

SvalGlac

Glacier dynamics modelling group activities

NEW MEMBERS:

R. Cossu (Italy)
A. Di Mascio (Italy)
Timo Riikilä (Finland)
Rupert Gladstone (Finland)

GROUP MEMBERS:

Bucchignani, Edoardo (Italy)
Corcuera, María Isabel (Spain)
Cuadrado, María Luisa (Spain)
Dunse, Thorben (Norway)
Forieri, Alessandro (Italy)
Mansutti, Daniela (Italy)
Navarro, Francisco (Spain)
Otero, Jaime (Spain)
Pettersson, Rickard (Sweden)
Pontrelli, G. (Italy)
Schäfer, Martina (Finland)

SvalGlac Steering Committee Metting, Atockholm, 27 October 2012

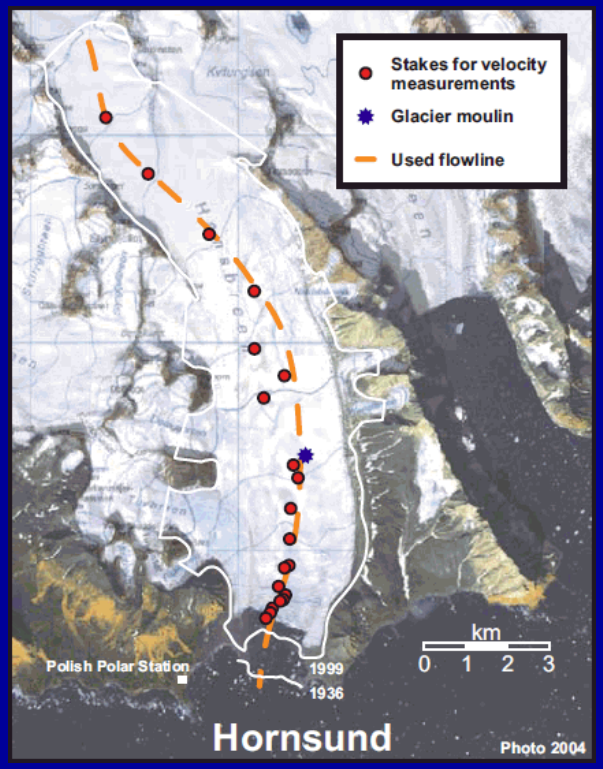
SPANISH TEAM

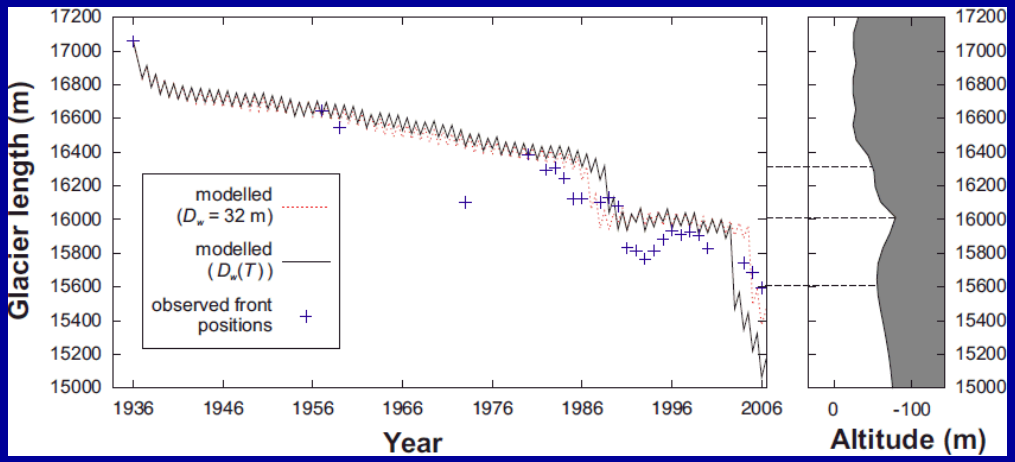
2-D modelling of Hansbreen:

