Land Ice Verification and Validation Kit

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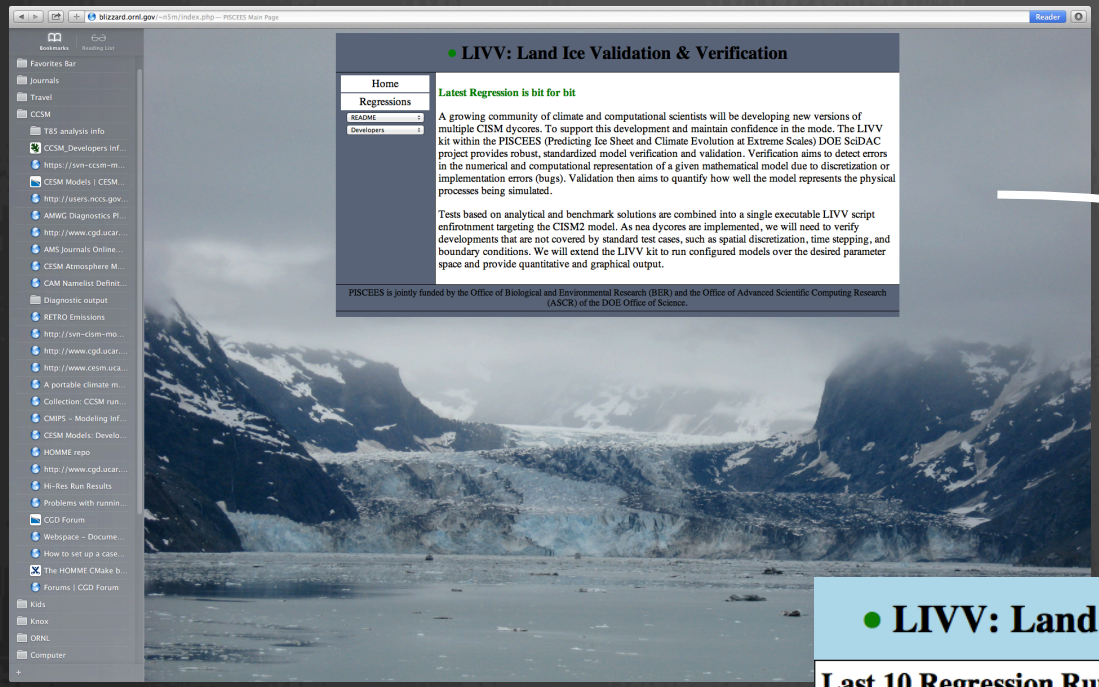
LIVV Kit 'Raison d'etre'

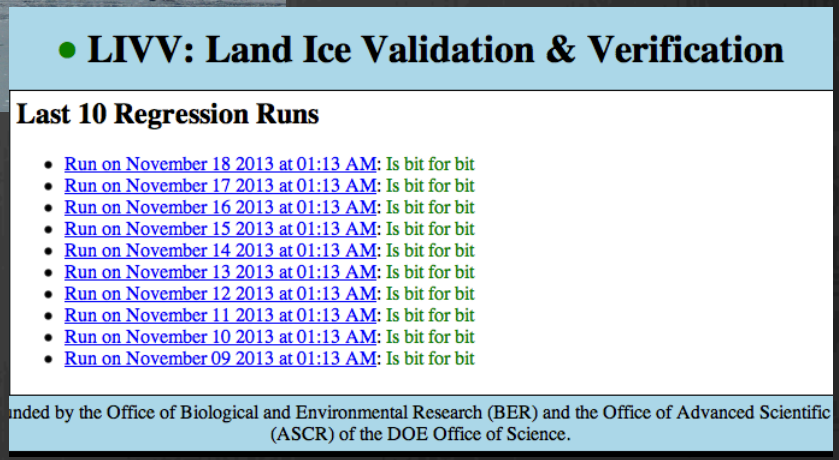
- Provide verification test suite for CISM testing as standalone and within CESM
- Nightly autotesting of the code for bit-4-bit reproducibility
- Python and NCL based code sits within CISM repo
- Based on glide dycore, and working to extend it to others with access to output format to parse/process
- Comes with build, submit, and LIVV set-up script designed for OLCF, NERSC, MAC OSx rel06 platforms
- Performance V&V underway.
- Need to talk as a community about validation, Thanks to Steve and Jer for starting this conversation.

