



# Generation of the Daily OLR Climate Data Record

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# Outline

- Overview of NOAA Daily OLR CDR
- OLR Estimation Methods
- LEO-Geo Blending Process
- Validations/Evaluations Results
- Summary

# Product Description

## DAILY OLR CLIMATE DATA RECORD:

- Daily mean OLR
- $1^\circ \times 1^\circ$  equal-angle grid in global coverage
- Jan 1, 1979 – present
- Updated daily (two-day lag)

## OBSERVATIONAL DATA INPUT:

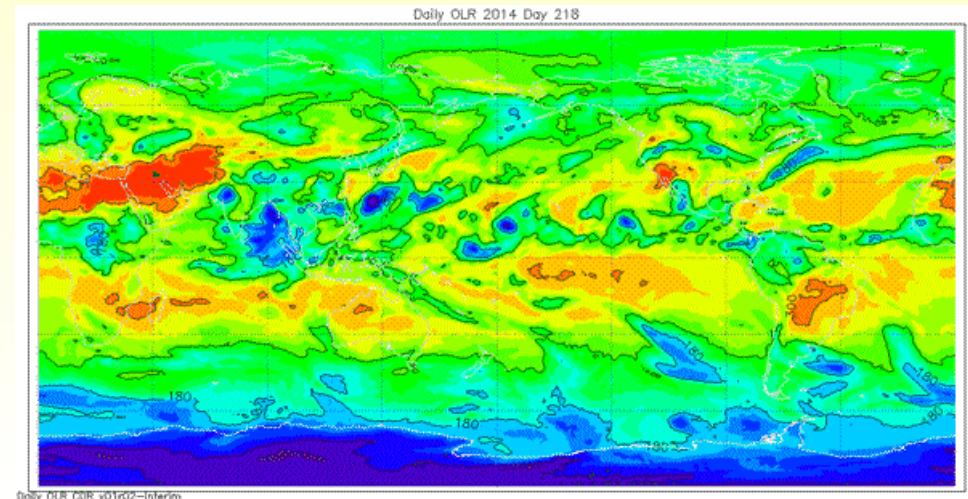
- HIRS Level-1b data
- Imagers observations via *Gridsat CDR* and NESDIS Geostationary Surface and Insolation (*GSIP*) products

## MANAGEMENT AND SPONSORSHIP

- NOAA CDR Program at NCDC

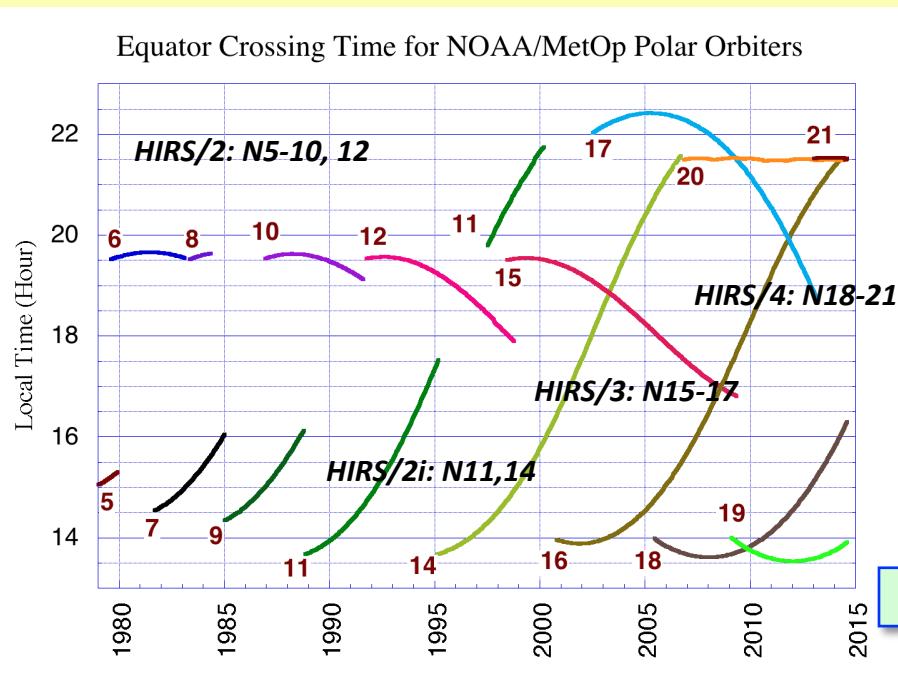
## APPLICATIONS

- Climate variability (Essential Climate Variable)
- Earth radiation budget studies
- Numerical model verification
- Precipitation estimate
- MJO and Monsoon diagnostics/forecast
- Tropical expansion studies

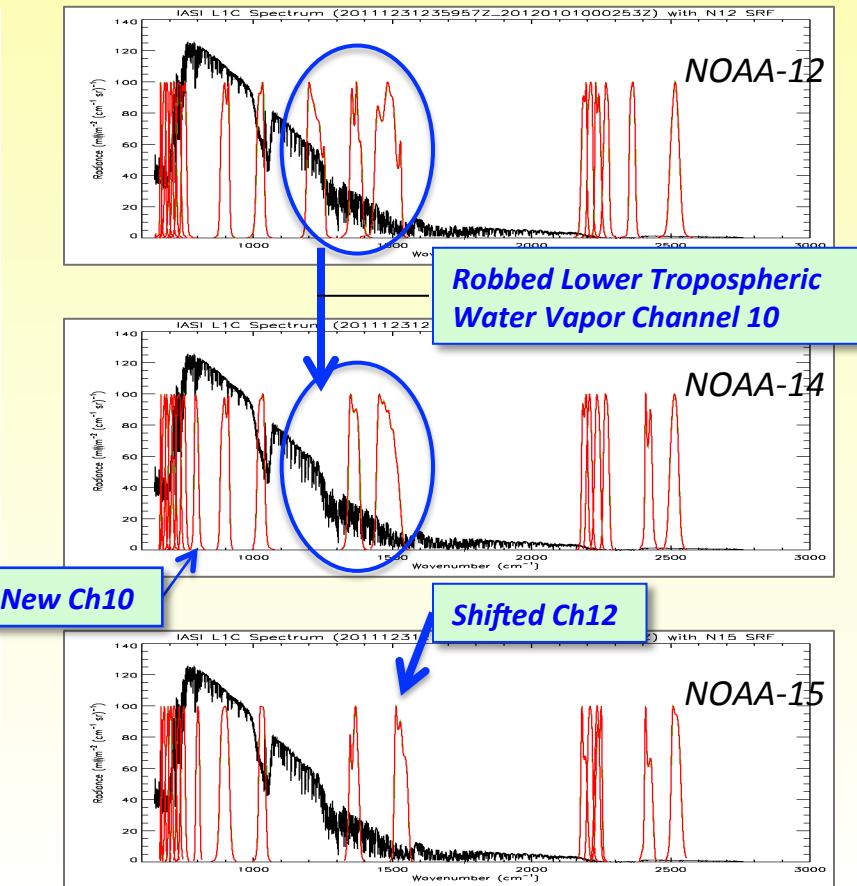


# **OLR Estimation Method**

# HIRS Observations



**HIRS on-board NOAA TIROS-N Series and Eumetsat MetOp A/B (since late 1978)**



# HIRS OLR Estimation Algorithm

Ellingson et al. (1989)

$$OLR = a_0(\theta) + \sum_i a_i(\theta) \cdot N_i(\theta)$$

V2.2  
(old)

