Written testimony of

Dr. Andrea Dutton
Visiting Associate Professor, Department of Geoscience
University of Wisconsin-Madison, Madison, WI

Before the

U.S. Senate Environment and Public Works Subcommittee on Clean Air and Nuclear Safety
Hearing on "Reducing Emissions While Driving Economic Growth: Industry-led Initiatives"

October 17, 2019

Thank you, Chairman Braun, Ranking Member Whitehouse, and committee members for inviting me to speak today.

As of August, I am a faculty member at the University of Wisconsin-Madison in the Department of Geoscience. Prior to that, I was an Associate Professor at the University of Florida.

I am a geochemist and field geologist who conducts research on past climate and sea-level change. The main focus of my research is the behavior of sea level and polar ice sheets during past warm periods to better inform us about future sea-level rise. My research accomplishments have been widely recognized, for example as a Fellow of the Geological Society of America, as a Fulbright Scholar, and as a newly-minted MacArthur Fellow.

I am here today to offer you my expert opinion as a geologist and climate scientist on the scale of the challenge we face from industrial greenhouse gas emissions and resulting human-caused global warming.

The devastating impacts of climate change will vary by region: some will contend with worsened wildfires, while others will grapple with intensified inland flooding or rainfall, inundation from sea-level rise, or more intense, slower-moving hurricanes[1]. This list may evoke ***personal*** memories of extreme weather events from the past few years. That is because climate change is already here and it is going to get worse before it can get better[2].

All regions of the U.S. will experience higher temperatures. Consider Florida, where I have lived for the past 9 years. Florida is home to 10 of the 25 hottest cities in the U.S. Miami is the hottest. In 2000, Miami had 24 days with a heat index at or above 105 °F, the official danger level according to the National Weather Service[3]. By 2030, Miami is projected to experience 126 danger days a year—about 1 in 3 days—where crippling heat will make it dangerous for people to be outdoors[4].

Are voluntary reductions in industrial emissions enough to avoid such futures?

---

[1] 4th National Climate Assessment, Vols. I & II, United States Global Change Research Program (USGCRP). https://www.globalchange.gov/nca4

[2] IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)].

[3] Hot temperatures combined with high humidity create dangerous conditions for humans. When the heat index exceeds 104°F, the National Weather Service defines it as a dangerous day. The heat index is a combination of heat and humidity, sometimes referred to as the “feels like” temperature. Under such conditions, sunstroke and heat exhaustion are likely, and physical activity or being outside for long periods is risky, and can lead to heat stroke. Dangerous heat days pose the greatest risk to the young and the elderly, and to those who don’t have easy access to air conditioning.

[4] Analysis by Climate Central (https://www.climatecentral.org/news/sizzling-summers-20515#dangerdays). Projections of the days each year above a threshold temperature are made assuming current emissions trends continue and are based on a downscaled and bias-corrected ensemble of climate models known as CMIP5 (the same models used in the IPCC).

The answer is ***NO***. They don't even come close. Voluntary reductions are but proverbial drops in the bucket. Because of decades of relative inaction, the scale of the problem has grown and time to act is rapidly shrinking (Figs. 1, 2.). Policy solutions must therefore be bold, moving us rapidly towards net-zero emissions with the aid of stringent and integrated policy interventions including putting a price on carbon[5-6]. Reductions don't happen in a vacuum. They are driven by policy, which in turn drives innovation to meet new targets.

The scientific consensus tells us that we are on a tight timeline: by the year 2030, a little over 10 years from now, we must reach net-zero emissions to keep global climate at or below 1.5 °C[7].

The United States has a pivotal role in determining our future climate. Although China's emissions have been growing and now exceed those of the U.S., the U.S. has contributed the most in terms of total (cumulative) carbon dioxide emissions and our emissions of carbon dioxide per person dwarf those of China by more than 2:1 (Figs. 3, 4). Experience shows us that the introduction of policy can be extremely effective, and drive rapid changes in emissions that can translate to recovery from environmental degradation. An example of this is the implementation of the Montreal Protocol, which was designed to phase out the production of multiple substances that contribute to ozone depletion. Measurements reveal that the Antarctic ozone hole is slowly healing, providing evidence that the Montreal Protocol is working[8].

As a geologist, with the perspective that **deep time** brings to this issue, I offer **these four critical insights**:

(1) We are conducting an uncontrolled and unprecedented experiment here on planet Earth. Our extensive knowledge of past climate change reveals that there is **no other event in Earth history** that approaches the combined rate and magnitude of change that ***we*** are causing, aside from cataclysmic events such as the massive asteroid impact that marked the end of the Cretaceous. While Earth survived, the dinosaurs did not, nor did about 75% of all marine species[9]. Climate change is not about saving our planet, it is about maintaining thriving ecosystems that support human civilization.

