

# Does Climate Control Valley Fever Incidence in California?

Charlie Zender<sup>1</sup>, Jorge Talamantes<sup>2</sup>, and Sam Behseta<sup>3</sup>

<sup>1</sup>Department of Earth System Science, University of California, Irvine

<sup>2</sup>Department of Physics and Geology, California State University, Bakersfield

<sup>3</sup>Department of Mathematics, California State University, Bakersfield

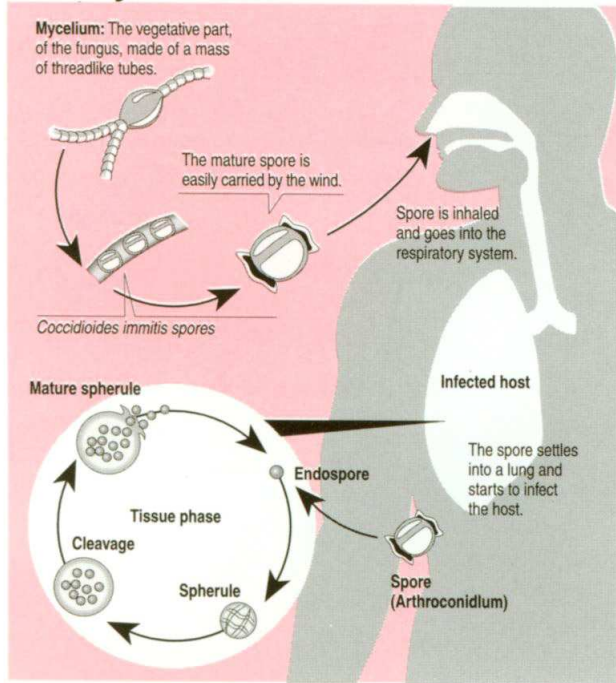
Contributions from:

F. Beltran (CSUB), E. Chaput (KCDPH), K. Emery (KCDPH),  
T. Larwood, R. Reynolds (USGS), S. Sebesta (CDHS), U. Urbina (CSUB)

Presented to: American Meteorological Society 2007 Annual Meeting, San Antonio TX

(Web: [http://dust.ess.uci.edu/smn/smn\\_ccd\\_ams\\_200701.pdf](http://dust.ess.uci.edu/smn/smn_ccd_ams_200701.pdf))

# Life Cycle of *Coccidioides Immitis*



Source: Kern County Health Department  
Courtesy of **KENT KUEHL**/THE BAKERSFIELD CALIFORNIAN

