Dynamics of intraseasonal sea level and thermocline variability in the equatorial Atlantic during 2002-2003

Weiqing Han

Department of Atmospheric and Oceanic Sciences

University of Colorado at Boulder

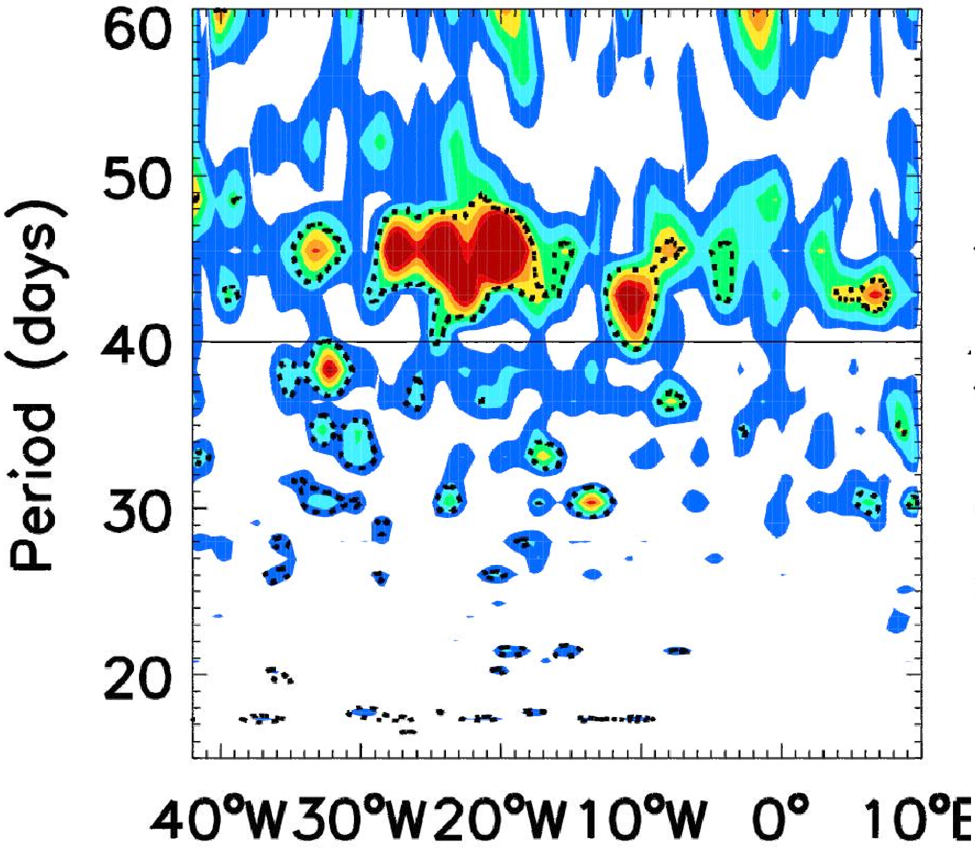
Collaborators:

P. J. Webster
J. Lin
W. Timothy Liu
Rong Fu
D. Yuan
A. Hu

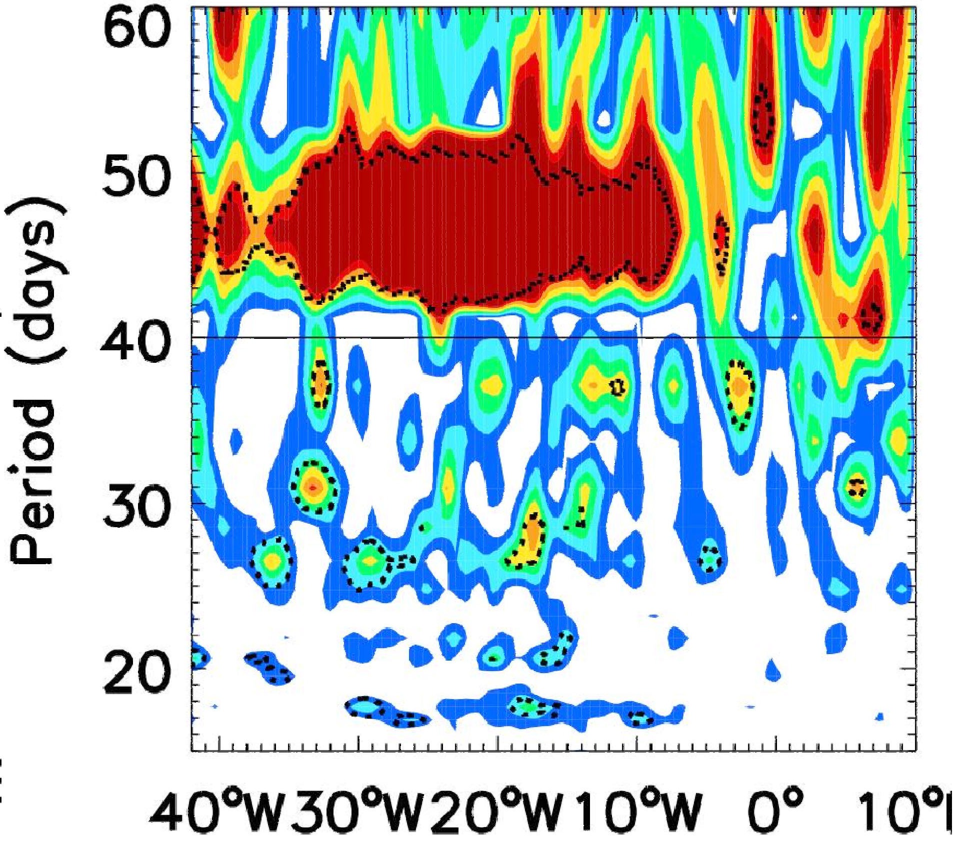
1. Observational Background

Variance spectra of AVISO SSHA, 2S-2N Atlantic

2002-2003

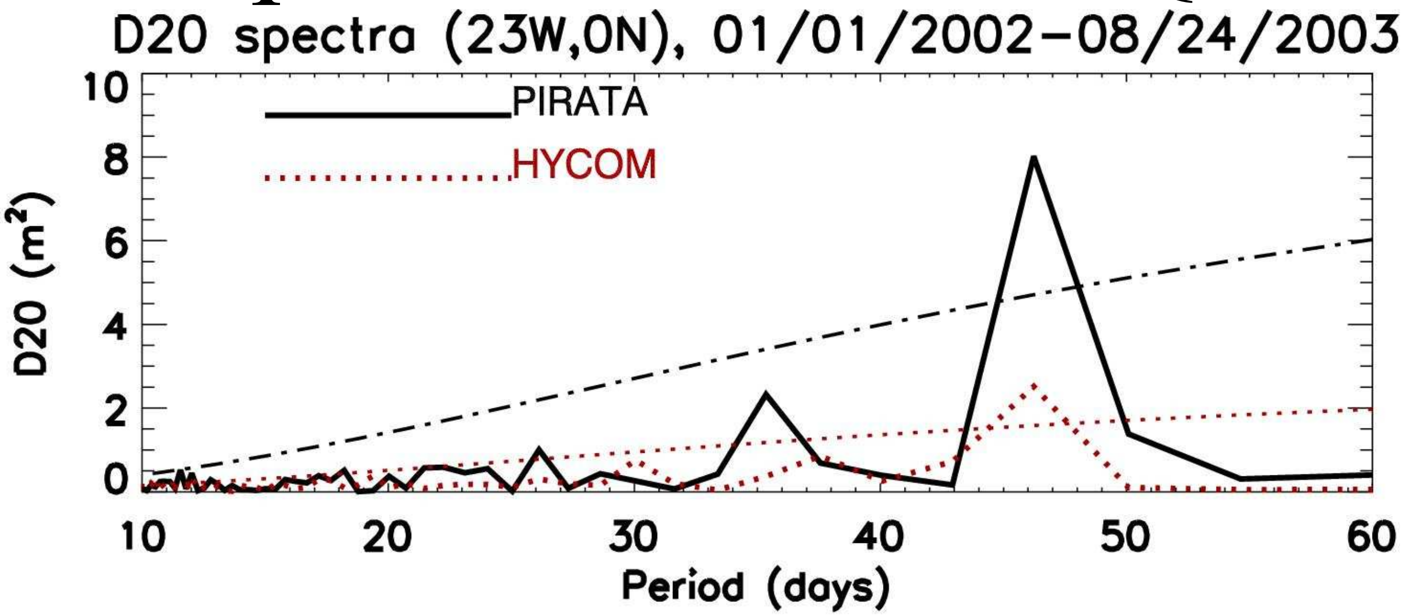


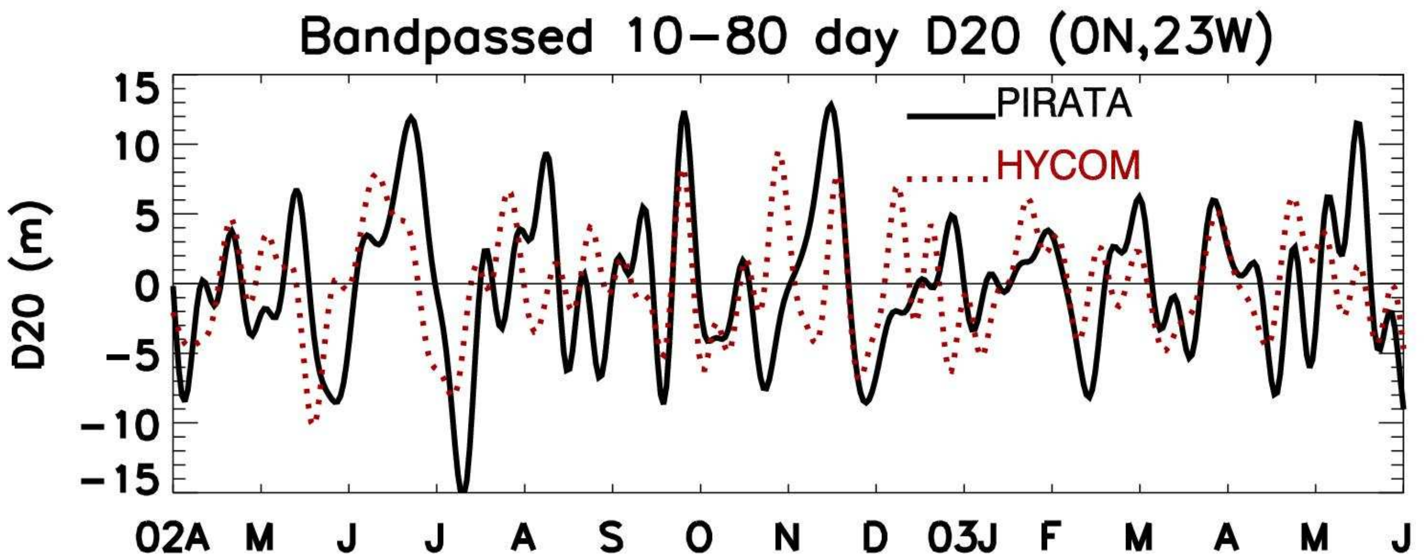
2002



TIWs: peak periods: 15-40 days

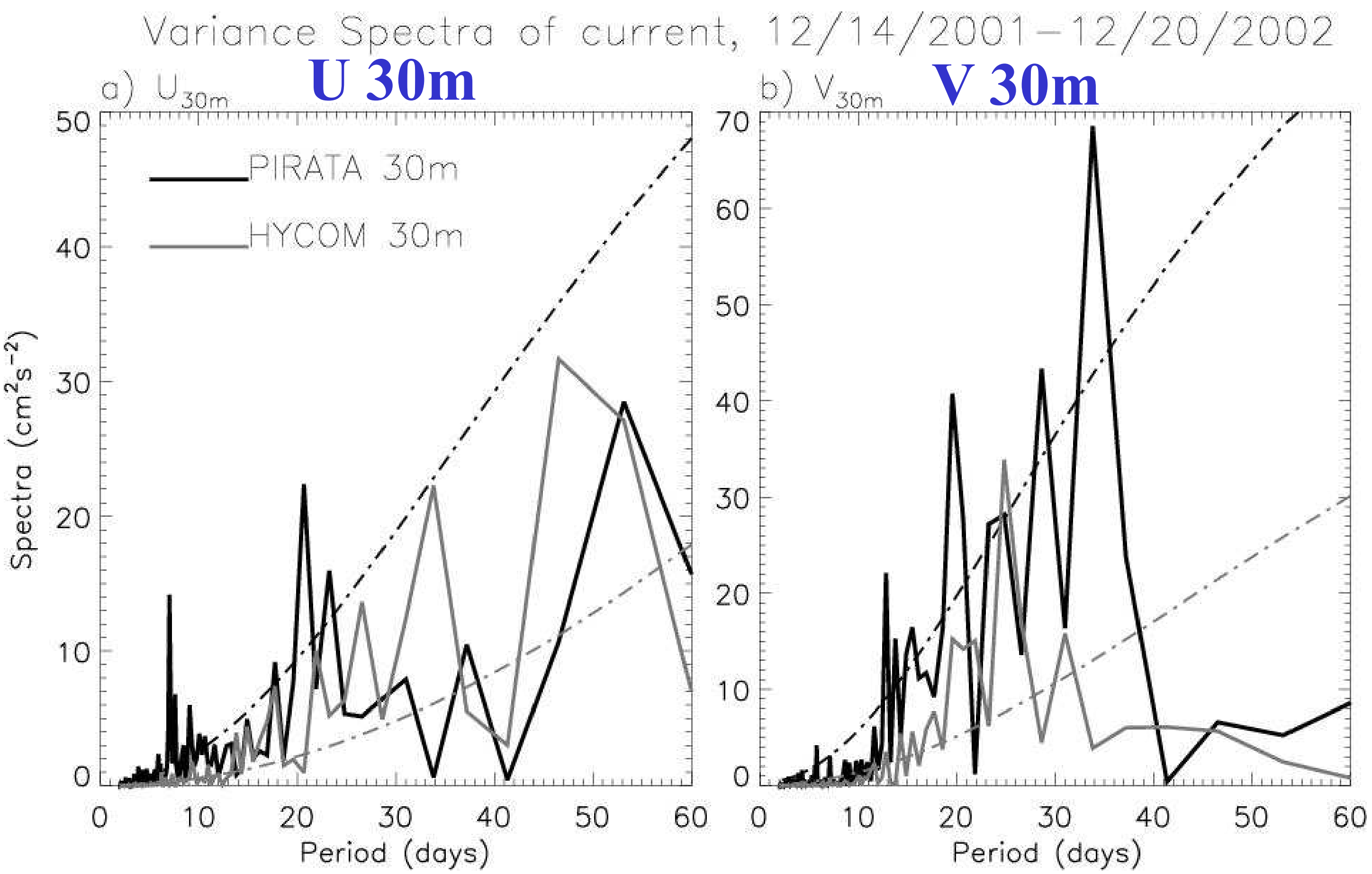
Variance spectra of D20 at EQ Atlantic





Mean: 78m

Variance spectra of PIRATA current, (23W, 0N) 2002-2003



TIWs: peak periods: 10-40 days

Most obs/model studies: TIWs; Robust especially at 10-40d;

Modeling studies: wind effects are lack;