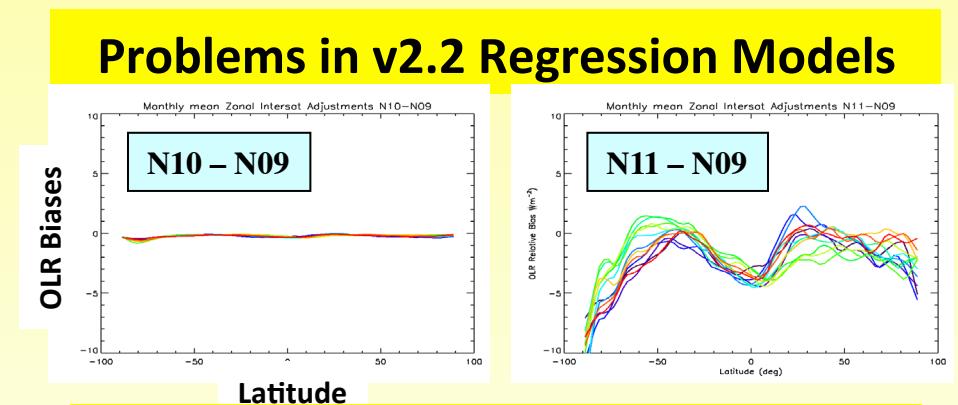
HIRS-2:  
Channels: 3, 7, 10, 12

HIRS-2I/3/4:  
Channels: 3, **10**, 11, 12

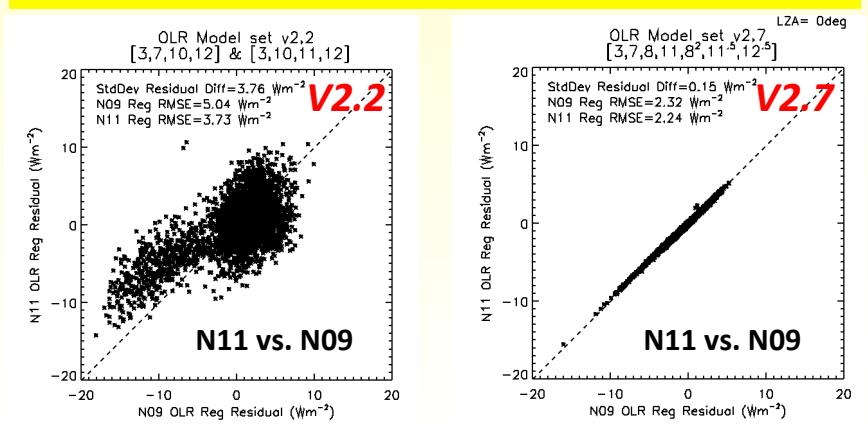
V2.7  
(new)

HIRS-2/2I/3/4:  
Predictors: 3, 7, 8, 11,  $8^2$ ,  $11^{0.5}$ ,  $12^{0.5}$

## Problems in v2.2 Regression Models



## V2.7 Improves Retrieval Consistency



# Gridsat Imager OLR Algorithm

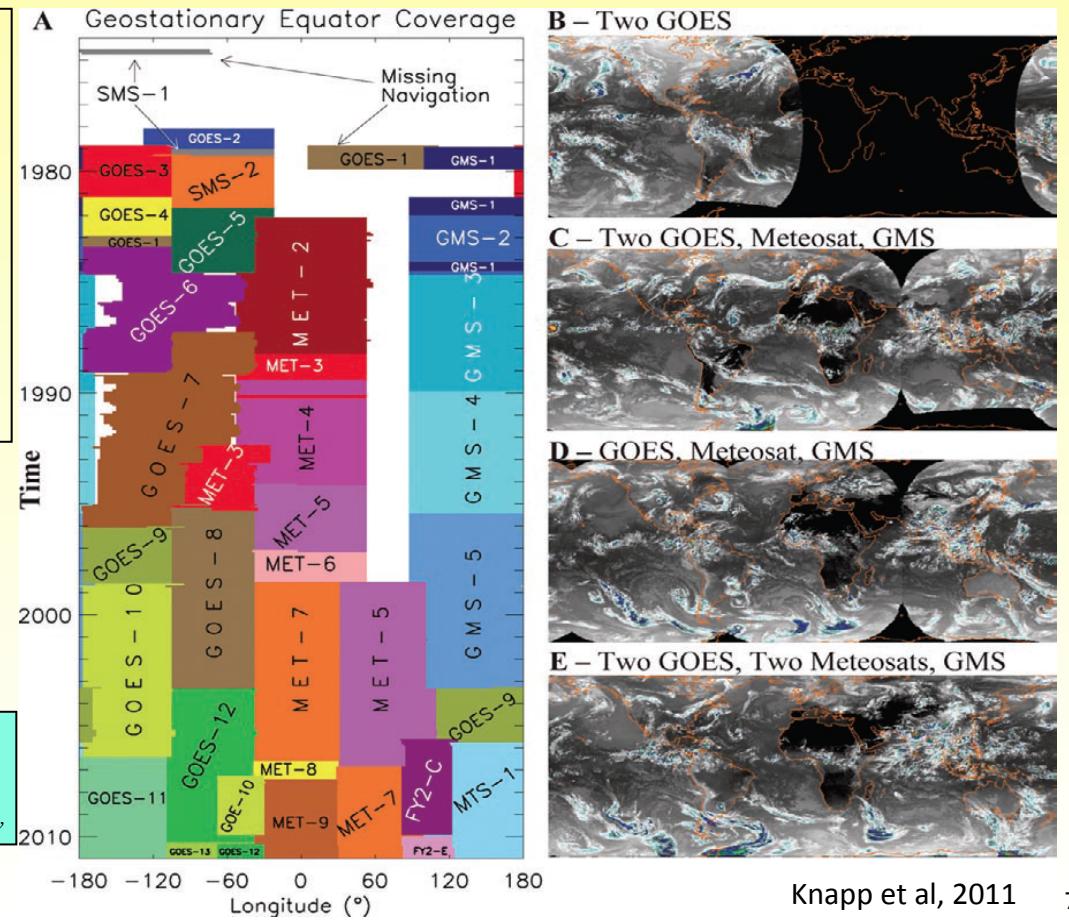
**Gridsat CDR Product (v02r01)** (Knapp et al, 2011) provides cross-calibrated brightness temperatures for the atmospheric window and  $\sim 6.7 \mu\text{m}$  water vapor channels, with limb correction, for 1980-2014. (Calibration reference is NOAA-14 HIRS channels 8 and 12).

[Refer <http://www.ncdc.noaa.gov/cdr>]

Adapted from Wark et al (1962)  
[cf. AVHRR OLR algorithm]

