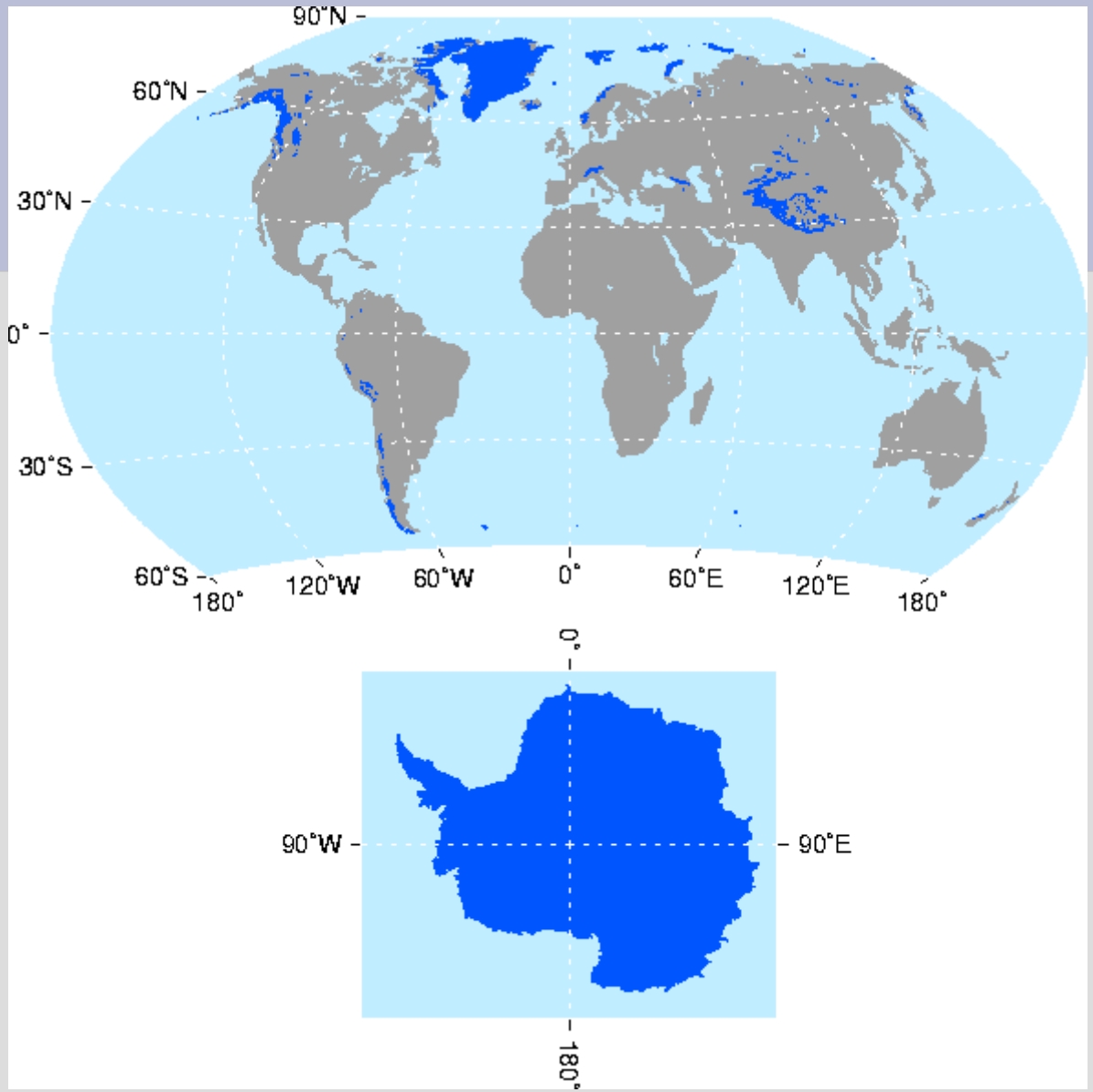
Global Land Ice Measurements from Space (GLIMS): status and Asian activity

Asia CliC Meeting 2006, Yokohama

Presented by Bruce Raup
National Snow and Ice Data Center
Boulder, Colorado



Glaciers are a widely distributed, highly detailed target.

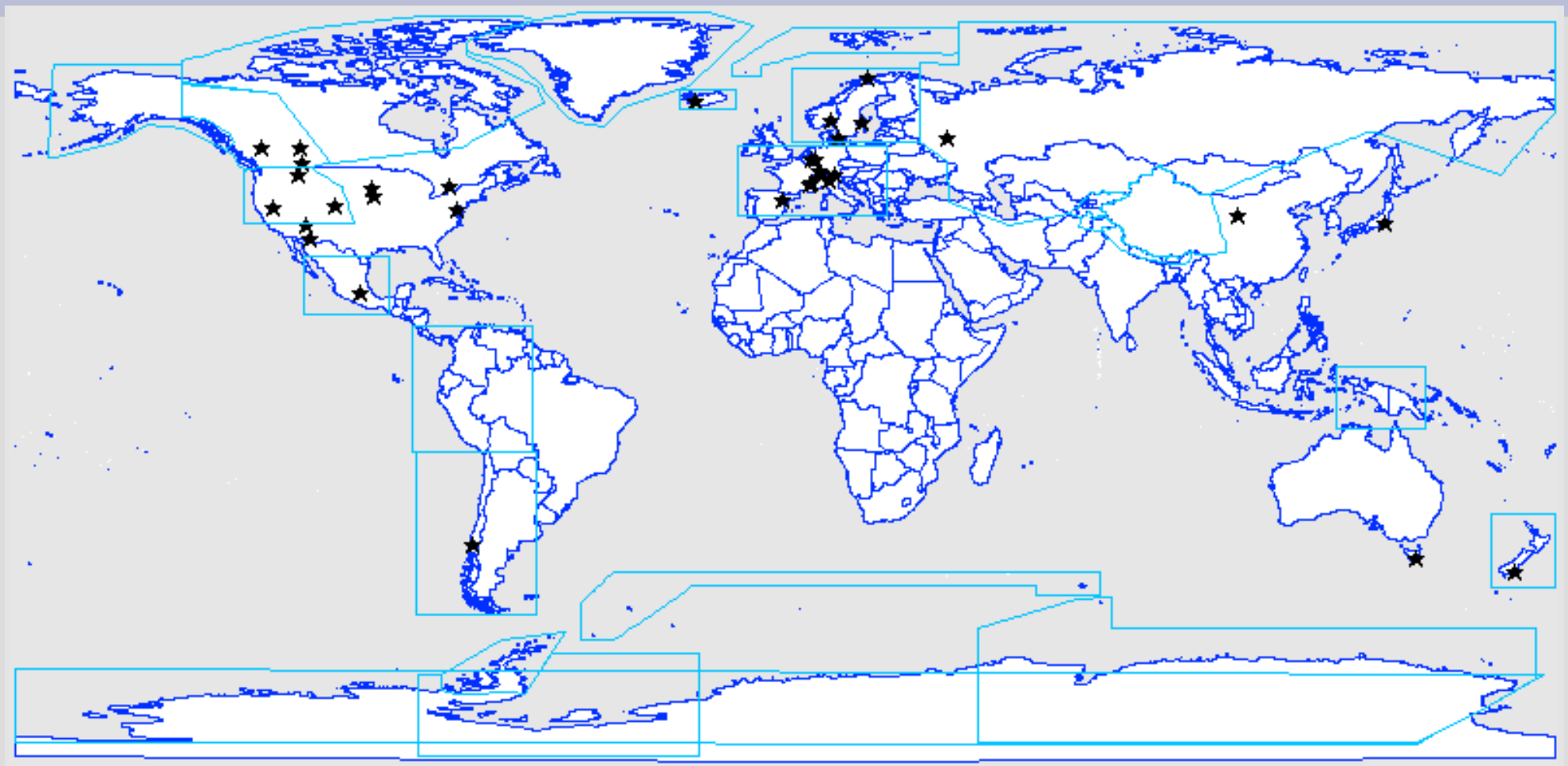
Global Land Ice Measurements from Space (GLIMS)

Goal: to map and measure glacier parameters from space

GLIMS involves:

- 112 people
- 70 institutions
- 28 countries

GLIMS Regions and Institutions



As of 2006-04-15

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [ ] [ ] ASTER Footprints
- [ ] [ ] Regional Center Outlines
- [ ] [ ] GLIMS Participants
- [ ] Glaciers from DCW
- [ ] [ ] World Glacier Inventory
- [ ] STAR Outlines
- [x] [ ] Countries

Background Data:

- [ ] MODIS Blue Marble
- [x] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date:1990-01-01

Year Month Day

End Date:2005-12-31

Year Month Day

Refresh Map

GLIMS Glacier Database

Zoom to... Map Size...

Segment:
Total Dist:

Latitude: 59.842
Longitude: -134.188

Download GLIMS Data

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [ ] [ ] ASTER Footprints
  - [x] Day Images Only
- [ ] [ ] Regional Center Outlines
- [ ] [ ] GLIMS Participants
- [ ] Glaciers from DCW
- [ ] [ ] World Glacier Inventory
- [ ] STAR Outlines
- [x] [ ] Countries

Background Data:

- [ ] MODIS Blue Marble
- [ ] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date:1990-01-01

Year | Month | Day

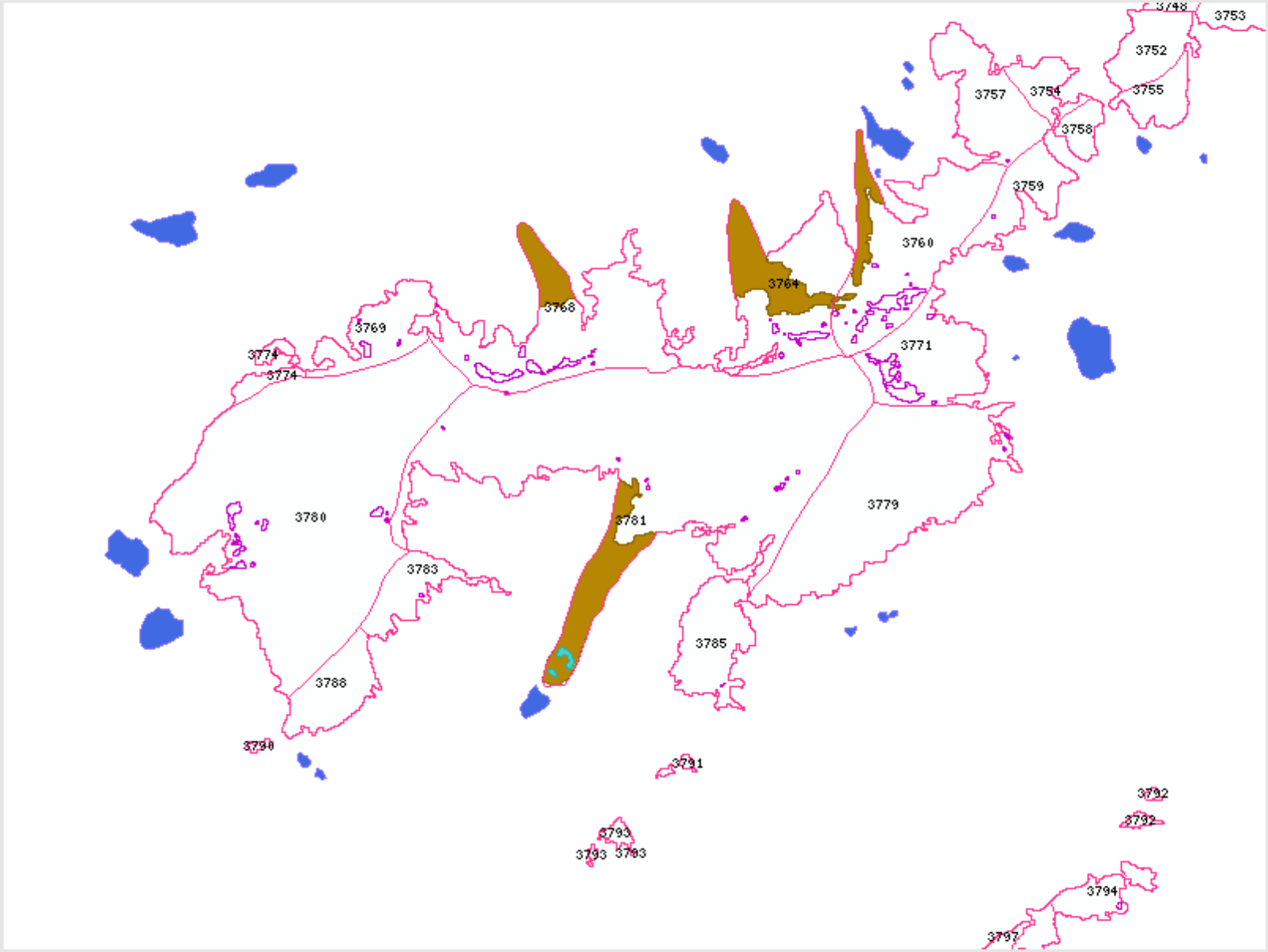
End Date:2005-12-31

Year | Month | Day

Refresh Map

GLIMS Glacier Database

Zoom to... | Map Size...



