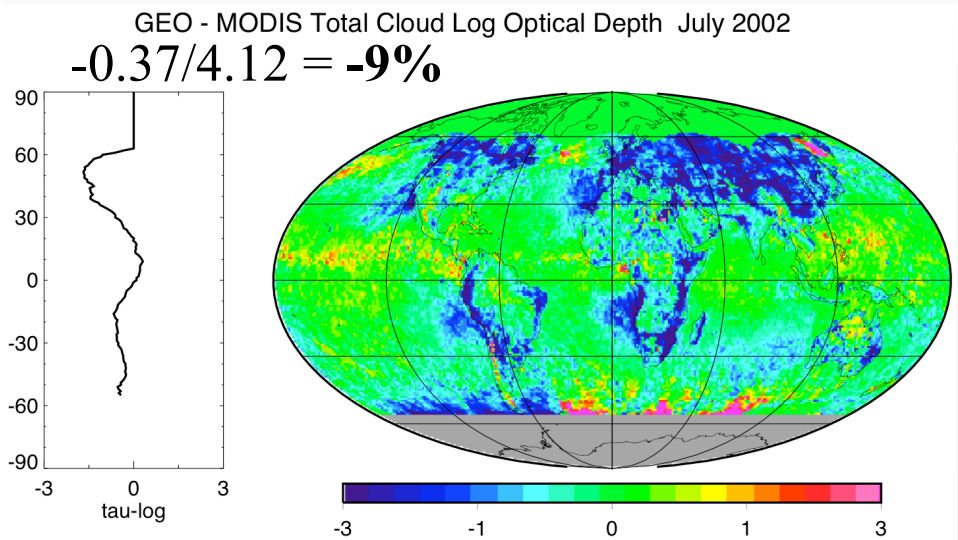


GEO *minus* MODIS
Cloud Amount & Cloud Tau

EXP [ln(tau_geo) - ln(tau_modis)]



	GEO	MODIS	BIAS	reg RMS
Global	64.39	61.49	2.90	7.81
60N-60S	63.36	60.23	3.13	
30N-30S	57.34	55.67	1.66	



-0.37/4.12 = **-9%**

	GEO	MODIS	TAU Difference	BIAS	reg RMS
Global	3.95	4.31		-0.37	1.10
60N-60S	3.82	4.20		-0.38	
30N-30S	3.18	3.36		-0.18	

