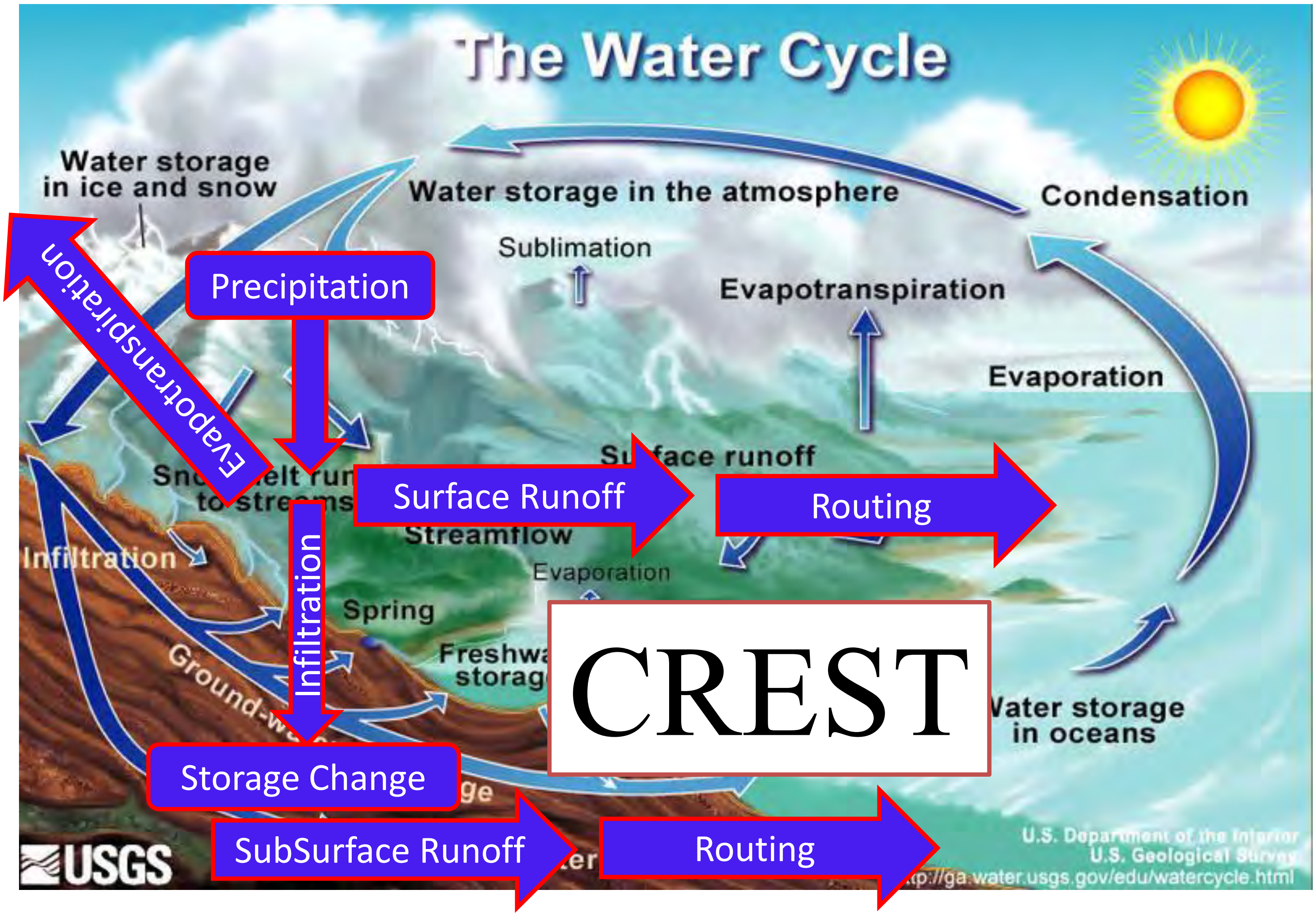
CREST Hydrologic Model on Okavango River

