

GeoFramework: Example of using frameworks in geophysics

Mike Gurnis
Caltech

Tectonic Modeling Workshop
June, 2005

A hierarchy of software components

Superstructure

?

Geodynamic Specific

?

Infrastructure

?

Library ?

Superstructure and Geodynamic Specific Layers

Superstructure

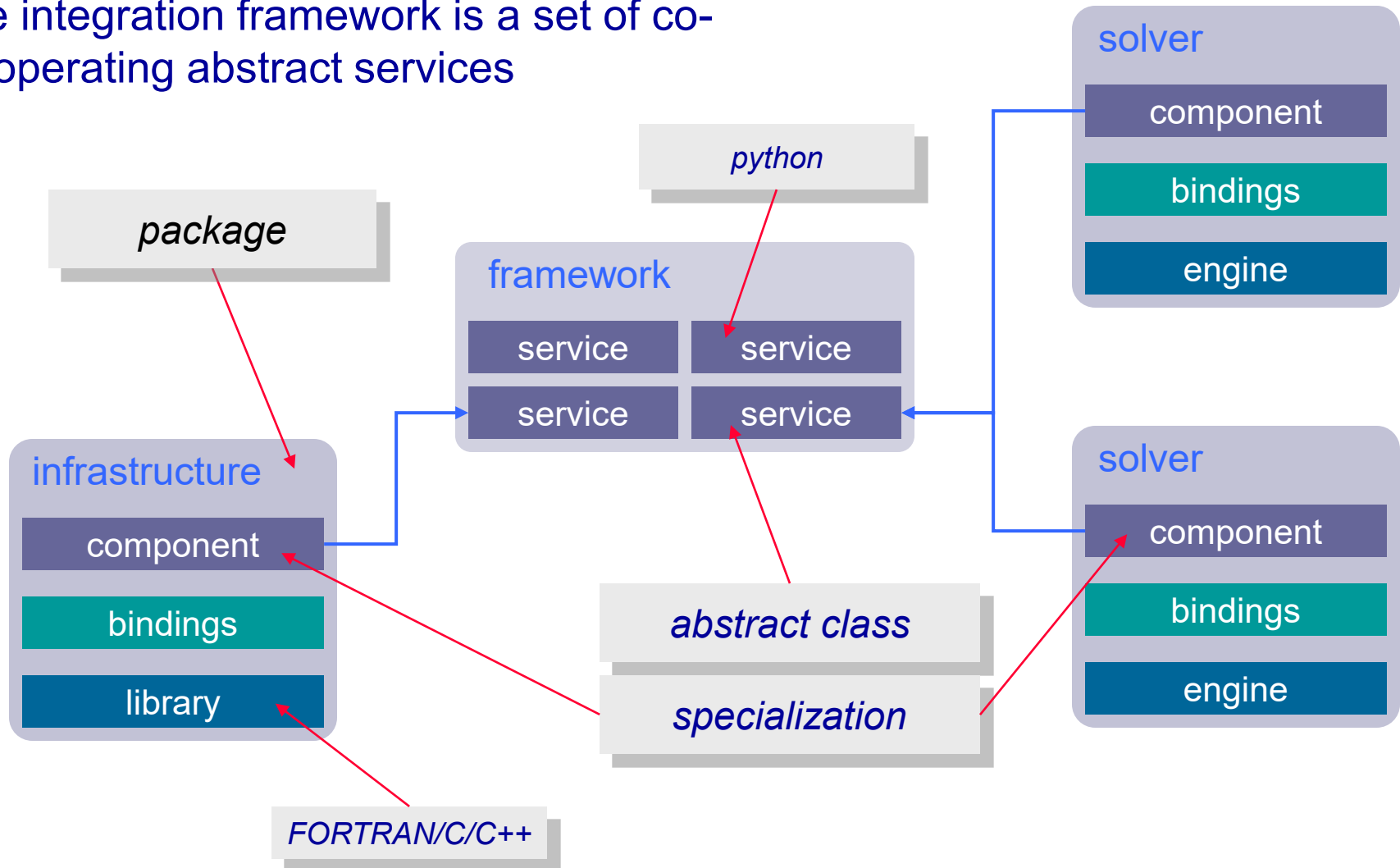
- Simulation controller
- Monitor Simulation
- Couple Fluid to Solid

Geodynamic Specific

- Component A
- Component B
-

Pyre Framework (Science Neutral)

