ALADIN
(climate experiments in Prague)

Aleš Farda, CHMI

Motivation:

- Studying present-day climate information and physical processes at regional scale.
- Preparation for studies on future climate using the climate change scenario(s).
- Providing the information needed for an assessment of impacts of the future climate in hydrology, agronomy, forestry etc.

Framework:

- Using the model ALADIN and utilizing on the experience with ALADIN NWP
- Cooperation and information exchange with partners in France, Hungary and Bulgaria
- Building on experience gained in the past work in the climate community with different models (RegCM)
- Participation in national and international projects (ENSEMBLES, CECILIA)

Recent activities - project ENSEMBLES

Short introduction:

- Aimed at providing quality information on present-day and future climate (climate scenarios) with focus on Europe.
- Use of present global and regional climate models.
- Common compulsory input data, integration area and period for regional models to ease model intercomparison and assessment of uncertainties.
- Development of methods for assessment and weighting of individual models performance.

- MF participation with ALADIN-Climate led to the decision to choose a different version in order not to double results (with respect to project constraints).

Experiments setup

- Model choice: ALADIN CY28T3 branch ‘stratus’. Capitalizing on recent development in the physical parameterizations.
  - ACRANEB_new radiation scheme.
  - Improved cloudiness scheme (Xu-Randall).
  - Semi-Lagrangian Horizontal Diffusion scheme.
  - New mountain drag and lift scheme (mean orography).
  - ISBA with 4 soil layers for temperature, 2 layers for moisture and single layer snow scheme.
  - Moist gustiness formulation.

- Input data: ERA40 IFS CY24 global reanalysis (T159 horizontal resolution, 60 atmosphere levels for the years 1960-2000)

Technology line & evaluation methods

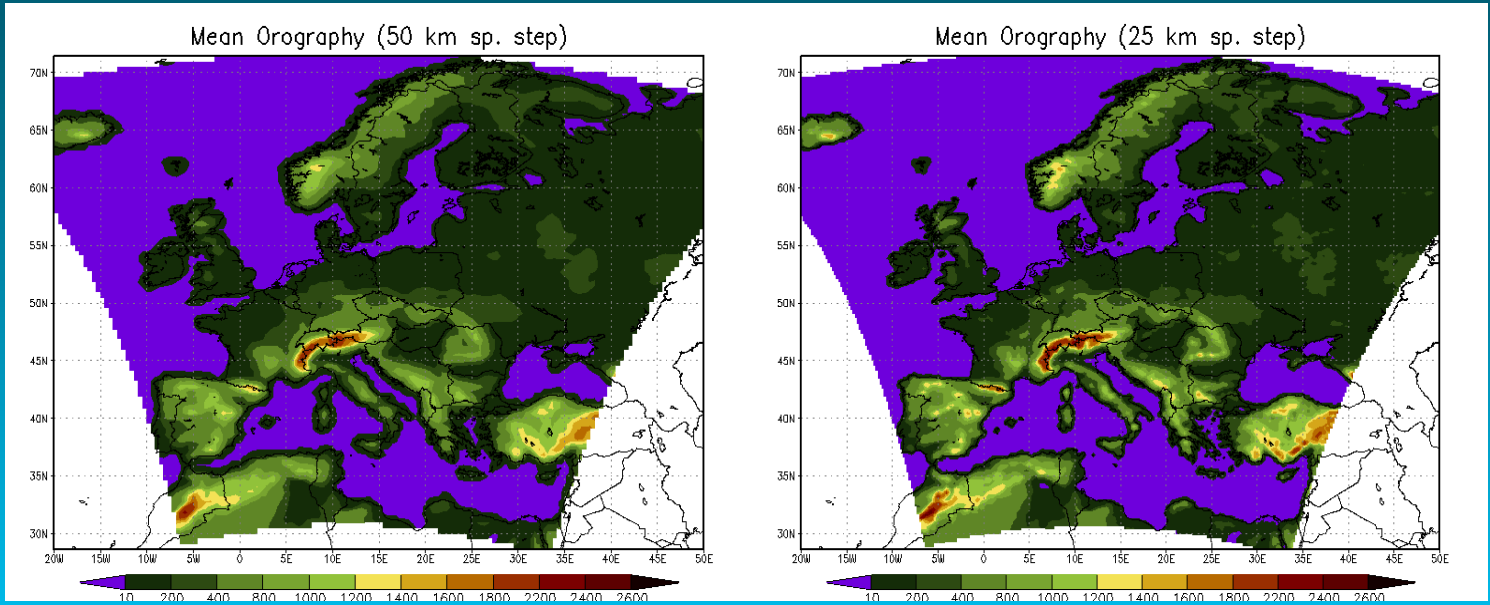
- Technology line almost identical to that of HMS & MF
  - 923, 901 and 927 configuration to create climate and LBC files
  - Few more fields needed by ISBA
  - Initialization from ERA40
  - 6h coupling frequency
  - Appropriate monthly update of SST, CO_2 concentrations and other climate fields