Zachary Flamig – University of Oklahoma, USA
Mc-cloud Katjizeu – Dept. of Hydrology, Namibia



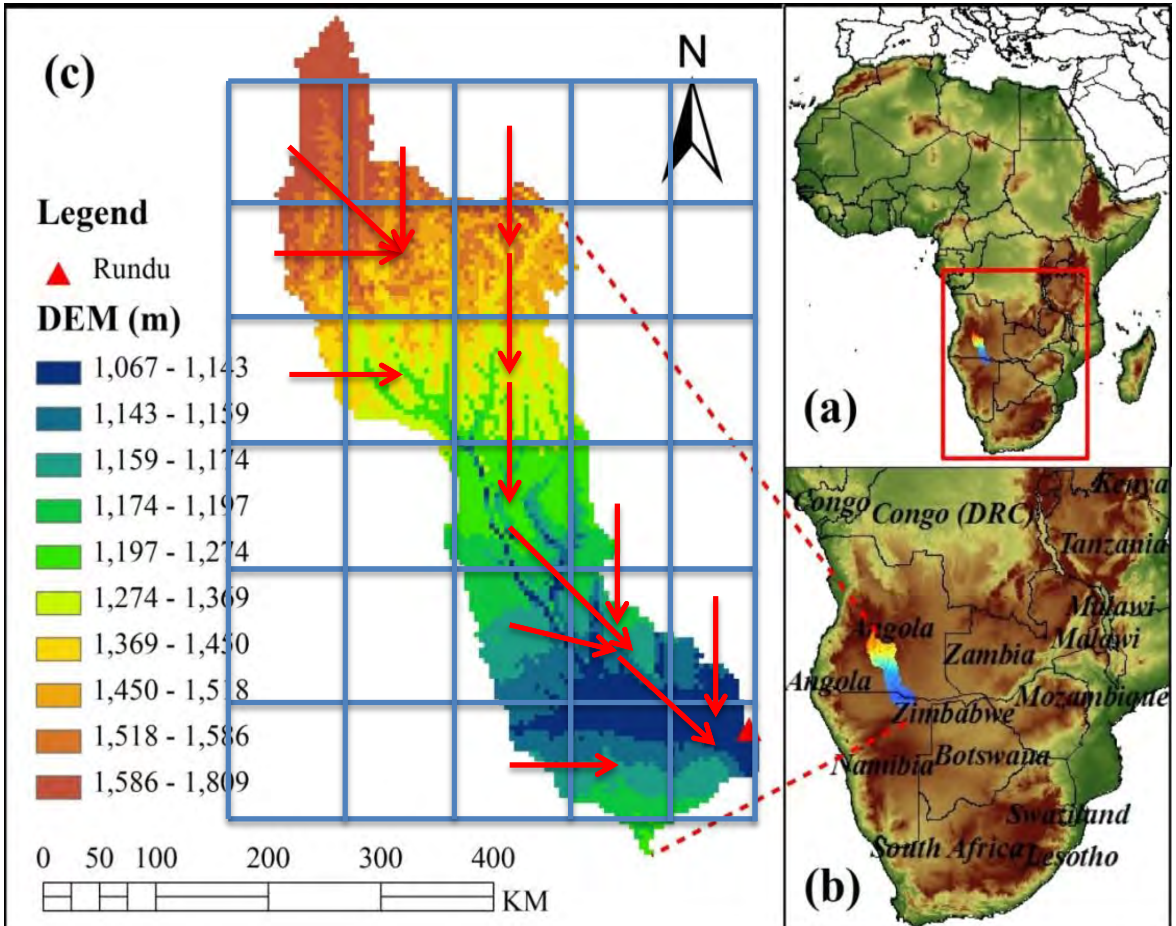
The Water Cycle
Water storage in ice and snow
Water storage in the atmosphere
Condensation
Sublimation
Evapotranspiration
Evaporation
Precipitation
Evapotranspiration
Surface Runoff
Routing
Streamflow
Evaporation
Infiltration
Spring
Infiltration
Storage Change
SubSurface Runoff
Routing
CREST
in oceans
U.S. Department of the Interior
U.S. Geological Survey

What does a hydrologic model tell you?

