



# The SunPy Project: Past, Present, and Future

AGU Fall Meeting  
15 December 2022

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Nabil Freij, Laura Hayes, Jack Ireland,  
Stuart Mumford, Albert Shih, David  
Stansby, and the SunPy Community

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# Past: A Brief History of SunPy



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**9/2010**—Idea conceived  
at SIP Workshop

**Goals:** OSS, testing, version control,  
coordinated development



# Past: A Brief History of SunPy



**3/2011**—Development work began at NASA GSFC



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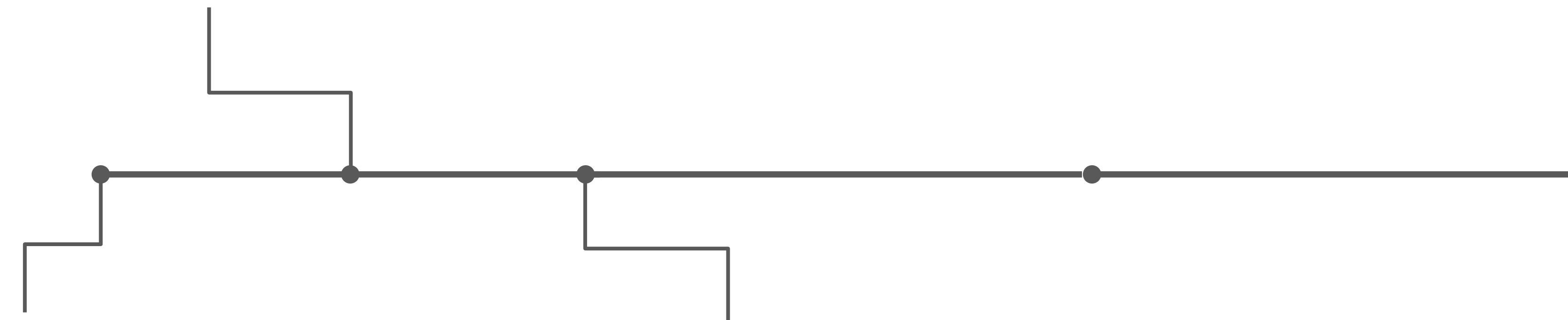
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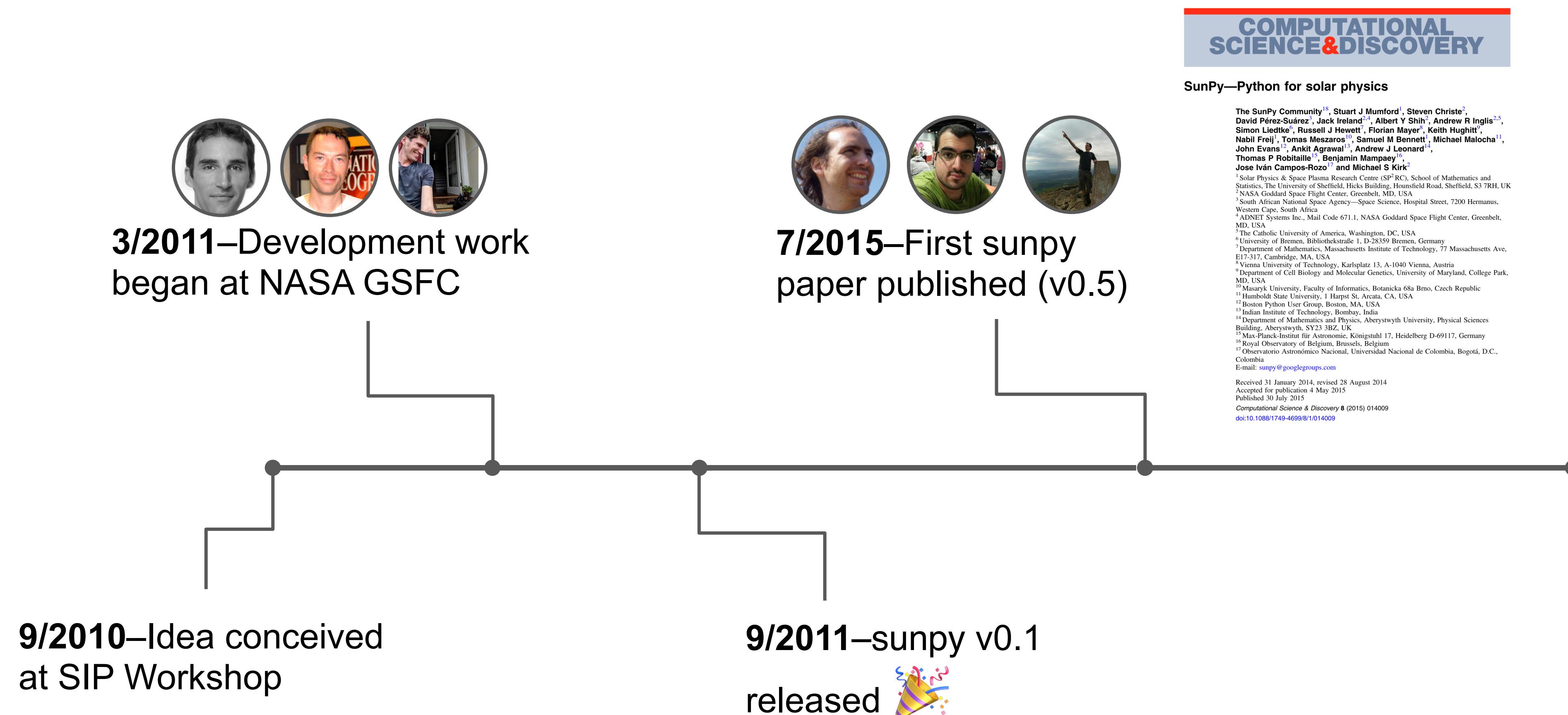
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**9/2011**—sunpy v0.1 released 

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## SunPy—Python for solar physics

The SunPy Community<sup>18</sup>, Stuart J Mumford<sup>1</sup>, Steven Christe<sup>2</sup>, David Pérez-Suárez<sup>3</sup>, Jack Ireland<sup>4</sup>, Albert Y Shih<sup>5</sup>, Andrew R Inglis<sup>2,6</sup>, Simon Liedtke<sup>6</sup>, Russell J Hewett<sup>6</sup>, Florian Mayer<sup>7</sup>, Keith Hughitt<sup>8</sup>, Nabil Freij<sup>9</sup>, Tomáš Mészáros<sup>10</sup>, Samuel M Bennett<sup>11</sup>, Michael Malocha<sup>11</sup>, Thomas P Robitaille<sup>12</sup>, Benjamin Mampae<sup>13</sup>, Jose Iván Campos-Rozo<sup>17</sup> and Michael S Kirk<sup>2</sup>

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<sup>10</sup> Masaryk University, Faculty of Informatics, Botanická 68a Brno, Czech Republic

<sup>11</sup> Hamilton State University, 1 Harpur St, Arcata, CA, USA

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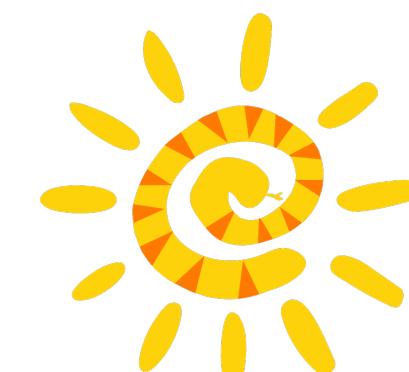
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**3/2011**—Development work began at NASA GSFC



