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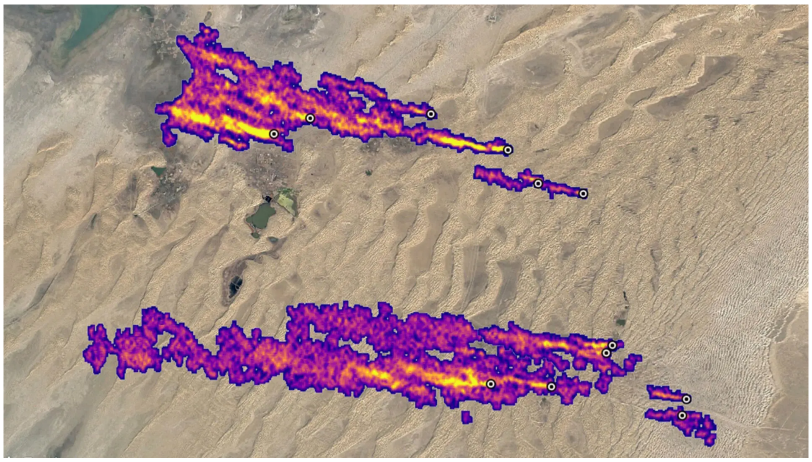
Management in Practice

How Satellites Can Help Win the Climate Fight

Satellites can track methane leaks and other greenhouse gas emissions back to the source. But what will it take to act on the insights offered by space technology? Karen Jones '89, senior technology strategist in the Center for Space Policy and Strategy at The Aerospace Corporation, says the key is getting people to move out of their comfort zones to work across disciplines, silos, and sectors.



A NASA image showing methane plumes in Turkmenistan.
NASA/JPL-Caltech (https://www.nasa.gov/feature/jpl/methane-super-emitters-mapped-by-nasa-s-new-earth-space-mission)

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Interview conducted and edited by Ted O'Callahan | February 13, 2023

Q: How has space-based technology contributed to our ability to understand and address climate change?

Since 1972 the U.S. Geological Survey Landsat Earth Observation satellites have been providing an alarming picture of the planet changing quickly: shrinking polar ice caps, shrinking rainforests, ocean pollution, and a range of climate and other environmental impacts.

Today, with over 5,000 operating satellites in orbit, all told, we can spot illegal resource extraction—mining, logging, and fishing as it's happening. Specialized sensors such as multispectral remote sensing systems to measure the sources of greenhouse gas emissions and synthetic aperture radar to estimate forest canopy.

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Space technology can also contribute to both energy security and our climate goals. It may sound like science fiction but a very good study commissioned by the UK government concluded that space-based solar power is technically feasible and affordable. It has huge potential as part of our energy portfolio.

Q: Would you give an example of how space technology can help track greenhouse gas emissions?

Methane is such a powerful greenhouse gas that it’s justifiably one of the first targets we should look at as we try to reach our climate goals. Both commercial and nonprofit organizations have launched systems that can see methane plumes from landfills, oil and gas wells and pipelines, and even from animal husbandry. This year GHGSat detected methane emissions (https://www.reuters.com/lifestyle/science/satellites-detect-california-cow-burps-major-methane-source-space-2022-04-30/) from cow belches and flatulence at a feedlot in California.

Sometimes the satellite image shows a diffuse fog of methane, but sometimes the methane shows as a plume, which is like a big red arrow pointing back to exactly where it’s coming from. The next step is, what do you do about it? And that gets a little more difficult.

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> It’s frustrating to many people, including people in high places, to have the capacity to watch this tragedy unfold from space without a clear path to act on the data.

I would like to see our regulators start to use satellites routinely to investigate large sources of emissions. The remote sensing tools exist. The data is out there.

Q: That seems like an important point. The technology is a tool, not a solution. Having the information doesn’t necessarily mean there is accountability. You co-authored a paper, “Toward Environmental Accountability: Transforming Satellite Data Into Action.” (https://csps.aerospace.org/papers/toward-environmental-accountability-transforming-satellite-data-action) **Would you expand on the idea of moving from data to action?**

Yes. It’s frustrating to many people, including people in high places, to have the capacity to watch this tragedy unfold from space without a clear path to act on the data.

Depending entirely on ground sensors to find greenhouse gas leaks can be like searching for a needle in a haystack but merging satellites with terrestrial and airborne sensors creates an integrated earth observation data system. That's a path to accountability.

State regulatory commissions can identify the operator of a leaking fracking operation, well, or pipeline. Though I will also say that I was in the oil business, and operators know leaks are lost money. In fact, GHGSat, which has six satellites for remote sensing of greenhouse gases, is partially funded by the energy industry, and their business model includes selling their imagery to oil and gas companies who want to know about and stop leaks in order to sell the methane, not lose it into the atmosphere.

Most importantly, to turn data into action, we need to engage across disciplinary silos. The space industry, governments and regulators, landowners, industry, and civil society groups—we all have our comfort zones. To make use of the extraordinary data being generated by satellites, we need to get out of our comfort zones. We have to talk to each other and work together.

