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Education

1973 B.S. Physics, National Taiwan University.

1981 Ph.D. Earth Sciences, Scripps Institution of Oceanography, University of California, San Diego (thesis adviser: Prof. Freeman Gilbert).

Academic Experience

1975 ~ 1981 Research Assistant, Scripps Institution of Oceanography, University of California, San Diego.

1981 ~ 1983 NRC Research Associate, Geodynamics Branch, NASA Goddard Space Flight Center (GSFC), Maryland, USA.

1983 ~ 1996 Geophysicist, Geodynamics Branch, NASA/GSFC.

1993 ~ 1995, NASA Geophysics Program Manager, on detail NASA Headquarters.
1993 (Spring), Visiting Scientist, Japan National Astronomical Observatory, Mizusawa, Japan.

1997 ~ 2004 Head, Space Geodesy Branch, NASA/GSFC.

2005 ~ 2006 Chief, Space Geodesy Laboratory, NASA/GSFC.

2005 (summer), Visiting Scientist, National Central University, Taiwan.

2006 ~ 2010 Dean, College of Earth Sciences, National Central University, Taiwan.

2010 ~ 2013 Director, Institute of Earth Sciences, Academia Sinica, Taiwan.

2010 ~ 2020 Distinguished Fellow, Institute of Earth Sciences, Academia Sinica, Taiwan.

2015 (Spring), Visiting Scientist, Kyoto University, Kyoto, Japan.

2016 (Spring), Visiting Scientist, University of Science and Technology of China, Hefei, China.

2017 (Spring), RISH Visiting Scientist, Kyoto University, Kyoto, Japan.

2107 (Fall), Visiting Scientist, Alicante University, Spain.

2018 (Spring), Visiting Scientist, Shanghai Astronomical Observatory, Shanghai, China; University of Science and Technology of China, Hefei, China.

2019 (Spring), Green Scholar, IGPP, Scripps Institution of Oceanography, University of California, San Diego, USA.

2020 ~ present Distinguished Visiting Chair, Institute of Earth Sciences, Academia Sinica, Taiwan.

Honors and Awards

1990 Excellence in Refereeing: J. Geophys. Res., American Geophysical Union (AGU).

1991, 1992, 1994, 1995, 1996, 1998, 2000, 2003, 2004 (9 times) NASA GSFC Outstanding Performance Awards.

1995 Fellow, International Association of Geodesy.

2005 Honorary Professorship, University of the Chinese Academy of Sciences, Beijing.

2005 The Einstein Professorship, Chinese Academy of Sciences.
2006 ~ 2008 TSMC Outstanding Chair Professorship.
2009 ~ 2010 Foundation for the Advancement of Outstanding Scholarship Award.
2010 ~ Distinguished Research Fellow, Academia Sinica.
2019 Fellow, American Geophysical Union.

Professional Societies and Services

Member, American Geophysical Union, since 1976.
Chairman, IUGG/IAG Special Study Group "Global Geodynamic Variations", 1991-1994.
Direction and Review Committee, Journal of Geophysical Research - Solid Earth, 1998-1999.
International Earth Rotation Service (IERS) Directing Board member, 1998 - 2004.
Head (founding), IERS Global Geophysical Fluids Center (GGFC), 1998 – 2004.
Chair, IERS/GGFC Special Bureau for Mantle, 1998 - 2006.
Mission Scientist, NASA GRACE Mission, 2000 - 2002.
NASA Solid Earth Science Working Group, 2000 - 2002.
Workgroup lead of NASA's Earth Science Enterprise Visions2025, 2001 - 2003.
Directing Board, Sub-Commission Geophysical Fluids, Commission 3, IAG, 2003 - 2007.
Review Board member, for the University of California System-wide Institute of Geophysics and Planetary Physics, 2004.
President, Geodesy Section, American Geophysical Union (AGU), 2004 - 2006. President-elect, 2002 - 2004.
International Award Committee, American Geophysical Union (AGU), 2006 - 2008.
Director (founding), GPS Scientific Applications and Research Center, Taiwan, 2006 - 2008.
President, Chinese Geoscience Union (CGU), 中華民國地球科學學會 理事長, 2008 - 2011.
Organizing Committee, IAU/IAG Commission 19/A2, 2009 - .
Associate Editors, J. Geophys. Res. – Solid Earth (1998 - 2006; 2009 - 2020); Earth, Planets, Space (1997 - present); J. Geodynamics (1996 - present)
Chair, The Nomenclature Committee for Earth Sciences, commissioned by the Taiwan Ministry of Education, 2013 - 2019.
President, Asia-Oceania Geosciences Society (AOGS), 2016 - 2018. Vice President, 2015 - 2016, 2018 - 2019. Award Committee Chair, 2019 - 2021.
Scientific Advisory Council member, GeoForschungsZentrum (GFZ), Germany, 2019 - .

