Remember the ozone hole? A signature environmental concern of the 1980s has become a signature environmental success story. While a strong international treaty regulates ozone-depleting substances, scientists at NASA and NOAA continue to keep a close eye on the evolving state of ozone in the atmosphere.

Yes, an ozone hole above Antarctica still forms each year – just six years ago in 2006 it reached its largest size ever, covering more than 11 million square miles. The ozone hole this year is back, but is somewhat smaller than in the past because of the usual variations in Antarctic weather conditions. In the long term, worldwide adherence to the Montreal Protocol and its amendments has scientists expecting that the ozone layer will once again reach full strength – but they don't expect a return to 1980 global levels until 2050. The ozone hole itself could be completely eliminated by 2065. It will be a slow recovery and there may be obstacles along the way.

While the Montreal Protocol may have averted disaster, the ozone layer remains in flux, and will stay in the sights of atmosphere-observing satellites for a long time.

Satellite instruments that provide measurements of atmospheric ozone, such as the Ozone Mapping Profiler Suite (OMPS) on the Suomi National Polar-orbiting Partnership satellite and continuing on the Joint Polar Satellite System (JPSS) will become even more important as international ground-based measurement programs are being scaled back because of government budget cuts. The JPSS program will ensure continuity of OMPS for nearly the next 20 years.

The Antarctic Ozone Hole

In 1957, the British Antarctic Survey began routine observations at the Halley Bay ground station to better understand the Antarctic ozone layer. Their Dobson spectrophotometer measured the total amount of ozone between the surface and space over the station. In 1974, Drs. Mario Molina and F. Sherwood Rowland theorized that the chlorine from chlorofluorocarbons (CFCs) could lead to ozone depletion; they later won the 1995 Nobel Prize for their contributions. In 1985, the British science team published results that revealed a sharp decline in ozone in the Antarctic spring. We had a problem: Above Antarctica, the ozone layer that protects Earth from harmful solar radiation was disappearing.

"They did not know the extent of it because they only had data from one spot," said Pawan K. Bhartia, a NASA atmospheric scientist who was on the team analyzing NASA's Antarctic satellite data. The satellite readings also showed ozone levels so low the team thought it might be instrumental error. A few months after the British Antarctic Survey's paper, the NASA team presented findings at an atmospheric sciences conference in Prague that confirmed the ozone hole was real.

"After that," Bhartia said, "all hell broke loose."

The British Antarctic Survey data was accurate but the issue was more widely recognized when satellite images revealed that the ozone depletion was not confined over Halley Bay, but was continental in size. The NASA paper released a satellite image that showed the size and magnitude of the damage and made the "ozone hole" a well-known environmental phenomena. Word of the ozone hole spread through news headlines like wildfire, as people began to realize the significance of a region in the stratosphere that most had never heard of before.

Without the ozone layer Earth would be very different. Earth's gaseous envelope, the atmosphere, is made up of layers. When present near the surface, ozone (an unstable molecule composed of three oxygen atoms) is a pollutant. But in the stratosphere, the atmospheric layer 6 to 30 miles (10 to 50 KM) above the surface, ozone absorbs Ultraviolet-B (UV-B) radiation from the sun, which can damage DNA and lead to skin cancer in humans.

"The evolution of life is tied to the evolution of ozone," Bhartia said. "Ozone is critical for the longtime survival of the species."

Discussion questions:

1) Consider the highlighted statement in the article: “The satellite readings also showed ozone levels so low the team thought it might be instrumental error.” Suppose there was an automatic data cleaning algorithm which replaced observations valued at 0 (assumed to be instrumental error) with a value from a missing value algorithm such as last value carried forward or mean imputation. What would be the impact of this decision on the detection of the ozone hole?
2) As big data collection efforts expand, what problems do you see with automatic ways of handling missing data?