Modeling and Natural Resources

Science and the Resource Management Agencies

The Climate and Deserts Workshop:

Adaptive Management of Desert Ecosystems

in a Changing Climate

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National Park Service - Mojave National Preserve

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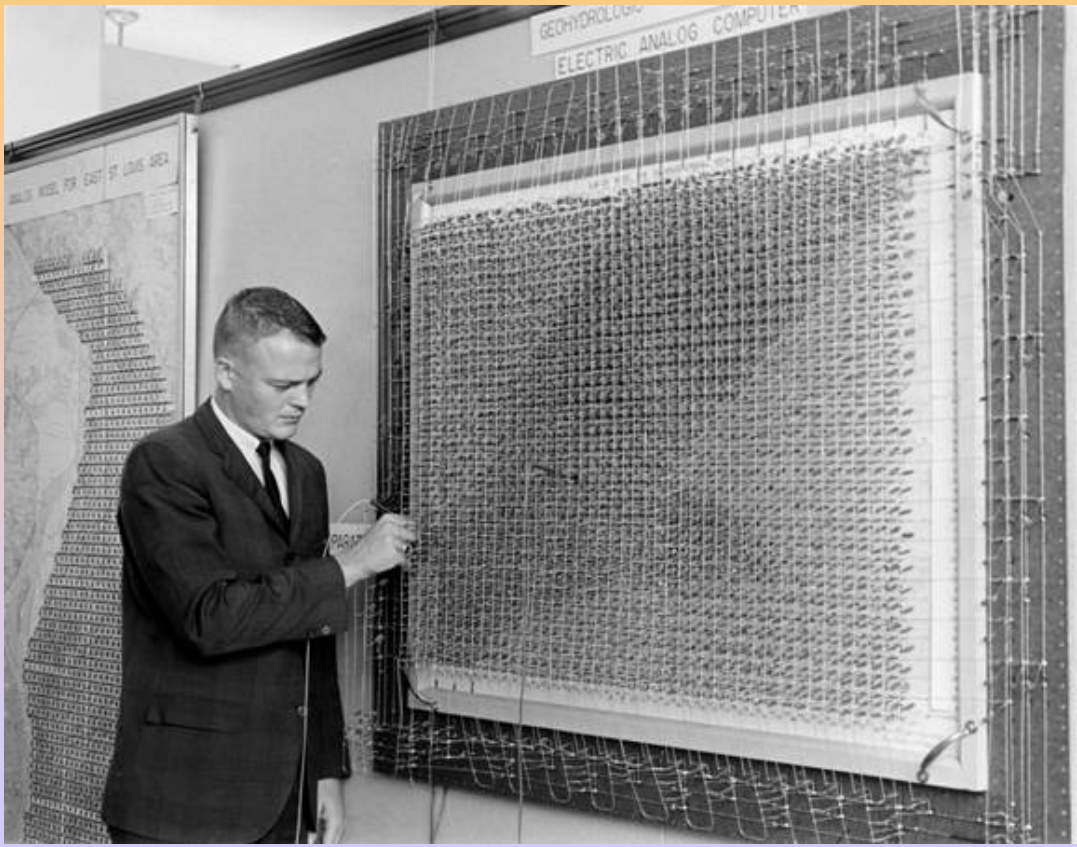
Aquarius Casino Resort

Laughlin, Nevada

What is a model?

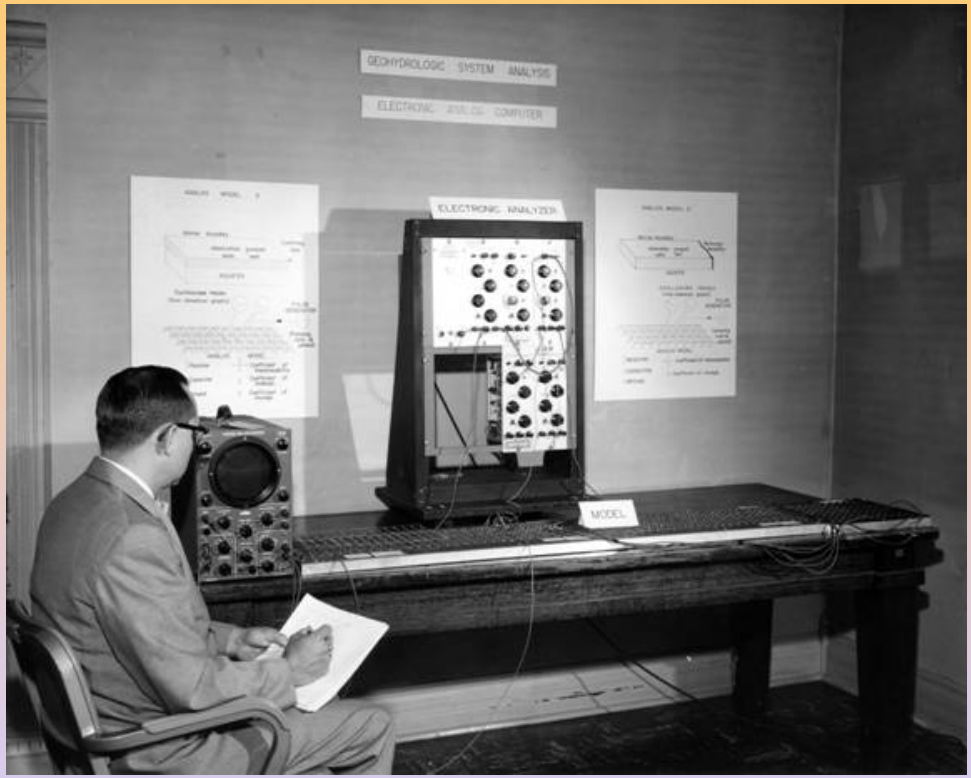


A model is a theoretical description of a complex entity or process.

A model is a representation of something, usually on a smaller scale.

What is a model for?

