Carlos A. Cruz

WORK ADDRESS	Building 28, Room W250	*Voice:* (301) 286-3716
	NASA Goddard Space Flight Center	*Fax:* (301) 286-1775
	Mailstop 606	*E-mail:* carlos.a.cruz@nasa.gov
	Greenbelt, MD 20771	

| HOME ADDRESS | 7011 Devereux Circle Dr. | *Phone:* (703) 405-4721 |
| | Alexandria, VA 22315 | *E-mail:* carlos.a.cruz@gmail.com |

EDUCATION

George Mason University, Fairfax, VA USA
Department of Atmospheric, Oceanic, and Earth Sciences
  Ph.D., Climate Dynamics, December 2010
  Dissertation Topic: "Global Circulation Variability Induced by Southern Ocean Winds"
  Advisor: Dr. Barry Klinger

George Mason University, Fairfax, VA
Computational Sciences and Informatics
  Completed coursework and thesis proposal toward a Ph.D. degree in Computational Materials
  Science. Proposal title: "Optimization of molecular clusters", February, 2000

George Mason University, Fairfax, VA
Department of Physics
  M.S., Applied Physics, May, 1996
  B.S., Physics, May, 1988

RESEARCH INTERESTS

Software engineering for scientific applications, climate dynamics, numerical modeling of physical systems, machine learning.

SKILLS

- Experience in running climate, weather, and data assimilation systems of operational complexity on high-performance computers
- Weather and climate models: NCAR WRF, NASA GISS' modelE, NASA GMAO's GEOS-5, GFDL's MOM4, RSMA's HyCOM
- Programming languages: Fortran, Python, C/C++, shell scripting.
- High-performance computing tools: MPI, totalView, Allinea, TAU.
- Visualization and editing tools: Matlab, Grads, LaTeX, MS Office.
- Operating Systems: Unix/Linux, Darwin OS, Microsoft OS.

PROFESSIONAL EXPERIENCE

NASA/GSFC, Advanced Software and Technology Group, Greenbelt, MD
SSAI Chief Scientific Programmer Analyst, 5/12 - present
- Lead software engineer for the NASA Unified Weather Research and Forecasting (NU-WRF) modeling system.
- Lead software engineer in *eViz* visualization project. The project involves the development of tools to help visualize Earth system model data streams.
- Team member in the TERRAHydro project. The goal of this project is to develop a reusable AI-first framework, the Coupled Reusable Earth Systems Tensor (CREST) framework, for building Earth System Models (ESMs) or Earth System Digital Twins (ESDTs) and to leverage CREST to build the TERRAHydro land surface model (LSM).
- A lead member in the modelE re-engineering effort. The work consisted of refactoring and testing the NASA-GISS modelE climate model to reduce the long-term cost of maintaining and extending

model code.

- Over the years I have supervised and trained various junior members within the organization to perform sub-tasks within the aforementioned modeling efforts.
- Developed a Python based regression testing framework, **reg**, used in GISS modelE and NU-WRF.
- Helps to organize and train scientists and engineers in NASA's Training Bootcamps.

NASA/GSFC, Advanced Software and Technology Group, Greenbelt, MD
NGIT Physicist IV, 1/07 - 4/12

- Lead developer in the giga-particle trajectory model. This model was developed *ab initio* in C++ using test-driven development techniques. The model was parallelized using MPI and was capable of performing stratospheric trajectory simulations with billions of parcels.
- Team member in the Moving Objects Database (MOD) project. The application used various techniques to automate the identification of meteorological events by ingesting the required data (satellite, reanalysis, etc) into a database for cataloging. I developed various JAVA classes used to ingest data sources and was responsible for executing and diagnosing the production runs.
- Collaborated in the the Elastic Parallel IO (EPIO) project where I provided advice and direct support to the EPIO staff in their efforts to port their software to NASA computer systems. The EPIO project aims to use an optimized IO library called ADIOS that will significantly improve the IO performance of GEOS5 and potentially modelE.
- Developed the online GEOS-5 GCM user's guide on NASA's modeling guru website. I am also the primary moderator (and frequent contributor) of various communities on the NASA modeling guru website.
- Helped in the development and creation of the scripts and workflow configurations that run a climate model (GEOS-5) under a JAVA-based workflow tool. Scripts perform setup, execution, and archival of GEOS-5 experiments.
- Helped to develop a MAPL component analyzer tool written in Perl (MAPL is a software layer and set of conventions to standardize the use of the Earth System Modeling Framework (ESMF)).
- Have assisted in various efforts to make GEOS-5 model components to be ESMF and/or MAPL compliant.

