Air – sea interaction in the Gulf of Guinea at intraseasonal timescales :

a quasi-biweekly oscillation in the eastern equatorial Atlantic

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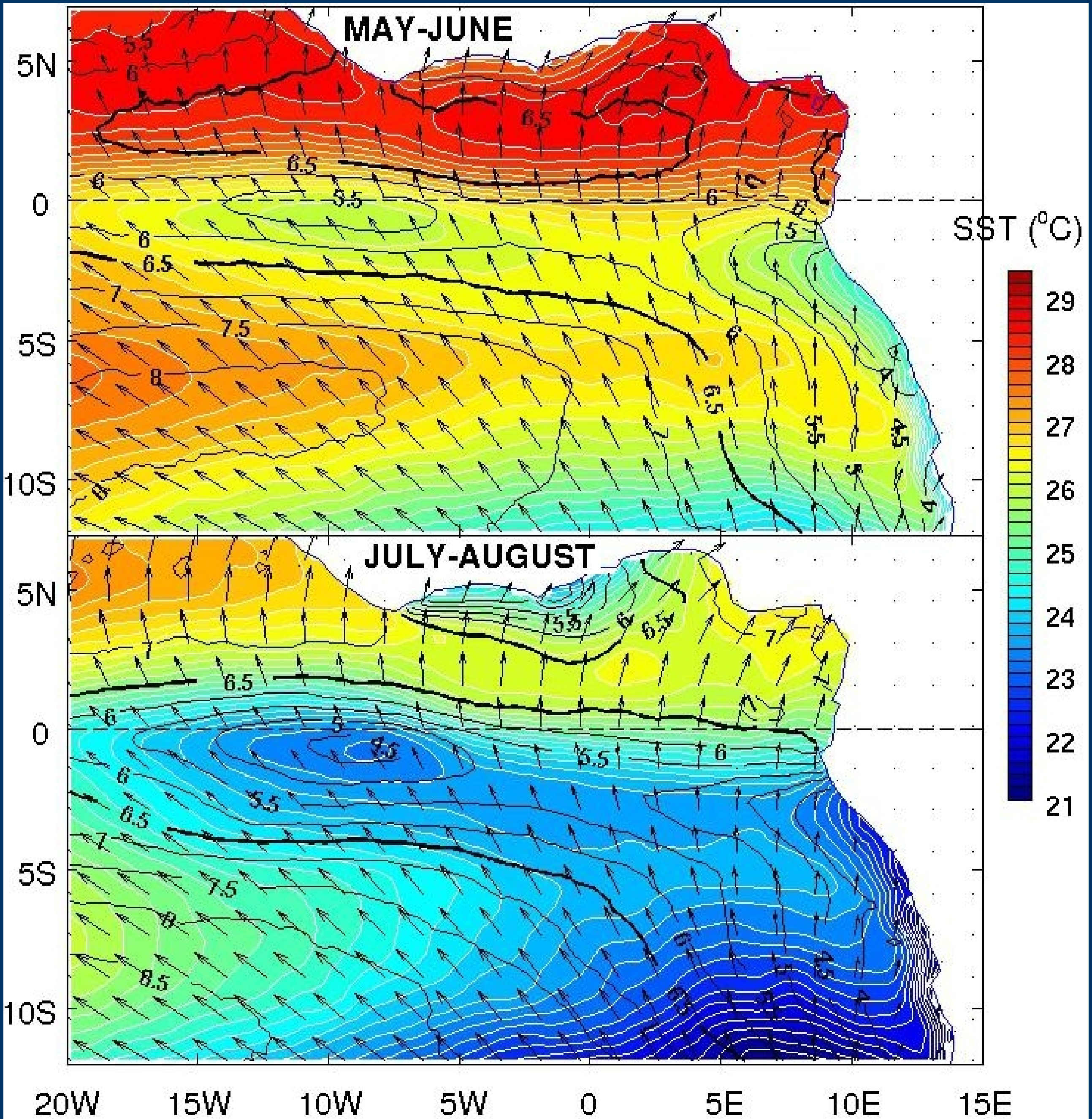
AMMA conference, 2-6 July 2012, Toulouse

2000 – 2009



Reynolds SST (colors)
QSCAT wind (black contours)

1°) <u>wind drives SST :</u>

- surface heat fluxes,

- oceanic dynamics.

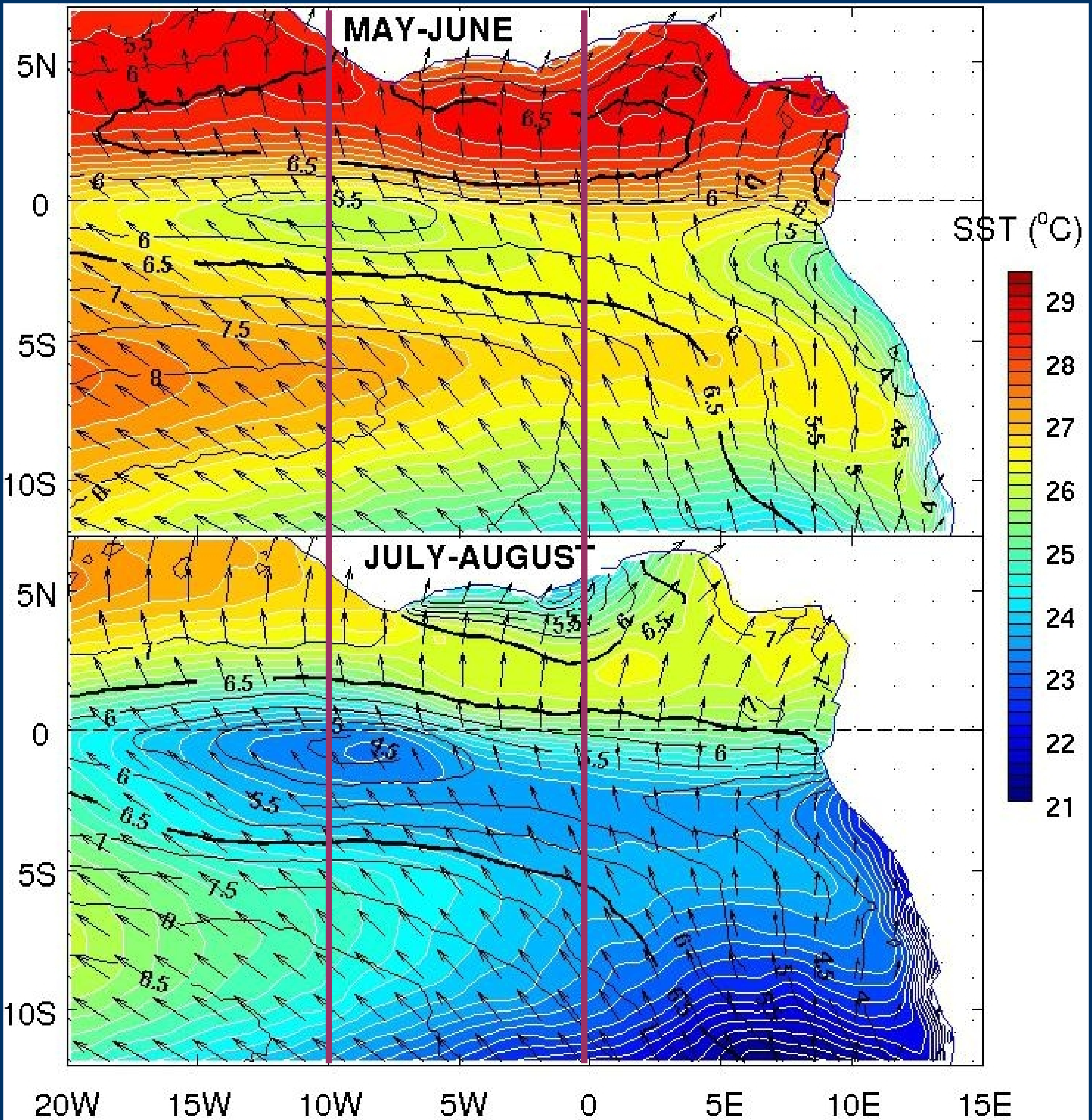
2°) <u>SST drives surface wind :</u>

-SST gradient => SLP gradient (Lindzen and Nigam 1987),

-SST=> atmospheric boundary layer (ABL) dynamics (Sweet et al. 1981, Hayes et al. 1989, Wallace et al. 1989, Small et al. 2008, Chelton et al., etc.),

-a mix of both (Bryan et al. 2010, …).

2000 – 2009



Reynolds SST (colors)
QSCAT wind (black contours)

Definition of intraseasonal anomalies:

high-pass filtered (Lanczos), cutoff = 90 days

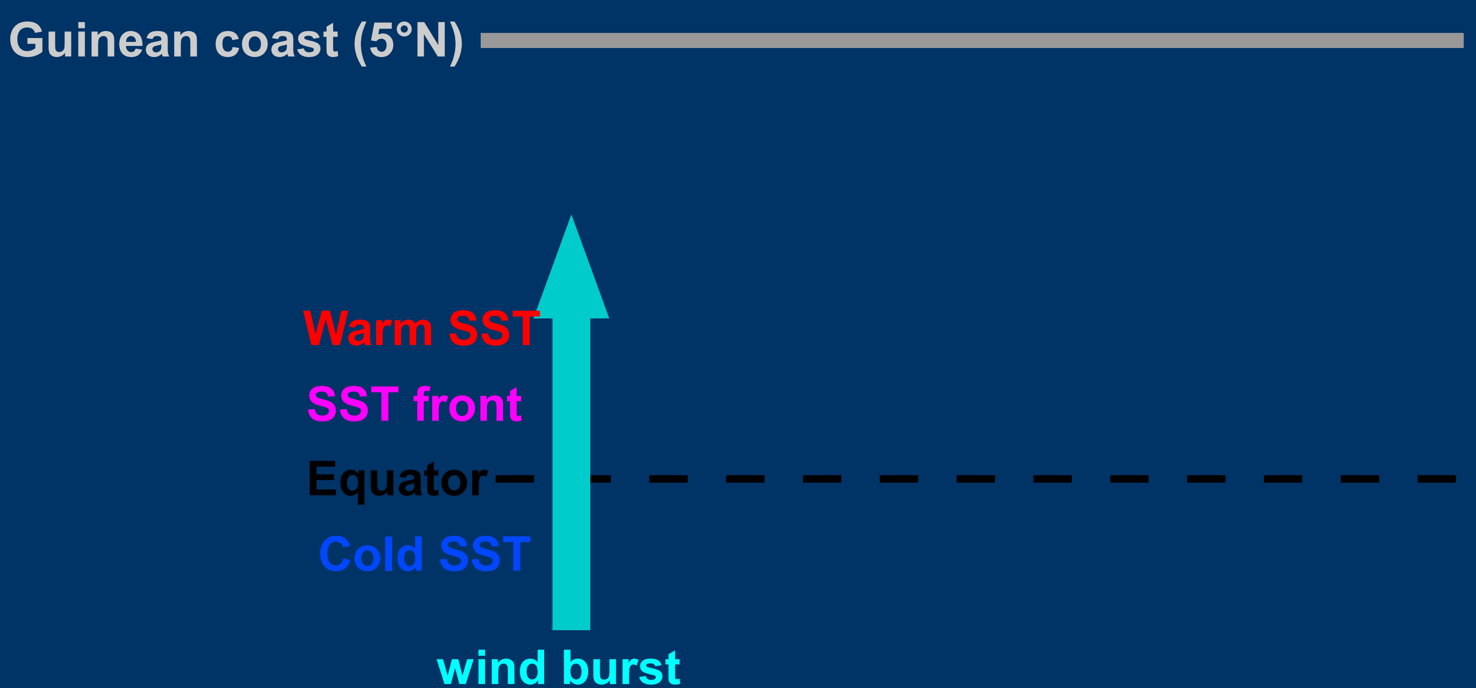
Seasonal = > 90 days
Intraseasonal = < 90 days

1°) large-scale southern wind burst (stronger southeasterlies) in the Gulf of Guinea :

=> equatorial SST cooling (due to northward oceanic horizontal advection + vertical dynamics, ~5-6 days).

2°) equatorial SST cooling / intensification of the front (further north) :

=> A) immediate MABL stabilization effect : equatorial weakening of southerlies / strengthening further north



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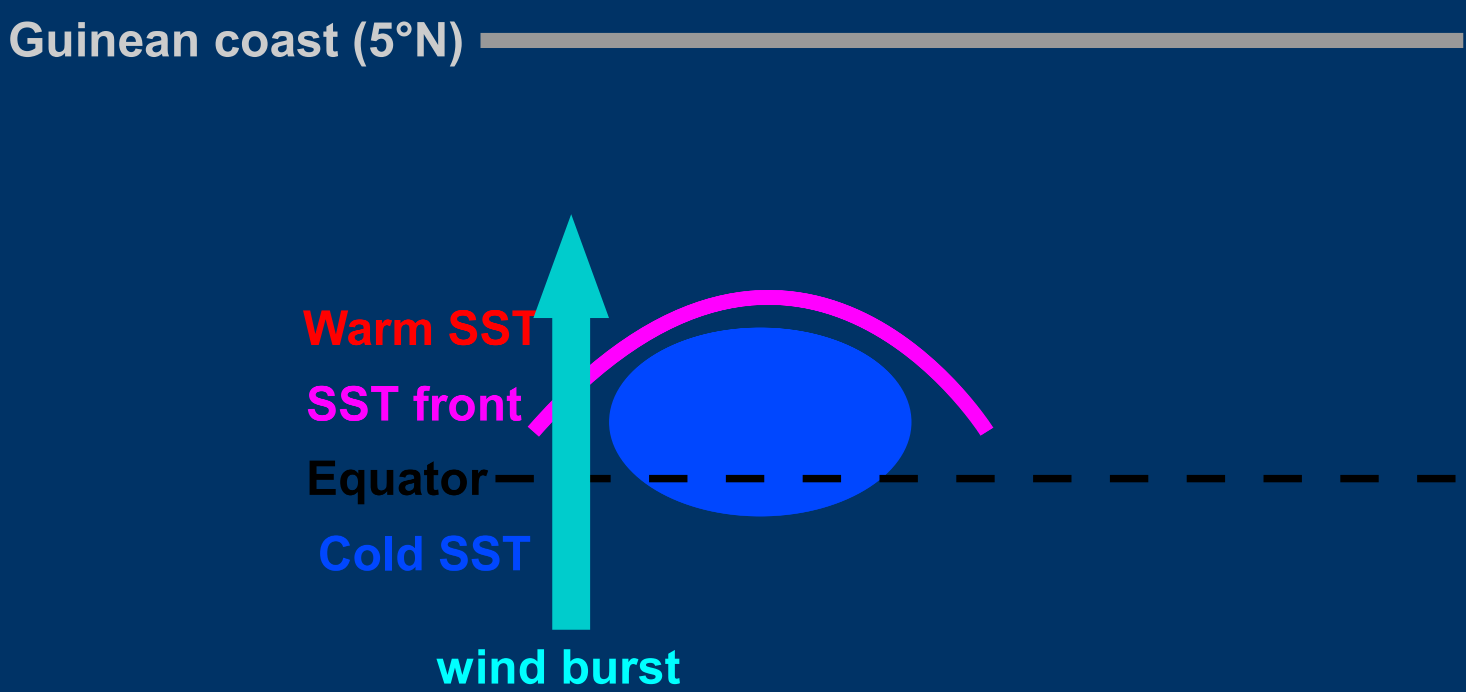

