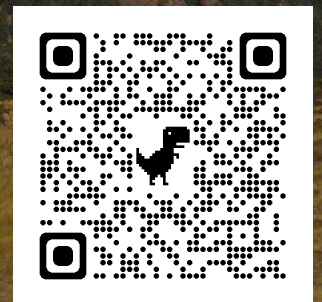


# Workshop on Correctness and Reproducibility for Climate and Weather Software

November 9-10, 2023



# Welcome

*Thomas Hauser*  
*Computational and Information*  
*Systems Lab (CISL) Director*







## Workshop on Correctness and Reproducibility for Climate and Weather Software

*... to bring together the NCAR applications community with the broader HPC community, including potential industry partners, to address the practical challenges faced by climate and weather model applications in terms of correctness and reproducibility.*

***The goal is to raise awareness and find new collaborations that will enable us to come up with mutually beneficial solutions for our socially significant and mission-critical applications.***

### **Funding:**

- President's Strategic Initiative Fund (PSIF) of University Corporation for Atmospheric Research (UCAR)
- Computational & Information Systems Laboratory (CISL)
- Climate & Global Dynamics Laboratory (CGD)



## Workshop on Correctness and Reproducibility for Climate and Weather Software

### Co-chairs

- [Allison Baker](#), Computational & Information Systems Lab, NCAR
- [Alper Altuntas](#), Climate & Global Dynamics Lab, NCAR

### Committee

- [Ilene Carpenter](#), Earth Sciences Segment Manager, Hewlett Packard Enterprise
- [Brian Dobbins](#), Climate & Global Dynamics Lab, NCAR
- [Michael Duda](#), Mesoscale & Microscale Meteorology Lab, NCAR
- [Dorit Hammerling](#), Applied Math and Statistics, Colorado School of Mines
- [Thomas Hauser](#), Computational & Information Systems Lab, NCAR
- [Karsten Peters-von Gehlen](#), Department of Data Management, DKRZ

### Administrators

- [Taysia Peterson](#), NCAR
- [Lisa Larson](#), NCAR
- [Kristen Pierri](#), NCAR

## A few things:

- **UCAR's code of conduct applies to all participants at all times.** Important points:

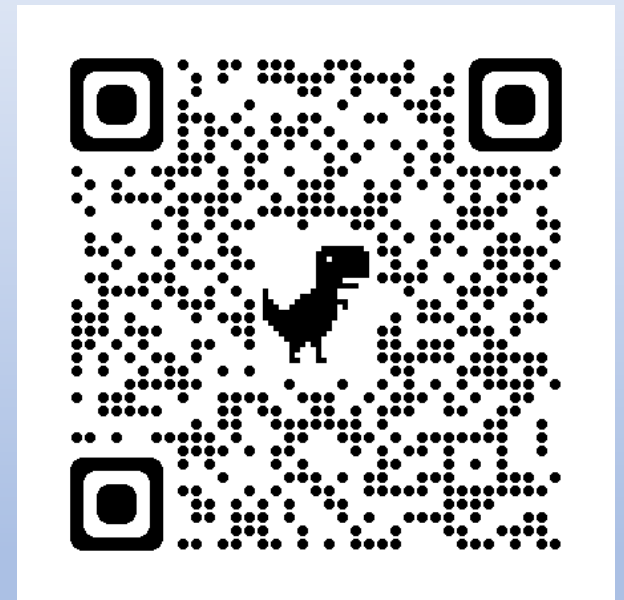
- Be considerate, respectful, and collaborative
- Value a diversity of views and opinions

- **Workshop program is on the website**

- 4 Keynote talks (45 min + 15 min/questions)
- 17 contributed talks (15 min + 5 min/questions)
- 1 Panel discussion (Friday afternoon)
- Open discussion at the end of each day
- 30 minute break mid-morning and mid-afternoon

- **All are encouraged to participate**

- If remote:
  - use Zoom “raise hand” feature, and moderator will call on you
  - we will monitor the chat also
- In person:
  - use microphone



Workshop Website



## Lunch:

**Don't lose your red tickets!**

-- this is how you "pay" each day in the cafeteria

-- we cannot replace them!



Go through the line and choose one of the following options:

- Hot Lunch Special with Side
- Build Your Own Sandwich or Burger with Side
- Large Salad with Side Item
- Small Salad with Bowl of Soup

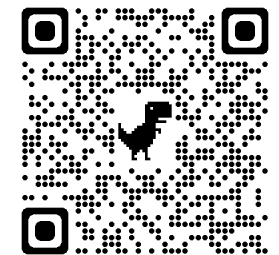
\*all options include dessert and beverage



