An integrated speleothem proxy and climate modeling study of the last deglacial climate in the Pacific Northwest

Jerry Potter – UC Davis, University of Michigan, NASA GSFC

Isabel Montanez, University of California Davis

Jessica Oster, Vanderbilt University

Bette Otto-Bliesner, Esther Brady, Nan Rosenbloom, and Christine Shields, NCAR

Zhengyu Liu and Feng He, University of Wisconsin

Cecelia DeLuca and Sylvia Murphy, NOAA/CIRES

Lan Zhao, Purdue University

Outline

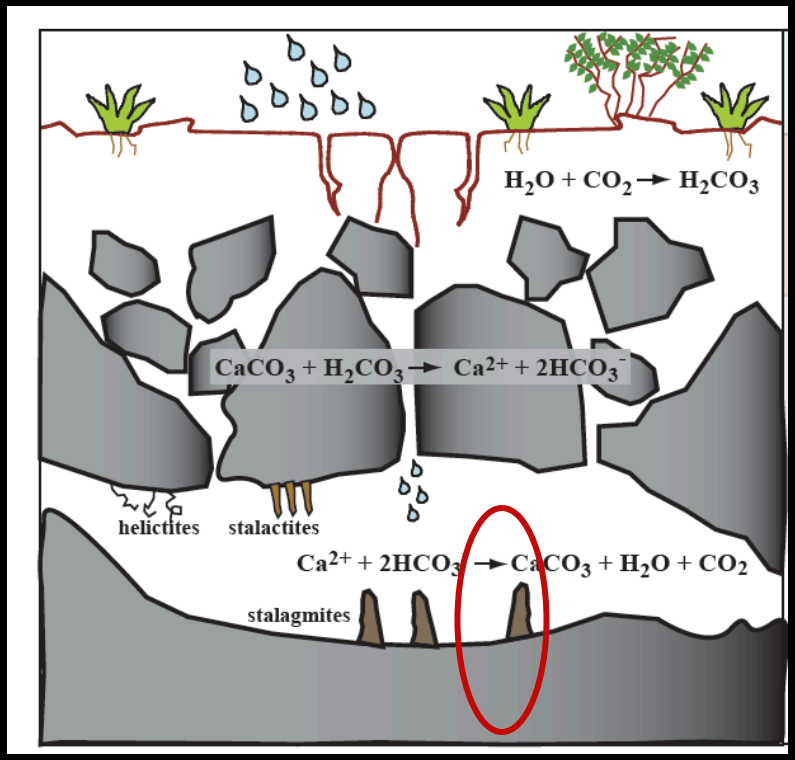
- Using speleothems as a proxy for climate change in the Pacific Northwest
- Comparing proxy data with the TRACE and other paleoclimate simulations
- The need for resolution
- Experimental design
- Using the TRACE restarts
- Bringing new tools to new users


Oregon
Idaho
Lake Shasta Caverns
Davis
Black Chasm
Nevada
Moaning Cave
500 k


Stalagmite Records


Cave Monitoring

How do speleothems record climate change?



These deposits can be dated with U-Pb isotopes captured by the growing crystals – to a precision of 1 to 2% of their ages
Build a 'rock calendar' of how cave conditions and the climate above changed through time

8.82 ±0.13ka

12.24 ±0.33ka

12.42 ±0.42ka

14.97 ±0.22ka

16.53 ±0.35ka

7cm

Younger Dryas

Moaning Cave Core 1

TRACE run compared to proxy data

Rainwater is characterized by O and H isotope compositions – the fingerprints of rainfall – each source has a different fingerprint and how much it has rained out on the path from the source to the cave makes that fingerprint that much more unique