Model Untuned-Observed

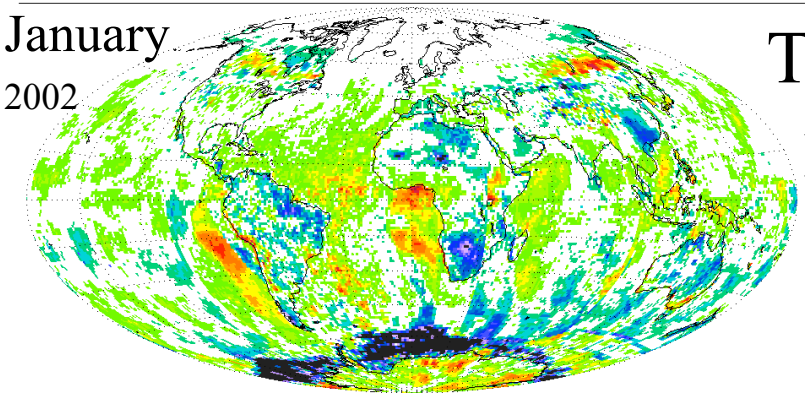
TOA FLUX

Beta4 SYNI

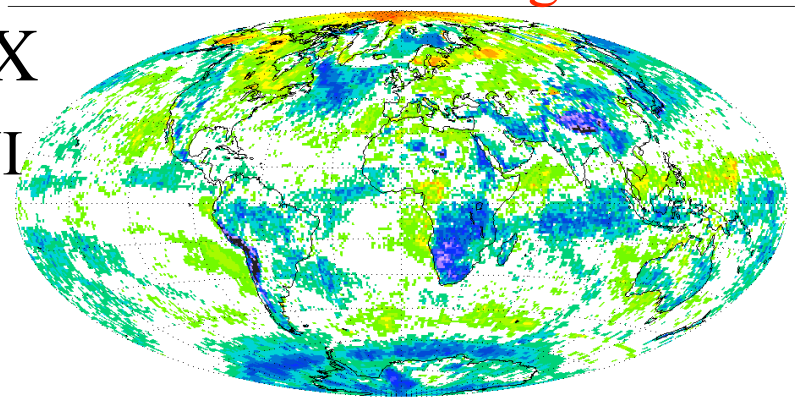
Shortwave

Longwave

January 2002

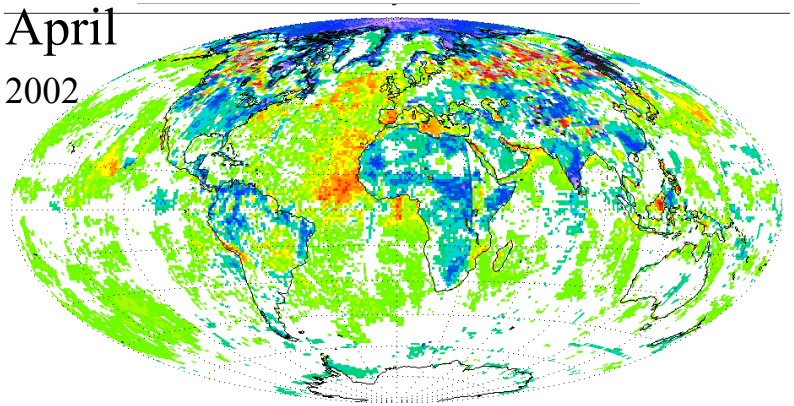


Mean= 0.13

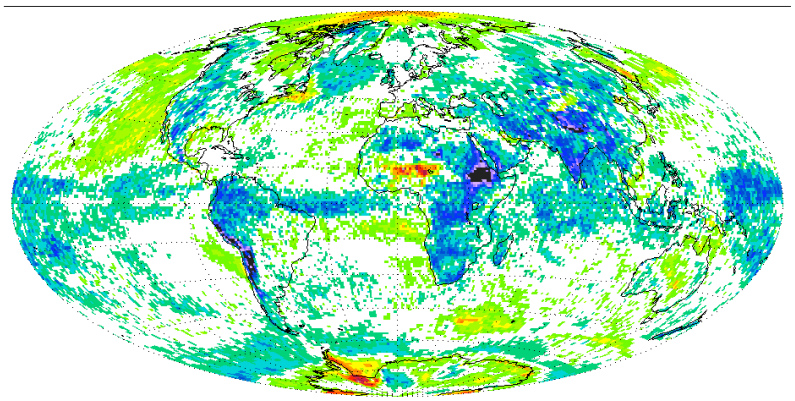


