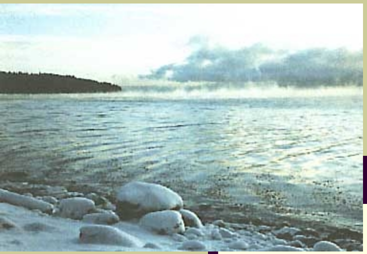




Lake Parameterization in HIRLAM

E. Kourzeneva, RSHU

RSHU

needs for a lake parameterization

- in some regions lakes may cover the significant part of the territory
- lakes affect surface fluxes
- ice covered/ ice free surface – different physics
- SST analysis technology may lead to errors for lakes

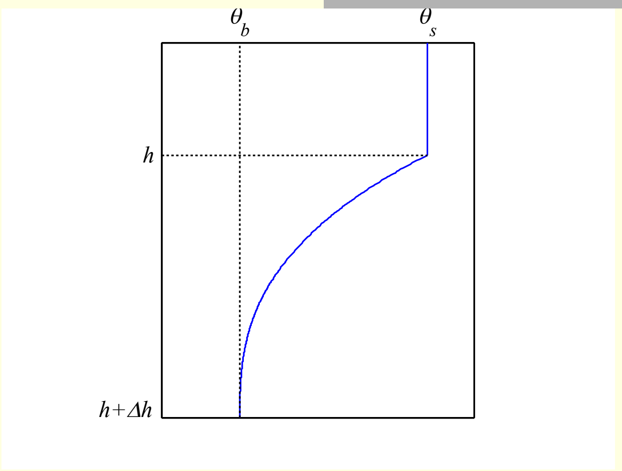
contents

- lake model FLake
- coupling with RCA – previous results
- issues:
  external data – lake database
  cold start data
- first results for HIRLAM

lake model FLake (author D. Mironov, DWD)

- **Lake model should**

be computationally cheap, incorporate most of essential physics, not need tuning for the specific lake, need minimum of specific lake parameters



- **Lake model FLake**

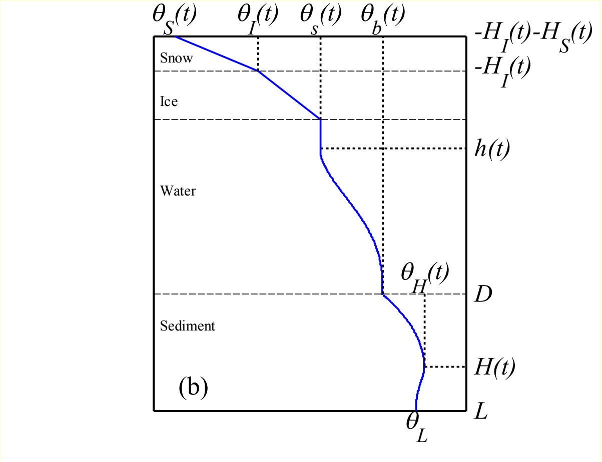
based on two-layer parametric representation of the temperature profile and self-simularity concept

$\theta_s(t)$ – *mixed layer temperature*

h(t) – mixed layer depth

$\theta_b(t)$, *–bottom temperature*

D=h+Δh – lake depth.



RSHU

to represent temperature profile shape-function and shape-factor are used

$$\theta = \begin{cases} \theta_s \,, & 0 \le z \le h \\ \theta_s - (\theta_s - \theta_b)\Phi_\theta(\xi), & h \le z \le D \end{cases}$$

$$\xi = (z-h) \big/ (D-h)$$

$$\Phi_\theta \equiv (\theta_s - \theta) \big/ (\theta_s - \theta_b)$$ – is approximated by polinom (ξ)

$$C_\theta = \int_0^1 \Phi_\theta(\xi)\, d\xi$$

basic equations:

- for mean water temperature

$$\frac{\partial \overline{\theta}}{\partial t} = \frac{1}{\rho_w c_w}\left[Q_s + I_s - Q_b - I(D)\right]$$

- for bottom temperature

$$\frac{1}{2}(D-h)^2 \frac{d\theta_s}{dt} - \frac{d}{dt}\left[C_{\theta\theta}(D-h)^2(\theta_s - \theta_b)\right] =$$

$$= \frac{1}{\rho_w c_w}\left[C_Q (D-h)(Q_h - Q_b) + (D-h)I(h) - \int_h^D I(z)dz\right]$$

