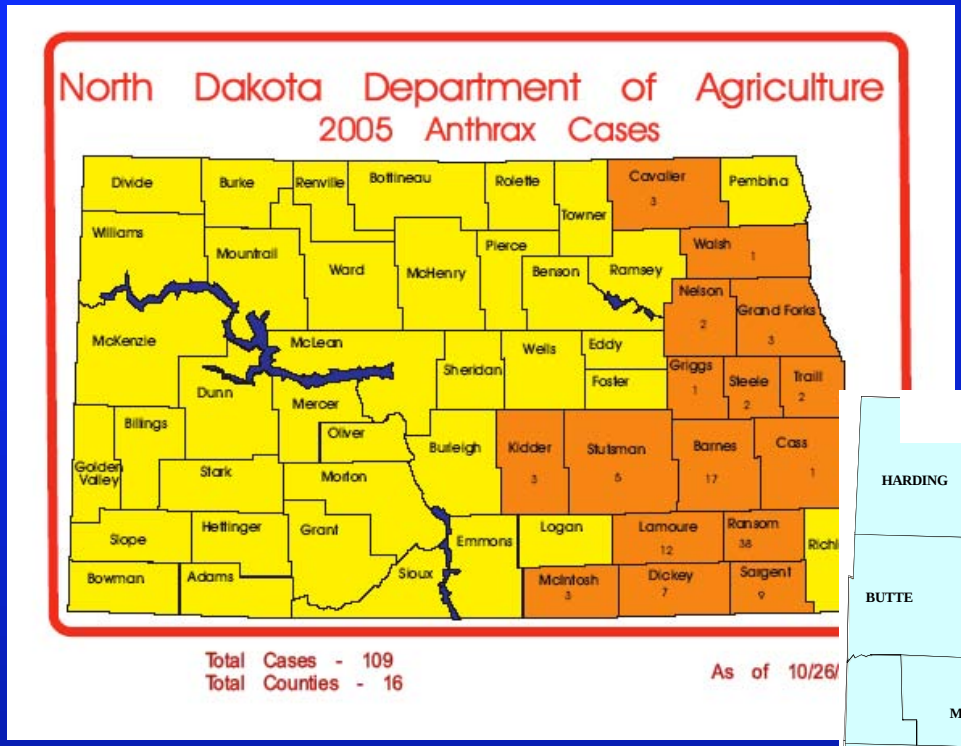
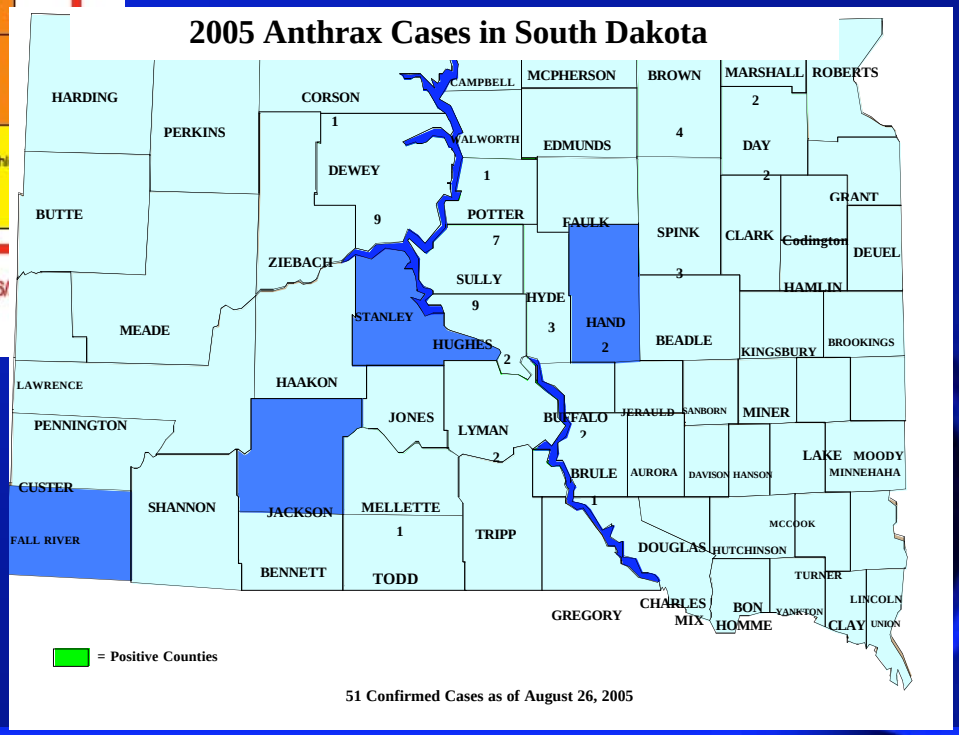
Utilizing predictive models to evaluate the distribution & ecology of *Bacillus anthracis* in North America and Central Asia

Jason K. Blackburn, Yerlan Pazilov, Larissa Luknova, Yerlan Sansyzbayev, David Rogers, & Martin Hugh-Jones

WHY USE GIS AND PREDICTIVE MODELING FOR DISEASES?

All too often ONLY county-level mapping is done.



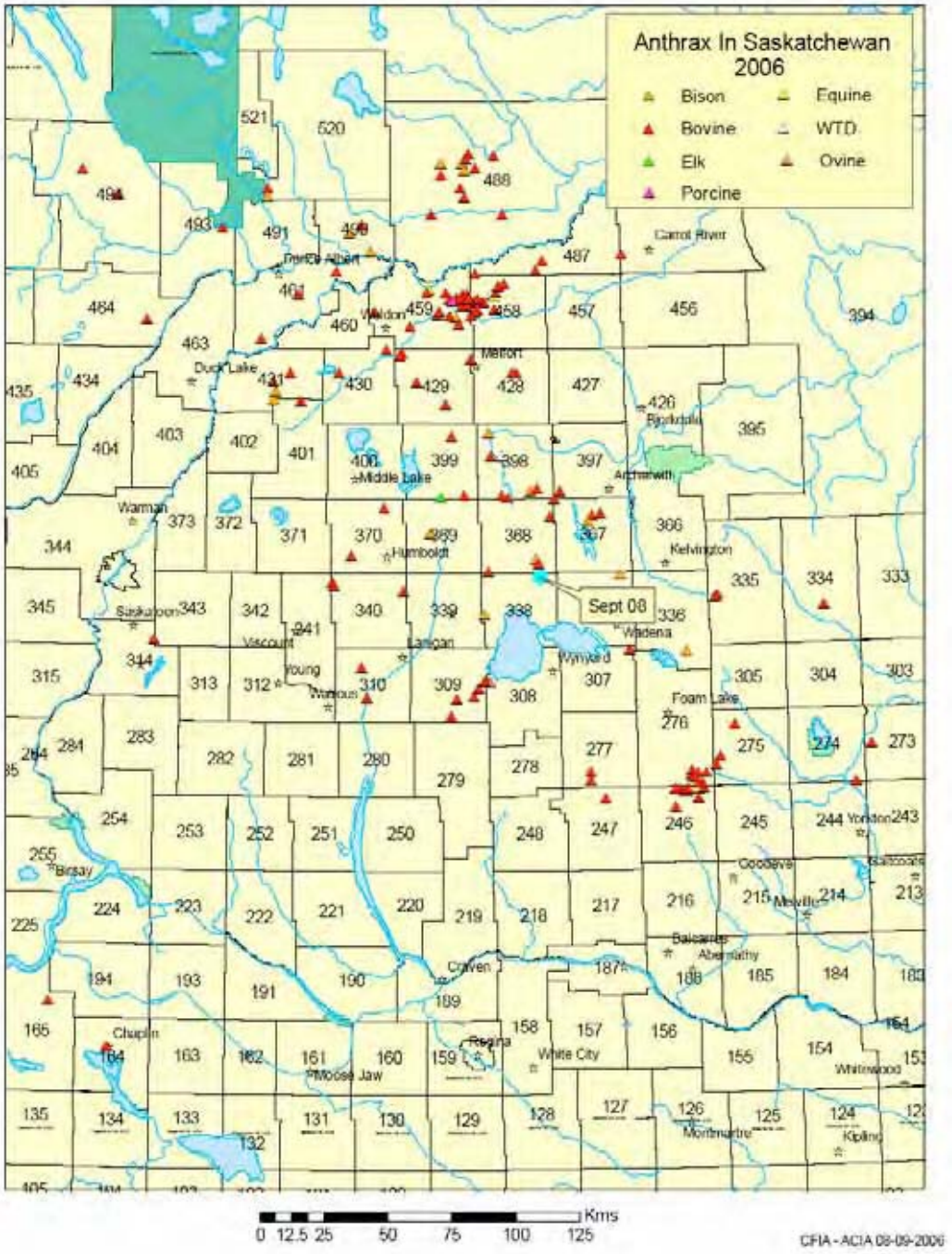


Saskatchewan 2006

This epidemic started on 26th June and finally stopped in mid-September by when 153 farms had been affected and 800 deaths of which 493 were of cattle and 254 bison.

The outbreaks in Manitoba and Minnesota had stopped in late August.

We need to run with this GIS opportunity.



Ecological Niche Modeling for Predicting Geographic Distributions

Ecology

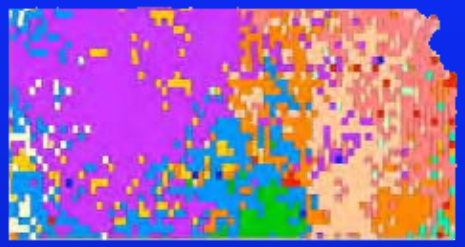
Geography

McNyset & Blackburn (2006)

Ecological Niche Modeling for Predicting Geographic Distributions

Ecology

Ecological variables



GARP

Geography

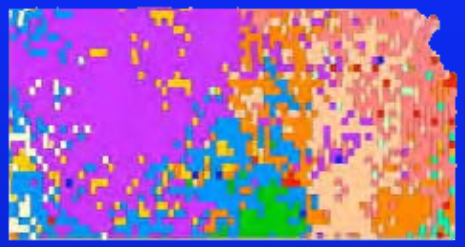
Distributional Points

McNyset & Blackburn (2006)

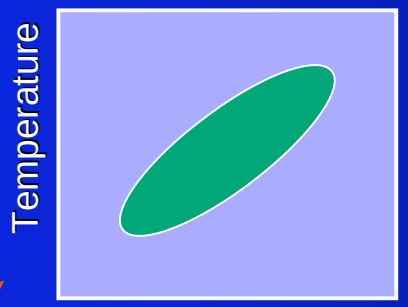
Ecological Niche Modeling for Predicting Geographic Distributions

Ecology

Ecological variables



Ecological niche model



GARP

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Distributional Modeling for Predicting Geographic Distributions

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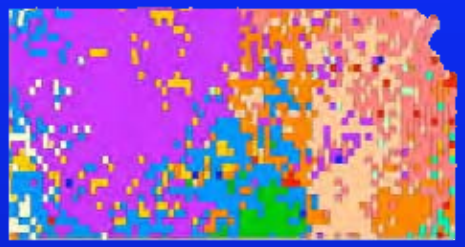
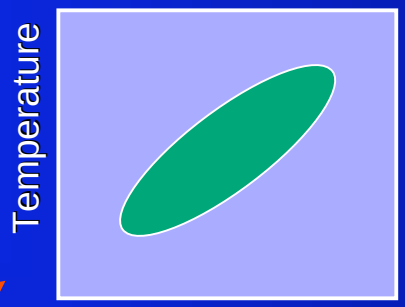