Observations: Katz, 1987, 1997: wind forced Kelvin waves;

Garzoli, 1987, Houghton and Colin 1987, Bunge et al. 2006,2007

~14d Yanai waves;

Goal

Understand the causes for the intraseasonal variability of sea level and thermocline. Specifically:

Estimate effects of wind forcing & TIWs

2. Ocean models

An OGCM: the Hybrid Coordinate Ocean Model (HYCOM).

A Linear continuously stratified model (LM).

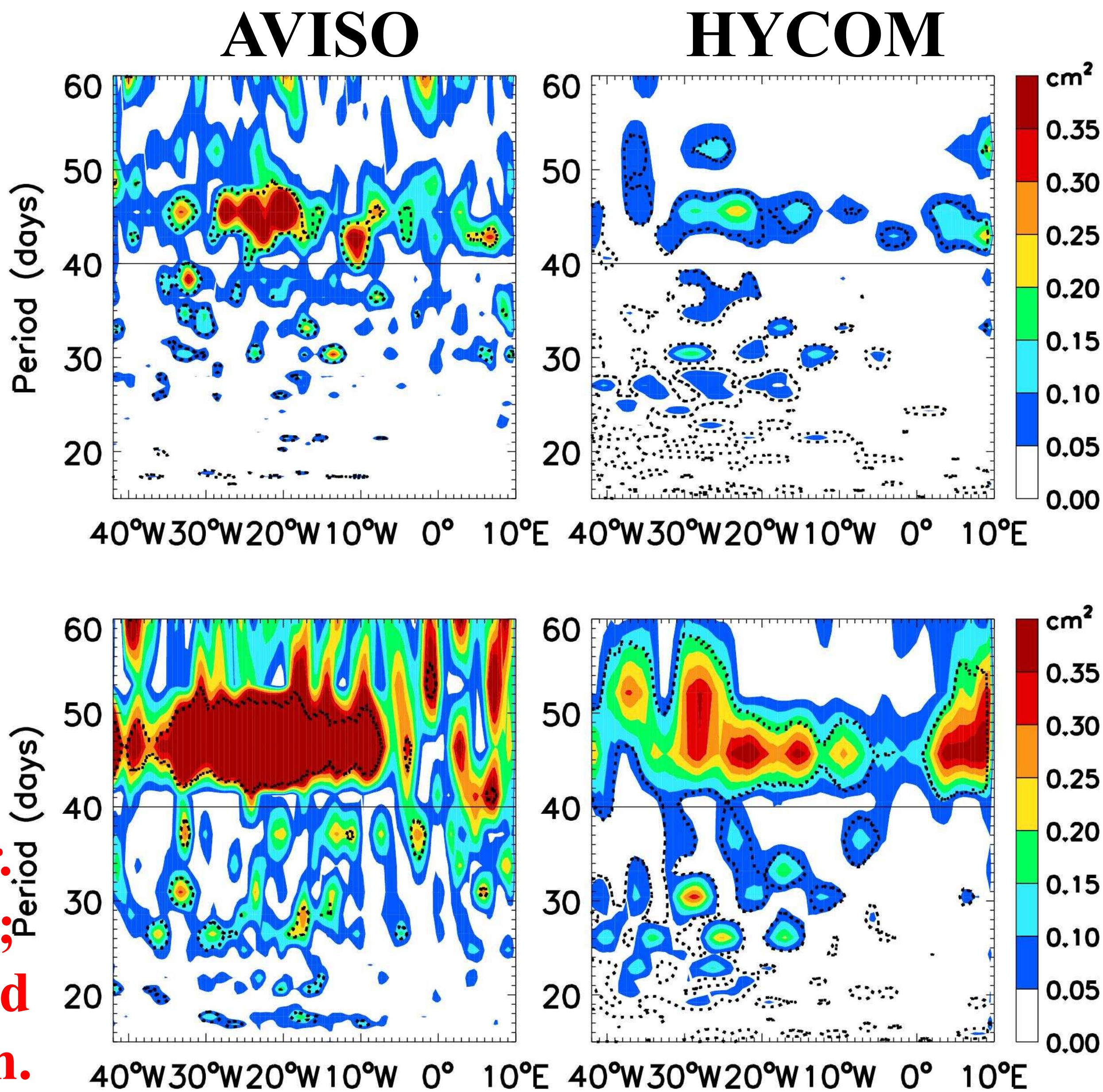
Experiments	Forcing	Description
HYCOM MR	Daily (QSCAT)	TIWs+wind forc.
HYCOM EXP	Lowpassed 80-d	TIWs
LM	Daily (QSCAT)	wind forcing

