

# Third Elmer/Ice users meeting 14 April 2015 – Vienna (EGU 2015)

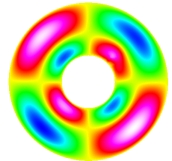
# Program

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- ✓ What is new? – Olivier Gagliardini (LGGE)
  
- ✓ new Git repository – Thomas Zwinger (CSC)
  
- ✓ Current developments
  - ✓ Friction at Grounding Line – (OG)
  - ✓ Elmer/Ice-sheet – (OG)
  - ✓ Colle Gnifetti (Carlo Licciulli)
  - ✓ ?
  
- ✓ Discussion / Prospective / Strategy for the future developments

# Elmer/Ice in relation to Elmer

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Elmer is an open-source, parallel, Finite Element code, mainly developed by the CSC-IT Center for Science Ltd. in Finland.

Elmer is constantly developed towards improved performance, utilizing international projects such as FP7 PRACE and HPC Europa2.



Elmer/Ice builds on Elmer and includes developments related to glaciological problems. Elmer/Ice includes a variety of dedicated solvers and user functions for glaciological applications and its development is supported by various groups and funding...



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Top-level Research Initiative



# Important links

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Elmer at CSC (documentation, how to install, ...)

<http://www.elmerfem.org/>

<http://www.csc.fi/english/pages/elmer>

Elmer Forum

<http://elmerfem.org/forum/>

Elmer/Ice webpage

<http://elmerice.elmerfem.org/>

Elmer/Ice wiki

<http://elmerice.elmerfem.org/wiki/doku.php?>

# Elmer/Ice mailing list

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To subscribe to the Elmer/Ice list *elmerice@elmerfem.org*, just sent an email to *majordomo@elmerfem.org*, with in the body the text:

subscribe elmerice

If you do not know how to use mailing lists run by majordomo you may sent a mail with "help" in the message body.

# What's new this year?

# ElmerPost is dead

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Use Paraview !

ElmerGrid now contains the vtu format:

```
ElmerGrid 2 5 elmermeshdir
```

will create a elmermeshdir.vtu file of the mesh

# Elmer/Ice courses

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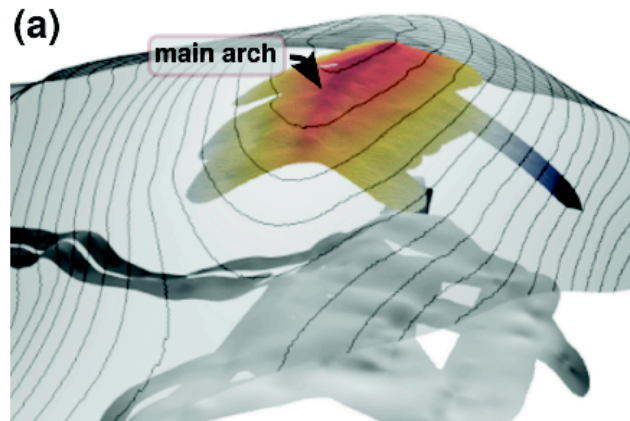
- 3-day beginner Elmer/Ice course, 27-29 Oct. 2014, IMO, Reykjavík, Iceland (Thomas Zwinger and Olivier Gagliardini)
- 3-day Elmer/Ice course, 12-14 November 2014, ACE-CRC, Hobart, Tasmania (Rupert Gladstone)

Should we organize a new advanced Elmer/Ice course ?

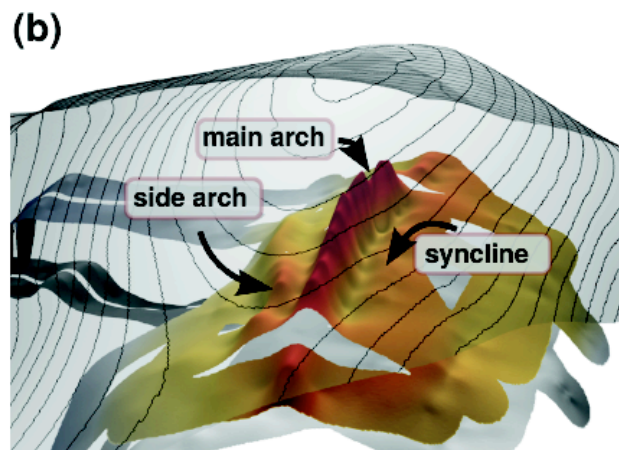


# Few recent examples (2015 publications)

Drews, R, K. Matsuoka, C. Martín, D. Callens, N. Bergeot and F. Pattyn, 2015. Evolution of Derwael Ice Rise in Dronning Maud Land, Antarctica, over the last millennia, *Journal of Geophys. Res. Earth Surf.*, DOI: 10.1002/2014JF003246



