

The Current Feedback to the Atmosphere: Consequences on Ocean Dynamics and Climate

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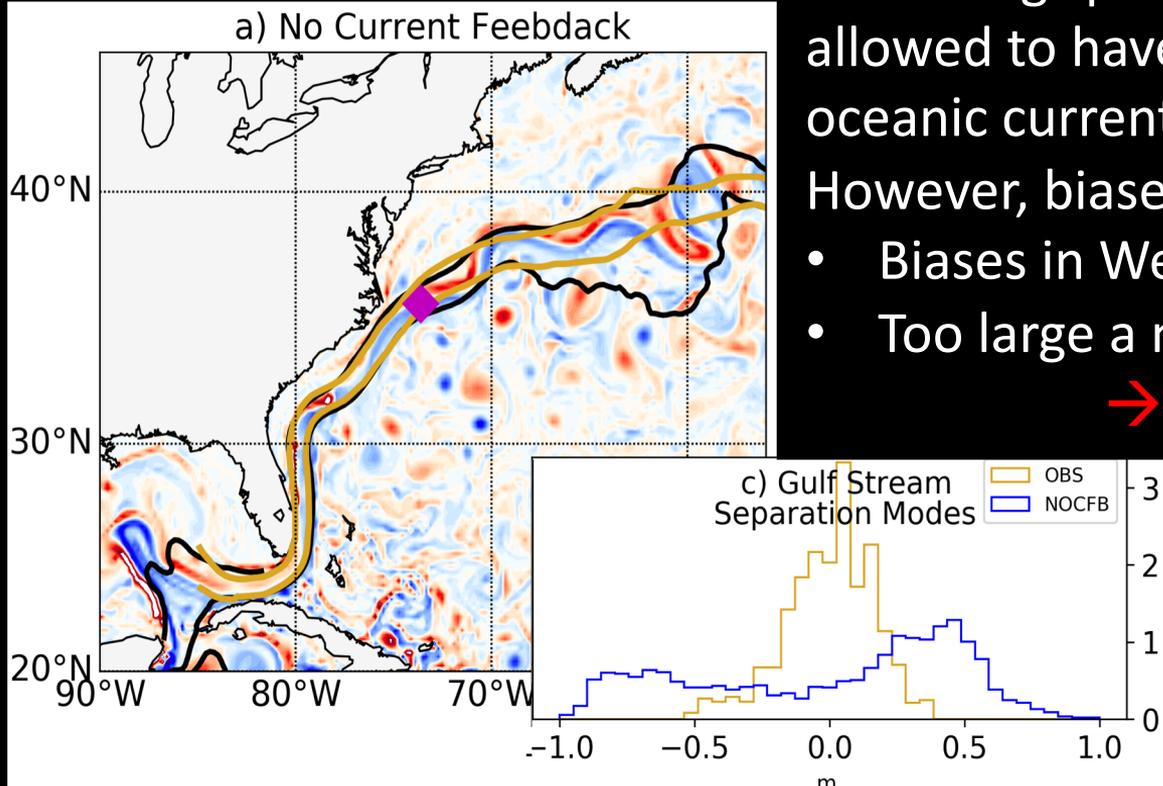
Motivations

Increasing spatial resolution of models allowed to have a much representation of oceanic currents.

