

## Sergey Frolov, Ph.D.

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Research Gate Profile: [https://www.researchgate.net/profile/Sergey\\_Frolov](https://www.researchgate.net/profile/Sergey_Frolov)

Google scholar: <https://scholar.google.com/citations?hl=en&user=WtnhgsAAAAAJ>

### PROFESSIONAL PREPARATION:

Ph.D.: Environmental Science and Engineering, Oregon Health & Science University, Portland, 2007

M.S. Environmental Science and Policy, Central European University, 2000

B.S. Environmental fate of radionuclides, International Sakharov Environmental University, 1999

### APPOINTMENTS:

2019-present **Physical Scientist**, Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder (under contract to PSD/ESRL/NOAA).

2016-2019 **Physical Scientist**, Naval Research Laboratory, Monterey, CA

2017 (summer) **ERA-CLIM Visiting Scientist**, European Center for Medium Range Weather Forecasting, Reading, UK

2012-2016 **UCAR Visiting Scientist**, Naval Research Laboratory, Monterey, CA

2011-2012 **Research Specialist**, Monterey Bay Aquarium Research Institute, Moss Landing, CA

2008-2011 **Postdoctoral Fellow**, Monterey Bay Aquarium Research Institute, Moss Landing, CA

2007-2008 **Senior Research Assistant**, NSF Science and Technology Center for Coastal Margin Observation and Prediction, Portland, OR

2001-2007 **Graduate Research Assistant**, Oregon Health & Science University, Portland, OR

2000-2001 **Software and database developer**, Credo-Dialog, Minsk, Belarus.

### STATEMENT OF EXPERTISE:

Dr. Frolov is a data assimilation and coupled model forecasting expert with strong track record of formulating and implementing advance computing algorithms that drive Earth Science modeling and observation workflows. Past contributions include scientific support for negotiation of the US-Canada water sharing treaty; design of the US strategy for harmful algal bloom observations; implementation of the coupled data assimilation and coupled ensemble forecast component of the Navy's S2S forecast model. Dr. Frolov's present focus is on the development of the coupled reanalysis using NOAA's Unified Forecast System.

### RECENT PUBLICATIONS (29 TOTAL / 12 FIRST AUTHOR):

1. Crawford W., **Frolov S.**, McLay J., Reynolds C., Barton N., Ruston B., Bishop C. (2020) Using analysis corrections to address model error in atmospheric forecasts, *Monthly Weather Review*.
2. Yaremchuk M., Nechaev D., **Frolov S.** (2020) On the ensemble-based linearization of numerical models, *Quarterly Journal of the Royal Meteorological Society*.
3. Allen D., **Frolov S.**, Langland R., Bishop C., Hoppel K., Kuhl D., Yaremchuk M. (2020) Challenges of Increased Resolution for the Local Ensemble Tangent Linear Model, *Monthly Weather Review*.
4. **Frolov S.**, W. Campbell, B. Ruston, C. Bishop, D. Kuhl, J. McLay, M. Flatau, (2020) Assimilation of low-peaking satellite observations using the coupled interface framework, *Monthly Weather Review*.
5. Moore A., M. Martin, H. Arango, P. Oke, A. Weaver, **S. Frolov** (2019) Synthesis of Ocean Observations using Data Assimilation: Toward a More Complete Picture of the State of the Ocean, *OceanObs19*.
6. Penny G., et.al. (2019) Observational Needs for improving Ocean and Coupled Reanalysis, S2S Prediction, and Decadal Prediction, *Frontier in Marine Science*.

