

Atmospheric excitation of Earth rotation/polar motion at high temporal resolution

D. A. Salstein¹ J. Nastula², K. Quinn¹, D. Macmillan³, P. Mendes Cerveira⁴

¹Atmospheric and Environmental Research, Lexington, Massachusetts, USA

² Space Research Center of the PAS, Warsaw, Poland

³ Goddard Space Flight Center, Greenbelt, MD, USA

⁴ Vienna University of Technology, Austria

Journées Systèmes de référence spatio-temporels
September 19, 2007



QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.



QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Outline

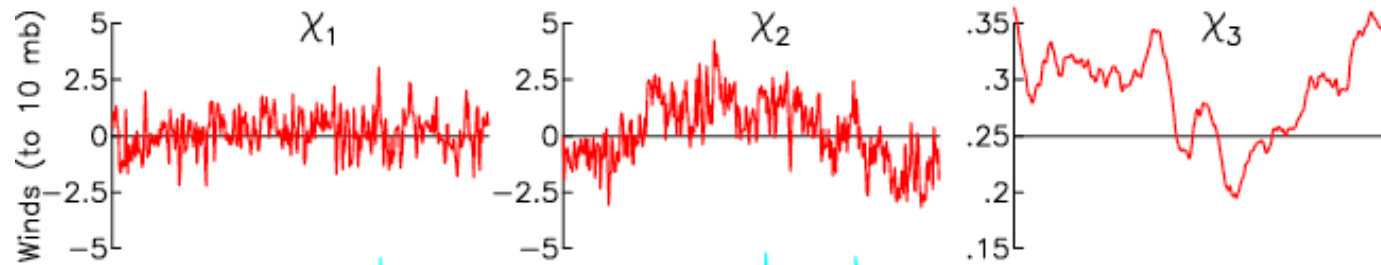
1. Atmospheric excitation of length of day/polar motion related to winds (motion) and pressure (mass)
2. High frequencies strong in polar motion wind terms: daily signals related to atmospheric tides, modulated by annual cycle.
3. Using NASA GEOS-4 analysis/forecast system to examine subdaily signals. Six-hourly values based on *analysis*, but hourly based on *model*: October 2002.-We need to deal with discontinuities at 6 hour.
4. Waiting for next NASA system which will be smoother (the MERRA system)

Reanalysis Earth rotation excitation (2002)