The integration framework is a set of co-operating abstract services



Developed by Michael Aivazis

GeoFramework TECTON Solver

TECTON package

component

high-level python code that drives the solution and interfaces with other pyre components

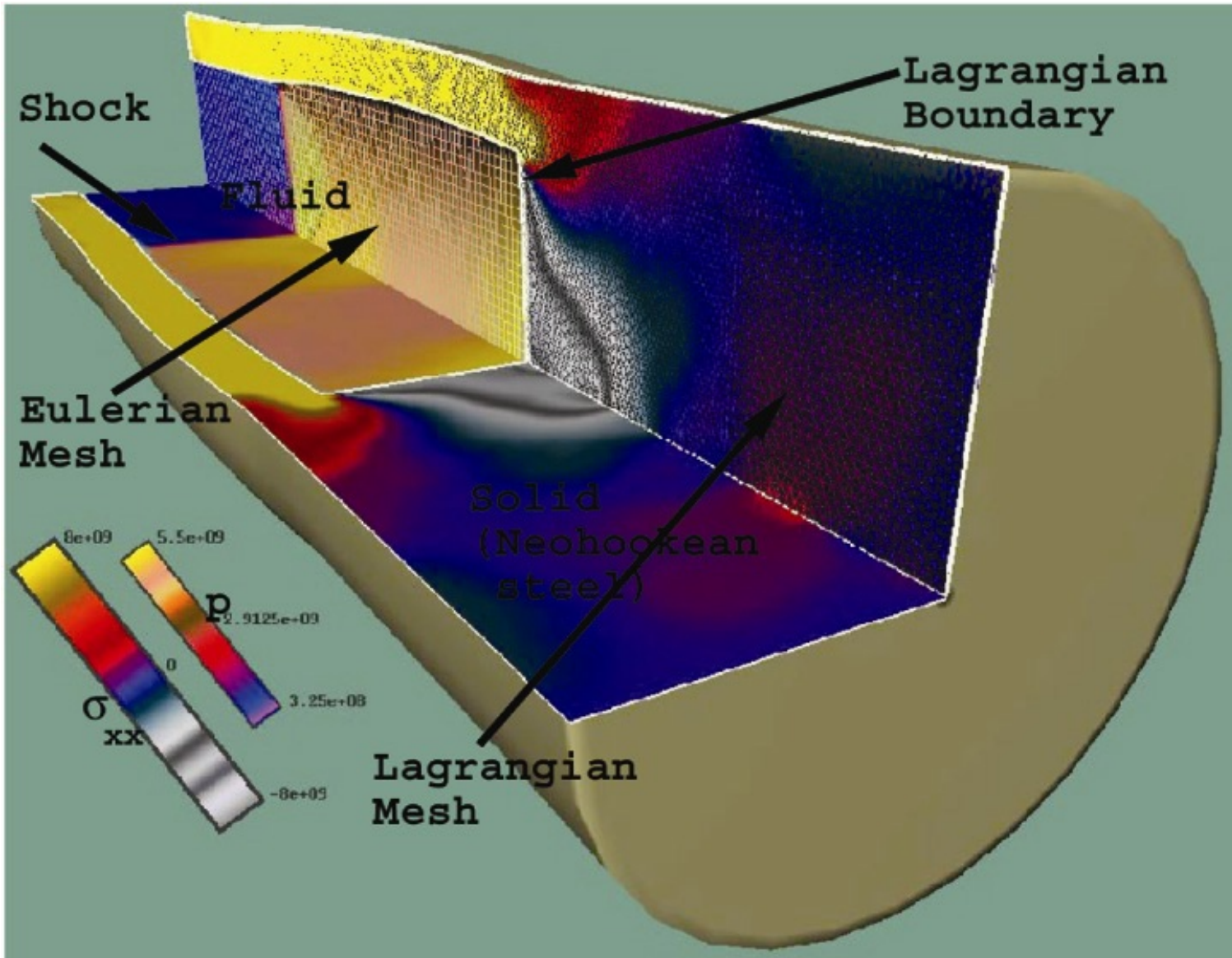
bindings

C/C++ code to bind python functions to f77 code and to provide facilities not available in f77 (memory allocation, throwing exceptions, etc.)

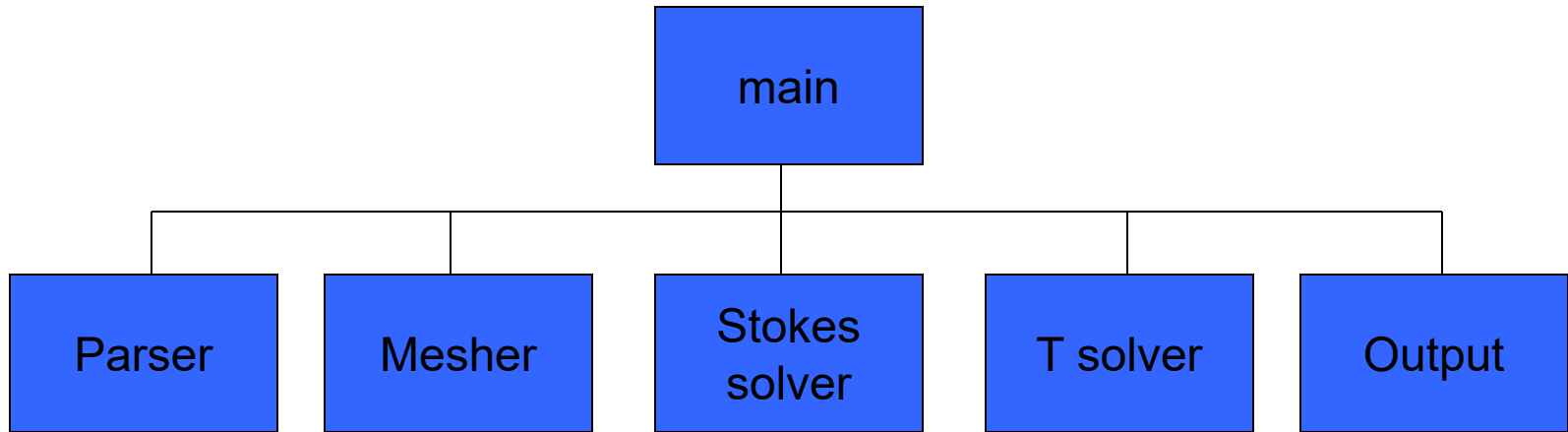
library

original, modified, and new TECTON subroutines implemented as a dynamic shared library

