

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

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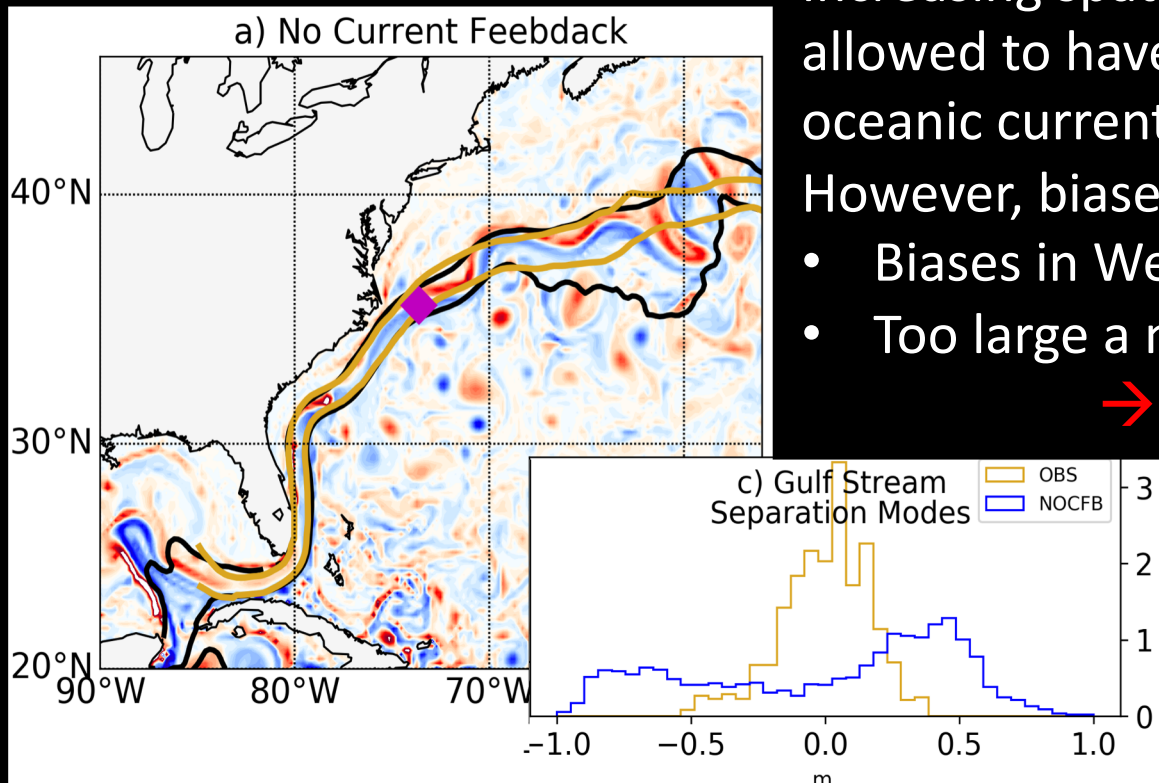
Motivations

