

## Instructions on how to obtain GNSS TEC from the Madrigal Database

(<http://cedar.openmadrigal.org/>)

Currently we produce vertical total electron content maps from approximately 6000 GNSS dual-frequency receivers world-wide. TEC data is stored in 1 deg by 1 deg bins at a 5 minute cadence and produce global TEC maps at a 20 minute cadence in bins of 3 deg by 3 deg. This TEC data is available on line from 2000 on.

A new product – the line of sight TEC data – is available for the last 3 years. These data files are extremely large, typically over a gigabyte per day. They provide TEC for every receiver, every 30 seconds (time), for every receiver and every satellite. The files are in HDF5 format.

To obtain both types of data ( the gridded gps and los files), go to a madrigal website.

<http://cedar.openmadrigal.org>

You may have to register your name and institution.

Then - from the main page select : Access Data

A list will appear – hit select single experiment to start.

The screenshot shows the CEDAR Madrigal Database website. The top navigation bar is blue with white text for the following links: CEDAR Home, Access data (with a dropdown arrow), Access metadata (with a dropdown arrow), Run models (with a dropdown arrow), Documentation, Other Madrigal sites (with a dropdown arrow), and OpenMadrigal. A dropdown menu is open under 'Access data', showing four options: List experiments, Select single experiment, Create a command to download multiple exps, and FTP-like access. The main content area has a white background with a blue header that reads 'Welcome to the CEDAR Madrigal Database'. Below this, there is introductory text: 'Madrigal is an upper atmosphere science instrument database available throughout the world. Madrigal is a robust, World Wide Web based system capable of a wide range of upper atmospheric science instruments. Data at each Madrigal site is locally controlled and can be updated at any time, but shared metadata is available from any Madrigal site. To see a list of all Madrigal sites, use the *Other Madrigal sites* pull down menu. Data can also be accessed directly, using APIs which are available for several sites. An archive of all Madrigal software and documentation is available from the [Open Madrigal](#) Web site. The latest version of Madrigal and the remote API's may vary. The CEDAR Madrigal database architecture and implementation [meets and exceeds FAIR guiding principles](#) in all aspects.

Use of the Madrigal Database is generally subject to the CEDAR Rules-of-the-Road. Prior permission to access the data is not required. However, the user is requested to discuss the intended usage. Data are often subject to limitations which are not immediately evident to new users. Before they are formally submitted, data-supplying organizations along with an offer of co-authorship to scientists who have provided data. This offer may be declined. The Database and the organization responsible for the data will be acknowledged whenever this data is made available through another database. If you have any questions about appropriate use of these data, contact [brideout@haystack.edu](mailto:brideout@haystack.edu).

Use all Madrigal sites:

Instrument category:

Choose instrument type: ▾

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FOR: instrument category

distributed ground based satellite receivers

FOR: choose instruments

world-wide gnss receiver network (1998-2019)

THEN fill in start and stop dates and times

**Select single Madrigal experiment**

Use all Madrigal sites:

Instrument category:

Instrument:

Year:

Month:

Date:

S	M	T	W	T	F	S
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	30	31				

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there will be one or two data files available in hdf5 format.

**Select single Madrigal experiment**

Use all Madrigal sites:

Instrument category:

Instrument:

Year:

Month:

Date:

Select experiment:

PI: Anthea Coster - please contact before using this data      Email me if this experiment OR if any World-wide GNSS Receiver Network experiment is updated.

Select file:

- Select file
- gps200319g.002.hdf5: TEC binned 1 degree by 1 degree by 5 min - final
- los\_20200319.001.h5: Line of sight TEC data - Final
- site\_20200319.001.h5: List of sites used in daily TEC data - Final

S	M	T	W	T	F	S
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	30	31				

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The gps files are the 1 degree by 1 degree binned TEC files every 5 minutes

The los files are larger and are the line of sight files.

The site files show you what sites were used to compute the los and gps files.

If you select either of these files – you should have the availability to look at our plots or our TEC maps when you hit the button called show plots.

← → ↻ Not Secure | cedar.openmadrigal.org/single/?isGlobal=on&categories=17&instruments=8000&years=2020&months=3&days=19

CEDAR Home Access data Access metadata Run models Documentation Other Madrigal sites OpenMadrigal

### Select single Madrigal experiment

Use all Madrigal sites:

Instrument category:

Instrument:

Year:

Month:

Date:

S	M	T	W	T	F	S
1	2	3	4	5	6	7
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Select experiment:

PI: Anthea Coster - please contact before using this data  Email me if this experiment OR if any World-wide GNSS Receiver Network experiment is updated.

