What Processes control the Wind in the Boundary-Layer of the ITCZ

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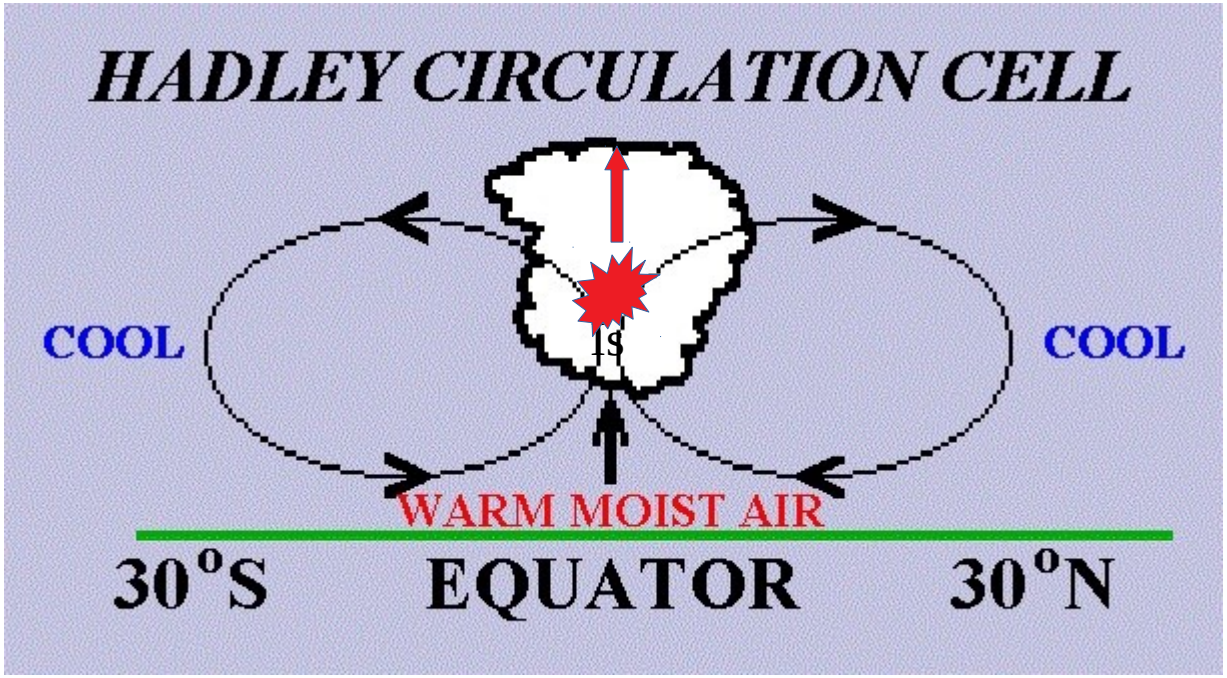


- Convergence of humidity is the engine of precipitation
- Processes involved in the wind convergence in the ITCZ
- Low-level wind-convergence forces deep convection
- Deep convection/latent heat release induces low-level convergence
- Circular relationship between low-level convergence and deep convection
- Low-level Convergence a cause or a consequence of deep convection ?
- Roles of ABL/SST versus deep tropospheric processes in influencing low-level wind-convergence

Meso-NH Configuration

- Meso-NH : **Lafore et al. (1998) ; Lac et al. (2018)**

- Non hydrostatic anelastic model covering a wide range of scales
- u, v,w, θ, 4 water phases as pronostic variables
- Full physical package

- Set up of the model for our study :

- Pronostics TKE, 1D Turbulence — Cuxart et al. (2000) and Bougeault Lacarrère (1989)
- Mixed-phase cloud parameterization — Pinty and Jabouille (1998)
- EDKF mass-flux scheme for shallow convection and thermals — Pergaud et al. (2009)
- Deep convection from Kain-Fritsch-Bechtold — Bechtold et al. (2005)
- Radiation from ECMWF

- Surface (SURFEX interface)

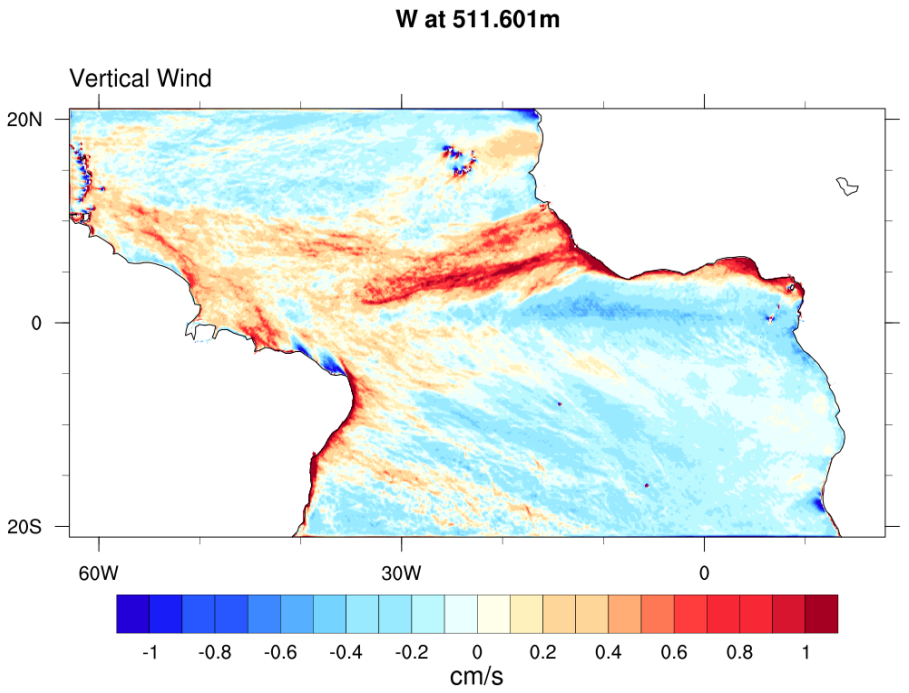
- Interactive continent with prescribed vegetation — (Noilhan and Planton, 1989)
- SST prescribed (ERA-I/6h)
- Ocean-atmosphere fluxes computed from ECUME3 parameterization — (Belamari 2005)

