

Seasonal and Interannual Variability of Turbulent Fluxes over the Atlantic Tropical Ocean

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- **New Release (2009) of momentum latent and sensible heat fluxes derived only from satellite data.**
- **Accuracy Assessment: Analysis of the Spatial and Temporal Patterns**

Surface Flux Determination from Satellite Data : Bulk Aerodynamic Method

Wind stress $\tau = (\tau_x, \tau_y) = \rho C_D \bar{U} (u, v)$

Latent heat flux $Q_{latent} = -l \rho C_E \bar{U} (q_a - q_s)$

Sensible heat flux $Q_{sens} = -\rho C_p C_h \bar{U} (T_a - T_s)$

➤ U, u, v, q_a, q_s, T_a, T_s : **Satellite data**

Flux Method Description

➤ Wind :

– Scatterometer : $\rightarrow \sigma^\circ = F(U, \chi, \theta, f_c, P, \dots)$ (ERS-1/2)

$\downarrow \uparrow$ *Intercomparisons* (Bentamy et al, 2002)



\rightarrow L2B (NSCAT; QuikSCAT)

– Radiometer: $\rightarrow U = F(T_B, WV)$ (SSM/I F10 – F15) (Bentamy et al, 1999)

➤ Specific Air Humidity :

– Radiometer: $\rightarrow Qa = F(T_B)$ (SSM/I F10 – F15) (Bentamy et al, 2003)

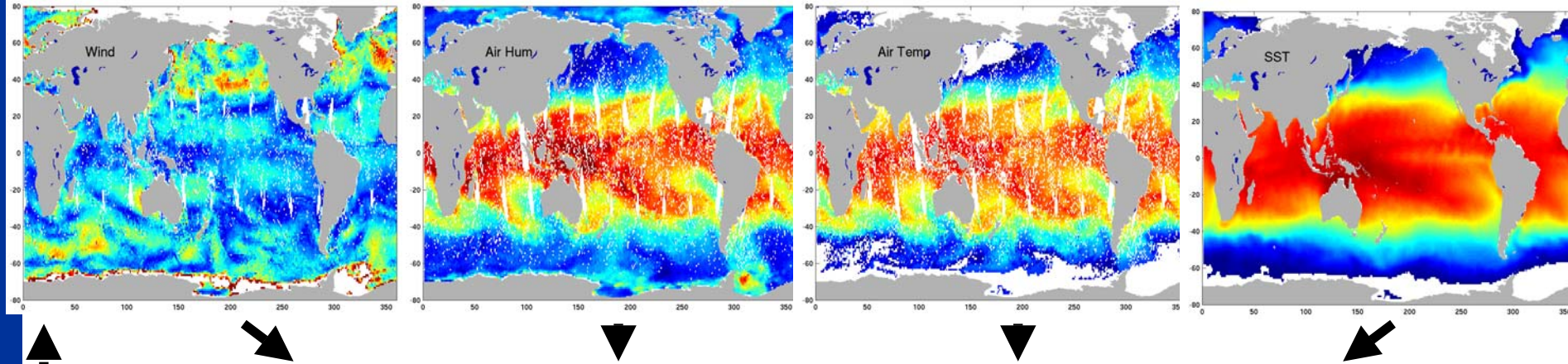
➤ HR SST (<http://www.ncdc.noaa.gov/oa/climate/research/sst/griddata.php>)

➤ Air Temperature:

– Radiometer & Scatterometer: $\rightarrow Ta = F(T_B, U, Qa, SST)$ (Konda et al, 2003; Ayina et al, 2007)

Flux Calculation Procedure : Averaged Fluxes www.ifremer.fr

(Bentamy *et al*, 2007)



Bulk Parametrisation(Coare3: Fairall *et al*, 2003)
 Daily Wind Stress, Latent and Sensible Heat Fluxes Estimations

Objective Method

1°x1° Weekly and Monthly Averaged Fluxes (L4 products)
 Γ : Spatial and Temporal Structure Function for each Variable.

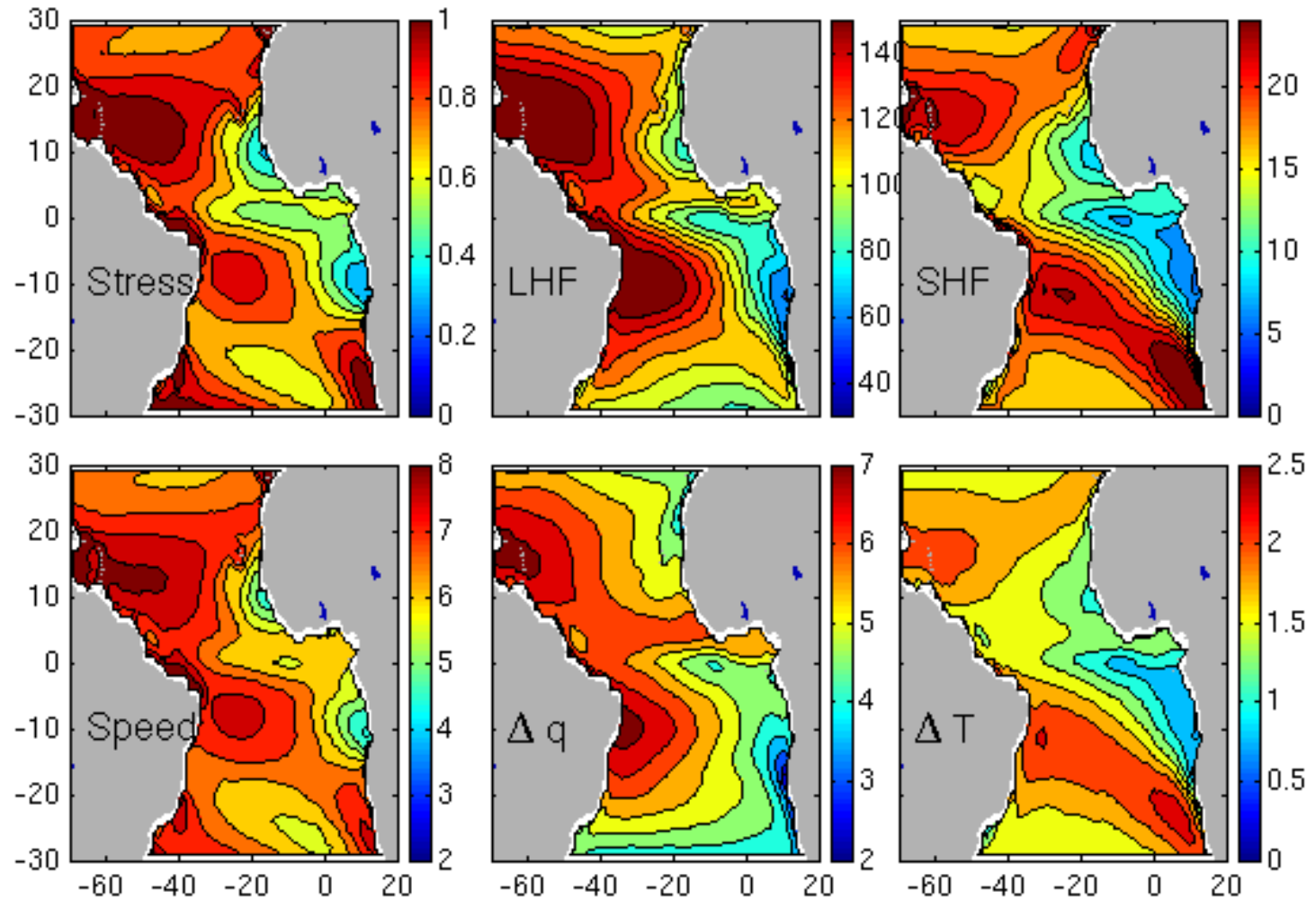
$$\tilde{U} = \sum_i \lambda_i V_i \quad \sum_{i=1}^N \lambda_i = 1$$

