Finalizing circa-2000 Landsat global lake database and initiating circa-2015 lake mapping using Landsat-8

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Objectives

- ☑ To produce decadal high-resolution systematic global lake products using:
  - Circa-2000 Landsat-7 ETM+ images;
  - Circa-2015 Landsat-8 OLI images.
- ☑ To access lake dynamics at global scales;

- ☑ by mapping:
  - Millions of lakes (>0.5 ha) at 30 m resolution;
  - ~30,000 Landsat scenes acquired at appropriate seasons.

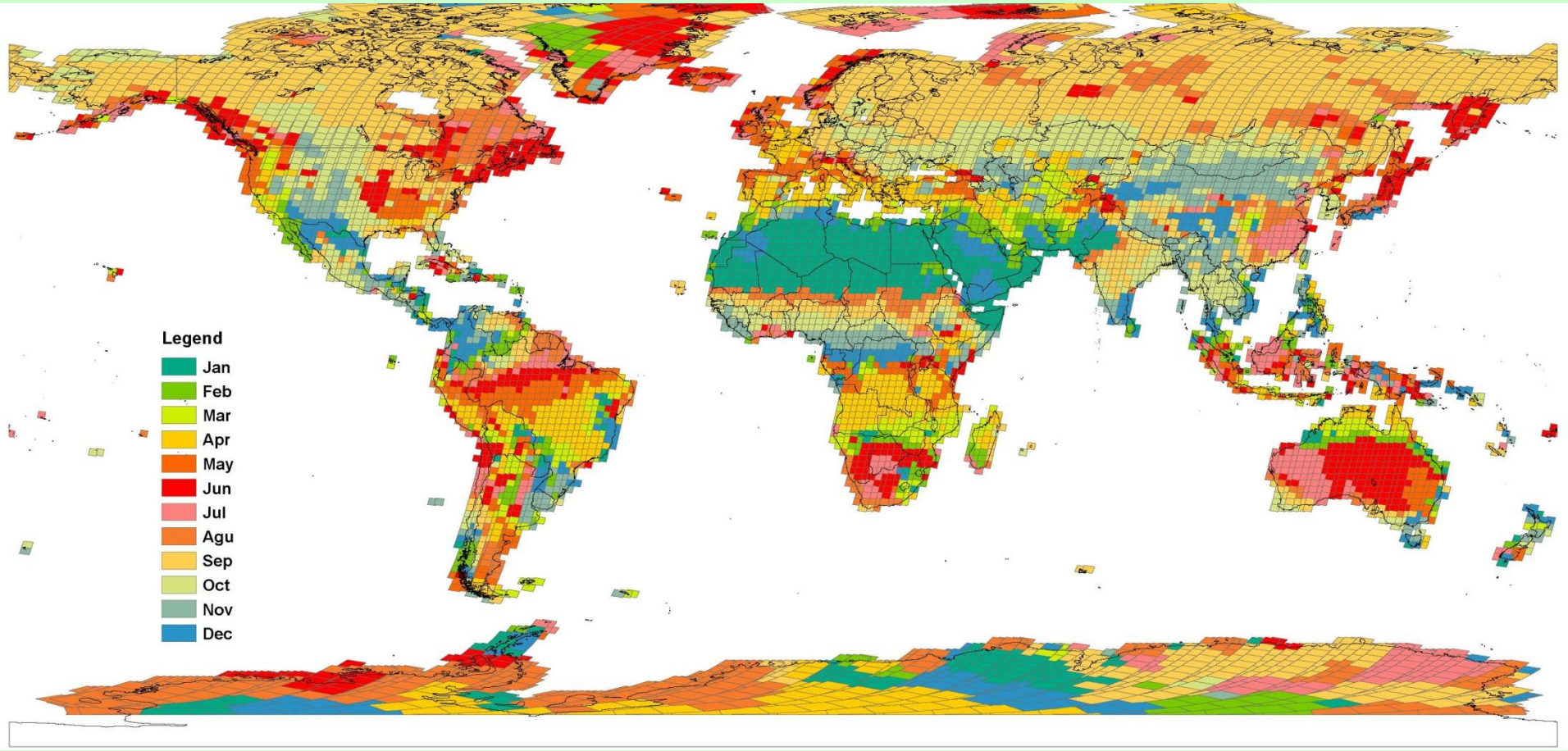
Current Status of Global Lake Inventory

- ☑ Meybeck (1995) estimation:
  - 1.25 M lakes (>10 ha) in 2.6 M km^2;
  - 7.2 M lakes (1-10 ha) in 0.2 M km^2.
- ☑ Downing (2006) projection:
  - 304 million lakes and ponds in ~4.2 M km^2.
- ☑ McDonald (2012) projection:
  - 64 million lakes (> 0.1 ha) in ~3.8 M km^2.
- ☑ GLWD (Lehner and Doll, 2004):
  - 0.25 M lakes (>10 ha);
- ☑ SWBD (SRTM Water Body, 2003):
  - 0.58 M lakes (>600m x 183m = 11 ha);
  - 56°S – 60°N;
- ☑ GLOWABO (Verpoorter et al, 2014):
  - 117 M lakes (> 0.2 ha) in 5 M km^2;
  - 27 M lakes (> 1 ha) in 4.76 M km^2.

Challenges to Remote Sensing of Global Lake Dynamics

- ☑ Characteristics of lakes:
  - Abundant in small-size classes;
  - Various types of lakes;
  - Variant from season to season;
  - Stable season variant from region to region.
- ☑ Critical issues:
  - Large quantity of high-resolution images!
    - >10,000 scenes of cloud-free Landsat images.
  - Images to be acquired in “appropriate” monitoring season;
  - Robust lake dynamics mapping techniques:
    - Replicability and Automation!
  - QA/QC.

Circa 2000 ETM+ Image Acquisition Time



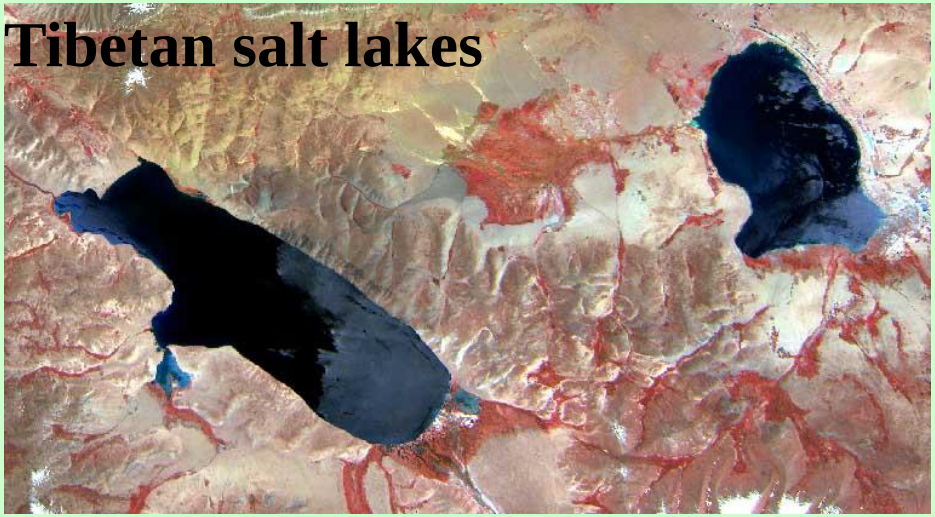
Lake Mapping

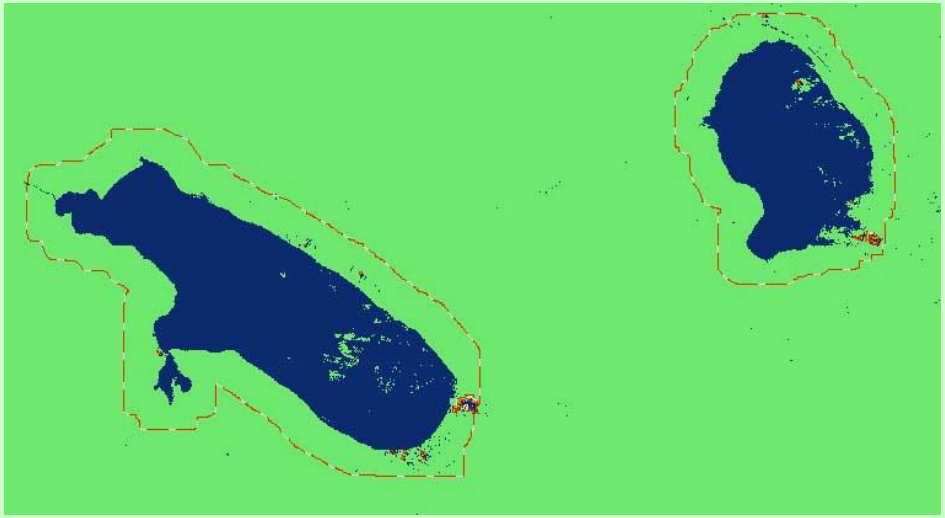
- ☑ Water-body identification in remote sensing:
  - Easy at local scales;
  - Difficult at regional and global scales.

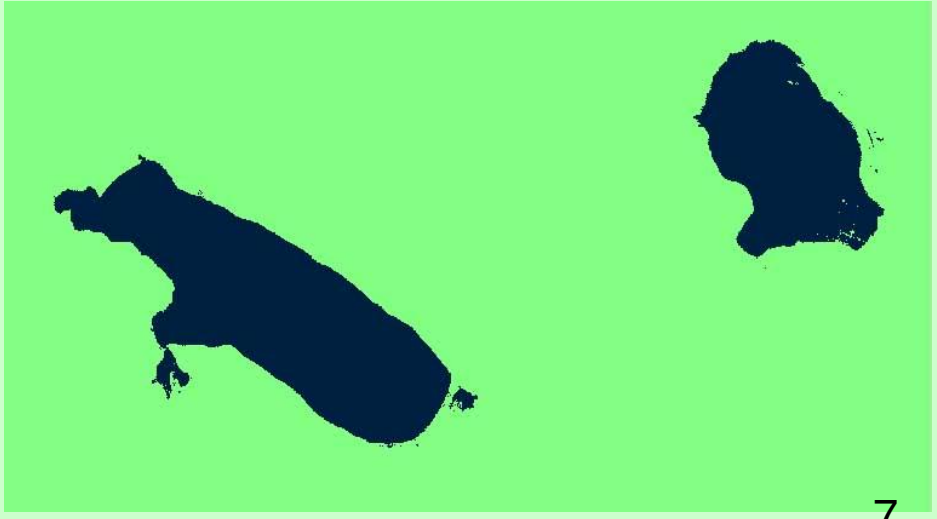
- ☑ Replicability and Automation!

- ☑ Adaptive hierarchical lake mapping approach：
  - Simulating human operator's delineation procedures;
  - Adding and kicking-out mechanisms;
  - Mountain shadow modeling using DEM;
  - … …
  - Tested world wide.

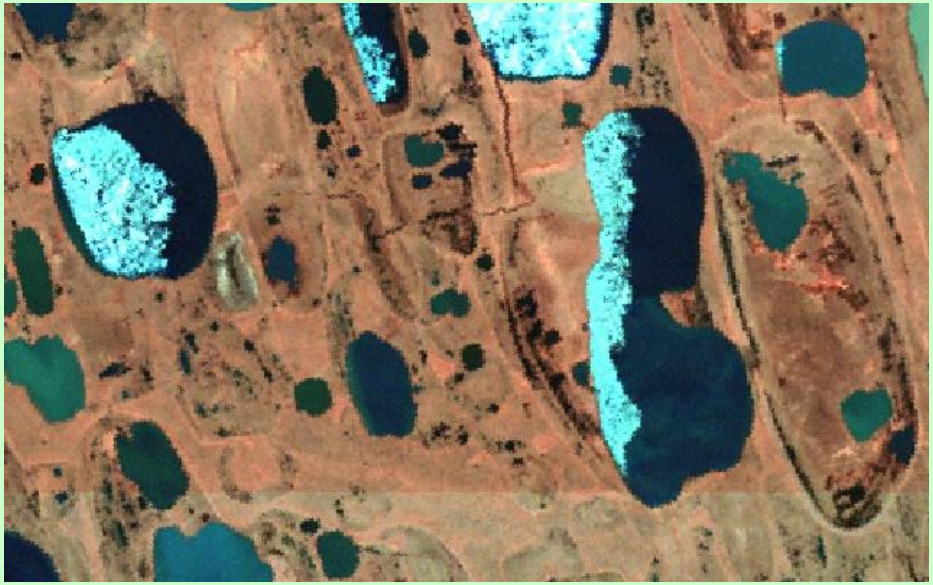
Adaptive Hierarchical Lake Mapping:
Automated and Replicable

