pysat : A Bridge Between Worlds

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Snakes on a Spaceship
CEDAR

General Problem Space

- Large variety of data sets in space science
  - Different data formats
  - Different metadata standards
  - Range of dimensionality
  - Variety of data sources
  - Variety of data cleaning standards
  - Variety of supporting data standards
- Lack of specific transparency and validation of code used for research papers
- Solutions to these problems are usually institution/research group specific
  - Historically, these software solutions are not shared
- pysat abstracts away all of these tedious details leaving more time for science!

Python Satellite Data Analysis Toolkit

- PySat implements the general process of space science data analysis
  - Provides a simple, flexible, and consistent interface to any dataset
- Instrument independent data, metadata, and processing support
- Design evolved over ~10 years
- Contains solutions to ~all of the processing problems the group has encountered so far

- Package with support for common problems such as
  - Downloading
  - Organizing Files
  - Loading
  - Cleaning
  - Modifying/Processing
  - Exploit routines from other packages
  - Instrument specific analysis
  - Instrument independent analysis

AGU100 ADVANCING EARTH AND SPACE SCIENCE

JGR

Journal of Geophysical Research: Space Physics

TECHNICAL REPORTS: METHODS

10.1029/2018JA025297

PYSAT: Python Satellite Data Analysis Toolkit

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Key Points:

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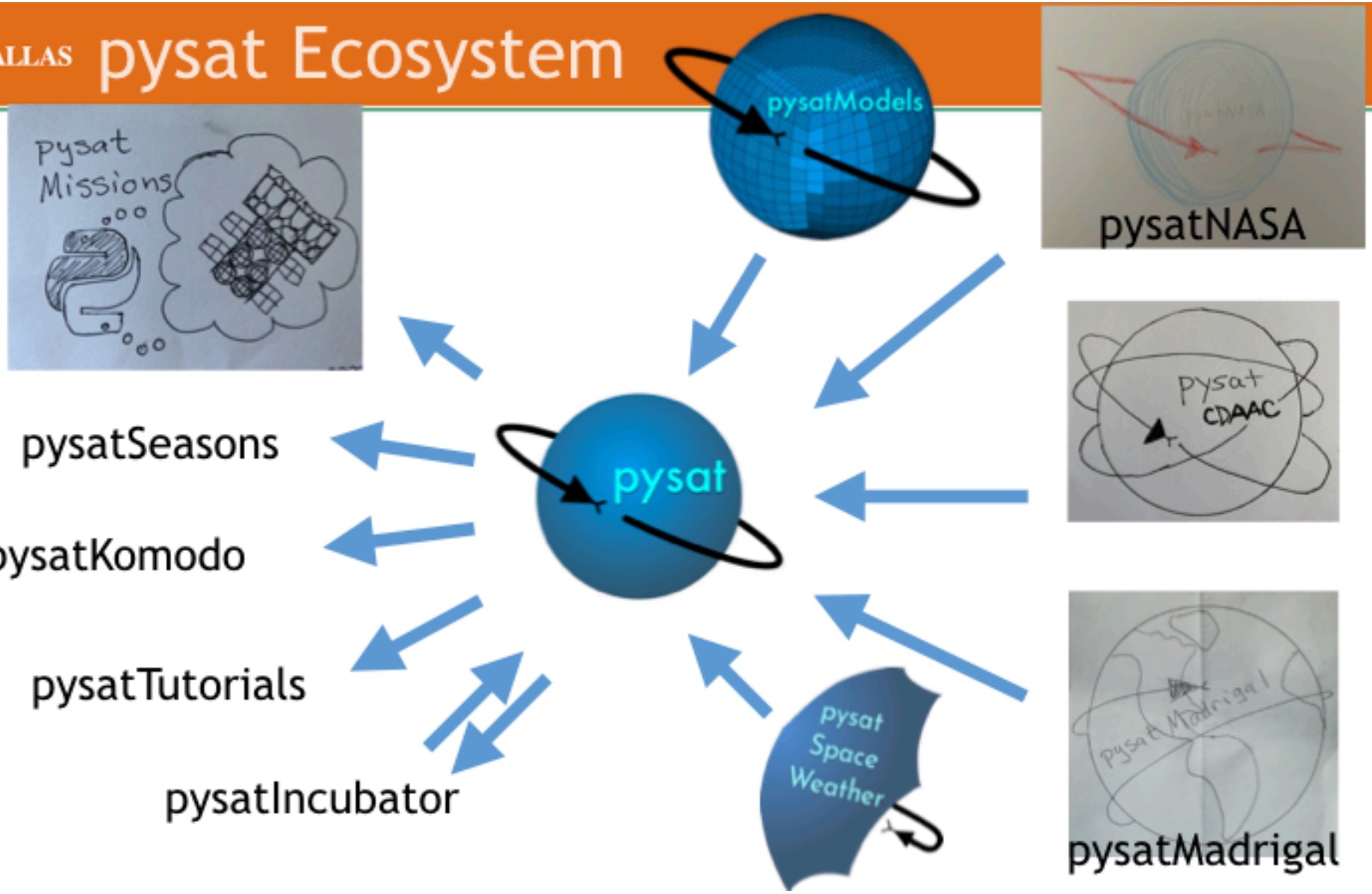
pysat Ecosystem



