

# **SANDIA REPORT**

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## **Uncertainty Quantification of US Southwest Climate from IPCC Projections**

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# Uncertainty Quantification of US Southwest Climate from IPCC Projections

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## **Abstract**

The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) made extensive use of coordinated simulations by 18 international modeling groups using a variety of coupled general circulation models (GCMs) with different numerics, algorithms, resolutions, physics models, and parameterizations. These simulations span the 20<sup>th</sup> century and provide forecasts for various carbon emissions scenarios in the 21<sup>st</sup> century. All the output from this panoply of models is made available to researchers on an archive maintained by the Program for Climate Model Diagnosis and Intercomparison (PCMDI) at LLNL. I have downloaded this data and completed the first steps toward a statistical analysis of these ensembles for the US Southwest. This constitutes the final report for a late start LDRD project. Complete analysis will be the subject of a forthcoming report.



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# 1 Summary of Accomplishments

- Reviewed literature
- Briefed Tom Hunter & prepared BOD briefing
- Downloaded and analyzed archived data
- Comparison to historical data
- Statistical framework development
- Built ongoing collaboration with UNM
- Convened 2 AGU sessions on UQ/climate
- Organized CCSM Workshop UQ session



## 2 Presentations

Climate presentations at the following conferences were funded, at least in part, by this project. Abstracts and presentations associated with this project after the end of the fiscal year made use of this project's results.

Dec. 2009: American Geophysical Union 2009 Fall Meeting, San Francisco.

June 2010: Community Climate System Model Workshop, Breckenridge.

July 2010: Research Experience in Carbon Sequestration (invited keynote), Albuquerque.

July 2010: American Quaternary Association (invited plenary), Laramie.

Nov. 2010: Geological Society of America, Denver.

Dec. 2010: American Geophysical Union 2010 Fall Meeting, San Francisco.

Mar. 2011: (upcoming) AGU Chapman Conference on Climates, Past Landscapes,  
Civilizations, Santa Fe.



### **3 Selected presentation graphics**

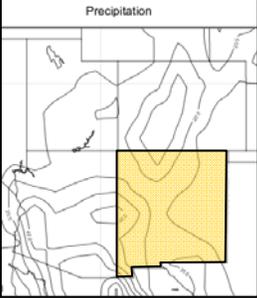


## Uncertainty Quantification of US Southwest Climate from IPCC Projections (140641)

Mark Boslough (1433), Patrick Brady (6310), FY09: \$100k, FY10: \$150k

### Purpose, Goals, Approach

*Develop rigorous analysis of uncertainties in regional forecasts using today's GCMs to help identify needs and metrics associated with performing uncertainty quantification for climate forecasts with tomorrow's higher-resolution models*



### Significance of Results

*Objective methods of risk assessment are needed to bridge the gap between science and policy. Uncertainty quantification can be used objectively by decision makers to prepare for and respond to regional climate change. Backus et al. (2010) "Chu Report" used similar methods.*

### Key Accomplishments

- Reviewed literature
- Briefed Tom Hunter & prepared BOD briefing
- Downloaded and analyzed archived data
- Comparison to historical data
- Statistical framework development
- Built ongoing collaboration with UNM
- Convened 2 AGU sessions on UQ/climate
- Organized CCSM Workshop UQ session

### What's Next

- Programmatic interest: We are already to using the experience gained by this project to build collaborations with other labs and for proposals to DOE, DoD, and IC customers
- UQ experience has fed into new NNSA/BER climate project and proposed CSSEF project.
- Time to impact: NOW!






## IA should provide the following information

1. Which SMU(s) will benefit from this R&D, and over what time frame ?
 

**Primarily ECI (formerly ERN, but now with the word "climate" in the name! Also (DSA, HSD, and STE). ECI is already seeing the benefit, others (<2yrs).**
2. What is the impact/legacy of this project?
 

**Multiple impacts include follow-on work, and new programs including NNSA BER climate project, Greenhouse Gas Information System (GHGIS), Brinkman Initiative (CSSEF) as well as multiple strategic partners.**






## Background: Global Climate Sensitivity

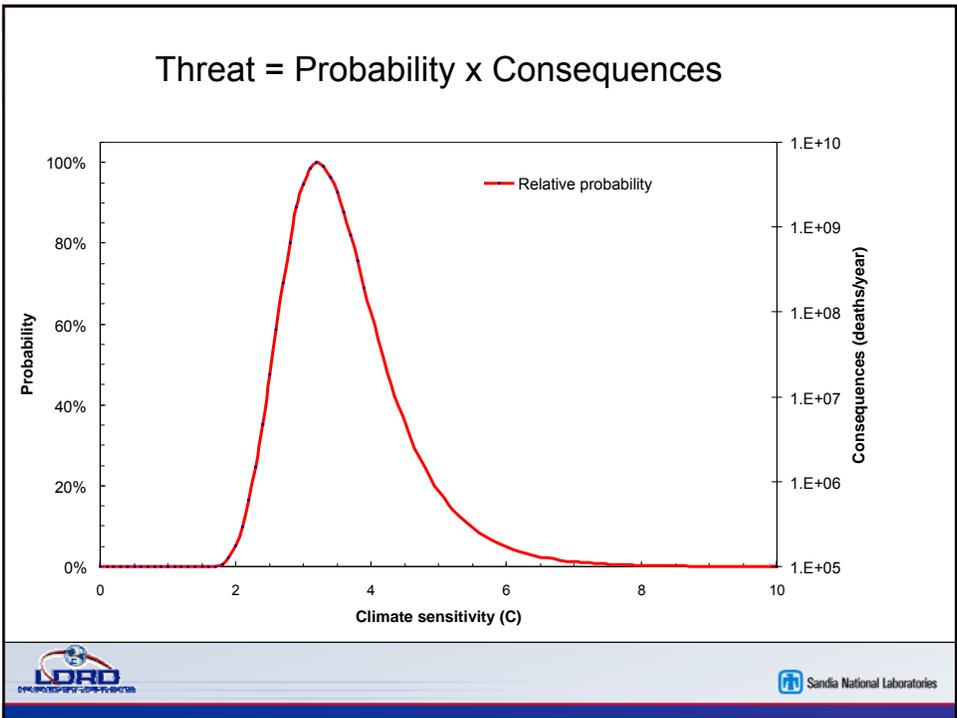
Best estimate is not sufficient. Policy needs uncertainty!