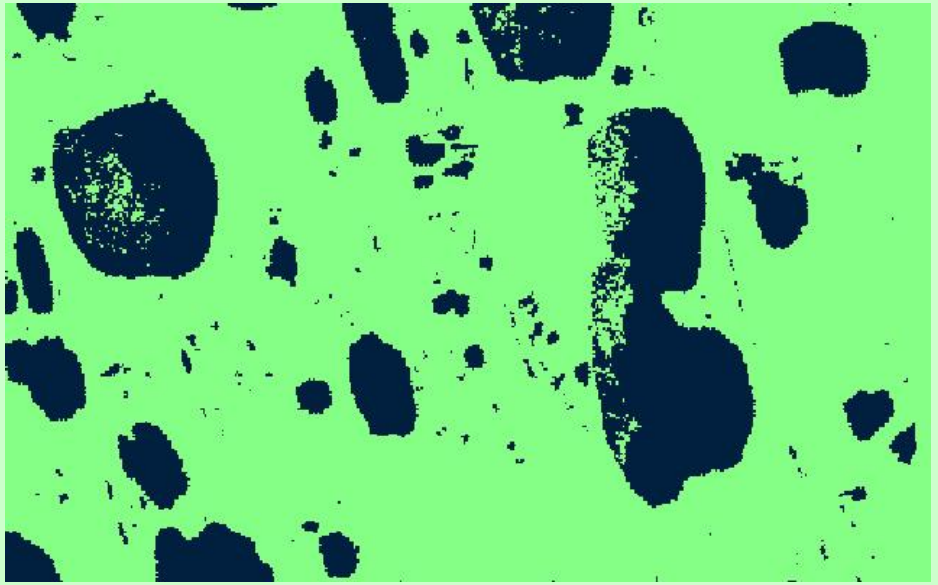


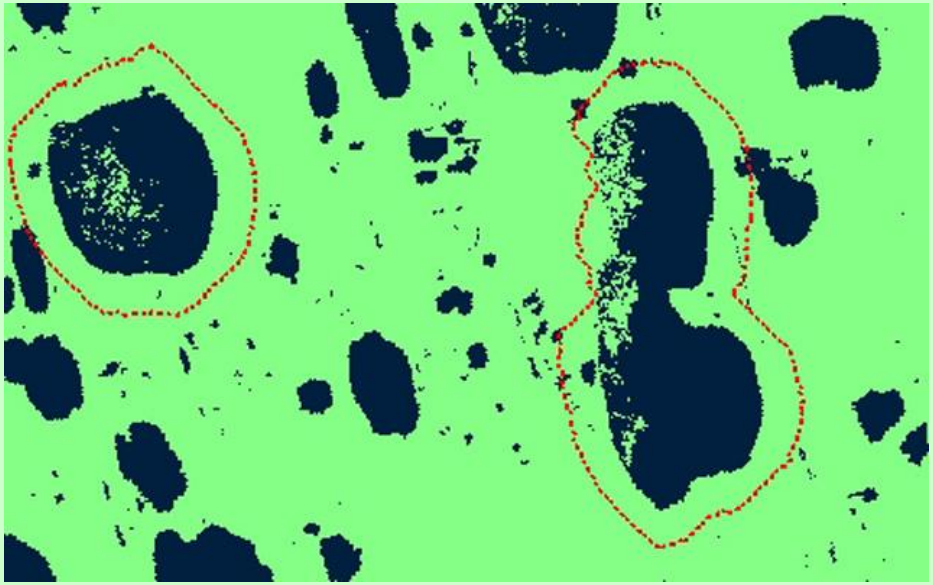


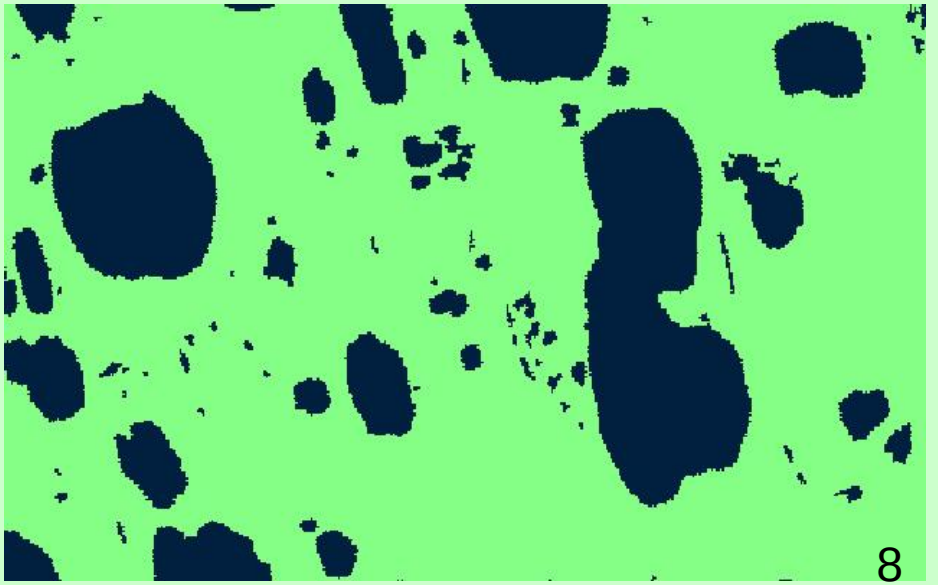


Arctic freshwater lakes







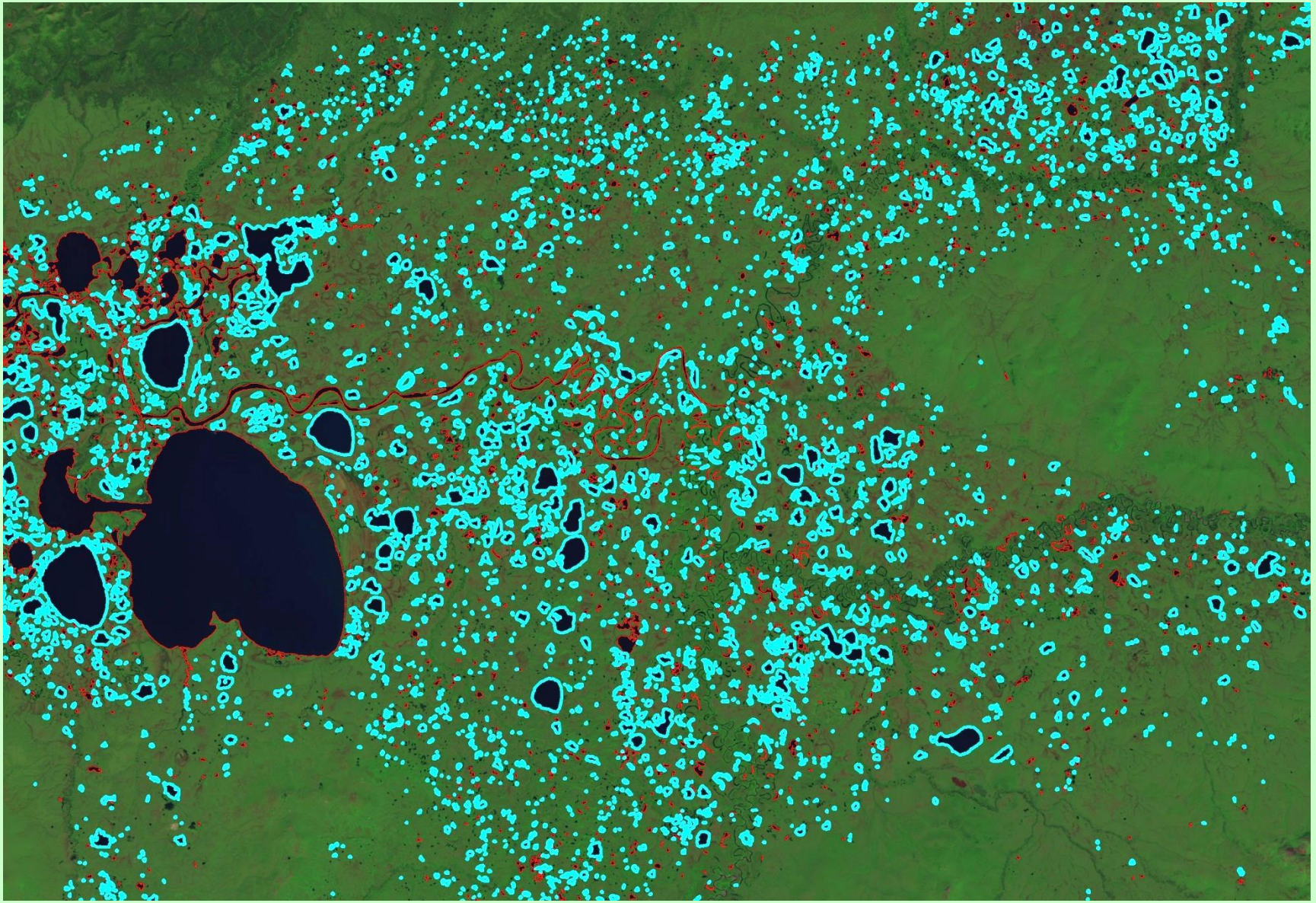


Quality Assurance & Quality Control (QA/QC)

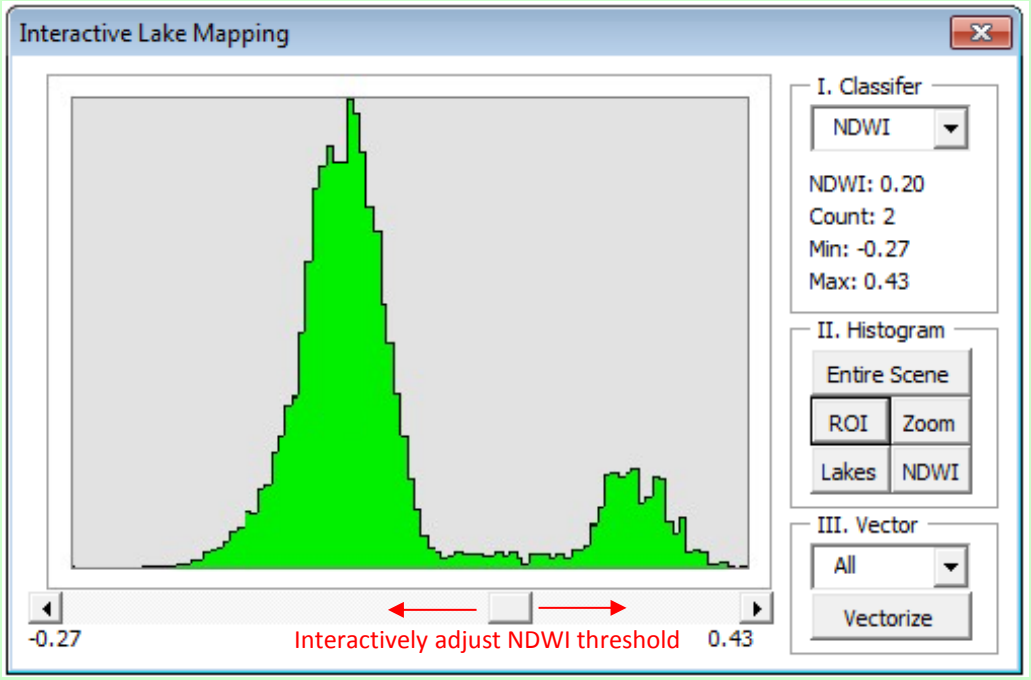
- ☑ Commission and omission errors;
  - Mountain shadows;
  - Cloud contamination;
  - Stream segments;
  - Salt lakes.
- ☑ Inadequately delineated lake boundaries.
- ☑ Super high workloads;
- ☑ **Automation!**
  - Automated QA/QC;
  - Semi-automated tools.