Select file:

Plots/docs Download file Print file View file info Cite this file

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Try hitting Plots/docs

CEDAR Home Access data Access metadata Run models Documentation Other Madrigal sites OpenMadrigal

### Select single Madrigal experiment

Use all Madrigal sites:

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Select file:

Plots/docs Download file Print file View file info Cite this file

- Data source list for TEC processing
- Python programming tips for reading line-of-site TEC files
- Papers describing processing algorithms used
- [Click here for TEC maps for 2020-03-19](#)
- Create interactive TEC/SuperDARN plots
- [Click here for plots of raw LOS converted to vertical TEC for 2020-03-19](#)

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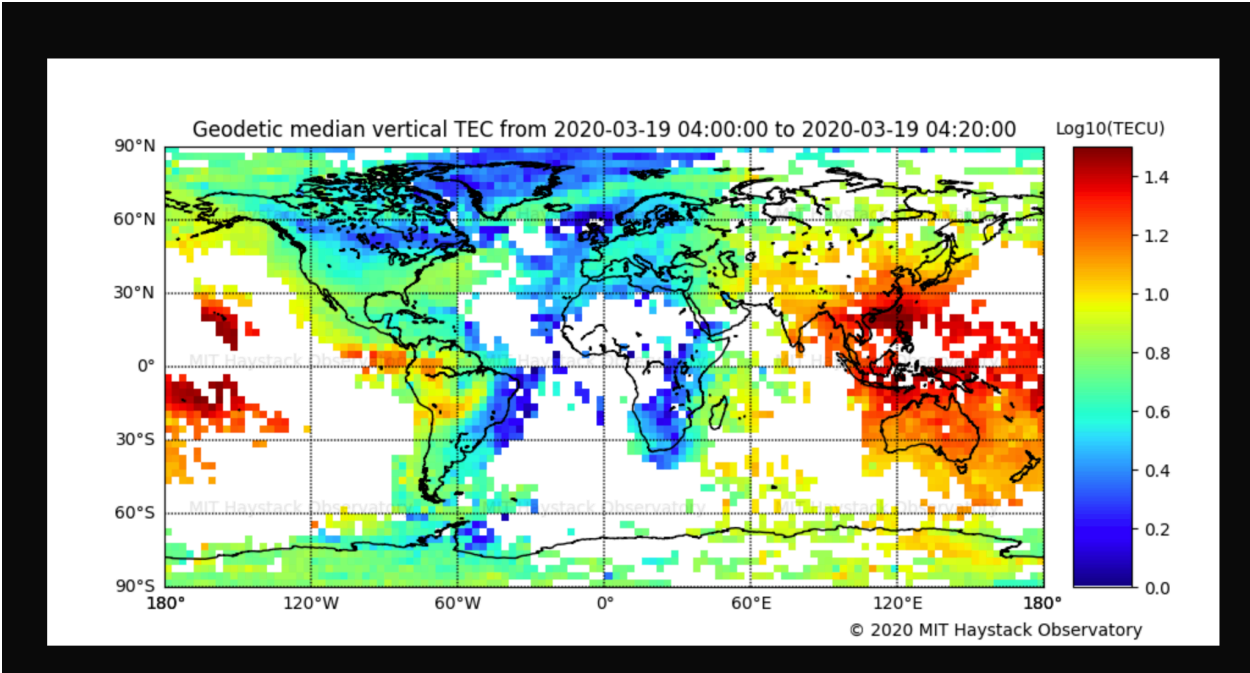
Try the click here for TEC maps for 2020-03-19.

