

GPS Data available through Madrigal and/or through MIT Haystack

Anthea Coster
MIT Haystack Observatory

CEDAR 2017
19 June - 23 June 2017

The Madrigal database stores data from a wide variety of upper atmosphere research instruments in the Cedar database format.

Incoherent Scatter Radar



TEC via GPS

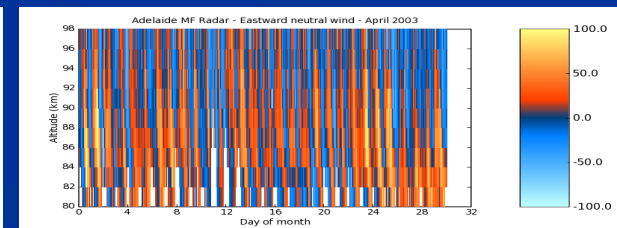
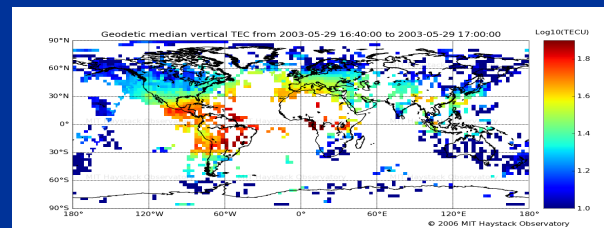
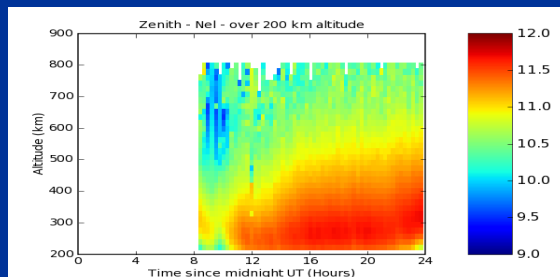


MF Radar



Cedar database format

Loading programs can be written in Python, C, or Tcl



Other instrument types in Madrigal: Meteor radar, Digisonde, Fabry-Perot, Geophysical indices

Standard TEC Data in Madrigal

- 1. Provided in 1 degree by 1 degree bins**
- 2. Provided every 5 minutes**
- 3. Vertical TEC data estimates and Errors on these estimates**
- 4. Geographic Lat and Long**
- 5. Only provides data where observations are available. Does not attempt to model TEC where data is not available. Uses all GNSS data available.**
- 6. New TEC products are on the horizon ...**

Welcome to the CEDAR Archival Madrigal Database

- [Tutorial](#)
- [Simple Local Data Access](#)
- [Full Data Access](#)
- [Run Models](#)
- [Documentation](#)
 - [Web access](#)
 - [Script access](#)
- [Open Madrigal](#)

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Instrument:

World-wide GPS Receiver Networ 1998-2017 ▾

Year:

2013 ▾

Month:

June ▾

June 2013

Sun	Mon	Tue	Wed	Thu	Fri	Sat
26	27	28	29	30	31	01
02	03	04	05	06	07	08
09	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	01	02	03	04	05	06

Selected Instrument:

- *World-wide GPS Receiver Network*
- PI: [Anthea Coster](#) - please contact before using this data

Experiment: World-wide Total Electron Content: 2013-06-14 00:00:00 - 2013-06-15 00:00:00

Select File:

gps130614g.002: Minimum Scallop TEC Processing - final ▾

Selected date:

- 2013-06-14

Email me if [this experiment](#) OR if [any World-wide GPS Receiver Network experiment](#) is updated.

