ASTRO BEAT

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Figure 1: Earth from space taken by the Suomi NPP satellite. Image credit: NASA.

Climate Change and the Astronomical Perspective

By Jacob White
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I grew up in Texas, a place that is known for both starry night skies and high temperatures. The former helped generate my curiosity in the cosmos at an early age and led me down the path to becoming an astrophysicist. The latter has helped shape my view of the impacts of rising temperature due to anthropogenic climate change.

Years later, when I was working as a professional astrophysicist in Hungary, my work and the impacts of climate change collided. In the summer of 2019, I attended a week-long astronomy conference in Lyon, France (EWASS, now called EAS) along with thousands of other astronomers. There happened to be a significant heatwave in France at the time. The temperatures were nearing 45 C. (113 F.) and the conference venue (and my

Figure 2: Astronomers for Planet Earth is an international organization that was founded in 2019.

hotel) did not have air conditioning. The temperatures were so high, serious consideration was given to canceling the conference. Heatwaves like this are not normal. I grew up in the heat, I know how dangerous it can be. Discussion ensued and the conversation turned to climate change, and how the evidence is overwhelming that we're in a climate crisis (e.g. see Fig. 3).

Questions were arising such as - What can we do about climate change? How can astronomers be involved in the solution?

A small group of attendees with a shared interest in addressing the climate crisis got together at the conference. After more discussion in the following weeks, the group "Astronomers for Future" was formed. Shortly thereafter, the group merged with a similar group in North America, and **Astronomers for Planet Earth** became a global community (https://astronomersforplanet.earth/). This is a global network of 800+ professional astronomers, amateur astronomers, astronomy students, and astronomy educators from 40+ countries around the world. We all share one common goal - doing as much as we can to address the climate crisis from an astronomical perspective. See Fig. 4.

But what can an astrophysicist do to help combat climate change? Well, we can capitalize on our understanding of how unique our planet is and help relay that info to others.

Astronomers have a deep understanding of planets... we've observed thousands of them outside our Solar System. There is no shortage of diversity in these "exoplanets" - some of them are even Earth-like! At first, this can spark hope. If climate change becomes insurmountable, could we pack our bags and head off to Earth 2.0? Well... unfortunately, space is big. Like really really big.

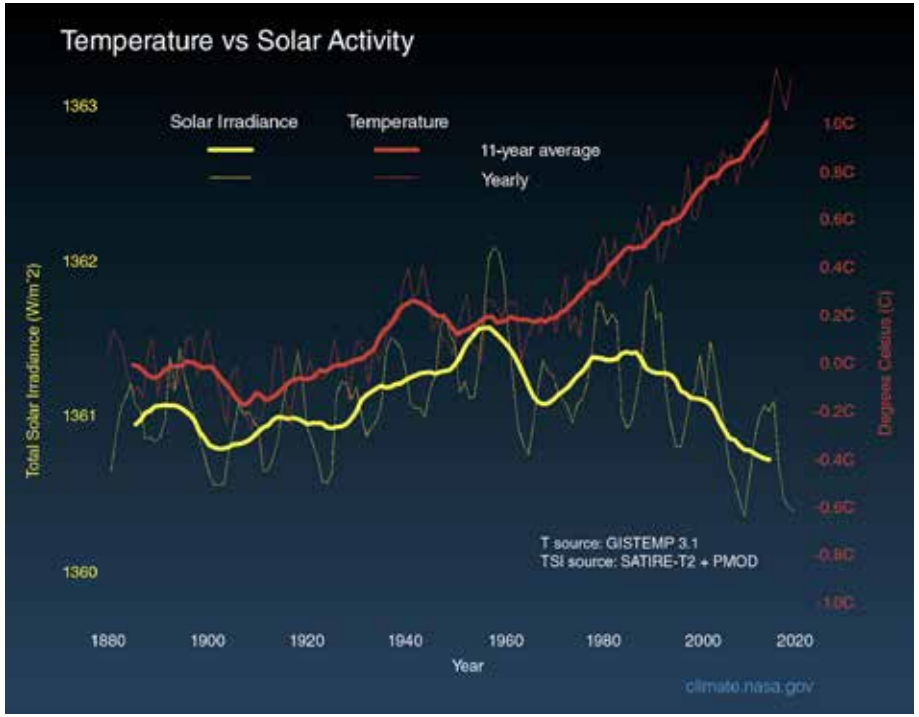

Figure 3: Global temperature and Solar activity versus time. Image Credit: NASA-JPL/Caltech

