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Symmetry methods in dynamic meteorology

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Symmetry transformations are a characteristic feature that a great number of differential equations in science possess. They reflect important properties of the underlying processes of nature they are a model for. Symmetry transformations map solutions of a differential equation to solutions. They can be used for various purposes, such as the construction of new solutions from known ones, the derivation of special classes of solutions of differential equations, the construction of conservation laws and for finding transformations which relate equivalent differential equations.

Although the use of symmetry transformations is quite classical in hydrodynamics, there are yet only few applications in dynamic meteorology. In this presentation, we will discuss examples for the utilisation of symmetry transformations of the barotropic (potential) vorticity equation in Cartesian and spherical coordinates in both a rotating and non-rotating reference frame. We will discuss the physical importance of the admitted symmetry transformations and will construct classes of exact solutions including the famous Rossby (–Haurwitz) waves. The differences between potential vorticity equation and the vorticity equation in Cartesian coordinates will be studied in light of their respective symmetry properties. In a similar way we aim to investigate the differences between the vorticity equation in a rotating and non-rotating reference frame.