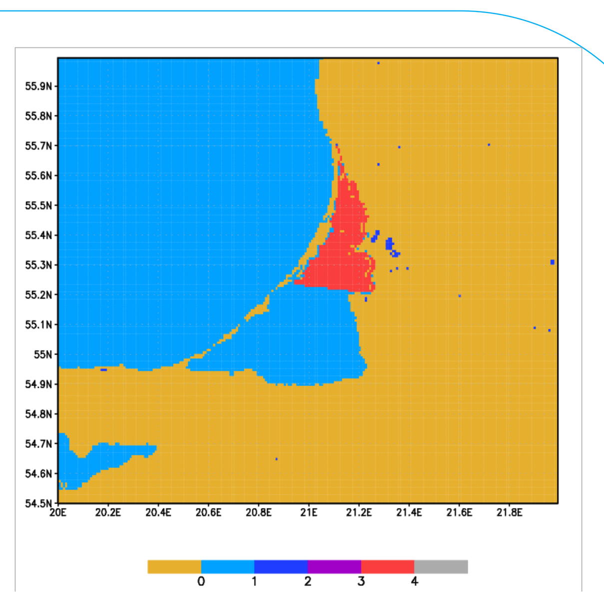
ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Status of lake and sea ice developments in HARMONIE

Ekaterina Kurzeneva (FMI), Margaret Choulga (RSHU), Yurii Batrak and Mariken Homleid (Met.no)

Lake modelling status & GLDB

- **Tests with PGD.** "Water body" covers were carefully examined. Result: some Covers are poorly defined! Example: Curonian lagoon, Covers 552, 554, 555, 556 contain up to 20% of land
- Solution: 1) to fix the binary cover map (done) 2) to change the partition between tiles (done).
- Problems with consistency of the lake depth and fraction fields: for fiords and coastal lagoons. Fixed in the code.
- **GLDBv2** is included into SURFEX, but problems with large rivers were found (fixing ongoing)
- **GLDBv3** is ongoing + tests with fine resolution …
- **1D experiments** for Lake Kyyvesi. To study the dependency of the model error on the lake depth. No dependecy in summer (due to the positive bias up to 7°C in FLake), strong dependency in autumn.

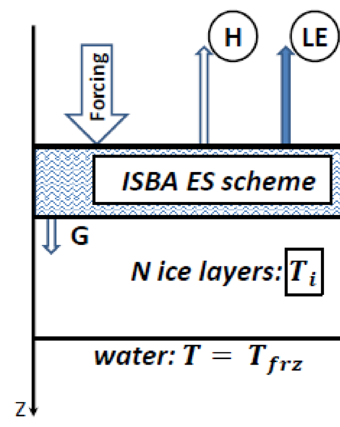


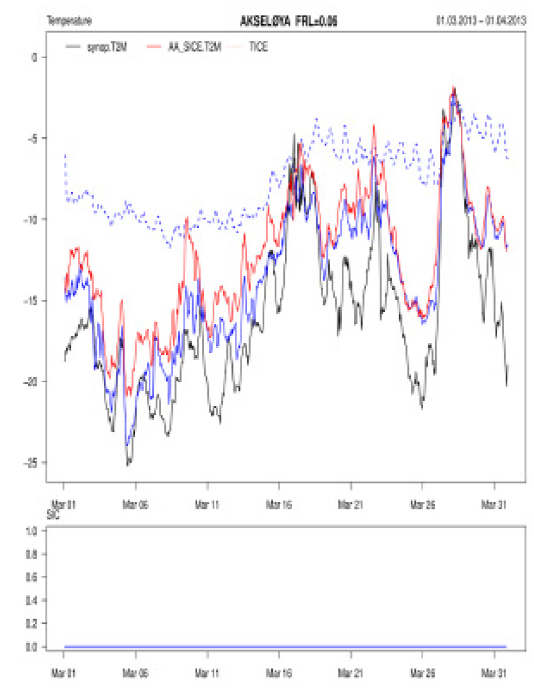
	Cover type	Current partition	Remarks	Suggestions
124	Warm tropical wetlands	nature – 80% inland water – 20%	-	nature – 100 %
125	Subpolar wetlands	nature – 80% inland water – 20%	-	nature – 100 %
176	Rice fields	nature – 80% inland water – 20%	"False" cover, does not exist on the binary map	-
238	Temperate wetlands	nature – 80% inland water – 20%	"False" cover, does not exist on the binary map	-
239	Subpolar wetlands	nature – 80% inland water – 20%	Exist only in Iceland	nature – 100 %
240	Peat bogs	nature – 80% inland water – 20%	"False" cover, does not exist on the binary map	-
241	Salines and salt marshes	nature – 50% inland water – 50%	"False" cover, does not exist on the binary map	-
242	Intertidal flats	nature – 50% sea water – 50%	"False" cover, does not exist on the binary map	-
243	Coastal lagoons	sea water – 100%	"False" cover, does not exist on the binary map	-
249	INLAND WATERS1	inland water – 100%	Polders and coastal lagoons	sea water – 100%
550	UNDEFINED1	nature – 45% inland water – 55%	In Europe: sea water near the coast, coastal lagoons, river estuaries. In Ukraine and Turkey: lakes. In Asia: land.	Several cover fixes in binary map: from 550 to 2 or from 550 to the major cover type in the vicinity. For the rest: nature – 45% sea water – 55%
551	INLAND	nature – 5%	"False" cover, does not exist on the	-