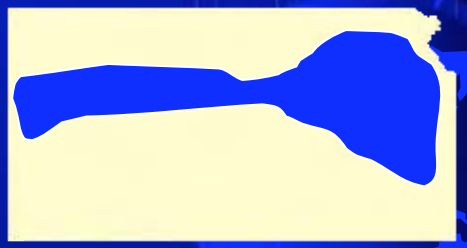
Multivariate Statistical Model



Map probabilities onto geography

Geography

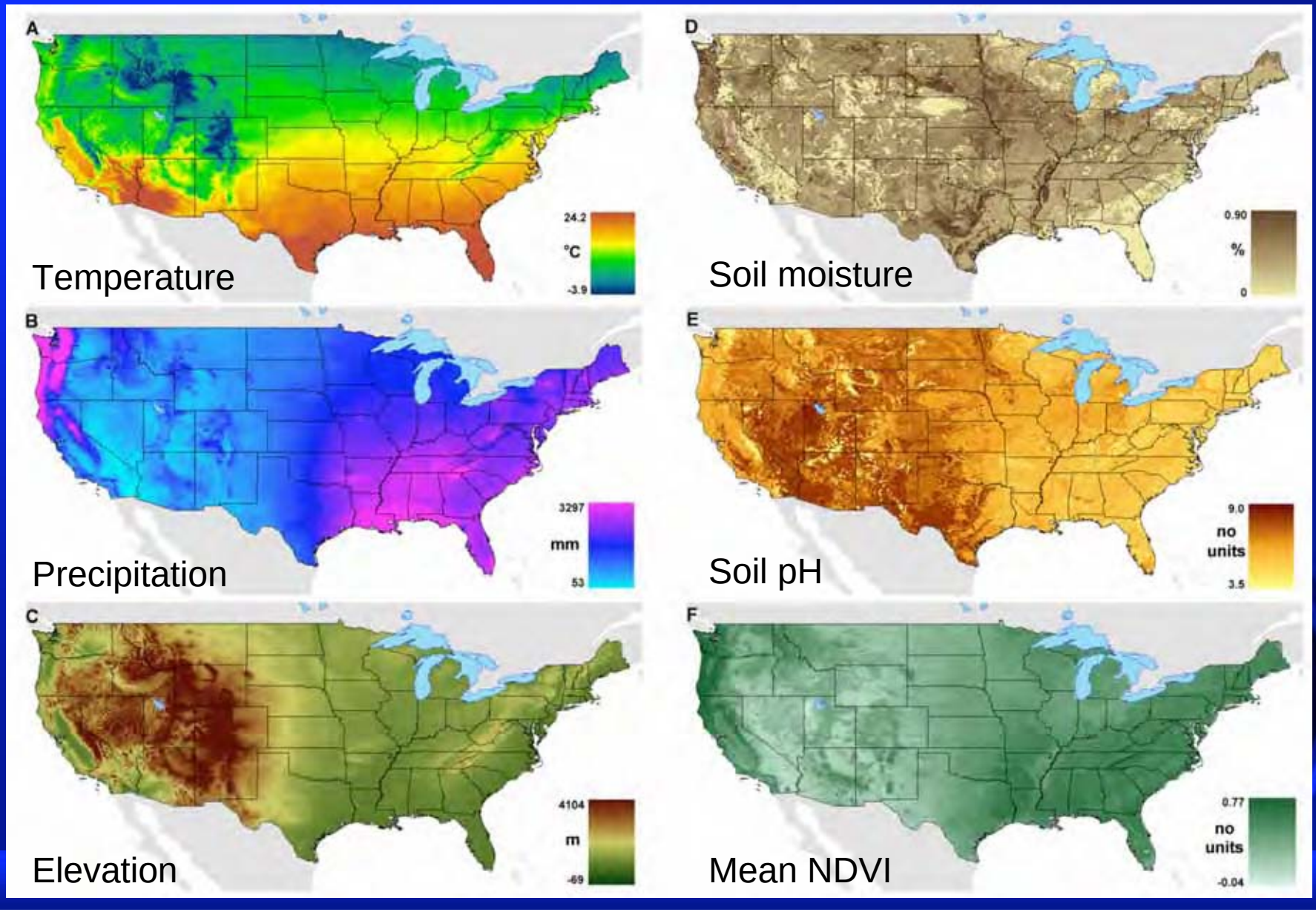
Distributional Points

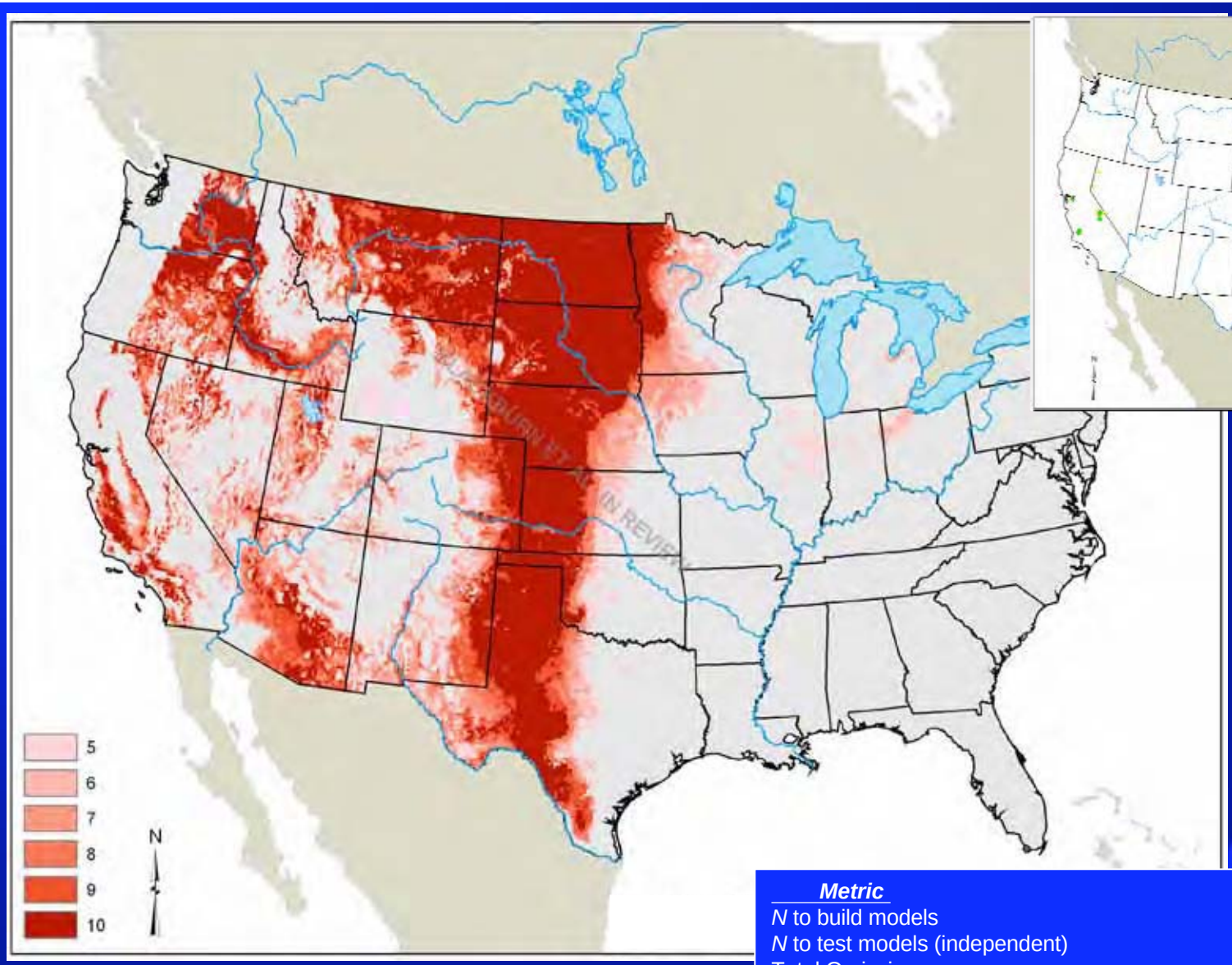


Distributional Prediction

McNyset & Blackburn (2006)

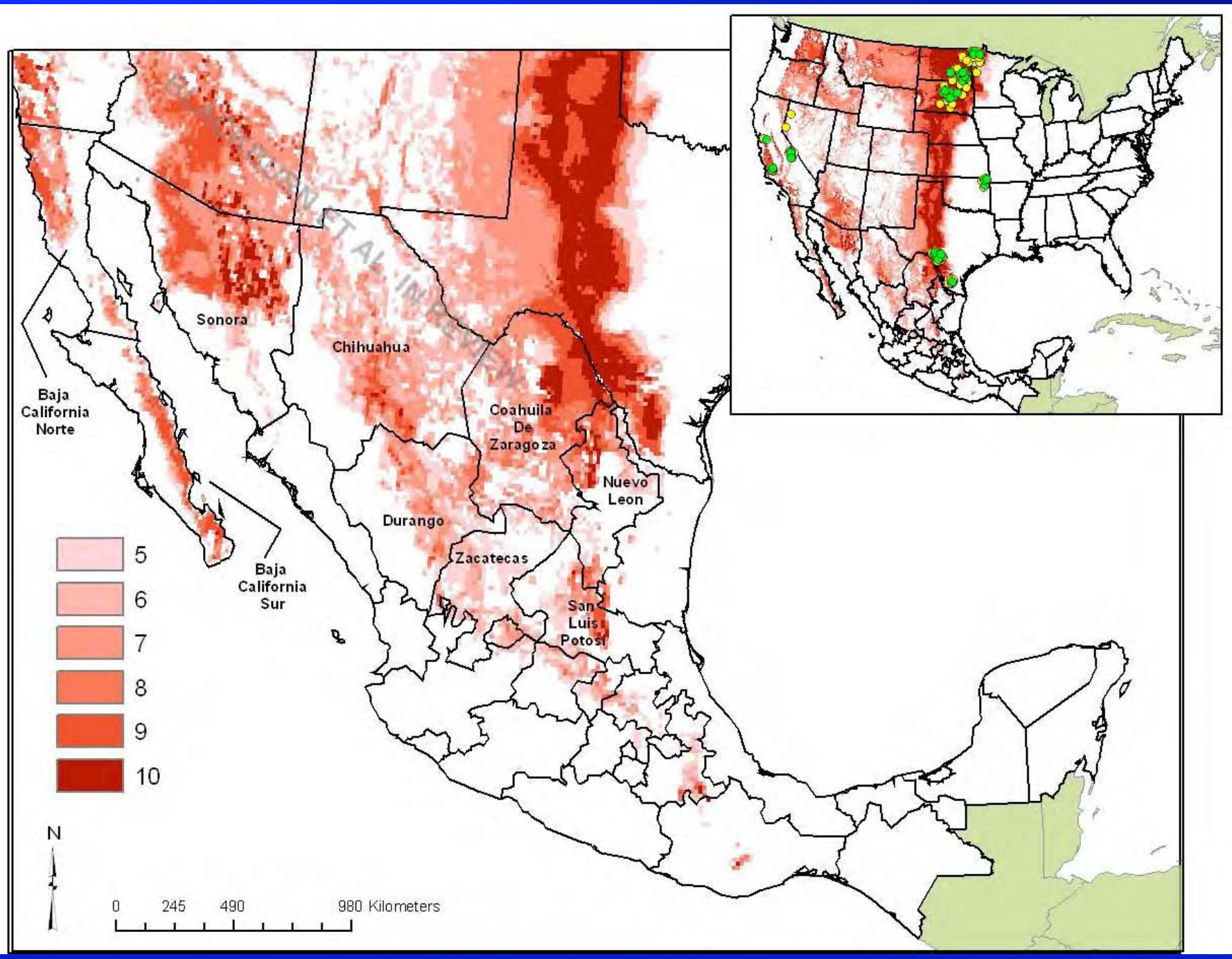
Develop a “hypervolume” from Remotely Sensed data sets
ECOLOGICAL SPACE (and) GEOGRAPHIC SPACE





