Intraseasonal latent heat flux based on satellite observations

Semyon A. Grodsky[1], Abderrahim Bentamy[2], James A. Carton[1], and Rachel T. Pinker[1]

DEPARTMENT OF ATMOSPHERIC & OCEANIC SCIENCE
UNIVERSITY OF MARYLAND 1

Ifremer 2

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Outline

- IFREMER LHTFL
- Validation
- Spatial patterns of intraseasonal variability
- LHTFL and SST
- LHTFL and SWR
- Summary

LHTFL is the recent update of weekly satellite-based turbulent fluxes over the global Ocean (1992-2007) of *Bentamy et al.* (2003, 2008)

$$\frac{Q_E}{\rho L} = -C_E \left|\mathbf{u}_a - \mathbf{u}_s\right| (q_a - q_s)$$

$\left|\mathbf{u}_a - \mathbf{u}_s\right|$ Merged ERS-1 (1992-1996), ERS-2 (1996-2001), and QuikSCAT (1999-2007)

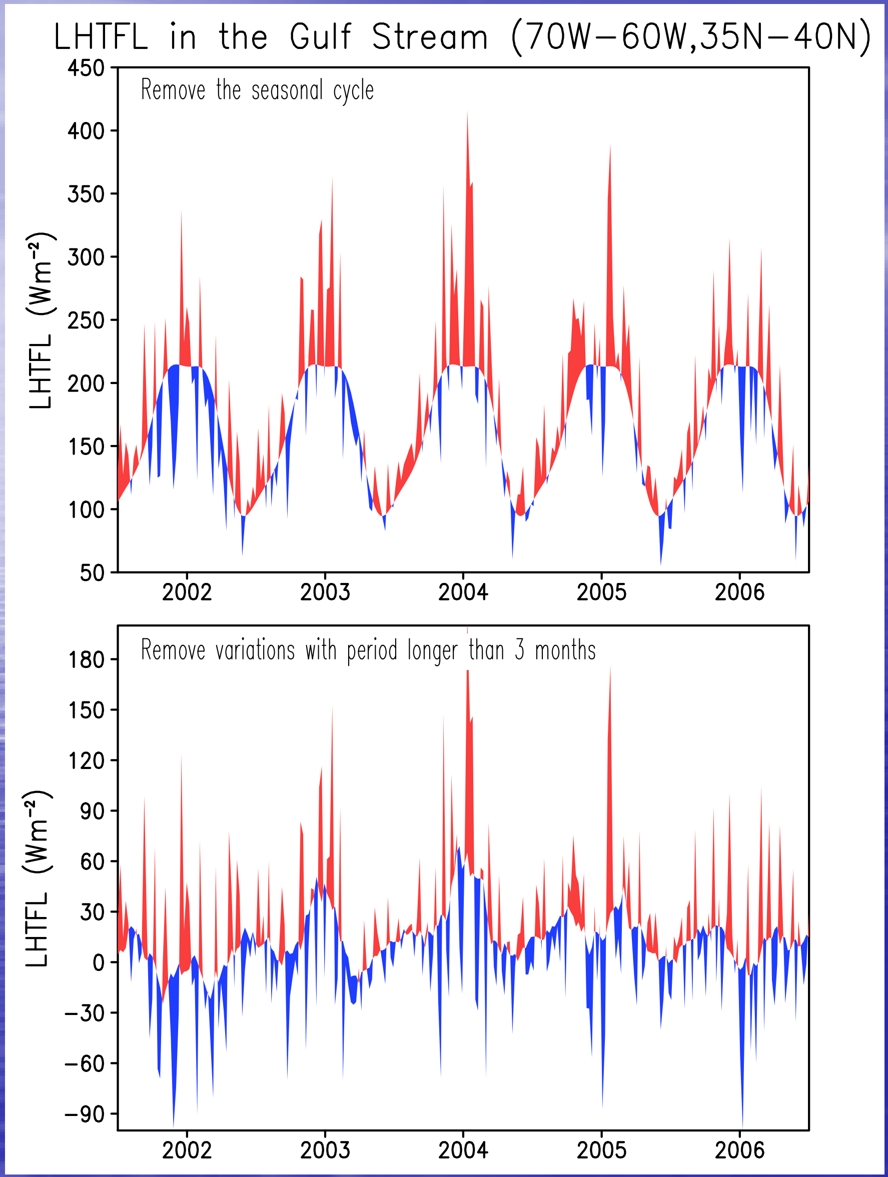
q_a SSM/I multi channel brightness temperatures

q_s daily averaged SST of *Reynolds et al*. (2007)

$T_a = F(\left|\mathbf{u}_a - \mathbf{u}_s\right|, q_a, q_s, T_s)$ *Ta* is determined based on the Bowen ratio method of *Konda et al.* (1996)

$C_E = F(\left|\mathbf{u}_a - \mathbf{u}_s\right|, T_a, T_s, q_a)$ Dalton number, C_E, is based on the *Fairall et al.* (2003) algorithm (COARE3 version)

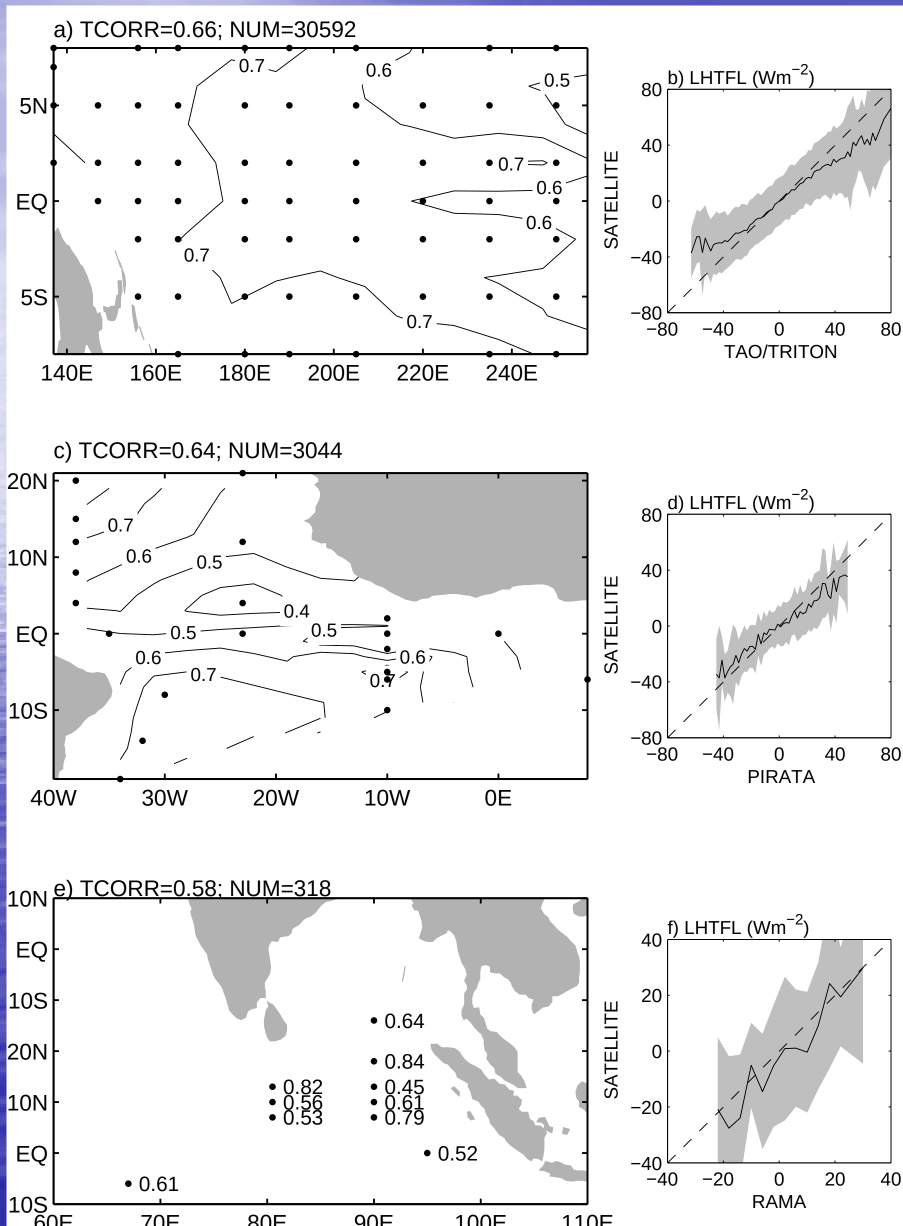
Calculation of the intraseasonal component



At each grid point the anomalous LHTFL is calculated by removing the seasonal cycle (sum of the three first annual harmonics).