Scientific Interests and Achievements

My scientific interests lie primarily in global geophysics using space-geodetic and seismological observational data; they pertain to a broad range of geophysical areas listed below in the order of effort over the years (in a majority of cases collaborating with colleagues and students):

(1) Earth rotation and low-degree gravitational variations: We studied the geophysical excitations of the length-of-day variations, the polar motion, as well as the Earth's oblateness (J_2) changes (e.g. the 1998 anomaly) due to surface geophysical fluids (atmosphere, ocean, land hydrology, cryosphere, in association with ENSO and other climatic fluctuations), tidal influences, core fluid motion, and co-seismic deformations. For the latter we developed the calculation method using normal-mode summation. We also extended such studies to understand the rotation and gravity of Mars and its two satellites.

(2) Earth's rotational normal modes: I derived mathematical (convolution) expressions for the

excitation of a rotational normal mode in a spinning reference frame (such as the Earth), and applied them to the Chandler wobble and the free-core nutation (e.g. to determine their natural frequencies and Q -values). I derived (multipole) expressions for the mantle-inner core gravitational torques using density multipole formalism, and delineated their connection to the inner-core libration and inner-core wobble. We found a 6-year variation in the Length-of-day relating to the inner-core libration, which in turn creates a 6-year westward propagating wave-2 rotary motion manifested in the GPS, geomagnetic, and global gravity observations, leading to meaningful inversion for the lower-mantle LLSVP constructs' density anomalies.

(3) Harmonic analysis method: I developed the autoregressive (AR) estimation method in the frequency domain for determining the complex frequency (frequency and Q) of a free oscillation, and further extended it to form a highly sensitive and high-resolution AR- z spectrum. We successfully applied them to the detection and analyses of Earth's free oscillations, tidal and other harmonic signals in various rotational and gravitational phenomena.

(4) We explored with the utility of empirical orthogonal function (EOF) and wavelet spectrum to study time-variable gravity from the GRACE satellite and ocean radar altimetry observations, particularly for oceanographic phenomena (e.g. Antarctica Circum-polar Current and the Argentine gyre).

(5) I studied the anthropogenic effects of water impoundment of reservoirs on global geophysics, particularly for sea level variation.

(6) I have written numerous general Earth-scientific articles featured in AGU's EOS, as well as for popular-science magazines (in Chinese) in Taiwan and China.

Refereed Publications (174 publications as of August 2020, of which 75 are first/sole authored, 25 second/corresponding* authored with students, 4 in *Science*, 2 in *Nature*):

Chao, B. F., and F. Gilbert, Autoregressive estimation of complex eigenfrequencies in low frequency seismic spectra, *Geophys. J. Roy. Astron. Soc.*, 63, 641-657, 1980.

Chao, B. F., Symmetry and terrestrial spectroscopy, *Geophys. J. Roy. Astron. Soc.*, 66, 285-312, 1981.

Chao, B. F., Excitation of normal modes on non-rotating and rotating earth models, *Geophys. J. Roy. Astron. Soc.*, 68, 295-315, 1982.

Chao, B. F., Autoregressive harmonic analysis of the Earth's polar motion using homogeneous ILS data, *J. Geophys. Res.*, 88, 10299-10307, 1983.

Chao, B. F., Normal mode study of the Earth's rigid-body motions, *J. Geophys. Res.*, 88, 9437-9442, 1983.

Chao, B. F., Interannual length-of-day variation with relation to the Southern Oscillation / El Niño, *Geophys. Res. Lett.*, 11, 541-544, 1984.

Chao, B. F., On the excitation of the Earth's free wobble and reference frames, *Geophys. J. Roy. Astron. Soc.*, 79, 555-563, 1984.

Chao, B. F., Predictability of the Earth's polar motion, *Bull. Geod.*, 59, 81-93, 1985.

Chao, B. F., On the excitation of the Earth's polar motion, *Geophys. Res. Lett.*, 12, 526-529, 1985.

Chao, B. F., As the world turns, *EOS, Trans. Amer. Geophys. Union*, 46, 766-770, 1985.

Gross, R. S., and B. F. **Chao**, Excitation study of the LAGEOS-derived Chandler wobble, *J. Geophys. Res.*, 90, 9369-9380, 1985.