Mean= -0.85

April 2002

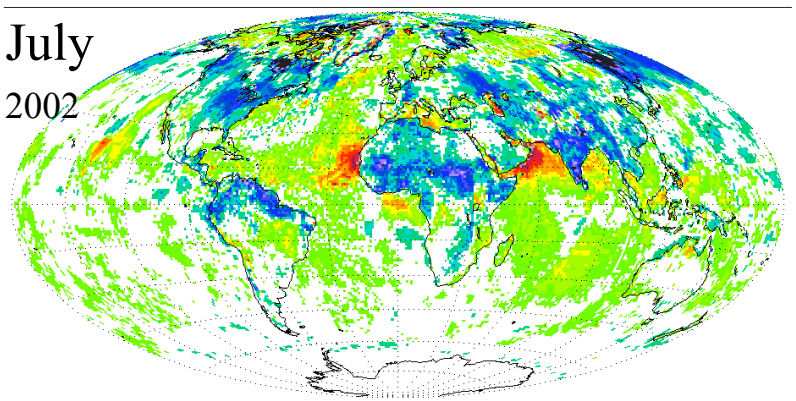


Mean= 0.46

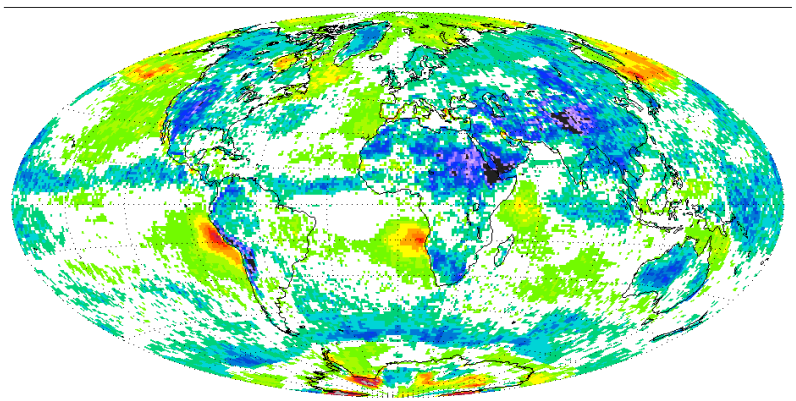


Mean= -0.94

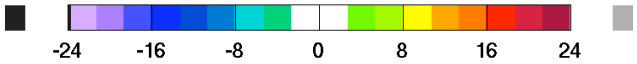
July 2002



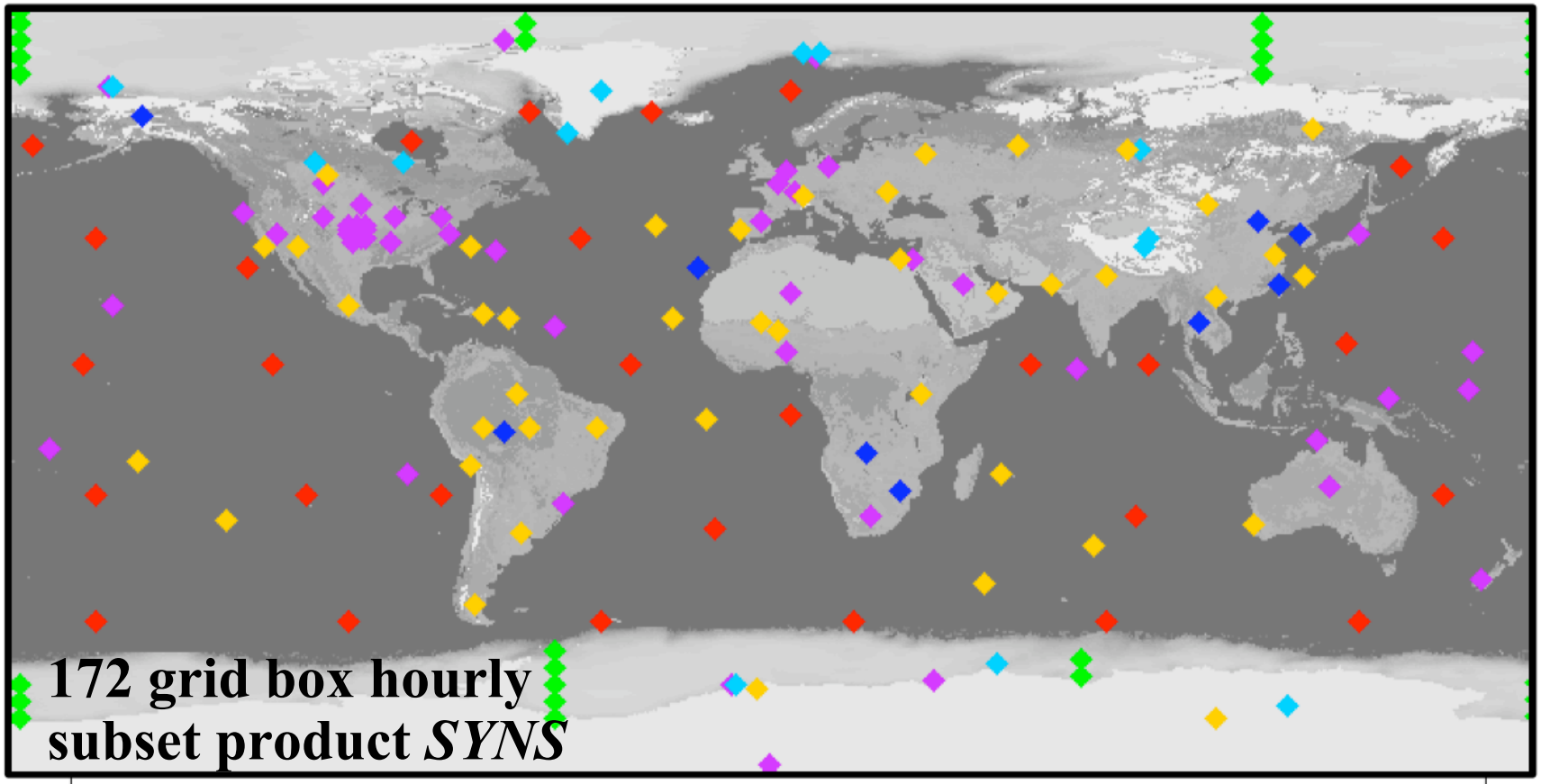
Mean= 0.41