pysat Ecosystem

pysatSeasons

pysatKomodo

pysatTutorials

pysatIncubator

pysatModels

pysatNASA

pysat

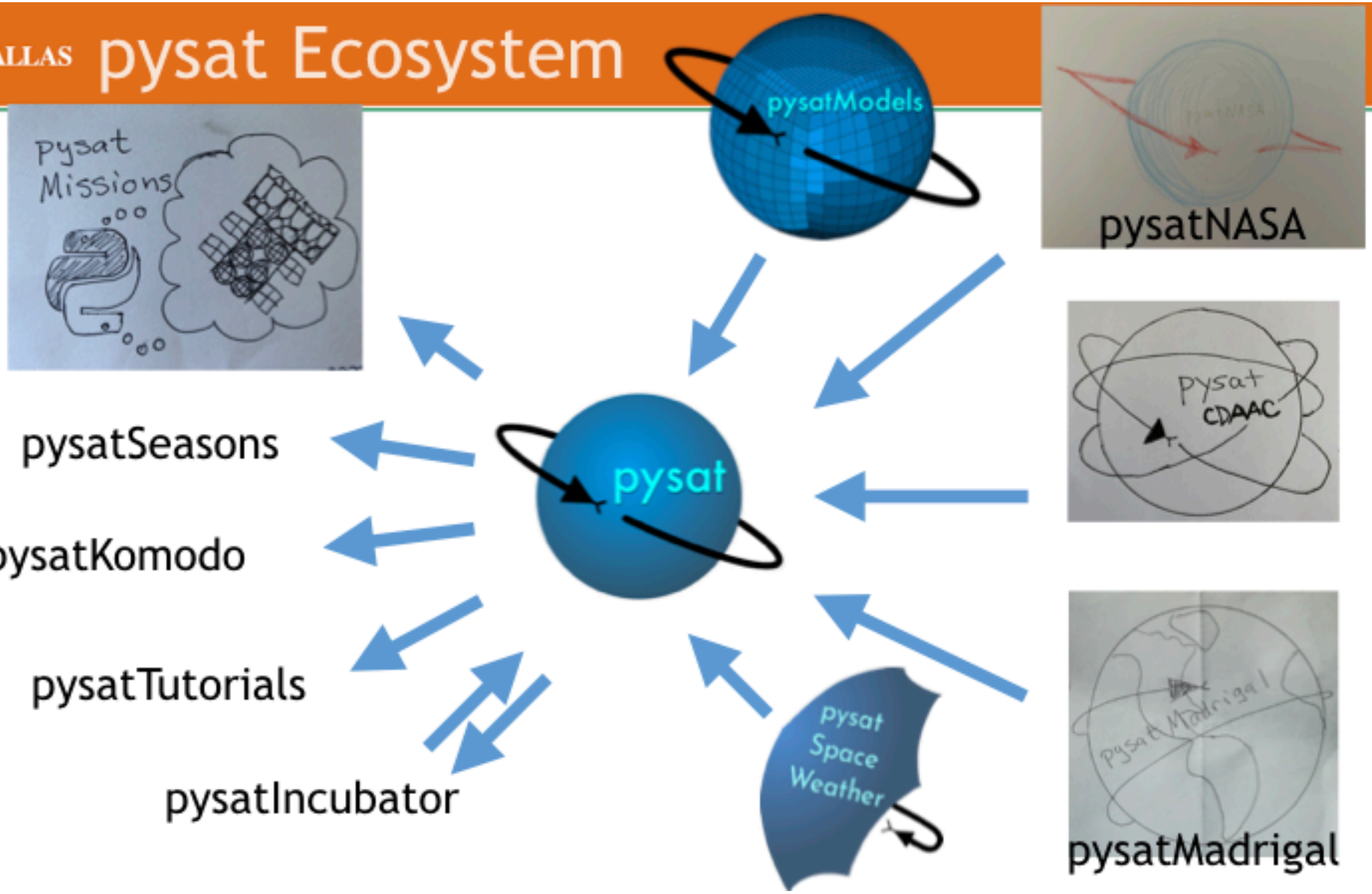
pysat CDAAC

pysat Space Weather

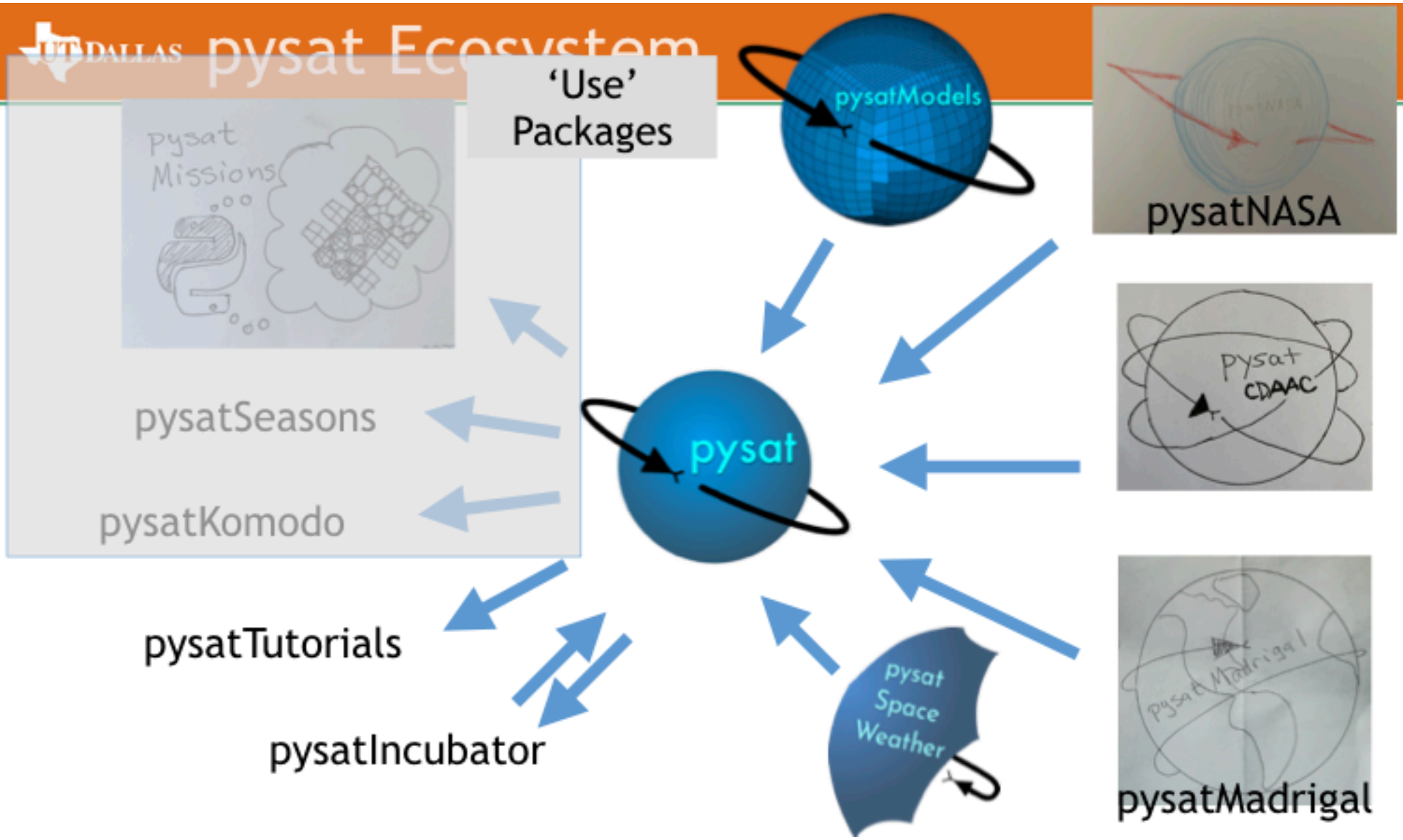
Data Source Plugins

pysatMadrigal

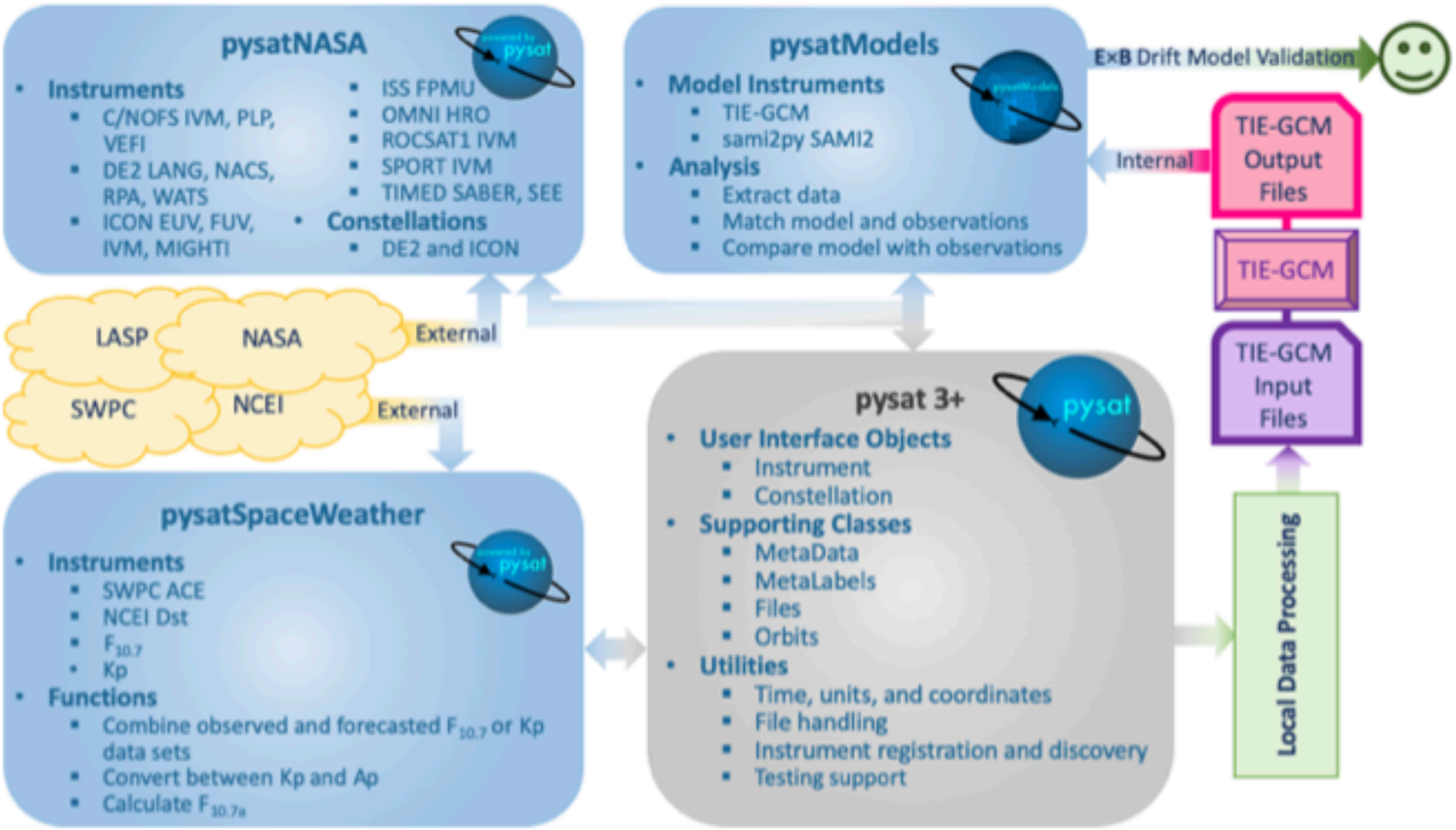
pysat Ecosystem



pysat Ecosystem

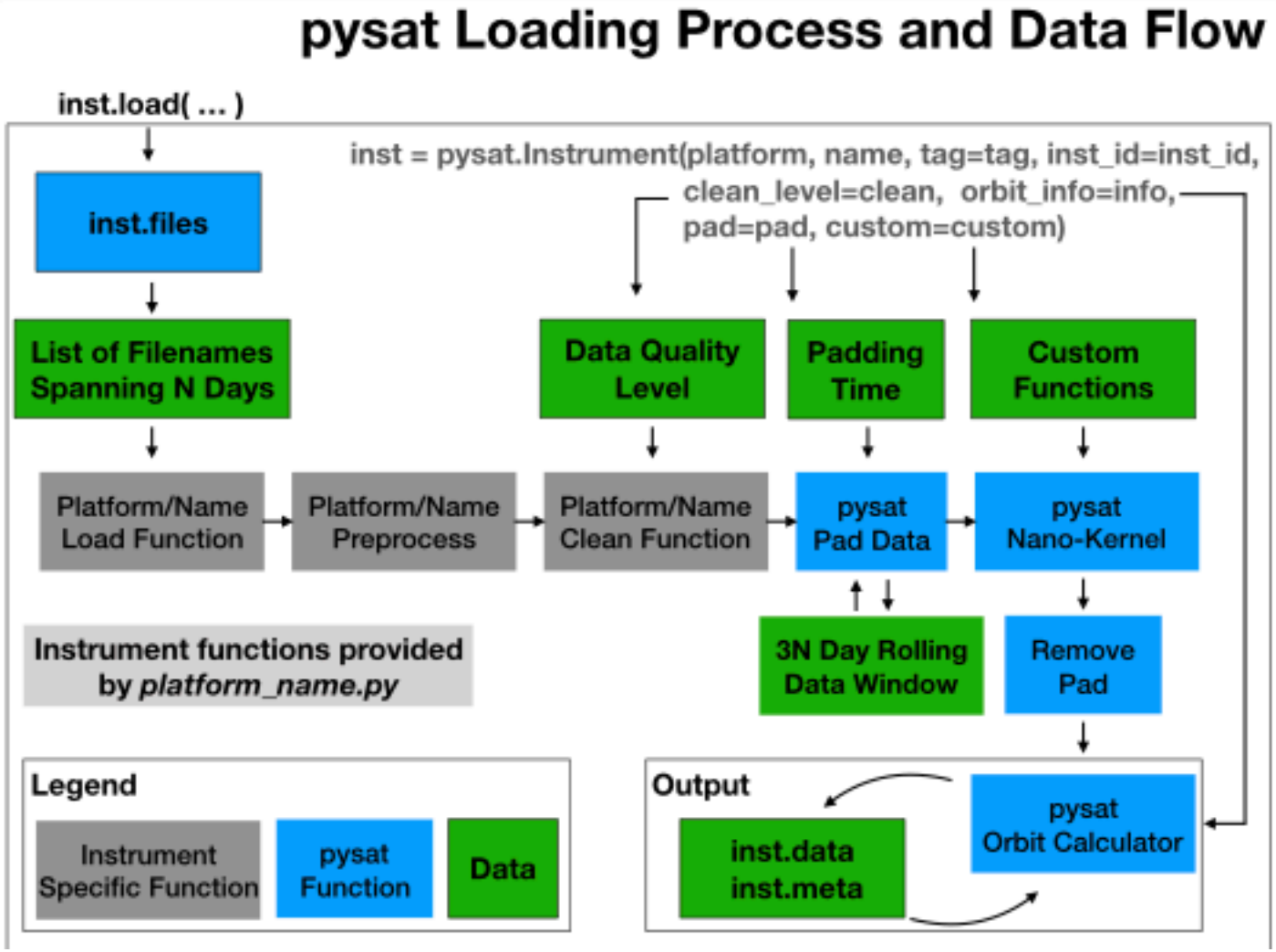


Example Workflow



pysat.Instrument Data Flow

- Instrument object has built-in data flow
- Supports arbitrary relationships between loaded data and data on disk
- Supports robust and testable processing
- Supports robust and testable analysis



pysat in Use

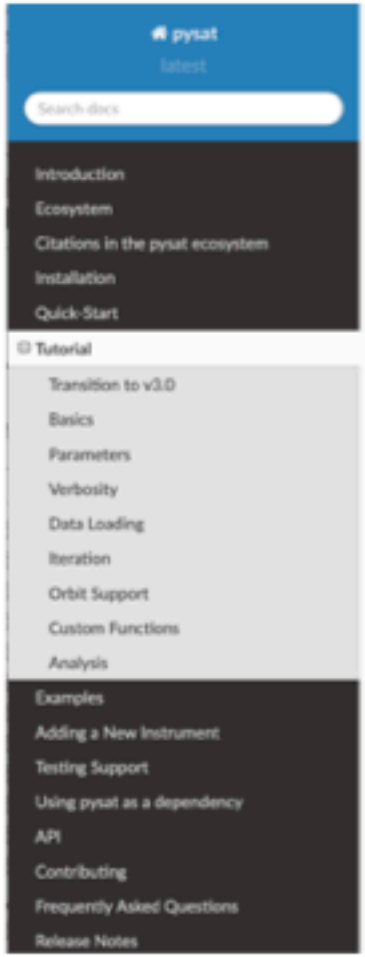
- Processes measurements from the Ion Velocity Meter on
  - NASA ICON
  - NOAA/NSPO COSMIC-2
  - NASA SORTIE CubeSat
  - pysat's .to_netCDF used to create public data files
- Used to aggregate data as part of DARPA funded project at NRL to produce next generation space weather predictions
- Used by pysat team for science

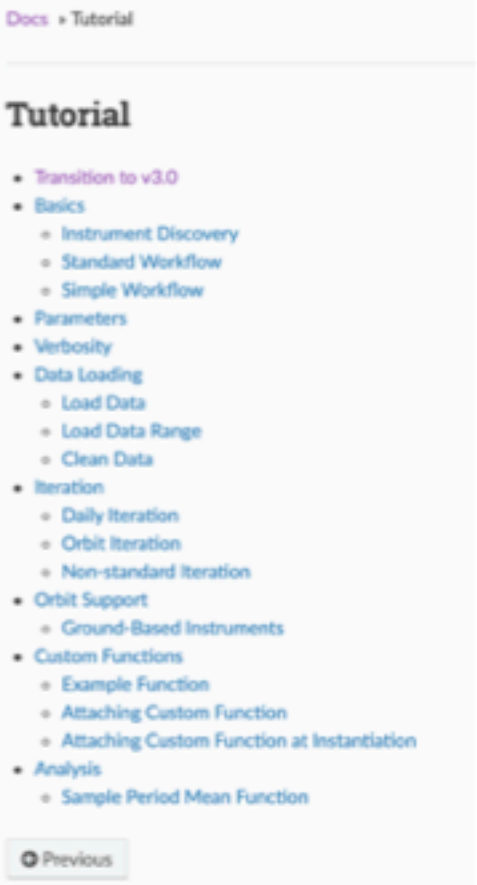
- pysat provides an ideal platform for CubeSat and other satellite missions to process, manage, distribute, and analyze data and makes it easy to contribute any improvements back to the community

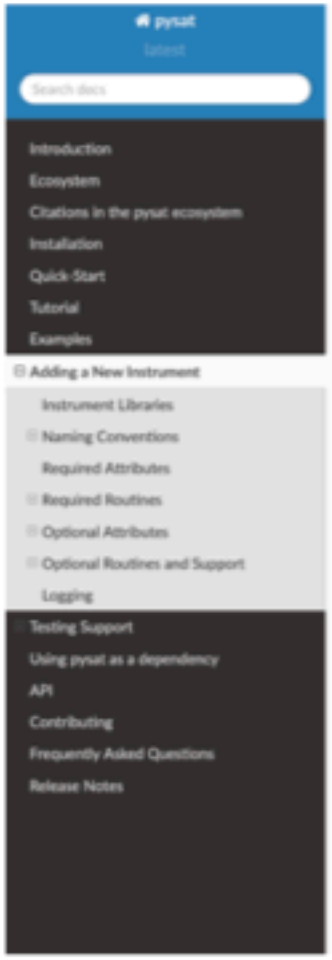
pysat Standards

- pysat is intended to support the development of higher level packages that use pysat as the primary interface for data
  - Requires high code standards
  - All pysat code undergoes review and unit testing
    - v3.0 has ~96% test coverage
  - Documentation, including tutorials, API, etc…
  - Supports pysat.Instruments outside the main package
    - Use and testing
  - Thread and process safe
  - Uses logging
  - Reduced installation requirements (no pysatCDF!)

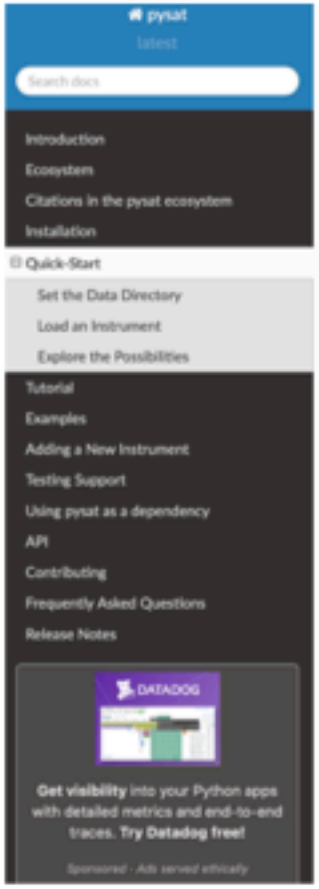
Lots of Documentation!

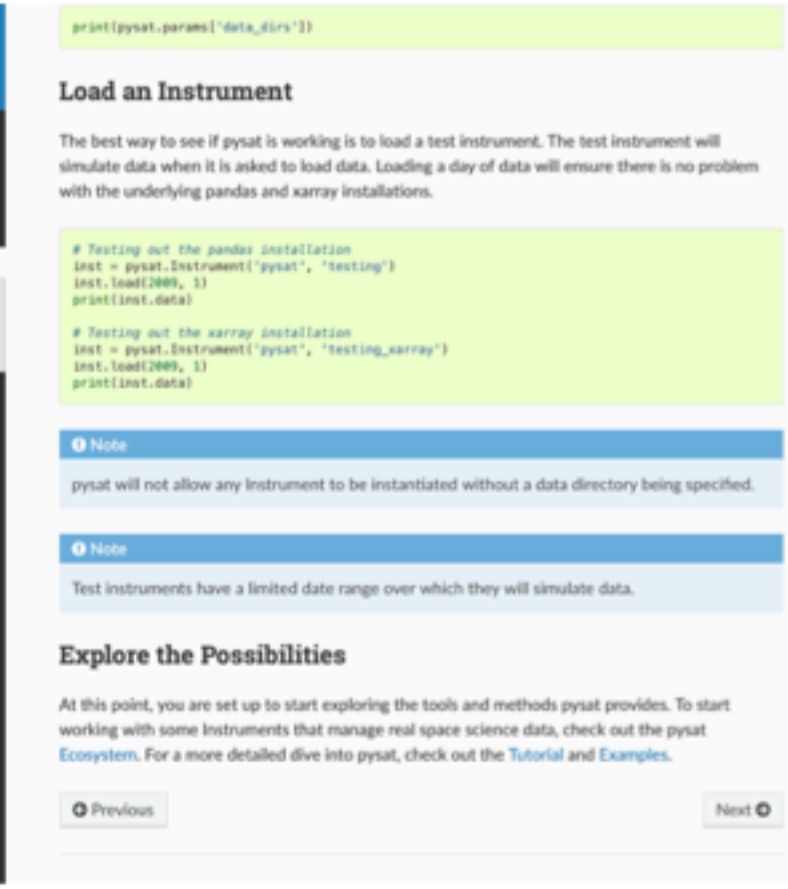


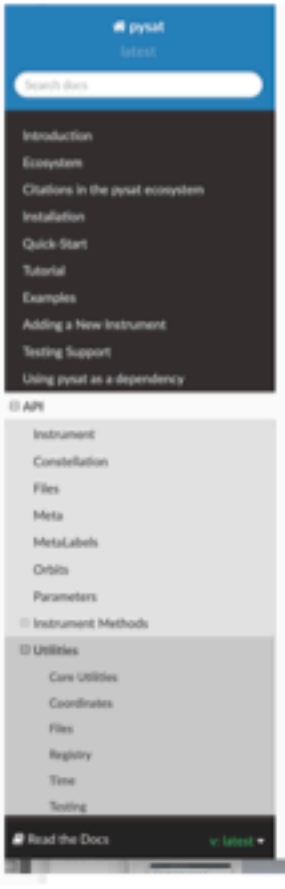




Lots of Documentation!





