The expansion of Valley fever endemic regions in response to climate change

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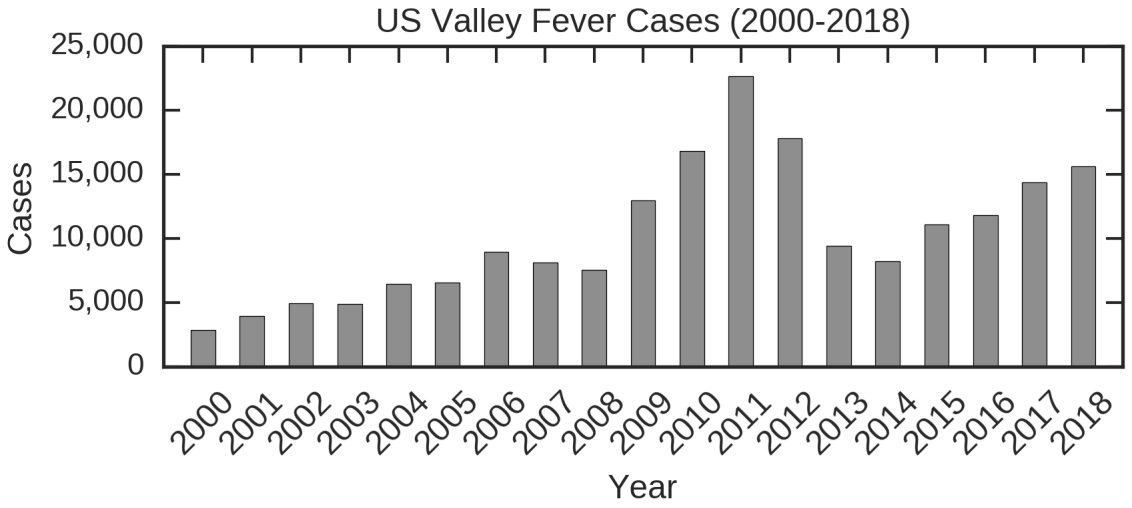
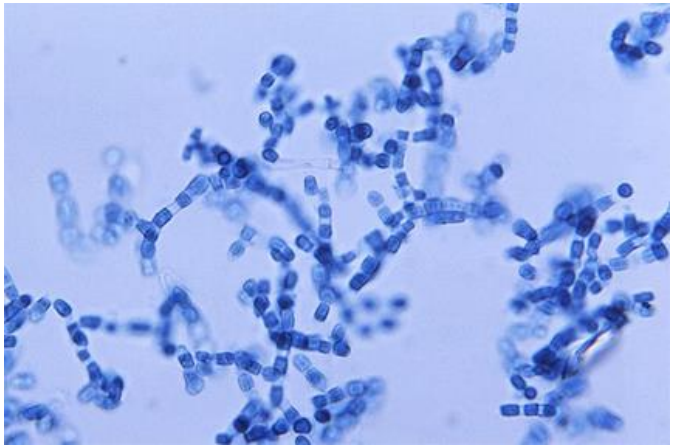
NDSEG

Valley fever

- Coccidioidomycosis
- Caused by inhaling the fungus *Coccidioides* spp. (Cocci)
- Symptoms range from flu to long term morbidity
- Is not communicable
  - Cases are a result of environmental exposure





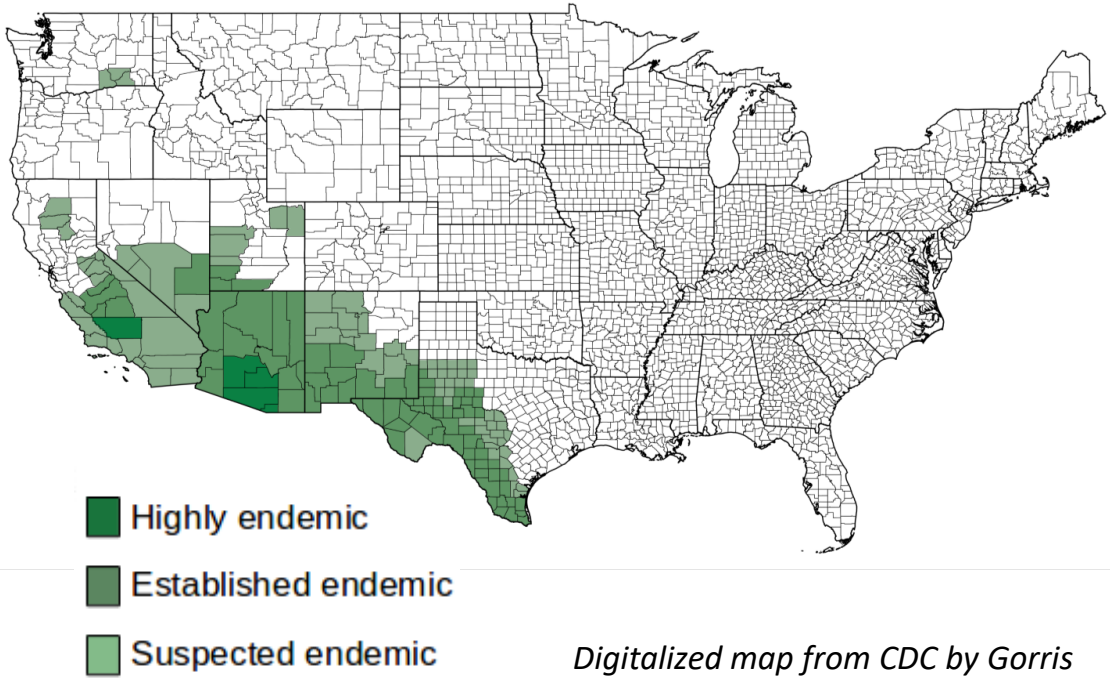
Coccidioides spp., CDC Website

Valley fever

- Found in the SW US, Central America, and South America
- Mostly limited to hot and dry areas
  - This map is 60+ years old
- Warming temperatures and shifts in rainfall driven by climate change may shift where Valley fever is endemic