$$OLR = \sigma T_f^4$$

$$T_f^4 = (a_0 + a_1 T_{win}) \cdot T_{win} + (b_0 + b_1 T_{wv}) \cdot T_{wv}$$

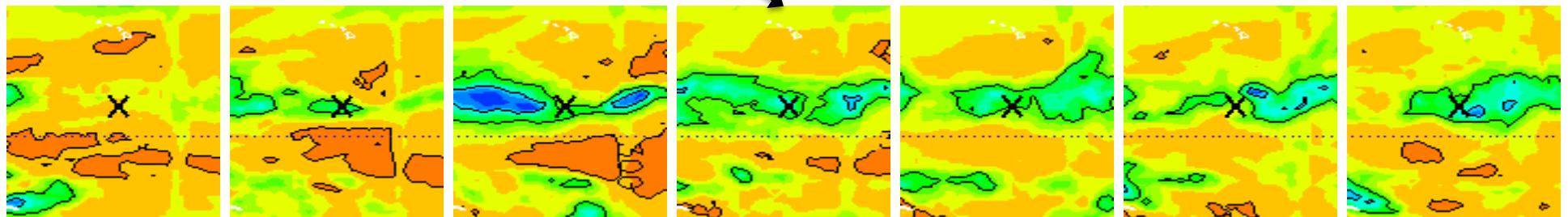
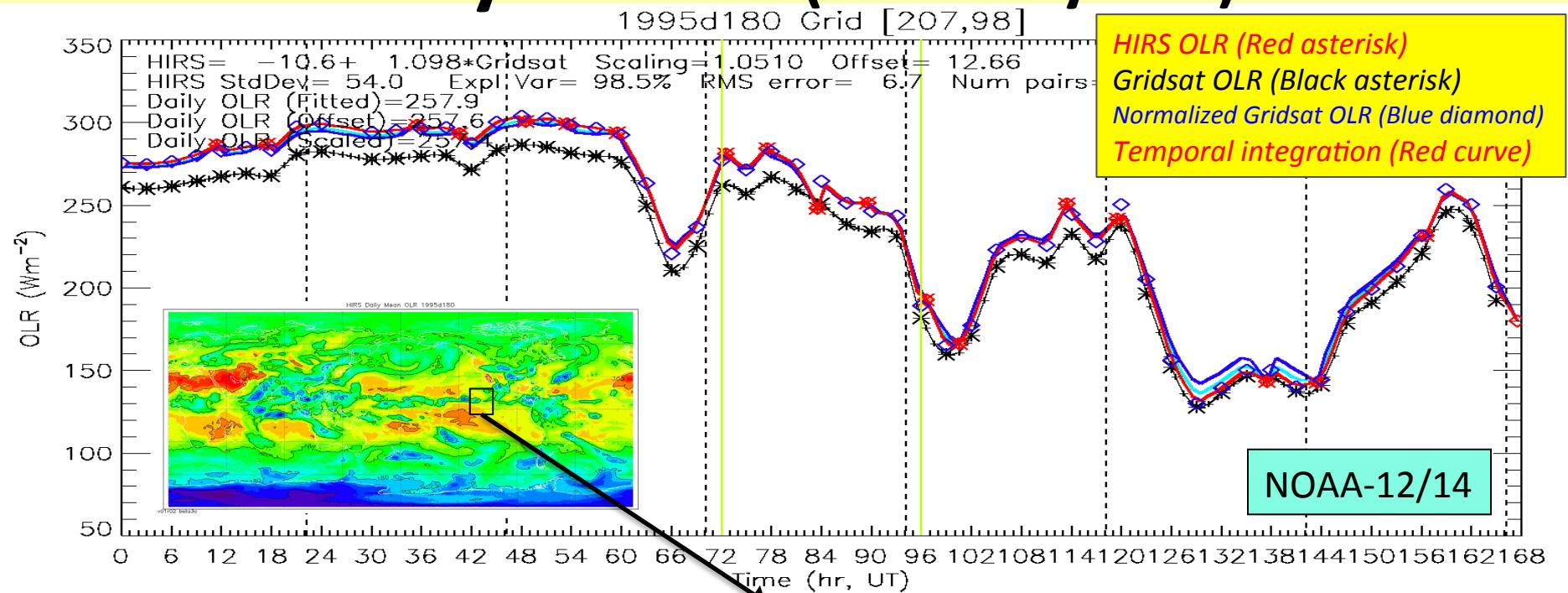


Knapp et al, 2011

# LEO-Geo Blending Process

*Radiative Normalization and  
Temporal Integration Schemes with  
the “Grid-based 7-day Boxcar”*

# 7-Day Boxcar (1995 day 180)



# Inter-comparisons

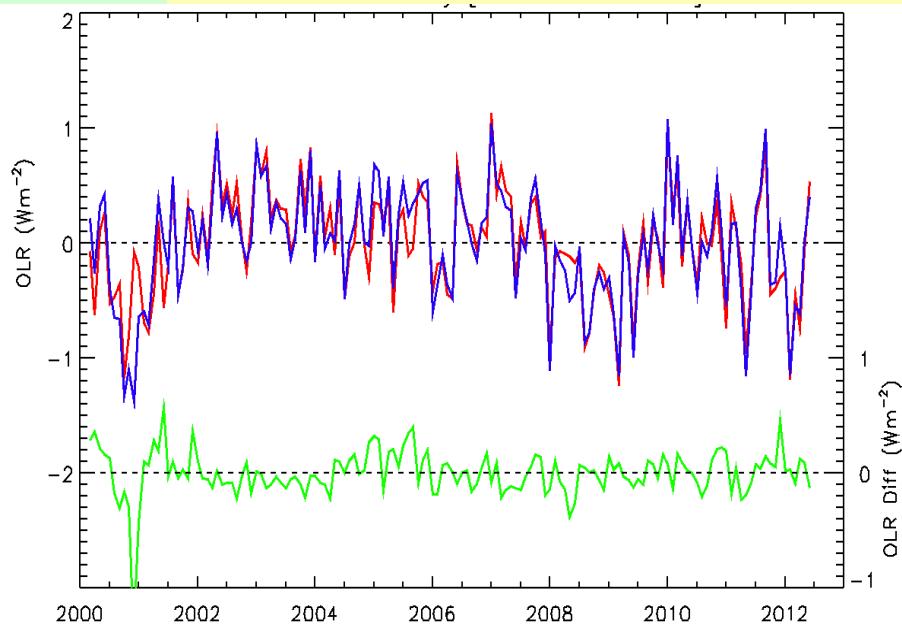
*Daily OLR CDR v01r02*

*vs.*

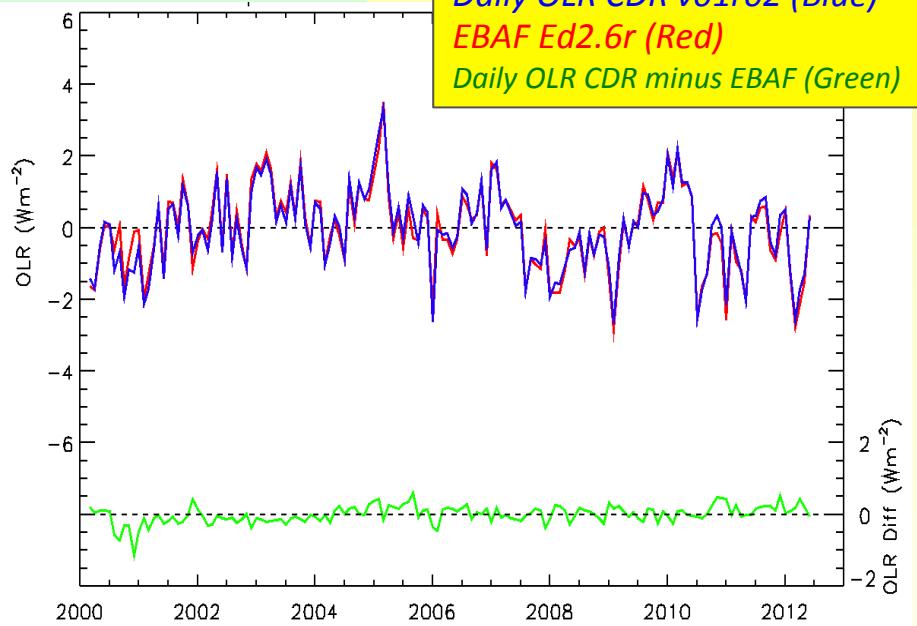
*CERES EBAF Ed2.6r & ERBS WFOV Ed3r1*  
*(in monthly means)*

# OLR Anomalies (Mar2000-Jun2012)

Global

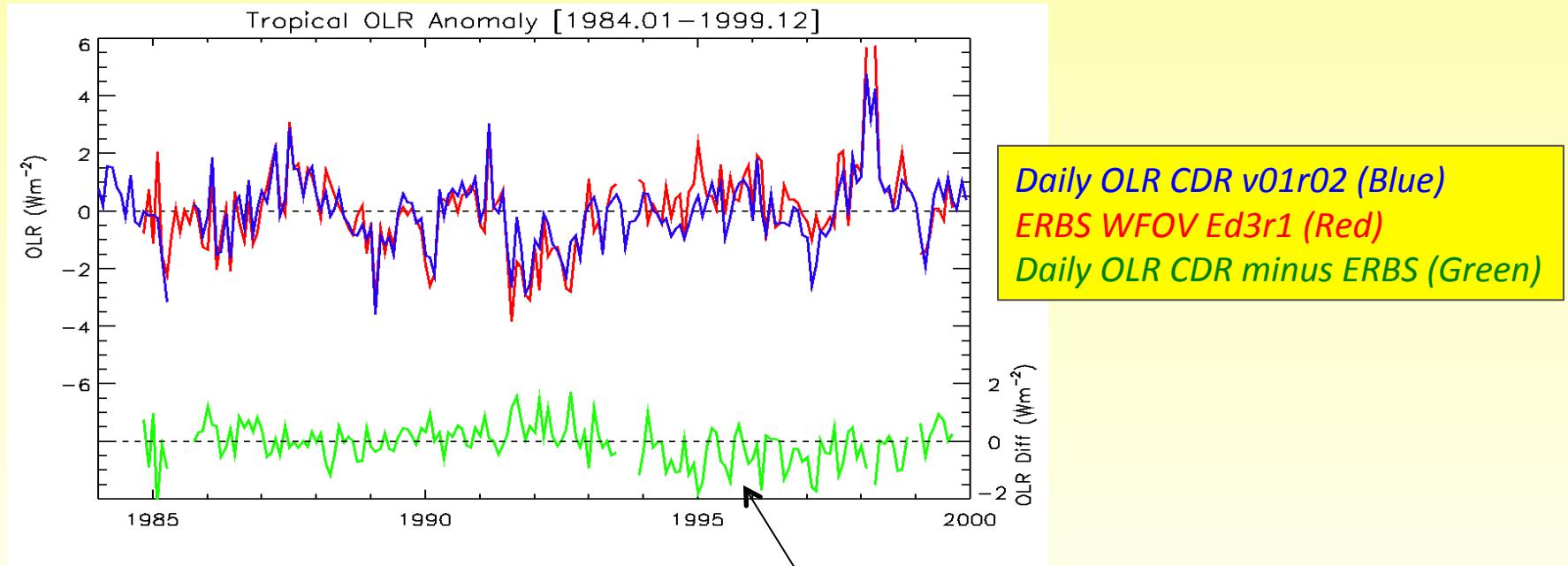


Tropical [20S-20N]



