

Data analysis tools:

Ionogram Scaling

WITH IDENTIFICATION OF IONOSPHERIC STRUCTURES

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BOREALIS GLOBAL Designs

DISPEC

Chania, Greece
21 September 2026



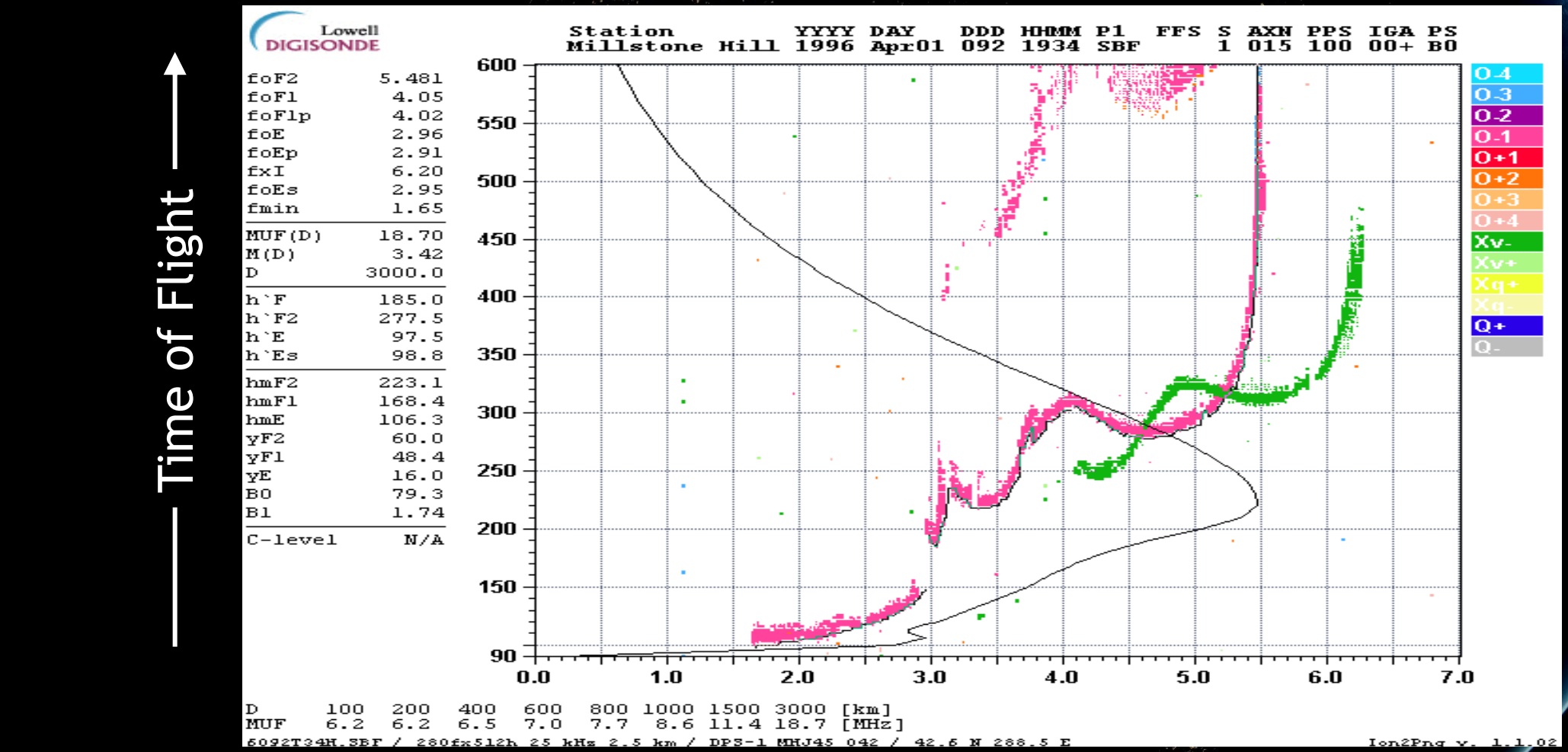
Outline

- Intro: ionograms
- Getting to scaled data
- Getting data scaled



Galloping Introduction to ionograms

Ionogram image and ionogram-derived data



Time of Flight

Frequency



Access to ionogram-derived (scaled) data

Not quite 100% open data…

giro.uml.edu/didbase/RulesOfTheRoad.html

GIRO | Ionogram Data | Plasma Drift Data | TID Data | GAMBIT Weather Maps | Radio Link Evaluation | Examples | Info



Lowell GIRO Data Center (LGDC)

RULES OF THE ROAD

for DIDBase, DriftBase, TIDBase, and GAMBIT repositories



Release date: September 11, 2013, **Last updated:** January 14, 2021

Summary

⚠️ Please read carefully.

LGDC data collections are released to public under CC BY-NC-SA 4.0 license restrictions. It is an open dataset that can be freely used, re-used, and redistributed, as long as:

- (NC): Data are not used or shared for commercial purpose (Rule 1 below)
- (BY): Data provider is involved and/or acknowledged in publications (Rules 2 and 3)
- (SA): Shared, modified, or annotated data retain their original license (Rule 4)
- (--): Development of substantially *derivative* products based on the acquired GIRO data is not restricted (Rule 5).
    - Manually edited data with corrected errors of processing or automatic interpretation are considered *modified*, rather than derived product.

Access to scaled data

GIRO Web Portal (read-only)			SAO Explorer App (download, edit and display)		GAMBIT Explorer
Interactive browsing	API for downloads	Latest	Online to DIDBase*	Offline	Online to AWS GAMBIT database
DIDBase: images	/ionoweb/ionoimage !	/ionoweb/latest https://giro.uml.edu/IonogramMovies/	DIDBase I, II, III (and mirrors)*	Local file collections	Local weather
FastChar: tabulated	/fastchar/getbest /fastchar/getmuf	Latest 24 hours via servlets			
Local 24-hour weather images	/rix/gambit-local-nowcast	Latest 24 hours via servlets			

ALL SERVLETS @ https://giro.uml.edu

* User account is required



Web Portal Practice

https://giro.uml.edu/tutorial-2026.html



General comment about autoscaled values

- In most cases, ARTIST is able to recognize a problem with its interpretation of the image
  - System of sanity checks
  - System of quality assessment criteria
  - e.g. fxF2-foF2 should be ½ fce
- Two metrics of autoscaling quality are generated automatically
  - Confidence Level (C-level)
    - Originally developed for ARTIST-4 software in the mid-1990s
    - Goes from 11 (best) to 55 (worst)
  - Confidence Score
    - Developed for ARTIST 5 in the 2010s
    - Goes from 0 (worst) to 100 (best)
- Please pay attention to low-confidence records in unattended use cases



SAO Explorer

Ionogram Editor and other tips and tricks

SAO Explorer online and offline –which is best?



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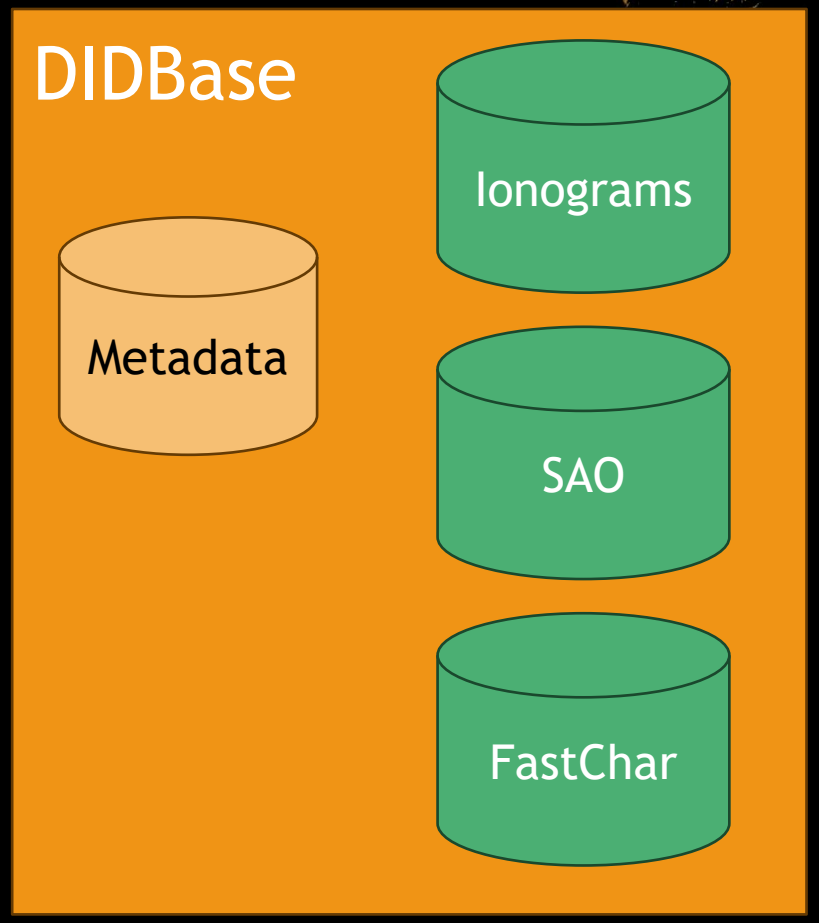
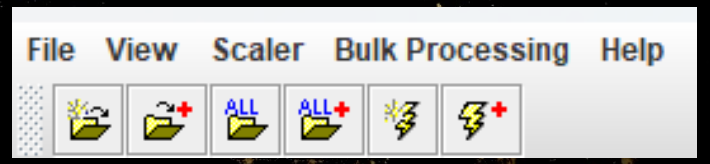
Lowell or mirror site



