Effect of Irrigation on land surface hydrological modeling

Keyvan

Research question

- How do climate change and irrigation management impact land atmosphere interaction through soil moisture and evapotranspiration?
- How does change in irrigation efficiency impact water availability and agricultural production?

Irrigation systems

Modern irrigation systems

- Higher efficiency
- Higher uniformity
- More benefits for farmers

But Change in irrigation efficiency cause change in water availability

- Change the timing of the peak flow

- Change amount of return flow:
    - Increase in crop actual ET by increase in water availability in field and irrigation uniformity
    - Decrease in deep percolation

- For example 50% of applied water can be infiltrated in surface irrigation while deep percolation from drip systems is almost 0.

Effect of increase in efficiency

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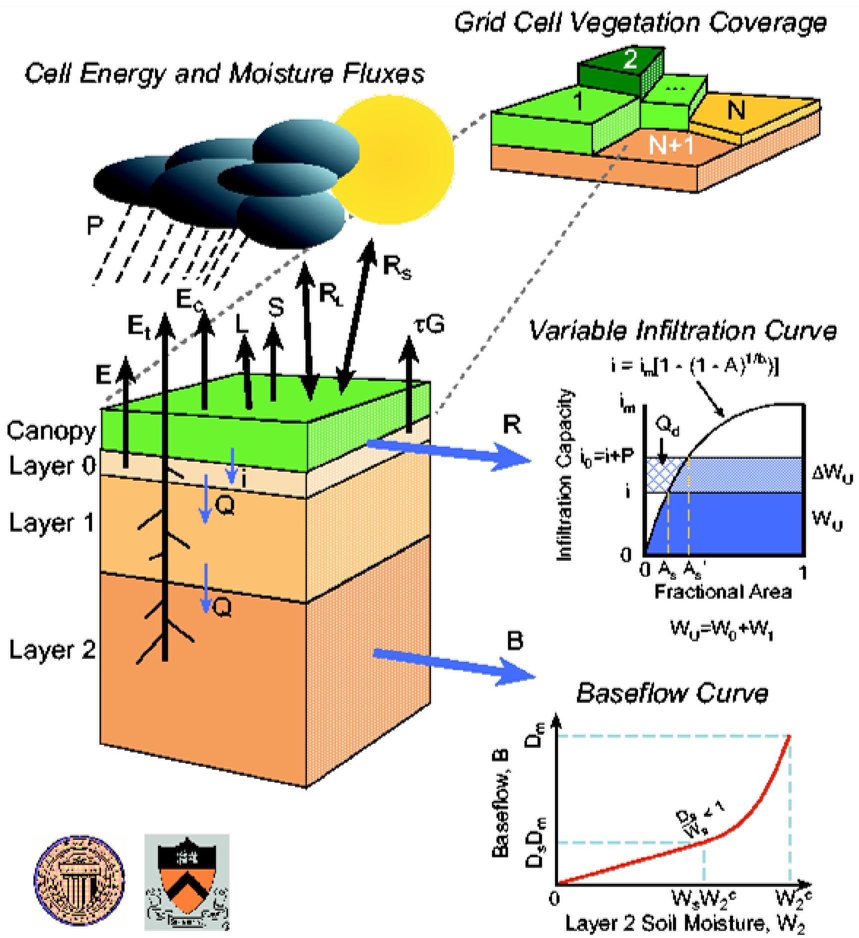
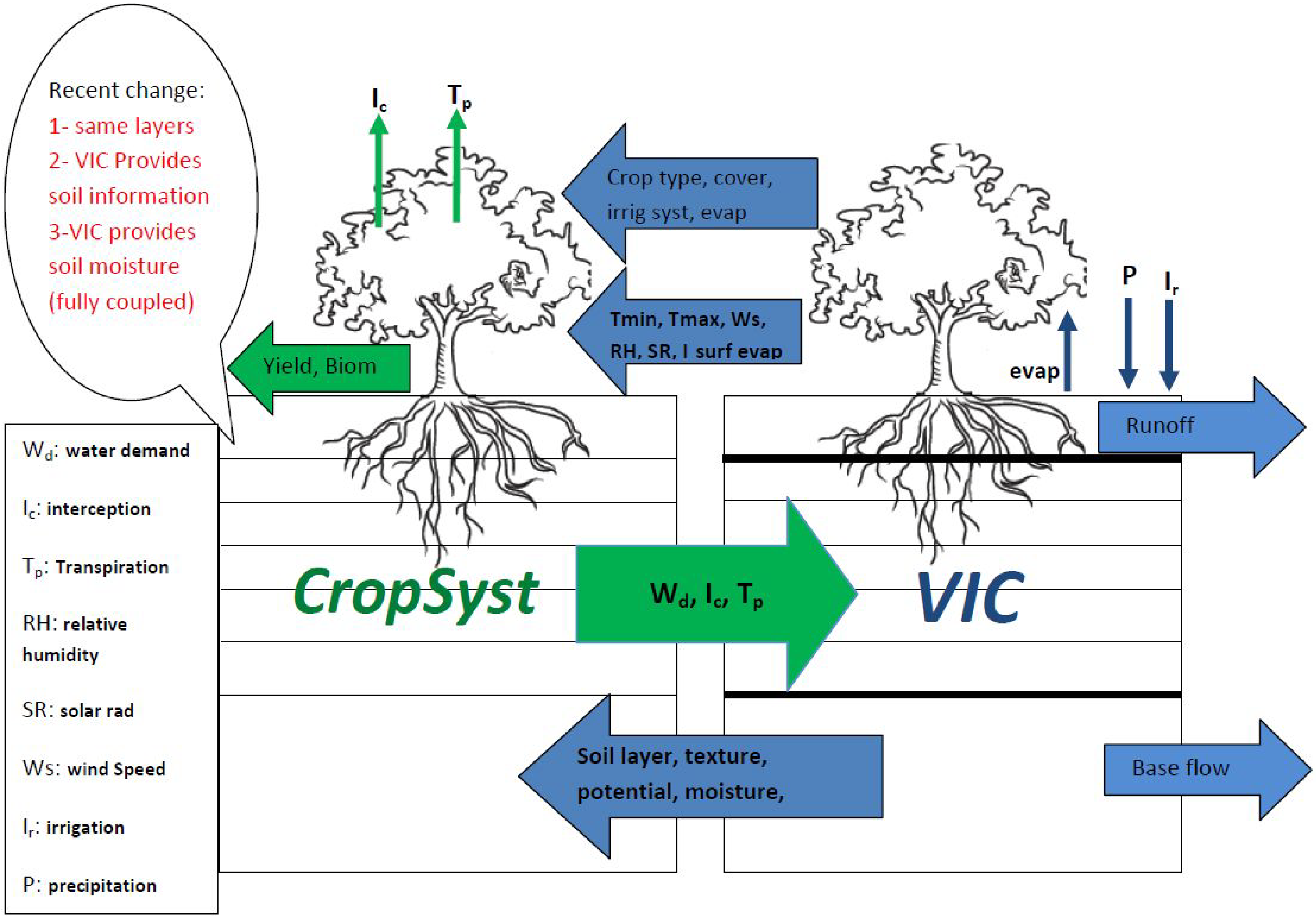
modeling