- for mixed layer temperature

$$h\frac{d\theta_s}{dt} = \frac{1}{\rho_w c_w}\left[Q_s + I_s - Q_h - I(h)\right]$$

model blocks

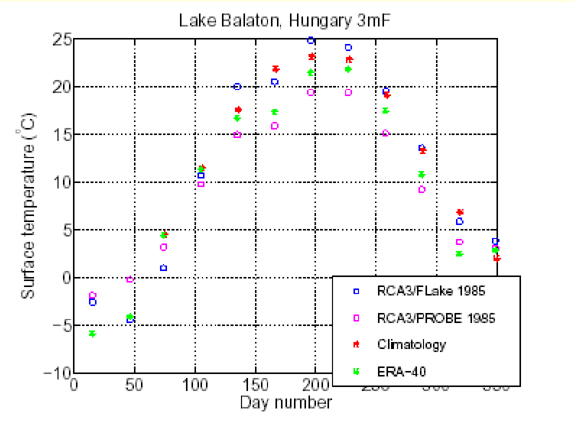
- prediction of mixed layer depth
  - convection
  - neutral and stable stratification
- short-wave radiation transfer
- ice and snow
- bottom sediments

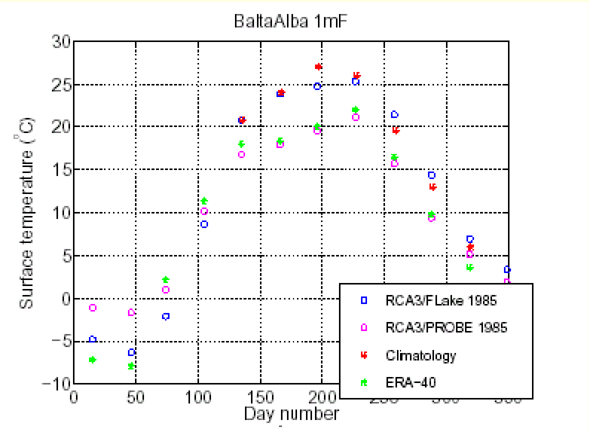
individual lake parameter: depth!

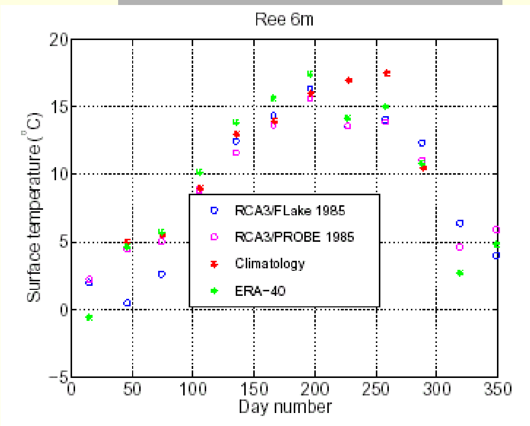
previous results: coupling with RCA

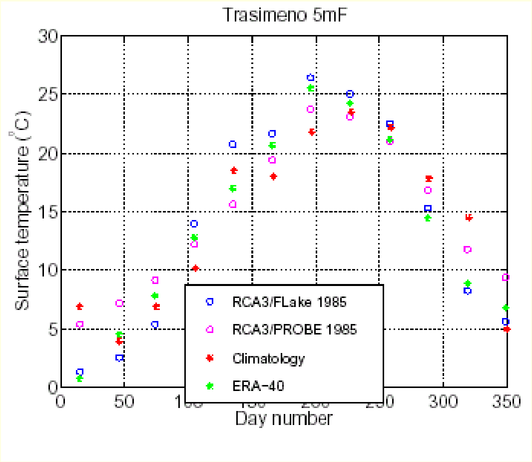
- included into RCA as a parameterization,
  every time step
- RCA provided fluxes, FLake – surface temperature
- Europe, resolution 40 km
- database for lake depth for Sweden,
  d=10m for most of European lakes,
  real depth for big European lakes
- sub-tiling – according to Swedish lake database
  shallow (depth=3 m),
  medium (depth=7.4 m),
  deep (real depth)
- start in autumn – all the lakes are mixed down to the bottom

