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Impact of gustiness in turbulent fluxes parameterization on the air-sea coupling and ocean feedbacks in climate simulation

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The turbulent fluxes across the ocean/atmosphere interface, which represent one of the main drivers of the global atmospheric and oceanic circulations, are parameterized in climate models. To improve the representation of turbulent fluxes, a new parameterization has been developed in the IPSL model. It takes into account the gustiness effects which are calculated thanks to the coupling between the bulk formula (used to compute the surface turbulent fluxes) and the thermal and the convection schemes (that provide the deep and free convection effect on the subgrid variability of surface winds).

Here we investigate how this new effect modulates the ocean-atmosphere interactions and feedbacks. We consider both atmosphere only and coupled ocean-atmosphere simulations ran with the IPSL climate model. We focus on the thermodynamical and the dynamical adjustments of the atmospheric and oceanic circulation induced by the coupling between gustiness and turbulent fluxes.

In atmospheric stand-alone simulations, the gustiness has a direct effect on turbulent fluxes through the increase of low-level wind used for their calculation. This increases wind stress and leads to indirect effect by reducing the low-level wind. In addition, gustiness significantly impacts latent heat flux in weak wind regions. This modifies the zonal humidity gradient in the Pacific Ocean, which affects the Walker circulation. In coupled ocean-atmosphere simulations, part of the latent heat flux effect is offset by the ocean adjustment through ocean heat storage and sea surface temperature changes. A feedback loop between the wind stress and ocean circulation also affects the overall ocean and atmospheric circulations. The relative amplitude of these feedbacks will be discussed, considering the role of changes in surface turbulent fluxes on ocean and atmospheric circulations, which control heat transports and inter-basin teleconnections.