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Your File Votre référence

Our File Notre référence
A-2009-00695 / mb

MAR 0 4 2010

Ms. Claire Demers
130 Albert Street
Suite 910
Ottawa, Ontario
K1P 5G4

Dear Ms. Demers:

We have completed processing your request under the Access to Information Act (the Act) for:

"All advice (memos, emails, decks, etc.) on climate science prepared for Minister Prentice. August 1, 2009 to December 31, 2009"

Attached please find the complete release package in response to this request.

Please be advised that you are entitled to file a complaint with the Information Commissioner concerning the processing of your request within sixty days of the receipt of this notice. In the event you decide to avail yourself of this right, your notice of complaint should be addressed to:

Information Commissioner
Tower B, Place de Ville
112 Kent Street, 22nd Floor
Ottawa, Ontario
KlA 1H3

If you have any questions regarding this request, please do not hesitate to contact Michael Bogues at (819) 953-5689.

Yours sincerely,

Pierre Bernier
Access to Information
and Privacy Coordinator

Enclosure

MEMORANDUM TO CHIEF NEGOTIATOR

POST-IPCC FOURTH ASSESSMENT REPORT SCIENCE: INFORMATION AND ADVICE IN SUPPORT OF CLIMATE CHANGE NEGOTIATIONS

(For Information)

PURPOSE

To advise you on the role of post-IPCC Fourth Assessment Report science in climate change negotiations and to inform you of emerging science on key issues relevant to negotiations.

SUMMARY

- The IPCC Fourth Assessment Report (AR4) continues to be recommended as the most comprehensive and rigorous source of scientific information for climate change negotiations.
- Science that has emerged since the AR4 should be treated cautiously while it is progressively integrated into the larger body of scientific literature and assessed against other emerging findings. This is particularly true for individual papers; however, there are now three years of published research since that assessed in the AR4, and some relevant signals from this body of work are emerging.
- Key findings from the recent scientific literature on issues of relevance to climate change negotiations include:
    - Recent research has shown that the chance of keeping to below global temperature targets (aimed at avoiding dangerous climate change) is determined by the accumulated emissions of long-lived greenhouse gases (GHGs) like CO_2, regardless of the emissions pathway. This implies that CO_2 emissions reduction targets for any specific year (e.g. 2020, 2050) should be devised with a cumulative emission limit in mind.
    - Recent studies indicate that elevated atmospheric concentrations of black carbon (BC) and deposition of BC on ice and snow have a warming effect in the Arctic and globally. Reductions in BC emissions should almost immediately reduce BC caused warming, although it is difficult to estimate the amount by which warming would be reduced because our understanding of the amount of BC caused warming is uncertain. Reducing BC emissions may help to delay, but would not counter, the warming due to long-lived GHGs.
    - Improvements in understanding ice sheet contributions to future sea level rise (SLR) are key to providing better estimates of SLR on different timescales. Recent advances in this respect indicate that the SLR projections for this century may be somewhat underestimated in the AR4, but by a factor of 2 at most.
    - Ocean acidification caused by the absorption of CO_2 from burning fossil fuels is altering the fundamental chemistry of the oceans and raising concerns about potential impacts on ecosystems. High-latitude ocean surface waters in particular are expected to show large adverse effects within the next several decades.

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Information and Advice in Support of Climate Change Negotiations

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MIN-130383

MEMORANDUM TO MINISTER

SCIENCE PUBLISHED AFTER THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE FOURTH ASSESSMENT REPORT: INFORMATION AND ADVICE IN SUPPORT OF CLIMATE CHANGE NEGOTIATIONS

(For Information)

PURPOSE

To inform you of the developments in climate science that may be relevant to negotiations since the release the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4).

SUMMARY

- The IPCC AR4 continues to be recommended as the most comprehensive and rigorous source of scientific information for climate change negotiations.
- Scientific findings published in individual papers since the AR4 should be treated cautiously while they are progressively integrated into the larger body of scientific literature and assessed against other findings.
- However, three years of published research have accumulated since the AR4, and some relevant signals from this body of work are emerging. Policy relevant findings from the recent scientific literature include:
  - the possibility of staying below global temperature targets is determined by the accumulated emissions of long-lived greenhouse gases (GHGs) like carbon dioxide (CO_2), regardless of the pathway in which emissions are released. This implies that CO_2 emissions reduction targets for any specific year (e.g., 2020, 2050) should be devised with a cumulative emission limit in mind;
  - elevated atmospheric concentrations of black carbon (BC) and deposition of BC on ice and snow have a warming effect in the Arctic and globally, but the total amount of BC-caused warming is uncertain. Reducing BC emissions may help to delay near-term warming effects, but would not counter the warming due to long-lived GHGs;
  - increased understanding of the contribution of ice sheets to future sea-level rise indicates that sea-level rise projections for this century may have been under-estimated in the IPCC AR4, but not by more than a factor of 2; and
  - ocean acidification caused by the absorption of CO_2 from burning fossil fuels is altering the fundamental chemistry of the oceans and raising concerns about potential impacts on ecosystems. High-latitude ocean surface waters in particular are expected to show large adverse effects within the next several decades.

