CPC New OLR Data Is Ready For You to Use

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CPC All Hands Meeting
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OLR Data Is Widely Used in CPC Operations

- Outgoing longwave radiation (OLR) is a primary component of the global and regional energy budget and transfer

- Estimation of OLR made from satellite measurements has been widely used for over 40 years to:

  - *Quantify energy budget of the earth system*
  - *Document the state and variations of the atmospheric system;*
  - *Monitor and assessing tropical convection and global climate variability;*
  - *Verify climate model performance; and*
  - *Estimate precipitation over the tropical and sub-tropical regions;*

AVHRR OLR Data Set Has To Be Terminated Soon

- Currently operational CPC OLR data was developed ~40 years ago;
  - *Derived about ~40 years ago by gridding the NESDIS level 2 OLR retrievals (satellite orbit data) estimated from the AVHRR (Advanced Very High-Resolution Radiometer) measurements;*
  - *Janowiak J. E., A.F.Krueger, P.A. Arkin and A. Gruber, 1985: Atlas of Outgoing Longwave Radiation Derived from NOAA Satellite Data NOAA Atlas No. 6 (Available from Climate Prediction Center), 44pp.*
  - *Monthly / pentad data from 1979 on a 2.5^{o}lat/lon grid over the globe;*
  - *Updated near real-time;*
  - *Daily / orbit grid data also created;*
- AVHRR sensor is no longer on the new NOAA operational satellites and NESDIS will stop the production of AVHRR OLR level 2 orbit data (inputs to CPC's gridding process) **by the end of THIS MONTH!!!**

Requirements for the New OLR Data Set

- **Long-term Record** of reasonable quantitative accuracy and temporal homogeneity;
  - *Starting from at least 1991 to ensure the definition of a 30-year climatology;*
  - *No significant artificial trend caused by satellite changes and / or satellite orbit time (observation time in a diurnal cycle) shifts;*
- **Fine time / spatial resolution** resolving major weather / climate phenomena over the entire globe;
  - *Ideally daily / 0.25^{o}lat/lon grid;*
- **Updated real-time in a 7/24 operational environment**
  - *Production latency no longer than 24 hours (ideally 12 hours or so);*
  - *Production is executed in an operational environment maintained 7/24 by dedicated staff;*

OLR Data Available on the Market (1/3)

- NASA CERES Broadband OLR Data

➔ **Best quality but with a short record and not updated real-time on a development mode**

- *OLR data derived from sensors dedicated for the measurements of radiation energy budget studies;*
- *OLR data developed carefully with manual inspections month by month (widely considered the OLR data of the best quality);*
- *OLR data generated on native satellite pixels (called FOV, field of view) along the satellite paths;*
- *Starting from March 2000 (a little bit too short);*
- *Updated at a delay of 3-4 months (too late for monitoring applications);*

OLR Data Available on the Market (2/3)

- NESDIS Hyperspectral OLR Data

  ➔ **Very good quality from advanced sensors, generated real-time in a 7/24 environment by NESDIS Operations, but relatively short record (10+ years);**

  - *OLR data derived from advanced sensors (AIRS, IASI, CrIS) aboard new generation polar orbiting satellites;*
  - *Quantitative accuracy not as high as that for the NASA broadband but very high OLR;*
  - *Starting from March 2006 (not enough for climate application);*
  - *Generated by NESDIS Operations 7/24 at a delay of hours (great for real-time monitoring);*

OLR Data Available on the Market (3/3)

- HIRS OLR Data

➔ Quite good quality, covering long period (back to 1979) with heritage sensors (HIRS) but not produced in a 7/24 environment and the source data from the HIRS sensors are also terminated by NESDIS;

- *Developed by Dr. Hai-Tien Lee;*
- *Derived from measurements from HIRS (High-Resolution Infrared Radiation Sounder);*
- *Daily and Monthly OLR Climate Data Record (CDR) starting from 1979 updated quasi real-time, primarily based on HIRS OLR, are available from NOAA/NCEI CDR program. The OLR estimated from hyperspectral instruments, IASI and CrIS, radiance observations will be used to extend the OLR CDR along with and beyond HIRS;*
- *The OLR CDR is currently not produced in a 7/24 environment;*
- *NESDIS is terminating the Radiation Budget Products, both AVHRR and HIRS OLR.*

Strategy for the Development of the New OLR

- Our goal is to produce an OLR grid data set easy for climate users to work with **(➔a grid data set);**
- We will take advantage of existing products / techniques as much as possible;
- Our part of the work will be limited to **straightforward gridding** with inputs of raw satellite data (level 2 orbit data) from organizations (e.g. NASA, NESDIS) instead of PIs;
- Future refinement and maintenance of the new OLR product require limited expertise and background knowledge on satellite / radiation; **(Easy maintenance)**
- The real-time production will be carried out in a **7/24 operational environment**;

How Do We Construct the New OLR Data

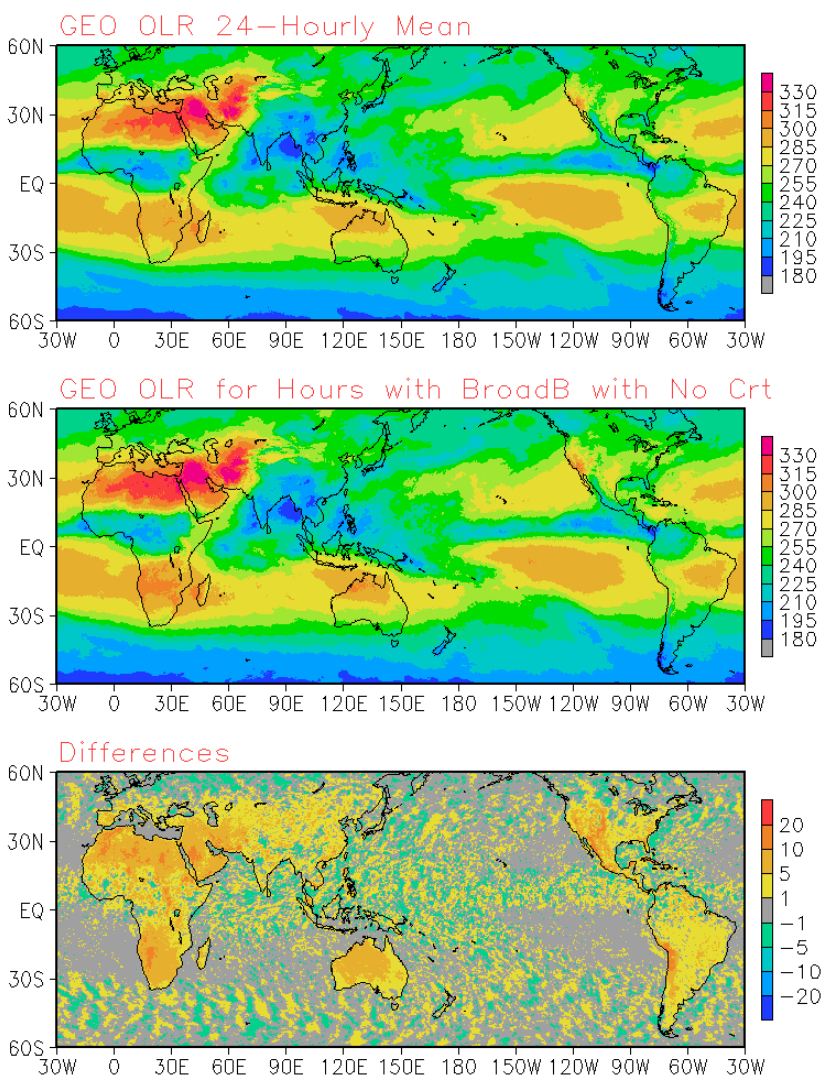
- Utilize the **NASA Broadband OLR as the backbone** of the new Data Set;
  - *Defining the OLR for 2000 to the present with the NASA CERES broadband level 2 OLR orbit data;*
- Take the **NESDIS hyperspectral OLR to fill in the real-time gaps for recent months** when the broadband OLR is not available;
  - *NESDIS hyperspectral OLR is calibrated against the broadband OLR using overlapping data for close quantitative agreements;*
- Use the **HIRS OLR to back extend the new OLR** to historical period before 2000;
  - *The HIRS OLR is also calibrated against the broadband OLR using overlapping data to ensure homogeneous time series;*