Q: What enables that to happen?

Making remote sensing data freely available encourages transparency, cooperation, and good behavior. It lets academics, civil society groups, and citizen scientists work with the raw data in ways that add value and insight. Open data, which means making data accessible, machine-readable, and free to reuse and distribute, is a growing trend. Broad access to data is an important and powerful tool.

For example, SkyTruth is a nonprofit that doesn't own satellites but lends its technical expertise to make use of existing satellite imagery for specific projects including Global Fishing Watch, which is a partnership among SkyTruth; an ocean conservation organization, Oceana; and Google, which provides the data processing and management expertise.

Global Fishing Watch uses remote sensing data to track illegal fishing activity along with AI and machine learning to overcome efforts to obscure vessel identities. That mix of satellite data and AI processing puts countries in a position to do monitoring and enforcement at ports in a way that wasn't previously possible.

Whether they are focused on environmental issues, climate issues, or the many areas of overlap, these sorts of efforts are only going to become more possible. One of my policy colleagues at the Aerospace Corporation, Josef Koller, published a paper (https://csps.aerospace.org/papers/future-ubiquitous-real-time-intelligence-geoint-singularity) describing a near-future where remote sensing data, processed by AI, will be able to deliver information to a specific user's needs anywhere in the world in near-real time. He calls that the Geospatial Intelligence (GEOINT) Singularity. It creates a nowhere-to-hide capability where data to action is achievable.

The potential for improved oversight doesn't have to polarize industry and environmentalists. These capabilities can create cooperation and good behavior, especially if they serve to quickly nip problems in the bud.

Q: You've pointed to the need as well as many opportunities to work across sectors. How achievable is it to harmonize economic and environmental priorities?

In January, the White House released the U.S. National Strategy to Develop Statistics for Environmental Economic Decisions. I believe it's a hugely important policy that can go a long way toward aligning economic and environmental priorities.

Right now, there's a dissonance between our capitalist structure and the physical environment. Climate change and the range of other environmental issues show that we haven't connected the environment to the economy. Yet, our health and our wealth depend on natural systems functioning.

The U.S. National Strategy to Develop Statistics for Environmental Economic Decisions is a map that both acknowledges the value of nature and lets us navigate within our capitalist system in a way that's rational, in a way that applies a cost benefit analysis that doesn't keep us moving towards planetary destruction.

And it's another area where remote sensing systems can play a significant role in creating the natural capital inventory that we need to measure our existing environmental assets.

Q: You mentioned that space solar is a possibility. What should we know about it?

By 2050 global energy demand is expected grow by 50%. COP26 climate pledges have us reaching net zero, also by 2050. Dramatically reducing greenhouse gas emissions while significantly increasing power supply is going to be hard. But the 2021 Frazer-Nash report makes clear that space solar is a complex engineering challenge, not fundamentally a research issue that requires additional breakthroughs before it's viable.

There have already been such dramatic improvements in solar cell efficiency and a significant drop of the cost of access to space that prototypes are in the works. The potential is huge. That said, the engineering challenges are substantial.

Q: What's the timeline?

There are a lot of prototypes currently in play now. Japan is building a demonstration system (https://industryeurope.com/sectors/energy-utilities/japan-to-demonstrate-space-solar-power-by-2025/) they hope to launch in 2025. China has low earth orbit prototype that they plan to launch by 2028. If that goes well, they will launch another test into geostationary orbit in 2030. Geostationary orbit is where you want to be because that's where solar panels get sunlight 24/7. And that's quite honestly what's makes space-based solar valuable. Rather than the intermittent power we get from terrestrial solar, space solar could provide dispatchable, base load power.

Q: What would it look like?

To be utility scale, the array of solar panels would need to be vast, multiple kilometers across. There are multiple approaches being explored but a modular architecture is likely the best both to get it into space and so that broken components can be repaired with a plug-and-play approach which adds a lot of resilience.

On the ground there would also need to be a very large receiving antenna, known as a rectenna, to capture the beamed power. Smaller mobile rectennas would serve some uses like post-disaster recovery work or military forward operating bases. For utility scale, proposed designs have rectennas on the order of six kilometers by nine kilometers. And rectennas then need to integrate with the existing electric grid. It's a big endeavor, both in space and on the ground.

The frequencies used to beam power is in the non-ionizing part of the spectrum, so it should be safe. But just like the mobile cellular industry, there need to be health and safety studies to ensure that there are no unexpected issues.

Q: Do you think space-based solar can be a utility-scale source of energy by 2050?

No. I believe utility-scale space solar is doable. But 2050 is not that far away. My personal opinion is that we won't be at utility scale by 2050. Others certainly believe it is possible.

Q: What about the economics?

There are a lot of questions to be answered. It would be so valuable to have an unbiased academic economist come in and look at space solar in an unvarnished way. That's a challenge because the economist would need to completely understand both space and energy, but it would really help this move forward. Similarly, engineers and project managers who can navigate both energy and space—without being biased on one side or the other—are very much needed.

This is yet another endeavor where the capacity to work across disciplines will be critical to success.

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