Period: 2000-2003

3. Results: Variance Spectra for SSHA

2002-2003

2002

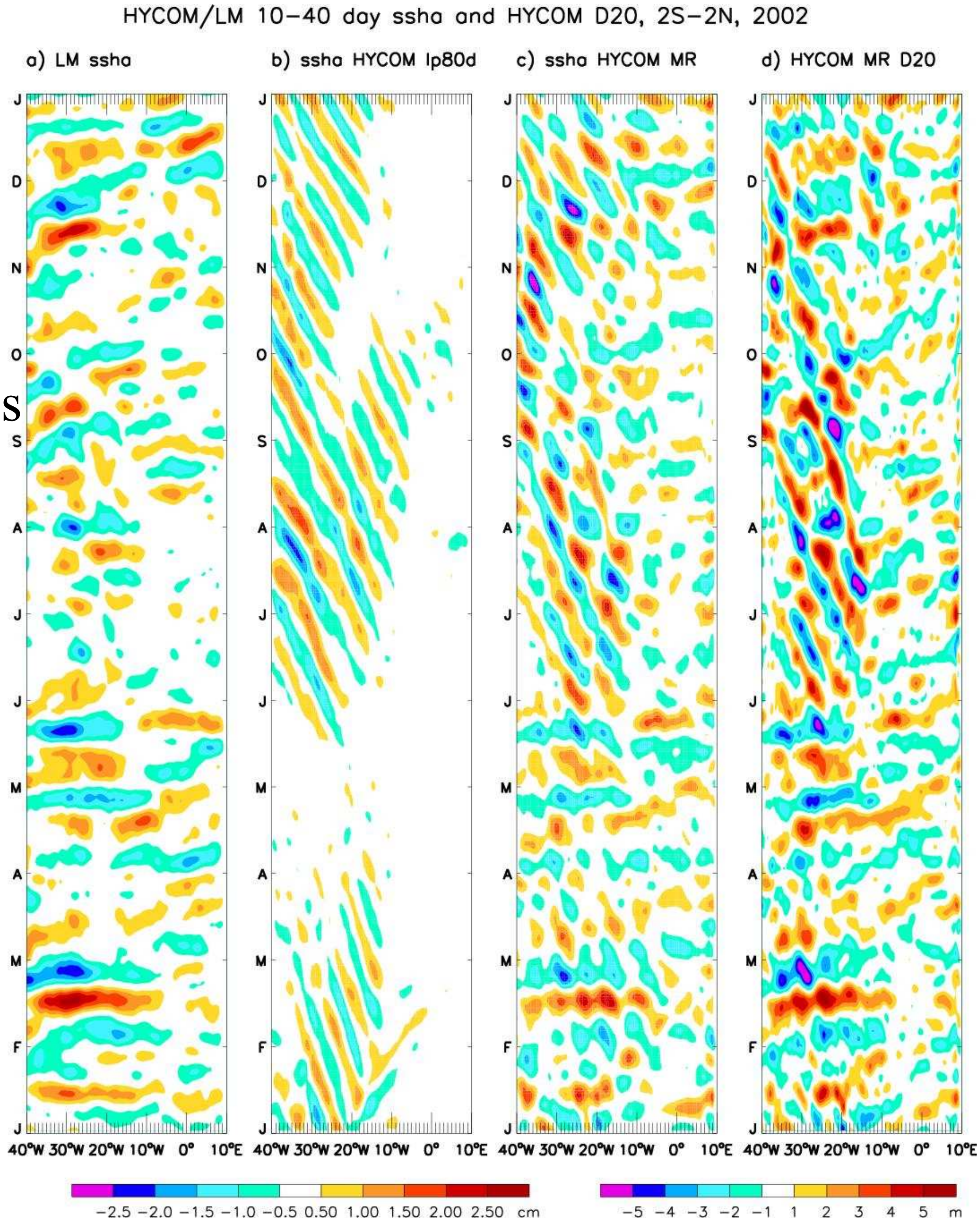


Dominance symmetr.
40-50d: AMS air-sea;
Here, focus on:10-40d
Symmetric + antisym.

Processes:

Symmetric component

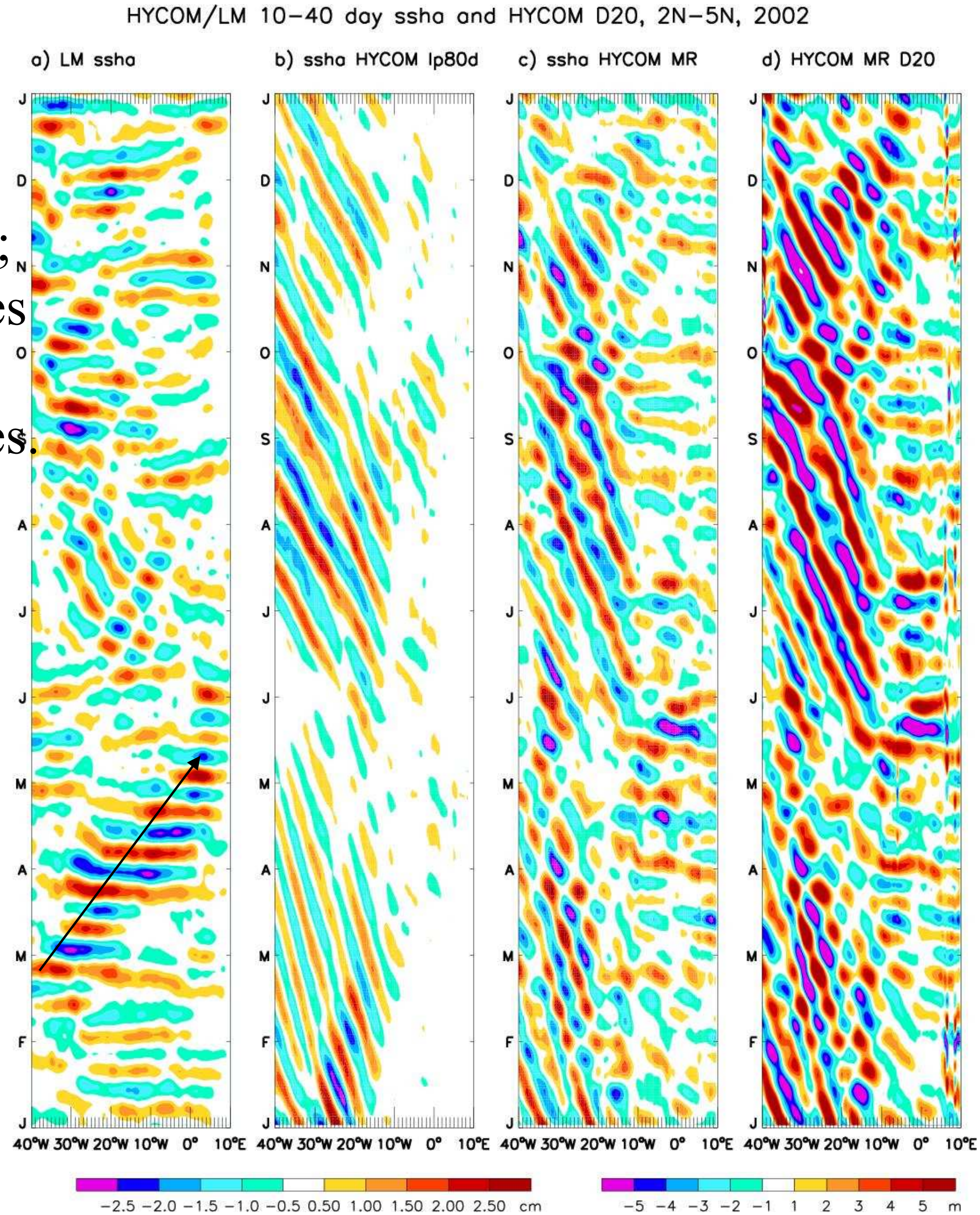
a. TIWs:mainly sum.-fall;
b. Wind: all year, dominates east 0E;
c. Spring: wind dominated.