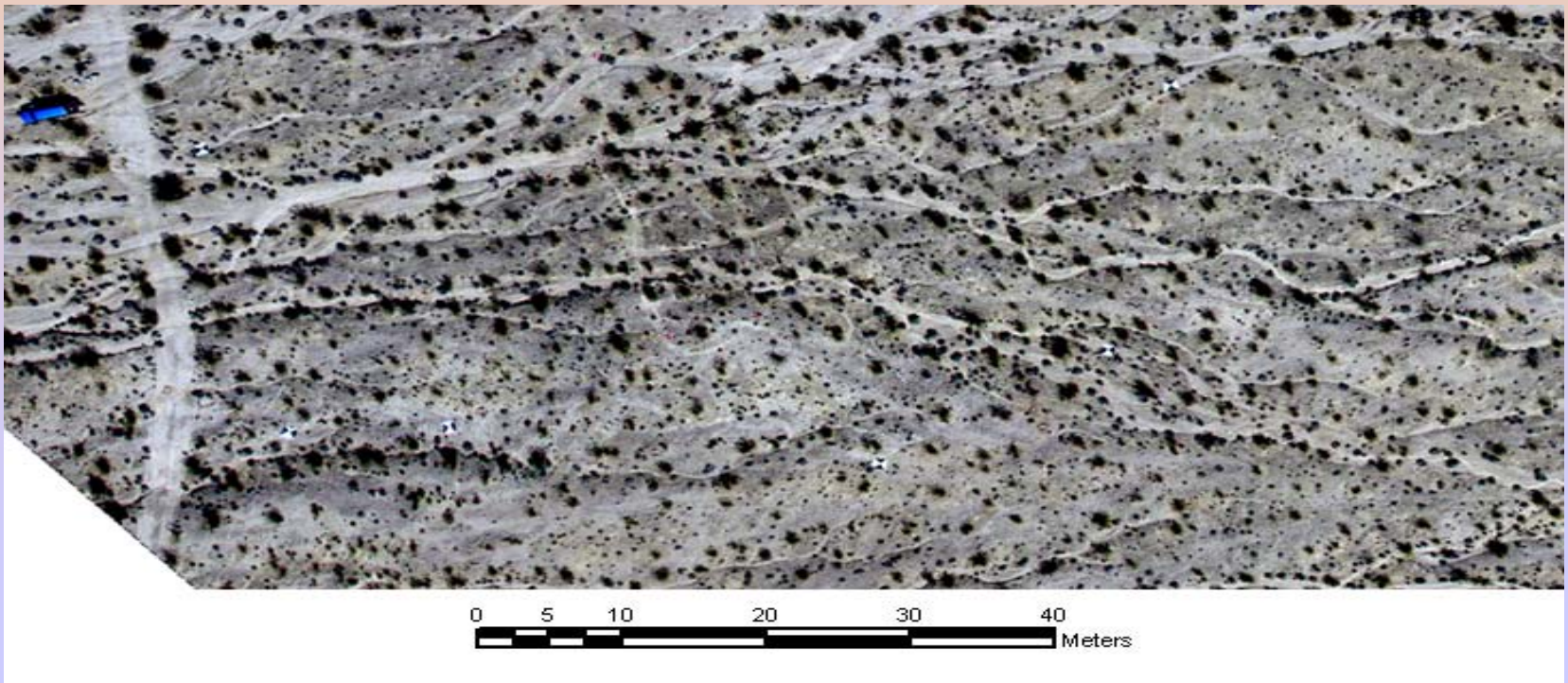
- Simulation
- Hypothesis Testing
- Visualization
- Communication
- Prediction



A model often integrates much of what is known about a natural system.

Issues

- Verification
- Calibration – tuning
- Validation – history matching
- Uncertainty



