Universiteit Utrecht

TM5 in EC-Earth

Integrating the parameterization of aerosol wet deposition

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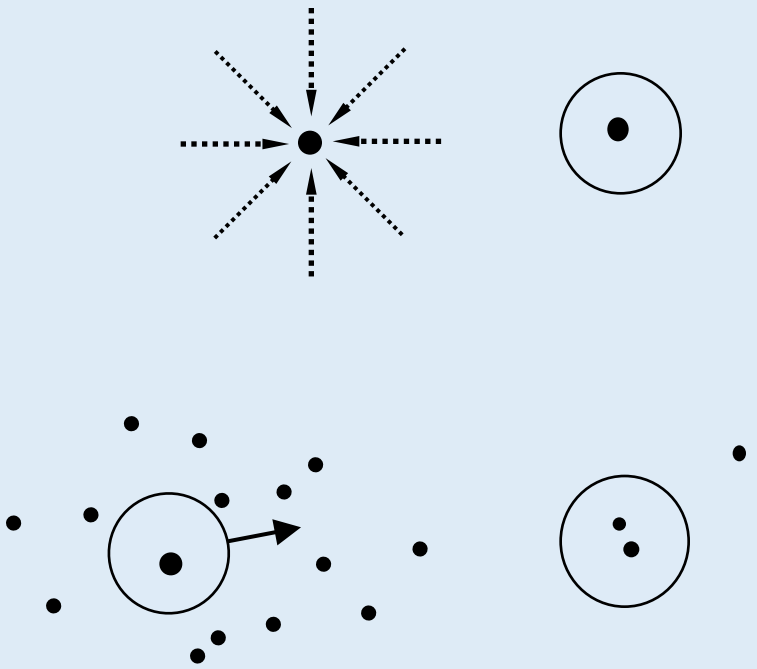
Overview

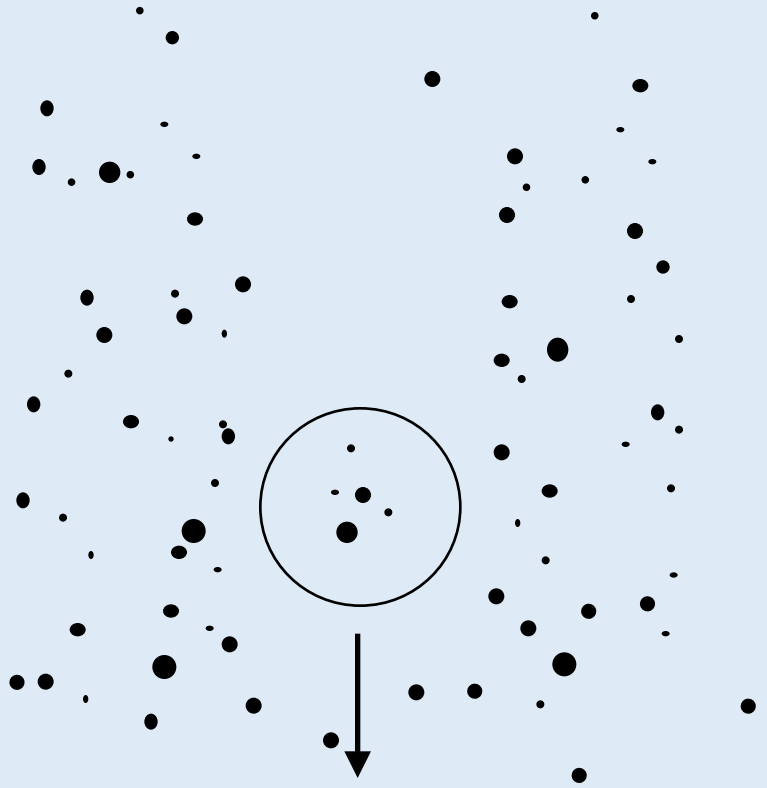
- Aerosol wet deposition
- Current coupling between IFS and TM5
- Proposed coupling for wet deposition
- First look
- Remaining challenges

How are aerosols removed?

- *In-cloud* scavenging by nucleation and impaction



- *Below-cloud* scavenging by falling precipitation



How are aerosols removed?