- When it rains, how much water infiltrates? How much runs off?
  - Runoff Coefficient = Runoff/Precipitation
- How is the water routed, what is the time until the flood wave reaches a point of interest?
  - Prediction from observed rainfall
  - Can also do prediction from forecast rainfall
    - Account for additional future rainfall
- A hydrologic model will **not** tell you water height/flood extent.

How does the CREST Hydrologic Model Work?

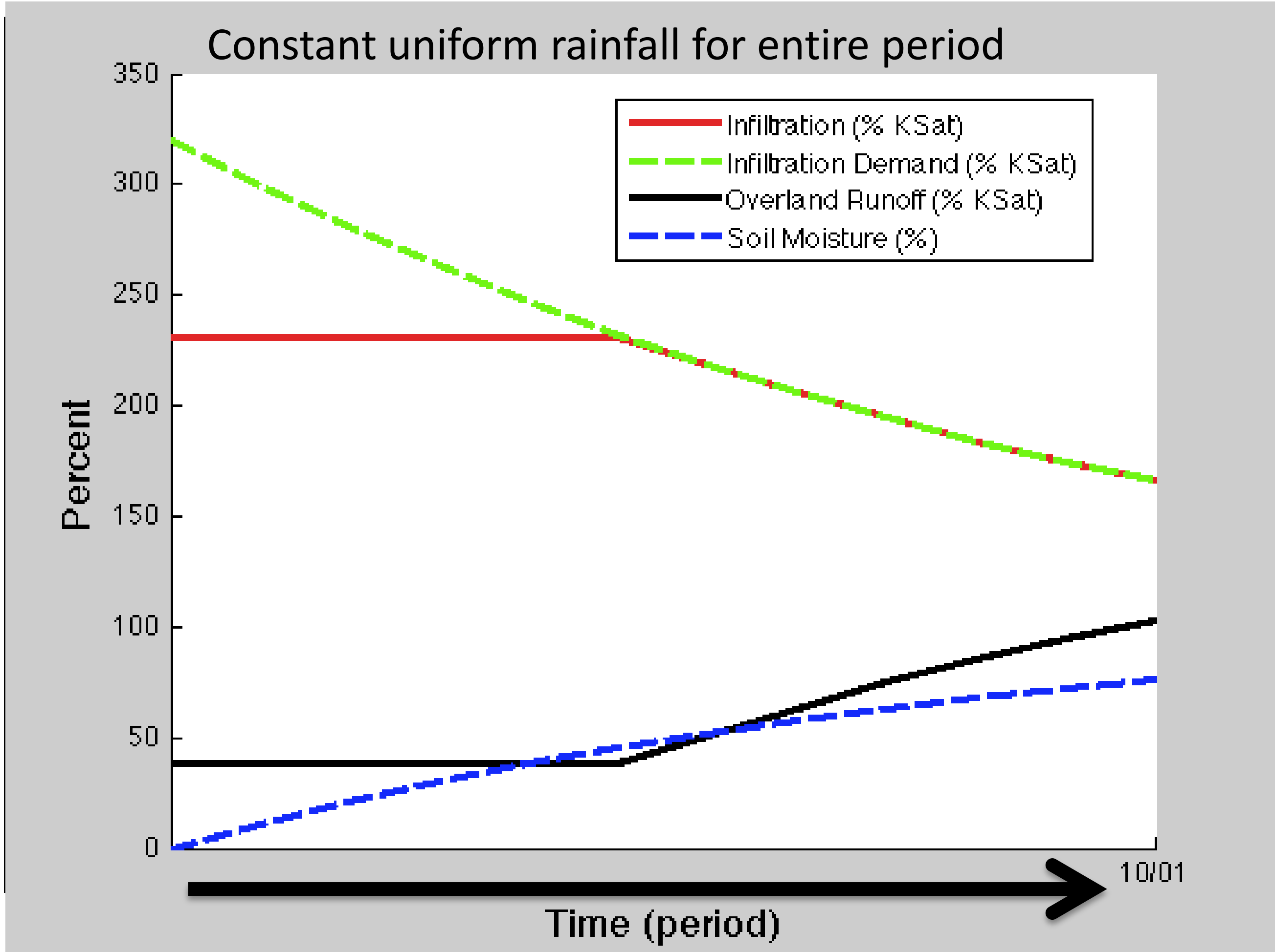
- Distributed Hydrologic Model
  - Finite difference (i.e. grid cells)



