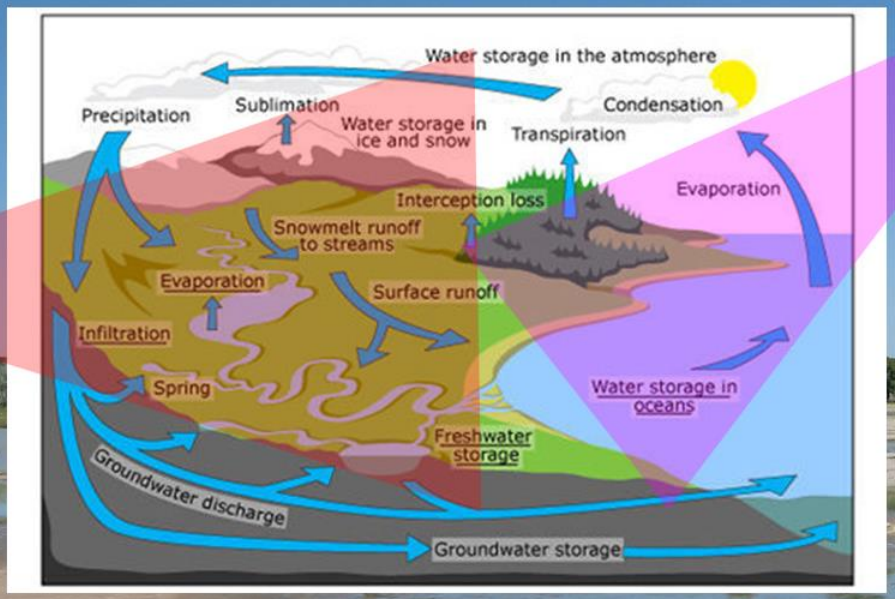
Satellite data for integrated water resource assessments and modeling



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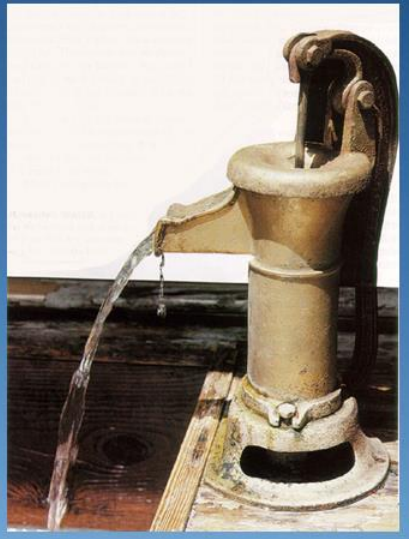
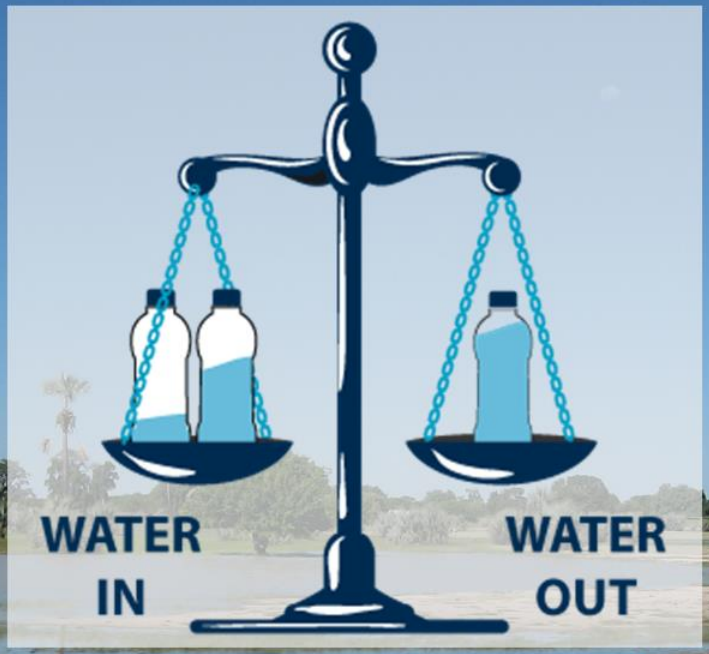
CLOSURE

So let's start the Lectures





A water Balance and its closure….

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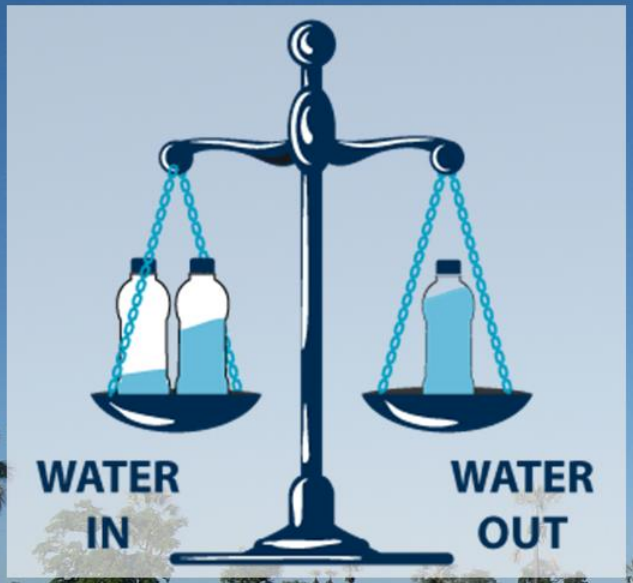


Real world closure…..no Problem I would say.

Can we Close in Digital world?

What domains ? + what data sources ?

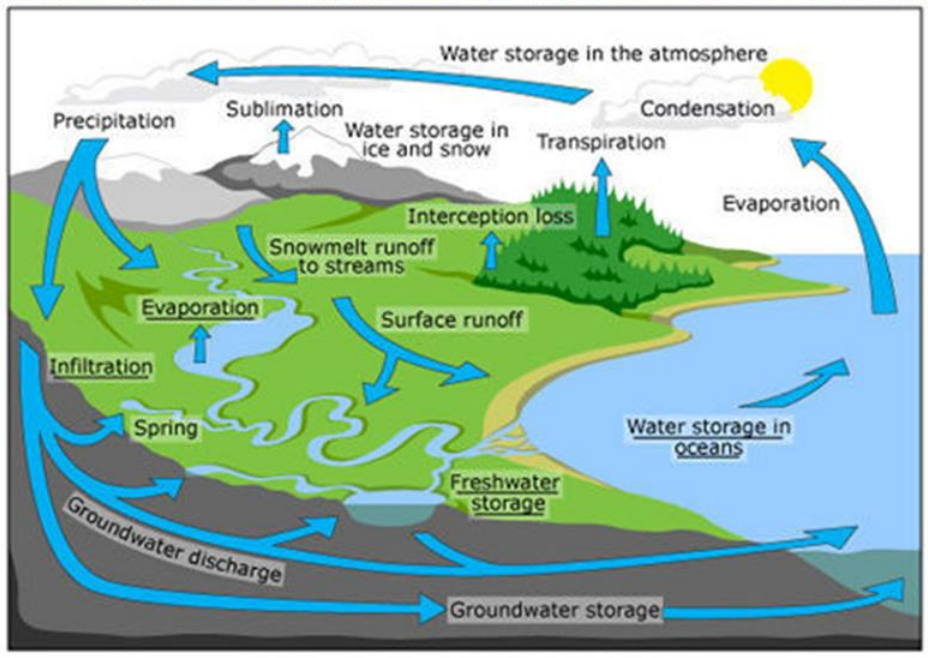
What tools?

So What is a Water Balance?

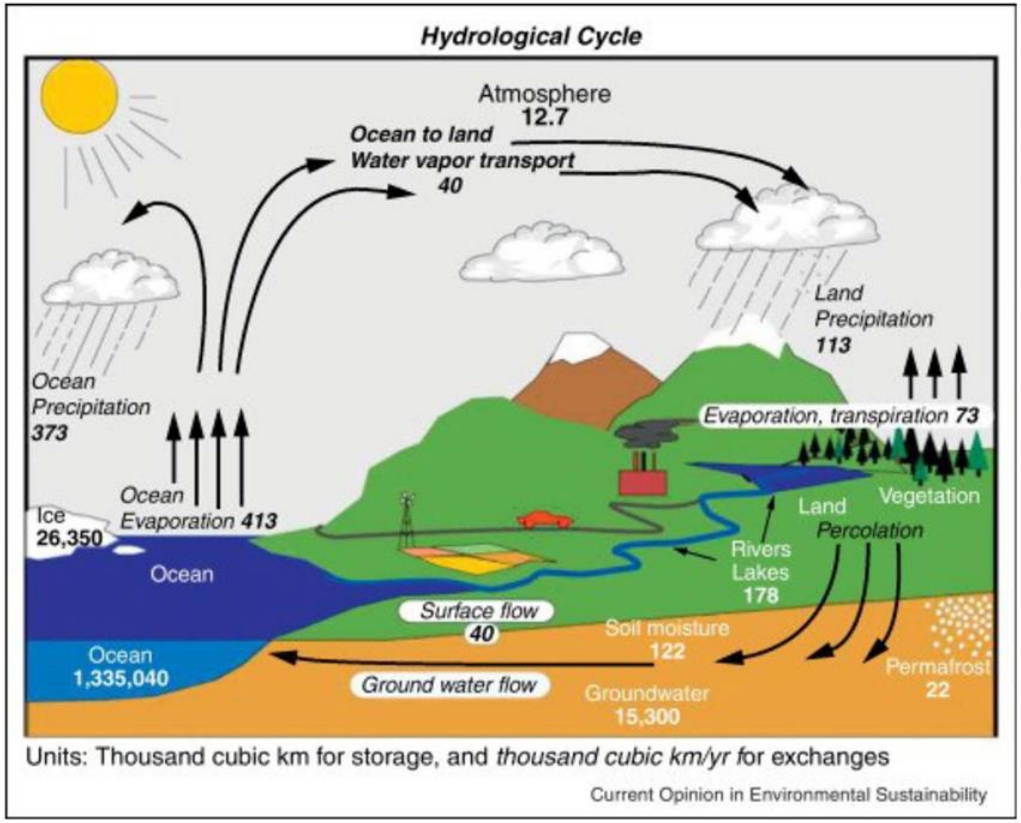
Where to apply?

How to solve?

How to parameterize?

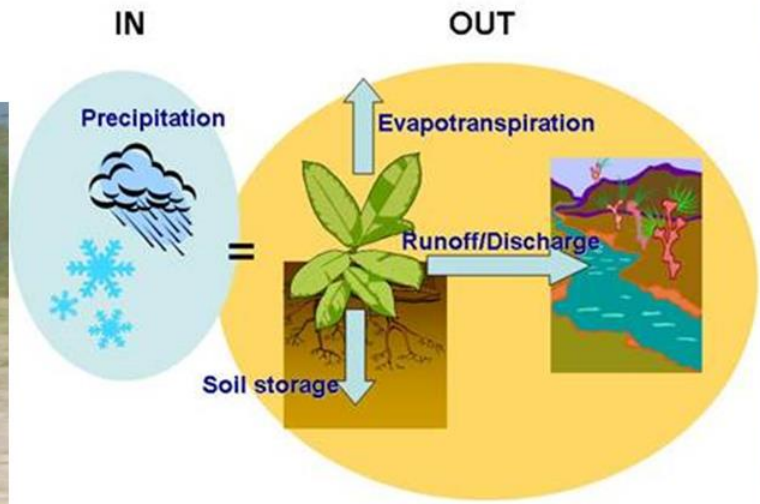


A water Balance and its closure….



The balance is very Simple!

So what is the problem?



The balance is very Simple!

We (only) have Storage terms! &

We have Flux/ Exchange terms!

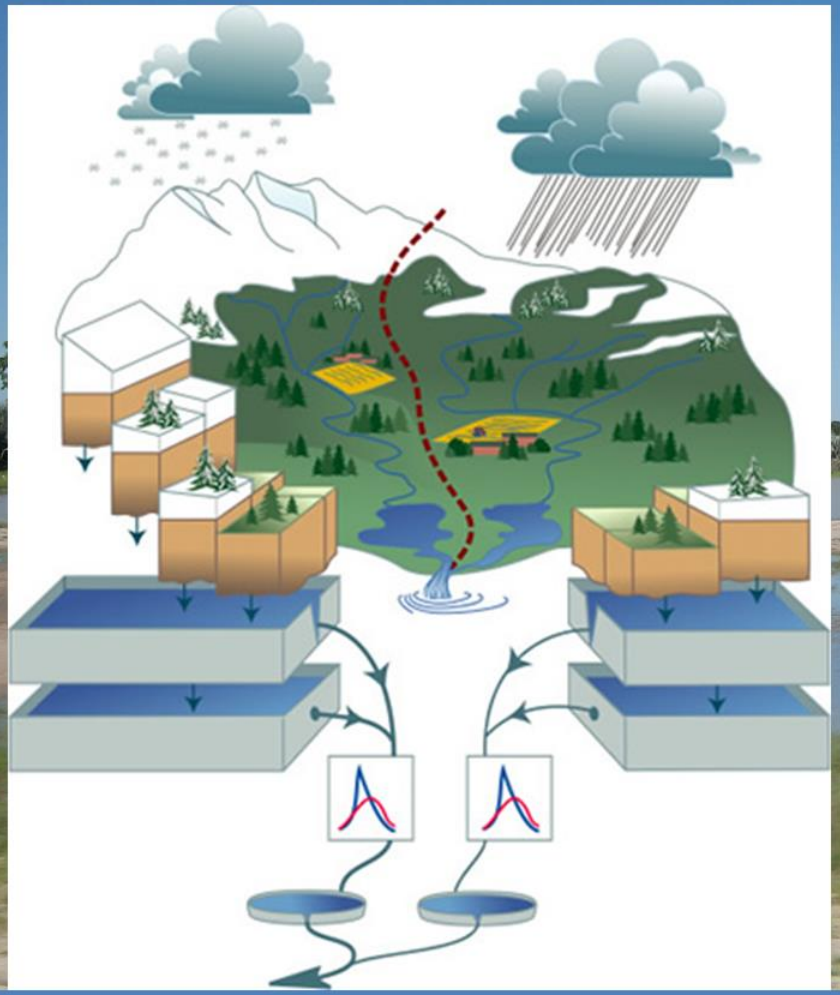
A water Balance and its closure….

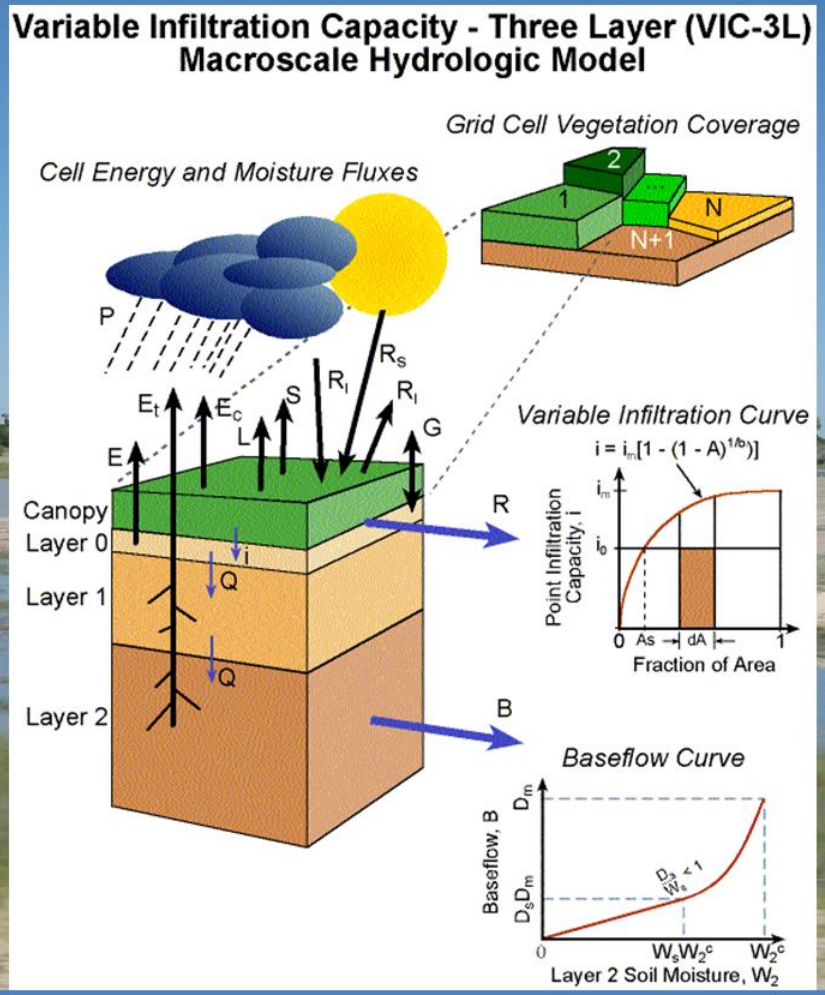
Table 1. Estimate of the world water balance. **Source:** MIT OpenCourseWare.

