A New Daily OLR Dataset for Identifying the MJO and Tropical Waves

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Comparison with ESRL Product

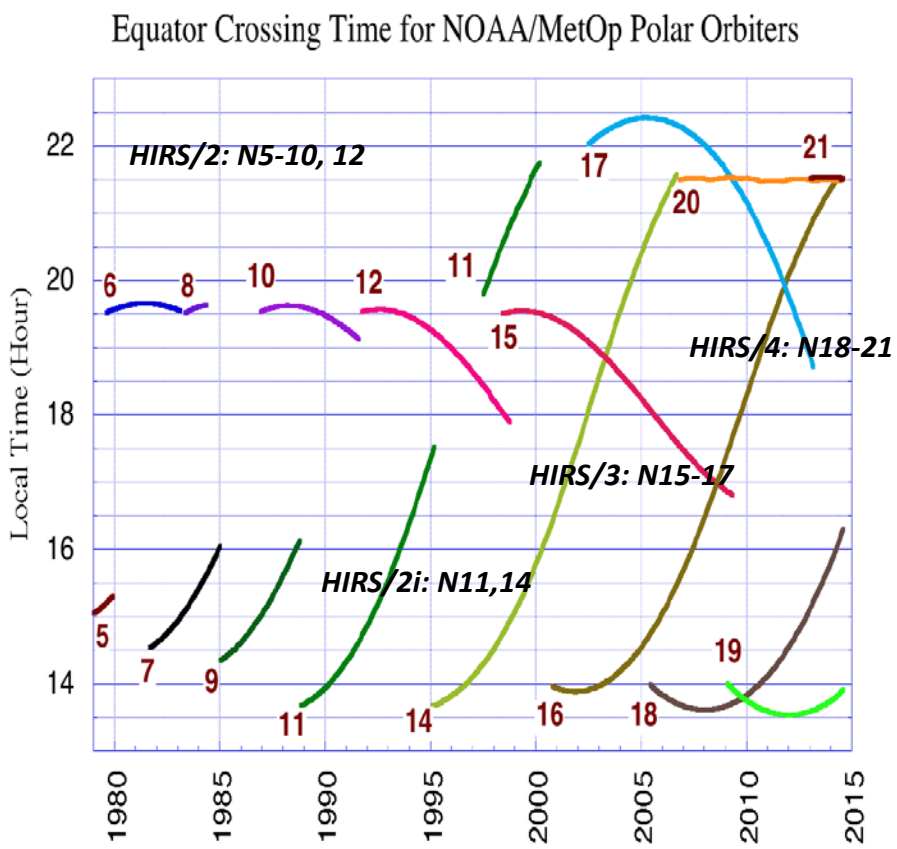
	ESRL/PSD – AVHRR	UMD/CDR* – HIRS
Sensors	AVHRR	Inter-satellite calibrated HIRS and Geostationary
Resolution	Daily, 2.5°	Daily, 1.0°
Period of Record	1974–2013	1979–2013
Gaps in Data	1978: 280 days	1980–82: 25 days 1985: 179 days 1994: 4 days

*CDR: Climate Data Record

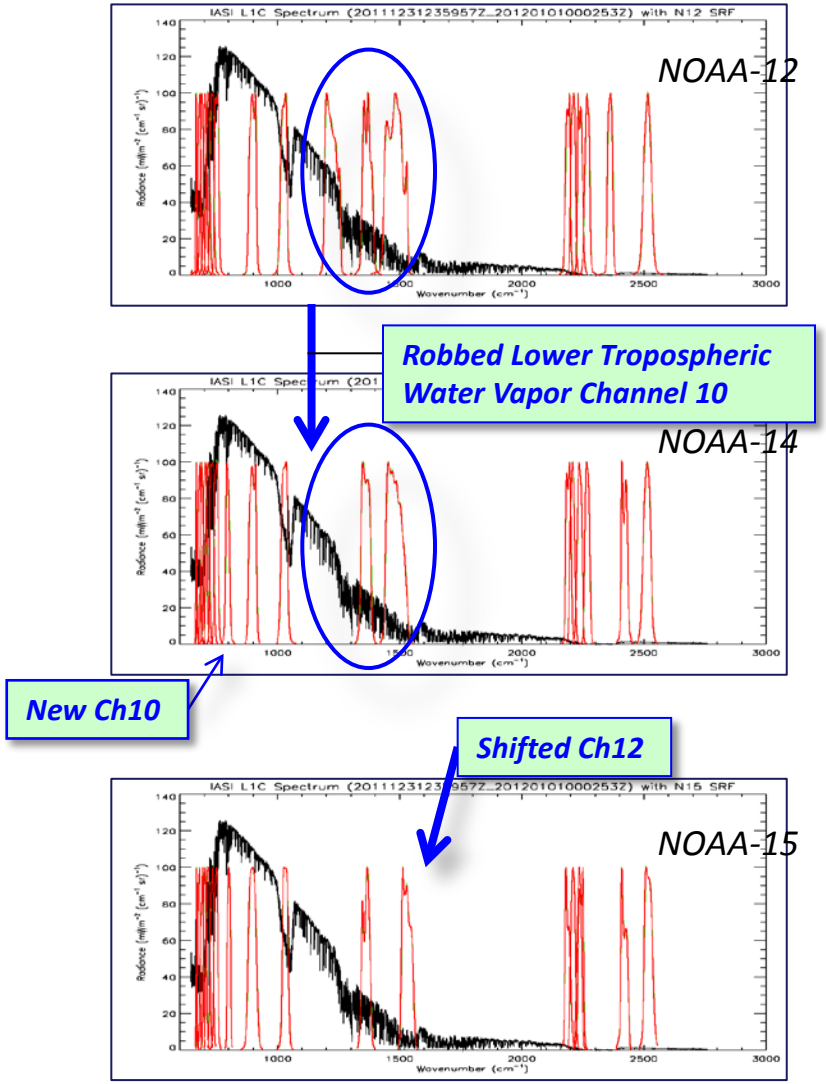
Comparison with ESRL Product

	ESRL/PSD – AVHRR	UMD/CDR – HIRS
Satellites	Afternoon POESS	All available POESS, MetOp, and Geostationary
Daily Averaging	• Interpolate missing values from day and night overpasses separately • Average interpolated day and night data	• Use 7-day boxcar to calibrate Geostationary to HIRS • Time-weighted average of all available OLR estimates

HIRS Observations



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



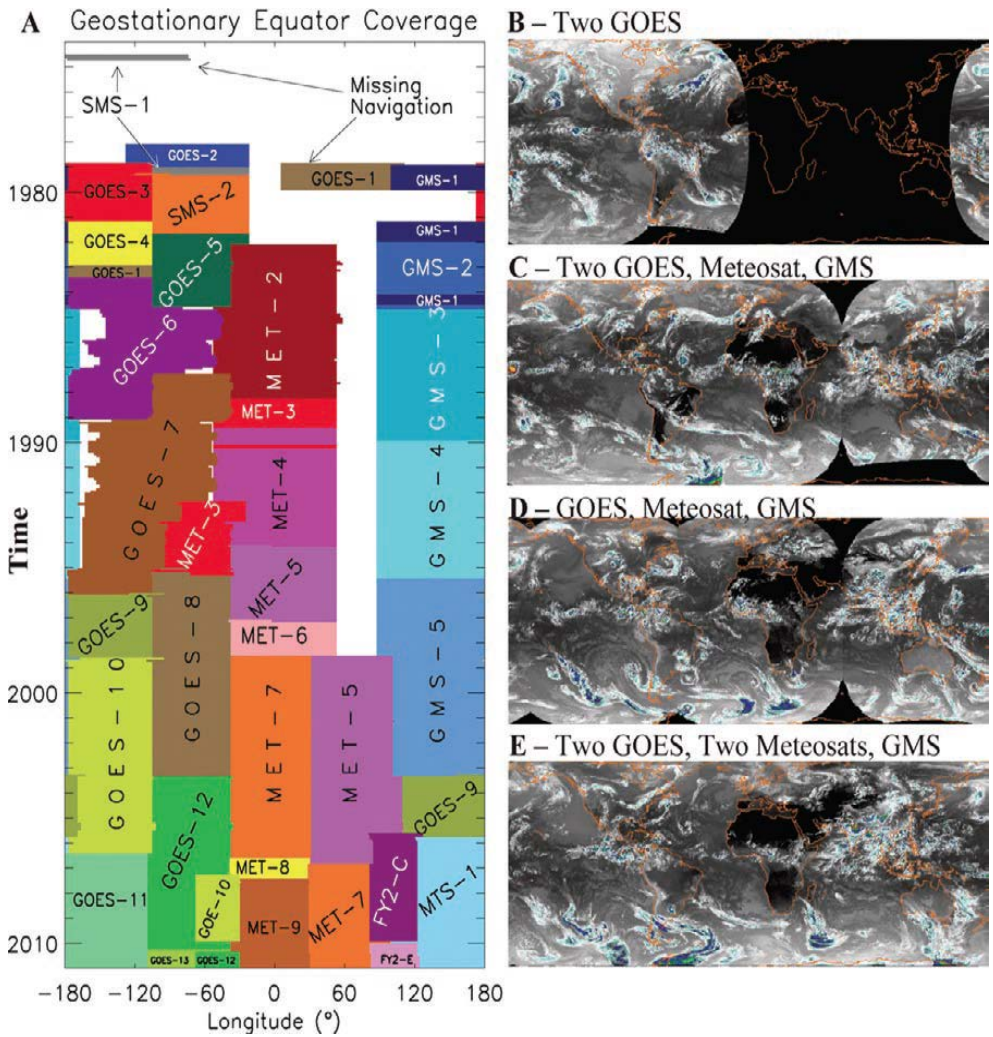
GridSat Imager OLR Algorithm

Gridsat CDR Product (v02r01) *(Knapp et al, 2011) provides cross-calibrated brightness temperatures for the atmospheric window and ~6.7 mm 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]

