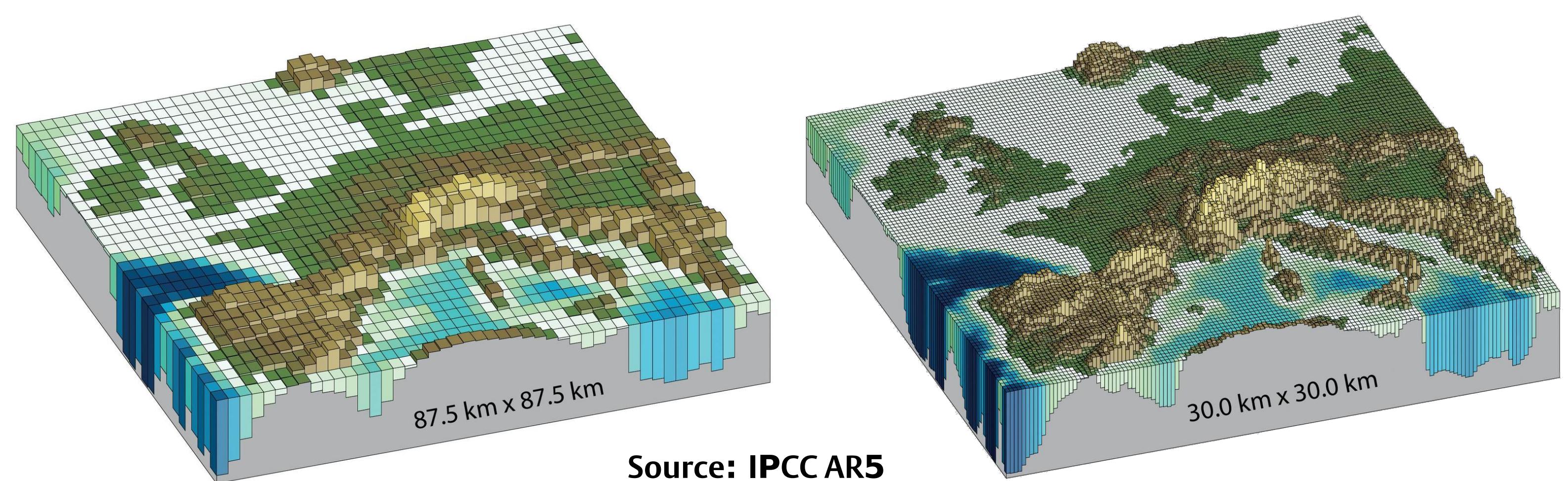


Improving numerical accuracy over steep slopes

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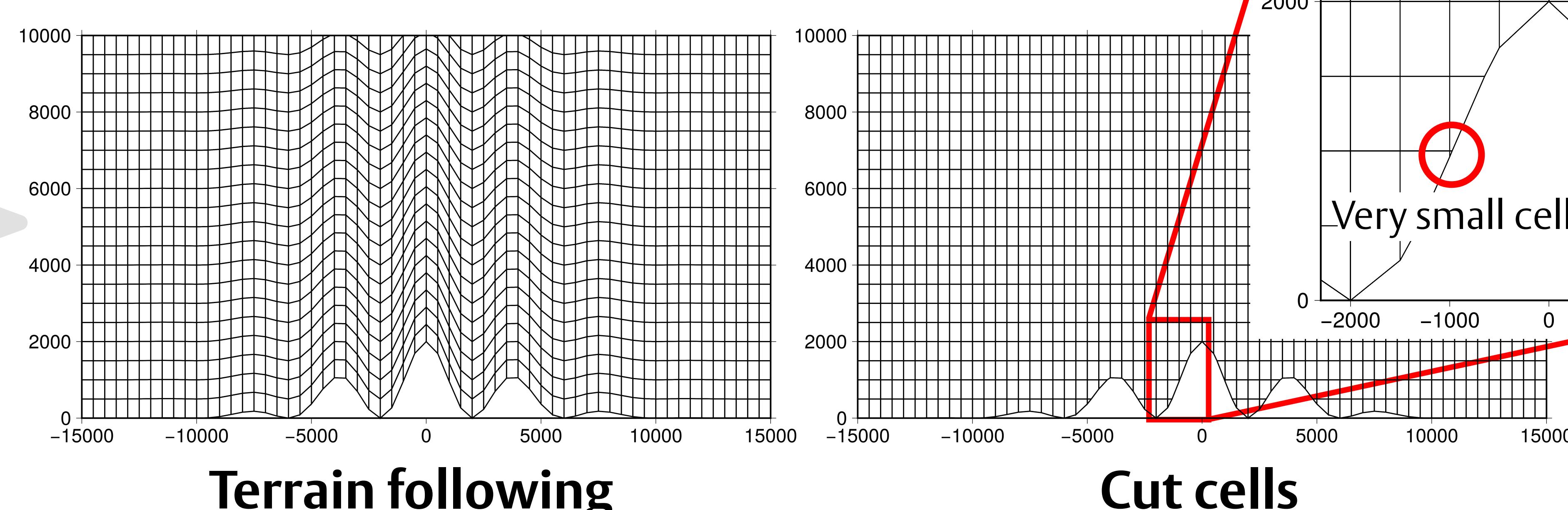
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Motivation



