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

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  - data for individual lakes
  - the map
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introduction

Lakes affect:

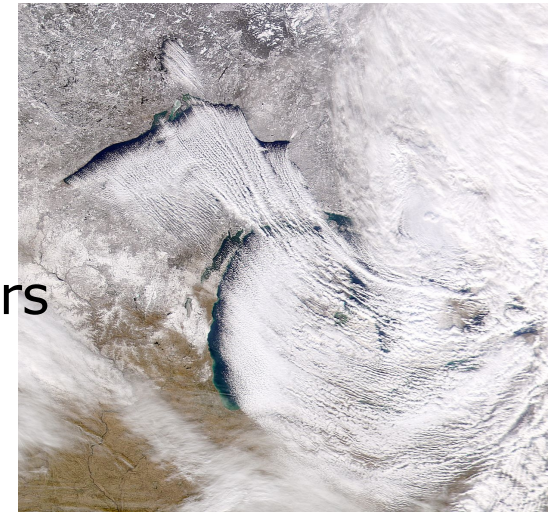
- surface fluxes and the structure of the boundary layer
- local weather conditions and local climate – where the percentage of lake area is high

We increase the resolution!

- more attention to the specific features of surface
- for lakes, we rely on SST analysis: errors for LST!

Lakes should be parameterized!

- we need a lake model
- we need fields of external lake parameters (physiographyc fields) => **global lake database**



introduction

What parameters?

- from sensitivity tests: lake depth, mean or bathymetry
- lake fraction

What is specific for atmospheric modeling?

- global coverage
- all lakes included
- great fidelity is not critical
  (e. g. in comparison with hydrological applications)

What can we get from hydrologists?

- direct measurements
- regional databases: individual characteristics of lakes but no mapping
- global databases: a good 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: data 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_soer/5_ 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

  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	89.8	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	13.268	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

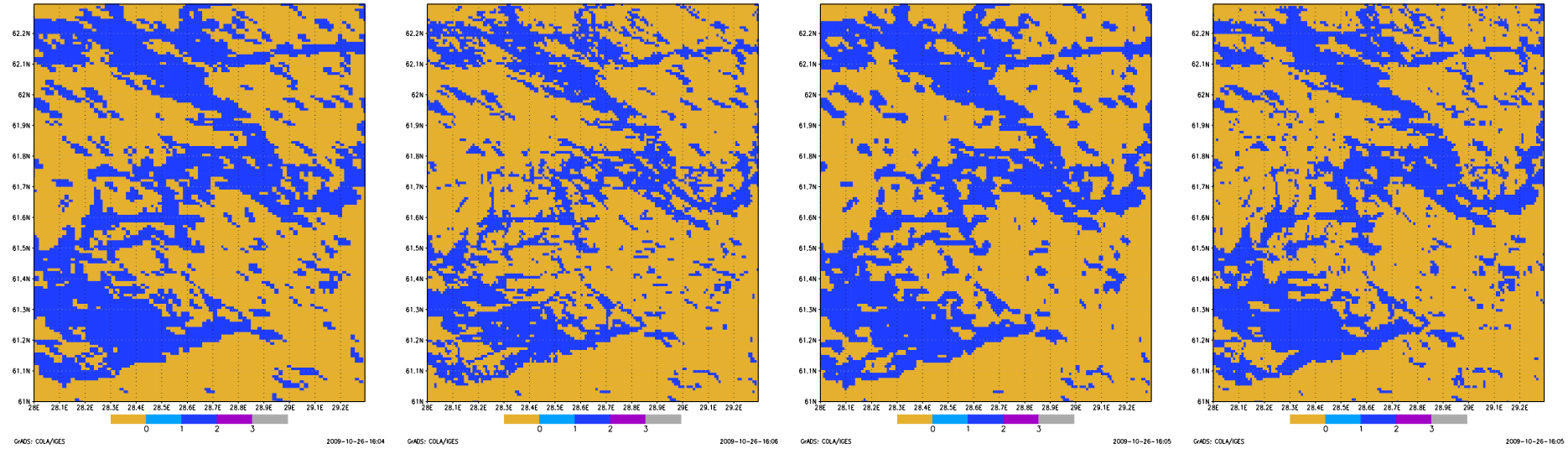
220 saline lakes and endorheic basins

295 references

Is it many or few?