Basic Workflow on LCF Systems

- Access to code on hopper/titan/mac/blizzard
  - Copy over reg_test and perf_test from the project space location on lustre at OLCF for benchmark files
  - Copy over the /higher_order directory from the CISM repo to the execution area (LCF only)
  - Run the master build script for that platform, pointing to reg_test location. If successful, it will launch the submit scripts to the machine and run all the tests
- Access to LIVV 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

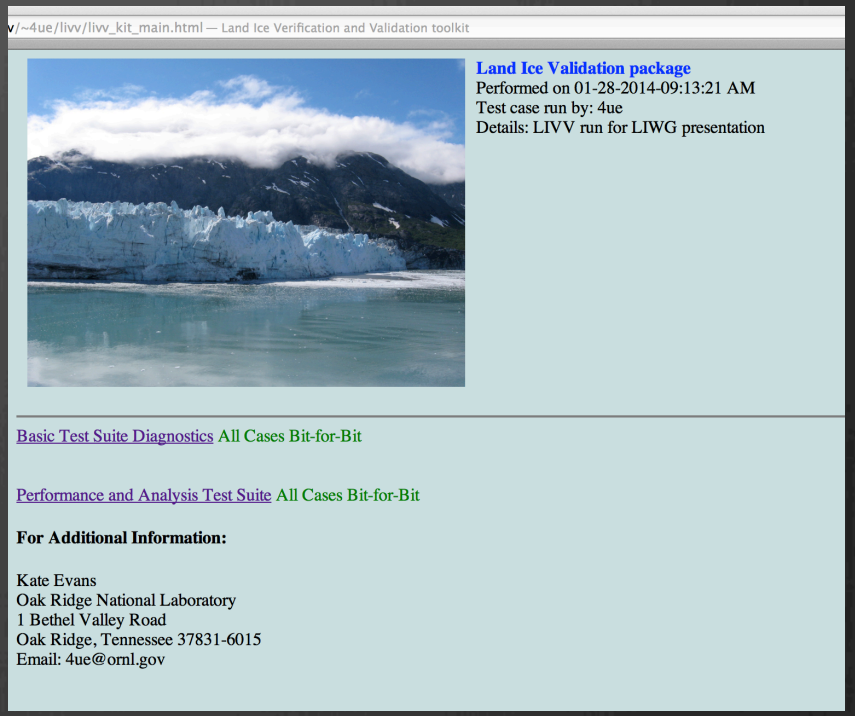




Blizzard.ornl.gov

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



*Website location can be set as a subdirectory of a project
Example: http://users.nccs.gov/~4ue/livv/livv_kit_main.html

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

- 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 wvel 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