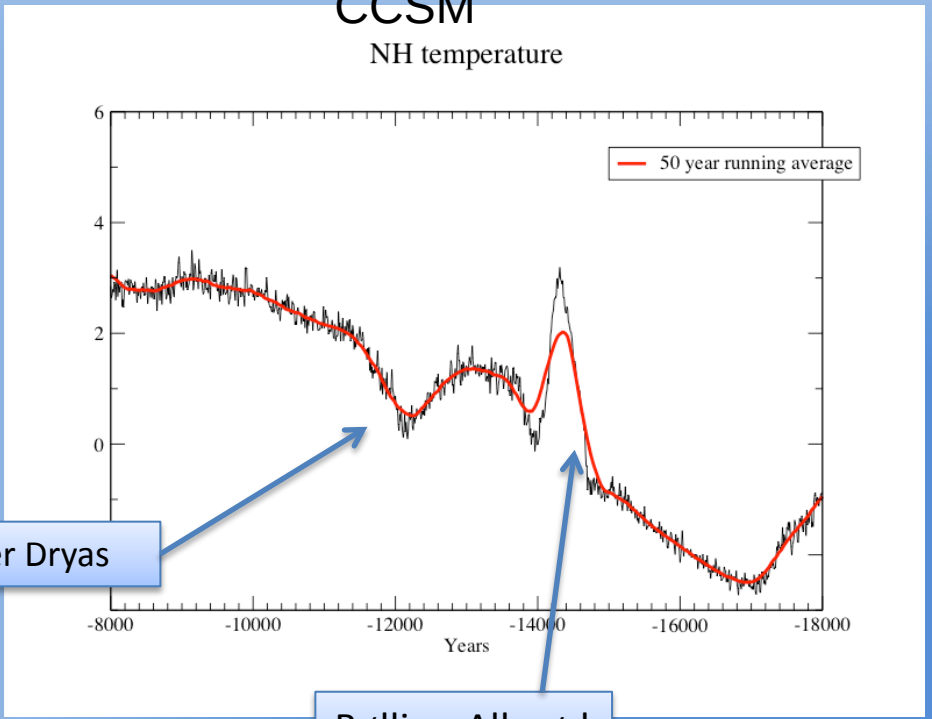
Oster et al.

