UCDAVIS
UNIVERSITY OF CALIFORNIA

PHY256B, Spring 2014
Project Talks

Using Hidden Markov Random Fields for Estimating the Uncertainty in Groundwater Flow

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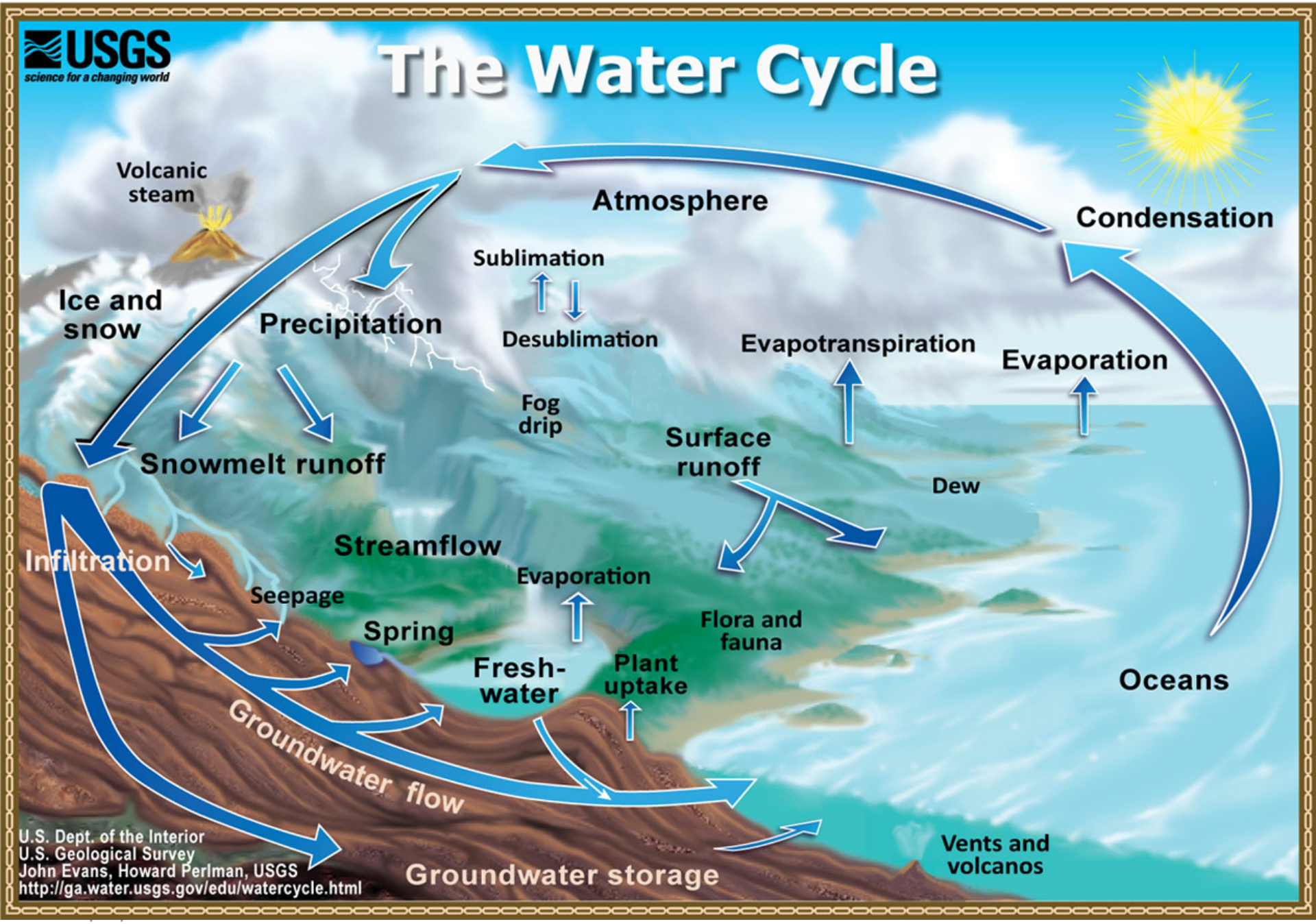

USGS
science for a changing world
The Water Cycle
Volcanic steam
Atmosphere
Condensation
Sublimation
Desublimation
Ice and snow
Precipitation
Evapotranspiration
Evaporation
Fog drip
Surface runoff
Snowmelt runoff
Dew
Infiltration
Streamflow
Evaporation
Seepage
Spring
Flora and fauna
Fresh-water
Plant uptake
Oceans
Groundwater flow
Vents and volcanos
Groundwater storage
U.S. Dept. of the Interior
U.S. Geological Survey
John Evans, Howard Perlman, USGS
http://ga.water.usgs.gov/edu/watercycle.html