$$\sum_{i=1}^N \lambda_i \Gamma(i, j) + \Gamma(j, 0) - \tau + \lambda_j \sigma^2 = 0$$

$$E((\hat{U} - U)^2) = \Gamma(0, 0) + \tau + \sum_{i=1}^N \lambda_i \Gamma(i, 0)$$

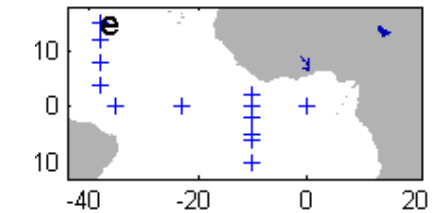
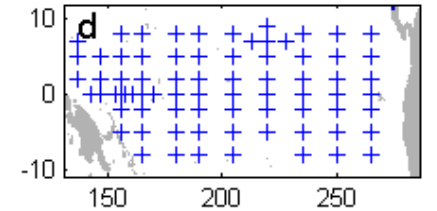
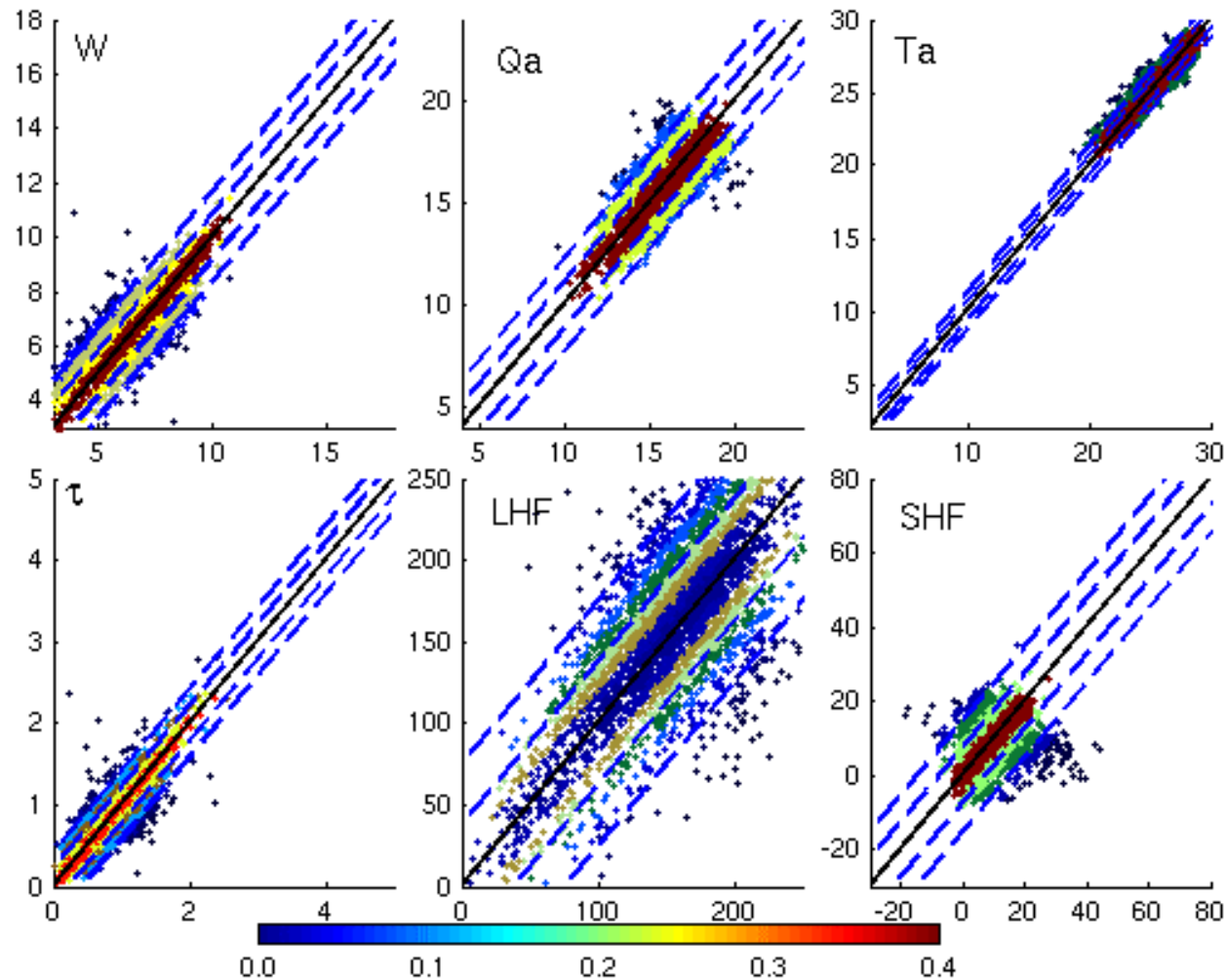
Quality Control / Validation

