Status and progress in GLDB developments

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Plitvice lakes, Croatia

- Background
- GLDBv1
- Mapping method
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- GLDBv3 + problems
- Conclusions & Future plans

Bled lake, Slovenia

Background

Ohrid lake,

Balkan Mountains

- For lakes, with water surface area ≥ 0.002 km^2, that are not situated in Greenland and Antarctica:
  - the total area of lakes is 4.0% of the Earth's surface;
  - the total number of lakes is 117 million;
  - the vast majority of lakes are freshwater – vital resource.
- In the atmospheric modeling for parameterization of lakes the external parameters of lakes are needed – **depth.** (Effect of lakes is handled in NWP and climate models through parameterization)
- Accuracy, reliability of depth data – not critical, **global coverage** – essential for the atmospheric modeling applications
(no direct measurements → rough estimates).

History of GLDB

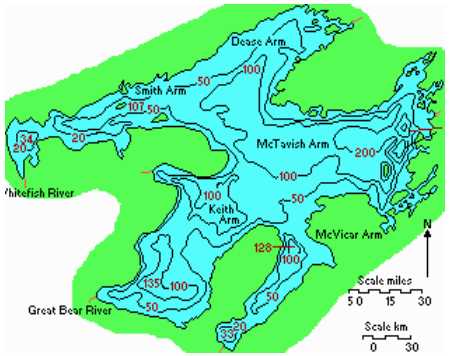
Version of GLDB	Year of issue	Notes
1	2008	is already used
2	2012	indirect estimates of the mean lake depth from the geological origin for boreal zone
3	2015	- // - for the whole world

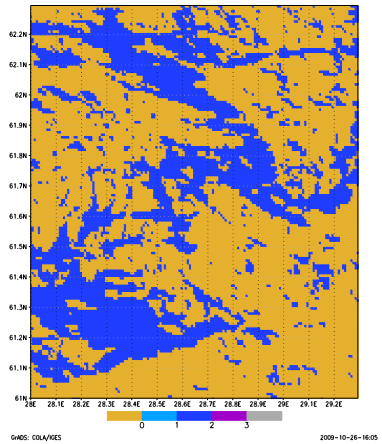
Similarities of GLDB

Data sources:

- the mean depth for individual lakes, from different regional databases (different total number of lakes in each version);
- global map – ecosystem dataset ECOCLIMAP2;
- bathymetry data for 36 large lakes from ETOPO1 and digitized navigation and topographic maps.

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	349	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	13.258	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	Hallstaetter_See	Austria
48.82	15.136	1.4	2.5	0.6	Heidauer_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	12.216	12.8	36	0.6	Hintersteiner_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

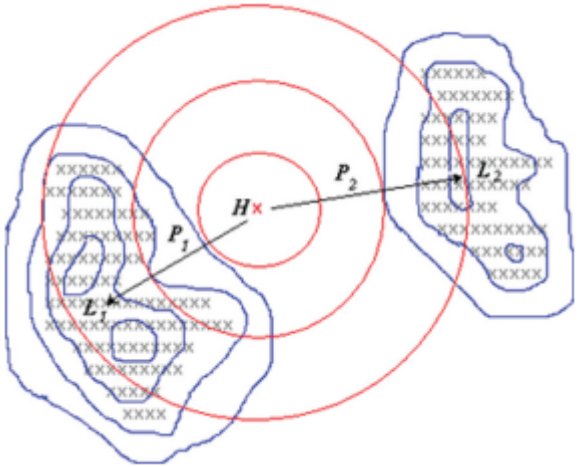




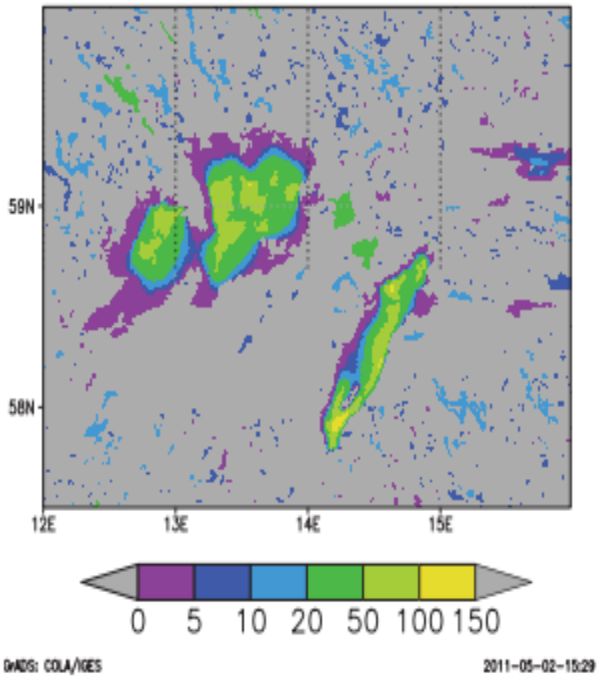
GLDBv1

- The **individual lake list** consist of ≈ **13’000 lakes**.
- The global gridded lake depth data set includes information about real lake depths and “default” lake depth.
- The additional global gridded data set containing coded information about sources of data was made.
- **Only** data on **freshwater lakes** are processed (data on saline lakes are skipped).
- The **“default” lake depth** is set to the value of **10 m**.

Mapping method



- Automatic
  – for mapping the mean depth data for individual lakes
- Probabilistic
  – it is assumed that all data sources have random errors
- For lakes with no information, the **"default" depth** is used
  GLDBv1 – 10 m, in later versions – main subject of study
- Result
  – global lake depth data set with the resolution of 30" (approximately 1 km)



GLDBv2

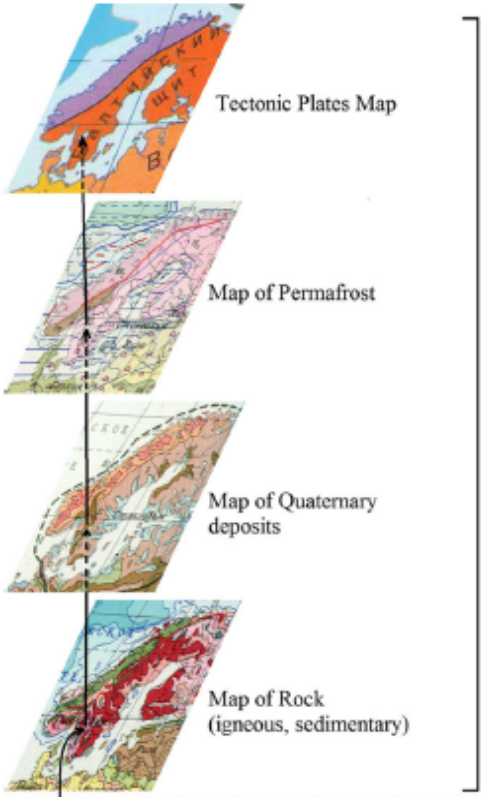
- The **individual lake list** from GLDBv1 was **increased by ≈ 500 lakes**.
- The global gridded lake depth data set from GLDBv1 was completed with **indirect estimates of the mean lake depth** from the geological origin **for boreal zone** (we allocated **141 regions** with homogeneous geological origin of lakes).
- The **analytical equations** approximating statistical dependencies distributions **of the mean lake depth** for different climate zones depending on the lake area were **introduced**.
- The additional global gridded data set containing coded information about sources of data was updated.
- **Only** data on **freshwater lakes** are processed (data on saline lakes are skipped).
- The **“default” lake depth** is set to the value of **10 m**.

Geological approach

according to the depth estimation of uninspected freshwater lakes

- Water bodies of the same origin and the same age should have a similar size
- To find the typical lake depth for allocated regions were used:
  - statistical analysis
    (building histograms, special filter)
  - method of analogies
    (extrapolation – in case of scarce statistics for one region and sufficient for another with similar geological/geomorphologic structure)
  - improved geomorphologic method
    (relations between lake volume and surface area for each region with different geological situation – only for Northwest Russia, middle size lakes)
  - geographical method
    (mutual distribution of lake parameters specific for each geographical zone – not related to lake origin, may implicitly account for morphology of territory through dependency of vegetation on lithology of rock or permafrost conditions)

Algorithm combines lake location and geological information. For boreal zone – 141, for non-boreal – 233 regions were outlined.



Lat, °	Lon, °	Mean depth, m	Max depth, m	Surface area, km^2	Lake name	Country
58.903	13.595	27.0	106.0	5648.0	Vanern	Sweden
58.320	14.560	39.9	128.0	1856.0	Vattern	Sweden
59.520	17.030	11.9	61.0	1140.0	Malaren	Sweden
59.220	15.770	6.1	22.0	478.0	Hjaelmaren	Sweden
58.980	14.280	26.8	9999.0	9999.0	Skagern	Sweden
56.630	14.730	3.1	9999.0	9999.0	Aasnen	Sweden

List of lakes (latitude, longitude)

