2nd Workshop on Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling

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Global database for the parameterization of lakes in NWP and climate modelling

METEO FRANCE
Toujours un temps d'avance

contents

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  - data for individual lakes
  - the map
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introduction

Lakes should be parameterized
we may use different lake models, **BUT**

- we need fields of external lake parameters (physiographyc fields) =>

  global lake database

- we need lake climate data for the “cold start” =>

  global lake climate

introduction

What parameters?

- lake depth (mean or bathymetry)
- optical characteristics - **?**
- lake fraction

What is specific for the atmospheric modeling? *(e. g. in contrast to hydrological applications)*

- global coverage with all lakes included
- fidelity is not critical

What can we get from hydrologists?

- direct measurements
- regional databases: individual characteristics of lakes but no mapping
- global databases: global map, but very few information about individual lake parameters
  GLCC, ECOCLIMAP, GLWD …

objectives

to combine information from different sources with a map and to develop
GLOBAL GRIDDED LAKE DEPTH DATASET

History:

- RSHU-DWD: Europe
- RSHU, EU Commission (INTAS)
- RSHU-HIRLAM
- METEO FRANCE

} Global

Lake fraction is calculated in a standard way

data sources: dataset for individual lakes

- 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_soe , 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

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

- **Wikipedia!** – *"semi-scientific", but …*

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
47.765	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	89.9	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	13.268	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	13.665	65.1	125.2	8.6	Hallstaatter_See	Austria
48.82	15.136	1.4	2.5	0.6	Haslauer_Teich	Austria
47.456	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

13 000 freshwater lakes

220 saline lakes and endoteric basins

295 references

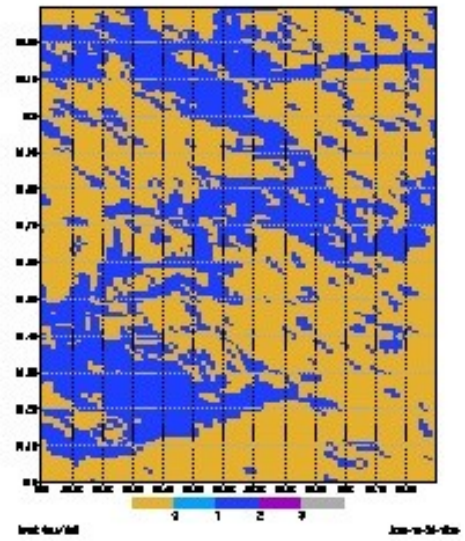
Is it many or few?

data sources: the map

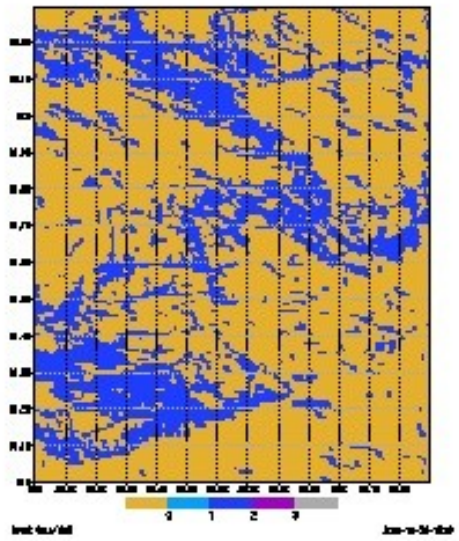
GLCC, ECOCLIMAP, GLC2000, CORINE, GLOBCOWER …

inaccuracies in the coastline!

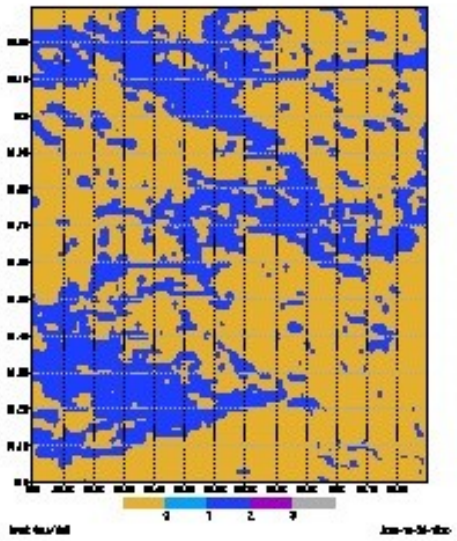
=> express-intercomparison



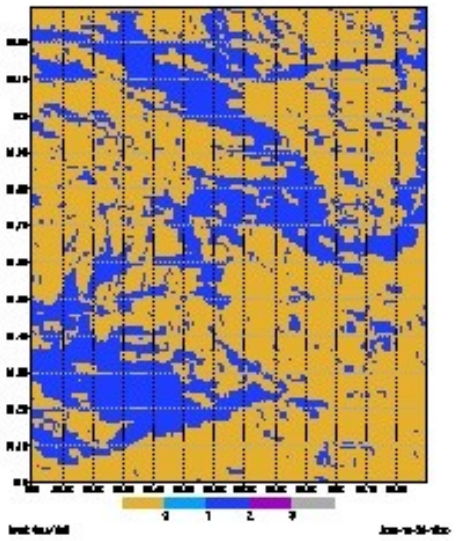
GLCC



GLWD



ECOCLIMAP1

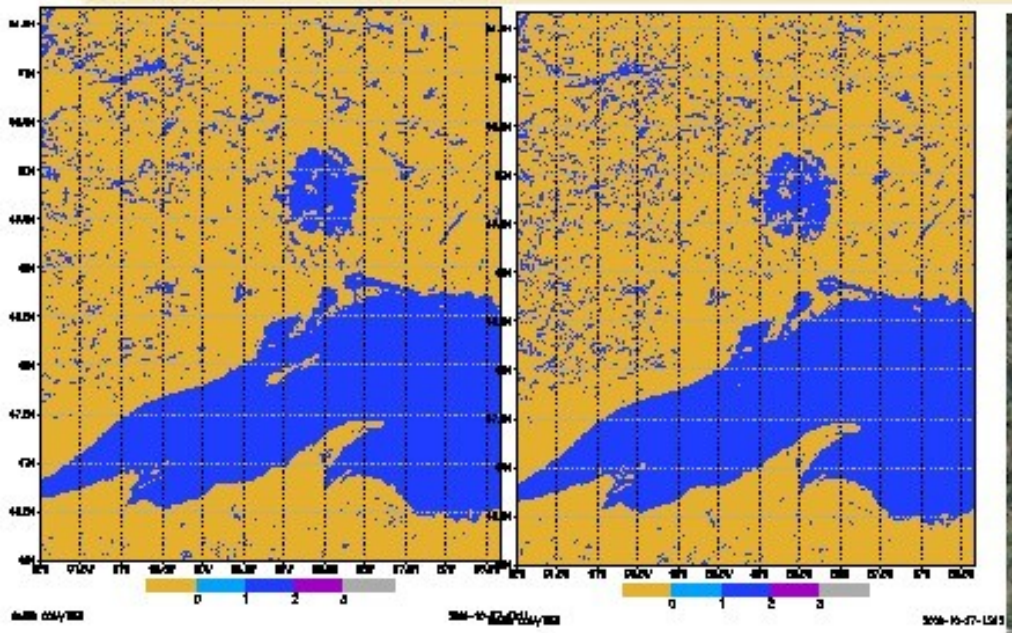


ECOCLIMAP2

Finland

Norrköping, Sweden

data sources: the map



GLCC ECOCLIMAP2

- Visual comparison with remote sensing data
- Too much water/ too few water
- Artifacts

