HIRS Daily OLR Climate Data Record Development and Evaluation

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Overview

- **New 1°x1° Daily OLR CDR (v01r02 beta3c) 1979-2012**:
  - **HIRS** onboard NOAA and ESA operational polar-orbiting satellites
  - **Imagers** onboard multi-national geostationary satellites
- **Revised OLR regression models** – improve retrieval consistency; greatly reduced inter-satellite calibration errors; increased OLR time series stability
- **LEO/GEO Blending** - Imager OLR is normalized to HIRS OLR in a *grid-by-grid 7-day boxcar*
- **Significant improvements** - Spurious trend in global mean OLR previously shown in current HIRS Monthly OLR CDR was removed.

OLR Estimation Method

Multi-spectral HIRS OLR Algorithm

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

a_i=regression coefficients

Ellingson et al. (1989)

Old:

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

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

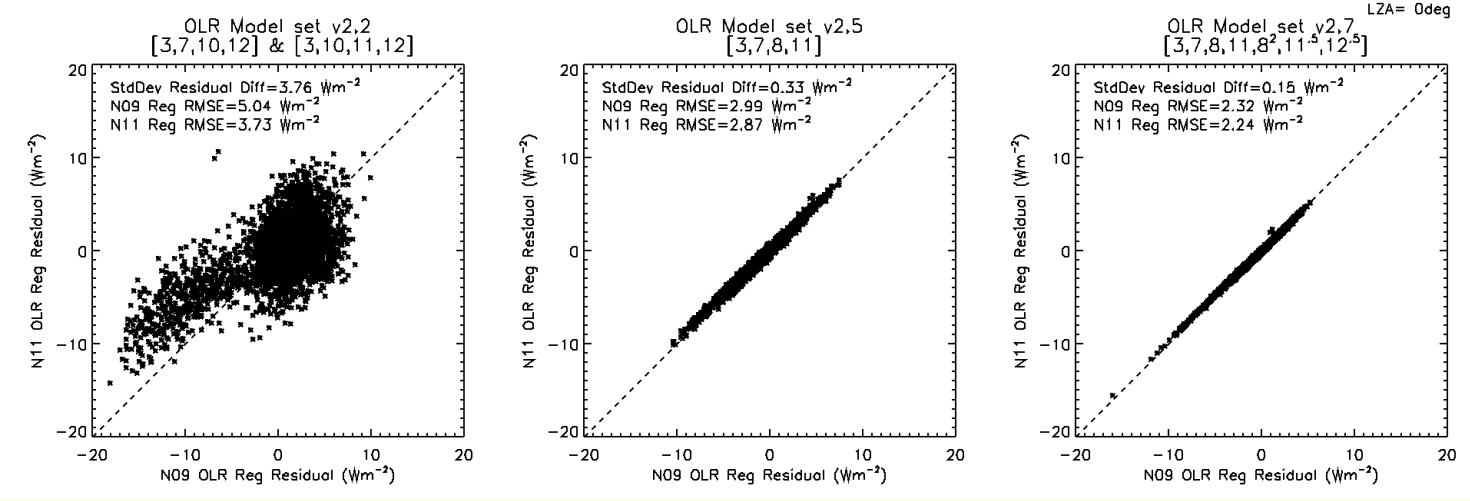
New:

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

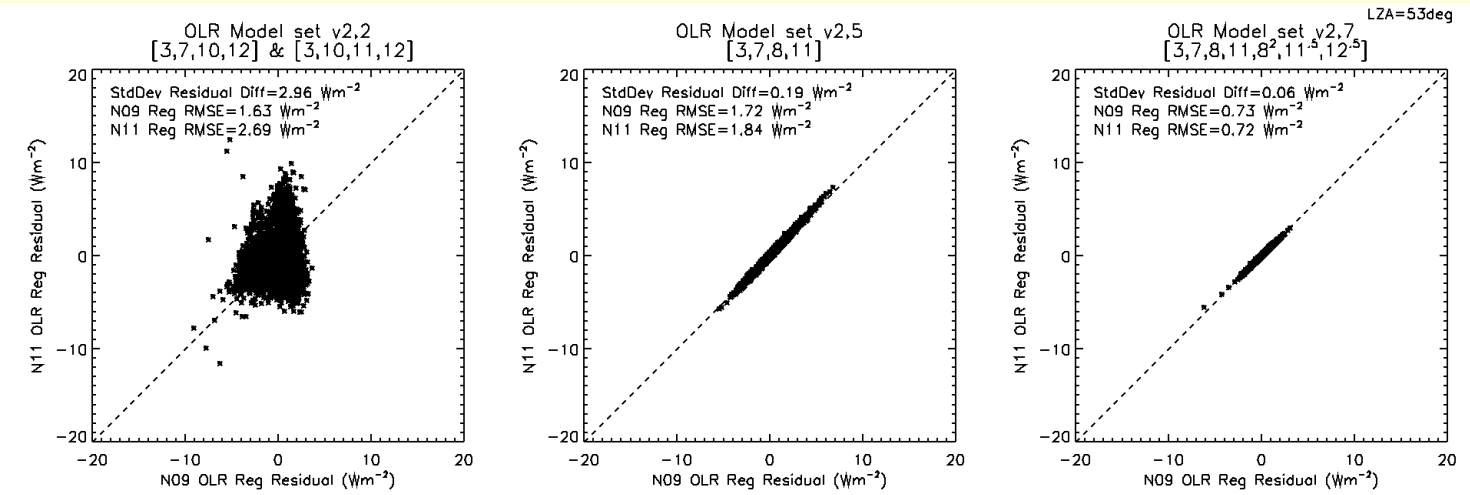
Improvement in OLR Models

Consistency in Residual Behavior

NOAA-11 vs. NOAA-09



LZA=0°



LZA=53°

Old

New

Imager OLR Algorithm

$$OLR = \sigma T_f^4$$

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

a_i, b_i=regression coefficients

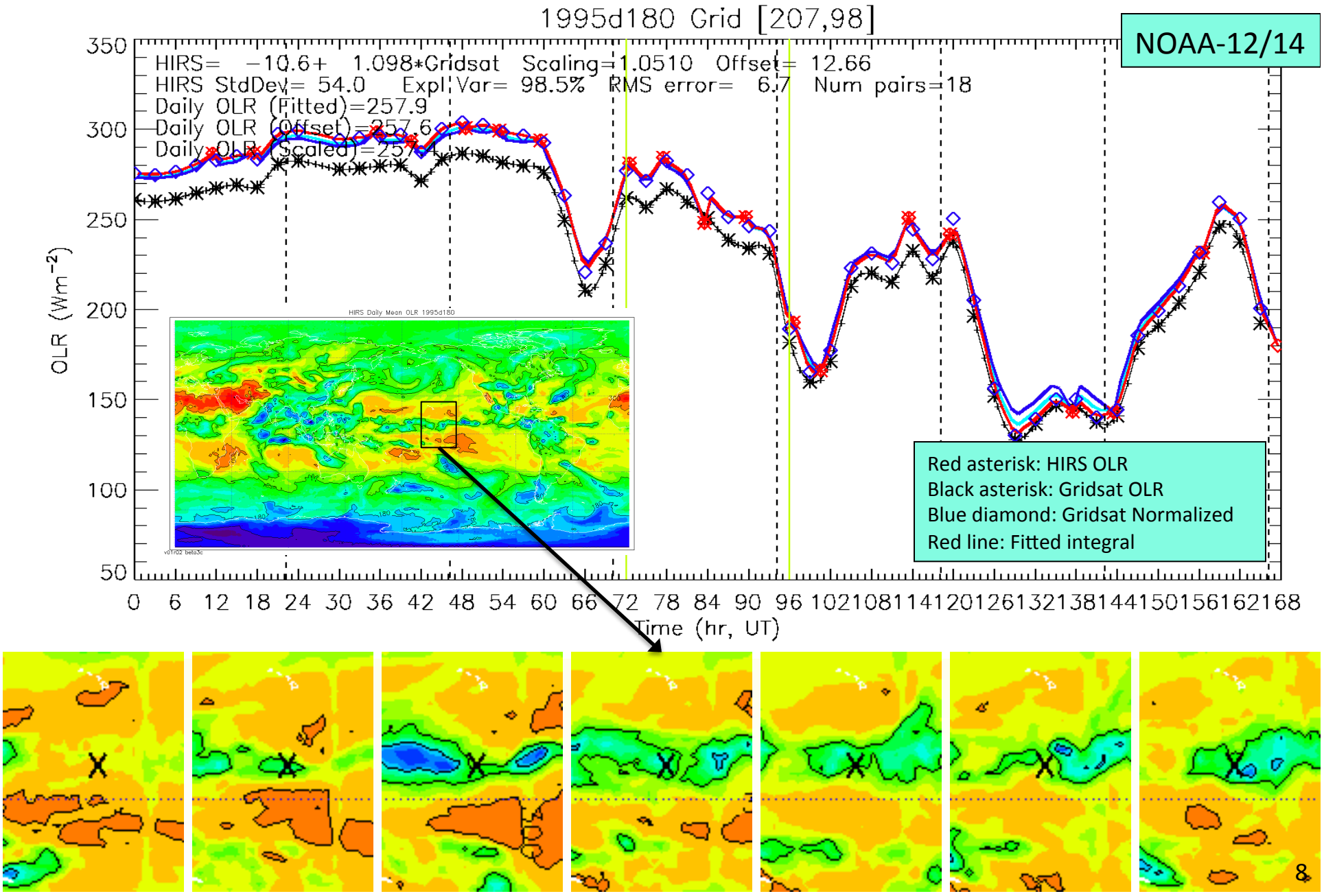
Adapted from Wark et al (1962)