Consistency with other developments is needed!

Simple sea ice model

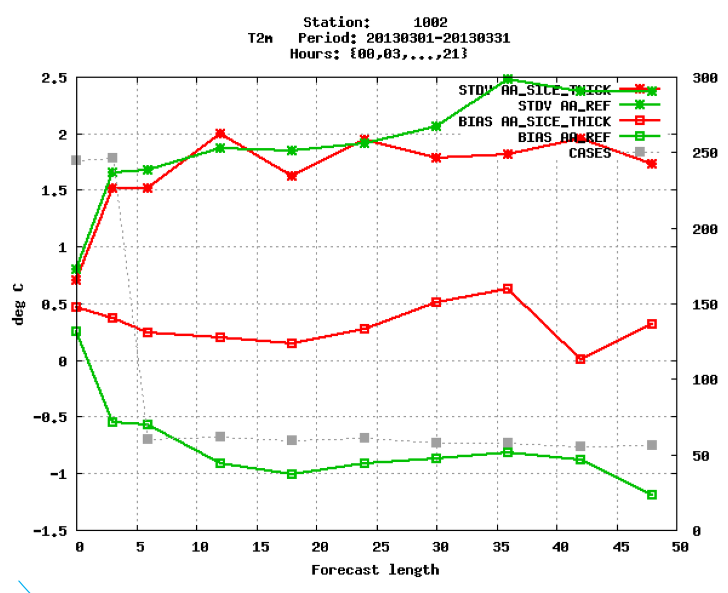
- **SICE:** Constant ice depth, tuning parameter (~0.75m)
- Solution of the heat diffusion equation for N layers in ice
- Snow on ice with ES from SURFEX is technically possible
- The ice fraction is from the analysis
- No analysis for temperature: starts from the previous forecast or from the interpolated/extrapolated ECMWF ice surface temperature analysis and the linear temperature profile in ice
- **Tests** over AROME Arctic domain
- SST and SIC fields in fiords need to be improved



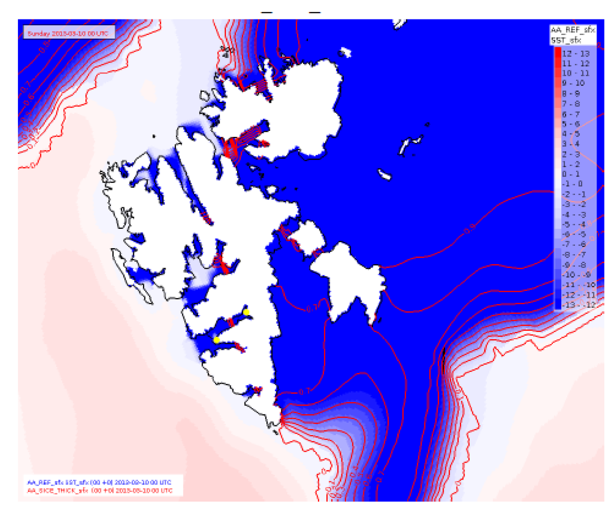


AA_REF – reference
(default ICEFLUX scheme)
AA_SICE_THICK – SICE with H=0.75m

REF T2M



Red contours – SIC, blue shadowing – SST extrapolated from ECMWF analysis and land