After removing some artifacts – **ECOCLIMAP2**

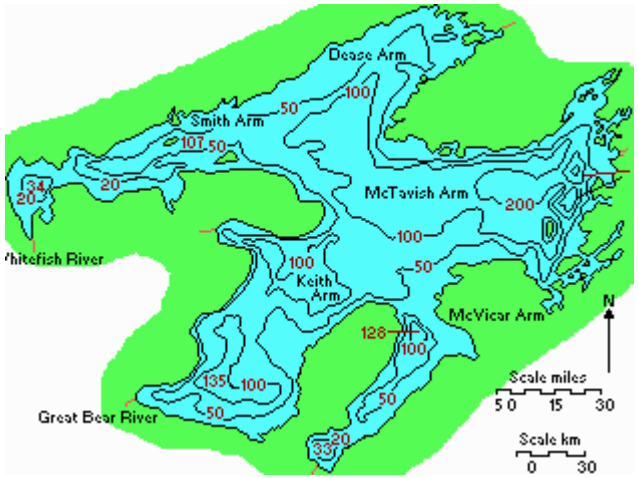
Norrköping, Sweden

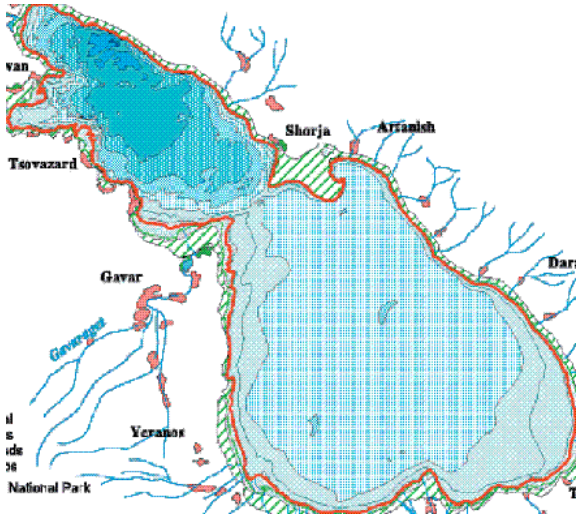
data sources: bathymetry for large lakes

- ETOPO1 – for Great Lakes

- Topographic, navigation, etc. – maps in graphic form
  – for other large lakes
  digitizing with kriging interpolation method for gridding
  only lakes that can't be characterized by the mean depth

- Totally 36 large lakes

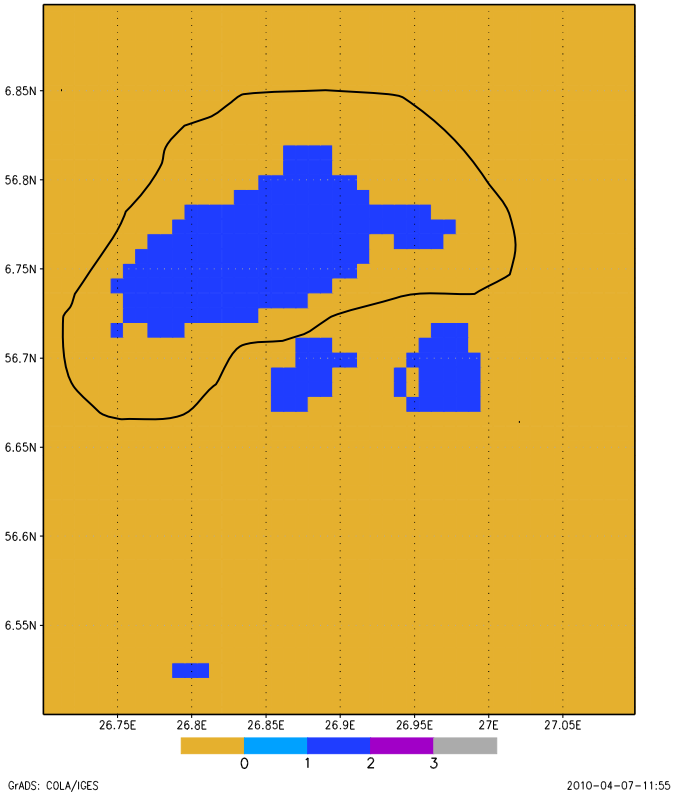




Norrköping, Sweden, September 15-17 2010

mapping method

- Fully automatic
- “Spot-lake” is a set of conterminal pixels with “inland water type”
- Random errors in the dataset for individual lakes and random inaccuracies in the coastline =>
- Using of the probabilistic approach, the optimization task



mapping method

- The coordinate vector of a point on the lake water surface: a **random value**, **the Gaussian distribution**.
- The expected value: in the dataset for individual lakes the standard deviation: prescribed, 1.5 km.
- The **event** that the lake pixel on a raster map corresponds to this lake in reality.
- The **probability of the event is appointed,** it depends on the distance from the coastline:

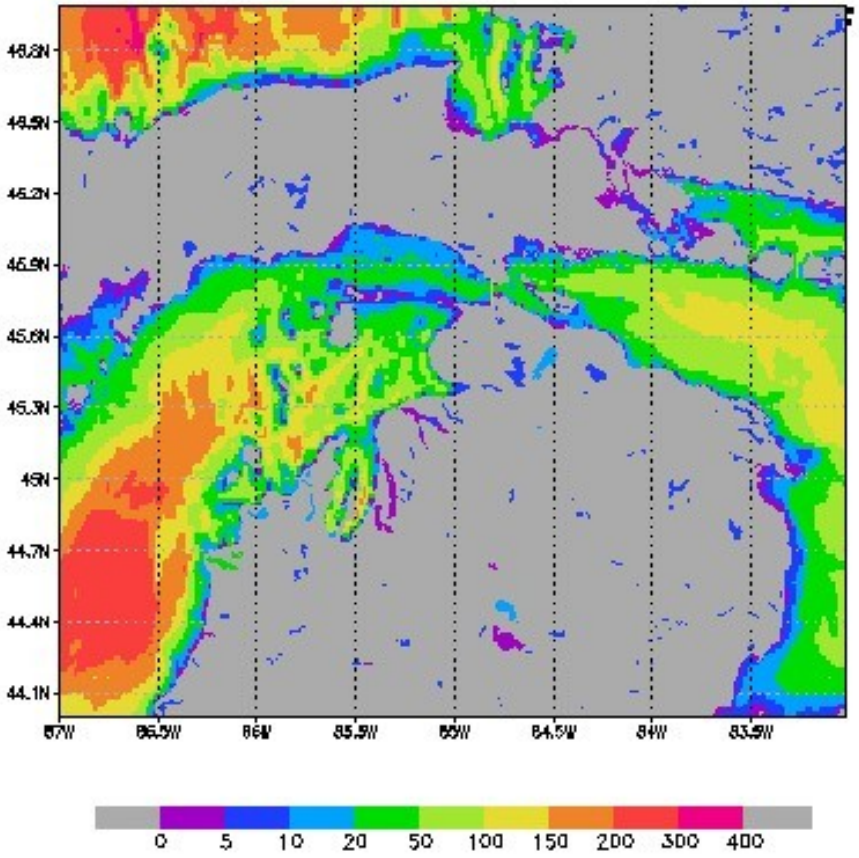
$$P_b\left(B_{ij}\right) = P_{\max,\,l} - \frac{P_{\max,\,l} - P_{\min,\,l}}{\sum_{n=1}^{R_b} 8 \cdot n \cdot f(n)} \sum_{n=1}^{R_b} m_n \cdot f(n)$$