Gridsat CDR Product (v2.2) *(Knapp et al, 2011) provides cross-calibrated brightness temperatures for the atmospheric window and ~6.7 μm water vapor channels, with limb correction applied, for 1980-2012. (Calibration reference is NOAA-14 HIRS channels 8 and 12).*

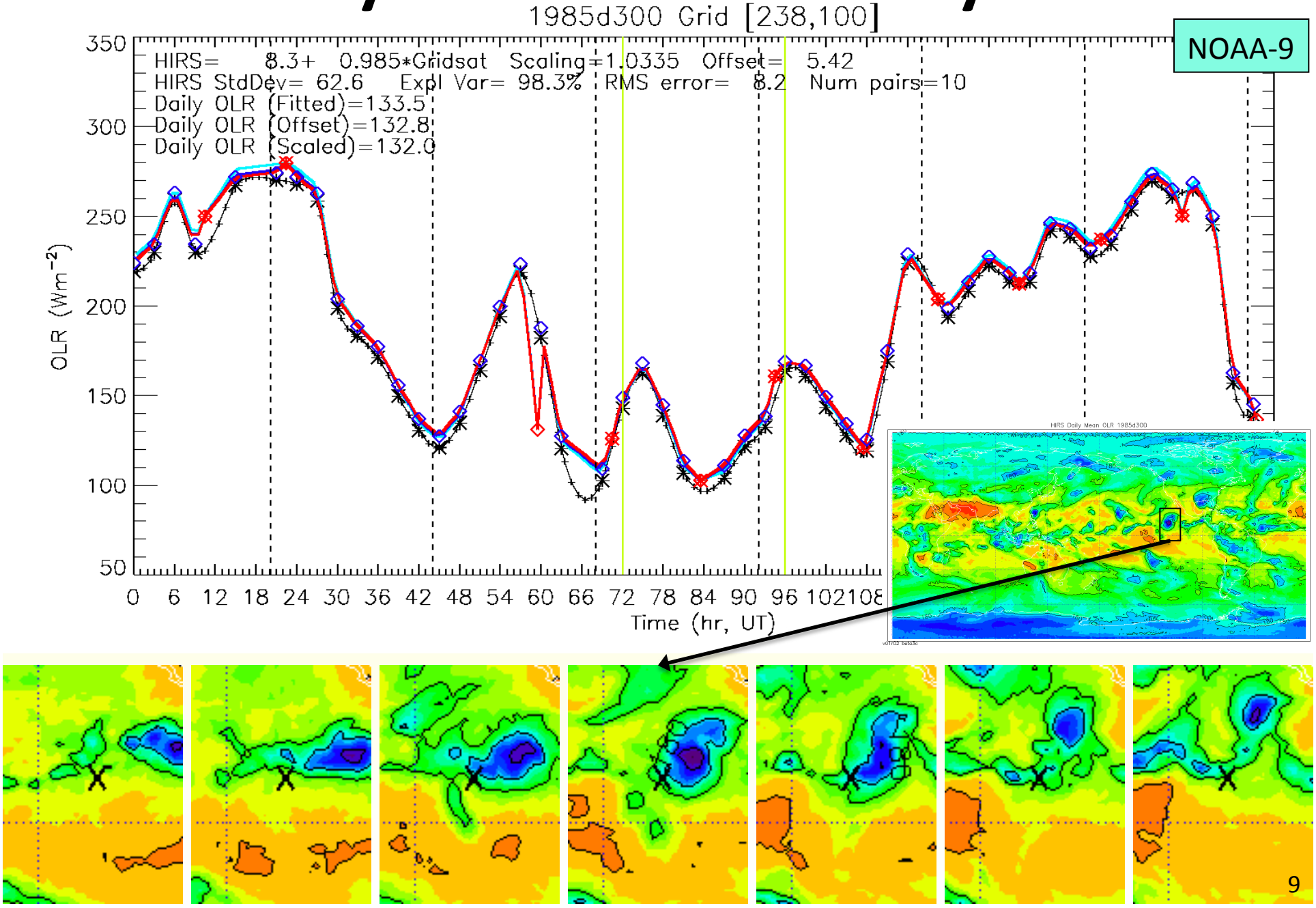
Radiometric Normalization and Temporal Integration Schemes

"Grid-based 7-day Boxcar"

7-day Boxcar for 1995day180



7-day Boxcar for 1985day300



Inter-comparison

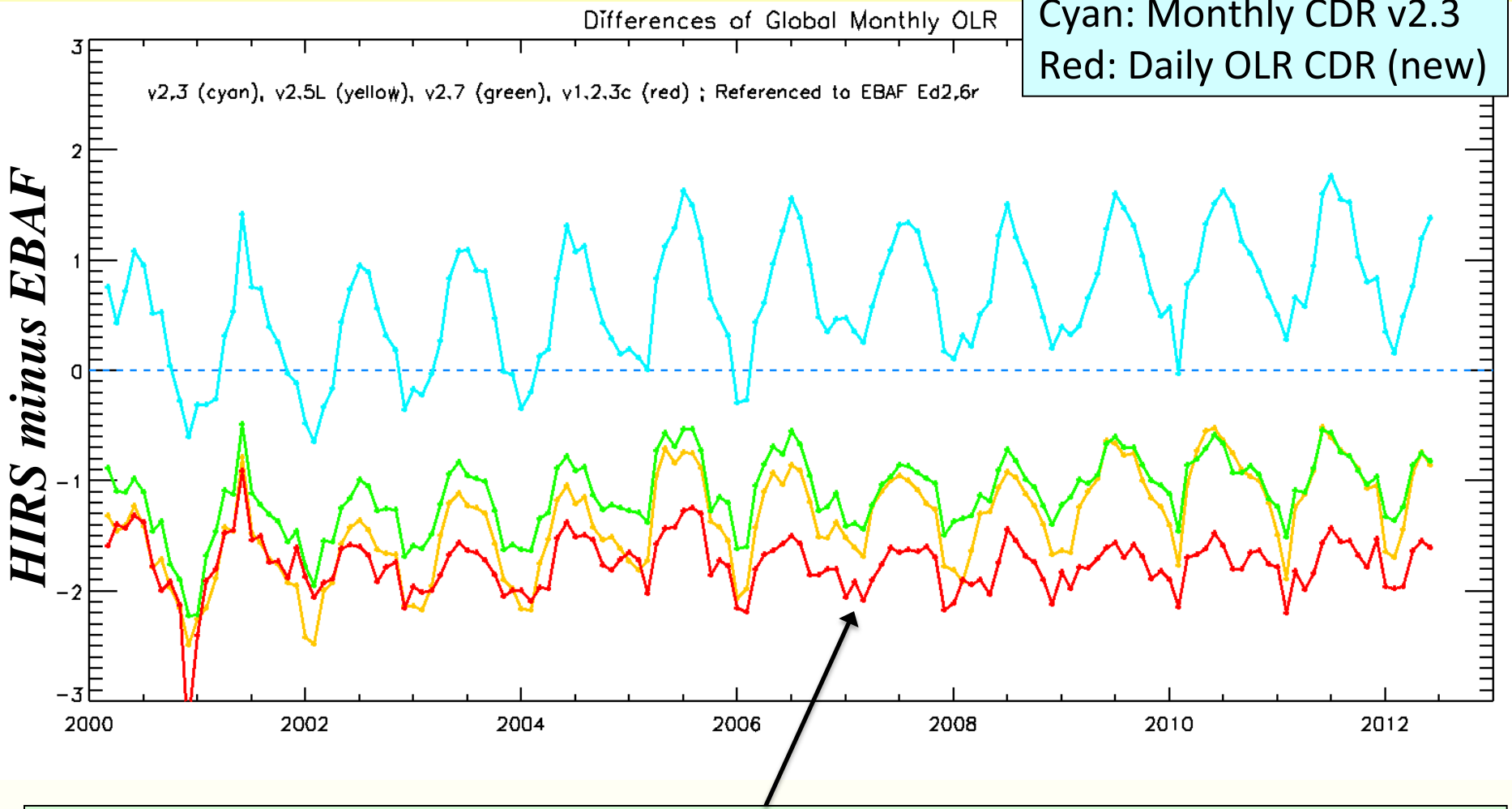
HIRS Daily OLR CDR

vs.

