**Topic 1: Coupled modelling of regional Earth systems**

**Budget study of internal variability of ensemble simulations of HIRHAM5 for the Arctic**

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**Introduction**

- Chaotic and nonlinear nature of atmospheric dynamics [1]
- Changes in initial conditions (IC) of climate models influence the evolution of simulations

**Model Setup**

- HIRHAM5 [4] is a hydrostatic regional climate model first applied on a circum-Arctic region by [5]
- Combination of HIRLAM [6] (dynamics) and ECMWF [7] (physical parametrization)
- Driven by ERA-Interim [8]

- Runs with a spatial resolution of 25 km covering 218x200 grid cells and 40 vertical levels up to 10 hPa over the Arctic region (Fig. 3)
- Runs without nudging
- 5 simulations covering May 2012 differ only in IC (starting times for each run shifts about 1 day)

**Equations and Method**

- **IV** is defined as the inter-member variance of each variable [2,3] $\sigma^2_\phi \approx \langle \varphi^2 \rangle$ (Eq. 1)
- Emanating from the first law of thermodynamics and the mass-continuity equation in vertical pressure coordinates for potential temperature using the Reynolds decomposition
- Results in a IV budget equation (Eq. 3) developed by O. Nikiema [2,3]

**Results**

- IV of the vertical- and domain-averaged potential temperature is smallest at the bottom, at 400 hPa and at the model top at 10 hPa (Fig. 4)
- Highest IV is simulated in the upper troposphere and smaller peak at the middle troposphere probably due to meridional wind speed maxima
- Largest contribution to growth of IV is provided by $B_h$ (Fig. 5)
- $B_v$ and $E_h$ reduce the IV (Fig. 5)
- The terms $A_h$, $A_v$, $E_v$, and $C$ have only a small contribution (Fig. 5)
- Stronger peaks during time evolution indicate synoptic events [2,3] (Fig. 5)

**Outlook**

- Development of the ensemble of simulations
  - Low ice years and high ice years
  - Calculations for 3-hourly output
  - At least 20-member simulations changing only in IC
- Detailed analysis of the time evolution, of vertical profiles including single levels and of the spatial distribution of the contributions to IV
- Budget study for absolute and relative vorticity and kinetic energy

**References**