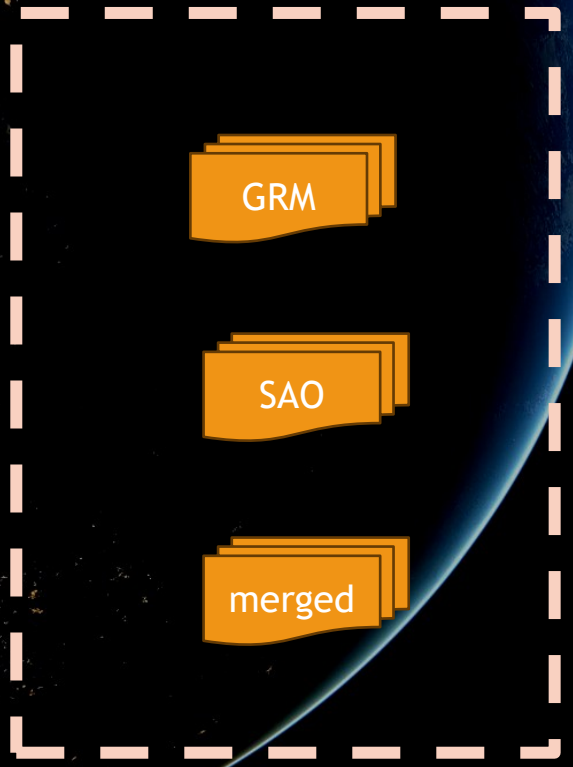
~55 million measurements



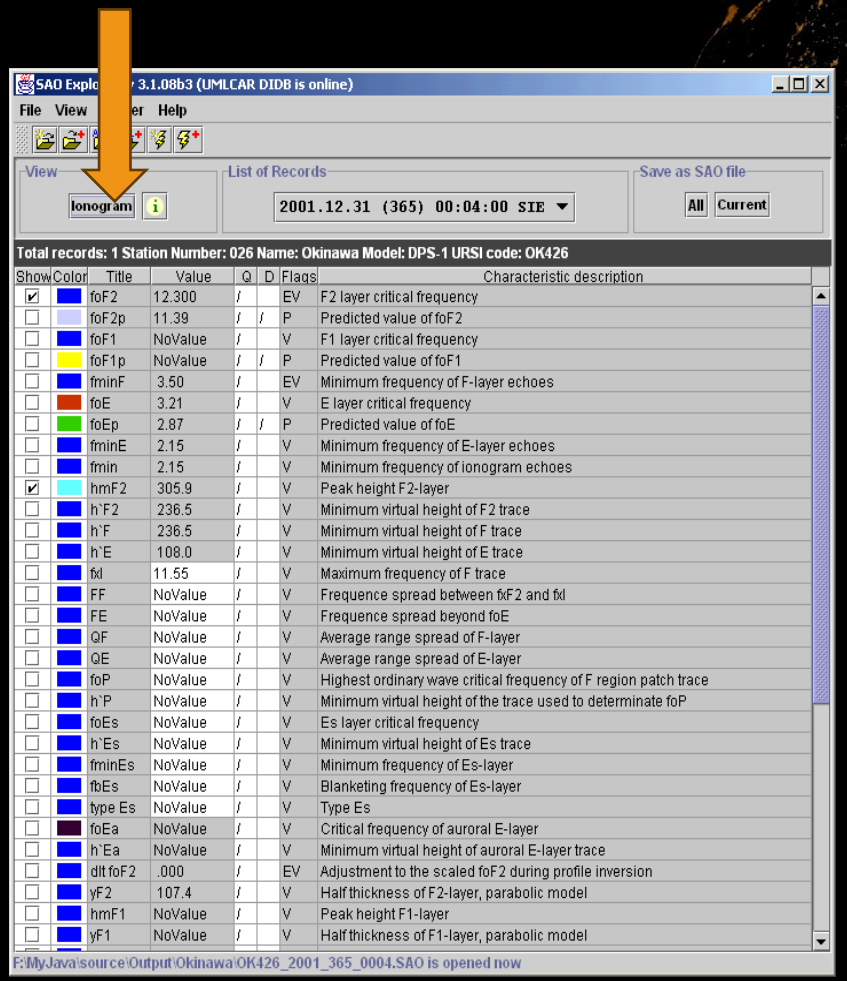


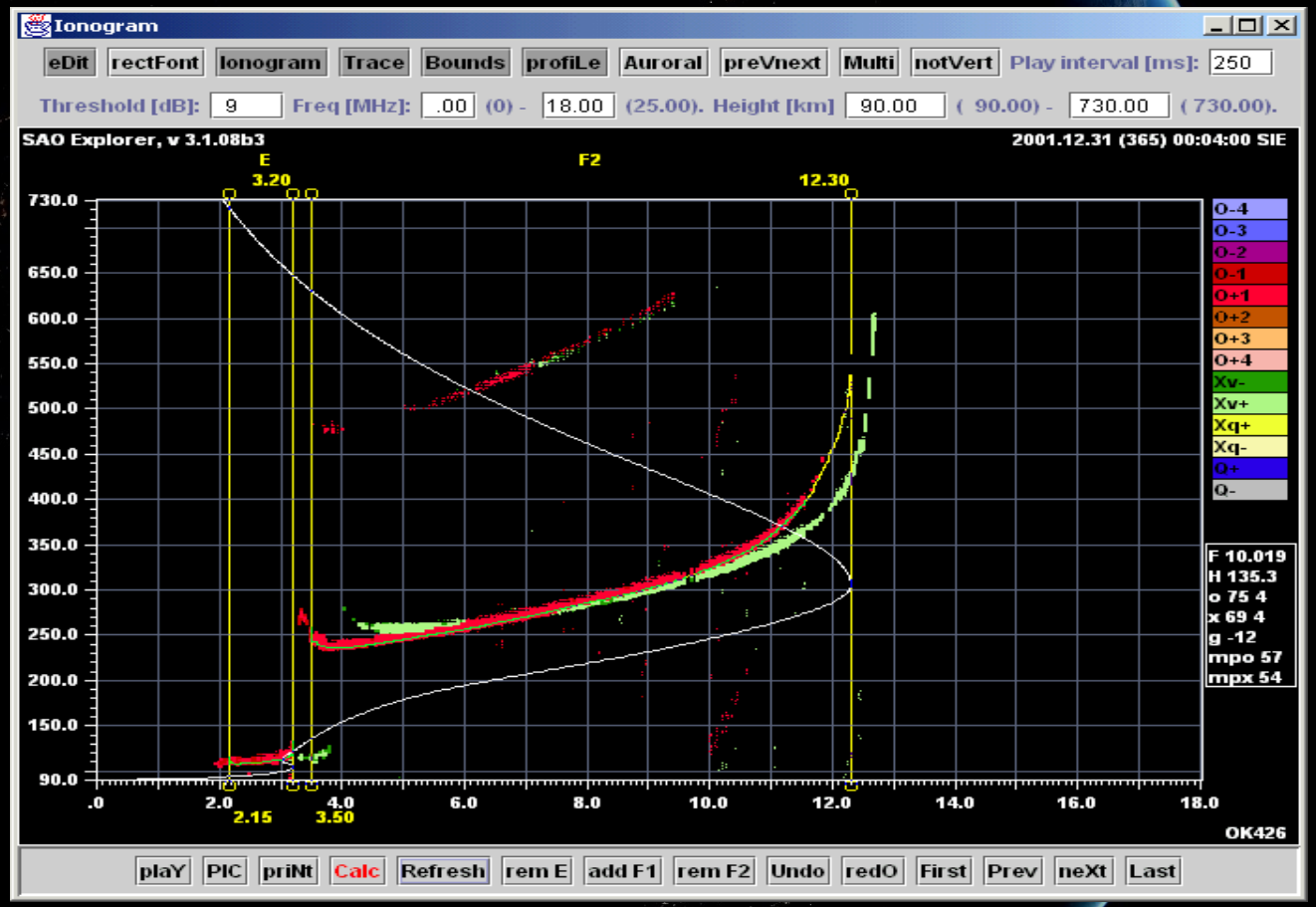
SAO Explorer

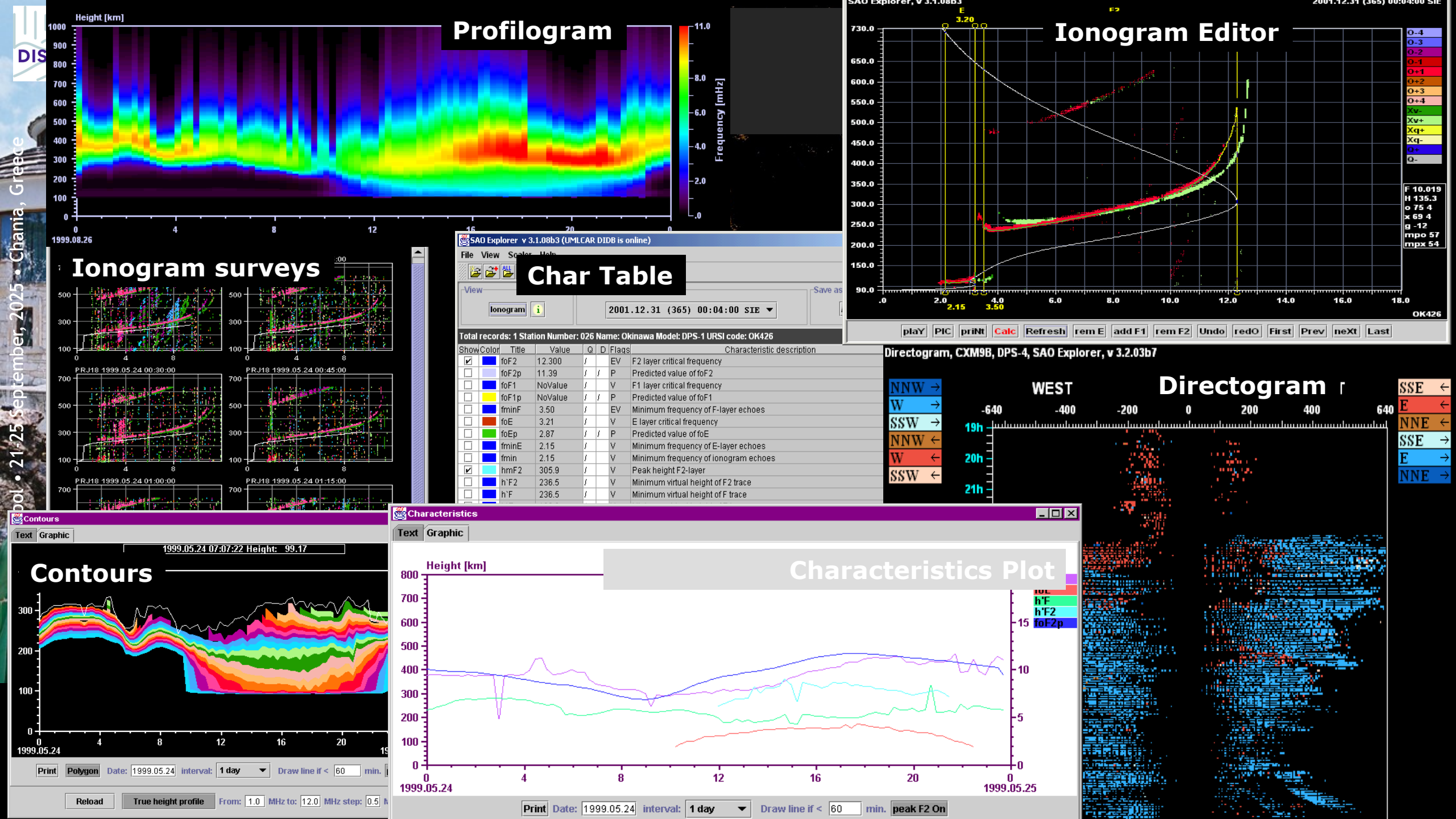
Local Computer



Getting to the ionogram editor







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Working with files



