BACKGROUNDER

The State of Climate Science in Light of Recent Claims

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Introduction and summary

Over the past several months, there has been an increase in public and media concern about the scientific basis for action to combat climate change. This concern has been driven by quotations from e-mail correspondence stolen from the University of East Anglia's Climatic Research Unit and posted online in November 2009 and by allegations against the Intergovernmental Panel on Climate Change (IPCC), the UN body mandated to advise governments on climate science. These allegations followed the IPCC's acknowledgement that a paragraph in its 2007 Fourth Assessment Report contained a poorly substantiated projection of the timing of glacier loss in the Himalayas in response to climate change.

This backgrounder assesses the implications of these recent events for the state of climate science. Sections A and B respectively evaluate claims related to the stolen e-mails and the IPCC's report. Section C assesses related claims that global warming has stalled or stopped. Section D provides conclusions on whether there has been any change to the case for urgent action to reduce greenhouse gas emissions.

In summary: while the tone and content of several e-mails may raise questions about transparency and scientists' conduct, and the error relating to Himalayan glacier loss highlights a poor application of the IPCC's rigorous review procedures, neither alters the core conclusions of the Fourth Assessment Report that "warming of the climate system is unequivocal" and that most of the observed warming in the past half-century is more than 90% certain to have been caused by greenhouse gases from human activities.[1] As 18 leading American science bodies noted in an open letter to Congress in October 2009: "These conclusions are based on multiple independent lines of evidence, and contrary

[1] R.K. Pachauri and A. Reisinger, eds., *Climate Change 2007: Synthesis Report*, Summary for Policymakers (Geneva: IPCC, 2007), 2, 5. Available online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.

assertions are inconsistent with an objective assessment of the vast body of peer-reviewed science."[2]

Other alleged mistakes by the IPCC turn out not to be factual errors, with the exception of one that is trivial. Overall, then, the recent events do not affect the IPCC's conclusion that continued greenhouse gas emissions at or above current levels can be expected to produce a host of impacts[3] that people generally judge to be very serious. Likewise, recent events do not alter the joint conclusion of the National Science Academies of all G8+5 countries that "climate change is happening even faster than previously estimated" and "the need for urgent action to address [it] is now indisputable."[4] Rapid reductions in greenhouse gas emissions remain as important as ever.

A: University of East Anglia e-mails

Context: Selections from more than a decade of e-mail correspondence by researchers at the University of East Anglia's Climatic Research Unit (CRU), along with other data files, were stolen and posted online in November 2009.

Claims: Some commentators and bloggers — who have dubbed the controversy "climategate"— have alleged the e-mails show scientists deliberately destroyed records, manipulated data to exaggerate global warming, and failed to comply with Freedom of Information requests. They conclude that this invalidates, or at least calls into question, the scientific basis for action to combat climate change.

Analysis: While the results of two formal investigations are pending (see "Steps taken" below), other reviews of the e-mails make clear that claims that the science has been falsified are without substance:

- The UK House of Commons' Science and Technology Committee published the findings of their inquiry into the stolen e-mails on March 31, 2010. After hearing evidence from a broad range of organizations and individuals and carrying out their investigation, the cross-party panel of MPs rejected allegations of data manipulation, conspiracy, or distortion of peer-review, and broadly exonerated the CRU and its head, Phil Jones. And while the scientific findings of the CRU will be thoroughly investigated by Lord Oxburgh's Scientific Assessment Panel (see "Steps taken" below), the committee found that "[e]ven if the data that CRU used were not publicly available—which they mostly are—or the methods not published—which they have been—its published results would still be credible: the results from CRU agree with those drawn from other international data sets; in

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[2] American Association for the Advancement of Science et al., *open letter to Congress*, October 21, 2009. Available online at http://www.aaas.org/spp/cstc/climateletterfinal.pdf.

[3] Pachauri and Reisinger, 10–11.

[4] G8+5 Academies' Joint Statement, *Climate Change and the transformation of energy technologies for a low-carbon future*, May 2009. Available online at www.scj.go.jp/ja/info/kohyo/pdf/kohyo-21-s1.pdf. G8+5 member countries are: Brazil, Canada, China, France, Germany, India, Italy, Japan, Mexico, Russia, South Africa, UK, USA.

other words, the analyses have been repeated and the conclusions have been verified."[5]

Based on the scope of its inquiry, the committee concluded that "the scientific reputation of Professor Jones and CRU remains intact. We have found no reason in this unfortunate episode to challenge the scientific consensus as expressed by [Government Chief Scientific Adviser] Professor Beddington, that "global warming is happening [and] that it is induced by human activity."[6]

Accusations of dishonesty were found to be baseless. Professor Jones' actions on the sharing of data and computer codes "were in line with common practice in the climate science community," though the committee suggests "that the community consider becoming more transparent by publishing raw data and detailed methodologies."[7] It also notes, however, that several countries, including Canada, imposed conditions in commercial agreements that the raw data they provided to the CRU would not be published.[8]

Lastly, while the committee did find preliminary evidence suggesting improper treatment of Freedom of Information requests, they acknowledge the researchers' sense that many of these were from critics seeking to discredit their work rather than advance the science and "consider that much of the responsibility should lie with [University of East Anglia], not CRU."[9] These allegations should be investigated in full through the two further independent reviews underway (see "Steps taken" below).