CDC Valley Fever Endemicity Map

Edwards and Palmer, 1957



Digitalized map from CDC by Gorris

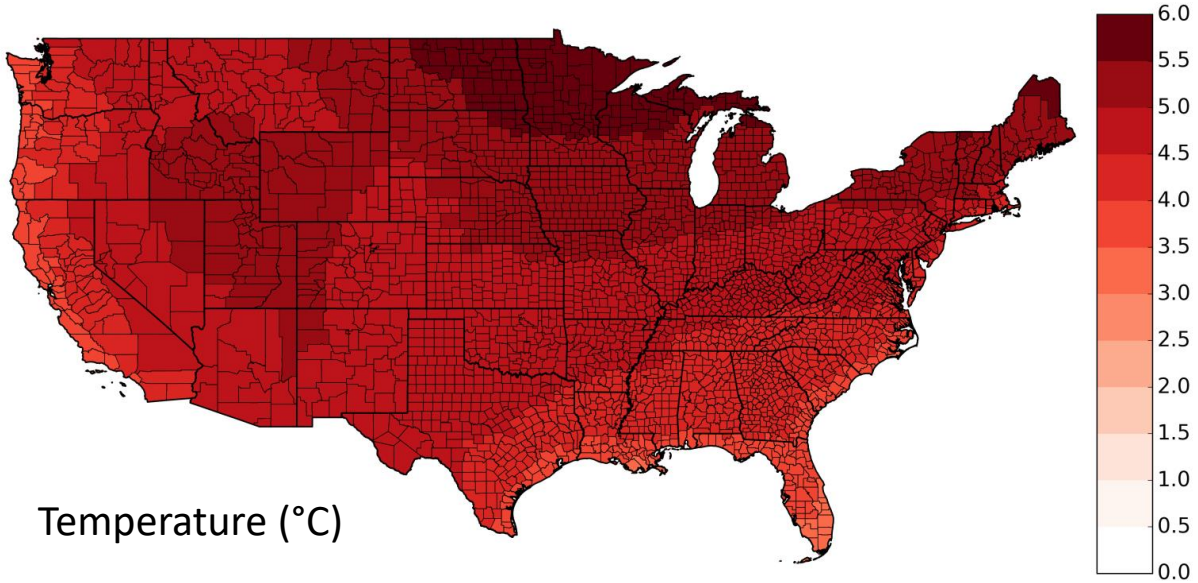
Climate Change in the US

High emissions, high warming (RCP8.5)

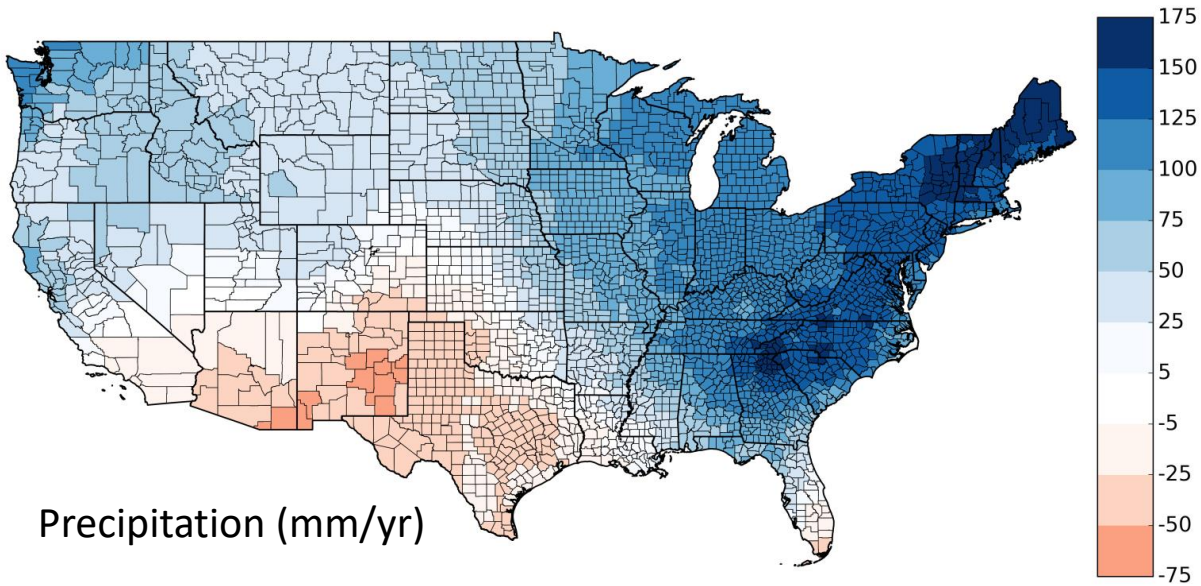
2000-2015 to 2090-2100

Mean annual temperature:
↑ 3-6°C

Mean annual precipitation:
↓75 mm/yr
↑175 mm/yr



Temperature (°C)



Precipitation (mm/yr)

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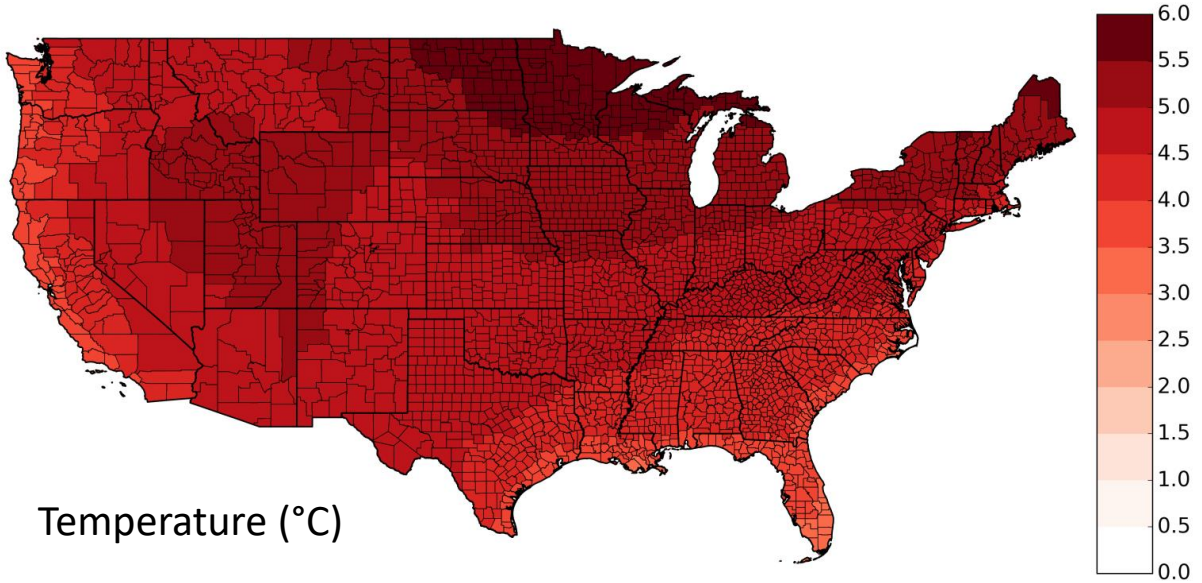
Shift the geographical range of Valley fever



