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RESPONDER

NERC SCIENCE OF THE ENVIRONMENT

A 3D full-Stokes model of Store Glacier, Greenland, with coupling of ice flow, subglacial hydrology, submarine melting and calving

Samuel Cook, Poul Christoffersen, Joe Todd, Donald Slater, Nolwenn Chauché and Martin Truffer



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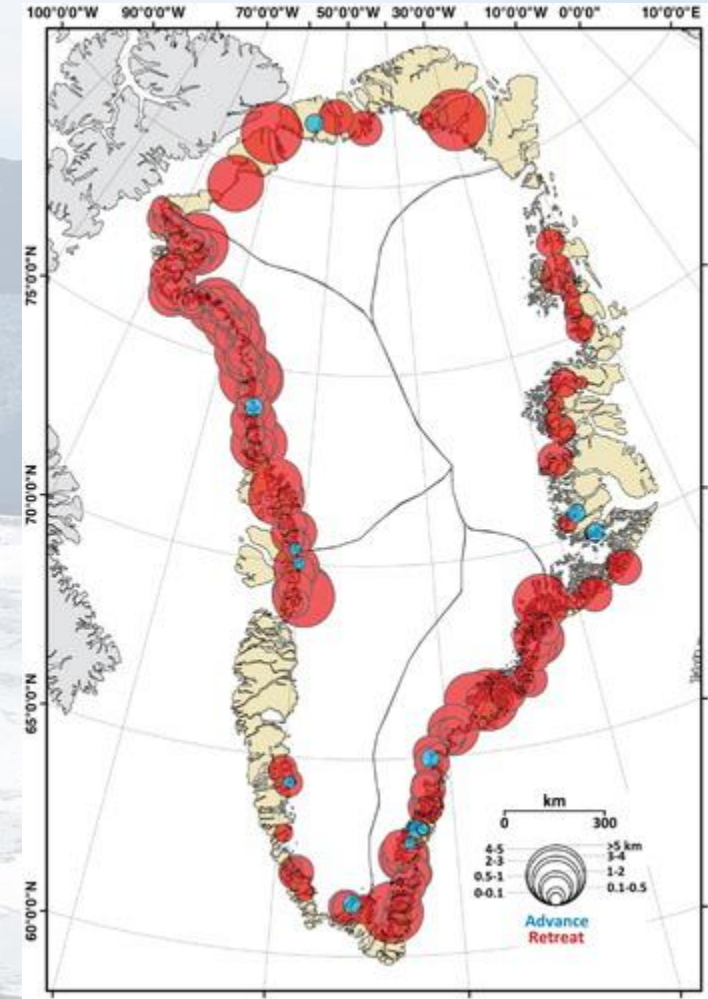
SCRIPPS INSTITUTION OF OCEANOGRAPHY



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Why Model Tidewater Glaciers?