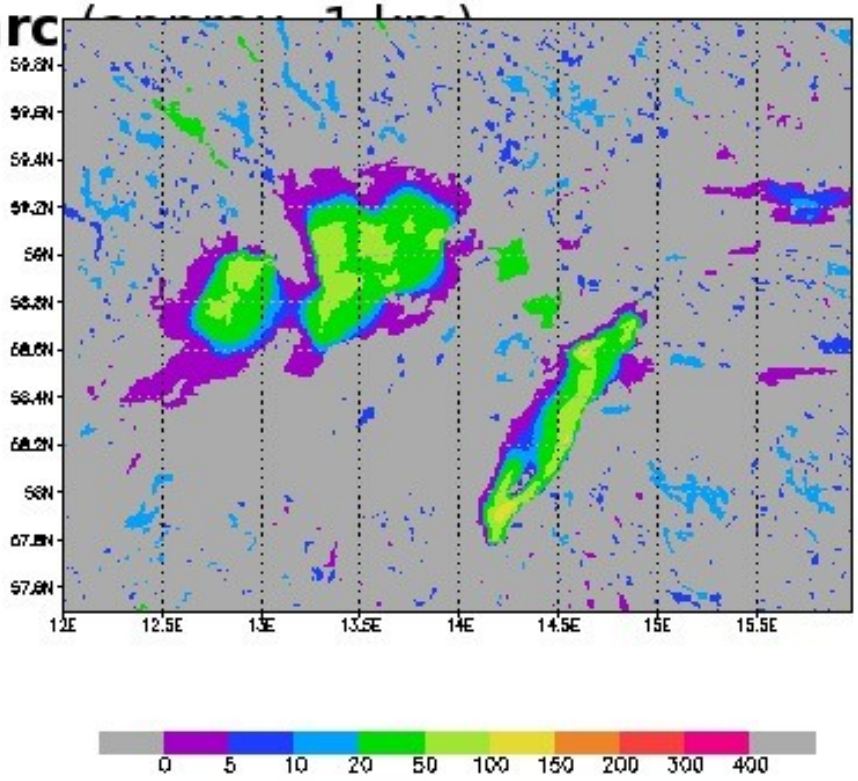
$$P_b\left(B_{ij}\right) = P_{\min,\,nl} + \frac{P_{\max,\,nl} - P_{\min,\,nl}}{\sum_{n=1}^{R_b} 8 \cdot n \cdot f(n)} \sum_{n=1}^{R_b} m_n \cdot f(n)$$

- The **total probability** of the correspondence between a lake from the dataset for individual lakes and a “spot-lake”
- For every “spot-lake” : the correspondence with **maximum total probability** (if it is =0, the “spot-lake” is not recognized)

products

- The **global gridded dataset** with the mean lake depth or the bathymetry





2010-02-18-15:54

2010-02-18-18:08

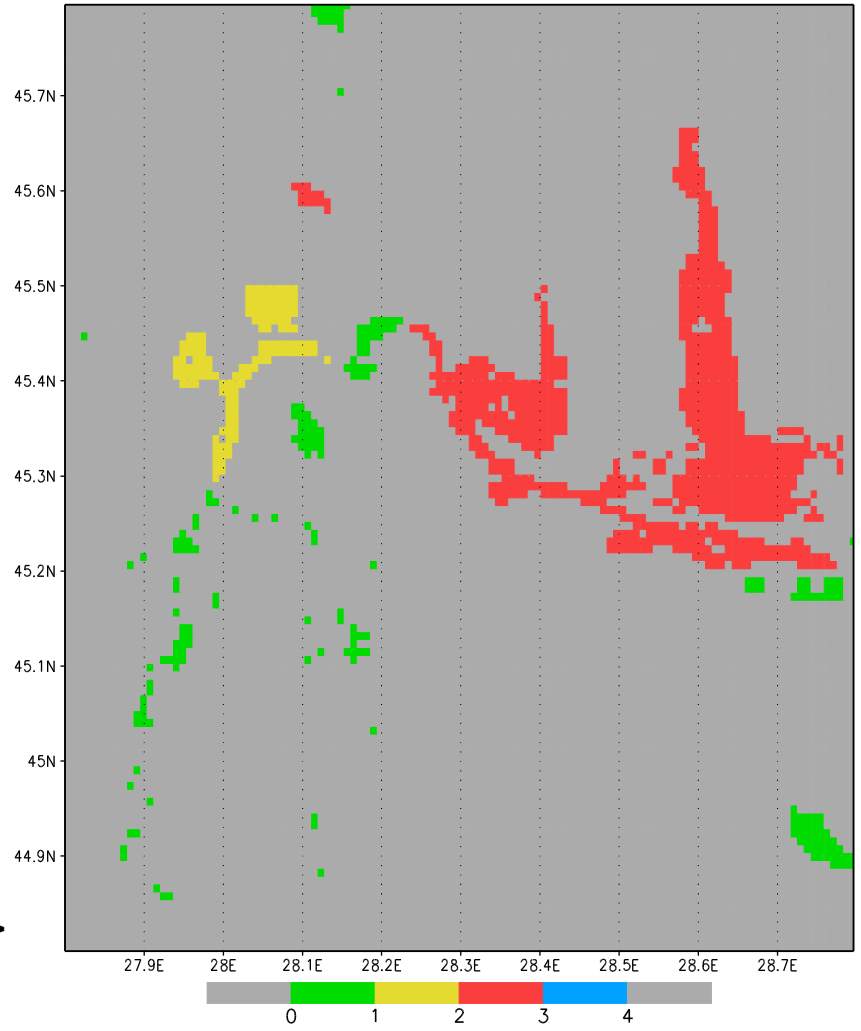
Norrköping, Sweden

products

- The additional dataset for S (the reliability of information):
  S=1 - a ”spot-lake” was not recognized,
  S=2 - a ”spot-lake” was recognized but with missing information,
  S=3 - a ”spot-lake” was recognized,
  S=4 - a river