Virtual Test Facility (VTF): Example From Pyre

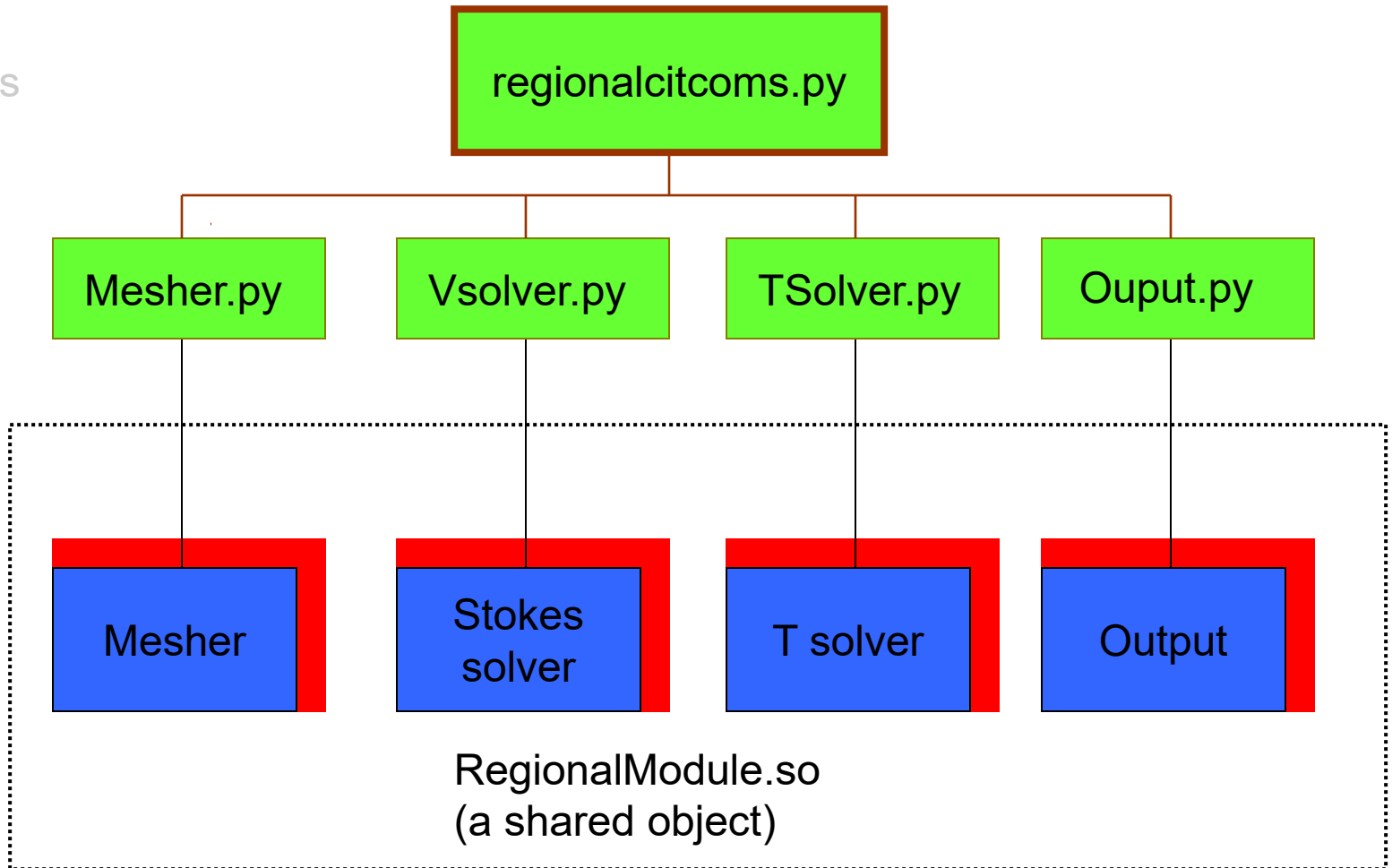


CitcomS

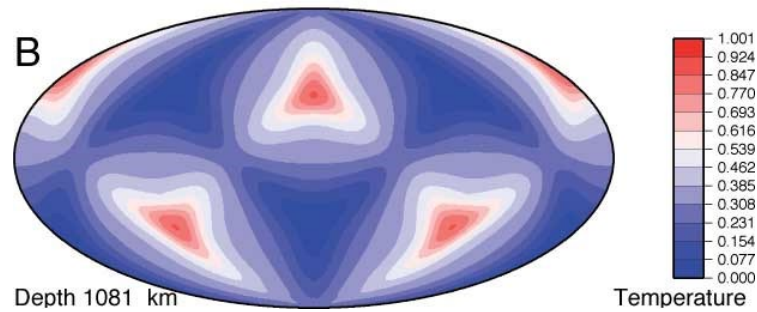
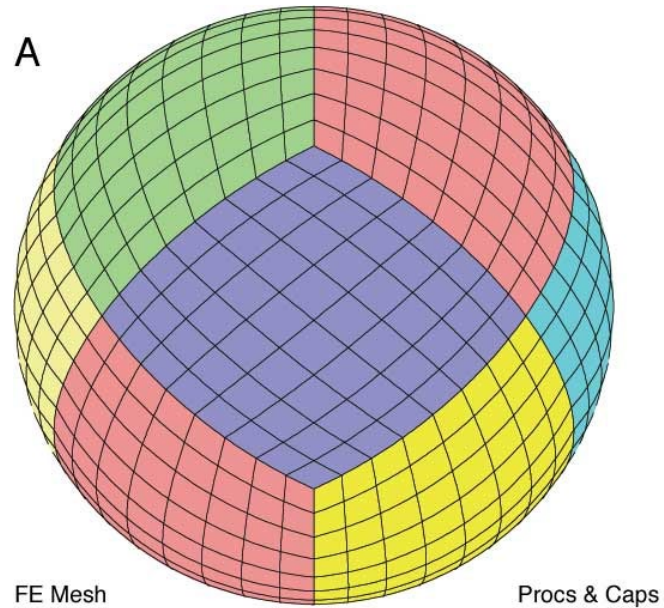


