Columbia Law School

SABIN CENTER FOR CLIMATE CHANGE LAW

June 11, 2021

The Honorable Gary Gensler
U.S. Securities and Exchange Commission
100 F Street, NE
Washington, DC 20549

Re: Public Input on Climate Change Disclosures

The Sabin Center for Climate Change Law ("Sabin Center") submits these comments in response to the SEC's request for information on whether current disclosures adequately convey climate change information to investors, registrants, and other market participants.

These comments focus on the science of climate attribution, detection, and prediction—the body of research drawing on multiple lines of evidence that describes the role of human activity in climate change—addressing questions two (2) and fourteen (14) in Commissioner Lee's March 15, 2021 request for public input.[1] The goal of these comments is to explicate the quantifiable information that climate science makes available to private companies for the particular purpose of projecting localized impacts of climate change on infrastructure, operations, and supply chains, and the potential adverse consequences that might result from disruptions caused by those impacts. The sections below further explain these key points:

- Observed physical impacts of climate change—including, among others, sea level rise and rising average temperatures—can be attributed to anthropogenic climate change with high confidence.
- There is also a robust body of studies finding a causal connection between anthropogenic influence on climate and immediately-felt consequences of climate change such as heat-related mortality, freshwater availability, agricultural productivity, wildfire risk, and more.
- Impacts that have been attributed to anthropogenic climate change can be attributed to specific emission sources in a variety of ways, including on a proportional basis.
- The degree of confidence with which scientists can attribute climate impacts to anthropogenic influence frequently meets or exceeds the level of evidence required in legal and regulatory contexts.
- Information about regional and local climate impacts is available to private companies.

[1] Allison Herren Lee, *Public Input Welcomed on Climate Change Disclosures*, SEC.GOV (March 15, 2021), https://www.sec.gov/news/public-statement/lee-climate-change-disclosures.

Attribution Science's Scope, Data Sources, and Limitations

Attribution science refers to the body of research that explores the link between human activity and climate change.[2] The field seeks to identify the contributions of specific entities, sectors, and activities to changes in the global climate, and whether (and to what extent) those changes have impacts on human activities. As further detailed below, a robust body of attribution studies explains and quantifies the role of human activity in climate change to date and can provide a means of quantifying valuable information about the scope of an entity's contribution to global climate change as well as the ways in which extreme events and other climate change-related phenomena may affect a company's assets and operations.

A. Scope of Attribution Research

The body of existing climate attribution research can be broken down into four conceptual areas: climate change attribution, impact attribution, extreme event attribution, and source attribution.

- Climate change attribution studies explore how human activities have changed and continue to change the global climate system broadly defined. These studies explain, for example, how burning fossil fuels alters atmospheric concentrations of carbon dioxide.[3]
- Impact attribution studies examine the role that climate change plays in, as noted by the Intergovernmental Panel on Climate Change ("IPCC"), "effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period."[4]
- Extreme event attribution is the body of research that investigates the links between climate change and extreme weather events. For example, several studies have assessed the role of climate change in Hurricane Harvey.[5]
- Source attribution is a distinct but related body of research that aims to quantify the contributions that specific industries, entities, and activities have made to climate change overall. Leading source attribution work assesses, for example, the cumulative greenhouse

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[2] *See* Michael Burger, Jessica Wentz, and Radley Horton, *The Law and Science of Climate Change Attribution*, 45 COLUM. J. ENVTL. L. 57, 64 (2020).

[3] Climate change attribution studies examine many different aspects of the global climate system. *See, e.g.*, Yang Chen et al., *Future Increases in Arctic Lightning and Fire Risk for Permafrost Carbon*, 11 NAT. CLIM. CHANGE 404 (2021); Lauren J. Vargo et al. *Anthropogenic Warming Forces Extreme Annual Glacier Mass Loss*, 10 NAT. CLIM. CHANGE 856 (2020); Qiaohon Sun et al., *A Global, Continental, and Regional Analysis of Changes in Extreme Precipitation*, 34 J. CLIMATE 243 (2020).