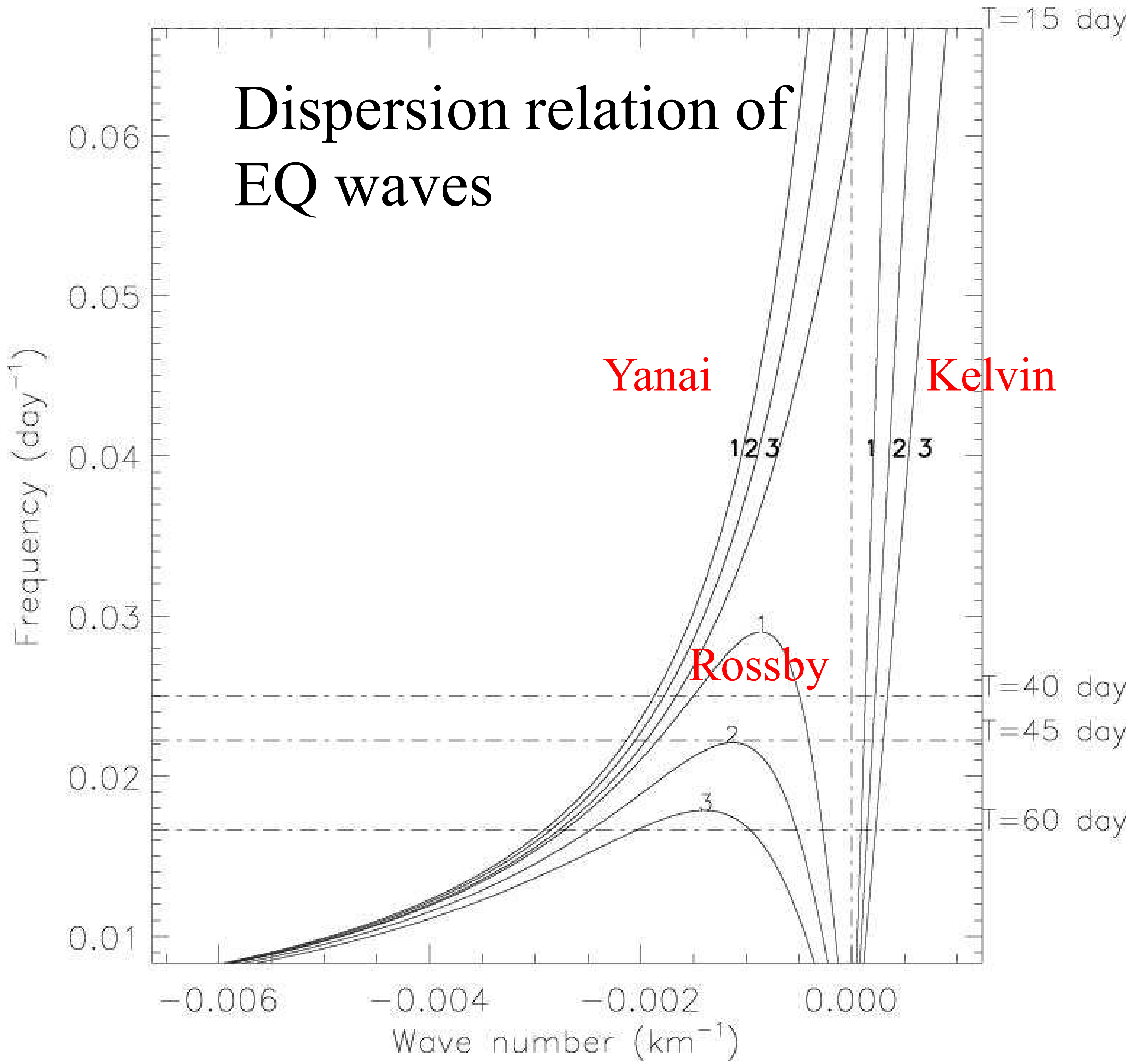


Anti-symmetric:

a. TIWs:dominate summer;
b. Wind: all year, dominates east of 0E;
c. Spring: 14-d Yanai waves.