Groundwater Flow

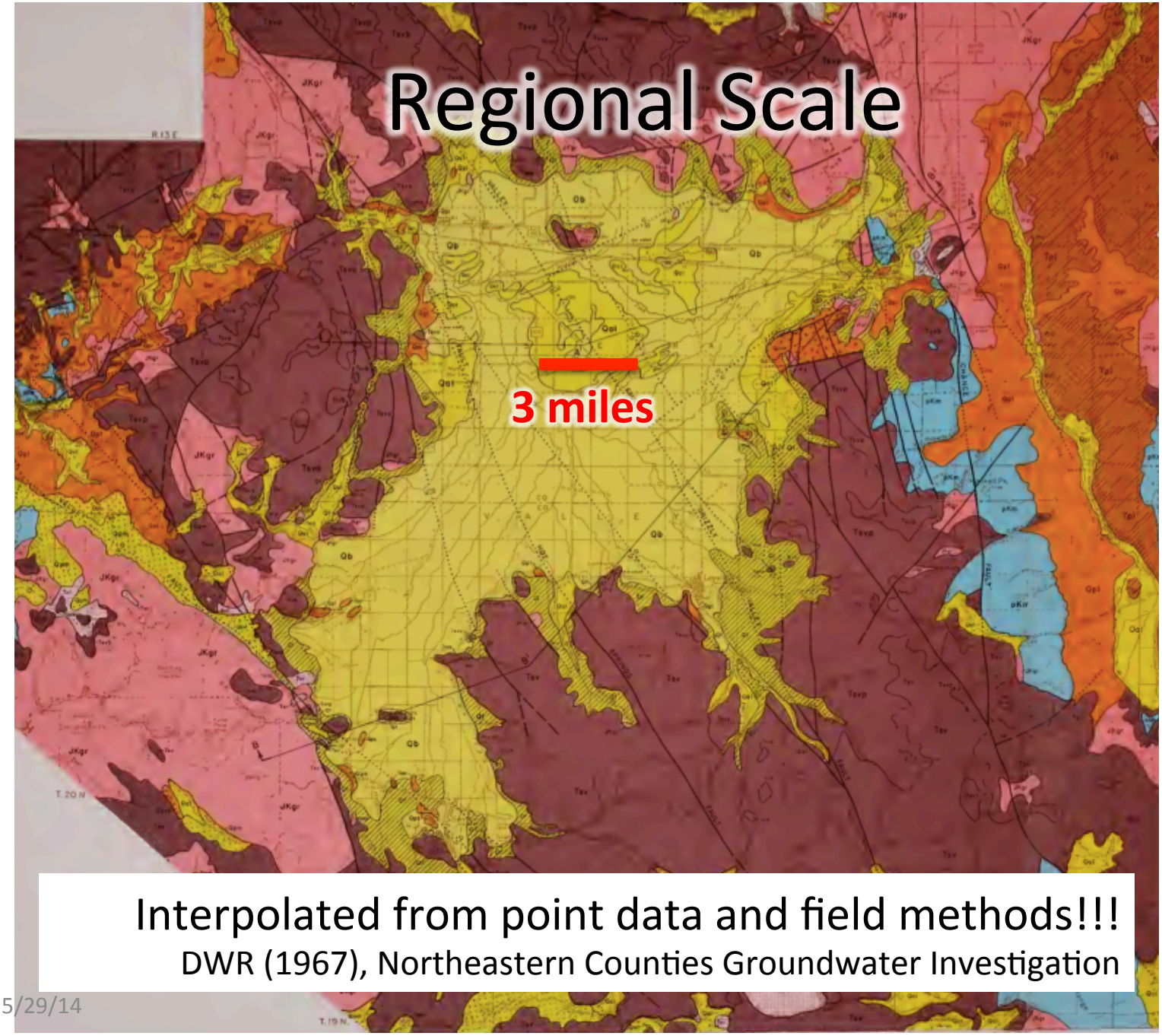
- A form of Diffusion Equation,

$$S\frac{\partial h}{\partial t} = T\,\nabla^2 h + R$$

Source/Sink
Recharge/Pumping

Aquifer Parameters
Storage & Transmissivity

  - *Derived from the continuity equation for a REV where parameters are assumed to be effectively constant - (lab scale),*
  - *Darcy's Law is used to describe the fluxes.*



Interpolated from point data and field methods!!!

DWR (1967), Northeastern Counties Groundwater Investigation

Modeling the Uncertainty

- Monte Carlo simulations, many realizations are needed;

