INTERGOVERNMENTAL PANEL ON climate change

Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties

IPCC Cross-Working Group Meeting on Consistent Treatment of Uncertainties
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At its 32nd session, the IPCC Panel urged the implementation of this Guidance Note.

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These guidance notes are intended to assist Lead Authors of the Fifth Assessment Report (AR5) in the consistent treatment of uncertainties across all three Working Groups. These notes define a common approach and calibrated language that can be used broadly for developing expert judgments and for evaluating and communicating the degree of certainty in findings of the assessment process. These notes refine background material provided to support the Third and Fourth Assessment Reports[1,2,3]; they represent the results of discussions at a Cross-Working Group Meeting on Consistent Treatment of Uncertainties convened in July 2010. They also address key elements of the recommendations made by the 2010 independent review of the IPCC by the InterAcademy Council.[4] Review Editors play an important role in ensuring consistent use of this calibrated language within each Working Group report. Each Working Group will supplement these notes with more specific guidance on particular issues consistent with the common approach given here.

The AR5 will rely on two metrics for communicating the degree of certainty in key findings:

- Confidence in the validity of a finding, based on the type, amount, quality, and consistency of evidence (e.g., mechanistic understanding, theory, data, models, expert judgment) and the degree of agreement. Confidence is expressed qualitatively.
- Quantified measures of uncertainty in a finding expressed probabilistically (based on statistical analysis of observations or model results, or expert judgment).

In order to develop their key findings, author teams should evaluate the associated evidence and agreement. Depending on the nature of the evidence evaluated, teams have the option to quantify the uncertainty in the finding probabilistically. In most cases, author teams will present either a quantified measure of uncertainty or an assigned level of confidence.

It is important for author teams to develop findings that are general enough to reflect the underlying evidence but not so general that they lose substantive meaning. For findings (effects) that are conditional on other findings (causes), consider independently evaluating the degrees of certainty in both causes and effects, with the understanding that the degree of certainty in the causes may be low. In particular, this approach may be appropriate for high-consequence conditional outcomes with a high degree of certainty. Finally, be aware that findings can be constructed from the perspective of minimizing false positive (Type I) or false negative (Type II) errors, with resultant tradeoffs in the information emphasized.[5]

Sound decisionmaking that anticipates, prepares for, and responds to climate change depends on information about the full range of possible consequences and associated probabilities. Such decisions often include a risk management perspective. Because risk is a function of probability and consequence, information on the tails of the distribution of outcomes can be especially important. Low-probability outcomes can have significant impacts, particularly when characterized by large magnitude, long persistence, broad prevalence, and/or irreversibility. Author teams are therefore encouraged to provide information on the tails of distributions of key variables, reporting quantitative estimates when possible and supplying qualitative assessments and evaluations when appropriate.

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Treat Issues of Uncertainty

1) At an early stage, consider approaches to communicating the degree of certainty in key findings in your chapter using the calibrated language described below. Determine the areas in your chapter where a range of views may need to be described, and those where the author team may need to develop a finding representing a collective view. Agree on a moderated and balanced process for doing this in advance of confronting these issues in a specific context.

2) Be prepared to make expert judgments in developing key findings, and to explain those judgments by providing a traceable account: a description in the chapter text of your evaluation of the type, amount, quality, and consistency of evidence and the degree of agreement, which together form the basis for a given key finding. Such a description may include standards of evidence applied, approaches to combining or reconciling multiple lines of evidence, conditional assumptions, and explanation of critical factors. When appropriate, consider using formal elicitation methods to organize and quantify these judgments.[6]

3) Be aware of a tendency for a group to converge on an expressed view and become overconfident in it.[7] Views and estimates can also become anchored on previous versions or values to a greater extent than is justified. One possible way to avoid this would be to ask each member of the author team to write down his or her individual assessments of the level of uncertainty before entering into a group discussion. If this is not done before group discussion, important views may be inadequately discussed and assessed ranges of uncertainty may be overly narrow.[8] Recognize when individual views are adjusting as a result of group interactions and allow adequate time for such changes in viewpoint to be reviewed.