Process influenced by:

- *Precipitation (formation) rates*
- Accurate cloud and raindrop distributions
- Accurate aerosol distribution
- Scavenging efficiencies of aerosol + droplet combinations

Current coupling

- 13 variables received from IFS
  - e.g. entrainment rate, detrainment rate, cloud fraction, cloud liquid water, cloud ice water, humidity, temperature, divergence, vorticity, surface precipitation
- 3 or 6 hourly

- Mimic of received fields from ERA-Interim

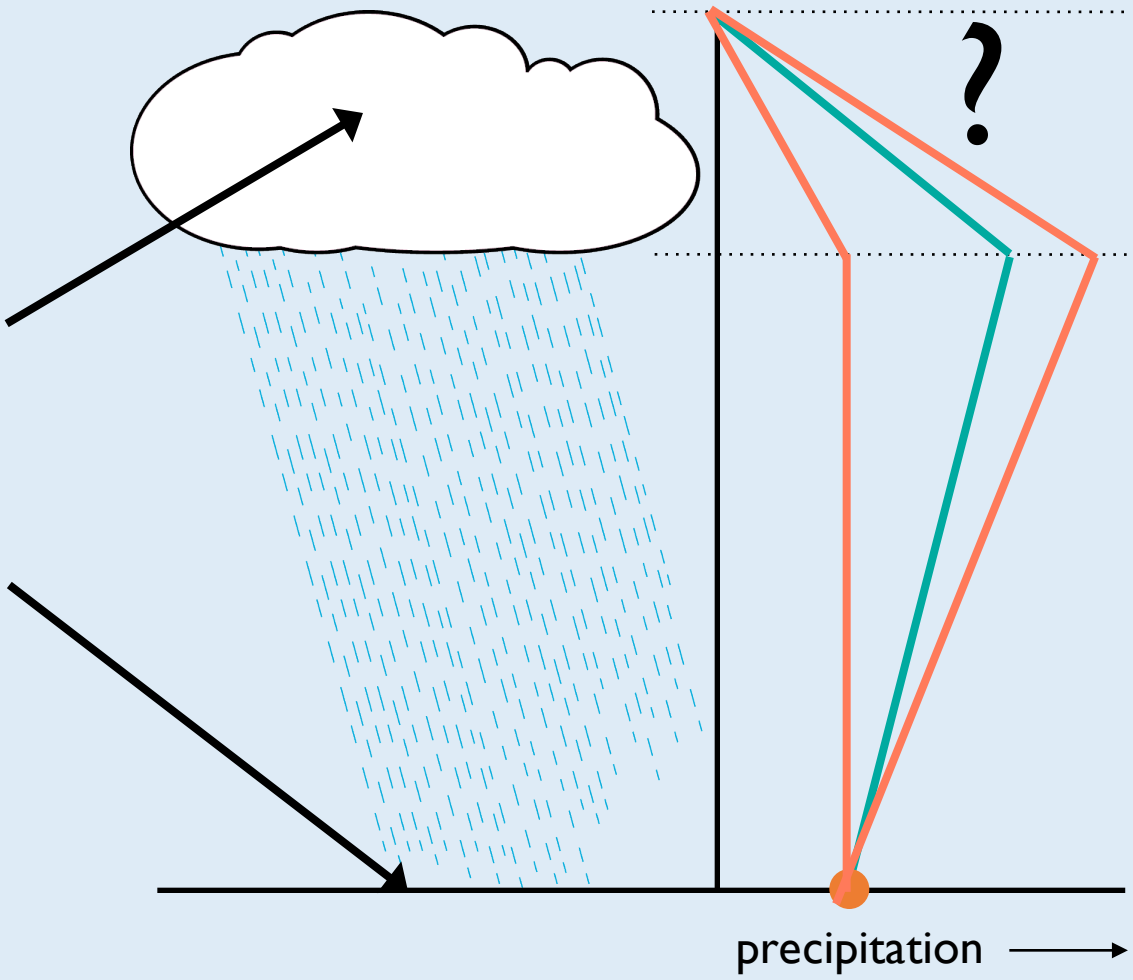
Current TM5 wet scavenging scheme

3D

Cloud liquid water content
Cloud ice water content

Large scale precipitation

2D



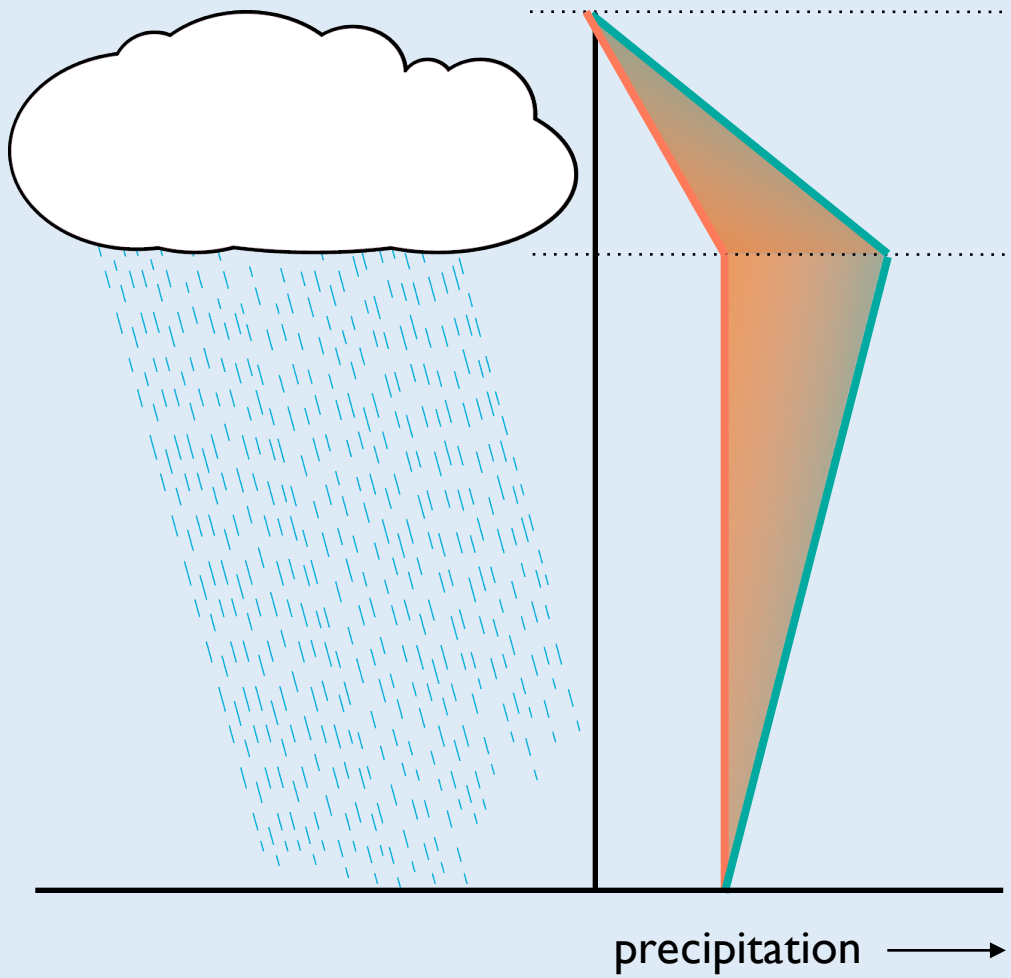
Current TM5 wet scavenging scheme

Precipitation formation too low: in-cloud scavenging underestimated

Total column precipitation too low: Below-cloud scavenging underestimated (when rescaled to surface precipitation)

No evaporation:

Missing resuspension of aerosols

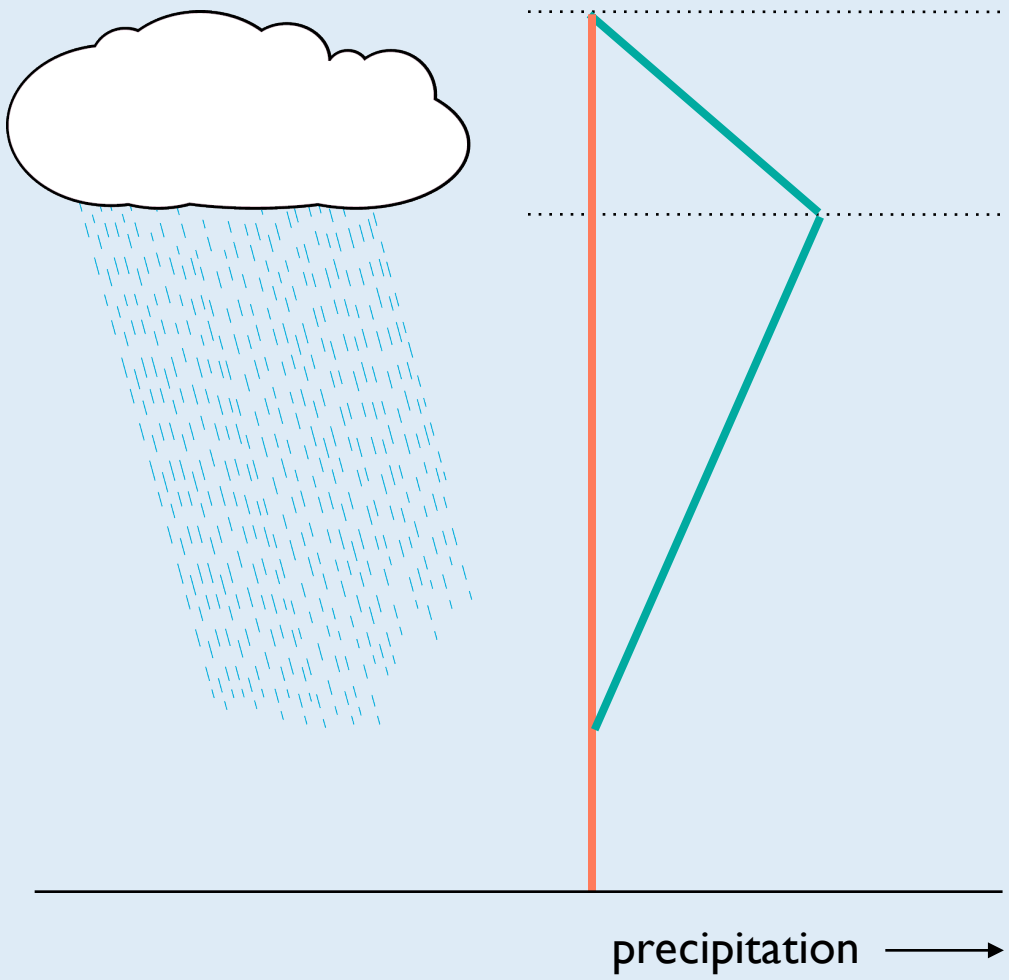


Full evaporation

What if precipitation evaporates before reaching the surface?

- No removal of aerosol from atmosphere, but:

- Downward transport



Proposed new coupling

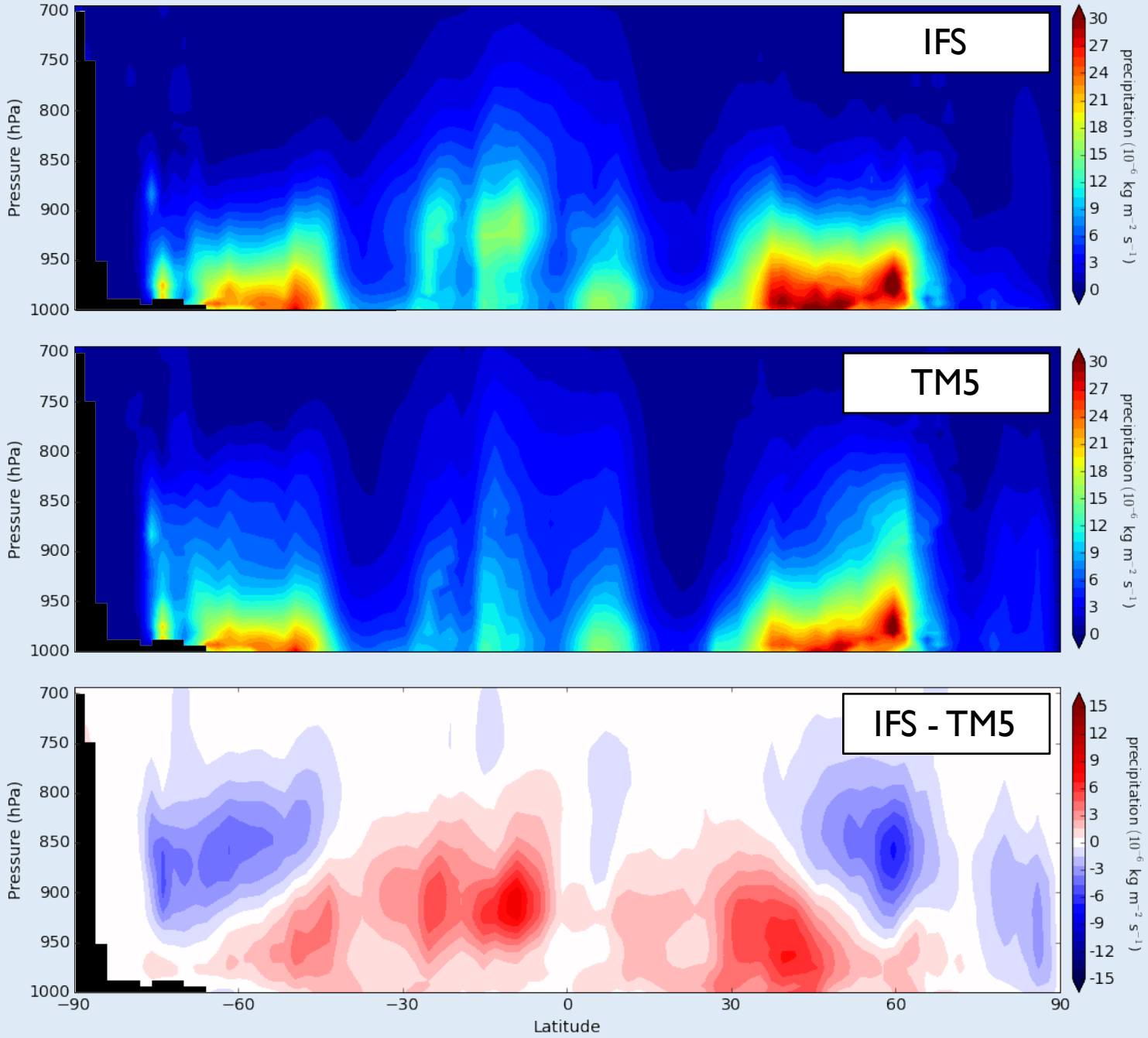
- Pro's: Exploiting possibilities of
  'Earth System model' set-up
- Con's: Deviation from stand-alone version of TM5

