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Rich Cebula ’78 leads a team that is processing and analyzing data from a NASA mission to determine the health of Earth’s protective ozone layer.

Cebula, pictured above, at the Goddard Space Flight Center. *(Photo by Hilary Schwab)*

By Ann Aubry

July 15, 2004
3:02 a.m. PDT
Vandenberg Air Force Base, Calif.
The *Boeing Delta II* rocket blasts into the sky, straining mightily out of cloud and flame against the forces of gravity. If all goes well, in a little over an hour the spacecraft *Aura* will ease into a 438-mile orbital slot above the Earth. At that point, it will officially begin its six-year mission to help answer vital questions about atmospheric changes, particularly in the ozone layer.

Rich Cebula ’78 is not under the actual g-forces, but he feels the weight of this launch. It’s been a long time coming: six years of planning, months of delays, and two preceding days of launches scrubbed at the final seconds. Watching from the visitors’ center of NASA’s Goddard Space Flight Center in Maryland, where scientists are managing the mission, Cebula joins in the cheers and the collective sigh of relief as the *Aura* satellite successfully rises toward orbit.

It isn’t the first launch he’s watched with bated breath. The author of over 170 publications and presentations and winner of numerous achievement awards for contributions to NASA’s long-term ozone monitoring program, Cebula has supported scientific space flights for more than two decades — including several of NASA’s space shuttle missions. He recalls those countdowns always carried “a deep prayer,” because of the human lives on board. Yet he has reason to care dearly about the unmanned *Aura* satellite and the specialized equipment it carries.

“I really did find this one to be a bit more heart-pounding than launches in the past,” he comments later. “If the satellite had had an anomaly, had a failure, had it not reached orbit, there would have been some very significant consequences for the people who work with me. I think that added to the anxiety level.”

In NASA’s view, the $785-million *Aura* project “is fundamentally a mission to understand and protect the very air we breathe.” Dedicated to understanding the health of the Earth’s atmosphere, *Aura* is the third and last satellite in NASA’s Earth Observing System — joining the earlier *Terra* and *Aqua* satellites in examining the Earth’s land, water system, and now

atmosphere. Aura's suite of instruments includes the Ozone Monitoring Instrument, or OMI (pronounced OH-mee in acronym shorthand). Cebula's stake in the mission is twofold: he is manager of the NASA-contracted team responsible for OMI's data processing system, and he is a member of the U.S. OMI Science Team.

In the months since liftoff, *Aura* and OMI have passed the "launch and early operations phase" — a lengthy process of putting the complex satellite and instrument through their initial paces. NASA planned to release the first results from OMI and other onboard instruments in mid-December. "I'm very, very pleased to say that everything is working wonderfully," Cebula reported in late October. "The spacecraft and our instrument are performing flawlessly, so we couldn't be happier."

The Earth's ozone layer has thinned over Antarctica by 50 percent since 1980. Data from the satellite Aura (illustrated above) will help clarify why the ozone layer is decreasing. *(Image provided by NASA)*

In his role on the U.S. OMI Science Team, Cebula's focus is on evaluating OMI's performance so scientists can be confident in the accuracy of the data it produces. Cebula also manages the 40-person Ozone Group at Science Systems and Applications, Inc. (SSAI), a Maryland company contracted by NASA to develop OMI's science data processing system and process the instrument's data into scientifically useful data products.

Says Cebula, "We'll process about 26 gigabytes of data each day, or about 150 terabytes of data over Aura's planned six-year mission" — a figure representing trillions of computer memory units.

Built by the Netherlands and Finland in collaboration with NASA, OMI is a spectrometer whose 1,616-mile viewing swath will completely map the Earth's atmosphere once each day. As Cebula explains, OMI measures solar-reflected (or backscattered) light in a selected range of the ultraviolet and visible spectrum. The results of these measurements will tell scientists how much ozone is over a particular area, and how much ozone the area is gaining or losing over time. OMI also measures a number of other atmospheric trace species that are important to understanding ozone, air quality, and climate change.

