

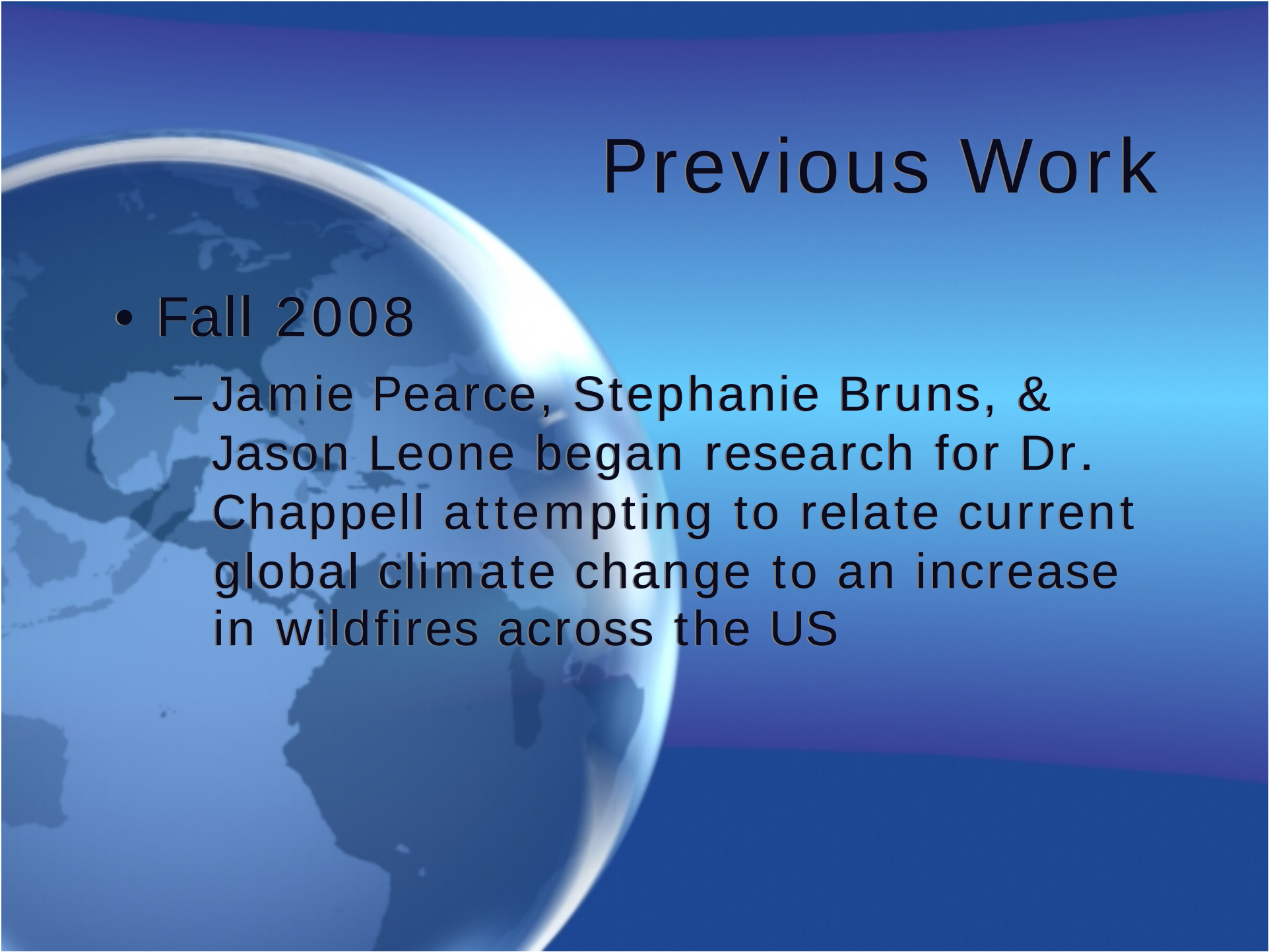


“Forecasting Wildfires and Examining the Impact of Global Climate Change”

Jason Leone, Jamie Pearce, & Kristen Gore

Client: Dr. Linda Chappell & Mr. Tom Pace, USEPA Office of Air Quality Planning & Standards

