High-Level Processing, Visualization and Madrigal Loading

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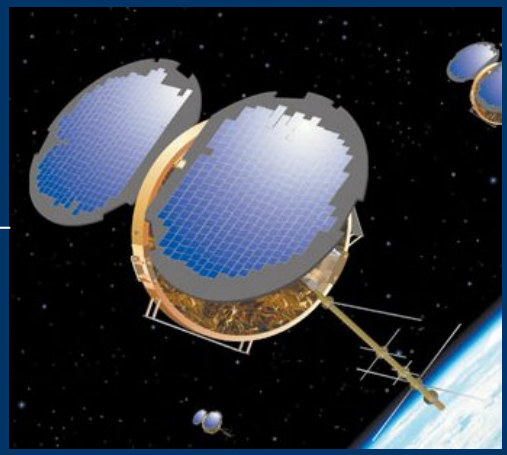
Signal voltages

Tuner



Raw voltage data

Signal processing

Processed voltage data

Scintillation parameters and TEC

High-level processor

Madrigal loader

Plotter

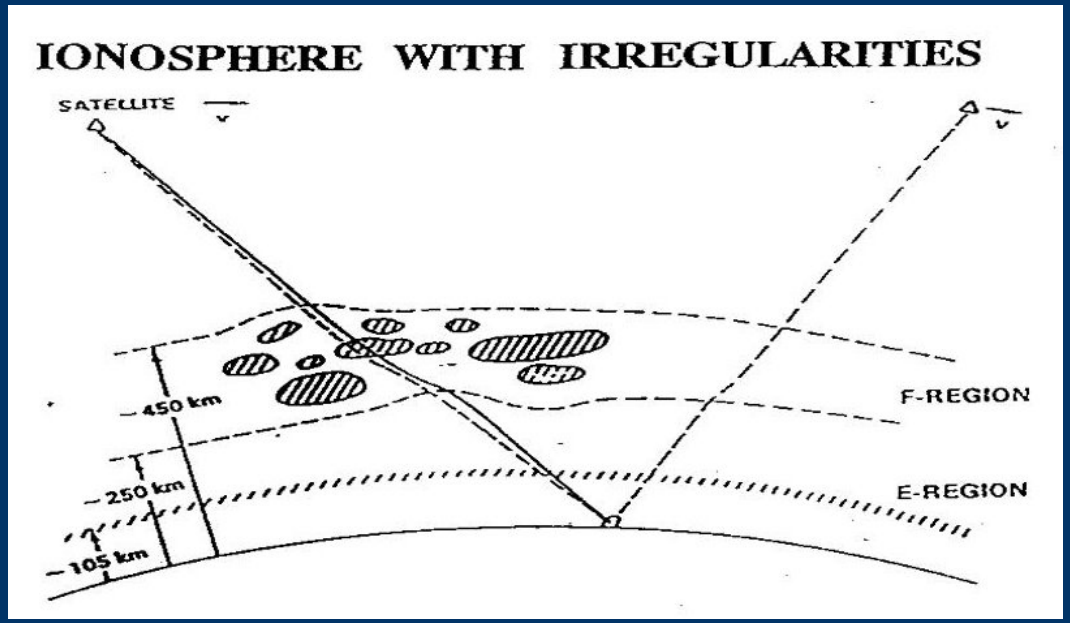
Plots

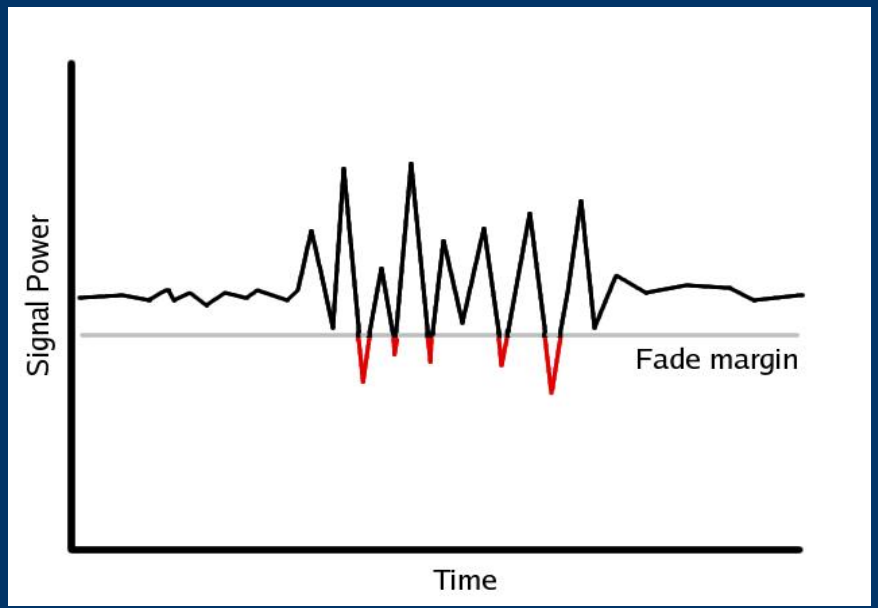
Madrigal scientific database

Science users

Scintillations

- Radio waves travel through irregularities in the ionosphere