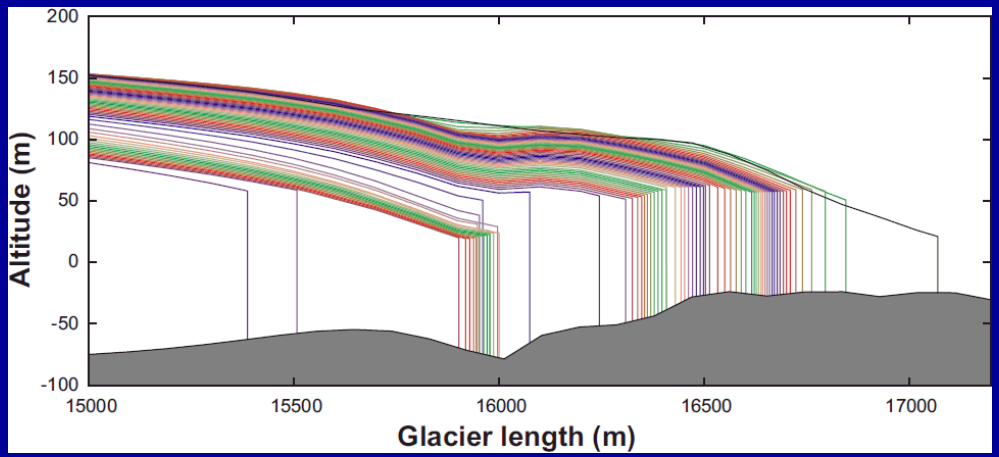
Improvements in 2D full-Stokes (Elmer) modelling of the transient dynamics of Hansbreen, including a Benn-type calving low:

- Improved basal boundary conditions: introduced initialization scheme according to Arthern & Gudmundsson (2010).
- Improved treatment of lateral drag.

Still facing problems with inconsistent field data!







Modelling of Amundsenisen:

After 3D-modelling and supply to Italian partners 2D flowlines, consulting activities to Italian partners on physics of model and interpretation of results.

National Research Council of Italy

SvalGlac

ESF Project

Outline of the activities developed by the Italian team (2011/2012)

Daniela M., E. Bucchignani, A. Forieri, G. Pontrelli; R. Cossu, A. Di Mascio

According to the Plan of Activity:

AIM: Diagnostic study of a subglacial lake and of mechanisms underlying the icefield/lake system via an *in-house* computational code.

Testing on Amundsenisen icefield with data provided by J. Otero & F. Navarro.

>>> Physical aspects added in the code during the past one year:

- viscosity dependency on deformation tensor (Glen's law, n=3) and constant water content in temperate ice
- firn thermal field (according to field data by Zagorodnov, 1985)
- tuning of eddy viscosity/diffusion coef-ficients of lake Large Eddy Simulation

>>> Difficulties have been faced at computational level:

- mesh refinement at ice/lake interface (lake side) is mandatory for correct description of phase change mechanism
- strong dependence of Large Eddy Simulation of lake flow on basin geometry (Antarctic lakes are quite different!)
- guess of an initial lake flow and thermal field (combined with lengthy time evolution)

>>> Improved understanding of the physics of icefield/lake system:

- the presence of a firn layer cannot be neglected, in particular when dealing with temperate icefields

>>> Work in progress:

- estimation of ice local water content according to conservation equation
- experimentation of deeper lake basin geometry
- acquisition of firn density from Zagorodnov data (1985) within computational code
- further tuning of sliding law constant (ice/rock) (...if required)
- inclusion of water filtration at bedrock (...perhaps!)

In addition:

Study of system sensitivity to *geothermal heat flux* and *external temperature* .

Focus on physical parameters to be observed and measured on field for improvement of subglacial lake diagnostic simulation.

Now, in order to release the products that we have planned in our project we would need six months extra time.

>>> List of conference contributions, reports and papers:

R. Cossu, D. Mansutti and M. Blaszczyk, *Delimitation of glacier zones in Svalbard using SAR images*, MASCOT 11, IMACS Series in Comput. and Applied Mathematics, vol. 17, 2012.

