Does Climate Control Valley Fever Incidence in California?

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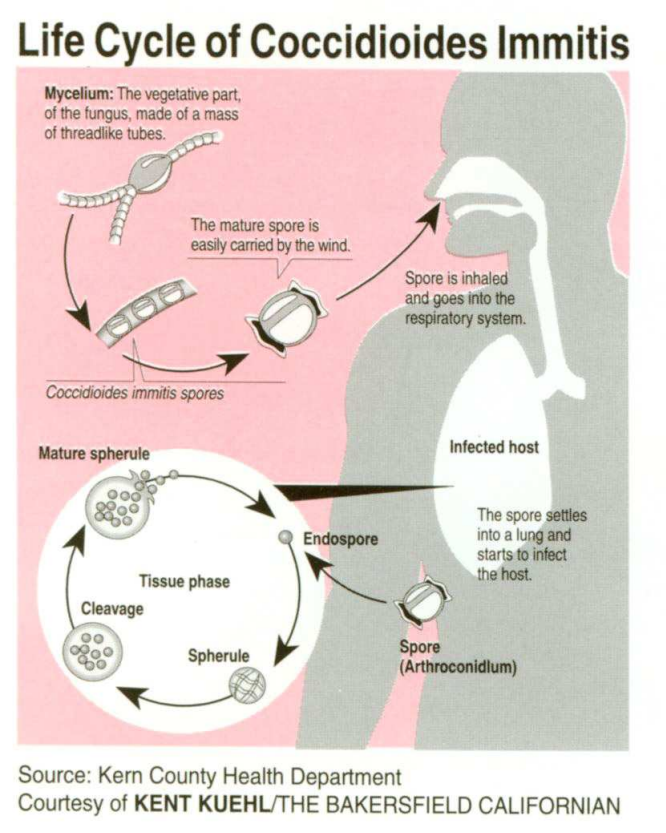

Figure 1: Lifecycle of coccidioidomycosis (Courtesy Kent Kuehl, *Bakersfield Californian*)

Valley fever (*coccidioidomycosis*, or "cocci") caused by *C. immitis*, a fungus which

- has two lifecycle phases
  - Saprophytic
  - Parasitic
- is dislodged from soils by mechanical disturbances

Multiple climate connections:

1. *C. immitis* blooms in moist conditions
2. *C. immitis* is drought-tolerant
3. VF infection vector is wind-borne dust

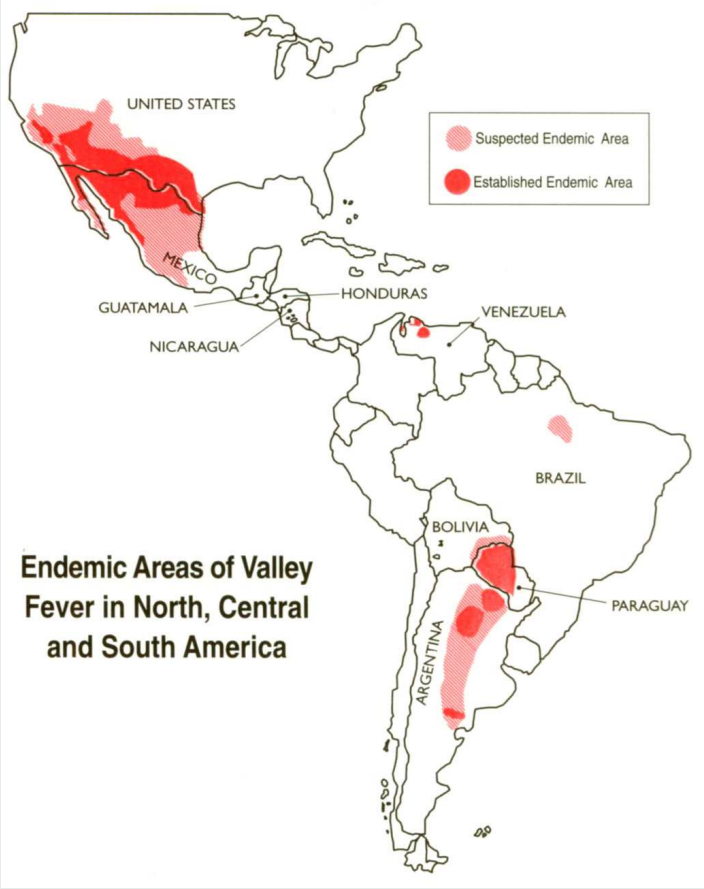

Figure 2: Endemic regions of coccidioidomycosis

Endemic regions:

- Only in the Americas
- Found, Argentina 1892
- Found, San Francisco 1894
- Isolated, San Joaquin Valley 1930s

Toll on Kern County:

- Incidence $N_0 = 500\,[\#\,\mathrm{yr}^{-1}]$, $N = 85\,[\#\,\mathrm{yr}^{-1}\,(100{,}000)^{-1}]$ (about $0.1\,\%\,\mathrm{yr}^{-1}$)
- Dissemination $\sim 5\%$
- Death $\sim 1\%$
- Economic cost $\$5$–$25\,\mathrm{M\,yr}^{-1}$ (*Pappagianis*, 1988; *Jinadu*, 1995; *Barnato et al.*, 2001)

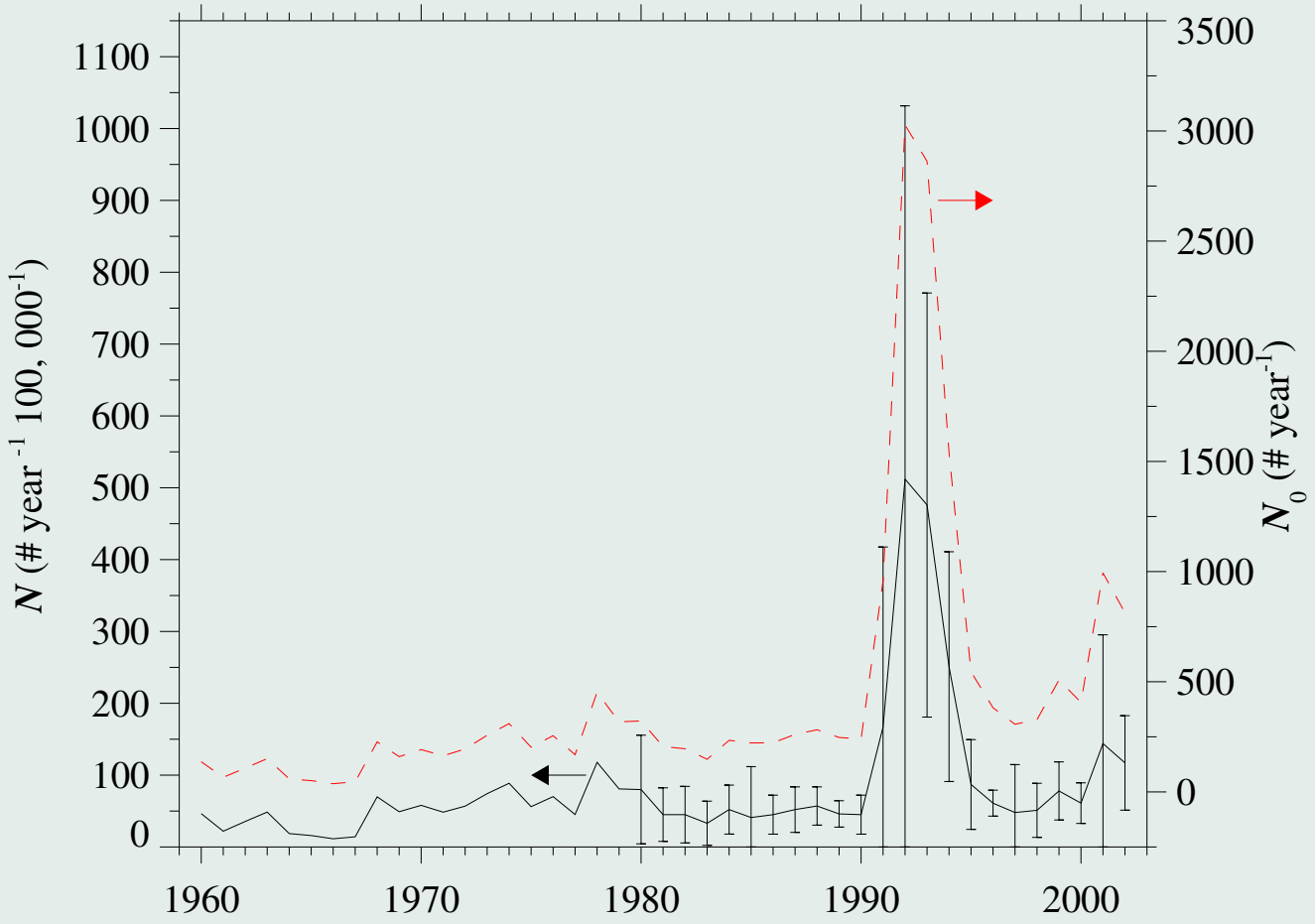

Figure 3: Annual incidence N [# yr^{-1} $(100{,}000)^{-1}$] (solid line) and total number of reported cases N_0 [# yr^{-1}] (dashed line) of valley fever in Kern County from 1960–2002 (*Zender and Talamantes*, 2006).

1. Methods

Previous studies demonstrate strong climate-incidence links in AZ:

1. *Kolivras and Comrie* (2003): Antecedent Precipitation P and surface temperature explain up to 50% incidence anomalies
2. *Komatsu et al.* (2003): Cumulative 7-month P explains up to 75% of monthly 1998–2001 incidence
3. *Comrie* (2005): Previous summer P and current PM10 explains up to 80% of 1992–2003 incidence

We examine wind, precipitation, temperature links to CA incidence:

1. Test autoregression-corrected monthly incidence anomalies for significant lag correlations with wind U, precipitation P, and temperature T anomalies (*Zender and Talamantes*, 2006)
2. Use Generalized Auto Regressive Moving Average (GARMA) technique to construct predictive models based on antecedent incidence, climate, and both (*Talamantes et al.*, 2007)

