

The Met Office BLASIUS model

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- **BLASIUS – Boundary Layer Above Stationary, Inhomogeneous Uneven Surfaces**
- **Developed in Atmospheric Processes and Parametrizations (APP), Met Office.**
- **Numerical schemes used are similar to those described by Clark (1977).**

Description of the model

The Equations

- **Boussinesq or anelastic equation set**
- **Height based terrain-following coordinate system (Gal-Chen and Somerville, 1975)**
- **1st order (mixing length) or 1-1/2 order (TKE transport equation) turbulence closure models**
- **LES capability using Smagorinsky sub-grid model + stochastic backscatter (Thompson and Mason, 1992)**

Description of the model

Discretisation

- **Finite differences on a staggered C-grid**
- **Momentum equations: 2nd order centred differences (Piacsek and Williams, 1970) for advection**
- **Potential temperature (and other scalars) advected with Ultimate-Quickest (TVD) scheme (Leonard et al. 1993).**
- **Vertical grid stretched**

Description of the model

Boundary conditions

- **No-slip** (similarity laws for surface stress) or **free-slip** lower boundary conditions (Durran and Klemp, 1983)
- Canopy model incorporated
- Periodic, inflow-outflow or radiative lateral boundary conditions

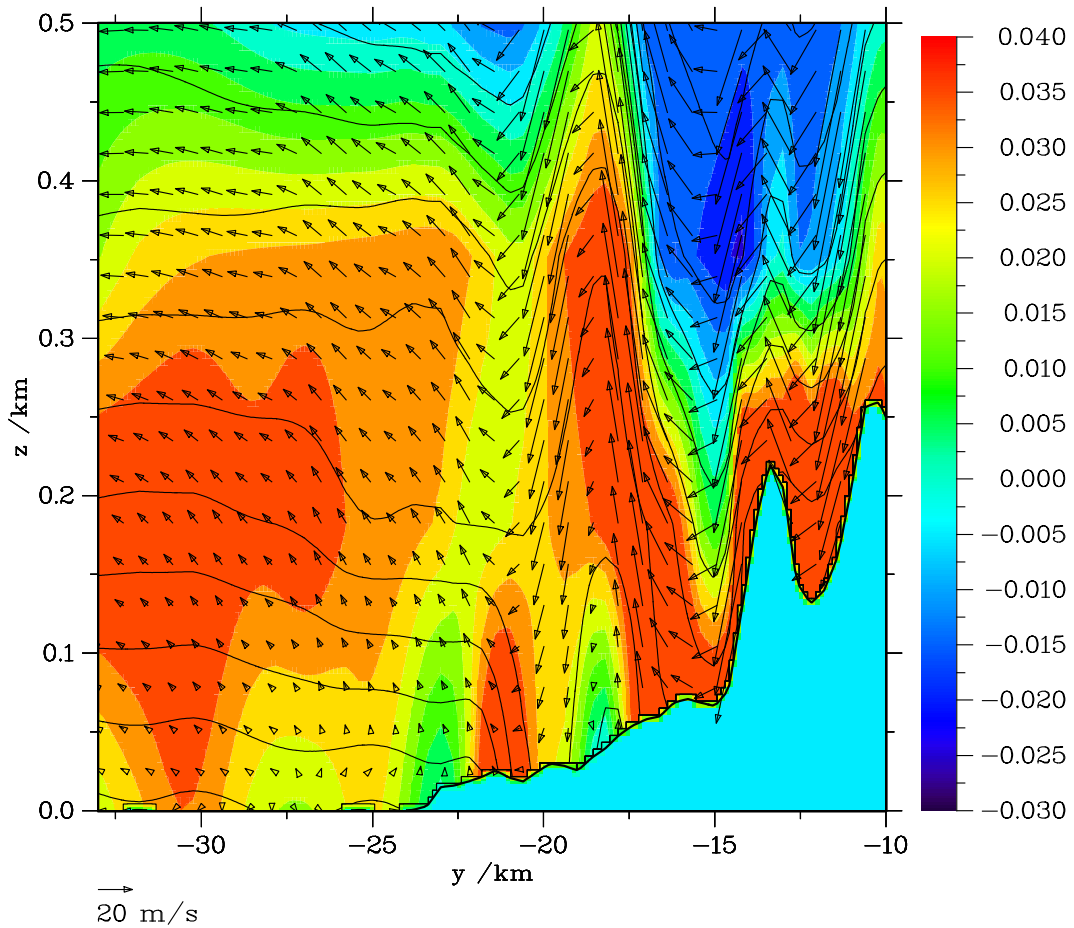
Solution procedure

- Explicit leap-frog time integration scheme