Intraseasonal LHTFL is calculated by removing variations with periods exceeding 3 months from the anomalous LHTFL.

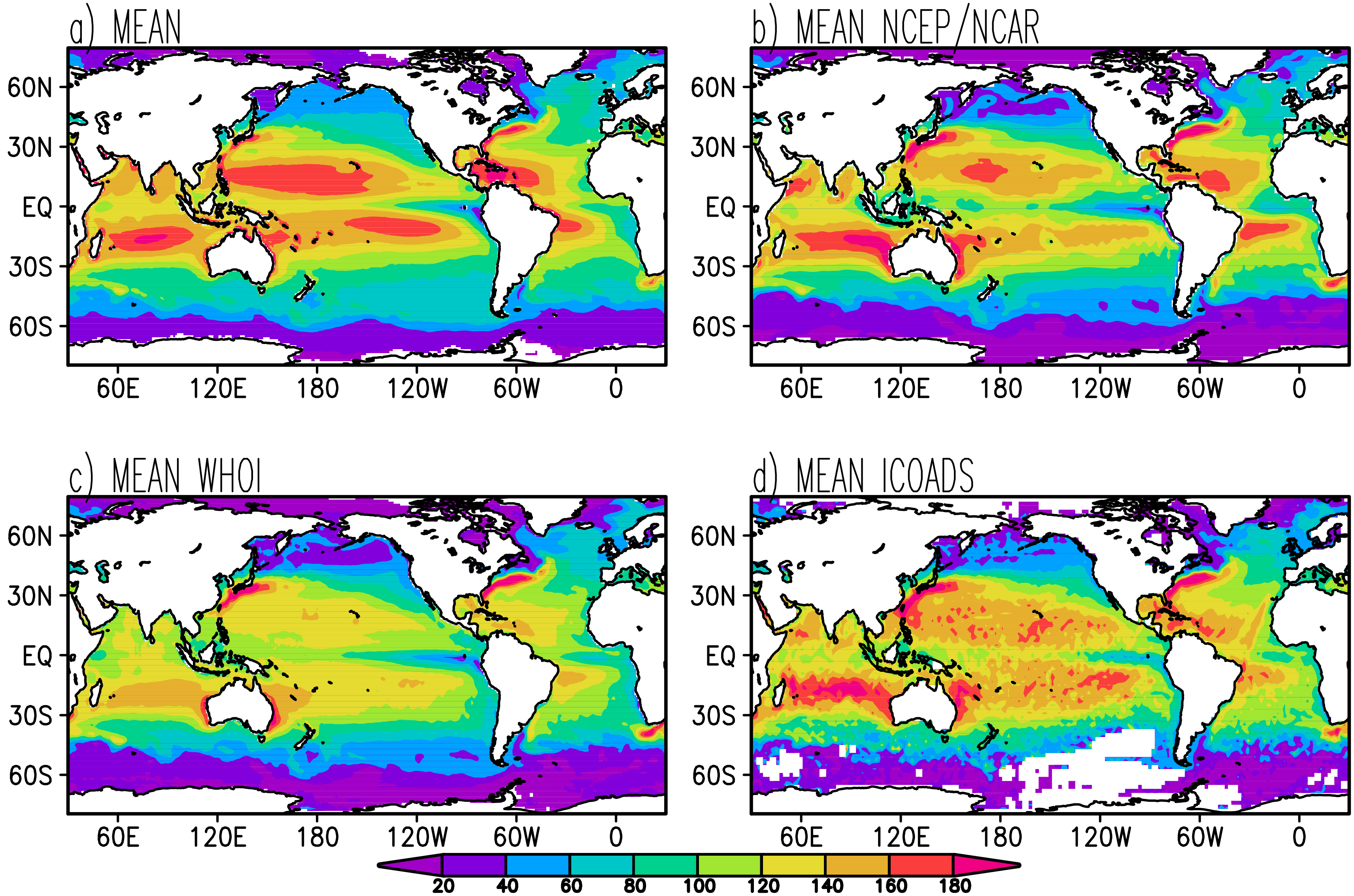
Intraseasonal LHTFL validation against the tropical ocean moorings



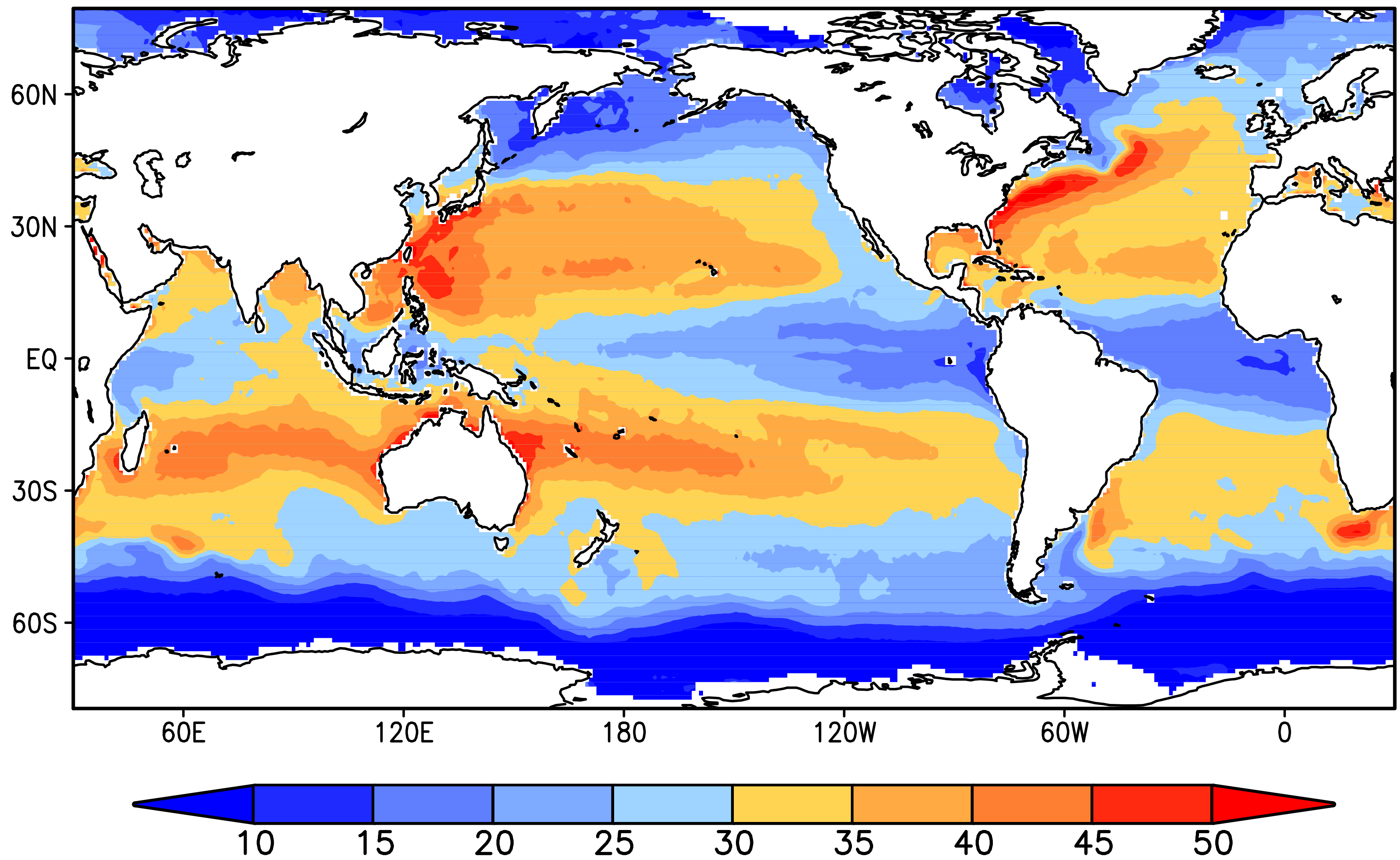
Satellite and buoy intraseasonal LHTFL are in good correspondence. But satellite LHTFL underestimates magnitudes of 'strong' events. Are some strong events missing by twice-a-day observations?