[4] IPCC: CLIMATE CHANGE 2014: SYNTHESIS REPORT. CONTRIBUTION OF WORKING GROUPS I, II AND III TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 5 (2015), https://www.ipcc.ch/report/ar5/syr/.

[5] *See* Kevin Trenberth et al., *Hurricane Harvey Links to Ocean Heat Content and Climate Change Adaptation*, 6 EARTH'S FUTURE 730 (2018); S-Y Simon Wang et al., *Quantitative Attribution of Climate Effects on Hurricane Harvey's Extreme Rainfall in Texas*, 13 ENVTL. RES. LETTERS 1 (2018); Geert Jan van Oldenborgh et al., *Attribution of Extreme Rainfall from Hurricane Harvey, August 2017*, 12 ENVTL. RES. LETTERS 1 (2017); Mark Risser & Michael Wehner, *Attributable Human-Induced Changes in the Likelihood and Magnitude of the Observed Extreme Precipitation During Hurricane Harvey*, 44 GEOPHYSICAL RES. LETTERS 12457 (2017).

gas emissions attributable to specific oil, natural gas, coal, and cement producers.[6] Comparable studies explore the impact of certain political jurisdictions, including nations[7] and cities,[8] and other studies aim to quantify impacts of specific industries, such as tourism or agriculture.[9]

B. Data Sources

With the partial exception of source attribution, attribution studies share a common set of data sources and overlapping analytical techniques. The key sources of data on which all these studies rely are summarized here. Attribution studies frequently rely on a combination of observational data; understanding of how climate processes function and relate to human systems; and statistical analyses that are used to measure and understand data.

1. Observation and Analysis of Measured Climate Variables

Observational data includes, among others, measurements of carbon dioxide concentrations in the atmosphere, surface temperatures, sea levels throughout the world, water vapor, precipitation, sea ice, and wind speed. Observational data is used both to create baselines against which future changes can be measured, and in conjunction with statistical analysis to detect changes in the climate system. Those changes include more frequent and severe extreme events, as well as non-event changes like higher average temperatures and sea level rise. Trend analyses of historical data can allow scientists to determine whether there has been a statistically significant change in a variable.

Physical understanding refers to scientific understanding of physical properties and climate-related processes. Examples include the heat trapping effects of greenhouse gases, which can be tested using laboratory and modeling experiments.[10] Understanding the physical properties of climate processes provides a basis for developing experiments and models that can evaluate how variables in the climate system interact with each other and with human systems.

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[6] *See, e.g.*, RICHARD HEEDE, CARBON MAJORS: ACCOUNTING FOR CARBON AND METHANE EMISSIONS 1854–2010: METHODS & RESULTS REPORT (2014), https://climateaccountability.org/pdf/MRR%209.1%20Apr14R.pdf.

[7] *See, e.g.*, Sourish Basu et al., *Estimating US fossil fuel CO2 emissions from measurements of 14C in atmospheric CO*, 24 PROC. NAT'L ACAD. SCI. 117 (2020).

[8] C40 CITIES CLIMATE LEADERSHIP GROUP, CONSUMPTION-BASED GHG EMISSIONS OF C40 CITIES (2018), https://www.c40.org/researches/consumption-basedemissions.

[9] *See, e.g.*, Emrah Koçak et al., *The Impact of Tourism Developments on CO2 Emissions: An Advanced Panel Data Estimation*, 33 TOURISM MGMT. PERSPECTIVES (2020) (tourism in the most visited countries 1995 to 2014); Dario Caro et al., *Greenhouse Gas Emissions Due to Meat Production in the Last Fifty Years, in* QUANTIFICATION OF CLIMATE VARIABILITY, ADAPTATION AND MITIGATION FOR AGRICULTURAL SUSTAINABILITY 27 (Mukhtar Ahmed & Claudio O. Stockle eds., 2017) (production of beef cattle, pork and chickens).

