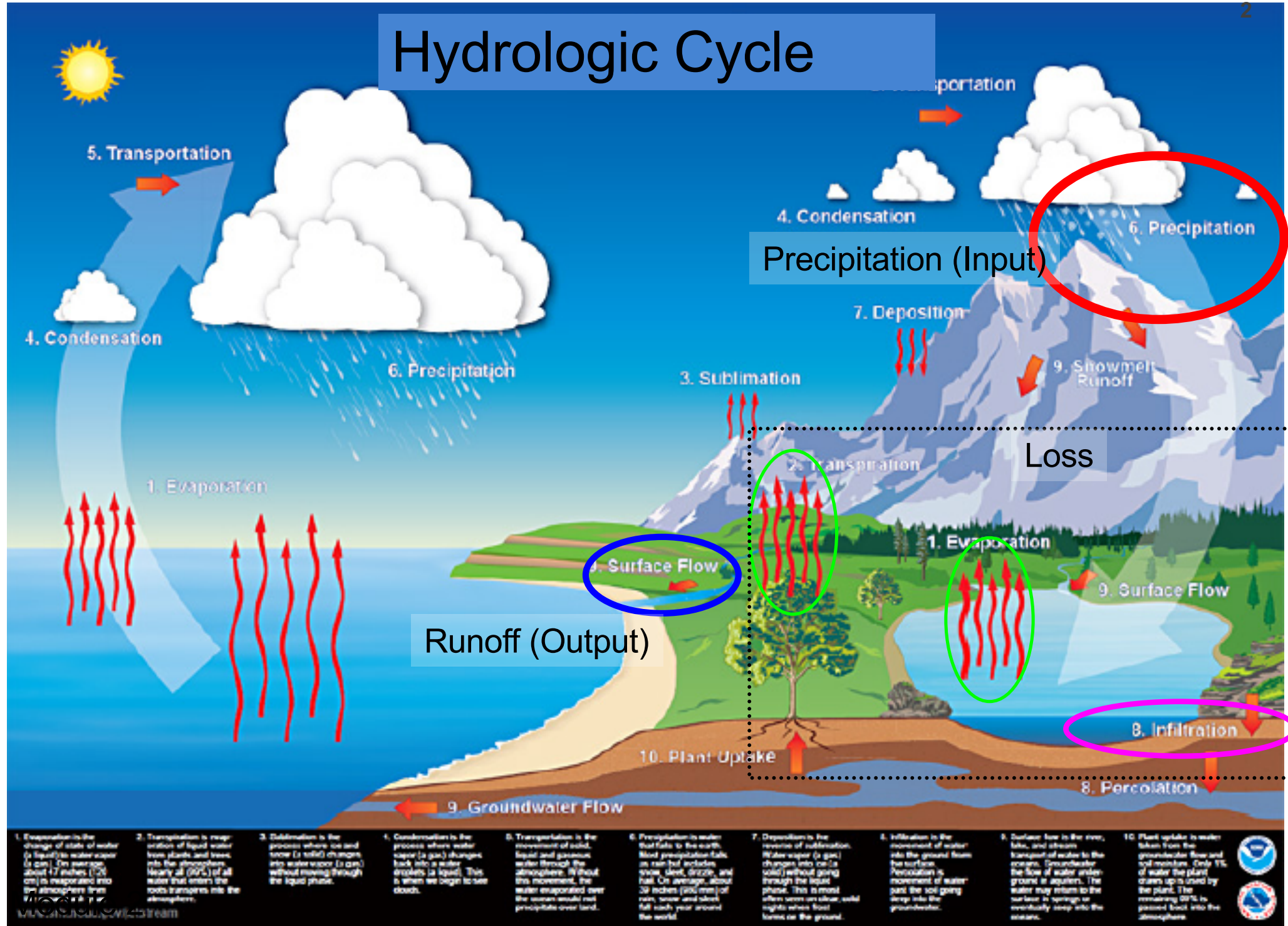


CE 3354 SURFACE WATER HYDROLOGY

WATERSHED PROCESS: DEPRESSION AND CANOPY STORAGE



Hydrologic Cycle



Precipitation (Input)

Runoff (Output)