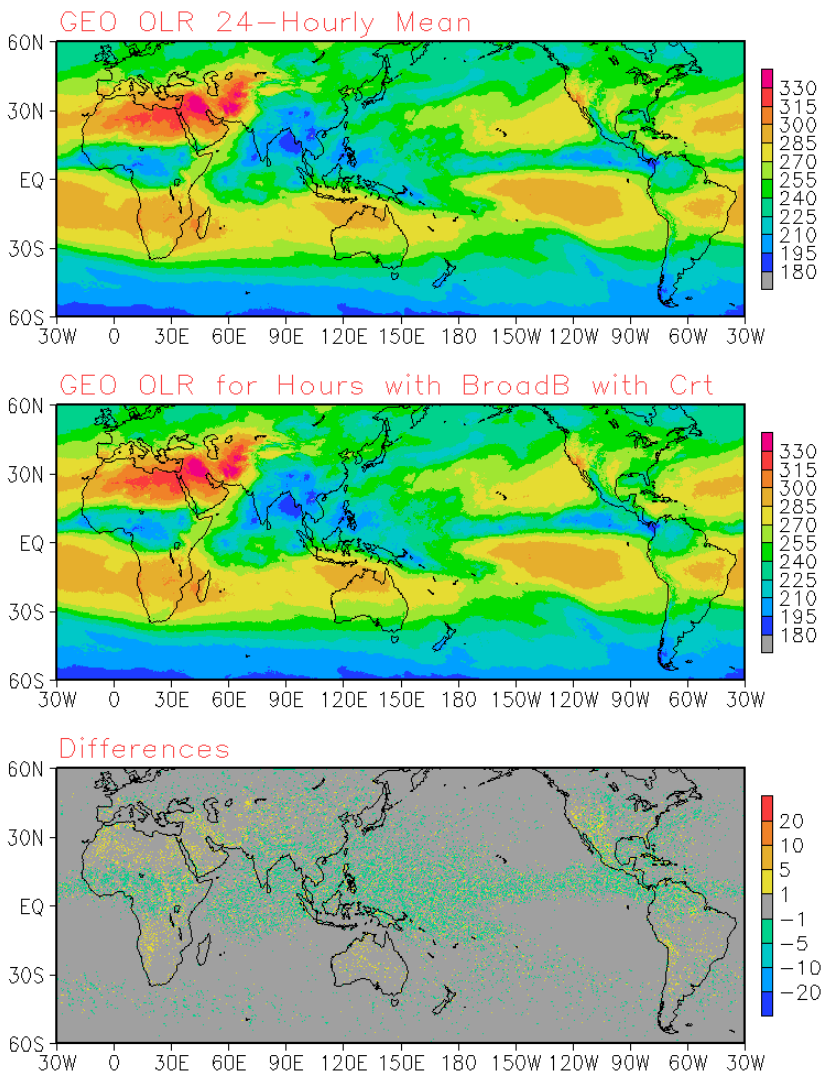
Some Additional Technical Details

- The primary OLR product is DAILY MEAN on 0.25^{o}lat/lon grid;
- In defining daily mean from unevenly scheduled satellite sampling, diurnal cycle is of OLR is considered using hourly / 3-hourly geostationary satellite observations;
- NESDIS real-time hyperspectral OLR and HIRS historical OLR are both calibrated against the NASA broadband OLR to ensure temporal homogeneity;
- Calibration is conducted through PDF matching using overlapping data;

Defining Daily Mean OLR w/wo Diurnal Correction

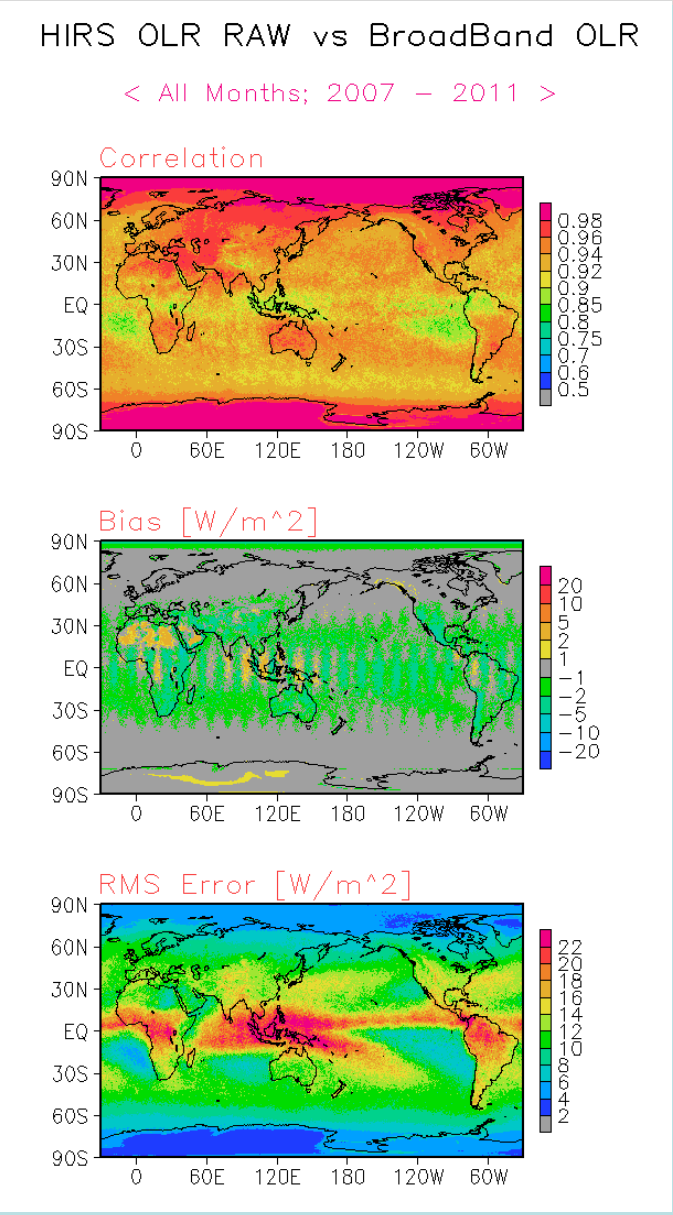
July 2019 (Simulations with Hourly GEO OLR)

