ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

First attempts to simulate lake ice in Finland with FLake and REMO regional climate model

Jussi Kaurola

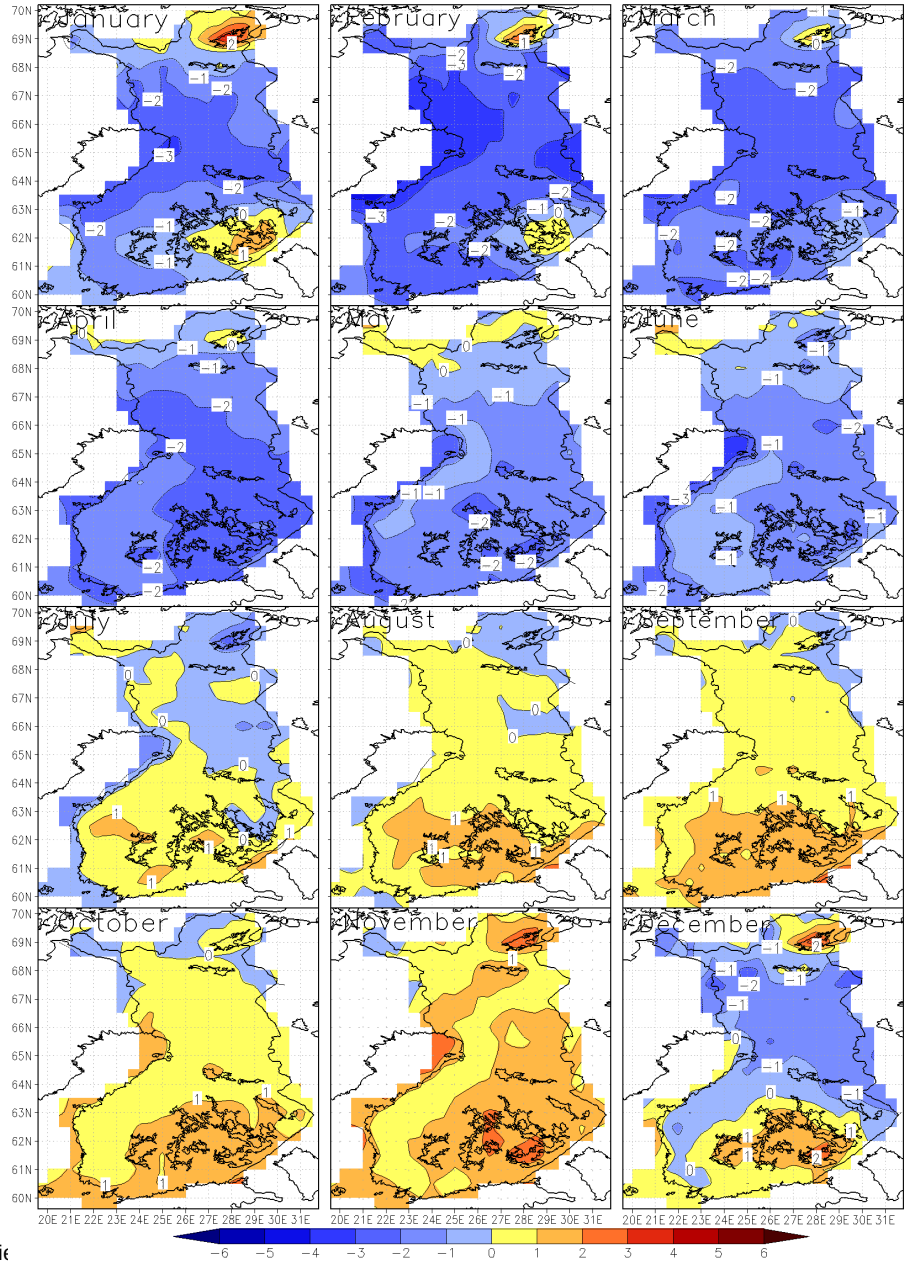
My background

- Degrees:
  - MSc Meteorology, University of Helsinki, 1990
  - PhD Meteorology, University of Helsinki, 1996
    "*Diagnostics of the Present and Future Climate in the ECHAM3 Model: Storm Tracks and Wave Propagation During the Boreal Winter*"
- Career:
  - Research Scientist, University of Helsinki, 1988-1996
  - Senior Scientist, FMI, 1996-present
    - Ozone and UV radiation: 1996-2010
    - Regional Climate Modeling: 2010-

Regional Climate model REMO at FMI

- Aerosols and Clouds
- Hydrological studies
- Land surface processes
  - Changes in land use
  - Greenhouse gas exchange
- Etc.

