

CURRICULUM VITAE

HUMBERTO C. GODINEZ VASQUEZ

Research Scientist II

T-5: Applied Mathematics & Plasma Physics

Theoretical Division

Mail Stop B284

Los Alamos National Laboratory

Los Alamos NM 87545,

Phone: 505-665-9188

Fax: 505-665-5757

e-mail: hgodinez@lanl.gov

Web: <http://hcgodinez.googlepages.com/>

EDUCATION

03/2009 Ph.D. in Mathematical Sciences, Portland State University

Adviser: Prof. Dacian N. Daescu

Thesis title: Data Assimilation, Adaptive Observations and Applications.

05/2004 M.S. in Applied Mathematics, Washington State University

Adviser: Prof. V. S. Manoranjan

10/2001 B.S. in Mathematics, Universidad de Guadalajara, Mexico

Adviser: Prof. M. O. Gomez

RESEARCH INTERESTS

My area of research is on sensitivity analysis, uncertainty quantification, and data assimilation methods for improving the predictability of dynamical models. Specifically, the development and implementation of ensemble-based data assimilation methods to complex dynamical systems, such as hurricanes, radiation belts, solar models, upper atmospheric models (ionosphere-thermosphere), and Arctic models, and the influence of model errors and uncertainty in complex dynamical systems. Given the large nature of many of the models, my research also involves the use of high performance computing capabilities for the efficient simulation and assimilation of data to large-scale models. Previous experience in this field includes the simulation of a large-scale hurricane model in the Cray X5 Jaguar supercomputer. My research also includes the development of targeting strategies for adaptive observations in the context of 4D-Var and ensemble data assimilation methods, as well as predictive targeting strategies that are derivative free for ensemble-based data assimilation. I also studied the influence of model errors and uncertainty in data assimilation methods for complex dynamical systems.

All of these projects require development and implementation of advanced numerical methods, often integrated into a highly sophisticated code base using Fortran, C/C++, Python and Matlab, and optimized for modern high performance super computers (Jaguar XT5, Pleiades, Coyote, Lobo, Conejo, Mustang).

My research interest also include numerical methods of Partial Differential Equations, numerical linear algebra and computational fluid dynamics. Large scale computer simulation and modeling as well as parallel implementation of numerical methods for mathematical models.

RESEARCH EXPERIENCE

Los Alamos National Laboratory, Los Alamos, New Mexico

Applied Mathematics & Plasma Physics

Research Scientist II, 11/2012 – present

- Implemented a local ensemble Kalman filter data assimilation method to a Global Ionosphere-Thermosphere model (GITM). This is part of the Integrated Modeling of Perturbations in Atmospheres for Conjunction Tracking (IMPACT) project at Los Alamos National Laboratory (<http://www.impact.lanl.gov/>)
- Developed and implemented a local adaptive inflation technique for the assimilation of electron density observations into a three-dimensional radiation belt model.

Los Alamos National Laboratory, Los Alamos, New Mexico

Applied Mathematics & Plasma Physics

Postdoctoral Research Associate, 04/2009 – 11/2012:

- Developed new targeting strategy methodologies that use first and second-order adjoint information for increased predictability.
- Developed a new matrix-free implementation of Ensemble Kalman Filter (EnKF) data assimilation for large data sets.
- Implemented parallel ensemble capabilities for a hurricane model based on HIGRAD, an atmospheric model developed at Los Alamos National Laboratory. Performed simulation on the Cray X5 Jaguar supercomputer.
- Developed and implemented a localized adaptive inflation technique for the assimilation of data in a ionospheric radiation belt model using an ensemble Kalman filter.
- Actively contributing to the development of data assimilation techniques for the spacepy project (<http://spacepy.lanl.gov>)
- Contributed to the Dynamic Radiation Environment Assimilation Model (DREAM) Project (<http://dream.lanl.gov>)
- Implemented a localized ensemble transform Kalman filter technique to the Air Force Data Assimilative Photospheric Flux Transport (ADAPT) Model, a collaborative project with the Air Force Research Laboratory.