DA for lakes

- **EKF:** Experiments with LWST in-situ obs from SYKE + selected MODIS obs for early spring, open water period, summer 2011
- Cross-validation for 4 lakes: RMSE decreases strongly!
- Some a posteriori statistics: the impact of obs is high!
- Preliminary study of the filter components (Jacobian, Kalman gain, background error cov): no divergence, annual cycle
- The performance of the mean water and bottom temperatures is strongly dependent on the quality of early spring observations.Testing with deep water temperature obs is important!
- Decoupling problem in summer: difficult to correct the LWST
- Bug fixes
- **New structure functions for LWST,** different from that for SST - ongoing, Homa Kheyrollah Pour, UW

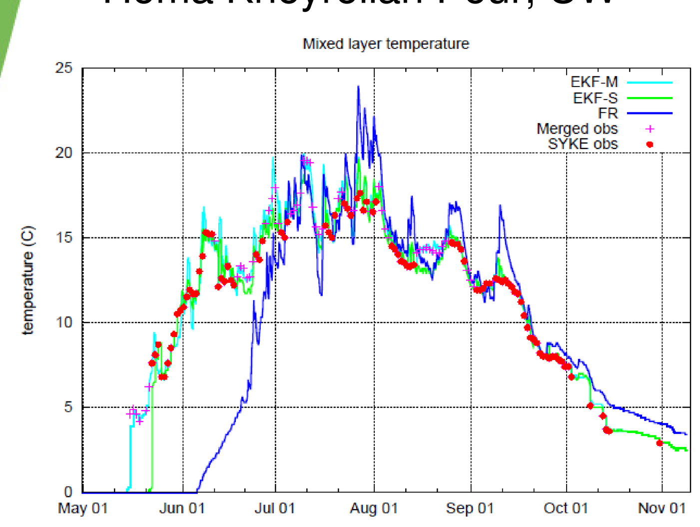
The bias, RMSE and ESTD (°C) for the assimilation of the merged LWST obs (in-situ + MODIS) (a positive bias means an overestimation of LWST).

Lake	no DA			EKF		
	Bias	RMSE	ESTD	Bias	RMSE	ESTD
Inarijärvi	-2.03	5.02	4.59	0.12	0.96	0.96
Saimaa	-1.07	3.67	3.52	-0.04	1.11	1.11
Lappajärvi	0.19	2.87	2.87	0.46	1.51	1.44
Tuusulanjärvi	0.83	2.92	2.80	0.85	1.41	1.13

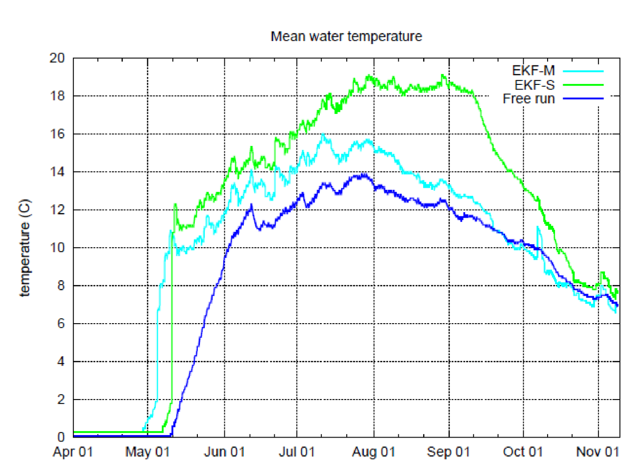
The impact $I = \frac{RMSE_{mod} - RMSE_{assim}}{RMSE_{mod}} \cdot 100\%$ of the assimilation of in-situ obs.