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

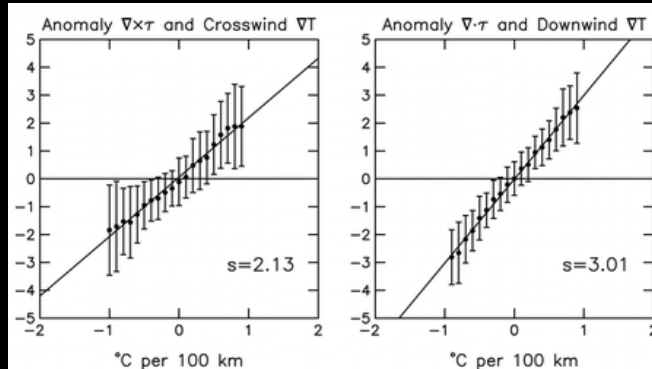
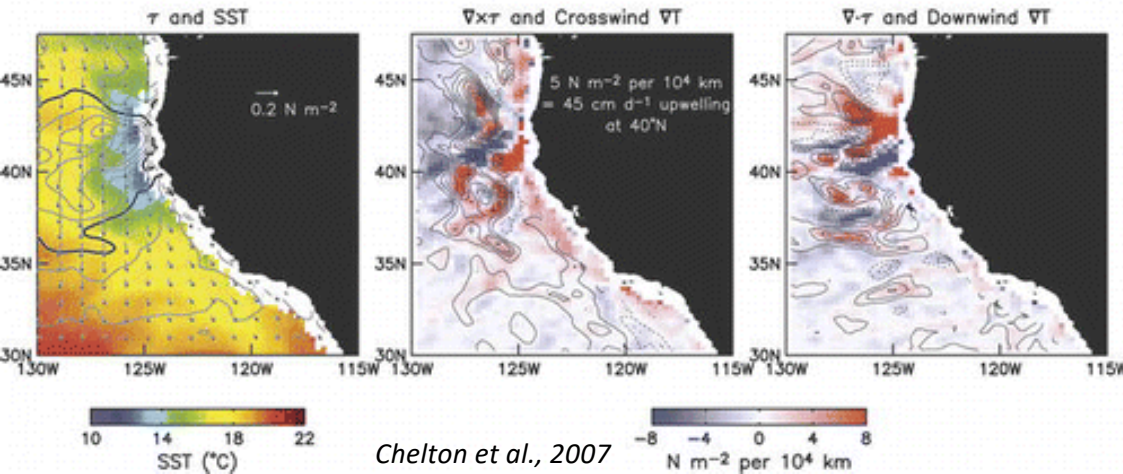
→ Lack of sink of energy



- 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



- 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

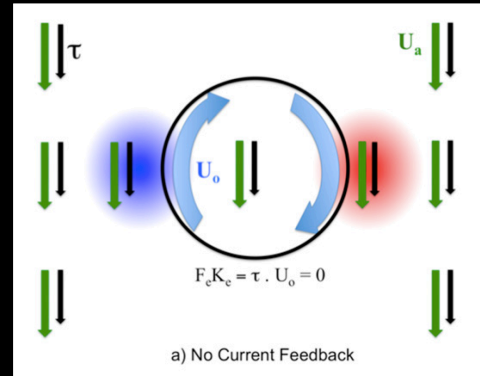
Current Feedback

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”

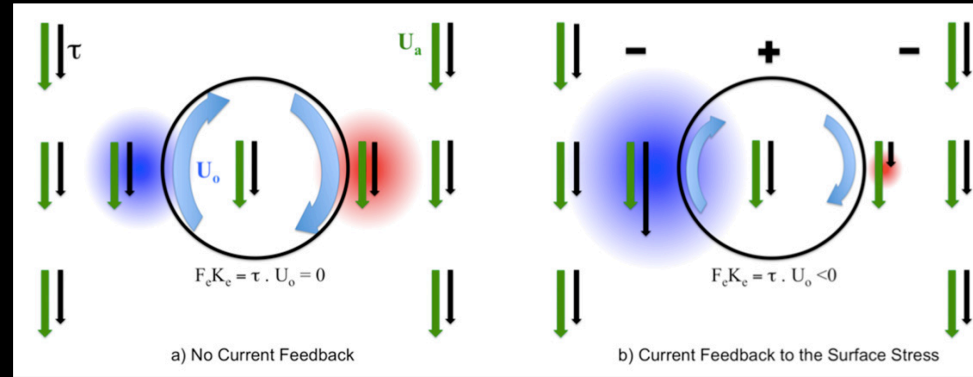


Renault et al., 2016c

Duhaut and Straub 2006; Dewar and Flierl 1987; Dawe and Thompson 2006; Hughes and Wilson 2008; Eden and Dietze 2009; Seo et al., 2016,2018,2019; Renault et al., 2016cd; Renault et al., 2017ab