	Surface area (million km^2)	Volume (million km^3)	Volume (%)	Equivalent depth (m)	Residence time
Oceans and seas	361	1,370	94	2,500	~4,000 years
Lakes and reservoirs	1.55	0.13	<0.01	0.25	~10 years
Swamps	<0.1	<0.01	<0.01	0.007	1-10 years
River channels	<0.1	<0.01	<0.01	0.003	~2 weeks
Soil moisture	130	0.07	<0.01	0.13	2 weeks to 50 years
Groundwater	130	60	4	120	2 weeks to 100,000 years
Icecaps and glaciers	17.8	30	2	60	10 to 1,000 years
Atmospheric water	504	0.01	<0.01	0.025	~10 days
Biospheric water	<0.1	<0.01	<0.01	0.001	~1 week

Now one step further…

A water Balance Model and its closure….

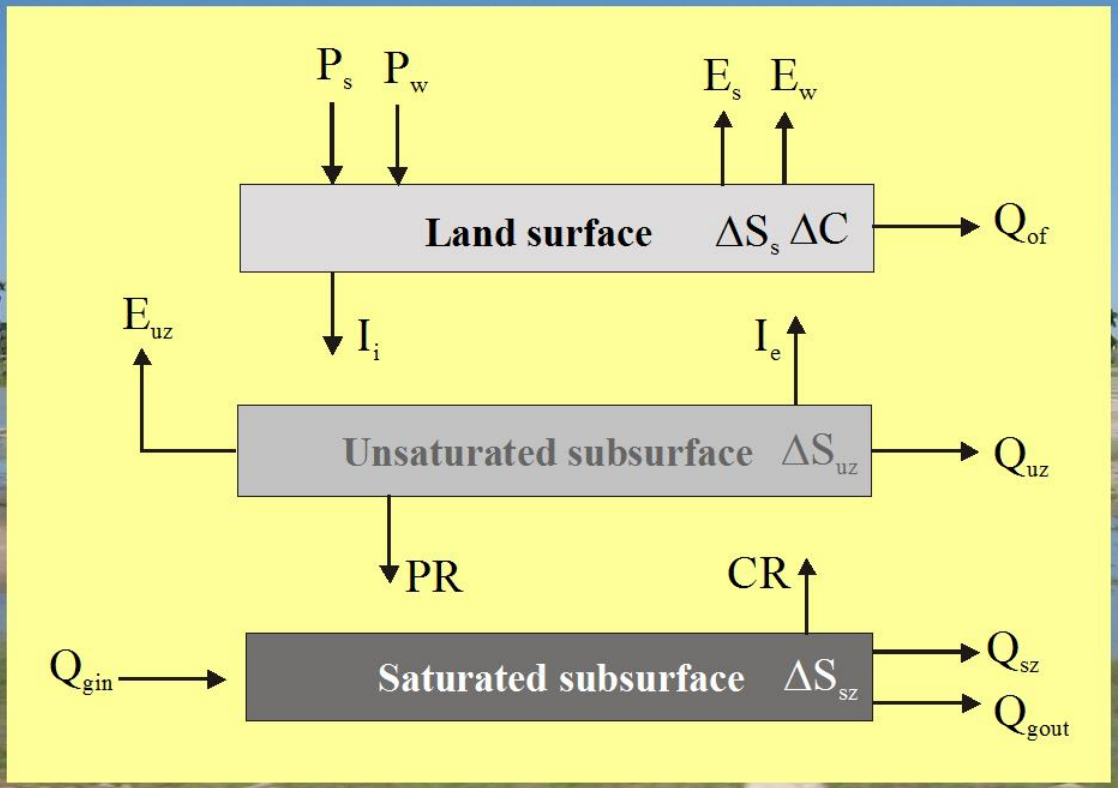




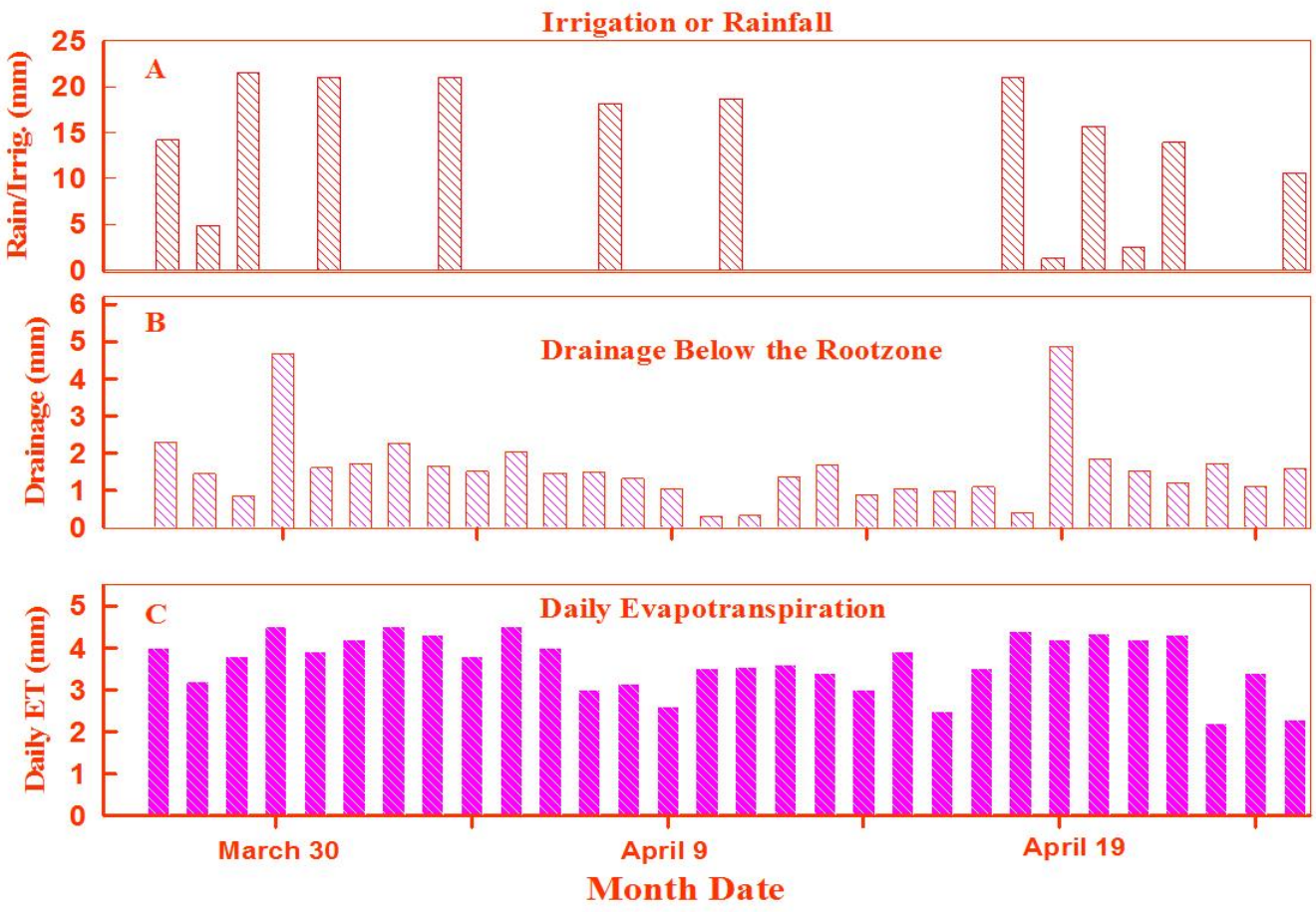
HBV Water balance => VIC Water + Energy balance…

Water balance modelling

$$\frac{\Delta S}{\Delta t} = \sum (Q_{in} - Q_{out})$$



In the time domain….. Water availability? ….Droughts?