- Fluctuations in received signal power and phase
- Dependent on time, frequency, and location
- Disrupt satellite communications





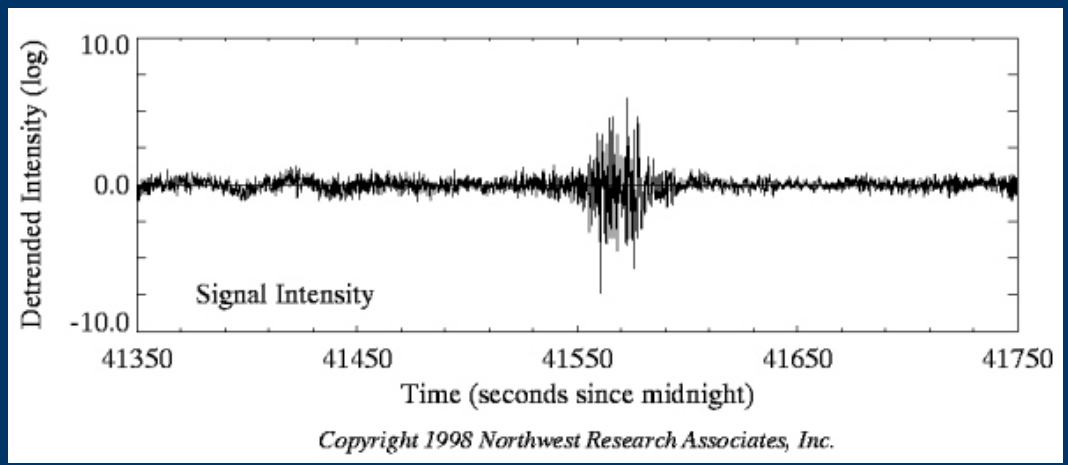
Processing

Calculated parameters:

- S4
- Sigma-phi
- TEC

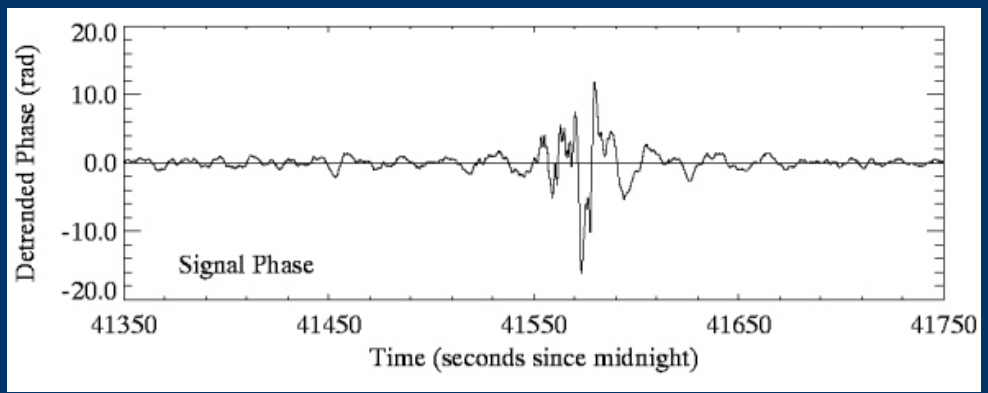
Processing: S4

- Most used scintillation parameter
- Normalized standard deviation of signal power
- Measures severity of amplitude scintillation
  - 0: No scintillation
  - 1: Signal power is essentially random
- Measured throughout the pass