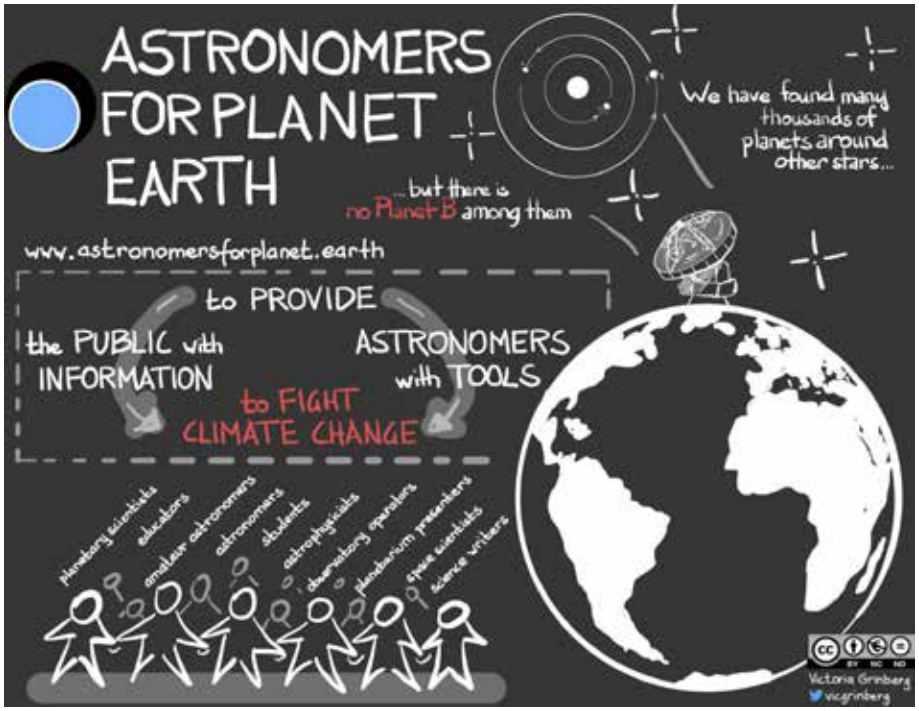

Figure 4: Astronomers for Planet Earth described in a concise graphic made by Victoria Grinberg.

Let's do a quick thought experiment!

The closest star to our Solar system is Proxima Centauri. It is about 4.2 light years away. The fastest spacecraft ever launched is the Parker Solar Probe, which reached a speed of 430,000 mph (690,000 kph). Even this speed demon would take about 6,500 years to arrive at our neighboring star system. Therefore, it isn't possible to travel to planets outside of our Solar system within our lifetimes (or maybe ever).

But let's come back home for a bit, or at least to our Solar neighborhood. Venus, for example, is very similar in size to Earth. If we saw it around a different star, we may even think it is Earth-like. But, it has a runaway greenhouse effect making it too hot, as described further in this news article, "NASA climate modeling suggests Venus may have been habitable" (Cabbage & McCarthy, 2016, https://climate.nasa.gov/news/2475/nasa-climate-modeling-suggests-venus-may-have-been-habitable/). This incredible heat is due to the abundance of carbon dioxide (CO_2) in its atmosphere. CO_2, a greenhouse gas, can significantly raise the average temperature of a planet. And it is currently doing it to Earth, our home. Our only home.

What Can Be Done?

The time for climate action is slowly ticking away. We know how to fix this problem, so we must fix it. To minimize the negative impacts of the climate crisis as much as possible, we have to drastically lower our collective carbon footprint. And none of us are too important or exempt from this.