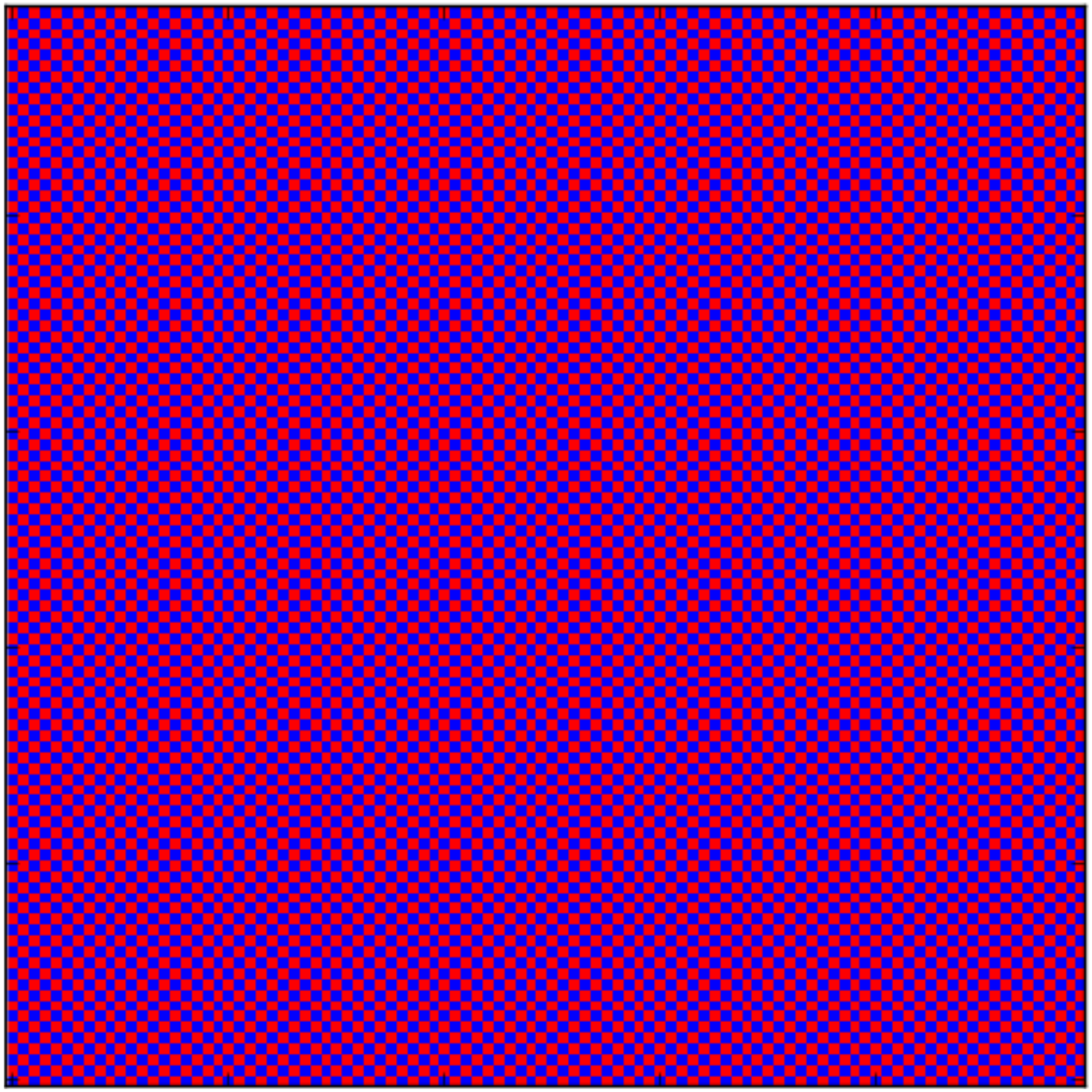
- Often hydrogeologic parameters are assumed to be random constants,
- Rarely Discrete/Continuous Markov Fields are used.