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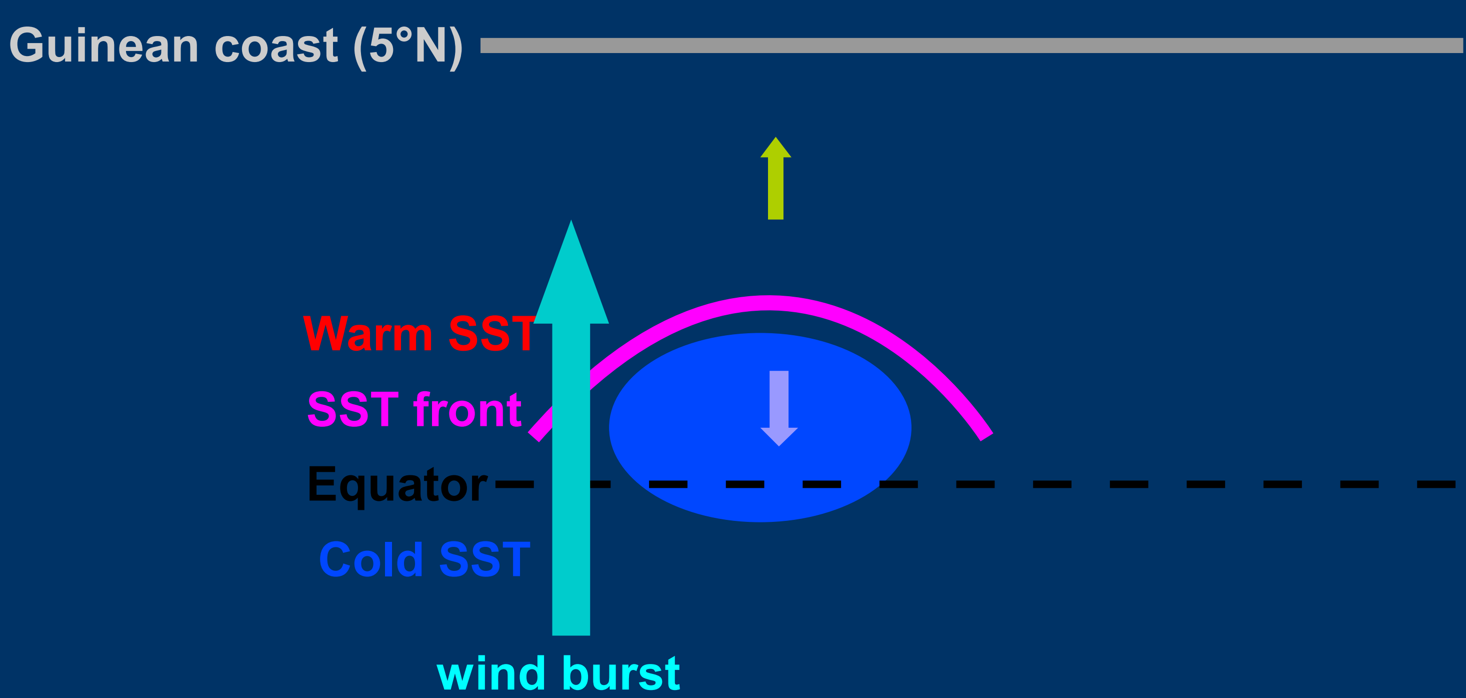

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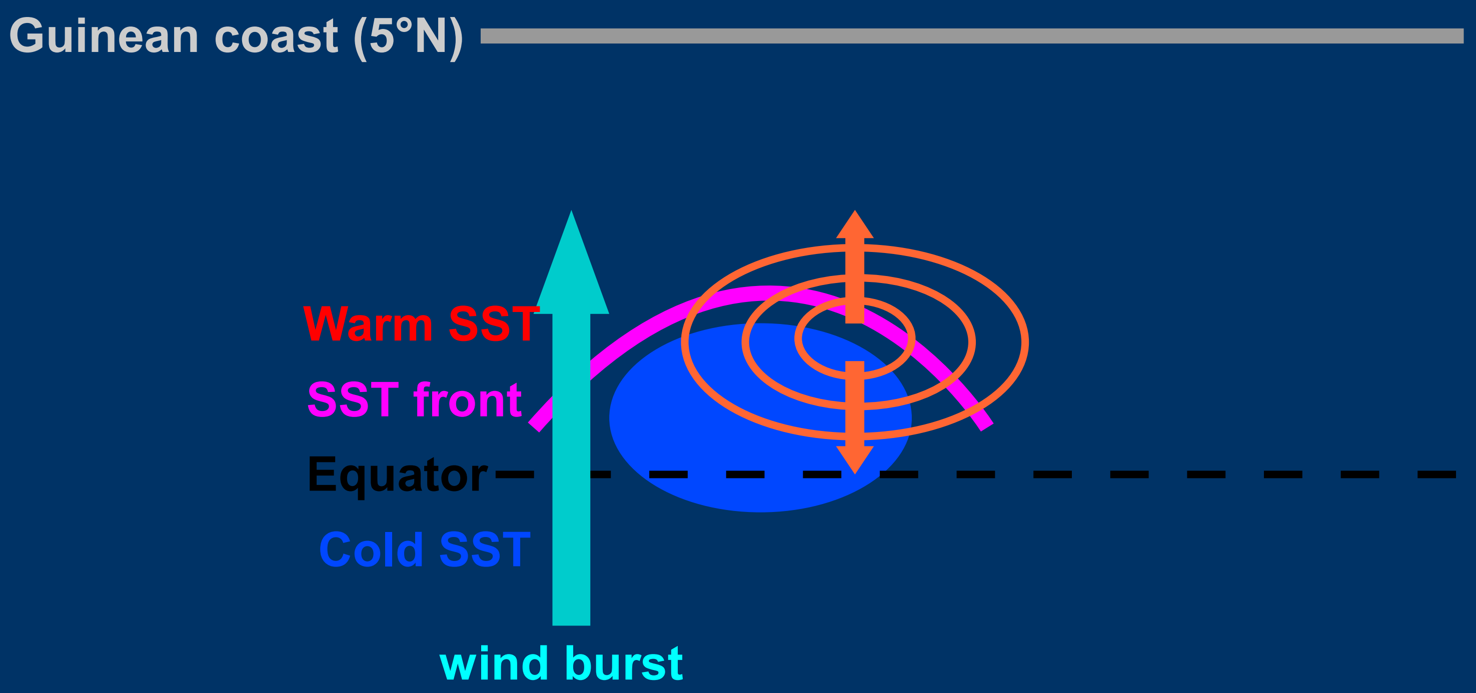
=> B) delayed (~1-3 day) response of the SLP



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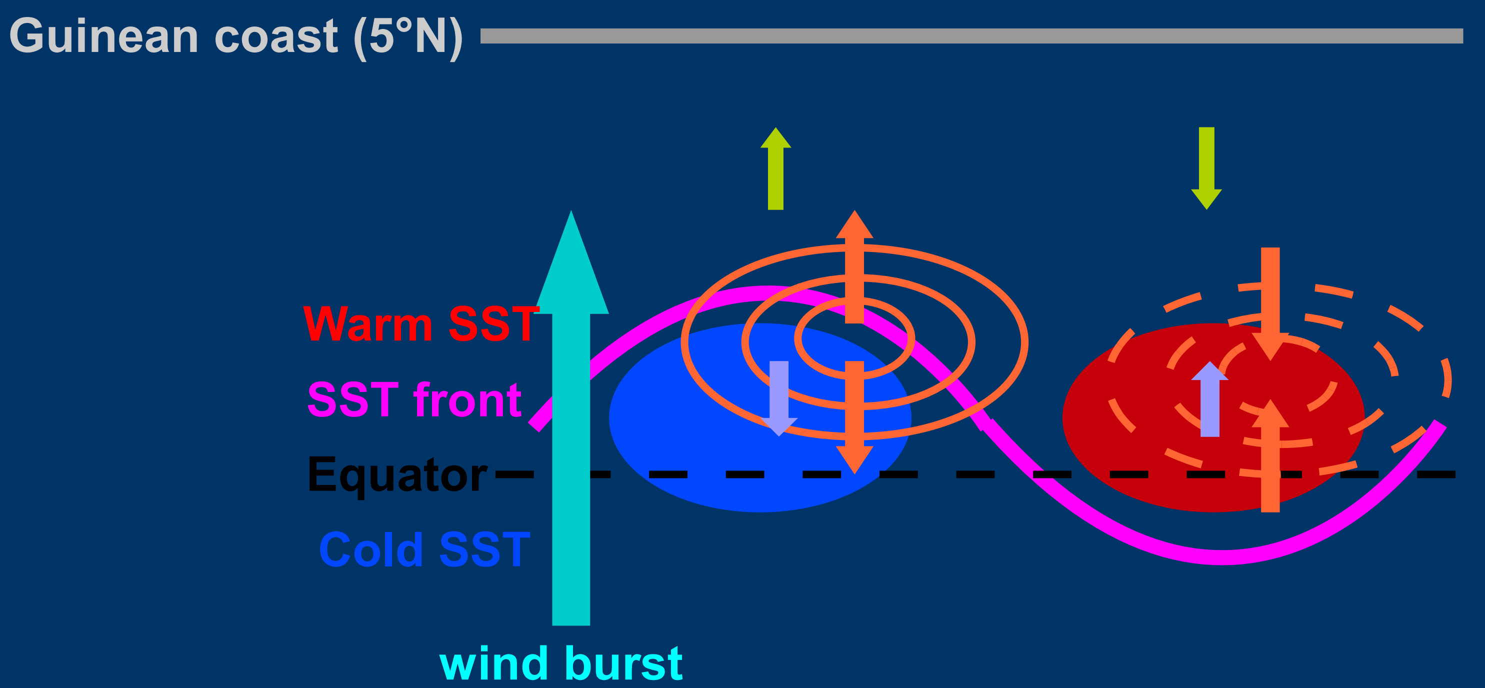

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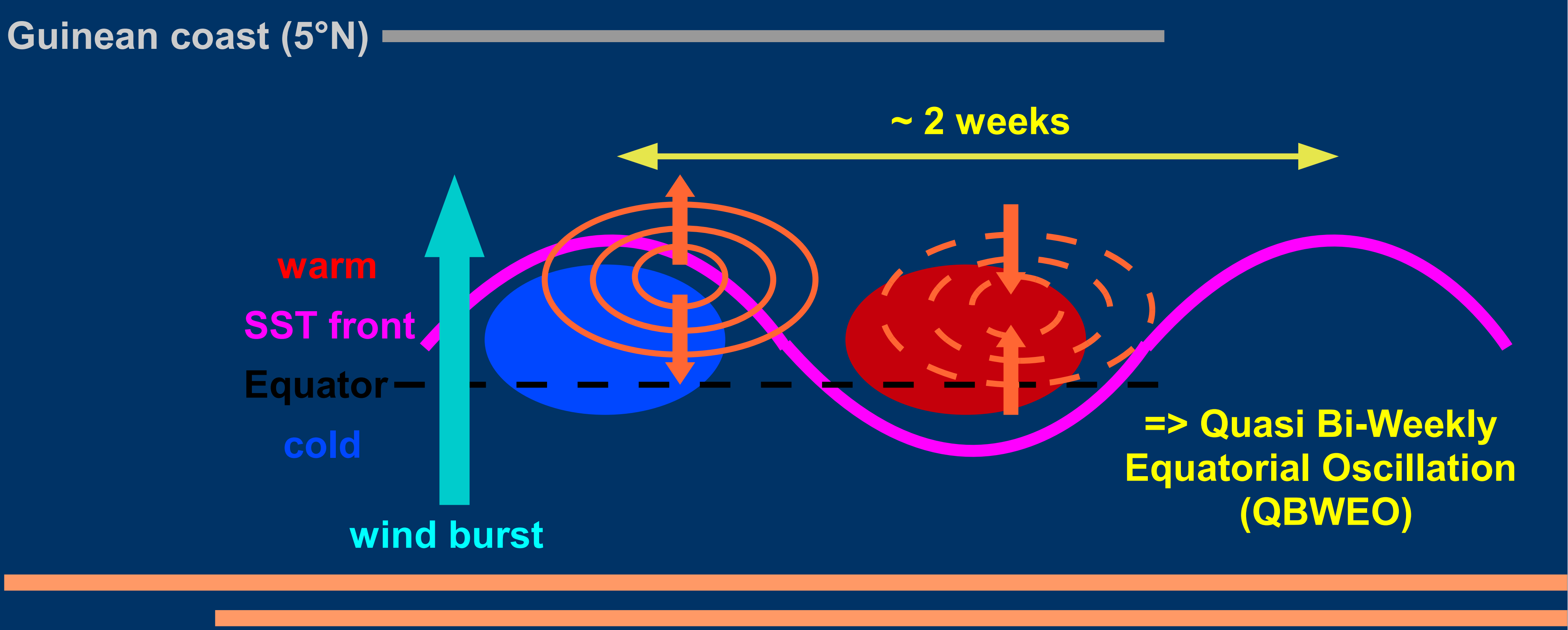
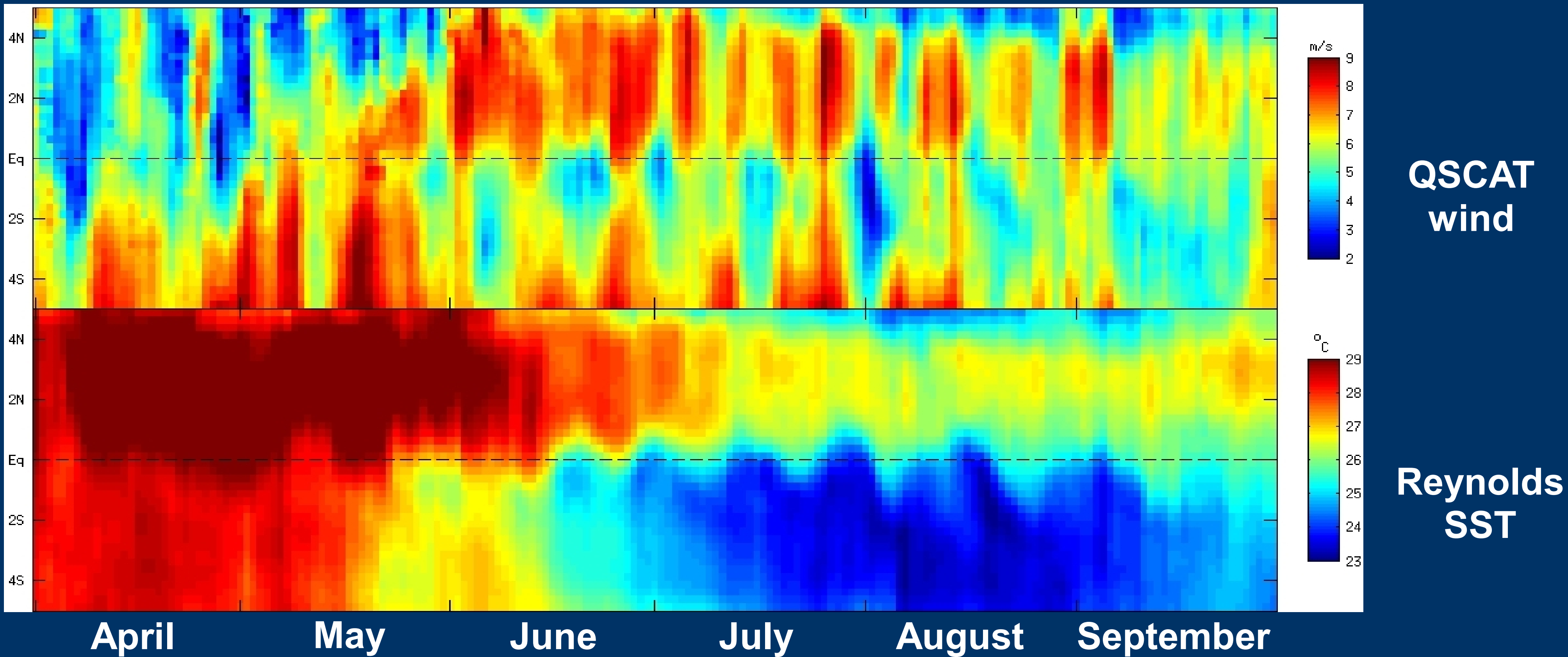


