Karlsruhe Institute of Technology

DFG Deutsche Forschungsgemeinschaft

How reservoir regulation modifies the water cycle?

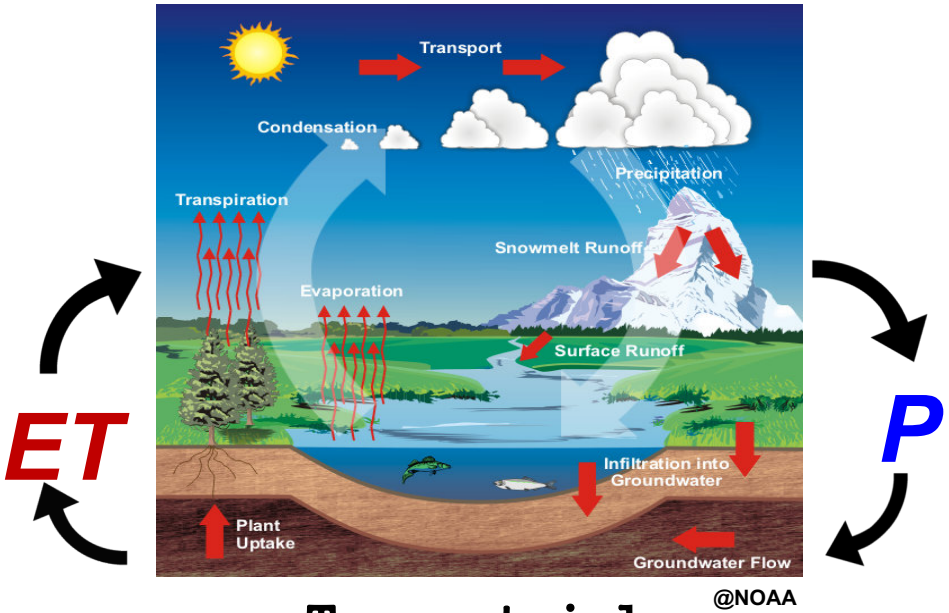
Incorporation of a reservoir regulation network module into a fully coupled hydrological-atmospheric model

J. Wei[1] (jianhui.wei@kit.edu), N. Dong[2], J. Arnault[1], B. Fersch[1], S. Wagner[1], Z. Zhang[1], P. Laux[1], C. Yang[2], Q. Yang[2], Z. Yu[2], and H. Kunstmann[1]