data sources: the map

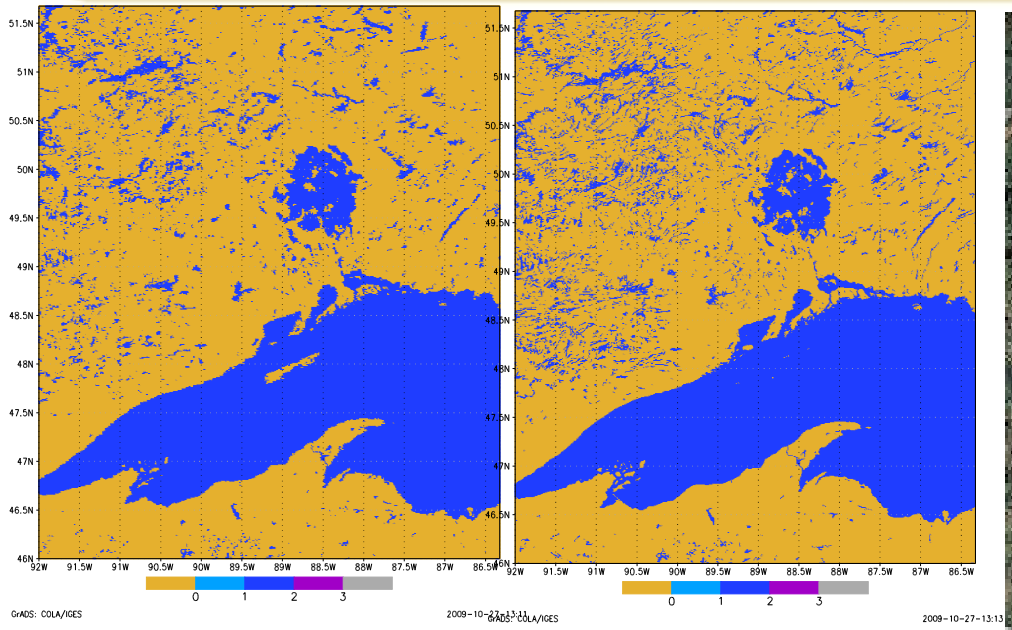
GLCC, ECOCLIMAP, GLC2000, CORINE, GLOBCOWER ... *but*
inaccuracies in the coastline!
=> intercomparison



GLCC GLWD ECOCLIMAP1 ECOCLIMAP2

Finland

data sources: the map



GLCC ECOCLIMAP2

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

After fixing some artifacts – **ECOCLIMAP2**

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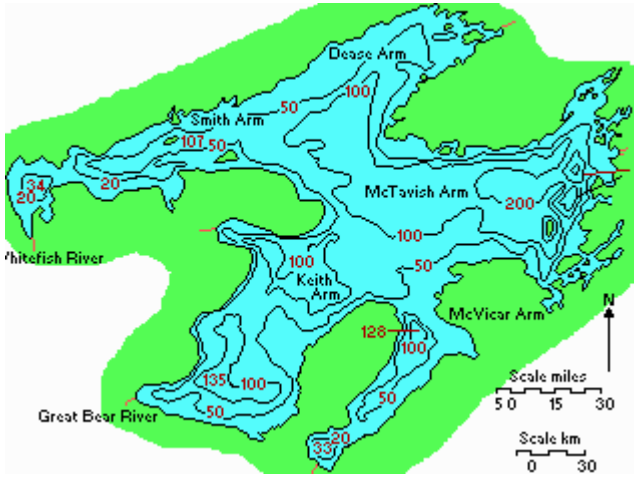
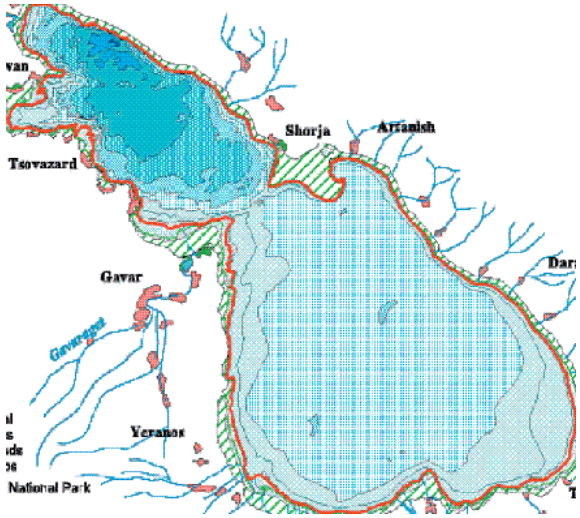
data sources: bathymetry for large lakes

