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Directionality of the turbulent exchange of momentum: an eigen-decomposition approach

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Atmospheric processes cover a wide range of spatial and temporal scales, where turbulence occurs at the lowest range of this spectrum of motions. The scale determines whether a process may be directly solved in a weather and climate model, or needs to be represented by a simplified empirical formulation due to computational limits.

Existing formulations of near-surface turbulence were developed for flat and horizontally homogeneous terrain, not representative of the majority of earth's land surface. There is evidence that including the information on the directionality of the turbulent exchange of momentum (anisotropy), represented by the eigenvalues of the stress tensor, may improve the empirical formulations used in models and allow their extension to complex orography.

The present contribution explores how specific sets of eigenvalues (determining the shape of anisotropy) and eigenvector's directions are related to specific components of momentum exchange in the coordinate system widely applied in turbulence studies. The approach investigates the uniqueness of the relation between eigenvalues and momentum exchange, and if eigenvectors'direction is physically constrained (e.g. by atmospheric stability, height above ground) as this could give insights for turbulence models. To answer these questions two datasets from a relatively flat terrain and a glacier site are used. It is shown that eigenvectors'direction depends on the examined site and other factors not straightforward to isolate.

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