

### Katherine Evans\*

# Verification

Does the model work?

Continent-scale, dynamical, ice-flow models are computationally expensive and have large, complex code bases. As developers add in new, cutting-edge, methods from researchers, there is a strong need to be able to determine the effects of changes on the model solution. By comparing new model output against a preserved model output, or benchmark, we can determine if, and how much a new feature or method effects the model solution. Because of the complexity of the code base, these evaluations need to happen for each and every change to the model.

## Automatic verification tests with LIVV



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# LIVVkit: Advanced software and workflow for analysis of continental-scale ice-sheet modeling

Joseph Kennedy\*

Andrew Bennett\* Patrick Worley\*

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Scaled Difference

# Performance

### How well does it work?

Continent-scale, dynamical, ice-flow models are computationally expensive and have large, complex code bases. As developers add in new, cutting-edge, methods from researchers, there is a strong need to be able to determine the effects of changes on the model solution. By comparing new model output against a preserved model output, or benchmark, we can determine if, and how much a new feature or method effects the model solution. Because of the complexity of the code base, these evaluations need to happen for each and every change to the model.

## Automatic performance tests with LIVV

A plots for dome240         Ing Summary         ade         Yarlable       Average       Minimum       Maximum         10 Writeback       0.22400 (-0.001)       0.21100 (-0.010)       0.23000 (0.000)         Simple Glide       15.15800 (+15.158)       15.15800 (+15.158)       15.15800 (+15.158)         Initial Diagonal Soive       15.52000 (-0.068)       14.84300 (-0.562)       15.78600 (0.000)         Velocity Driver       15.51727 (-0.068)       14.84200 (-0.561)       15.78300 (0.000)         News/fik/Documents/Code/LIVV/perf test/dome240/data_ittan /out.240.glide.timing/cism       N/A       N/A       N/A         Initial Diagonal Soive       64.33670 (0.000)       47.50600 (0.000)       131.54500 (0.000)         Velocity Driver       64.33870 (0.000)       47.50600 (0.000)       131.54200 (0.000)         Velocity Driver       64.33870 (0.000)       47.50600 (0.000)       131.54200 (0.000)         Velocity Driver       64.33870 (0.000)       47.50600 (0.000)       131.54200 (0.000)         Ifguration Files       Maximu       Maximu       Maximu         dome.240.glissade.config Files match       Gene.240.glissade.config Files match       His match	Ite       Ite         ing Summary       sade <ul> <li>Ite State</li> <li>It</li></ul>	ne performance of various t	est cases.				
And Control       Minimum       Maximum         Ing Summary       0.21100 (0.010)       0.23000 (0.000)       0.0000         Simple Glide       0.24000 (0.001)       0.21100 (0.010)       0.23000 (0.000)         Intial Diagonal Solve       15.15800 (1.51.58)       15.15800 (1.51.58)       15.15800 (0.000)         Intial Diagonal Solve       15.52000 (0.068)       14.84300 (0.562)       15.78600 (0.000)         Velocity Driver       15.51727 (-0.68)       14.84200 (-0.561)       15.78300 (0.000)         New More/Ijk/Documents/Code/LINV/perf test/dome240/data_titan       N/A       N/A       N/A         Noto (0.000)       Velocity Driver       64.33870       47.50600       131.54200 (0.000)         New More/Ijk/Documents/Code/LINV/perf test/dome240/data_titan       N/A       N/A       N/A         Noto (0.000)       Velocity Driver       64.33870       47.50600       131.54200 (0.000)         Velocity Driver       64.33870       47.50600       131.54200 (0.000)       (0.000)       (0.000)         Velocity Driver       64.33870       47.50600       131.54200 (0.000)       (0.000)       (0.000)       (0.000)       (0.000)       (0.000)       (0.000)       (0.000)       (0.000)       (0.000)       (0.000)       (0.000)       (0.000)       (0.000) </th <th>Ite       Ite         ing Summary       sade            <ul> <li>Ite State</li> <li>It</li></ul></th> <th>0 dome120 dome240 dor</th> <th>me500 scalingDome</th> <th></th> <th></th> <th></th> <th></th>	Ite       Ite         ing Summary       sade <ul> <li>Ite State</li> <li>It</li></ul>	0 dome120 dome240 dor	me500 scalingDome				