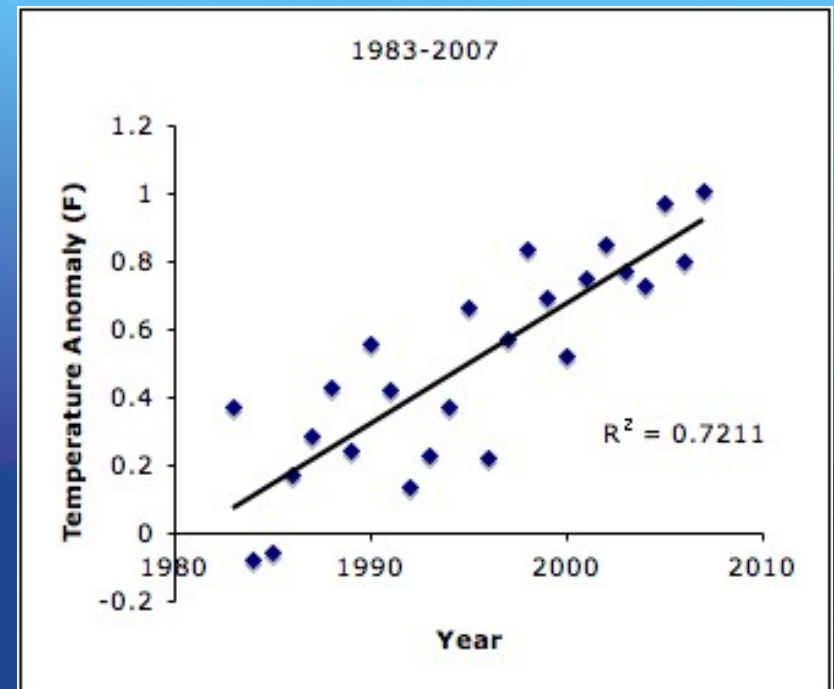
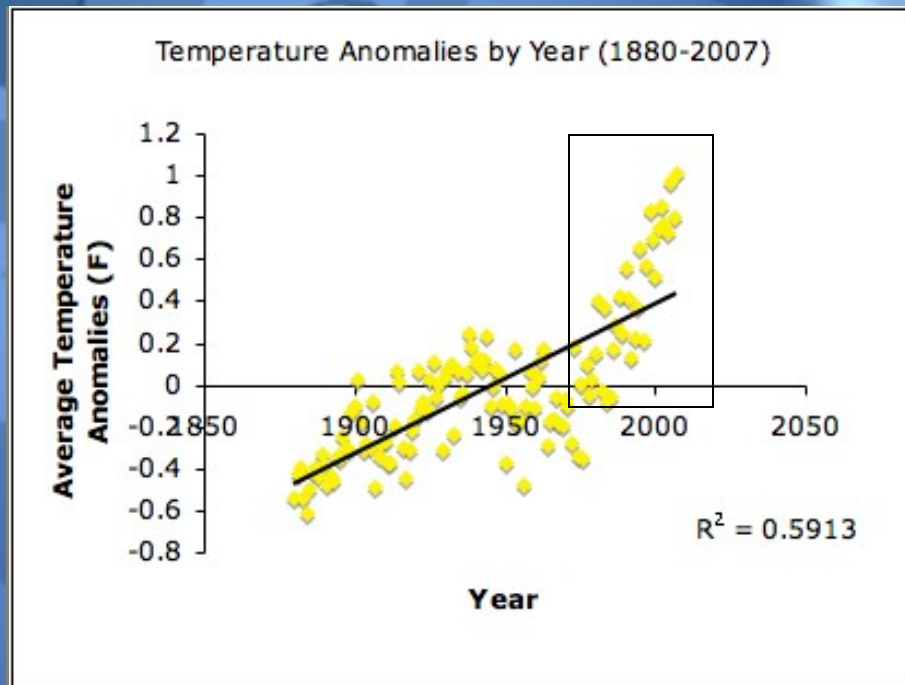
Special thanks to: Mr. Dan O'Brien, Mr. Jim Szykman, Mr. Joel Levine, Dr. Robert Tolson, Dr. Shaopeng Huang, Professor Bill Hunt, and Kevin Jones



Previous Work

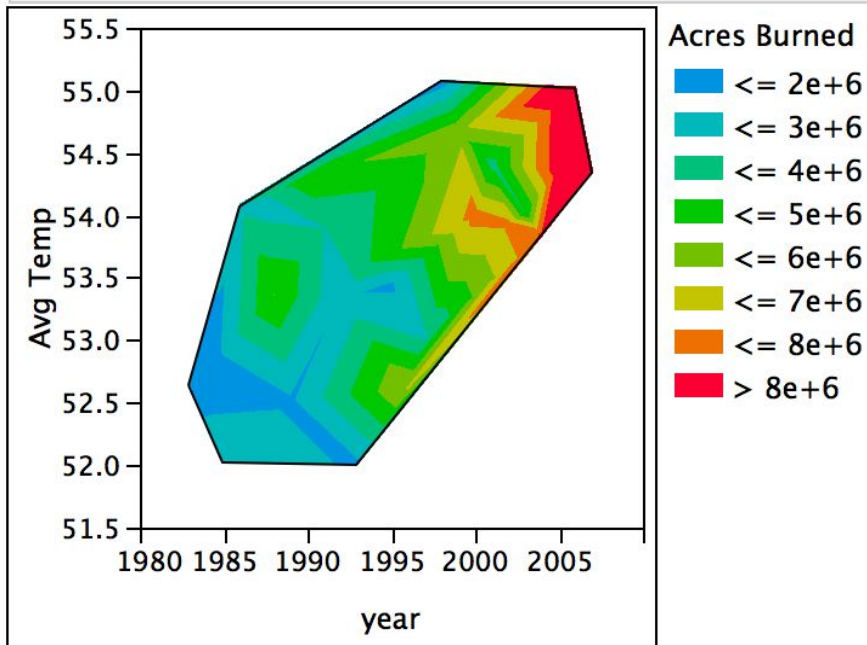
- Fall 2008
 - Jamie Pearce, Stephanie Bruns, & Jason Leone began research for Dr. Chappell attempting to relate current global climate change to an increase in wildfires across the US

