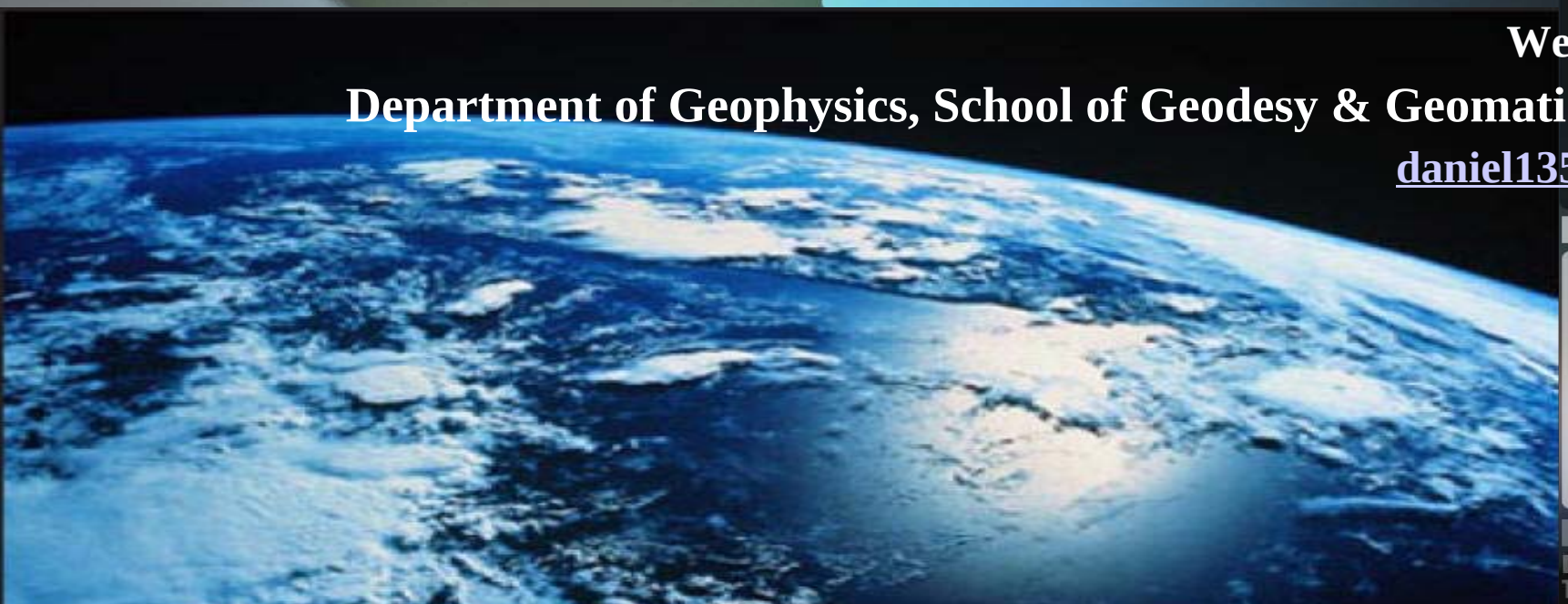
Rotational Evaluations of Global Geophysical Fluid Models and Improvement in the Annual Wobble Excitation

Wei Chen & WenBin Shen

Department of Geophysics, School of Geodesy & Geomatics, Wuhan University

daniel135@126.com, 5 July 2011



Introduction

- **To study the climate variations and the interactions between the solid Earth and its fluid envelope, various atmospheric, oceanic and hydrological models are established**
  - NCEP/NCAR (National Centers for Environmental Prediction / National Center for Atmospheric Research) reanalyses: AAM, HAM
  - ECMWF (European Centre for Medium-Range Weather Forecasts) reanalyses: AAM, OAM, HAM
  - JMA (Japan Meteorological Agency) products: AAM
  - UKMO (United Kingdom Meteorological Office) products: AAM
  - ECCO (Estimating the Circulation and Climate of the Ocean) Assimilation products: OAM
  - GLDAS (Global Land Data Assimilation System) products: HAM

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Introduction

- **Consistencies among these atmospheric, oceanic and hydrological models are quite important**
  - Consistency: the models of the ocean and hydrology should be driven by outputs from the same atmospheric model as it had been used to derive the AAM (Brzezinski, 2011, private communication)

- **Four consistent data sets are used (with the IB model based on a private communication with Richard Gross, 2010)**
  - NCEP AAM + ECCO OAM + NCEP HAM (since 1948)
  - ECMWF ERA40 AAM + OAM + HAM (1958 ~ 2001)
  - ECMWF ERAinterim AAM + OAM + HAM (since 1989)
  - ECMWF operational AAM + OAM + HAM (since 2000)

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Model Evaluations I: Daily data

- **Data used**
  - IERS EOP 08 C04 (1993 ~ 2008)
  - NCEP reanalysis AAM + ECCO kf080 OAM + NCEP reanalysis / GLDAS HAM (1993 ~ 2008)
  - ECMWF ERA40 (1993 ~ 2001) plus ECMWF operational (2002 ~ 2008) AAM + OAM + HAM

    (ERAinterim data don't own significant difference against this data set, and thus will not be shown here; However, ERAinterim data will be displayed in Model Evaluations II: 6-hour data)

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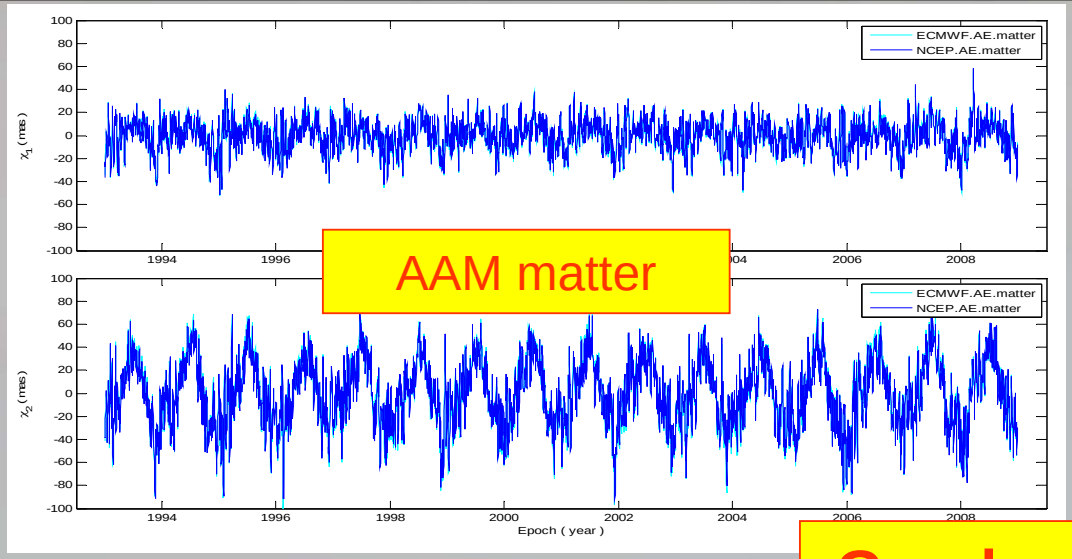
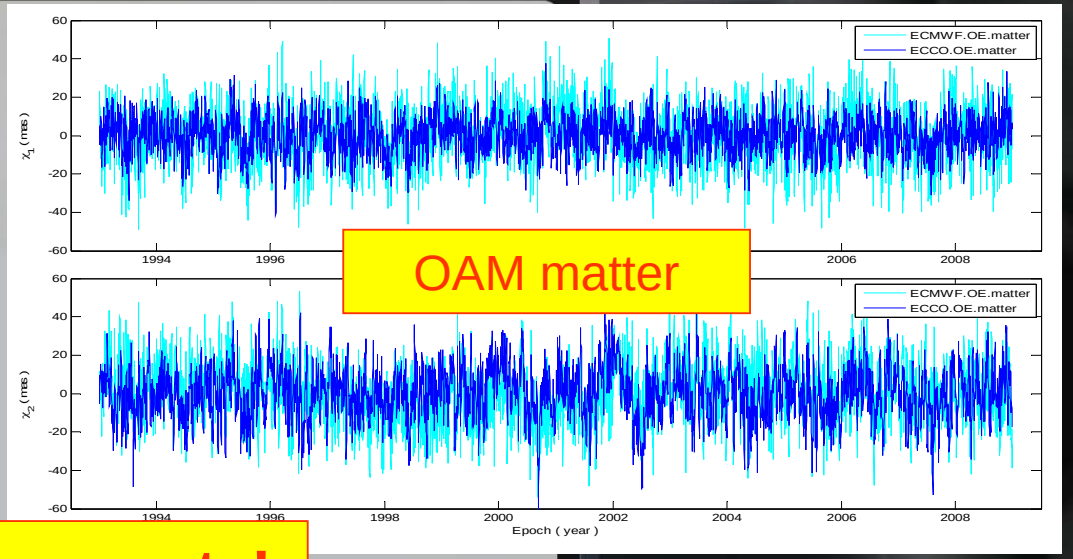
Time Series Comparisons (1d)