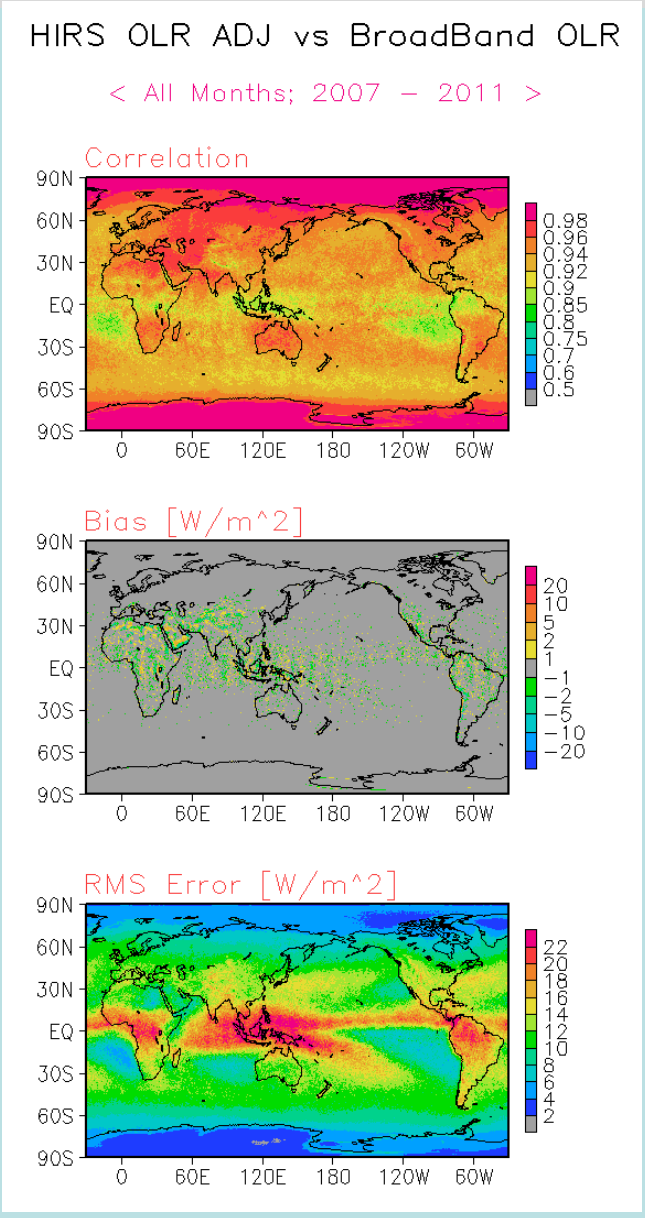




Calibrating HIRS against Broadband OLR

Sample Verification Results





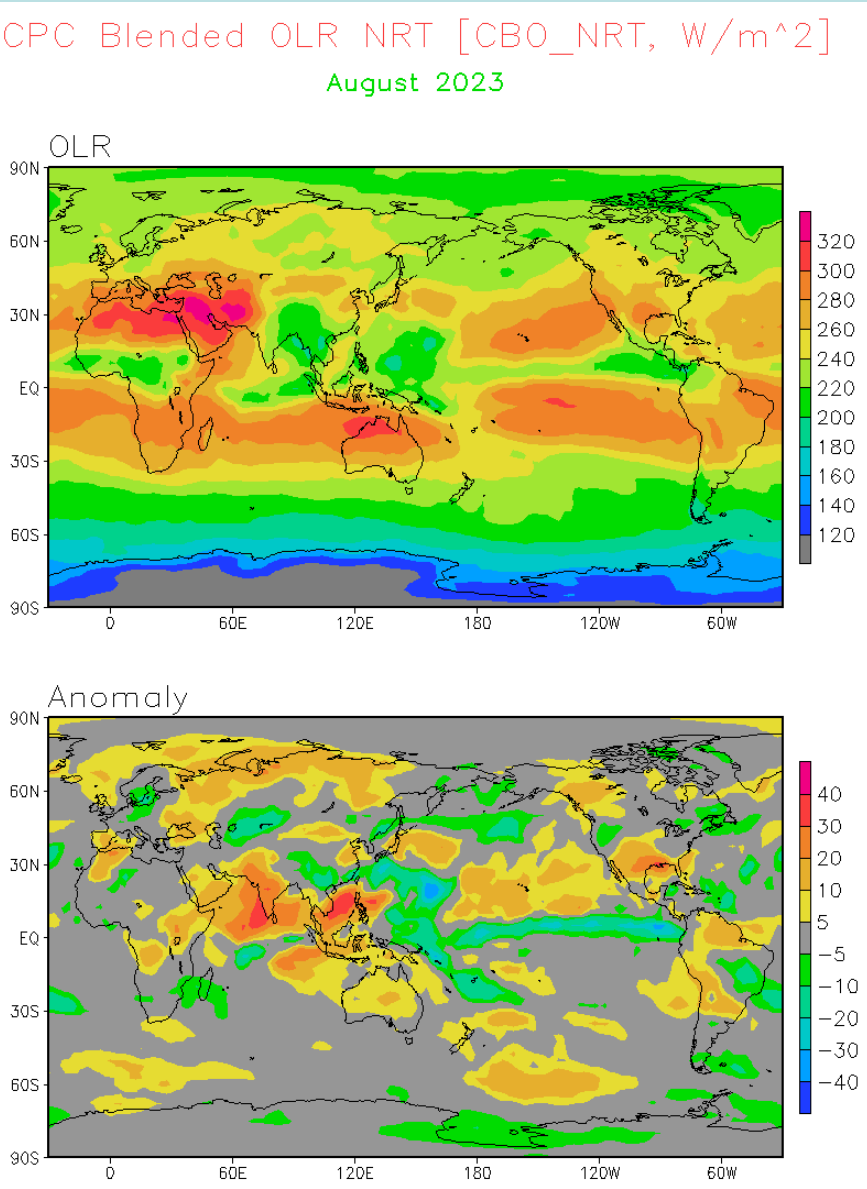
Where Do We Stand?

