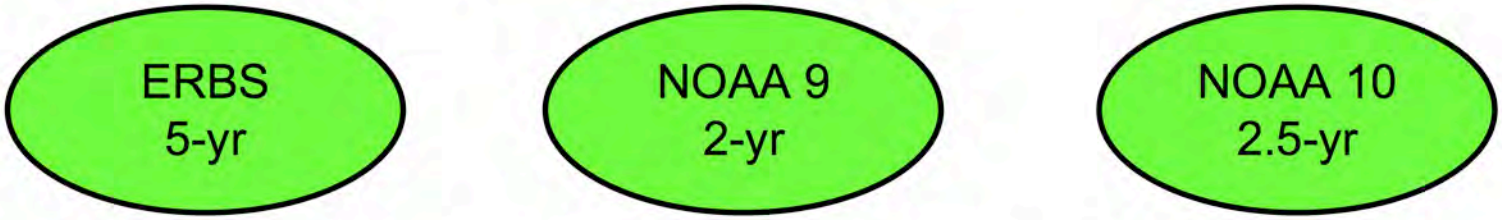
Degradation Pattern of the NOAA 9 WFOV Radiometer

G. Louis Smith[1], Kathy Bush[2],
Robert B. Lee, III[1], Takmeng Wong[3]
and Pamela E. Mlynczak[2]

[1]National Institute of Aerospace, Hampton, VA
[2]SSAI, Hampton, VA
[3]NASA Langley Research Centre, Hampton, VA

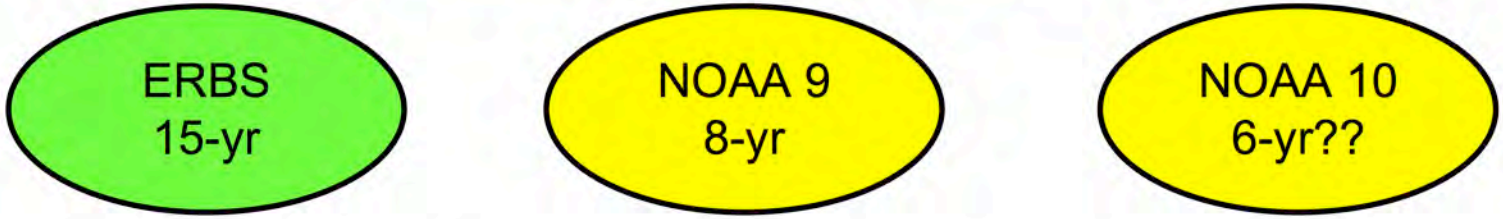
Earth Radiation Budget Experiment (ERBE)

Scanner Data



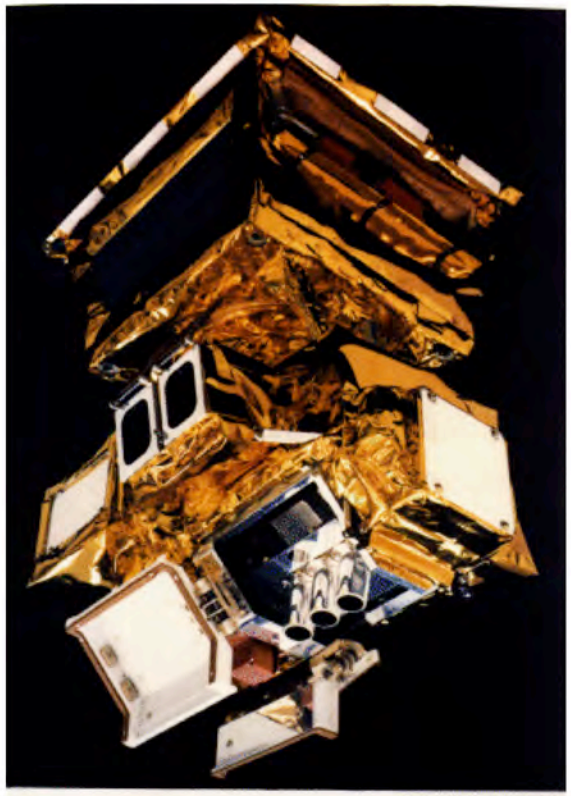
- ERBE combined global satellite scanner datasets (ERBS + NOAA 9 and ERBS + NOAA 10) have been used extensively in the Science Community.

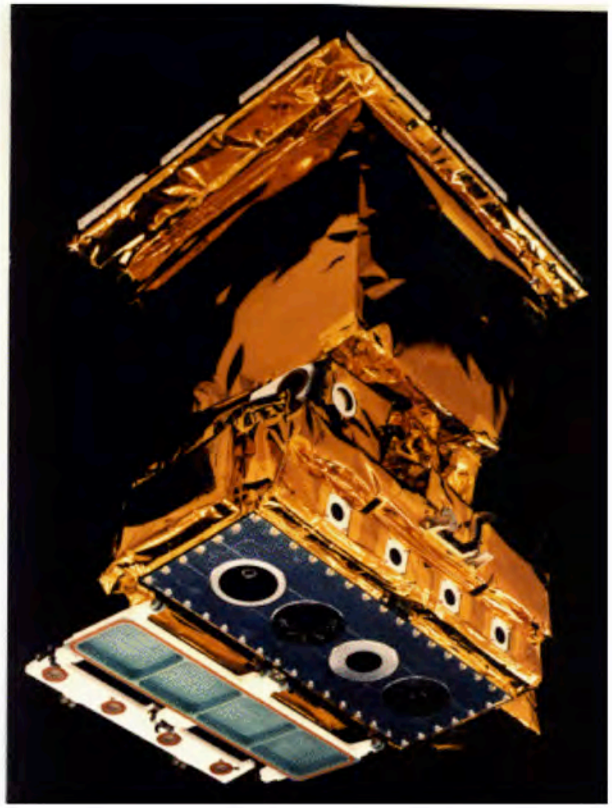
Nonscanner Data



- ERBS Nonscanner WFOV 15-yr data was used in the latest IPCC report (2007) for decadal variability and ocean heat storage comparison. NOAA-9 and 10 Nonscanner datasets have not been examined in detail.