Time correlation (TCORR) of satellite and buoy intraseasonal LHTFL is well above the 99% confidence level. But TCORR is weaker in the ITCZ region. Is this a consequence of const RH in the *Konda* algorithm?

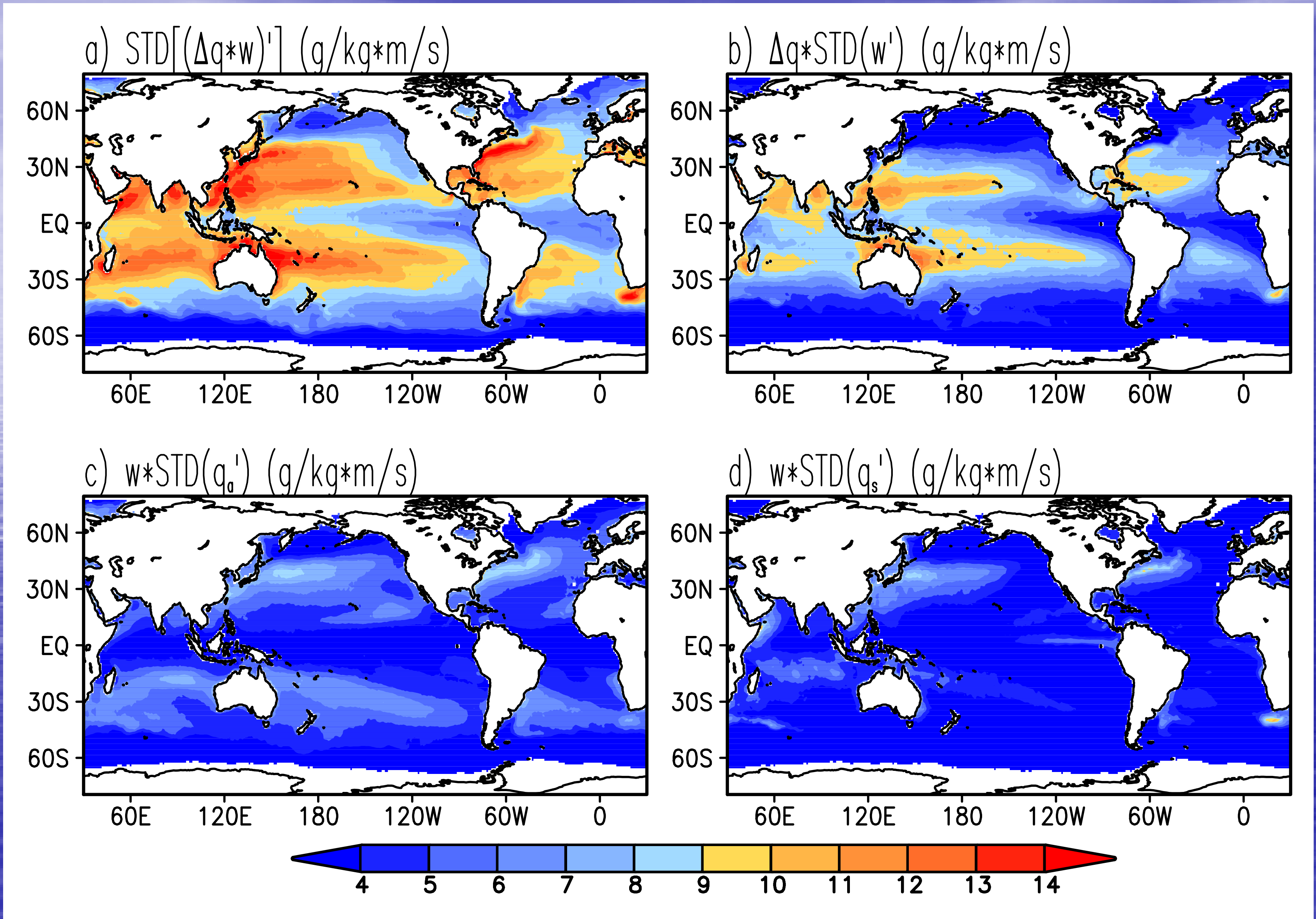
Time mean LHTFL (Wm^{-2})



STD of the intraseasonal LHTFL (Wm^{-2})



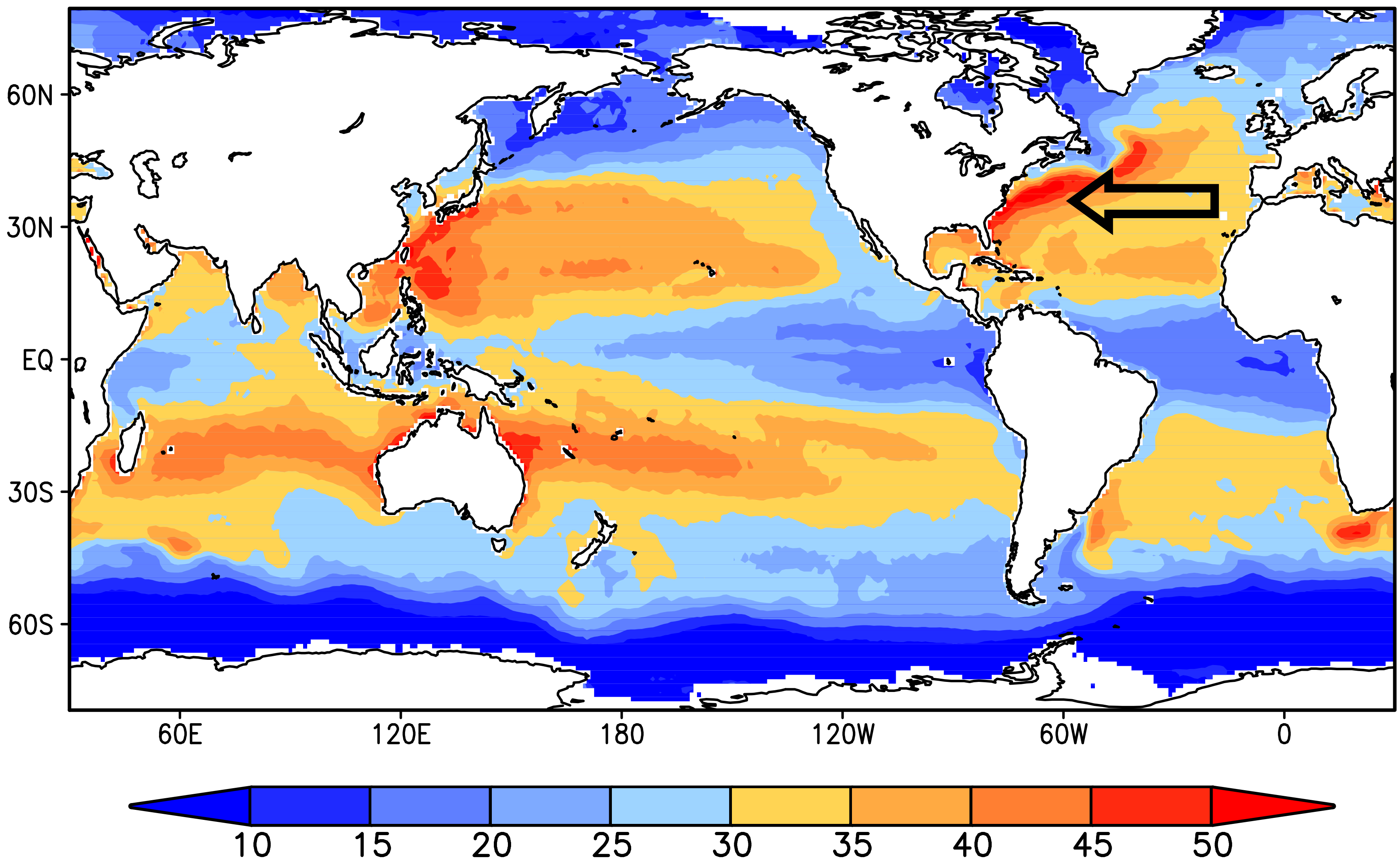
Intrasesonal LHTFL: contribution of wind speed, humidity, and SST