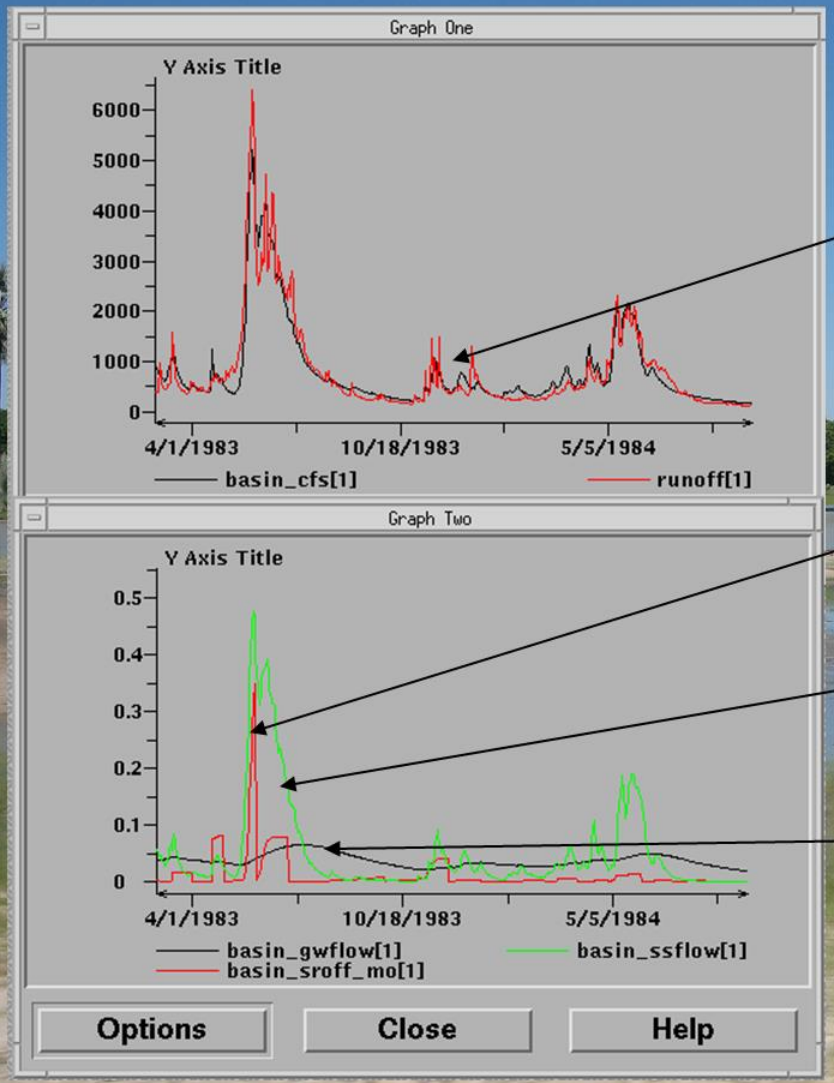
Water accounting…..keeping track of water depth (or volumes)

Extremes in Water balances

Droughts

Floods

STREAMFLOW : Integration of a variety of runoff generation processes



Simulated and Observed Hydrographs

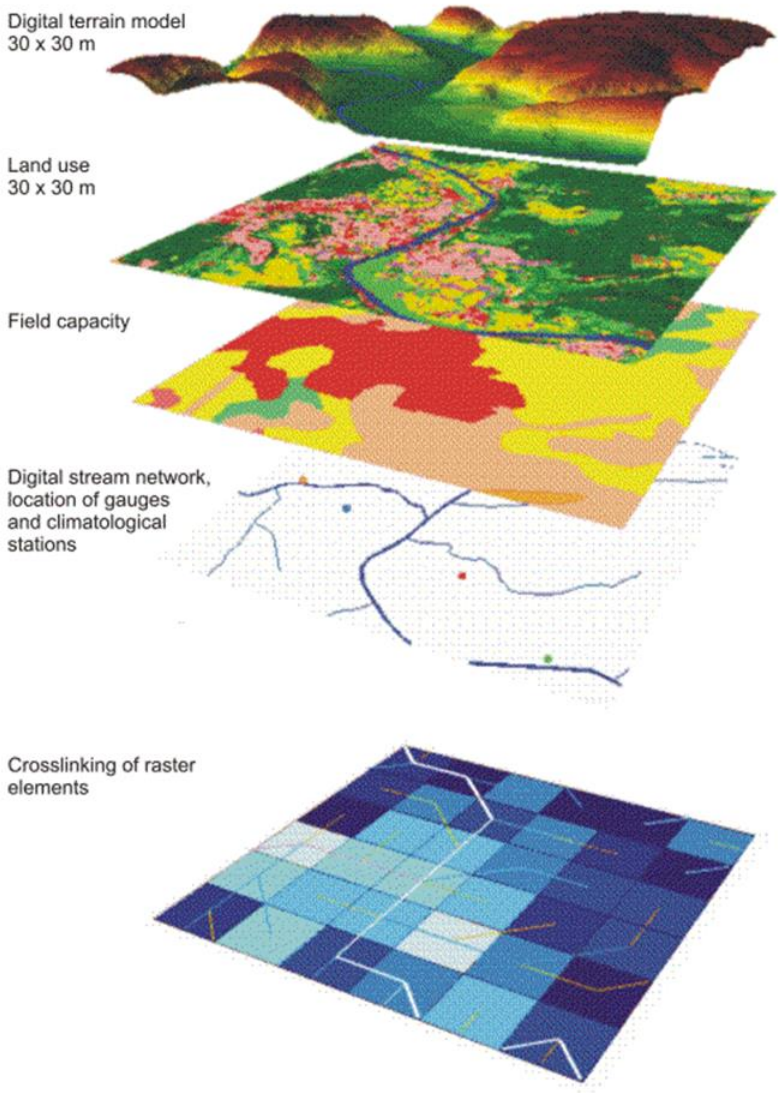
Surface Runoff

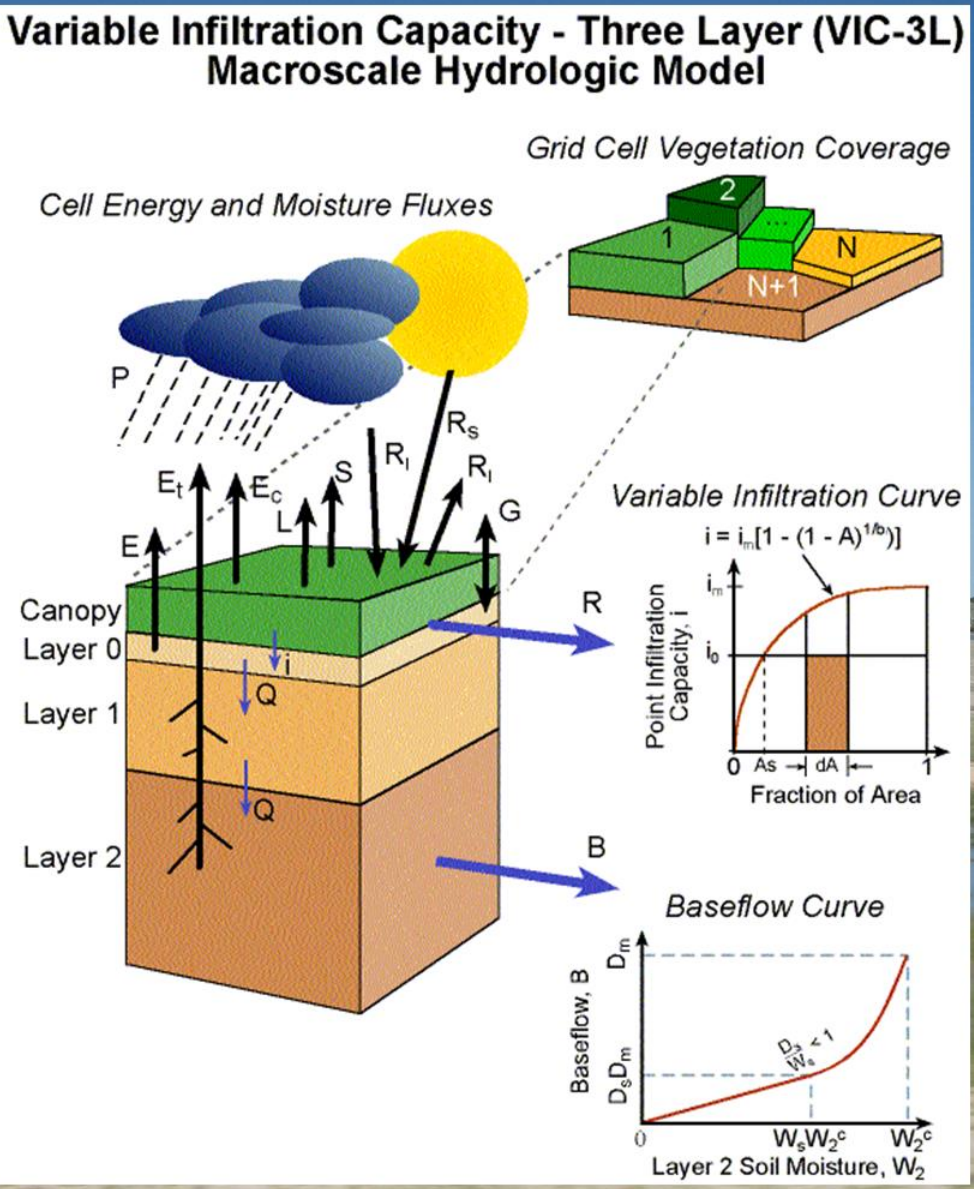
Subsurface Flow (Interflow)