NOAA 9 ERBE Instruments





Scanner: 2/1985 to 1/1987

Small footprint (40km)

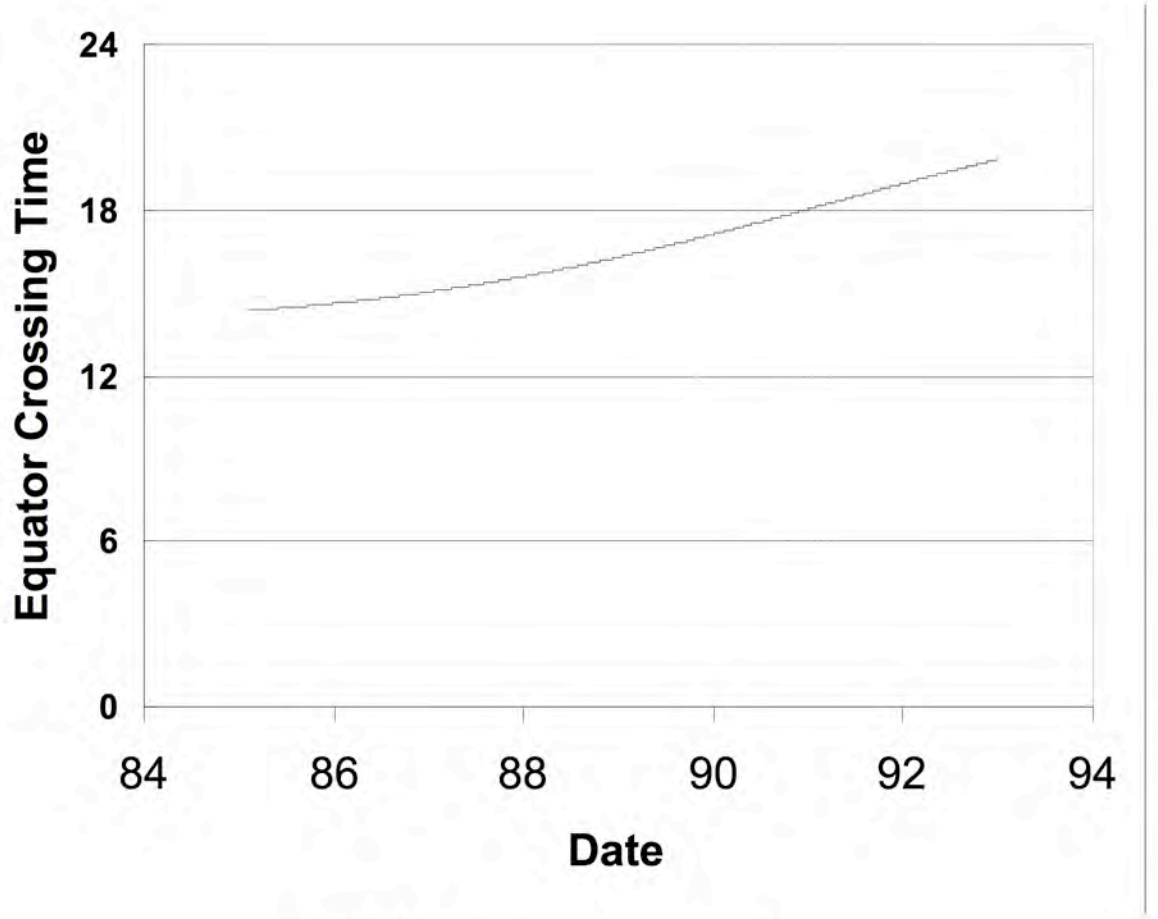
Nonscanner: 1985 to 1992

Large footprint (5-10 deg)

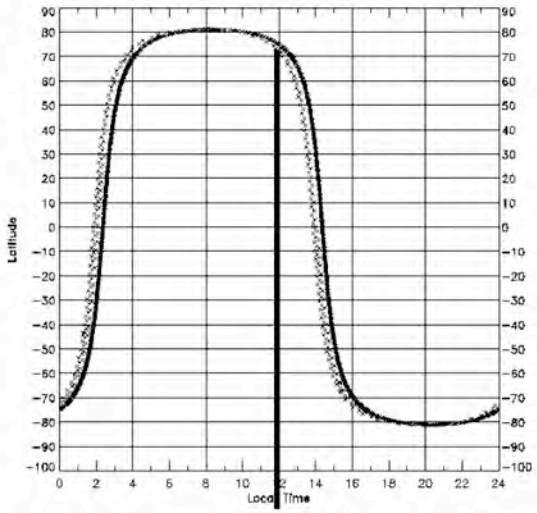
NOAA 9 WFOV Data are needed for Climate Research

- NOAA 9 ERBE WFOV data are the only continuous broadband calibrated ERB measurements poleward of 60^{o} latitude for the period from1985 to 1992.
- Climate research requires a long data record. NOAA 9 ERBE WFOV 8-year record may contain important clues to polar climate change.
- However, non-uniform degradation of the WFOV SW filter (a Quartz Dome) created unacceptable errors.
- The NOAA 9 WFOV data set must be upgraded.
- This talk presents a method to compute the dome degradation pattern; which is needed to correct the data products.

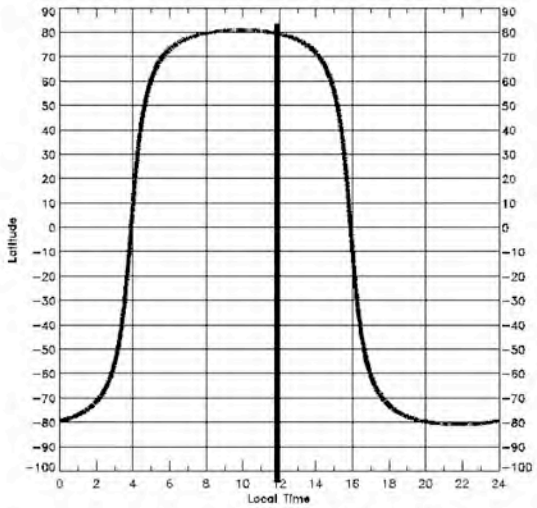
Equator Crossing Time of NOAA 9 Spacecraft