Models come in several flavors

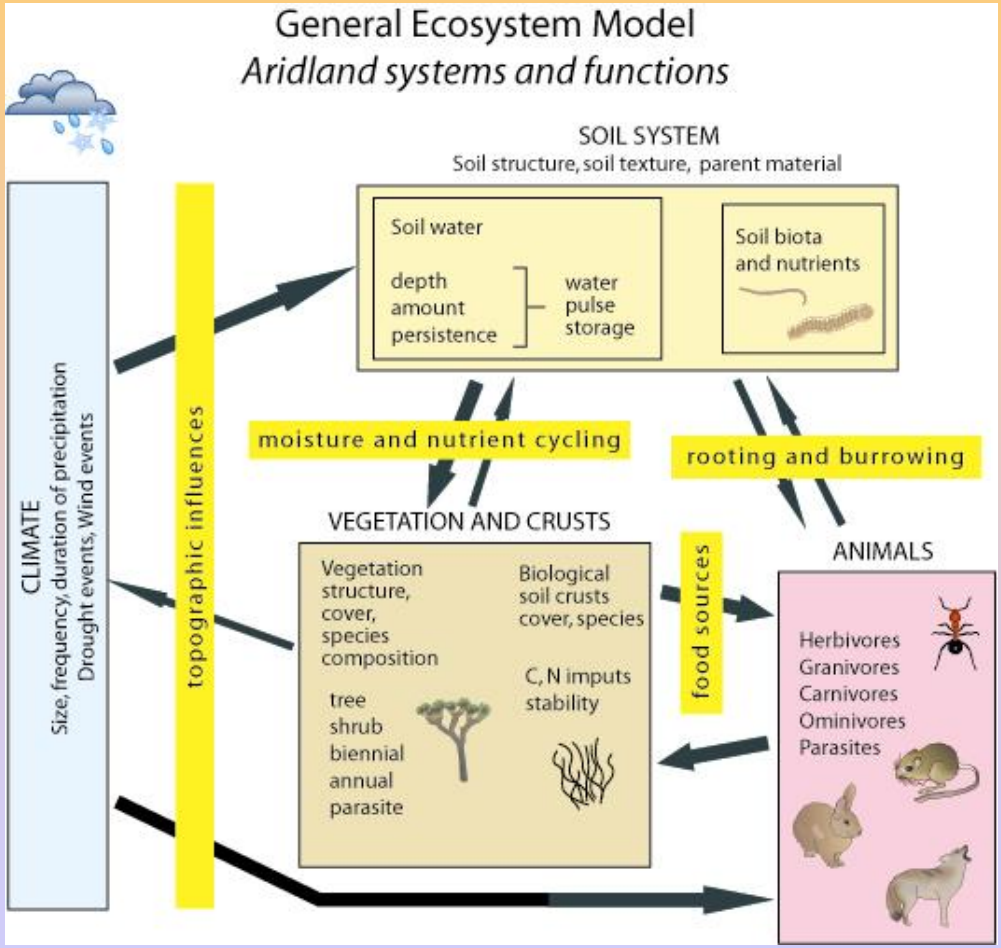
Conceptual models

Heuristic models

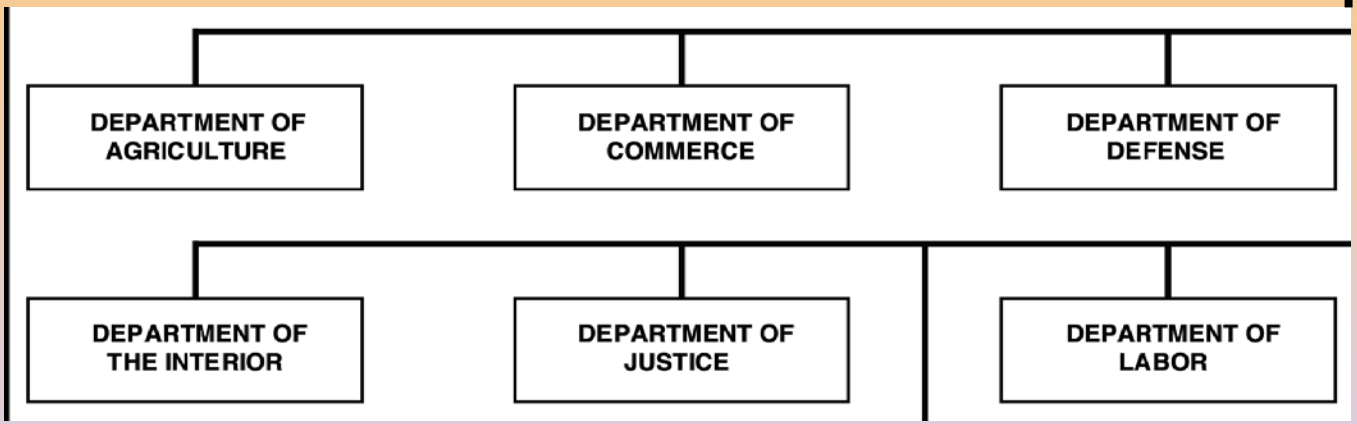
Analytical models

Primitive equations

Numerical models

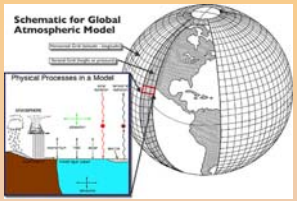


EXECUTIVE BRANCH

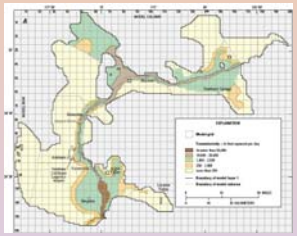


Natural resources on public lands are managed by the Executive Branch of the U.S. Government

Three examples of models and managers.



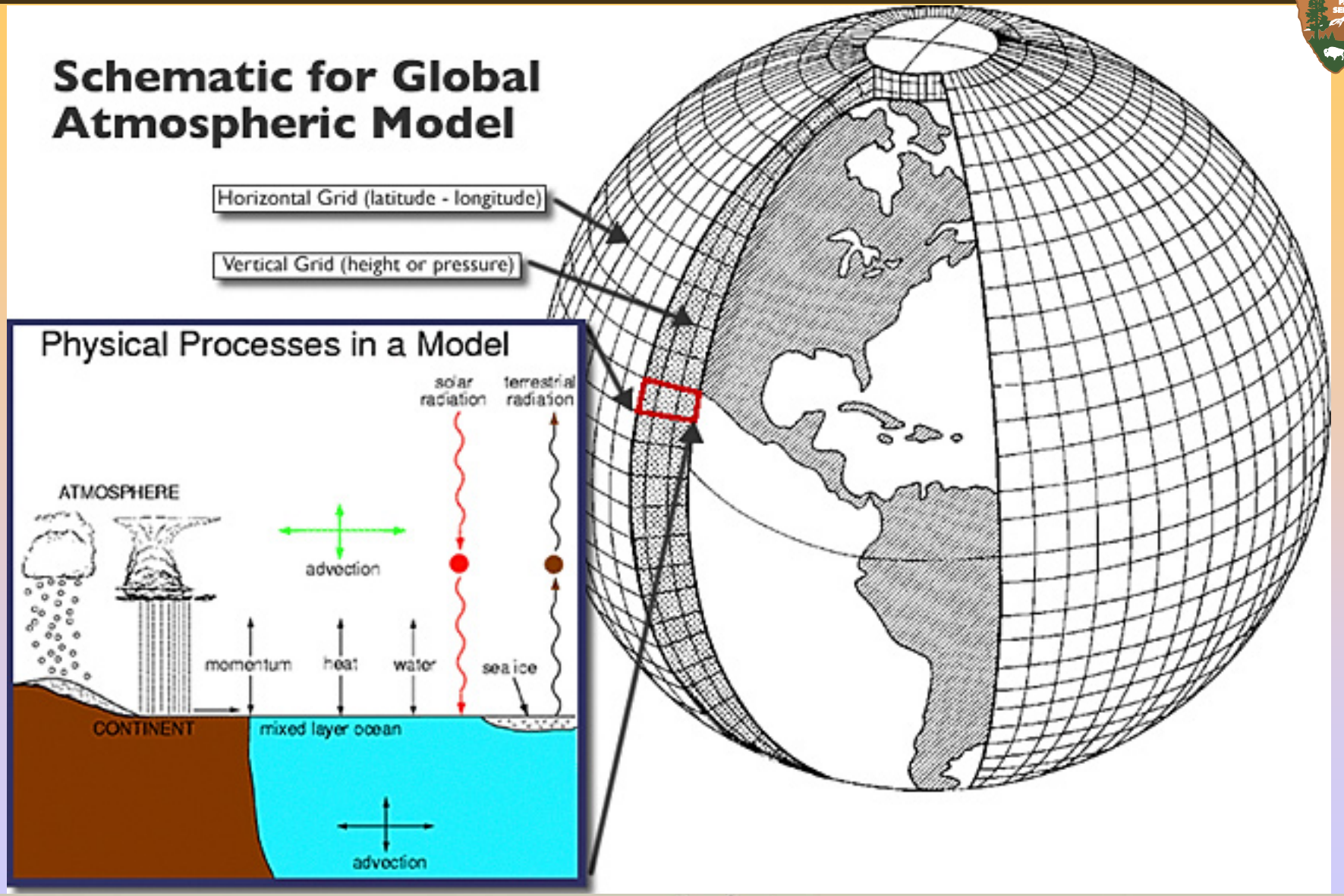
Global Circulation Model (GCM) – prediction of global warming, the topic of this workshop.



Groundwater Flow Model – water resource shortages as a consequence of climate change.