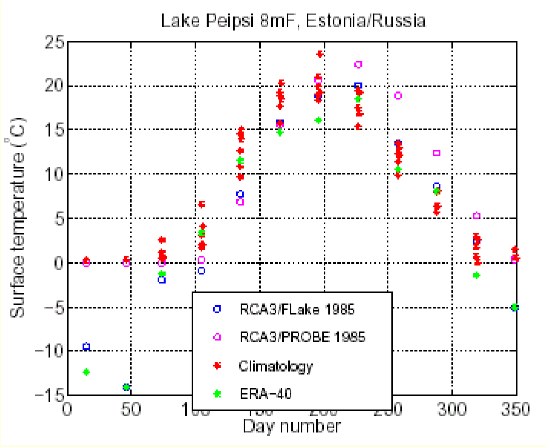
experiments and verification: for individual lakes

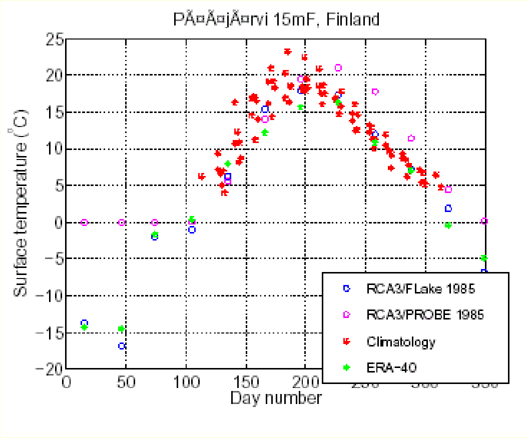






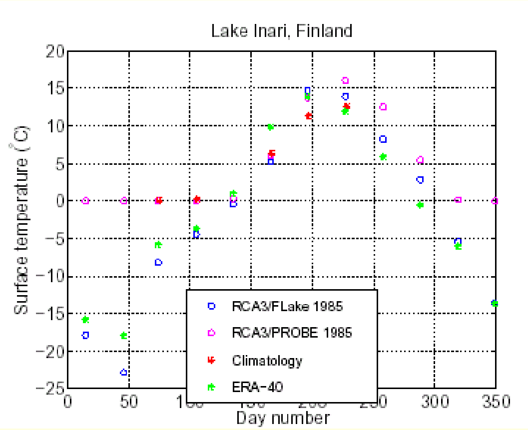


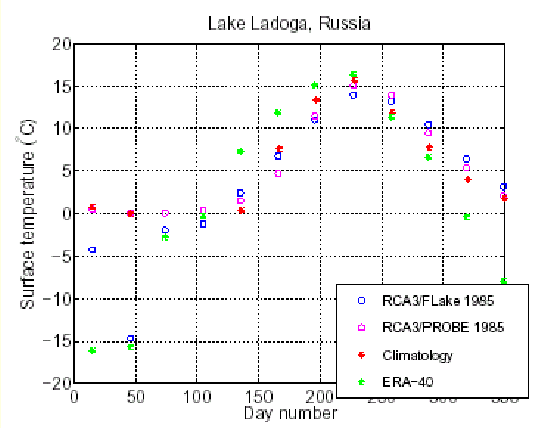


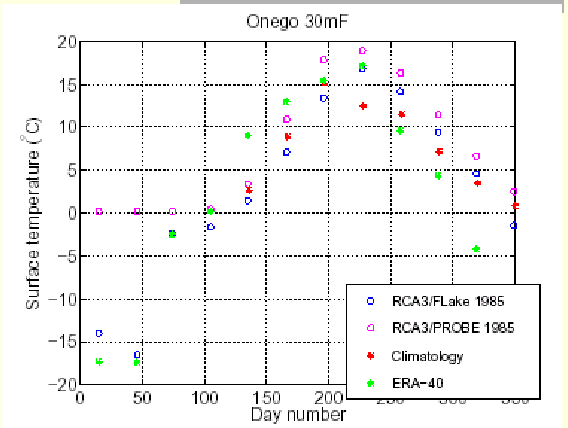


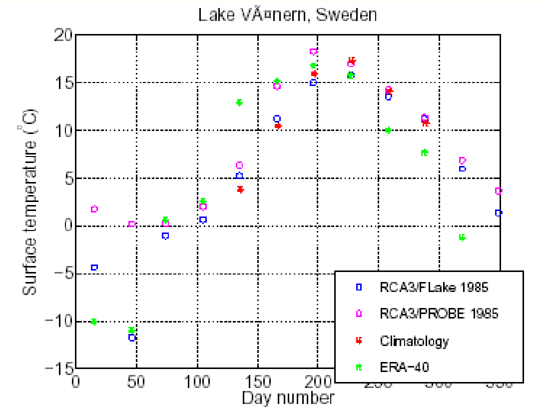
RSHU

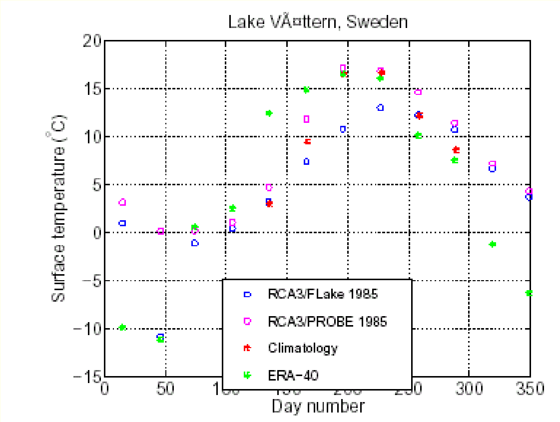
experiments and verification: for individual lakes

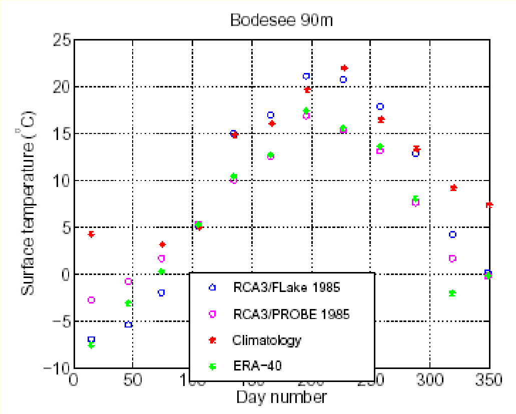












external fields – lake depth, lake fraction