drier/warmer

Sierra Nevada Stalagmites - moisture

Greenland Ice Core -temperature

CCSM

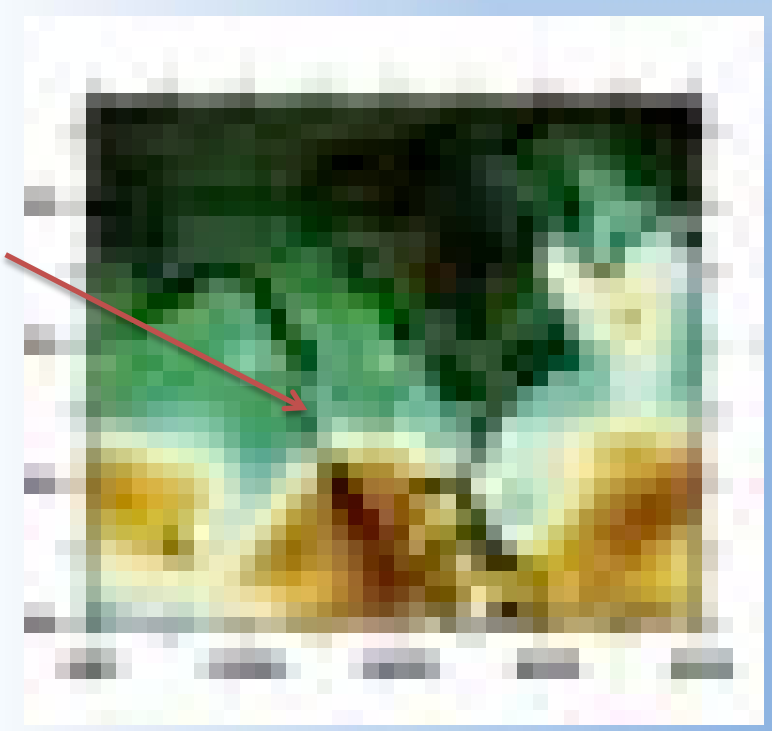


Younger Dryas

Bølling-Allerød

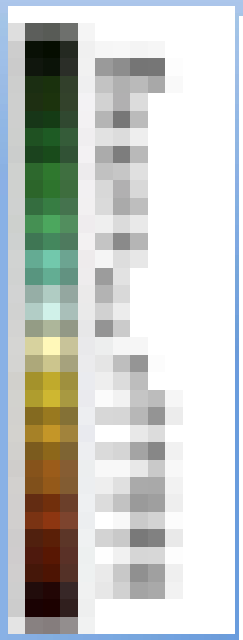
Jessica Oster et al. have established the cave data likely shows increased precipitation in the Western US during the Younger Dryas

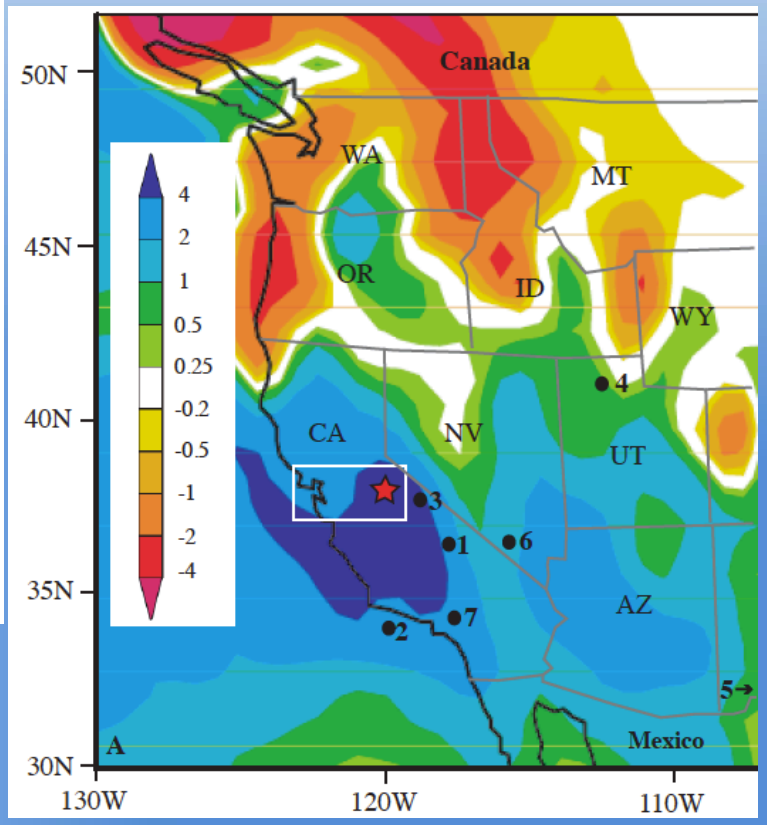
This appears to be the case comparing IPCC/LGM simulations



IPCC Ar4 (DJF precip)

Last glacial Maximum





Kim et al. (DJF)

Occurrence of Atmospheric Rivers: an additional complication (Dettinger, 2009)