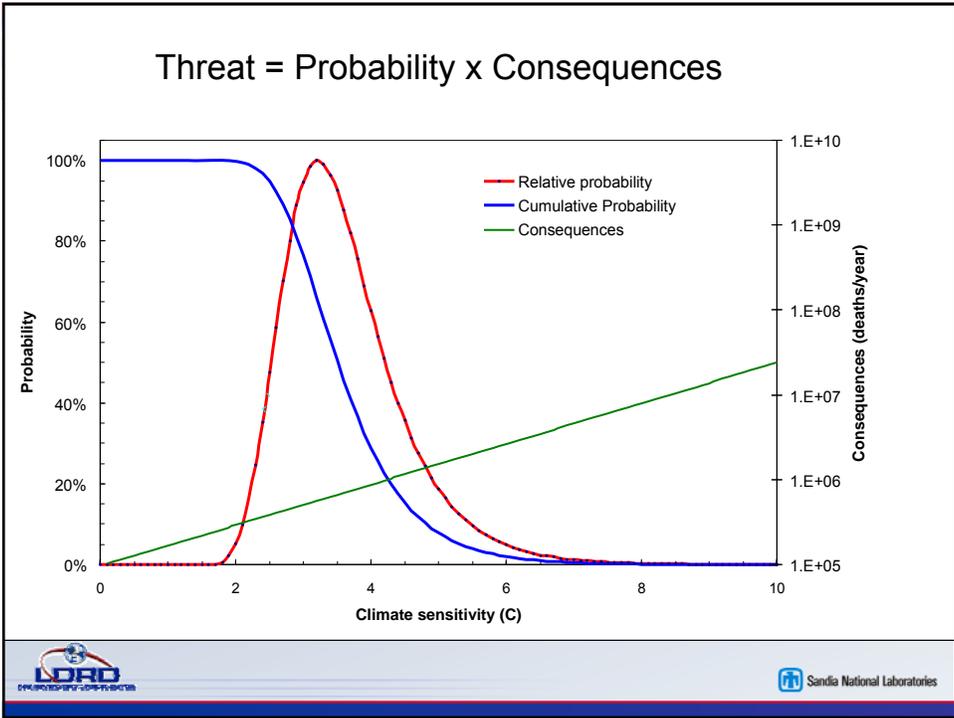
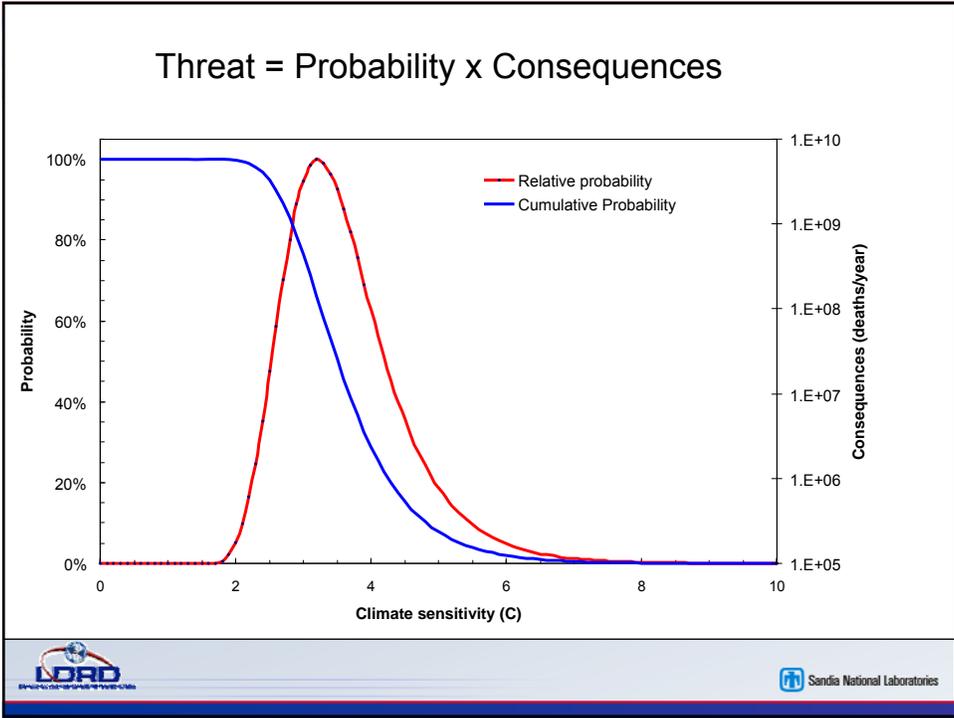
Climate Sensitivity  $\Delta T_{2x}$

