

The GEWEX Radiative Flux Assessment Project

CERES Science Team Meeting

NASA GISS, New York City, NY

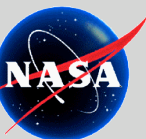
27-29 October 2008

Presenter: Takmeng Wong (NASA LaRC)

**Oversight Committee: Atsumu Ohmura (ETH), Ehrhard Raschke
(U. of Hamburg), William Rossow (NASA GISS), Paul
Stackhouse (NASA LaRC) and Bruce Wielicki (NASA LaRC)**

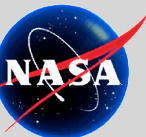
~75 assessment participants (TOA, surface, and both)

**Local Contributors: Lin Chambers (LaRC), Takmeng Wong (LaRC),
Laura Hinkelman (NIA), J. Colleen Mikovitz (AS&M), Taiping Zhang,
Atmospheric Science Data Center**



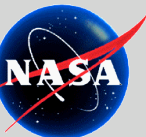
GEWEX-RFA: Status Overview

- **Purpose and Introduction**
- **Review web site status**
- **Review data set inventory**
- **Selected Results**
- **Next Steps**



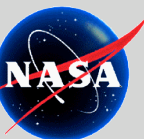
Radiative Flux Assessment Overview

- Purposes:
 - Assess our current understanding and capability to
 - *derive TOA and surface radiative fluxes from analysis of satellite observations*
 - *validate these fluxes with surface observations*
 - *simulate these fluxes with models and assimilation*
 - Assess uncertainties and outstanding issues in flux estimation, particularly long-term variability
 - *sources include satellite calibration, input data sources, and assumptions (particularly in regards to spatial and temporal gap filling)*
 - *Compare surface fluxes to surface based measurements*
 - *intercompare existing data products*
 - *identify largest uncertainties and needs*
 - Report methods and uncertainties to be useful for future IPCC reports on long-term data uncertainty.
 - Develop climate system observation requirements for radiative fluxes and compare to current product accuracies.
 - Assess GCM and reanalysis products.



GEWEX RFA Activities to Date

- **1st Workshop held (Oct. 2004 - Zurich, Switzerland)**
 - Discussed issues & developed pieces of draft document
 - Assigned TOA and surface groups
- **Draft Document Outline**
 - Proposed intercomparison activities
- **2nd Workshop held (Feb. 2006 - Williamsburg, VA)**
 - Refined document outline & surface/TOA actions and goals
 - Assigned authors
- **Web Site (Rel. 1.2) Now Operational**
 - Includes document framework
 - Datasets ingested and ready for analysis
- **3rd Workshop held (June 2007 - New York City, NY)**
 - Results discussed
 - Preliminary conclusions discussed relevant to document
- **Collecting and Editing Document Chapter/Sections**
 - Several chapters submitted; editing beginning
 - Work continuing for analysis/writing/assembly of report



GEWEX-RFA Site

(<http://gewex-rfa.larc.nasa.gov/>)

NASA NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FIND IT @ NASA : + GO

Global Energy and Water Cycle Experiment

GEWEX

WCRP

Langley Research Center

Radiative Flux Assessment

About GEWEX-RFA | Data Access | View Sample Data | Google Group | For Authors | Contacts

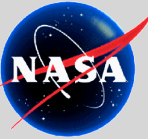
[New: Reference list](#)

INTRODUCTION

The ultimate goal of the [Global Energy and Water Cycle Experiment \(GEWEX\)](#) global data analysis projects is to obtain observations of the elements of the global energy and water cycle with sufficient detail and accuracy to diagnose the causes of recent climate variations in terms of the energy and water exchanges among the main climate components (atmosphere, ocean, land, cryosphere, biosphere).

The GEWEX-Radiative Flux Assessment (RFA) project will provide a forum for consistent analysis of long-term radiative flux products, primarily top-of-atmosphere (TOA) and surface fluxes, to establish a foundation for better global radiation budget analysis.

[Read more »](#)



Data Access Web Page

(<http://eosweb.larc.nasa.gov/GEWEX-RFA/>)



GEWEX Radiative Flux Assessment



The ultimate goal of the [Global Energy and Water Cycle Experiment \(GEWEX\)](#) global data analysis projects is to obtain observations of the elements of the global energy and water cycle with sufficient detail and accuracy to diagnose the causes of recent climate variations in terms of the energy and water exchanges among the main climate components (atmosphere, ocean, land, cryosphere, biosphere). The GEWEX Radiative Flux Assessment (RFA) project will provide a forum for consistent analysis of long-term radiative flux products, primarily top-of-atmosphere (TOA) and surface fluxes, to establish a foundation for better global radiation budget analysis.

Data access is restricted to assessment participants until the data are made publicly available (currently anticipated to be May 2009). To access the interim data you need an ASDC user account and approval from the LaRC GEWEX-RFA organizing committee. [Join the assessment team.](#)

[GEWEX-RFA Home Page](#) | [Data Provider Instructions](#) | [File Conventions](#) | [List of Participants](#)

| Top of Atmosphere (TOA) Data Products | Surface Data Products | Ground-Based Measurements |
|--|--|--|
| <ul style="list-style-type: none">• Maps• Time Series• Hovmöller Diagrams• High Time/Space Resolution | <ul style="list-style-type: none">• Maps• Time Series• Hovmöller Diagrams• High Time/Space Resolution | <ul style="list-style-type: none">• Time Series• Chuck Long's Derived Parameters (RFA FTP site) |

Note: The data files provided here are subsets of larger data sets. Links to the full data archive for each product can be found in the corresponding product description files.

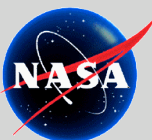
Acknowledgement

The GEWEX-RFA data products should not be used in publications while the assessment is underway. After the assessment has been completed, when data from the GEWEX Radiative Flux Assessment are used in a publication, we request the following acknowledgment be included: "The GEWEX Radiative Flux Assessment data were obtained from the NASA Langley Research Center Atmospheric Science Data Center." In addition, the provider of each data set used should be specifically acknowledged. See the product description file(s) for details.

[View Cart](#) | [ASDC Home Page](#) | [Join GEWEX-RFA News List](#) | [Questions/Feedback](#)



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Site Administration/Help: NASA Langley ASDC User Services (larc@eos.nasa.gov)
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Last Updated: Mon Sep 22 2008 13:42:47 GMT-0400 (EDT)



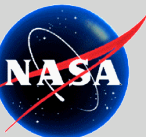
GEWEX-RFA Data Archive

To date, data have been submitted from:

- ASRB (Swiss surface radiation measurements)
- U. Oregon Surface Sites (>20 years)
- BSRN (Baseline Surface Radiation Network)
- CAVE (CERES-ARM Validation Experiment web site)

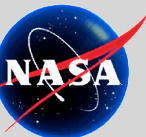
Also non-standard surface data from Chuck Long.

