Thirty Years Reporting on NASA's Earth Science Program

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A Thirtieth Anniversary Reflection from the Executive Editor

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The March–April 2019 issue marks the thirtieth anniversary of the release of the first issue of *The Earth Observer* newsletter in March 1989. This is a remarkable achievement for a NASA publication. It's also a source of immense pride for me, because my entire professional career has been spent supporting work related to NASA Earth Science. More specifically, I've been reviewing content and occasionally contributing articles for *The Earth Observer* since 2001—and since 2006, I have been its executive editor. In that role, I not only edit every word that is published in the newsletter, in consultation with other members of the editorial team (and with the EOS senior project scientist as required), I also plan each issue and project an overall vision for the publication. When one is immersed in the creation of a publication for nearly 20 years, one inevitably becomes somewhat of an authority on its history (and the closely related history of the Earth Observing System, discussed below). Spending so many years working on the same publication also allows me to offer a unique perspective on its evolution over time. Thus, while production of *The Earth Observer* is a true team effort,[1] the reflections you are about to read are my own. They do not necessarily reflect NASA's official position on the newsletter—although I hope they would agree.

If we could travel back in time to 1989—to around the time *The Earth Observer* began—we would find that, owing to a series of discoveries over the past few decades—and backed up by compelling satellite images that illustrated the problems in ways that facts and figures alone never could—our society had had its environmental consciousness awakened. The world was starting to come to grips with the detrimental impact our species *might* be having on the planet we call home. The previous summer, **Jim Hansen** [then Director of the NASA Goddard Institute for Space Studies (GISS)] spoke before Congress about the possible impacts of human-produced carbon dioxide emissions on the environment, which raised public consciousness about so-called *global warming*. (The fact that the Congressional hearings coincided with a record heat wave in Washington, DC, didn't hurt!)

The consensus of the scientific community at the time was that we at least needed to investigate. But how? As the late **Piers Sellers** [former NASA Astronaut, and Deputy Director of the Space and Earth Science Directorate at NASA's Goddard Space Flight Center] put it in an article he wrote for *The Earth Observer* describing the early history of EOS: "[At that time] our methods for quantifying important land surface properties…from satellite data were pretty much at the 'hand-waving' stage of development." By that he meant that we simply didn't have the data we needed to test our hypotheses. In order to establish a baseline and then understand how climate might be changing with time, long-term, continuous time series of observations of key atmospheric parameters would be essential. And at the time such data were lacking.

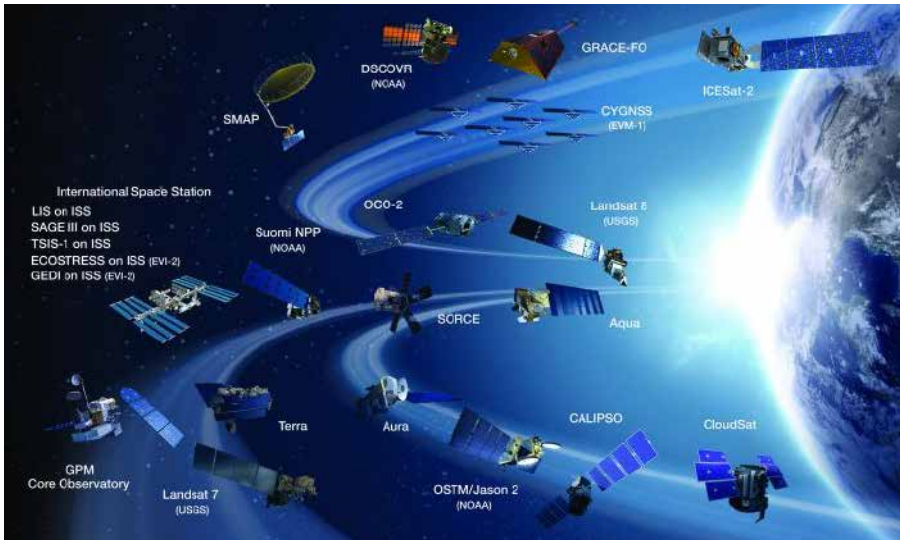

Figure 1. NASA Earth Science Division operating missions as of December 7, 2018.

Scientists realized that satellites would be a useful tool for obtaining the long-term global datasets they needed. NASA had been launching satellites since 1958, and by the 1980s their capabilities for Earth observation were truly coming of age. Like unwavering sentinels, satellites could continuously monitor large swaths of the planet—or the whole globe, depending on their exact orbit. Pioneering satellite observations (e.g., Explorer, Vanguard, TIROS, Nimbus) tantalized these researchers with how much data about the Earth might be obtained from the vantage point of space.