International Panel on Climate Change Northern Hemispheric Temperature Anomalies

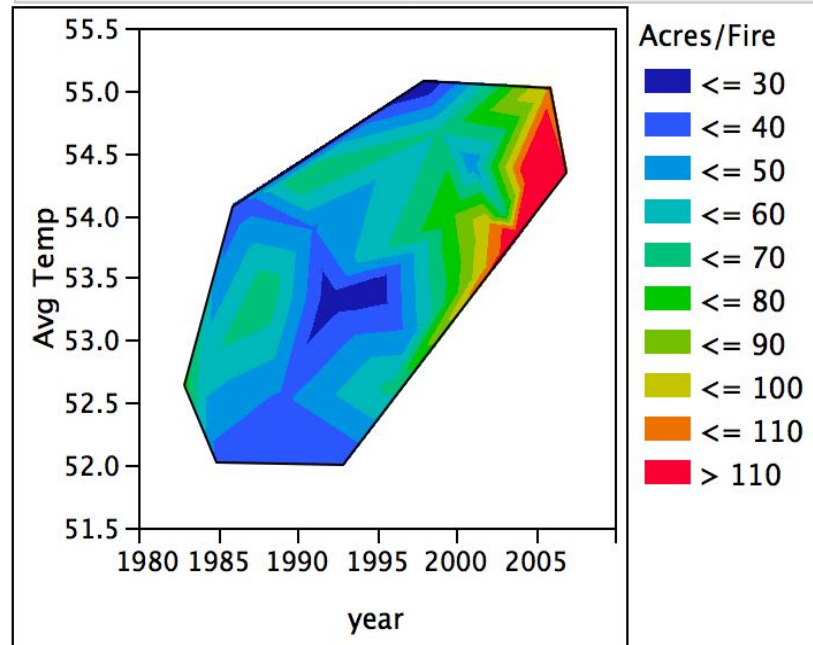


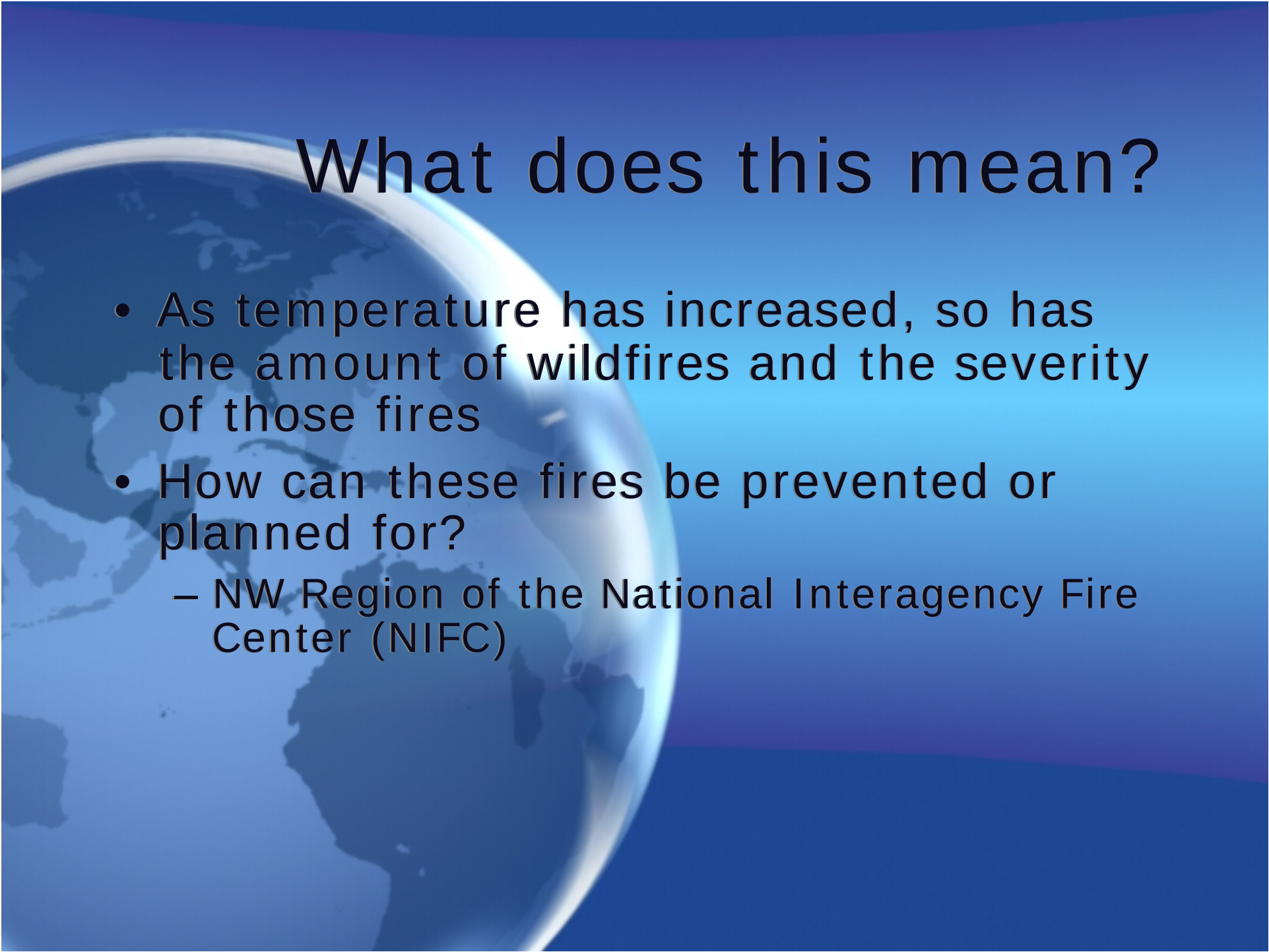
Annual National Acres Burned and Acres per Fire by Temperature Contour Plots

Contour Plot for Acres Burned



Contour Plot for Acres/Fire





What does this mean?

- As temperature has increased, so has the amount of wildfires and the severity of those fires
- How can these fires be prevented or planned for?
 - NW Region of the National Interagency Fire Center (NIFC)

The background of the slide is a blue-toned image of the Earth as seen from space, showing the curvature of the planet and some cloud patterns. The title is centered at the top in a large, black, sans-serif font.

