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Exploring Large-scale Parameterization of Irrigation in the Northern High Plains

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Exploring Large-scale Parameterization of Irrigation in the Northern High Plains

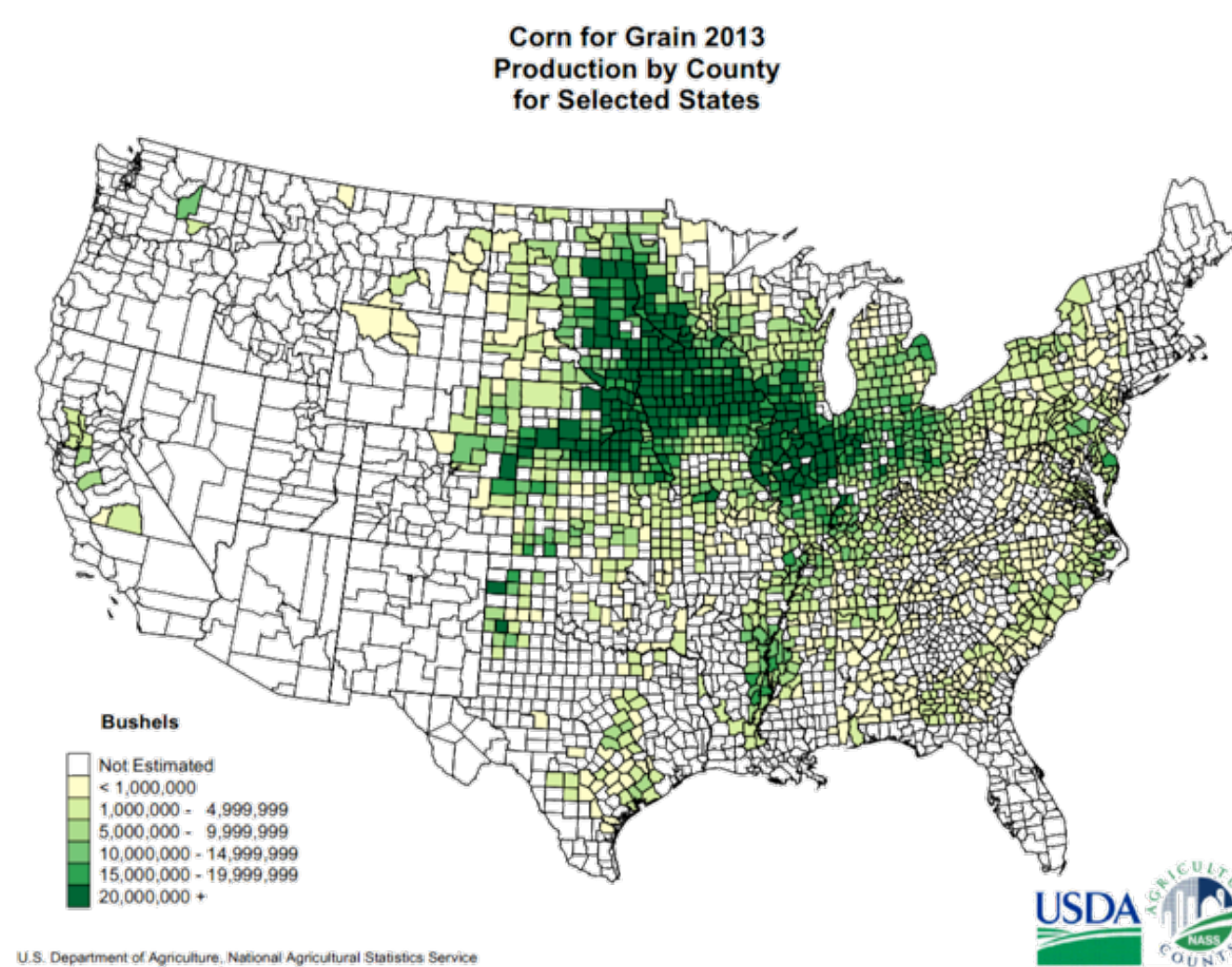
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University of Nebraska-Lincoln

Introduction

Irrigation in Nebraska

- Ranked 1st for number of irrigated acres, with 3 out of every 8 acres being irrigated
- Nebraska has 100,000 irrigation wells
- As of 2007, Nebraska had 8.56 million irrigated acres
- 15% of irrigated acres nationally are located in Nebraska
- Nebraska is the 3rd largest producer of corn



Irrigation is extremely important to the agricultural industry in Nebraska

Why do we want to study irrigation?

