Consiglio Nazionale delle Ricerche

Istituto per le Applicazioni del Calcolo "Mauro Picone"

Outline of the activities developed by the Italian group

Italian team: Daniela Mansutti, Edoardo Bucchignani, Alessandro Forieri, Giuseppe Pontrelli;
Rossella Cossu and Andrea Di Mascio (new entries).

SvalGlac ESF Project

3rd year, by 27-10-'12 (4th SSC meeting, Uppsala)

According to the Italian Plan of Activity:

Diagnostic study of a subglacial lake and mechanisms underlying the icefield/lake system via an *in-house* computational code. Testing on Amundsenisen icefield upon data provided by J.Otero and 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 coefficient
- thermal field of firn (according to field data by Zagorodnov, 1985)
- calibration of eddy viscosity/diffusion coefficients of lake Large Eddy Simulation (LES)

>>> *Work in progress:*

- estimation of local ice water content according to conservation equation
- acquisition of firn density from Zagorodnov data (1985)
- further tuning of sliding law constant (ice/rock) (... if necessary)
- inclusion of water density dependency on pressure
- inclusion of water filtration at rocky bottom (... out of SvalGlac)

Further aims that will be pursued within the project:

Study of system sensitivity to *geothermal heat flux* (with melting at ice-rock interface) and *external temperature* (with unsteady top ice surface).

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

Aside SvalGlac:

Working on the premises for future cooperation with SvalGlac research team (e.g. ESFRI SIAEOS program)

Application of a segmentation technique for SAR images, based on level set modeling and *in-house* numerical code, aimed at identifying different ice zones (snow, firn, ice) for comparison within time sequences (*feasibility under evaluation* with Jacek J., Malgorzata B.)

Reports, conferences, publications:

R. Cossu, D. Mansutti and M. Blaszczyk, *Delimitation of glacier zones in Svalbard using SAR images*, MASCOT 11, IMACS Series in Computational 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 volumes description of an icefield with firn cover and subglacial lake. An Arctic test case.* (in preparation to be submitted to intern'l Scie. 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)

Budgetary Issues

3rd year budget, initial:	+ euro 16 560,00
partecipation to EGU 2012, Wien:	- euro 1 157,00
3rd year contract for Dr. Ing. Edoardo Bucchignani:	- euro 10 500,00
overhead (10%):	- euro 1 656,00
3rd year budget, residual at this date:	+ euro 3 180,00

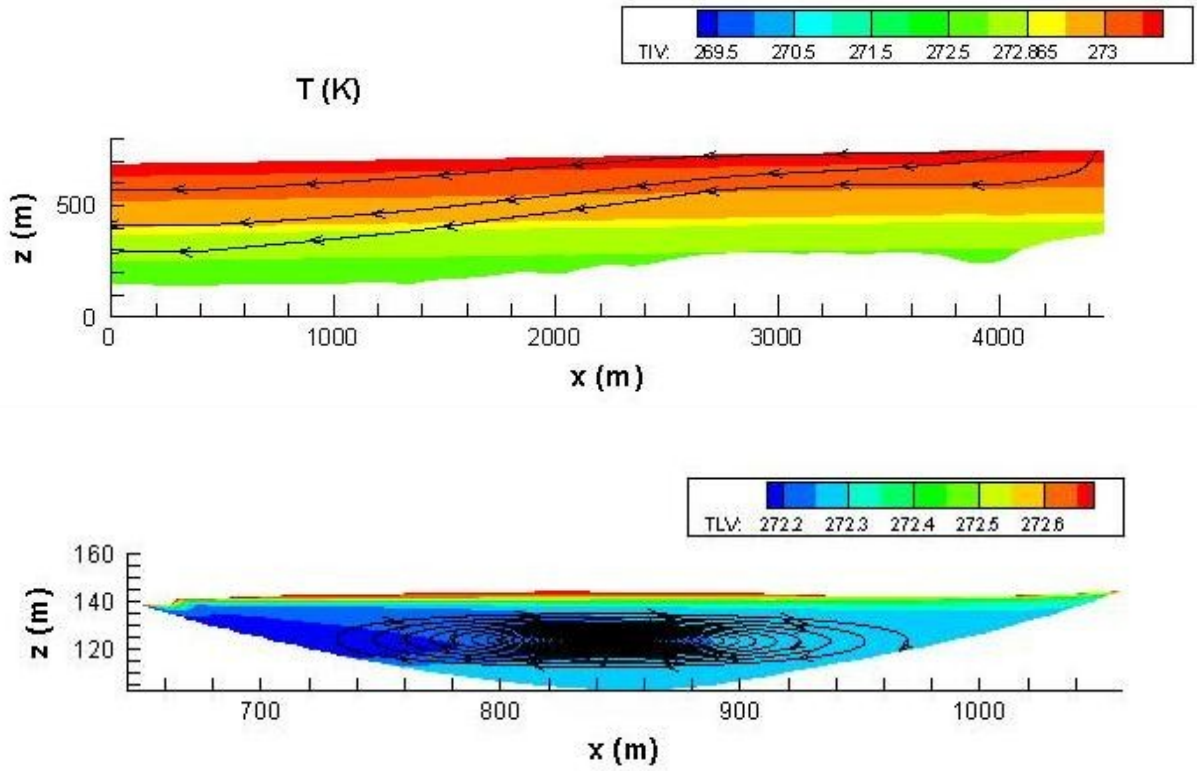
for partecipation to NASC-IAG annual meeting (Obergurgl) (or similar conference) and final SvalGlac meeting.

Test case: **Amundsenisen,**
section upon conjectured subglacial lake

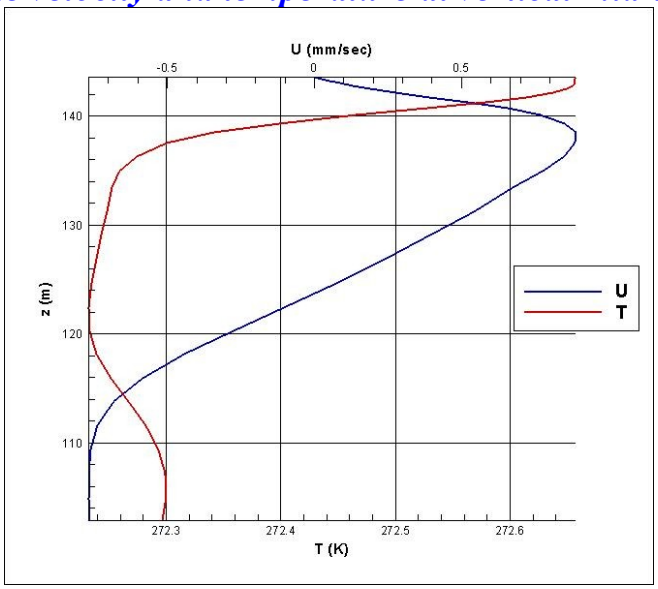
Initial condition: (t = 0)
fully developed ice field flow and lake at rest;
temperate ice and temperature conducting profile in the lake

Numerical solution at time t=530 d

Icefield and Lake temperature and particle tracks



Lake velocity and temperature at vertical mid-line

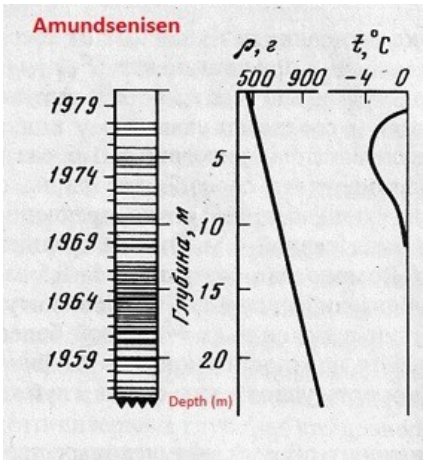


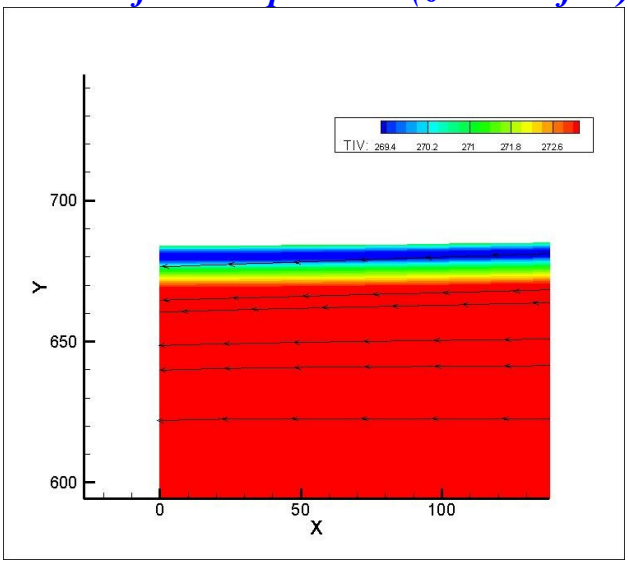
OBS: **Numerical Lake temperature appears too low**

Heat (conduction) balance arguments $\Rightarrow$

- **Firn layer contribution appears non negligible**
- **Simulated lake depth is less than *estimated* minimal lake depth**

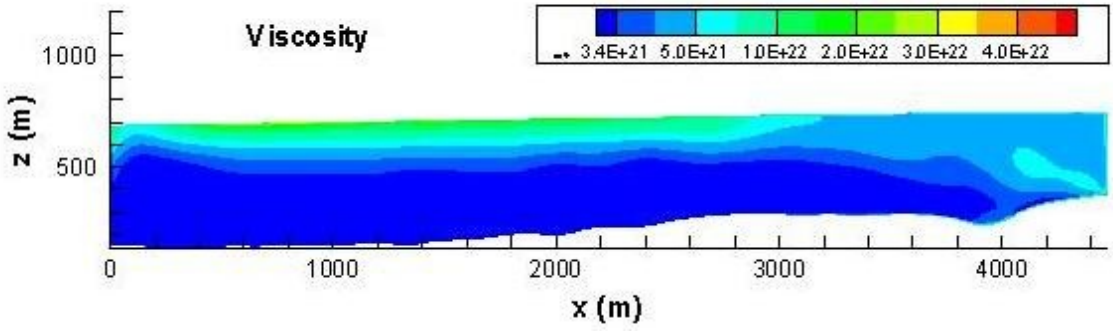
Icefield temperature (zoom on firn)