However, biases persisted or appeared

- Biases in Western Boundary Currents
- Too large a mesoscale activity

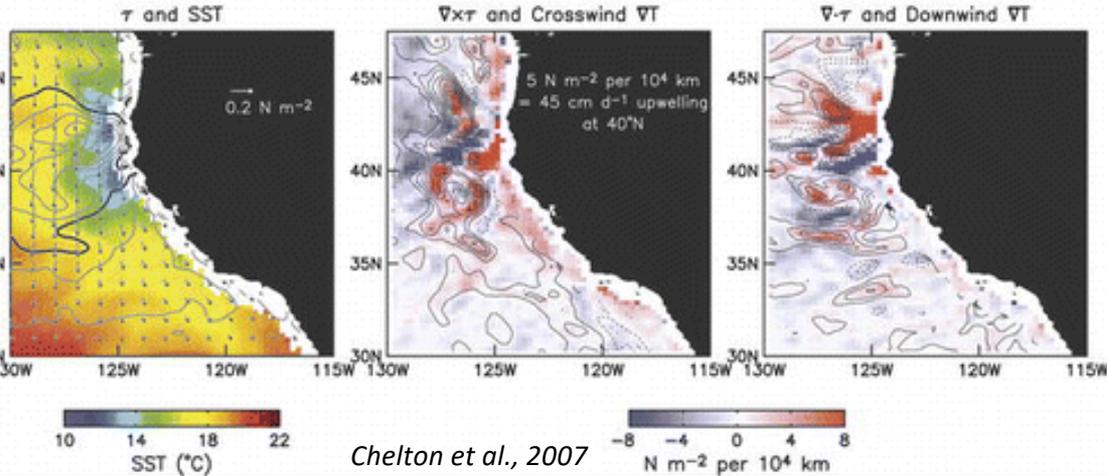
→ Lack of sink of energy



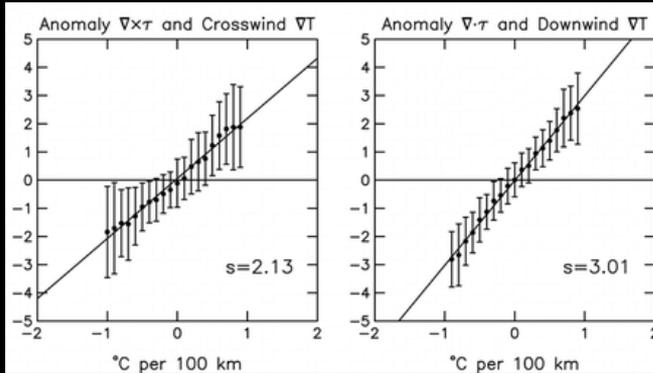
- Diffusive advection scheme ?
- Forward cascade and submesoscale missing?
- Lack of current feedback to the atmosphere (CFB)

Air-Sea Interactions

b) 29 September 2002, QuikSCAT and AMSR



Chelton et al., 2007



- Large Scale: main mode variability are coupled (Thermal Feedback)
- Mesoscale Thermal Feedback: influence on turbulent heat fluxes, wind, wind, etc
- Wave Feedback: modulation of momentum exchange, etc
- Current Feedback

Current Feedback

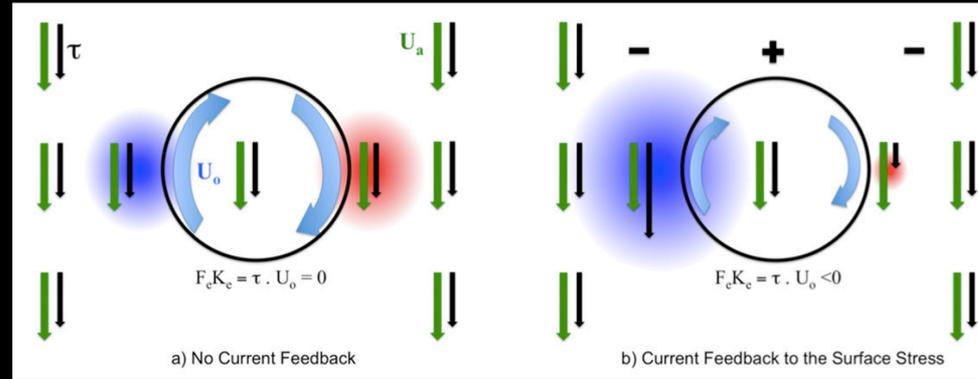
Influence of the Surface Current on the Surface Stress and Low-level wind

In a coupled model, when estimating the surface stress:

$$U = U_a - U_o$$

“Mechanical Damping” or “Eddy Killing”

