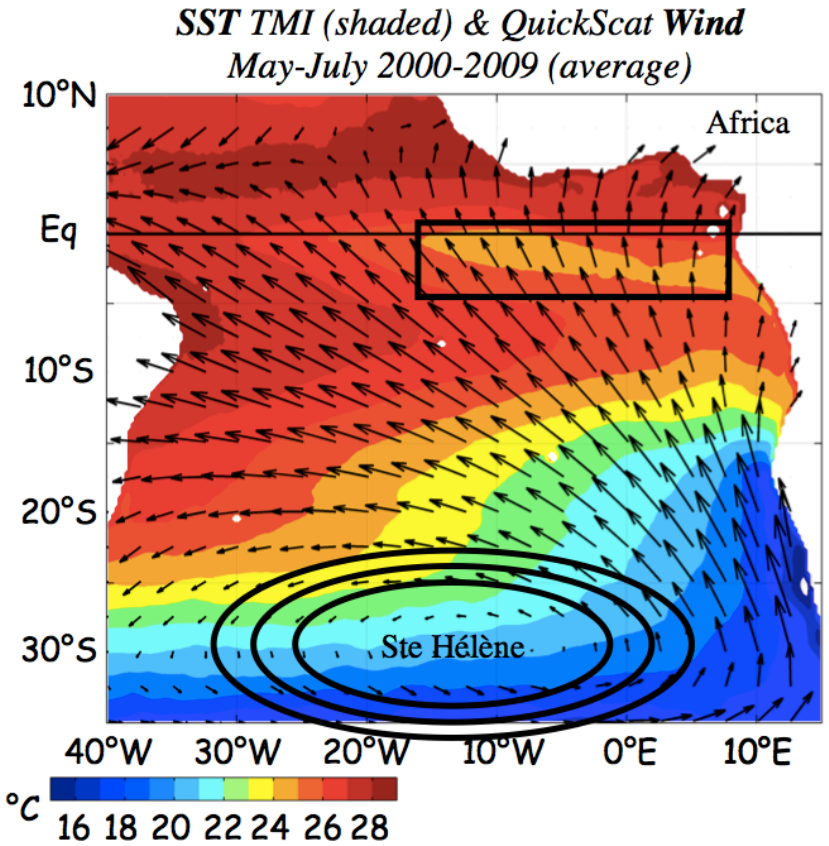
Impact of the air-sea coupling in the Gulf of Guinea on the water cycle in boreal spring

R. **Meynadier**, G. De Coetlogon, L. Eymard, M. Leduc-Leballeur, S. Bastin, S. Janicot, O. Bock and C. Flamant



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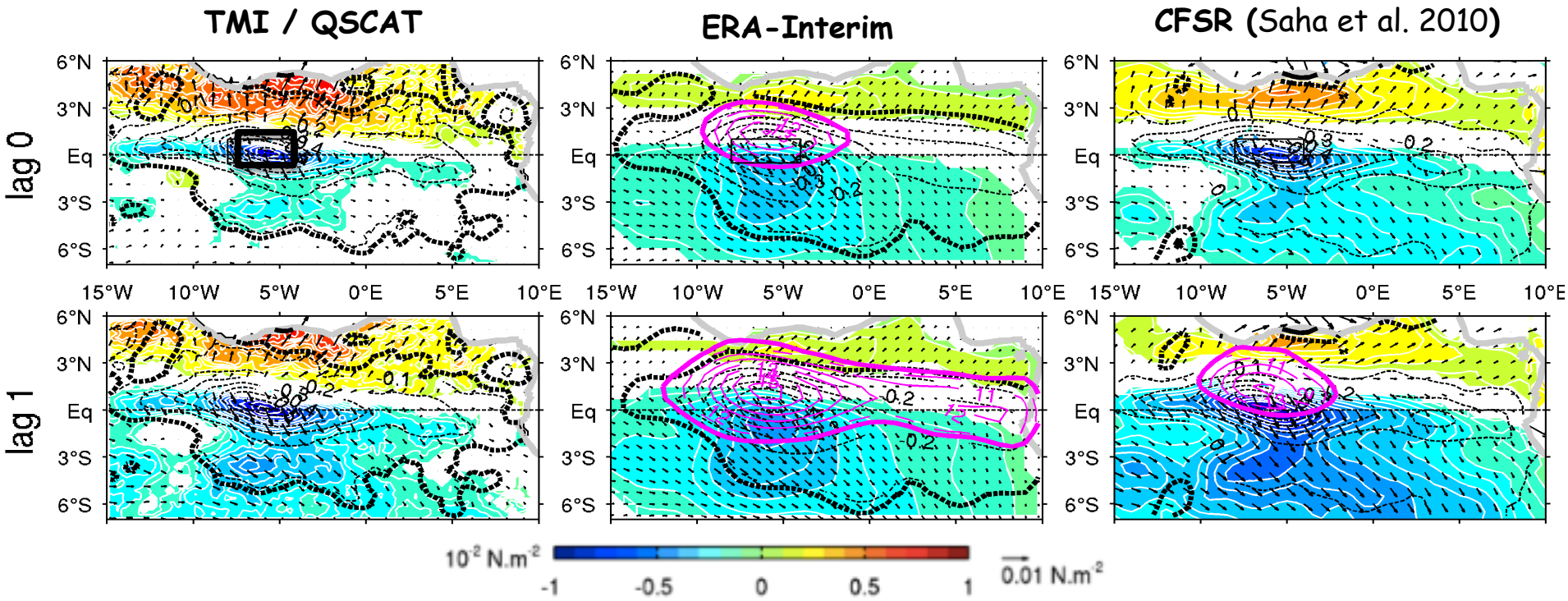
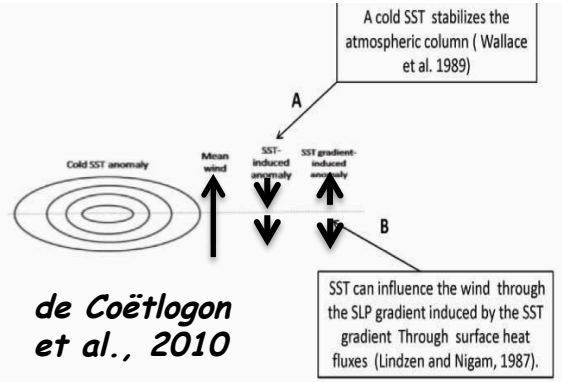
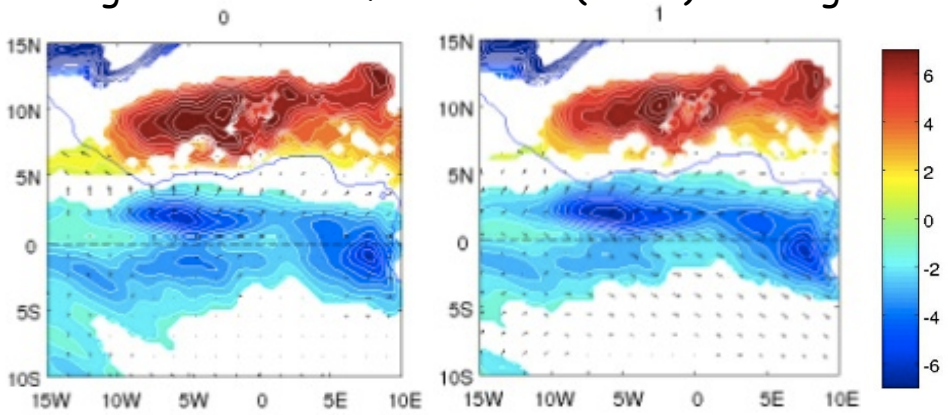
Ocean-Atmosphere Coupling in the Gulf of Guinea (GG)