CURRENT STATUS

An interdepartmental science working group was formed in July 2008 to provide information and advice in support of Canada's role in international climate change negotiations. The working group is composed of federal scientists representing six different government departments. This group has produced an update on some of the key scientific developments that have been published since the IPCC AR4, which is provided in Annex I for your reference. Annex I has also been provided to Michael Martin (Chief Negotiator and Ambassador for Climate Change).

Recent media reports in the aftermath of the hacking incident at the Climatic Research Unit (CRU) of the University of East Anglia (DM-130534) has raised some concerns about the reliability and robustness of some of the science considered in the IPCC AR4. Despite these developments, the department continues to view the IPCC AR4 as the most comprehensive and rigorous source of scientific information for climate change negotiations.

CONSIDERATIONS

The IPCC assessments rely primarily on scientific research published in well-established journals with robust peer-review processes. While not 100% foolproof, the peer-review process results in science with a very high degree of reliability and credibility. The peer-review process, together with the possibility that scientific results and interpretations, once published, may be challenged by others, ensures that scientists take full responsibility for their published results.

The additional, extensive review of the IPCC assessments further increases the reliability of the science that is ultimately incorporated into the IPCC Summaries for Policy Makers, which are the key documents that synthesize the results of IPCC assessments. The IPCC review process involves (i) review of an initial draft of the report by experts; (ii) review by governments and experts of a revised draft that takes into account the comments of the experts on the initial draft; (iii) review by governments of the summary for policy makers; and (iv) acceptance of the report and line-by-line approval of the summary for policy makers by the governments at a meeting of the IPCC called specifically for this purpose. In the case of the Working Group I (WGI) contribution to the IPCC AR4, which assesses the Physical Science Basis, the review process was open to any expert who wished to register on the IPCC website, and generated in excess of 30,000 comments. IPCC authors were required to respond to each and every comment. Furthermore, each chapter in the IPCC AR4 WGI report was assigned three Review Editors who had the responsibility to ensure that the comments were dealt with and responded to appropriately. 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. For example, in the case of the all-important global surface temperature record, the IPCC AR4 assessed four compilations of land surface air temperature observations. They were produced by groups at the CRU (in collaboration with the Hadley Centre of the UK Meteorological Office), the US National Climate Data Centre (NOAA), the Goddard Institute for Space Studies (NASA), and the Carbon Dioxide Information Analysis Center (part of the US Department of Energy); all 4 data sets provide a very similar picture of the warming over land over the 20th century. The IPCC AR4 also assessed three compilations of ocean surface temperature variations produced by the Hadley Centre, the US National Climate Data Center, and a Japanese group, and they also provide a very similar picture of how the ocean surface has warmed over the 20th century. Redundancy in the data sources used, in the models that are used to interpret changes seen in those data sources, and in the approaches and methods used in the analysis of observations and climate models all contribute to the robustness of the IPCC assessment and help to make it more reliable.

Ian Shugart

c.c.: Associate Deputy Minister

Attachments (1):