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/out.240.glide.timing/cism_timing_stats       N/A       N/A       N/A         /out.240.glide.timing/cism_timing_stats       N/A       N/A       N/A         Initial Diagonal Solve       64.33670       47.50900       131.54500         (0.000)       Velocity Driver       64.33380       47.50600       131.54200         (0.000)       0.0000       0.00000       0.00000       0.00000         Simple Glide       0.00000       0.00000       0.00000         (0.000)       0.00000       0.00000       0.00000         (0.000)       0.00000       0.00000       0.00000         (0.000)       0.00000       0.00000       0.00000         (0.000)       0.00000       0.00000       0.00000         (0.000)       0.00000       0.00000       0.00000         (0.000)       0.00000       0.00000       0.00000         (0.000)       0.00000       0.00000       0.00000         (0.000)       0.00000       0.00000       0.00000         (0.000)       0.00000       0.00000       0.00000         (0.000)       0.00000       0.00000       0.00000         (0.000)       (0.0000)       (0.0000)       0.00000         (0.00	/out.240.glide.timing/cism_timing_stats       IN/A       IN/A       IN/A         /out.240.glide.timing/cism_timing_stats       IN/A       IN/A       IN/A         Initial Diagonal Solve       64.33670       47.50900       131.54500         (0.000)       Velocity Driver       (0.000)       (0.000)       (0.000)         Velocity Driver       (0.000)       (0.000)       (0.000)       (0.000)         Simple Glide       0.00000       0.00000       (0.000)       (0.000)         filguration Files						
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Velocity Driver Simple Glide         64.33380 (0.000)         47.50600 (0.000)         131.54200 (0.000)           0.00000 (0.000)         0.00000 (0.000)         0.00000 (0.000)         0.00000 (0.000)         0.00000 (0.000)           figuration Files         dome.240.config Files match	Velocity Driver Simple Glide       64.33380 (0.000)       47.50600 (0.000)       131.54200 (0.000)         • oliguration Files         • dome.240.config Files match         • dome.240.glissade.config Files match         • dome.240.glide.config Files match         • dome.240.glide.config Files match						131.54500
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	rformed by fjk at 04-07-2015 16:29:42 a of code	Files match	Sim	-	0.00000	0.00000	0.00000
	rformed by fjk at 04-07-2015 16:29:42 a of code	<ul> <li>dome.240.config Files match</li> <li>dome.240.glissade.con Files match</li> <li>dome.240.glide.config</li> </ul>	nfig	-	0.00000	0.00000	0.00000
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formed by fjk at 04-07-2015 16:29:42 of code		<ul> <li>+ dome.240.config Files match</li> <li>+ dome.240.glissade.con Files match</li> <li>+ dome.240.glide.config Files match</li> </ul>	nfig	-	0.00000	0.00000	0.00000
		<ul> <li>dome.240.config Files match</li> <li>dome.240.glissade.con Files match</li> <li>dome.240.glide.config Files match</li> <li>rformed by fjk at 04-07-203</li> </ul>	nfig	-	0.00000	0.00000	0.00000
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Test case description and	Test case description and	<ul> <li>dome.240.config Files match</li> <li>dome.240.glissade.con Files match</li> <li>dome.240.glide.config Files match</li> <li>dome.240.glide.config Files match</li> </ul>	nfig 15 16:29:42	ple Glide	0.00000 (0.000)	0.00000	0.00000
Test case description and	•	<ul> <li>dome.240.config Files match</li> <li>dome.240.glissade.con Files match</li> <li>dome.240.glide.config Files match</li> <li>dome.240.glide.config Files match</li> </ul>	nfig 15 16:29:42 descriptio	ple Glide	0.00000 (0.000)	0.00000	0.00000
Test case description and illustrations	•	<ul> <li>dome.240.config Files match</li> <li>dome.240.glissade.con Files match</li> <li>dome.240.glide.config Files match</li> <li>dome.240.glide.config Files match</li> </ul>	nfig 15 16:29:42 descriptio	ple Glide	0.00000 (0.000)	0.00000	0.00000