- D. Mansutti and E. Bucchignani, *Numerical results propedeutical to the simulation of a subglacial lake at Amundsenisen*, IAC Reports n. 201 (2/2012).
- E. Bucchignani, D. Mansutti, F. J. Navarro, J. Otero and P. Glowacki, *Numerical modelling of Amundsenisen Icefield for compatibility check of a subglacial lake. Preliminary tests*, Geophysical Research Abstracts Vol. 14, EGU2012-8148, 2012 (EGU General Assembly 2012) (poster).
- E. Bucchignani, D. Mansutti, F. J. Navarro, J. Otero and P. Glowacki, *Arguments about the existence of a subglacial lake at Amundsenisen Icefield (Svalbard) from modelling and scientific computing*, IGS Nordic Branch Meeting, Stockholm, October 25-27, 2012 (poster)
- E. Bucchignani, D. Mansutti, F. J. Navarro, J. Otero and P. Glowacki, *Finite volume modelling of an icefield with subglacial lake,* Congress on Numerical Methods in Engineering (SEMNI), Bilbao (2013) *(submitted abstract)*
- E. Bucchignani, D. Mansutti, F. J. Navarro, J. Otero and P. Glowacki, *Thermo-mechanical finite volume description of an icefield with firn cover and subglacial lake. An Arctic test case. (in preparation, to be submitted* to Int. Sci. Comp. J.)

>>> Planned papers:

> On the numerical simulation of temperate icefield with computed water content
> On the effect of climate change on icefield+subglacial lake system
(with 6 months extension of project duration)

Finland


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elmer
ice

Timo Riikilä

- supervised by
  - ✓Jan Åström, Tuomas Tallinen and Prof. J. Timonen
  - ✓University of Jyväskylä
- 1 year research project (before master level), half of it funded by SvalGlac
- unsure continuation of project
- construction of a discrete element model for viscoelastic materials with fracture: application calving

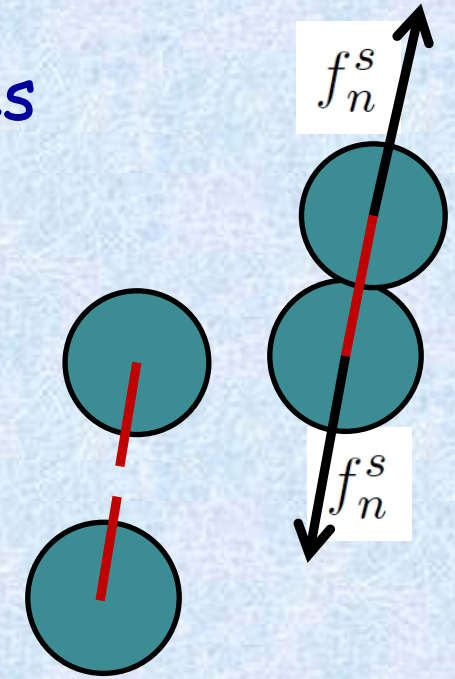
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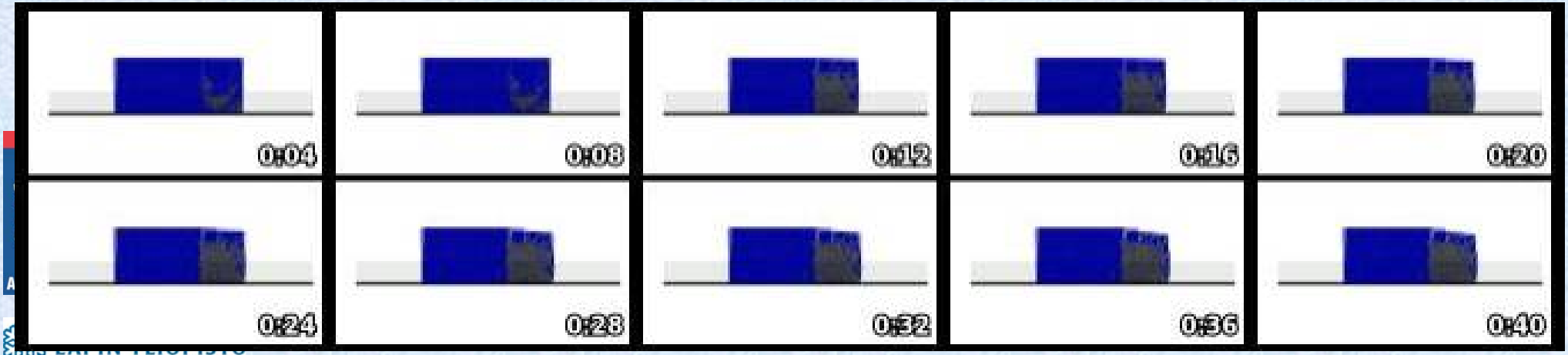
elmer ice