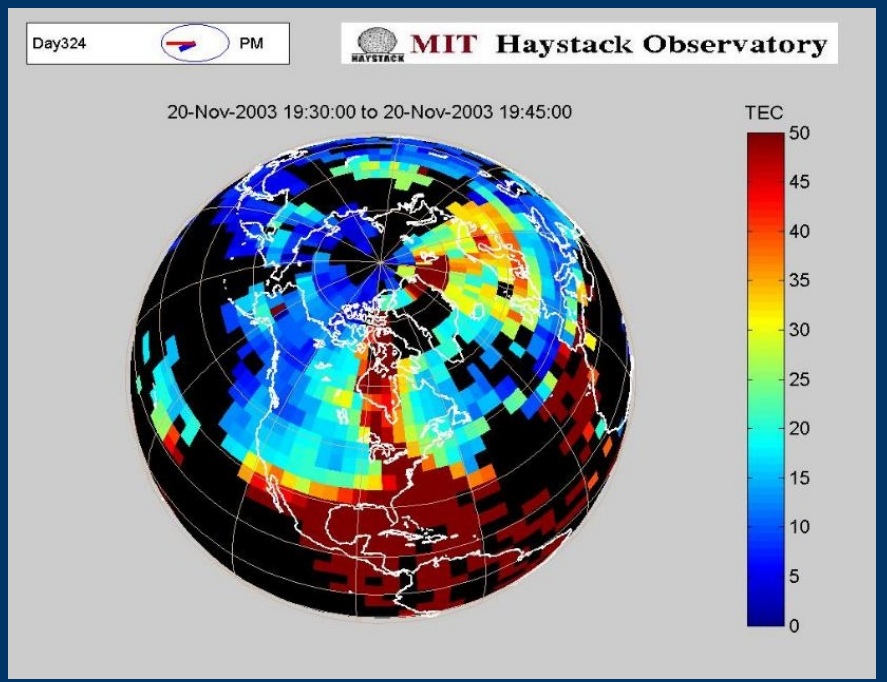
Processing: Sigma-phi

- Measures severity of phase scintillation
- Standard deviation of signal phase
- Harder to calculate: satellite range changes phase constantly
- Why both S4 and sigma-phi?
  - Amplitude and phase scintillation don't always coincide
  - Different systems are more susceptible to amplitude scintillation (such as voice communications) or phase scintillation (such as GPS)