Baseflow

Components of hydrograph

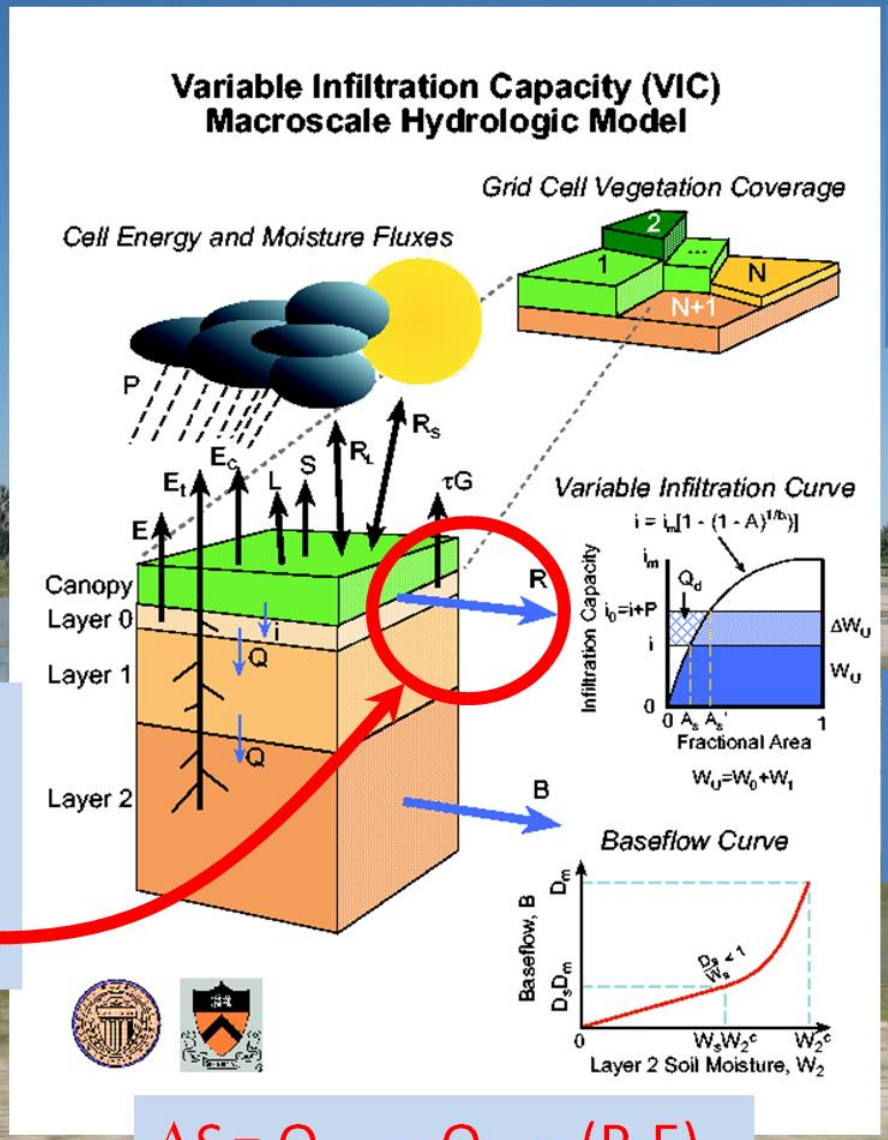
Model complexity and data sources..





Water & Energy Fluxes in Global Water Cycle

From Precipitation (GPM, TRMM), Clouds (CloudSat), and Soil Moisture Missions (HYDROS, SMOS)



From Land Cover & Land Use Change Missions (e.g., LandSat, MODIS, etc.)

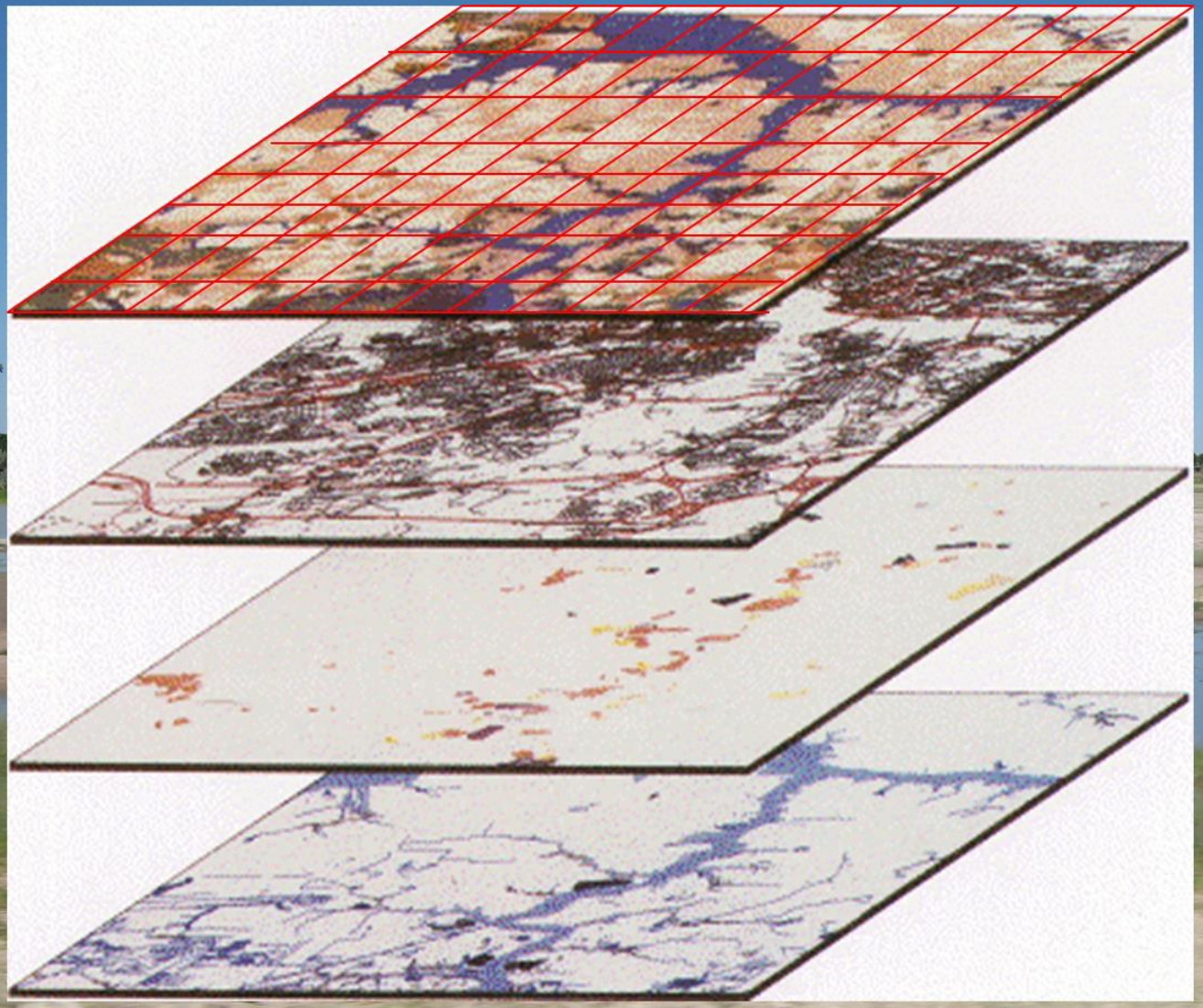
Global Needs:

1. **Surface water area for evaporation & direct precipitation**
2. **ΔS and Q**

From Soil Moisture Mission (e.g., SMOS, HYDROS)