Furthering our Research

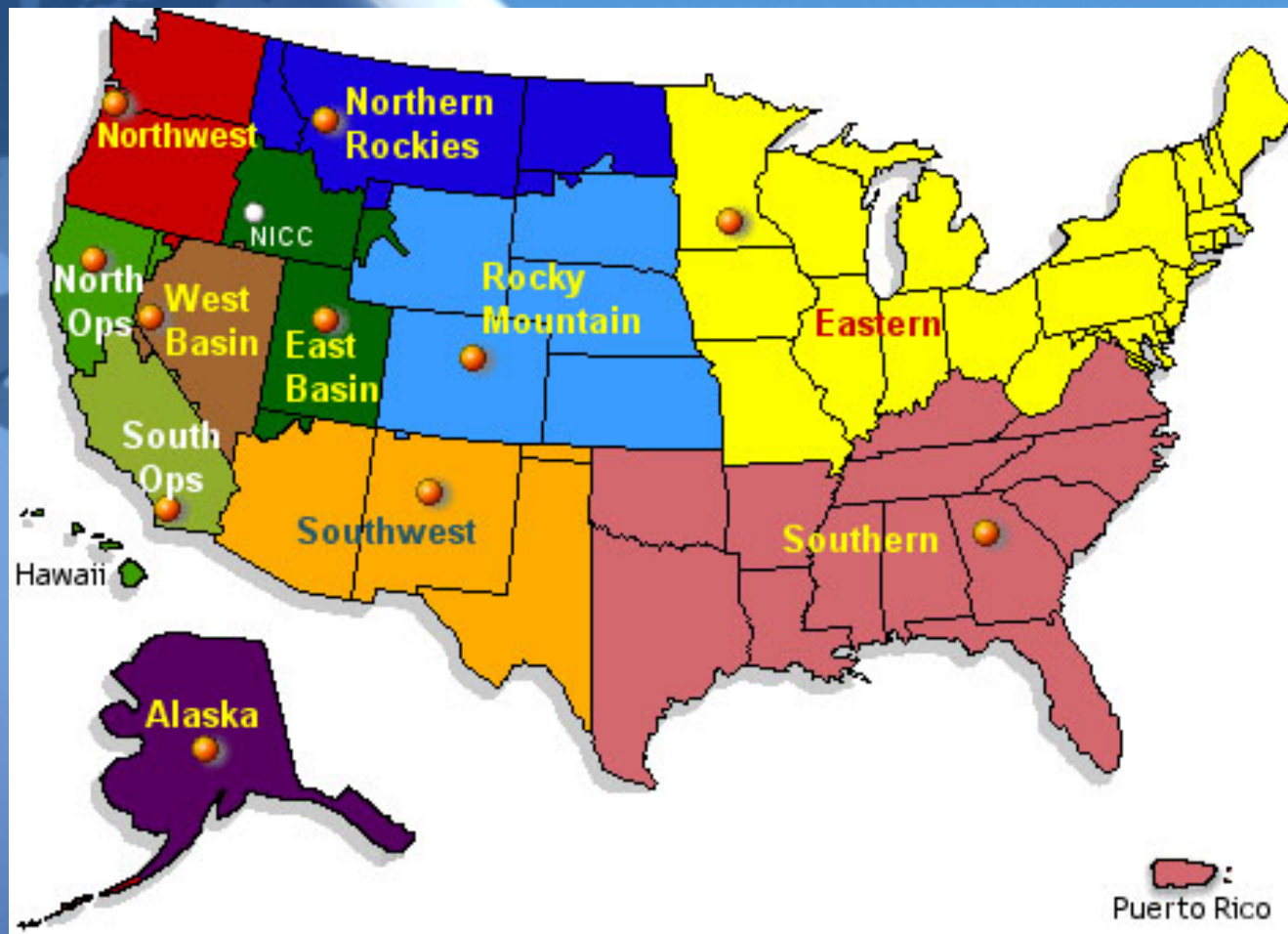
- After presenting at the State of North Carolina Undergraduate Research and Creativity Symposium, two directions emerged for our project
 - Forecasting and modeling problematic areas (California, NW US)
 - Examining solar activity to determine natural or man-made warming risk

Forecasting Wildfires

- Data obtained as of 3/10/09 to begin constructing model to forecast wildfires starting with NW region of US
 - Next step is determining the meteorological variables that could influence fires and cause discrepancies (i.e. temperature, precipitation, drought conditions, etc.)
 - Data retrieved from NIFC through Geographic Area Coordination Centers (GACC)

*Special thanks to Mr. Dan O'Brien, Data Coordinator for the NW GACC Region

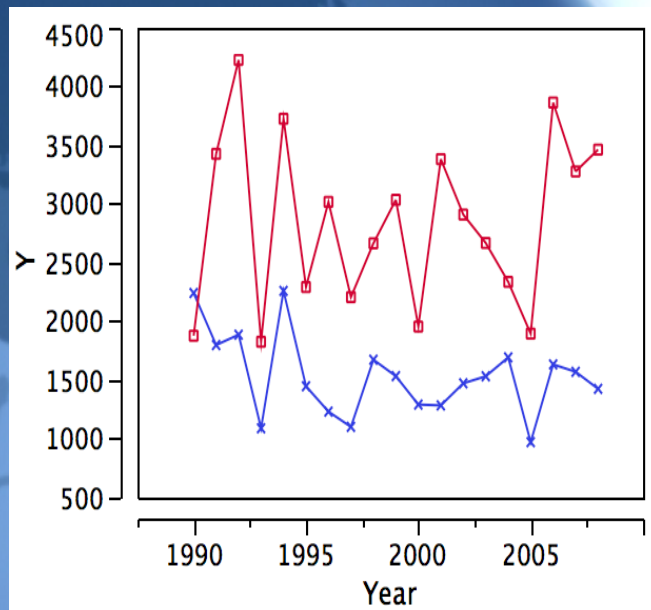
NIFC GACC Map



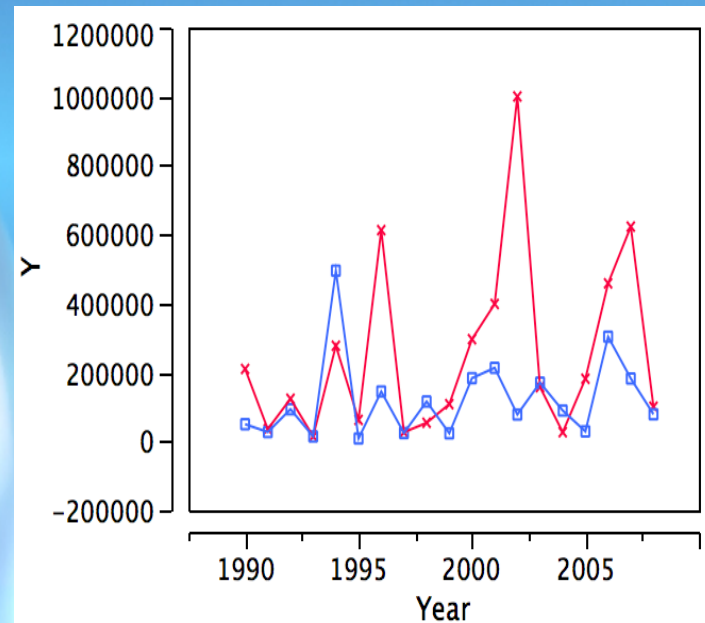
Closer Look at Oregon and Washington Data

- Oregon Totals
 - Fires = 54,057
 - Acres = 4,761,702
- Washington Totals
 - Fires - 31,160
 - Acres = 2,354,937
- Noticeable differences? Bordering States?