Daily Linear Regressions on SST – index between May and June 2000-2009





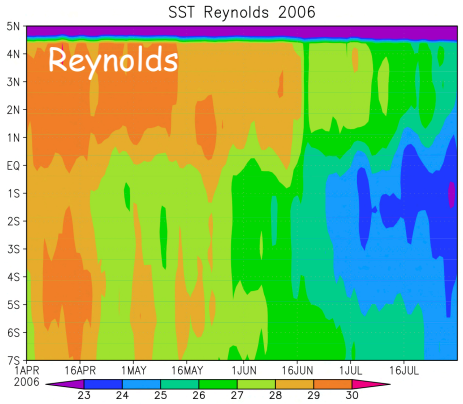
Regression on surface PWAT (CFSR) x10^{-2} kg.m^{-2}



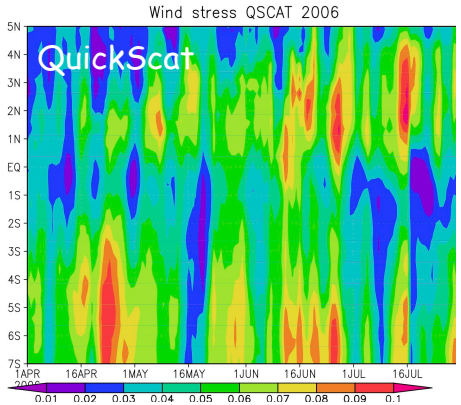
Impact of air-sea interaction on the water cycle seen by **satellite data** and **CFSR** reanalysis

Time-latitude diagram averaged between 10°W and 0°E for April-July 2006

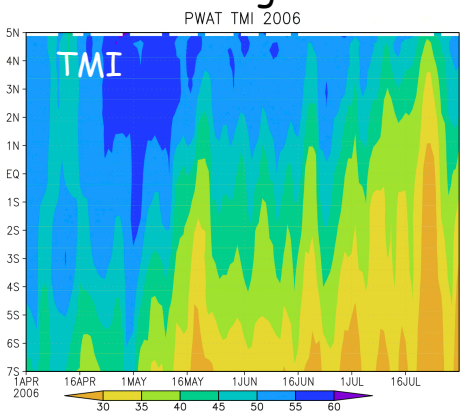
SST °C



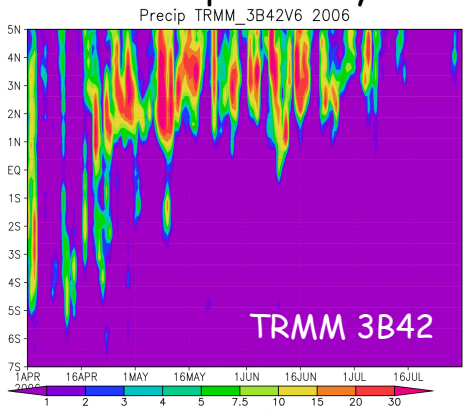
TAUY $N.m^{-2}$

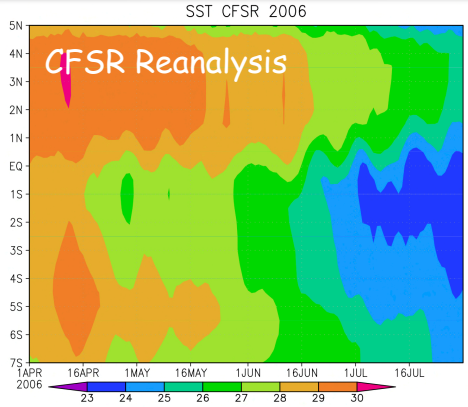


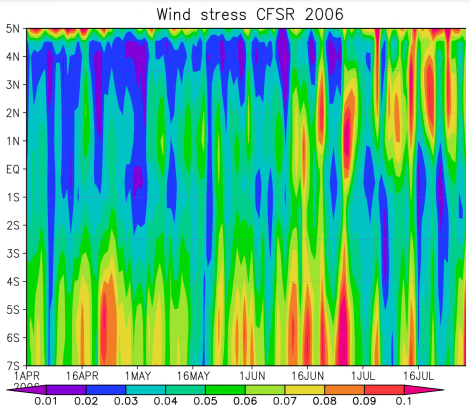
PWAT $kg.m^{-2}$

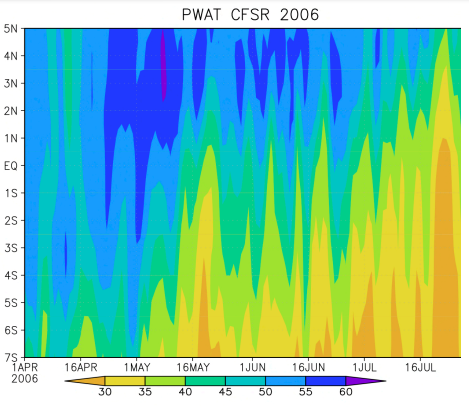


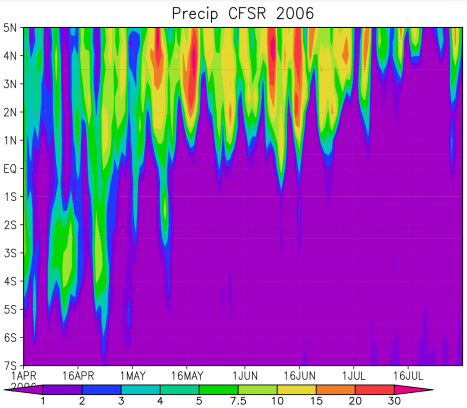
Precip mm/day

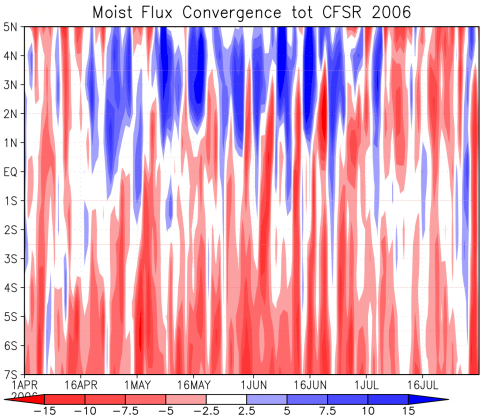


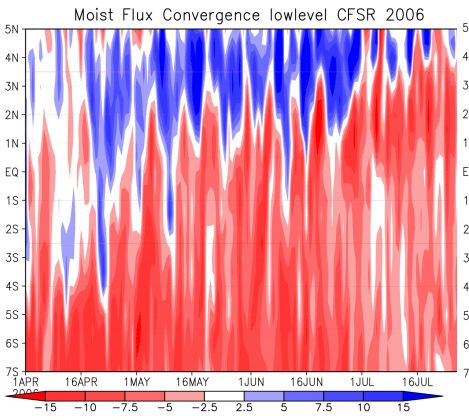


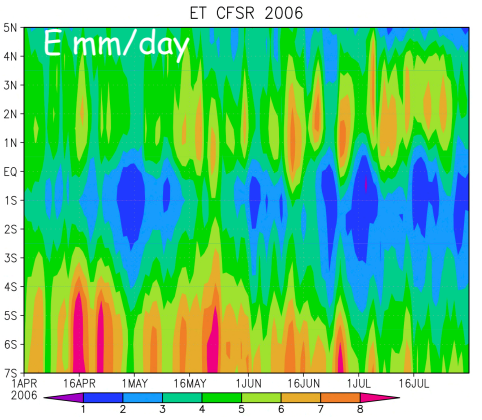






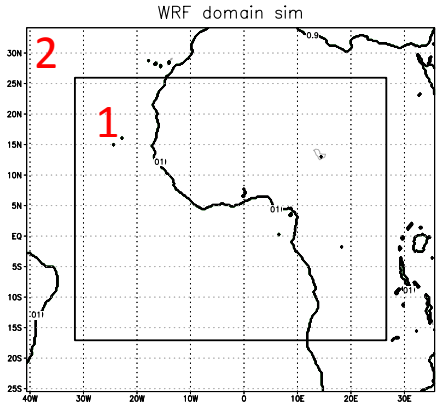






Moisture Flux Convergence mm/day

Study of air-sea interactions with WRF regional model and its impact on water cycle