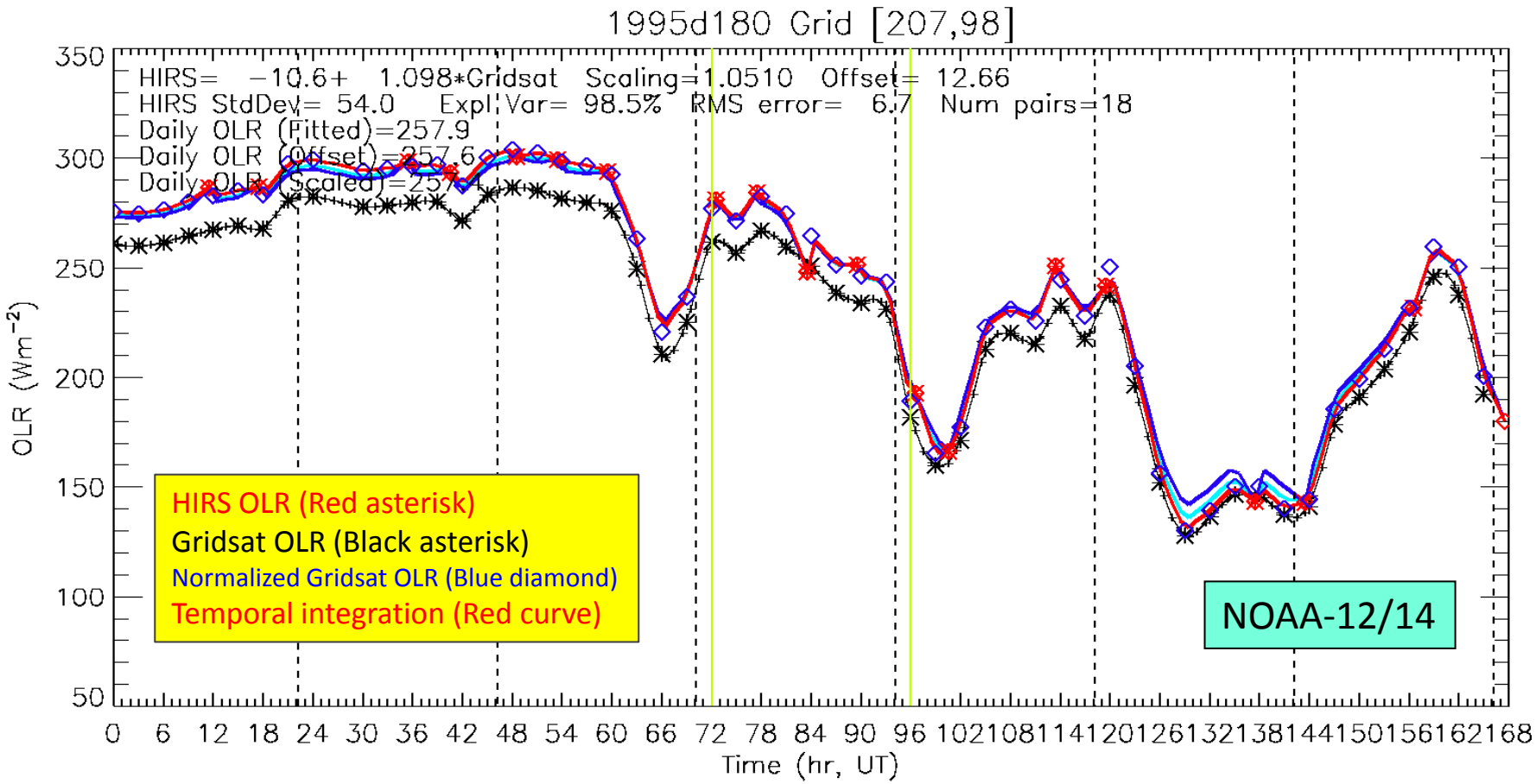
$$OLR = \sigma T_f^4$$

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

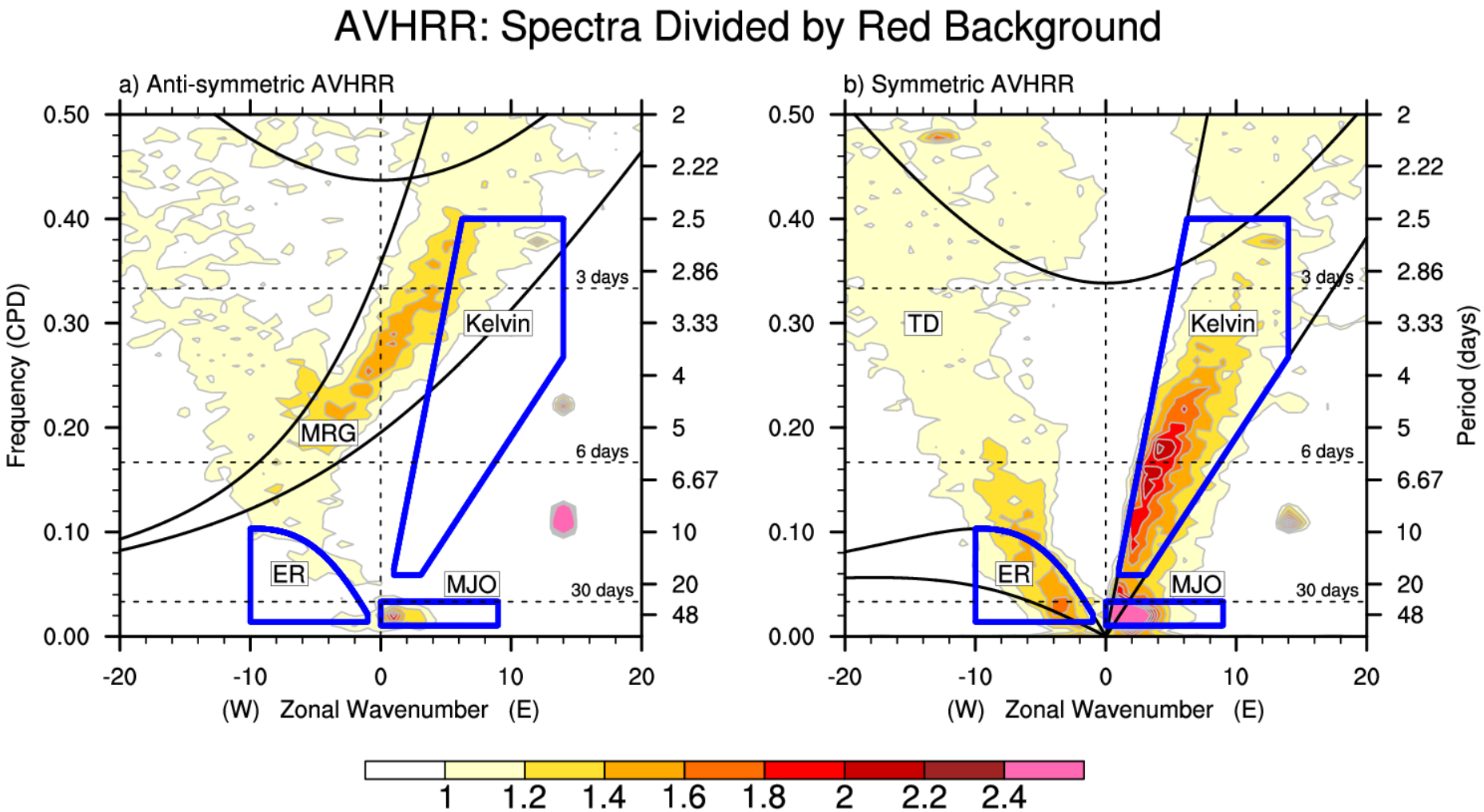


Knapp et al, 2011

7-Day Boxcar (1995 day 180)