Open one file

Add another file

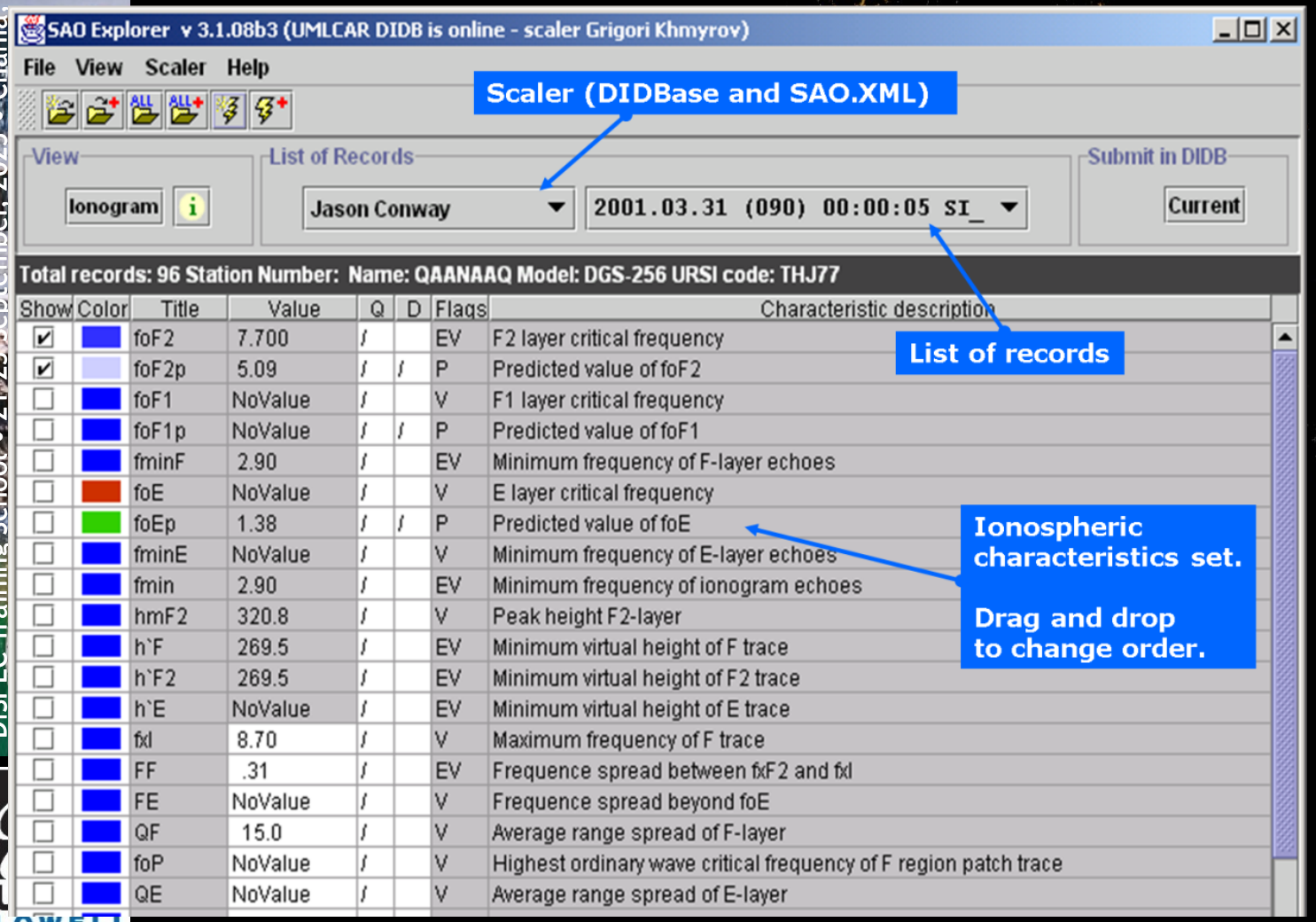
Open all files in the folder with the same extension

Add all files in the folder with the same extension

But where do we get files?

- From your digisondes/archives
- From DIDBase using SAO Explorere
  - Save all ionosgrams
  - Save all SAO records