This research is funded by DOE Office of Science, Advanced Scientific Computing Research (ASCR) program in Applied Mathematical Sciences, contract DE-AC52-06NA25396.

Los Alamos National Laboratory, Los Alamos, New Mexico

Applied Mathematics & Plasma Physics

Summer Graduate Intern, Summer 2008

Los Alamos National Laboratory, Los Alamos, New Mexico

Applied Mathematics & Plasma Physics

Summer Graduate Intern, Summer 2007

Portland State University, Portland, Oregon

Department of Mathematics & Statistics

Research Assistantship 03/2006 – 03/2009

- Developed new targeting strategy methodologies with second-order adjoint information in sensitivity analysis as well as a unifying methodology that leverages both first- and second-order adjoint information.
- Investigated the potential impact of model errors in the sensitivity fields using higher order derivatives.

This research was supported by the NASA Modeling, Analysis and Prediction Program under award NNG06GC67G and by the 2006 Intel Oregon Faculty Fellowship program. Support came also from a scholarship from Consejo Nacional de Ciencia y Tecnologia (CONACyT), Mexico

Mathematical Sciences Research Institute, Berkeley, California,

Summer Research Workshop Summer 2006: Data Assimilation for the Carbon Cycle, Mathematical Sciences Research Institute (MSRI) Berkeley, California. Research lead by Dr. Inez Fung studying the improvement of measurements for the sinks and sources of CO_2 in the atmosphere.

Washington State University, Pullman, Washington

Department of Mathematics & Statistics

Research Experience for Undergraduates in Applied Mathematics, Summer 2000

FUNDED PROPOSALS

2013: “Predictability of Thermospheric Winds using Advanced Data Assimilation Methods”, awarded by the Institute for Geophysics, Planetary Physics, and Signatures, amount: \$10.6K

2013-2016: “Data Assimilation Effort for the Global Sun Model”, awarded by NASA, amount for LANL: \$174.4K, (PI: Mansour Nagi, NASA Ames Research Center)

2016–2018: Early Career Research proposal: “Assimilation Algorithms for Data Fusion in Large-scale Non-linear Dynamical Systems”, awarded by the Laboratory Directed Research and Development program from the Department of Energy: \$445.0K

SERVICE TO THE COMMUNITY

Reviewer: Applied Numerical Mathematics, Space Weather, Annales Geophysicae, Journal of Hydroinformatics, Journal of the Atmospheric Sciences, Journal of Geophysical Research - Space Physics, Geoscientific Model Development.

Co-organizer of AGU session titled “Data Assimilation for Space Physics and Aeronomy”, AGU Fall Meeting 2014, San Francisco, CA Dec. 15–19, 2014.

Co-organizer of Data Assimilation and Inverse Problems session in the 2012 SIAM Conference on Uncertainty Quantification, Raleigh North Carolina, April 2-5 2012.

Organizer of the T-5 (Applied Mathematics & Plasma Physics group) Postdoc seminar series, and Co-organizer of the T-5 talk series.

STUDENTS

Mentor to Kyle Hickmann, Postdoctoral researcher at the Applied Mathematics and Plasma Physics group (T-5) in LANL

Mentor to Andrew Walker, Postdoctoral researcher at the Space Science and Applications group (ISR-1) in LANL

Student mentor for Quintin Schiller (University of Colorado at Boulder) for the LANL Space Weather Summer School 2012 (<http://www.swx-school.lanl.gov/>)

Student mentor for Sean Elvidge (University of Birmingham, UK) for the LANL Space Weather Summer School 2013 (<http://www.swx-school.lanl.gov/>)

Federico Gasperini (University of Colorado, Boulder) for the LANL Space Weather Summer School 2013 (<http://www.swx-school.lanl.gov/>)

Ryan Mcgranaghan (University of Colorado, Boulder) for the LANL Space Weather Summer School 2014 (<http://www.swx-school.lanl.gov/>)

PAPERS

H.C. Godinez, Y. Yu, V.K. Jordanova, and B. Larsen: *Ring Current Pressure Estimation with RAM-SCB using Data Assimilation and Van Allen Probe Flux Data*, Geophysical Research Letters, in preparation.