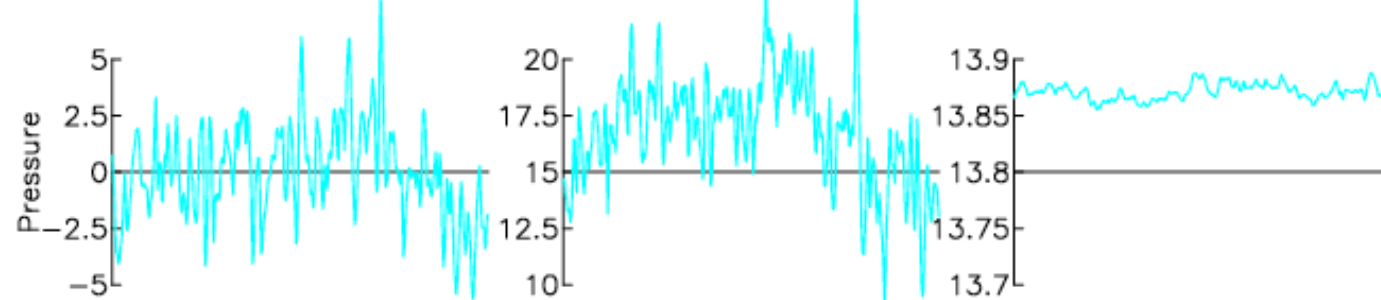
OO
UT

$\times 10^{-7}$

motion

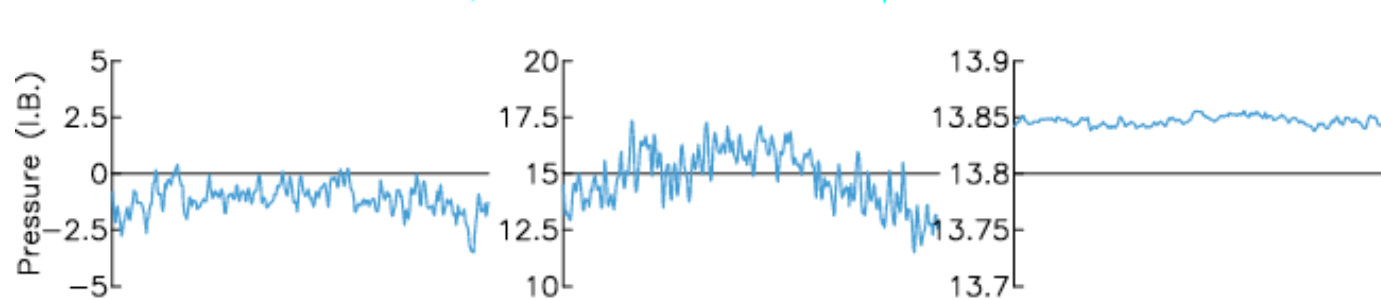


mass



Mass--

IB



IB=Inverted
Barometer

J F M A M J J A S O N D

J F M A M J J A S O N D

J F M A M J J A S O N D

Polar motion

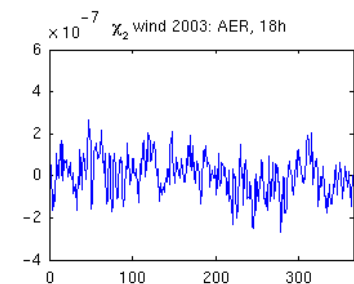
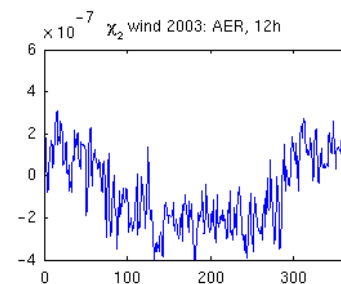
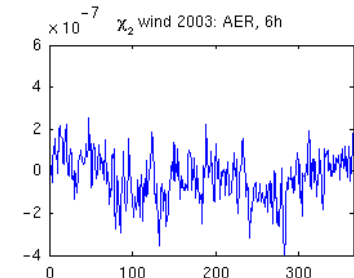
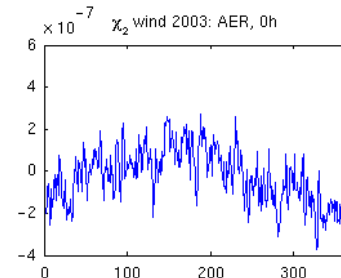
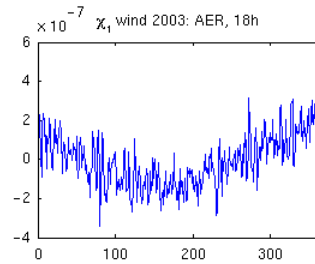
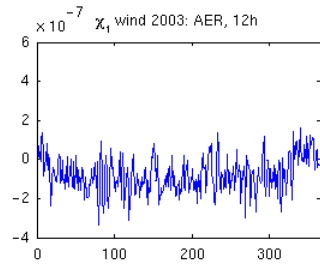
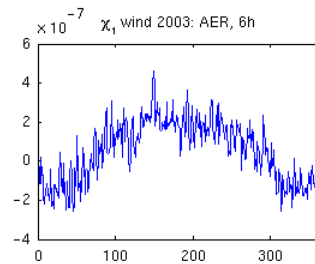
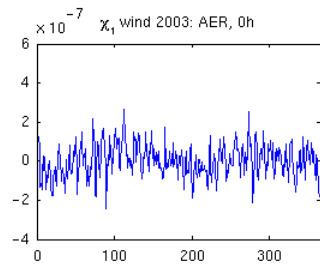
Length of day

