R: Irrigation effects on land surface-subsurface water and energy fluxes simulated by the ACME Land Model

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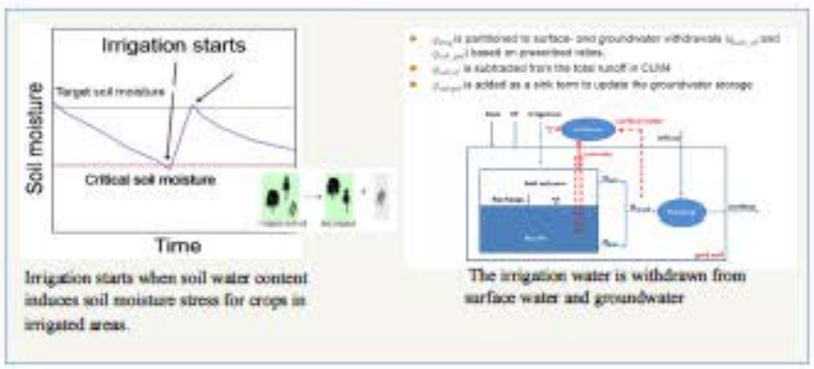
Objective

1. Demonstrate the capacity of ACME Land Model (ALM) for representing human impacts using irrigation as an example.
2. Enhance the parameterization of irrigation water use in ALM in terms of irrigation amount, irrigation source and irrigation method
3. Identify future development needs for better representing irrigation water use

Approach

Key Features:

1. **Irrigation amount is calibrated against FAO census data (Leng et al. 2015)**
2. **Irrigation water can be withdrawn from surface water and groundwater (GW) source constrained by FAO census**
3. **Different irrigation method can be adopted**



Irrigation starts when soil water content induces soil moisture stress for crops in irrigated areas.

The irrigation water is withdrawn from surface water and groundwater

Numerical Experiments

Name	Climate dataset [simulation period]	Irrigation	Calibrated	Pumping
CTRL	Qian Data (1972-2004)	no	---	---
IRRIG		yes	Yes	no
PUMP		yes	Yes	Yes
Drip		yes	Yes	Yes
Flood		yes	Yes	Yes
Sprinkler		yes	Yes	Yes

Sprinkler Irrigation

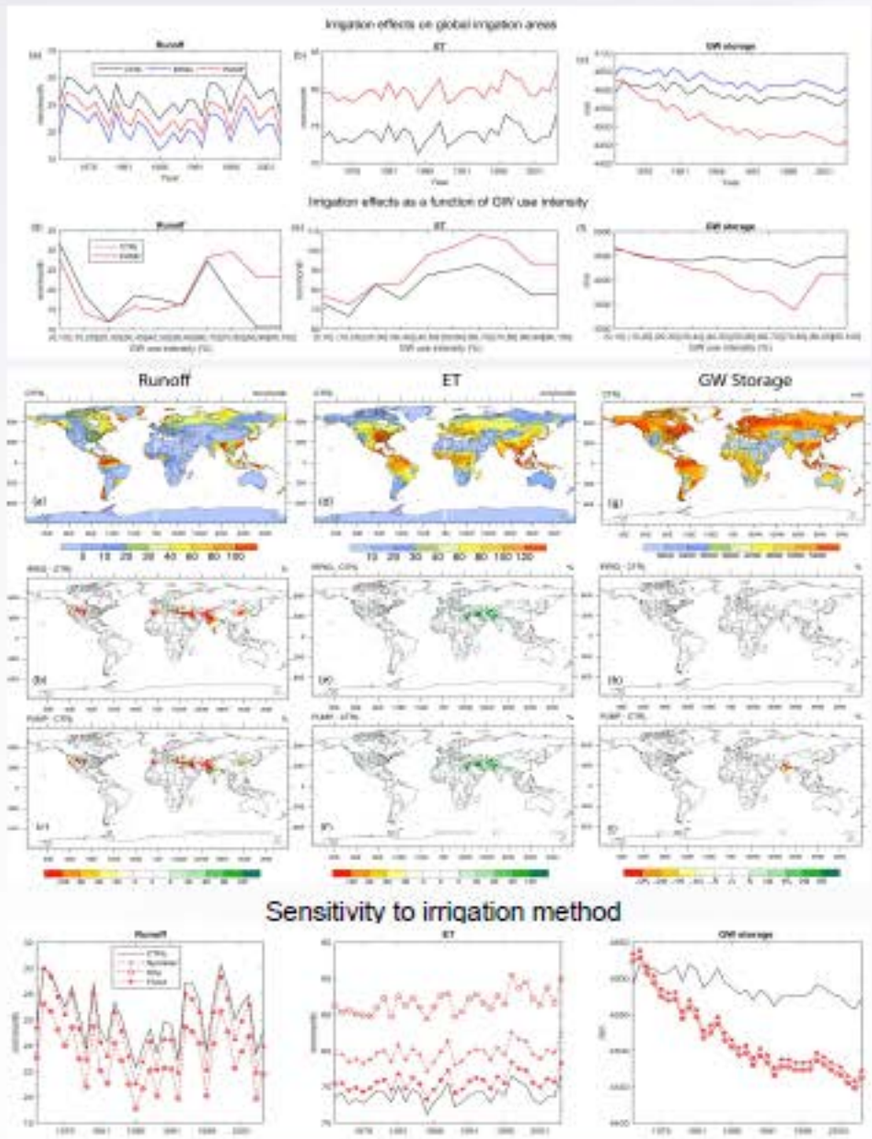
Water is applied uniformly as precipitation (Ozdogan et al. 2010)

Flood Irrigation

Water is applied to the root zone in 30 minutes (Yilmaz et al. 2014)

Drip Irrigation

Water required is immediately transpired rather than added to the soil column (Evans and Zaitchik, 2008)



Impact

1. Irrigation lead to increase of ET, and decrease of runoff and GW storage when averaged over global irrigation areas. However, in certain regions, runoff could increase due to return flow of pumped groundwater applied to the surface. GW storage would increase due to enhanced recharge in surface water dominant regions.
2. GW pumping lead to consistent aquifer depletion with magnitude depending on the its intensity.
3. Irrigation effects especially for ET depend largely on the irrigation methods (i. e. sprinkler, flood and drip irrigation techniques)
4. The ACME Land Model (ALM) can be well used for investigating irrigation water use effects and more efforts are needed for testing the assumptions in the parametrizations

ACME Accelerated Climate Modeling for Energy

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