Segment:
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Latitude: -9.38
Longitude: -77.49

Download GLIMS Data

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [ ] [ ] ASTER Footprints
- [ ] [ ] Regional Center Outlines
- [ ] [ ] GLIMS Participants
- [ ] Glaciers from DCW
- [ ] [ ] World Glacier Inventory
- [ ] STAR Outlines
- [x] [ ] Countries

Background Data:

- [ ] MODIS Blue Marble
- [x] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date:1990-01-01

Year Month Day

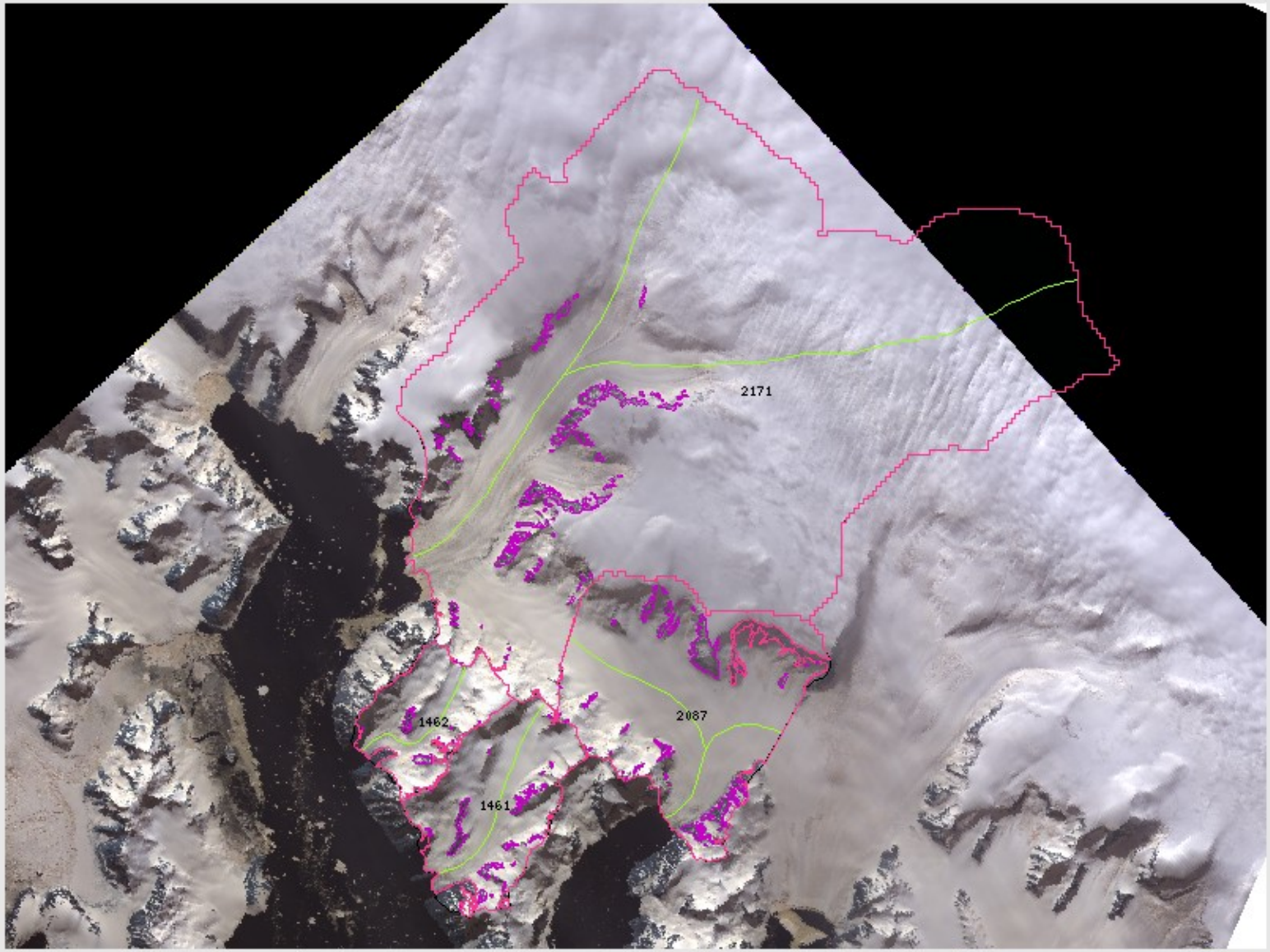
End Date:2005-12-31

Year Month Day

Refresh Map

GLIMS Glacier Database

Zoom to... Map Size...



Segment:
Total Dist:

Latitude: -68.375
Longitude: -66.007

Download GLIMS Data

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [x] [ ] ASTER Footprints
- [x] [ ] Regional Center Outlines
- [x] [ ] GLIMS Participants
- [x] Glaciers from DCW
- [x] [ ] World Glacier Inventory
- [x] STAR Outlines
- [x] [ ] Countries

Background Data:

- [x] MODIS Blue Marble
- [x] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date:1990-01-01

Year Month Day

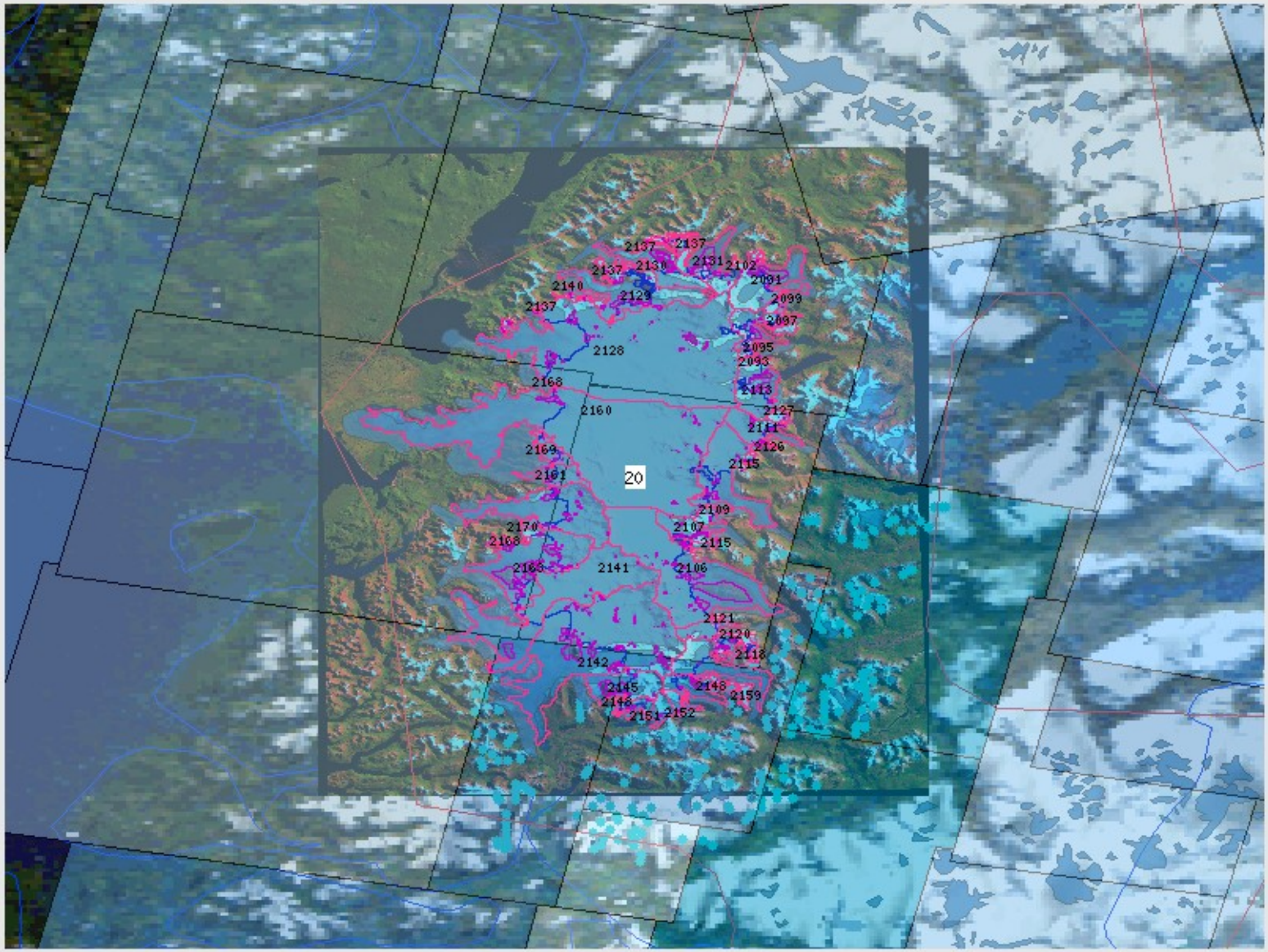
End Date:2005-12-31

Year Month Day

Refresh Map

GLIMS Glacier Database

Zoom to... Map Size...



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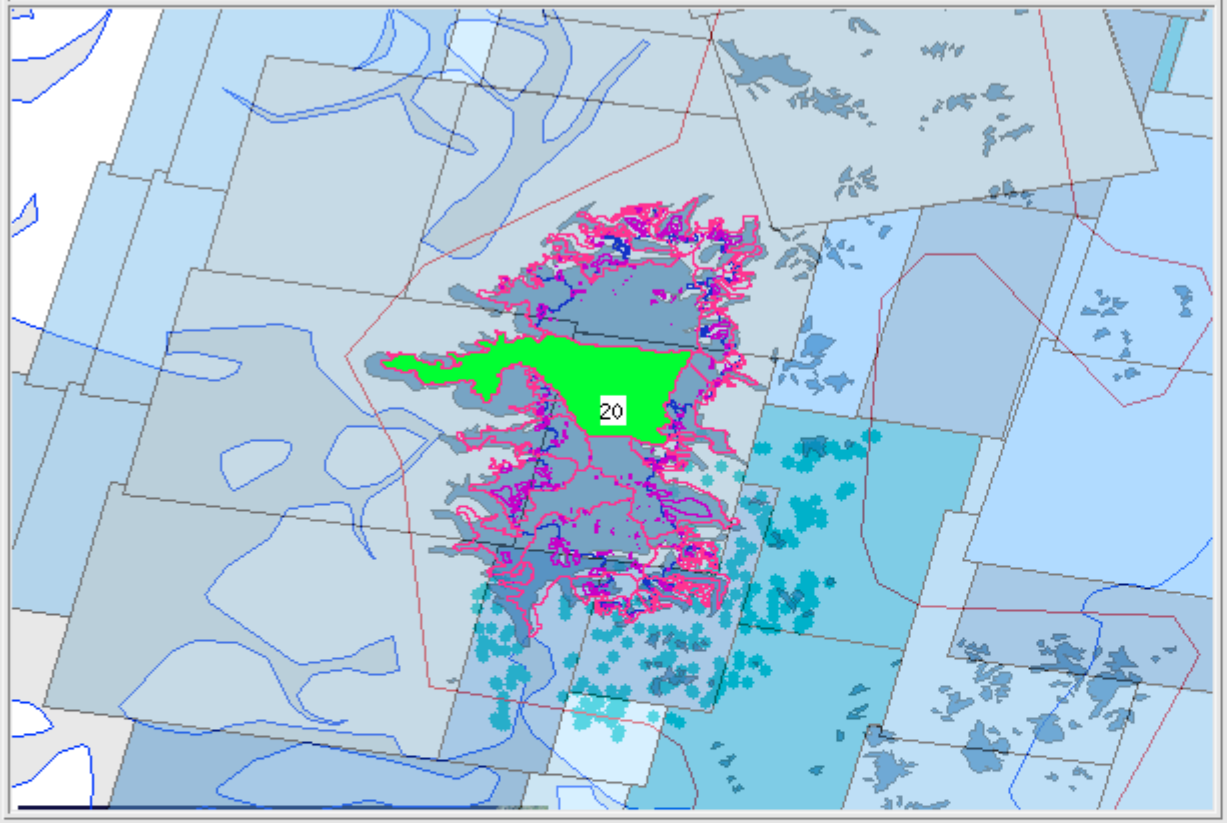
Download GLIMS Data

Selected Features



Glacier Outlines

Download Selected Glacier Outlines

Glacier Name	Glacier ID	Data Acquisition Date	WGMS ID	Contributor's Local Glacier ID	Analysis ID	Area, km^2	Analyst Name	Institution	URL	Date Available
San Quintin	G286485E46923S	2001-03-11 00:00:00		NPI-8	2160	789.8	Francisca Bown	Centro de Estudios Cienticos (CECS)	http://www.cecs.cl	2005-12-20 19:43:58

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [x] [x] ASTER Footprints
- [x] [ ] Regional Center Outlines
- [x] [ ] GLIMS Participants
- [x] Glaciers from DCW
- [x] [ ] World Glacier Inventory
- [x] STAR Outlines
- [x] [ ] Countries

Background Data:

- [x] MODIS Blue Marble
- [x] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date: 1990-01-01

Year Month Day

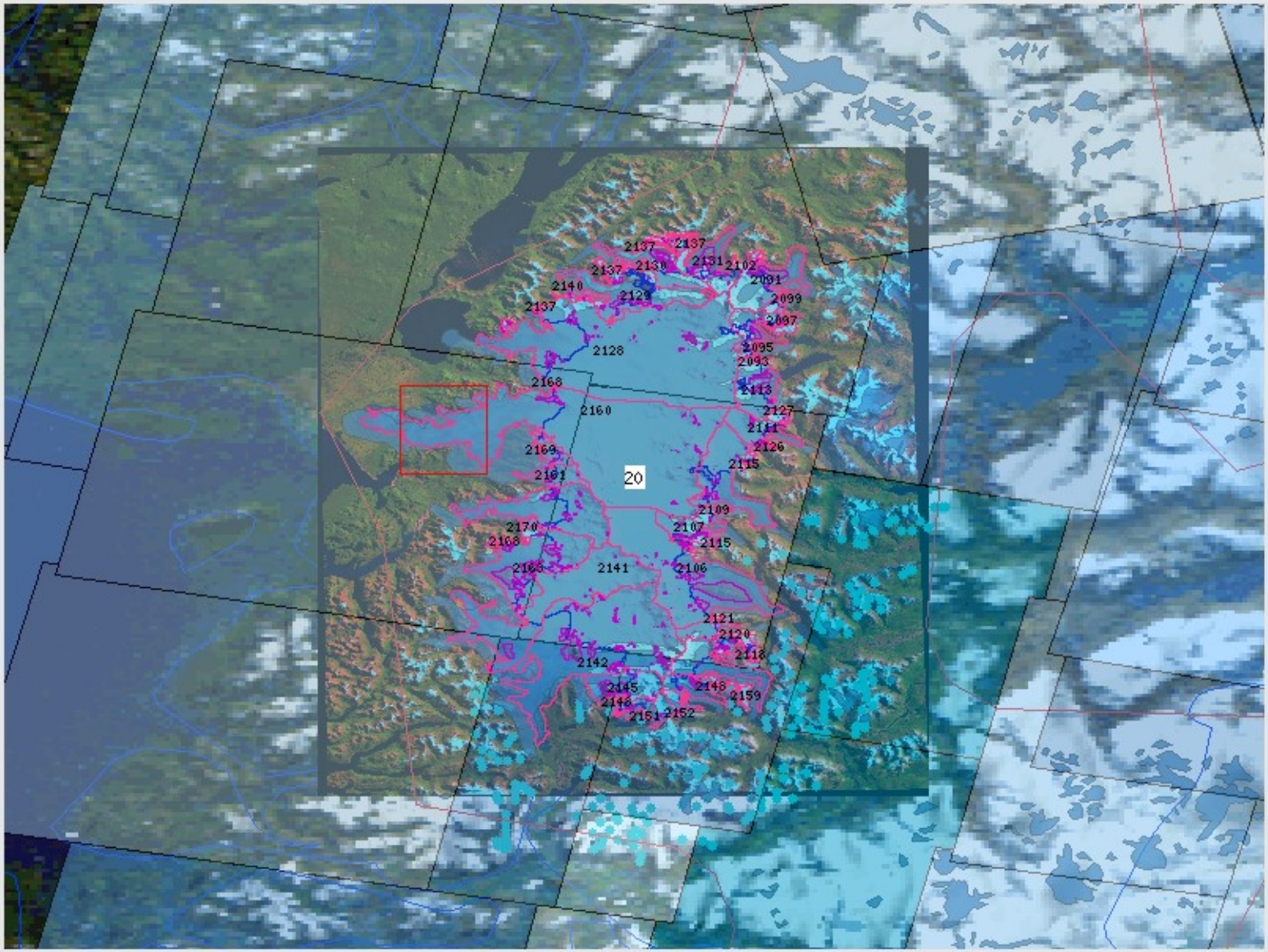
End Date: 2005-12-31

Year Month Day

Refresh Map

GLIMS Glacier Database

Zoom to... Map Size...