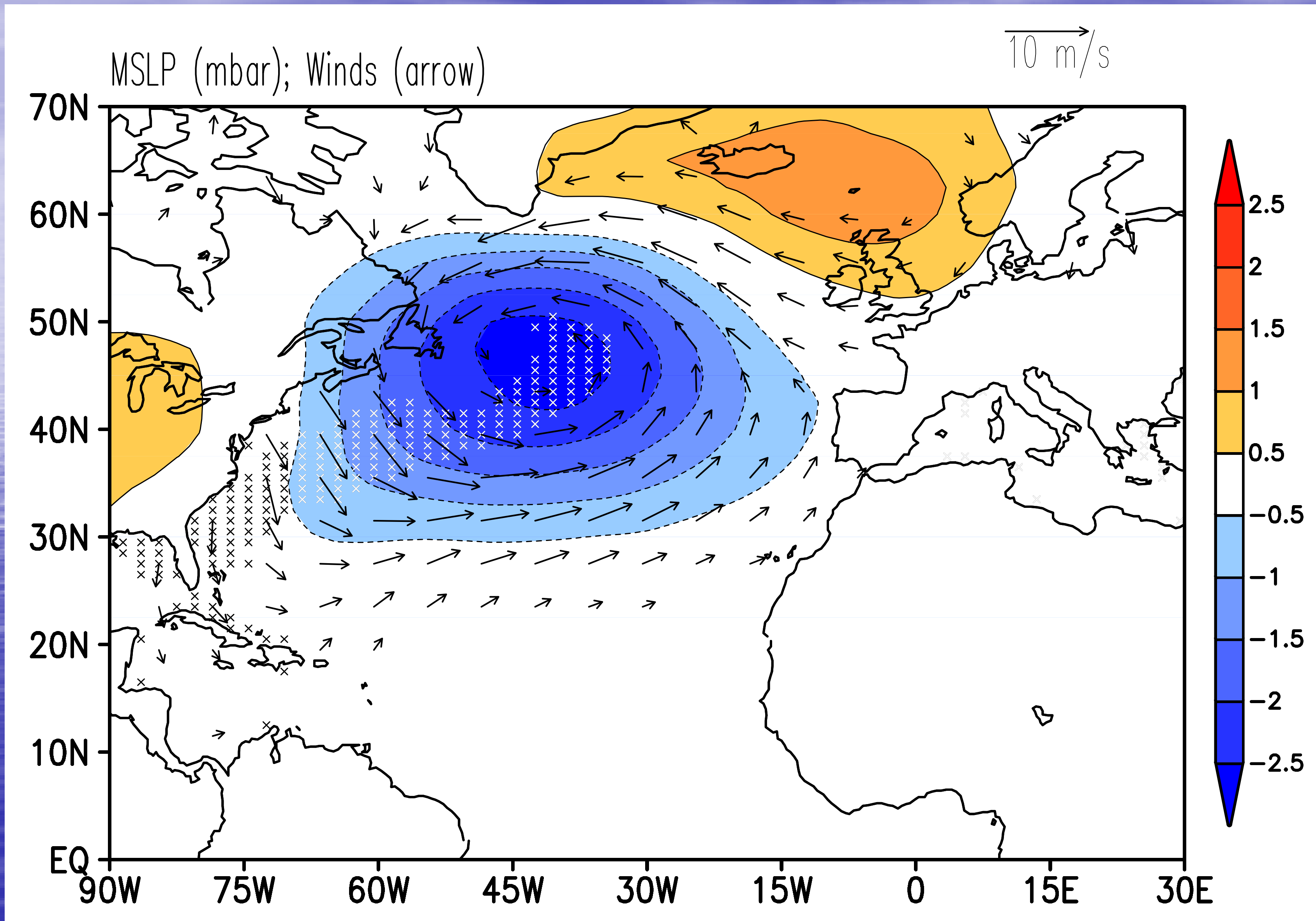
Link between intraseasonal LHTFL and weather systems

- Gulf Stream
- Agulhas Current

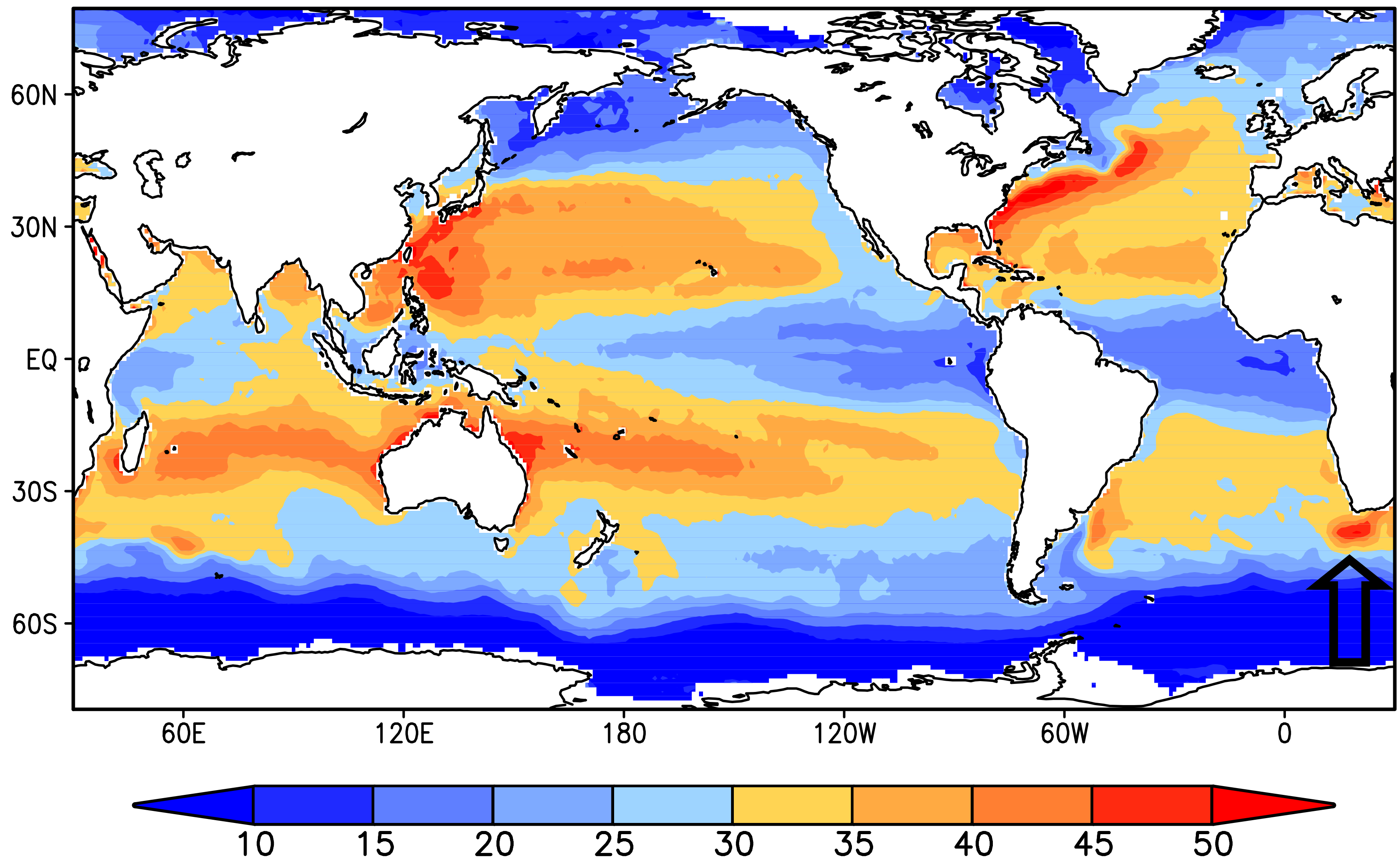
Which weather system produces LHTFL amplification in the Gulf Stream area ?



