Introduction

Almost any geophysical dynamical model will need parameterisations for sub-scale processes that take place on scales below the model resolution. We introduce the term “adaptive parameterisation scheme” for a scheme, which uses spatial and temporal correlations in the resolved geophysical fields to make the parameterisation computationally more efficient. This poster presents two adaptive radiative transfer (RT) parameterisation schemes for the COSMO numerical weather prediction (NWP) model.

Adaptive parameterisation scheme

An adaptive parameterisation consists of two parts (visualised in the plate below):

- Intrinsic calculation of sub-scale processes
  - Called in fraction of the time steps, grid boxes
  - More complex and physical
  - Can be called by the adaptive generalisation

- Simple (statistical) adaptive generalisation
  - Generalises the results to the full domain and time steps
  - Utilises near-intrinsic calculations
  - Uses temporal and spatial correlations

Conclusions & Outlook

- The poster illustrates two adaptive schemes
  - Adaptive spatial method
  - Adaptive temporal model
- The schemes are over a factor two more accurate or three times more efficient relative to the common persistence assumption
- We expect the general idea is useful for other parameterisations
- The two schemes may be combined
- More info and an article can be found on http://www.meteo.uni-bonn.de/en/en/news/adaptive_parameterisations/

Spatial adaptive scheme

- This scheme uses spatial correlations (mainly in the cloud field)
- In every 4x4 intrinsic region, one intrinsic (2-stream RT calculation) is performed every 10 minutes
- In which column the intrinsic calculation is called depends on the regular pattern to the right

Adaptive temporal scheme

- A simple regression scheme is used to calculate the changes
- If the changes become too large, a new intrinsic calculation is performed

Simple RT parameterisation

A multiple regression algorithm is used to calculate the changes:
- Solar flux (y)
- Infra-red flux at the ground (y)

Surface pressure Cloud free Cloudy
Surface albedo Area
Multiple scattering "Aer." Cloud cover (low clouds)
Cloud cover (all clouds)
Liquid water path (LWP)
Cloud cover profile
Gas absorption, aerosols, ground albedo
Cloud top pressure
Cloud formation time

Error of the persistence assumption (y) j.e. the solar net flux field of (1) and the two adaptive schemes (h) (i) relative to the "truth" (x): a 2-stream calculation on the full field at 12:30 h. For comparison the liquid water path (LWP) and the surface albedo (x) are shown.

Reconstructed solar flux

Surface net fluxes

Radiative transfer scheme

- COSMO-LM uses the delta 2-stream radiative transfer approximation
- Liquid and ice cloud water, cloud cover profile, gas absorption, aerosols, ground albedo
- Called once every hour
- Costs 5-7% of calculation time
- One hour time lead to physical inconsistencies (plate to the right)
- Other weather prediction
- The standard scheme can be called "too complex", as it should be executed more often
- Adaptive scheme allows the utilisation of the 2-stream method at high temporal resolution

Physical inconsistencies

- Comparison of LM runs with 2-stream parameterisation with T = 2.5 and 60 minutes
- T = 60 minutes (blue curve) leads to too much cases with high insolation and rain at the same time compared to the 2.5 min run (red curve)

The horizontal lines indicate the range from the 25 to the 75 percentile showing that also the strength of the relation between rain rate and insolation differs

COSMO-LM weather prediction model

- Formerly called the Lokal Modell (LM)
- Nonhydrostatic dynamical equations for:
  - the wind vector, pressure perturbation, air temperature, specific humidity of water vapor, cloud, liquid water and ice, and precipitation in the form of rain, snow and graupel
- Diversification: horizontal resolution 2.5 km, 50 vertical layers
- Boundary conditions from coarse resolution global model (GME)
- Case study: 19th September 2001, 12:30 h UTC

Results

- The two adaptive schemes have a shorter correlation length (a) autocorrelation function for solar net flux, (b) time in red
- Work on stochastic parameterisations shows that an error field with a weaker correlation has less influence on the model dynamics

Efficiency adaptive schemes

- The RMS error of the schemes for the solar flux (a) and the infra-red surface net flux (b) as a function of the number of intrinsic calculations
- Even with a strong reduction in the number of intrinsic calculations, the adaptive schemes are still quite accurate