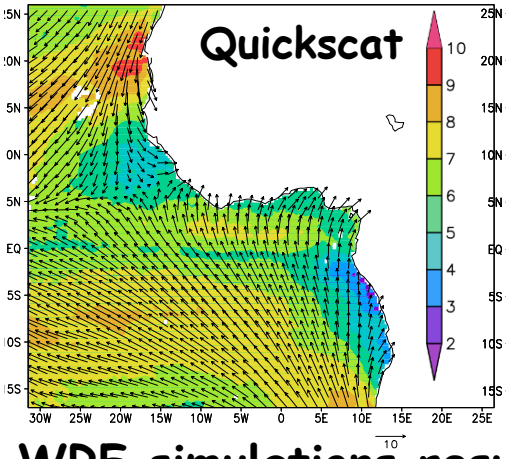
- WRF model description -

WRF-ARW Version 3.3.1 non-hydrostatic
15Avril-15July 2006 25kmx25km
35 vertical levels
ERA-Interim initial and lateral forcing (6h)
SST Reynolds forcing (24h)

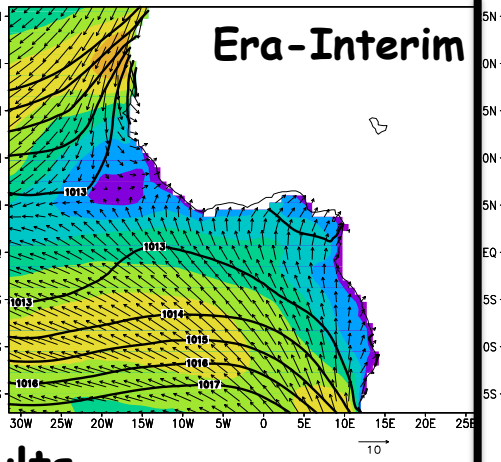
Convection	PBL	Radiation	Microphysics	Surface layer	Land surface	SST forcing	domain
Kain-Fritsch **(KF)**	Yonsei Universite **(YSU)**	RRTM / **Dudhia**	Morrison (2 moments)	Monin-Obukhov MO	NOAH	ERAI	1
KF	**YSU**	**Dudhia**	Morrison	MO	NOAH	ERAI	**2**
KF	**YSU**	**Dudhia**	Morrison	MO	NOAH	**Reynolds**	**1**
KF	**Mellor Yamada Janjic (MYJ)**	**Dudhia**	Morrison	MO	NOAH	**Reynolds**	**1**
KF	**(MYJ)**	**RTTMG**	Morrison	MO	NOAH	**Reynolds**	**1**
KF (moisture advection trigger)	**Mellor Yamada Janjic (MYJ)**	**Dudhia**	Morrison	MO	NOAH	**Reynolds**	**1**
Grell 3-D (GR3D)	Mellor Yamada Janjic**(MYJ)**	**Dudhia**	Morrison	MO	NOAH	**Reynolds**	**1**