- Increasingly fine meshes allow atmospheric models to resolve small-scale, steep slopes
- Steep slopes reduce accuracy when traditional numerical schemes are used
- I am exploring new meshes and numerical schemes to improve accuracy over steep slopes

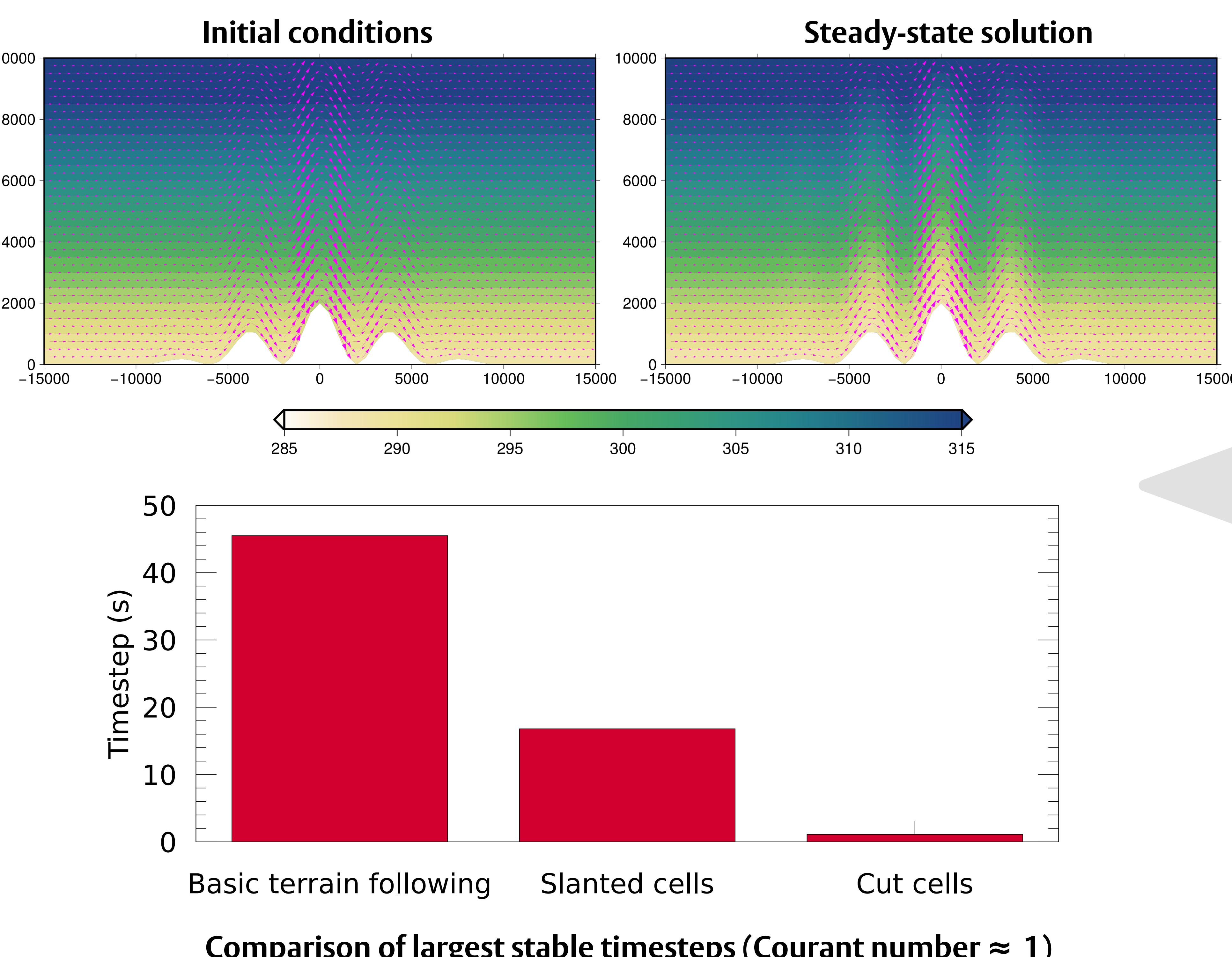