Observed Bunge et al. 2006,2007





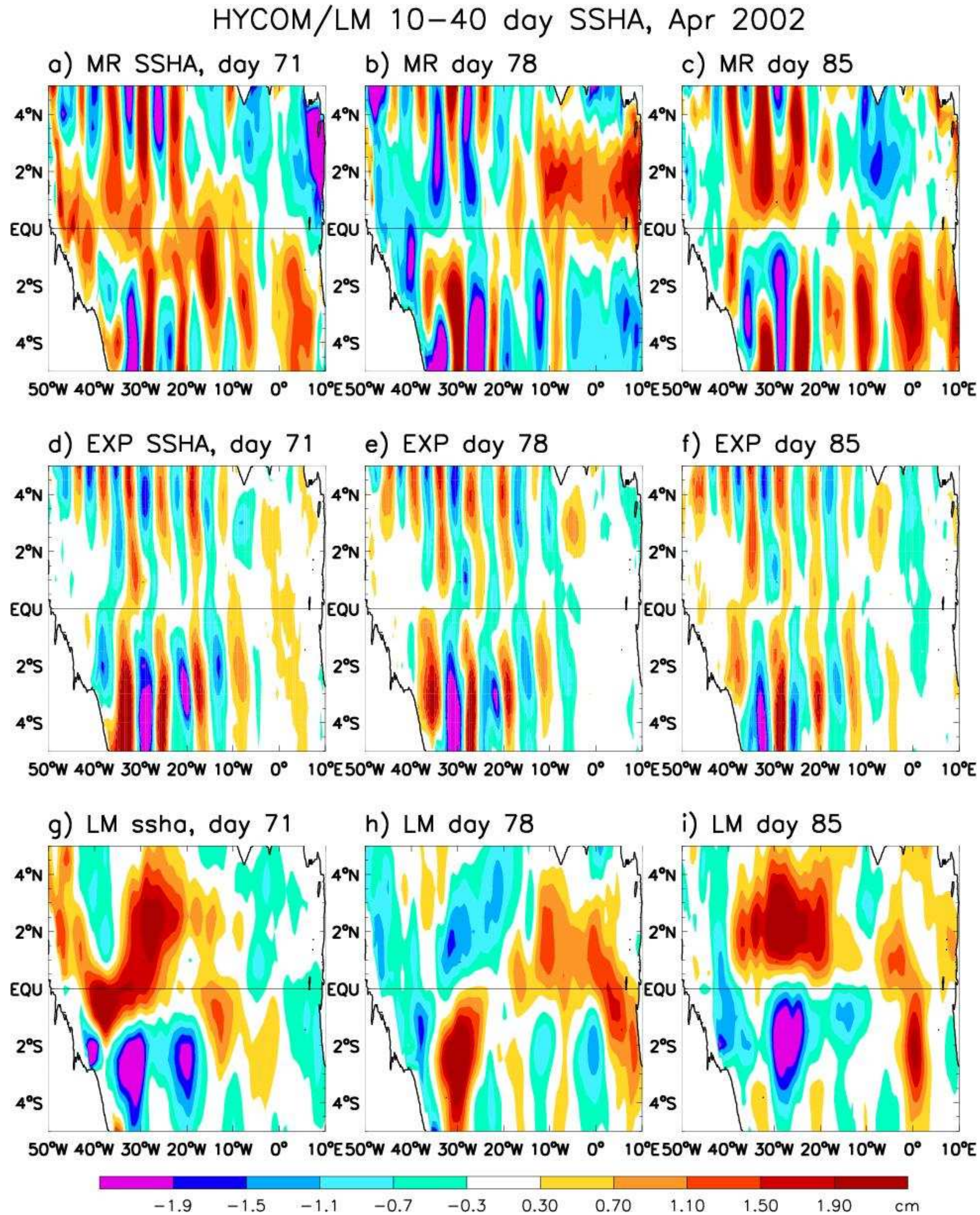
Dispersion relation of EQ waves
Yanai
Kelvin
Rossby
1 2 3
1 2 3
1
2
3
T=15 day
T=40 day
T=45 day
T=60 day
0.06
0.05
0.04
0.03
0.02
0.01
Frequency (day^{-1})
−0.006
−0.004
−0.002
0.000
Wave number (km^{-1})

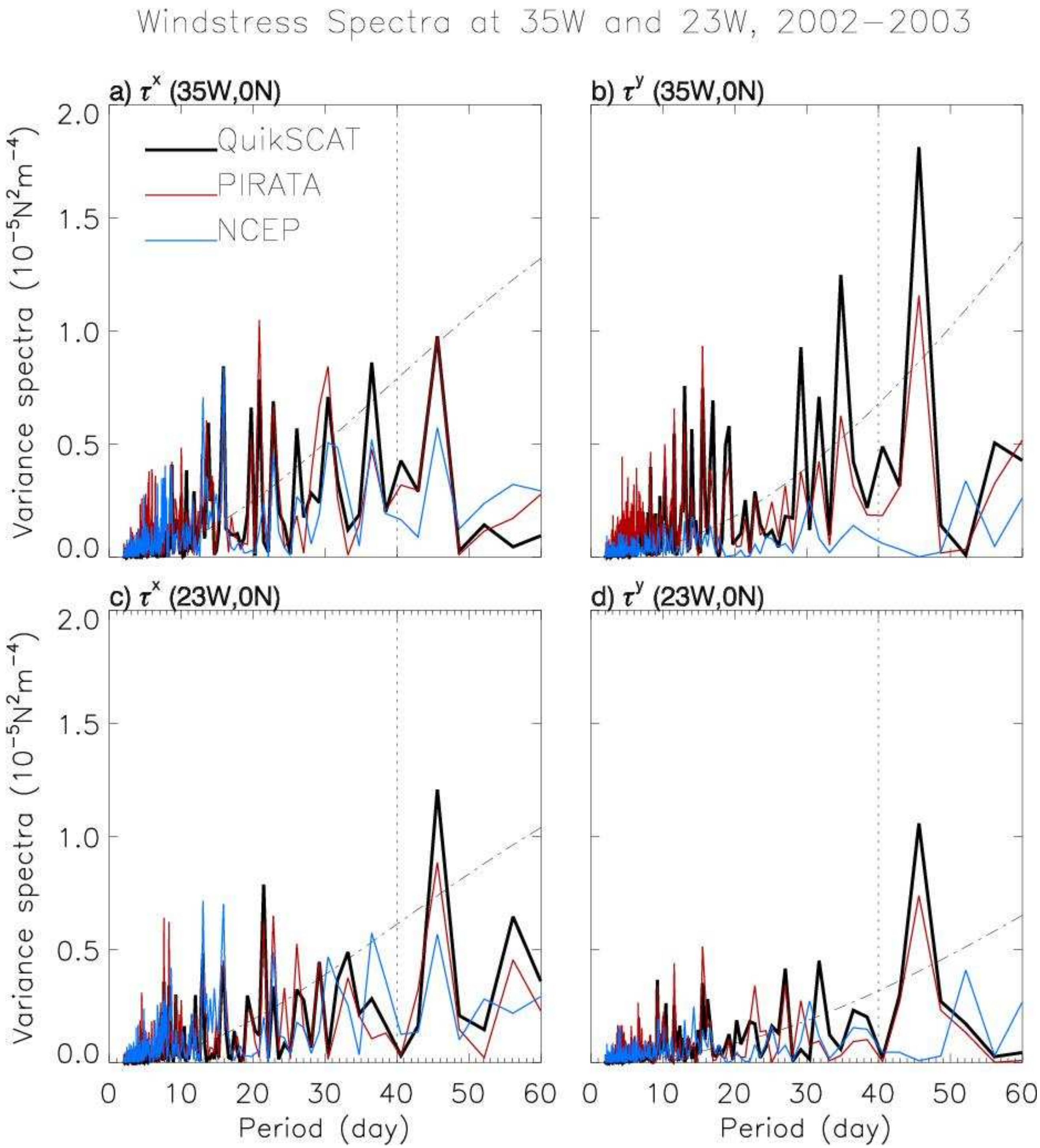
Case: Apr 2002
SSHA 14-d cycle:

HYCOM MR
(TIWs+wind)

HYCOM EXP
(TIWs)

LM
(wind forced)