On the individual level, we must start making changes such as: eating less meat, taking public transit more frequently, flying less, and properly managing the temperature in our homes. These may seem small — but they add up. Your actions may seem inconsequential, but just like a galaxy is a collection of stars, our global society is just a collection of people and their individual actions.

On the organizational level, we must adopt sustainability as a core goal. This means making decisions based on adhering to that goal. Universities and astronomical observatories are no exception to this rule. Just because they (or we) do not produce physical products, doesn't mean they (we) don't have a significant carbon footprint. Computational resources, travel, or even operating telescopes come with a lot of associated carbon emissions. In fact, some studies have shown that the average

astronomer has a much larger carbon footprint than the average person (Stevens et al. 2020).

As astronomers and as educators, we can inspire people. We know how unique our planet is and the vast distances required to find another habitable planet. We can educate people on the impacts and severity of the climate crisis and we can prioritize sustainable practices in our daily lives. We can leverage our position to help communicate the severity of the climate crisis.

Figure 5: Surface map reconstruction of Venus. Image credit: NASA/JPL.

Public polling constantly finds that scientists are viewed as very trustworthy (Skinner & Clemence, 2019, https://www.ipsos.com/en/its-fact-scientists-are-most-trusted-people-world). As astronomers, we can use this to our advantage when engaging in education and public outreach initiatives. We can tie together the sheer awesomeness that is our universe with a broad-level overview of the negative impacts of climate change. We can highlight we only have one home and if we don't protect it, there is no "Planet B". Outreach initiatives also present the opportunity to show how our work is either related to climate change, could be impacted by climate change, or shares similar tools to climate change research - like atmospheric studies of the runaway greenhouse effect on Venus.

Of course, most astronomers are not actively involved in teaching climate-related courses, nor do we necessarily have a background in climate-related teaching/research. But this doesn't mean the climate cannot be brought into astronomy lectures in some capacity. For example, some educators (e.g. Rector 2019, Williamson et al. 2019) are leading efforts to bring climate change instruction into university astronomy courses. Others have developed open-source textbooks for middle school-aged students that connect the Earth, space, and climate science (e.g. from Jeffrey Bennett, at https://grade8science.com/). These initiatives highlight how to effectively teach and incorporate climate change into curricula, since most astronomy educators may not have a background in climate change research.

If you're not sure about what more you can do to help combat the climate crisis - then check out Astronomers for Planet Earth (A4E)! We presented a recent paper further describing the grassroots organization (White et

Figure 6: Brand new graphic logo for the **ASP2021 Summer Symposium: *Addressing Climate Change from an Astronomical Perspective,*** a partnership between Astronomers for Planet Earth and the ASP. Credit: David Barker.

al 2021, https://baas.aas.org/pub/2021i0202/release/1). A4E members have access to a community of like-minded astronomers that are passionate about combating the climate crisis, and we have developed a groups.io page, webinar Q&A, mailing list, Slack workspace, and Google Drive resources. Please visit https://astronomersforplanet.earth/join-us-1 and consider joining us. There is no commitment required and you can be as engaged as you choose to be.

Astronomers for Planet Earth is partnering with the ASP for a special virtual event, July 22-23, 2021: **ASP2021 Summer Symposium: *Addressing Climate Change from an Astronomical Perspective.*** This symposium will have a series of talks, panels, and workshops. Participants will engage with ASP's and Astronomers for Planet Earth's global communities to learn about causes, consequences, and solutions related to the climate crisis. We will collectively come away with new knowledge and tools to better communicate, educate, and advocate for solutions to climate change. Please consider joining us online for this. Learn more at https://astrosociety.org/get-involved/events/event-calendar.html/event/2021/07/23/asp2021-summer-symposium-astronomers-for-planet-earth/332162.

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Figure 7: (Top left) The author standing inside one of the antennas that make up the 27 element interferometer of the Very Large Array in Socorro, NM. Each antenna is 25 meters (82 feet) across and some of the receivers for the various instruments can be seen in the middle of the dish.

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