**7/2015**—First sunpy paper published (v0.5)

**9/2010**—Idea conceived at SIP Workshop

**9/2011**—sunpy v0.1 released



**6/2019**—sunpy v1.0 released



**Goals:** OSS, testing, version control, coordinated development

## COMPUTATIONAL SCIENCE & DISCOVERY

### SunPy—Python for solar physics

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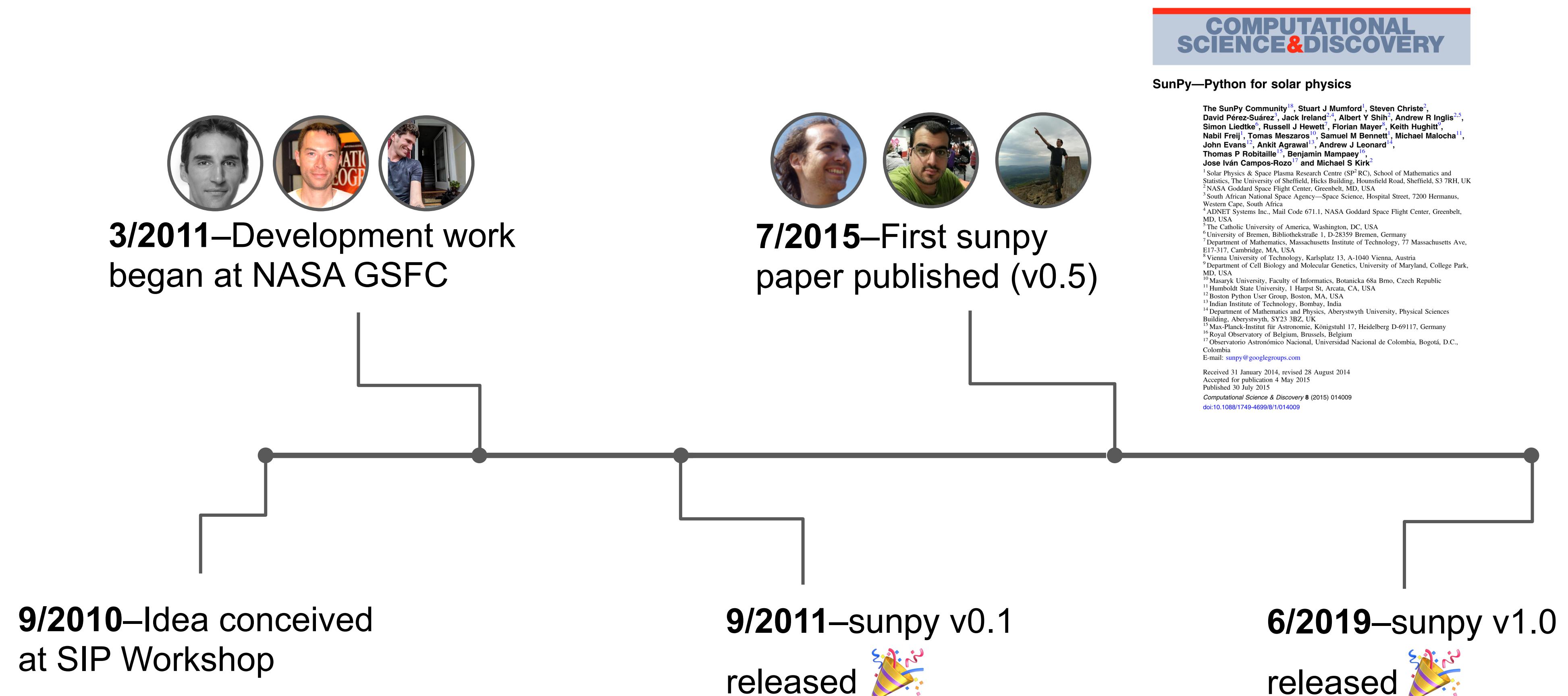