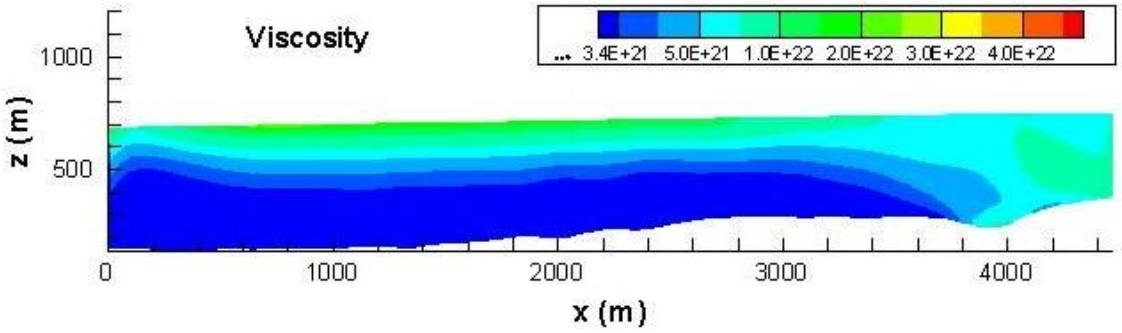


(Zogorodnov, 1985)

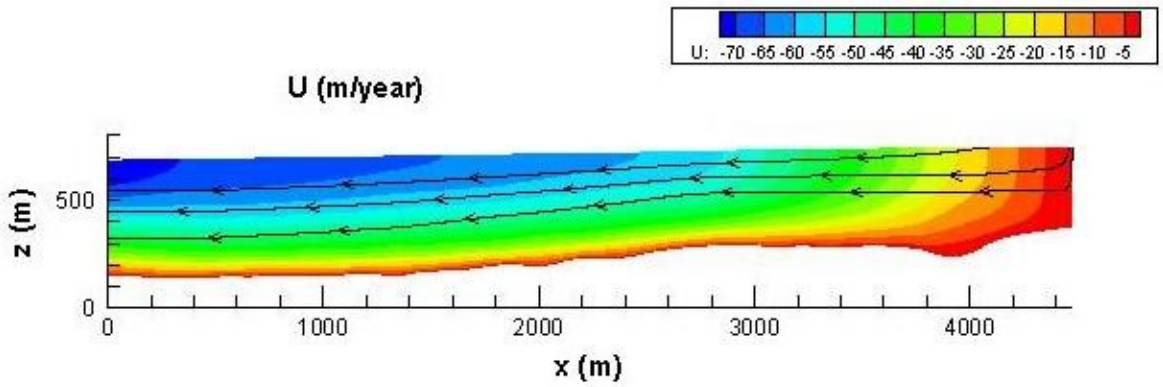
<u>Numerical solution at time t=30 d</u> *(with firn)*



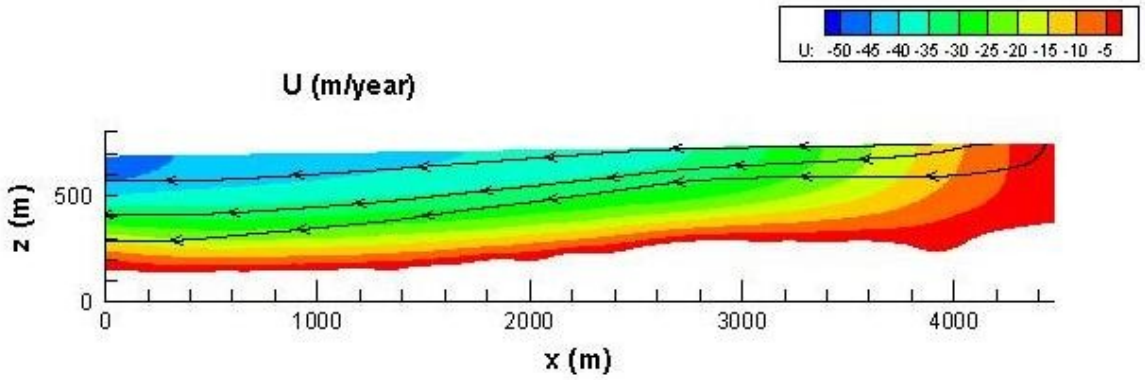
(without firn)



(with firn)



(without firn)



OBS: numerical **Icefield Viscosity** and horizontal velocity, **U**, fields exhibit <u>significant differences</u> in cases ***with*** and ***without firn***.

Then numerical simulation continues with firn layer description included with deeper subglacial lake **(Work in progress)**.