Pyre version of CitcomS

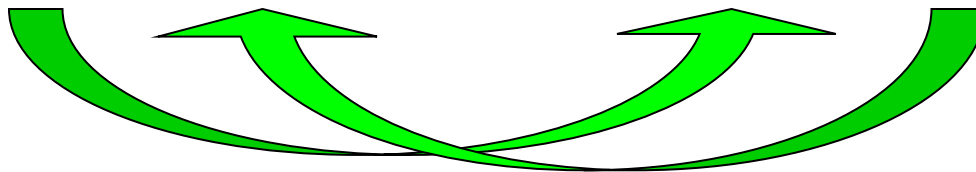
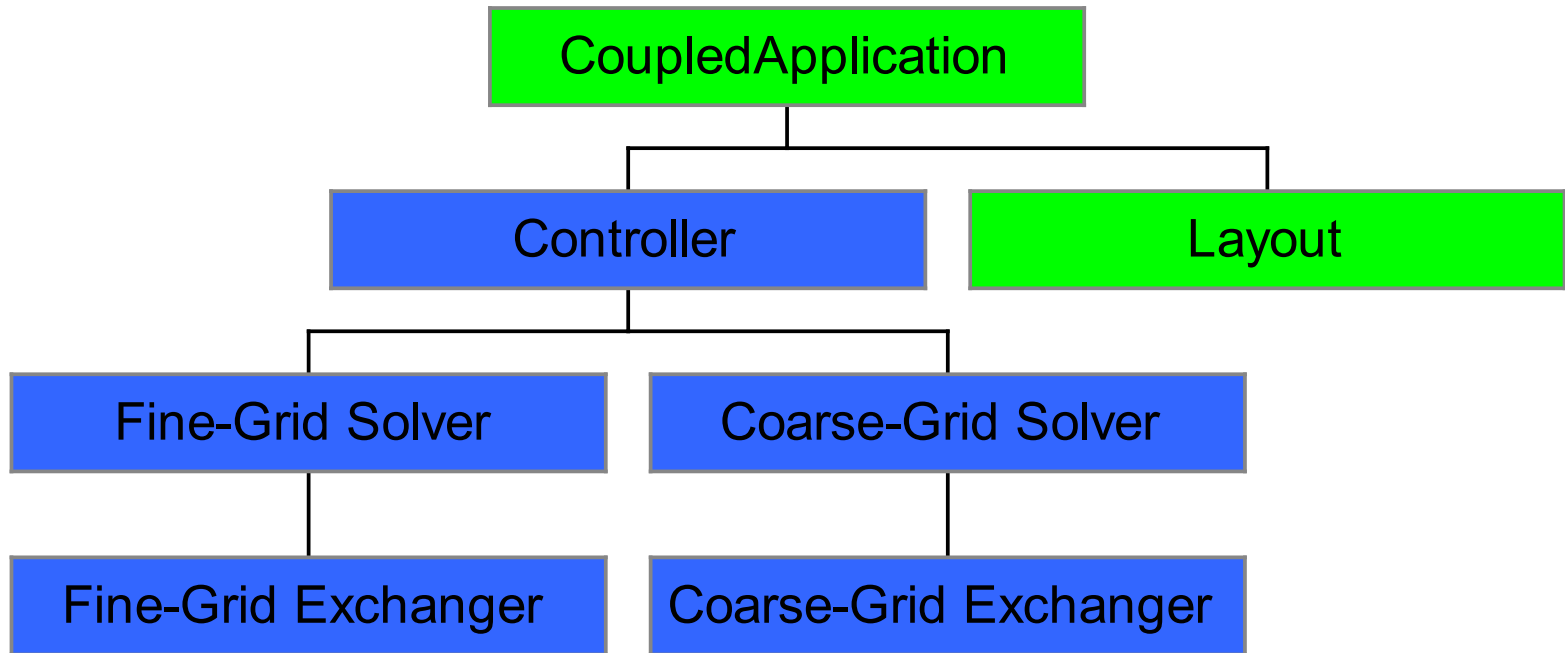
Components
(Python)



