Institute for Governance & Sustainable Development

Distinguished Professor of Climate and Atmospheric Sciences
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Professor V. Ramanathan ("Ram"), Distinguished Professor of Climate and Atmospheric Sciences at Scripps Institutions of Oceanography, University of California, San Diego, is a unique force in both climate science and policy, and *the* pioneer who identified the critical role non-CO_2 short-lived climate pollutants (SLCPs) play in warming the Planet.

Ram's message on the critical role of SLCPs has been heard around the world and is motivating some of the most powerful global figures to speak out and act more forcefully to slow climate change by cutting SLCPs. Ram's historic research on climate and atmospheric science is playing a critical role in setting climate policy.

Until the mid-1970s, scientists assumed that CO_2 emitted by the burning of fossil fuels and widespread deforestation were the primary forces that lead to global warming. This understanding was permanently altered when Ram discovered the greenhouse effect of chlorofluorocarbons (CFCs) and reported his findings in a 1975 paper in *Science*. He demonstrated that one CFC molecule in the atmosphere has the same warming effect of more than 10,000 molecules of carbon dioxide. In his paper, he also showed that if CFC concentrations were allowed to reach just a few parts per billion (as predicted by scientists based on the wide-spread use of CFCs), their greenhouse effect would rival that of manmade CO_2. In awarding the Tyler prize to Ram in 2009, the committee wrote: "This finding was the first to demonstrate the degree to which trace gases could alter global climate, and it's credited with opening the door to examination of other trace gases for greenhouse potential." Within a year of the CFC findings, he published a study, *Sensitivity of Surface Temperature and Atmospheric Temperature to Perturbations in the Stratospheric Concentration of Ozone and Nitrogen Dioxide*, on the effect of stratospheric ozone depletion on the earth's energy budget. With these two publications, for the first time, atmospheric physics was linked to atmospheric chemistry leading to a paradigm shift in the way climate scientists approached the problem of global warming.

In rapid succession, several other trace gases were added by other scientists and in response, WMO, UN Environment, NASA and European agencies asked Ram to lead an international study on the climate effects of non- trace gases. Ramanathan's 1985 report, *Trace Gas Effect on Climate*, concluded that non-CO_2 trace gases were currently (1980s) adding as much as CO_2 to the anthropogenic greenhouse effect. These findings were all confirmed in the IPCC reports.

Ram's also has played a leading role in climate policymaking. In 2009 Ram joined Nobel Laureate Mario Molina and others to write a paper, *Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO_2 emissions*, on the need for fast near-term mitigation, emphasizing the role HFCs and other SLCPs can play. This and other work by Ram with United Nations Environment, including his leadership of the Atmospheric Brown Cloud initiative, played a central role in the formation of the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants in 2012.

Ram's early work identifying that CFCs were powerful climate forcers played a critical role in the Kigali Amendment of 2016 to phase down HFCs under the Montreal Protocol, a strategy that can avoid up to 0.5˚C of warming by 2050, as reported in the 2013 paper, *The role of HFCs in mitigating 21st century climate change*, co-authored by Ram, with Yanyyang Xu, Guus Velders, and D. Zaelke. The effort to phase down HFCs under the Kigali Amendment to the Montreal Protocol is considered by many observers to be the single most significant international mitigation success to date, and a critical contribution to the subsequent success of the Paris Agreement.

Ram's more recent work shows that reducing SLCPs is one of the best and perhaps the only way to provide significant near-term relief from increasing warming and associated impacts, which cannot be addressed fast enough through the reduction of CO_2 and other long-lived gases. He and Xu calculated that reducing SLCPs could avoid up to 0.6˚C of warming by mid-century, compared to 0.1 to 0.3˚C from aggressive CO_2 mitigation, and 1.2 ˚C from SLCPs at end of century, compared to 1.6 to 1.9˚C for CO_2. In September 2017, Ram encapsulated the immediate need for drastic climate action in a paper in *PNAS*, *Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes*, that characterized the potential for unmitigated warming to breach uncharted territory that would bring existential threats to humanity and ecosystems around the world. The paper outlined the need for a three-prong approach to avoiding this bleak future, which Ram and Xu conclude is still possible: reducing SLCPs for the benefit of limiting near-term warming, achieving carbon neutrality, and incorporating carbon extraction technologies. This effort was further elaborated by the 33 co-authors of the report, *Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change*, co-chaired by Ram, Mario Molina, and D. Zaelke.

Ram also has been a leader in efforts to promote the "need for speed" in climate change mitigation, and why this is critical to protecting public health, safeguarding the poor and most vulnerable, and slowing the accelerating climate feedback mechanisms, as articulated in his piece in the *Commentary* in *Nature Climate Change*.