Bias of monthly T_{2m} in REMO during 1995–2005 (REMO-Obs). Taru Balk, MSc. 2011.



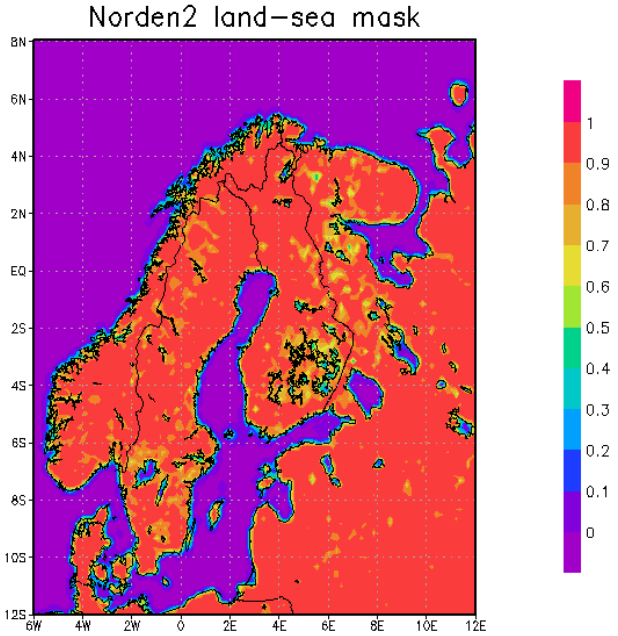
REMO (www.remo-rcm.de)

- Hydrostatic 3D regional atmospheric model developed in Hamburg, Max-Planck-Institut für Meteorologie, Daniela Jacob et al.
- Version 2009
- Rotated spherical grid
- Leap-frog time stepping with semi-implicit correction and Asselin-filter
- fractional surface cover: land, water, sea ice

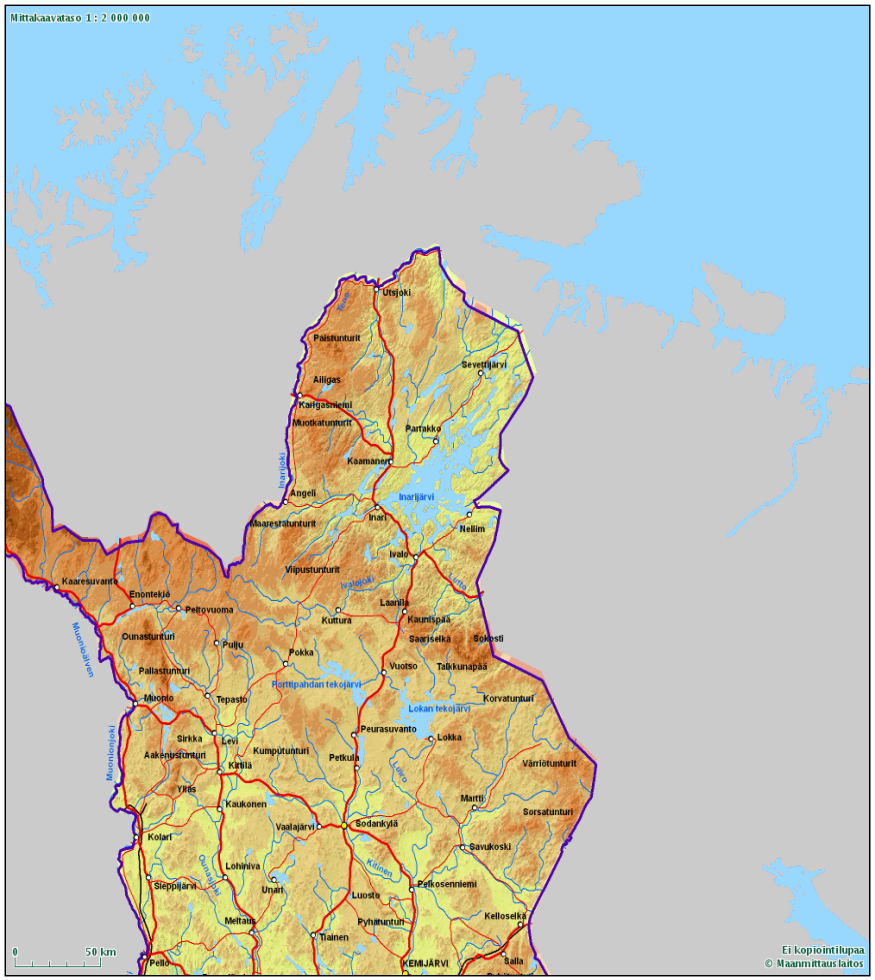
FLake (www.flake.igb-berlin.de)