EBAF Ed2.6r

(in monthly means)

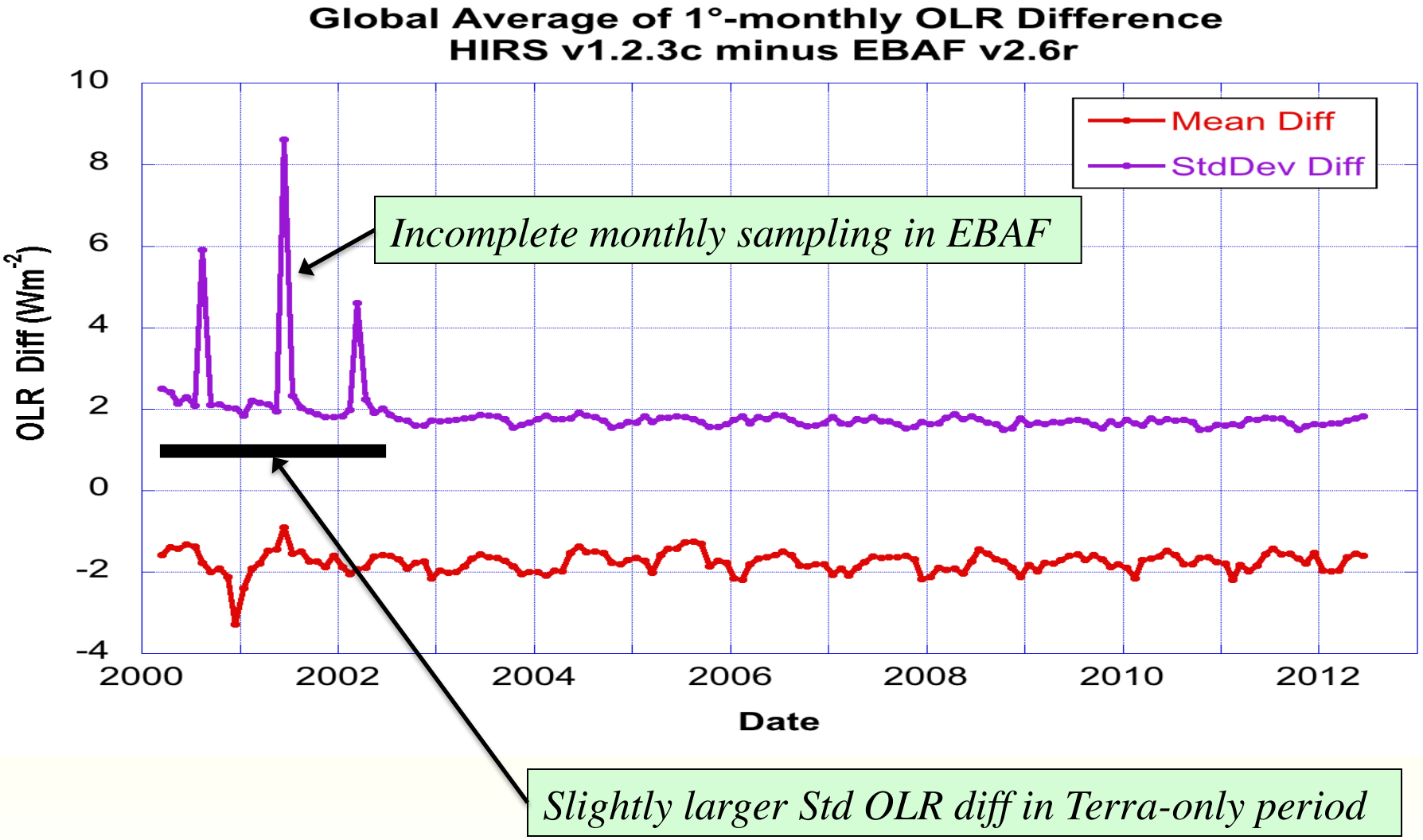
Global Monthly OLR Differences 2000-2012



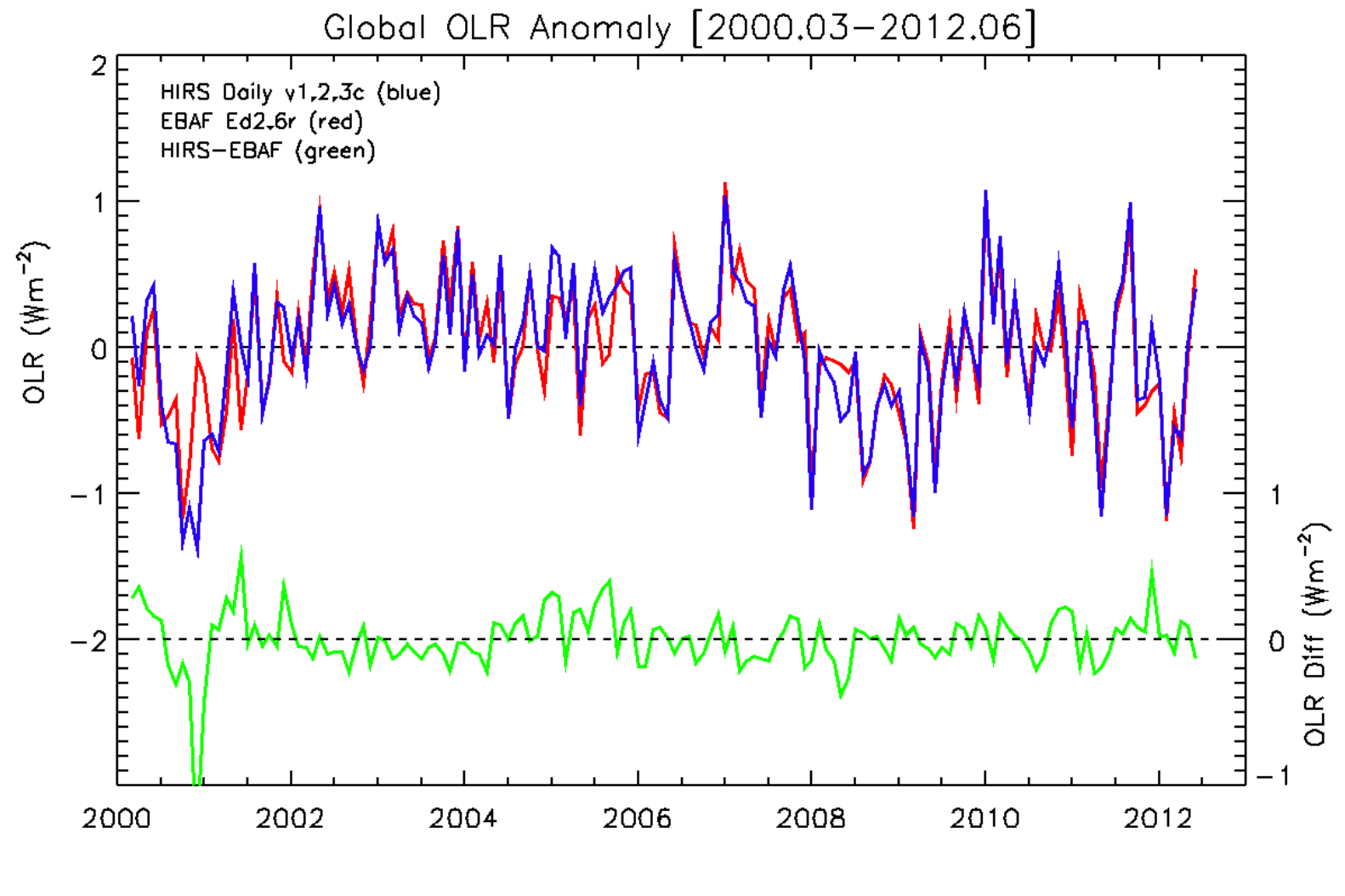
Cyan: Monthly CDR v2.3
Red: Daily OLR CDR (new)