4) Be aware that the way in which a statement is framed will have an effect on how it is interpreted (e.g., a 10% chance of dying is interpreted more negatively than a 90% chance of surviving).[9] Consider reciprocal statements to avoid value-laden interpretations (e.g., report chances both of dying and of surviving).

5) Consider that, in some cases, it may be appropriate to describe findings for which evidence and understanding are overwhelming as statements of fact without using uncertainty qualifiers.

Review the Information Available

6) Consider all plausible sources of uncertainty. Experts tend to underestimate structural uncertainty arising from incomplete understanding of or competing conceptual frameworks for relevant systems and processes.[7] Consider previous estimates of ranges, distributions, or other measures of uncertainty, their evolution, and the extent to which they cover all plausible sources of uncertainty.

7) Assess issues of uncertainty and risk to the extent possible. When appropriate probabilistic information is available, consider ranges of outcomes and their associated probabilities with attention to outcomes of potential high consequence. Additional value can come from information that supports robust decisions for a wide range of climate and socio-economic futures.[10]

Evaluate and Communicate at the Appropriate Level of Precision

The following process and language should be applied to evaluate and communicate the degree of certainty in key findings. Paragraph 8 explains the basis of confidence in terms of level of evidence and degree of agreement. Paragraph 9 defines the confidence scale. Paragraph 10 discusses quantified measures of uncertainty. Finally, Paragraph 11 provides criteria for communication of uncertainty at different levels of precision.

8) Use the following dimensions to evaluate the validity of a finding: the type, amount, quality, and consistency of evidence (summary terms: "limited," "medium," or "robust"), and the degree of agreement (summary terms: "low," "medium," or "high"). Generally, evidence is most robust when there are multiple, consistent independent lines of high-quality evidence. Provide a traceable account describing your evaluation of evidence and agreement in the text of your chapter.

   - For findings with high agreement and robust evidence, present a level of confidence or a quantified measure of uncertainty.
   - For findings with high agreement or robust evidence, but not both, assign confidence or quantify uncertainty when possible. Otherwise, assign the appropriate combination of summary terms for your evaluation of evidence and agreement (e.g., robust evidence, medium agreement).

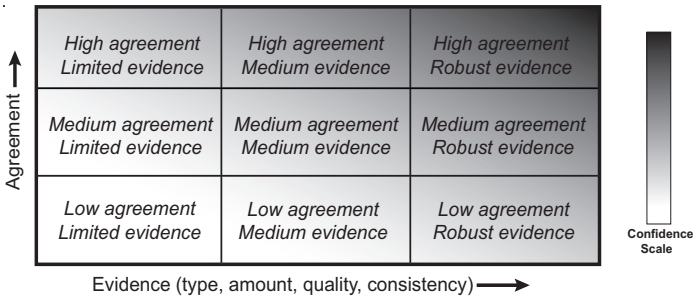

Figure 1: A depiction of evidence and agreement statements and their relationship to confidence. Confidence increases towards the top-right corner as suggested by the increasing strength of shading. Generally, evidence is most robust when there are multiple, consistent independent lines of high-quality evidence.

- For findings with low agreement and limited evidence, assign summary terms for your evaluation of evidence and agreement.
- In any of these cases, the degree of certainty in findings that are conditional on other findings should be evaluated and reported separately.

9) A level of *confidence* is expressed using five qualifiers: "very low," "low," "medium," "high," and "very high." It synthesizes the author teams' judgments about the validity of findings as determined through evaluation of evidence and agreement. Figure 1 depicts summary statements for evidence and agreement and their relationship to confidence. There is flexibility in this relationship; for a given evidence and agreement statement, different confidence levels could be assigned, but increasing levels of evidence and degrees of agreement are correlated with increasing confidence. Confidence cannot necessarily be assigned for all combinations of evidence and agreement in Figure 1 (see Paragraph 8). Presentation of findings with "low" and "very low" confidence should be reserved for areas of major concern, and the reasons for their presentation should be carefully explained. Confidence should not be interpreted probabilistically, and it is distinct from "statistical confidence." Additionally, a finding that includes a probabilistic measure of uncertainty does not require explicit mention of the level of confidence associated with that finding if the level of confidence is "high" or "very high."