- 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

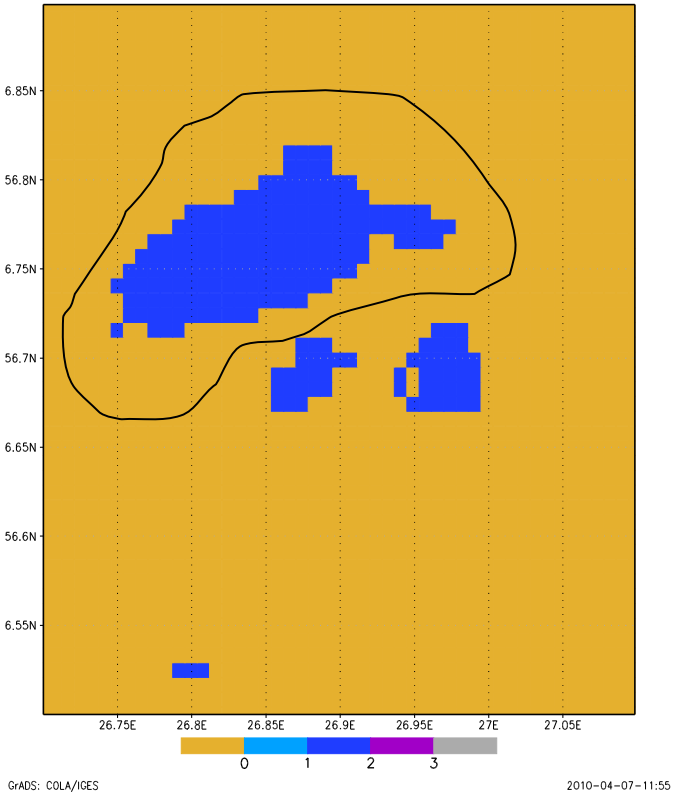
- Totally 36 large lakes





mapping method

- Using of a **raster map** – pixels are classified as ”inland water/no inland water”
- A lake on the raster map – “spot-lake” is a set of conterminal pixels with “inland water type”
- There are random errors in the coordinates of a point on the lake water surface in the dataset for individual lakes; the shoreline on a map is also defined with random errors =>
- Using of the probabilistic approach



mapping method

- The coordinate vector of a point on the lake water surface: a **random value**, **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 is appointed,** it depends on the distance from the coastline:

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

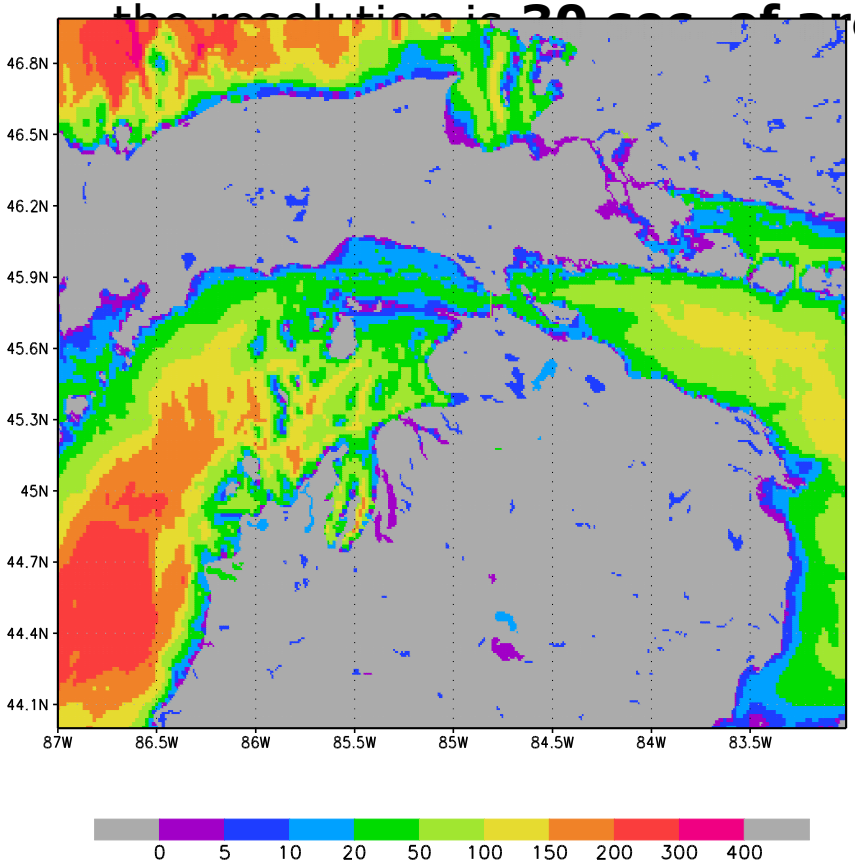
$$P_b\left(B_{ij}\right) = P_{\min,nl} + \frac{P_{\max,nl} - P_{\min,nl}}{\sum_{n=1}^{R_b} 8 \cdot n \cdot f(n)} \sum_{n=1}^{R_b} m_n \cdot f(n)$$

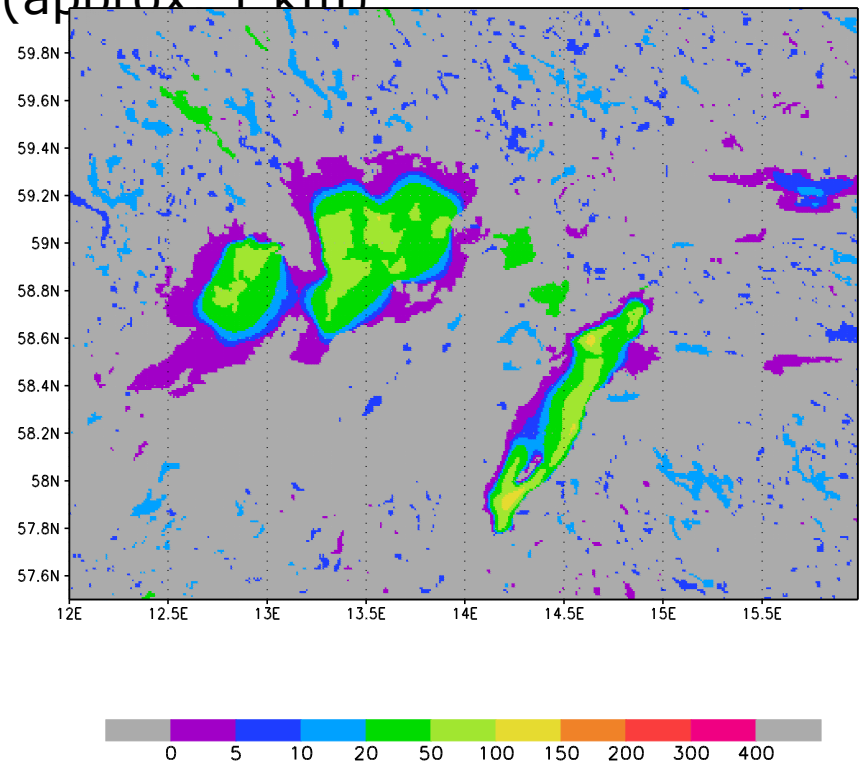
- The **total probability** of the correspondence between a lake from the dataset for individual lakes and a "spot-lake"
- For every "spot-lake" : the correspondence with **maximum total probability** (if it is =0, the "spot-lake" is not recognized)