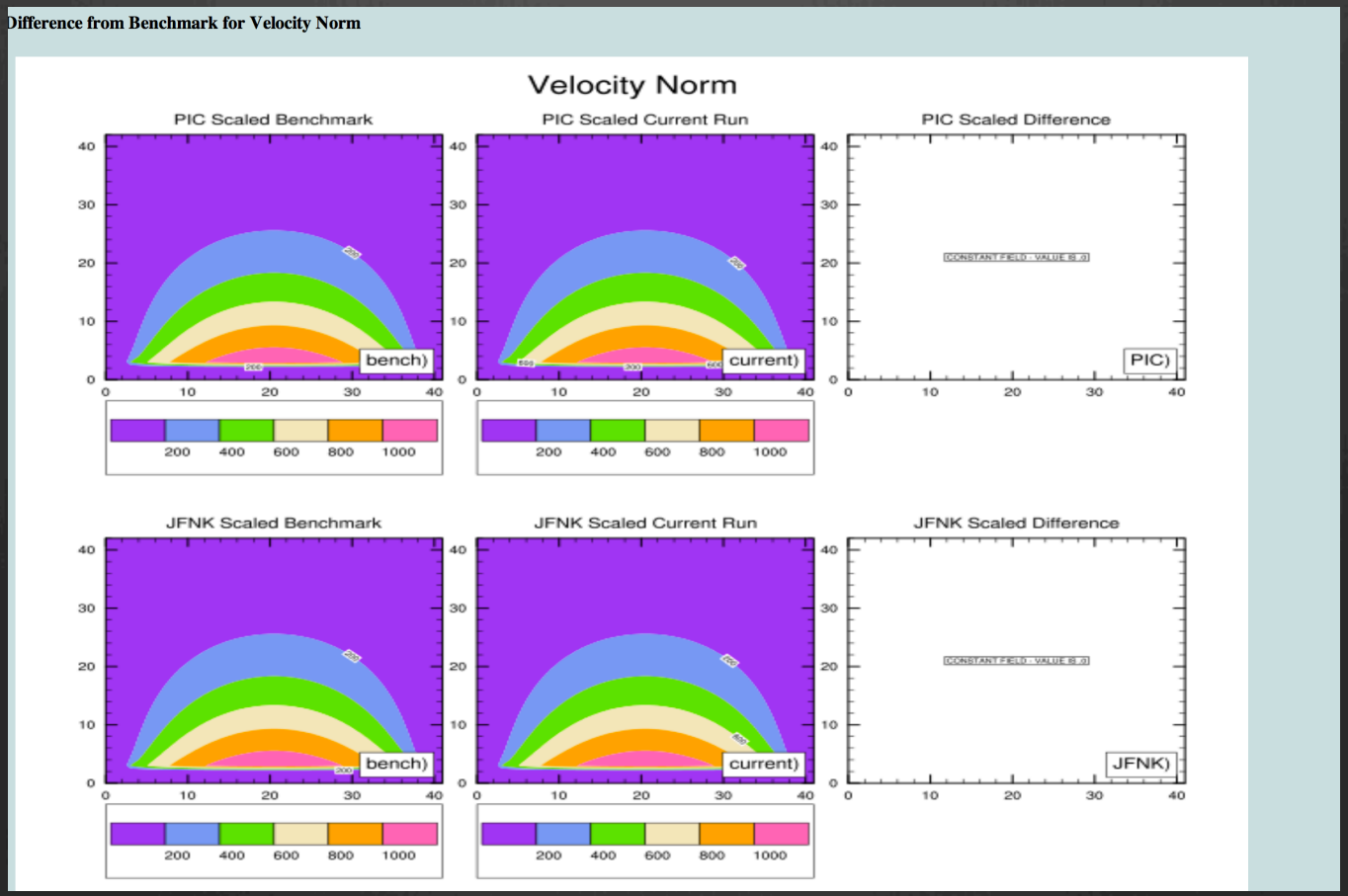
Preconditioner: Picard

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)



Recently added features for verification

- Added capability of selecting specific test cases to run within the bash scripts for LIVV
- Added ismip hom a 20km test case with infrastructure for others
- Include benchmarks from each machine run (titan, hopper, mac, rhel6)
- LIVV automatically creates www directory and puts it in the html path so as not to interfere with user's other webpages
- Comprehensive error messages, proceeding when appropriate
- Improved label bars on contour plots

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 to exercise scaling and performance behavior is included
  - Dome 60,120,240,500,1000
  - Extend to evolving dome
- perf_test benchmark directory structured like reg_test
- GIS 4km,2km,1km steady state have been run and created
  - Next they will be added to perf_test
  - Time stepping added when complete in FELIX (soon!)

Test Runs for Performance

- Dome 60 through Dome 1000 test cases (currently diagnostic, will eventually be evolving) to enable problem size scaling info
- Contains similar verification checks 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