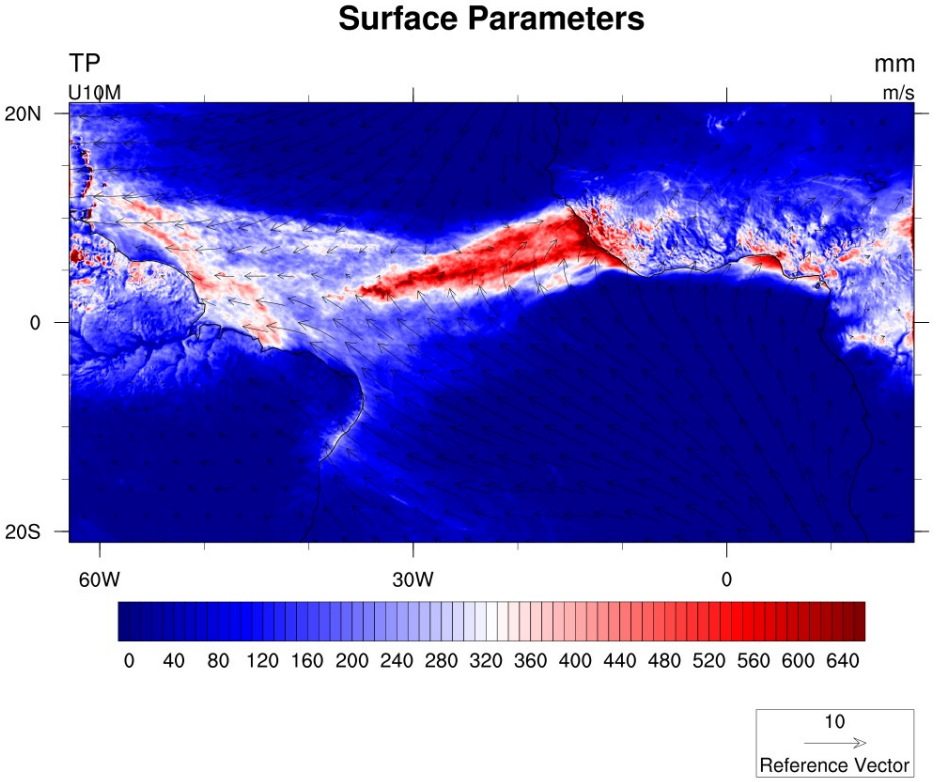
- Numerical Configuration :

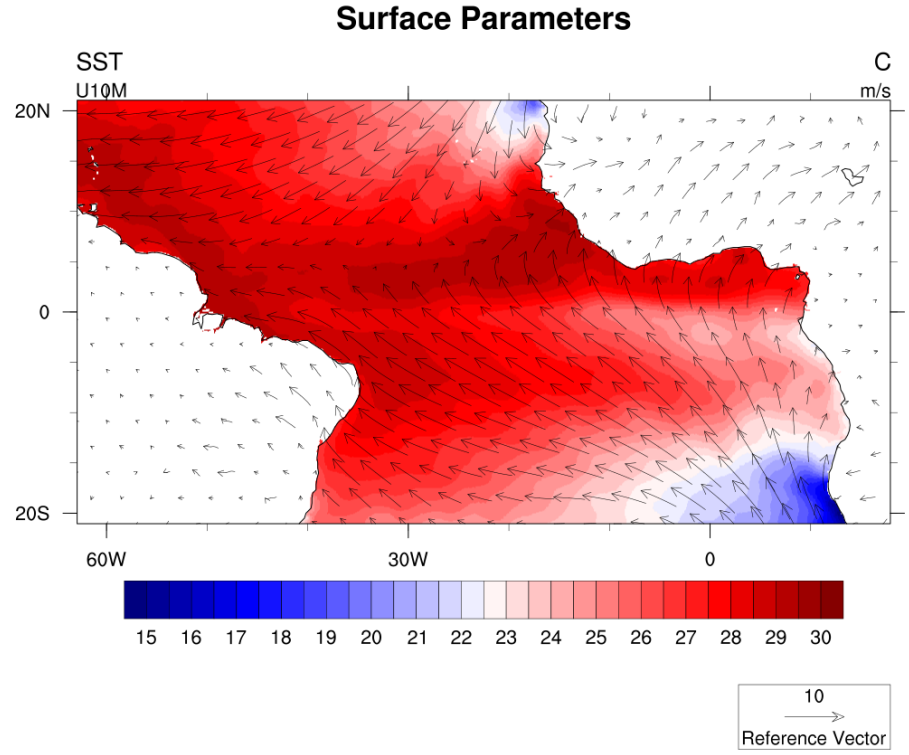
- Domain Extension : 65W-19E 21S-21N
- $\Delta x=\Delta y=10$ km with convection parametrized (900x480 points)
- Δz from 10 m to 600 m with 70 verticals levels

- 1-month simulation from 1-30 June 2010, with hourly output !
- Initial fields and lateral boundary conditions from ERAInterim

- For information :$\Delta t=30$s with 4th order centered advection scheme + Runge-Kutta temporal scheme