Existing types of mesh



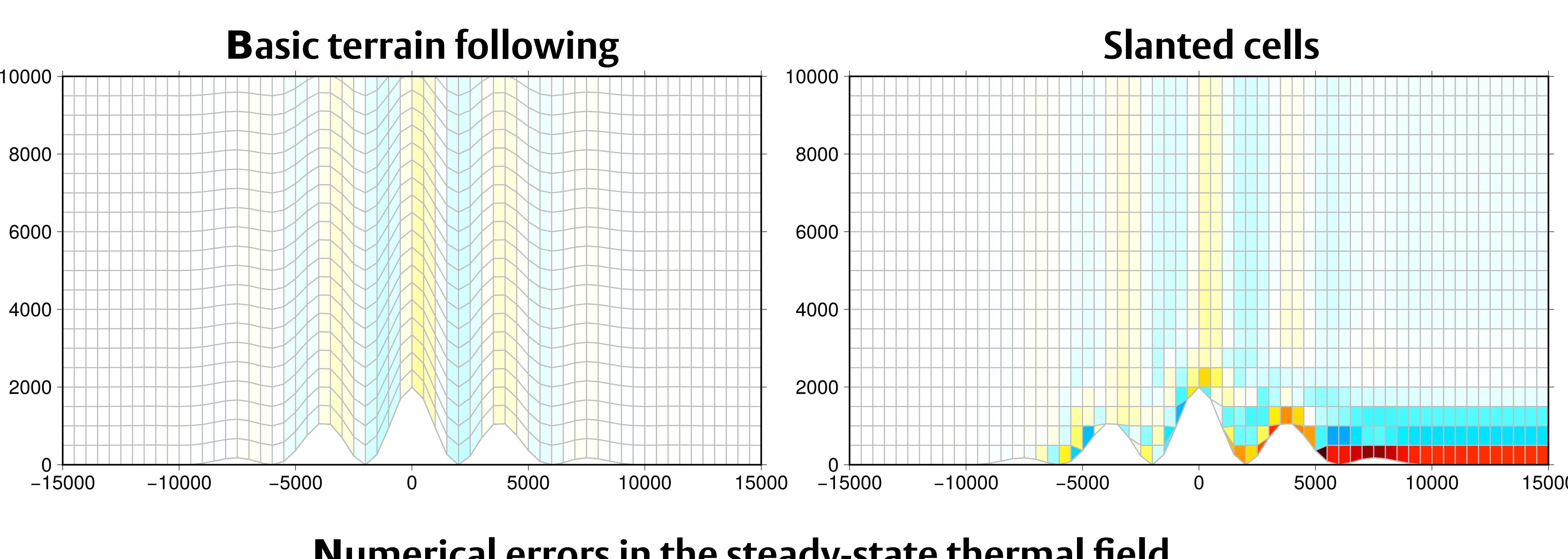
- + Widespread operational use
- + Modelled with simple data structures
- Mesh can be highly distorted
- + More orthogonal
- + Can improve numerical accuracy
- Small cells constrain the timestep

Slanted cells avoid severe timestep constraints

- A new advection test is used to examine timestep constraints on the slanted cell mesh
- The test has a stratified thermal profile advected in a prescribed wind field
- Mimics real atmospheric flow over orography
- Steady-state thermal field has an analytic solution



- Slanted cells alleviate the timestep constraint associated with cut cells



- Work is ongoing to improve stability and accuracy for arbitrary meshes

A new type of mesh: the slanted cell mesh

- The slanted cell mesh is designed to improve accuracy without severely constraining the timestep

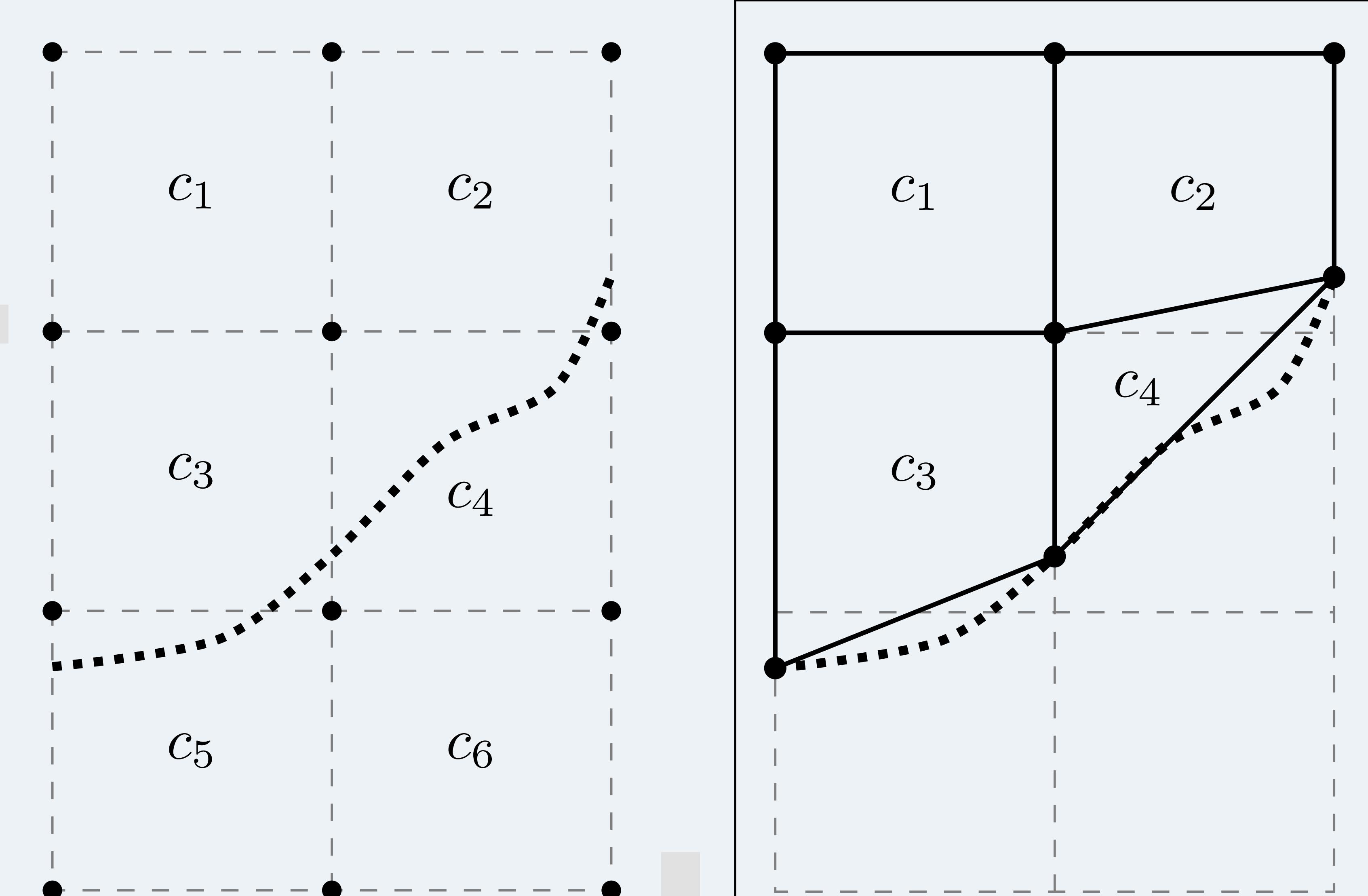
Make your own slanted cell mesh

The push pins are the cell vertices and the elastic bands form the cell edges