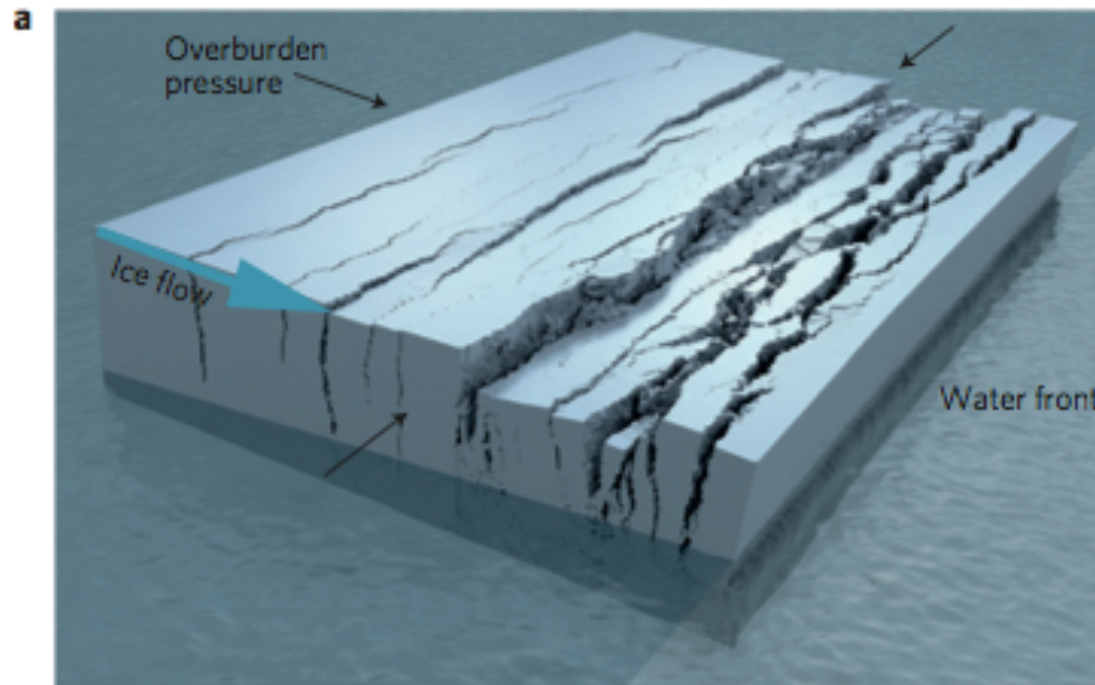
3D application  
Anisotropic rheology



# Few recent examples (2014 publications)

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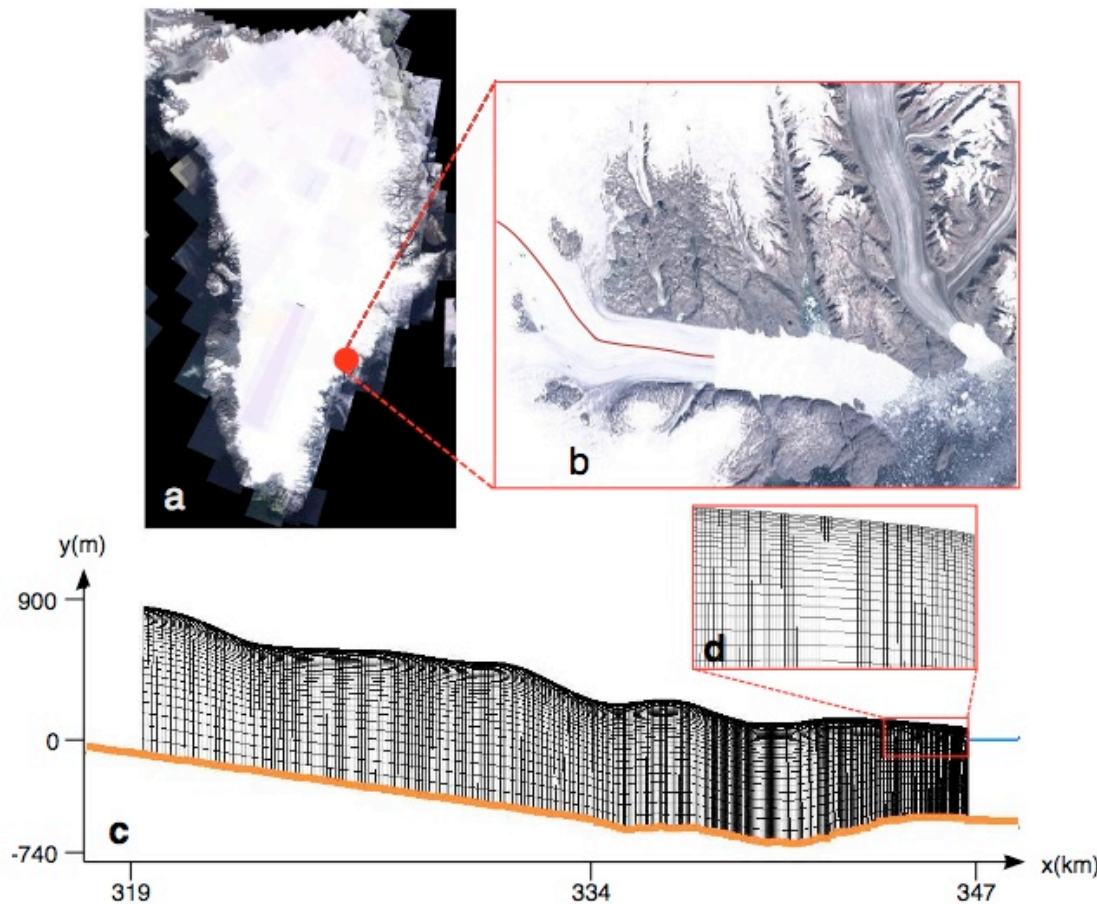
Åström, J.A., D. Vallot, M. Schäfer, E.Z. Welty, S. O'Neel, T.C. Bartholomäus, Yan Liu, T.I. Riikilä, T. Zwinger, J. Timonen, and J.C. Moore, 2014. Termini of calving glaciers as self-organized critical systems, *Nature Geoscience*, 7, 874-878, doi:10.1038/ngeo2290



Coupling of Elmer/Ice with a discrete particles model

# Few recent examples (2014 publications)

Krug, J., J. Weiss, O. Gagliardini and G. Durand, 2014. Combining damage and fracture mechanics to model calving, *The Cryosphere*, 8, 2101-2117, doi:10.5194/tc-8-2101-2014

