External Data for Lake Parameterization in NWP and Climate Modeling

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  - hydrological lake dataset
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Introduction

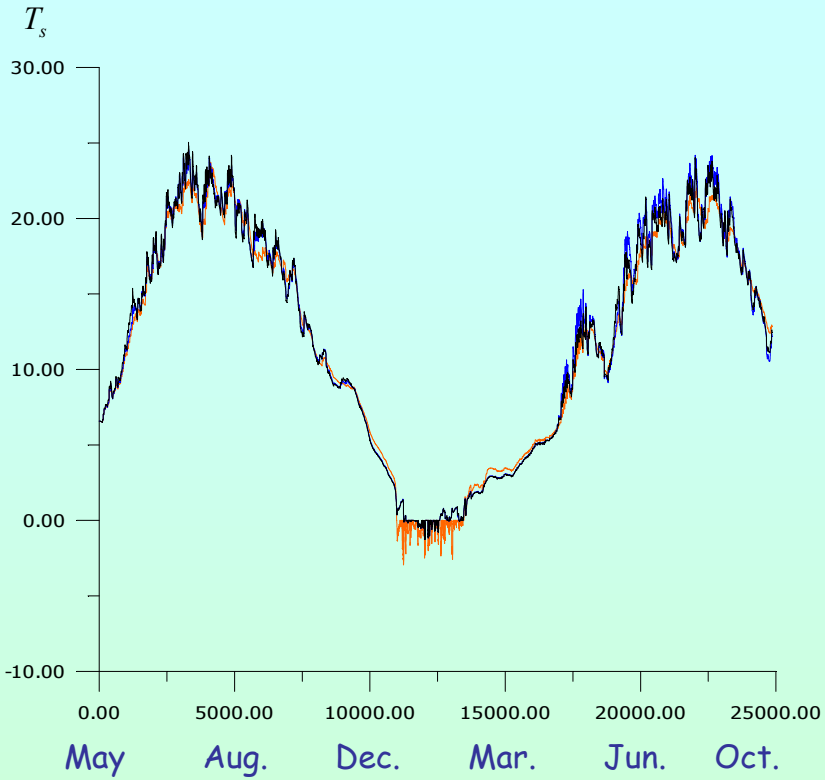
- Different kinds of lake models need different sets of external parameters; 3D/1D
- To consider all the lakes in the atmospheric model domain - to know the parameters for all of them
- Atmospheric models: for Climate modeling and for NWP, global and regional (but easily set to any region), with/without tiling approach in the surface scheme
- Universal lake database for all the atmospheric modeling – **GLOBAL** !

BUT:

- ? what are the basic?
- ? what data to contain? which parameters are essential from the atmospheric modeling point?
- ? sources of data? Direct measurements - not enough, in different institutions. Indirect measurements – geological conditions, something else?
- ? large, medium, small lakes – same parameters?
- ? how to combine lake data with physiographical datasets commonly used in atmospheric modeling?
- ? any software could be used for the development?

BIG JOB ! – experience: INTAS innovation project and cooperation with COSMO

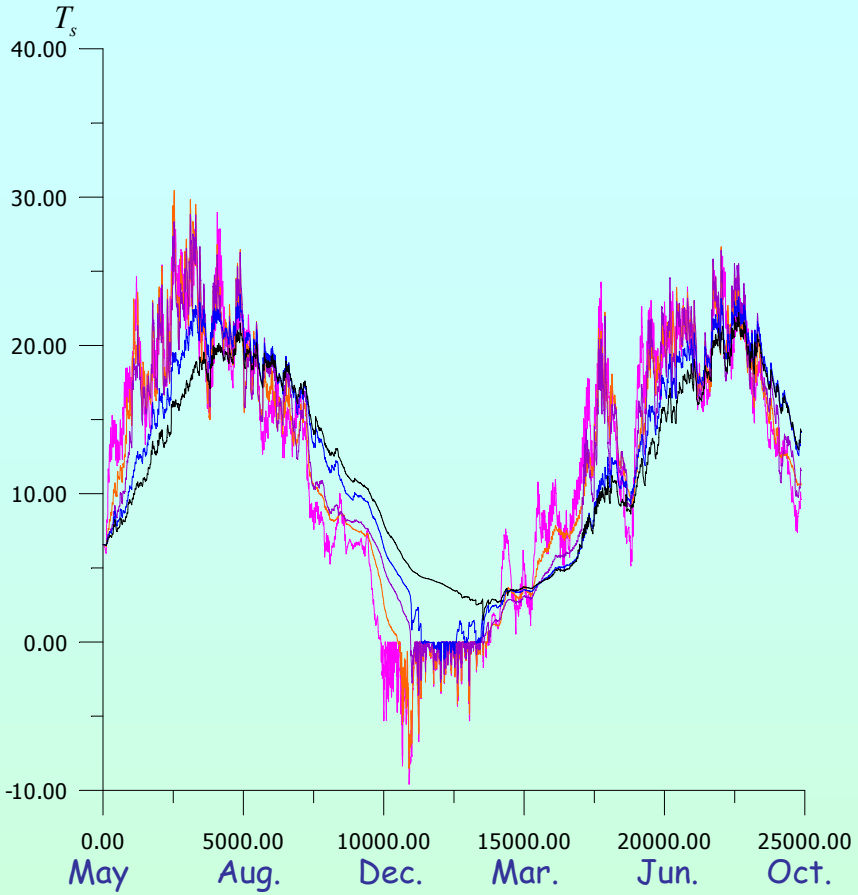
Sensitivity tests:



_____ - extinction coefficient = 5 m^{-1}

_____ - extinction coefficient = 2 m^{-1}

_____ - extinction coefficient = 0.1 m^{-1}



_____ - depth = 40 m

_____ - depth = 27 m

_____ - depth = 14 m

_____ - depth = 6 m

_____ - depth = 1 m

Conclusion: the lake model Flake is mostly sensitive to the lake depth in reproducing surface temperature and not so sensitive to the optical parameters of the water

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Lake database

- DATA: mean lake depth
  lake fraction – for tiling approach or for the lake mask
- in one grid box lakes of different depth and of different surface area may be located
- data on lakes can't be averaged!
- but data can be aggregated using the empirical PDFs
- the sources of data: the hydrological lake dataset
  the dataset for ecosystems
  + information about target grid (atmospheric model grid)
  (different coordinate systems, different grids …)

Lake database: hydrological lake dataset

- Austria: data from Bundesministerium fur Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Gisela Ofenboeck, gisela.ofenboeck_at_lebensministerium.at
- Denmark: data from Environmental Research Institute of Denmark, http://www2.dmu.dk/1_Viden/2_Miljoe-tilstand/3_vand/4_soer/5_enkelte_soer/default.asp, Nina Haugbelle, rontlinien_at_frontlinien.dk
- Finland: data from Finnish Environmental Instutute via Finnish Meteorological Institute, Riitta Teiniranta, riitta.teiniranta_at_vyh.fi, Karl Fortelius, carl.fortelius_at_fmi.fi
- former USSR: data from State Hydrological Institute of Russian Federation, Valentin Bayadjan, ggigwk_at_sg3309.spb.edu
- Germany: data from Umweltbundesamt Peter Treffler, peter.treffler_at_uba.de
- Iceland: data from Orkustofnun (National Energy Authority), Vatnamaelingar (Hydrological Service), Stefania G. Halldorsdottir, <sgh_at_os.is>
- Ireland: data from Environmental Protection Agency, Ireland, Jim Bowman, j.bowman_at_epa.ie
- Norway: data from Norwegian Water and Energy Directorate, Department for Water Resources, Section for Geoinformation, Lars Stalsberg, lst_at_nve.no
- Poland: data from Instytut Meteorologii i Gospodarki Wodnej, Jerzy Janczak, jerzy.janczak_at_imgw.pl

Lat, deg	Lon, deg	Mean Depth, m	Max Depth, m	Surface area, km**2	International Name	Country
42.2	19.3	5	8.3	372.3	Scutari_(Skadar)	Albania
41	20.8	143	286	340	Ohrid	Albania
41	21	9999	9999	313.6	Big_Prespa	Albania
40.8	21.05	9999	9999	47.4	Small_Prespa	Albania
47.434	11.717	67.7	133	7.1	Achensee	Austria
47.755	13.959	2.5	5	0.9	Almsee	Austria
47.641	13.786	34.3	52.8	2.1	Altausseer_See	Austria
48.25	16.41	2.2	6.8	1.6	Alte_Donau	Austria
47.89	13.55	85.3	170.6	46.2	Attersee	Austria
47.511	9.679	89.8	254	539	Bodensee	Austria
48.592	15.4	14	40	1.5	Dobrastausee	Austria
47.542	15.058	24	38	0.5	Erlaufsee	Austria
46.578	13.924	14.9	29.5	2.2	Faaker_See	Austria
47.806	13.288	36	66.3	2.7	Fuschlsee	Austria
48.601	15.142	1.4	3.2	0.6	Gebhartsteich	Austria
46.932	10.739	53.8	112	2.6	Gepatsch_Stausee	Austria
47.992	13.095	9.7	14	1.3	Grabensee	Austria
47.636	13.881	41.1	63.8	4.1	Grundlsee	Austria
47.493	10.573	11	22	0.8	Haldensee	Austria
47.553	13.685	65.1	125.2	8.6	Hallstaatter_See	Austria
48.82	15.136	1.4	2.5	0.6	Haslauer_Teich	Austria
47.458	10.772	40.4	80	1.4	Heiterwanger_See	Austria
47.75	13.247	9.3	22	0.7	Hintersee	Austria
47.542	12.215	12.8	36	0.6	Hinterstoiner_See	Austria
47.924	13.305	14.9	32	3.5	Irrsee	Austria
46.588	14.182	10.4	15.6	1.4	Keutschacher_See	Austria