- The Associated Press conducted "an exhaustive review" of the e-mails. Five AP reporters read and re-read each of the 1,073 messages and referred many to an independent scientific panel. The review found "the messages don't support claims that the science of global warming was faked." While at times petty, "the exchanges don't undercut the vast body of evidence showing the world is warming because of man-made greenhouse gas emissions." The review also rejected claims of a "culture of corruption," concluding "that is not what the AP found."[10]
- Pennsylvania State University undertook a thorough inquiry into the work of leading climatologist and faculty member Michael Mann based on the e-mails. Their review found "there exists no credible evidence that Dr. Mann had or has ever engaged in, or participated in, directly or indirectly, any actions with an

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[5] UK House of Commons Science and Technology Committee, *The disclosure of climate data from the Climatic Research Unit at the University of East Anglia: Eight Report of Session 2009-10* (London, UK: House of Commons, 2010), 18. Available online at http://www.publications.parliament.uk/pa/cm200910/cmselect/cmsctech/387/387i.pdf.

[6] Ibid, 46.

[7] Ibid.

[8] Ibid, 13.

[9] Ibid, 46.

[10] Seth Borenstein et al., "AP Impact: Science Not Faked, But Not Pretty," *Associated Press*, December 12, 2009, http://www.sfgate.com/cgi-bin/article.cgi?f=/n/a/2009/12/12/international/i045626S28.DTL.

intent to suppress or to falsify data,… any actions with intent to delete, conceal or otherwise destroy emails, information and/or data related to AR4 [the IPCC's Fourth Assessment Report]," nor "any misuse of privileged or confidential information available to him in his capacity as an academic scholar." It also directly refuted claims about one of the e-mails most commonly taken out of context, finding "the so-called 'trick' was nothing more than a statistical method used to bring two or more different kinds of data sets together in a legitimate fashion by a technique that has been reviewed by a broad array of peers in the field."[11]

- Based on its review of the e-mails, *Nature*, often regarded as the world's most prestigious multidisciplinary scientific journal, found no credible basis to investigate any papers published in the journal. Further, it concluded that "nothing in the e-mails undermines the scientific case that global warming is real — or that human activities are almost certainly the cause. That case is supported by multiple lines of evidence, including several that are completely independent of the climate reconstructions debated in the e-mails."[12]
- An internal memo prepared by an interdepartmental climate science working group for Canada's Minister of Environment concluded that, "[d]espite these developments [media reports about the CRU e-mails], the department continues to view the IPCC AR4 as the most comprehensive and rigorous source of scientific information for climate change negotiations. … There is no scientific assessment process extant that is as thoroughly reviewed as the IPCC process. … In addition, the key IPCC assessments are supported by multiple lines of evidence and multiple sources of data wherever possible."[13] The group consists of federal scientists representing six different government departments, and its role is to provide information and advice in support of Canada's role in international climate negotiations.

Quotations taken out of context

Many quotations from the e-mails have been taken out of context. The "trick," as referred to above, was a perfectly legitimate technique to address a well-known problem in a particular set of tree-ring data.[14] Both the problem and the specific technique to address it

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[11] Pennsylvania State University, "RA-10 Inquiry Report: Concerning the Allegations of Research Misconduct Against Dr. Michael E. Mann, Department of Meteorology, College of Earth and Mineral Sciences, The Pennsylvania State University," February 3, 2010. Available online at www.research.psu.edu/orp/Findings_Mann_Inquiry.pdf.

[12] Editorial, "Climatologists Under Pressure," *Nature* 462 (2009), 545. Available online at http://www.nature.com/nature/journal/v462/n7273/full/462545a.html.

[13] Environment Canada, "Memorandum to Minister: Science published after the Intergovernmental Panel on Climate Change Fourth Assessment Report: Information and Advice in support of Climate Change Negotiations," briefing note, (Ottawa, ON: Government of Canada, December 3, 2009), 000010–11. The Pembina Institute obtained this briefing note through an Access to Information request.

[14] *Nature* (2009).

had been previously discussed in the literature.[15] The two papers that one of the CRU e-mail correspondents threatened to exclude from the IPCC's Fourth Assessment Report were, in fact, included and referenced in the report.[16]

The authors of the e-mails could likely have done a better job of putting each point in context and moderating their criticism of the work of others. But, as an editorial in *Nature Geoscience* noted recently, "it must be remembered that e-mails are an essential scientific tool when research groups span continents and schedules are tight. Yes, there is a limit to what should be put in writing. But in messages that are not meant for the public eye, there must be room for an open minded and opinionated discussion, for example, of the quality of papers published by other authors. … Making every private e-mail between scientists unambiguous and fit for public consumption would seriously hinder the progress of science."[17]