Satellite Turbulent Fluxes : 1992 - 2008

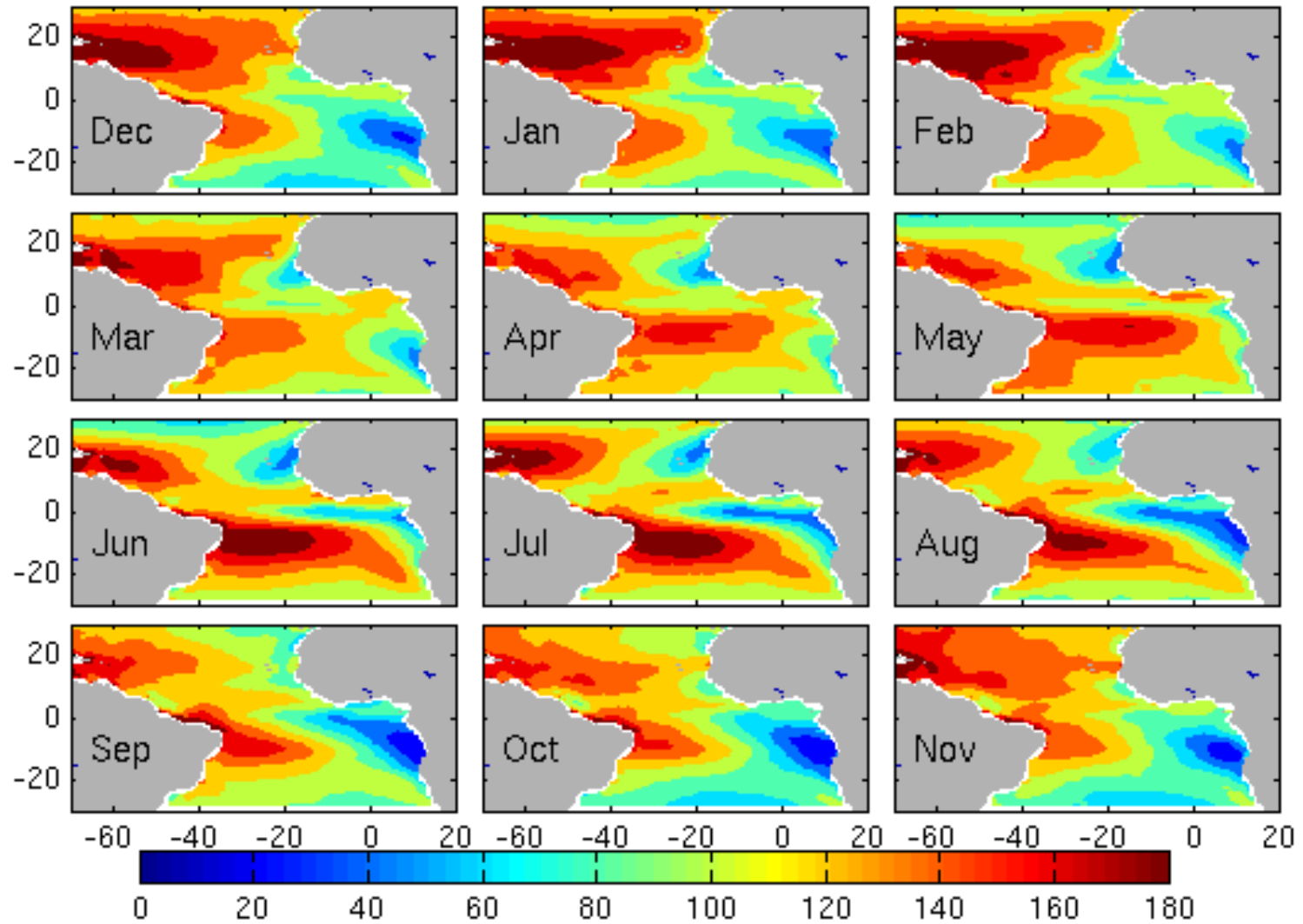


Weekly Flux Evaluation

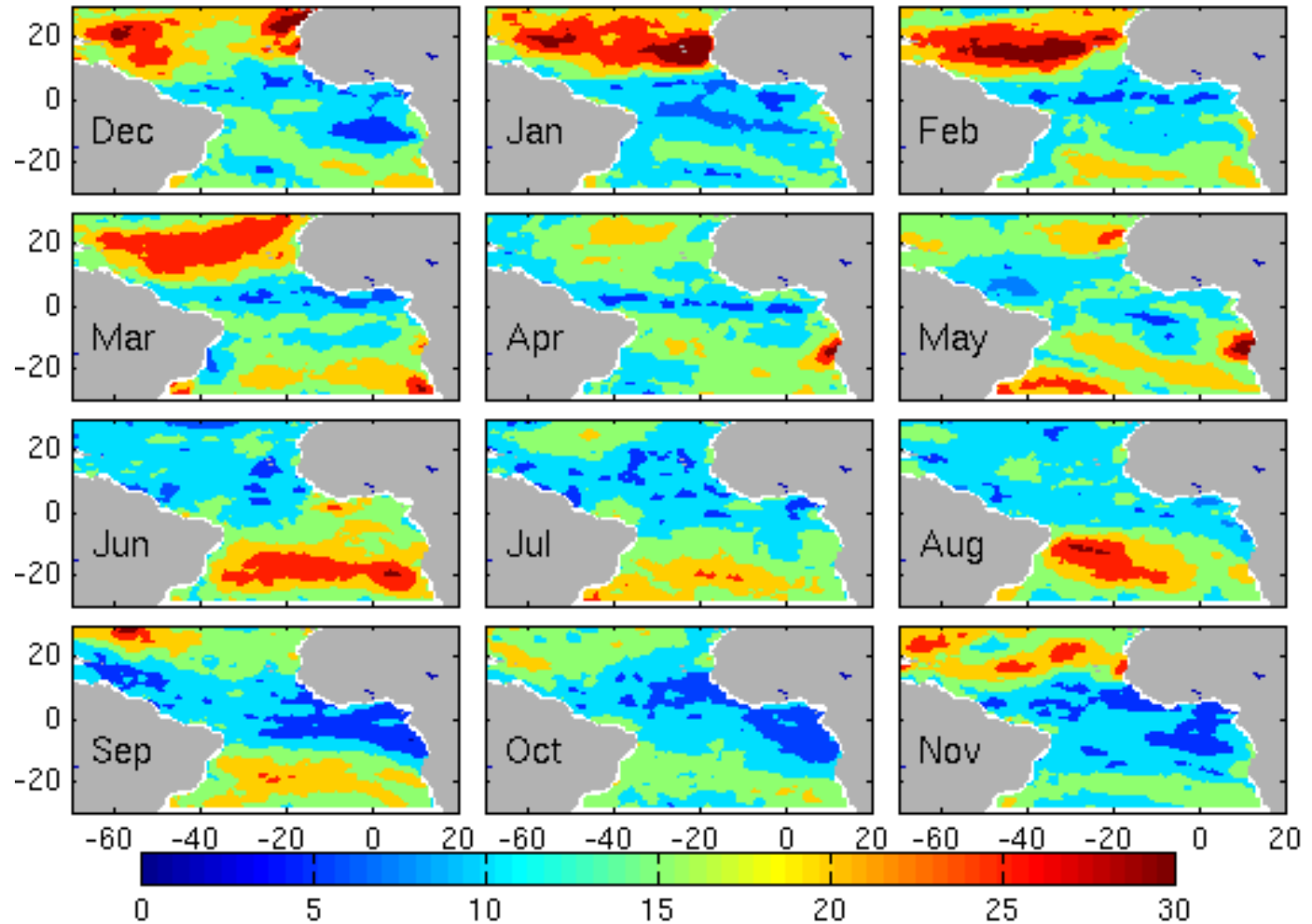