- CERES (ERBE-like, SRBAVG, SRBAVG-GEO and EBAF)
- DLR ISIS (ISCCP based SW TOA and Surface fluxes)
- ERBE (ERBES - TOA SW, LW and Net Fluxes)
- FORTH (TOA, Surface SW, LW from ISCCP D1)
- HIRS IR (OLR only)
- ISCCP-FD (TOA, Surface, SW and LW fluxes)
- ScaRaB (TOA SW and LW fluxes)
- NASA/GEWEX SRB (ISCCP TOA, Surface SW and LW fluxes)
- U. Maryland SRB (Z. Li and R. Pinker - ISCCP/MODIS SW)
- GFDL CM 2.1 (Surface, SW and LW fluxes)
- NCEP R2 (TOA, Surface, SW and LW fluxes), ERA-40?



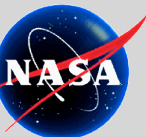
GEWEX-RFA Results To Date

- **Smith et al., 2006: ERB calibration intercomparison**
- **Raschke et al., 2006, GRL: SRB, ISCCP TOA comparison**
- **Zhang et al., 2006a,b: Near-surface meteorological and radiative properties**
- **Wong et al, 2006 => ERBE, HIRS, ISSCP-FD time series**
- **Loeb et al. (JCLim, 2007): CERES/Terra vs. ISCCP-FD, CERES/Terra vs. SeaWiFS PAR, and CERES/Terra vs. CERES/Aqua; CERES EBAF (Loeb et al., 2008)**
- **SRB/CERES/ISCCP teams: Various intercomparisons**
- **Roesch et al. (not published): Sensitivity of monthly averages to treatment of data gaps**
- **Hinkelman et al. (not published): Preliminary time series analysis**
- **Freidenreich: GFDL model results vs. ISCCP-FD**
- **Schaaf: Surface albedo studies**
- **Kinne and Raschke: comparisons to AMIP runs;**



Recent GEWEX-RFA Activities

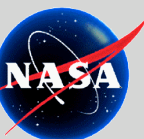
- ROSES 2007 GEWEX-RFA proposal fully funded for FY08-09; part-time support for Chambers (PI), Wong, and Hinkelman => needed help!
- Added new monthly hourly satellite dataset at 15 surface sites for diurnal cycle comparisons
- Added NCEP/R2, (ERA-40??), and CERES EBAF data to the RFA archive
- Presented a GEWEX-RFA poster at IRS meeting
- Updating inter-comparisons of regional, global and tropical mean TOA fluxes with new GEWEX-RFA datasets
- Set up draft report webpage “dashboard” and Google group for easier exchange of draft report information
- Working with participants to assemble draft report and moving the RFA project through its final phase



GEWEX-RFA Draft Report Website

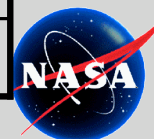
| No. | Section | Responsible Author | Status |
|---------|--|--------------------------------------|-------------------------|
| 1.0 | Executive Summary | TBO | At and |
| 2.0 | Introduction | Chapter Lead: Rossow | |
| 2.1 | Assessment Objectives | Rossow | |
| 2.2 | Observation System Requirements | Rossow | |
| 3.0 | Conclusions and Recommendations | Chapter Leads: Wielicki & Stackhouse | |
| 3.1 | Assessment of TOA Fluxes | TBO | |
| 3.2 | Assessment of Surface Fluxes | TBO | |
| 3.3 | Assessment of Atmospheric Divergence | TBO | |
| 3.4 | Identification of Key Issues | TBO | |
| 4.0 | Incoming Solar Radiation at TOA | Chapter Leads: Raschke with Kopp | Draft |
| 5.0 | Long-Term TOA Flux Data Product Comparisons | Chapter Leads: Wielicki and Rossow | |
| 5.1 | TOA Flux Comparison Studies | | |
| 5.1.1 | Monthly Gridded Maps | Wong | |
| 5.1.2 | Monthly Time Series: Global Land/Ocean, Zonal Land/Ocean | TBO | |
| 5.1.3 | Seasonal Gridded Map of Diurnal Cycle TEC | | |
| 5.1.4 | Characterize Variability of Global, Zonal, Regional | | |
| 5.1.4.1 | Observation Variability | Wong | Section does not match? |
| 5.1.4.2 | Model Variability | Elingo | |
| 5.1.5 | Metecrological Regimes | Jakob, Rossow | |
| 5.1.6 | Time Series at Selected Surface Sites | Rossow | |
| 5.1.7. | High Time/Space Resolution Comparisons: June and July 2004 | Richard Bantges | |

- Listing of all sections
- Name of each section
- Responsible authors
- Status of each section
- Color coded for easy reading
- Archive of all old draft versions



RFA Report Status

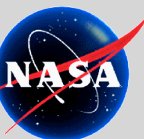
| Section | Title | Responsible Author(s) | Status |
|---------|--------------------------------------|-----------------------------|------------------|
| 1.0 | Executive Summary | TBD | Last |
| 2.0 | Introduction | Rossow | None |
| 3.0 | Conclusion and Recommendations | Wielicki and Stackhouse | None |
| 4.0 | Incoming Solar Irradiance | Raschke and Kopp | Draft |
| 5.0 | TOA Fluxes | Wielicki and Rossow | 1 draft section; |
| 6.0 | Surface Fluxes | Stackhouse, Wild and Ohmura | 5 draft sections |
| 7.0 | Vertical Column Flux Divergence | Raschke | None |
| 8.0 | Global Radiation Budget Diagram | Loeb | Draft 80% |
| A | Data Sets and Uncertainties | Pinker and Dutton | 3 sections |
| B | Radiative Transfer Model Comparisons | Kato | Draft |
| C | Contributed Papers | Various | 2 drafts |
| D | Lessons Learned | Co-Chairs | draft |



GEWEX-RFA Google Group

The screenshot shows the Google Groups interface for the 'GEWEX Radiative Flux Assessment' group. At the top, the user 'takmeng.wong@nasa.gov' is logged in, with links for 'My Groups', 'Favorites', 'Profile', 'Help', 'My Account', and 'Sign out'. The group name is 'GEWEX Radiative Flux Assessment' with a search bar and 'Search this group' and 'Search Groups' buttons. The main content area is divided into sections: 'Home' (New since last time: 1 message), 'Discussions' (1 of 3 messages, view all, + new post), 'Members' (4 members, view all), and 'Files' (All 3 files, view all, + upload file). The 'Members' section lists Dr. Lin Chambers (Member), Paul (Member), Takmeng Wong (you) (Member), and laura (Group owner). The 'Files' section lists three PDF documents: 'Chapter 5.1.4.2_GFDL_v001_2008.pdf', 'Chapter 5.1.4.1_GERB_v001_2008.pdf', and 'Chapter 6.3.1_v001_2008.pdf', all last updated by laura...@u.washington.edu on Apr 22. A 'Create some pages' section is also visible. At the bottom, there is an 'XML' button and a link to 'Send email to this group: gewex-radiative-flux-assessment@googlegroups.com'. The footer contains links for 'Create a group', 'Google Groups', 'Google Home', 'Terms of Service', and 'Privacy Policy', along with the copyright notice '©2008 Google'.