Spurred on by the successes of these pioneers in satellite remote sensing, in the early- to mid-1980s a concept emerged to obtain coordinated Earth observations from space. The earliest designs envisioned having several large platforms in space, each carrying many instruments, that could be serviced via the Space Shuttle, akin to how the Hubble Telescope was reserviced. However, that approach eventually morphed into the present "fleet" of small-to-mid-sized satellites launched on unmanned rockets (see **Figure 1**):

[1] Kudos to the current members of *The Earth Observer*'s editorial team: to **Heather Hanson**, **Douglas Bennett**, **Debbi McLean**, and **Cynthia Trapp** [all employed by Global Science & Technology Inc.]; to **Mitchell Hobish** [Sciential Consulting, LLC] and **Ernest Hilsenrath** [University of Maryland, Baltimore County] both of whom are editorial consultants to GST for *The Earth Observer*; and to **Claire Parkinson** [NASA's Goddard Space Flight Center—*Aqua Project Scientist*], who routinely conducts a final review of the content prior to printing. The consistent quality readers have come to expect would not be possible without the contributions of all the members of the team.

e.g., Terra was launched on an Atlas IIAS rocket; Aqua and Aura were launched on Delta II rockets. The idea became a program and was given a name: the Earth Observing System (EOS).

Making EOS a reality would require a fundamental shift in how Earth scientists approached their research. Traditionally, individual science disciplines tended to focus on their own specific areas of expertise, and only occasionally worked together. The idea behind EOS was to study Earth as a system of interrelated systems—an approach called *Earth system science*. Functionally, that meant that scientists from different disciplines would need to collaborate much more than they had in the past, reflecting the system-of-systems approach of Earth system science.

In short, EOS was a grand vision: that we'd someday have a fleet of satellites (as well as complementary ground observations and computing systems) continuously taking the pulse of our home planet and sending back large amounts of data—and that scientists would come together to work on this problem. But just how would it all work in practice? No one knew for sure back then. Ask anyone who attended those early EOS meetings—see photos on page 3—they were like and they are likely to use words such as "chaotic" and "challenging" to describe them. In an article he wrote for *The Earth Observer*, **Darrel Williams** [former Project Scientist for Landsat 7, currently Chief Scientist at Global Science & Technology, Inc.] recalled that Piers Sellers once described the overall experience of trying to take EOS from idea to reality as being, "...like putting socks on an octopus."

Sellers definitely had a unique way with words. Whatever creative metaphor one might use to describe it, there is no doubt that those first EOS investigators had a huge challenge before them! Not only did they have to work out the details of the flight hardware and computing systems for EOS pretty much from scratch, but they also had to figure out the practical details of how they would actually work together.

As challenging as developing space flight hardware was (and still is), at that time there was an even larger logistics issue that needed to be addressed. A huge program involving hundreds of researchers strewn all over the nation—and eventually the globe—was trying to get off the ground, and they needed a means to communicate. The Internet, which we take for granted today, was in its infancy at that time. If you wanted to get the word out about upcoming meetings, results from those meetings, announcements, and the like, print media was still the way to go. Enter *The Earth Observer*!

Space does not permit the full story of the intimately interconnected history of the evolution of *The Earth Observer* and EOS to be repeated here. For this context, it suffices to say that the idea, or concept of EOS faced a difficult journey—and evolved a great deal—before it became what it is today, and that, from its inception, *The Earth Observer* has chronicled that story.

By the time I made my first contribution to *The Earth Observer* in 2001, the EOS satellite fleet was beginning to take shape. Terra had been launched only a couple years earlier and the other flagship missions (Aqua and Aura) would follow in the next three years.[2] *The Earth Observer* has chronicled the establishment and now graceful aging of members of NASA's Earth observing fleet of satellites, and has also reported on airborne and ground-based sensors. We continue to report on NASA Earth Science as we move beyond the EOS era into the Suomi National Polar-orbiting Partnership (NPP) and Joint Polar Satellite System (JPSS) era, and into other endeavors such as Decadal Survey missions, including the Earth Venture element. We've reported on the launches of new (or recently launched) missions along the way (e.g., Landsat 8, Suomi NPP, GPM Core Observatory, OCO-2, SAGE III on ISS, CYGNSS, LIS on ISS, the "A-Train" Constellation, GOES-16, ICESat-2), as well as on the remarkable scientific achievements of existing ones as, one by one, they exceeded their planned mission lifetime—often by many years—and celebrated a decade or more in orbit (e.g., GRACE@10, Aqua@10, SORCE@10, Aura@10, Terra@15, CloudSat/CALIPSO@10, EO-1@15).

As described above, *The Earth Observer* has reported on historical satellite missions and programs, and the pioneering role that these programs and/or missions played in laying the groundwork for EOS and the missions and programs that build on its rigorous scientific and technical heritage. There have also been articles that look ahead to preview future satellite missions (e.g., PACE, TEMPO) or give an overview of both current and future Earth-observing capabilities from a particular vantage point (e.g., Earth observations from geostationary orbit).

It was also noted earlier that EOS wasn't simply a satellite-based program. *The Earth Observer* has also reported on the complementary ground elements, describing results from field campaigns and other ground-based observation programs over the years [e.g., Students Cloud Observations Online (S'COOL), Total Column Carbon Observing Network (TCCON), Network for the Detection of Atmospheric Composition Change (NDACC), GLOBE Observer].

