Implementation and validation of the

ECMWF IFS convection scheme

in COSMO-CLM

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Motivation from a climate perspective

A climate projection without at least some estimate of the uncertainty involved is worthless
Motivation from a climate perspective

A climate projection without at least some estimate of the uncertainty involved is worthless

An estimate for the „model uncertainty“ can come from comparing various models or having various configuration choices within one model
Our long-term motivation

<table>
<thead>
<tr>
<th></th>
<th>operational / supported?</th>
<th>itype_conv</th>
<th>tested/tuned?</th>
<th>quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ti</td>
<td>yes (DWD), incl.</td>
<td>0 (default)</td>
<td>yes</td>
<td>****/*****</td>
</tr>
<tr>
<td></td>
<td>implementation</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Ti-CAPE</td>
<td>no</td>
<td>lcape=.TRUE.</td>
<td>no</td>
<td>*</td>
</tr>
<tr>
<td>KF</td>
<td>no</td>
<td>1</td>
<td>partly</td>
<td>**</td>
</tr>
<tr>
<td>KFB</td>
<td>no</td>
<td>[2]</td>
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<td>***</td>
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Tiedtke scheme is the only supported convection scheme in COSMO!
## Our long-term motivation

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<tr>
<td>Ti-IFS</td>
<td>yes (ECMWF)</td>
<td>[4]</td>
<td>in progress</td>
<td>***** (?)</td>
</tr>
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Characteristics of IFS convection scheme

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<tr>
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<th>IFS</th>
<th>Tiedtke</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Closure</strong></td>
<td>instability (deep)</td>
<td>moisture convergence (all types)</td>
</tr>
<tr>
<td></td>
<td>surface fluxes (shallow)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>moisture converg. (mid-level)</td>
<td></td>
</tr>
<tr>
<td><strong>Which type</strong></td>
<td>~ cloud depth</td>
<td>~ moisture convergence</td>
</tr>
<tr>
<td><strong>Parcel Ascent</strong></td>
<td>several mixed ones</td>
<td>surface parcel only</td>
</tr>
<tr>
<td><strong>Precipitation</strong></td>
<td>full microphysics</td>
<td>cloud water &amp; conversion factor</td>
</tr>
<tr>
<td></td>
<td>prognostic rain/snow/ice/water</td>
<td></td>
</tr>
<tr>
<td><strong>Cloud cover</strong></td>
<td>(linear with cloud depth)</td>
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</tr>
</tbody>
</table>
Setup

- 50km resolution (CLIMATE !!!)
- v4.7
- 1-year simulation (1980)
- diagnostic precipitation
- „old“ reference atmosphere pressure-hybrid

IFS convection scheme:
- src_conv_ifs.f90
  implementation calling a
  library that is compiled from
  52 files (ECMWF, updates easy)
Mean Temperature Bias

IFS 4.7

Ti 4.7

DJF

JJA

Temperature Bias (K)
Mean Temperature Bias

IFS 4.7

Ti 4.7

Ti 4.3

DJF

JJA
Mean Temperature Bias

Cold bias remains, mainly in winter

DJF

JJA

IFS 4.7

Ti 4.7

Ti 4.3
Mean Temperature Bias

Cold bias remains, mainly in winter

Why difference in summer v4.7 vs. v4.3?
Side remark:
v4.7 versus v4.3 (Tiedtke)

conv. cloud cover (%)

non-conv. cloud cover (%)

Cloud ice (mg/kg)

Cloud water (mg/kg)
Mean Precipitation Bias

IFS 4.7  Ti 4.7  Ti 4.3

DJF

JJA

mm/day

-2  -1  0  1  2
Convective Ratio

IFS 4.7 vs. Ti 4.7

@Langen:

30% vs. 2%

80% vs. 40%

multiple parcels vs. surface parcel

may play a role here

„which one is correct?“
Hourly Intensity-Frequency Distribution

Central Germany JJA

Ti 4.3
Ti 4.7
IFS 4.7

0.01 mm/h bins
Hourly Intensity-Frequency Distribution

Central Germany JJA

Convective drizzle is enhanced (some may not like this...)

Grid-scale precipitation at mid- & high intensities is reduced in turn
Snapshot on a strongly convective day

IFS 4.7

Ti 4.7

14 July 2006
13-14 UTC

mm/h
Diurnal Cycle of Precipitation

Central Germany JJA 1980

IFS

Ti 4.7

(Example OBS)

(somewhat) positive news for IFS:

- smaller amplitude
- smoother decay
- slightly later peak (?)
Summary

- Implementation routine for the ECMWF IFS convection scheme, which calls a convection library
- **One-year** simulation (longer studies needed)
- Performance comparable to Tiedtke for mean temperature and precipitation
- Considerably higher *convective contribution*
- More *convective drizzle*, in turn less mid-high grid-scale precipitation
Our immediate motivation: soil-moisture precipitation feedback

Diurnal cycle of July precipitation, with varied initial soil-moisture (+-30%)

Soil-moisture precipitation feedback varies even in sign!!

Hohenegger et. al., JC, revised
Our immediate motivation: soil-moisture precipitation feedback

Impact for:

- Seasonal and annual forecasts:
  - Soil moisture memory
  - Heatwave & flash flood incidence

- Climate Simulations:
  - Potential impact on precipitation statistics, especially extreme value statistics

We need various convection schemes in COSMO-CLM to span this uncertainty!