ATMOSPHERIC FORCING OF A BAROTROPIC OCEAN MODEL TO DEALIAS ALTIMETRY AND GRACE: FIT TO TOPEX/POSEIDON.

Ahmed Ali[(1)], V. Zlotnicki[(2)],
R. M. Ponte[(3)], F. Flechtner[(4)]

[(1)]Raytheon ITSS
[(2)]Jet Propulsion Laboratory, California Institute of Technology
[(3)]Atmospheric and Environmental Research, Inc
[(4)]GeoForschungsZentrum-Potsdam

mailto:vz@pacific.jpl.nasa.gov

Last Updated 2002-06-01

OVERVIEW

- Fukumori et al (1997), Stammer et al (2000) and Tierney et al (2000) showed that the ocean's short-period response to wind, and departures from IB, alias altimetry significantly, a 'correction' not currently available.
  Gravity missions especially need such dealiasing.
- In previous work (Hirose et al., 2000) we optimized the friction, bottom topography and no-slip conditions of a barotropic ocean model to dealias altimetry from the effect of the ocean response to wind and pressure at periods shorter than 20 days.
- Here we first focus on the effect of various atmospheric pressure and wind products, the key forcing function.
- We show the importance of considering Atmospheric Stability in the conversion of wind to stress.
- We also show the significant effect of the S_2 atmospheric tide which is included in the ocean tide models.

MODEL DESCRIPTION

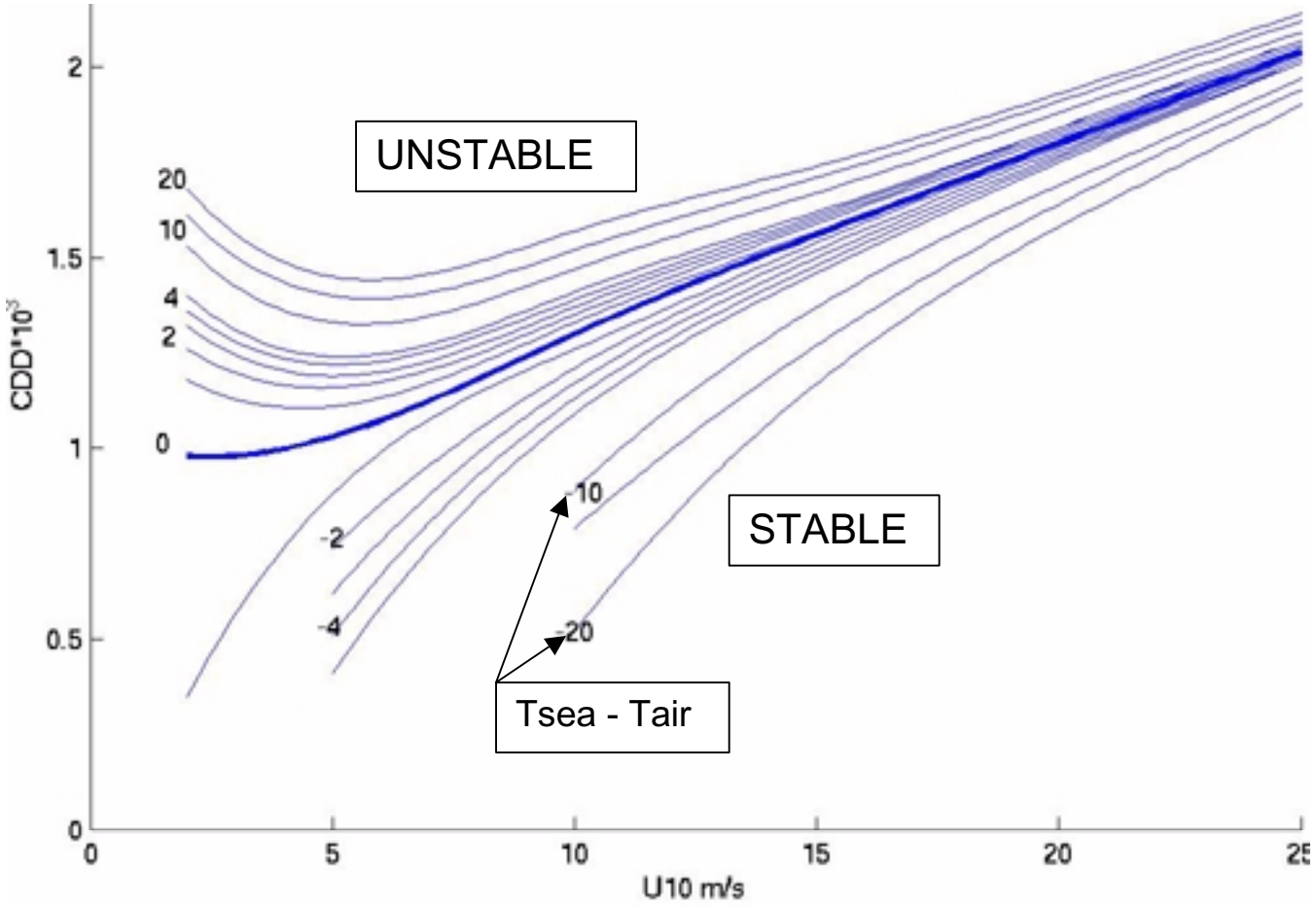
- Barotropic model 'PPHA' of Pacanowski (Ponte 1991, 93, 97), with following modifications (Hirose et al, 2001):
  - subsurface no-slip condition
  - fine topography
  - optimized friction parameter: -bu/H, b=2 cm/s
- plus these modifications (A. Ali, 2002)
  - parallelized code
  - new landmask and corresponding bathymetry
- Resolution: 1.125° x 1.125°
- Coverage: global, 75°S to 65°N.
  Includes Mediterranean, smaller enclosed seas and bays.
- Winds and pressure: 6 or 12 hourly, from NCEP or ECMWF and one QSCAT, operational or reanalysis, 2.5 or 1.0 or 0.5 degree.

WIND PRODUCTS COMPARED

- Forcing comparisons for Jan-Dec 2000, or Jan-Jun 2001
- Wind and Pressure forcing
- Data Sources:
  - NCEP operational, 2.5 deg, 12 hr, NCAR DS083.0 (also available in NRT from ftp.ncep.noaa.gov)
  - NCEP REANALYSIS, gaussian 2.5 grid, 6 hr, NCAR DS090.0 (12 hr filtered)
  - QUIKSCAT blended with NCEP reanal, NCAR DS744.4, 1 deg grid.
  - ECMWF operational 2.5 deg, 12 hr, NCAR DS111.2
  - ECMWF operational 0.5 deg, 6 hr, at GFZ.
- NCEP REANALYSIS is the only one with wind STRESS, others have 10m wind.