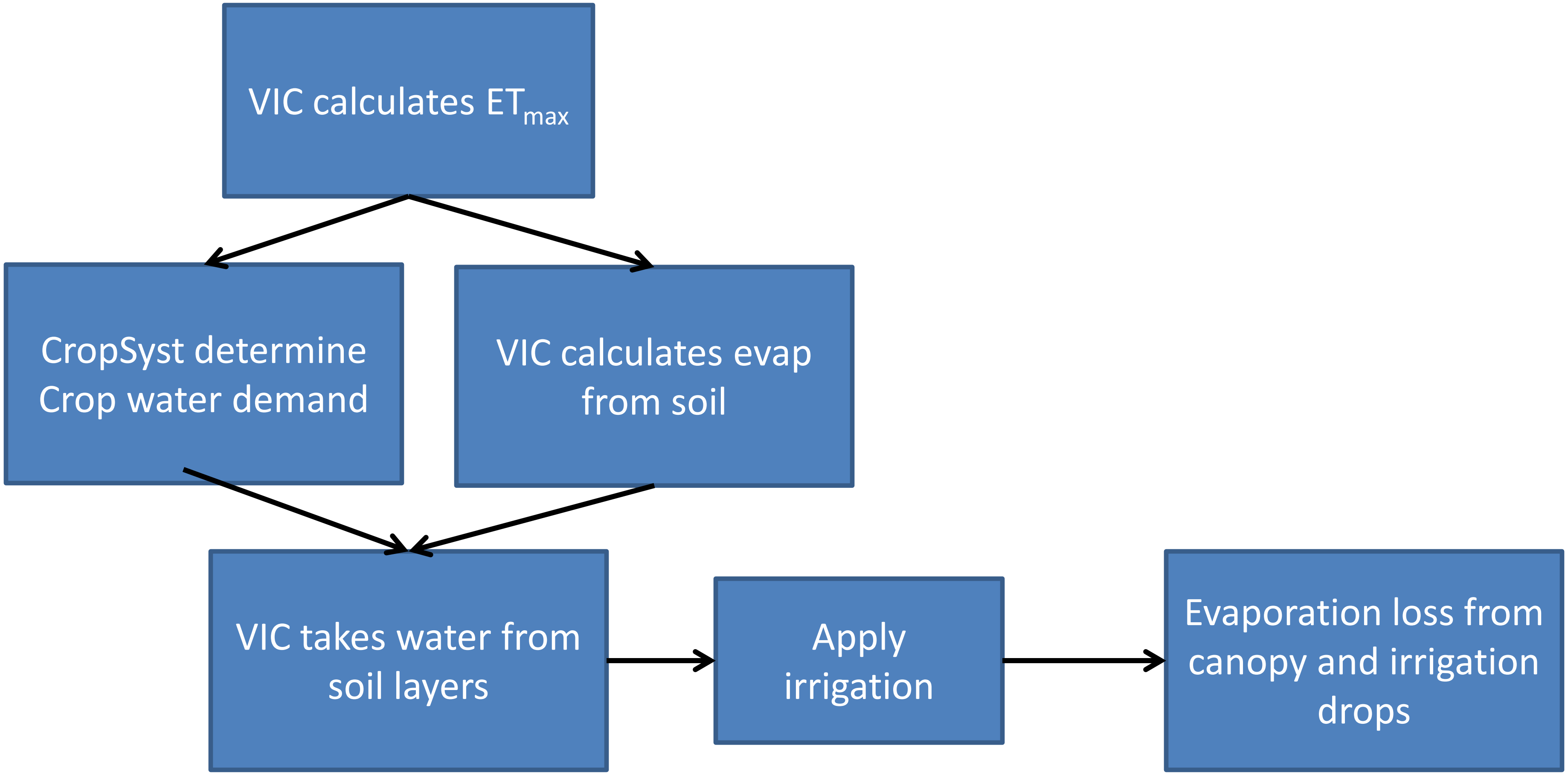
- We are using VIC_CropSyst to look at the effect of change in irrigation efficiency
- We also need to consider the effect of climate change