- projects: of COSMO, INTAS - lake database
- sources: hydrological lake database
  dataset for ecosystems (GLCC at present, 1 km res.)
- hydrological lake database:

  for Europe - national databases and water cadastres of Norway, Sweden, Finland, Russia (former USSR), Poland, Germany, Austria, Switzerland and others
  for the rest of the world – International Lake Environment Committee

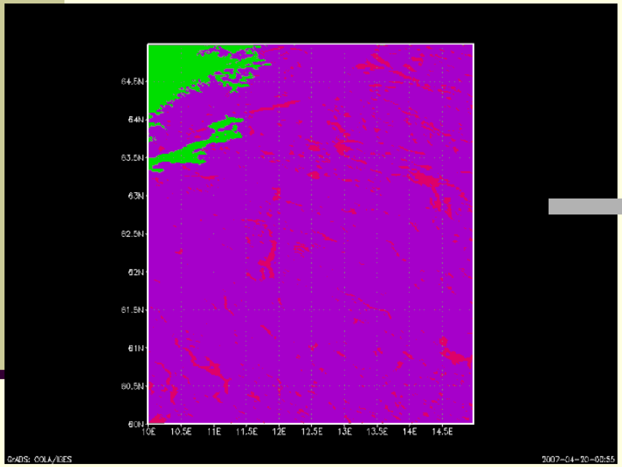
  9500 lakes

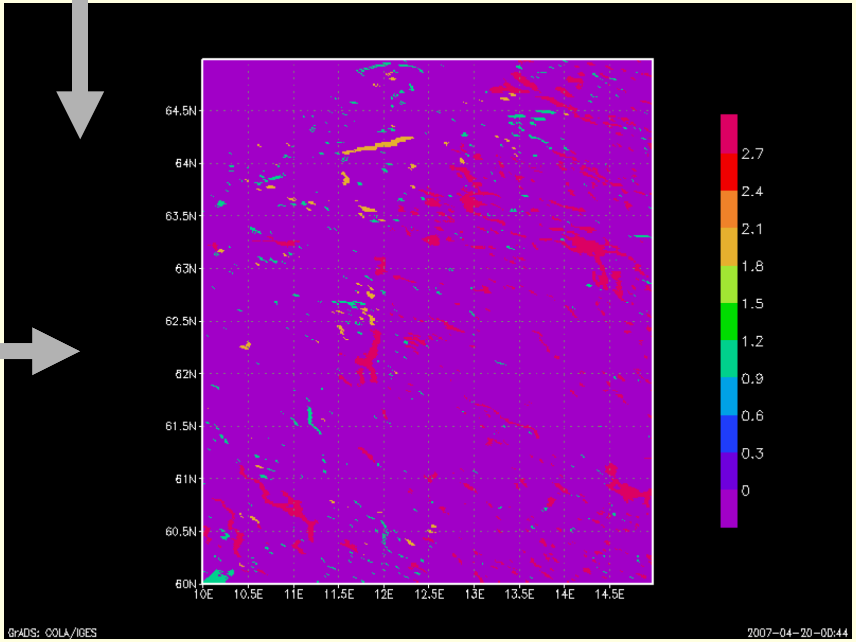
  lon, lat, mean depth, max. depth, area, name, country