Surface wind speed (m.s^{-1}) and SLP May-June 2006

QSCAT MJ 2006

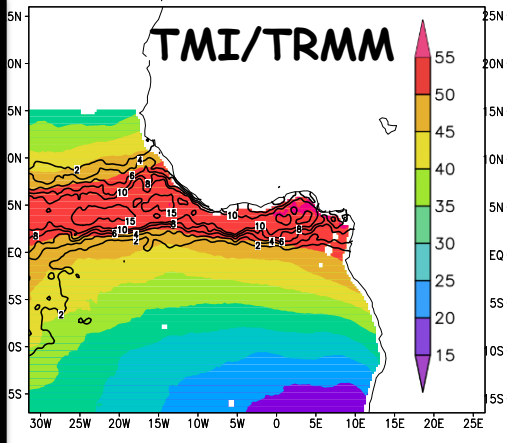


ERAI MJ 2006

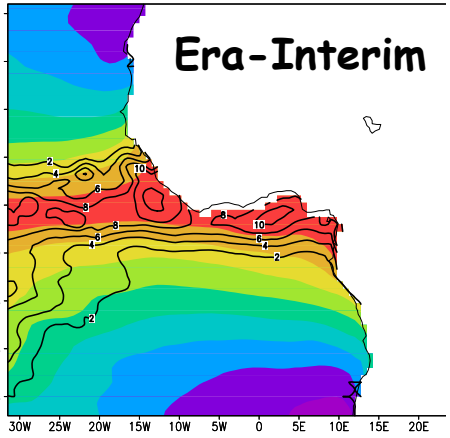


PWAT (mm) and Precip (mm/d) May-June 2006

TMI / TRMM 3B42V6 MJ2006

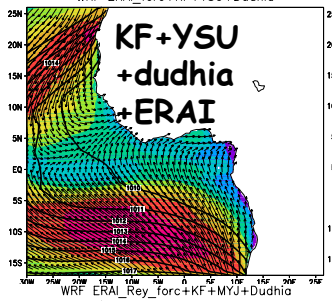


ERAI MJ2006

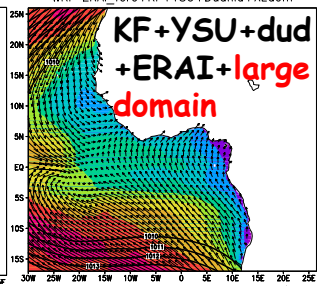


WRF simulations results

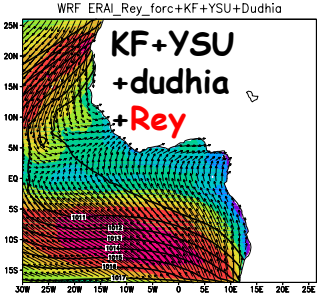
WRF ERAI_forc+KF+YSU+Dudhia



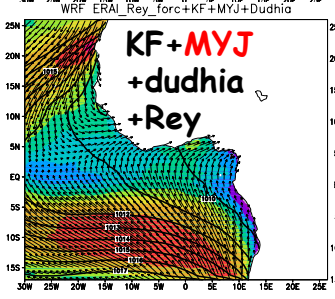
WRF ERAI_forc+KF+YSU+Dudhia+XLdom



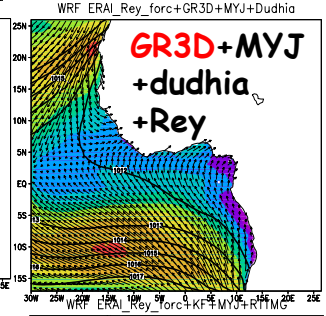
WRF ERAI_Rey_forc+KF+YSU+Dudhia



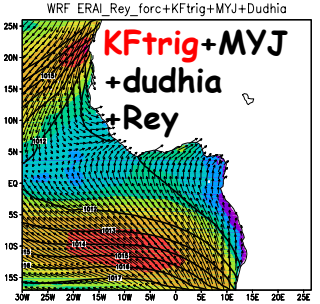
WRF ERAI_Rey_forc+KF+MYJ+Dudhia



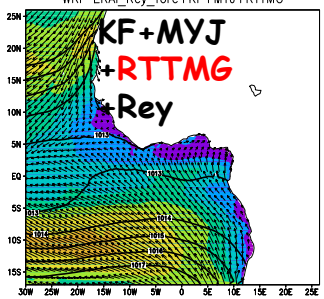
WRF ERAI_Rey_forc+GR3D+MYJ+Dudhia



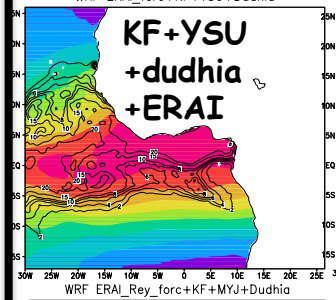
WRF ERAI_Rey_forc+KFtrig+MYJ+Dudhia



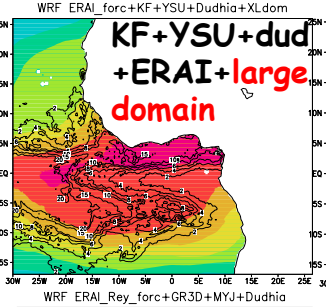
WRF ERAI_Rey_forc+KF+MYJ+RTTMG



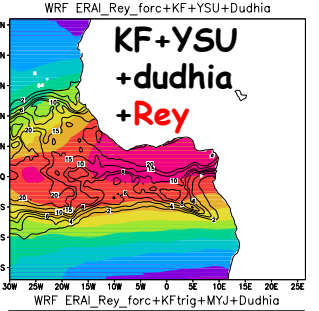
WRF ERAI_forc+KF+YSU+Dudhia



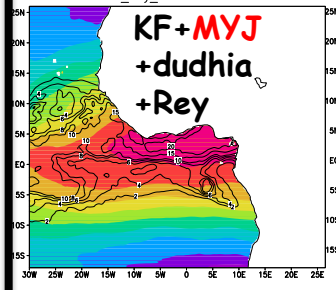
WRF ERAI_forc+KF+YSU+Dudhia+XLdom



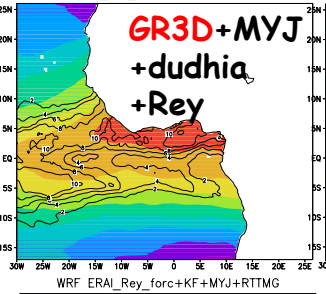
WRF ERAI_Rey_forc+KF+YSU+Dudhia



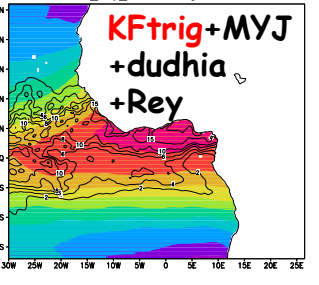
WRF ERAI_Rey_forc+KF+MYJ+Dudhia



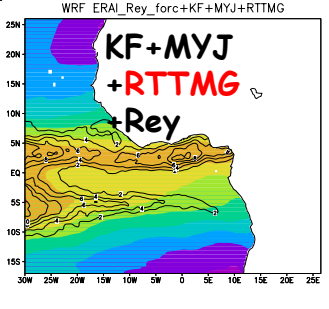
WRF ERAI_Rey_forc+GR3D+MYJ+Dudhia



WRF ERAI_Rey_forc+KFtrig+MYJ+Dudhia



WRF ERAI_Rey_forc+KF+MYJ+RTTMG

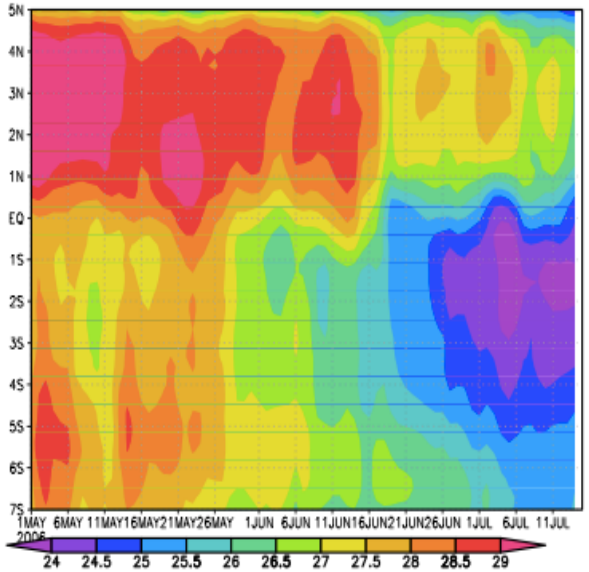


WRF simulations results at intra-seasonal scales and impact of air-sea interactions on water cycle

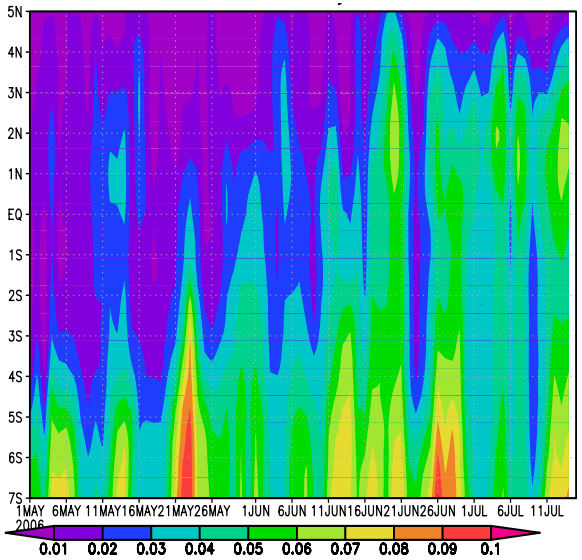
Time-latitude diagram averaged between 10°W and 0°E for May-July 2006

WRF [GR3D+MYJ+dudhia+Rey]

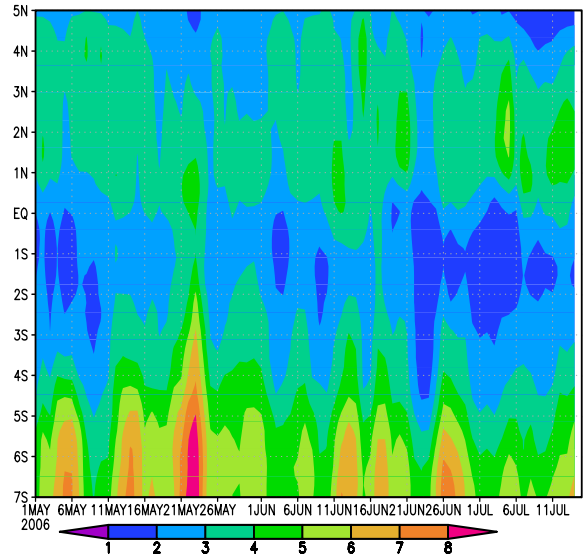
SST °C



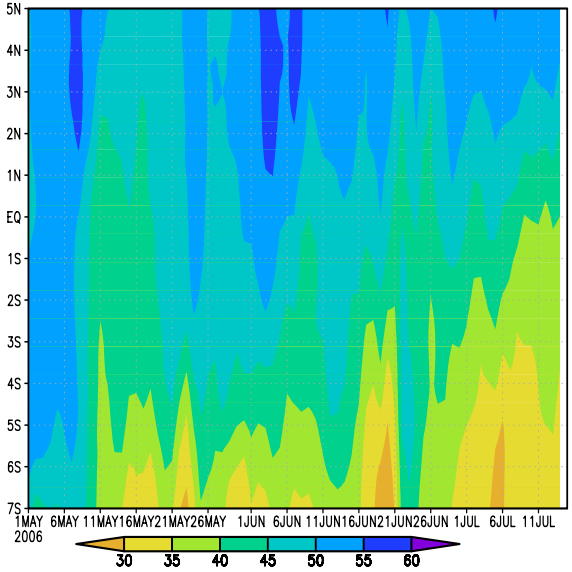
TAUY (N/m²)