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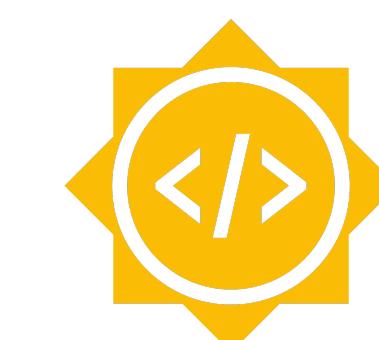
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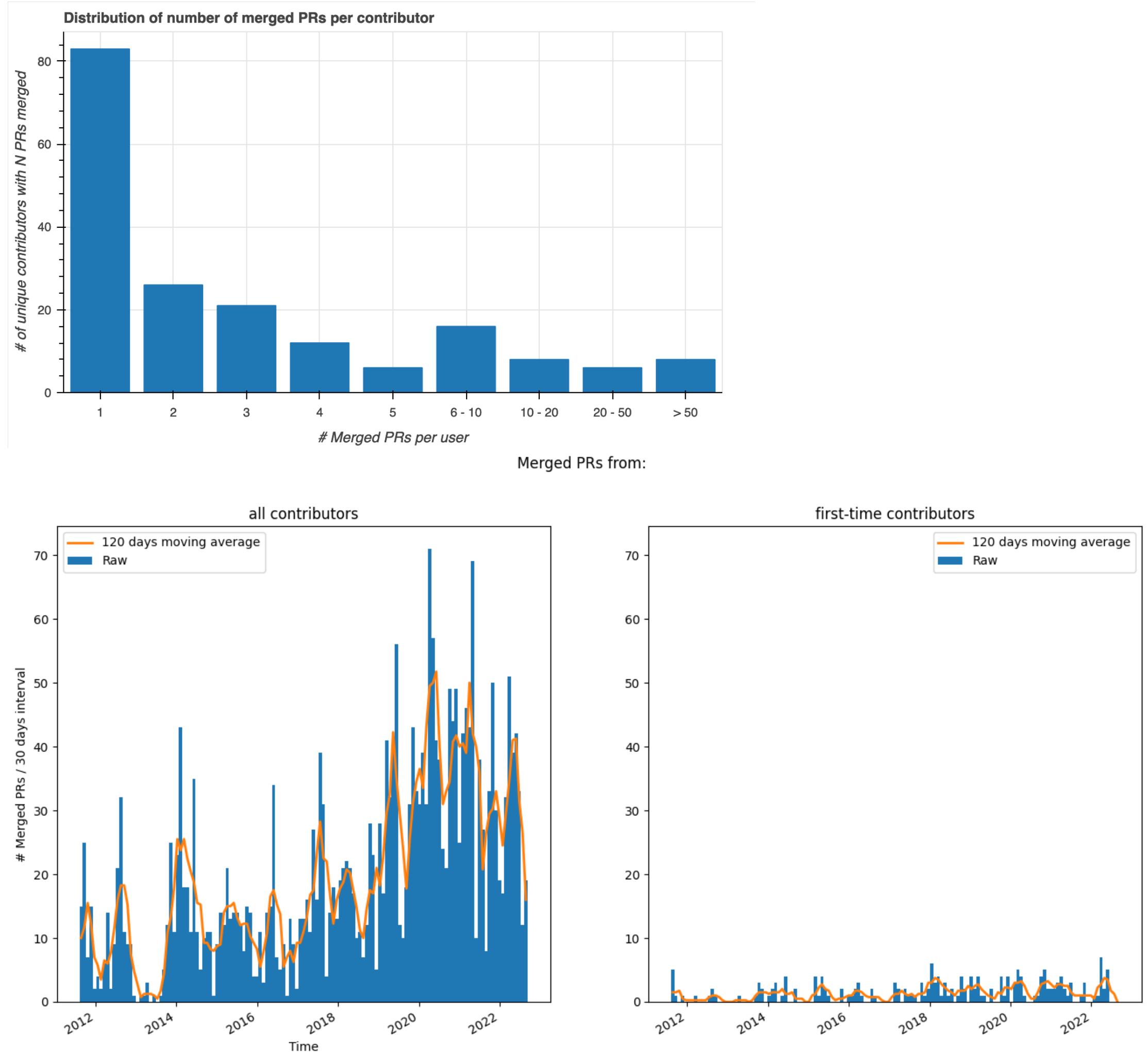


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*Summer of Code in Space*



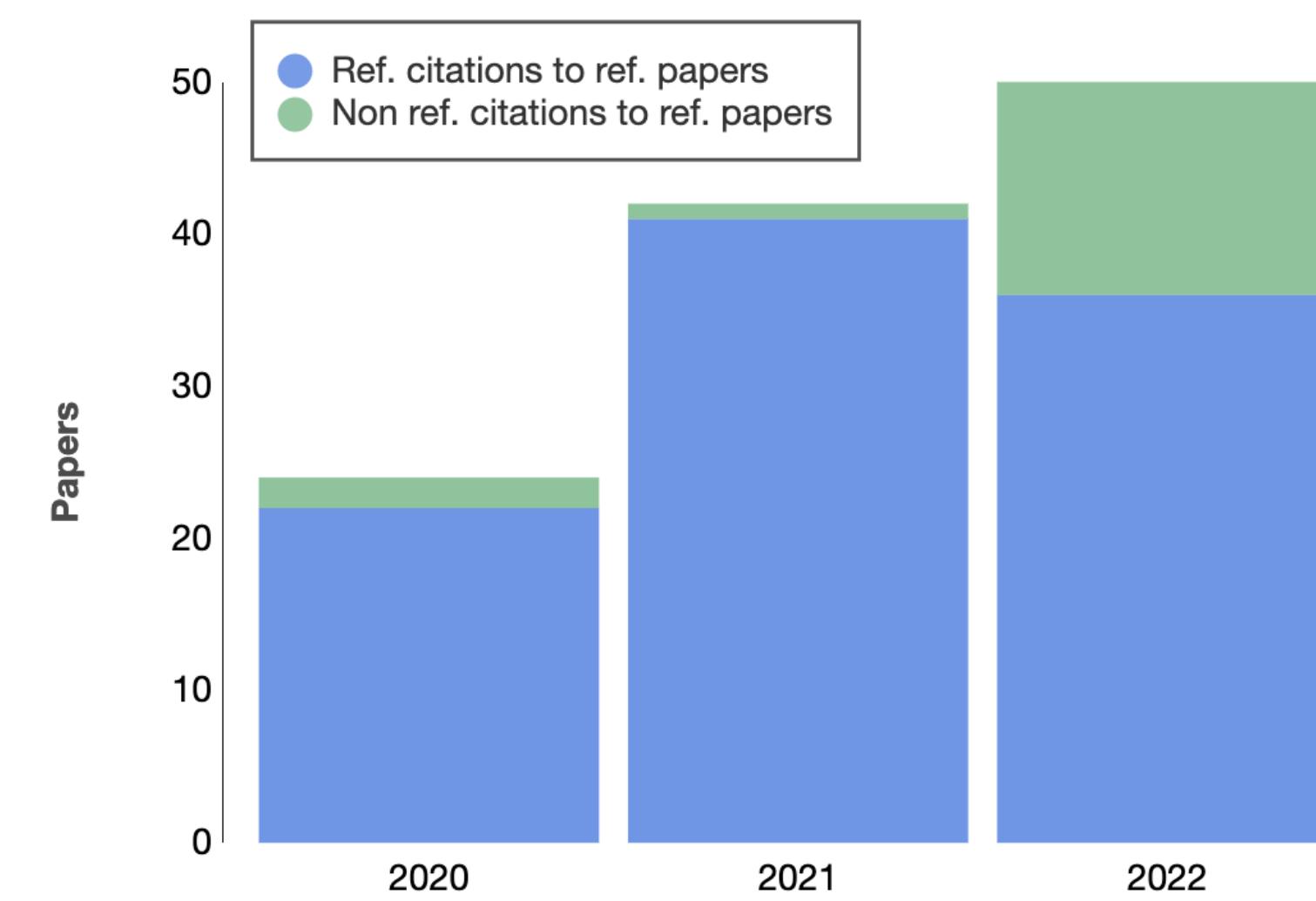
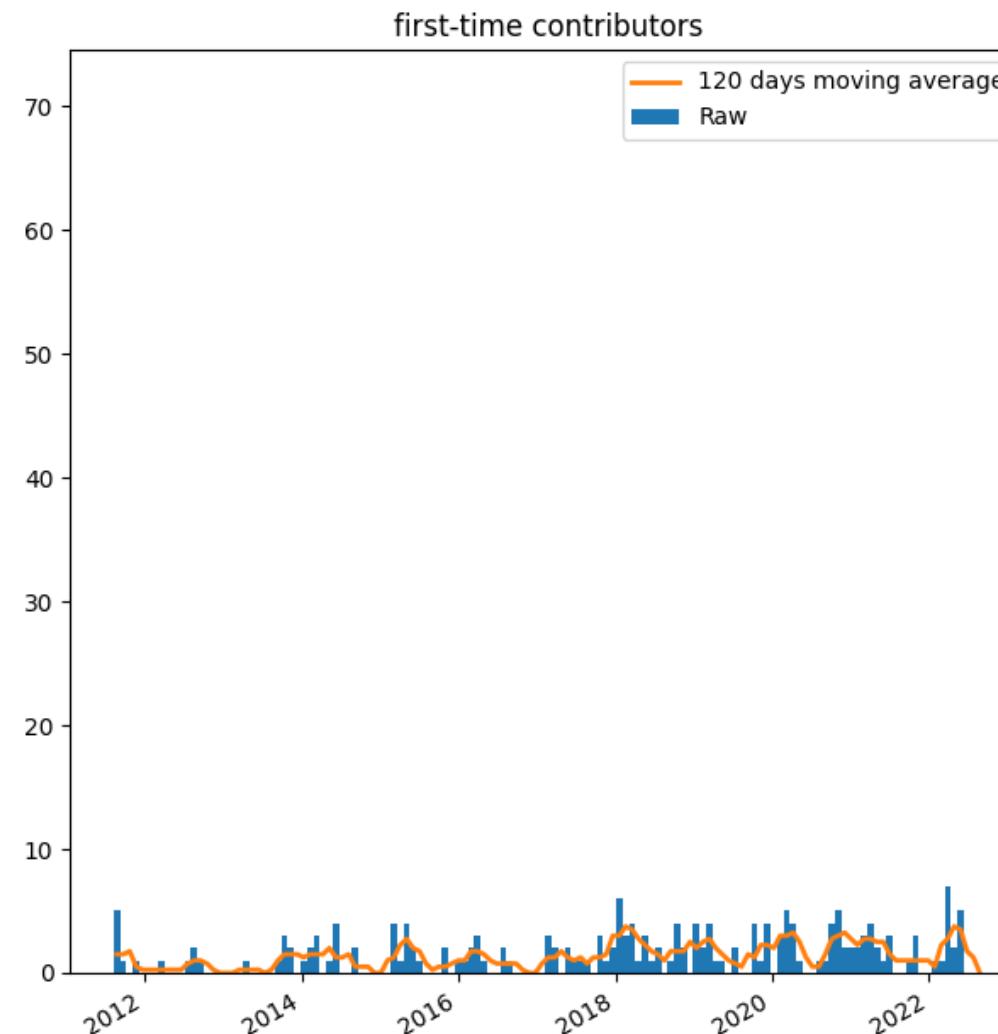
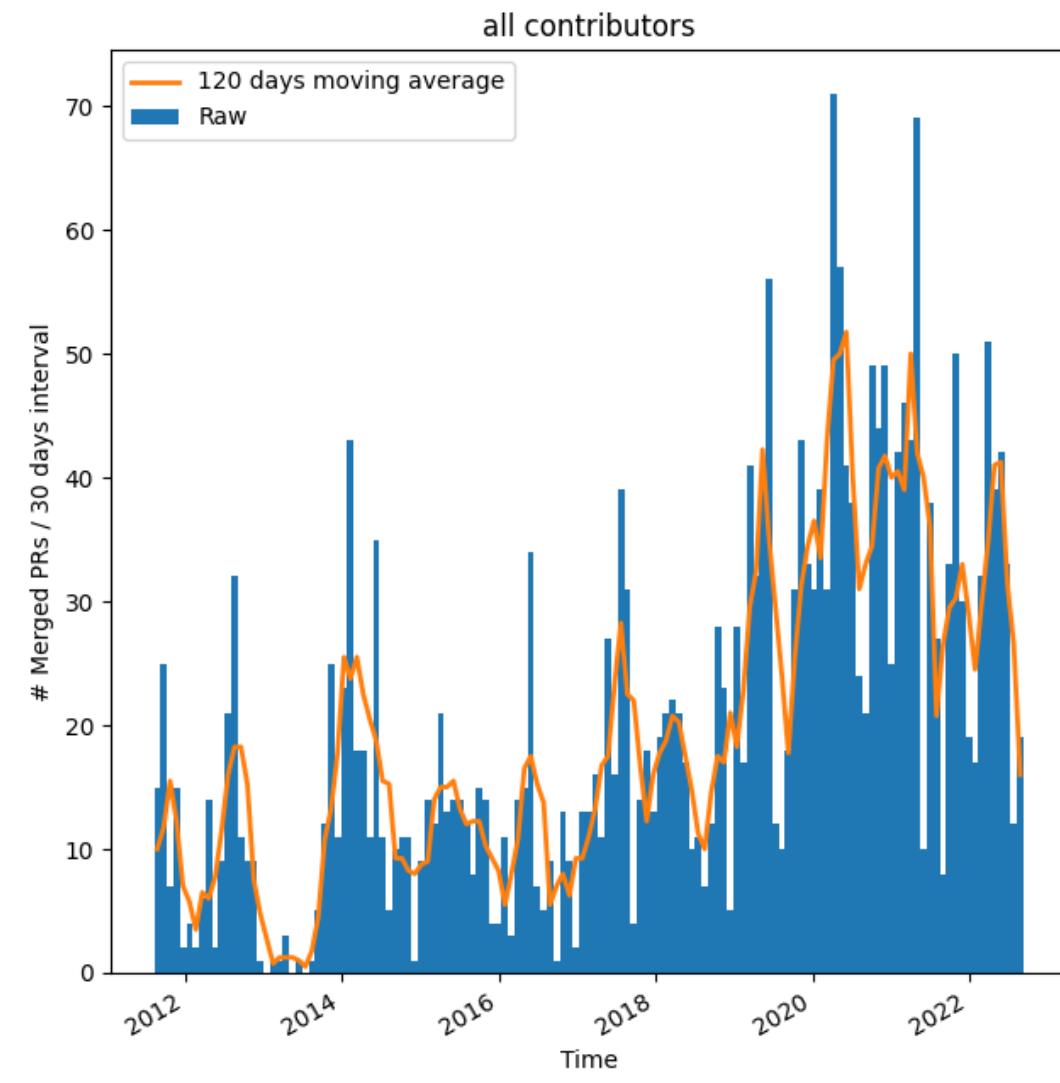
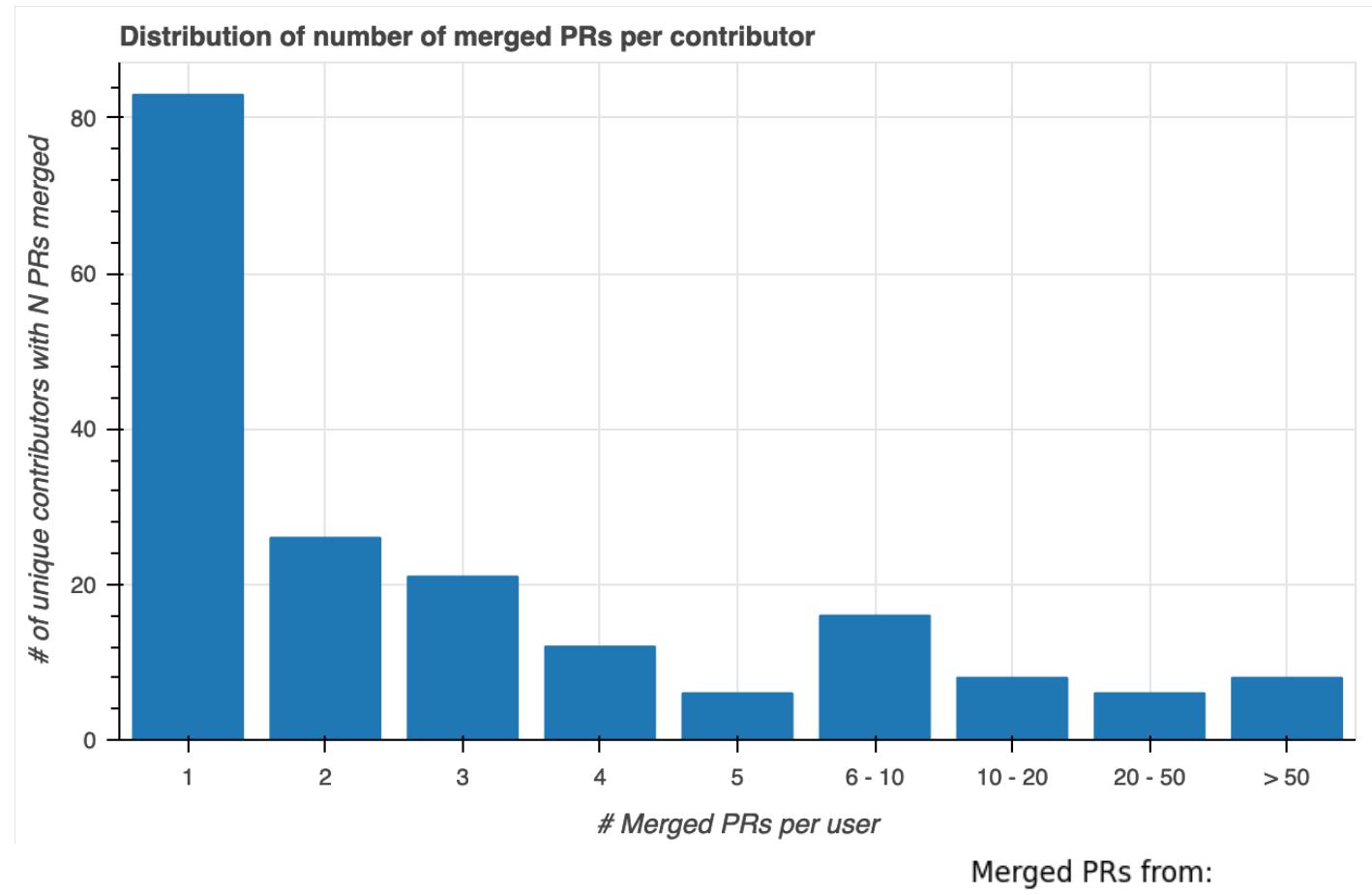
# Present: A Growing Community