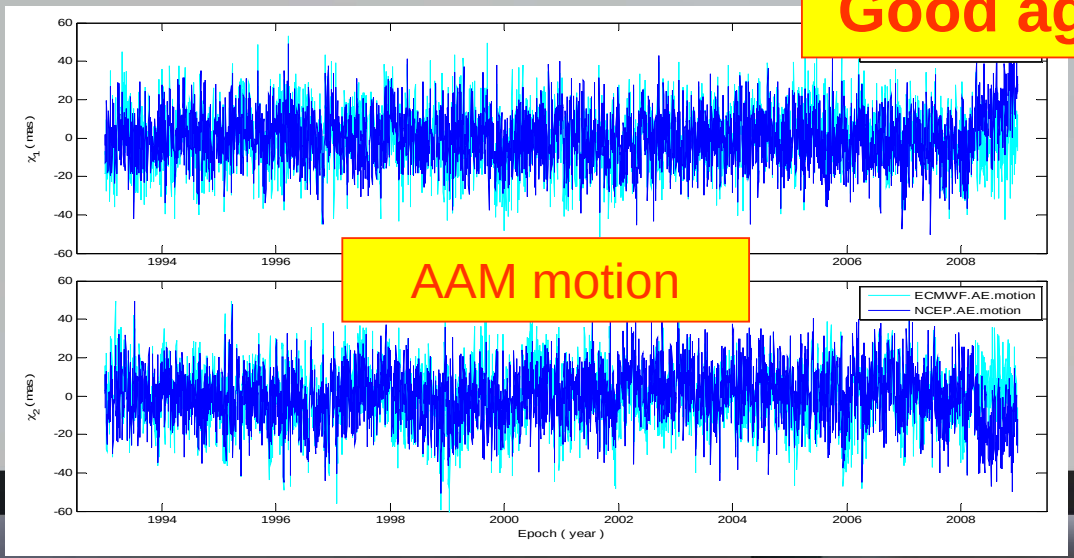


AAM matter

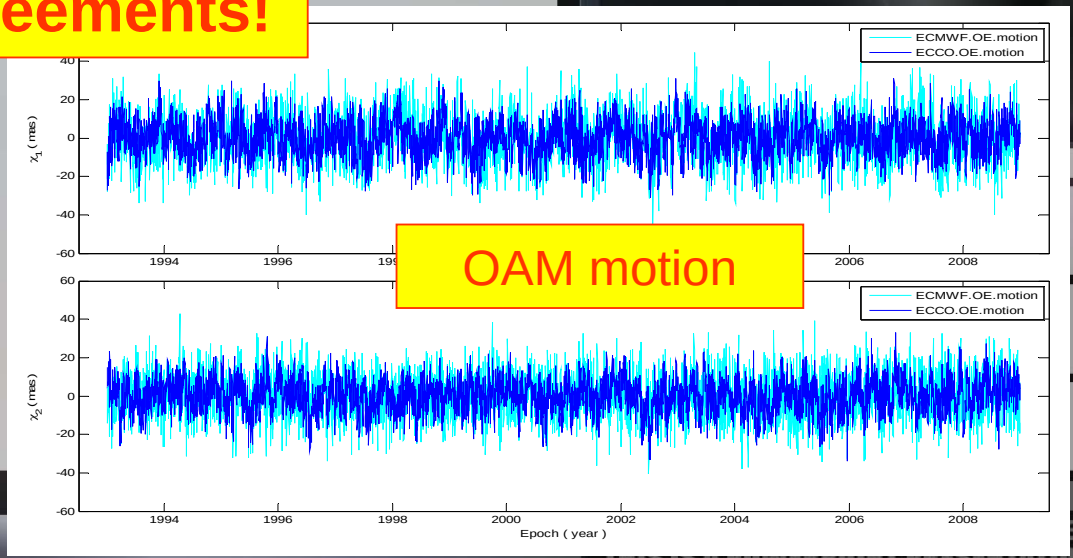


OAM matter

Good agreements!

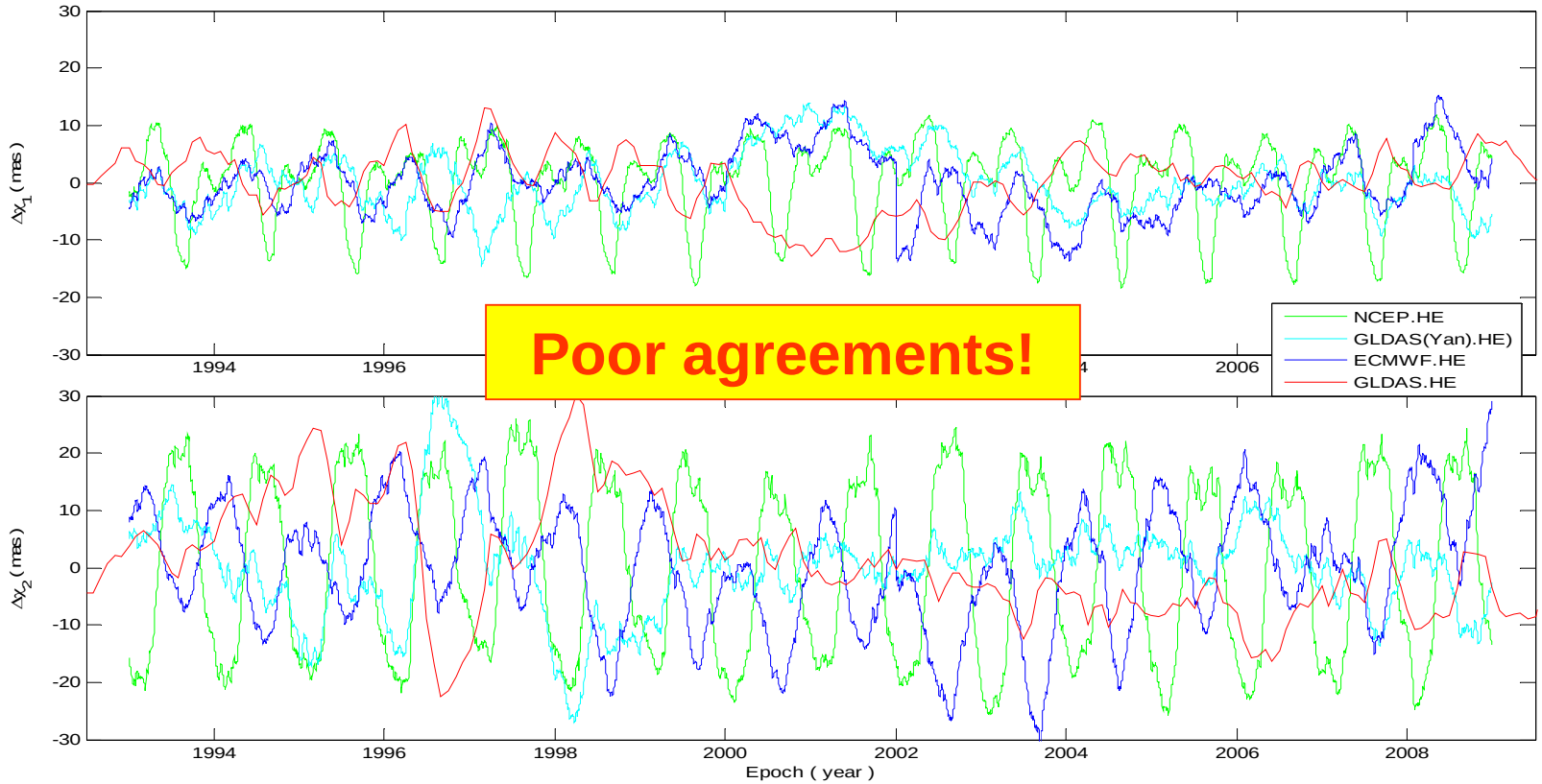


AAM motion



OAM motion

Time Series Comparisons (1d)



- GLDAS(Yan).HE (cyan line) is provided by Dr. Haoming Yan
- GLDAS.HE (red line) is our estimate

