CDR DEVELOPMENT PROJECT

Development of a Radiation Climate Data Record Combining ERBE and AVHRR

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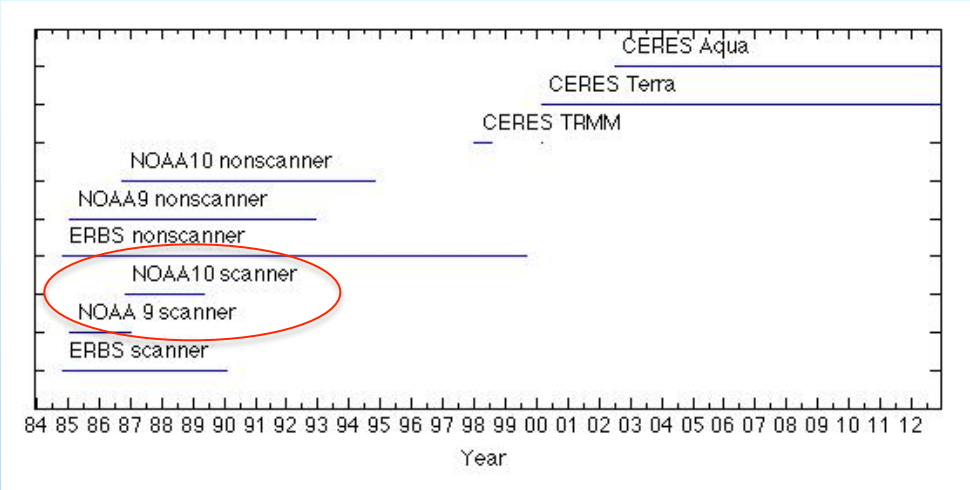
CDR Team Meeting
July 30 – Aug 1, 2013

Outline

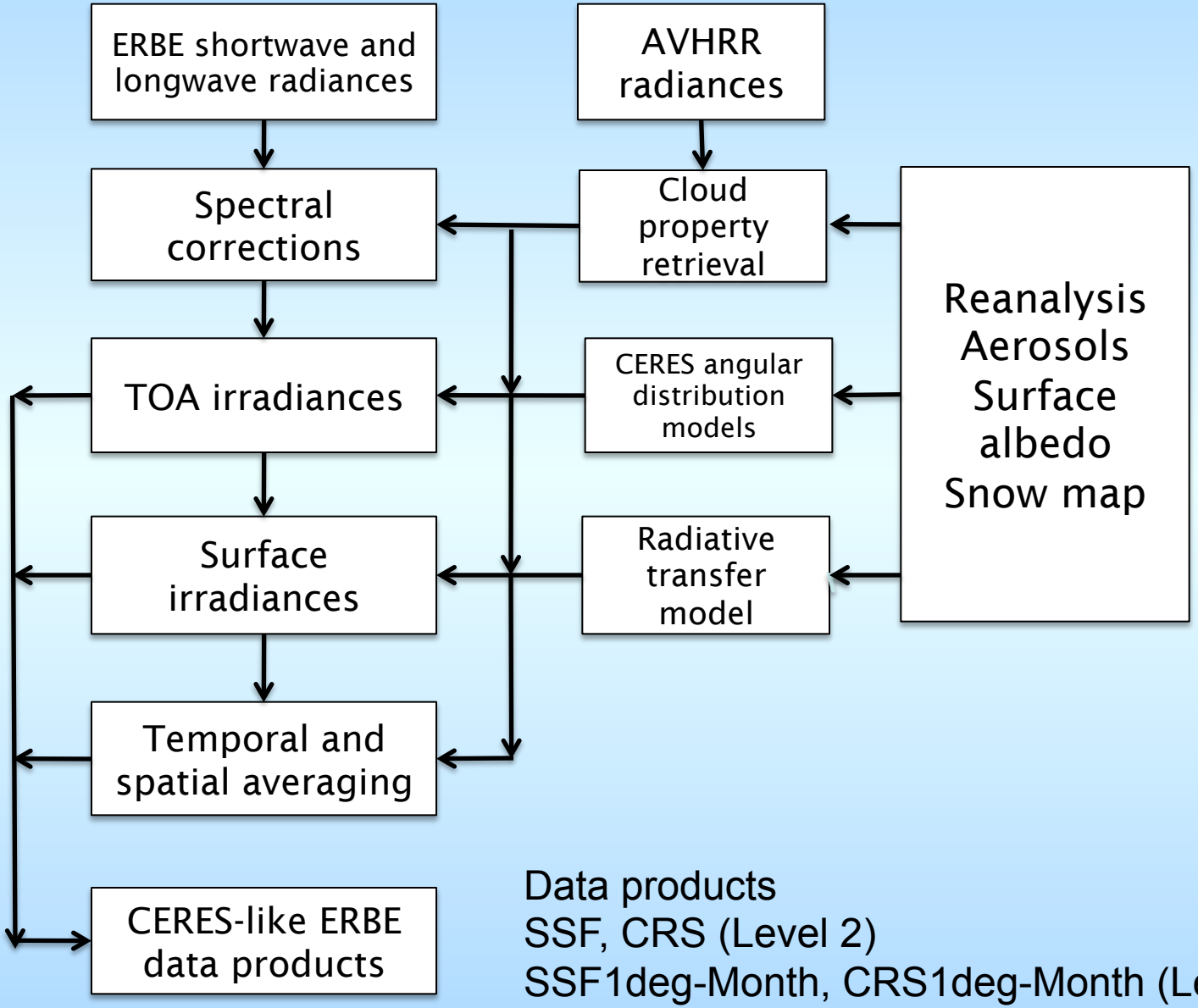
- Project Description
- Production and QA Approach
- Applications
- Schedule & Issues