[10] Additional examples include experiments that explore the reflectivity of sea ice, *see* Bonnie Light, Regina C. Carns, and Stephen G. Warren, *'Albedo Dome': A Method for Measuring Spectral Flux-Reflectance in a Laboratory for Media with Long Optical Paths*, 54 APPLIED OPTICS 5260 (2015), and the effect of increased soil temperatures on specific plant species, *see* Anne Marie Panetta et al., *Climate Warming Drives Local Extinction: Evidence from Observation and Experimentation*, SCI. ADVANCES 4, eaaq1819 (2018).

Statistical analysis refers to formulas, models, and techniques that researchers use to analyze data. These analyses are used both to detect and attribute climate change. Statistical analysis provides a means of detecting climate change by measuring whether observed changes are statistically significant departures from historical baselines. In attribution studies, statistical analysis can quantify the likelihood that an observed change would have occurred with or without human influence on the climate. Both observational data and physical understanding of climate processes provide the basis for calibrating and verifying climate models.

2. Modeling

Modeling allows researchers to simulate interactions between variables within the climate system using quantitative methods. Models allow scientists to explore the effect of changes to specific climate variables—greenhouse gas concentrations, temperatures, sea ice, and more—to evaluate the effect of changing one or more of those climate drivers. Attribution modeling generally involves running a model that reflects a world without anthropogenic influences on climate, then re-running the same model with actual greenhouse gas concentrations as an input and seeing what changes.

Scientists have developed standard climate simulations that are specifically designed for detection and attribution. These simulations can evaluate the probability that an event or impact would have occurred with its observed characteristics, with or without certain observed changes in the climate. These experiments leverage the same models that have been used to project future climate changes. These tools, outputs, and the models themselves are increasingly being made available to the public.

3. Documentary Evidence

Documentary evidence is particularly relevant to source attribution and refers to information contained in documents and reports that relates to human emissions of greenhouse gases. Paradigmatic examples of this type of information include historical records of fossil fuel producers and consumers that show the amount of fossil fuels that have been consumed over the course of an entity, project, or activity's existence. These records allow researchers to calculate an individual entity's contribution to global climate change by, for example, determining the amount of carbon dioxide emitted by burning a known quantity of coal, comparing that figure to the total concentration of anthropogenic carbon dioxide in the atmosphere, and accounting for factors that have an effect on the translation of emissions to atmospheric carbon dioxide concentrations.[11] Key sources of documentary evidence include national greenhouse gas inventories, securities disclosures, and reports prepared by governments and private actors that quantify emissions or sequestration impacts of particular activities.

4. Overcoming Challenges and Uncertainties

Attribution science is sufficiently robust to assess the likelihood of certain extreme weather events, describe some of the consequent impacts those events will have on companies'

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[11] *See, e.g.*, CARBON MAJORS REPORT, supra *note* 7.

operations and infrastructure, accurately identify human fingerprints on the changing climate, and quantify the impact particular entities have had to date; but there are limitations in how attribution science can be used and some remaining uncertainties. As explained in this section, researchers have techniques and language to manage these challenges, so that climate attribution science remains a robust source of useful climate information.

First, attribution is increasingly challenging as the focus of research moves from long-term, broad-scale changes in the climate towards more discrete, local events. Attribution studies that focus on specific climate impacts have to manage the role of confounding (also called "exogenous") variables, which are more difficult to isolate at fine scales. Separating climate change from other variables is made harder by the fact that natural and anthropogenic variables may relate in a non-linear way, and because multiple different human activities have changed climate variables in the past, often simultaneously.

Because of the difficulty of managing confounding variables, most impact attribution studies focus on a single link in the causal chain of climate change. This approach, often called single-step attribution, provides a way for researchers conducting an impact attribution study to manage the uncertainties that confounding variables create. A study of this kind will focus on the relationship between climate impacts and an observed change in mean climate variables or extremes without drawing conclusions about every causal step between anthropogenic influence and a climate impact. Examples of these studies include research linking local sea level rise to increased global average temperature, or research that links increased global average temperature to changes in atmospheric concentrations of greenhouse gases. Single-step attribution studies assume that human influence is a primary driver of climate change. Thus, when a particular impact can be attributed to climate change, we can infer that the impact was at least in part caused by anthropogenic causes.