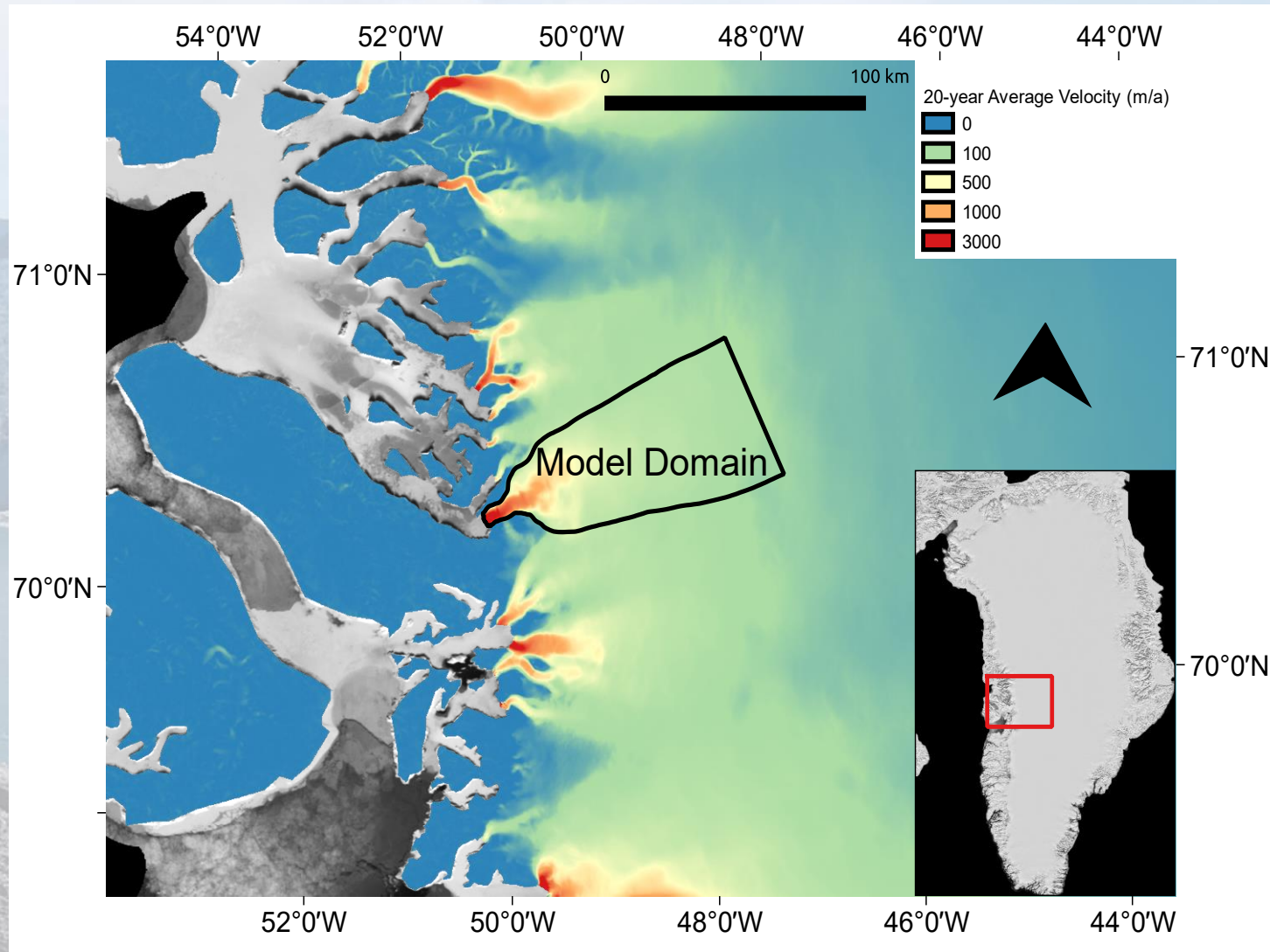
- Since 2000, the 15 largest Greenland outlet glaciers responsible for 77% of additional mass loss due to acceleration (Enderlin et al., 2014)
- Therefore, understanding these large tidewater outlet glaciers critical
- Very complex systems
- Difficult to observe



Murray et al. (2015)

Study Site

- Store Glacier
- Large, tidewater glacier
- Stable
- Domain about 110 x 40 km



The Fully Coupled Model

- Fully coupled modelling suite now exists in Elmer that can model:
 - Ice flow (obviously)
 - Calving (Joe's 3D calving stuff)
 - Subglacial hydrology (GlaDS, but somewhat modified)
 - Plumes (New 1D model based on Donald Slater's work)
- It even works!
 - Though its complexity does mean it does just fall over occasionally
 - And relaxation is a right pain
 - Also, runtime....

Overall Strategy

- Two meshes
 - Interpolation
 - Body Force BCs
- Dynamic hydrology source
- Different timesteps
- Continuous line plumes

Modified Files

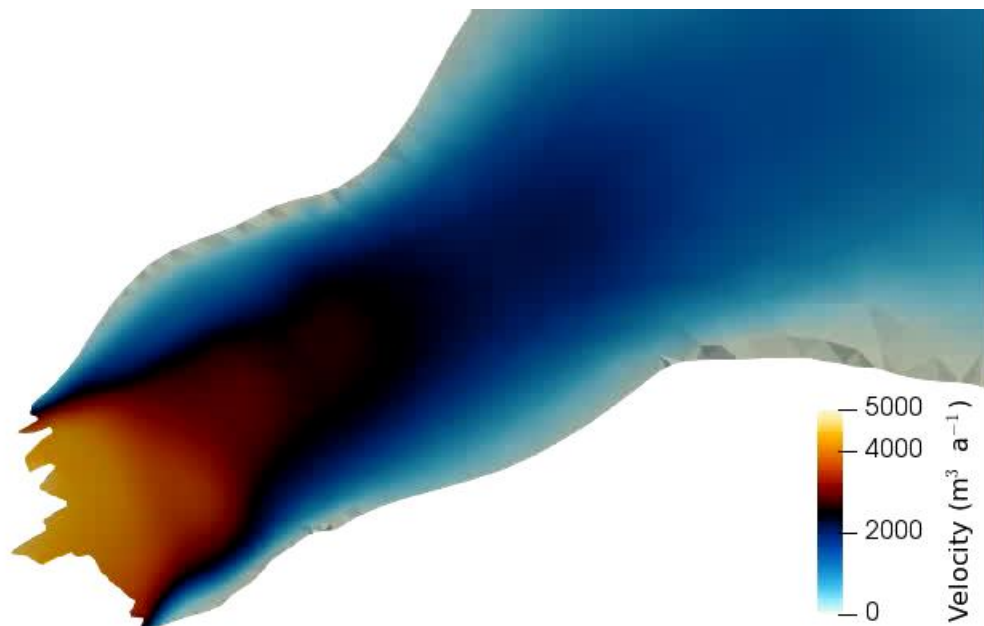
- GlaDSCoupledSolver.F90
- GlaDSchannelSolver.F90
- MeshUtils.F90
- CalvingRemesh.F90
- GroundedSolver.F90
- InterpVarToVar.F90
- ModelDescription.F90
- ElmerSolver.F90