- Each grid cell is treated as a "subbasin"
  - Water balance is solved per grid cell
  - Grid cell can have parameters reflecting soil properties for that location
    - Ksat, Available Water Capacity, Mannings Roughness
- Grid cells flow downstream
  - Routing

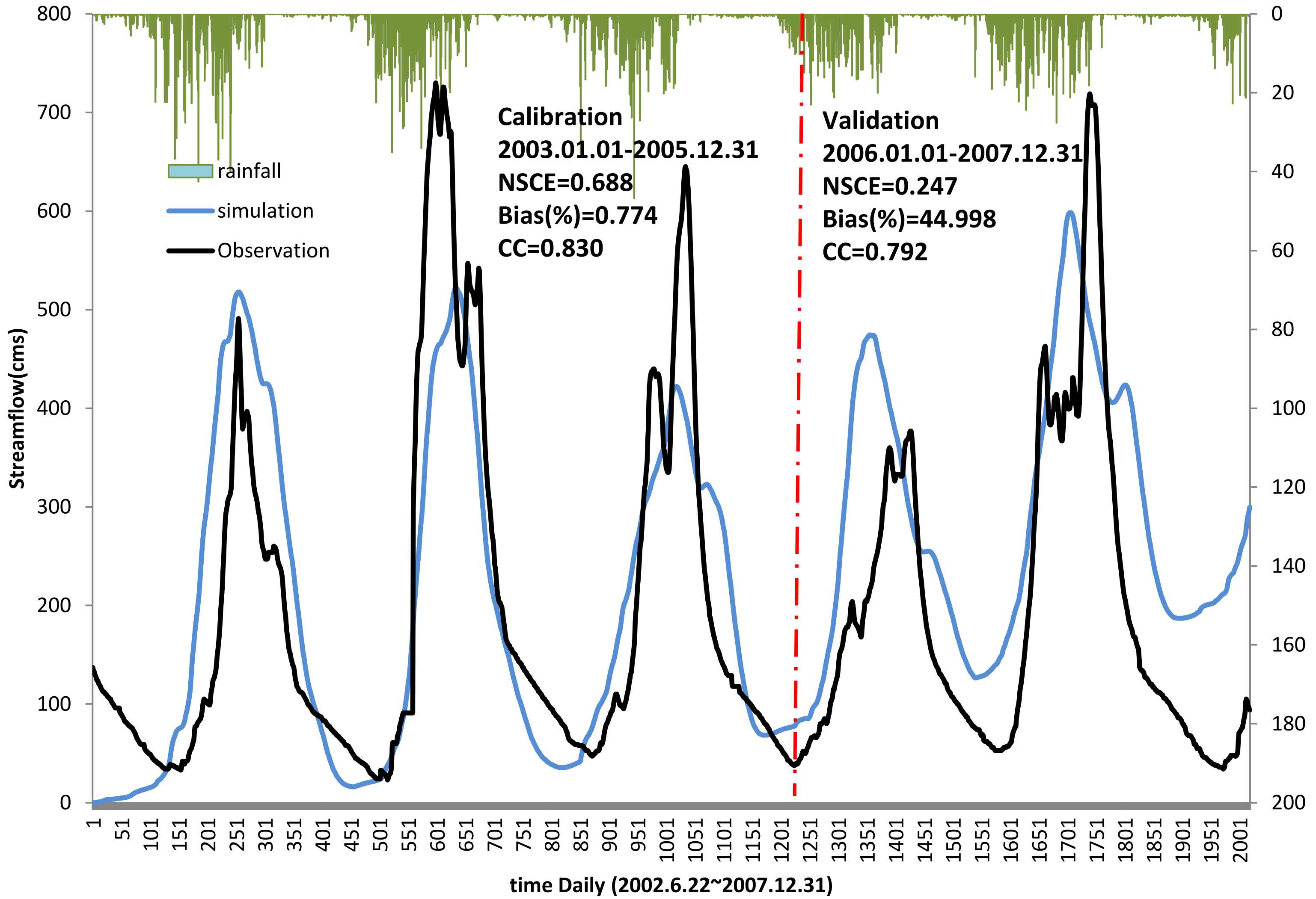
CREST Distributed Hydrologic Model

For each grid cell:



- 2 Forcing Data (Rainfall, PET)
- 11 Parameters
- 11 Outputs available for Any Time Steps and Any Locations