For example : YEAR 2007 (10°W - 0)



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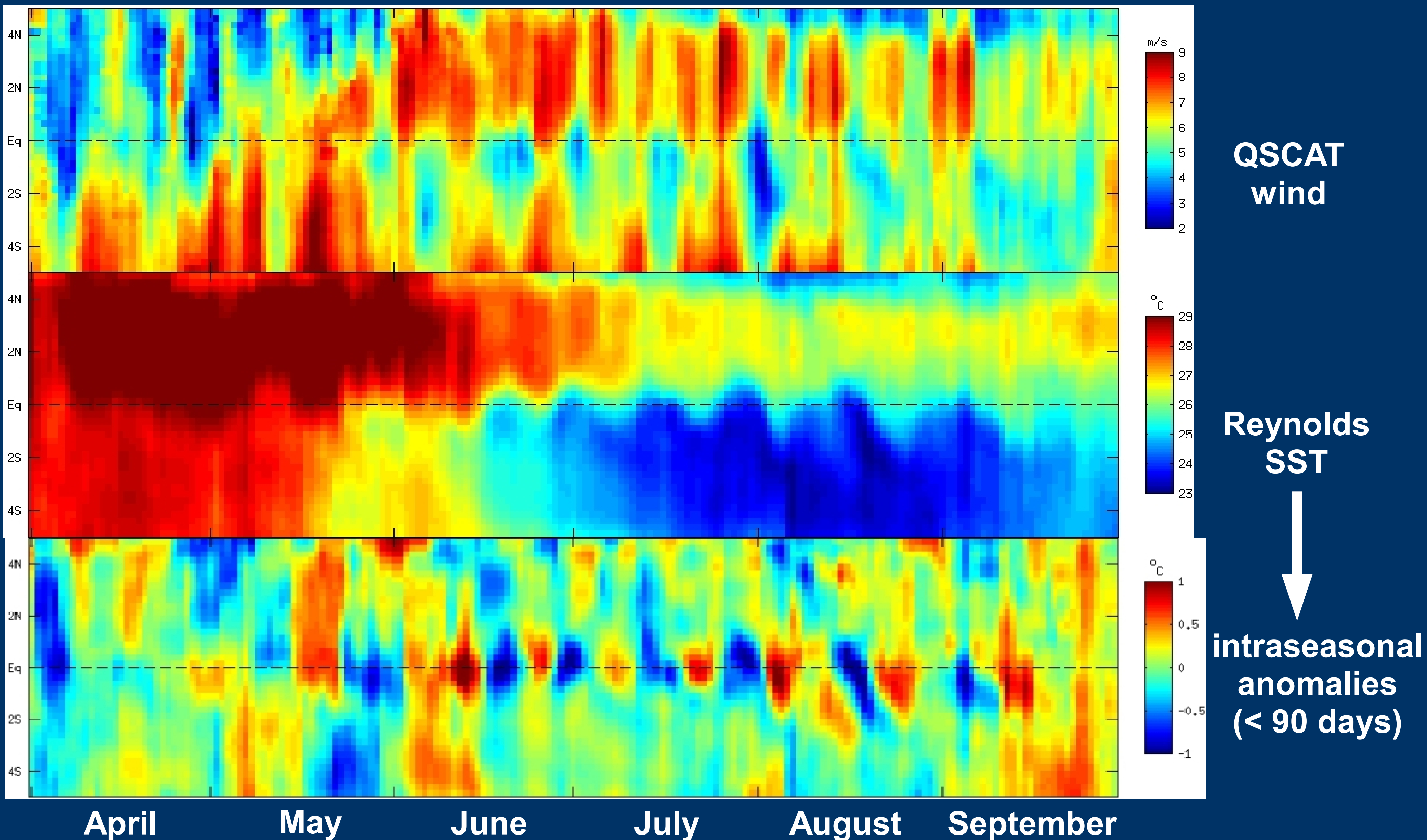

BWEO = a coupled mechanism ?

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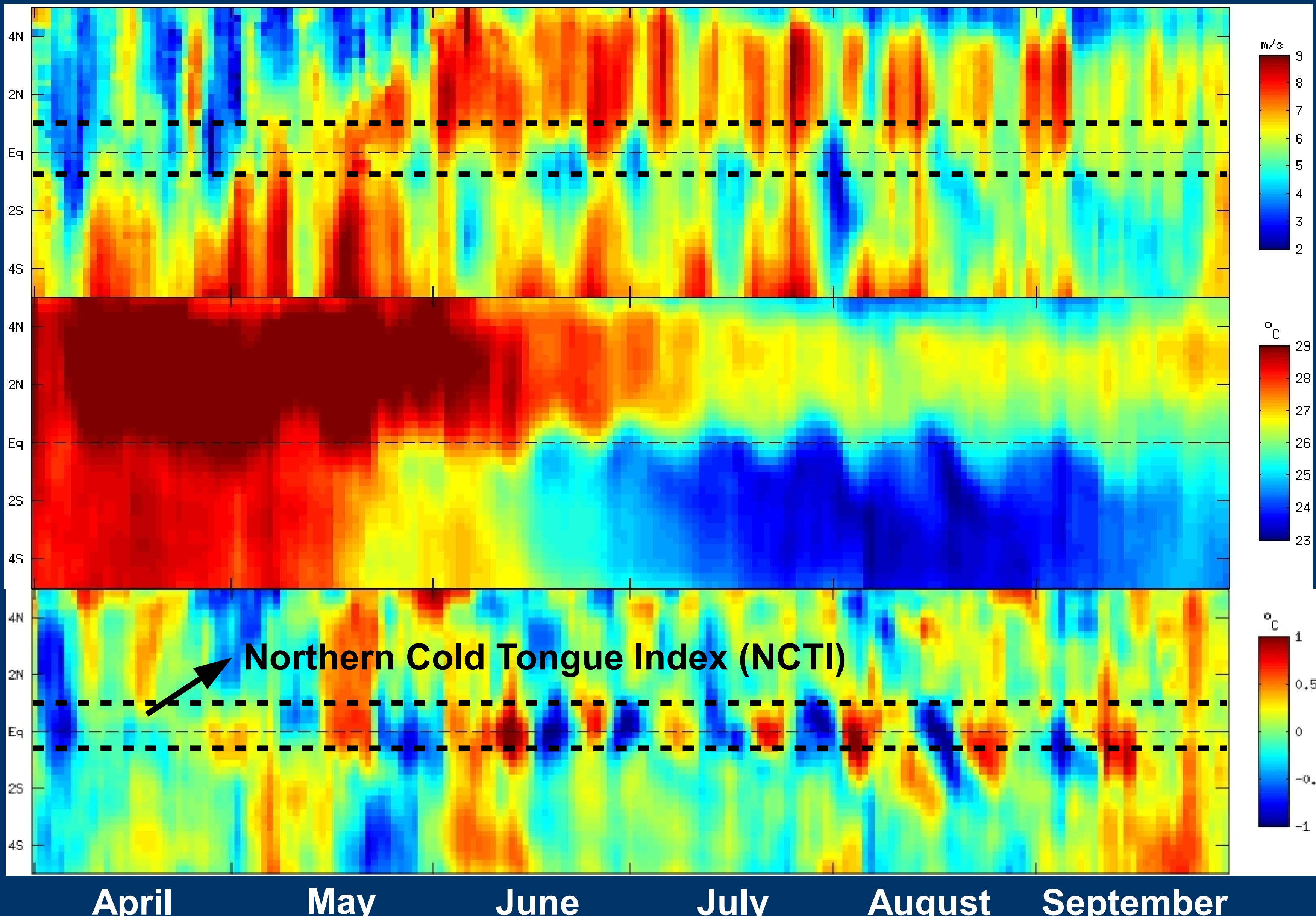


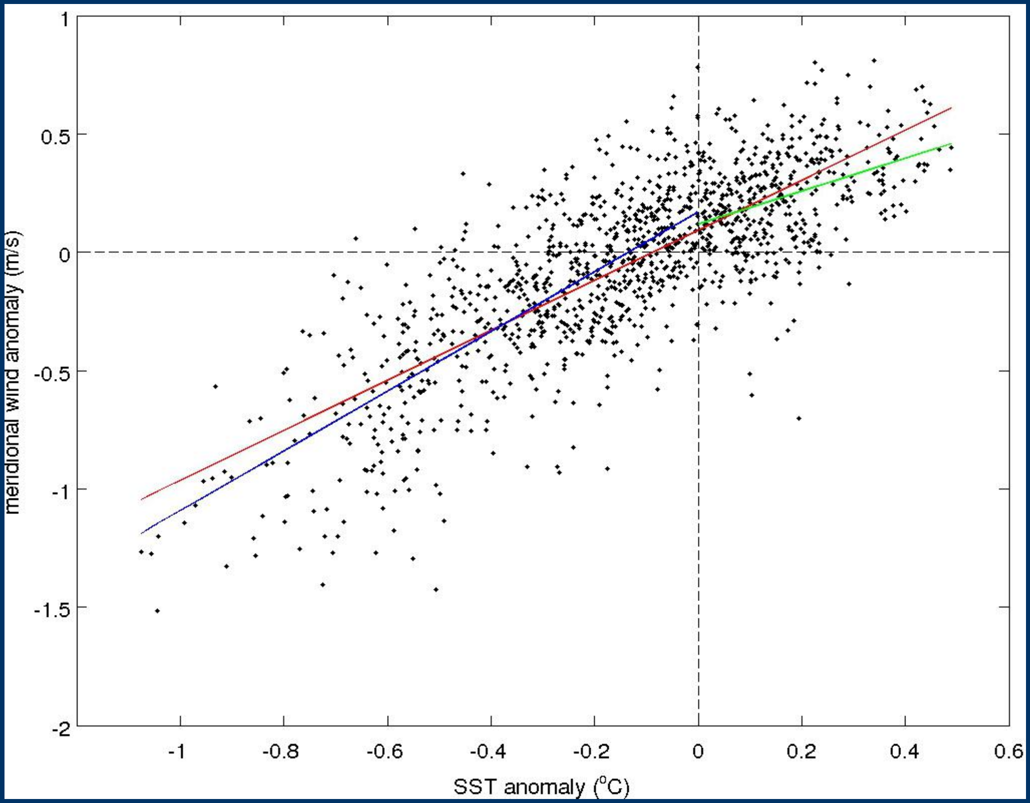
QSCAT wind

Reynolds SST

intraseasonal anomalies (< 90 days)

Lagged linear regression : May-June 2000 - 2009

Spatially high-pass filtered wind (10°W-0 / 0.5°S-1°N)



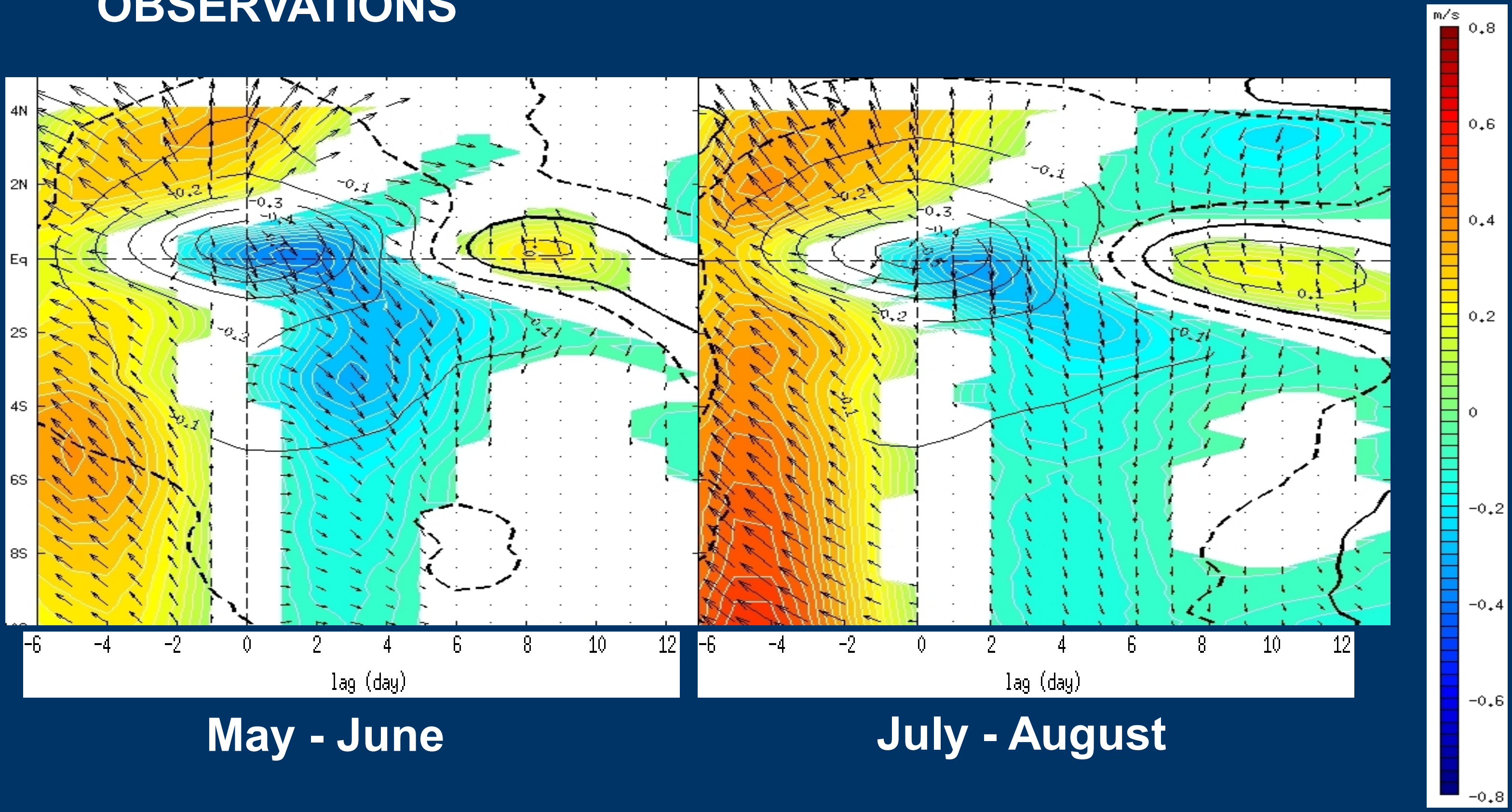
Spatially high-pass filtered SST (10°W-0 / 0.5°S-1°N)