1. Karlsruhe Institute of Technology, Garmisch-Partenkirchen Germany
2. Hohai University, Nanjing, China

Water Cycle & Human Activities

Atmospheric branch



@NOAA

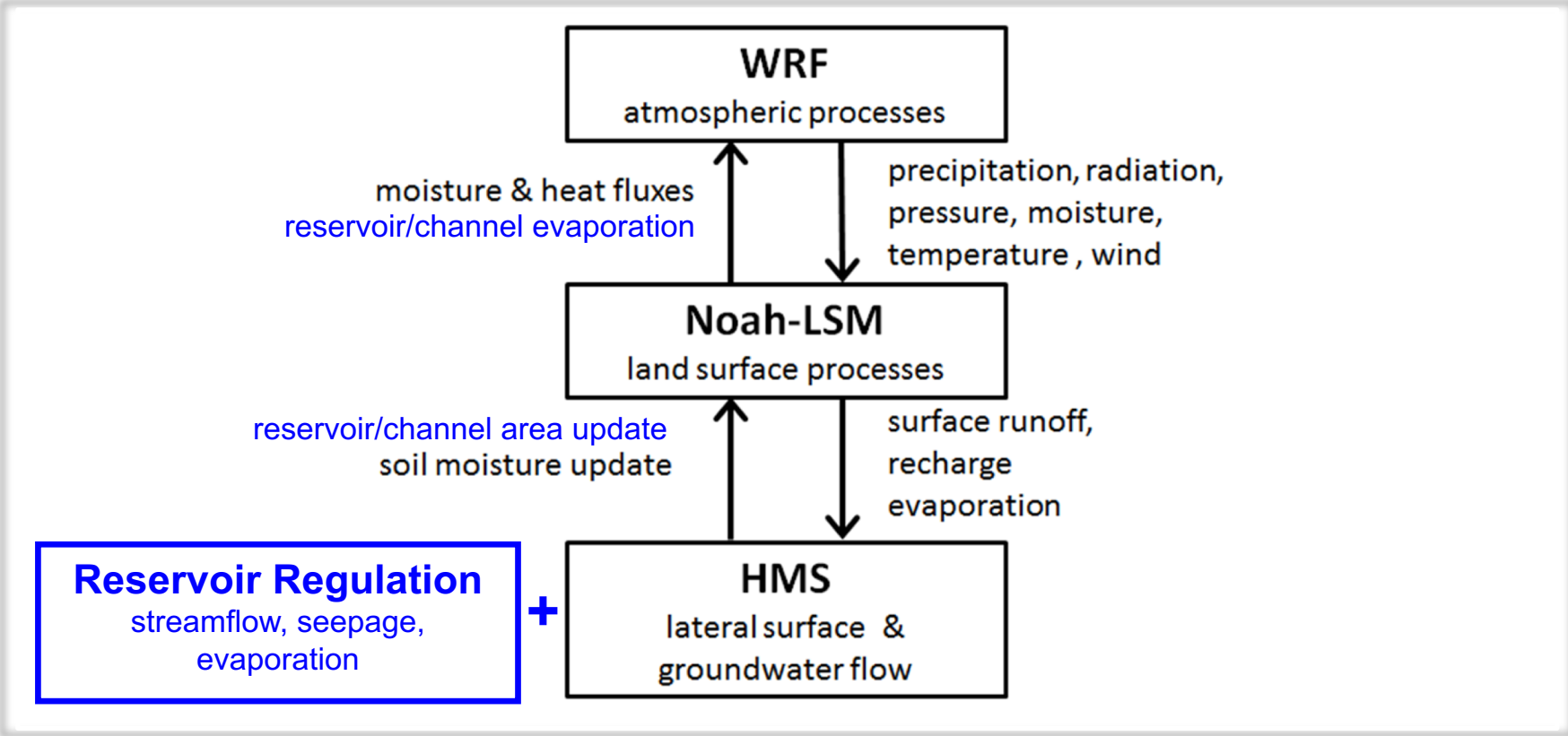
Terrestrial branch

- The regional water cycle is altered by human activities.
- Reservoir regulation is a way to spatially and temporally allocate water resources in a basin for multi-purposes.

Institute of Meteorology and Climate Research (IMK-IFU) Karlsruhe Institute of Technology
jianhui.wei@kit.edu

Representing Reservoirs in HMS (WRF-HMS)

- Represent **reservoir regulation** in a fully-coupled atmospheric-hydrolocial modeling system **WRF-HMS**.



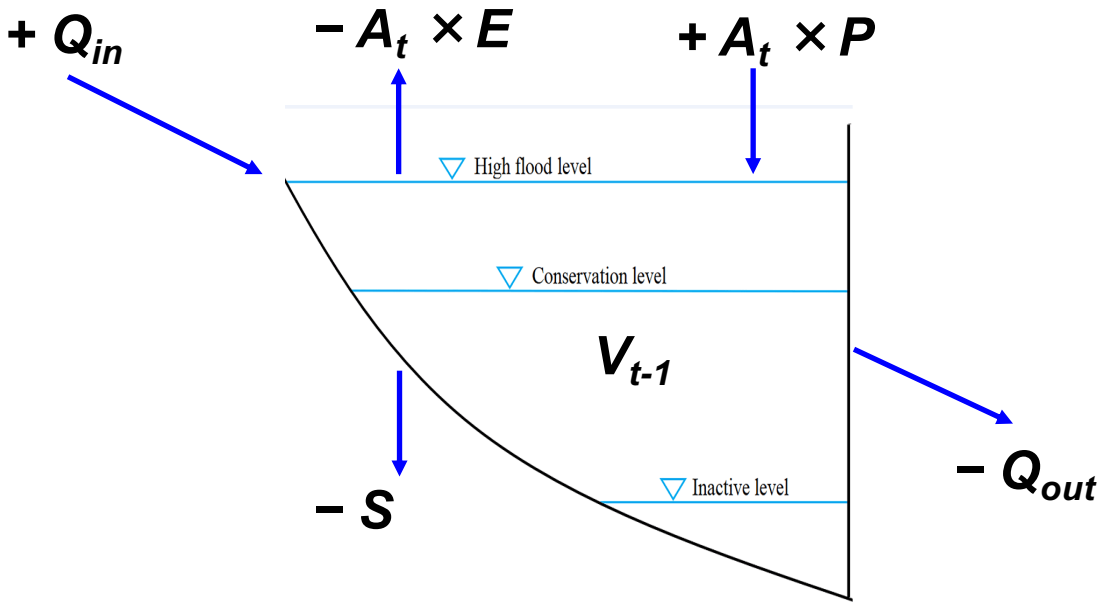
- Assess the **modification** of the water cycle due to **reservoir regulation**

