Confidence and credibility

Confidence: feeling or belief that one can rely on something
Credibility: the quality of being trusted and believed in

- Verification and validation (V&V) is a set of confidence building techniques.
- V&V is a continuous process tandem to, and essential to, development.
- V&V is not enough! Credibility relies on:
  - Reproducibility
  - Transparency
  - Discoverability

LIVVkit is designed to build user and developer confidence, as well as, scientific credibility

- Tests and analyses can be quickly repeated
- Results are portable and web-ready
- Integrates easily into the developer workflow
- Nightly builds and tests of CISM (the community ice sheet model)
  - http://blizzard.ornl.gov
  - Runs on PCs and HPCs with the same interface
- Public code releases on github:
  - Code: https://github.com/LIVVkit/LIVVkit
  - Docs: https://github.com/LIVVkit/LIVVkit/wiki
  - Example: http://livvkit.github.io/LIVVkit/
- Private development to protect novel analyses and intellectual property
  - Code: https://github.com/ACME-Climate/LIVV

Verification

Software verification
The process of determining if the software’s implementation accurately represents the developers’ specifications. This is an engineering problem:

“Did we build what we intended?”

Bit-for-bit failure plot

![Bit-for-bit failure plot](image)

Thickness

Failure description with error details -- max and RMSE

Test configuration comparison

Automatic failure plot generation

LIVVkit: verification

Numerical (algorithm) verification
The process of comparing the approximate numerical solution of the model, or parts of the model, against a numerical benchmark (e.g., an analytical solution or a manufactured solution). This is a math problem:

“Are we solving the equations correctly?”

ISMIP-HOM comparison for H0 dynamics:

![ISMIP-HOM comparison](image)

Validation

Software validation
The process of determining how well the software is able to be used for its intended task. In the case of ice-sheet models, especially for those coupled to a global-climate model, performance aspects will be the focus of software validation. This is a design problem:

“Did we build what the users needed?”

Scaling plot

![Scaling plot](image)

Physical validation
The process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model. This is a physics problem:

“Are we using the right physics?”

User example
Jeremy Fyke (LANL) is using LIVVkit to analyze ongoing open-beta stress testing of CISM2 in a ‘real-world’ configuration, using a validation test module that he and Lauren Vargo (UNM/LANL) developed for LIVVkit. The were able to fix a bad configuration setting that resulted in a 2.5 km high ice cliff (bottom-left). All plots were produced by LIVVkit.

LIVVkit: performance

LIVVkit: validation

Planned development

Released soon

- Support more CISM dycores
- Better performance metrics and plots
- Initial validation tests
- Numerics module

Later

- Interactive tables and plots
- Support other ice-sheet models
- Antarctica!
- Suggestions?

Easy deployment

- Internal dependency management
- Automatic website generation

User friendly

- Command line options or saved configurations
- Modular for easy test and feature additions
- Jinja2 for website generation
- Templated for easy changes

Extensible and maintainable

Good Design = Good Tools

Increase productivity