MADRIGAL

```
In [1]:  from datetime import datetime, timedelta
         # Self Created Functions ---------------------------
         # Plot NIMO and Madrigal TEC together
         from Madrigal_NIMO2 import NIMO_MAD_DailyFile, load_madrigal, mad_nimo
         from Load_NIMO2 import load_nimo
         import pysat
         import pysatMadrigal as pymad
```

Download Madrigal data that coincides with model data.

Madrigal NIMO single Plot

Function: Madrgial_NIMO2.NIMO_MAD_DailyFile
Plot up to 12 panels including Madrigal TEC with
standard devation as error bars,filtered Madrigal TEC,
and NIMO TEC along with the corresponding EIA Types

Required Parameters

> mad_dc : dictionary of madrigal data from load_madrigal function
> nimo_dc : dictionary of nimo data from load_nimo function

Key Word arguments

> lon_start : starting longitude for plot. i.e. -90
>
> > Plot will range between -90 to -60 as a Default

> stime : datetime for plot
> mlat_val : int magnetic latitude cutoff
> max_nan : double of Maximum acceptable percent nan values in a
> pass fosi : int font size

load_madrigal

Function: Madrigal_NIMO2.load_madrigal
Loads madrgial data into a dictionary

Required Parameters

> stime: datetime Universal time for the desired madrigal output

fdir : str directory where file is located

Returns

mad_dc : dictionary object

dictionary of the madrigal data including:
tec, geographic latitude, geographic longitude,
dtec, timestamp, date (datetime format),
magnetic latitude, magnetic longitude

Notes

This takes in madrgial files of format gps%y%m%dg.002.netCDF4
5 minute cadence

load_nimo

Function : Load_NIMO2.load_nimo
Loads Nimo file inot a dictionary

Required Parameters:

stime : datetime of desired Nimo data

Key Word Arguments

fdir : directory of NIMO file
name_format : string

format of NIMO filename including date format before
.nc
Default: 'NIMO_AQ_%Y%j'

_var : str of variable names for NIMO

variable names to be opened in the NIMO file

ne, lon, lat, alt, hr, min, tec, hmf2, nmf2
Defaults

electron density - 'dene'
geo longitude - 'lon'
geo latitude - 'lat'
altitude - 'alt'

> > hour - 'hour'
> > minute - 'minute'
> > TEC - 'tec'
> > hmf2 - 'hmf2'
> > nmf2 - 'nmf2'

nimo_cadence: int

> time cadence of NIMO data in minutes
> default is 15 minutes

Retunrs

> nimo_dc : dictionary
>
> > dictionary with variables:
> > dene,lon,lat,alt,hour,minute,date, tec,hmf2

In [2]:
```python
stime = datetime(2020, 4,1,0,30)
load_file = '~/data/gnss/tec/vtec/'
nim_dir = '~/NIMO/'
mad_dc = load_madrigal(stime, load_file)
nimo_dc = load_nimo(stime, fdir=nim_dir)
lon_start = -90
mlat_val = 30
mad_nimo_single_plot(mad_dc, nimo_dc, lon_start, stime,
                     mlat_val);

# TO make a map use
#-------------------
# where nimo_map comes from:
#nimo_df, nimo_map = nimo_mad_conjunction(nimo_dc, mlat_val,
#                                          glon_val, stime)
# madrigal_nimo_world_maps(stime, mad_dc, nimo_map)
```

Madrigal TEC from 2020-04-01 00:30:00 to 2020-04-01 00:45:00
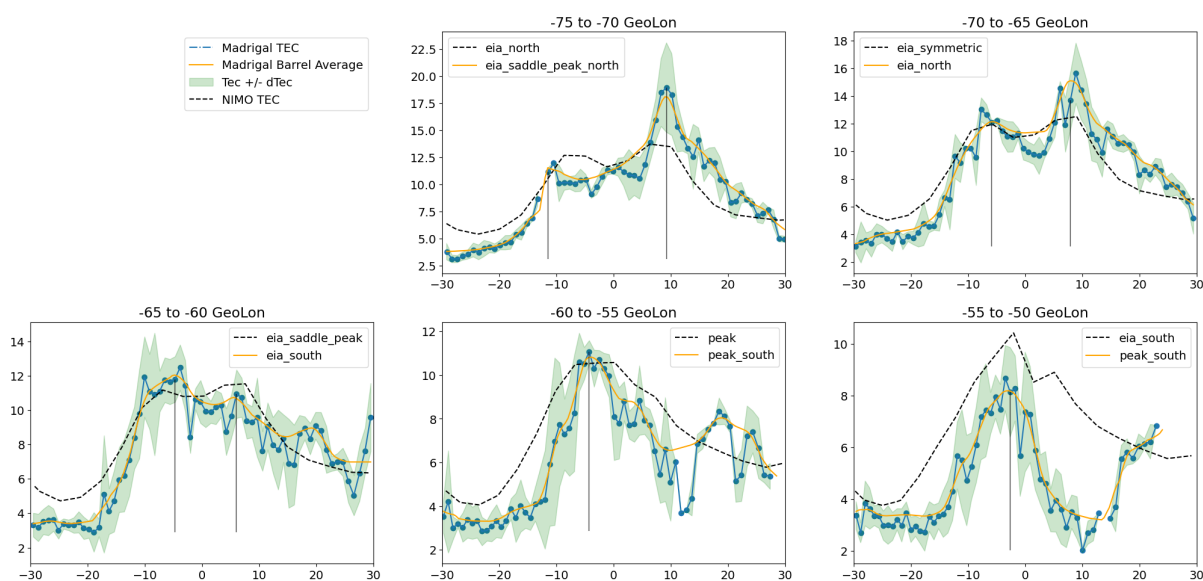
Madrigal NIMO Daily Files and plots