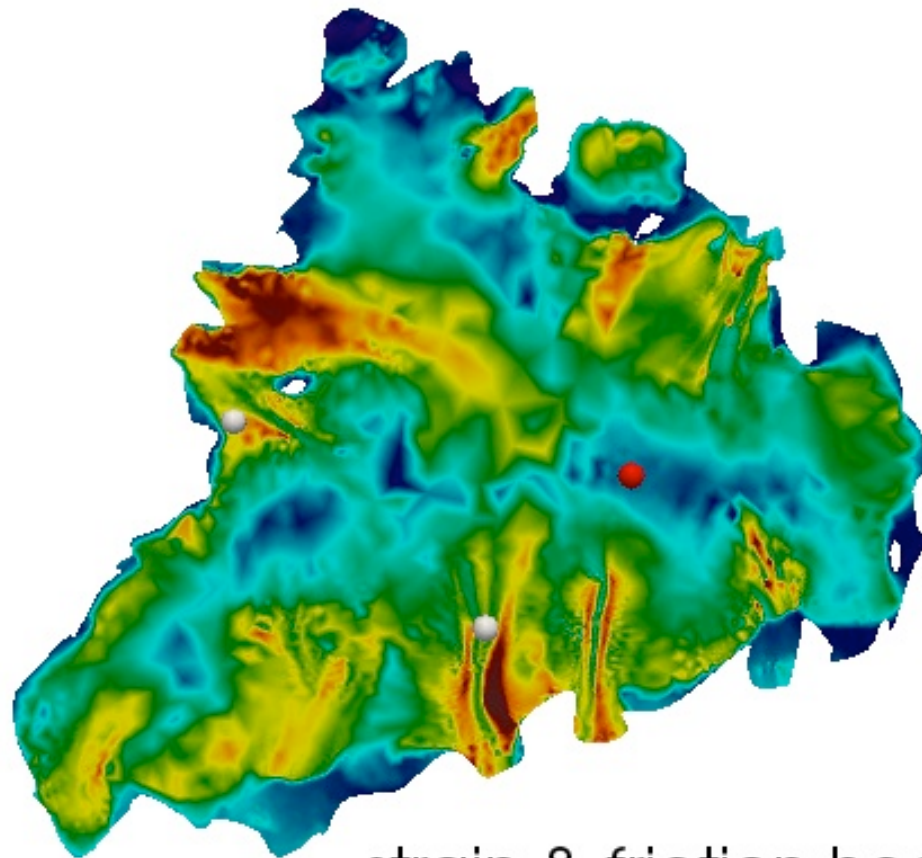


2D application  
Transient  
Calving law based on damage and fracture mechanics

# Few recent examples (2014 publications)

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Schäfer, M., F. Gillet-Chaulet, R. Gladstone, R.A. Pettersson, V. Pohjola, T. Strozzzi and T. Zwinger, 2014. Assessment of heat sources on the control of fast flow of Vestfonna ice cap, Svalbard, The Cryosphere, 8, 1951-1973, doi:10.5194/tc-8-1951-2014.

