Elmer/Ice course

28th and 29th October 2019, Reykjavik

Introduction

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Program

Monday 28th October

9:00-9:15 Arrival of the participants

9:15-9:30 Welcome words by Guðfinna Aðalgeirsdóttir, general announcements

9:30-9:45 Introduction on Elmer/ice (OG)

9:45-10:30 Short description of Solver Input File (sif file) (PR)

10:30-11:00 Coffee break

11:00-12:00 Toy flow-line model: basic diagnostic (TZ)

12:00 Lunch (on your own expense)

13:00-15:30 Toy flow-line model: thermo-mechanical coupling (TZ)

15:30-16:00 Coffee break

16h00-17h30 Toy flow-line model: sliding, prognostic runs (TZ)

19h Course dinner (place to be specified, on your own expense)

Program

Tuesday 29th October

9:00-9:30 Tête Rousse Context (OG)

9:30-10:30 Tête Rousse setup and diagnostic (OG)

10:30-11:00 Coffee break

11:00-12:00 Tête Rousse prognostic (OG)

12:00 Lunch (on your own expense)

13:00-15:30 Midtre Lovenbreen application (PR)

15:30-16:00 Coffee break

16:00-18:00 Questions on your own modeling

Short history of Elmer/Ice (not anymore so short...) 1/3

- ✓ EGU2002: OG was looking for a 3D FE code to model the flow of strain-induced anisotropic polar ice – meet TZ

- ✓ March 2003: OG visited CSC for few days: AIFlowSolver and FabricSolver partly implemented

- ✓ August 2005 – One year visit of OG at CSC (Anisotropy, cavity, glaciers, ISMIP tests, ...)

- ✓ February 2008 – First Elmer/Ice Course - Grenoble

- ✓ June 2011 – SVALI summer school – Finland

- ✓ 2012 – Elmer/Ice has now a website, a logo and a mailing list

- ✓ 2012 – Elmer/Ice comes as a Elmer Package – New wiki

- ✓ 2012 – Elmer/Ice course at UBC/SFU

- ✓ 2013 – Elmer/Ice courses at Univ. Washington and Univ. Alberta

- ✓ 9 April 2013 – First Elmer/Ice users meeting – EGU 2013

Short history of Elmer/Ice (not anymore so short...) 2/3

- ✓ May 2013 – Second SVALI summer school – Finland

- ✓ 2-day beginner Elmer/Ice course, 3-4 Oct. 2013, LGGE, Grenoble, France

- ✓ 3-day Elmer/Ice advanced workshop, 4-6 Nov. 2013, CSC, Espoo, Finland

- ✓ April 2014 – Second Elmer/Ice users meeting – EGU 2014

- ✓ **3-day beginner Elmer/Ice course, 27-29 Oct. 2014, IMO, Reykjavík, Iceland**

- ✓ April 2015 – Third Elmer/Ice users meeting – EGU 2015

- ✓ 2-day beginner course, 1&2 Nov 2015, CIC, Copenhagen, Denmark

- ✓ 3-day Elmer/Ice advanced workshop, 30 Nov, 1&2 Dec 2015, LGGE, Grenoble, France

- ✓ 3-days beginner course, Oct 2016, Oslo

- ✓ April 2017 – Fourth Elmer/Ice users meeting – EGU 2017

Short history of Elmer/Ice (not anymore so short...) 3/3

- ✓ - 2-day beginner Elmer/Ice course, 23rd and 24th Oct. 2017, University of Stockholm, Sweden

- ✓ 3-day advanced Elmer/Ice workshop, 22nd, 23rd and 24th Nov. 2017, IGE, Grenoble, France

- ✓ 2-day beginner Elmer/Ice course, 22nd & 23rd Oct. 2018, University of Lapland, Rovaniemi, Finland

- ✓ 3-day Elmer/Ice advanced users workshop, 29th-31st Oct. 2018, CSC, Espoo, Finland

