The two new studies rein in those soaring upper limits for climate sensitivity while reinforcing the substantial lower limit. Climate modeller Gabriele Hegerl of Duke University in Durham, North Carolina, and colleagues started with Northern Hemisphere temperatures between 1270 and 1850 extracted from records such as tree rings. In those preindustrial times, volcanoes, the waxing and waning of the sun, and natural variations in greenhouse gases were changing temperature. Hegerl and her colleagues then combined the preindustrial temperature response to those climate forcings with the global response in the 20th century to volcanoes, rising greenhouse gases, and thickening pollutant hazes. In this week’s issue of Nature, they report a 5% probability that climate sensitivity is less than 1.5°C and a 95% chance that it’s less than 6.2°C. That’s still pretty high, but a far cry from 9°C or 11°C.

In a similar study published on 18 March in Geophysical Research Letters, climate modelers James Annan and Julia Hargreaves of the Frontier Research Center for Global Change in Yokohama, Japan, found the same lower limit of 1.5°C and a 95% upper limit of 4.5°C. They combined published 20th century warming data with records of coolings after recent volcanic eruptions and estimates of chilling in the depths of the last ice age.

“Combining multiple lines of evidence is certainly the way to go,” says Forest. An extremely high climate sensitivity “is probably less likely than we thought a year ago,” agrees climate researcher Reto Knutti of the National Center for Atmospheric Research in Boulder, Colorado. More importantly, “we start to see a much better agreement on the lower bound,” says Knutti. “We can be pretty sure the changes will be substantial” by the end of the century, he says.

—RICHARD A. KERR

PALLAVA BAGLA

SCIENCE Vol 312 21 April 2006

EPA Air Review Draws Fire
Activists are criticizing a proposal by the Environmental Protection Agency (EPA) to speed up its regular review of air-quality standards. They fear that some of the changes would allow undue political influence on staff scientists who develop the standards.

By law, EPA must revisit its National Ambient Air Quality Standards every 5 years. Staff scientists evaluate the latest research and propose ranges for new standards, which are then reviewed by the agency’s Clean Air Scientific Advisory Committee (CASAC). Because EPA regularly misses its deadline and gets sued, an internal EPA committee proposed several suggestions in April for speeding up the process. Among them, the panel called for “early involvement of EPA senior management and/or outside parties in the framing of policy-relevant issues.”

That language set off “flashing red lights” for John Walke of the Natural Resources Defense Council, who worries about political interference. “The idea isn’t to have the policy drive the science,” counters EPA chief scientist George Gray. Instead, he says, management and CASAC would help experts focus on the most relevant research. EPA is eager to act soon, but Gray says there will be opportunities for public comment.

—ERIK STOKSTAD

Nuke Tests Prove Critical Issue
DELHI—Casting further doubts on the uncertain fate of a landmark nuclear pact, India has rebuffed a U.S. bid for India to forswear further atomic bomb tests.

Under the deal last month, India agreed to place a majority of its power reactors under safeguards in exchange for the right to import nuclear energy technology (Science, 10 March, p. 1356). With approval required from legislators skeptical of the deal’s nonproliferation merits, the U.S. government earlier this month sent India a draft agreement that includes a clause declaring an end of cooperation if India were to detonate a nuclear device. Although India has adhered to a self-imposed moratorium on nuclear tests since its last round of detonations in 1998, the government deemed the clause a poison pill.

“There was no place for any such provision” in an agreement, says a spokesperson for India’s Foreign Office. Negotiations are ongoing, with a team of senior U.S. officials expected in Delhi some time next week to continue talks.

CLIMATOLOGY

Latest Forecast: Stand By for a Warmer, But Not Scorching, World

While newly climate-conscious news reporters seek signs of apocalyptic change in hungry polar bears and pumped-up hurricanes, evidence-oriented researchers are working to nail down some numbers. They are concerned with climate sensitivity: how much a given increase in atmospheric carbon dioxide will warm the world. If it’s extremely high, continued emissions of greenhouse gases could ignite a climatic firestorm. If it’s very low, they might merely raise the global thermostat a notch or two.

Now two new studies that combine independent lines of evidence agree that climate sensitivity is at least moderately strong—moderate enough so that a really scorching warming appears unlikely. Even with the most conservative assumptions, says climate researcher Chris E. Forest of the Massachusetts Institute of Technology in Cambridge, the studies cool the maximum warming. And the reinforced low end of the range, he says, means continued emissions will fuel a substantial warming in this century.

The new studies use a technique called Bayesian statistics to gauge how adding new information improves past estimates of climate sensitivity. Most previous estimates used only a single line of evidence, such as how climate warmed as greenhouse gases increased during the 20th century or how climate cooled right after the debris from a major volcanic eruption shaded the planet. Lately, such analyses have tended to support a 25-year-old guess about climate sensitivity: If the concentration of CO₂ were to double, as is expected by late in the 21st century, the world would warm between a modest 1.5°C and a hefty 4.5°C (Science, 13 August 2004, p. 932). The low end of that range looked fairly firm; the negligible warming claimed by greenhouse contrarians looked very unlikely. But no one was sure about the high end. Some studies allowed a real chance that doubling CO₂ could raise temperatures by 7°C, 9°C, or even 11°C (Science, 28 January 2005, p. 497).

Sharpening the odds. Analyzing how climate forces changed temperature in the past yields a wide range for climate sensitivity (left), but combining independent data sets (right) narrows the range.

CREDIT ADAPTED FROM HEGERL ET AL. NATURE 2006

Constraining Climate Sensitivity

Probability density function

Composite record

Combined analysis

Climate Sensitivity (°C)

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7

0 1 2 3 4 5 6 7 8 9 10