Contribution of lateral terrestrial water flow to precipitation – A WRF-Hydro ensemble analysis and continental evaporation tagging for Europe

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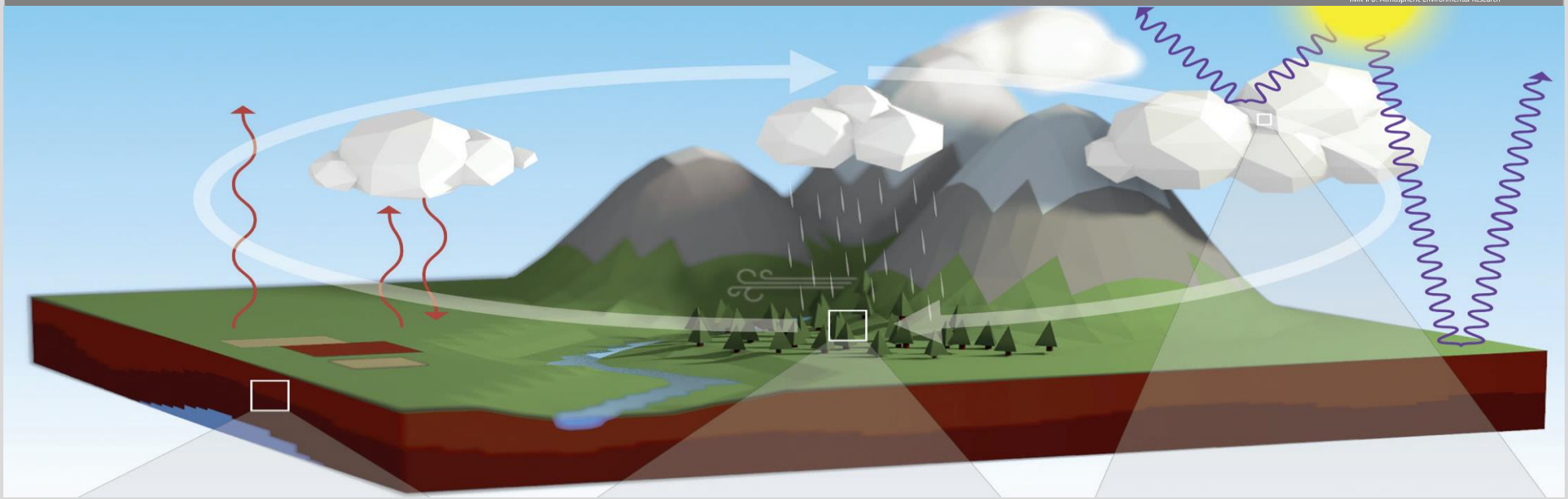

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Lateral terrestrial water flow – precipitation feedback

- Research question: How and to which extend the lateral terrestrial water flow modifies precipitation?

- Method:

  - Comparison between WRF and WRF-Hydro simulations to extract the impact of enabled lateral terrestrial water flow on simulation results

  - Continental-scale simulations to assess the full impact of modified land surface evaporation on precipitation

  - E-tagging to quantify this impact

  - Ensemble generation to disentangle the contribution of modified land surface evaporation and atmospheric chaotic behavior on precipitation

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Lateral terrestrial water flow – precipitation feedback

- About E-tagging (e.g. Wei et al. 2015, Arnault et al. 2016)
  - A so-called „tagged hydrological“ cycle is added to the WRF source code
  - Surface evaporation from a source region is defined as „tagged evaporation“
  - Tagged water variables quantify the amount of water originating from the source region in each water compartments of the model
  - The tagged precipitation gives the amount of regional recycling occurring in the source region

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Lateral terrestrial water flow – precipitation feedback

- About the ensemble generation with SKEBS
  - WRF has an option to add random noise to the prognostic variables with a Stochastic Kinetic Energy Backscatter Scheme (SKEBS, e.g. Shutts, 2005)
  - Random fields are added to prognostic variables U, V, T at each time step and each grid point
  - Default amplitude used for the random perturbations
  - Selection of 10 „seed numbers“ to generate 10 different WRF and WRF-Hydro members

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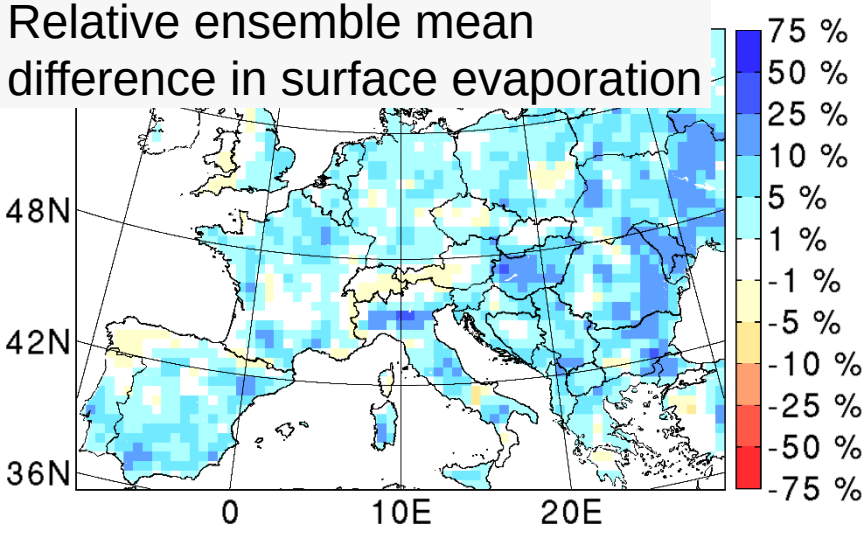
Lateral terrestrial water flow – precipitation feedback