Temperature record not exaggerated

Allegations that the CRU has been "cooking the books" to exaggerate global temperature increases do not stand up to scrutiny. The temperature record jointly maintained by the CRU and the UK Met Office's Hadley Centre (HadCRUT) was recently reviewed by the European Centre for Medium-Range Weather Forecasts, using the broadest set of data available. This independent analysis found that the HadCRUT record is at the lower end of likely warming. According to the Met Office, "the new analysis estimates the warming to be higher than that shown from HadCRUT's more limited direct observations. This is because HadCRUT is sampling regions that have exhibited less change, on average, than the entire globe over this particular period. This provides strong evidence that recent temperature change is at least as large as estimated by HadCRUT."[18] Indeed, NASA's temperature record, which simulates broader coverage in these regions, registers slightly more warming in recent years than CRU's.[19]

As for estimates of temperatures over the past two millennia, the key features of the "hockey stick" graph of temperature reconstructions (which features in many of the e-mails) have been replicated and supported in several rigorous reviews, including one by the U.S. National Academy of Sciences.[20]

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[15] Editorial, "The CRU Hack," *RealClimate,* November 20, 2009, http://www.realclimate.org/index.php/archives/2009/11/the-cru-hack/.

[16] *Nature* (2009).

[17] Editorial, "Big Brother Meets Climate Change," *Nature Geoscience* 3 (2010): 1.

[18] Met Office, "New Evidence Confirms Land Warming Record," news release, December 18, 2009. Available online at http://www.metoffice.gov.uk/corporate/pressoffice/2009/pr20091218b.html.

[19] James Hansen et al., *Current GISS Global Surface Temperature Analysis,* draft for comment (New York, NY: NASA Goddard Institute for Space Studies, 2010), 15-19. Available online at http://data.giss.nasa.gov/gistemp/paper/gistemp2010_draft0319.pdf.

[20] Board on Atmospheric Sciences and Climate, National Research Council, *Surface Temperature Reconstructions for the Past 2,000 Years* (Washington, DC: National Academies Press, 2006). Available online at http://www.nap.edu/catalog.php?record_id=11676. See also Michael Mann et al., "Proxy-based

Answers needed on transparency and appropriate conduct

The illegal publication of the CRU e-mails has shed light on the daily lives of a group of dedicated researchers under considerable pressure and scrutiny, often from those actively seeking to discredit their work. Several of the e-mails suggest that their authors attempted to avoid complying with Freedom of Information requests, on the basis that those requests were simply attempts to busy them unnecessarily and undermine their research for reasons divorced from scientific inquiry.[21] Whatever the motives, this does raise legitimate questions about transparency and appropriate conduct by scientists. To ensure the credibility of climate science, questions regarding transparency and proper treatment of Freedom of Information requests must be answered. The ongoing inquiries described below (see "Steps taken") should help to provide those answers.

No impact on the substance of climate science

In sum, the e-mails do not alter the substance of the science of climate change. The two main scientific "products" at the centre of the e-mails controversy, Professor Mann's "hockey stick" graph and the CRU's temperature record, have both been supported and replicated by external verifications. The results of the independent scientific review led by Lord Oxburgh (see below) will further address the substance and quality of the CRU's work.

As *The Economist* concluded, "[t]hat the e-mails and documents should be inspected in some sort of systematic way for evidence of poor practice or even chicanery is a fair next step. But it is ludicrous to think that climate science is a house of cards that will collapse if the e-mails were to discredit CRU's work."[22]

Despite the e-mails' apparent lack of scientific significance, however, their publication has affected the public credibility of climate science, and thorough investigations are helpful in restoring it. Regardless of the scrutiny they are under, scientists should be expected to maintain the highest ethical standards. But a similar standard should also be expected of those communicating to the public on this topic. A critical lens must be applied to *all* claims; spurious ones should not be reported as fact.

Steps taken: In addition to the investigations of the e-mails outlined above, the University of East Anglia has launched two independent reviews of the conduct and research of CRU staff. Sir Muir Russell, a physicist, former senior civil servant and university administrator, is examining whether there is any evidence of suppression or manipulation of data, the CRU's treatment of Freedom of Information requests, and its practices

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reconstructions of hemispheric and global surface temperature variations over the past two millennia," *Proceedings of the National Academy of Sciences of the United States* 105 (2008), 13252. Available online at http://www.pnas.org/content/105/36/13252.full.

[21] *Nature* (2009). See also UK House of Commons Science and Technology Committee.

[22] "Reply All: a Row Over Climate Change E-mails Grows Louder," *The Economist,* December 4, 2009, http://www.economist.com/sciencetechnology/displayStory.cfm?story_id=15051965.

concerning the management and release of data.[23] A complementary independent Scientific Assessment Panel, conducted by an international team of experts recommended by the Royal Society and chaired by Lord Oxburgh, a former academic geologist, civil servant and businessman (also nominated by the Royal Society), is reappraising the science in the CRU's key publications.[24] Both reviews are expected to publish their findings this spring.