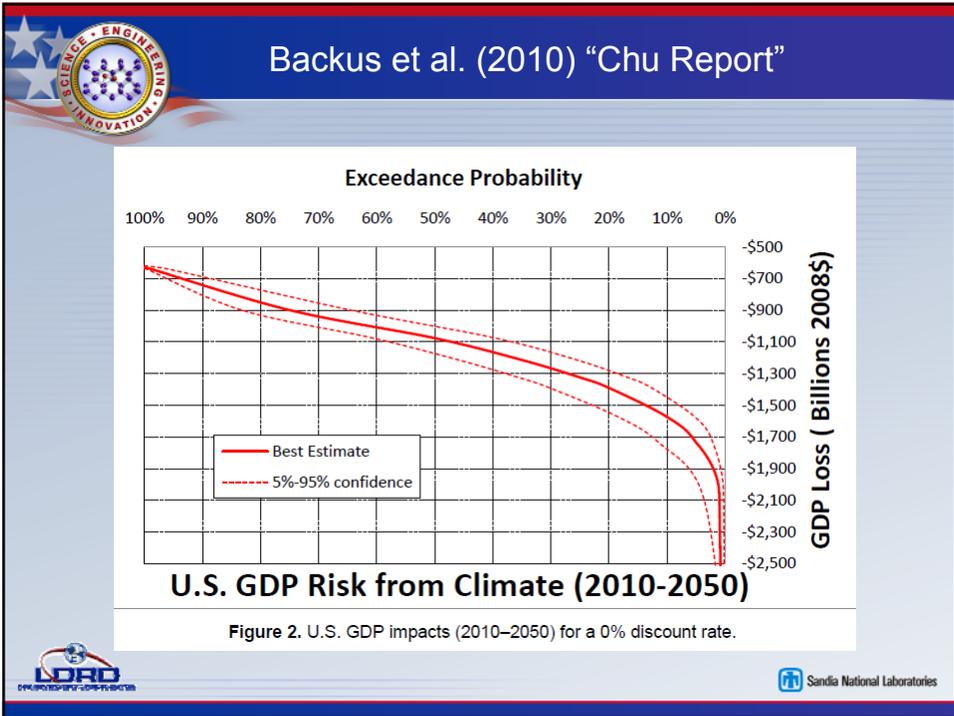
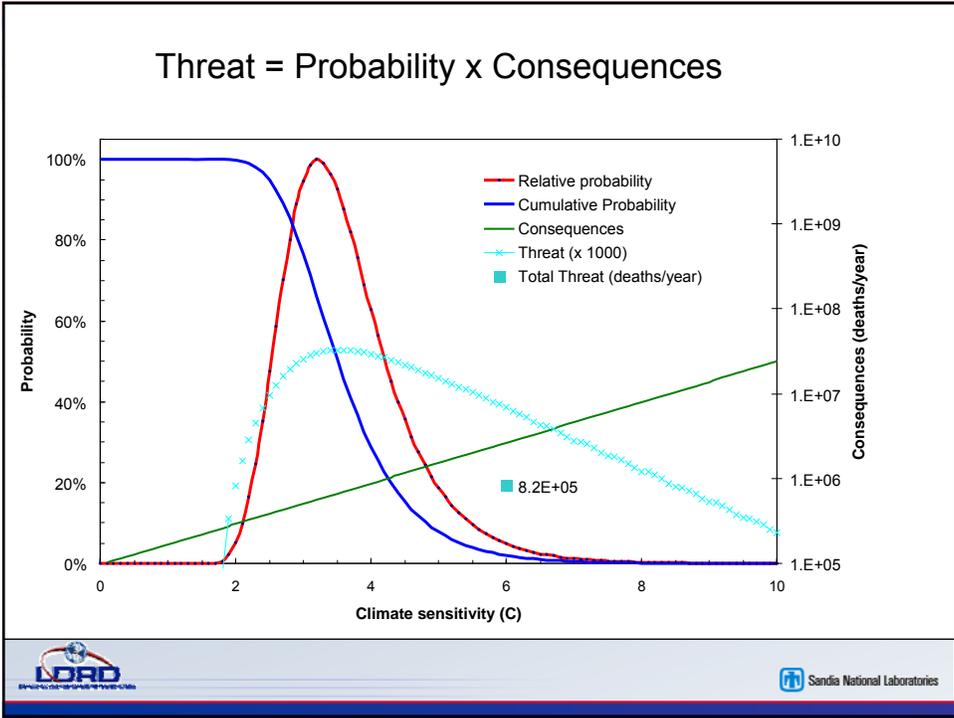
The increase in equilibrium mean global surface temperature due to the equivalent forcing (with short-term feedbacks) of doubled  $\text{CO}_2$ . There is a strong scientific consensus that the best estimate is about  $3^\circ\text{C}$ , but until recently there has been very little effort at uncertainty quantification. The degree of uncertainty is not yet “settled science”.

*This is not useful by itself for assessing regional climate change*



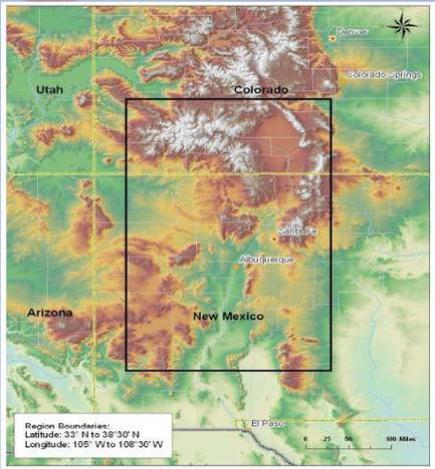






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## Current resolution is too low for regional forecasts



Region Boundaries:  
Latitude: 33° N to 38° 30' N  
Longitude: 105° W to 108° 30' W

*Data taken from IPCC models are based on global grids and underresolved from the perspective of regional climate forecasts.*

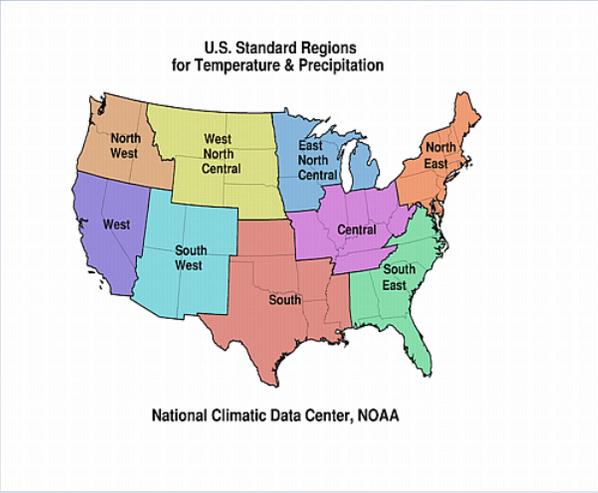
*Parameterizations are used for physical and biological processes that take place on smaller scales. Regional topographic influences and local climates are entirely ignored. Nevertheless, gross changes in climate variables that are influenced by larger-scale processes (e.g. radiative imbalance, ocean temperatures and jet stream location) are properly accounted for.*

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## Adopt NCDC U.S. Standard Region definitions

