WEATHER AND CLIMATE RISKS:
Possible, Probable, and Effectively Certain

Improved communication of risks and opportunities relating to weather, water, and climate would help the broader society benefit from the scientific advances the AMS community routinely provides.

One persistent challenge to using weather and climate information results from the difficulty in communicating complex scientific information to user communities and the public. To help address this challenge, a recent AMS Policy Program study on climate information needs for financial decision making (from which this column is adapted) proposed three predefined levels of certainty for communicating with user communities about weather and climate risks: "possible," "probable," and "effectively certain."

Possible impacts are those for which the likelihood is assessed to be less than coin-flip odds (less than a 50% chance) or for which the likelihood is unknown. *Probable* describes impacts that are assessed to be more likely to occur than not (i.e., greater than 50% chance of occurrence). *Effectively certain* impacts are those for which the chance of occurrence is assessed to be at least 95% (i.e., in 19 out of 20 cases an outcome that is effectively certain would be expected to occur).

This language is based, in part, on the three terms used to characterize petroleum reserves: "possible," "probable," and "proven." The study replaced "proven" with "effectively certain" because science rarely, if ever, deals in absolutes in the ways implied by the term "proven." "Effectively certain" captures this critical characteristic of scientific information (thereby avoiding the potential for claims at odds with scientific understanding), but in a way that can help prevent confusion among nonscientists hearing the message (thereby reducing the potential for nonexperts to misunderstand the nature of risks and opportunities).

Critically, these terms can work well for communicating about any geophysical risk or opportunity such as those relating to extreme weather events, climate variability and change, space weather, floods and droughts, wildfire, earthquakes, and tsunamis.

The divergence between scientific and public understanding of climate change provides a terrific illustration of the potential of this more intuitive and streamlined characterization of risks. A great deal of information is already available to allow scientists to characterize potential risks using these three categories. For example, it is effectively certain that 1) increasing greenhouse gas concentrations will warm the climate, 2) changes in climate will change weather patterns, 3) a warmer climate will cause increases in temperature extremes, 4) a warmer climate will cause an increase in average sea level, 5) an increase in sea level will cause an increase in storm surge height, 6) a warmer climate will cause more intense precipitation at some locations, and 7) a warmer climate will cause the degradation of permafrost.

Furthermore, it is probable that warming will cause 1) increases in the intensity of some severe events (e.g., tropical cyclones), 2) more intense flooding at some locations, 3) shifts in the distributions and characteristics of biological systems, and 4) an increase in the intensity and/or duration of drought.

Finally, it is possible that human-caused warming will cause 1) major and widespread changes to existing weather patterns, 2) major and widespread impacts to physical systems (e.g., coastal boundaries, permafrost, and snow pack), 3) major and widespread impacts to biological systems and the goods and services they provide (e.g., crop pollination; purification of water, soil and air; pest control; nutrient cycling; and flood and drought prevention), 4) major and widespread impacts on social institutions (e.g., agriculture, water resource management, transportation infrastructure, and public health), and 5) disruptions to key planetary-scale life-support services.

Of course, these three predefined levels of certainty cannot fully capture the full details of scientific understanding, particularly as they relate to multidimensional challenges like the potential impacts associated with weather events, water resources, and climate variability and change. Instead, this streamlined terminology can provide an easier point of entry for those unfamiliar with (and uninterested in) the scientific details.

For example, Intergovernmental Panel on Climate Change (IPCC) reports describe the likelihood of climate impacts using ten categories of increasing probability from "exceptionally unlikely" through "virtually certain." This broad range of likelihood categories is effective at increasing understanding among climate experts for whom the relatively fine distinctions are useful and the categories clearly defined. However, the number of categories and the nonintuitive definitions of each category likely constitute barriers to communication with outside users and lay audiences.

Critically, a great deal of information relevant to financial analysis is already available and could be used if characterized more clearly and compellingly. The use of more streamlined and intuitive terms like "possible," "probable," and "effectively certain" can help nonexperts more easily access and use scientific information. This provides the user communities with greater capacity to assess for themselves the implications of potential impacts (and likelihoods) on decision making.

To be most valuable, weather and climate information must be actionable and communicated effectively to the user communities that need it. After multiple decades of intensive research, a great deal is known about the climate system and the risks and opportunities to society posed by weather events and climate variability and change. However, much of what is known and understood has proven difficult to communicate effectively to user communities and the public. Improved communication of these risks can be a key step in maximizing societal benefits of scientific knowledge and understanding.

The AMS Policy Program study "Climate Information Needs For Financial Decision Making," on which this column is based, is available at www.ametsoc.org/cin.

—Paul Higgins, AMS Policy Program Director