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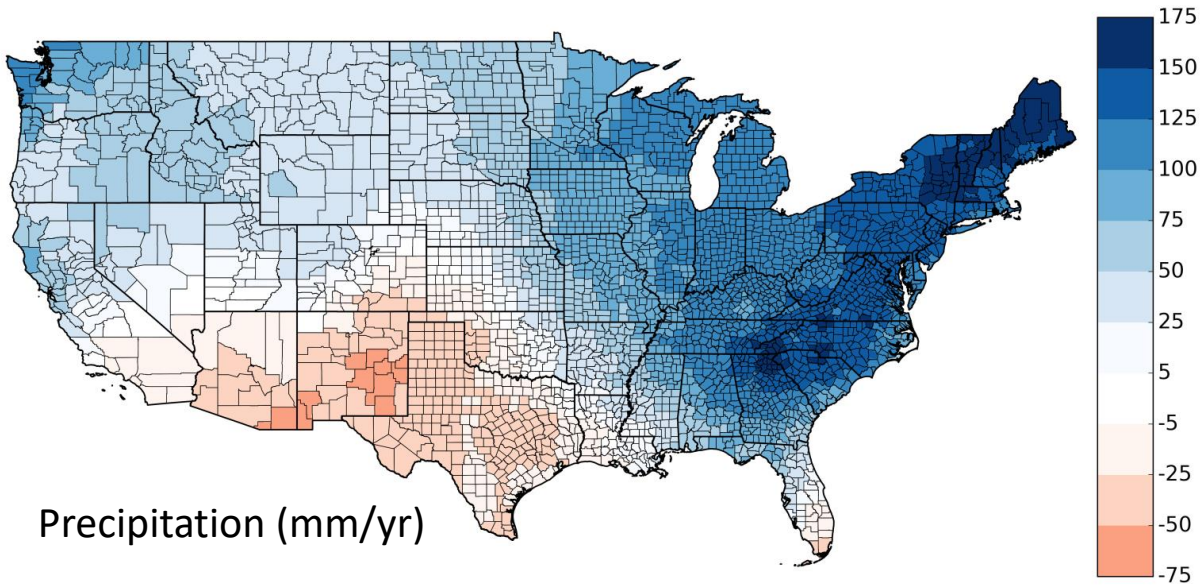

Precipitation (mm/yr)

How might climate change influence Valley fever?