TAO PIRATA Buoy / Satellite Comparisons



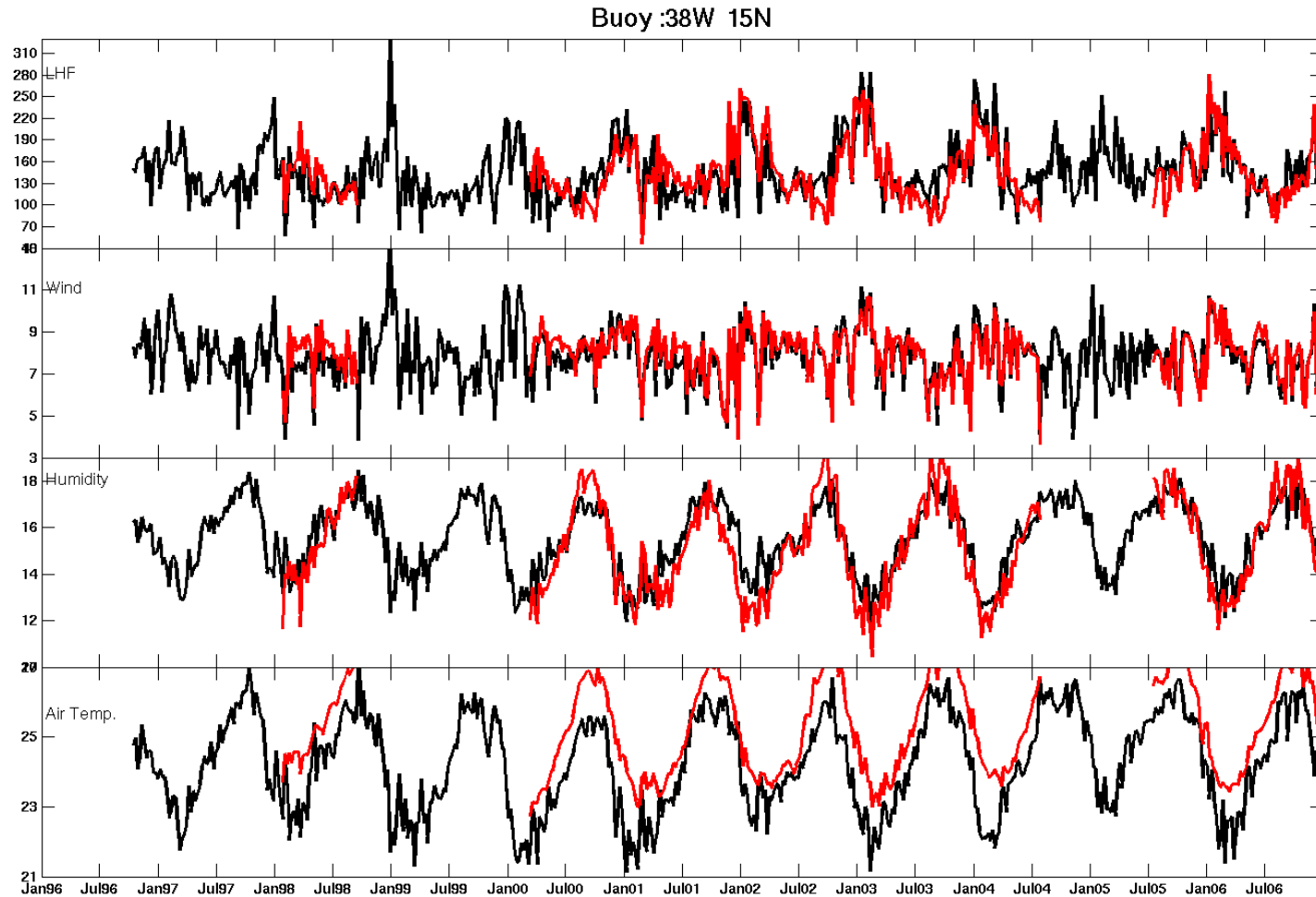
Monthly Mean of Latent Heat Flux: 1992 - 2008