Loss

1. Evaporation is the change of state of water (a liquid) to water vapor (a gas). On average, about 17 inches (1.25 cm) is evaporated into the atmosphere from the oceans each year.
2. Transpiration is the evaporation of liquid water from plants and trees into the atmosphere. Nearly all (99%) of all water that enters the soil is transported into the atmosphere.
3. Sublimation is the process where ice and snow (a solid) changes into water vapor (a gas) without moving through the liquid phase.
4. Condensation is the process where water vapor (a gas) changes back into a water droplet (a liquid). This is when we begin to see clouds.
5. Transportation is the movement of solid, liquid and gaseous water through the atmosphere. Without this movement, the water evaporated over the oceans would not precipitate over land.
6. Precipitation is water that falls to the earth. Most precipitation falls as rain but includes snow, sleet, drizzle, and hail. On average, about 39 inches (99 cm) of rain, snow and sleet fall each year around the world.
7. Deposition is the reverse of sublimation. Water vapor (a gas) changes into ice (a solid) without going through the liquid phase. This is most often seen on snow-cold nights when frost forms on the ground.
8. Infiltration is the movement of water into the ground from the surface. Percolation is movement of water past the soil going deep into the groundwater.
9. Surface flow is the river, lake, and stream transport of water to the oceans. Groundwater flow is the flow of water under ground. It is used by the water that returns to the surface. In springs or eventually seep into the oceans.
10. Plant uptake is water taken from the groundwater flow and soil moisture. Only 1% of water the plant draws up is used by the plant. The remaining 99% is passed back into the atmosphere.



