

MAXIMIZING “Experience Index”

OF GIRO DATA SERVICES, WEB PORTAL, AND API

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UMass Lowell Space Science Laboratory
Lowell Digisonde International, LLC



22 SEPTEMBER **PRE-FORUM SCIENCE DAY**

IGF 2025

23-26 SEPTEMBER **XVI INTERNATIONAL GIRO FORUM**

Big question

- How do we get to your data?
 - Easy... or not.

Experience Index

- (*def.*) A merit system to identify the impact of design on user experiences
 - “great”, “good”, “not-so-good”, “poor” experience
 - The merit system identifies key drivers for a great experience

The goal:

Build great GIRO services that keep people coming back.

How do we do that?



What do we all want?



GIRO Users:

- Model ionosphere
- Study processes
- Locate relevant data
- Access data **quickly**
- Get good quality data
- Avoid format problems
- Avoid fighting computers
- Publish **quickly**
- Enjoy life

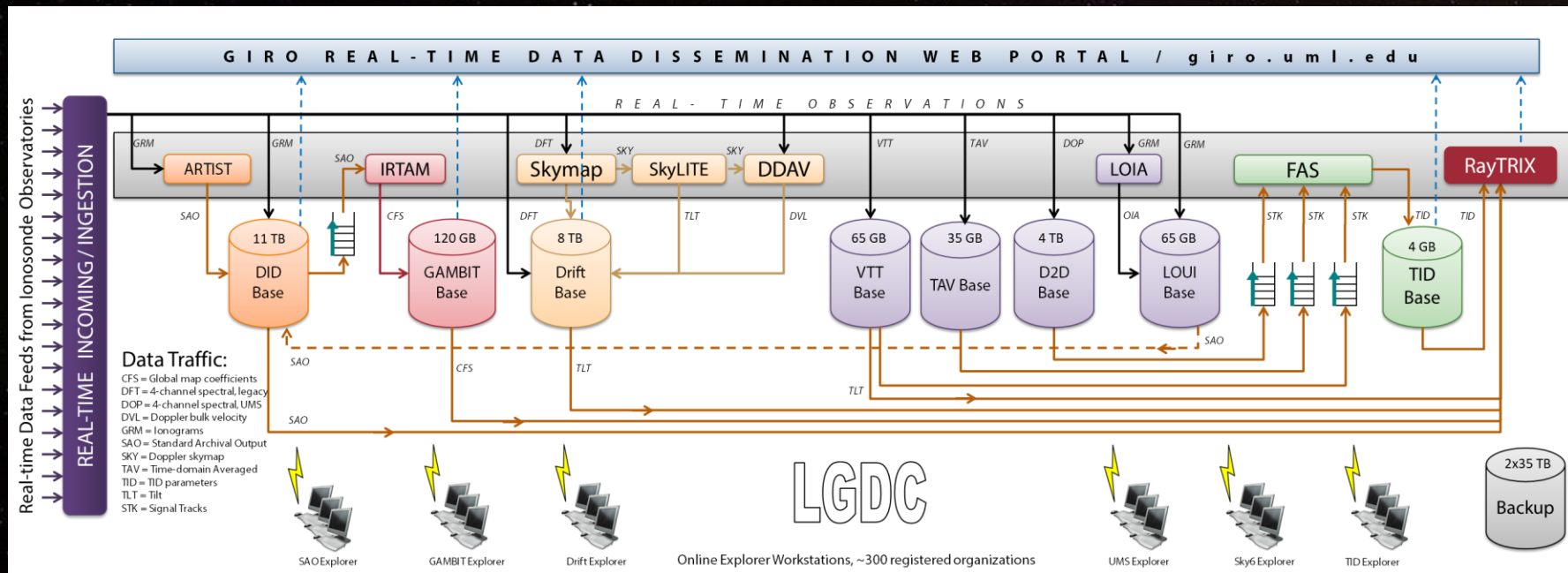
© NASA HPDE



GIRO Crew:

- Enjoy life
- Make GIRO a powerful tool
- Cut development costs
- Cut maintenance costs
- Cut troubleshooting costs
- Cut documentation costs
- Cut computer HW costs
- Cut networking costs

Lowell GIRO Data Center: LGDC



What do you want from LGDC?

YES PLEASE

- Search and locate relevant data
- Access data quickly
- Trust data quality

OH NO!

- Missing data
 - Incomplete data
 - Wondering if data are incomplete
- A long wait
- Unknown format
- Data errors
 - Autoscaling

What do we want from LGDC?