- Evaluation tools:
  - University of Eastern Anglia CRU TS 2.0 dataset (~20 km resolution)
    - Fine grid
    - Not available over sea
    - Known deficiencies in certain areas (Scandinavia, N Russia)
  - ERA40 data
    - Lot of fields available
    - Coarse grid
  - Data from meteorological stations

Experiments setup (integration areas)

Domain choices (50 and 25 kilometers mesh size):

- Lambert conform projection (tangent)
- coordinated with MF: the same coordinates for grid-points (but smaller domain)
- domain ‘A’: 50 km mesh size, 111 x 100 points, 27 atmosphere levels, 1200 s. time step (~ 5200 s./ month integration at NEC SX68)
- domain ‘B’: 25 km mesh size, 216 x 192 points, 31 atmosphere levels, 900 s. time step

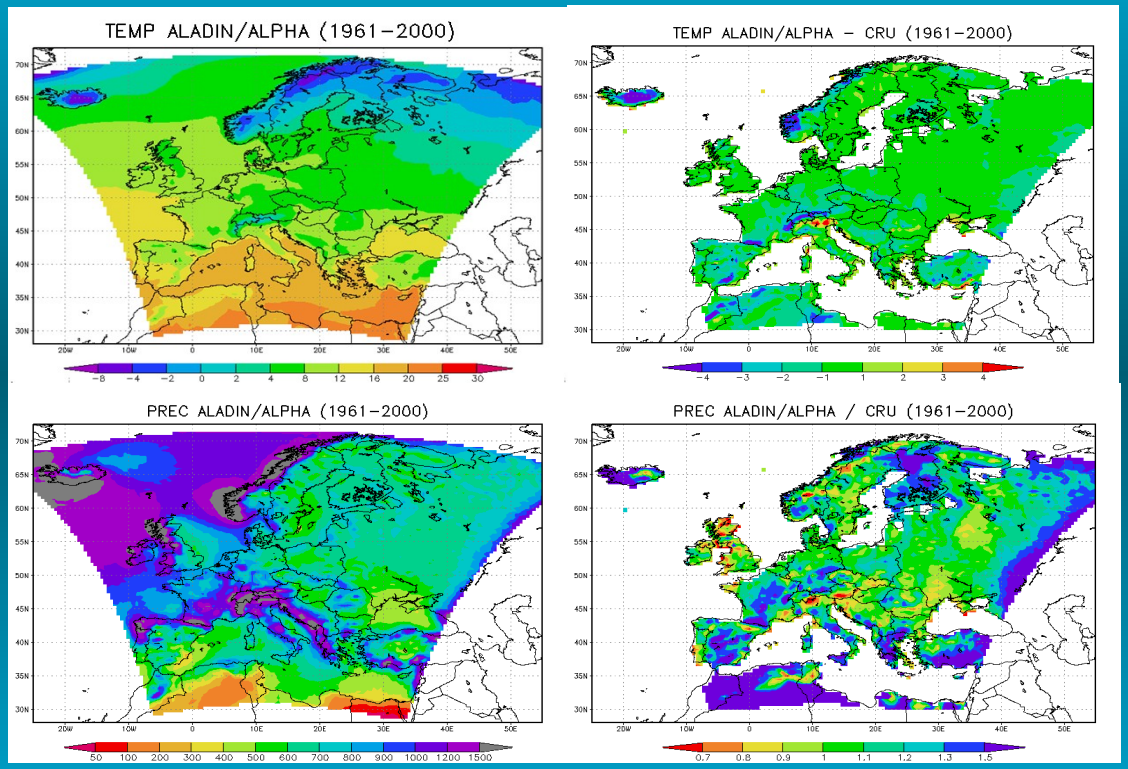


41-year integration at 50 km – experiment ALPHA

Annual mean temperature & precipitation compared to CRU dataset

Temperature:
good accordance with CRU – unfortunately masking deficiencies in single seasons.

Precipitation:
mostly in the range +/- 25% over Europe. Errors affiliated especially with orographically complicated areas. WE and Mediterranean more wet.



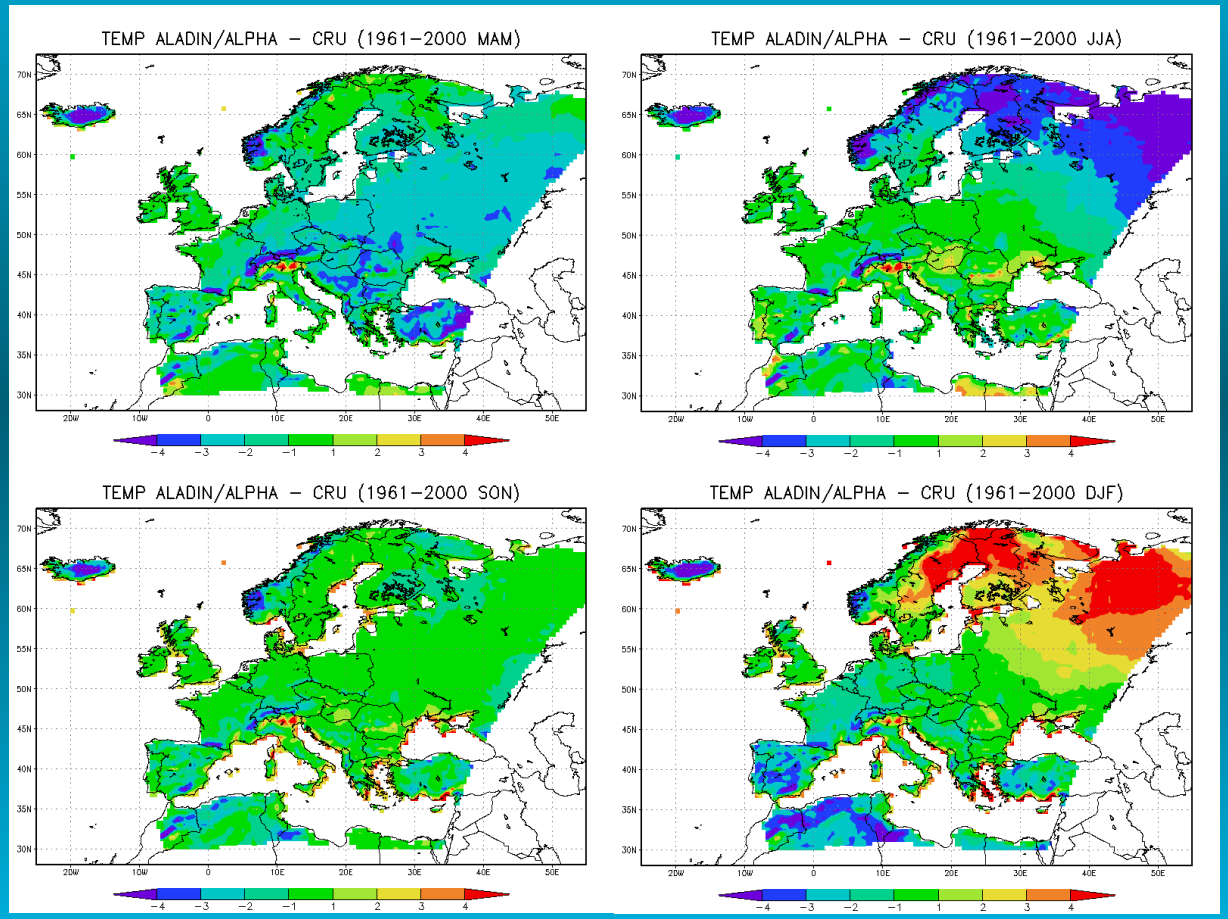
Temperature – seasonal averages comparison to CRU

Spring: significant negative bias over the major part of Europe.

Summer: good accordance with exception of mountain areas. (CRU problem In Scandinavia)

Autumn: quite good accordance with CRU.

Winter: negative bias over the W, SW Europe and N. Africa. (CRU problem in Scandinavia)



Precipitation - seasonal sums comparison to CRU

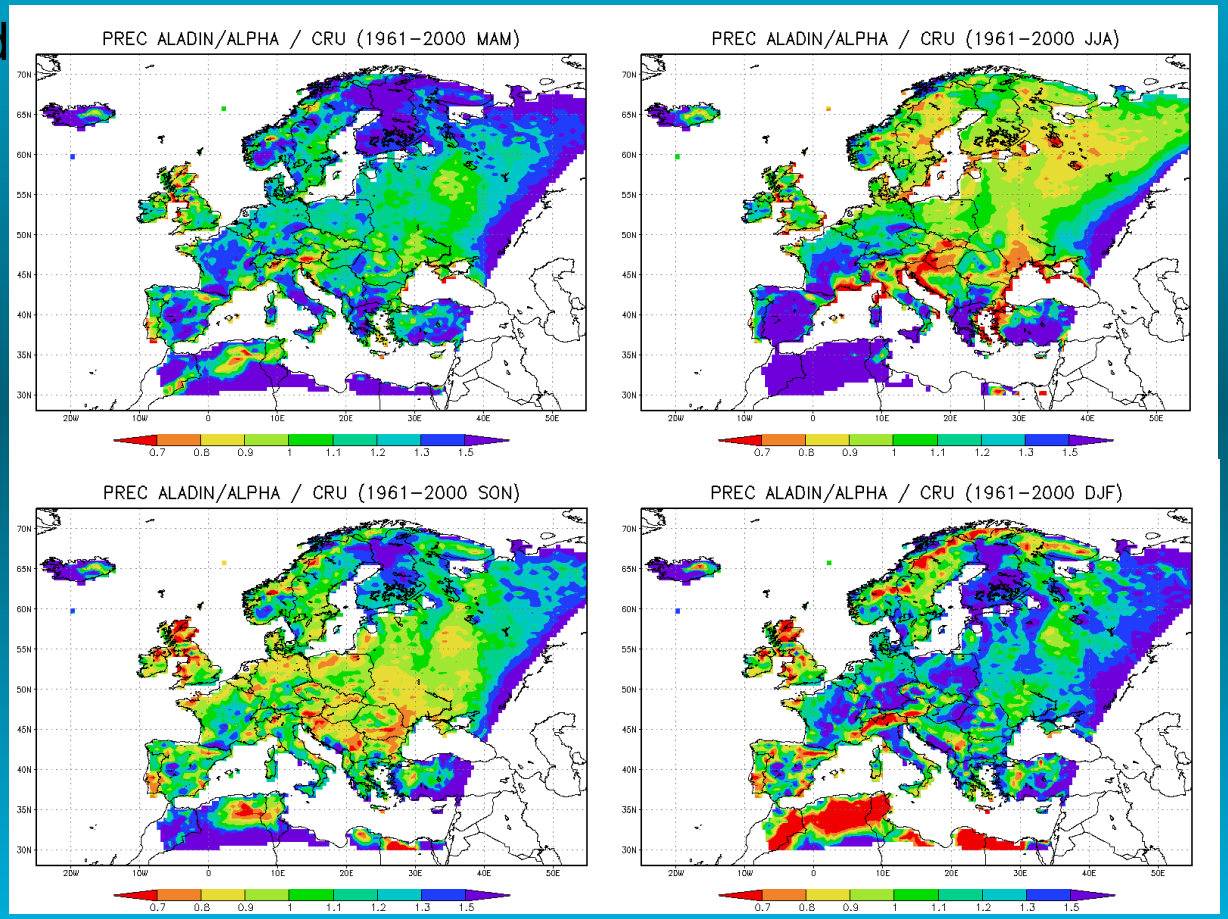
Spring: “wet” season – precipitation overestimated over the whole Europe.

