El Niño, La Niña, and Walker Circulation
Mar 2000 – Jun 2011

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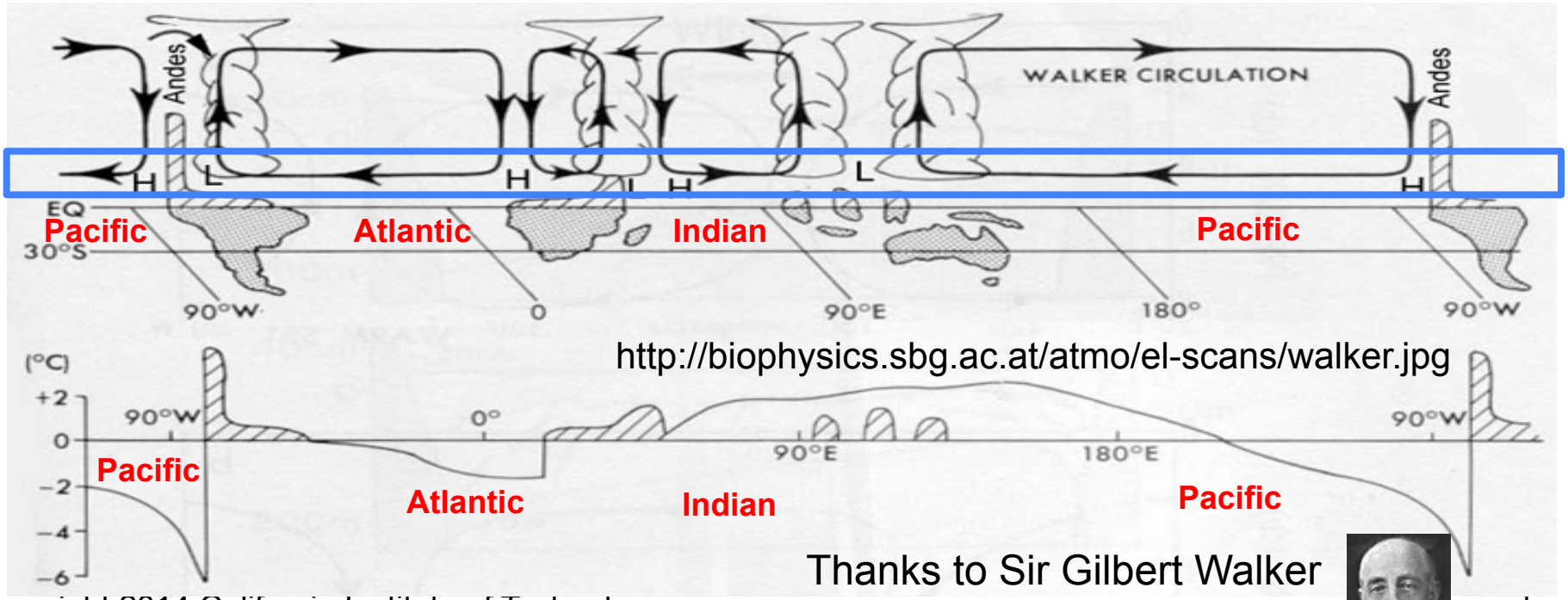
Thanks to Joshua Cheng, Caltech, for computer programming support.



http://biophysics.sbg.ac.at/atmo/el-scans/walker.jpg

Thanks to Sir Gilbert Walker (1868-1958) for the idea.

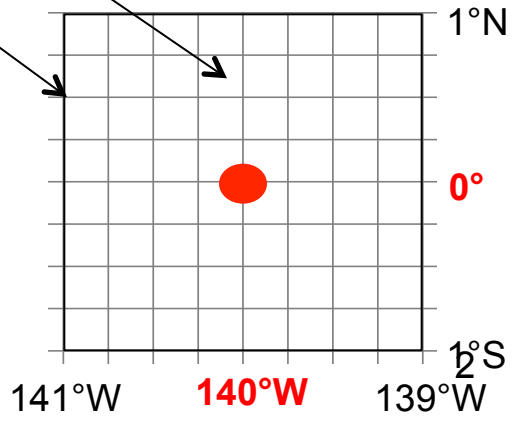
MISR, ASCAT and SeaWinds Dataset Design

	ECT	Global Coverage (days)	Horiz. Res. (km)	Height (m)
SeaWinds	06:00	1.0	25	10
ASCAT	09:30	1.5	25	10
MISR	10:30	7-9	17.6	many

Δ diurnal = 0.35 m s^{-1} (Halpern, 1988)

- RSS reprocessed ASCAT and SeaWinds datasets with similar methodology and calibration target
- RSS archives ascending & descending speed and direction (U, V) retrievals in 1 day, 0.25°x0.25° cell
- We created 1-day averaged <U>, <V> in 2°x2° tile
  - No rain in 0.25°x0.25° cell
  - No rain in adjacent 0.25°x0.25° cell
- Collocated Datasets, 1 Jun 2007 – 31 Oct 2009
  - N_{TOTAL} = 884 days
  - SeaWinds ~ 550 days
  - ASCAT/SeaWinds ~ 250 days
  - MISR/ASCAT/SeaWinds ~ 30 days

$Bias_{ASCAT-SeaWinds}$ < 0.1 m s^{-1}
01.06.07–31.10.09
(Halpern & Ricciardulli, In preparation)