Correlation ~= 0.7 (0.44 without spatial filter)

(~0.5°C <=> ~0.5 m/s)

Lagged linear regression on the NCTI, 2000 – 2009, 10°W-0 :

OBSERVATIONS



May - June

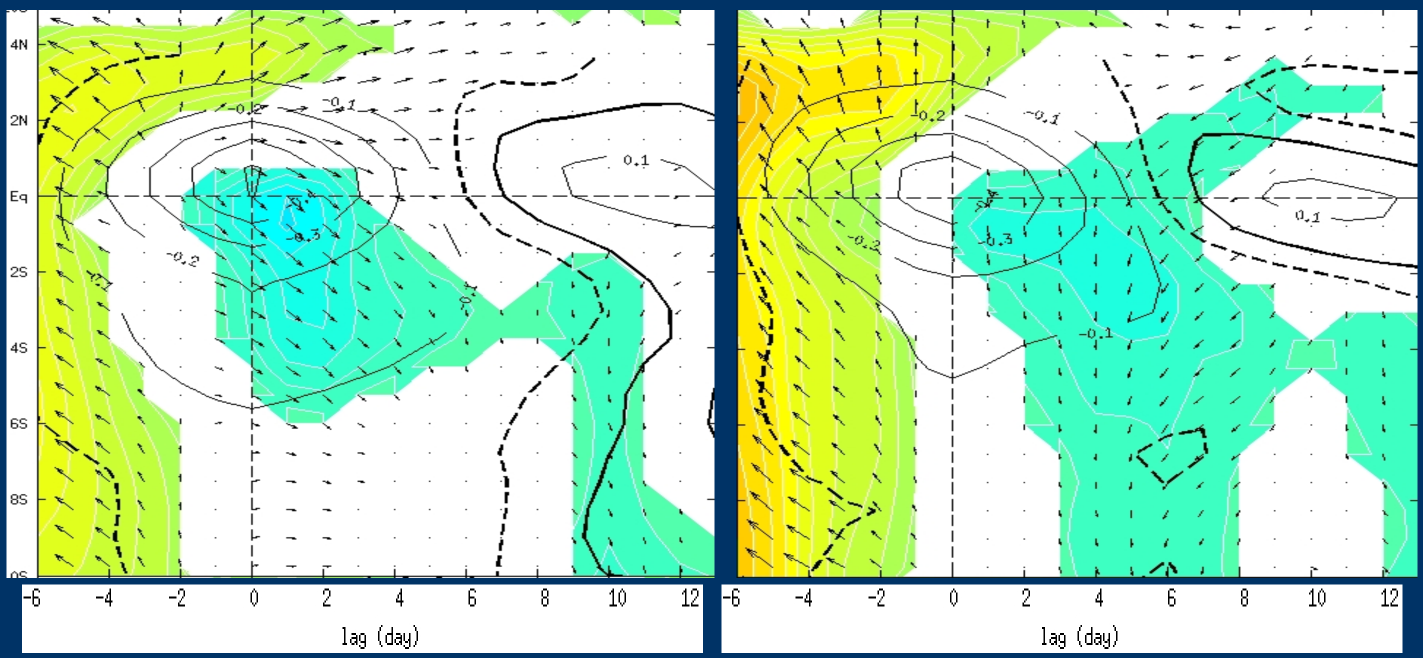
July - August

QSCAT wind anomaly (color)
Reynolds SST anomaly (black contours)

(~ -0.5°C <=> ~ -0.5 m/s)

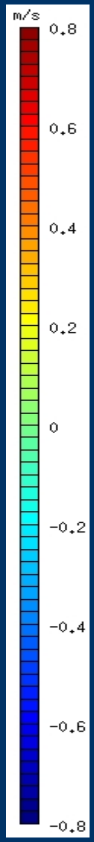
Lagged linear regression on the NCTI, 2000 – 2009, 10°W-0 :

ERAI reanalyses



May - June

July - August

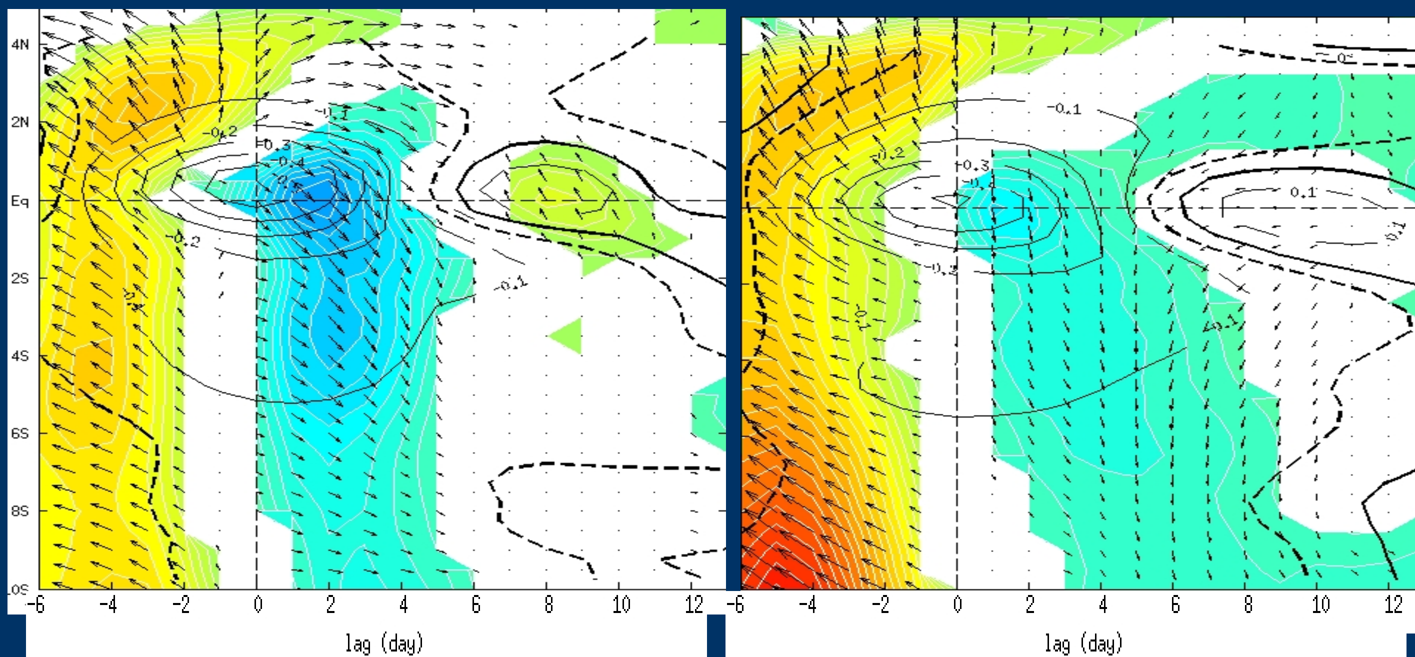


10-m wind anomaly (color)
SST anomaly (black contours)

(~ -0.5°C <=> ~ -0.2 m/s)

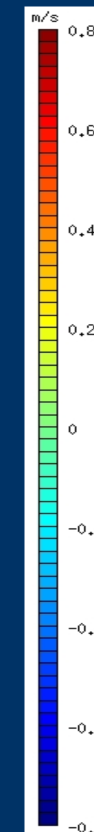
Lagged linear regression on the NCTI, 2000 – 2009, 10°W-0 :

NCEP CFSR reanalyses



May - June

July - August

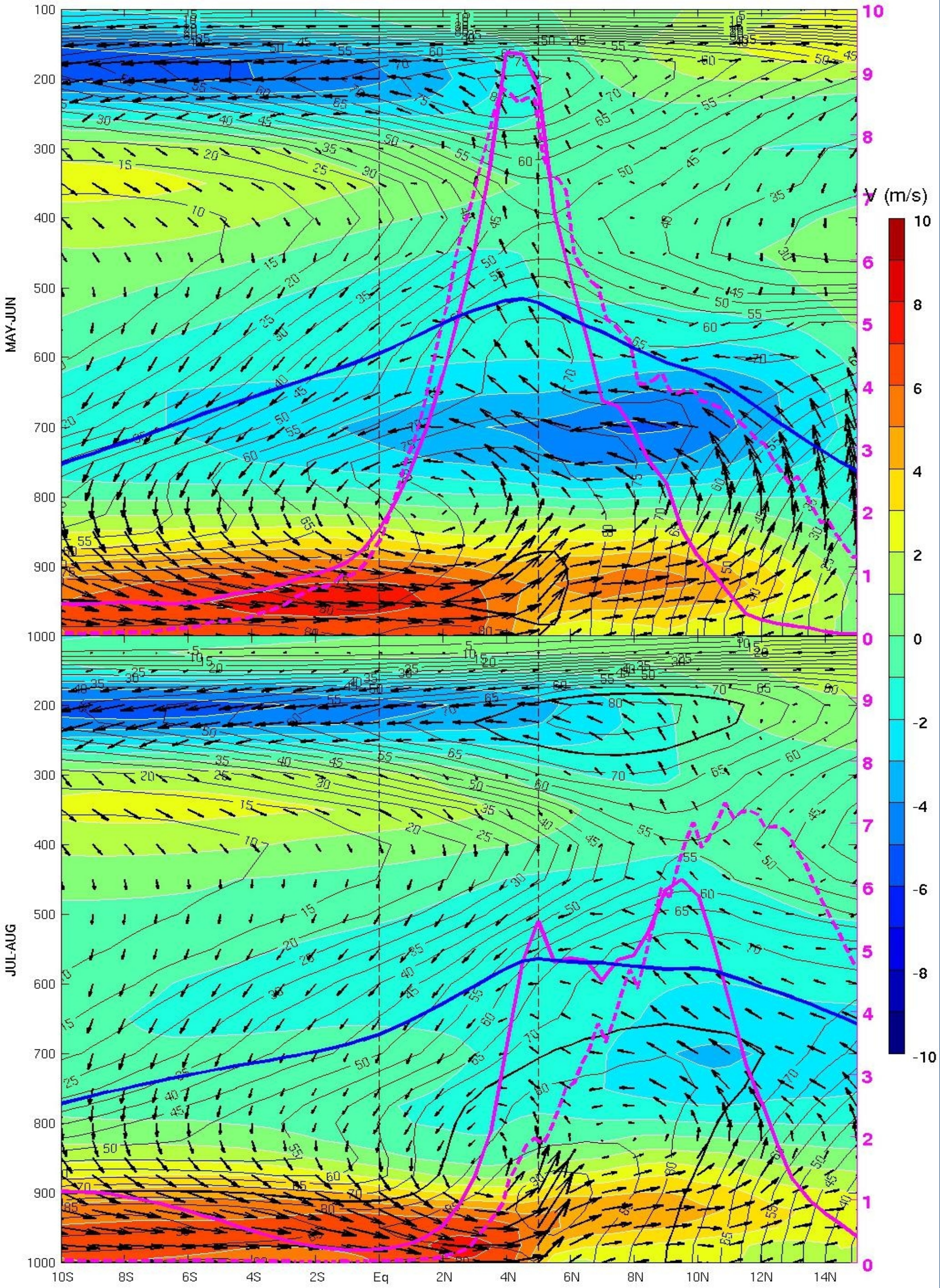


10-m wind anomaly (color)
SST anomaly (black contours)

(~ -0.5°C <=> ~ -0.4 m/s)

- better resolution ? (0.5° vs 0.75°...)
- atmosphere GCM coupled to an ocean GCM => stronger feedback!