[Download data](#)[Print data](#)[View info](#)[Show Plots](#)[More parameters](#)

Movies and images of world-wide TEC distribution for 2013-06-14

- World-wide TEC movie (animated gif) for [2013-06-14](#)
- World-wide TEC movie (mpeg format) for [2013-06-14](#)

Individual images of world-wide TEC for 20 minute periods:

- TEC image for [00:00](#)
- TEC image for [00:20](#)
- TEC image for [00:40](#)
- TEC image for [01:00](#)
- TEC image for [01:20](#)
- TEC image for [01:40](#)
- TEC image for [02:00](#)
- TEC image for [02:20](#)
- TEC image for [02:40](#)
- TEC image for [03:00](#)
- TEC image for [03:20](#)
- TEC image for [03:40](#)
- TEC image for [04:00](#)
- TEC image for [04:20](#)
- TEC image for [04:40](#)
- TEC image for [05:00](#)
- TEC image for [05:20](#)
- TEC image for [05:40](#)
- TEC image for [06:00](#)
- TEC image for [06:20](#)
- TEC image for [06:40](#)
- TEC image for [07:00](#)
- TEC image for [07:20](#)
- TEC image for [07:40](#)
- TEC image for [08:00](#)
- TEC image for [08:20](#)
- TEC image for [08:40](#)
- TEC image for [09:00](#)
- TEC image for [09:20](#)

My recommendation (and Bill Rideout's)

Use globalDownload command to obtain multiple days (even years) of our TEC product. The globalDownload command is available in python, matlab, and IDL scripts.

TEC data can be provided in HDF5 or ascii format. HDF5 is faster.

Successful Example of running globalDownload.py

```
globalDownload.py
--url=http://madrigal.haystack.mit.edu/madrigal
--outputDir=/Users/ajc/Dropbox-MIT
--user_fullname="anthea_coster"
--user_email=costera@mit.edu
--user_affiliation=MIT
--startDate=01/01/2003
--endDate=01/03/2003
--format=hdf5
--inst=8000
```

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Madrigal remote data access programming tutorial - Table of Contents

- [1. Introduction](#)
- [2. Madrigal web services](#)
- [3. Matlab API and examples](#)
- [4. Python API and examples](#)
- [5. IDL API and examples](#)

What is in HDF5 file of TEC - Using HDFView

Data Parameters at /Metadata/ [gps030101g.002.hdf5 in /Users/ajc/Dropbox-MIT]

Table



	mnemonic	description	isError	units	category
0	YEAR	Year (universal time)	0	y	Time Related Parameter
1	MONTH	Month (universal time)	0	m	Time Related Parameter
2	DAY	Day (universal time)	0	d	Time Related Parameter
3	HOUR	Hour (universal time)	0	h	Time Related Parameter
4	MIN	Minute (universal time)	0	m	Time Related Parameter
5	SEC	Second (universal time)	0	s	Time Related Parameter
6	UT1_UNIX	Unix seconds (1/1/1970) at start	0	s	Time Related Parameter
7	UT2_UNIX	Unix seconds (1/1/1970) at end	0	s	Time Related Parameter
8	RECNO	Logical Record Number	0	N/A	Time Related Parameter
9	GDLAT	Geodetic latitude of measurement	0	deg	Geographic Coordinate
10	GLON	Geodetic longitude of measurement	0	deg	Geographic Coordinate
11	TEC	Vertically integrated electron density	0	tec	I. S. Radar Basic Parameter
12	DTEC	Error in Vertically integrated electron density	1	tec	I. S. Radar Basic Parameter

gps030101g.002.hdf5

- Data
 - Table Layout
- Metadata
 - Data Parameters
 - Experiment Notes
 - Experiment Parameters

Table Layout at /Data/ [gps030101g.002.hdf5 in /Users/ajc/Dropbox-MIT]