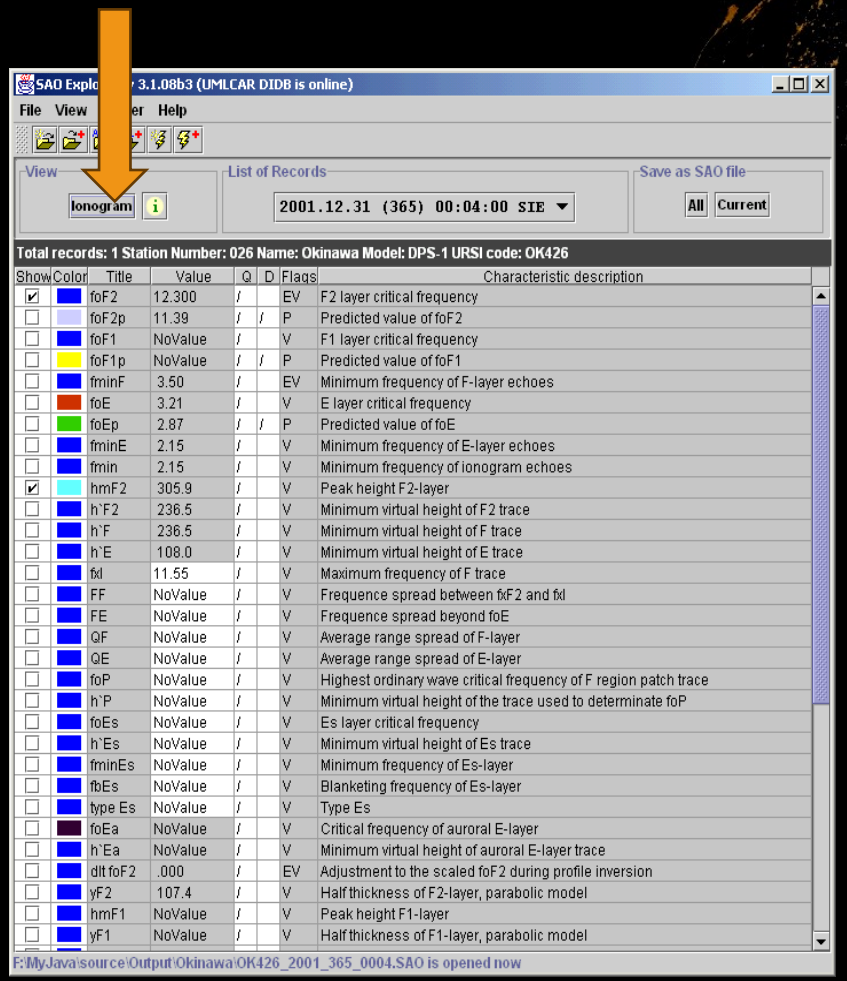
Tips and Tricks: Chars Window

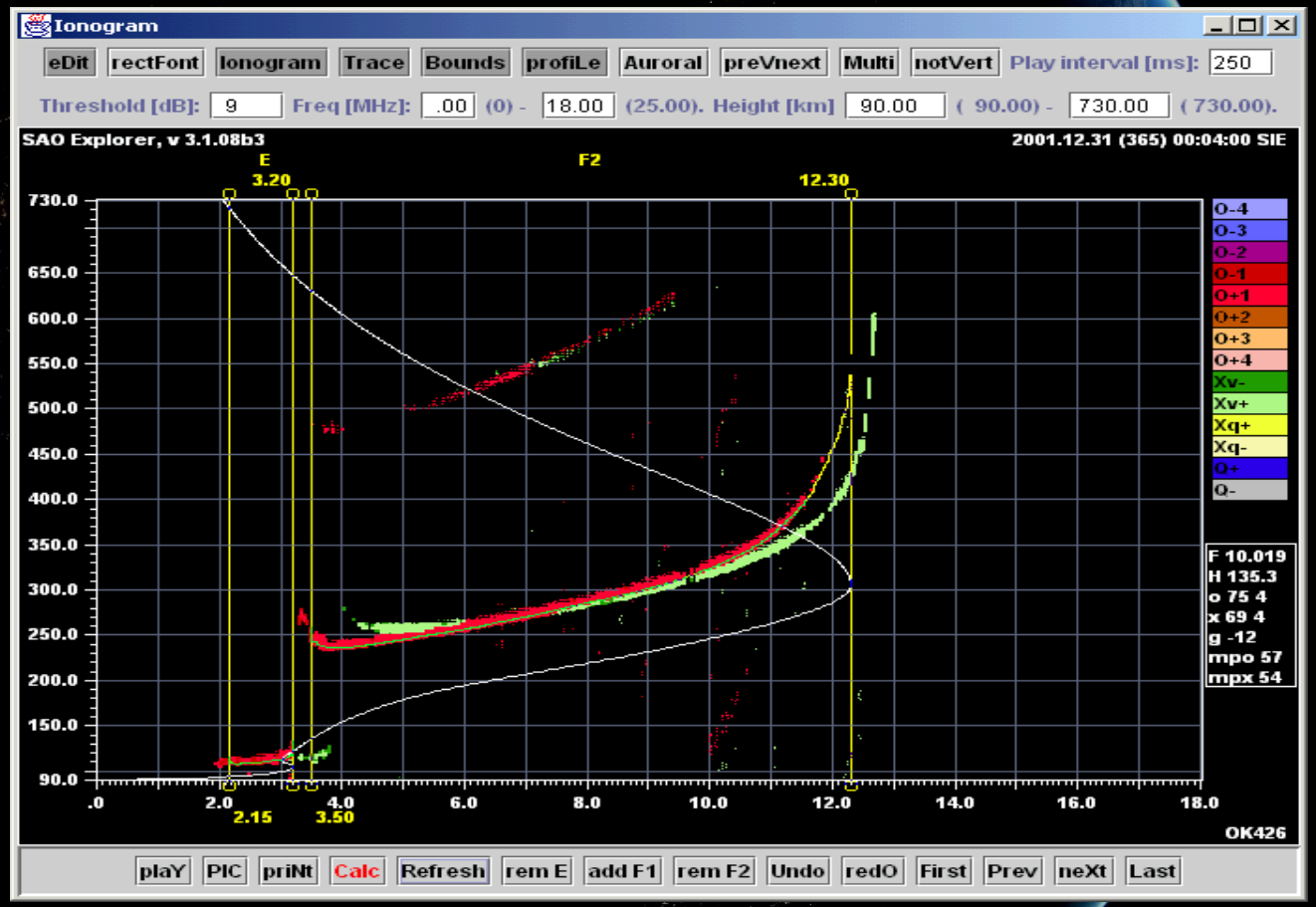


Show	Color	Title	Value	Q	D	Flags	Characteristic description
☑		foF2	7.700	/		EV	F2 layer critical frequency
☑		foF2p	5.09	/	/	P	Predicted value of foF2
☐		foF1	NoValue	/		V	F1 layer critical frequency
☐		foF1p	NoValue	/	/	P	Predicted value of foF1
☐		fminF	2.90	/		EV	Minimum frequency of F-layer echoes
☐		foE	NoValue	/		V	E layer critical frequency
☐		foEp	1.38	/	/	P	Predicted value of foE
☐		fminE	NoValue	/		V	Minimum frequency of E-layer echoes
☐		fmin	2.90	/		EV	Minimum frequency of ionogram echoes
☐		hmF2	320.8	/		V	Peak height F2-layer
☐		h`F	269.5	/		EV	Minimum virtual height of F trace
☐		h`F2	269.5	/		EV	Minimum virtual height of F2 trace
☐		h`E	NoValue	/		EV	Minimum virtual height of E trace
☐		fxI	8.70	/		V	Maximum frequency of F trace
☐		FF	.31	/		EV	Frequence spread between fxF2 and fxI
☐		FE	NoValue	/		V	Frequence spread beyond foE
☐		QF	15.0	/		V	Average range spread of F-layer
☐		foP	NoValue	/		V	Highest ordinary wave critical frequency of F region patch trace
☐		QE	NoValue	/		V	Average range spread of E-layer

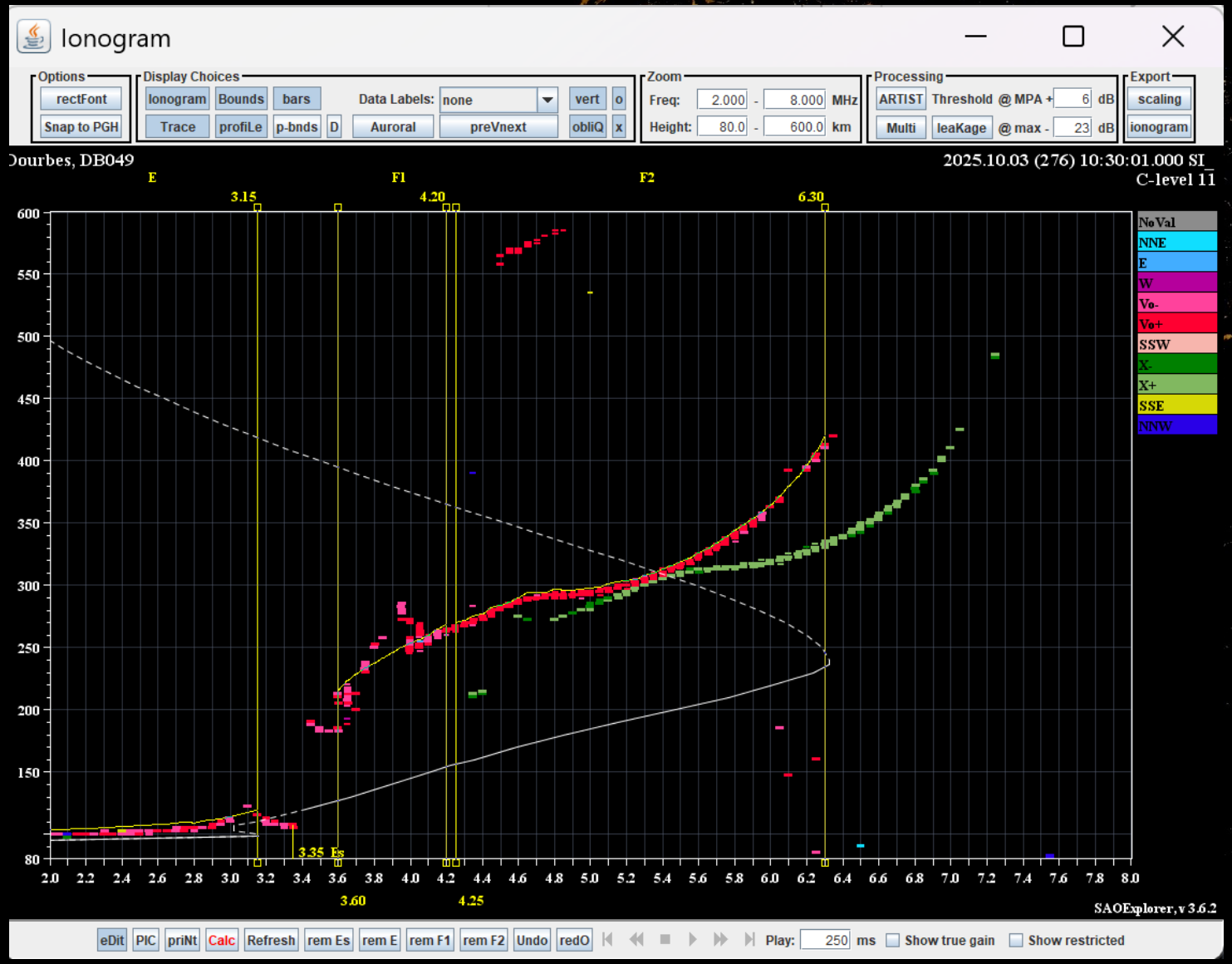
- Drag and Drop to rearrange the order of chars