WIND *VELOCITY* TO WIND *STRESS (1)*

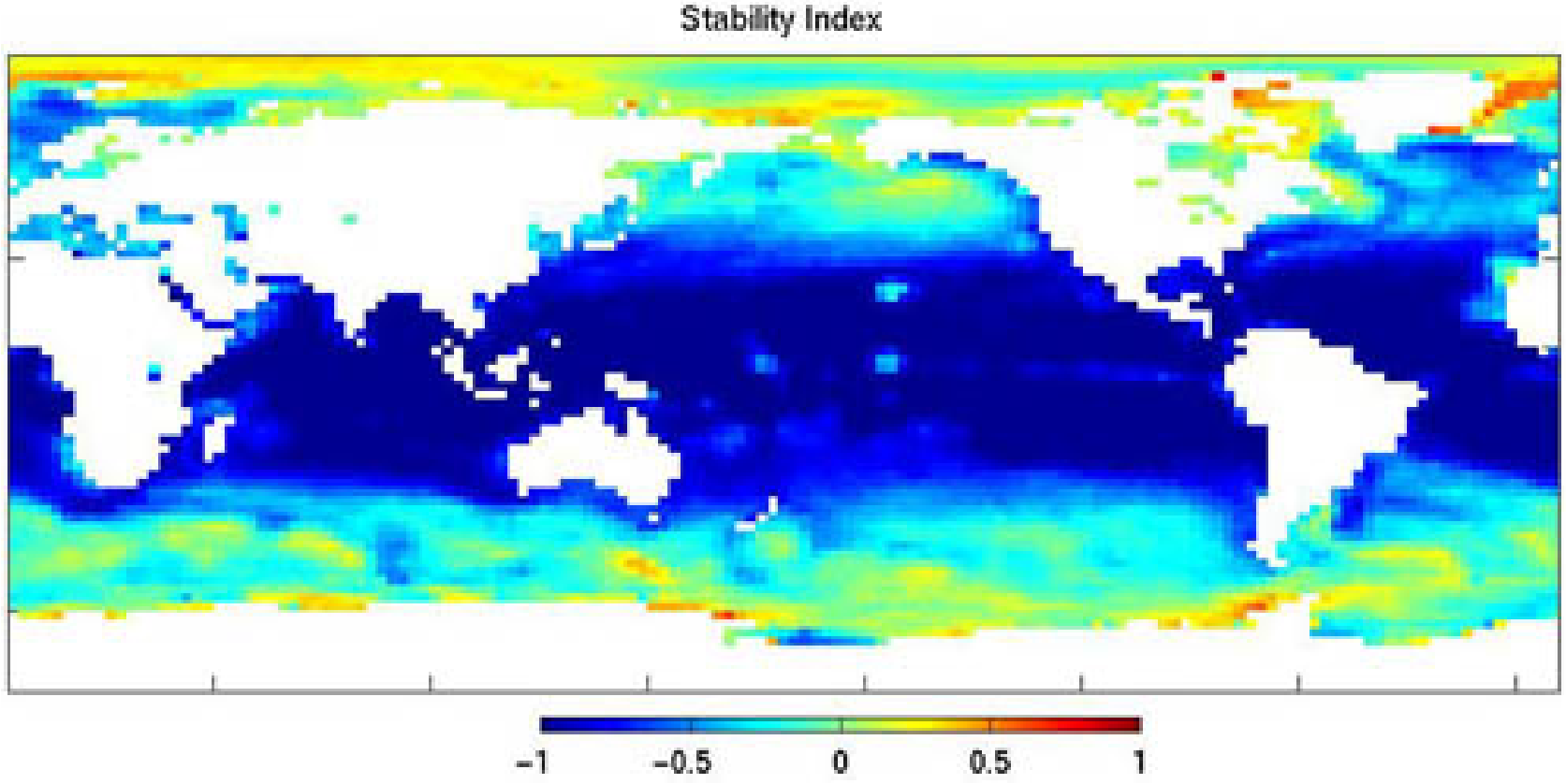
- $\tau = C_d \; U_{10} | U_{10} |$
- C_d function of wind speed itself, atmospheric stability, waves and swell.
- Atmospheric stability= function(Tair, Tsea, RelHumid, Pmsl)



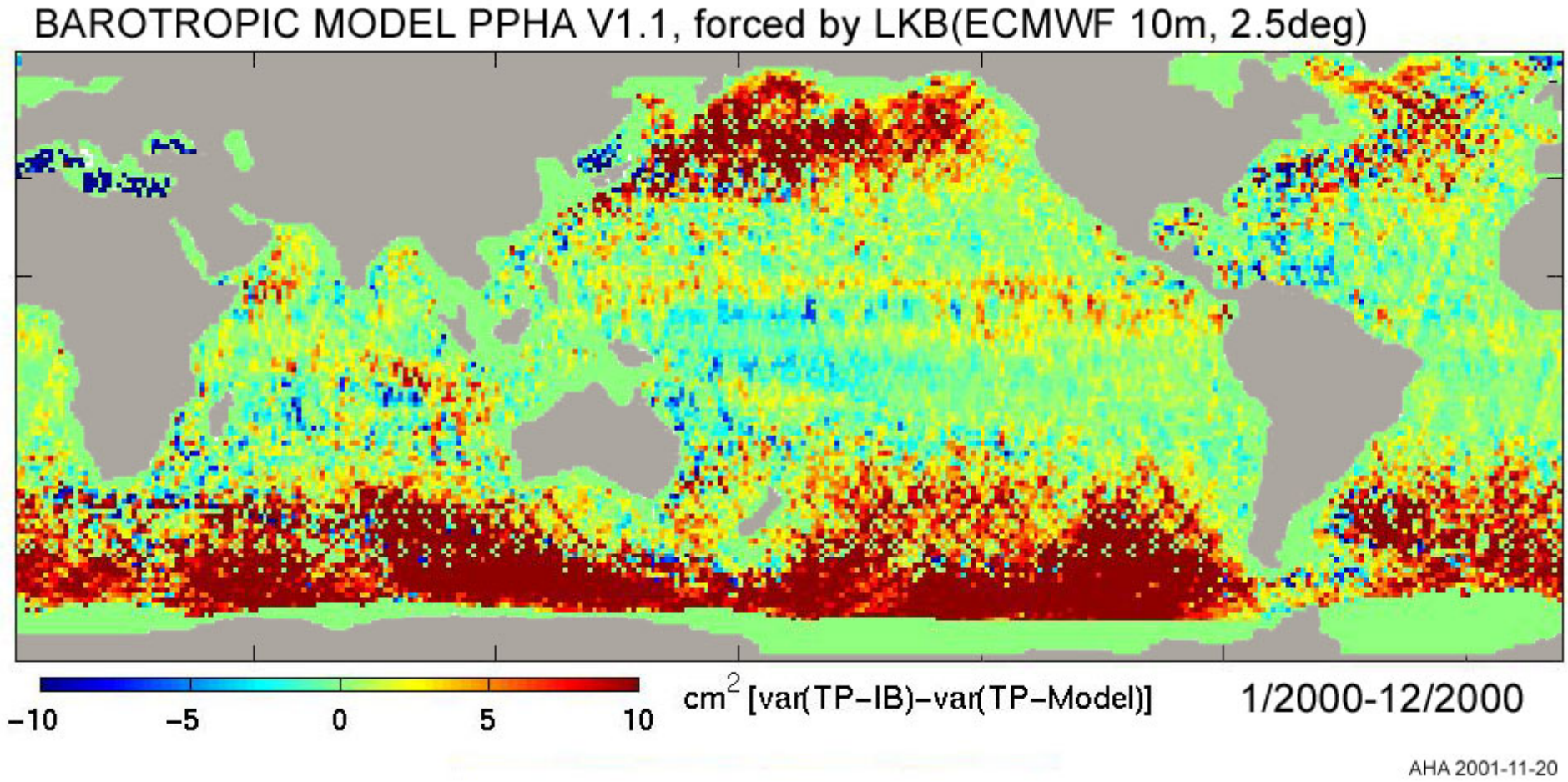
WIND *VELOCITY* TO WIND *STRESS(2)*

- Some Neutral Stability Algorithms:
  Kondo, J., 1975
  Large W. and S. Pond 1982.