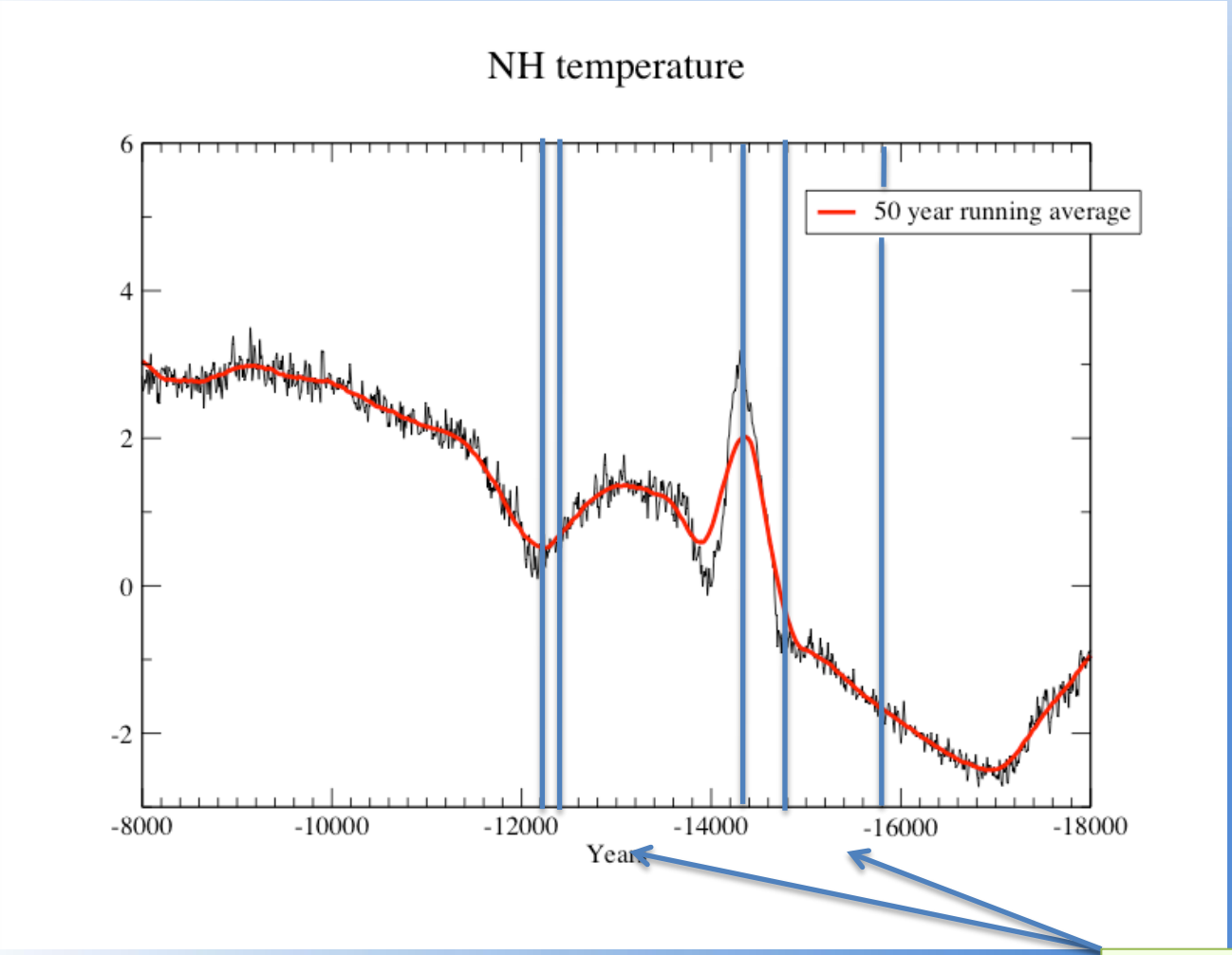
Numbers of AR storms on Central California coast in 7 climate-change projections & historical record

	Average # per yr	# yrs < 5 ARs	# yrs > 15 ARs	# yrs > 20 ARs
Reanalysis 1961-2000	5.8 days/yr	42 % of yrs	3 % of yrs	0 % of yrs
Projections				
1961-1980	**8.5**	**25**	**16**	**5**
1981-2000	**9.0**	**27**	**16**	**8**
2046-2065	**11.6**	**12**	**28**	**10**
2081-2100	**11.7**	**16**	**32**	**12**
	30% increase	**53% decrease**	**100% increase**	**85% increase**

The case of cooler-wetter and warmer-drier isn't settled

- Inconsistent picture of how the regional climate changes in western North America
- In some studies late Pleistocene cooling events in the North Atlantic region have been correlated to cool but dry climates in the Sierra Nevada and western Great Basin regions (Oster at al.)