NCEP CFSR reanalyses
10°W-0, 2000-2009



May - June

meridional wind (color)
RH (black contours, %)

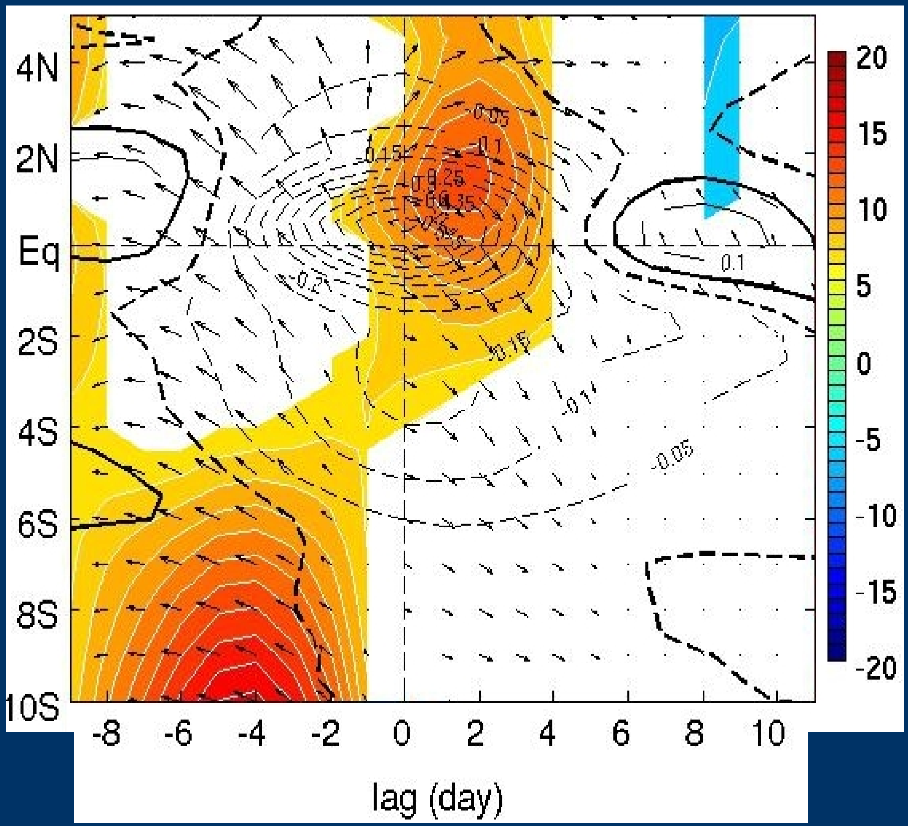
CFSR PPT (mm/d)

TRMM PPT (mm/d)

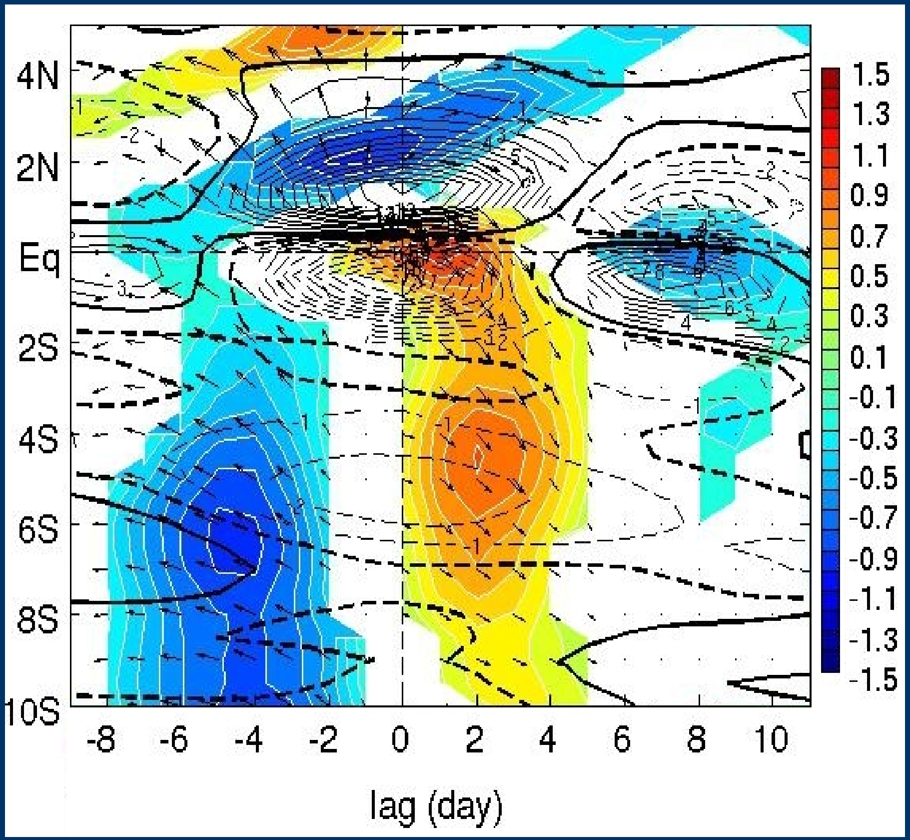
July - August

=> good confidence for CFSR, May-June

Lagged linear regression on the NCTI, CFSR reanalyses, 2000 – 2009, 10°W-0 :

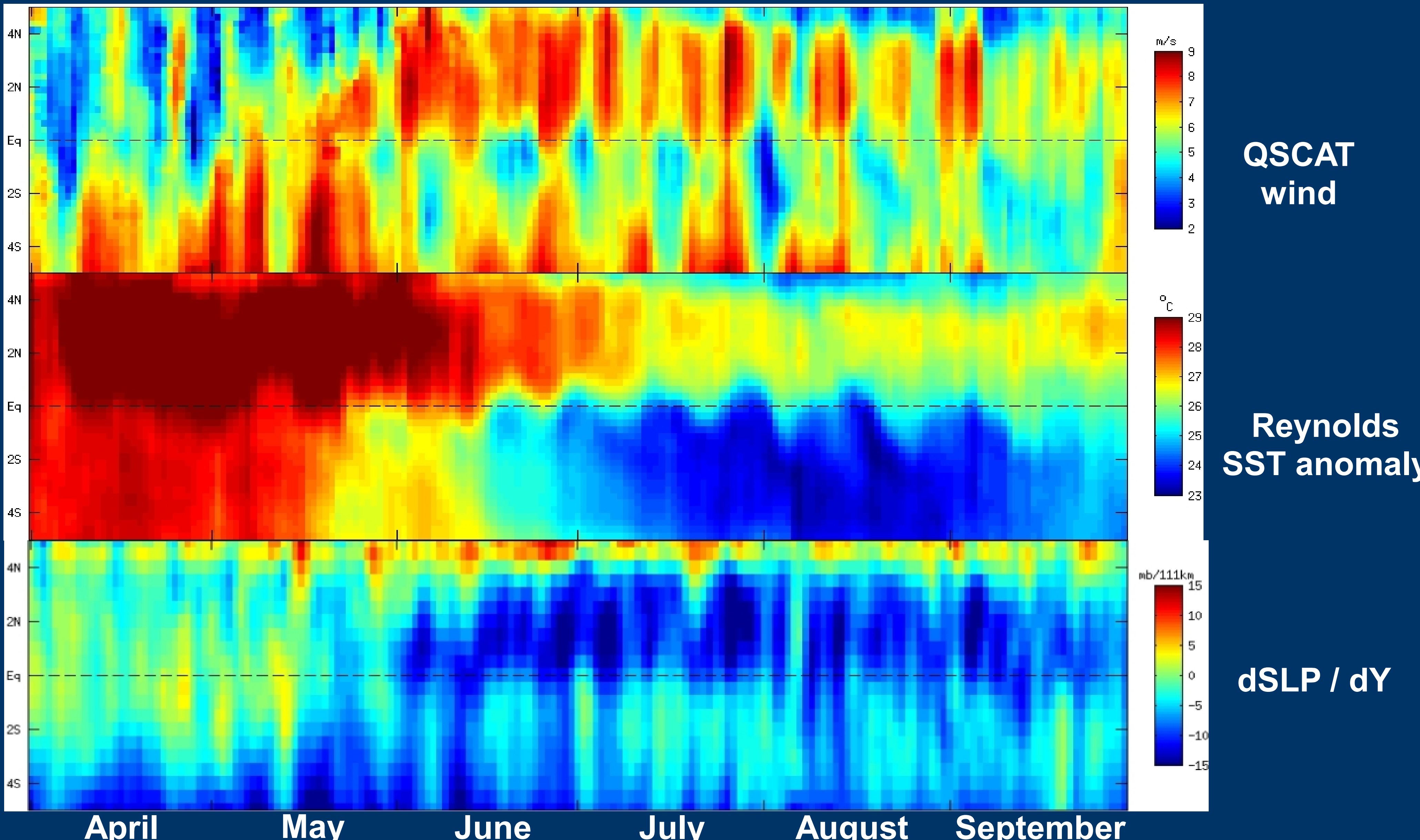


SLP anomaly (colors, Pa)
SST anomaly (black contours, °C)



dSLP/dY anomaly (colors, Pa / 111 km)
dSST/dY anomaly (black contours, °C / 111 km)

For example : YEAR 2007 (10°W - 0)



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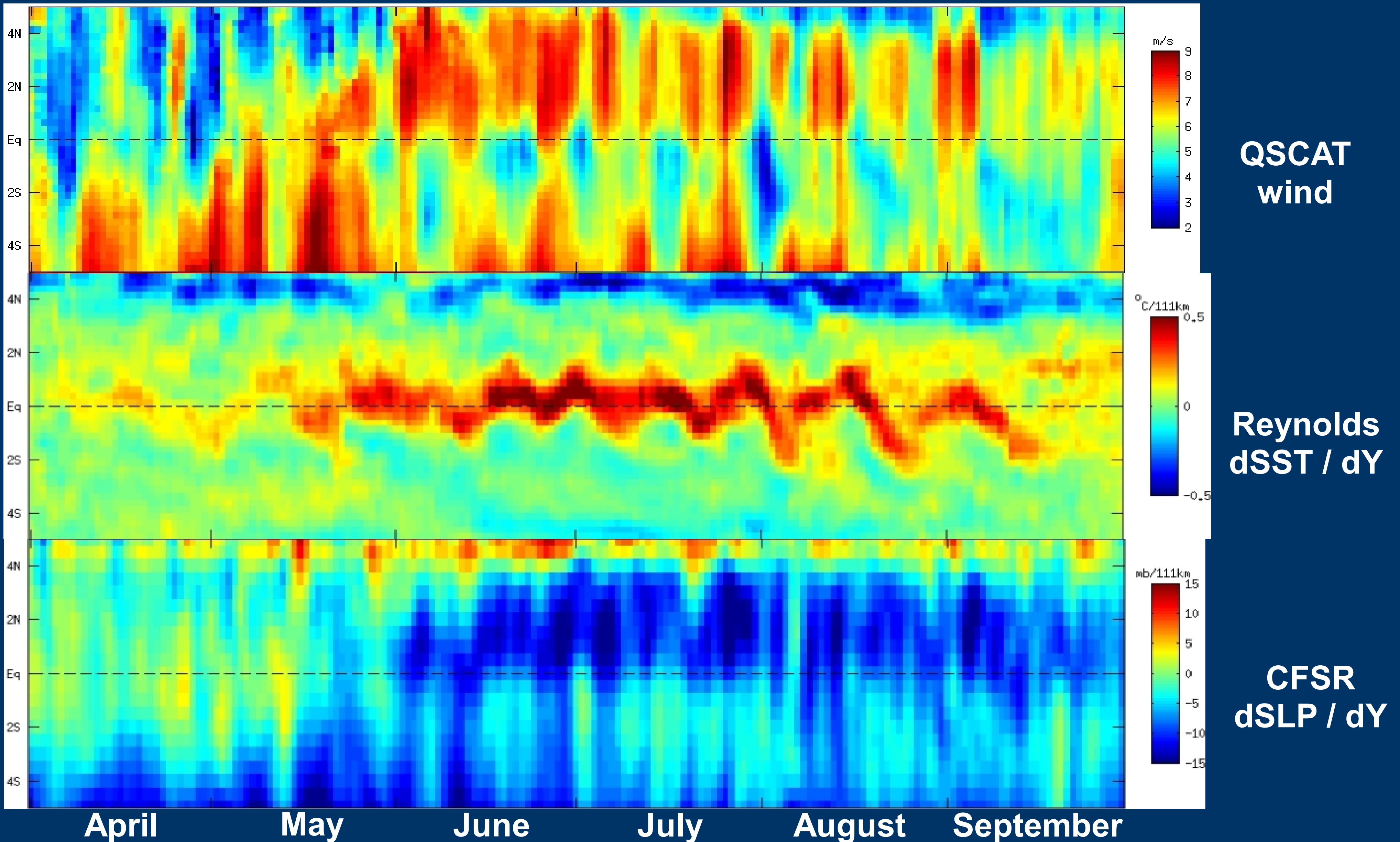
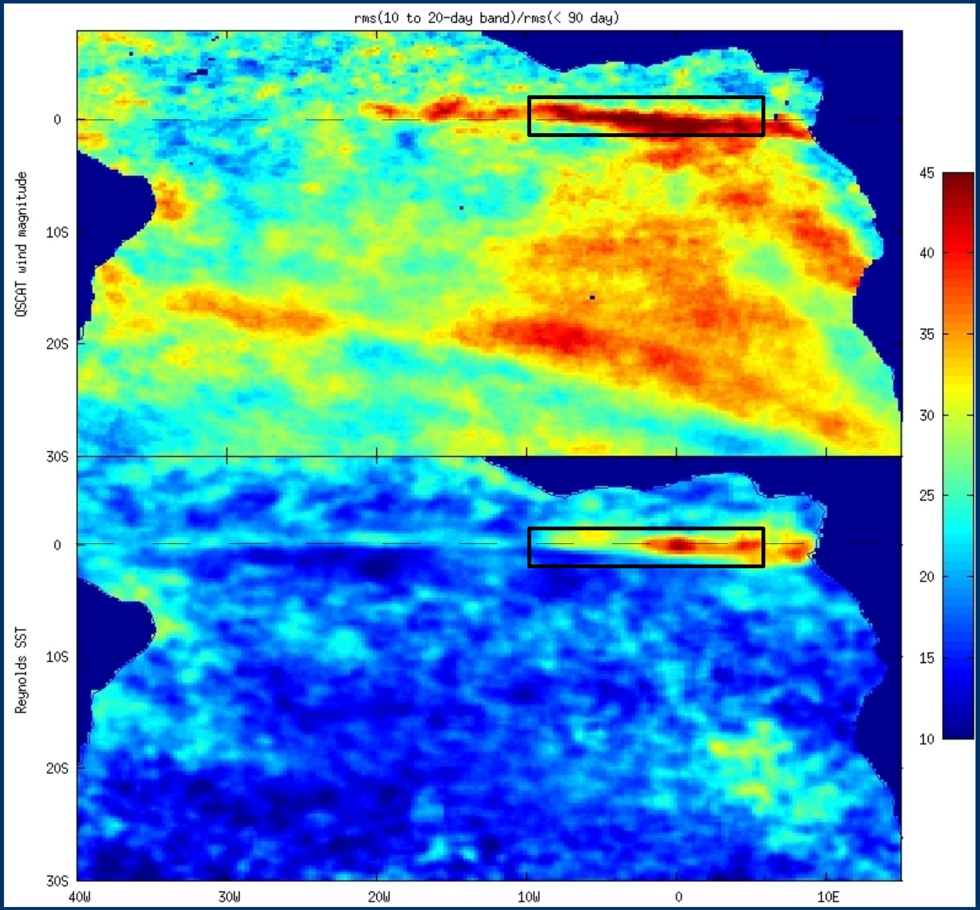


An estimation of the bi-weekly importance in intraseasonal timeseries: rms(10 to 20-day) / rms(<90-day) in MJJA, 2000-2009



QSCAT wind

Reynolds SST

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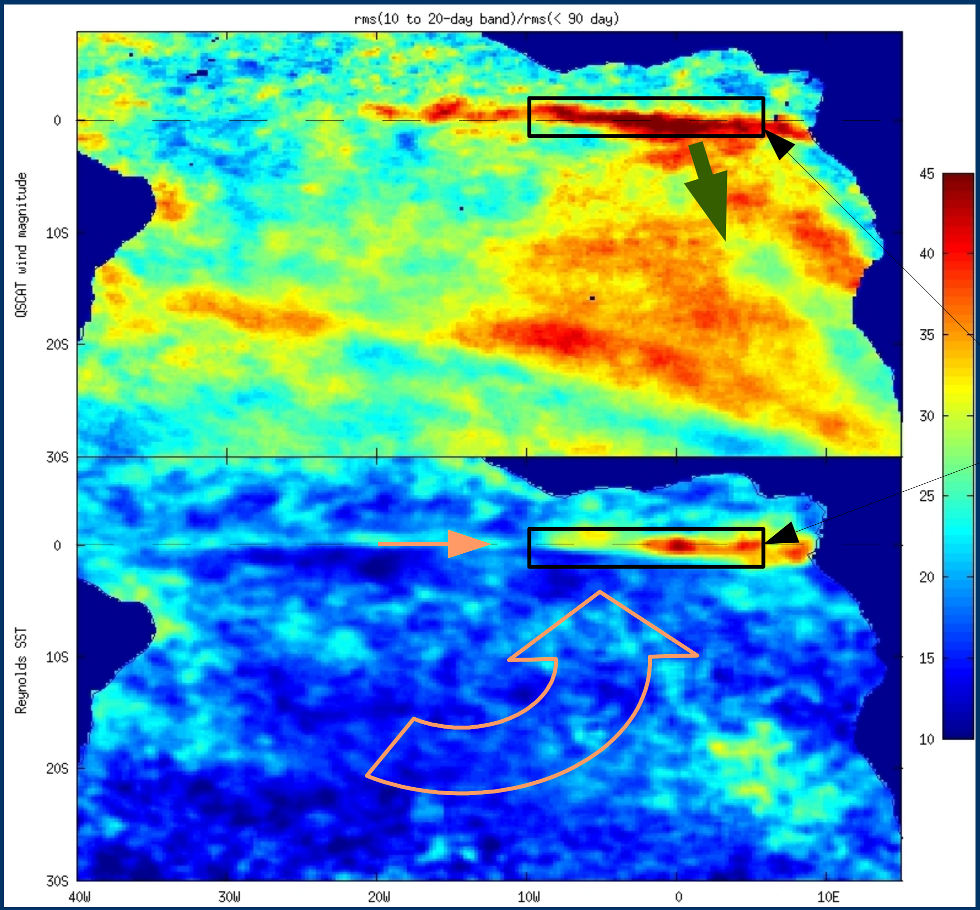


QSCAT wind

I – intraseasonal variability « fueling » from larger scales atmospheric circulation

II - active air-sea coupling => enhances quasi-biweekly variability (by about 50%...)

