Detection and Attribution of Observed Impacts of Climate Change in IPCC AR5 WG2:

Revised Guidance on Definitions and Confidence Assessment (with some Examples)

The IPCC WG2 Chapter 18 author team has made significant updates to its guidance on definitions of detection and attribution of observed impacts, and the associated confidence language since the First Order Draft, and again following feedback received during and after the cross cut session in Buenos Aires at LAM3. The revised definitions, along with some guidance on confidence assessment towards the AR5 synthesis assessments are given below, followed by a few illustrative examples.

Throughout the Second Order Draft (SOD) preparation period, the chapter 18 team will be ready to assist other chapters in incorporating detection and attribution into their text (as required by the plenary approved outline). Your designated chapter link persons will continue to be the best point of contact. Of course you can also always approach our CLAs Wolfgang Cramer (Wolfgang.Cramer@pik-potsdam.de) and Gary Yohe (gyohe@wesleyan.edu) or our chapter scientist Gerrit Hansen (gerrit.hansen@pik-potsdam.de). We intend to re-engage in Webinars with the whole DnA group, or appropriate subgroups, in due time.

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1) Definitions of Detection and Attribution and Assessment of Confidence

Chapter 18 assesses the degree to which predicted impacts of climate change on natural and human systems can be detected and attributed to recent climate change and, wherever possible, its anthropogenic component.

Detection *addresses the question of whether a system is changing beyond what might be considered normal behaviour in the absence of climate change.* Typically, studies of detection involve the initial assumption of climate being at least one of the drivers of that change, but other drivers (such as changes in land use) may be recognized to play a significant role, too. For many systems, the role of these confounding factors may exceed that of climate change. This assessment may be based on process understanding as encapsulated in a model or, where available, analysis of historical observations.

Attribution *addresses the question of whether climate change has contributed substantially to the detected change in a system.* In practice, attribution studies ask how much of the observed change is due to climate change. Attribution requires the evaluation of the contributions of all external drivers to the system change.

Confidence in detection in a synthesis assessment depends on the quality, coverage and independence of studies, their agreement and the confidence in the individual detection assessments.

Confidence in attribution in a synthesis assessment also depends on the quality, coverage and independence of studies, their agreement and the confidence in the individual attribution assessments. Statements of confidence in attribution should be made after stating **a specified magnitude** of the contribution of the climate driver relative to the effect of other drivers.

The specified magnitude statements for attribution could be:

- *A minor* role (a small contribution relative to other drivers of the detected change)
- *A major* role (one of the main drivers of the detected change)

The two statements require an assessment of the contribution of all drivers responsible for the detected change.

2) Choice of method for confidence in attribution

Initially, the chapter 18 team argued for a concept which formulates attribution confidence assessments *conditional* on confidence in the associated detection assessments. However, the feedback we received during the cross cut session at LAM3 and after has convinced us that our proposed approach was not straightforward to understand, counter to the intention of these assessments.

Thus we are now advising to consider confidence in the detection assessment to be an explicit component of the assessment of confidence in attribution. An important implication of this is that the assessment of confidence in an attribution assessment *cannot* be higher than the associated detection confidence assessment.

3) Traceable accounts

The WGII Technical Support Unit (TSU) advised against the use of supplementary information for the material underlying the D&A illustration. Therefore, the traceable account for the D&A assessment in all chapters must be included in the text and/or the figure caption. For the latter, cross-references to the relevant sections of your text will be sufficient.

4) Illustrations

Chapter 18 is currently working with TSU on improved templates for the standardized D&A illustration. If you currently work with the earlier template, please continue to use it and we will transcribe it into the new clarified format.

5) Examples: Detection and Attribution in a Synthesis Assessment

Here we provide a few examples of the development of the assignment of confidence to synthesis assessments of detection and attribution. They are intended to be illustrative and should not be construed as definitive "real world" assessments.

A. Temperature Impacts – Irrigated Rice Yields

Number of studies: Large

Independence and quality of studies: High

Number of Non-Climate Drivers: Large (e.g. fertilization, irrigation, management, improved varieties, pest infestations)

Spatial Coverage: Large

Expected Climate Change Impact: In the absence of climate change, yields would be expected to continue to grow. With climate change, decline in yield growth, or dropping yields due to rising night-time temperatures and increased extreme heat events would be the expected outcome.

