Electronic Supplement:

Table 1: Space geodetic techniques and their applications

Technology	Acronym/type	Agency	Time	Applications
Positioning				
VLBI	Very Long Baseline Interferometry	NASA, Int.	1970-present	Solid Earth
LLR	Lunar Laser Ranging	NASA	1970-present	
SLR	Satellite Laser Ranging	NASA, Int.	1970-present	
DORIS	Doppler Orbit determination and Radiopositioning Integrated on Satellite	CNES	1992-present	Solid Earth, Ionosphere
Advanced Positioning techniques: Global Navigation Satellite Systems (GNSS)				
GPS	Global Positioning System	DoD	1980-present	Solid Earth, hydrology, Glaciology, atmosphere, ionosphere, natural hazards
GLONASS	**GLO**bal **NA**vigatsionnaya **S**putnikovaya **S**istema	USSR/Russia	1982-present	
Galileo		ESA	2005-present	
Beidou-1		China	2000-present	
IRNSS		India	In planning	
Altimetry				
SeaSAT	Radar Altimetry	DoD	1978	Oceanography
GeoSAT	Radar Altimetry	DoD	1985-1986	Oceanography, hydrology, glaciology, geoid determ.
TOPEX/Poseidon	Radar Altimetry	NASA/CNES	1992-2005	
Jason-1	Radar Altimetry	NASA	2001-present	
ERS-2 (RA)	Radar Altimetry	ESA	1995-prsent	
ENVISAT (RA-2)	Radar Altimetry	ESA	2002-present	
ICESAT	Laser Altimetry	NASA	2003-present	Glaciology, hydrology, oceanography
CryoSAT	SAR / Interferometric Radar Altimeter	ESA	Scheduled to be launched in 2009	
(InSAR) Interferometric Synthetic Aperture Radar				
SeaSAT	L-band, HH polarization (pol)	DoD	1978	Oceanography
ERS-1	C-band, VV pol	ESA	1992-1996	Solid Earth, hydrology, glaciology, oceanography, geotechnical, natural hazards
ERS-2 (SAR)	C-band, VV pol	ESA	1996-present	
JERS-1	L-band, HH pol	JAXA	1992-1998	
RADARSAT-1	C-band, HH pol	CSA	1995-present	
Space Shuttle (SRTM)	C-band, X-band, fixed baseline interferometer	NASA	2000	
ENVISAT (ASAR)	C-band, VV+VH, HH+HV pol	ESA	2002-present	
ALOS (PALSAR)	L-band, quad-pol	JAXA	2006-present	
RADARSAT-2	C-band, quad-pol	CSA	2007-present	
TerraSAR-X	X-band, quad-pol	DLR	2007-present	
COSMO-SkyMed	X-band, quad-pol	Italian	2007-present	
Gravity missons				
LAGEOS-1/2	Laser Geodynamics Satellites	NASA	1976-present	Geoid determ., oceanography, hydrology, glaciology
Ajisai		JAXA	1986-present	
CHAMP	Challenging Minisatellite Payload	DLR	2000-present	
GRACE	The Gravity Recovery and Climate Experiment	NASA/DLR	2002-present	
GOCE	Gravity field and steady-state Ocean Circulation Explorer	ESA	Scheduled to be launched in 2008	

Agencies: CNES - National Space Study Center (France); CSA – Canadian Space Agency; DLR - German Aerospace Center; DoD – Department of Defense (USA); ESA – European Space Agency ; Int. – International agencies and research institutes; JAXA - Japan Aerospace Exploration Agency; NASA – National Aeronautics and Space Administration (USA).

Figures 1 and 2– sources and links.

1a) Tectonic plate motion – UNAVCO image;

http://sps.unavco.org/crustal_motion/dxdt/

1b) Geoid determination – NASA image:

http://nasascience.nasa.gov/earth-science/oceanography/physical-ocean/ocean-surface-topography/?searchterm=image%20of%20geoid

1c) Bathymetry (ocean) – Sandwell, unpublished image related to research:

Smith, W. H. F., and D. T. Sandwell, Global seafloor topography from satellite altimetry and ship depth soundings, Science, v. 277, p. 1957-1962, 26 Sept., 1997.