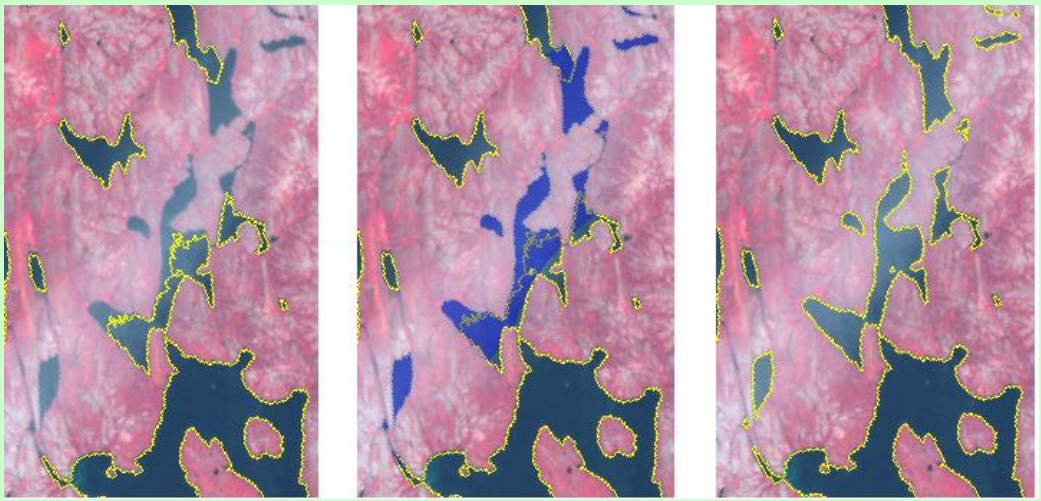
Automated QA

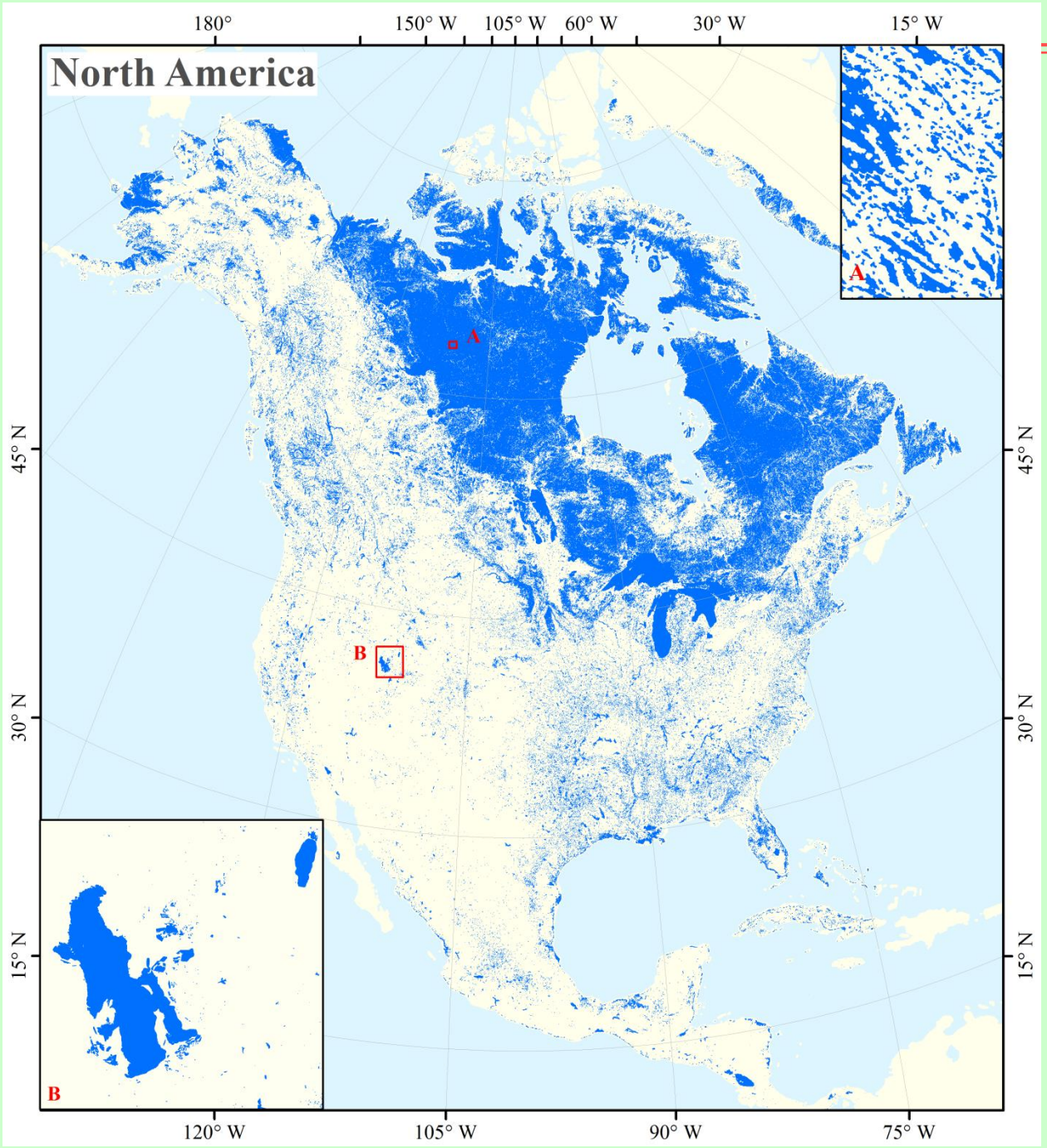
Mapping the Earth twice



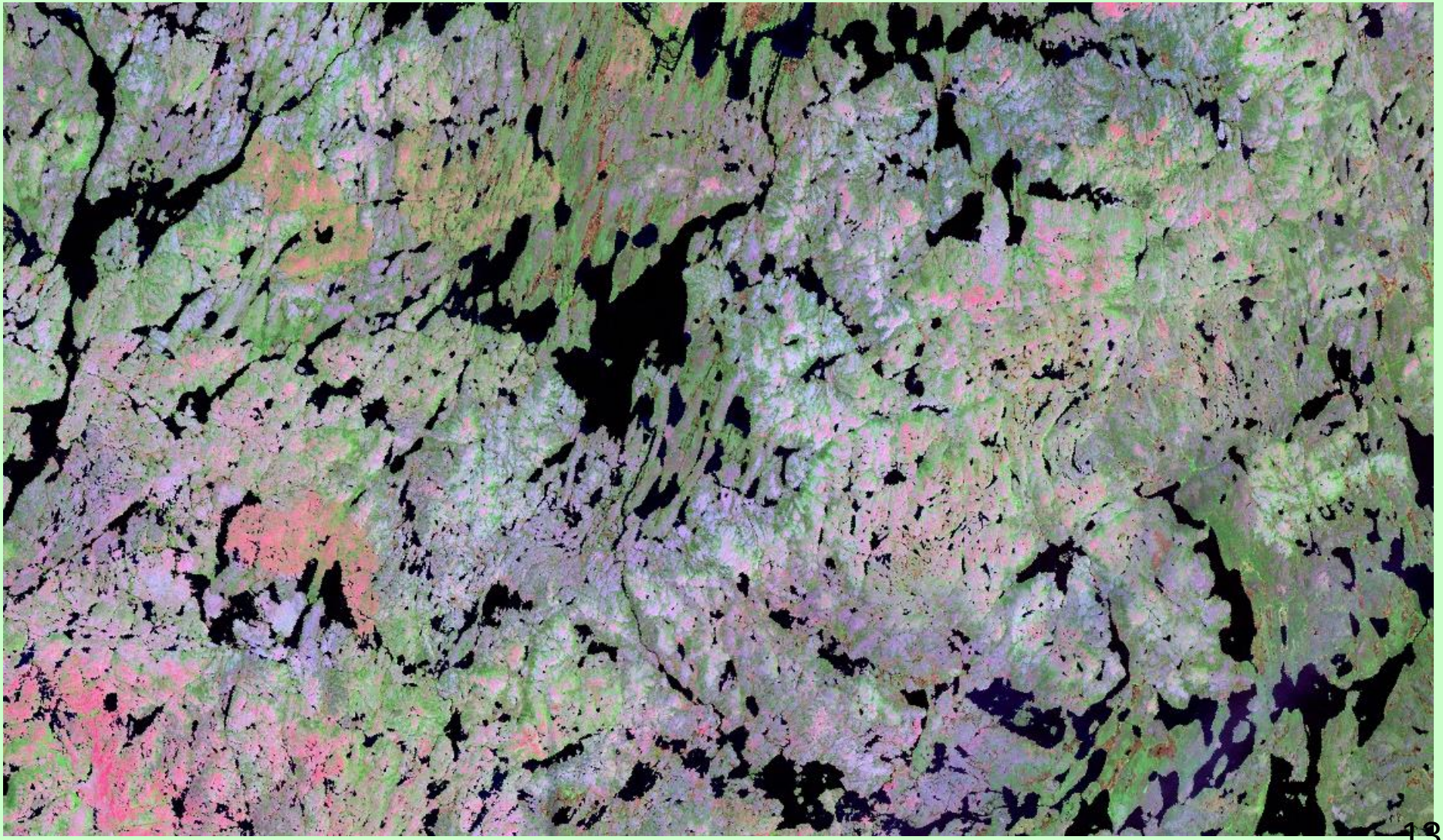
Semi-Automated QC



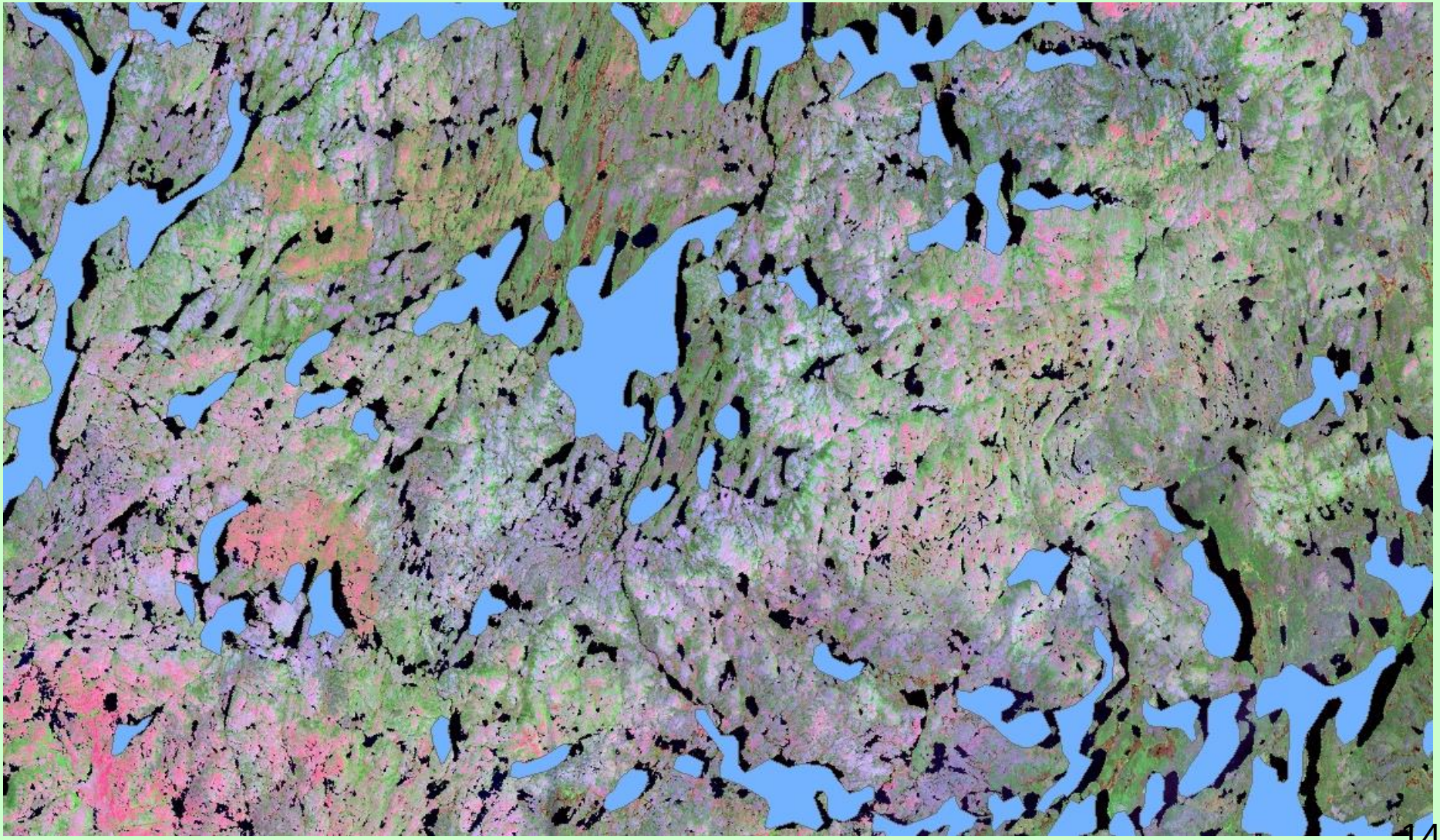



North America
180°
150° W
105° W
60° W
30° W
15° W
45° N
30° N
15° N
120° W
105° W
90° W
75° W
A
B

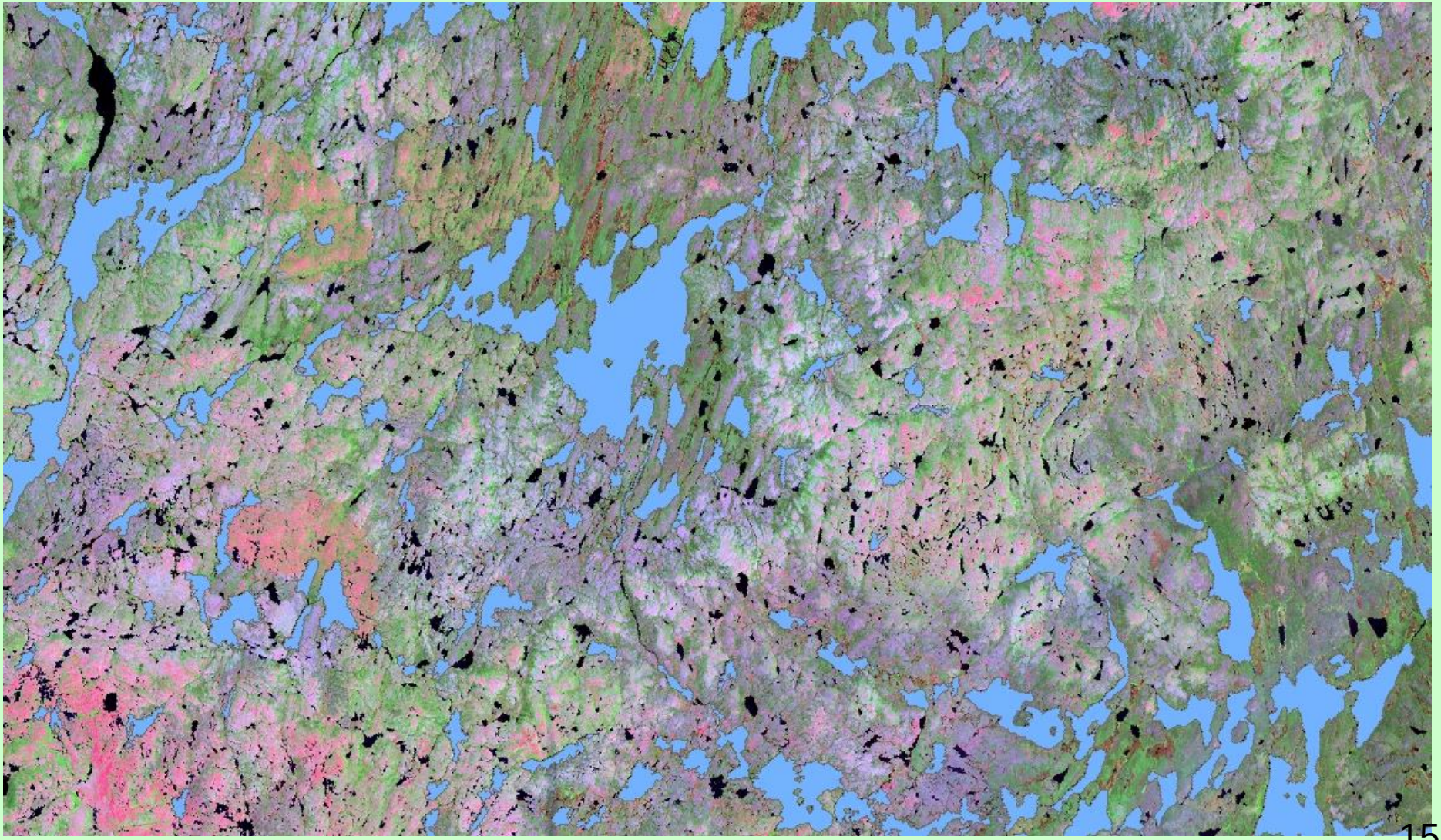
Landsat ETM+ Image (70W, 56N)