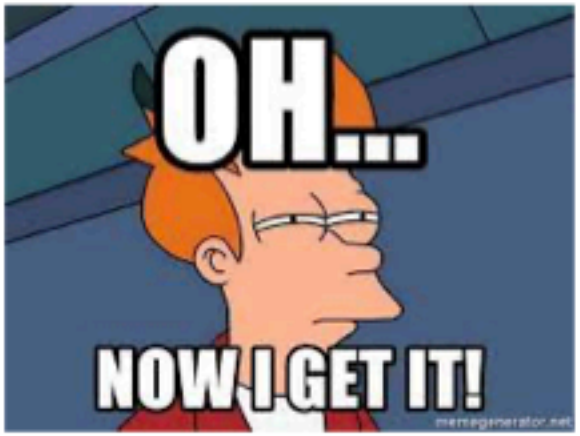


Come Join The Fun!

- pysat is open-source and open for contributions
- pysat penumbra packages would benefit from additional instruments
  - Adding an instrument is easy!*
    - General methods already exist for a given data provider
    - Template and examples are provided
    - Many instruments only require trivial updates
      - Proper development of instrument data cleaning functions requires knowledge or investigation as to what constitutes data quality
      - Many data sets include quality flags!
  - pysatSpaceWeather, pysatNASA, and pysatMadrigal are great places to start

pysat Ecosystem: https://github.com/pysat

Code Review by Meme



Larger Developments

- pysat v3.0.1 Release Candidate 1 is out and pysat team open for feedback
  https://github.com/pysat/pysat/pull/821
  https://test.pypi.org/project/pysat/3.0.1rc1/

- pysat has the potential for an extremely broad impact, both within and outside of space science
  - The world is challenged by working with a variety of data sets, not just scientists

- Leaving UTDallas to start a research center, Stoneris
  - Enable more focus on research in general and pysat development in particular

This is The End

Thank you!
Questions?

Follow-on slides contain a variety of examples

pysat.Instrument

- Instrument object is the primary user interface

```
import pysat
gps = pysat.Instrument('cosmic', 'gps', tag='ionprf')
```

- Instrument object includes standard functions for working with data
  - Download data
  - Manage files
  - Load data
  - Access data
  - Manage data customization

Identifier	Description
platform	Name of the platform supporting the instrument
name	Name of the instrument
tag	Label for an instrument data product
inst_id	Label for instrument sub-group

Getting Updated Data

- Each Instrument maintains list of its files
- Compare local list to server
- Download files with newer version, revision, or cycle
- Also supports downloading specific date range

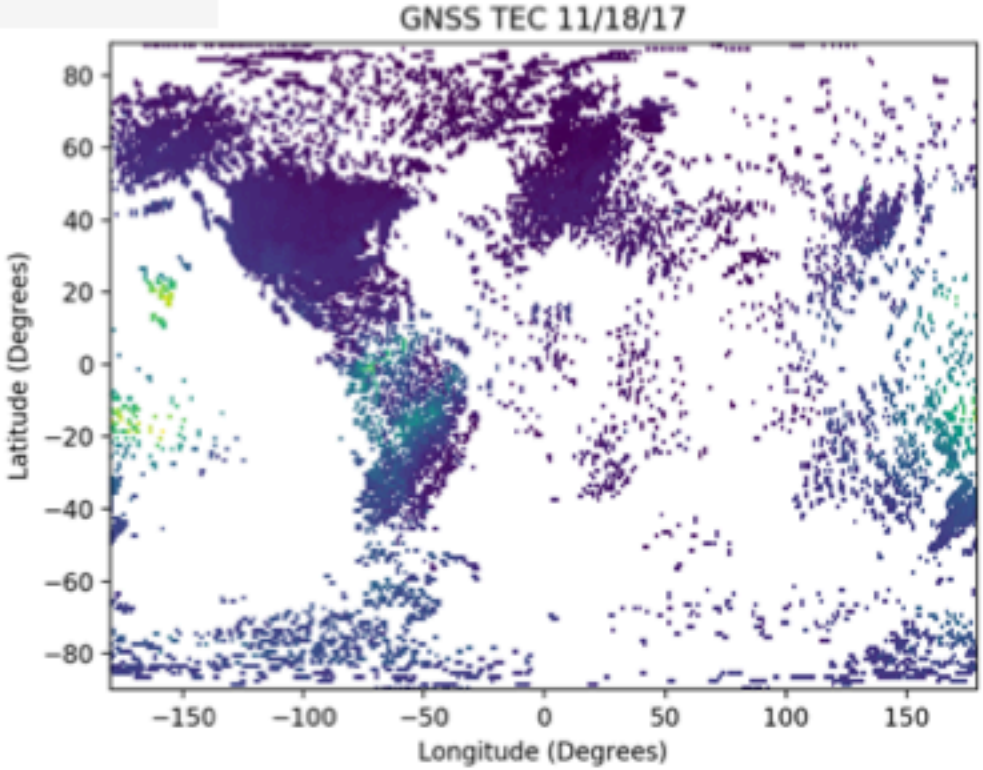
- With pysat, users never have to ask, 'How do I get the data?' or 'How do I load the data' or 'Is my data the most recent?'

```
In [10]: nmax = pysat.Instrument(platform='ses14', name='gold', tag='nmax')
pysat WARNING: Time stamps may be non-unique because Channel A and B are differe
nt instruments.  An upgrade to the pysat.Constellation object is required to sol
ve this issue. See pysat issue #614 for more info.

In [11]: nmax.files.files
Out[11]:
2018-10-05    gold_l2_nmax_2018_278_v01_r01_c01.nc
2018-10-06    gold_l2_nmax_2018_279_v01_r01_c01.nc
2018-10-07    gold_l2_nmax_2018_280_v01_r01_c01.nc
2018-10-09    gold_l2_nmax_2018_282_v01_r01_c01.nc
2018-10-10    gold_l2_nmax_2018_283_v01_r01_c01.nc
                                 ...
2020-12-27    gold_l2_nmax_2020_362_v01_r01_c02.nc
2020-12-28    gold_l2_nmax_2020_363_v01_r01_c02.nc
2020-12-29    gold_l2_nmax_2020_364_v01_r01_c02.nc
2020-12-30    gold_l2_nmax_2020_365_v01_r01_c02.nc
2020-12-31    gold_l2_nmax_2020_366_v01_r01_c02.nc
Length: 795, dtype: object

In [12]: nmax.download_updated_files()

In [13]: nmax.files.files
Out[13]:
2018-10-05    gold_l2_nmax_2018_278_v01_r01_c01.nc
2018-10-06    gold_l2_nmax_2018_279_v01_r01_c01.nc
2018-10-07    gold_l2_nmax_2018_280_v01_r01_c01.nc
2018-10-09    gold_l2_nmax_2018_282_v01_r01_c01.nc
2018-10-10    gold_l2_nmax_2018_283_v01_r01_c01.nc
                                 ...
2020-12-27    gold_l2_nmax_2020_362_v02_r02_c01.nc
2020-12-28    gold_l2_nmax_2020_363_v02_r02_c01.nc
2020-12-29    gold_l2_nmax_2020_364_v02_r02_c01.nc
2020-12-30    gold_l2_nmax_2020_365_v02_r02_c01.nc
2020-12-31    gold_l2_nmax_2020_366_v02_r02_c01.nc
Length: 817, dtype: object
```

Loading Data

```
import pysatMadrigal
pysat.utils.registry.register_by_module(pysatMadrigal.instruments)
vtec = pysat.Instrument('gnss', 'tec', 'vtec')
```

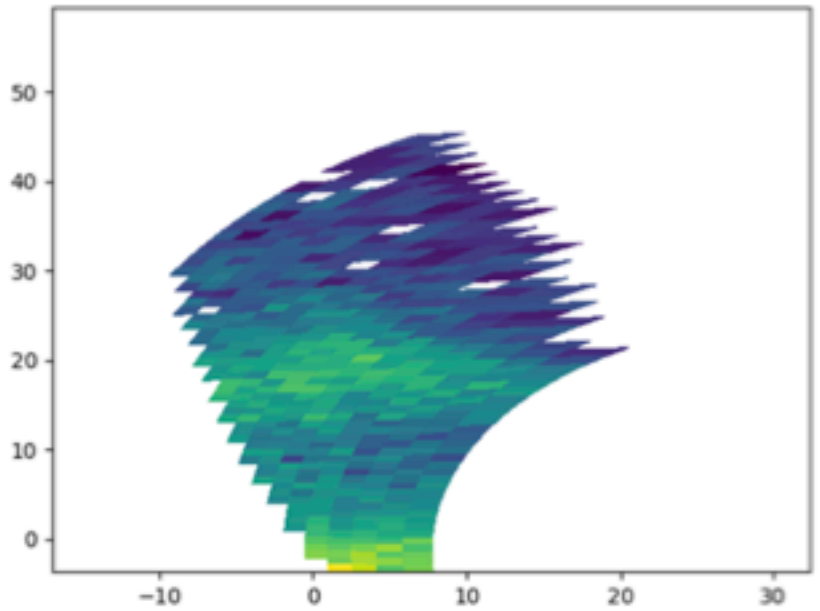
```
In [8]: vtec.load(date=dt.datetime(2017, 11, 18))

In [9]: vtec.data
Out[9]:
<xarray.Dataset>
Dimensions:    (gdalt: 1, gdlat: 180, glon: 360, time: 
Coordinates:
  * time       (time) datetime64[ns] 2017-11-18T00:02:3
  * gdlat      (gdlat) float64 -90.0 -89.0 -88.0 -87.0 
  * glon       (glon) float64 -180.0 -179.0 -178.0 -177.
  * gdalt      (gdalt) float64 350.0
Data variables:
```



- Supports loading by file, year/doy, date, as well as corresponding ranges (new in v3)

Simple Plot Example

- Data called from the instrument object directly can be fed into matplotlib or other plotting routines

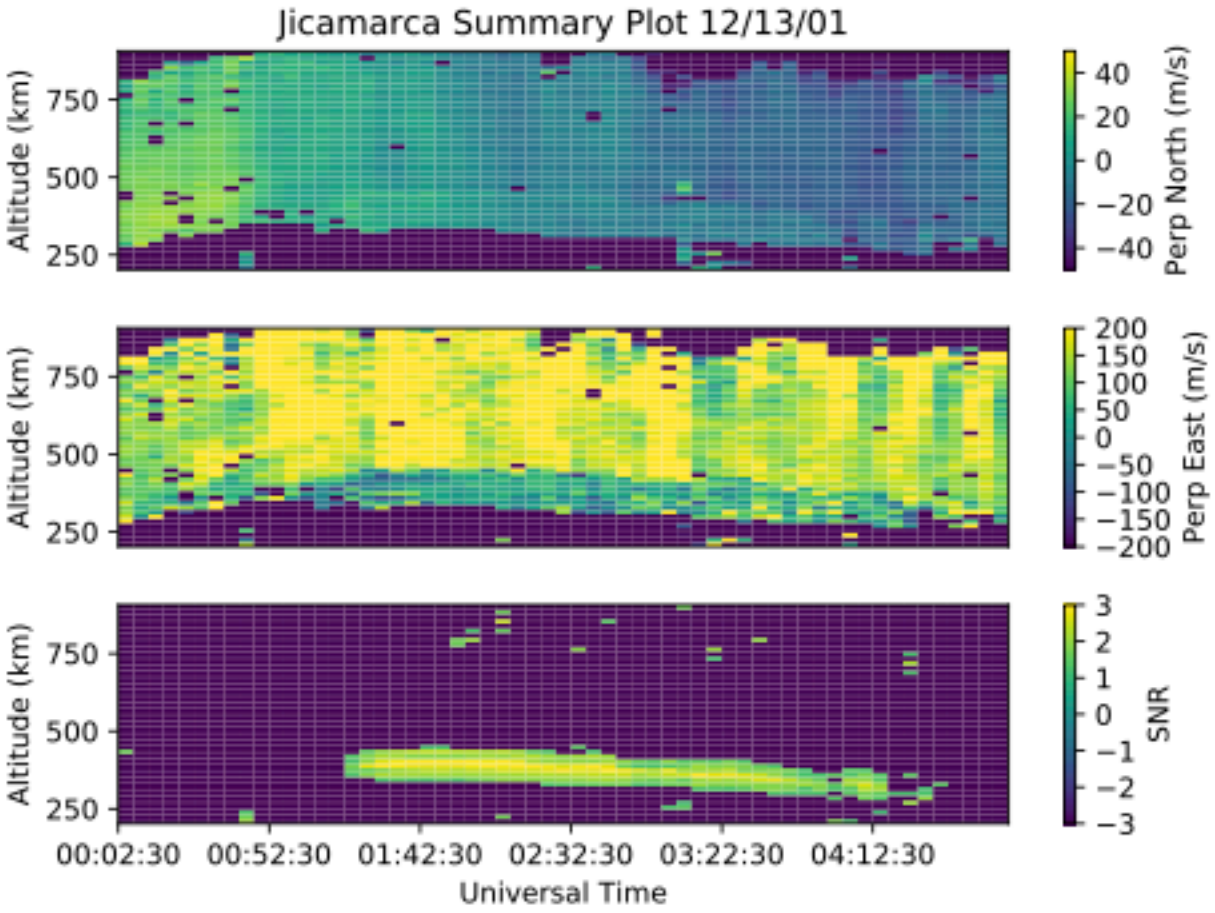



```
In [36]: import matplotlib.pyplot as plt

In [37]: plt.ion()

In [38]: plt.pcolor(nmax['longitude'][0,:,:], nmax['latitude'][0,:,:], nmax['nmax'][0,:,:])
```