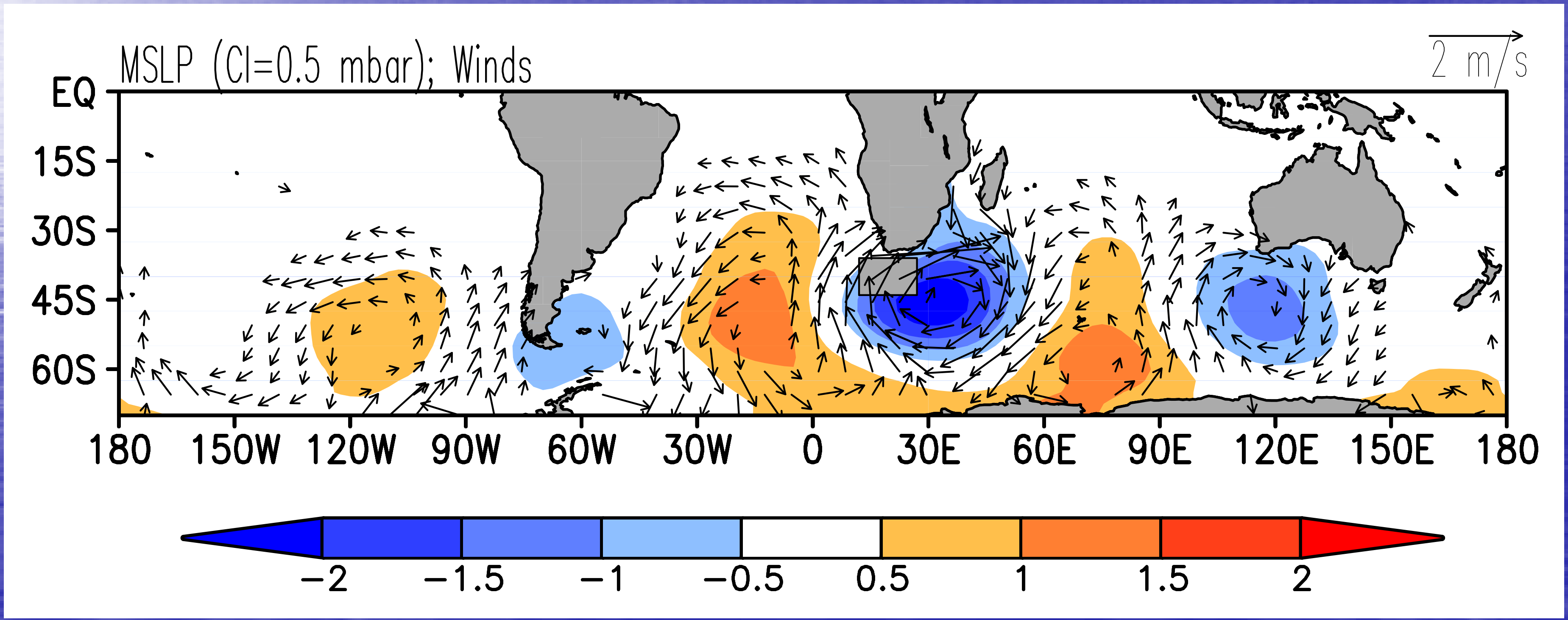
MSLP and wind anomalies corresponding to 1-sigma increase of LHTFL in the Gulf Stream region

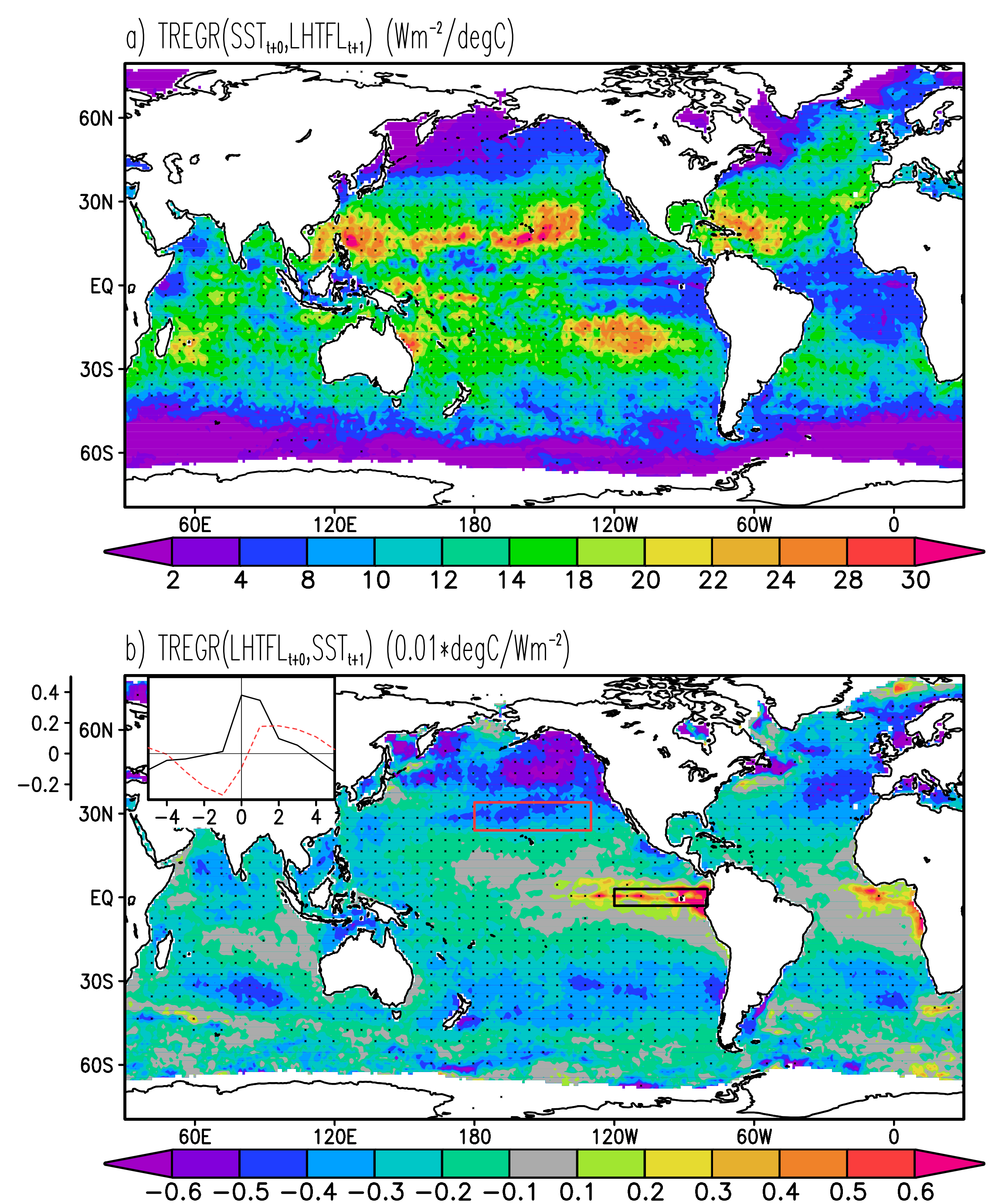


Which weather system produces LHTFL amplification in the Agulhas current area ?