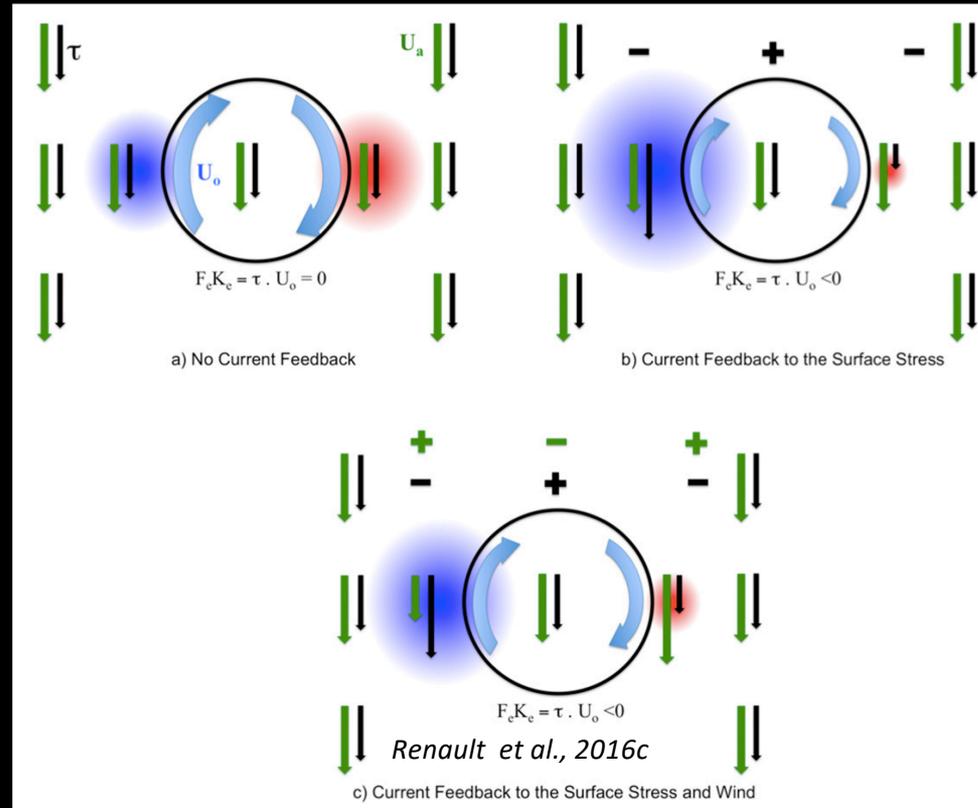
- Not only reduction of $F_e K_e$ but negative $F_e K_e$ (Deflection of energy ocean \rightarrow atmosphere)



Renault et al., 2016c

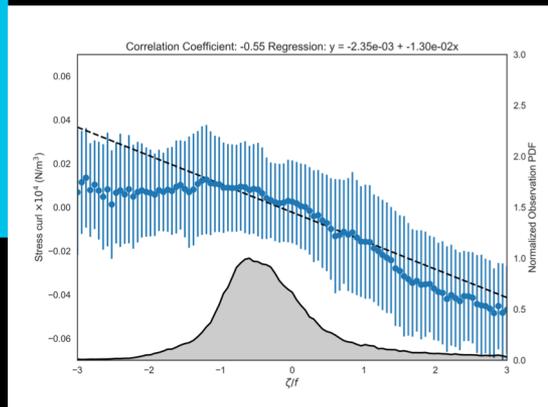
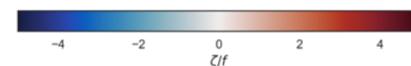
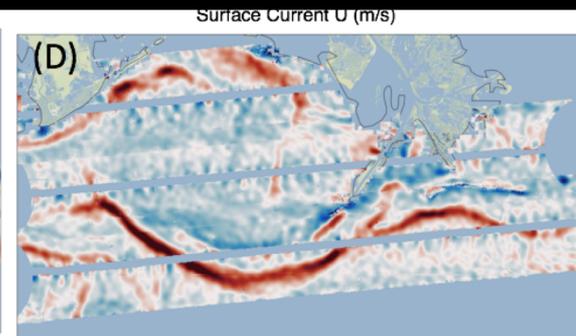
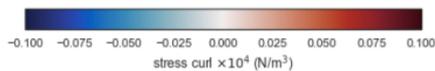
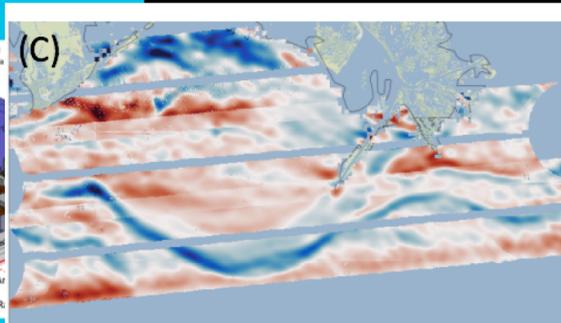
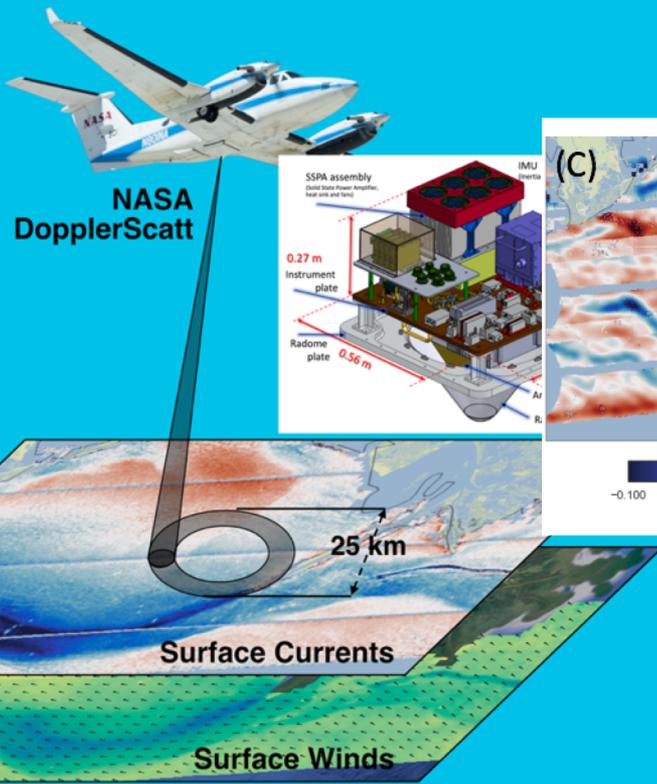
“Mechanical Damping” or “Eddy Killing”