products

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

the resolution is **30 sec. of arc** (approx. 1 km)



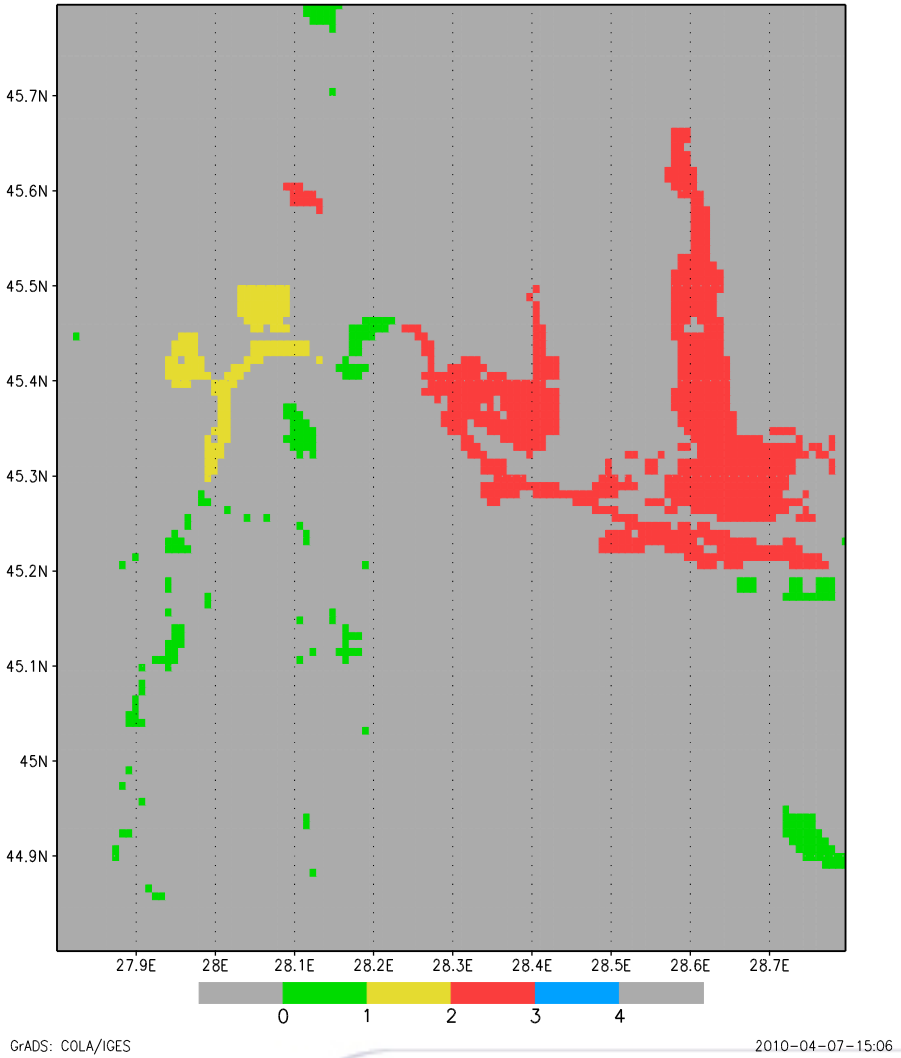


products

- 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

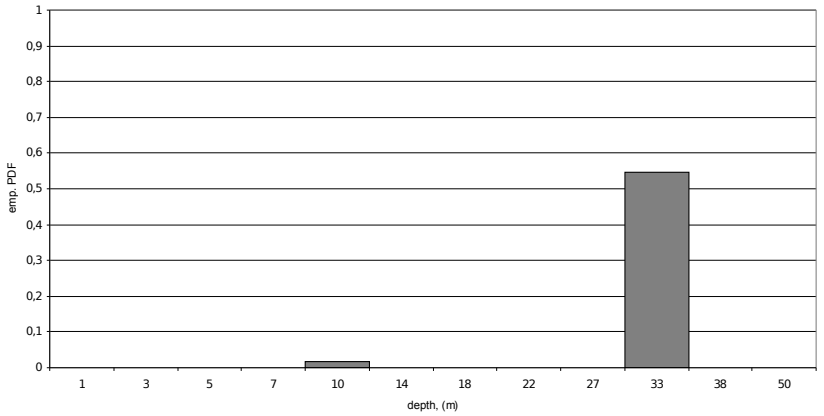
- Useful to estimate the quality of data.