Institute of Meteorology and Climate Research (IMK-IFU) Karlsruhe Institute of Technology
jianhui.wei@kit.edu

Representing Reservoirs in HMS (WRF-HMS)

Water balance equation for reservoir + Regulation scheme (dry+wet) :

$$V_t = V_{t-1} + Q_{in} - A_t \times E + A_t \times P - S - Q_{out}$$



Interactions of reservoir with the water cycle

@land surface

affect streamflow rounting via 2D diffusion wave equation (***Q_{out}***)

interact with the atmosphere via evaporation of reservoir+channel (***E***)

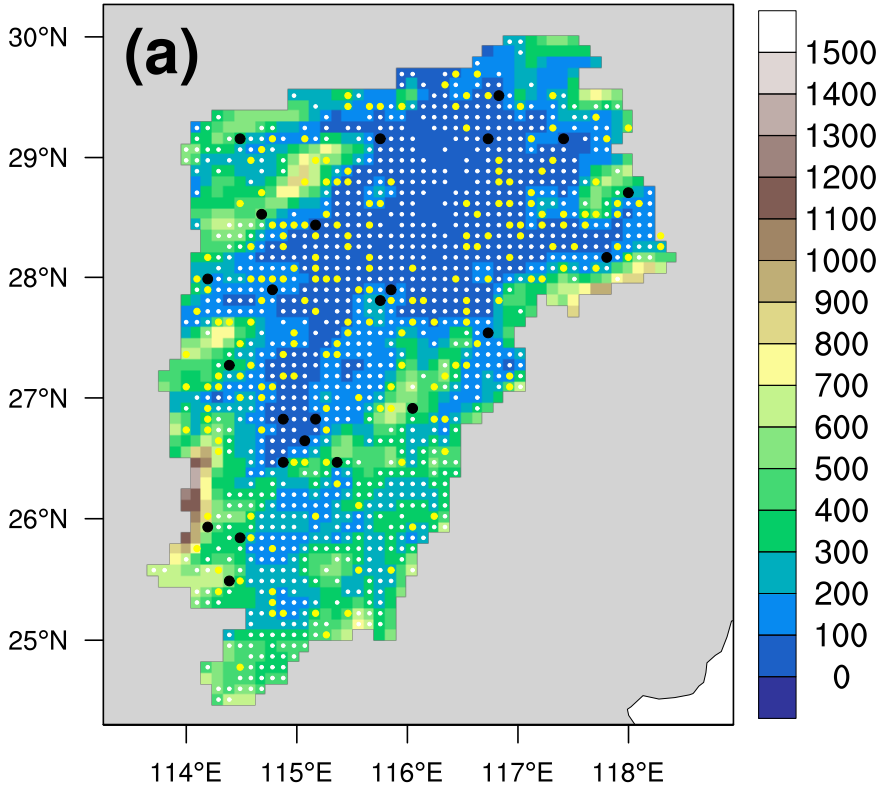
@subsurface

alter groundwater depth via seepage from reservoirs (***S***)

Institute of Meteorology and Climate Research (IMK-IFU) Karlsruhe Institute of Technology
jianhui.wei@kit.edu