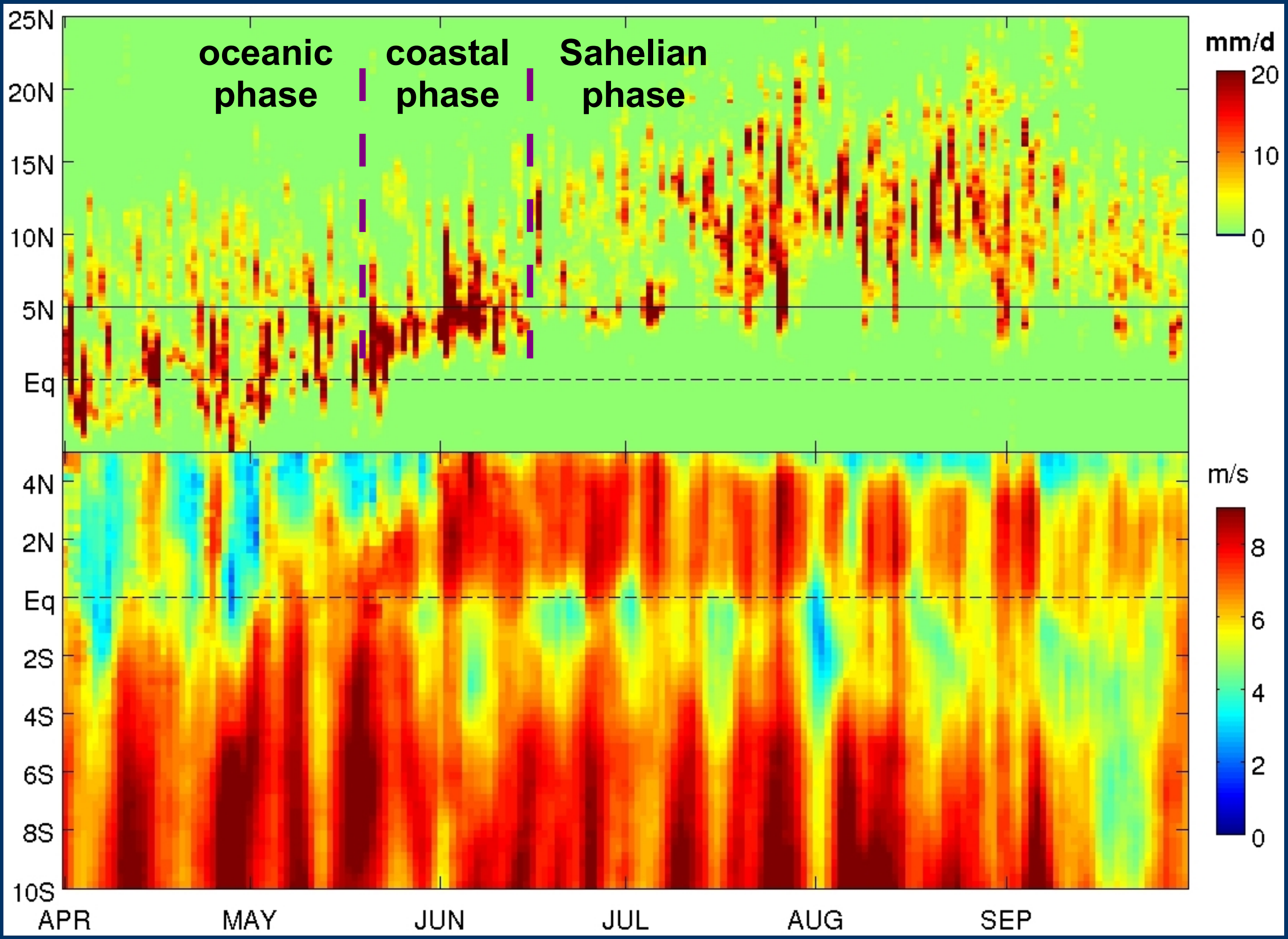
III – « radiation » over the whole GG, through pressure gradient anomalies

Reynolds SST

I) reanalyses made with coupled model (as NCEP CFSR) clearly improve the QBWEO representation => importance of the coupling in studies with regional - or global – models

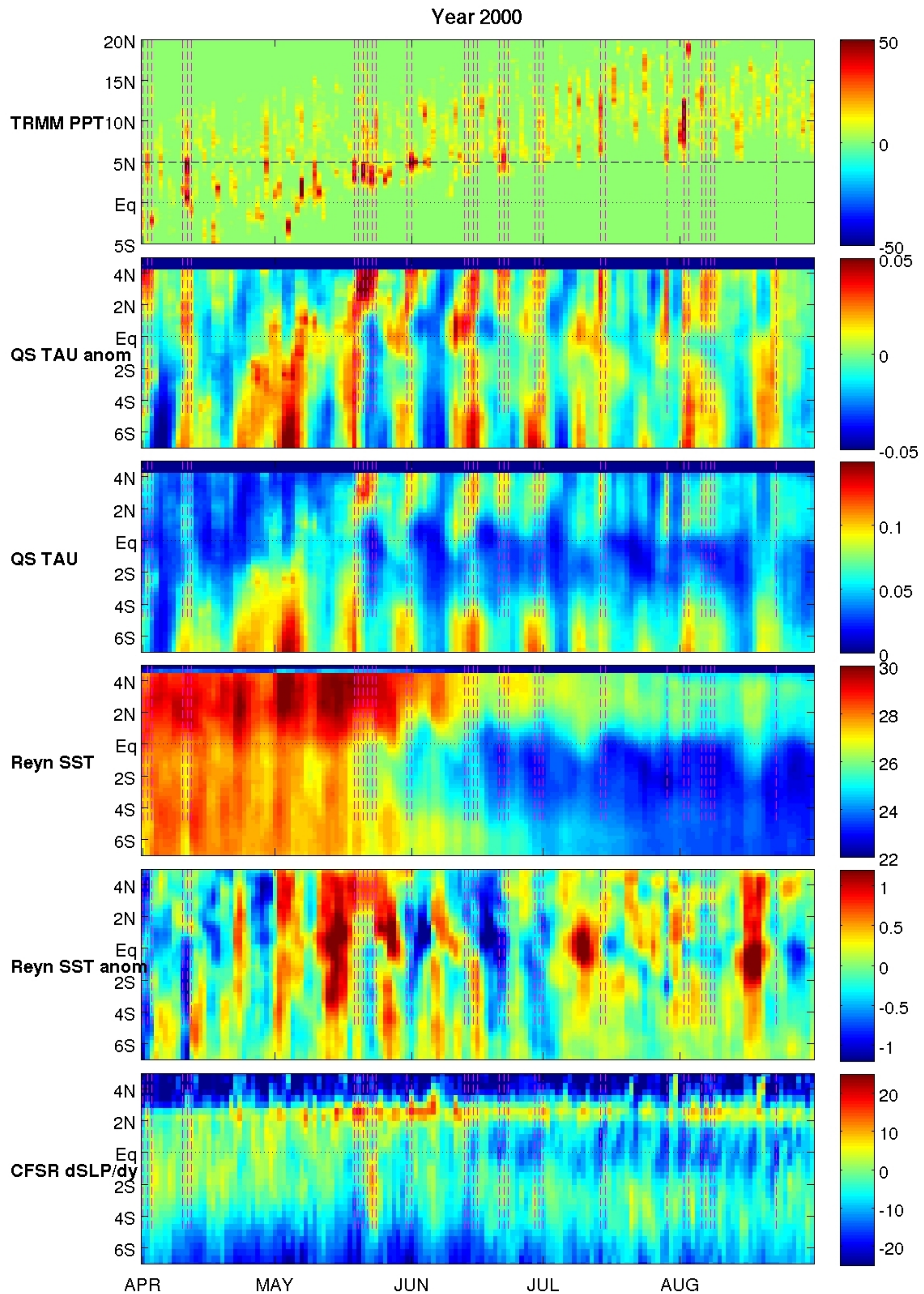
II) important control of this bi-weekly variability on the seasonal evolution of the rainfall, through southerlies fluctuations between the Equator and the coas (see Leduc-Leballeur et al. 2012, and Marion's talk tomorrow...!)

For example : YEAR 2007 (10°W - 0)



TRMM rainfall

QSCAT wind



Year 2000
TRMM PPT
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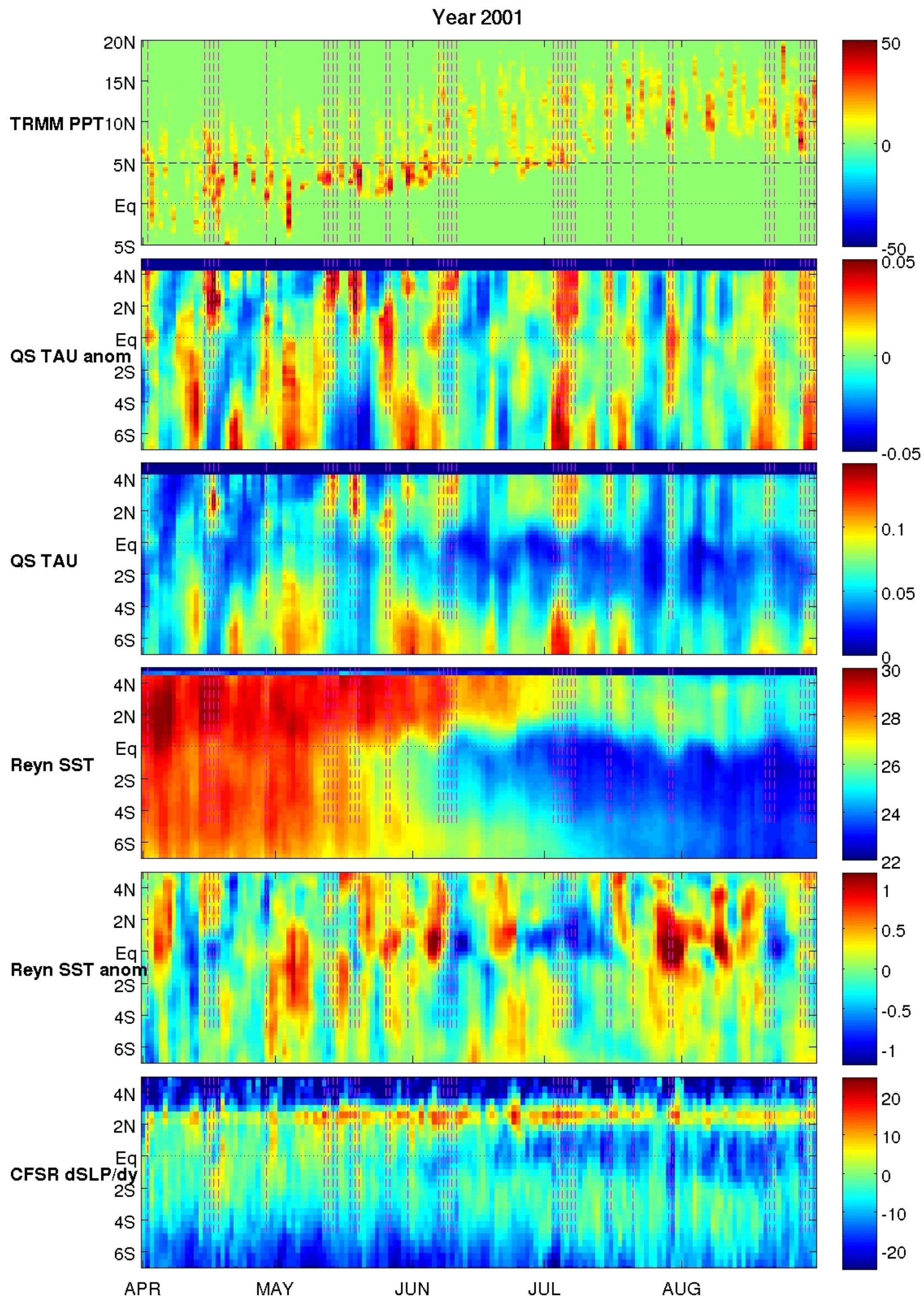

