

A hybrid and nonlocal convection parameterisation scheme for the LM

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Motivation:

convection crucial for **redistribution** of heat, moisture, and **mass**

→ precipitation forecast...

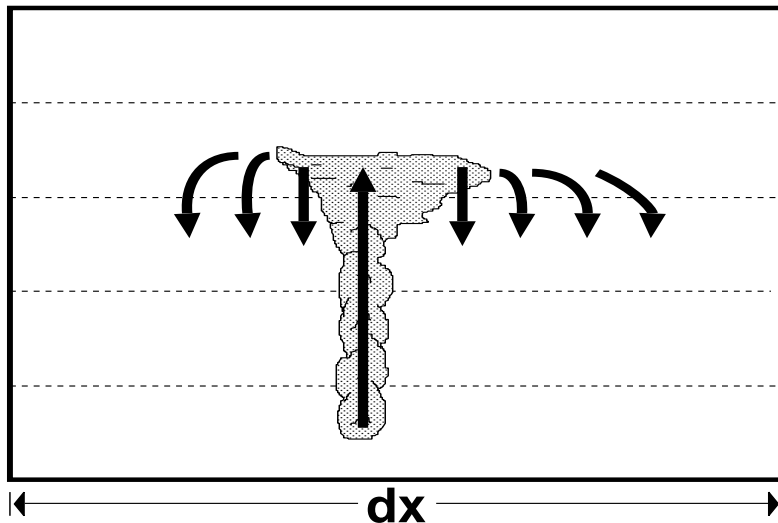
convection usually parameterised

→ mass flux schemes (**but no direct mass transport!**)

classical schemes

grid size $> 20\text{...}50$ km:

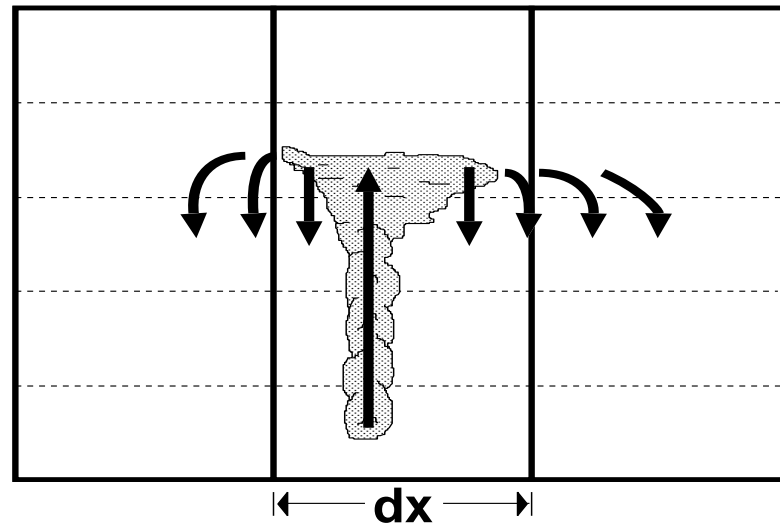
conv. **entirely subgrid scale**



new scheme

grid size $\approx 1\text{...}20$ km:

convection **partially resolvable**



Hybrid scheme:

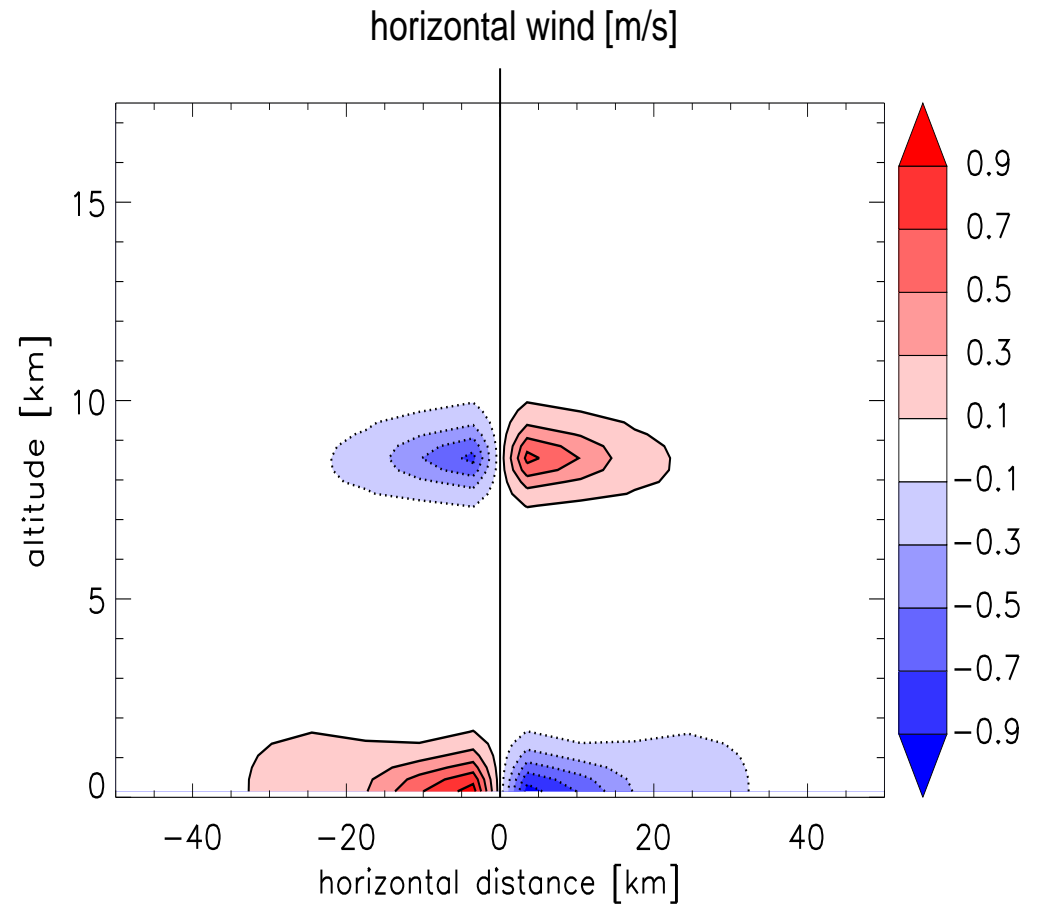
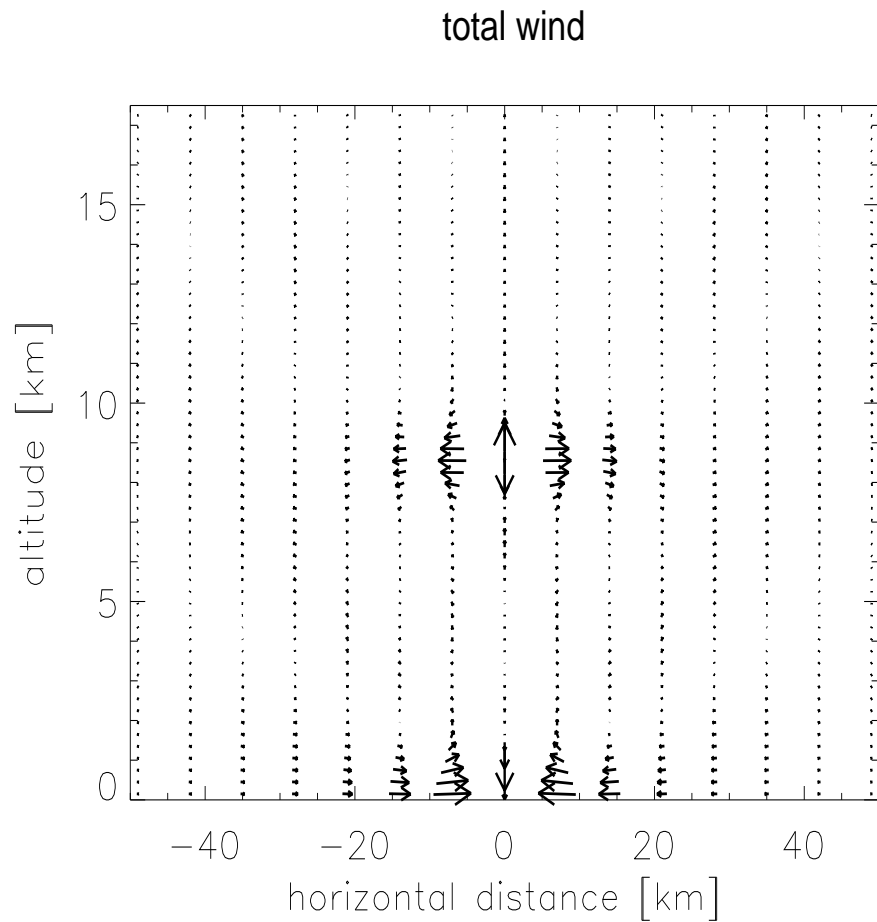
- parameterise up/downdraft (**subgrid scheme**)
environmental subsidence by **grid scale equations**
→ also influences neighbouring grid boxes; non-local scheme
- *net* mass transport by parameterisation scheme
- split mass flux into **grid scale** and **subgrid scale** contribution:

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{v}) + \nabla \cdot \mathbf{J}_m = 0$$

- treat convective moisture and heat fluxes analogously...
- more realistic dynamics, independence on grid size of hosting model