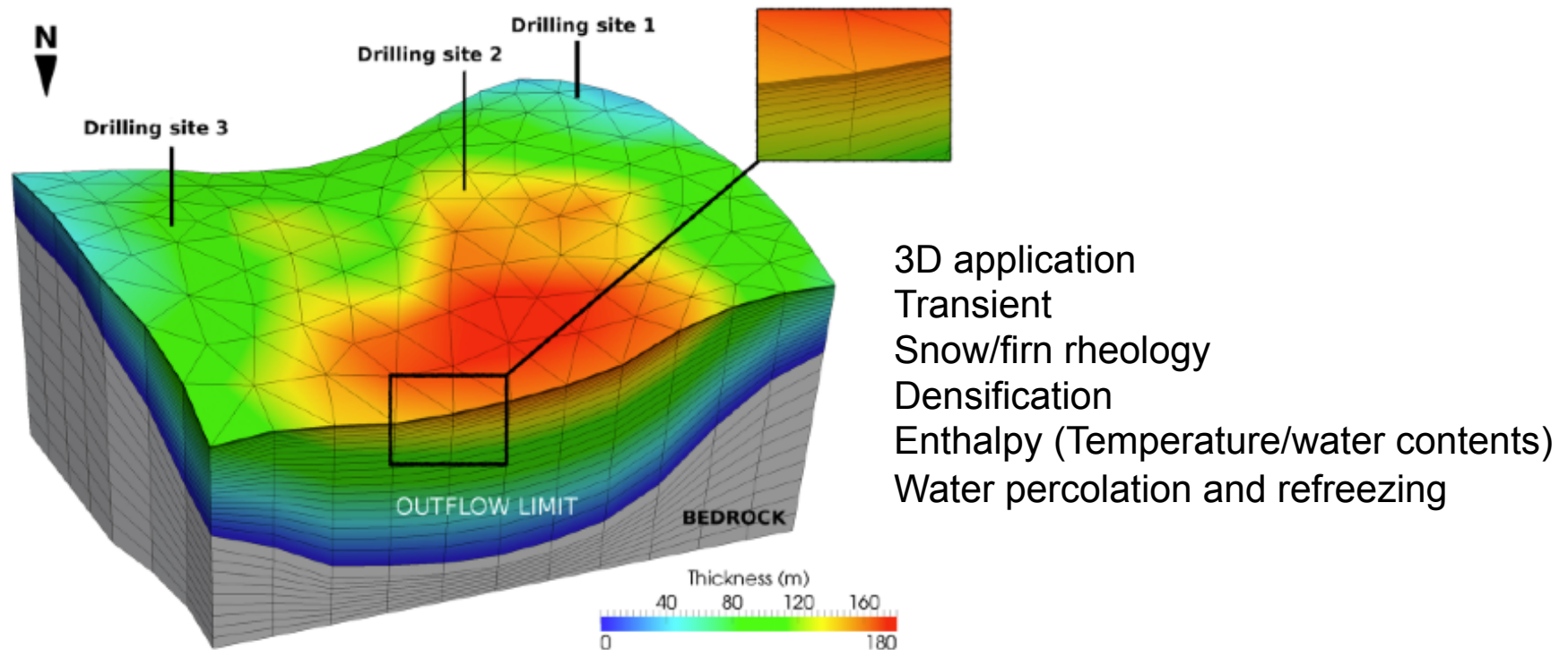


3D application  
Inverse methods

+ strain & friction heat

# Few recent examples (2014 publications)

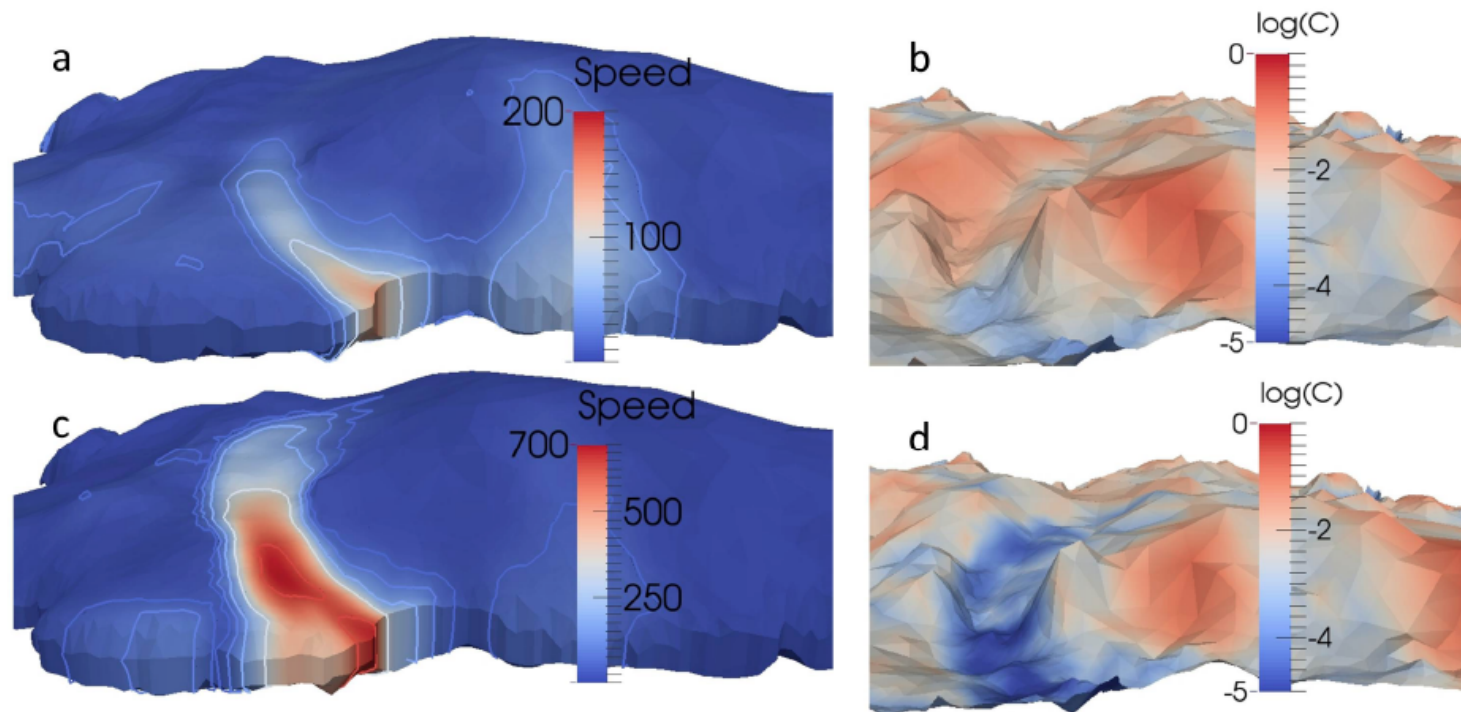
Gilbert, A., O. Gagliardini, C. Vincent, and P. Wagon, 2014. A 3-D thermal regime model suitable for cold accumulation zones of polythermal mountain glaciers, J. Geophys. Res. Earth Surf., 119, doi: 10.1002/2014JF003199.