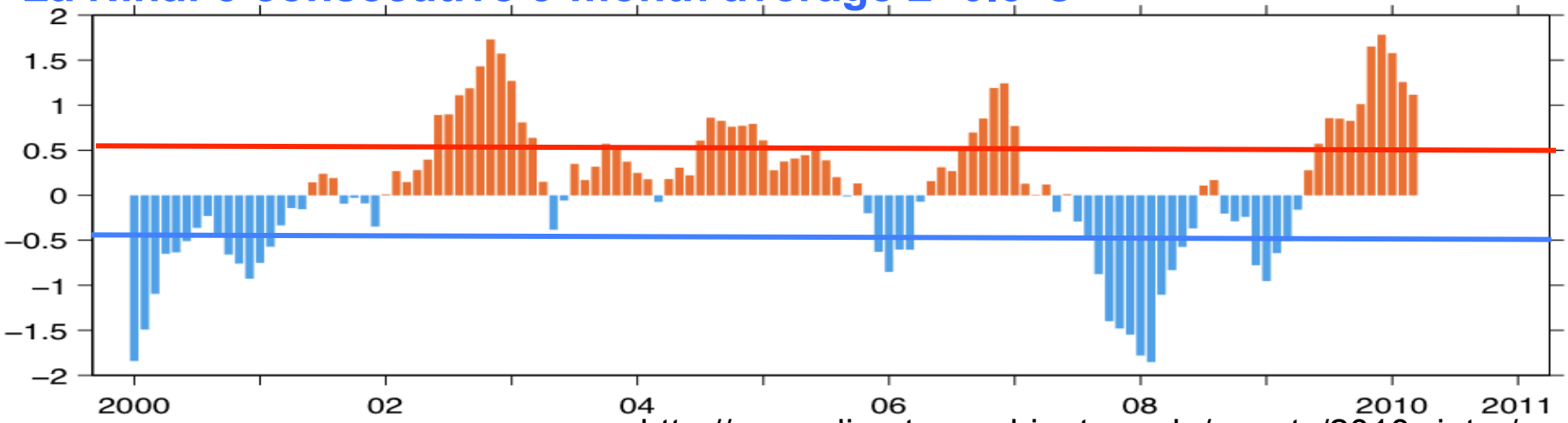
NOAA Oceanic Niño Index (ONI)
SST Anomaly Nino 3.4 (170-120°W, 5°S-5°N)

2000	**-1.7**	**-1.5**	**-1.2**	**-0.9**	**-0.8**	**-0.7**	**-0.6**	**-0.5**	**-0.6**	**-0.6**	**-0.8**	**-0.8**
2001	**-0.7**	**-0.6**	**-0.5**	-0.4	-0.2	-0.1	0.0	0.0	-0.1	-0.2	-0.3	-0.3
2002	-0.2	0.0	0.1	0.3	**0.5**	**0.7**	**0.8**	**0.8**	**0.9**	**1.2**	**1.3**	**1.3**
2003	**1.1**	**0.8**	0.4	0.0	-0.2	-0.1	0.2	0.4	0.4	0.4	0.4	0.3
2004	0.3	0.2	0.1	0.1	0.2	0.3	**0.5**	**0.7**	**0.8**	**0.7**	**0.7**	**0.7**
2005	**0.6**	0.4	0.3	0.3	0.3	0.3	0.2	0.1	0.0	-0.2	**-0.5**	**-0.8**
2006	**-0.9**	**-0.7**	**-0.5**	-0.3	0.0	0.1	0.2	0.3	**0.5**	**0.8**	**1.0**	**1.0**
2007	**0.7**	0.3	-0.1	-0.2	-0.3	-0.3	-0.4	**-0.6**	**-0.8**	**-1.1**	**-1.2**	**-1.4**
2008	**-1.5**	**-1.5**	**-1.2**	**-0.9**	**-0.7**	**-0.5**	-0.3	-0.2	-0.1	-0.2	**-0.5**	**-0.7**
2009	**-0.8**	**-0.7**	**-0.5**	-0.2	0.2	0.4	**0.5**	**0.6**	**0.8**	**1.1**	**1.4**	**1.6**
2010	**1.6**	**1.3**	**1.0**	**0.6**	0.1	-0.4	**-0.9**	**-1.2**	**-1.4**	**-1.5**	**-1.5**	**-1.5**
2011	**-1.4**	**-1.2**	**-0.9**	**-0.6**	-0.3	-0.2	-0.2	-0.4	**-0.6**	**-0.8**	**-1.0**	**-1.0**

http://www.cpc.ncep/noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

El Niño: 5 consecutive 3-month average ≥ 0.5°C

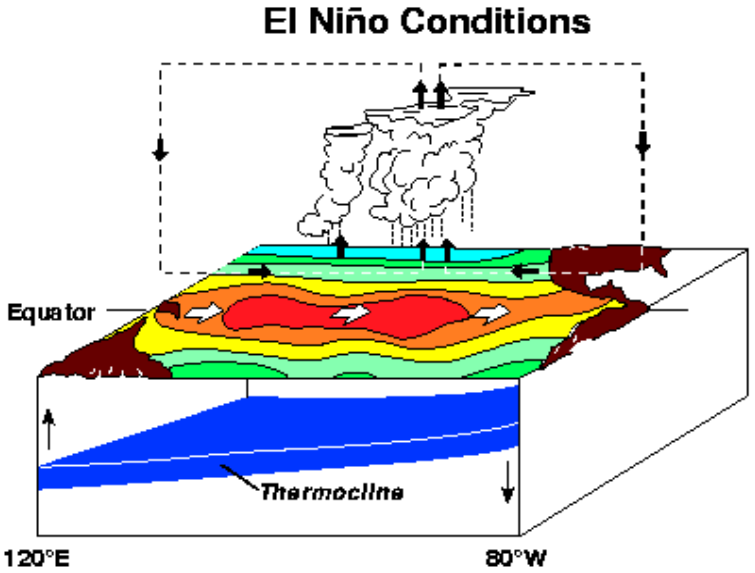
La Niña: 5 consecutive 3-month average ≤ -0.5°C



http://www.climate.washington.edu/events/2010winter/

El Niño, La Niña, and Walker Circulation (Pacific)