1. Currently, where may Valley fever be endemic?

2. Where might Valley fever be endemic in the future?

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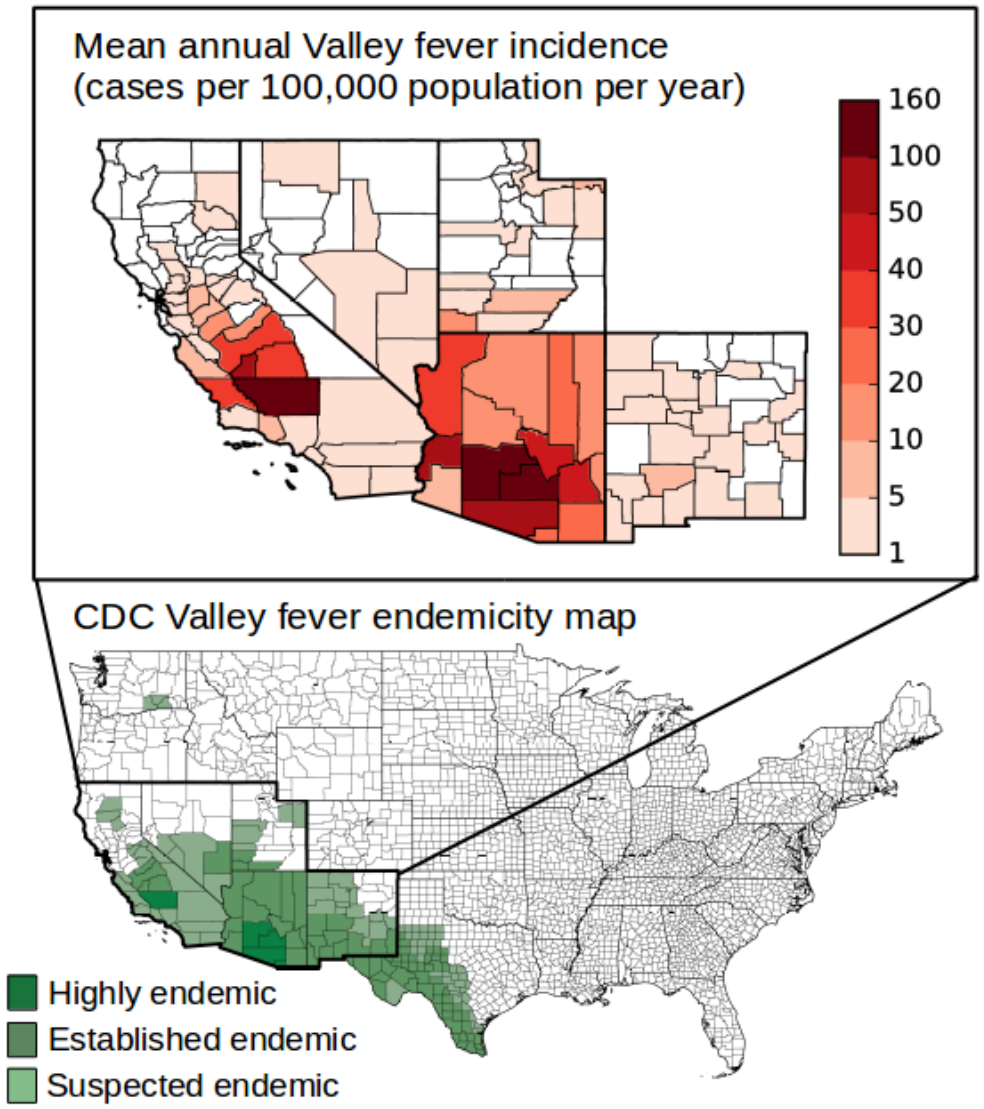
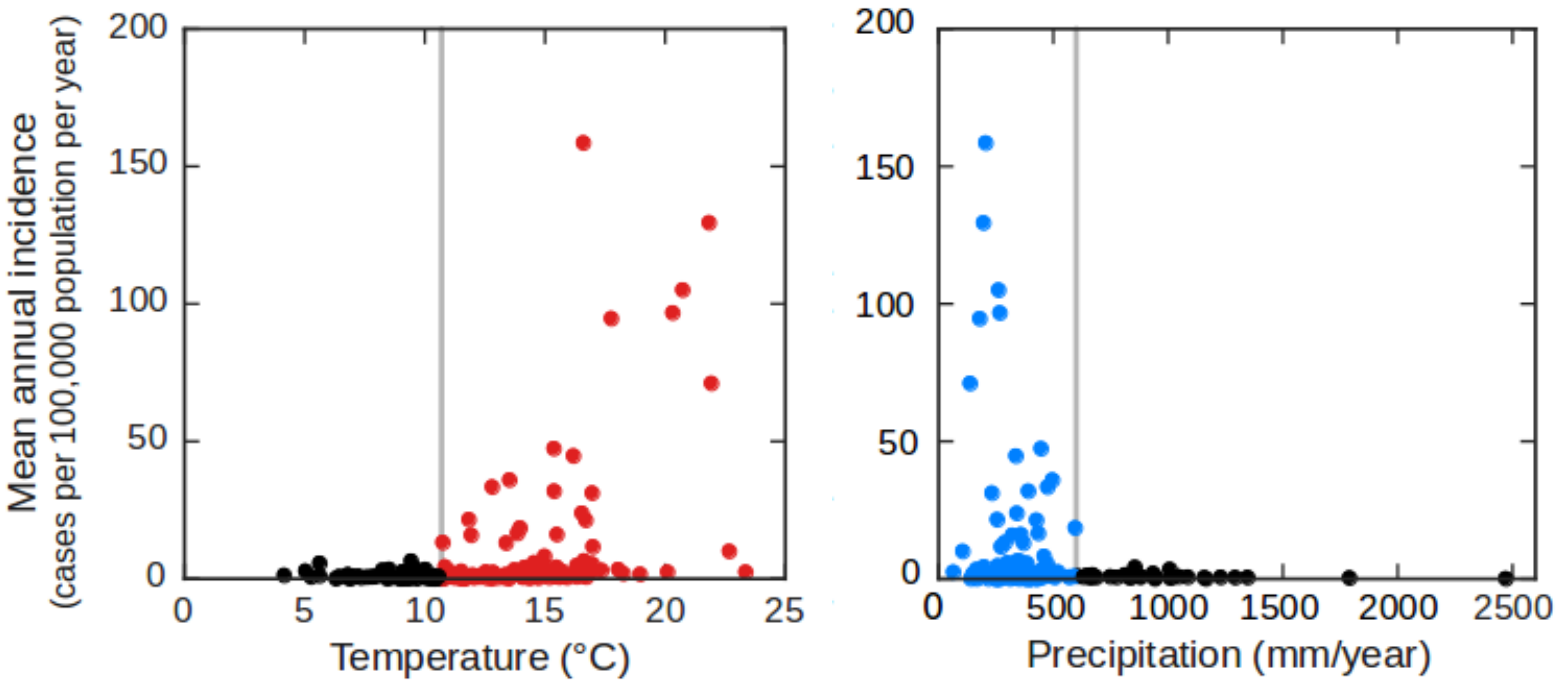
Valley fever case data

- Best way to study this disease is from case counts
- 2000-2015
- 149,286 cases
- New measure of endemicity
  - Where the disease is present
- Areas with high incidence extend further north than depicted by the CDC