NASA/GSFC, Global Modeling and Assimilation Office, Greenbelt, MD
NGIT Senior member of technical staff, 5/02 - 12/06

- Participated in developing Earth System Modeling Framework (ESMF) applications to be used in the GEOS-5. GEOS-5 integrates the GEOS-5 AGCM with the Grid-point Statistical Interpolation (GSI) atmospheric analysis developed jointly with NOAA/NCEP/EMC. The GEOS-5 systems are being developed in the GMAO to support NASA's earth science research in data analysis, observing system modeling and design, climate and weather prediction, and basic research.
- Responsible for computational requirement identification, planning, data structure and algorithm design, and software implementation for Part III of the ESMF (Data Assimilation) project suite working under the guidance of the principal investigator. Acquired practical experience with satellite radiances, satellite-based climate data records and data assimilation. Programming activity includes design and development of new parallel software, and modification and adaptation of existing software packages and libraries in multi-language environments.

NASA/GSFC, Science Data Systems Branch, Greenbelt, MD
NGIT Senior member of technical staff, 1/02 - 4/02

- Lead a study to develop a disease forecasting tool: Tool consisted of a disease forecasting system that helped identify the spread of a vector-borne disease as a function of weather.
- Developed task goals, performed literature review, identified statistical tools, data sets and began tool development.

NASA/GSFC, NASA Center for Computational Sciences , Greenbelt, MD

NGIT Senior member of technical staff, 4/00 - 12/01
- Helped to develop a coupler component used to provide an interface between two systems, a weather model and a data assimilation system, defined on different computational grids. Main responsibilities included design, development, and testing of scientific code on a cray SV1 and O2K computer systems. Programming was performed in Fortran 90.
- Additional responsibilities included writing unix scripts and utilizing several software packages to aid in the software engineering process.

US Bureau of the Census, Suitland, MD
SAIC Programmer, 8/98 - 3/00
- Extensive involvement in the creation of new software that interfaces with the TIGER database system for aiding in the census 2000 map production. My main contribution was the creation of a software module that implemented a genetic algorithm to solve a map coloring problem used in the creation of census maps.
- Programming was performed in C running under a Perl script in a UNIX environment.
- Responsible for modifying existing code, writing and implementing change requests, and other facets of the software design process.

CACI Federal, Inc, Arlington, VA
Systems Engineer, 3/96 - 1/97
- Developed and tested code for various modules of the Configuration Management Information System (CMIS) software.
- Designed Graphical User Interface (GUI) for the CMIS project using OBJECTVIEW. Developed stored procedures and triggers in ORACLE7 to maintain database integrity. Maintained the data transfer utility programs for the CMIS project.

Walter Reed Army Institute of Research, Bioengineering Section, Washington D.C.
Research assistant, 10/90 - 10/95
- Aided in developing experimental test models for the Filmless Dental Imaging (FDI) Project.
- Performed all the statistical data analysis and mathematical analysis. Wrote computer code to aid in the project when needed.
- Experiments involved the use of oscilloscopes, multimeters and Geiger counters.
- Performed all kinds of mechanical duties involving machine shop instrumentation. Assisted in inventories, stocks, general laboratory management, and various administrative duties.
- Involved in the analysis of polymers with a 300 MHz NMR for the Micro-encapsulation Project.
- Developed software and participated in viscosity experiments for the same project.

MENTORING

Anna Boone, University of Oregon, 2024 NASA Summer Intern. Project: "sViz: a browser tool for creating visualizations using eViz"

Aarav Khanna, Cornell University, 2023 NASA Summer Intern. Project: "eViz: Enhanced visualization utilities for NU-WRF models"

Deon Kouatchou, Carnegie Mellon University, 2023 NASA Summer Intern. Project: "ASSERT - A Software Suite for Earth-Systems Regression Testing"

Deepthi Raghunandan, University of Maryland, 2021 NASA Summer Intern. Project: "eViz: Exploring Earth System Data Products and Diagnosing Earth System Models using a visualization environment"

Trisha Michael, South Dakota School of Mines and Technology, 2012 NASA Summer Intern. Project: "Preliminary Analysis of Tornado Producing Mesoscale Convective Systems using

Event Tracker Program"

TEACHING   **Adjunct Assistant Professor**, Department of Computational and Data Sciences, George Mason University University, Fairfax, VA. 8/18-present:
- Modeling and Simulation I (CDS 230)
- Elements of High Performance Computing (CDS 351).
- Computing for Scientists (CDS 130) - Spring 2020