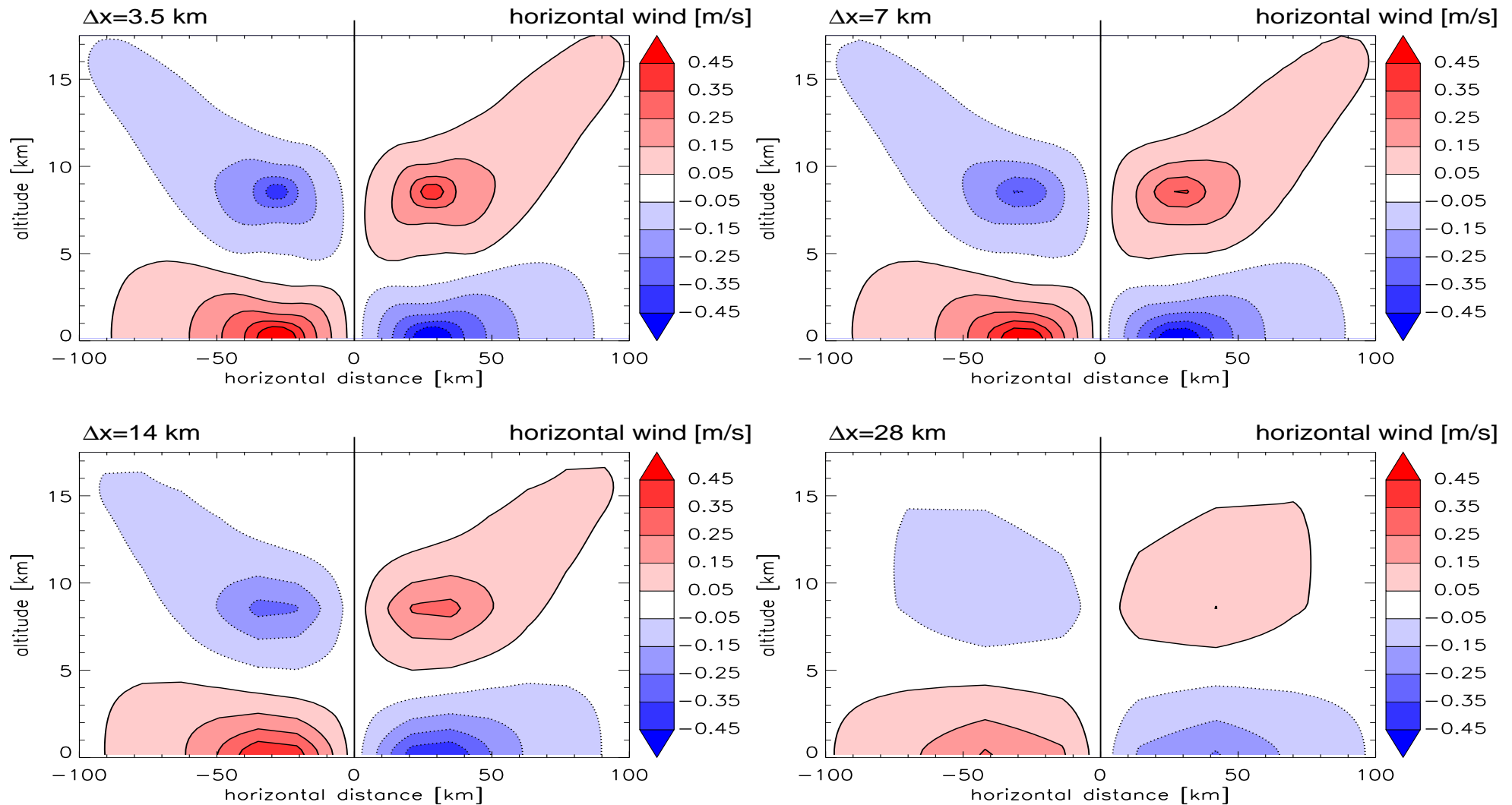
Check mass transport:

LM, $\Delta x=7$ km, dry **subgrid scale mass transport** in single grid column
(detrainment at environmental temperature)



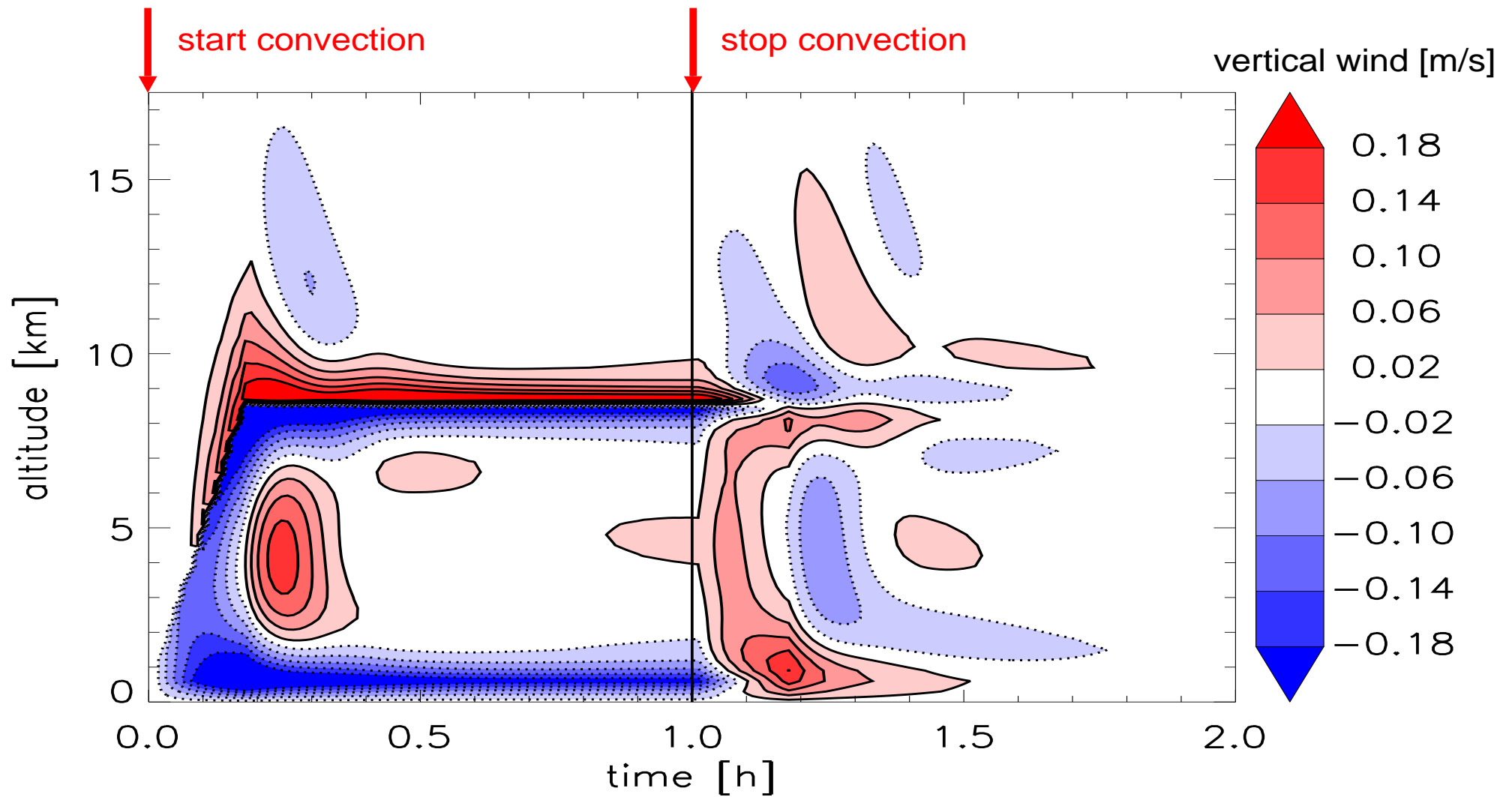
Check independence on grid size:

convective cells in fixed area ($56 \text{ km} \times 56 \text{ km}$), fixed mass flux and mass flux density but **different grid resolutions in LM**



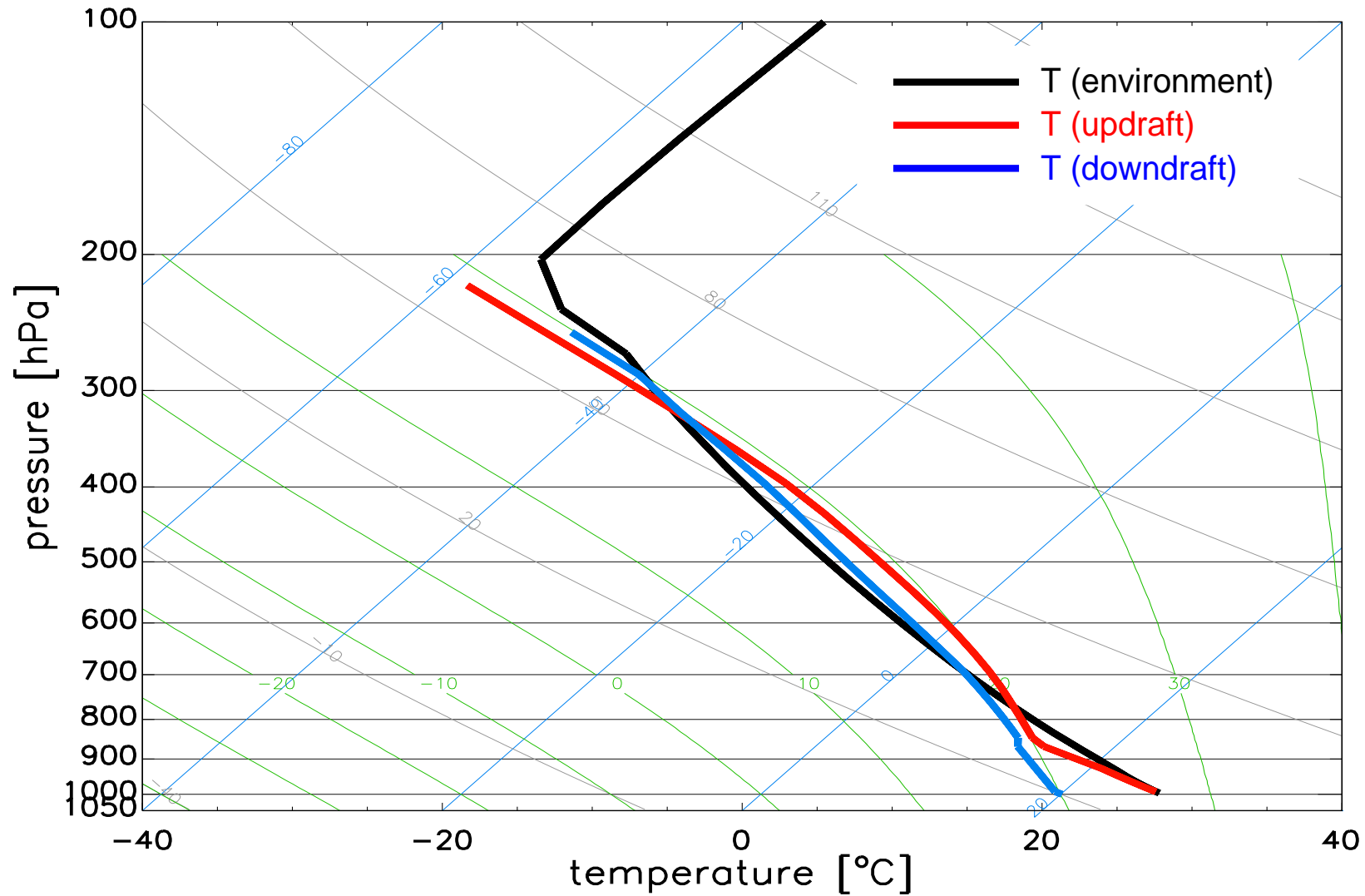
Gravity waves:

linear growth of conv. cell, switch convection smoothly on/off

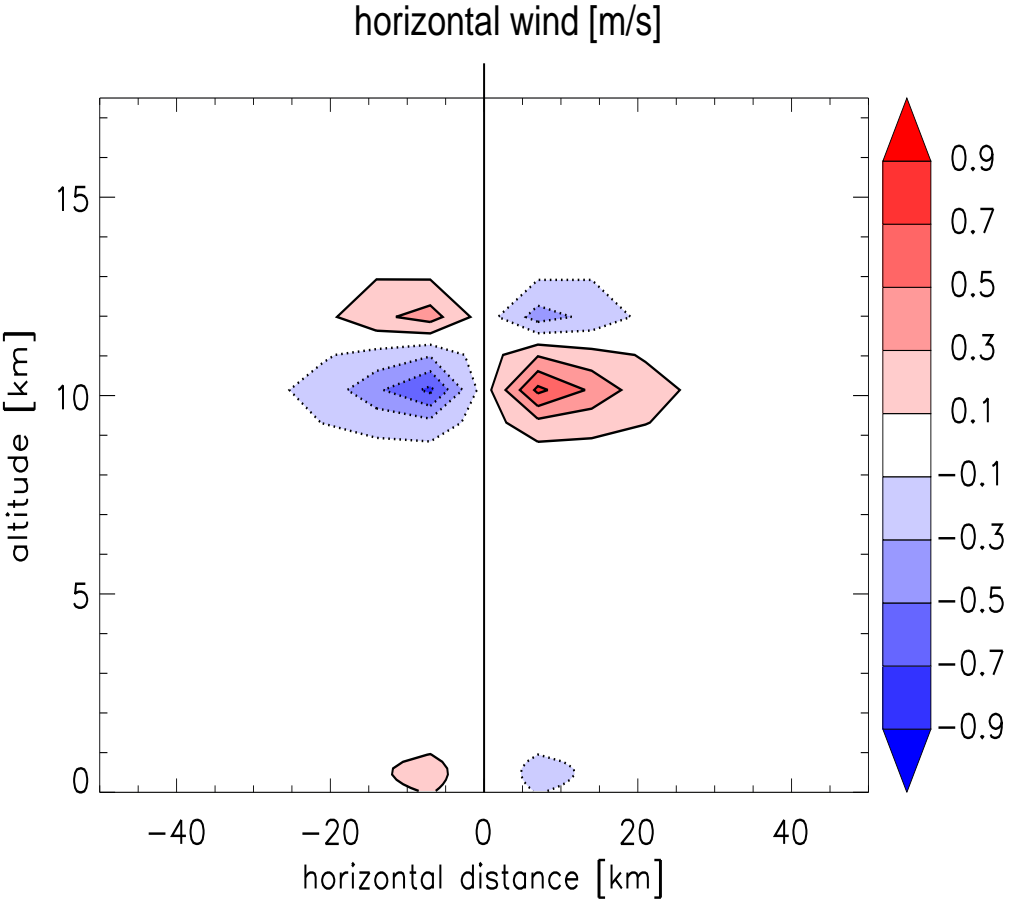
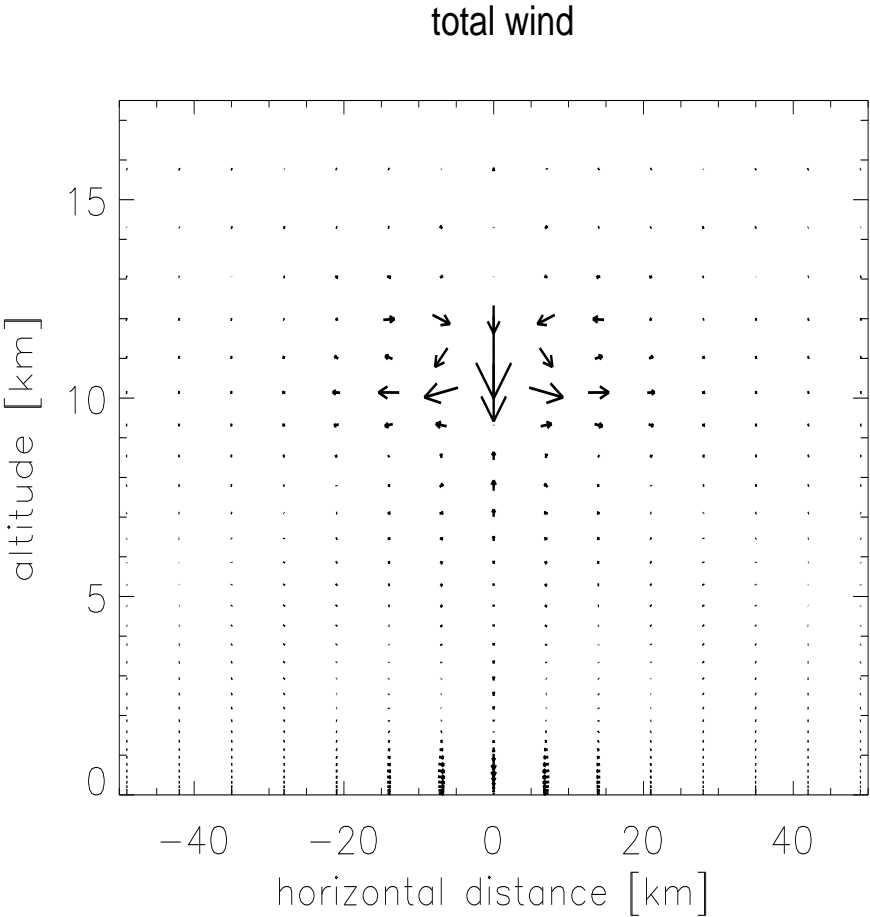