Because single-step attribution studies do not account for every step in the causal chain that produces a climate impact, they are not able to isolate the proportional contribution of human influence on that impact. As a result, single-step attribution studies typically communicate results in terms of whether there is human influence on a particular impact rather than quantifying the magnitude of the influence. This approach has the advantage of being simpler than accounting for every relevant variable, and can still generate robust, quantitative attribution findings where an impact study can be linked to other studies establishing the role of human influence in the change in climate variable that gave rise to the climate impact.

In addition, there is a growing body of multi-step attribution studies aiming to combine the two steps described above: linking a climate impact to a changing climate variable, and then linking the changing climate variable to human activity. Multi-step attribution theoretically provides a more complete picture of the causal relationships in the climate system, but must contend with the potential for additional, "cascading" uncertainty with each new step that is added to the analysis.

Finally, researchers undertaking an impact attribution study can manage the difficulty of untangling confounding variables from climate forcing by communicating a qualitative description of impacts rather than quantitative analyses of impacts. Describing impacts in a qualitative way can provide valuable insight into climate change impacts for which uncertainty makes quantitative analysis impossible. Those impacts include ones that have not received a great deal of scientific or public attention to date. Qualitative results are useful climate information because they alert investors to risks that are significant but incompletely understood.

Second, models must overcome uncertainties and manage the challenges associated with attributing climate impacts at a fine scale. By comparing models to observational data scientists can assess how well a model functions, but even after checking a model against reality some dimensions of uncertainty linger. Observational measurements themselves may not be perfect. And, for many systems and places, standardized long term data sets are simply not available. Moreover, when models are used to assess extreme events at finer scales than the models themselves operate, downscaling or bias correction is needed and introduces additional uncertainties.

Researchers making use of climate models can address those challenges by articulating the nature and extent to which local climate predictions may differ from regional predictions modeled at a larger scale. The results of a study of likely future climate impacts on a particular city, for example, may be that while regional modeling suggests that North America will experience increased average surface temperature, factors like land use, local aerosol concentrations, and small scale natural variability may cause a particular city in North America to experience more or less warming than elsewhere on the continent. Moreover, uncertainties about observational data can be reported as well. The IPCC concludes, for example, that there is low confidence in Antarctic surface air temperature changes but that a key reason for that level of confidence is the scarcity of temperature measurements, and the fact that most are limited to the coasts.[12] So while some uncertainties about modeling persist, researchers can frame results at an appropriate scale and use language that clearly communicates the extent to which modeling does produce results with a high level of confidence. Those techniques allow a company using this information to effectively use the results of models and have already been demonstrated in the case studies below.

Third, the results of individual studies are typically conveyed in terms of degrees of confidence, rather than absolute certainty. A study may conclude, for example, that a result is "virtually certain (>99% probability)"[13] or a conclusion is reached "with high confidence."[14] But some degree of probabilistic language is common across many fields of scientific study.

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[12] Nathaniel L. Bindoff et al., *Detection and Attribution of Climate Change: from Global to Regional, in* CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (T.F. Stocker et al. eds., 2013), https://www.ipcc.ch/report/ar5/wg1/.

[13] *See, e.g.*, R. F. Stuart-Smith et al., *Increased Outburst Flood Hazard from Lake Palcacocha Due to Human-Induced Glacier Retreat*, 14 NATURE GEOSCIENCE 85–90 (2021).

[14] Thomas Frölicher, et al., *Marine Heatwaves Under Global Warming*, 560 NATURE 360, 362 (2018).