Jicamarca Radar Observatory

- Interfaces with Madrigal

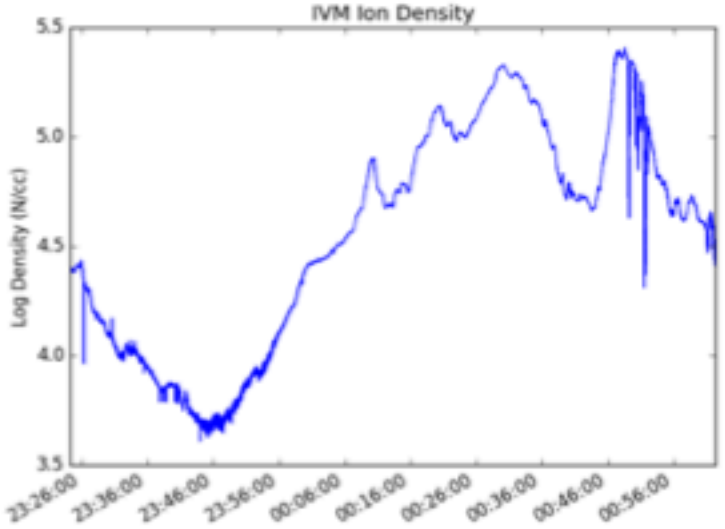
```
jro = pysat.Instrument('jro', 'isr', 'drifts')
jro.download(date1, date2)
jro.load(date=date1)
custom_drifts_plot(jro)
```



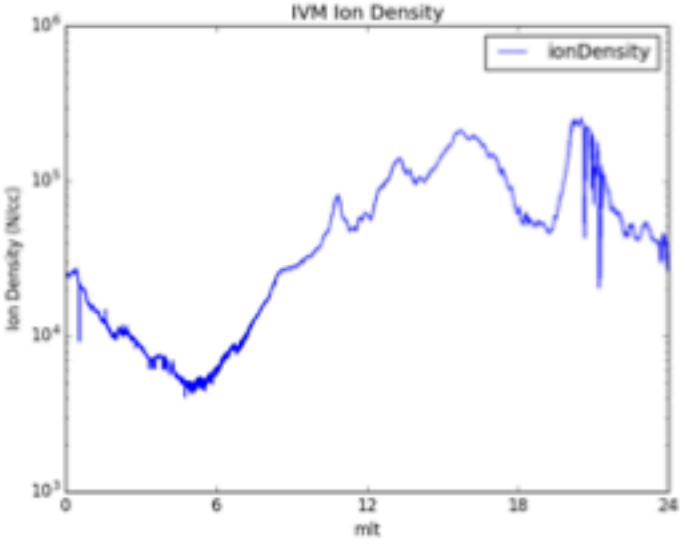
Iteration by Orbit

```
In [40]: ivm = pysat.Instrument('cnofs', 'ivm',
    ...:                        clean_level='dirty',
    ...:                        orbit_info={'index':'mlt'})
    ...: ivm.load(2010,2)
    ...: ivm.orbits.next()
    ...: np.log10(ivm['ionDensity']).plot(title='IVM Ion Density')
    ...: plt.ylabel('Log Density (N/cc)')
Returning cnofs ivm data for 01/02/10
Returning cnofs ivm data for 01/01/10
Returning cnofs ivm data for 01/02/10
Loaded Orbit:0
Out[40]: <matplotlib.text.Text at 0x1250fab90>
```

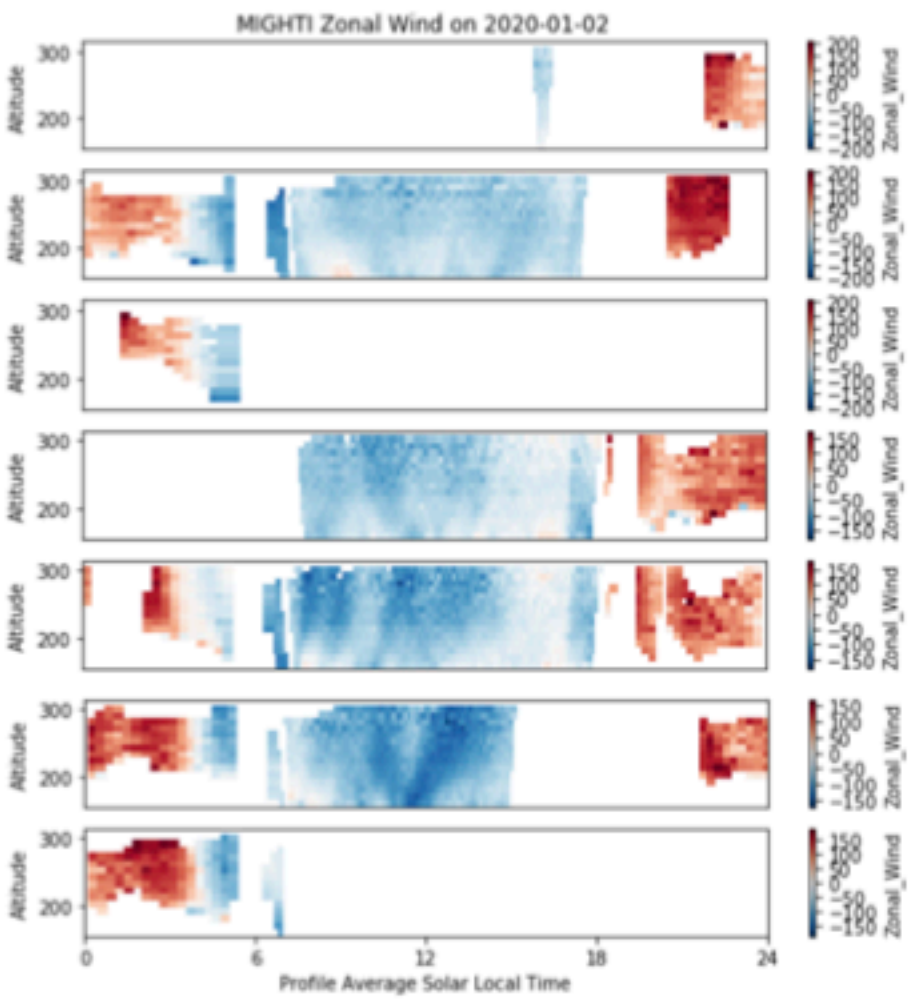
Constructs full orbits across file/day breaks!

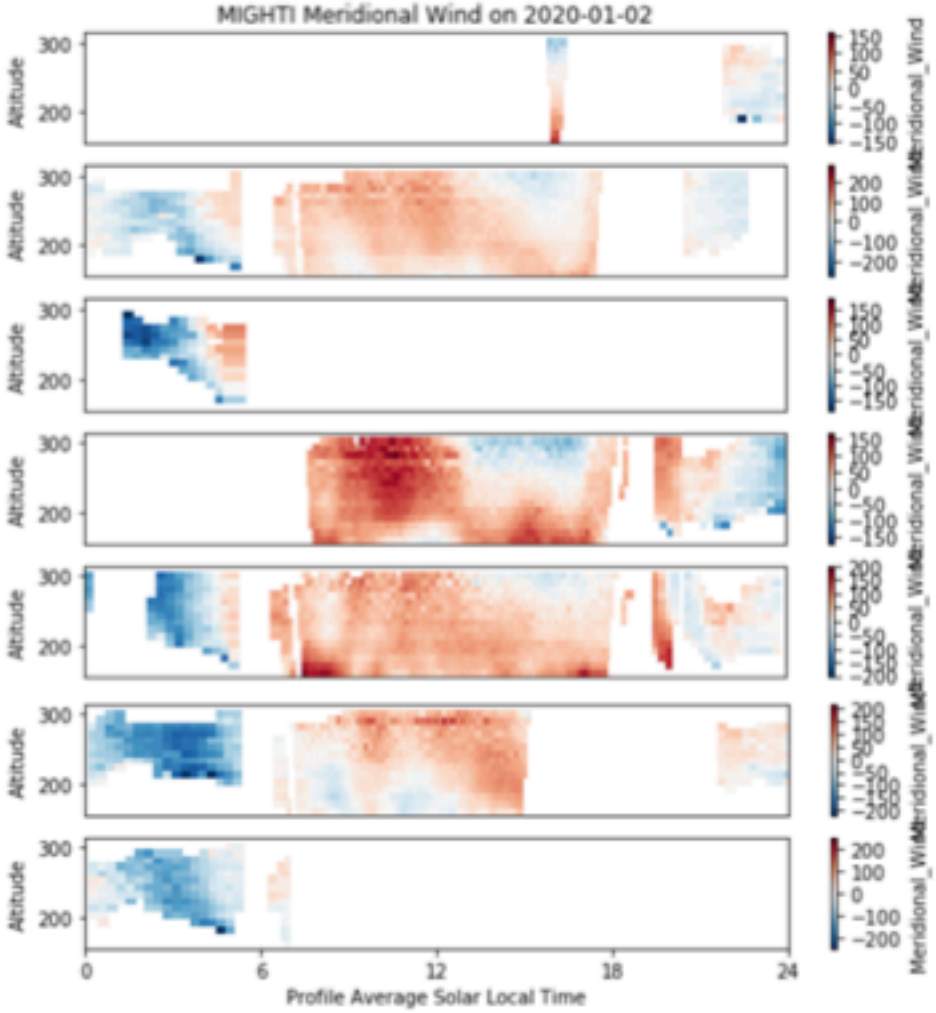



```
In [48]: ivm = pysat.Instrument('cnofs', 'ivm',
    ...:                        clean_level='dirty',
    ...:                        orbit_info={'index':'mlt'})
    ...: ivm.load(2010,2)
    ...: ivm.orbits.next()
    ...: ivm.data.plot(x='mlt', y='ionDensity',
    ...:               title='IVM Ion Density',
    ...:               logy=True,
    ...:               xticks=[0,6,12,18,24])
    ...: plt.ylabel('Ion Density (N/cc)')
Returning cnofs ivm data for 01/02/10
Returning cnofs ivm data for 01/01/10
Returning cnofs ivm data for 01/02/10
Loaded Orbit:0
Out[48]: <matplotlib.text.Text at 0x1284af410>
```