Excitation of polar motion--wind term at each of 4 times during the day

0, 6
12, 18

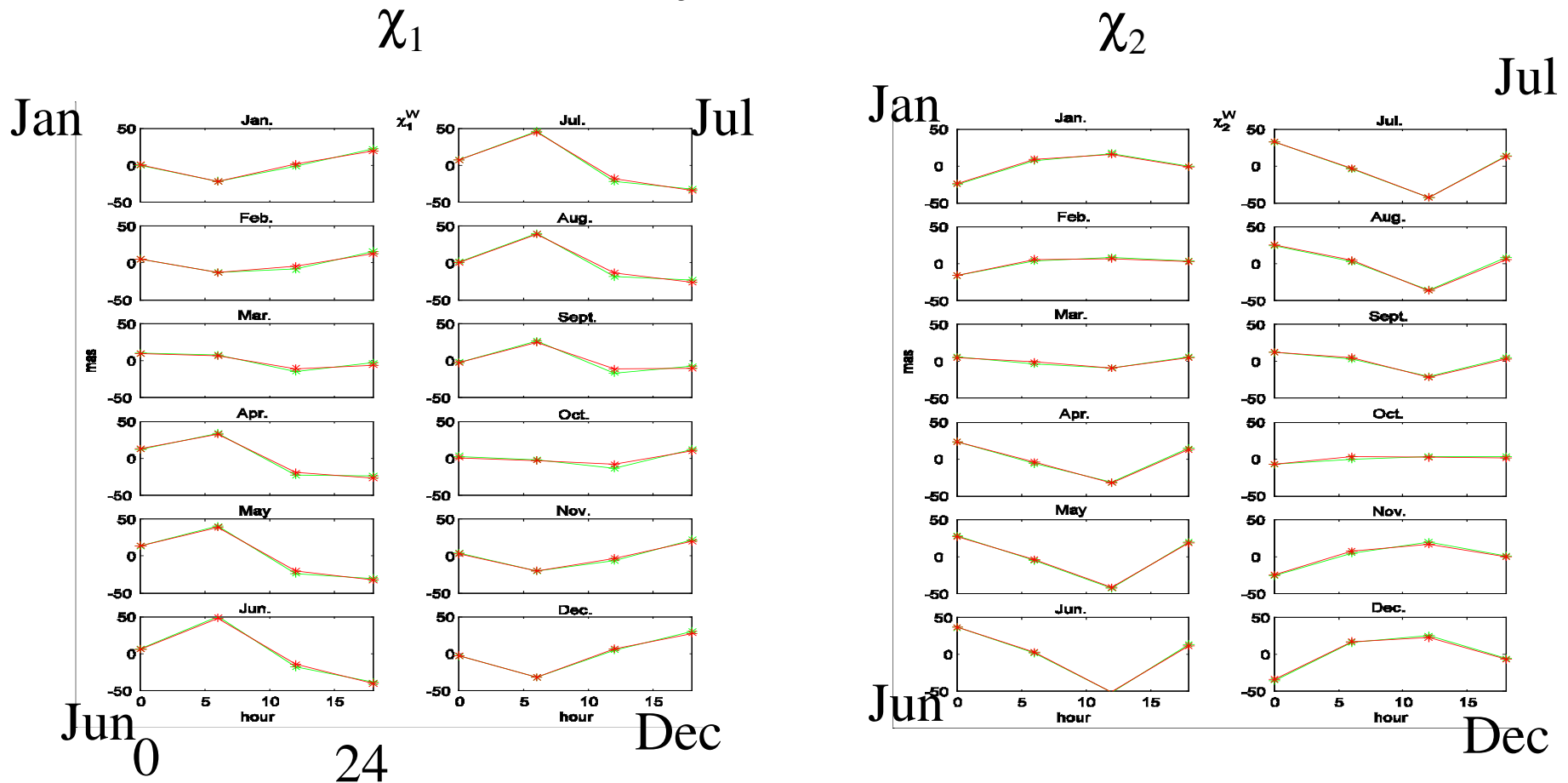
UT
 χ_2

χ_1

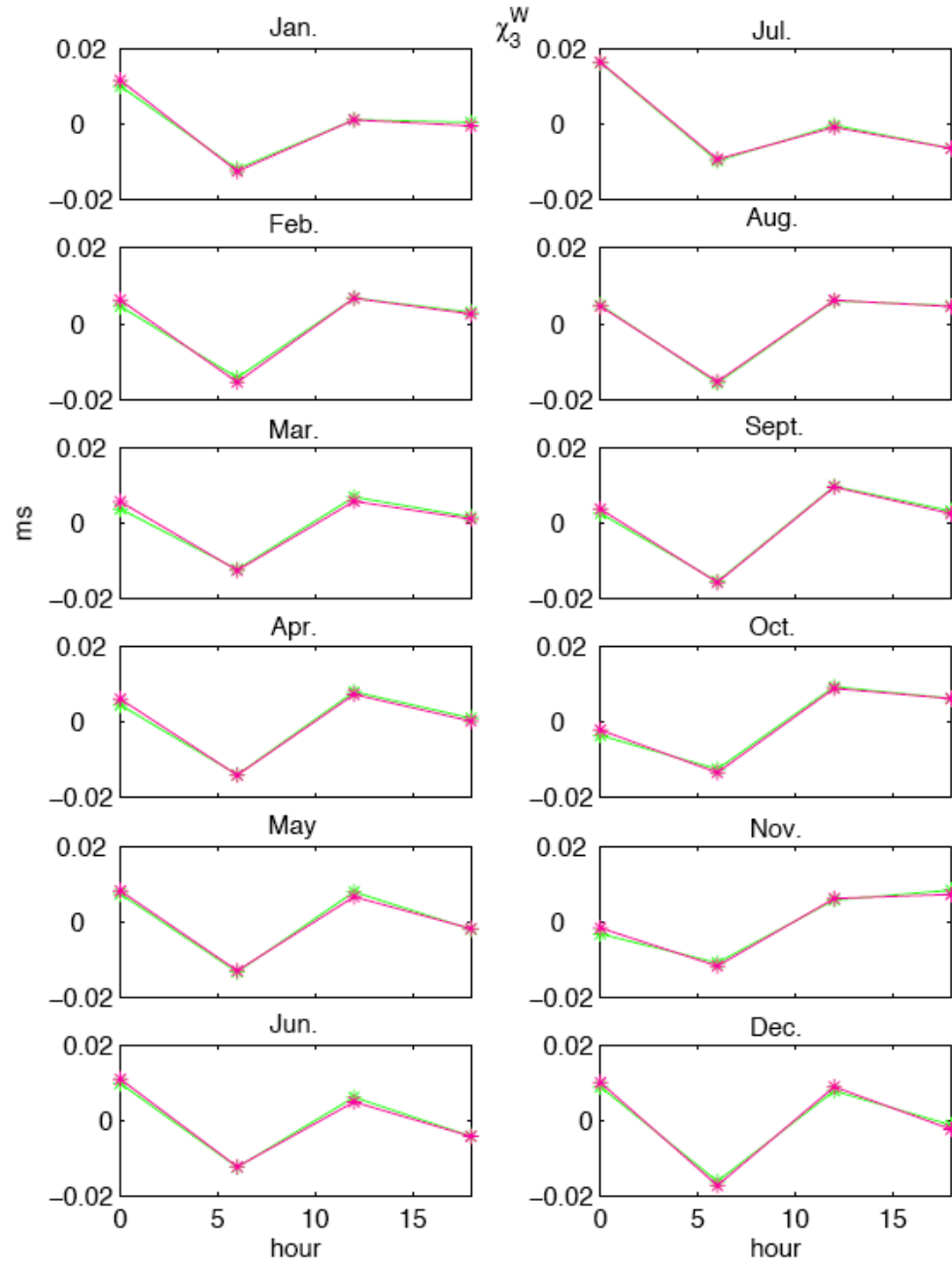


Each box is one year long (2003)