Timo Riikilä

- model consists of variable sized mass spheres connected with massless springs
- springs are allowed to break when a certain threshold is exceeded (fracture)
- viscotic behaviour is modeled with breaking and forming of springs under breakdown limit with small propability

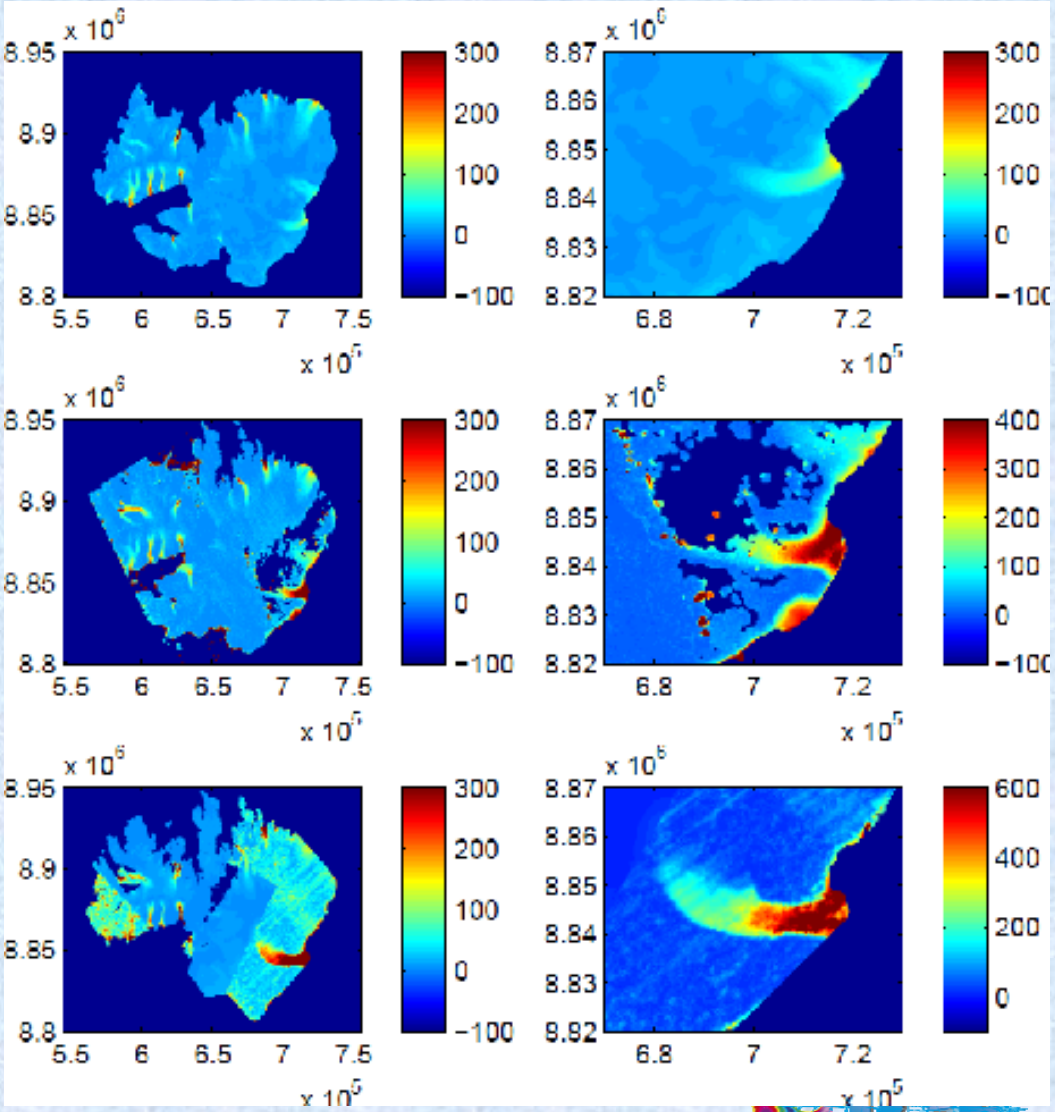


- example: effect of meltwater streams on calving



Rupert Gladstone

- 1 year postdoc, 6-8months of it funded by SvalGlac, then continued within SVALI
- modeling Austfonna ice-cap
- satellite based observations of velocity fields on the surface of the Nordaustlandet ice-caps:
  - ✓ "Basin 3" region enlarged on the right (Basin 3 is a surging glacier on Austfonna)
  - ✓ from top to bottom velocities from 1995, 2008 and 2011
- ✓ used to construct a refined mesh for use with the Elmer/Ice model