VIC_CropSyst

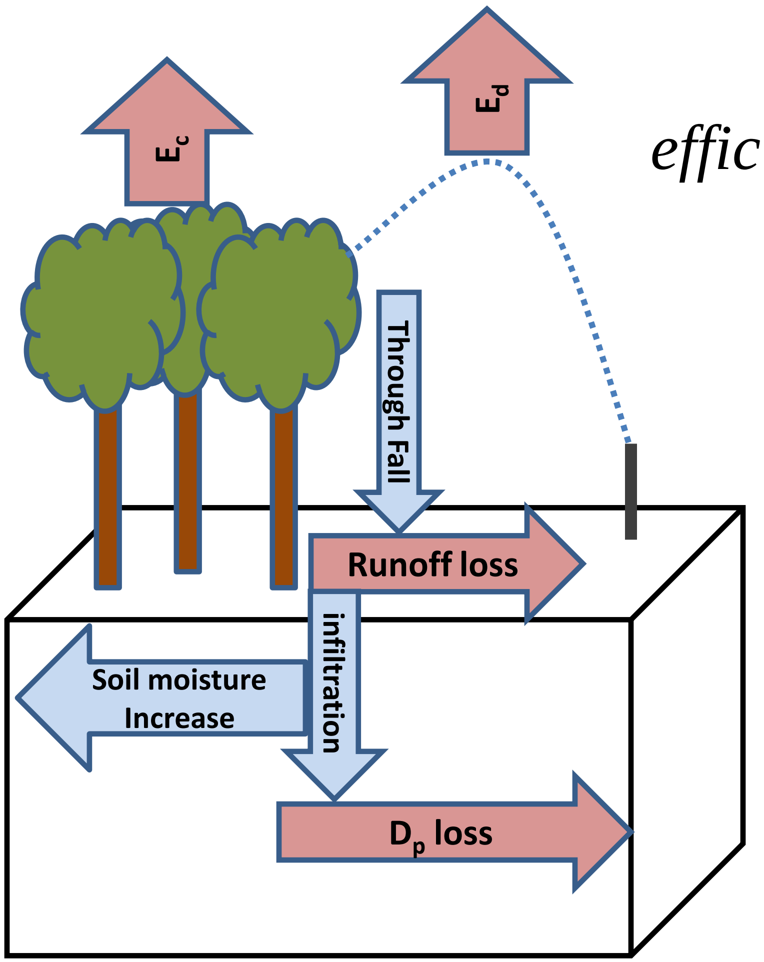


Current VIC_CropSyst coupling




VIC calculates ET_{max}
CropSyst determine Crop water demand
VIC calculates evap from soil
VIC takes water from soil layers
Apply irrigation
Evaporation loss from canopy and irrigation drops

For simulation of irrigation systems We need to be able to simulate losses



$$efficiency = 1 - \frac{E_d + E_c + R + D_p}{total\ applied\ water}$$