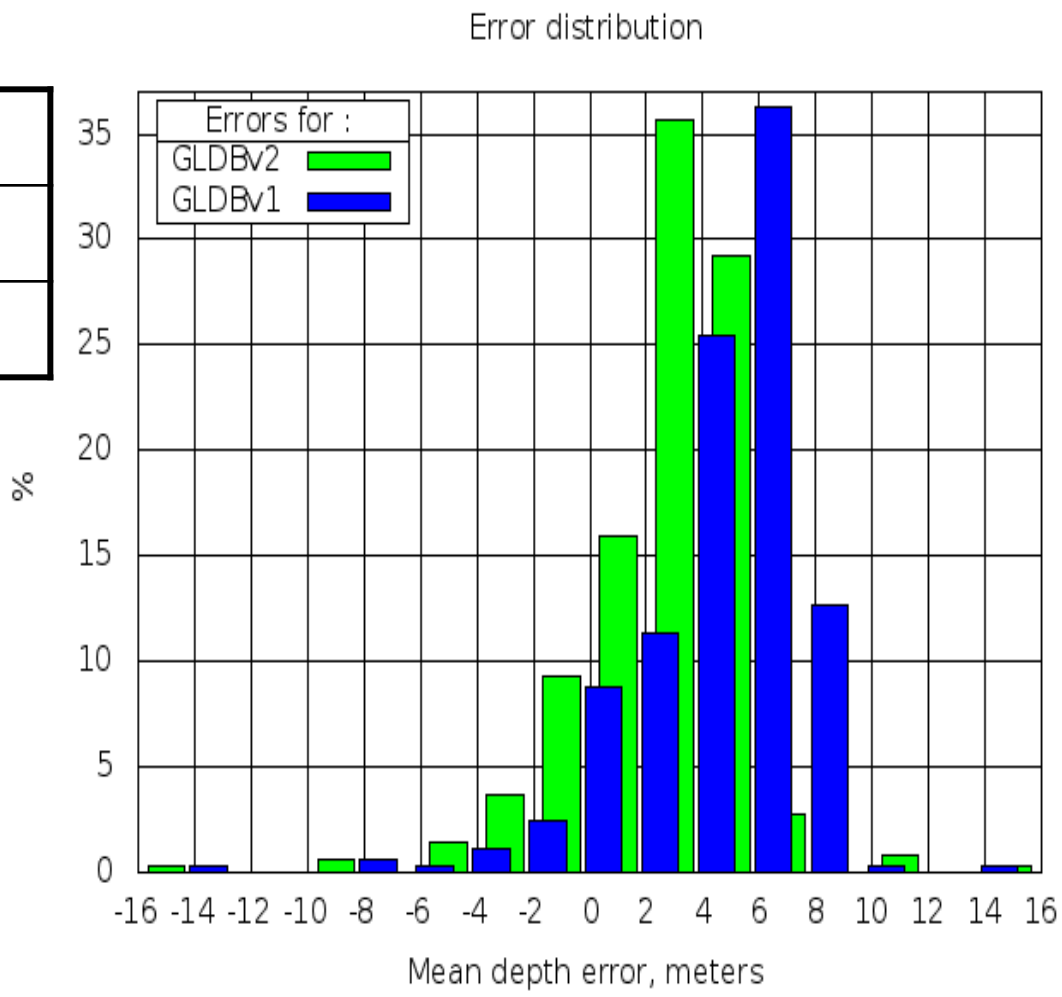
Text form

Verification of geological approach against new lake depths observations

Error – difference between depth of the lake from GLDBv1 and GLDBv2, and actual depth

	GLDBv2	GLDBv1
BIAS	2.64	5.36
RMSE	3.97	6.13

New data for 353 Finnish lakes – updated SUKE base



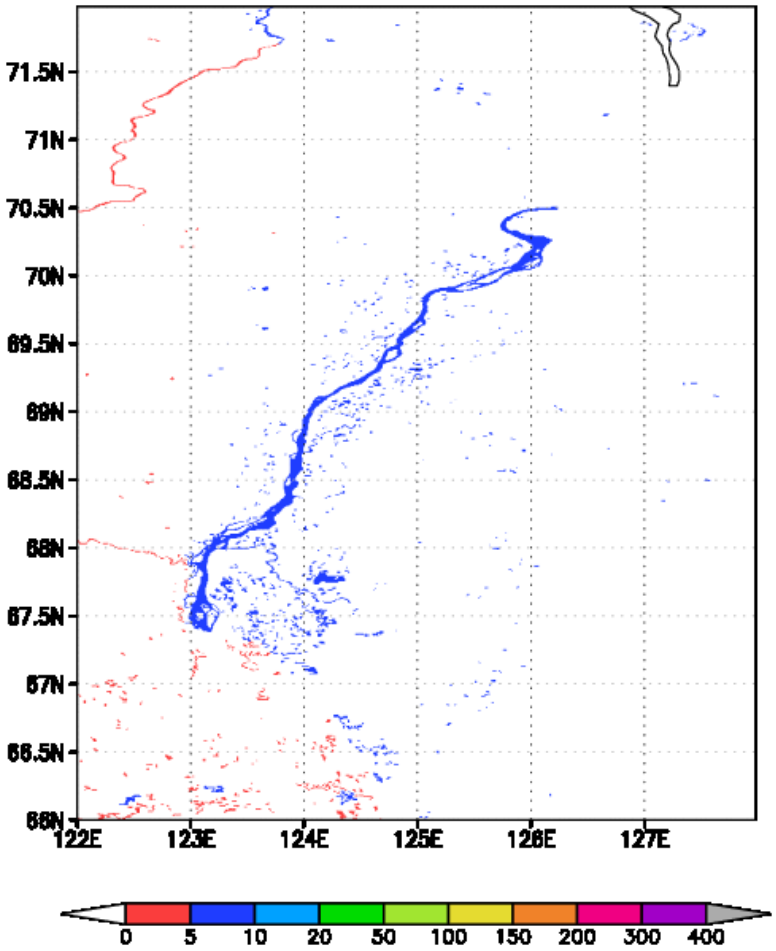
GLDBv3

- The **individual lake list** from GLDBv1 was **increased by ≈ 1’500 lakes**.
- The global gridded lake depth data set from GLDBv1 was completed with **indirect estimates of the mean lake depth** from the geological origin **for the whole world** (we additionally allocated **233 regions** with homogeneous geological origin of lakes).
- The **analytical equations** approximating statistical dependencies distributions **of the mean lake depth** for different climate zones depending on the lake area were **updated**.
- The additional global gridded data set containing coded information about sources of data was updated.
- All data (on **fresh-water and saline lakes**) are processed.
- The “default” depth for fresh-water lakes and saline lakes is different – **“default” fresh-water lake depth** is set to the value of **10 m** and the **“default” saline lake depth** is set to the value of **5 m**.
- Were introduced: **list of artificial (man-made) lakes and reservoirs** with unknown depths – the “default” depth value of **10 m**; **list of crater and caldera lakes** – the “default” depth value of **50 m**.

Problem with rivers: Lena

13 rivers with surface area ≥ 1000 km^2 were marked as lakes

Depth, meters



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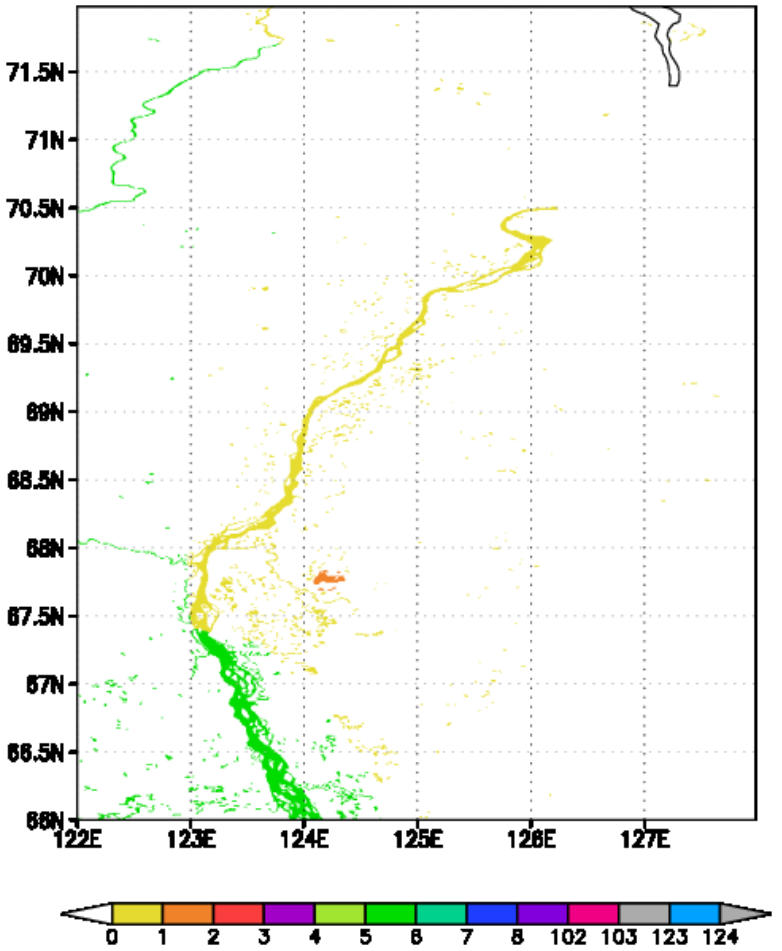
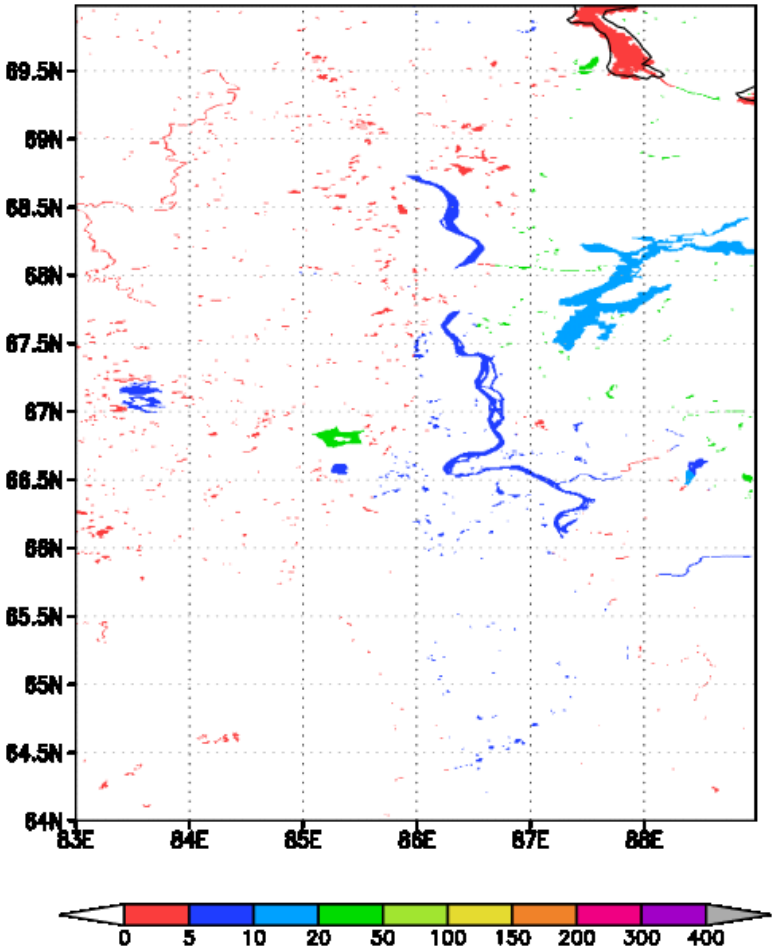