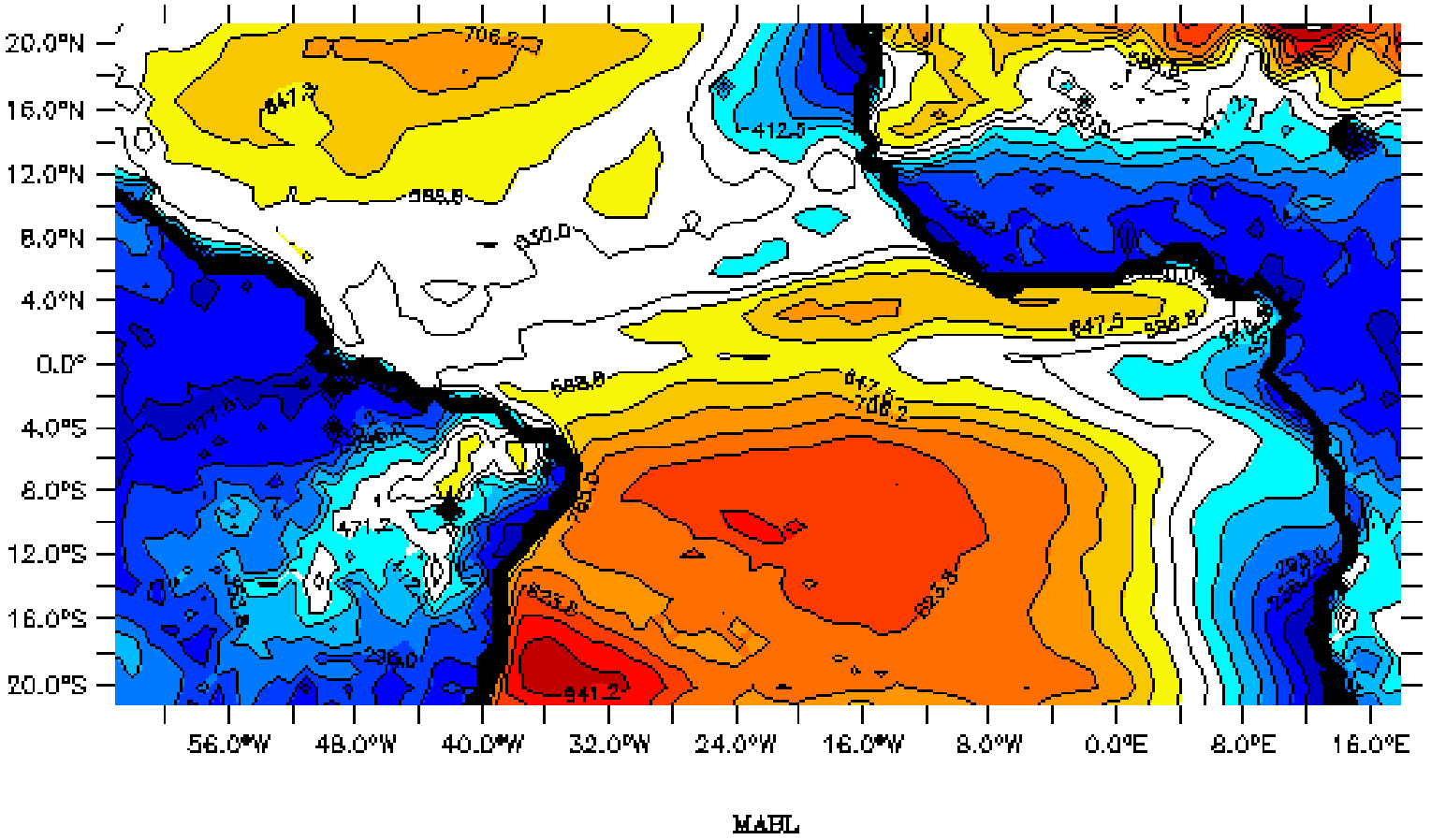




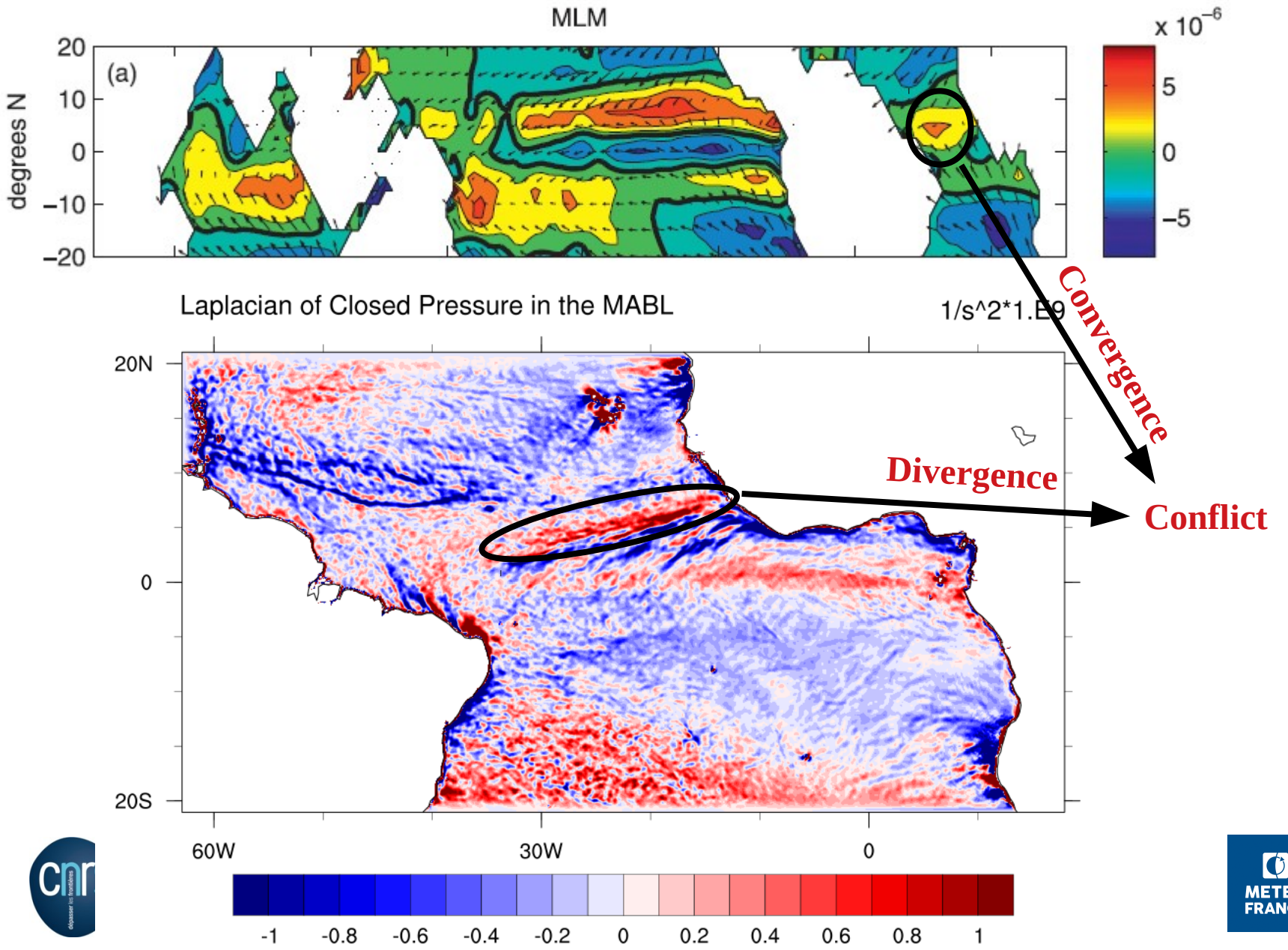


- Upward motion and precipitation are collocated with highest SSTs
- Subsidence close to the Equator induced by the Cold Tongue