http://www.ilec.or.jp/database/database.html

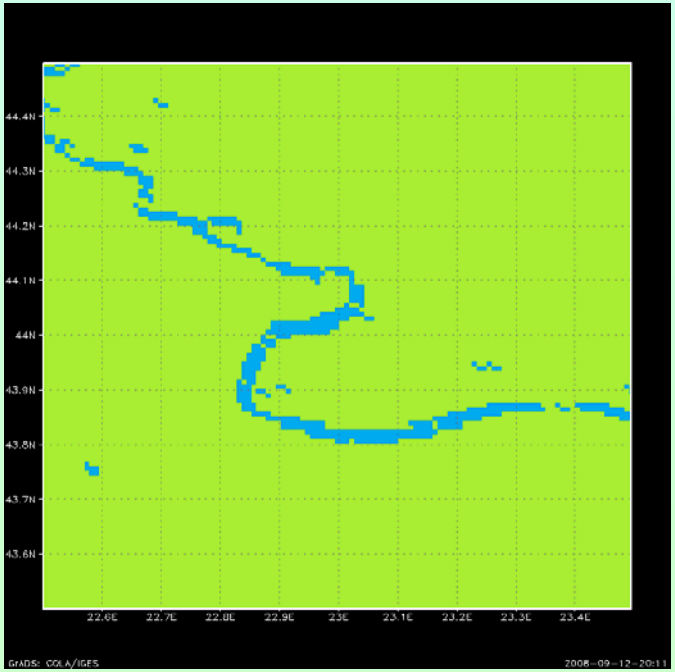
9 500 lakes
is it many or few?