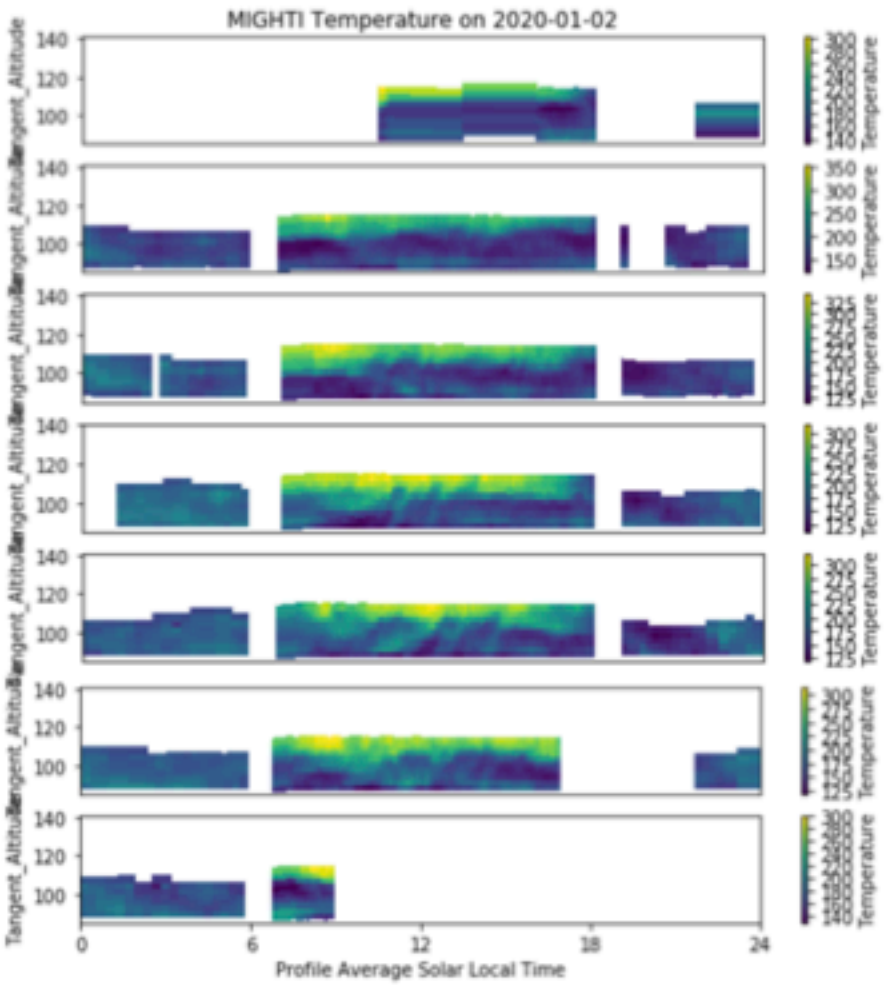


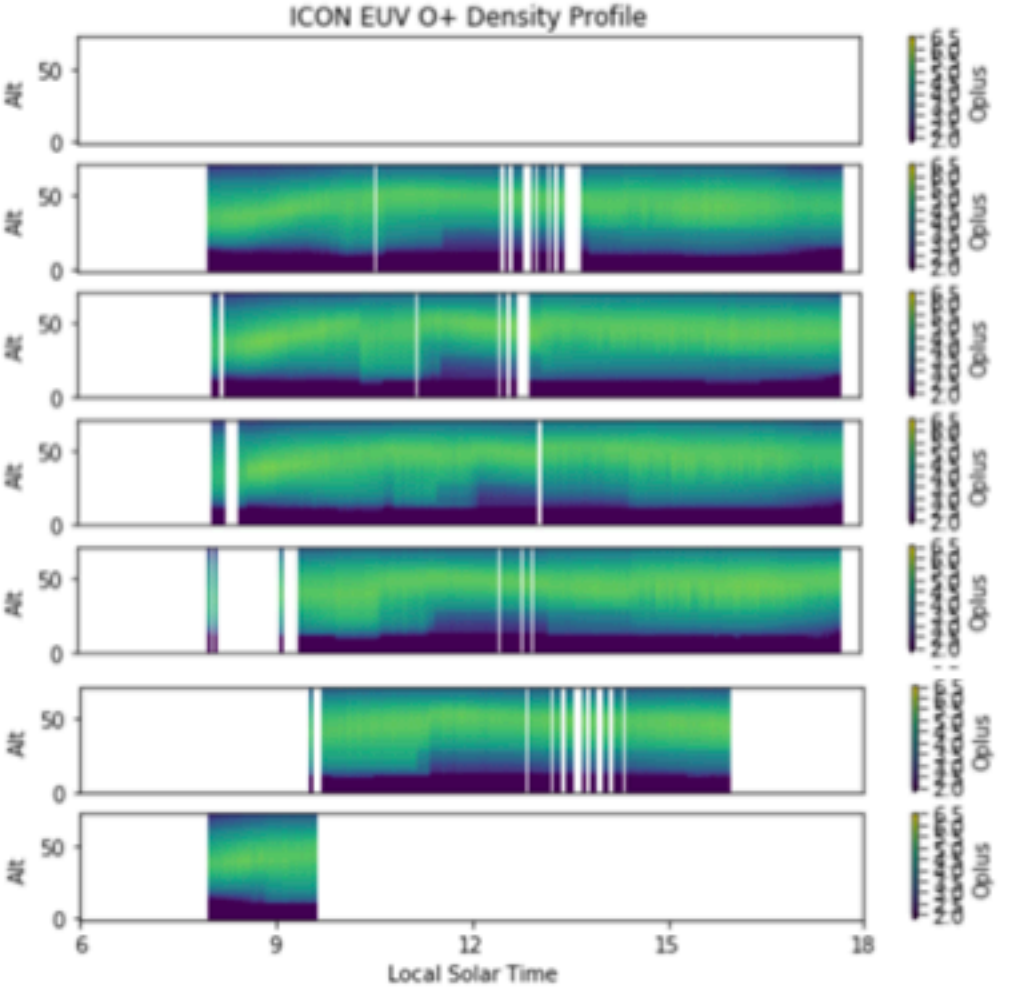
ICON plots via orbits





More ICON plots via orbit



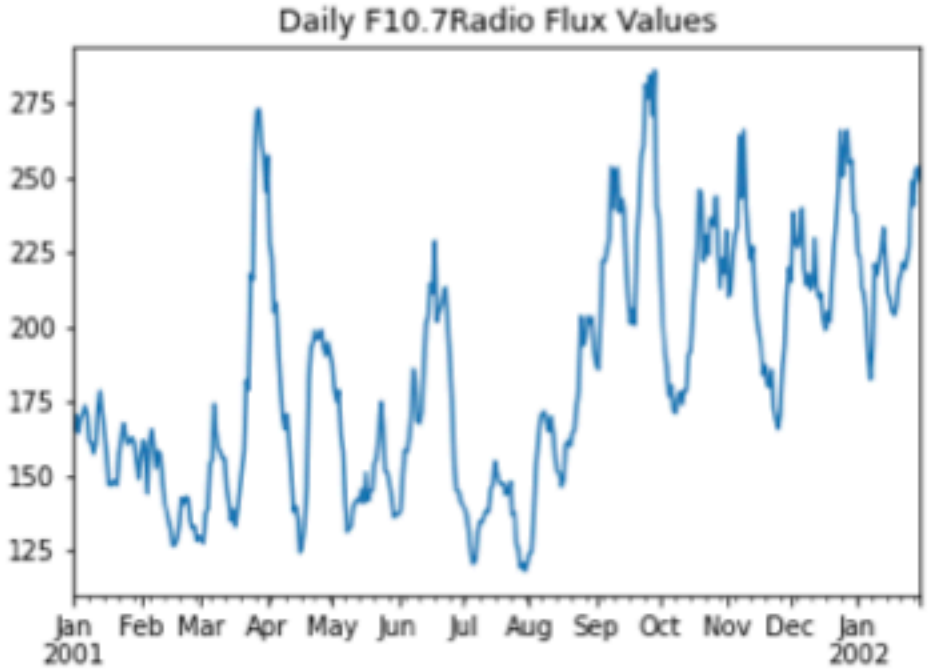


Loading Data Ranges

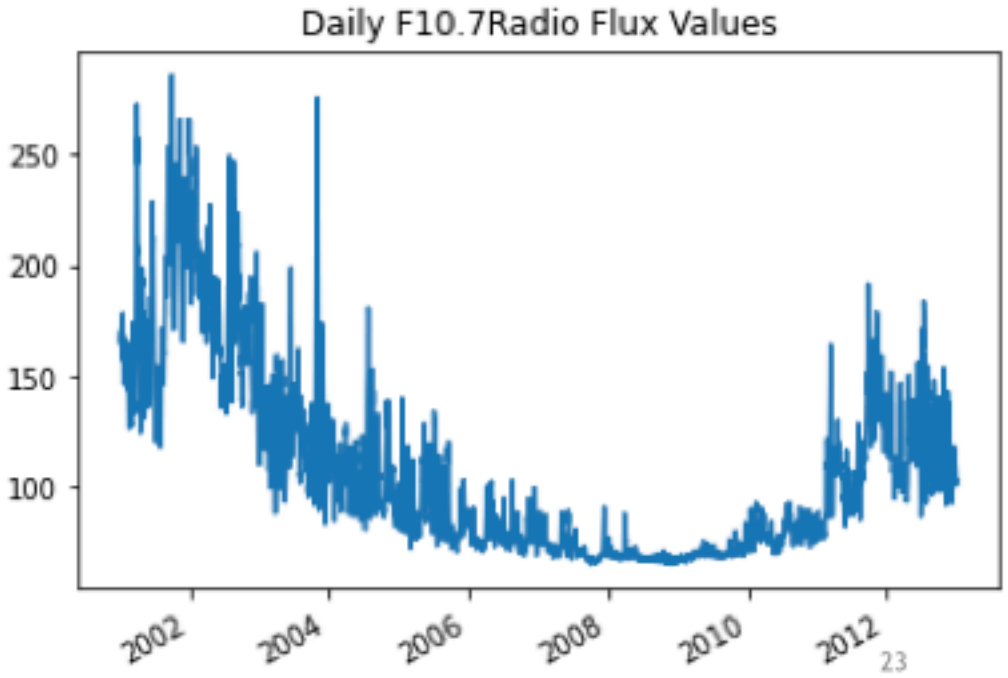
```
f107 = pysat.Instrument('sw', 'f107')
```

```
f107.load(2001, 1, end_yr=2002, end_doy=31)
```

```
f107['f107'].plot(title='Daily F10.7Radio Flux Values')
```



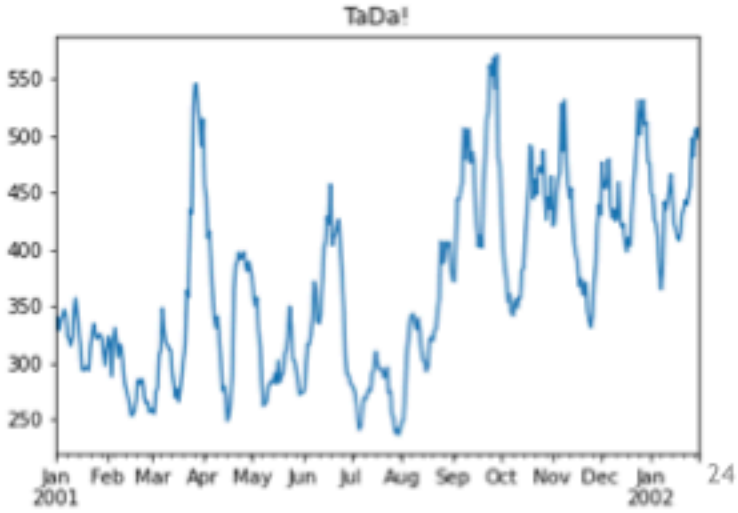

```
import datetime as dt
f107.load(date=dt.datetime(2001, 1, 1),
          end_date=dt.datetime(2012, 12, 31))
f107['f107'].plot(title='Daily F10.7Radio Flux Va
```



Cleaning and Modifying Data

- pysat allows users to preselect several levels of cleaning
  - clean, dusty, dirty, none
  - Actual cleaning performed by instrument specific function
  - Cleaning performed as part of the loading process
- pysat also supports easy modification of data while loading
- Any user accessible data is presented in a ‘known’ state

```
def custom_function(inst):
    """Modify data in inst to make it custom """
    inst['new_variable'] = inst['f107'] * 2.
    return
f107 = pysat.Instrument('sw', 'f107')
f107.custom_attach(custom_function)
f107.load(2001, 1, end_yr=2002, end_doy=31)
f107['new_variable'].plot(title='TaDa!')
```



Accessing Data

- pysat supports both pandas DataFrames and xarray DataSets

```
f107.data
```

	f107
2001-01-01	165.3
2001-01-02	170.2
2001-01-03	164.2
2001-01-04	168.8
2001-01-05	170.5
...	...
2012-12-26	106.2
2012-12-27	103.2
2012-12-28	102.3
2012-12-29	100.9
2012-12-30	103.2

4378 rows × 1 columns

```
import pysat
gps = pysat.Instrument('cosmic', 'gps', tag='ionprf',
                       strict_time_flag=False)
```

```
gps.load(2008, 1)
```

```
<ipython-input-9-bb6939bfe4e3>:1: UserWarning: Metadata set to defaults, as they were mis
  gps.load(2008, 1)
<ipython-input-9-bb6939bfe4e3>:1: UserWarning:  Loaded data is not unique.
  gps.load(2008, 1)
```

```
gps.data
```

xarray.Dataset

This particular dataset still in development

▸ Dimensions: (RO: 669, **time**: 1199)

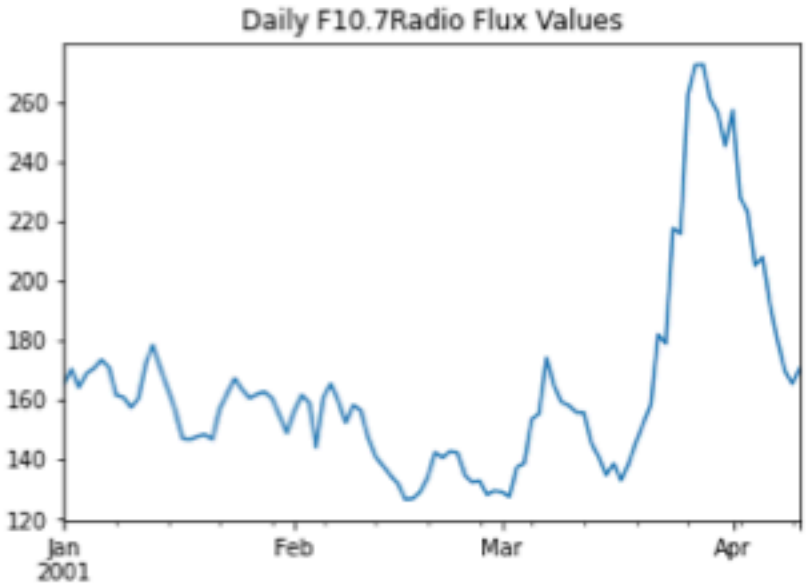
▾ Coordinates:

time	(time)	datetime64[ns]	2008-01-01T00:08:16 ... 2008-01-...
MSL_alt	(time, RO)	float64	51.46 54.22 56.97 ... nan nan nan
GEO_lat	(time, RO)	float64	34.3 34.32 34.33 ... nan nan nan
GEO_lon	(time, RO)	float64	-85.61 -85.62 -85.63 ... nan nan
OCC_azi	(time, RO)	float64	131.1 131.0 130.9 ... nan nan nan

▸ Data variables: (53)

Accessing Data

```
f107[0:100, 'f107'].plot(title='Daily F10.7Radio
```




```
In [30]: nmax['nmax']
Out[30]:
<xarray.DataArray 'nmax' (time: 24, nlats: 100, nlons: 52)>
[124800 values with dtype=float32]
Coordinates:
    channel     (time) |S50 ...
    hemisphere  (time) |S50 ...
  * time        (time) datetime64[ns] 2020-01-02T20:10:48 ... 2020-01-0
  * nlats       (nlats) int64 0 1 2 3 4 5 6 7 8 9 ... 91 92 93 94 95 96
  * nlons       (nlons) int64 0 1 2 3 4 5 6 7 8 9 ... 43 44 45 46 47 48

In [31]: nmax['nmax'][0,:,:]
Out[31]:
<xarray.DataArray 'nmax' (nlats: 100, nlons: 52)>
array([[nan, nan, nan, ..., nan, nan, nan],
       [nan, nan, nan, ..., nan, nan, nan],
       [nan, nan, nan, ..., nan, nan, nan],
       ...,
       [nan, nan, nan, ..., nan, nan, nan],
       [nan, nan, nan, ..., nan, nan, nan],
       [nan, nan, nan, ..., nan, nan, nan]], dtype=float32)
Coordinates:
    channel     |S50 ...
    hemisphere  |S50 ...
    time        datetime64[ns] 2020-01-02T20:10:48
  * nlats       (nlats) int64 0 1 2 3 4 5 6 7 8 9 ... 91 92 93 94 95 96
  * nlons       (nlons) int64 0 1 2 3 4 5 6 7 8 9 ... 43 44 45 46 47 48
```

MetaData

- metadata will be exported to netcdf as attributes when using pysat.utils.to_netcdf()
- Tracks ‘units’, ‘long_name’, etc.
- Supports programmatic access to metadata
  - Different datasets can call metadata different things and it still gets mapped to the same user determined set of labels
- User centric view

```
In [20]: nmax.meta.data
Out[20]:
                          units          long_name  ... DISPLAY_TYPE TIME_BASE
mask_oi_1356                          mask_oi_1356  ...          NaN       NaN
mask_wavelength                   mask_wavelength   ...          NaN       NaN
radiance_oi_1356        Rayleighs  radiance_oi_1356  ...        image       NaN
channel                                    channel  ...          NaN       NaN
nmax_unc_ran       electrons/cm^3      nmax_unc_ran  ...        image       NaN
nmax_unc_mod       electrons/cm^3      nmax_unc_mod  ...        image       NaN
nmax_unc_sys       electrons/cm^3      nmax_unc_sys  ...        image       NaN
latitude                      deg          latitude  ...        image       NaN
oi_1356_unc_ran         Rayleighs    oi_1356_unc_ran  ...        image       NaN
counts_oi_1356                        counts_oi_1356  ...        image       NaN
dqi                                              dqi  ...          NaN       NaN
scan_start_time               s      scan_start_time  ...          NaN     J2000
nmax_dqi                                    nmax_dqi  ...        image       NaN
solar_zenith_angle          deg  solar_zenith_angle   ...        image       NaN
longitude                   deg           longitude  ...        image       NaN
time_utc                      s           time_utc   ...          NaN     J2000
nmax               electrons/cm^3                nmax  ...        image       NaN
input_l1c_file                        input_l1c_file  ...          NaN       NaN
emission_angle              deg       emission_angle  ...        image       NaN
scan_stop_time                s       scan_stop_time  ...          NaN     J2000
oi_1356_unc_sys         Rayleighs    oi_1356_unc_sys  ...        image       NaN
hemisphere                              hemisphere     ...          NaN       NaN
time                                          time     ...          NaN       NaN
nlats                                        nlats     ...          NaN       NaN
nlons                                        nlons     ...          NaN       NaN
nmask                                        nmask     ...          NaN       NaN

[26 rows x 23 columns]
```