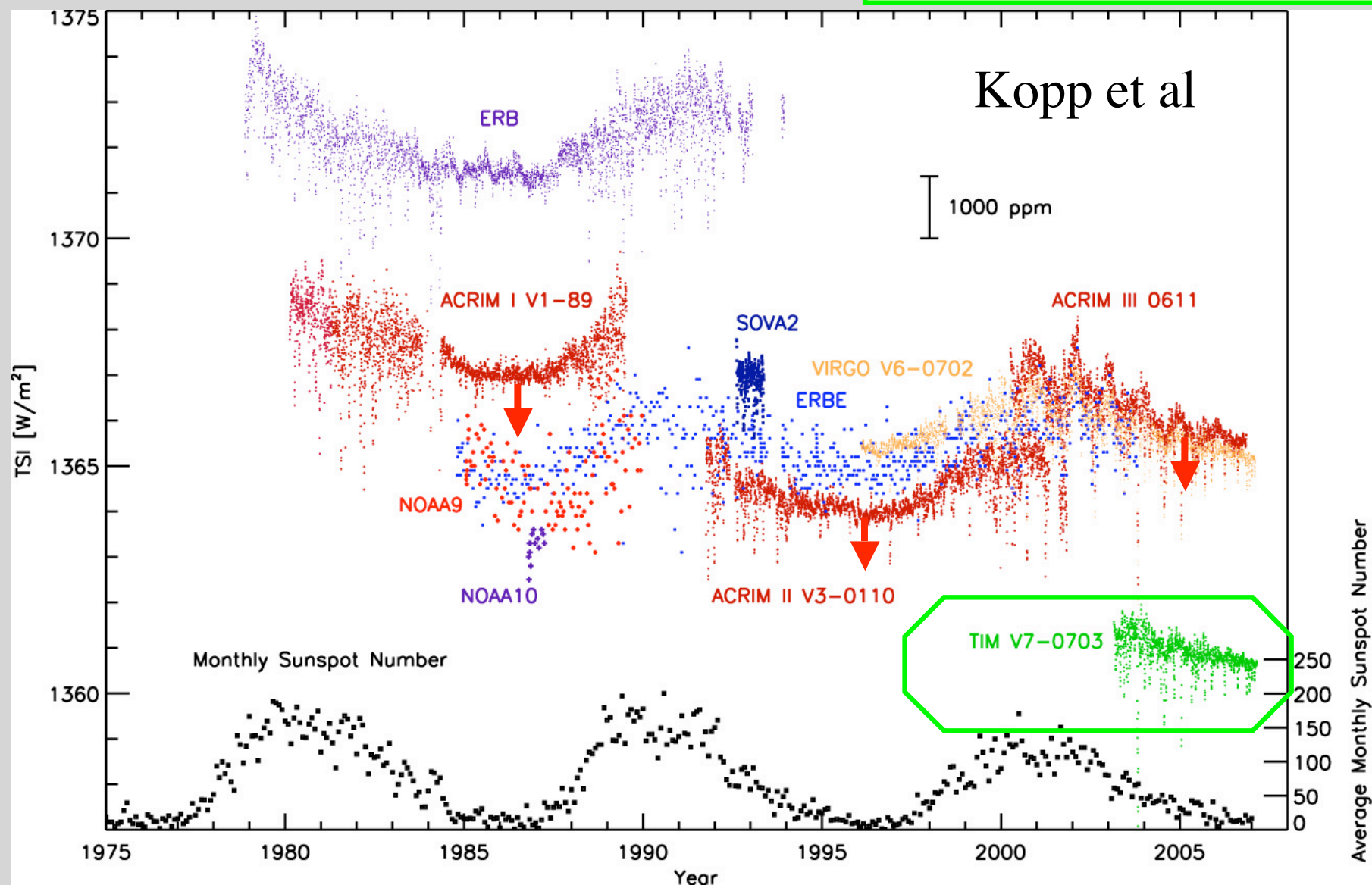
- Easier access for our international participants; solving on-going problems associated with NASA computer security requirements



Radiative Flux: **SORCE TIM** Indicates Lower TSI Value

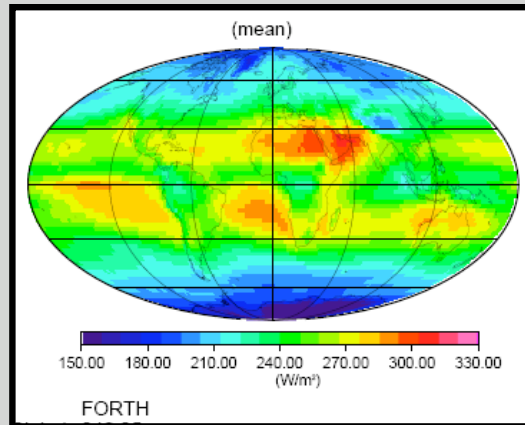
Fundamental discovery that the TSI is $\sim 1361 \text{ W/m}^2$, not 1366 W/m^2 (TIM).

SORCE/TIM result motivated detailed examination by NIST and TSI community.