New Files

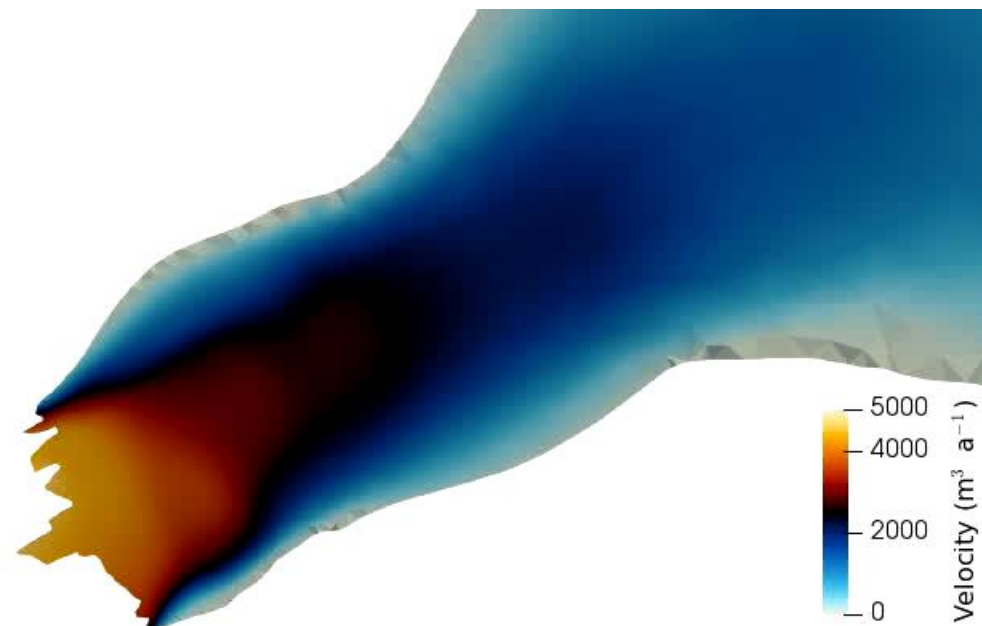
- PlumeSolver.F90 (and associated ODEPack library files: opkda1.F, opkda2.F, opkdmain.F)
- CalvingHydroInterp.F90
- HydroRestart.F90
- USF_SourceCalcCalving.F90
- BasalMelt3D.F90
- GMValid.F90