- Not only reduction of $F_e K_e$ but negative $F_e K_e$ (Deflection of energy ocean \rightarrow atmosphere)
 - Partial re-energization by the atmospheric response
- \rightarrow need parameterization in a forced ocean model



Can be seen from DopplerScatt

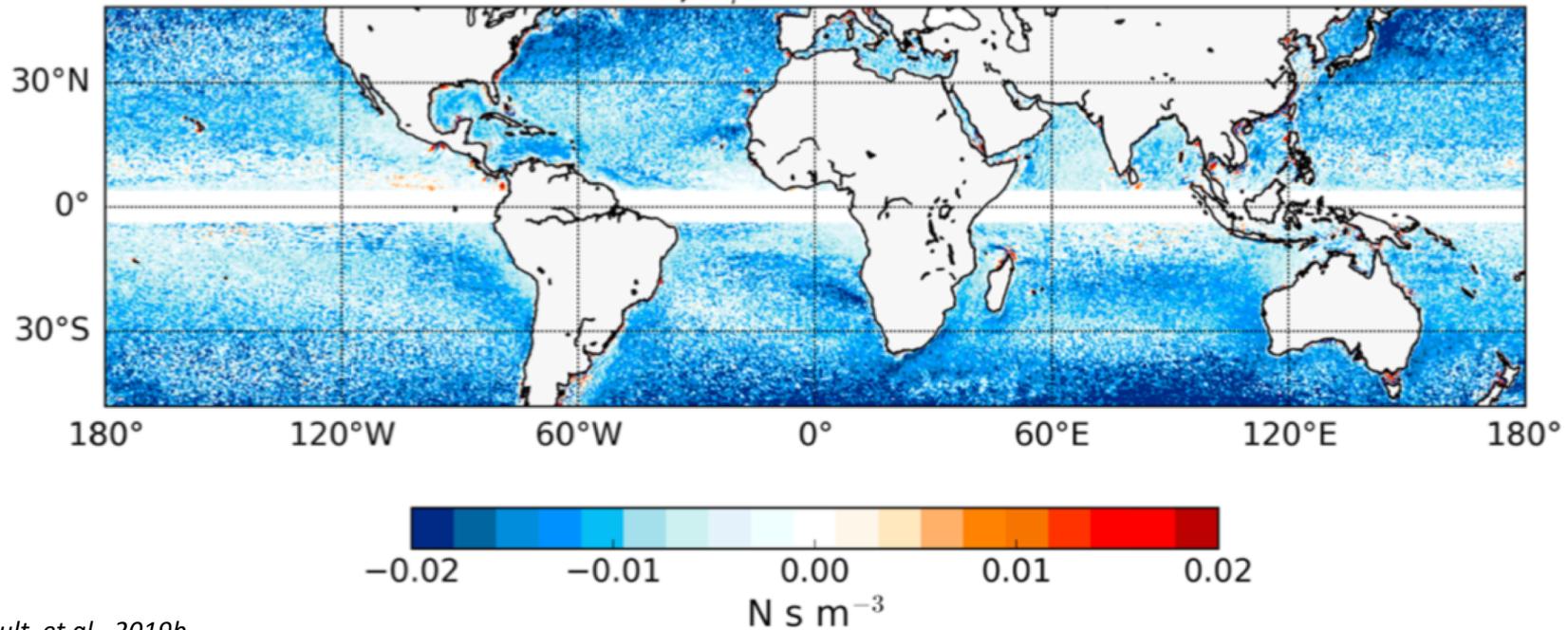
Courtesy from E. Rodriguez (NASA)