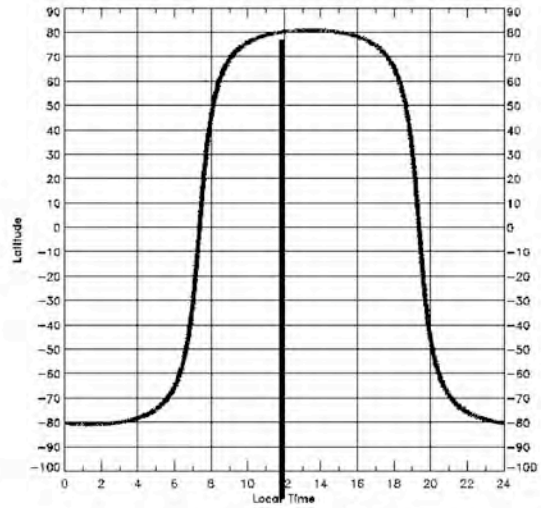
NOAA 9 Ground Tracks



February 1985



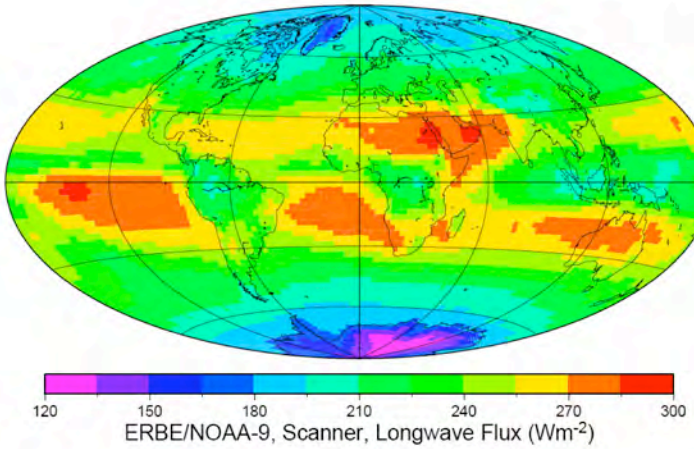
June 1988

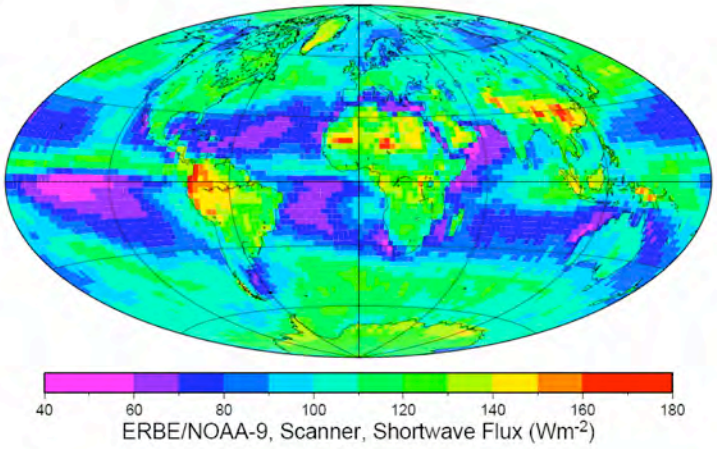


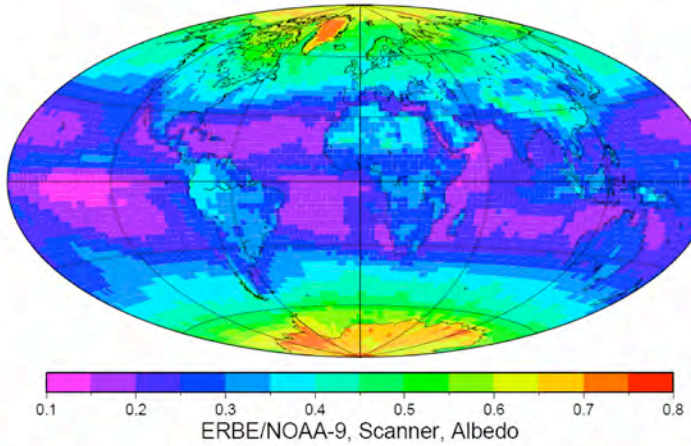
June 1992

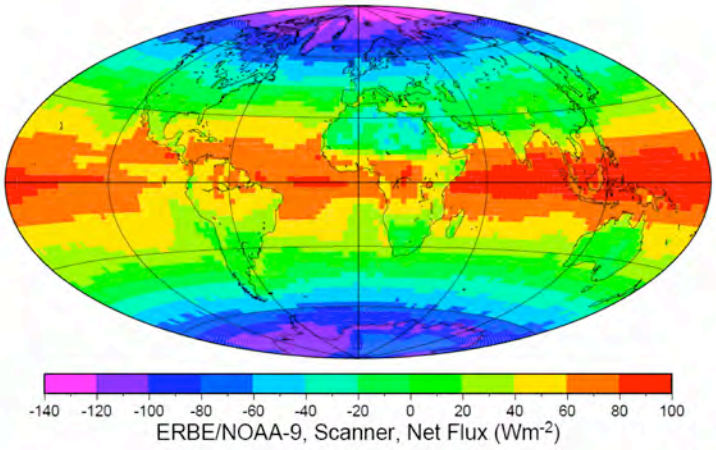
For data period 1985 through 1992, the NOAA 9 WFOV has excellent viewing conditions for shortwave fluxes at high latitudes in Northern Hemisphere and complements the ERBS record (60°S to 60°N).