“Mechanical Damping” or “Eddy Killing”

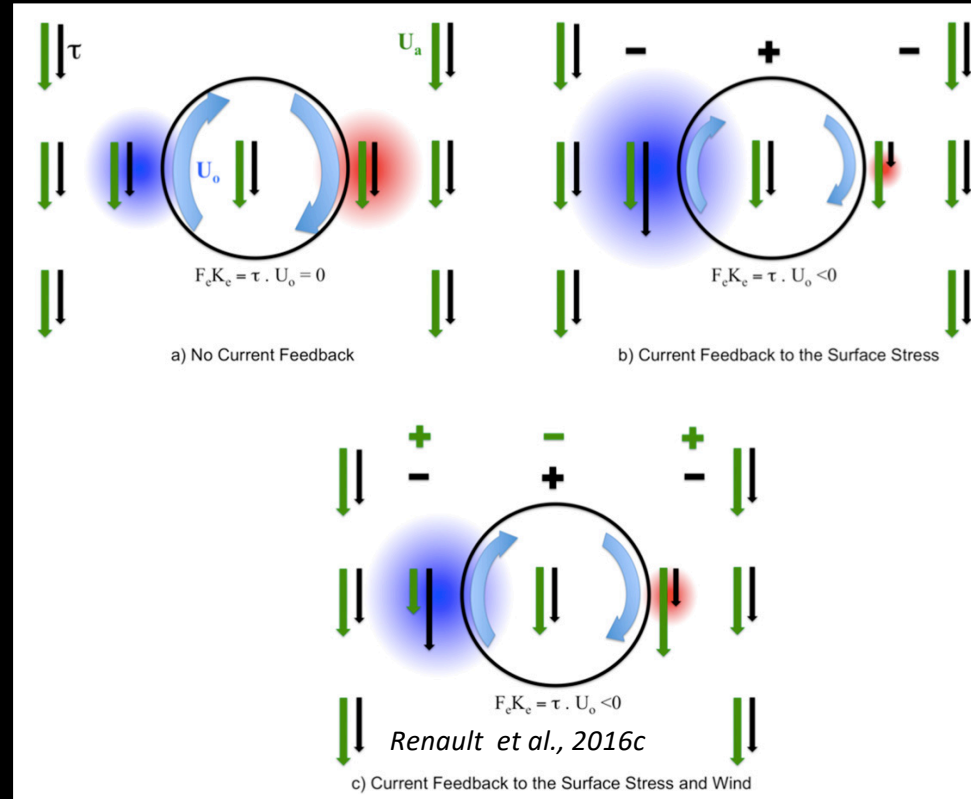
- Not only reduction of $F_e K_e$ but negative $F_e K_e$ (Deflection of energy ocean \rightarrow atmosphere)



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

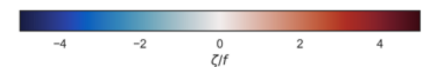
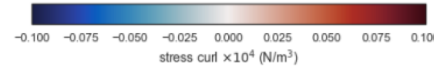
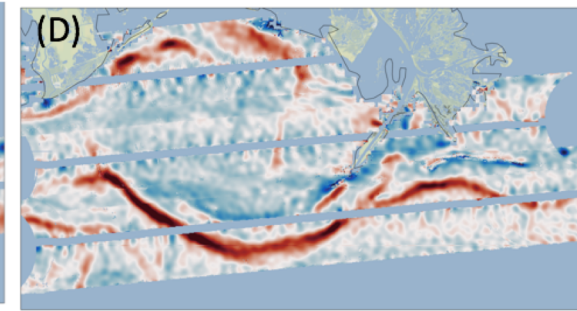
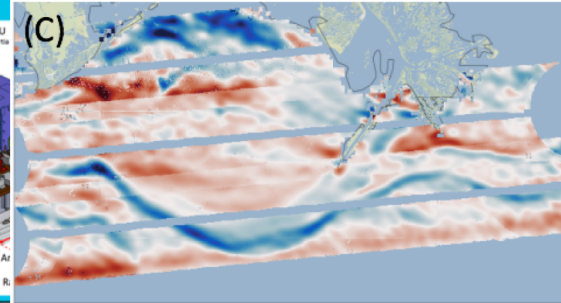
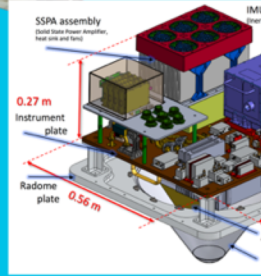