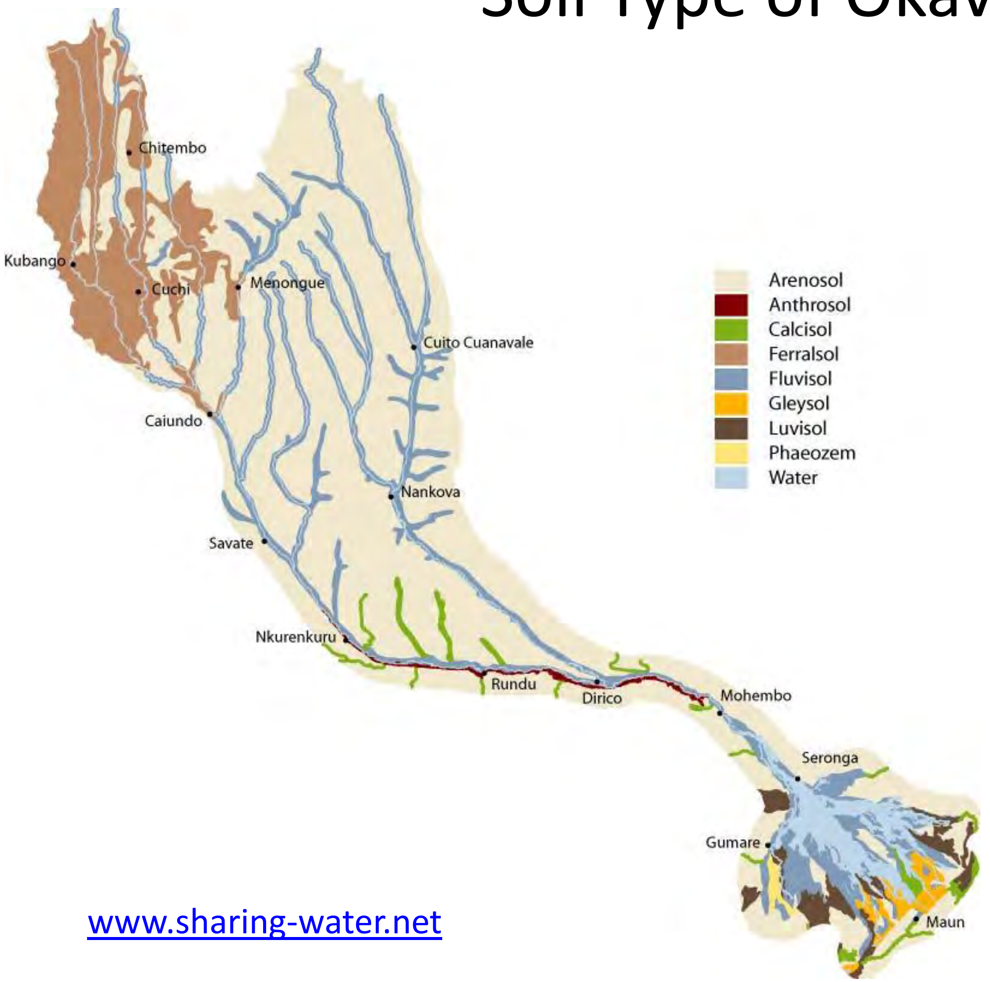
Sample CREST Results for OKavango



Not very good, yet!

- Add distributed soil information

Soil Type of Okavango Basin



www.sharing-water.net

Definition of Arenosol:

1. Having a texture which is loamy sand or coarser either to a depth of at least 100cm from the soil surface, or to a plinthic, petroplinthic or salic horizon between 50 and 100cm from the soil surface
2. Having less than 35 percent of rock fragments or other coarse fragment within 100cm of the soil surface
3. Having no diagnostic horizons other than an ochric, yermic or alblic horizon, or salic horizon below 50 cm from the soil surface

http://www.isric.org/ISRIC/webdocs/docs/major_soils_of_the_world/set3/ar/arenosol.pdf

Hydraulic Conductivity Issue

Texture	Hydraulic Conductivity
Arenosol	3000-300000mm/day
Sandy Soils	600-6000mm/day
Clay Soils	2.4-24mm/day

http://www.isric.org/ISRIC/webdocs/docs/major_soils_of_the_world/set3/ar/arenosol.pdf

Code	Texture	abbr.	Fild Capacity θ_{fc}(m^3/m^3)	Permanent Wilting Point θ_{pw} (m^3/m^3)	Hydraulic conductivity K_{sat} (mm/day)
0	No_Soil	NS	0	0	0.0024
1	Clay(heavy)	CH	0.36	0.21	7.2
2	Silty Clay	SIC	0.36	0.21	12
3	Clay	C	0.36	0.21	18
4	Silty Clay Loam	SICL	0.34	0.19	24
5	Clay Loam	CL	0.34	0.21	24
6	Silt	SI	0.32	0.165	118.8
7	Silt Loam	SIL	0.3	0.15	156
8	Sandy Clay	SC	0.31	0.23	36
9	Loam	L	0.26	0.12	81.6