Lecturer,NASA Goddard Space Flight Center. Teaching duties:
- "ASTG Fortran Training", Goddard Space Flight Center, Fall 2024
- "ASTG Fortran Training", Goddard Space Flight Center, Spring 2024
- "ASTG Fortran Training", Goddard Space Flight Center, Fall 2023
- "ASTG Fortran Training", Goddard Space Flight Center, Spring 2023
- "ASTG Fortran Training", Goddard Space Flight Center, Fall 2022
- "ASTG Fortran Training", Goddard Space Flight Center, Spring 2022
- "ASTG Fortran Training", Goddard Space Flight Center, Fall 2021
- "GSFC Python Boot Camp", Goddard Space Flight Center, Summer 2020
- "GSFC Python Boot Camp", Goddard Space Flight Center, Summer 2019
- "NASA Langley Best Practices Workshop", SSAI Hampton, VA, Spring 2019
- "NASA Langley Fortran Training", SSAI Hampton, VA, Fall 2018
- "GSFC Python Boot Camp", Goddard Space Flight Center, Summer 2018
- "GSFC Python Boot Camp", Goddard Space Flight Center, Summer 2017
- "NASA Langley Python Training", SSAI Hampton, VA, Spring 2017
- "NASA Langley Python Training", SSAI Hampton, VA, Fall 2016
- "GSFC Python Boot Camp", Goddard Space Flight Center, Summer 2016

Teaching Assistant, Department of Computational and Data Sciences, George Mason University University, Fairfax, VA.
- Department of Physics, George Mason University University, Fairfax, VA. 1/97-5/98
- Department of Physics, George Mason University University, Fairfax, VA. 1/89-12/89

PUBLICATIONS   Xue, P., Huang, C., Zhong, Y., Notaro, M., Kayastha, M. B., Zhou, X., Zhao, C., Peters-Lidard, **C., Cruz**, and Kemp, E.: Enhancing Winter Climate Simulations of the Great Lakes: Insights from a New Coupled Lake-Ice-Atmosphere (CLIAv1) Model on the Importance of Integrating 3D Hydrodynamics with a Regional Climate Model, Geosci. Model Dev. Discuss. [preprint], `https://doi.org/10.5194/gmd-2024-146`, in review, 2024.

Larissa S. Nazarenko, Nick Tausnev, Gary L. Russell, David Rind, Ron L. Miller, Gavin A. Schmidt, Susanne E. Bauer, Maxwell Kelley, Reto Ruedy, Andrew S. Ackerman, Igor Aleinov, Michael Bauer,Rainer Bleck,Vittorio Canuto, Grégory Cesana, Ye Cheng, Thomas L. Clune, Ben I. Cook, **Carlos A. Cruz**, Anthony D. Del Genio, Gregory S. Elsaesser, Greg Faluvegi, Nancy Y. Kiang,D aehyun Kim,Andrew A. Lacis,Anthony Leboissetier, Allegra N. LeGrande,Ken K. Lo,John Marshall,Elaine E. Matthews, Sonali McDermid, Keren Mezuman,Lee T. Murray,Valdar Oinas, Clara Orbe,Carlos Pérez García-Pando,Jan P. Perlwitz, Michael J. Puma,Anastasia Romanou, Drew T. Shindell, Shan Sun, Kostas Tsigaridis, George Tselioudis, Ensheng Weng, Jingbo Wu, Mao-Sung Yao 2022: "Future Climate Change Under SSP Emission Scenarios With GISS-E2.1" J. Adv. Model. Earth Syst., (2022), Vol 14, Issue 7

Michael Notaro, Yafang Zhong, Pengfei Xue, Christa Peters-Lidard, **Carlos Cruz**, Eric Kemp, David Kristovich, Mark Kulie, Junming Wang, Chenfu Huang, and Stephen J. Vavrus, 2021: Cold season performance of the NU-WRF regional climate model in the Great Lakes region. Journal of Hydrometeorology, 22, 2423-2454

Kim, D., M. Chin, **C. A. Cruz**, D. Tong, and H. Yu. 2021. "Spring Dust in Western North America and Its Interannual Variability—Understanding the Role of Local and Transported Dust." Journal of Geophysical Research: Atmospheres, 126 (22)