Wheeler–Kiladis Spectra



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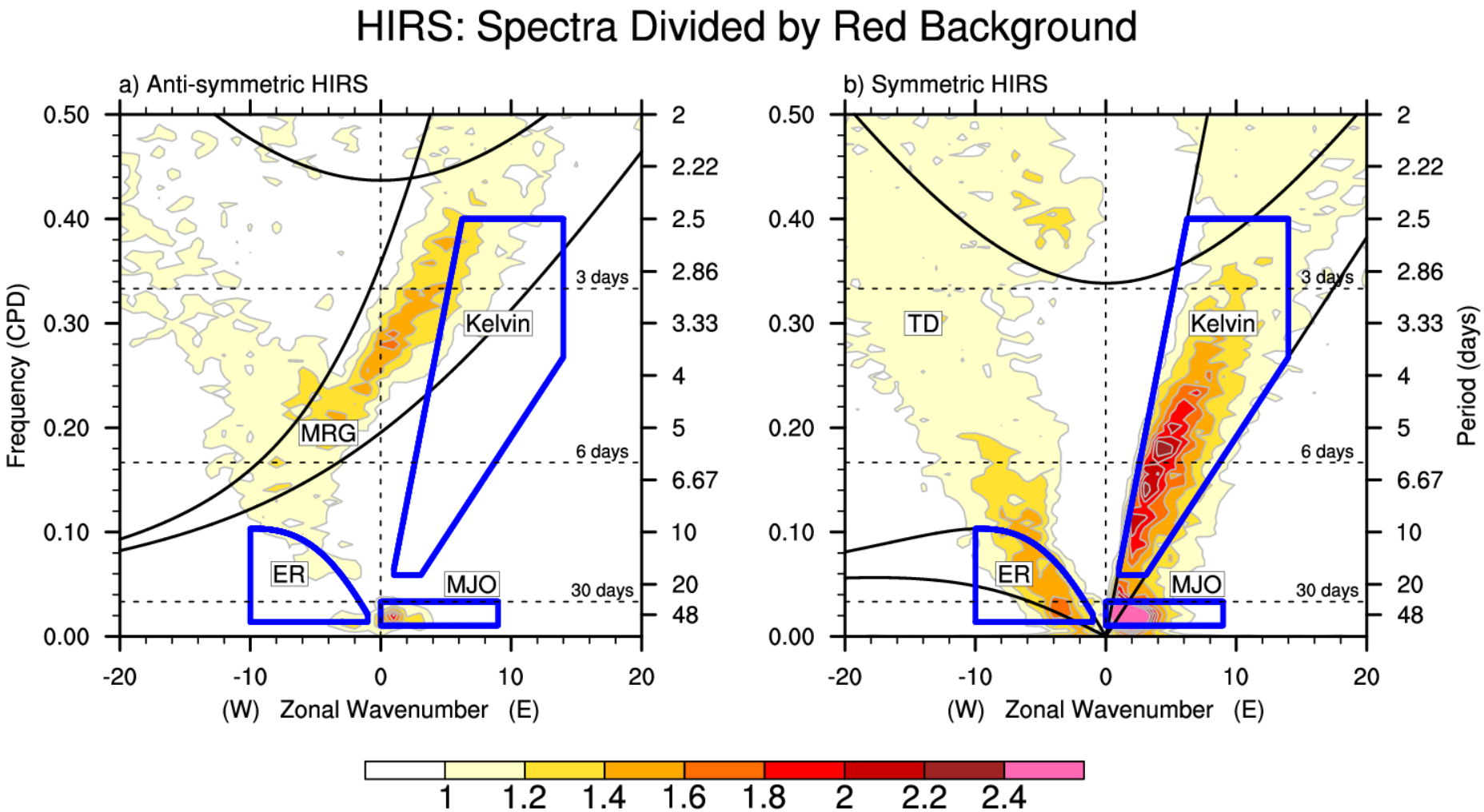
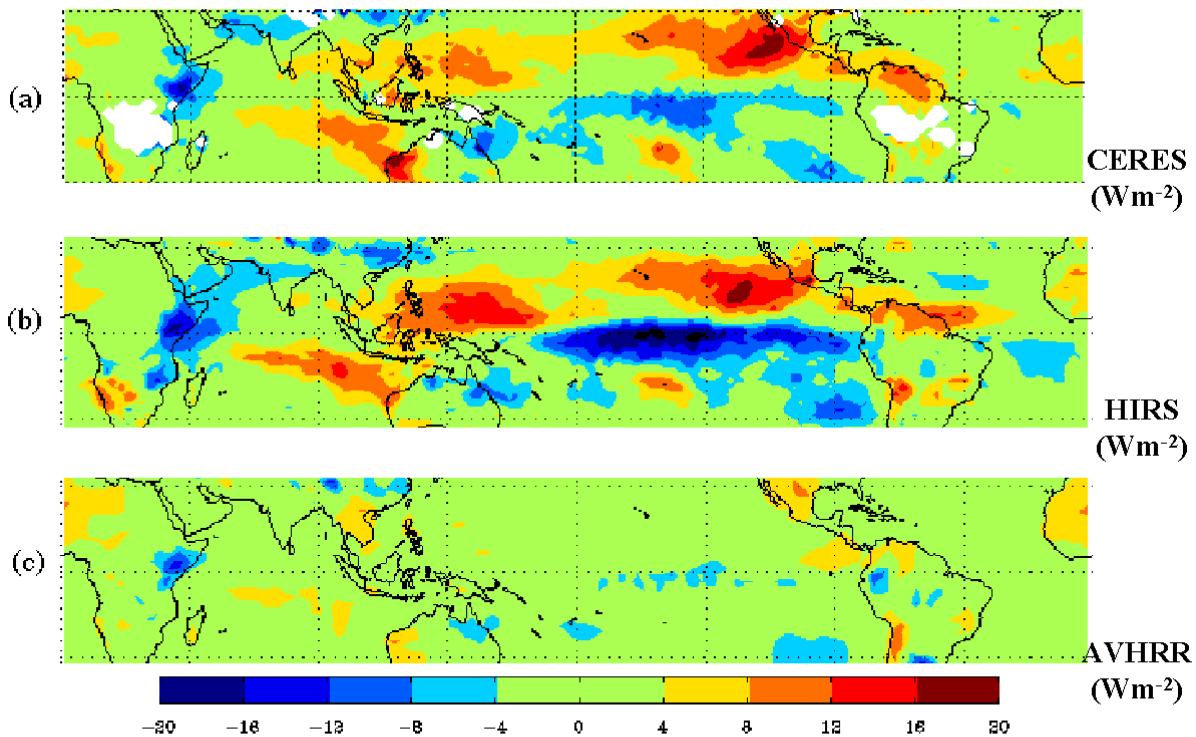


Clear-sky OLR Anomaly (Jan 1998)

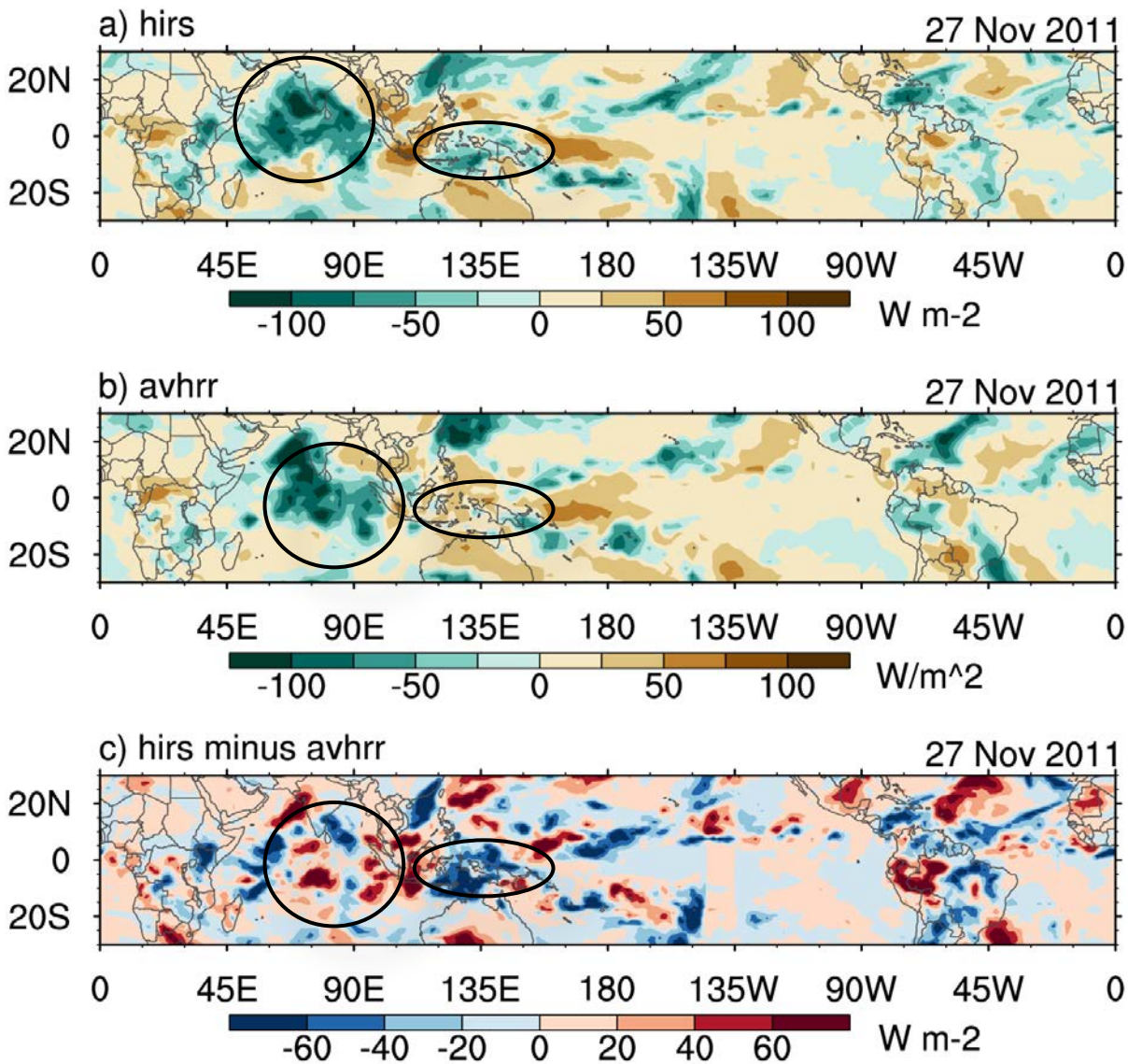
- Sources of Clear-sky variations:
  - Surface temperatures
  - Water Vapor
- HIRS and CERES both detect these
- AVHRR lacks water vapor sensitivity