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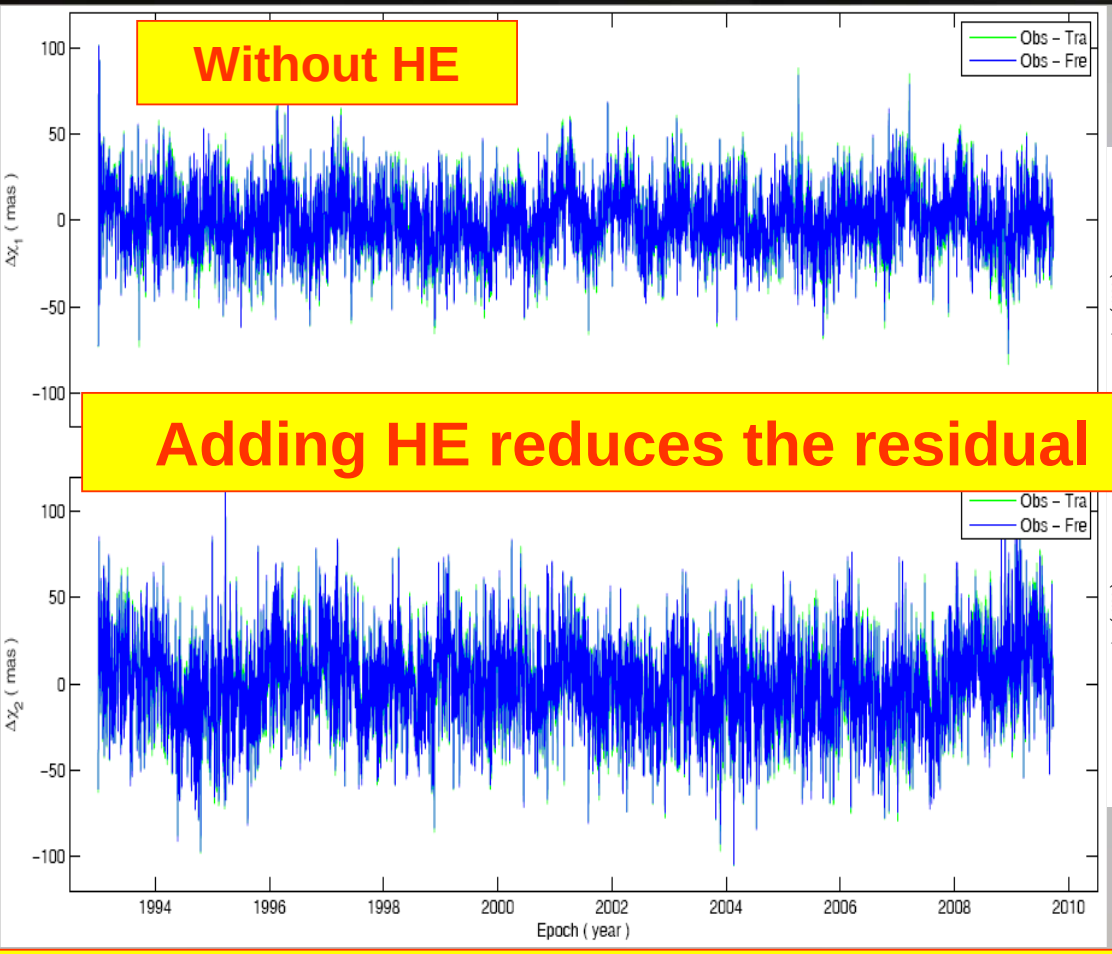
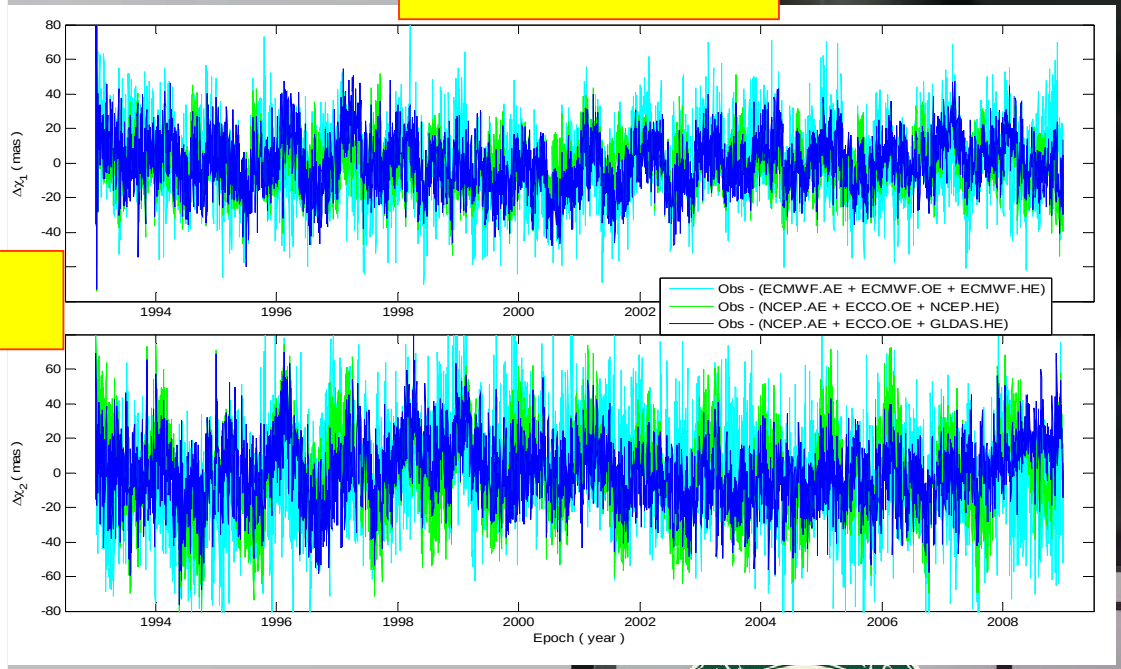
Time Series Comparisons (1d)

Without HE



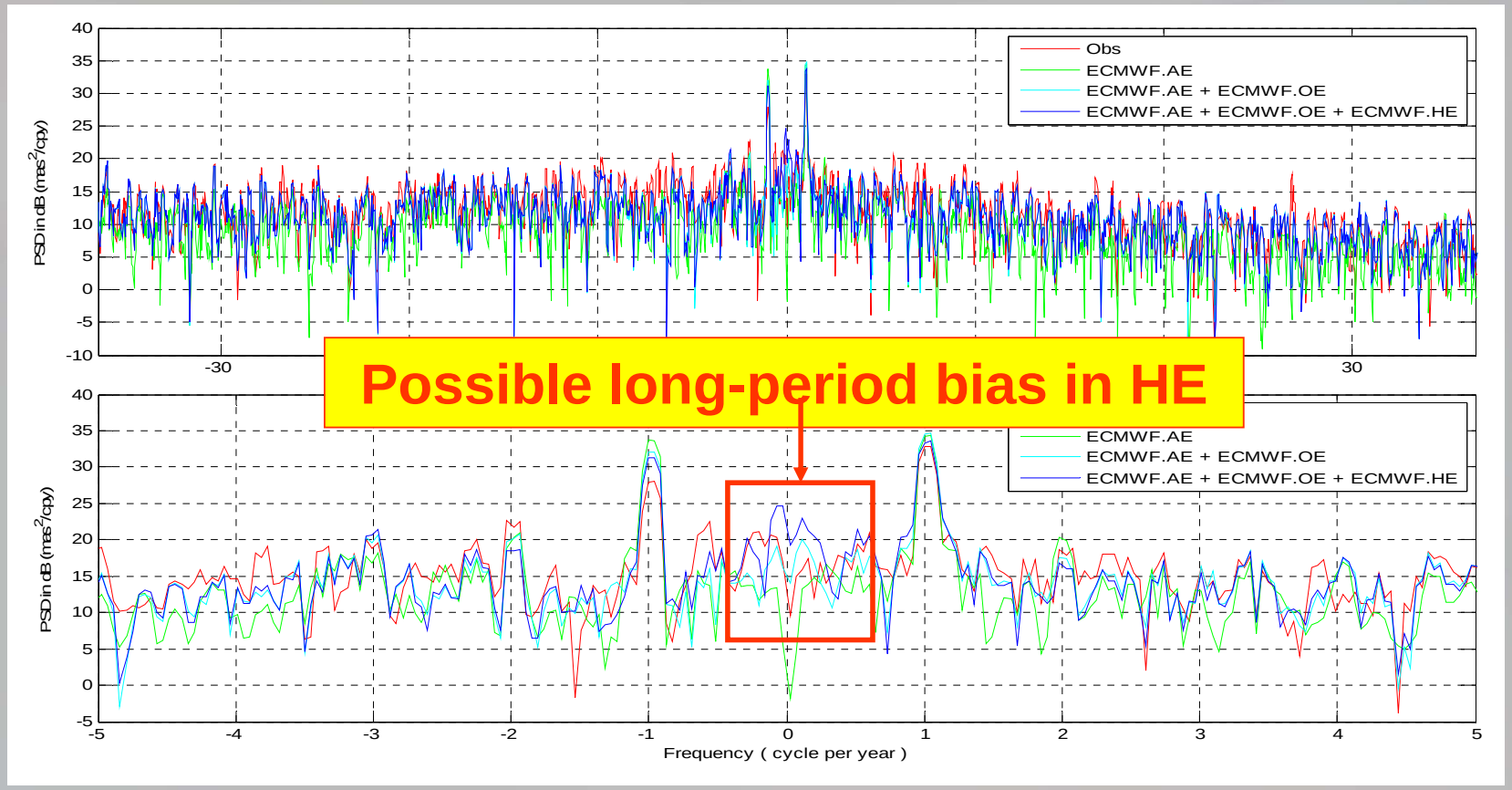
With HE



Adding HE reduces the residual

Residuals are large and models need to be improved!

Spectrum Comparisons (1d)