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

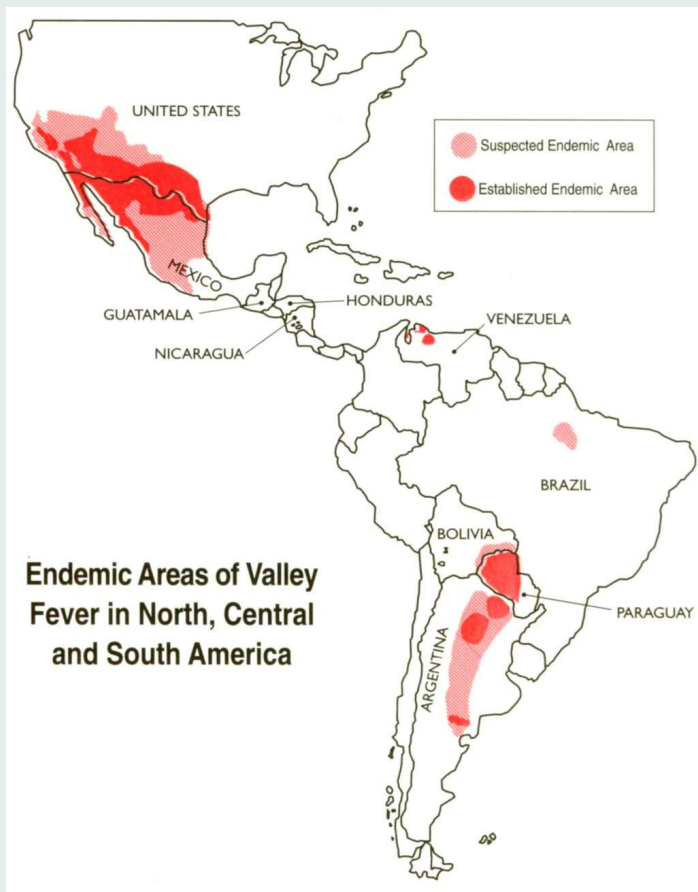


Figure 2: Endemic regions of coccidioidomycosis

## Endemic regions:

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

## Toll on Kern County:

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

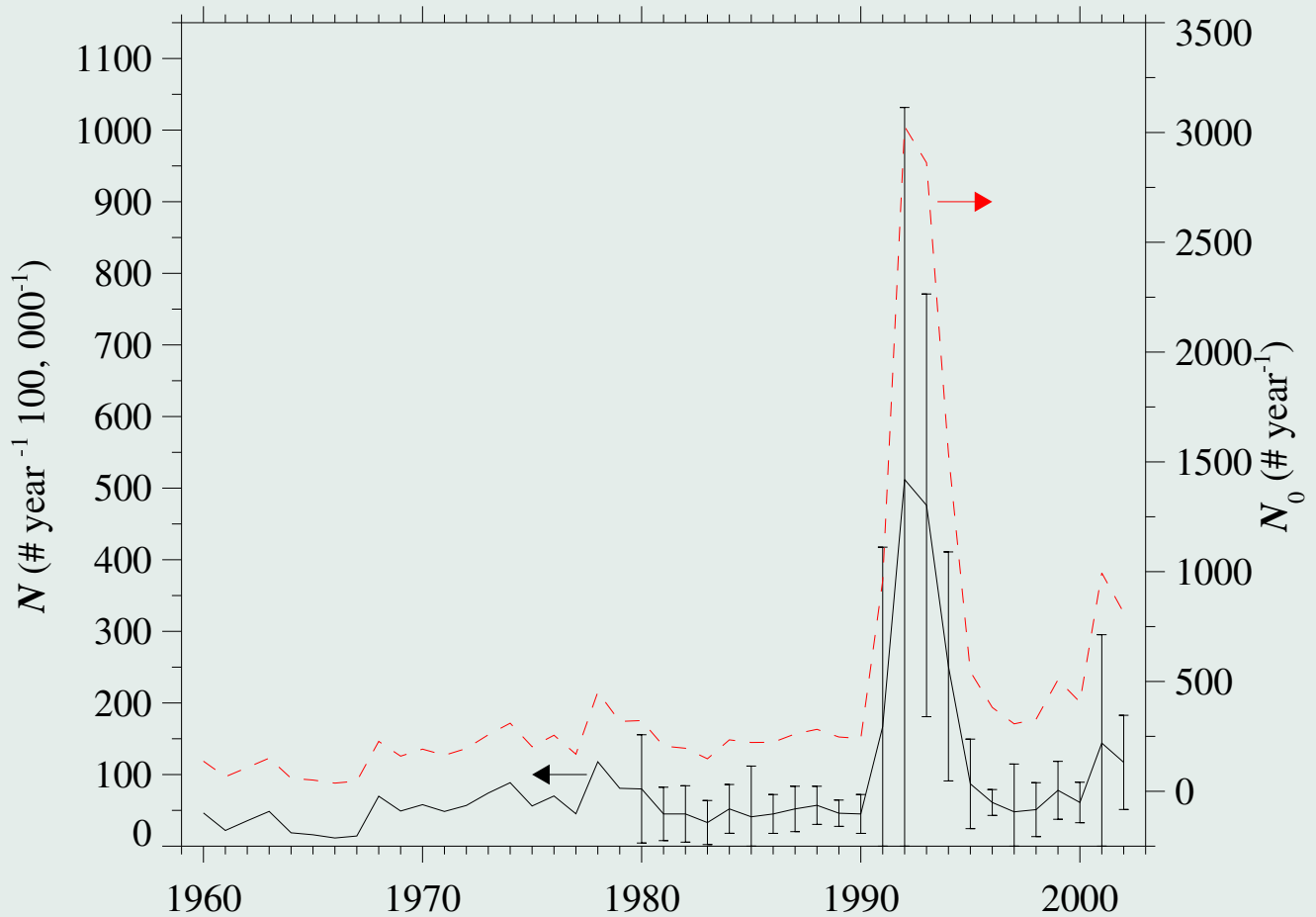


Figure 3: Annual incidence  $N$  [ $\# \text{ yr}^{-1} (100,000)^{-1}$ ] (solid line) and total number of reported cases  $N_0$  [ $\# \text{ yr}^{-1}$ ] (dashed line) of valley fever in Kern County from 1960–2002 (*Zender and Talamantes, 2006*).