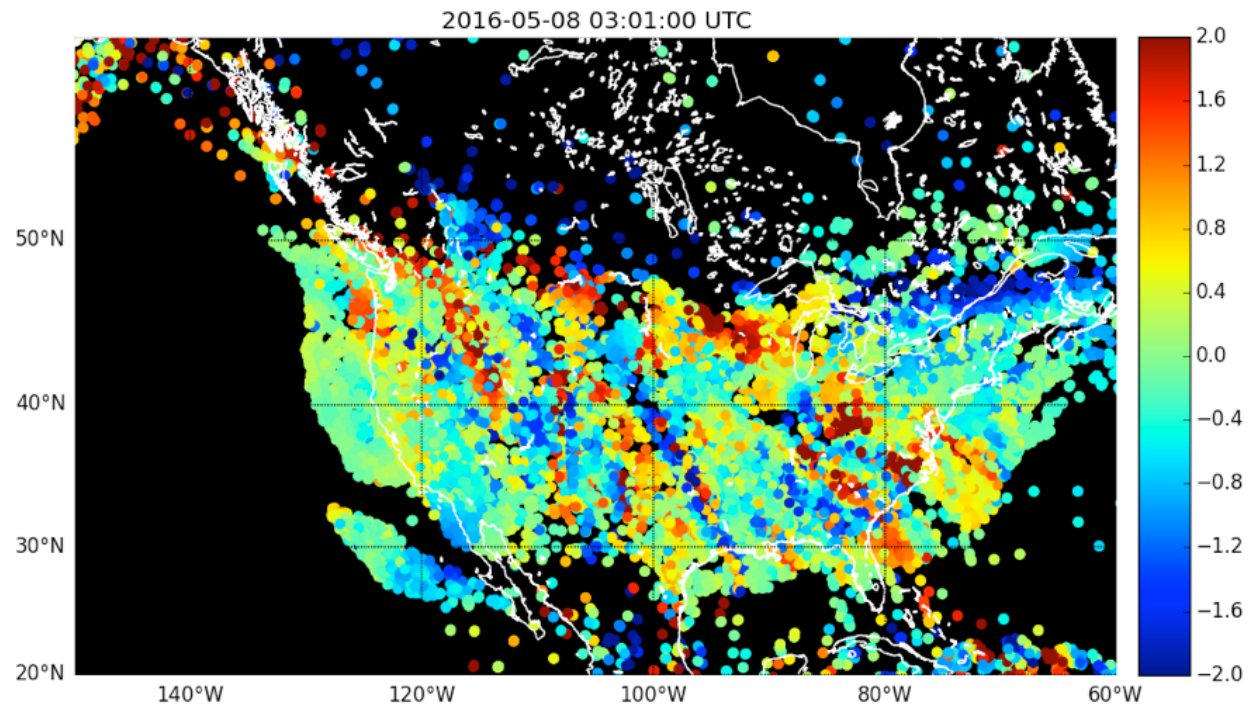
Table



	year	month	day	hour	min	sec	ut1_unix	ut2_unix	recno	gdlat	glon	tec	dtec
0	2003	1	1	0	2	30	1041379...	1041379...	2	-80.0	4.0	12.5	5.1
1	2003	1	1	0	2	30	1041379...	1041379...	2	-79.0	4.0	12.7	3.4
2	2003	1	1	0	2	30	1041379...	1041379...	2	-79.0	8.0	10.0	3.1
3	2003	1	1	0	2	30	1041379...	1041379...	2	-78.0	7.0	10.3	2.9
4	2003	1	1	0	2	30	1041379...	1041379...	2	-78.0	8.0	10.1	4.0
5	2003	1	1	0	2	30	1041379...	1041379...	2	-77.0	-22.0	17.3	5.1
6	2003	1	1	0	2	30	1041379...	1041379...	2	-77.0	-21.0	17.2	3.5
7	2003	1	1	0	2	30	1041379...	1041379...	2	-77.0	-20.0	17.0	5.0
8	2003	1	1	0	2	30	1041379...	1041379...	2	-77.0	91.0	17.6	2.5
9	2003	1	1	0	2	30	1041379...	1041379...	2	-77.0	92.0	17.7	2.4
10	2003	1	1	0	2	30	1041379...	1041379...	2	-76.0	-53.0	13.3	4.4
11	2003	1	1	0	2	30	1041379...	1041379...	2	-76.0	34.0	8.3	3.0
12	2003	1	1	0	2	30	1041379...	1041379...	2	-76.0	47.0	14.3	4.1
13	2003	1	1	0	2	30	1041379...	1041379...	2	-76.0	48.0	14.3	3.2
14	2003	1	1	0	2	30	1041379...	1041379...	2	-76.0	49.0	14.4	3.2
15	2003	1	1	0	2	30	1041379...	1041379...	2	-76.0	50.0	14.4	3.4
16	2003	1	1	0	2	30	1041379...	1041379...	2	-76.0	51.0	14.5	3.4
17	2003	1	1	0	2	30	1041379...	1041379...	2	-76.0	91.0	17.5	3.7
18	2003	1	1	0	2	30	1041379...	1041379...	2	-76.0	126.0	17.6	4.6
19	2003	1	1	0	2	30	1041379...	1041379...	2	-76.0	127.0	17.5	4.5
20	2003	1	1	0	2	30	1041379...	1041379...	2	-75.0	-53.0	13.1	3.4
21	2003	1	1	0	2	30	1041379...	1041379...	2	-75.0	-15.0	12.7	2.7