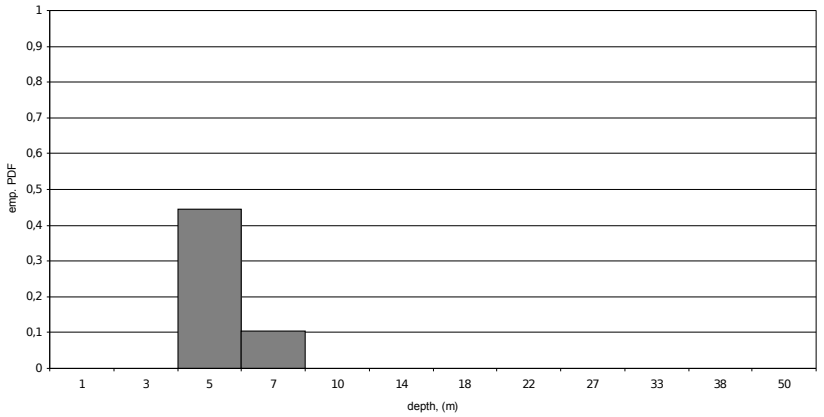
Romania =>



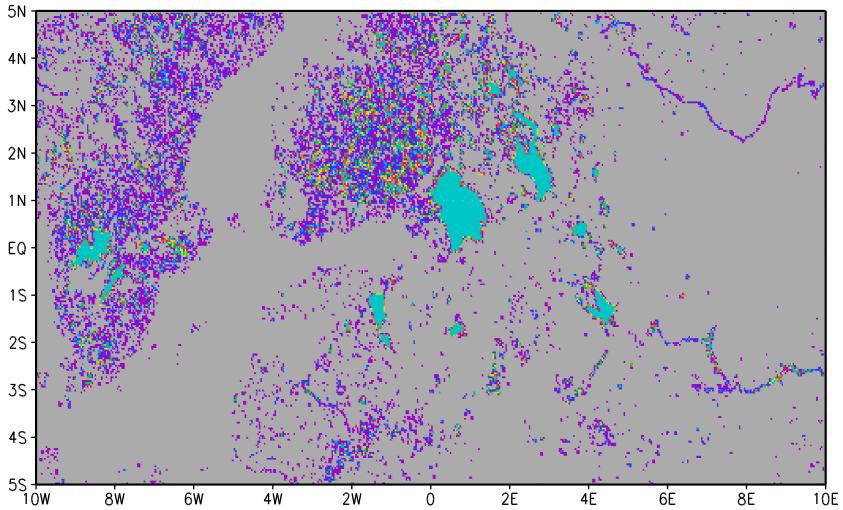
projection onto an atmospheric model grid

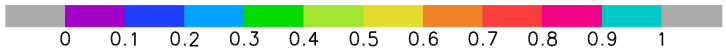
- The lake depth field is discontinuous => **averaging is incorrect**
- To make histogram (the empirical probability density function) and to use **the most probable value**
- Product: FORTRAN90 **routine** ProjectLake.90, makes this for one grid box defined as a polygon
- Result: the field of the most probable lake depth and of the lake fraction on **the atmospheric model grid**





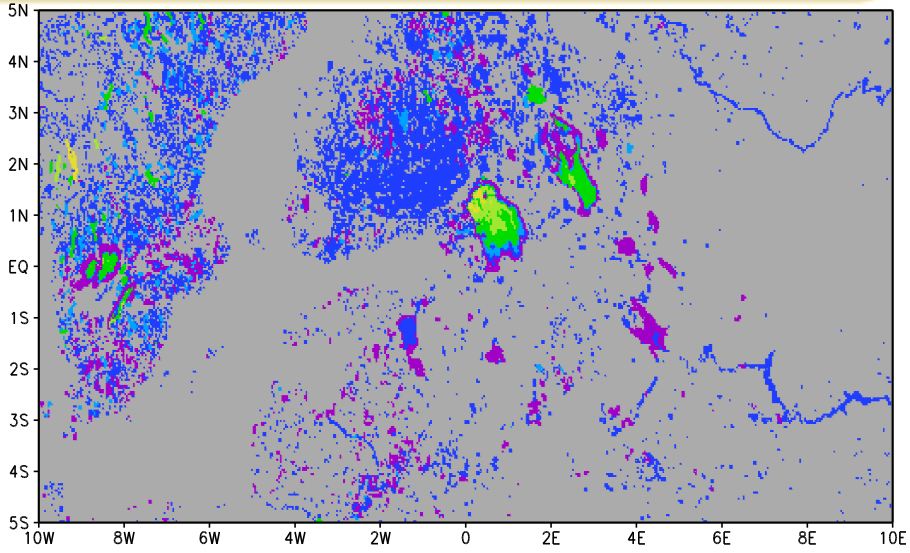
projection onto an atmospheric model grid

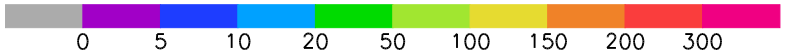




lake fraction

GrADS: COLA/IGES 2010-03-03-17:36





lake depth, m

GrADS: COLA/IGES 2010-02-16-16:4

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

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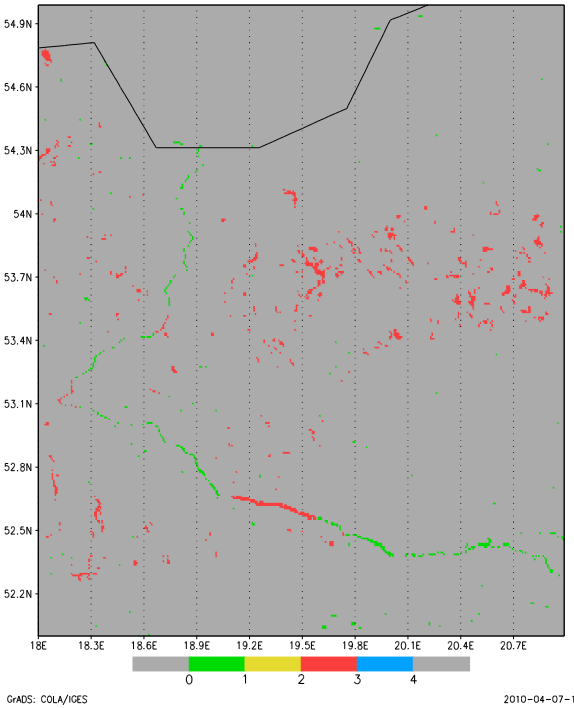
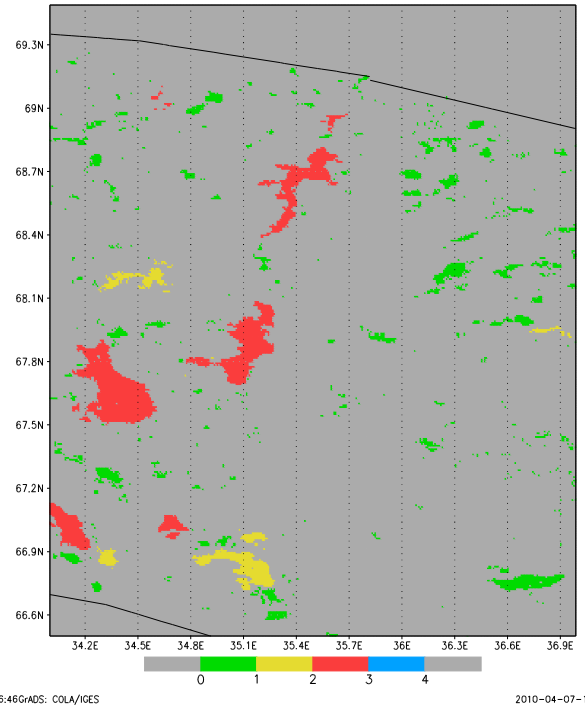
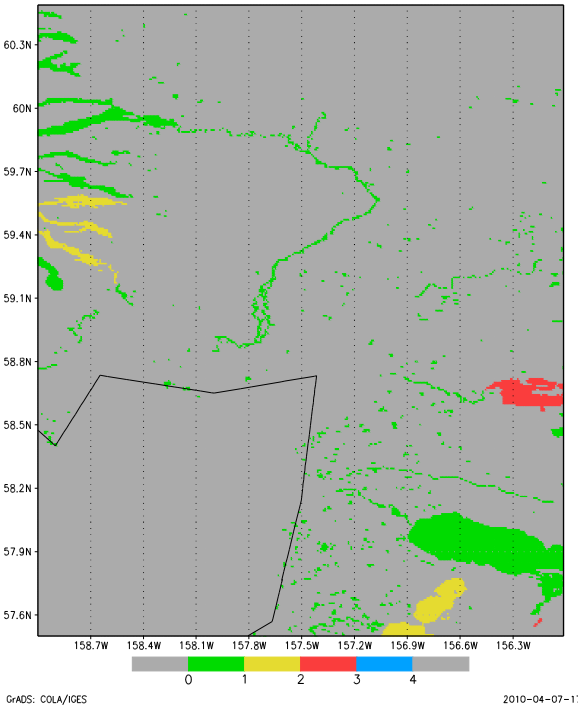
problems