Summer: wet WE and Mediterranean, underestimation over Hungary, Croatia and N. Italy.

Autumn:quite good accordance with CRU

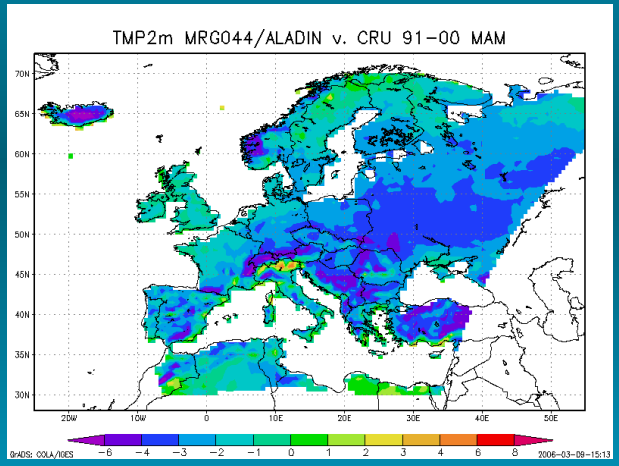
Winter: Similar to spring, very wet.

Ratio [ALADIN/CRU]



Negative spring temperature bias in ALADIN (what is behind)

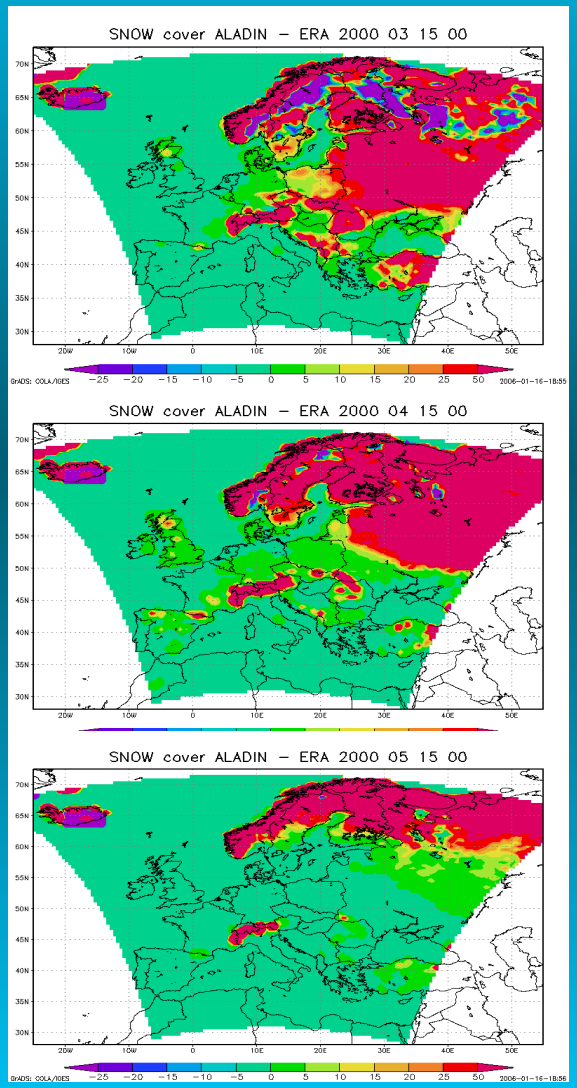
Snow cover ALADIN – ERA [Δ cm]
(15th of March 2000)



Negative T2m bias in 1991–2000 (ALADIN NWP version)

(15th of April 2000)