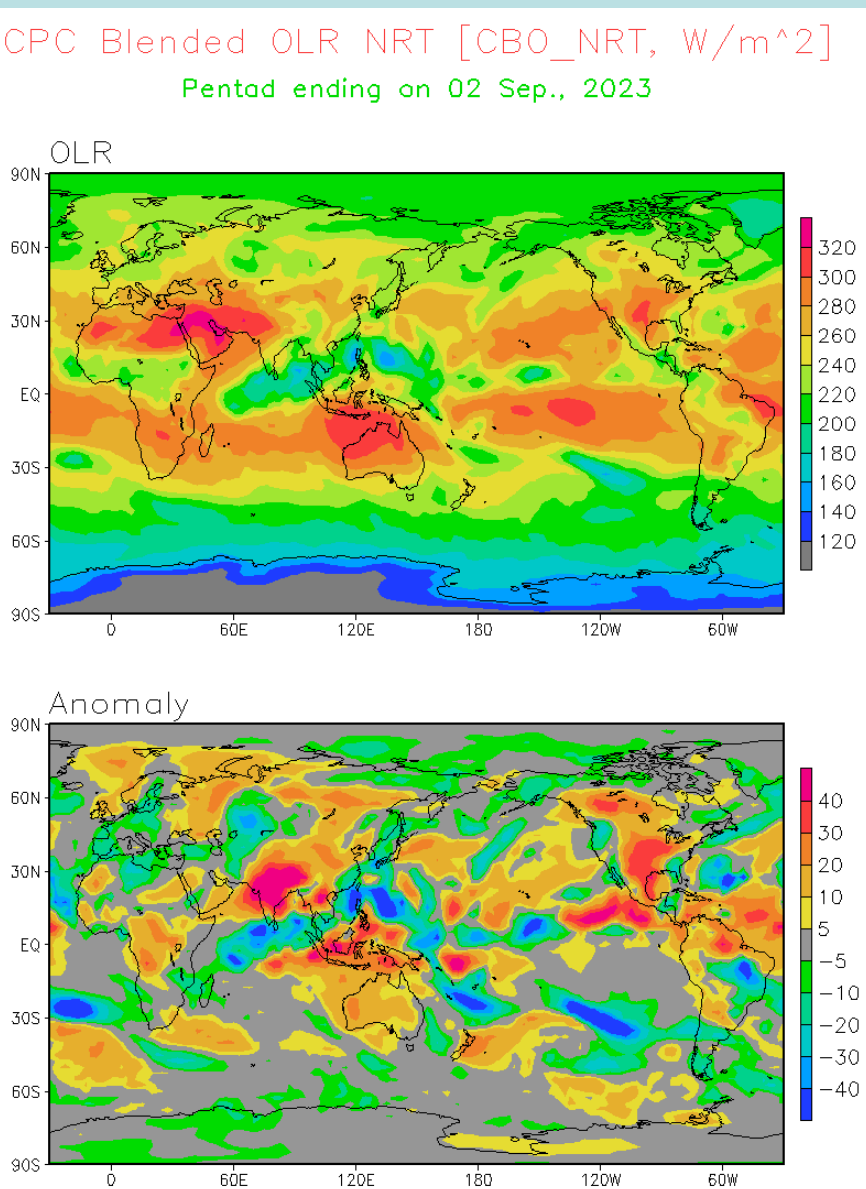
- Historical Data Record
  - *Completed construction of the new OLR for a 32+ year period from January 1991 to May 2023 (waiting for the NASA broadband OLR data for further update);*
  - *1991-2020 30-year climatology constructed;*

- Real-time Updates
  - *Constructed a production system on the Compute Farm for real-time production;*
  - *The new OLR data set updated on a real-time basis at a delay of less than 12 hours;*
  - *Real-time version OLR data re-run for a period from 1 January, 2023, to fill in the gap of historical version and to allow for comparisons;*

- Products:
  - *CPC Blended OLR (CBO)*
  - *Time / space resolution*
    - *Temporal Resolution: Daily; Pentad; Weekly; Monthly;*
    - *Spatial Grid: 0.25^{o}lat/lon; 1^{o}lat/lon; 2.5^{o}lat/lon; CORe Gaussin Grid*
  - *Variables:*
    - *Total OLR ; Anomaly*

