Methods of group analysis will be applied to issues related to numerics of differential equations and in particular to models arising in dynamic meteorology. Invariant discretization schemes for the shallow-water equations in Eulerian variables will be constructed and implemented. The invariant schemes will be designed using both difference invariants and the method of invariantization of existing schemes by moving frames. With this approach, it is guaranteed that the constructed finite difference schemes will inherit symmetry properties of the shallow-water model. Evaluation of convergence rates, conservation properties and turbulence spectra of the invariant schemes will be carried out, together with extensive comparison with existing classical (non-invariant) schemes. Techniques of inverse and direct group classification of differential equations will be employed to determine parameterization schemes with invariance characteristics. Application of these methods to the shallow-water equations and an atmospheric boundary layer model will be given. Lie symmetries of partial differential equations arising in dynamic meteorology will be used within classical Lie reduction and partially invariant reduction for finding exact solutions of the respective models. The systems to be investigated include the two-dimensional shallow-water equations in Eulerian variables, the anelastic equations and the pseudoincompressible model. Optimal lists of inequivalent subalgebras of the respective maximal Lie invariance algebras will be determined. Based on these optimal lists, Lie reduction and partially invariant reduction will be carried out. The exact solutions to be obtained will be composed to test suites that can be used as benchmarks for the quality of numerical discretizations of the selected models.

The planned commencement of the project is July 2011, the planned end is June 2014. The two-year abroad phase of the project should be done at the Centre de recherches mathématiques at the Université de Montréal under the principal guidance of Professor Pavel Winternitz. The one-year return phase will be completed at the Faculty of Mathematics at the University of Vienna.