Linear relationship between mesoscale stress and current \rightarrow coupling coefficient

Coupling coefficient Estimated from coupled simulations

b) s_T from CTRL



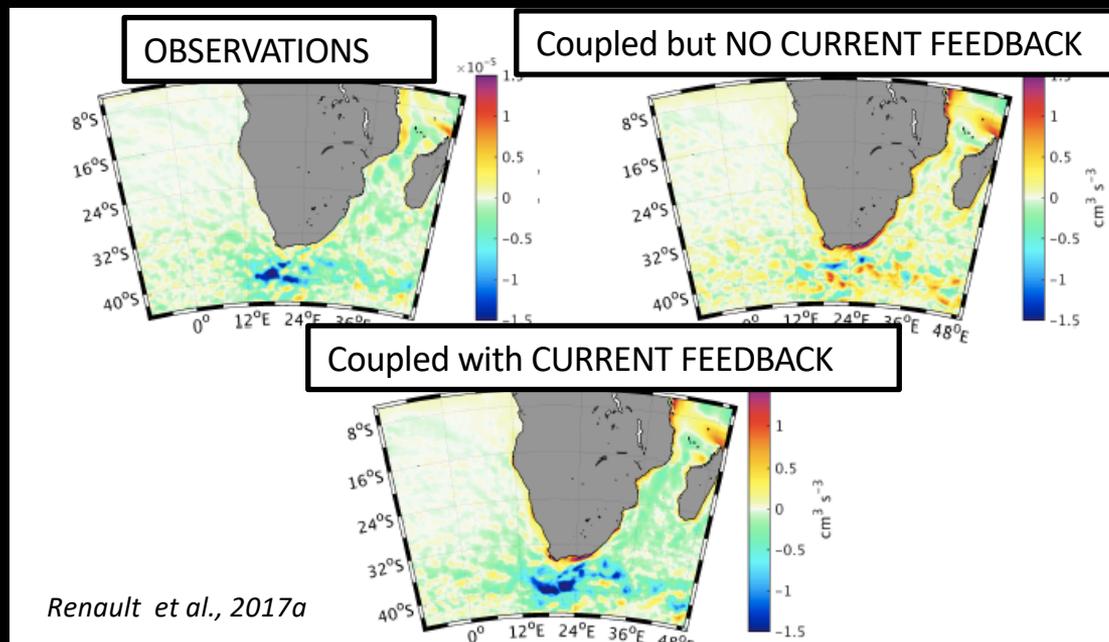
It Induces Transfer of Energy from Mesoscale

Eddies to the Atmosphere

Main Effects:

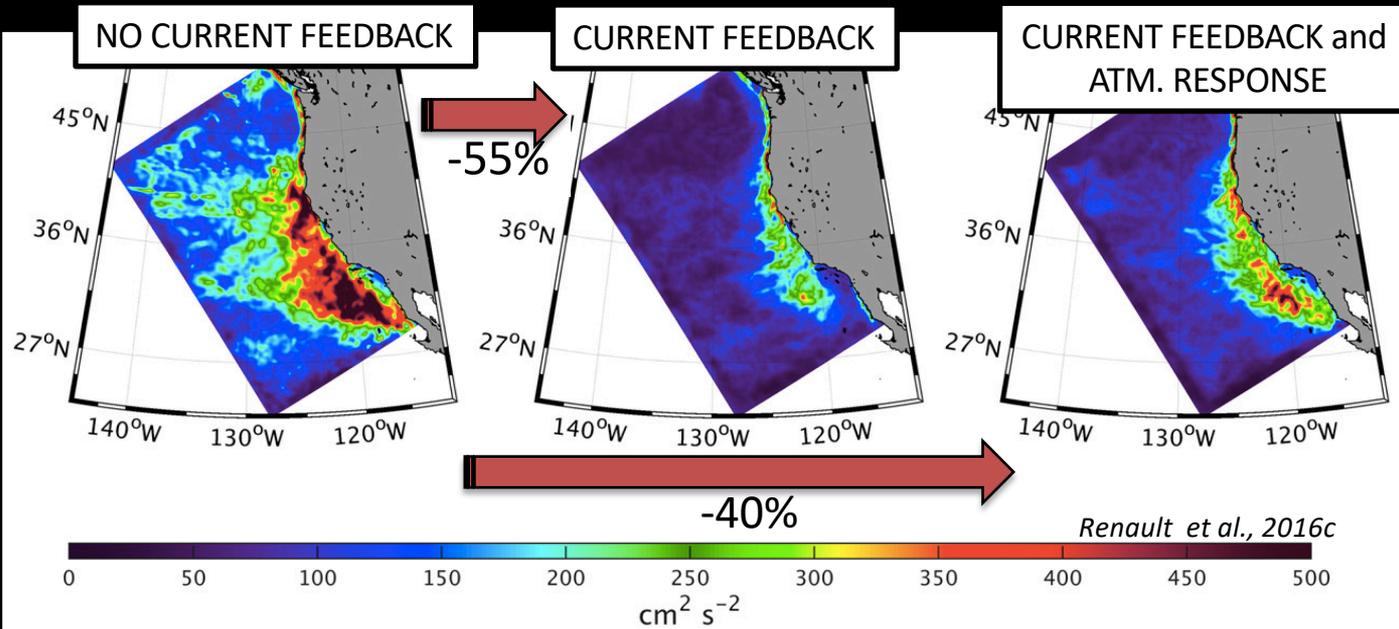
- Slow down of the mean circulation*
- Sinks of Energy from Mesoscale Current to the Atmosphere*
- Can be observed everywhere*

Mean Eddy Wind Work



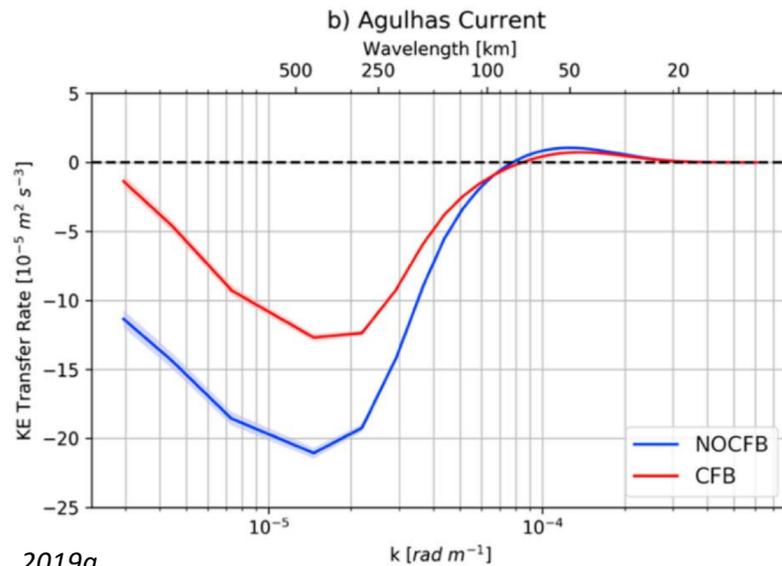
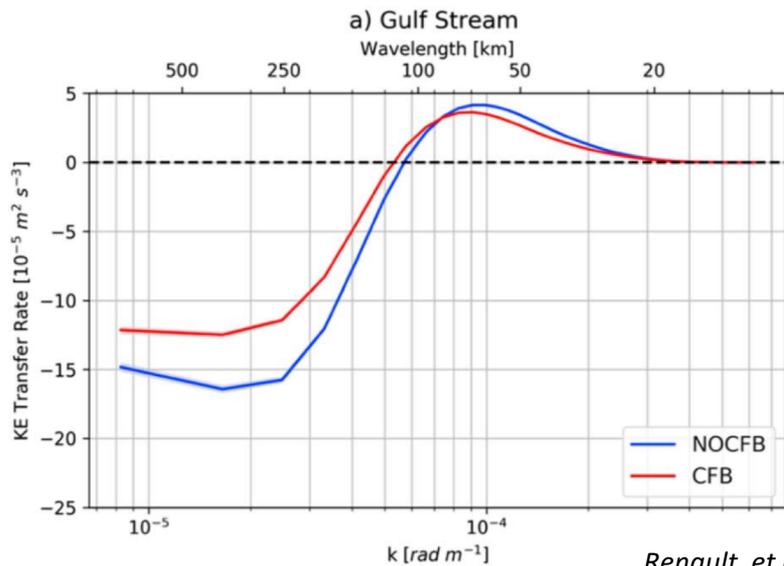
Main Direct Effects