Excitation of polar motion--wind term by time of day, modulated by month



Axial wind term - χ_3



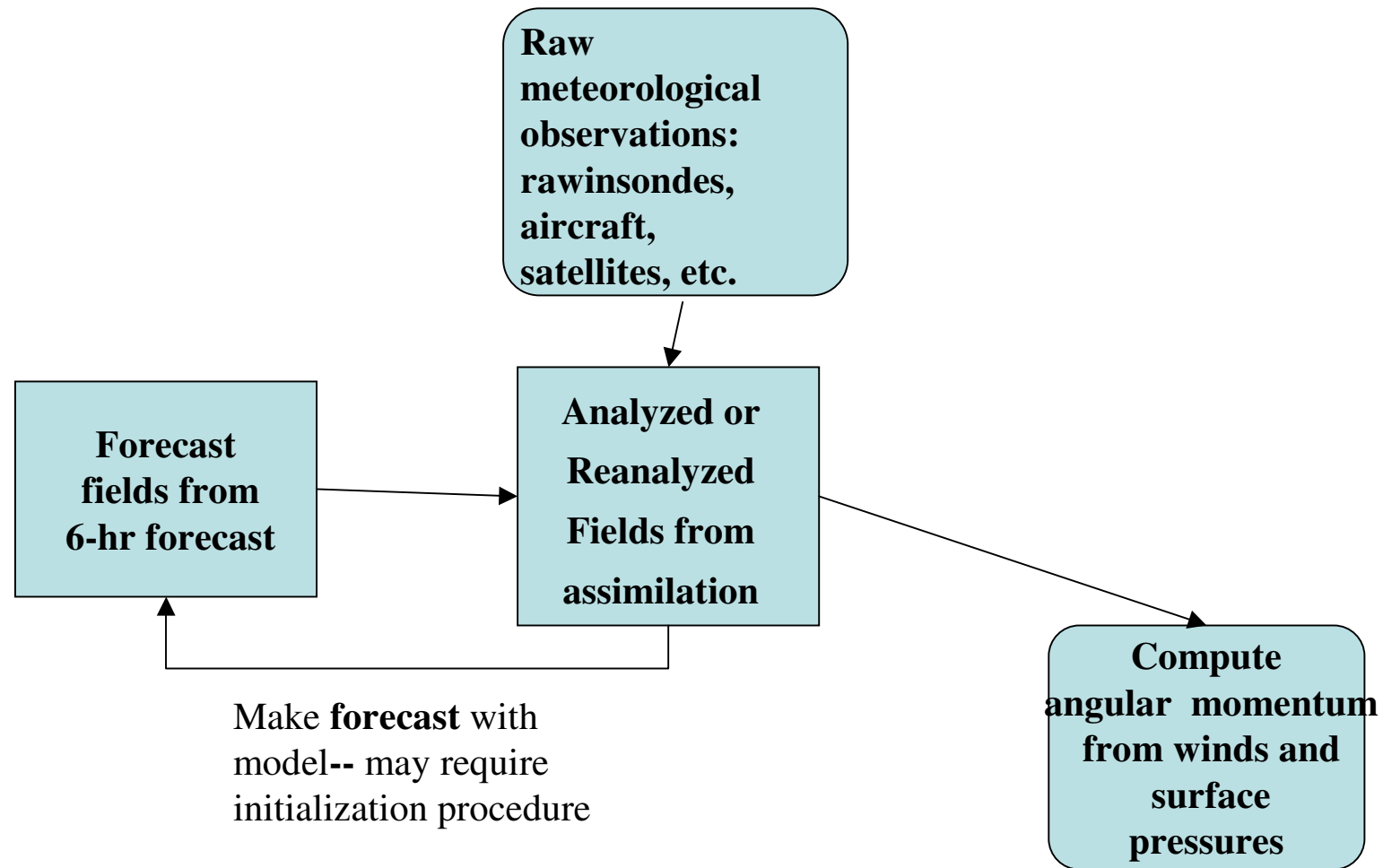
High temporal resolution angular momentum analysis with NASA system

NASA's GEOS-4 Data Assimilation System: Run on a 1.25° longitude, 1° latitude resolution. Although it is updated every 6 hours, we have worked with the Global Model and Assimilation Office to save winds and surface pressures from the model portion on hourly time resolution.

October 2002: CONT02--continuous VLBI observation campaign has examined subdiurnal variability. We are computing the angular momentum (excitation) terms on this time scale.

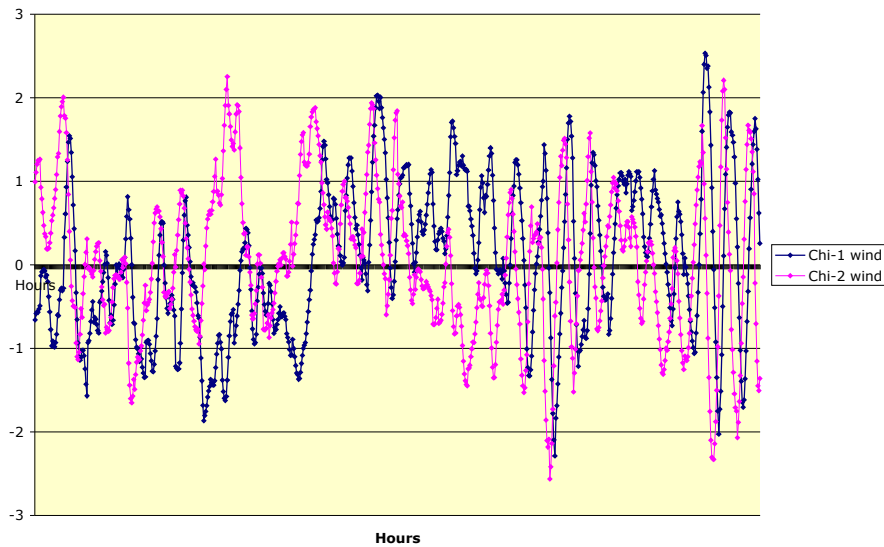
Mode of Earth, ~ 8 hours, has been detected, but what is its cause?