Slope of OLR anomalies differences:  
Global:  $0.03 \pm 0.09 \text{ Wm}^{-2}/\text{decade}$  with 2-sigma  
Tropical:  $0.28 \pm 0.10 \text{ Wm}^{-2}/\text{decade}$  with 2-sigma

# Tropical OLR Anomalies (1985-1999)



Slope of OLR anomalies diff =  $-0.34 \pm 0.24 \text{ Wm}^{-2}/\text{decade}$  with 2-sigma

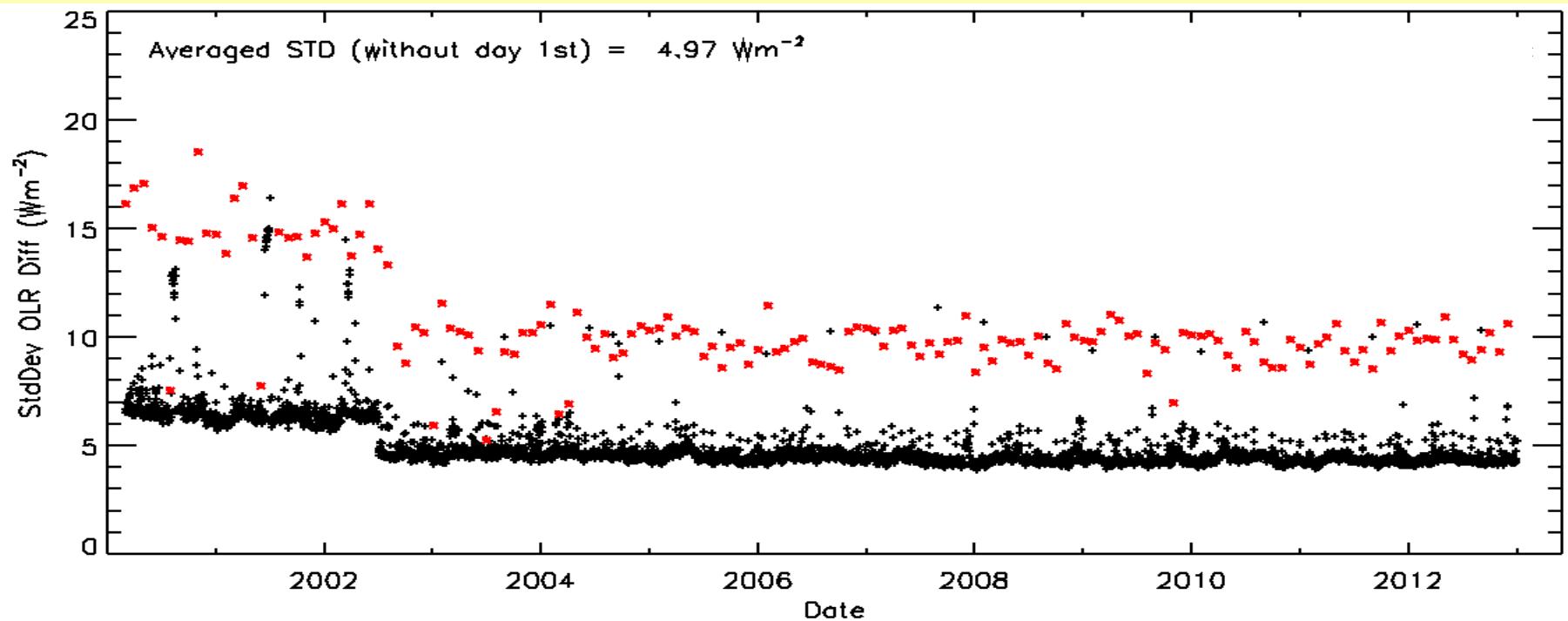
# Inter-comparisons

*Daily OLR CDR v01r02*

*vs.*

*CERES SYN1deg Ed3A  
(in daily means)*

# STD of Global Daily OLR Differences

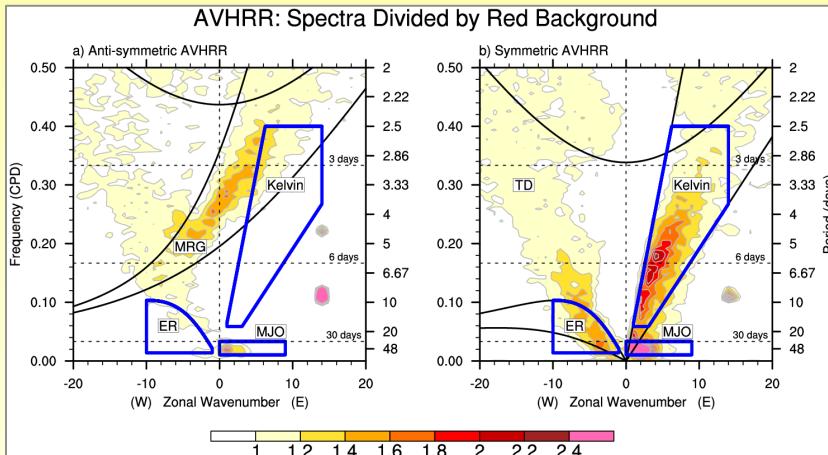


- Time series ‘shock’ due to CERES sampling change when Aqua entered in July 2002.
- Processing bug near the beginning of each month (red points) in SYN1deg Ed3A.