B: Credibility of the IPCC

Context: The IPCC has recently acknowledged two errors in its 2007 Fourth Assessment Report: one is a poorly substantiated projection of the timing of glacier loss in the Himalayas,[25] and the second is an incorrect statement of the percentage of the Netherlands lying below sea-level.[26] In the latter case, the erroneous figure was provided by a Dutch government agency.[27] The percentage of the Netherlands lying below sea level — whether it is 26% (the correct figure using the common definition) or 55% (the figure mistakenly provided by the Netherlands Environmental Assessment Agency, which includes areas prone to river flooding) — does not significantly affect assessments of the seriousness of climate change, even within the Netherlands.[28] Both paragraphs in question occur within the body (but not the Summary for Policymakers) of the 938-page *Impacts, Adaptation and Vulnerability* volume compiled by the IPCC's Working Group II (WGII). Counting also the volumes from Working Groups I and III, the full Fourth Assessment Report amounts to nearly 3,000 pages.

Claims: Critics claim these errors undermine the credibility of the IPCC as a whole, and cast doubt on the science of climate change in general. Further allegations of mistakes in the Fourth Assessment Report have been made, but these turn out not to be factual errors:

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[23] University of East Anglia, "Sir Muir Russell to head the Independent Review into the allegations against the Climatic Research Unit (CRU)," news release, December 3, 2009. Available online at http://www.uea.ac.uk/mac/comm/media/press/2009/dec/CRUreview.

[24] University of East Anglia, "CRU Scientific Assessment Panel announced," news release, March 2010. Available online at http://www.uea.ac.uk/mac/comm/media/press/CRUstatements/SAPannounce. See also University of East Anglia, "New Scientific Assessment of Climatic Research Publications Announced," news release, February 11, 2010. Available online at http://www.uea.ac.uk/mac/comm/media/press/CRUstatements/New+scientific+assessment+of+climatic+research+publications+announced.

[25] IPCC, "IPCC Statement on the Melting of Himalayan Glaciers," statement, January 20, 2010. Available online at http://www.ipcc.ch/pdf/presentations/himalaya-statement-20january2010.pdf.

[26] "UN Climate Panel Admits Dutch Sea Level Flaw," Reuters, February 19, 2010, http://www.reuters.com/article/idUSTRE61C1V420100213.

[27] Netherlands Environmental Assessment Agency, "Correction wording flood risks for the Netherlands in IPCC report," http://www.pbl.nl/en/dossiers/Climatechange/content/correction-wording-flood-risks.html.

[28] Ibid. The Netherlands Environmental Assessment Agency's statement notes: "[t]he Netherlands is sensitive to climate change. Sea level rise as well as peak river discharges require precautionary measures. The incorrect wording in the IPCC report does not affect this conclusion."

- "Amazongate:" A story by Jonathan Leake in *The Sunday Times* (with "research by Richard North," a blogger[29])[30] alleged that a statement in WGII's report that "up to 40% of the Amazonian forests could react drastically to even a slight reduction in precipitation" was "based on an unsubstantiated claim by green campaigners who had little scientific expertise." But this is a matter of incorrect citation of sources, not a factual error: the WGII volume cited a report produced by the environmental organization WWF rather than the peer-reviewed primary research supporting the statement. Dan Nepstad, an expert whose peer-reviewed studies were cited in the WWF report, replied to Leake's query two days before the story ran and supported the IPCC's statement as correct but improperly referenced.[31] His public statement notes: "The IPCC statement on the Amazon is correct, but the citations listed in the [WWF] report were incomplete."[32] Simon Lewis, the expert portrayed as critical in Mr. Leake's story, had in fact also told him several times before the story ran that the IPCC's claim was factually accurate and well supported in the literature.[33] In response to a query from Leake, he wrote:

  > "Your statement [that the IPCC claim had so support and contradicted other studies] is untrue, there is a wealth of scientific evidence suggesting that the Amazon is vulnerable to reductions in rainfall. The IPCC statement itself is poorly written, and bizarrely referenced, but basically correct. It is very well known that in Amazonia tropical forests exist when there is more than about 1.5 meters of rain a year, below that the system tends to 'flip' to savanna, so reductions in rainfall towards this threshold could lead to rapid shifts in vegetation. Indeed, some leading models of future climate change impacts show a die-off of more than 40% Amazon forests, due to projected decreases in rainfall. The most extreme die-back model predicted that a new type of drought should begin to impact Amazonia, and in 2005 it happened for the first time: a drought associated with Atlantic, not Pacific sea-surface temperatures. The effect on the forest was massive tree mortality, and the remaining Amazon forests changed from absorbing nearly 2 billion tonnes of CO2 from the atmosphere a year, to being a massive source of over 3 billion tonnes."[34]

  Lewis has filed a detailed formal complaint against Leake and *The Sunday Times* with the UK's Press Complaints Commission, calling the article "materially

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[29] See http://eureferendum.blogspot.com/.

[30] Jonathan Leake, "The UN Panel and the Rainforest Claim," *The Sunday Times*, January 31, 2010, http://www.timesonline.co.uk/tol/news/environment/article7009705.ece. Note: Article originally ran under the headline "UN climate panel shamed by bogus rainforest claim."

[31] Eli Kintisch, "Scientist Disputes Claim of 'Bogus' IPCC Reference on Threatened Rainforests," *Science Insider*, February 3, 2010, http://news.sciencemag.org/scienceinsider/2010/02/forest-scientis.html.