Detection Finding: There is good agreement across studies that rice yield growth is slowing, which is consistent with temperature impacts due to climate change. 60% of studies show a slowdown in growth of yields. Due to the good coverage of a large number of independent studies, confidence in detection is *medium*.

Attribution Finding: Confidence that climate change is a major driver in the studies that detect a slowdown in yield growth is *high*. Other drivers resulting in slower yield growth include soil depletion, and increased pressure from pesticide resistant pests. As confidence in detection is *medium* only, the **confidence in attribution of a global slowdown in yield growth for rice to climate change is also *medium*.**

B. Temperature Impacts - Permafrost in the Arctic

Number of studies: Large

Independence and quality of studies: High

Number of Non-Climate Drivers: Few and localized other drivers

Spatial Coverage: Large

Expected Climate Change Impact: Measurable recession in permafrost coverage across the Tundra of all northern continents**.**

Detection Finding: There is good agreement across studies that permafrost coverage has been receding, which is consistent with temperature impacts due to climate change. 100% of studies show this recession. Due to the large spatial coverage of a high number of independent studies, confidence in detection is *very high*.

Attribution Finding: Confidence that climate change is a major driver in the studies that detect a recession in permafrost is *high*. Other localized drivers include resource extraction and transport. As confidence in detection is *very high*, the confidence in attribution of the Tundra recession to climate change is *high*.

C. Temperature Impacts – Electricity Peak Load

Number of studies: Large

Independence and quality of studies: High

Number of Non-Climate Drivers: Large (e.g. Rising incomes, Adoption of Air Conditioners, Changing Usage Patterns, Urban Heat Island Effects).

Spatial Coverage: Large

Expected Climate Change Impact: In the absence of climate change, peak load would be expected to grow due to growth in non-climate drivers. Climate change would lead to an additional increase in peak load**.**

Detection Finding: There is medium agreement across studies that peak loads during summer in grids across the globe have increased measurably, which is consistent with temperature impacts due to climate change. 50% of studies show a statistically significant increase. Due to the good coverage of a large number of independent studies, confidence in detection is *medium*.

Attribution Finding: Confidence that climate change is a major driver in the studies that detect increased summer peak loads is *low*. Other drivers include rising incomes, adoption of air conditioners, changing usage patterns, urban heat island effects. Confidence in detection is *medium*, yet the **confidence in attribution of global increases in peak load to climate change is *low*.**

D. "Temperature impacts – Impaired winter travel of indigenous peoples in Alaska"

A "grey" reference is citing indigenous peoples' reporting reduced possibility for winter travel due to shrub encroachment on their traditional winter migration routes in Alaska. A high number of peer-reviewed studies have linked increased shrub growth and encroachment in areas along the treeline to local warming, but none of those studies has looked at the area of this particular migration route. Reports in the grey literature from the local indigenous peoples of the effect of their travel are qualitative and have support through a clear causal chain and through a relatively absolute standard of calibration (passable versus impassable).

Climate change leading to vegetation change:

Number of studies: Large

Independence and quality of those studies: High

Spatial Coverage: Large

Number of Non-Climate Drivers: Few

Vegetation change leading to impact on dogsled travel:

Number of studies: Few

Independence and quality of those studies: Low

Spatial coverage: Small

Number of Non-Climate Drivers: None

Expected Climate Change Impact: Normal system conditions consist of treeless high plains covered by snow, suitable for passage of dogsleds. Expected climate change impact is a vegetation change towards dense willow shrubland, with the canopy well over the snow surface throughout the winter blocking snowsleds.

Overall detection finding: While shrub encroachment across the tundra of Alaska has been detected with *high confidence*, the resulting impact on traditional ways of travel has only been detected with *low confidence.*

Overall attribution statement: Shrub encroachment can be attributed to climate change (major factor) with *high confidence*. For the reported observations of impaired dogsled travel, climate change is assessed to be a major driver with *high confidence*, as the mechanical blocking of the sleds is clearly caused by the shrubs.. However, as confidence in detection of the observed impact is *low*, the **confidence in attribution of observed limitations to dogsled travel in Alaska to climate change is *low*.**

6) Illustration showing the examples discussed above, with illustrative caption as suggestion for traceable account

