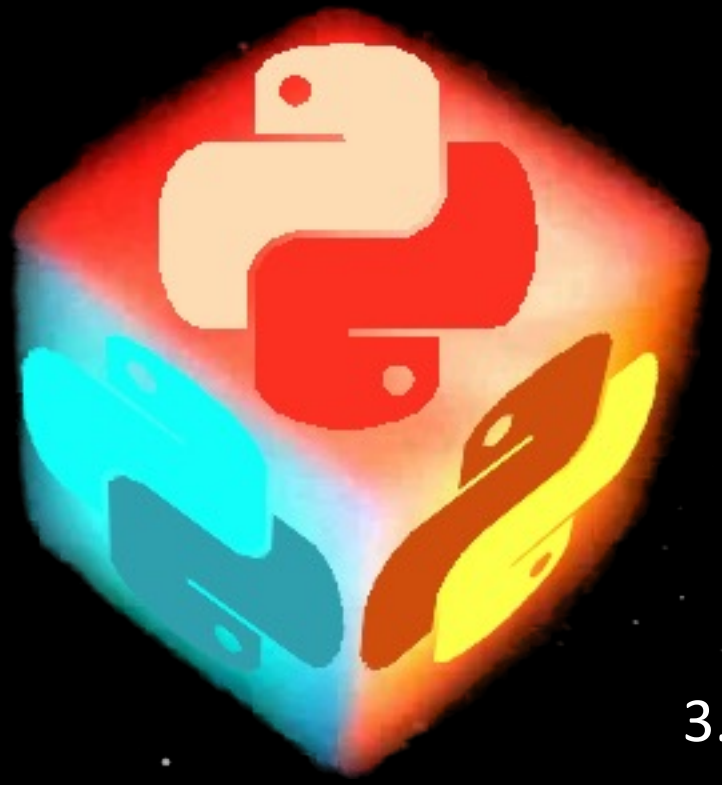

Snakes on a Spaceship: The Python Maneuver

1. Tutorial: Environment Management
2. PyIRTAM – Victoriya Forsythe
3. cavsiopy: a Python package to calculate and visualize spacecraft instrument orientation – Ceren Eyiguler
4. Managing GEMINI numerical ionospheric model input and output data via pygemini – Matt Zettergren and Michael Hirsch
5. The Python in Heliophysics Community (PyHC): updates since CEDAR 2023 – Julie Barnum
6. Discussion

Session Notes: Tutorial

- Tutorial: Environment Management
  - Juyter and kernels - generally poorly understood by everyone
  - Kernels can use different programs
  - CAN use pip inside conda (as long as it’s the pip that conda installs)
  - Requirements.txt file - versions on packages, makes it easy to set up environments
  - Software release in pypi vs conda - just different package managers

Session Notes: PyIRTAM

- PyIRTAM
- Kind of a follow on to pyIRI, but structure of code is completely different
- PyIRI
  - Rewrite of original FORTRAN IRI
  - pyIRI only accounts for a few of the initial IRI settings
  - Calculates model electron density of ionosphere
  - Two different sets of coefficients (CCIR, URSI)
  - Monthly mean variance
  - Daily variance
  - Global spherical harmonics ish coefficient
  - 13 diurnal functions, 76 global functions, 2 levels of solar activity (min and max)
  - Diurnal functions effectively fourier decomposition
  - Global takes account of magnetic field inclination
  - Original IRI re-reads the coefficient file for every single point called
  - PyIRI replaces expensive loops with matrix multiplications
  - Start with global array of positions and only opens coefficient file ONCE
  - Space weather journal - publication available
- PyIRTAM
  - GIRO - network of ionosondes
  - Diurnal trends in each ionosonde with additional term to characterize tilt
  - Need to run once every 15 minutes
  - Similar modifications for improving efficiency
- Q&A
  - What was making FORTRAN so slow?
    - File IO
    - Loop calculations of function forms
    - Array broadcasting and where function to construct 3D density profiles

Session Notes: cavsiopy

- e-PoP/Swarm-E/CASSIOPE/RRI
- Radiowave sometimes does not hit dipole perpendicularly
- Instrument state vector - where instrument is on spacecraft
- Transformation between multiple reference frames
- Can be used in general for any spacecraft now
- Installation with pip
- Ephemeris_importer - import ephemerous information from various sources
- Transformations - uses rotation matrices; all this is handles all this internally
- Frontiers in Astronomy and Space Sciences, Eyiguler et al, 2023
- Field-of-view plotter - for camera facing directly downwards
- 2d look direction plotting functions - work on map
- 3d visualization - view direction, spacecraft to target
- Auxiliary functions

Session Notes: GEMINI

- GEMINI VERY large physics-based model of the ionosphere
- KHI, GDI, EPB
- Visualization of output
- Pygemini - make it less painful to deal with the core model
- Core model - massively parallel, written in C, C++, FORTRAN
- Making inputs in these languages is challenging (really more annoying and time consuming?)
- Visualizing output is nontrivial
- Pygemini is a front and back end for complicated model
- These large models generally need to be in compiled languages, but input and visualization you want in a scripting language
- Modeling output is on a complicated grid - pygemini has sampling functionality
- Pygemini adopts using hdf5 for output - self documenting
- Take hdf output files and read them into sensible dictionaries
- Run a simulation, want to look at an output and look at it in an intuitive way
- Interpolation to intuitive grid
- AMR - practically speaking are unstructured meshes
  - Still struggling with this
  - Use paraview a lot
- Fully available on GH
- Repository in OK shape, needs more documentation and testing
- Examples for how models are set up

Session Notes: PyHC Updates

- PyHC: The Python in Heliophysic Community
- Community of open-source python programers
- Facilitating the use and development of open-source heliophysics software
- Improving collaboration and communication
- Maintain a set of software development standards
- Encourage reproducibility and interoperability
- No specific one main PyHC package - all are developed mostly independently
- pyhc.org
- Bi-weekly telecons
- Summer School
  - Educating on what software are available (7 core packages)
  - Create more diversify community
  - Encourage and promote use of OSS and open science
  - How to create packages
  - About 400 participants (mostly remote)
  - NSF travel funding
  - Longer summer school?
  - Successful HelioCloud partnership
  - Interactive tutorials
  - In future, less content and more time actively coding
  - Filling holes in PyHC
- PHEPs
  - PyHC Enhancement Proposal
  - Update standards, information for the community
  - Standards, Informational, and Process PHEP
  - Heavily community involvement - two votes
  - Currently only 3
  - All open on GH