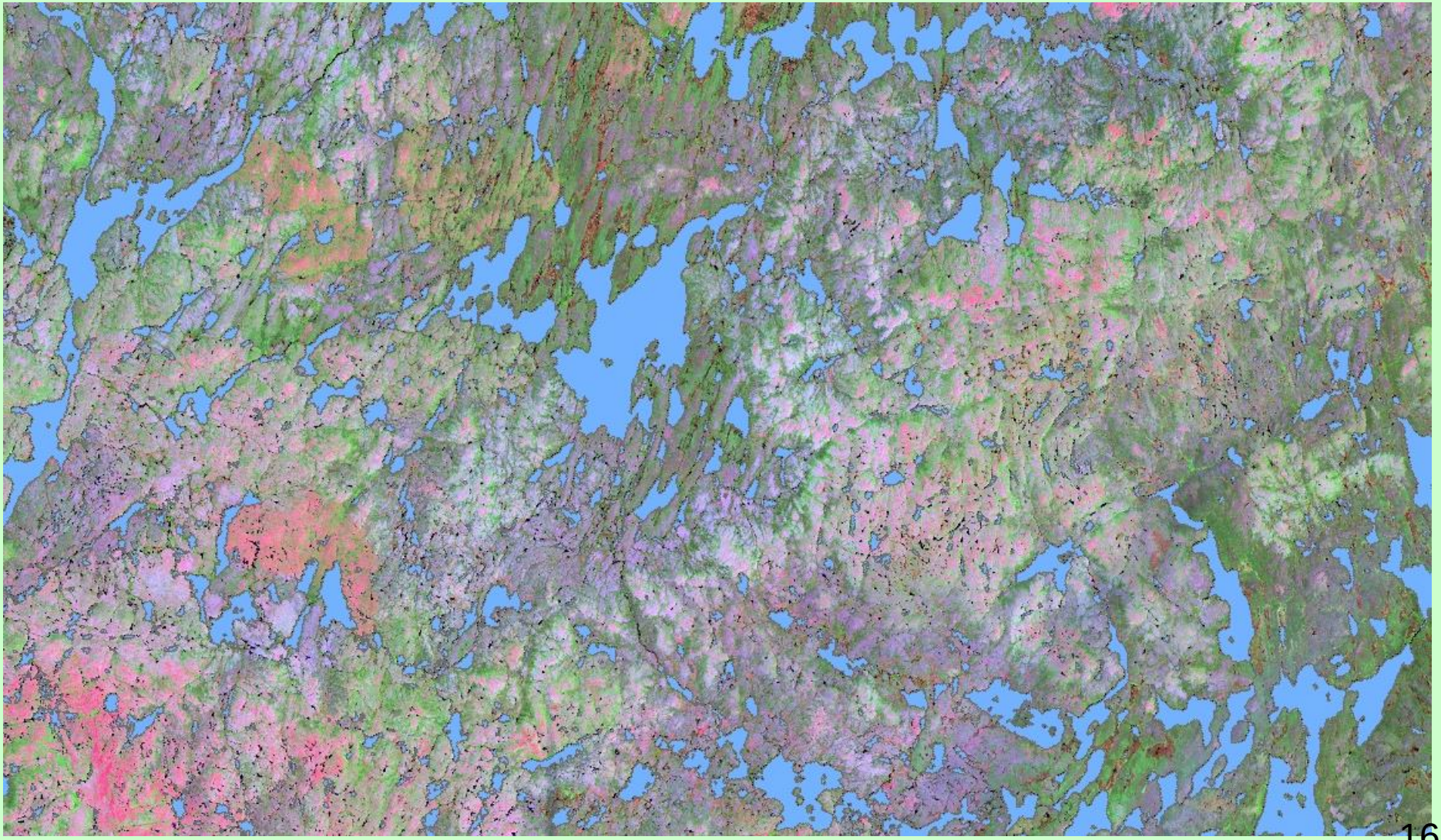
GLWD



SWBD



The Pan-Arctic Product



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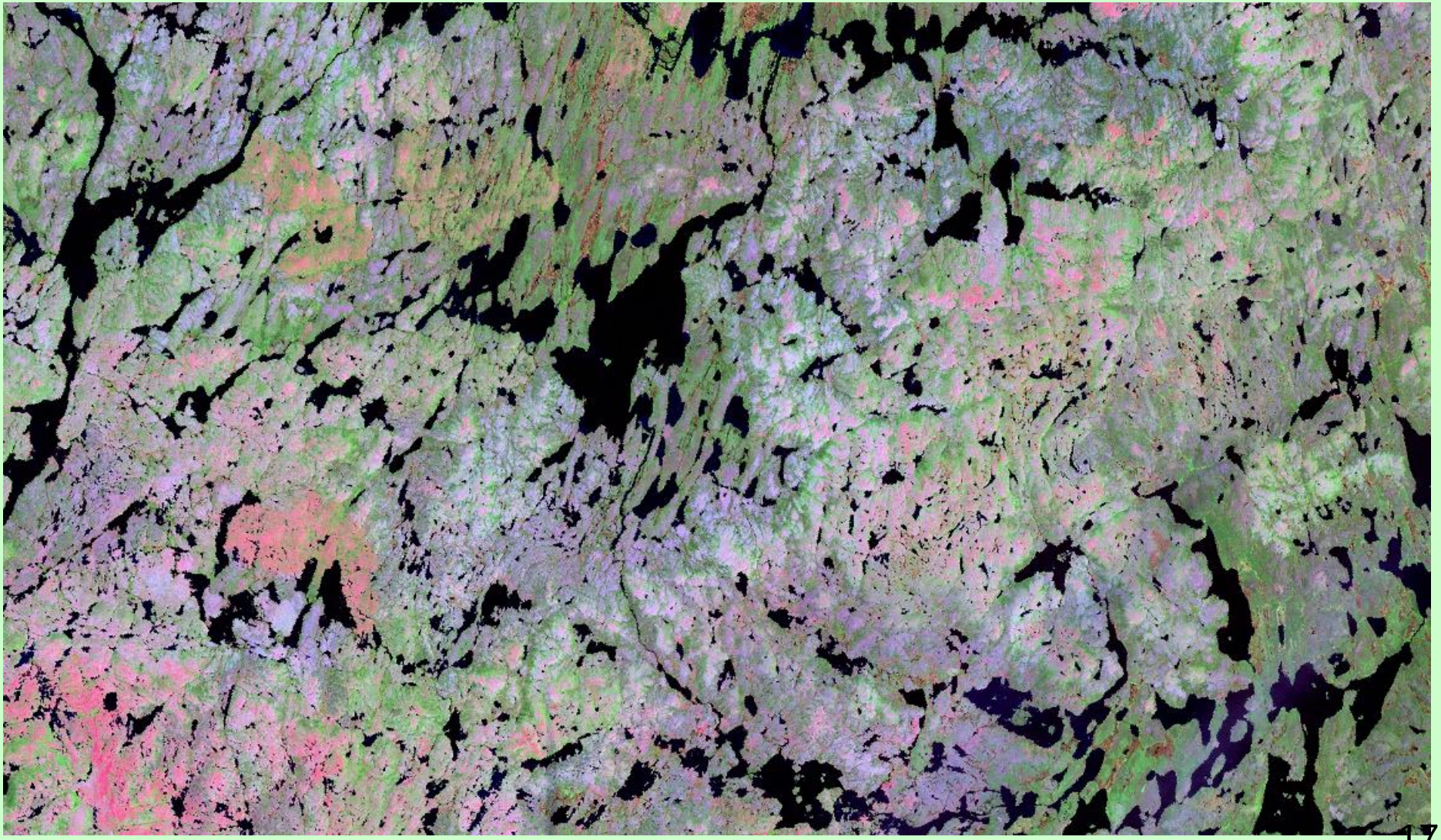
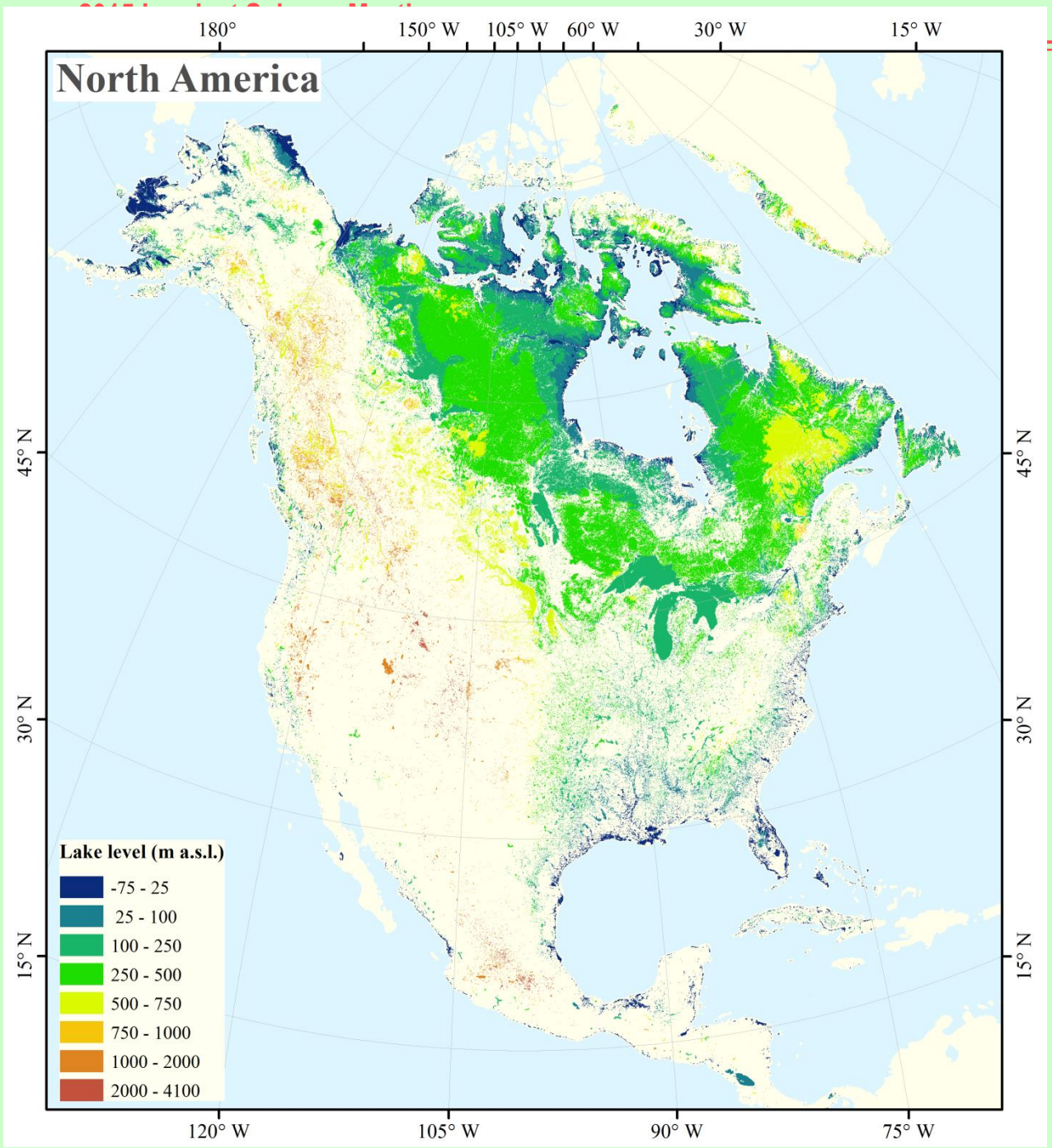
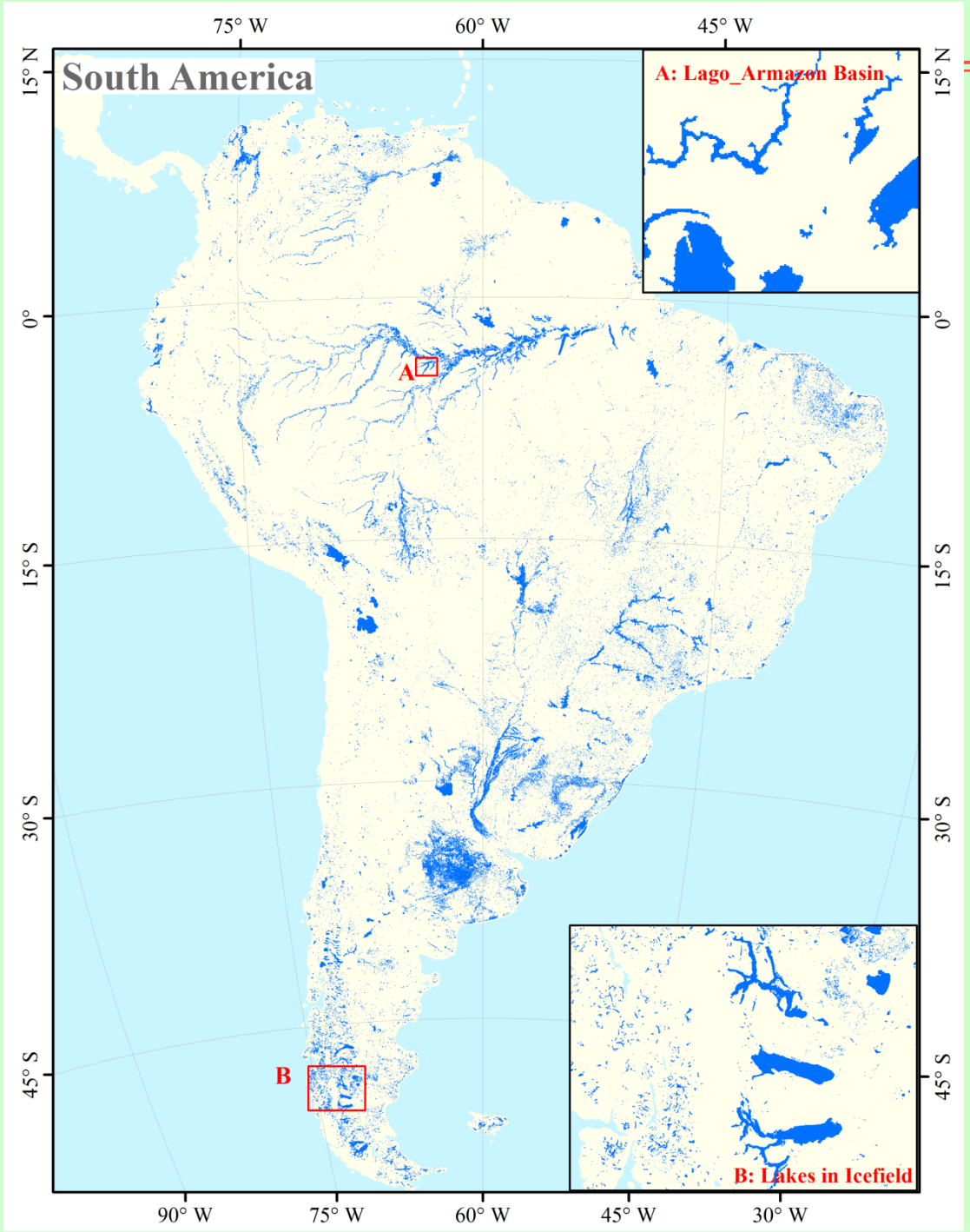
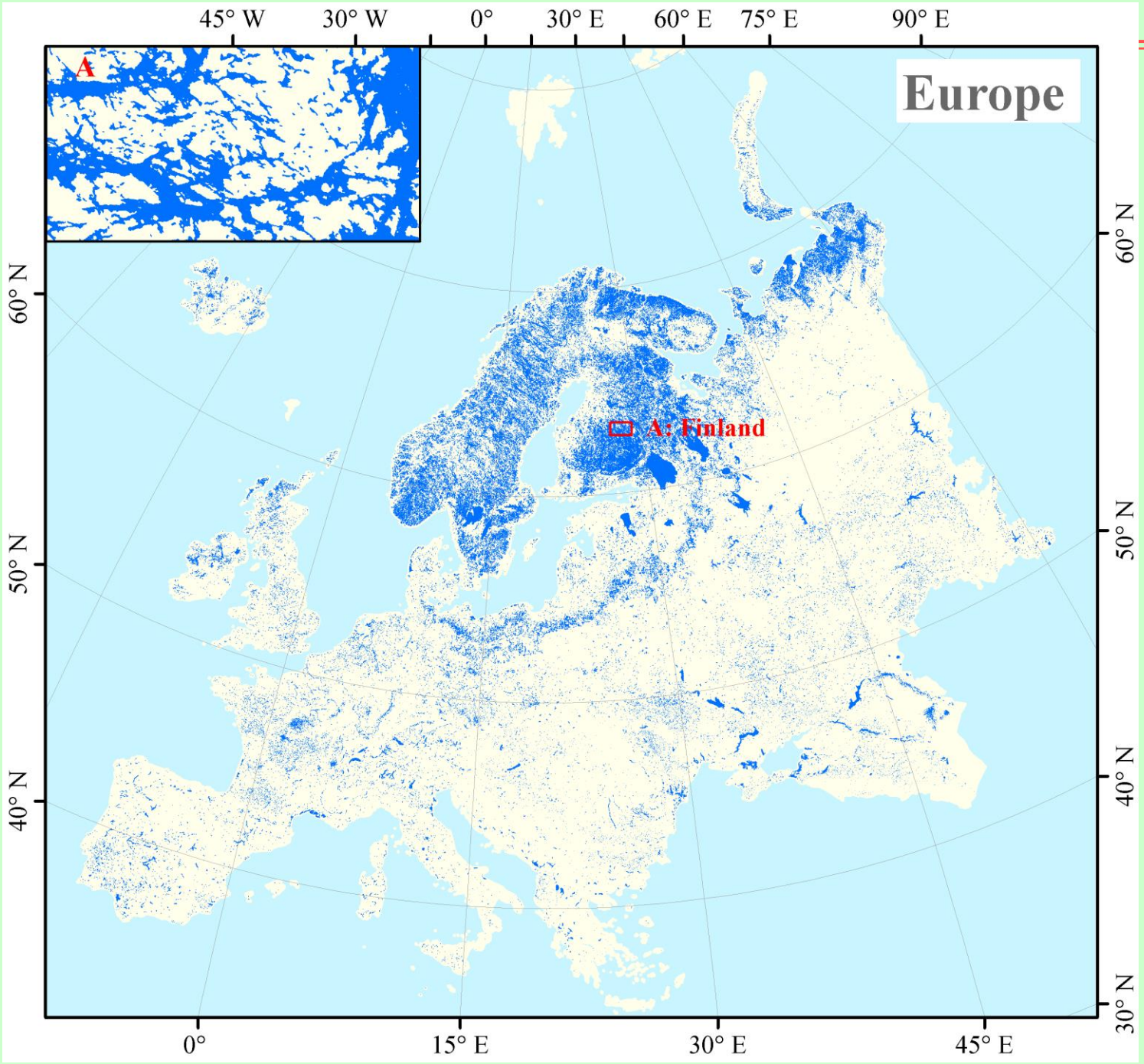
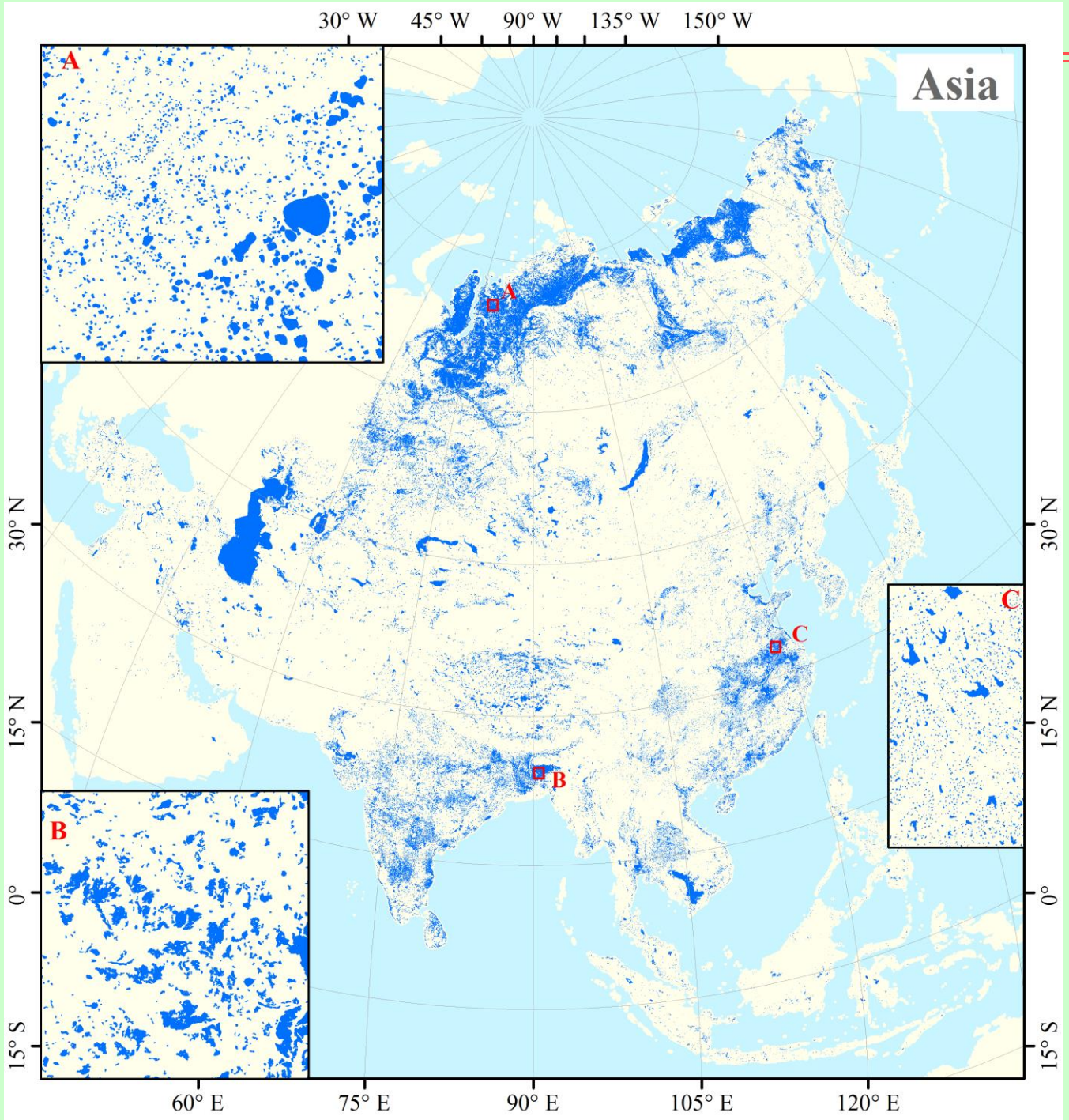
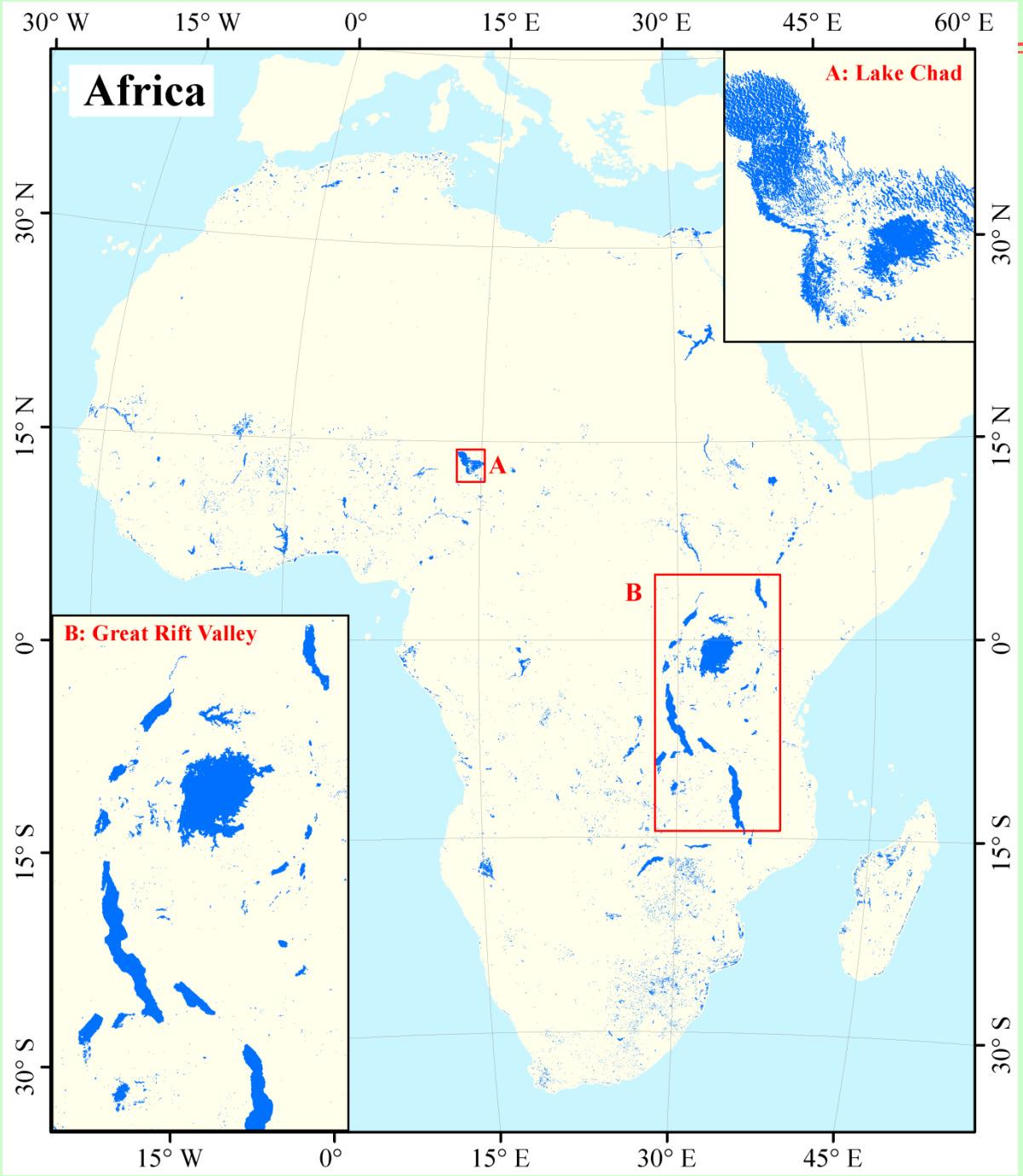