Ec: evaporation from canopy intercepted water
Ed : evaporation from irrigation droplet
Dp: deep percolation loss
R : Runoff loss

How losses are modeled in the VIC_CropSyst

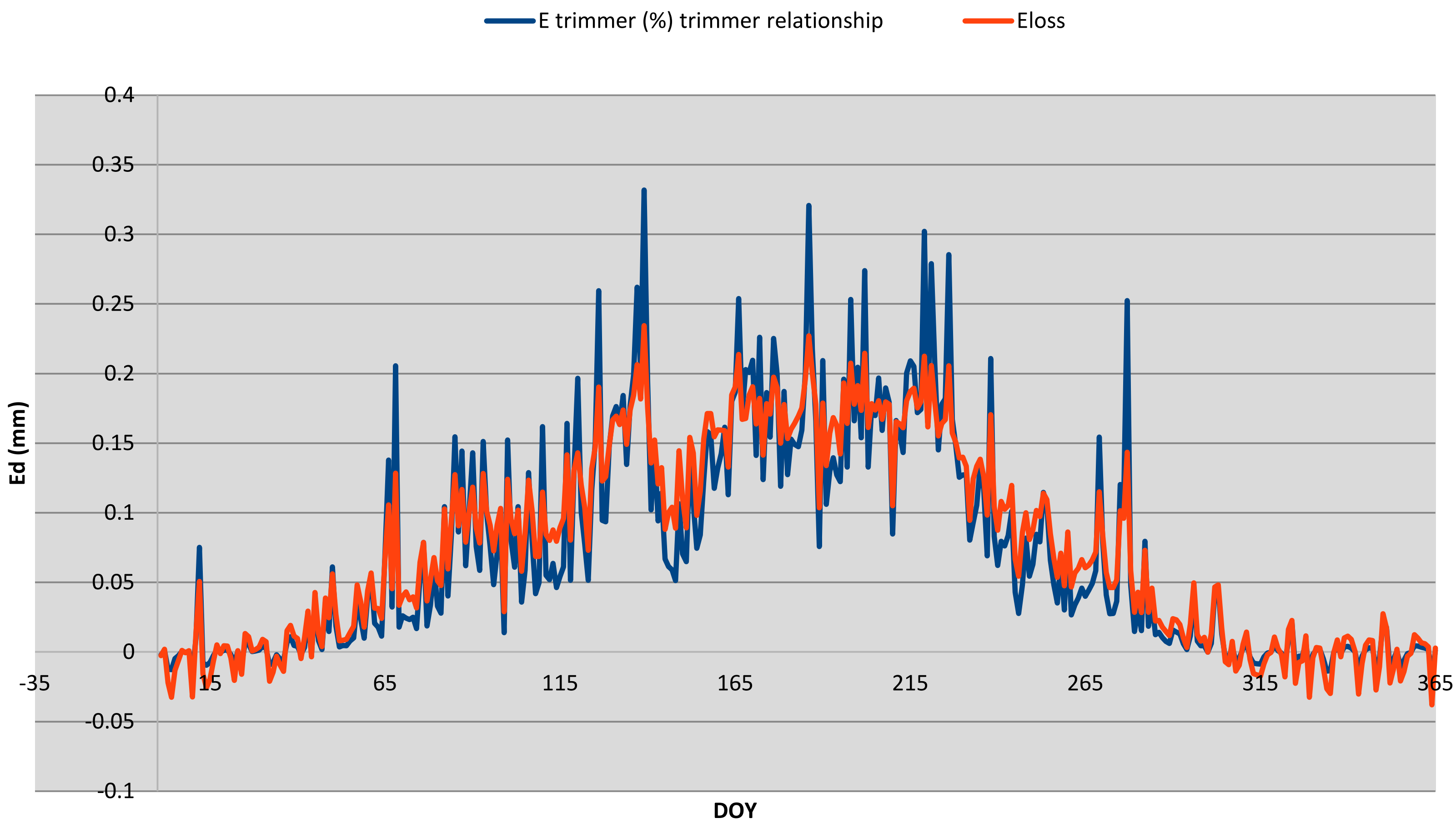
- E_c : VIC algorithm
  - Depends on LAI
- D_p : VIC algorith
  - Base flow algorithm
- R : dependent on irrigation system
  - A lumped value for each irrigation system
- E_d : a semi-empirical formulation