# **MJO & Tropical Waves**

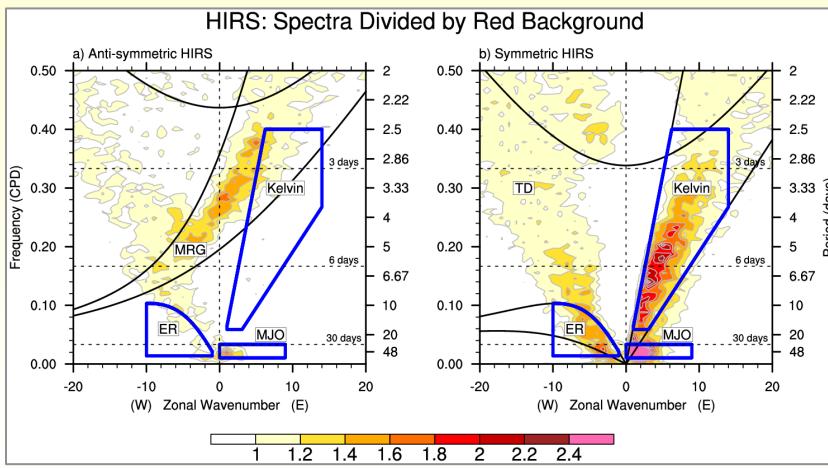
# Wheeler-Kiladis Space-Time Spectra

**ESRL AVHRR OLR**



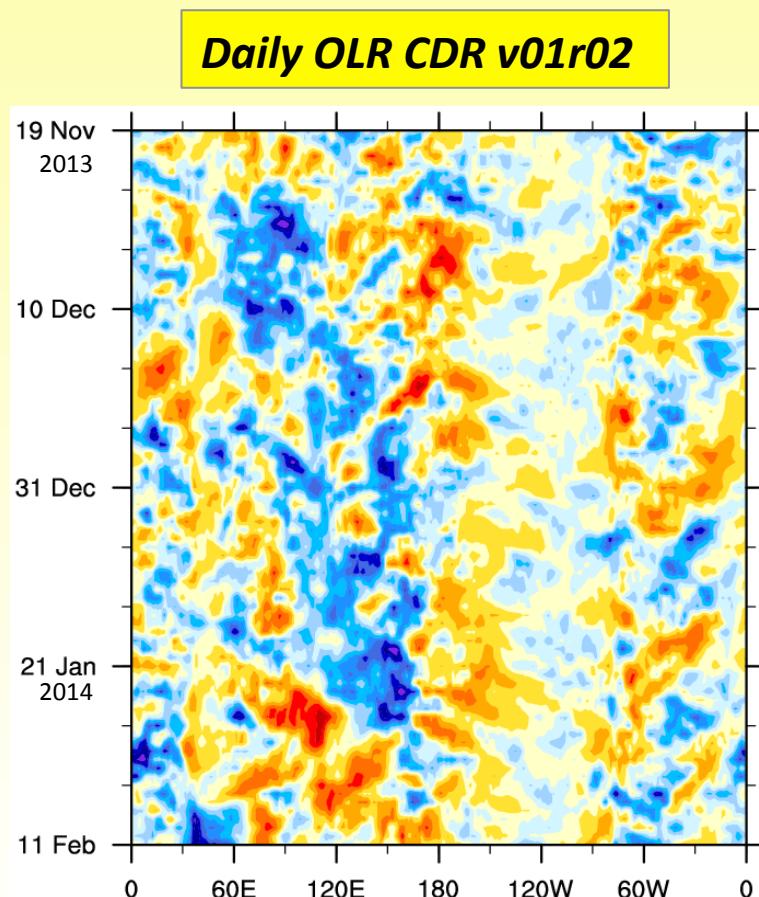
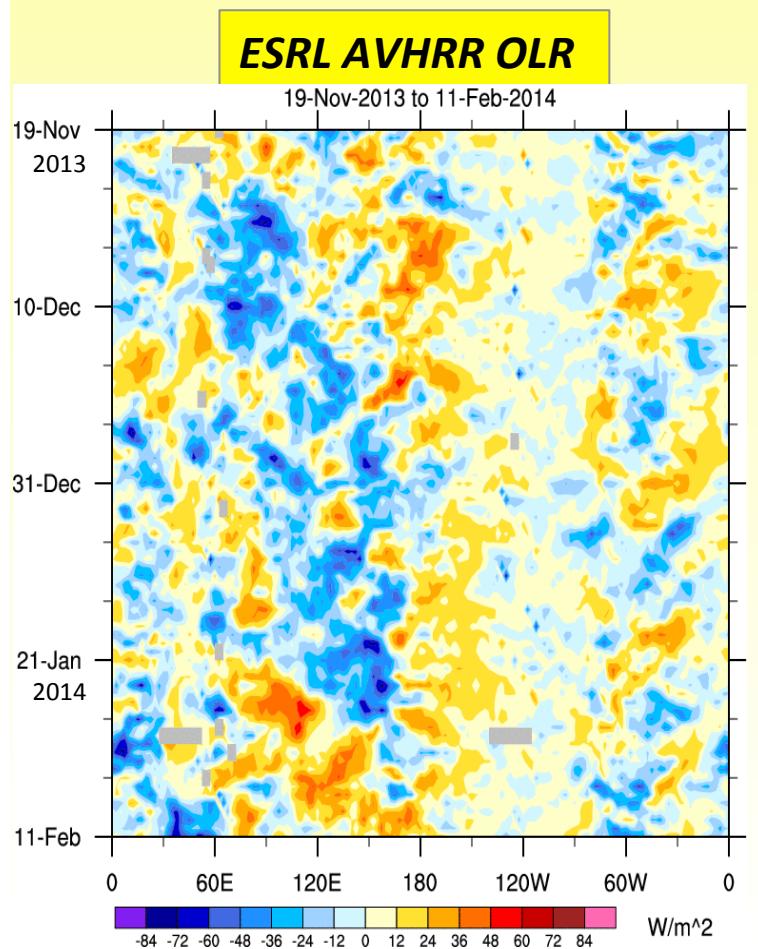
Spurious signals at wavenumber 14 with period 4.5 and 9 days are seen in the power spectra of **ESRL AVHRR OLR**.

**Daily OLR CDR**  
v01r02



*Inclusion of geostationary data in **Daily OLR CDR** eliminates aliasing from the orbital precession of the polar-orbiters.*

# Hovmöller Diagram for OLR Anomalies 7.5°S-7.5°N



**Daily OLR CDR** shows more distinct signals due to higher spatial resolution and higher precision attributed to the better OLR estimation and the explicit accounting of diurnal variations.

# Final Remarks

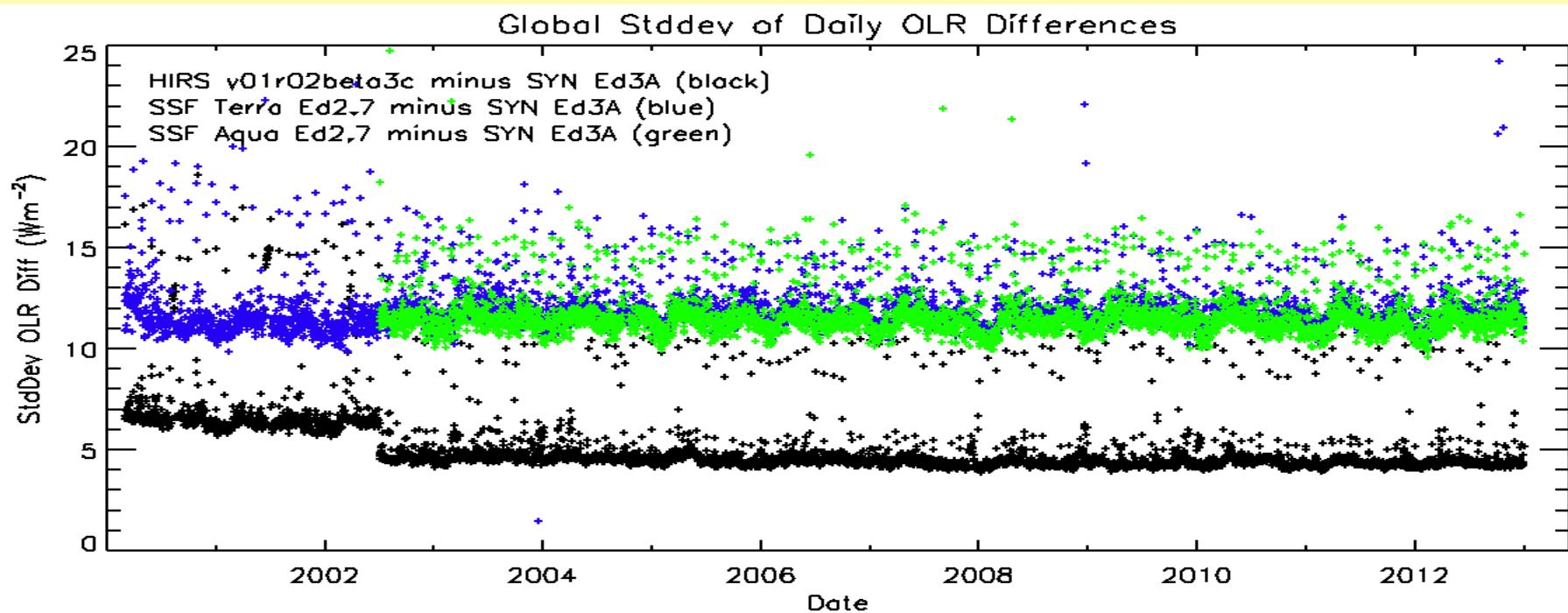
- New 1°x1° Daily OLR CDR product for 1979 to present
  - Major enhancements & improvements over previous Monthly OLR CDR
  - Full synergy of LEO and GEO taking advantages of both observing systems
  - Operational production with a 2-day lag. Visit <http://OLR.UMD.EDU>
- Quality Control evaluations
  - Well compared to CERES EBAF, SYN1deg and ERBS WFOV OLR products
  - Possible local artifacts (around 1995). Missing days (~250) to be filled.
- Recommend replacement of AVHRR OLR (tropical dynamics)
- **Future works:** Use of **IASI** and **CrIS** for OLR time series extension (seeking supports and collaborations)