Getting to the ionogram editor



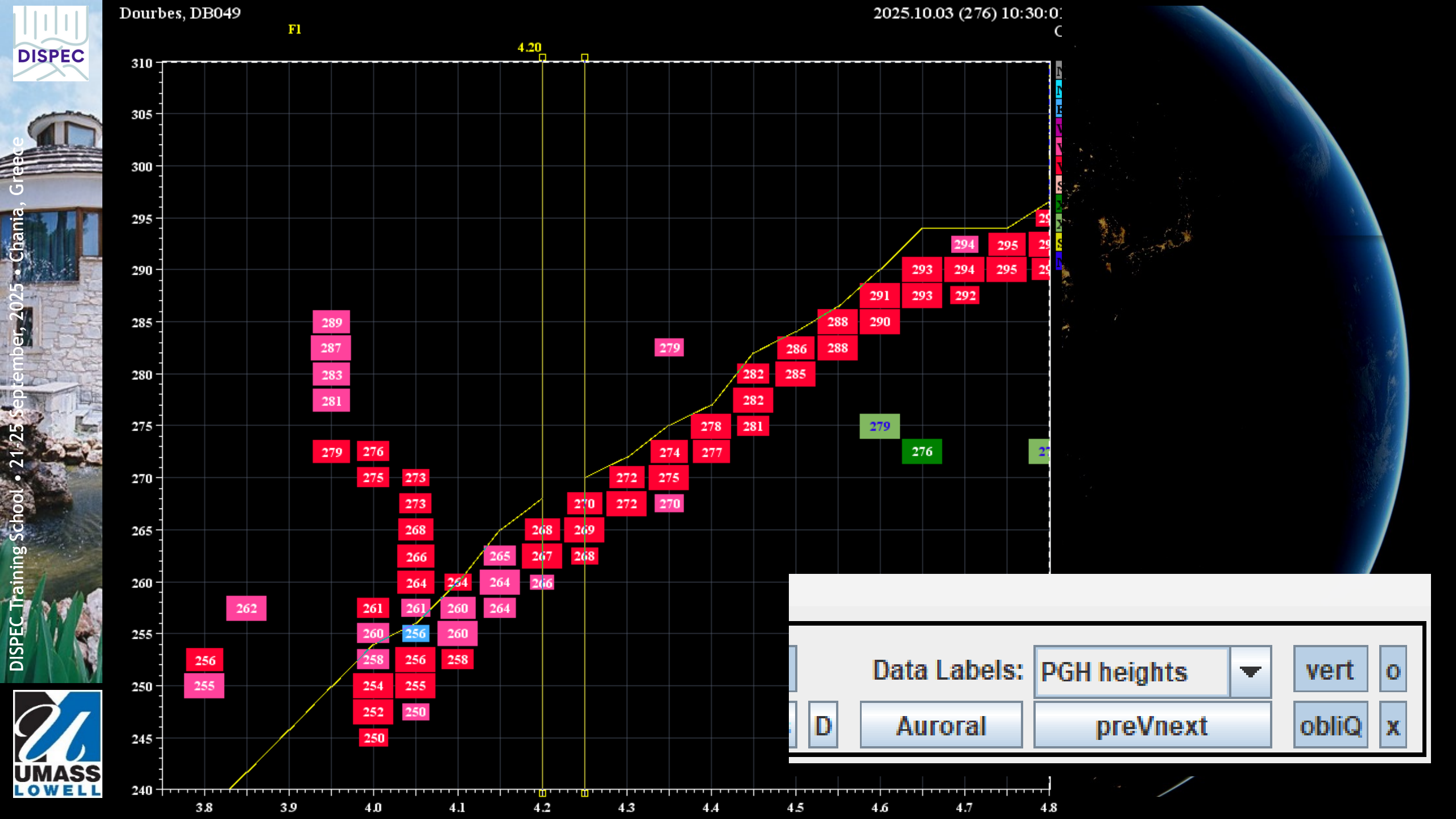


Ionogram editor tips and tricks



IMPORTANT…

- Always Snap to PGH
- Use navigation control to soom in for more accurate cusp tracing
  - hmF2 is critically dependent on cusp tracing
  - Zoom-in for better accuracy
- Add Characteristics window to look for data noise
- Use foF1p as guidance
- Use second hop as guidance
- Do not overlook:
  - Es chars
  - Spread F chars
- No need to hit the anchor circles on trace boundaries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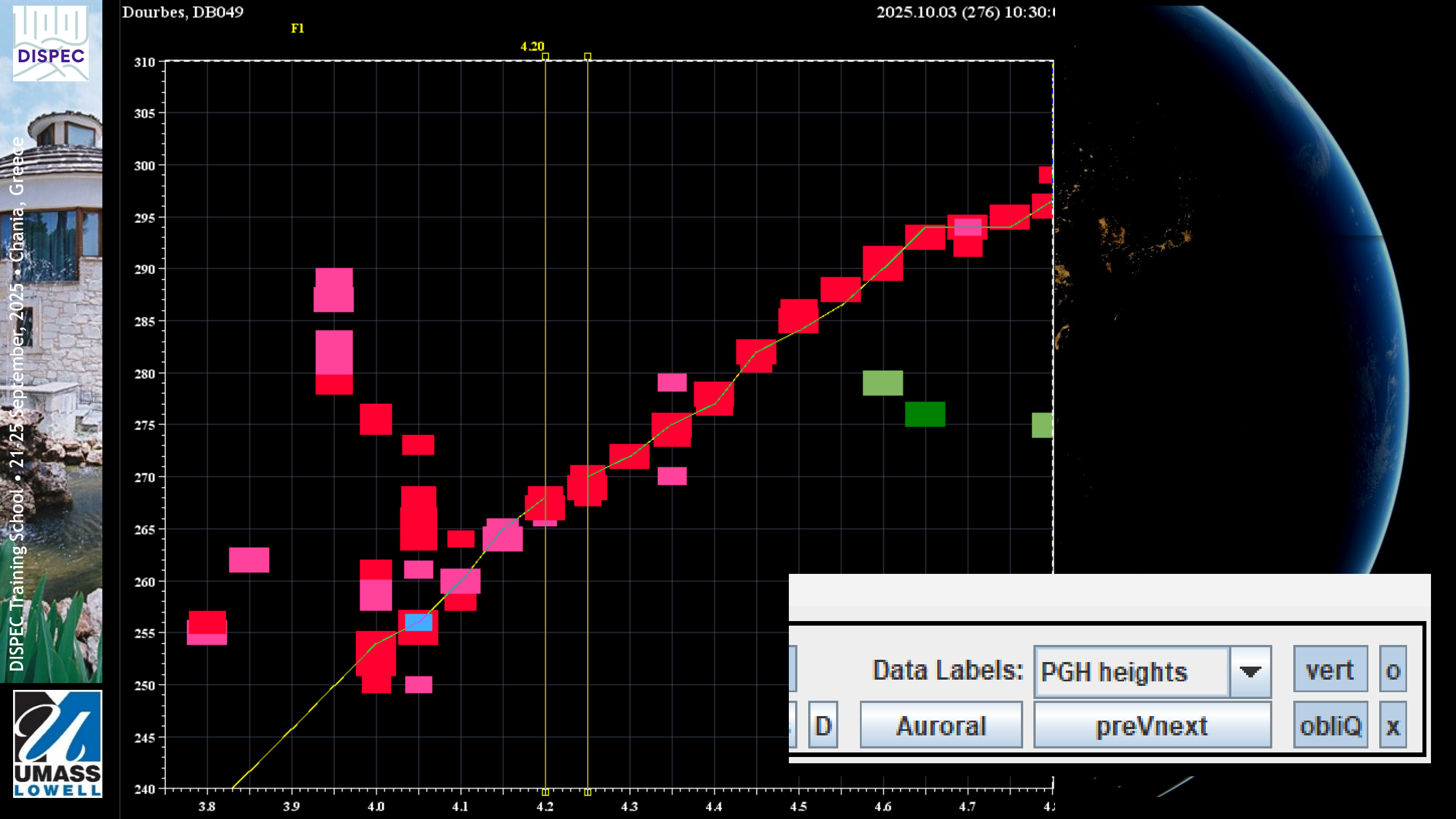
UMASS LOWELL
Dourbes, DB049
2025.10.03 (276) 10:30:0
F1
4.20
Data Labels:
PGH heights
vert
o
D
Auroral
preVnext
obliQ
x

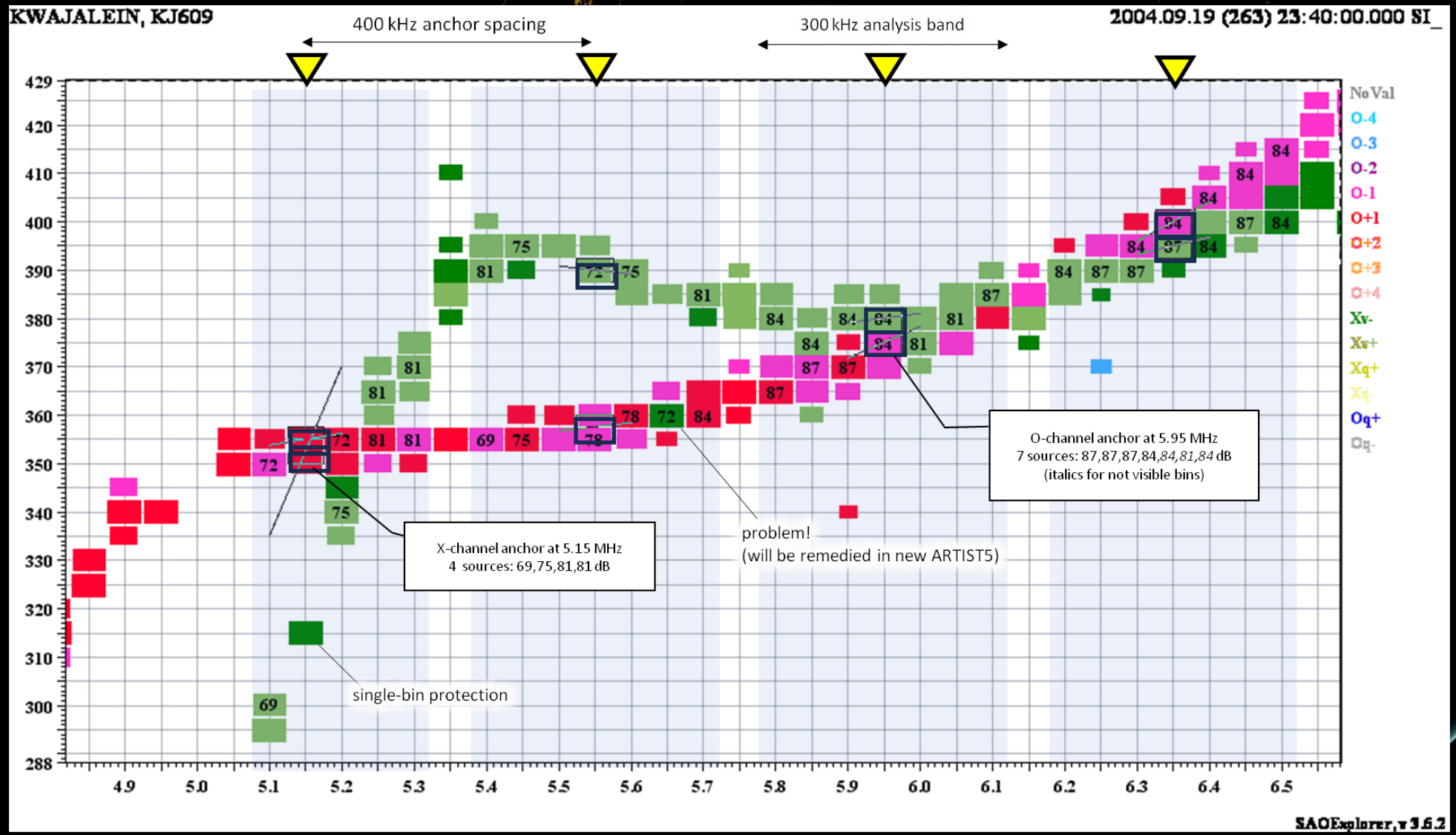

DISPEC
DISPEC Training School • 21-25 September, 2025 • Chania, Greece
UMASS LOWELL
Dourbes, DB049
2025.10.03 (276) 10:30:
F1
4.20
310
305
300
295
290
285
280
275
270
265
260
255
250
245
240
3.8
3.9
4.0
4.1
4.2
4.3
4.4
4.5
4.6
4.7
Data Labels:
PGH heights
vert
o
D
Auroral
preVnext
obliQ
x