Much improved agreement in annual cycle between HIRS and EBAF

HIRS-EBAF Global Monthly OLR Differences 2000-2012

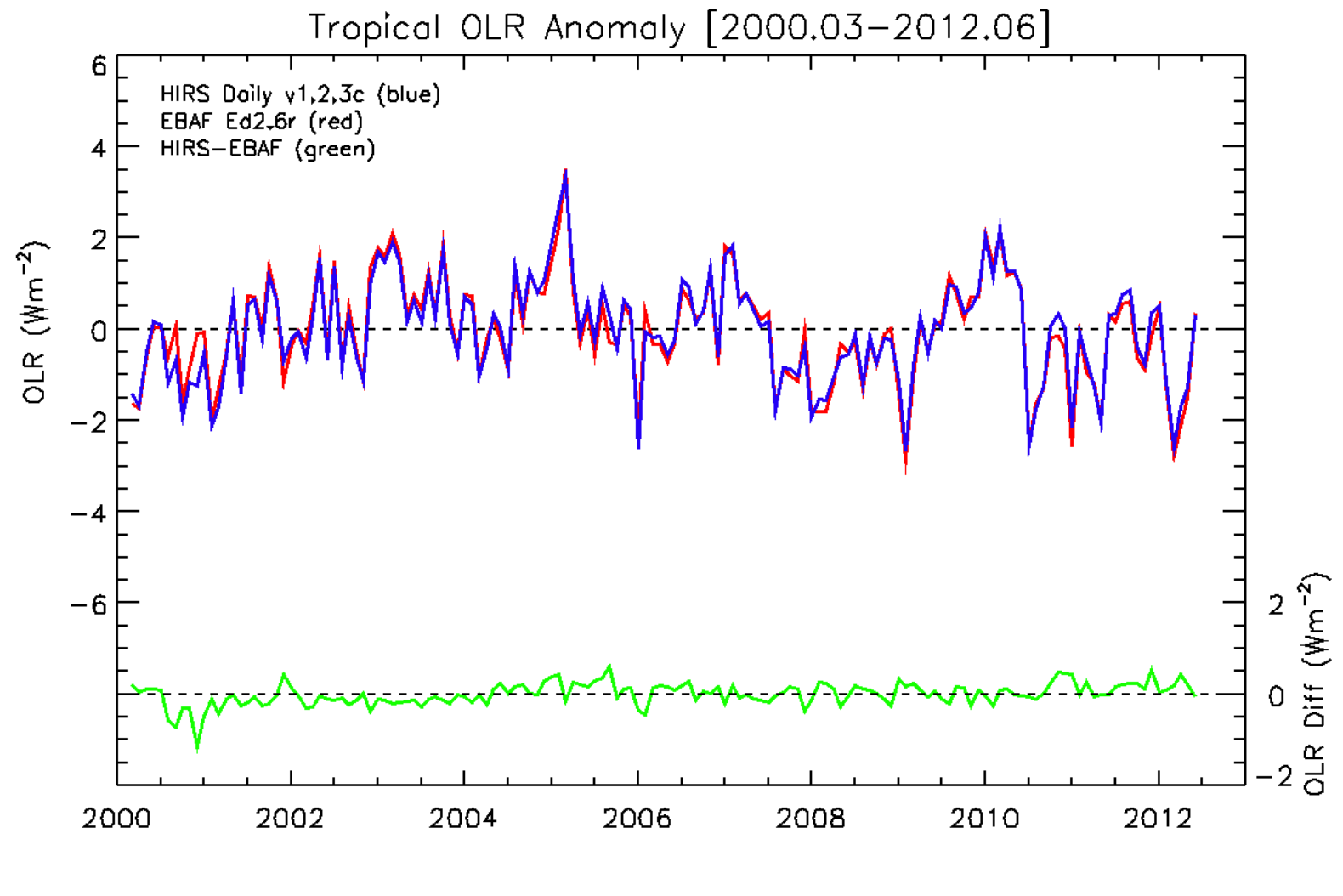


Global OLR Anomalies (2000-2012)



Slope of OLR anomalies diff = 0.03 ± 0.09 Wm^{-2}/decade with 2-sigma

Tropical OLR Anomalies (2000-2012)



Slope of OLR anomalies diff = 0.28 ± 0.10 Wm^{-2}/decade with 2-sigma

Inter-comparison

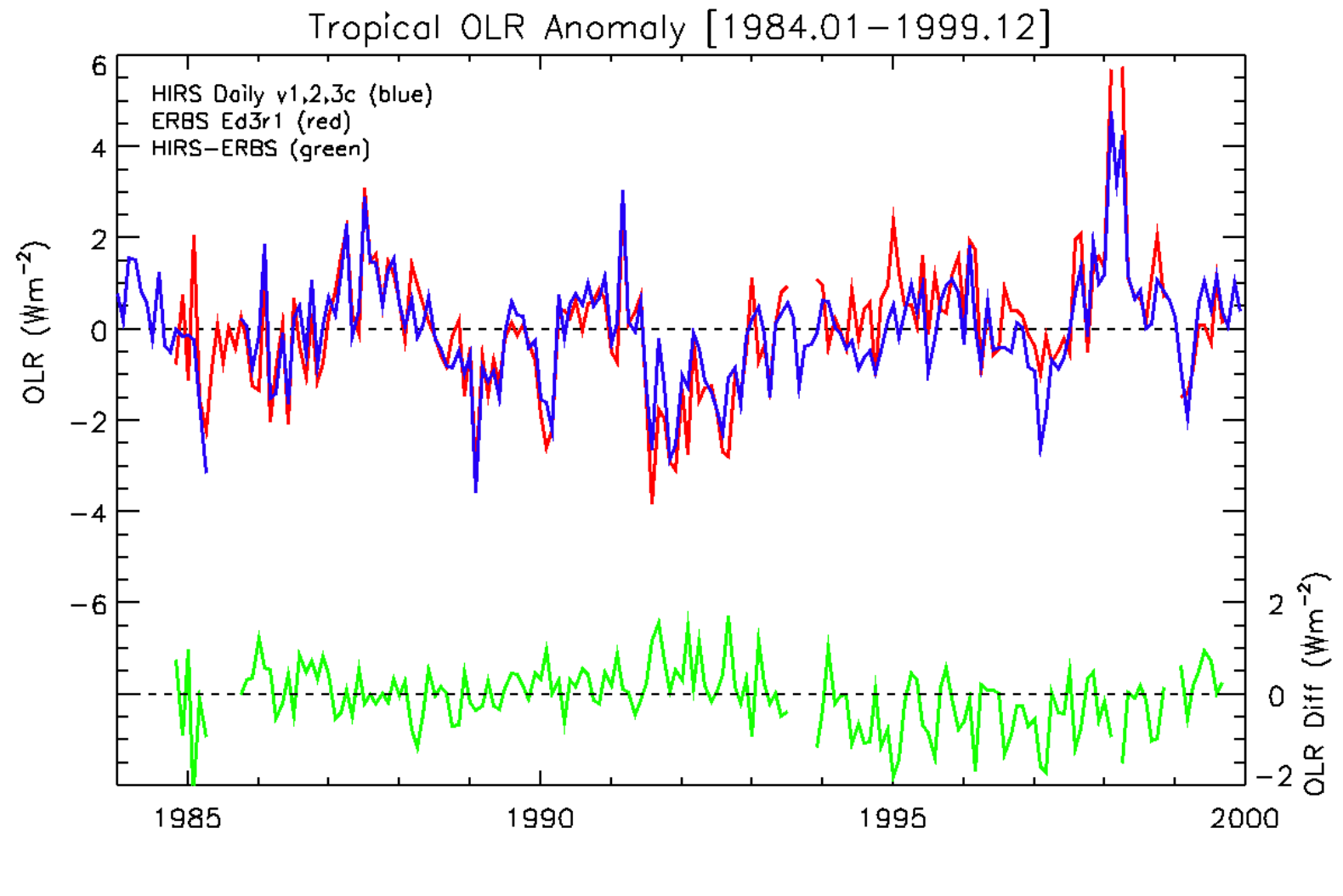
HIRS Daily OLR CDR

vs.

ERBS Ed3_rev1

(in monthly means)

Tropical OLR Anomalies (1985-1999)