- Agricultural crop enterprise is dependent on the sustainability of irrigation.
- Learn how to manage crop irrigation requirements (CIRs) in response to extreme hydrometeorological events.
- The chosen study domain was the Platte River Basin
- Irrigation operates at field-scale but is subject to multi-scale surface water and groundwater availability
- Local-to-national water resources management is poorly understood

Variable Infiltration Capacity Model (VIC)

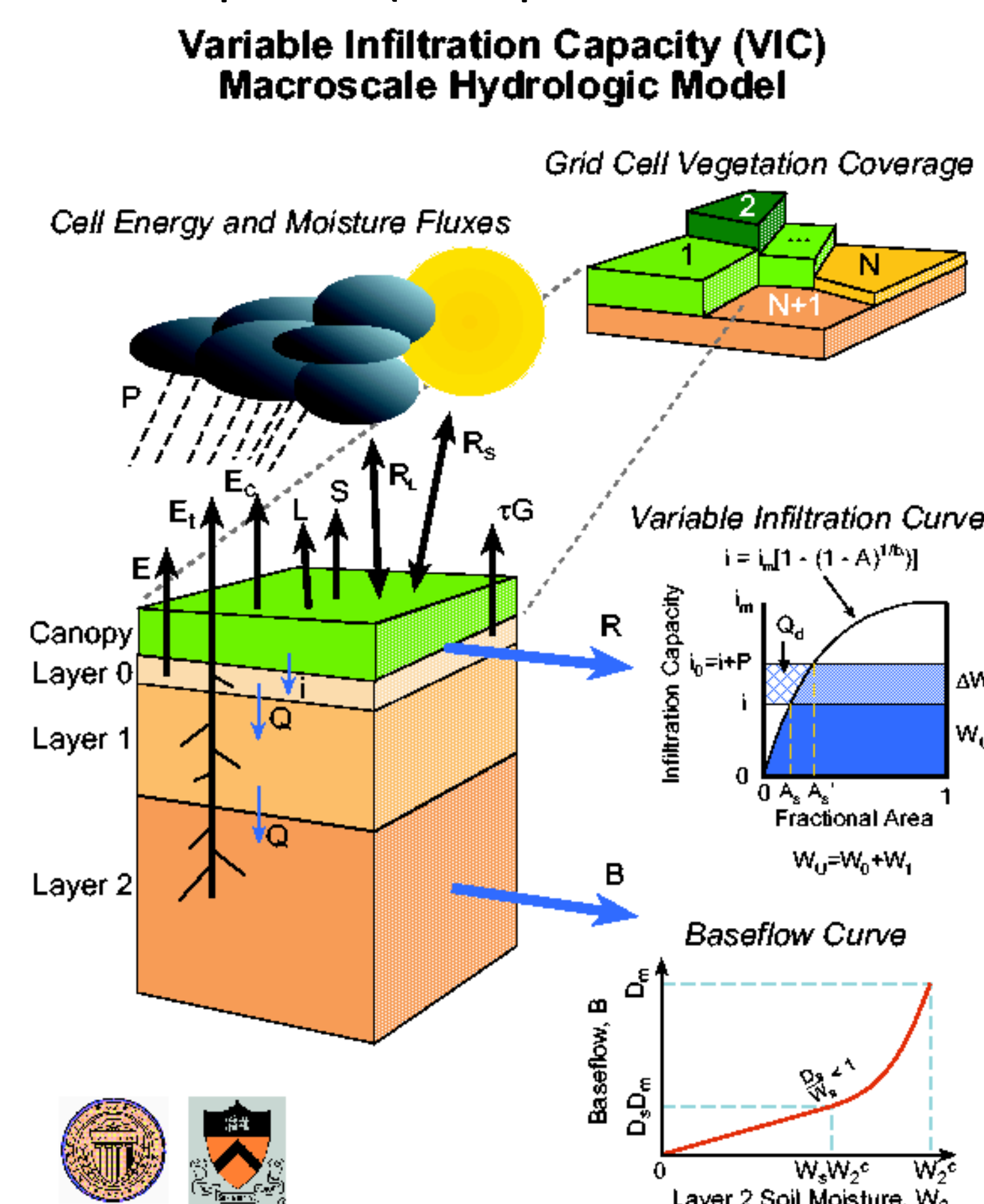
- Large-scale hydrologic model
- Land surface is modeled as a grid (1/16th degree spatial resolution)
- Inputs are time series of daily meteorological drivers (Forcings)
- Simulations occur at a daily time step
- Water enters a grid cell via the atmosphere (except in the case of irrigation)
- No grid cell interaction
- Grid cell Routing of stream flow is performed separately using a separate model (Routing Model)