Hydrological lake database

Lat, deg	Lon, deg	Mean Depth, m	Max Depth, m	Surface area, km**2	International Name	National Name	Country
42.200	19.300	5.0	8.3	372.3	Scutari_(Skadar)	Scutari_(Skadar|	Albania
41.000	20.800	143.0	286.0	340.0	Ohrid	Ohrid	Albania
41.000	21.000	9999.0	9999.0	313.6	Big_Prespa	Big_Prespa	Albania
40.800	21.050	9999.0	9999.0	47.4	Small_Prespa	Small_Prespa	Albania
47.434	11.717	67.7	133.0	7.1	Achensee	Achensee	Austria
47.755	13.959	2.5	5.0	0.9	Almsee	Almsee	Austria
47.641	13.786	34.3	52.8	2.1	Altausseer_See	Altausseer_See	Austria
48.250	16.410	2.2	6.8	1.6	Alte_Donau	Alte_Donau	Austria
47.890	13.550	85.3	170.6	46.2	Attersee	Attersee	Austria
47.511	9.679	89.9	254.0	539.0	Bodensee	Bodensee	Austria_???????
48.592	15.400	14.0	40.0	1.5	Dobrastausee	Dobrastausee	Austria
47.542	15.058	24.0	38.0	0.5	Erlaufsee	Erlaufsee	Austria
46.578	13.924	14.9	29.5	2.2	Faaker_See	Faaker_See	Austria

Dataset for ecosystems – GLCC, 1 km resolution



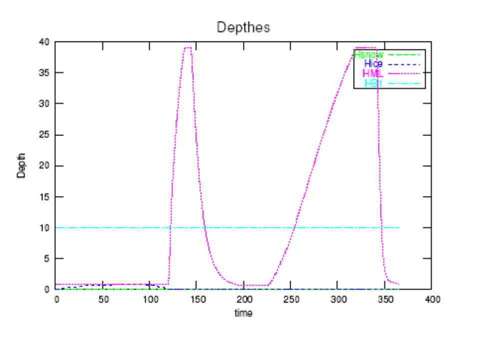


Soft: interface to combine data for specific atmospheric model grid and domain considering errors in both sources of data

06.04.2008

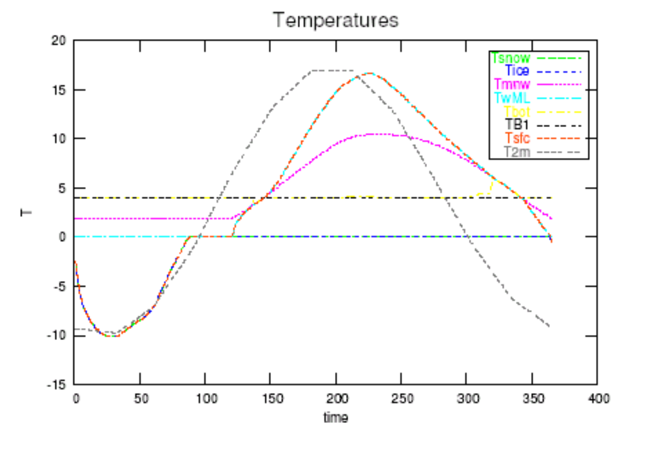
Hirlam RSHU

issues for the parameterization development for climate modeling and for NWP



cold start (climate) data

need climate fields for all prognostic variables (mixed layer temperature, mixed layer depth, … etc.)