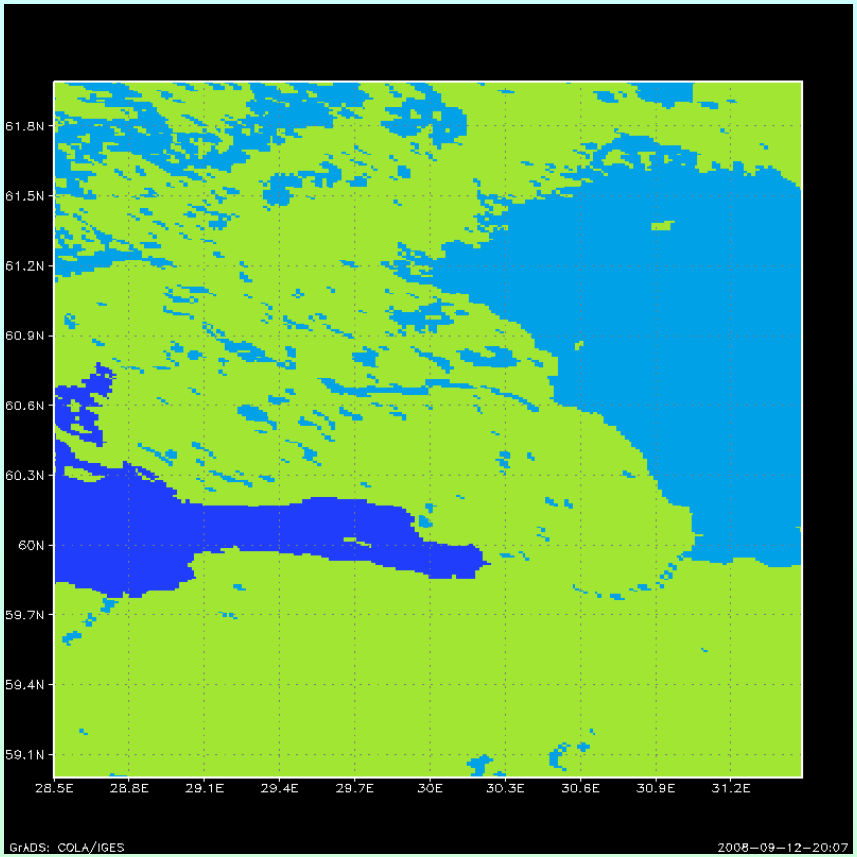
Lake database: dataset for ecosystems

GLCC (USGS) - 1km resolution

"inland water" – lakes, rivers,
BUT + inland seas, fiords

other datasets: ECOCLIMAP?
"inland water" - lakes, rivers,
BUT + wetland: swamps, marshes ?





"spot-lake" is the set of the conterminal pixels
- MILLIONS of "spot-lakes"!

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Lake database: interface

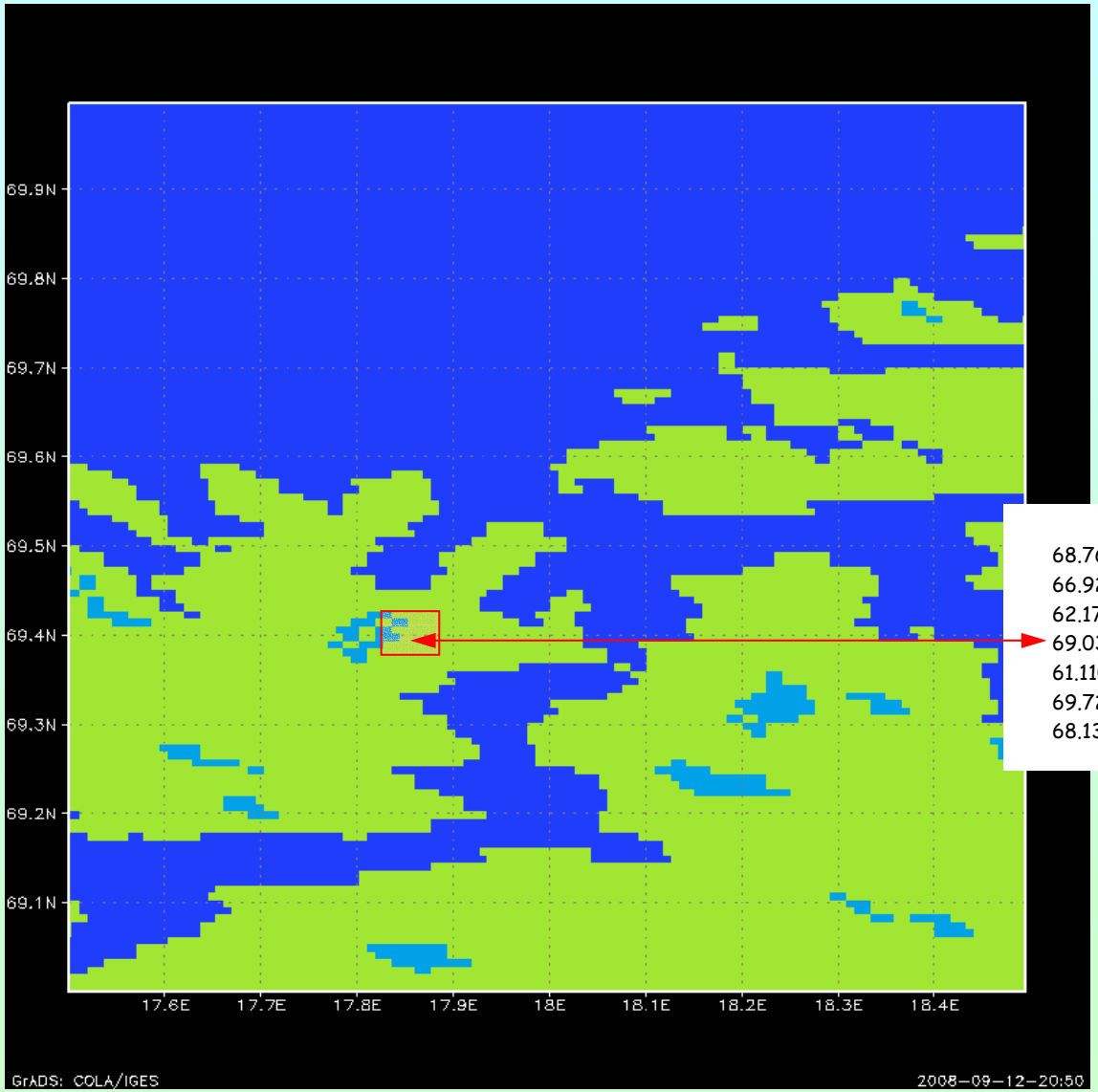
Errors and uncertainties both in the hydrological lake dataset and the dataset for ecosystems!