M. Morzfeld and H.C. Godinez: *Orbit determination and prediction with Bayesian statistics and implicit sampling*, Journal of Spacecraft and Rockets, in preparation.

Elvidge, S., Godinez, H. C., and Angling, M. J.: *Improved Forecasting of Thermospheric Densities using Multi-Model Ensembles*, Geosci. Model Dev. Discuss., doi:10.5194/gmd-2015-203, in review, 2016.

H.C. Godinez, E. Lawrence, D. Higdon, A. Ridley, J. Koller and A. Klimenko: *Specification of the Ionosphere-Thermosphere Using the Ensemble Kalman Filter*, Lecture Notes in Computer Science, Volume 8964, 2016.

McGranaghan, R., D. J. Knipp, T. Matsuo, H. Godinez, R. J. Redmon, S. C. Solomon, and S. K. Morley: *Modes of high-latitude auroral conductance variability derived from DMSP energetic electron precipitation observations: Empirical Orthogonal Function analysis*, J. Geophys. Res. Space Physics, 120, 2015.

K.S. Hickmann, H.C. Godinez, J. Koller, C. Nick Arge, and Carl J. Henney: *Advancements in the ADAPT Photospheric Flux Transport Model*, Solar Physics Journal, Volume 290, Issue 4, pp 1105-1118, 2015.

- Y. Yiqun, J. Koller, V.K. Jordanova, S.G. Zaharin, and H.C. Godinez: *Radiation belt data assimilation of a moderate storm event using a magnetic field configuration from the physics-based RAM-SCB model*, *Annales Geophysicae*, Vol. 32, pages 473-483, 2014.
- C. Nick Arge, Carl J. Henney, Irene Gonzalez-Hernandez, W. Alex Toussaint, Josef Koller and Humberto C. Godinez: *Modeling the Corona and Solar Wind using ADAPT Maps that Include Far-Side Observations*, *AIP Conf. Proc.* 1539, pp. 11-14, 2013.
DOI:10.1063/1.4810977
- H.C. Godinez and V.S. Manoranjan: *Modeling Convection Diffusion with Exponential Upwinding*, *Applied Mathematics*, Vol. 4 No. 8A, pp. 80-88, 2013.
DOI:10.4236/am.2013.48A011
- Schiller, Q., X. Li, J. Koller, H. Godinez, and D. L. Turner (2012), *A parametric study of the source rate for outer radiation belt electrons using a Kalman filter*, *J. Geophys. Res.*, 117, A09211
DOI:10.1029/2012JA017779
- H.C. Godinez, J. Reisner, A.O. Fierro, Stephen R. Guimond: *Determining key environmental parameters of rapidly intensifying Hurricane Guillermo(1997) using the Ensemble Kalman Filter* *Journal of the Atmospheric Sciences*, Vol. 69, No. 11., pp. 3147-3171
DOI: 10.1175/JAS-D-12-022.1
- H.C. Godinez and J. Koller: *Localized Adaptive Inflation in Ensemble Data Assimilation for a Radiation Belt Model* *Space Weather*, Vol. 10, S08001, 11 pp., 2012
DOI:10.1029/2012SW000767.
- H.C. Godinez and J.D. Moulton: *An Efficient Matrix-free Implementation of the Ensemble Kalman Filter* *Journal of Computational Geosciences*, Vol. 16, Issue 3, pp. 565-575, 2012
DOI: 10.1007/s10596-011-9268-9.
- H.C. Godinez and D.N. Daescu: *Observation Targeting with a Second Order Adjoint Method for Increased Predictability*, *Computational Geosciences*, Vol. 15, Number 3, pp. 477-488, 2011
DOI: 10.1007/s10596-010-9217-z.
- H.C. Godinez and D.N. Daescu: *A Second Order Adjoint Method to Targeted Observations* G. Allen et al. (Eds.): *ICCS 2009, Part II*, LNCS 5545, pp. 322-331, 2009.