Evaporation from irrigation systems

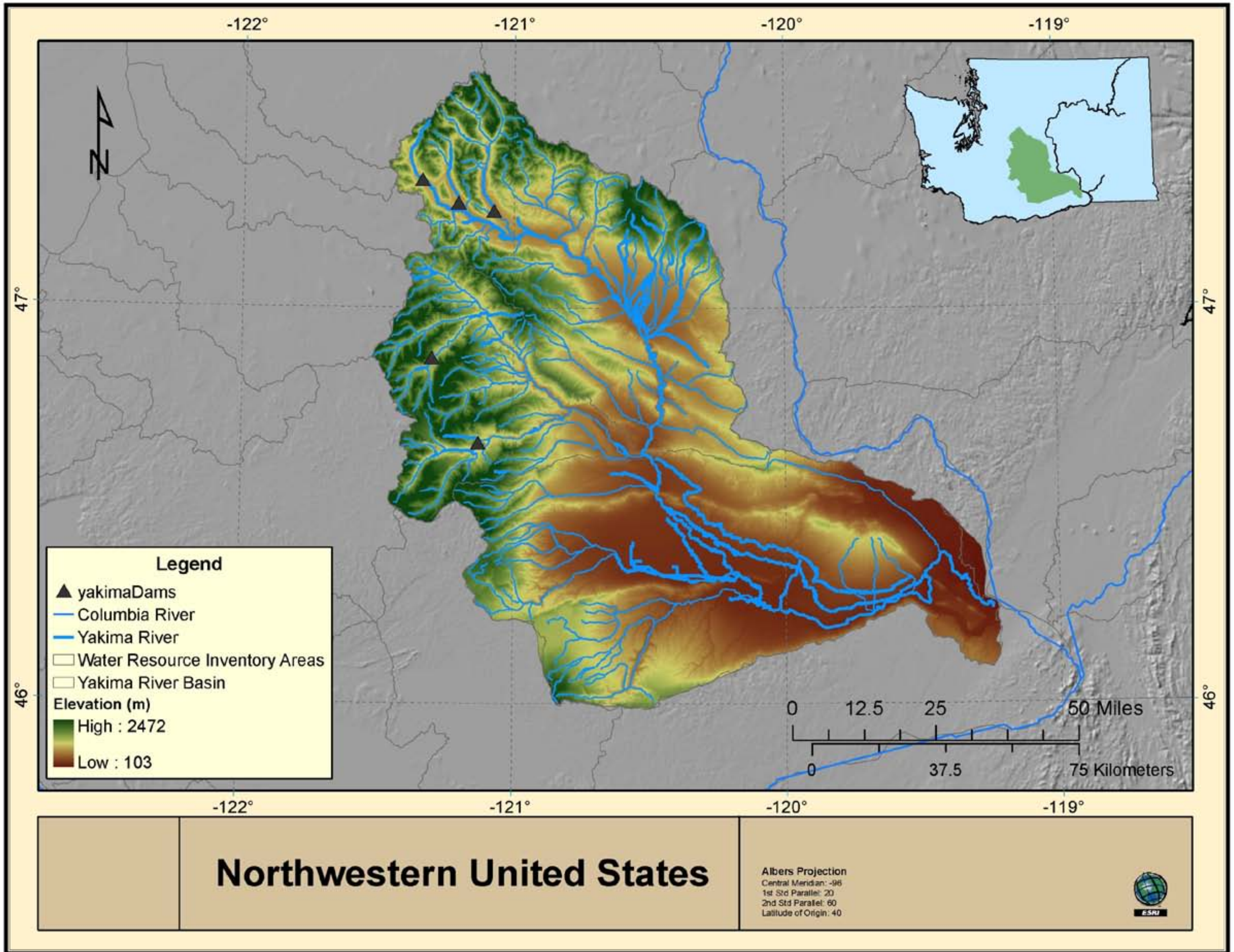
- Evaporation from irrigation droplets depends on:
  - Total available energy for evaporation (ET0)
  - Percentage of Area covered with irrigation system at a time (Ap)
  - Droplet size (D)
  - Available time for evaporation (ta)