Forcings

- Precipitation
- Minimum Temperature
- Maximum Temperature
- Wind Speed

Parameters

- Soil physical properties
- Vegetation
- Snow Elevation Bands



Non-irrigation and Irrigation Parameterization

Similarities

- Forcing Files
- Vegetation Cover File
- Soil Characteristic File

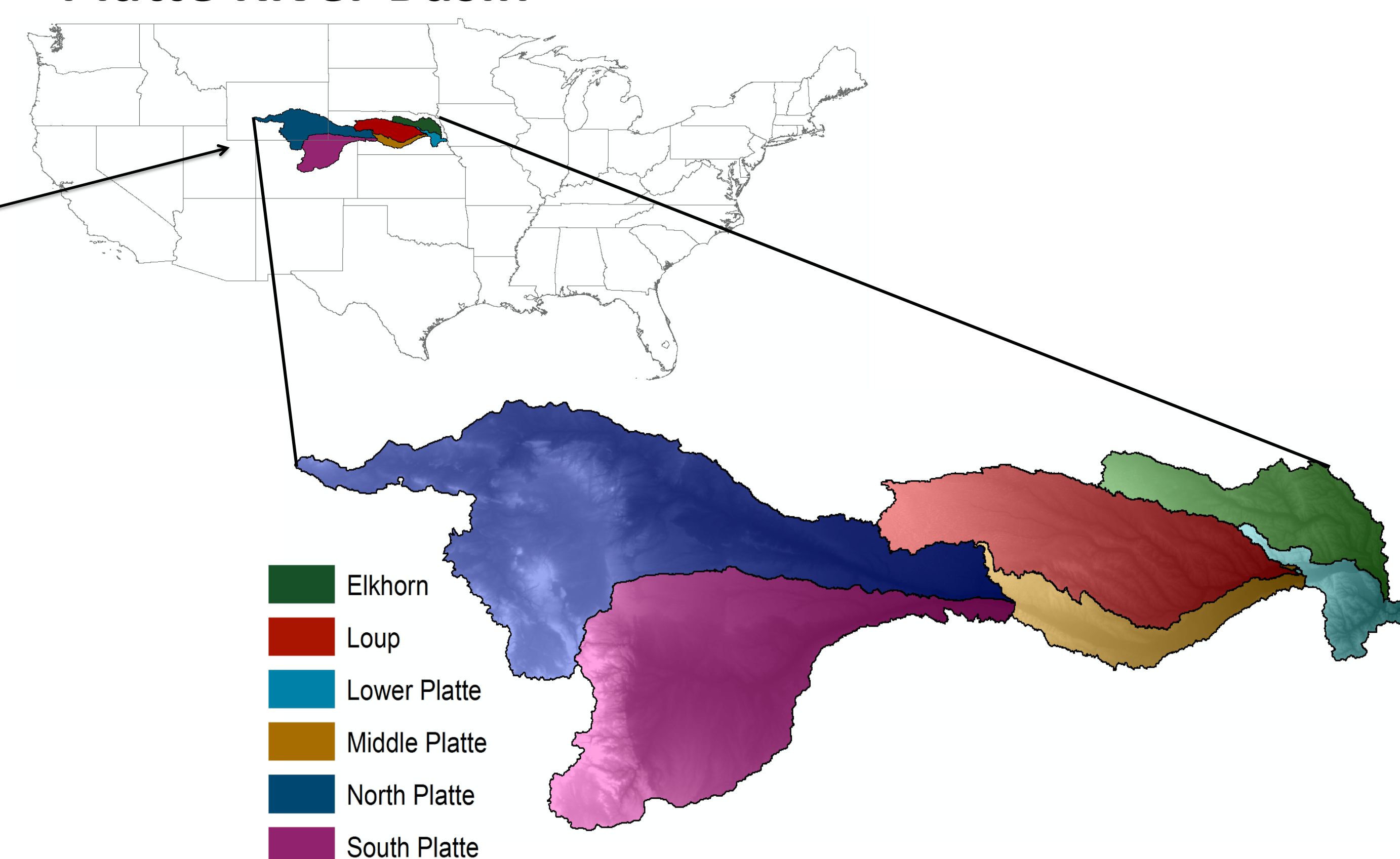
Differences

- Irrigation Parameterization includes Crop Fraction File, which represents amount of land equipped for irrigation for every grid cell

The Irrigation Parameterization

- Irrigation water is assumed freely available
- Irrigation takes place when soil moisture drops below wilting point, applying the necessary water to reach field capacity