Courtesy of [devstats.scientific-python.org](https://devstats.scientific-python.org)



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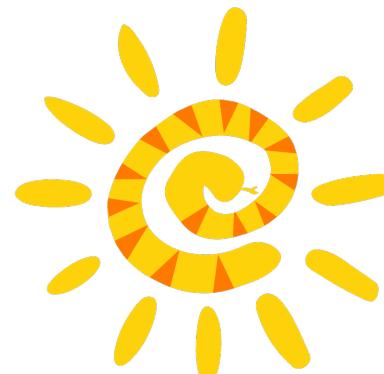
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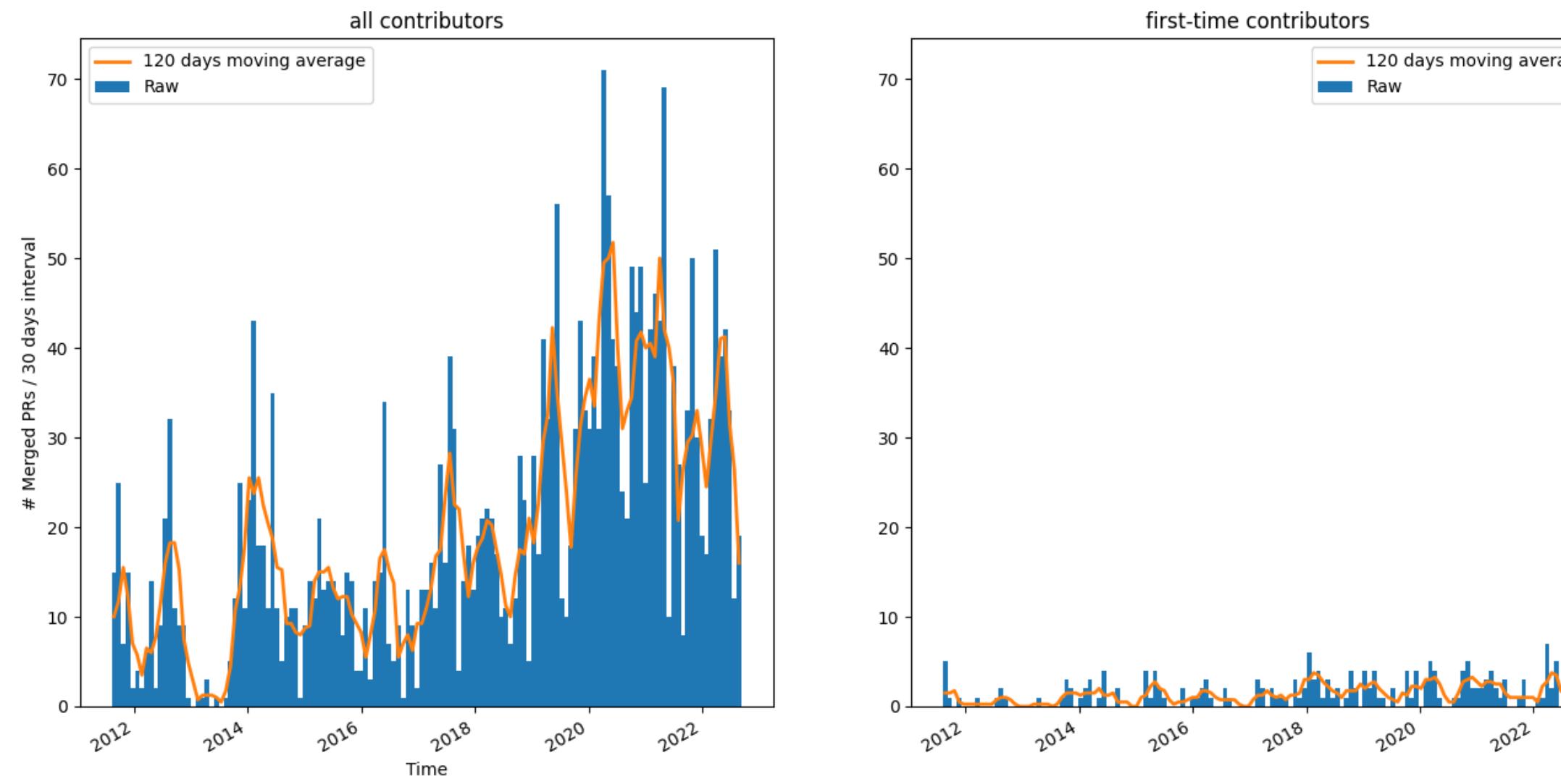
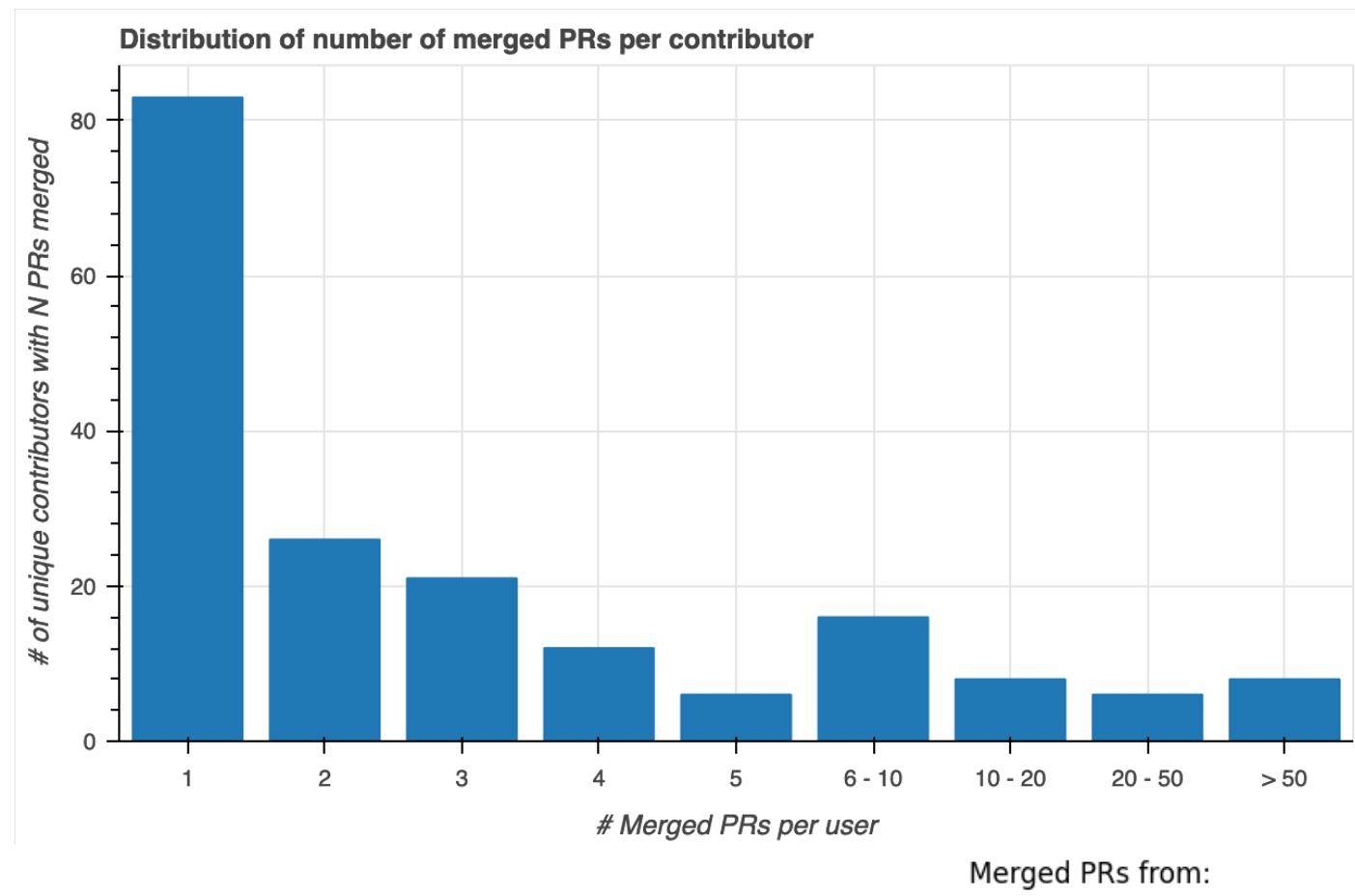
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## The SunPy Project: Open Source Development and Status of the Version 1.0 Core Package