Year 2001
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QS TAU
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Reyn SST anom
CFSR dSLP/dy
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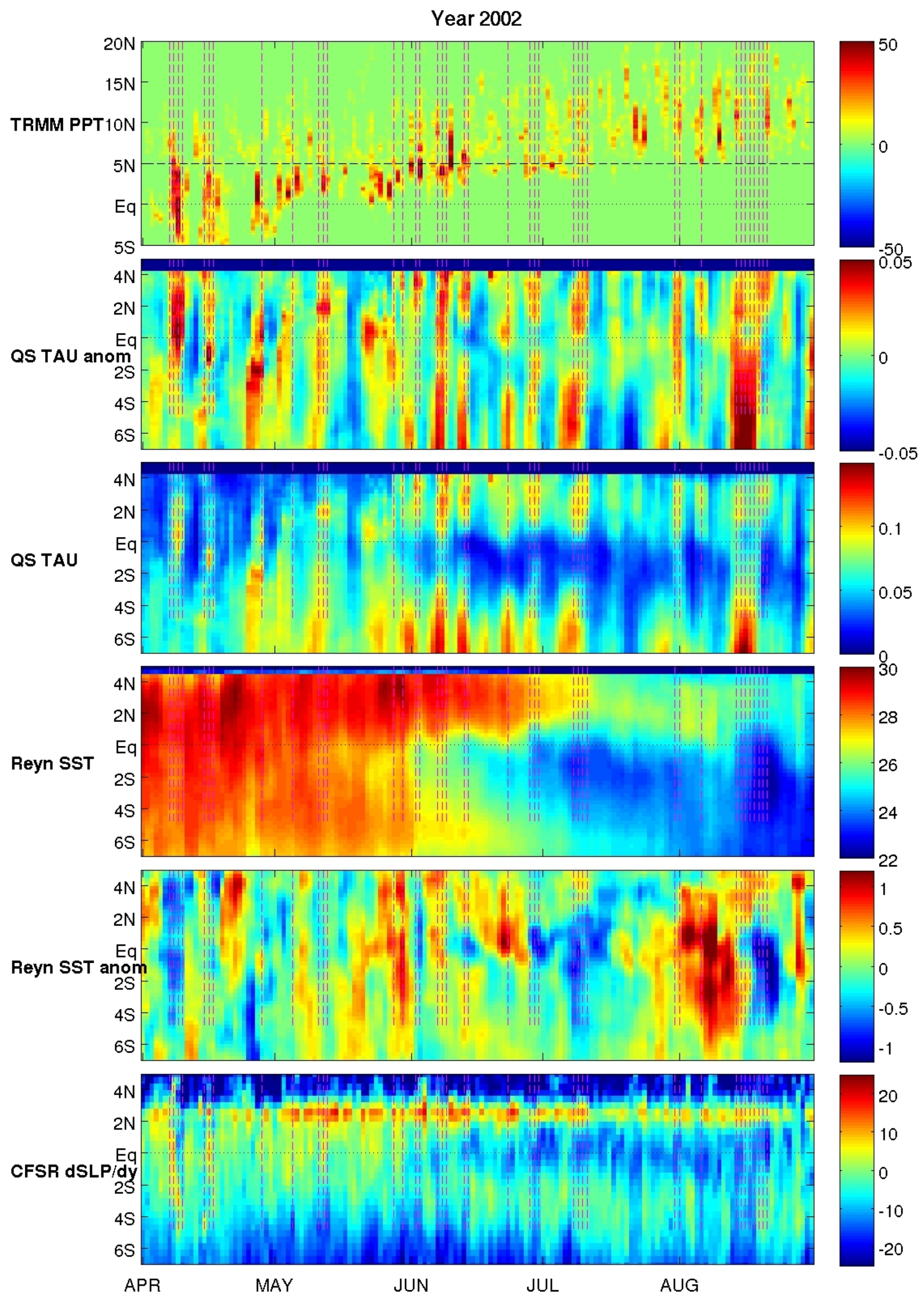

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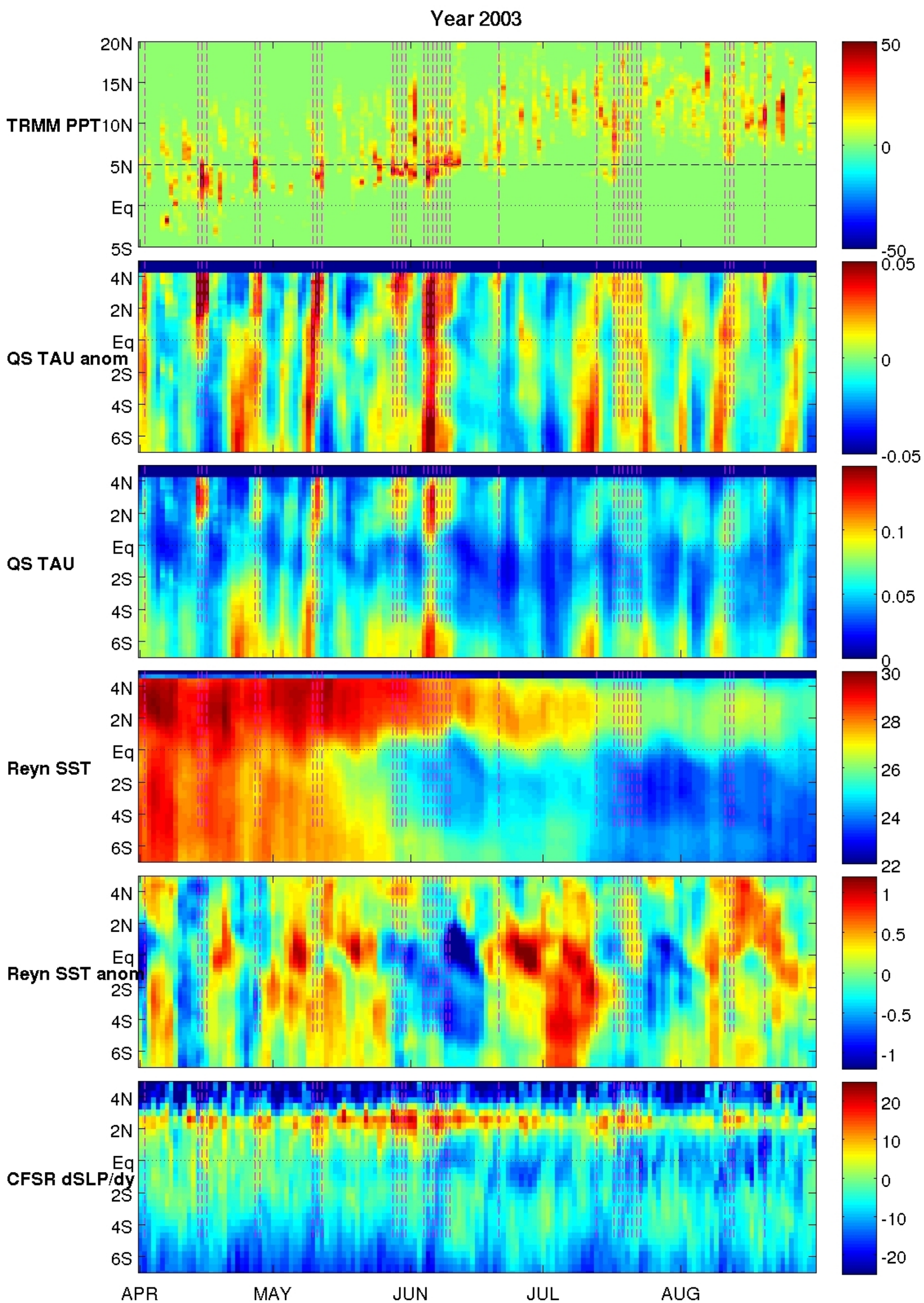

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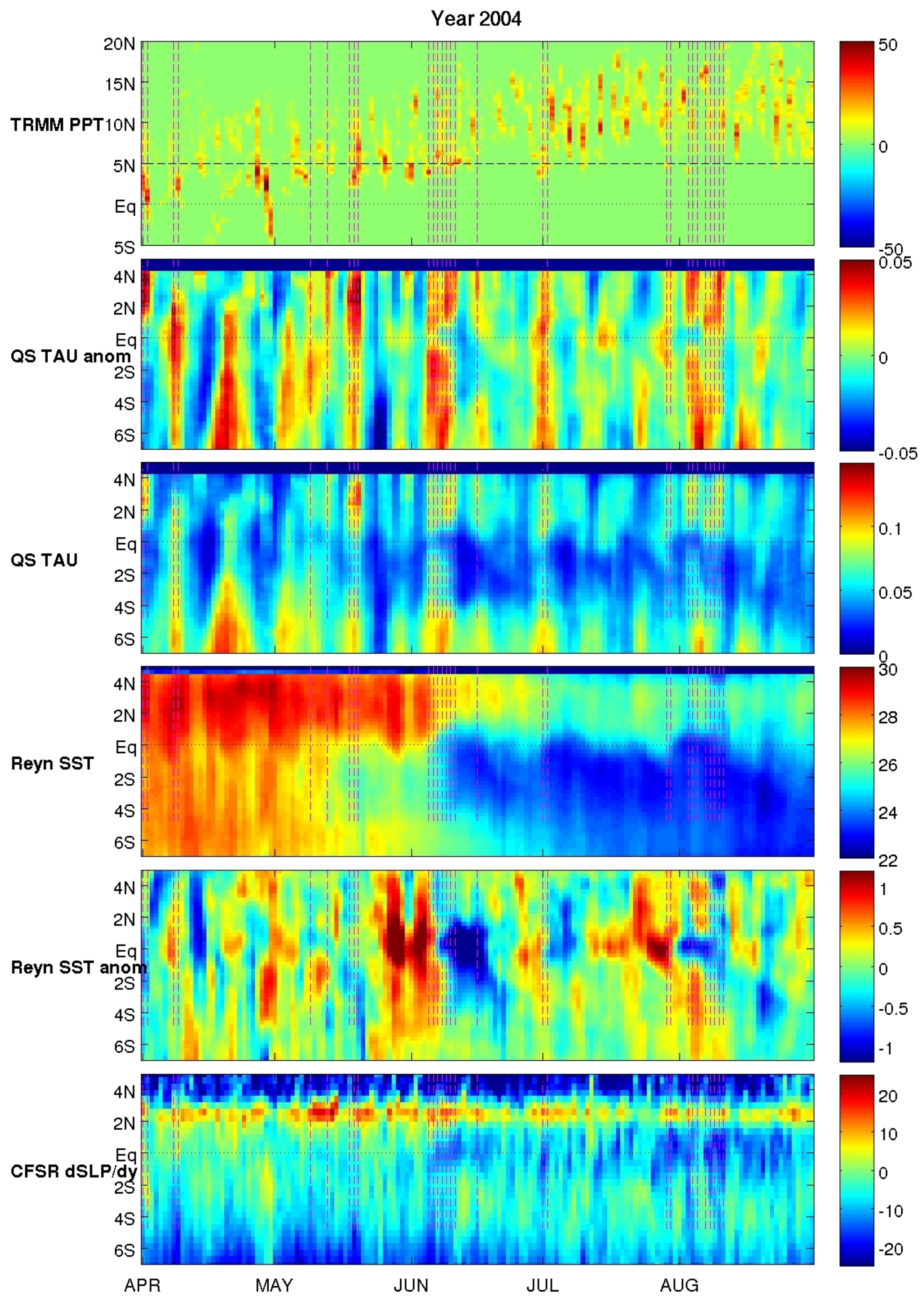