# Acknowledgments

- NOAA Climate Data Record Program
- Data Centers:
  - NOAA NCDC CLASS
  - NASA LaRC ASDC
- *Robert G. Ellingson, Arnold Gruber, Istvan Laszlo, Vladimir Kondratovich*
- *CERES Scientist Team*

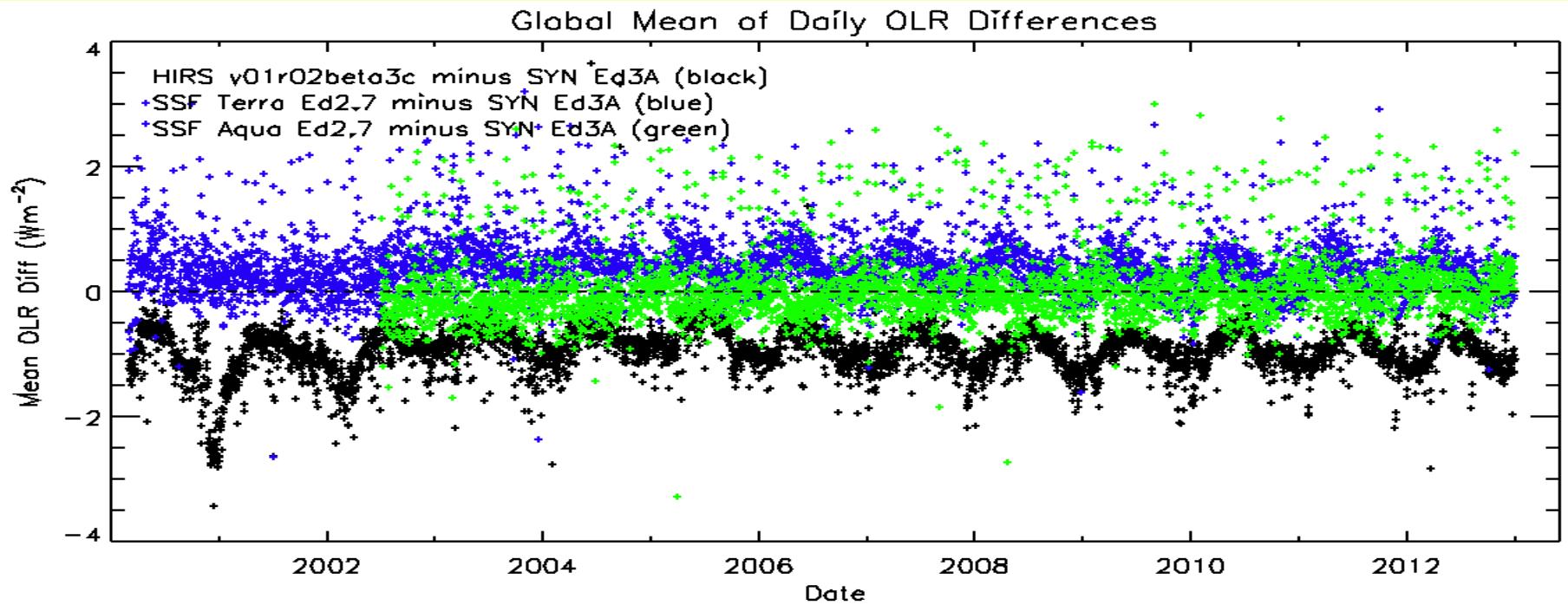
# **Backup Slides**

# STD of Global Daily OLR Differences



- StdDev of CERES SSF minus CERES SYN OLR are about  $12 \text{ Wm}^{-2}$
- StdDev of Daily OLR CDR minus CERES SYN OLR are about  $5 \text{ Wm}^{-2}$

