With added support, the NRCM will be able to simulate a variety of 21st-century climates, from which statistical portraits of the future atmosphere can be produced. The NRCM cannot tell us exactly where a drought, a hurricane, or a winter storm will strike thirty years from now. However, it can give us a better idea of how and where weather patterns are likely to shift from decade to decade and how specific high-impact weather events, such as hurricanes, may change in frequency, intensity, size, and rainfall. This is the guidance that stakeholders need to help manage resources, protect lives, and deal with changes in society and our environment.

The Nested Regional Climate Model is an initiative of the National Center for Atmospheric Research (NCAR), in collaboration with university, government and private-industry colleagues. NCAR is sponsored by the National Science Foundation (NSF) and managed by the University Corporation for Atmospheric Research (UCAR).

www.ncar.ucar.edu
www.nsf.gov
www.ucar.edu

Atmospheric components of the NRCM

The Community Climate System Model (CCSM) is an NCAR-led effort supported by NSF and the U.S. Department of Energy, with additional contributions from the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA). It is manxaged by a steering committee and user groups made up of scientists from universities, other national laboratories, and NCAR.

www.ccsm.ucar.edu

The Weather Research and Forecasting (WRF) model is a multiagency effort sponsored and developed by NCAR in collaboration with several NOAA laboratories, the Air Force Weather Agency, and the international academic community.

www.wrf-model.org

NCAR

For more information:

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Photo credits:

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Pg. 1, clockwise from top left: © UCAR; NASA-GSFC, data from NOAA GOES; © UCAR; U.S. Fish and Wildlife Service
Pg. 4, from top: Jocelyn Augustino, FEMA; © UCAR

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What if...

- **We could estimate** the chance that hurricane seasons in the 2020s or 2040s will be worse than those in recent years?
- **We knew how quickly** water supplies in the western United States could shift as snow melts sooner and droughts parch the land?
- **We could improve** our understanding of tomorrow's climate using tools and ideas we have on hand today?

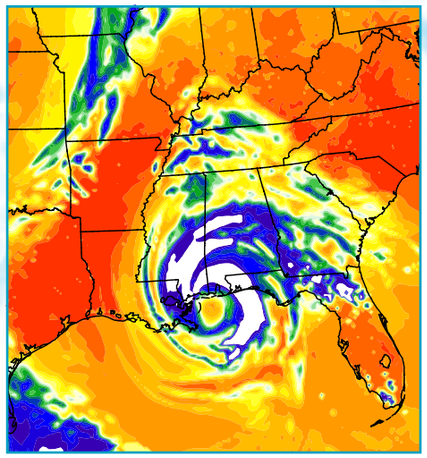
The Nested Regional Climate Model is a promising and ambitious new approach to help answer these questions.

Science tells us that Earth's climate is warming, largely as a result of human actions. The causes are known. The risks are large. The consequences for U.S. society could be severe. But policymakers still lack the regional detail needed to move ahead with confidence.

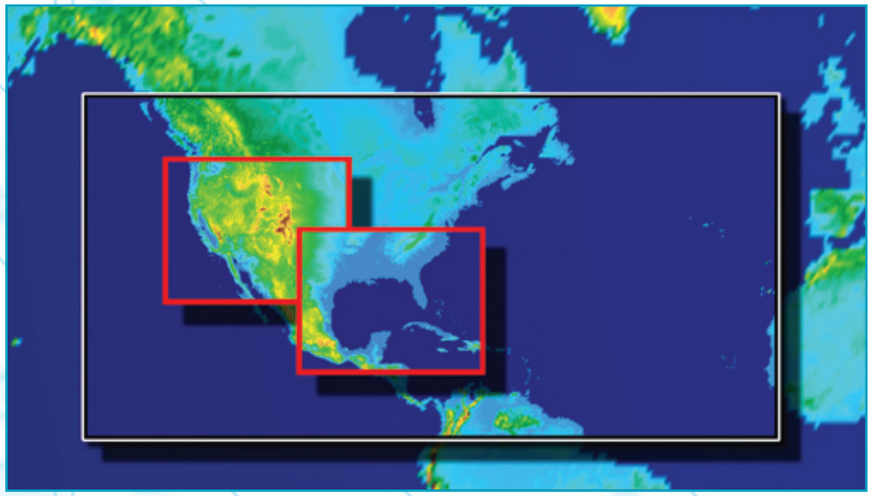
As we adapt to ongoing climate change and work to reduce our climate-warming emissions, we need a clearer sense of how the atmosphere might respond in vulnerable locations, from the storm-plagued Gulf and Atlantic coasts to the water-scarce West. As concluded by the Intergovernmental Panel on Climate Change and the U.S. Climate Change Science Program, some risks are already clear.

- Extreme weather events such as heavy rainfall and heat waves will become more frequent.
- More precipitation will fall as rain instead of snow.
- Snow will melt sooner, increasing runoff and the risk of flooding in early spring.
- In summer, the risk of drought and wildfire will go up as the warmer air dries the land.
- Ocean temperatures in the tropical Atlantic will likely continue to warm, providing more fuel for hurricanes and making it easier for them to become intense when other conditions are favorable.

All of these changes have enormous implications for public safety, agriculture, water resources, and urban planning. But current climate models cannot portray the local processes or the complex topography required to predict such high-impact events on a local or regional scale.



In a simulation of hurricanes for the decade 2045–2055, the NRCM produced realistic depictions, such as this one of a major hurricane striking the central Gulf Coast. The simulation is not a literal forecast of any particular hurricane, but by representing a decade's worth of cyclones with fidelity, the NRCM shows great potential for identifying long-term changes in hurricane behavior.