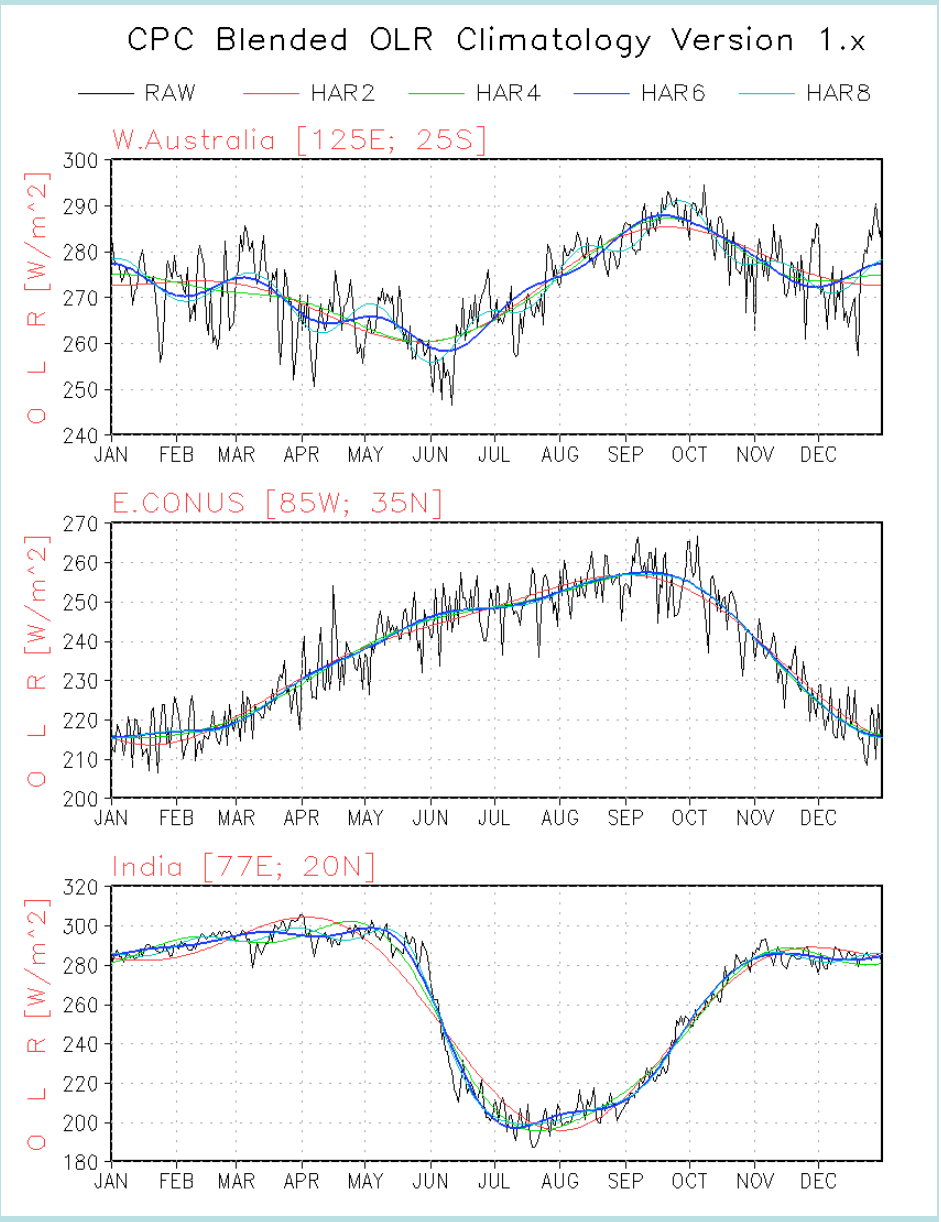
Sample Real-Time Products





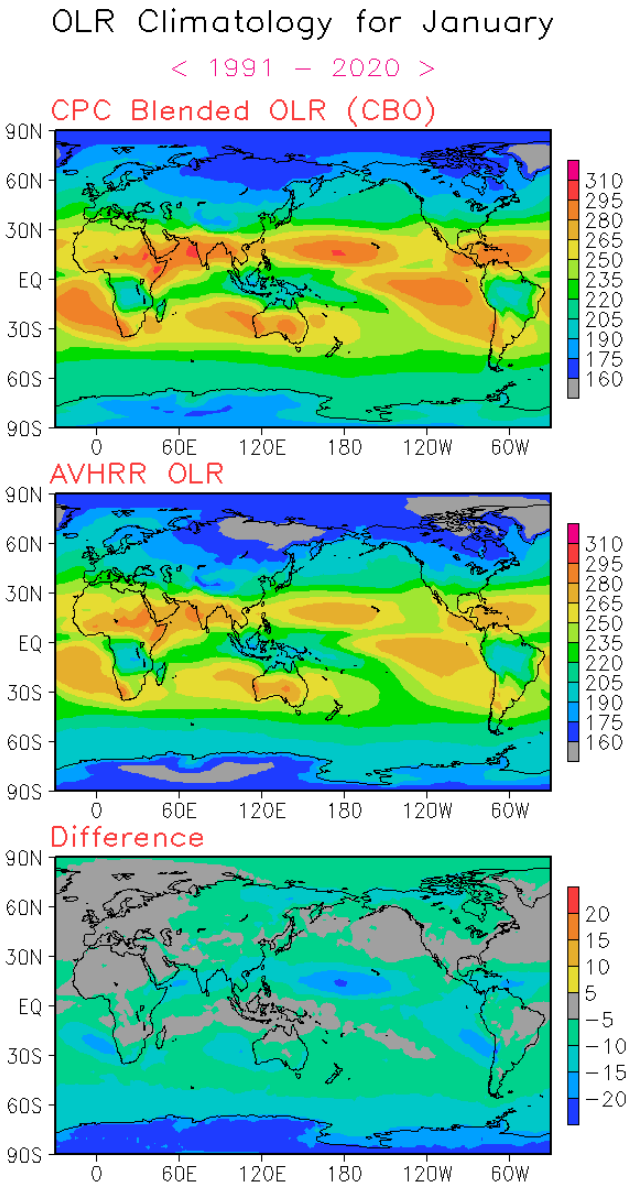
Definition of 1991-2020 Climatology

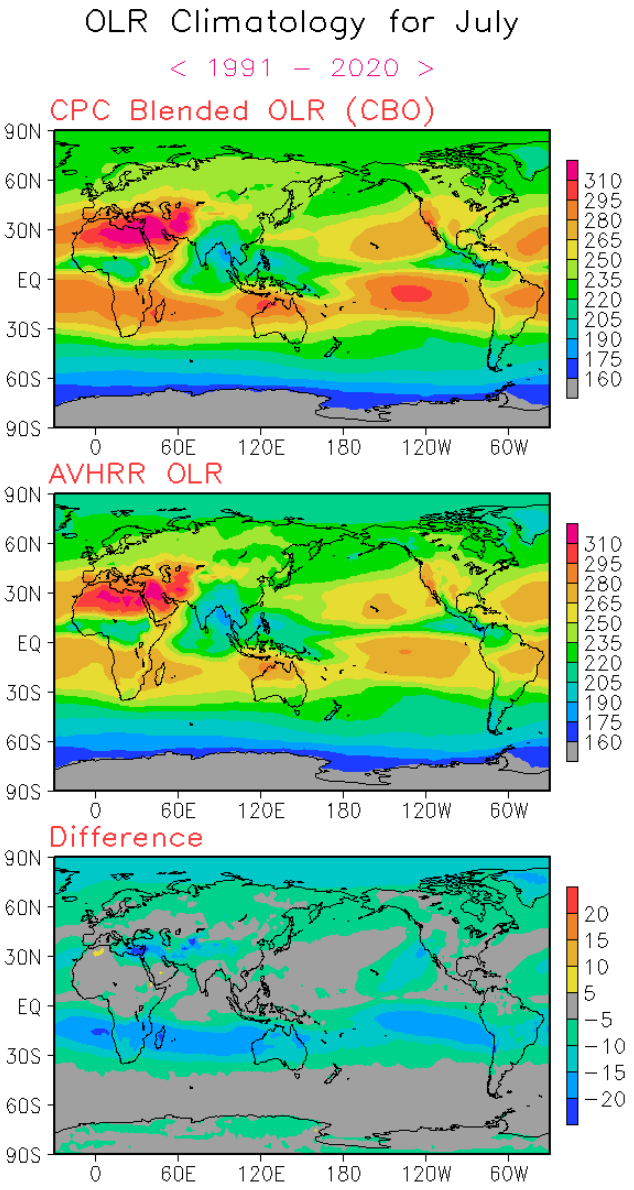
- Daily climatology defined as the summation of the first 6 harmonics of the 365-day time series of 30-year mean OLR;
- Pentad, weekly, and monthly climatology is constructed by averaging the daily climatology over the respective periods;