Workshop Website

# Thursday Morning

8:30 - 8:40	<b>OPENING REMARKS</b>	
8:40 - 9:40	<b>KEYNOTE:</b> Models, Data, and Wisdom: How do we know when to trust a climate model?	Steve Easterbrook <i>School of the Environment and Department of Computer Science, University of Toronto</i>
9:40 - 10:00	<b>TALK:</b> Component Level Regression Testing in a Hierarchical Architecture	Thomas Clune <i>NASA Goddard Space Flight Center</i>
10:00 - 10:20	<b>TALK:</b> High Performance Climate and Weather Benchmark (HPCW): a framework for reproducible benchmarks of ESM models and mini-applications	David Guibert <i>Center for Excellence in Performance Programming, Eviden</i>
10:20 - 10:50	<b>BREAK</b>	
10:50 - 11:10	<b>TALK:</b> Correctness Challenges in HPC and ML	Harvey Dam, Ganesh Gopalakrishnan <i>Department of Computer Science, University of Utah</i>
11:10 - 11:30	<b>TALK:</b> Reliable and reproducible Earth System Model data analysis with ESMValTool	Valeriu Predoi* <i>NCAS-CMS, University of Reading</i>
11:30 - 11:50	<b>TALK:</b> Testing approach for porting legacy 4-mode Modal Aerosol Model (MAM4) to C++/Kokkos	Balwinder Singh <i>Atmospheric Sciences and Global Change Division, Pacific Northwest National Laboratory</i>
11:50 - 12:10	<b>TALK:</b> Verification of the ICON model with the GT4Py dycore - challenges and insights	Abishek Gopal* <i>Institute for Atmospheric and Climate Science, ETH Zurich</i>
12:10 - 1:10	<b>LUNCH</b>	<i>Mesa Lab Cafeteria</i> <i>Included with Registration</i>



# Thursday Afternoon

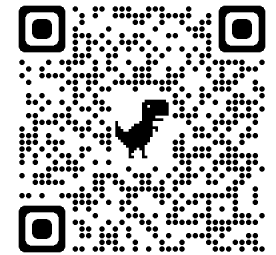
12:10 - 1:10	<b>LUNCH</b>	<i>Mesa Lab Cafeteria</i> <i>Included with Registration</i>
1:10 - 2:10	<b>KEYNOTE:</b> Earth system models of the future	Peter Dueben* <i>Earth System Modelling Section, European Centre for Medium Range Weather Forecasts (ECMWF)</i>
2:10 - 2:30	<b>TALK:</b> A Theory of Scientific Programming Efficacy	Michael Coblenz <i>Department of Computer Science, UC San Diego</i>
2:30 - 2:50	<b>TALK:</b> An overview of the MOM6 development cycle	Marshall Ward* <i>Geophysical Fluid Dynamics Lab, NOAA</i>
2:50 - 3:20	<b>BREAK</b>	
3:20 - 3:40	<b>TALK:</b> Challenges in Ensuring Reproducibility for Machine Learning Weather Model Training and Deployment	David John Gagne <i>Computational and Information Systems Lab, NCAR</i>
3:40 - 4:00	<b>TALK:</b> METplus: The Long and Winding Road to Unified Verification	Tara Jensen* <i>Research Applications Lab, NCAR</i>
4:00 - 4:20	<b>TALK:</b> Unit Testing NCEPLIBS	Edward Hartnett <i>CIRES/NOAA</i>
4:20 - 5:00	<b>OPEN DISCUSSION</b>	





# Friday Morning

8:30 - 9:30	<b>KEYNOTE:</b> Lightweight Formal Methods: The What, Why, and How	John Baugh* <i>Civil Engineering and Operations Research, North Carolina State University</i>
9:30 - 9:50	<b>TALK:</b> What could the next 30 years of software verification in climate science look like?	Dominic Orchard* <i>Department of Computer Science and Technology, University of Cambridge and School of Computing, University of Kent</i>
9:50 - 10:10	<b>TALK:</b> Parallel reproducibility of the SHYFEM-MPI model	Francesco Carere* <i>Euro Mediterranean Center on Climate Change Foundation (CMCC Foundation)</i>
10:10 - 10:40	<b>BREAK</b>	
10:40 - 11:40	<b>KEYNOTE:</b> Contained Chaos: Quality Assurance for the Community Earth System Model	Dorit Hammerling <i>Applied Mathematics and Statistics, Colorado School of Mines</i>
11:40 - 12:00	<b>TALK:</b> Methods and Tools for the Application of UF-ECT to New Climate Models	Teo Price-Broncucia <i>Department of Computer Science University of Colorado Boulder</i>
12:00 - 12:20	<b>TALK:</b> Ensure the correctness and reproducibility in UFS Weather Model CI	Jun Wang <i>NOAA NWS/EMC</i>
12:20 - 1:20	<b>LUNCH</b>	<i>Mesa Lab Cafeteria</i> <i>Included with Registration</i>



# Friday Afternoon

12:20 - 1:20	<b>LUNCH</b>	<i>Mesa Lab Cafeteria</i> <i>Included with Registration</i>
1:20 - 1:40	<b>TALK:</b> Towards Ensuring Statistical Climate Reproducibility of Earth System Models in the Exascale Age	Salil Mahajin <i>Computational Earth Sciences Group, Oakridge National Laboratory</i>
1:40 - 2:00	<b>TALK:</b> Improvements in Reproducibility Testing Through False Discovery Rate Correction	Michael Kelleher <i>Computational Earth Sciences Group, Oakridge National Laboratory</i>
2:00 - 3:30	<b>PANEL:</b> Correctness and verification across platforms <b>Panelists:</b> <ul style="list-style-type: none"><li>- Ilene Carpenter, Hewlett Packard Enterprise</li><li>- Karsten Peters-von Gehlen, Deutsches Klimarechenzentrum GmbH (DKRZ)</li><li>- Ganesh Gopalakrishnan, University of Utah</li><li>- Aaron Donahue, Livermore National Laboratory</li></ul> <b>Moderator:</b> Brian Dobbins, NCAR	
3:30 - 4:00	<b>BREAK</b>	
4:00 - 5:00	<b>CLOSING DISCUSSION</b>	