- Some Stability-Dependent Algorithms:
  Liu, W. T., K. B. Katsaros, and J. A. Businger, 1979.
  Smith S.D.1988

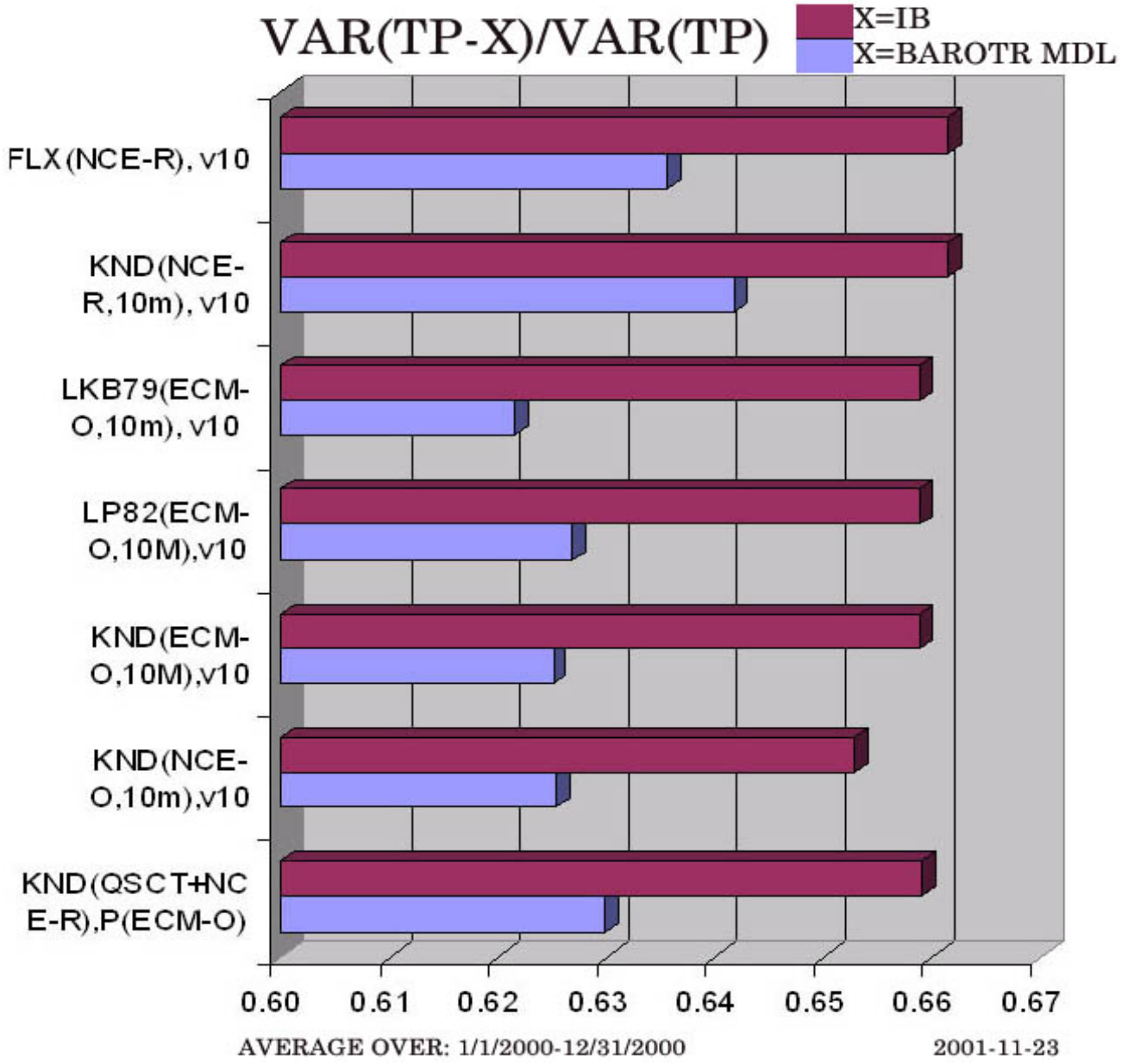


VARIANCE REDUCTION in TOPEX DATA due to MODEL

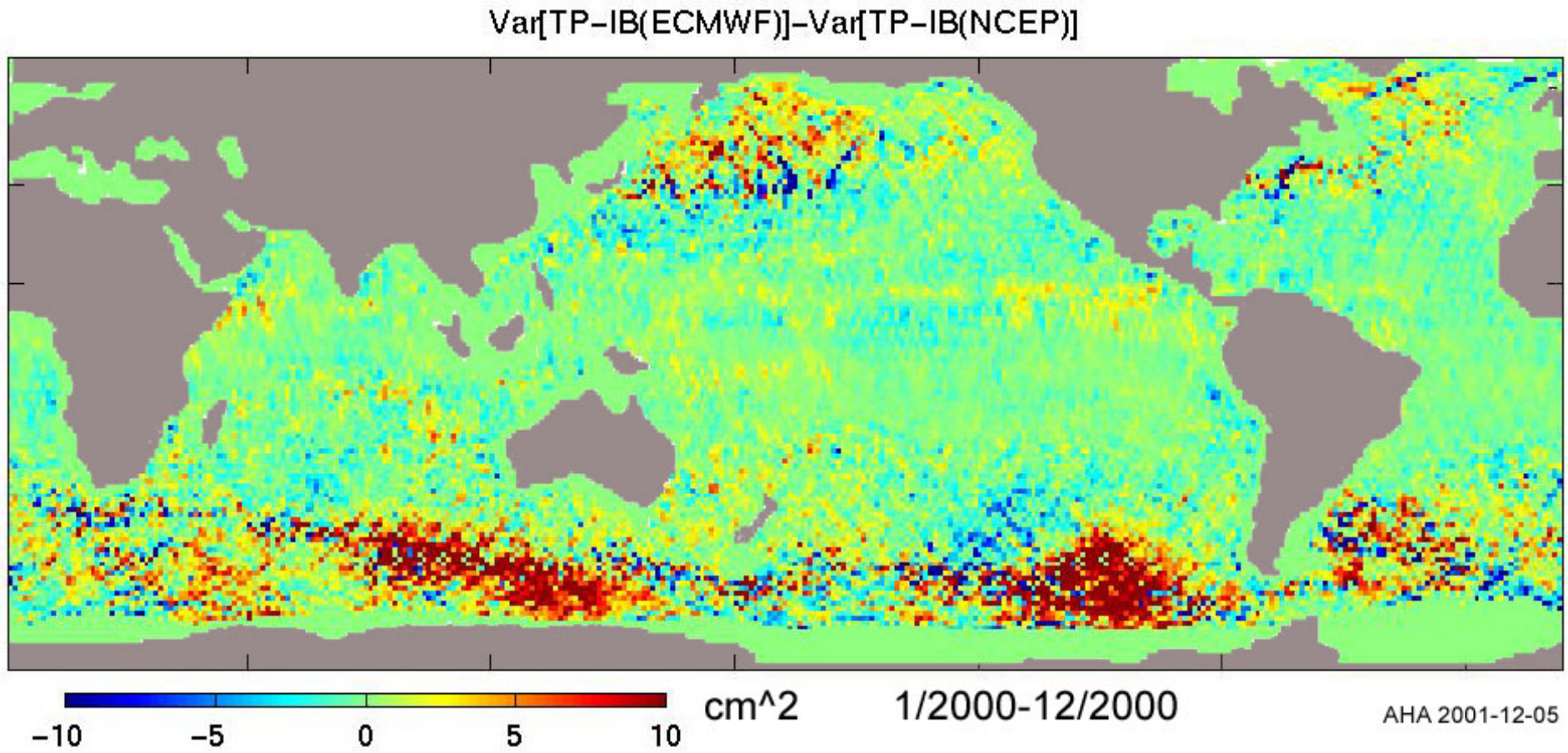


- Variance difference is wrt IB.
- Yellow, Red = Good.
- Light and dark blue: not good.