Project Goals

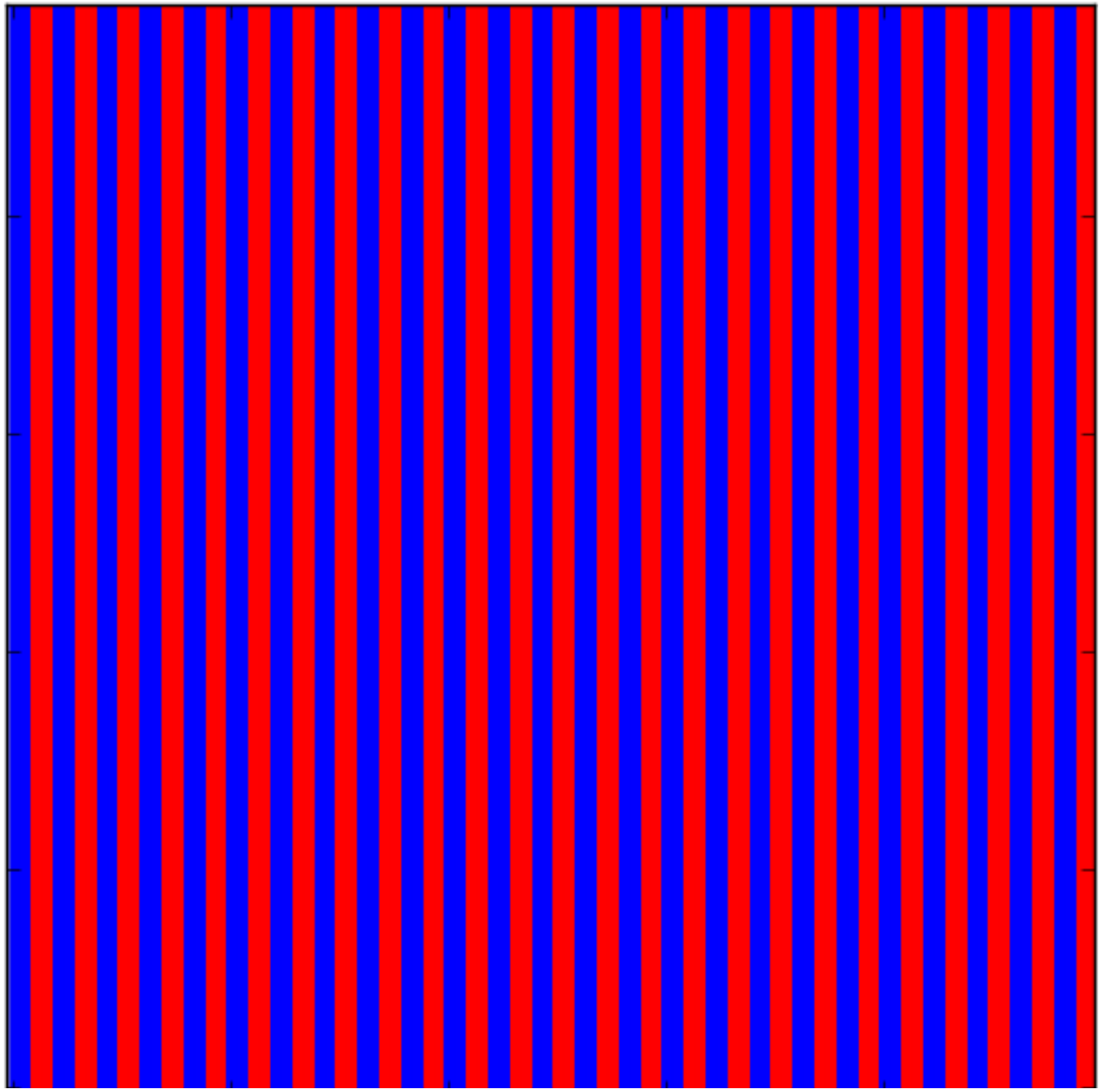
- Estimate the information stored by the system - How random the system is?

- Use transition probabilities to generate other possible realizations.

Test Runs



Test Runs



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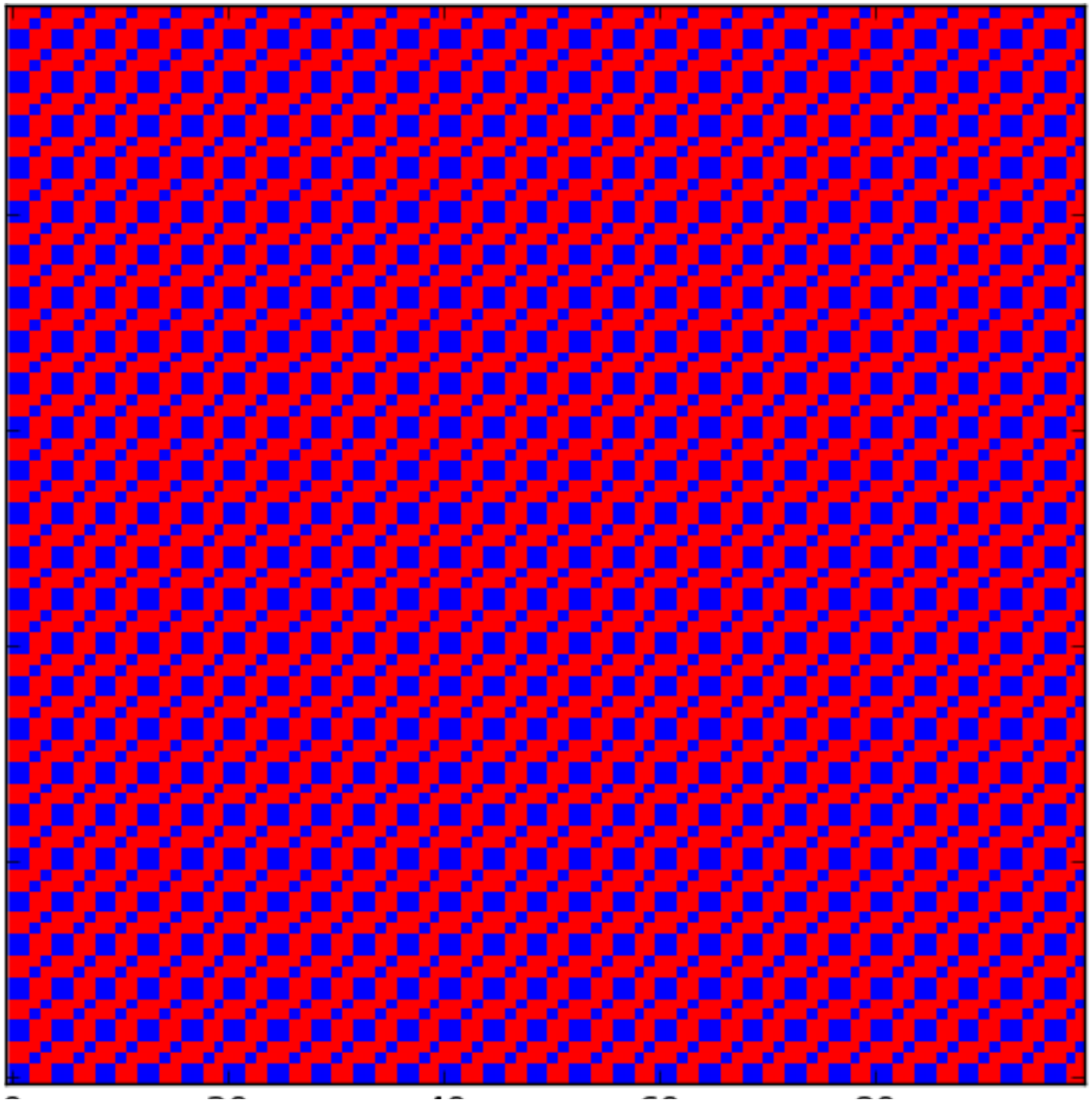

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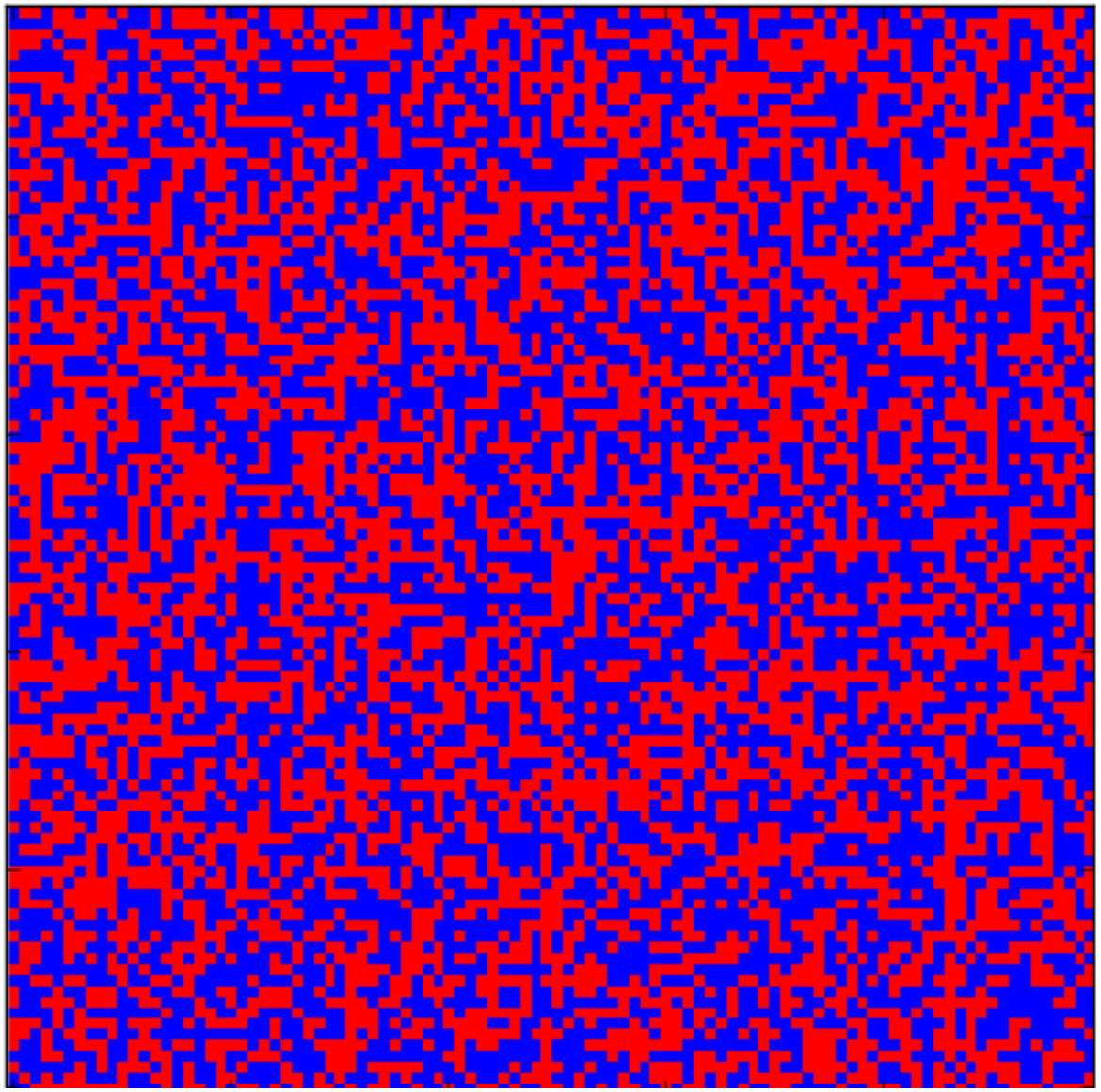