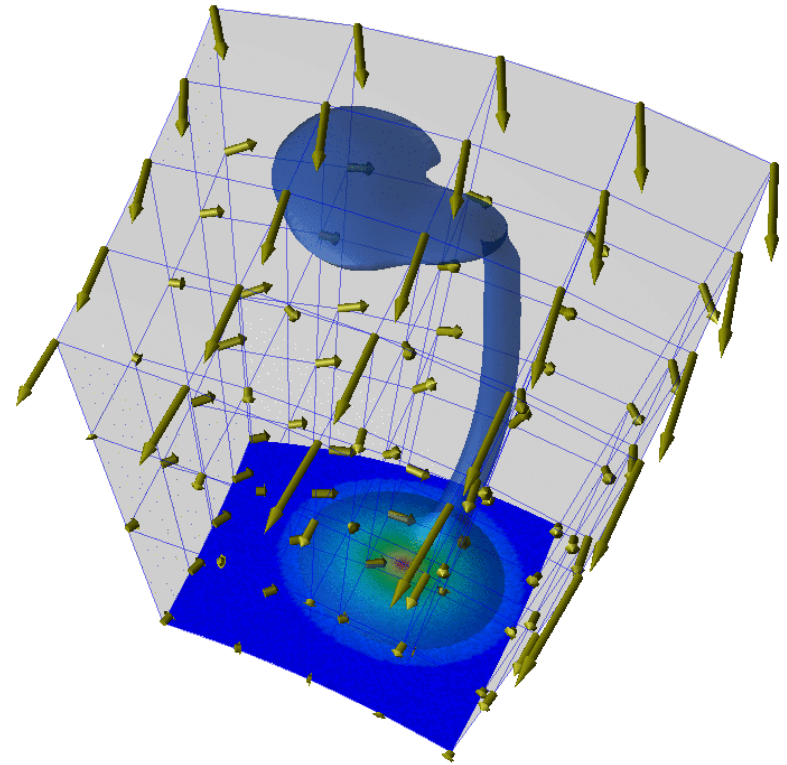
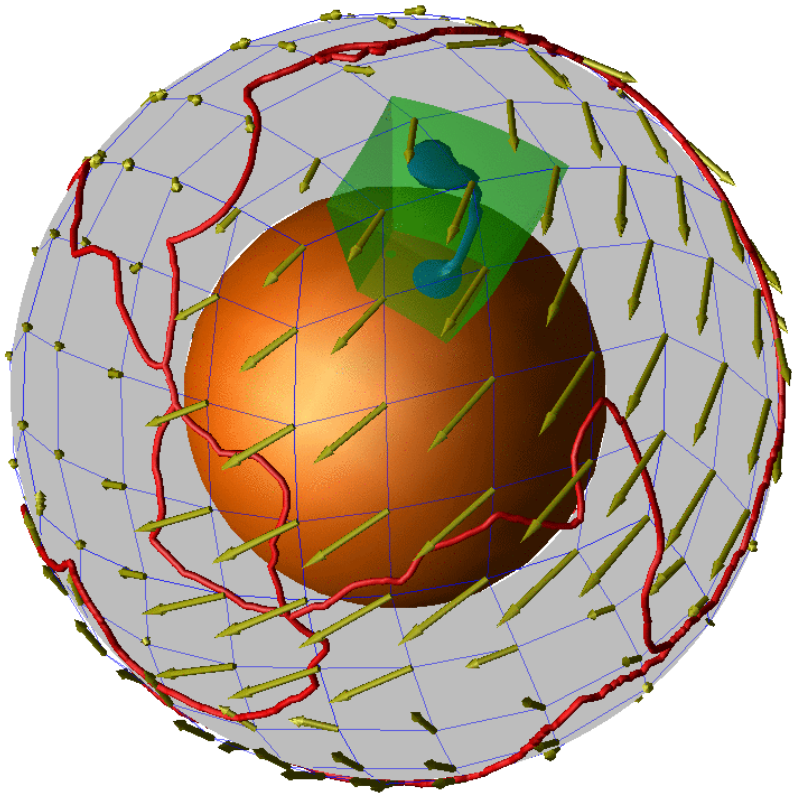
CitcomS.py as a single component