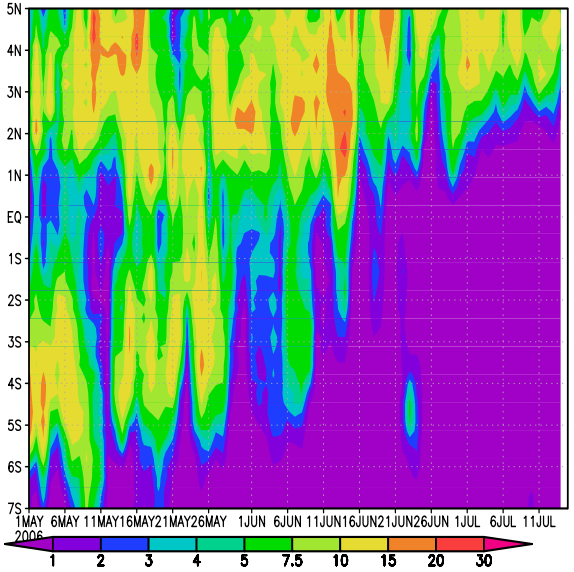
E (mm/d)



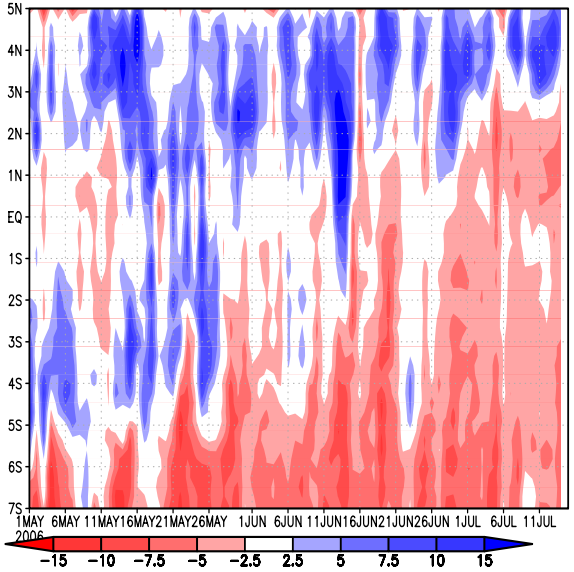
PWAT mm



Precip (mm/d)



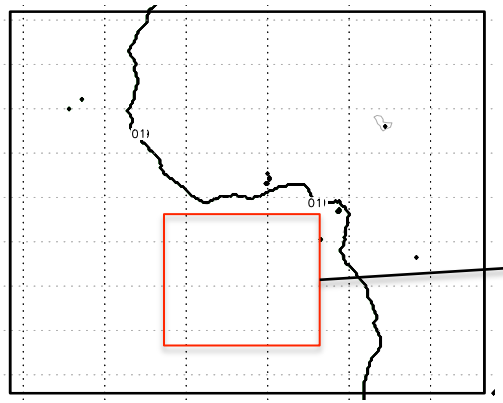
MConv (mm/d)



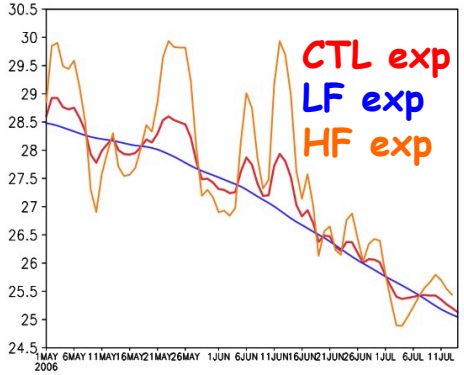
WRF experience design : quantify influence of SST fluctuations on the water cycle terms ?

SST filtered using a low-pass filter with a 1/90 day cut-off :

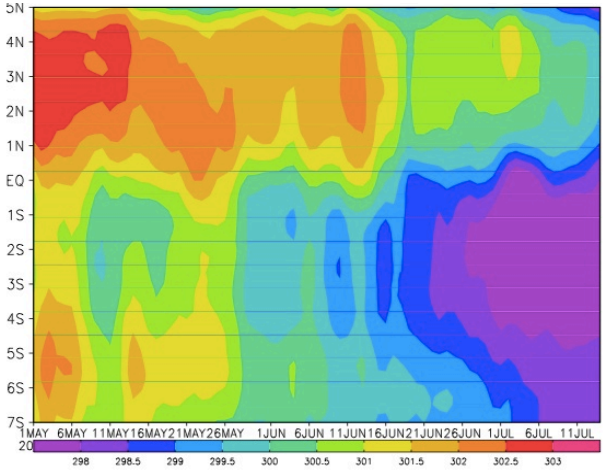
- to keep the seasonal cycle and remove intra-seasonal variability **LF exp**
- to keep the seasonal cycle and amplify (x3) intra-seasonal variability **HF exp**



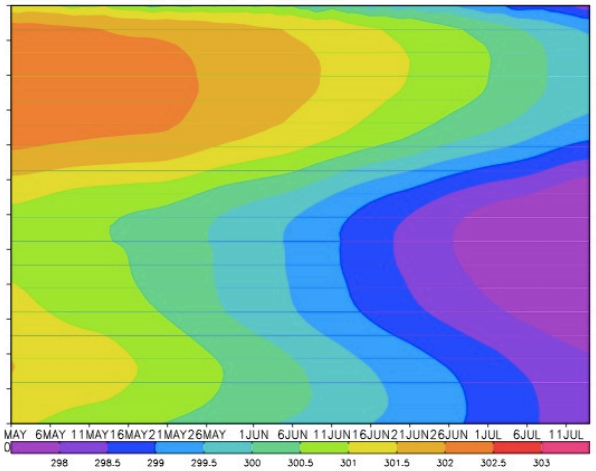
SST(°C)