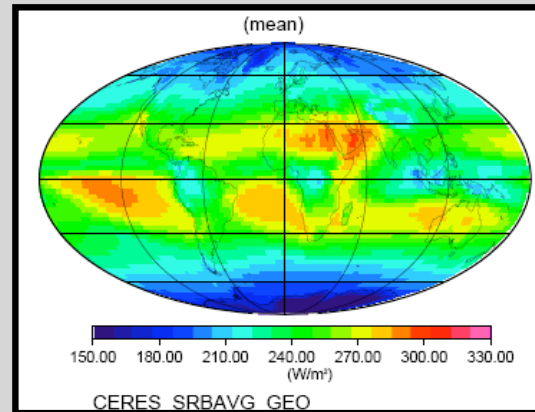


Annual Mean LW TOA Fluxes

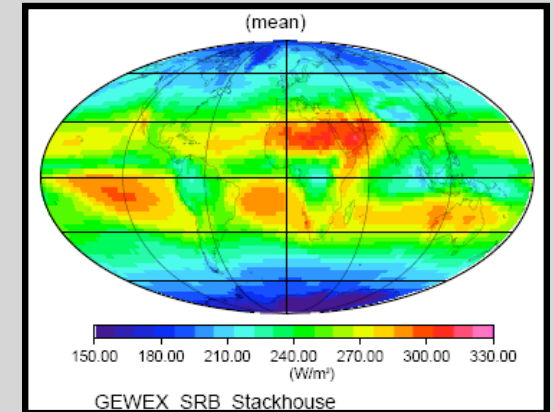
FORTH



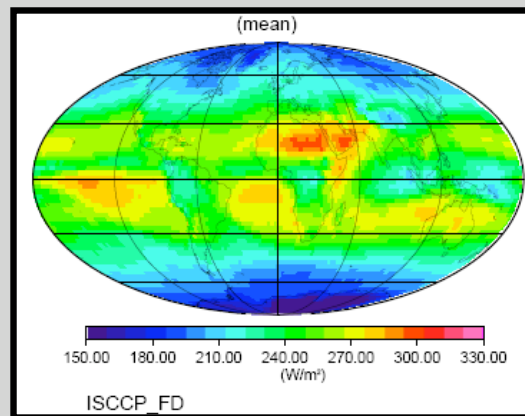
CERES SRBAVG GEO



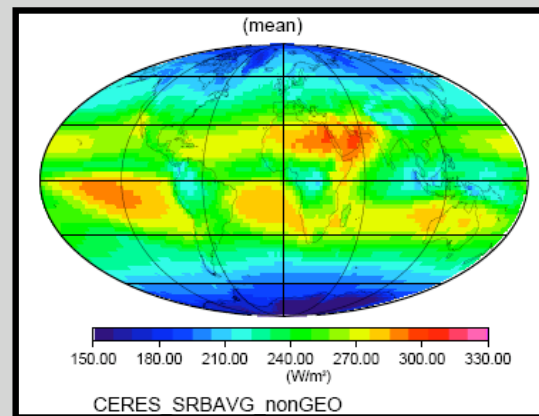
GEWEX SRB/LaRC



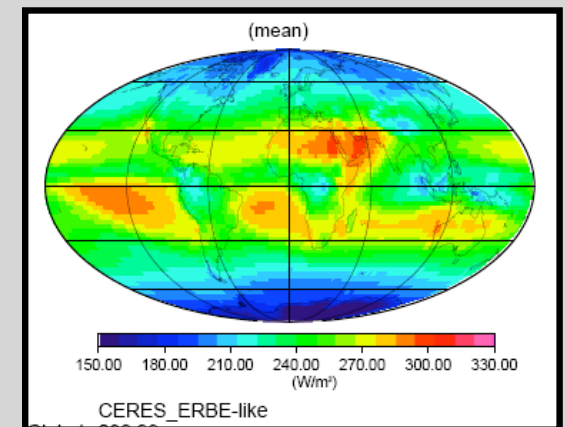
ISCCP-FD



CERES SRBAVG NONGEO



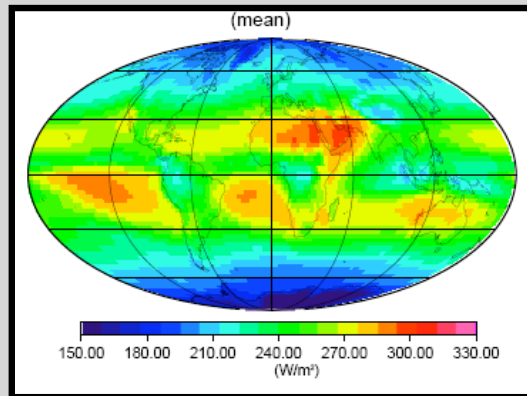
CERES ERBE-LIKE



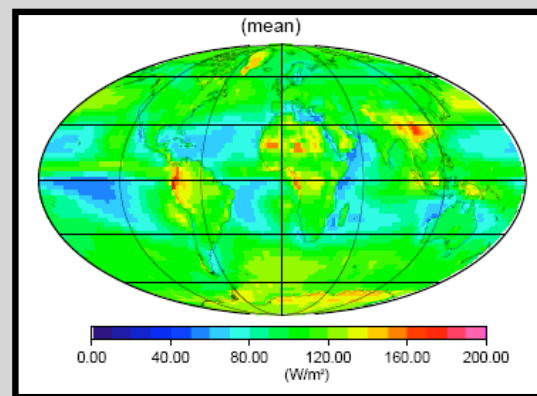
Data Period: 3/2000 to 2/2005

Multi-Dataset TOA Ensemble Mean

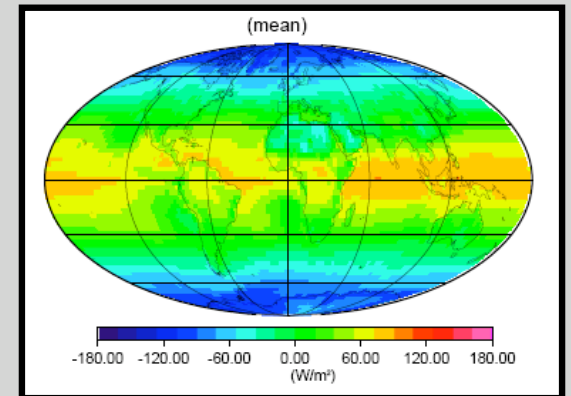
LW



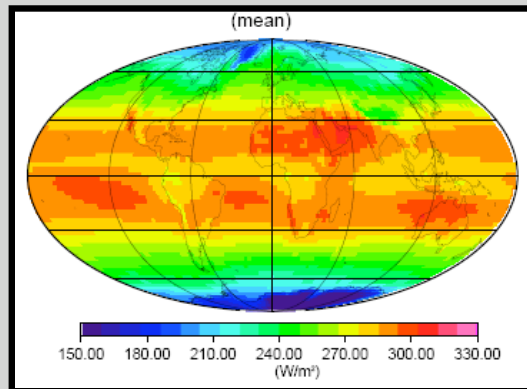
SW



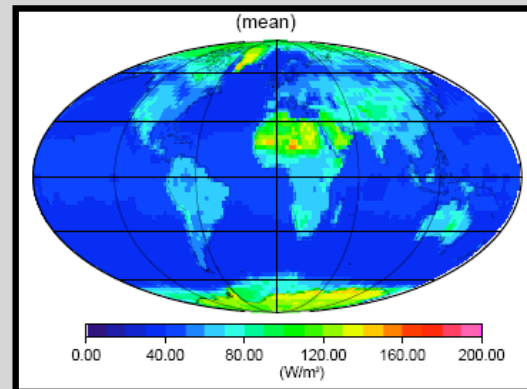
Net



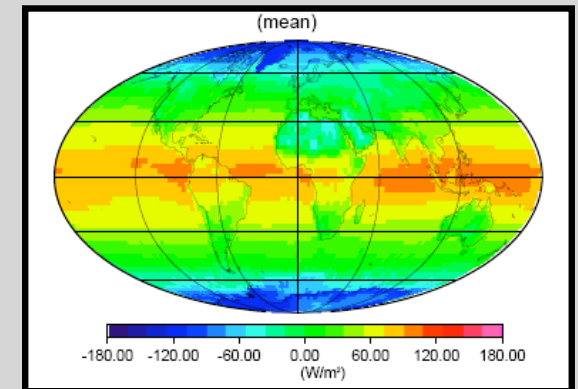
Clear LW



Clear SW



Clear Net

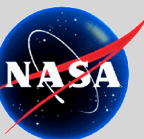