# Few recent examples (2014 publications)

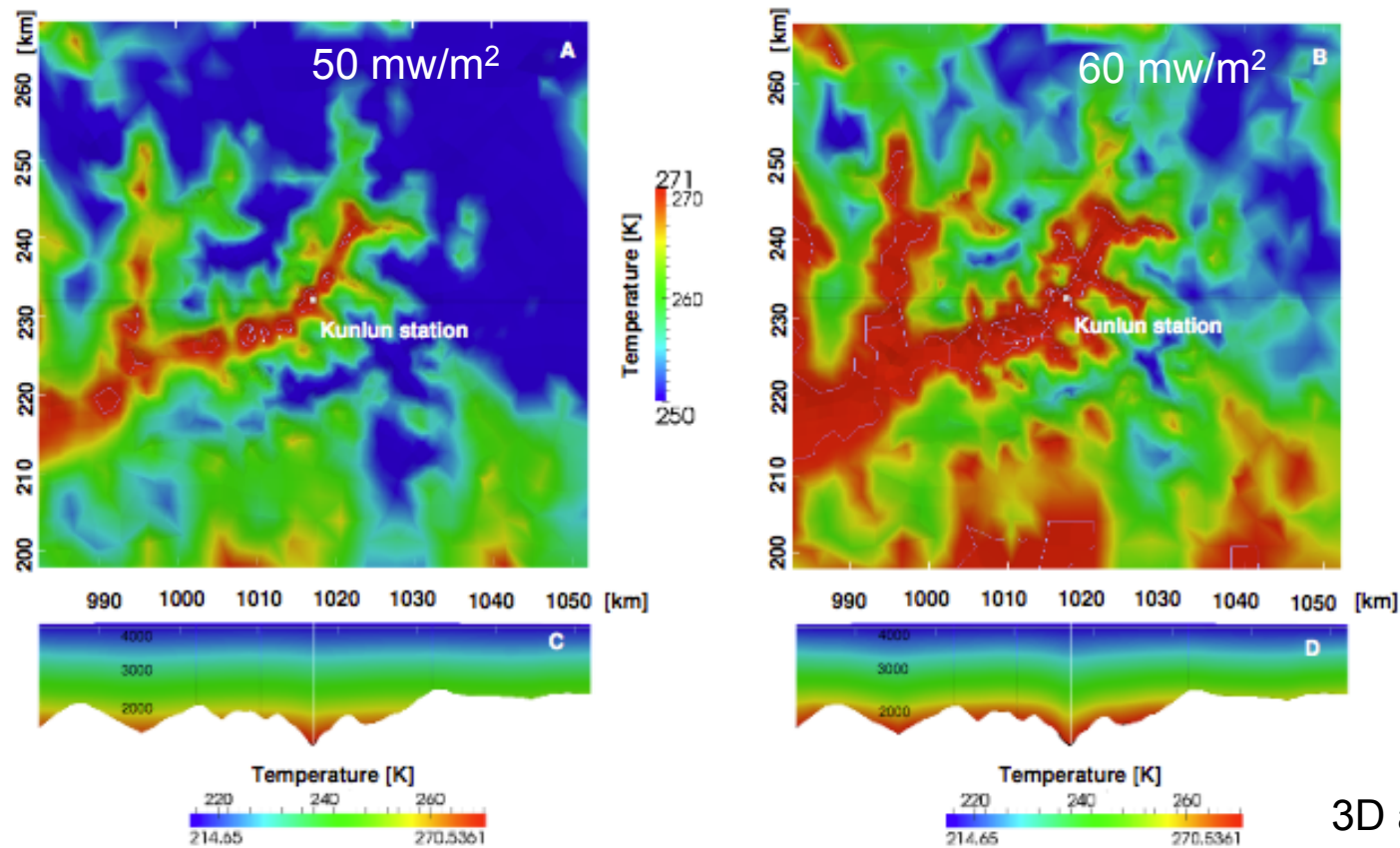
Gladstone, R., M. Schäfer, T. Zwinger, Y. Gong, T. Strozzi, R. Mottram, F. Boberg, and J.C. Moore, 2014. Importance of basal processes in simulations of a surging Svalbard outlet glacier, *The Cryosphere*, 8, 1393-1405, doi:10.5194/tc-8-1393-2014