Using the TRACE simulations to look in detail at periods of interest



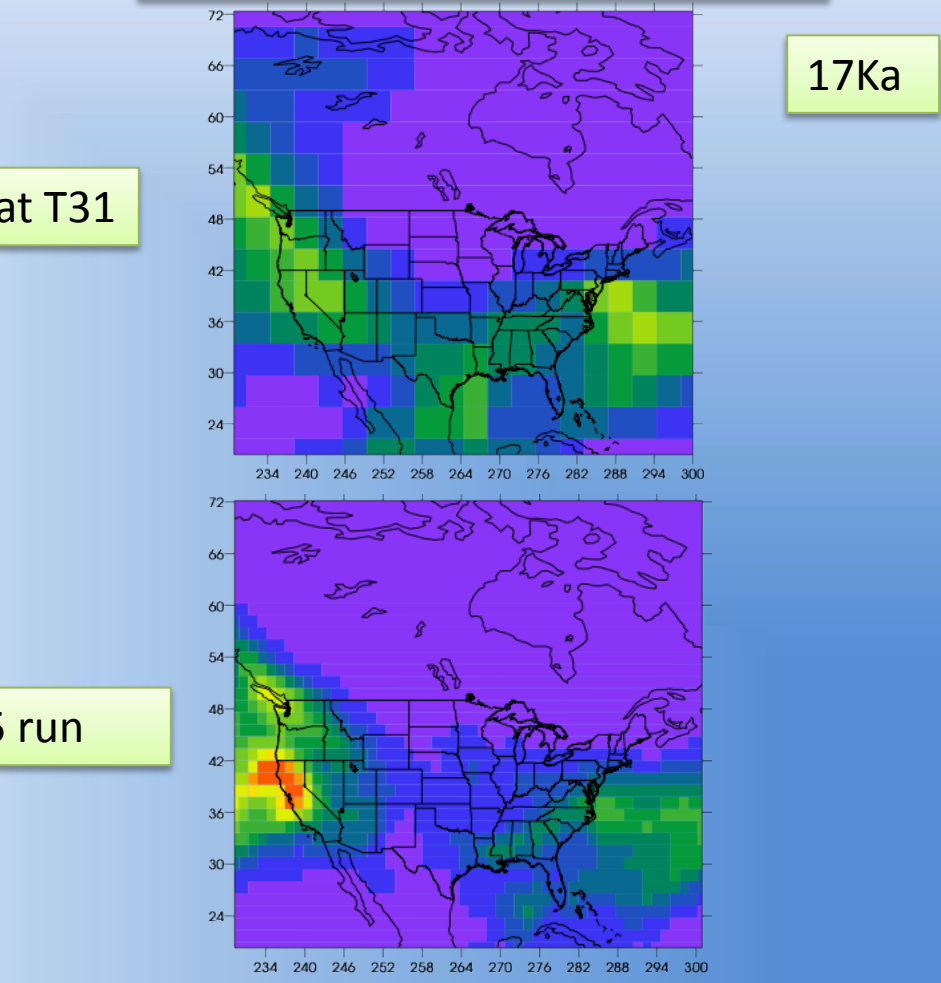
Need for higher resolution to study West Coast