The question of ozone depletion is crucial for a simple reason: the ozone layer that exists in the Earth's stratosphere protects us from harmful ultraviolet (UV) solar radiation. Discovery of the now-infamous "ozone hole" over Antarctica in 1985 prompted an international agreement to restrict the production of man-made chlorofluorocarbons, or CFCs, which contribute to the

destruction of ozone in the upper atmosphere. Aura's and OMI's mission includes assessing whether the Earth's ozone layer is recovering.

OMI will continue a 34-year satellite ozone record, mapping global ozone change. Cebula has contributed his talents to help compile that record for the past 21 years, working on OMI predecessors such as the Total Ozone Mapping Spectrometer (TOMS). The increased capabilities of OMI makes it equivalent to launching roughly 1,500 of the predecessor instruments, Cebula says. One example of OMI's superiority: previously the highest resolution ozone-monitoring instruments could only resolve to a scale of 31x31 miles. The OMI instrument resolves down to 8x15 miles — sufficient to monitor a single urban center.

"So (OMI is) really a beautiful instrument. Hopefully it's going to work the way we expect it to. One of the things that I've learned in these many years is that each instrument throws you a curve, and you can never quite predict what that curve will be. Each one will behave in a certain way; they'll have mannerisms, characteristics on orbit that are different from the previous instruments. They all seem to have distinct personalities" — so much so that Cebula sometimes refers to the family of instruments he's worked on as "siblings."

"I guess that, like having children, there are joys and there are things that make you absolutely crazy about each instrument," he says, adding, "I really enjoy that challenge."

While embracing challenges has become a theme in Cebula's career, he attributes his lifelong interest in science to being a "child of the Sixties," growing up amid the heyday of NASA's Mercury, Gemini, and Apollo programs. He joined rocket clubs in junior high and high school, building and launching model rockets. Little did he know then that someday he would be involved with NASA personally.

He certainly couldn't have known such a dream-come-true scenario lay ahead when, as a college freshman, he teetered on the edge of switching his major to something less arduous than physics.

Although liberal arts beginnings aren't particularly common in the field of atmospheric science, Cebula believes he needed the individual attention provided at Illinois Wesleyan before he could continue his education, ultimately earning his master's and doctorate degrees in physics at the Johns Hopkins University. In fact, in his early days at IWU, Cebula wasn't really sure he wanted to pursue a scientific course of studies.

"While I was taking my introductory physics courses, I was also taking a humanities course with (English) professor Harold Hungerford," Cebula recalls. "I was struggling with the sciences and I seriously considered changing my major. There was a bit of a conspiracy between Professors Hungerford and (then-physics chair Gary) Kessler to keep me in physics. I use the term 'conspiracy' very nicely."

Cebula says that his IWU physics professors gave him the individual attention he needed to succeed in a scientific career. Those professors included, above, Gary Kessler and Lew Detweiler.

He came to dearly love the small physics department, which included Kessler, who died in 1995; Ray Wilson, now emeritus but still active in the department; and Lew Detweiler, who remains teaching full-time at Illinois Wesleyan.

"At a large institution, the typical freshman is going to be in a very large lecture session and then a recitation section led by a teaching assistant. Illinois Wesleyan is a much more nurturing environment, which in my case was really needed. Professors Kessler and Hungerford took the time to listen and work with me." Soon, Cebula was helping set up lab demonstrations, "and by my sophomore year, I was helping the freshmen do their laboratory work. It really got me tied in to the physics department much more than I ever would have been otherwise."

With Detweiler, Cebula studied variable stars, which are stars that change their brightness, at the University's Evans Observatory. He also worked with Wilson on spectroscopy, the study of the interaction of electromagnetic radiation, such as ultraviolet and visible light, with matter.