Comparison with AVHRR OLR

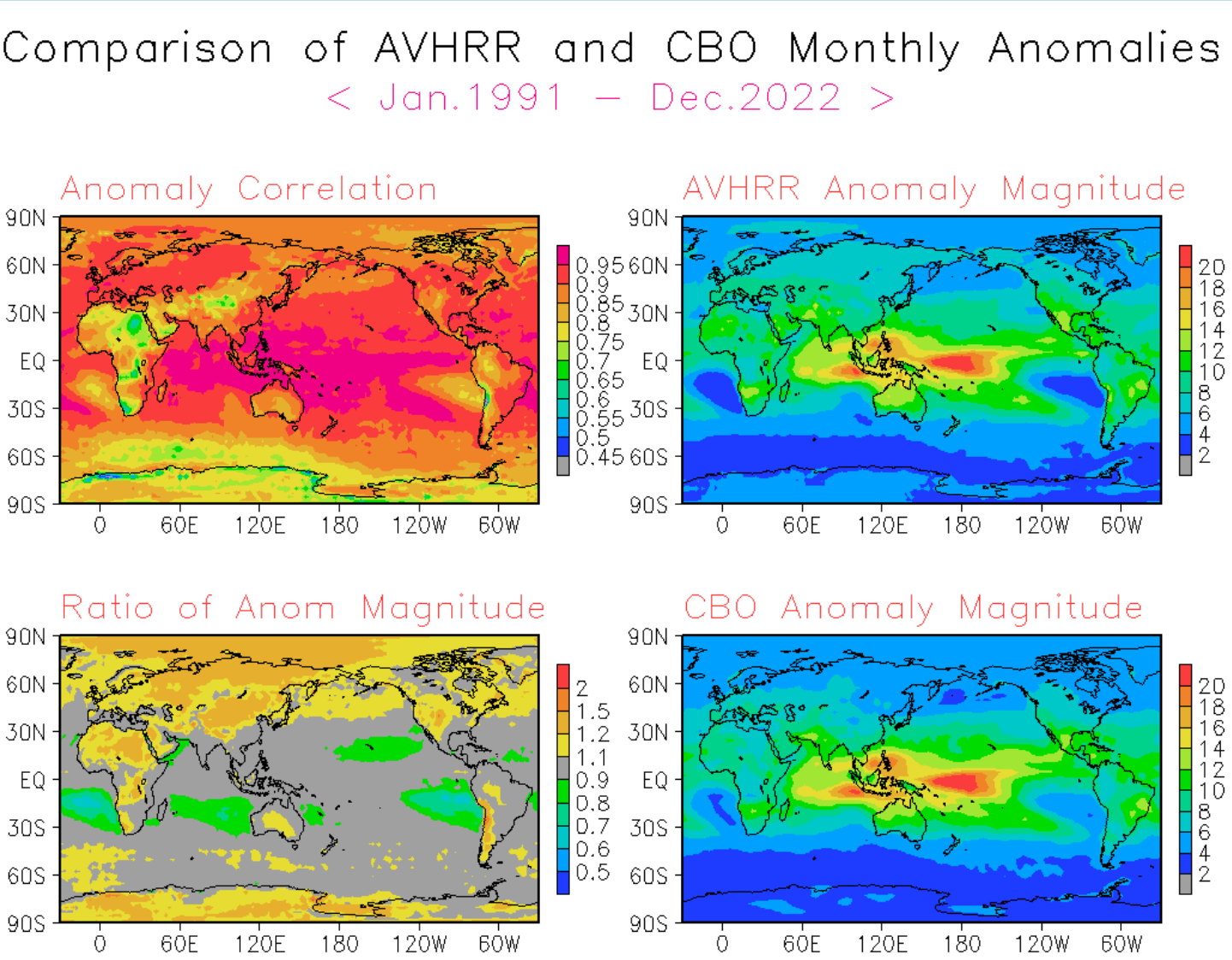
1) Climatology





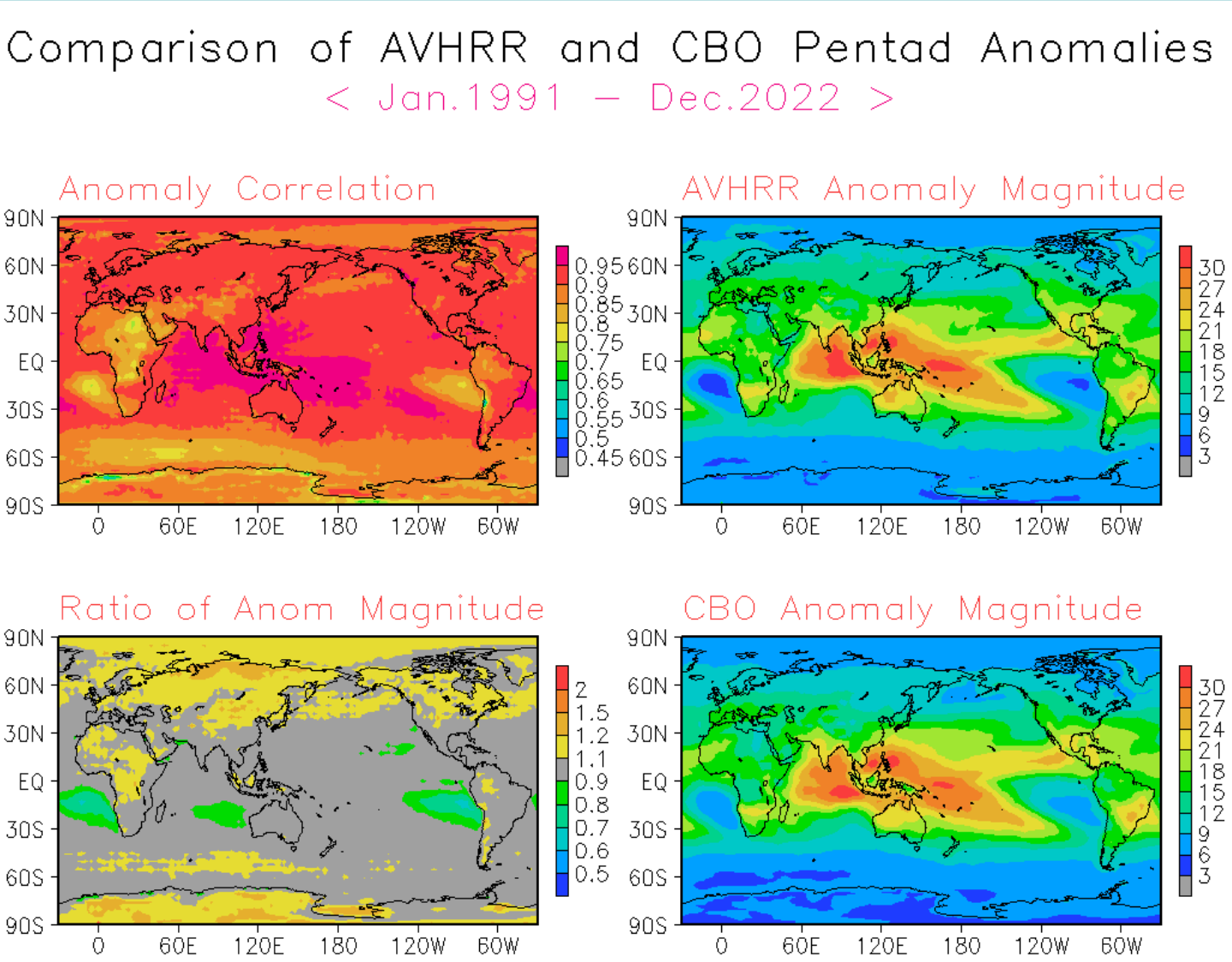
Comparison with AVHRR OLR

2) Monthly Anomalies



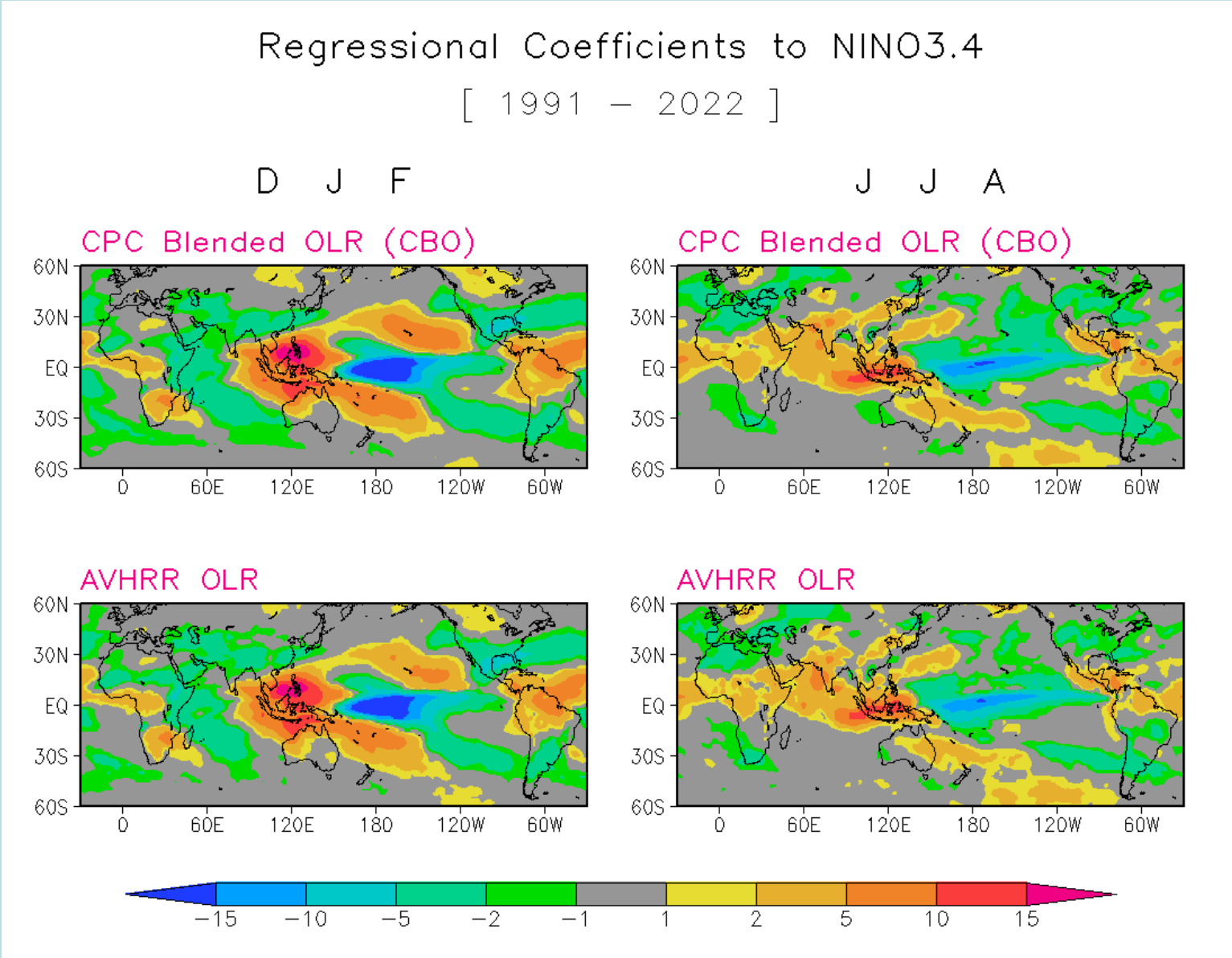
Comparison with AVHRR OLR

3) Pentad Anomalies



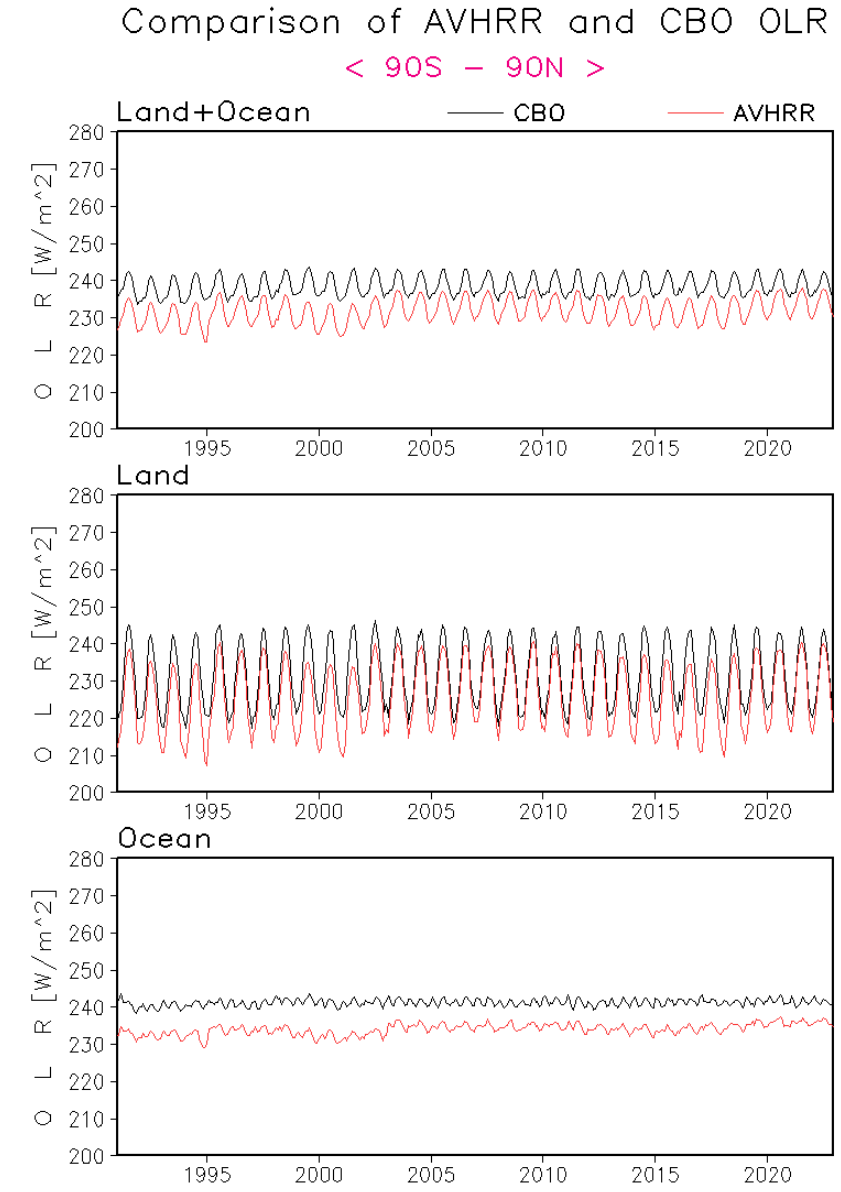
Comparison with AVHRR OLR

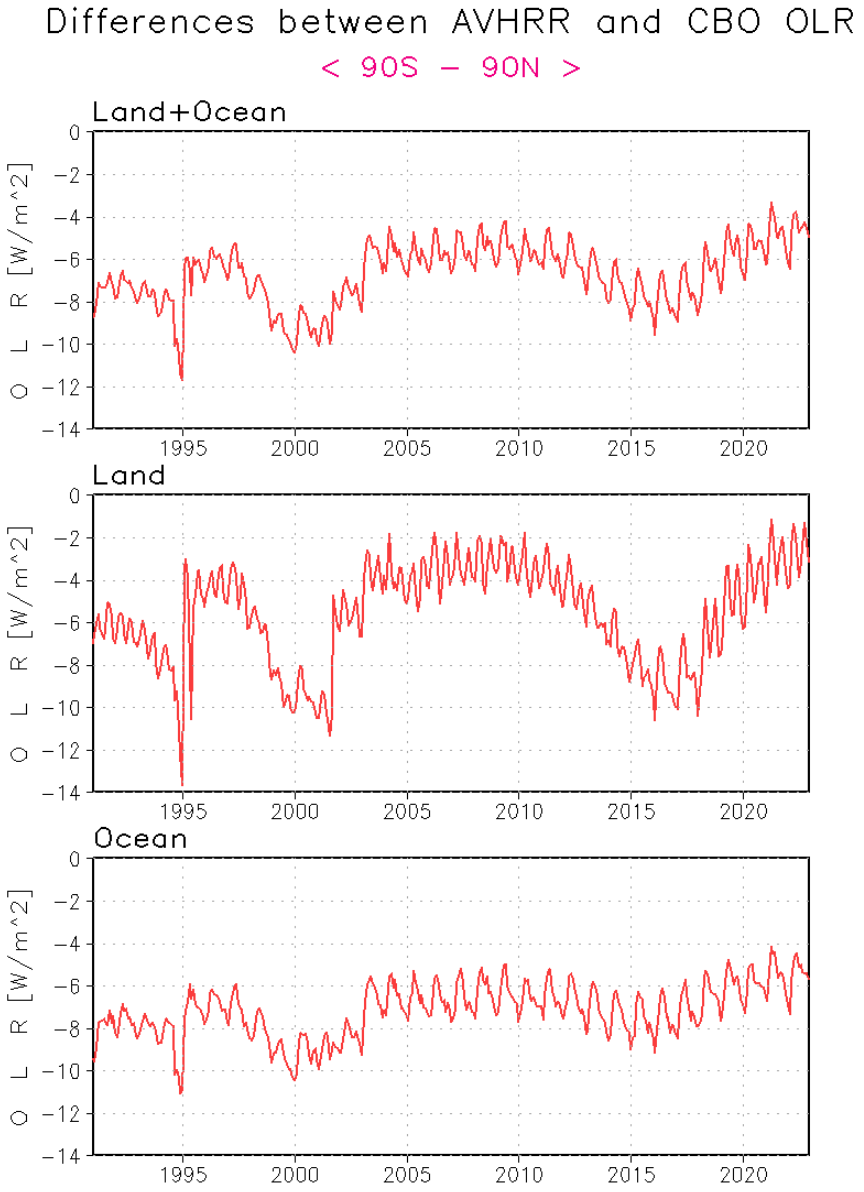
4) Regressional Coefficients to NONI3.4



Comparison with AVHRR OLR

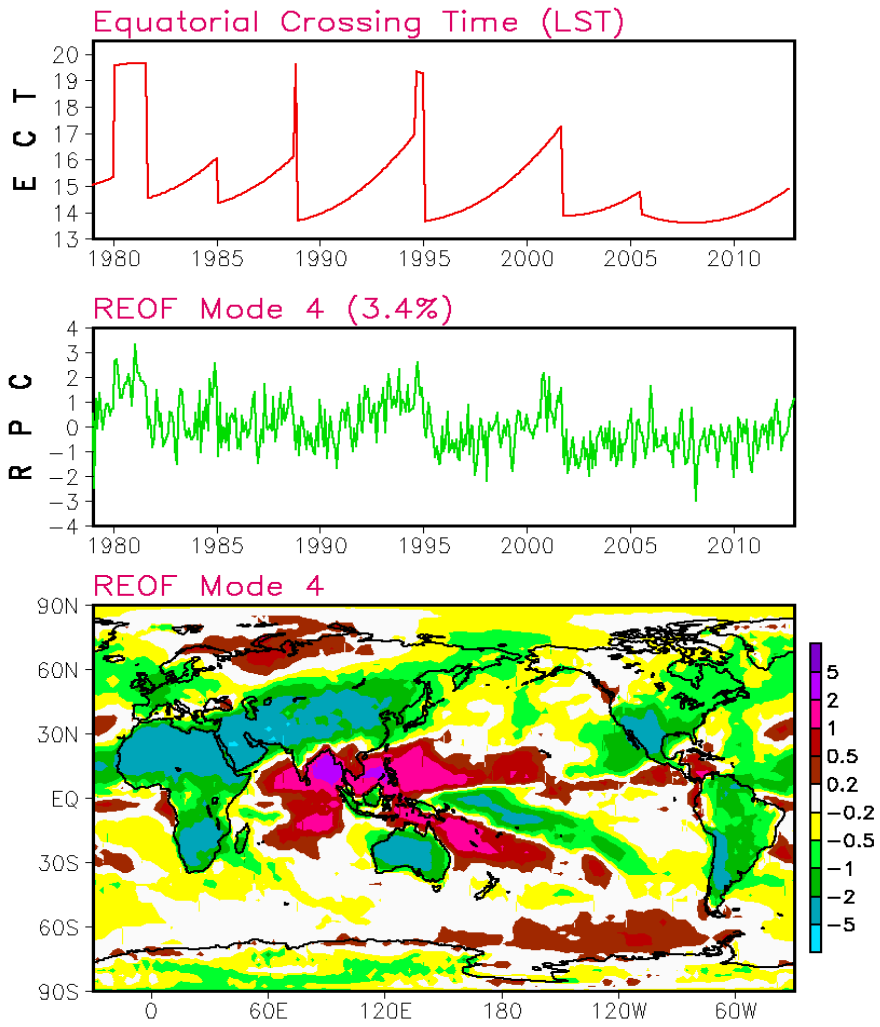
5) Time Series of Global Mean OLR





Comparison with AVHRR OLR

6) Possible Causes of the Differences with AVHRR OLR



←Time series (middle) of the principal component (PC) and the spatial loading (bottom) of the forth mode of the