(2) **While there are natural, stabilizing processes that draw down carbon dioxide levels in the atmosphere, they are too slow—by *several orders of magnitude*—to keep up with the rate at which we are pumping carbon dioxide into the atmosphere[10].** It would take many thousands of years to draw down the carbon dioxide that we have already emitted.

---

[5] IPCC, 2018: Global Warming of 1.5°C.

[6] International Monetary Fund (IMF) (2019) *Fiscal Monitor: How to Mitigate Climate Change*, Washington, D.C., October.

[7] Ibid.

[8] Strahan, S.E. and Douglass, A.R. (2018) Decline in Antarctic Ozone Depletion and Lower Stratospheric Chlorine Determined From Aura Microwave Limb Sounder Observations, *Geophysical Research Letters*, 45, 382-390.

[9] Jablonski, D. (1995) Extinctions in the fossil record, *in* Extinction Rates (eds. Lawton, J. H. & May, R. M.), 25–44, Oxford University Press, Oxford.

[10] Archer, D., Eby, M., Brovkin, V., Ridgewell, A., Cao, L., Mikolajewicz, U., Caldeira, K., Matsumoto, K., Munhoven, G., Montenegro, A., Tokos, K. (2009) Atmospheric lifetime of fossil fuel carbon dioxide, Annual Review of Earth and Planetary Science, 37, 117-134.

(3) **Our actions today will impact the climate for millennia**, a lesson drawn from studies of geological changes[11]. The U.S. leads the world in cumulative carbon emissions[12]. The faster we slash emissions, the less dangerous the outcomes. Committing to additional fossil fuel infrastructure, conversely, locks in more dangerous impacts.

(4) **Finally, the geologic record tells us that we can expect big impacts from what sound like small perturbations.** We are already witnessing the effects of climate change at just over 1 °C and every fraction of a degree matters. For comparison, Earth was no more than *four* degrees °C (7 °F) colder during the peak of the last ice age, when ice sheets more than a mile thick covered parts of North America and mammoths and mastodons roamed present day Florida[13]. My own research tells us that increasing Earth's temperature by as little as 1 °C could commit us to at least 6 meters—that's 20 feet—or more sea-level rise[14].

If we don't enact policies to reduce greenhouse gas emissions as the best available science dictates, we are committing to a very expensive and dangerous future. Talking to Floridians on the front lines of sea-level rise, I know they are deeply concerned about climate change[15] and want to know what's being done.

During the recent global climate strike led by our youth, millions took to the streets telling us—in no uncertain terms—that it is up to us to act now or we take their future from them. As a mother, as a scientist, and as a citizen of the United States, I hear their call. I hope that you will too.

Thank you.

---

[11] Clark, P.U., Shakun, J.D., Marcott, S.A., Mix, A.C., Eby, M., Kulp, S., Levermann, A., Milne, G.A., Pfister, P.L., Santer, B.D., Schrag, D.P., Solomon, S., Stocker, T.F., Strauss, B.H., Weaver, A.J., Winkelmann, R., Archer, D., Bard, E., Goldner, A., Lambeck, K., Pierrehumbert, R.T., Plattner, G-K. (2016) Consequences of twenty-first-century policy for multi-millennial climate and sea-level change, *Nature Climate Change*, 6, 360-369.

[12] Le Quéré, C., et al. (2018) Global Carbon Budget, *Earth System Science Data*, 10, 1-54.

[13] Shakun, J.D., Clark, P.U, He, F., Marcott, S.A., Mix, A.C., Liu, Z., Otto-Bliesner, B., Schmittner, A., Bard, E. (2012) Global warming preceded by increasing carbon dioxide concentrations during the last deglaciation, *Nature*, 484, 49–54.

[14] Dutton, A., Carlson, A.E., Long, A.J., Milne, G.A., Clark, P.U., DeConto, R., Horton, B.P., Rahmstorf, S., Raymo, M.E. (2015) Sea-level rise due to polar ice-sheet mass loss during past warm periods, *Science*, 349, aaa4019.

[15] https://climatecommunication.yale.edu/news-events/ahead-of-the-first-democratic-presidential-primary-debate-new-poll-shows-florida-voters-support-climate-action/ See linked pdf on polling data: "Florida Voters Support Climate Action."