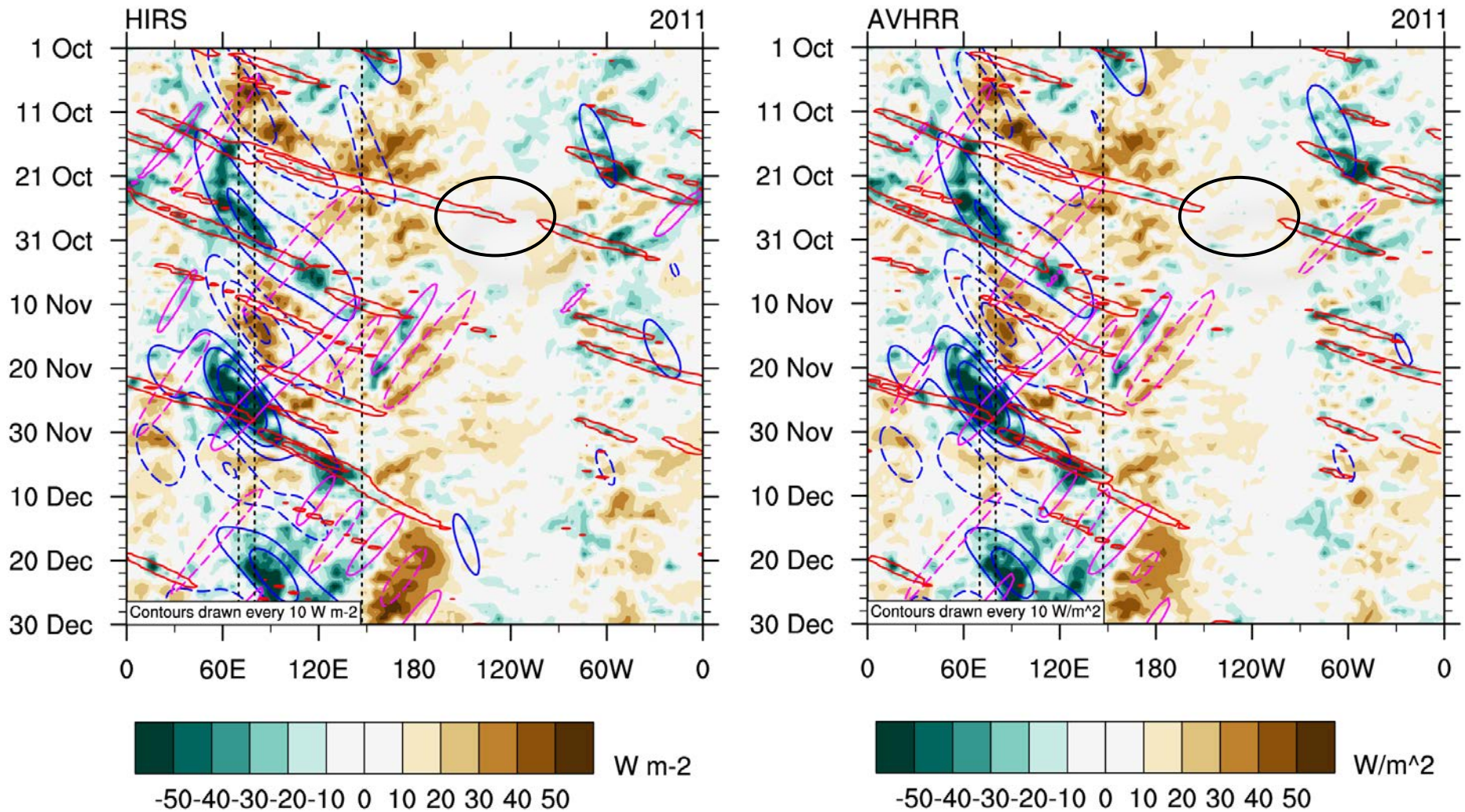
Anomaly fields of CERES, HIRS, and AVHRR clear-sky OLR for January 1998.

Maps from DYNAMO

- 1.0° degree resolution in HIRS product provides more detail
- Also note the effects of water vapor

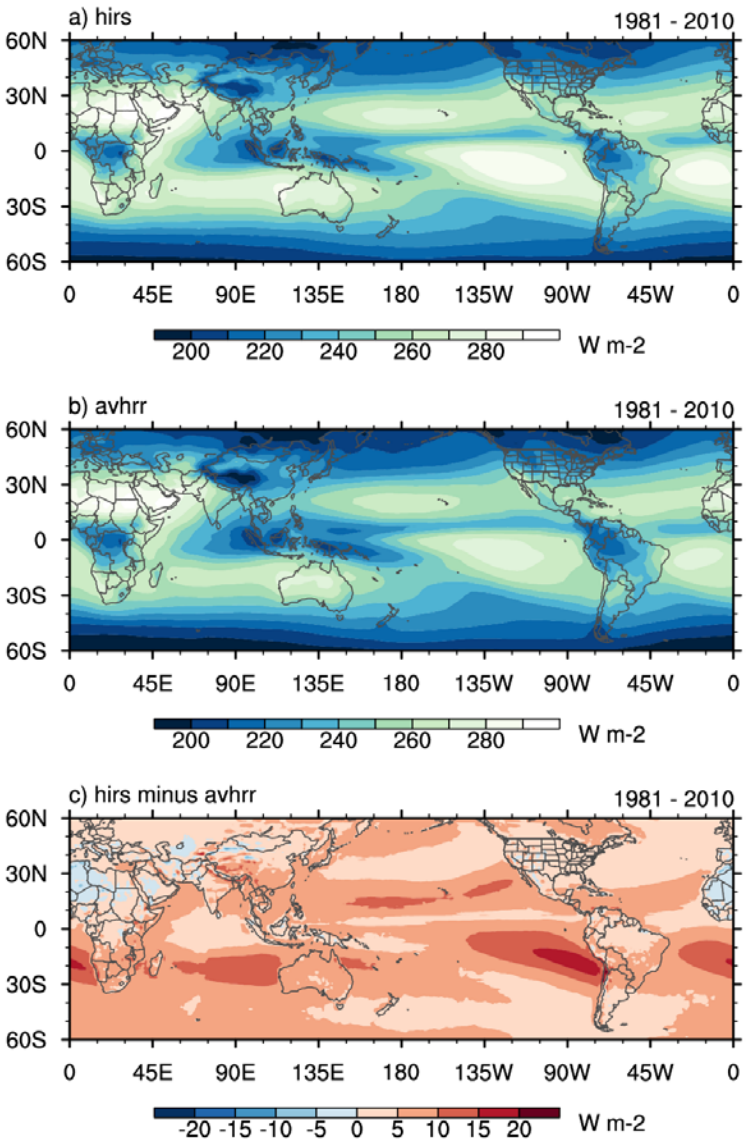


DYNAMO Hovmöllers



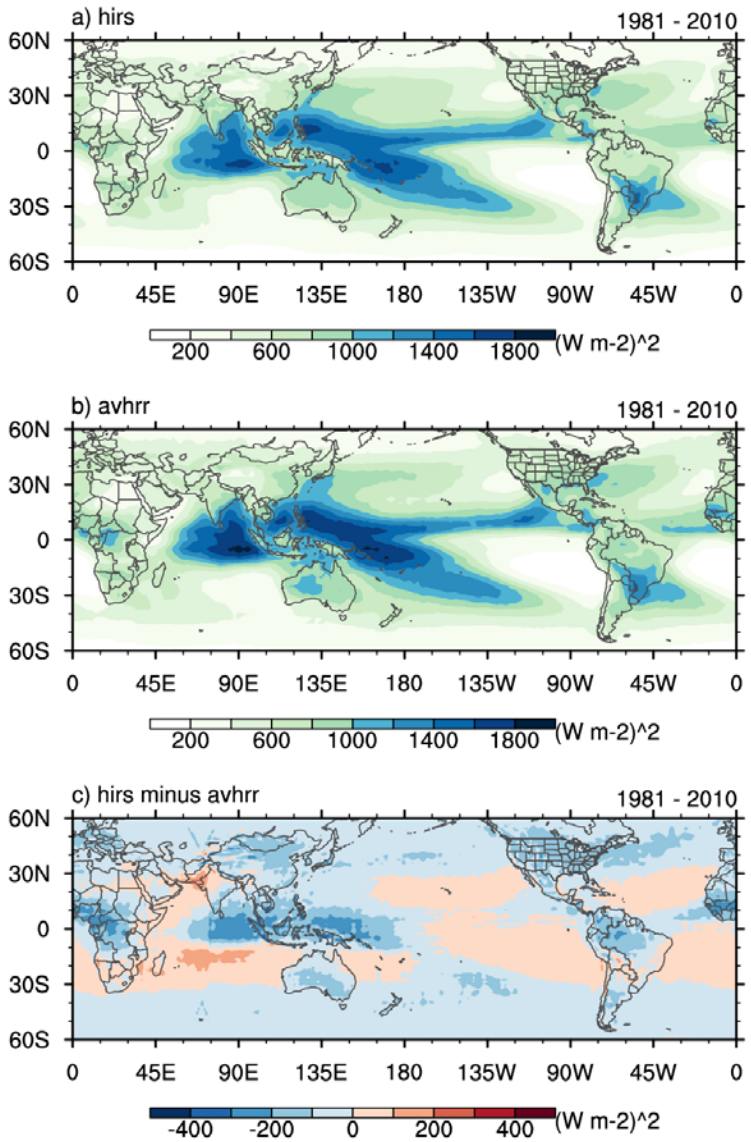
Mean OLR

- HIRS has higher values in most regions
  - Esp. subtropical oceans
- AVHRR is a little higher over continental deserts