7. Laloyaux, P., **S. Frolov**, and M. Bonavita, 2018: Implicit and explicit cross-correlations in coupled data assimilation. *Q. J. R. Meteorol. Soc.*, doi:10.1002/qj.3373.
8. Shulman, I., R. W. G. Jr., **S. Frolov**, S. McCarthy, B. Penta, S. Anderson, and P. Sakalaukus, 2018: Bio-Optical Data Assimilation With Observational Error Covariance Derived From an Ensemble of Satellite Images. *Journal of Geophysical Research: Oceans. J. Geophys. Res.*, 1801–1813, doi:10.1002/2017JC013171.
9. **Frolov, S.**, D. R. Allen, C. H. Bishop, R. Langland, K. W. Hoppel, and D. D. Kuhl, 2018: First Application of the Local Ensemble Tangent Linear Model ( LETLM ) to a Realistic Model of the Global Atmosphere. *Mon. Weather Rev.*, 2247–2270, doi:10.1175/MWR-D-17-0315.1.
10. Penny, S., et al. (2017) Coupled Data Assimilation for Integrated Earth System Analysis and Prediction: Goals, Challenges, and Recommendations, A report of the World Meteorological Organization.
11. Bishop, C. H., **S. Frolov**, D. R. Allen, D. D. Kuhl, and K. Hoppel, 2017: The Local Ensemble Tangent Linear Model: an enabler for coupled model 4DVAR. *Q. J. R. Meteorol. Soc.*
12. Allen, D. R., C. H. Bishop, **S. Frolov**, K. W. Hoppel, D. D. Kuhl, and G. E. Nedoluha, 2017: Hybrid 4DVAR with a Local Ensemble Tangent Linear Model: Application to the Shallow Water Model. *Mon. Weather Review*.
13. Solabarrieta, L., **S. Frolov**, M. Cook, J. Paduan, A. Rubio, M. González, J. Mader, and G. Charria, 2016c: Skill Assessment of HF Radar–Derived Products for Lagrangian Simulations in the Bay of Biscay. *J. Atmos. Ocean. Technol.*
14. **Frolov, S.**, and C. H. Bishop, 2016b: Localized Ensemble-Based Tangent Linear Models and Their Use in Propagating Hybrid Error Covariance Models. *Mon. Weather Review*.
15. **Frolov, S.**, C. H. Bishop, T. R. Holt, J. A. Cummings, and D. D. Kuhl, 2016a: Facilitating strongly-coupled ocean-atmosphere data assimilation with an interface solver. *Mon. Weather Review*.
16. Goebel, N. L., **S. Frolov**, and C. A. Edwards, 2014: “Complementary Use of Wave Glider and Satellite Measurements: Description of Spatial Decorrelation Scales in Chl-a Fluorescence Across the Pacific Basin”, *Methods in Oceanography*.
17. **Frolov, S.**, Garau B., Bellingham J. (2014) " Can we do better than the grid survey: Optimal synoptic surveys in presence of variable uncertainty and decorrelation scales", *Journal of Geophysical Research*.
18. Shulman I., **Frolov, S.**, Stephanie Cayula, Brad Penta, Rick Gould, Peter Sakalaukus, Sherwin Ladner (2013) “Impact of bio-optical data assimilation on short-term coupled physical, bio-optical model predictions”, *Journal of Geophysical Research*.
19. **Frolov, S.**, R., Kudela, J., Bellingham (2012c) “Monitoring of harmful algal blooms in the era of diminishing resources: a case study of the U.S. West Coast”, *Harmful Algae*.
20. **Frolov, S.**, J. Paduan, M. Cook, J. Bellingham (2012b) “Improved statistical prediction of surface currents based on historic HF-Radar observations”, *Ocean Dynamics*.
21. **Frolov, S.**, J., Ryan; F., Chavez (2012a) “Predicting euphotic-depth-integrated chlorophyll-a from discrete-depth and satellite-observable chlorophyll-a off central California”, *Journal of Geophysical Research*.
22. **Frolov, S.**, J. Bellingham, W. Anderson, and G. Hine, 2011: Wave Glider—A platform for persistent monitoring of algal blooms. *IEEE OCEANS 2011*.
23. Das, J., Rajan, K., **Frolov, S.**, Py, F., Ryan, J., Caron, D. A., and Sukhatme, G. S. (2010), "Towards Marine Bloom Trajectory Prediction for AUV Mission Planning," in IEEE International Conference on Robotics and Automation., Anchorage, Alaska.