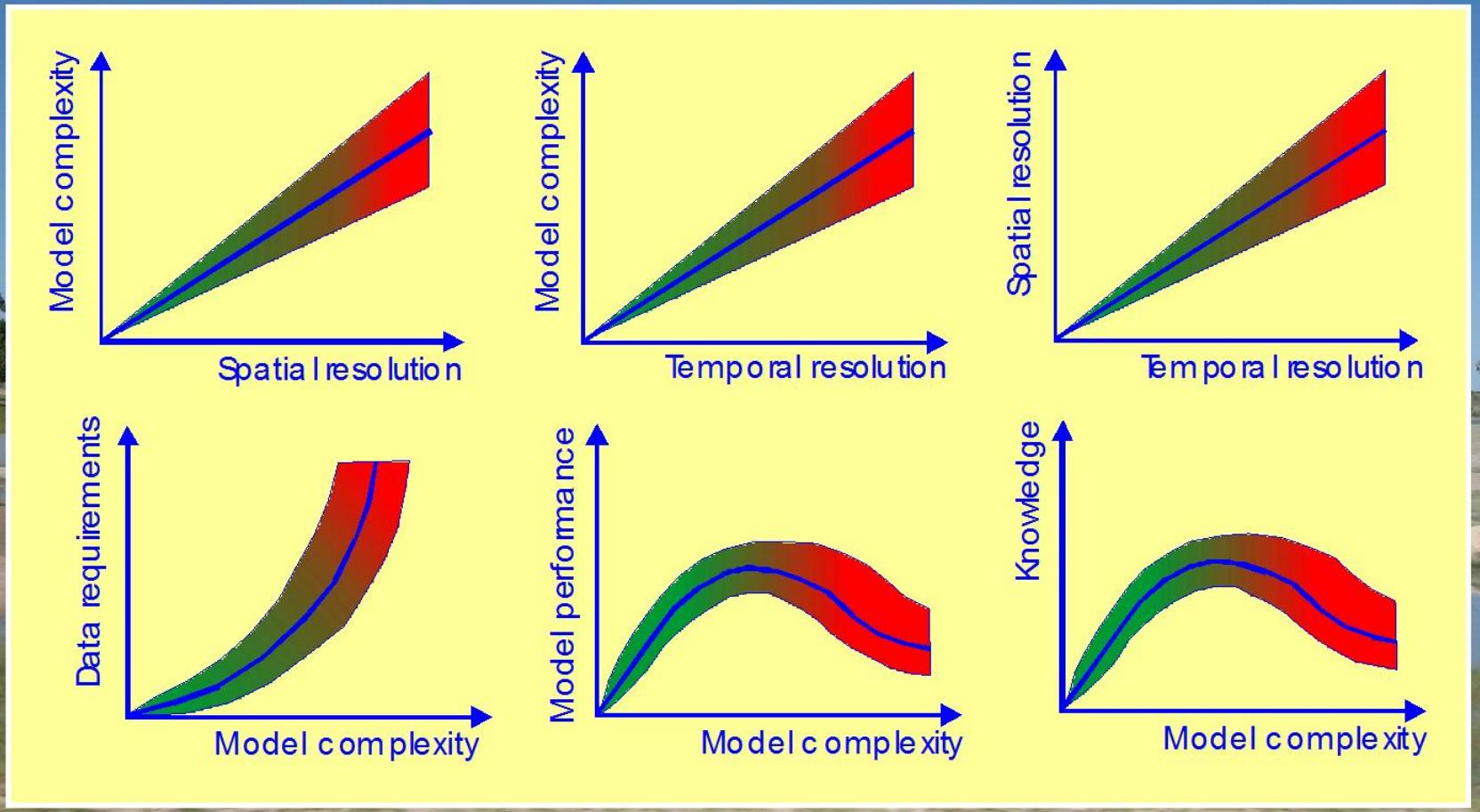
$$\Delta S = Q_{out} - Q_{in} - (P\text{-}E)$$

Define “unifying” scale …..for representation and parameterisation of flow equations?

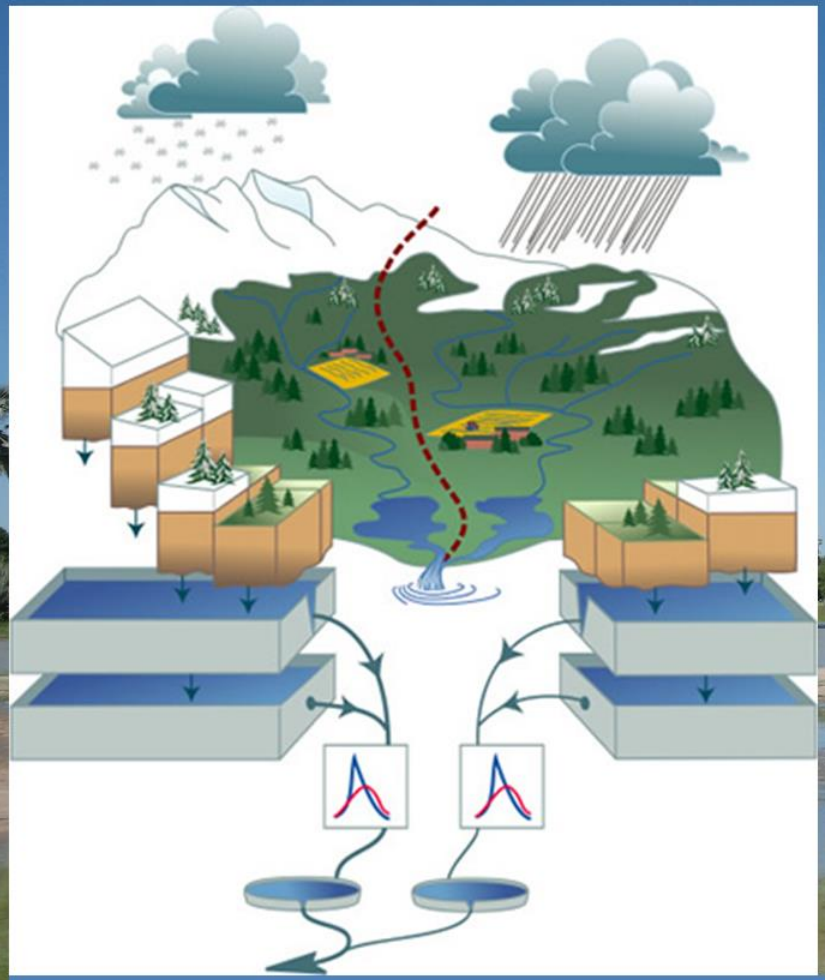


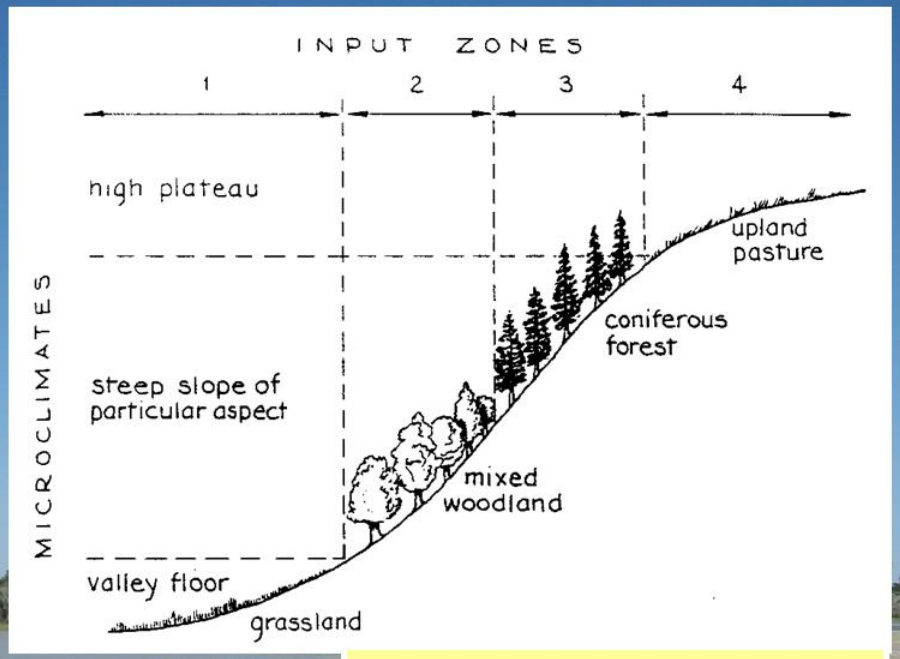
What are the trade offs?