3D application  
Diagnostic/Transient  
Inverse methods  
Temperature

# Few recent examples (2014 publications)

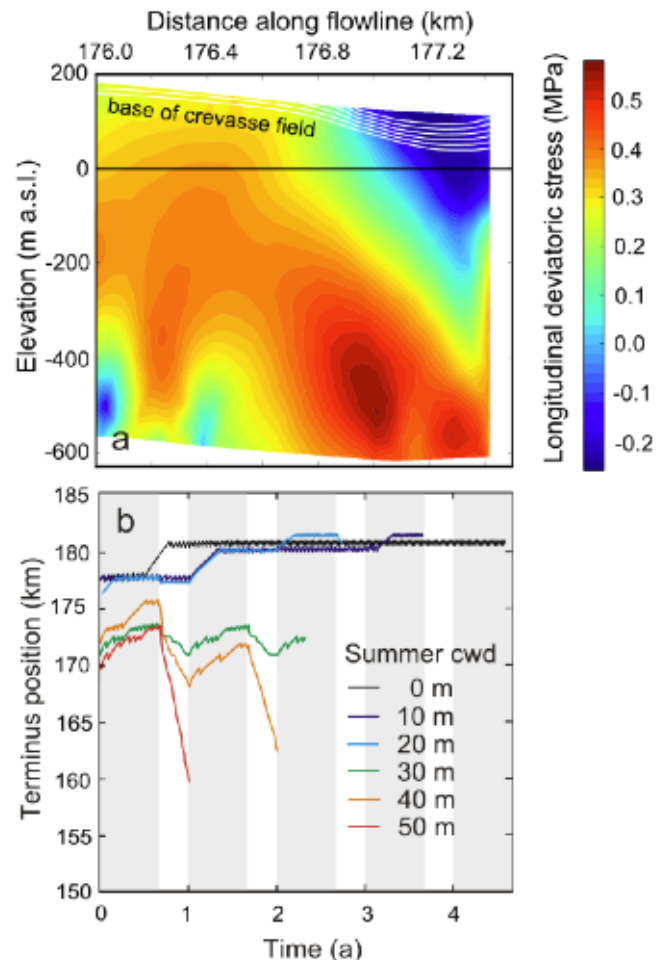
Sun, B., Moore, J. C., Zwinger, T., Zhao, L., Steinhage, D., Tang, X., Zhang, D., Cui, X., and Martín, C., 2014. How old is the ice beneath Dome A, Antarctica?, *The Cryosphere*, 8, 1121-1128, doi:10.5194/tc-8-1121-2014.



3D application  
Anisotropic ice rheology  
Temperature

# Few recent examples (2014 publications)

Cook, S., I.C. Rutt, T. Murray, A. Luckman, T. Zwinger, N. Selmes, A. Goldsack, and T.D. James, 2014. Modelling environmental influences on calving at Helheim Glacier in eastern Greenland, *The Cryosphere*, 8, 827-841, doi:10.5194/tc-8-827-2014



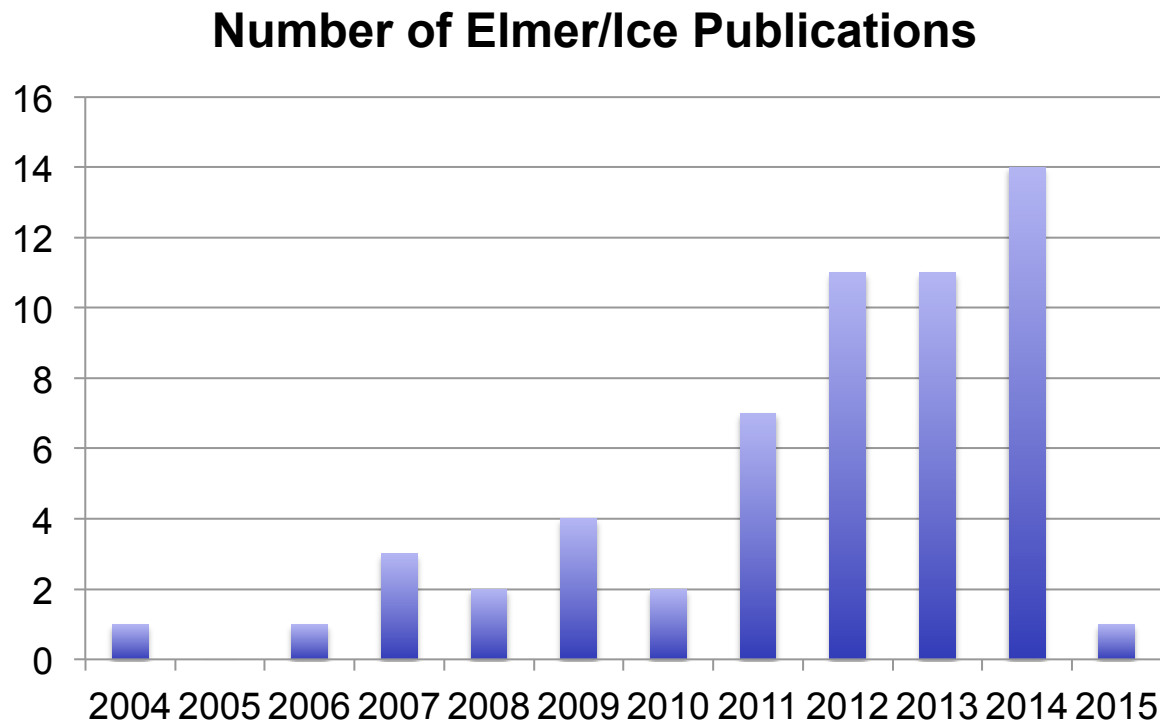
2D flow line application  
Transient  
Calving