22	2003	1	1	0	2	30	1041379...	1041379...	2	-75.0	33.0	8.0	3.9
23	2003	1	1	0	2	30	1041379...	1041379...	2	-75.0	34.0	8.0	4.8
24	2003	1	1	0	2	30	1041379...	1041379...	2	-75.0	83.0	18.4	2.8
25	2003	1	1	0	2	30	1041379...	1041379...	2	-75.0	84.0	18.3	3.5
26	2003	1	1	0	2	30	1041379...	1041379...	2	-74.0	-45.0	11.4	4.4
27	2003	1	1	0	2	30	1041379...	1041379...	2	-74.0	-44.0	11.6	7.1
28	2003	1	1	0	2	30	1041379...	1041379...	2	-74.0	-15.0	13.7	2.8
29	2003	1	1	0	2	30	1041379...	1041379...	2	-74.0	11.0	11.1	3.5
30	2003	1	1	0	2	30	1041379...	1041379...	2	-74.0	12.0	11.1	3.6
31	2003	1	1	0	2	30	1041379...	1041379...	2	-74.0	27.0	7.9	6.0
32	2003	1	1	0	2	30	1041379...	1041379...	2	-74.0	28.0	8.4	3.2
33	2003	1	1	0	2	30	1041379...	1041379...	2	-74.0	53.0	11.7	3.1
34	2003	1	1	0	2	30	1041379...	1041379...	2	-74.0	54.0	11.4	3.2
35	2003	1	1	0	2	30	1041379...	1041379...	2	-74.0	118.0	17.8	2.9
36	2003	1	1	0	2	30	1041379...	1041379...	2	-73.0	-77.0	11.4	2.8
37	2003	1	1	0	2	30	1041379...	1041379...	2	-73.0	-76.0	11.3	3.0
38	2003	1	1	0	2	30	1041379...	1041379...	2	-73.0	-70.0	12.3	2.2

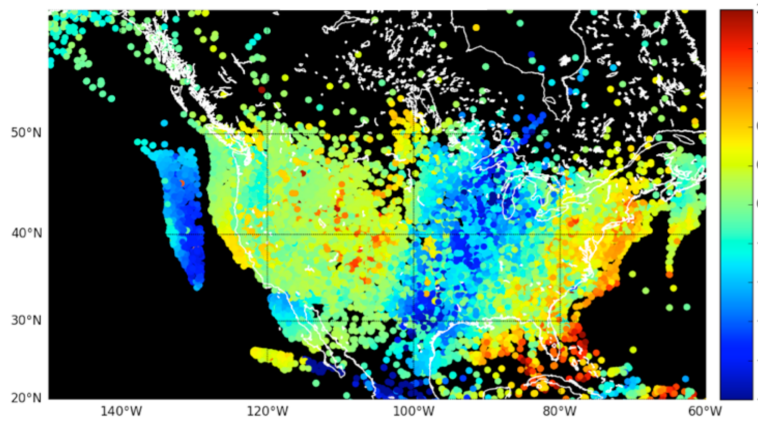
Future Madrigal TEC products

- GNSS Processing soon to be in Madrigal
 - Line of sight TEC values for each receiver processed. Each receiver tracks multiple GPS satellites.
 - For each line of sight TEC value, a pierce point latitude and longitude will be provided.
 - We hope to also process GLONASS satellites shortly.