Can be seen from DopplerScatt

Courtesy from E. Rodriguez (NASA)



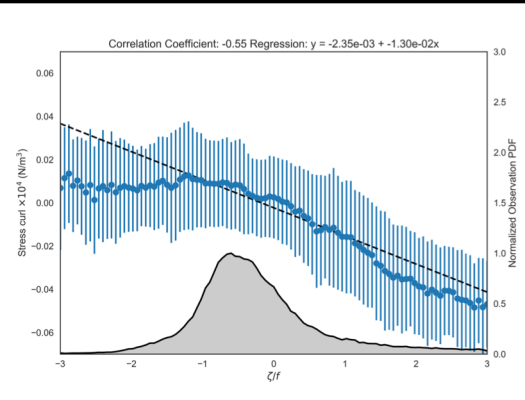
NASA
DopplerScatt



Surface Currents

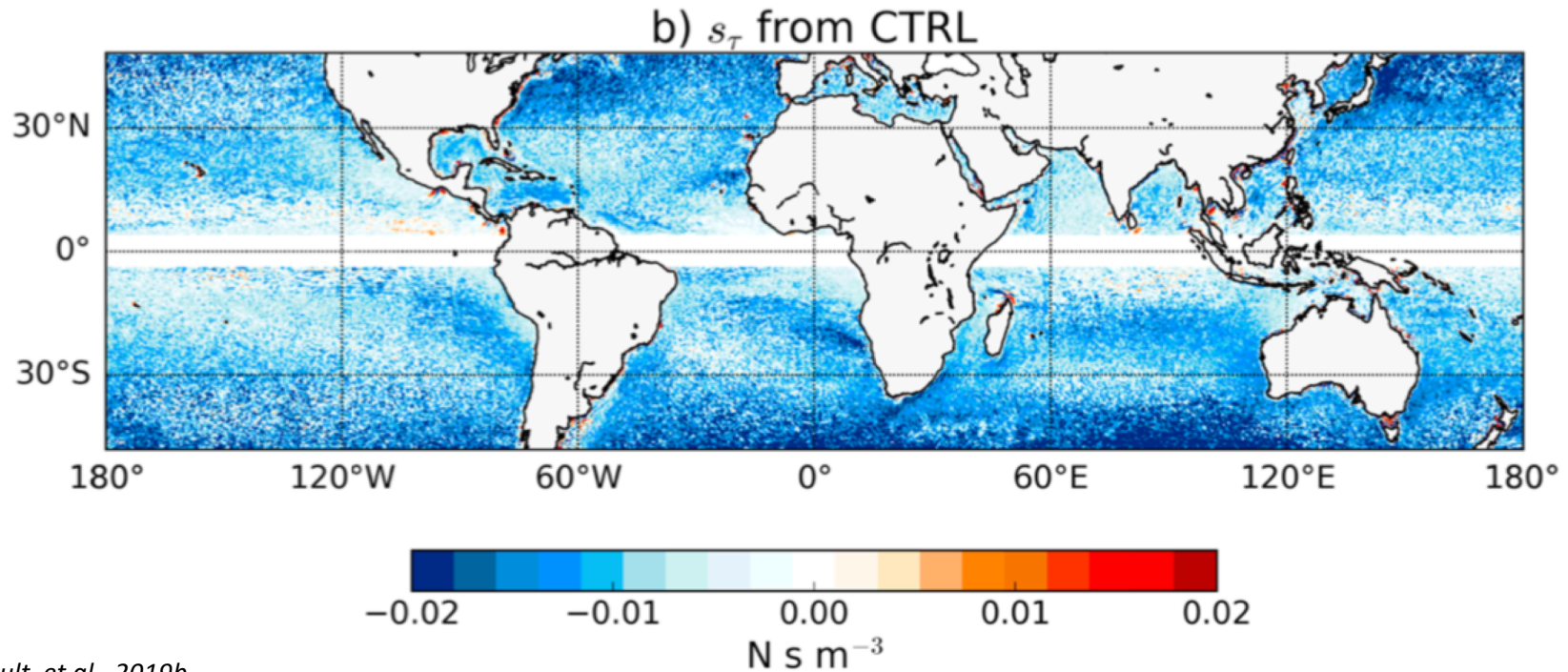
Surface Winds

25 km



*Linear relationship
between mesoscale
stress and current →
coupling coefficient*