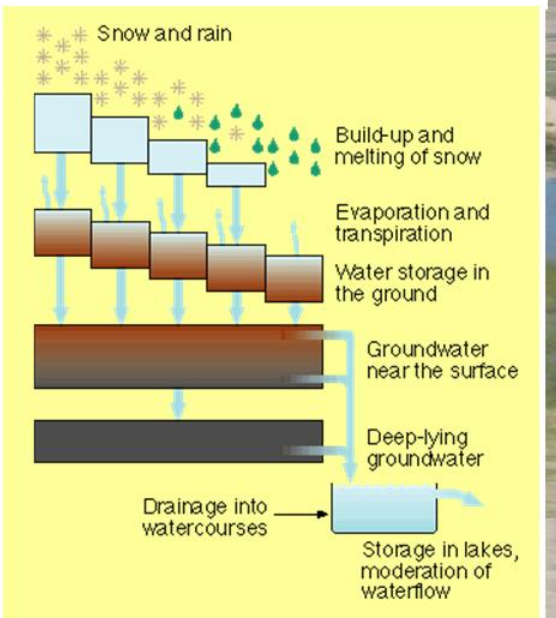
Relations between model resolutions, model complexity, data requirements, model performance and knowledge



“Selected RS inputs!”



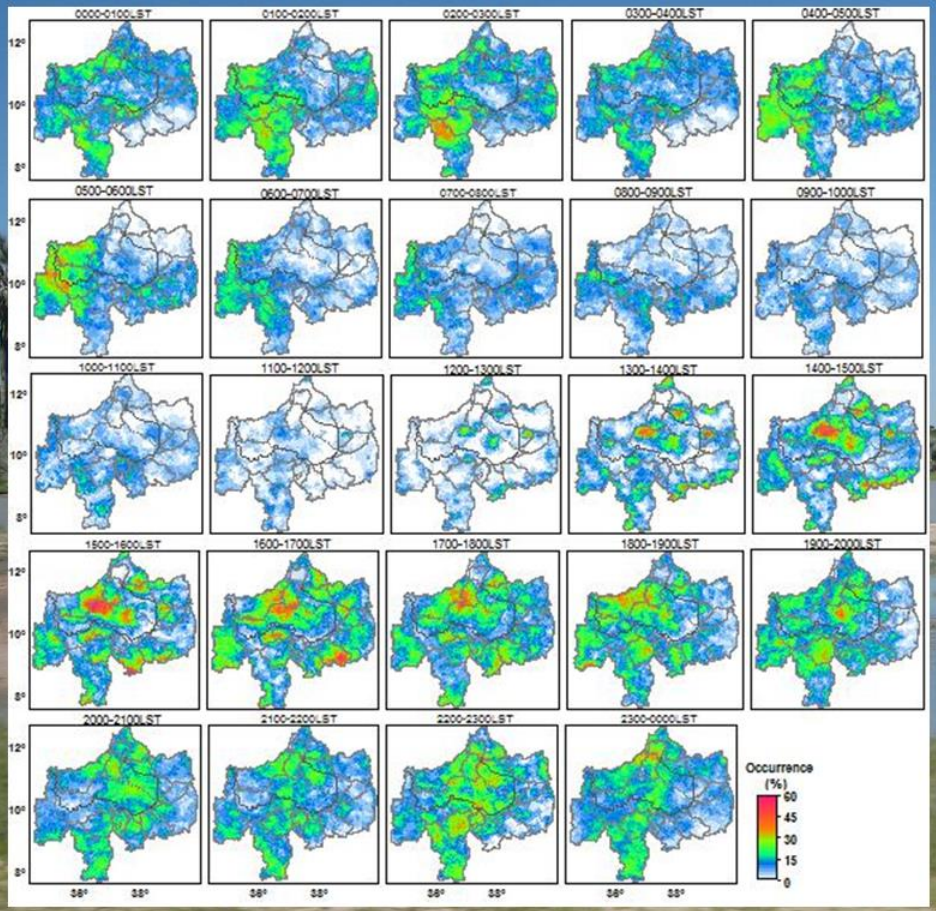




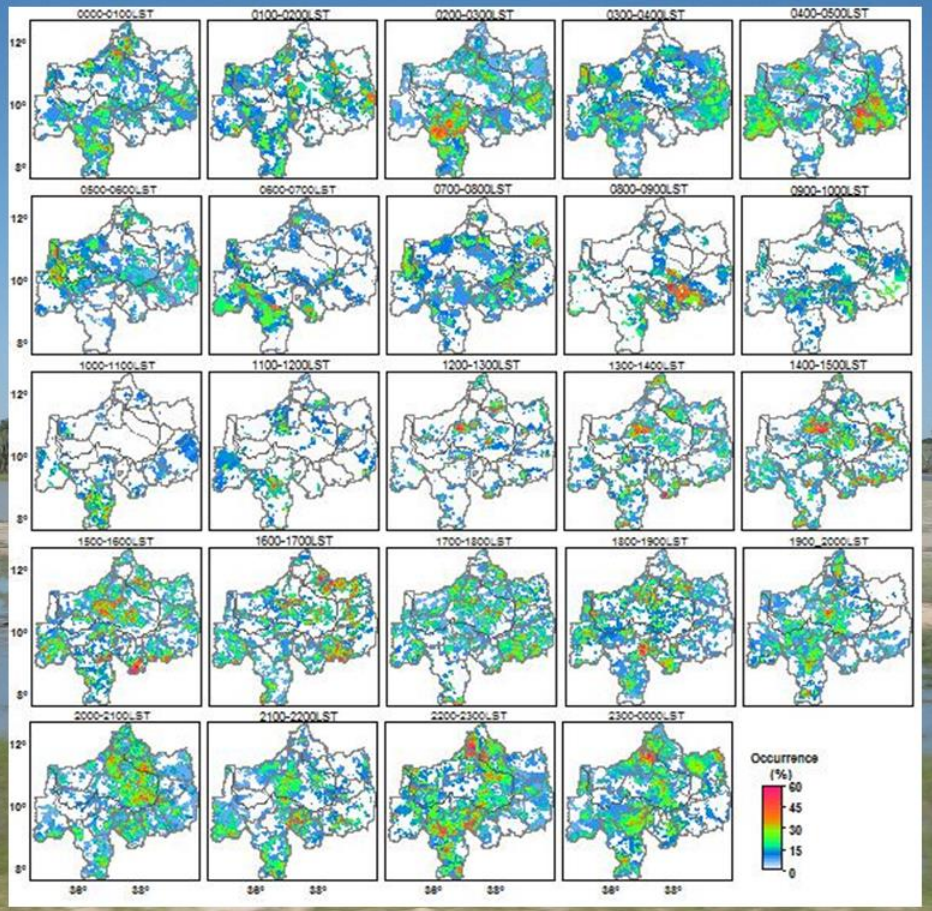
Concept relies on
Zone of “Elevation –Vegetation ” &
Precipitation –Temperature laps rates ..