- ✓ interface: smart, provide "soft" links between lakes from hydrological lake dataset and "spot-lakes"
- ✓ using of empirical PDFs is highly desired as the statistical approach considers errors and uncertainties
- ✓ hydrological lake dataset should be easily updated
- ✓ the interface should provide data for arbitrary target grids and domain

Lake database: interface

Step 1

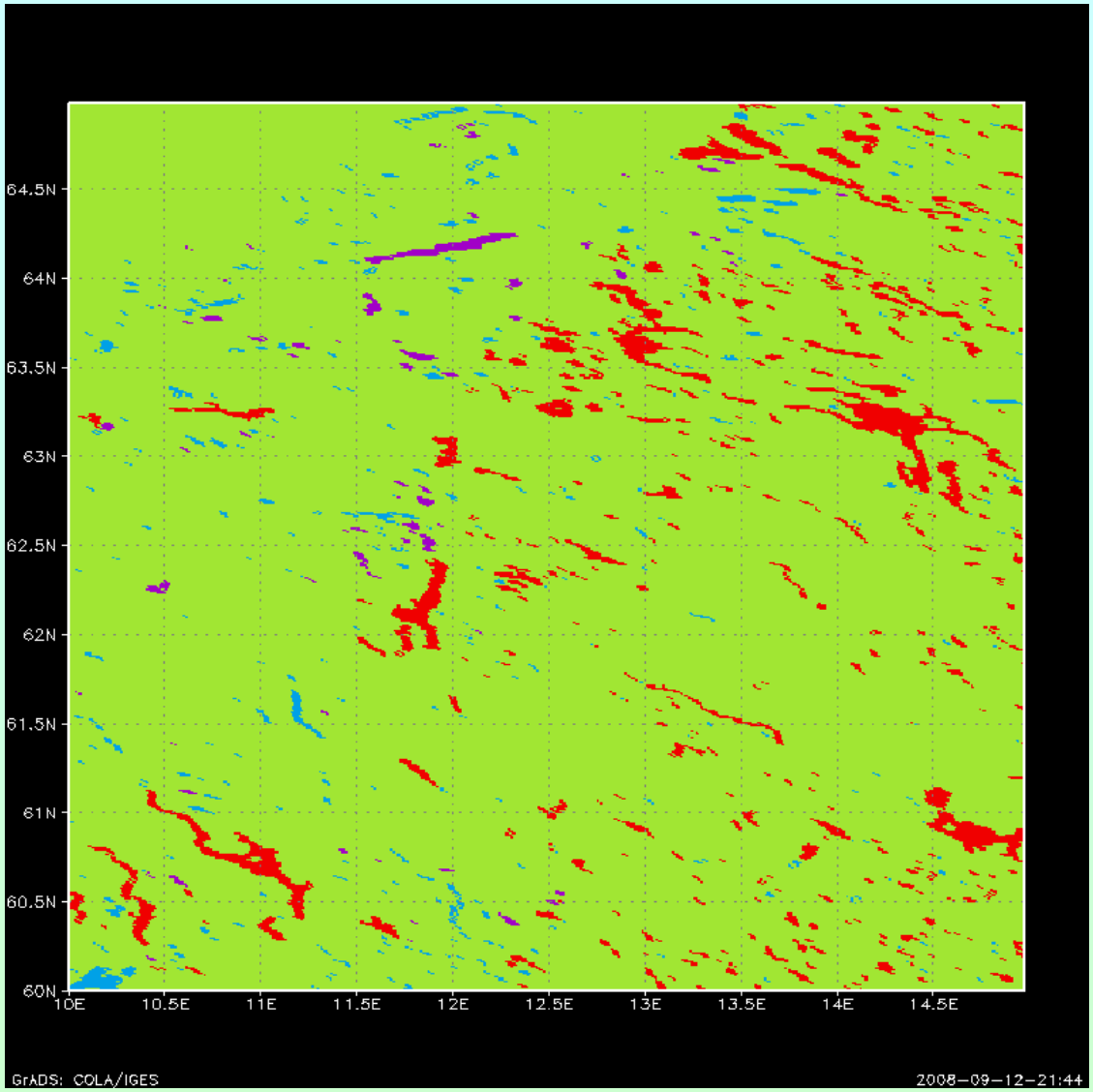
On the basis of the coordinates of any point of water surface of a lake from hydrological dataset we make links between lakes from hydrological dataset and "spot-lakes" on the bitmap; while searching the appropriate "spot-lake" at the bitmap we scan some territory trying to find this lake.
On the basis on these links we write the mean depth of the lake from hydrological dataset into every pixel of the "spot lake" on the bitmap.