Data Period: 3/2000 to 2/2005

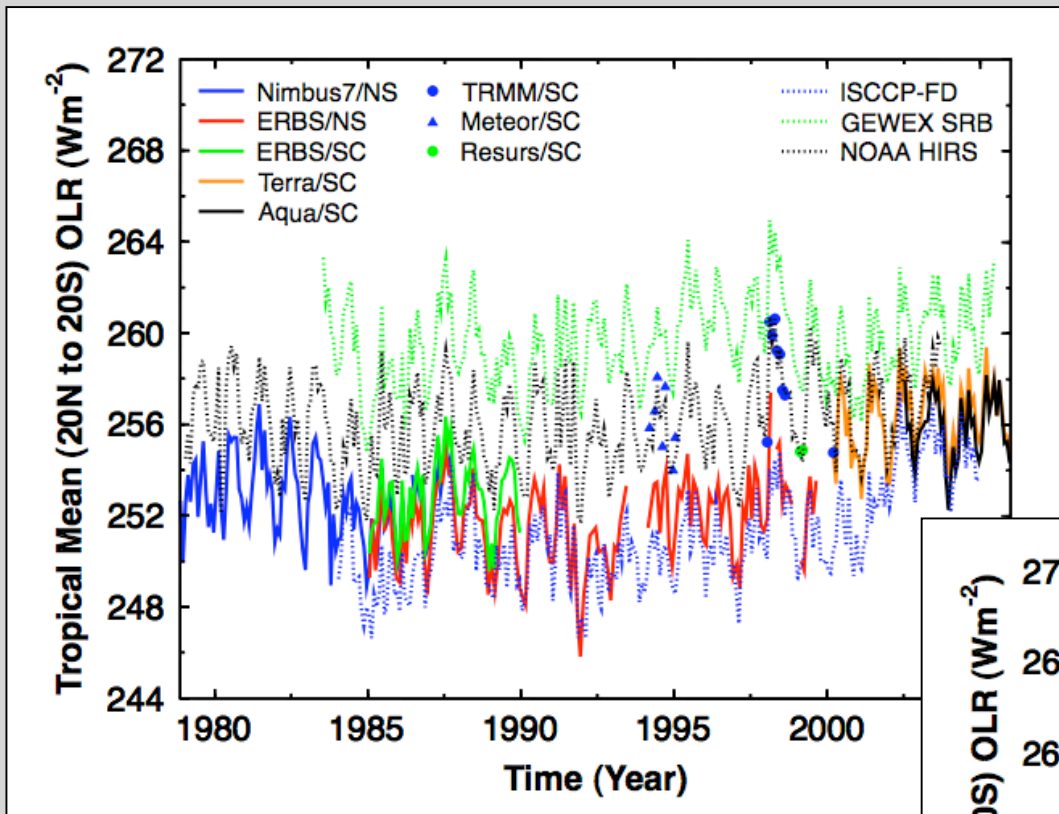
Annual Global Mean TOA Budget

| | Mean | Range |
|------------------|--------------|---------------------|
| Solar In. | 341.0 | 339.5, 341.8 |
| LW | 238.8 | 236.2, 240.6 |
| SW | 99.8 | 96.8, 107.0 |
| Net | 4.4 | -0.9, 8.3 |
| CLW | 266.2 | 263.3, 266.9 |
| CSW | 51.8 | 49.3, 54.3 |
| CNet | 24.9 | 19.9, 28.6 |

Data Period: 3/2000 to 2/2005



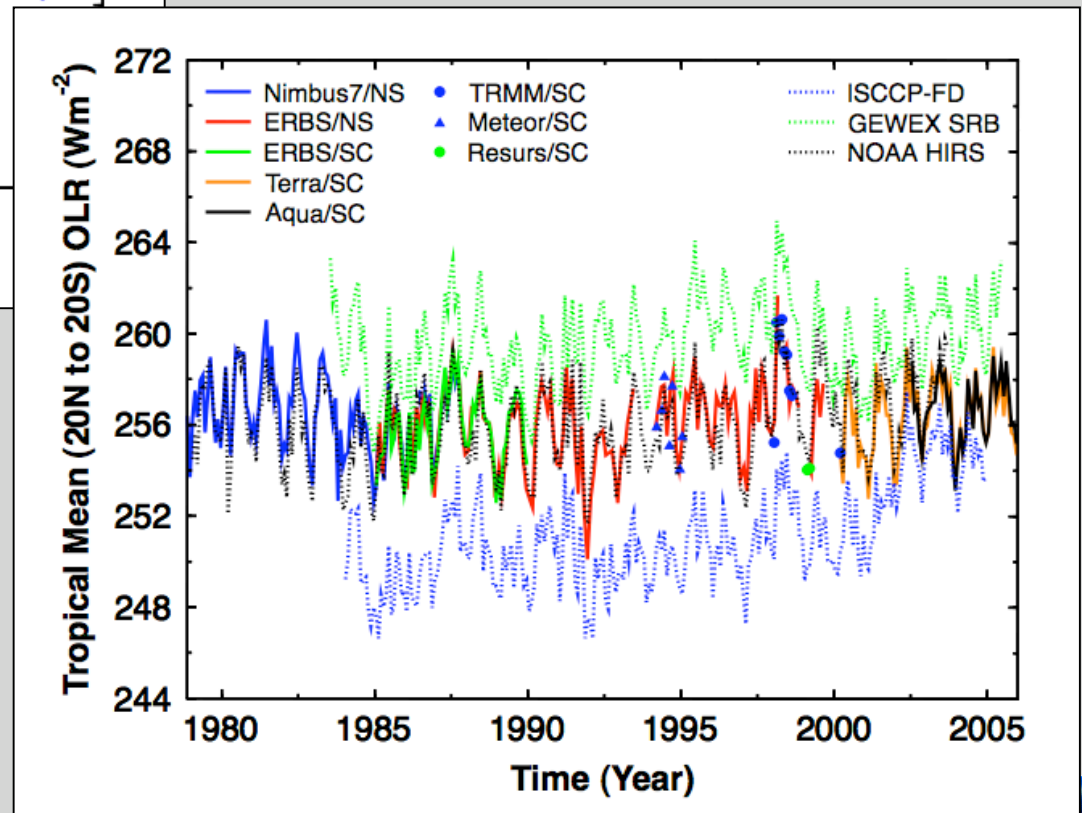
Tropical OLR Intercomparisons



Data as it, without any adjustments; Current spread about 5 - 10 Wm^{-2} ; Narrows After 2001

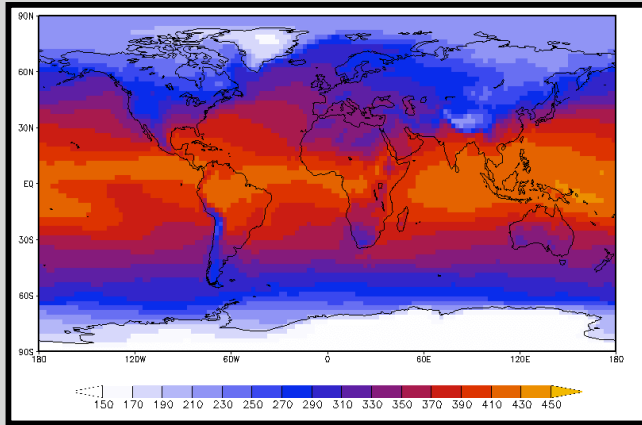


Broadband data overlap adjustment to remove absolute calibration differences using TRMM as an anchor point