- *At the Large Scale: Slow down of the mean circulation*
- *Damping of the EKE at both Mesoscale and Submesoscale (but **Wind Response induces a partial re-energization of the ocean !**)*



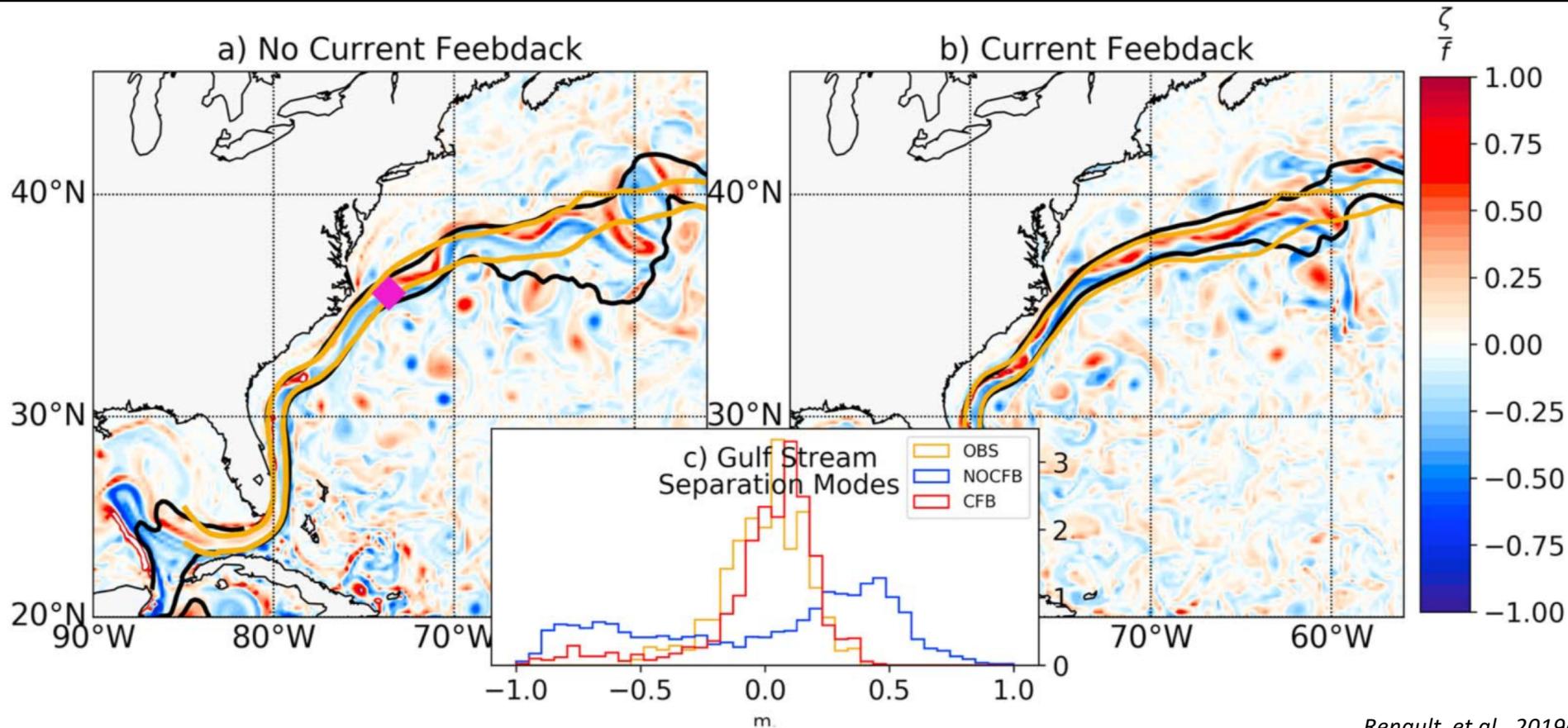
40% US West Coast;
27% North Atlantic;
25% Agulhas Current;
25% Western Mediterran
Sea;
40% Peru-Chile,
35% globally (Renault et al.,
2016ab,2017a,2018,2019a,
2020ab; Seo et al.,
2016,2017; Oerder et al.,
2017; Jullien et al., 2020).