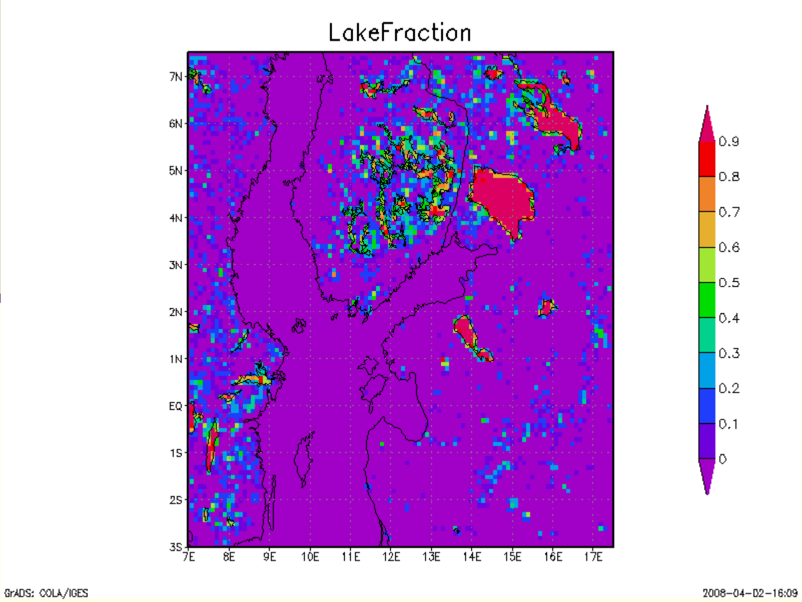
- perpetual year FLake runs (annual periodic regime)
  atm. climate in => lake climate out

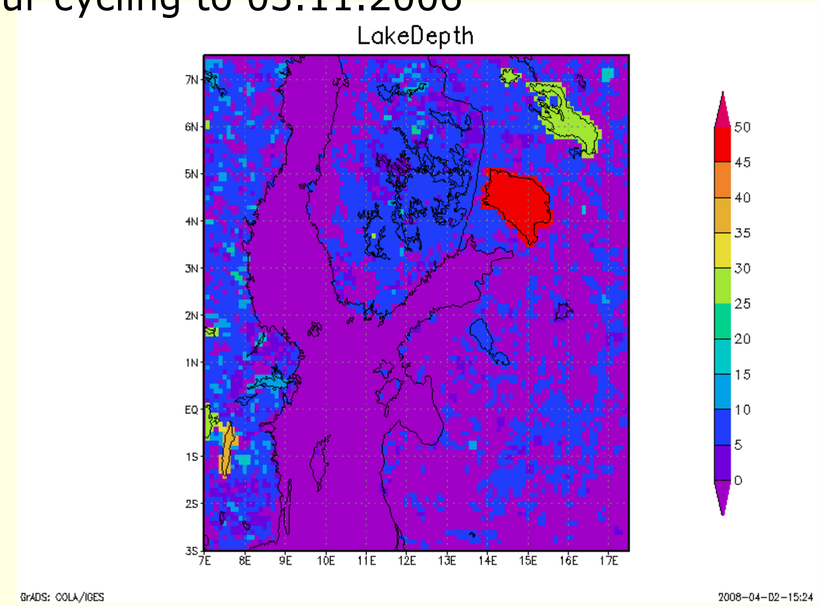
- use NCEP reanalysis data for all NCEP grid boxes, for all lakes with depth gradations of

  -99999.0, 0.0, 2.0, 4.0, 6.0, 8.0, 12.0, 16.0, 20.0, 24.0, 30.0, 36.0, 42.0, 99999.0

first results for HIRLAM

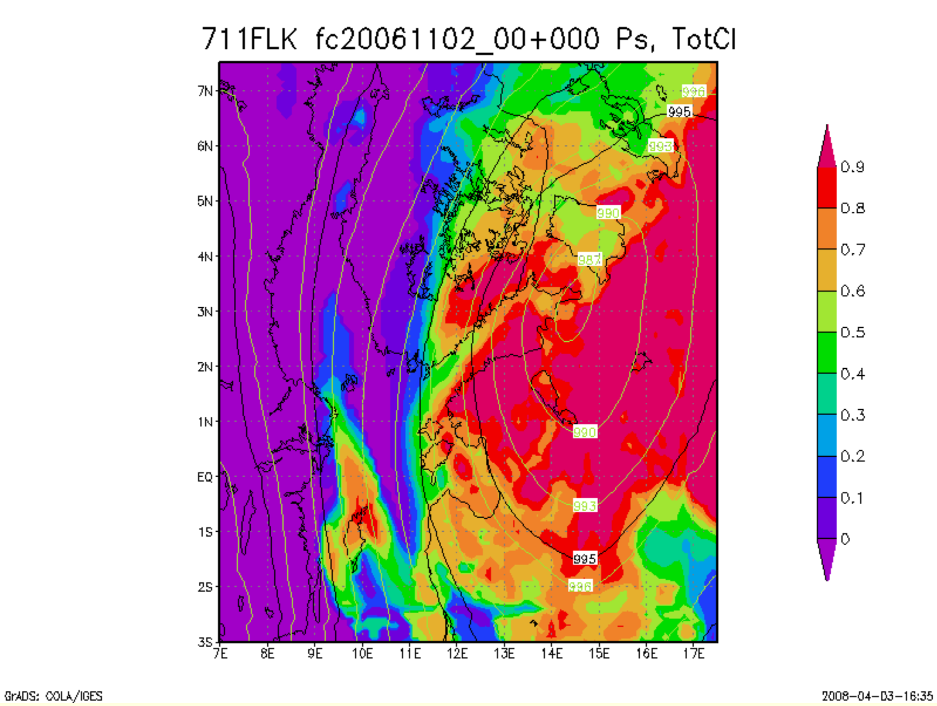
experiment:
lake database - yes
cold start data – no, all lakes are mixed down to the bottom – Ok for November (but mixed layer temperature from SST)
newsnow version
11km res.
November 2006 – significant warm anomaly
cold start – 02.11.2006, hot starts with 6-hour cycling to 03.11.2006