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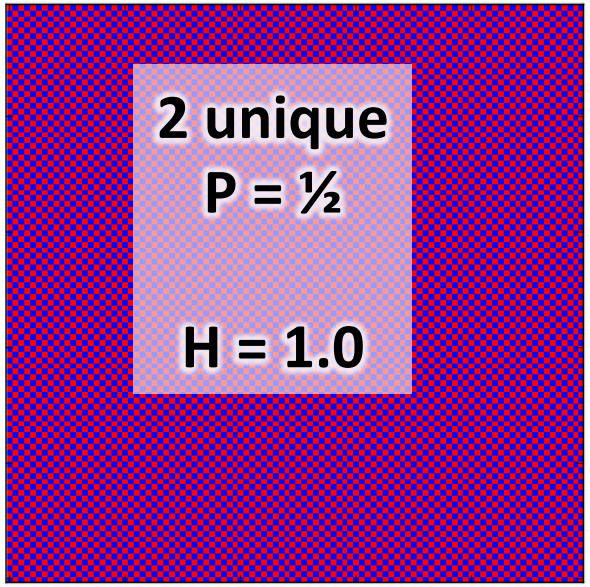
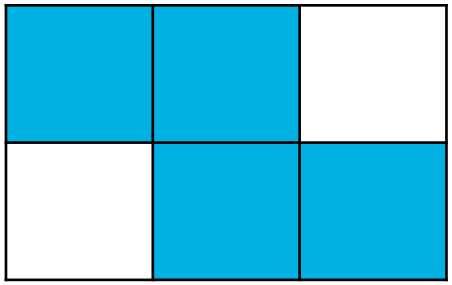
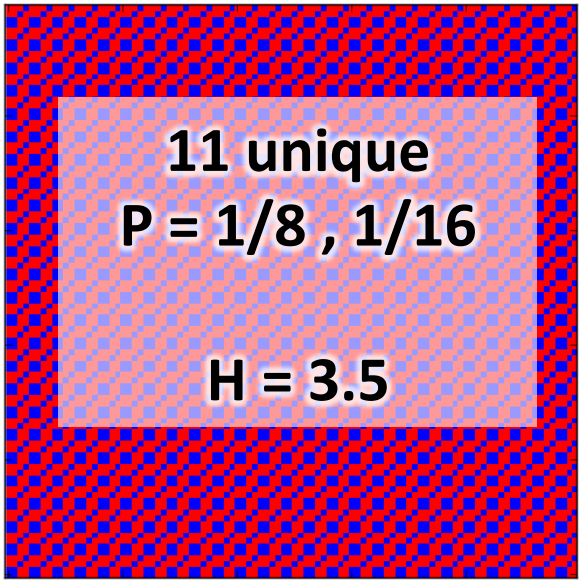
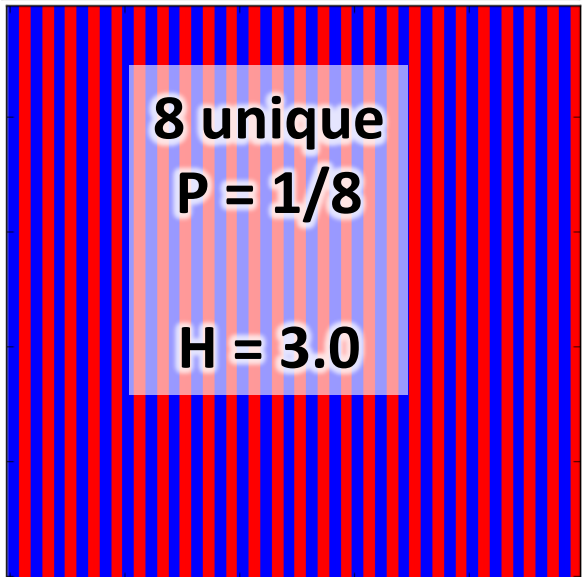
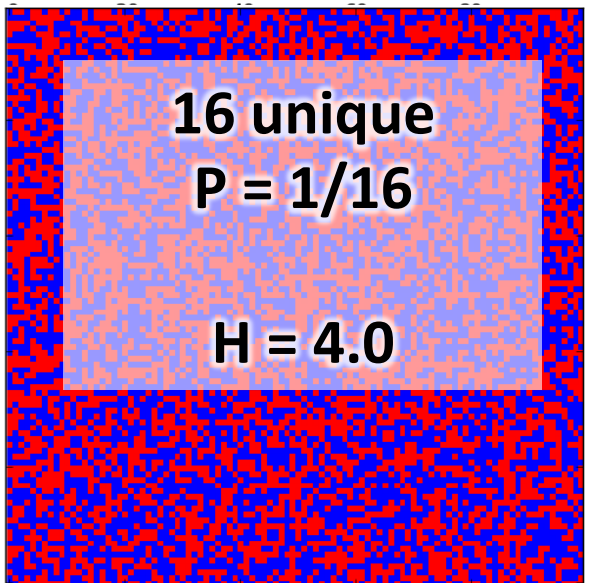