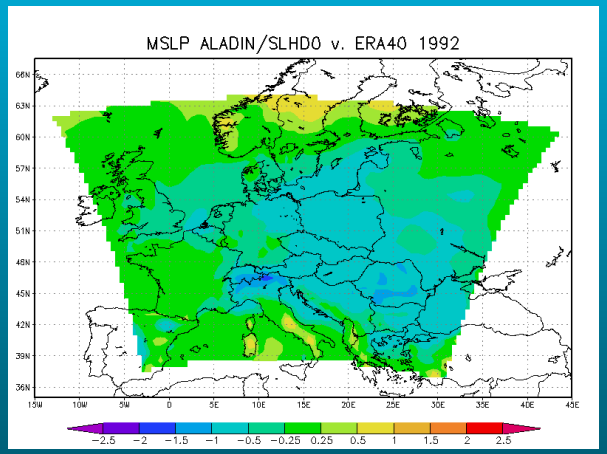
(15th of May 2000)

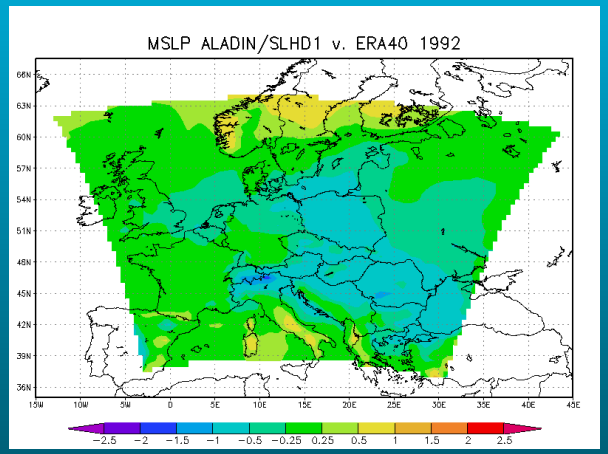


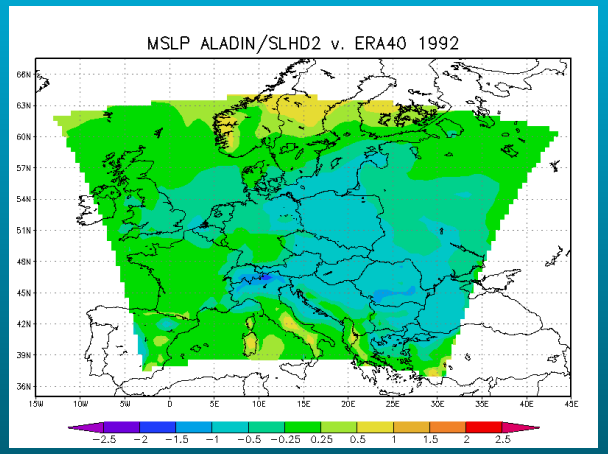
SLHD & climate experiments

- Motivation: could help to ease problems negatively influencing long time simulations
- Concerns: NWP version of SLHD could cause accumulation of positive pressure bias during long integrations (use of vertical diffusive interpolators).
- Answer: 2D version using only semi-horizontal interpolators designed by Filip Váňa for climate research purposes.
- Tests: an ensemble of experiments was set-up to test differences between the impacts of spectral horizontal diffusion, 2D and 3D SLHD at 50, 25 and 10 kilometers mesh size during 4 years integrations. Using the same tuning of SLHD as in the operational version.
- Assessed quantity: annual average bias of MSLP in 4th year of integration (comparison to ERA40 data).

Results for experiments at 25 km







ALADIN – ERA40 [Δ hPa]

- In case of all three chosen resolutions there was detected no significant bias (25 kilometer experiment is quite representative for 50 and 10 kilometer one).
- In case of 50 and 25km experiments there is no significant impact of SLHD use on temperature, precipitation, humidity.
- First with 10 kilometer grid visible albeit weak influence on long-time averages/sums of meteorological quantities.

Conclusions:

- 41-year ERA40 integration provided sufficiently consistent results – well capturing basic climate features over Europe.
- ALADIN performs sufficiently well when compared to other RCMs.
- Thus ALADIN (CY28) could be considered as a feasible tool for climate simulations.
- **But** there is a clear need for further development and tuning (more advanced precipitation scheme?).

- The necessity of further international cooperation on ALADIN-Climate project.
- This could possibly leading to one climate version.

Thanks for your attention.