24. Dang, T., Bulusu, N., Feng, W.-C., **Frolov, S.**, and Baptista, A. (2010), "A framework for tracking dynamic features with static and mobile sensors," in IEEE INFOCOM'2010, San Diego, CA.
25. Burla, M., Baptista, A. M., Zhang, Y., and **Frolov, S.** (2010), "Seasonal and inter-annual variability of the Columbia River plume: A perspective enabled by multi-year simulation databases," *Journal of Geophysical Research*.
26. **Frolov, S.**, Z. Lu, R. van der Merwe, T.K. Leen, and A.M. Baptista, (2009). Fast Data Assimilation Using a Nonlinear Kalman Filter and a Model Surrogate: an Application to the Columbia River Estuary, *Dynamics of Atmospheres and Oceans*.
27. **Frolov, S.**, A. M. Baptista, Y. Zhang, C. Seaton, (2009). Estimation of Ecologically Significant Circulation Features of the Columbia River Estuary and Plume Using a Reduced-Dimension Kalman Filter, *Continental Shelf Research*.
28. **Frolov, S.**, A.M. Baptista, M. Wilkin, (2008). Optimizing Placement of Fixed Observational Sensors in a Coastal Observatory, *Continental Shelf Research*.
29. van der Merwe, R., Leen, T. K., Lu, Z., **Frolov, S.**, and Baptista, A. M. (2007), "Fast Neural Network Surrogates for Very High Dimensional Physics-Based Models in Computational Oceanography," *Neural Networks*, 20, 462-478.

#### PROFESSIONAL AND COMMUNITY SERVICE:

- **Mentor/Supervisor** – mentored postdoctoral fellow (1), co-advised graduate students (2), mentored graduate and undergraduate interns (8), supervised (3) science professionals.
- **Reviewer** – Scientific journal including: Science; Monthly Weather Review; Quarterly Journal of Royal Meteorological Society; Ocean Modeling; JGR-oceans; and GRL. Scientific organizations: National Science Foundation and National Oceanographic and Atmospheric Administration.
- **Active memberships:** CLIVAR panel on processes observation and synthesis; task team on ocean assimilation for Global Ocean Data Assimilation Experiment (GODAE); US CLIVAR working group on Ocean Uncertainty quantification.
- **Past committee work:** OHSU/OGI student Council (2004-2007), MBARI professional development (2009-2010); associate editor of Monthly Weather Review; strategic planning committee at NRL-MRY; NRL-MRY diversity and inclusion team, NRL-FNMOC-NPS committee for development of S2S products.
- **Meeting organizer** – Transitioning from Academia to Industry, Navy-relevant products for sub seasonal prediction.

#### GRANTS:

- NOAA Unified Forecast System: Data Assimilation Reanalysis and Re-forecast: Co-PI (3.3M, NOAA PSL share 700K in 2020).
- Navy Earth System Prediction Capability, Coupled Data Assimilation. PI, ONR, NRL share \$1.6M (2015-2019).
- DOD HPC Frontier computing project, Co-PI, 1.2B CPU hours (2019-2022).
- Navy Earth System Prediction Capability, Coupled Ensembles for S2S forecasting. Co-PI, ONR, NRL share \$2.4M (2014-2019).
- Ocean Atmosphere State Estimation and Targeting Using Coupled Ensembles, Co-PI, ONR, NRL Share \$400K (2012-2015).
- Compact ocean models enable onboard AUV autonomy and decentralized adaptive sampling, Co-PI, ONR, MBARI share \$300K (2010-2013).
- Monterey Bay Aquarium Postdoctoral Fellowship, Packard Foundation, (2008-2010).

#### SOFTWARE SKILLS:

- Programming: C++, Modern Fortran, Matlab, Python, NCL, Unix Shell, SQL.
- High Performance Computing: PBS, MPI, OpenMP, CYLC meta-scheduler, ESMF coupler.