## 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*)

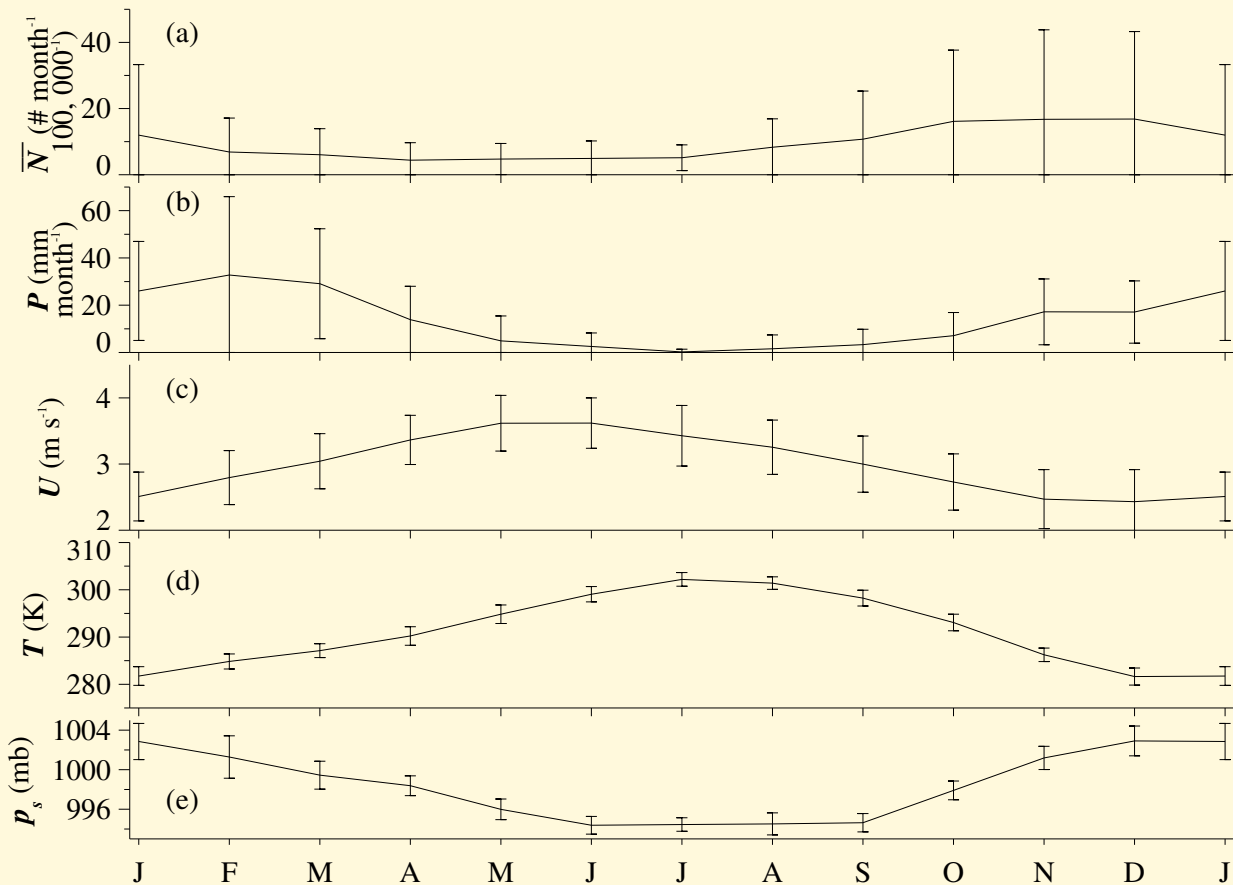


Figure 4: Annual cycle of coccidioidomycosis incidence and potential climate risk factors from 1980–2002. Shown are monthly mean (a) incidence  $\bar{N}$  [# mo<sup>-1</sup> (100,000)<sup>-1</sup>] (b) precipitation  $\bar{P}$  [mm mo<sup>-1</sup>], (c) wind speed  $\bar{U}$  [m s<sup>-1</sup>], (d)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