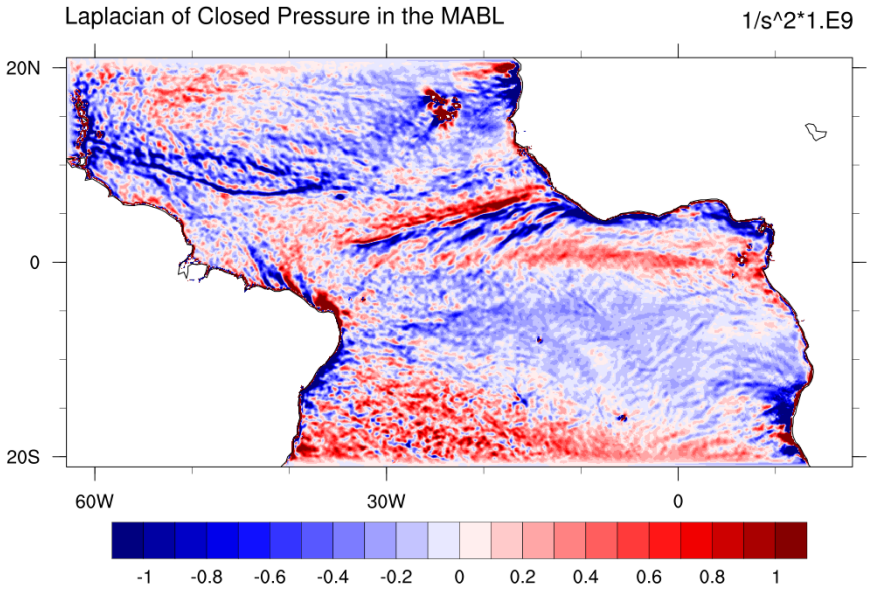
Marine Atmospheric Boundary-Layer



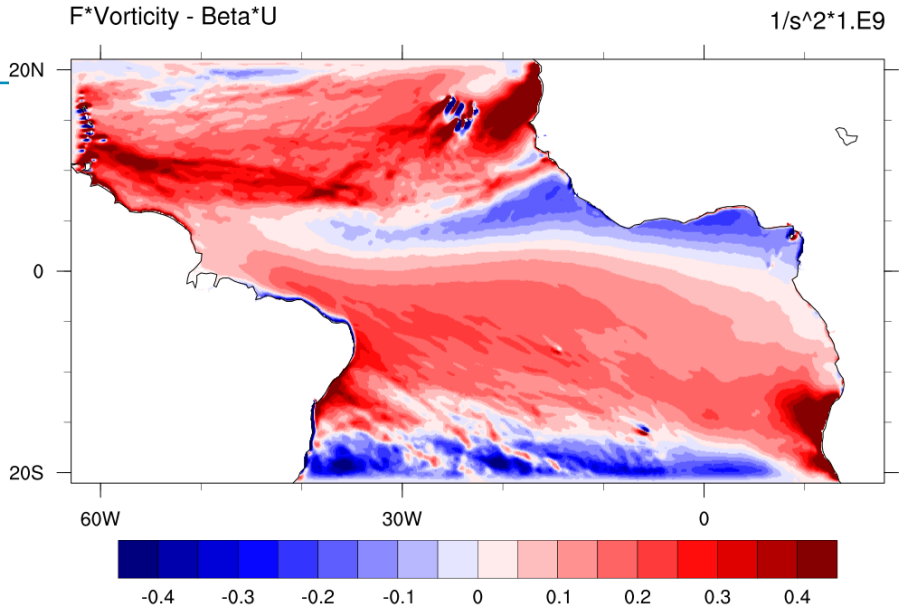
Linear Mixed-Layer Model Back & Bretherton, 2009, *J. Clim*



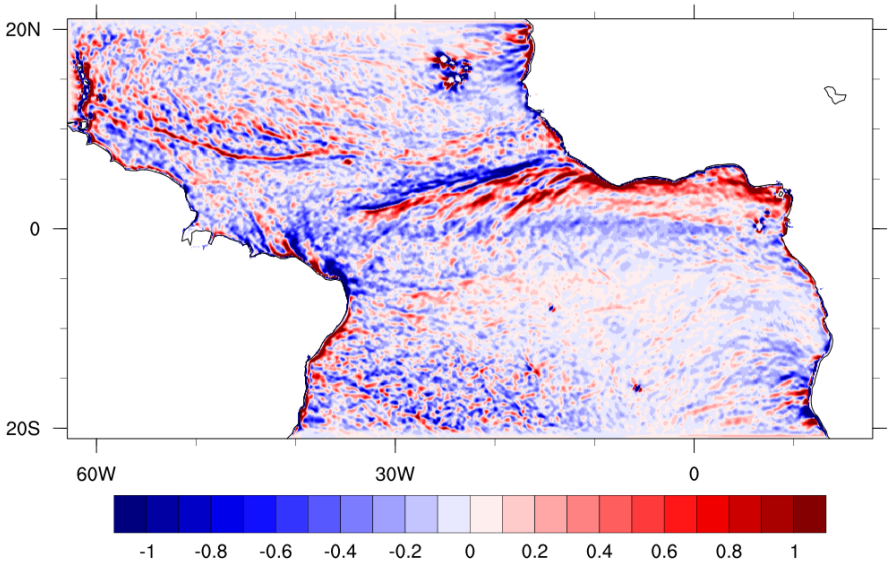
Laplacian of Closed Pressure in the MABL