Problem with river: Yenisei

13 rivers with surface area ≥ 1000 km^2 were marked as lakes

Depth, meters



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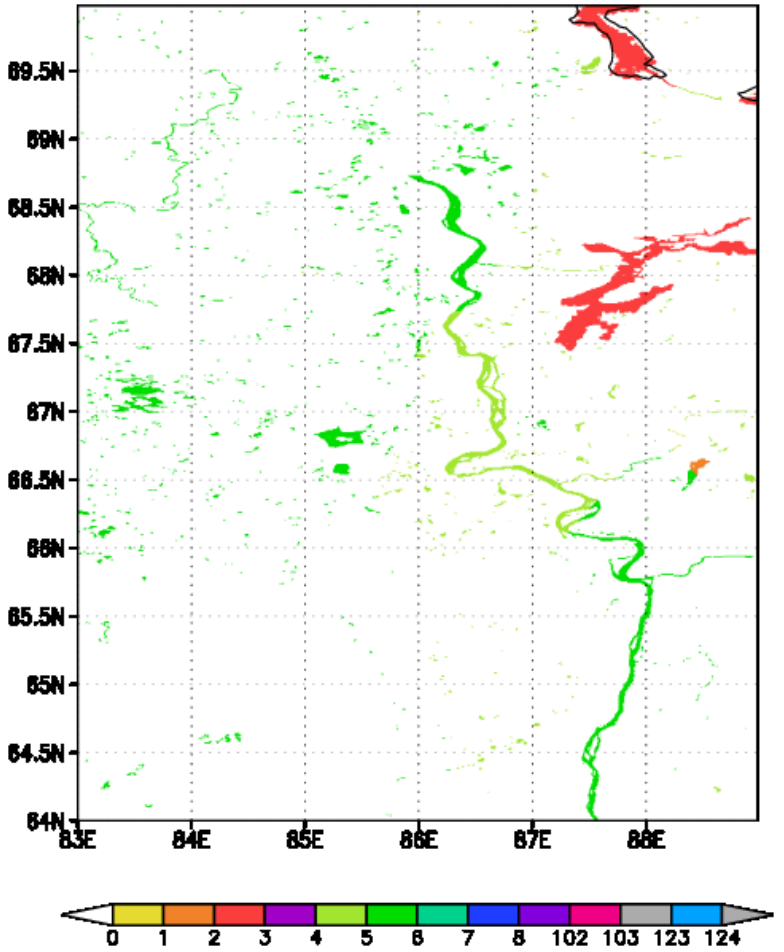
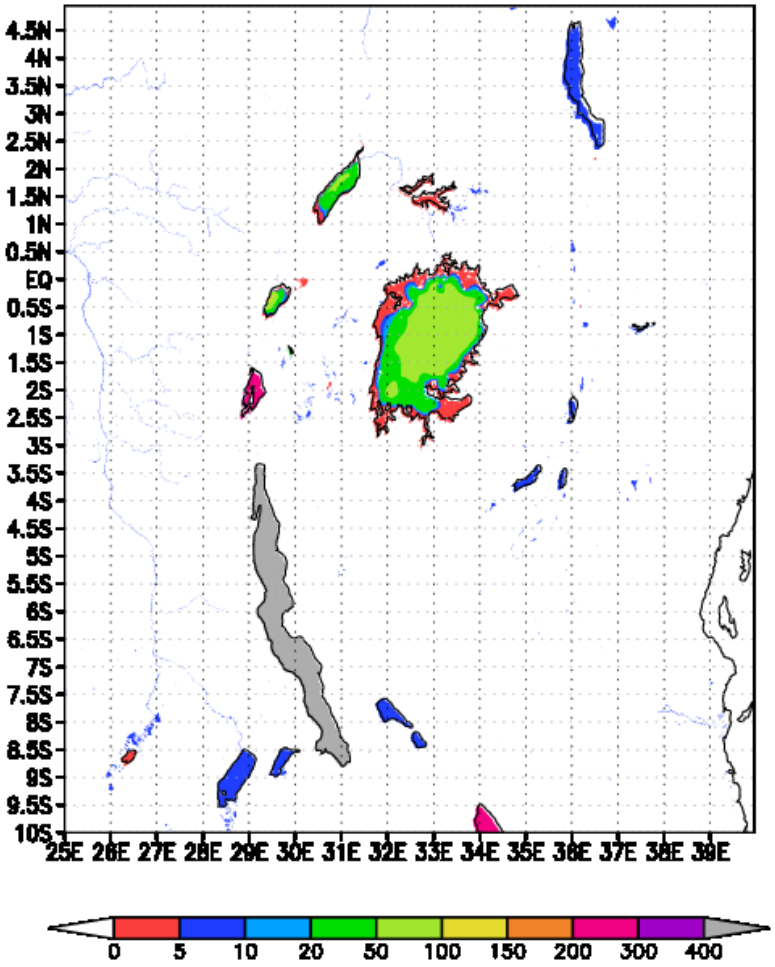
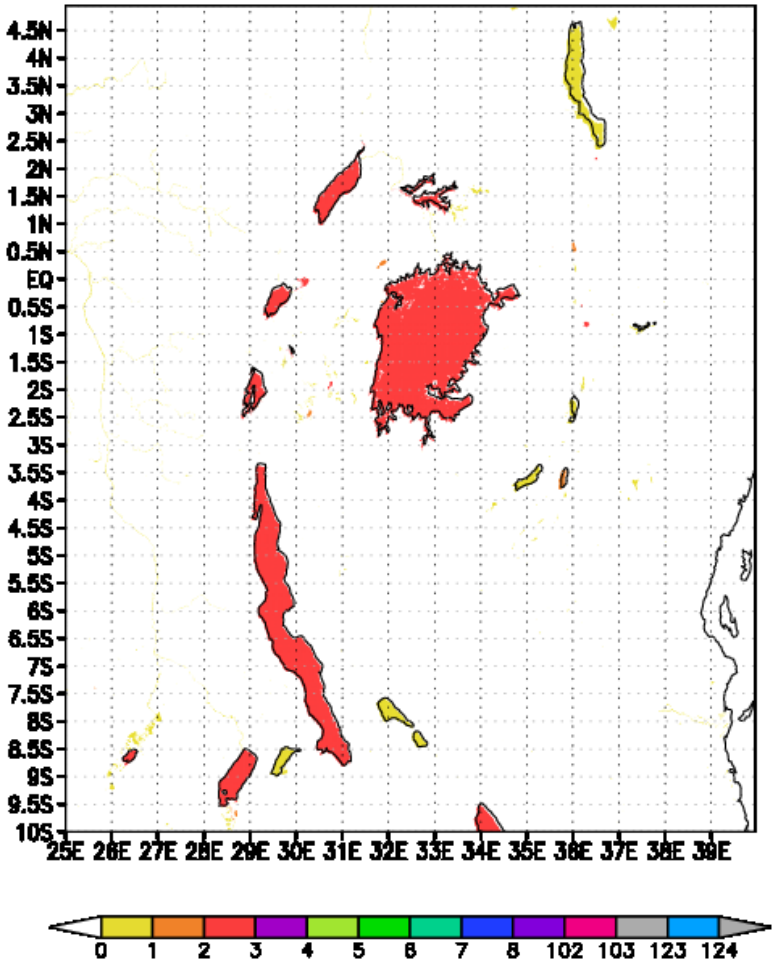
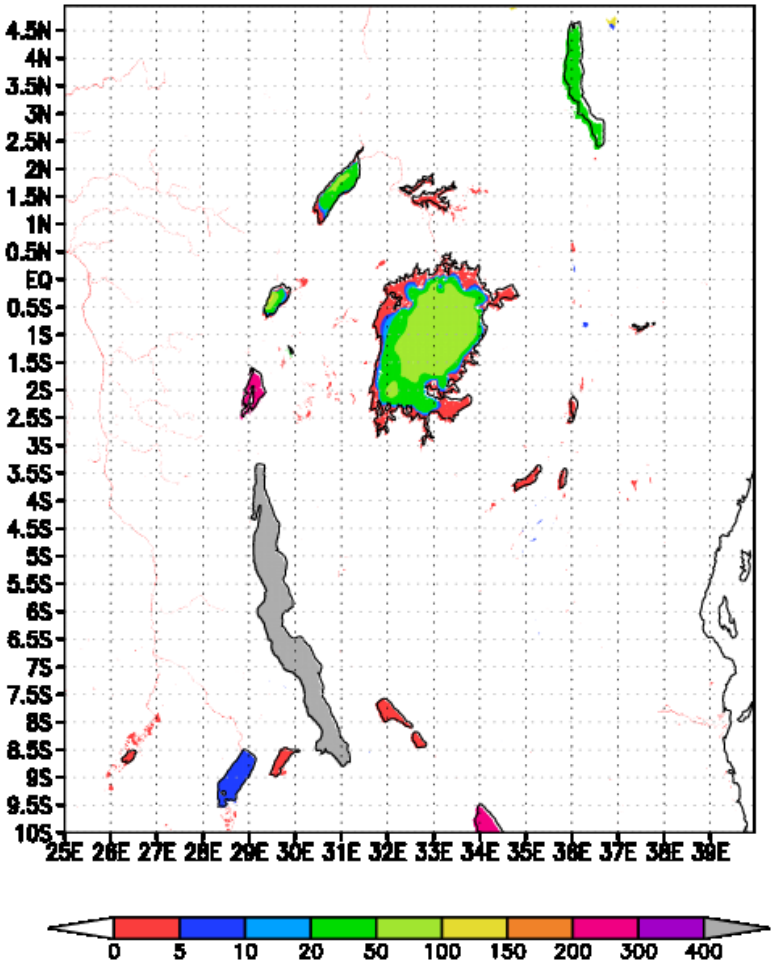


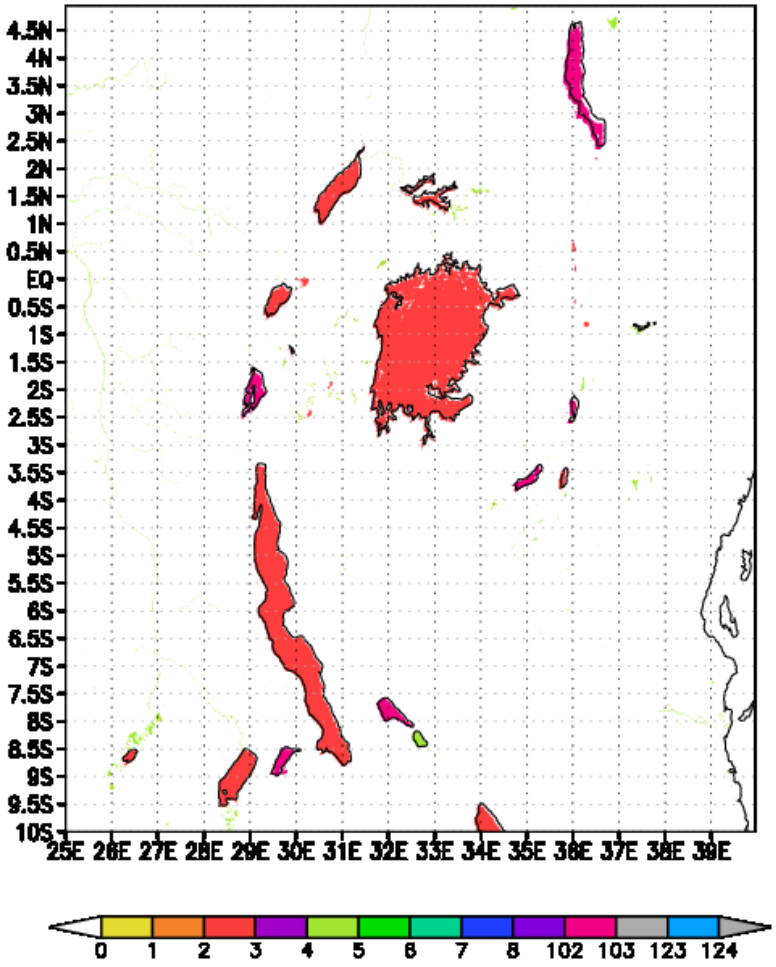
Comparison of GLDBv2 and GLDBv3: **GLDBv2** – surroundings of lake Victoria