68.760	23.680	9999.0	9999.0	6.3	Bajasjavri	Norway
66.920	14.250	9999.0	9999.0	6.3	Sokumvatnet	Norway
62.170	11.580	16.0	42.0	6.3	Langsjzzeroen	Norway
69.030	17.880	41.0	119.0	6.2	Skzzerovatnet	Norway
61.110	10.640	9999.0	9999.0	6.1	Mesna	Norway
69.720	30.360	9999.0	9999.0	6.0	Myggvatn	Norway
68.130	16.010	9999.0	9999.0	6.0	Kilvatnet	Norway

Lake database: interface

We write the **default** depth of **10 m** into the pixels of the "spot-lakes" on bitmap, which have not got the links to the lakes from hydrological dataset (not found lakes) or when there is a gap in mean depth data in the hydrological dataset .



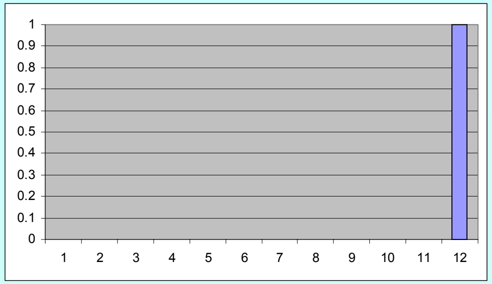
Lake database: interface

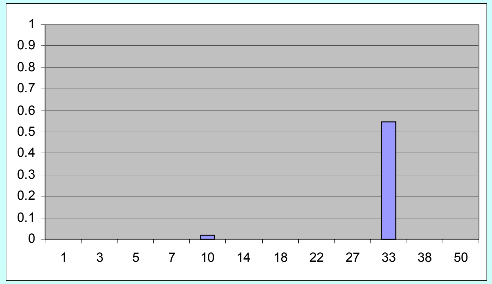
Step 2.

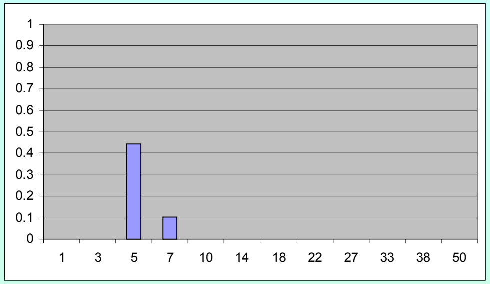
On the base of the information about the depth, written into pixels of bitmap, we make empirical PDF for every grid box of the target grid.

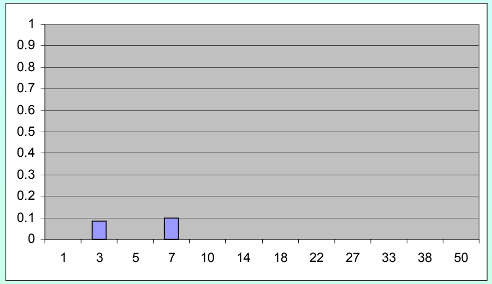
Lake depth for the grid box – the mode (most probable) depth value from empirical PDF.

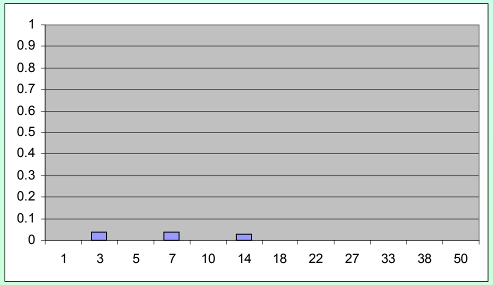
Fraction of lakes in every grid box of the target grid is calculated on the basis of the information from the bitmap