Poland Karelia Alaska

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

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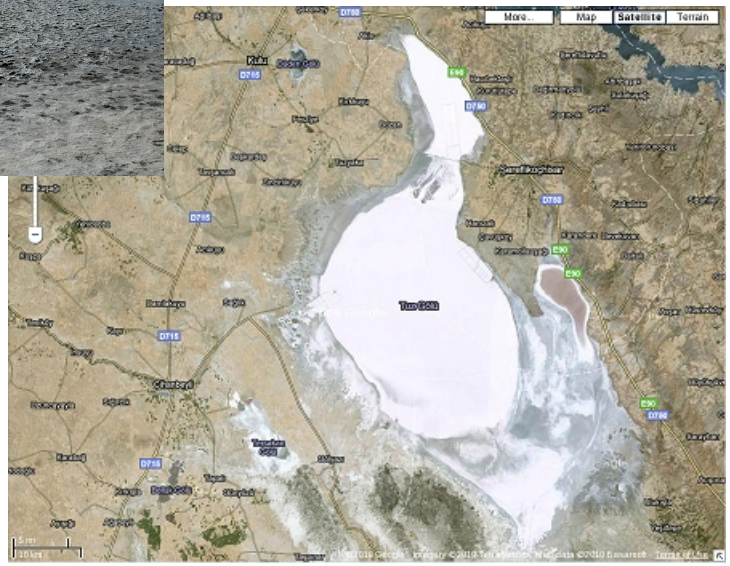
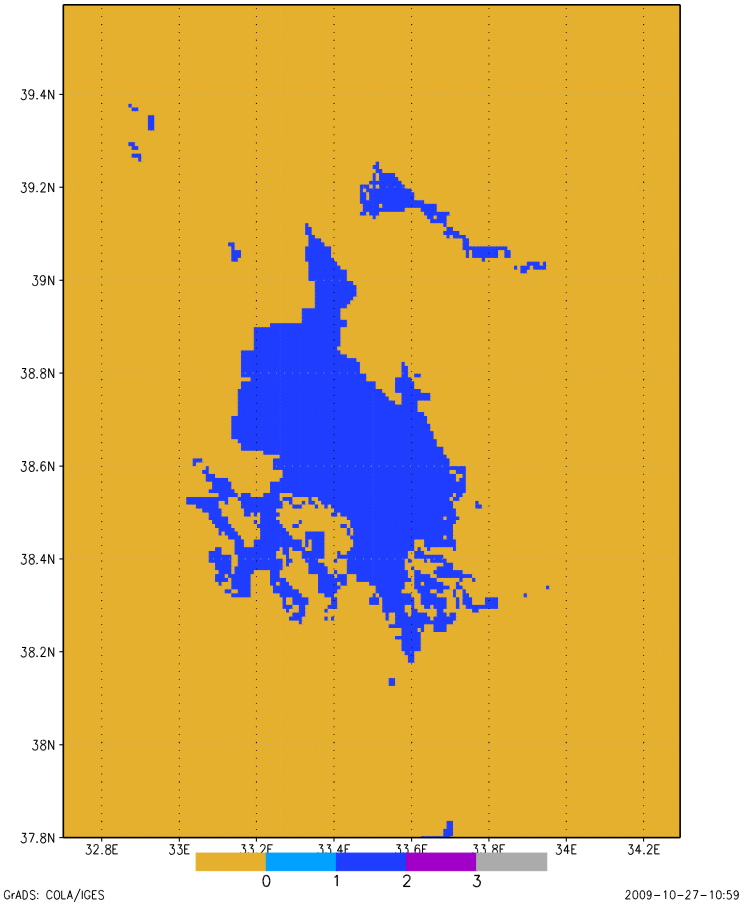
problems