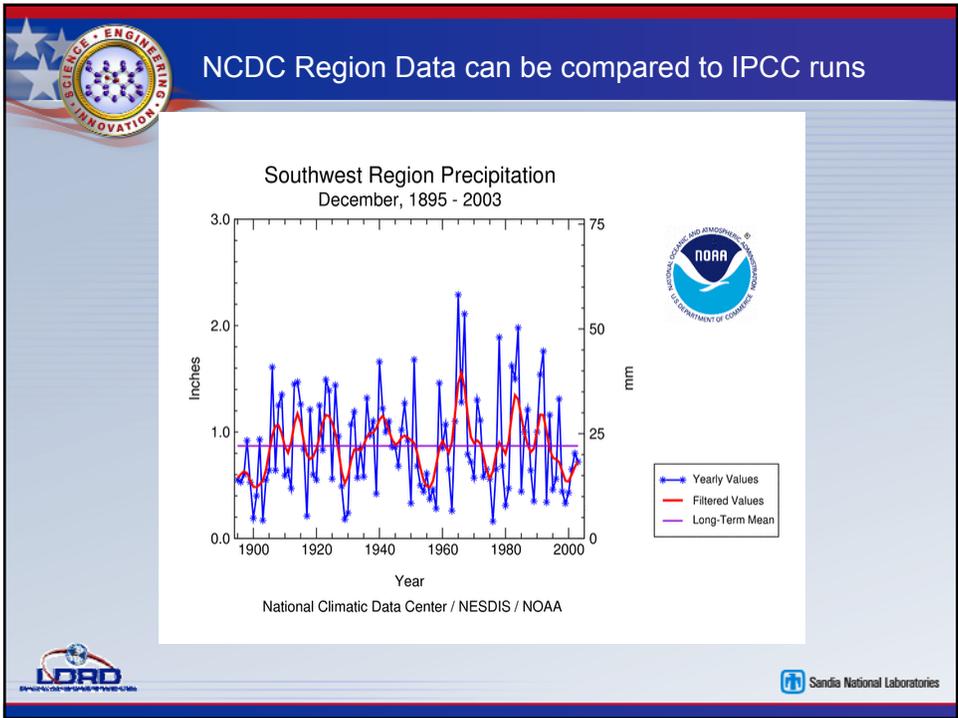


U.S. Standard Regions  
for Temperature & Precipitation

National Climatic Data Center, NOAA

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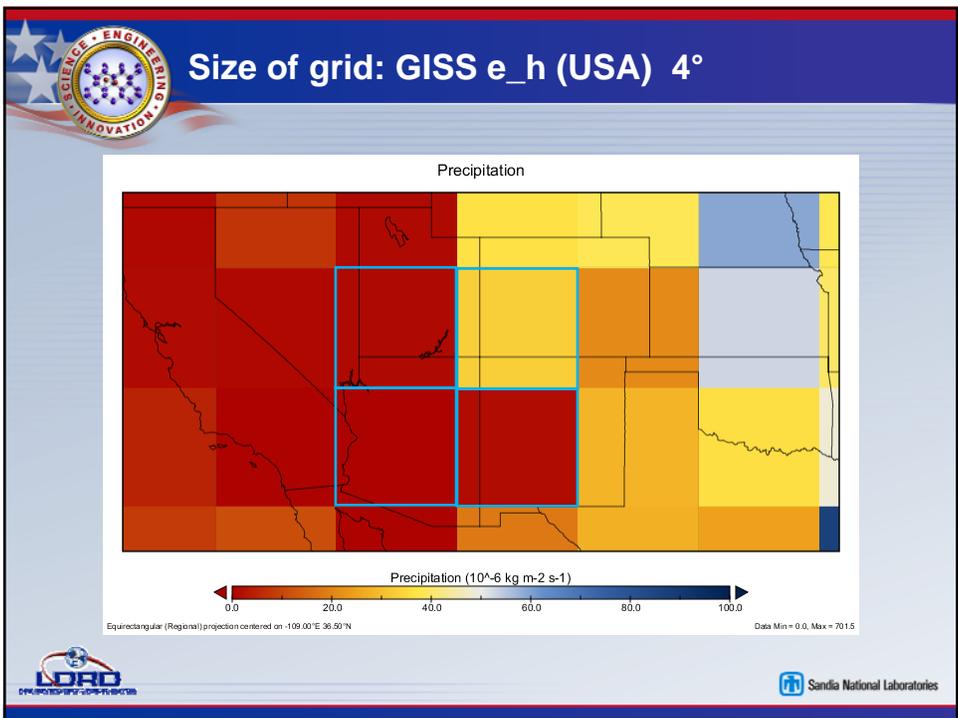