Metric	Model Specifications
N to build models	130†
N to test models (independent)	47
Total Omission	6.8%
Average Omission	23.2%
Total Commission	66.5%
Average Commission	41.6%
AUC	0.7916*‡

†*N* was divided into 50% training / 50% testing at each model iteration
*z=10.503 (p<0.01), ‡SE = 0.0394


Sonora
Chihuahua
Baja California Norte
Coahuila De Zaragoza
Nuevo Leon
Durango
Zacatecas
Baja California Sur
San Luis Potosí
5
6
7
8
9
10
N
0
245
490
980 Kilometers

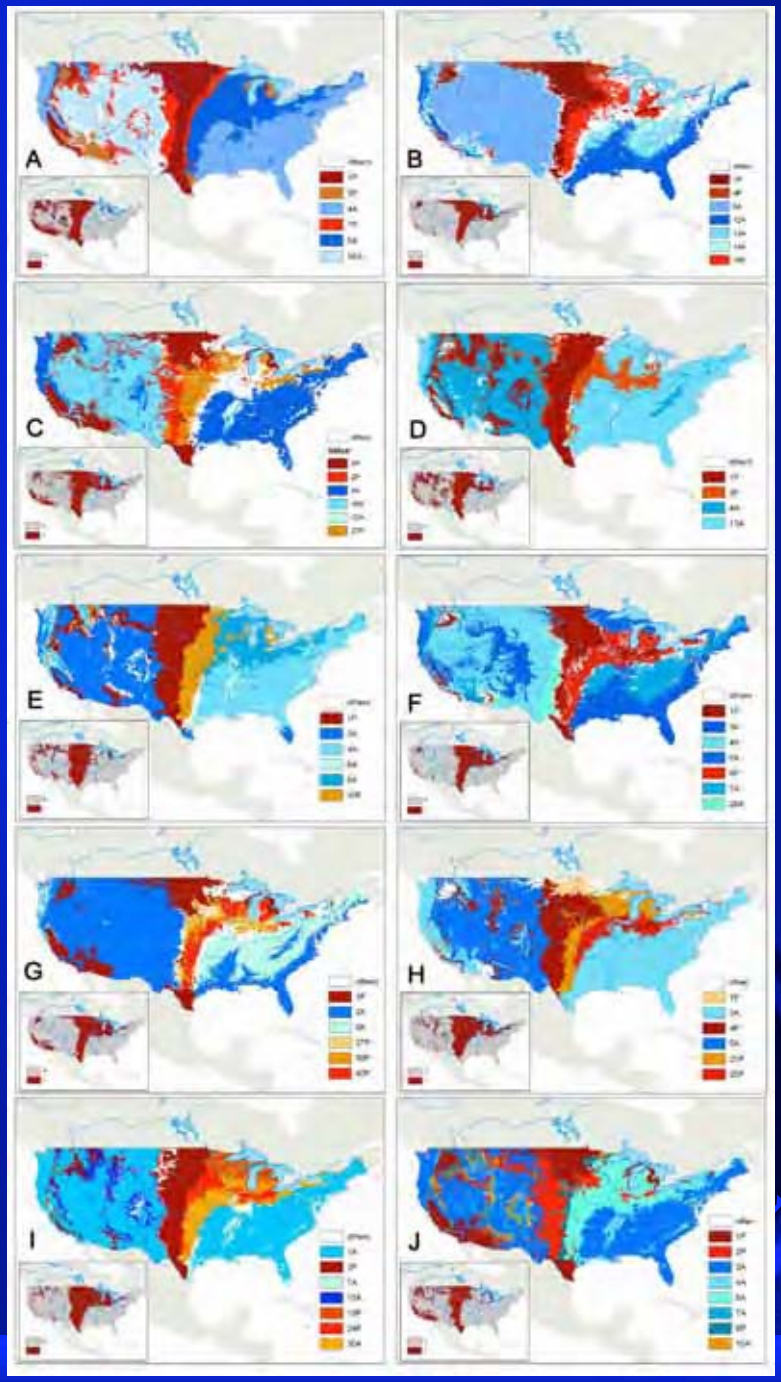
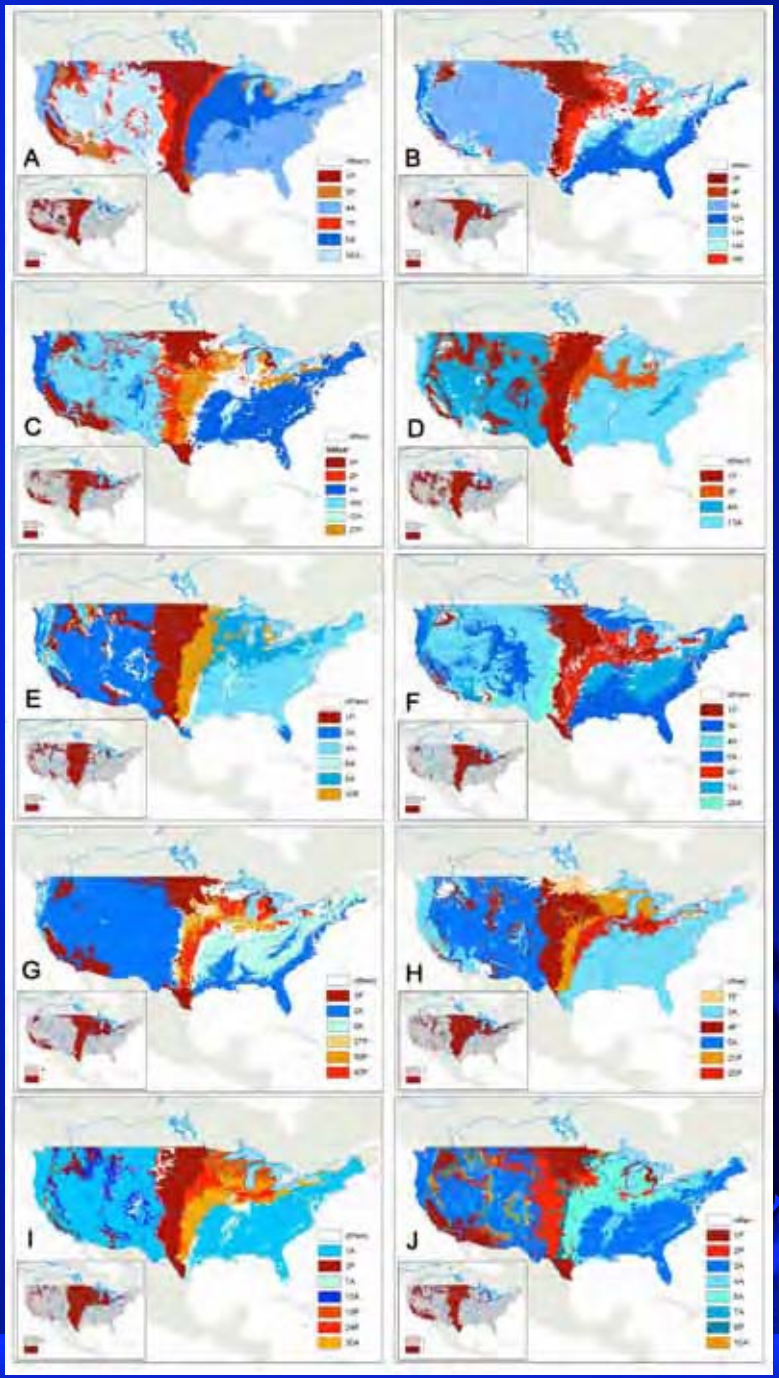


Figure to the right illustrates the conservative nature of rule-sets across a 10-model best subset. The red and orange rules define predicted presence of *B. anthracis*. Notice the high agreement of presence rules across models.

Despite opportunity for heterogeneity and the high number of possibilities:

- **GARP IS CONSERVATIVE FOR ANTHRAX;**



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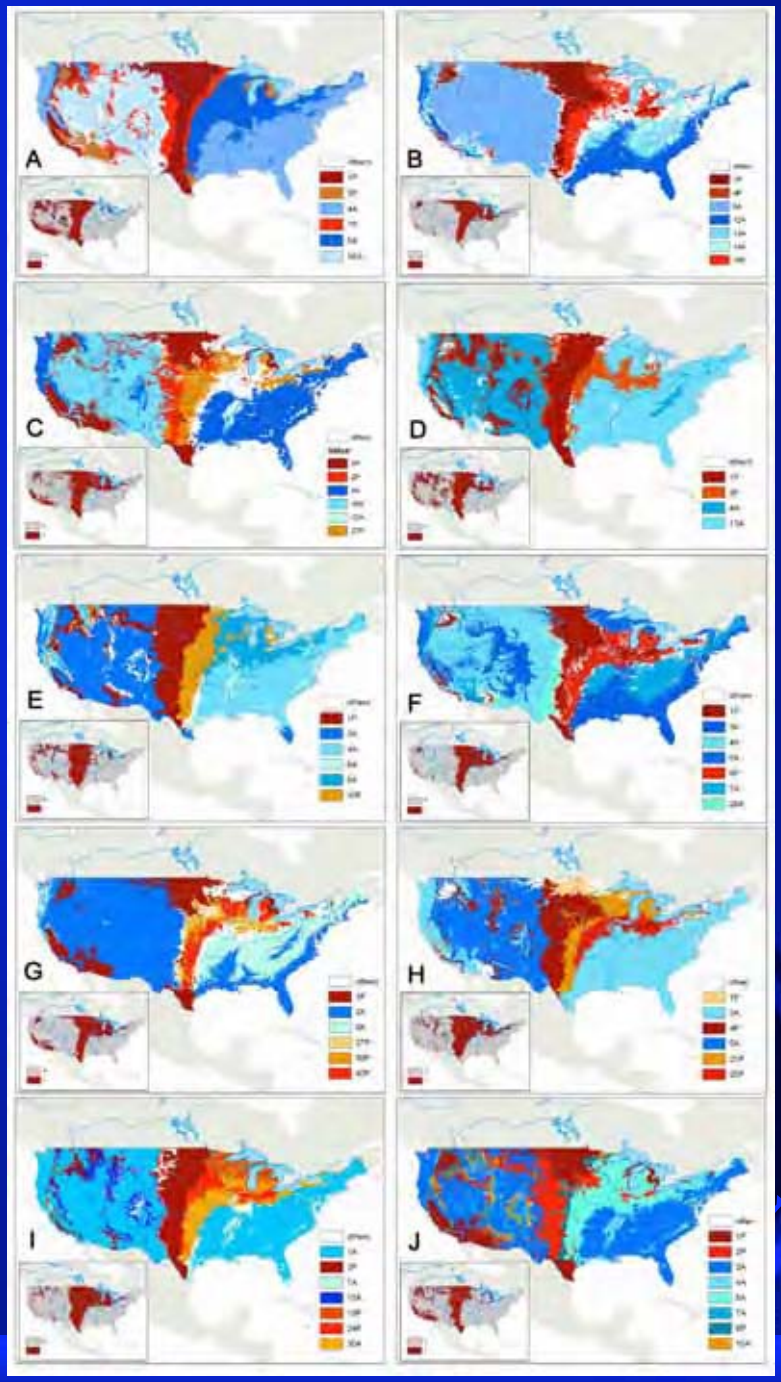
Despite opportunity for heterogeneity and the high number of possibilities:

- **GARP IS CONSERVATIVE FOR ANTHRAX;**

- **Rules are dominated by range rules supporting the evolutionary ecology definition of the niche as representing the mean phenotype of the population (Holt and Gaines 1992);**