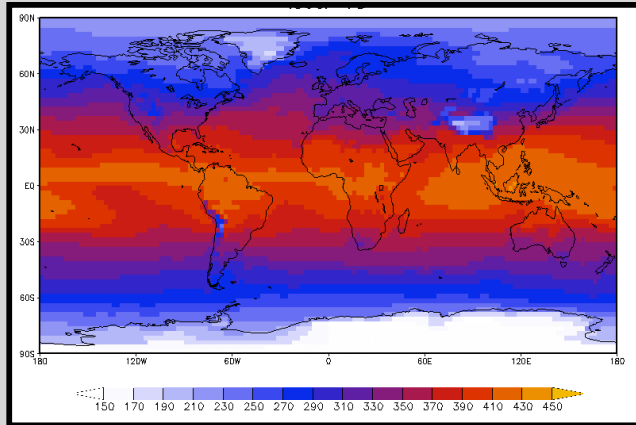


Annual Mean Surface LW Down Fluxes

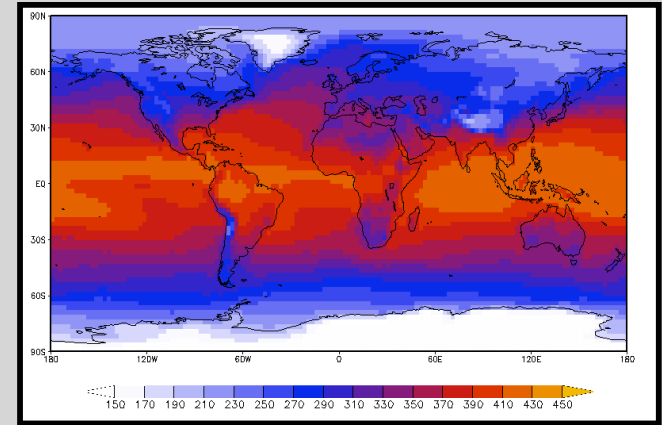
CERES SRBAVG GEO



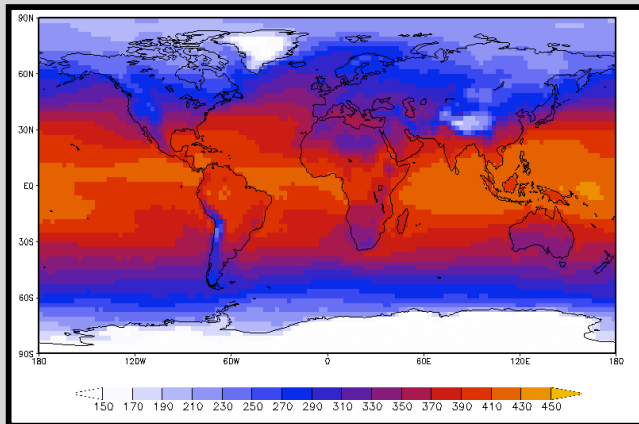
ISCCP-FD



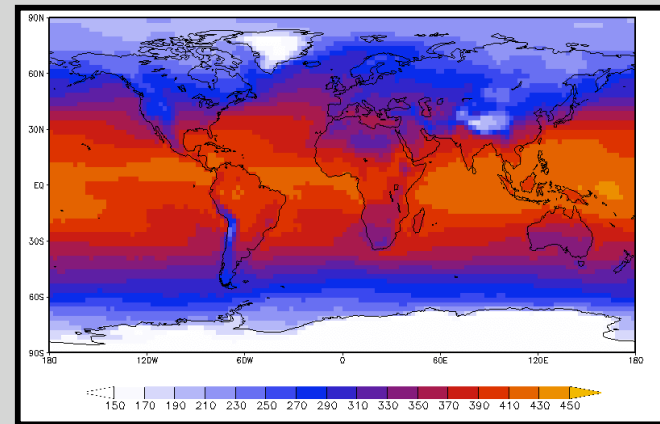
GEWEX SRB/LaRC



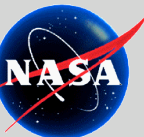
FORTH



NCEP R2

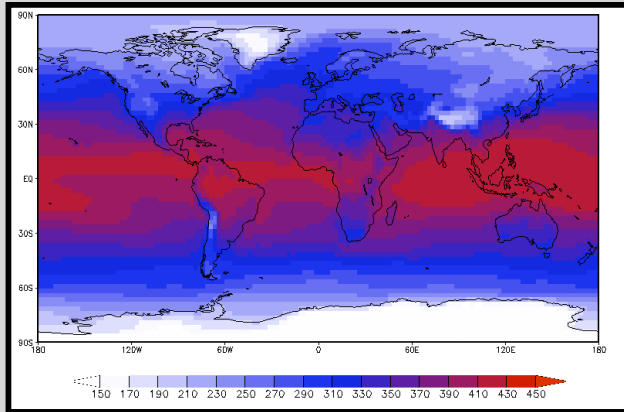


Data Period: 3/2000 to 2/2005

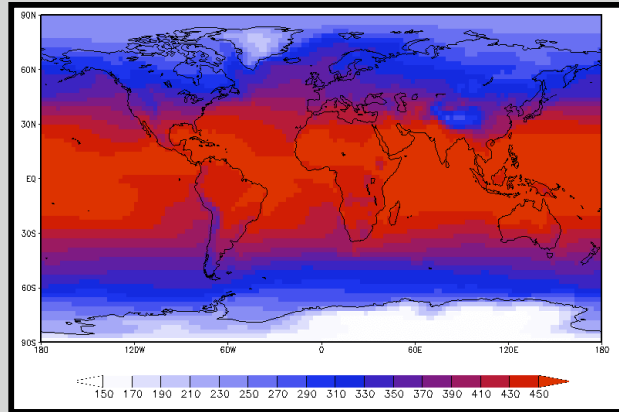


Multi-Dataset Surface Ensemble Mean

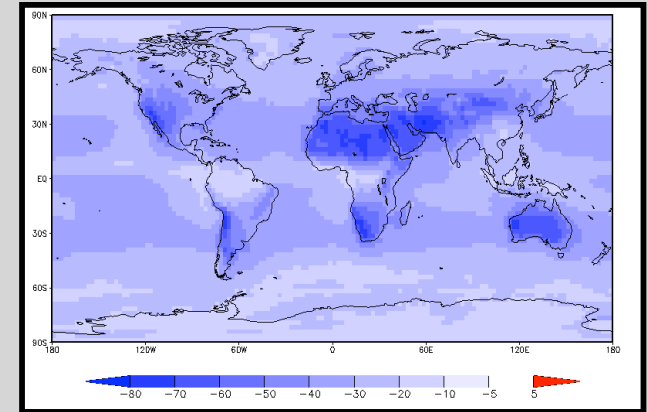
LW Down



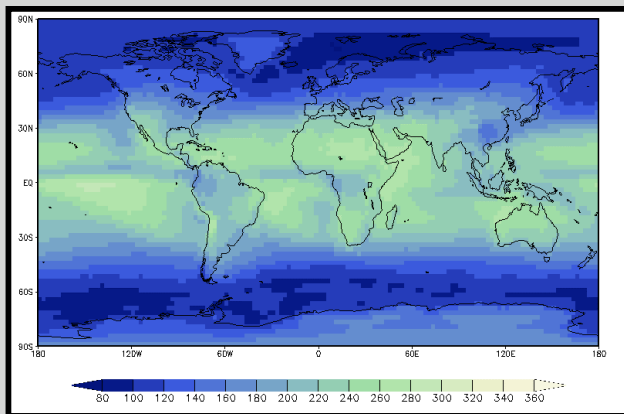
LW Up



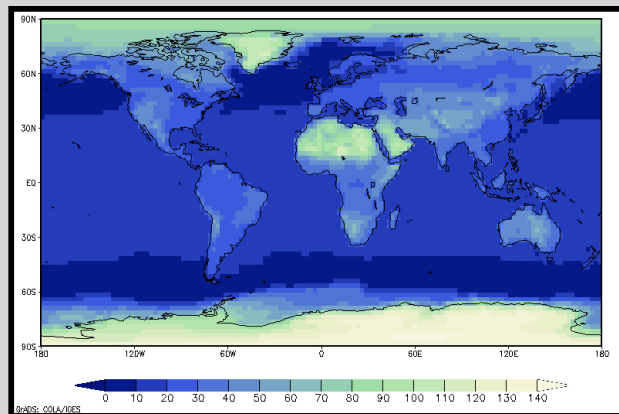
LW Net