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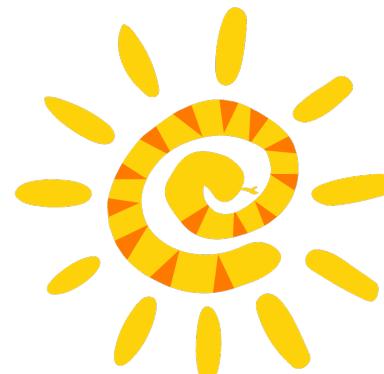
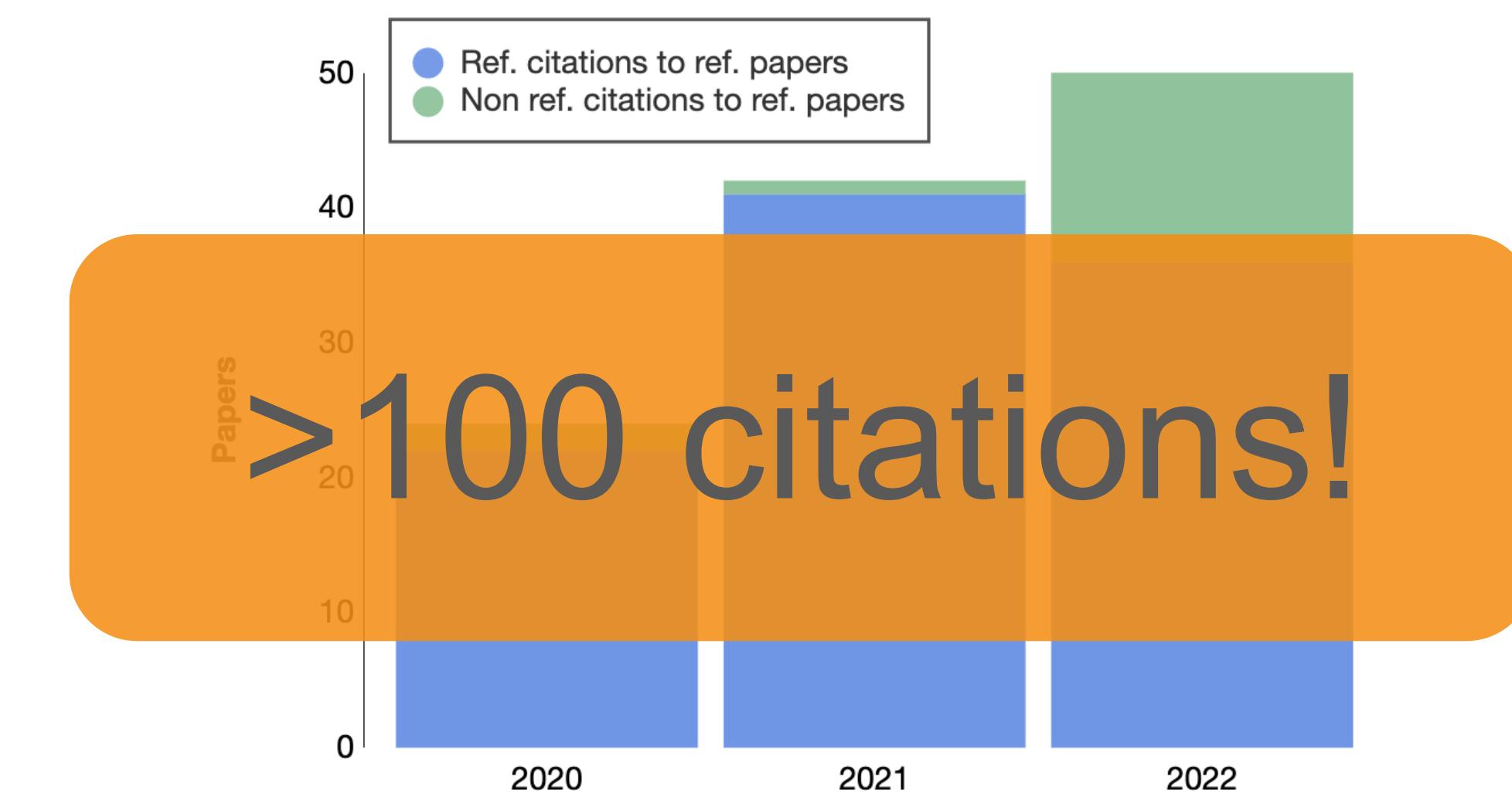
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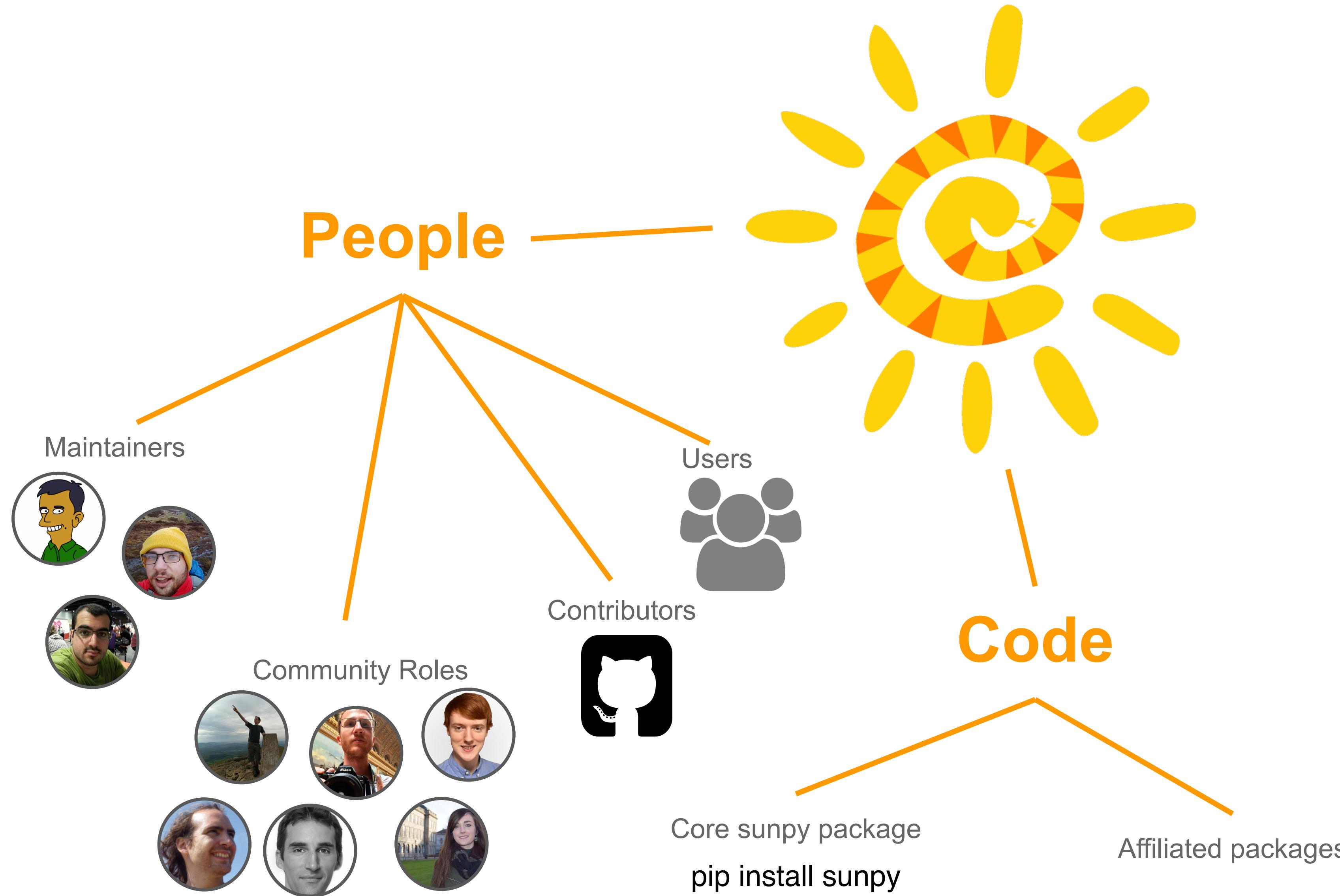