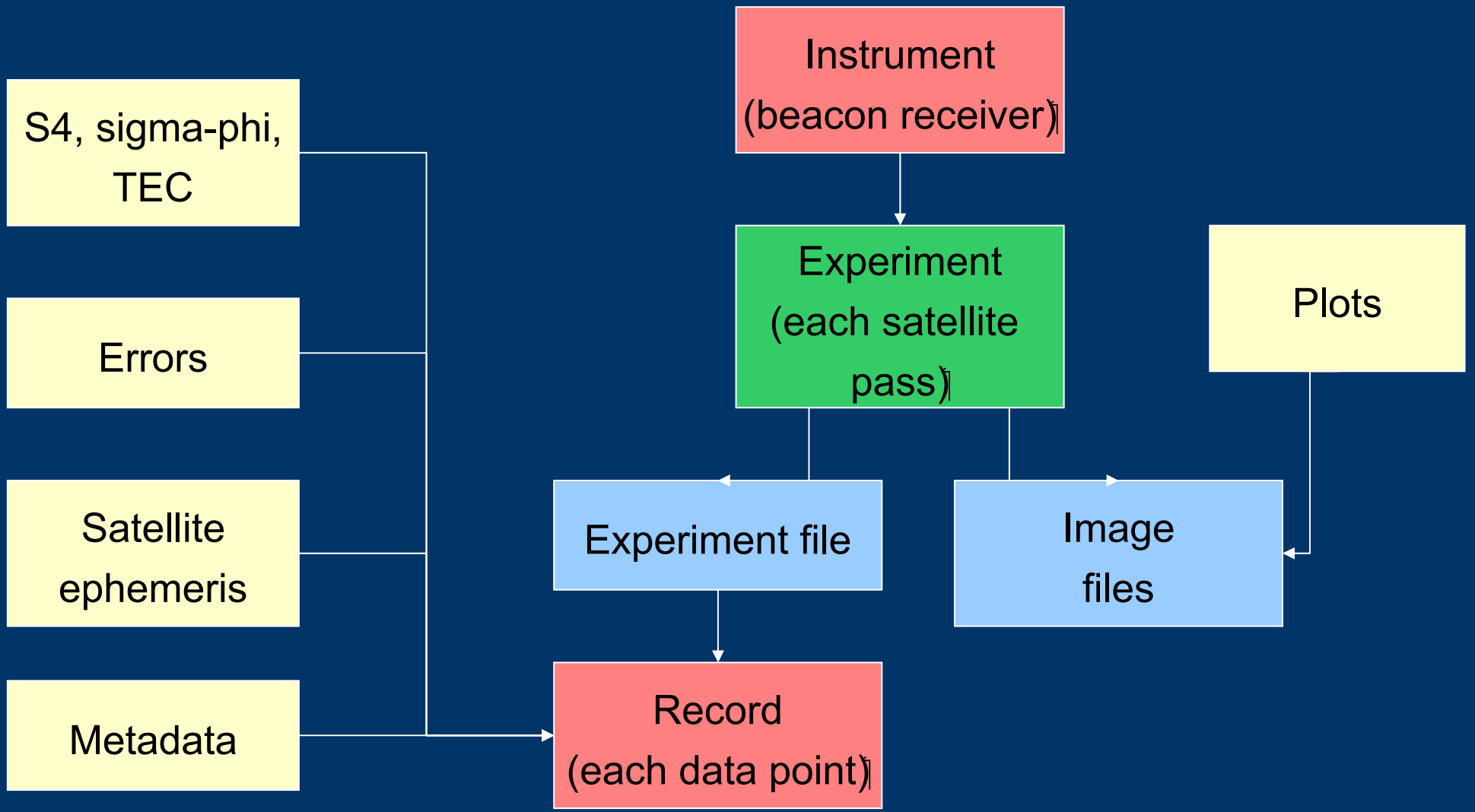


Processing: TEC

- Total electron content: number of electrons from satellite to receiver per square meter
- Helps understand structure of ionosphere
- Gives context to scintillation data
  - Scintillation and TEC gradients
- Calculation
  - Need at least two frequencies
  - Path-length vs. vertical TEC