Popular keyboard shortcuts

- 0 1 2 3 4 5 6 – signal detection threshold
- F10 – run ARTIST
- Z – step back in time
- X – step forward in time
- C – compute density profile
- Arrows -- go up/down in height and left-right in frequency
- Num-Plus and Num-Minus – zoom in/out; Esc – back to full content

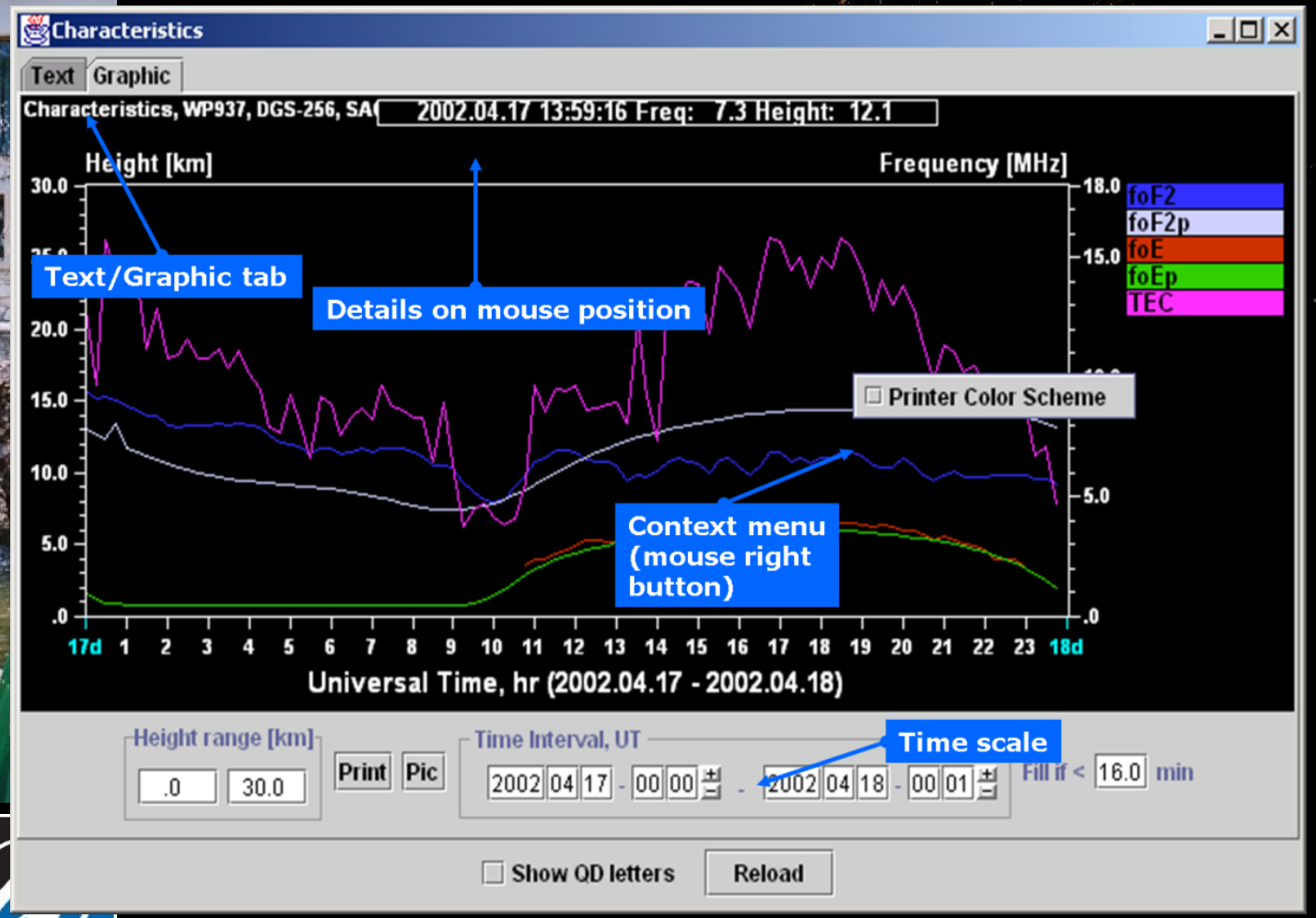
SAO-X New Feature: D-region



SAO-X New Feature: D-layer

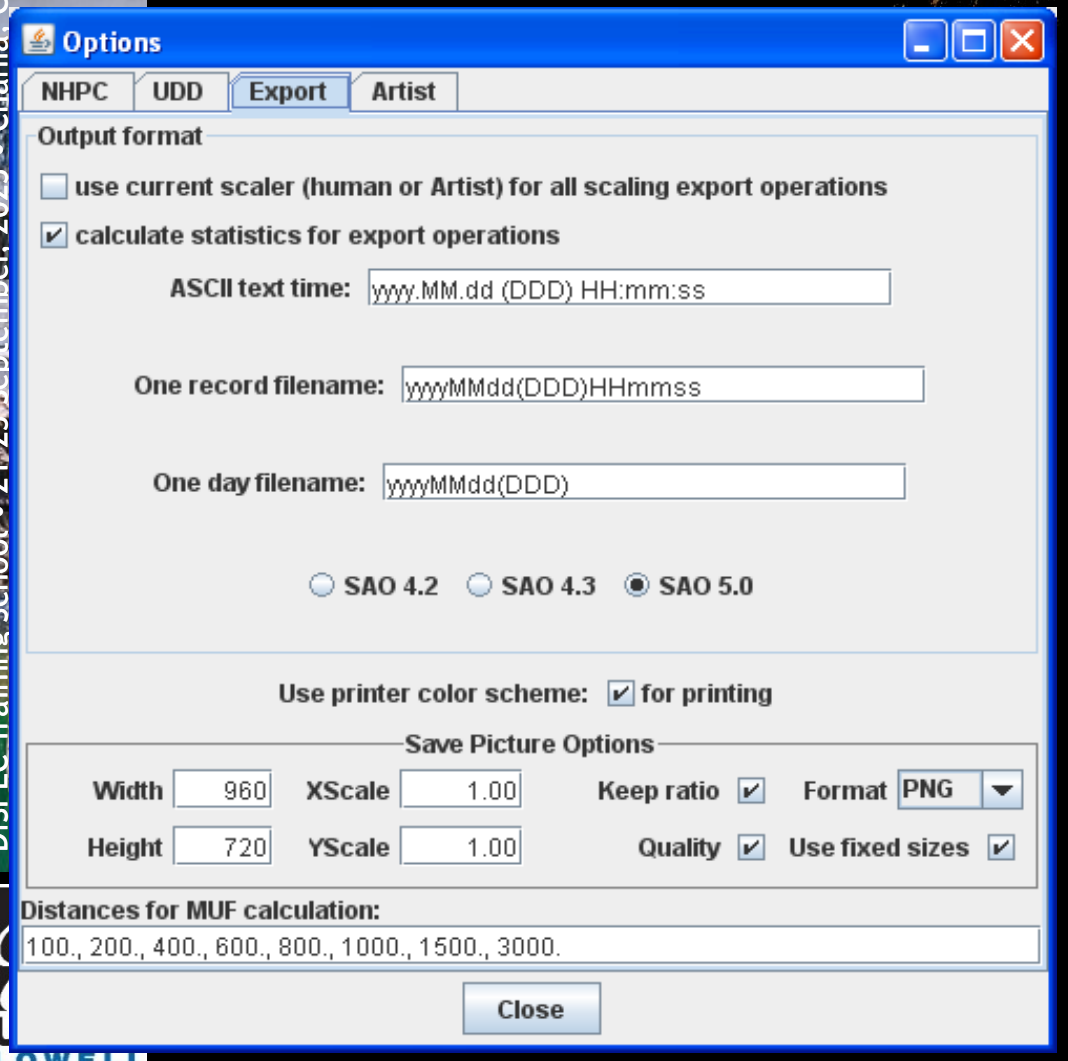
- Comparison of O- and X-polarization amplitudes to glean the D-layer density profile
  - SAO-X to prepare the standard input file for GPSII
  - ARTIST O-polarization trace available
    - Trace points may need manual adjustment
  - X-polarization points are searched automatically
    - In the vicinity of the O-trace point
    - Gradient of h’(f) computed for defocusing estimate