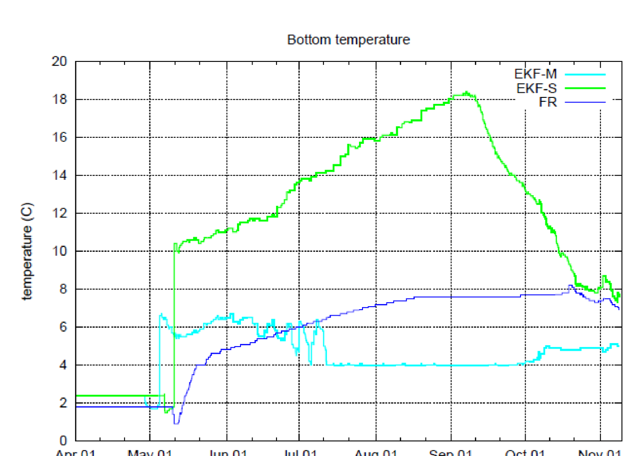
Name (lon, lat)	D, m	I, %	Name (lon, lat)	D, m	I, %
Kuivajärvi (23.9,60.8)	2.2	94.8	Rehja-Nuasjärvi (28.0,64.2)	8.5	95.5
Tuusulanjärvi (25.1,60.4)	3.2	94.3	Vaskivesi (23.8,62.1)	7.0	97.1
Pääjärvi 1 (24.5,62.9)	3.8	96.6	Haukivesi (28.4,62.1)	9.1	94.9
Pesiöjärvi (28.7,64.9)	3.9	95.4	Kallavesi (27.7,62.8)	9.7	96.3
Kyyvesi (27.1,62.0)	4.4	96.5	Pielinen (29.6,63.3)	10.1	94.6
Jääsjärvi (26.1,61.6)	4.6	96.2	Konnevesi (26.6,62.6)	10.6	95.4
Nilakka (26.5,63.1)	4.9	96.6	Saimaa (28.1,61.3)	10.8	94.5
Pyhäjärvi (22.3,61.0)	5.5	96.4	Ala-Rieveli (26.2,61.3)	11.2	92.4
Längelmävesi (24.4,61.5)	6.8	94.4	Päijänne (25.5,61.6)	14.1	93.7
Ounasjärvi (23.6,68.4)	6.6	97.3	Inarijärvi (27.9,69.1)	14.3	97.1
Lappajärvi (23.7,63.1)	6.9	93.4	Näsijärvi (23.8,61.6)	14.7	94.0
Oulujärvi (27.0,64.5)	7.0	95.0	Pääjärvi 2 (25.1,61.1)	14.8	96.7
Unari (25.7,67.1)	7.0	94.0	Kilpisjärvi (20.8,69.0)	19.5	96.8
Kevojärvi (27.0,69.8)	7.0	98.0			

FR is the free run, EKF-S and EKF-M are runs with assimilated SYKE (in-situ) and merged (in-situ+MODIS) LWST obs.

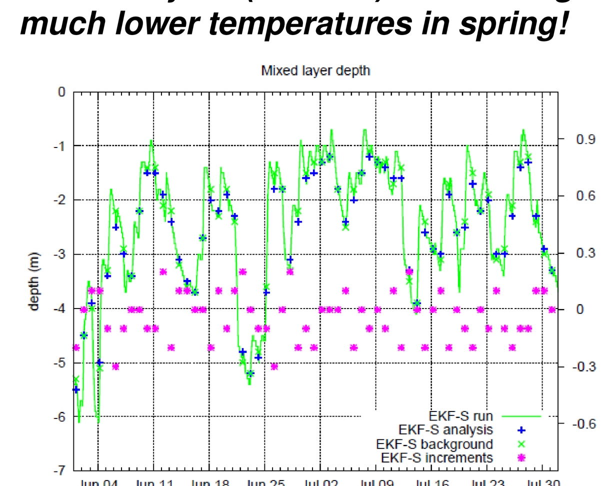


Lake Inarijärvi (d= 14 m). Note: merged obs start from much lower temperatures in spring!





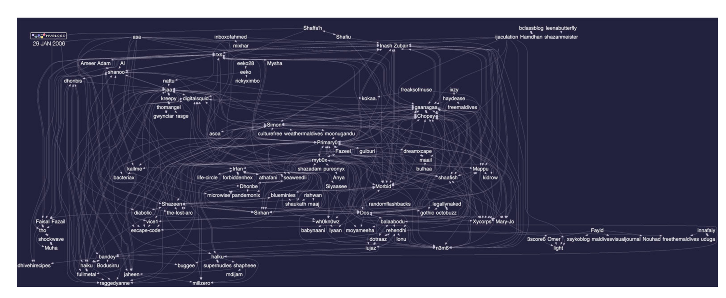
Lake Saimaa (d= 11 m). Note: in EKF-S the temperatures are too high!



Lake Saimaa (d= 11 m). Note the decoupling problem: the mixed layer depth tends to return fast to its initial values, increments are mainly negative.

By-product: ideas for the model documentation

- **Code structure:** How to study? How to explain?
- DOXYGEN produces lists (Ok!)… and graphs -???
- Producing graphs, DOXYGEN promises to provide the minimum number of intersections. But they are still almost useless.
- How to unravel the graph?



- Idea: to consider 3 main types of routines

Plain routine : is called only once, contains CALLs

Utility : is called from many places, contains no CALLs, contains simple methods

Block routine : is called from many places, contains CALLSs, contains complicated methods

Every **Block routine** starts the new graph!

- Automatic documentation is possible! – ongoing, welcome to join!