CERES-like ERBE Project Description

- To provide TOA and surface radiative fluxes derived from ERBE observations from February 1985 to January 1987 (NOAA 9) and from January 1987 to May 1989 (NOAA 10) for climate studies..
- Use consistent algorithms with the CERES process (e.g. scene ID given by AVHRR to use CERES angular distribution models, surface radiative fluxes, and better temporal and spatial interpolations)



CERES-like ERBE Project Flow Diagram



Data products
SSF, CRS (Level 2)
SSF1deg-Month, CRS1deg-Month (Level 3)

Project Description

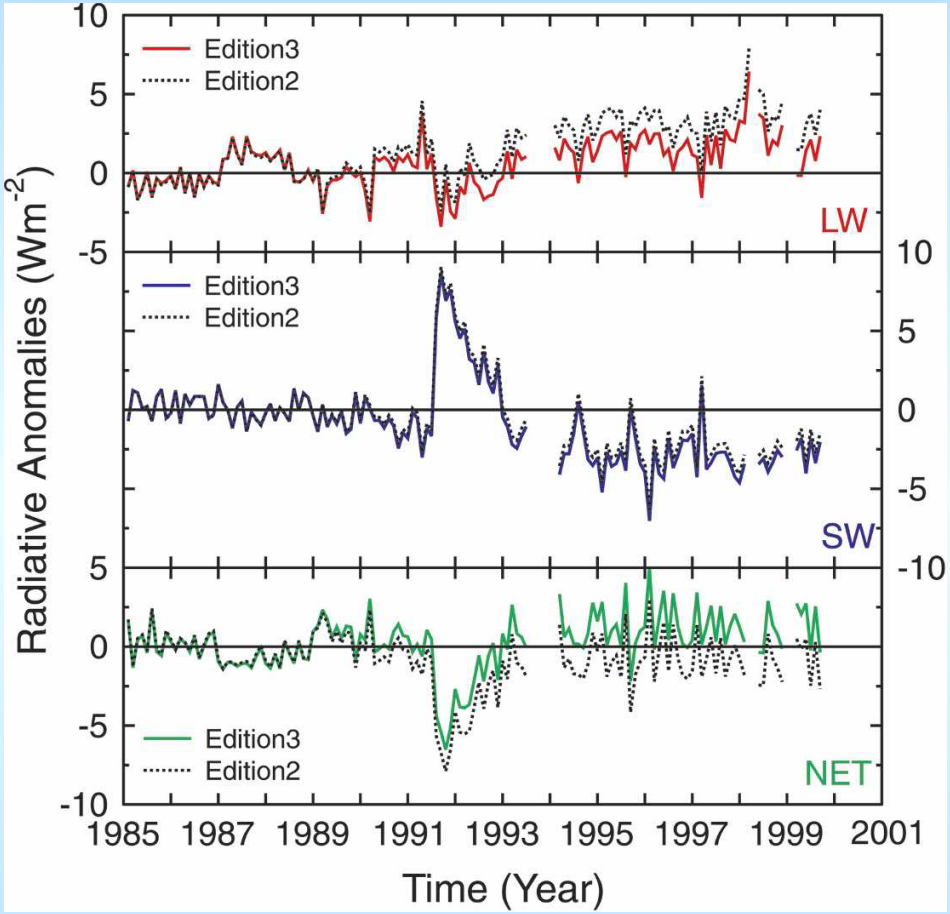
CDR(s)	Period of Record and Temporal Resolution	Spatial Resolution & Projection Used (if applicable)	Update Frequency	Data file distinction criteria	Inputs	Uncertainty Estimates (in percent or error)	Collateral Products (unofficial or unvalidated & produced alongside)
TOA reflected shortwave irradiance outgoing longwave irradiance **Surface** Upward shortwave irradiance Downward shortwave irradiance Upward longwave irradiance Downward longwave irradiance	February 1985 – January 1987 (NOAA 9) November 1986 – May 1989 (NOAA 10)	Level 2: 30 km ERBE footprint Level3: 1˚×1˚ Level2: Instantaneous Level3: Monthly	<How often is the record updated (i.e., extended in time) e.g., weekly, monthly, quarterly>	<What discriminates contents of the different data files delivered? i.e., are files defined by time period, orbit, satellite, channel, variable?