- *Annex I: Supplemental Information on post-IPCC AR4 science*

ANNEX I

SUPPLEMENTAL INFORMATION

SUMMARY

- The IPCC Fourth Assessment Report (AR4) continues to be recommended as the most comprehensive and rigorous source of scientific information for climate change negotiations.
- Science that has emerged since the AR4 should be treated cautiously while it is progressively integrated into the larger body of scientific literature and assessed against other emerging findings. This is particularly true for individual papers; however, there are now three years of published research since that assessed in the AR4, and some relevant signals from this body of work are emerging.
- Key findings from the recent scientific literature on issues of relevance to climate change negotiations include the following:
    - Recent research has shown that the chance of keeping to below global temperature targets (aimed at avoiding dangerous climate change) is determined by the accumulated emissions of long-lived greenhouse gases (GHGs) like CO_2, regardless of the emissions pathway. This implies that CO_2 emissions reduction targets for any specific year (e.g. 2020, 2050) should be devised with a cumulative emission limit in mind.
    - Recent studies indicate that elevated atmospheric concentrations of black carbon (BC) and deposition of BC on ice and snow have a warming effect in the Arctic and globally. Reductions in BC emissions should almost immediately reduce BC caused warming, although it is difficult to estimate the amount by which warming would be reduced because our understanding of the amount of BC caused warming is uncertain. Reducing BC emissions may help to delay, but would not counter, the warming due to long-lived GHGs.
    - Improvements in understanding ice sheet contributions to future sea level rise (SLR) are key to providing better estimates of SLR on different timescales. Recent advances in this respect indicate that the SLR projections for this century may be somewhat under-estimated in the AR4, but by a factor of 2 at most.
    - Ocean acidification caused by the absorption of CO_2 from burning fossil fuels is altering the fundamental chemistry of the oceans and raising concerns about potential impacts on ecosystems. High-latitude ocean surface waters in particular are expected to show large adverse effects within the next several decades

TREATMENT OF POST-IPCC FOURTH ASSESSMENT REPORT SCIENCE IN CLIMATE CHANGE NEGOTIATIONS

Canada's positions in upcoming climate change negotiations should continue to be based on the most robust source of scientific knowledge currently available which is that presented in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR4), published in 2007. The rigorous IPCC assessment and review process has been endorsed by national academies of science worldwide and other respected scientific bodies. IPCC Reports reflect different viewpoints existing within the scientific community, but major conclusions ultimately convey the consensus opinion of the expert community based on the weight of evidence assessed.

The IPCC produces Summaries for Policy Makers that are distilled from the full assessment reports and are approved by the full panel in plenary, presenting scientific information that is policy-relevant—though "policy-neutral" and non-prescriptive—for decision makers. The IPCC has recently launched its Fifth Assessment cycle, which will produce updated assessment reports over the period September 2013 to September 2014. In the interim, it is advisable that Canada's climate change policymakers and negotiators be made aware of those aspects of new scientific research published since the AR4 that are policy-relevant, although such new results should be treated with caution.

The following section of this memo provides information on four post-AR4 science issues that have been identified as relevant to negotiations. These issues will be thoroughly assessed in the next IPCC report, but that report will not be completed in time to inform current negotiations. The short summaries of these issues presented here are based on a selection of scientific papers from the peer-reviewed literature that, on the basis of expert judgment, are considered noteworthy. References are provided in an annex to this memo. These summaries do not constitute a robust or comprehensive assessment of post-AR4 science but are intended to indicate the extent to which new research is leading to new areas of scientific consensus.

INFORMATION ON POST-AR4 SCIENCE FOR ISSUES RELEVANT TO NEGOTIATIONS

1) Cumulative Emission Limits to Meet Climate Stabilization Targets

Mitigation efforts based only on annual emission reduction targets relative to a baseline year are insufficient for meeting global mean temperature targets. Recent research has found that the global temperature response to CO_2 emissions is governed mainly by the total emissions accumulated over a specified time period and not by the particular emissions pathway that is followed. This new science provides new possibilities for formulating mitigation policy, which would have as its objective the stabilisation of temperature rather than the stabilisation of the atmospheric concentration of CO_2. Specifically, the new science can be used to obtain estimates of the upper limit on the total emissions accumulated over time that would ensure that warming above the chosen temperature stabilisation target could likely be avoided. The science shows that this cumulative emissions limit depends upon two factors - the temperature stabilisation objective and the amount of certainty we want to have that this warming objective will not be exceeded. The cumulative emissions limit decreases when the amount of certainty required is increased. Policy that is formulated using this science would have to take these tradeoffs into account; that is, it would have set a cumulative emissions limit that takes account of an agreed temperature stabilization objective and an agreed level of certainty that this objective would not be exceeded.

Earlier research on allowable GHG emissions, such as that assessed in the Fourth Assessment Report of the IPCC, focused primarily on emissions compatible with different atmospheric CO_2 concentration stabilization levels. Such an approach is fundamentally different from the one discussed here. Stabilizing atmospheric CO_2 concentrations at present or higher levels would lead to a continued slow rise in global temperature for many centuries. In contrast, stabilizing global temperature below a threshold level, such as 2°C above pre-industrial, would require that atmospheric CO_2 concentrations peak and then decline. Since processes that permanently remove CO_2 from the atmosphere act very slowly, reducing atmospheric CO_2 concentrations requires that global anthropogenic emissions be brought down close to zero, eventually.