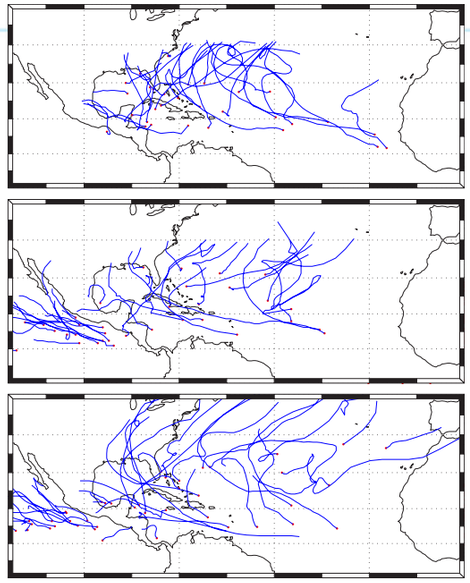


In one NRCM experiment, the atmosphere is simulated in three dimensions at resolutions ranging from about 20 miles between data points across a large part of the Northern Hemisphere to as fine as 2.5 miles in targeted areas of North America (red boxes). This strategy enables scientists to forecast future climate in detail for specific regions without overloading existing supercomputing resources. (Contrast between coarse- and fine-resolution boxes has been increased for illustrative purposes.)

The Nested Regional Climate Model can provide the next level of regional guidance for policymakers who must deal with tomorrow's climate. The NRCM unites the strengths of two leading tools of atmospheric science: the worldwide reach of a premier global climate model and the detail of the world's leading county- and city-scale weather model.

The sophistication of these models places great demands on even the world's most powerful computers. Global climate models typically track the atmosphere at points separated by 100 or more miles, so they cannot easily depict such features as hurricanes or thunderstorm complexes. Weather models can narrow the resolution to a mile or less, but they cannot span the globe with this capacity or cover periods longer than a few days.

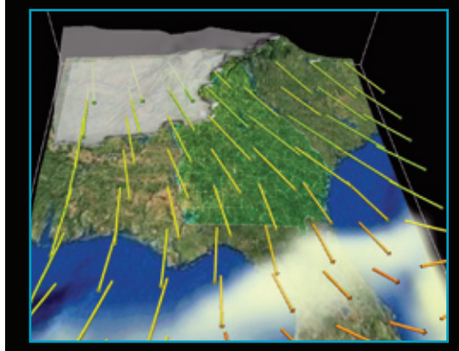
The power of NRCM is the ability to provide detail where and when it is most needed. By using nested domains (see far left), NRCM scientists can zero in on regions of particular interest, such as hurricane- or drought-prone areas or mountainous regions, without the much higher cost of simulating the entire globe with such detail. The model can also focus on especially important regions, such as the tropical Pacific Ocean, where small changes can lead to large effects across North America.



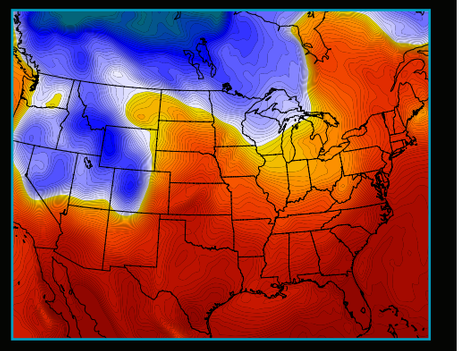
The NRCM has already demonstrated the increased skill possible through enhanced resolution in a reproduction of the 2005 Atlantic hurricane season, the busiest on record. When run with 7.5-mile spacing between grid points (top), the NRCM does a much better job than an identical simulation at grid resolution of about 22 miles (middle) in simulating the patterns of activity observed in the 2005 season (bottom), including the areas where the hurricanes form and make landfall.

At right: Many climate models, including those supporting the 2013 assessment of the Intergovernmental Panel on Climate Change, track the atmosphere in vertically stacked horizontal rectangles that typically span about 55 x 70 miles at midlatitudes (top). The NRCM approach improves the resolution to about 20 miles (center) across regions as large as ocean basins and continents, with detail as sharp as 2.5 miles or less (bottom) in areas of particular interest. This strategy provides greatly enhanced prediction and understanding of how rain and snow, snowmelt, drought, hurricanes, and other weather and climate phenomena could evolve in the 21st century.

The NRCM is based on two world-class models built by scientists at NCAR and their colleagues in government, academia, and private industry.



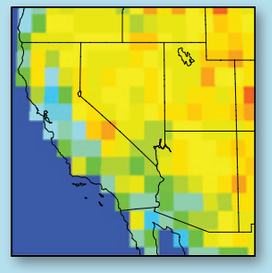
The Weather Research and Forecasting (WRF) model is the most widely used weather prediction system in the world. Developed expressly to serve the needs of both researchers and forecasters, WRF is used in 22 countries for day-to-day forecasting and by more than 8,500 scientists in more than 110 nations who are studying weather phenomena.

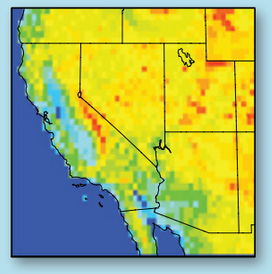


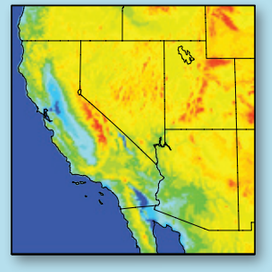
The Community Climate System Model (CCSM) is a comprehensive model for analyzing Earth's past, present, and future climate. The CCSM is one of the main tools that was used by the Nobel Prize–winning Intergovernmental Panel on Climate Change in its 2007 assessment report.

Nested Regional Climate Model

innovative guidance for regional weather and climate prediction







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