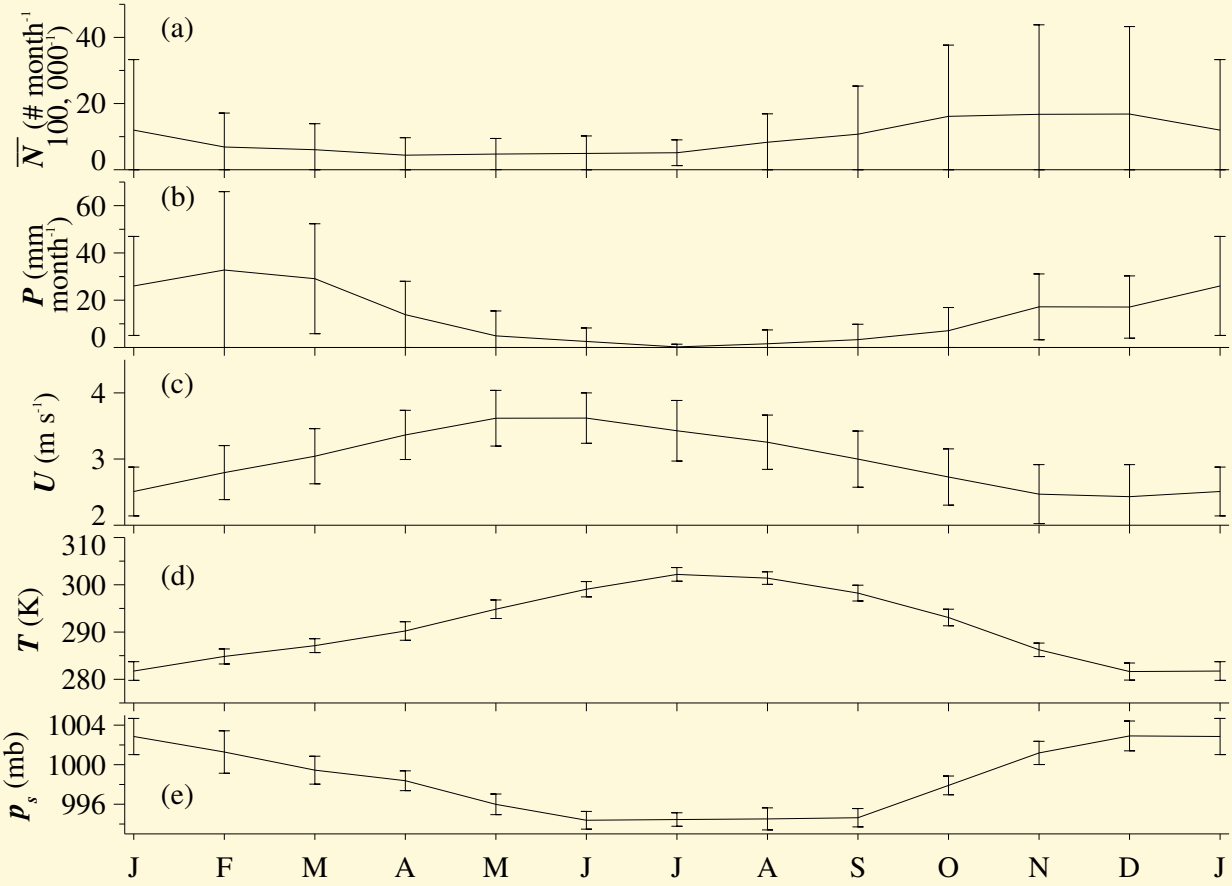

Figure 4: Annual cycle of coccidioidomycosis incidence and potential climate risk factors from 1980–2002. Shown are monthly mean (a) incidence $\bar{N}$ [# mo^{-1} (100,000)$^{-1}$] (b) precipitation $\bar{P}$ [mm mo^{-1}], (c) wind speed $\bar{U}$ [m s^{-1}], (d) surface temperature $\bar{T}_s$ [K], (e) surface pressure $\bar{p}_s$ [mb] (*Zender and Talamantes*, 2006).