Mean= -0.97



Synoptic SARB Validation Grid Boxes



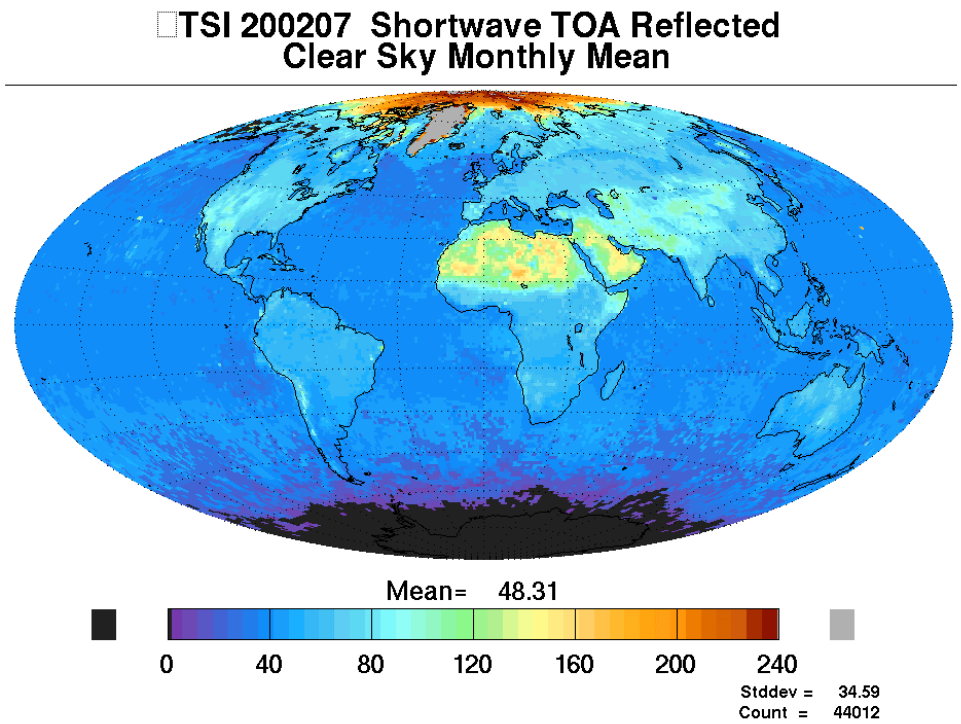
- CAVE sites (with surface flux)
- Ocean Sites
- CERES validation regions (no surface flux)
- AERONET (Limited MPL)
- AERONET Sites
- Polar Ice Sites