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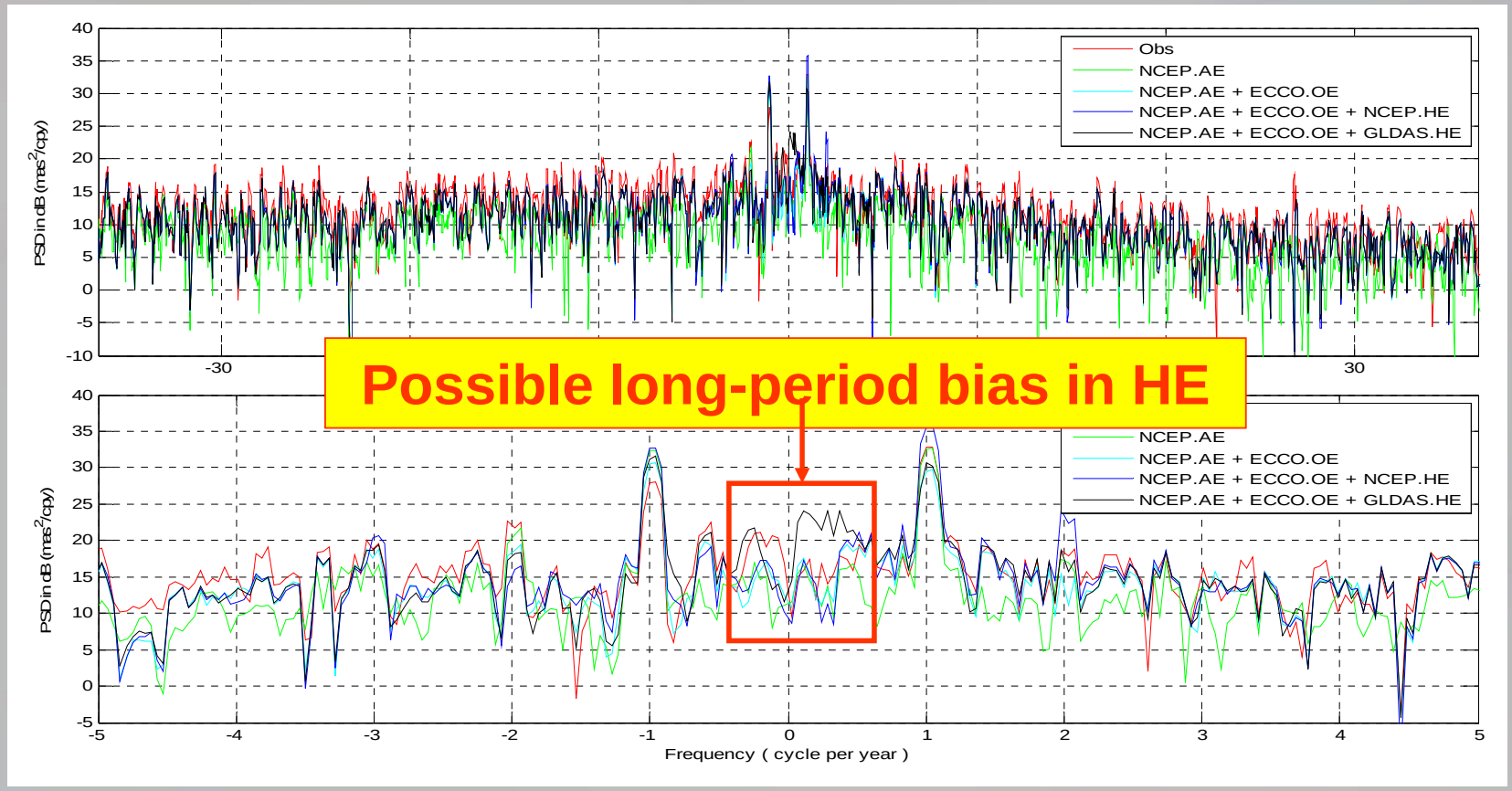
Spectrum Comparisons (1d)



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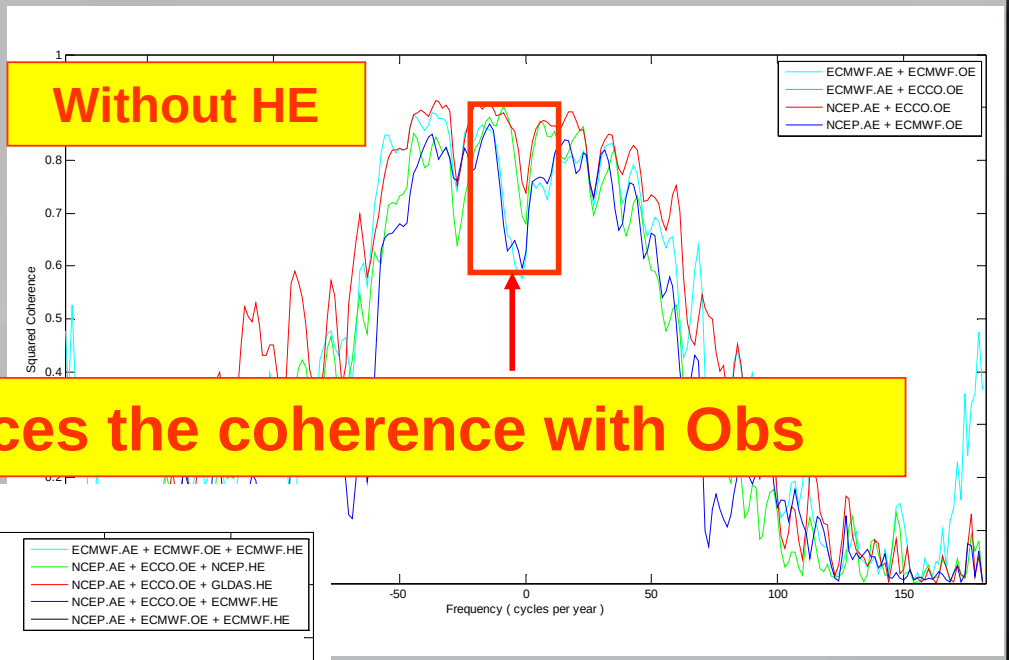
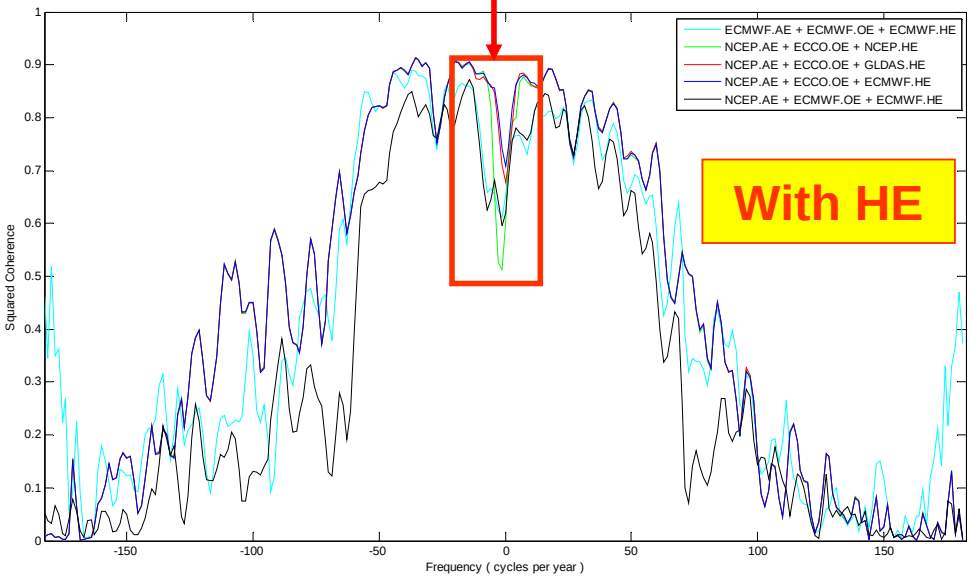
Coherence Comparisons (1d)



Adding HE reduces the coherence with Obs



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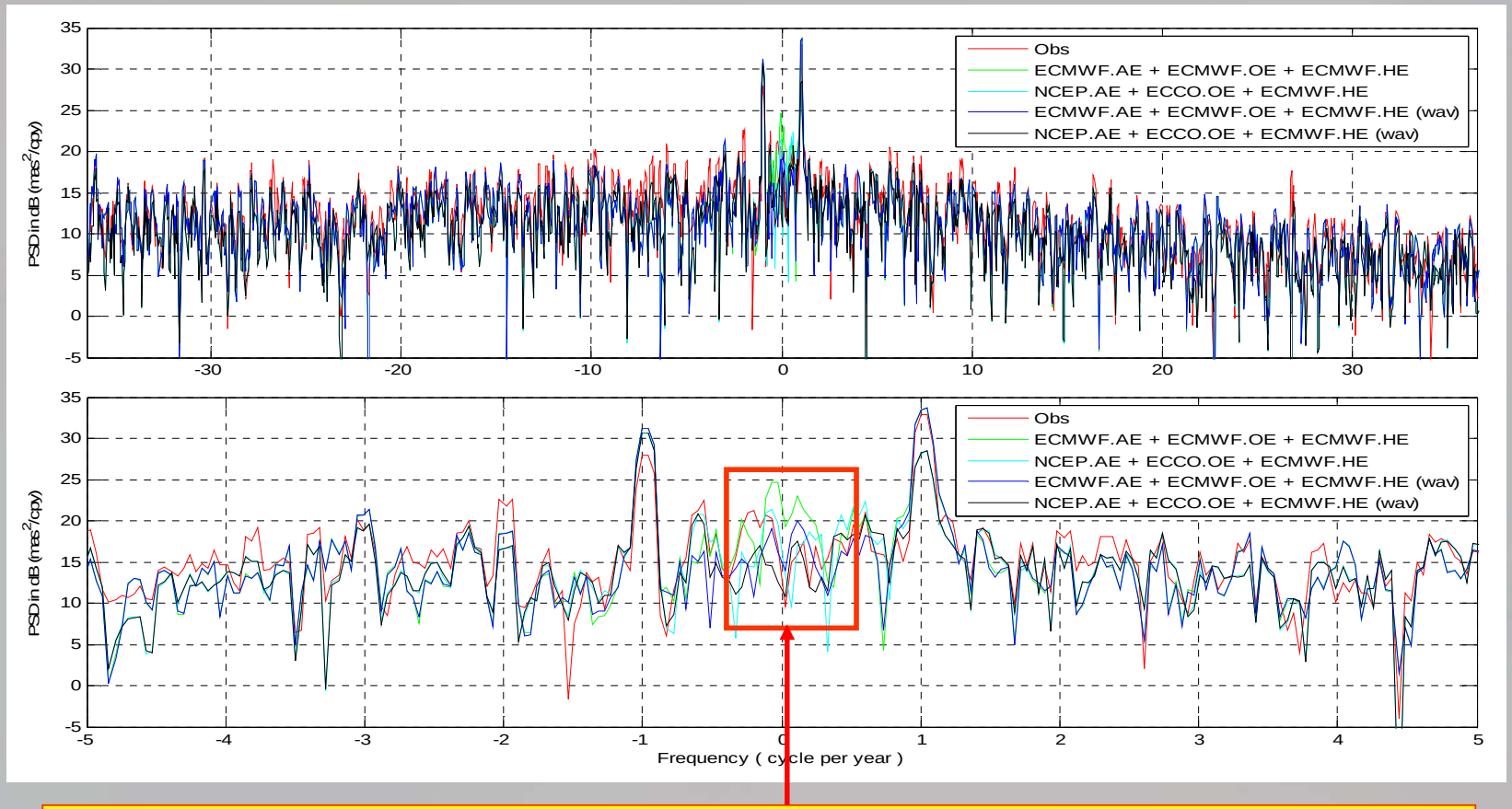
Effect of debias (1d)