- freshwater lake model by Dmitrii Mironov et al.
- vertical temperature structure and mixing conditions in lakes
- two-layer parametric representation of the evolving temperature profile and on the integral budgets of heat and kinetic energy
- The vertical structure is described using the concept of ***self-similarity*** (assumed shape) of the temperature-depth curve

REMO + FLake



- Nordic domain, resolution 0.167º (lat/lon)
- Time step = 2 min
- Fixed lake depth of 10 m
- Simulations 2001-2009 with ERA-Interim boundary data
- FLake modifications:
  - Snow on thin ice not allowed (when ice is less than 3 cm)
  - Negative values of mean buoyancy frequency reset to zero
- REMO modifications:
  - new fractional surface type: ”inland water”
  - Lake Surface Temperature calculated by FLake interacts with REMO (on-line coupling)

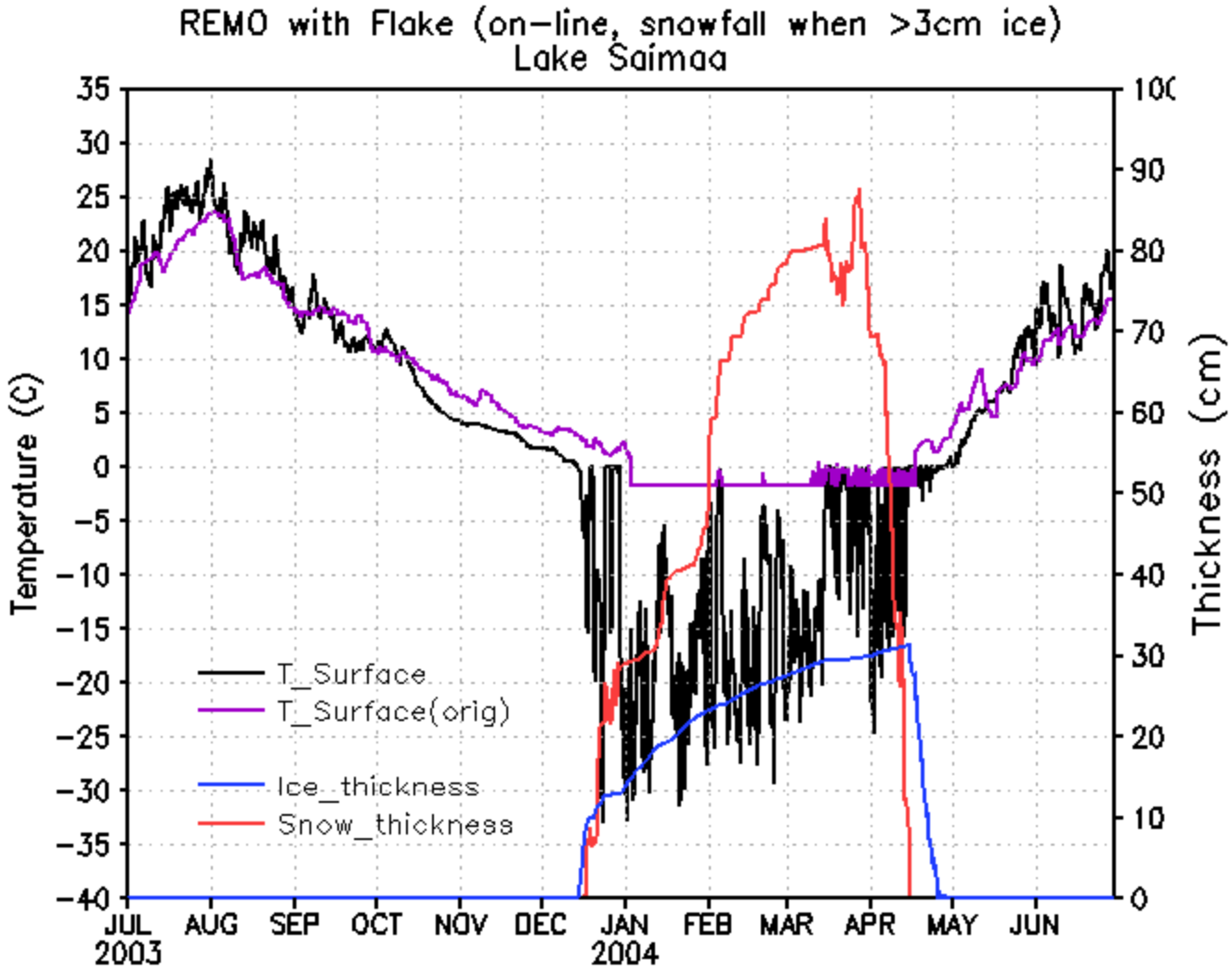


Lake Inari 1084 km^2

D_{max}=95 m D_{mean}=15 m

Lake Saimaa 1377 km^2

D_{max}=84 m D_{mean}=17 m


REMO with Flake (on-line, snowfall when >3cm ice)
Lake Saimaa
Temperature (C)
Thickness (cm)
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
100
90
80
70
60
50
40
30
20
10
0
JUL
2003
AUG
SEP
OCT
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2004
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MAY
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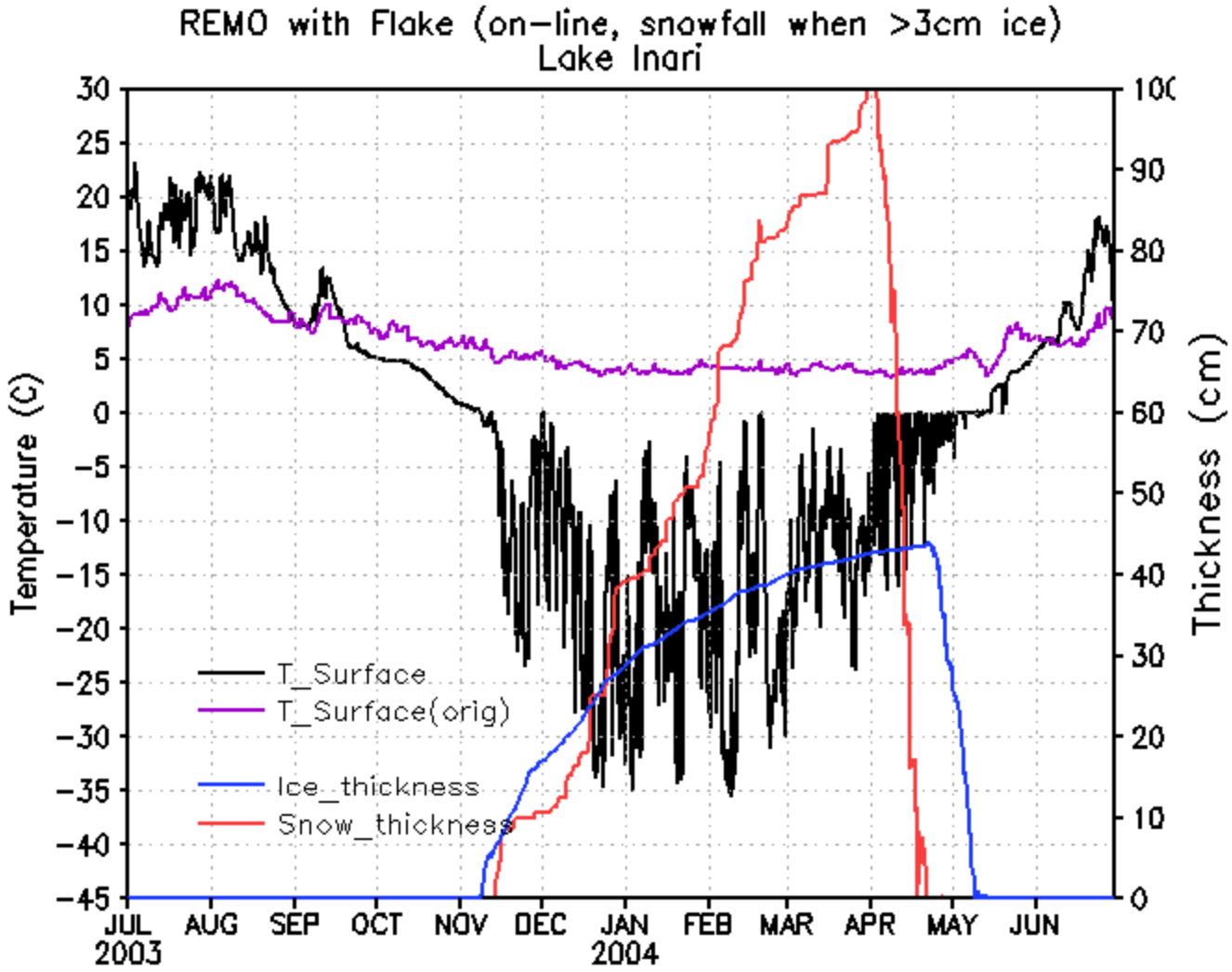
T_Surface
T_Surface(orig)
Ice_thickness
Snow_thickness