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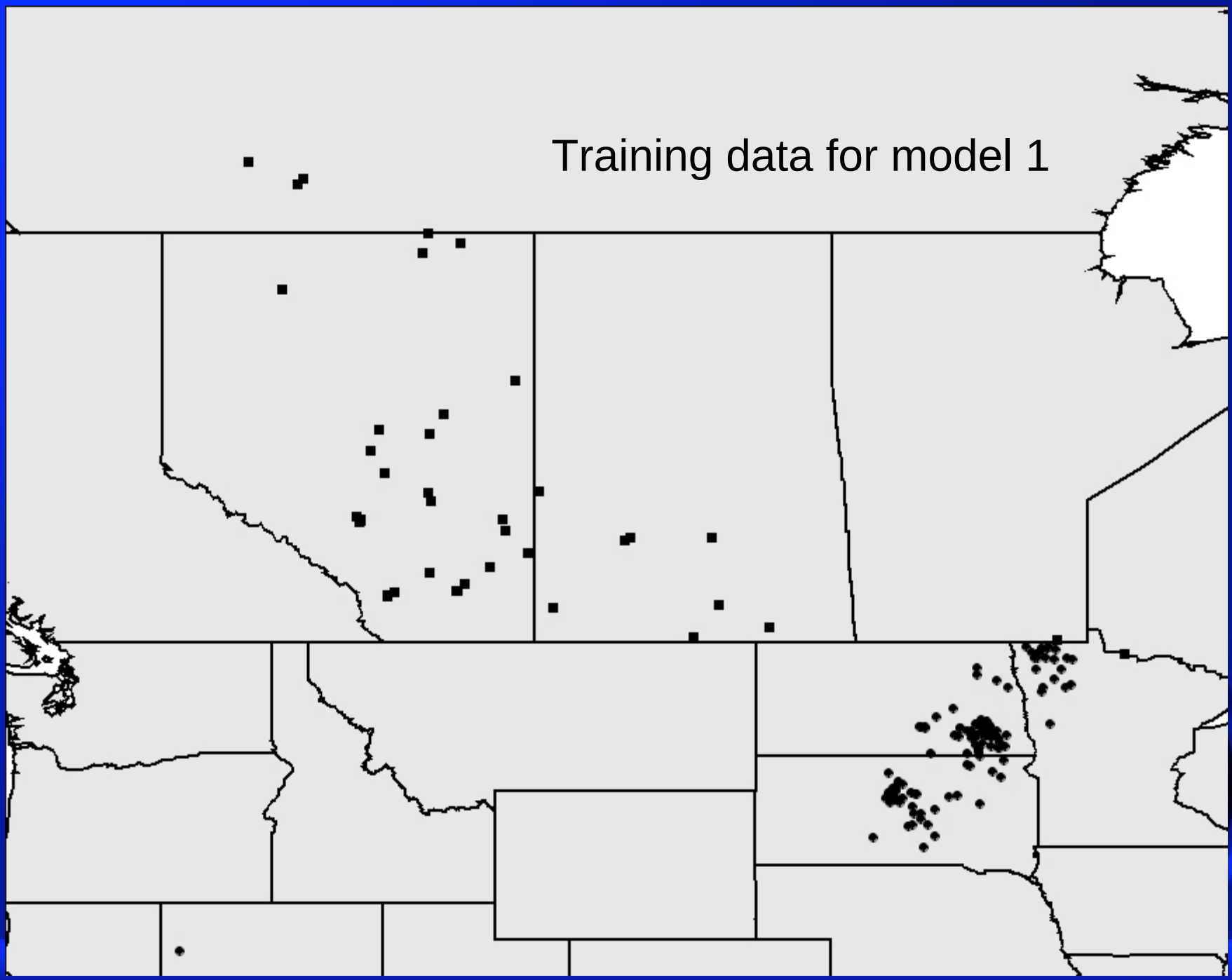
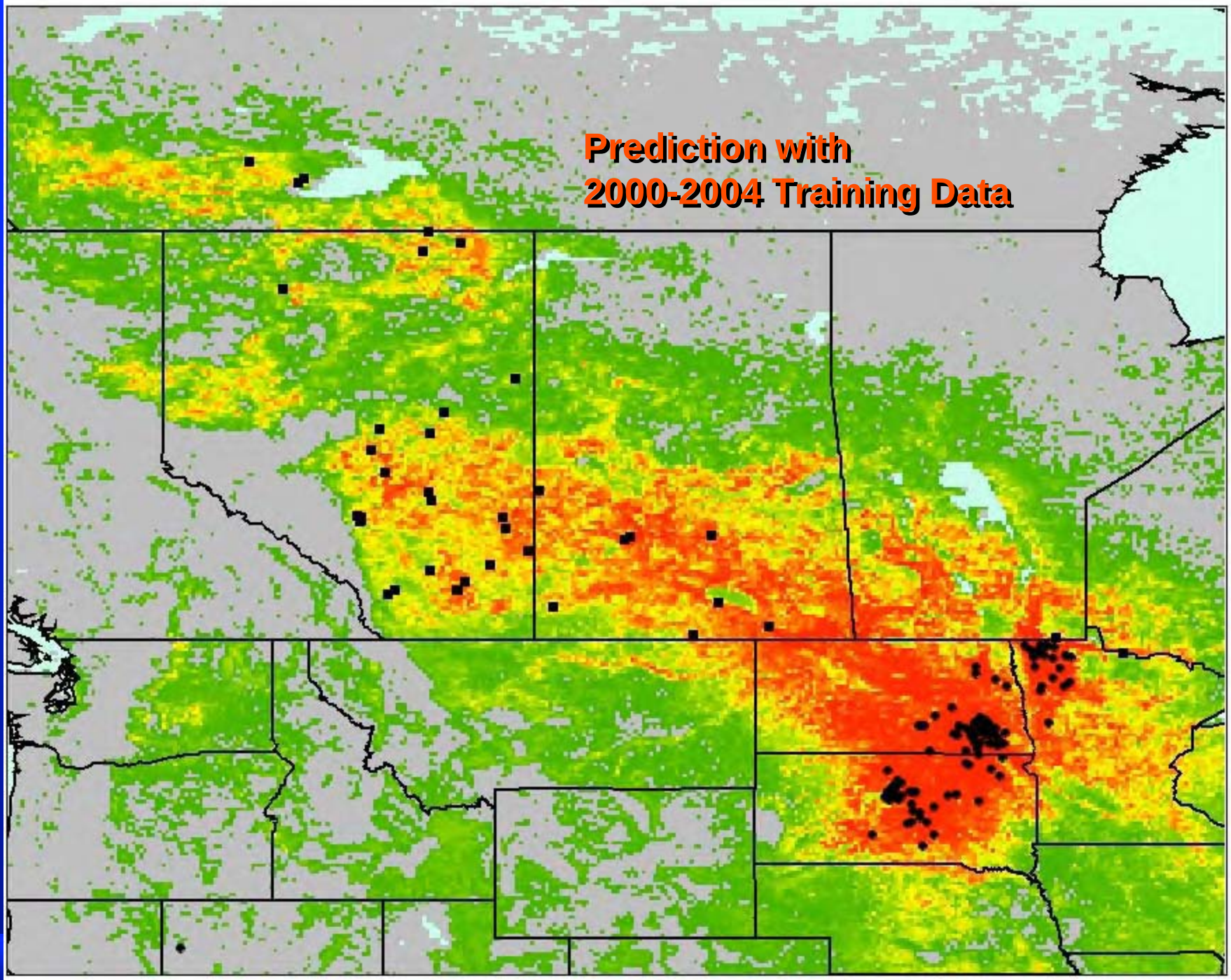
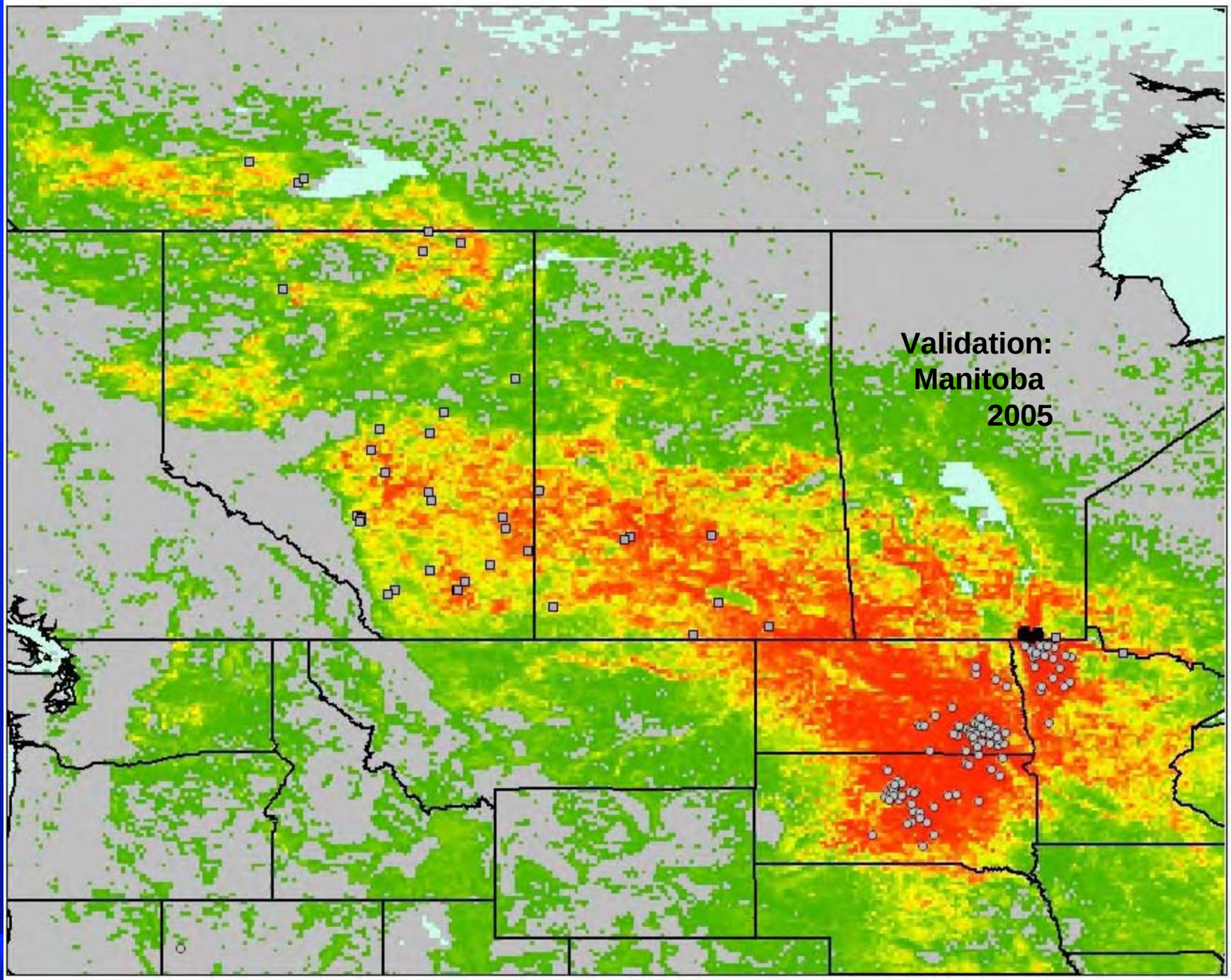
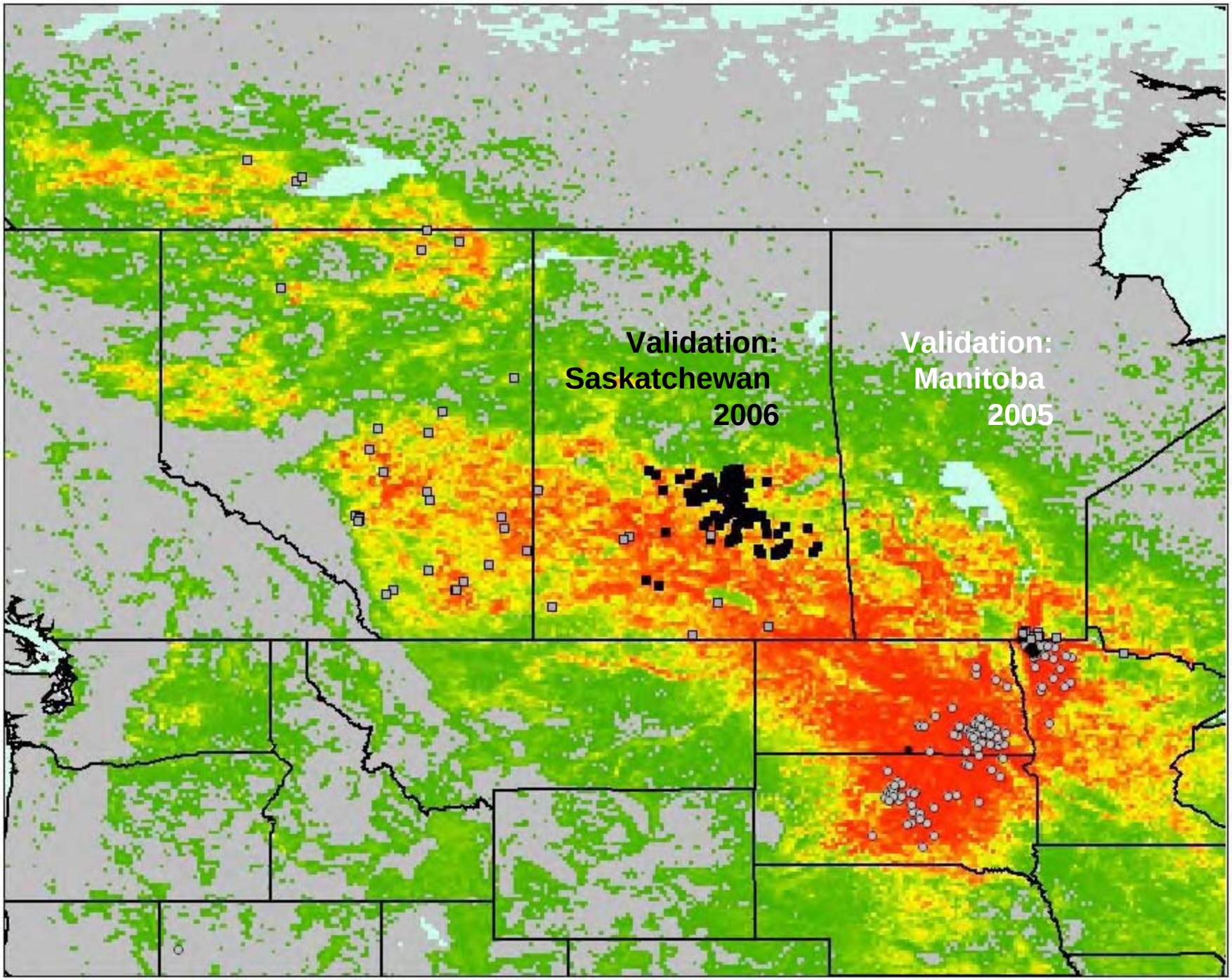
DISCUSSION (North American Models)