Debias removes the low-frequency discrepancies

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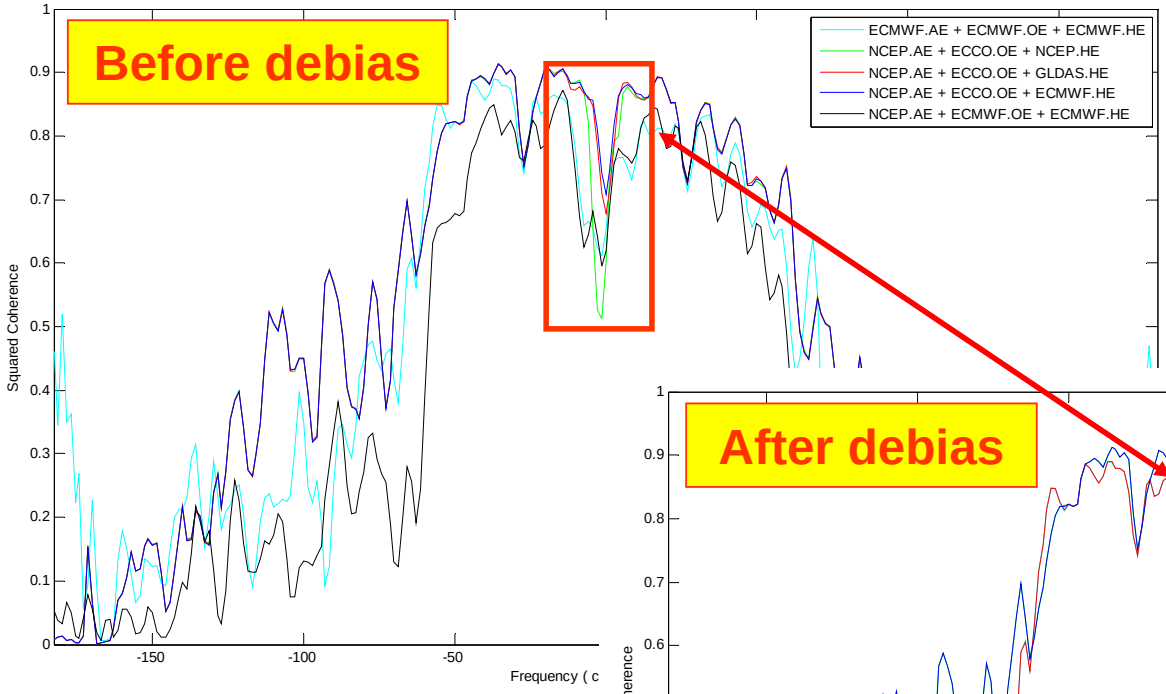
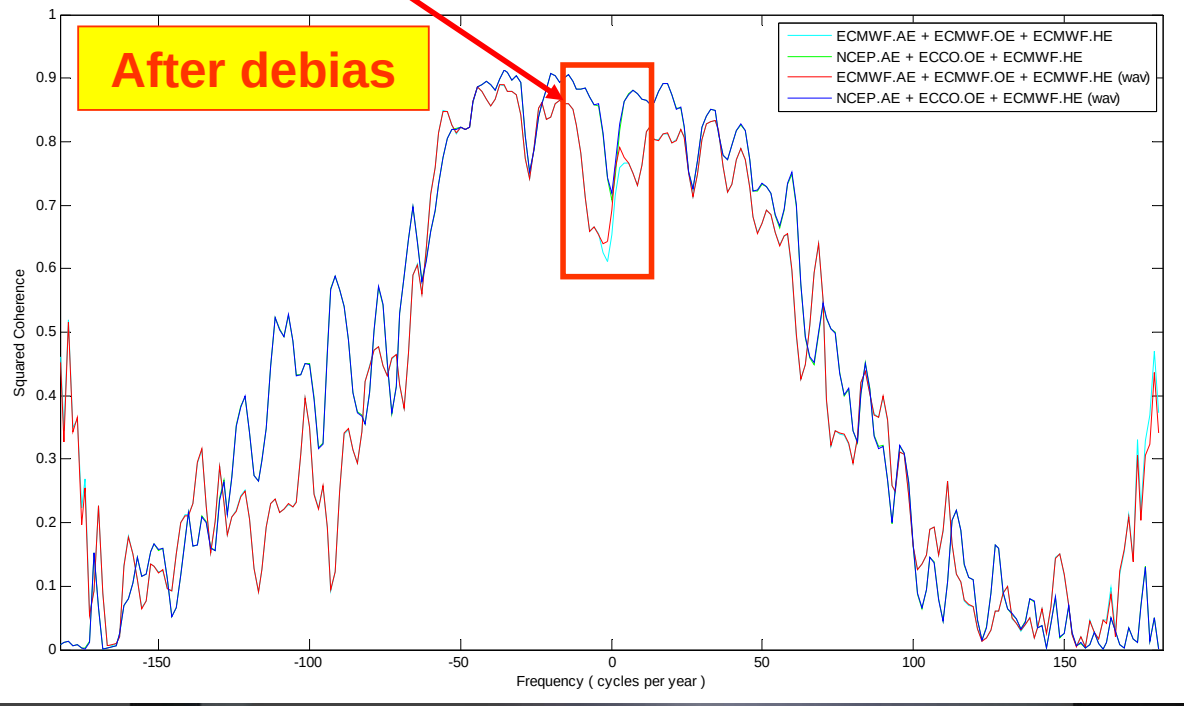
Effect of debias (1d)