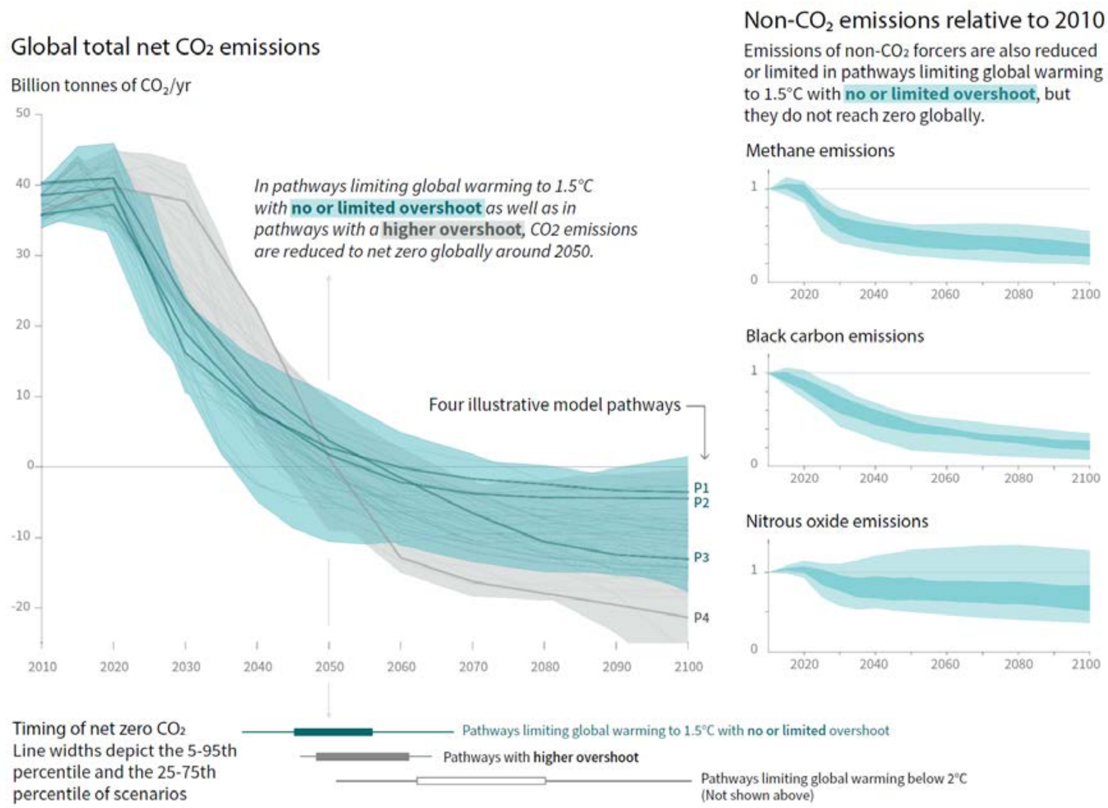

Figure 1. Global emissions pathways from the IPCC SR 1.5 (2018). Note the sharp reduction in CO_2 emissions required to limit global warming to 1.5 °C. Figure reproduced from Fig. SPM.3a in the IPCC Special Report on the impacts of global warming of 1.5 °C.

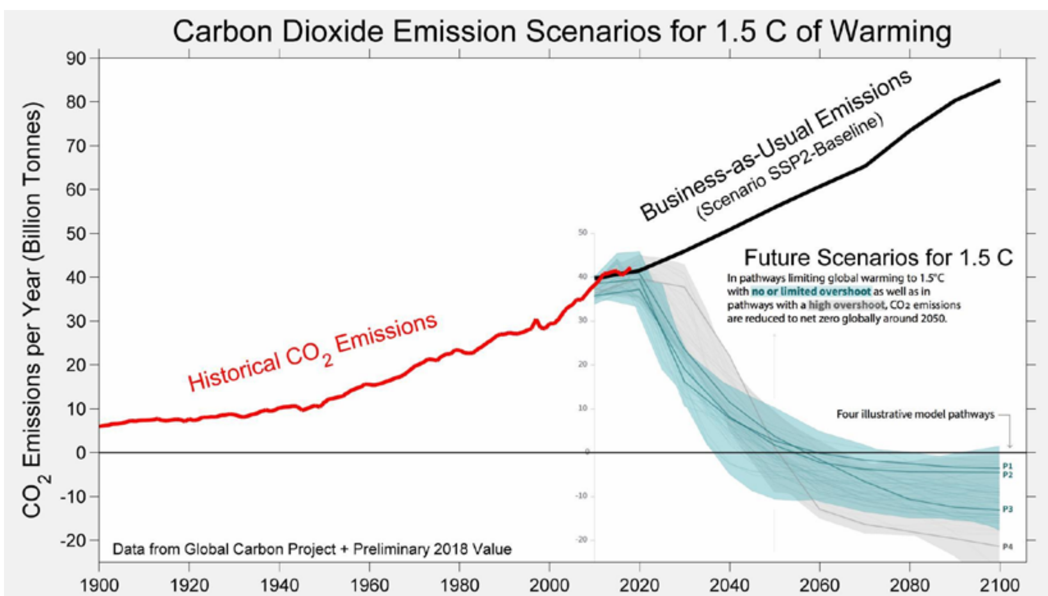

Figure 2. Historical context of emissions (from the Global Carbon Project) superimposed upon the main panel of Fig. 1 (above). The data for the SSP2 scenario comes from the International Institute for Applied Systems Analysis (IIASA) database of scenarios for the Coupled Model Intercomparison Project (CMIP6). Figure by Robert Rohde.