- Import variables from IFS:
- Precipitation
- Precipitation formation
- Precipitation evaporation
- Liquid/solid and large scale/convective

Research set-up

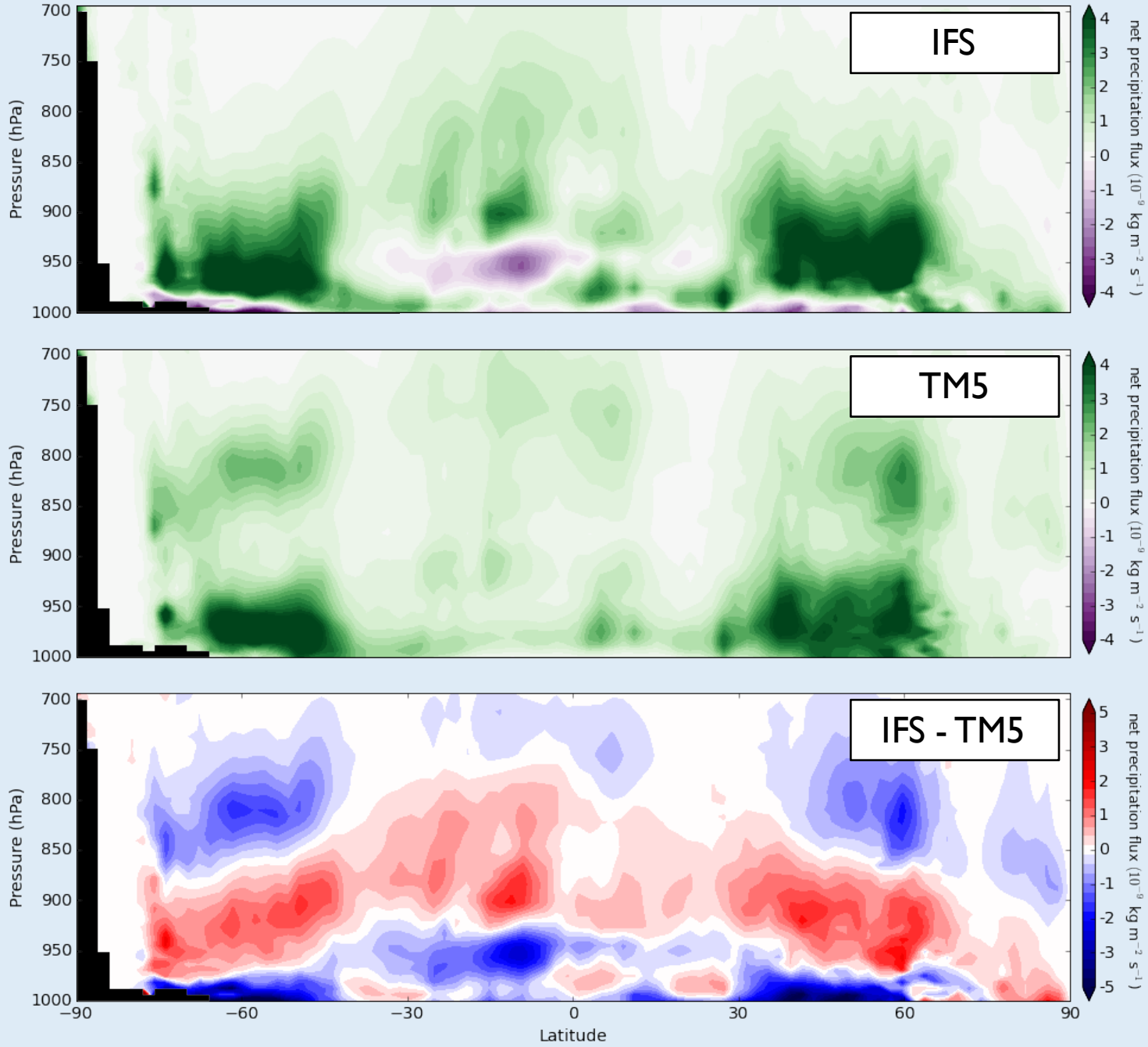
- 3 runs
- BASE: Status quo
- NOEVAP: Updated meteorology
- EVAP: Updated meteorology + evaporation