$$E_d = f(ET_0, A_p, D, t_a)$$

Evaporation from irrigation Droplets
Developed model Vs Trimmer (1987)



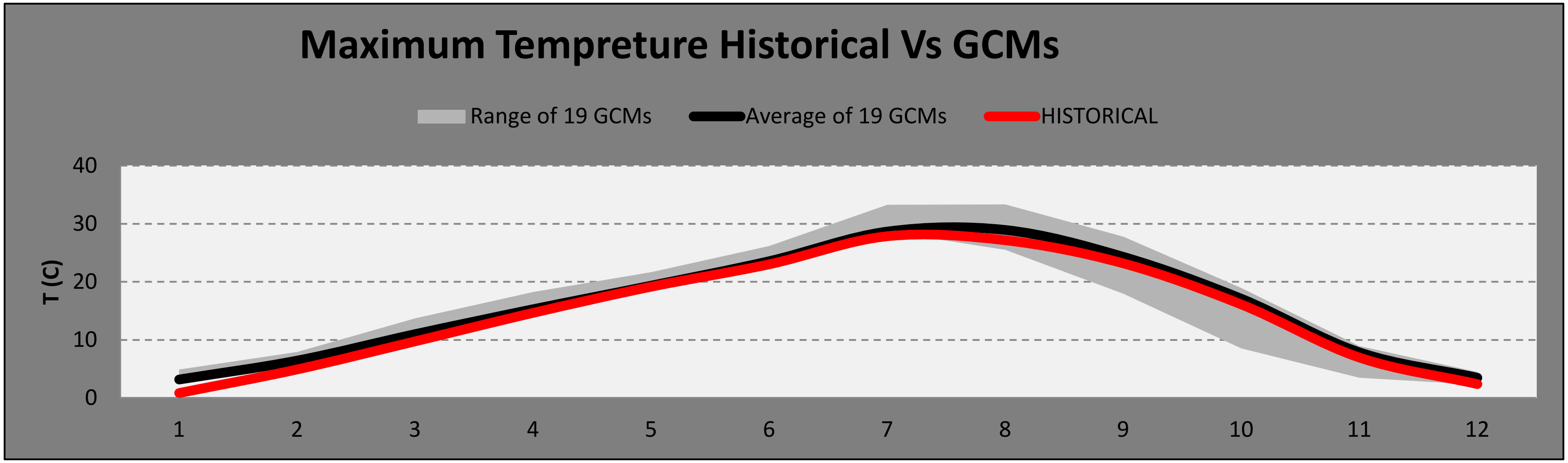
Yakima River Basin

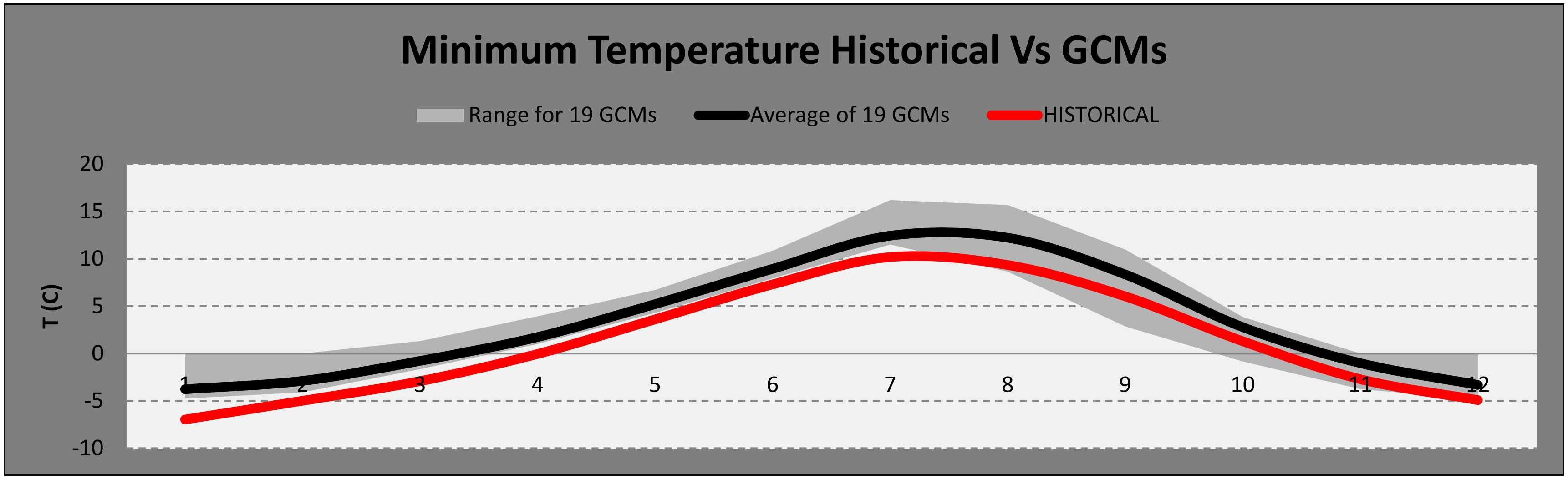


Importance of the issue

- **Income from just irrigated crops :1.3 billion $**
- **Irrigation Return flow contribute to about 40% of mid summer available water**

Sensitive to climate change





Ongoing efforts

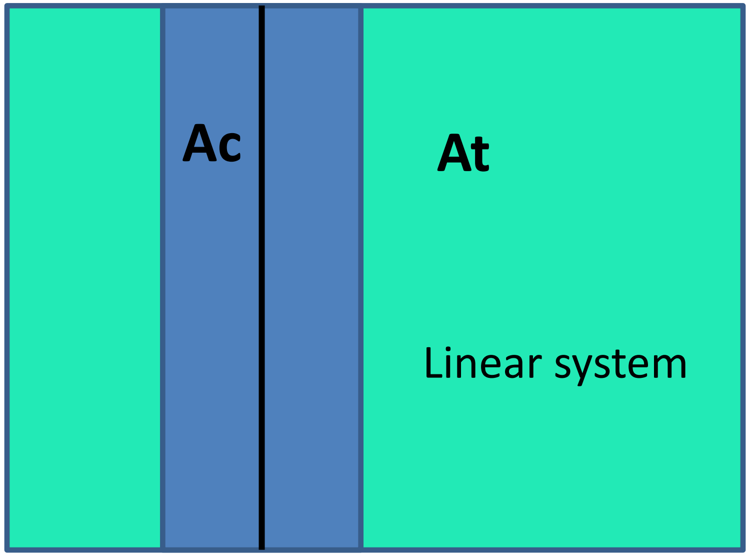
- Water balance issue fixed
- Applying the coupling on the most updated version of VIC which is VIC_4.1.2-e
- Change the structure of coupling to hold the energy balance
- Correction of ET calculation in the coupled model
- Consistent ET_p for all the ET components
- Soil evaporation from VIC