Language of this kind is used to manage uncertainties in a systematic way and should not be taken to mean that the conclusions a study reaches are unreliable.[15]

C. Information Available to Reporting Entities

As the sections above describe, attribution science makes available information about a company's contribution to climate change and its exposure to acute and slow-developing climate impacts. Several types of information are further discussed below, but these examples are not exhaustive, and available climate information will vary across different industries.

First, documents, reports, and other records that reflect a company's contribution to climate change. Internal records and other documents that describe the amount of fossil fuels used, energy purchased from outside suppliers, and related information would provide a means for investors to assess the degree to which a reporting entity is contributing to climate change overall.

Second, information about where climate impacts are likely to be felt. That information may allow a company to assess which of its physical assets, operations, and supply chains are located in areas known to be vulnerable to climate impacts and extreme events, and may enable the company to better understand the nature and extent of those vulnerabilities. Companies can use the output of climate models and climate impact models that produce a probabilistic assessment of impacts within a region to identify risks to assets in the effected region.[16] Using model outputs at a smaller scale than the model itself operates requires an acknowledgement that the local risk of an extreme event may differ from what the model predicts at a larger scale. A company could disclose, for example, that its principal place of business is within a geographic area that scientists have concluded is highly likely to experience climate-worsened flooding.

Third, information on how specific climate impacts are predicted to change in frequency or severity. Those impacts include both extreme events and longer term changes to the environment. Impact attribution studies that explore the linkages between climate change and specific impacts can provide insight into how those impacts will change over time, which may change the way those impacts affect particular assets or opportunities a company holds.

Case Studies

A pair of case studies highlights how private companies can make use of the data and analytical techniques highlighted in this letter to communicate useful information about those companies' contributions to climate change and their exposure to its impacts.

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[15] *See* Elisabeth A. Lloyd et al., *Climate Scientists Set the Bar of Proof Too High*, 165 CLIMACTIC CHANGE 55 (2021) ("[C]limate scientists have set themselves a higher level of proof in order to make a scientific claim than law courts ask for in civil litigation in the USA, the UK, and virtually all common law countries.").
[16] *See, e.g.*, INTER-SECTORAL IMPACT MODEL INTERCOMPARISON PROJECT, https://www.isimip.org/ (last visited June 11, 2021).

A. Con Ed's Climate Vulnerability Study

Consolidated Edison Company of New York's ("Con Ed") Climate Change Vulnerability Study provides an example of how companies can conduct (and ultimately disclose) an assessment of climate risk.[17] In the wake of Superstorm Sandy in 2013 the company undertook a comprehensive study to analyze the likelihood and consequences of a range of climate change scenarios. A copy of the study is attached to this letter.

Con Ed's study used customized downscaled projections to analyze five key climate variables over seven time periods from 2020 through 2080. The modeling that Con Ed used was only able to produce future climate projections at fairly large resolution—grid cells approximately 100km on a side. But by using historical weather station data from several stations in its service area to adjust the simulations to bring them closer to observed data, the study was able to achieve a somewhat more accurate picture of local climate projections for the New York City area.

The Con Ed study revealed significant, actionable information about the impacts of climate change on its assets and operations. The study's downscaled climate projections describe significant changes in climate in Con Ed's service territory. Those changes include a significant (575%) increase in the number of days with temperatures above 95ºF, a twenty-percent decrease in cold weather days, and extended heat wave events occurring twenty-five to seventy times more frequently by 2050. Hydrological changes in Con Ed's service territory are similarly expected to increase the company's vulnerability to climate change. As sea levels rise, the study forecasts 500-year floods occurring every ten years by 2100, and water-depth of present-day 100-year floods to increase by up to fifty percent. These projected changes have important implications for Con Ed's operations including, for example, allowing the company to identify specific assets at risk and plan for which of those assets need to be replaced or better prepared for climate change impacts.