January Precipitation, mm/day

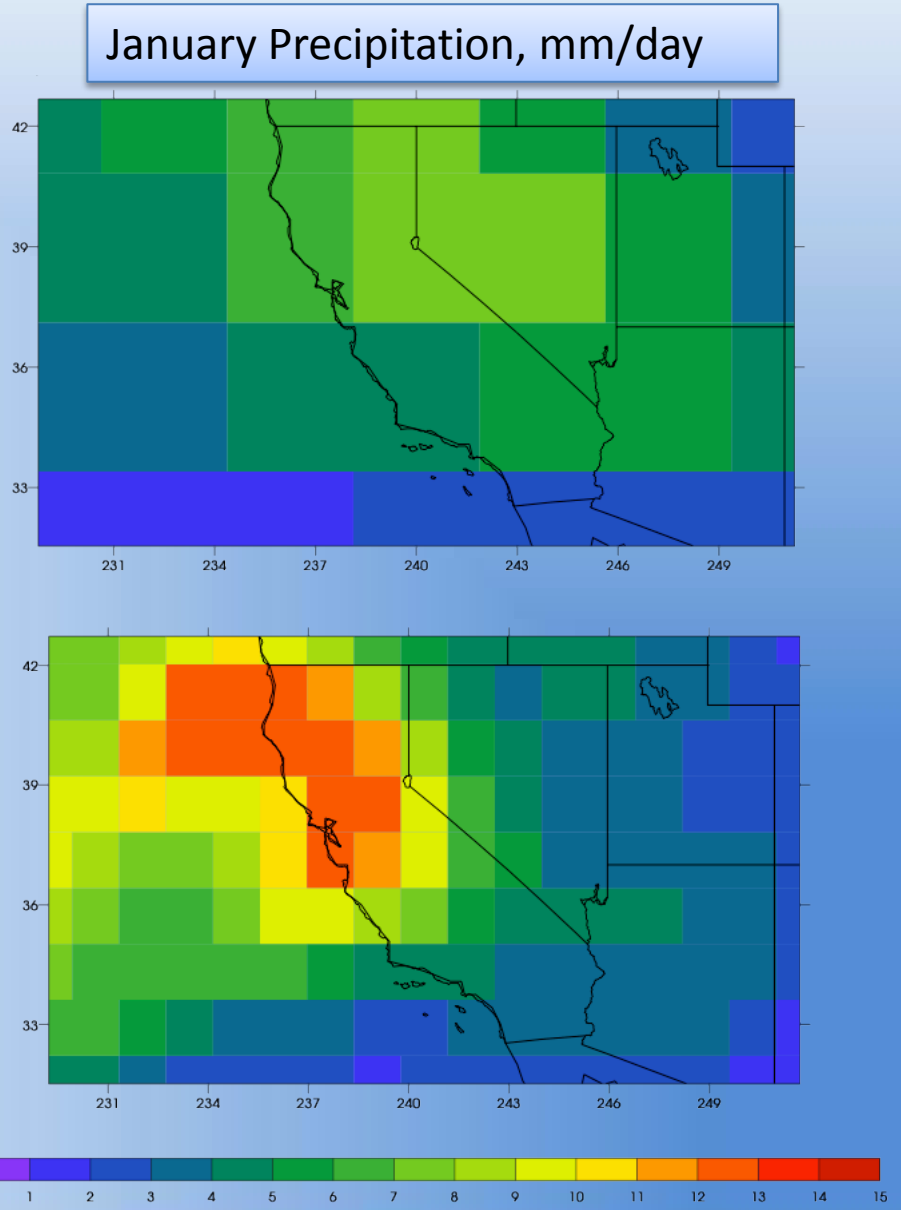
17Ka

TRACE run at T31

New TRACE T85 run



Rerunning time slices at T85 may provide the detail needed



17Ka

Bringing simulations to non-atmospheric scientists

- NCAR/University of Wisconsin group – simulations – made available to collaborators

