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Impact of shear and curvature on surface gravity wave stress

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It has been shown that surface gravity wave stress is sensitive to the low level wind profile shape. The simplest way of incorporating those effects in a theoretical model has been recently proposed, using a second order WKB approach, which leads to closed analytical formulae for the surface stress as a function of stability, low level wind and its two first derivatives (shear and curvature). In the present study, we assess the impact of those calculations on global scale gravity wave stress and the corresponding torque, using 6-hourly data from ERA-40 reanalysis, at full resolution. While the theory shows that linear wind shear leads to a reduced stress and curvature may lead to stress enhancement, the present results indicate that the latter effect is dominant. However, when one looks for regionally integrated stress fields for the large mountain ranges, where cancellation effects take place thorough time and space integration, the overall effect is one of drag enhancement in regions of dominant easterly flow, namely Antarctica and East Africa, leading to a slight reduction of the global westerly torque due to mountain waves. Drag enhancement due to wind profile curvature seems to be an important effect in Antarctic flow, where it accounts for a 50% increase in the mean regional torque, with implied consequences for the dynamics of the polar vortex.