MetaData

- Each instrument also includes references and acknowledgements

```
In [27]: nmax.acknowledgements
Out[27]: 'This is a data product from the NASA Global-scale Observations of the Limb and Disk (GOLD) mission, an He
liophysics Explorer mission of opportunity launched in January 2018.\n Responsibility of the mission science falls
to the Principal Investigator, Dr. Richard Eastes at University of Colorado/LASP.\n Validation of the L1B data prod
ucts falls to the instrument lead investigators/scientists.\n* EUV Dr. Bill McClintock\nValidation of the L2 data p
roducts falls to Computational Physics, Inc.\n* Dr. Jerry Lumpe\n (https://gold.cs.ucf.edu/).\nOverall validation o
f the products is overseen by the GOLD Project Scientist Dr. Alan Burns.\nUsers of these data should contact and ac
knowledge the Principal Investigator Dr. Richard Eastes and the party directly responsible for the data product and
 the NASA Explorers Project Office.'

In [28]: nmax.references
Out[28]: 'Eastes, R.W., McClintock, W.E., Burns, A.G. et al. The Global-Scale Observations of the Limb and Disk (GO
LD) Mission. Space Sci Rev 212, 383-408 (2017). https://doi.org/10.1007/s11214-017-0392-2'
```

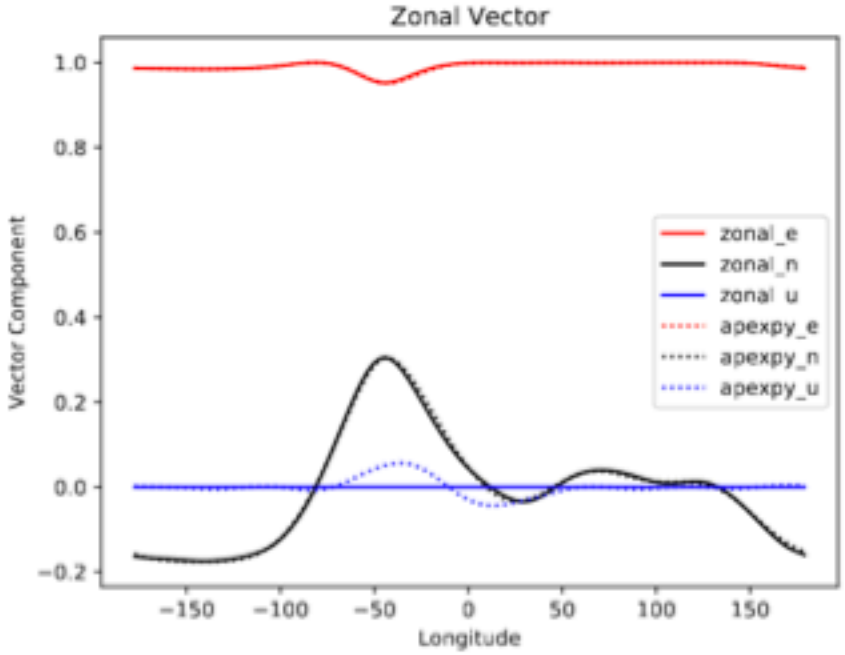
Many Supported Instruments (partial list)

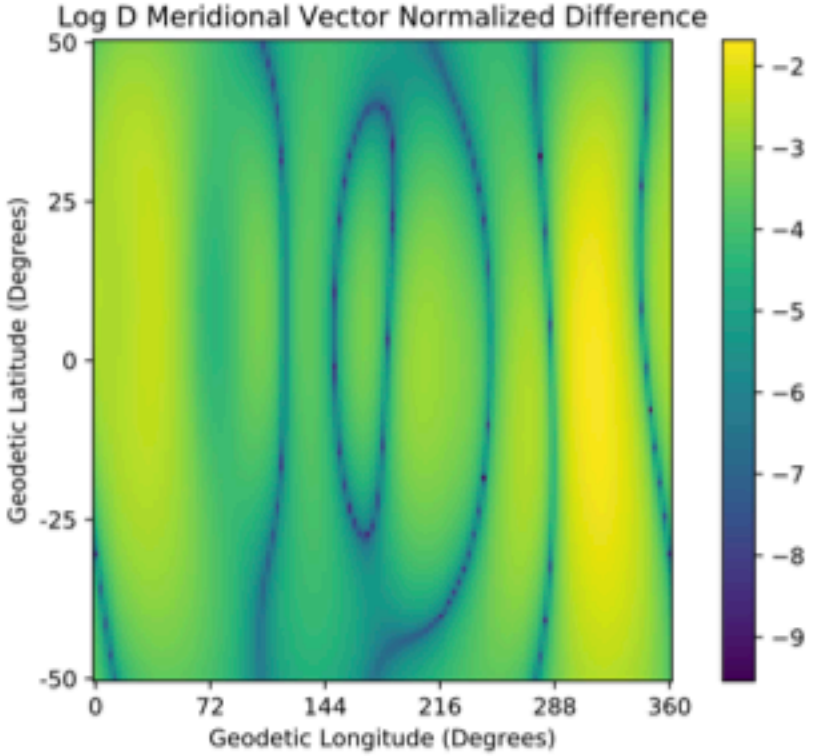
```
pysat.utils.display_available_instruments()
```

```
Platform   Name         [Tag   Inst_ID]  Description
-------------------------------------------------
'ace' 'epam'  ['realtime' '']  Real-time data from the SWPC
              ['historic' '']   Historic data from the SWPC
'ace' 'mag'  ['realtime' '']  Real-time data from the SWPC
             ['historic' '']   Historic data from the SWPC
'ace' 'sis'  ['realtime' '']  Real-time data from the SWPC
             ['historic' '']   Historic data from the SWPC
'ace' 'swepam'  ['realtime' '']  Real-time data from the SWPC
                ['historic' '']   Historic data from the SWPC
'cnofs' 'ivm'  ['' '']
'cnofs' 'plp'  ['' '']
'cnofs' 'vefi'  ['dc_b' '']  DC Magnetometer data - 1 second
'cosmic' 'gps'  ['ionprf' '']  Ionospheric Profiles
                ['wetprf' '']
                ['atmprf' '']  Atmospheric Profiles
                ['eraprf' '']
                ['gfsprf' '']
                ['ionphs' 'level_1b']
                ['podtec' 'level_1b']
                ['scnlv1' 'level_1b']
'de2' 'lang'  ['' '']  500 ms cadence Langmuir Probe data
'de2' 'nacs'  ['' '']  1 s cadence Neutral Atmosphere Composition Spectrometer
'de2' 'rpa'  ['' '']  2 sec cadence RPA data
'de2' 'wats'  ['' '']  2 s cadence Wind and Temperature Spectrometer data
'dmsp' 'ivm'  ['utd' 'f11']  UTDallas DMSP data processing
              ['' 'f11']  Level 2 data processing
              ['utd' 'f12']  UTDallas DMSP data processing
              ['' 'f12']  Level 2 data processing
              ['utd' 'f13']  UTDallas DMSP data processing
              ['' 'f13']  Level 2 data processing
              ['utd' 'f14']  UTDallas DMSP data processing
              ['' 'f14']  Level 2 data processing
              ['utd' 'f15']  UTDallas DMSP data processing
              ['' 'f15']  Level 2 data processing
              ['' 'f16']  Level 2 data processing
'gnss' 'tec'  ['vtec' '']  vertical TEC
'icon' 'euv'  ['' '']  Level 2 public geophysical data
'icon' 'fuv'  ['day' '']  Level 2 daytime O/N2
              ['night' '']  Level 2 nighttime O profile
'icon' 'ivm'  ['' 'a']  Level 2 public geophysical data
              ['' 'b']  Level 2 public geophysical data
'icon' 'mighti'  ['vector_wind_green' '']  Vector wind data -- Green Line
                 ['vector_wind_red' '']  Vector wind data -- Red Line
                 ['los_wind_green' 'a']  Line of sight wind data -- Green Line
                 ['los_wind_red' 'a']  Line of sight wind data -- Red Line
                 ['temperature' 'a']  Neutral temperature data
                 ['los_wind_green' 'b']  Line of sight wind data -- Green Line
                 ['los_wind_red' 'b']  Line of sight wind data -- Red Line
                 ['temperature' 'b']  Neutral temperature data
'iss' 'fpmu'  ['' '']
'jro' 'isr'  ['drifts' '']  Drifts and wind
             ['drifts_ave' '']  Averaged drifts
             ['oblique_stan' '']  Standard Faraday rotation double-pulse
             ['oblique_rand' '']  Randomized Faraday rotation double-pulse
             ['oblique_long' '']  Long pulse Faraday rotation
'omni' 'hro'  ['1min' '']  1-minute time averaged data
              ['5min' '']  5-minute time averaged data
'pydineof' 'dineof'  ['' '']  pydineof output file
                     ['test' '']  Standard output of pydineof for benchmarking
'pysat' 'ephem'  ['' '']  Satellite simulation data set
'pysat' 'sgp4'  ['' '']  Satellite simulation data set
'sami2py' 'sami2'  ['' '']  sami2py output file
                   ['test' '']  Standard output of sami2py for benchmarking
'ses14' 'gold'  ['nmax' '']  Level 2 Nmax data for the GOLD instrument
'sport' 'ivm'  ['' '']  Level-2 IVM Files
               ['l1' '']  Level-1 IVM Files
               ['l0' '']  Level-0 IVM Files
'sw' 'dst'  ['' '']
'sw' 'f107'  ['' '']  Daily LASP value of F10.7
             ['all' '']  All LASP F10.7 values (deprecated, use '' instead)
             ['prelim' '']  Preliminary SWPC daily solar indices
```

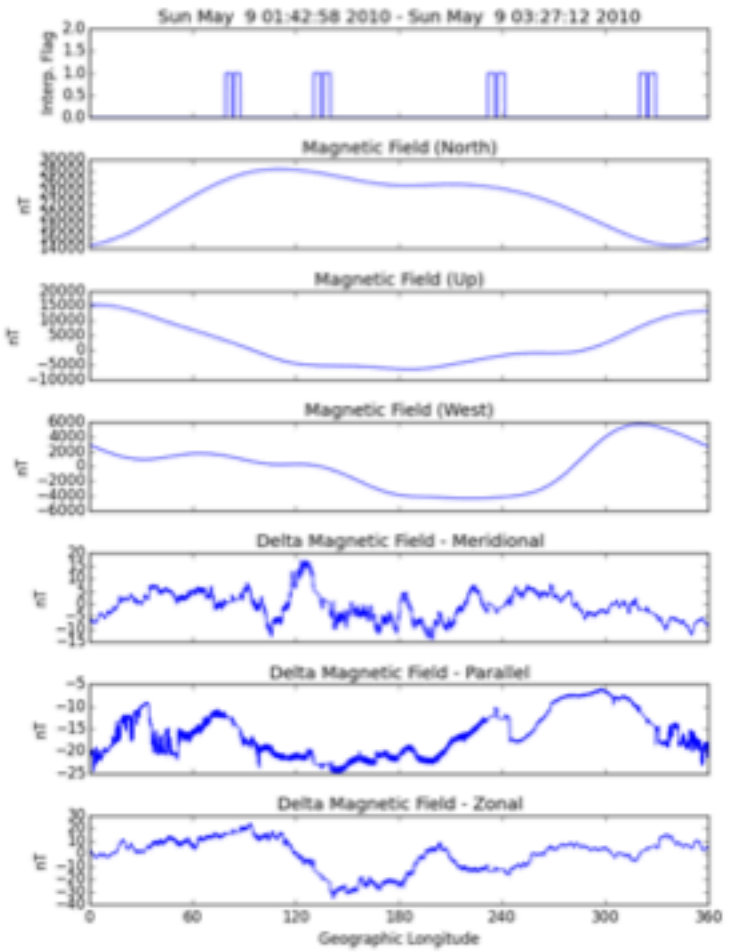
OMMBV uses pysat

- First **orthogonal** geomagnetic coordinate system for multi-pole magnetic fields (drift mapping accurate to ~2%)
- Supports mapping observed electric fields along geomagnetic field-lines
- Used by ICON, COSMIC-2, SORTIE