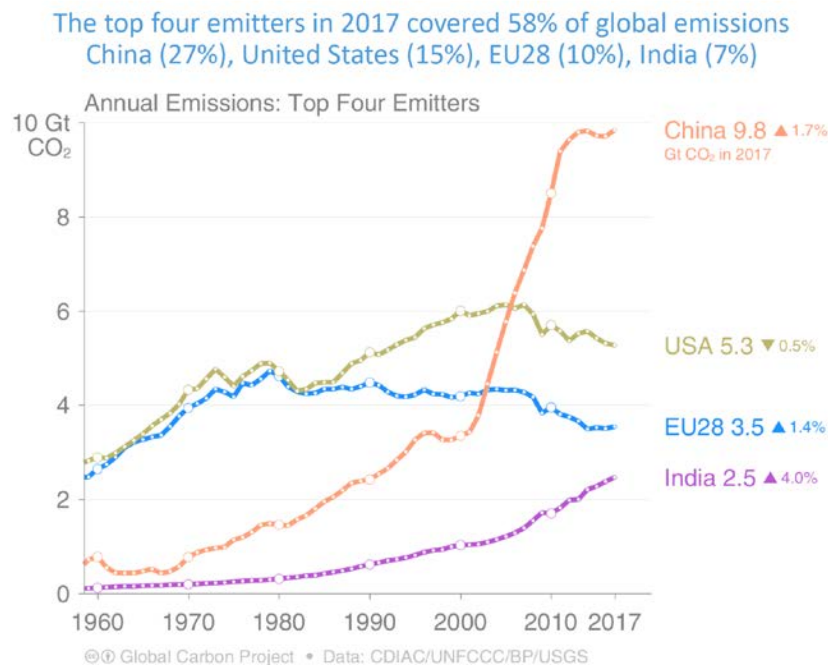

Figure 3. The top four emitters in 2017 comprise 58% of global carbon dioxide emissions. Source: Carbon Dioxide Information Analysis Center (CDIAC); Le Quéré et al, 2018 (see footnote #10); Global Carbon Budget 2018. Figure from the Global Carbon Project: Global Carbon Budget 2018.

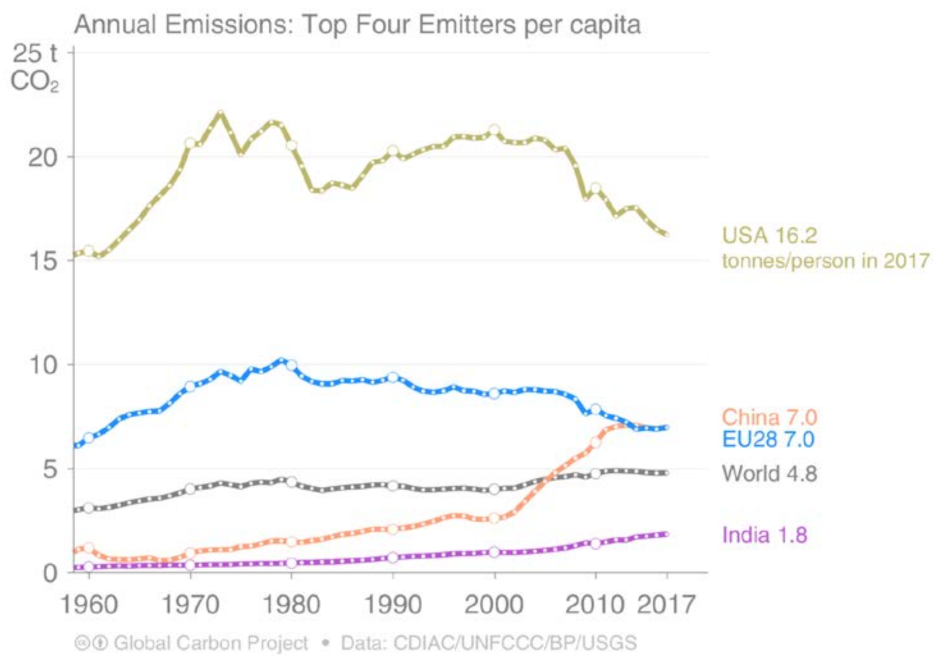

Figure 4. The top four emitters per capita of carbon dioxide emissions. Source: Carbon Dioxide Information Analysis Center (CDIAC); Le Quéré et al, 2018 (see footnote #10); Global Carbon Budget 2018. Figure from the Global Carbon Project: Global Carbon Budget 2018.