REMO with Flake (on-line, snowfall when >3cm ice)
Lake Inari
Temperature (C)
Thickness (cm)
T_Surface
T_Surface(orig)
Ice_thickness
Snow_thickness
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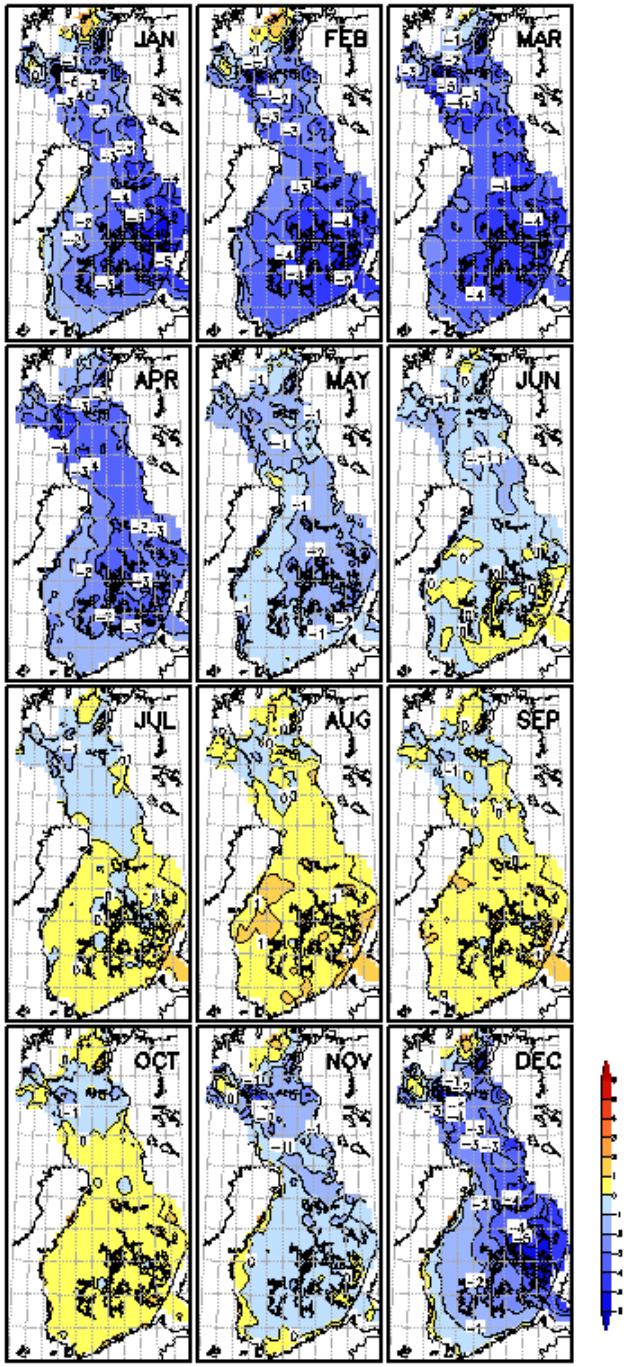
T2m 2001–2009: REMO_FLAKE_3CM – OBS
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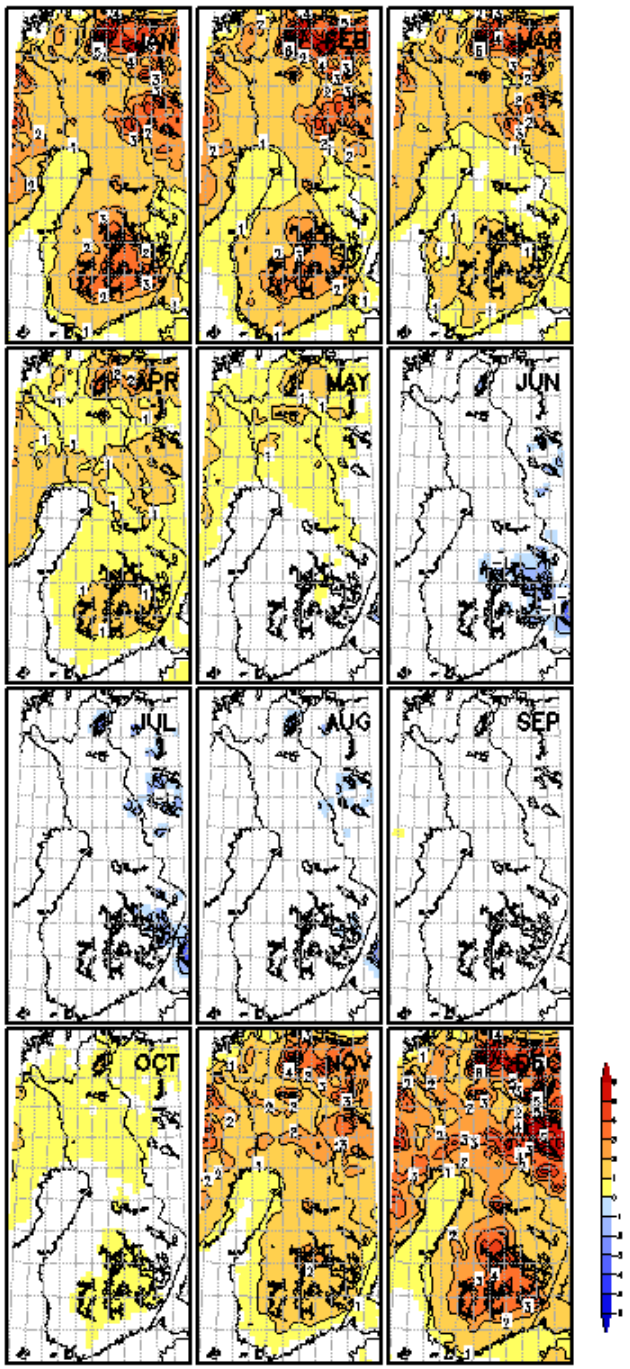
T2m 2001–2009: REMO_ORIG – REMO_FLAKE
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AUG
SEP
OCT
NOV
DEC

What to do next?

- Observed lake depths instead of constant 10m
  - Lake-Depth Data Set, *Kourzeneva, E., 2009: Global dataset for the parameterization of lakes in Numerical Weather Prediction and Climate modeling.*
- Calculate surface energy fluxes with REMO
- Use constant $\rho_{snow} = 300$ kg/m^3 in FLake
- Validate results with SYKE[1] lake ice observations
- For Finnish lakes, compare results with SYKE ice model which includes porous ice

1) Finnish Environment Institute


Thank you!