- Chao**, B. F., On the excitation of the Earth's polar motion -- Reply, *Geophys. Res. Lett.*, *14*, 247, 1987.
- Chao**, B. F., W. P. O'Connor, A. T. C. Chang, D. K. Hall, and J. L. Foster, Snow-load effect on the Earth's rotation and gravitational field, 1979-1985, *J. Geophys. Res.*, *92*, 9415-9422, 1987.
- Chao**, B. F. and Gross, R. S., Changes in the Earth's rotation and low-degree gravitational field induced by earthquakes, *Geophys. J. Roy. Astron. Soc.*, *91*, 569-596, 1987.
- Rubincam, D. P., B. F. **Chao**, K. H. Schatten, and W. W. Sager, Non-Newtonian gravity or gravity anomalies? *EOS, Trans. Amer. Geophys. Union*, *69*, 1636, 1987.
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- Chao**, B. F., and W. P. O'Connor, Effect of a uniform sea level change on the Earth's rotation and gravitational field, *Geophys. J.*, *93*, 191-193, 1988.
- Chao**, B. F., and W. P. O'Connor, Global surface water-induced seasonal variations in the Earth's rotation and gravitational field, *Geophys. J.*, *94*, 263-270, 1988.
- Chao**, B. F., Correlation of interannual length-of-day variation with El Niño / Southern Oscillation, 1972-1986, *J. Geophys. Res.*, *93*, 7709-7715, 1988.
- Chao**, B. F., Excitation of the Earth's polar motion due to mass variations in major hydrological reservoirs, *J. Geophys. Res.*, *93*, 13811-13819, 1988.
- Chao**, B. F., Feynman dining hall dynamics, *Phys. Today*, *42*, #2, 15, 1989.
- Chao**, B. F., Length-of-day variations caused by El Niño-Southern Oscillation and Quasi-Biennial Oscillation, *Science*, *243*, 923-925, 1989.
- Rubincam, D. P., B. F. **Chao**, and K. H. Schatten, Application of internal gravitational field equations to geophysical measurement of G, *J. Geophys. Res.*, *94*, 7563-7566, 1989.
- Chao**, B. F., and D. P. Rubincam, The gravitational field of Phobos, *Geophys. Res. Lett.*, *16*, 859-862, 1989.
- Chao**, B. F., Comment on "Moment of inertia of three-dimensional models of the Earth" by T. Tanimoto, *Geophys. Res. Lett.*, *16*, 1075, 1989.
- Chao**, B. F., and D. P. Rubincam, Variations of Mars' gravitational field and rotation due to seasonal CO₂ exchange, *J. Geophys. Res.*, *95*, 14755-14760, 1990.
- Chao**, B. F., Comment on "A new method of spectral analysis and its application to the Earth's free oscillation: the "Sompi" method" by Hori et al., *J. Geophys. Res.*, *95*, 19789-19790, 1990.
- Gross, R. S., and B. F. **Chao**, The global geodynamics effect of the Macquarie Ridge earthquake, *Geophys. Res. Lett.*, *17*, 1009-1012, 1990.
- Chao**, B. F., On the use of maximum-entropy autoregressive spectrum in harmonic analysis of time series, *Pure and Applied Geophys.*, *134*, 303-311, 1990.
- Chao**, B. F., and A. Y. Au, Temporal variation of the Earth's zonal gravitational field caused by atmospheric mass redistribution: 1980-1988, *J. Geophys. Res.*, *96*, 6569-6575, 1991.
- Chao**, B. F., and A. Y. Au, Atmospheric excitation of the Earth's annual wobble: 1980-1988, *J. Geophys. Res.*, *96*, 6577-6582, 1991.
- Liu, H. S., and B. F. **Chao**, The Earth's equatorial principal axes and moments of inertia, *Geophys. J. Int.*, *106*, 699-702, 1991.
- Chao**, B. F., Man, water, and sea level, *EOS, Trans. Amer. Geophys. Union*, *72*, 492, 1991.
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- Chao**, B. F., D. N. Dong, H. S. Liu, and T. A. Herring, Libration in the Earth's rotation, *Geophys. Res. Lett.*, *18*, 2007-2010, 1991.
- Chao**, B. F., Excitation of Earth's polar motion by atmospheric angular momentum variations, 1980-1990, *Geophys. Res. Lett.*, *20*, 253-256, 1993.
- Nerem, R. S., B. F. **Chao**, A. Y. Au, J. C. Chan, S. M. Klosko, N. K. Pavlis, and R. G. Williamson,