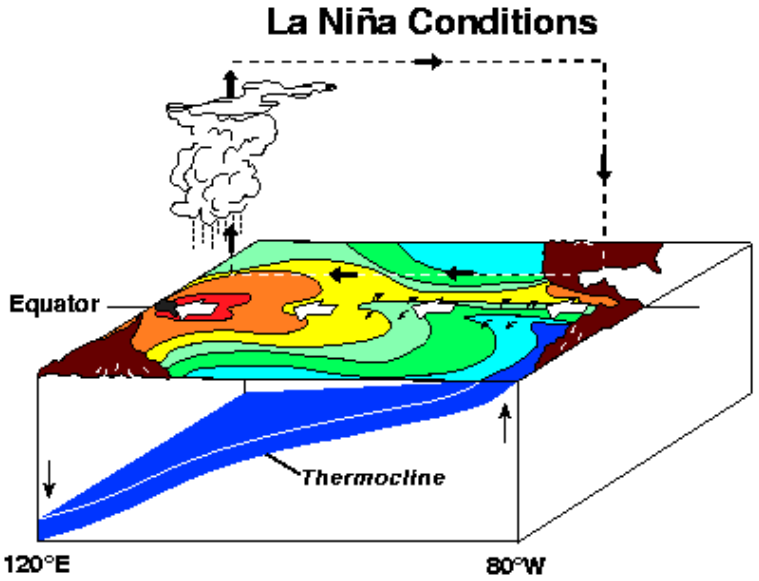
- Westerly surface winds in west Pacific
- Easterly surface winds in east Pacific



East Pacific
- Reduced westward wind
- Reduced upwelling
- Increased thermocline depth

Conventional Wisdom

- Easterly surface winds throughout Pacific



East Pacific
- Stronger westward wind
- Increased upwelling
- Reduced thermocline depth

http://www.pmel.noaa.gov/tao/elnino/nino_normal.html

Climatological Mean Wind Mar 2000 – Jun 2011
Collocated 2°x2° Along Equator

SeaWinds < Oct 2009
ASCAT > Nov 2009
H = 10m

MISR
H = 700m

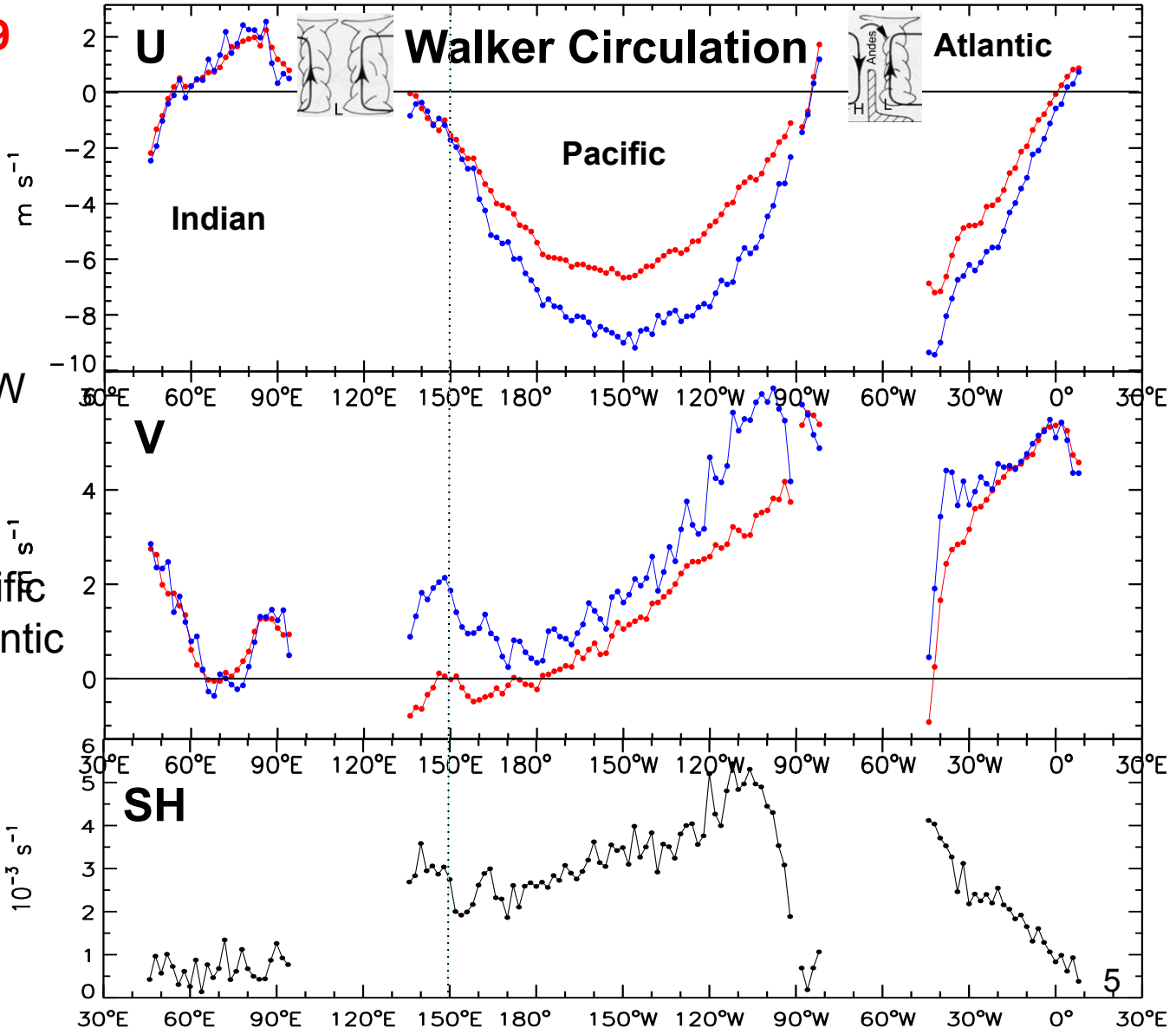
- Walker Circulation
- U_{min} @ ~ 150°W, 40°W
- Transverse wind
- Pacific: $S_{700m} > S_{10m}$
- Small SH in Indian
- Large SH in east Pacific
- Large SH in west Atlantic