Segment:
Total Dist:

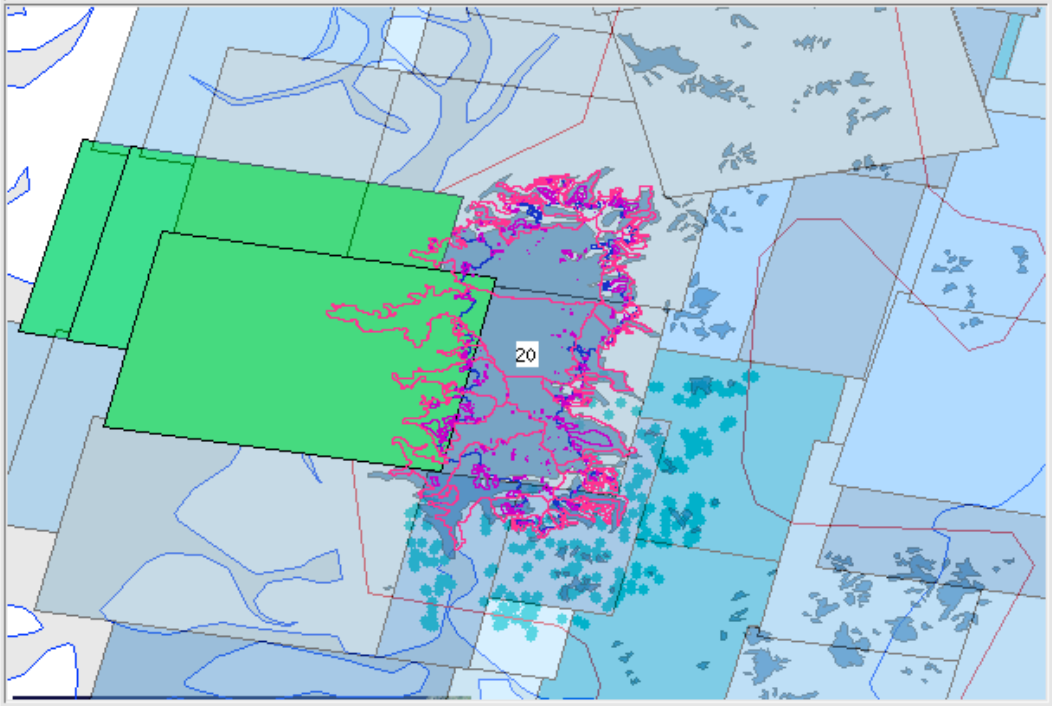
Latitude: -46.505
Longitude: -72.221

Download GLIMS Data

Go

GLIMS Query Results

Selected Features



GLIMS ASTER Footprints

Granule ID	EDC ID	Short Name	Day or Night	Capture Date	Cloud Cover	Gain Settings	View Browse
SC:AST_L1B.003:2017442091	2017442091	AST_L1B	Day	2001-01-22	100	01 HGH, 02 HGH, 3N NOR, 3B NOR, 04 NOR, 05 NOR, 06 NOR, 07 NOR, 08 NOR, 09 NOR	View Image
SC:AST_L1B.003:2018584500	2018584500	AST_L1B	Day	2001-10-05	100	01 HGH, 02 HGH, 3N NOR, 3B NOR, 04 NOR, 05 NOR, 06 NOR, 07 NOR, 08 NOR, 09 NOR	View Image
SC:AST_L1B.003:2021774914	2021774914	AST_L1B	Day	2004-03-10	0	01 HGH, 02 HGH, 3N NOR, 3B NOR, 04 NOR, 05 NOR, 06 NOR, 07 NOR, 08 NOR, 09 NOR	View Image

Done

Go

http://gli...2004-03-10

-74.5636 -46.6301 -73.6055 -46.7614

-74.731 -47.1853 -73.7633 -47.3179

Image Date: 2004-03-10

Go Back

Done

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [x] [x] ASTER Footprints
- [x] [ ] Regional Center Outlines
- [x] [ ] GLIMS Participants
- [x] Glaciers from DCW
- [x] [ ] World Glacier Inventory
- [x] STAR Outlines
- [x] [ ] Countries

Background Data:

- [x] MODIS Blue Marble
- [x] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date: 1990-01-01

Year Month Day

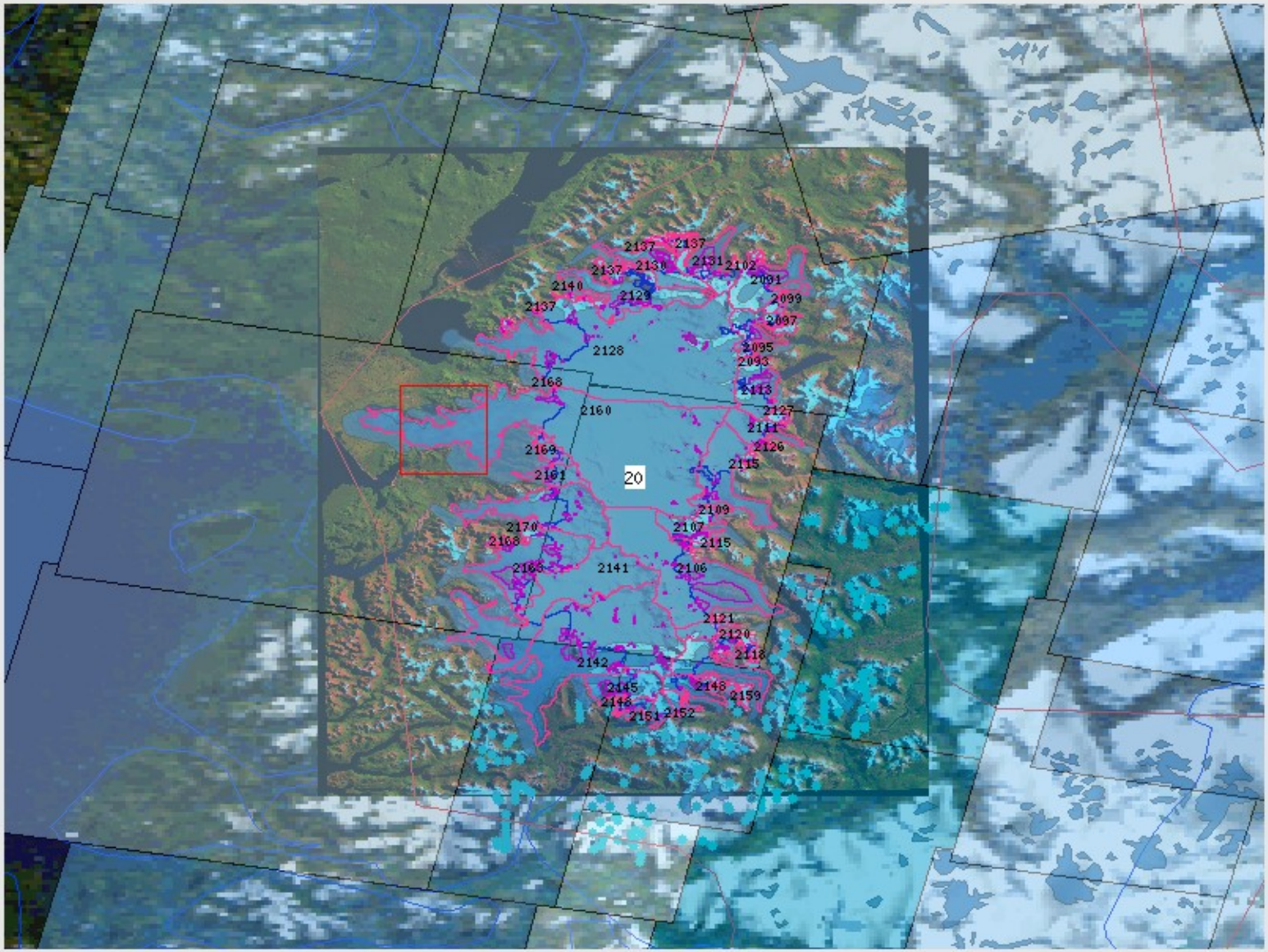
End Date: 2005-12-31

Year Month Day

Refresh Map

GLIMS Glacier Database

Zoom to... Map Size...



Segment:
Total Dist:

Latitude: -46.505
Longitude: -72.221

Download GLIMS Data

HELP Window View Legend

Database Layers:

- GLIMS Glaciers
- ASTER Footprints
- Regional Center Outlines
- GLIMS Participants
- Glaciers from DCW
- World Glacier Inventory
- STAR Outlines
- Countries

Background Data:

- MODIS Blue Marble
- Source Images

Temporally Constrain Data

- GLIMS Glaciers
- ASTER Footprints

Start Date:2004-01-01

Year Month Day

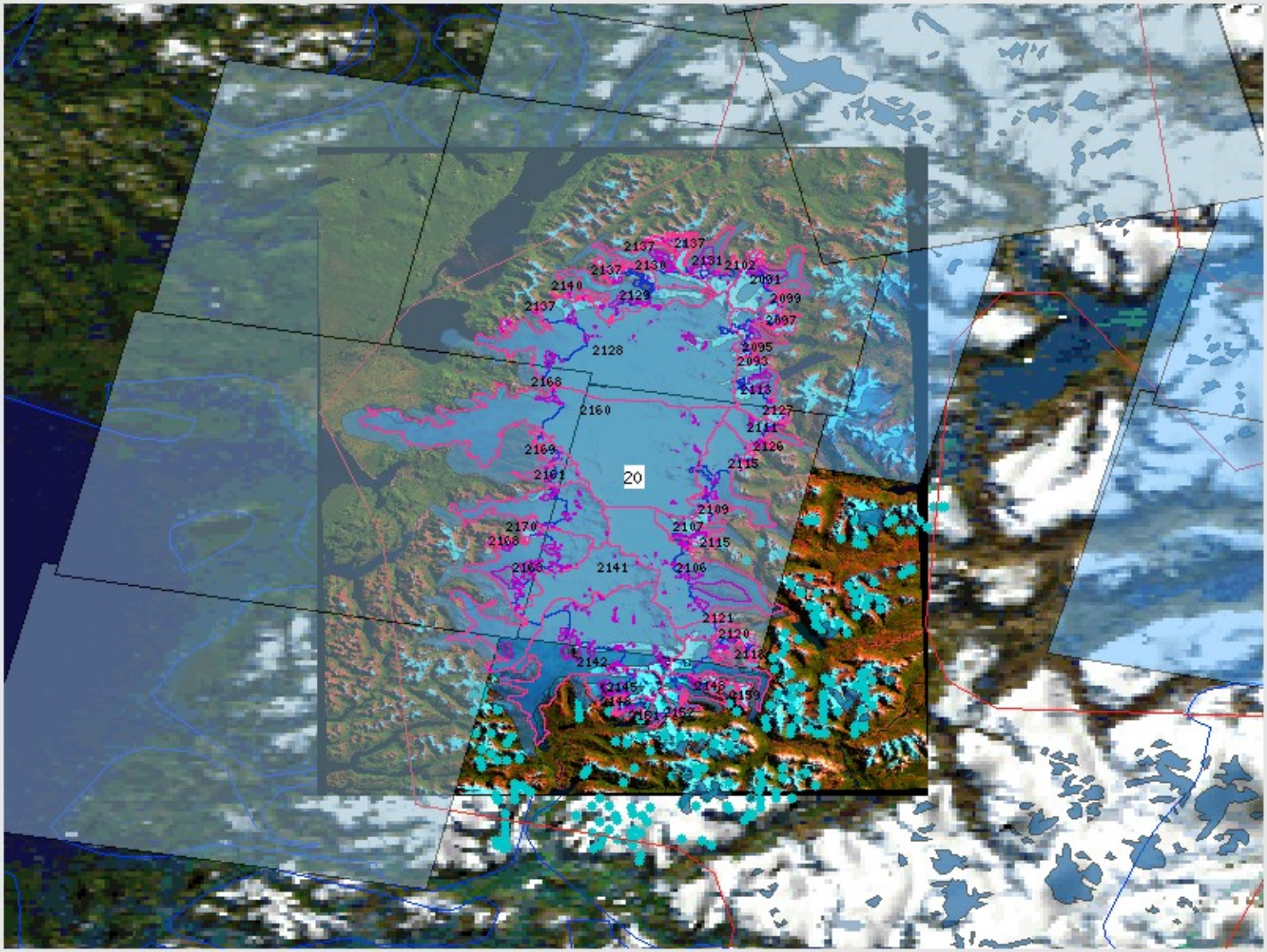
End Date:2005-12-31

Year Month Day

Refresh Map

GLIMS Glacier Database

Zoom to... Map Size...



Segment:
Total Dist:

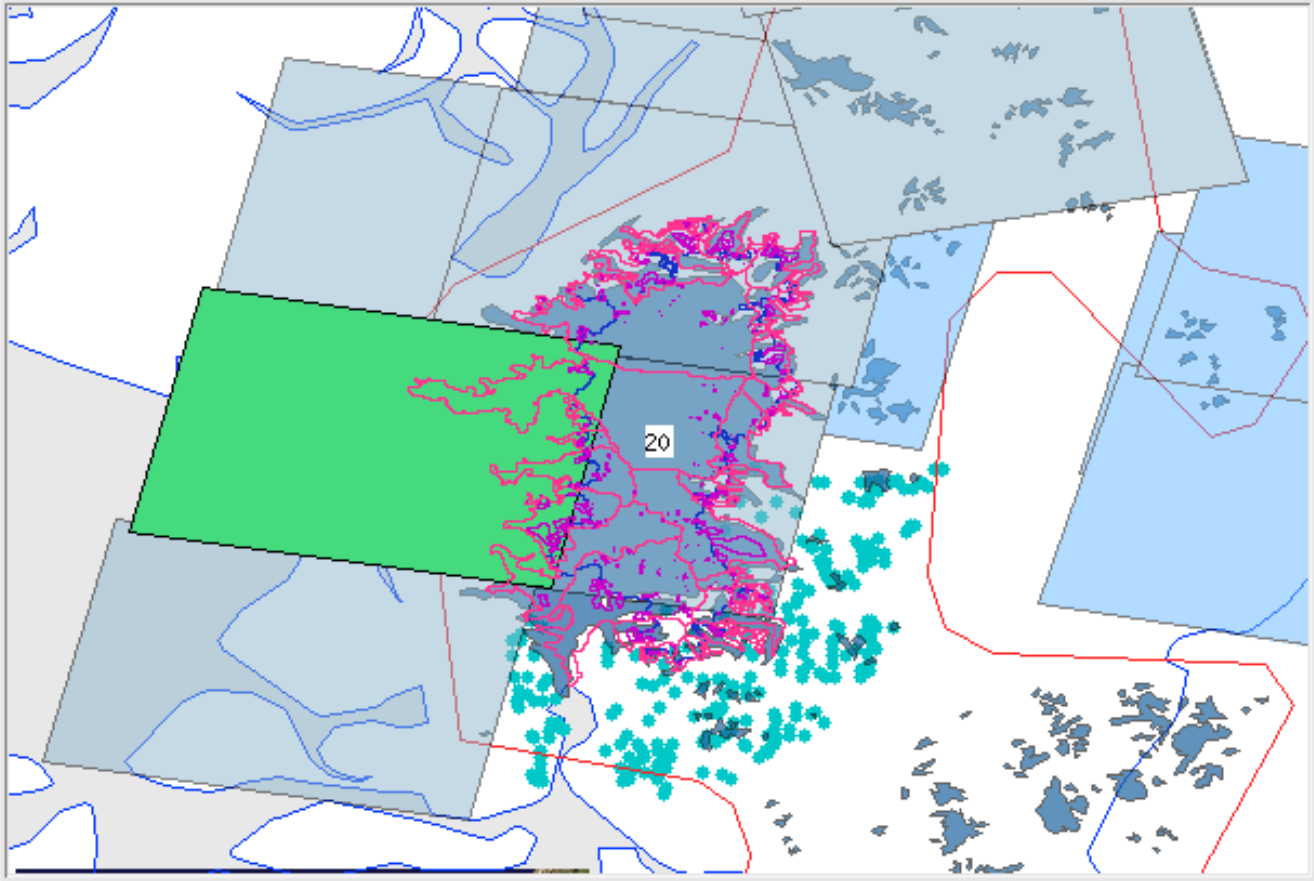
Latitude: -46.277
Longitude: -72.268

Download GLIMS Data

Go

GLIMS Query Results

Selected Features



GLIMS ASTER Footprints

Granule ID	EDC ID	Short Name	Day or Night	Capture Date	Cloud Cover	Gain Settings	View Browse
SC:AST_L1B.003:2021774914	2021774914	AST_L1B	Day	2004-03-10	0	01 HGH, 02 HGH, 3N NOR, 3B NOR, 04 NOR, 05 NOR, 06 NOR, 07 NOR, 08 NOR, 09 NOR	View Image

Done

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [ ] [ ] ASTER Footprints
- [ ] [ ] Regional Center Outlines
- [ ] [ ] GLIMS Participants
- [ ] Glaciers from DCW
- [ ] [ ] World Glacier Inventory
- [ ] STAR Outlines
- [x] [ ] Countries

Background Data:

- [x] MODIS Blue Marble
- [x] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date:2004-01-01

Year | Month | Day

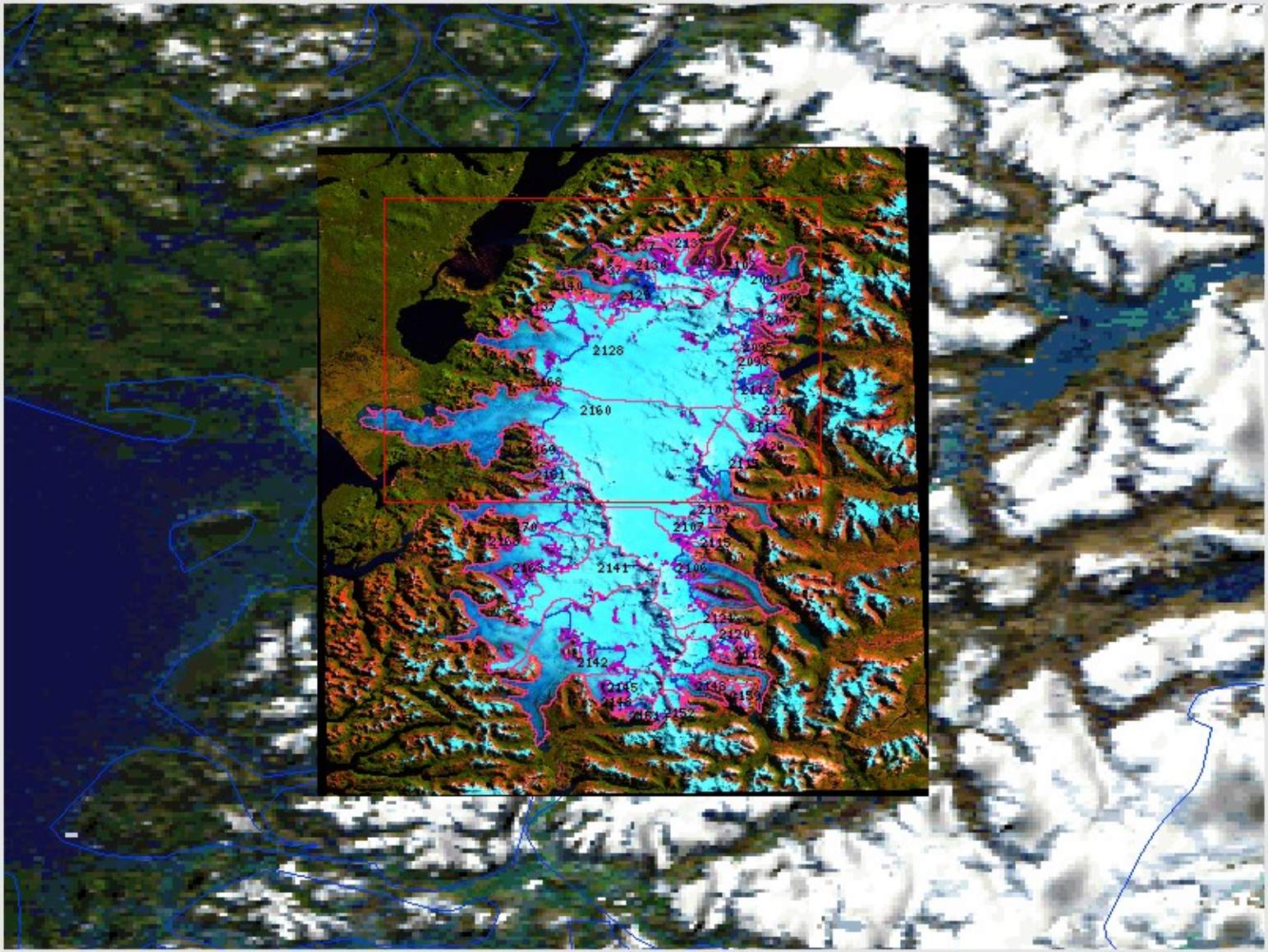
End Date:2005-12-31

Year | Month | Day

Refresh Map

GLIMS Glacier Database

Zoom to... | Map Size...

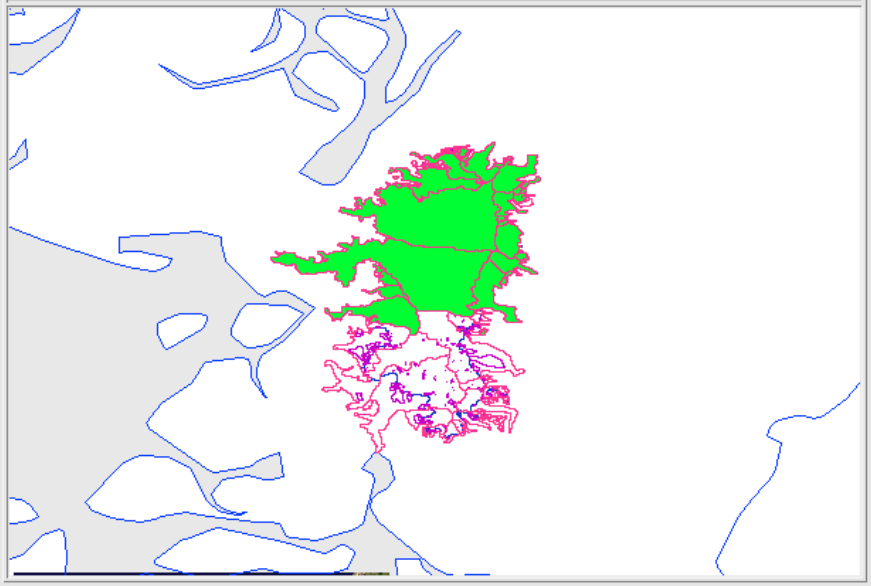


Segment:
Total Dist:

Latitude: -46.119
Longitude: -72.221

Download GLIMS Data

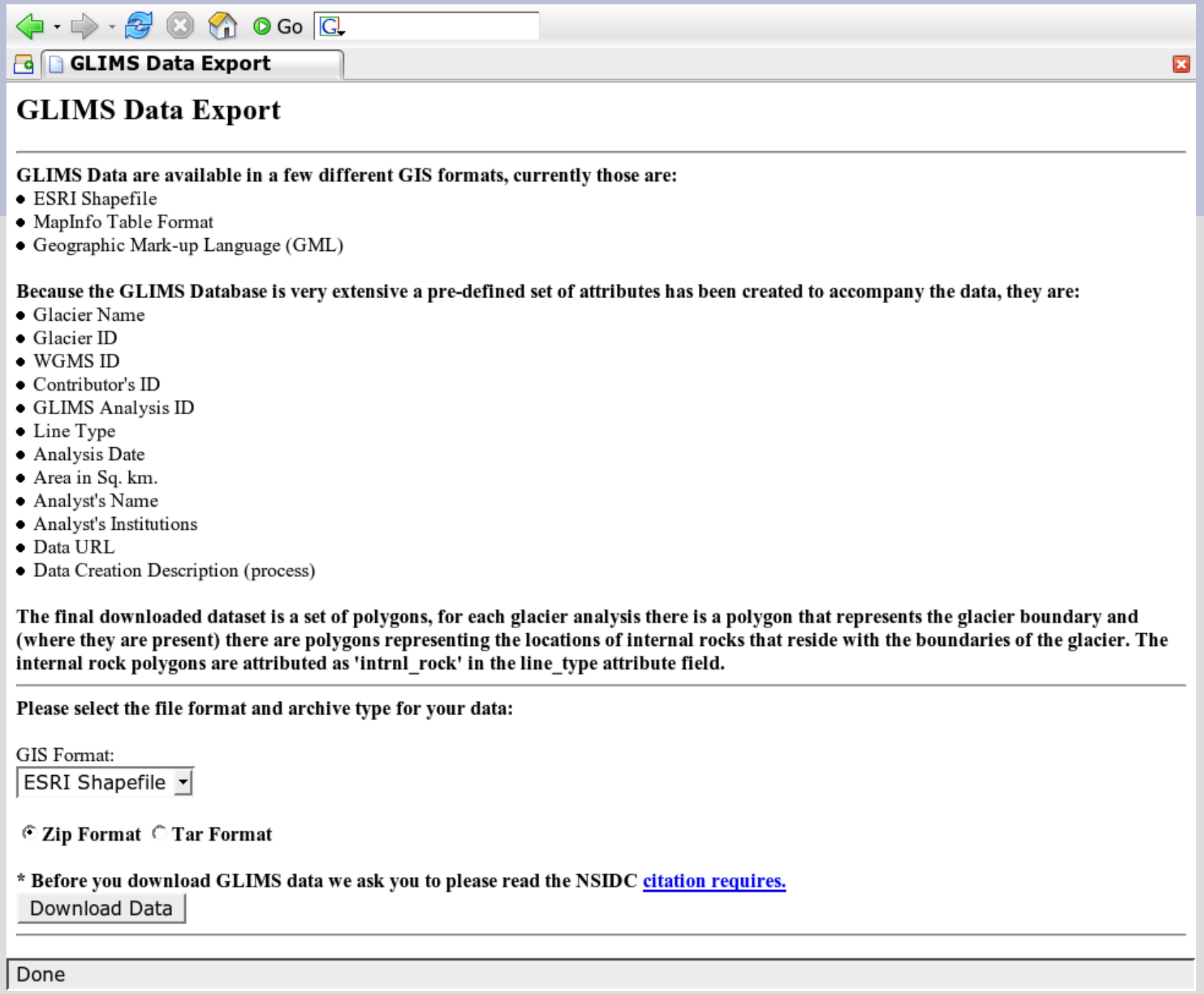
Selected Features



Glacier Outlines

Download Selected Glacier Outlines

Glacier Name	Glacier ID	Data Acquisition Date	WGMS ID	Contributor's Local Glacier ID	Analysis ID	Area, km^2	Analyst Name	Institution	URL	Date Available
Exploradores	G286716E46597S	2001-03-11 00:00:00		NPI-38	2091	85.75	Francisca Bown	Centro de Estudios Cienticos (CECS)	http://www.cecs.cl	2005-12-20 19:46:04
Fiero	G286697E46659S	2001-03-11 00:00:00		NPI-35	2092	41.5	Francisca Bown	Centro de Estudios Cienticos (CECS)	http://www.cecs.cl	2005-12-20 19:46:04
Cristal	G286714E46737S	2001-03-11 00:00:00		NPI-33	2093	5.36	Francisca Bown	Centro de Estudios Cienticos (CECS)	http://www.cecs.cl	2005-12-20 19:46:04
Mocho	G286707E46722S	2001-03-11 00:00:00		NPI-34	2094	5.16	Francisca Bown	Centro de Estudios Cienticos (CECS)	http://www.cecs.cl	2005-12-20 19:46:04
Group of small glaciers	G286735E46710S	2001-03-11 00:00:00		NPI-39	2095	34.6	Francisca Bown	Centro de Estudios Cienticos (CECS)	http://www.cecs.cl	2005-12-20 19:46:04
Group of small	G286735E46710S	2001-03-11 00:00:00		NPI-39	2095	34.6	Francisca Bown	Centro de Estudios Cienticos	http://www.cecs.cl	2005-12-20 19:46:04


Go
GLIMS Data Export
GLIMS Data Export
GLIMS Data are available in a few different GIS formats, currently those are:
• ESRI Shapefile
• MapInfo Table Format
• Geographic Mark-up Language (GML)
Because the GLIMS Database is very extensive a pre-defined set of attributes has been created to accompany the data, they are:
• Glacier Name
• Glacier ID
• WGMS ID
• Contributor's ID
• GLIMS Analysis ID
• Line Type
• Analysis Date
• Area in Sq. km.
• Analyst's Name
• Analyst's Institutions
• Data URL
• Data Creation Description (process)
The final downloaded dataset is a set of polygons, for each glacier analysis there is a polygon that represents the glacier boundary and (where they are present) there are polygons representing the locations of internal rocks that reside with the boundaries of the glacier. The internal rock polygons are attributed as 'intrnl_rock' in the line_type attribute field.
Please select the file format and archive type for your data:
GIS Format:
ESRI Shapefile
Zip Format
Tar Format
* Before you download GLIMS data we ask you to please read the NSIDC citation requires.
Download Data
Done

Search the Global Land Ice Measurements from Space Database

This interface is designed to provide a text based method for interacting with the GLIMS Glacier Database. The entire database can be accessed by searching on different criteria (see below). Each glacier outline returned in a result set can be viewed and downloaded in different GIS formats (except those under a specified embargo period)

You must check a search box (on the left) in order to enable searching on that parameter. Checking a box and not entering any search criteria will result in the entire database being returned. Likewise, not checking a box will will result in an empty return set.

Please Enter your search parameters to search GLIMS Database.

Main Search Fields

- ☐ Glacier Name
- ☐ Country — Select… — **NOTE:** This may take several minutes.
- ☐ Glacier Area — min: ____ km^2 max: ____ km^2

Advanced Search Fields

- ☐ Glacier ID
- ☐ WGMS ID
- ☐ WGMS Classification — Select…
- ☐ Regional Center — Select…
- ☐ Glacier Width(m) — min: ____ max: ____
- ☐ Glacier Length(m) — min: ____ max: ____
- ☐ Glacier Elev(m) — min: ____ max: ____

Search | Reset

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [x] [ ] ASTER Footprints
  - [x] Day Images Only
- [ ] [ ] Regional Center Outlines
- [ ] [ ] GLIMS Participants
- [ ] Glaciers from DCW
- [ ] [ ] World Glacier Inventory
- [ ] STAR Outlines
- [x] [ ] Countries

Background Data:

- [ ] MODIS Blue Marble
- [ ] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date:1990-01-01

Year | Month | Day

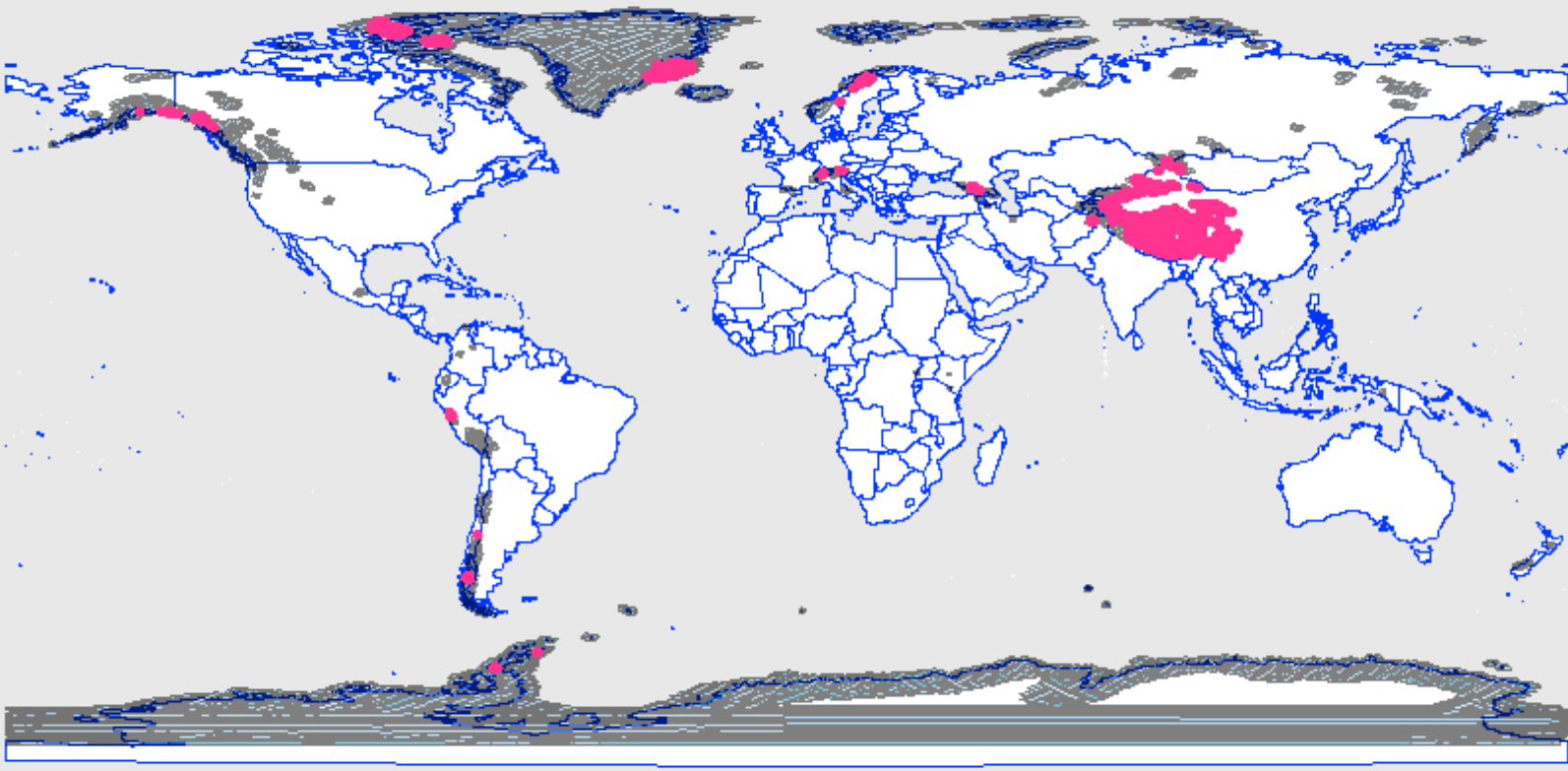
End Date:2005-12-31

Year | Month | Day

Refresh Map

GLIMS Glacier Database

Zoom to... | Map Size...



0 4600 9200 13800 18400 km

Segment:
Total Dist:

Latitude: 104.337
Longitude: -178.924

Download GLIMS Data

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [x] [ ] ASTER Footprints
  - [x] Day Images Only
- [ ] [ ] Regional Center Outlines
- [ ] [ ] GLIMS Participants
- [ ] Glaciers from DCW
- [ ] [ ] World Glacier Inventory
- [ ] STAR Outlines
- [x] [ ] Countries

Background Data:

- [ ] MODIS Blue Marble
- [ ] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date:1990-01-01

Year | Month | Day

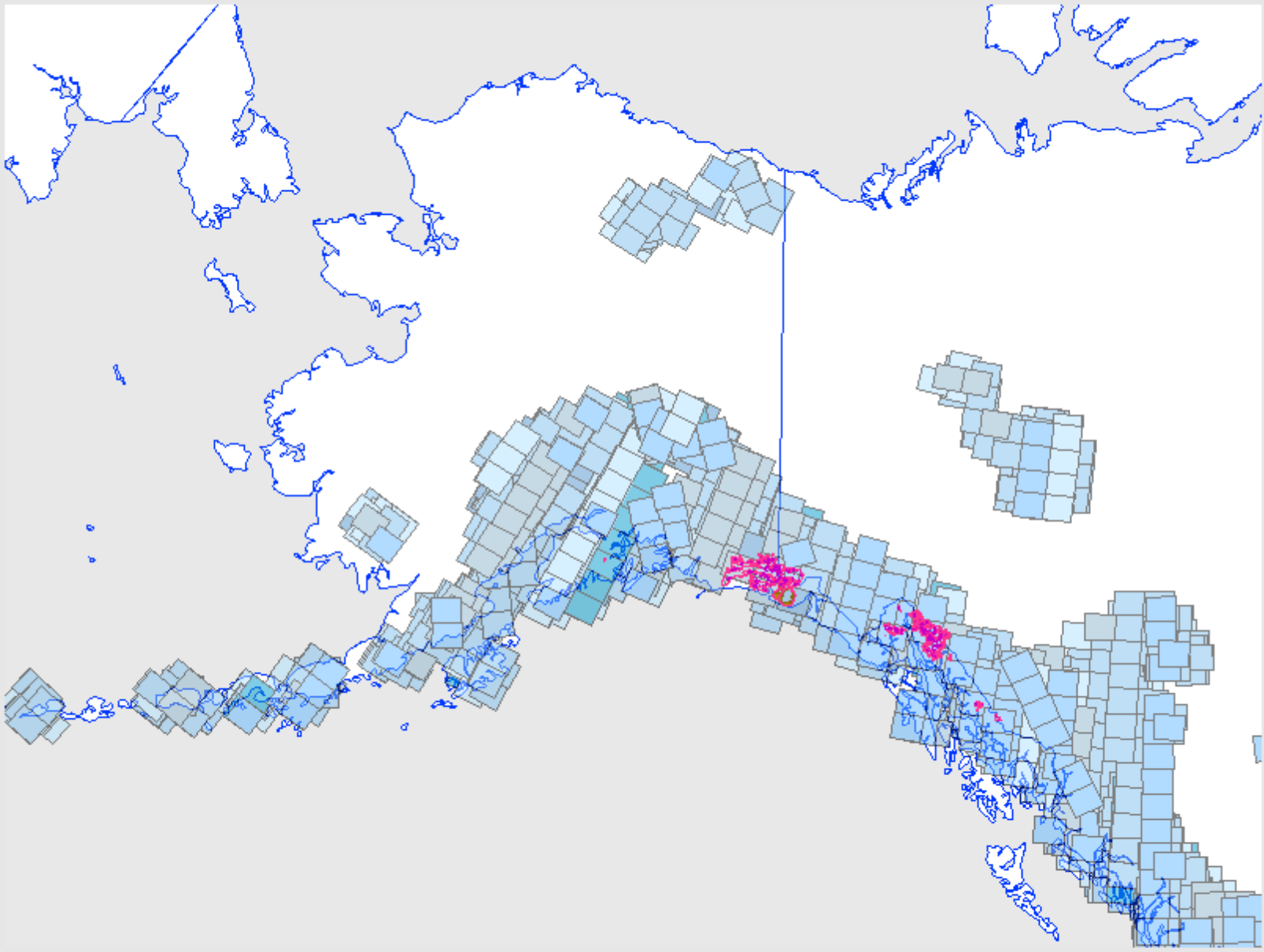
End Date:2005-12-31

Year | Month | Day

Refresh Map

GLIMS Glacier Database

Zoom to... | Map Size...



Segment:
Total Dist:

Latitude: 55.363
Longitude: -168.599

Download GLIMS Data

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [x] [ ] ASTER Footprints
  - [x] Day Images Only
- [ ] [ ] Regional Center Outlines
- [ ] [ ] GLIMS Participants
- [ ] Glaciers from DCW
- [ ] [ ] World Glacier Inventory
- [ ] STAR Outlines
- [x] [ ] Countries

Background Data:

- [ ] MODIS Blue Marble
- [ ] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date:1990-01-01

Year | Month | Day

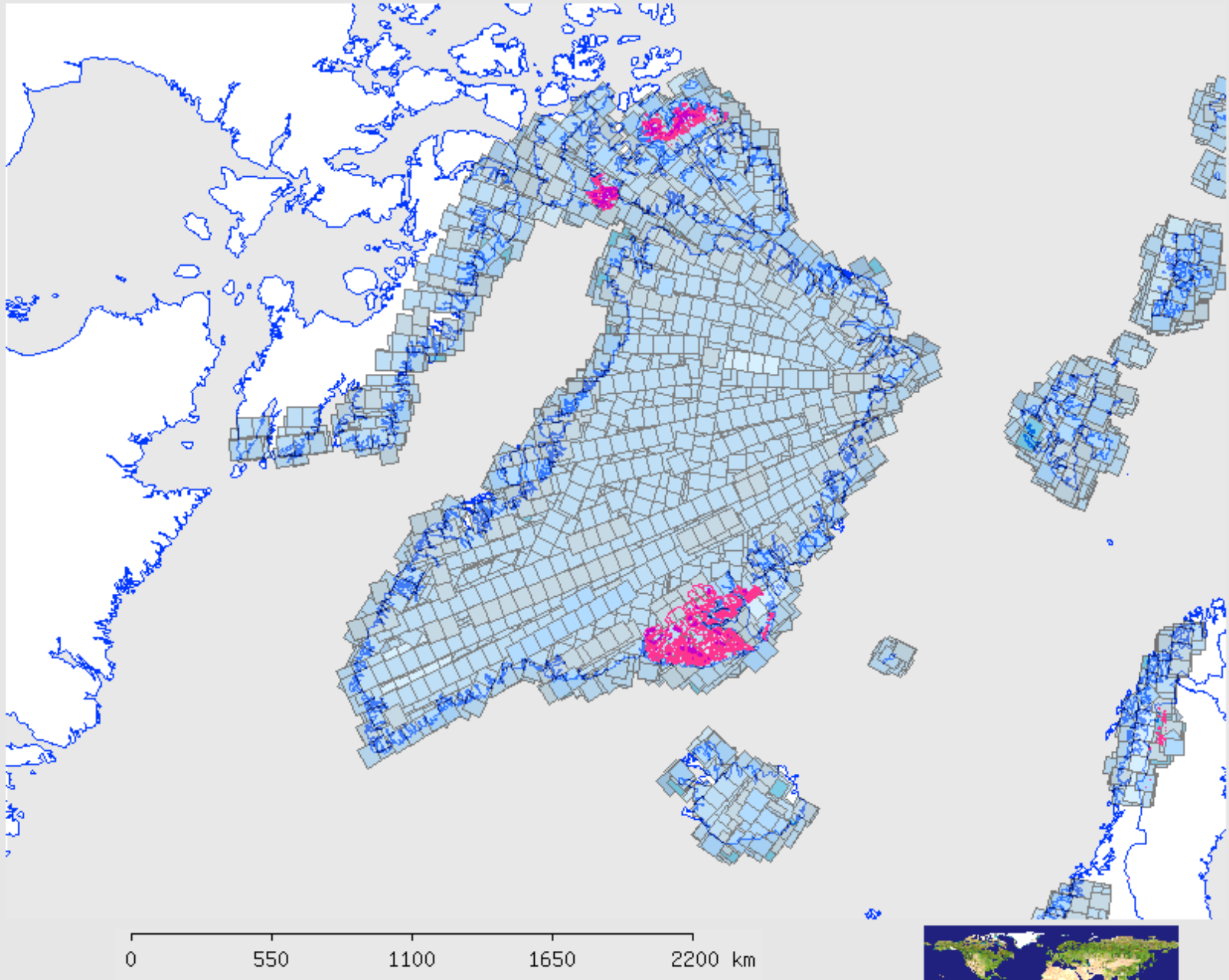
End Date:2005-12-31

Year | Month | Day

Refresh Map

GLIMS Glacier Database

Zoom to... | Map Size...