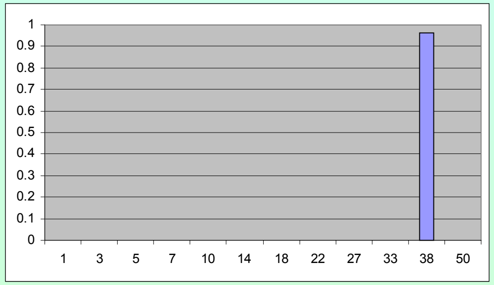


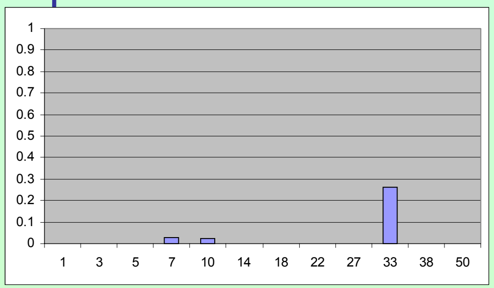


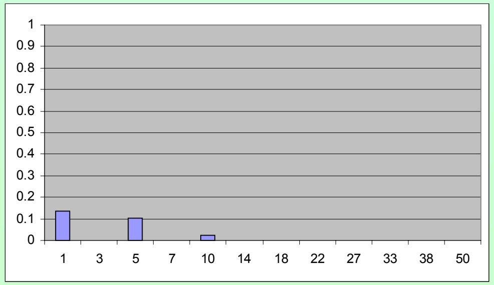


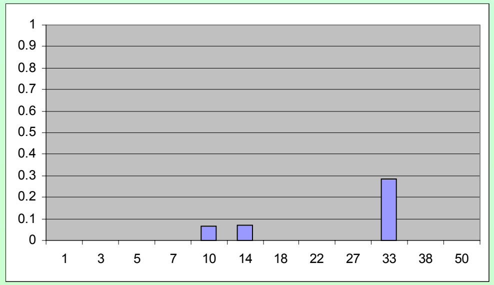












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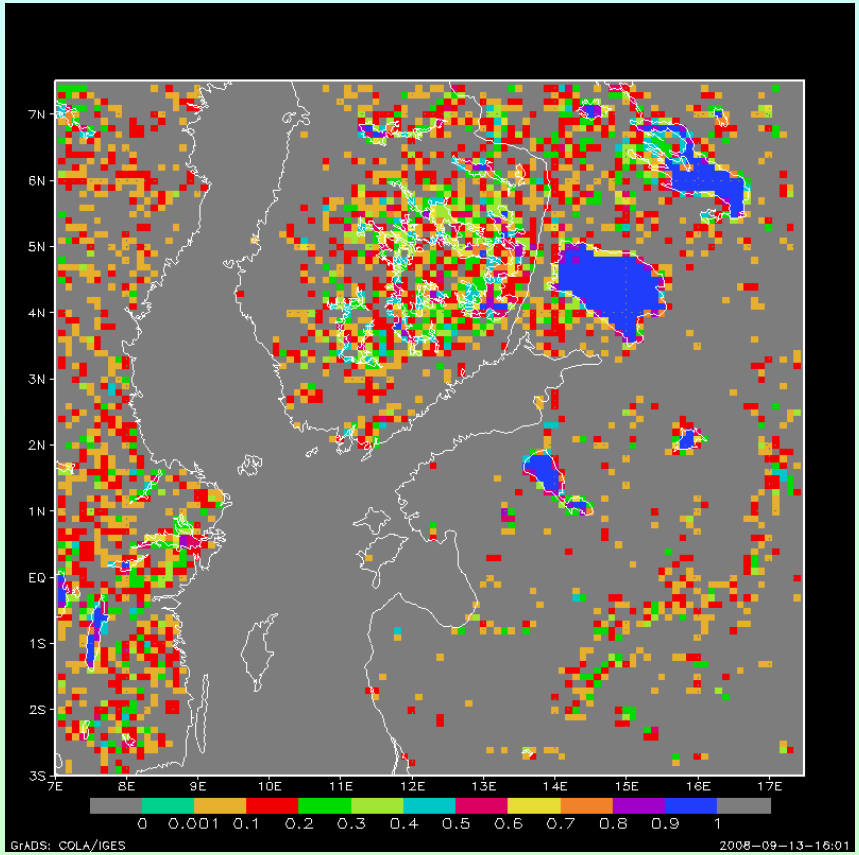
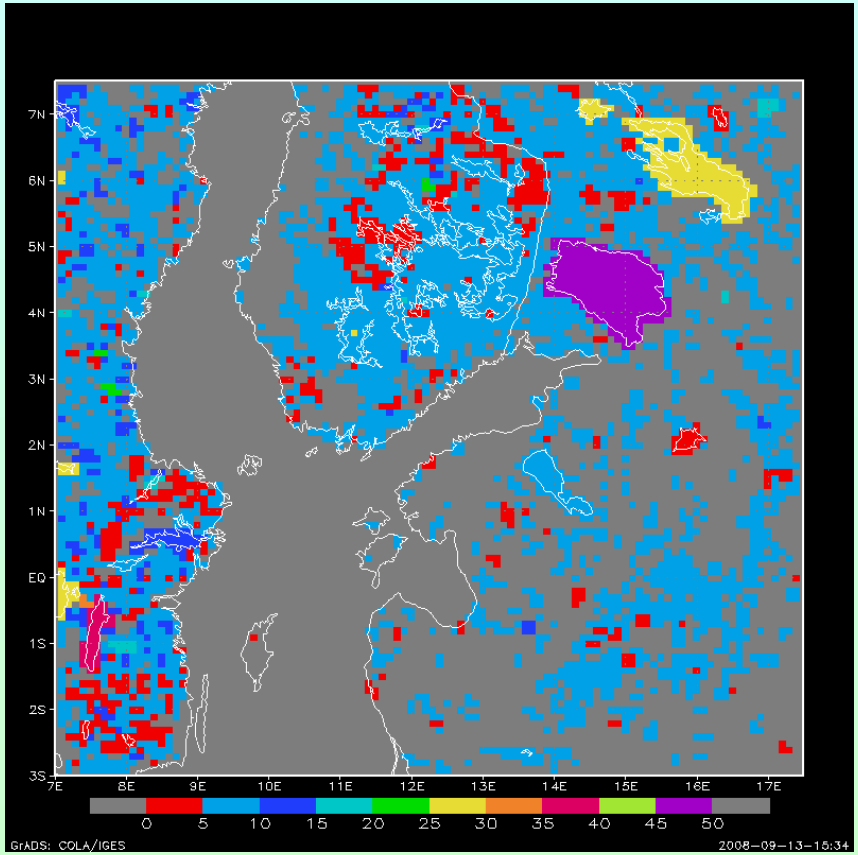
Lake database: the example of the output