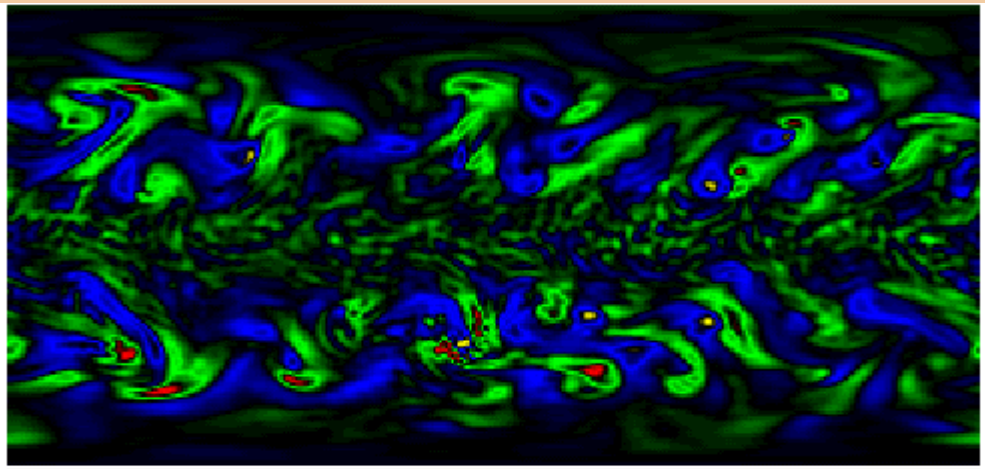
Desert Tortoise Habitat Model – requested by the Desert Managers Group.

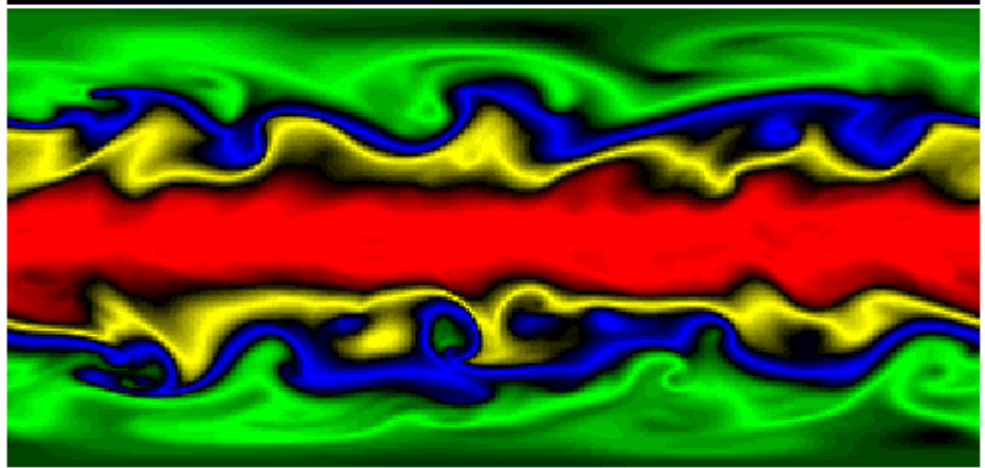
Schematic for Global Atmospheric Model



General Circulation Models (Global Climate Models) do a reasonably good job of representing the Earth's climate.

Global Climate Models unanimously agree that increasing greenhouse gases will increase overall temperature.





"We're facing a period of dramatic uncertainty. What managing nature would mean is a dramatic unknown. We don't know what our goals would have to be." "We're literally talking about things that have only been talked about for months, rather than years."

Dr. David Graber, Chief Scientist
National Park Service, Pacific West Region

GCMs generally agree that the southwest will get drier.

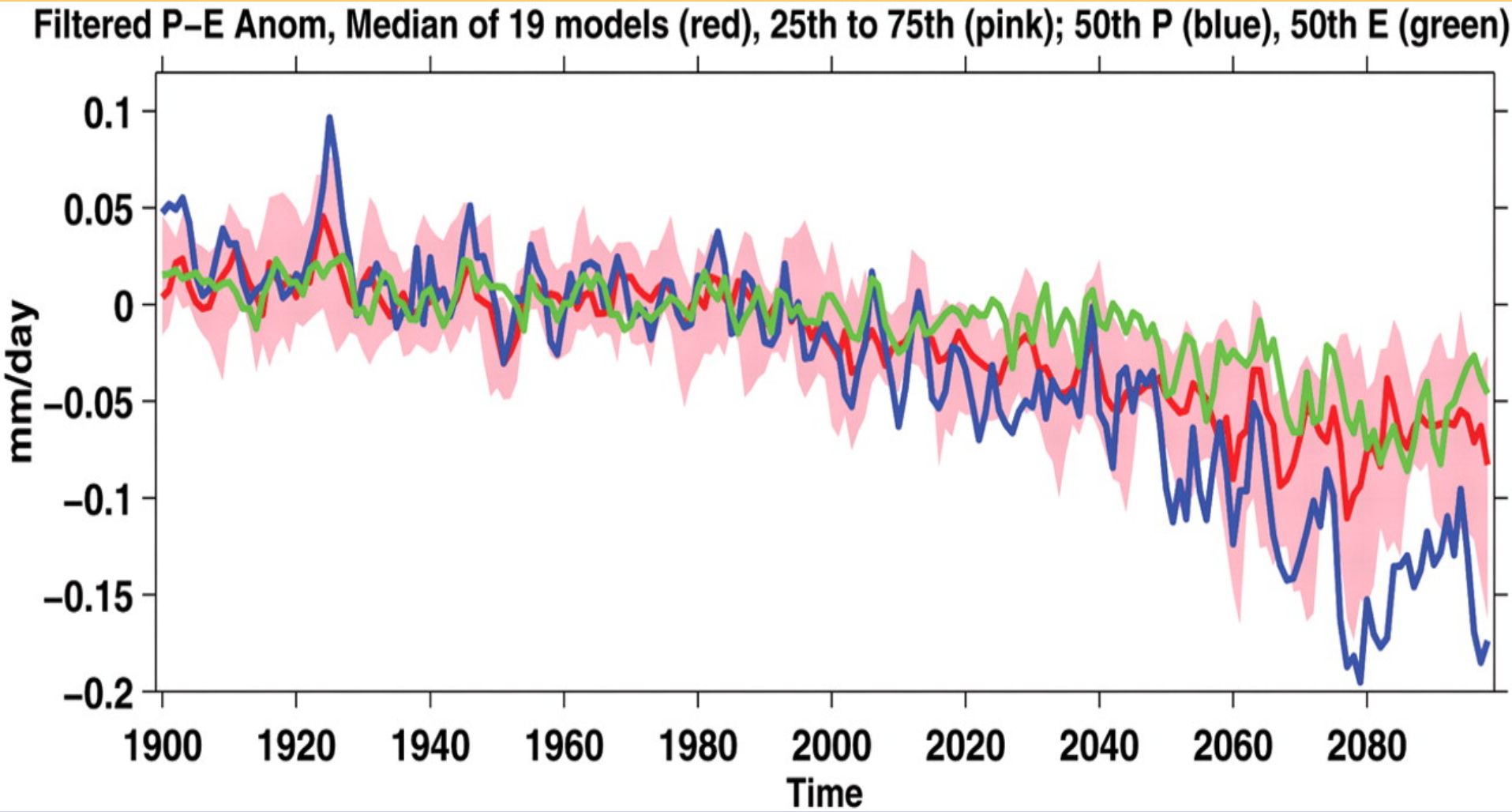


Fig. 1. Modeled changes in annual mean precipitation minus evaporation over the American Southwest (125{degrees}W to 95{degrees}W and 25{degrees}N to 40{degrees}N, land areas only), averaged over ensemble members for each of the 19 models