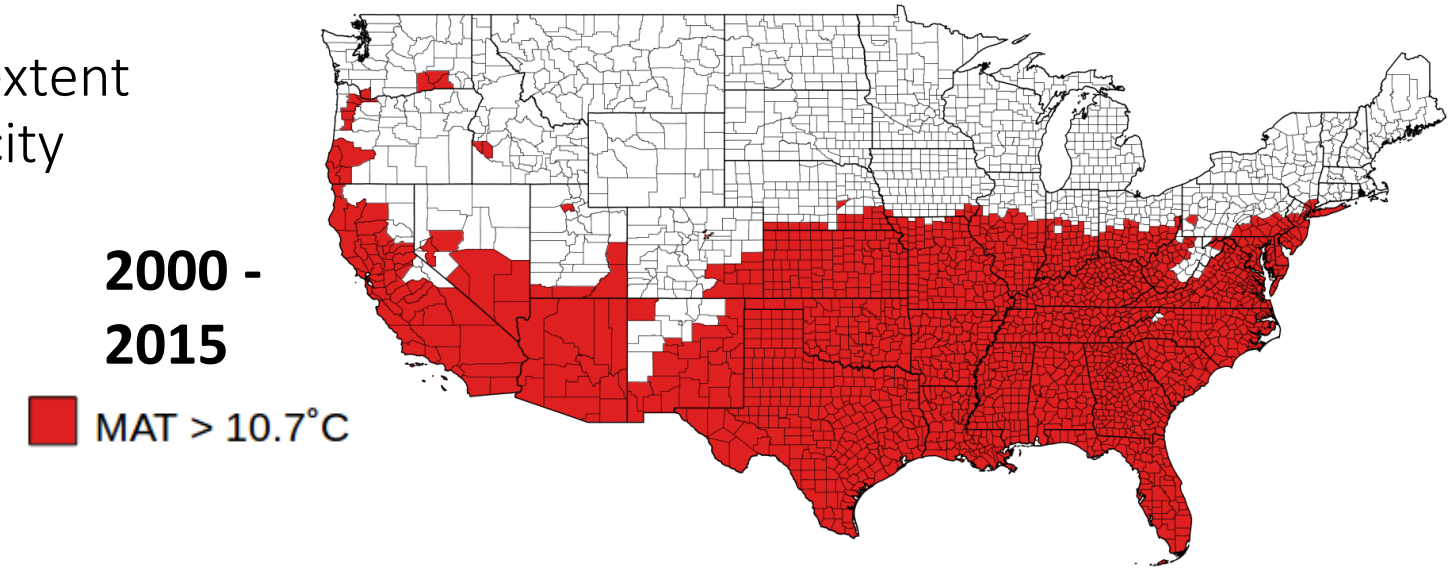
Gorris et al. 2018, GeoHealth



- Two main climate controls are temperature and precipitation
  - Non-linear positive relationship between temperature and incidence
  - Non-linear negative relationship between precipitation and incidence
- Endemicity threshold of 10 cases per 100,000 population per year
  - Mean annual temperature > 10.7°C
  - Mean annual precipitation < 600 mm/yr

Estimating the spatial extent of Valley fever endemicity

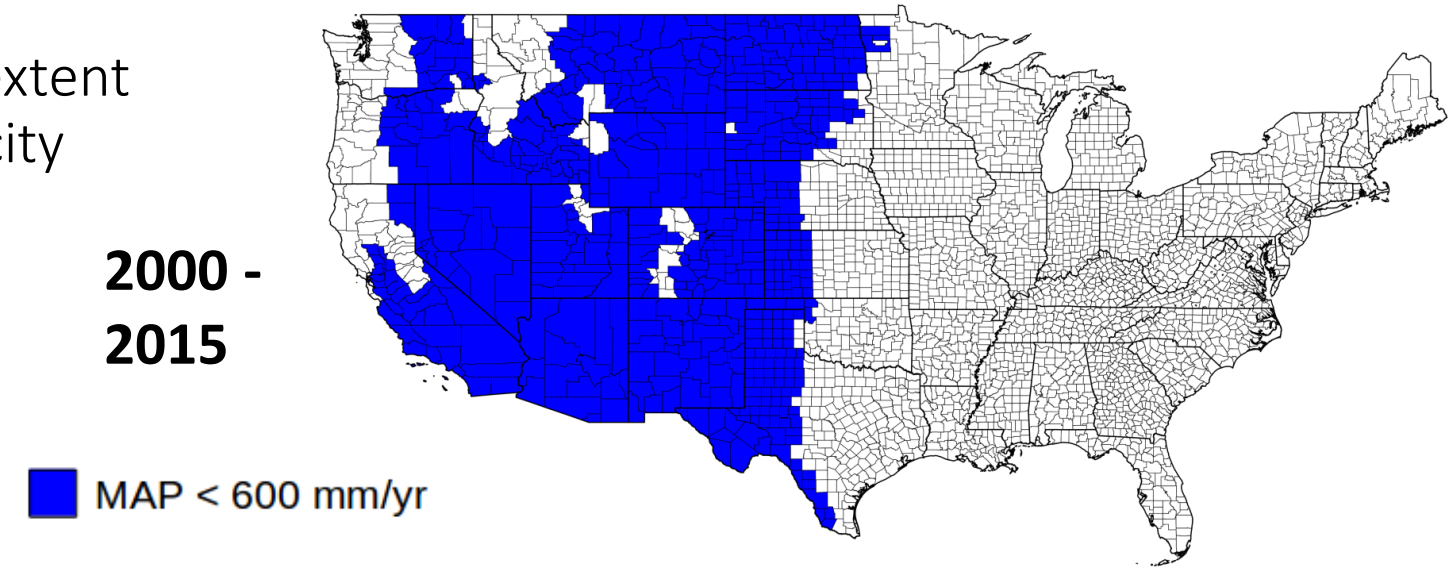
- 2000-2015 mean annual temperature threshold



Estimating the spatial extent of Valley fever endemicity

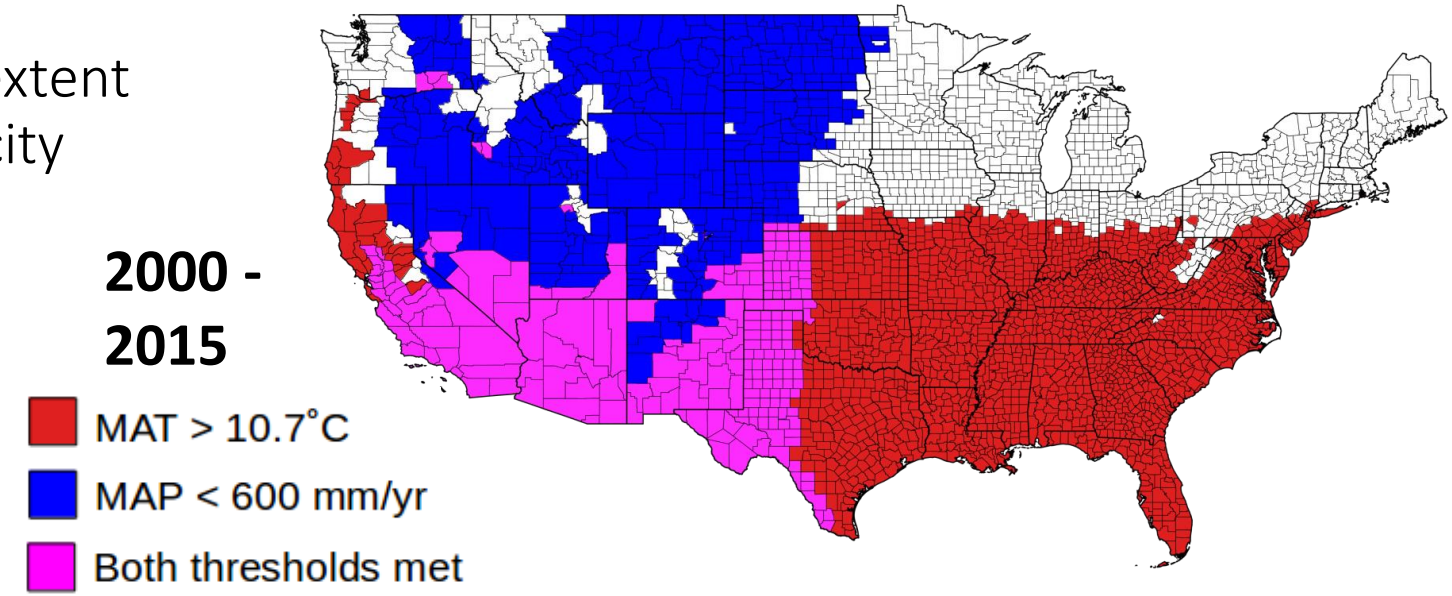
- 2000-2015 mean annual precipitation threshold