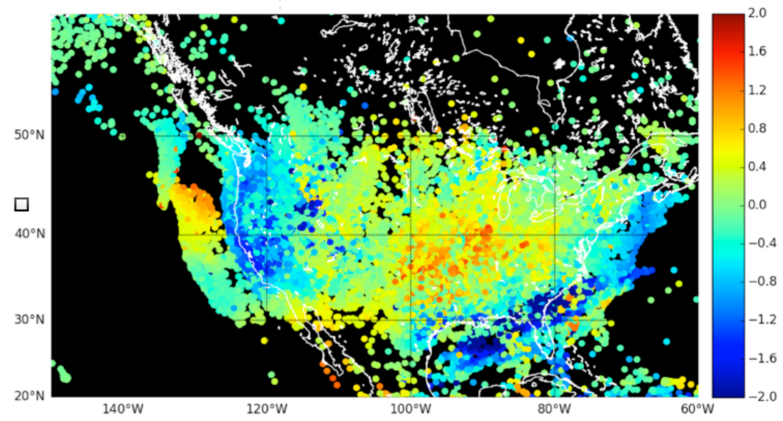


01-16-2013

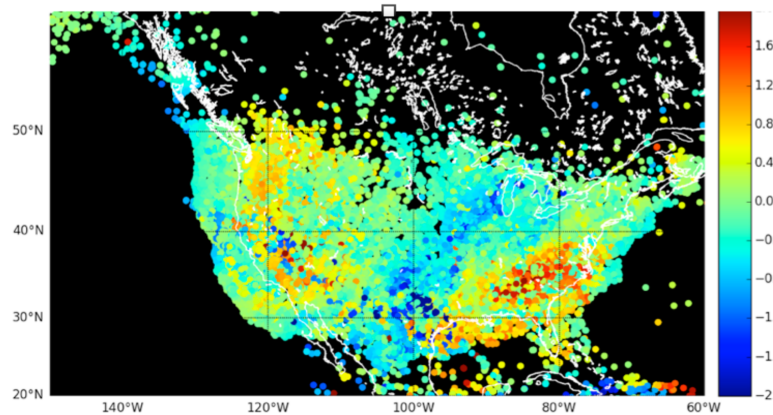
13:02 UT



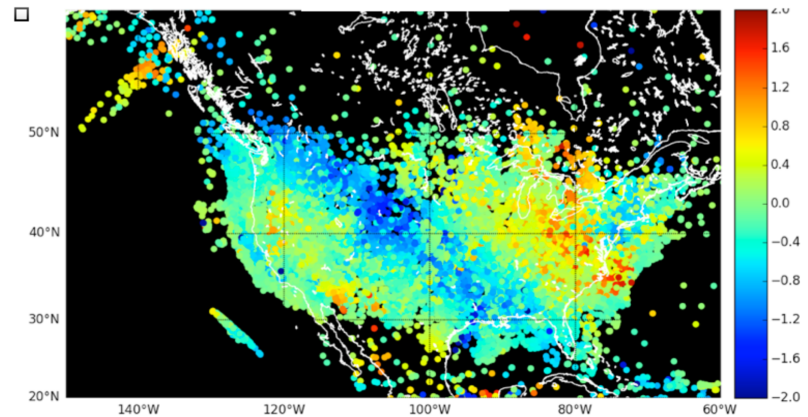
15:00 UT



16:27 UT



22:53 UT



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[Madrigal home page](#)

Choose instrument type:

Ground Based Satellite Receivers

South Pole Scintillation Recei [2011-2013]

Year:

2011

Month:

April

Selected Instrument:

- *South Pole Scintillation Receiver*
- PI: [Allan T. Weatherwax](#) - please contact before using this data

Experiment: Scintillation: 2011-04-08 00:00:46 - 2011-04-08 23:59:46

Select File:

1630_5_00.gps_all.out: Ionospheric scintillation - Final

Selected date:

- 2011-04-08

Email me if [this experiment](#) OR if [any South Pole Scintillation Receiver experiment](#) is updated.