Variability (Std) of Latent Heat Flux



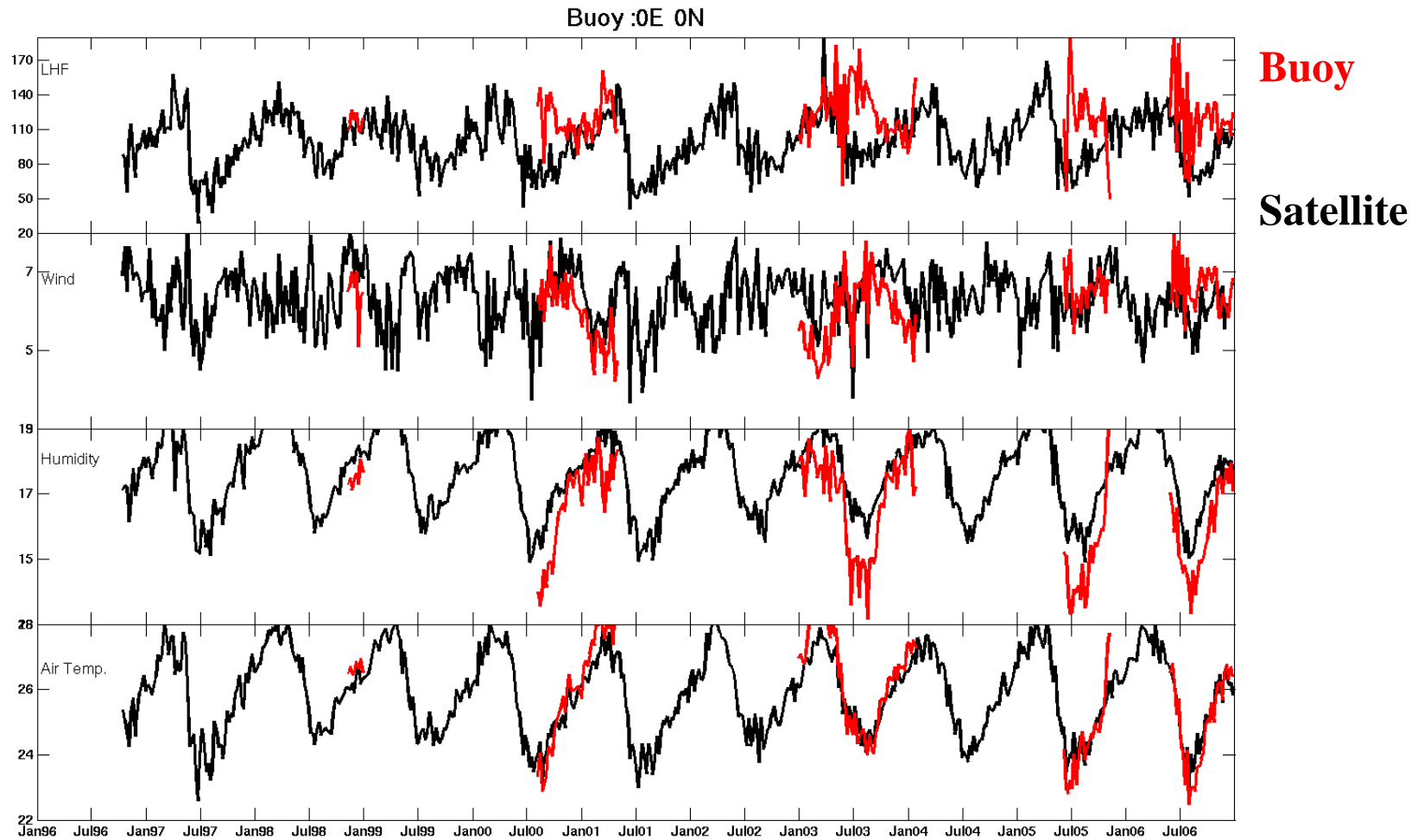
Time Series of Latent Heat Flux and of Bulk Variables



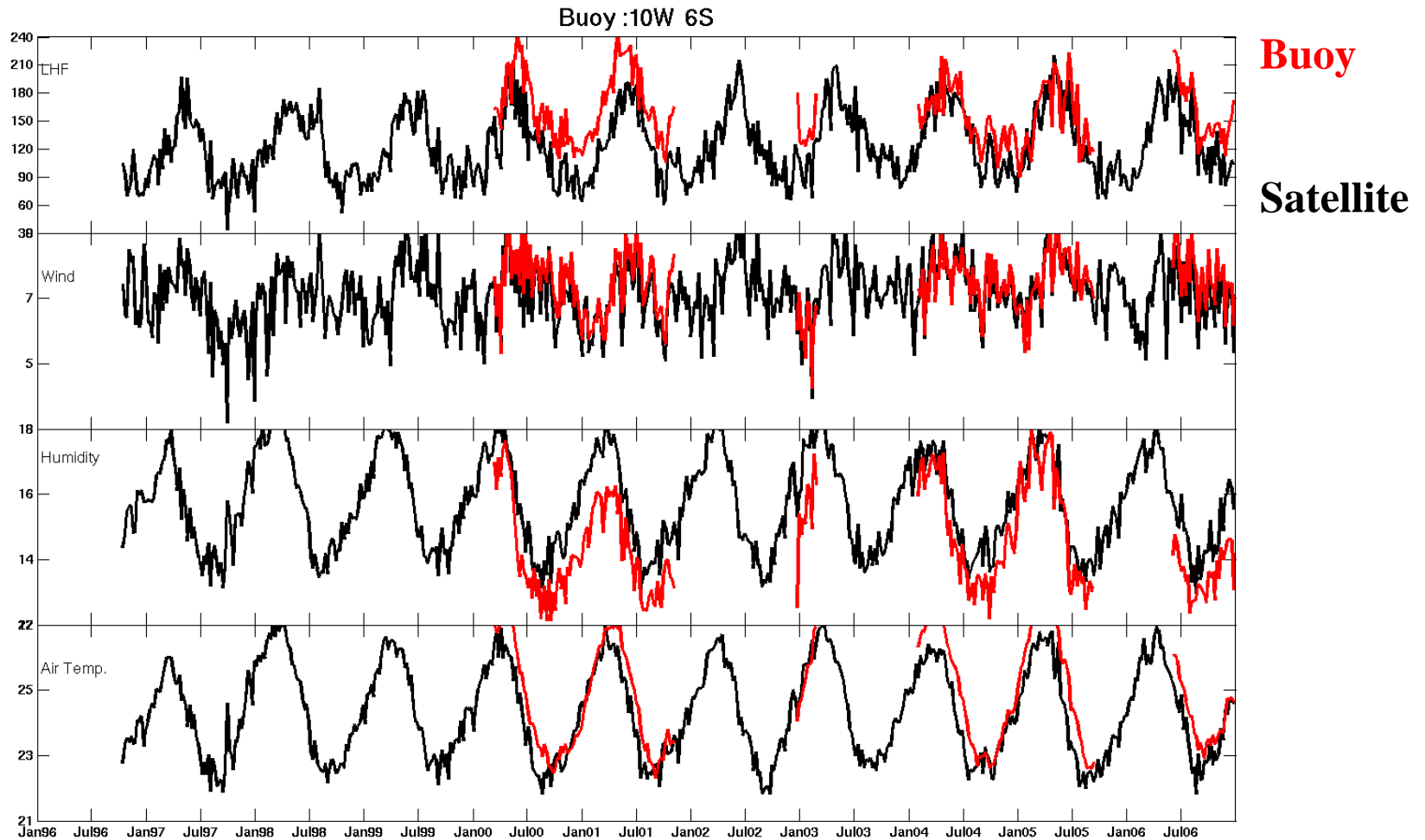
Buoy

Satellite

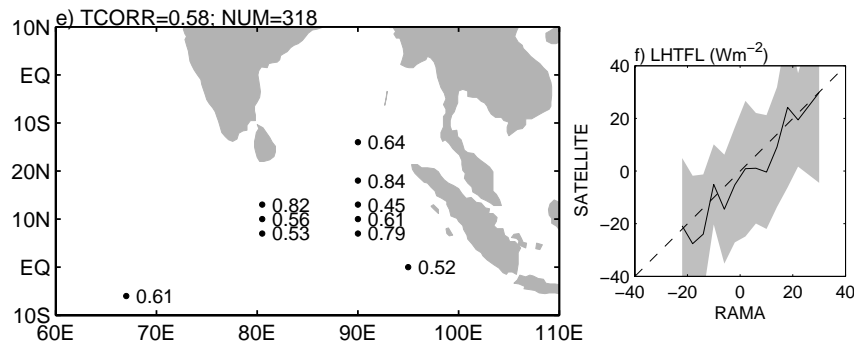
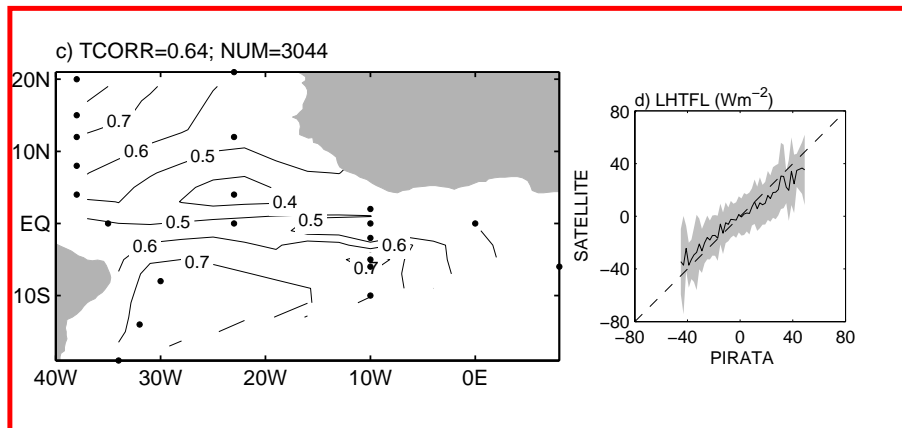
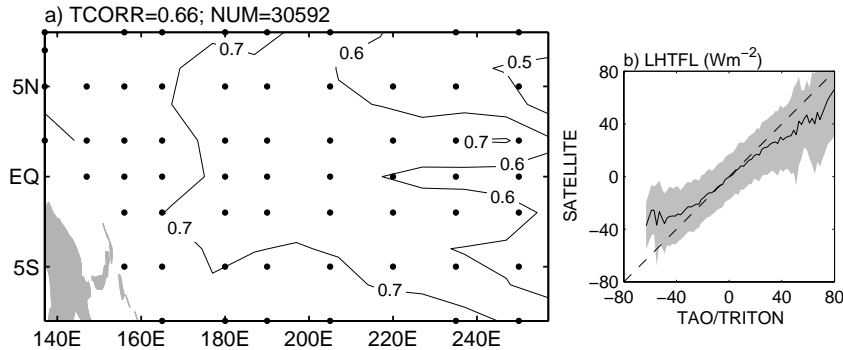
Time Series of Latent Heat Flux and of Bulk Variables



Time Series of Latent Heat Flux and of Bulk Variables



Intraseasonal LHTFL validation against the tropical ocean moorings (Grotsky et al, 2009)