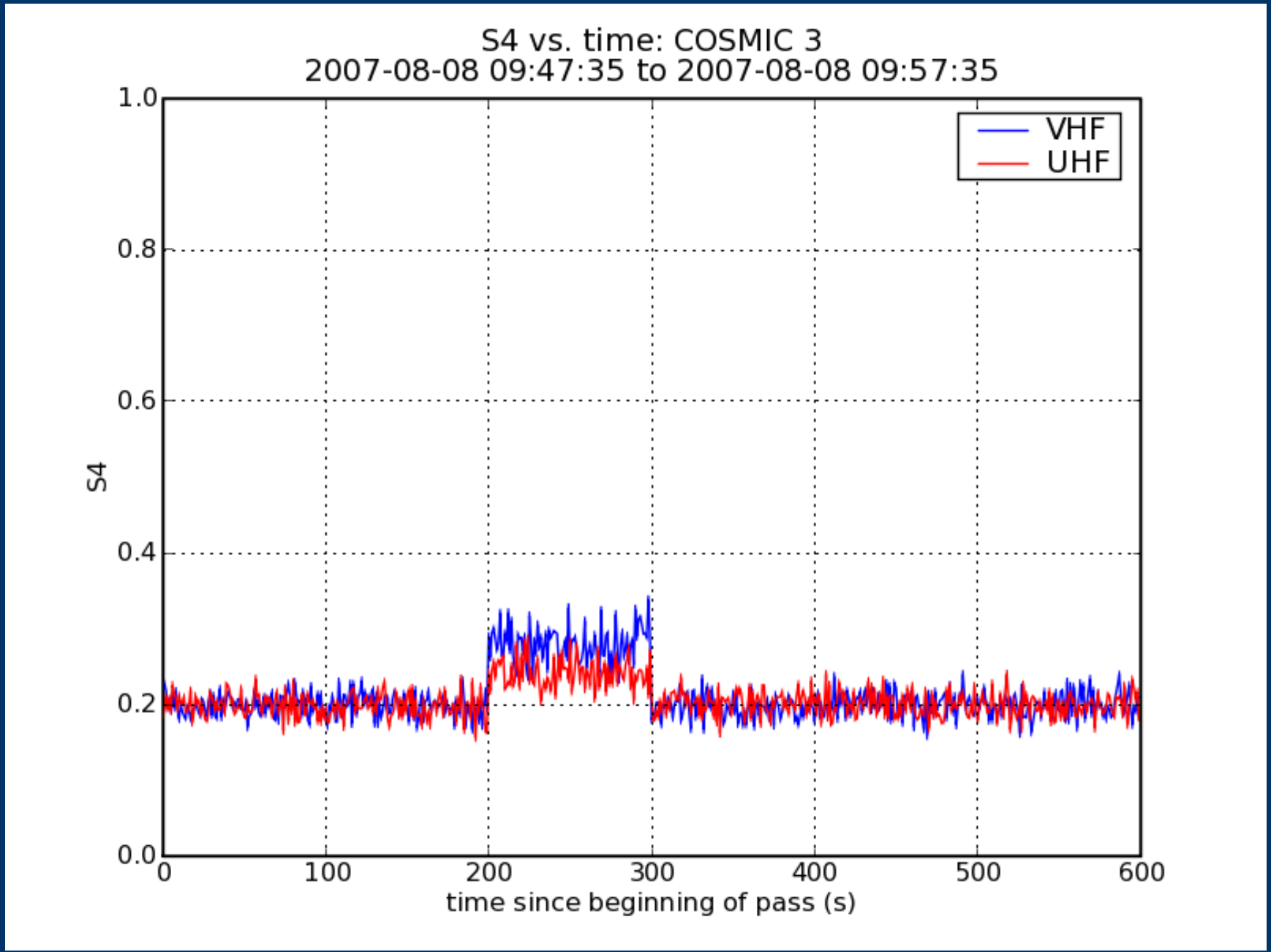


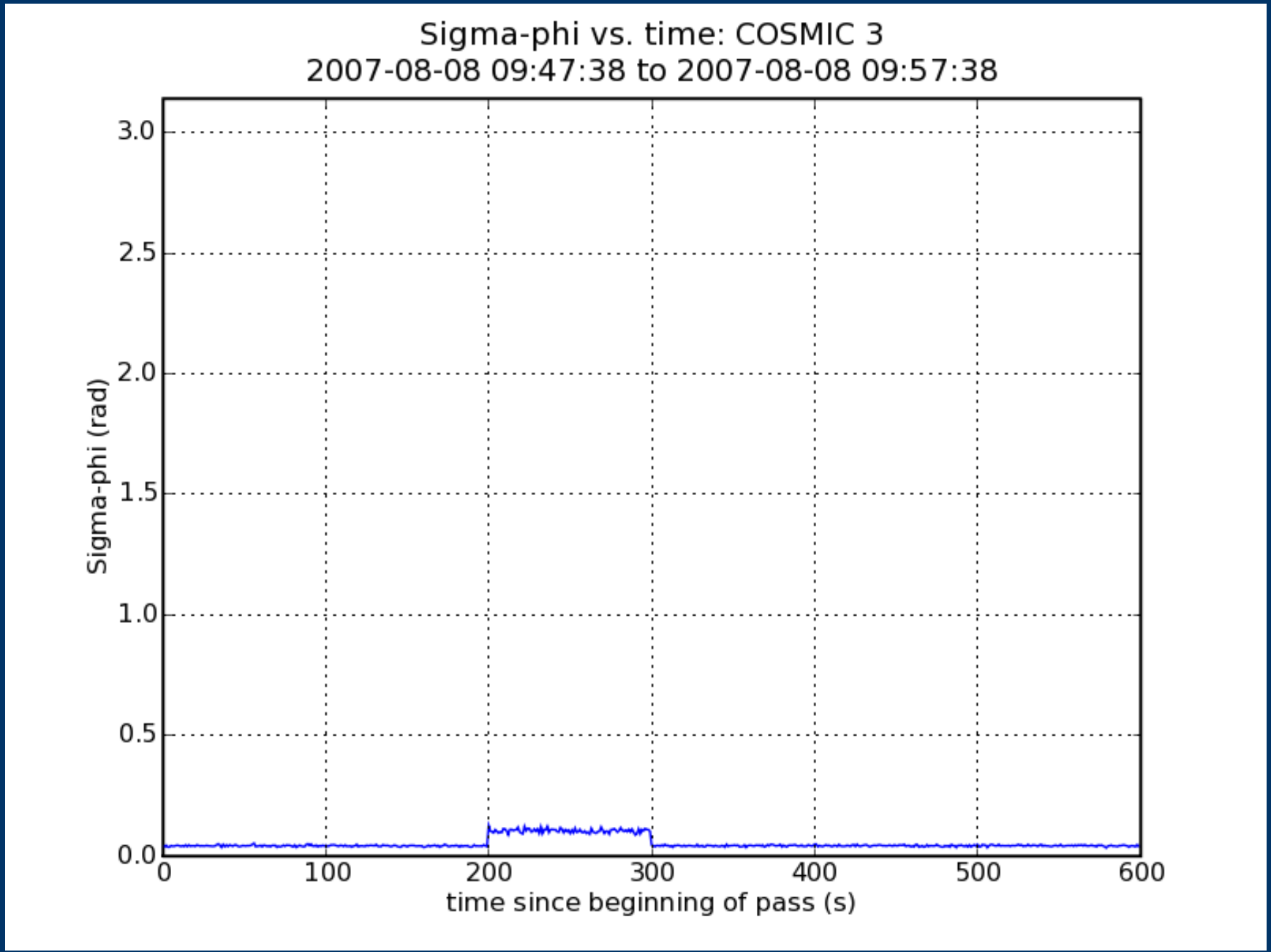
Loading into Madrigal

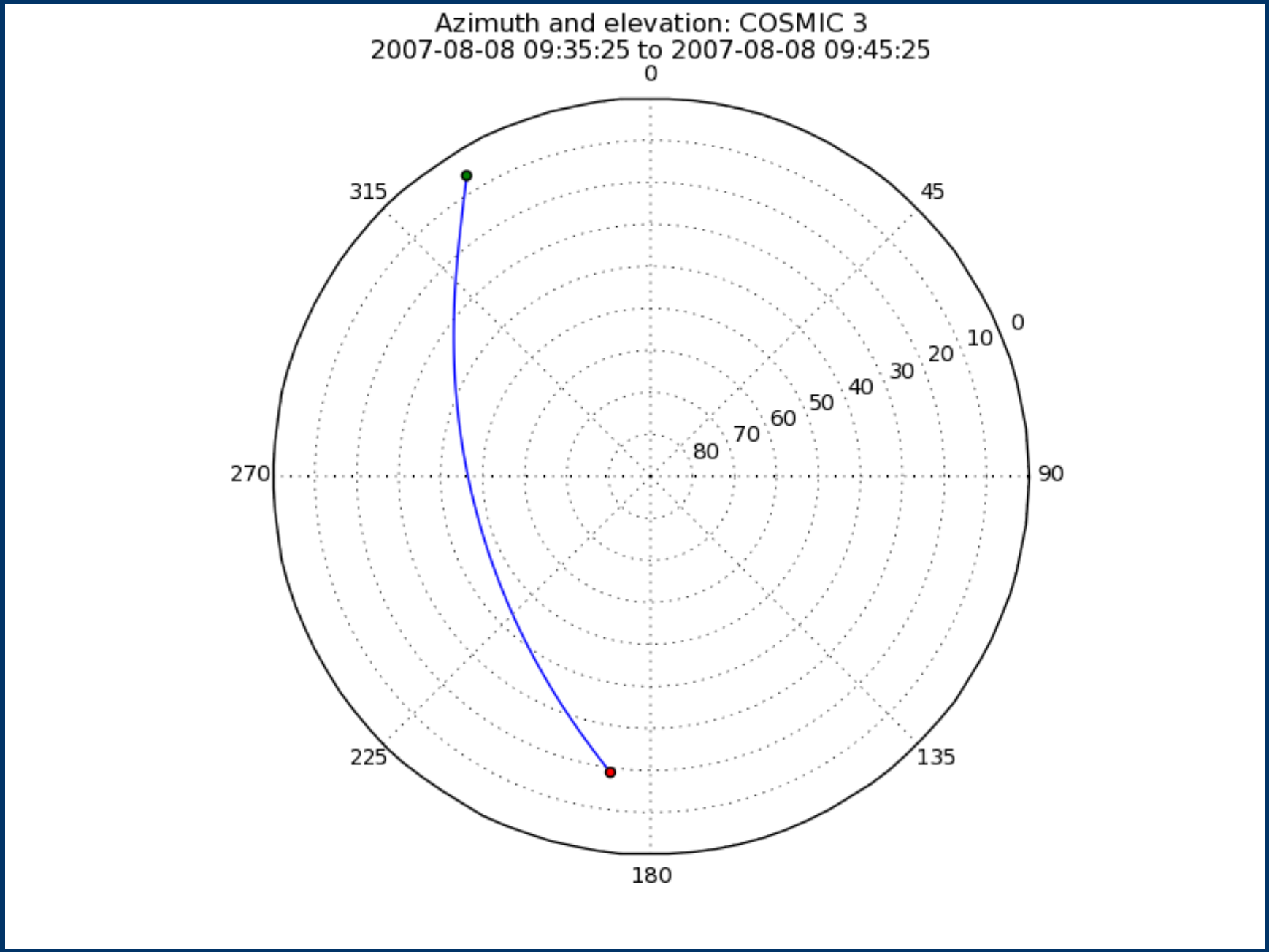