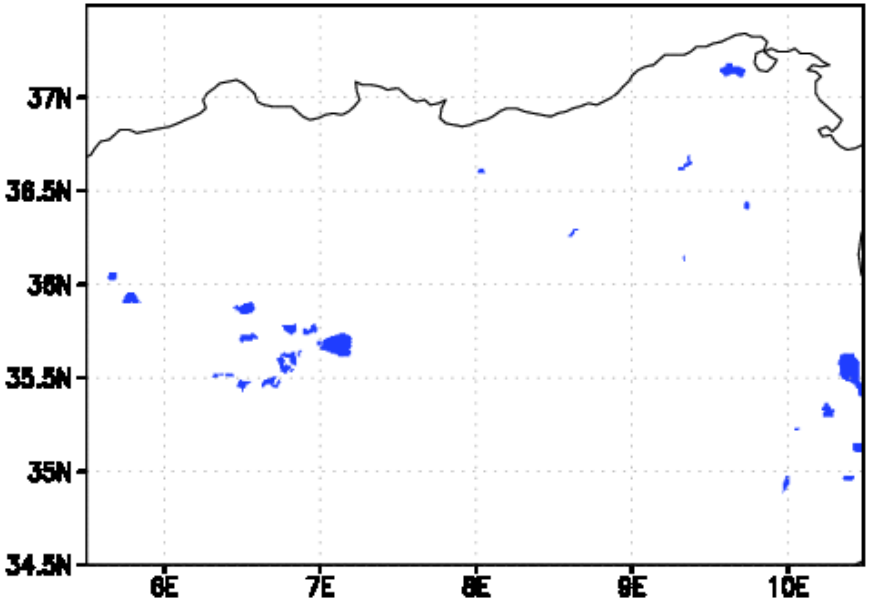


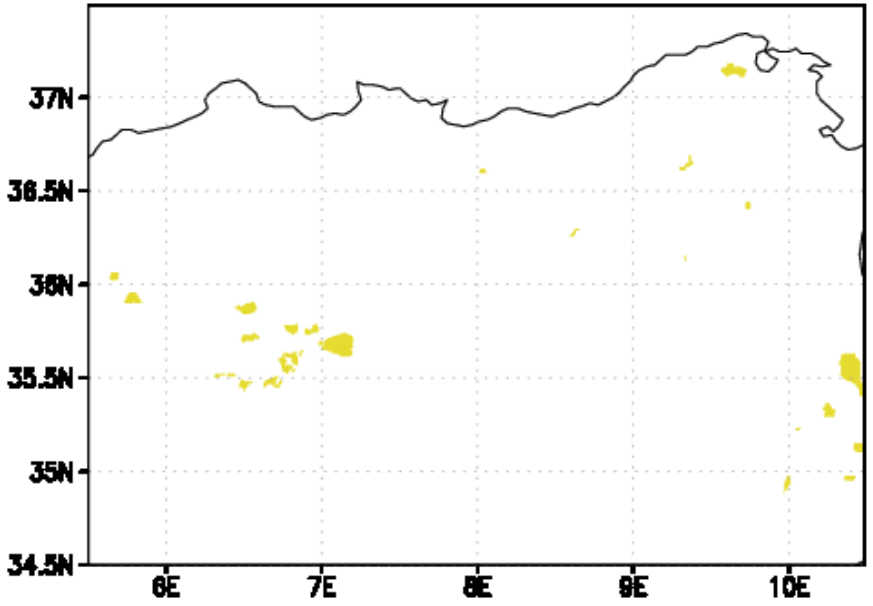
Comparison of GLDBv2 and GLDBv3: **GLDBv3** – surroundings of lake Victoria

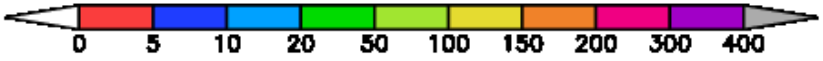




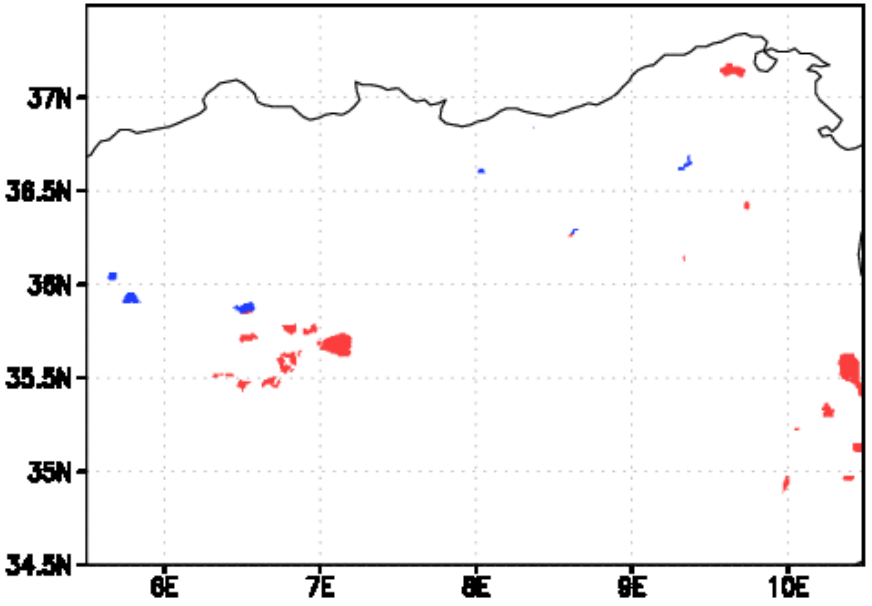
Comparison of GLDBv2 and GLDBv3: **GLDBv2** – Algeria, Tunisia

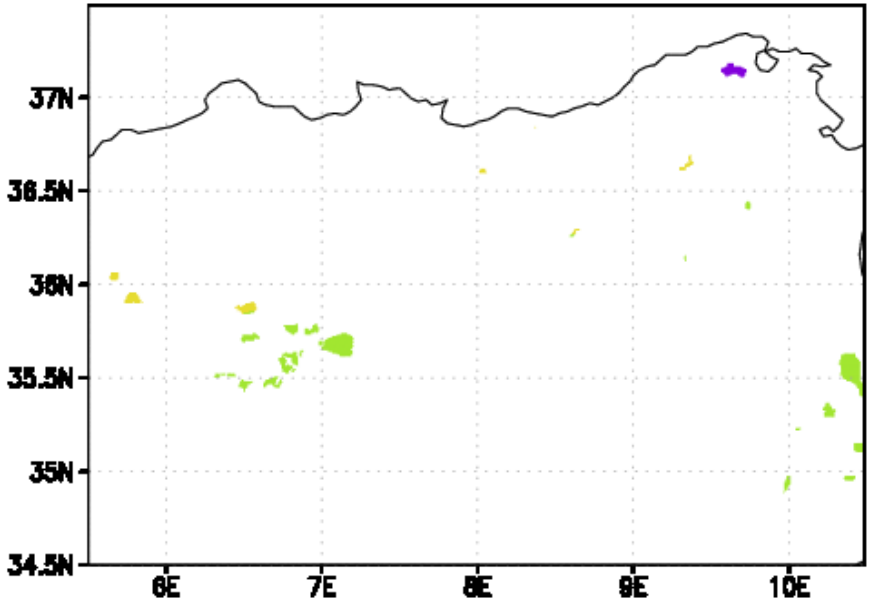


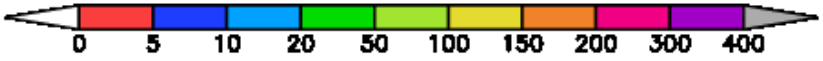




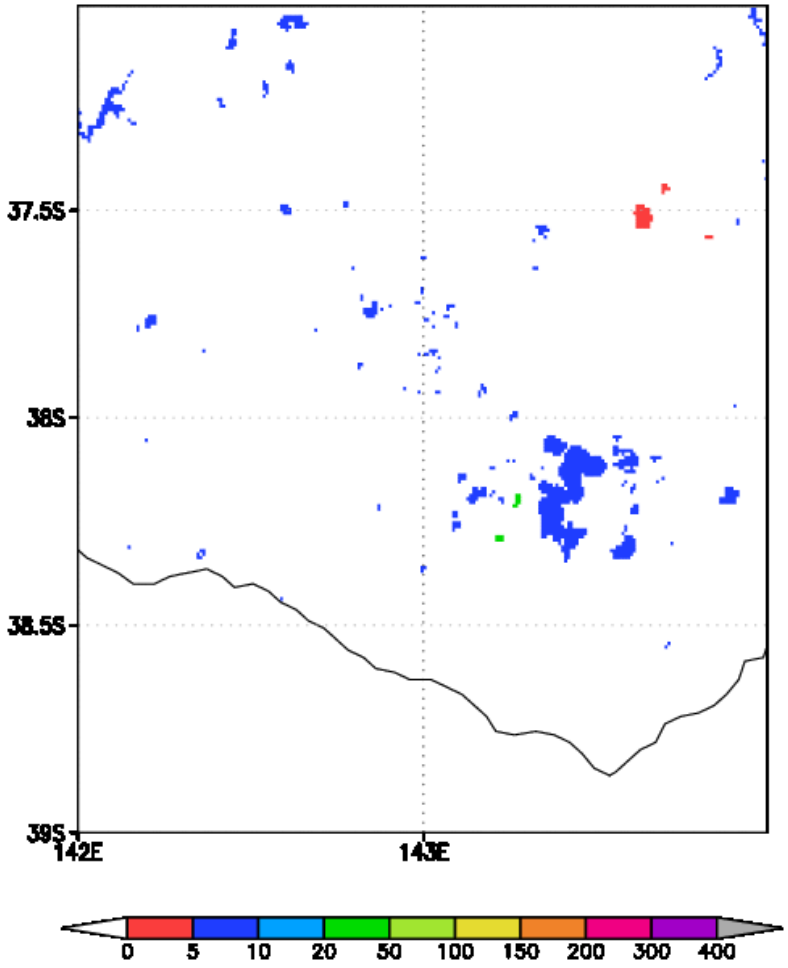
Comparison of GLDBv2 and GLDBv3: **GLDBv3** – Algeria, Tunisia