Lake fraction



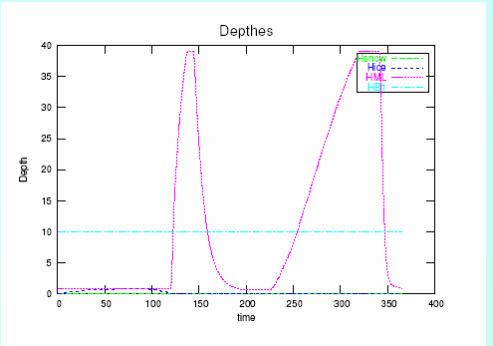
Lake depth

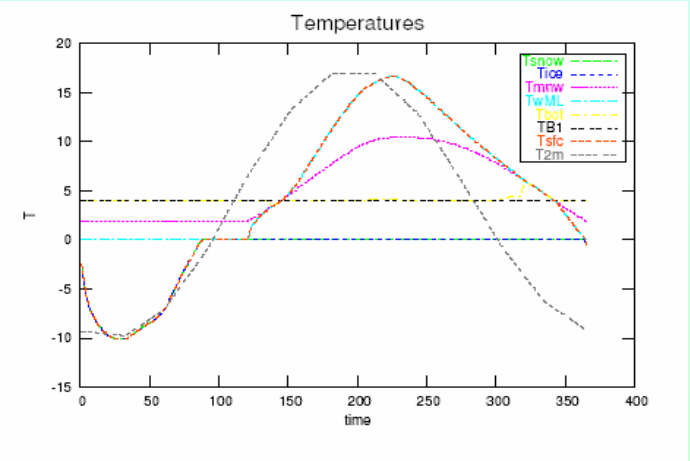


issues for the parameterization development for climate modeling and for NWP

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

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Conclusion remarks …

- We need different parameters of lakes as an external data for a lake parameterization in an atmospheric model; the lake depth is the most important if we use 0D lake model
- Use statistical approach based on empirical PDFs to process data
- Direct measurements of lake depth exist, use them
- Different datasets for ecosystems may be used
- To distinguish wetlands and lakes in the ecosystem datasets
- For the regions rich in data the efficiency may be quite high

… and next steps

- Make really global lake database
- Use indirect measurements for lake parameters (geological information or …)
- Add data on optical parameters, etc.
- Distinguish between small, medium and large lakes, use different parameters for them
- More adequate mathematical instruments ?

Acknowledgements

- People, who provided lake data – impossible to give all the list here!

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Thank you for attention!