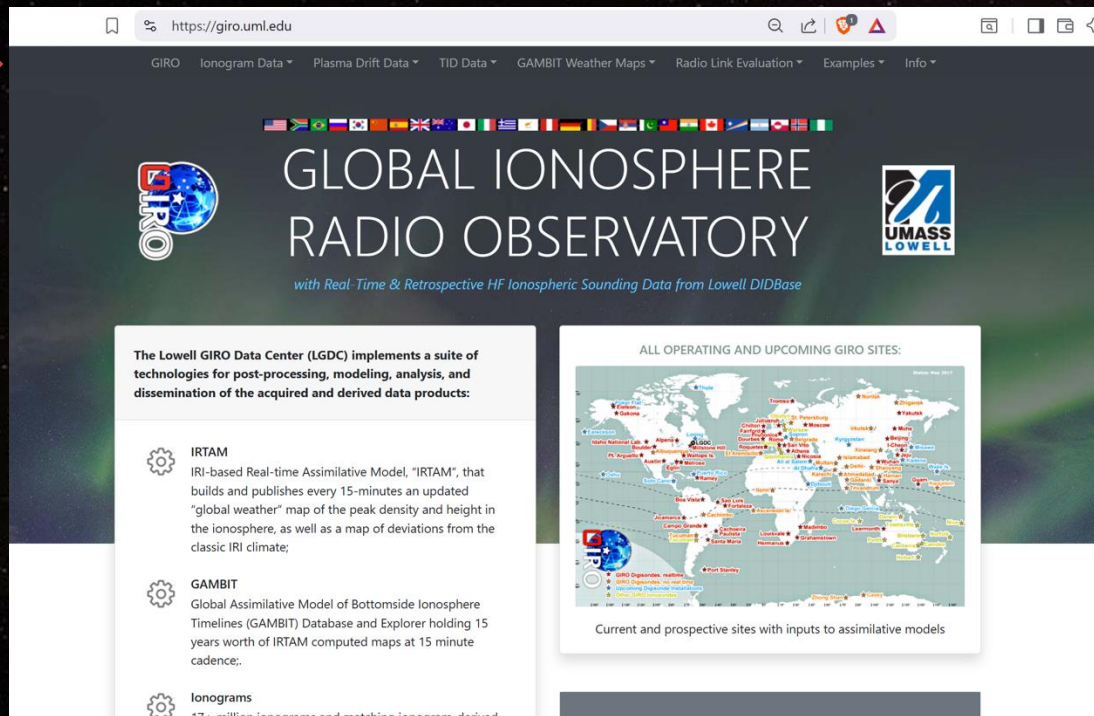
YES PLEASE

- Everything works without our supervision:
 - Ingestion
 - databasing
 - frontend servlets
 - real-time processors
 - backups

OH NO!

- Cyber-attacks
- Vulnerability prevention duties (upgrades)
- Online software crashes
- Computer failures

GIRO Web Portal, giro.uml.edu

The screenshot shows the GIRO Web Portal homepage. At the top is a navigation bar with links: GIRO, Ionogram Data, Plasma Drift Data, TID Data, GAMBIT Weather Maps, Radio Link Evaluation, Examples, and Info. Below the navigation bar is a header section featuring a row of flags, the GIRO logo, the text "GLOBAL IONOSPHERE RADIO OBSERVATORY", and the UMass Lowell logo. A tagline reads "with Real-Time & Retrospective HF Ionospheric Sounding Data from Lowell DDBase".

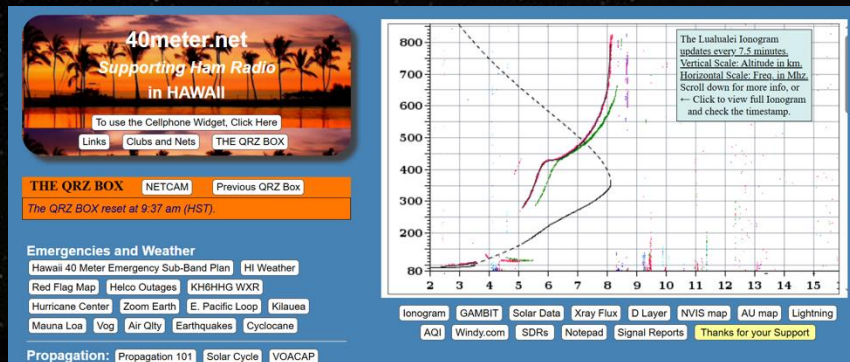
The main content area is divided into two columns. The left column, titled "The Lowell GIRO Data Center (LGDC) implements a suite of technologies for post-processing, modeling, analysis, and dissemination of the acquired and derived data products:", lists three key services:

- IRTAM**: IRI-based Real-time Assimilative Model, "IRTAM", that builds and publishes every 15-minutes an updated "global weather" map of the peak density and height in the ionosphere, as well as a map of deviations from the classic IRI climate;
- GAMBIT**: Global Assimilative Model of Bottomside Ionosphere Timelines (GAMBIT) Database and Explorer holding 15 years worth of IRTAM computed maps at 15 minute cadence;
- Ionograms**: 17.4 million ionograms and matching ionogram-derived

The right column, titled "ALL OPERATING AND UPCOMING GIRO SITES:", features a world map showing the locations of current and prospective sites. Below the map, it states "Current and prospective sites with inputs to assimilative models".