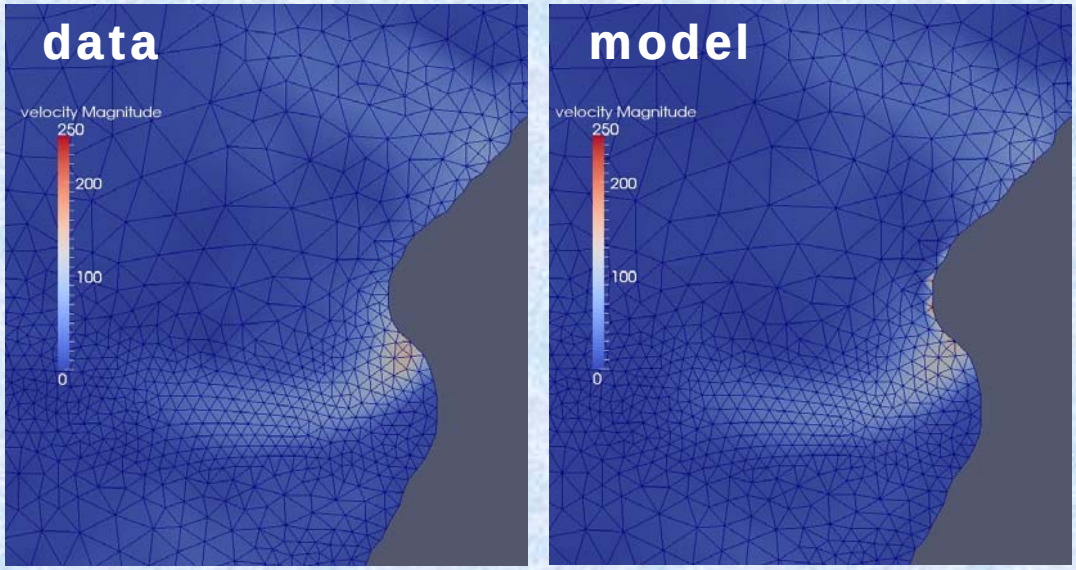


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Rupert Gladstone

- inverse techniques (developed by Rob Arthern of the British Antarctic Survey and implemented in Elmer/Ice by Fabien Gillet-Chaulet of the Laboratoire de Glaciologie et Géophysique de l'Environnement at Grenoble) used to infer the spatial distribution of basal stress of Austfonna
  - ✓ involves optimising the basal stress coefficient to minimise the discrepancy between modelled and observed velocities
  - ✓ modelled velocities are shown for Basin 3 for 1995



- plans:
  - ✓ use the results of the inverse modelling to investigate the possible relationship between temperature and basal drag
  - ✓ implementation of basal drag law that will allow for surging behaviour
  - ✓ simulations of future behaviour of Austfonna