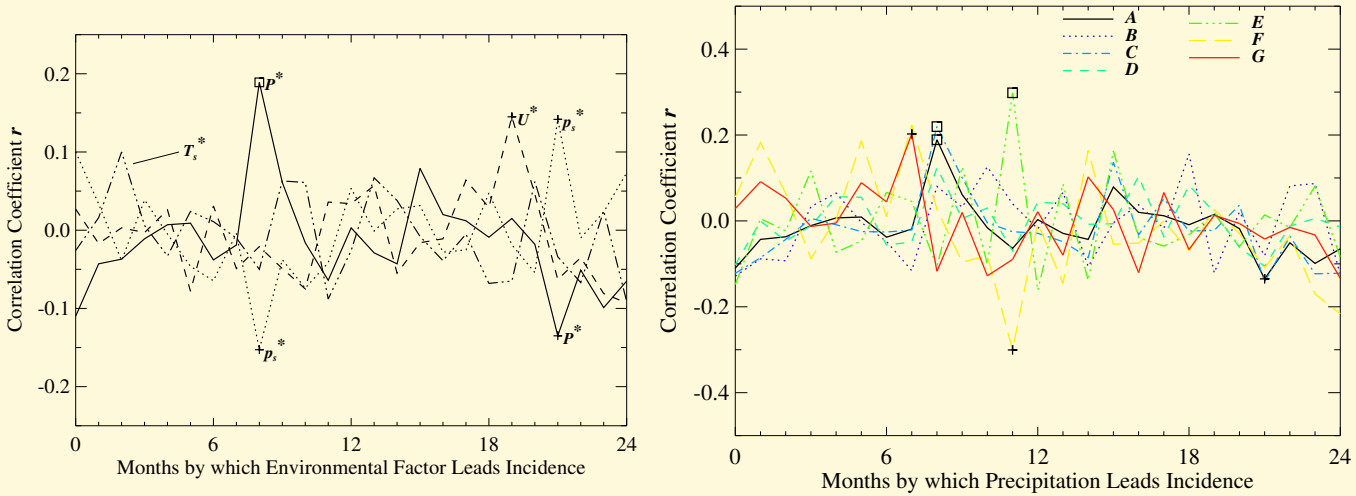

Figure 5: (a) Lag correlation coefficient r between valley fever incidence anomaly N^* and climate anomalies P^*, U^*, T_s^*, and p_s^*. Plusses (+) and squares (□) indicate confidence statistics p better than 5% and 1%, respectively. (b) Lag correlation of N^* and P^* for seven different periods bracketing the 1991-1995 epidemic (*Zender and Talamantes*, 2006).