Platte River Basin



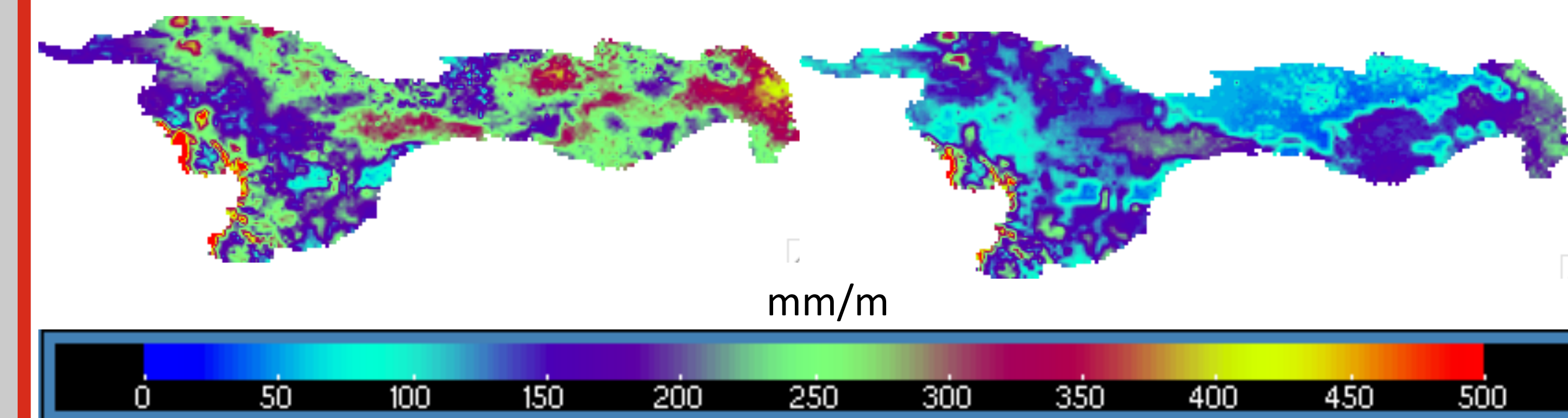
Results

These figures were results from VIC without the parameterization of irrigation.

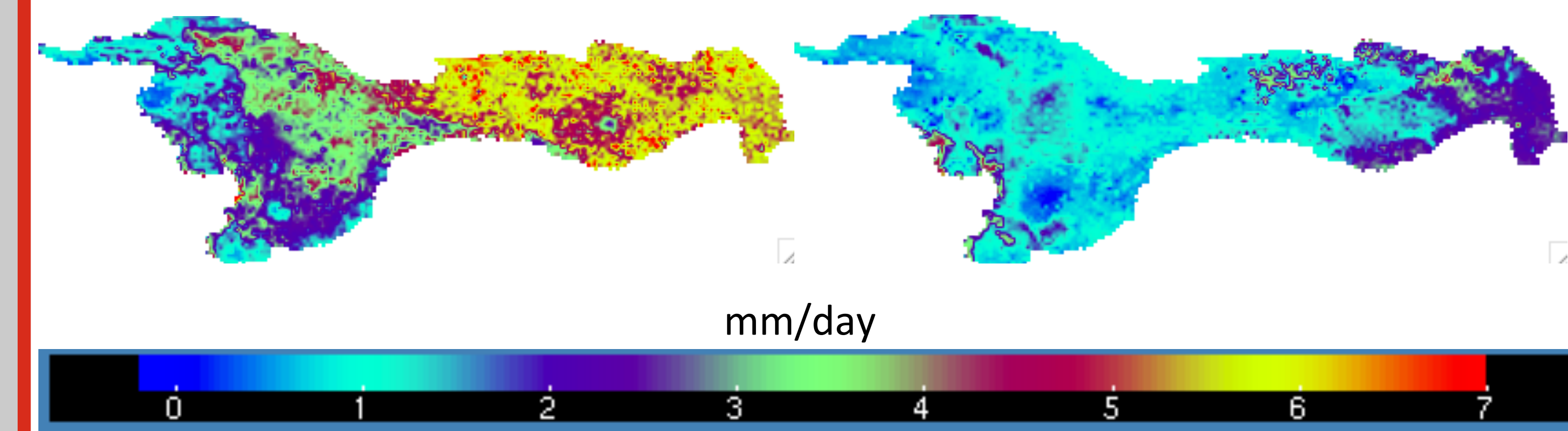
July 1, 2010

July 1, 2012

Total Soil Moisture



Evapotranspiration



2010 was a relatively wet year compared to 2012, having approximately 45% more precipitation. 2012 would have been a year with extensive irrigation. With the irrigation parameterization, ET could be modeled to see if similar levels of ET could be obtained using irrigation to meet the deficit of crop water requirements.