- ✓ April 2019 - Fifth Elmer/Ice Users Meeting - EGU 2019

and now back in Reykjavik

A growing community
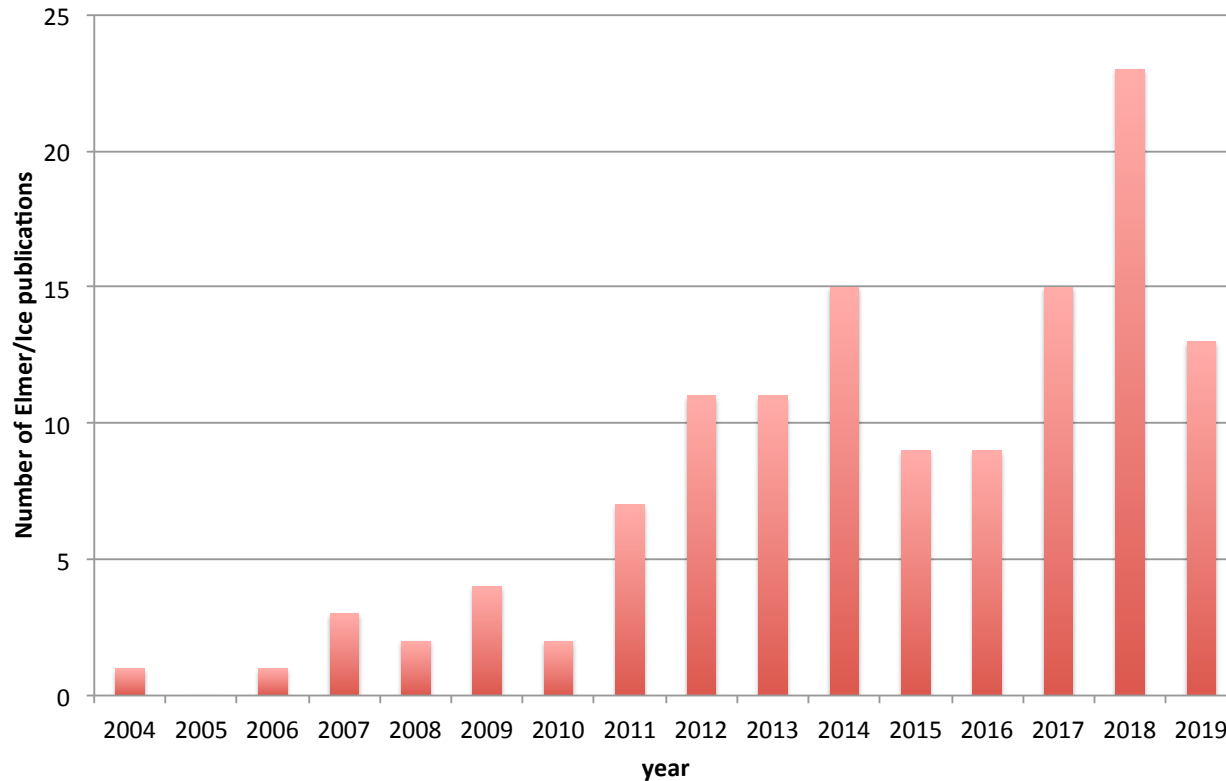
17 Courses ~ 320 participants