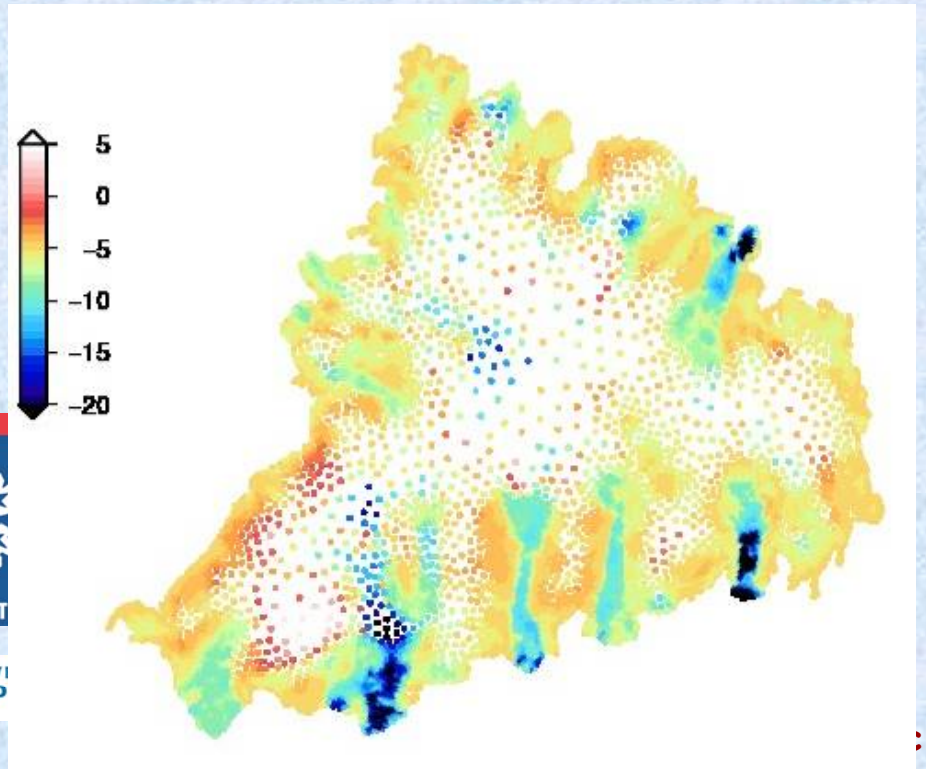
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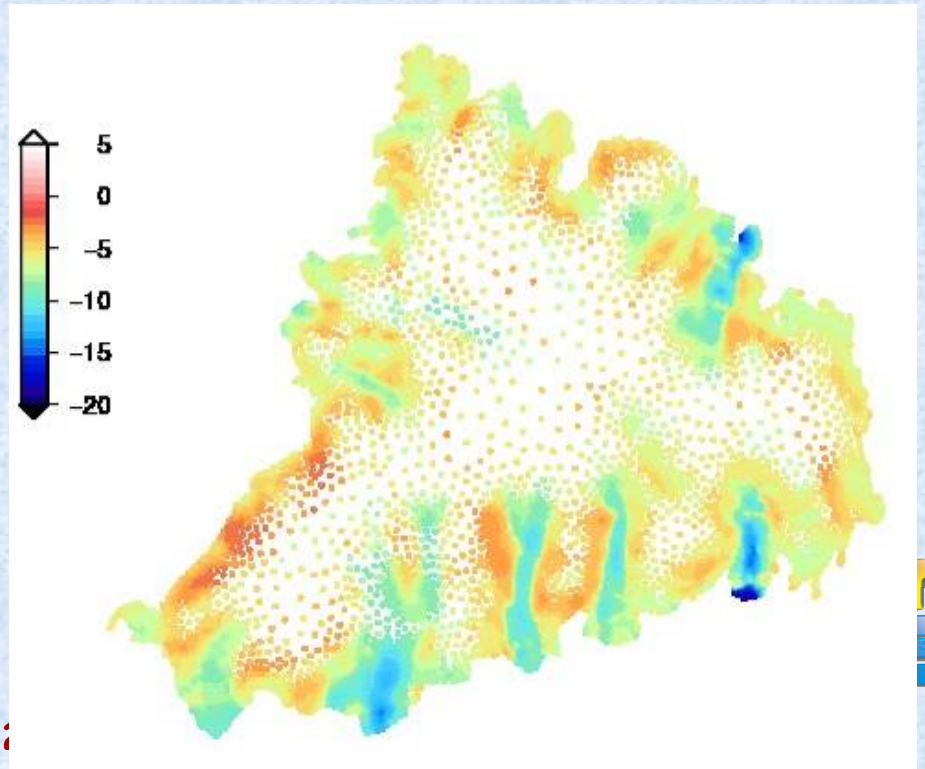
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elmer ice