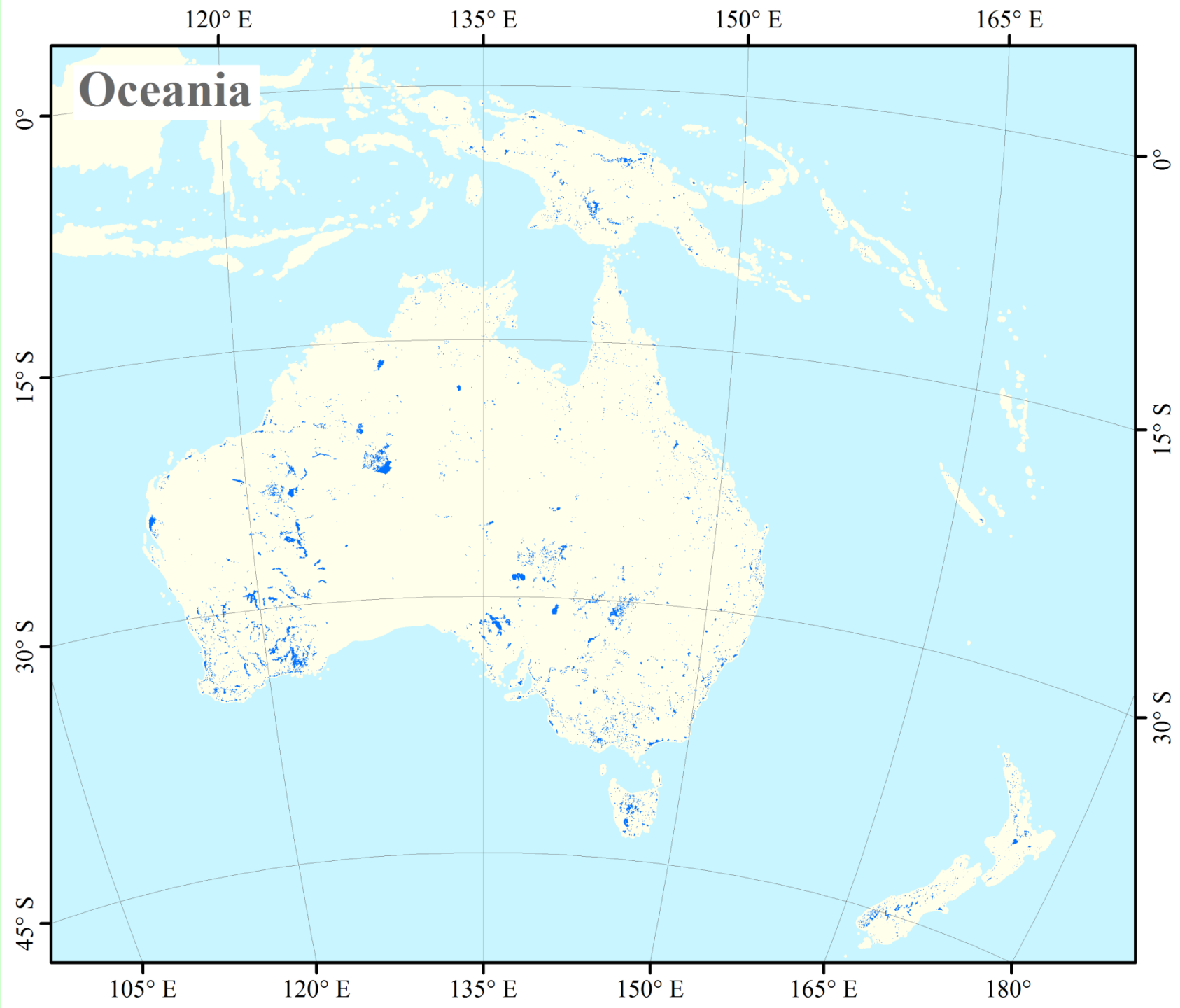

North America
180°
150° W
105° W
60° W
30° W
15° W
45° N
30° N
15° N
120° W
105° W
90° W
75° W
Lake level (m a.s.l.)
-75 - 25
25 - 100
100 - 250
250 - 500
500 - 750
750 - 1000
1000 - 2000
2000 - 4100


South America
A: Lago_Armazon Basin
B: Lakes in Icefield
A
B
75° W
60° W
45° W
15° N
0°
15° S
30° S
45° S
90° W
75° W
60° W
45° W
30° W


45° W
30° W
0°
30° E
60° E
75° E
90° E
A
Europe
A: Finland
60° N
50° N
40° N
30° N
0°
15° E
30° E
45° E


Asia
A
B
C
30° W
45° W
90° W
135° W
150° W
30° N
15° N
0°
15° S
60° E
75° E
90° E
105° E
120° E


Africa
A: Lake Chad
B: Great Rift Valley
A
B
30° W
15° W
0°
15° E
30° E
45° E
60° E
30° N
15° N
0°
15° S
30° S


Oceania
120° E
135° E
150° E
165° E
0°
15° S
30° S
45° S
105° E
120° E
135° E
150° E
165° E
180°

