First Global Monthly
TSI / SYNI /AVG @ SCF
“Diurnally Resolved Radiative Transfer”

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TSI: Cloud & Toa Flux
Inputs for SYNI “Synoptic Sarb”

– TOA Flux
  • ~Twice daily CERES
  • 3 hourly GEOstationary Flux
    – narrowband to broadband
  • Other times interpolated
– Clouds
  • MODIS: (Multi-channel)
    – Fraction, Optical depth, Height, Phase, Part. Size
  • GEOstationary: (Vis & IR only)
    – daytime: Fraction, Optical depth, Height
    – night: Fraction, Height
TSI: Calibrate GEO visible radiances against MODIS

- Geostationary Visible **not** calibrated onboard satellite
- Calibrate to MODIS over oceans to mitigate spectral response function differences between geostationary satellites
- Regress Co-located, Co-angled, Co-incident radiances within 15 minutes
- Validate by cross-calibrating geostationary satellite pairs
GOES-8 visible calibration with Terra-MODIS

January 2003, GOES-8/Terra

Timeline

Terra-MODIS Radiance (Wm$^{-2}$sr$^{-1}$)

GOES-8 DC

Degradation rate = 365*1.136e-4 = 4.15%/year

NASA Langley Research Center / Atmospheric Sciences
TSI: Geostationary TOA SW Fluxes

• GEO Narrowband radiances converted to broadband
  – Modtran/Disort based (S.Kato)
  – Based on angles, surface type, ozone, cloud amount, phase, optical depth and GEO satellite spectral response.

• Invert broadband radiance to broadband flux
  – CERES TRMM ADMs
  – Using GEO Cloud product

• Shortwave Flux is normalized to CERES observations ....
Geo SW Normalization

• GEO clear-sky albedos are replaced with CERES
  – Land spectral differences are difficult to account for in GEO
  – No day to day variation in the clear-sky albedo
• Snow regions use the non-GEO method
  – GEO cloud properties over snow are suspect
  – Bright surfaces have little diurnal variation
• Perform regressions of GEO-derived and CERES matched SW fluxes
  – Slope and offset used to account for GEO visible calibration inadequacies and regional NB to BB variability
  – 5x5 surrounding regions and matches within 90 minutes
  – Regions are limited to GEO-satellite, and GEO-type
  – No glint matches are used
  – Regions with insufficient matches use 5° zonal regions
TSI: Geostationary TOA LW Fluxes

- GEO satellites have onboard IR calibration

- IR radiances are converted to narrowband fluxes using simple limb darkening model

- Apply empirical NB->BB relationship which includes a water vapor term
  - Currently one regression will be enhanced in future editions.

- Normalize GEO derived interpolated fluxes with CERES at coincident times
SYNI Product

- Hourly radiative transfer
  - Fu-Liou code
- CERES Equal Area grid (~1deg)
- TSI Cloud Inputs
  - CERES(12hr), +GEO(3hr) + Interpolated
- MOA Geos_4.0.3 Atmosphere
  - SMOBA Ozone
- Modis & Match Aerosols
- Grid Average Surface properties
Fu-Liou Broadband Radiative Transfer

- Gamma weighted 2-Stream (SW) , 2/4 Stream (LW)
  - Treats sub-computational scale Inhomogeneous clouds (S.Kato)
- 32 Bands : 18 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 [0 or 2500-57000 cm-1]
  - HITRAN 2000 (H₂O) w/(O₂,CO₂,CH₄)Fixed
- Longwave (0-2850cm-1) (3.5µ – Infinity)
  - H₂O ,CO₂ ,O₃ ,N₂0 ,CH₄ ,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 O₃ 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
SYNI Surface Optics

• **Scene Id:**
  – IGBP
  – Daily Snow Ice maps (NSIDC microwave)
  – Threshold of Cloud WG Daily 0.63 & 1.6 overhead sun albedo

• **Broadband Surface Albedo:**
  – COART ocean surface albedo via look up table
    • (tau, solar zenith angle, windspeed)
  – Clear land+snow
    • CERES TOA with LaRC Fu-Liou atmosphere correction LUT
  – Cloudy land: monthly min clear sky albedo
    • diurnal model

• **Spectral Albedo Shape**
  – COART (Ocean,Snow,Sea Ice)
  – CARE Experiment (grassland), Bowker (all other IGBP types)

• **Emissivity**
  – Cloud WG 12 month seasonal maps (3 window bands)
  – SOFA (IGBP based for other LW bands)
SYNI Aerosols

- MODIS (MOD04)
  - multi-channel AOT (7 wavelength ocean, 3 land)
- MATCH Daily Assimilation
  - Constituents
    - Small & Large Dust, Sea Salt, Sulfate, Black Carbon, Hydrophilic & Hydrophobic organic carbon
    - Basis for assignment of optical properties ($\beta, \omega, g$)
      - Tegin & Lacis, OPAC
    - MATCH optical depth used over high albedo land or ocean sunglint where MODIS AOT’s not available
  - Vertical profiles
First Run Issues

• First full end to end run attempt at SCF
  – FSW $\rightarrow$ TSI $\rightarrow$ SYNI $\rightarrow$ ZAVG $\rightarrow$ AVG
  – Data month July 2002

• TSI:
  – Unintended use of LOCAL time **not** GMT reference frame !!
  – Will add MODIS AOT’s
  – Will add Clear Geo Radiances for skin temperature retrieval
  – Will revise record indexing to Equal Area to reduce file size

• SYNI:
  – CRS like **NOT** grid averaged )Surface Optical properties
  – No MODIS Aerosol were available on TSI file
    • Instead used Stowe single wavelength AOTs over ocean
  – GMAO GEOS4.0.3 6 hourly skin temperatures used
    • 3 hourly to be used in future runs
  – 36 model level output ( huge file sizes )
    • 5 level in future runs (toa,70,200,500,.sfc)
First Look at SYNI Data

- Example time-height flux profile
- Scatterplots
  - Subset (5 deg in latitude)
- Global Maps
  - TSI, SYNI, SRBAVG
  - NOT from AVG Product
Example Time Height Profile Longwave Flux (36 level data)
SYNI 200207 UNTuned Surface SW Down Total Sky Monthly Mean

Mean = 181.23

Mean = 61.06

SYNI 200207 UNTuned Surface LW Down Total Sky Monthly Mean

Mean = 352.27

Mean = 0.17

SYNI 200207 Inital Aerosol Optical Depth

Standard Deviation = 81.70

Count = 44012

Standard Deviation = 64.87

Count = 44012

Standard Deviation = 20.57

Count = 44012

Standard Deviation = 0.17

Count = 44012
Summary

• First Run
• Has Known Problems
• Encouraging regardless
• Major cross group interfaces resolved