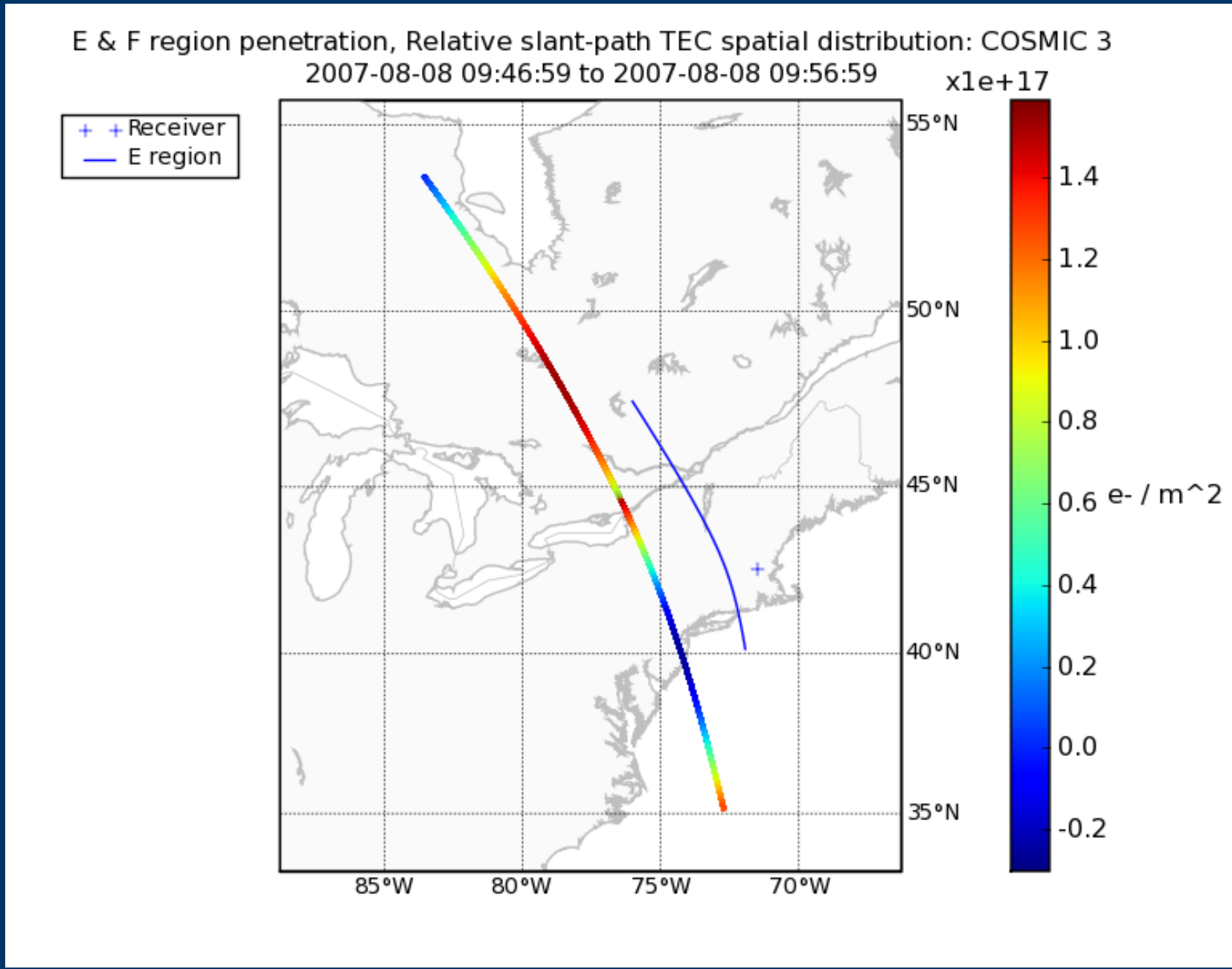
Testing: Simulated Pass

- Loaded into Madrigal
- Parameters plotted


S4 vs. time: COSMIC 3
2007-08-08 09:47:35 to 2007-08-08 09:57:35
VHF
UHF
S4
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500
600
time since beginning of pass (s)