An ensuing fascination with spectroscopy became the primary reason Cebula chose to continue his studies at Johns Hopkins, where he could take part in Hopkins' famed Sounding Rocket Program, involved in the launching of small, relatively inexpensive rockets used to study the Earth's atmosphere. The basic design of the instruments used by Cebula at Johns Hopkins for those sounding rockets experiments was also being used in the first studies from space of the Earth's ozone layer.

"And that's how I got involved in atmospheric ozone," Cebula explains. "It was really from an instrumentation standpoint, understanding the calibrations of the instruments."

Calibration is particularly important in ozone study because it involves the accumulation of long-term data: "Changes in the ozone layer globally are not that large when you look at those changes on a year-to-year basis — we are talking about only a few percent per decade." While that amount is significant in terms of the environment, it's small in terms of daily measurements. Detecting those small changes, and ensuring that the measurements were accurate and not due to variables related to instrument performance, was a large part of Cebula's focus in his early career.

This included some "heady days" of research connected with the space shuttle program, which Cebula worked on from 1986 to 1998. His specific focus involved instruments placed on the shuttle that performed "underflights" to help calibrate data from ozone monitoring instruments flown on NASA and NOAA (National Oceanic and Atmospheric Administration) satellites.

“Working in the shuttle environment is amazing. We were doing round-the-clock mission support for missions that typically lasted from one to two weeks, so you learned how to endure sleep deprivation really well.”

With multiple science experiments onboard, “integrating the timeline of what you needed to do and where you needed the shuttle to be pointing at what time with what everybody else was doing, was a challenge.” They even had to work around the shuttle astronauts’ housekeeping chores.

Cebula says that watching the control room during the *Aura* launch last July brought back vivid memories of his days on the shuttle program. “You see the men and women in front of their consoles and their computer screens, and they’ve got the little communicators in their ears and they’re listening to about five different conversations at once, and they are bombarded with data that they are monitoring — it’s just a very intense environment,” he says.

Such intensity could make the return to normal “mono-tasking” seem anti-climactic, Cebula admits. But he likes the way his career has continued to evolve.

Above, the Aura is given a weight check prior to launch.. *(Image provided by NASA).*

“These days, my principle responsibility is to enable other scientists and IT (information technology) professionals to do their work; to make certain they have the overall direction and tools to do their job,” he says. “I’m actually in this wonderful spot; I am still involved with the instruments at a pretty high level and am able to make technical contributions, while at the same time I’m at a point in my life and career where I really enjoy the human interaction more.”

Cebula finds it interesting that while he holds a bachelor’s through Ph.D. in physics, he is now primarily a manager. He recalls, “when I was a young scientist fresh out of graduate school and looking at my managers back then, I wondered why anyone who has a Ph.D. in physics and has all this technical expertise would ever want to be a manager?

“I think maybe it is an interesting irony of life that here I am, 20-some years later, and I do understand it, because for me the challenges are new and that’s enjoyable. And the fact that I have the technical insight is essential for success in my current role and it helps a lot in gaining the respect of the people who I work with.”

Although his career can be stressful, Cebula finds time for getting away with his wife Beth to their cabin in the West Virginia mountains, hiking and skiing with friends, or any excuse he can find to get out and observe nature. He also loves to travel. Among his favorite destinations are Alaska, the Netherlands, Poland, Germany, and Italy, which he has visited several times.

As Cebula strikes up conversations on his travels, his connection to NASA hardly ever fails to make an impression. While he realizes that his unusual line of work makes for "great party conversation," he says that's not what makes it so rewarding.

"I honestly feel very privileged to be involved with something that is as important as long-term monitoring of the Earth's atmosphere and climate. I'm very passionate about what I do. It's amazing to me how fortunate I am to be involved in looking at the health of the Earth on which we live ... to be able to assist NASA in understanding long-term changes to the Earth's ozone layer. I feel very fortunate indeed."