METEOROLOGICAL DATA ASSIMILATION SYSTEM



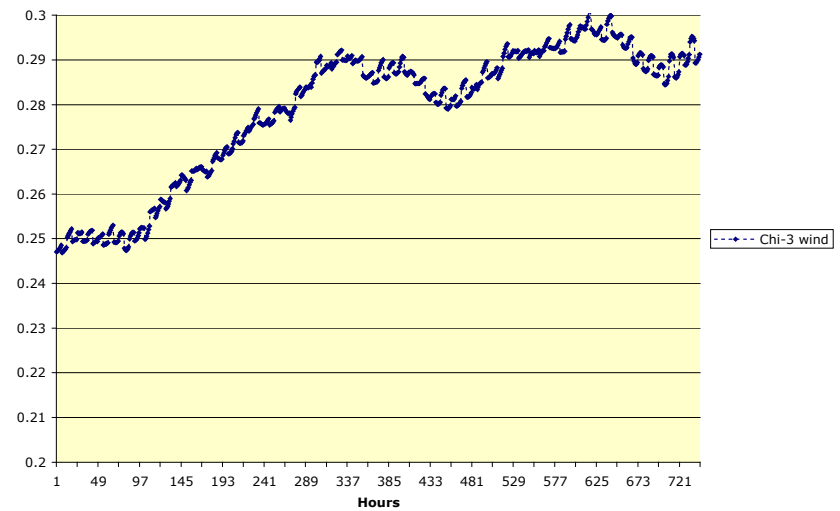
Excitations from GEOS-4 model/data assimilation system: wind terms

CHI-1 and CHI-2 WIND NASA/GEOS4 MODEL OCTOBER 2002



χ_1 and χ_2

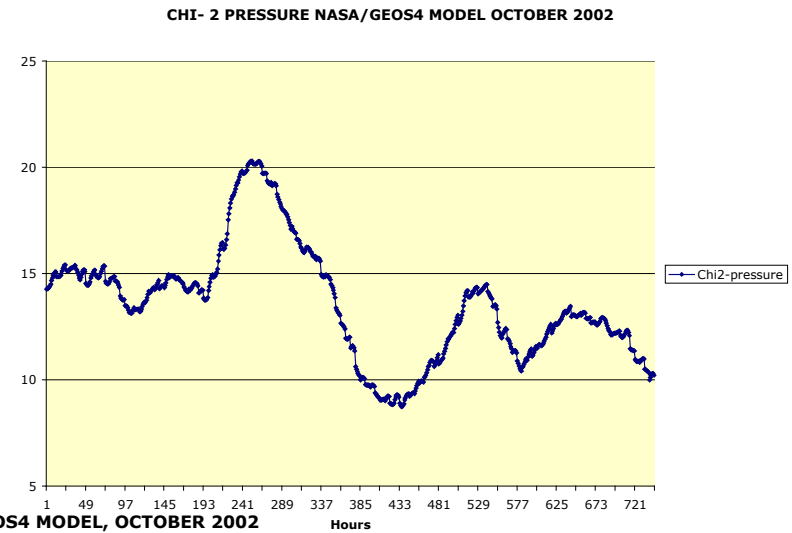
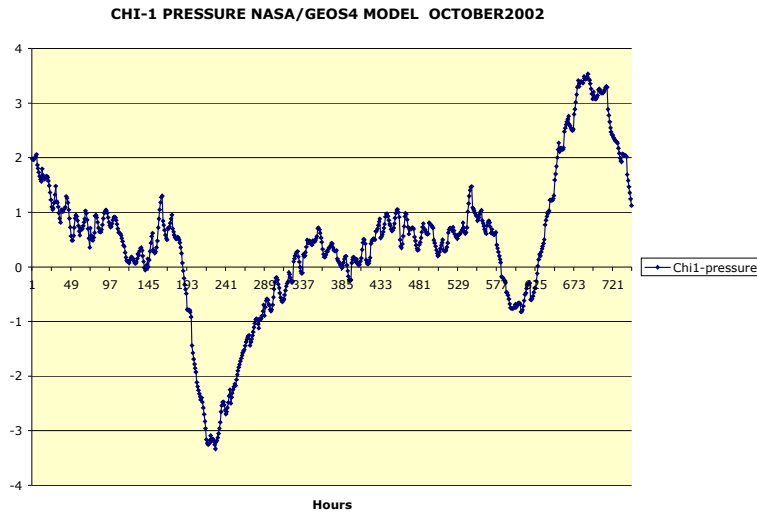
CHI-3 WIND NASA/GEOS4 MODEL, OCT2002



