GEORGE P. WOOLLARD AWARD

Presented to Timothy H. Dixon

Timothy H. Dixon
University of Miami

Citation by Shimon Wdowinski

Tim Dixon has pioneered the application of space geodesy (GPS, InSAR and DORIS) to study a fascinating variety of geologic processes. Nowadays space geodesy, with its amazing accuracy to measure small surface changes, is widely used in geological research and basically considered as a mainstream science. However 30 years ago, when Tim joined NASA as a young scientist, geological applications of space geodesy were mostly a vision. Tim's dedicated research, as well as the contribution of his generation of pioneering geodesists, has paved the road for a large number of researchers to use GPS, InSAR and other techniques in a large variety of geological applications. He is definitely a worthy recipient of the Woollard award that recognizes "outstanding contributions to geology through the application of the principles and techniques of geophysics."

Tim contributed to the development of space geodesy as a tool, as well as pushing the boundaries of the types of geologic problems that can be studied with these tools. Furthermore his publications on this topic, in particular his 1991 Reviews of Geophysics paper on GPS, as it was very early in the GPS era, have encouraged others to pursue this research tool. Tim and his students, post-docs and colleagues have used space geodesy to study plate motion, crustal deformation and faulting, earthquake hazard, mountain building, volcanic processes, post-glacial rebound, coastal subsidence, ground water depletion, and climate change-induced melting of the Greenland ice sheet. Some of Tim's and coworkers key contributions include studies of global plate motion (REVEL-1) and regional tectonic studies in the Andes, Caribbean, California, Central America, Iceland and other areas. He also had major contributions to studies of crustal deformation, faulting and seismic hazard assessments. For example, Tim pioneered GPS observations in the Caribbean and was the first to estimate a long-term rate and seismic hazard for the Eriquillo Fault that ruptured this January causing the devastating earthquake in Haiti. His accurate slip estimate from 1998, which was validated a decade later when much better data were available, was derived from only three GPS sites in Hispaniola, but with excellent understanding of the island's geology and of earthquake deformation processes.

Tim's research often brings together disparate data types, combining space geodesy with other information in new creative ways. For example, with his wife Jackie, he studied the weak upper mantle in the western US, combining data from geodesy, seismology, geochemistry, and laboratory data on material properties of minerals, to show that the weak mantle is a consequence of not only relatively high temperature but also high water concentration. This study was also one of the first to demonstrate consistency between laboratory and geodetic descriptions of olivine rheology, despite many orders of magnitude difference in strain rates between the two approaches.

More recently, Tim and coworkers have begun using space geodesy to address a number of socially important problems related to hydrology and global change. For example, they have used InSAR and GPS observations to study subsidence in Mexico City associated with ground water withdrawal in excess of recharge. These types of studies are likely to grow in importance as population pressure and climate change exacerbate water resource issues. Another example is sea level rise and the role of local subsidence in flood hazard. Tim and coworkers have been using space geodesy to address this issue in New Orleans. Their studies highlight the role of compaction and oxidation of Holocene organic-rich soils and marsh deposits in causing current high subsidence rates, and consequent low elevation in some parts of New Orleans, as contributors to the catastrophic flooding after Hurricane Katrina. They also showed that some of the levees that failed suffered very high subsidence rates in the three years prior to Hurricane Katrina, implying that the levees had simply subsided one or more meters below their design height, and were easily over-topped in the hurricane storm surge.

Perhaps one of Tim's most important accomplishments has been the establishment of a vigorous laboratory for space geodetic research at the University of Miami. This laboratory trains students and post-docs, and welcomes visitors, especially students, from all over the world, for extended periods of time. Visitors can learn the latest tools of space geodesy, and bring this expertise back to their home institutions, thereby promoting its use for a wide variety of geologic problems.

Tim's vision from three decades ago for using space geodesy as a tool in geological research became a reality. His scientific work, student and post-doc mentoring and contribution to the community make him a most appropriate recipient of the 2010 Woollard Award.

Response by Timothy H. Dixon

I am extremely grateful to GSA and members of the Geophysics Division for honoring me with this award.

The research that I have done would not have been possible without the contributions of a large number of dedicated scientists and engineers who create and maintain the infrastructure we call satellite geodesy. When Woollard was doing his work in the 1940's, 50's, and 60's, geodesy existed as a discipline, but it was not a widely used tool in geophysics. The advent of artificial satellites initiated geodesy as a both a measurement technique and major discipline. It is a global endeavor. More than most disciplines, it requires collective effort. It is usually not possible to recognize the people who contribute these efforts in a formal way, but I would like to remedy that now.

Most of us take it for granted that an inexpensive GPS receiver can tell us where we are within a few meters. But to support the type of measurements necessary for many geological applications, where location precise to a few millimeters may be needed, a large group of dedicated geodesists have to maintain a sophisticated global system. This system developed over many decades, beginning with the launch of Sputnik in 1957. In the early 1980's, shortly after engineers developed and launched the first satellites of the GPS system, several clever people figured out that these satellites could also be used for high precision geodesy. This built on developments in Very Long Baseline Interferometry (VLBI) and Satellite Laser Ranging (SLR) supported by NASA, NOAA, the Navy, and many international institutions. While VLBI and SLR were too large and expensive for most geological applications, many of the lessons learned still apply today to GPS and InSAR, for example how to generate high precision satellite ephemerides, and how to calculate and correct for variable atmospheric effects. On-going efforts in orbital mechanics, atmospheric physics, signal processing, and geophysical modeling continue to improve the precision and range of applications. Satellite geodesy is widely used today, including environmental and global change applications, with the support of individuals and institutions who maintain satellite tracking networks, calculate high precision ephemerides, write or improve software for data analysis, and maintain data archives, all in support of our global geodetic endeavor.

No one works in a vacuum, and I certainly owe more than most to the distinguished students, post-docs and faculty colleagues that I have had the privilege of working with. I cannot name everyone, but let me at least mention current and former students Ailin Mao, Edmund Norabuena, Peter LaFemina, Gina Schmalzle, Kim Outerbridge, Batuhan Osmanoglu, and Yan Jiang; post-docs and lab visitors Giovanni Sella, Andy Newman, Sang Wan Kim, Juliet Biggs, Sang Hoon Hong, Christina Plattner, and Francesca Cigna; and colleagues Falk Amelung, Enrique Cabral, Chuck Connor, Chuck DeMets, Roy Dokka, Kevin Furlong, Rob Govers, Chris Harrison, Pam Jansma, Jeff Lee, Glenn Mattiolli, Meghan Miller, Fred Pollitz, Marino Protti, Merith Reheis, Susan Schwartz, Seth Stein, Shimon Wdowinksi, and John Weber. I have also been privileged to study and work at institutions that have been both supportive and inspiring, including the University of Western Ontario in Canada, Scripps Institution of Oceanography in San Diego, the Jet Propulsion Lab, and the University of Miami. Finally, I owe a huge debt of gratitude to my wife Jackie, who has been my rock and partner in research, family and life, despite having a very productive career of her own in earth sciences. Thank you.