10	Sandy Clay Loam	SCL	0.33	0.175	36
11	Sandy Loam	SL	0.23	0.1	261.6
12	Loamy Sand	LS	0.14	0.06	717.6
13	Sand	S	0.12	0.04	2827.2

From CREST User manual

Calibration Approach

- Two methods, but cloud capable
  - Differential Evolution Adaptive Metropolis (DREAM)
    - Multi Chain Monte Carlo
    - Global optimization method
    - Requires 100,000s model runs (computationally expensive)
  - Genetic Algorithm
    - Non-global optimization
    - Used to feed into SCE or DREAM

Other things to consider

- Calibration Objective Function
  - Magnitude not so important right now
  - Correlation Coefficient?
  - Contingency Table Stats
    - How to define event? Must be objective
    - Avoid crying wolf, minimize FAR while maximizing POD => CSI

	Observed Flood	Observed No Flood
Predicted Flood	**HIT**	**FALSE ALARM**
Predicted No Flood	**MISS**	**CORRECT NULL**

Other things to consider

- Data Assimilation
  - Pull observed gauge data from Flood Dashboard for integration
- Different Precipitation Sources
  - Comparison with nearby gauges to get a handle on uncertainty
  - Differences between RT & V7 Products
- Different Model Physics
- *Ensemble Predictions*
  - *Combinations of above to quantify uncertainty*

End Goal!

- Use historical MODIS, Radarsat, and EO-1 Water Level Maps to relate **Hydrologic Model Streamflow** to **Spatial Extent of Flooding**.