[32] Woods Hole Research Centre, "Senior Scientist Daniel Nepstad endorses the correctness of the IPCC's (AR4) statement on Amazon forest susceptibility to rainfall reduction," statement, February 2010. Avaliable online at http://www.whrc.org/resources/online_publications/essays/2010-02-Nepstad_Amazon.htm.

[33] Simon Lewis, submission to PCC, March 2010. Available online at http://climateprogress.org/wp-content/uploads/2010/03/Lewis_S_Times_PCC_Complaint_As_Sent1.pdf.

[34] Ibid, 3-4. This same e-mail was sent to a BBC reporter and ran (nearly in full) in Roger Harrabin, "Harrabin's Notes: IPCC Under Scrutiny," *BBC News*, January 30, 2010, http://news.bbc.co.uk/2/hi/science/nature/8488395.stm.

misleading," and containing "inaccurate, misleading and distorted information" and "highly selective reporting."[35] Lewis writes, "[i]n short, there is no 'bogus rainforest claim,' the claim made by the UN panel was (and is) well-known, mainstream and defensible science, as myself and two other professional world-class rainforest experts (Professor Oliver Phillips and Professor Dan Nepstad) each told Jonathan Leake."[36] Lewis also states that his attempts to correct the article following its publication were ignored.[37]

- "Africagate:" Another story by Jonathan Leake in *The Sunday Times*[38] disputed the statement in WGII's Summary for Policymakers that "in some [African] countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020." The Summary for Policymakers cites a thorough and well-balanced discussion of this topic in the full WGII volume. There is no evidence to indicate the claim is incorrect, but it is possible that in condensing the discussion for inclusion in the summary key subtleties and qualifiers were lost. Robert Watson, a former Chair of the IPCC who was quoted in Mr. Leake's story, has elsewhere referred to this as an issue of "imprecise wording" where the summary report "failed to include the nuances and more detailed discussion in the underlying chapter."[39]

- "Disastergate:" A further story by Jonathan Leake in *The Sunday Times* alleged that the Fourth Assessment Report — again, the WGII volume — "wrongly linked global warming to natural disasters."[40] The IPCC responded with a statement calling the story "misleading and baseless."[41] The IPCC pointed out two key errors in Leake's story: firstly, his assumption that the section in question is the only one in the Fourth Assessment Report to deal with changes in extreme events and disasters, when in fact the report contains many other discussions of this topic; and secondly, his failure to acknowledge that the section in question provides a balanced discussion of the research available at that time, and recognizes that while one study had shown a trend of increasing economic losses, others had not. The authors of that one study have supported the IPCC's characterization of their work, stating that their organization, Risk Management Solutions, "believes the IPCC fairly referenced its paper, with suitable caveats around the results, highlighting the factors influencing the relationship that had

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[35] Lewis, 1.

[36] Ibid.

[37] Ibid, 1-2.

[38] Jonathan Leake, "Africagate: top British scientist says UN panel is losing credibility," *The Sunday Times*, February 7, 2010, http://www.timesonline.co.uk/tol/news/environment/article7017907.ece.

[39] Robert Watson, "The IPCC Needs to Change, but the Science Remains Sound," *Yale Environment 360*, February 25, 2010, http://e360.yale.edu/content/feature.msp?id=2245.

[40] Jonathan Leake, "UN wrongly linked global warming to natural disasters," *The Sunday Times*, January 24, 2010, http://www.timesonline.co.uk/tol/news/environment/article7000063.ece.

[41] IPCC, "IPCC Statement on Trends in Disaster Losses," statement, January 25, 2010. Available online at http://www.ipcc.ch/pdf/presentations/statement_25_01_2010.pdf.

been discovered between time and increased catastrophe costs. We believe it was appropriate to include the RMS paper in the report…".[42]

Analysis: It speaks well of the rigour of the IPCC's extensive review process (and of the overall reliability of its Fourth Assessment Report), that after several years of close scrutiny, only two errors (one of which is trivial), one imperfect citation, and perhaps one case of imprecise wording, have been found in a 3000-page report. Nonetheless, the disappointingly poor application of the review procedures in the case of the Himalayan glacier error has affected the public credibility of the IPCC's findings as a whole. The independent review of IPCC processes and procedures (see "Steps taken" below) should help ensure such mistakes are not repeated.

IPCC review processes are highly diligent and conservative

Despite the errors in the Fourth Assessment, the IPCC's reports remain the most comprehensive scientific assessments of climate change available. The IPCC's hundreds of volunteer authors compile their authoritative reports in a highly open process lasting several years, assessing and synthesizing the state of knowledge on this complex topic based on the published work of thousands of professional scientists worldwide, most of which has already gone through a rigorous peer-review process. The IPCC's three working groups work independently to produce their volumes. There is constant back-and-forth between governments and the author teams throughout the process. IPCC review procedures are remarkably open and transparent. All drafts from the Fourth Assessment Report, as well as the review comments (nearly 90,000) and responses to each, are tabulated and made public.[43] The Summaries for Policymakers of each working group report — as well as the Synthesis Report presenting the key findings of all three together — are approved line-by-line by representatives from virtually every government in the world. Key assertions made in the summaries are published along with confidence levels, which assess the strength of the supporting evidence.