>	AVHRR derived cloud properties MERRA (temperature, humidity, snow/ sea ice) AVHRR derived aerosol optical thiknce ss (ocean) Aerosol transport model (MATCH, climatol	**TOA** Monthly 20˚×20˚ regional Shortwave 1.3Wm^{-2} (out of 342Wm^{-2}) Longwave 0.8 Wm^{-2} (Effect of cloud retrieval errors is excluded) **Surface**[1] Monthly regional Shortwave up 11Wm^{-2} (out of 23 Wm^{-2}), Shortwave down 10Wm^{-2}(out of 192 Wm^{-2}) Longwave up 15Wm^{-2}, longwave	CERES (Jan. 1998 - August 1998, and March 2000 - present) ERBS scanner (Nov. 1984 – Feb. 1990) ERBS nonscanner (Nov. 1984 – Sep. 1999) NOAA 9 nonscanner (Feb. 1985 – Dec. 1992) NOAA 10 nonscanner (Oct. 1986 – Nov. 1994).

Production Approach

- Instrument spectral filtering effects is taken out using the CERES unfiltering algorithm (Loeb et al. 2001)
- ERBE observed radiances are converted to irradiances using CERES Aqua Angular Distribution Models (ADMs, Loeb et al. 2005)
- Scene ID (cloud fraction, cloud optical thickness, cloud top and surface temperature etc.) is given by AVHRR (CDR project, PI: P. Minnis)
- Averaging irradiances for 1°×1° and every hour box by temporally interpolating sampling from an sun-synchronous orbit
- Surface irradiances are computed using AVHRR derived cloud properties, GMAO reanalysis (MERRA), and aerosols from AVHRR (Mishchenko et al. 1999) and a transport model (MATCH, Collins et al. 2001).

Quality Assurance Approach

Tropical radiation anomalies



Wong et al. 2006 J Climate

Tropical mean decadal change
Between 1980s to 1990s
(Wong et al. 2006)