CONFERENCE PROCEEDINGS

- H.C. Godinez and Matthias Morzfeld: *Estimation and Prediction for an Orbital Propagation Model using Data Assimilation*, 24th AAS/AIAA Space Flight Mechanics Meeting, Santa Fe, New Mexico, Jan 26-30, 2014, pages AAS 14-246.
- Sean Brennan, Michael Shoemaker, Andrew Walker, Humberto C. Godinez, and Josef Koller: *Multi-Model Orbital Simulation Development with Python* 24th AAS/AIAA Space Flight Mechanics Meeting, Santa Fe, New Mexico, Jan 26-30, 2014, pages AAS 14-53.
- S. Elvidge, H.C. Godinez, and M.J. Angling: *Improved modelling of upper atmospheric densities using multi-model ensembles*, 3rd IMA Conference on Mathematics in Defence Proceedings, in press.
- Josef Koller, Sean Brennan, David Higdon, Moriba Jah, Thomas Kececy, Alexei Klimenko, Brian Larsen, Earl Lawrence, Richard Linares, Craig McLaughlin, Piyush Mehta, David Palmer, Aaron Ridley, Michael Shoemaker, Eric Sutton, David Thompson, Andrew Walker, Brendt Wohlberg, and Humberto C. Godinez: *The IMPACT Framework for Enabling System Analysis of Satellite Conjunctions* 24th AAS/AIAA Space Flight Mechanics Meeting, Santa Fe, New Mexico, Jan 26-30, 2014, pages AAS 14-53.
- Humberto C. Godinez, Earl Lawrence, David Higdon, Aaron Ridley, Josef Koller, and Alexei Klimenko: *Specification of the Ionosphere-Thermosphere using the Ensemble Kalman Filter*, proceedings of the Dynamic Data-driven Environmental Systems Science Conference, Massachusetts Institute of Technology, Cambridge, MA, Nov 5-7 2014, in press.