Results from four recent studies indicate that to have a 50% chance of limiting warming to no more than 2°C global above pre-industrial temperature, cumulative global carbon emissions from year 2000 onward must be limited to a best estimate of between 400 and 800 gigatonnes of carbon (GtC)[1] (corresponding to 1470 and 2940 $GtCO_2$). To increase the odds and have a 75% chance of avoiding a 2°C warming, cumulative carbon emissions from year 2000 onward must be limited to between 270 and 490 GtC (990 to 1800 $GtCO_2$). Since the year 2000, 90 GtC (330 $GtCO_2$) have already been emitted into the atmosphere with a current emission rate of approximately 10 GtC (37 Gt CO_2) per year. The longer we remain on the current (increasing) emission pathway, the quicker this cumulative limit is approached and the more rapidly subsequent emission reductions must be made in order to avoid surpassing that limit. Only the lower bound estimates of the ranges of total allowable CO_2 emissions given above take into account the climate effects of non-CO_2 greenhouse gases and aerosols. Fully accounting for these effects would reduce the upper limit on allowable CO_2 emissions.

Note that this approach for estimating cumulative emission limits that are consistent with avoiding specified long-term warming levels is most appropriately applied to long-lived GHGs only. Emissions of short-lived greenhouse gases and aerosols make little contribution to the eventual stabilized temperature of the earth system (unless emissions of such substances were to continue indefinitely), although they can have important impacts on short term warming rates.

2) Black Carbon and Impacts on Arctic Warming

Black Carbon (BC) is increasingly recognized as a climate warming agent. The contribution of BC to global and regional warming is an area of active research. BC has many natural and anthropogenic sources, including fossil fuel and biomass burning. It is a short-lived pollutant that is transported by wind and remains in the atmosphere from days to a few weeks, before being removed by rain and snowfall.

BC strongly absorbs solar radiation, and thereby warms the surrounding air. In addition, the presence of dark BC particles on bright surfaces, such as snow or ice, contributes to surface heating. Research since the IPCC AR4 has investigated the role of BC in Arctic warming and early indications are that elevated atmospheric concentrations and deposition of BC on ice and snow contribute to warming in the region. It has been estimated that 80% of the BC found in Arctic snow comes from human sources, mainly from Northern Eurasia, South and East Asia,

[1] The range is based on cumulative CO_2 emissions estimates of four different studies. Allen et al. (2009), Matthews et al. (2009) and Zickfeld et al. (2009) consider the climate effects of CO_2 only and calculate total cumulative CO_2 emissions after 2000 compatible with a 50% chance of avoiding a maximum warming of 2°C of approximately 500 GtC, 800 GtC and 800 GtC respectively. These studies do not account for the additional warming associated with increasing emissions of other greenhouse gases, which would tend to reduce these estimates. Meinshausen et al. (2009) estimate the cumulative emissions over the 2000-2050 period, compatible with a 50% chance of avoiding a 2°C warming at any point in the 21st century, to be approximately 400 GtC accounting for the climate effects of other greenhouse gases and aerosols. The cumulative emissions compatible with avoiding 2°C warming at the 75% level were taken from Meinshausen et al. (2009) (270 GtC) and Zickfeld et al. (2009) (490 GtC).

and North America. However, quantifying the contribution of anthropogenic BC to Arctic warming remains difficult.

Because of its short residence time in the atmosphere, reductions in BC emissions would almost immediately reduce the warming effect associated with BC. Reductions would also lead to improvements in air quality in BC source regions. Research published since the AR4 suggests that reducing BC emissions is only a short-term strategy that may act to delay (by a decade or so), rather than reverse, the ongoing warming due to long-lived greenhouse gases like CO_2.

Furthermore, the magnitude of the effects of BC emission reductions on climate are still not well understood, and this is particularly true for the Arctic. One issue is that, although BC acts to warm the climate, other aerosols which have a cooling effect (because they reflect rather than absorb solar radiation) are often emitted from the same sources. A further complication is that BC and other aerosols interact with clouds and so the net effect of BC reductions is not straightforward to predict.