Results:

1. Valley fever incidence is highly significantly ($p < 0.01$) correlated ($r = 0.04$) with precipitation nine months earlier (i.e., previous wet season)
2. Climate anomalies explain $< 5\%$ of VF incidence anomalies

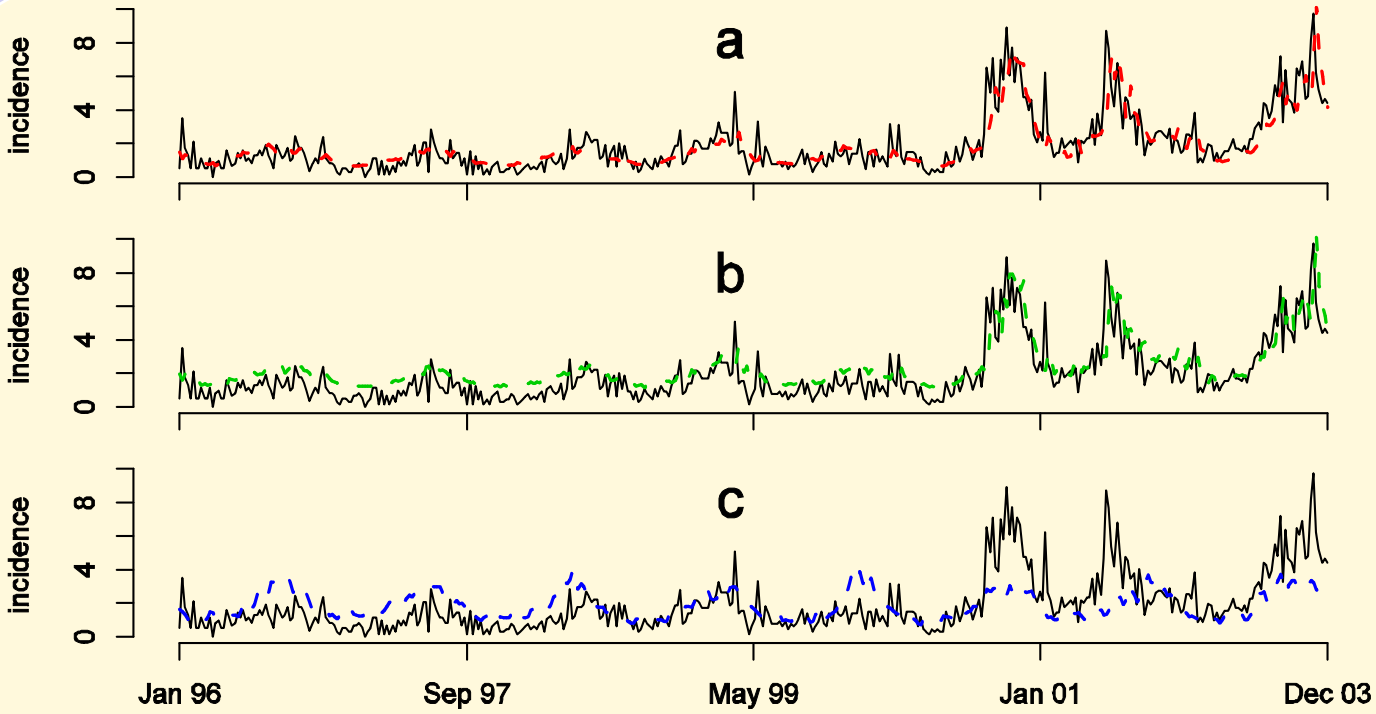

Figure 6: Reported weekly valley fever incidence (new cases per 100,000 population) in Kern County, California (solid lines) from Jan. 1996 to Dec. 2003 and three GARMA models: (a) full model, (b) prior incidence model, and (c) environmental model (*Talamantes et al.*, 2007).

1. Incidence 1, 2, 4, and 26 weeks prior skillfully predicts N
2. Prior weather adds negligible skill to VF prediction

2. Conclusions

Kern County California valley fever results:

- Climate does not (directly) control VF in Kern County
- Valley fever incidence is highly significantly ($p < 0.01$) correlated with previous wet season precipitation
- Climate anomalies explain $< 5\%$ of VF incidence anomalies
- Prior incidence is best known VF predictor

Attribution of Kern County VF anomalies:

- 1991-1995 epidemic and 2001–present surge consistent with non-climatic causes, e.g., anthropogenic activities such as excavation

Future Work:

- Examine other predictors (e.g., PM10, cumulative rainfall)
- Apply techniques to understand AZ/CA differences

3. References

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