CONFERENCES AND PRESENTATIONS

- Data assimilation for the inner ring current using RAM-SCB*, at CEDAR-GEM Summer workshop, Santa Fe, NM, June 19–24, 2016.
- Orthogonal Transformations for the Ensemble Kalman Filter*, at Conference on Data Analysis, Santa Fe, NM, March 2–4, 2016.
- Ring Current Pressure Estimation with RAM-SCB using Data Assimilation and Van Allen Probe Flux Data* at the AGU Fall Meeting 2015, San Francisco CA, December 14–18.
- Ring Current Pressure Estimation with RAM-SCB using Data Assimilation and Van Allen Probe Flux Data*, GEM Workshop, Snowmass CO, June 14–19, 2015.
- Orthogonal Transformations for the Ensemble Kalman Filter* at the SIAM Conference on Conference on Computational Science and Engineering, Salt Lake City, UT, March 14–18, 2015.
- Specification of the Ionosphere-Thermosphere Environment Using Ensemble Kalman Filter with Orthogonal Transformations* at the AGU Fall Meeting 2014, San Francisco CA, December 15–19 2014.
- Specification of the Ionosphere-Thermosphere using the Ensemble Kalman Filter*, Dynamic Data-driven Environmental Systems Science Conference, Massachusetts Institute of Technology, Cambridge, MA, Nov 5–7 2014. (with Earl Lawrence, David Higdon, Aaron Ridley, Josef Koller, and Alexei Klimenko)
- Multi-Model Ensemble to Enhance Model Prediction: Specification of Ionosphere-Thermosphere Environment* at the Conference on Data Analysis, Santa Fe NM, March 5–7, 2014. (with M. Shoemaker and S. Elvidge)
- Specification of the Ionosphere-Thermosphere Environment for Orbital Propagation* at the American Meteorological Society annual meeting, Atlanta GA, February 2–6, 2014. (with M. Shoemaker, E. Lawrence, D. Higdon, A. Walker, R. Linares, A. Ridley, and J. Koller)
- Implementation of Localized Ensemble Assimilation for a Three-Dimensional Radiation Belt Model*, **invited presentation** at the AGU Fall Meeting 2013, San Francisco CA, December 9–13 2012. (with Yue Chen; Adam C. Kellerman; Dmitriy Subbotin; Yuri Shprits)
- Online Estimation and Prediction for a Non-Gaussian Orbital Propagation Model*, presentation at the AGU Fall Meeting 2013, San Francisco CA, December 9–13 2013. (with Matthias Morzfeld)
- Atmospheric Density Specification with the Global Ionosphere-Thermosphere Model (GITM) using the Ensemble Kalman Filter*, Poster at the AGU Fall Meeting 2012, San Francisco CA, December 3–7 2012 (with Balu Nadiga, Aaron J. Ridley, Josef Koller, Earl Lawrence, and David Higdon).
- Localized Adaptive Inflation in Ensemble Data Assimilation: Application to a Radiation Belt Model*, Poster at the AGU Fall Meeting 2012, San Francisco CA, December 3–7 2012 (with J. Koller).
- Data Assimilation for Inner-Magnetospheric Plasma Systems*, The Geospace Environment Modeling (GEM) 2012 Summer Workshop, Snowmass CO, June 17–22, 2012.
- Model Covariance Sensitivity as a Guidance for Localization in Data Assimilation*, 2012 SIAM Conference on Uncertainty Quantification, Raleigh NC, April 2–5 2012 (with D.N. Daescu).
- Techniques and Examples of Data Assimilation Applied to Space Physics Models – A Review*, Inner Magnetosphere Coupling II, Los Angeles CA, March 19–22 2012 (with J. Koller).
- Localized Adaptive Inflation in Ensemble Data Assimilation for a Radiation Belt Model*, Inner Magnetosphere Coupling II, Los Angeles CA, March 19–22 2012 (with J. Koller).
- Data Assimilation for Dynamical Systems*, 2012 Joint Mathematics Meetings, Boston MA, January 4–7 2012. Abstract URL:
http://jointmathematicsm meetings.org/amsmtgs/2138_abstracts/1077-93-2730.pdf
- Localized Ensemble Assimilation for the Air Force Data Assimilative Photospheric Flux Transport (ADAPT) Model*, Poster at the AGU Fall Meeting 2011, San Francisco CA, December 5–9 2011 (with J. Koller, Charles N. Arge, and Carl J. Henney). Poster URL:
<http://eposters.agu.org/abstracts/localized-ensemble-assimilation-for-the-air-force-data-assimilative-photospheric-flux-transport-adapt-model>

Data Assimilation in Multiscale Systems. Poster at the 2011 DOE Applied Mathematics Program Meeting, Washington DC, October 17–19, 2011. Poster URL:

http://www.csm.ornl.gov/workshops/applmath11/documents/posters/Godinez_poster.pdf

Ensemble Data Assimilation: Theory and Applications. Invited talk at the National Severe Storms Laboratory Seminar, National Weather Center, Norman OK, July 6 2011.

Ensemble Data Assimilation for a Radiation Belt Model. CEDAR-GEM Joint Workshop, Santa Fe, New Mexico, June 26–July 01 2011 (with J. Koller).

The Dynamic Radiation Environment Assimilation Model Project (DREAM). SIAM Conference on Applications of Dynamical Systems, Snowbird UT, May 22-26 2011 (with J. Koller).

Computational Performance of a Parallel Matrix-free Implementation of the Ensemble Kalman Filter. SIAM Conference on Mathematics & Computational Issues in the Geosciences, Long Beach, CA, March 21-24, 2011 (with J.D. Moulton).

Adjoint Models in Sensitivity Analysis and Predictability. 2010 SIAM Annual Meeting, Pittsburgh, PA, July 12-16 2010 (with D.N. Daescu).

EnKF Data Assimilation of dual-Doppler radar data from hurricane Guillermo. Poster at the 29th Conference on Hurricanes and Tropical Meteorology, Tucson, Arizona, 10-14 May 2010 (with A.O. Fierro, and J. Reisner).

An efficient Matrix-free implementation of the Ensemble Kalman Filter. EGU General Assembly 2010, Vienna, Austria, May 2-7 2010 (with J.D. Moulton).

Comparison of Singular Vectors and a Second Order Adjoint Method for Targeted Observations 2010 Ocean Sciences Meeting, Portland, OR, February 22-26 2010 (with D.N. Daescu).

