

# Directions for climate research

Climate science is experiencing rapid development fueled by significant research budgets and spurred by important policy needs. Progress has occurred in generating new knowledge and in better delineating gaps and uncertainties that limit our current ability to know the extent to which humans are affecting climate and to predict future changes caused by both human and natural forces.

Expansion of scientific knowledge will take time and money. It requires extensive long-term data acquisition, breakthroughs in theoretical understanding of key climate processes, efforts to reconstruct better information about past climate, and the development of more-sophisticated computer models to assess understanding and simulate future climate changes.

Research should include two major thrusts. One supports curiosity-driven and blue-sky research. The pursuit of this type of knowledge will certainly lead to unanticipated results that may help overcome current gaps. Universities will likely take the lead in such research, which is one reason we are supporting climate-related research efforts at major universities, including Stanford and MIT. University programs will also help train students who will be needed to address these challenges over coming decades.

Research should also be designed and carefully managed to address policy needs. Government agencies should design programs that address the most important major areas of scientific uncertainty. The U.S. should also es-

tablish a structured effort to assess the consequences of climate change (accounting for both facts and uncertainties) and the feasibility and effectiveness of policies to adapt to and mitigate climate change.

Areas of uncertainty that require attention have been identified in numerous reports, including several by the National Research Council. Important areas include the role of

clouds and aerosols (small particles in the atmosphere), natural climate variability, oceanic currents and heat transfer, the hydrological cycle, and the ability of climate models to predict changes on a regional and local scale.

Agency-led programs should aim to: (1) better quantify levels of uncertainty and explain their relevance for policy decisions, (2) define and conduct studies to resolve uncertainty and (3) report periodically on results and progress. These programs would benefit from well-structured, independent scientific reviews to assure quality and to steer future efforts based on progress. Research does not always eliminate uncertainty, but such programs will lead to better understanding of what we know and do not know and how our knowledge may affect policy decisions.

The U.S. can be proud of its leadership — over several administrations — in advancing climate research. Despite differing views on what near-term policies are appropriate for addressing climate concerns, an ongoing investment in research will be essential to informing long-term, science-based decisions.

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## Research should address policy needs

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