rotated EOF analysis of the CPC AVHRR OLR monthly anomaly, together with (top) the time series of the equator crossing time (ECT) of the NOAA polar orbiting satellites from which the AVHRR data are utilized to construct the NOAA OLR. Correlation between the satellite ECT and the OLR time series, together with the land/ocean contrast in the EOF spatial loading, indicate that the ECT changes have produced artificial variability of OLR due to the sampling different phases of the diurnal cycle.

It is clear that the shift in satellite orbit time (top) has caused discontinuities and artificial inter-annual variations in the OLR data.

The Data Files are Available

- **1991-2020 Climatology**

  /cpc/olr/PRODUCTS/CLIM

- **1991- The (delayed) Present Historical Records**

  /cpc/olr/PRODUCTS/RETRO/CTL/*ctl

- **Real-Time Updates**

  /cpc/cpc/data/observations

  /land_air/long_range/global/CBO_V1.x/CTL

Summary

- The 40-year old AVHRR will be terminated in a couple weeks;
- A new OLR data set, called CPC Blended OLR (CBO), has been constructed for 1991 to the present and is updated on a quasi real-time basis;
- The new OLR shows differences with the AVHRR OLR in the overall magnitude but presents very close agreements in anomaly variation patterns and anomaly magnitude;
- Please double check if or not you have processes / products using the AVHRR OLR data and feel free to let us know if you have any requests or need our technical assistance!