NOAA 9 ERBE Scanner 2.5-deg Data
Annual Mean (2/1986 to1/1987)

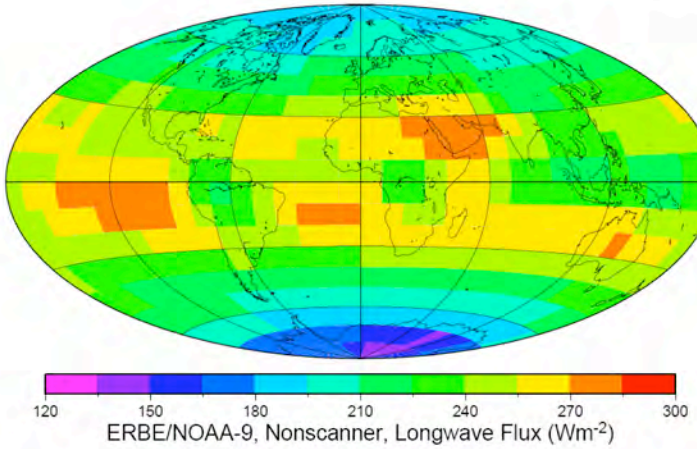


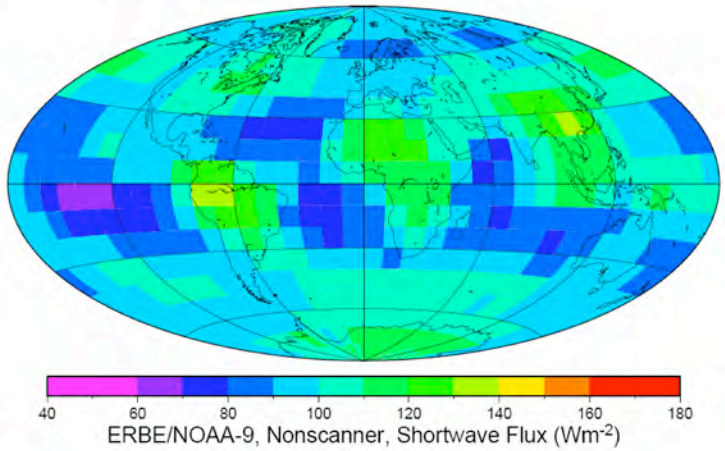


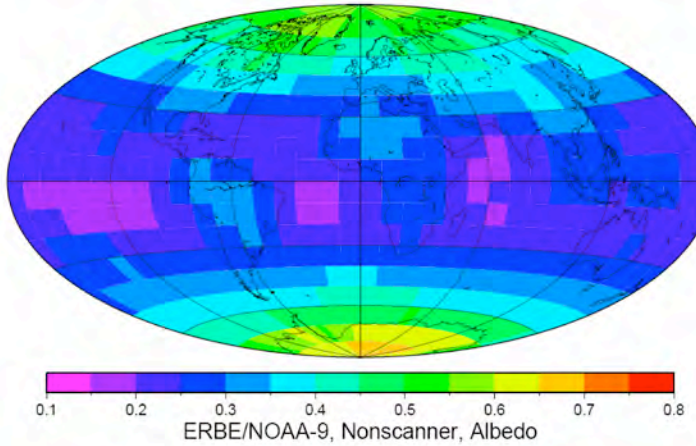


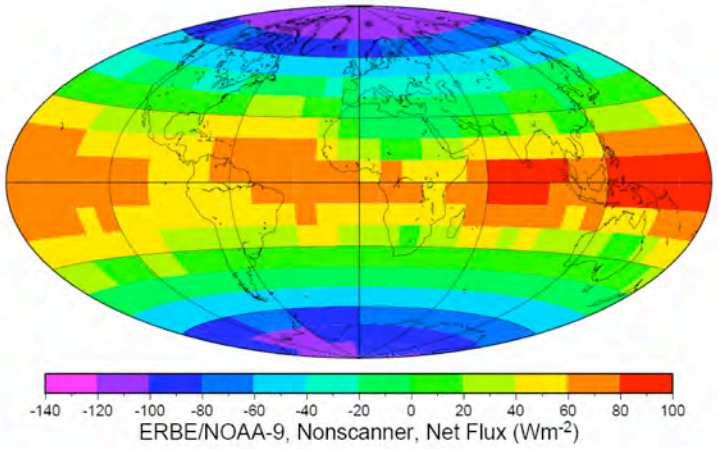


NOAA 9 ERBE WFOV 10-degree Data
Annual Mean (2/1986 to1/1987)