$$SH = [(\Delta U/\Delta Z)^2 + (\Delta V/\Delta Z)^2]^{1/2}$$

$$\Delta U = U_{700m} - U_{10m}$$

$$\Delta V = V_{700m} - V_{10m}$$

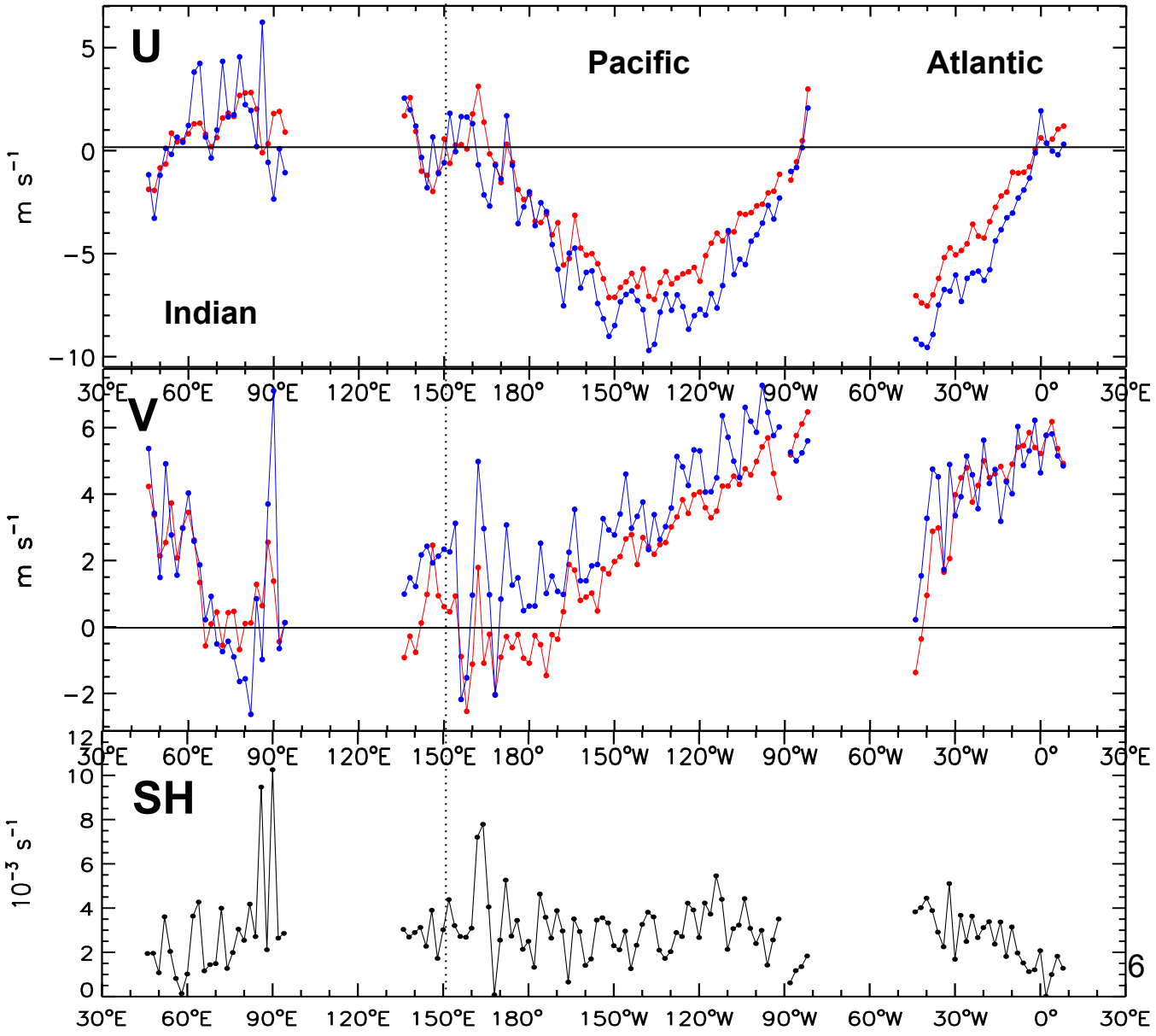
$$\Delta Z = 690m$$



El Niño
May 2002 – Feb 2003 (10 months)

SeaWinds 10m

MISR 700m



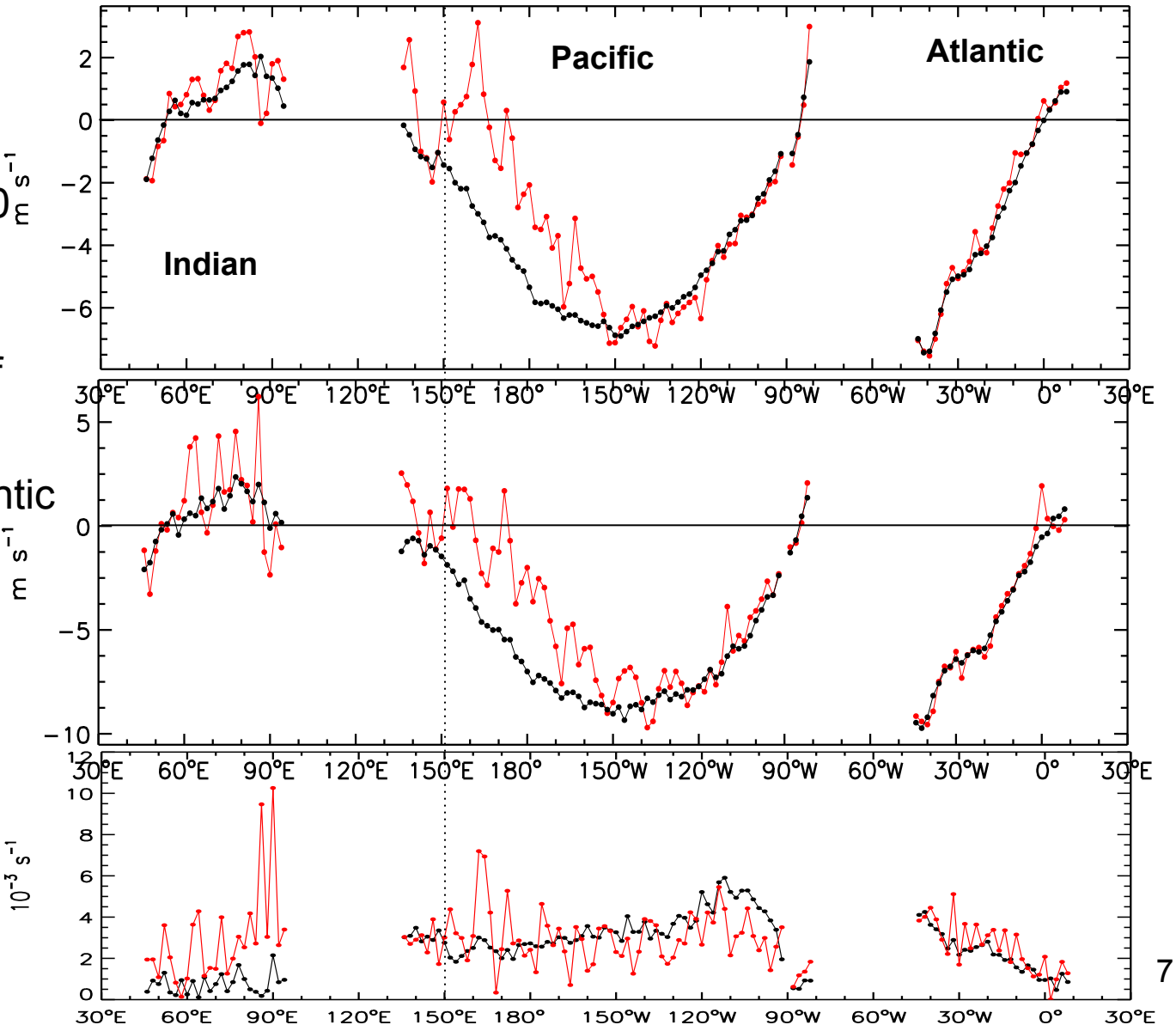
El Niño May 2002 – Feb 2003 (10 mo)
Climatology May - Feb 2000-2011 (10 mo)

U 10m

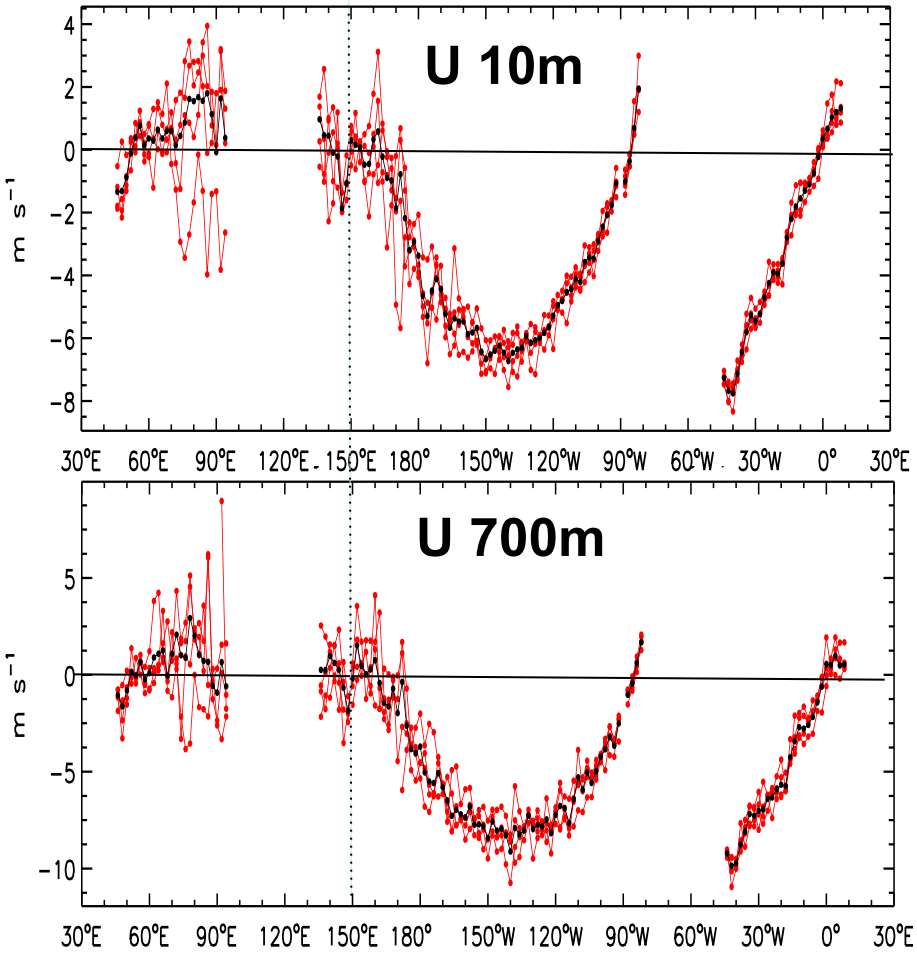
- Weaker El Niño easterly wind at 10 and 700 m from 150°E-150°W
- No change east of 150°W
- No change in Atlantic