Download data

Print data

View info

Show Plots

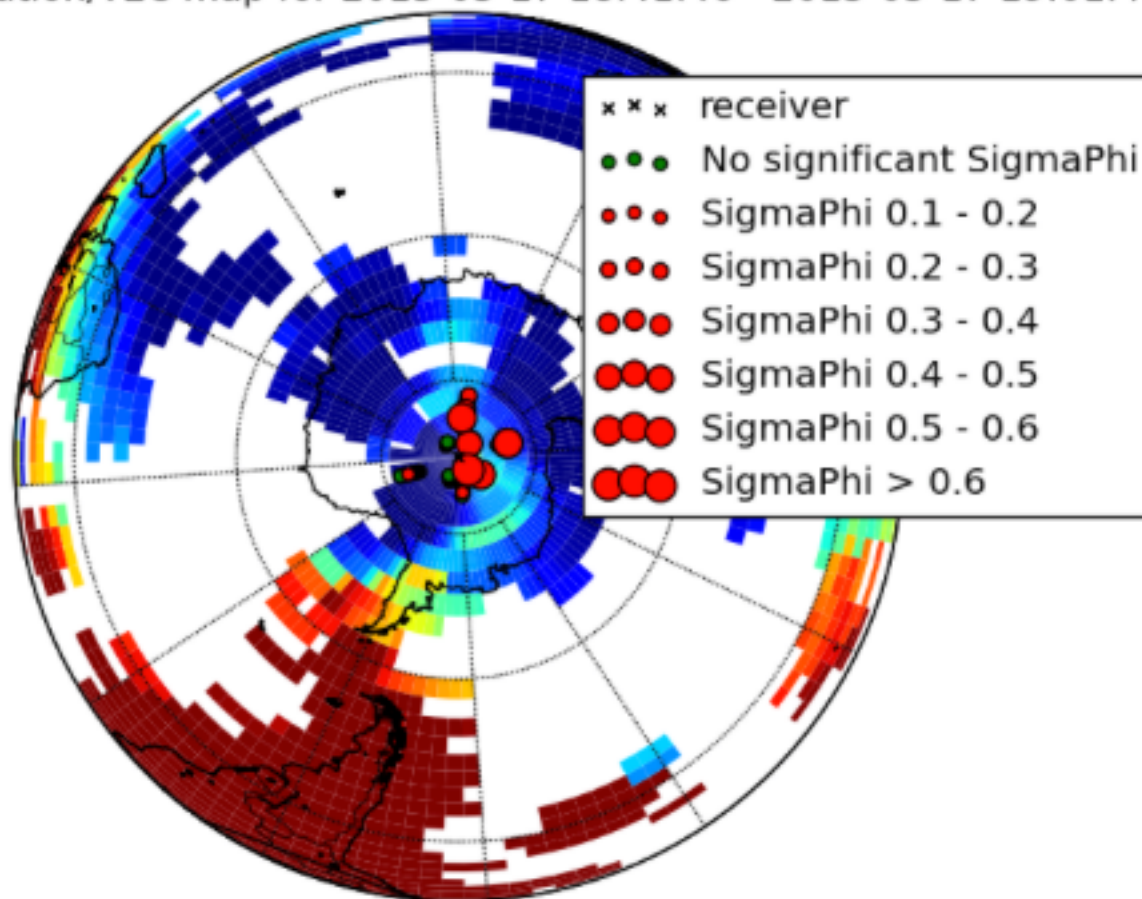
More parameters

- [Click here for combined scintillation/TEC maps for 2011-04-08](#)