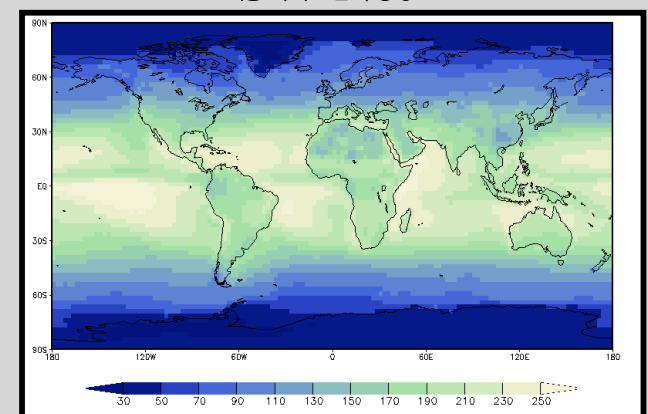
SW Down



SW Up



SW Net

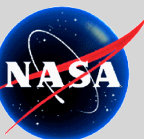


Data Period: 3/2000 to 2/2005

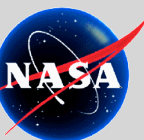
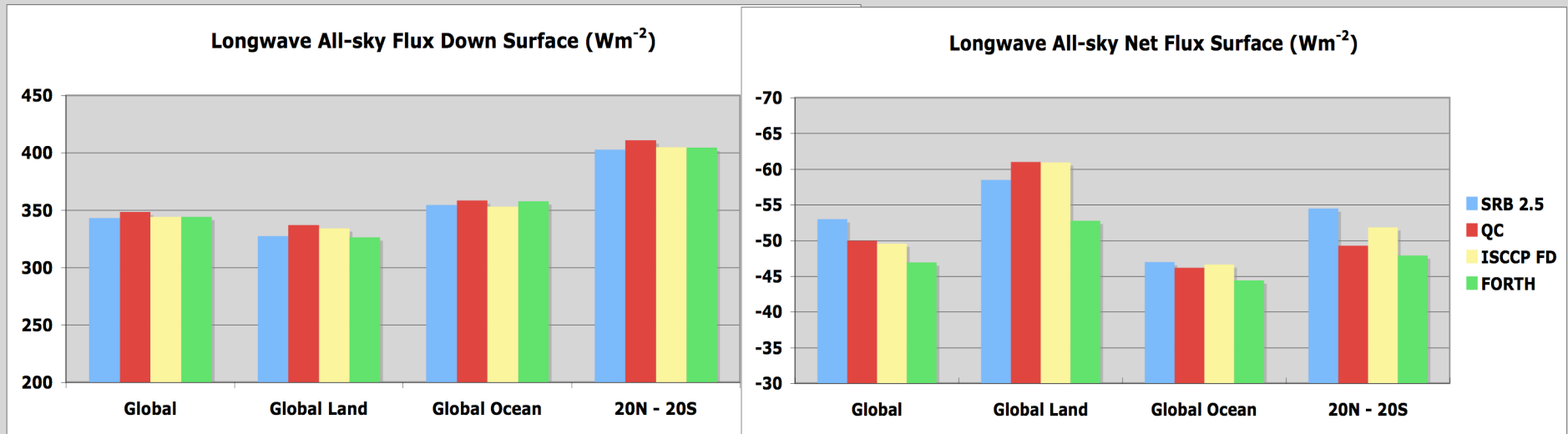
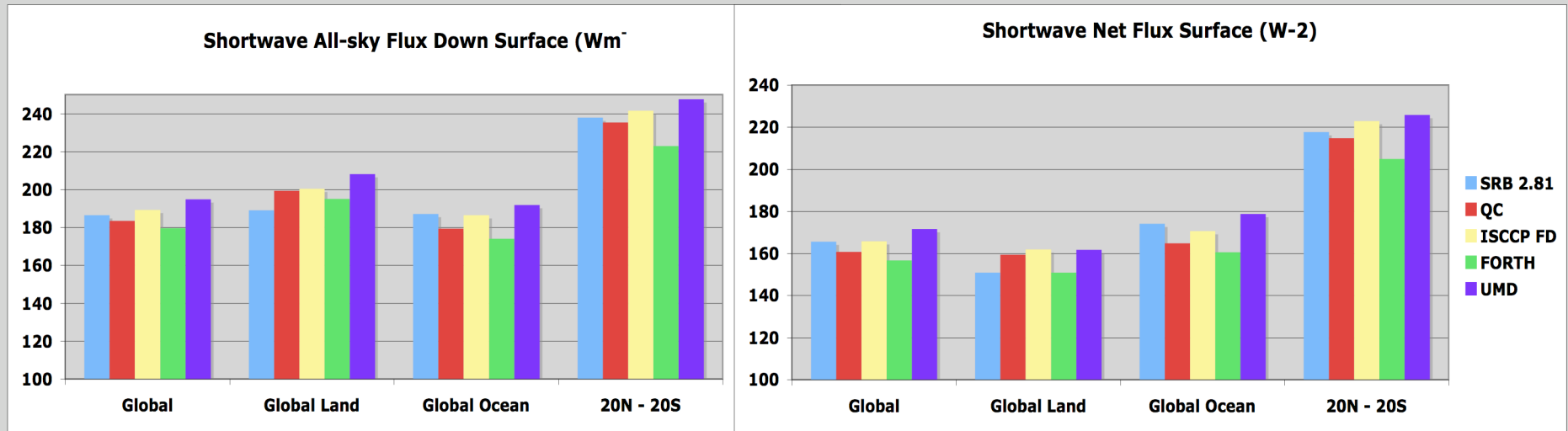
Annual Global Mean Sfc Budget

| | Mean | Range | # Models |
|----------------|--------------|---------------------|-----------------|
| SW Down | 188.7 | 178.4, 197.6 | 7 |
| SW Up | 24.1 | 20.6, 26.8 | 6 |
| SW Net | 165.1 | 152.9, 173.0 | 6 |
| LW Down | 343.4 | 340.3, 345.4 | 5 |
| LW Up | 394.4 | 391.9, 397.4 | 5 |
| LW Net | -51.0 | -47.6, -57.0 | 5 |