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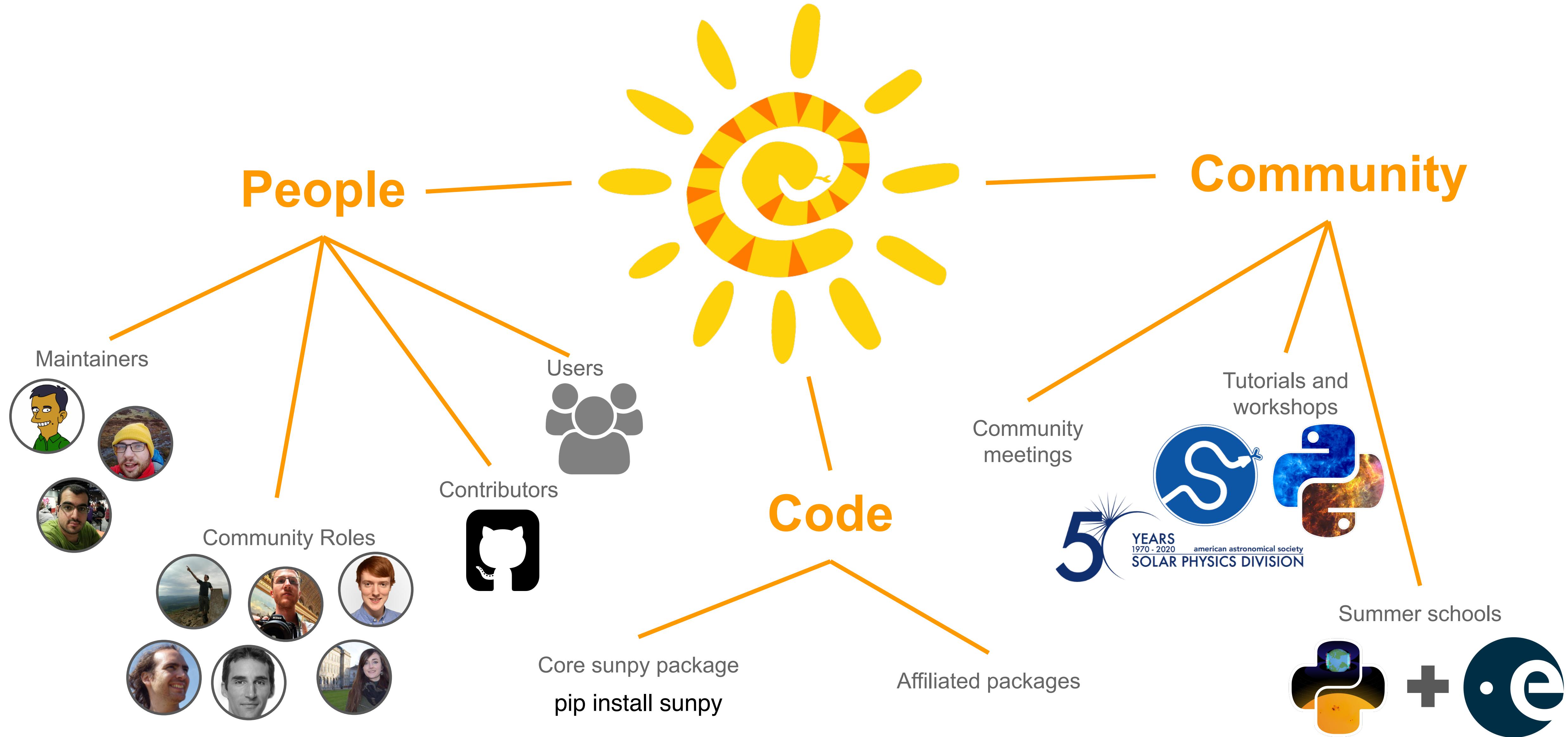
Core sunpy package  
pip install sunpy

Affiliated packages

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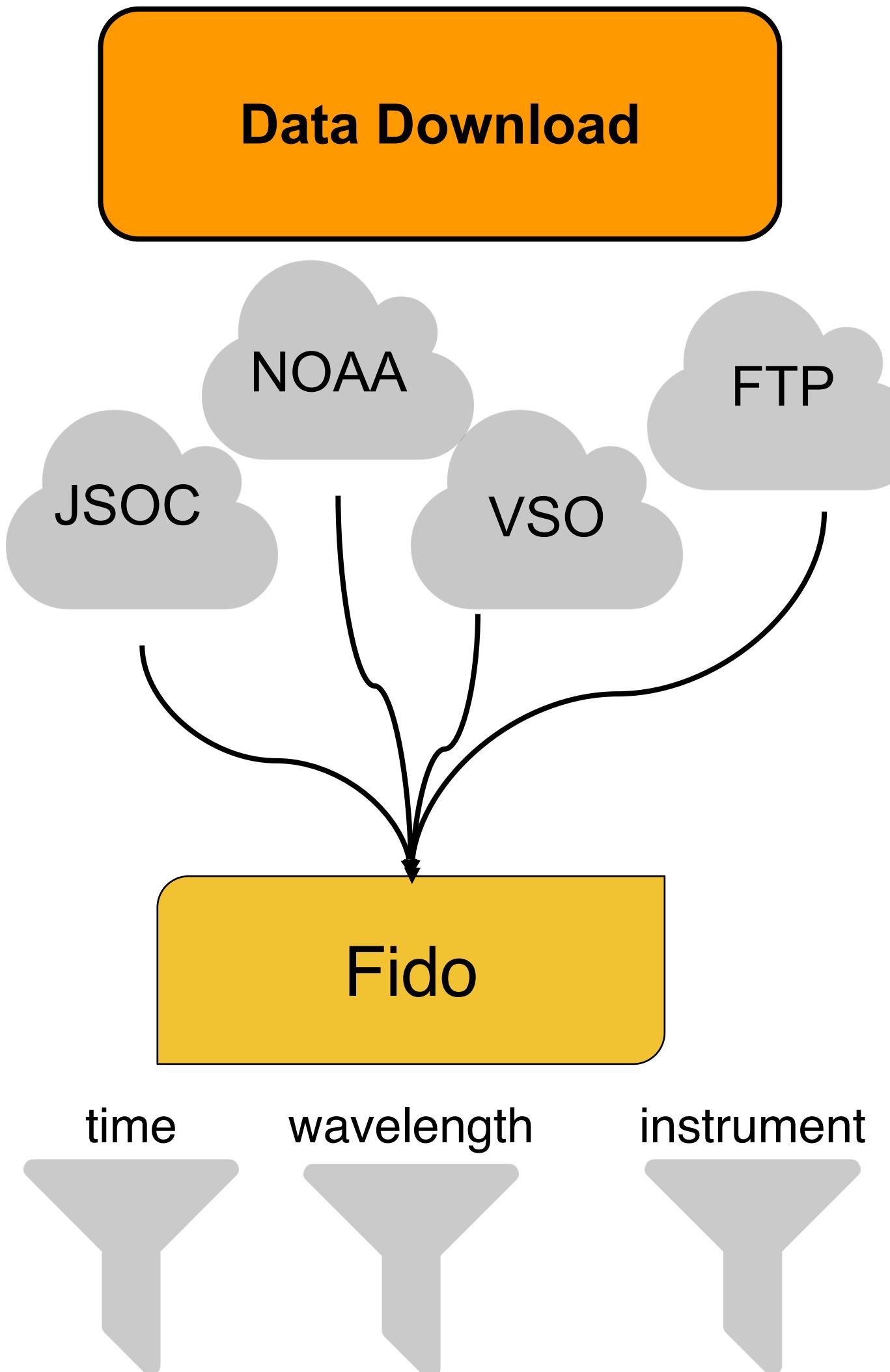


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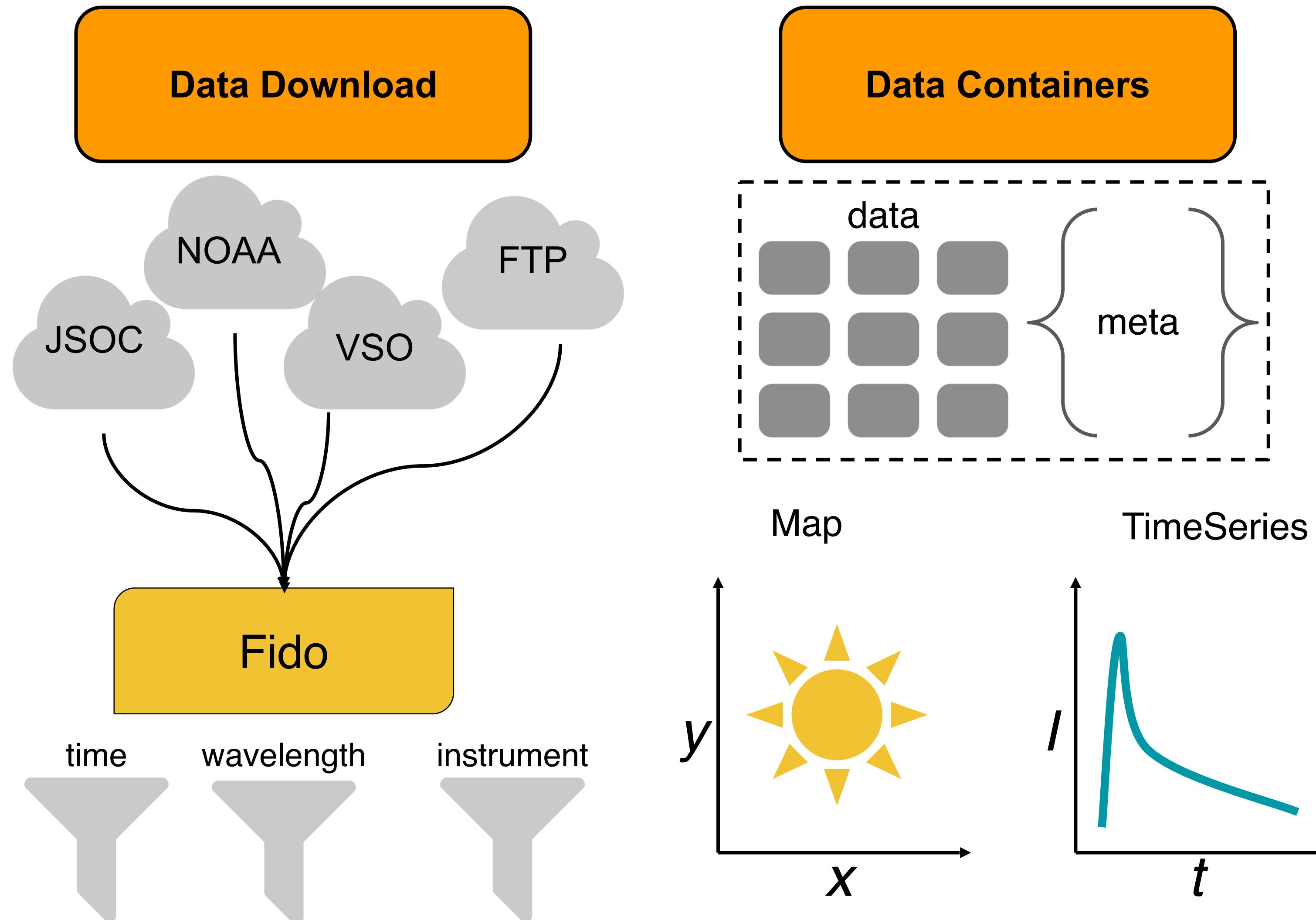