A Second Order Adjoint Method to Targeted Observations, 2009 International Conference on Computational Science, Baton Rouge, Louisiana, May 25-27, 2009 (with D.N. Daescu).

Sensitivity Analysis of Key Parameters and Initial Conditions in Atmospheric Models. Invited talk at the Atmospheric Sciences Seminar, College of Oceanic and Atmospheric Sciences, Oregon State University, 24 April 2008

Parametric Sensitivity Analysis in a New Cloud Resolving Aerosol Model. Poster at the AGU Fall meeting, San Francisco, CA, December 10-14, 2007 (with J.M. Reisner, and J.D. Moulton).

Sensitivity Analysis in a Cloud Resolving Aerosol Model. Los Alamos National Laboratory Student Symposium, Los Alamos, NM, August 1-2 2007 (with J.M. Reisner, and J.D. Moulton).

The Impact of Numerical Discretization on Targeted Observations. 2007 SIAM Conference on Mathematical and Computational Issues in Geosciences, Santa Fe, New Mexico, March 19-22, 2007 (with D.N. Daescu).

AWARDS

08/2007 Los Alamos National Laboratory Student Symposium 2007 Award: Outstanding presentation in Mathematics.

09/2003 – 09/2008 Scholarship from Consejo Nacional de Ciencia y Tecnologia (CONACyT), Mexico

08/2001 – 06/2003 Sidney G. and Evelyn Hacker Scholarship, Department of Mathematics and Statistics, Washington State University, Pullman, Washington.

MEMBERSHIPS

Society for Industrial and Applied Mathematics (SIAM)

American Mathematical Society (AMS)

Mathematical Association of America (MAA)

American Geophysical Union (AGU)

European Geosciences Union (EGU)

TEACHING EXPERIENCE

Portland State University, Portland, Oregon

Department of Mathematics & Statistics

Instructor, Fall 2004 – Spring 2006

Prepared lessons and tests, held office hours, and graded assignments and tests.

- Mth 111,112: Introductory College Mathematics I, II
- Mth 251,252: Calculus I, II
Differential and integral calculus of functions of a single variable.
- Mth 253: Calculus III
Analytic geometry, infinite series, and applications.
- Mth 254: Calculus IV
Differential and integral calculus of functions of several variables and applications.

Washington State University, Pullman, Washington

Department of Mathematics & Statistics

Teacher Assistant, Fall 2001 – Spring 2004

Led three supplemental instruction sessions per week and graded tests, assignments and projects.

- Math 171: Calculus I
Limits and derivatives, Continuity, Differentiation rules.
- Math 172: Calculus II
Integration, Infinite sequences and series, parametric equations, Polar coordinates, Three-dimensional vectors and the geometry of space.

Tutored courses and graded tests, assignments and projects.

- Math 315: Differential Equations

Universidad del Valle de Atemajac, Guadalajara, Mexico

Instructor, Fall 2000 – Summer 2001

Prepared lessons and tests, held office hours, and graded assignments and tests.

- Calculus I and II
- Linear Algebra
- Probability & Statistics

TECHNICAL SKILLS

High Performance Computing: The nature of my research demands expert knowledge in high performance computing (HPC). I have used supercomputing resources extensively for ensemble-based data assimilation techniques, applied to large-scale models for simulation of weather patterns and hurricanes, to name a few. I have also used them in adjoint- and ensemble-based sensitivity analysis studies for model initial conditions, boundary conditions, and input parameters. My HPC experience include:

- massive parallel computation for large-scale numerical simulation using MPI and OpenMPI,
- parallel computations on the Jaguar (XT5) high performance supercomputer (Oak Ridge National Laboratory), as well as the Coyote, Lobo and Conejo supercomputers (LANL),
- submitted proposals for CPU time in Jaguar (ORNL) and Pinto (LANL), which were awarded,
- familiarity with NASA supercomputers, such as Pleiades

Languages: Experienced with Fortran90/95, Python, MATLAB and Maple. Also familiar with C/C++ and Mathematica.