10) *Likelihood*, as defined in Table 1, provides calibrated language for describing quantified uncertainty. It can be used to express a probabilistic estimate of the occurrence of a single event or of an outcome (e.g., a climate parameter, observed trend, or projected change lying in a given range). Likelihood may be based on statistical or modeling analyses, elicitation of expert views, or other quantitative analyses. The categories defined in this table can be considered to have "fuzzy" boundaries. A statement that an outcome is "likely" means that the probability of this outcome can range from ≥66% (fuzzy boundaries implied) to 100% probability. This implies that all alternative outcomes are "unlikely" (0-33% probability). When there is sufficient information, it is preferable to specify the full probability distribution or a probability range (e.g., 90-95%) without using the terms in Table 1. "About as likely as not" should not be used to express a lack of knowledge (see Paragraph 8 for that situation). Additionally, there is evidence that readers may adjust their interpretation of this likelihood language according to the magnitude of perceived potential consequences.[11]

11) Characterize key findings regarding a variable (e.g., a measured, simulated, or derived quantity or its change) using calibrated uncertainty language that conveys the most information to the reader, based on the criteria (A-F) below.[12] These criteria provide guidance for selecting among different alternatives for presenting uncertainty, recognizing that in all cases it is important to include a traceable account of relevant evidence and agreement in your chapter text.

A) *A variable is ambiguous, or the processes determining it are poorly known or not amenable to measurement*: Confidence should not be assigned; assign summary terms for evidence and agreement (see Paragraph 8). Explain the governing factors, key indicators, and

Table 1. Likelihood Scale

Term*	Likelihood of the Outcome
Virtually certain	99-100% probability
Very likely	90-100% probability
Likely	66-100% probability
About as likely as not	33 to 66% probability
Unlikely	0-33% probability
Very unlikely	0-10% probability
Exceptionally unlikely	0-1% probability

* Additional terms that were used in limited circumstances in the AR4 (*extremely likely* – 95-100% probability, *more likely than not* – >50-100% probability, and *extremely unlikely* – 0-5% probability) may also be used in the AR5 when appropriate.

relationships. If a variable could be either positive or negative, describe the pre-conditions or evidence for each.

B) *The sign of a variable can be identified but the magnitude is poorly known*: Assign confidence when possible; otherwise assign summary terms for evidence and agreement (see Paragraphs 8 and 9). Explain the basis for this confidence evaluation and the extent to which opposite changes would not be expected.

C) *An order of magnitude can be given for a variable*: Assign confidence when possible; otherwise assign summary terms for evidence and agreement (see Paragraphs 8 and 9). Explain the basis for estimates and confidence evaluations made, and indicate any assumptions. If the evaluation is particularly sensitive to specific assumptions, then also evaluate confidence in those assumptions.

D) *A range can be given for a variable, based on quantitative analysis or expert judgment*: Assign likelihood or probability for that range when possible; otherwise only assign confidence (see Paragraphs 8-10). Explain the basis for the range given, noting factors that determine the outer bounds. State any assumptions made and estimate the role of structural uncertainties. Report likelihood or probability for values or changes outside the range, if appropriate.

E) *A likelihood or probability can be determined for a variable, for the occurrence of an event, or for a range of outcomes (e.g., based on multiple observations, model ensemble runs, or expert judgment)*: Assign a likelihood for the event or outcomes, for which confidence should be "high" or "very high" (see Paragraphs 8-10). In this case, the level of confidence need not be explicitly stated. State any assumptions made and estimate the role of structural uncertainties. Consider characterizing the likelihood or probability of other events or outcomes within the full set of alternatives, including those at the tails.

F) *A probability distribution or a set of distributions can be determined for the variable either through statistical analysis or through use of a formal quantitative survey of expert views*: Present the probability distribution(s) graphically and/or provide a range of percentiles of the distribution(s), for which confidence should be "high" or "very high" (see Paragraphs 8-10). In this case, the level of confidence need not be explicitly stated. Explain the method used to produce the probability distribution(s) and any assumptions made, and estimate the role of structural uncertainties. Provide quantification of the tails of the distribution(s) to the extent possible.

In summary, communicate uncertainty carefully, using calibrated language for key findings, and provide traceable accounts describing your evaluations of evidence and agreement in your chapter.

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