VARIANCE REDUCTION in TOPEX DATA

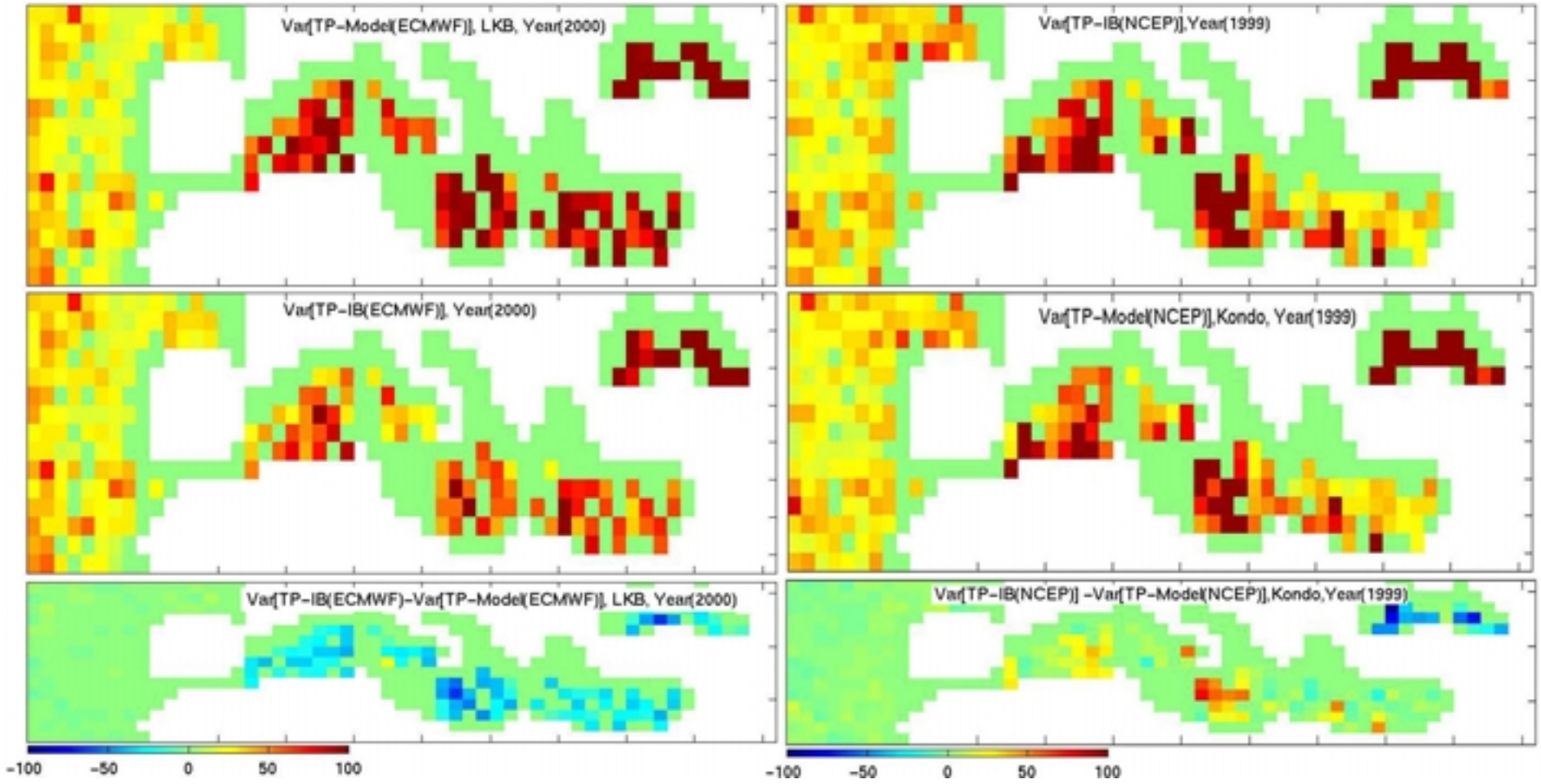


VARIANCE REDUCTION in TOPEX DATA NCEP-O vs ECMWF FORCING



- NCEP-O PRESSURE (2.5 DG GAUSS) DOES BETTER THAN ECMWF-O PRESSURE (2.5 DEG) IN CY 2000

MEDITERRANEAN: PROBLEM



- MEDITERR: NEEDS TO BE OPTIMIZED
- 2000/ECMWF RESULT NOT AS GOOD AS IB.
- 2001 ECWMF 0.5 deg, 6hr RESULTS BETTER THAN IB.

S2 PROBLEM

- BAROTROPIC CODE RAN AT GFZ. FOR 2001 AND 2002. CHECKED JAN-JUN 2001 FROM JPL AND GFZ RUN

- DIFFERENCES IN SETUP

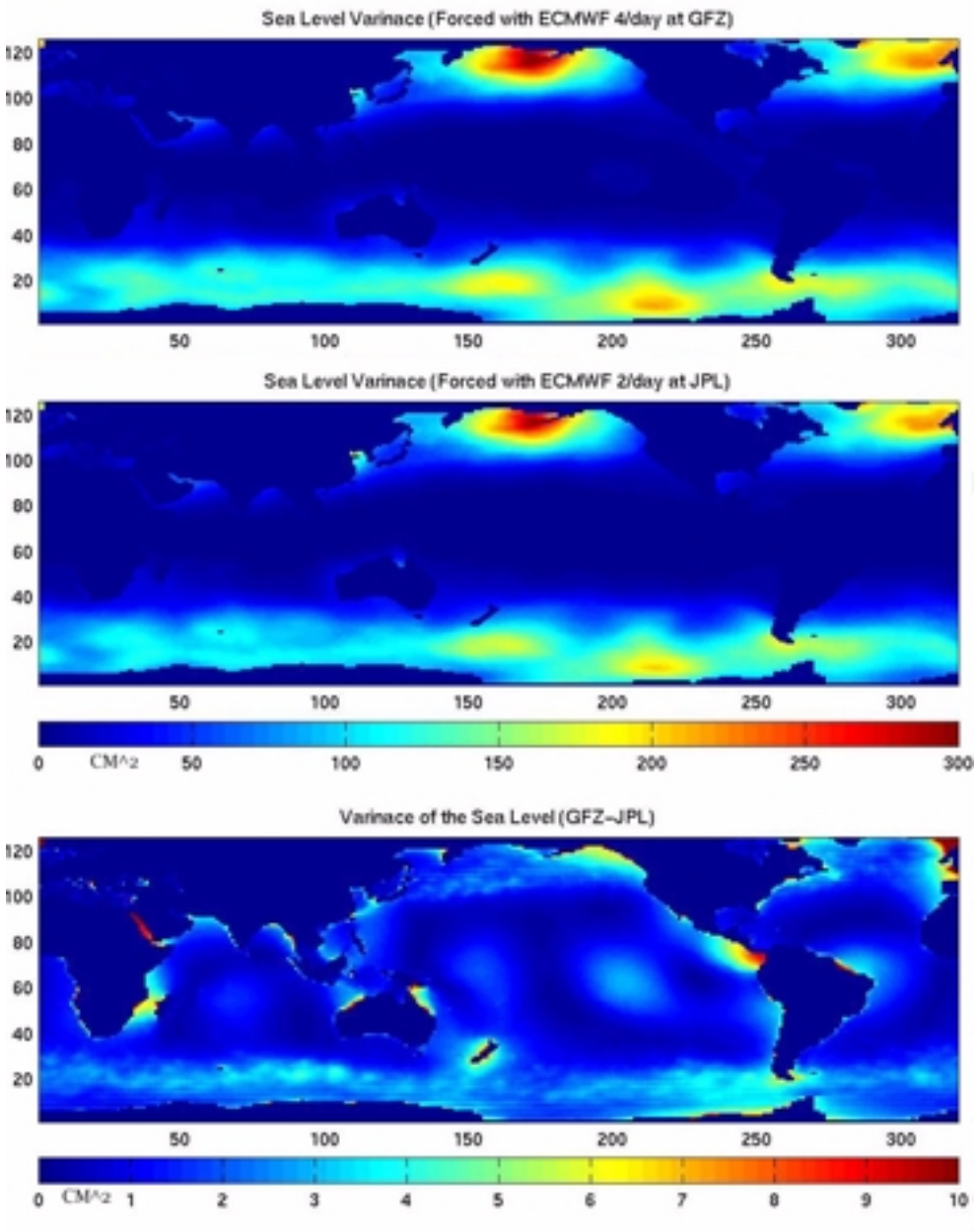
	GFZ	JPL
BAROTROPIC CODE	BTPPHA V1.12	SAME
TIME	1/2002-6/2002	SAME
ATM FORCING	ECMWF OPER	SAME
	0.5DEG	2.5DEG
	6HR	12HR
WIND TO STRESS	LIU/SMITH 98	SAME
	DEWPOINT	RELHUMID
OPERATION	1 RUN PER 1 DAY	1 RUN PER 6 MONTHS