Segment:
Total Dist:

Latitude: 57.095
Longitude: 83.186

Download GLIMS Data

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [x] [ ] ASTER Footprints
  - [x] Day Images Only
- [ ] [ ] Regional Center Outlines
- [ ] [ ] GLIMS Participants
- [ ] Glaciers from DCW
- [ ] [ ] World Glacier Inventory
- [ ] STAR Outlines
- [x] [ ] Countries

Background Data:

- [ ] MODIS Blue Marble
- [ ] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date:1990-01-01

Year Month Day

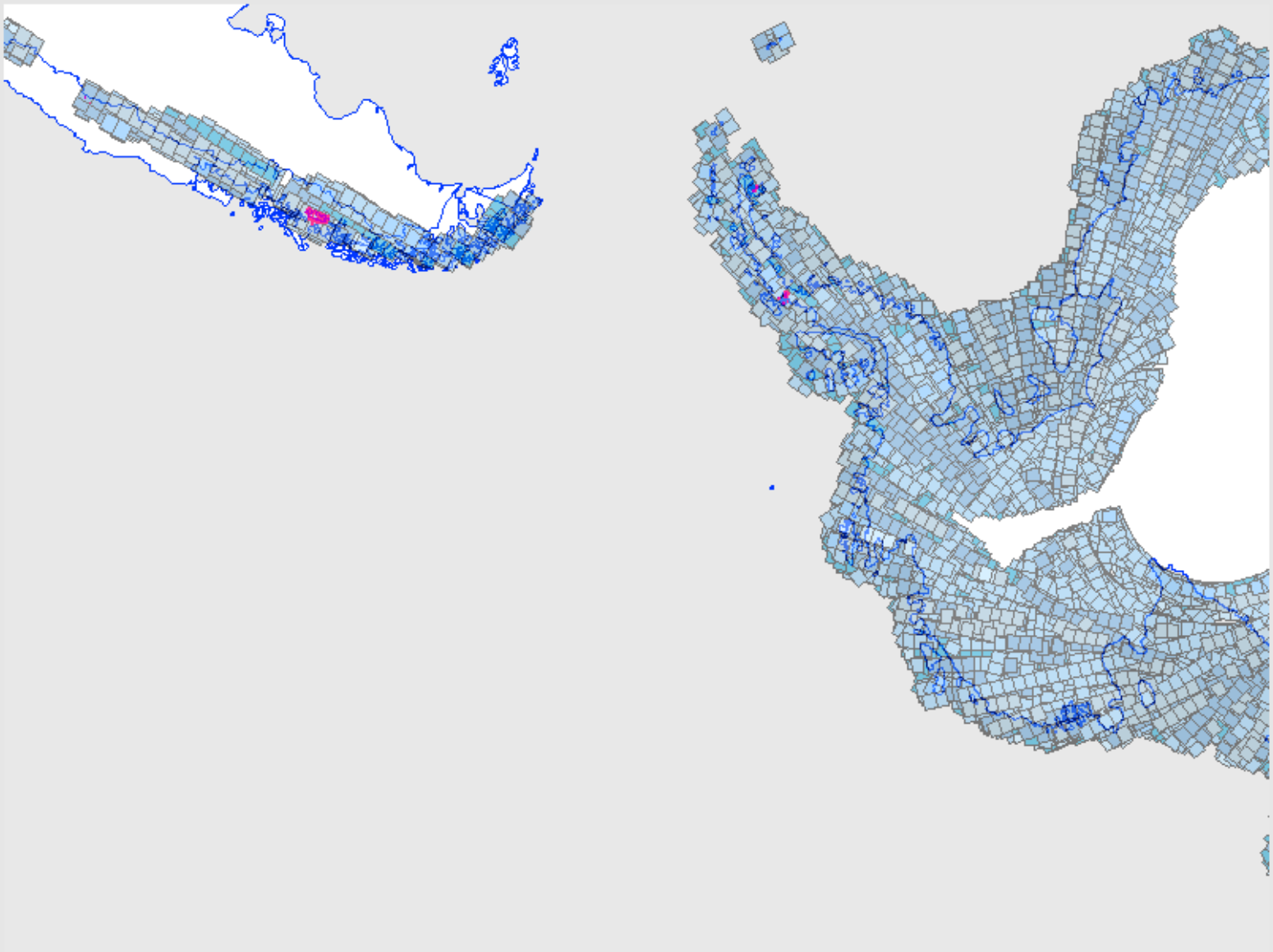
End Date:2005-12-31

Year Month Day

Refresh Map

GLIMS Glacier Database

Zoom to... Map Size...



0 770 1540 2310 3080 km

Segment:
Total Dist:

Latitude: -88.173
Longitude: 136.381

Download GLIMS Data

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [x] [ ] ASTER Footprints
  - [x] Day Images Only
- [ ] [ ] Regional Center Outlines
- [ ] [ ] GLIMS Participants
- [ ] Glaciers from DCW
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- [x] [ ] Countries

Background Data:

- [ ] MODIS Blue Marble
- [ ] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date:1990-01-01

Year Month Day

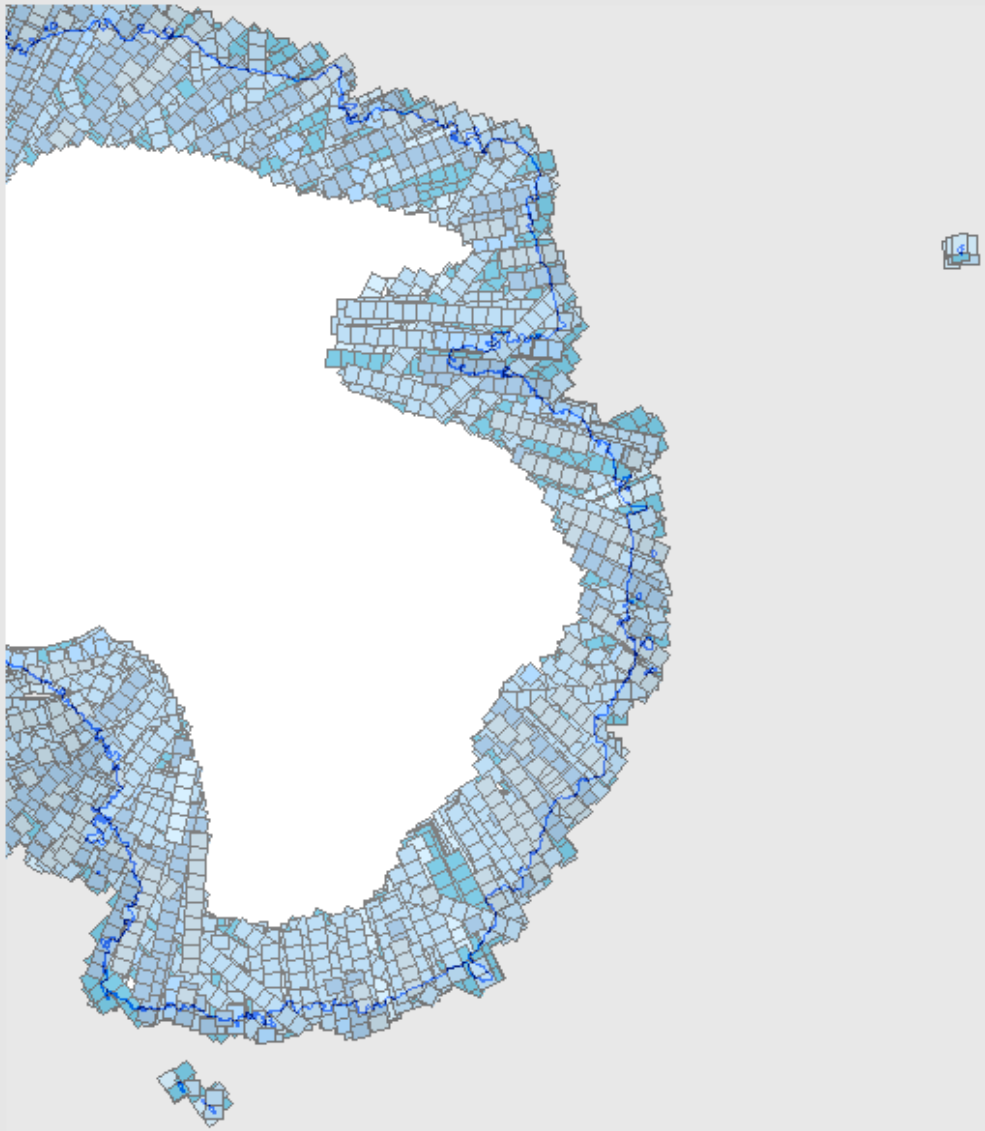
End Date:2005-12-31

Year Month Day

Refresh Map

GLIMS Glacier Database

Zoom to... Map Size...



0 770 1540 2310 3080 km

Segment:
Total Dist:

Latitude: -35.756
Longitude: 76.111

Download GLIMS Data

HELP Window View Legend

Database Layers:

- GLIMS Glaciers
- ASTER Footprints
  - Day Images Only
- Regional Center Outlines
- GLIMS Participants
- Glaciers from DCW
- World Glacier Inventory
- STAR Outlines
- Countries

Background Data:

- MODIS Blue Marble
- Source Images

Temporally Constrain Data

- GLIMS Glaciers
- ASTER Footprints

Start Date:1990-01-01

Year Month Day

End Date:2005-12-31

Year Month Day

Refresh Map

GLIMS Glacier Database

Zoom to... Map Size...

Segment:
Total Dist:

Latitude: 17.729
Longitude: -46.216

Download GLIMS Data

HELP Window View Legend

Database Layers:

- [x] [x] GLIMS Glaciers
- [x] [ ] ASTER Footprints
  - [x] Day Images Only
- [ ] [ ] Regional Center Outlines
- [ ] [ ] GLIMS Participants
- [ ] Glaciers from DCW
- [ ] [ ] World Glacier Inventory
- [ ] STAR Outlines
- [x] [ ] Countries

Background Data:

- [ ] MODIS Blue Marble
- [ ] Source Images

Temporally Constrain Data

- [ ] GLIMS Glaciers
- [ ] ASTER Footprints

Start Date:1990-01-01

Year | Month | Day

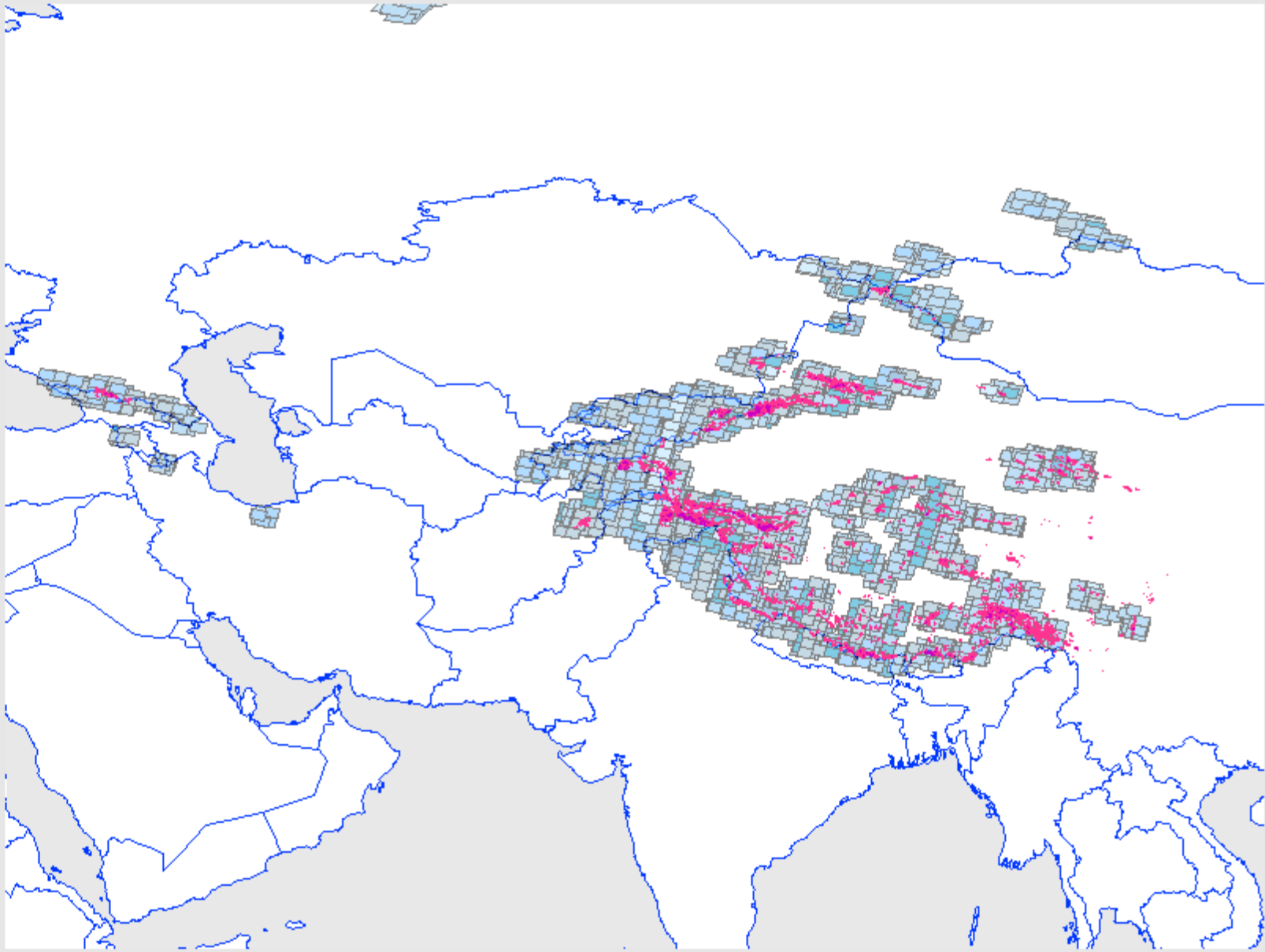
End Date:2005-12-31

Year | Month | Day

Refresh Map

GLIMS Glacier Database

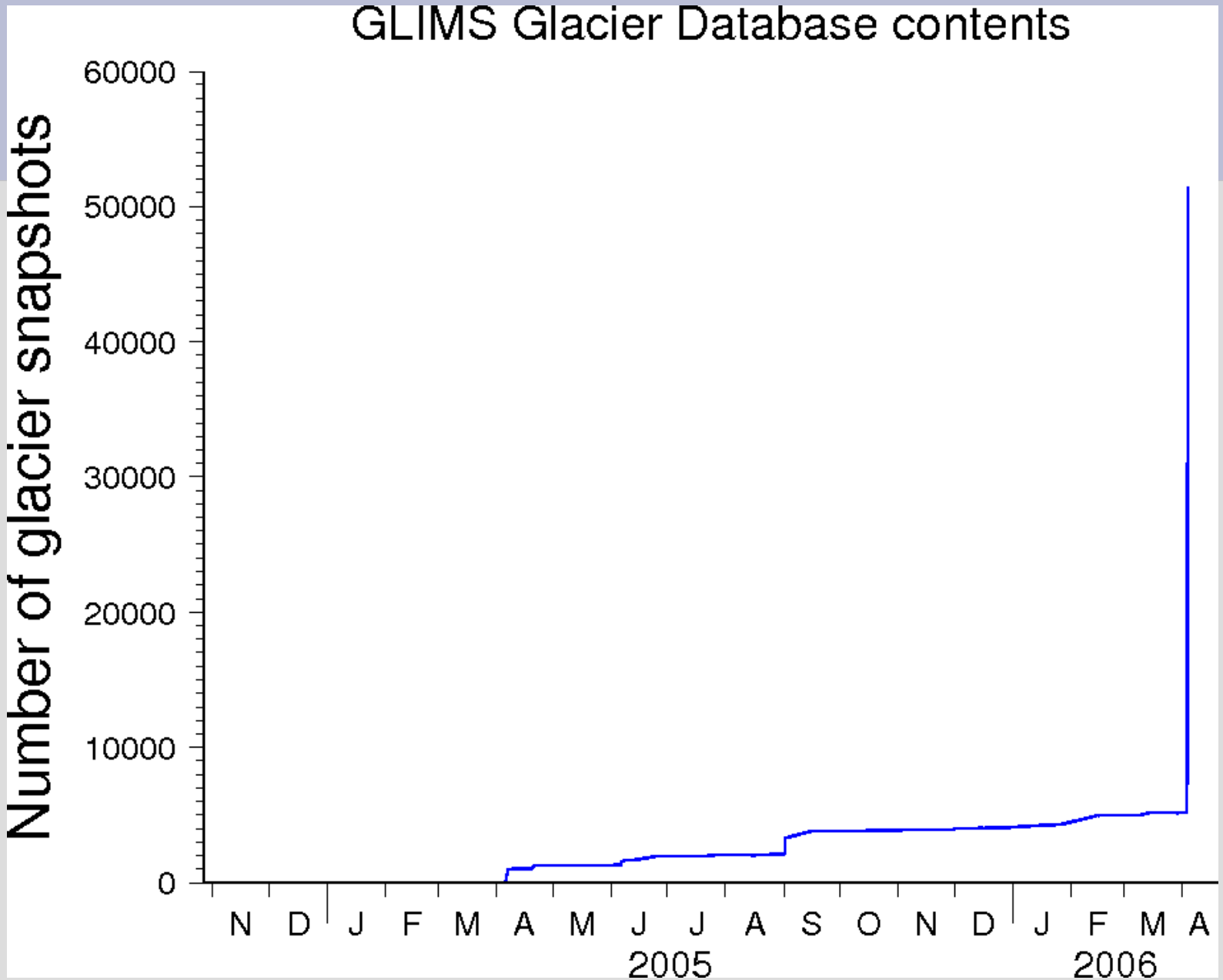
Zoom to... | Map Size...



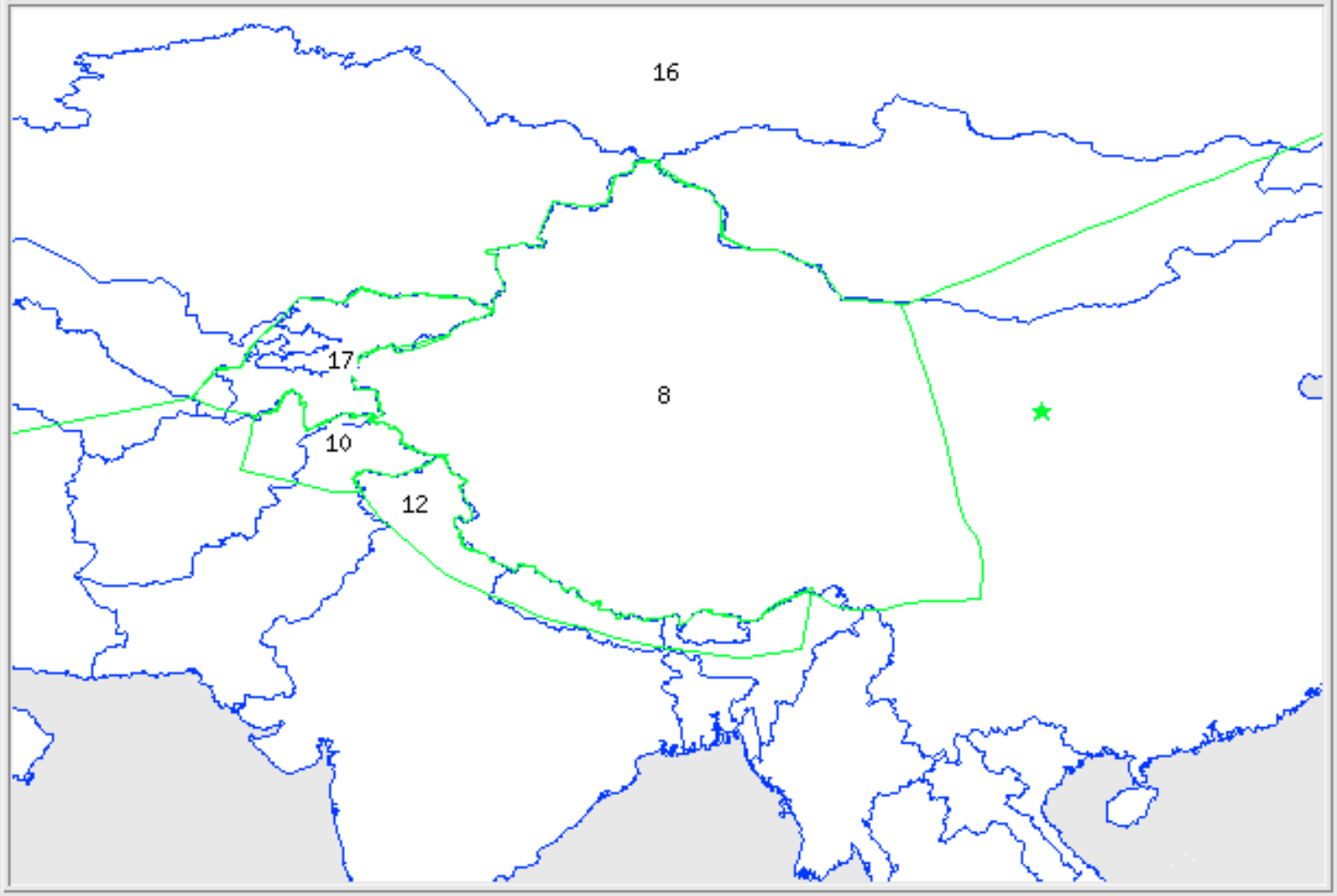
Segment:
Total Dist:

Latitude:
Longitude:

Download GLIMS Data


GLIMS Glacier Database contents
Number of glacier snapshots
60000
50000
40000
30000
20000
10000
0
N
D
J
F
M
A
M
J
J
A
S
O
N
D
J
F
M
A
2005
2006

Selected Features



Regional Center Outlines

RC ID	RC Name	Geographic Area	Contact
8	Chinese Academy of Sciences	Chinese Himalaya	Guodong Cheng
16	Geographical Institute	Russian Glaciers (exact boundaries of RC to be defined)	Vladimir Kotlyakov
12	Jawaharlal Nehru University	Himalaya (India, Nepal, Bhutan)	Syed I. Hasnain
17	Russian Academy of Sciences	Russian and former Soviet Union glaciers	Vladimir Konovalov
10	University of Nebraska at Omaha	Southwestern Asia (Pakistan + Afghanistan)	Michael P. Bishop

GLACE Experiments: Purpose

- Quantify inter-Regional Center variability in glacier classification and change detection due to both human and algorithmic differences
- Identify pitfalls in analysis methods and protocols
- In GLACE 2: Quantify variability in change detection

ASTER Analyses:

- [x] Analysis #1
- [x] Analysis #2
- [x] Analysis #3 Rocks
- [x] Analysis #3 Glacier
- [x] Analysis #4
- [x] Analysis #5
- [x] Analysis #6
- [x] Analysis #7
- [x] Analysis #8

Landsat-TM Analyses:

- [x] Analysis #1
- [x] Analysis #2
- [x] Analysis #4
- [x] Analysis #5
- [x] Analysis #6
- [x] Analysis #7
- [x] Analysis #8

Source Data:

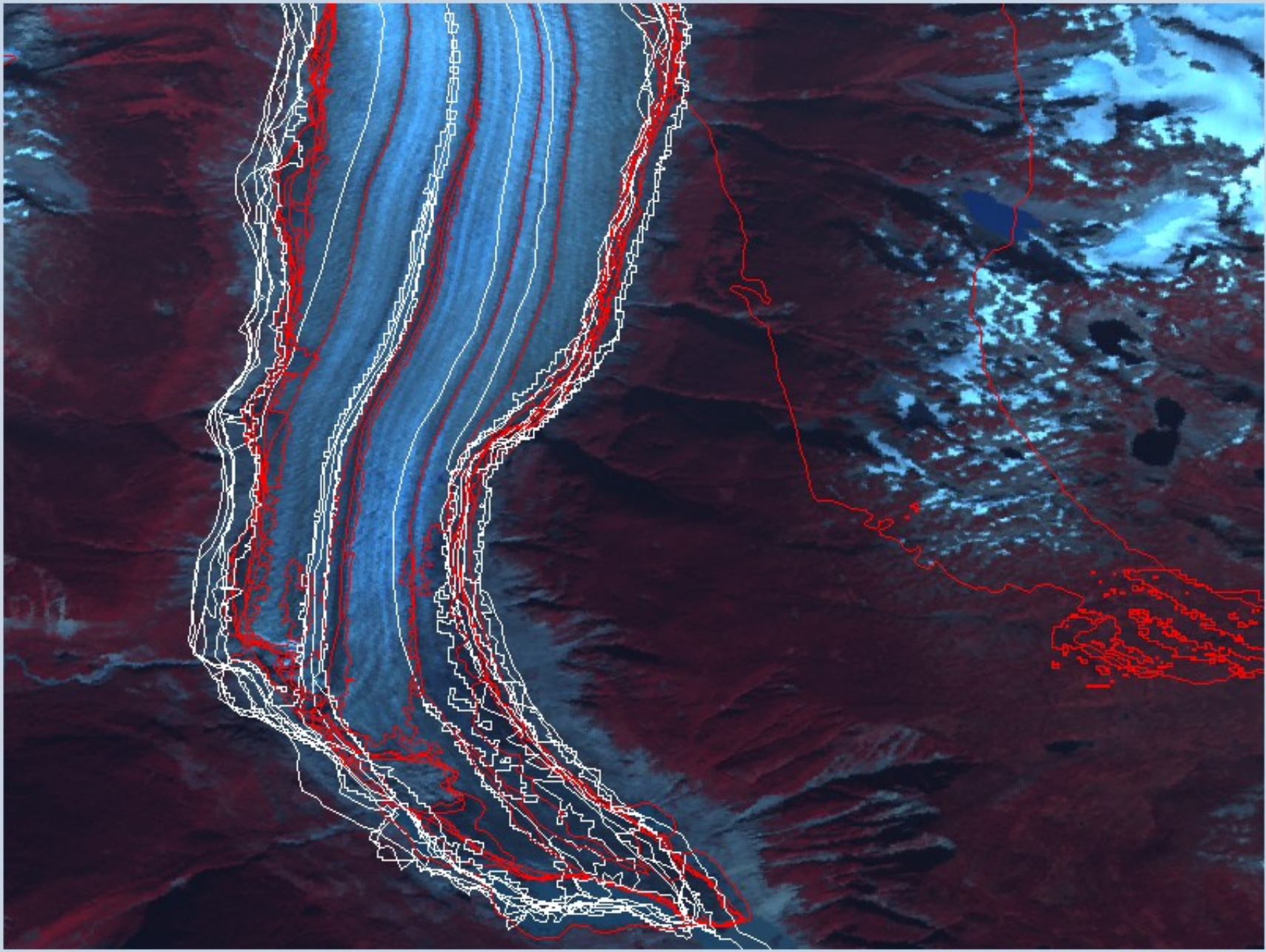
- [ ] ASTER Warp
- [x] ASTER
- [ ] LANDSAT-TM

Map Legend:

Analysis 8 Landsat
Analysis 8 ASTER
Analysis 7 Landsat
Analysis 7 ASTER
Analysis 6 Landsat
Analysis 6 ASTER
Analysis 5 Landsat

GLIMS GLACE II Results

Map Size...