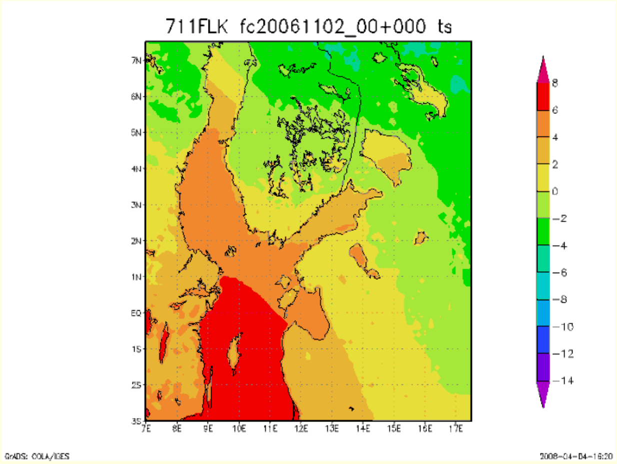
first results for HIRLAM

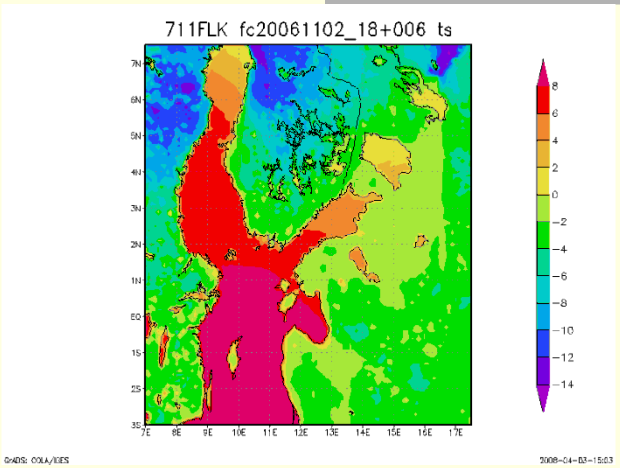
experiment:
lake database - yes
cold start data – no, all lakes are mixed down to the bottom – Ok for November (but mixed layer temperature from SST)
newsnow version
11km res.
November 2006 – significant warm anomaly
cold start – 02.11.2006, hot starts with 6-hour cycling to 03.11.2006