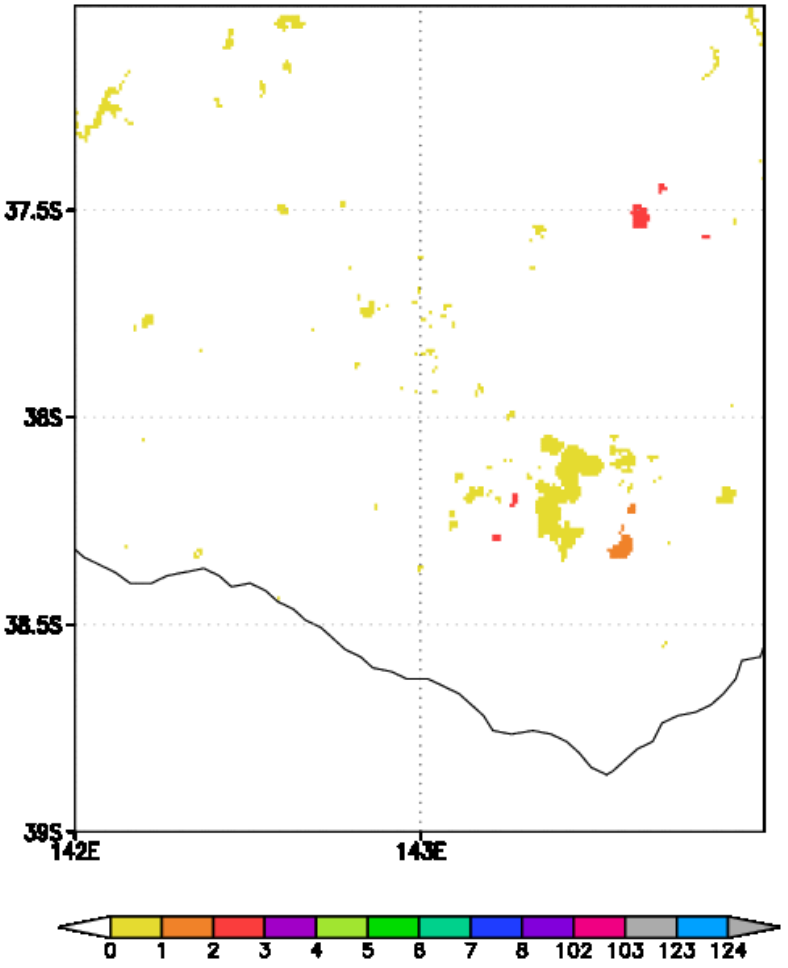




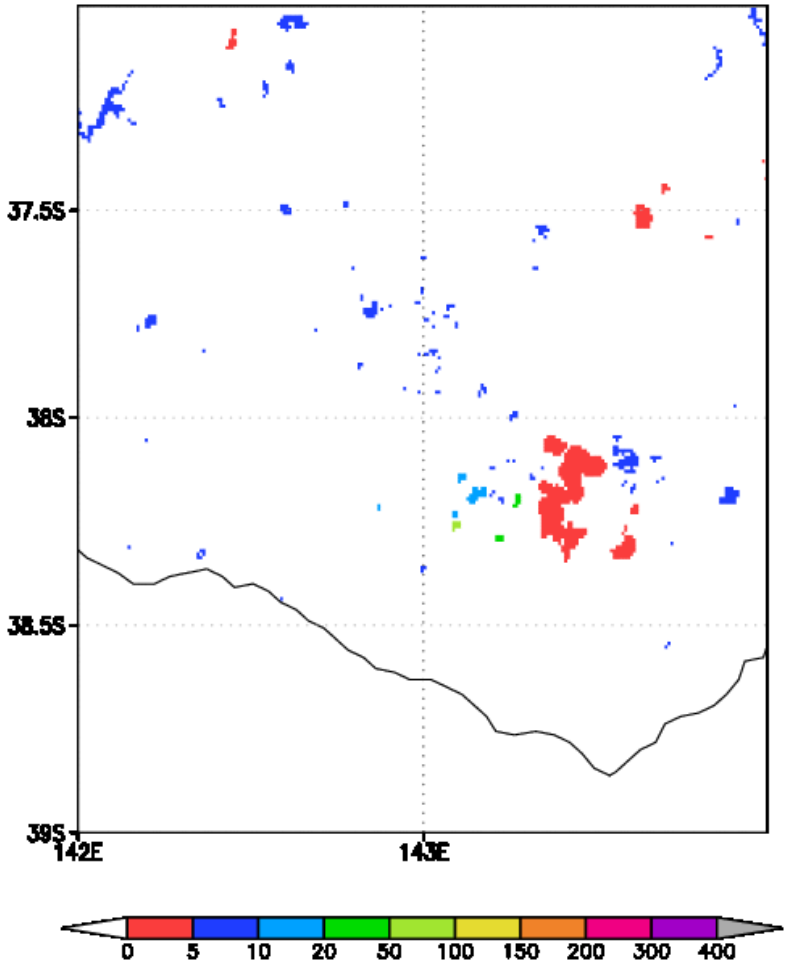


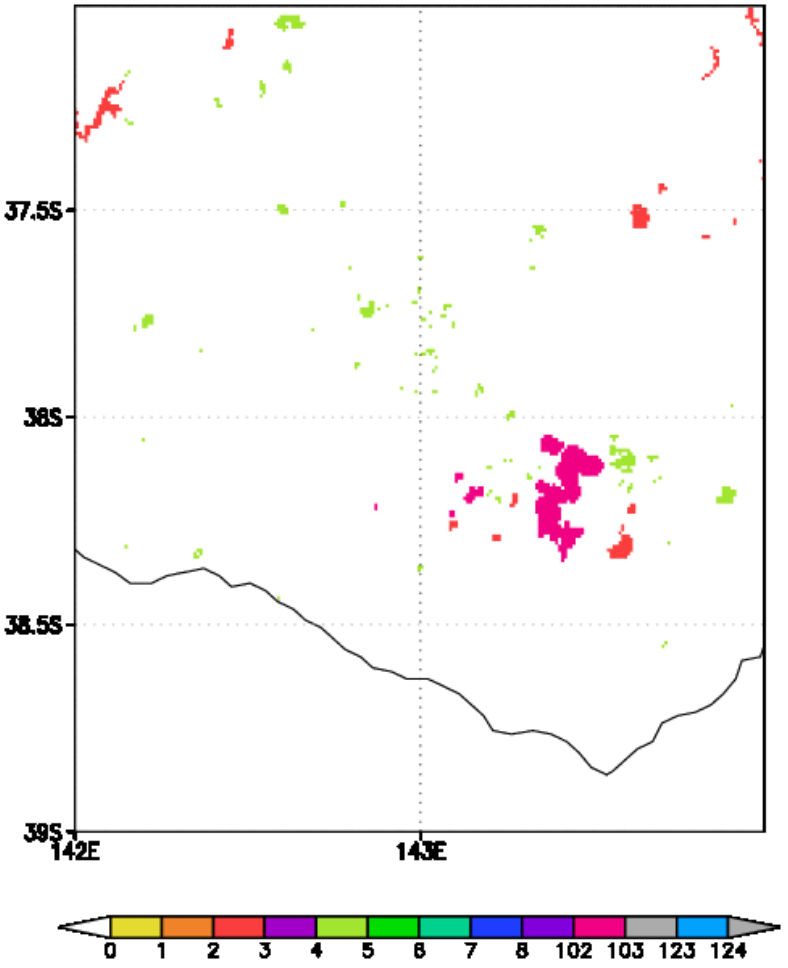
Comparison of GLDBv2 and GLDBv3: **GLDBv2** – South Africa