2015

Current Status of Global Lake Inventory

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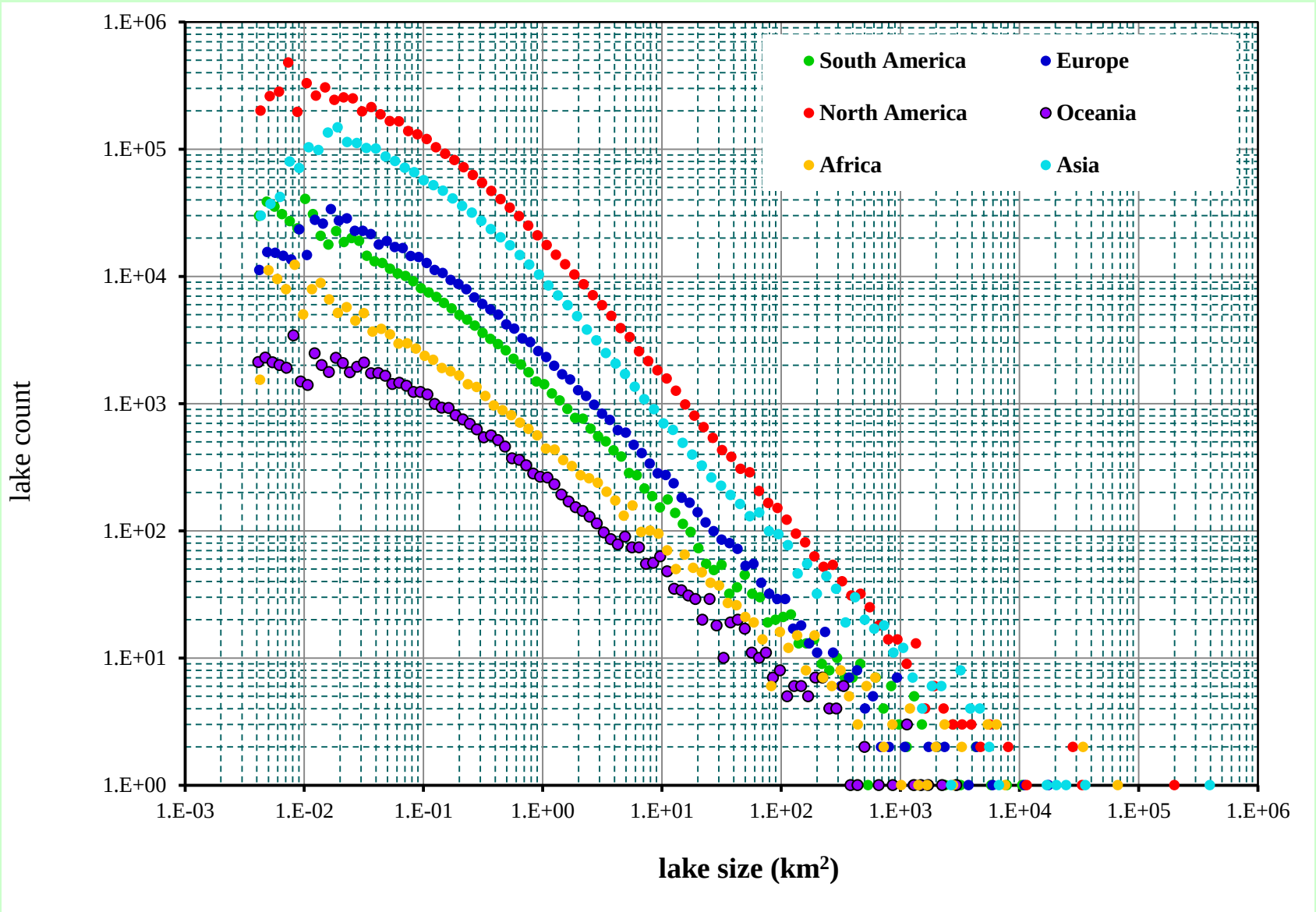
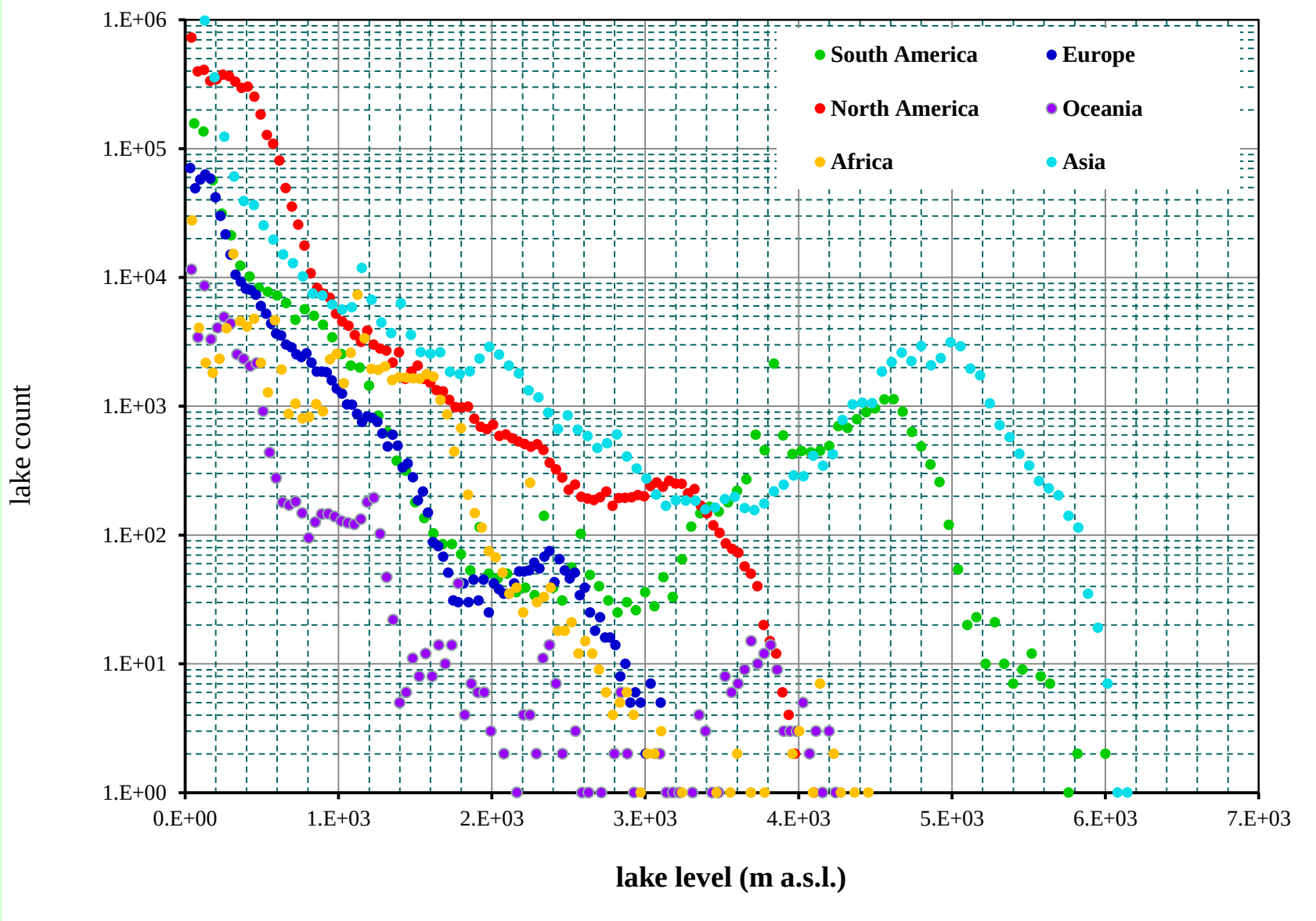
Lake count statistics on size



Lake count statistics on water level

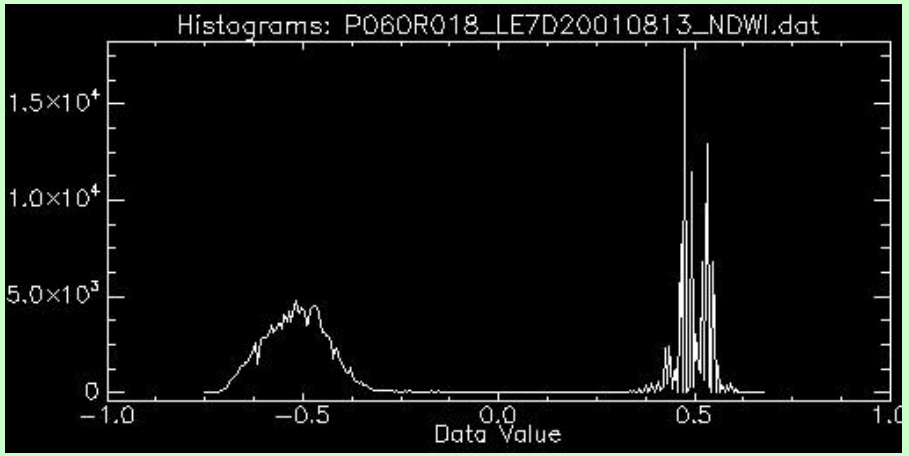


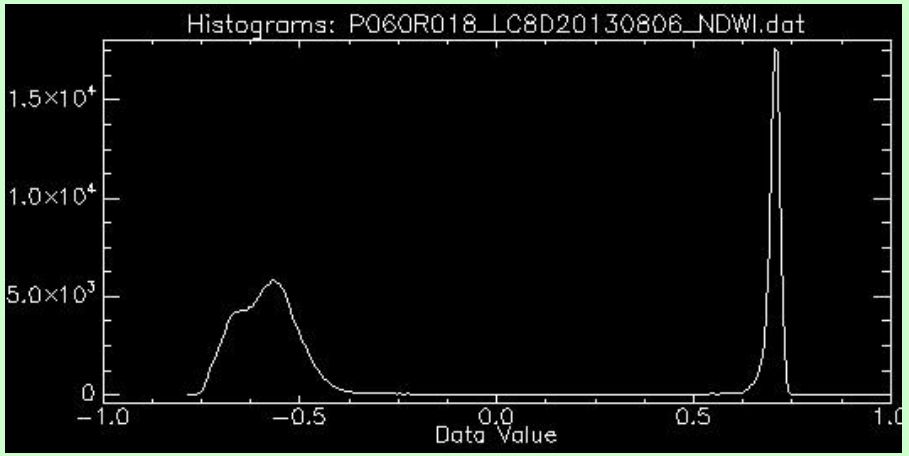
Circa-2015 Lake Mapping

- ☑ Using circa-2000 as reference;
- ☑ Using Landsat-8: a better sensor;
- ☑ Expecting better products;
- ☑ Automated QA/QC:
  - Multi-image involvement;
  - Circa-2000 cross-validation;
  - Least labor-work.

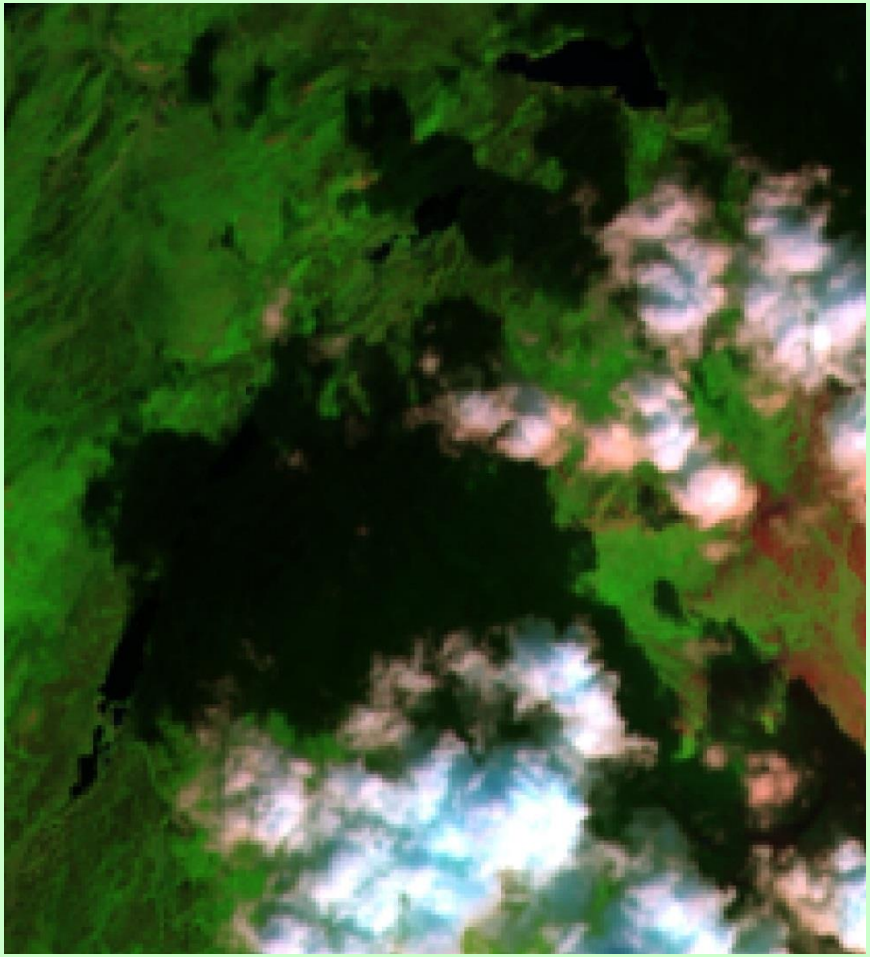
Landsat 8: Better Lake Mapping Capability