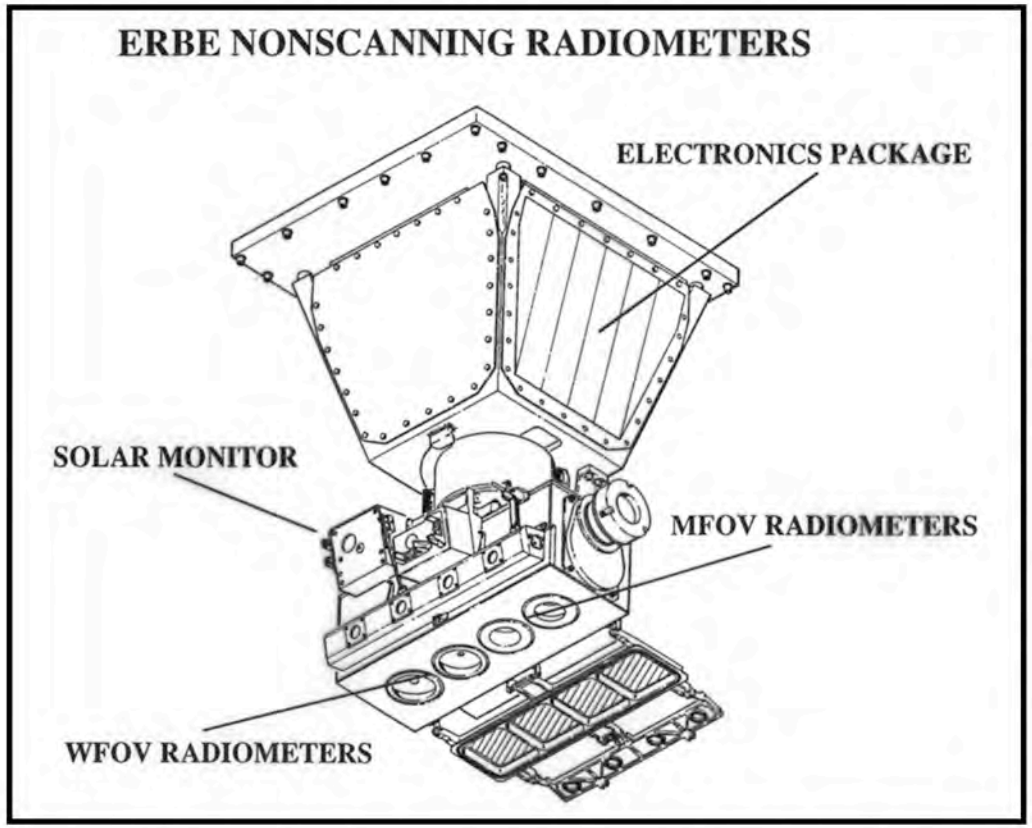








ERBE Nonscanner Instrument



Active cavity radiometer design

WFOV sensor ~ 10 degree

MFOV sensor ~ 5 degree

Total channel: 0.2 to 50 μm

SW channel: 0.2 to 5 μm

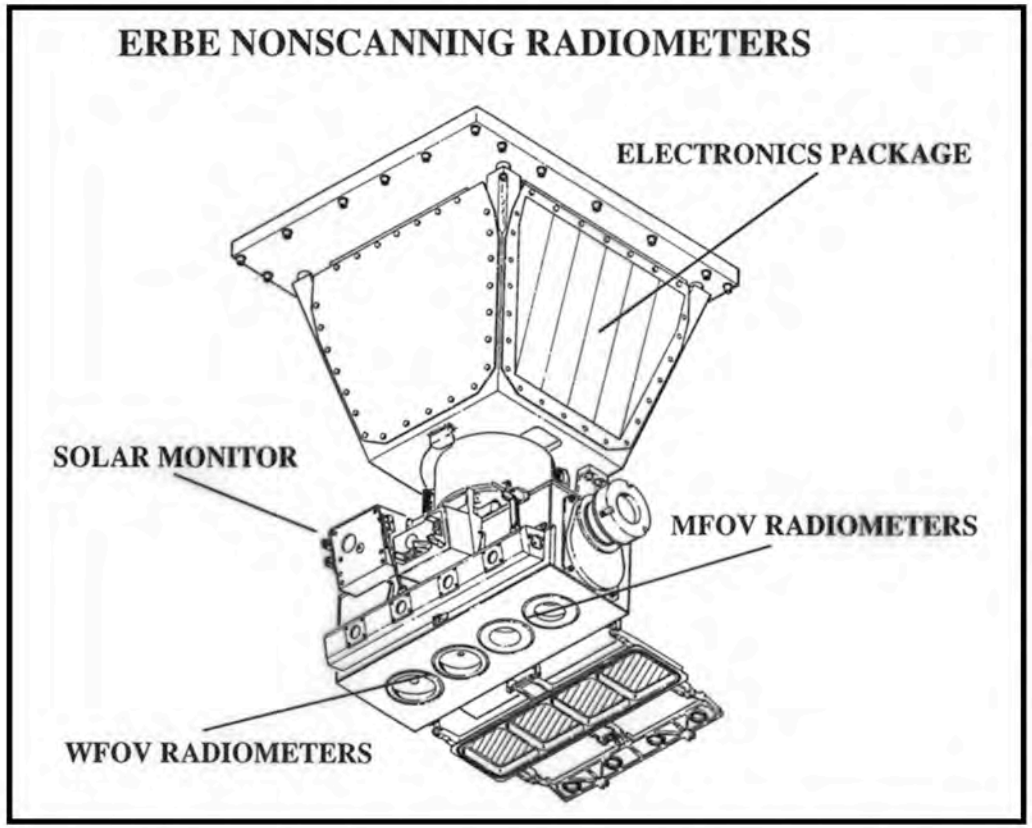
(Total with a SW filter dome)

On-orbit calibration using the Sun and internal BB

LW (night) = Total

LW (day) = Total – SW

ERBE Nonscanner Instrument



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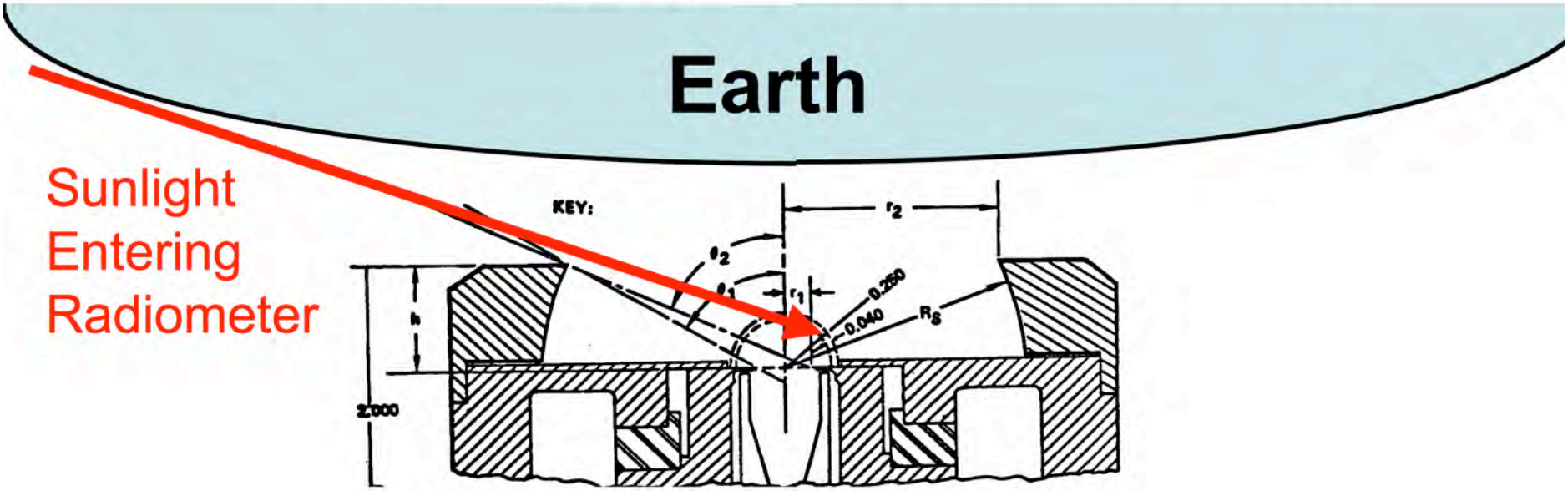
ERBE WFOV Radiometer