Function: Madrgial_NIMO2.NIMO_MAD_DailyFile

Daily Files include information about the conjunctions, peak locations, and EIA type

Plot up to 12 panels including Madrigal TEC with standard devation as error bars,filtered Madrigal TEC, and NIMO TEC along with the corresponding EIA Types

Includes a separate map plot for the TEC

Required Parameters

> start_day : datetime for daily file
> mad_file_dir : string file directory of Madrigal File
> nimo_file_dir : string file directory of NIMO File

Key Word Arguments

> MLat : Magnetic Latitude cutoff
>
> > 30° Default
>
> lon_start : starting longitude for plot. i.e. -90
>
> > Plot will range between -90 to -30 as a Default
> > Another Recommended Region is 60 to 120
>
> file_save_dir: string of output directory for file

> if it is left empty ('' default), then cwd will be used

fig_on : boolean specifying whether or not to make the file Default True

fig_save_dir: string of output directory for figures

> if it is left empty ('' default), then cwd will be used

max_nan : double specifying the maximum %nan is acceptable in a pass

mad_filt : str Desired Filter for madrigal data (default barrel_average)

mad_interpolate : int

> int that determines the number of data points in interpolation
> new length will be len(density)xinterpolate
> default is 2 indicating double number of points

mad_envelope : bool

> if True, barrel roll will include points inside an br envelope, if False (default), no envelope will be used

mad_barrel : double latitudinal radius of barrel for madrigal (default: 3 degrees maglat)

mad_window : double latitudinal width of moving window (default: 3 degrees maglat)

nimo_filt : filter for nimo data

> Default '' (no filter)

nimo_interpolate : linear interpolation parameter

> the number of data points will incrase by swarm_interpolate
> Default is 2 (doubles number of points)

nimo_envelope : boolean

> determines if an envelope is used if barrel is in filter
> Default is False (no envelope)

nimo_barrel : double deteriming magnetic latitude radius of barrel

> Default is 3°

nimo_window : double determing magnetic latitude moving average window size

> Default is 3°

fosi : int for plot font size

> Default 18
> Exceptions:
>
> > Super Title (fosi + 10)
> > legends (fosi – 3)

nimo_name_format : string specifying nimo filename before '.nc'

> Default is 'NIMO_AQ_%Y%j'

*_var : str of variable names for NIMO

> variable names to be opened in the NIMO file
> * ne, lon, lat, alt, hr, min, tec, hmf2, nmf2
> Defaults
>
> > electron density – 'dene'
> > geo longitude – 'lon'
> > geo latitude – 'lat'
> > altitude – 'alt'
> > hour – 'hour'
> > minute – 'minute'
> > TEC – 'tec'
> > hmf2 – 'hmf2'
> > nmf2 – 'nmf2'

nimo_cadence: int

> time cadence of NIMO data in minutes
> default is 15 minutes

max_tdif : double

> maximum time distance (in minutes) between a NIMO and Swarm
> conjunction allowed (default 15)

In [3]:
```python
stime = datetime(2020, 4,1,0,0)
fig_save = '~/Plots/NIMO_MADRIGAL/'
file_save = '~/Type_Files/Daily/'
mad_load_file = '~/data/gnss/tec/vtec/'
nim_dir = '~/NIMO/'
mad_df = NIMO_MAD_DailyFile(stime, mad_load_file, nim_dir,
                            mlat_val=30, lon_start=-90,
                            file_save_dir=file_save,
                            fig_on=True, fig_save_dir=fig_save)
```

In [8]:
```python
stime1 = datetime(2014, 1,1,0,0) # Starting Date
for i in range(31):  # How many days you want to make files for
    stime = stime1 + timedelta(days=i)
    print(stime)
    mad_df = NIMO_MAD_DailyFile(stime, mad_load_file, nim_dir,
                                mlat_val=30, lon_start=60,
                                file_save_dir=file_save,
                                fig_on=True, fig_save_dir=fig_save)
```

```
2014-01-01 00:00:00
2014-01-02 00:00:00
2014-01-03 00:00:00
2014-01-04 00:00:00
2014-01-05 00:00:00
2014-01-06 00:00:00
2014-01-07 00:00:00
2014-01-08 00:00:00
2014-01-09 00:00:00
2014-01-10 00:00:00
2014-01-11 00:00:00
2014-01-12 00:00:00
2014-01-13 00:00:00
2014-01-14 00:00:00
2014-01-15 00:00:00
2014-01-16 00:00:00
2014-01-17 00:00:00
2014-01-18 00:00:00
2014-01-19 00:00:00
2014-01-20 00:00:00
2014-01-21 00:00:00
2014-01-22 00:00:00
2014-01-23 00:00:00
2014-01-24 00:00:00
2014-01-25 00:00:00
2014-01-26 00:00:00
2014-01-27 00:00:00
2014-01-28 00:00:00
2014-01-29 00:00:00
2014-01-30 00:00:00
2014-01-31 00:00:00
```

In [ ]: