The ClimEx Project: Dynamical downscaling of a GCM large ensemble at very high resolution for Bavaria and Quebec

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1 SUMMARY

- **ClimEx** (Climate Change and Hydrological Extremes) is a project based on a long-term collaboration between Bavaria and Quebec to assess hydrological impact of climate change and extreme events and for the development of robust strategies for adapting to climate change
- **Modelling chain: Global -> Regional -> Hydrological Models**
  1. Canadian Earth System Model (CanESM2) (Canadian Centre for Climate Modelling and Analysis) - 50 members with RCP8.5
  2. Canadian Regional Climate Model (CRCM5) (*Université du Québec à Montréal* in collaboration with Environment Canada)
     - Two domains of interest: Bavaria and Quebec
     - Outputs of climatic and hydrologically relevant variables
  3. Hydrological models:
     - HYDROTEL (*Institut National de la Recherche Scientifique*)
     - WaSiM (www.wasim.ch)

2 CLIMEX MODELLING CHAIN

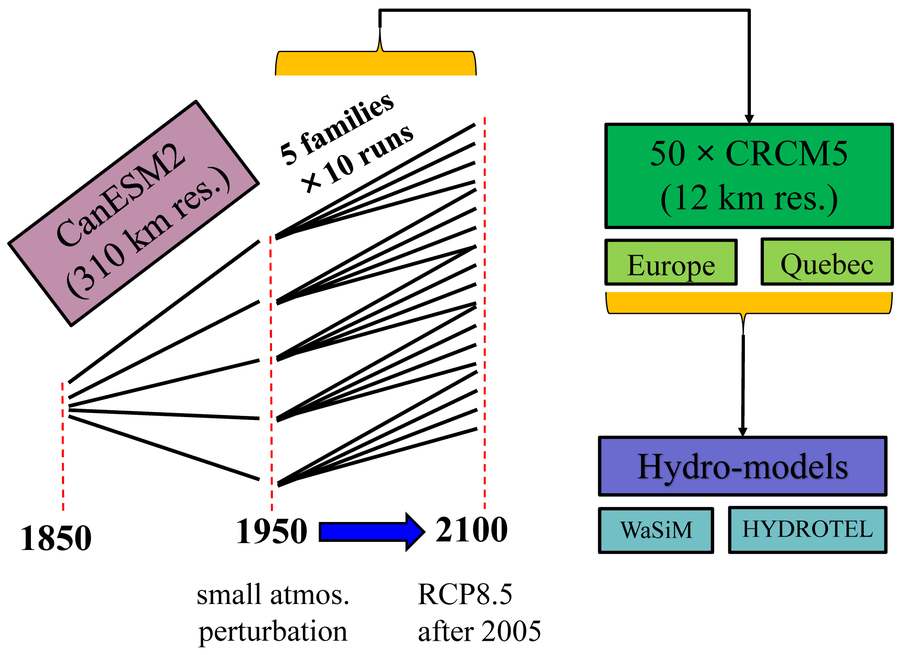

Figure 1: Scheme representing the ClimEx modelling chain where the CanESM2 members are generated to drive the CRCM5 and the hydrological models.

- **CanESM2 Earth System Model at a resolution of** 2.8° **(Fig. 1)**
  - 1850 control: CMIP5 "piControl" simulation (1000 yrs)
  - 1850-1950: 5 CMIP5 "historical" simulations employing CMIP5 forcings
  - 1950-2005: 50 additional CMIP5 historical ensemble members launched in 1950. Employing a small random perturbation, 10 new CMIP5 historical simulations are launched from each of the original 5 historical simulations in 1950.
  - 2006-2100: 50 CMIP5 future simulations following the representative concentration pathway RCP8.5
- **CRCM5 Regional Climate Model at a resolution of** 0.11° **(Figs. 1, 2, 3)**
  - 1950-2100: Driven by the 50 global runs over two domains
- **WaSiM+HYDROTEL Hydrological models (Fig. 1)**
  - 1955-2100: Post-processed CRCM5 outputs are used as inputs to the hydrological models

3 PRELIMINARY RESULTS: CRCM5 LARGE ENSEMBLE

- Figure 2 shows the CRCM5 domains (Quebec and Europe)