Scatter plots comparing Oregon and Washington



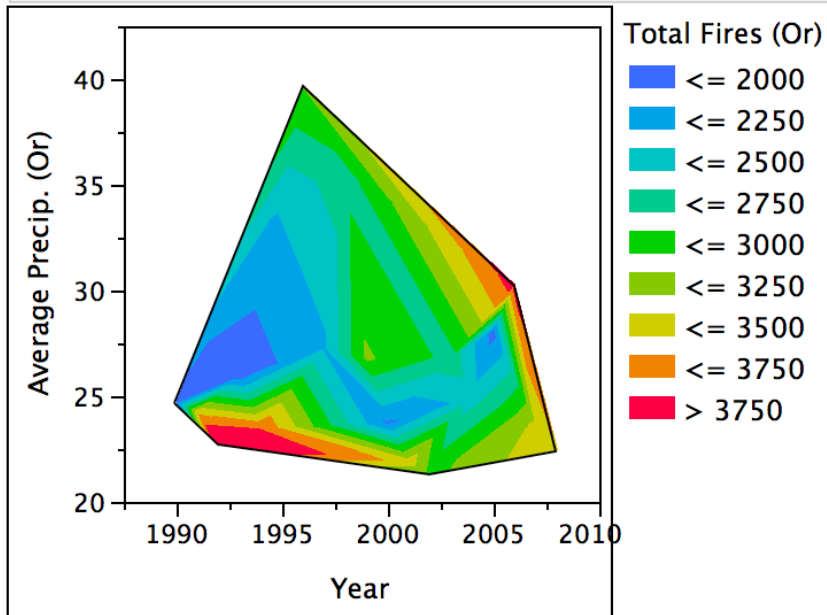
Y × — **Total Fires (Wa)** □ — **Total Fires (Or)**



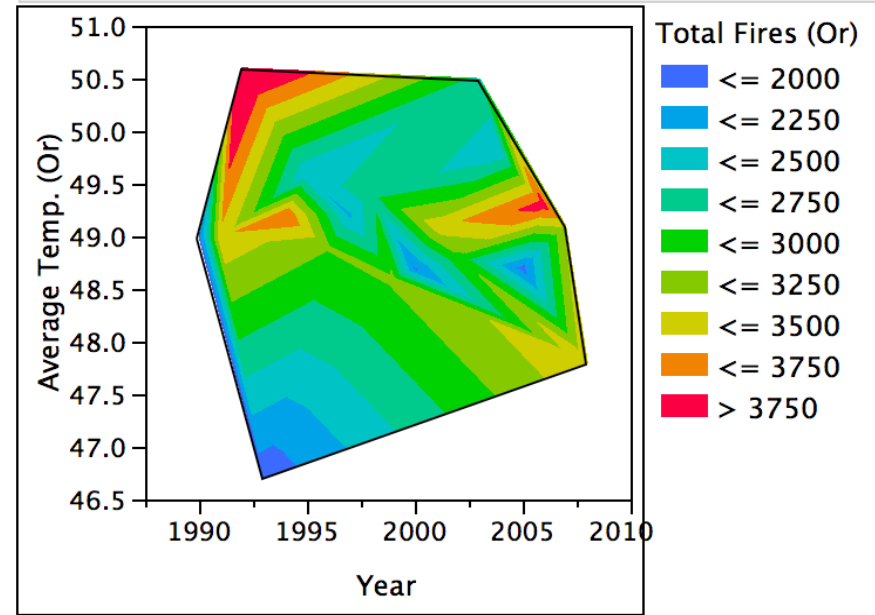
Y × — **Total Acres (Or)** □ — **Total Acres (Wa)**

Or. Contour Plots for Annual Total Fires

Contour Plot for Total Fires (Or)

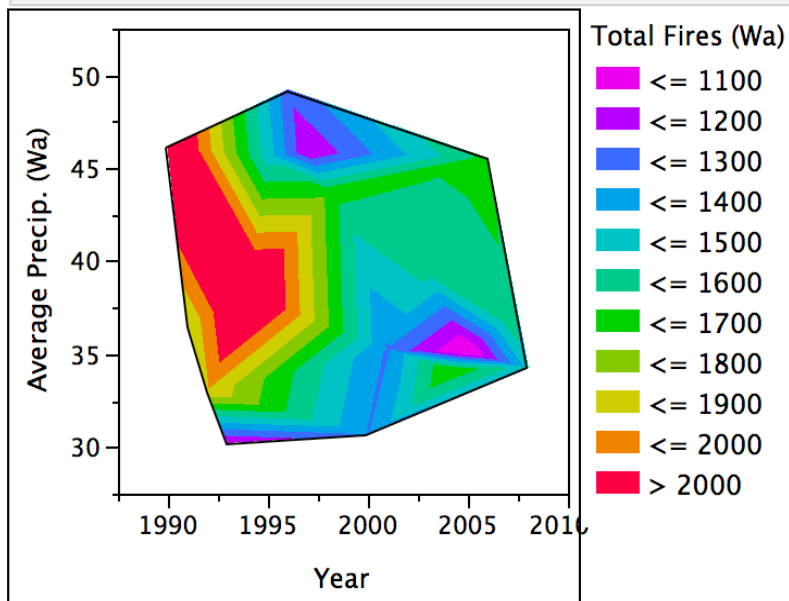


Contour Plot for Total Fires (Or)

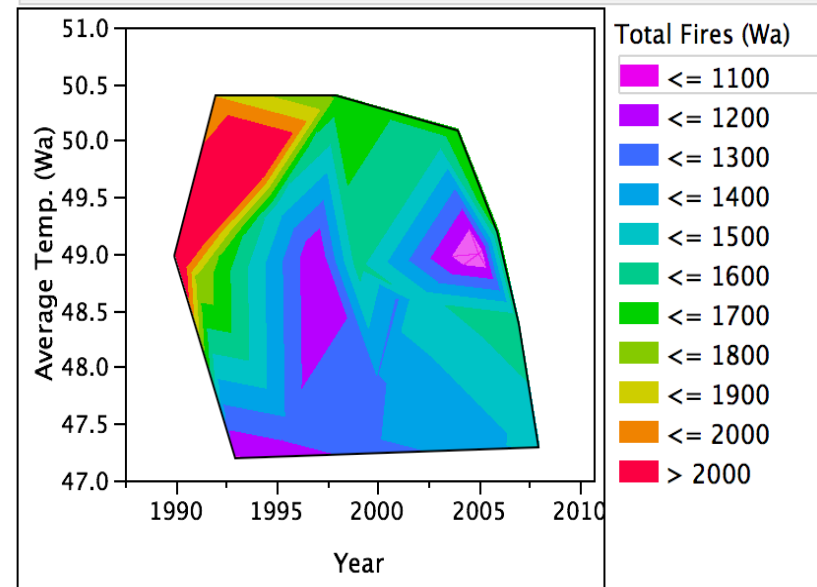


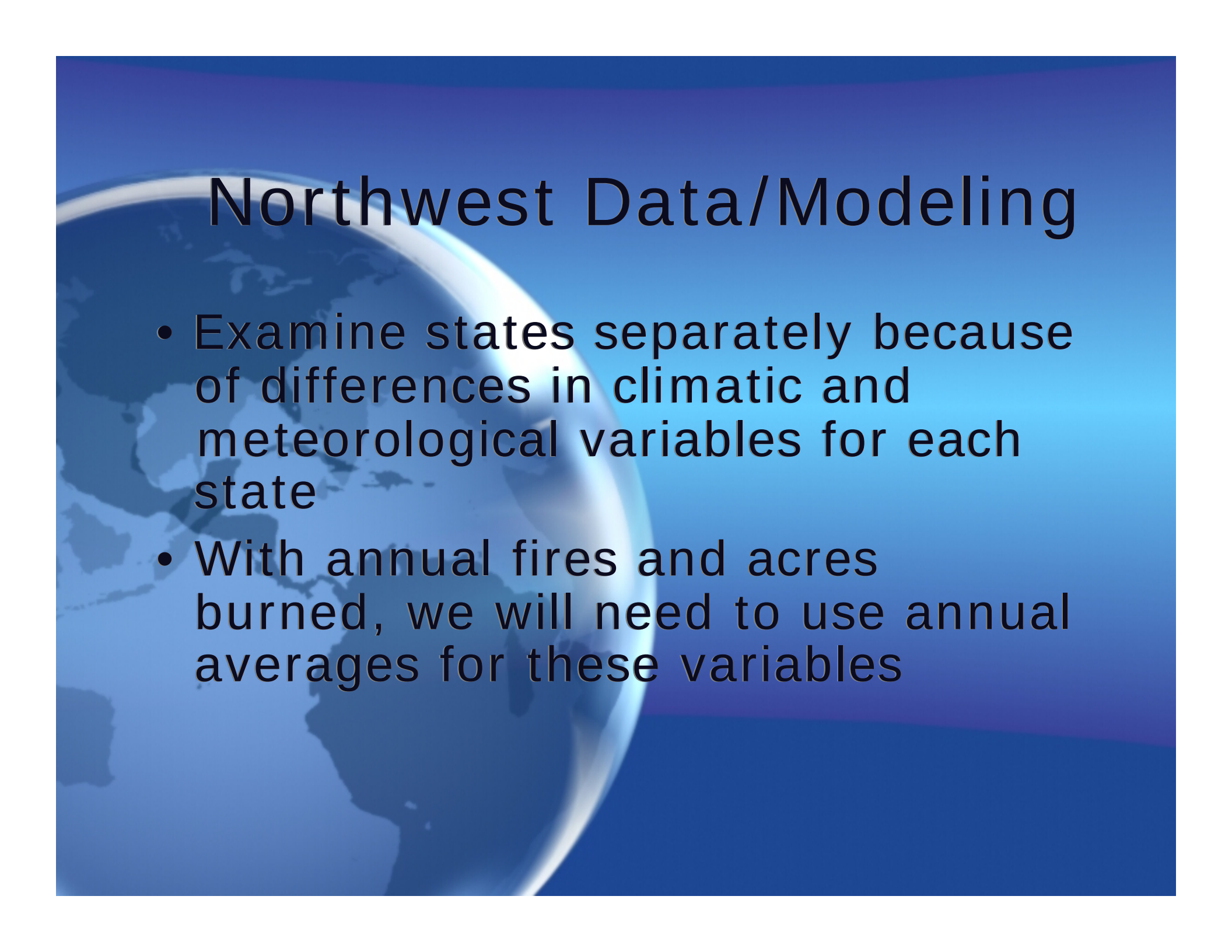
Wa. Contour Plots for Annual Total Fires

Contour Plot for Total Fires (Wa)



Contour Plot for Total Fires (Wa)





Northwest Data/Modeling

- Examine states separately because of differences in climatic and meteorological variables for each state
- With annual fires and acres burned, we will need to use annual averages for these variables

Theoretical Model

- Modeling Frequency of Wildfires using *Multiple Linear Regression*

$$\begin{aligned} - \hat{y} = & \beta_0 + \beta_1(\text{Temp}) + \beta_2(\text{rel_humidity}) + \beta_3(\text{precip}) + \\ & \beta_4(\text{wind_dir}) + \beta_5(\text{wind_spd}) + \beta_6(\text{day_of_yr}) + \beta_7(\text{year}) + \\ & \beta_8(\text{soil_moisture}) + \beta_9(\text{heat_degr_days}) + \beta_{10}(\text{multivar_indx}) + \\ & \beta_{11}(\text{soil_temp}) + \beta_{12}(\text{burn_acres_desig}) + \beta_{13}(\text{hrs_allowed_burn}) \\ & + \beta_{14}(\text{latitude}) + \beta_{15}(\text{longitude}) \end{aligned}$$

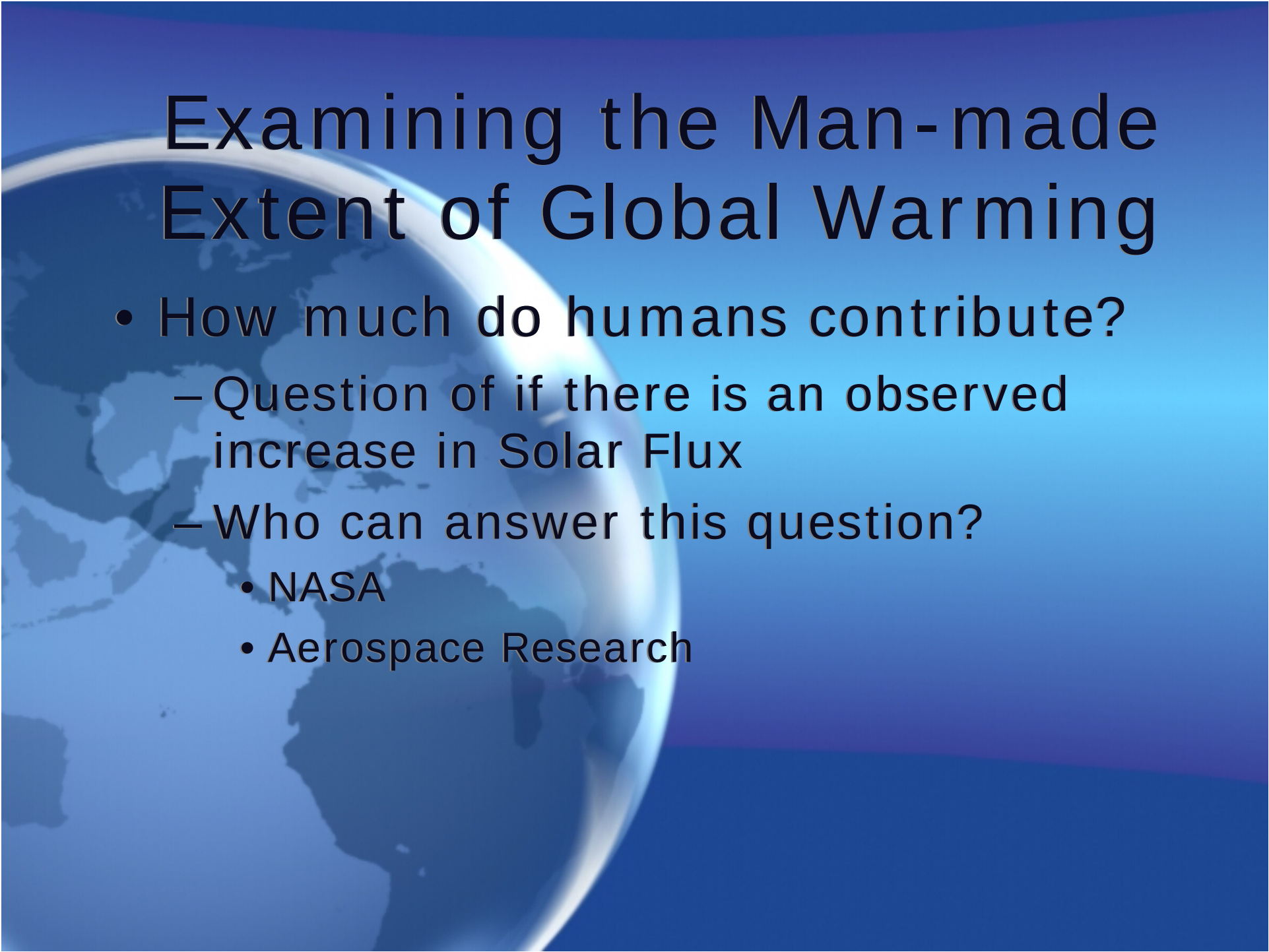
- $\hat{y} = \#$ (frequency) of wildfires on a given day
 - (Our model will use annual data)
- Variable selection method: STEPWISE REGRESSION
- Theoretical because of availability of ANNUAL data instead of DAILY values for variables

Theoretical Model Cont.