http://topex.ucsd.edu/marine_topo/

1d) Glacial Isostatic Ajustment –
Giovanni F. Sella, Seth Stein, Timothy H. Dixon, Michael Craymer, Thomas S. James,Stephane Mazzotti, and Roy K. Dokka, 2007, Observation of glacial isostatic adjustment in ‘‘stable’’ North America with GPS, Geophysical Research Letters, , Vol. 34, L02306, doi:10.1029/2006GL027081:

http://www.earth.northwestern.edu/people/seth/Texts/gpsgia.pdf

1e) Global/Regional water budget –
Hicks, G, 2007, ‘Getting at groundwater with gravity’

http://nasadaacs.eos.nasa.gov/articles/2007/2007_gravity.html

1f) GPS-Meteorology –
Braun, J. and C. Rocken, GPS Measured Water Vapor Variability at the ARM SGP CF, Proceedings of the Eleventh Annual Atmospheric Radiation Measurements(ARM) Science Team Meeting, Atlanta, Georgia, March 2001

http://www.cosmic.ucar.edu/~braunj/papers/arm01_paper.pdf

2a) Earthquake deformation cycle –

Garry Rogers and Herb Dragert, Episodic Tremor and Slip on the Cascadia Subduction Zone: The Chatter of Silent Slip, *Science* Express on 8 May 2003 and *Science* 20 June 2003:, Vol. 300. no. 5627, pp. 1942 – 1943, DOI: 10.1126/science.1084783:
http://gsc.nrcan.gc.ca/geodyn/pdf/ets.sciencexpress.may2003.pdf

2b) Magma-induced deformation – unpublished image, see similar images in

Amelung, F.,S-H. Yun, T.R. Walter, P. Segall and S.W. Kim, Stress control of deep rift intrusion at Mauna Loa volcano, Hawaii. Science 316: 1026-1030 [DOI: 10.1126/science.1140035], 2007.

http://mgg.rsmas.miami.edu/faculty/famelung/InSAR/Falk's%20webpage/research1.htm

2c) Glacier flow (InSAR) –

Richard M. Goldstein, Hermann Engelhardt, Barclay Kamb, and Richard M. Frolich, Satellite Radar Interferometry for Monitoring Ice Sheet Motion: Application to an Antarctic Ice Stream, Science 3 December 1993: Vol. 262. no. 5139, pp. 1525 - 1530DOI: 10.1126/science.262.5139.1525:

http://www.cacr.caltech.edu/SDA/images/new_sci.jpg

2d) Urban and infrastructure subsidence –

Dixon et al, T. H. Dixon, F. Amelung, A, Ferretti, F. Novali, F. Rocca, R. Dokka, G. Sella, S.-W. Kim, S. Wdowinski, D. Whitman: New Orleans Subsidence: Space Geodesy and Hurricane Katrina Flooding. Nature 2006

http://www.geodesy.miami.edu/articles/Dixon_etal_nature_2006.pdf

2e) Aquifer system deformation – unpublished image, see research basis for this figure in :

Amelung, F., D. Galloway, J. Bell, H. Zebker and R. Laczniak,1999, Sensing the ups and downs of Las Vegas: InSAR reveals structural control of land subsidence and aquifer-system deformation. *Geology, Volume 27, No. 6, p. 483—486*

http://www.stanford.edu/group/radar/vegas_3d_big.gif

2f) Landslide –

George E. Hilley, Roland Bürgmann, Alessandro Ferretti, Fabrizio Novali and Fabio Rocca, Dynamics of Slow-Moving Landslides from Permanent Scatterer Analysis, SCIENCE MAGAZINE, 25 June 2004, Volume 304, Number 5679, Pages 1952-1955

http://www.treuropa.com/HomeTRE/PSInSAR/Applications/Landslides/SanFrancisco/tabid/204/Default.aspx

2g) Wetland water level changes – image published in EOS, May, 2008, cover of the Spring AGU meeting in Ft. Lauderdale

ShimonWdowinski, Sang-Wan Kim, Falk Amelung, and Tim Dixon, 2006, Webland InSAR: A new space-based hydrological monitoring tool of wetlands surface water level changes, Proceedings for Globe Wetlands Meeting, Frascati, Italy.

http://www.rsmas.miami.edu/users/swdowinski/publications/Wdowinski-GlobWetlands-proceedings.pdf

2h) Rivers and Lakes water level – unpublished image, European Space Agency / DMU-EAPRS Lab based on work by Philippa Berry and Jérôme Benveniste reported at the EGU 2009 General Assembly.

http://earth.esa.int/riverandlake