Tips and Tricks: Time Series



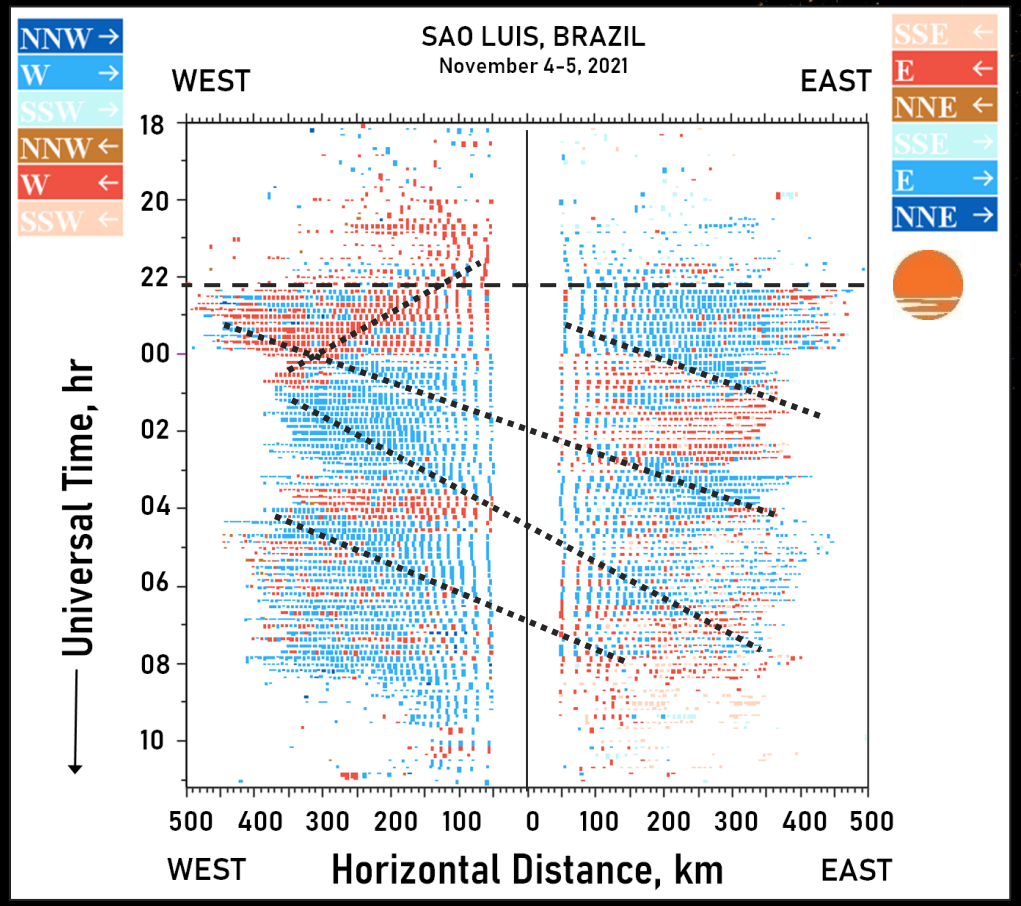
- Use Fast Chars from DIDBase for fastest access

Tools and Tricks: Figure Making



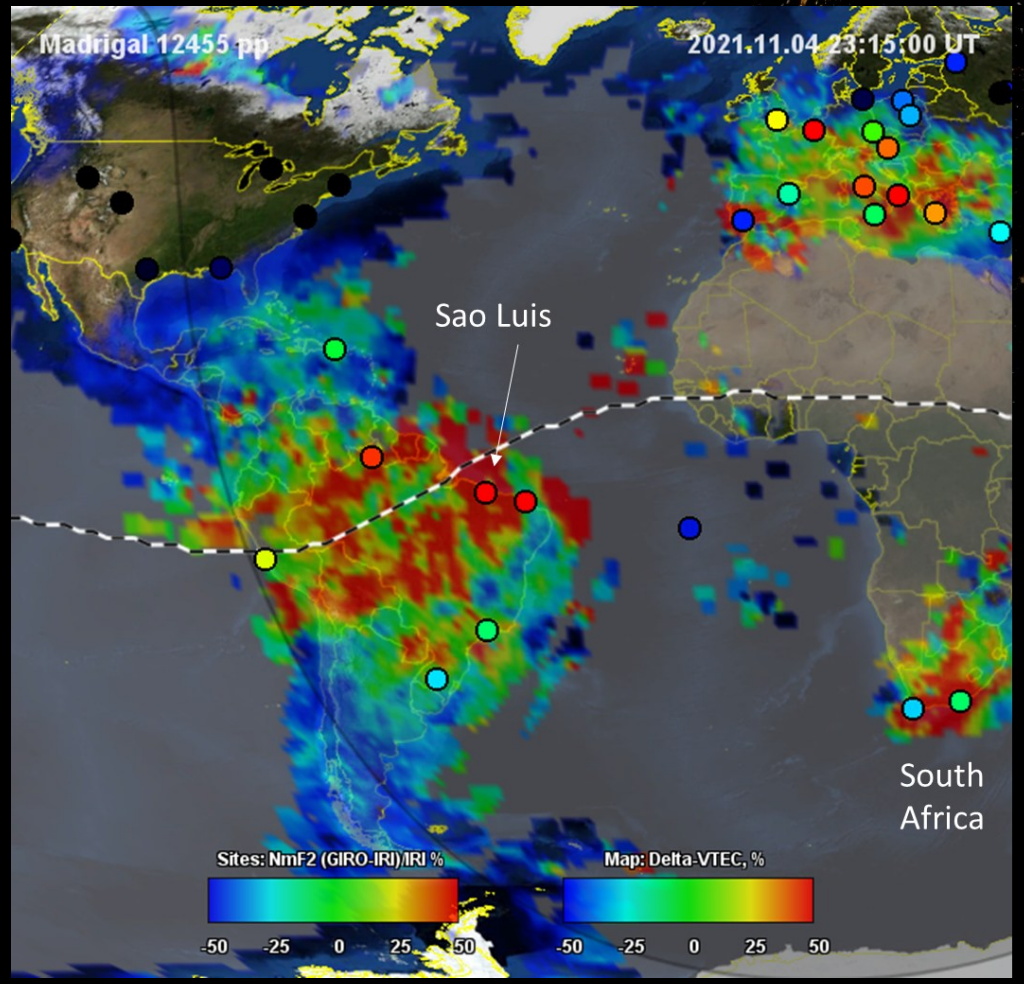
- No need to use Option window to change file format
  - Just put needed extension to the filename: .PNG, .JPG, .BMP
- Best quality for publications: EPS
  - Use a small window size and EPS format, edit in Adobe Illustrator
  - Alternatively, use a small window size, PNG format, and double the X and Y scales

Tips and Tricks: Directogram

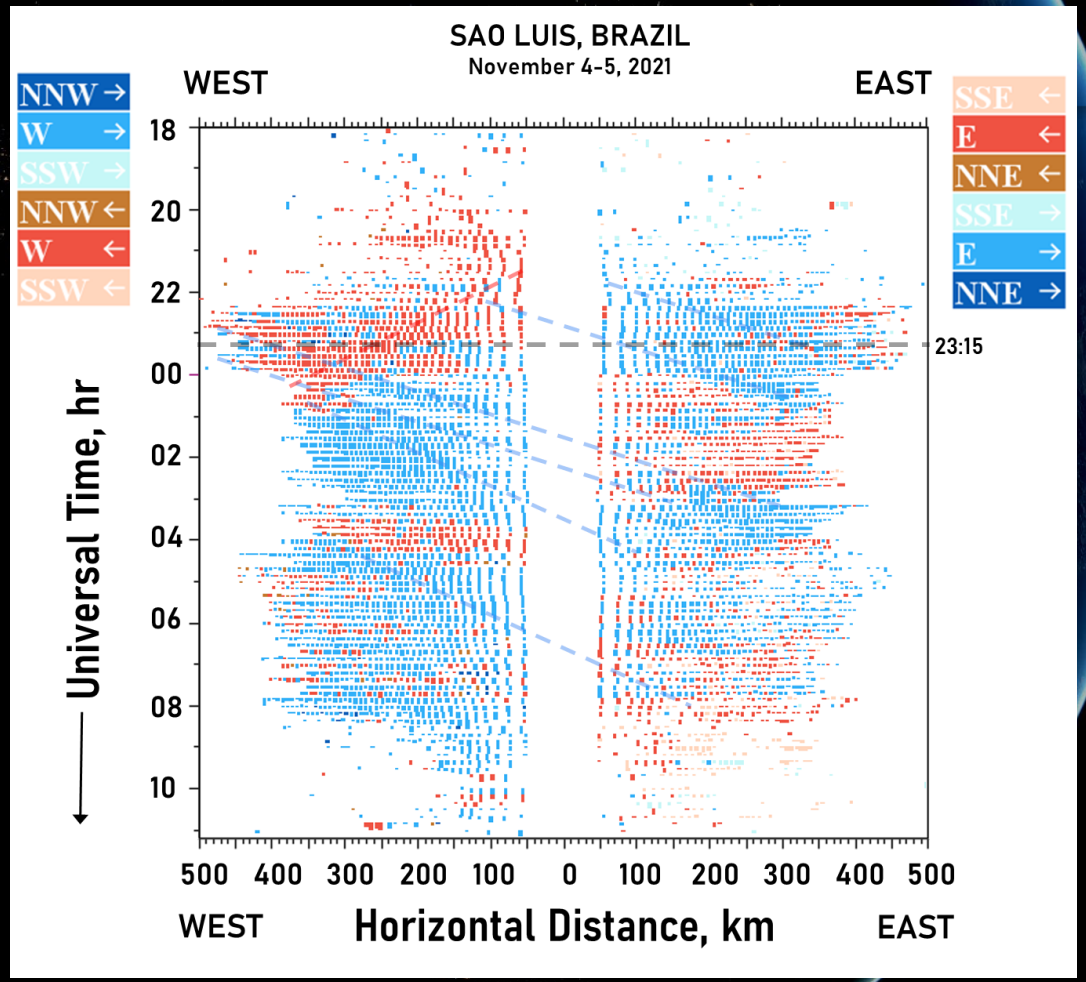


- Good for ESF research
- What can be done better?
  - Select primary axis (currently only W-E)
  - Plot sunset time (currently use “i“ button)

Hi-res VTEC and Directogram

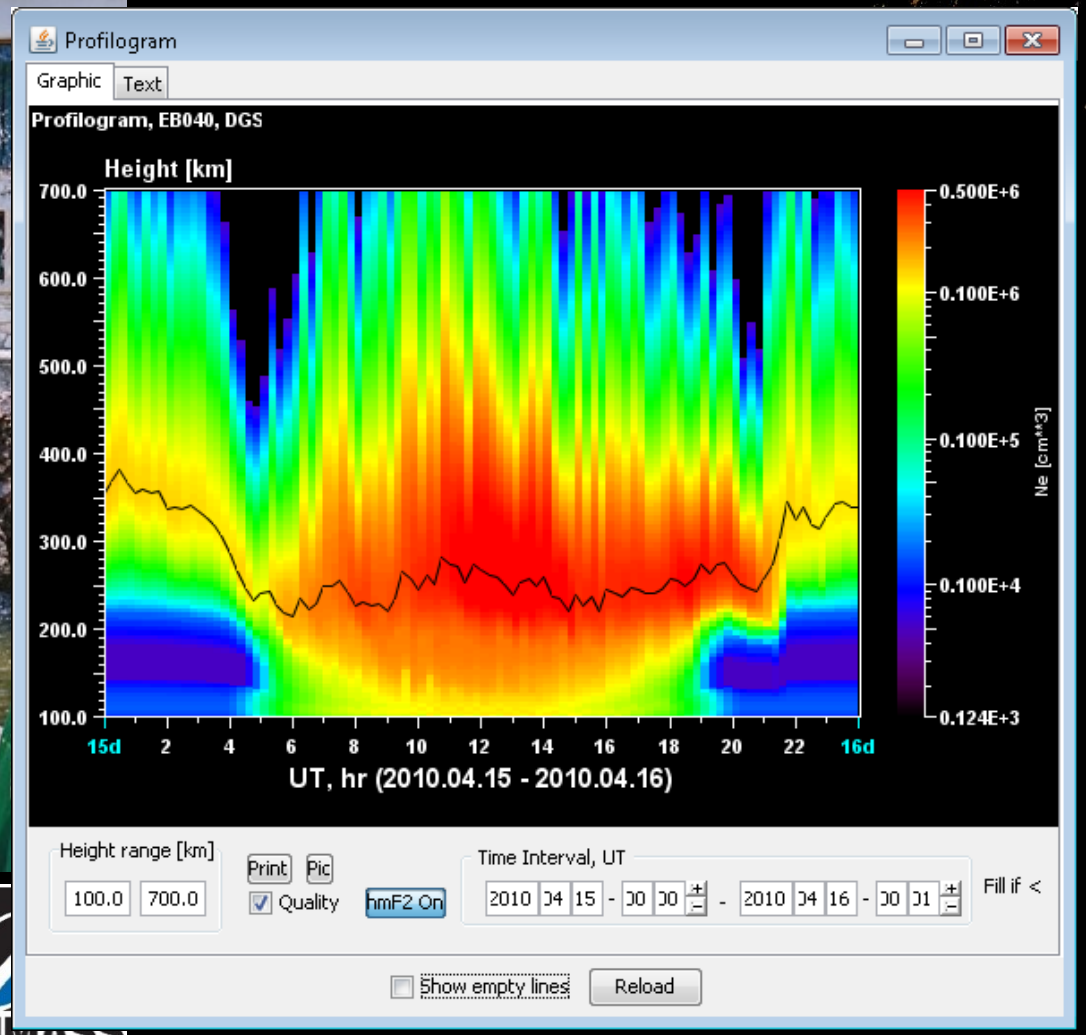


VTEC data courtesy of Anthea Coster, MIT Haystack Observatory



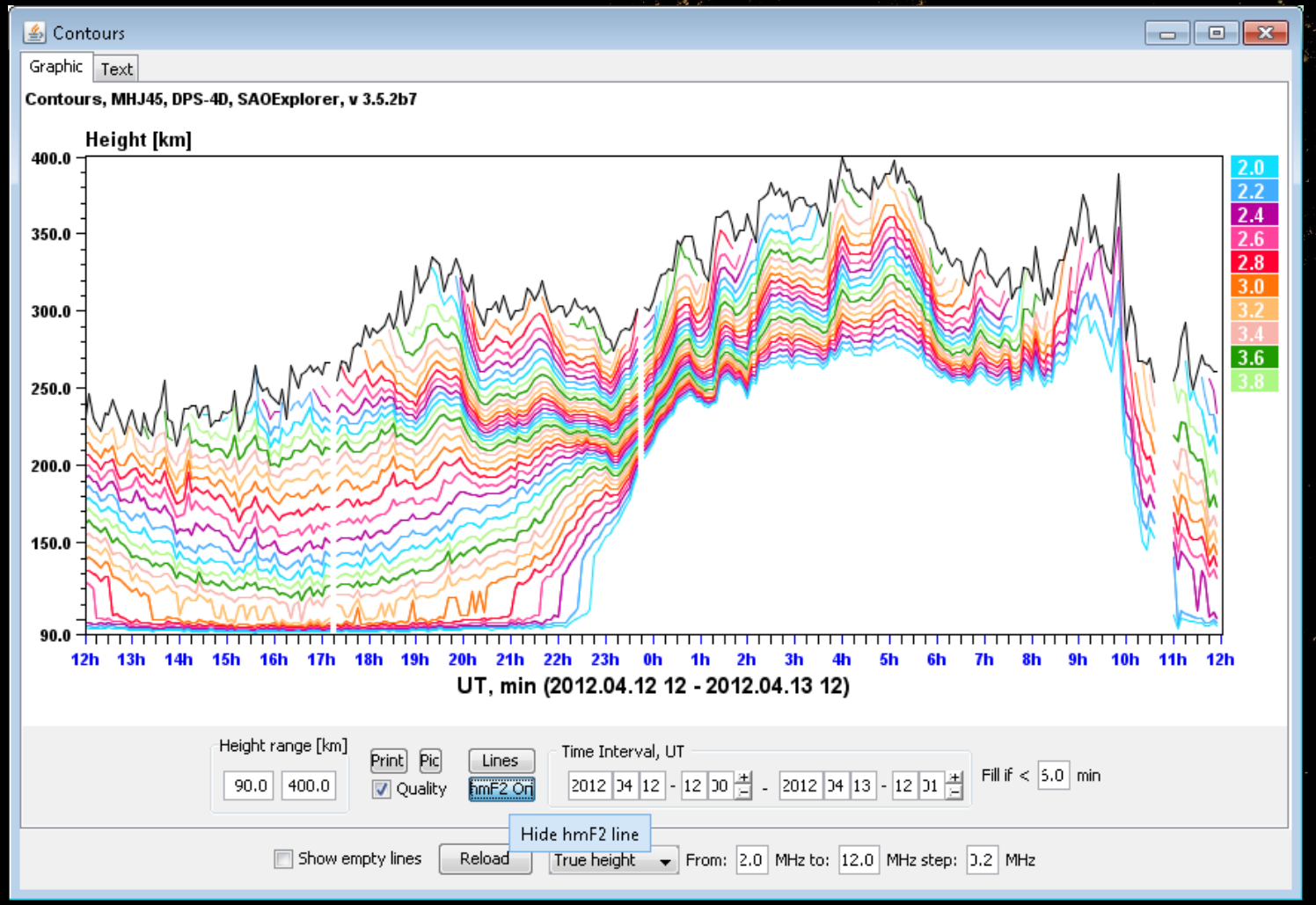
Sao Luis ionograms courtesy of Inez Batista, INPE

Tips and Tricks: Profilogram



- Add hmF2 to visually separate bottomside (observed) and topside (modeled) F2 layer
- Work on ionogram scaling until perfect hmF2

Tips and Tricks: Contours

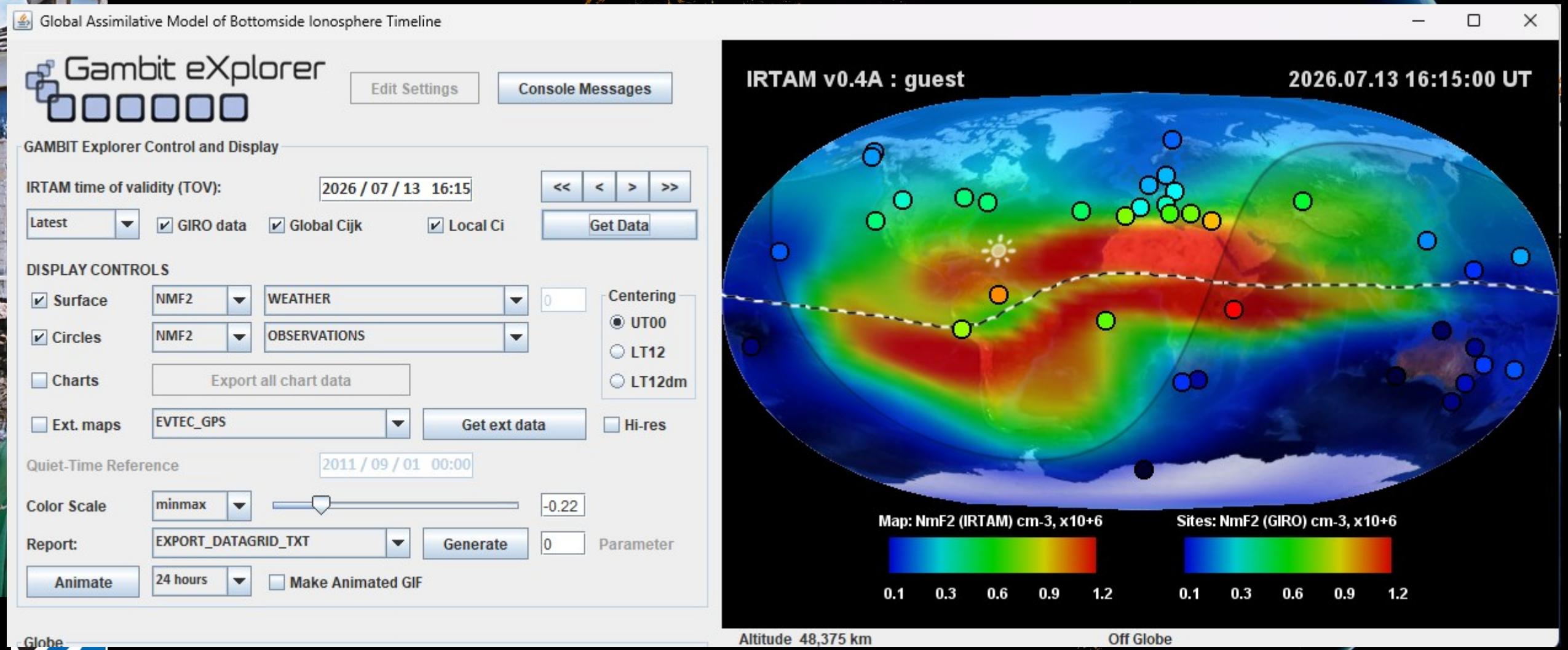


- Try virtual ranges
- Enable peak height



GAMBIT Explorer

GAMBIT Explorer front screen



Station weather charts in GAMIBIT-X