Coupling With Pyre



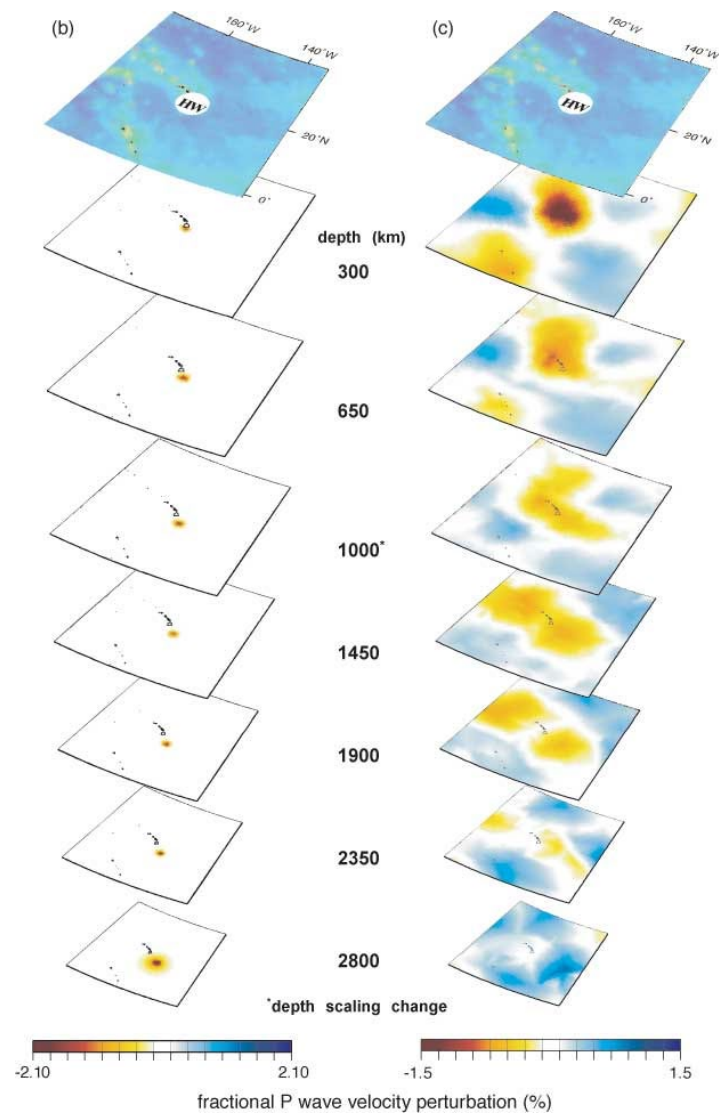
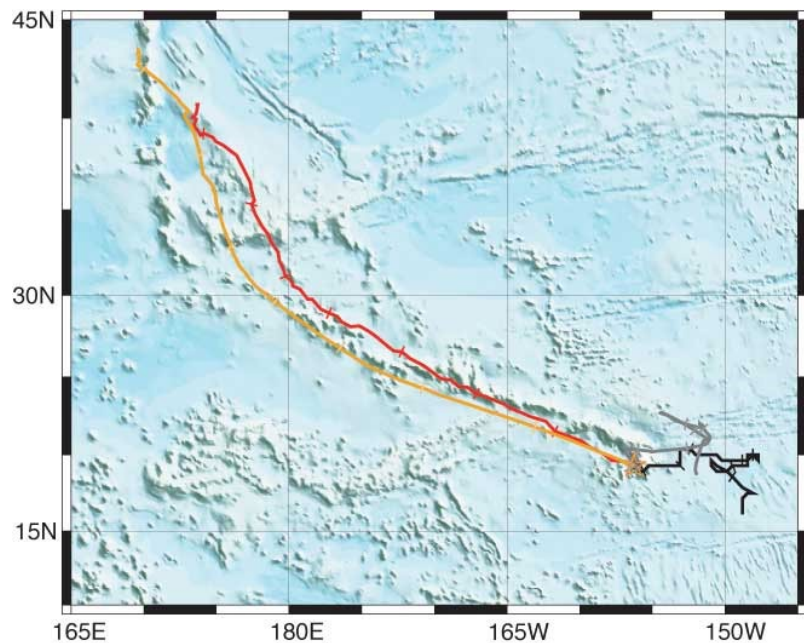
Regional and Global Mantle Flow Coupled with Pyre



Regional CitcomS coupled to full CitcomS

QuickTime™ and a
GIF decompressor
are needed to see this picture.

Predictions: Hot-spot track & synthetic tomography



Example: Mantle convection coupled to lithosphere

Superstructure

- Monitor Simulation
- Couple Fluid to Solid
- Visualization

Geodynamic Specific

- Self-contained geophysics (single physics)
- Rheology modules

Infrastructure

- Mesher: Solid & Fluid
- Solver: Solid & Fluid

Library: PETSc, BLAS, MPI

Example of Geodynamic Specific & Infrastructure Layers

Geodynamic Specific

- SNARK -- particle based FEM with implicit solver
- SNAC -- Lagrangian explicit FEM

Infrastructure

- StGermain: A framework with entry points & plugins for: building meshes, advecting particles, calling solvers, I/O.....

Library: PETSc, MPI

Example of Geodynamic Specific & Infrastructure Layers

- SNARK -- particle based FEM with implicit solver
- SNAC -- Lagrangian explicit FEM

•StGermain: A framework with entry points & plugins for: building meshes, advecting particles, calling solvers, I/O.....