Coupling coefficient Estimated from coupled simulations

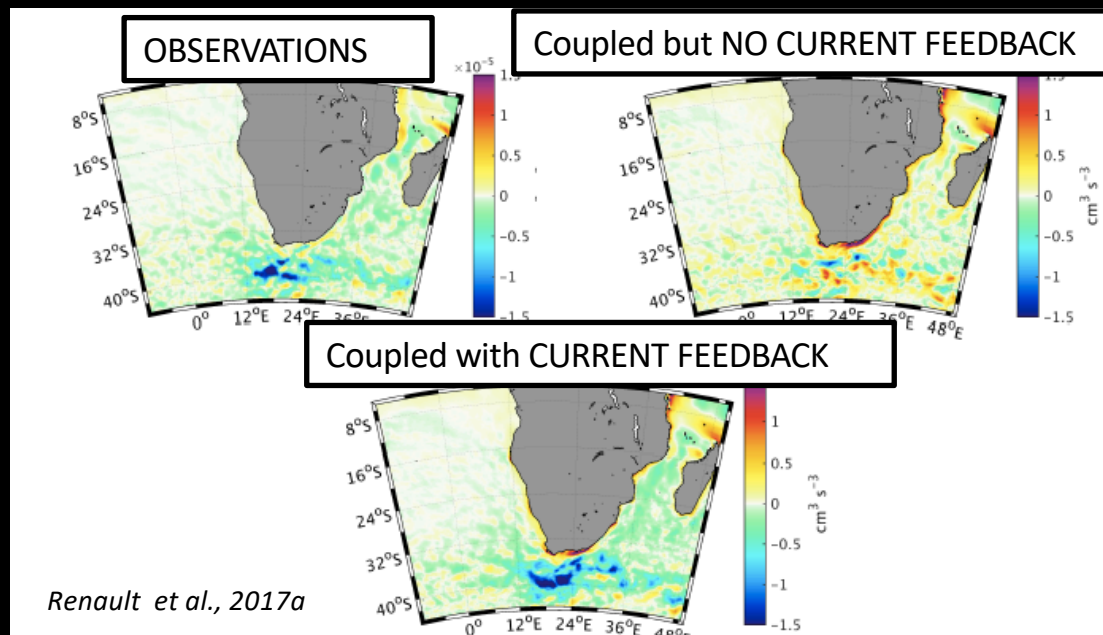


It Induces Transfer of Energy from Mesoscale

Main Effects: Eddies to the Atmosphere

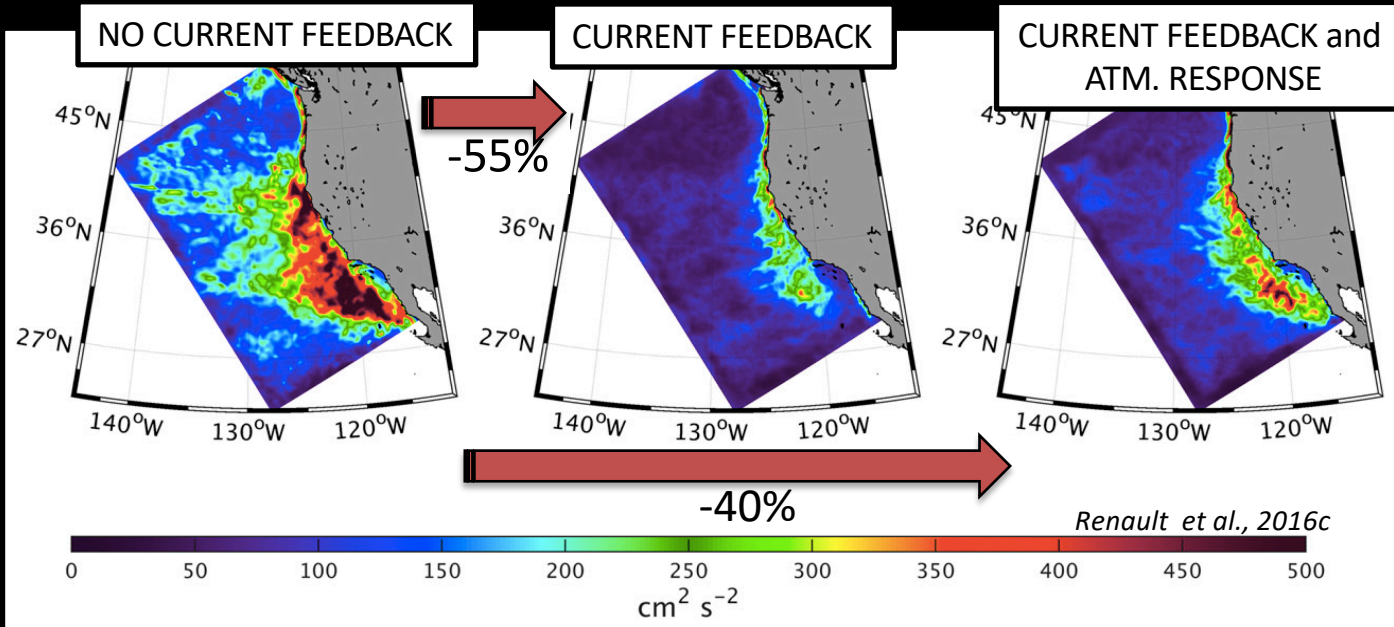
- Slow down of the mean circulation*
- Sinks of Energy from Mesoscale Current to the Atmosphere*
- Can be observed everywhere*