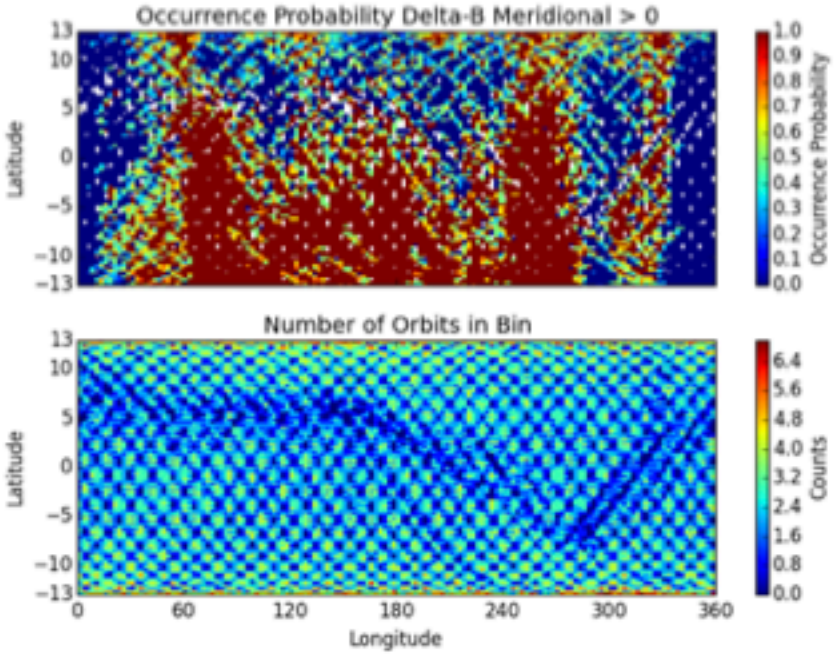


C/NOFS VEFI and pysatSeasons



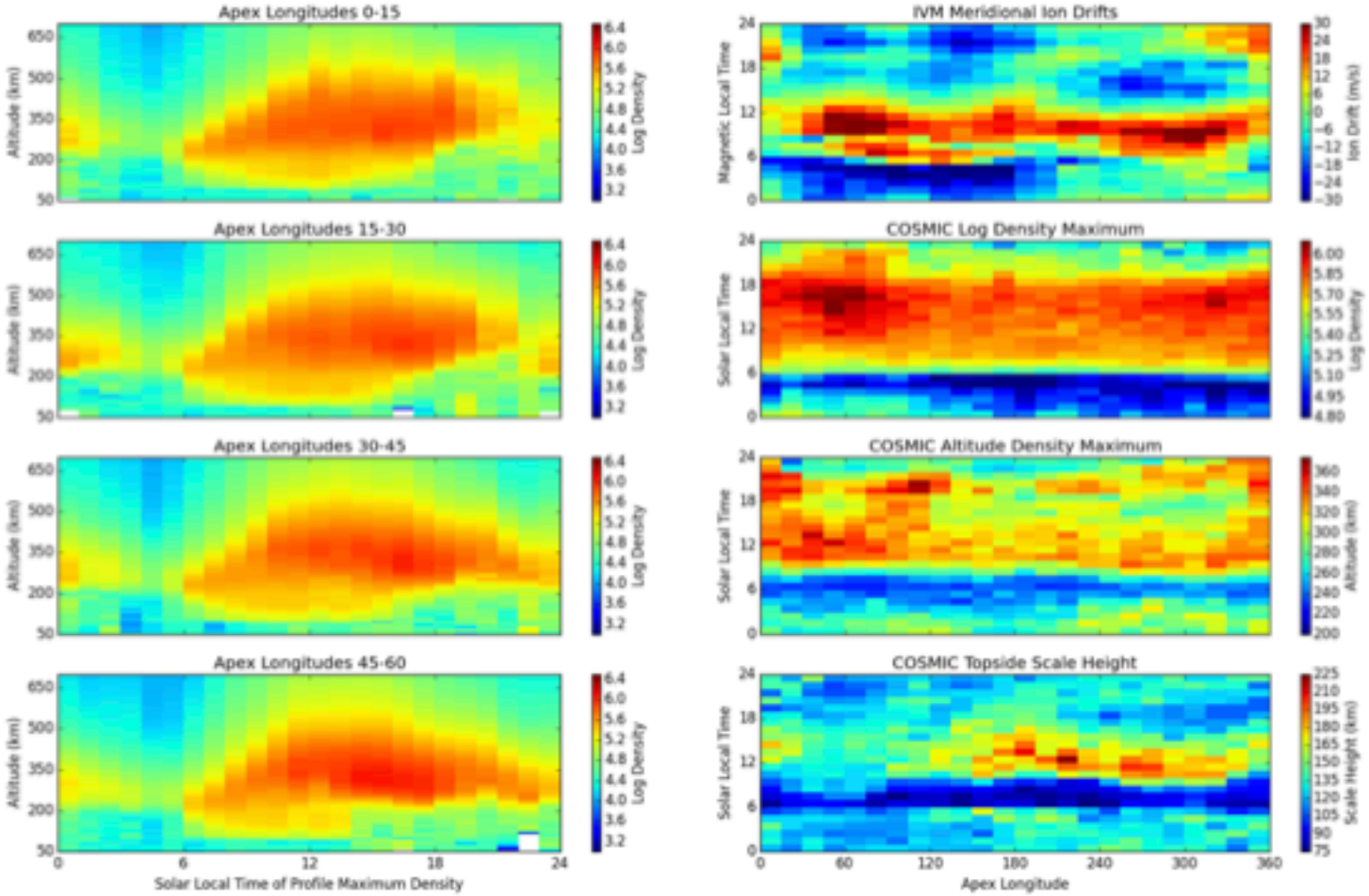

```
# select vefi dc magnetometer data, use longitude to determine where
# there are changes in the orbit (local time info not in file)
orbit_info = {'index':'longitude', 'kind':'longitude'}
vefi = pysat.Instrument(platform='cnofs', name='vefi', tag='dc_b',
                        clean_level=None, orbit_info=orbit_info)
```

```
# perform occurrence probability calculation
# any data added by custom functions is available within routine below
ans = pysat.ssnl.occur_prob.by_orbit2D(vefi, [0,360,144], 'longitude',
                [-13,13,104], 'latitude', ['dB_mer'], [0.], returnBins=True)
```

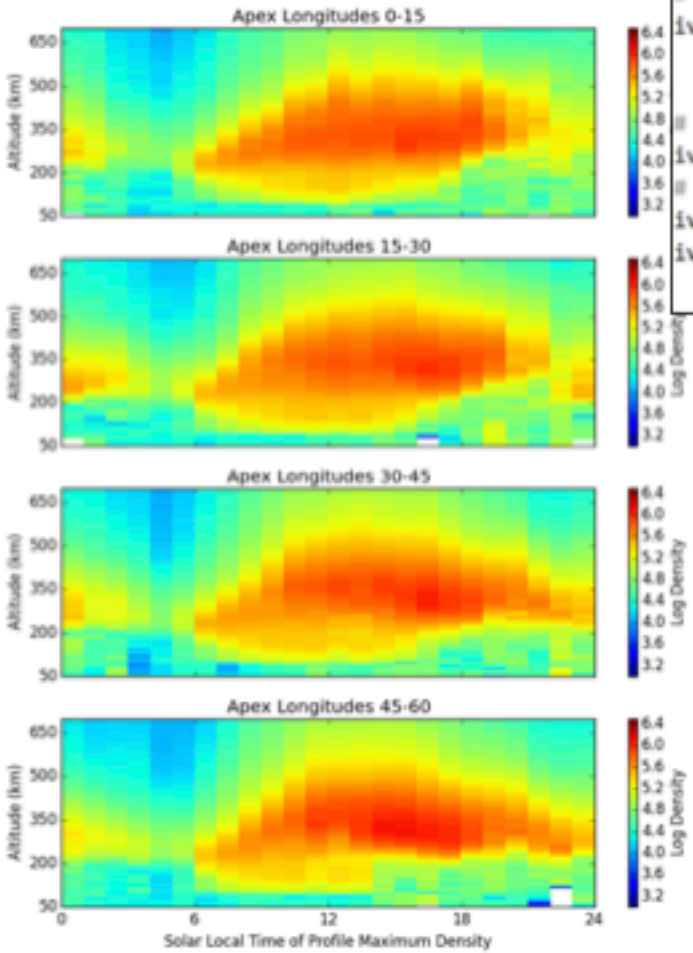


Full Code in Demo Area of Repo

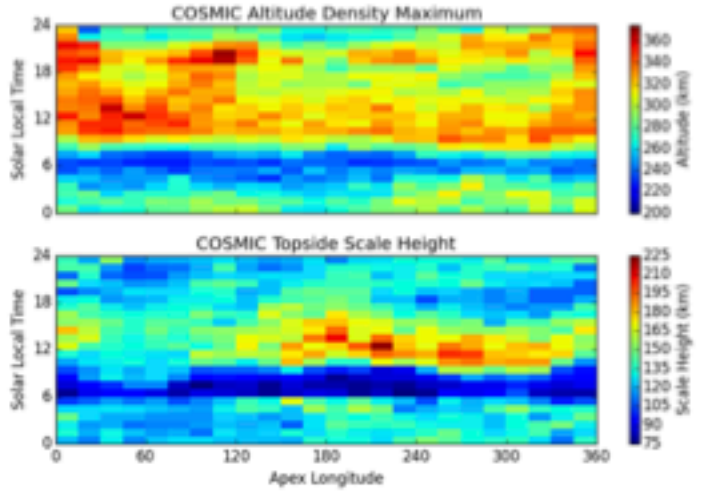
COSMIC and IVM Demo - pysatSeasons



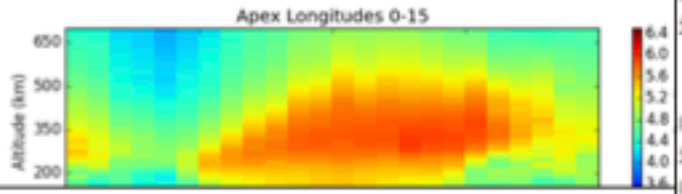
COSMIC and IVM Demo - pysatSeasons




```
# instantiate IVM Object
ivm = pysat.Instrument(platform='cnofs',
                       name='ivm', tag='',
                       clean_level='clean')
# restrict meausurements to those near geomagnetic equator
ivm.custom.add(restrictMLAT, 'modify', maxMLAT=25.)
# perform seasonal average
ivm.bounds = (startDate, stopDate)
ivmResults = pysat.ssnl.avg.median2D(ivm, [0,360,24], 'alon',
                    [0,24,24], 'mlt', ['ionVelmeridional'])
```

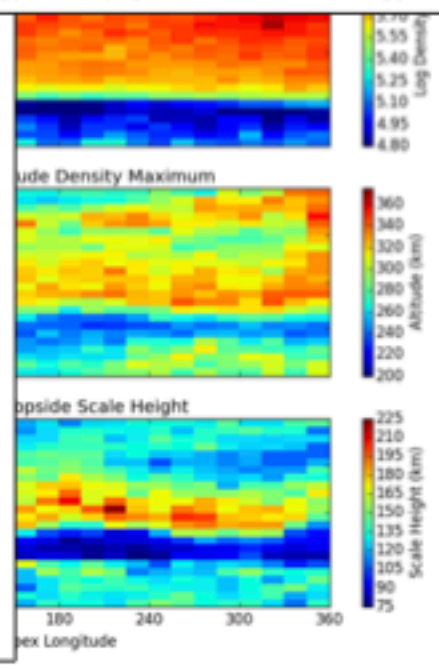


COSMIC and IVM Demo - pysatSeasons




```python
# create COSMIC instrument object
cosmic = pysat.Instrument(platform='cosmic2013',
                          name='gps',tag='ionprf'
                          clean_level='clean',
                          altitude_bin=3)
# apply custom functions to all data that is loaded through cosmic
cosmic.custom.add(addApexLong, 'add')
# select locations near the magnetic equator
cosmic.custom.add(filterMLAT, 'modify', mlatRange=(0.,10.) )
# take the log of NmF2 and add to the dataframe
cosmic.custom.add(addlogNm, 'add')
# calculates the height above hmF2 to reach Ne < NmF2/e
cosmic.custom.add(addTopsideScaleHeight, 'add')

# do an average of multiple COSMIC data products
# from startDate through stopDate
# a mixture of 1D and 2D data is averaged
cosmic.bounds = (startDate, stopDate)
cosmicResults = pysat.ssnl.avg.median2D(cosmic, [0,360,24], 'apex_long',
       [0,24,24],'edmaxlct', ['profiles', 'edmaxalt', 'lognm', 'thf2'])
```

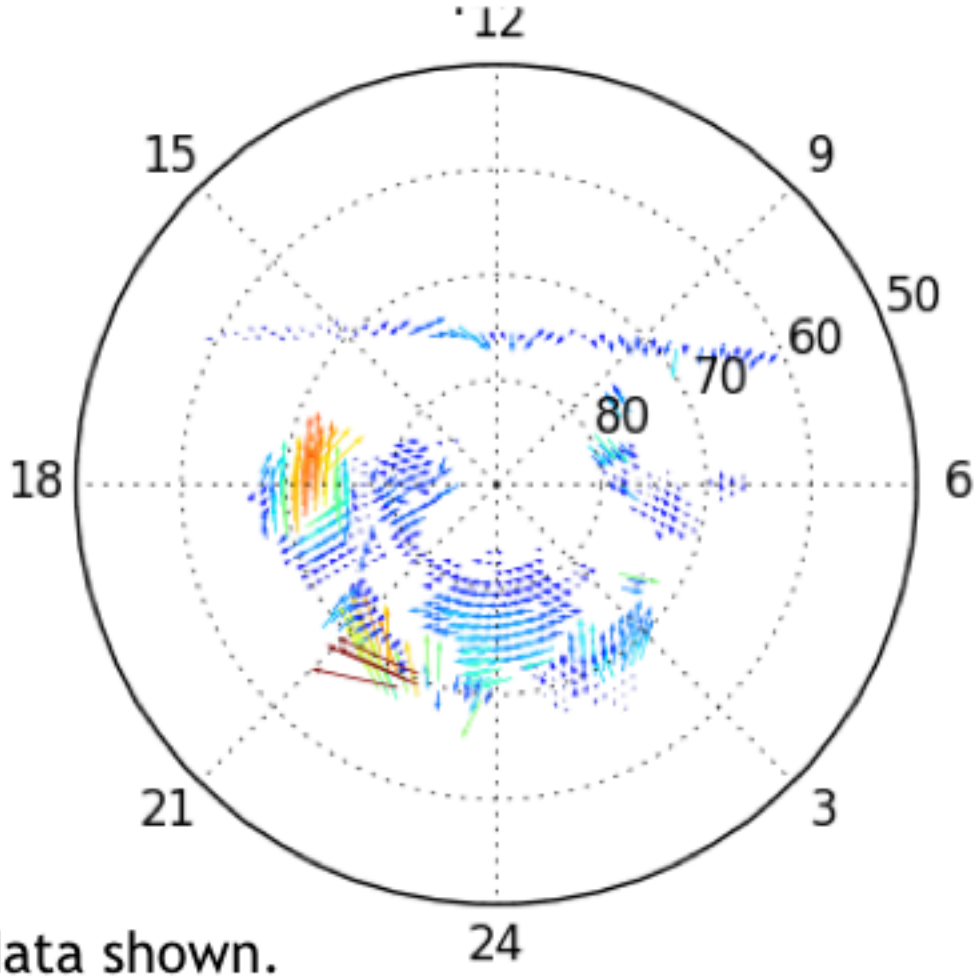
```python
# instantiate IVM Object
ivm = pysat.Instrument(platform='cnofs',
                       name='ivm', tag='',
                       clean_level='clean')
# restrict meausurements to those near geomagnetic equator
ivm.custom.add(restrictMLAT, 'modify', maxMLAT=25.)
# perform seasonal average
ivm.bounds = (startDate, stopDate)
ivmResults = pysat.ssnl.avg.median2D(ivm, [0,360,24], 'alon',
                [0,24,24], 'mlt', ['ionVelmeridional'])
```



SuperDARN (pysatIncubator)

- Interfaces with VT servers (shutdown)

```
sdarn = pysat.Instrument('superdarn', 'grdex', 'north')
sdarn.download(date1, date2)
sdarn.load(date=date1)
```



Support for SuperDARN uses community SuperDARN package

Plot including both DMSP and SuperDARN data shown.