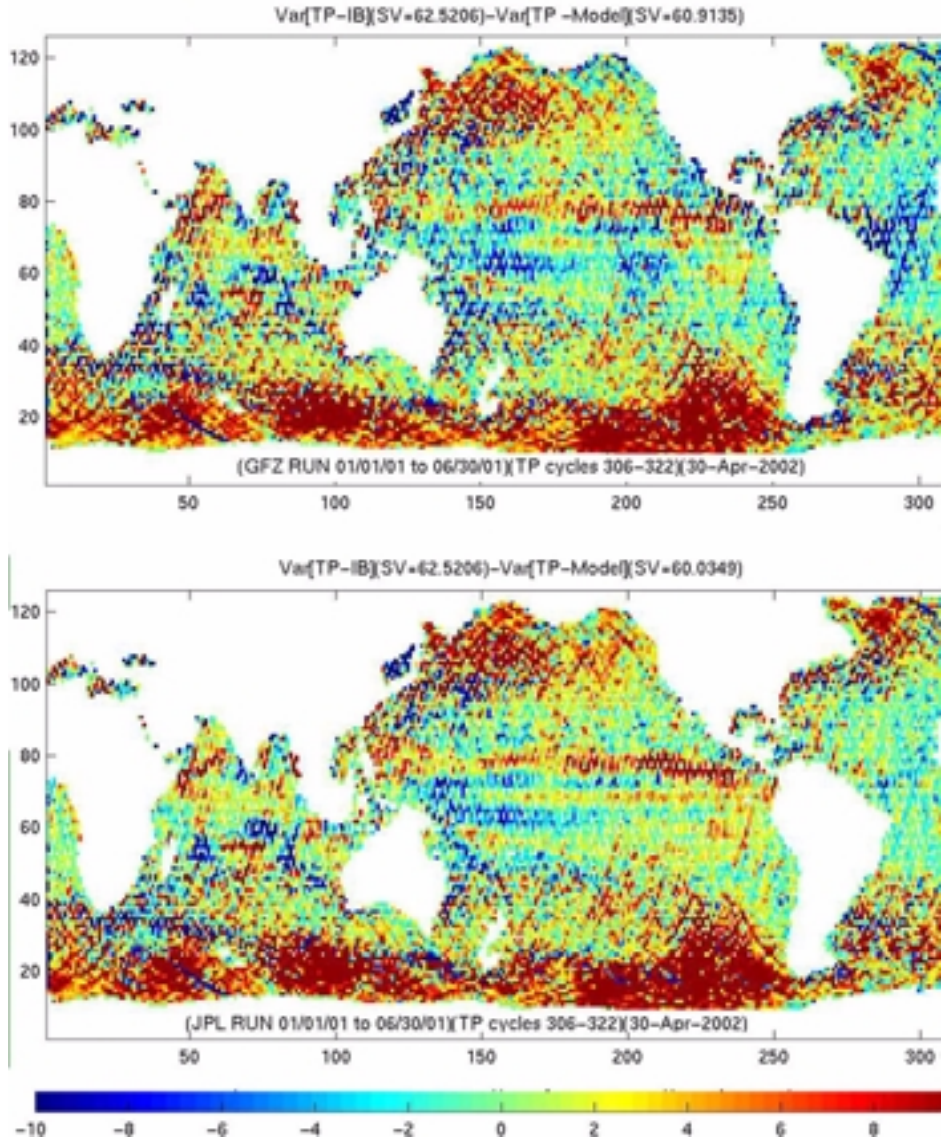
- DIFFERENCES IN FIT TO TOPEX DATA OVER 1/2002-6/2002

	GFZ	JPL
VARIANCE BEF/AFT	62.5/60.9 CM^2	62.5/60.0 CM^2

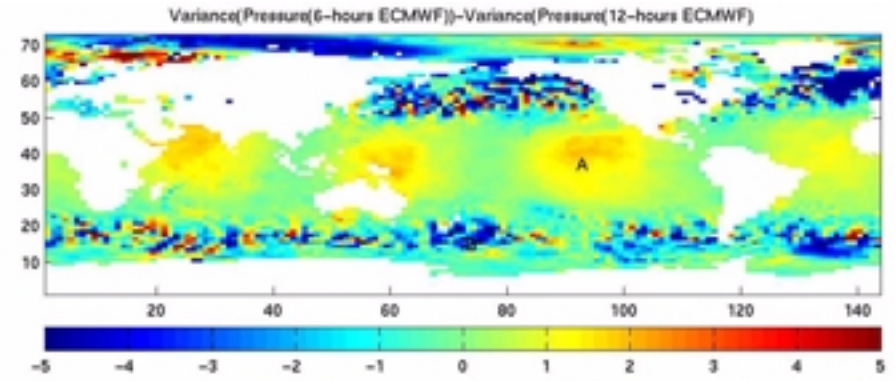
- WE CONCLUDED THE DIFF IS DUE TO SOLAR RADIATION TIDE. SAMPLING 2/DAY TENDS TO FILTER SRT, 4/DAY SAMPLES IT WELL. SRT IS BEING REMOVED TWICE FROM TPX DATA USED HERE: ONCE BY BAROTROPIC MODEL, ONCE BY TIDE MODEL (CSR 3.0)
- WILL FILTER MODEL OUTPUT TO KILL < 24 HR SIGNALS

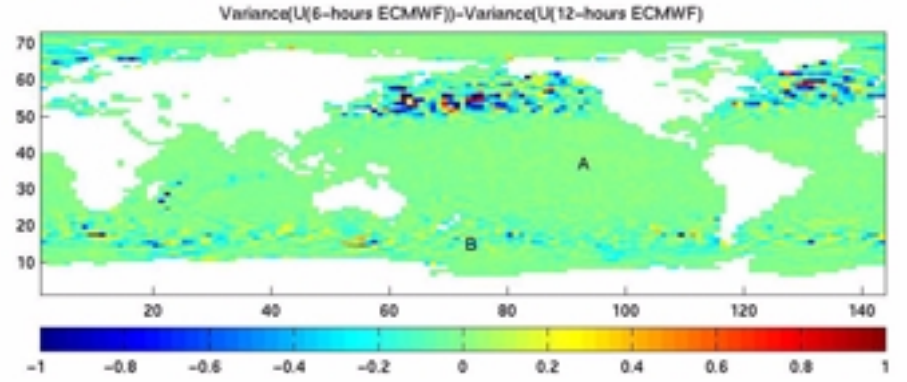
S2 PROBLEM ILLUSTRATED (1)

