

## ICHIRO FUKUMORI

PERSONAL INFORMATION:

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RESEARCH INTERESTS:

Climate variability; Sea level change; General circulation of the ocean; State estimation; Data assimilation; Numerical modeling; Satellite remote sensing

EDUCATION:

1989: Ph.D. (Physical Oceanography), Joint Program in Oceanography, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution  
1983: B.S. (Geophysics), University of Tokyo, Japan

PROFESSIONAL EXPERIENCE:

2005-2015: Supervisor, Ocean Circulation Group, Jet Propulsion Laboratory, California Institute of Technology.  
2003-present: Principal Scientist, Jet Propulsion Laboratory, California Institute of Technology.  
1999-2005: Team Leader, Ocean Data Assimilation, Jet Propulsion Laboratory.  
1992-2003: Research Scientist, Jet Propulsion Laboratory, California Institute of Technology.  
1990-1992: Resident Research Associate, National Research Council, at Jet Propulsion Laboratory, California Institute of Technology.  
1989-1990: Postdoctoral Associate, Massachusetts Institute of Technology.  
1983-1989: Research Assistant, Massachusetts Institute of Technology.  
1983: Research Assistant, Woods Hole Oceanographic Institution.

PROFESSIONAL ACTIVITIES:

ECCO Summer School, May 2019  
NASA Oceans Melting Greenland Science Team, 2015-present  
NASA Sea Level Change Team, 2014-2017  
NASA Ocean Surface Topography Science Team, 2013-2016  
Ecole de Physique des Houches, International Summer School, 2012  
NASA GRACE Science Team, 2011-present  
NASA Ocean Salinity Science Team, 2009-2015  
U.S. CLIVAR Working Group on Decadal Prediction, 2009-2011  
GODAE Summer School, September 2004  
U.S. CLIVAR Pacific Implementation Panel, 2004  
U.S. Argo Science Panel 2001-2013  
WOCE Young Investigator Workshop, June 2000  
U.S. Global Ocean Data Assimilation Experiment Steering Team, 1999-2003  
Consortium for Estimating the Circulation and Climate of the Ocean (ECCO), 1998-present  
International Global Ocean Data Assimilation Experiment Steering Team, 1997-2003  
NASA Jason-1 Science Working Team, 1997-2008

PROFESSIONAL AFFILIATIONS:

American Geophysical Union, American Meteorological Society, The Oceanography Society,

POSTDOCS ADVISED:

William Llovel, Zhengqing Ye, Peng Yu, Joshua K. Willis, Sophie Ricci, Ou Wang, Seungbum Kim, Mototaka Nakamura, Naoki Hirose

HONORS AND AWARDS:

NASA Exceptional Public Achievement Medal (2017)

NASA Group Achievement Award, Oceans Melting Greenland Team (2017, 2019)

NASA Exceptional Scientific Achievement Medal (2005)

National Research Council Postdoctoral Fellowship (1990-1992)

REFEREED PUBLICATIONS:

- 1) Piecuch, C. G., **I. Fukumori**, and R. M. Ponte, 2021: Intraseasonal Sea-Level Variability in the Persian Gulf, *J Phys Oceanogr*, (in press), <https://doi.org/10.1175/JPO-D-20-0296.1>.
- 2) Fournier, S., T. Lee, X. Wang, T. W. K. Armitage, O. Wang, **I. Fukumori**, and R. Kwok, 2020: Sea Surface Salinity as a Proxy for Arctic Ocean Freshwater Changes. *J. Geophys. Res. Ocean.*, **125**, e2020JC016110, <https://doi.org/https://doi.org/10.1029/2020JC016110>.
- 3) Ponte, R. M., and Coauthors, 2019: Towards comprehensive observing and modeling systems for monitoring and predicting regional to coastal sea level. *Frontiers in Marine Science*, **6**, doi: 10.3389/fmars.2019.00437.
- 4) Hughes, C. W., **I. Fukumori**, and Coauthors, 2019: Sea level and the role of coastal trapped waves in mediating the influence of the open ocean on the coast, *Surveys in Geophysics*, **40**, 1467-1492, doi:10.1007/s10712-019-09535-x.
- 5) Gregory, J. M., and Coauthors, 2019: Concepts and Terminology for Sea Level: Mean, Variability and Change, Both Local and Global, *Surveys in Geophysics*, **40**, 1251-1289, doi: 10.1007/s10712-019-09525-z
- 6) Khazendar, A., and Coauthors, 2019: Interruption of two decades of Jakobshavn Isbrae acceleration and thinning as regional ocean cools. *Nat Geosci*, **12**, 277-283, doi:10.1038/s41561-019-0329-3
- 7) Heimbach, P., **I. Fukumori**, and Coauthors, 2019: Putting It All Together: Adding Value to the Global Ocean and Climate Observing Systems With Complete Self-Consistent Ocean State and Parameter Estimates. *Frontiers in Marine Science*, **6**, doi: 10.3389/fmars.2019.00055
- 8) Qu, T., **I. Fukumori**, and R. A. Fine, 2019: Spin-Up of the Southern Hemisphere Super Gyre. *J Geophys Res-Oceans*, **124**, 154-170, doi: 10.1029/2018jc014391.
- 9) Quinn, K. J., R. M. Ponte, P. Heimbach, **I. Fukumori**, and J. M. Campin, 2019: Ocean angular momentum from a recent global state estimate, with assessment of uncertainties, *Geophysical Journal International*, **216**(1), 584-597, doi: 10.1093/gji/ggy452.
- 10) Ferster, B. S., B. Subrahmanyam, **I. Fukumori**, and E. S. Nyadjro, 2018: Variability of Southern Ocean Transports, *J Phys Oceanogr*, **48**(11), 2667-2688, doi: 10.1175/jpo-d-18-0055.1.
- 11) **Fukumori, I.**, P. Heimbach, R. M. Ponte, and C. Wunsch, 2018: A Dynamically Consistent, Multi-Variable Ocean Climatology, *B Am Meteorol Soc*, **99**(10), 2107-2128, doi:10.1175/bams-d-17-0213.1.
- 12) Piecuch, C. G., R. M. Ponte, C. M. Little, M. W. Buckley, and **I. Fukumori**, 2017: Mechanisms underlying recent decadal changes in subpolar North Atlantic Ocean heat content, *Journal of Geophysical Research: Oceans*, **122**(9), 7181-7197, doi:10.1002/2017JC012845.
- 13) Toyoda, T., et al. 2017: Interannual-decadal variability of wintertime mixed layer depths in the North Pacific detected by an ensemble of ocean syntheses, *Clim Dynam*, **49**(3), 891-907, doi:10.1007/s00382-015-2762-3.
- 14) Toyoda, T., et al. 2017: Intercomparison and validation of the mixed layer depth fields of global ocean syntheses, *Clim Dynam*, **49**(3), 753-773, doi:10.1007/s00382-015-2637-7.