LW	0.7 Wm^{-2}
SW	-2.1 Wm^{-2}
Net	1.4 Wm^{-2}

CERES TOA flux uncertainty 1σ

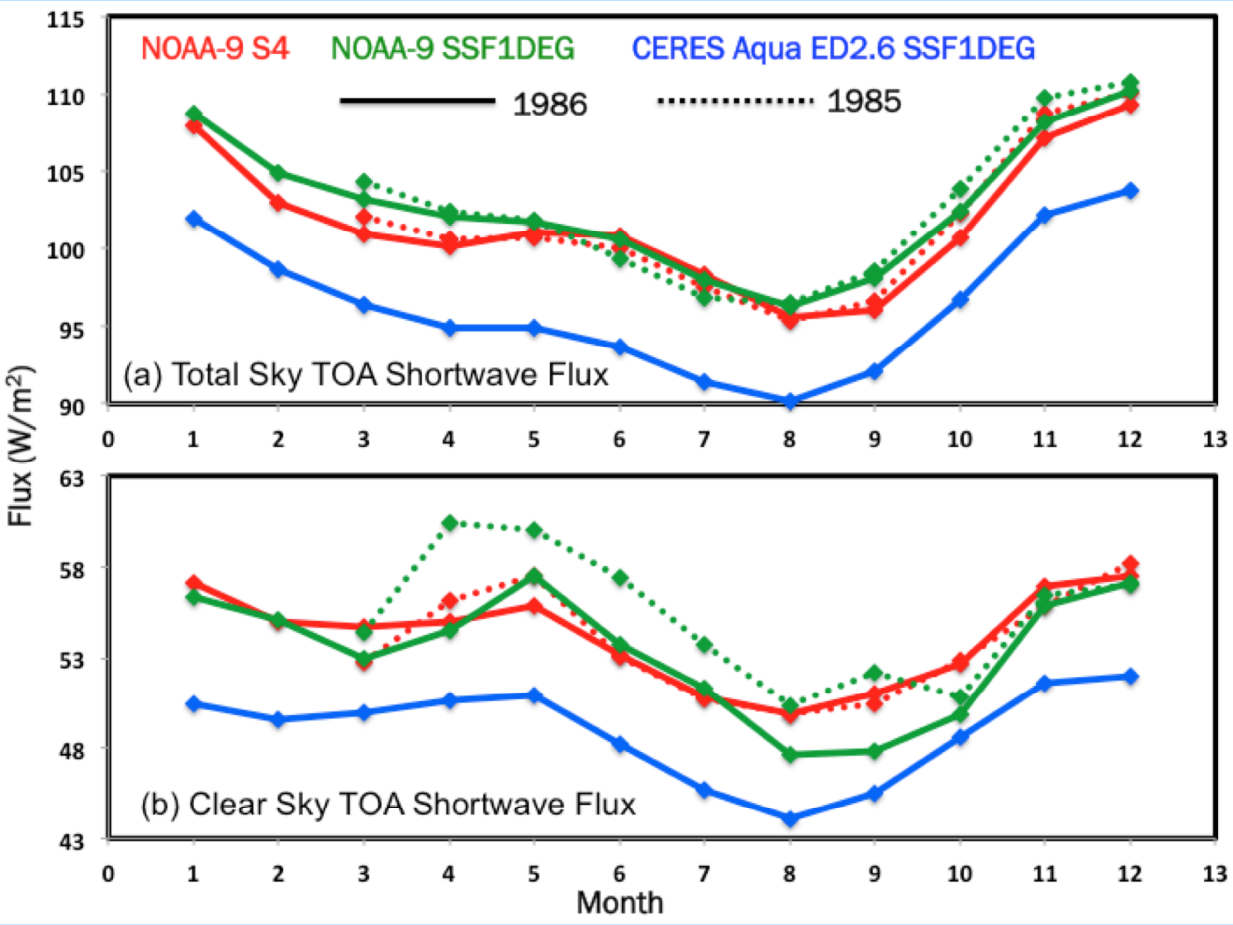
SW	1%
LW	0.8%

ERBE TOA flux uncertainty 1σ

SW	2%
LW	1.5%

Validation & Quality Assurance

TOA Shortwave irradiance comparison with CERES