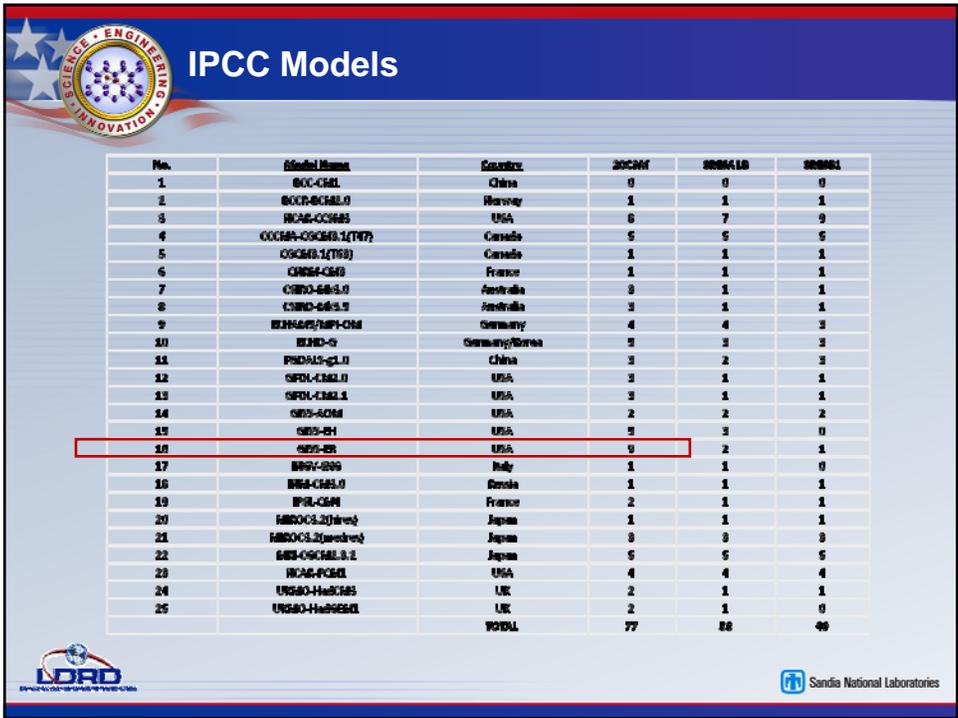
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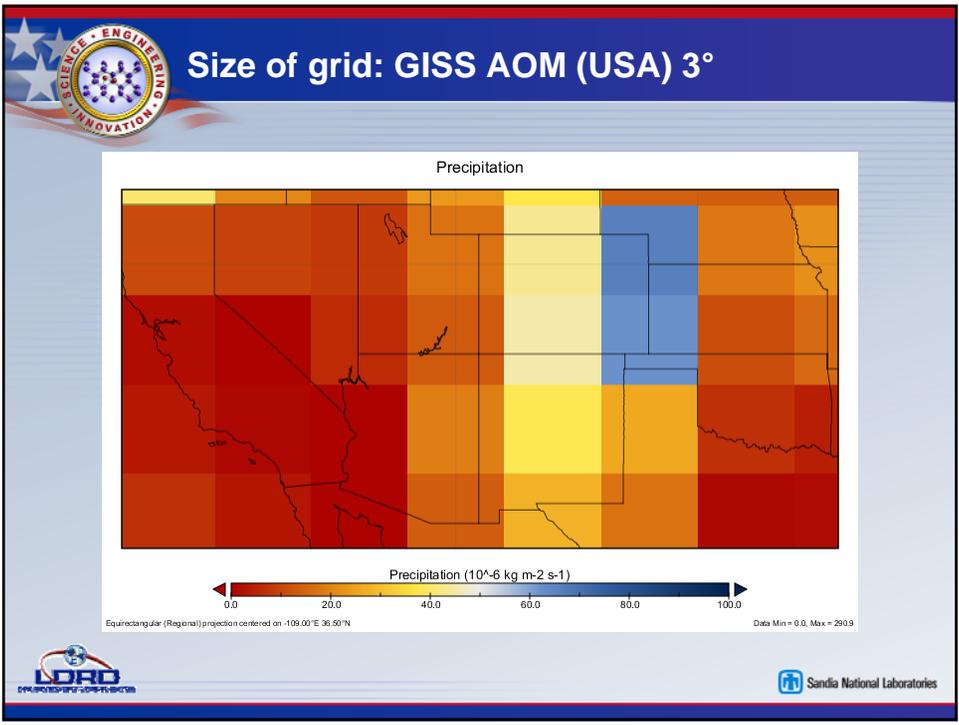
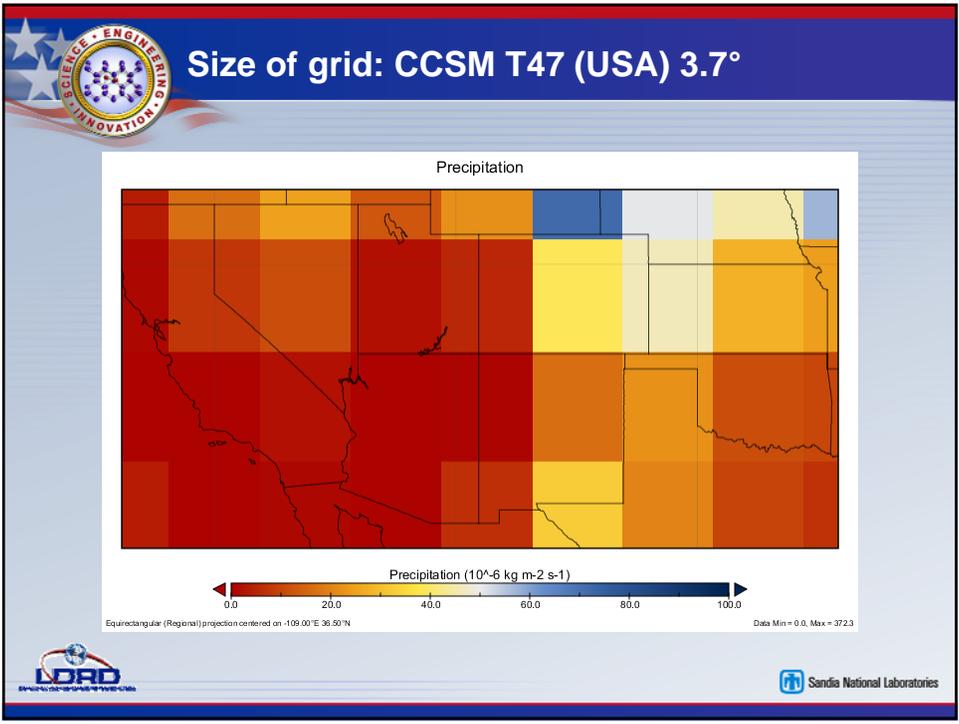