Research Question – Objective - Hypothesis

How does irrigation respond to the demands of Crop Irrigation Requirements under extreme hydrometeorological events?

Implement a parameterization of irrigation into the land surface hydrology model VIC.

Changes in evapotranspiration (ET) will be more conspicuous during dry years, highlighting the limiting role of soil moisture in the model.

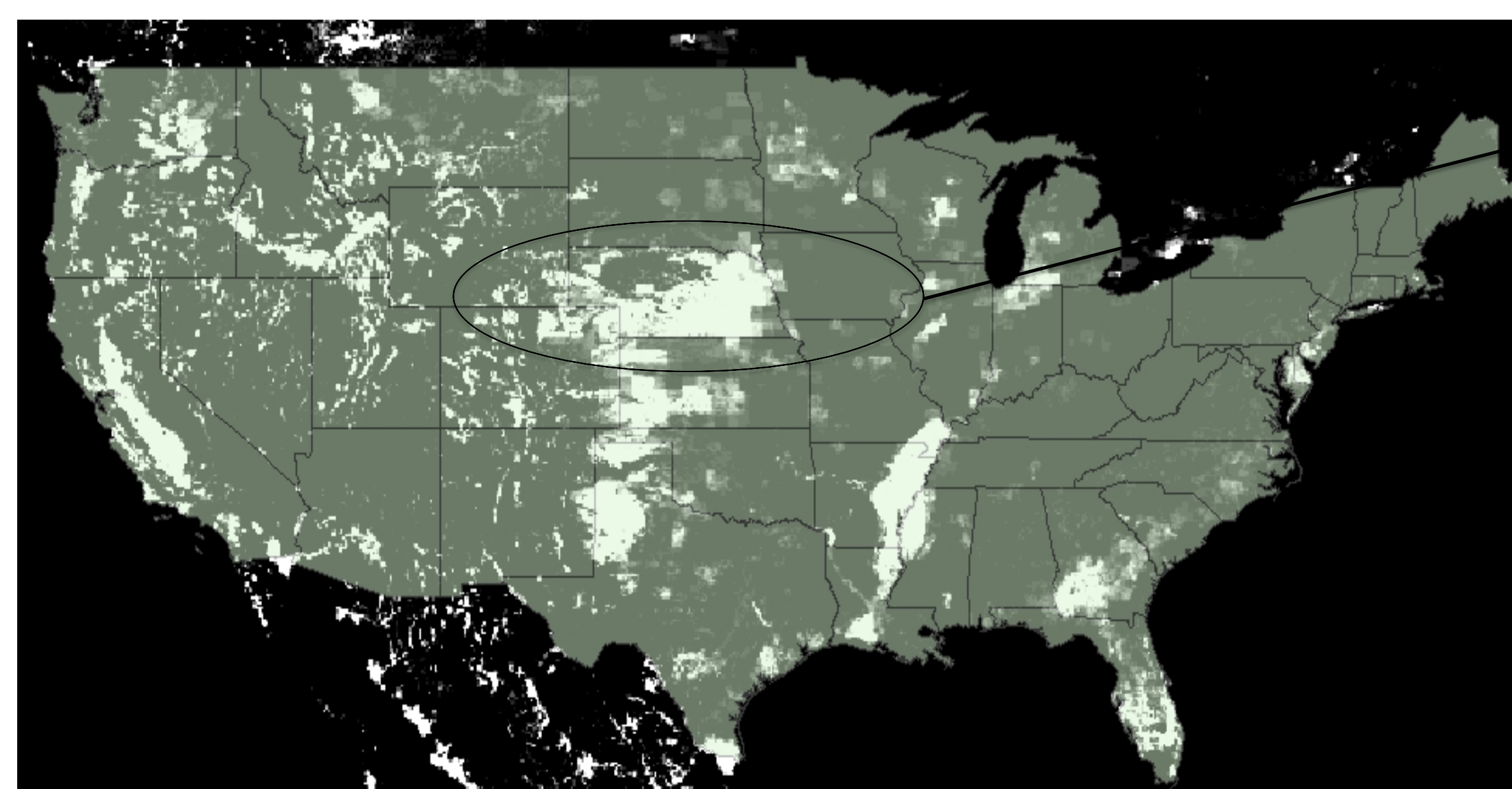


Figure shows spatial intensity of irrigation over the U.S.

Ongoing Activities

- The model show sensitivity to changes in soil moisture and ET in response to extreme hydrometeorological events
- A crop fraction file is under development transitioning from a 5-year to a 1-day file
- Additional results from using the model with parameterization of irrigation are expected to be presented in July's ASABE International Conference.