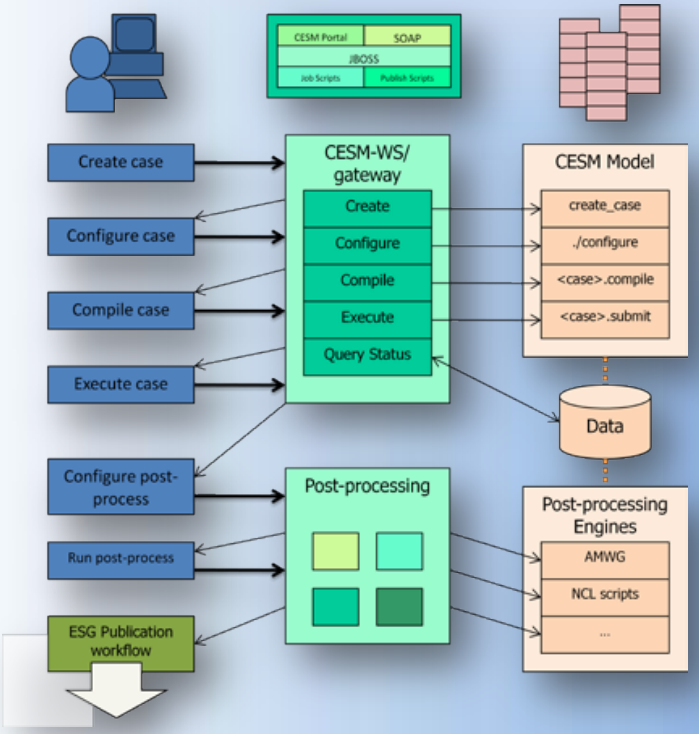
- Purdue/NOAA workflow as a model tool for new users – TeraGrid climate modeling environment

- UC Davis Geology bring proxy data with a problem to solve

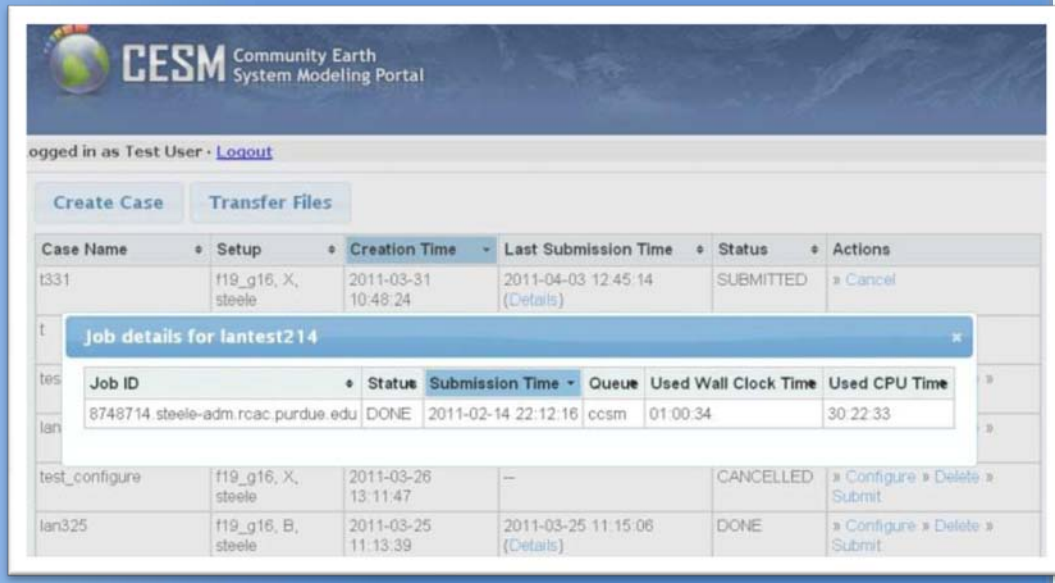
Using a workflow to investigate specific periods

- Tools in use today at Purdue
  - Workflow
  - Set up and perform model simulations
  - End-to-end (design and implementation of our prototype system as well as an end-to-end usage scenario which is broken down into three workflows: model execution, data publishing, and metadata collection/publishing.)
  - Geology students and faculty design numerical experiments
    - After analysis of test runs – more accurately determine important transitions
  - Data analysis and visualization using open source tools
- Increasing the breadth of both Atmospherics Science and Geology students.