2 unique
P = ½
H = 1.0

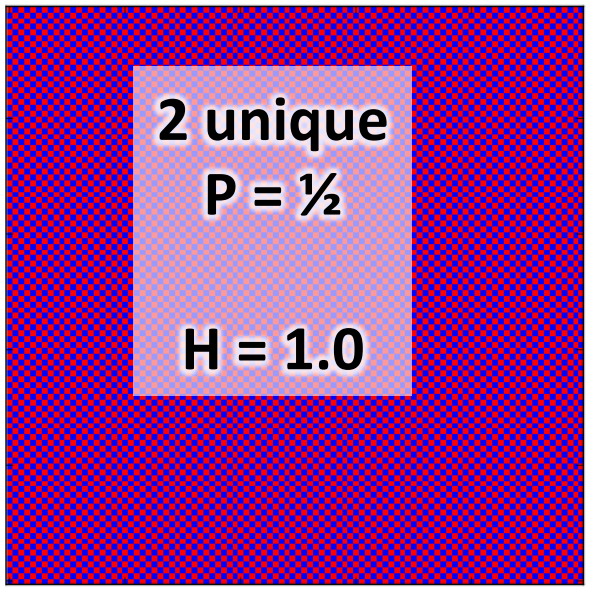


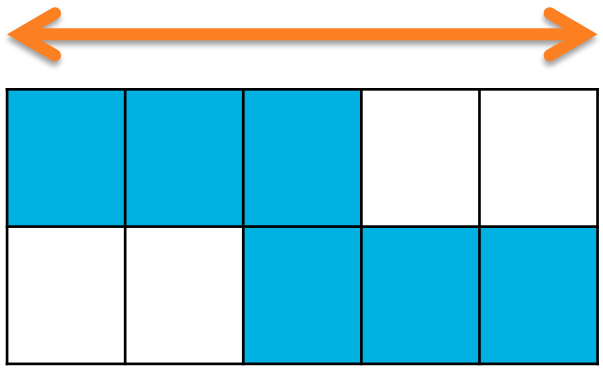

11 unique
P = 1/8 , 1/16
H = 3.5

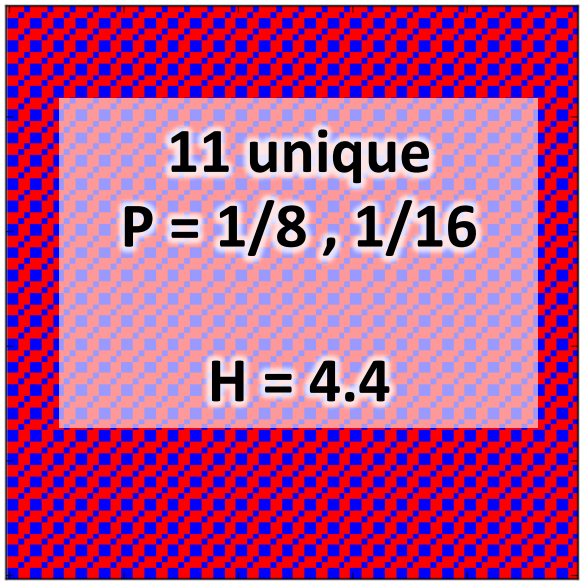

8 unique
P = 1/8
H = 3.0

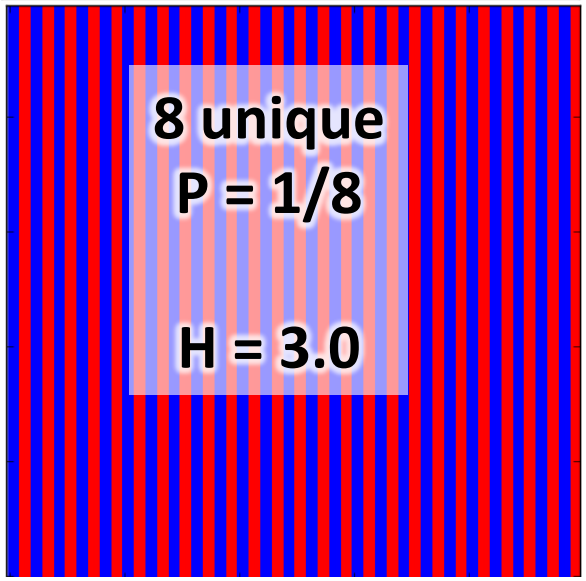

16 unique
P = 1/16
H = 4.0

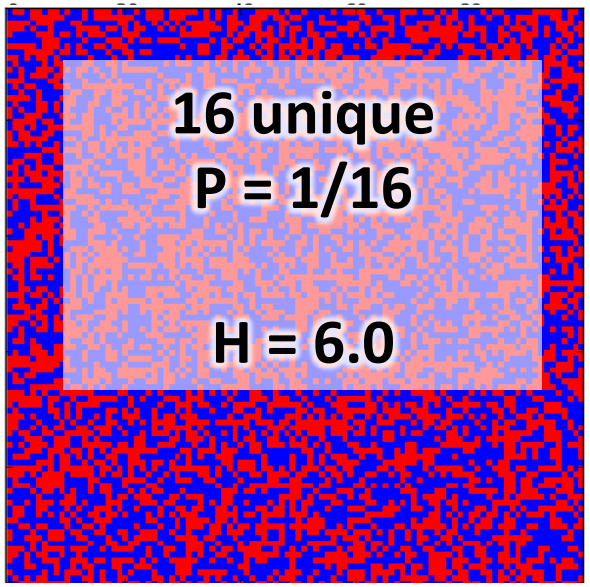