Data Period: 3/2000 to 2/2005



Surface Global and Zonal Averages (1984-2004)



Surface Measurement Example

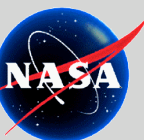
Uncertainty Matrix:

BSRN Operational Measurement Quality

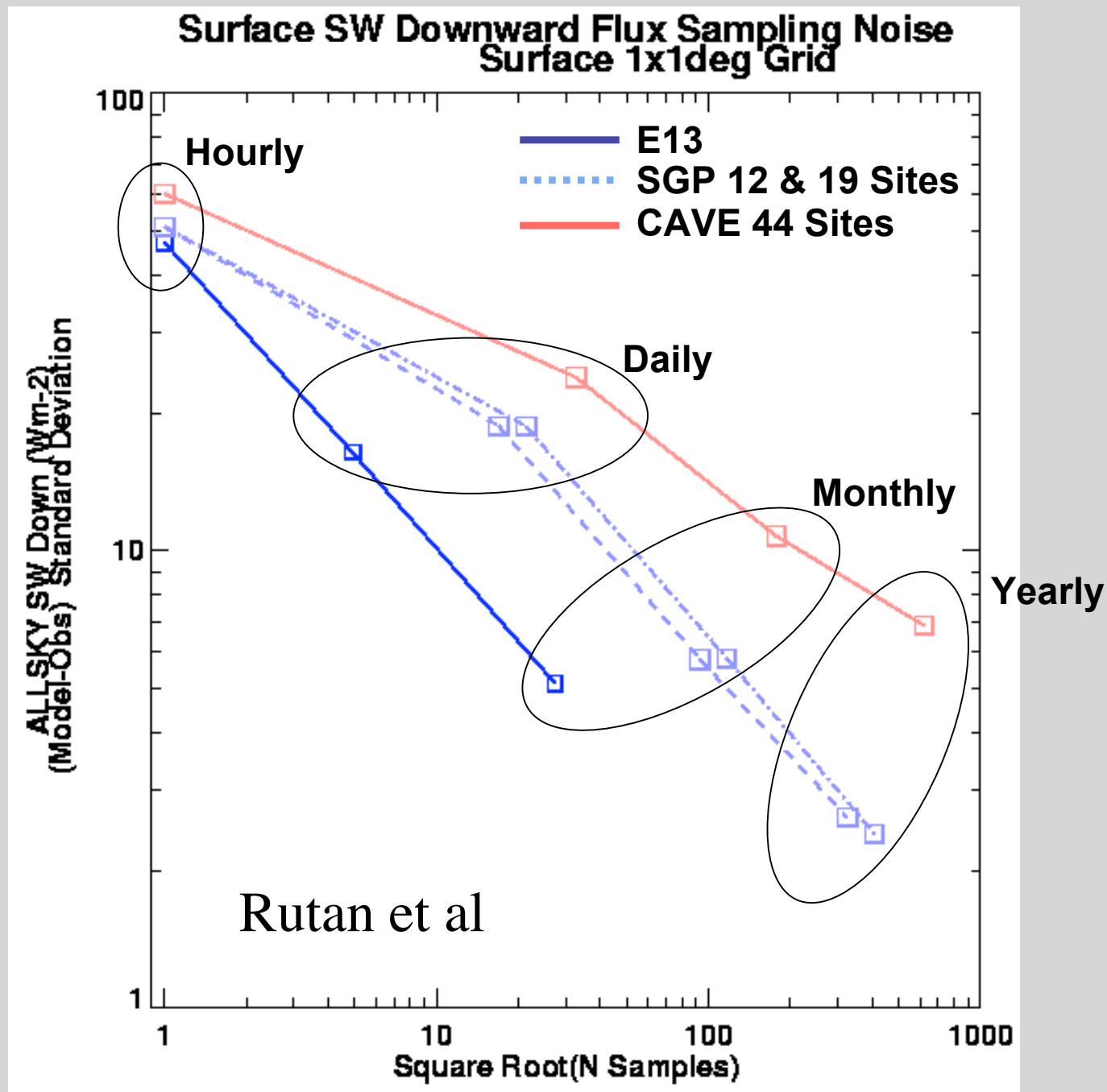
RMS Uncertainties for Radiative Measurements (Ohmura et al, 1998, BAMS; Michalsky et al., 1998; Shi and Long, 2002, Dutton et al., 2001; Ells Dutton personal comm.)

| Quantity (Instrument) | 1 Minute Avg. (1 Hz sampling) (W m ⁻²) | 1 Hour (W m ⁻²) | 1 Day (W m ⁻²) | 1 Month (W m ⁻²) | 1 Year (W m ⁻²) | 10 Years | Thermal Offset |
|---|--|-----------------------------|----------------------------|------------------------------|-----------------------------|----------|----------------|
| LW Broadband (pyrgeometer) | 5 - 7 (2%) | 5 | 3 -- 5 | 3 -- 5 | 3 -- 5 | ?? | --- |
| SW Broadband Global (direct+diffuse, pyranometer) | 25+ (4-5%) | 8 -- 20 | 5 -- 15 | 5 -- 15 | 5 -- 15 | ?? | up to -3% |
| SW Broadband Direct (NIP) | 5 - 15 (1.5%) | 1% or 2 | 1% or 2 | 1% or 2 | 1% or 2 | ?? | --- |
| SW Broadband Diffuse (shaded pyranometer) | 5 -- 7 (3-4%) | 5 -- 15 | 5 -- 15 | 5 -- 12 | 5 -- 12 | ?? | up to -10 |
| SW Broadband Total (shaded pyranometer + NIP) | 10 -- 15 (3.0%) | 5 -- 15 | 5 -- 15 | 5 -- 12 | 5 -- 12 | ?? | up to -10 |

Challenge: Derive similar tables for each network; survey and classify measurements (i.e., land, ocean)



SW Down: Noise from Multiple Sites



Radiative Flux Assessment Next Steps

- Data Analysis
 - Continue analysis of submitted datasets for TOA and Surface fluxes to complete sections
 - Continue evaluation of ingested datasets against surface site data; cross comparisons; different time and space scales - long-time scales emphasized
 - Collection, posting, discussion of analysis results
- Assembly of Radiative Flux Assessment Draft
 - Receive participant results and analysis for posting
 - Begin cross editing
 - Chapter leads; coordinate analysis; assemble chapters with submitted results
- Collaborative draft assessment document (Dec/Jan 2009)
- Final document (to follow, 3-4 months?) - meetings and/or teleconferences to be scheduled