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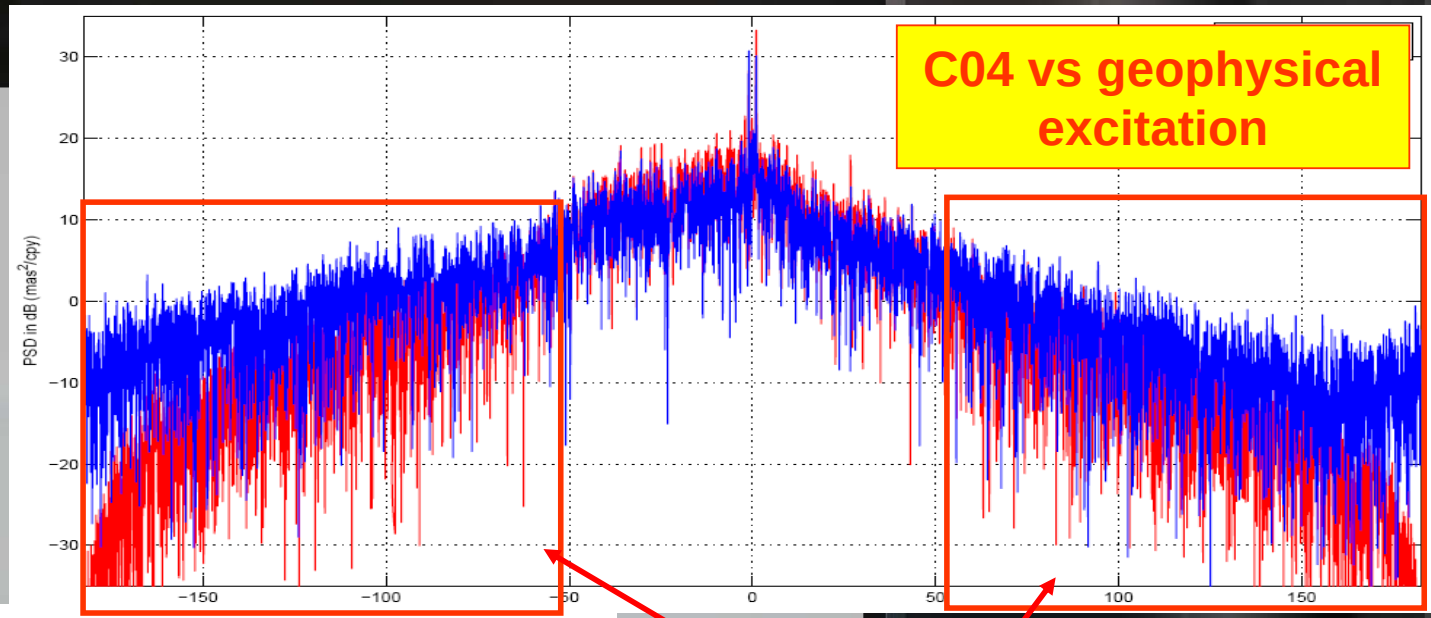
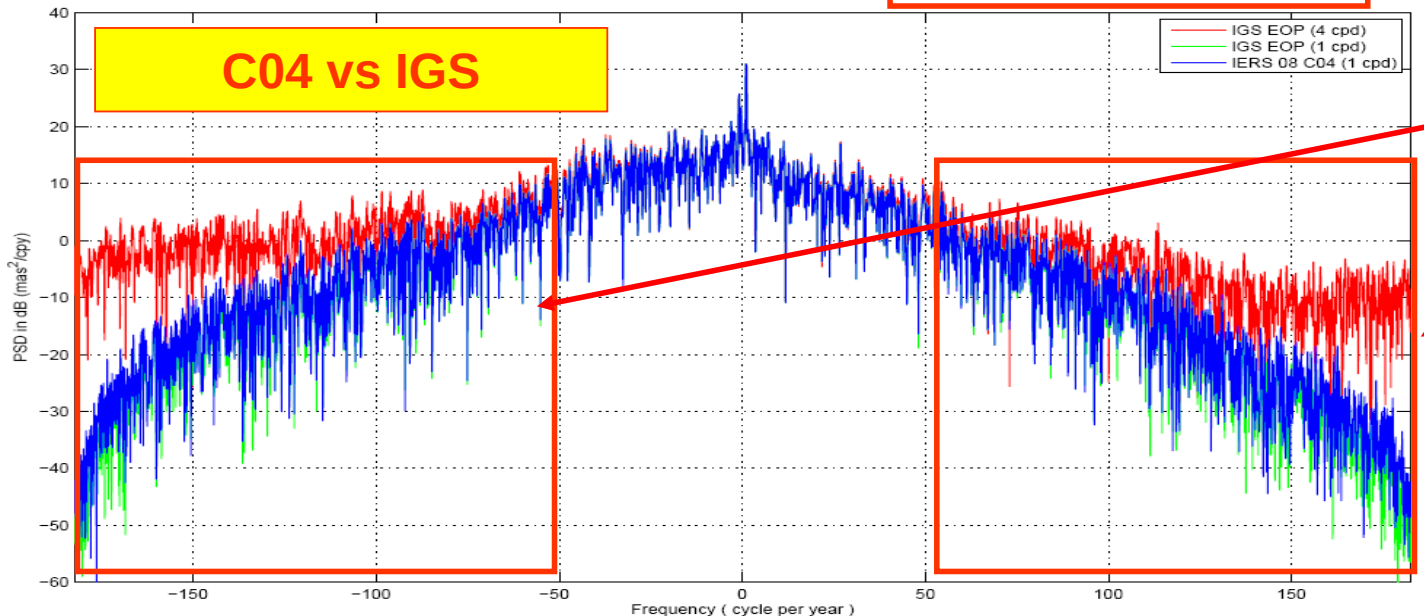
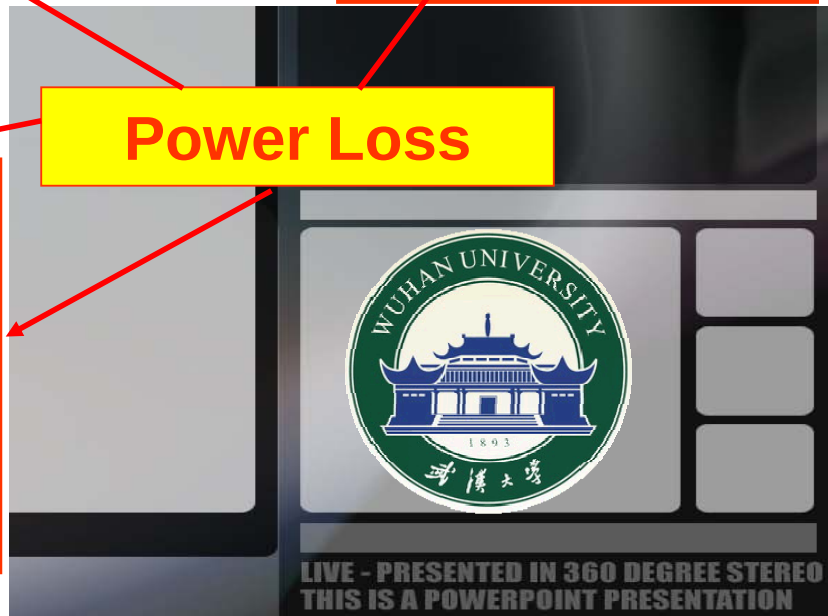
Power Loss

The IERS C04 EOP data seems to be over-smoothed compared to the IGS EOP and the geophysical excitations





Power Loss



Model Evaluations II: 6-h data

- **Data used (2004 ~ 2010)**
  - IGS EOP: ig1+igs+igu.erp (6-hour data; provided by Prof. Jim Ray)
  - NCEP reanalysis AAM (6h) + ECCO kf080 OAM (#) + NCEP reanalysis HAM (#)
  - ECMWF operational AAM (6h) + OAM (6h) + HAM (#)
  - ERAinterim AAM (6h) + OAM (6h) + HAM (#)
  - COMB: combined AAM (6h) + OAM (6h) + HAM (6h)

(#) originally daily, linearly interpreted to 6-hour data

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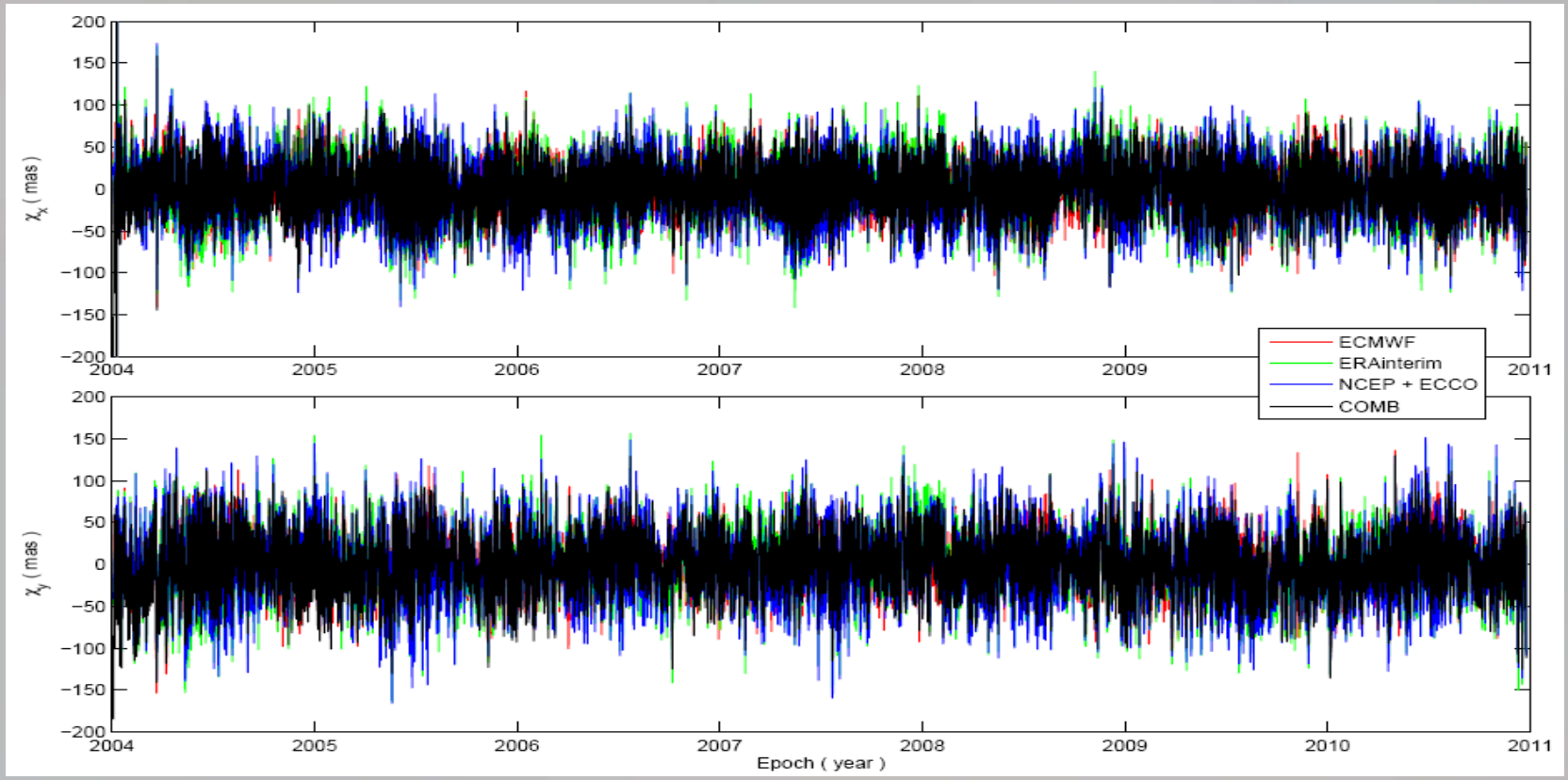
Time Series Comparisons (6h)



The residual for COMB is a little smaller!