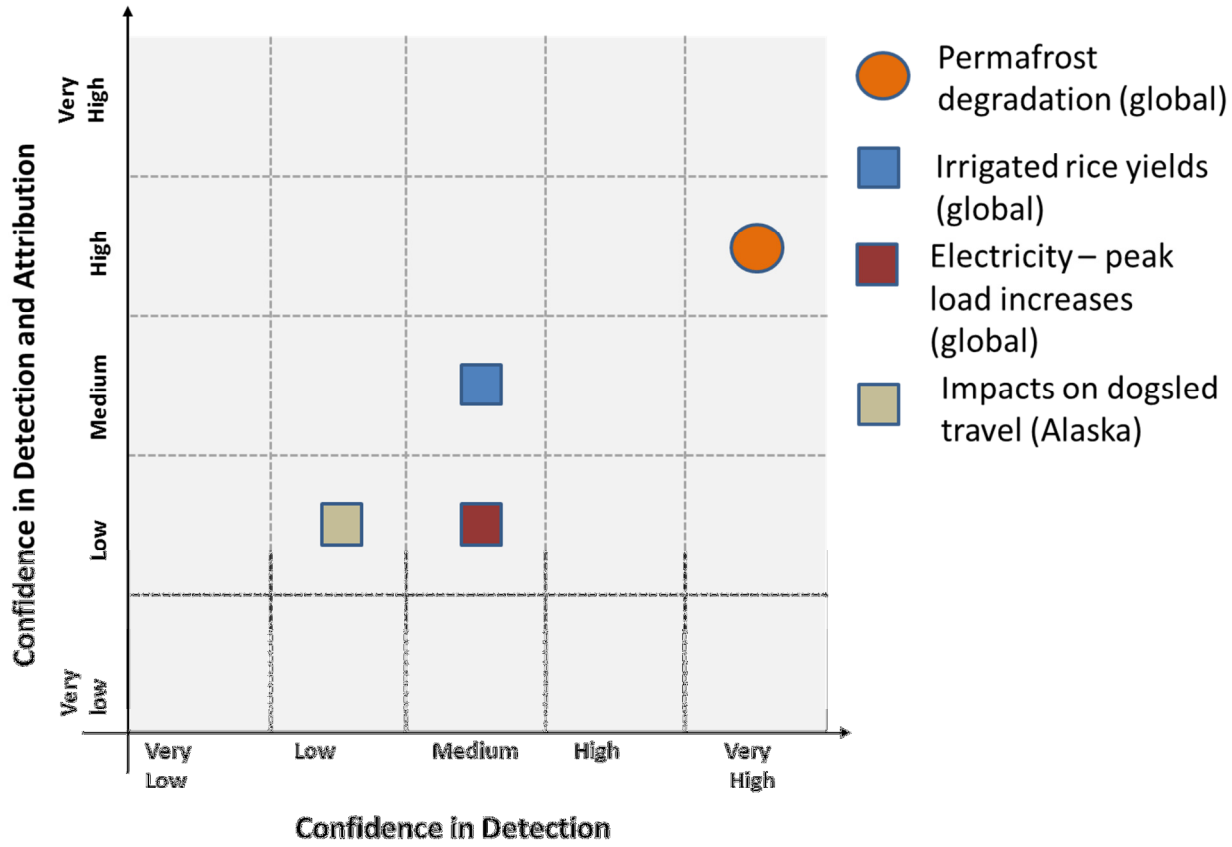

Figure X.DnA: Illustrative examples of confidence in detection and attribution of observed impacts of climate change. Confidence levels are derived based on expert judgement of the available literature, following the IPCC uncertainty guidance (Mastrandrea et al., 2010). Key references include: Permafrost degradation (Mang et al., 2012, Simon and Vadlavic, 2012; Tadic et al., 2011; IPCC WG1 4.y.z; see also Capter Y.5.3.1 and table X.5), Irrigated rice yields (Smith et al., 2009; Roses et al., 2010; Zhang at el., 2012; Walker and Cramer, 2013; Martinez et al., 2012; Gomez et al., 2011); Electricity Peak Loads (Smith and Walker, 2012; Sanchez et a., 2013; Wang et al., 2012; see also X.5.3.2 and table X.6); Dogsled travel (Windbreaker et al., 2012; Smith et al., 2010; see also table X.5).

Please note that design will be refined but not substantively altered.