2000 - 2015



Estimating the spatial extent of Valley fever endemicity

- # counties = 217
- # states = 12
- Pop. = 51.8M

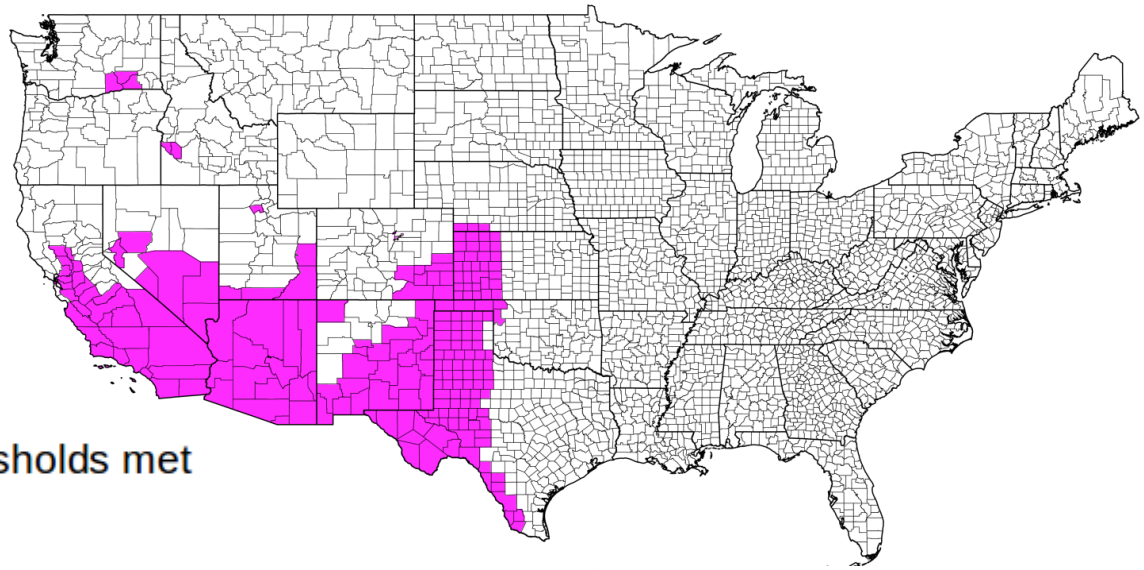


Estimating the spatial extent of Valley fever endemicity

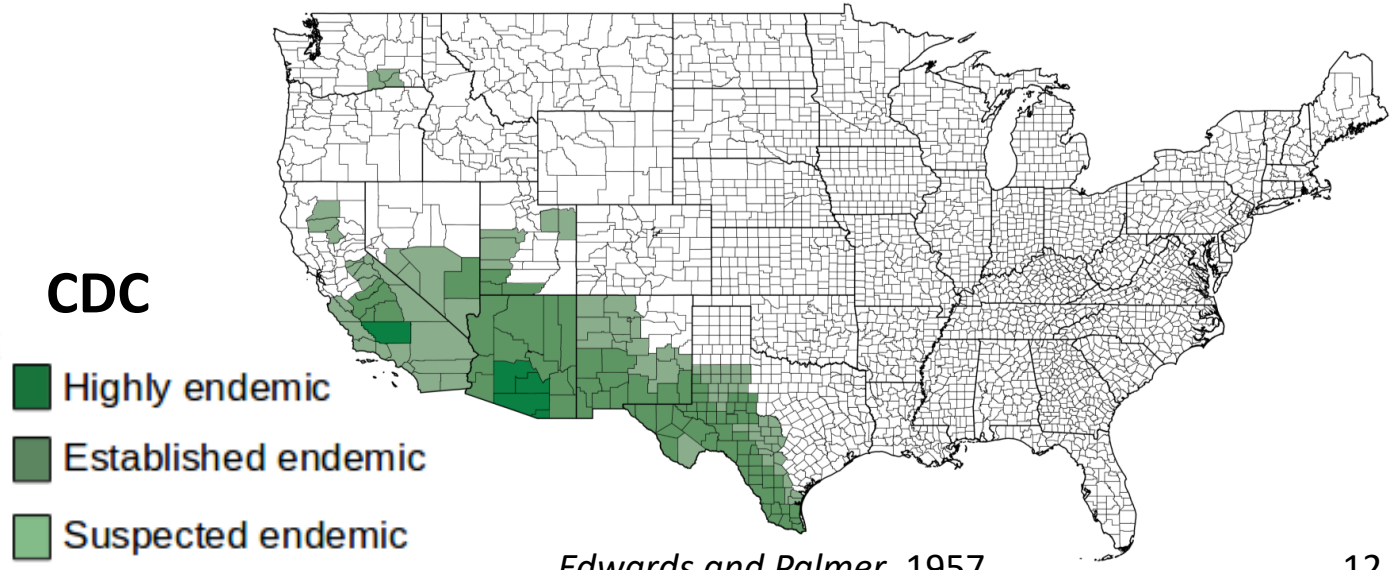
- Washington State Counties are highlighted