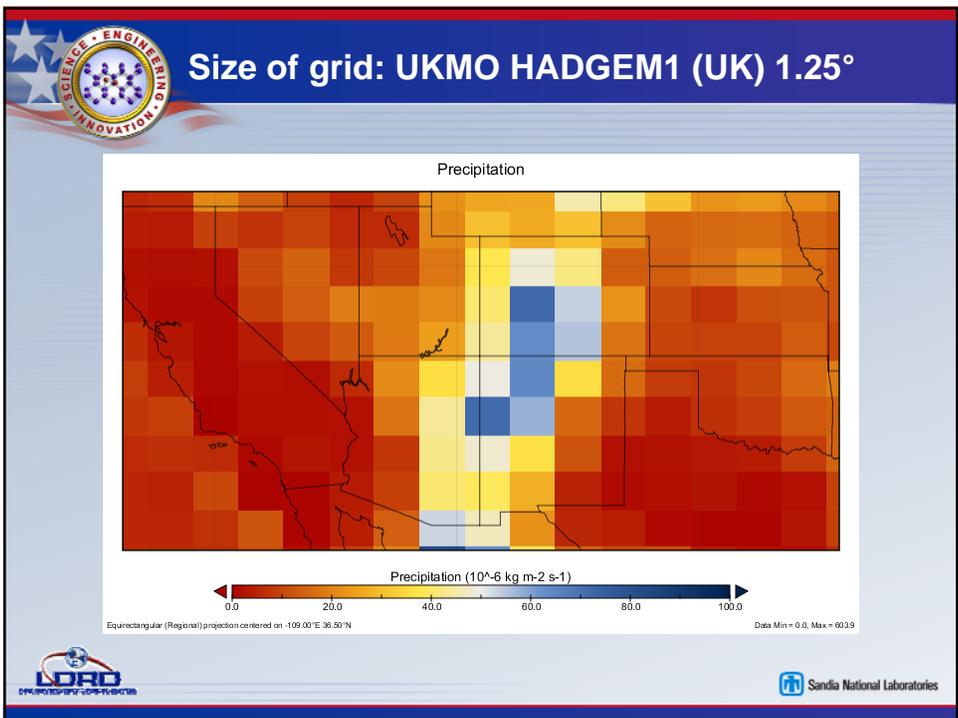
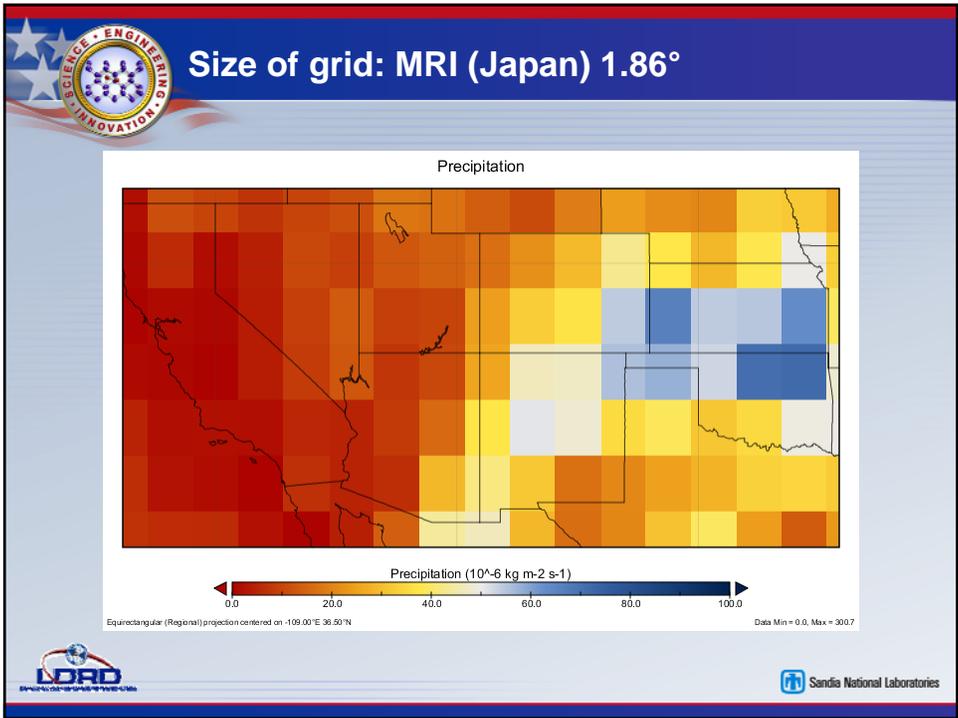
### IPCC Experiments