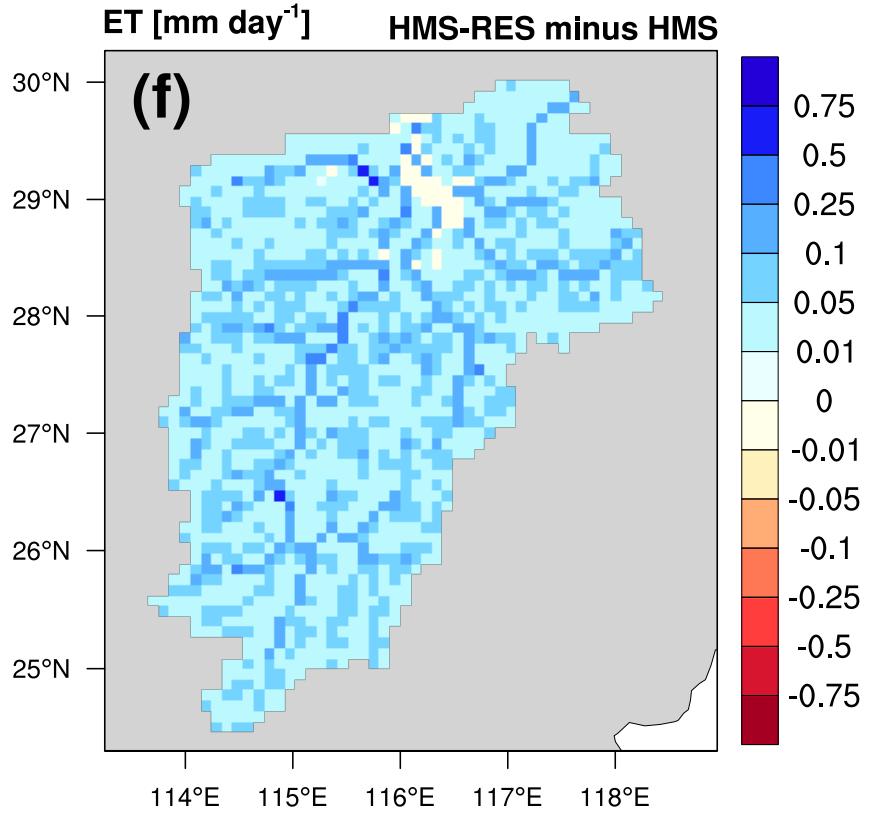
Reservoirs in HMS (in preparison)

Location of reservoirs



- 24 large reservoirs (>10^8 m^3, black)
- 201 medium reservoirs (10^7~10^8 m^3, yellow)
- 1037 small reservoirs (<10^7 m^3, white)

Multi-year average (1979-1986)



- Improving streamflow simualtion
- Regulating streamflow elevating groundwater level moistening soil,
- **enhancing ET**

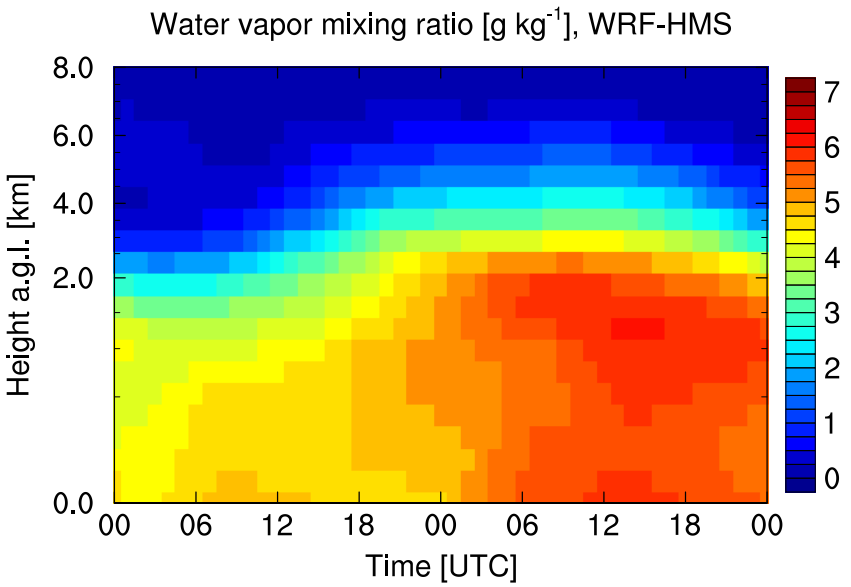
Institute of Meteorology and Climate Research (IMK-IFU) Karlsruhe Institute of Technology
jianhui.wei@kit.edu