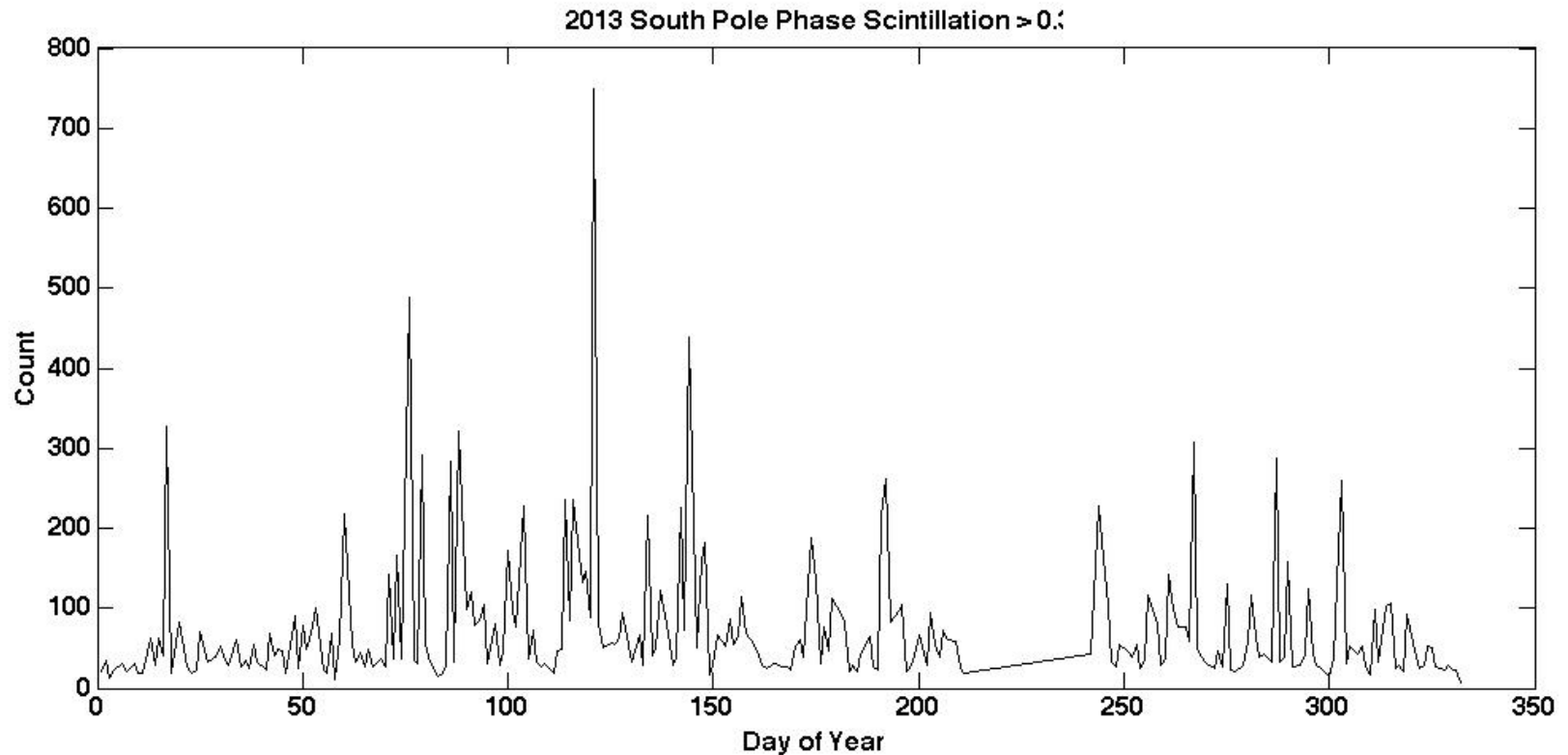
April 2011

Sun	Mon	Tue	Wed	Thu	Fri	Sat
27	28	29	30	31	01	02
03	04	05	06	07	08	09
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