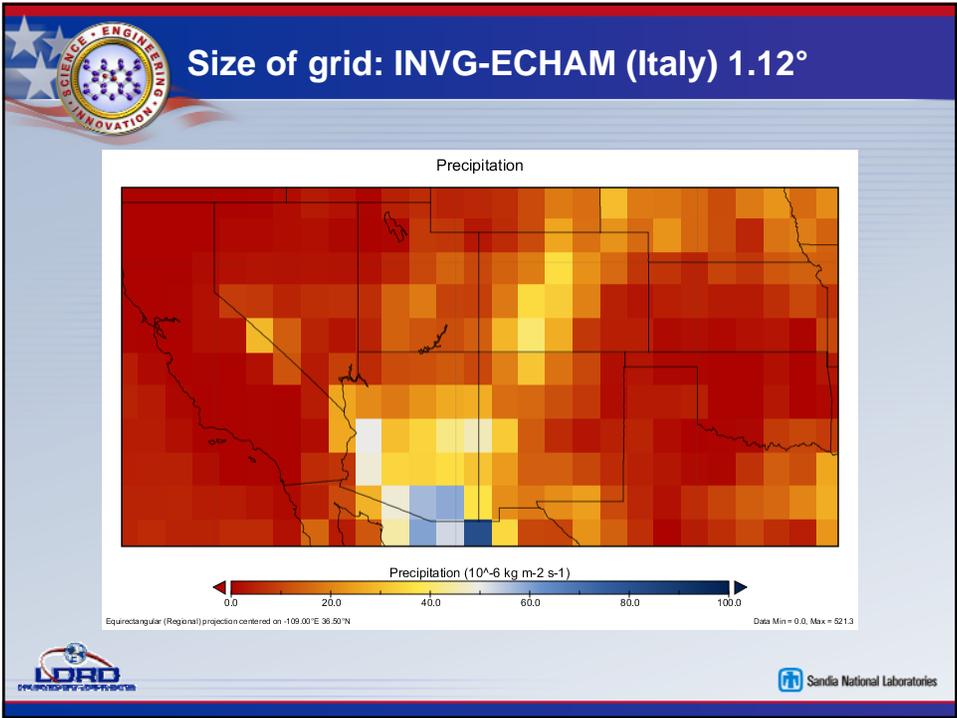
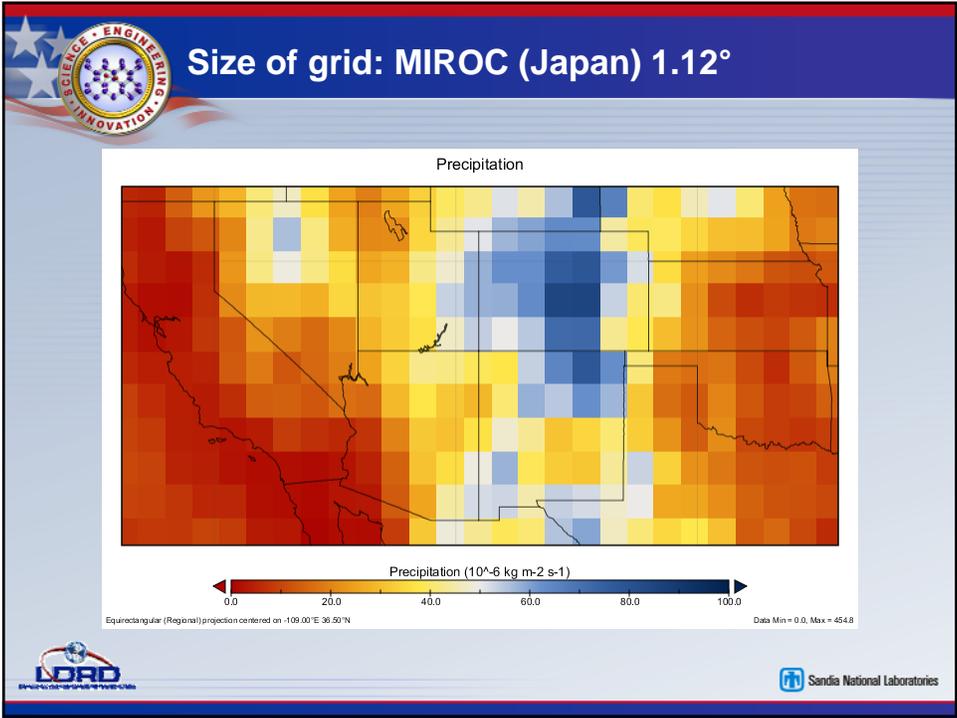
Exp. #	Name	Description	ID
1	Pre-industrial control	No anthropogenic or natural forcing. Simulations prior to ~1990.	PICTRL
2	Present-day control	No natural forcing and anthropogenic forcing is set to present day	POCTRL
3	Climate of the 20th century (20C3M)	Verification runs ~1950-present	20C3M
4	Committed climate change	Present - 2100, uses end of 20C3M as initial condition	COMMIT
5	SRES A2 experiment	Continuously increasing global population and economic growth, although more fragmented and slower than other scenarios. Present - 2100, uses end of 20C3M as initial condition	SRESA2
6	720 ppm stabilization experiment (SRES A1B)	Rapid economic growth, global population peaks in mid-century and declines after that. Rapid introduction for new technologies. Initialize w/ 20C3M and run to 2100. After 2100, hold concentrations steady and run to 2200	SRESA1B
7	550 ppm stabilization experiment (SRES B1)	Same as A1 conditions but future is based on clean and resource efficient technologies. Initialize w/ 20C3M and run to 2100. After 2100, hold concentrations steady and run to 2201	SRESB1
8	1% <sub>yr</sub> CO2 increase experiment to doubling	Hold CO2 fixed after it has doubled. Run is initialized with either pre-industrial or 20C3M.	1PCTO2X
9	1% <sub>yr</sub> CO2 increase experiment to quadrupling	Hold CO2 fixed after it has quadrupled. Run is initialized with either pre-industrial or 20C3M.	1PCTO4X

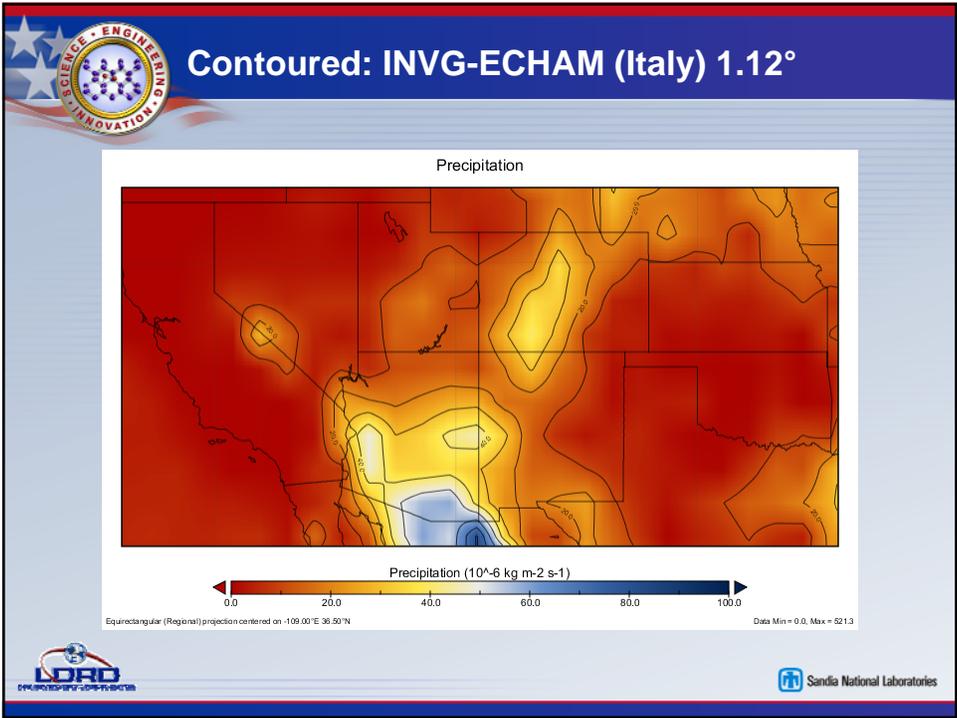
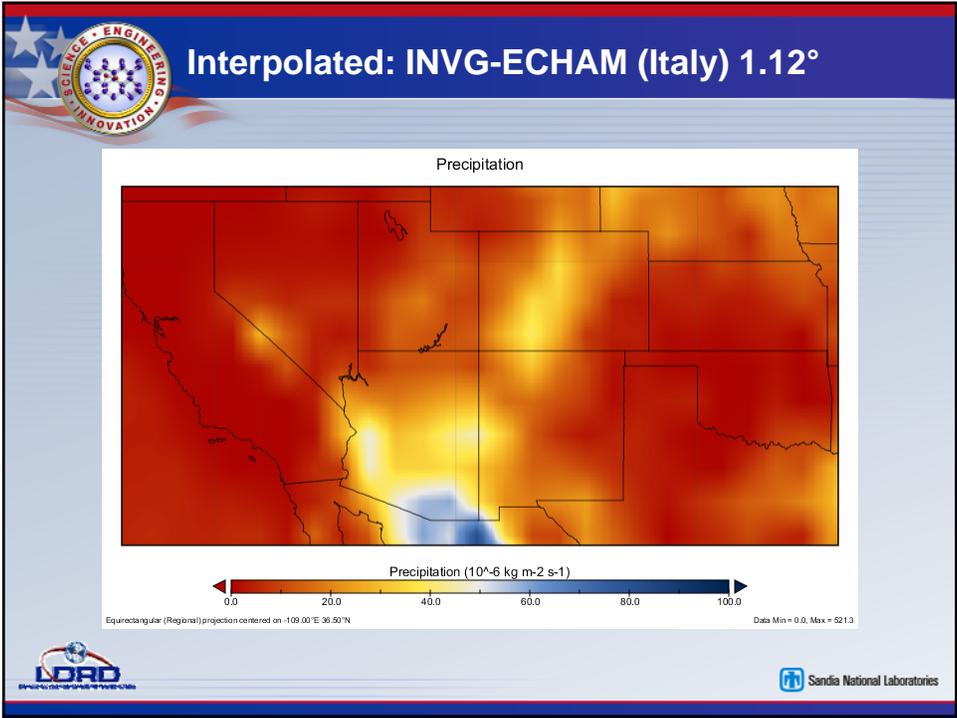
Logos: LORD (LORD OF INNOVATION), Sandia National Laboratories