To create a slanted cell mesh, start from a uniform mesh of quadrilaterals:

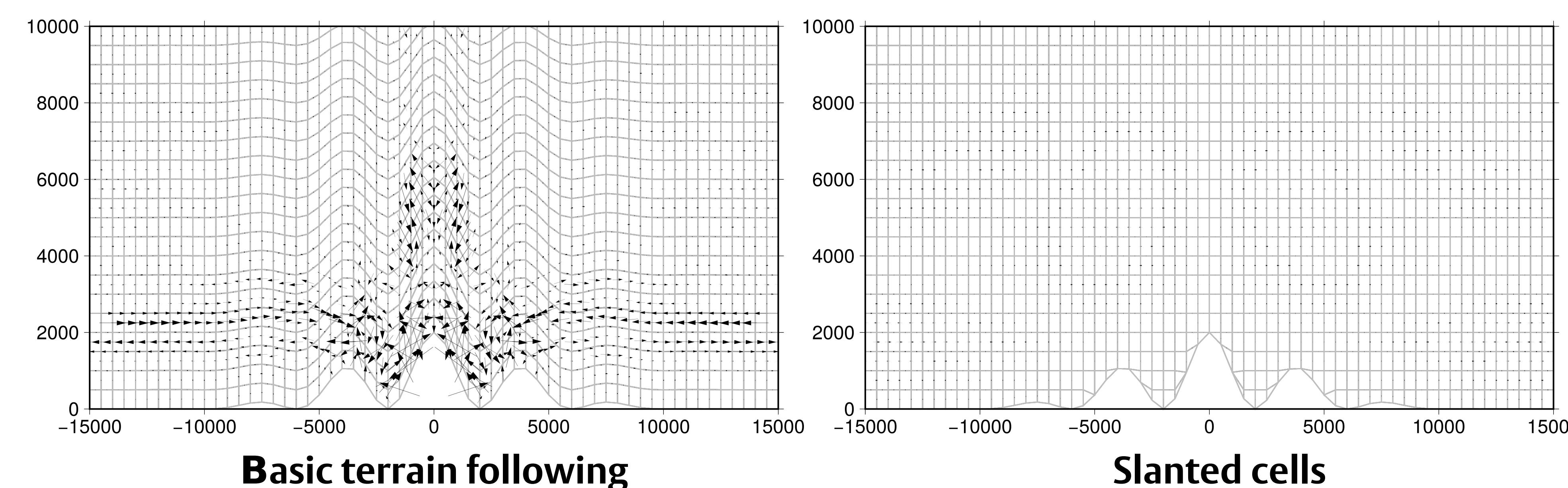
- Move any push pins that are just above the ground to the surface
- Move any push pins that are underground upwards so that they are at the surface
- Wrap elastic bands around the push pins to create triangles and quadrilaterals

Lift the flap to check that your mesh matches ours



Slanted cells reduce pressure gradient errors

- Numerical errors in calculating pressure gradients generate spurious circulations
- Calculations are tested using a stratified atmosphere initially at rest
- An inversion layer that intersects the orography challenges the numerical scheme



- Spurious circulations are much smaller on the slanted cell mesh