Through this open, thorough process, the IPCC's reports gain ownership not only from the scientific community but also, importantly, from governments. (As noted above, the Government of Canada's scientists continue to recommend the IPCC Fourth Assessment Report as "the most comprehensive and rigorous source of scientific information for climate change negotiations.") The high level of diligence, as well as the need for consensus throughout the process, results in most conclusions of the IPCC being quite conservative. As an example, two major summaries of post-Fourth Assessment Report science published in 2009 noted many climate indicators were already near or above the

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[42] Risk Management Solutions, *RMS FAQ: Research on Climate Change and Disaster Loss Costs and the IPCC*, 2010, www.rms.com/Publications/2010_FAQ_IPCC.pdf.

[43] WGI: http://hcl.harvard.edu/collections/ipcc/index.html; WGII: http://www.ipcc-wg2.gov/publications/AR4/ar4review.html; WGIII: http://www.ipcc-wg3.de/publications/assessment-reports/ar4/forth-assessment-review-comments.

upper end of the IPCC's earlier projections,[44,45] and a 2009 joint statement by the National Science Academies of all G8+5 countries agreed that "climate change is happening even faster than previously estimated."[46] This is especially true in relation to the loss of sea-ice and the melting of major ice caps, both of which are occurring decades ahead of IPCC-referenced projections. Some recent studies estimate sea-level rise this century is likely to be double or even triple the Fourth Assessment Report's projections.[47]

Glacier error has no impact on the body of climate science and the core conclusions of the Fourth Assessment Report

Given a full analysis of the allegations made against the IPCC, can it be reasonably claimed that the state of knowledge of climate change has been significantly diminished or that the conclusions of the Fourth Assessment Report are flawed? The answer is no. The basic physical processes of climate change are well understood. Understanding of the climate system, and levels of confidence in humanity's role in contributing to the current warming, have progressively improved since the IPCC's First Assessment Report in 1990. The warming of the climate system is "unequivocal" and remains fully supported by many independent lines of evidence.[48] Each of these points are clear from the work of the IPCC's Working Group I, none has been challenged by the allegations above, and none is premised upon the projected local impacts of climate change.

In addition, recent events do not affect IPCC Working Group II's conclusion that continued greenhouse gas emissions at or above current levels can be expected to produce a host of impacts[49] that people generally judge to be very serious.

The body of research supporting the IPCC's core conclusions continues to grow. A recent joint statement from UK's Royal Society, Met Office and Natural Environment Research Council asserts that "even since the 2007 IPCC Assessment the evidence for dangerous,

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[44] C.P. McCullen and J. Jabbour, *Climate Change Science Compendium 2009* (Nairobi: UNEP, 2009). Available online at http://unep.org/climatechange/Publications/Publication/tabid/429/language/en-US/Default.aspx?BookID=4064.

[45] Katherine Richardson et al., *Synthesis Report from Climate Change: Global Risks, Challenges & Decisions, Copenhagen 2009, 10–12 March*, second edition (Copenhagen, Denmark: University of Copenhagen, 2009). Available online at http://climatecongress.ku.dk/pdf/synthesisreport.

[46] G8+5 Academies' Joint Statement.

[47] Martin Vermeer and Stefan Rahmstorf, "Global sea level linked to global temperature," *Proceedings of the National Academy of Sciences of the United States* 106 (2009), 21527. Available online at http://www.pnas.org/content/106/51/21527.full?sid=9ce68f3e-7e0f-4f45-9ced-de86457e4aaf. See also W. T. Pfeffer et al., "Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise," *Science* 321: 1340 (2008) and A. Grinsted et al., "Reconstructing sea level from paleo and projected temperatures 200 to 2100AD," *Climate Dynamics* (2009).

[48] Thomas Stocker and Qin Dahe, "Statement by Working Group I of the Intergovernmental Panel on Climate Change on stolen emails from the Climatic Research Unit at the University of East Anglia, United Kingdom," statement, December 4, 2009. Available online at http://www.ipcc.ch/pdf/presentations/WGIstatement04122009.pdf.

[49] Pachauri and Reisinger, 10–11.

long-term and potentially irreversible climate change has strengthened."[50] A major review of recent research by an international team of scientists confirms both rapid change and a clear "fingerprint" of human influence on a much wider range of impacts than were identified in the Fourth Assessment Report.[51]

Steps taken: With the IPCC now beginning work on its Fifth Assessment Report, and in light of the recent media attention to the IPCC's work, the timing is right for a discussion of ways to further improve the organization's processes. Adjustments to the timing of working group contributions to the Fifth Assessment Report and the continued identification of key cross-cutting issues and methodologies indicate that the IPCC is already taking some steps to increase cooperation between its working groups.[52]

The UN Secretary-General and the IPCC have announced an external independent review of IPCC processes and procedures. The review, which is expected to report no later than August 31, 2010, is being conducted by the InterAcademy Council, the umbrella body representing the National Science Academies of countries around the world, and will be co-chaired by the Presidents of the Dutch and Chinese Academies of Sciences.[53] The IPCC should respond to the review's recommendations promptly, and implement any further mechanisms necessary to ensure that its rigorous review procedures are followed at all times.