- Extends further north than the CDC map
  - Central Plains
  - Central Valley of California
  - Idaho, Utah

2000 - 2015



CDC



Edwards and Palmer, 1957

Gorris et al. 2019, GeoHealth

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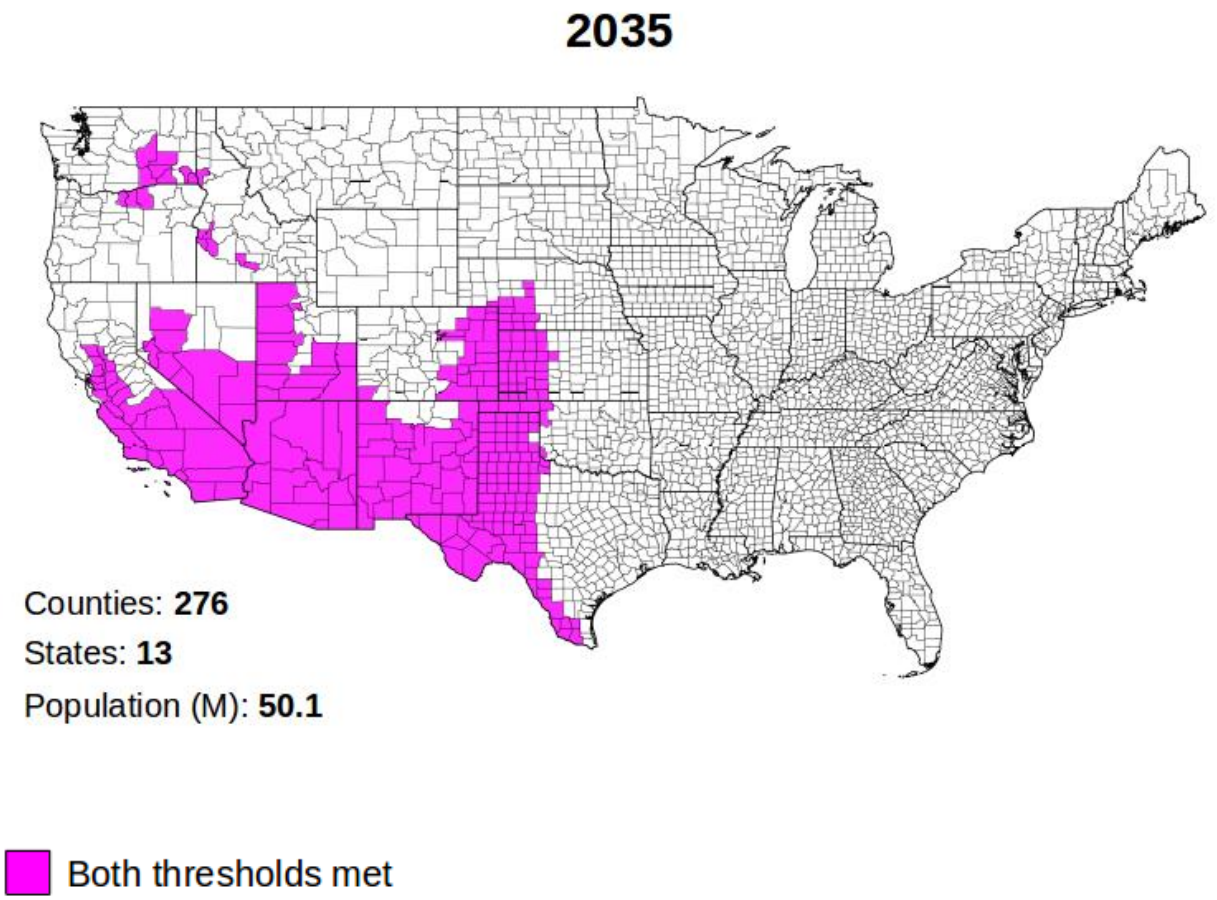
Estimating the spatial extent of Valley fever endemicity

- RCP8.5 (high climate warming)
- Valley fever endemicity travels north
  - Limited by cold Rockies and wet Pacific NW coast
- Eastward extent is suppressed by the dry line separating desert and gulf air masses