Slope of OLR anomalies diff = -0.34 ± 0.24 Wm^{-2}/decade with 2-sigma

Inter-comparison

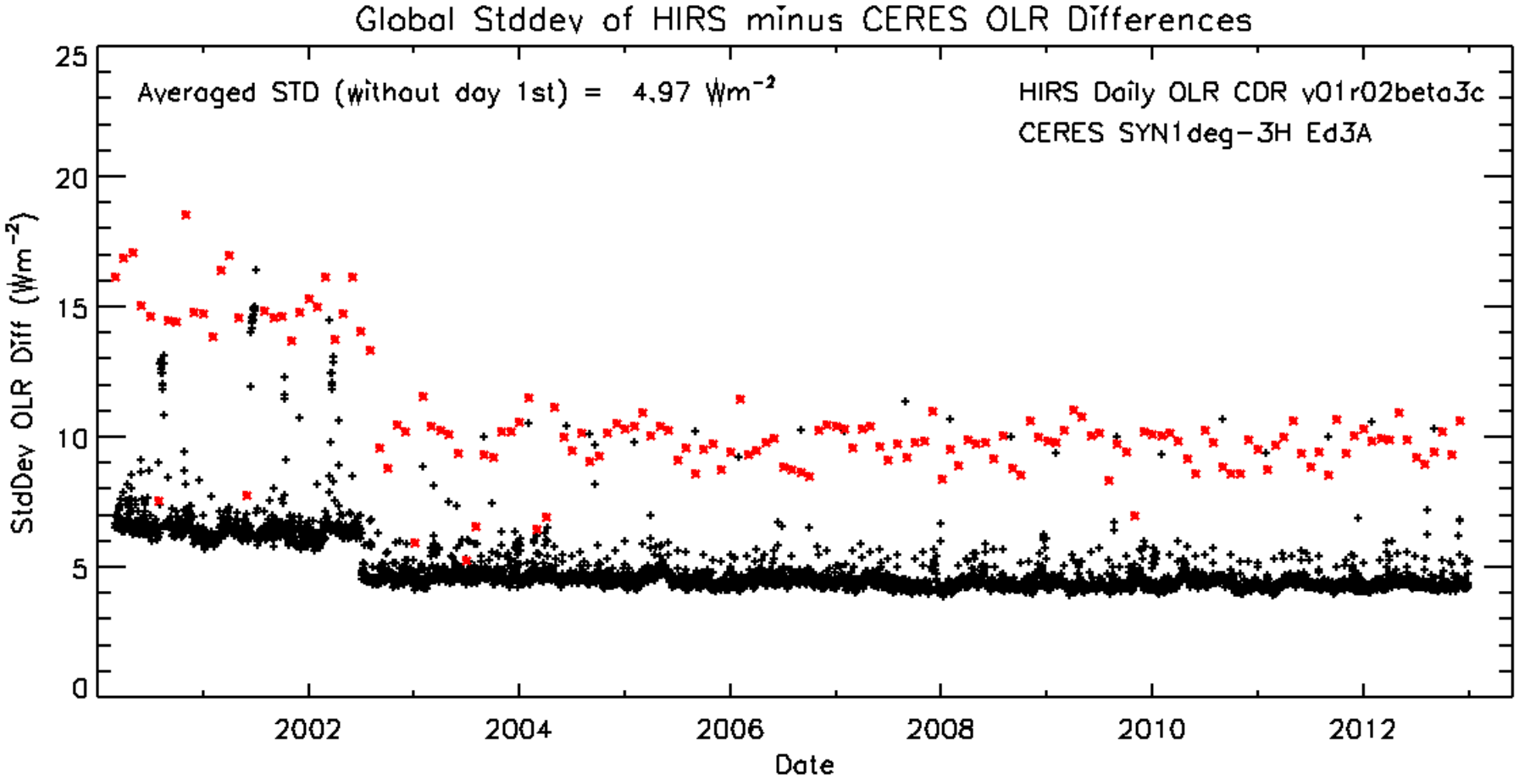
HIRS Daily OLR CDR

vs.

CERES SYN1deg-3H

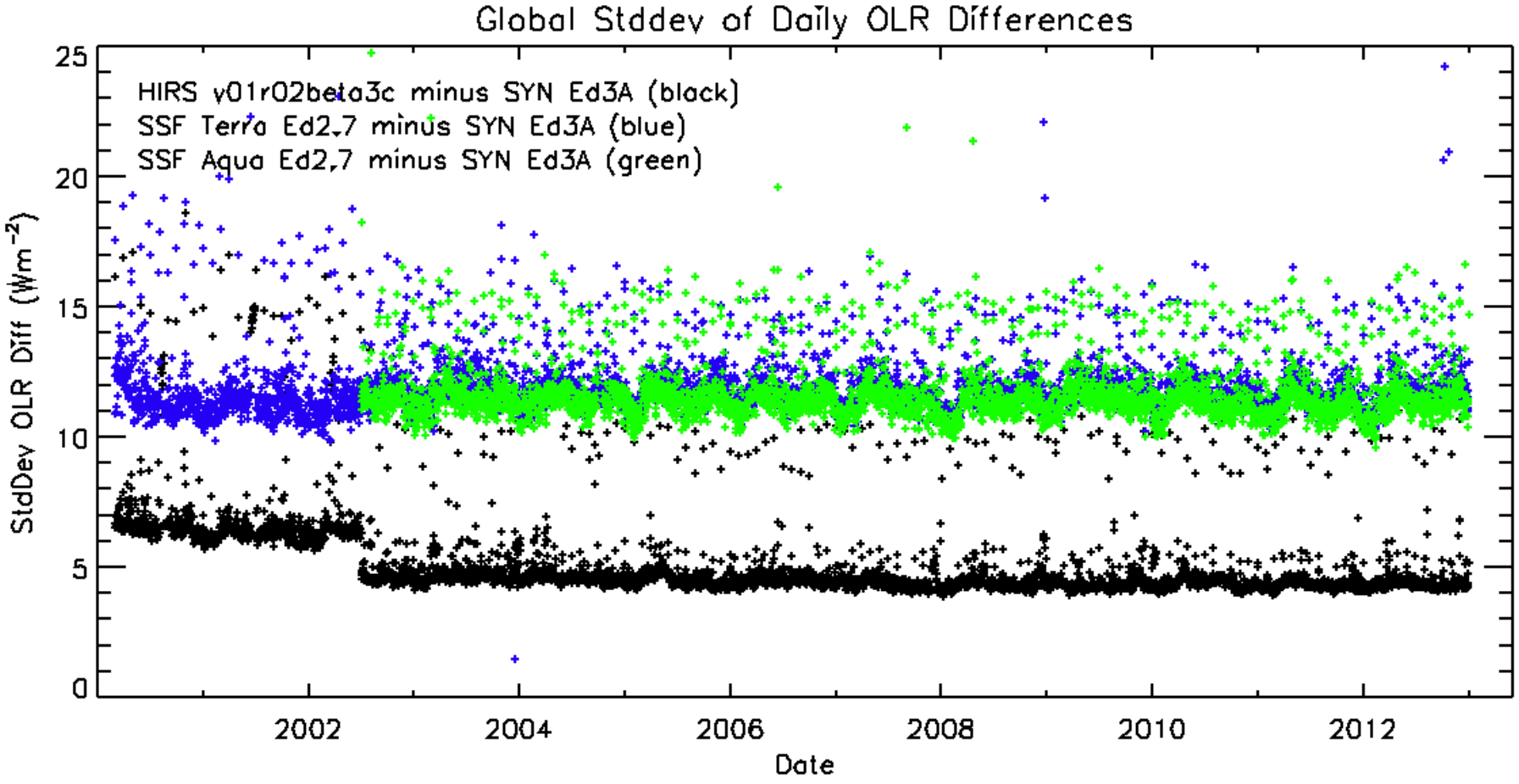
(in daily means)

Global STD of Daily OLR Differences



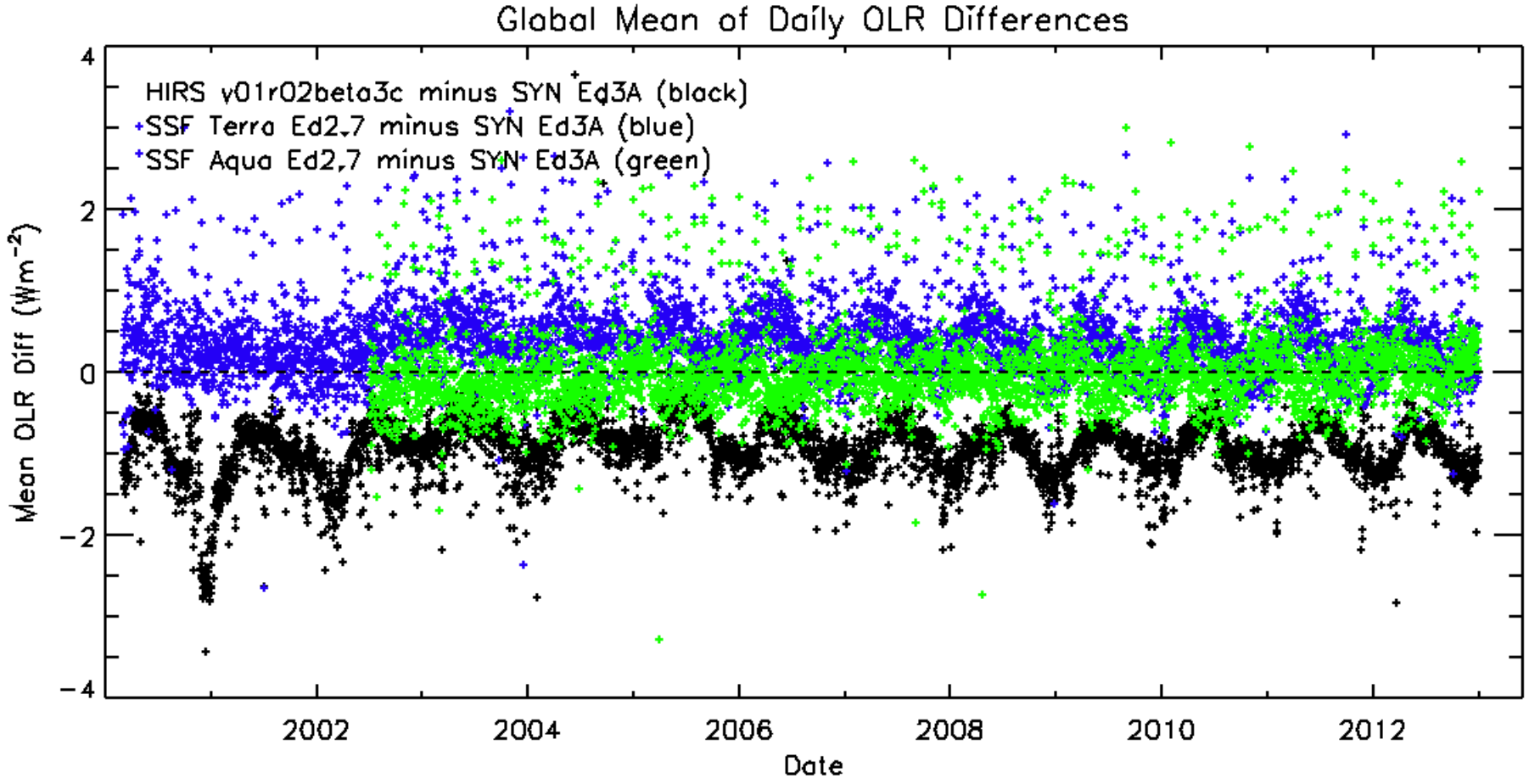
- *CERES SYN1deg-3H Ed3A has a processing bug on 1st day of each month (red points).*
- *Time series 'shock' due to CERES sampling change when Aqua entered in July 2002.*