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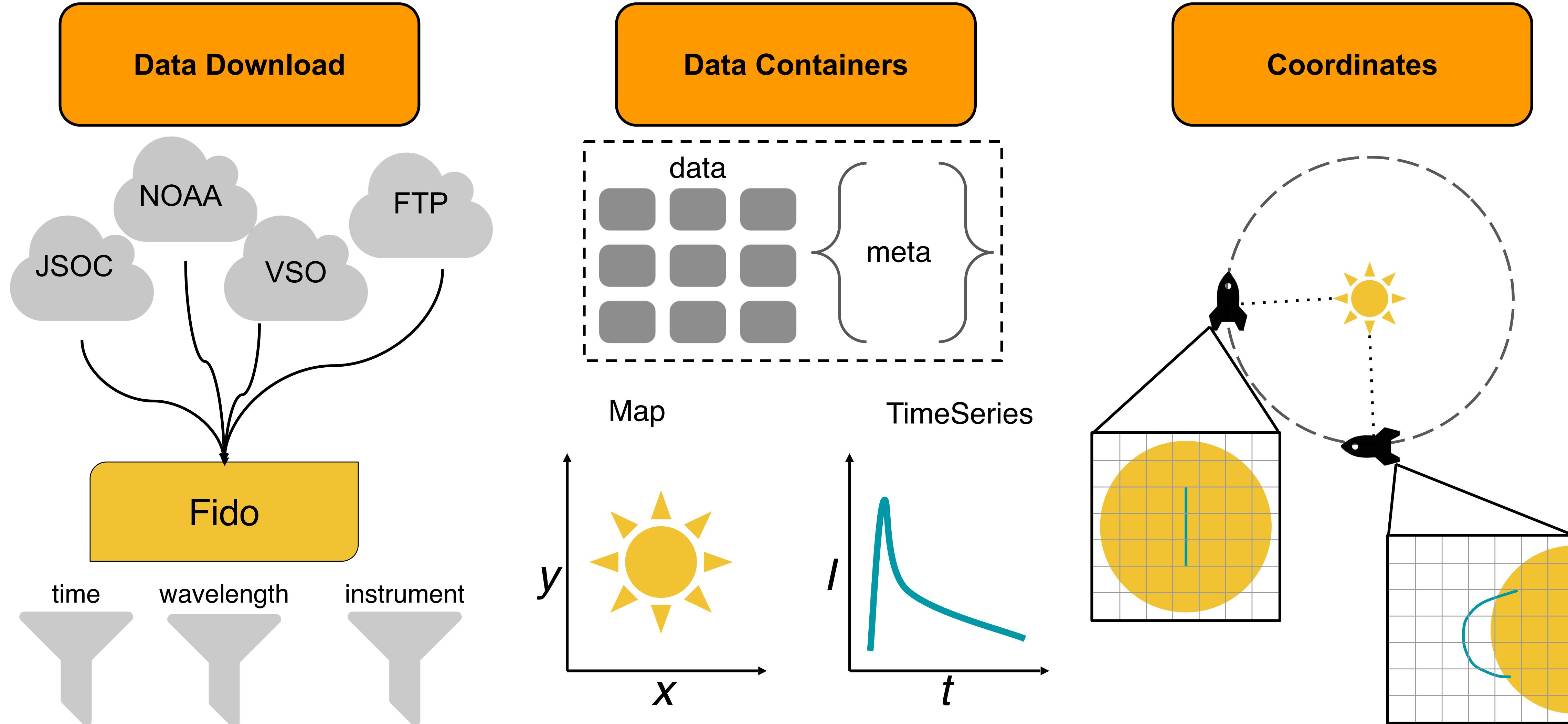
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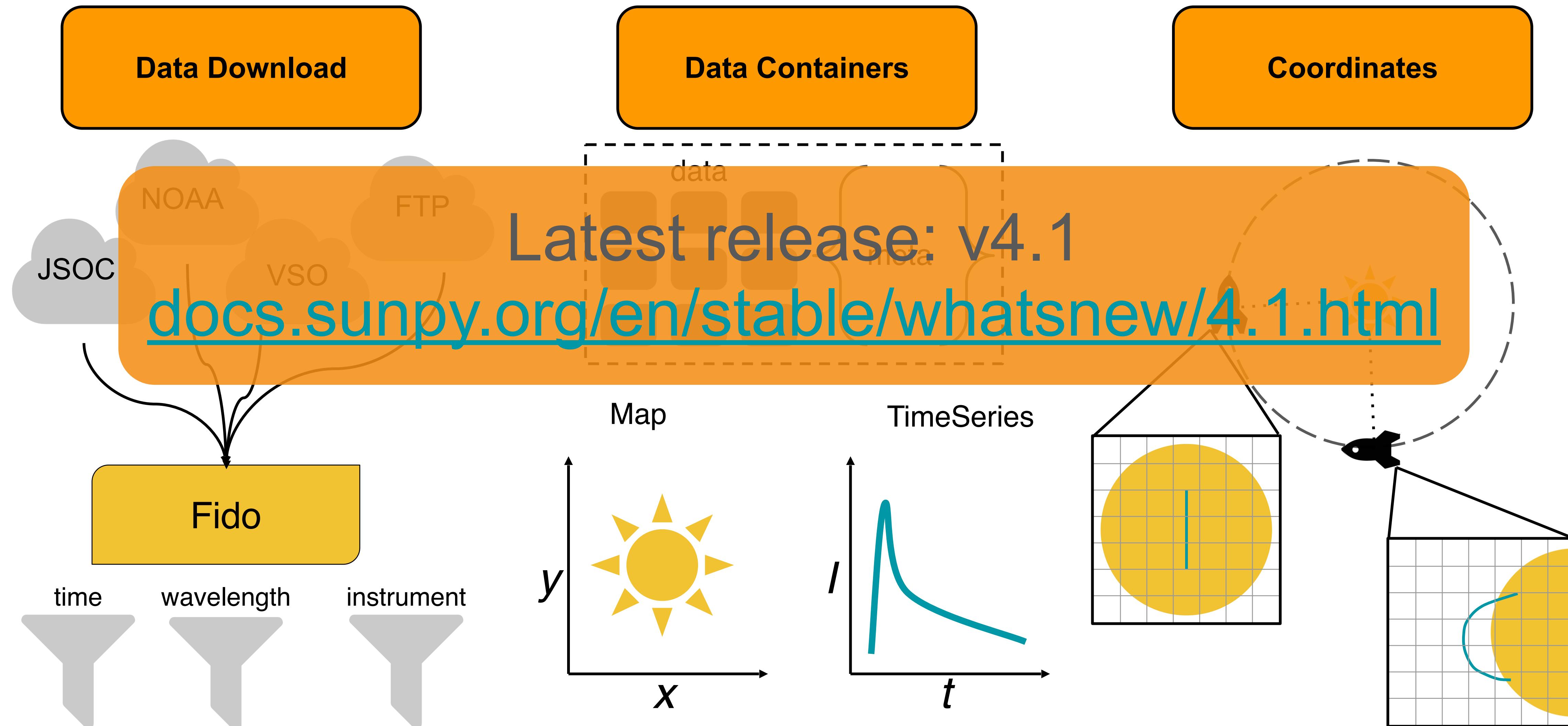
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# Present: Affiliated Packages



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ndcube



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ndcube

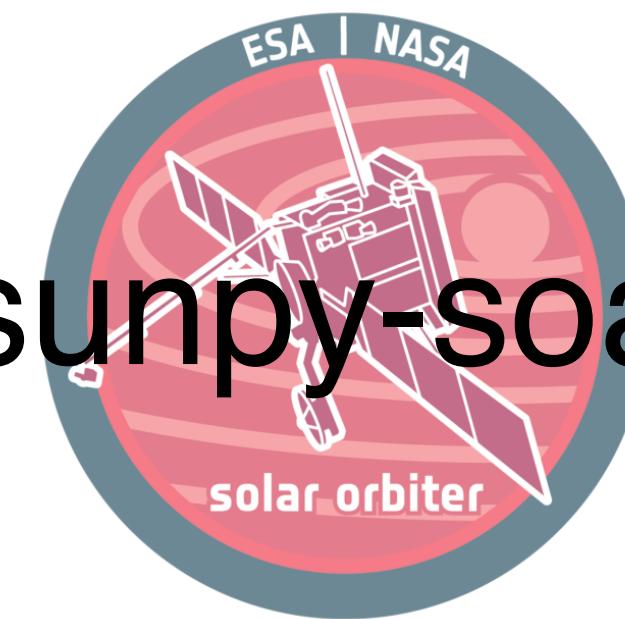


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ndcube



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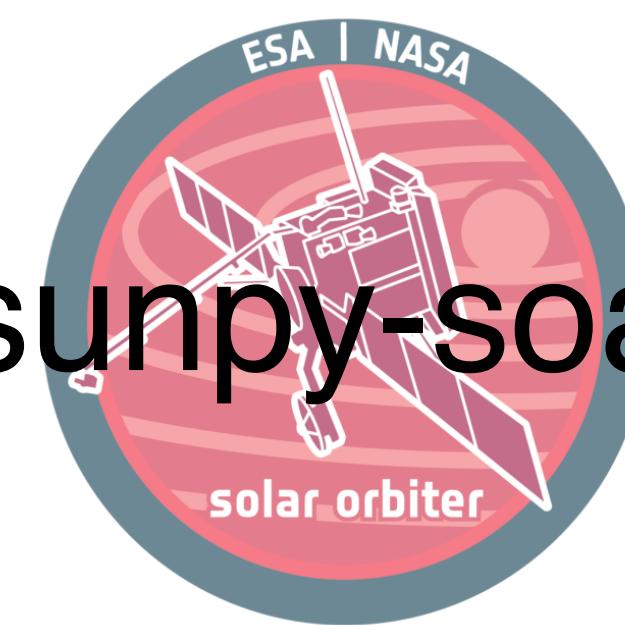


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ndcube



sunpy-soar



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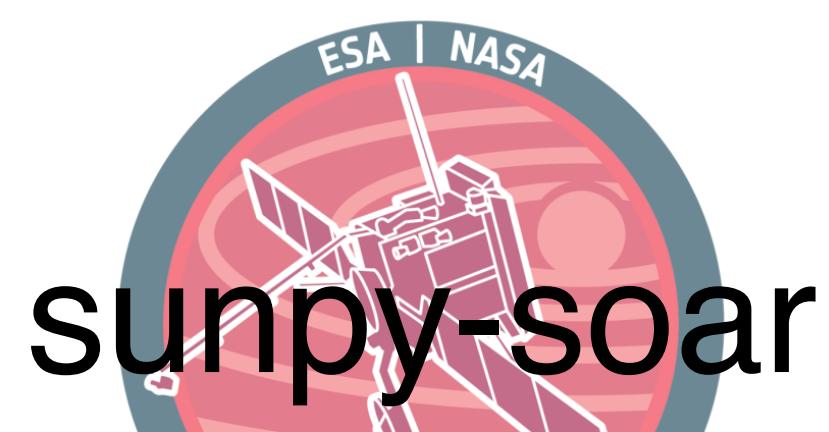


pfsspy



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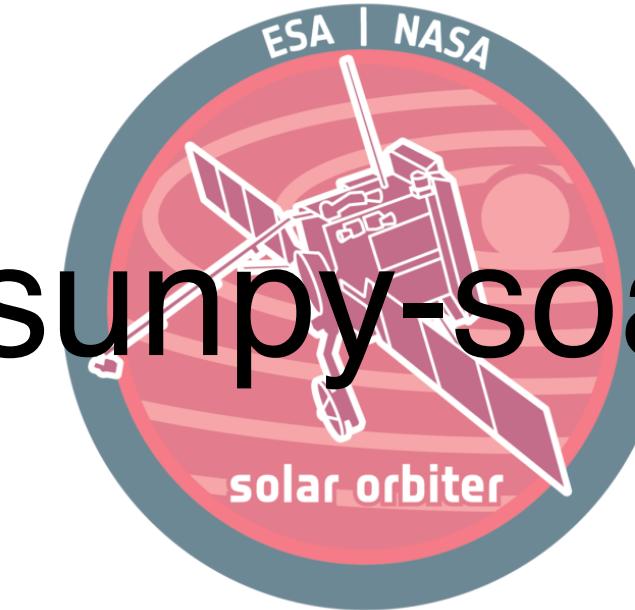