Reservoirs in WRF-HMS (preliminary results)

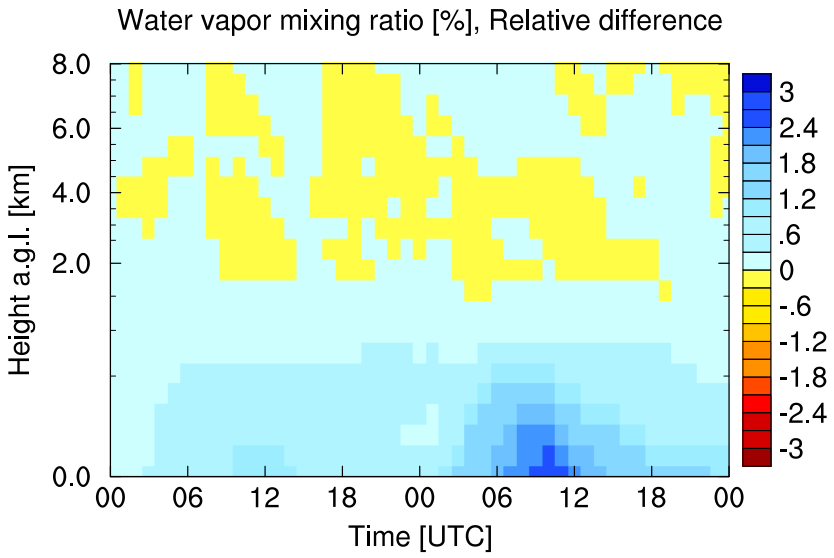
- WRF-HMS vs. WRF-HMS-RES for 2-day test run (1979 JAN 01-02)

Profile of basin-averaged water vapor

WRF-HMS



Reservoir-induced Rel. Diff.



Moister atmosphere within the plantary boundary layer due to evaporation of reservoir & channel

Institute of Meteorology and Climate Research (IMK-IFU) Karlsruhe Institute of Technology
jianhui.wei@kit.edu

References

- **WRF-HMS**

Water Resources Research

Research Article | Open Access

Fully coupled atmospheric-hydrological modeling at regional and long-term scales: Development, application, and analysis of WRF-HMS

Sven Wagner, Benjamin Fersch, Fei Yuan, Zhongbo Yu, Harald Kunstmann

First published: 29 March 2016 | https://doi.org/10.1002/2015WR018185 | Cited by: 10

- **Reservoir Regulation**

ELSEVIER

Journal of Hydrology

Volume 579, December 2019, 124148

Research papers

Climate-induced hydrological impact mitigated by a high-density reservoir network in the Poyang Lake Basin

Ningpeng Dong [a, b], Zhongbo Yu [a, b], Huanghe Gu [a, b], Chuanguo Yang [a, b], Mingxiang Yang [c], Jianhui Wei [d], Hao Wang [c], Joël Arnault [d], Patrick Laux [d, e], Harald Kunstmann [d, e]

Show more

https://doi.org/10.1016/j.jhydrol.2019.124148 Get rights and content

ELSEVIER

Journal of Hydrology

Volume 586, July 2020, 124903

Research papers

Water resources management in a reservoir-regulated basin: Implications of reservoir network layout on streamflow and hydrologic alteration

Ningpeng Dong [a, b, c], Mingxiang Yang [c], Zhongbo Yu [a, b], Jianhui Wei [d], Chuanguo Yang [a, b], Qianya Yang [a, b, d], Xuan Liu [e], Xiaohui Lei [c], Hao Wang [c], Harald Kunstmann [d, f]

Show more

https://doi.org/10.1016/j.jhydrol.2020.124903 Get rights and content

Institute of Meteorology and Climate Research (IMK-IFU) Karlsruhe Institute of Technology

jianhui.wei@kit.edu