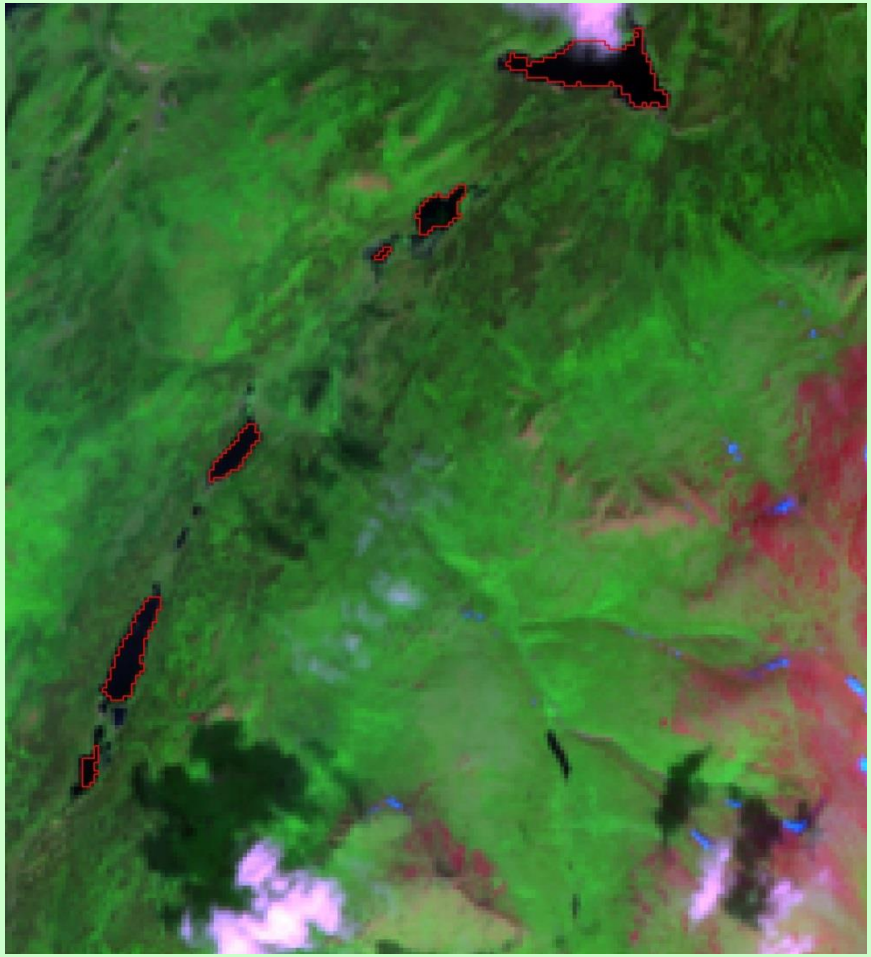
LE7: 08/13/2001 LC8: 08/06/2013

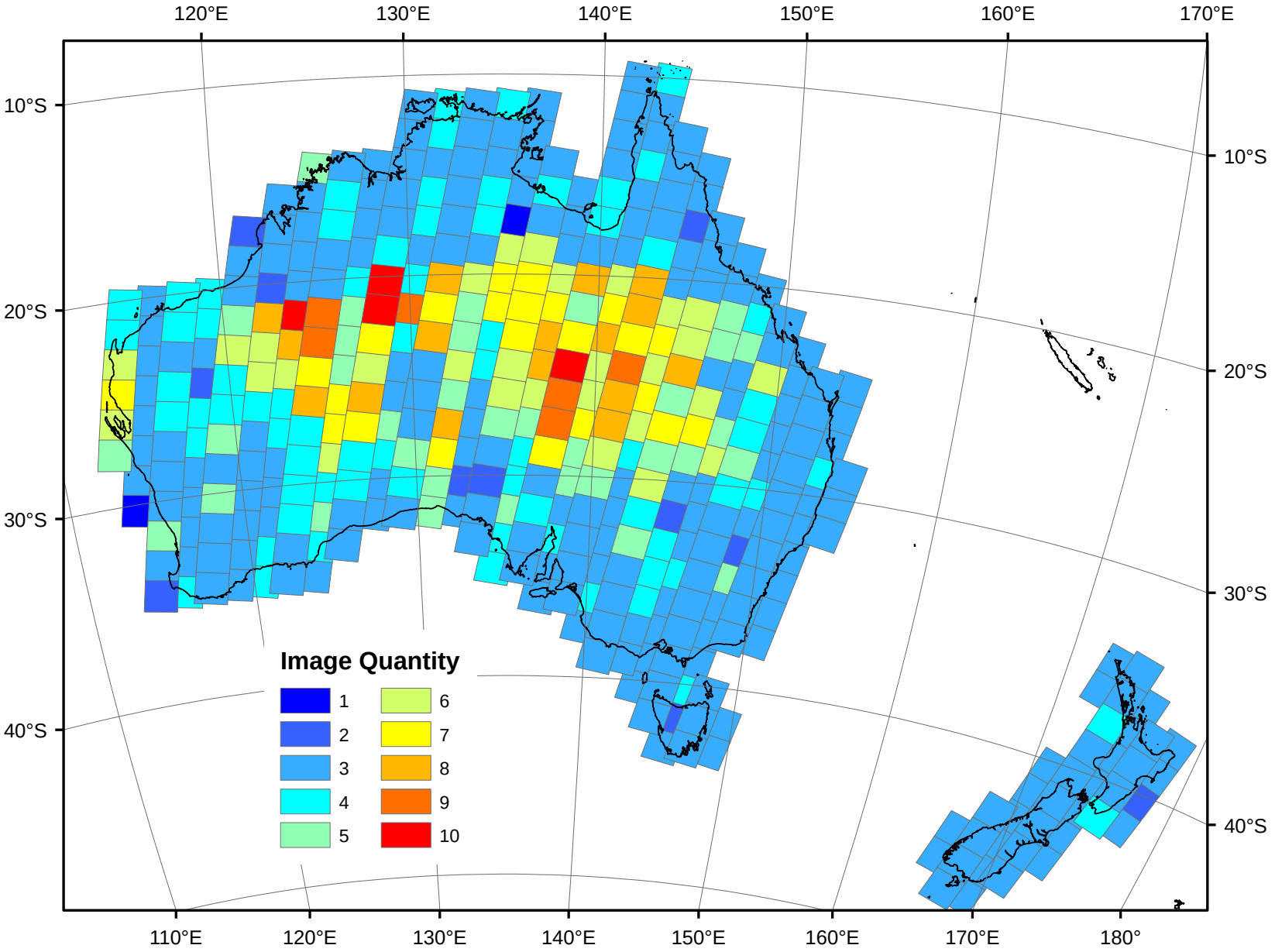




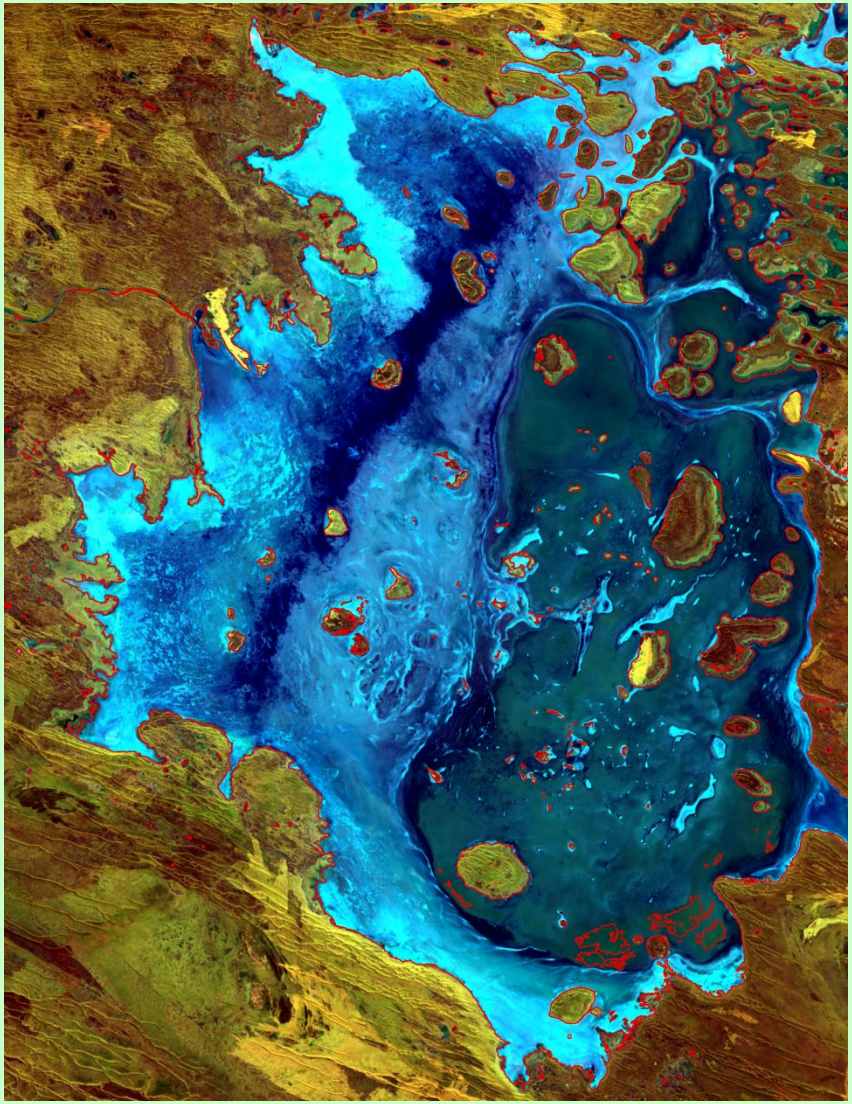
Water bodies identified in cloud shadows

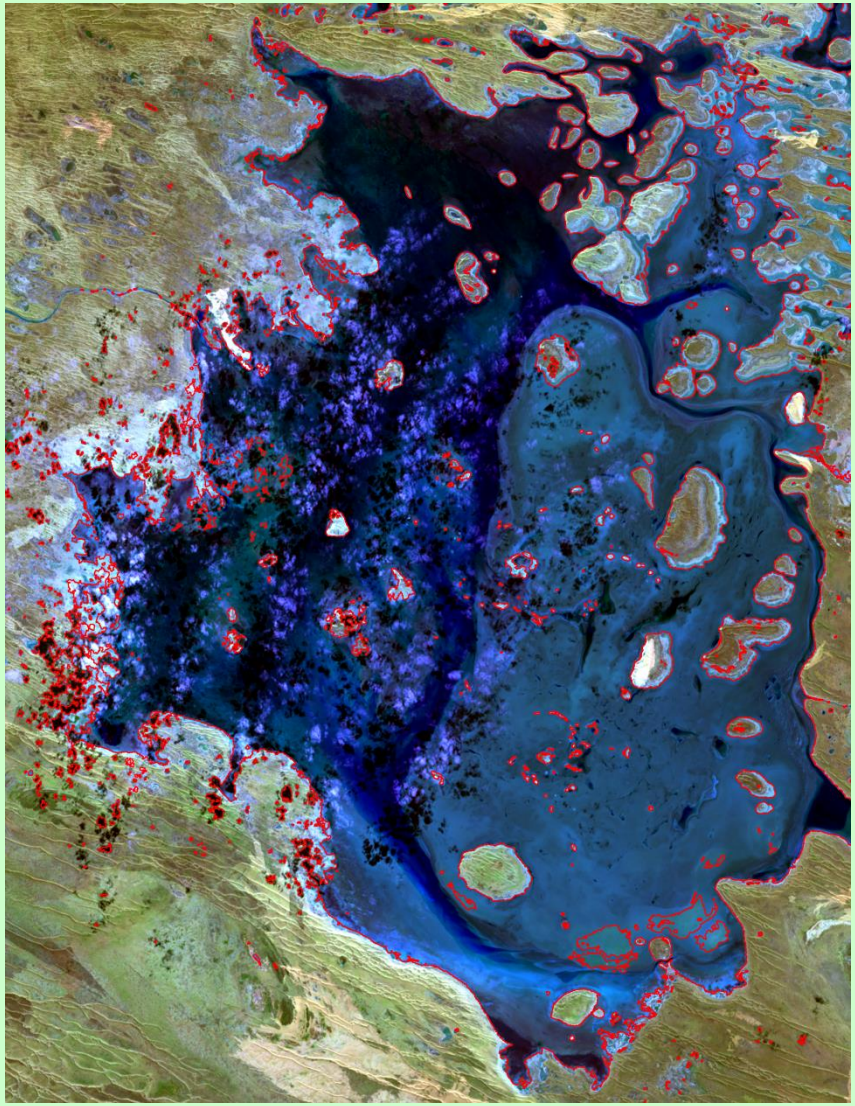


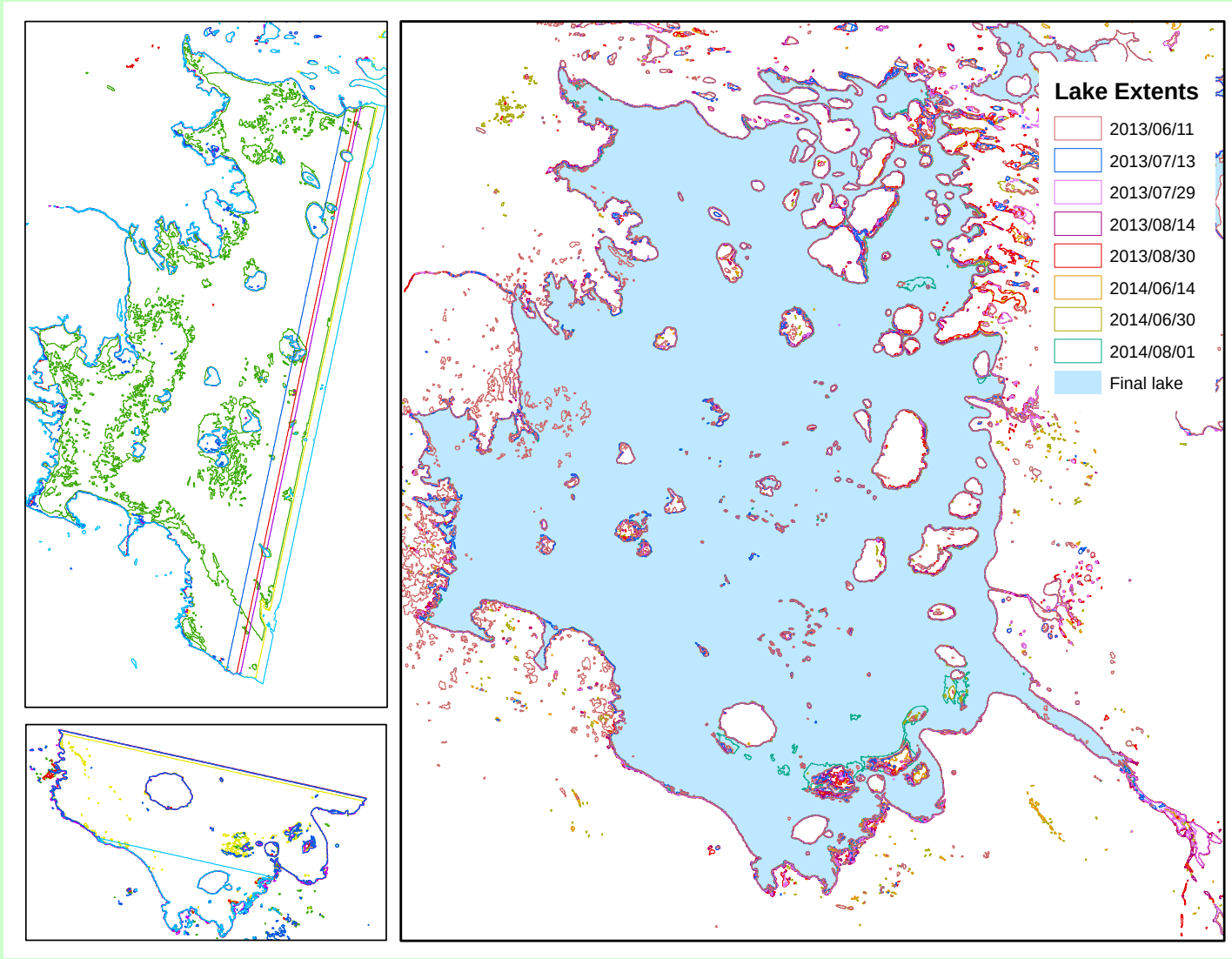


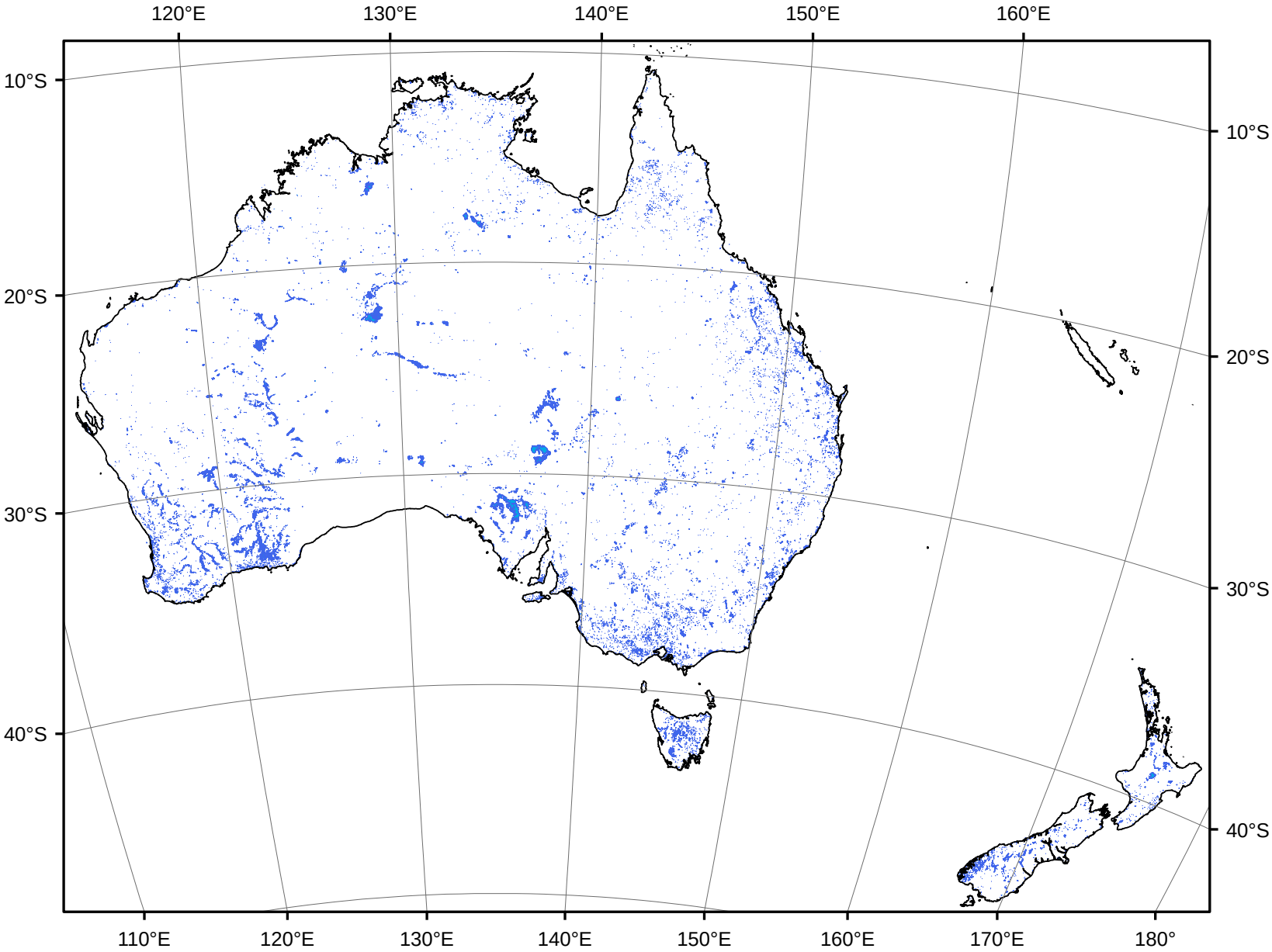

120°E
130°E
140°E
150°E
160°E
170°E
10°S
20°S
30°S
40°S
110°E
120°E
130°E
140°E
150°E
160°E
170°E
180°
Image Quantity
1
2
3
4
5
6
7
8
9
10