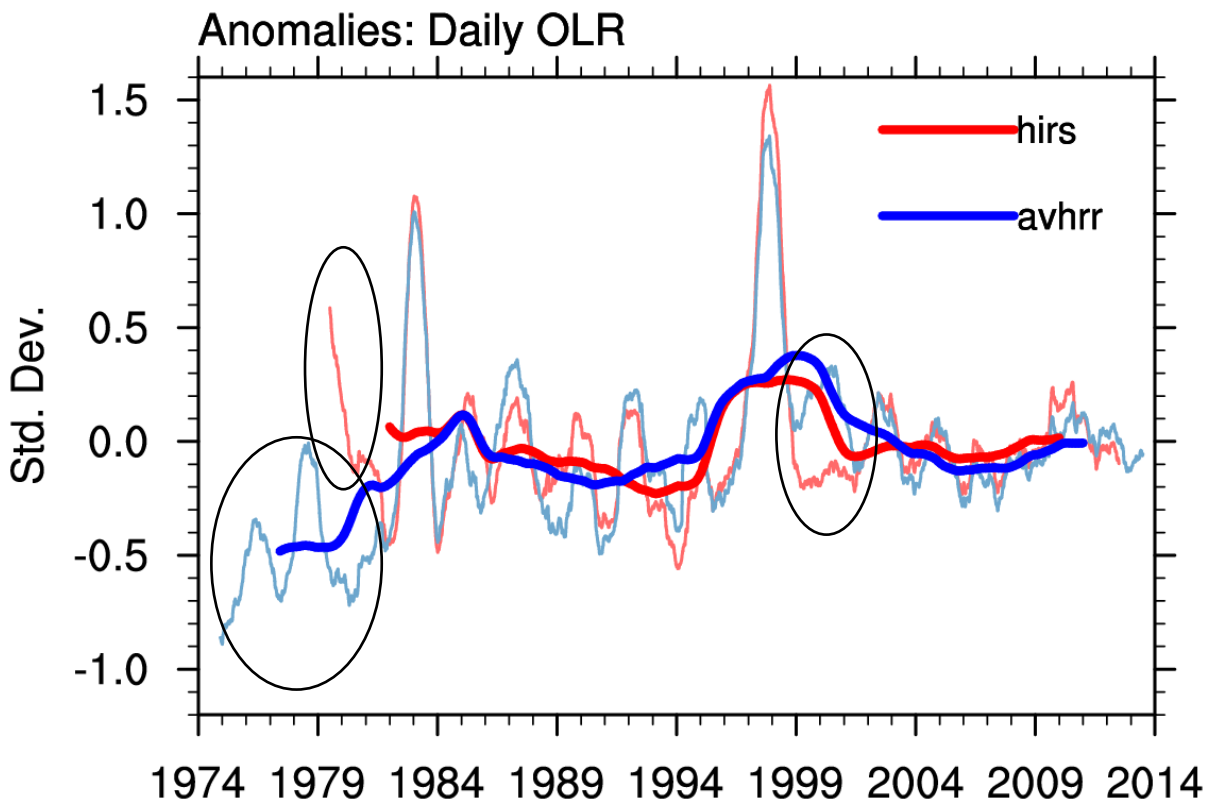
Total Variance

- Showing anomalies from seasonal cycle
- AVHRR has larger variance in ITCZ/monsoon regions
  - Esp. Indo-Pacific warm pool
- HIRS has more over subtropical oceans
  - Greater sensitivity to moisture



Total Variance

1. Square the anomalies
2. Average over the tropical strip 20° S–20° N
3. Standardize the time series relative to 1981–2010

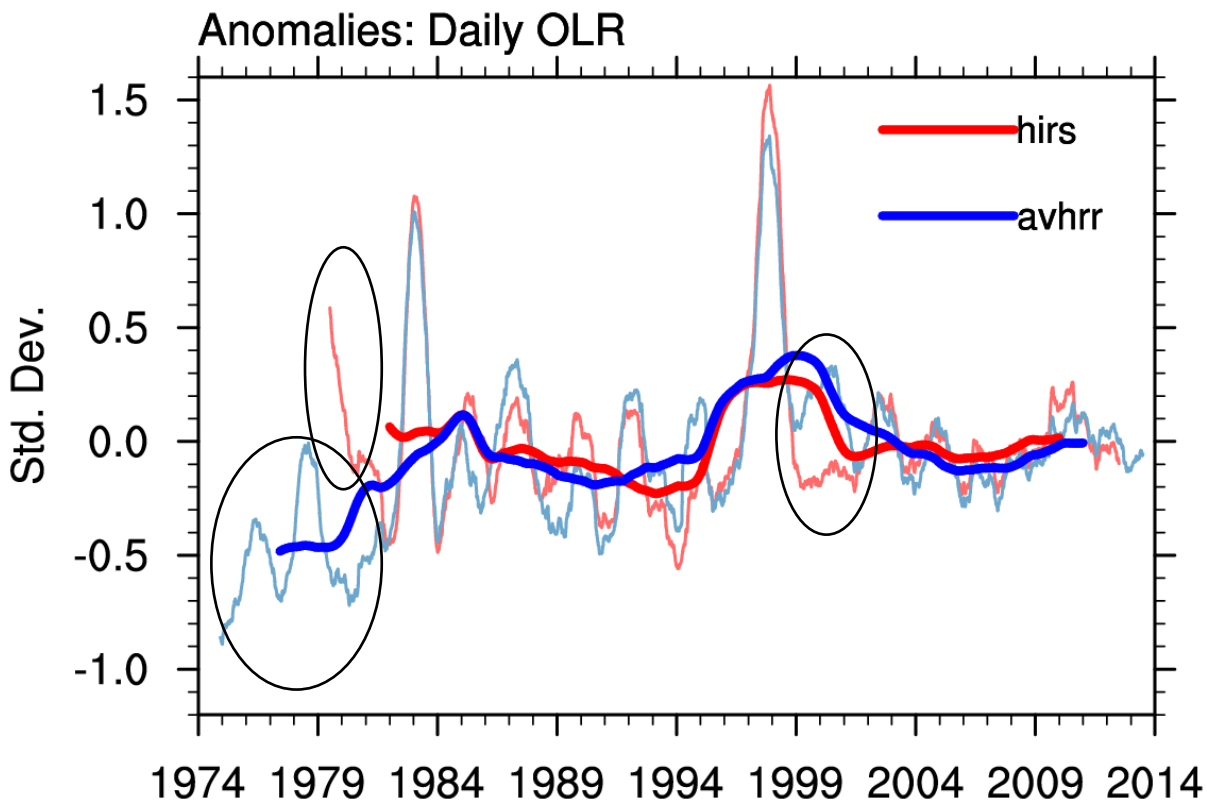


Think Lines: 1-year mean
Thick Lines: 5-year mean

Next…

Total OLR Variance

- Big difference before 1982
  - HIRS had limited GridSat Coverage
  - AVHRR also looks inconsistent with later period
- Notable differences during ENSO events