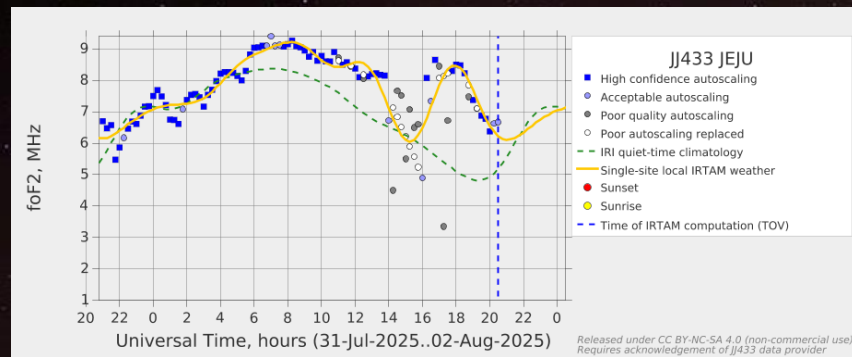
Success Story: *Latest* displays

Latest Local Ionogram



<https://lgdc.uml.edu/ionoweb/latest?&ursiCode=LL721>

Latest GAMBIT Local Weather



<https://lgdc.uml.edu/rix/gambit-local-nowcast?charName=foF2&site=LL721>

Success story: ionogram browser

[OL246](#) OLSZTYN 53.80 20.50
[SN437](#) OSAN AB 37.10 127.00
[PE43K](#) PERTH -32.00 116.13
[PK553](#) PETROPAVLOVSK 52.97 158.24
[PF765](#) POKER FLAT 65.13 212.55
[PSUJ](#) PORT STANLEY -51.60 302.10
[PQ052](#) PRUHONICE 50.00 14.60
[PA836](#) PT ARGUELLO 34.80 239.50
[SU18](#) PUERTO RICO 18.11 293.75
[PRJ18](#) RAMEY 18.50 292.90
[RM041](#) ROME 41.80 12.50
[RO041](#) ROME 41.90 12.50
[EB040](#) ROQUETES 40.80 0.50
[RV149](#) ROSTOV 47.24 39.63
[SH266](#) SALEKHARD 66.51 66.66
[VT139](#) SAN VITO 40.60 17.80
[SMK29](#) SANTA MARIA -29.73 306.29
[SA418](#) SANYA 18.34 109.42
[SAA0K](#) SAOLUIS -2.60 315.80
[SMJ67](#) SONDRESTROM 66.98 309.06
[SQ148](#) SOPRON 47.63 16.72
[SH42](#) SOUTH HEDLAND -20.40 118.50
[SO832](#) SQUIRT 32.42 253.71

Instructions

Start your data query by selecting a station's URSI code from the "DIDBase Fast Station List" to the left. The station list can be sorted by clicking on the column titles.

DIDBase will be queried and create links within year, month, and day for the selected station. To further refine your data selection select a year, month, and day by clicking on the available links.

Once a day is selected, the ionograms for that day will be available for display. You can navigate through the ionograms with the buttons at the bottom of the display.

Years for VT139

URSI Code	Latitude	Longitude
VT139	40.60	17.80
2000	2001	2002
2003	2004	2005
2006	2007	2008
2009	2010	2011
2012	2013	2014
2015	2016	2017
2018	2019	2020
2021	2022	2023
2024	2025	