Global STD of Daily OLR Differences



- *StdDev of SSF minus SYN OLR are about 12 Wm^{-2}*
- *StdDev of HIRS minus SYN OLR are about 5 Wm^{-2}*

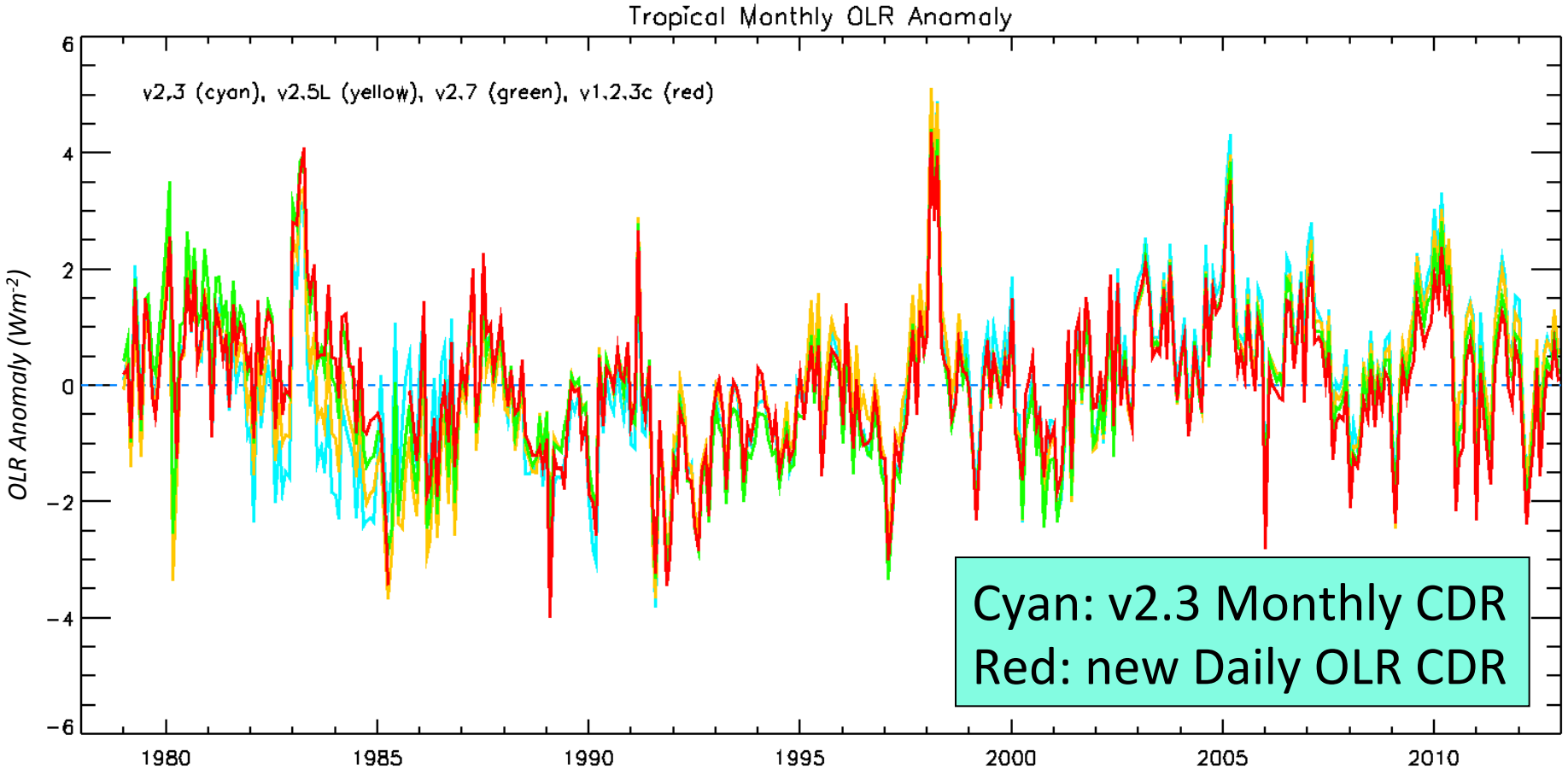
Global Mean of Daily OLR Differences



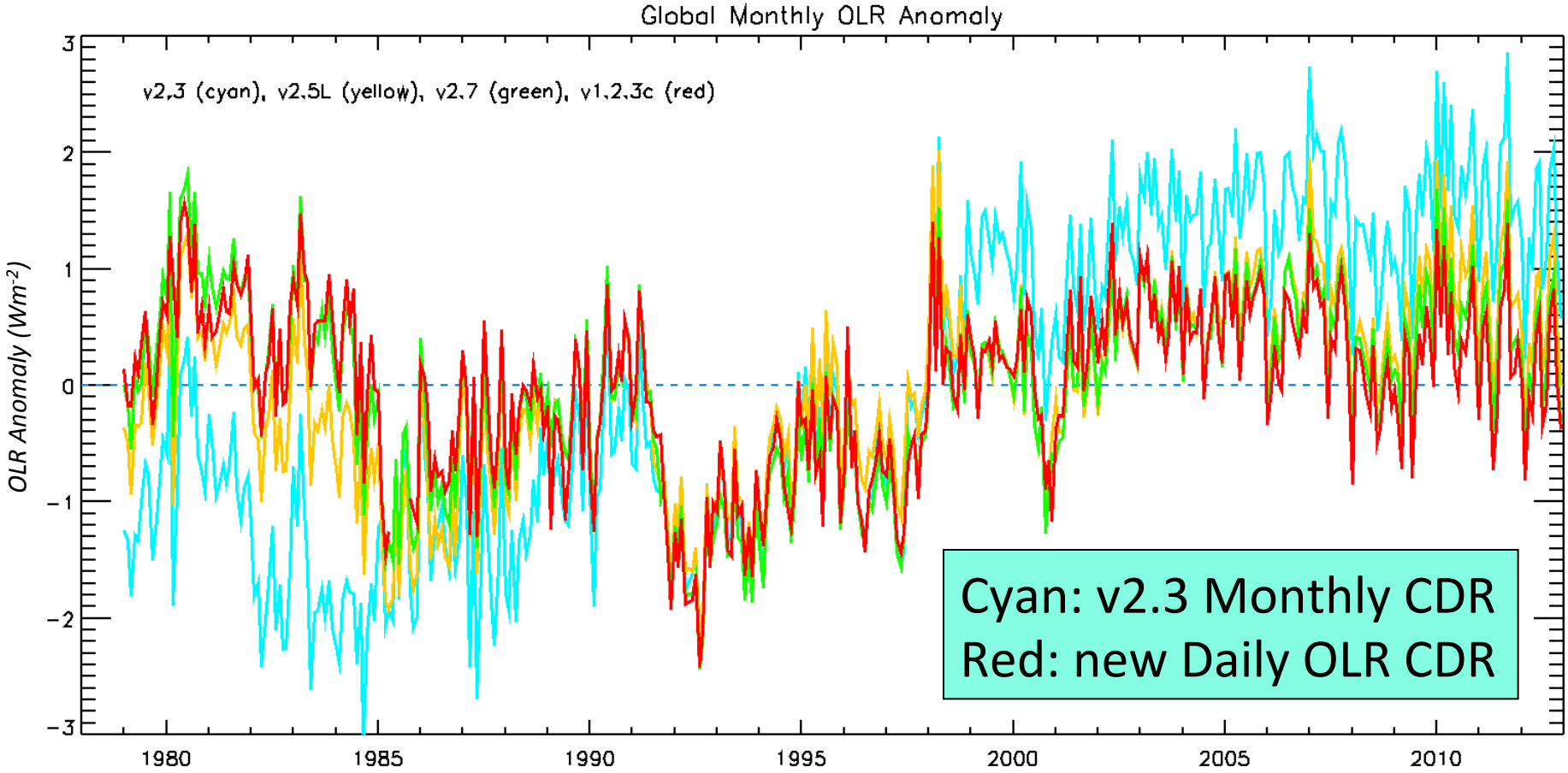
- *HIRS-SYN diff are well within CERES LW 1.5% uncertainty*
- *Global mean OLR diff vary seasonally in a range of about 1 Wm^{-2} in both HIRS and SSF data relative to SYN.*