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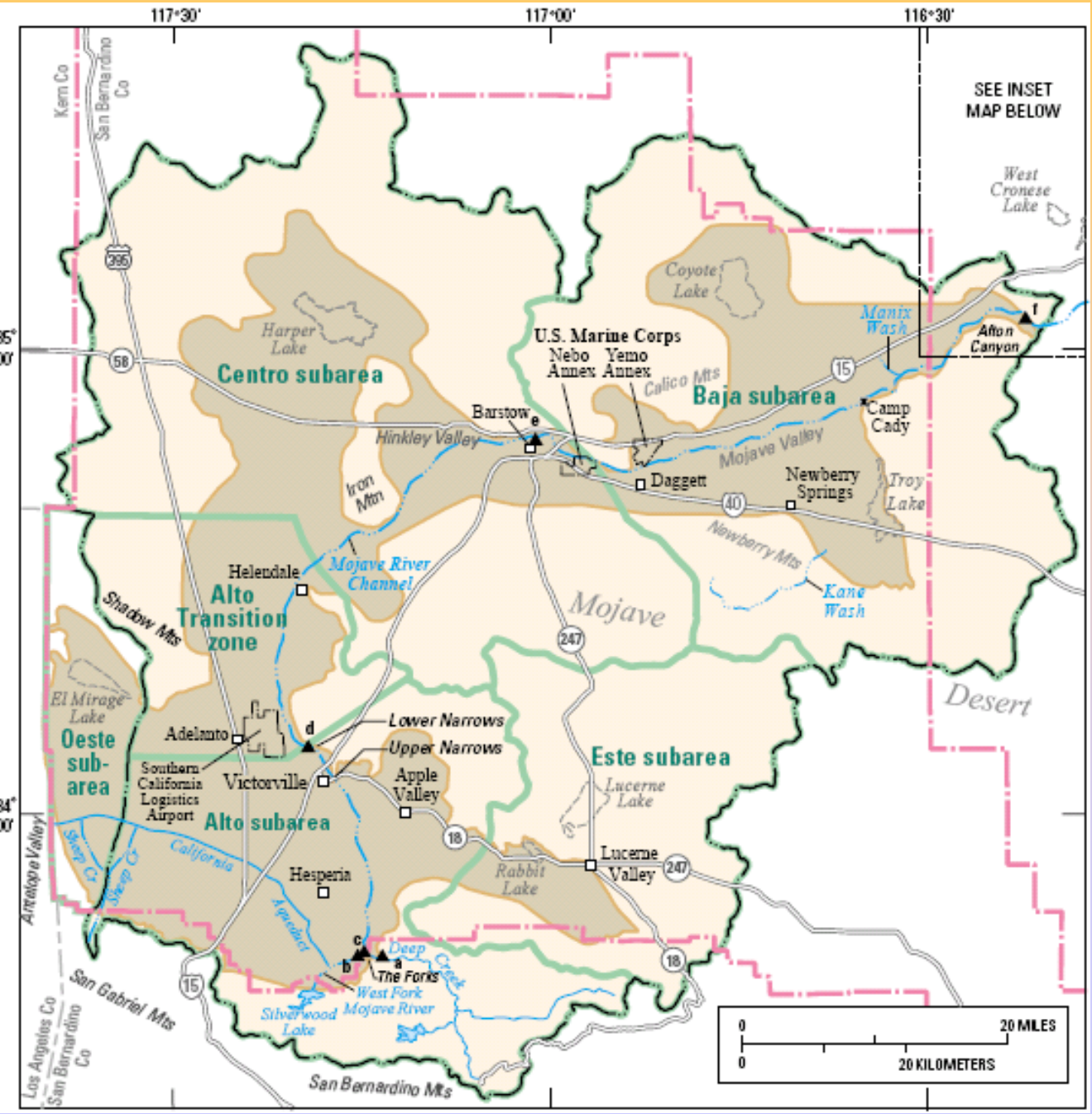
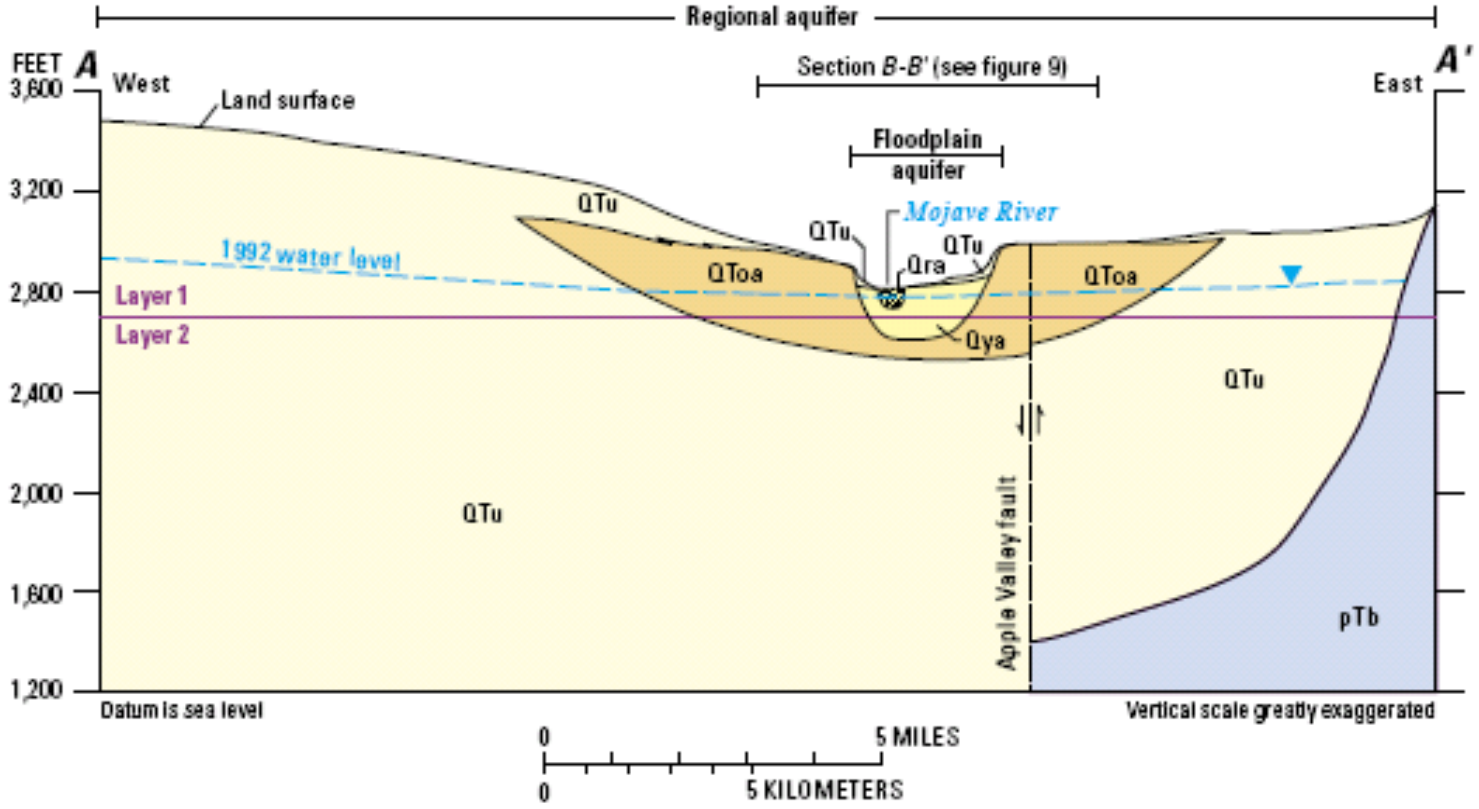
R. Seager et al., Science 316, 1181 -1184 (2007)

