**Global Temperature Analysis: Understanding Climate Change Trends**  
Welcome everyone. Today I'll be presenting an analysis of global temperature trends based on the work of researchers Ryan Weeks, Sarah Yawn, and Lisa Hansen. This project applies data science techniques to understand climate change patterns over time.

**Project Overview**  
This project represents a comprehensive analysis of global temperature data spanning several decades. The researchers focused on identifying regional warming trends, seasonal patterns, and climate anomalies using Python-based data science techniques. The work combines exploratory analysis with advanced statistical modeling to extract meaningful insights from historical temperature records.

Methodologically, the project employed a range of data science techniques. It began with exploratory data analysis to understand the basic patterns in the data, including the organization of countries into continental subgroups and the removal of inconsistent data reported before 1850. Next, regression modeling was implemented to quantify relationships between temperature anomalies, time, and geography. For forecasting, the researchers implemented both ARIMA and Facebook's Prophet models, which are specialized for time series prediction.

**Research Objectives**  
The research had several key objectives: to identify long-term temperature trends across different regions of the world, analyze seasonal patterns and climate anomalies, forecast future temperature changes using predictive models, and understand how dataset selection impacts climate conclusions. This multi-faceted approach helps build a more complete picture of climate change dynamics.

**Exploratory Analysis Findings**  
As we will see through the coming slides. Not only do mean temperatures appear to rise across all continents, but also an increase in volatility and abnormalities begin to really impact the world, depending on the continent, this volatility becomes notably worse between 1940 and 1980, getting steadily worse as we progress to the modern day. The analysis does take seasonal change into account, which is important when considering climate change has been known to make hotter summers and colder winters, possibly averaging out the change if scientists are only analyzing the mean values. However, when comparing the first half of the 20st century to the second, it is consistently clear all continents are hotter entering the 21st century than they were entering the 20th. This diagram include the 3 continents with the largest gaps for visual simplicity.

Note: perhaps a map averaging seasonal temperatures by continent between 1900-1940 and 1960-2000 may paint an interesting picture

**Regional Warming Trends**  
One key finding was the uneven nature of warming across different continents. Some regions are experiencing significantly faster warming than others, which has important implications for climate adaptation strategies. These regional differences were visualized to highlight areas of particular concern.

As you can see, Europe and Antarctica experienced a larger variance in their anomalies in the first half of the 20th century, while Asia seems to have replaced antarctica in the last half. While Europe seems to have stayed at a larger deviation of anomalies while also swinging wildly between a 0.3 and 0.6 standard deviation throughout the century, while the less volatile continents , Africa for example, only see a variation of about 1.5 to 2.5 variations throughout the same time frame.

**Regression Analysis**  
The regression analysis modeled temperature anomalies as a function of year and continent. This approach allowed the researchers to quantify warming rates while controlling for geographical factors. The model coefficients provide insight into how much warming has occurred over time in different regions.

Included is a visualization of the model (in red) compared to the observed anomalies (blue).

**Time Series Forecast**  
For forecasting future temperatures, the team first employed ARIMA models. These statistical models capture autoregressive and moving average components in time series data. The results include projections of future temperature anomalies with confidence intervals to represent uncertainty.

As an alternative forecasting approach, the researchers also implemented Facebook's Prophet model. This model is designed to handle seasonality and can incorporate trend changes. The forecast trajectories under current trends provide a sobering look at potential future warming if current patterns continue.

The inclusion of prophet in the forecasting model was increasing helpful. As it is important to note that while certain continents showed a more accurate forecast with ARIMA, most had more success with Prophet, and having the option to choose which continues to be most accurate in real-time, may provide a better choice for our scientists to identify which model should be used for which continent in the future.

**Important Dataset Exclusion**  
An important aspect of this research was comparing results across different dataset selections. The researchers found that conclusions about climate trends can be significantly affected by whether one uses the full historical record or only more recent, higher-quality data. This highlights the importance of data quality considerations in climate research.

Please note the variability before 1760, 1760 -1850, and 1850-1900

**Key Findings**  
To summarize the key findings: the analysis confirmed global warming trends while highlighting important regional variations. It quantified warming rates across different continents and identified changes in seasonal patterns. Perhaps most importantly, it demonstrated how dataset selection can impact climate analysis conclusions.

**Implications and Applications**  
This research has several important implications. It contributes to our scientific understanding of climate change patterns and provides methodological insights for climate data analysis. The regional findings could inform targeted climate adaptation policies, and the work suggests several promising directions for future research.

**In Conclusion**  
In conclusion, this data science approach to climate analysis provides valuable insights into global warming trends. While acknowledging limitations in historical data quality and modeling approaches, the research clearly demonstrates warming patterns with regional variations. Moving forward, continued refinement of these methods could further enhance our understanding of climate change dynamics. While there may be some intensive work to be done on cleaning pre-1900s data to be more consistent, at this time we have no way to prove the accuracy of that data.

I'm now happy to take any questions about this research.

**Q&A Section:**

1. **Q: How reliable are the temperature forecasts produced by this analysis?**  
   A: The forecasts represent statistical projections based on historical patterns and should be interpreted as possible scenarios rather than definitive predictions. Both ARIMA and Prophet models have limitations when applied to complex climate systems.
2. **Q: What time period does the historical data cover?**  
   A: The analysis includes centuries of temperature data, with specific comparisons between the full historical record and post-1850/post-1900 subsets to examine how data quality affects conclusions.
3. **Q: How were regional differences in warming trends accounted for?**  
   A: The analysis incorporated continent and country information into the models, allowing for comparison of warming rates across different geographical regions.
4. **Q: What are the main limitations of this analysis?**  
   A: Limitations likely include data quality issues in earlier historical records, simplification of complex climate systems into statistical models, and the inherent uncertainty in long-term forecasting.
5. **Q: How does this analysis compare to IPCC climate projections?**  
   A: This analysis focuses on statistical modeling of historical trends rather than the complex physical climate models used by the IPCC, but provides complementary insights on observed patterns.