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OPENFOAM COMPUTATIONAL FLUID DYNAMICS SIMULATIONS OF THERMAL WIND GENERATION IN MOUNTAIN/VALLEY CONFIGURATIONS

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Thermal winds appear in mountainous areas and valleys due to temperature gradients caused by the buoyancy effects associated with the diurnal heating-cooling cycle of the lower atmosphere. These winds develop over complex topographies of multiple scales, and reverse their direction twice a day, driven by formation and dissipation of temperature inversions. Winds may flow up-slope (anabatic winds), up-valley, or from the plain to the mountain massif during day-time. Conversely, during night-time, winds may flow down-slope (katabatic winds), down-valley, or from the mountain massif to the plain. Previous investigations have shown that such winds can reach relatively high speeds [1], which can be interesting for wind energy applications. Moreover, thermal winds showing higher regularity and periodicity than synoptic winds [1], can thus be more predictable, which is of special interest to the current energy market, aiming to match the energy demand with the renewable energy production, given the fact that wind energy and solar energy production cannot be controlled at will.
In this work, thermal wind generation is analysed using OpenFOAM, which is an open source computational fluid dynamics software. For this analysis, an idealized numerical model of a mountain-valley system with a mountain slope angle of 20º is used. Anabatic and katabatic winds are generated imposing altitude-dependent temperature boundary conditions on the slope. OpenFOAM's solver *buoyantBoussinesqPimpleFoam* is used, and validation of different turbulence models and initial conditions is done by comparing OpenFOAM simulations with results from the literature. The effects of the fluid domain height and of the valley width on the flow behaviour are also discussed. Conclusion on anabatic and katabatic wind formation and on their possible application to wind energy generation is finally drawn.

REFERENCES

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