Mean Eddy Wind Work



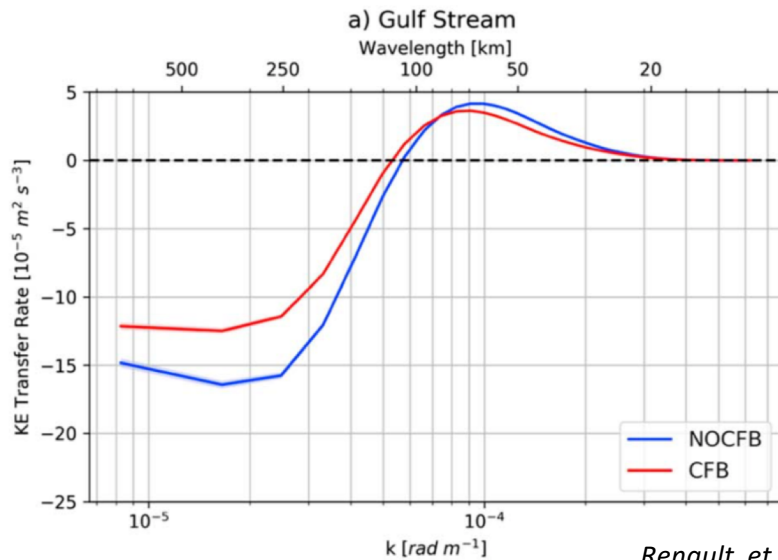
Main Direct Effects

- *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 !**)*

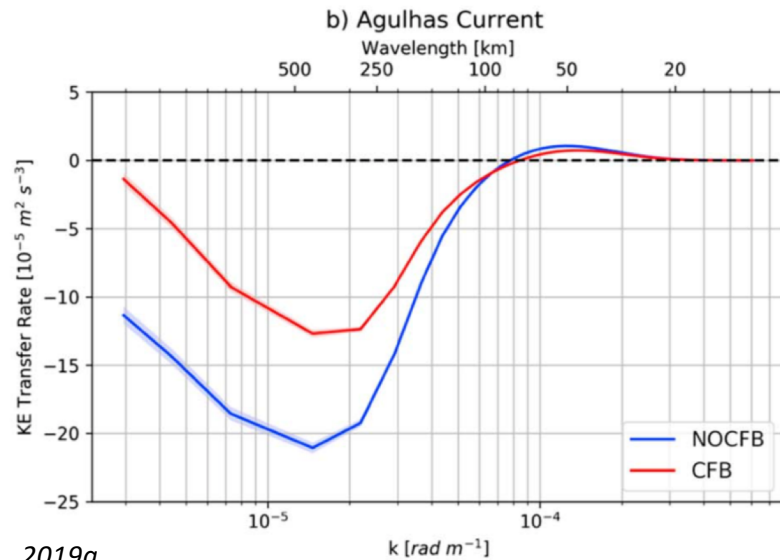


40% US West Coast;
27% North Atlantic;
25% Agulhas Current;
25% Western Mediterranean Sea;