Lake Disappointment






Lake Extents
2013/06/11
2013/07/13
2013/07/29
2013/08/14
2013/08/30
2014/06/14
2014/06/30
2014/08/01
Final lake


120°E
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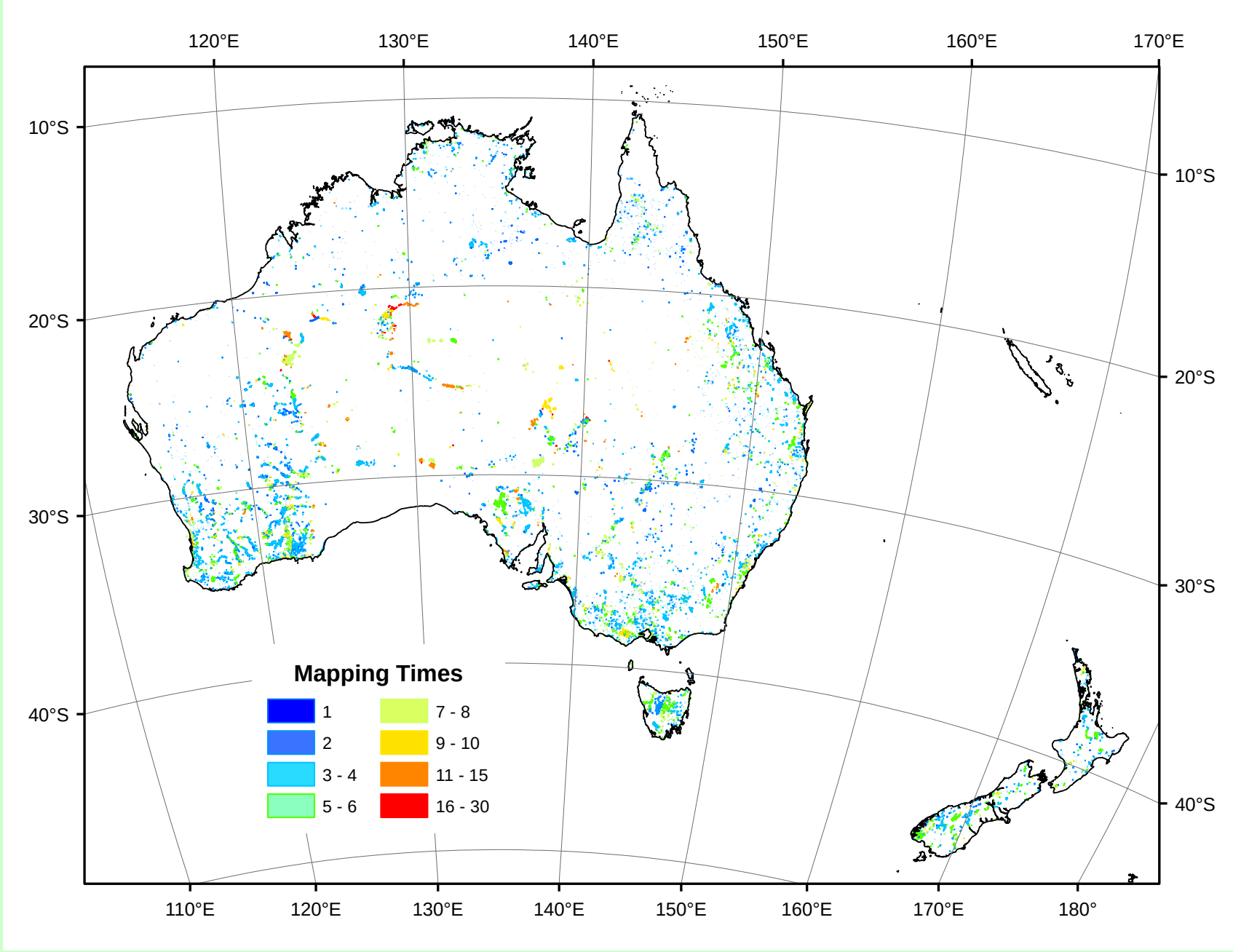
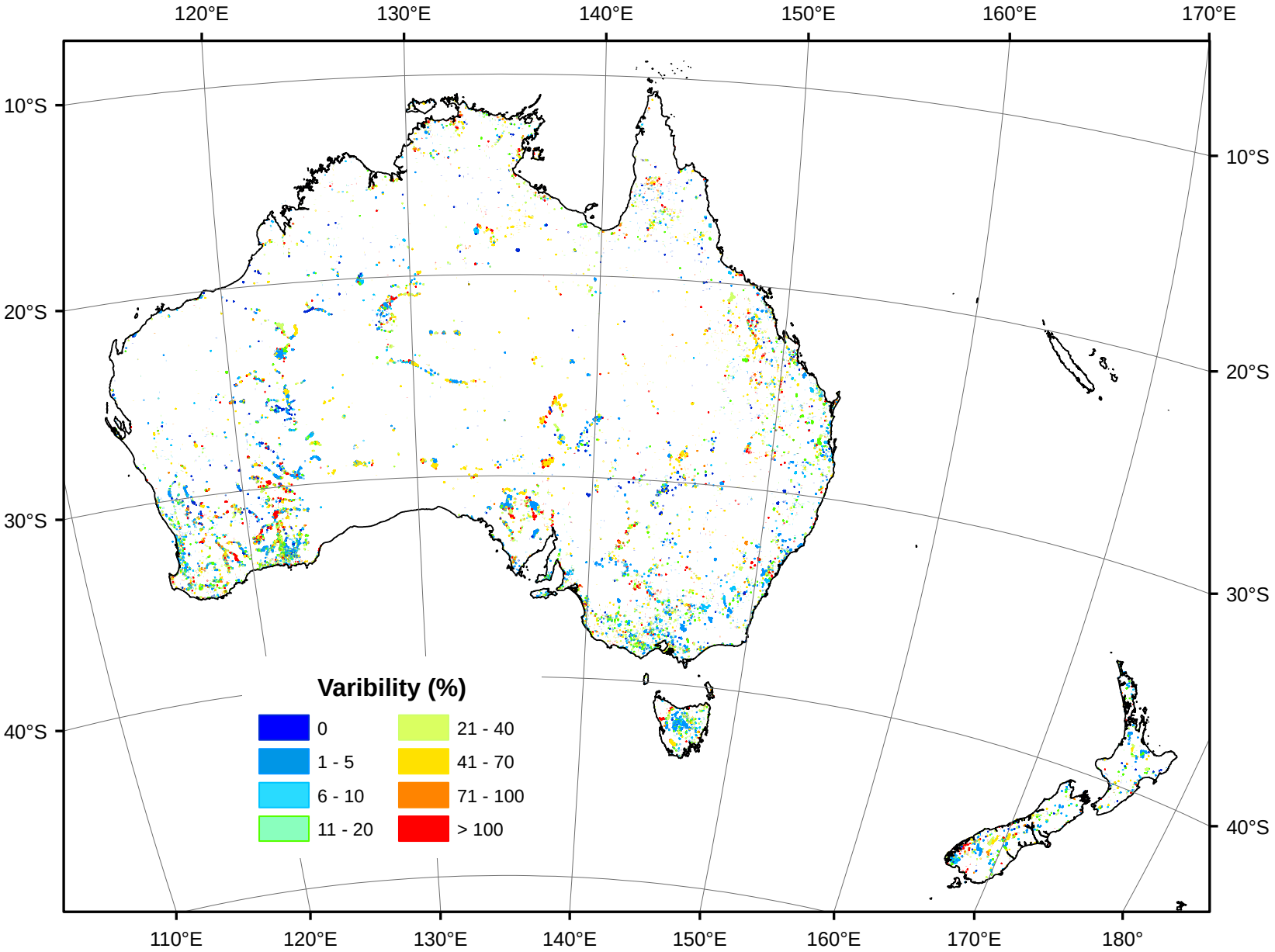
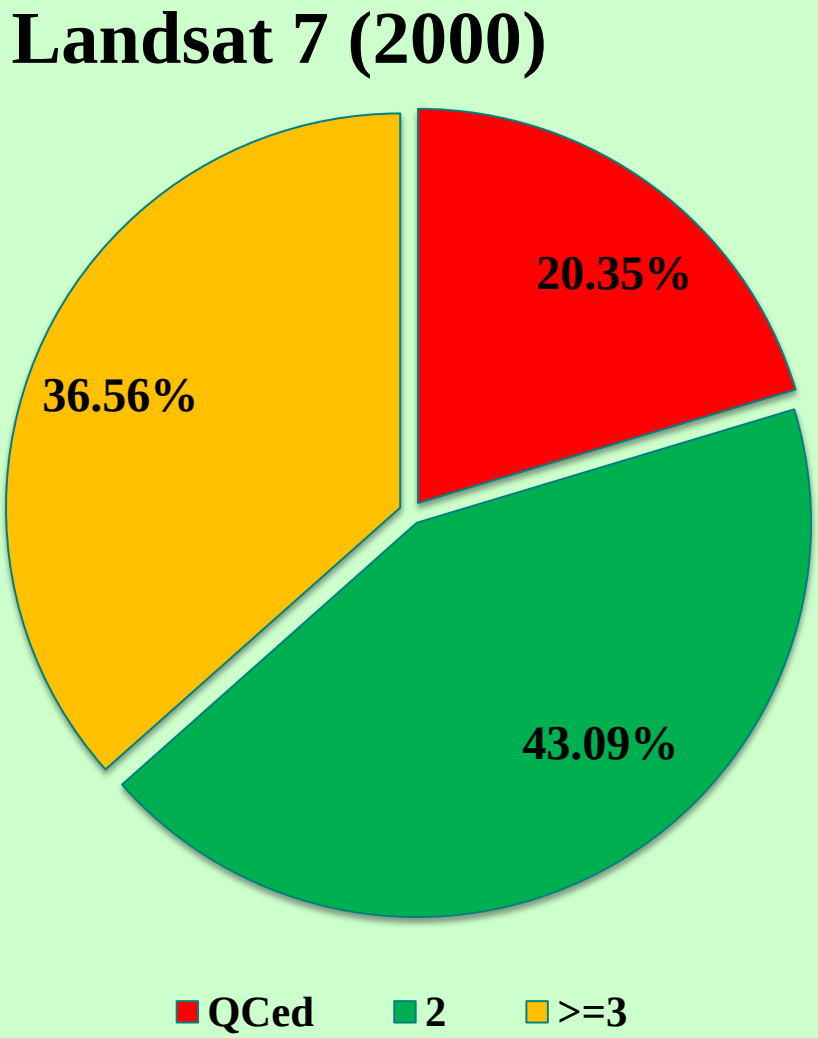
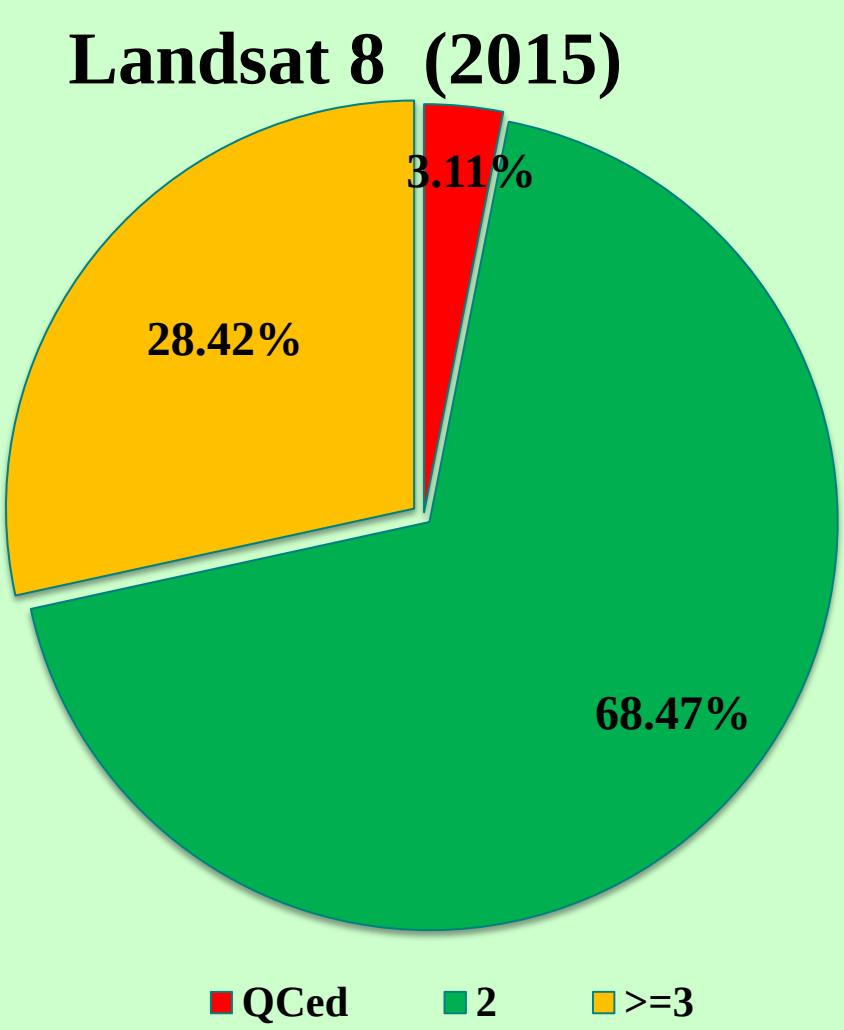
160°E
170°E
180°


120°E
130°E
140°E
150°E
160°E
170°E
10°S
20°S
30°S
40°S
110°E
120°E
130°E
140°E
150°E
160°E
170°E
180°
Mapping Times
1
2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 15
16 - 30


120°E
130°E
140°E
150°E
160°E
170°E
10°S
20°S
30°S
40°S
110°E
120°E
130°E
140°E
150°E
160°E
170°E
180°
Varibility (%)
0
1 - 5
6 - 10
11 - 20
21 - 40
41 - 70
71 - 100
> 100

Histogram Properties and QCed Lakes





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NASA Terrestrial Hydrology Program
USGS/NASA Landsat Science Team Program

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