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Representation of air-sea coupling in the Gulf Stream region in high resolution observations and model simulations

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Western boundary current (WBC) regions such as the Gulf Stream and the Kuroshio in the Northern Hemisphere and the Agulhas in the Southern Hemisphere, contribute to the transport of warm and salty waters from the equator to higher latitudes and are characterized by sharp sea surface temperature (SST) gradients (from 4ºC to 10ºC in 100 km) as well as an important eddy activity. Thus, they have a relevant role in the global climate system. Over the past decades, a better understanding of air-sea coupling in WBC regions has become possible with the development of new satellite measures. More specifically, the analysis over the Gulf Stream region of the relationship between surface winds and SST has revealed a small scale coupling between the atmosphere and the underlying ocean (Chelton et al. 2001). Using satellite observations, Minobe et al. (2008) also showed that SST fronts can influence the atmosphere through the entire troposphere. Western boundary currents can hence potentially influence the atmosphere beyond the boundary layer, with possible climate impacts over remote regions like Europe. Model simulations have also provided valuable analysis to better understand the mechanisms through which SST fronts can impact the large scale circulation (e.g. Woollings et al. 2010, Brachet et al. 2012, Small et al. 2014, Piazza et al. 2015). In this study, we examine the relationship in the Gulf Stream region between SST and wind stress in high-pass filtered observations and in two sets of atmosphere-land simulations forced by observed SST and sea ice for the period 1950-2014. The two sets of simulations were done using the atmospheric component of the newly developed CNRM-CM6 model, at low resolution (T127-130km) and at high resolution (T359-45km). These experiments are part of the high-res MIP/PRIMAVERA project. We investigate the importance of atmospheric resolution in the representation of surface storm tracks, convective precipitation and wind extremes. Further, in order to identify the region in which the ocean potentially drives the atmosphere, we look at the regional covariability between turbulent heat fluxes and SST. While increased resolution show clear improvement in the representation of air-sea coupling in the Gulf Stream region, we show that models biases remain important even with increased resolution. We further highlight the large uncertainty in the observationally-based datasets in representing the wind-SST coupling, which complicates the interpretation of the results.