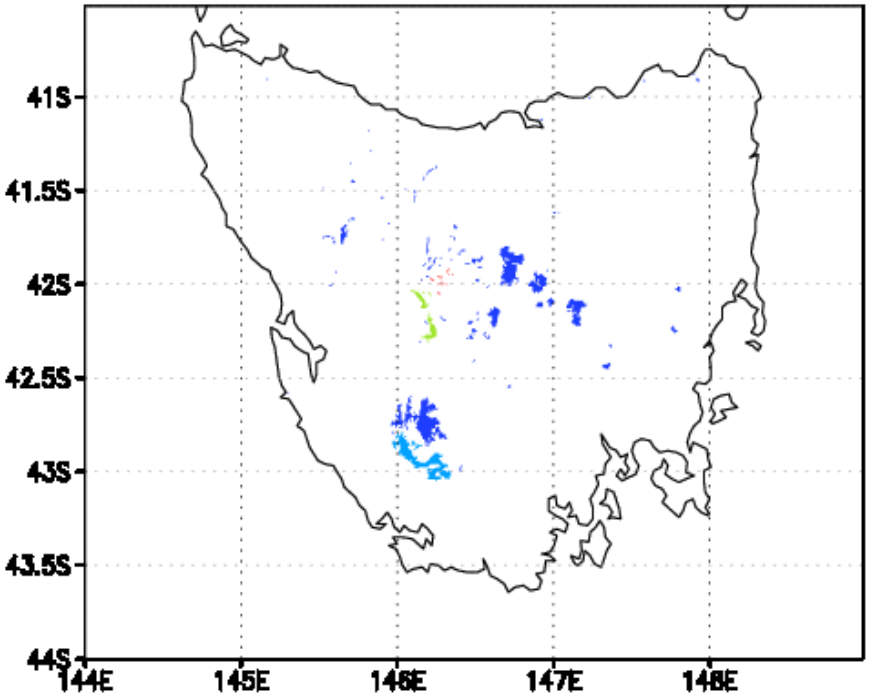


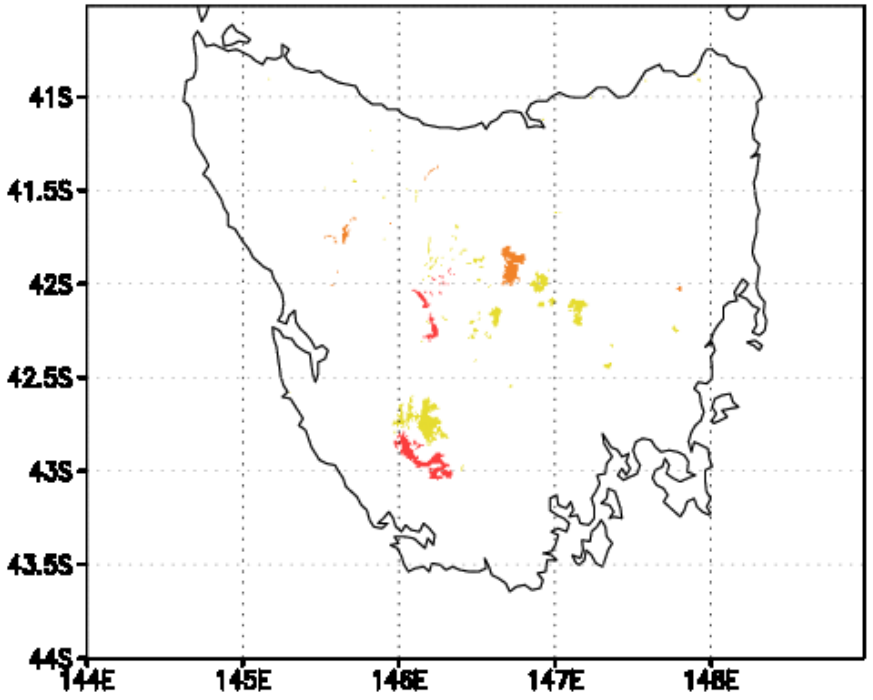
Comparison of GLDBv2 and GLDBv3: **GLDBv3** – South Africa

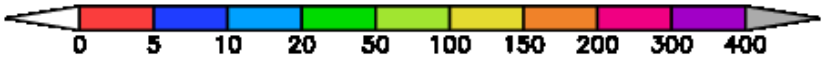




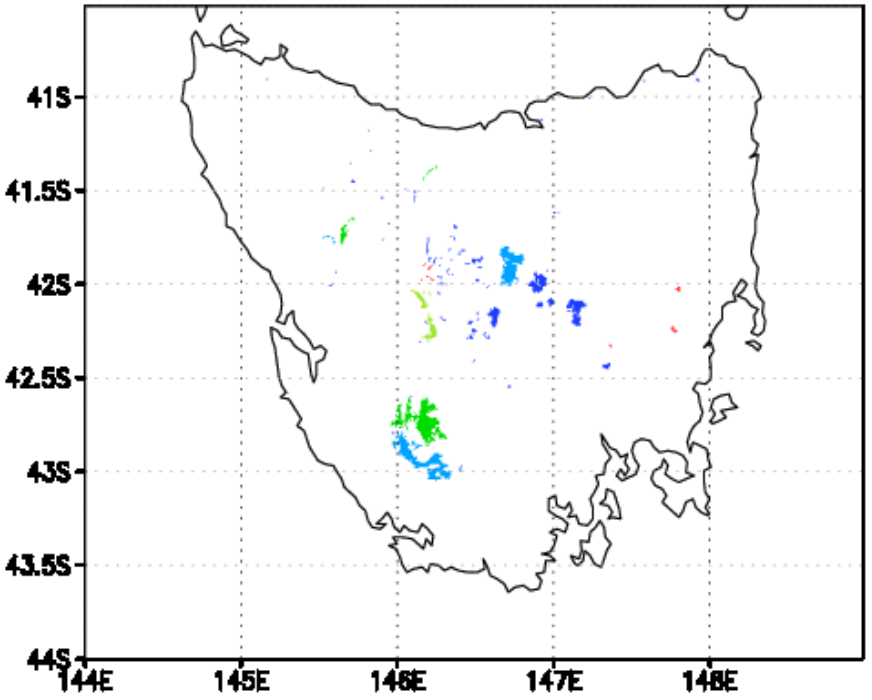
Comparison of GLDBv2 and GLDBv3: **GLDBv2** – Tasmania

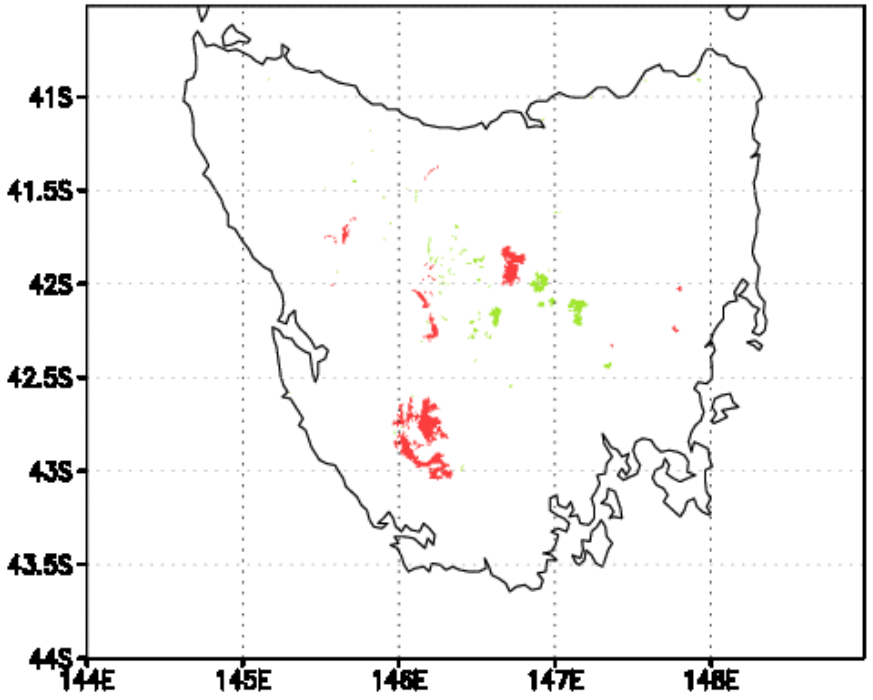


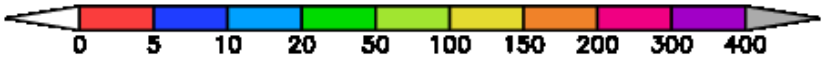




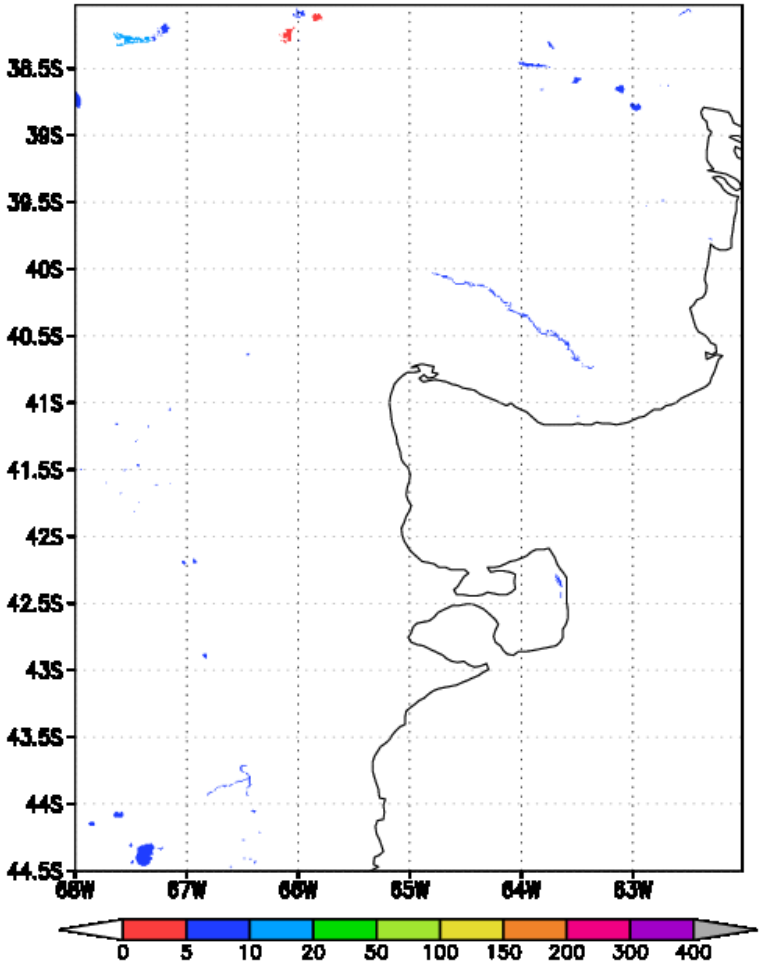
Comparison of GLDBv2 and GLDBv3: **GLDBv3** – Tasmania