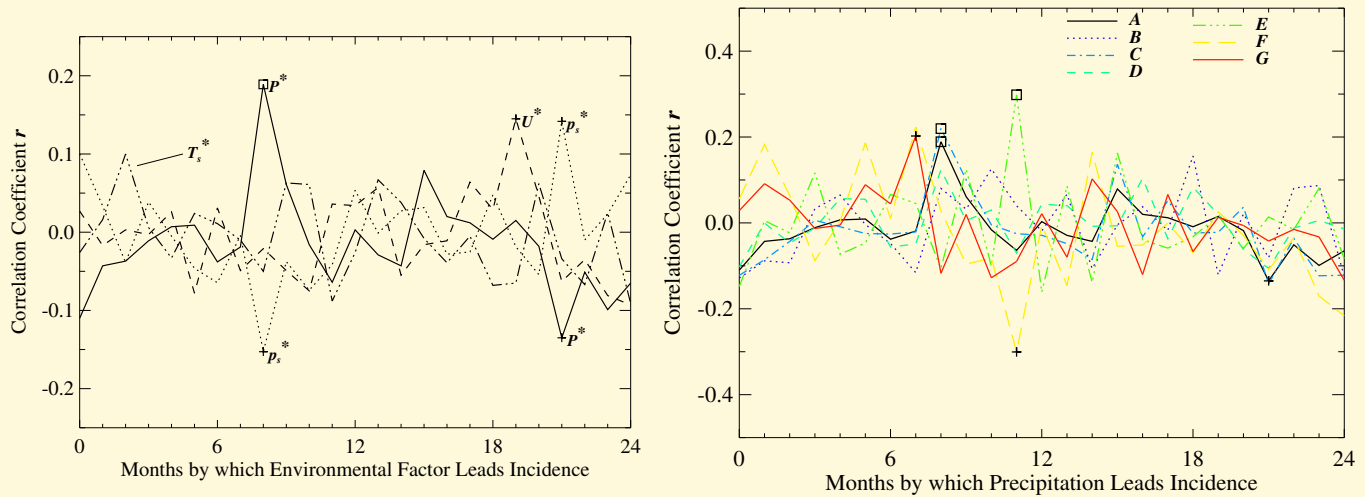


Figure 5: (a) Lag correlation coefficient  $r$  between valley fever incidence anomaly  $N^*$  and climate anomalies  $P^*$ ,  $U^*$ ,  $T_s^*$ , and  $p_s^*$ . Pluses (+) and squares ( $\square$ ) indicate confidence statistics  $p$  better than 5% and 1%, respectively. (b) Lag correlation of  $N^*$  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