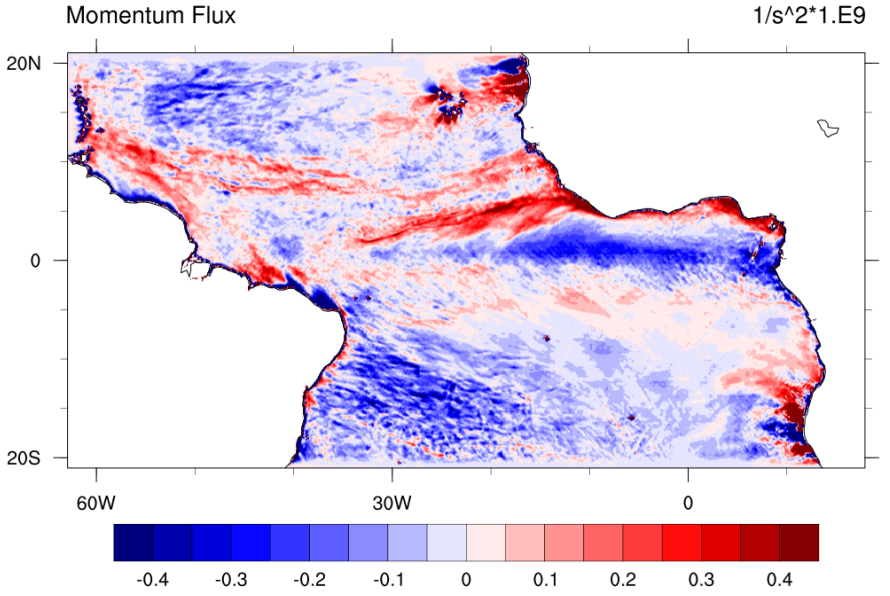
F*Vorticity - Beta*U

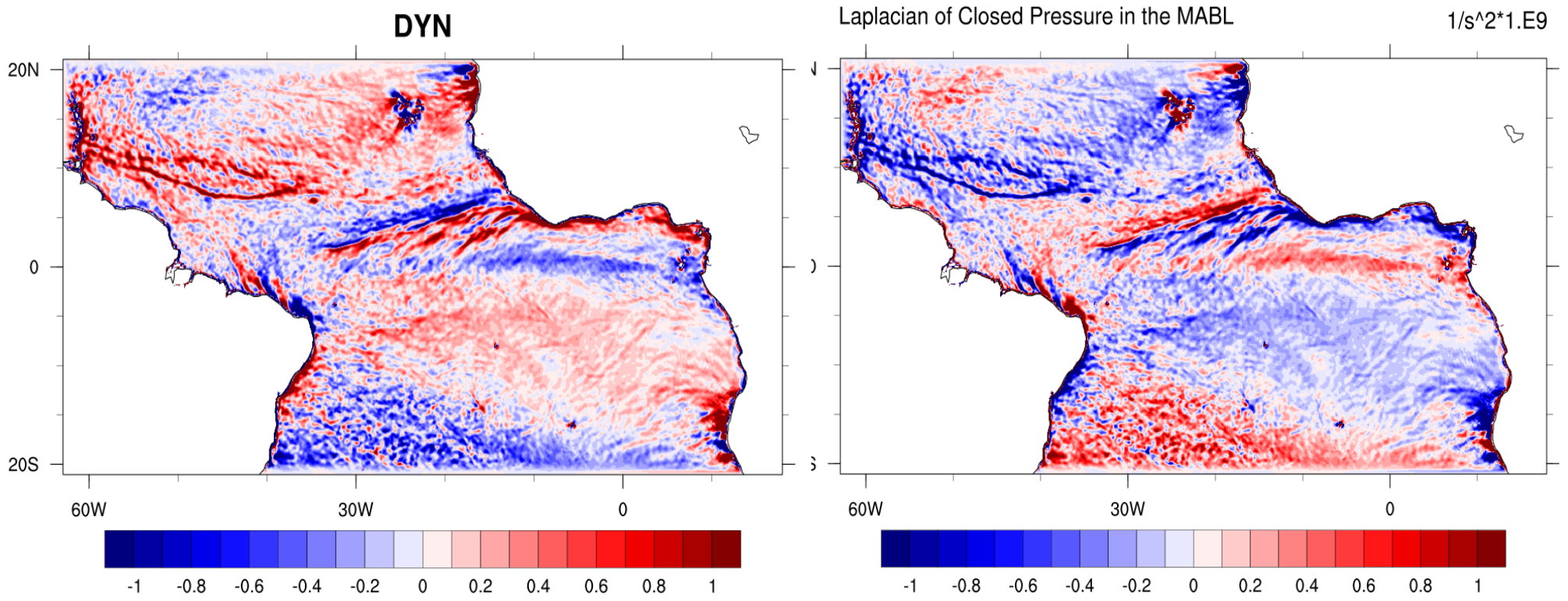


DEFO_ADV



Momentum Flux





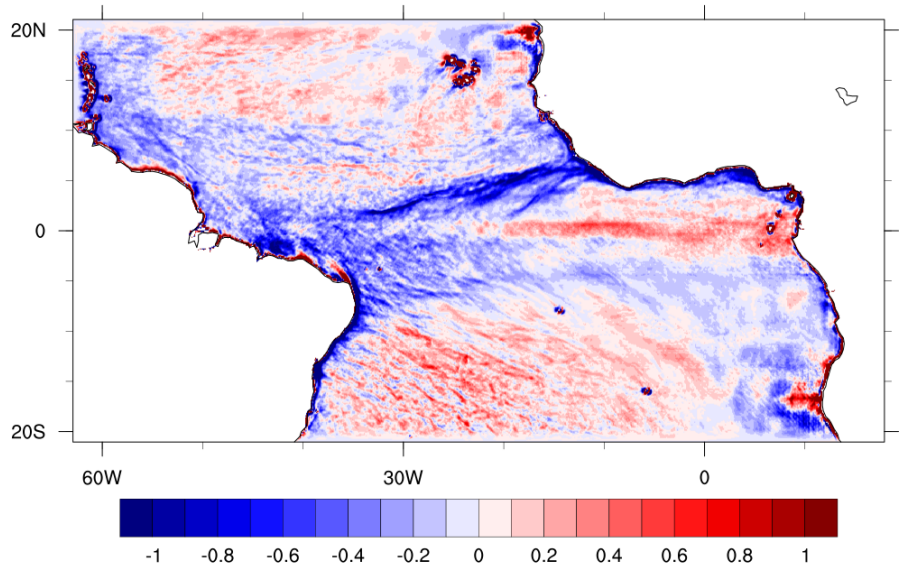
Dynamic and Pressure forcings balances

Circulation ⟺ Diabatic Processes ⟹ $\frac{\partial \delta}{\partial t} \simeq 0$

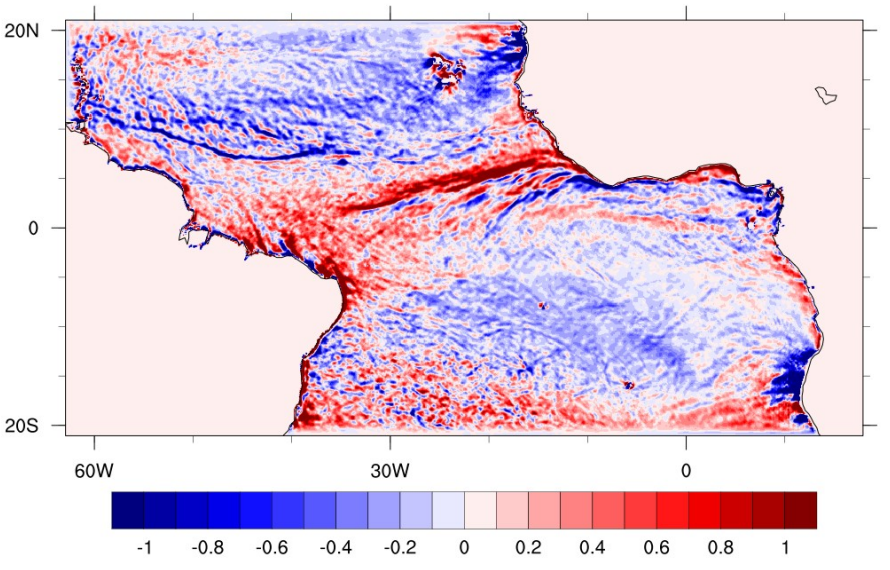
Wind-Divergence ⟺ Dynamic – Diabatic Adjustment