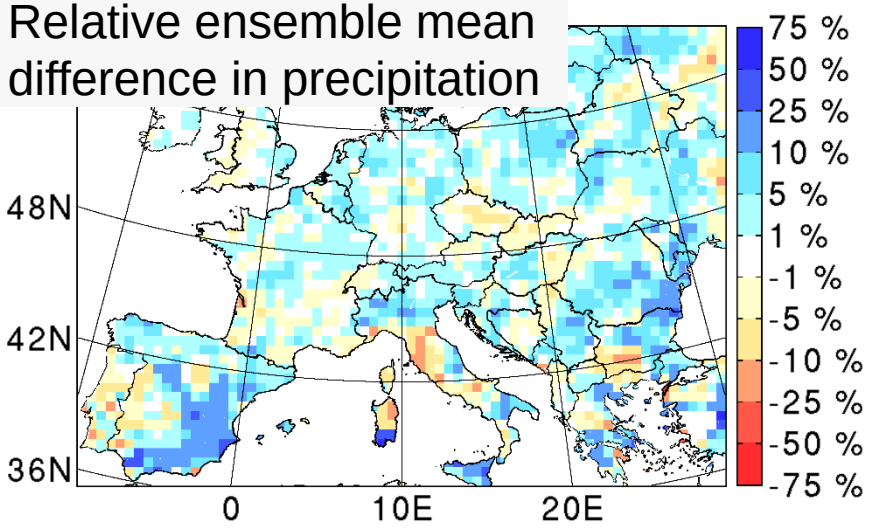
- WRF / WRF-Hydro ensemble setup
  - Atmospheric grid @5km, forcing from ERA5 reanalysis (WRF, WRF-Hydro)
  - Terrestrial water routing grid @250m (WRF-Hydro)
  - Simulated period: June-September 2008
  - E-tagging activated (source region: all the land in the simulation domain)
  - 10 WRF and 10 WRF-Hydro members

- Result for Jun-Sep 2008 (WRF-Hydro minus WRF)

Relative ensemble mean difference in surface evaporation



Relative ensemble mean difference in precipitation



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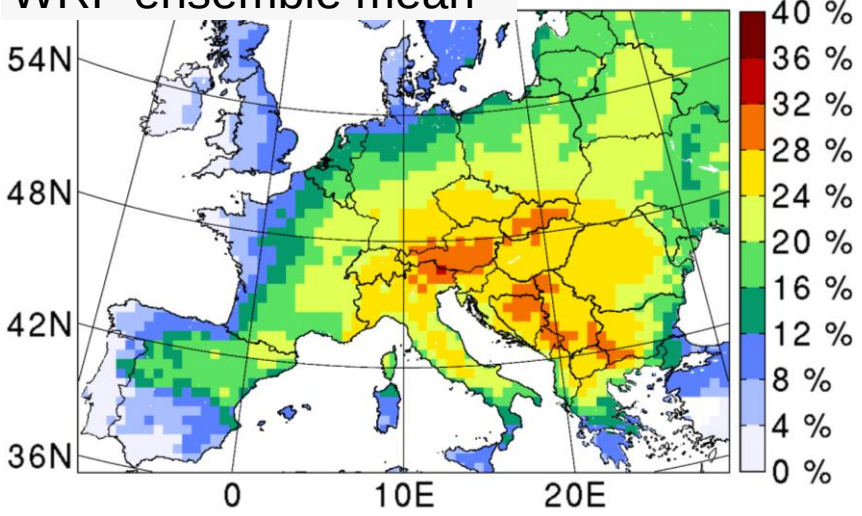
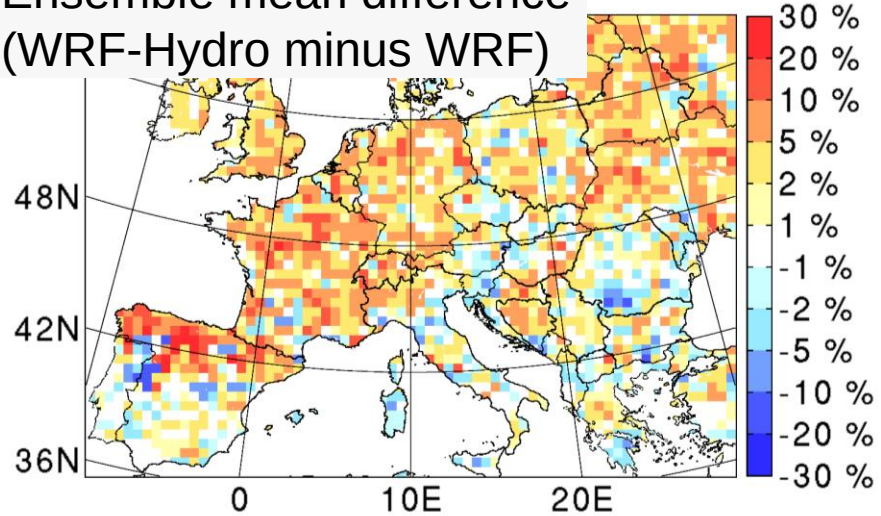
Lateral terrestrial water flow – precipitation feedback

- E-tagging result for Jun-Sep 2008 - Regional recycling

WRF ensemble mean



Ensemble mean difference
(WRF-Hydro minus WRF)



- The consideration of lateral terrestrial water flow at continental-scale clearly increases surface evaporation, precipitation and regional recycling

- Neglecting lateral terrestrial water flow would result in an underestimation of the strength of the land – atmosphere coupling in the simulation.

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