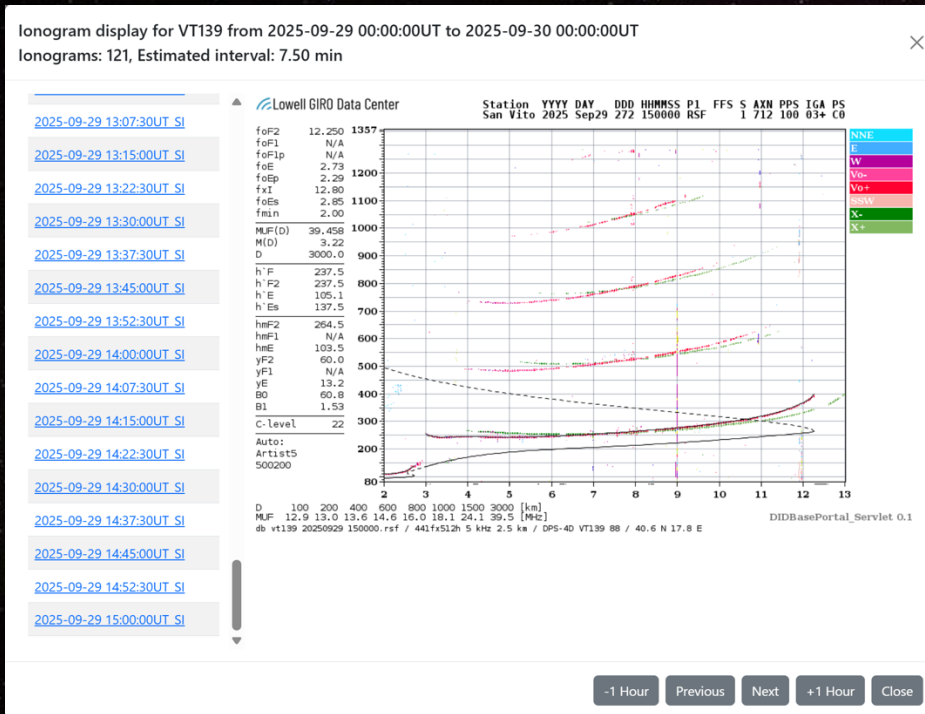
Months for 2025

Jan	Feb	Mar	Apr	May	Jun
Jul	Aug	Sep			

Days for September

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	

Success story: ionogram browser



Ionogram viewer overuse

- Requests to plot an ionogram image coming in at unreasonable pace (<1 Hz)

```
joint@lgdc /var/log/nginx $ tail -f access.log | grep 109.252.119.212
109.252.119.212 - - [04/Aug/2025:21:06:07 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630298&time=1996-07-28T06:44:58.000 HTTP/1.1" 200 50069 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:08 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630299&time=1996-07-28T06:49:58.000 HTTP/1.1" 200 49729 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:10 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630300&time=1996-07-28T06:54:58.000 HTTP/1.1" 200 49951 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:11 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630301&time=1996-07-28T06:59:58.000 HTTP/1.1" 200 51072 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:12 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630302&time=1996-07-28T07:04:58.000 HTTP/1.1" 200 49873 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:13 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630303&time=1996-07-28T07:09:58.000 HTTP/1.1" 200 51621 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:14 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630304&time=1996-07-28T07:14:58.000 HTTP/1.1" 200 50657 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:15 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630305&time=1996-07-28T07:19:58.000 HTTP/1.1" 200 51244 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:16 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630306&time=1996-07-28T07:24:58.000 HTTP/1.1" 200 50431 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:18 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630307&time=1996-07-28T07:29:58.000 HTTP/1.1" 200 50591 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:19 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630308&time=1996-07-28T07:34:58.000 HTTP/1.1" 200 50676 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:20 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630309&time=1996-07-28T07:39:58.000 HTTP/1.1" 200 50850 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:22 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630310&time=1996-07-28T07:44:58.000 HTTP/1.1" 200 50569 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:23 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630311&time=1996-07-28T07:49:58.000 HTTP/1.1" 200 50788 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:24 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630312&time=1996-07-28T07:54:58.000 HTTP/1.1" 200 50665 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:26 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630313&time=1996-07-28T07:59:58.000 HTTP/1.1" 200 50471 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:27 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630314&time=1996-07-28T08:04:58.000 HTTP/1.1" 200 51009 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:29 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630315&time=1996-07-28T08:09:58.000 HTTP/1.1" 200 51551 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:30 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630317&time=1996-07-28T08:14:58.000 HTTP/1.1" 200 50375 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:31 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630318&time=1996-07-28T08:19:58.000 HTTP/1.1" 200 50774 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:33 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630319&time=1996-07-28T08:24:58.000 HTTP/1.1" 200 50497 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:34 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630320&time=1996-07-28T08:29:58.000 HTTP/1.1" 200 50511 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:36 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630321&time=1996-07-28T08:34:58.000 HTTP/1.1" 200 50955 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:37 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630322&time=1996-07-28T08:39:58.000 HTTP/1.1" 200 51343 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:38 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630323&time=1996-07-28T08:44:58.000 HTTP/1.1" 200 50914 "-" "python-requests/2.25.1"
109.252.119.212 - - [04/Aug/2025:21:06:39 -0400] "GET /ionoweb/ionogram?ursiCode=CL424&mid=50630324&time=1996-07-28T08:49:58.000 HTTP/1.1" 200 50468 "-" "python-requests/2.25.1"
```