Where quantitative results are not available, the study conveys qualitative information. The study notes, for example, that "the percentage of very strong and destructive (i.e., Categories 4 and 5) hurricanes is projected to increase in the North Atlantic basin. It can therefore be argued that climate change could make it more likely for one of these storms to impact the New York Metropolitan Region, although the most dominant factor will remain unpredictable climate and weather variability."[18]

In sum, the Con Ed study provides a good example of the kinds of climate information that a company can use and describe, and it demonstrates how using several of the techniques described in this letter—for example, combining observational data and modeling, articulating

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[17] CONSOLIDATED EDISON, CLIMATE CHANGE VULNERABILITY STUDY (2019), https://www.coned.com/-/media/files/coned/documents/our-energy-future/our-energy-projects/climate-change-resiliency-plan/climate-change-vulnerability-study.pdf?la=en%23:~:text=Con%20Edison%20recognizes%20the%20global,occurring%20at%20an%20accelerating%20rate.&text=This%20Study%20evaluates%20present%2Dday,vulnerability%20to%20climate%2Ddriven%20risks.

[18] *Id.* at 24–25.

model-based probabilistic results, and describing qualitative narratives where quantitative data is unavailable—can produce useful information on a company's climate risk.

B. Rio Grande Project EIS

The Bureau of Reclamation's Final Environmental Impact Statement (the "EIS") for the Rio Grande Project provides another example of how private companies can use climate science to understand and communicate climate change risk.[19] The EIS highlights how downscaled climate projections and models can be used to predict climate and hydrologic conditions in a discrete area—in this case, the Rio Grande River basin. A copy of the EIS is attached to this letter.

The EIS assesses the impacts of continuing to operate (through 2050) the Rio Grande Project, which furnishes a full irrigation water supply for about 178,000 acres of land and electric power for communities and industries in the area. About sixty percent of the lands receiving water are in New Mexico; 40 percent are in Texas; and water is also provided for diversion to Mexico. The project's physical features include the Elephant Butte and Caballo Dams, hundreds of miles of canals and associated infrastructure, as well as a hydroelectric powerplant.

The project's climate impact analysis was designed to understand how the water management system would operate under future climate conditions (through 2050) and the corresponding effects on the environmental impacts of water management options. To do so, the study authors used projected climate conditions developed based on an ensemble of 112 statistically downscaled climate projections. Using those projections, the EIS developed three possible scenarios—a drier scenario, a median or "central tendency" scenario, and a wetter scenario. Hydrology models were then used to simulate changes in runoff and streamflow in the Rio Grande River basin based on the three climate scenarios.

The study authors were then able to evaluate potential environmental effects based on these scenarios.[20] The wetter scenario, for example, represents a worst case for species in Elephant Butte reservoir; the drier scenario is the worst case for species downstream of the Caballo Dam.

The EIS provides another good example of the kinds of climate information that a private company can develop and describe, and it demonstrates how using techniques outlined in this letter—notably here, employing qualitative narratives as appropriate and exploring multiple climate scenarios—can produce useful information on a company's climate risk.

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[19] BUREAU OF RECLAMATION, CONTINUED IMPLEMENTATION OF THE 2008 OPERATING AGREEMENT FOR THE RIO GRANDE PROJECT, NEW MEXICO AND TEXAS (2016), https://cdxnodengn.epa.gov/cdx-enepa-II/public/action/eis/details?eisId=218219.
[20] *Id.* at 55.

Conclusion

Climate attribution studies combine observational data, physical understanding, statistical analysis, and detailed models to generate useful findings. By clearly communicating those findings, the assumptions made, the confidence with which conclusions are reached, and potential areas of uncertainty or bias, researchers produce climate information that should be useful to investors in a broad range of sectors.

Sincerely,

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Attachments (3):

1. Michael Burger, Jessica Wentz, and Radley Horton, The Law and Science of Climate Change Attribution, 45 Columbia Journal of Environmental Law 57, 67 (2020).

2. Consolidated Edison, Climate Change Vulnerability Study (2019).

3. Bureau of Reclamation, Final EIS: Continued Implementation of the 2008 Operating Agreement for the, New Mexico and Texas (Sept. 30, 2016).