## **Movies and images of world-wide TEC distribution for 2020-03-19**

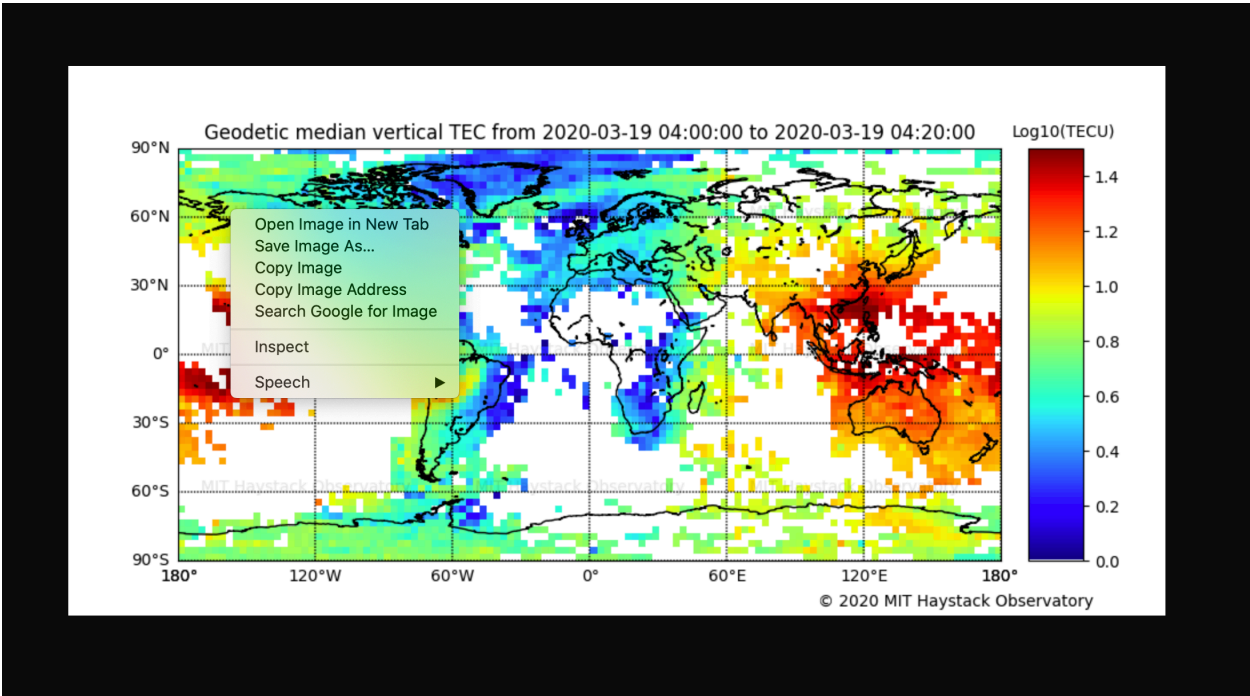
- World-wide TEC movie (animated gif) for [2020-03-19](#)
- World-wide TEC movie (mpeg format) for [2020-03-19](#)

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](#)
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- TEC image for [09:20](#)
- TEC image for [09:40](#)
- TEC image for [10:00](#)
- TEC image for [10:20](#)
- TEC image for [10:40](#)
- TEC image for [11:00](#)



To download map,



Hit cntrl shift enter to get above menu.

*Publications making use of Madrigal GPS TEC data must include the following acknowledgment text. In addition, please contact the Haystack GPS PI, Anthea Coster, ajc at [haystack.mit.edu](mailto:haystack.mit.edu), before submission.*

GPS TEC data products and access through the Madrigal distributed data system are provided to the community by the Massachusetts Institute of Technology under support from US National Science Foundation grant AGS-1242204. Data for the TEC processing is provided from the following organizations: UNAVCO, Scripps Orbit and Permanent Array Center, Institut Geographique National, France, International GNSS Service, The Crustal Dynamics Data Information System (CDDIS), National Geodetic Survey, Instituto Brasileiro de Geografia e Estatística, RAMSAC CORS of Instituto Geográfico Nacional de la República Argentina, Arecibo Observatory, Low-Latitude Ionospheric Sensor Network (LISN), Topcon Positioning Systems, Inc., Canadian High Arctic Ionospheric Network, Institute of Geology and Geophysics, Chinese Academy of Sciences, China Meteorology Administration, Centro di Ricerche Sismologiche, Système d'Observation du Niveau des Eaux Littorales (SONEL), RENAG : REseau NAional GPS permanent, GeoNet - the official source of geological hazard information for New Zealand, GNSS Reference Networks, Finnish Meteorological Institute, SWEPOS - Sweden, Hartebeesthoek Radio Astronomy Observatory, Crustal Dynamics Data Information System (CDDIS), Astronomical Institute of the University of Bern, TrigNet Web Application, South Africa, Australian Space Weather Services, RETE INTEGRATA NAZIONALE GPS, Estonian Land Board, and Virginia Tech Center for Space Science and Engineering Research.