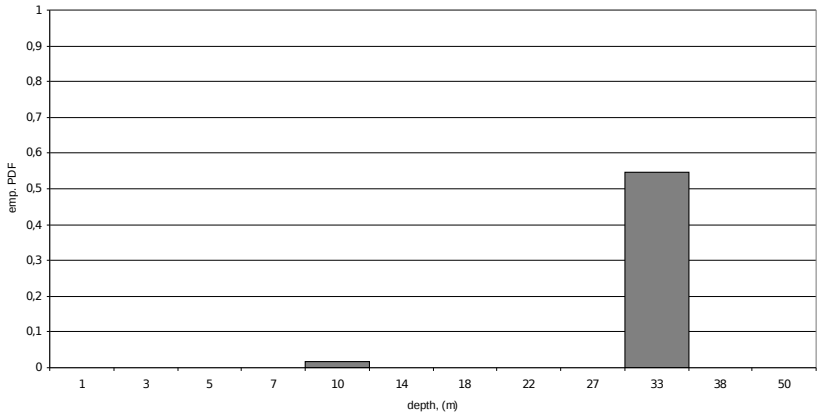
- Useful to estimate the quality of data.

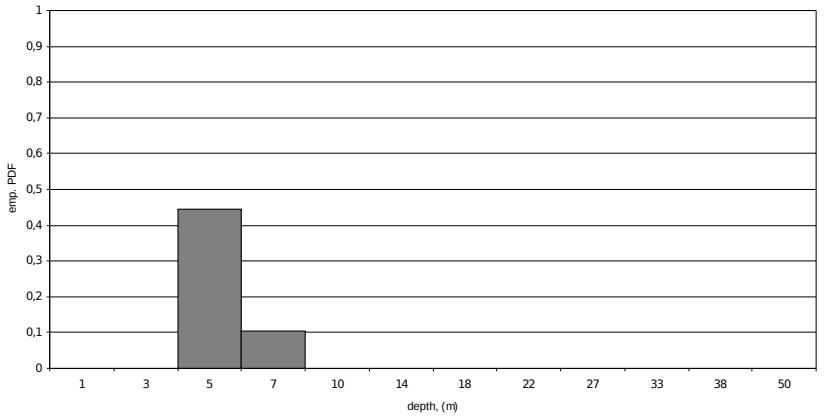
Romania =>



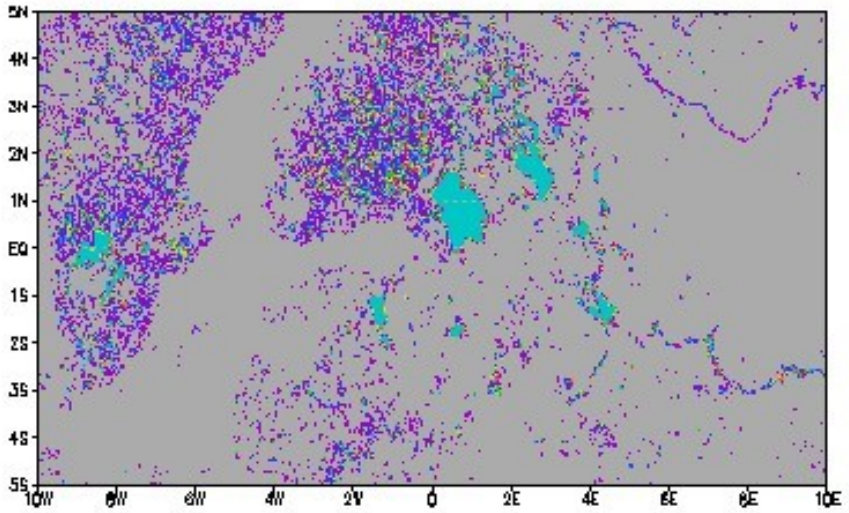
projection onto an atmospheric model grid

- The lake depth field is discontinuous => **averaging is incorrect**
- To make the histogram and to use **the most probable value**
- /for every grid box defined as a polygon
- **Result**: the field of the most probable lake depth and of the lake fraction on the atmospheric model grid

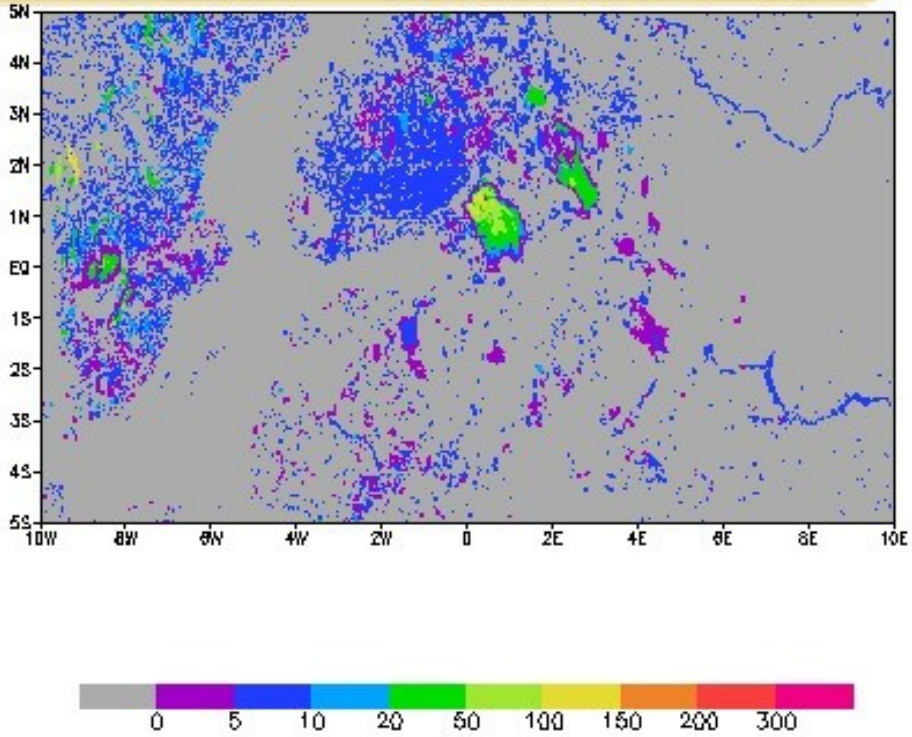




projection onto an atmospheric model grid



lake fraction



lake depth, m

the rotated spherical coordinates,
POLON= 30°, POLAT= -30°, d≈0.1°

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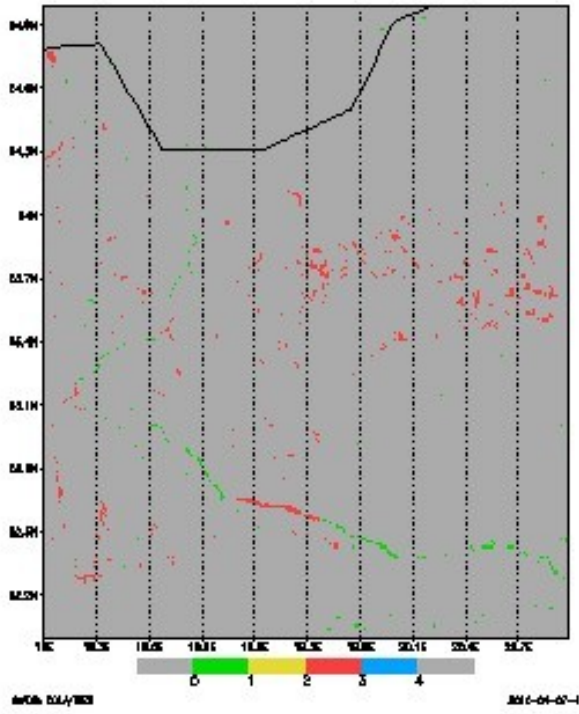
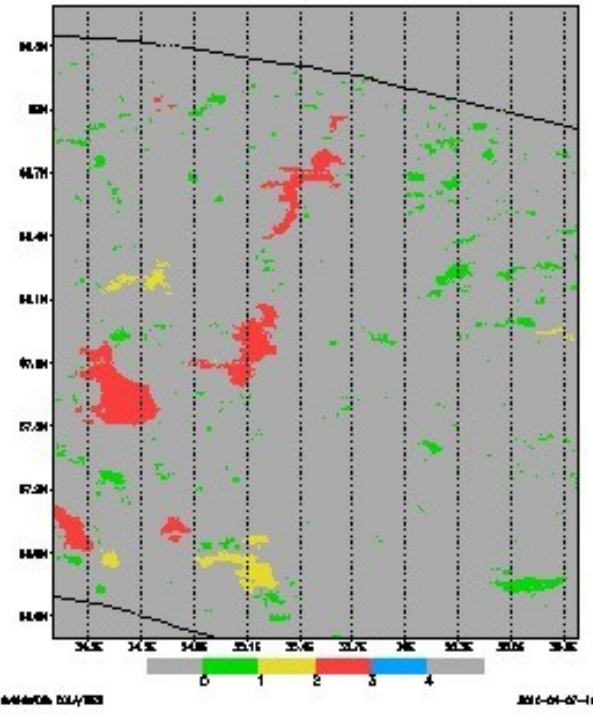
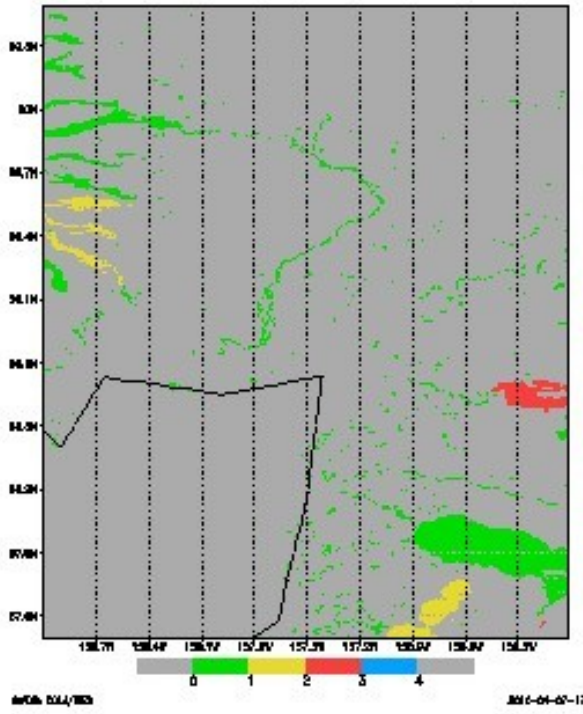
problems



Poland



Karelia



Alaska

- **add new lakes into the dataset for individual lakes**

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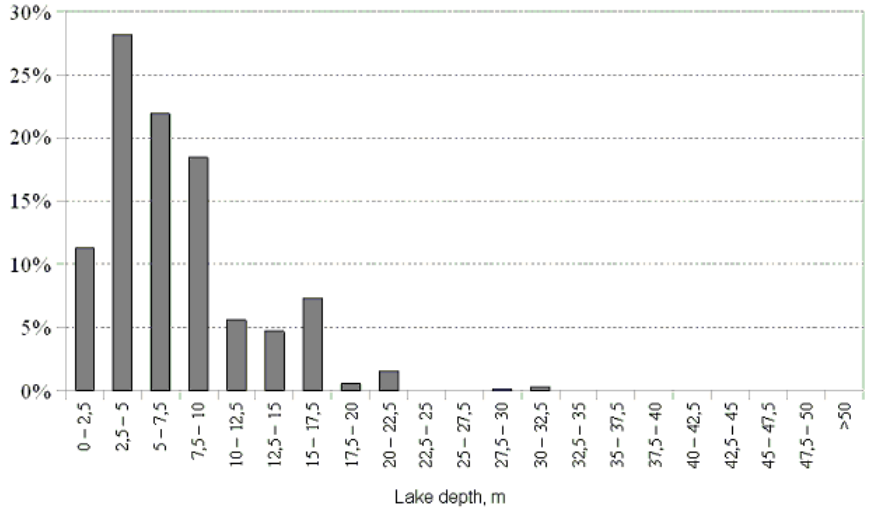
problems

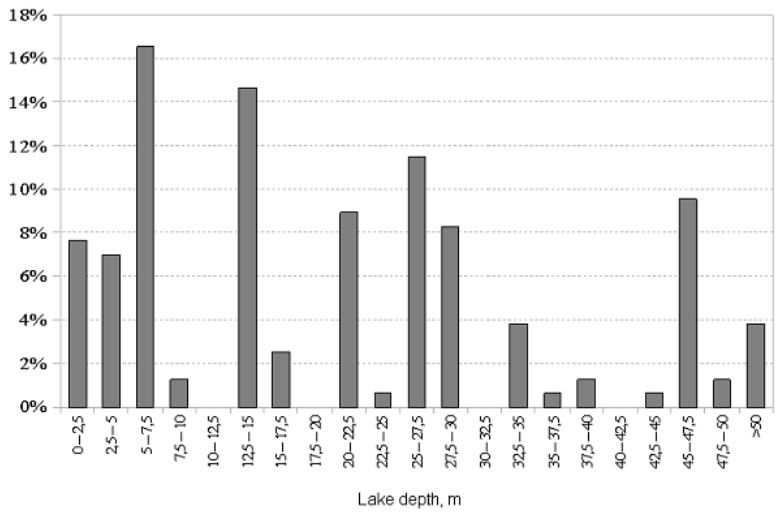
Indirect estimates of the lake depth

from the orography variation, from the origin and from the geographical location: feasibility study

- no correlation with the local orography variation
- may be maximum in the histogram



Southern Finland



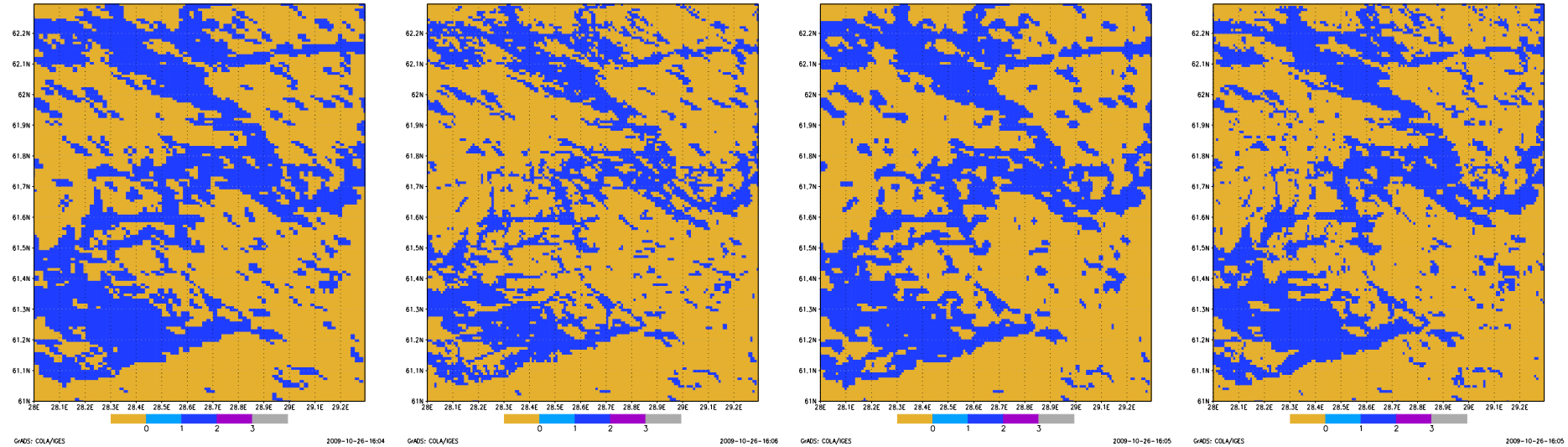
Caucasus

problems

Many maps exist, new maps will appear. Which is the best?

How to compare and to evaluate them?

Not only about lakes ...