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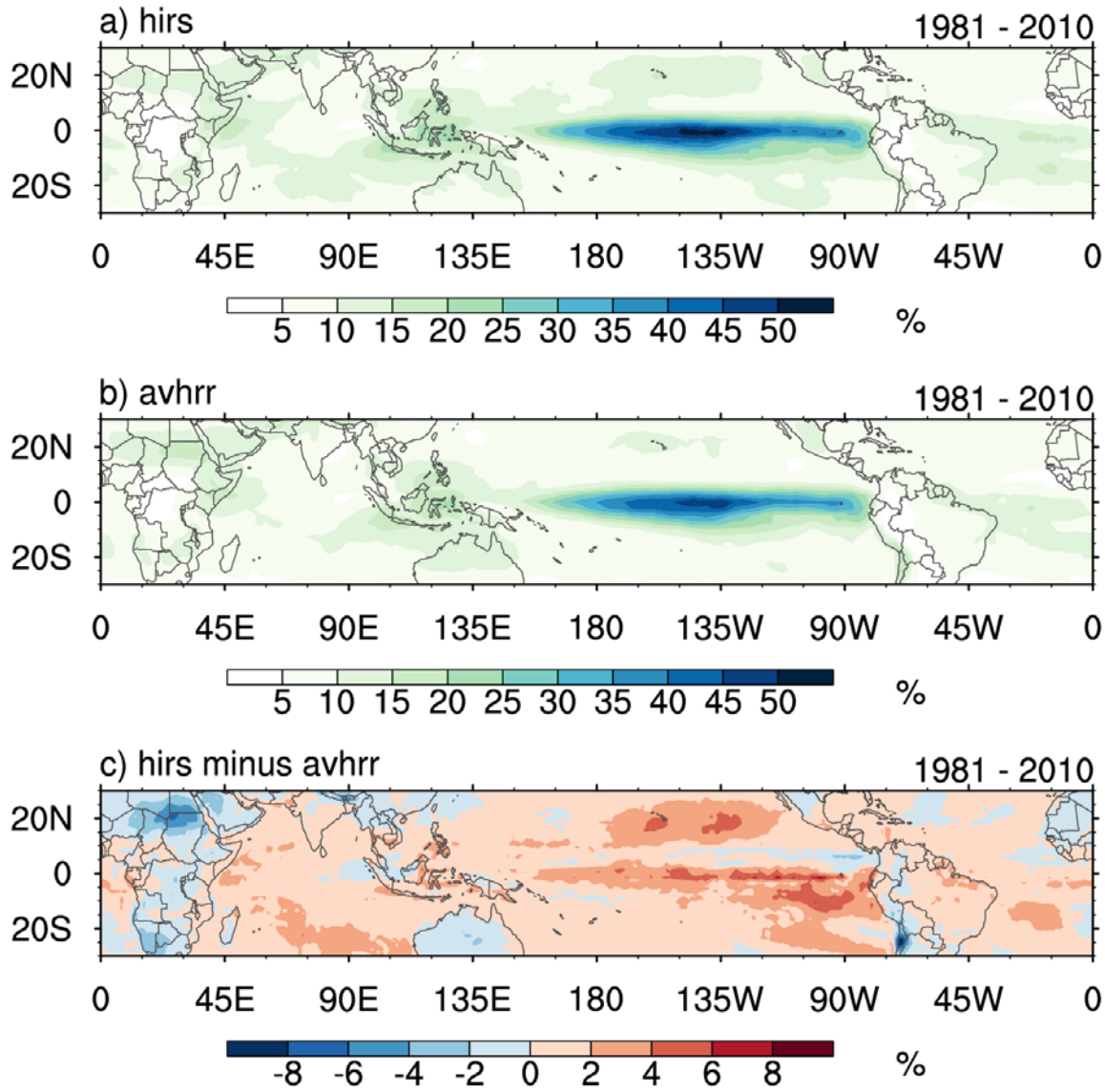
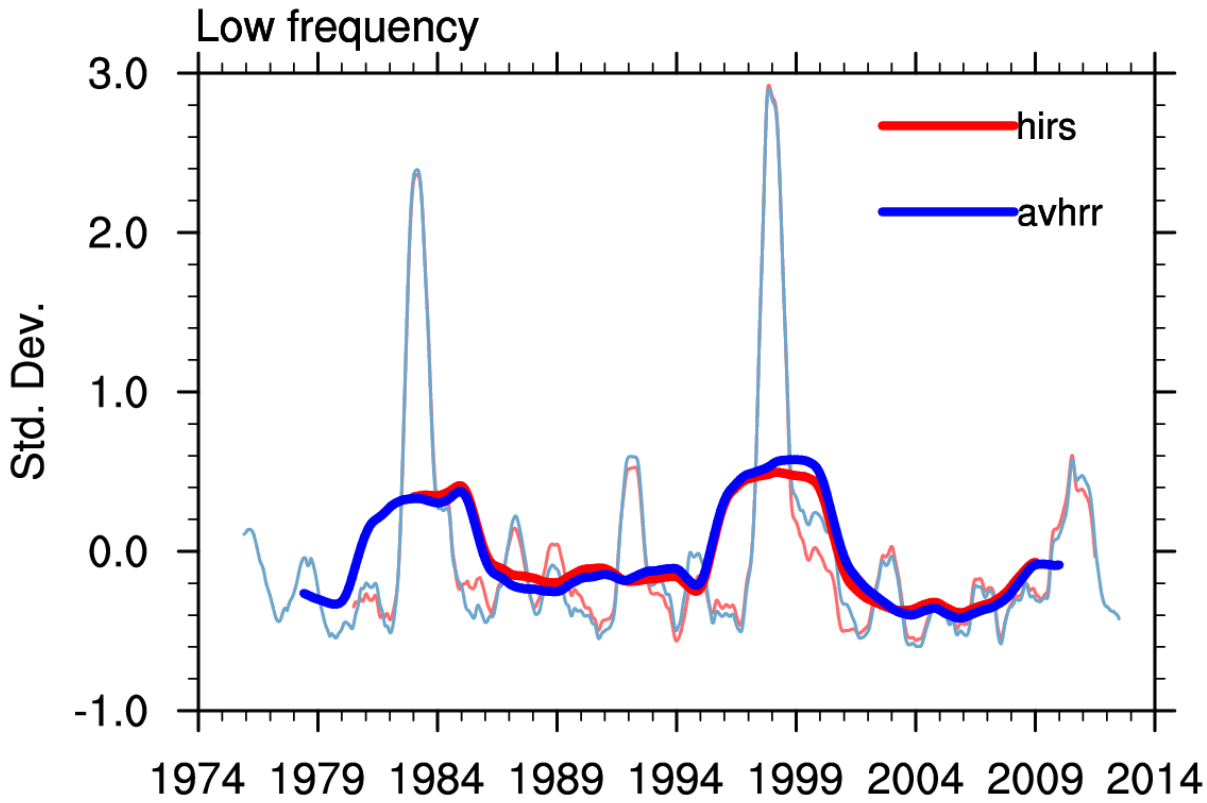
Low-Frequency (ENSO)

- HIRS has larger variance in the low-frequency band, esp. over the equatorial Pacific and the North Pacific



Low-Frequency/ENSO

- AVHRR is higher:
  - 1987 El Niño
  - 1992 El Niño
  - 1995 El Niño
  - 1998–2001 La Niña
- HIRS is higher:
  - 1985 La Niña
  - 1989 La Niña
  - 2003 El Niño