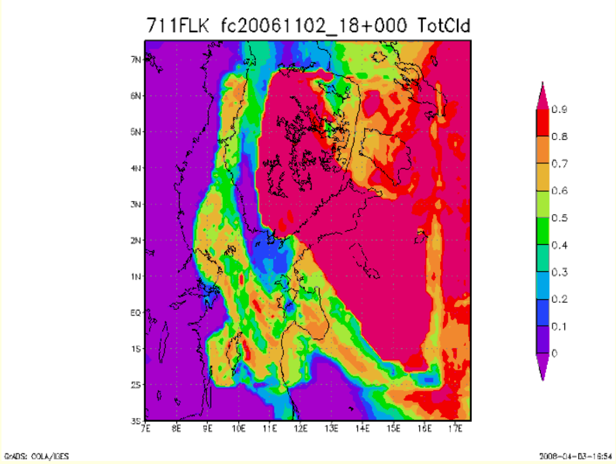


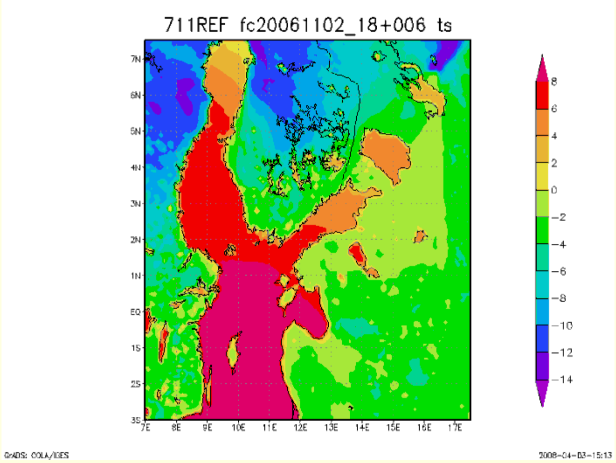
Hirlam RSHU

first results for HIRLAM



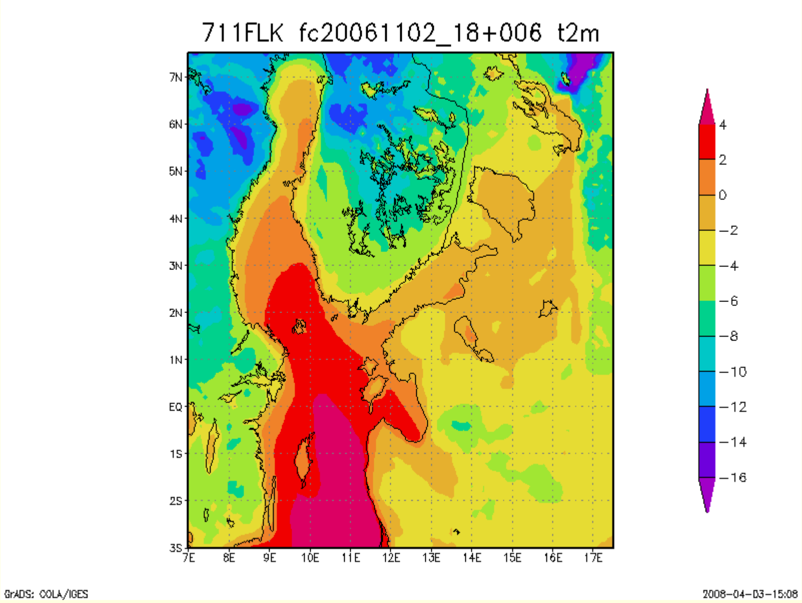


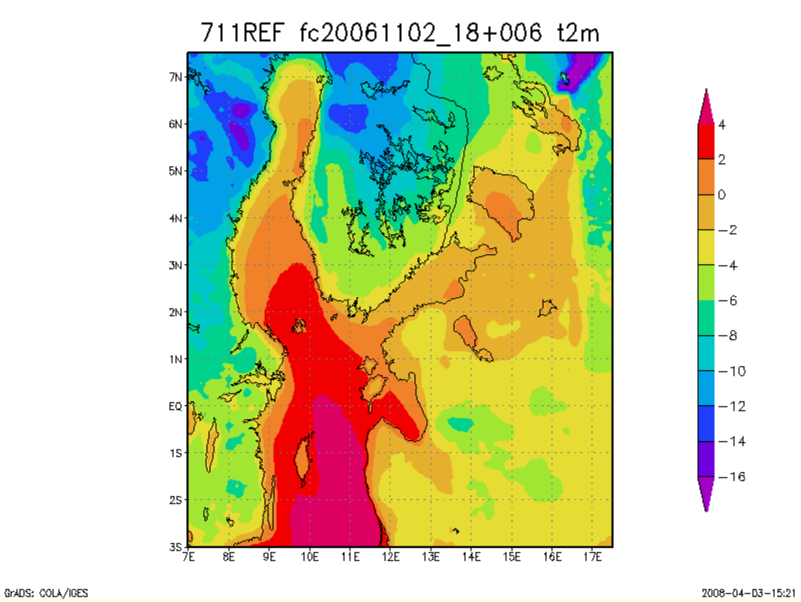




RSHU

first results for HIRLAM





to continue: cold start data, tests … data assimilation

Acknowledgements:

- D. Mironov, DWD, P. Samuelsson, SMHI, G. Ganbat, RSHU, L. Rontu, FMI, S. Gollvick, SMHI
- Nordic Council, Swedish Institute, INTAS

Thank you for attention!