Windstress Spectra at 35W and 23W, 2002–2003
a) τ^x (35W,0N)
b) τ^y (35W,0N)
c) τ^x (23W,0N)
d) τ^y (23W,0N)
QuikSCAT
PIRATA
NCEP
Variance spectra (10^-5N^2m^-4)
Period (day)

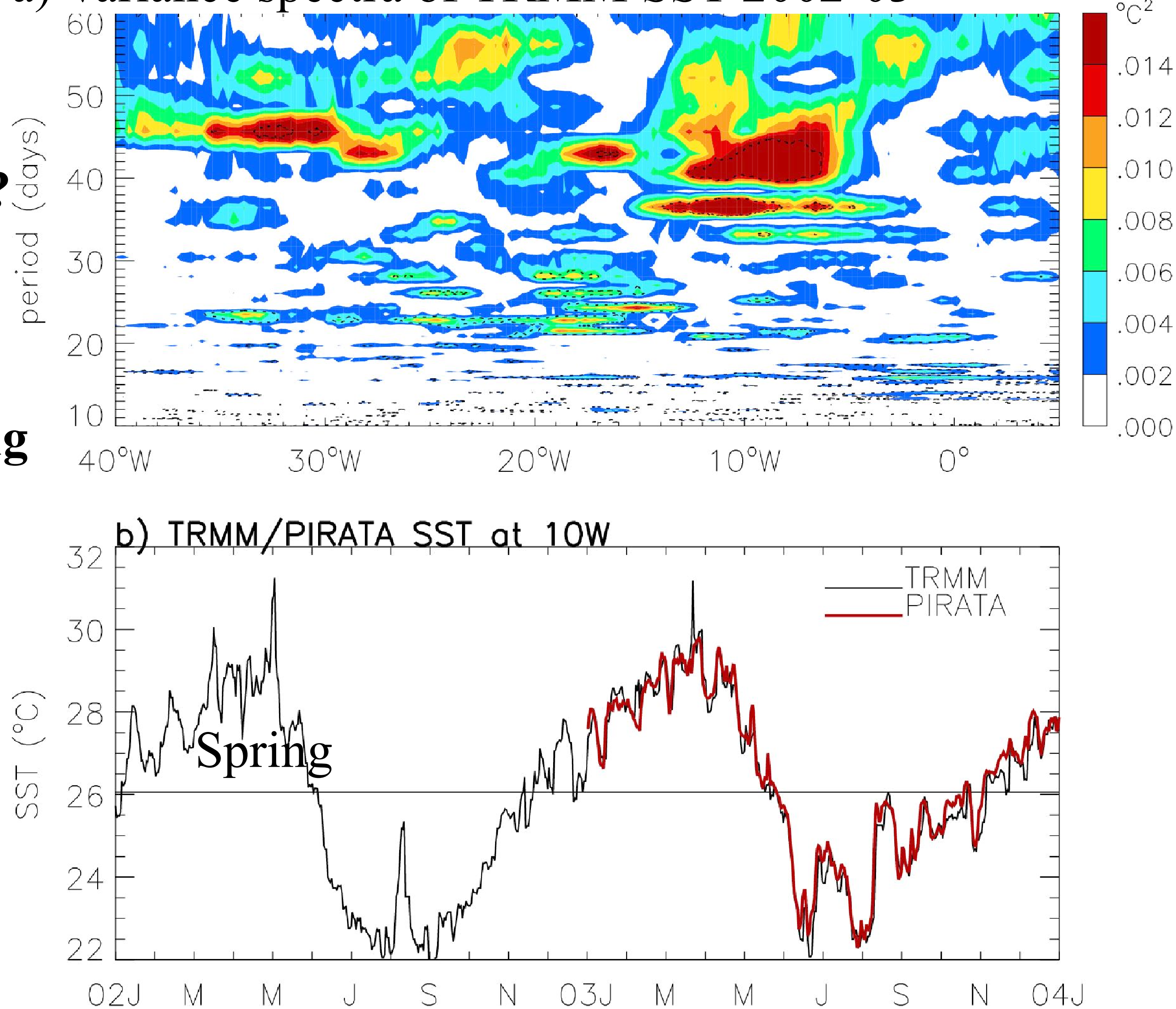
Why important?

1.Spring, ITCZ;

2. Atlantic Nino? (R. Fu)

3. 14-day Yanai: Guinea upwelling (Houghton and Colin 1987)