MSLP and wind anomalies corresponding to 1-sigma increase of LHTFL in the Agulhas region

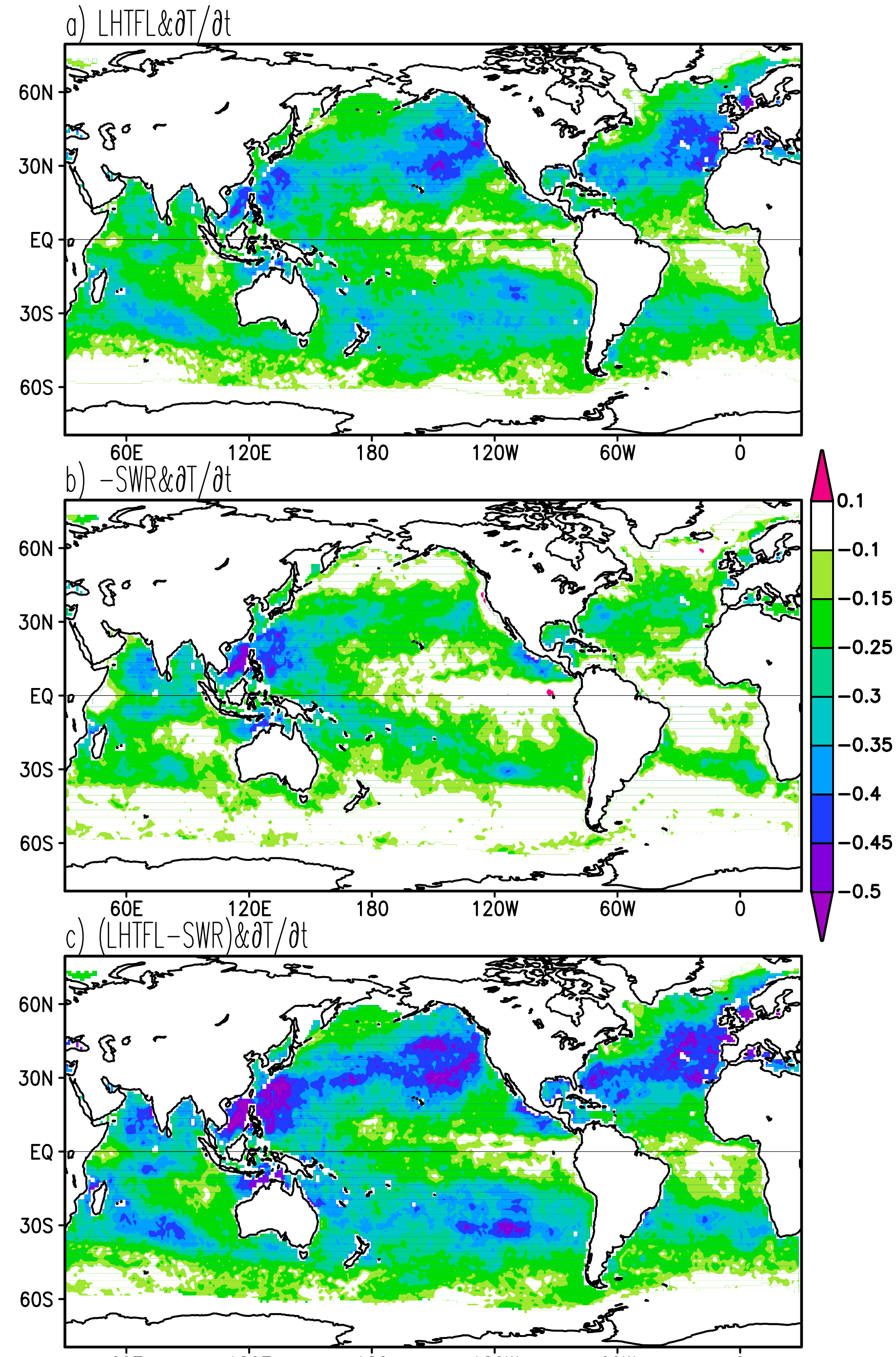




Relationship between the intraseasonal LHTFL and SST

<SST(t+0)*LHTFL(t+1)>

< LHTFL(t+0)*SST(t+1)>



Relationship between the intraseasonal LHTFL, SWR, and d(SST)/d(t)

$<\mathrm{LHTFL}^{*}\ \ \partial(\mathrm{SST})/\partial(t)>$

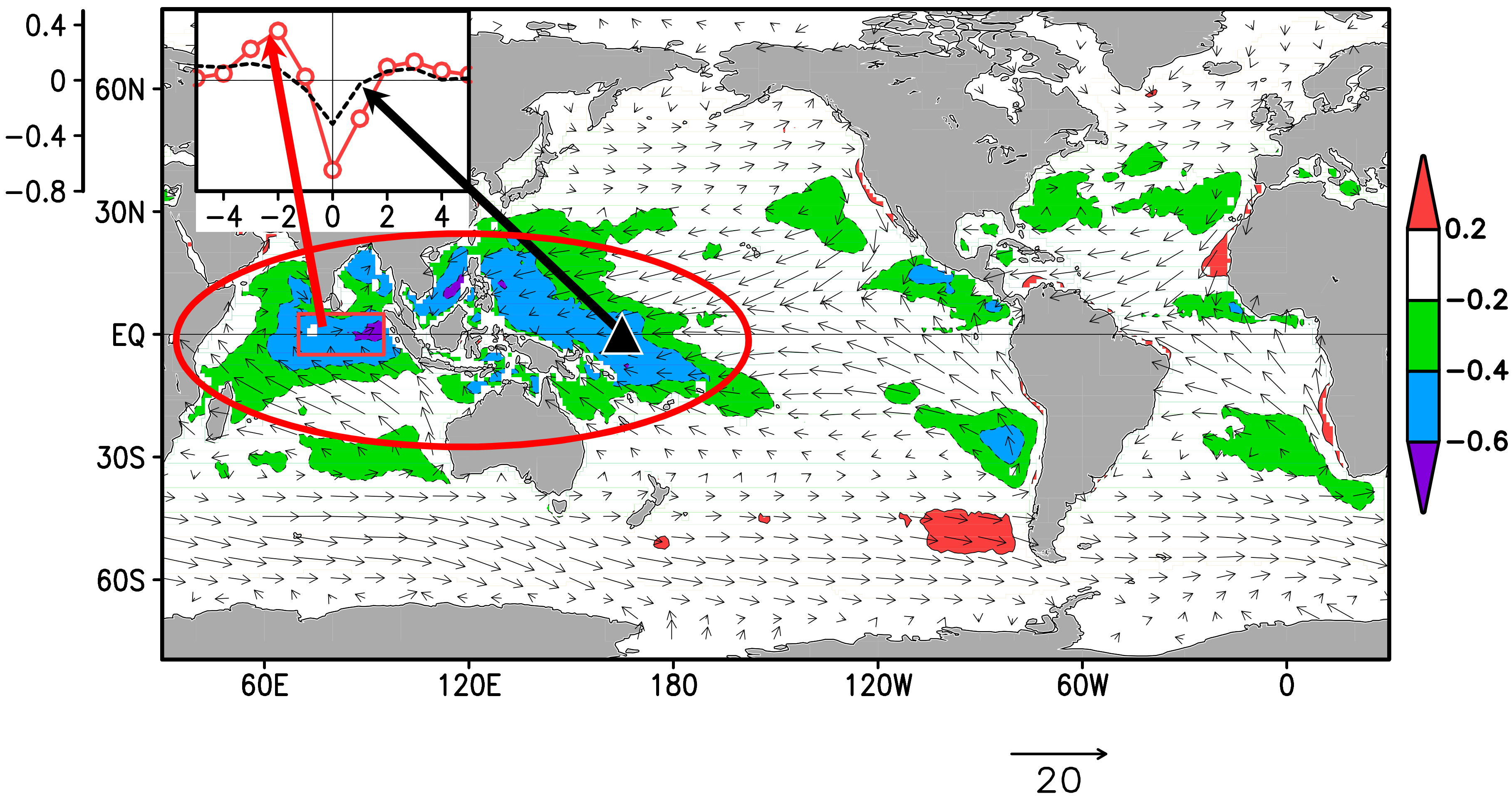
$<(-\mathrm{SWR})^{*}\ \ \partial(\mathrm{SST})/\partial(t)>$