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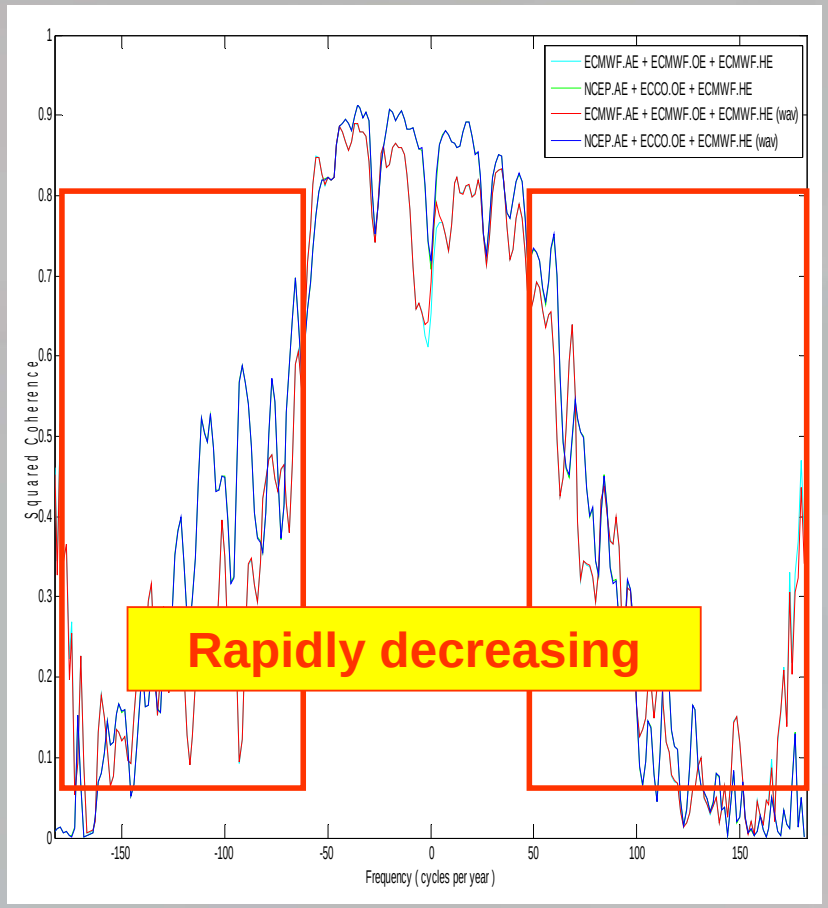
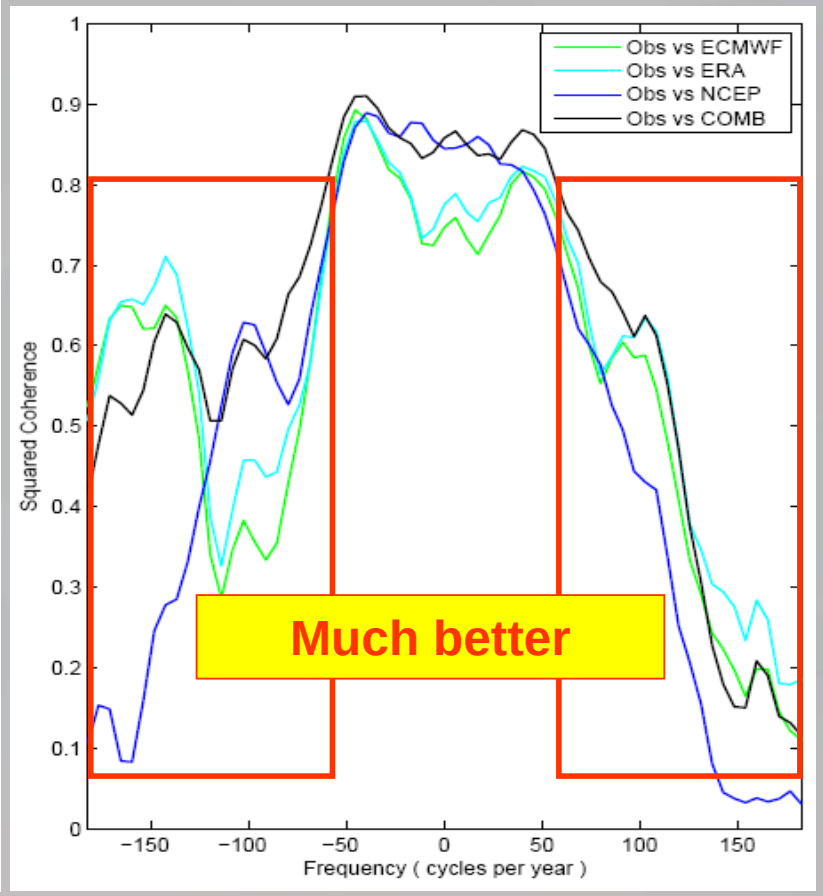
Coherence Comparisons (6h)





The COMB is the most coherent with the Obs!

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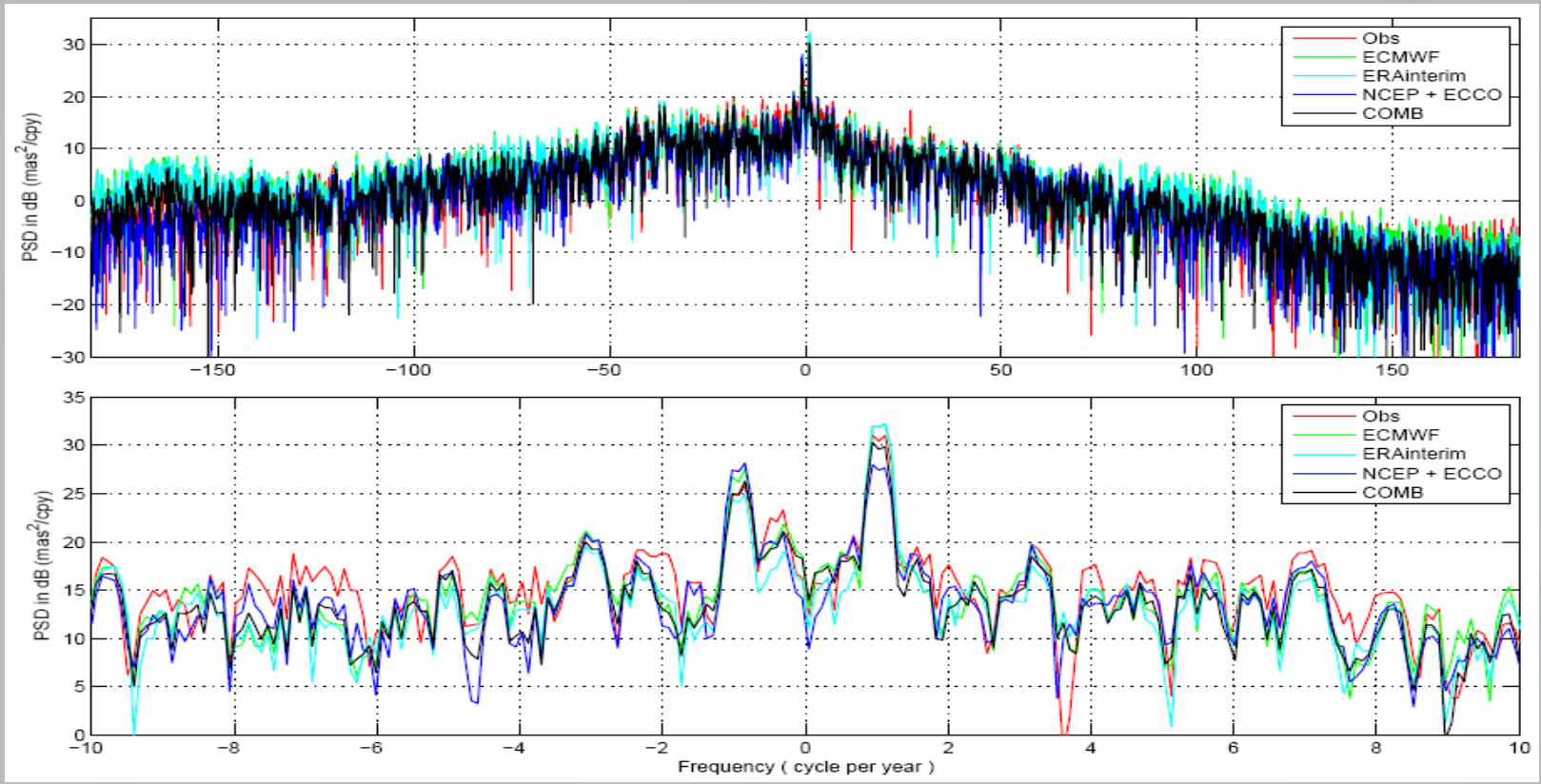
Spectrum Comparisons (6h)



The PSD for COMB agrees best with the Obs!