PRELIMINARY MODELING IN CANADA


Training data for model 1

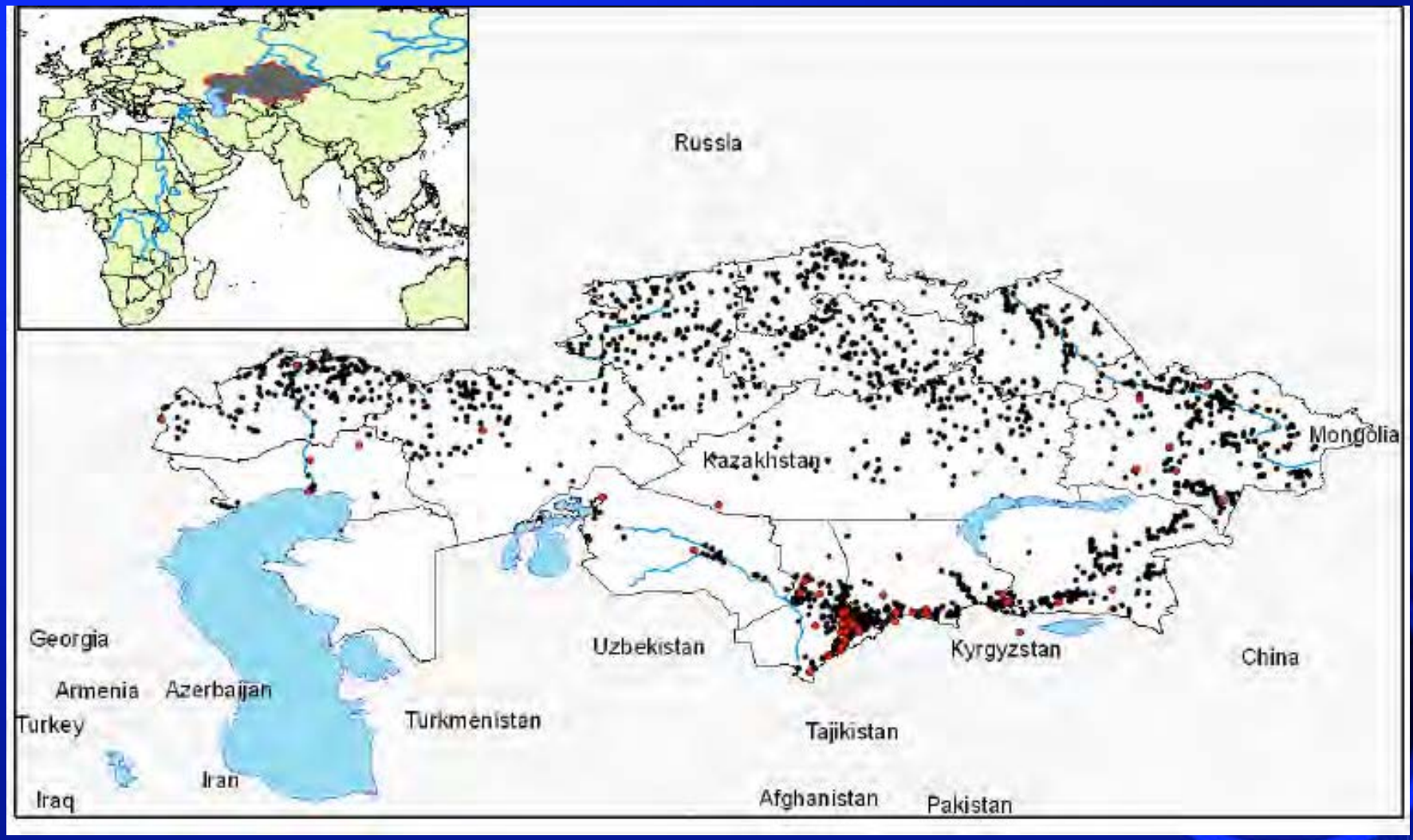

Prediction with
2000-2004 Training Data


Validation:
Manitoba
2005


Validation:
Saskatchewan
2006
Validation:
Manitoba
2005

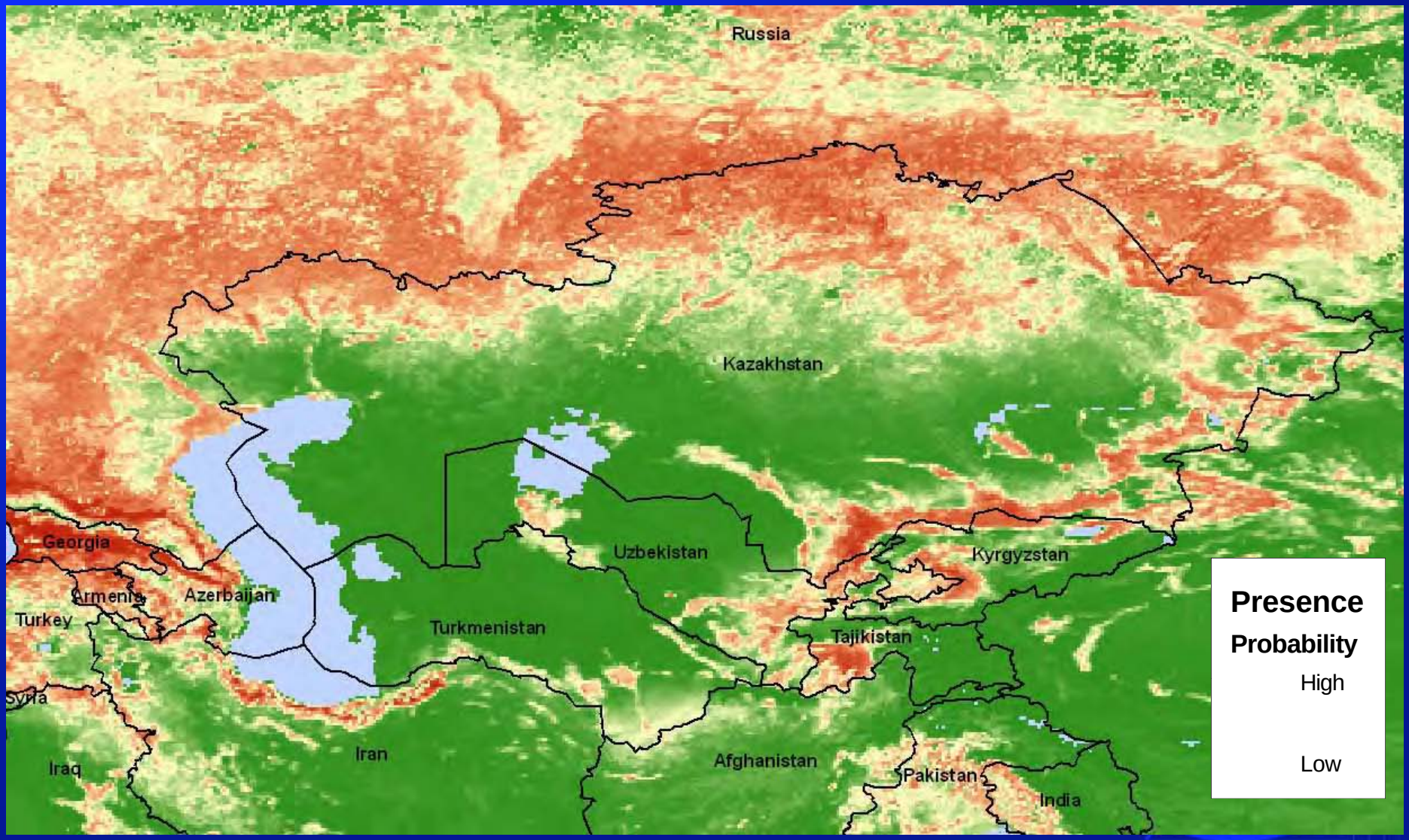
PRELIMINARY MODELING IN CENTRAL ASIA

Kazakhstan now maintains a real-time GIS of anthrax outbreaks