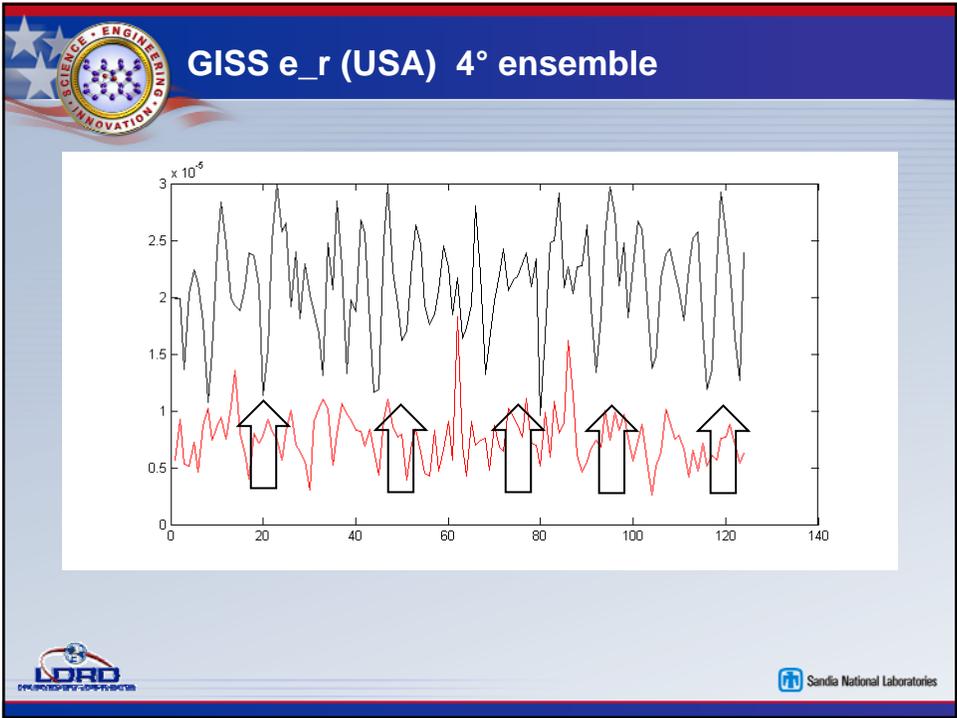
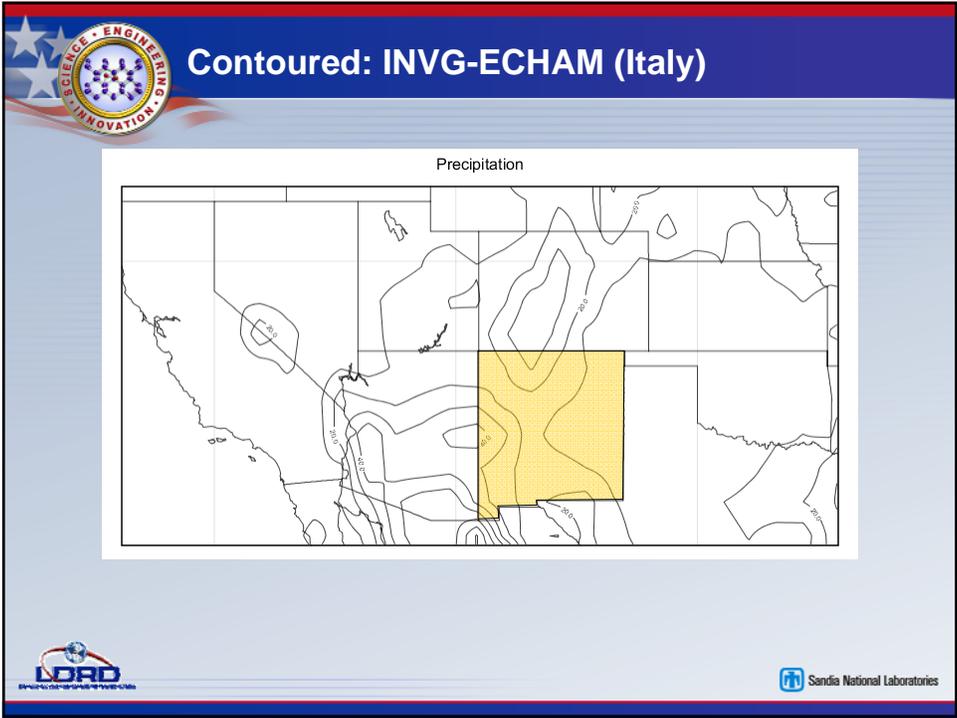














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