Moist convection:

simple cloud model (including ice) with updraft, downdraft, precipitation

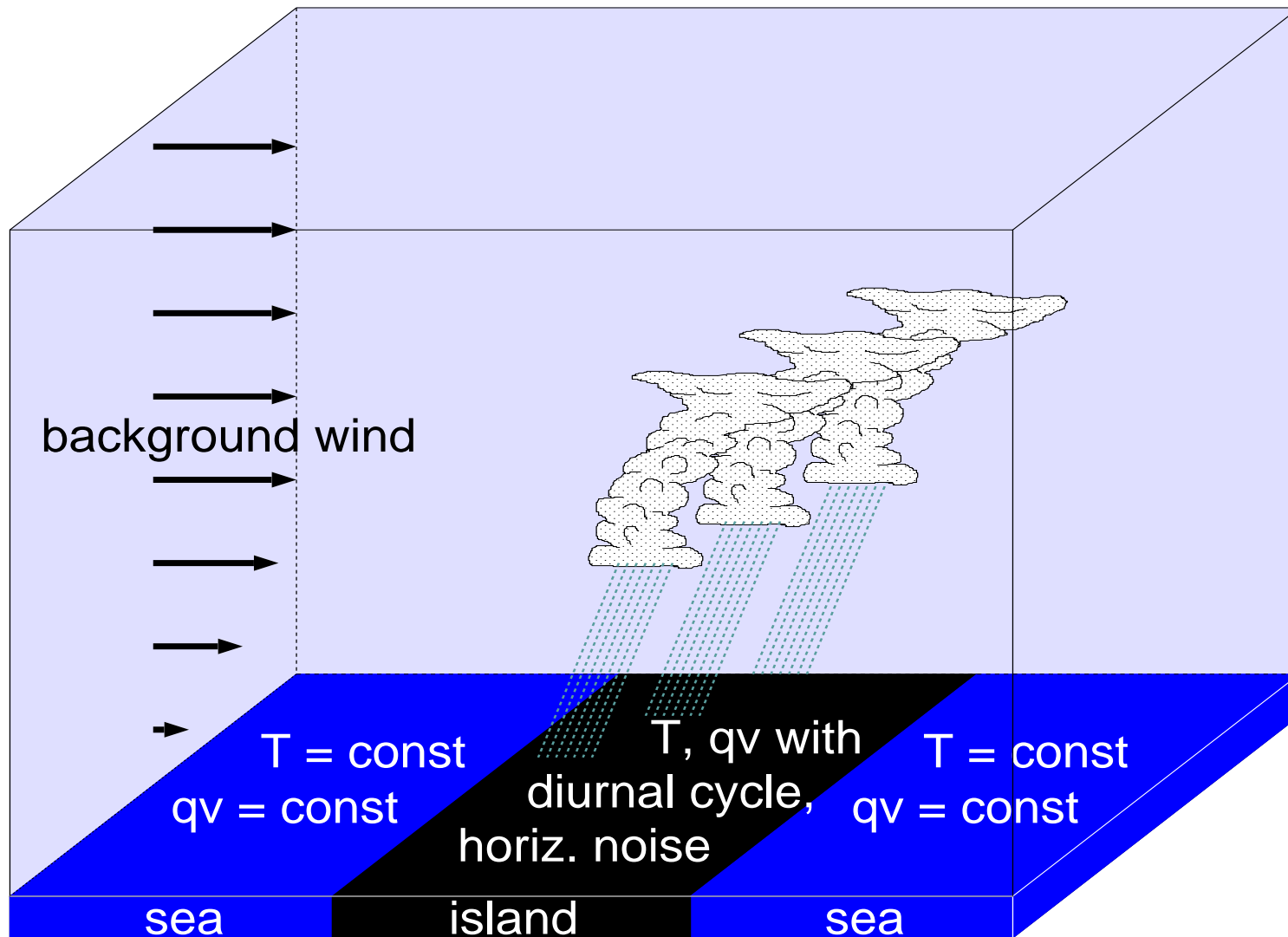


single convective cell
with cloud model and full thermodynamics



