Methods for Communicating about Uncertainty:
Levels of Confidence vs. Numerical Ranges

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Climate Science Communication

- An important issue facing climate scientists is how to communicate uncertainties (to the public).
- A variety of questions come up frequently in public & political debates
  - Some are related to the inherent uncertainties in climate science
  - Others reflect public’s imperfect understanding of climate-related issues (Pew Center, 2009)
  - Others related to the uncertainties of the experienced outcome
Climate Science Communication

- Critics have used the inherent uncertainty as an excuse to dismiss findings altogether (e.g., Begley, 2007)
- Thus, it is critical to address the public’s imperfect understanding of climate-related issues and misperceptions about the scientific consensus on the topic
  - By empirically testing the communications of climate-related findings and their underlying uncertainties
How can Communication be Evaluated?

- Communication is a two-way process
  - Develop an understanding of the science side
  - Develop an understanding of the stakeholder side
- Communications should target gaps between sides
  - Communications should then be tested for “success” at bridging gaps
Main Challenge

- The precision of the information conveyed to the public should match the precision of its source (Budescu & Wallsten, 1987; Wallsten & Budescu, 1994).

- Should not convey more precision than warranted by the evidence.

- Using precise probabilities in this case could be misleading.
## Translation Table

<table>
<thead>
<tr>
<th>Phrase</th>
<th>Likelihood of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtually certain</td>
<td>&gt; 99%</td>
</tr>
<tr>
<td>Very likely</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td>Likely</td>
<td>&gt; 66%</td>
</tr>
<tr>
<td>More likely than not</td>
<td>&gt; 50%</td>
</tr>
<tr>
<td>About as likely as not</td>
<td>33% to 66%</td>
</tr>
<tr>
<td>Unlikely</td>
<td>&lt; 33%</td>
</tr>
<tr>
<td>Very unlikely</td>
<td>&lt; 10%</td>
</tr>
<tr>
<td>Exceptionally Unlikely</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>
Addressing Precision

- Research has demonstrated that the use of verbal probability phrases generates more imprecision than intended by the IPCC.
  - Budescu, Broomell, and Por (2009)
  - Budescu, Por, and Broomell (2011)
Addressing Precision

- The amount of imprecision/uncertainty can be communicated using ratings of confidence.
  - Analytic Confidence has been defined to be based on:
    - Level/Quality of evidence used to produce the estimate
    - Level of agreement between experts in interpreting the evidence and producing the estimate
  - Analytic Confidence is intended to express various levels of uncertainty surrounding estimates.
    - Second Order Uncertainty
Confidence Definition:
Borrowed from National Intelligence Estimates

<table>
<thead>
<tr>
<th>Confidence in Estimate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Confidence</td>
<td>Indicates that estimates are based on high-quality of evidence and there is high agreement among experts. High confidence estimates are not a certainty and may still carry a risk of being wrong.</td>
</tr>
<tr>
<td>Moderate Confidence</td>
<td>Indicates that estimates are based on either a moderate amount of evidence or there is a moderate amount of agreement among experts. Moderate confidence estimates carry a risk of being wrong.</td>
</tr>
<tr>
<td>Low Confidence</td>
<td>Indicates that estimates are based on questionable evidence and there is low agreement among experts. Low confidence estimates carry a high risk of being wrong.</td>
</tr>
</tbody>
</table>
Research Question

- Are consumers of risk communication appropriately sensitive to expressions of uncertainty based on:
  - confidence levels?
    - High, Moderate, Low
  - numerical ranges?
An Empirical Test of Communication Methods

- 155 volunteers were exposed to hypothetical risk communications, and paid $5 for their time
  - (60% male; mean age 31)
- Subjects were randomly assigned to 3 conditions
  - Control
  - Verbal Confidence
  - Numerical Confidence
- The stimuli included:
  - Either phrases, *likely* and *unlikely*.
  - Either *high confidence* or *low confidence*
- Dependent measures included:
  - Best Estimate of Probability
  - Range of potential probability
Hypothesis

- Verbal Confidence Categories are psychologically incompatible with our definition of uncertainty, and will lead to error in interpretation.
  - Ranges will not be impacted
  - Best Estimates of likelihood will change with confidence
    - low confidence $\rightarrow$ probability phrase will be ignored
      - (estimates closer to 50%)
    - high confidence $\rightarrow$ probability phrase will be used
      - (estimates farther from 50%)
Verbal Confidence Condition

For example, if we use the word *likely* it is associated with the range (66% - 90%) from the table above:

A *high confidence* statement where chances could range from (76% - 80%) would be stated as follows:

*An event is likely (with high confidence) to happen.*

A *moderate confidence* statement where chances could range from (70% - 86%) would be stated as follows:

*An event is likely (with moderate confidence) to happen.*

A *low confidence* statement where chances could range from (66% - 90%) would be stated as follows:

*An event is likely (with low confidence) to happen.*

[Begin Experiment]
Example of Stimuli

Verbal Confidence

The Intergovernmental Panel on Climate Change (IPCC) has issued a warning that by 2015 it is likely (with low confidence) that global sea levels will have risen by 3 feet or more.

Based on the forecast of the IPCC, that it is likely (with low confidence) that global sea levels will rise by 3 feet or more by 2015, please provide a number between 0 (event is impossible) and 100 (event is certain to happen) that you think matches the chances of this event happening.

Numerical Confidence

The Intergovernmental Panel on Climate Change (IPCC) has issued a warning that by 2015 it is likely (66% - 90%) that global sea levels will have risen by 3 feet or more.

Based on the forecast of the IPCC, that it is likely (66% - 90%) that global sea levels will rise by 3 feet or more by 2015, please provide a number between 0 (event is impossible) and 100 (event is certain to happen) that you think matches the chances of this event happening.
Graphical Results: Distributions

Best Estimates

Best Estimate of Unlikely

Best Estimate of Likely
Graphical Results: Distributions

Range (Max - Min)

Range for Unlikely

Range for Likely
Thank You
Graphical Results: Means

Mean Best Estimate

- Control likely
- Control unlikely
- Verbal likely
- Verbal unlikely
- Numerical likely
- Numerical unlikely

Legend:
- Low Confidence
- High Confidence
Graphical Results: Means

Mean Log(Range)

![Graph showing mean log(range) for different categories with blue and red bars representing low and high confidence, respectively.](image-url)