3) Sea Level Rise and Ice Sheet Dynamics

Sea-level rise (SLR) is a result of thermal expansion of sea water (as the oceans warm), the addition of water to the oceans from melting glaciers and ice caps, and the enhanced flow of ice from the large ice sheets into the ocean. During the 20th century, sea level has risen at a rate of about 1.7mm per year, with evidence of acceleration during the latter half of the century. IPCC AR4 projections ranged from 0.18 to 0.59m of additional SLR by 2100, but the IPCC noted that recent evidence for enhanced outflow of ice from Antarctica and Greenland might increase this by an additional 0.1 to 0.2m. It should be noted that because of the long time required for the deep ocean to equilibrate with changes in the surface temperature, thermal expansion will continue for centuries, even if global temperatures are stabilized.

The extent to which enhanced ice outflow from the large ice sheets might accelerate SLR during the 21st century was a major source of uncertainty at the time of the AR4 and has been the subject of extensive research since. Satellite observations continue to show enhanced outflow in some of the ice streams on Greenland and Antarctica, associated with the break-up of floating ice shelves that act to constrain the ice flow.

Although enhanced discharge from both the Greenland and West Antarctic Ice Sheets has been identified as a possible 'tipping point' in the climate system, and could ultimately contribute several meters of sea-level rise, current research indicates that this occurs rather slowly (i.e. several centuries). At least two different lines of research published since the AR4 suggest that multi-meter SLR by the year 2100 is unlikely. Approaches based on the analysis of historical SLR and temperature relationships indicate SLR by 2100 similar to that projected by the AR4 or perhaps a factor of two higher; whereas an analysis based on the maximum plausible flow speed for ice streams suggests year 2100 SLR of 0.8m, with values above 2m deemed implausible.

Although substantial reductions in the volume of the Greenland and Antarctic ice sheets will likely take many centuries, an important issue is the extent to which, once begun, this process is irreversible. This continues to be an area of active research.

In summary, sea level will continue to rise as climate warms. IPCC AR4 projections of future rise remain defensible, though recent papers suggest that they may have to be revised upward somewhat. However, SLR of more than 1.5 – 2m by the end of the 21st century is unlikely given current scientific understanding. Improved understanding of the rate and magnitude of SLR over the next century is critical for adapting to climate change. Identifying trigger points for potentially irreversible melting of the ice sheets is key to discussions of avoiding dangerous climate change.

4) Acidification of the Ocean Due to the Uptake of Carbon Dioxide

Ocean acidification refers to changes in ocean chemistry that arise from ocean absorption of CO_2 emitted by human activities. Ocean acidification is therefore not a consequence of climate change; it is a direct consequence of CO_2 emissions. CO_2 reacts with seawater to form carbonic acid. Dissociation of carbonic acid makes seawater more acidic (lowers the pH). The IPCC Fourth Assessment (AR4) reported that ocean pH has decreased by 0.1 units since 1750 as a result of uptake of CO_2 from the atmosphere, which represents a 30% increase in acidity. The IPCC AR4 projected an additional decrease in pH of 0.14-0.35 by 2100. A decrease of 0.6 relative to the pre-industrial value would be unprecedented over at least the last 300 million years.

Increased acidity reduces the concentration of carbonate in the ocean. Many marine organisms have shells or skeletons of calcium carbonate and therefore their growth is negatively impacted by increasing acidity. A critical threshold is passed when waters shift from a state of super-saturation to under-saturation with respect to calcium carbonate, at which point shells and skeletons made of calcium carbonate start to dissolve. Cold, high latitude ocean waters are especially sensitive to the impacts of declining pH as they have a naturally low saturation state for calcium carbonate relative to other parts of the oceans.

Recent research has shown that surface waters in some areas of the Arctic Ocean are already under-saturated with respect to aragonite, a key calcium carbonate mineral found in marine organisms. Arctic waters may be particularly vulnerable because large inputs of fresh water from land and from melting sea ice reduce the ocean's capacity to absorb CO_2 without experiencing large changes in pH. In the Pacific, subsurface waters that have become undersaturated due to anthropogenic CO_2 have recently been observed on the biologically rich continental shelf, a situation that was not expected to occur for several decades yet.

At the time of the IPCC's Fourth Assessment, the effects of *observed* ocean acidification had not yet been documented. Accelerated efforts to understand the impacts of projected changes in ocean acidification on marine organisms in recent years have revealed diverse and complex responses and some species show clear evidence of impacts from levels of acidification already attained. The results of some recent research indicate that ocean chemistry and biology will be significantly perturbed even if atmospheric CO_2 concentrations are stabilized at low to moderate levels.

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