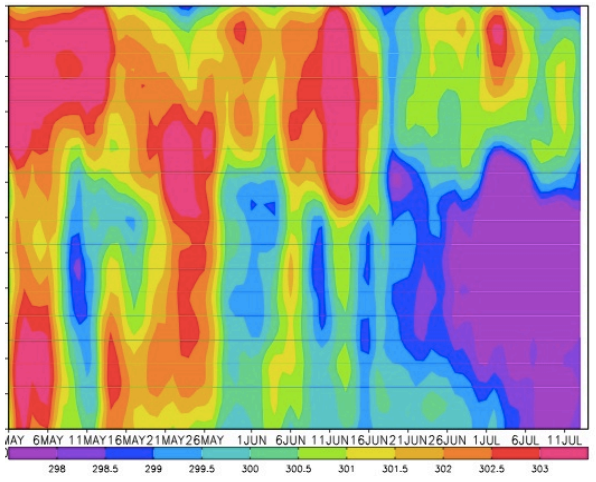
SST(°K) CTL exp

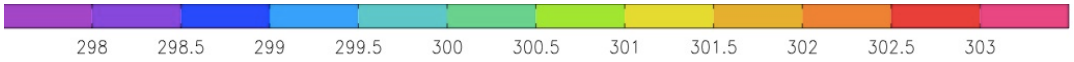


SST(°K) LF exp



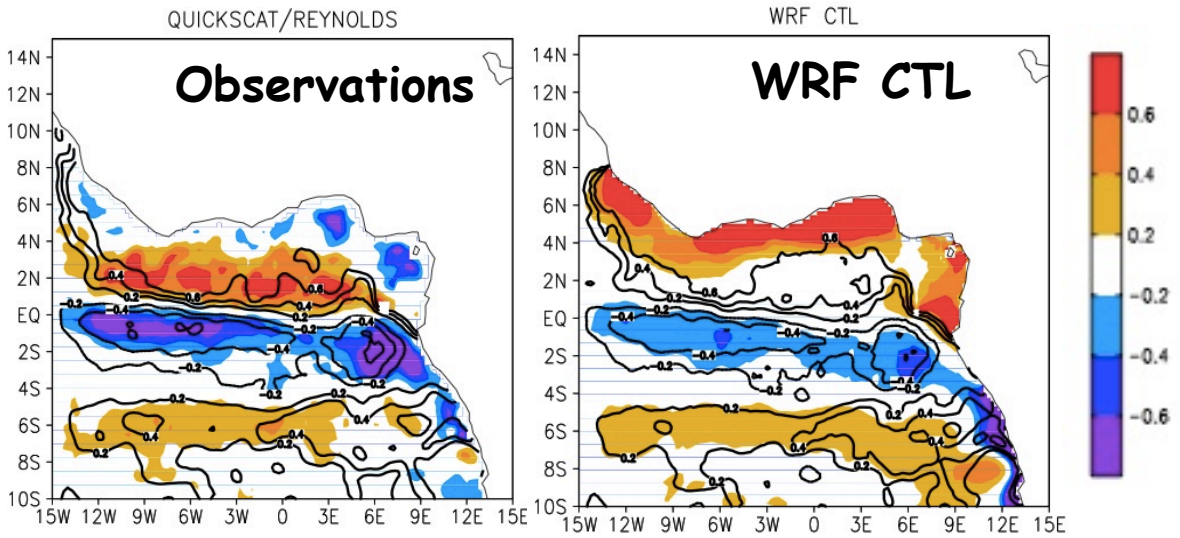
SST(°K) HF exp



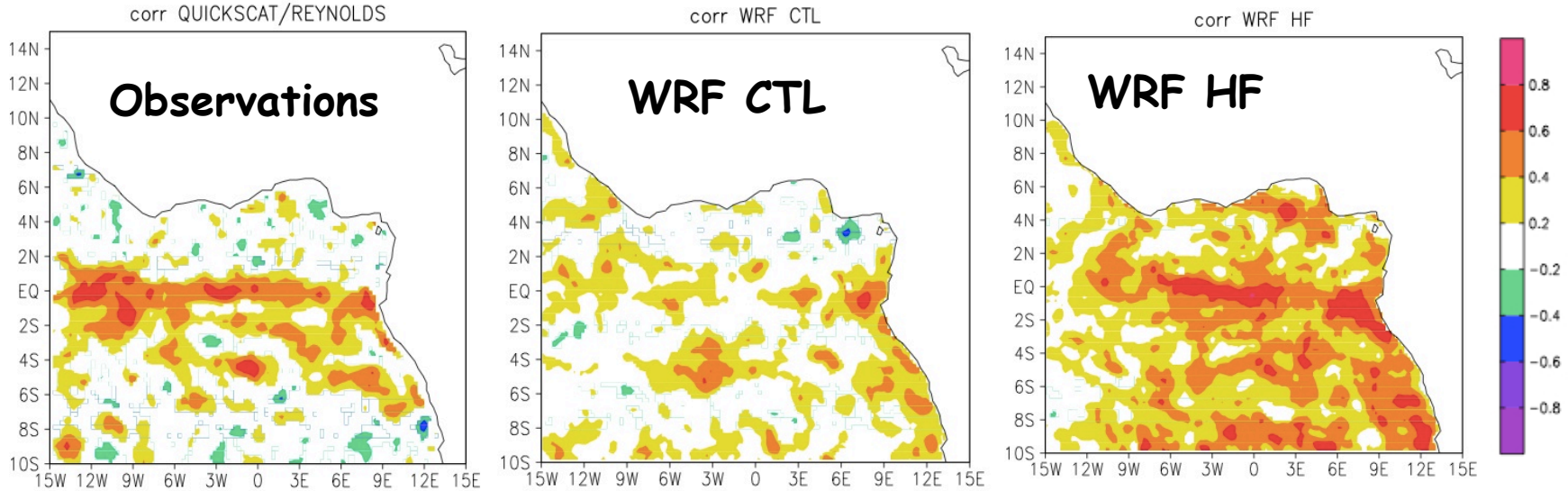


WRF SST experience : impact on air-sea coupling

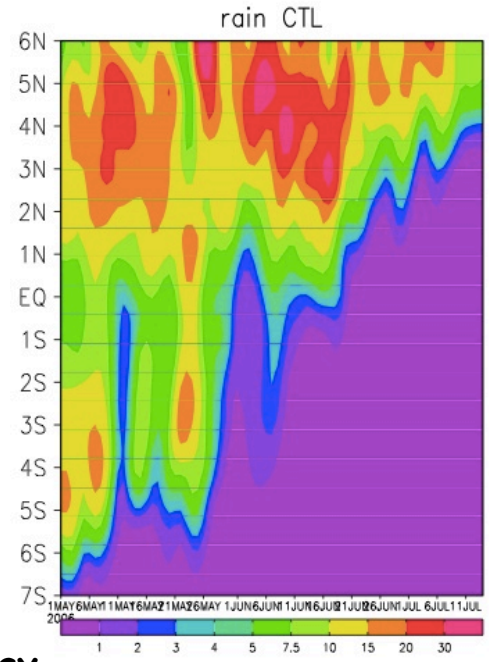
Spatially high-pass filtered wind speed (m/s) (shaded) and SST (°K) (contour) – May-June average

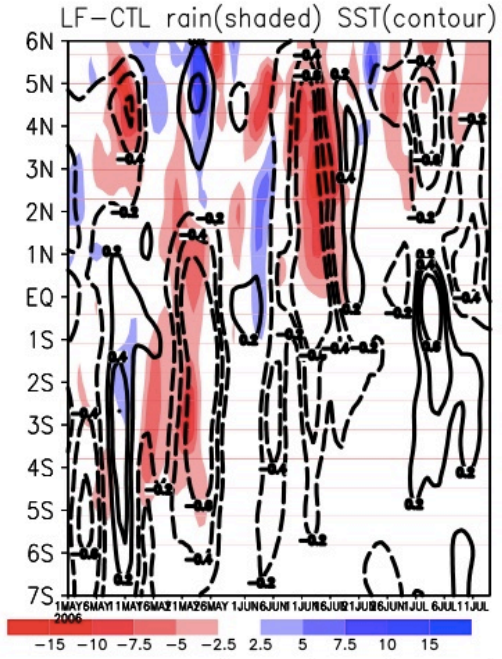


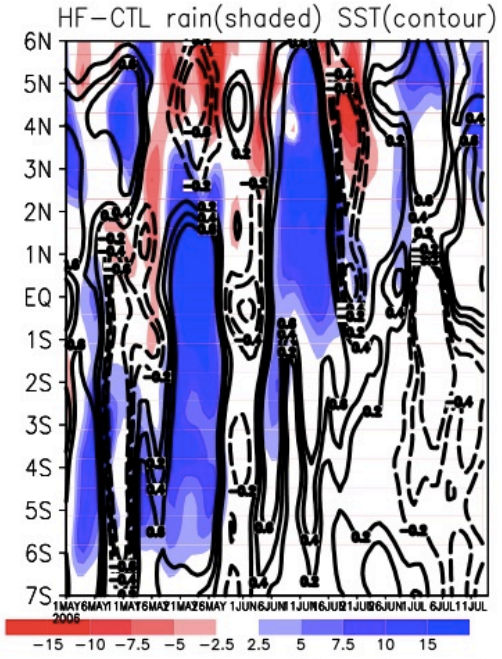
Temporal correlation (90 days) between high-pass filtered wind speed and SST