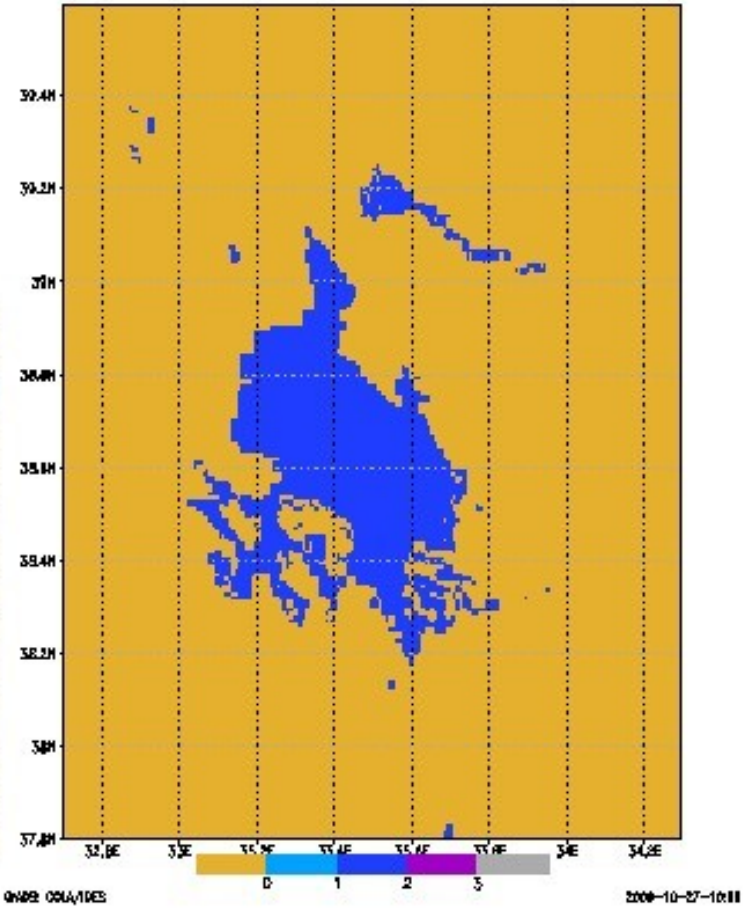


GLCC GLWD ECOCLIMAP1 ECOCLIMAP2

Finland

problems

- **Saline lakes**

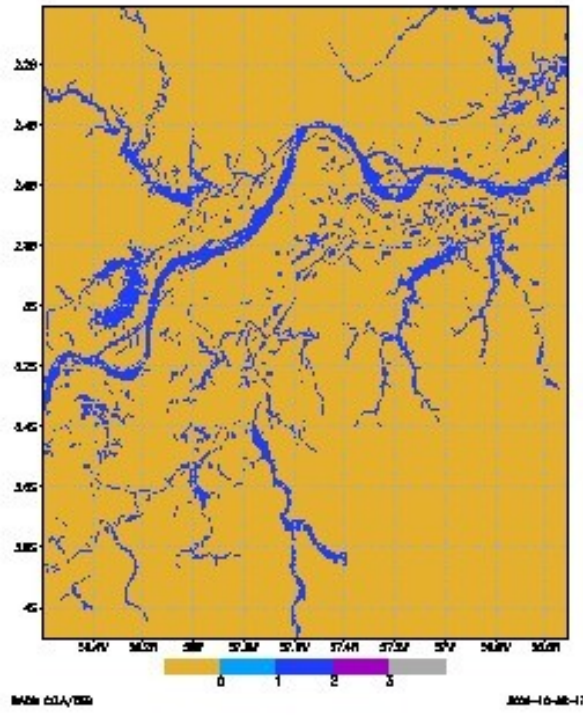


Lake Tuz, Turkey: S = **1600 ÷ 2500 km²**, h ≈ **5** m,
salinity ≈ **340 ‰**

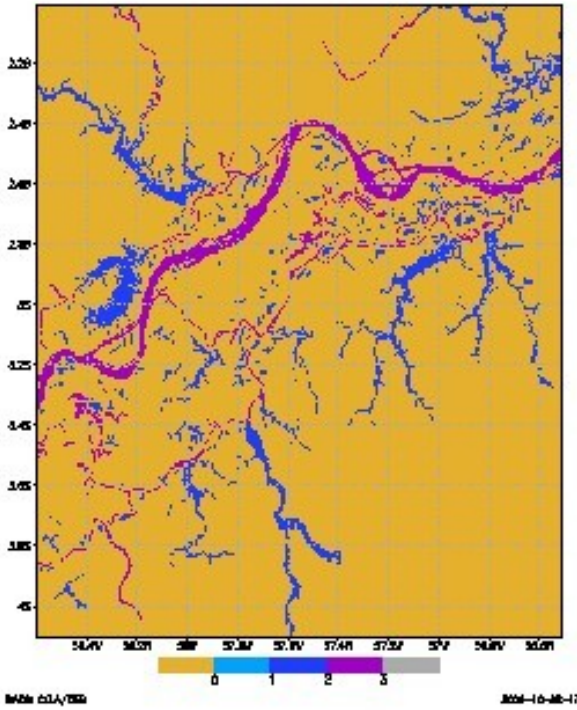
Norrköping, Sweden

problems

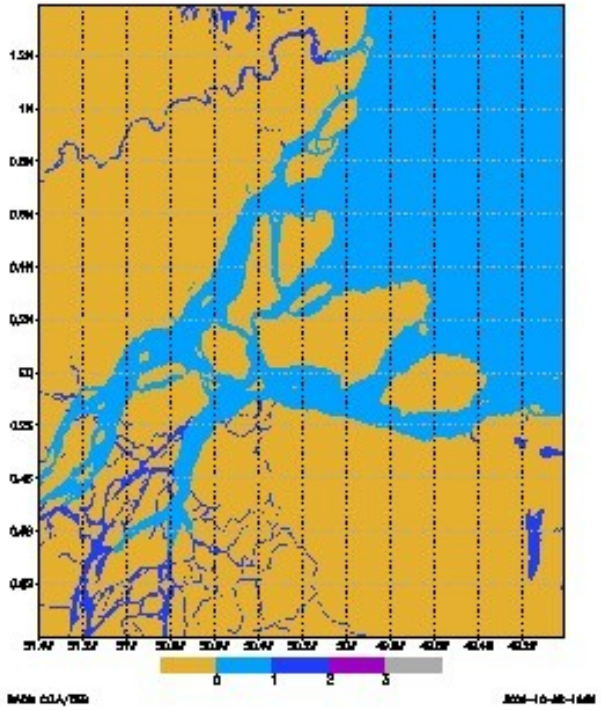
- **Rivers and estuaries**



Mid Amazonia, ECO2



Mid Amazonia, GLWD



Low Amazonia, ECO2

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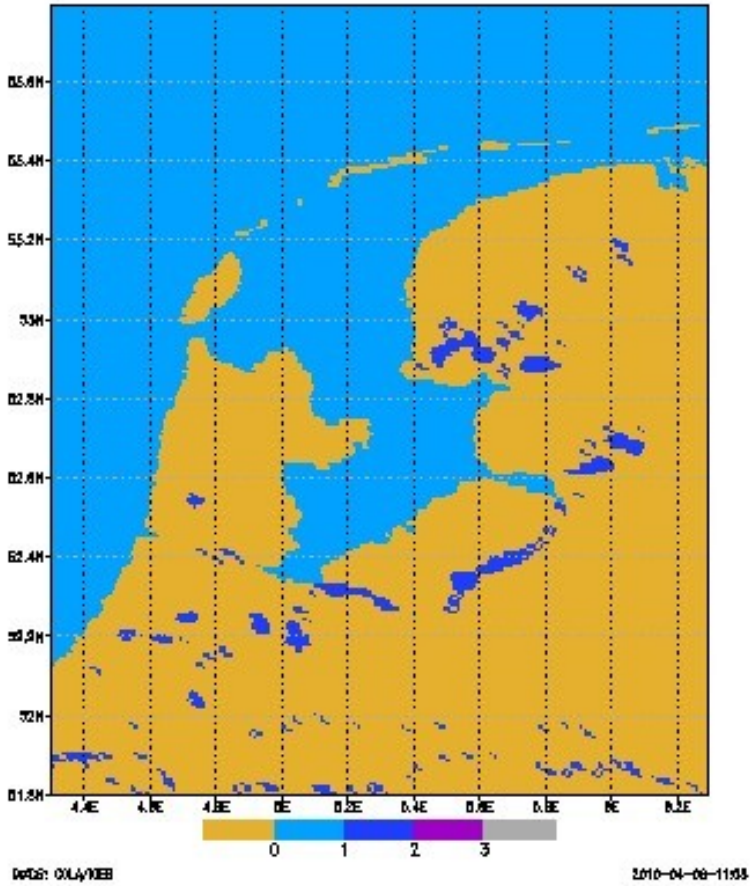
problems

- **Coastal lagoons**



IJsselmeer Lake, S = **1100 km²**, h ≈ **2** m

Markermeer Lake, S = **700 km²**, h ≈ **5** m

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problems

- **Better raster maps:**

  some lakes with the surface area of more than **100** km^2 do not exist at any of analyzed maps!
  Lake Toshka, Egypt, S = **1300** km^2