C: Global temperature trend

Context: The 2000s were the warmest decade on record, and very likely in well over a millennium, but the warming trend for global average surface temperatures from 2000–09 may have been less pronounced than the warming trend during 1990–99.

Claims: Some commentators have suggested that global warming has stalled or stopped. Others have claimed there is now a global cooling trend.

Analysis: The climate is a very complex system, and so global warming does not occur smoothly. Natural year-to-year fluctuations are superimposed on the underlying trend of global warming. For example, a very strong El Niño event caused 1998 to register as the warmest year in some global temperature records (while others show 2005 as the warmest), whereas a La Niña event in 2008 led to a relatively cooler year. Over a period as short as 10 years, the natural fluctuations can mask the underlying warming trend.

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[50] Natural Environment Research Council et al., "Climate science statement from the Met Office, NERC and the Royal Society," statement, November 24, 2009. Available online at http://www.nerc.ac.uk/press/releases/2009/29-climate.asp.

[51] Peter Stott et al., "Detection and attribution of climate change: a regional perspective," *Wiley Interdisciplinary Reviews: Climate Change* Early View (published online before print, March 5, 2010).

[52] IPCC, "The IPCC's Fifth Assessment Report," backgrounder. Available online at http://www.ipcc.ch/pdf/ar5/ar5-leaflet.pdf. [accessed 29/03/2010]

[53] IPCC, "Scientific Academy to Conduct Independent Review of the Intergovernmental Panel on Climate Change's Processes and Procedures at Request of United Nations and IPCC," news release, March 10, 2010. Available online at http://www.ipcc.ch/pdf/press/pr-1003210-UN.pdf.

Climate is usually measured over longer periods (e.g., 30 years), where a long-term global warming trend is very clear. Recent analysis from NASA concludes that "there has been no reduction in the global warming trend of 0.15˚C–0.20˚C/decade that began in the late 1970s."[54]

The Earth is still warming

All the independent sets of temperature records agree that the 2000s were the warmest decade on record — well ahead of the 1990s. Further, according to NASA's record, 2009 was tied as the second-warmest year in the historical record, behind 2005.[55] Analysis performed both with and without tree-ring data concludes that these temperatures are likely the warmest in well over a millennium.[56] Further, recent measurements of heat content in the oceans (where over 90% of the heat trapped by greenhouse gases from human activities has been stored to date[57]) show an unbroken increase through the decade to 2008, the most recent year with data available at time of publication.[58,59] Despite being in a period when, as NASA notes, "the recent minimum of solar irradiance is having its maximum cooling effect,"[60] the earth is continuing to warm.

In a recent "test," the Associated Press provided two sets of global temperature data to four independent statistical experts, who were not told that the data represented temperature. None were able to detect any negative (cooling) trend.[61]

Trends evident in Canada

The long-term warming trend is equally clear in Canada, where "annual [average] temperatures have warmed over the last 62 years by 1.4°C," according to Environment Canada's latest annual analysis,[62] and the winter of 2009–10 was 4˚C above normal, the

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[54] Hansen et al., 28. Based on consideration of the five-year and eleven-year running means (minimizing El Nino and solar variability, respectively) up to January 2010.

[55] NASA / Goddard Institute for Space Studies, "2009: Second Warmest Year on Record; End of Warmest Decade," news release, January 21, 2010. Available online at http://www.giss.nasa.gov/research/news/20100121/.

[56] Michael Mann et al.

[57] D.M. Murphy et al., "An observationally based energy balance for the Earth since 1950," *Journal of Geophysical Research* 114 (2009), D17107.

[58] Ibid.

[59] K. Von Schuckmann et al., "Global hydrographic variability patterns during 2003-2008," *Journal of Geophysical Research* 114 (2009), C09007.

[60] Hansen et al., 28.

[61] Seth Borenstein, "AP Impact: Statisticians Reject Global Cooling," Associated Press, October 26, 2009, http://www.msnbc.msn.com/id/33482750/ns/us_news-environment/.

[62] Environment Canada, "Temperature and Precipitation in Historical Perspective – Annual 2009," *Climate Trends and Variations Bulletin* (2009), http://www.msc-smc.ec.gc.ca/ccrm/bulletin/annual09/national_e.cfm.

warmest since record-keeping began.[63] Indeed, according to Environment Canada, "all seasons have shown a warming trend since 1948."[64] The evidence of this warming is readily observable. In the most comprehensive scientific assessment to date of climate change within our borders, Natural Resources Canada found "the impacts of changing climate are already evident in every region of Canada."[65] This is particularly true in northern Canada, which has seen the greatest temperature change.

Experts taken out of context

The comments and findings of two experts in particular are often taken out context to support claims that global warming has stopped.