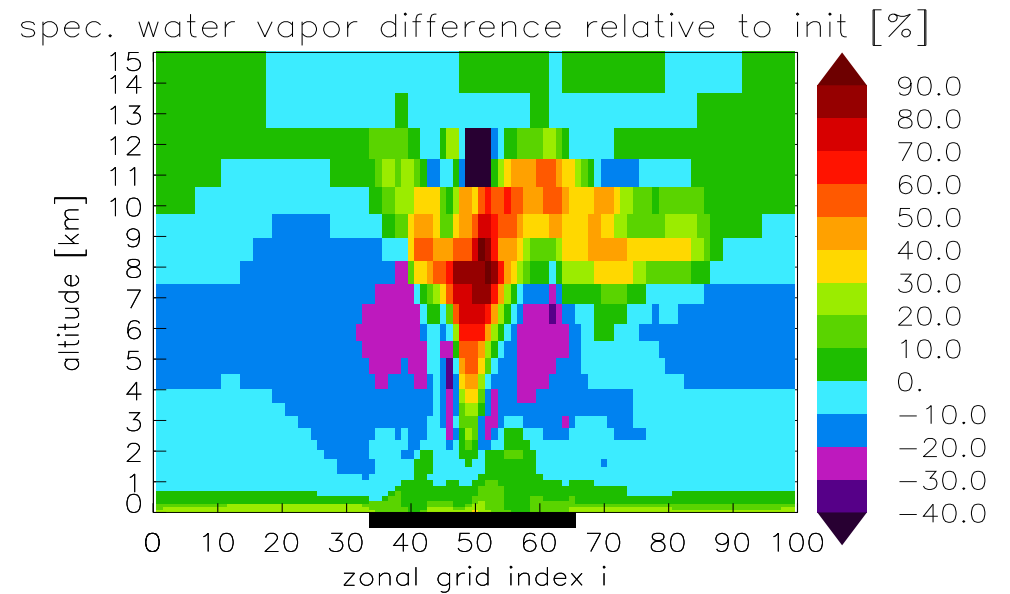
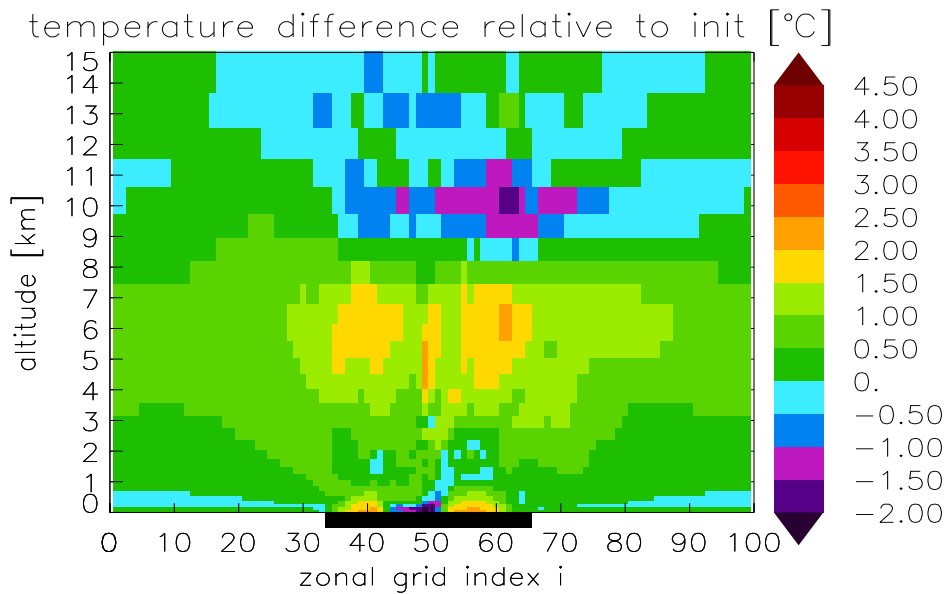
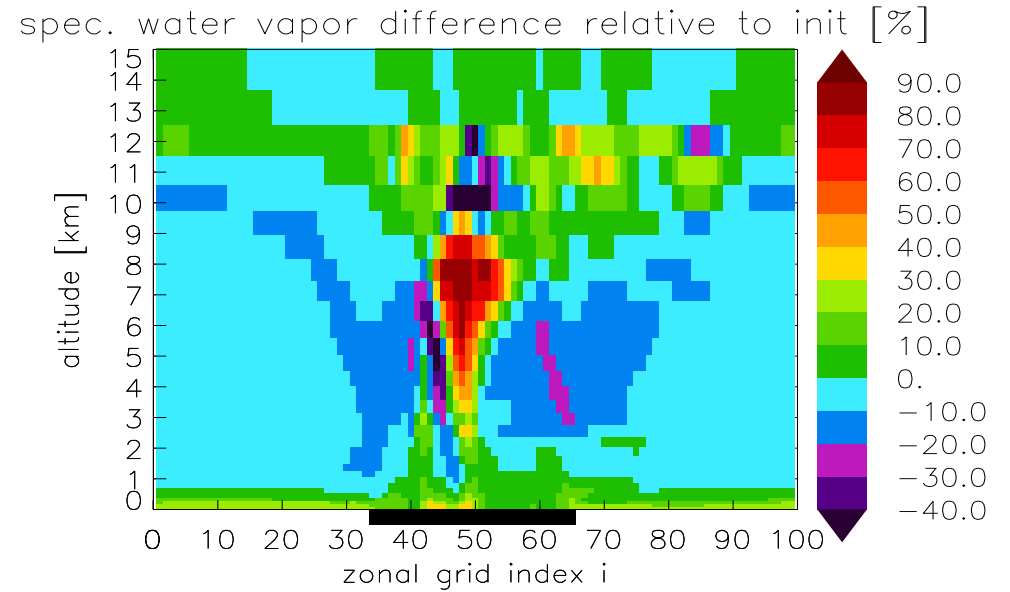
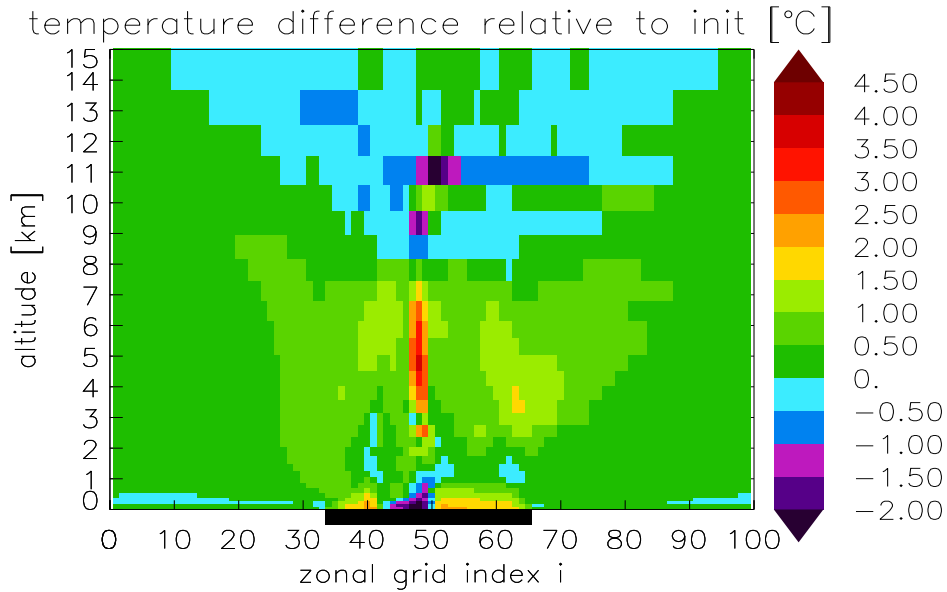
Idealised sea-breeze simulation:

cloud model, subgrid scale transport of mass, heat, moisture components
preliminary trigger (Fritsch-Chappel type) and closure (Tiedtke type)

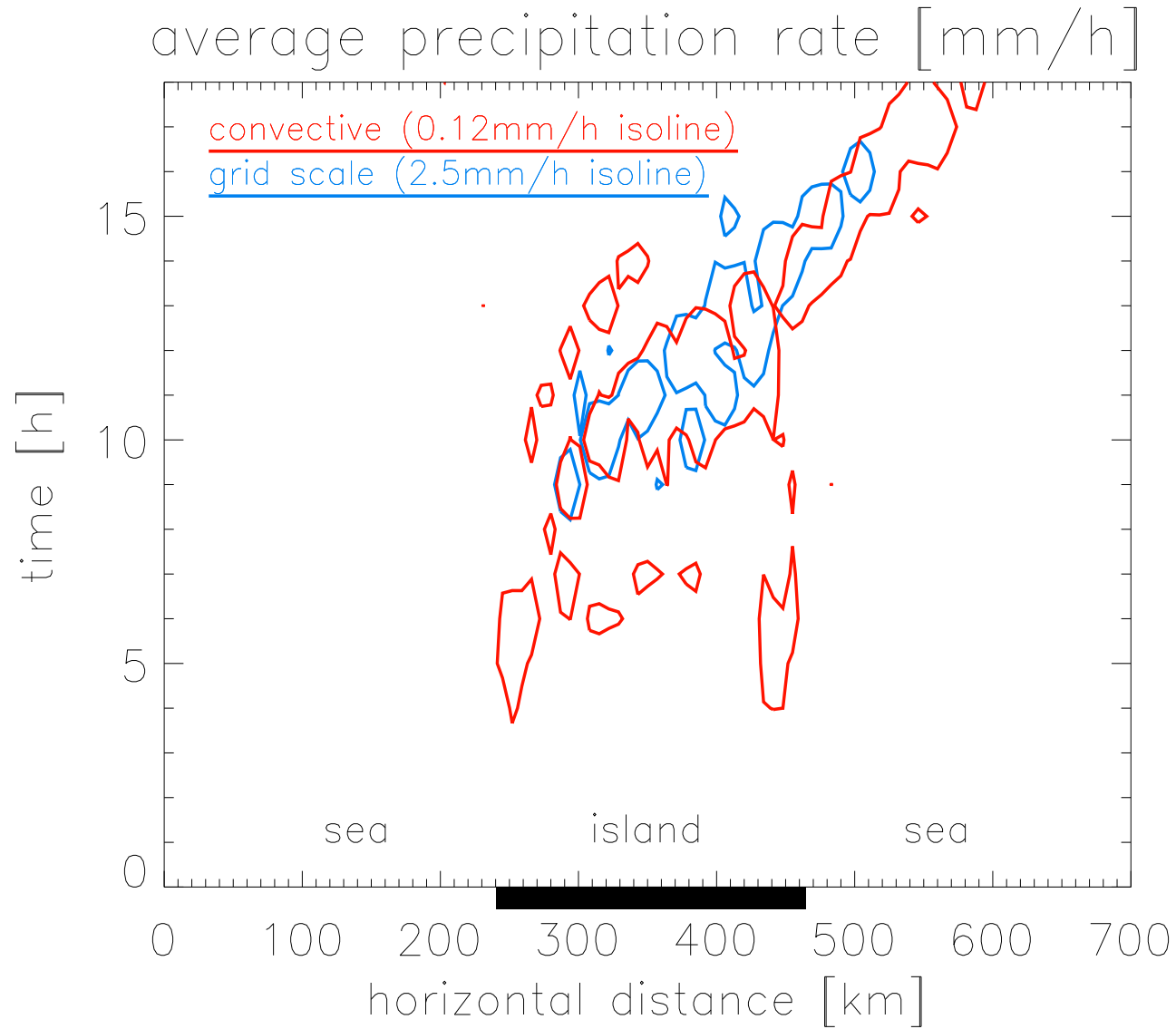


Intercomparison:

our scheme (top) with Kain-Fritsch scheme (bottom)



Grid scale and convective (subgrid scale) precipitation:



Outlook:

- transport and parameterisation of life cycle of conv. cells
- improvement of trigger and closure
- improvement of shallow convection
- tuning with observational data (DWD, QUEST, GOP, COPS/IOP)
- validation and verification