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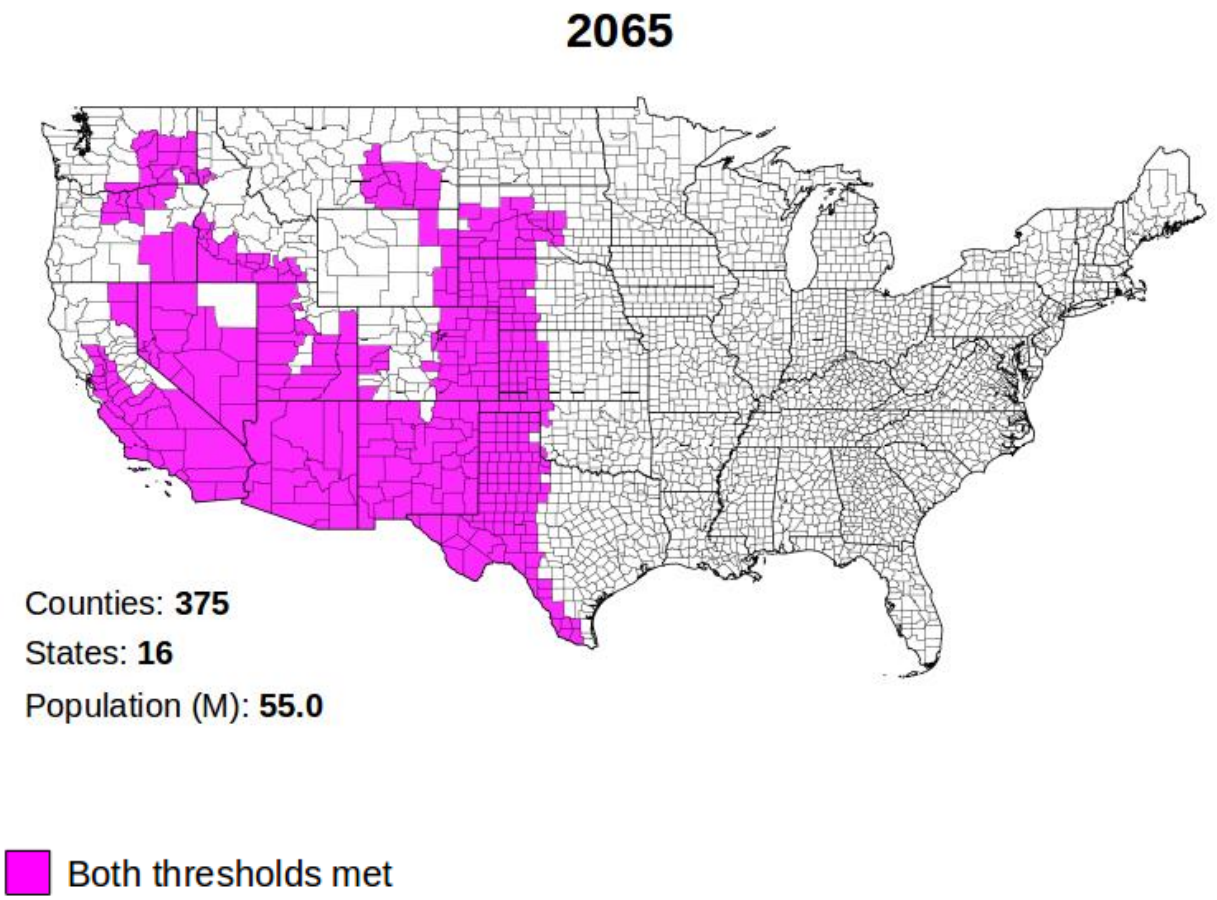

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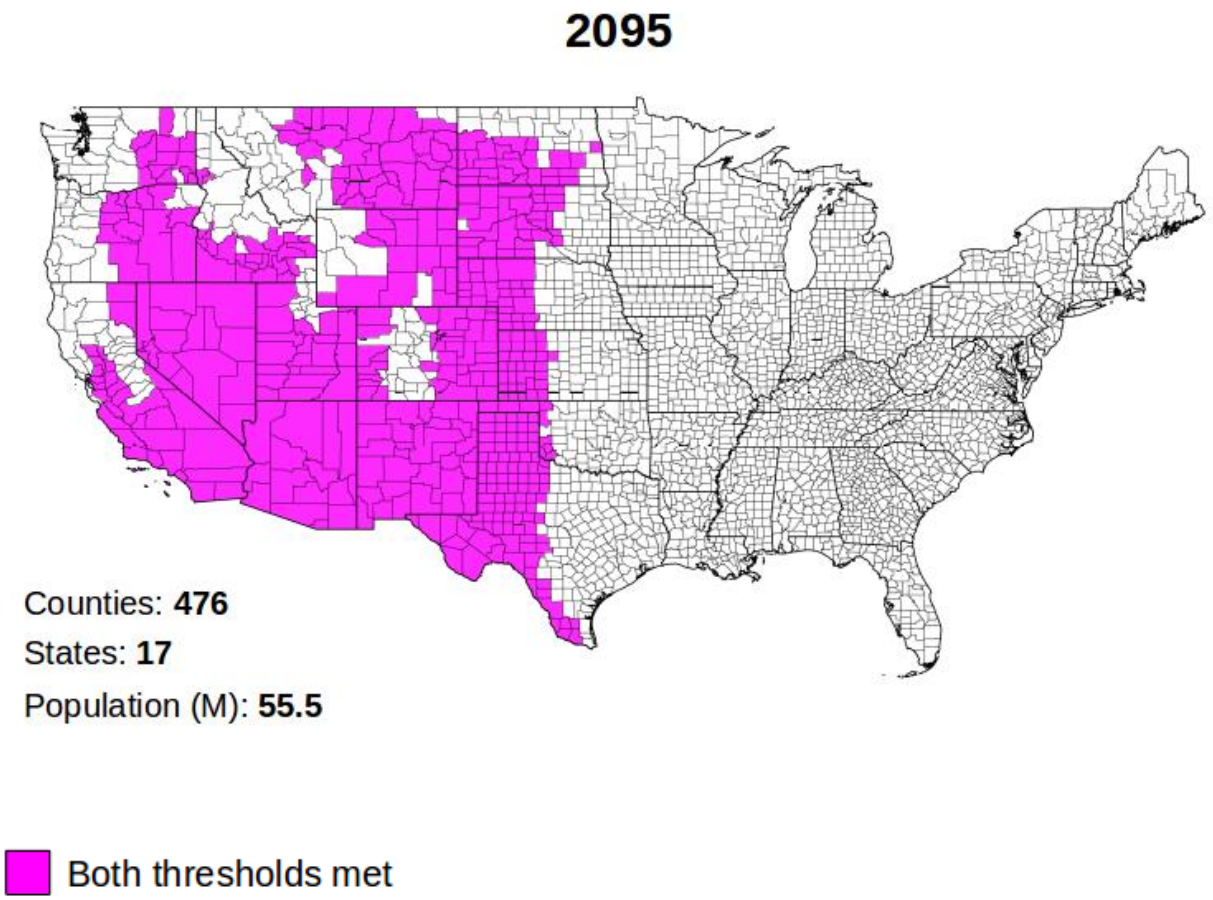

Conclusions

1. Currently, where may Valley fever be endemic?

   May extend further north than previously thought

2. Where might Valley fever be endemic in the future?

   Much of the western US; a 54% increase (217 to 476) in endemic counties for RCP8.5 climate by 2100

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Gorris et al. (2019), Expansion of coccidioidomycosis endemic regions in the United States in response to climate change, *GeoHealth,* 3, 308– 327. https://doi.org/10.1029/2019GH000209