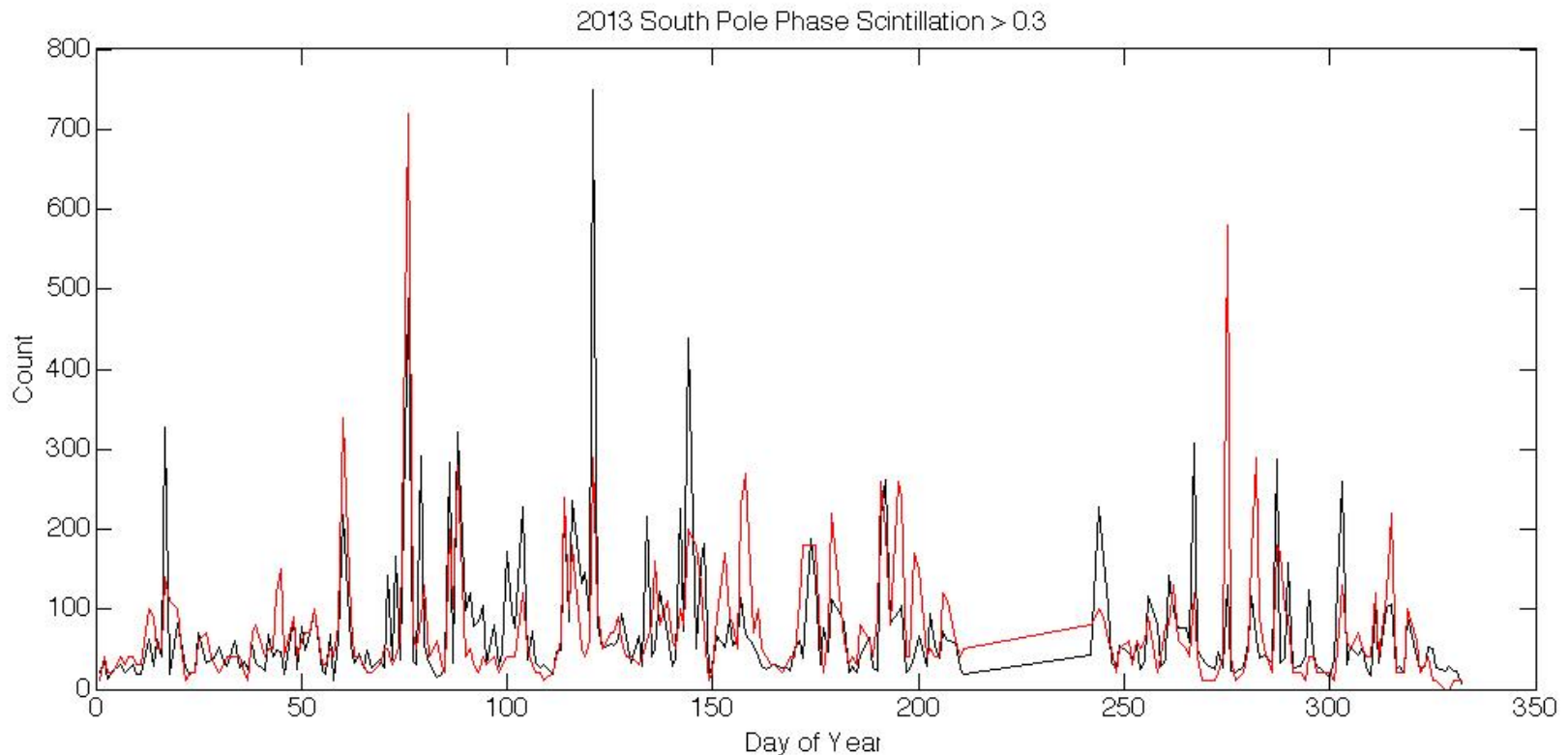
Phase scintillation/TEC map for 2013-03-17 18:41:46 - 2013-03-17 19:01:46



South Pole Phase Scintillation > 0.3 Counts per Day 2013



South Pole Phase Scintillation > 0.3 Counts per Day 2013 versus Ap



Questions with Madrigal

- Start with Bill Rideout
brideout@haystack.mit.edu