- These are robots of course, but built by clever humans
- There are 45,000,000+ ionograms, what are they thinking about?
 - It will take 2+ years per user to get images
 - There will be millions more ionograms in 2 years

Data Avalanche at LGDC

- DIDBase (since 2001):
 - 45.0 million raw ionograms
 - 61.5 million SAO scalings
 - 1.3 billion FastChar values
- Hats off to Firebird DBMS

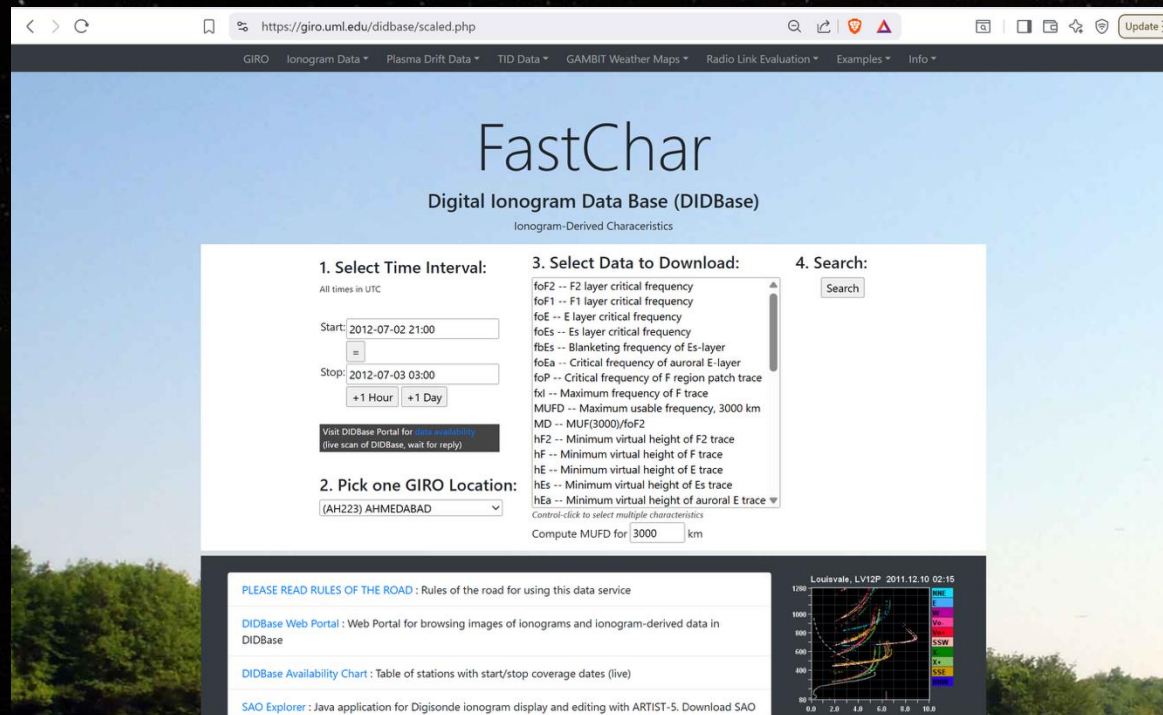
If process 200 ionograms/day,
then ~800 work-years are
needed to look at these
ionograms

By that time, new millions of
ionograms will be available to
process



Thanks!

Success story: FastCar



FastChar
Digital Ionogram Data Base (DIDBase)
Ionogram-Derived Characteristics

1. Select Time Interval:
All times in UTC
Start: 2012-07-02 21:00
Stop: 2012-07-03 03:00
+1 Hour +1 Day
Visit DIDBase Portal for data availability (live scan of DIDBase, wait for reply)

2. Pick one GIRO Location:
(AH223) AHMEDABAD

3. Select Data to Download:
foF2 -- F2 layer critical frequency
foF1 -- F1 layer critical frequency
foE -- E layer critical frequency
foEs -- Es layer critical frequency
fbEs -- Blanketing frequency of Es-layer
foEa -- Critical frequency of auroral E-layer
foFp -- Critical frequency of F region patch trace
foF -- Maximum frequency of F trace
MUF3000 -- Maximum usable frequency, 3000 km
MD -- MUF(3000)foF2
hF2 -- Minimum virtual height of F2 trace
hF -- Minimum virtual height of F trace
hE -- Minimum virtual height of E trace
hEs -- Minimum virtual height of Es trace
hEa -- Minimum virtual height of auroral E trace
Control-click to select multiple characteristics
Compute MUF for 3000 km