U 700m

SH

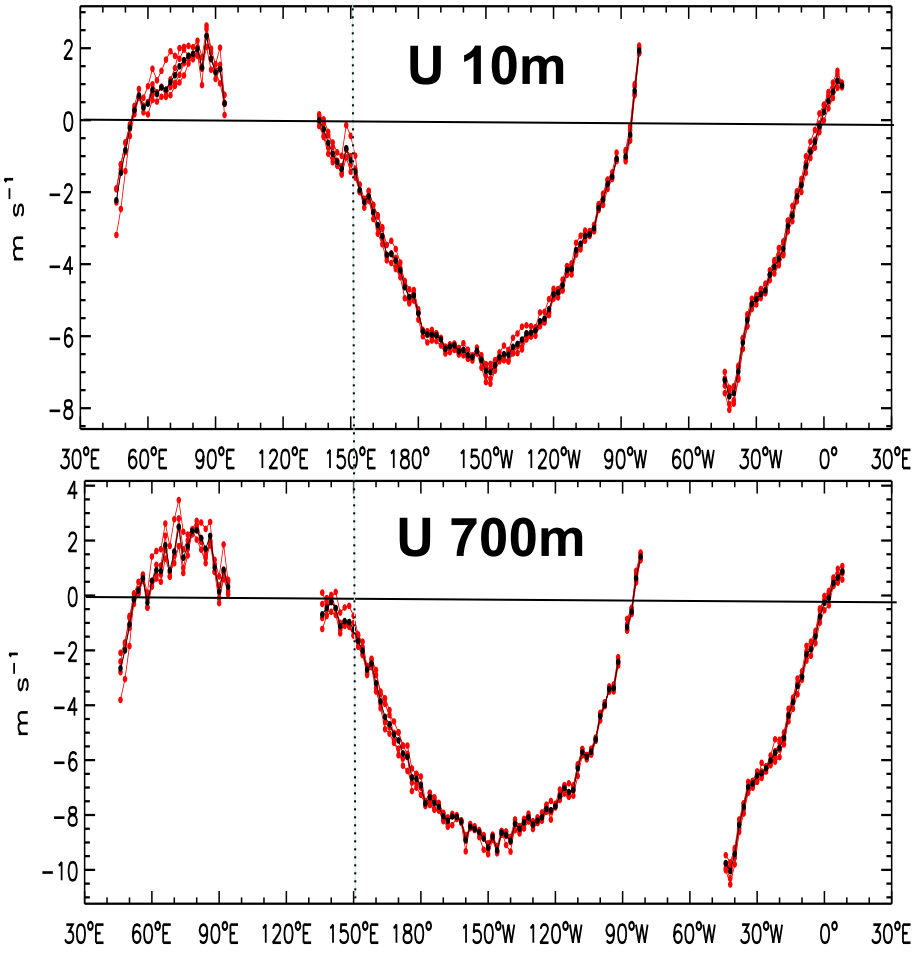


Four El Niños
Mean Value



May 2002 – Feb 2003
Jul 2004 – Jan 2005
Sep 2006 – Jan 2007
Jul 2009 – Apr 2010

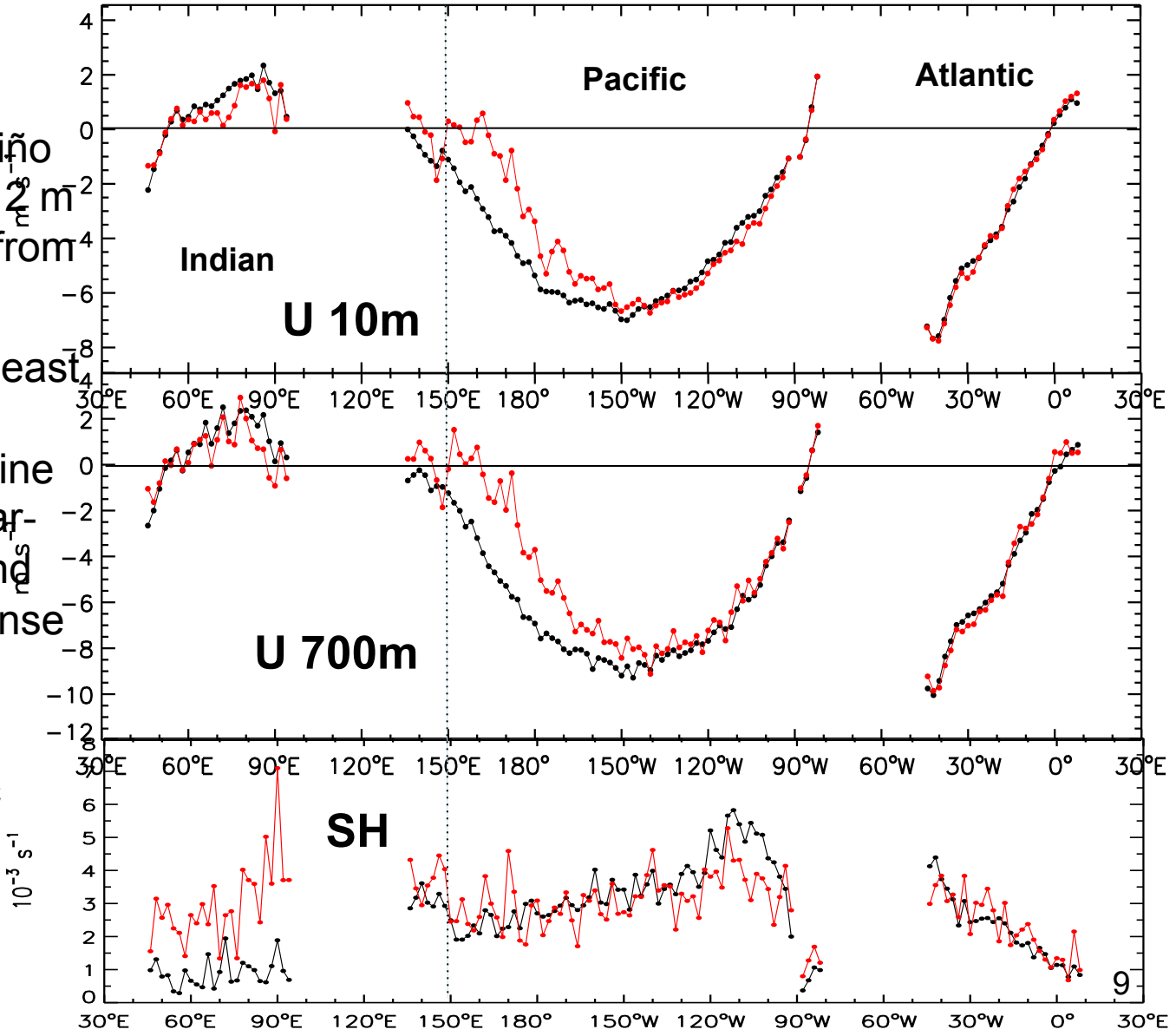
Four Climatological Periods
Mean Value



May 2000 – Feb 2011
Jul 2000 – Jan 2011
Sep 2000 – Jan 2011
Jul 2000 – Apr 2011