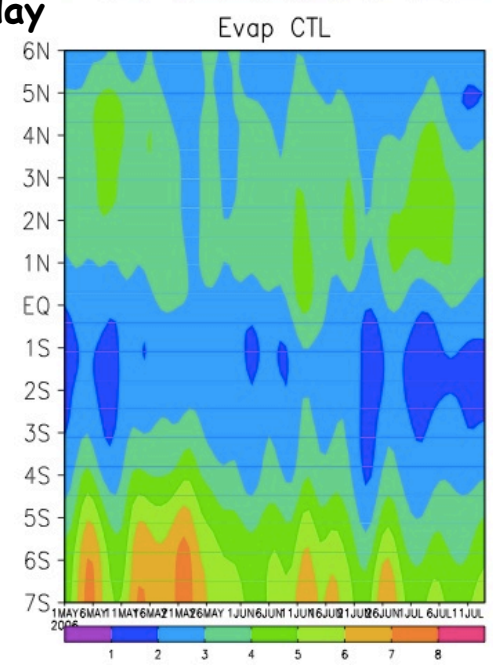
WRF SST-experience : impact on water cycle

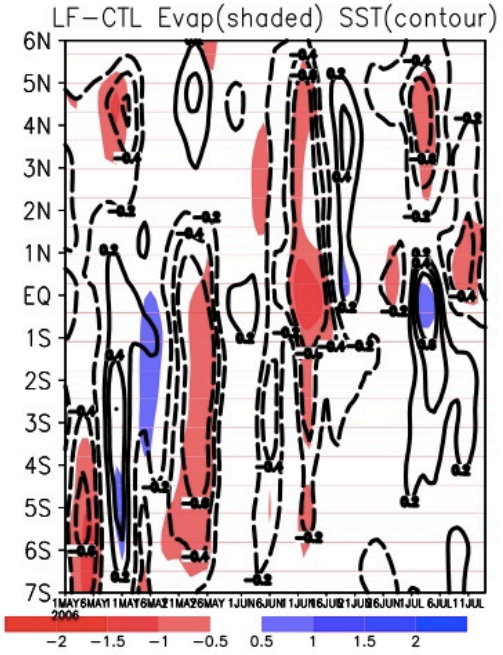


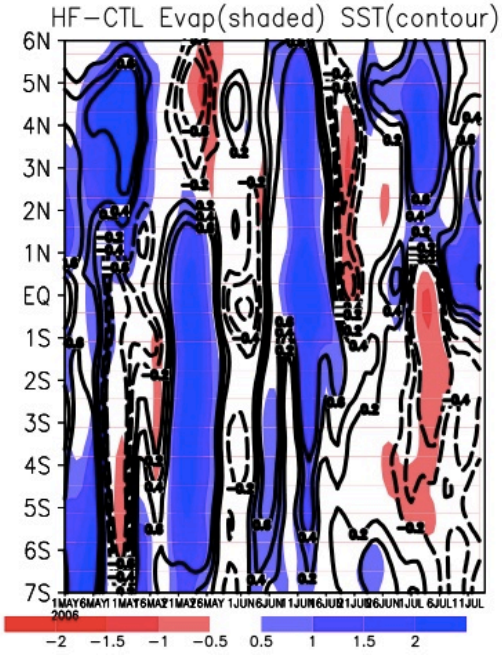




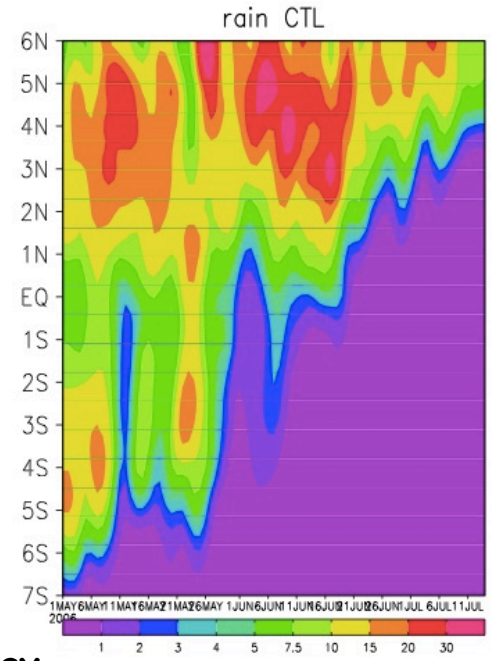
mm/day

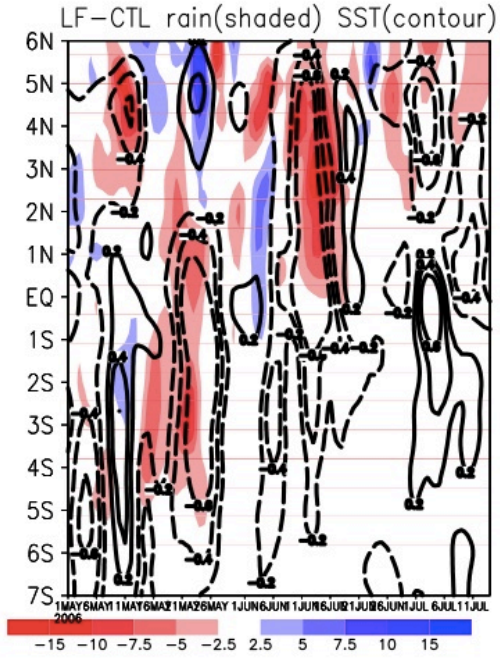


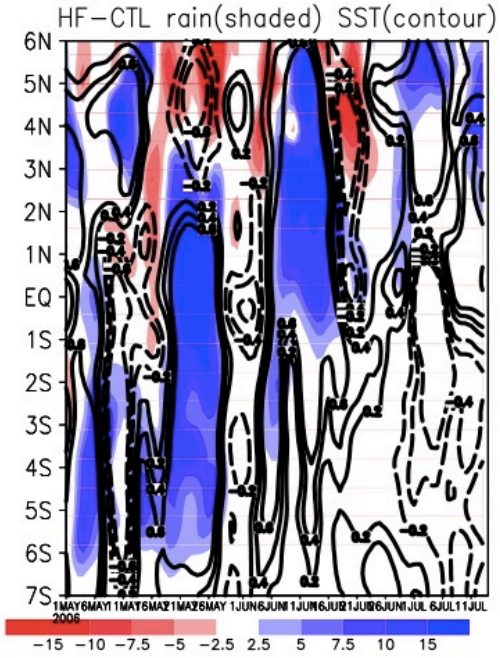




WRF SST-experience : impact on water cycle







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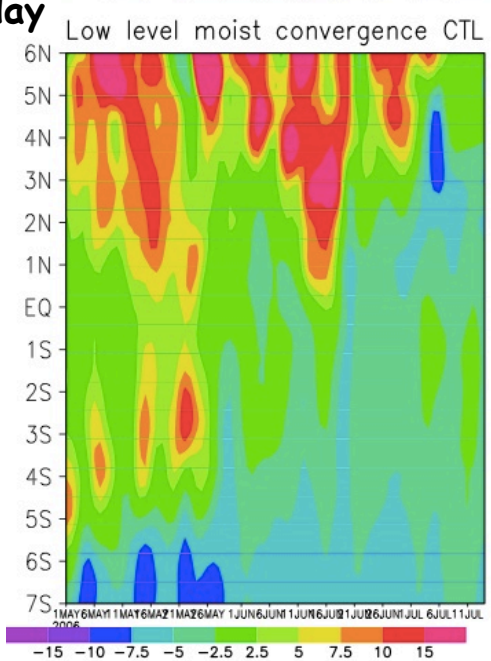
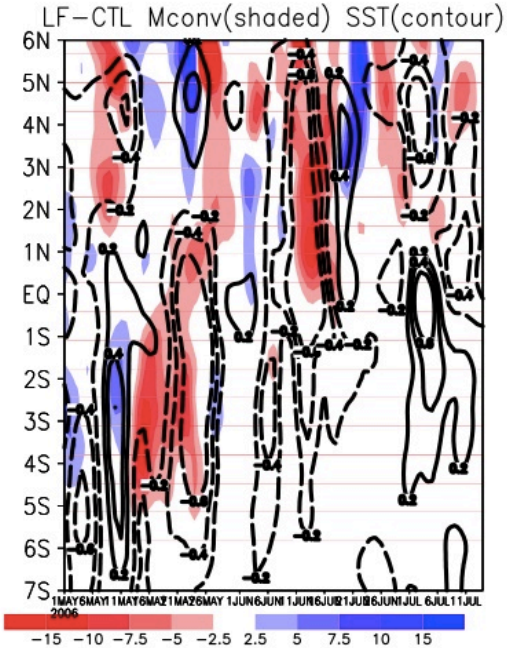
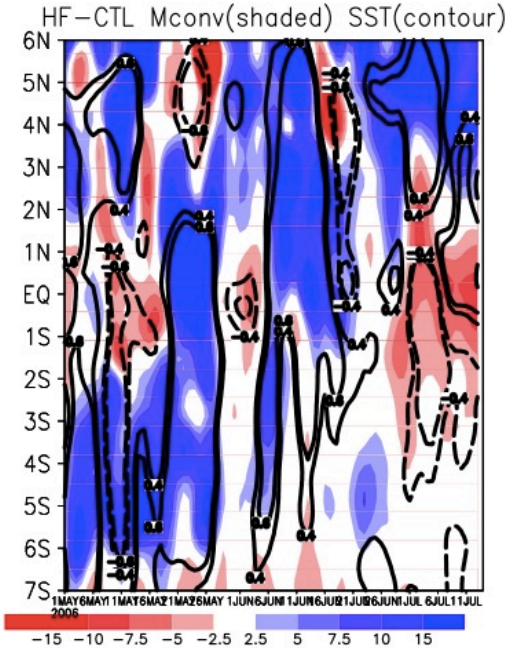


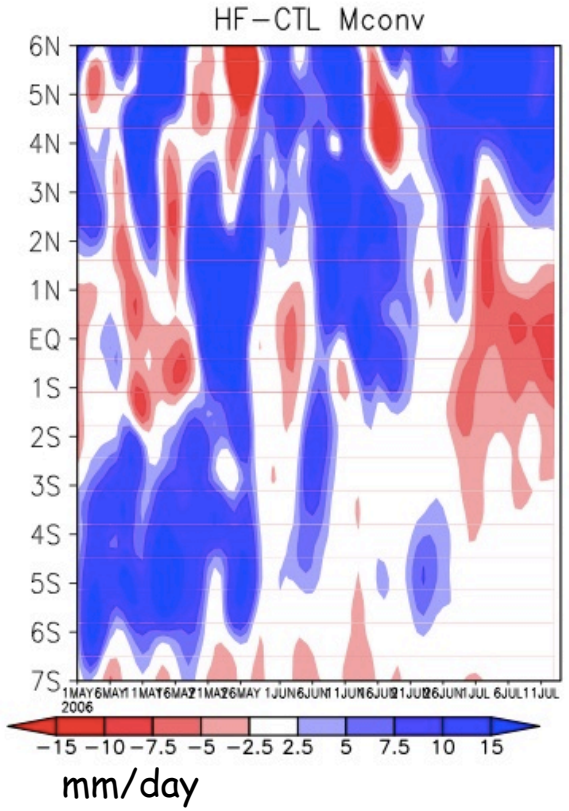




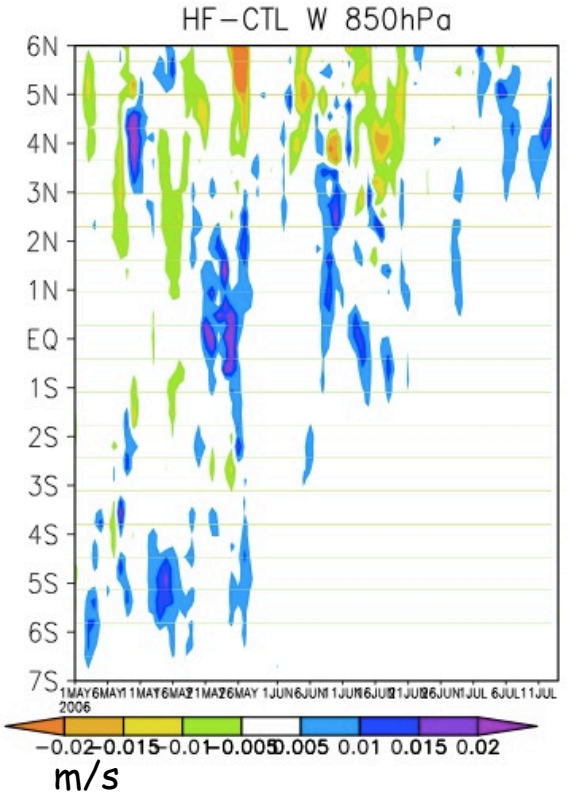
WRF SST-experience : impact on water cycle

Low-level moisture flux convergence cause or consequence of deep convection ?

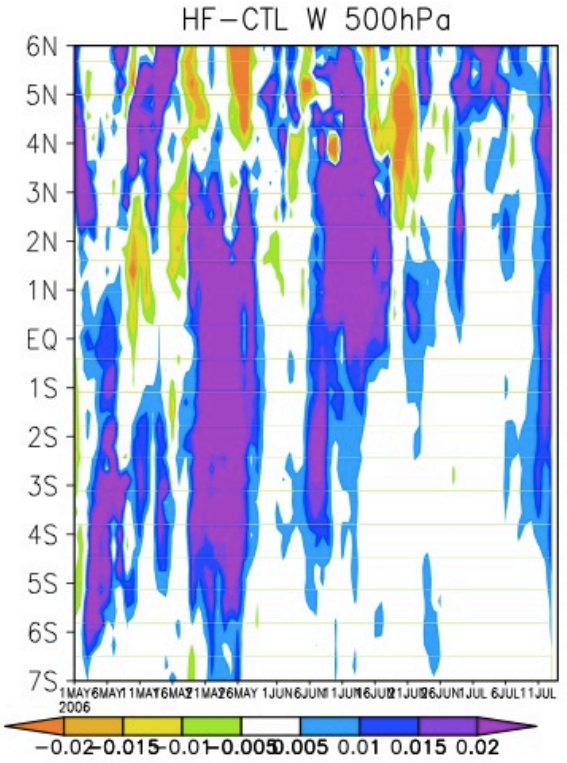
Low level moisture convergence



Vertical wind @ 850hPa



Vertical wind @ 500hPa



Conclusion / Perspective

- Strong coupling between SST and surface winds in the GG seen by satellite observations and CFSR reanalysis

- It has strong influence on the functioning of the Guinean rainfall water budget (onset, day-to-day variability, demise)

- WRF forced simulations fairly reproduces SST/surface winds couplings (but weaker) and its influence on the water cycle but at 25km resolution the impact of parameterizations is proved to be important (excessive rainfall in the ITCZ).

  KF(moist adv trigger) or GR3D + MYJ + Dudhia found to better represent the air/sea coupling and rainfall volume

- Preliminary study on WRF Intra-seasonal SST fluctuations influence on the water cycle :

  rainfall amounts and low-level moisture flux convergence are strongly modulated by the amplitude of SST fluctuations

Perspective :

-WRF simulations 2000-2009 to further analyse air-sea interactions on water budget

- Next step WRF-NEMO set up to fully characterize air-sea interactions