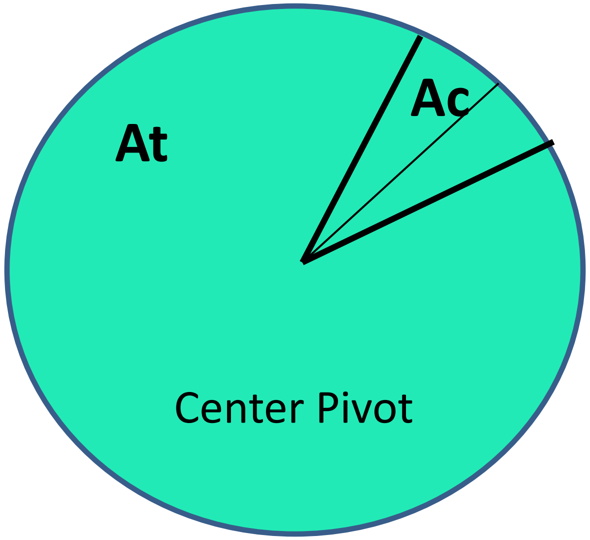
Thank you

ET0, Ap

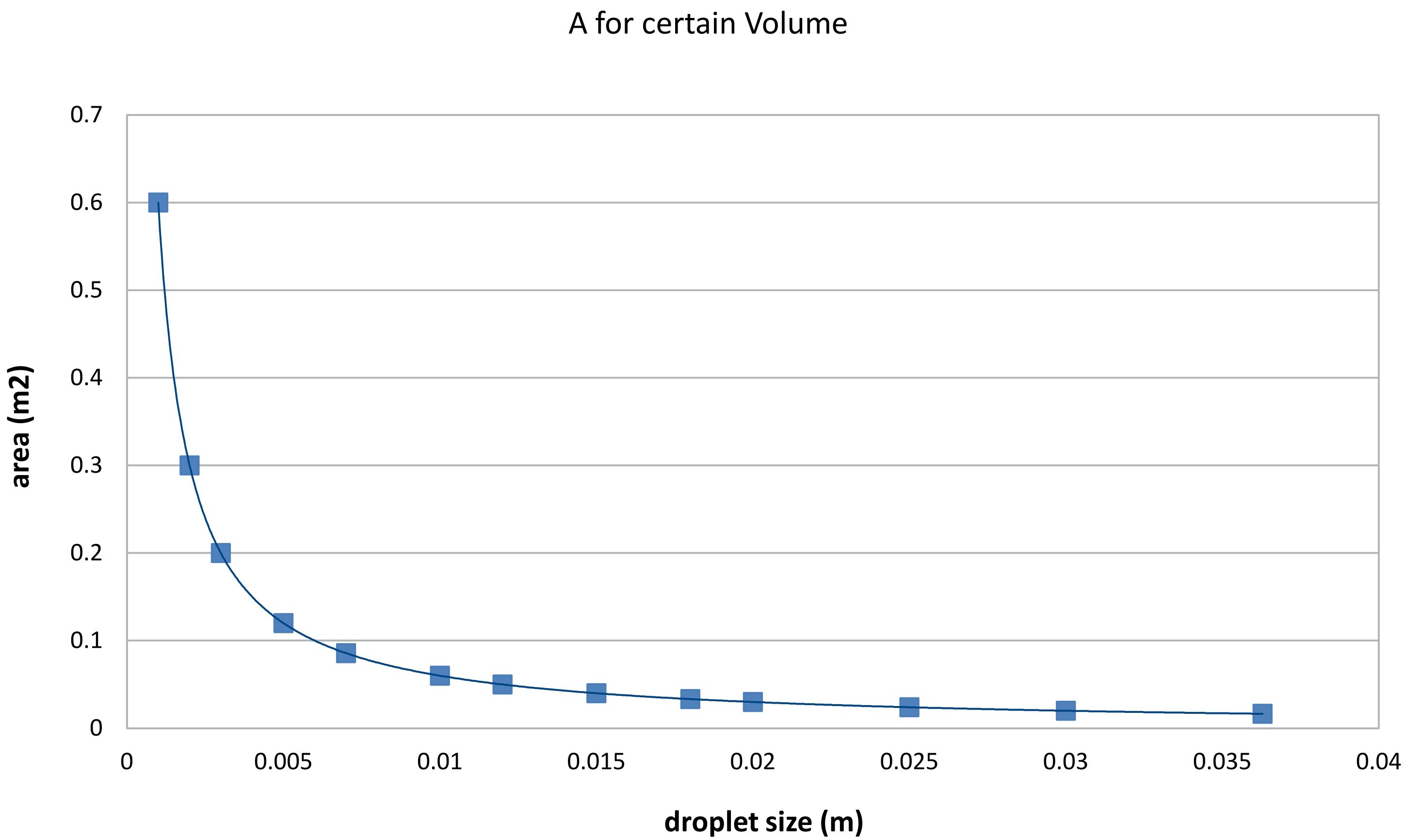
-ET0 is calculated based on Penman Monteith short grass reference ET

$$A_p = \frac{A_c}{A_t}$$





D
Smaller D brings higher contact area



t_a

- Depends

- 1- system type
- 2- nuzzle diameter and coefficient
- 3- sprinkler height and alignment
- 4- system pressure
- 5- crop height