- 15) Storto, A., et al. 2017: Steric sea level variability (1993–2010) in an ensemble of ocean reanalyses and objective analyses, *Clim Dynam*, **49**(3), 709-729, doi:10.1007/s00382-015-2554-9.
- 16) **Fukumori, I.**, 2017: Kamifusen no kagaku: Tsukuto fukuramu shikumi no kousatsu, *Kagaku*, **87** (4), 309-312. (in Japanese)
- 17) **Fukumori, I.**, 2017: Kamifusen, the self-inflating Japanese paper balloon, *Physics Today*, **70**(1), 78-79, doi:10.1063/pt.3.3437.
- 18) Fenty, I., et al. 2016: OCEANS MELTING GREENLAND Early Results from NASA's Ocean-Ice Mission in Greenland, *Oceanography*, **29**(4), 72-83, doi:10.5670/oceanog.2016.100.
- 19) **Fukumori, I.**, O. Wang, W. Llovel, I. Fenty, and G. Forget, 2015: A near-uniform fluctuation of ocean bottom pressure and sea level across the deep ocean basins of the Arctic Ocean and the Nordic Seas, *Prog. Oceanogr.*, **134**, 152-172, doi:10.1016/j.pocean.2015.01.013.
- 20) Piecuch, C. G., **I. Fukumori**, R. M. Ponte, and O. Wang, 2015: Vertical structure of ocean pressure variations with application to satellite-gravimetric observations, *J. Atmos. Oceanic Tech.*, **32**(3), 603-613, doi:10.1175/JTECH-D-14-00156.
- 21) **Fukumori, I.**, 2015: Combining models and data in large-scale oceanography: Examples from the Consortium for Estimating the Circulation and Climate of the Ocean (ECCO), in “*Advanced Data Assimilation for Geosciences: Lecture Notes of the Les Houches School of Physics: Special Issue, June 2012*”, E. Blayo, M. Bocquet, E. Cosme, and L. F. Cugliandolo Eds., Oxford University Press, Oxford, UK, 608pp, doi: 10.1093/acprof:oso/9780198723844.003.0023.
- 22) Llovel, W., J. K. Willis, F. W. Landerer, and **I. Fukumori**, 2014: Deep-ocean contribution to sea level and energy budget not detectable over the past decade, *Nature Climate Change*, **4**(11), 1031-1035, doi:10.1038/nclimate2387.
- 23) Vinogradova, N. T., R. M. Ponte, **I. Fukumori**, O. Wang, 2014: Estimating satellite salinity errors for assimilation of Aquarius and SMOS data into climate models, *J Geophys Res-Oceans*, **119**(8), 4732-4744, doi:10.1002/2014jc009906.
- 24) Qu, T., S. Gao, and **I. Fukumori**, 2013: Formation of salinity maximum water and its contribution to the overturning circulation in the North Atlantic as revealed by a global GCM, *Journal of Geophysical Research: Oceans*, **118**(4), 1982-1994, doi:10.1002/jgrc.20152.
- 25) **Fukumori, I.**, and O. Wang, 2013: Origins of heat and freshwater anomalies underlying regional decadal sea level trends, *Geophys. Res. Lett.*, **40** (3), 563-567, doi: 10.1002/grl.50164.
- 26) Llovel, W., **I. Fukumori**, and B. Meyssignac, 2013: Depth-dependent temperature change contributions to global mean thermosteric sea level rise from 1960 to 2010, *Global and Planetary Change*, **101**, 113-118, doi:10.1016/j.gloplacha.2012.12.011.
- 27) Goddard, L., et al., 2013: A verification framework for interannual-to-decadal predictions experiments, *Clim Dynam*, **40**(1-2), 245-272, doi:10.1007/S00382-012-1481-2.
- 28) Marcus, S. L., J. O. Dickey, **I. Fukumori**, and O. de Viron, 2012: Detection of the Earth rotation response to a rapid fluctuation of Southern Ocean circulation in November 2009, *Geophys. Res. Lett.*, **39**, doi:10.1029/2011GL050671.
- 29) Song, T., **I. Fukumori**, C. K. Shum, and Y. Yi, 2012: Merging tsunamis of the 2011 Tohoku-Oki earthquake detected over the open ocean, *Geophys. Res. Lett.*, **39**, doi:10.1029/2011GL050767
- 30) Wu, X., X. Collilieux, Z. Altamimi, B. L. A. Vermeersen, R. S. Gross, and **I. Fukumori**, 2011: Accuracy of the International Terrestrial Reference Frame origin and Earth expansion, *Geophys. Res. Lett.*, **38**, L13304, doi:10.1029/2011GL047450.
- 31) Qu, T., S. Gao, and **I. Fukumori**, 2011: What governs the North Atlantic salinity maximum in a global GCM?, *Geophys. Res. Lett.*, **38**, L07602, doi:10.1029/2011GL046757.
- 32) Solomon, A., et al., 2011: Distinguishing the roles of natural and anthropogenically forced decadal climate variability, Implications for Prediction, *Bull. Amer. Met. Soc.*, **92**, 141-156, doi:10.1175/2010bams2962.1.
- 33) Gao, S., T. Qu, and **I. Fukumori**, 2011: Effects of mixing on the subduction of South Pacific waters identified by a simulated passive tracer and its adjoint, *Dyn. Atmos. Oceans.*, **54**, 45-54,

doi:10.1016/J.Dynatmoce.2010.10.002.