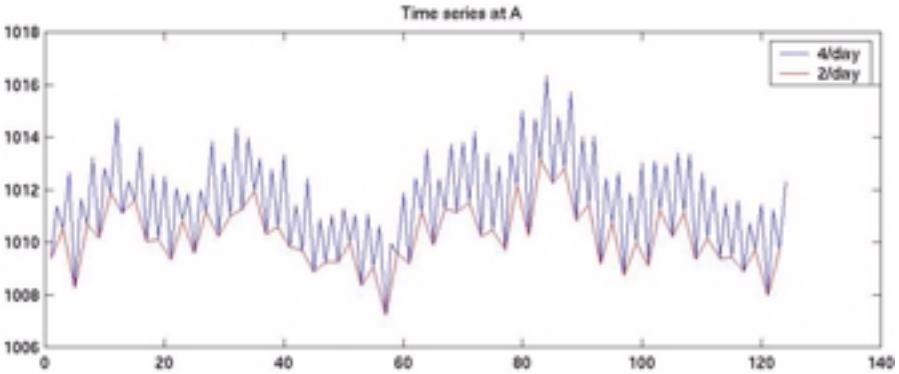


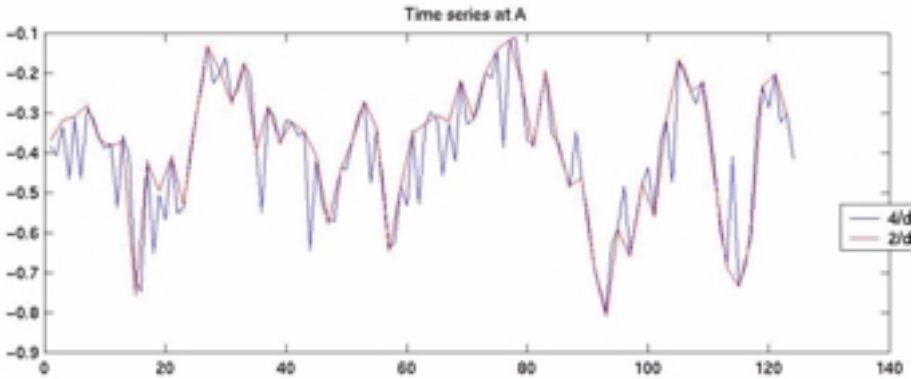


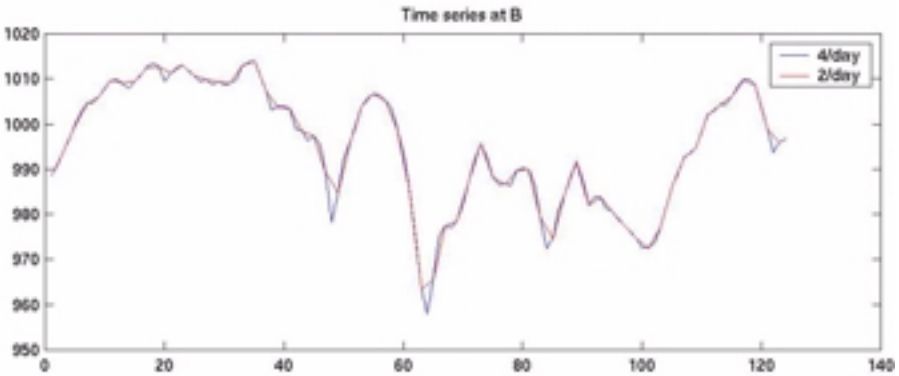
S2 PROBLEM ILLUSTRATED (2)