Difference = 6.6 Wm^{-2}

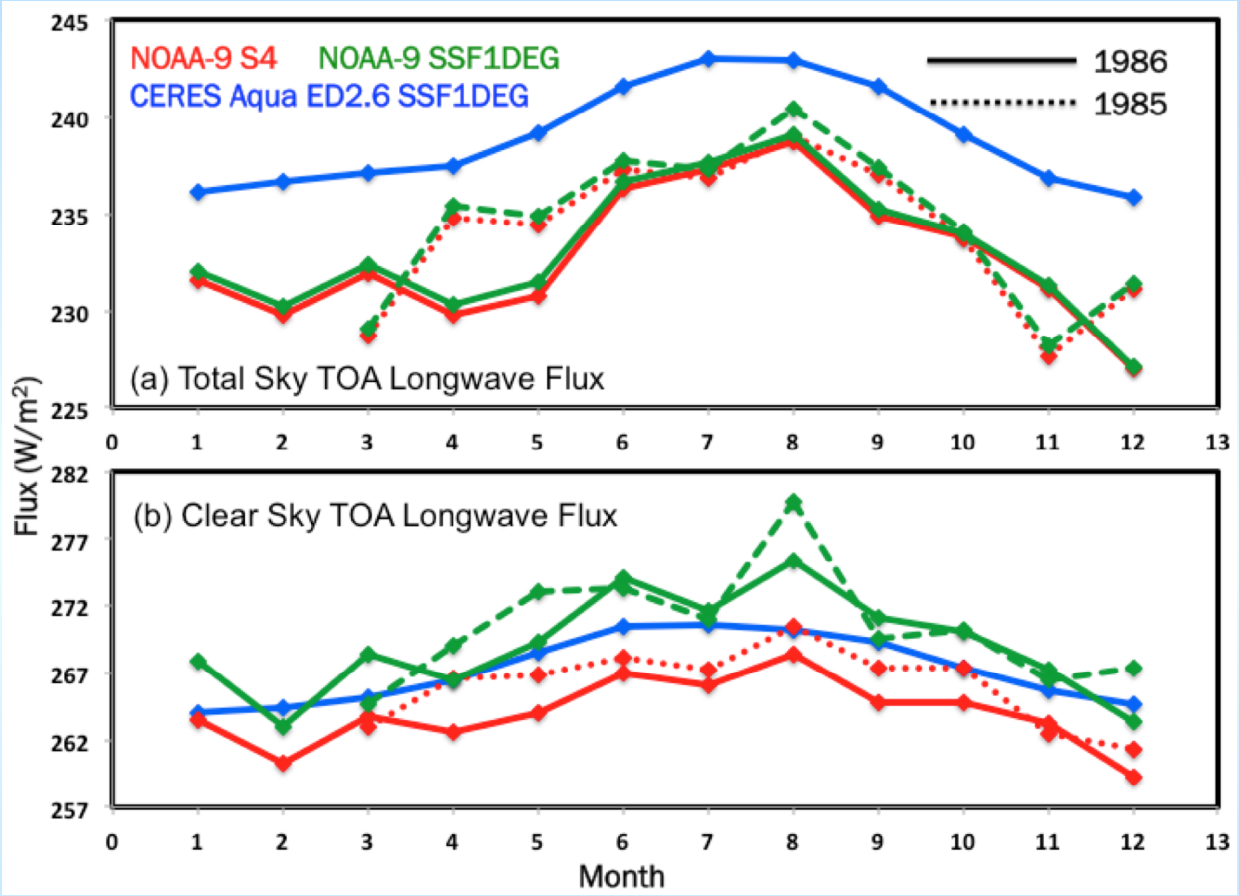
$1\sigma = 2.1+1+2 = 5.1 Wm^{-2}$

$2\sigma = 2.1+2+4 = 8.1\ Wm^{-2}$

All-sky	NOAA-9 S4	NOAA-9 SSF1deg-Month	CERES Aqua SSF1deg-Month
Annual mean (Wm^{-2})	101.9	103.0	96.4