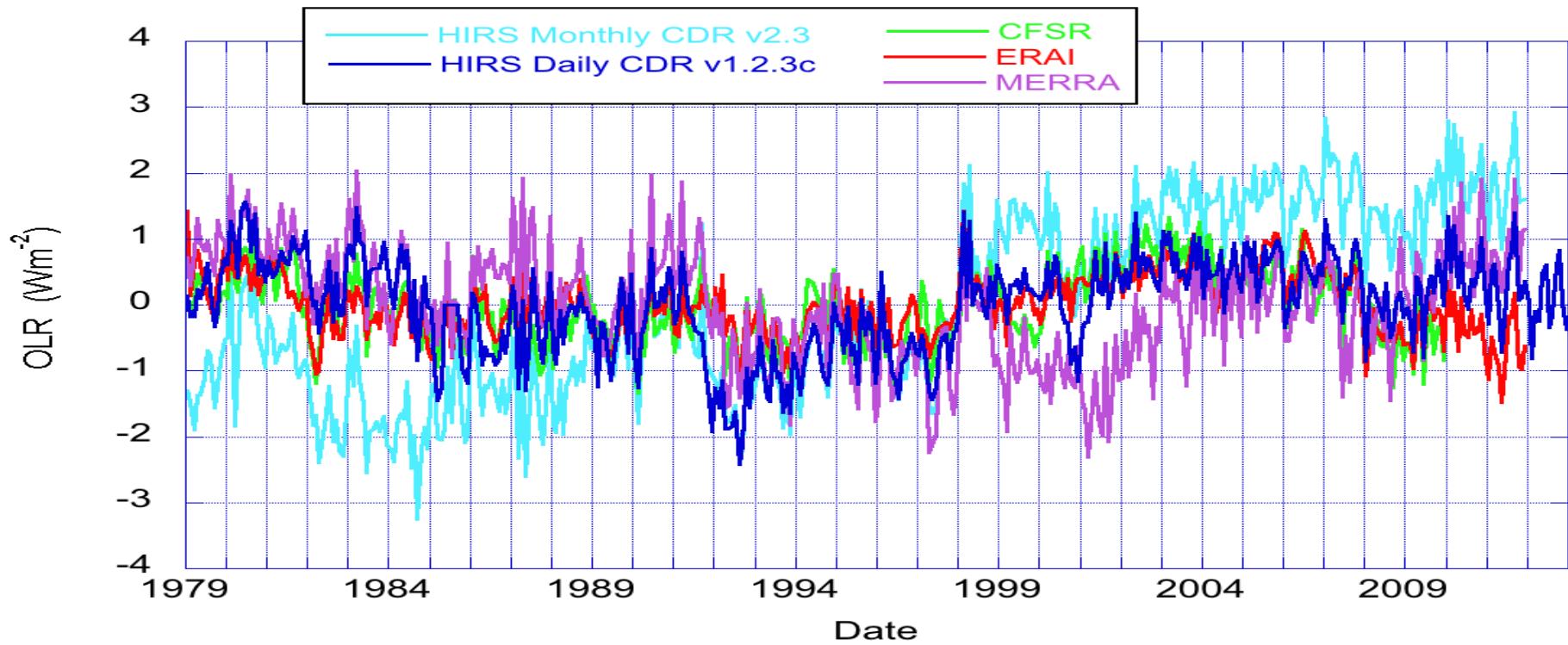
# Mean of Global Daily OLR Differences



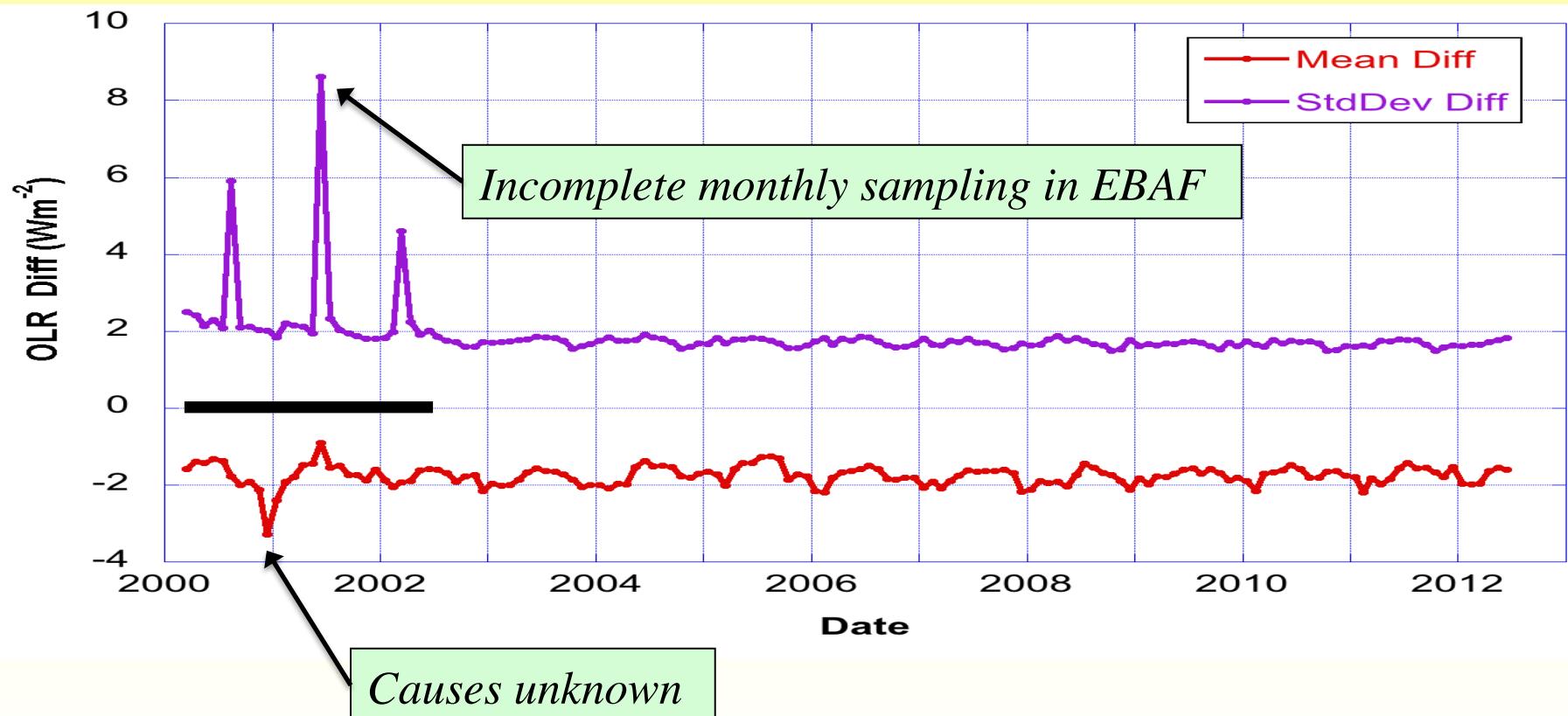
- *HIRS-SYN diff are well within CERES LW 1.5% uncertainty*
- *Global mean OLR diff vary seasonally in a range of about 1  $\text{Wm}^{-2}$  in both HIRS and SSF data relative to SYN.*