40% Peru-Chile,
35% globally (Renault et al., 2016ab, 2017a, 2018, 2019a, 2020ab; Seo et al., 2016, 2017; Oerder et al., 2017; Jullien et al., 2020).

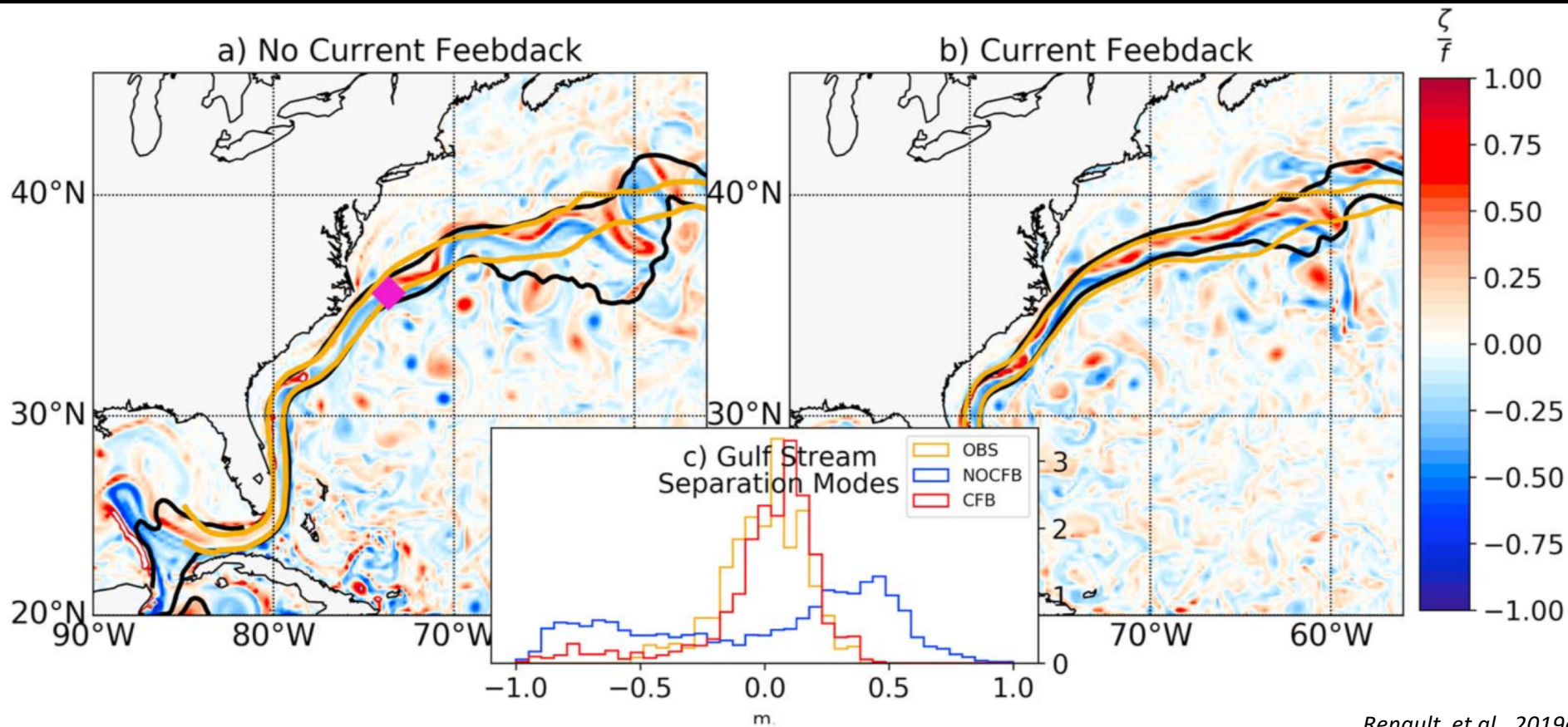
Partial Control of Western Boundary Current through a reduction of the inverse cascade of energy