Partial Control of Western Boundary Current through a reduction of the inverse cascade of energy



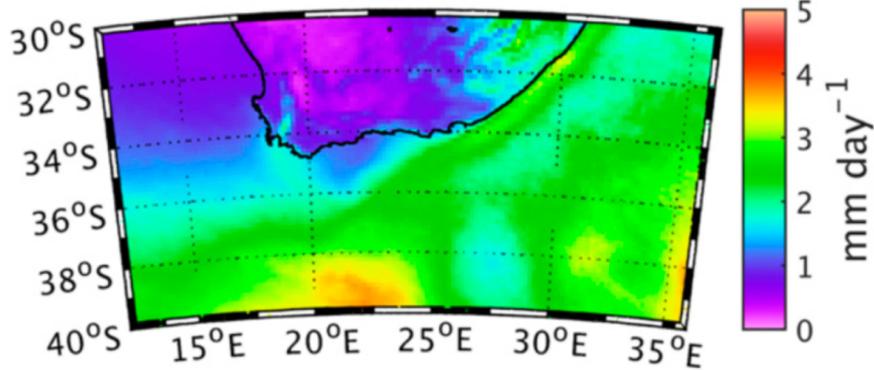
Renault et al., 2019a

Partial Control of Western Boundary Current through a reduction of the inverse cascade of energy

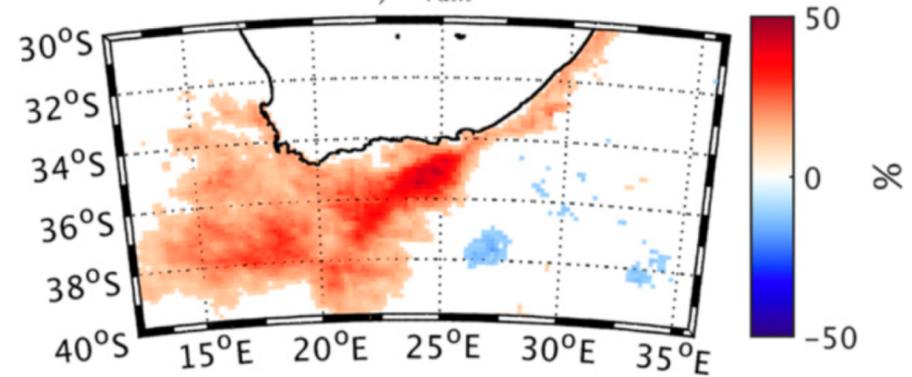


Indirect Modulation of Precipitations

a) Precipitation, CURR



b) C_{rain}



Renault et al., 2017a

Similar results are found over the Western Boundary Currents

Conclusion

- Current feedback to the Atmosphere has a crucial role in determining the energy transfer and oceanic circulation
- Sinks of Energy
- Reduction of the mean Currents
- Damping of the (sub)mesoscale activity
- Partial control of Western Boundary Currents
- Indirect consequences on precipitations
- Need more observations !

Thanks for your attention

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