WEBSITES

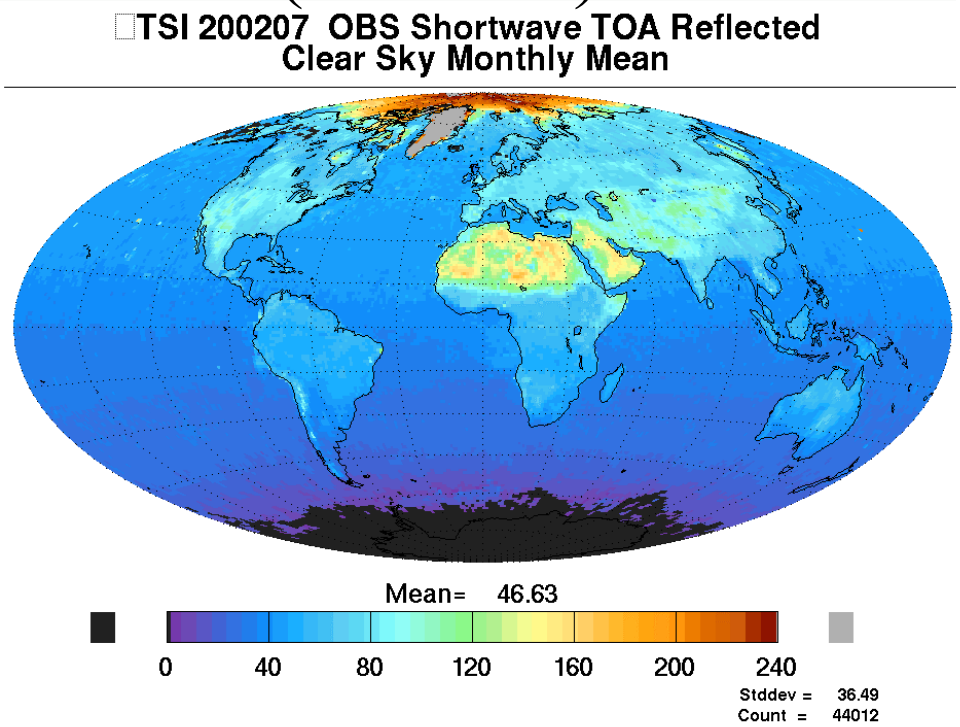
- **SYNI plots of output fields (including movies) from developmental SCF runs**
  - **http://snowdog.larc.nasa.gov/rose/syni/**
- **CERES ARM Validation Experiment(CAVE)**
  - **http://www-cave.larc.nasa.gov/cave/**

Last Minute
Obs SW Clear Sky problem

- Pre TSI Clear Sky OBS SW Bug Fix



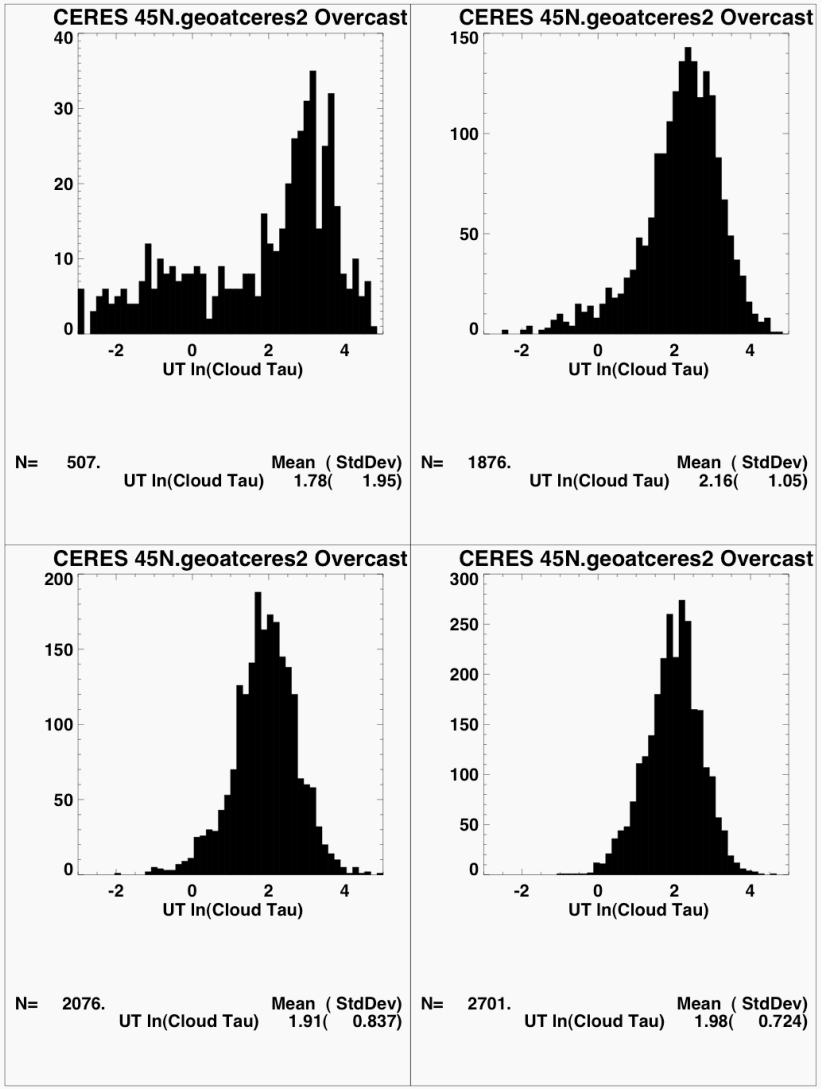
- Post Bug Fix (11-8-07)