Validation & Quality Assurance

TOA Longwave irradiance comparison with CERES



Difference = 5.3 Wm^{-2}

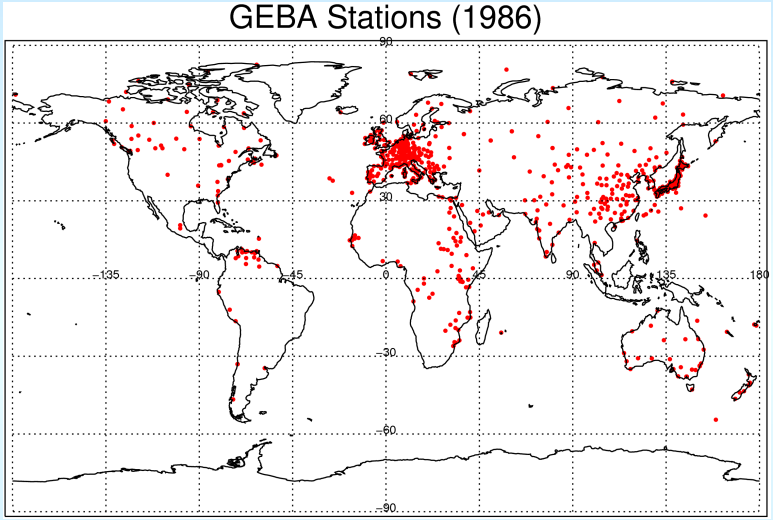
$1\sigma = 0.7+2+4 = 6.7 Wm^{-2}$

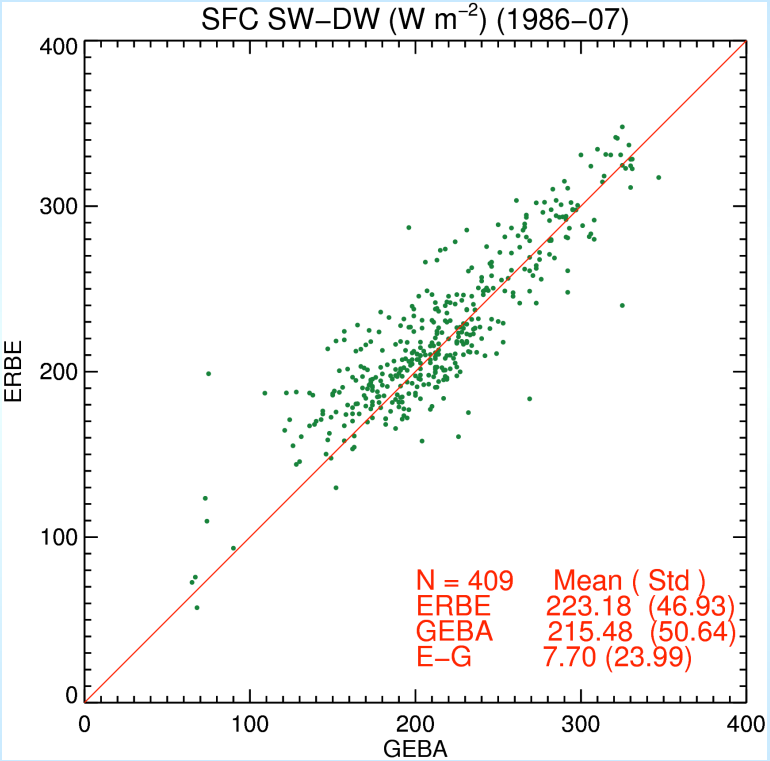
$2\sigma = 0.7+4+8 = 12.7\ Wm^{-2}$

All-sky	NOAA-9 S4	NOAA-9 SSF1deg-Month	CERES Aqua SSF1deg-Month
Annual mean (Wm^{-2})	233.1	233.6	238.9

Validation & Quality Assurance

Surface downward shortwave irradiance comparison with GEBA data





Only downward shortwave irradiance observations are available
Most surface stations are concentrated in Europe