STORAGE

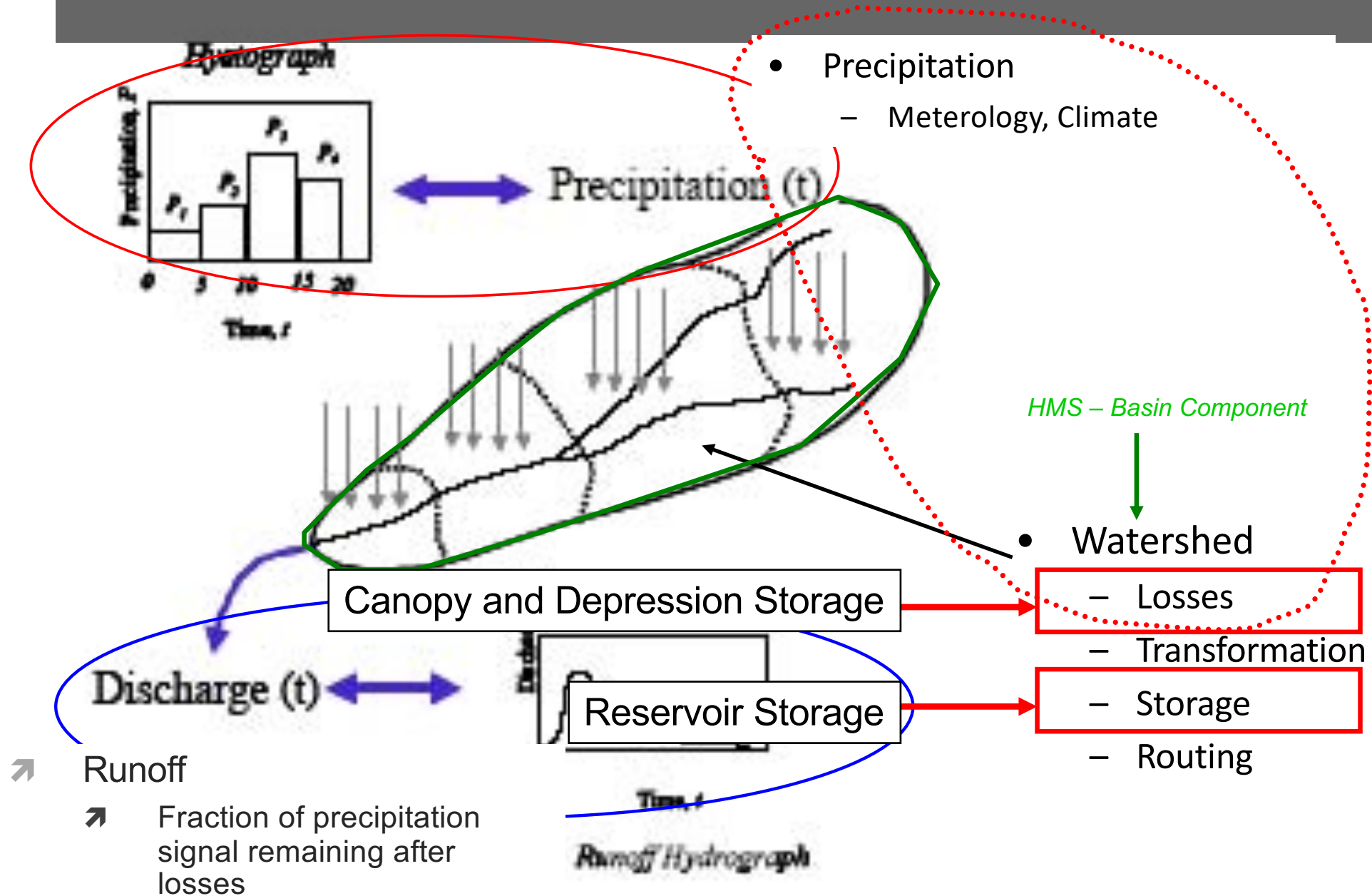
➤ Surface Storage

- Usually treated as abstractions:
 - Canopy (interception) storage
 - Depression storage

