

# Land Ice Verification and Validation Kit

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# LIVV Kit 'Raison d'etre'

- ⊗ Provide verification test suite for CISM testing as standalone and within CESM
- ⊗ Nightly autotesting of the code for bit-4-bit reproducibility
- ⊗ Python and NCL based code, points to baseline test results
- ⊗ Operates on glide or glissade dycores, and will extend it to others as they are incorporated into CISM
- ⊗ Comes with submit scripts designed for OLCF, NERSC, MAC OSx and rel06 platforms
- ⊗ Performance V&V operational on Titan and Hopper\* (several punch list items)
- ⊗ Validation has begun. LIVV can create some test plots given a data source.

# Basic Workflow on LCF Systems

- ⊗ Download CISM code to hopper/titan/mac/linux box
- ⊗ Use Doug Ranken's (LANL) new auto build/run/test script on a given platform
  - ⊗ Copy over reg\_test and perf\_test from the project space location to access benchmark results for a given machine
  - ⊗ Copy over the /higher\_order directory from the CISM repo to the execution area (LCF only)
  - ⊗ Build and run code in glide and glissade modes. If successful, it will run all the tests for b4b and performance within a predefined envelope
- ⊗ Access to LIVV will be in carver/rhea/mac/blizzard in /higher-order
  - ⊗ Select options of interest (evaluate performance or just output?)
  - ⊗ Execute the script, view the website

# Main Page: Auto-verification and Docs

blizzard.ornl.gov/~ism/index.php - PISCES Main Page

Home

Regressions

README

Developers

## • LIVV: Land Ice Validation & Verification

### Latest Regression is bit for bit

A growing community of climate and computational scientists will be developing new versions of multiple CISM dycores. To support this development and maintain confidence in the mode, The LIVV kit within the PISCES (Predicting Ice Sheet and Climate Evolution at Extreme Scales) DOE SciDAC project provides robust, standardized model verification and validation. Verification aims to detect errors in the numerical and computational representation of a given mathematical model due to discretization or implementation errors (bugs). Validation then aims to quantify how well the model represents the physical processes being simulated.

Tests based on analytical and benchmark solutions are combined into a single executable LIVV script environment targeting the CISM2 model. As new dycores are implemented, we will need to verify developments that are not covered by standard test cases, such as spatial discretization, time stepping, and boundary conditions. We will extend the LIVV kit to run configured models over the desired parameter space and provide quantitative and graphical output.

PISCES is jointly funded by the Office of Biological and Environmental Research (BER) and the Office of Advanced Scientific Computing Research (ASCR) of the DOE Office of Science.

## • LIVV: Land Ice Validation & Verification

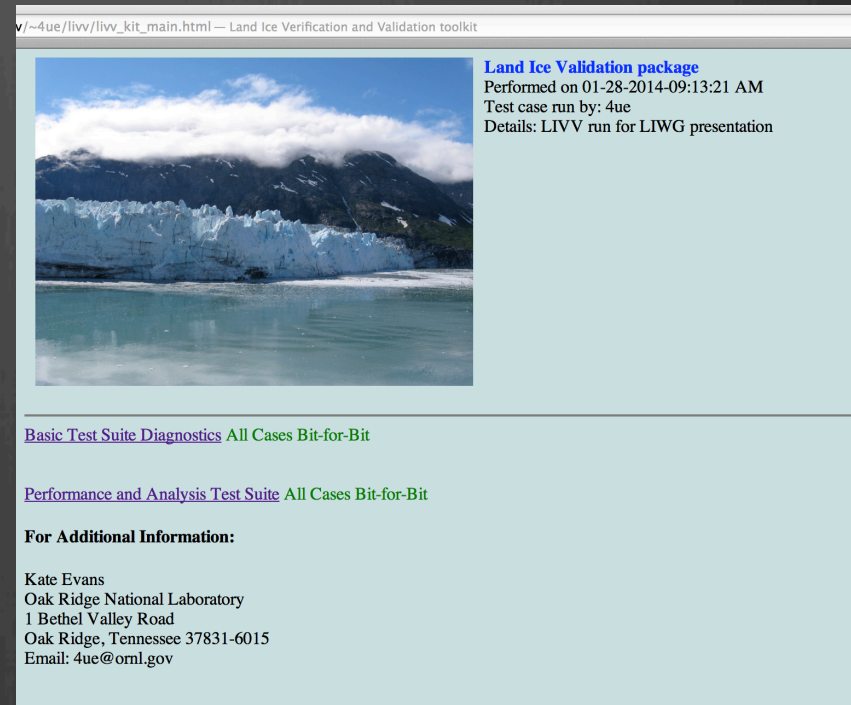
### Last 10 Regression Runs

- [Run on November 18 2013 at 01:13 AM](#): Is bit for bit
- [Run on November 17 2013 at 01:13 AM](#): Is bit for bit
- [Run on November 16 2013 at 01:13 AM](#): Is bit for bit
- [Run on November 15 2013 at 01:13 AM](#): Is bit for bit
- [Run on November 14 2013 at 01:13 AM](#): Is bit for bit
- [Run on November 13 2013 at 01:13 AM](#): Is bit for bit
- [Run on November 12 2013 at 01:13 AM](#): Is bit for bit
- [Run on November 11 2013 at 01:13 AM](#): Is bit for bit
- [Run on November 10 2013 at 01:13 AM](#): Is bit for bit
- [Run on November 09 2013 at 01:13 AM](#): Is bit for bit

unded by the Office of Biological and Environmental Research (BER) and the Office of Advanced Scientific  
(ASCR) of the DOE Office of Science.

# Title Page for each LIVV run: Production or Test Suite Output

- ❁ User decides to run Verification, Performance, and/or Validation tests.
- ❁ LIVV runs all tests for which there is output for each type of run
- ❁ Top level assessment for verification, so no need to delve further



The screenshot shows a web browser window with the URL `v/~4ue/livv/livv_kit_main.html` and the page title "Land Ice Verification and Validation toolkit". The main content area features a photograph of a large glacier. To the right of the image, the text reads: "Land Ice Validation package", "Performed on 01-28-2014-09:13:21 AM", "Test case run by: 4ue", and "Details: LIVV run for LIWG presentation". Below the image, there are two links: "Basic Test Suite Diagnostics All Cases Bit-for-Bit" and "Performance and Analysis Test Suite All Cases Bit-for-Bit". At the bottom, under the heading "For Additional Information:", contact details for Kate Evans at Oak Ridge National Laboratory are provided, including the address, phone number, and email address.

\*Website location can be set as a subdirectory of a project  
Example: [http://users.nccs.gov/~4ue/livv/livv\\_kit\\_main.html](http://users.nccs.gov/~4ue/livv/livv_kit_main.html)

# Test Page: 3 types of info and a hierarchy of information

~/4ue/livv/test\_suite.html — Test Suite Diagnostics

## Test Suite Diagnostics

[Test Suite Descriptions](#)

**Diagnostic Dome 30 Test: Bit-for-Bit**

[Velocity Solver Details](#)  
[Case and Parameter Settings Details](#)  
[Plots](#)  
Time of Last Simulation: 01/27/2014 08:34 AM

**Evolving Dome 30 Test: Bit-for-Bit**

[Velocity Solver Details](#)  
[Case and Parameter Settings Details](#)  
[Plots](#)  
Time of Last Simulation: 01/27/2014 08:34 AM

**Circular Shelf Test: Bit-for-Bit**

[Velocity Solver Details](#)  
[Case and Parameter Settings Details](#)  
[Plots](#)  
Time of Last Simulation: 01/27/2014 08:34 AM

**Confined Shelf Test: Bit-for-Bit**

[Velocity Solver Details](#)  
[Case and Parameter Settings Details](#)  
[Plots](#)  
Time of Last Simulation: 01/27/2014 08:34 AM

**ISMIP HOM A 80KM Test: Bit-for-Bit**

[Velocity Solver Details](#)  
[Case and Parameter Settings Details](#)  
[Plots](#)  
Time of Last Simulation: 01/27/2014 08:34 AM

**ISMIP HOM A 20KM Test: Bit-for-Bit**

[Velocity Solver Details](#)

- BFB check for each test
- Times of last simulation to check if new
- Velocity Solver Details
  - Nonlinear and Linear iteration count
  - Presented in plot or list form depending on whether it's a time dependent case
- Case Details
  - All runtime settings are listed as a reference and for reproducibility
- Output plots of the benchmark, new run, and difference are presented for comparison

# Test case configuration

- Runtime settings for the code are presented for each case and highlighted in red if different from the benchmark values
- Settings within the code are not incorporated (should be moved to runtime if changed frequently)

## Case Details:

### Configure File Settings

Output available from test run: acab artm beta topg thk usurf uvel vvel vvel flwa velnorm temp bheatflx bmlt bwat kinbcmask  
Grid Size (vert by ew by ns): 11x150x280  
Grid Spacing (ew by ns): 10000x10000  
Start/End Time: 0.,10.0, Number of time steps = 10.0

### Parameters

-----  
flow\_factor = 1

### Options

-----  
flow\_law = 2 different than benchmark value: 0  
evolution = 3  
temperature = 1 different than benchmark value: 3

### HO Options

-----  
which\_ho\_babc = 4  
which\_ho\_efvs = 2 different than benchmark value: 0

## Velocity Solver Settings:

### XML File Settings

-----  
Preconditioner: Picard

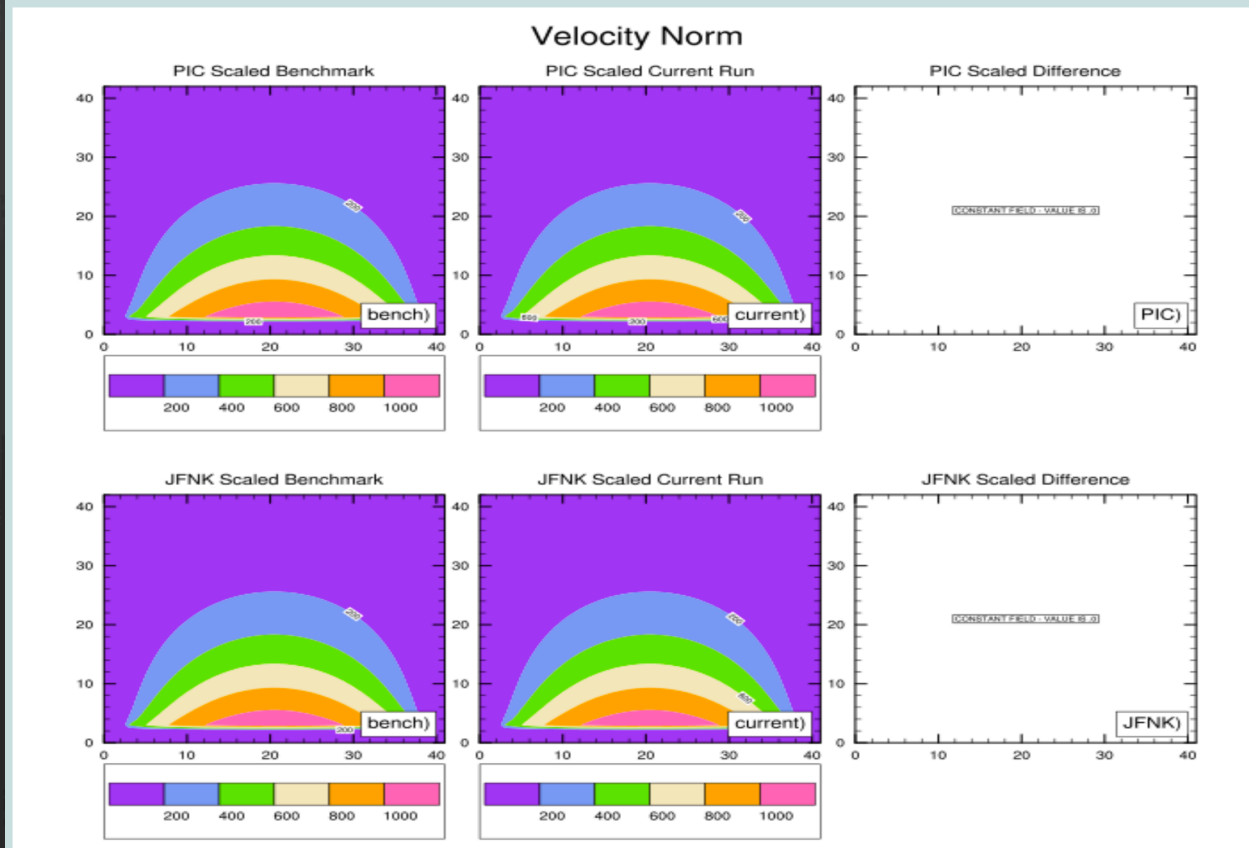
-----  
Block GMRES: Convergence Tolerance = 1e-11  
Block GMRES: Maximum Iterations = 100  
Preconditioner Type = Ifpack  
Prec Type = ILU  
Overlap = 1  
Fact: Level-of-Fill = 1

-----  
Solver: NK

-----  
Newton: Jacobian Operator = Matrix-Free  
Newton: Forcing Term Method = Type 2  
Newton: Forcing Term Alpha = 2.0  
Newton: Forcing Term Gamma = 0.10

# Tri-Plots (Test, Benchmark, and Difference Plots)

Difference from Benchmark for Velocity Norm





# Performance V&V (pLIVV)

- ⊗ Development of automated information and metrics to evaluate performance of code
  - ⊗ Regression tests of performance changes
  - ⊗ Quantify performance changes due to new code features or bugs
- ⊗ Simple dome problem for a range of problem sizes(60,120,240,500) to exercise scaling and performance behavior is included
- ⊗ `perf_test` benchmark directory structured like `reg_test`
- ⊗ Run 10 benchmark simulations to gather min, max, average stats about run speed.

# Test Runs for Performance

- ❁ Dome 60 through Dome 500 to enable problem size scaling info
- ❁ Contains similar verification checks with plots and configure settings as with test problems
- ❁ Case run times are compared to a suite of runs on LCF systems, which are variable.

## Performance and Analysis Test Suite

[Test Suite Descriptions](#)

### Diagnostic Dome 60 Test: **Bit-for-Bit**

[Diagnostic Dome 60 Velocity Solver Details](#)

[Solver Parameter Settings: Diagnostic Dome 60 XML Details](#)

[Diagnostic Dome 60 Case Details](#)

Time of Last Simulation: 11/04/2013 01:27 PM

### Diagnostic Dome 120 Test: **Bit-for-Bit**

[Diagnostic Dome 120 Velocity Solver Details](#)

[Solver Parameter Settings: Diagnostic Dome 120 XML Details](#)

[Diagnostic Dome 120 Case Details](#)

Time of Last Simulation: 11/08/2013 05:20 PM

### Diagnostic Dome 240 Test: **Bit-for-Bit**

[Diagnostic Dome 240 Velocity Solver Details](#)

[Solver Parameter Settings: Diagnostic Dome 240 XML Details](#)

[Diagnostic Dome 240 Case Details](#)

Time of Last Simulation: 11/08/2013 05:05 PM

### Diagnostic Dome 500 Test: **Bit-for-Bit**

[Diagnostic Dome 500 Velocity Solver Details](#)

[Solver Parameter Settings: Diagnostic Dome 500 XML Details](#)

[Diagnostic Dome 500 Case Details](#)

Time of Last Simulation: 11/08/2013 05:15 PM

[Home](#)

# pLIVV on LCF systems

**JFNK: Timing Data**

|                                         | Avg           | Max           | Min           | Current Run                   |
|-----------------------------------------|---------------|---------------|---------------|-------------------------------|
| <b>Simple Glide</b>                     | 344.780460069 | 347.8940625   | 342.401523437 | <a href="#">342.032421875</a> |
| <b>Glissade Initial Diag Var Solver</b> | 340.290125868 | 341.254296875 | 339.491875    | <a href="#">339.466875</a>    |
| <b>Glam Velo Driver</b>                 | 340.281848958 | 341.246757812 | 339.485625    | <a href="#">339.456640625</a> |
| <b>Calc F</b>                           | 15.3121831597 | 15.4598554687 | 15.210359375  | 15.2719179687                 |
| <b>Belos: Operation Prec*x</b>          | 309.514726562 | 309.783046875 | 308.902382812 | 309.150078125                 |
| <b>Nox Preconditioner U</b>             | 158.868489583 | 159.48859375  | 158.395742187 | 158.678125                    |
| <b>Nox Preconditioner V</b>             | 150.631193576 | 151.029257812 | 150.250195313 | 150.45703125                  |
| <b>Glide IO Writeall</b>                | 1.12322664931 | 1.20909335937 | 1.08116679688 | <a href="#">1.07027851563</a> |

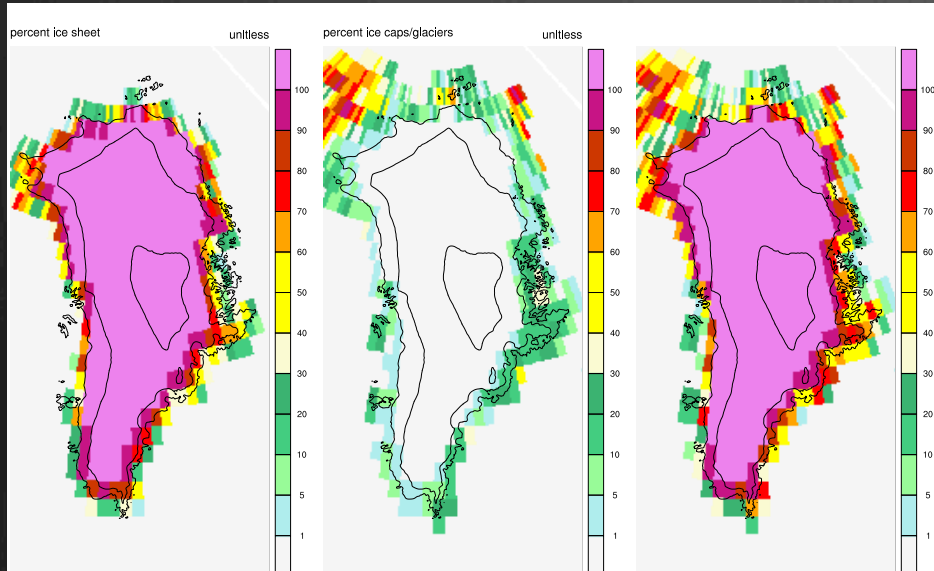
[Less than the Min](#)

**Greater than the Max**

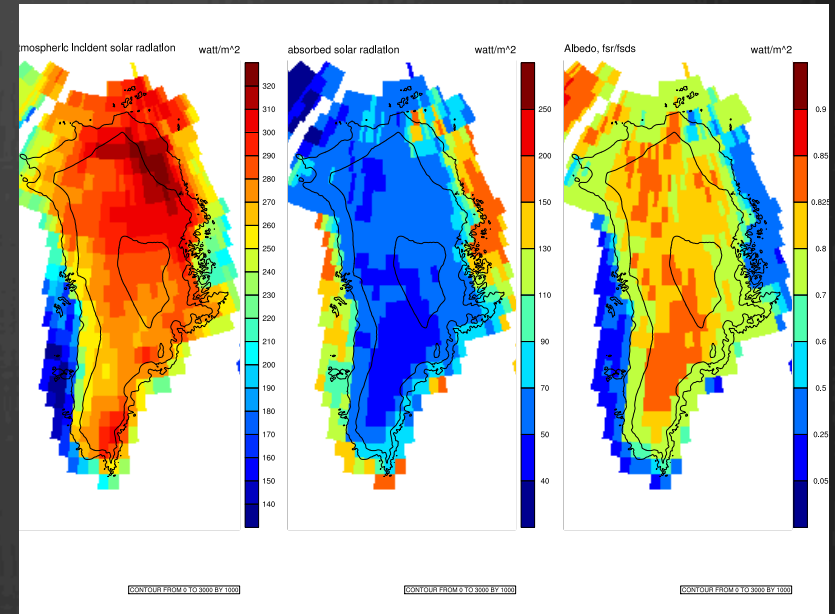
# CISM Validation Plans

- ⊗ Based on Vizcaino et al. (2013) analysis of CESM with an active CISM1 model from 1960-2005.
- ⊗ Settings within LIVV for local model data location and years to analyze
- ⊗ Present mean values in tabular form for a range of ice sheet, atmosphere, and land variables
- ⊗ Present 2D plots for a range of variables in CESM-CISM relevant for ice sheet simulation
- ⊗ Compare to RACMO, reanalysis, and observational data where possible

# CISM Validation Plots



Percent ice sheet, percent glaciers, sum of both



Atmospheric incident, absorbed solar radiation, albedo