Status Quo of HIRS OLR CDR

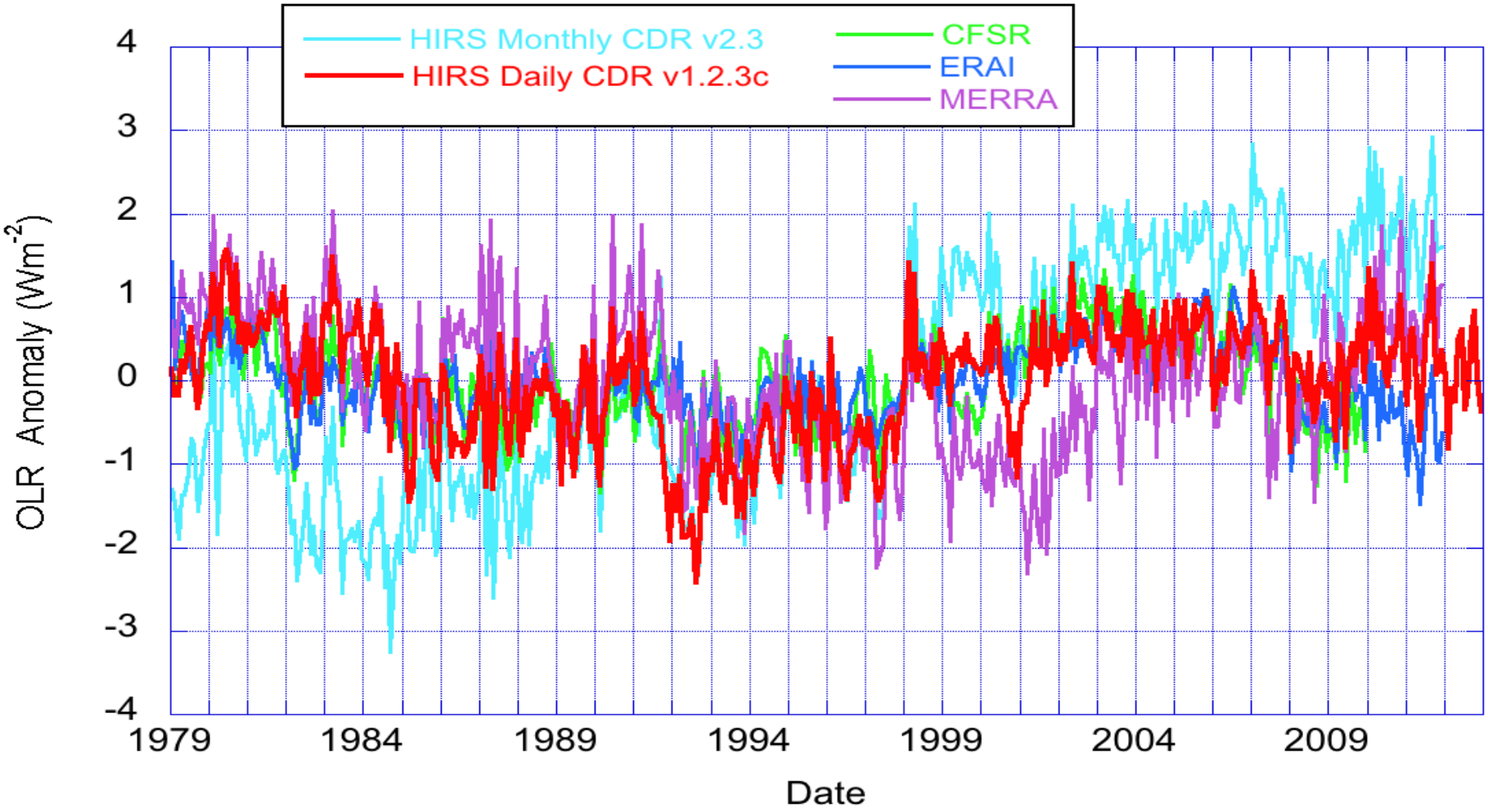
Tropical Monthly OLR Anomalies (1979-2012)



Global Monthly OLR Anomalies (1979-2012)