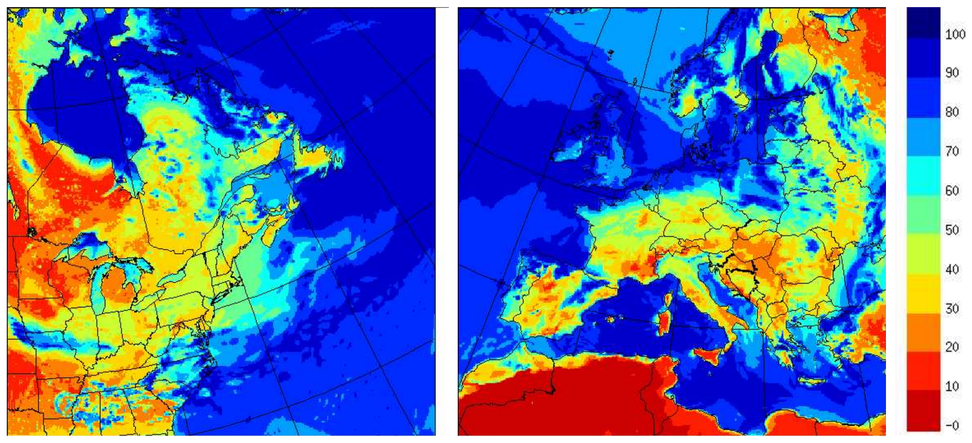

Figure 2: Snapshot of surface relative humidity (in %) as simulated by the CRCM5 over the Quebec (left panel) and Europe domains (right panel) for a day in July.

- Figure 3 shows the time series (slp) of the first simulated month by CRCM5. 50 Europe-runs are shown over one grid point.
  - For each family (represented by different colors), the 10 members slowly diverge due to the chaotic nature of the climate system.
  - Simulations from the same family remain clustered in the first half of the month (left panel) while they are mostly indistinguishable in the second half (right panel).
  - The spin-up time can vary significantly among variables. It corresponds to a few days for atmospheric variables while it may take months to years for soil variables to reach an equilibrium with the other components of the system.

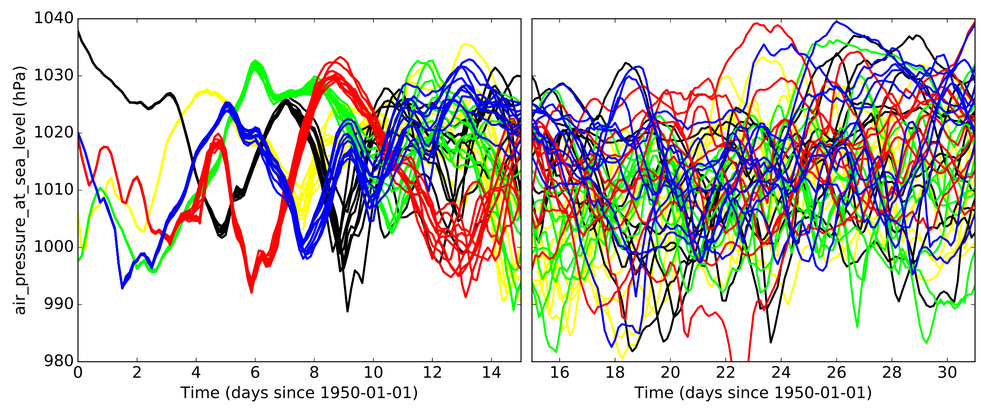

Figure 3: Spin-up of the CRCM5 Large Ensemble represented by sea-level pressure near Munich for January 1950 (days 0 to 15 on the left panel, days 15 to 31 on the right).

4 PERSPECTIVES AND FUTURE WORK

- The CRCM5 Large Ensemble (LE) is unprecedented in terms of sampling natural climate variability and extreme events (hourly archiving of precipitation, 3-hourly for many other variables)
  - Production phase of the CRCM5-LE is ongoing and planned for completion in Fall 2016
  - CRCM5-LE will be used to drive hydrological models, thus opening new views on flood risk management and proactive adaptation strategies.
- **Caveat:** Neither the uncertainty due to the GHG concentration pathway nor the GCM/RCM models climate sensitivity are sampled in the CRCM5-LE framework, which rather focuses on representing natural climate variability in its finest details.

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