Acknowledgements

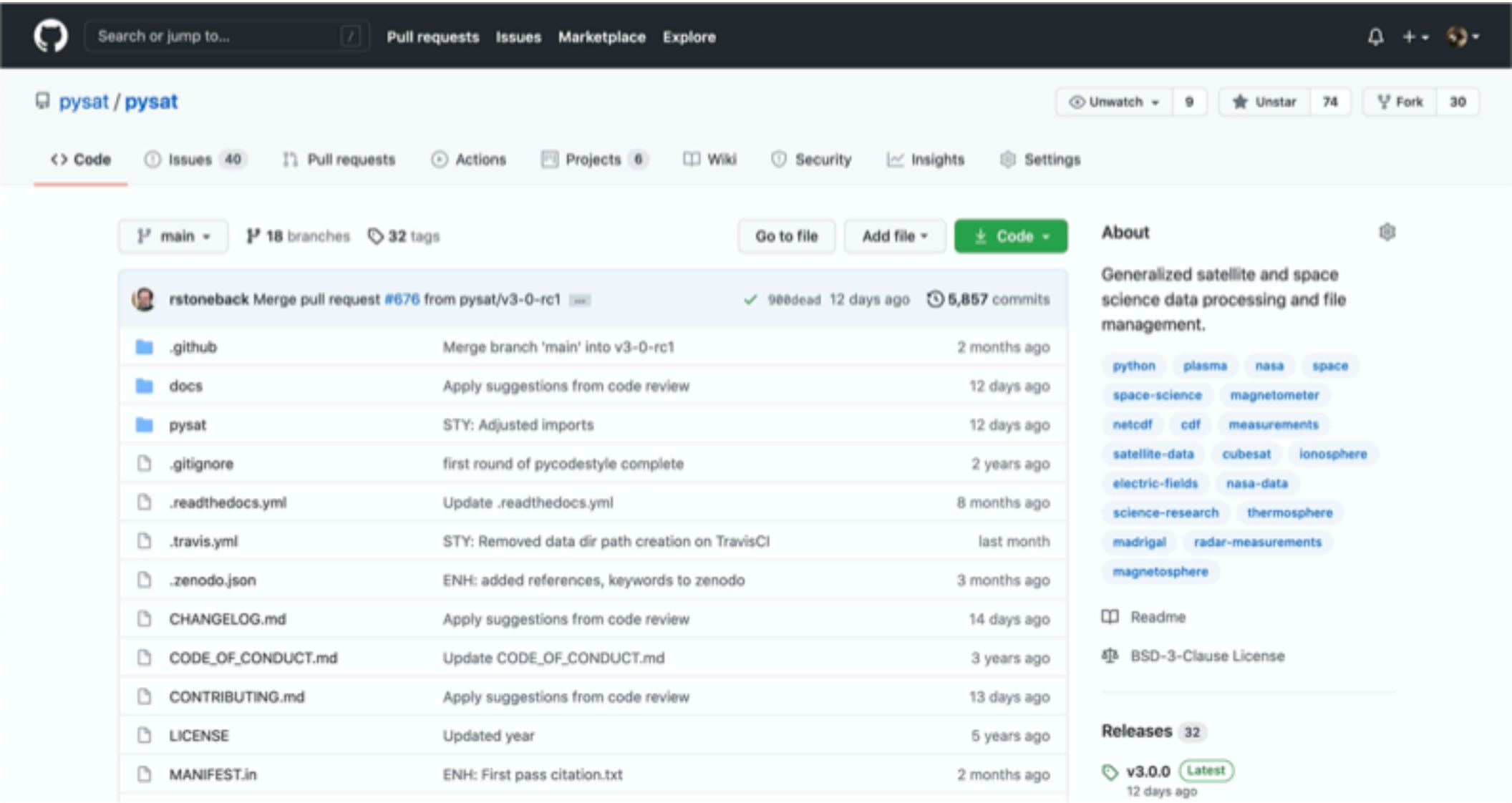
The research performed by A.G. Burrell was funded by the Chief of Naval Research

pysat source code available at https://github.com/pysat/pysat

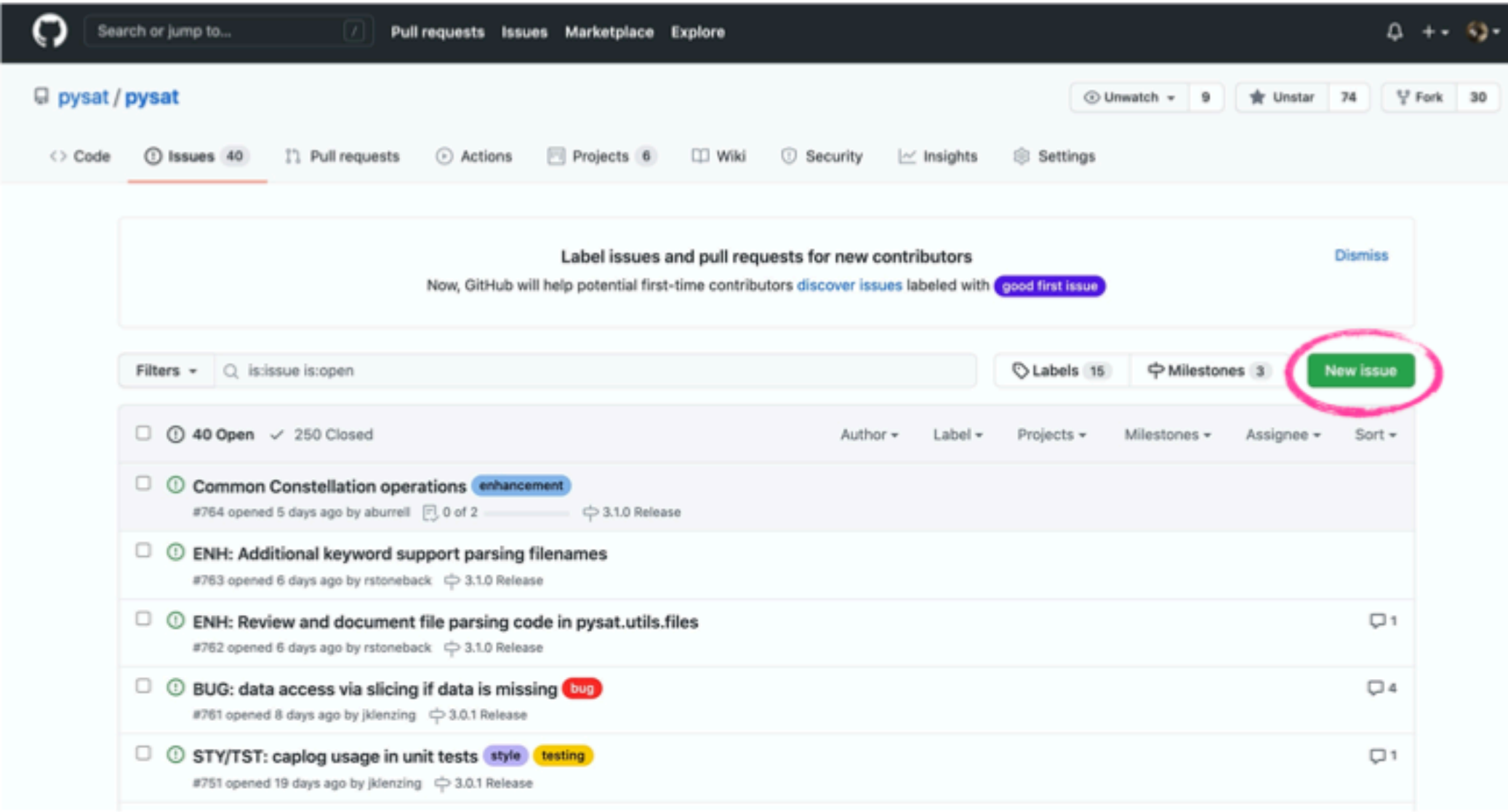
Or 'pip install pysat'
Version 3.0 Recently Released!

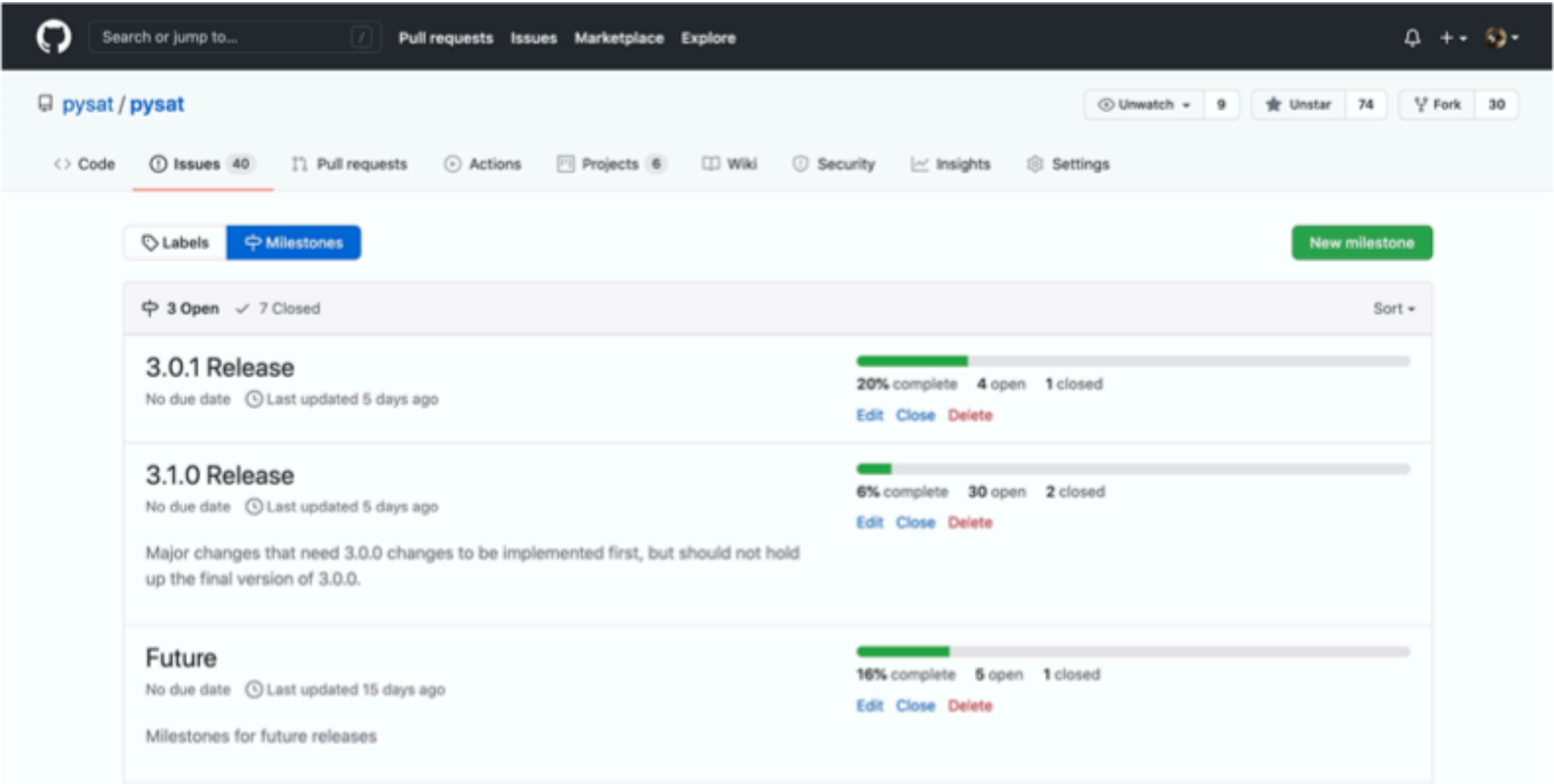
pysat ecosystem available at https://github.com/pysat

OMMBV available at https://github.com/rstoneback



https://github.com/pysat/pysat


Search or jump to...
Pull requests
Issues
Marketplace
Explore
pysat / pysat
Unwatch 9
Unstar 74
Fork 30
Code
Issues 40
Pull requests
Actions
Projects 6
Wiki
Security
Insights
Settings
Label issues and pull requests for new contributors
Dismiss
Now, GitHub will help potential first-time contributors discover issues labeled with good first issue
Filters
is:issue is:open
Labels 15
Milestones 3
New issue
40 Open
250 Closed
Author
Label
Projects
Milestones
Assignee
Sort
Common Constellation operations enhancement
#764 opened 5 days ago by aburrell 0 of 2 3.1.0 Release
ENH: Additional keyword support parsing filenames
#763 opened 6 days ago by rstoneback 3.1.0 Release
ENH: Review and document file parsing code in pysat.utils.files
1
#762 opened 6 days ago by rstoneback 3.1.0 Release
BUG: data access via slicing if data is missing bug
4
#761 opened 8 days ago by jklenzing 3.0.1 Release
STY/TST: caplog usage in unit tests style testing
1
#751 opened 19 days ago by jklenzing 3.0.1 Release


Search or jump to...
Pull requests
Issues
Marketplace
Explore
pysat / pysat
Unwatch 9
Unstar 74
Fork 30
Code
Issues 40
Pull requests
Actions
Projects 6
Wiki
Security
Insights
Settings
Labels
Milestones
New milestone
3 Open
7 Closed
Sort
3.0.1 Release
No due date
Last updated 5 days ago
20% complete
4 open
1 closed
Edit
Close
Delete
3.1.0 Release
No due date
Last updated 5 days ago
6% complete
30 open
2 closed
Edit
Close
Delete
Major changes that need 3.0.0 changes to be implemented first, but should not hold up the final version of 3.0.0.
Future
No due date
Last updated 15 days ago
16% complete
5 open
1 closed
Edit
Close
Delete
Milestones for future releases