a) Variance spectra of TRMM SST 2002-03

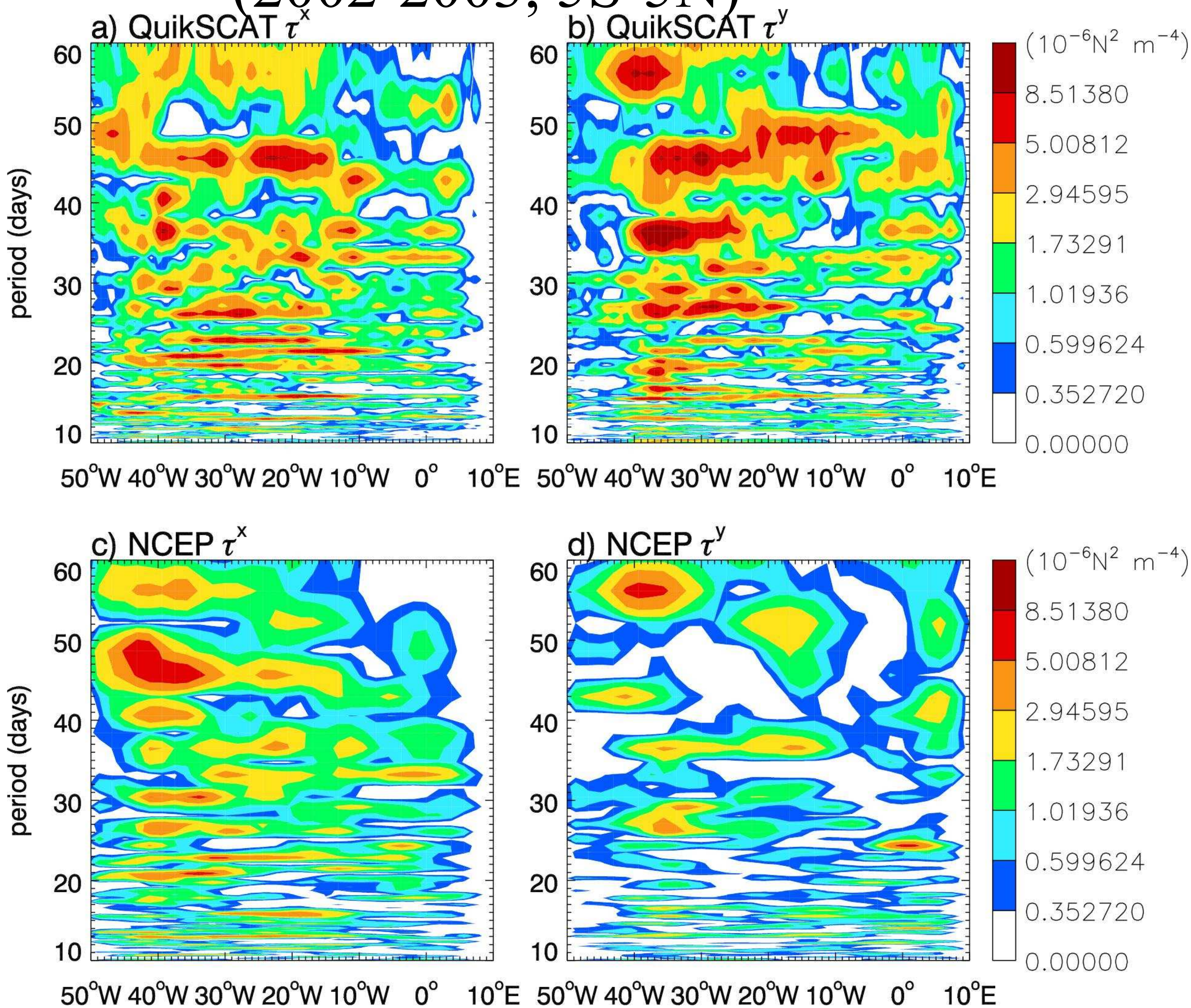


4. Summary

On 10-40-day timescales:

- West of 10^{o}W, TIWs play an important role in causing sea level and thermocline variability within 5^{o}S-5^{o}N; wind-driven EQ waves also provide significant contributions.
- East of 10^{o}W, SSHA and D20 variations result largely from wind-driven equatorial Kelvin and Yanai waves;
- During spring 2002 when TIWs are weak, wind driven Kelvin waves dominate SSHA across the EQ basin.

Variance spectra of QuikSCAT & NCEP winds (2002-2003, 5S-5N)

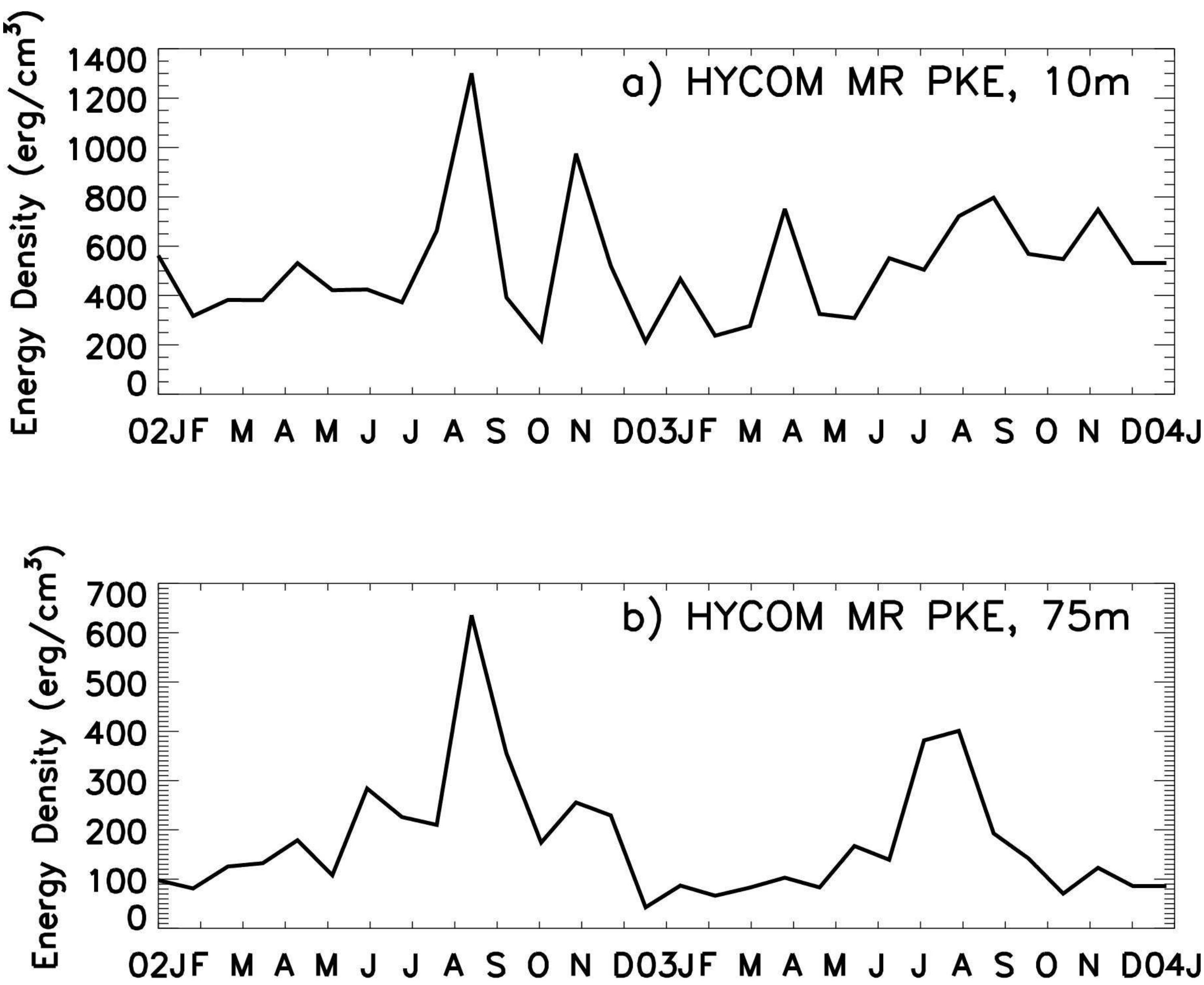


Where are the winds from?

1: MJO from the Indian-Pacific?
Foltz & McPhaden (2004)
2: ISOs originate from Amazon Rainfall?
(Wang and Fu 2007)

We are currently investigating the sources.

PKE of TIWs



a) HYCOM MR PKE, 10m
Energy Density (erg/cm³)
1400
1200
1000
800
600
400
200
0
02JF M A M J J A S O N D03JF M A M J J A S O N D04J
b) HYCOM MR PKE, 75m
Energy Density (erg/cm³)
700
600
500
400
300
200
100
0
02JF M A M J J A S O N D03JF M A M J J A S O N D04J

Variance spectra of model SSHA, 2S-2N Atlantic

HYCOM MR
(TIWs+wind)

HYCOM EXP
(TIWs)

LM (wind)