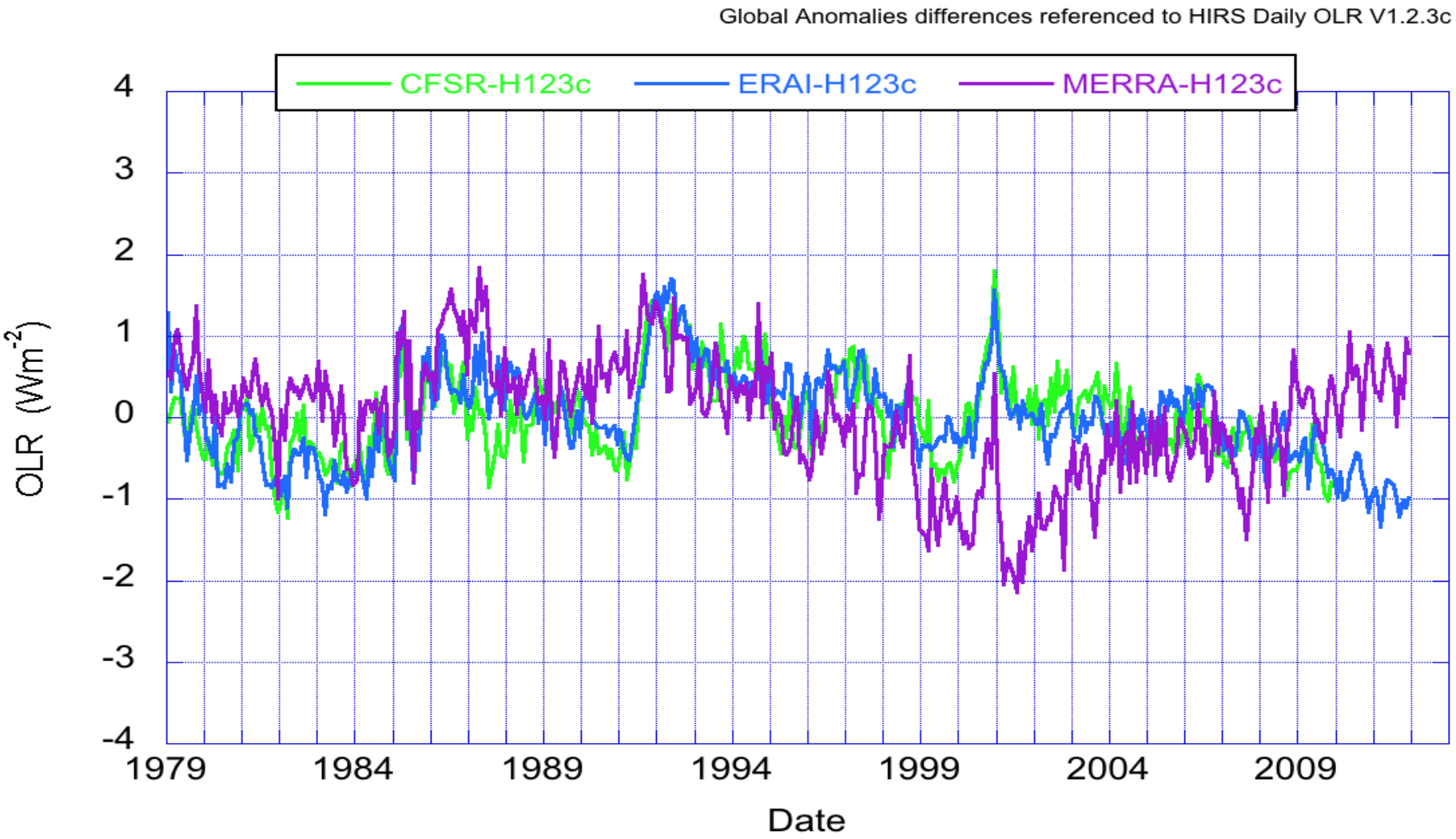


Global Monthly OLR Anomalies 1979-2012



BACKUP SLIDES

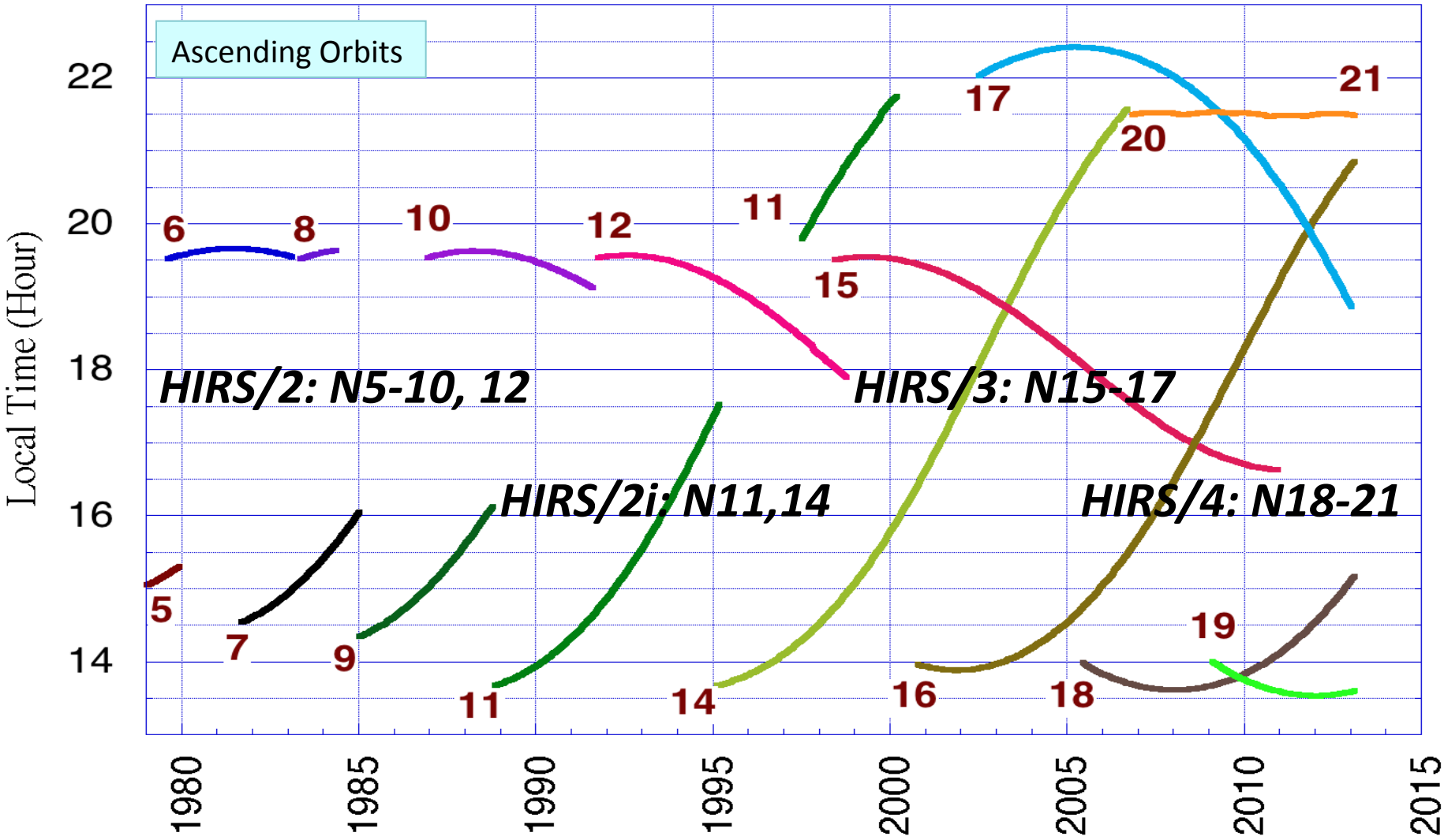
Difference of Global OLR Anomalies
Reanal minus HIRS



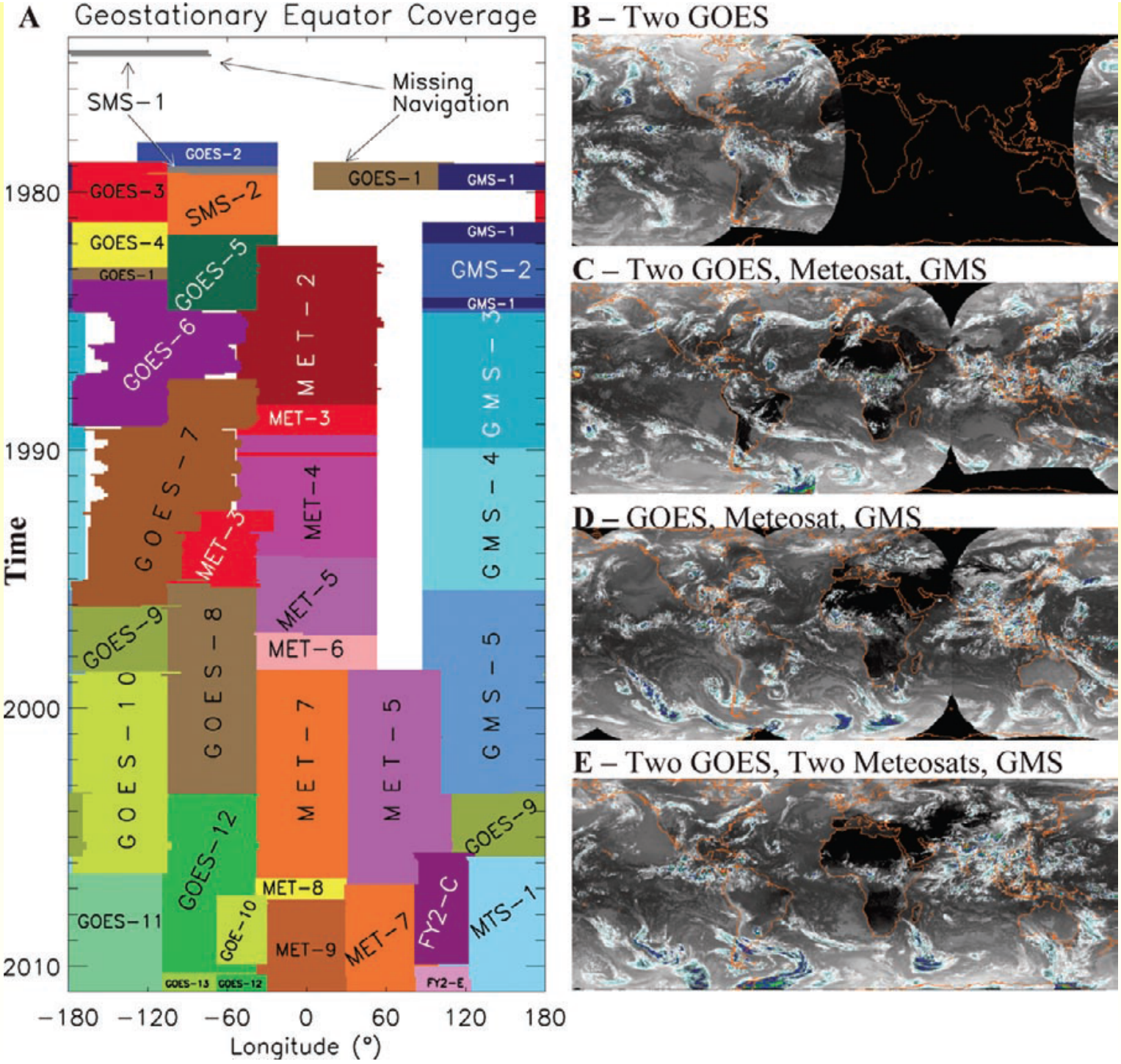
Datasets

- **HIRS** Monthly OLR Climate Data Record v2.2/v2.3 and Daily OLR CDR v1.2.3c for 1979.01-2012.12 (*UMD-CICS/ NCDC CDR Program*)
- CERES **EBAF Ed2.6r**, **Terra/Aqua SSF1deg Ed2.6, SYN1deg Ed3A**. 2000.03-2012.06 (*NASA LaRC ASDC*)
- NCEP Climate Forecast System Reanalysis (**CFSR**) 1979.01-2009.12 (*NCAR CISL Data Research Archive*)
- ECMWF European Reanalysis (**ERA**) Interim 1979.01-2011.12 (*ECMWF*)
- NASA Modern-Era Retrospective Analysis for Research and Applications (**MERRA**) 1979.01-2012.02 (*NASA GES DISC*)

HIRS Family and Time of Observations



5=TIROS-N; 6-19: NOAA; 20=MetOp-2, 21=MetOp-1


A Geostationary Equator Coverage
SMS-1
Missing Navigation
GOES-2
GOES-1
GMS-1
GOES-3
SMS-2
GOES-4
GOES-5
GMS-2
GOES-6
MET-2
MET-3
GOES-7
GMS-3
GMS-4
MET-4
MET-3
MET-5
GOES-9
MET-6
GOES-8
GMS-5
GOES-10
MET-7
MET-5
GOES-12
GOES-9
MET-8
GOES-11
GOE-10
MET-9
MET-7
FY2-C
MTS-1
GOES-13
FY2-E
1980
1990
2000
2010
Time
−180 −120 −60 0 60 120 180
Longitude (°)
B – Two GOES
C – Two GOES, Meteosat, GMS
D – GOES, Meteosat, GMS
E – Two GOES, Two Meteosats, GMS