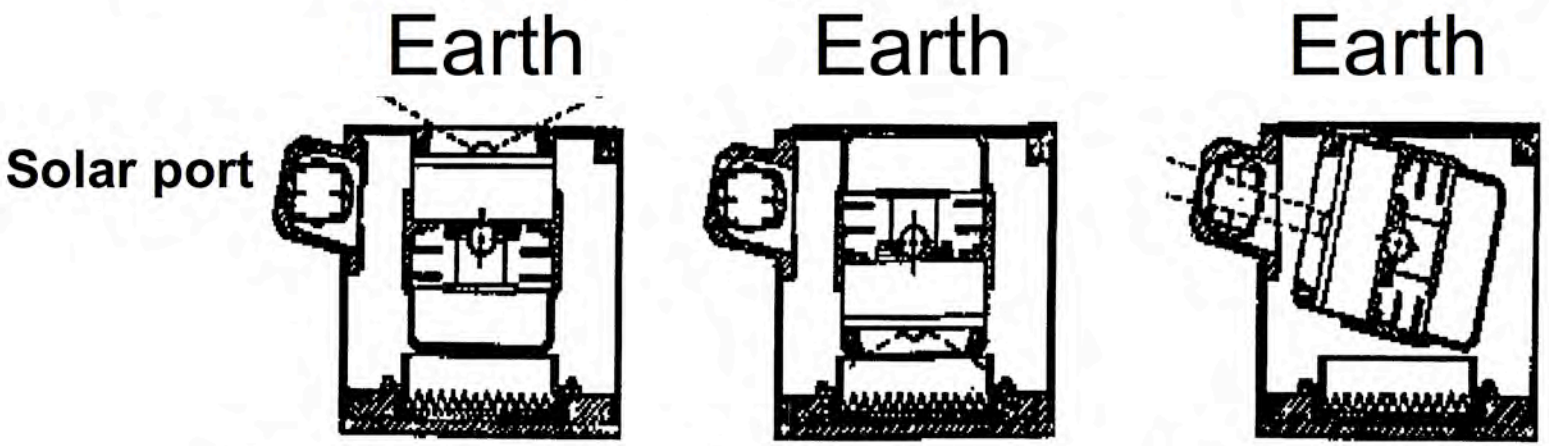
Earth nearly filling Field of View of Radiometer



WFOV SW Sensor

As the Spacecraft enters and leaves the Earth's Shadow, direct Sunlight impinges on the SW Dome Filter, causing Degradation.