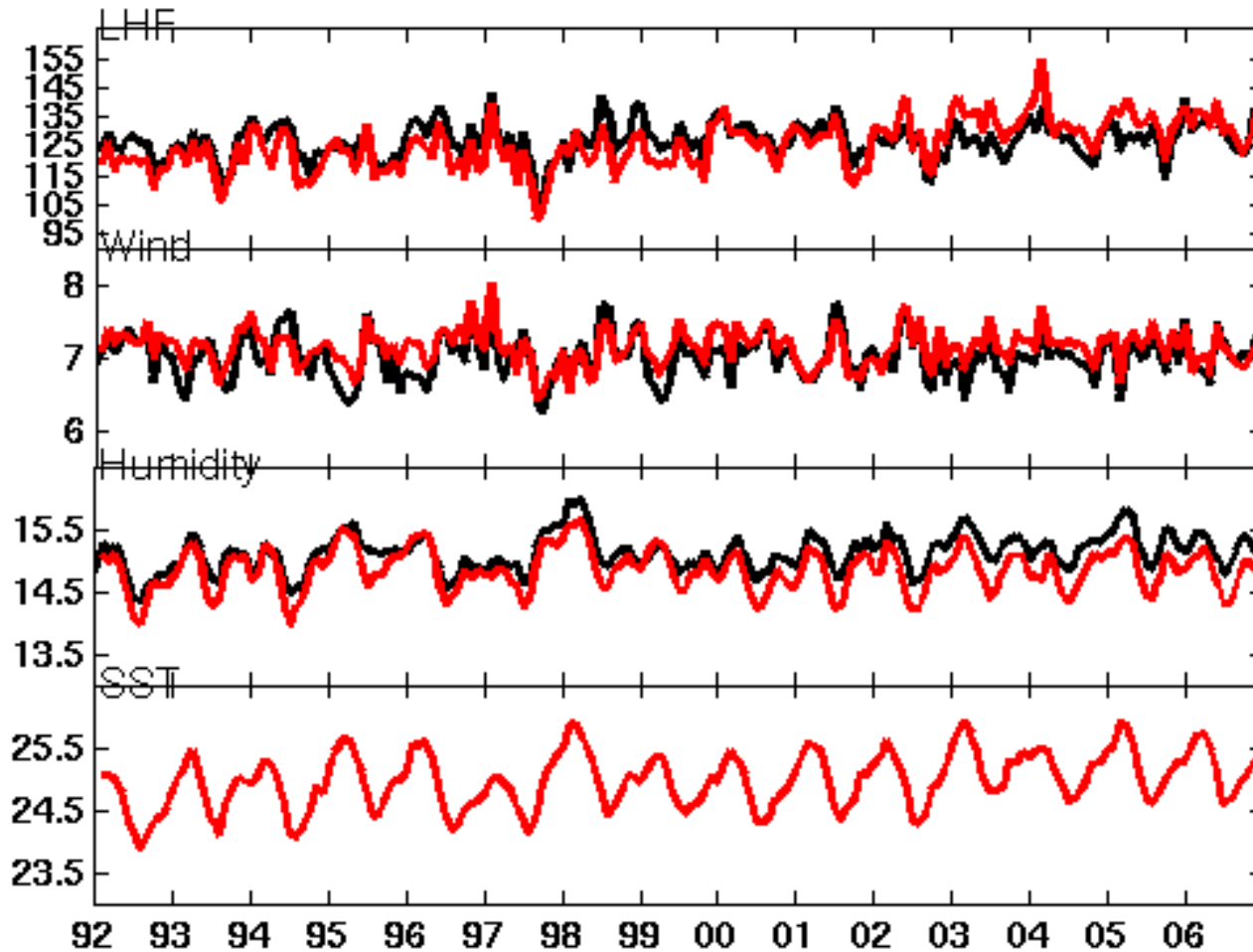


Satellite and buoy intraseasonal LHTFL are in good correspondence. But satellite LHTFL underestimates magnitudes of 'strong' events. Are some strong events missing by twice-a-day observations?

Time correlation (TCORR) of satellite and buoy intraseasonal LHTFL is well above the 99% confidence level. But TCORR is weaker in the ITCZ region.

Time Series of Monthly-Averaged LHF and Bulk Variables Inter-Tropical Atlantic Ocean