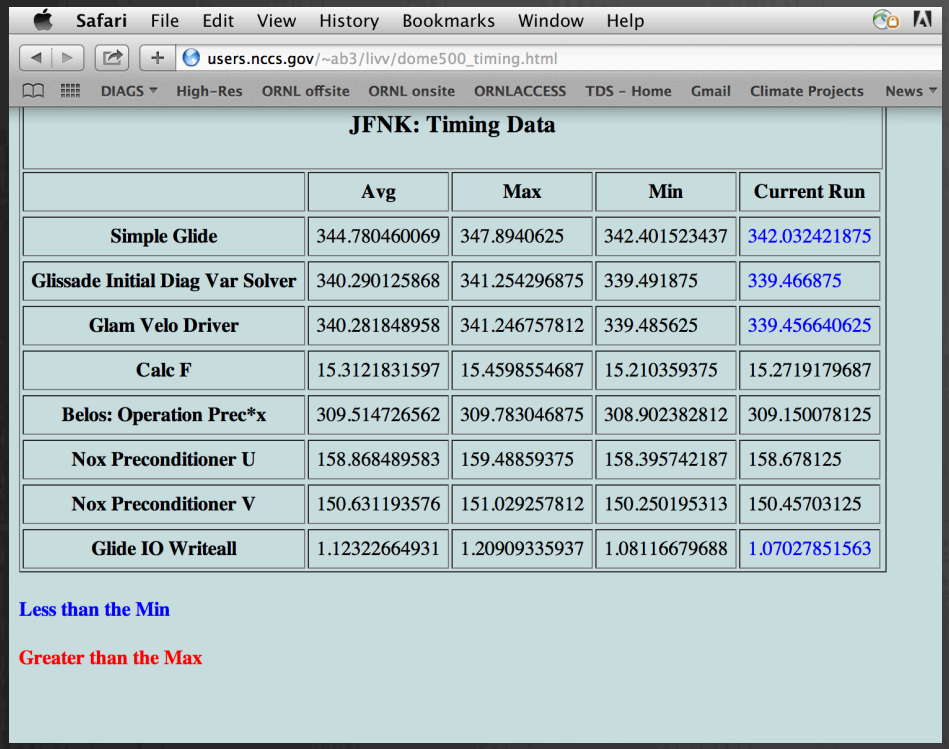
Diagnostic Dome 240 Velocity Solver Details
Solver Parameter Settings: Diagnostic Dome 240 XML Details
Diagnostic Dome 240 Case Details
Time of Last Simulation: 11/08/2013 05:05 PM

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 data collection on LCF systems



JFNK: Timing Data

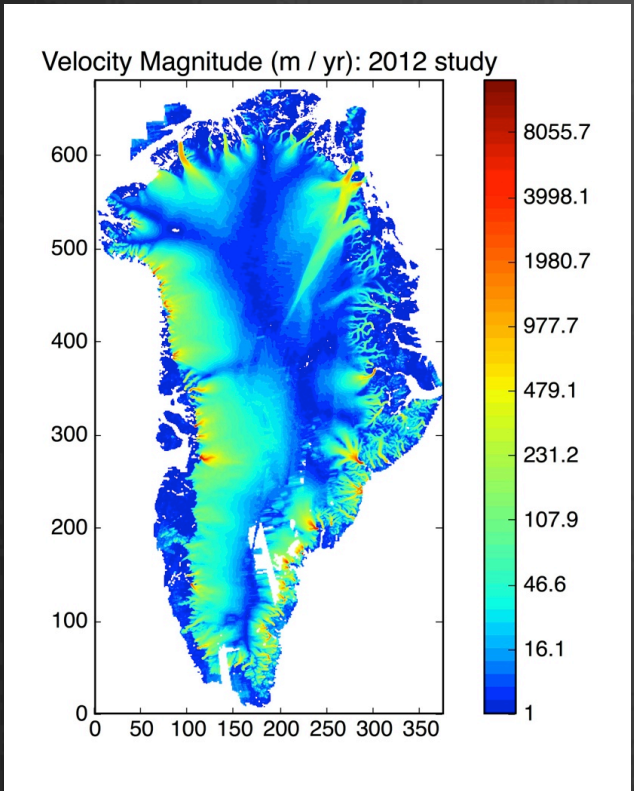
	Avg	Max	Min	Current Run
Simple Glide	344.780460069	347.8940625	342.401523437	342.032421875
Glissade Initial Diag Var Solver	340.290125868	341.254296875	339.491875	339.466875
Glam Velo Driver	340.281848958	341.246757812	339.485625	339.456640625
Calc F	15.3121831597	15.4598554687	15.210359375	15.2719179687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

Less than the Min

Greater than the Max

- Runs of each case performed multiple times to create avg performance using offline scripts
- New runs are compared to the avg and max/min for individual model modules and highlighted if they are outside the range
- Performance behavior is much like climate behavior and so ensembles are useful

Initialization: Greenland Combined Data File

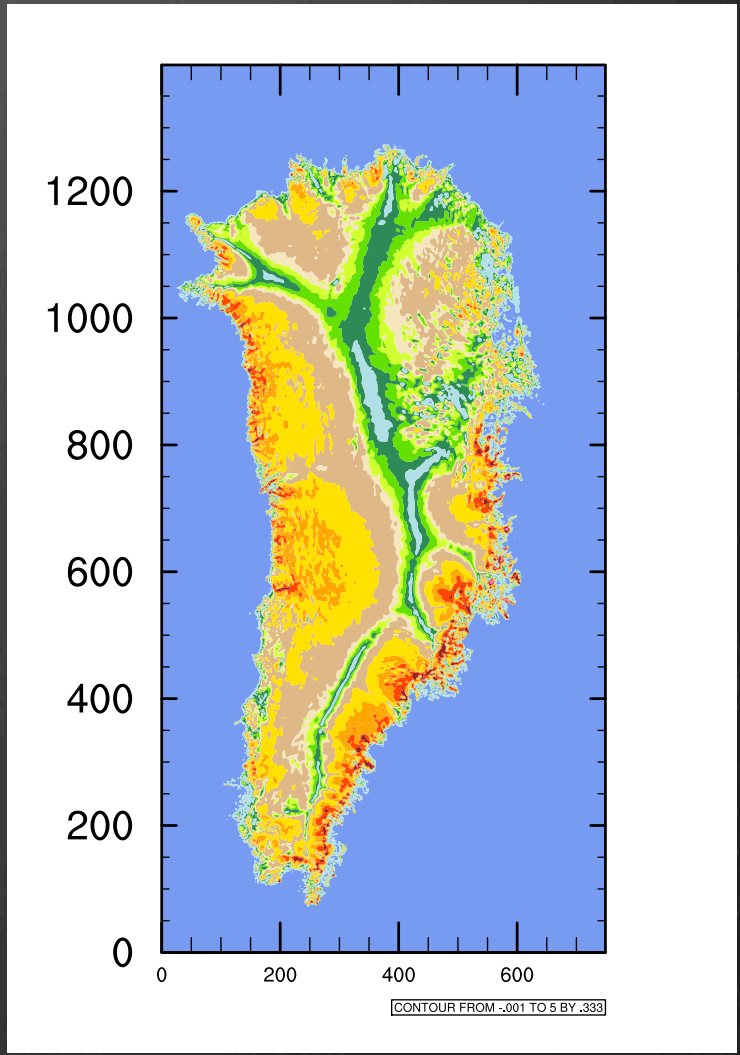


- Data
  - Topography / bathymetry, thickness, upper surface, upper surface error: Bamber, J.L. et al., The Cryosphere, 2013
  - Basal Heat Flux: Shapiro, N.M. & Ritzwoller, M.H., Earth & Plan. Sci. Lett., 2004
  - 2m Air Temp: Ettema J., et al., Geophys. Res. Lett., 2009
  - 1km SMB, Racmo-generated
  - 500m Velocities and errors: Joughin, et al., J. Glaciology, 2010, [Updated in 2012]
- Workflow for 1km files
  - Merge Bamber w/ Basal Heat Flux, 2m Air Temp, & SMB
  - Project velocity data to Bamber projection & interpolate
- Optional hyper-diffusive filter
  - Selectively damp sharp gradients in thickness & upper surface
  - Reconstruct topography from thickness & upper surface

Solving with new initial datasets with the FELIX Dycore

- Initial adjustment step of 4km, 2km, 1km GIS from initial state is very difficult to solve with CISM and is being completed successfully with FELIX
- Like CISM, FELIX solves 'higher-order' version of Stokes
- Need good results for validation (RACMO?)
- Having time stepping option is a priority
- CESM timers to FELIX and Trilinos have been added to provide consistent performance data format, these timers are now available on the mac version of the model

BISICLES is running on titan and within CISM so its next!



Norm of velocity 2km GIS

Near term work to extend and improve the software

- Use benchmark performance data and pLIVV to conduct regular performance testing of BISICLES and FELIX for large-scale problems on NERSC and LCF platforms
- Extend LIVV to include support for regular testing of additional CISM dycores
- Extend LIVV to include support for regular testing of additional model configurations and test cases, including CISM runs coupled to CESM and ACME
- Develop a model validation test case for Greenland, using time series of observed SMB and outlet glacier flux for model forcing and comparing model output to time series of observed surface elevation change

Validation Plans

- Will be done now:
  - Take output from standalone and coupled runs and create plots same as other model components in the coupled case in one place
  - Adapt plots to be maximally useful to CISM folks (i.e. zoom on over high latitudes)
- Will be done next:
  - Take list from Jeremy's tale this AM for the model and add anything not yet captured
- Will be done extending forward
  - Add in comparisons to data and regional models as available