Miller, R.L., G.A. Schmidt, L. Nazarenko, S.E. Bauer, M. Kelley, R. Ruedy, G.L. Russell, I. Aleinov, M. Bauer, R. Bleck, V. Canuto, G. Cesana, Y. Cheng, T.L. Clune, B. Cook, **C.A. Cruz**, A.D. Del Genio, G.S. Elsaesser, G. Faluvegi, N.Y. Kiang, D. Kim, A.A. Lacis, A. Leboissetier, A.N. LeGrande, K.K. Lo, J.C. Marshall, S. McDermid, E.E. Matthews, K. Mezuman, L.T. Murray, V. Oinas, C. Orbe, C. Pérez García-Pando, J.P. Perlwitz, M.J. Puma, D. Rind, A. Romanou, D.T. Shindell, S. Sun, N. Tausnev, K. Tsigaridis, G. Tselioudis, E. Weng, J. Wu, and M. Yao, 2019: "CMIP6 Historical Simulations (1850-2014) with GISS-E2.1". J. Adv. Model. Earth Syst., (2020), Vol 13, Issue 1

Kelley, M., G.A. Schmidt, L. Nazarenko, R.L. Miller, S.E. Bauer, R. Ruedy, G.L. Russell, I. Aleinov, M. Bauer, R. Bleck, V. Canuto, G. Cesana, Y. Cheng, T.L. Clune, B. Cook, **C.A. Cruz**, A.D. Del Genio, G.S. Elsaesser, G. Faluvegi, N.Y. Kiang, D. Kim, A.A. Lacis, A. Leboissetier, A.N. LeGrande, K.K. Lo, J.C. Marshall, S. McDermid, E.E. Matthews, K. Mezuman, L.T. Murray, V. Oinas, C. Orbe, C. Pérez García-Pando, J.P. Perlwitz, M.J. Puma, D. Rind, A. Romanou, D.T. Shindell, S. Sun, N. Tausnev, K. Tsigaridis, G. Tselioudis, E. Weng, J. Wu, and M. Yao, 2019: "GISS-E2.1: Configurations and climatology". J. Adv. Model. Earth Syst., (2020), Vol 12, Issue 8

T. Clune, **C. Cruz**. "pFLogger: The parallel Fortran logging framework for HPC applications" Conference Paper: Proceedings of 2017 International Workshop on Software Engineering for High-Performance Computing in Computational and Data-Enabled Science and Engineering.

Z. Liu, B. Wang, T. Wang, Y. Tian, C. Xu, Y. Wang, W. Yu, **C. Cruz**, S. Zhou, T. Clune, S. Klasky "Profiling and Improving I/O Performance of a Large-Scale Climate Scientific Application" Conference Paper: Computer Communications and Networks (ICCCN), June 2013

S. Zhou, **C. Cruz**, D. Duffy, R. Tucker, M. Purcell "Accelerating climate and weather simulations through hybrid computing" Concurrency Computat: Pract. Exper. 2012; 24(1): 54-62

B.A. Klinger, **C.A. Cruz**. "Decadal Response of Global Circulation to Southern Ocean Zonal Wind Stress Perturbation" J. Phys. Ocean. 39(8) pp 1888-1904, (2009)

S. Zhou, V. Balaji, **C. Cruz**, A. da Silva, C. Hill, E. Kluzek, S. Smithline, A. Trayanov, W. Yang. "Cross-organization interoperability experiments of weather and climate models with the Earth System Modeling Framework" Concurrency Computat: Pract. Exper. 2007; 19:583-592

J. Joiner, E. Brin, R. Treadon, J. Derber ; P. Van Delst, A. da Silva, J. Le Marshall, P. Poli, R. Atlas, D. Bungato, **C. Cruz**. "Effects of data selection and error specification on the assimilation of AIRS data" Q. J. R. Meteorol. Soc. 133; 181-196 (2007)

B.A. Klinger, **C.A. Cruz**, P. Schopf. "Targeted Shapiro Filter in an Ocean Model" Ocean Modeling 13 (2006) 148-155

C. Hill, C. DeLuca, V. Balaji, A. da Silva, W. Sawyer, **C.A. Cruz** et al. "Implementing Applications with the Earth System Modeling Framework" Lecture Notes in Computer Science (2006) Vol 32, pp 563-572

TECHNICAL REPORTS

S. Freeman, **C. Cruz**, R. Burns · K.S. Kuo · T. Clune · J. Kouatchou, "Tool for Automated Retrieval of Generic Event Tracks (TARGET)", NASA Tech Brief GSC-16665-1, July 2013

C.A. Cruz, B.A. Klinger. "Atlantic and Indo-Pacific Responses to a Southern Ocean Zonal Wind

Stress Perturbation" Submitted to J. Phys. Ocean September 2012

Cruz C., Kelly M., Clausen M., Zhou S., and Higgins G., "Coupled Ocean-Atmosphere Shallow Water Model", TASC Internal Report, 2001

C.A. Cruz, E. Blaisten-Barojas "Structure and energetics of Silica clusters" GMU Technical Report, Spring 1998

C.A. Cruz, A. Haque, S. Landsberg, T. Zedan. "A crystal structure database of the elements and select diatomic compounds" GMU Technical Report, Fall 1997

POSTERS

C. Cruz, 2018: "NU-WRF Development and Support at NASA GSFC". 2018 WRF Workshop, Boulder, CO.

C. Cruz, T. Clune, L. Lait, S. Freeman, R. Burns, U. Ranawake 2009: "A giga-particle atmospheric trajectory model". 2009 AGU Fall Meeting, San Francisco, CA.

Cruz C., and Klinger, B. A., 2009: "Time-dependent Response of SST and Overturning to a Southern Ocean Wind Perturbation". First U.S. AMOC Annual Meeting 2009, Annapolis, MD.

C.A. Cruz, A. da Silva, W. Yang, A. Trayanov, 2005: "Data Assimilation Systems Using the Earth System Modeling Framework" 21st International Conference on Interactive Information Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, Jan 9-13, 2005. San Diego CA

CONFERENCE PROCEEDINGS

Jan Mandel; and M. Halem, C. Da, A. Kochanski, A. Farguell, M. Weldegaber, **C. A. Cruz**, Z. Yang, and J. Sorkin "Integrating WRF-SFIRE-CHEM in NASA Unified WRF (NUWRF)" 2024 AMS Fall Meeting, Baltimore MD.

C. Cruz, V. Valenti "EViz - Empowering Earth System Model Data Visualization " 2024 AMS Fall Meeting, Baltimore MD.

Z. Tao, H. Bian, D. Kim, **C. A. Cruz**, and M. Chin "Improving Aerosol Representation in NU-WRF in Support of the Emerging GEO LEO Satellite Observation of Air Quality" 2023 AMS Fall Meeting, Denver CO.

D. Raghunandan, **C. Cruz**, V. Valenti, J. Kouatchou, K. Emma Knowland, M. Damon, C. Pelissier "Diagnosing NASA Earth Science Models (ESM) using a live visualization environment: A novel approach" 2021 AGU Fall Meeting, New Orleans, LA.

V. Valenti, **C. Cruz**, D. Raghunandan, J. Kouatchou, K. Emma Knowland, M. Damon, C. Pelissier "Improving Data Exploration of Earth Systems Model Data with iViz: A Powerful Easy-to-use Interactive Visualization Toolkit" 2021 AGU Fall Meeting, New Orleans, LA.

K.S. Kuo, Y. Hang, T. Clune, S. Freeman, **C. Cruz**, J. Kouatchou, R. Burns "Automated Tracking of Tornado-Producing Mesoscale Convective Systems in the United States" 2011 AGU Fall Meeting, San Francisco, CA.

Cruz C. and B. A. Klinger, 2008: "Sensitivity of Meridional Overturning Response to Switched-on Southern Ocean Wind". AGU/ASLO Ocean Sciences 2008, Orlando, FL.

C. Cruz, E. Blaisten-Barojas, "Silica Clusters: Structures and Energetics" ACS Middle Atlantic Regional Meeting, American Chemical Society, May 2000

C. Cruz, E. Blaisten-Barojas, "Minimum Energy Structure of Silica Clusters", Virginia Academy of Science, Norfolk, Va., May 1999

AWARDS
- Computational Sciences and Informatics Fellowship: 1997-98 academic year.
- TASC Special Achievement Award: February, 2001.
- Robert H. Goddard Exceptional Achievement Team Award for Science: August 2010 (part of team)
- Northrop Grumman TAP award: December, 2011

SOCIETIES
- Member of the American Geophysical Union.
- Member of the American Meteorological Society.
- Sigma Xi: The Scientific Research Society

SPECIAL QUALIFICATIONS
- Numerical Methods
- Scientific Programming
- Parallel Programming
- Geophysical Modeling
- Molecular Modeling
- Foreign language - fluent in Spanish
- U.S. citizen

VOLUNTEERISM
- Tutor, Alexandria city public schools, 2016-2017 Academic year.
- Tutor, Fairfax county adult education, Spring 2014.
- Frequent science fair judge at Alexandria and Fairfax public schools.
- Sigma Xi Research showcase online judge.