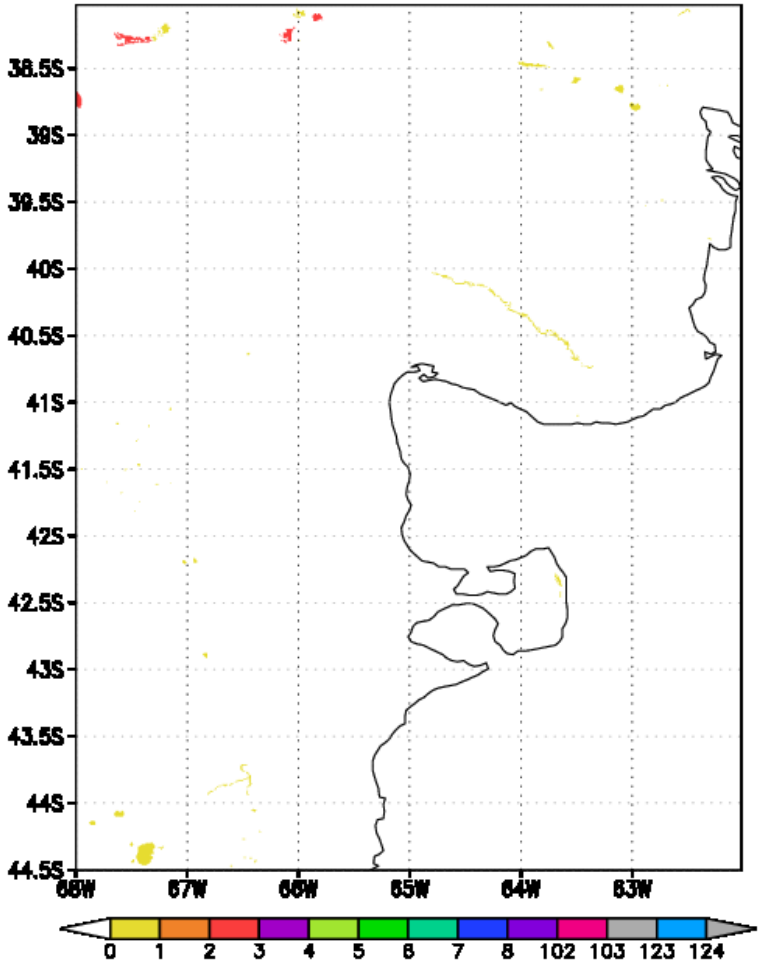




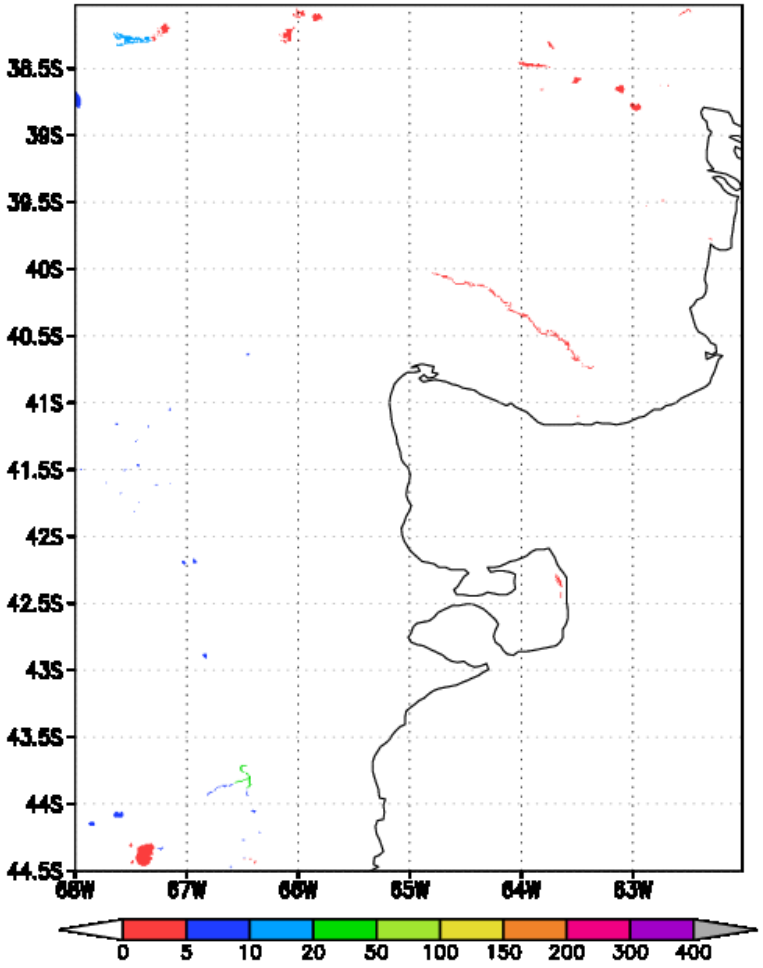


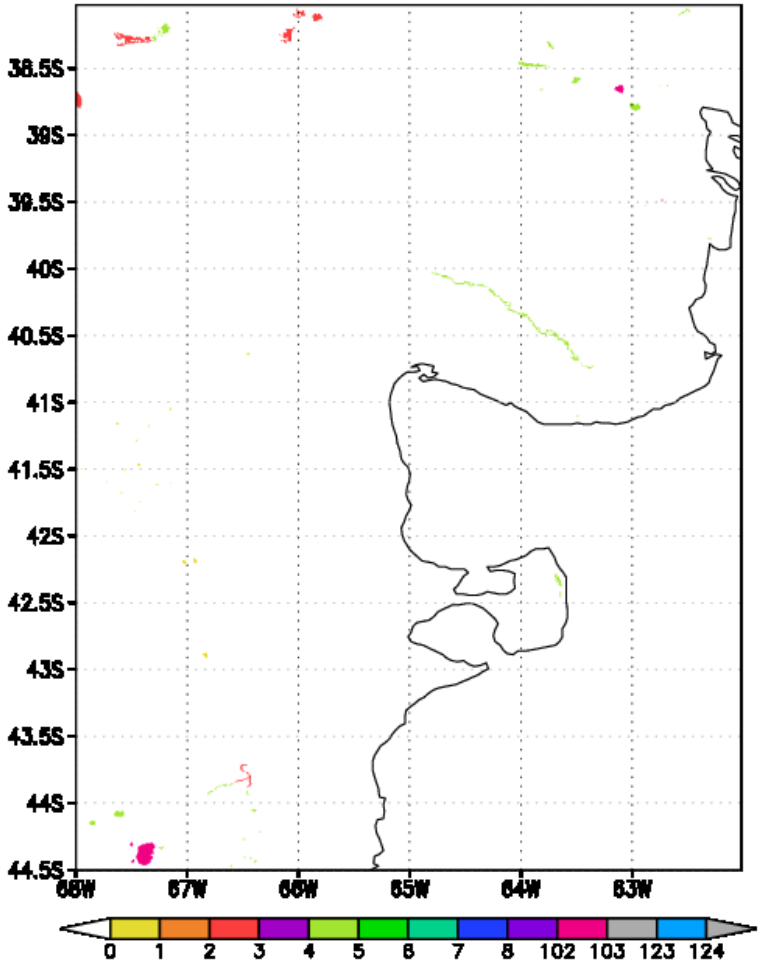
Comparison of GLDBv2 and GLDBv3: **GLDBv2** – Argentina





Comparison of GLDBv2 and GLDBv3: **GLDBv3** – Argentina



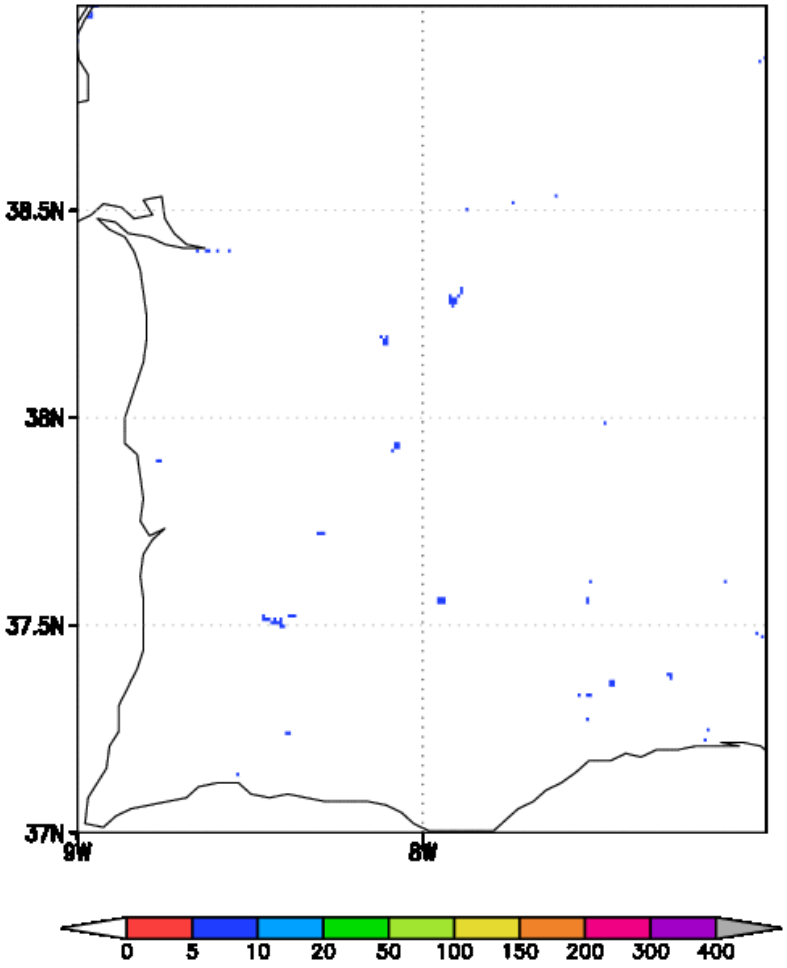


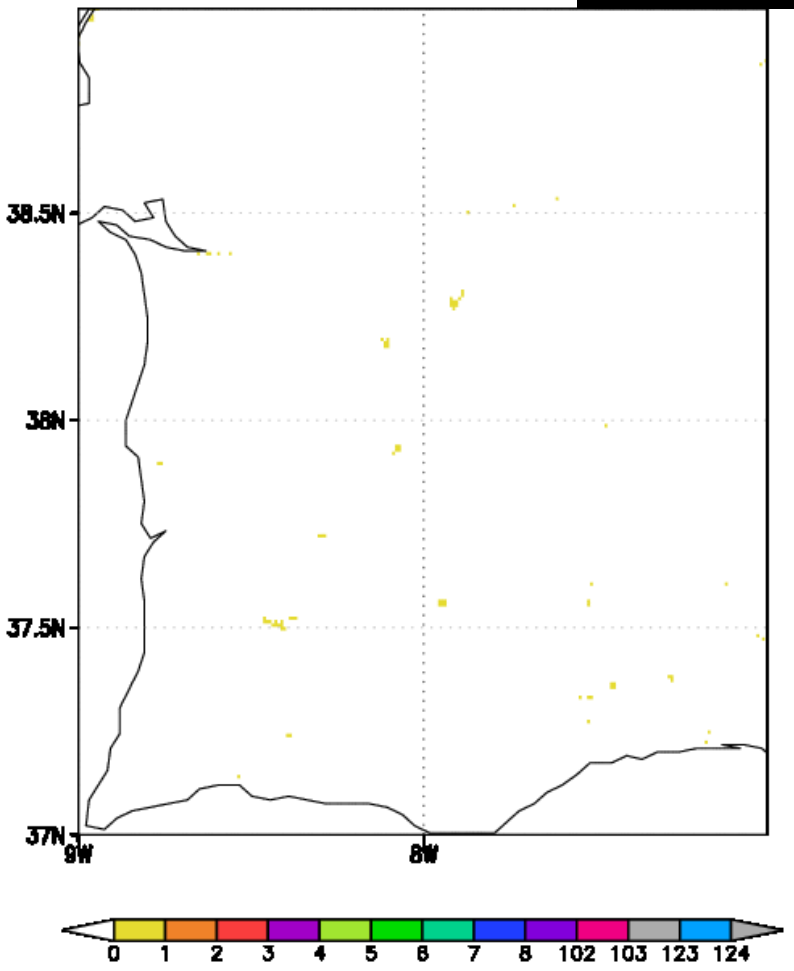
Conclusions & Future plans

- Work on adaptation GLDB to the much higher resolution land cover map (GLOBCOVER) is in progress.
- Constant update of the GLDB with mean depth data for individual lakes.
- Adding bathymetry data for large lakes.
- Adding data for reservoirs and salt lakes.