30S - 30N / 70W - 20E

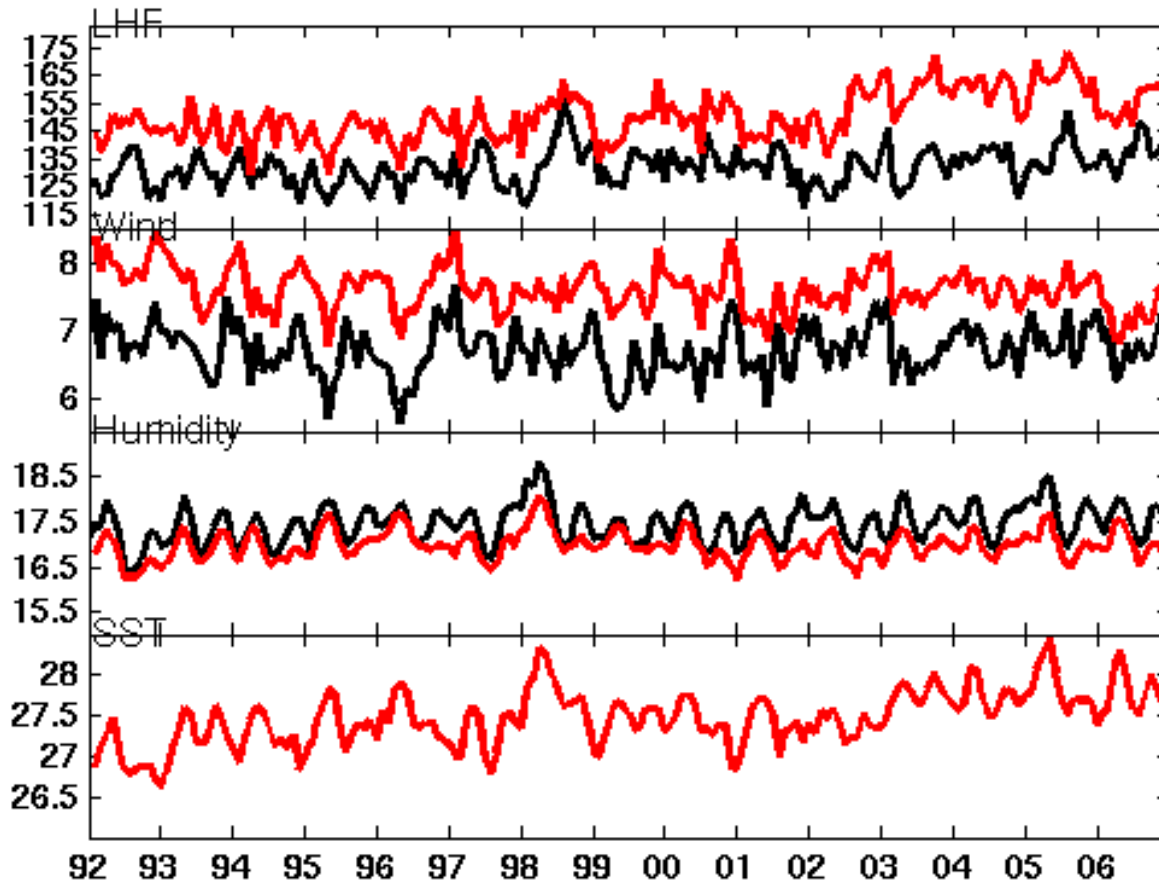


Satellite

Era Interim

Time Series of Monthly-Averaged LHF and Bulk Variables Western Equatorial Atlantic Basin

10S - 10N / 70W - 20W



Satellite
Era Interim

Using Available
PIRATA Buoys (6)

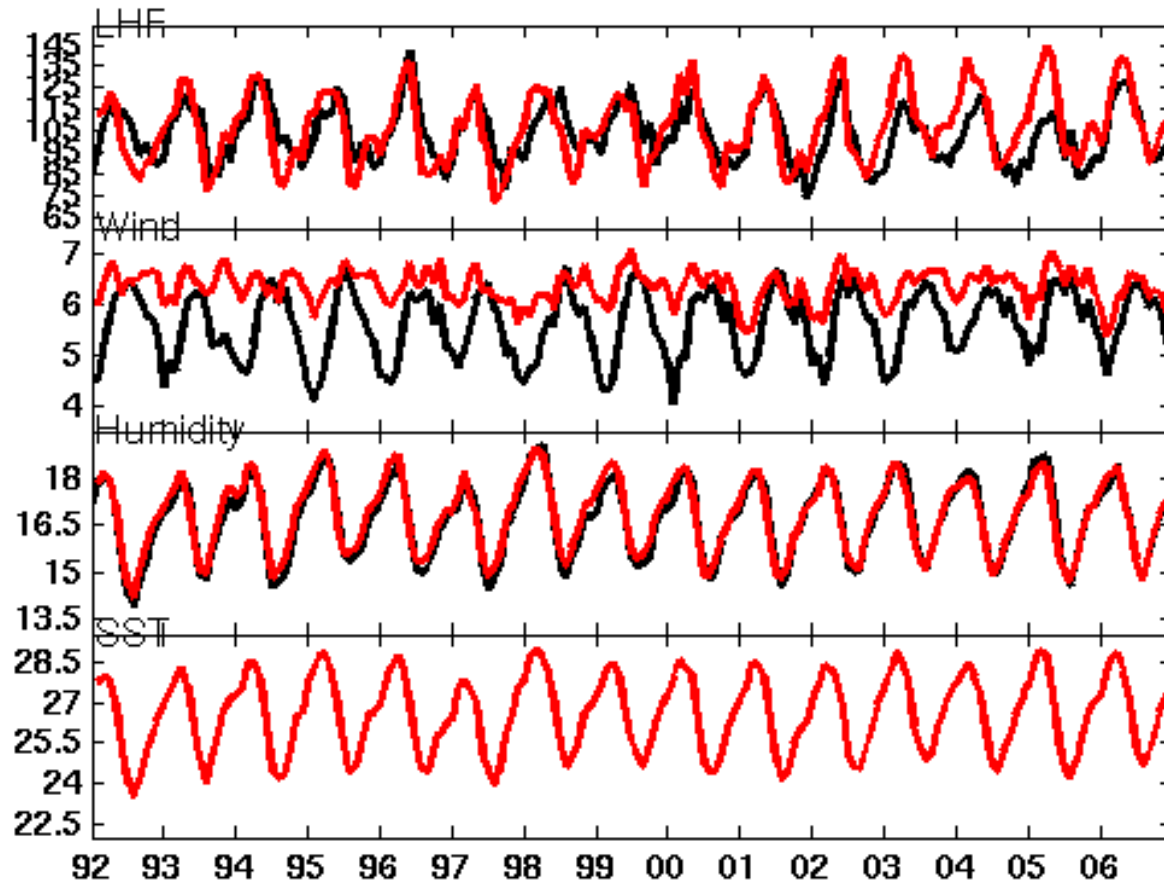
	Buoy/ Satellite	Buoy/ ERA Interim
Bias	-0.16	0.34
Std	0.82	0.43
Corr	0.88	0.96

Summary / Perspectives

- **17 years of satellite fluxes are available**
<ftp://ftp.ifremer.fr/ifremer/cersat/products/gridded/flux-merged/flux/data/>
- **Resolutions : Weekly : Monthly / Climatology; 1°**
- **Satellite and buoy flux estimates compare well**
 - Wind Stress and LHF Bias : $0.5 \cdot 10^{-2} \text{N/m}^2$ and 7.0W/m^2
 - rms : $1.5 \cdot 10^{-2} \text{N/m}^2$ and 29W/m^2 .
- **Tropical Satellite and buoy fluxes exhibit similar time features**
- **Discrepancies suggest:**
 - Better Q_a and T_a estimations
 - Consistency between retrievals : Scatterometers; Radiometers
 - Impact of SST (AVHRR / AMSR)
- **Re-analysis of satellite fluxes since 1992 (earlier?)**
- **Using New data : exp. METOP/ASCAT ; AMSR-E**

Time Series of Monthly-Averaged LHF and Bulk Variables Eastern Equatorial Atlantic Basin

10S - 10N / 20W - 20E



Satellite

Era Interim