$<(\mathrm{LHTFL}-\mathrm{SWR})^{*}\ \ \partial(\mathrm{SST})/\partial(t)>$

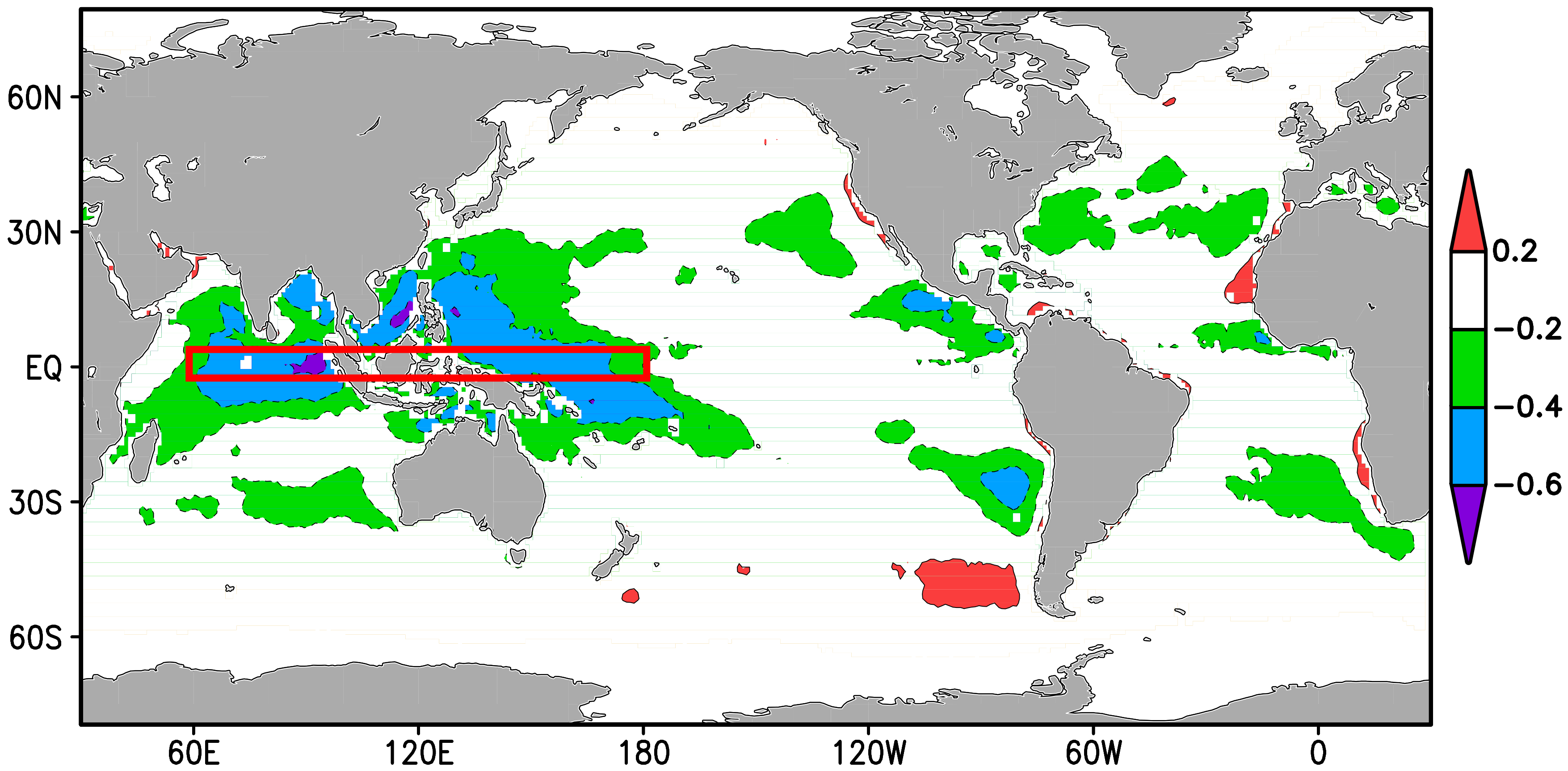
LHTFL>0 upward

SWR>0 downward

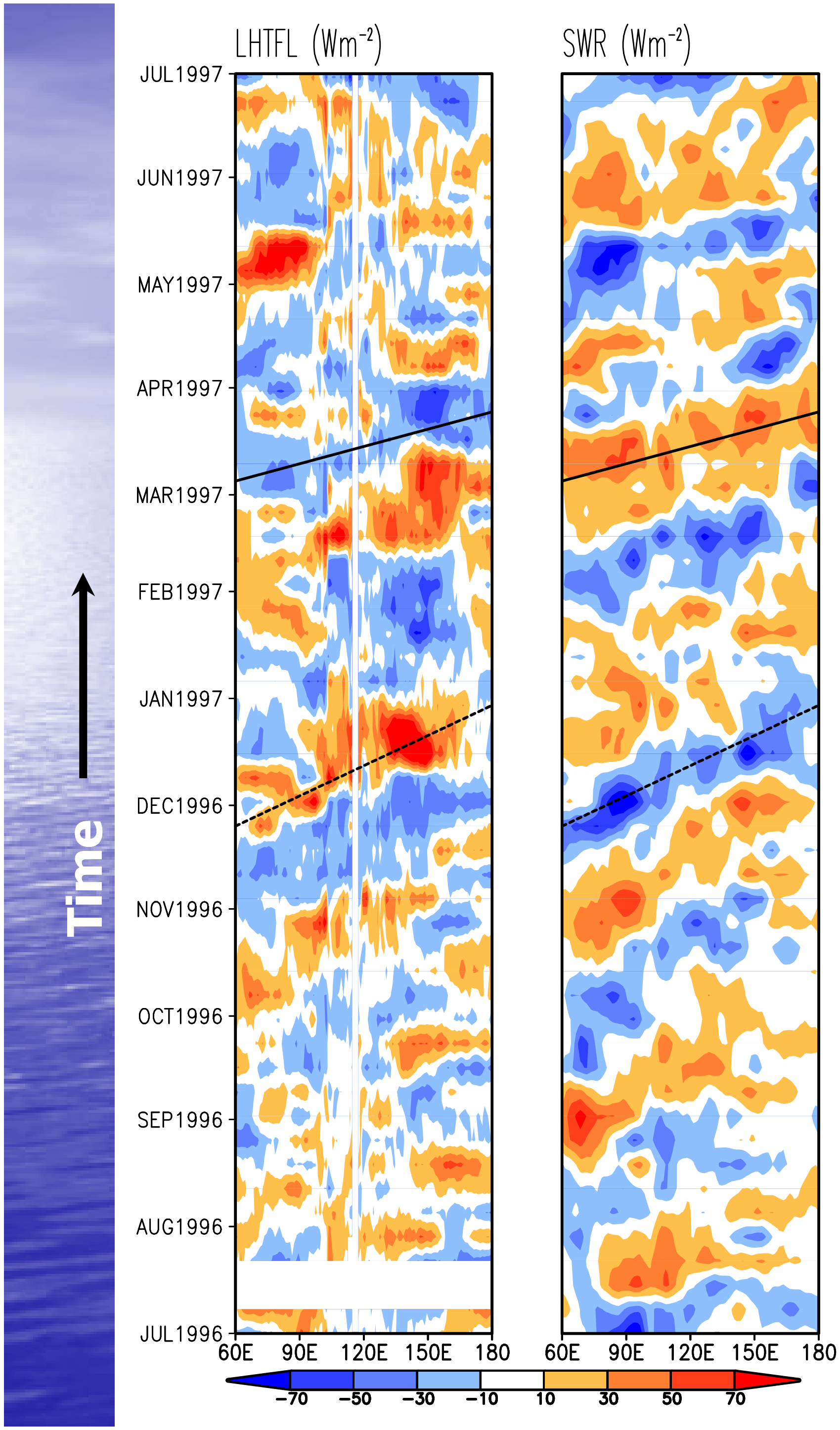
Instantaneous (spatial map) and lagged correlations between the intraseasonal LHTFL and SWR