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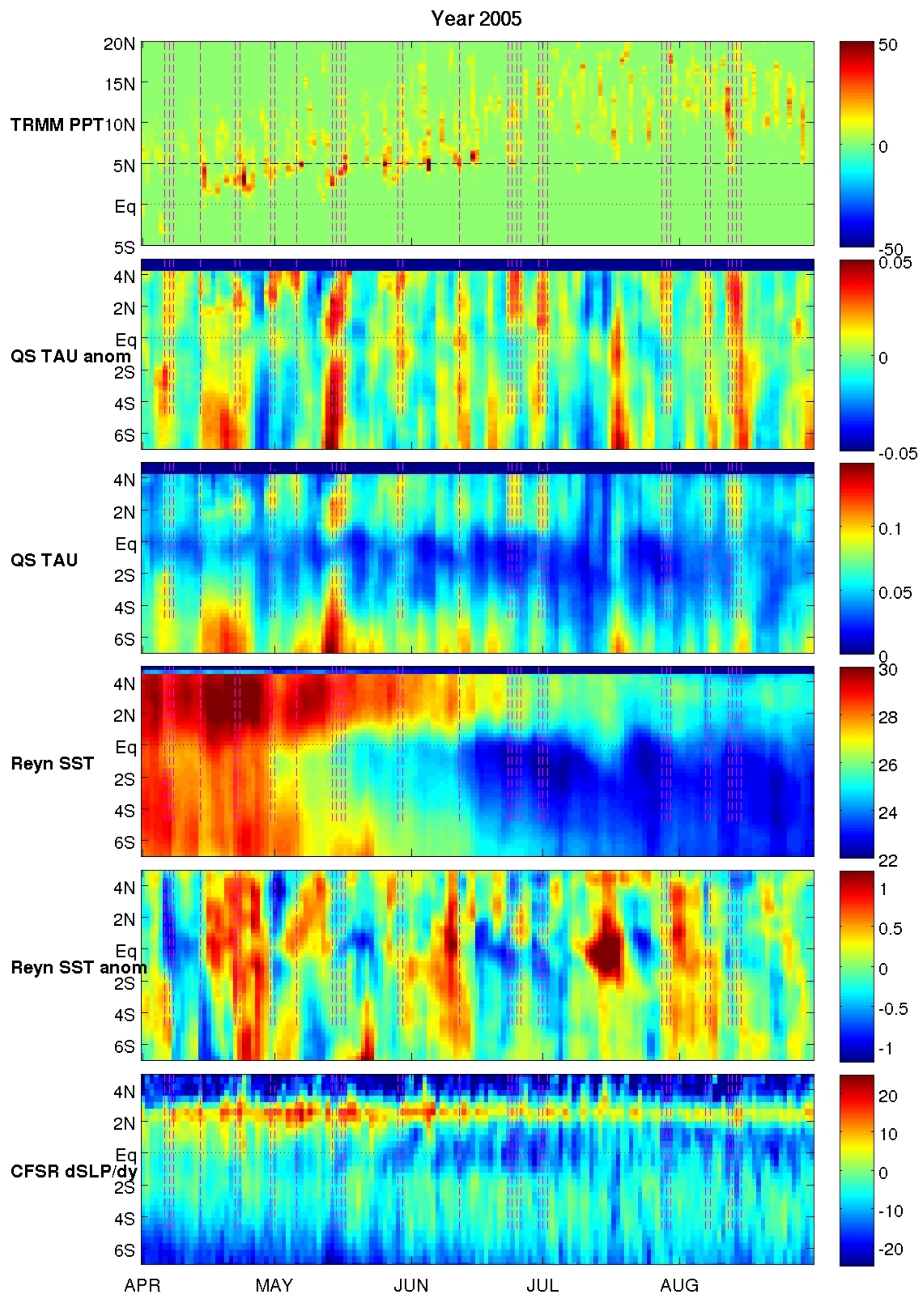
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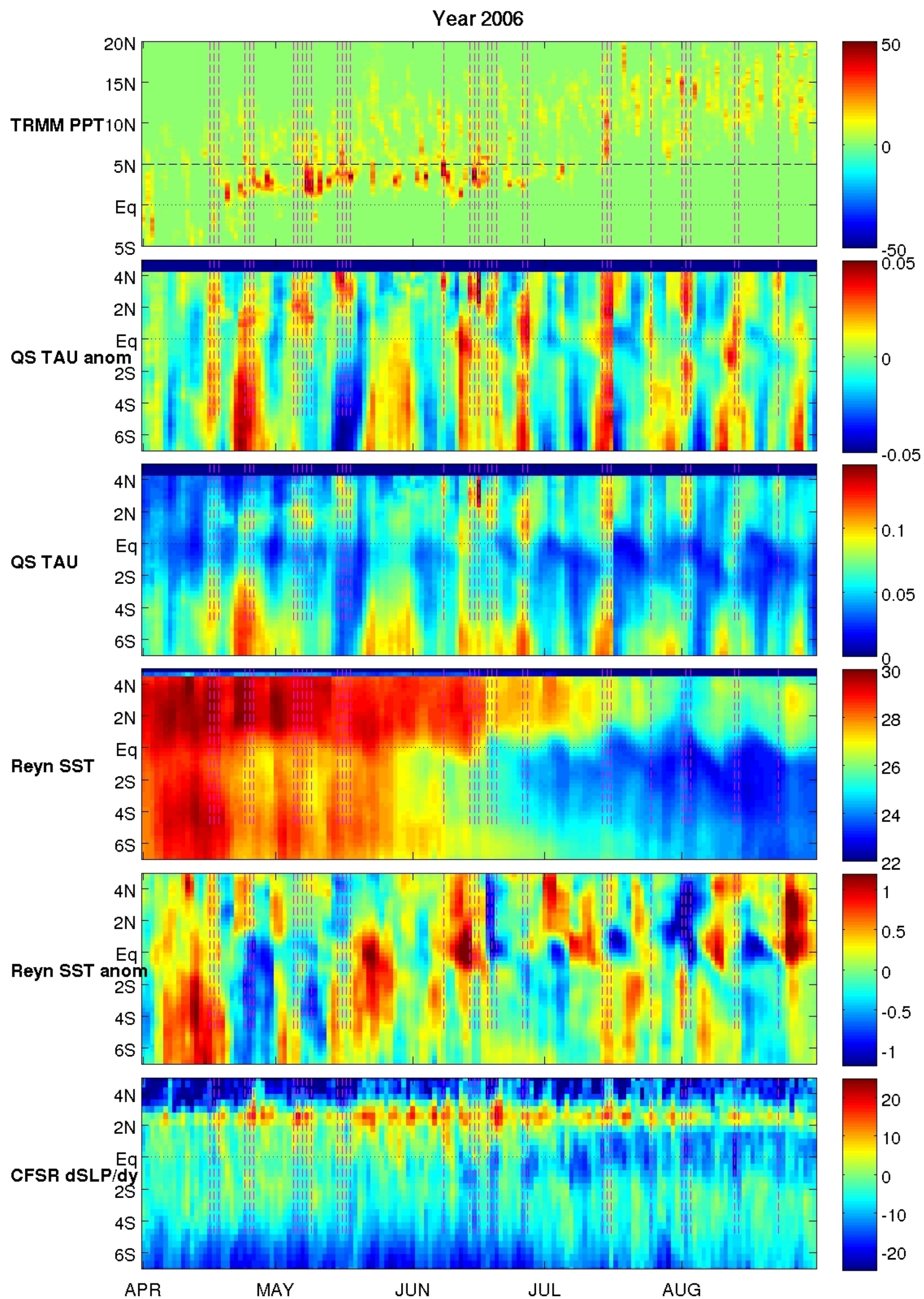
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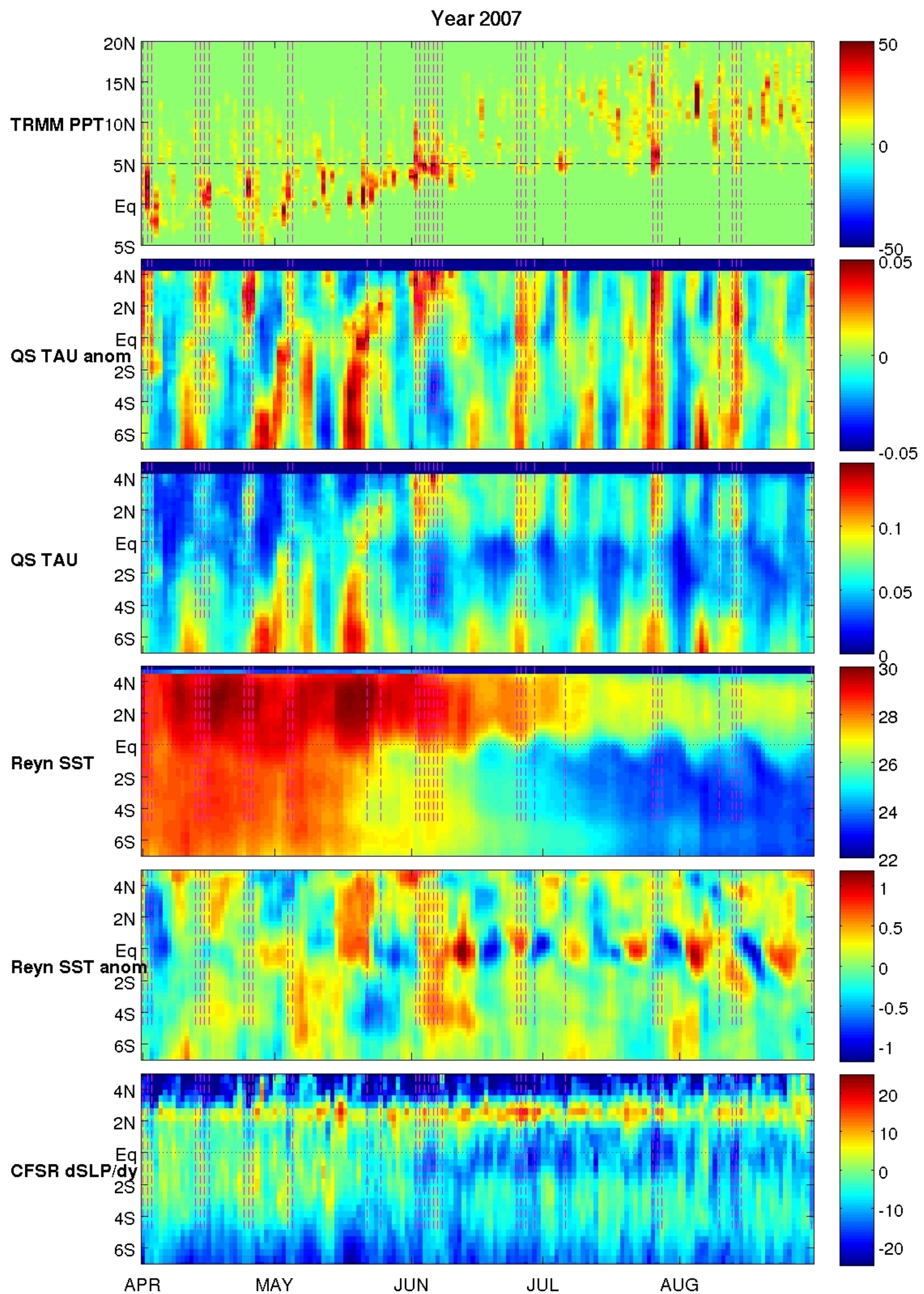
Year 2007
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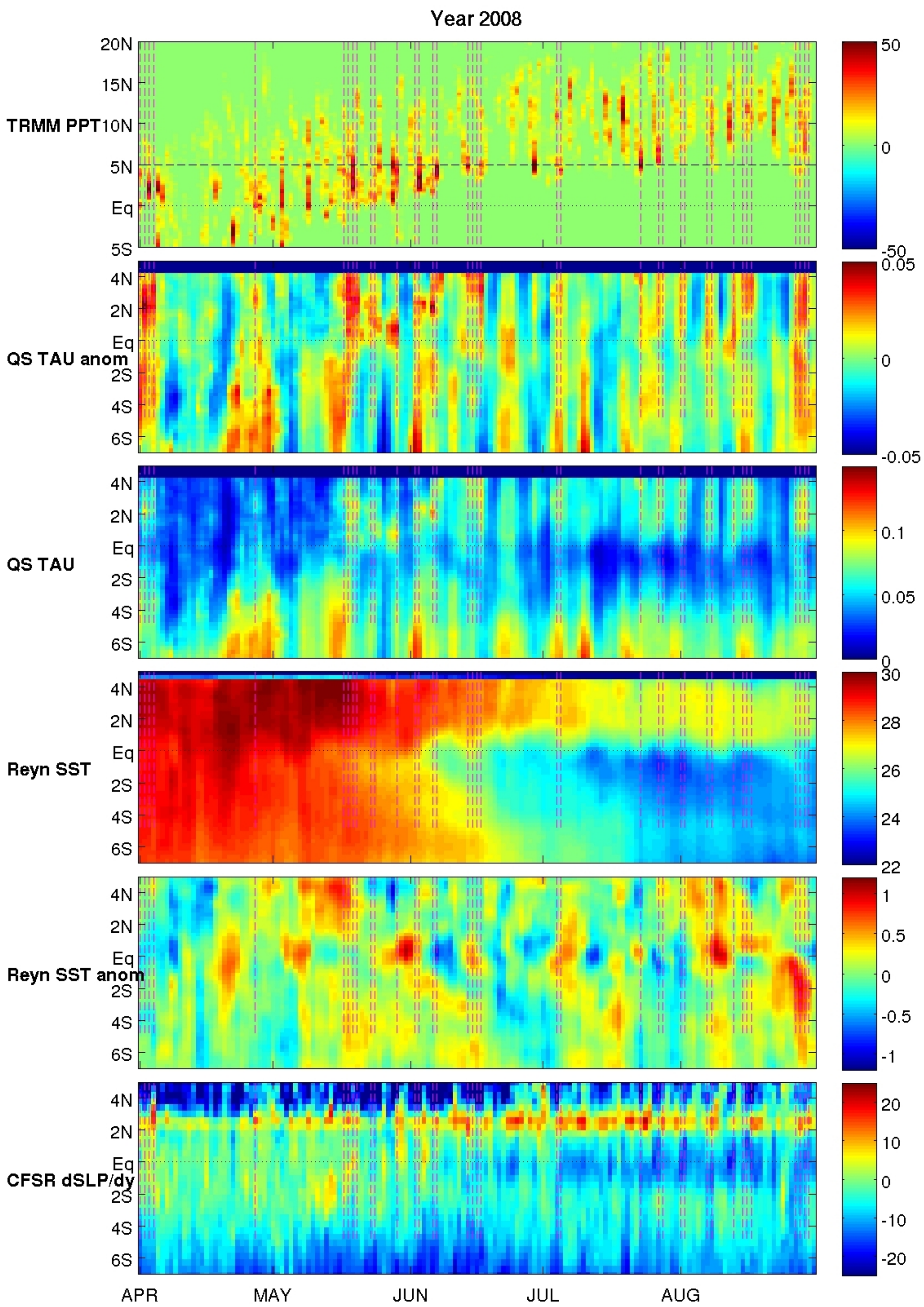
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Reyn SST anom
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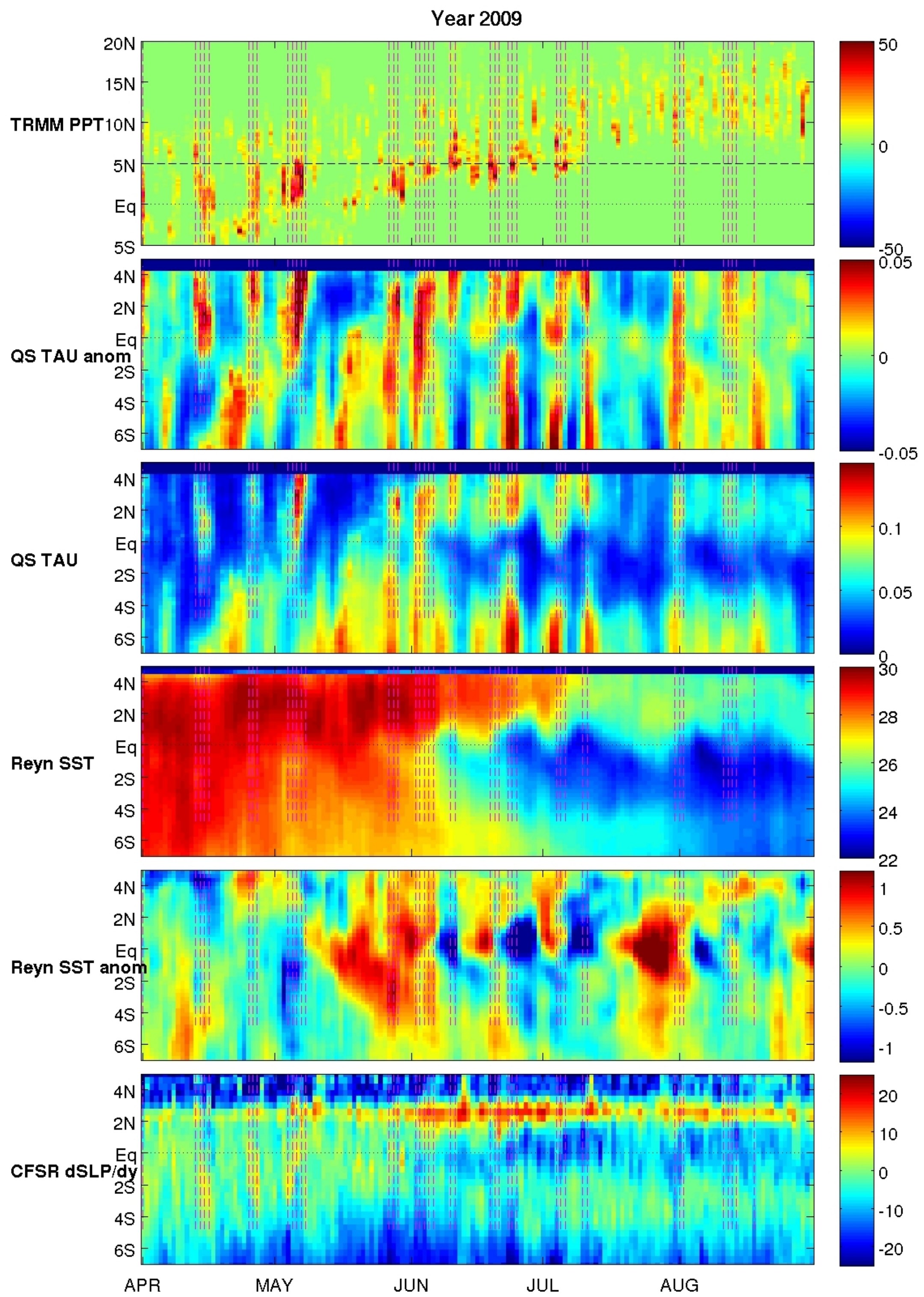
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