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- Chao**, B. F., Are autoregressive models sensitive to initial conditions? *EOS, Trans. Amer. Geophys. Union*, 74, 132-134, 1993.
- Chao**, B. F., The Geoid and Earth Rotation, in *Geophysical Interpretations of Geoid*, ed. P. Vanicek and N. Christou, CRC Press, Boca Raton, 1994.
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- Chao**, B. F., R. S. Gross, and Y. B. Han, Seismic excitation of the polar motion, 1977-1993, *Pure and Applied Geophysics*, 146, 407-419, 1996.
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- Chao**, B. F., R. D. Ray, J. M. Gipson, G. D. Egbert, and C. Ma, Diurnal/semidiurnal polar motion excited by oceanic tidal angular momentum, *J. Geophys. Res.*, 101, 20,151-20,163, 1996.
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- Chao**, B. F., and R. D. Ray, Oceanic tidal angular momentum and Earth's rotation variations, *Prog. in Oceanog.*, 40, 399-421, 1997.
- Gross, R. S., B. F. **Chao**, and S. D. Desai, Effect of long-period ocean tides on the Earth's polar motion, *Prog. in Oceanog.*, 40, 385-397, 1997.
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- Liu, H. S., and B. F. **Chao**, Wavelet spectral analysis of the Earth's orbital variations and paleoclimatic cycles, *J. Atmos. Soc.*, 55, 227-236, 1998.
- Rubincam, D. P., B. Bills, and B. F. **Chao**, The incredible shrinking tropics, *Sky and Telescope*, 95, #6, 36-38, 1998.
- Clark, T. A., C. Ma, J. W. Ryan, B. F. **Chao**, J. M. Gipson, D. S. MacMillan, N. R. Vandenberg, T. M. Eubanks, A. E. Niell, Earth rotation measurement yields valuable information about the dynamics of the Earth system, *EOS, Trans. Amer. Geophys. Union*, 79, 205-209, 1998.
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- Zhou, Y., D. Zheng, M. Zhao, and B. F. **Chao**, Interannual polar motion with relation to the North Atlantic Oscillation, *Global and Planetary Change*, 18, 79-84, 1998.
- Klosko, S. M., and B. F. **Chao**, Secular variations of the zonal gravity field, global sea level, and polar motion as geophysical constraints, *Physics and Chemistry of the Earth*, 23, 1091-1102, 1998.
- Ray, D. R., B. G. Bills, and B. F. **Chao**, Lunar and solar torques on the oceanic tides, *J. Geophys. Res.*, 104, 17,653-17,659, 1999.
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- Chao**, B.F., Reply to "That 'Dahm' Layer", *EOS, Trans. Amer. Geophys. Union*, 81, 210, 2000.
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- Chao**, B. F., and R. S. Gross, Coseismic excitation of the Earth's polar motion, in *Polar Motion: Historical and Scientific Problems*, IAU Coll. 178, ed. S. Dick, D. McCarthy, and B.

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- Chao**, B. F., W. O'Connor, D. Zheng, and A. Y. Au, Wind stress forcing of the North Sea "pole tide" -- Reply, *Geophys. J. Int.*, 146, 266, 2001.
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Others

Hosted and collaborated with visiting scholars and post-doctoral fellows: Richard Gross, William O'Connor, Andrew Au, Zhou Yonghong, Masato Fuyuya, Chen Jianli, Daniel Steinberg, Masayuki Fujita, Thomas Johnson, Liu Lanbo, Isabel Vigo, David Garcia, Olivier de Viron, Jean-Paul Boy, Jacques Hinderer, Yves Rogister, David Salstein, Lo Chungliang, Ryoko Ogawa, Yan Hao-Ming, Zhang Zhi-Zang, Yuan Lin-Guo, Kuang Weijia, Jose Maria Sanchez-Reales, Koji Matsuo, Severine Rosat, Hsieh Hsian-Hsiang, Maxime Mouyen, Lei Xiang-E, Shogo Komori, Hsieh Yi-Kai, Xu Chang-Yi, Ding Hao, Hu Caibo, Yusaku Tanaka, Ou Jiaming, Gao Chunchun, Xi Hui.

Non-profit community services: Board Member of the MeiHwa Chinese School in Washington Metropolitan Area, 1992-94, and Principal, 2000-2004. President of the Goddard Chinese-American Club, 1994-1996. Board Member of the National Taiwan University Alumni Association in the Washington Metropolitan Area, 2000-2002. Member of the Directing Board (vice-president) of the Chinese-American Oceanic and Atmospheric Association, 2002-2004. Directing Board Member of the Science Monthly Foundation (Taiwan 科學月刊社), 2012-2018.

I was elected and served as the President-elect and subsequently the President of the Geodesy Section of the American Geophysical Union during 2004 - 2008. In 2010, while serving as the President of the Chinese Geoscience Union (CGU, 中華民國地球科學學會 理事長), of Taiwan, I initiated the establishment of the Oceanographic Society of the Republic of China (OSROC, 中華民國海洋學會), leading subsequently to its inauguration in 2011. Again in 2014 I (together with other scientists) launched and established the new Geodesy Society of the Republic of China (GSROC, 中華民國測地學會). In 2015 I was elected to be the President of the Asia-Oceania Geosciences Society (AOGS), serving a two-year term of 2016-2018 plus two more years as the Vice President.