Science
AAAS



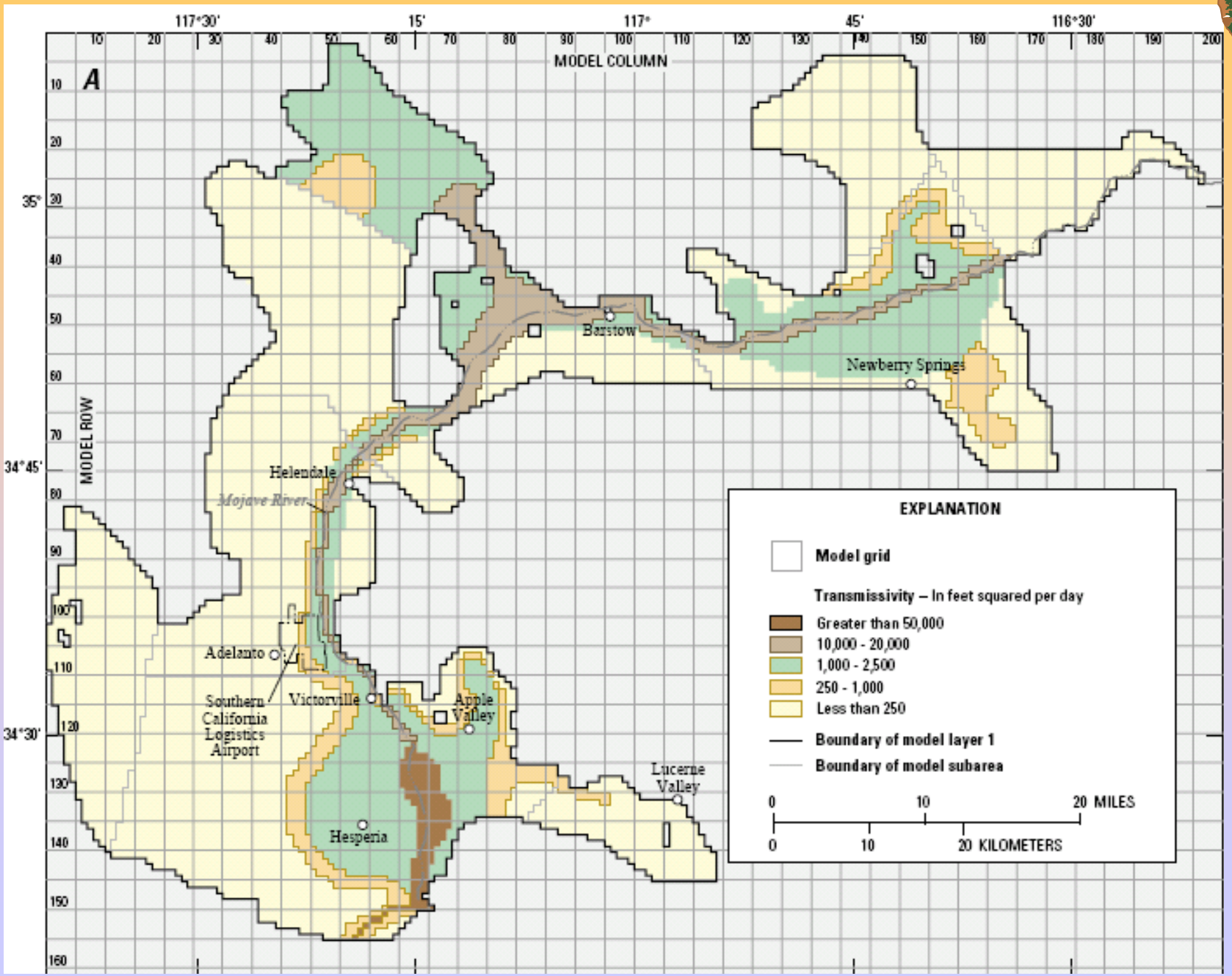
What does a drier climate mean for water resources?