- 34) Qu, T., S. Gao, **I. Fukumori**, R. A. Fine, and E. J. Lindstrom, 2010: The obduction of Equatorial 13°C Water in the Pacific identified by a simulated passive tracer, *J. Phys. Oceanogr.*, **40**, 2282-2297, doi:10.1175/2010jpo4358.1.
- 35) Lee, T., W. R. Hobbs, J. K. Willis, D. Halkides, **I. Fukumori**, E. M. Armstrong, A. K. Hayashi, W. T. Liu, W. Patzert, and O. Wang, 2010: Record warming in the South Pacific and western Antarctica associated with the strong central-Pacific El Niño in 2009-10, 2010: *Geophys. Res. Lett.*, **37**, L19704, doi:10.1029/2010GL044865.
- 36) Lee, T., T. Awaji, M. Balmaseda, N. Ferry, Y. Fujii, **I. Fukumori**, B. Giese, P. Heimbach, A. Kohl, S. Masina, E. Remy, A. Rosati, M. Schodlock, D. Stammer, and A. Weaver, 2010: Consistency and fidelity of Indonesian-throughflow total volume transport estimated by 14 ocean data assimilation products, *Dyn. Atmos. Oceans.*, **50** (2), 201-223, doi:10.1016/J.Dynatmoce.2009.12.004.
- 37) Cummings, J., L. Bertino, P. Brasseur, **I. Fukumori**, M. Kamachi, M. J. Martin, K. Mogensen, P. Oke, C. E. Testut, J. Verron, and A. Weaver, 2009: Ocean data assimilation systems for GODAE, *Oceanography*, **22** (3), 96-109, doi:10.5670/oceanog.2009.69.
- 38) Qu, T., S. Gao, **I. Fukumori**, R. A. Fine, and E. J. Lindstrom, 2009: Origin and pathway of Equatorial 13°C Water in the Pacific identified by a simulated passive tracer and its adjoint, *J. Phys. Oceanogr.*, **39**, 1836-1853, doi:10.1175/2009jpo4045.1.
- 39) Wunsch, C., P. Heimbach, R. M. Ponte, and **I. Fukumori**, 2009: The global general circulation of the ocean estimated by the ECCO-Consortium, *Oceanography*, **22** (2), 88-103, doi:10.5670/oceanog.2009.41.
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- 41) Kuo, C.-Y., C. K. Shum, J.-Y. Guo, Y. Yi, A. Braun, **I. Fukumori**, K. Matsumoto, T. Sato, and K. Shibuya, 2008: Southern Ocean Mass Variation Studies Using GRACE and Satellite Altimetry, *Earth, Planets, and Space*, **60**, 477-485, doi:10.1186/BF03352814.
- 42) Qu, T., S. Gao, **I. Fukumori**, R. A. Fine, and E. J. Lindstrom, 2008: Subduction of South Pacific waters, *Geophys. Res. Lett.*, **35**, L02610, doi:10.1029/2007GL032605.
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- 44) Kim, S.-B., T. Lee, and **I. Fukumori**, 2007: Mechanisms controlling the interannual variation of mixed layer temperature averaged over the NINO3 region, *J. Climate*, **20**, 3822-3843, doi:10.1175/Jcli4206.1.
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- 46) Menemenlis, M., **I. Fukumori**, and T. Lee, 2007: Atlantic to Mediterranean sea level difference driven by winds near Gibraltar Strait, *J. Phys. Oceanogr.*, **37**, 359-376, doi:10.1175/Jpo3015.1.
- 47) **Fukumori, I.**, D. Menemenlis, and T. Lee, 2007: A near-uniform basin-wide sea level fluctuation of the Mediterranean Sea, *J. Phys. Oceanogr.*, **37**, 338-358, doi:10.1175/Jpo3016.1.
- 48) Wu, X., M. B. Heflin, E. R. Ivins, and **I. Fukumori**, 2006: Seasonal and interannual global surface mass variations from multisatellite geodetic data, *J. Geophys. Res.*, **111**, B09401, doi:10.1029/2005JB004100.
- 49) Kim, S.-B., **I. Fukumori**, and T. Lee, 2006: The closure of ocean mixed layer temperature budget using level-coordinate model fields, *J. Atmos. Oceanic. Tech.*, **23** (6), 840-853, doi:10.1175/Jtech1883.1.
- 50) **Fukumori, I.**, 2006: What is data assimilation really solving, and how is the calculation actually done?, in “*Ocean Weather Forecasting: An Integrated View of Oceanography*”, E. P. Chassignet and J. Verron, Eds., Springer, 578pp, doi:10.1007/1-4020-4028-8\_11.

