The effects of surface stress in surface thermally driven circulation

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We report an experimental study of wind forcing effects in STF-driven (STF, Surface Thermal Forcing) circulation. A variable speed convey belt is applied at the surface of the STF-driven convection to simulate the wind forcing in the ocean. It is found that in the low shear strength regime, the shear along the direction of the STF-driven boundary flow (positive shear) can promote the boundary flow and significantly enhance the heat transfer efficiency by about 26%, while shear that is opposite to the direction of the STF-driven boundary flow (negative shear) will slow down the boundary flow and reduce the heat transfer efficiency by about 10%. In the high shear strength regime, the global heat transfer efficiency slightly decreases with the increase of positive shear stress and reach a plateau finally. In the case with negative shear, the shear-driven shallow cell brings the cold water beneath the cold plate to the region under hot plate. As a result, the stably stratified boundary layer beneath the hot plate is destroyed and the heat transfer efficiency is significantly enhanced. It is further found that the thickness of the stably stratified boundary layer under the hot plate is the key parameter in determining the global heat transfer efficiency of the system. This result suggests that the sea surface wind direction is a factor that should not be neglected in the study of oceanic circulation heat transport.

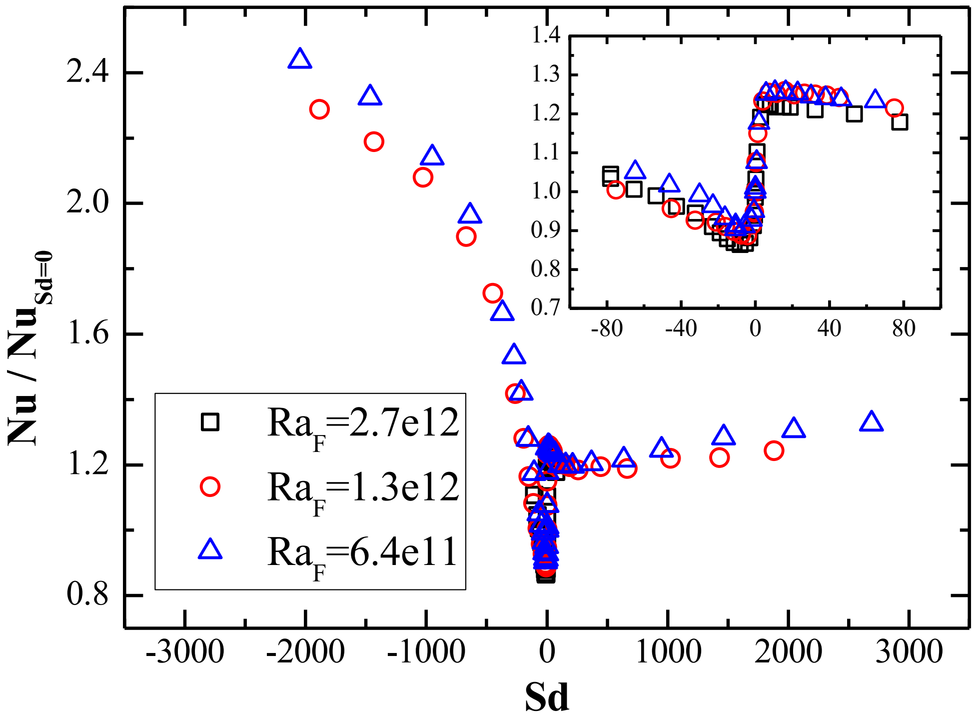

Figure 1: Nu as a function of Sd (non-dimensional shear strength) for different Ra_F. Inset: zoom-in of the main figure.

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