# Elmer/Ice applications

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57 publications using Elmer/Ice since 2004



# Elmer/Ice at EGU 2015

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## **PICO CR2.3 Applied Geophysics in Cryosphere Sciences (Tuesday 14th of April)**

14:04–14:06 Reinhard Drews, Sophie Berger, Lionel Favier, and Frank Pattyn, Ice-shelf channel evolution in Antarctic ice shelves

## **CR6.1 Modelling ice sheets and glaciers (including Arne Richter Award Lecture for OSY) Wed, 15 Apr, 08:30–12:30 / Room R13**

08:45–09:00 Thomas Zwinger, Torsten Malm, Martina Schäfer, Carlos Martín, and John C. Moore, Investigations on the origins and maintenance of the Scharffenbergbotnen blue ice area by combined surface wind and ice flow simulations

09:45–10:00 Cyrille Mosbeux, Fabien Gillet-Chaulet, and Olivier Gagliardini, Comparative Study of Three Data Assimilation Methods for Ice Sheet Model Initialisation

## **Posters Attendance Wed, 15 Apr, 17:30–19:00 / Yellow Posters**

Y163 Olivier Passalacqua, Frédéric Parrenin, Olivier Gagliardini, Catherine Ritz, and Fabien Gillet-Chaulet, Old ice investigation along the Dome C ridge using a 2.5D thermomechanical ice flow model

Y164 Julien Brondex, Olivier Gagliardini, Fabien Gillet-Chaulet, Jean Krug, and Gaël Durand, Accounting for damage to model the influence of a pinning point on the grounding line dynamics

Y167 Carlo Licciulli, Pascal Bohleber, Dietmar Wagenbach, Olaf Eisen, Olivier Gagliardini, and Martin Hoelzle, Supplementing ice core time series at a small scale Alpine glacier with a 3D full Stokes ice flow model using Elmer/Ice

Y168 Olivier Gagliardini, Julien Brondex, Fabien Gillet-Chaulet, Laure Tavard, Vincent Peyaud, Johannes Fuerst, and Gaël Durand, On the way the friction is applied in the close vicinity of the grounding line in Elmer/Ice

Y170 Vincent Peyaud, Fabien Gillet-Chaulet, Laure Tavard, Johannes J. Fürst, Olivier Gagliardini, and Gaël Durand, Comparison of Full Stokes and Shallow Shelf solutions regarding grounding line dynamics on a variety of synthetic geometry.

## **CR6.3 Ice shelves - dynamics, interactions, observations, modelling, Thu, 16 Apr, 08:30–10:00 / Room R13**

08:45–09:00 Johannes J. Fürst, Gaël Durand, Fabien Gillet-Chaulet, Laure Tavard, and Olivier Gagliardini, Susceptibility of the Antarctic ice sheet to changes in ice shelf buttressing

# Elmer/Ice capabilities

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- **Full-Stokes** equations but also SIA, SSA, diagnostic or transient
- Various **rheologies** (Glen's law, firn/snow and anisotropic flow laws)
- **Temperature** solver accounting for the upper limit at melting point, Enthalpy method
- **Transport equations** for density, fabric, age ...
- **Post-processing solver** for strain-rate and stress fields
- Various **friction laws** (Weertman, effective-pressure dependent friction law)
- **Free surface evolution** as a contact problem (Grounding line dynamics)
- **Inverse methods** (linear adjoint and Arthern and Gudmundsson 2010 methods)
- Tools or plug-ins for **meshing** (YAMS, external and internal extrusion of footprint)
- **Highly parallel** Stokes solver
- **Basal hydrology** (2 approaches, one in the distribution)
- **Calving** (3 approaches, not yet in the distribution)
- **Damage mechanics**