Uses & Applications

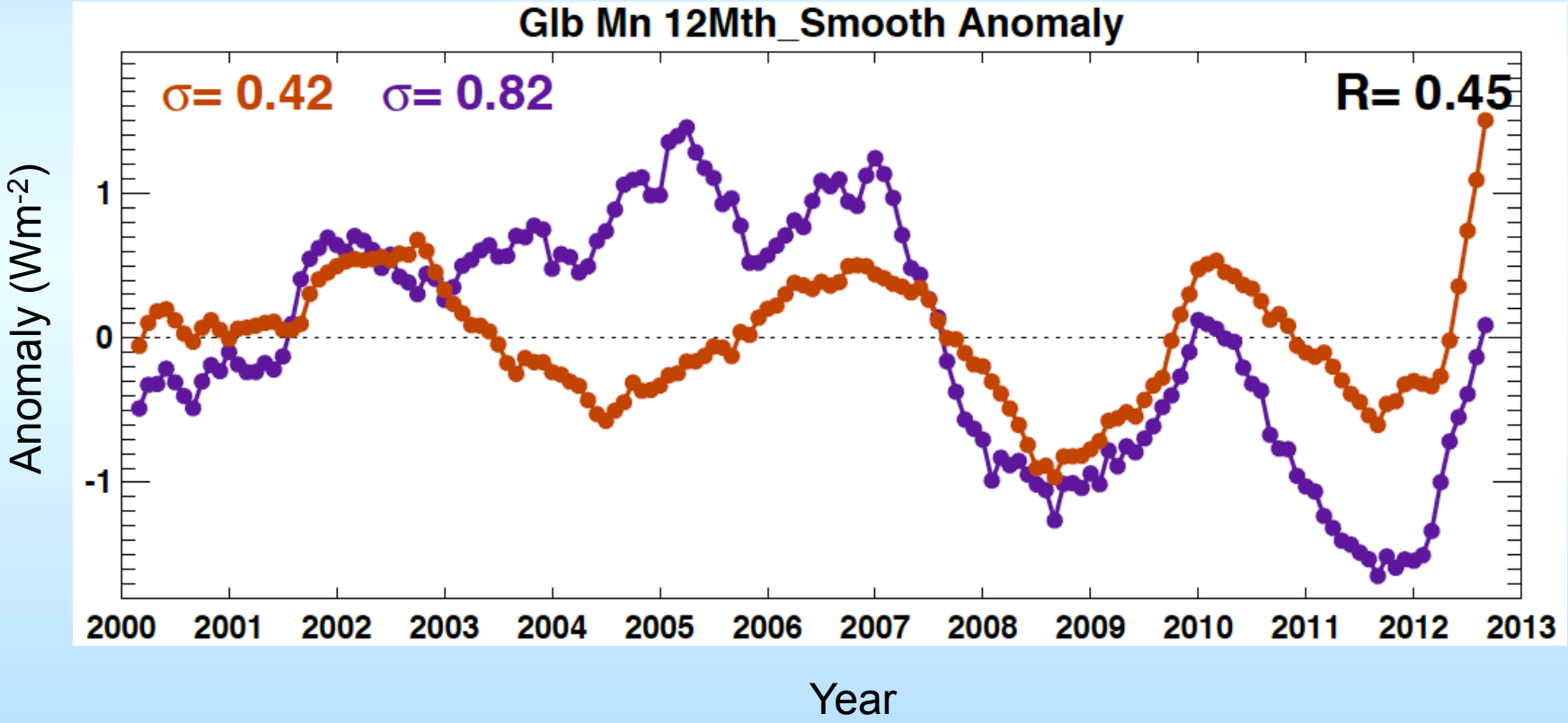
- Applications and Uses
  - –Based on the study by Cooke et al. (2013, *Journal of Environment, Systems and Decisions*, doi:10.1007/s10669-013-9451-8)
    - ➢The probability density of climate sensitivity has a median value of 3C, drops rapidly for values below 2C, but drops slowly for high climate sensitivity values until it is truncated at a value of 10C.
    - ➢An uncertainty of climate sensitivity of a factor 4 (the 90% confidence level) can drive uncertainty in economic impact of a factor 16.
    - ➢If the trend is detected accurately and sooner (the value of information of climate observing system), it has a significant economic impact.

  –Global annual mean surface net irradiance balances with the sum of latent and sensible heat fluxes. Their mean and anomalies can be used to assess the uncertainty.

  –Time series of anomalies comparison provides mutual quality checks

Comparison of atm net and precipitation (GPCP vs. CERES data)

GPCP
Minus Atmospheric NET irradiance



Uses & Applications

- Key Scientific Findings
  - A paper entitled "Unfiltering Earth Radiation Budget Experiment (ERBE) scanner radiances using the CERES algorithm and its evaluation with nonscanner observations" was submitted to Journal of Atmospheric and Oceanic Technology

Schedule & Issues

- Accomplishments over past year and project status
  - Algorithm to process NOAA 9 data is ready
  - Algorithm has not been tested with NOAA 10 data

- Milestones (with dates) to finish development & testing. Include:
  - A paper entitled "Unfiltering Earth Radiation Budget Experiment (ERBE) scanner radiances using the CERES algorithm and its evaluation with nonscanner observations" was submitted to Journal of Atmospheric and Oceanic Technology
  - NOAA 9 ERBE data products (SSF, CRS, SSF1deg-Month, CRS1deg-Month) can be delivered 3 months after AVHRR clouds are delivered
  - NOAA 10 ERBE data products (SSF, CRS, SSF1deg-Month, CRS1deg-Month) can be delivered 6 months after AVHRR clouds are delivered