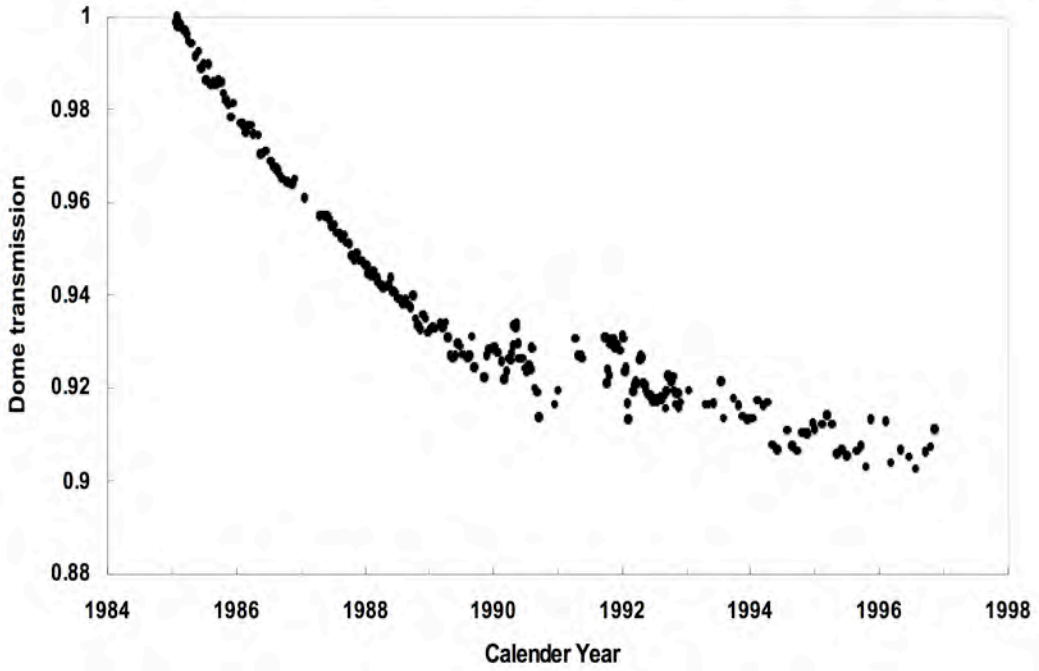
Calibration of Radiometer using Sun



Earth Viewing **Internal BB Calib.** **Sun Calib.**

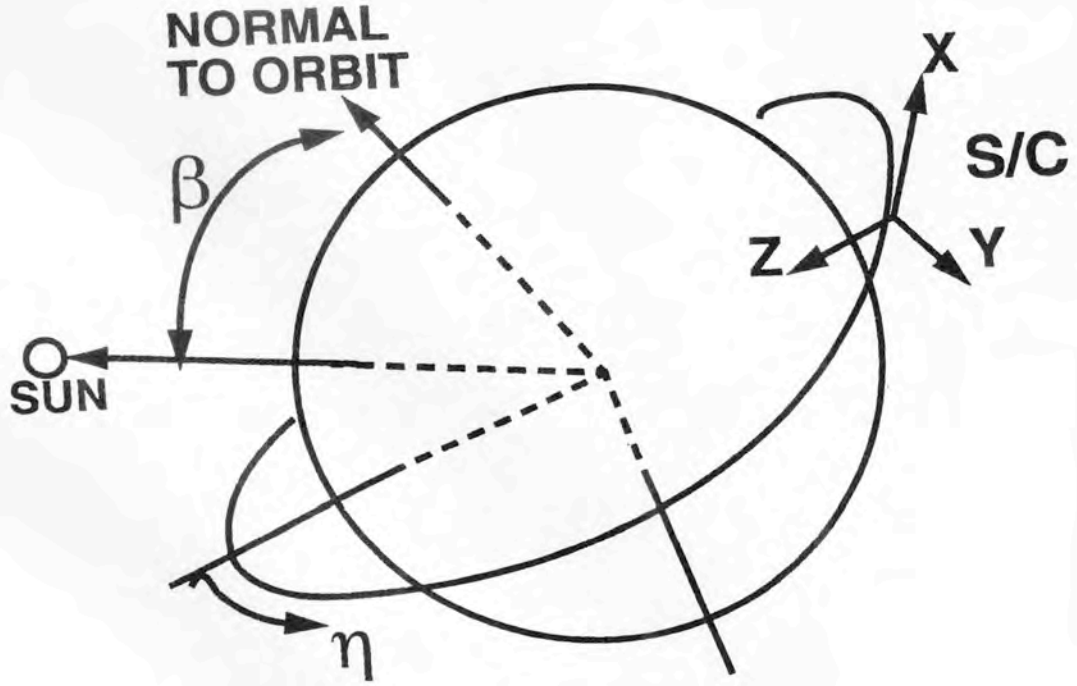
- The radiometer rotates from Earth viewing position every 14 days to look at Sun for short period for calibration.
- These solar calibration data are used to determine SW dome transmission, which is used to correct the SW fluxes.

Dome Transmission derived from Solar Calibration Data



- Recent ERBE studies indicate that this calibration method may not be sufficient to remove all instrument artifacts for cases with large non-uniform SW dome degradation.

NOAA 9 Sun-Synchronous Orbit



- The Sun is always on the same side of the NOAA 9 spacecraft and radiometer and this can lead to heavy non-uniform dome degradation

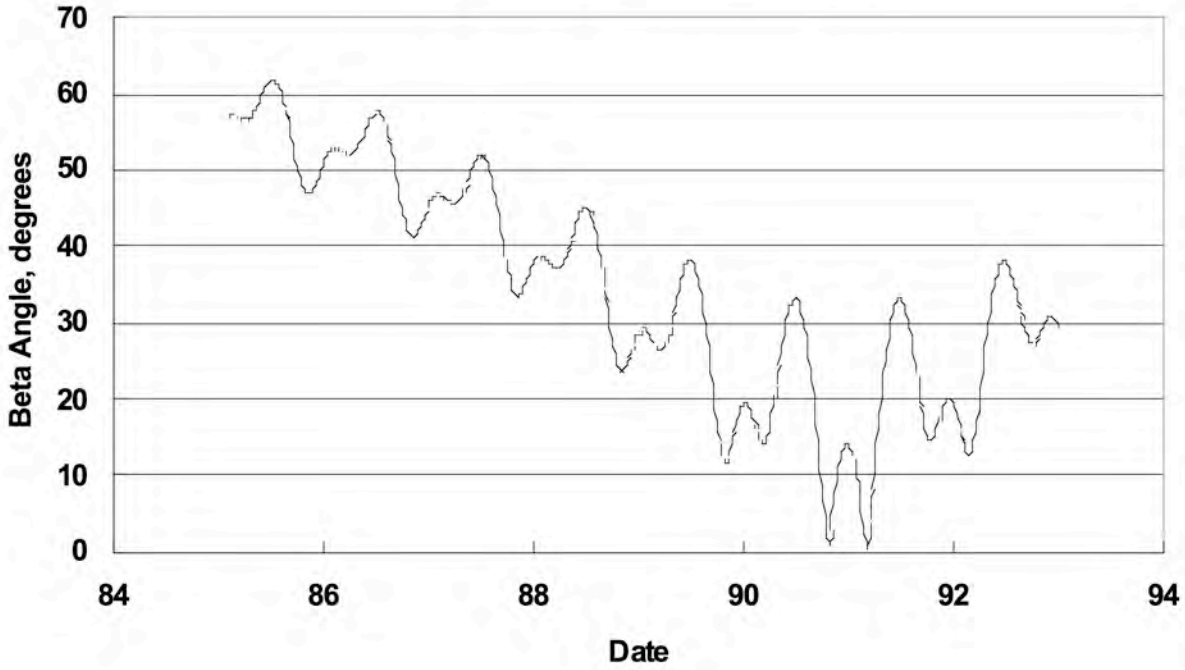
Model for Transmission Loss

- It is assumed that the transmission loss of the dome filter depends only on dosage of direct sunlight:

$$D(r,t) = \int_0^t h * n dt$$

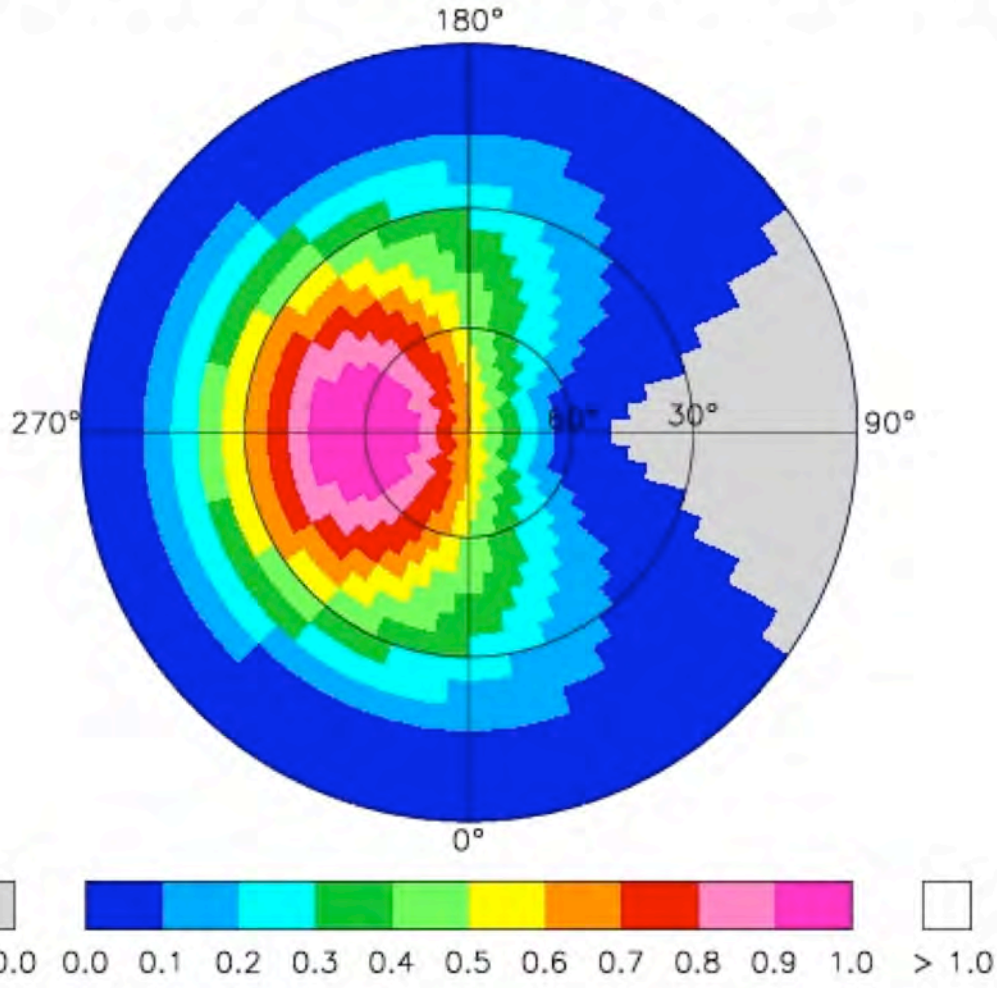
- Given the satellite beta angle history and the geometry of the ERBE WFOV instrument, the dosage can be computed.

Time Variation of Sun Relative to Orbit Plane

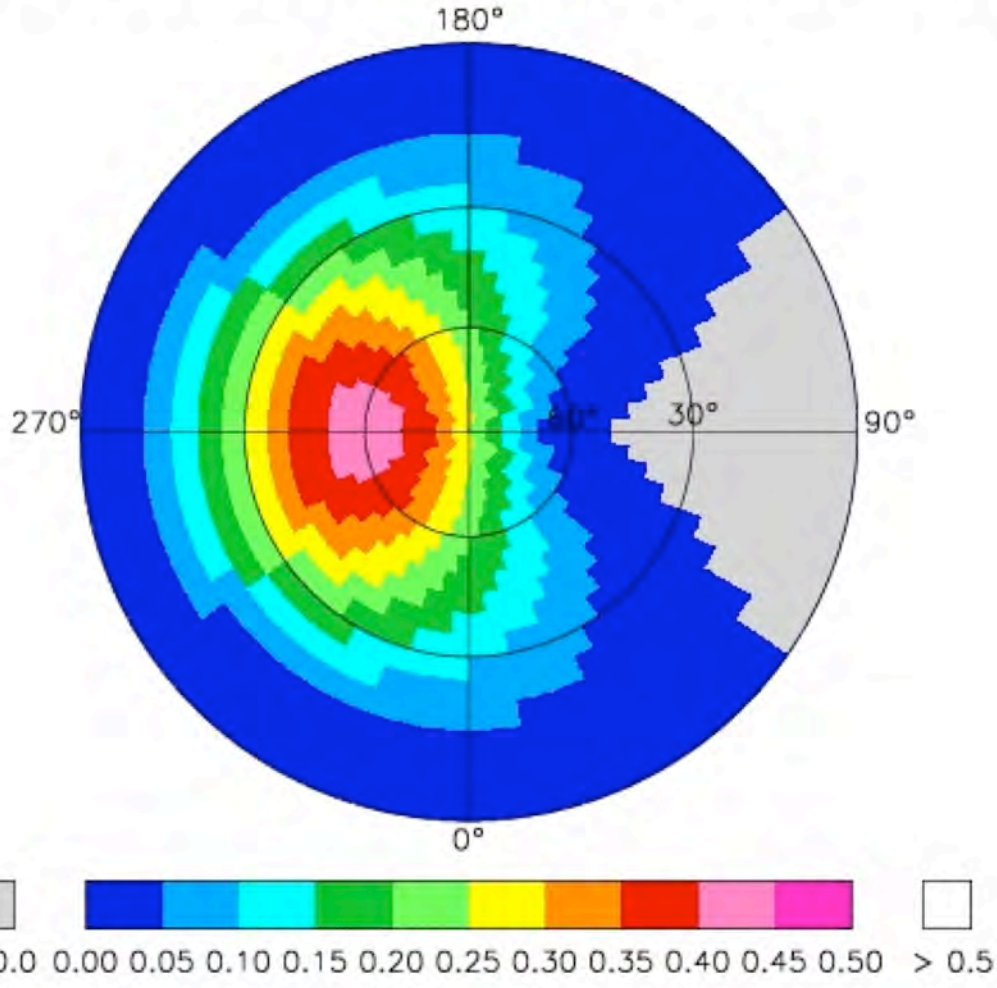


- BETA angle is the angle between the Earth-Sun vector and the normal to a satellite's orbital plane. This dictates how much sunlight the spacecraft receives per orbit

Normalized Dosage at Dec. 1992



Normalized Dosage at Dec. 1988



Next Steps

- Relate transmission loss from non-uniform dome degradation to calibration using solar dosage pattern information
- Apply new calibration results to the NOAA 9 WFOV data
- Validate the new NOAA 9 WFOV data with existing NOAA 9 ERBE scanner and ERBS scanner and WFOV data

Summary

- Historical NOAA-9 ERBE Nonscanner data may contain important climate change information in the polar region.
- Similar to ERBS ERBE Nonscanner dataset, the scientific value of the NOAA-9 ERBE WFOV data is in ability to track long term climate change over large region. It is not designed for small regional studies.
- However, there is currently a small instrument related issue that needs to be corrected.
- These Nonscanner data need to be updated before all ERBE experts retired; It will be difficult to improve these old data afterward.