Martina Schäfer

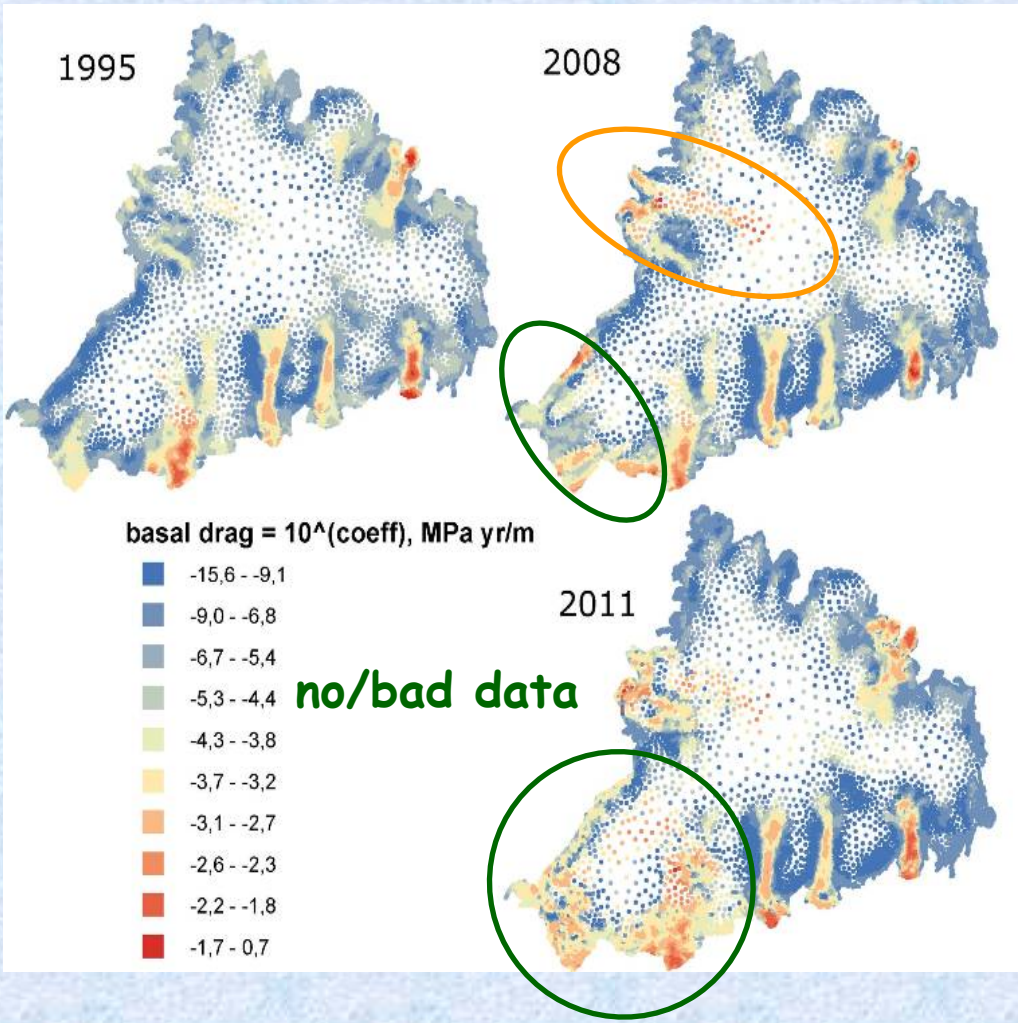
- SvalGlac funding used for traveling + fieldwork
- Vestfonna
  - ✓ similar to ASF project
  - ✓ TC paper http://www.the-cryosphere.net/6/771/2012/tc-6-771-2012.html
  - ✓ study of temperature distribution inside the icecap (friction heat is the most important heatsource in the fastflowing outlets) and link to basal drag obtained from inverse method
  - ✓ log(basal drag) shown left with approximated temperature, right with full temperature evolution (1995)





Martina Schäfer

- ✓ intercomparison of basal drag in 1995, 2008, 2011 inferred with inverse method from surface velocities
  - basal drag observed at 3 different periods is shown
  - acceleration at Franklinbreen visible
- ✓ paper in progress, hopefully submission before end of 2012



× Paierlbreen

- ✓ first modeling steps, but mainly still data gathering phase
  - bedrock data OK
  - velocity data search still undergo, TerrraSAR-X images ordered for December 2012
  - no modeling results will be achieved before end of Finnish SVALGLAC

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