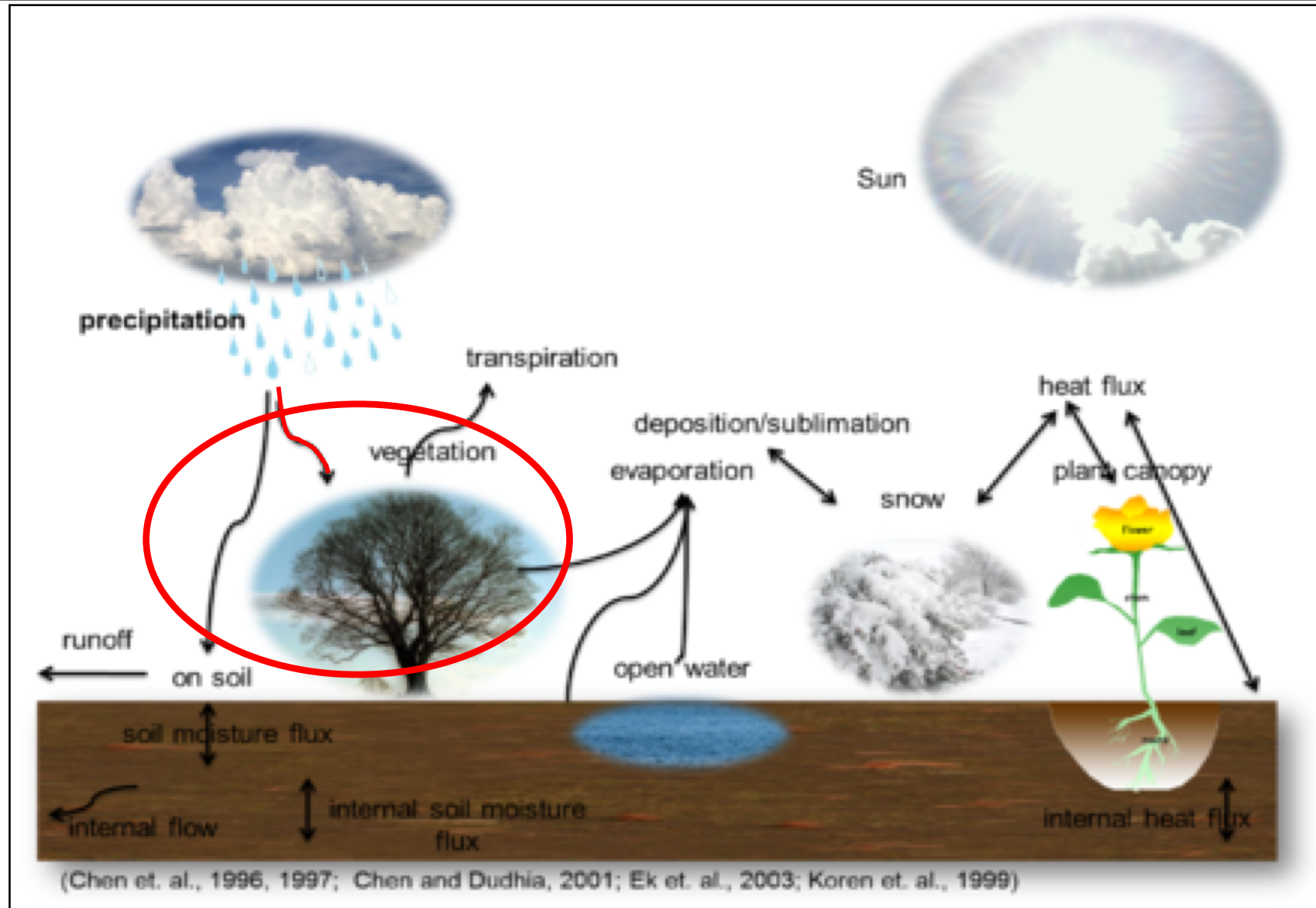
➤ Reservoir Storage

- Usually treated as hydrologic/hydraulic elements
 - Reservoirs (regulated and unregulated)
 - Detention basins
 - Certain stormwater BMPs