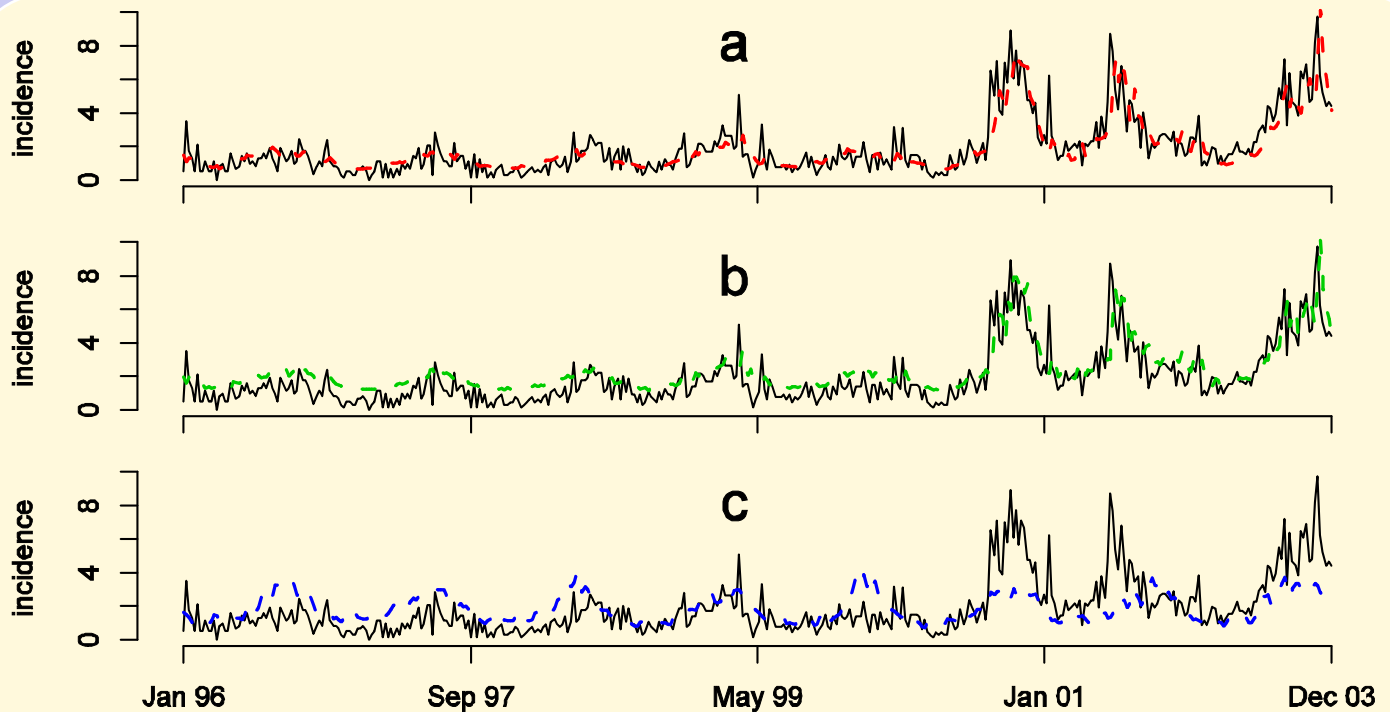


Figure 6: Reported weekly valley fever incidence (new cases per 100,000 population) in Kern County, California (solid lines) from Jan. 1996 to Dec. 2003 and three GARMA models: (a) full model, (b) prior incidence model, and (c) environmental model (*Talamantes et al.*, 2007).

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

#### References

- Barnato, A. E., G. D. Sanders, and D. K. Owens (2001), Cost-effectiveness of a potential vaccine for *Coccidioides immitis*, *Emerging Infectious Diseases*, 7(5), 797–806.
- Comrie, A. C. (2005), Climate factors influencing Coccidioidomycosis seasonality and outbreaks, *Environmental Health Perspectives*, 113(6), 688–692, doi:10.1289/ehp.7786.
- Jinadu, B. A. (1995), Valley Fever Task Force report on the control of *Coccidioides immitis*, *Tech. rep.*, Kern County Health Department, Bakersfield, CA.
- Kolivras, K. N., and A. C. Comrie (2003), Modeling valley fever (coccidioidomycosis) incidence on the basis of climate conditions, *Int. J. Biometeorol.*, 47, 87–101, doi:10.1007/s00,484–002–0155–x.

- Komatsu, K., et al. (2003), Increase in coccidioidomycosis — Arizona, 1998–2001, *Morbidity and Mortality Weekly Report*, 52(6), 109–112.
- Pappagianis, D. (1988), Epidemiology of coccidioidomycosis, in *Current topics in medical mycology*, vol. 2, edited by M. McGinnis, pp. 199–238, Springer Verlag, New York, New York.
- Talamantes, J., S. Behseta, and C. S. Zender (2007), Statistical modeling of valley fever data in Kern County, California, *In Press in Int. J. Biometeorol.*
- Zender, C. S., and J. Talamantes (2006), Environmental factors controlling valley fever incidence in Kern County, California, *Int. J. Biometeorol.*, 50(3), 174–182, doi:10.1007/s00,484–005–0007–6.