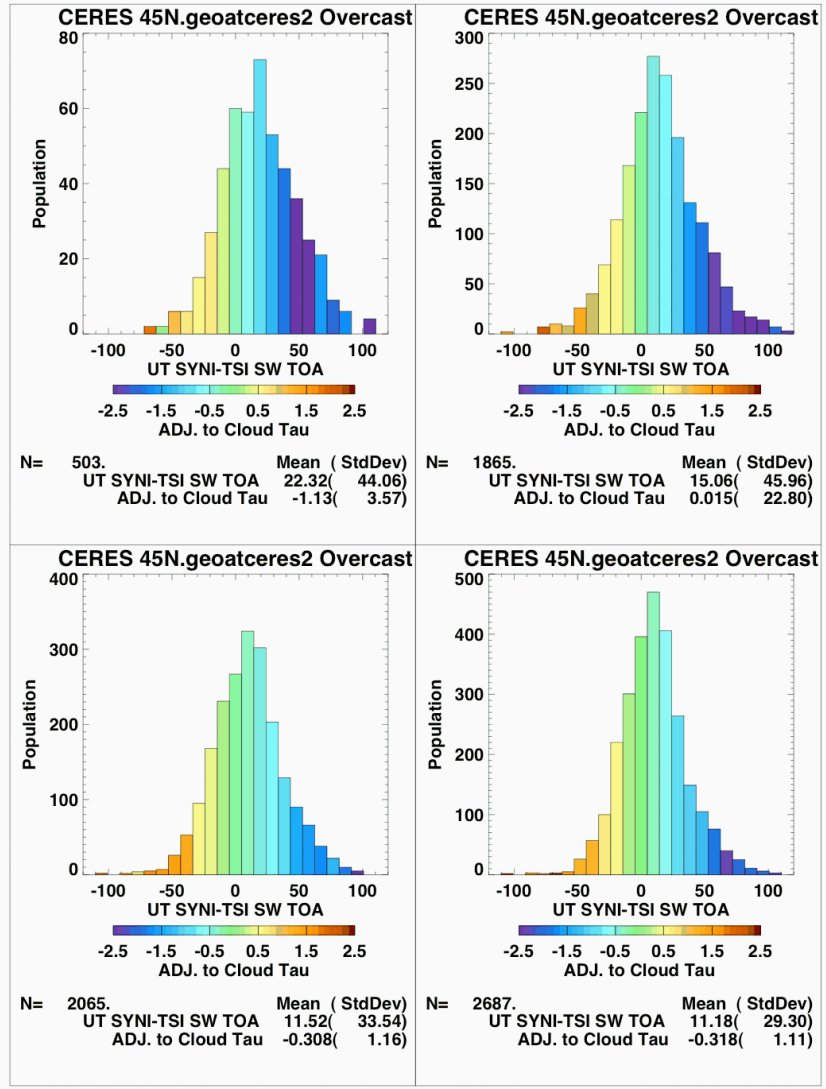


ERES/sarb-sanlhome/rose/syni_beta4/avg/tsisynavg.B4g8.avg Thu Oct 11 09:50:24 200ERES/sarb-sanlhome/rose/syni_beta4/avg/tsisynavg.B4g9.200207.avg Thu Nov 8 12:43:52 200