Rainfall-Runoff Process

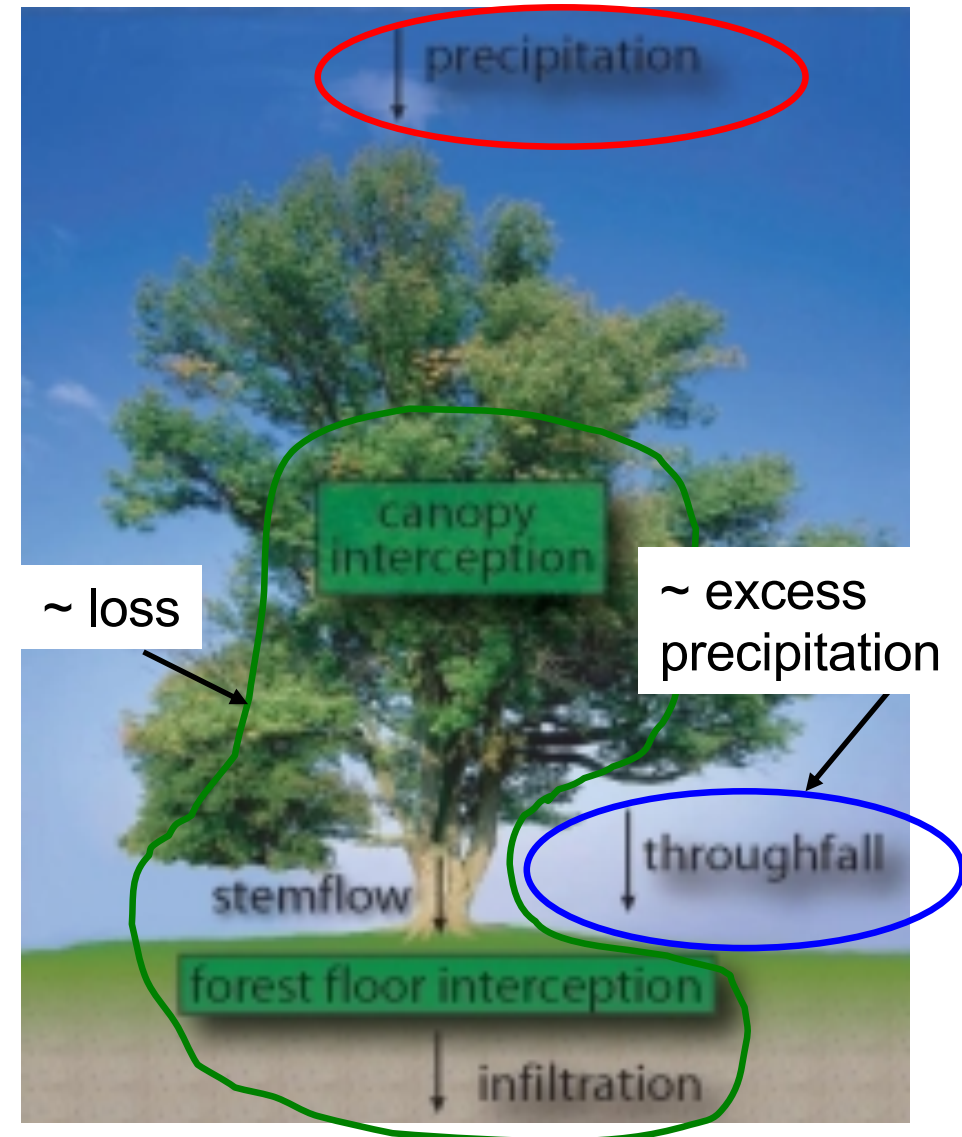


Canopy (Interception) Storage



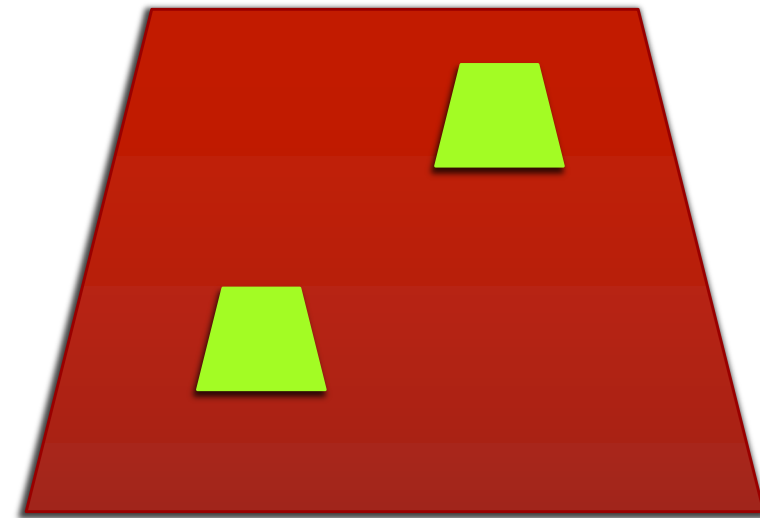
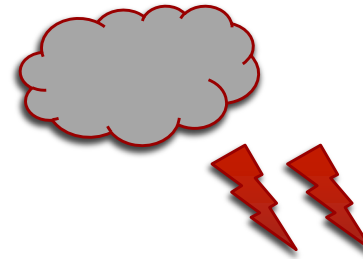
Canopy (Interception) Storage

- Interception is precipitation that does not reach the soil, but is instead intercepted by the leaves and branches of plants and the forest floor.
- The intercepted water generally evaporates and leads to loss of that precipitation for the drainage basin.



CANOPY STORAGE

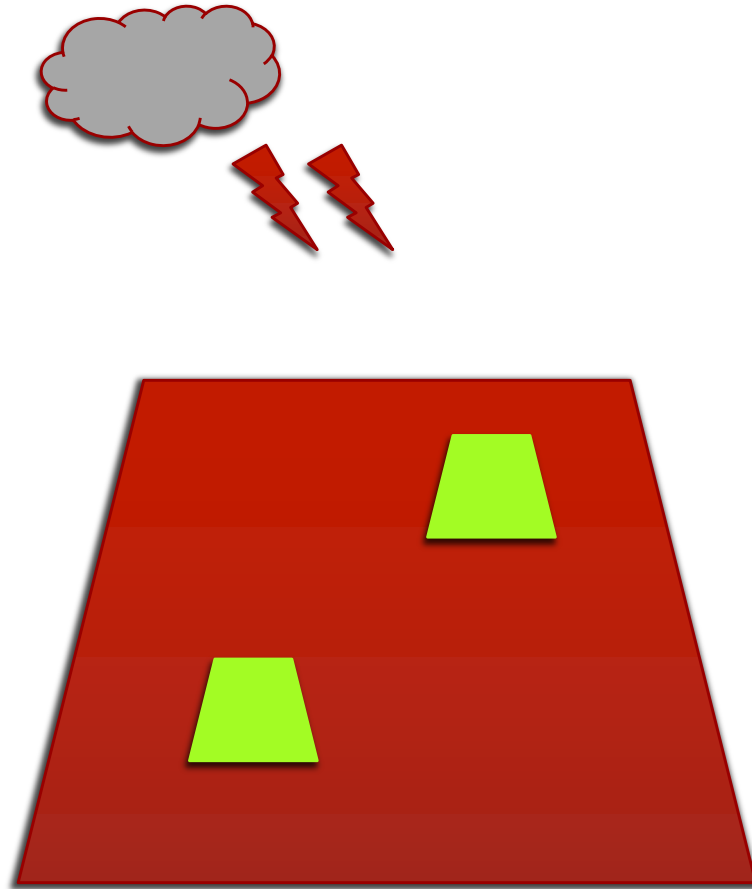
- All precipitation intercepted until storage capacity satisfied.
- Excess precipitation then directed to surface (depression) storage if any.
- Then excess to runoff component.
- Also considers potential evapo-transpiration (PET) as part of the hydrologic cycle.



