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Effects of atmospheric stratification and surface properties on the Ekman boundary layer

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About a century ago, Ekman provided analytical solutions on how frictional stresses impact on ocean currents on a rotating Earth. He was able to predict that the surface wind direction was at 45 degrees to the isobars assuming constant eddy diffusivity. The velocity profiles actually observed in the Ekman boundary layer indicate significant deviations from these solutions. This talk addresses the following questions: How are the thickness and the shape of the Ekman layer profiles modified by stratification and the surface properties? How do these profiles differ from classical Ekman spiral?

By choosing appropriate parameterizations for eddy diffusivity, we show that unstable stratification can lead to enhanced veer whereas stable stratification can lead to reduced veer. The reduced veer is well pronounced as the stability increases. We further show that changes in surface conditions (such as vegetation) can generally enhance momentum transfer, reduce wind speeds and increase the cross isobar angle. We conclude by showing the effect of distributed surface properties on Ekman pumping.