Boundary Layer and Free Tropospheric Contributions

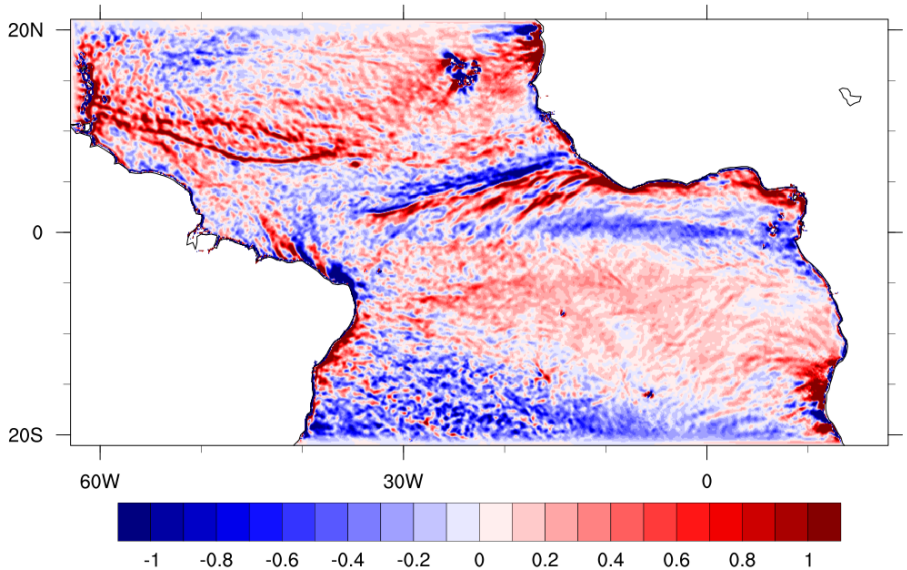
Laplacian of the MABL Pressure



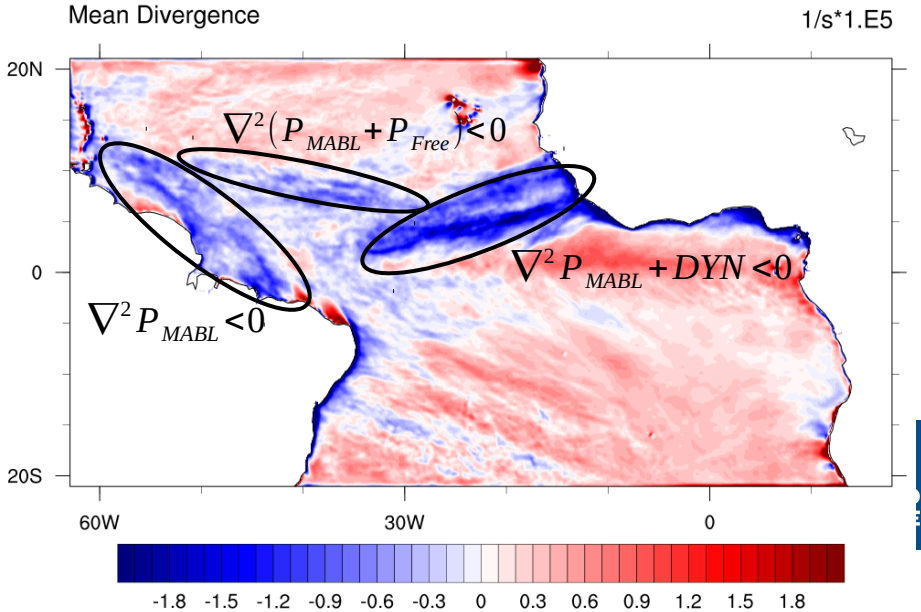
Laplacian of the free Troposphere Closed Pressure