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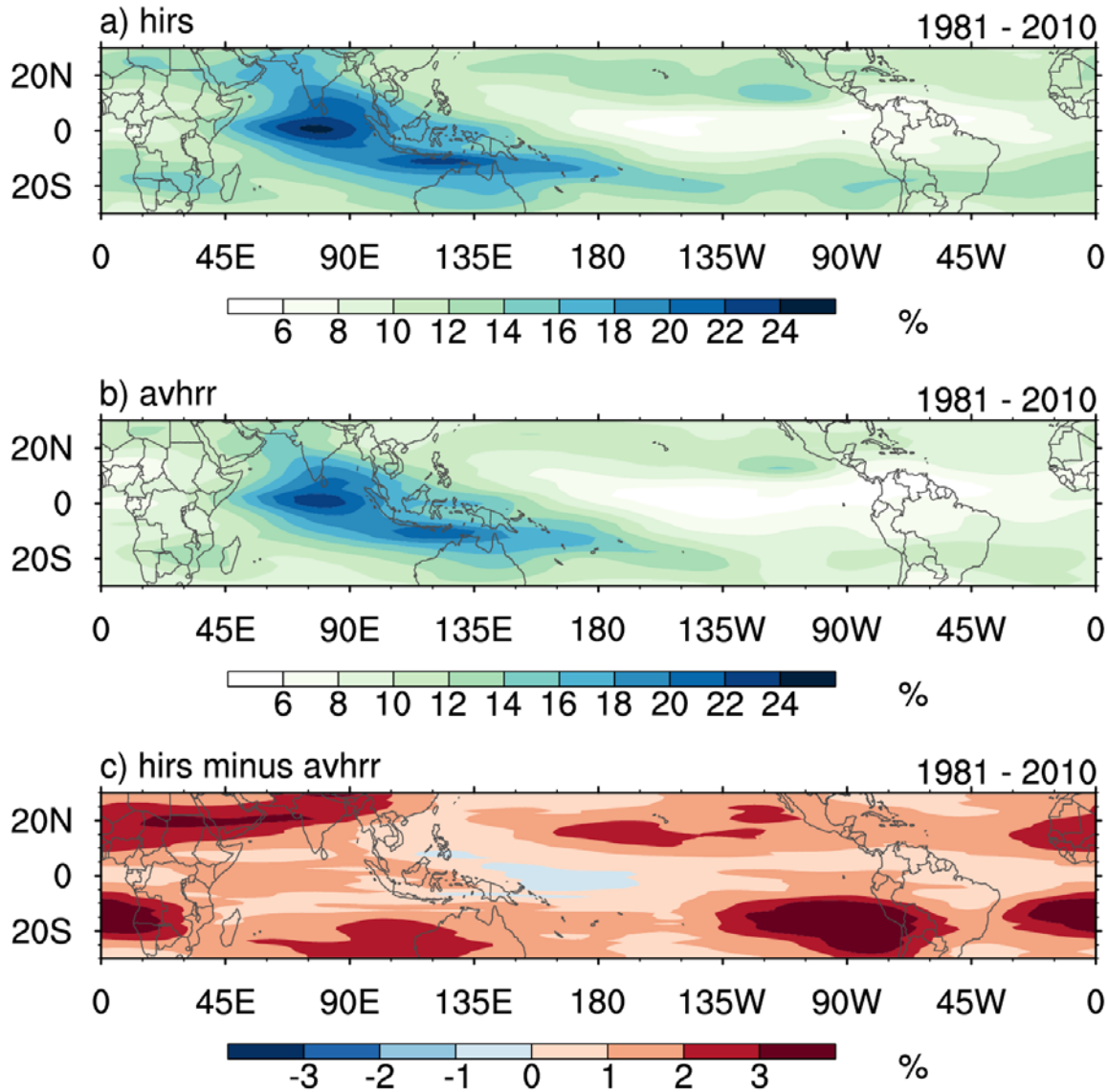
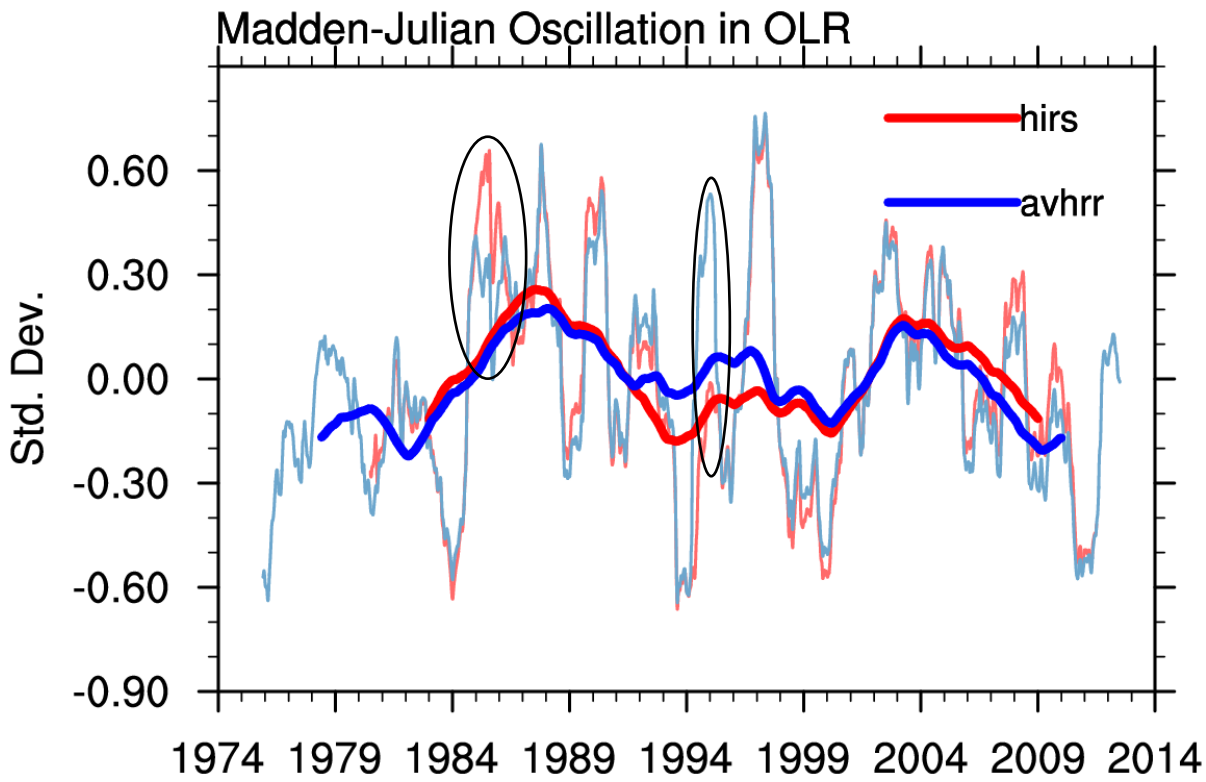
Madden–Julian Oscillation

- MJO explains a larger fraction of variance in the HIRS data, esp. in the subtropics



Madden–Julian Oscillation

- HIRS is higher in 1985
  - Possible reflection of missing data?
- AVHRR is higher during 1994/95



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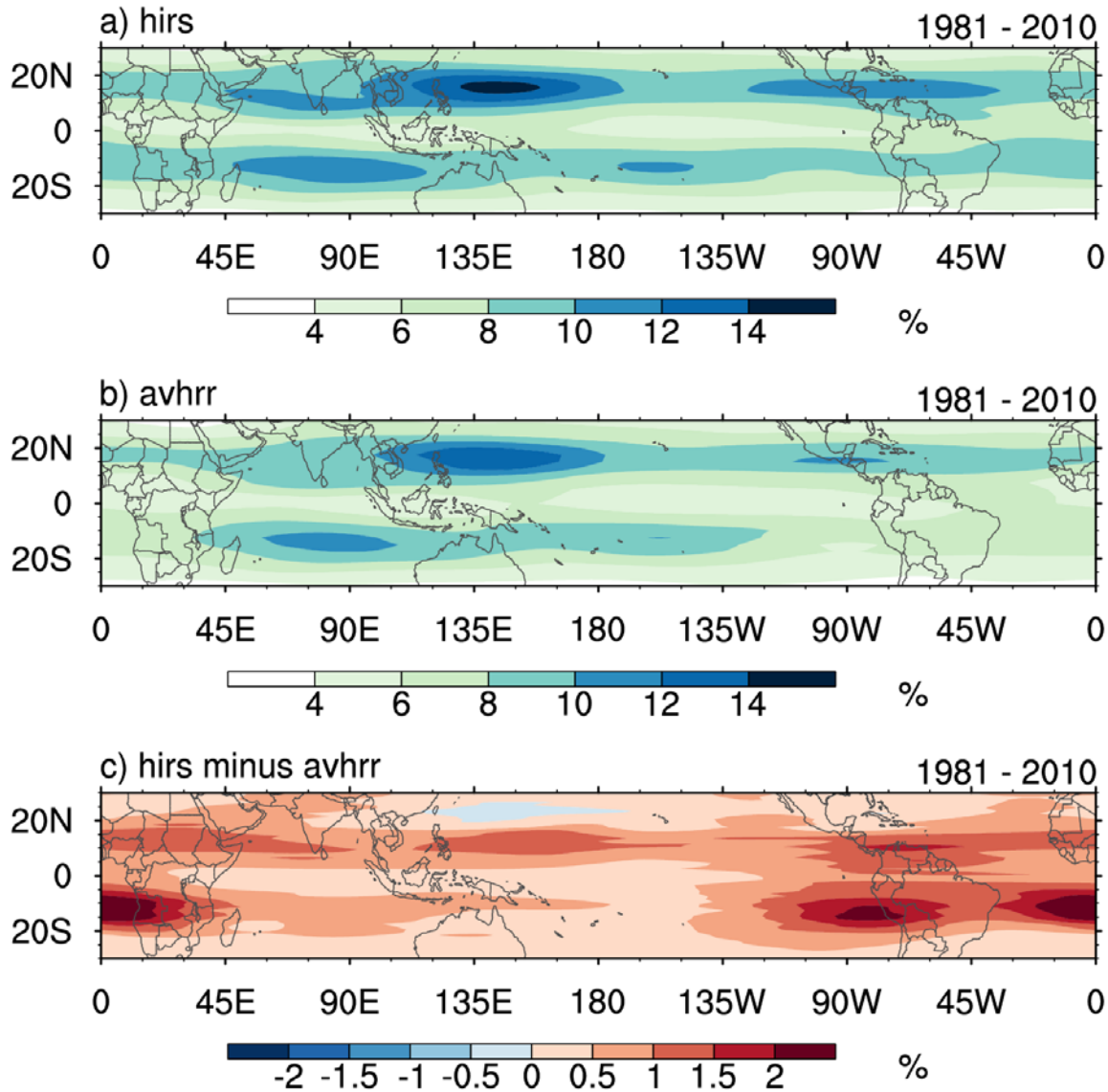
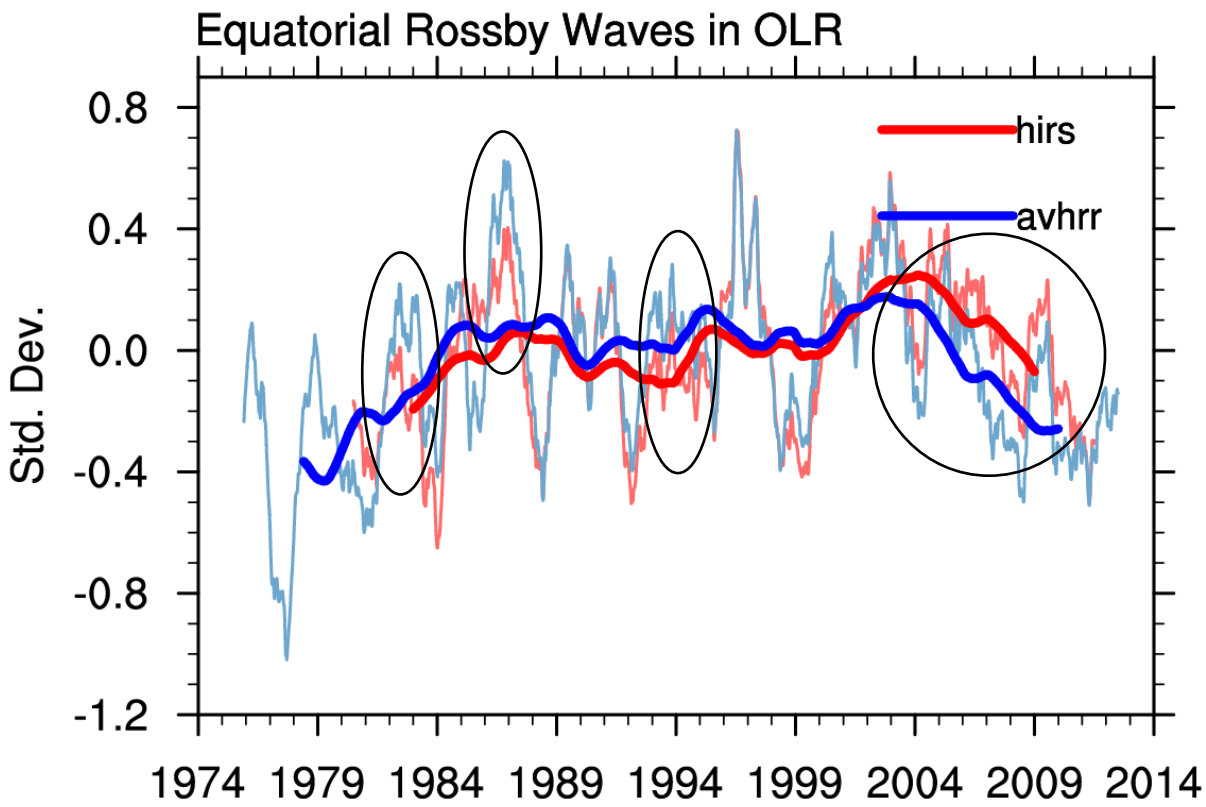
Equatorial Rossby Waves