# Global Monthly OLR Anomalies

## 1979-2012

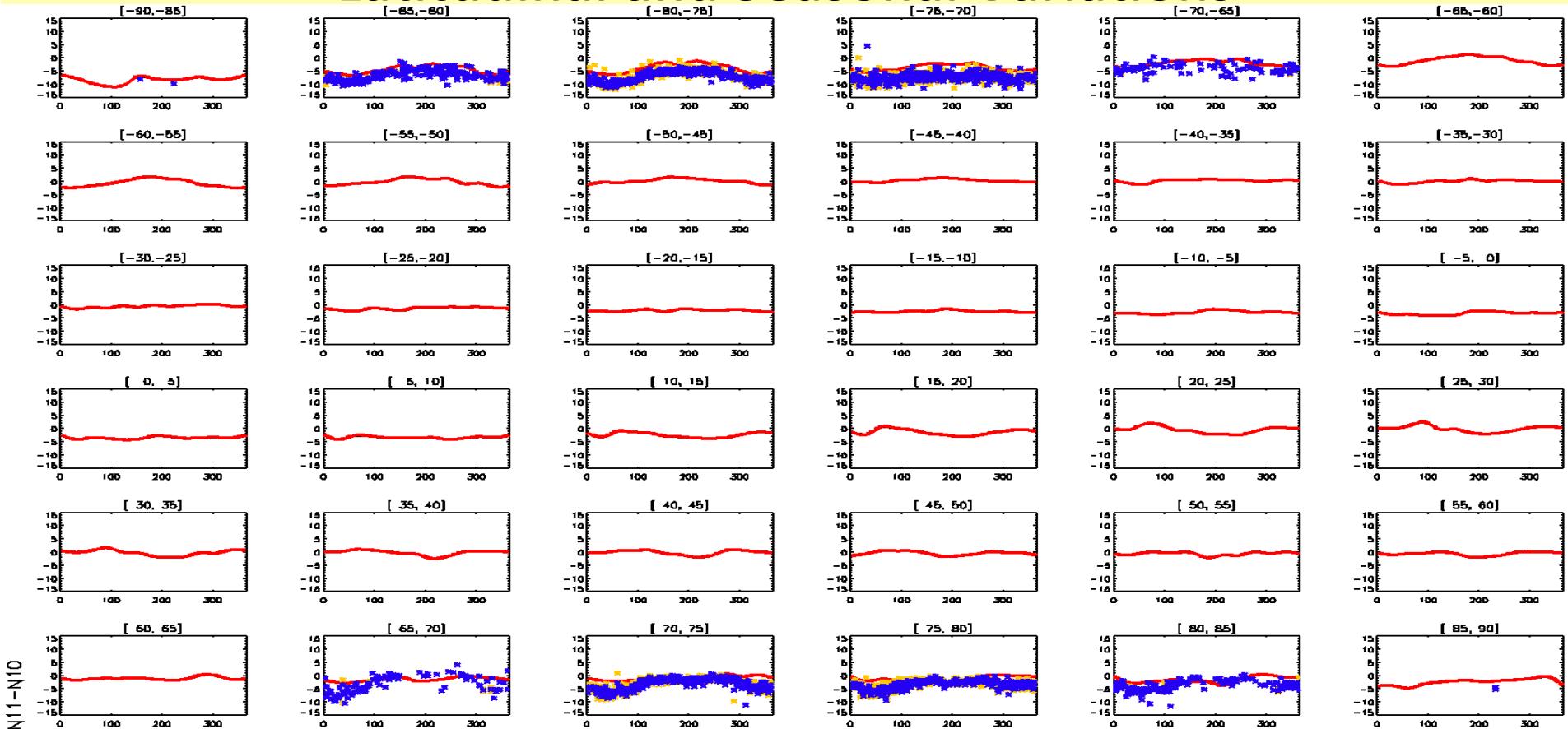


# HIRS-EBAF Global Monthly OLR Differences 2000-2012



# OLR Relative Bias for N11-N10

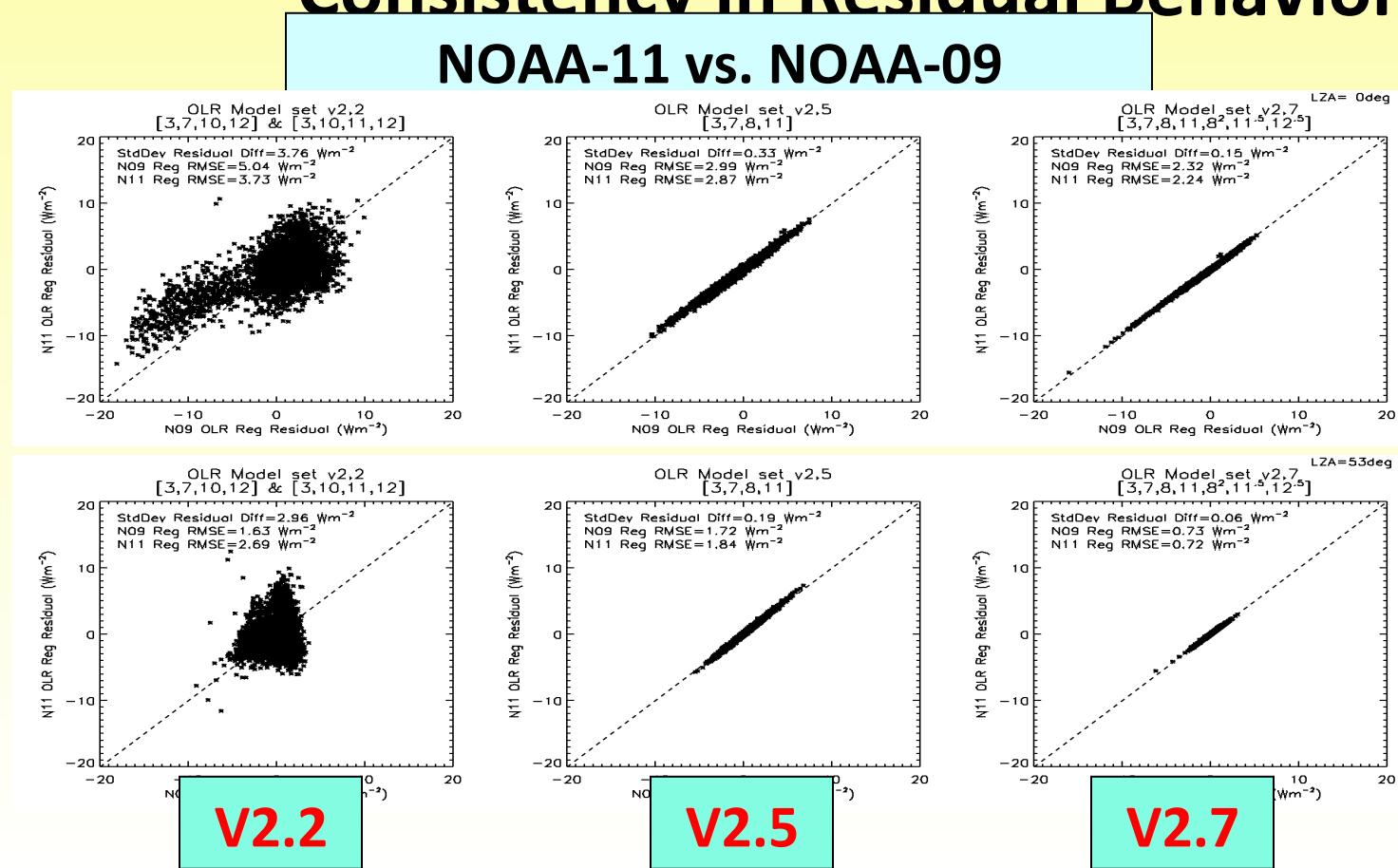
## Latitudinal and Seasonal Variations



# Improvement in OLR Models

## Consistency in Residual Behavior

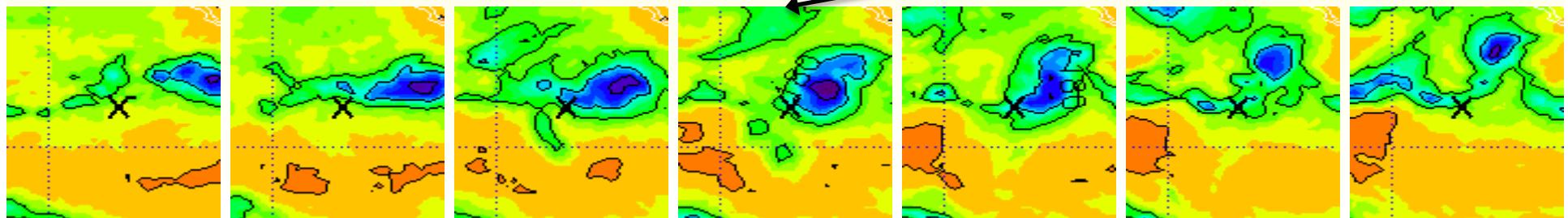
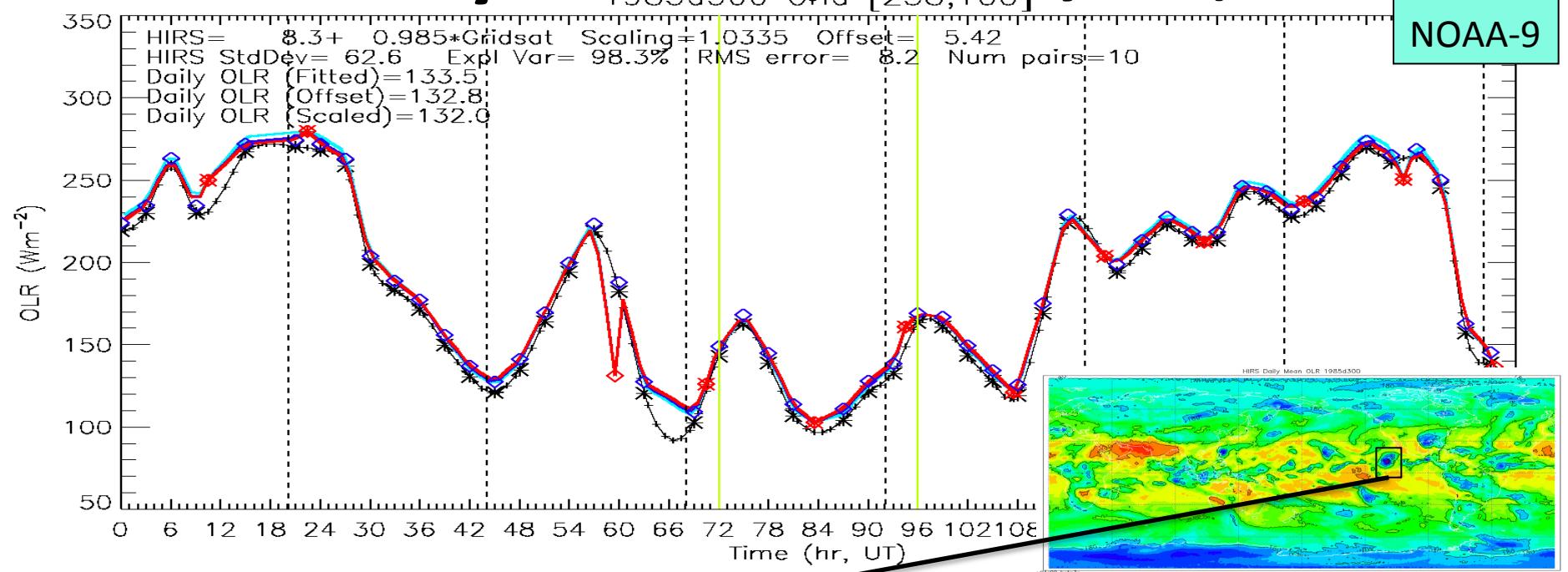
### NOAA-11 vs. NOAA-09



**LZA=0°**

**LZA=53°**

# 7-Day Boxcar (1985 day 300)



## **Abstract**

A long time series of the daily mean outgoing longwave radiation (OLR) data set at one by one-degree resolution has been produced for the period of 1979 to 2012 as a new product to be released and operationally maintained by the US Climate Data Record (CDR) Program. This data set is an important contribution to the climate change studies and monitoring as well to the atmospheric dynamics applications. This data set was generated with the radiance observations from infrared sensors onboard multi-national operational environmental satellites of both polar-orbiting and geostationary types. Accurate OLR is retrieved using the multi-spectral algorithm (Ellingson et al, 1989) with the High-resolution Infrared Radiation Sounder (HIRS) radiance observations. The OLR diurnally resolving information is derived from the Gridsat CDR product, which provides the inter-calibrated Imager observations from a collection of geostationary satellites since 1980. A blending method is designed to calibrate the Imager-based OLR to the HIRS OLR on the regional and dynamical bases. The resulting daily mean OLR time series maintains the same radiometric level of the HIRS OLR retrievals with an internally 3-hourly resolving power for its diurnal variations. This new data set brings significant enhancement and improvement over the existing Monthly OLR CDR product.