- **Bathymetry:**

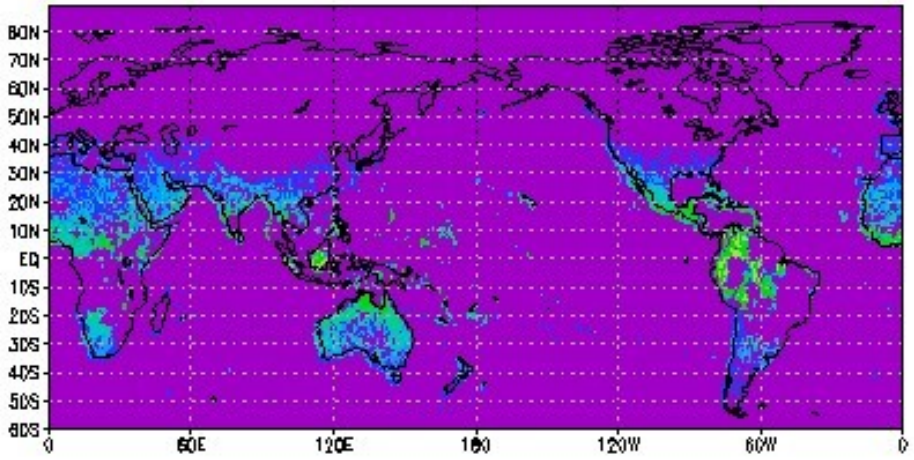
  420 lakes with S > **200** km^2

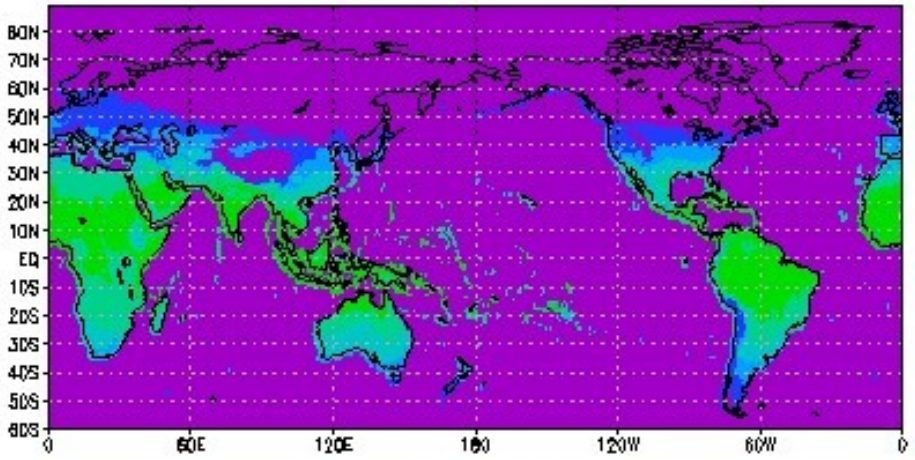
Lake Cold Start Dataset

- climatological 20-year FLake run
- for the globe, resolution 1 deg.
- offline with the forcing from GSWP2 (global soil wetness project)
- for the different classes of the lake depth
- 10-day representation of the annual cycle
- system to extract information for the atmospheric model grid

Lake Cold Start Dataset

- for warm deep lakes, the bottom temperature was relaxed to t2m climatological mean
- consistency of the parameters, PDFs for the ice depth



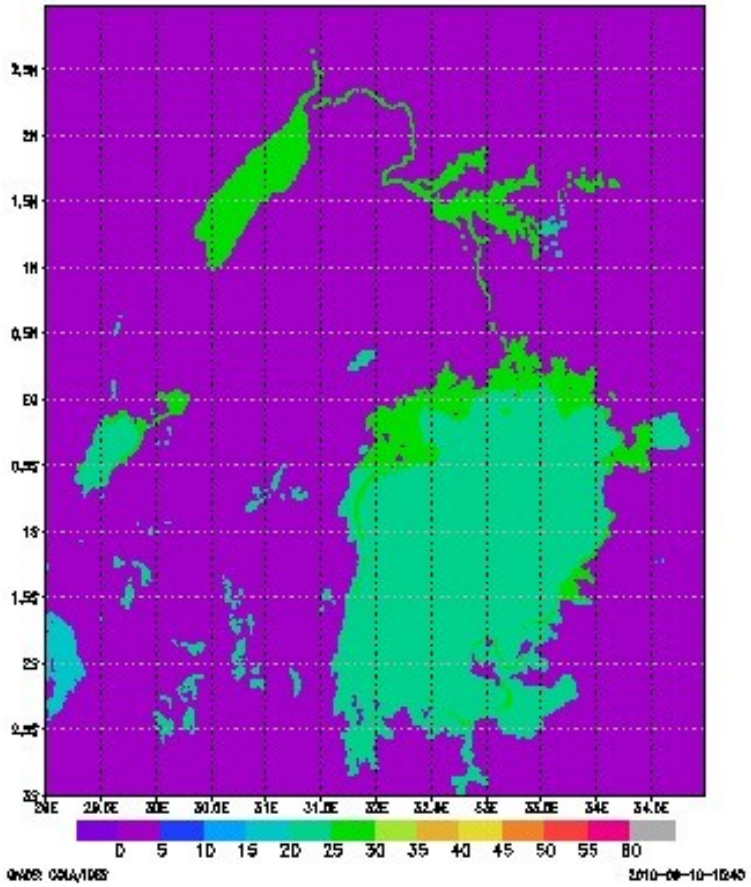


T bot, July, 1

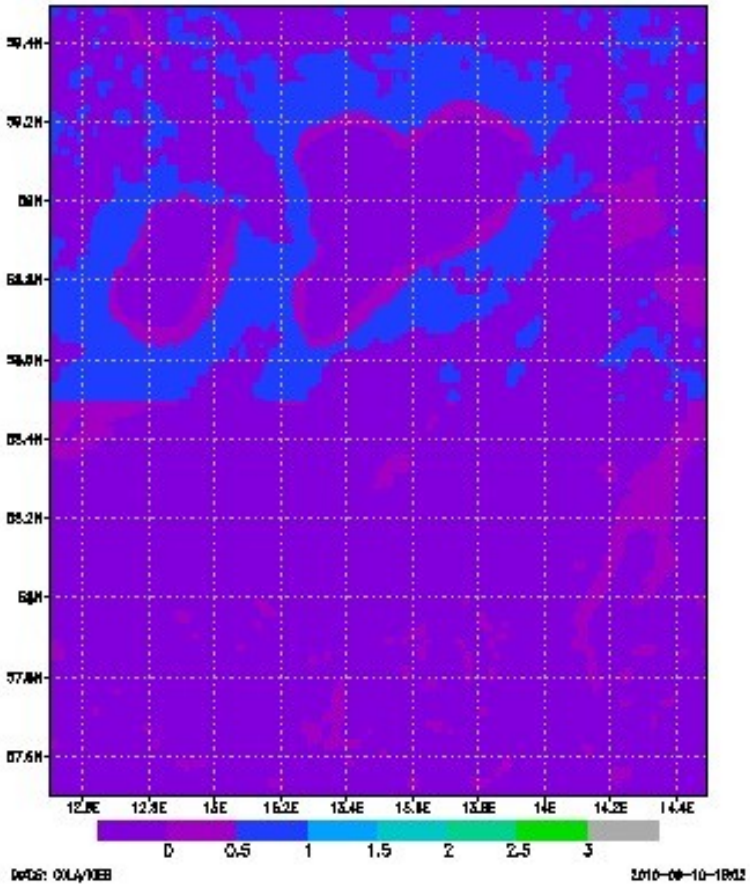
FLake

FLake with relaxation

Lake Cold Start Dataset



Mean water temperature, C,
Lake Victoria, July, 1



Ice depth, m,
Lake Vanern and Lake Vattern,
January, 1

Norrköping, Sweden

conclusion

- The Global Database for the parameterisation of lakes in Numerical Weather Prediction and climate modelling is developed:

- **GLOBAL GRIDDED DATA FOR THE LAKE DEPTH**, the mean values or the bathymetry, with the resolution of 30 sec. of arc

- To project the lake depth data onto an atmospheric model grid, the method of empirical probability density functions is recommended

- The global dataset for the cold start of lake variables (Lake Cold Start Dataset) is developed

- **Maintenance of the product is needed**

Thank you for attention!

- **Acknowledgements:**

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The dataset for individual lakes was made possible by people who kindly provided lake data, their names are listed in the dataset header.

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MERCI DE VOTRE ATTENTION

METEO FRANCE
Toujours un temps d'avance