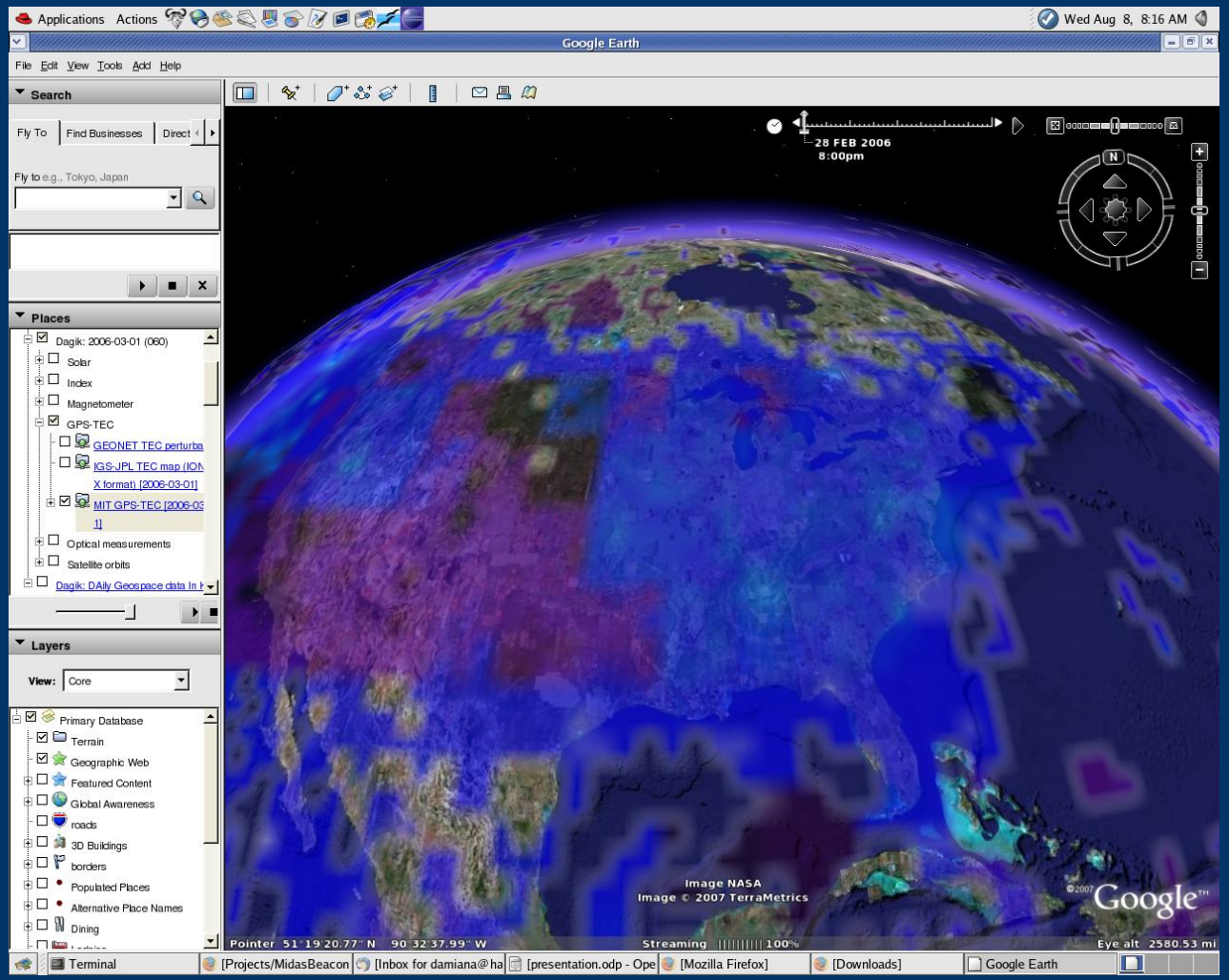

Sigma-phi vs. time: COSMIC 3
2007-08-08 09:47:38 to 2007-08-08 09:57:38
Sigma-phi (rad)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
100
200
300
400
500
600
time since beginning of pass (s)


Azimuth and elevation: COSMIC 3
2007-08-08 09:35:25 to 2007-08-08 09:45:25
0
45
90
135
180
225
270
315
0
10
20
30
40
50
60
70
80


E & F region penetration, Relative slant-path TEC spatial distribution: COSMIC 3
2007-08-08 09:46:59 to 2007-08-08 09:56:59
Receiver
E region
x1e+17
1.4
1.2
1.0
0.8
0.6
e- / m^2
0.4
0.2
0.0
-0.2
55°N
50°N
45°N
40°N
35°N
85°W
80°W
75°W
70°W

In the Future...

- Calibration
- Automation
- Separate user interface
  - Interactive
  - More plots
  - Google Earth



Acknowledgments

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- Jim Marchese

And my fellow beacon receiver REUs:

- Harendra Guturu
- William Harmon