5 Elmer/Ice users meetings

126 publications

An international community

Affiliation of principal investigators of Elmer/Ice publications

(2017)
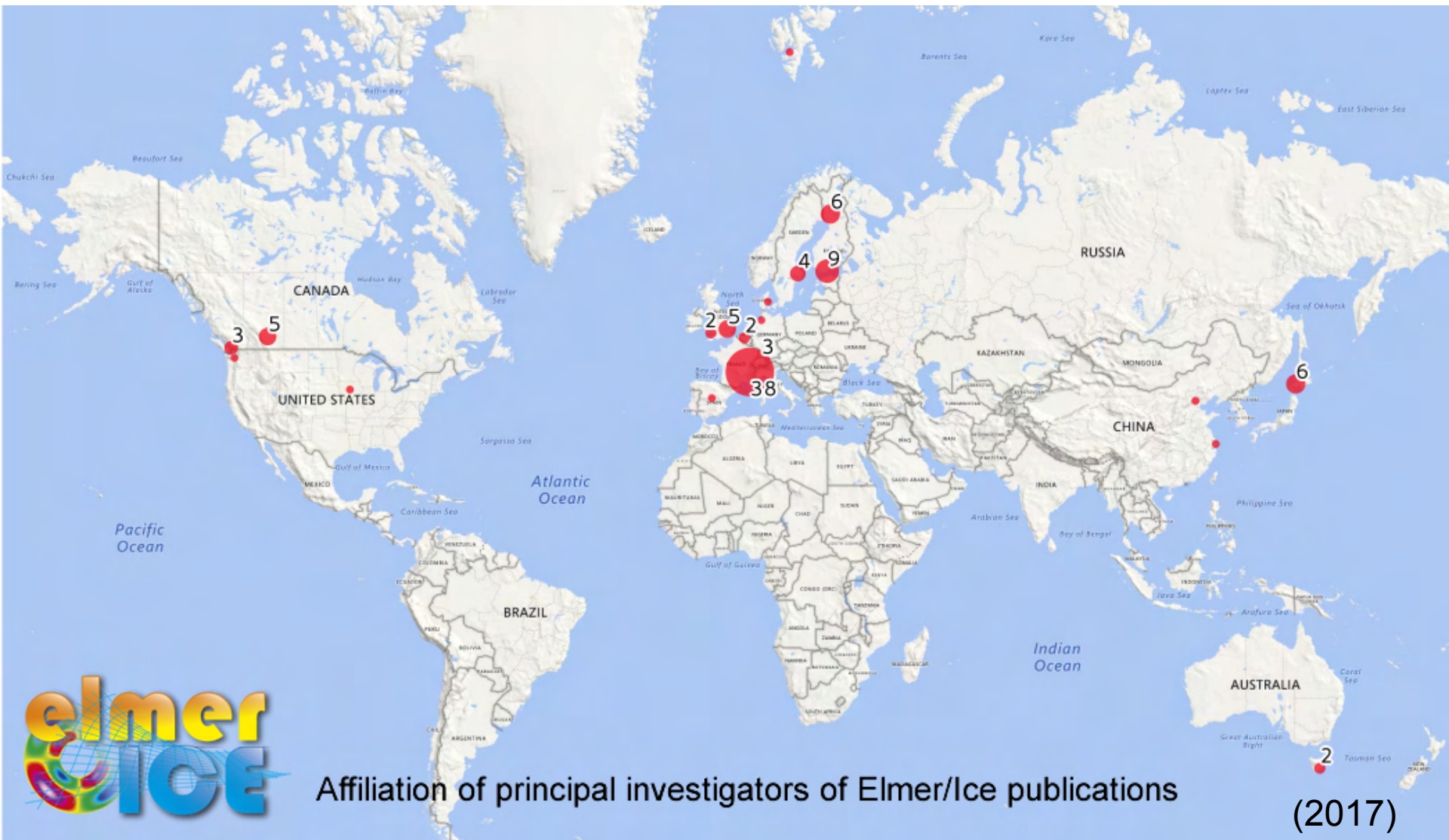
Gagliardini et al., GMD 2013 – 121 citations

Elmer/Ice applications

126 (known) publications using Elmer/Ice since 2004

- ISMIP, MISMIP, MISMIP-3d, ISMIP6

- 2D and 3D Grounding line dynamics

- Ice2sea and SeaRISE contributions (Greenland)

- Inverse methods (Variegated, Vestfonna ice-cap, GIS, Antarctica)