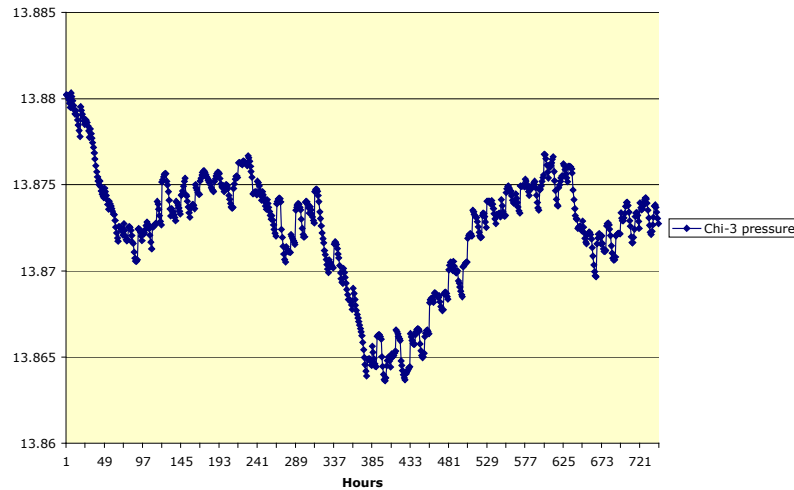
χ_3

October 2002

Excitations from GEOS-4 model/data assimilation system: pressure terms



CHI-3 PRESSURE NASA GEOS4 MODEL, OCTOBER 2002

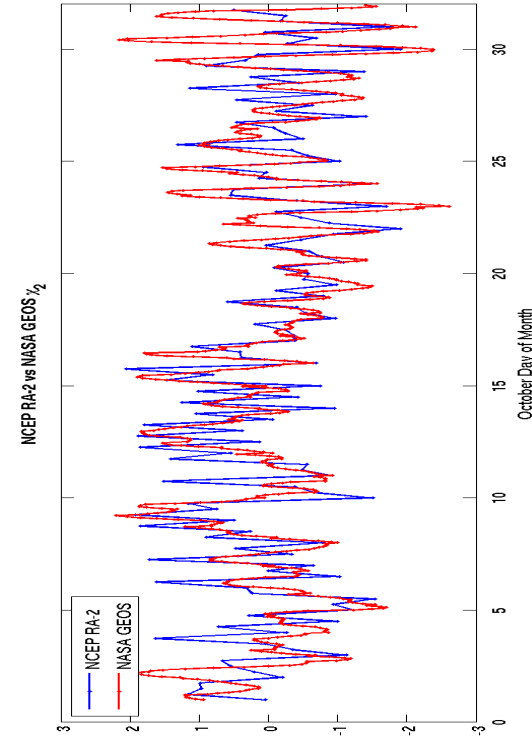
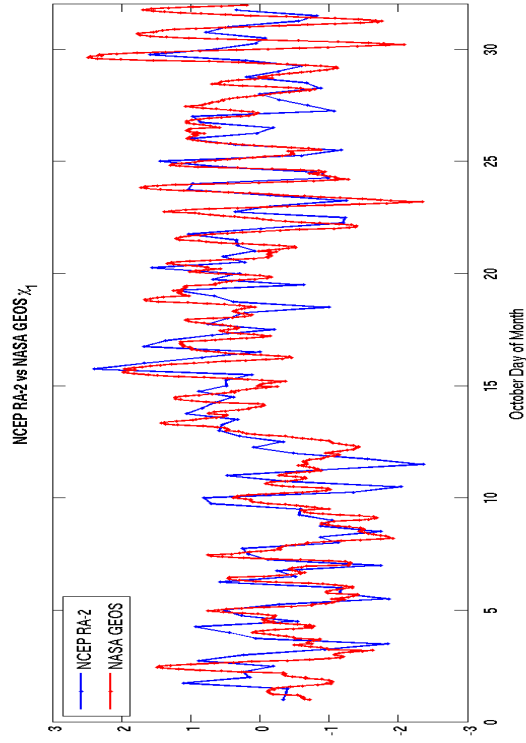