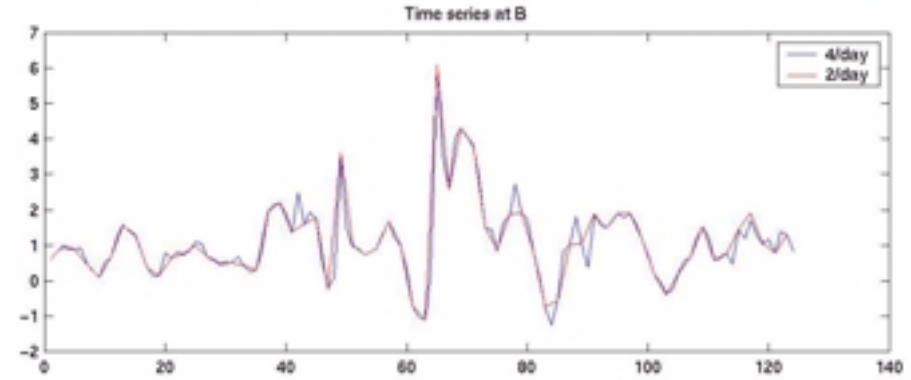




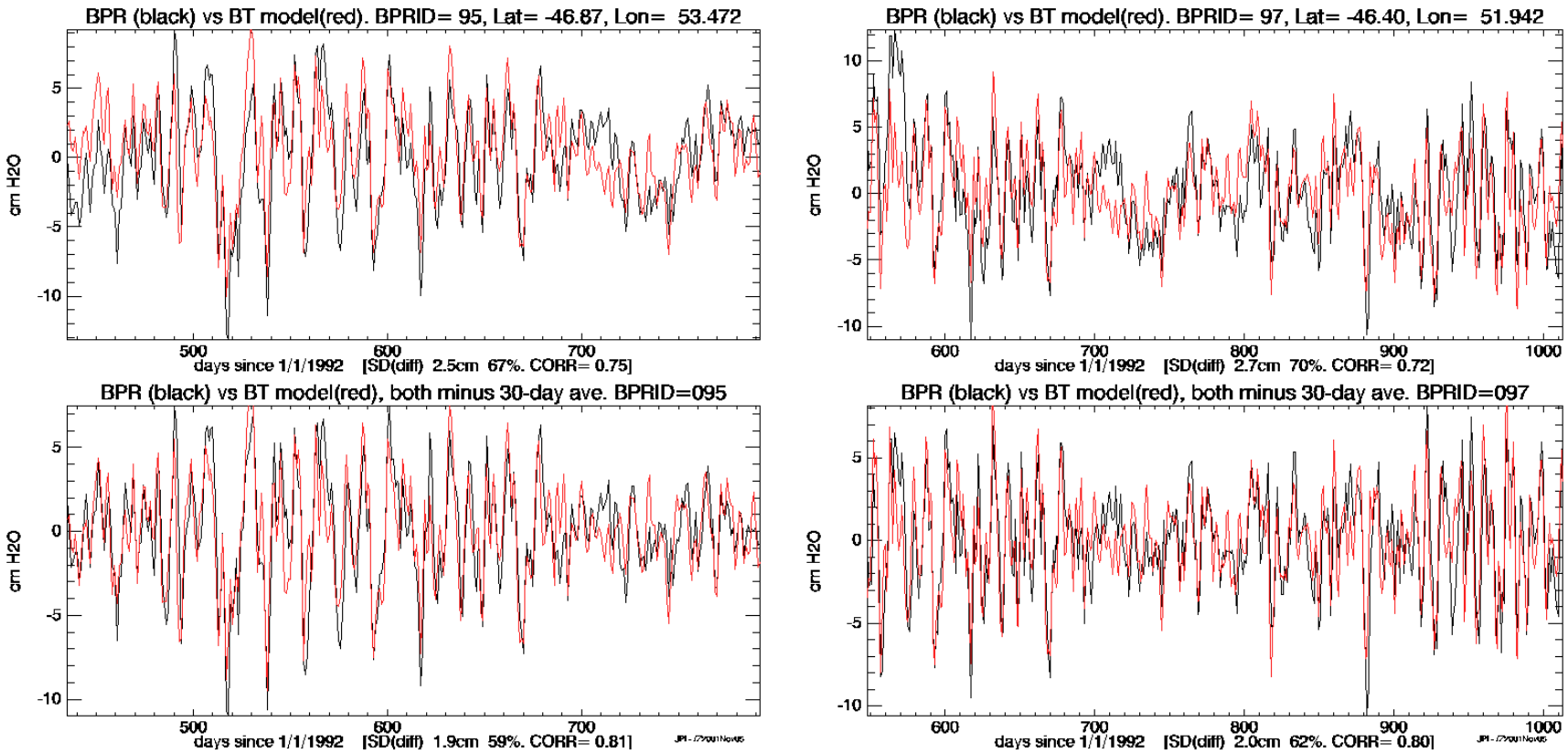






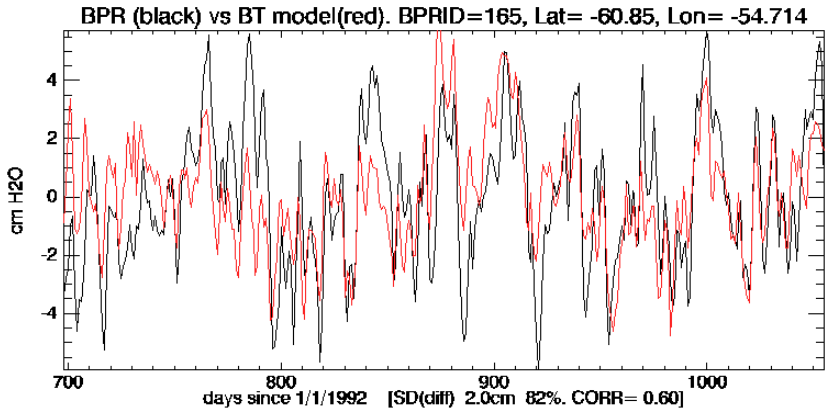


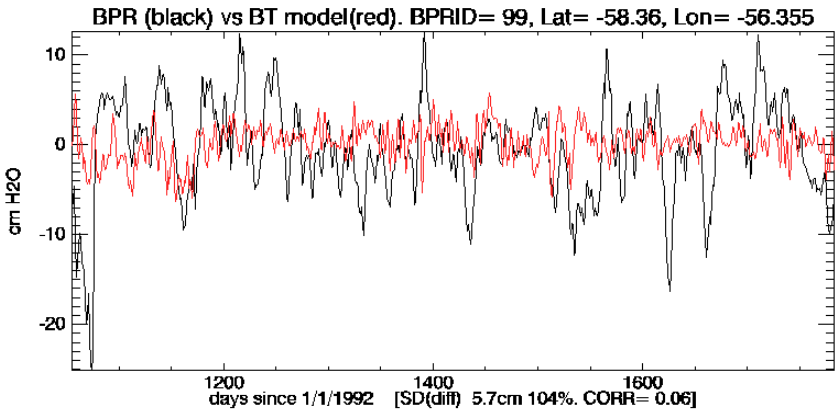
VARIANCE REDUCTION in BPR DATA 1

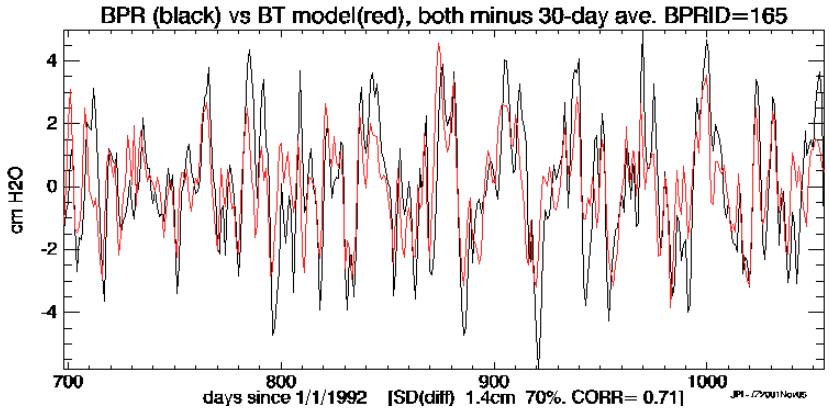


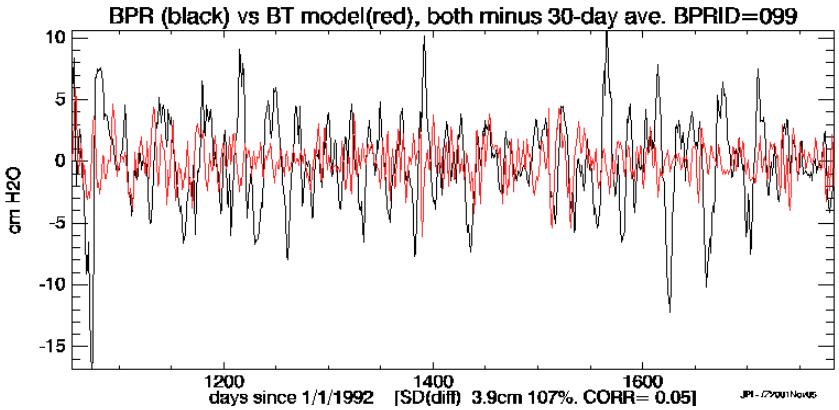
Model version PPHA 1.0
Driven with P(NCEP-R), Kondo(NCEP-R, 1000mb)
Results for 1993-1999