BACKUP SLIDES

GEOSTATIONARY CLOUDS (20N 200207)

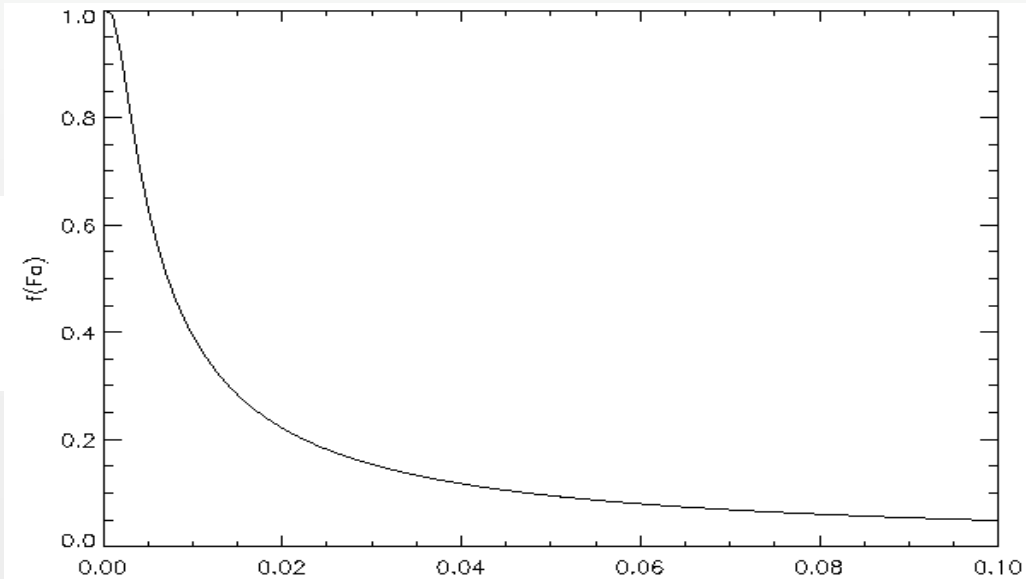




Aerosol Forcing to Surface Albedo Retrieval Weighting

- Retrieve Twice
  - Sa1) Pristine (no aerosol)
  - Sa2) Using MATCH (AOT ,ω)
- Use Aerosol Forcing to Surface Albedo
  - f(Sa2-Sa1) = 1.0-(exp(-0.005/abs(Sa2-Sa1)))
    - Maximum Weight = 1.0 when NO forcing
    - Weight = 1/e (~0.36) @ 1% absolute albedo forcing
    - Lowest weights when large aerosol forcing likely

Retrieval Weighting Factor



(Sa2-Sa1) Aerosol forcing to Sfc Alb

Broadband Surface Albedo Mode

- OCEAN
  - COART *apriori* surface albedo via look up table
    - (τ , solar zenith angle, wind speed, chlorophyll)
- Clear Land (at least 10% of gridbox has clear data)
  - *'CERES'* SW TOA with LaRC Fu-Liou atmosphere correction LUT
    - Clear sky CERES monthly mean diurnally modeled (NOT Geo)
- Cloudy: Land+SeaIce + *snow when no grain size retrieved*
  - Monthly Surface Albedo History 10' grid based on clear sky albedo retrieval from Ed2 SSF
  - **Perturbed** according to Daily microwave SeaIce *or Snow(<90%)*
  - Diurnal model to diffuse angle
- Snow (> 90% gridbox coverage)
  - Clear sky via CERES only snow grain size retrieval
  - Cloudy sky albedo uses grain size in snow spectral albedo LUT
  - Non-CERES times use last retrieved grain size in snow spectral albedo LUT