- Groundwater pumping
- Litigation over distribution
- Impacts to resources managed by agencies

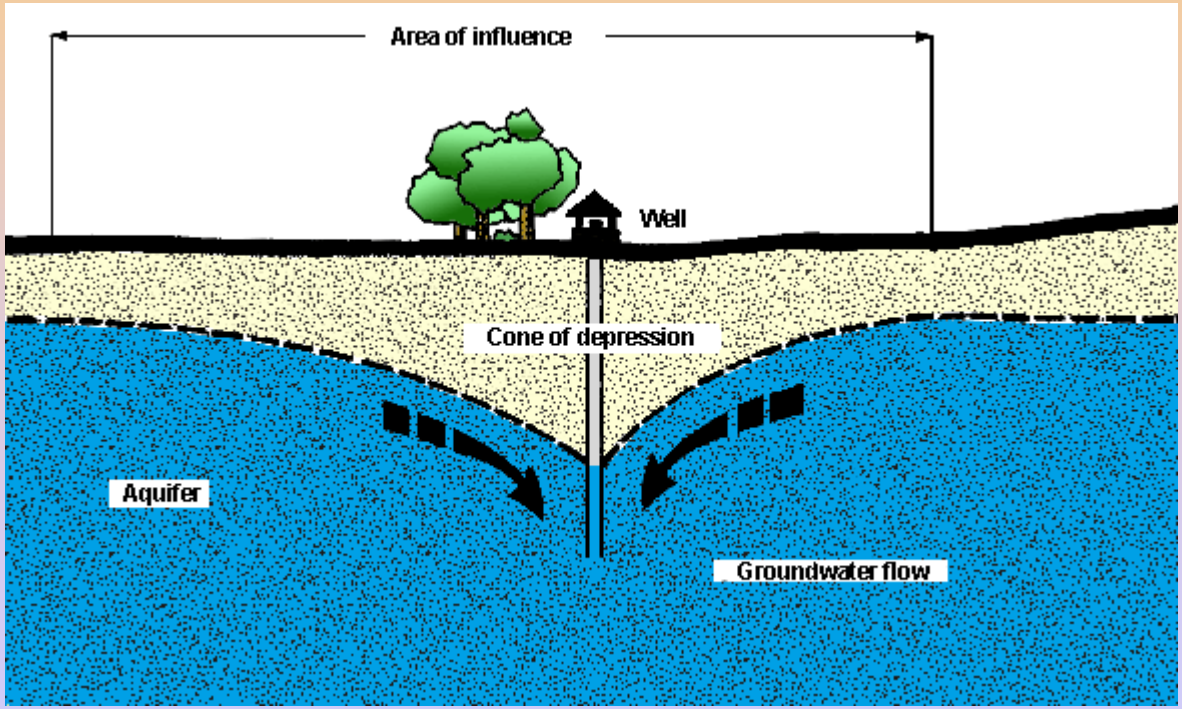


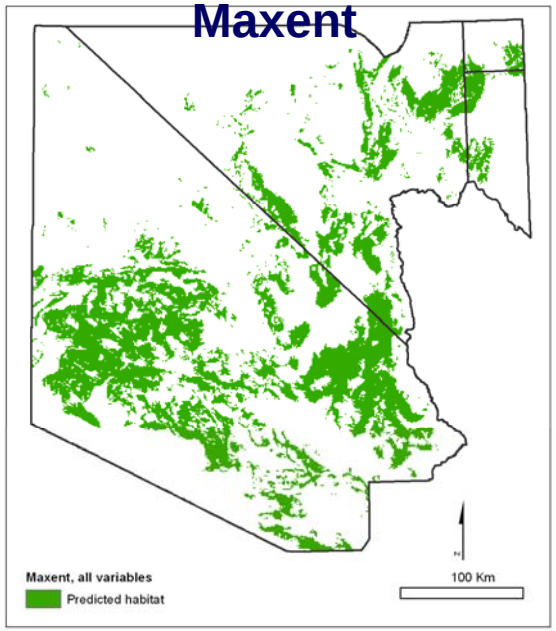
EXPLANATION

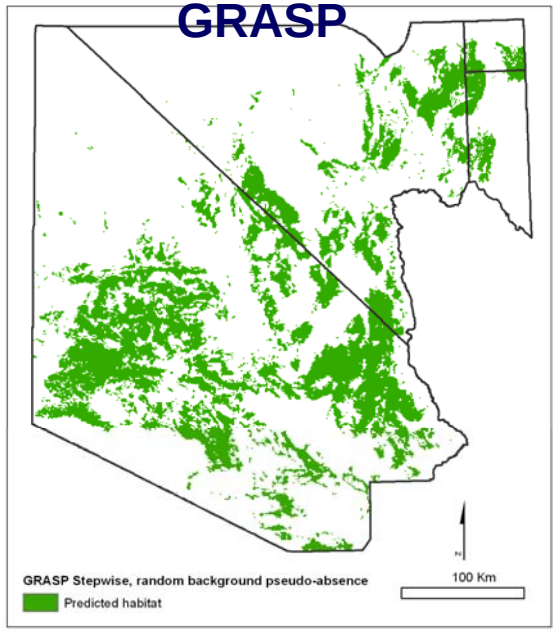
- Qra — Recent Mojave River alluvium, *Holocene* — Floodplain aquifer
- Qya — Younger Mojave River alluvium, *Holocene to Pleistocene* — Floodplain aquifer
- QTu — Undifferentiated alluvium, *Holocene to Pliocene* — Regional aquifer
- QToa — Older alluvium of ancestral Mojave River, *Pleistocene to Pliocene* — Regional aquifer
- pTb — Igneous and metamorphic basement complex, *Pre-Tertiary*

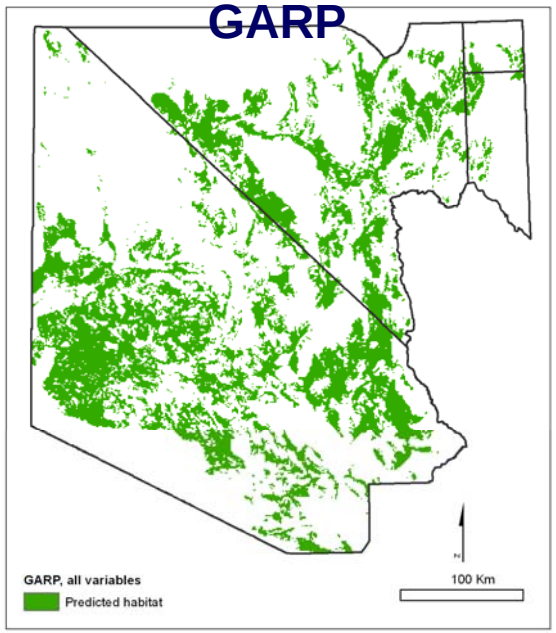

117°30'
15'
117°
45'
116°30'
MODEL COLUMN
A
MODEL ROW
35°
34°45'
34°30'
Barstow
Newberry Springs
Helendale
Mojave River
Adelanto
Southern California Logistics Airport
Victorville
Apple Valley
Lucerne Valley
Hesperia
EXPLANATION
Model grid
Transmissivity – In feet squared per day
Greater than 50,000
10,000 - 20,000
1,000 - 2,500
250 - 1,000
Less than 250
Boundary of model layer 1
Boundary of model subarea
0 10 20 MILES
0 10 20 KILOMETERS