Comparison of test con

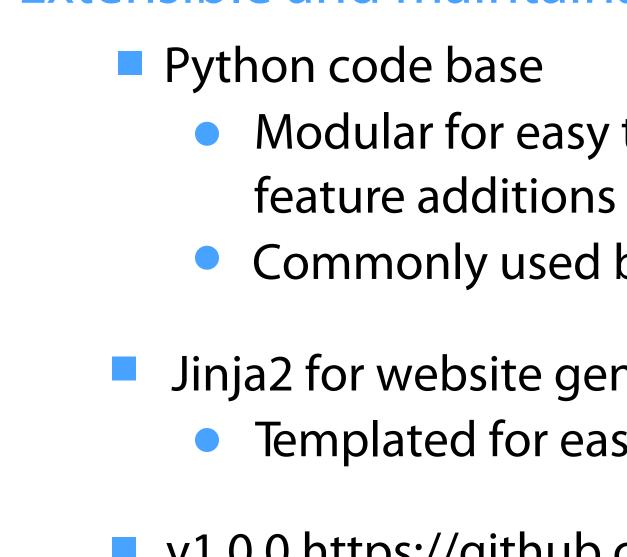
### Internal dependency management

Automatic website generation

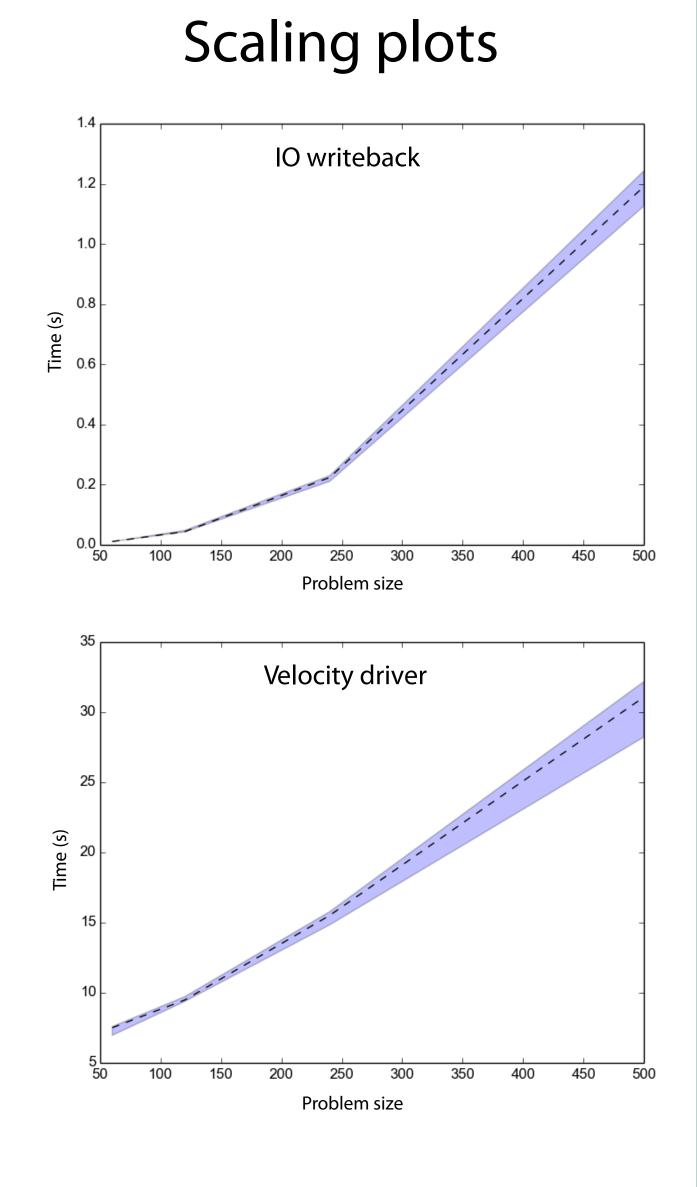
Command line options or saved

Open Source release on github 7/15/2015

figurations



Stephen Price Matthew Hoffman



Automatic generation for multiple, relvant metrics.

### Extensible and maintainable

- Modular for easy test and Commonly used by scientists
- Jinja2 for website generation Templated for easy changes

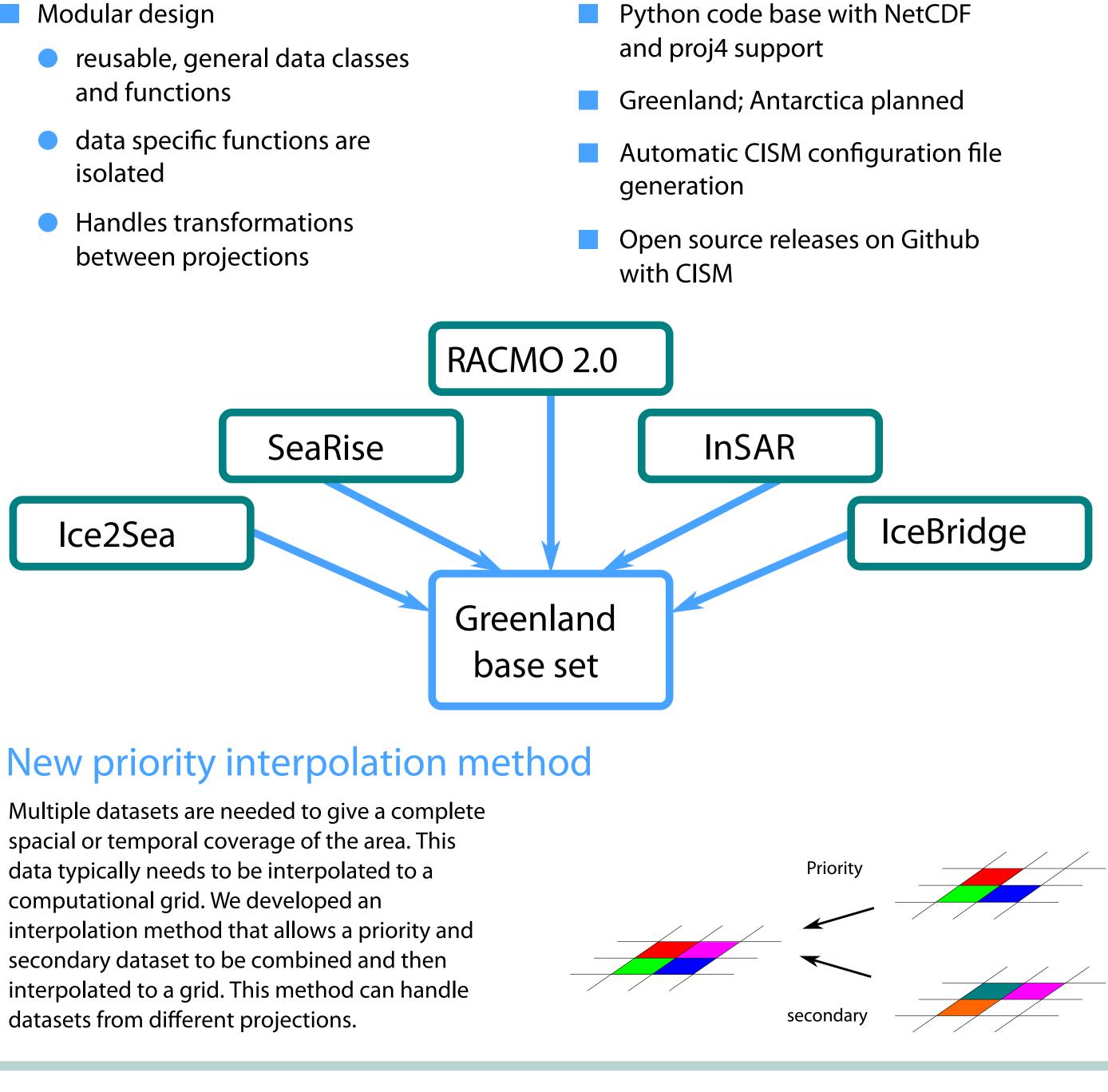
v1.0.0 https://github.com/LIVVkit/LIVVkit

### Present day initialization and comparison

To quantify how well continent-scale, dynamical, ice-flow models capture the true dynamics of polar ice sheets, a robust validation procedure is being developed as well. Recent advances in data collection tools and data analysis procedures are enalbing us to create a proper set of initial conditions for present-day simulations. The next step is to perform validation of these runs, often using similar techniquies to prepare the data. As a statring point we creat the initial data sets using a suite of scripts to interpolate the data to the model grid.



- and functions
- isolated
- between projections



# Planned development

### Soon

- Support more CISI dycores
- More performance metrics and plots
- Initial validation te
- Newer datasets

This work is based upon work, authored in part by contractors [UT-Battelle LLC, manager of Oak Ridge National Laboratory (ORNL)], and supported by the U.S. Department of Energy, Office of Science, Office of BER and ASCR SciDAC PISCEES project. This study used the resources of the Oak Ridge Leadership Computing Facility at the Oak Ridge National Laboratory, which is supported by the Office of Science of the U.S. Department of Energy under Contract No. DE-AC05-00OR22725.







# Validation

## Methodology

	Later				
5M	Integrate into developer work flow				
ce S	Nightly builds and tests of CISM				
tests	Antarctica!				
	Support other ice-sheet models				