- Runtime: 1 year, nudged to 2010 meteorology for comparison/validation.


IFS
TM5
IFS - TM5
Pressure (hPa)
700
750
800
850
900
950
1000
precipitation (10^{-6} kg m^{-2} s^{-1})
30
27
24
21
18
15
12
9
6
3
0
-3
-6
-9
-12
-15
−90
−60
−30
0
30
60
90
Latitude

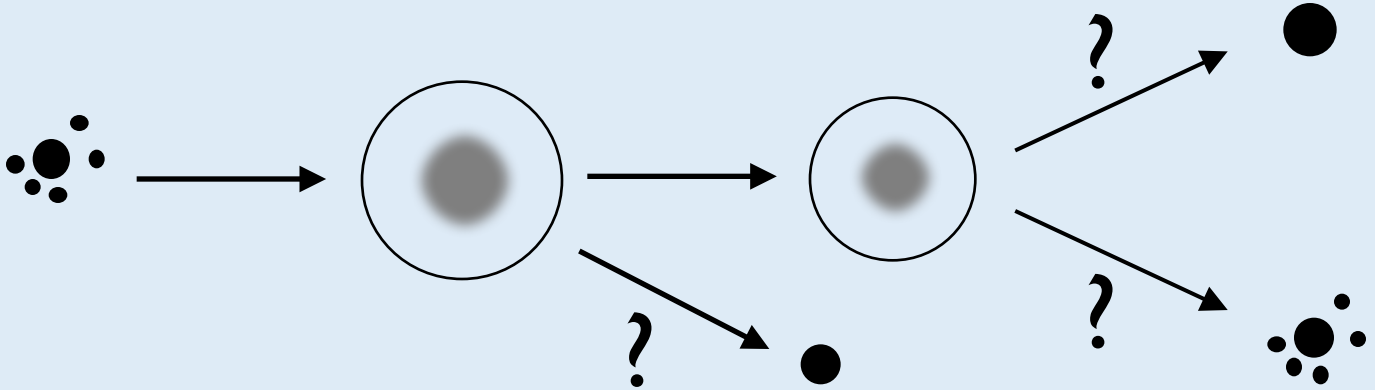
What causes these differences?

- Wrong shape of precipitation formation?
- Multiple cloud layers: Complete evaporation of precipitation from highest layer?


IFS
TM5
IFS - TM5
Pressure (hPa)
700
750
800
850
900
950
1000
−90
−60
−30
0
30
60
90
Latitude
net precipitation flux (10^{-9} kg m^{-2} s^{-1})
4
3
2
1
0
-1
-2
-3
-4
5
-5

Challenges

- Validation
- Handling of re-suspension of aerosol after evaporation of precipitation



Summary

- Combining TM5 with IFS in EC-Earth allows usage of a larger array of meteorological fields

- Possibilities for improvement with wet scavenging parameterization:
  - Current parameterization underestimates precipitation for single cloud layers, but overestimates precipitation from high (ice) clouds
  - Introducing rain evaporation

- Challenges for validation and aerosol resuspension