Satellite based rainfall estimation : below

Rainfall occurrence in Blue Nile basin Ethiopia

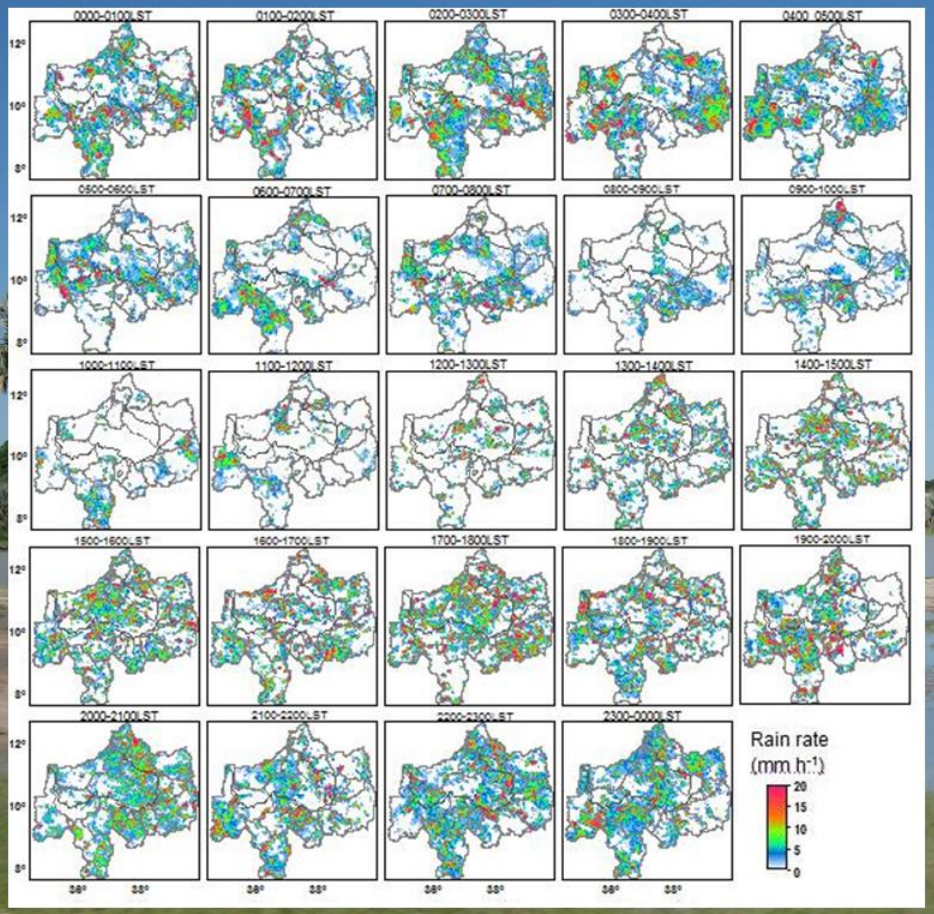


TRMM PR

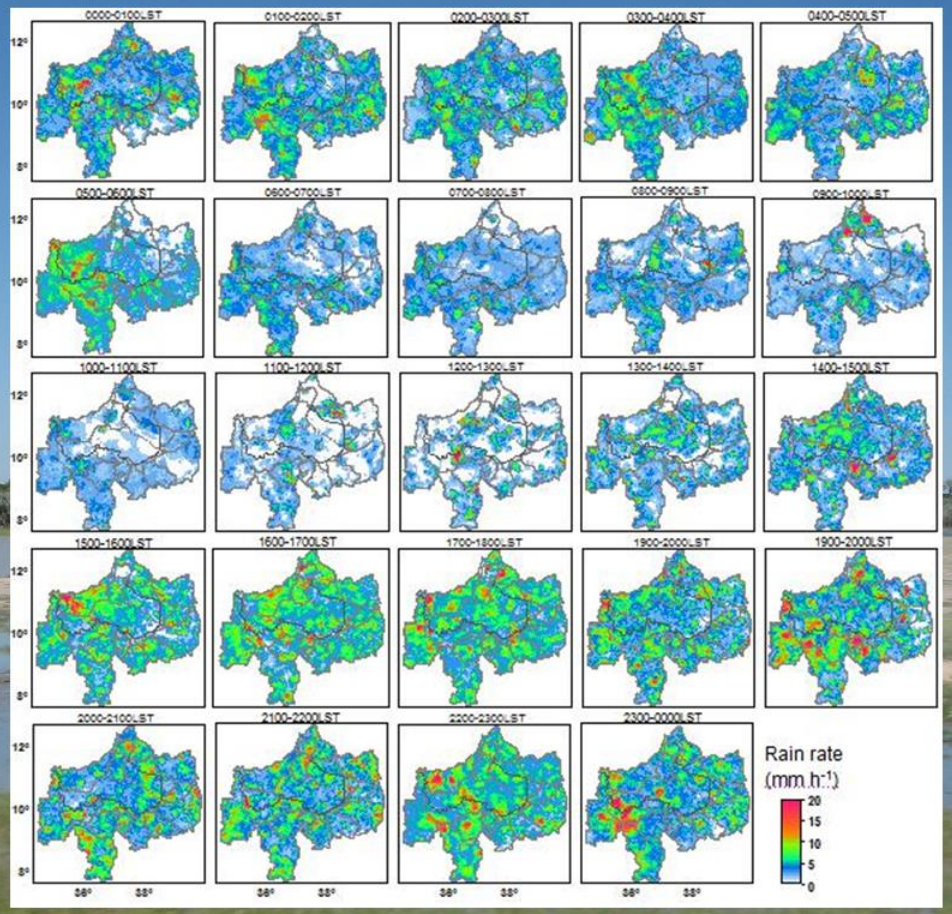


TRMM TMI

Satellite based rainfall estimation : below Rainfall rates in Blue Nile basin Ethiopia

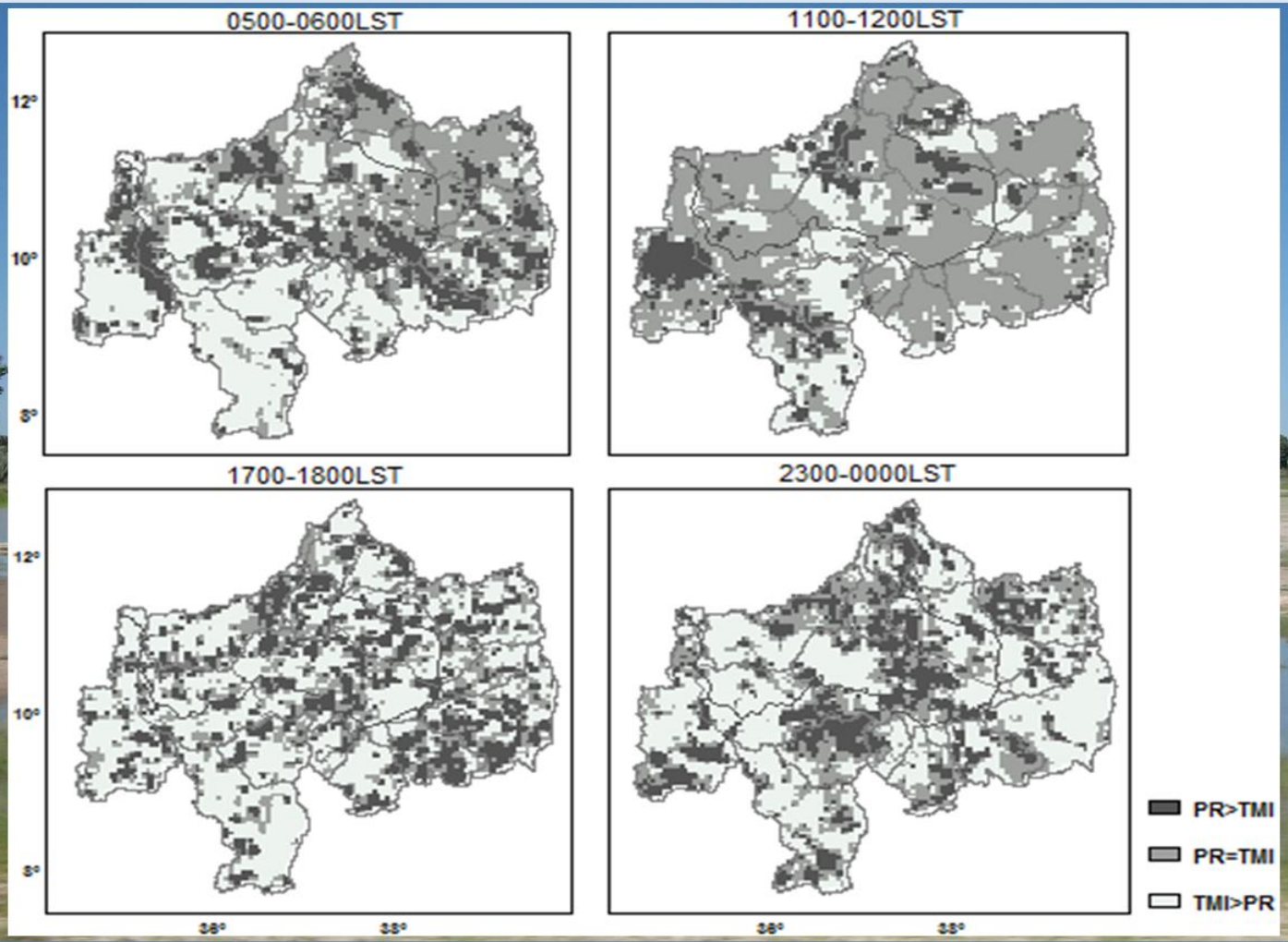


TRMM PR



TRMM TMI

Comparing Precipitation Radar (PR) and TRMM Microwave Imager (TMI) observations of mean rain rate for selected Local Standard Time (LST) (JJAS, 2002-2008).



So which product to use? ….how is the water balance closed?

Rainfall comparison (Gauged vs TRMM data)

Babahoyo basin, Ecuador

Descriptive statistics:

Description	Gauged	TRMM
Mean	5.63	2.98
Standard Deviation	10.23	6.45
Minimum	0.00	0.00
Maximum	88.10	65.41
Sum	6171.31	3265.50
Count	1096	1096

Total rainfall and ratio:

Total rainfall (mm)	
Meteorological stations	17863219.66
TRMM 3B42 product	9450503.36
Ratio:	**1.89**