Intraseasonal LHTFL and SWR in the Indian Ocean and western tropical Pacific



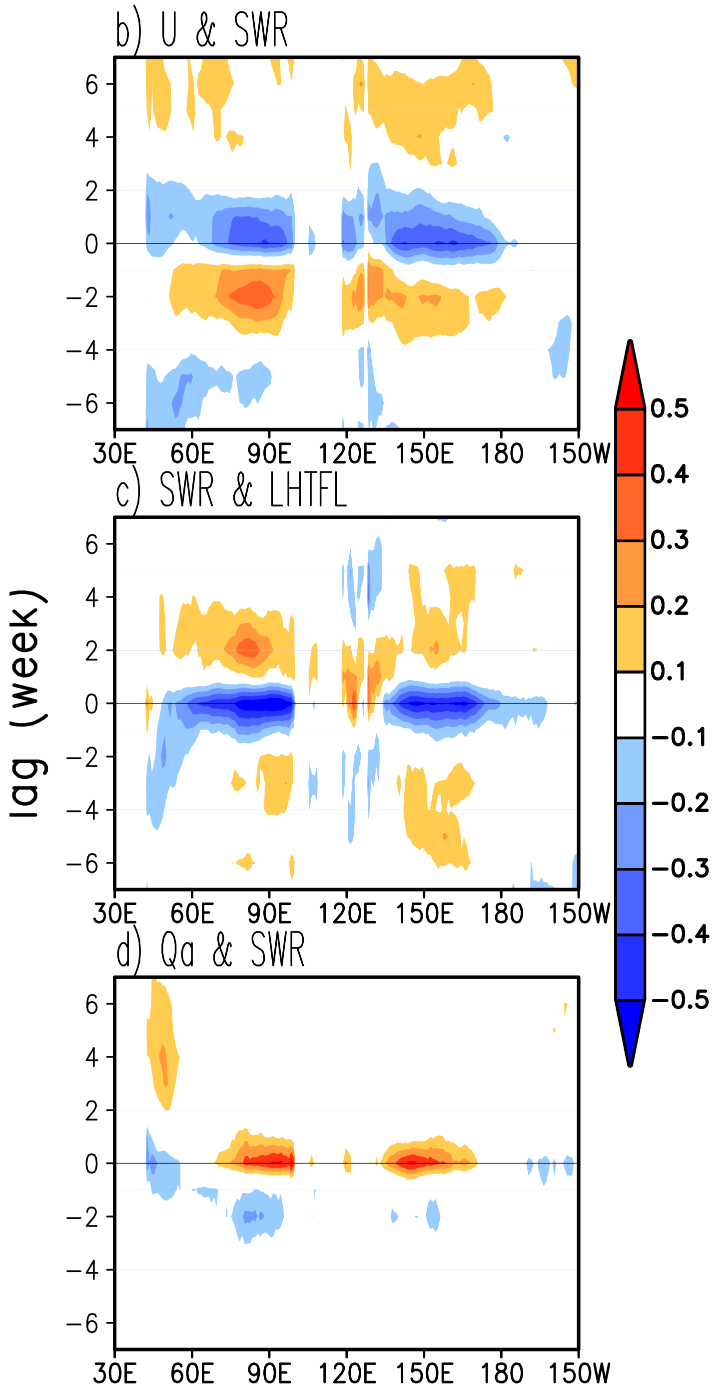
Intraseasonal LHTFL and SWR in the Indian Ocean and western tropical Pacific



7.5 m/s

4.5 m/s

Time-longitude diagram along the equator



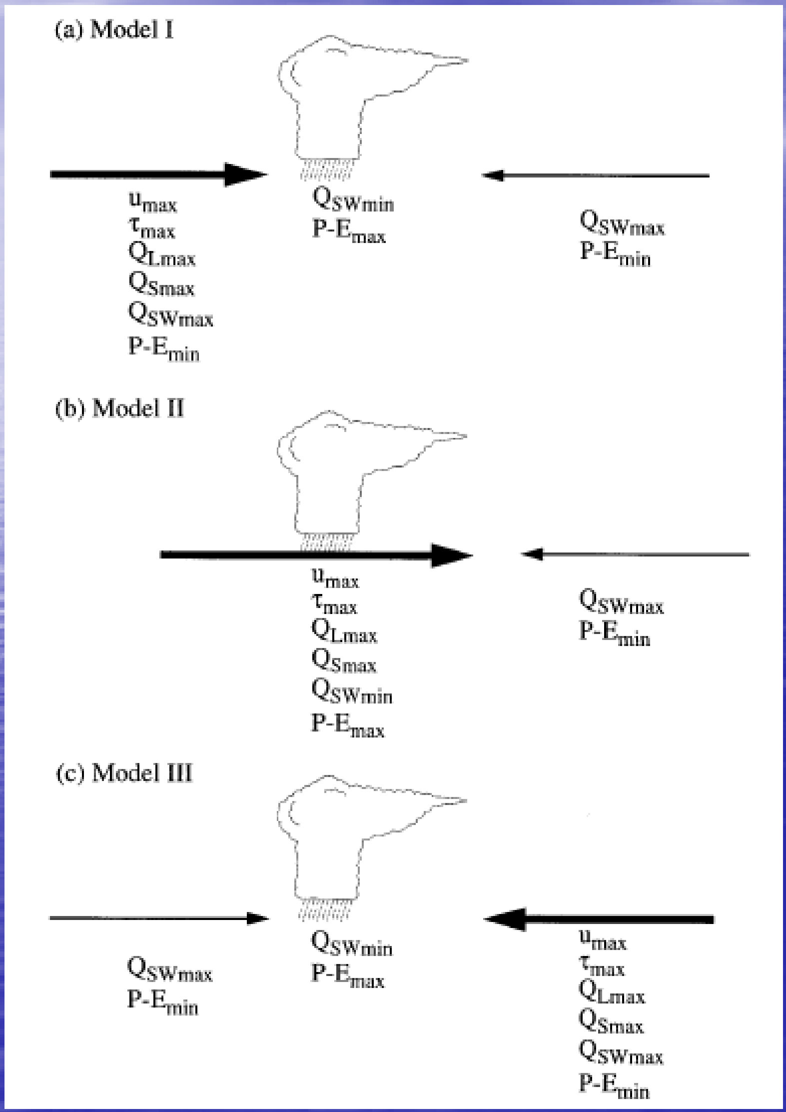
Lagged correlations

SWR leads zonal wind (U) by 1 week

LHTFL amplifies just below convective clusters

Humidity (Qa) drops below convective clusters

Different MJO models predict different phase relationships among components of atmospheric surface forcing.



Cloud symbols represent large-scale convective centers. Horizontal arrows denote surface zonal wind directions with thicker arrows representing stronger wind speed.

Other symbols are: *u* for surface zonal wind, σ for wind stress, Q_L for latent heat flux, Q_S for sensible heat flux, Q_{SW} for solar radiation flux, and *P - E* for net freshwater flux.

Zhang, C., and M.J. McPhaden, 2000: Intraseasonal Surface Cooling in the Equatorial Western Pacific. *J. Climate*, **13**, 2261–2276.

Summary

New release of satellite-based weekly LHTFL (1992-2007) compares well with tropical buoy data (TAO/TRITON, PIRATA, RAMA).

Although the major portion of the intraseasonal variability of LHTFL is accounted for by winds, neither components (wind, air humidity, or sea surface humidity) dominates the variability globally.

The strongest variability of the intraseasonal LHTFL (~50 Wm^{-2}) occurs at middle latitudes where the regional maxima are linked to areas of major SST fronts.

Significant intraseasonal variability of LHTFL (~ 20 to 30 Wm^{-2}) due to MJO is observed in the tropical Indian and Pacific Oceans. West of the dateline the intraseasonal LHTFL and SWR vary out-of-phase, i.e. evaporation enhances just below the convective clusters. East of the dateline both, intraseasonal LHTFL and SWR, are weak and their relationship is not significant.

Over much of the global ocean anomalous LHTFL provides negative feedback on the underlying intraseasonal SST anomaly, although there are considerable geographical variations. The feedback exceeds 20 $Wm^{-2}/^{o}C$ in the regions around 20^{o} S and 20^{o} N, but decreases at high latitudes and in the eastern tropical Pacific and Atlantic where the time average LHTFL is weak.