- Predicting the likelihood of a Wildfire (daily basis) using logistic regression:
 - $p_hat = [1 + \exp(-12.0966 * \text{Intercept} + 0.00507 * \text{year} + 1 * \text{lightningAcres} + 1 * \text{humanAcres} + 0.12742 * \text{codedState1} - 0.04337 * \text{temp} + 0.00053 * \text{precip})]^{-1}$
 - Reminder: DAILY Models preferred, however we are unavailable to construct them -> Annual Models

Primitive Regression Model

- $\text{totalAcres} = -12.0966 * \text{Intercept} + 0.00507 * \text{year} + 1 * \text{lightningAcres} + 1 * \text{humanAcres} + 0.12742 * \text{codedState1} - 0.04337 * \text{temp} + 0.00053 * \text{precip}$
- $\text{codedState2} = \text{Intercept} - \text{codedState1}$
 - codedState1: Oregon
 - codedState2: Washington
- $R^2 = 0.6727$
- Also will be performing stepwise variable selection as more variables become available for analysis



Examining the Man-made Extent of Global Warming

- How much do humans contribute?
 - Question of if there is an observed increase in Solar Flux
 - Who can answer this question?
 - NASA
 - Aerospace Research

Finding Contacts

- Mr. Tom Pace, formerly of USEPA -> Mr. Jim Szykman, USEPA/NASA and Mr. Joel Levine, NASA
- Mr. Szykman/Mr. Levine -> Dr. Robert Tolson, NCSU and Head of Atmospheric Science for the National Institute of Aerospace
 - Interesting leads on extent of increased heat output from the Sun
 - Constant Solar Flux? Constant solar radiance?
 - In the interest of time, this aspect of the project will have to be examined by future students/researchers

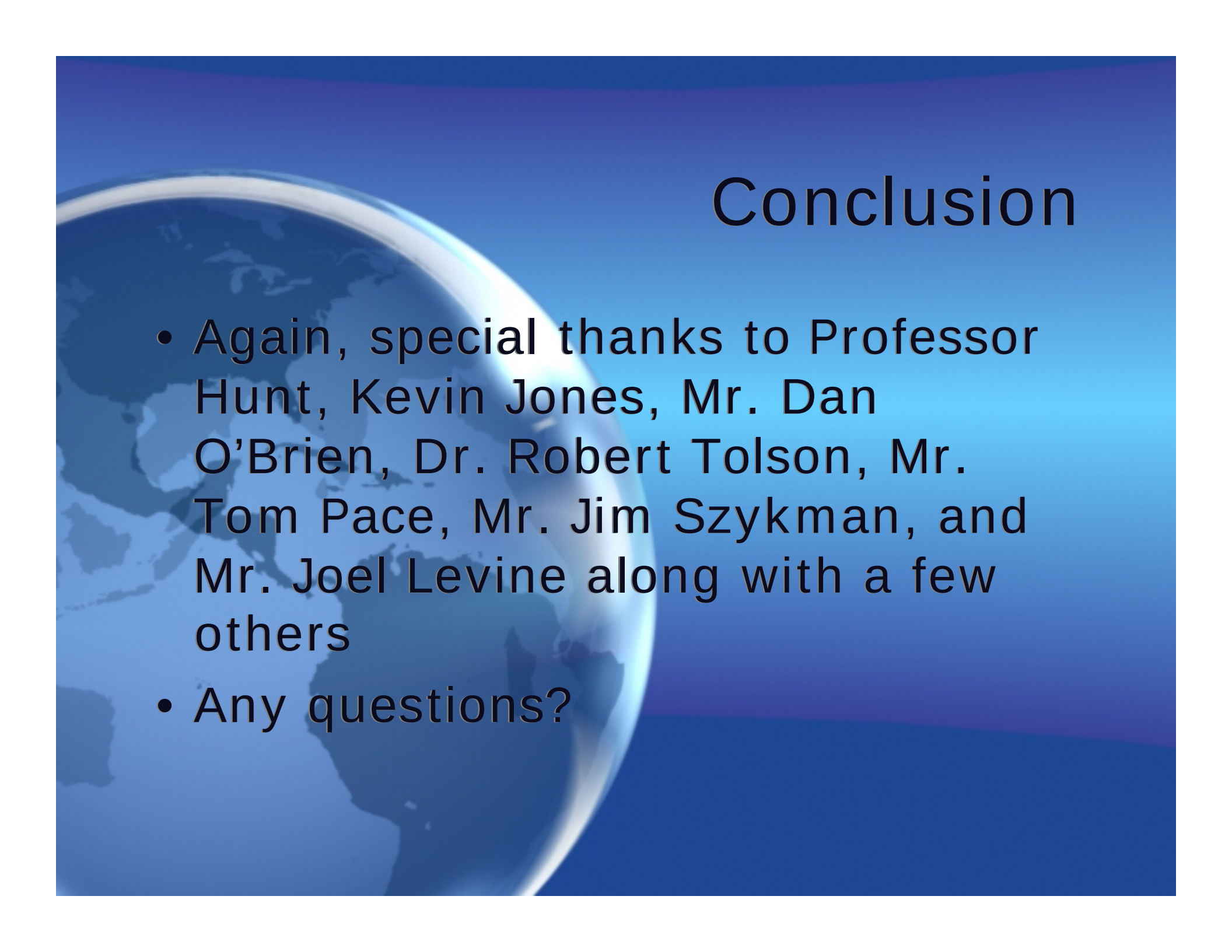
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Suggestions

- We recommend that more measures be taken by agencies throughout the nation to develop planning models such as the NW GACC to increase preparedness for wildfires
 - Include work to conform GACC's in practice so NIFC is a more uniform agency
- Also, furthering research into which variables are significant predictors for wildfires
- Explore the effects of high year to low year trends
 - Could this suggest that a better policy for prescribed burning would help curtail the amount of acres burned?

Future Plans

- Finalize model for Or. And Wa., then construct model for Ca. regions
 - By the projects completion, we hope to construct models for each state where wildfires are or could potentially become a serious problem
- Continue to analyze or verify Dr. Tolson's comment on a constant solar flux
- Presentations throughout the spring into August as well
 - International Emissions Inventory Conference (April 14-15)
 - NCSU Undergraduate Research Symposium (April 16)
 - UNC-CH Presentation (April 20)
 - Joint Statistical Meeting (August 1-6)

The background of the slide is a blue gradient with a faint, stylized image of the Earth's horizon and continents visible on the left side.

Conclusion

- Again, special thanks to Professor Hunt, Kevin Jones, Mr. Dan O'Brien, Dr. Robert Tolson, Mr. Tom Pace, Mr. Jim Szykman, and Mr. Joel Levine along with a few others
- Any questions?