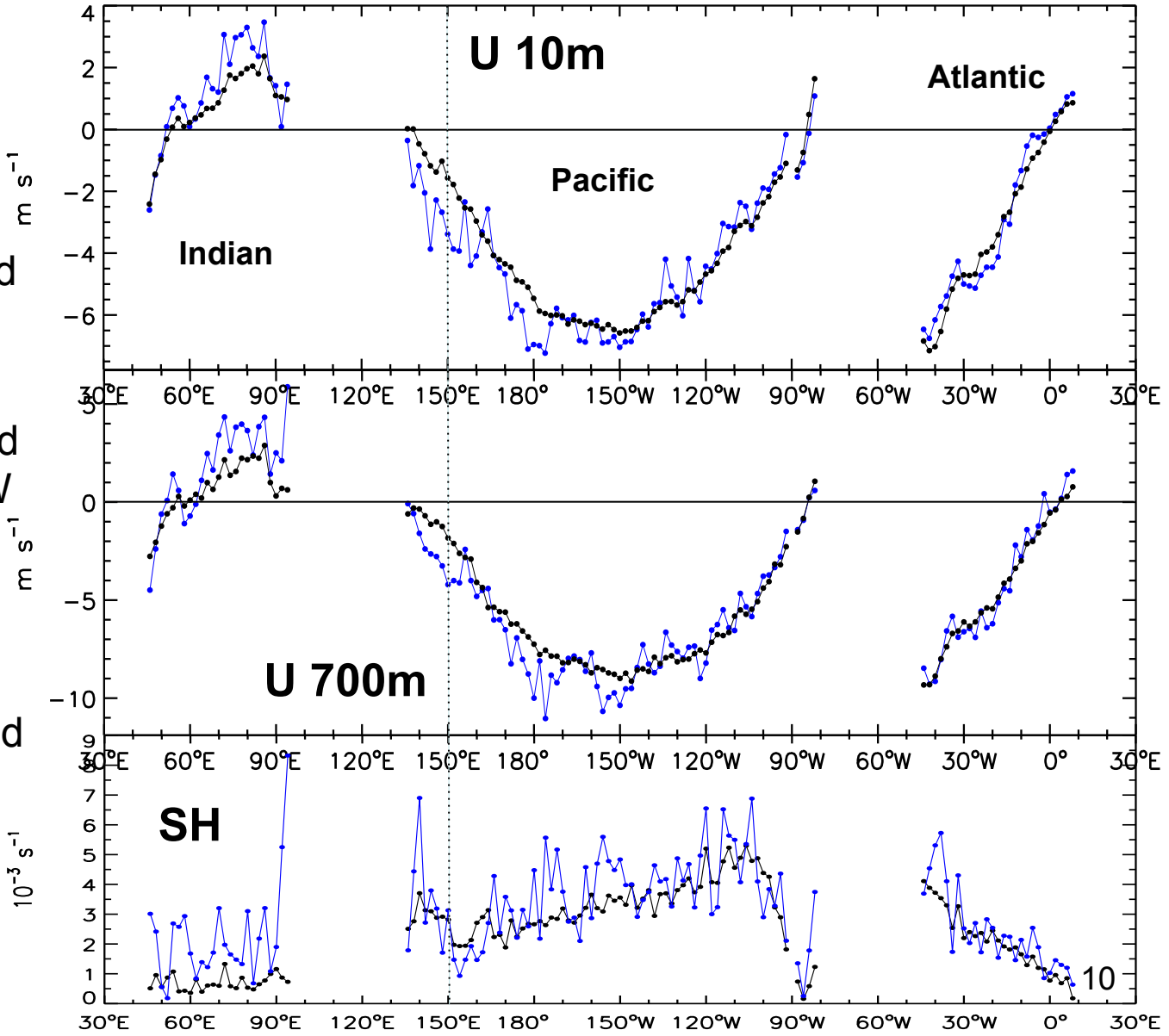
<El Niño 2002-2010> and <Climatology>

- Pacific: reduced El Niño easterly wind (Δ_{max} ~ 2 m s^{-1}) at 10 and 700 m from 150°E-150°W
- No change in Pacific east of 150°W
  - ➢ El Niño thermocline deepening is a far-field response and not a local response to "change" in upwelling
- No change in Atlantic



