Using CLM4 in a Regional Climate Model over the Arctic

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Regional Climate Model HIRHAM5

HIRHAM5 ...
- consists of HIRLAM7 as dynamical core, ECHAM5 physics
- horizontal resolution of 0.25°
- 60 vertical levels up to 0.1hPa (~65km)
- covers the pan-Arctic domain north of 60°N
- is run on a rotated grid that allows for approximately equally sized grid cells
Motivation

HIRHAM5

• does fairly well in representing climate over the Arctic
• has been used in studies of climate extremes, cyclon paths, cloud cover parametrizations ...

Why use CLM instead of ECHAM‘s inbuilt landsurface-soil-model?  
the inbuilt soil model:

• uses a bucket approach for soil moisture
• it does not account for phase changes in the soil
• it does not distinguish between different pfts ...

➢ it has severe limitations when you are interested in landsurface – atmosphere interactions!
Things we want to play with ...

- changing pft distribution (eg shift the treeline to the north)
- run with a dynamic vegetation model
- changing soil composition (eg introducing peatlands to modeled Arctic soils)
- run with Carbon cycling in the soil and Carbon emission from degrading permafrost
- ...

➢ see how those changes impact on climate and general circulation over the Arctic in a coupled setup
➢ need a more sophisticated land model: CLM
HIRHAM5 – CLM4 coupling

- follows the approach suggested by NCAR
- replace NCAR atmospheric model with HIRHAM5

Diagram:
- Land
- Latent heat flux
- Sensible heat flux
- Albedo (swr)
- Surface temperature (lwr)
- Evaporation
- Atmospheric forcing
- Surface energy budget
- Solar radiation, long wave radiation, lowest atmospheric level temperature, pressure, specific humidity and wind speed, reference height, precipitation
- Temperature
- Humidity, Cloud water

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HIRHAM5 – CLM4 coupling

What impact does the coupling have on modeled climate?

- control run over the ERAInterim period with the CLM „standard setup“
- model forced at ist lateral and lower boundaries with the ERAInterim data
- so far finished: 1979-1984
- variables analyzed: soil temperature, air temperature, mean sea level pressure
Direct Improvement: Soil Temperature

- mean over **atmosphere only model run** from Jan 1979 to Dec 1984
- comparison data set: Russian Historical Soil Temperature (70 stations)
Direct Improvement: Soil Temperature

- mean over **coupled model run** from Jan 1979 to Dec 1984
- comparison data set: Russian Historical Soil Temperature (70 stations)
Direct Improvement: Soil Temperature

56.20°E, 62.70°N

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Direct Improvement: Soil Temperature

134.50°E, 60.40°N

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Impact on 2m air temperature

atmosphere only  | ERAInterim  | atmosphere only – ERAInterim

DJF

coupled  | ERAInterim  | coupled – ERAInterim
Impact on 2m air temperature

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atmosphere only

ERAInterim

coupled

atmosphere only – ERAInterim

coupled – ERAInterim

JJA
Impact on mean sea level pressure

**atmosphere only**

**ERAInterim**

**atmosphere only – ERAInterim**

**coupled**

**ERAInterim**

**coupled – ERAInterim**

**DJF**
Impact on mean sea level pressure

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JJA
Impact throughout the atmosphere

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<th>coupled – atmosphere only</th>
<th>JJA atmosphere only</th>
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Outlook and Conclusions

coupling HIRHAM5 and CLM4:

- improves modeled soil temperature
- improves modeled air temperature and mean sea level pressure
- has impacts throughout the atmospheric column and on general circulation

after the control run is finished:

- experiment with vegetation distribution
- experiment with new soil properties/pfts
- ...

or directly move on to CLM4.5?