The Earth Observer has also published feature articles on more-general topics, such as Earth Science Mission

[2] The Tropical Rainfall Measuring Mission, which launched in 1997, had two EOS instruments onboard (CERES and LIS). Landsat 7 and QuikSCAT (both EOS missions) also launched before Terra in 1999, but Terra was the first "flagship" mission to launch. ACRIMSAT launched two days after Terra.

Operations, responsible for keeping the fleet flying safely, and Earth Science Data Operations, which includes the EOSDIS. We've also published shorter articles on EOSDIS applications, such as Worldview and the Global Imagery Browse Service, as well as tutorial articles on data-related topics such as Hierachical Data Format for EOS and Digital Object Identifiers, to better inform our readership of the vital supporting role these tools play in providing timely access to Earth science data and information, which is critical to the success of NASA's research endeavors.

Shown here are snapshots of past EOS Investigator's Working Group (IWG) meetings, gleaned from *The Earth Observer* archives.

[*Left to Right*] **Shelby Tilford**, **Dixon Butler**, and **Stan Wilson** in March 1990 at an EOS IWG meeting.

[*Left to right*] **Darrel Williams**, **Bruce Barkstrom**, and **Alexander Goetz** at the November 1990 EOS IWG.

Ghassem Asrar [*left*] and **Michael King** [*right*] at the March 1993 EOS IWG.

Perhaps the series I take the most personal pride in is our *Perspectives on EOS* series, which ran from 2008 through 2011. It really didn't begin with a series in mind; it started with an article that I wrote for the newsletter's twentieth year, and grew organically into a compendium of recollections and memories from key members of the EOS program. It is often said that history is the telling of a personal story, and that was certainly true with these articles, as the story-tellers had actually lived them. The list of authors reads like a veritable *Who's Who in EOS History*: **Dixon Butler**, **Darrel Williams**, **Piers Sellers**, **Greg Williams**, **H. K. "Rama" Ramapriyan**, **Mark Abbott**, **Michael King**, **Lisa Shaffer**, and **Ghassem Asrar**. We later compiled this series into a single volume (linked to earlier in this paragraph), and one of our hopes in doing so was that sharing these stories of lessons learned while making EOS a reality could be applied by those tasked with implementing new missions through today and into the future. Feedback we have received on those articles indicates that we attained that objective. If ever someone endeavors to write an official history of EOS, these articles, combined with other content from our newsletter, should prove to be a valuable resource.

[*Left to right*] **Bruce Guenther**, **Bill Barnes**, **Les Thompson**, and **Dot Zukor** at the November 1990 EOS IWG.

[*Left to right*] **Peter Brewer**, **Jeff Dozier**, **Bruce Barkstrom**, **Mark Abbott**, and **Dave Glover** [*seated*] at the 1994 EOS IWG.

feature articles

Figure 2. The look of *The Earth Observer* has evolved over the years. This graphic shows the different front-page layouts that have been used. Note how our logo evolved and eventually disappeared. After 2004, new NASA communications guidelines required the NASA logo to be shown on the front instead of the individual program logo. Since 2011, online issues of *The Earth Observer* have been available in color.

Meeting summaries and workshop reports have been part of *The Earth Observer* from the very first issue and remain so today. In the early days, when Internet access wasn't nearly as widespread as it is today, the newsletter printed meeting minutes almost verbatim. At that time, a printed summary was the most efficient—and often the only—way to get the word out about the results of the meeting. The problem was that meeting minutes don't make for the most interesting newsletter articles. If you aren't a member of the science team or an expert on the workshop's subject matter, you could quickly lose interest. Today, the details of virtually every meeting are readily available online, and printing lengthy summaries in the newsletter is no longer economically or environmentally justifiable. Instead, we focus on "telling the story" of each event, providing a high-level summary with more-detailed reporting on individual presentations as deemed appropriate. We always include a URL that interested readers can follow to find more detailed information. This is clearly a viable approach, as some of the teams who reported in those first issues in 1989 are still contributors to our newsletter today. As an example, the MODIS Science Team has reported in *The Earth Observer* from the beginning (although the first article is not available online), and our January–February 2019 issue included a summary of the most recent meeting of the combined MODIS–VIIRS Science Team.

In many ways, the current publication doesn't look much like the first issue did in March 1989, shortly after the official beginning of EOS—see **Figure 2**. However, while much has changed aesthetically and in terms of content in 30 years, *The Earth Observer*'s core commitment remains the same as it has always been: *to report timely news and events from NASA's Earth Science Program*. As has been the case for the past three decades, the future will inevitably require us to learn to navigate new modes of communication (e.g., we've experimented with an *iBook* version of the newsletter and ways to get more of our material posted online—like this article). Regardless of communications medium, our core commitment to telling compelling stories about NASA Earth Science remains the same. It has been my honor to serve as executive editor for a baker's dozen of years, and I look forward to seeing what comes next for *The Earth Observer* as we begin our fourth decade. I think it's been a good run so far—but I hope our best is yet to come! ■