- 51) Hirose, N., **I. Fukumori**, C. H. Kim, J.-H. Yoon, 2005: Numerical simulation and satellite altimeter data assimilation of the Japan Sea circulation, *Deep-Sea Research, Part II*, **52**, 1443-1463, doi:10.1016/J.Dsr2.2004.09.034.
- 52) Gross, R. S., **I. Fukumori**, and D. Menemenlis, 2005: Atmospheric and oceanic excitation of decadal-scale Earth orientation variations, *J. Geophys. Res.*, **110** (B9), B09405, doi:10.1029/2004jb003565.
- 53) Menemenlis, D., **I. Fukumori**, and T. Lee, 2005: Using Green functions to calibrate an ocean general circulation model, *Mon. Weather Rev.*, **133** (5), 1224-1240, doi:10.1175/Mwr2912.1.
- 54) Menemenlis, D., C. Hill, A. Adcroft, J. Campin, B. Cheng, B. Ciotti, **I. Fukumori**, P. Heimbach, C. Henze, A. Koehl, T. Lee, D. Stammer, J. Taft, J. Zhang, 2005: NASA Supercomputer Improves Prospects for Ocean Climate Research, *EOS, Transactions, American Geophysical Union*, **86**, 89, 95-96, doi:10.1029/2005EO090002.
- 55) Kim, S.-B., T. Lee, and **I. Fukumori**, 2004: The 1997-99 abrupt change of the upper ocean temperature in the Northcentral Pacific, *Geophys. Res. Lett.*, **31** (22), L22304, doi:10.1029/2004GL021142
- 56) Wang, O., **I. Fukumori**, T. Lee, and B. Cheng, 2004: On the cause of eastern equatorial Pacific Ocean T-S variations associated with El Niño, *Geophys. Res. Lett.*, **31**, L15309, doi:10.1029/2004GL020188.
- 57) Lee, T., **I. Fukumori**, and B. Tang, 2004: Temperature advection: Internal versus external processes, *J. Phys. Oceanogr.*, **34** (8), 1936-1944, doi:10.1175/1520-0485(2004)034<1936:Taivep>2.0.Co;2.
- 58) **Fukumori, I.**, T. Lee, B. Cheng, and D. Menemenlis, 2004: The origin, pathway, and destination of Niño3 water estimated by a simulated passive tracer and its adjoint, *J. Phys. Oceanogr.*, **34**, 582-604, doi:10.1175/2515.1.
- 59) Wang, O., **I. Fukumori**, T. Lee, and G. Johnson, 2004: Eastern equatorial Pacific Ocean T-S variations with El Niño, *Geophysical Research Letters*, **31** (4), L04305, doi:10.1029/2003GL019087.
- 60) Gross, R. S., **I. Fukumori**, D. Menemenlis, P. Gegout, 2004: Atmospheric and oceanic excitation of length-of-day variations during 1980-2000, *J. Geophys. Res.*, **109** (B1), B01406, doi:10.1029/2003jb002432.
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- 67) **Fukumori, I.**, 2002: A partitioned Kalman filter and smoother, *Monthly Weather Review*, **130**, 1370-1383, doi:10.1175/1520-0493(2002)130<1370:Apkfas>2.0.Co;2.
- 68) Hirose, N., **I. Fukumori**, R. Ponte, and V. Zlotnicki (2001), Modeling the high-frequency

- barotropic response of the ocean to atmospheric disturbances: Sensitivity to forcing, topography, and friction, *Journal of Geophysical Research*, **106**, 30987-30995, doi:10.1029/2000jc000763.
- 69) Hirose, N., **I. Fukumori**, and R. Ponte 2001: A non-isostatic global sea level response to barometric pressure near 5-days, *Geophysical Research Letters*, **28**, 2441-2444, doi:10.1029/2001gl012907.
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- 79) Fu, L.-L., **I. Fukumori**, and R. N. Miller, 1993: Fitting dynamic models to the Geosat sea level observations in the tropical Pacific Ocean. Part II: A linear wind-driven model, *Journal of Physical Oceanography*, **23**, 2162-2181, doi:10.1175/1520-0485(1993)023<2162:Fdmmtg>2.0.Co;2.
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NON-REFEREED PUBLICATION:

**Fukumori, I.**, 2017: What does data assimilation actually solve?, *Kaiyo Monthly*, **59**, 37-49. (in Japanese).