Alqueva reservoir: **GLDBv2**

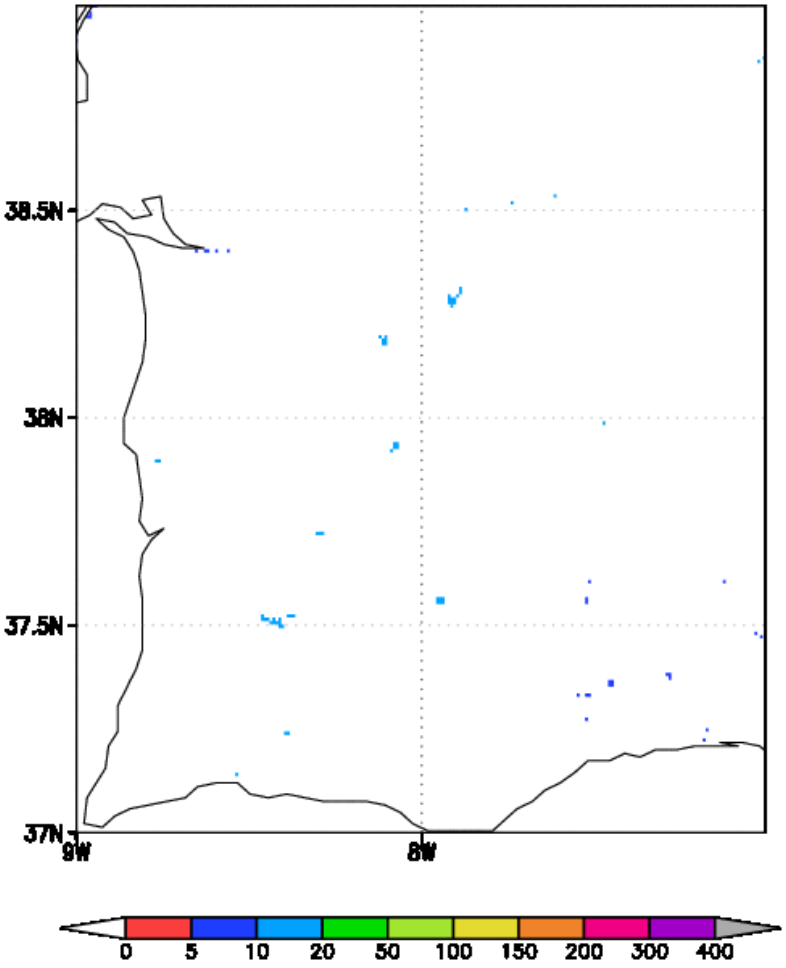
mean depth = 12.6 meters; surface area = 250.0 km^2

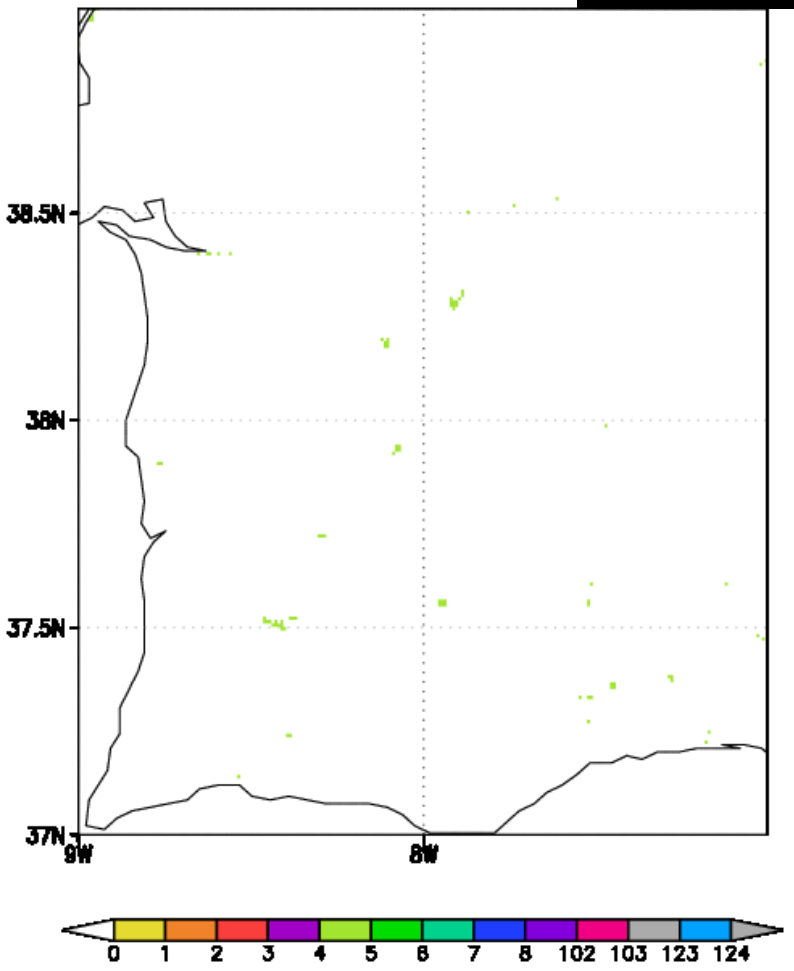




Alqueva reservoir: **GLDBv3**

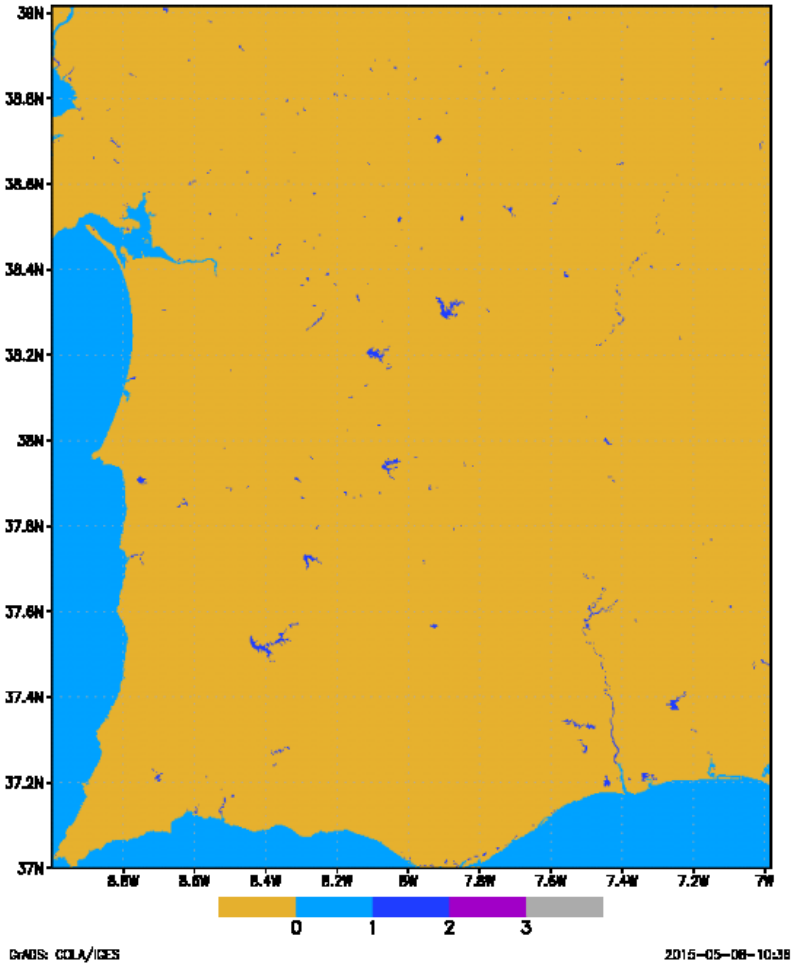
mean depth = 12.6 meters; surface area = 250.0 km^2

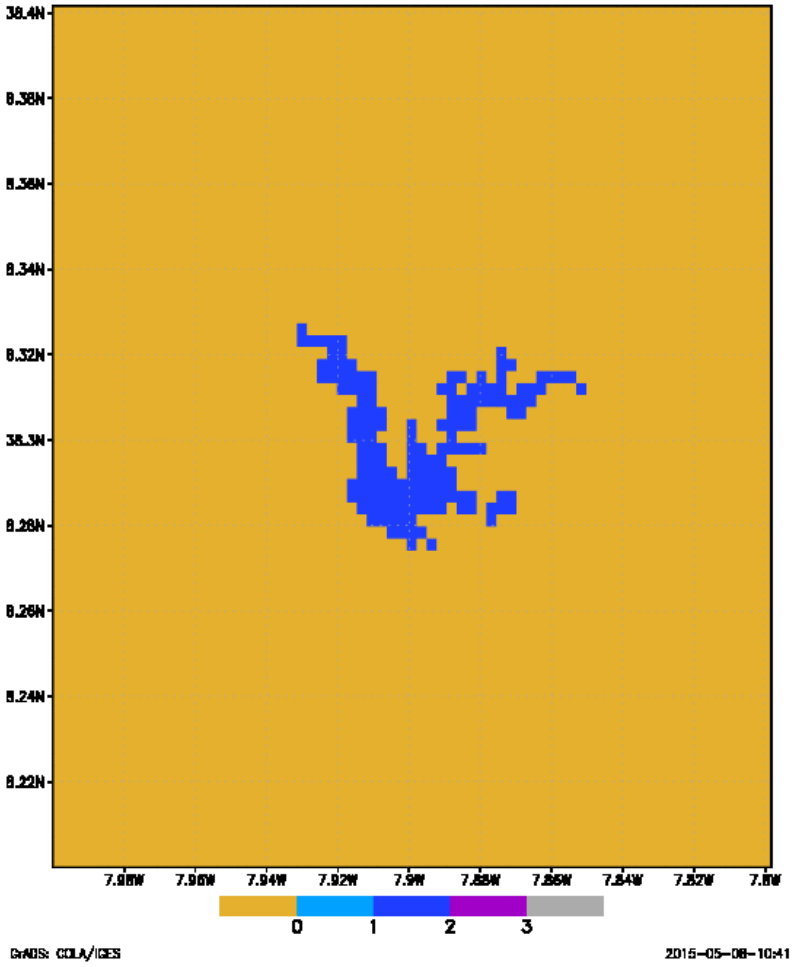




Alqueva reservoir: **GlobCover2009**

mean depth = 12.6 meters; surface area = 250.0 km^2





Thank you for your attention! Questions?