Geodynamic Specific

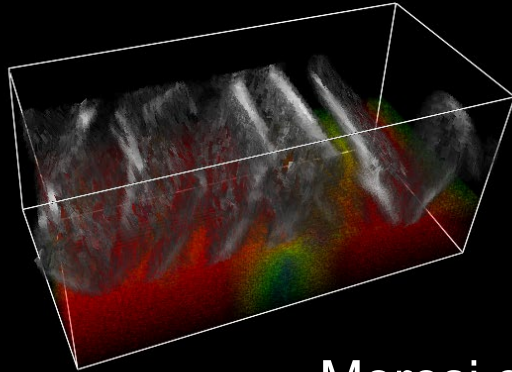
SNARK: Monash group
(Moresi)

SNAC: Caltech/Texas groups
(Gurnis, Lavier)

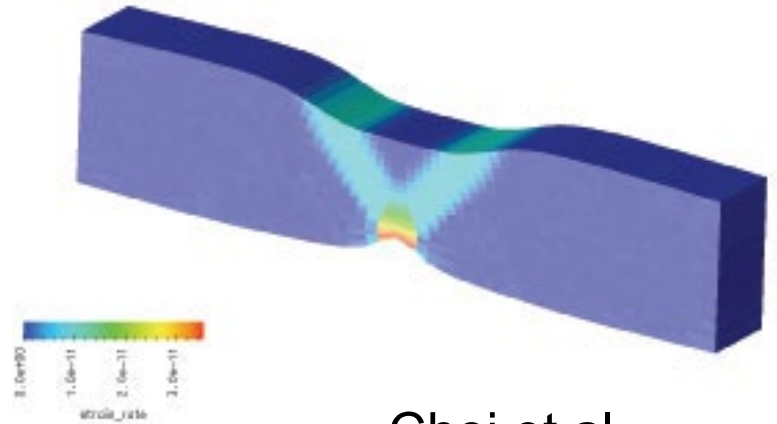
Infrastructure:

Software Engineers at the
Victorian Partnership for
Advanced Computing
(Steve Quenette Team Leader)

SNARK & SNAC



Moresi et al.



Choi et al.

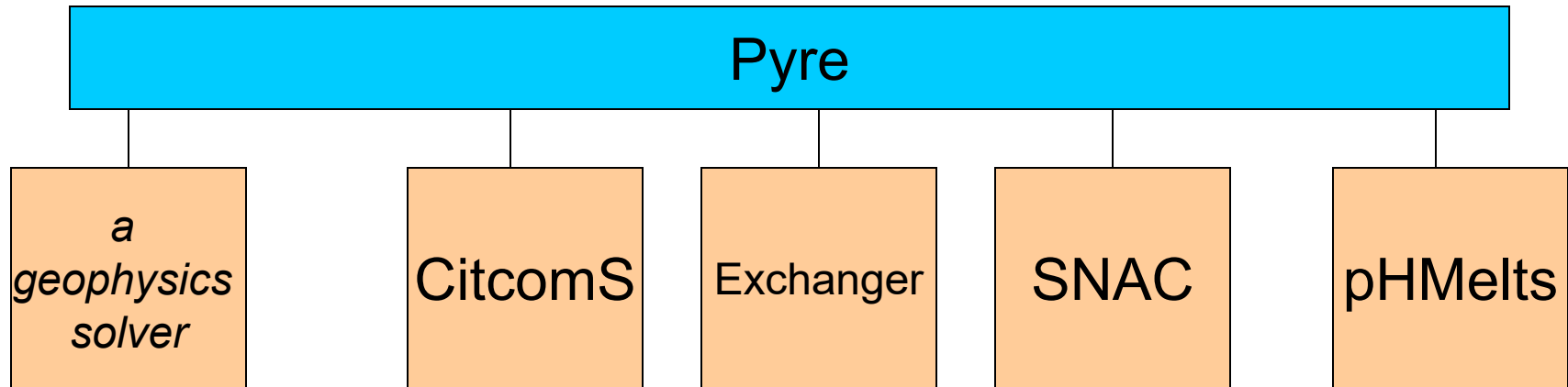
StGermain: A framework with entry points & plugins for: building meshes, advecting particles, calling solvers, I/O.....

Quenette et al.

SNAC

QuickTime™ and a
GIF decompressor
are needed to see this picture.

Examples of coupling codes with Pyre (“superstructure” framework): GeoFramework



SNAC CitcomS coupling (Crust-Mantle Interaction)