Modelled calving and plumes for the whole of 2012 and 2017

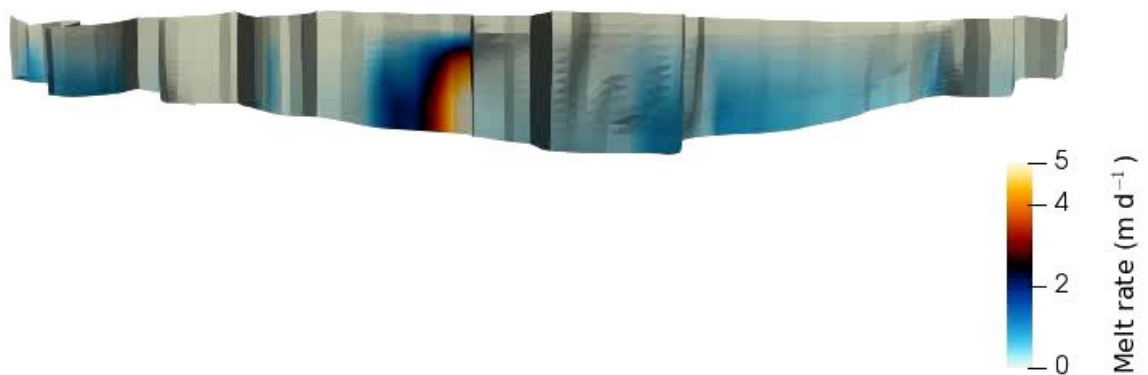
2012



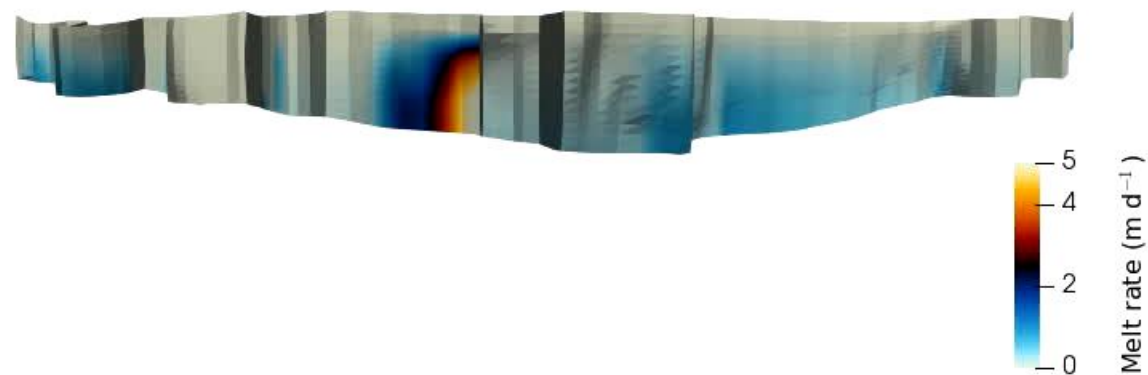
2017



2012



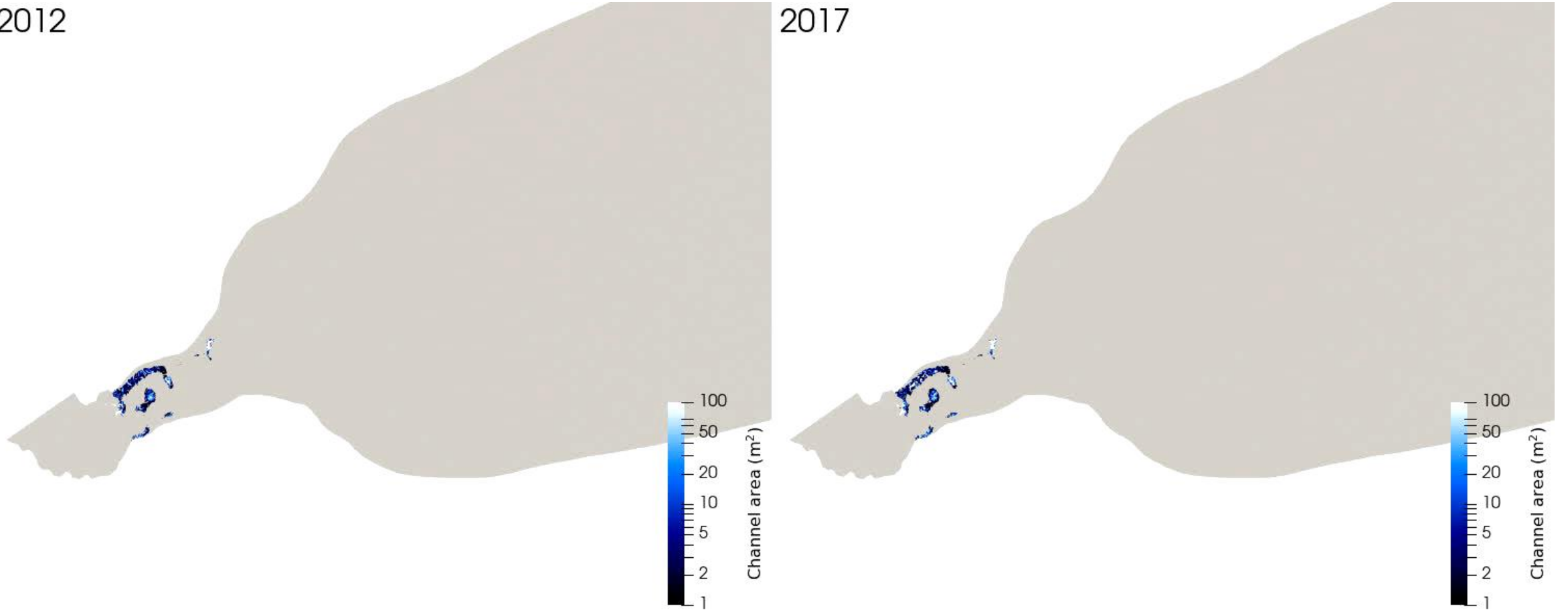
2017



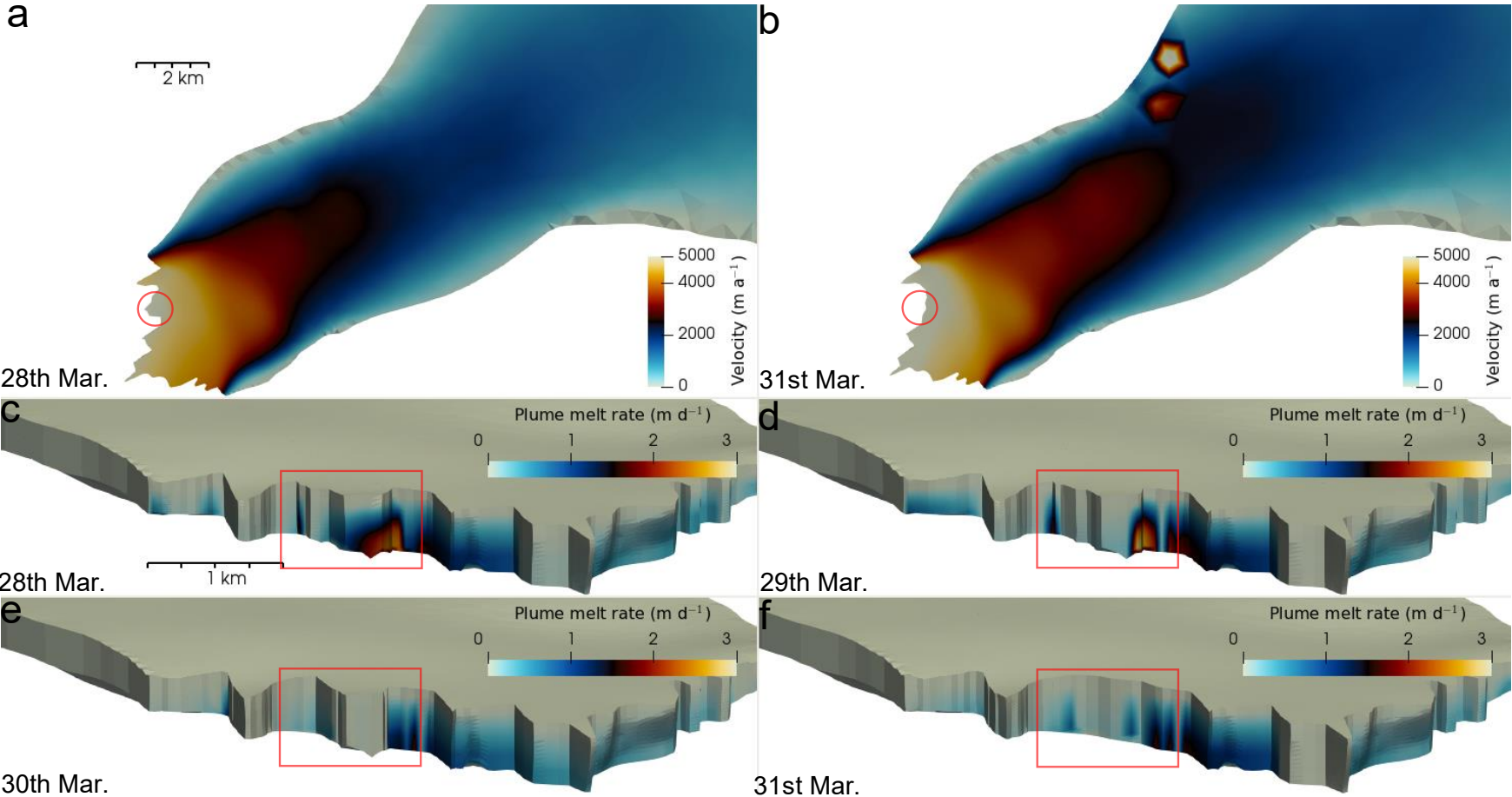
Modelled hydrology for the whole of 2012 and 2017

2012

2017



Plume-calving example (2012)



Availability and Documentation

- Currently working to get all code up on Elmer/Ice repository
 - Nearly there!
 - Test case exists – pretty much, does it crash.... ;)
- I have written user-level documentation
 - It's quite long, because this is complex
 - I will try to get this up on the wiki once all the code is up
 - Otherwise, contact me (sc690@cam.ac.uk)