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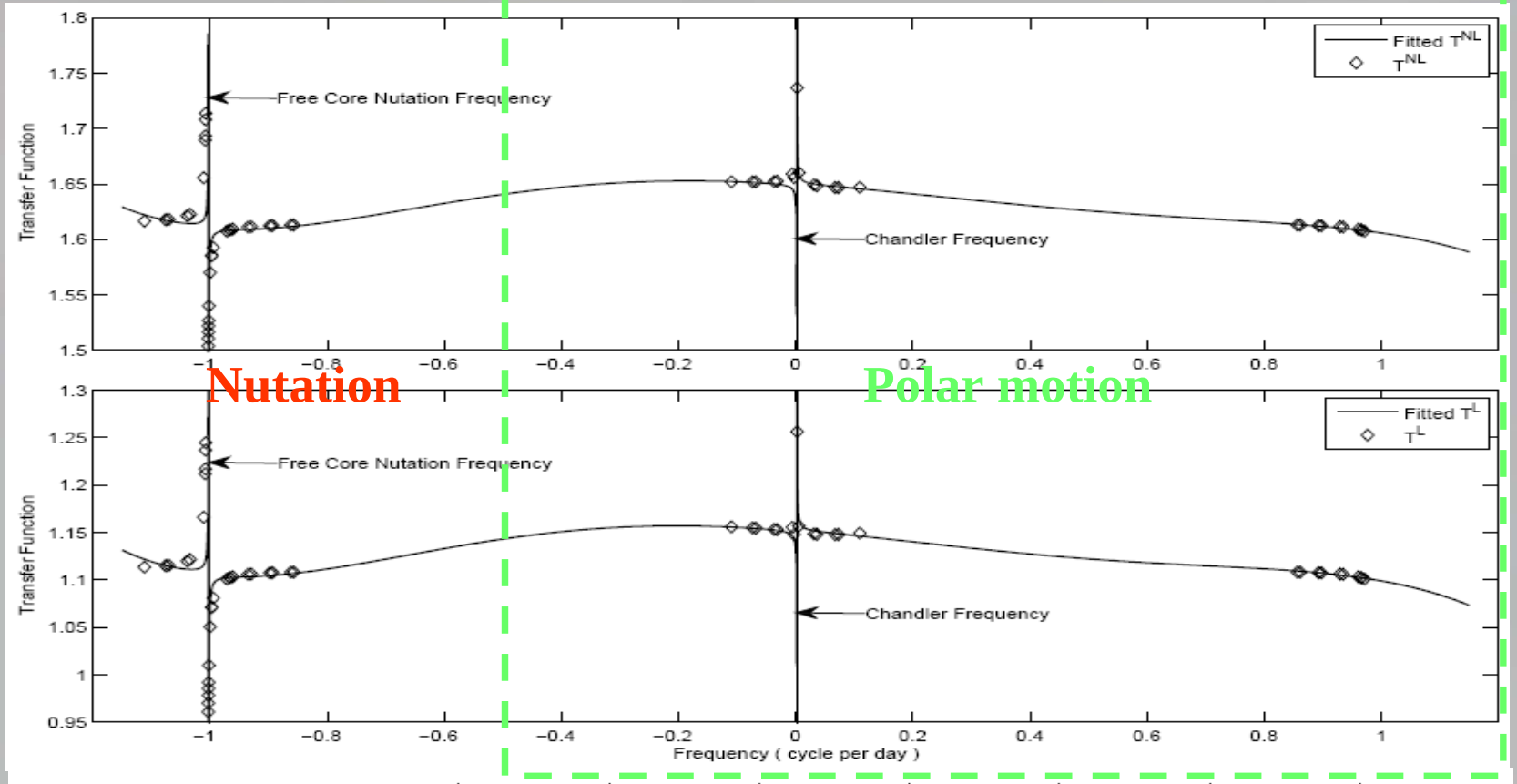
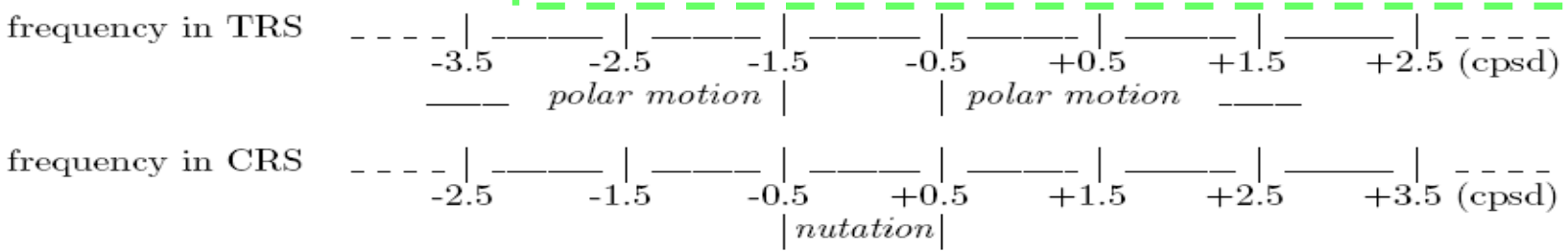
Frequency-dependent Response (FDR)





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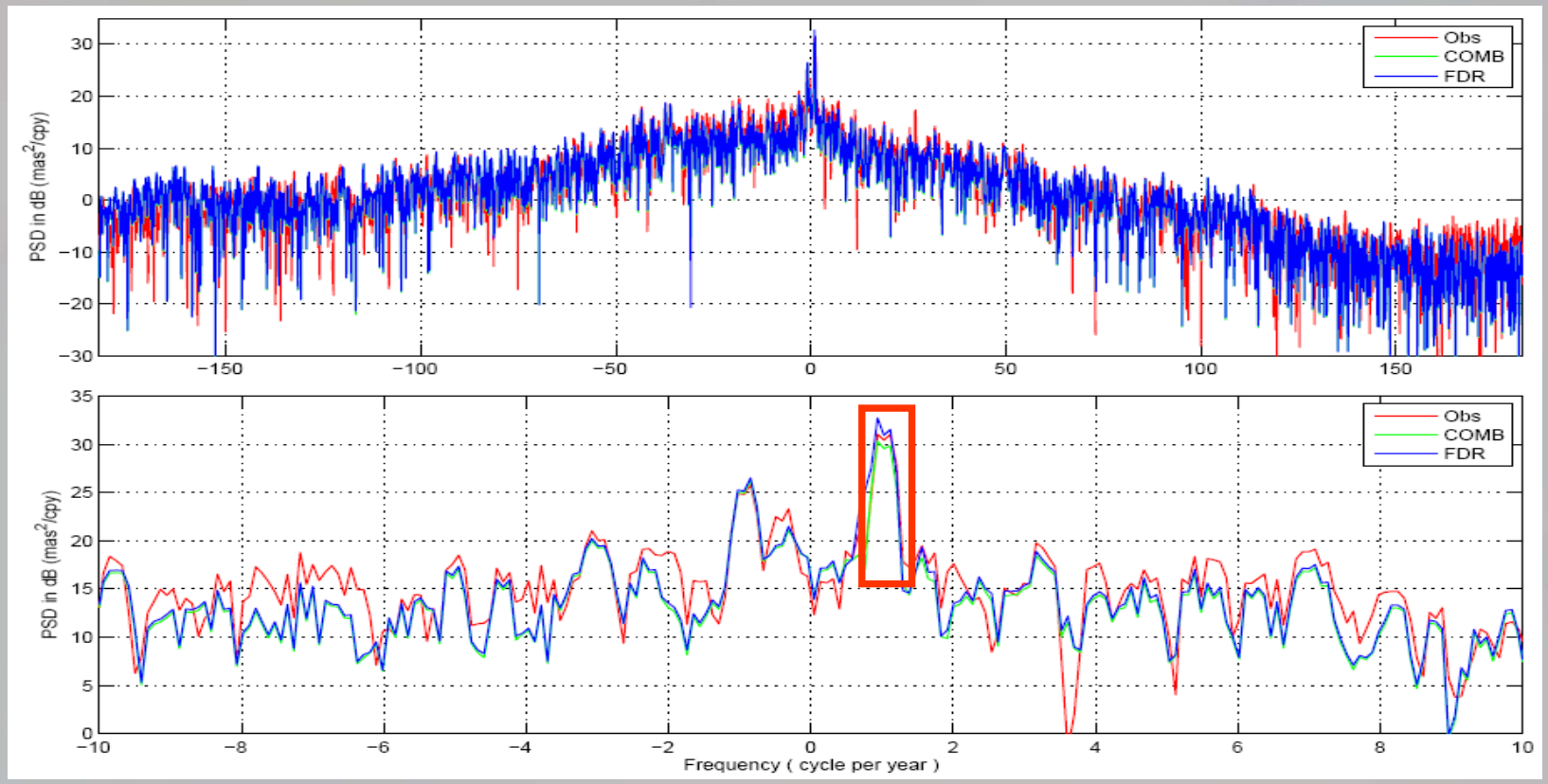
Spectrum Comparisons (6h)



Taking into account the FDR will be still better!

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Comparisons of AW Excitation

	A_p (mas)	α_p (deg)	A_r (mas)	α_r (deg)
χ_{OBS}	19.0226	–63.3790	9.3598	–133.9719
$\chi_{ECMWFop}$	21.4724	–76.9744	11.7103	–138.2239
$\chi_{ERAinterim}$	21.4901	–59.8073	8.7894	–144.5591
$\chi_{NCEPECCO}$	12.5831	–60.3468	12.5226	–153.8468
χ_{COMB}	16.4714	–55.4271	9.4278	–148.6883
χ_{FDR}	20.7431	–54.6075	9.7328	–149.6897

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Conclusions

- Hydrological models are less reliable than the atmospheric and oceanic ones
- Hydrological models might contain some long-period biases
- IERS C04 EOP: over-smoothed; suitable for long-period (> one week) excitations
- IGS EOP: suitable for short-period (<= one week) excitations, but the IB/DB effects should be determined first

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Conclusions

- **Coherence between the geodetic and the geophysical excitations goes down around and above 50 cpy**
  - Due to the deficiency of the IB model
  - If we use the C04 EOP data, it is at least partly caused by the artificial power loss of the EOP data
  - The break-down point (period) for the IB model might be around one week
- **Combined AAM + OAM + HAM might be better**
- **Considering the FDR can bring notable improvement to the estimate of the AW excitation**

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Acknowledgement

- Prof. Jim Ray (IGS Analysis Center Coordinator) kindly generated a special version of the IGS EOP data, and provided us important information on different versions of the EOP data
- Prof. Aleksander Brzezinski provided us valuable comments and suggestions on the original abstracts
- W. Chen has consulted Prof. Richard Gross on the IB-assumption and the ECCO/JPL model
- Dr. Haoming Yan provided us his estimate of the GLDAS HE

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Thanks for your attention!

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