NIH GREEN ZONE NEWSLETTER

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Climate Change Series: What Contributes to Climate Change?

**This is the second article in a series about climate change. This article builds off topics discussed in the July 2021 issue. Please continue to read each monthly issue for the conclusion of the series.*

In our previous article, we introduced the basics of climate change, specifically the long-term nature of climate change. We also discussed how climate change is largely driven by the interactions of solar radiation within the Earth's atmosphere. But why are we experiencing such drastic climate change now and into future decades? What conditions have shifted in the past century to cause the current climate crisis?

As mentioned in the July 2021 issue, radiation from the sun has many complex interactions with the Earth's surface and atmosphere. Radiation is scattered and/or absorbed in various amounts based on the interactions with certain types of terrain and chemical compounds in the atmosphere. The balance between scattering and absorption determines how much solar radiation is held within our atmosphere, thus playing a large role in determining the climate. The atmosphere, more so than the Earth's surface, is in constant flux and will change composition over the span of many years in accordance to both natural events and anthropogenic (human generated) activities. The Earth naturally goes through cooling and warming cycles, although our current climate crisis far exceeds the bounds of this natural cycle. Natural events can cause deviations in this cycle, most notably volcanic eruptions. Volcanoes release substantial amounts of ash and SO_2 into the stratosphere.[1] The SO_2 oxidizes into sulfuric acid (H_2SO_4), which forms new sulfate aerosol particles or adds to existing aerosol particles.[1] These eruptions cause a cooling effect on the climate, although the last major eruption was from Mt. Pinatubo in 1991 and it's influence decayed to negligible effect in the late 1990s.[1] Overall, volcanic eruptions and other natural drivers have had a relatively small impact on the current climate crisis.[1]

Increases in anthropogenic activities can be directly correlated to climate change. The most notable of these anthropogenic drivers are greenhouse gases (GHGs) emitted from activities like the combustion of fossil fuels, mining, natural gas extraction, and fertilizer use.[1] The three GHGs of largest concern are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). These compounds have increased in atmospheric concentration coinciding approximately with the start of the industrial revolution (beginning in the late 1700s).[1] Concentrations since this time have increased steadily to far surpass the typical cycles observed in the past 800,000 years. For example, CO_2 typically cycled between 160 ppm and 280 ppm until the late 1700s.[1] Following the industrial revolution, CO_2 rapidly hit the previous high mark of 280ppm and has increased to over 400 ppm in recent years.[1] This same trend has been identified for CH_4, N_2O and other well-mixed GHGs.[1]

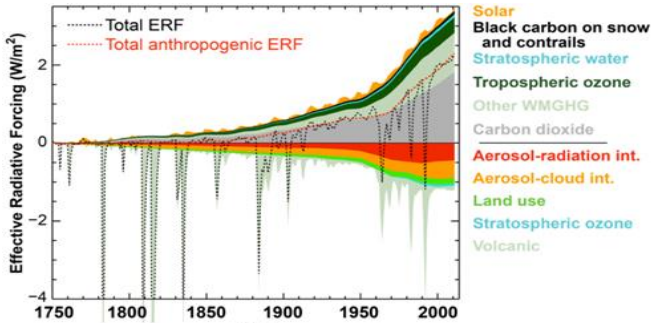

Figure 1. The changes in Effective Radiative Forcing since 1750 for the major natural and anthropogenic drivers.[1]

When considering the cumulative effect of the changes to the atmosphere over the past 250 years, it becomes apparent that anthropogenic activities are driving climate change. Effective Radiative Forcing (ERF) is a metric that can be used to describe the effect of certain interactions on global warming. Figure 1 shows the ERF for the most prevalent natural and anthropogenic drivers over the past 250 years.[1] We established in the July 2021 issue that ERF plays a major role in determining the climate. Thus, this chart estimates the cumulative effect of these drivers on climate change. From this chart, it is clear that the ERF from CO_2 (gray) and other well-mixed GHGs (light green) has increased greatly since the 1950s.[1] Even with relatively large dips from major volcanic eruptions (pale green) and the increased negative (cooling) contributions from aerosol particles (which also pose health issues), the total ERF (black dotted line) closely follows the anthropogenic ERF (red dotted line).[1] This illustrates that anthropogenic emissions, namely from CO_2 and other GHGs, are driving the increasing ERF. Thus, human activities are responsible for the majority of climate change over the past few centuries and altering these activities is the key to combatting the current climate crisis. Please join us for the conclusion of this series in the future as we discuss ways to counteract climate change.

SPOTLIGHT

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Did you know? Carbon dioxide concentrations in the atmosphere are now over 400ppm, well beyond any other time in the last 800,000 years.[1] To learn more about climate change and the NIH, please visit the NEMS Training webpage to view a short (20 minute) NIH environmental awareness training video.