VARIANCE REDUCTION in BPR DATA 2

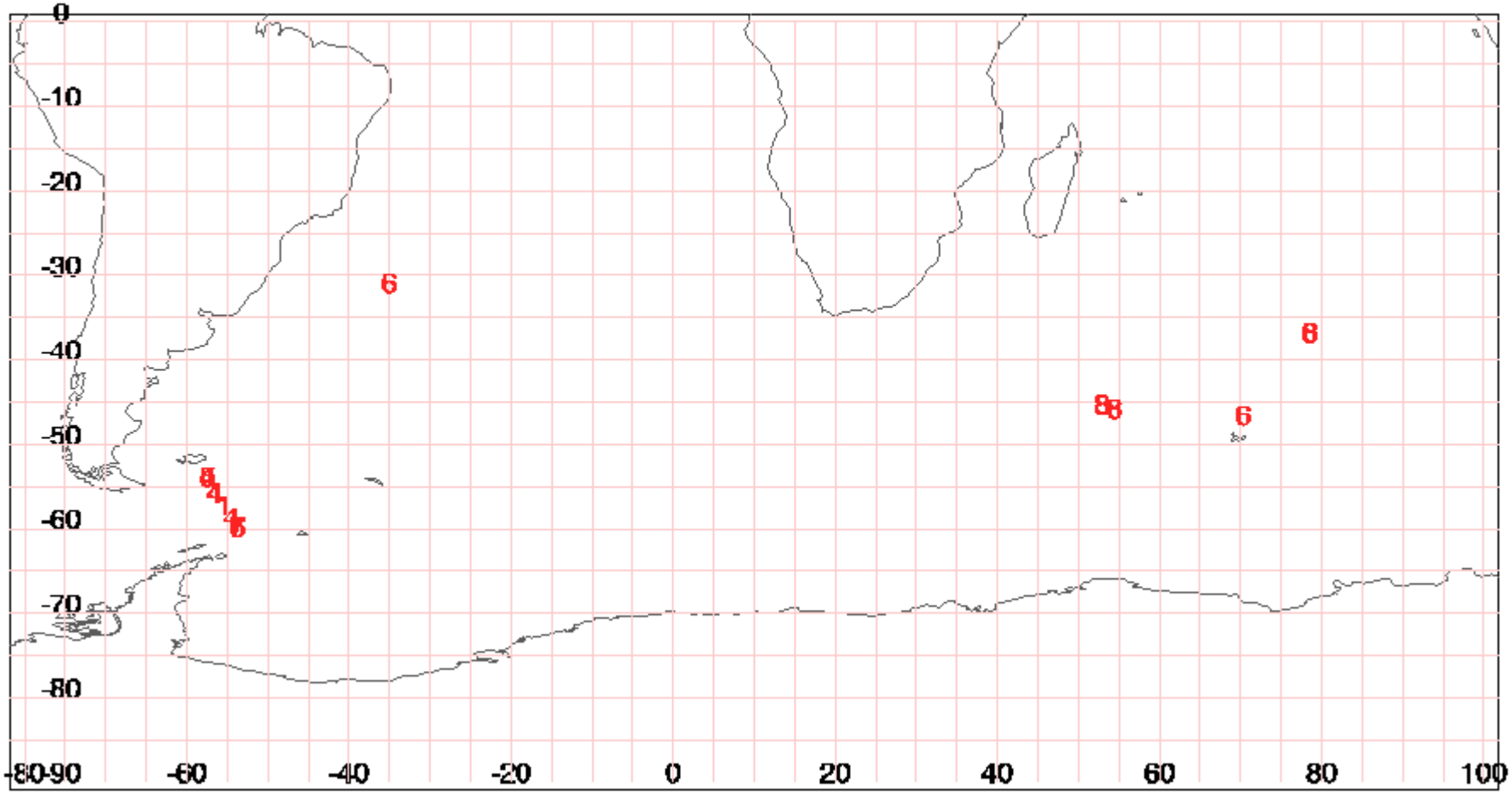




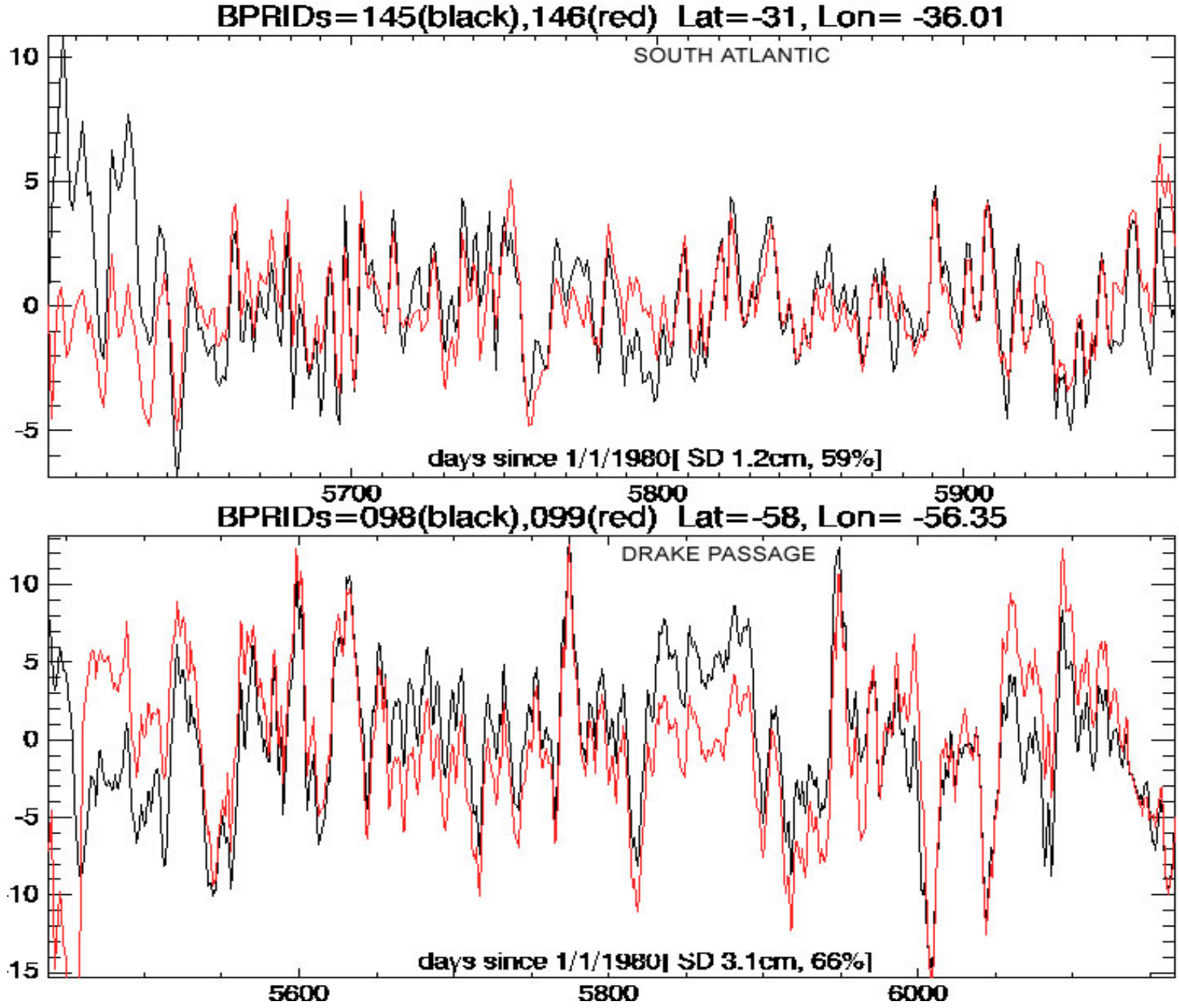




VARIANCE REDUCTION in BPR DATA 3
CORRELATION*10, HIGH FREQ (<30d)



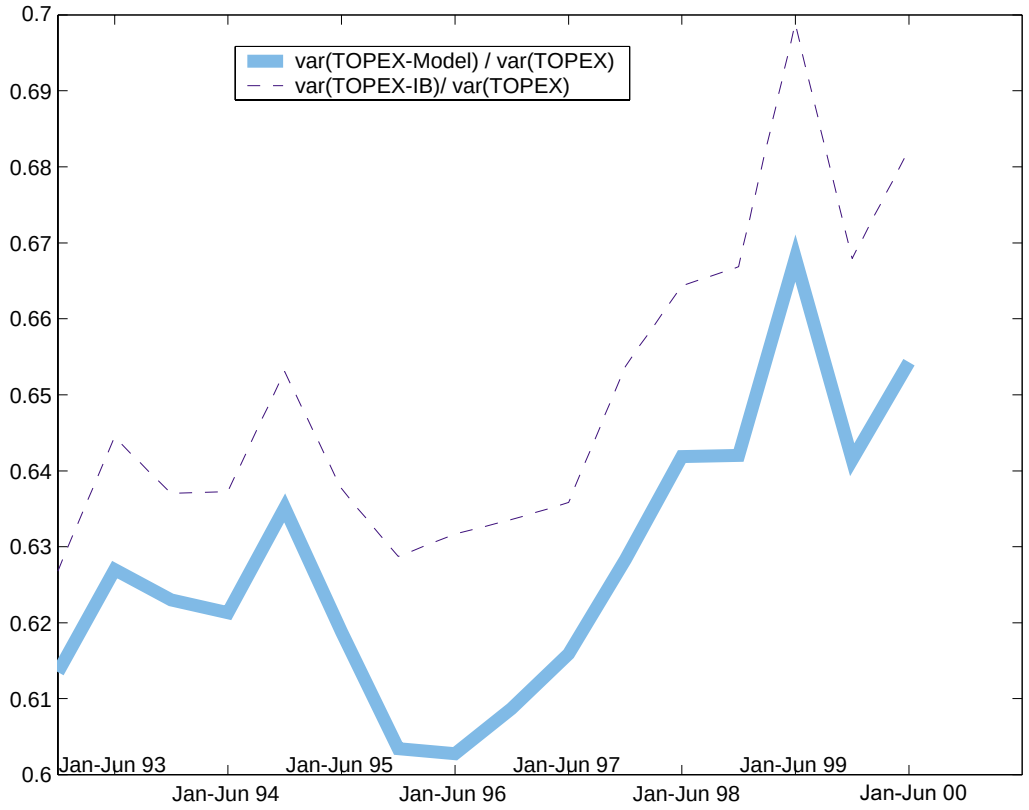
COLOCATED BPR-BPR AGREEMENT



Ali et al., 2001. Barotropic Ocean Model, Atm. Forcing.

OPERATIONAL MODEL

- Even with Kondo(NCEP reanalysis, 1000mbar wind) for 1992-2000 the model removes more variance than just IB at all times.



CONCLUSIONS

- IN THE SOUTHERN OCEAN, THIS BAROTROPIC MODEL EXPLAINS UP TO 40% OF THE TP DATA VARIANCE, MOST OF IT A HIGH-FREQUENCY (< 30 day) SIGNAL
- BAROTROPIC MODEL IS GOOD FOR T < 100 DAYS (TIERNEY ET AL)
- ECMWF-O AND NCEP-O (OPER) DO BETTER THAN NCEP-R (REANALYSIS), a 1886 version that has since evolved.
- STABILITY-DEPENDENT LKB ALGORITHM DOES BETTER THAN NEUTRALLY STABLE ALGORITHMS (KONDO, L&P).
- NCEP-O PRESSURE DOES BETTER THAN ECMWF-O PRESSURE IN CY 2000
- NCEP-O AND ECMWF-O WIND & PRESSURE COMBINED PERFORM INDISTINTIGUISHABLY IN CY 2000.
- FOR 1999, NCEP-O REDUCED MORE VARIANCE THAN ECMWF-O.
- MEDITERR: NOT AS GOOD AS IB with 2.5 deg ECMWF, better with 0.5
- 2001 COMP. HIGHLIGHTS THE NEED TO FILTER OUT S2.

PLANNED IMPROVEMENTS

- Self-attraction
- Friction vs subscale bathymetric roughness (see Hirose)
- T < 2-3 days
- Time Filtering, Tidal frequencies
- Forced mode vs assimilation mode