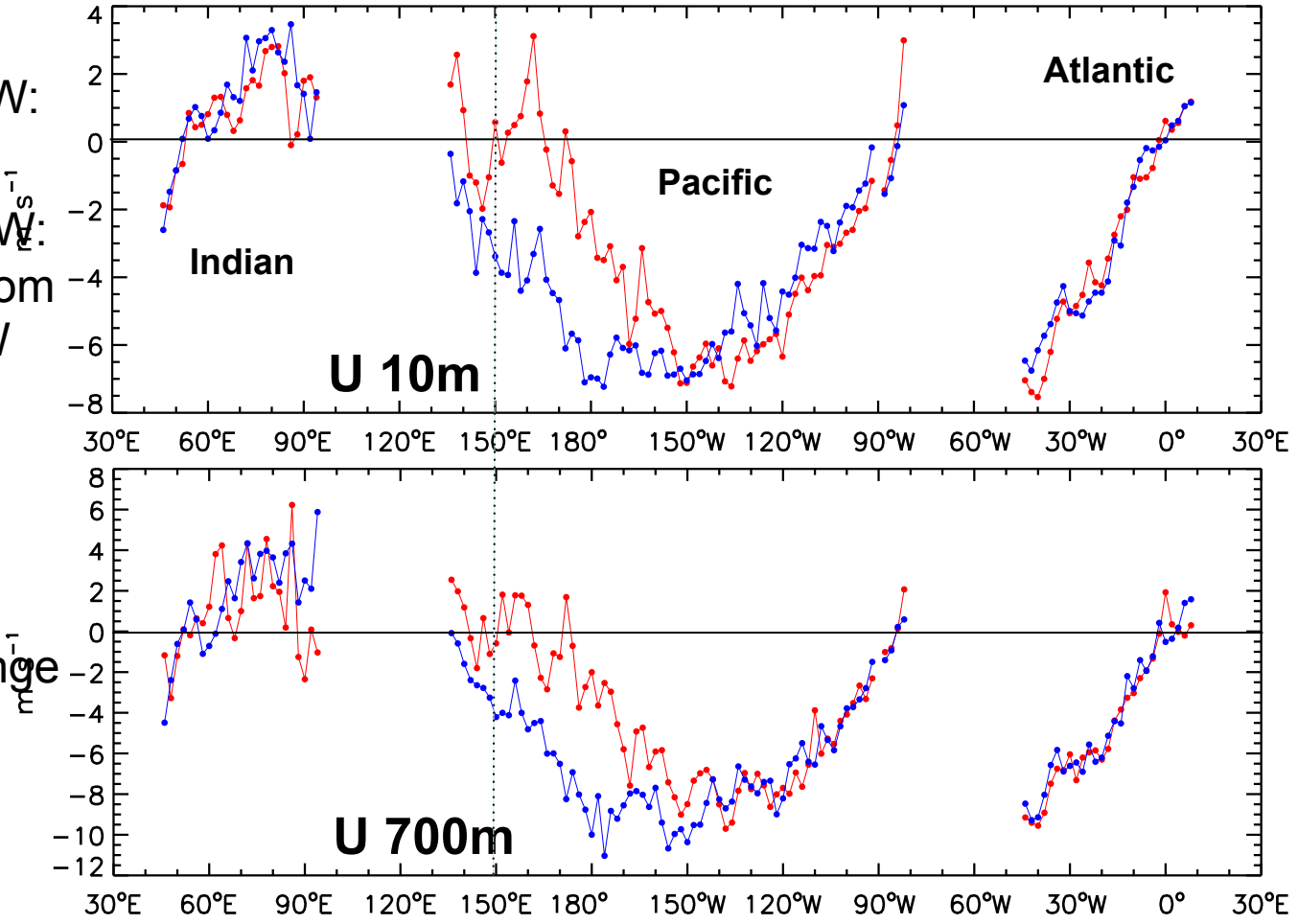
La Niña Mar 2000 – Mar 2001 (13 mo)
Climatology Mar – Mar 2000-2011 (13 mo)

- Stronger easterly wind at 10 and 700 m from ~ 135°E-180°
- No La Niña zonal wind change east of 150°W
  - ➢ No La Niña local thermocline uplift
- No change in Atlantic
- Stronger westerly wind in Indian



El Niño May2002-Feb2003 and La Niña Mar2000-Mar2001

- Pacific, east of 150°W:
  - No change
- Pacific, west of 150°W:
  - Δ_{max} = 3 m s^{-1} from ~ 160°W–170°W
  - $\Delta_{El\ Niño} > \Delta_{La\ Niña}$
- Atlantic:
  - No change
- Indian:
  - Virtually no change
- Results at U 10m ~ Results at U 700m



Summary (Work in Progress)

- Limited sampling by MISR-on-Terra instrument did not seriously impede analysis of wind vector components at 700 m
- Surface limb of Pacific (Atlantic) cell of Walker Circulation has eastward winds east of 90°W (0°) and maximum westward wind speeds (-6.5/10m and -9.0/700m) at ~ 150°W (40°W)
- Comparison of zonal wind component during four El Niños in the 2002-2010 period with climatology showed:
  - Pacific, west of 150°W – reduction in 10- and 700-m westward wind speeds ⇨ thermocline uplift
  - Pacific, east of 150°W – no difference with climatology ⇨ observed thermocline deepening would be independent of reduced upwelling (i.e., far-field response)
  - Atlantic – no difference with climatology
  - Indian – virtually no difference with climatology
- Comparison of zonal wind component during one La Niña event showed:
  - Stronger easterly winds at 10m and 700m from ~ 135°E-180°
  - No zonal wind change east of 150°W ⇨ no local upwelled decrease in thermocline depth
  - No change in Atlantic
  - Stronger westerly wind in Indian

Questions?


תודה
Dankie
Gracias
Спасибо
شكراً
Merci
Takk
Köszönjük
Terima kasih
Grazie
Dziękujemy
Dėkojame
Ďakujeme
Vielen Dank
Paldies
Kiitos
Täname teid
谢谢
Thank You
Tak
感謝您
Obrigado
Teşekkür Ederiz
감사합니다
Σας ευχαριστούμε
ขอบคุณ
Bedankt
Děkujeme vám
ありがとうございます
Tack