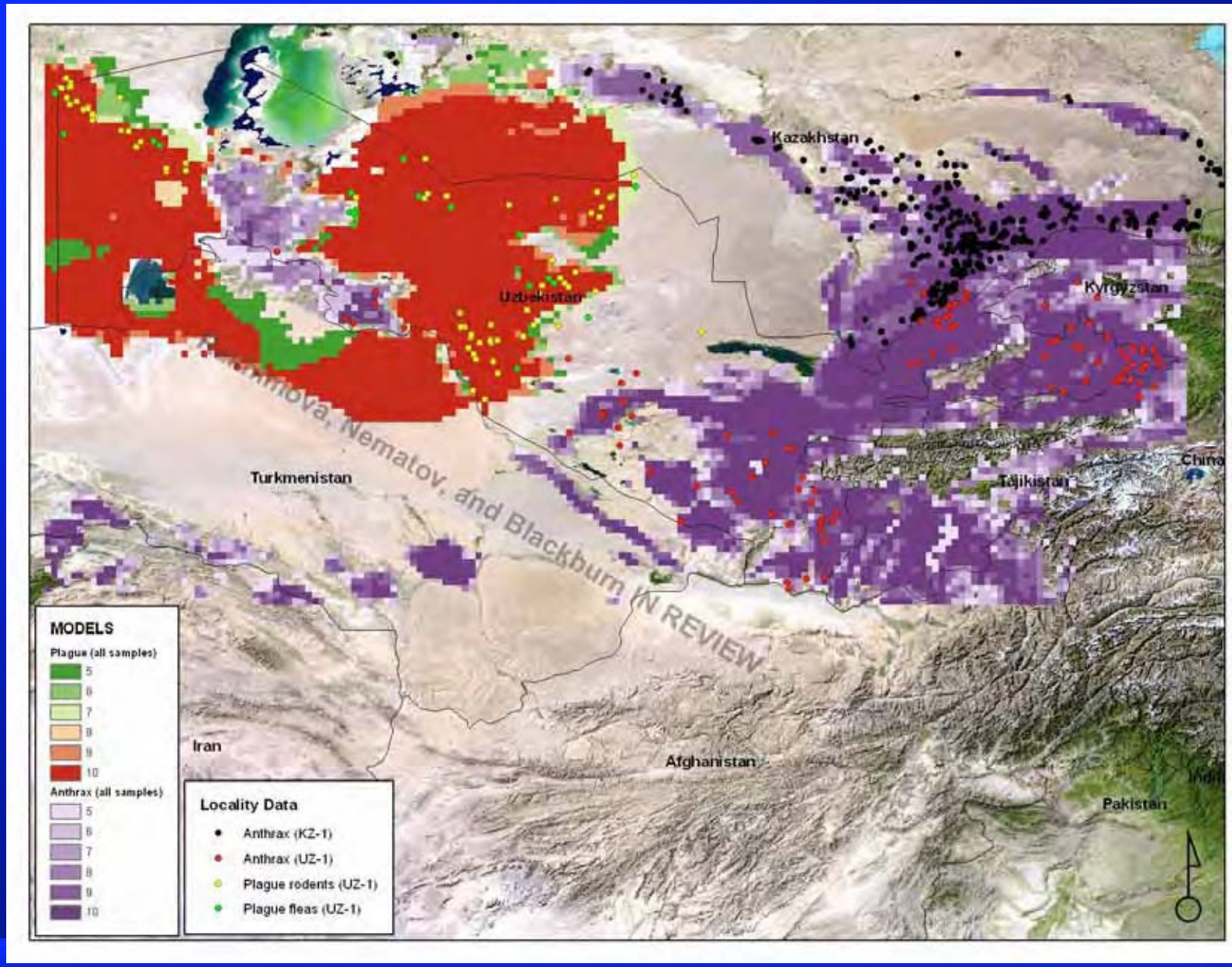


Aikimbayev et al. *In preparation*

TALA MODEL OF CENTRAL ASIA



GARP MODEL FOR PLAGUE & ANTHRAX IN UZBEKISTAN



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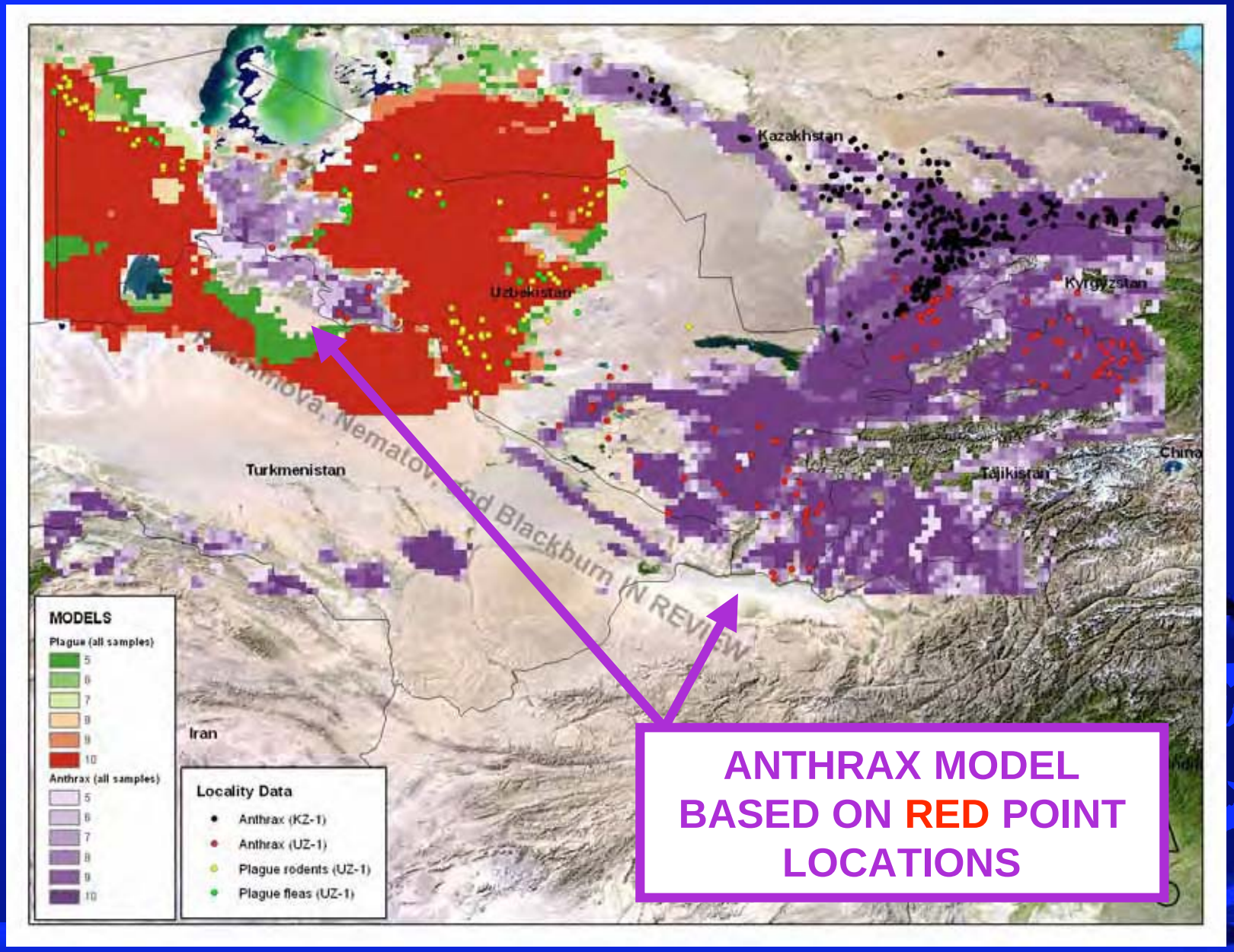

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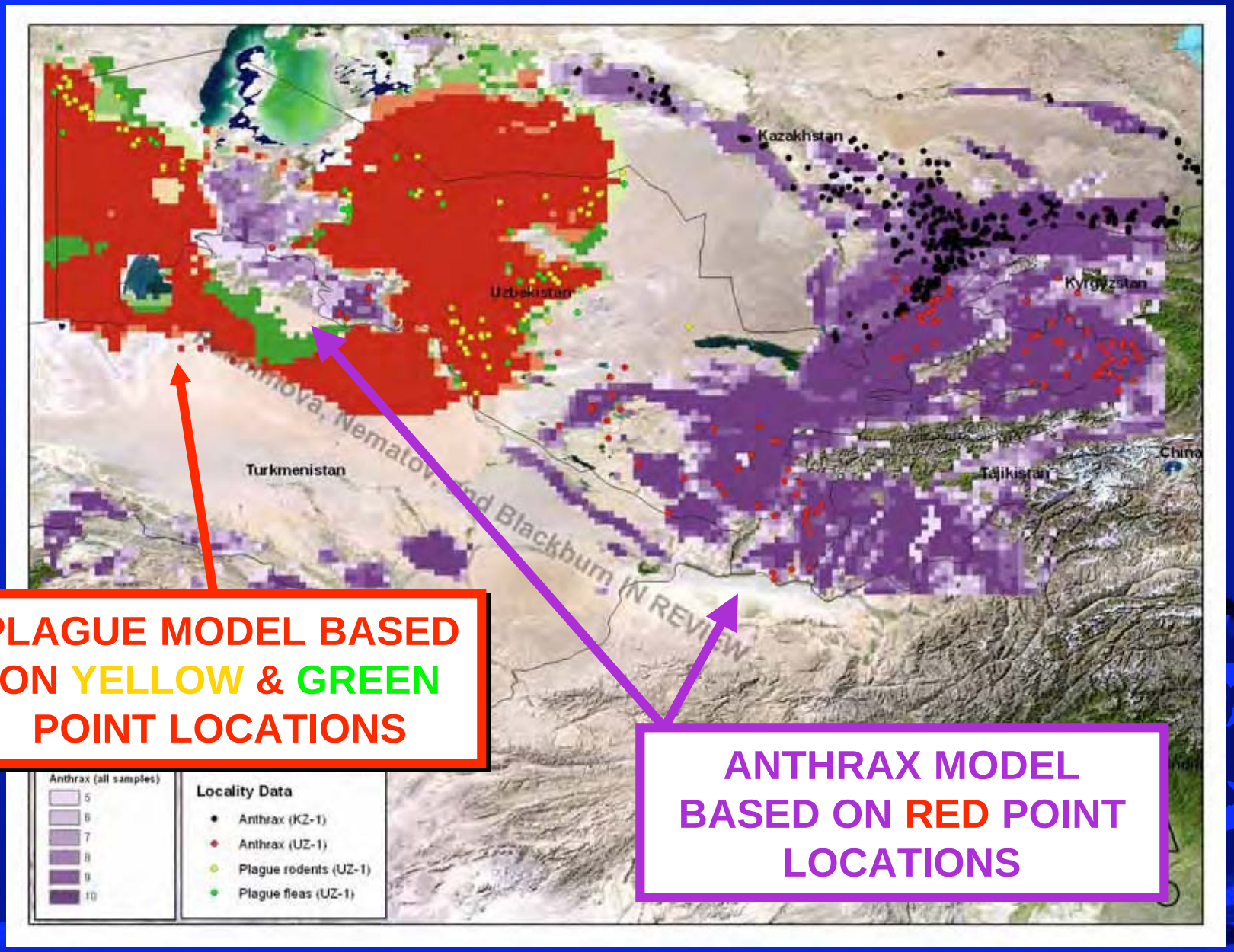
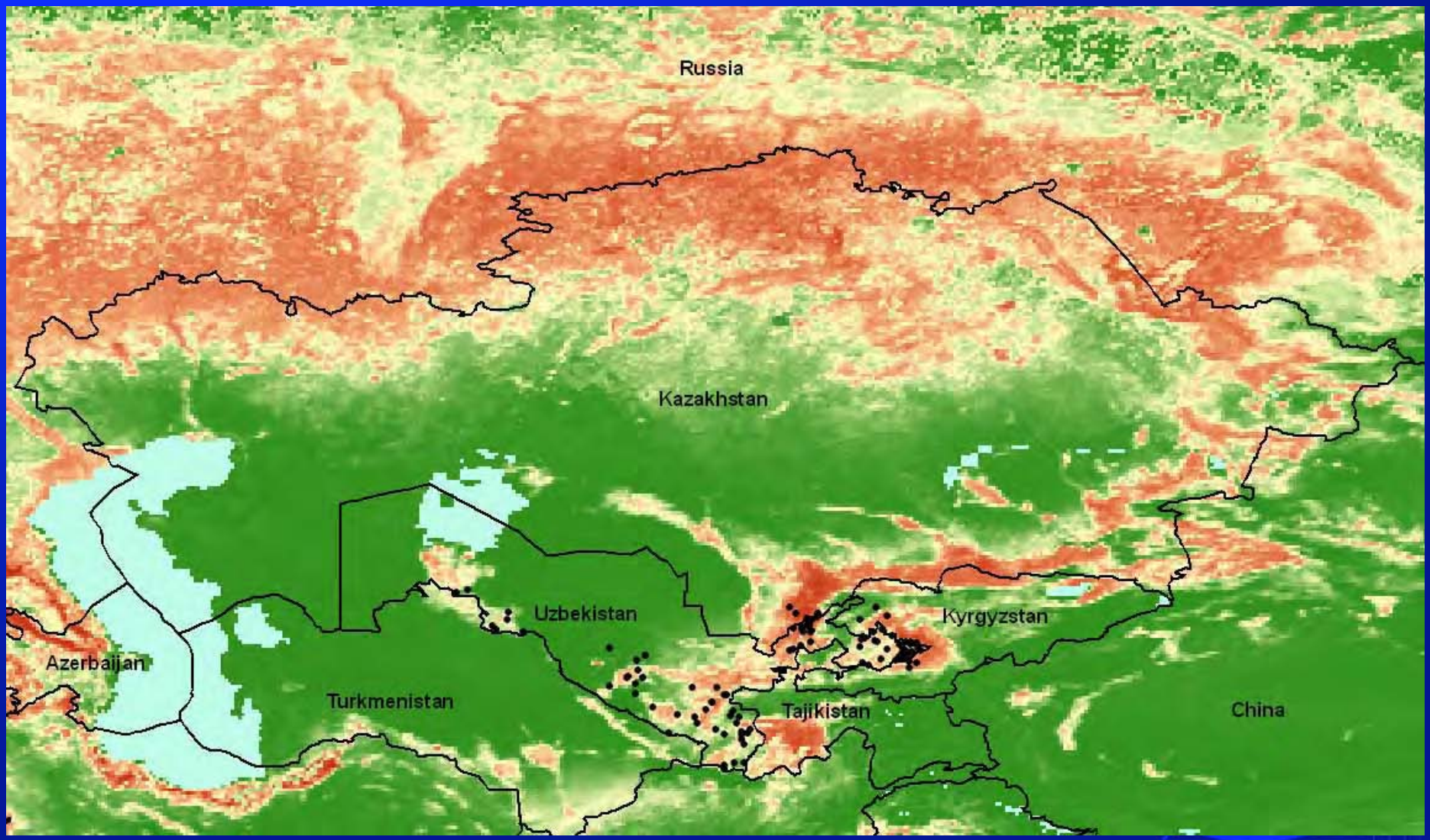