- **Saline lakes**

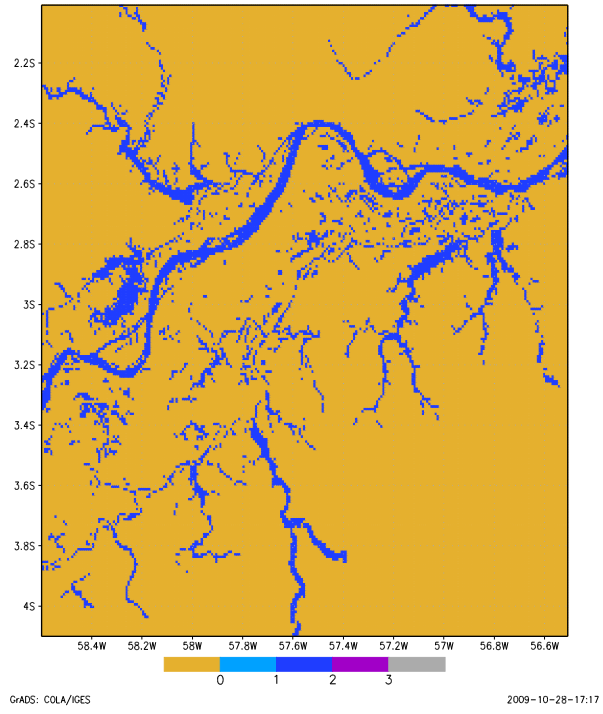


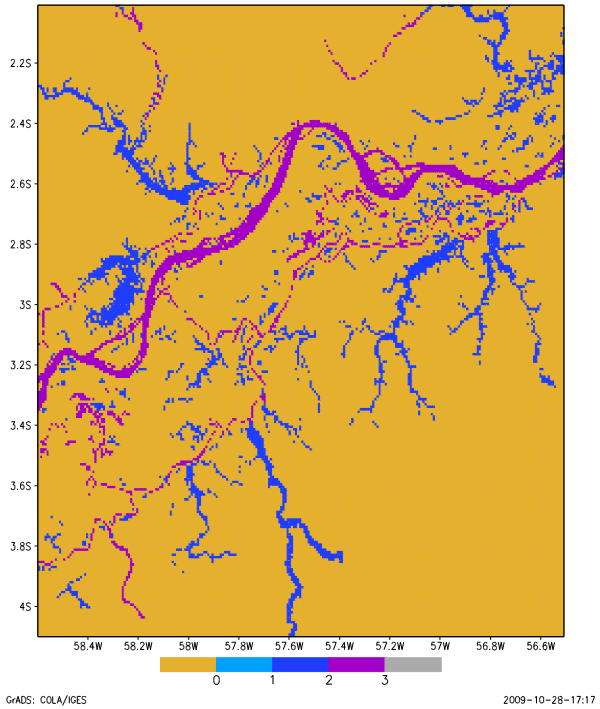


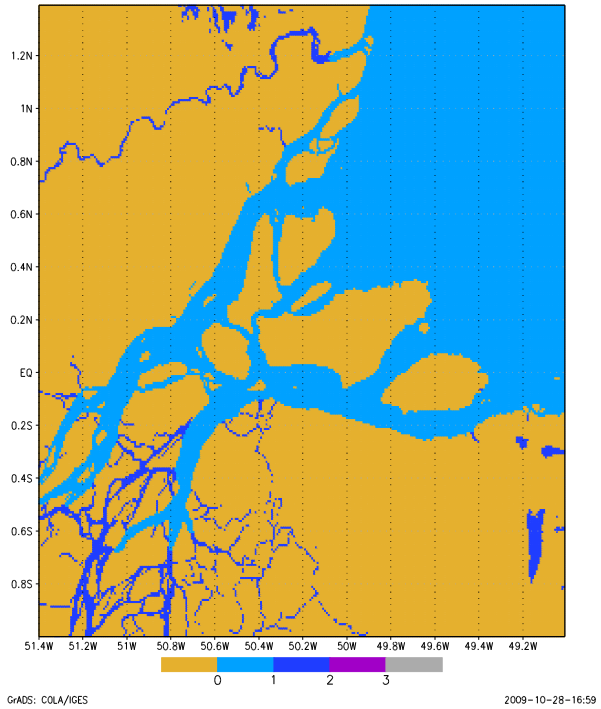
Lake Tuz, Turkey: S = **1600 ÷ 2500 km²**, h ≈ **5** m,
salinity ≈ **340 ‰**

problems

- **Rivers and estuaries**



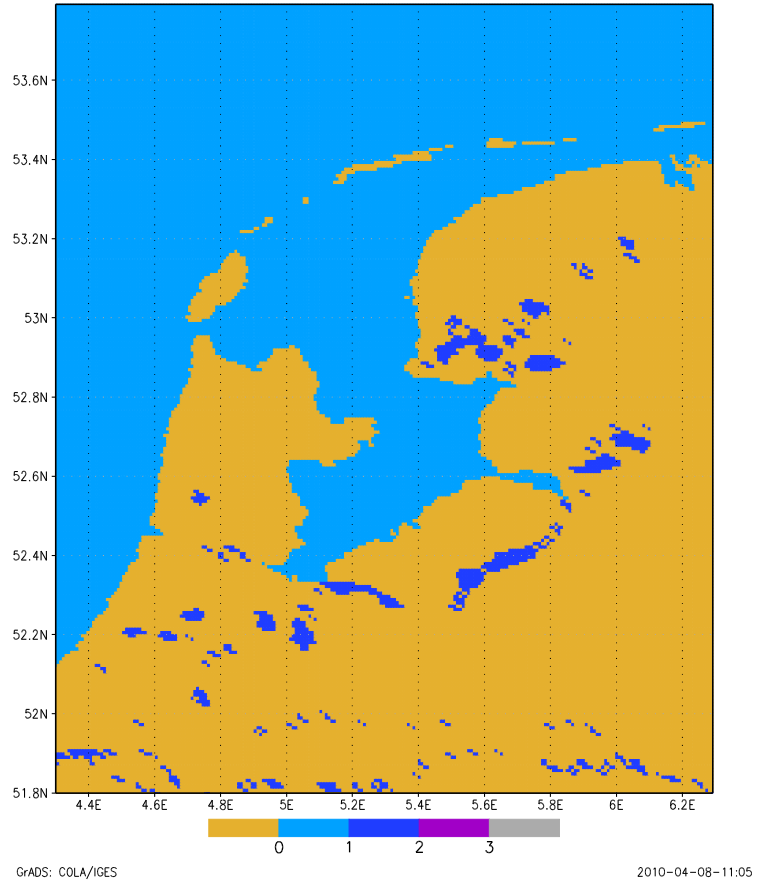




Mid Amazonia, ECO2 Mid Amazonia, GLWD Low Amazonia, ECO2

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

- **Bathymetry:**

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

- **Indirect estimates of lake depth:**

  orography variation? temperature annual cycle?

conclusion

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

- **GLOBAL GRIDDED DATA FOR LAKE DEPTH**, the mean values or the bathymetry, with the resolution of 30 sec. of arc and the additional dataset about the reliability of the depth data

- To project the lake depth data onto an atmospheric model grid, the method of empirical probability density functions is recommended - (FORTRAN90 routine)

- **Maintenance of the product is needed**

Thank you for attention!

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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

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