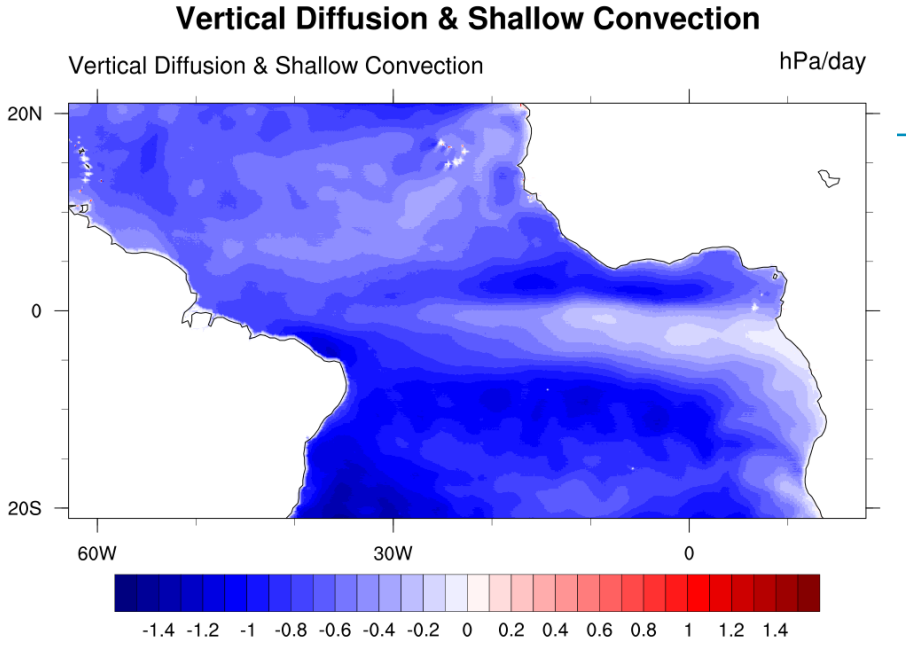
DYN

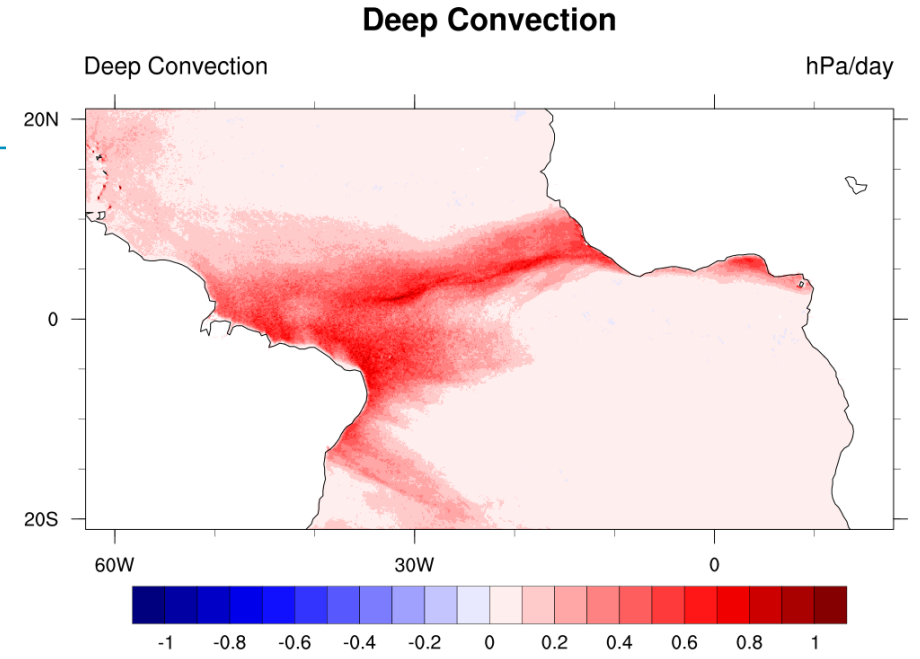


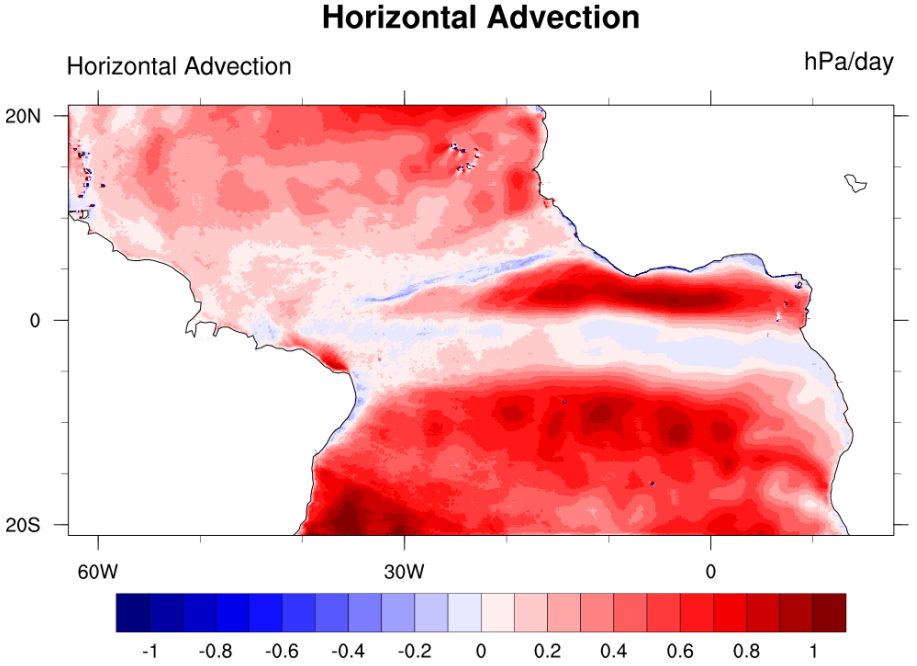
Mean Divergence

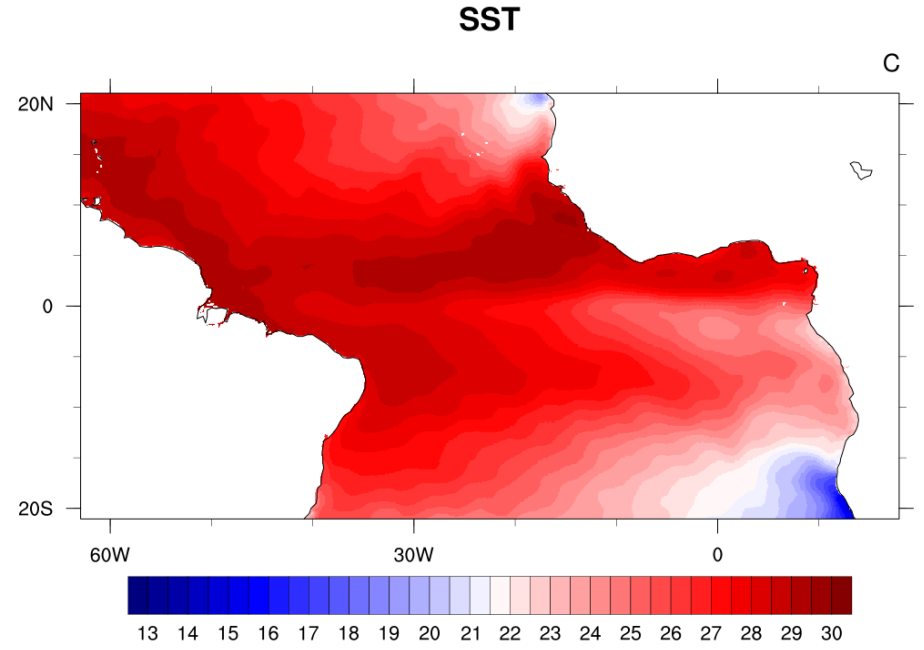


Pressure Trends in the MABL

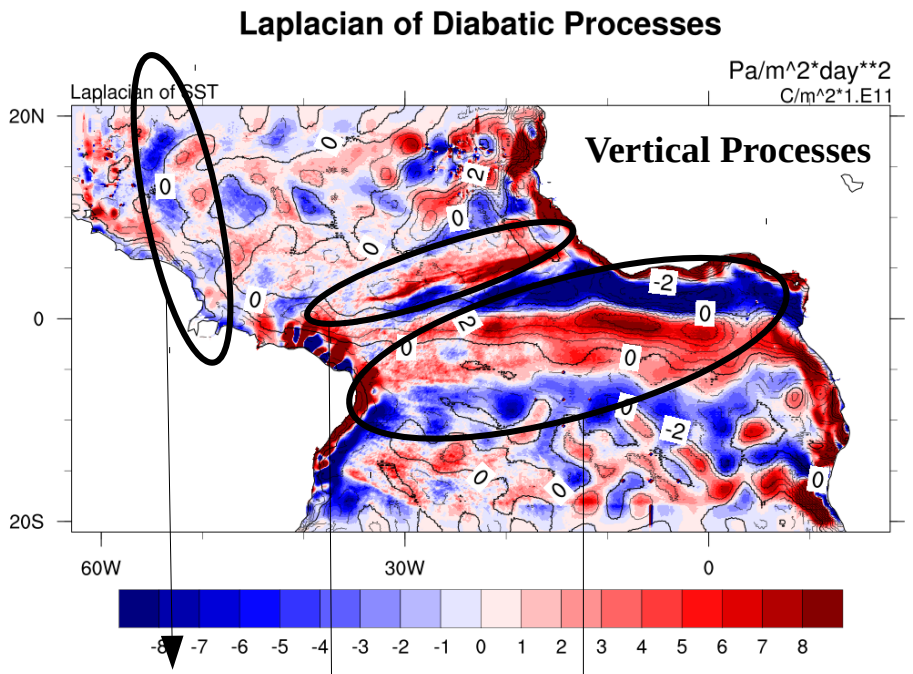


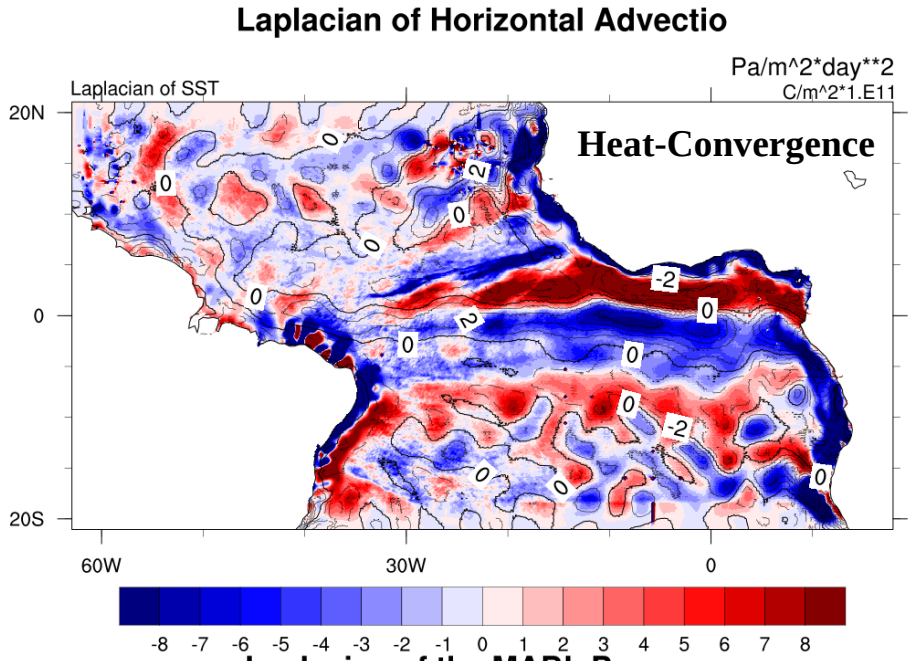




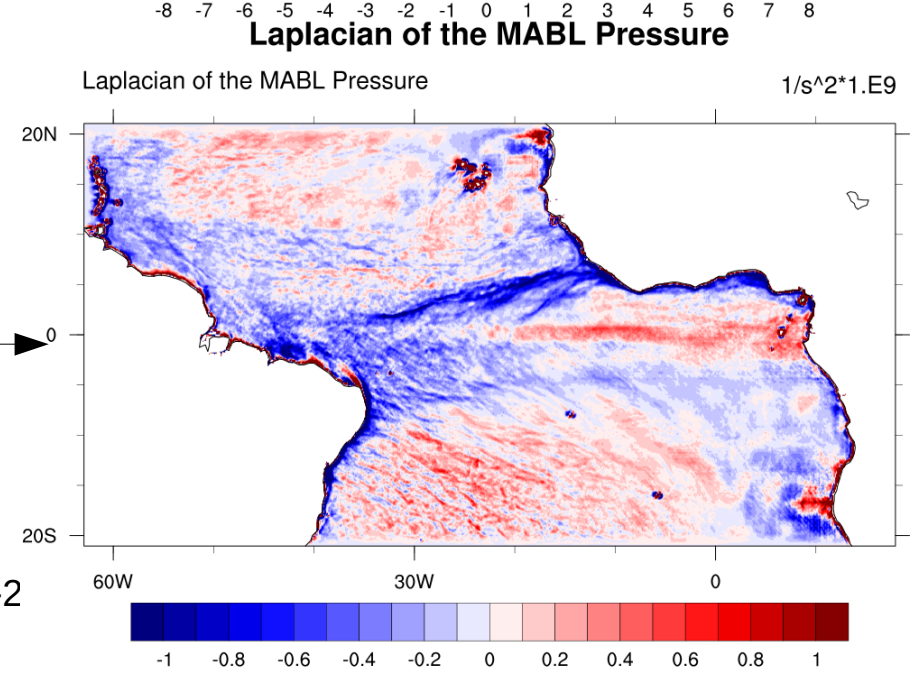


Diabatic → Wind-Divergence Trend





Pressure-induced wind-divergence →



Conclusion

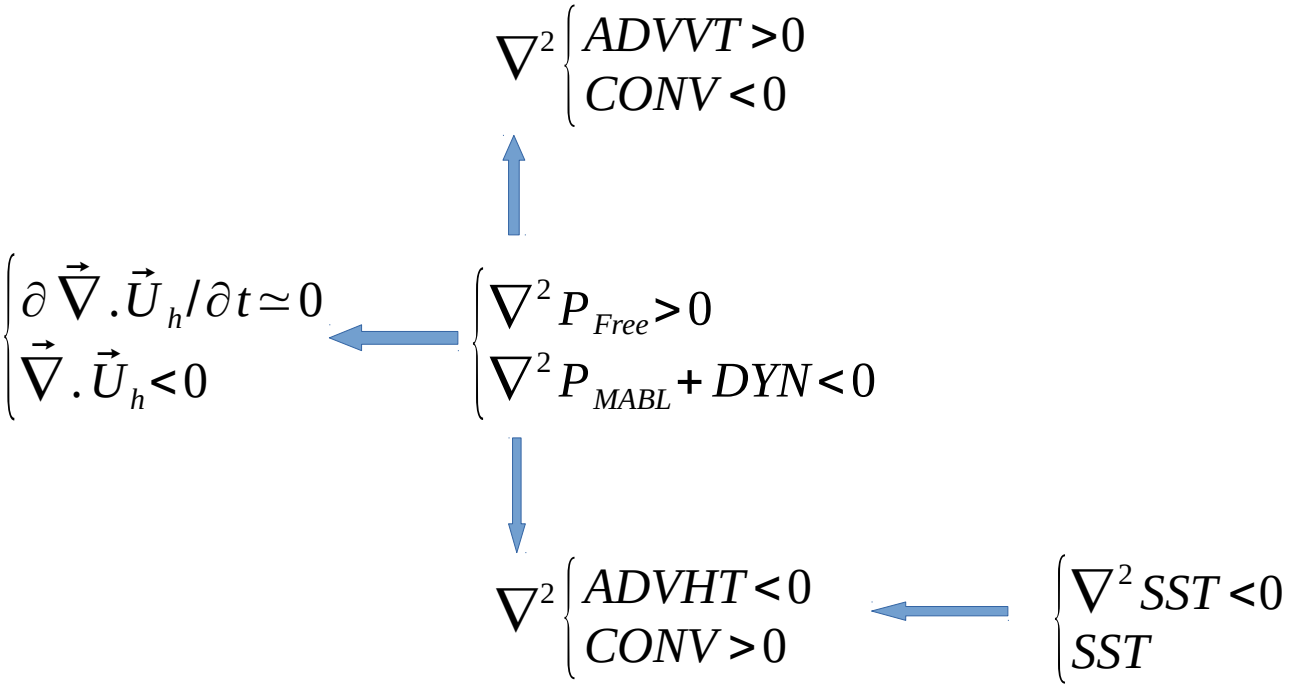
Sources of low-level wind-convergence in the ITCZ :

- Boundary-Layer Pressure (Laplacian)
- Deformation field in the **c**hannel of Easterly waves
- Mitigation by the Free-Tropospheric Pressure in the channel and along the Brazilian coasts

Diabatic Sources of low-level wind-convergence in the ITCZ :

- Heat Convergence
- Heat Convergence coupled to SST

Convergence in the ITCZ



Divergence over the Equatorial Front

$$\begin{cases} \partial \vec{\nabla}.\vec{U}_h / \partial t \simeq 0 \\ \vec{\nabla}.\vec{U}_h > 0 \end{cases} \leftarrow \nabla^2 P_{MABL} > 0$$

$$\downarrow$$

$$\nabla^2 \begin{cases} DIFF > 0 \\ ADVHT < 0 \end{cases} \leftarrow \nabla^2 SST > 0$$