- Elliptic equation solved for pressure at each time step ensures continuity equation is satisfied. Solver based on Fourier transform method. Iteration required due to bent nature of the grid.

Examples of uses of BLASIUS

- **Stable, convective and neutral boundary-layer flows past hills**
- **Lee-wave rotors – idealised and real case studies**
Some verification of hydraulic jump flows with Falklands field data.
- **LES of neutral and convective boundary layer flows past hills.**
Neutral flows verified against wind tunnel data.
- **Flows over forested hills**
- **Flows through mountain passes**

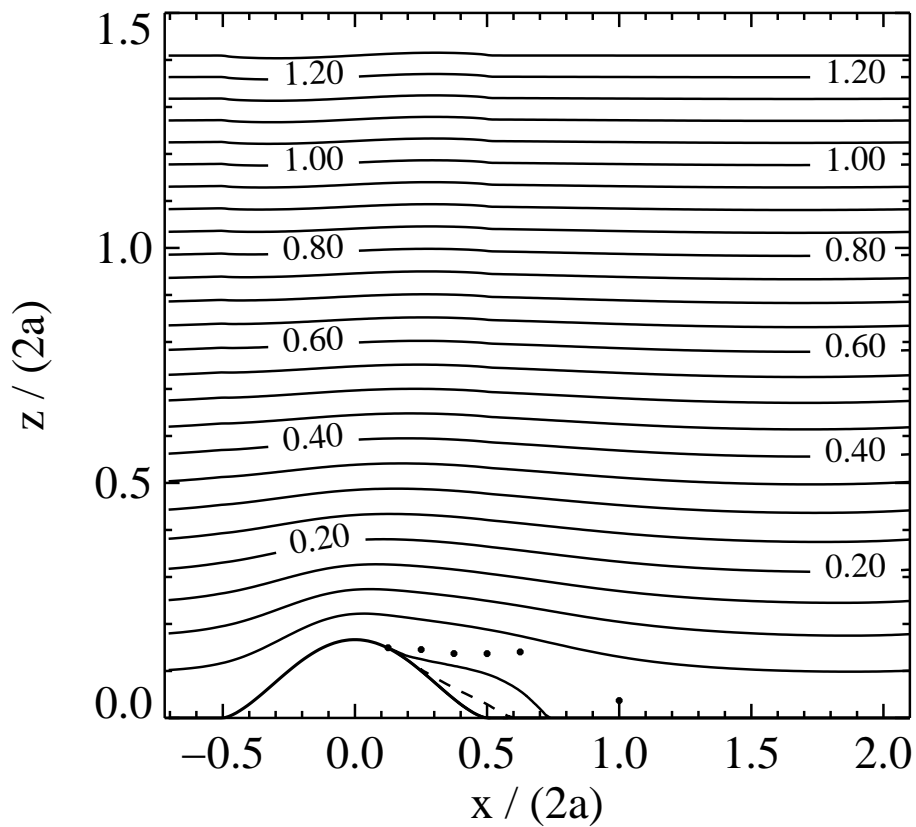
Examples of uses of BLASIUS



Cross-stream vorticity (colour), isentropes and velocity in a hydraulic jump flow over the Falkland

Islands

Examples of uses of BLASIUS



The average streamfunction from a BLASIUS LES Rushil simulation. The dots show the location of the zero streamfunction measured in the wind-tunnel. Broken line shows mixing length results.

Limitations

- Hill slopes generally limited to about 0.45 for pressure solver convergence
- Pressure solver can be expensive for separated flows behind steep hills (60% of CPU time)
- CFL constraints due to explicit time integration (problematic for high resolution e.g. LES)
- Has a stretched horizontal grid capability but this slows down pressure solver considerably