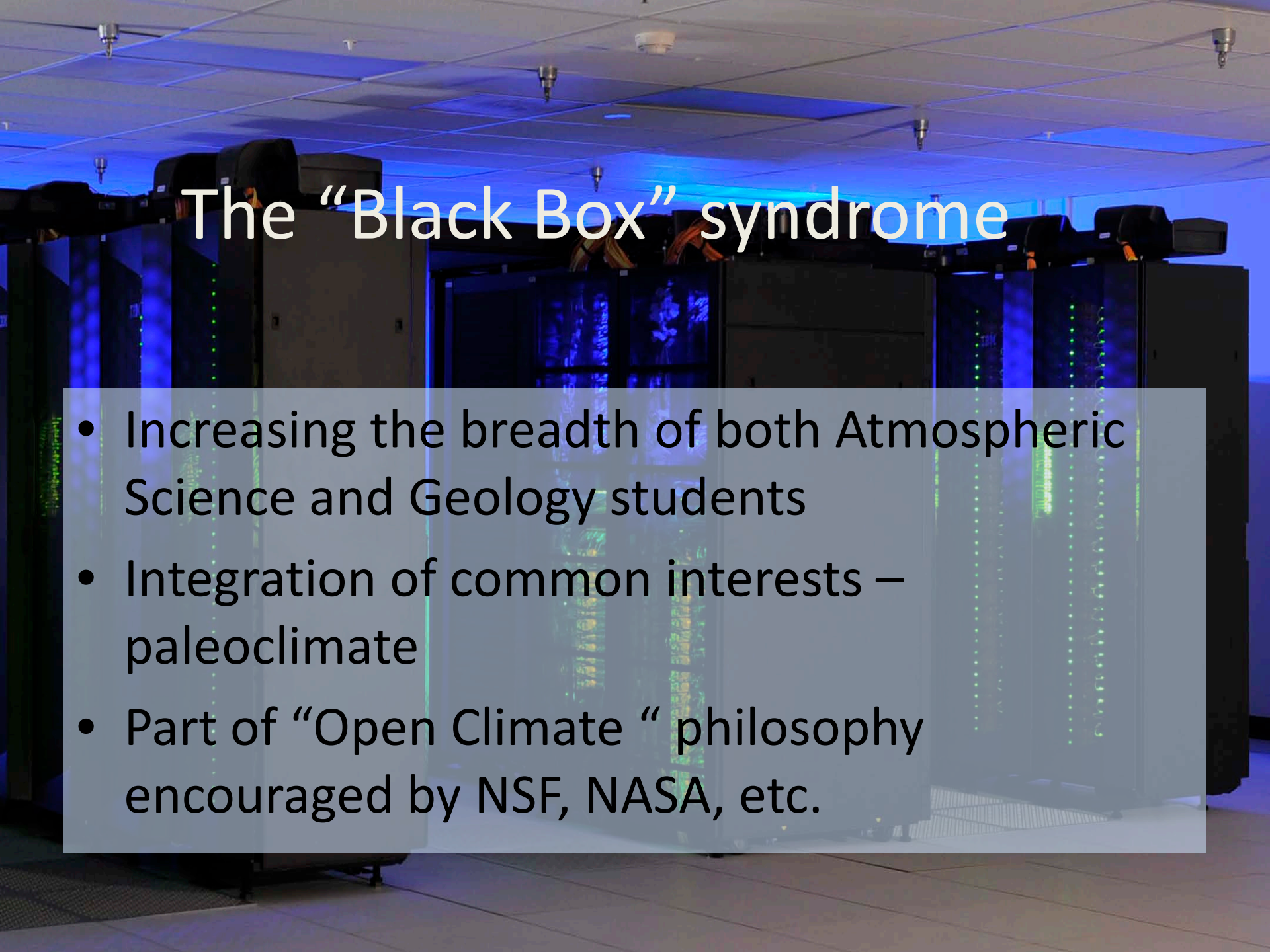
End-to-end TeraGrid climate modeling environment



Model execution workflow



Portal job table interface



The “Black Box” syndrome

- Increasing the breadth of both Atmospheric Science and Geology students
- Integration of common interests – paleoclimate
- Part of “Open Climate “ philosophy encouraged by NSF, NASA, etc.