Consider an Equivalent Projected Area of Vegetative Cover

CANOPY STORAGE

- Sophisticated hydrologic abstraction
 - Uncommon in engineering hydrological applications, esp. because of the PET feedback.
 - Utility in “scientific investigation”
 - Measurements are practically non-existent -- relies heavily on agronomy literature



DEPRESSION STORAGE

- Depression storage.
- The volume of water contained in natural depressions in the land surface, such as puddles. (After Horton, 1935, p. 2)



DEPRESSION STORAGE

➤ Green-Ampt model

- water ponds at non-zero depth; hence depression storage is arguably important for such infiltration models.



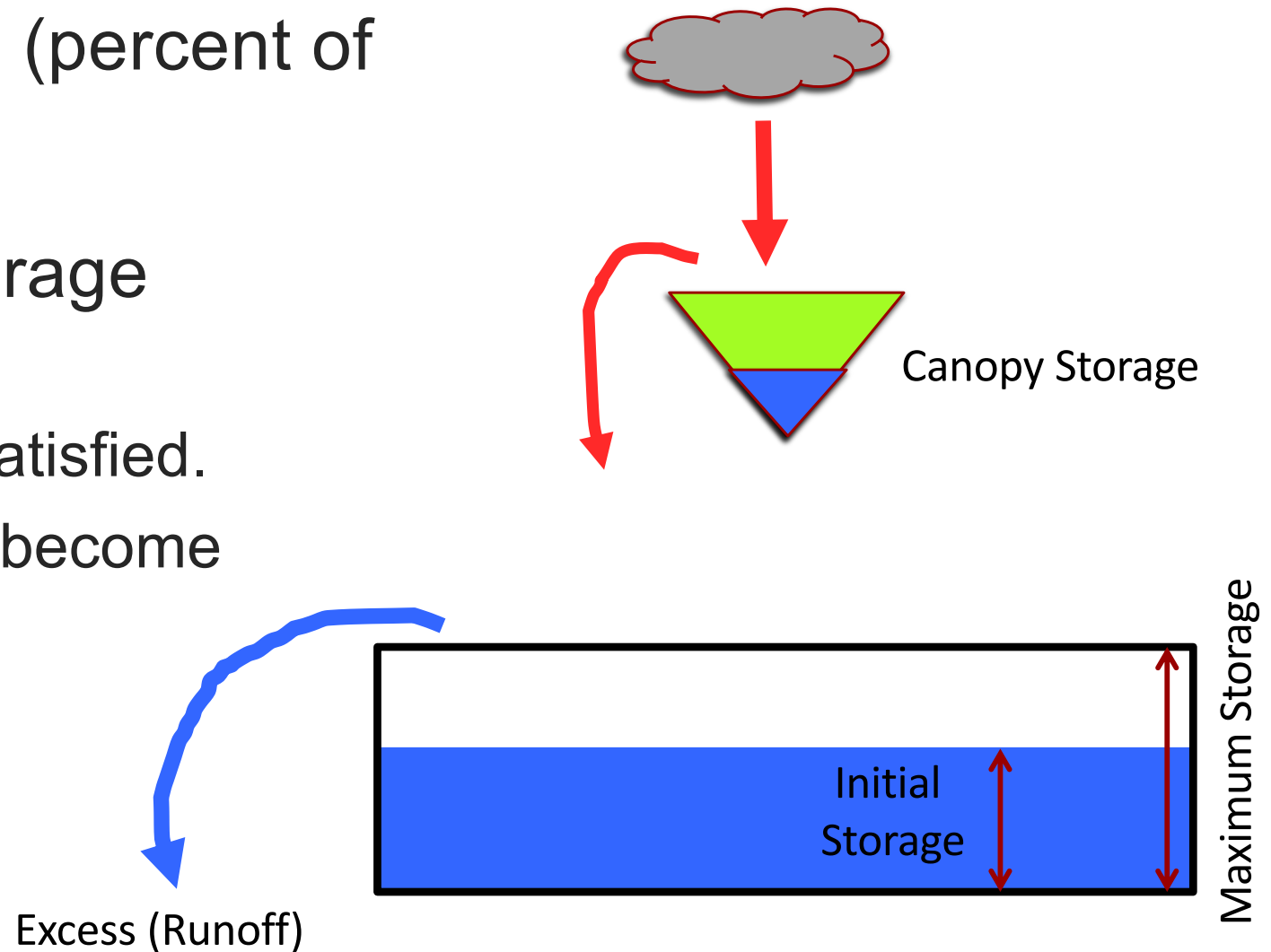
DEPRESSION STORAGE

- The interaction of depression storage and infiltration is one basis of Hortonian overland flow



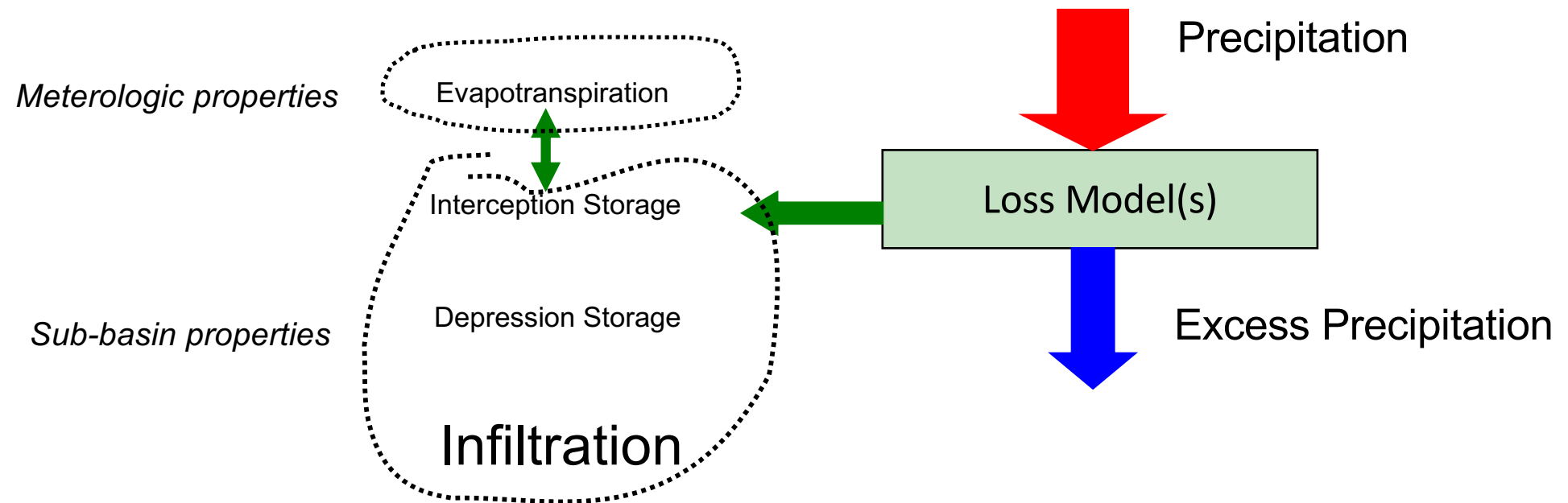
DEPRESSION STORAGE

- Initial storage (percent of maximum)
- Maximum storage (depth)
 - Storage is satisfied.
 - Excess can become runoff.



Rainfall-Runoff

➤ As a process diagram:



RESERVOIR STORAGE

➤ Reservoir

➤ A pond, lake, or basin, either natural or artificial, for the storage, regulation, and control of water.

➤ Regulated reservoir

➤ Outflow controlled by moveable gates and valves.

➤ Head, and valve settings determine outflow.

➤ Unregulated reservoir.

➤ Outflow controlled by fixed weirs and orifices.

➤ Head and constructed weir height determine outflow.

SUMMARY

- Storage types:
 - Abstraction:
 - Canopy and Depression
 - Hydrologic/Hydraulic
 - Reservoir
 - Channel
 - Abstraction storage is a sophisticated concept, hard to estimate parameters; few measurements
 - Reservoir storage is fundamental in watershed models
 - Detention facilities
 - BMPs