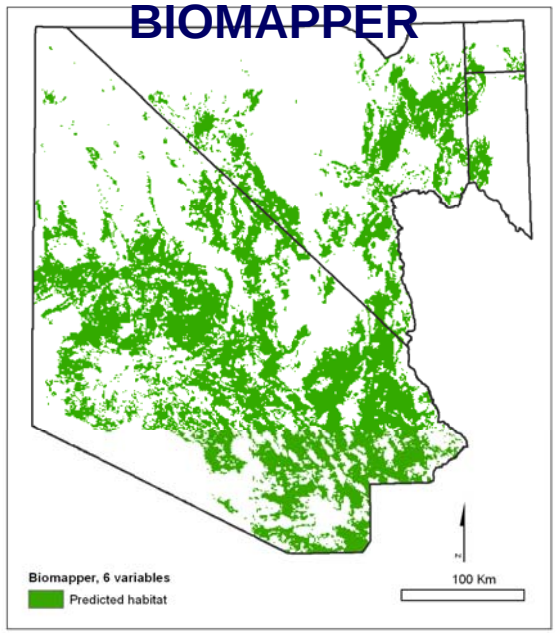
Managers could use gw flow models to identify resources at risk (e.g. runways threatened by land subsidence, springfed wetlands and vegetation threatened by over pumping) and begin early planning for management actions.





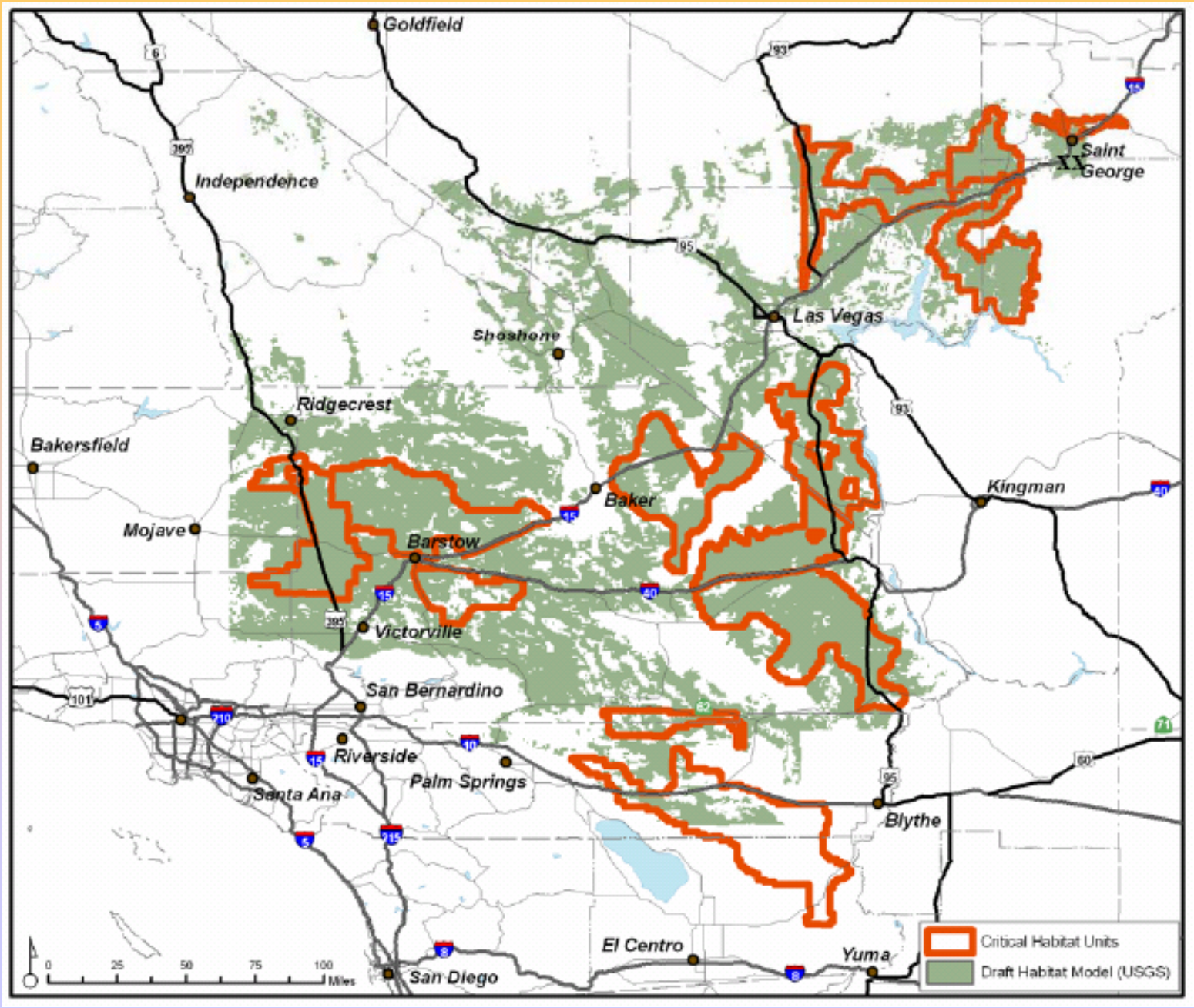






Habitat Model for desert tortoise

- Maximum Entropy
- Generalized Regression Analysis and Spatial Prediction
- Genetic Algorithm for Rule Set Production
- Ecological Niche Factor Analysis


Goldfield
Independence
Saint George
Las Vegas
Shoshone
Ridgecrest
Bakersfield
Baker
Kingman
Mojave
Barstow
Victorville
San Bernardino
Riverside
Palm Springs
Santa Ana
Blythe
El Centro
Yuma
San Diego
0 25 50 75 100 Miles
Critical Habitat Units
Draft Habitat Model (USGS)

Summary *(1 of 2)*

- Land managers must make decisions based on the best available science.
- Models integrate much of what is known about the science and the data (calibration and validation).
- Land management agencies may ignore or react to the results of models rather than use models.
- Land managers could get ahead of the curve on incipient problems and proactively deal with existing problems by using models.

Summary

Managers could use models

- for future scenario simulations
- to identify and prioritize resources at risk
- to stimulate and inform the discussion of various possible management actions