- Mojib Latif (a German climatologist): Following an article that he co-authored in *Nature* in 2008 and a talk that he gave in 2009, some commentators have mischaracterized Latif's work as predicting either a decade or more of cooling or a long pause in global warming. In fact, Latif's projections anticipate that several natural oscillations may combine to stabilize temperatures for several years (until 2015 at the latest) before more rapid warming catches up to the long-term trend. He notes "you can't miss the long-term warming trend" that is "driven by the evolution of greenhouse gases."[66] Latif's colleague, the lead author of the *Nature* article in question, confirms that their research does not contradict estimations that the decade 2010–20 will likely be the warmest on record, and see faster temperature rise than any decade since the authors' calculations began in 1960.[67]
- Phil Jones (head of the University of East Anglia's Climate Research Unit until temporarily stepping down in November 2009): The *Daily Mail* ran a story with the highly misleading headline "Climategate U-turn as scientist at centre of row admits: There has been no global warming since 1995,"[68] based on a BBC interview with Jones. This is a very inaccurate characterization of Professor Jones' comments in the interview, which concerned the "statistical significance"

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[63] Environment Canada, "Temperature and Precipitation in Historical Perspective – Winter 2009/2010," *Climate Trends and Variations Bulletin* (2010), http://www.msc-smc.ec.gc.ca/ccrm/bulletin/national_e.cfm.

[64] Ibid.

[65] D.S. Lemmen et al., *From Impacts to Adaptation: Canada in a Changing Climate 2007 – Synthesis Report* (Ottawa: Government of Canada, 2008), 1. Available online at http://adaptation.nrcan.gc.ca/assess/2007/index_e.php.

[66] Joseph Romm, "Exclusive: Dr. Mojib Latif sets the record straight on what his work says about global warming and what it doesn't say about global cooling," *Climate Progress*, January 14, 2010, http://climateprogress.org/2010/01/14/science-dr-mojib-latif-global-warming-cooling/.

[67] Joseph Romm, "Nature article on 'cooling' confuses media, deniers: next decade may see rapid warming," *Climate Progress*, May 2, 2008, http://climateprogress.org/2008/05/02/nature-article-on-cooling-confuses-revkin-media-deniers-next-decade-may-see-rapid-warming/.

[68] Jonathan Petre, "Climategate U-turn as scientist at centre of row admits: There has been no global warming since 1995," *The Daily Mail*, February 14, 2010, http://www.dailymail.co.uk/news/article-1250872/Climategate-U-turn-Astonishment-scientist-centre-global-warming-email-row-admits-data-organised.html.

of recent warming. Statisticians generally only regard a trend as "significant" if it is more than 95% probable to be real.[69] As the professional climate scientists who maintain the *RealClimate* website have commented, *"What Jones actually said is that, while the globe has nominally warmed since 1995, it is difficult to establish the statistical significance of that warming given the short nature of the time interval (1995–present) involved. The warming trend consequently doesn't quite achieve statistical significance. But it is extremely difficult to establish a statistically significant trend over a time interval as short as 15 years — a point we have made countless times."*

This interpretation has been confirmed by Jones as correct.[70]

D: The case for action

The essential question following the events discussed in this backgrounder is whether they have affected the case for urgent action to reduce greenhouse gas emissions. It is clear the answer is a resounding "no." As *Nature* reminds us, "the core science supporting anthropogenic [manmade] global warming has not changed. This needs to be stated again and again, in as many contexts as possible."[71]

The urgency of tackling greenhouse gas emissions grows with each year of delay, as do the costs.

Analyses by global consulting firm McKinsey & Company,[72] the International Energy Agency[73] and many others[74] show that it is still possible to limit global warming to 2˚C above pre-industrial levels — a degree of warming widely regarded as a dangerous threshold[75] — at a cost that is small compared to the size of the economy (and a net

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[69] See http://en.wikipedia.org/wiki/Statistical_significance.

[70] Editorial, "Daily Mangle," *RealClimate,* February 15, 2010, http://www.realclimate.org/index.php/archives/2010/02/daily-mangle/.

[71] Editorial, "Climate of Fear," *Nature* 464 (2010), 141. Available online at http://www.nature.com/nature/journal/v464/n7286/full/464141a.html.

[72] *Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve* (McKinsey & Company, 2009). Available online at http://www.mckinsey.com/clientservice/ccsi/pathways_low_carbon_economy.asp.

[73] International Energy Agency, *World Energy Outlook 2009* (Paris: Organization for Economic Co-operation and Development, 2009). Available online at http://www.worldenergyoutlook.org/.

[74] See, notably, Nicholas Stern, *Stern Review: The Economics of Climate Change* (London, UK: HM Treasury, 2006). Available online at http://www.hm-treasury.gov.uk/stern_review_report.htm. See also *Synthesis Report from Climate Change: Global Risks, Challenges & Decisions, Copenhagen 2009, 10–12 March.*

[75] *Bali Climate Declaration by Scientists* (Sydney, Australia: University of New South Wales, 2007). Available online at http://www.ccrc.unsw.edu.au/news/2007/Bali.html. This limit has also been recognized by the leaders of the world's major economies. See *Declaration of the Leaders of the Major Economies Forum on Energy and Climate* (2009). Available online at http://www.g8italia2009.it/static/G8_Allegato/MEF_Declarationl.pdf.

economic benefit, when the avoided cost of climate change itself is factored in). But this window of opportunity is closing rapidly. Without swift and ambitious action, options to limit warming to relatively manageable levels will quickly pass out of the realm of technological, economic and political feasibility, while the costs of inaction will only continue to grow.