- Flow of anisotropic ice

- Glaciers, Greenland, Antarctica

- 9 cited references including results from Elmer/Ice in the 5th IPCC report

Elmer/Ice website

http://elmerice.elmerfem.org/

Elmer/Ice website   http://elmerice.elmerfem.org/

Much more material available than what we will present today
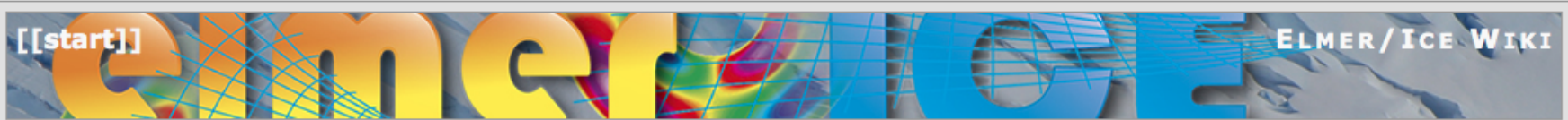
Elmer/Ice wiki http://elmerice.elmerfem.org/wiki/doku.php

Elmer/Ice mailing list

Subscribe to the Elmer/Ice mailing list:

http://mail.elmerfem.org/mailman/listinfo/
elmerice_elmerfem.org

Not a big flux, but important information (bug, new version, etc..)

Currently 46 members

Elmer/Ice Forum

Under

http://www.elmerfem.org :

- Go to **Elmer Forum:** find answers on all aspects of Elmer
- Click on **Elmer/Ice** link: find answers specific to Elmer/Ice
- To get access: **Register** in upper right corner

Elmer/Ice on Twitter   @ElmerIce1

Important links (summary)

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?id=start

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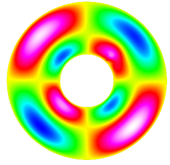
Elmer is an open-source, parallel, Finite Element code, mainly developed by the CSC-IT Center for Science Ltd. in Finland.

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...

Elmer/Ice Package

All the Solvers, User Functions and Meshers presented on the Elmer/Ice wiki comes as an Elmer/Ice package on the Elmer distribution (in `elmerice/`)

To get Elmer/Ice installed, add the following option to the cmake build command:

`-DWITH_ElmerIce:BOOL=TRUE`

To use it (in the SIF file):

`Procedure = File "ElmerIceSolvers" "`*NameSolver*`"`
or
`Procedure = File "ElmerIceUSF" "`*NameUSF*`"`

Important notices

In this course

-   We will not teach finite element method (can give references)

-   We will focus on some technical aspects of using Elmer for glaciological applications

What we expect from this course ?

- giving you a kick-start in Elmer/Ice
- some fruitful collaborations to begin

Elmer/Ice capabilities

- **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 solver)

- **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 on the distribution)

- **Calving** (3 approaches, one in the distribution)

- **Damage mechanics**

Elmer/Ice capabilities

Flow equations		Stokes	SSA	SSA*	SIA	ISCAL
Rheology	Glen	X, Inv Adj + Rob	X, Inv Adj	X	X	X
	GOLF	X				
	CAFFE	X				
	POROUS	X				
	Damage	X	X	X	X	X
Basal friction	Linear	X, Inv Adj + Rob	X, Inv Adj	X		
	Weertman	X	X	X		
	Coulomb	X	X	X		
	Budd	X	X	X		
	Tsai		X	X		
Free surface	dS/dt	X	X	X	X	X
	dH/dt	X, Inv	X, Inv	X, Inv	X, Inv	X, Inv
Grounding line	Contact	X				
	Hydrostatic	X	X	X	X	
Calving	Fracture+Damage	2D				
	crevasse depth	X				
Temperature	Temperate	X	X	X	X	X
	Enthalpy	X	X	X	X	X
Hydrology	Two layers	X	X	X		
	GlaDS	X	X	X		