- HIRS is more sensitive to ER waves too



Equatorial Rossby Waves

- AVHRR is higher in
  - 1982-83 El Niño
  - 1986-88 El Niño
  - 1992-95 weak El Niño
- HIRS is higher in
  - 2005-2010



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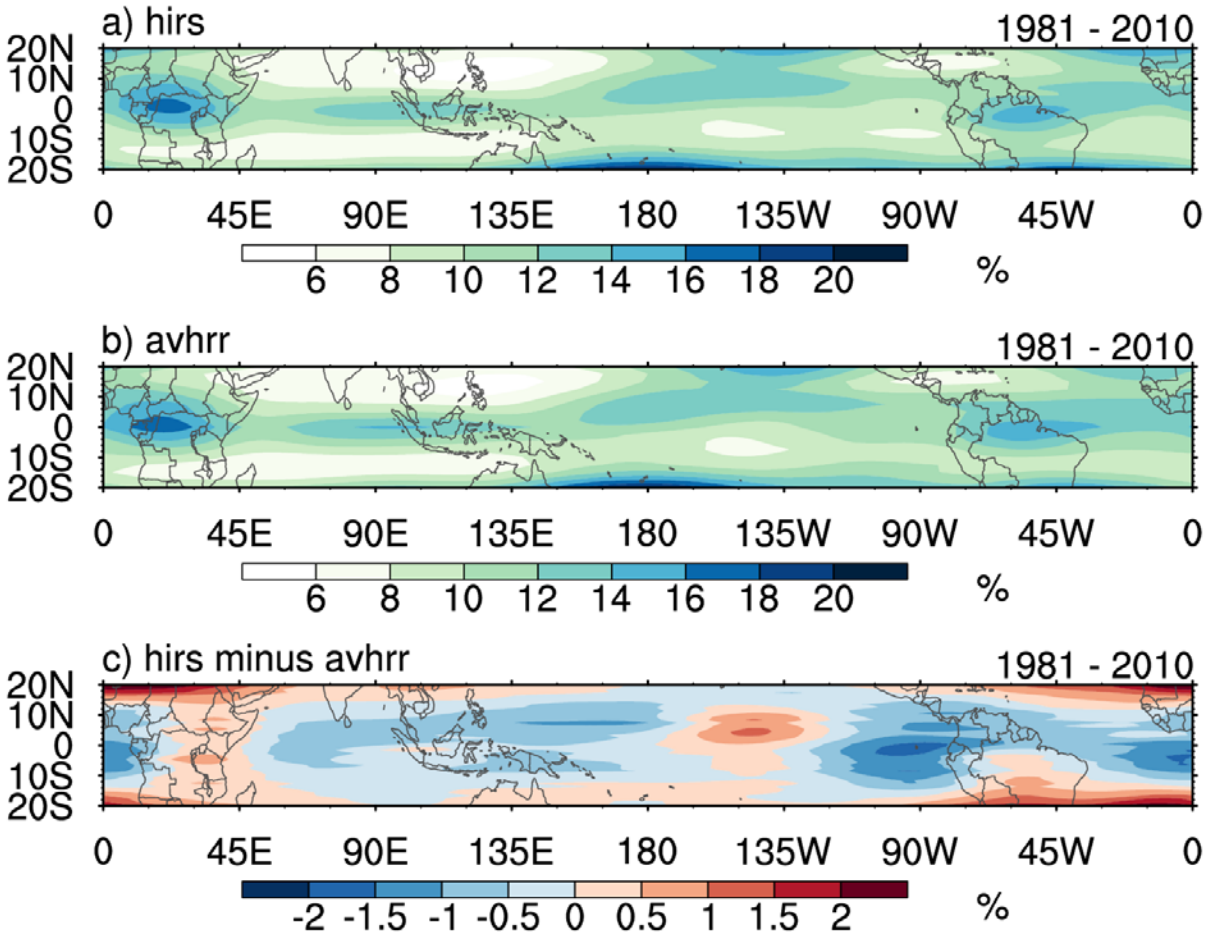
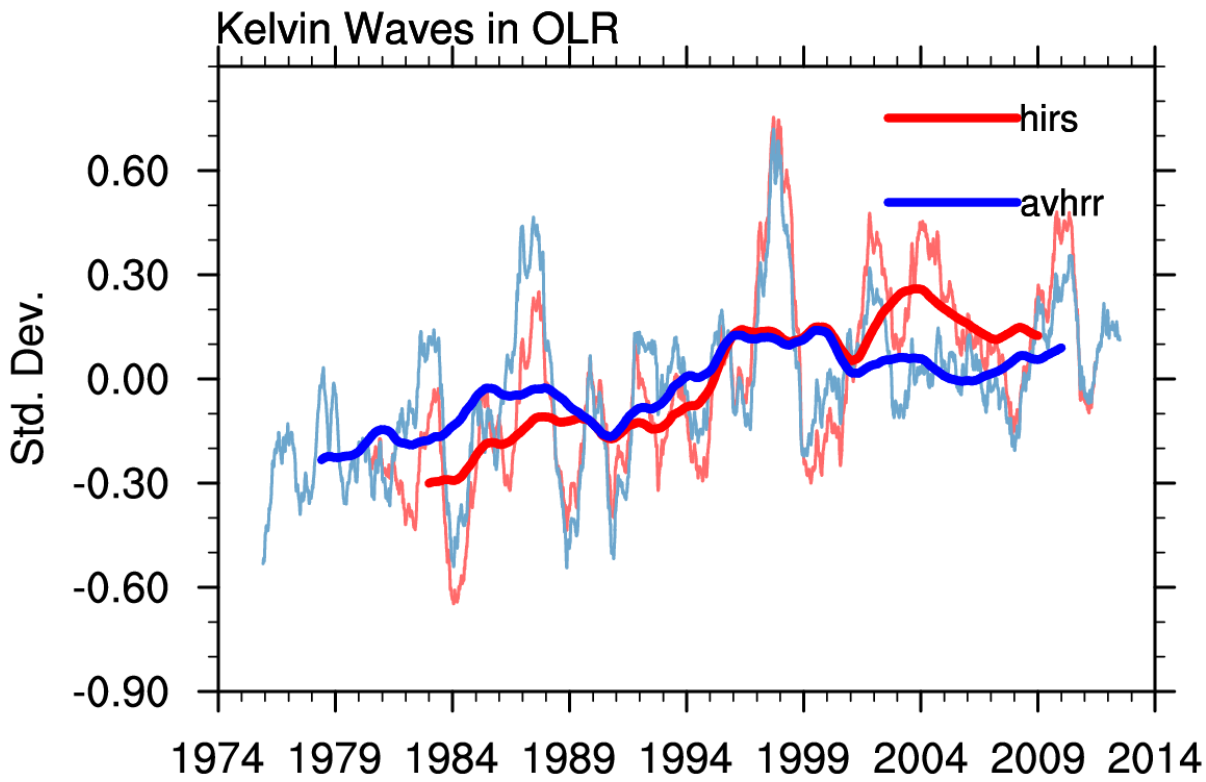
Kelvin Waves

- Kelvin signal is mixed, generally more in the AVHRR band



Kelvin Variance

- Both dataset show increasing trends in variance
  - Stronger in HIRS



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Highlights of New HIRS OLR

- Higher Spatial Resolution (1.0°)
- Better handling of diurnal cycle
  - No spectral ringing from orbital precession
- More sensitive to water vapor
  - Useful for cloud-free regions
- More homogeneous
  - Useful for examining climate trends