χ_1

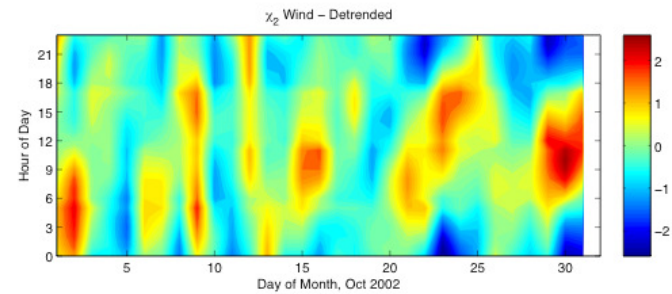
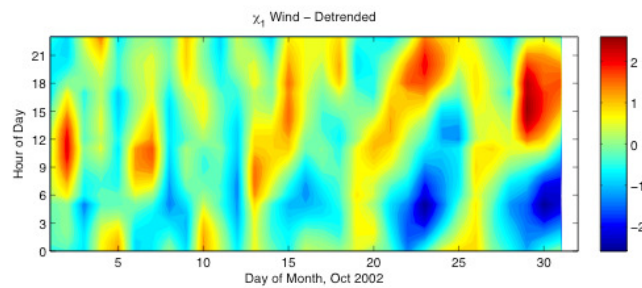
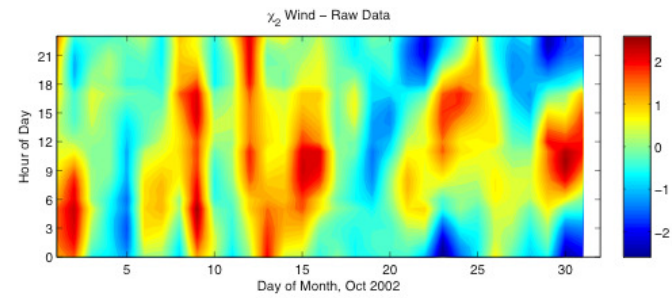
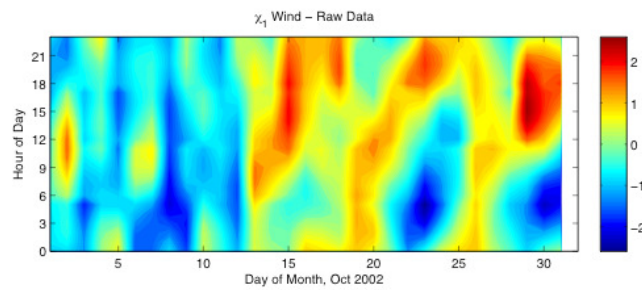
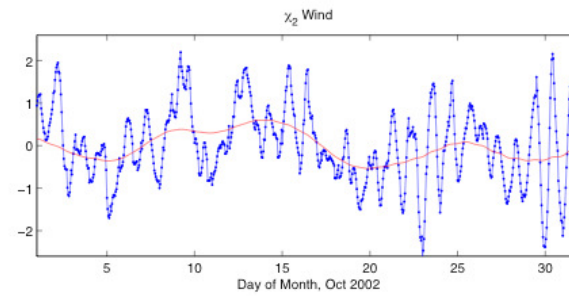
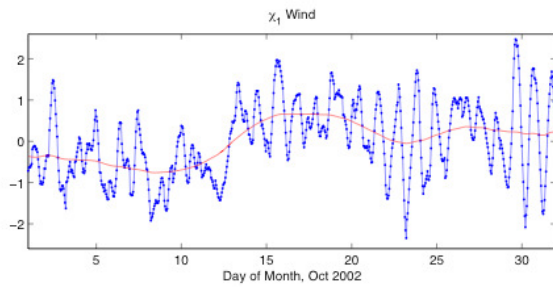
χ_2