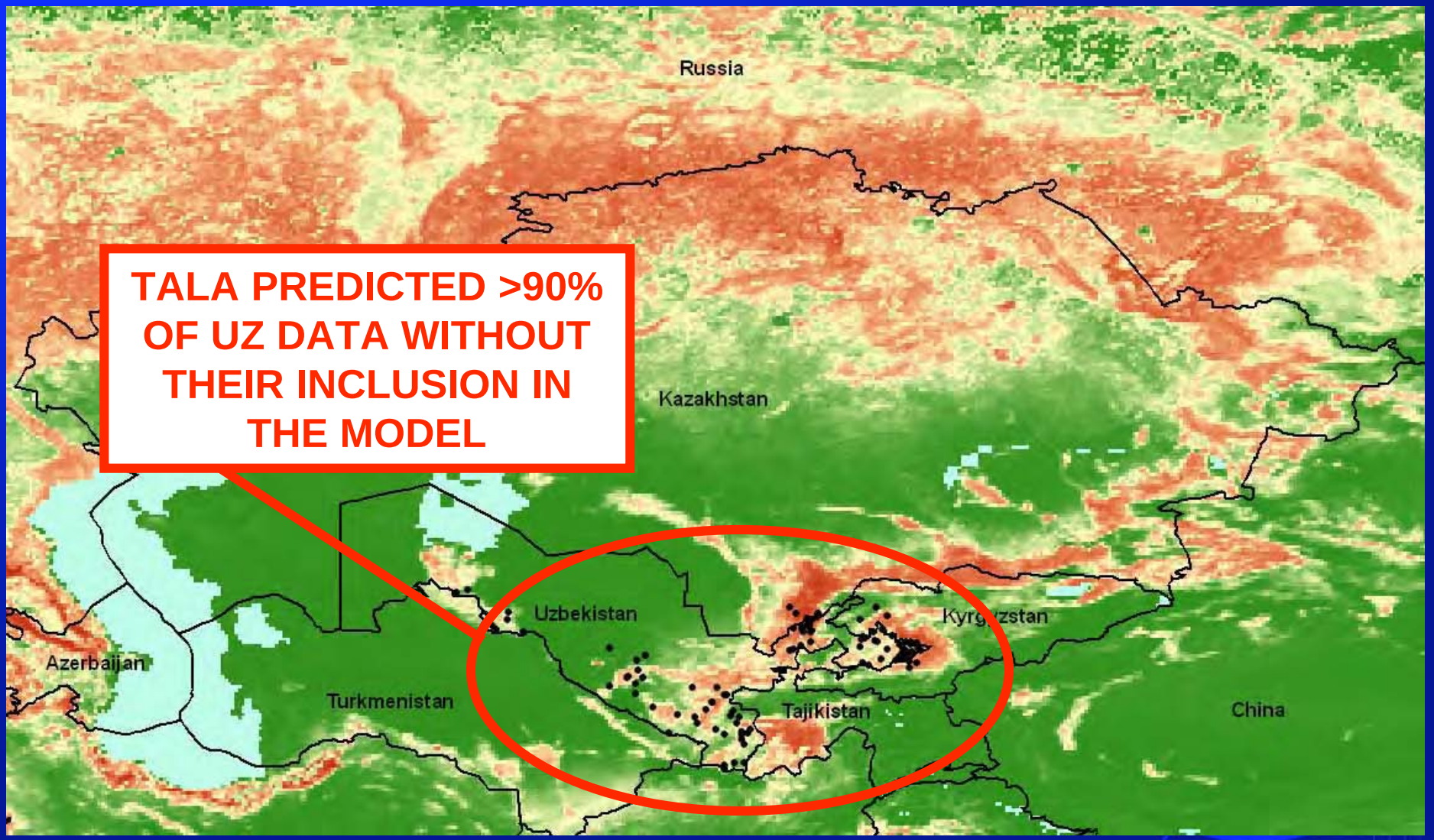
PLAGUE MODEL BASED ON YELLOW & GREEN POINT LOCATIONS

ANTHRAX MODEL BASED ON RED POINT LOCATIONS

DO THE MODELS WORK?



DO THE MODELS WORK?



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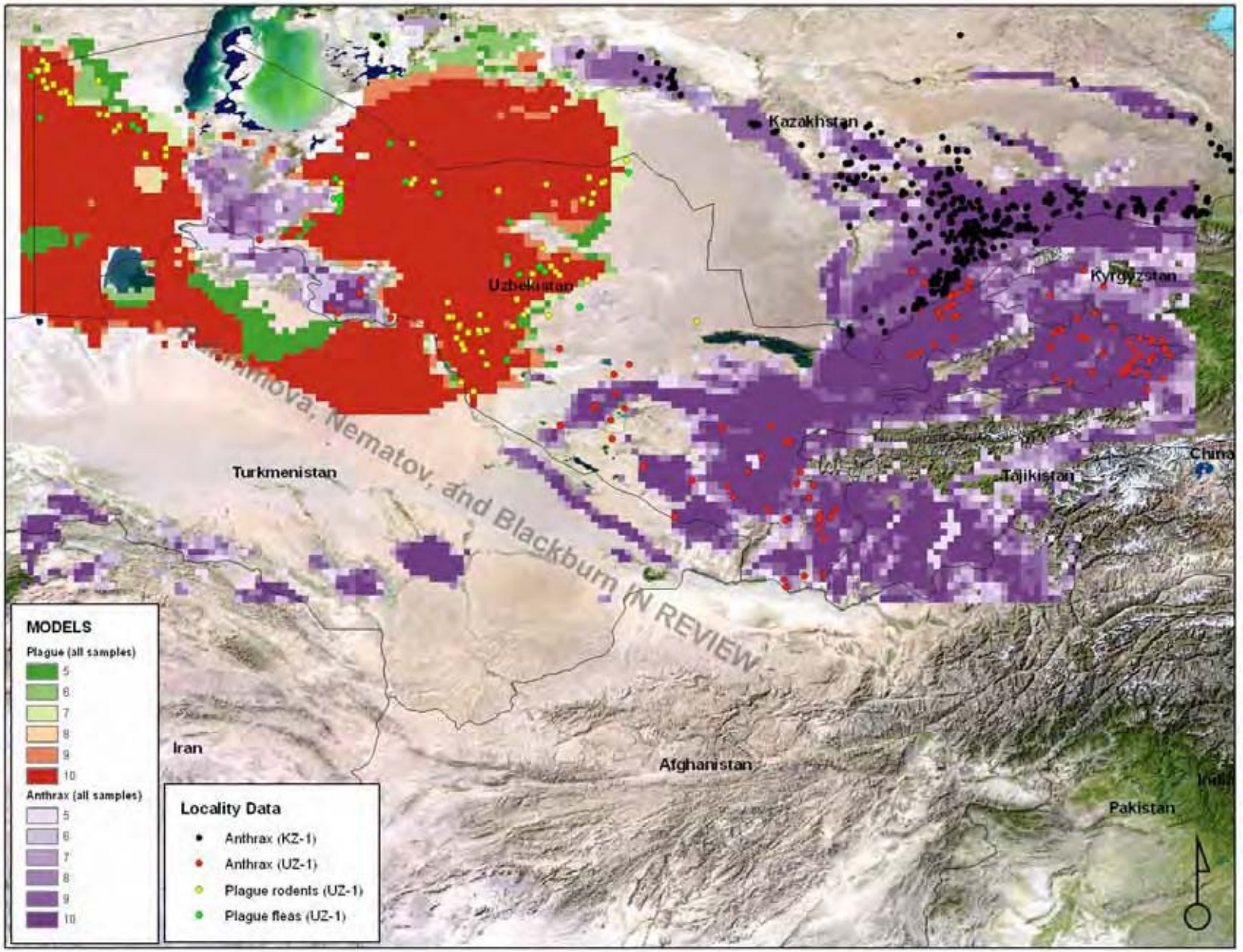

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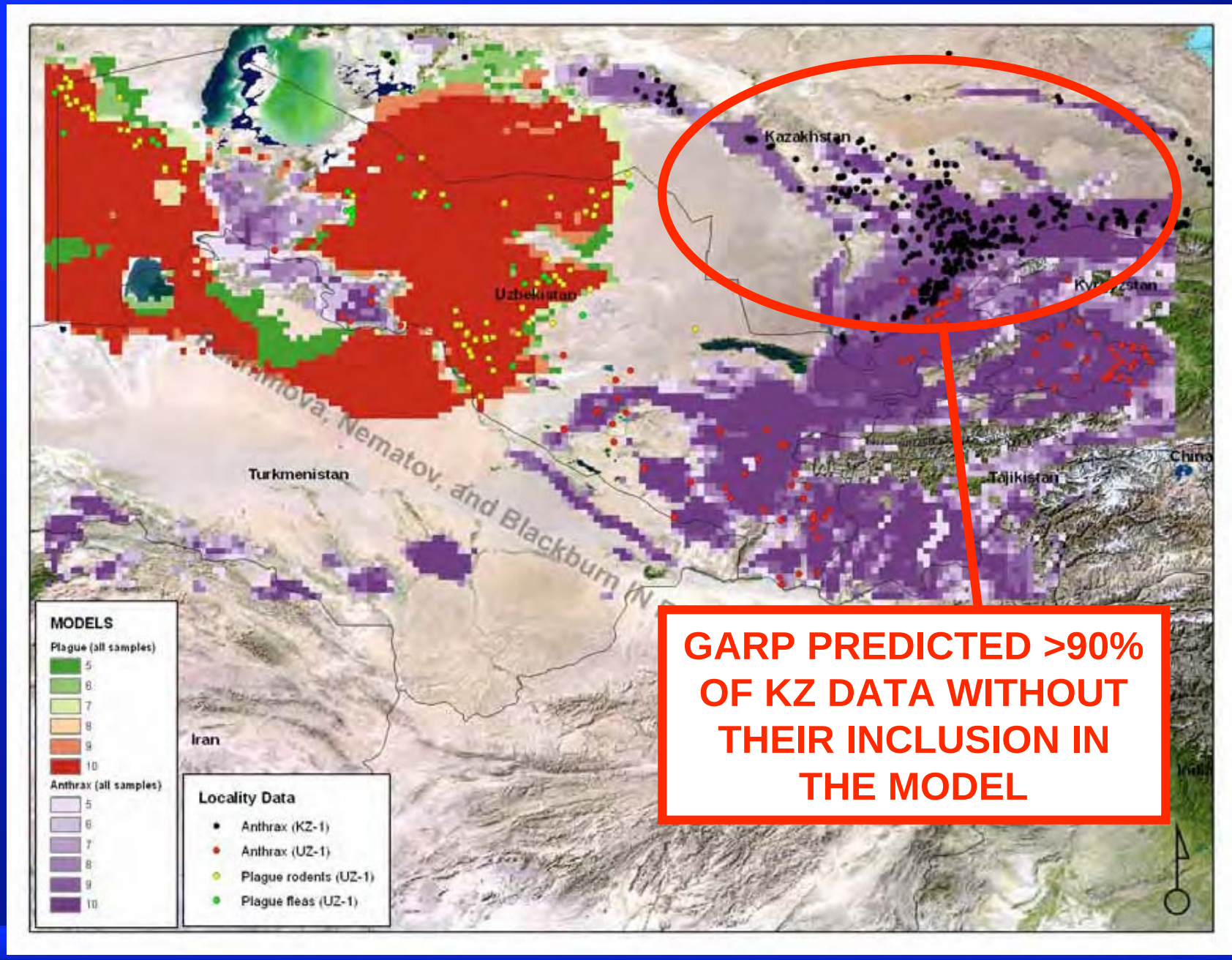
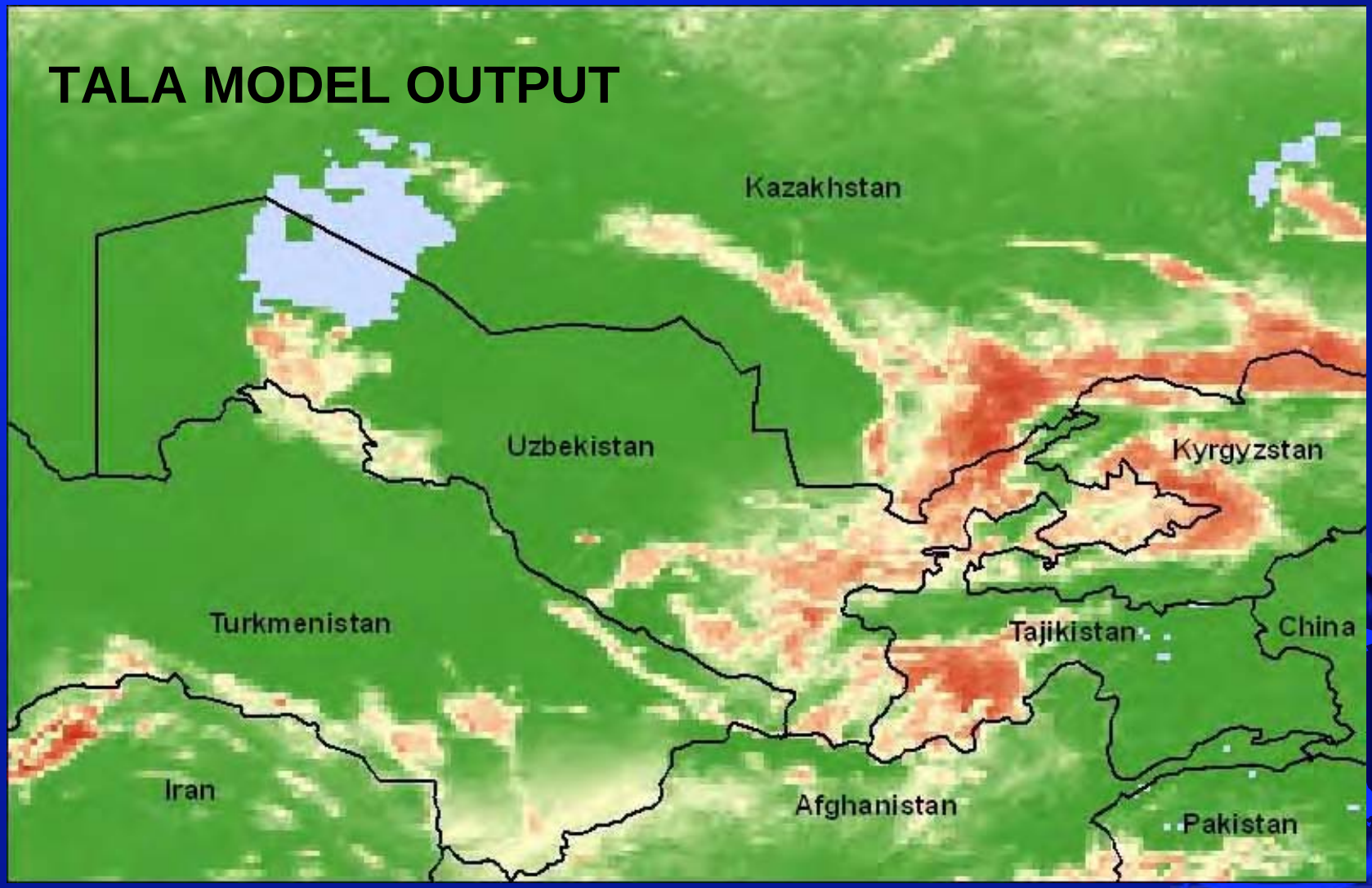


DO THE MODELS AGREE?



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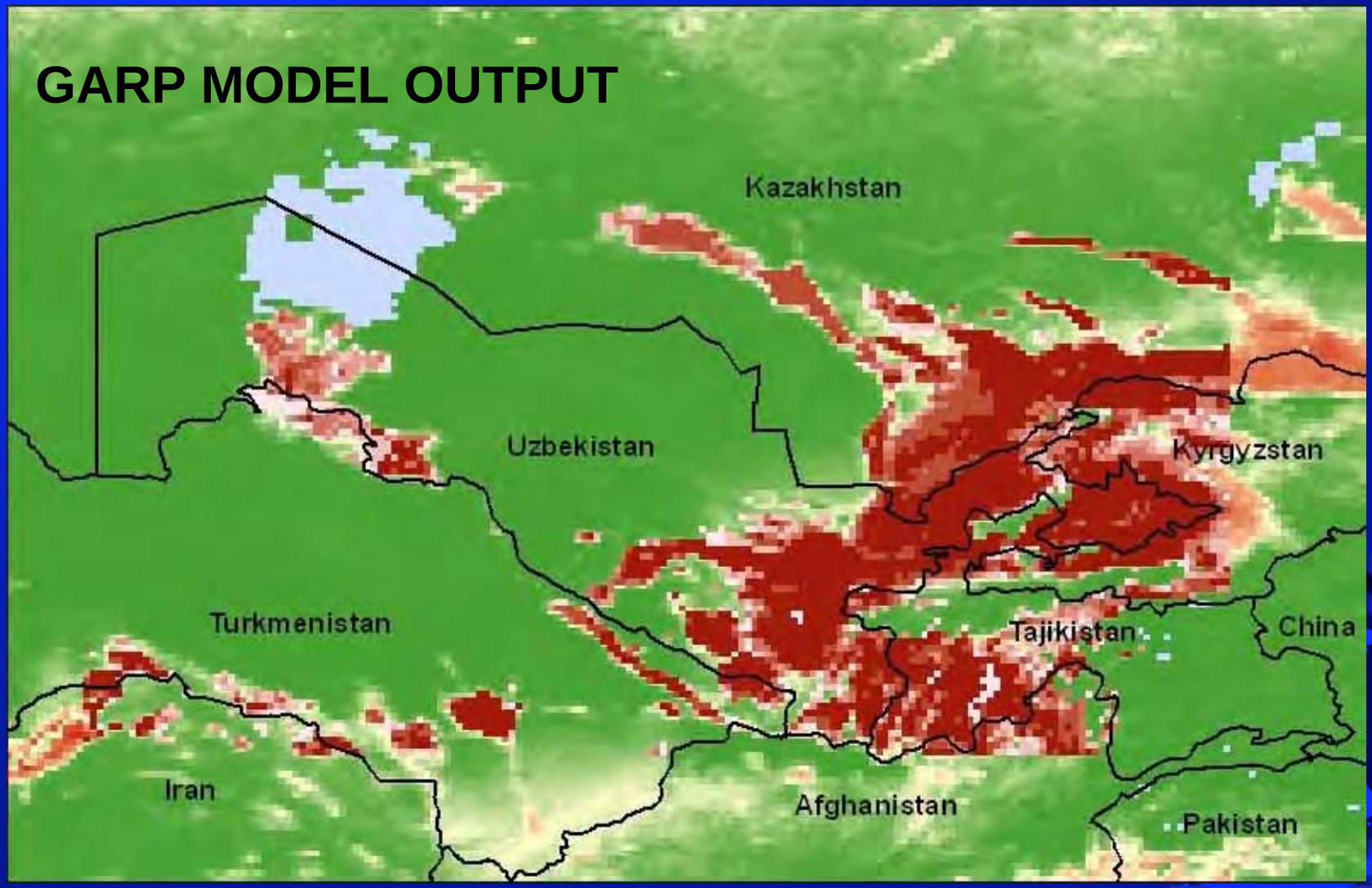

WHY USE PREDICTIVE MODELING FOR ANTHRAX?


GRP 19, Grand Detour
31. 8. 2001 13:46

Can you pick out the Bison herd?

And now?

Infra-Red Scanning Track

25 Aug

26 Aug

Infra-Red Scanning Track

25 Aug

26 Aug

There is a dead wood bison in this view.

CARC 03

ACKNOWLEDGEMENTS

Special thanks Dr. Shahlo Rakhimova (CPQMHI, Tashkent), Dr. A. Nematov (CPQMHI, Tashkent), Dr. Alim Aikimbayev (KSCQZD, Almaty), Dr. Andrew Curtis (LSU WHOCC), Dr. Simon Hay (Oxford University), Mr. T. Andrew Joyner (LSU WHOCC), Ms. Sarah Hinman (LSU WHOCC), Ms. Caroline Silverstein (CRDF), Ms. Sarah Stevenson (CRDF), Dr. James Bartholomew (SAIC), Dr. Gavin Braunstein (DTRA)

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