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Observing Earth's Environment from Space: Opportunities and Challenges

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Progresses in space technology in recent decades have left indelible impacts on human life. For example, communication by cell phone would not be possible without sophisticated Earth-orbiting satellites and the vehicles that launch them into space. Another remarkable achievement of the satellite systems is the initiation of global monitoring of Earth's environment such as atmospheric temperature and ocean currents. Those satellite observations have been used to improve weather forecast and detect long-term trends of Earth's climate. While cell phone communications are now operated by private companies on a self-sustained basis, the Earth observing system faces a more uncertain future. The subtle difference between the two stems from the fact that the latter has always been supported and run by major government laboratories. Its continued development will be affected by government funding for space research, which has seen strong ebbs and tides in recent years. Combined with another trend of privatization of space, they hint at an emerging new era for space-based monitoring of the global environment. We shall examine the background of this development and explore the opportunities and challenges that arise from it.

The first generation of the Earth-observing satellite system was developed in the 1970s-80s in response to the needs for monitoring extreme weather events (such as hurricanes) and for initializing numerical models for short-term weather forecast. The pioneering projects, led by the National Oceanic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA), were great successes. Satellite remote sensing fills the gap of observation over the oceans where conventional meteorological stations are nearly nonexistent. Satellite imagery provides real-time monitoring of hurricanes and severe storms. The assimilation of satellite data into global weather prediction models has led to a reduction of forecast error that is comparable to the reduction due to the improvement of model resolution and algorithms. This success cemented long-term support for the operation of "weather satellites" to this day and likely indefinitely into the future. The focus of our concern, however, is on a different and more ambitious type of Earth observing systems that have grown out of the success of weather satellites. Broadly speaking, they aim to perform long-term monitoring of Earth's climate on decadal and longer time scales. Drawing the parallel to weather prediction, the data accumulated by those observations may someday help advance long-term climate prediction. This is a far more complicated endeavor, for two reasons. First, many "slow" components in the Earth system that can be ignored for weather prediction must now be measured because they affect the long-term evolution of climate. Some examples are the ocean circulation, sea ice concentration, and the distribution of water masses over land. The techniques that are needed to measure those components are complicated. State-of-the-art satellite measurements of the variation of water bodies on earth are made possible with sophisticated detector of gravity anomalies and advanced altimeters [1]. The list goes on. While those are outstanding technical achievements, they also reflect the reality that the cost for comprehensive measurements of all major climatic variables will likely far exceed that for the basic observation of atmospheric temperature and wind for weather prediction. Secondly, if the aim is climate instead of weather prediction, the time scale of the required continuous observation is on the order of decades. Practical applications and societal benefits that arise from the project will not be fully established in the short term. Any program of such nature will be deemed curiosity-driven and prone to the fluctuation of government research funding, provided that such funding continues to be the sole source of support for the enterprise as it is now.

Given this background, what would be the best strategy for sustaining a useful system for long-term climate monitoring from space? Before exploring the possibilities, we cannot ignore the emerging trend of privatization of space. As a prime example, NASA's Space Shuttle Program recently ended after *Atlantis* concluded its last flight in July, 2011. The replacements are expected to be privately designed spacecrafts with reduced cost and less government backing. We do not yet know what the new prototypes will look like, but the development may be viewed positively for two reasons. First, there will be multiple proposals to join the competition. The one(s) that win out must have efficient designs that make sense economically. This natural selection process would ensure that the new designs and their future successors are sustainable. Secondly, when the space enterprise is decentralized, it may speed up the cycle of innovation since there will be less burden to maintain out-of-date hierarchies of leftovers from previous missions. The same points could be applied to the long-term Earth observing system if one anticipates decentralization and partial privatization. During the previous era of a rapid expansion of government-sponsored research (that saw the development of space shuttles), the prevailing philosophy was to push the limit resource-wise in order to do the best science possible. This relied on the assumption that government funding will keep increasing anyway. The involuntary termination of several big science projects in recent years proved otherwise [2]. Going in the opposite direction, the emerging engineering challenge for global climate monitoring will be to build a new generation of Earth observing systems that are more efficient and economically more sustainable. To advance climate prediction, it may prove to be more useful to accumulate long-term, sustained, global observations of selected key variables than to put all resource in an exhausting but short-lived campaign to measure everything under the sun. It may also be useful to explore the possibility of hard-wiring the Earth observing system into existing, commercially sustained, platforms. For example, the data collected by the Global Positioning System have been used to retrieve the thermodynamic profiles of the atmosphere [3].

We expect government agencies and laboratories to continue play an important role in space-based climate monitoring in the near future. This is due in part to the aforementioned concern that the

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societal and economical benefits of climate observations can be firmly established only on decadal and longer time scales. Nevertheless, we expect the role of private institutions to increase. To draw an inspiration from the field of telecommunications, the government is involved in the regulatory aspects of it, but private institutions lead the way in sustaining the network and pushing the technology forward. We envision that space-based global environmental monitoring systems may someday achieve a similar status. We have not discussed the detail of private sponsorship. It is, however, worth noting that climate information has already been used by insurance companies, among others, for risk assessment involving natural disasters [4]. It is reasonable to solicit sponsorship from potential users of climate data. Other forms of private sponsorship should also be explored. In the post-Space Shuttle era, it has been suggested that space tourism may serve as a way to support the development of the new generation of spacecrafts. We should likewise be creative in exploring a much broader base of private support for the Earth observing systems. In order for any of this to work, technology must continue to evolve to make future observing systems not bigger, but ever more efficient and economically viable. Thus, engineering innovations ultimately hold the key to sustained long-term climate monitoring from space.

References

1. Chambers DP (2006) Observing seasonal steric sea level variations with GRACE and satellite altimetry. J Geophys Res 111: 13
2. An important case is Tevatron, the premier particle accelerator for high-energy physics research in the U.S. It was permanently closed in 2011 with no replacement planned.
3. Cucurull L (2010) Improvement in the use of an operational constellation of GPS radio occultation receivers in weather forecasting. Wea Forecasting 25: 749-767
4. Mills E (2005) Insurance in a climate of change. Science 309: 1040-1044