χ_3

Comparison of GEOS hourly and NCEP-NCAR 6-hourly

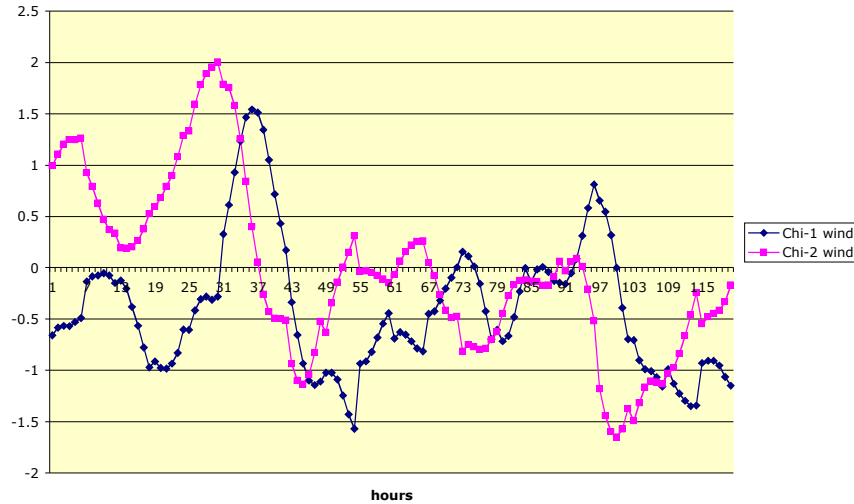


Wind-based polar motion excitations



6-hour discontinuities in the data

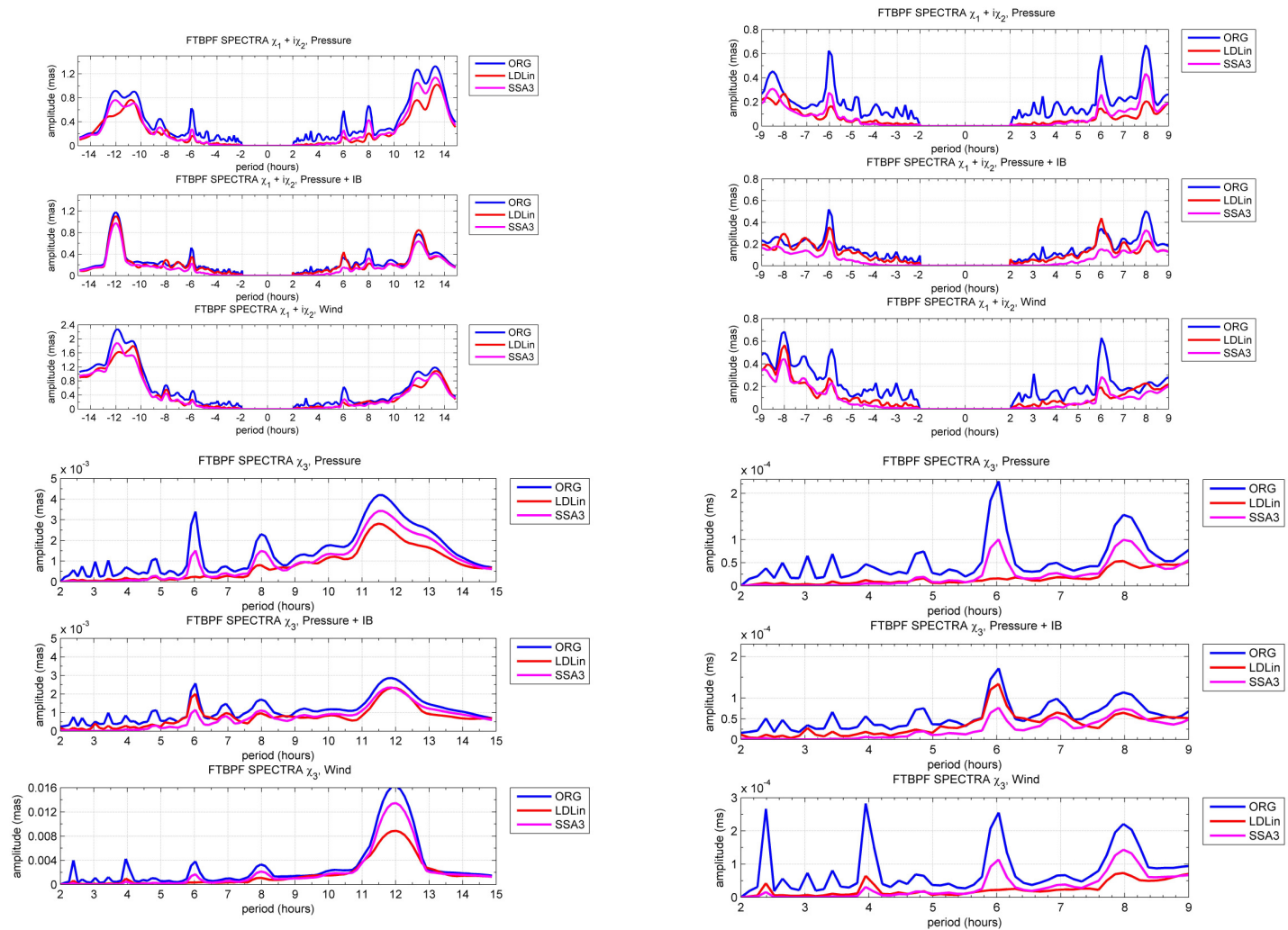
CHI-1 and CHI-2 WIND EXCITATION, NASA/GEOS4 MODEL
1-5 OCT 2002



Two methods to remove jumps: Linear (LDLIN) and SSA

QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.

Spectra before and after jump removal:



Estimates of very high frequency spectra of geodetic measurements of polar motion

MERRA - Modern Era Retrospective Analysis for Research and Applications

A “reanalysis” system making use of NASA’s and other remote sensing systems on satellites.

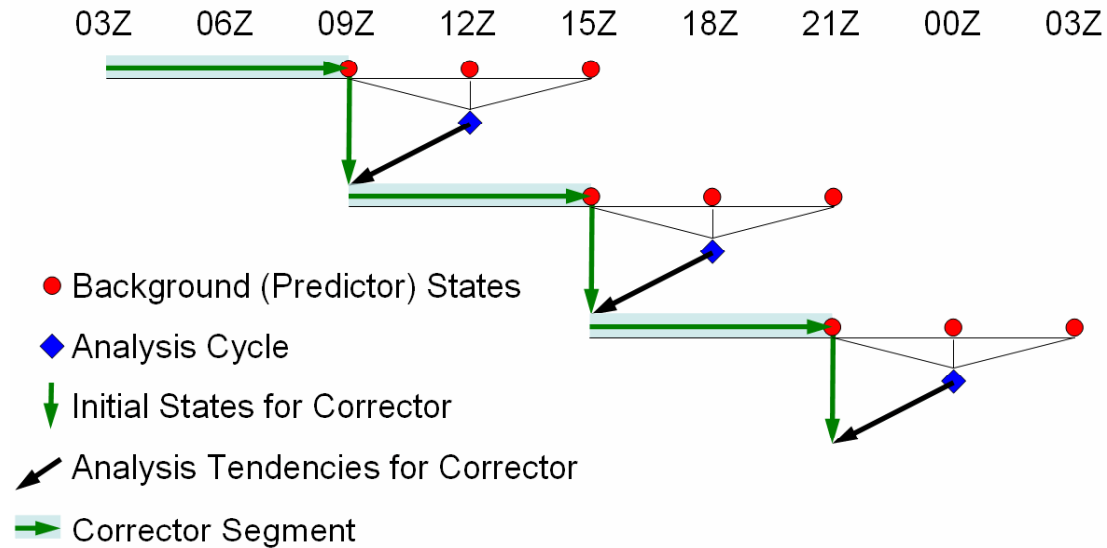
High resolution horizontally (1/2 deg. x 2/3 deg. and vertically (72 layers)

Regular output: 6 hours 3 dimensional fields; 3 hours 2 dimensional fields (surface pressure)

Request for *hourly* winds and pressures, as for GEOS-4

Smoother than earlier systems because of Incremental Analysis Update

Incremental Update Procedure -- used in MERRA



MERRA In test phase now: first results within a month.

Highlights

- Diurnal variability by the wind-excitation terms is seasonally modulated--exists in more than one assimilation system
- GEOS4: hourly results available based on model in between analysis steps...forecast and analysis in relative agreement for wind-polar motion terms, though diverge for axial-wind term
- Techniques developed to remove discontinuities at the 6-hour mark (reduces power at the some harmonics)

Acknowledgments: US National Science Foundation: ATM-0429975; NASA Solid Earth and Natural Hazards Prgm: NNG04G060G, NNG04GP70G, NASA GSFC/University of Maryland Baltimore County GEST program; YHZhou and the Decartes Fellowship that supported him at AER.