Wind turning in the boundary layer - observations, reanalysis and CMIP5 models

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In the boundary layer, the wind turns toward lower pressure and generally veers with height. The angle of wind turning is closely related to the cross-isobaric flow, which is important for cyclone development and the large-scale flow. Numerical weather forecast models and also many climate and earth system models are more diffusive in stable conditions than what is observed. This is in order to avoid too much synoptic activity and reduce nighttime cold biases, but also entails some known modeling problems including too deep stable boundary layers, underprediction of low-level jets and too small wind turning angles. However, these evaluations are mainly based on a few point studies or LES comparisons. Recently large-scale climatologies of the planetary boundary layer height have emerged, but to our knowledge, no such climatology exists of the wind turning. In this study, we aim at presenting a climatology of the angle of wind turning between the surface and the top of the boundary layer, based on radiosonde observations from over 800 locations. The observed climatology is also compared with results from reanalyses and a suite of models participating in the Coupled Model Intercomparison Project Phase 5.
It is found that both the magnitude of the angles of wind turning and the variations in the wind turning angles are smaller in ERA-Interim and the models than what is observed. The turning of the wind increases with wind speed and decreases with the depth of the boundary layer. This is to some extent captured by the models.