Test Runs

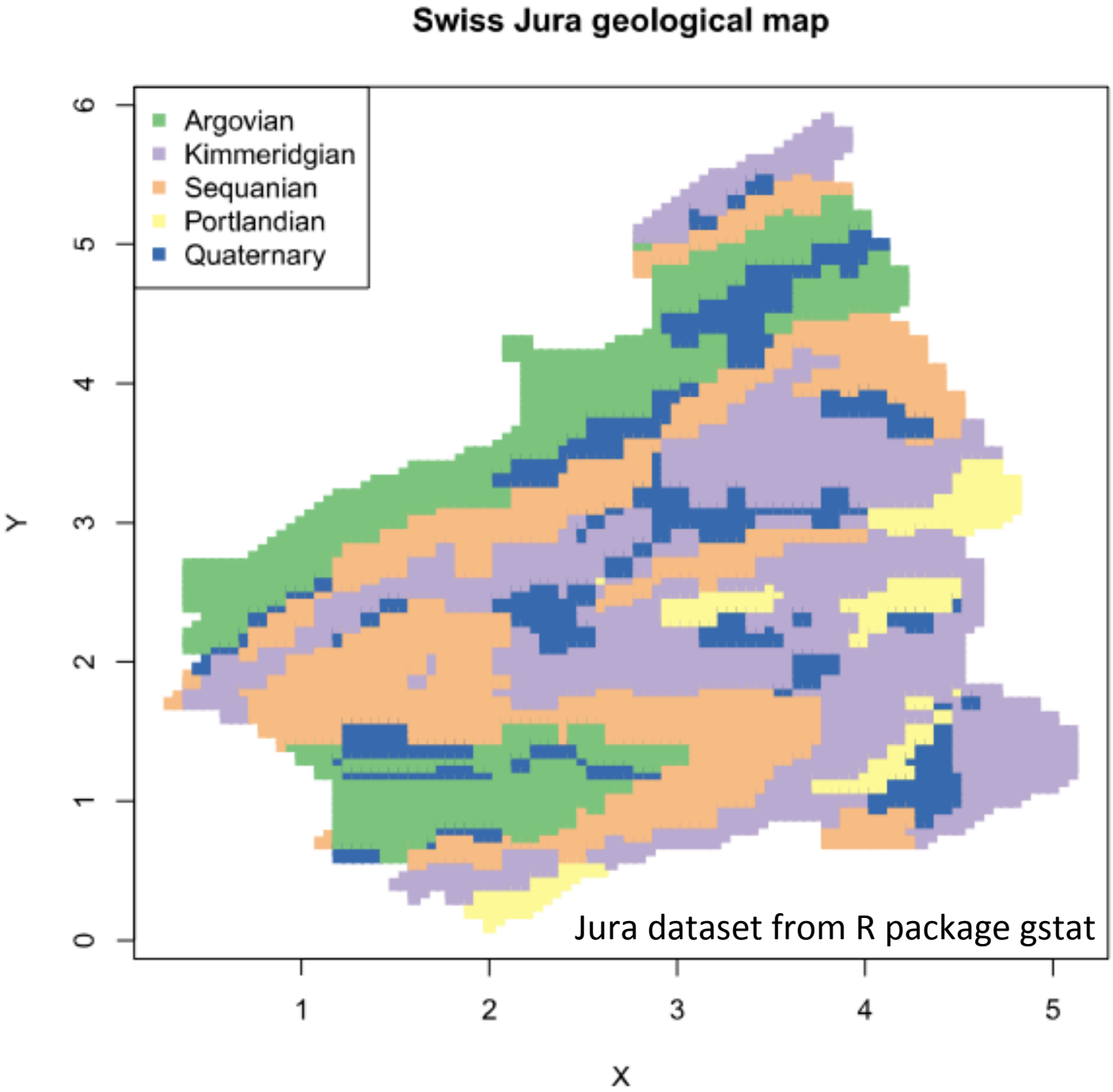

2 unique
P = ½
H = 1.0




11 unique
P = 1/8 , 1/16
H = 4.4


8 unique
P = 1/8
H = 3.0


16 unique
P = 1/16
H = 6.0


Swiss Jura geological map
Argovian
Kimmeridgian
Sequanian
Portlandian
Quaternary
Jura dataset from R package gstat
Y
X
0
1
2
3
4
5
6
1
2
3
4
5

Thanks!