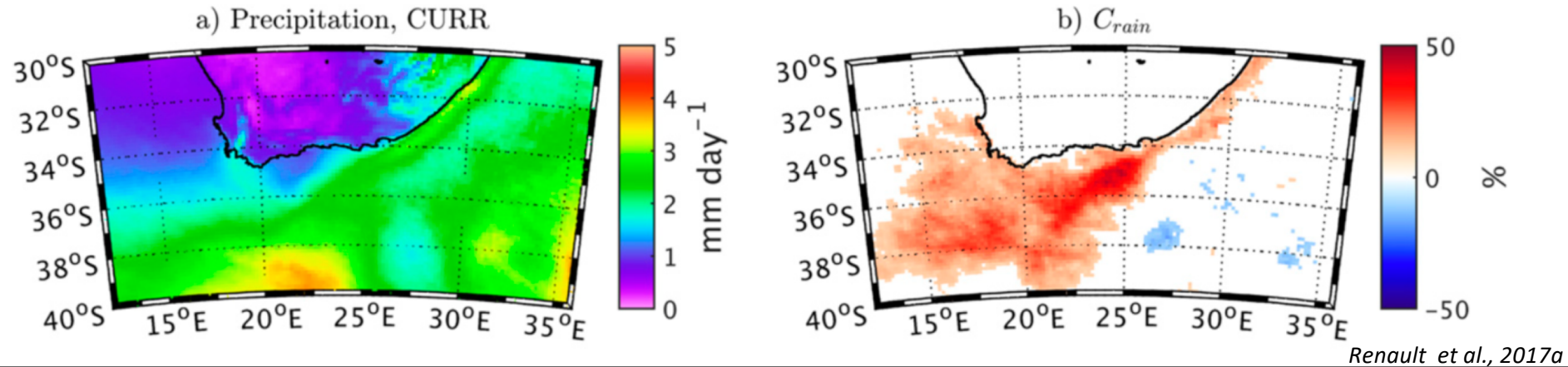
Renault et al., 2019a



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



Indirect Modulation of Precipitations



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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