GLACE 2 Summary statistics

Analysis No.	Gl area AST	Gl area TM	Rock area AST	Rock area TM	Area ch, km2	Area ch, %
1	409.5	408.6	77.91	85.4	0.9	0.22
2	474.4	479.9	58.8	55.2	-5.5	-1.15
3	677.7		145.8			
4	454.4	453.4	38.6	44.2	1	0.22
5	450.7	441.3	44.3	65.6	9.4	2.13
6	304.7	316.8	0	0	-12.1	-3.82
7	402.1	413.7	102	90.3	-11.6	-2.8
8	459.8	503.9	6	5.5	-44.1	-8.75
Min	304.7	316.8	0	0	-44.1	-8.75
Max	677.7	503.9	145.8	90.3	9.4	2.13
Mean	454.16	431.09	59.18	49.46	-8.86	-1.99
Std Dev	105.2	60.77	48.79	35.73	17.31	3.59
Median	452.55	441.3	51.55	55.2	-5.5	-1.15

GLACE Conclusions

- Results for GLACE 2 better than for GLACE 1
- Main differences are in accumulation areas
- This points to the need for:
  - increased used of topographic information
  - protocols for how to define a “glacier”
- The reality is better than this appears: QC steps at data ingest time would have disqualified several of the GLACE analyses.

Summary

- GLIMS Glacier Database stores geospatial data and many scalar attributes of ~52000 glaciers.
- Database is accessible via the Web at http://glims.colorado.edu/glacierdata/ and http://glims.colorado.edu/textsearch/
- Chinese Glacier Inventory makes up most of the current data volume.
- GLACE Experiments are improving the quality of GLIMS data processing and protocols.

Thank you!

Got questions?

Interactive maps:

http://glims.colorado.edu/glacierdata/

Text field search:

http://glims.colorado.edu/textsearch/

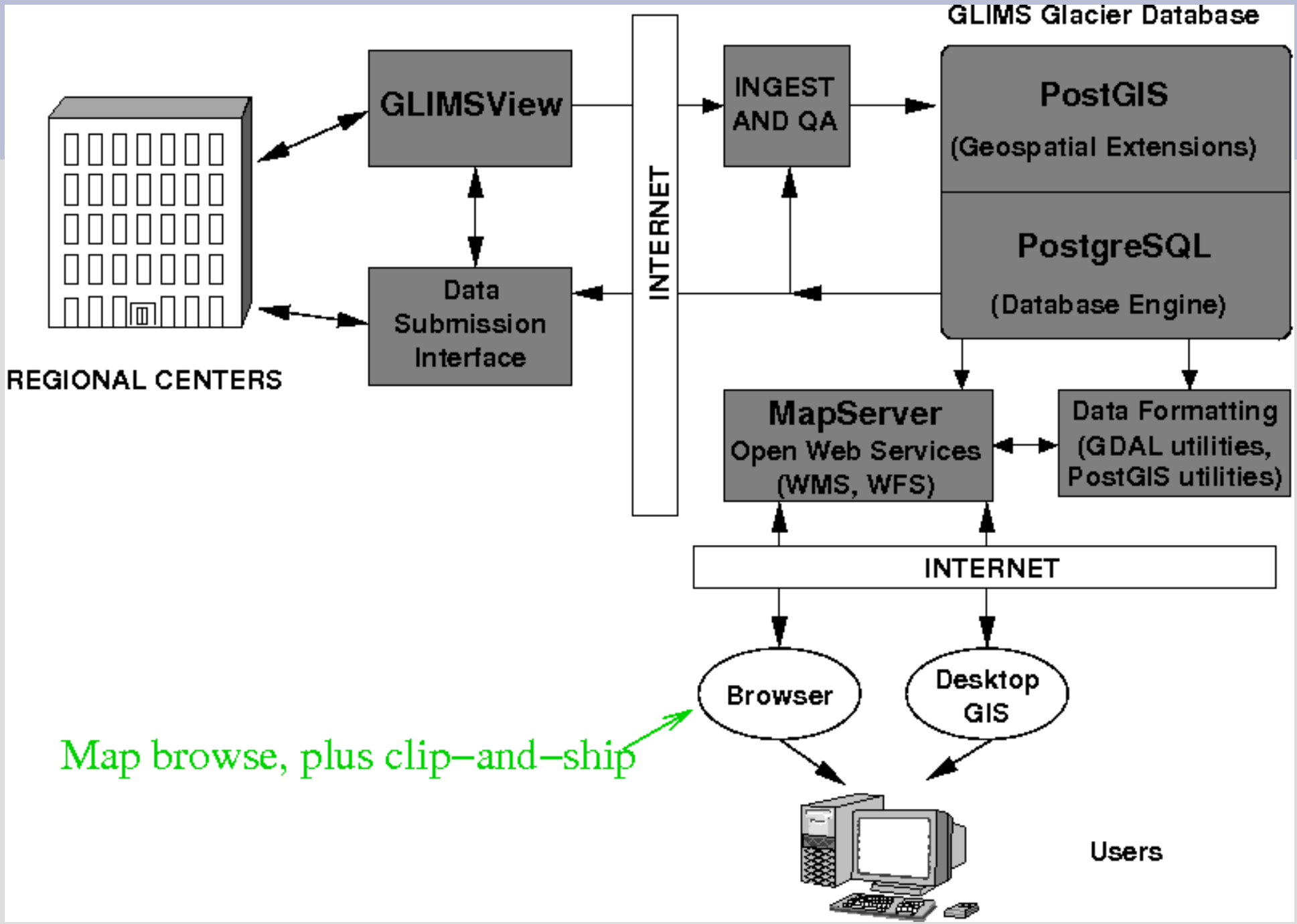
Main GLIMS Website:

http://www.glims.org/

System components

- PostgreSQL (relational database)
- PostGIS (geospatial extensions and functions)
- MapServer (OGC compliant WMS and WFS)
- Proj.4 (projection library and utilities)
- GDAL (Geospatial Data Abstraction Library)
- Perl, PHP, Shapelib, ...

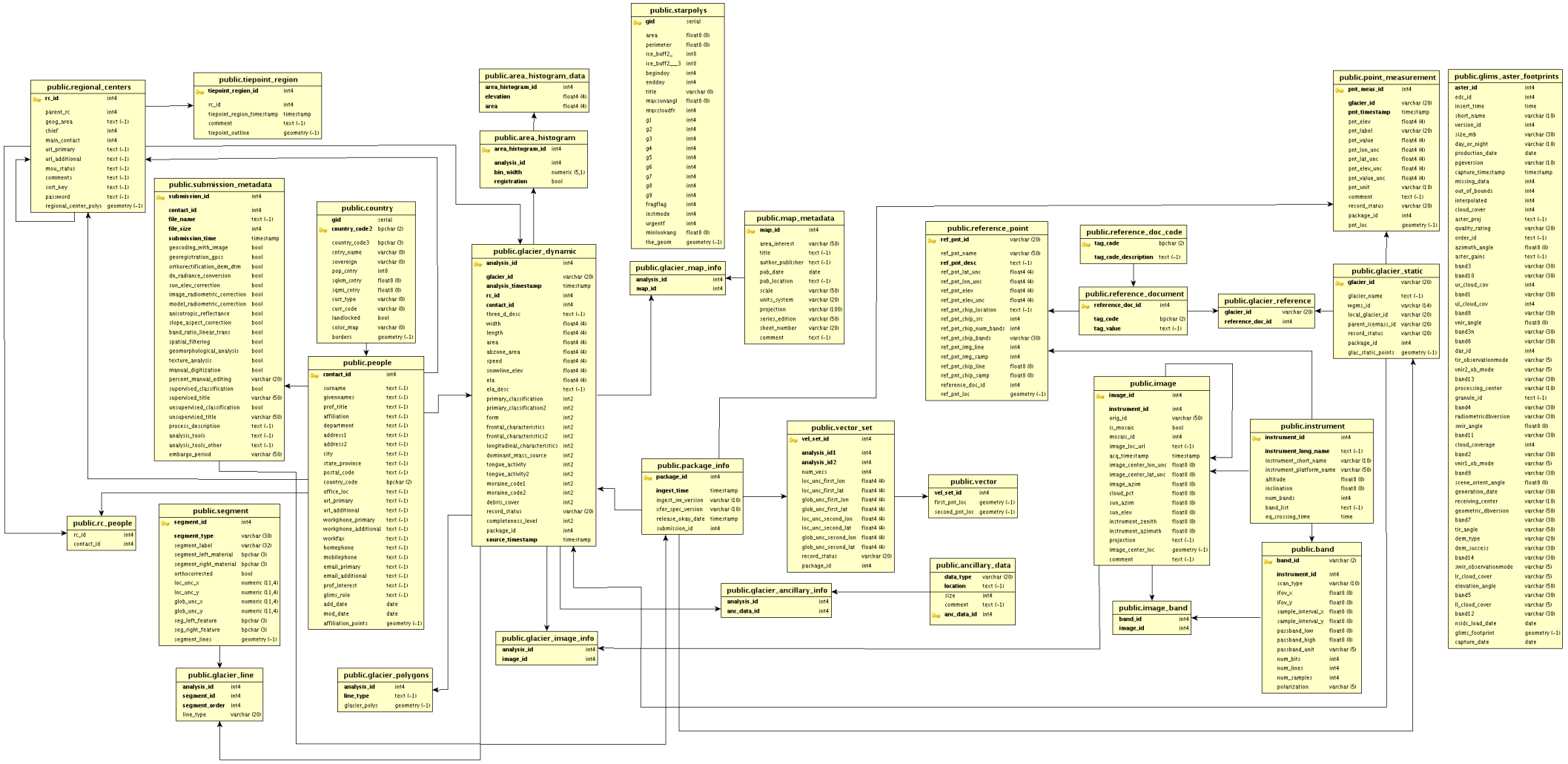
GLIMS Glacier Database System Architecture



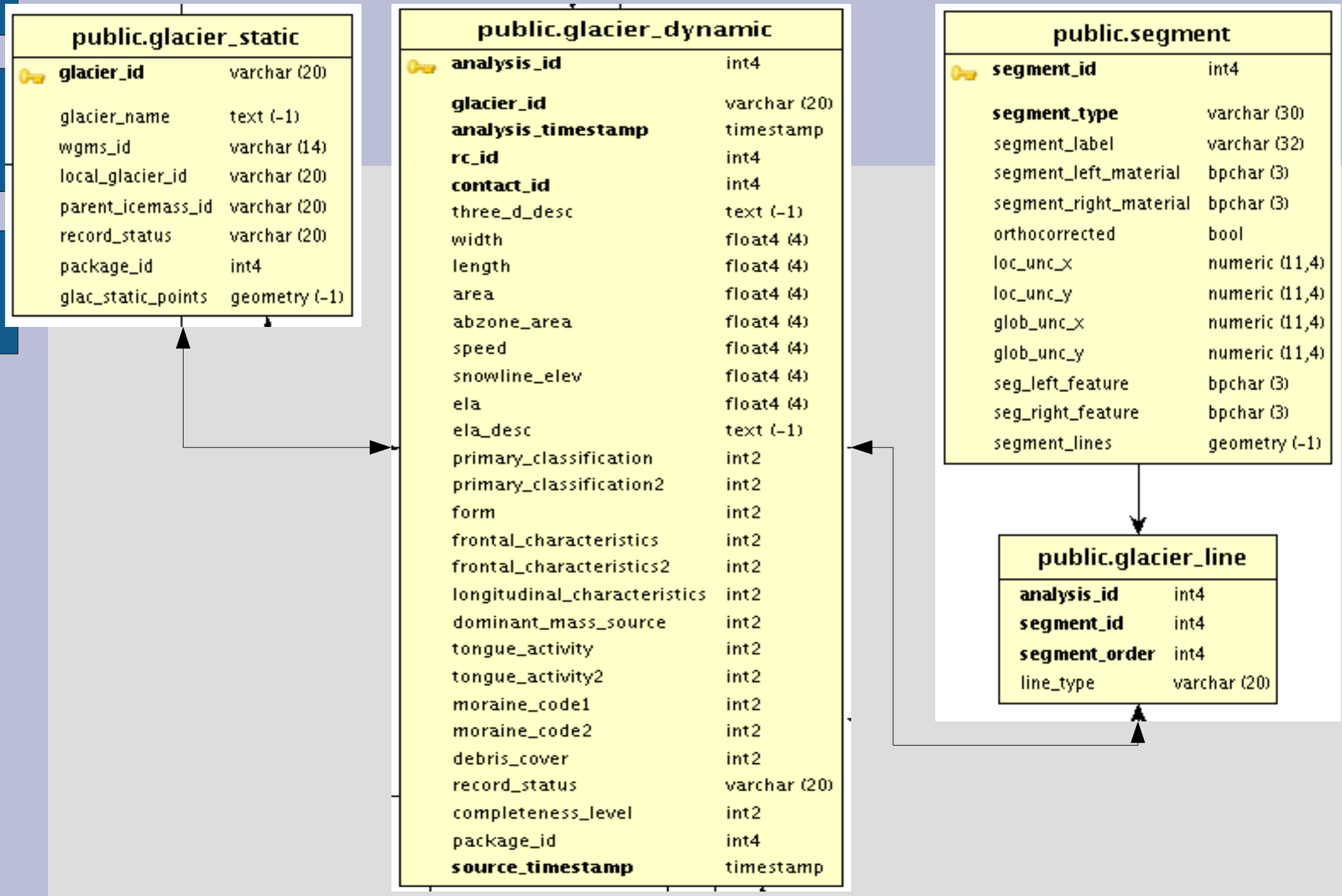
Reasons for choosing Open Source

- Flexibility – easy to script and add new capabilities (temporal constraints).
- Ability to share the whole system with other Regional Centers (many of whom have small budgets).
- Capable, and fast!
- Runs on Linux, where we can take advantage of our stock of Linux-based tools.

COMPLETE ENTITY-RELATIONSHIP DIAGRAM



MAIN DATABASE TABLES



Future Work

- Ship FGDC metadata with downloaded data
- Interface improvements and fixes
  - handle projections better
  - implement Google Maps-like no-refresh style interface (probably using open-source ka-Map)
  - better presentation of multi-temporal data
  - Offer more choices for attribute sets