4. Search:

PLEASE READ RULES OF THE ROAD : Rules of the road for using this data service
DIDBase Web Portal : Web Portal for browsing images of ionograms and ionogram-derived data in DIDBase
DIDBase Availability Chart : Table of stations with start/stop coverage dates (live)
SAO Explorer : Java application for Digisonde ionogram display and editing with ARTIST-5. Download SAO

Lowell, LV12P 2011.12.10 02:15

```
# Global Ionospheric Radio Observatory
# GIRO Tabulated Ionospheric Characteristics, Version 1.0 Revision B
# Generated by DIDGetValues on 2025-09-29T19:19:25.384Z
#
# Location: GEO 40.6N 17.8E, URSI-Code VT139 SAN VITO
# Instrument: Ionosonde, Model: DPS-4D
#
# Query for measurement intervals of time:
# 2025-09-29T00:00:00.000Z - 2025-09-30T00:01:00.000Z
#
# Data Selection:
# CS is Autoscaling Confidence Score (from 0 to 100, 999 if manual scaling, -1 if unknown)
# foF2 [MHz] - F2 layer critical frequency
# hmF2 [km] - Peak height F2-layer
#
# All GIRO measurements are released under CC-BY-NC-SA 4.0 license
# Please follow the Lowell GIRO Data Center RULES OF THE ROAD
# https://ulcar.uml.edu/DIDBase/RulesOfTheRoadForDIDBase.htm
# Requires acknowledgement of VT139 data provider
#
#Time      CS   foF2 QD   hmF2 QD
2025-09-29T00:00:00.000Z 90 5.575 // 407.6 //
2025-09-29T00:07:30.000Z 95 5.525 // 393.5 //
2025-09-29T00:15:00.000Z 95 5.525 // 387.8 //
2025-09-29T00:22:30.000Z 95 5.500 // 382.7 //
2025-09-29T00:30:00.000Z 90 5.500 // 387.5 //
2025-09-29T00:37:30.000Z 100 5.425 // 388.4 //
2025-09-29T00:45:00.000Z 75 5.425 // 398.8 //
2025-09-29T00:52:30.000Z 95 5.375 // 395.5 //
2025-09-29T01:00:00.000Z 95 5.375 // 397.6 //
2025-09-29T01:07:30.000Z 100 5.350 // 391.3 //
2025-09-29T01:15:00.000Z 95 5.325 // 391.8 //
2025-09-29T01:22:30.000Z 90 5.325 // 396.7 //
2025-09-29T01:30:00.000Z 100 5.325 // 395.9 //
2025-09-29T01:37:30.000Z 100 5.250 // 386.8 //
2025-09-29T01:45:00.000Z 95 5.325 // 395.9 //
2025-09-29T01:52:30.000Z 90 5.300 // 389.7 //
2025-09-29T02:00:00.000Z 90 5.450 // 401.9 //
2025-09-29T02:07:30.000Z 95 5.400 // 379.8 //
2025-09-29T02:15:00.000Z 95 5.525 // 386.0 //
2025-09-29T02:22:30.000Z 95 5.575 // 384.9 //
2025-09-29T02:30:00.000Z 95 5.625 // 389.5 //
2025-09-29T02:37:30.000Z 90 5.650 // 379.0 //
2025-09-29T02:45:00.000Z 95 5.675 // 373.6 //
2025-09-29T02:52:30.000Z 95 5.700 // 367.0 //
2025-09-29T03:00:00.000Z 95 5.700 // 365.6 //
2025-09-29T03:07:30.000Z 75 5.675 // 353.5 //
2025-09-29T03:15:00.000Z 95 5.675 // 345.4 //
2025-09-29T03:22:30.000Z 90 5.650 // 336.3 //
2025-09-29T03:30:00.000Z 95 5.625 // 332.5 //
```


Experience index of LGDC Services

- How do we access data *better*?
 - Faster
 - More conveniently
- How do we have entire data?
 - LGDC to store *all* ionogram data ever collected by human civilization

Quick-access tools

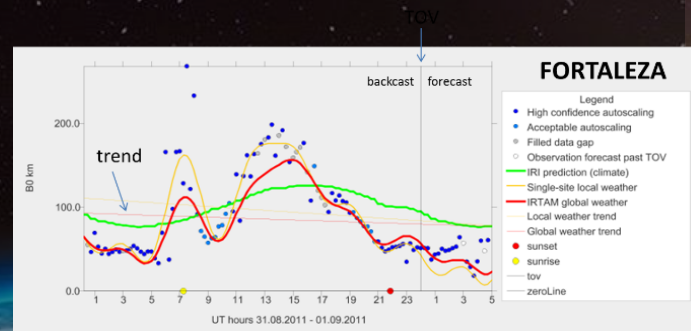
- SAO Explorer is not a quick access tool
- Quick access:
 - FastChar table in DIDBase
 - GAMBIT
 - Servlets/API
 - Various latest displays
- MUF Computations using ionograms and raytracers

MUF Computations

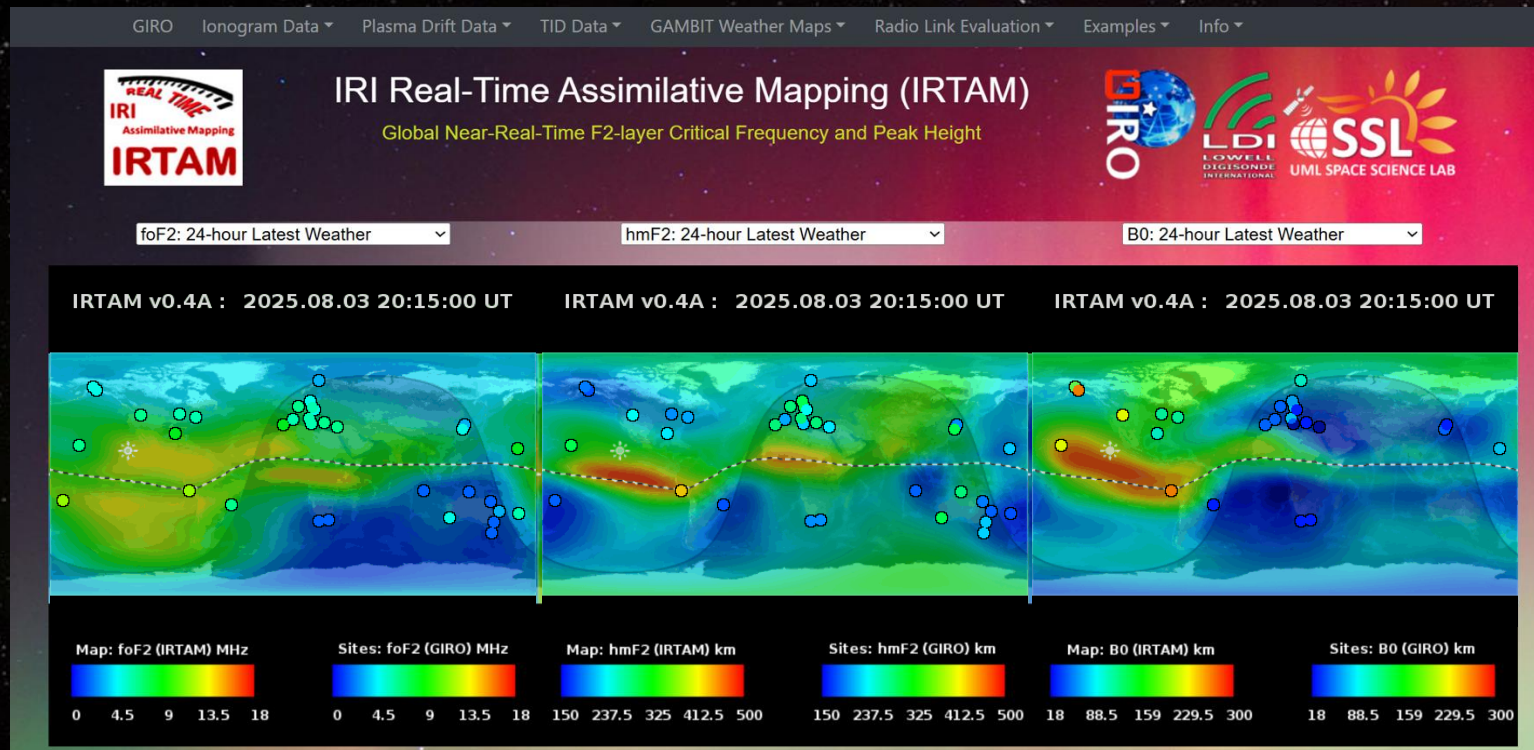
- Digisonde *.MUF files
- LGDC resources
 - MUF servlets (Digisonde sites, any D)
 - */fastchar/getmuf* servlet
 - *<https://giro.uml.edu/rix/MUF/>* landing page
 - GAMBIT MUF3000 (global map, IRTAM weather)
 - */rix/gambit-muf-message*
 - RayTRIX CQP (any radio link, 2-hop supported)
 - *<https://giro.uml.edu/rix/oi-synth/>*

Use GAMBIT instead of DIDBase

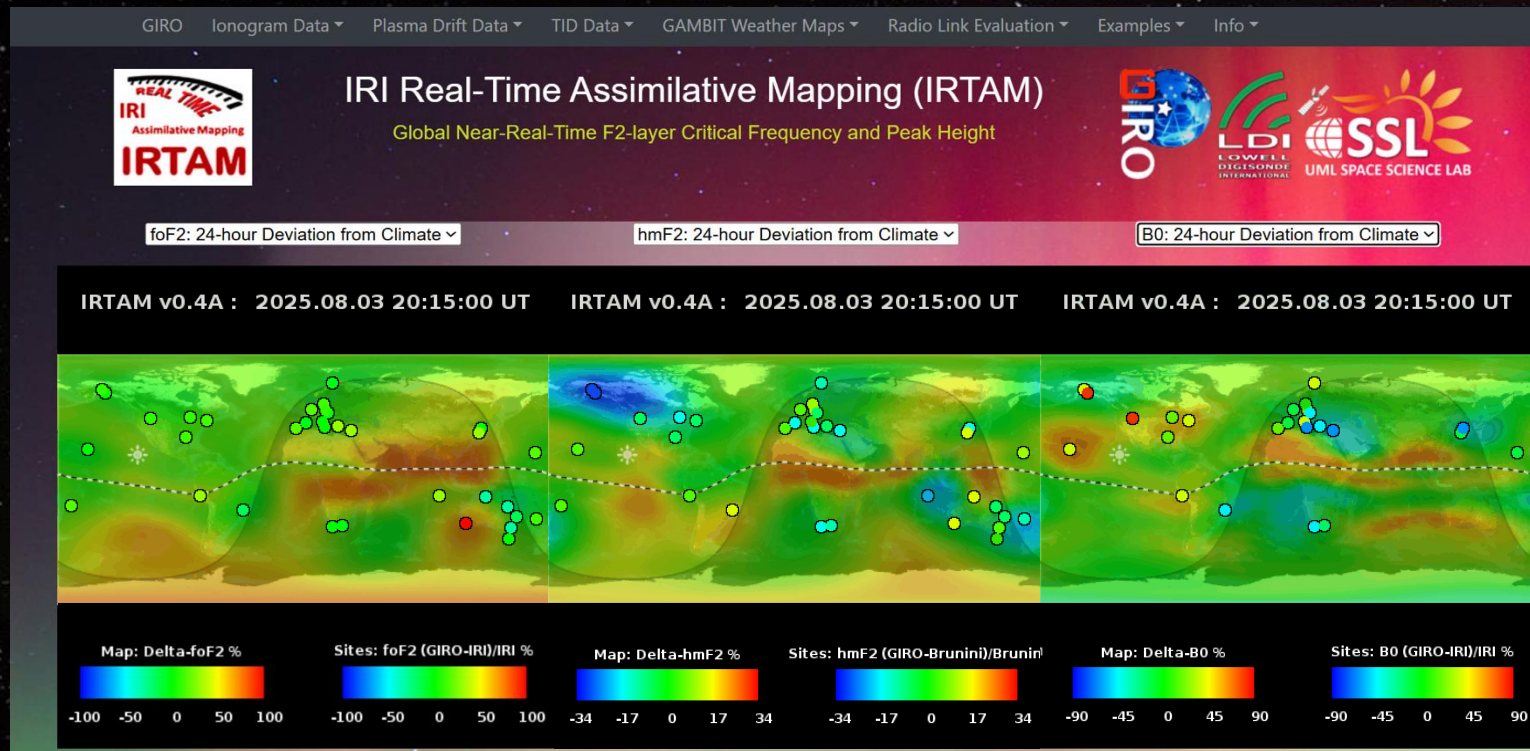
- Separate database from DIDBase
- Holds foF2, hmF2, B0, and B1 observations
 - 24-hour timelines per station
- Also, IRTAM(ss) coefficients
- Data access servlets available
 - global (needs authorization)
 - local for each site (..)



Not very popular: animated maps



“Weather-minus-climate” maps



Use MUF(3000) instead of B0?

22 SEPTEMBER PRE-FORUM SCIENCE DAY
23-26 SEPTEMBER XVI INTERNATIONAL GIRO FORUM IGF 2025

Dalu

감사합니다

Gracias

Danke

Ευχαριστίες

THANK YOU

Obrigado

Köszönöm

Dank

Спасибо

谢谢

Merci

ありがとう

Tack

Grazie

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IGF 2025