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ndcube



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sunkit-instruments



aiapy



sunkit-image



pfsspy

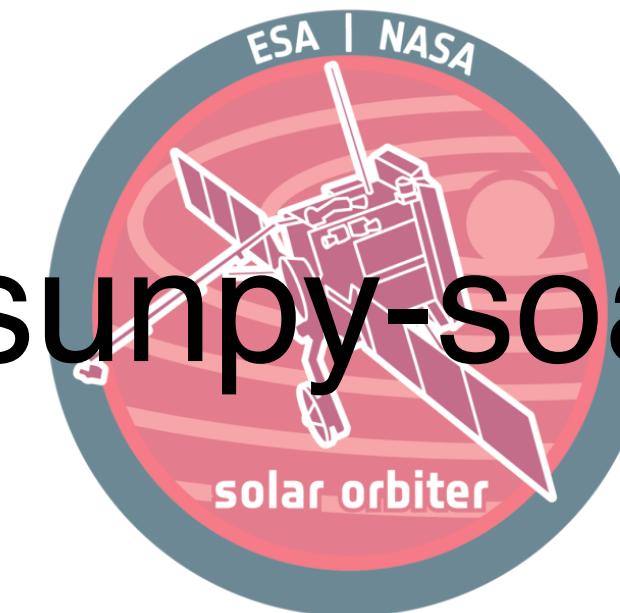


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ndcube



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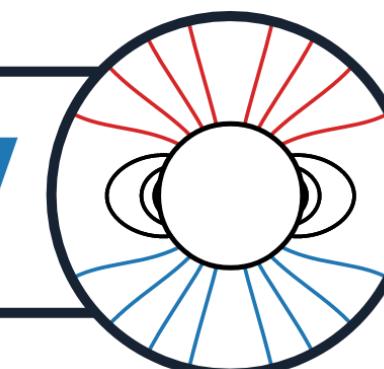
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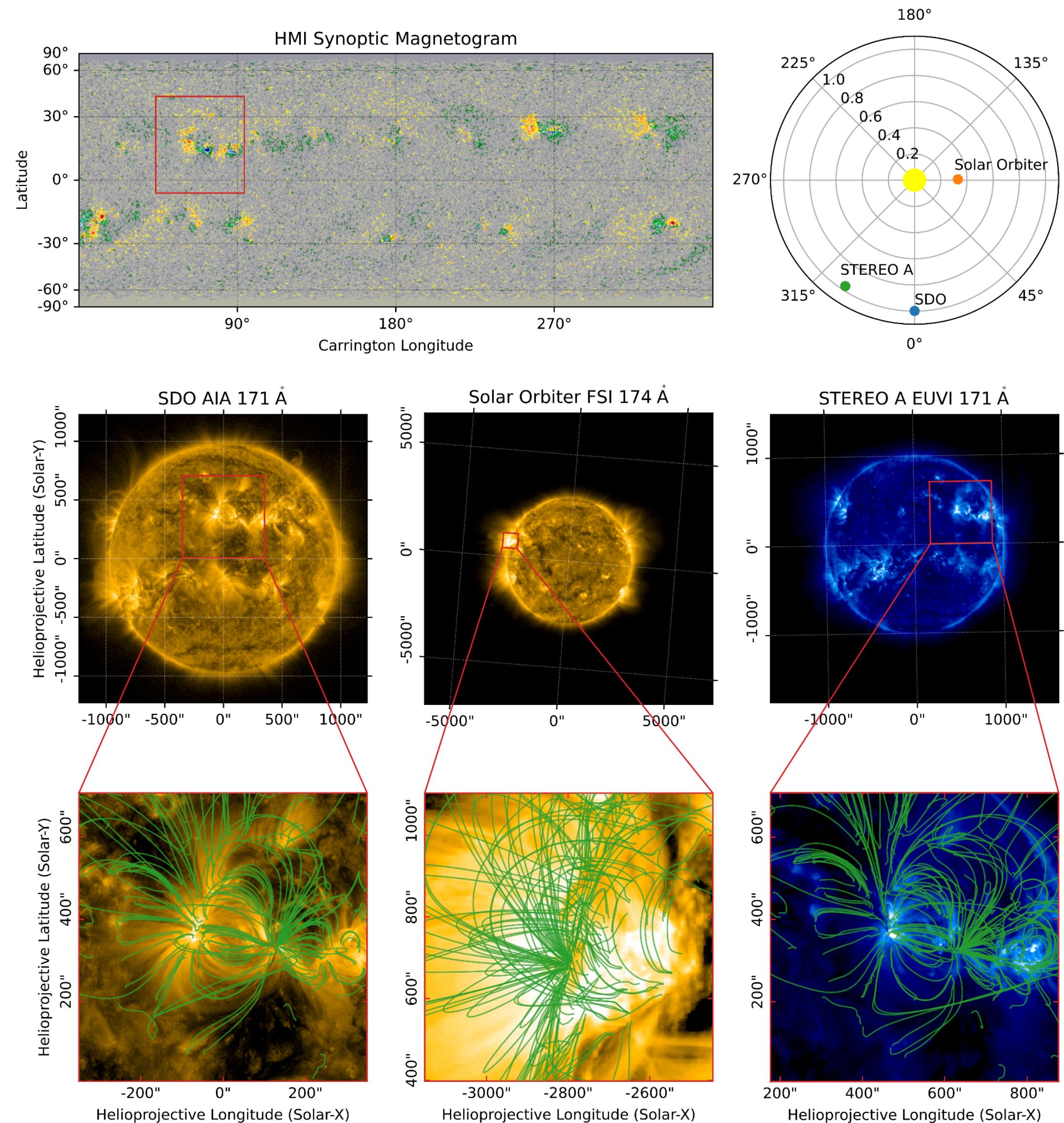
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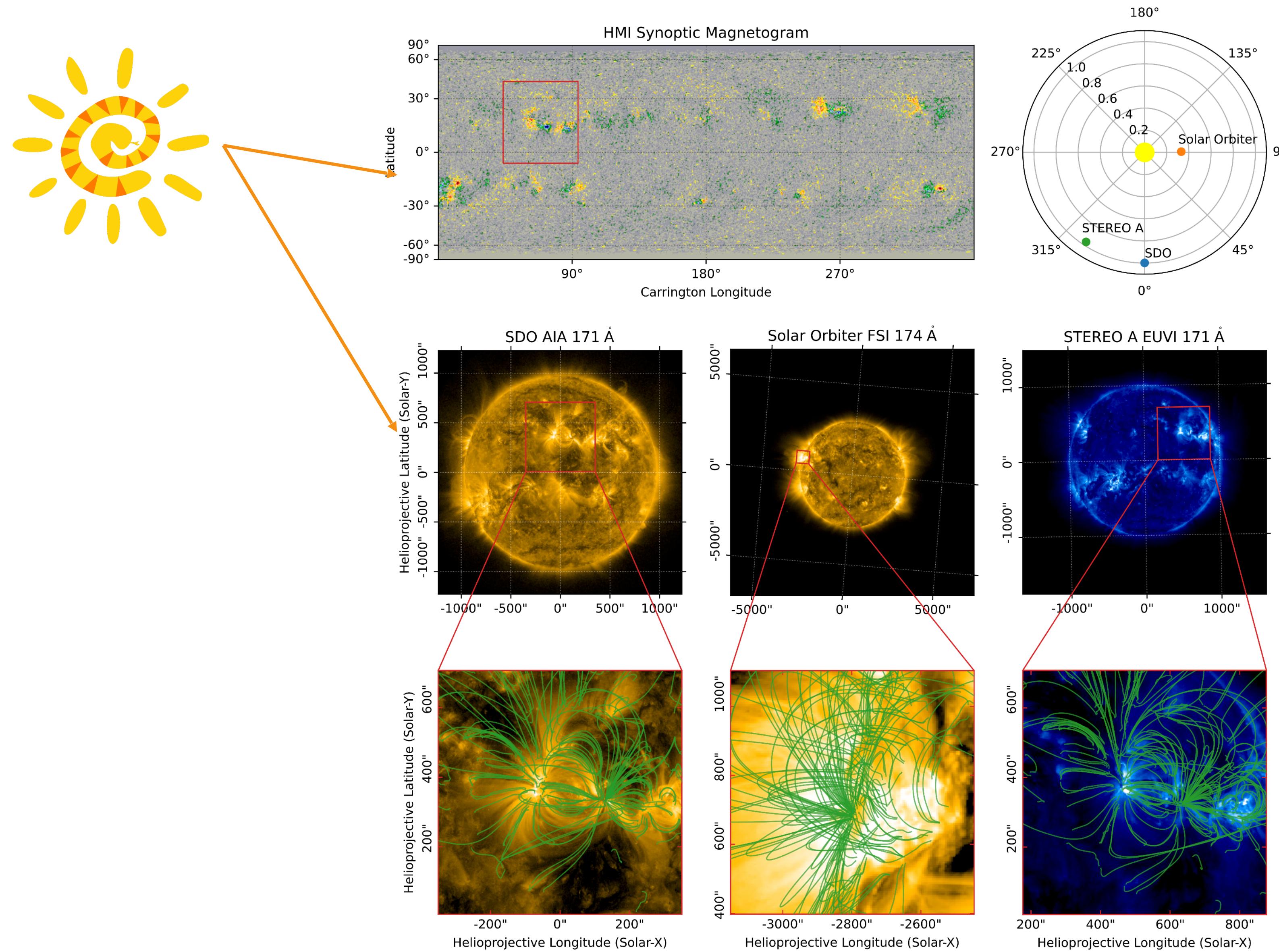
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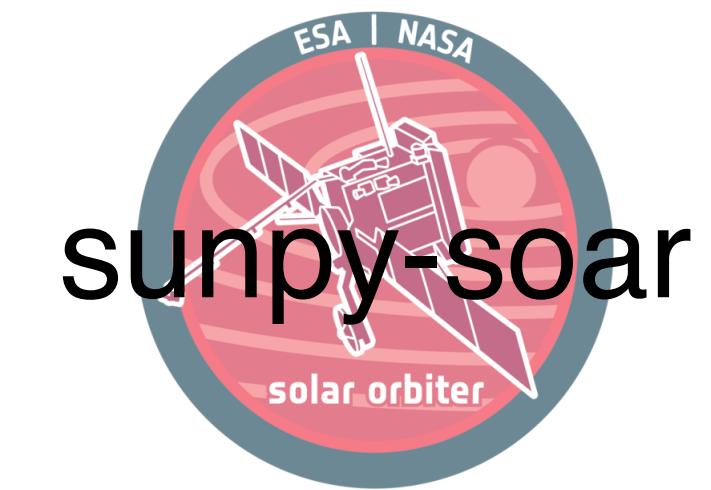
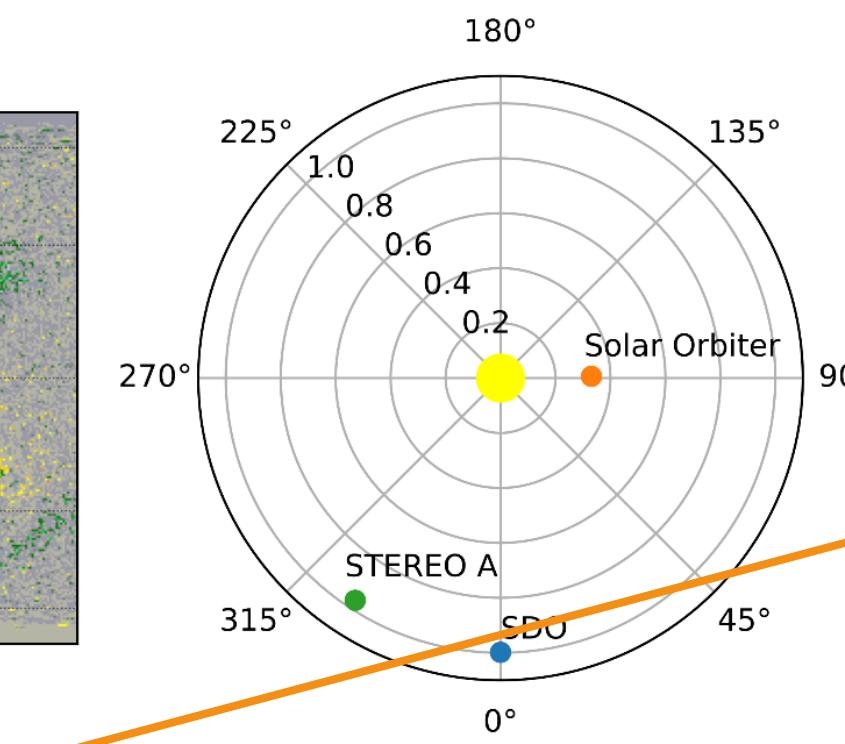
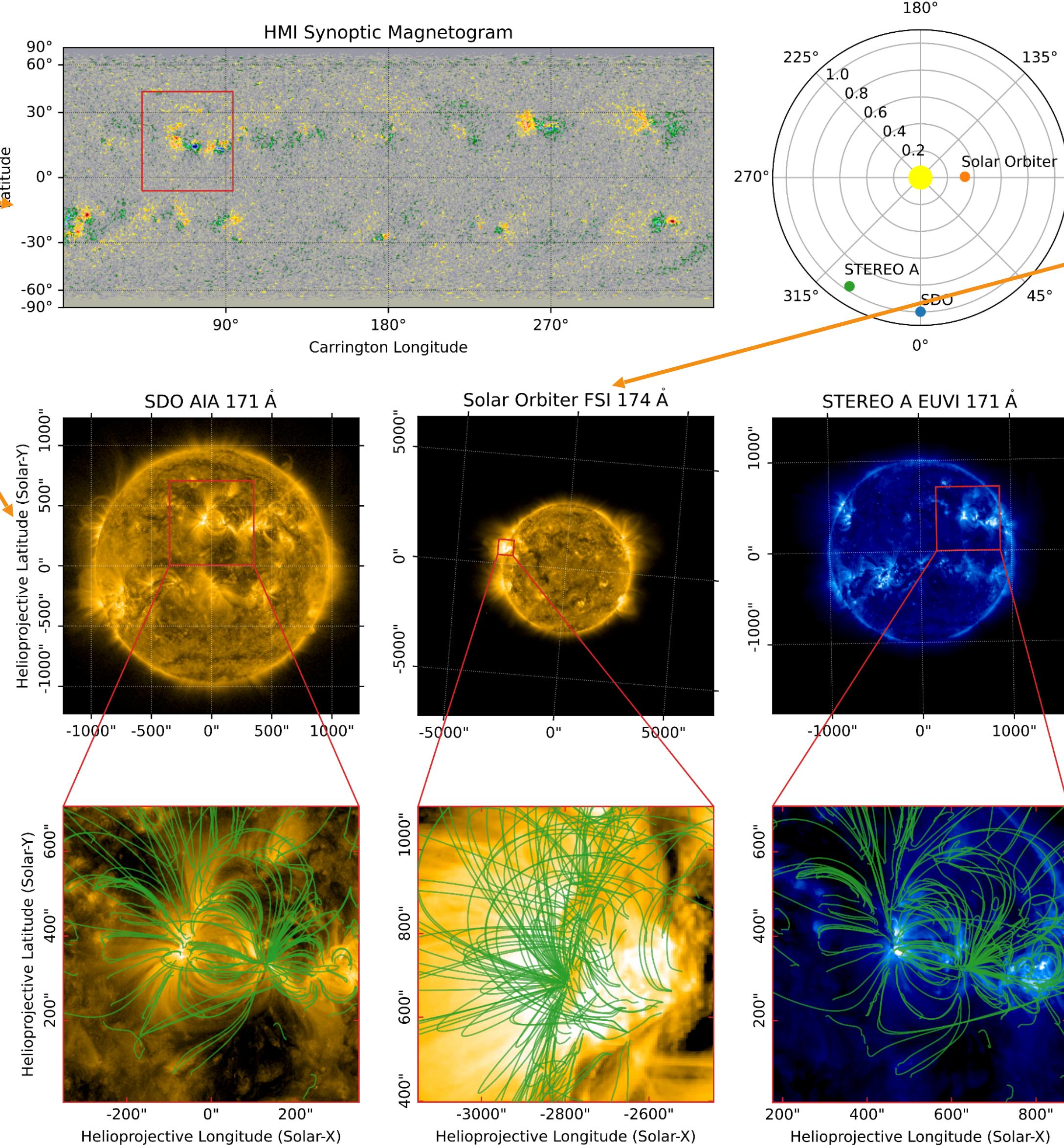
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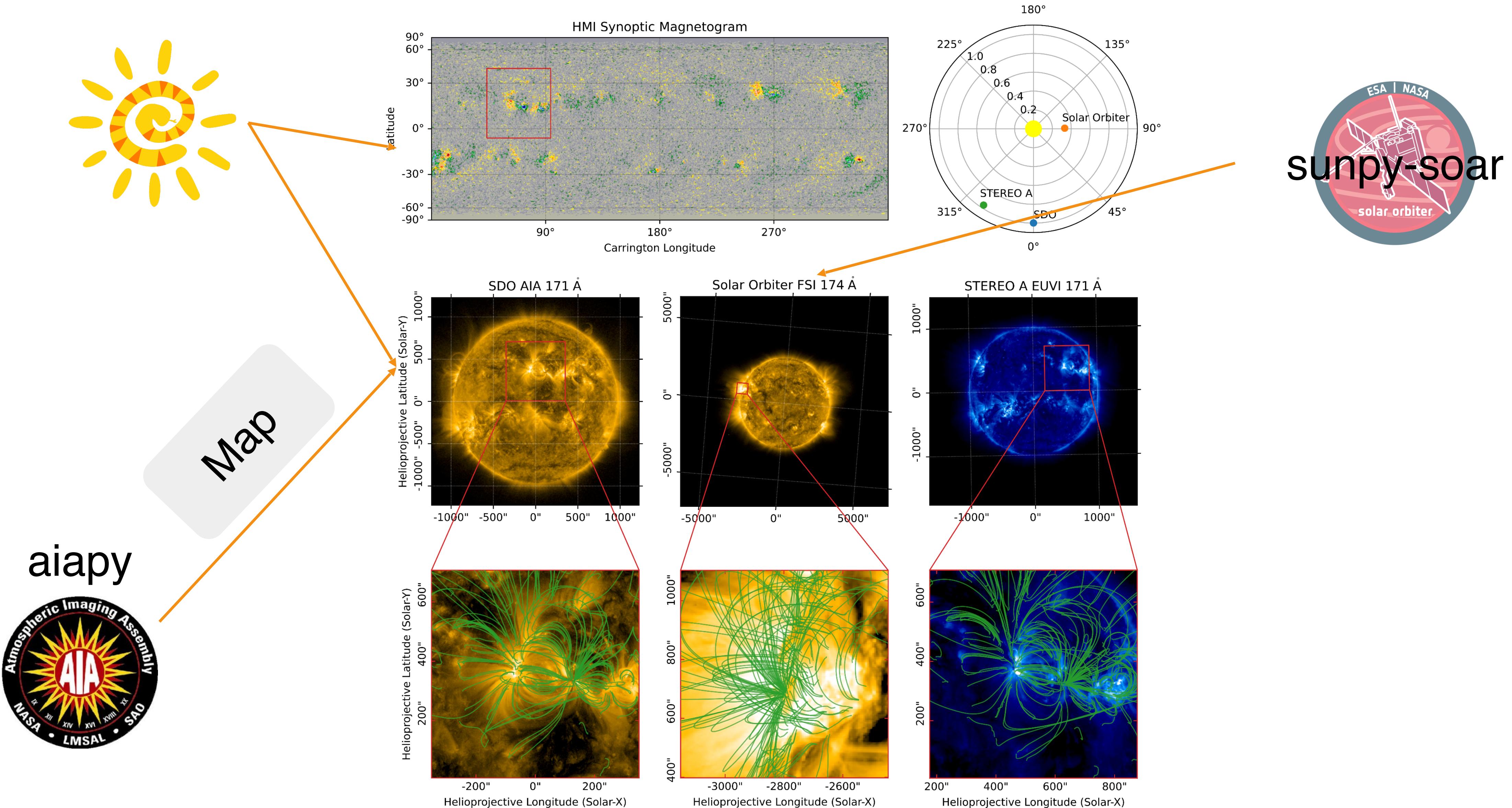
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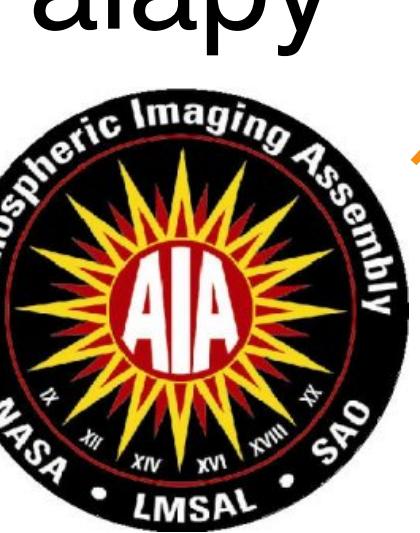
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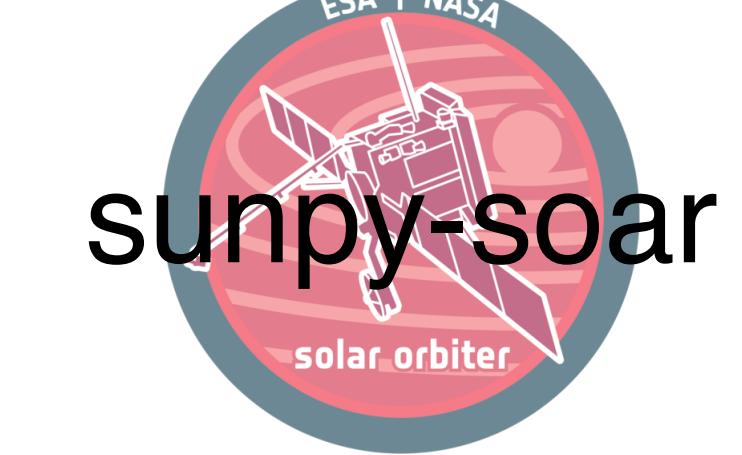
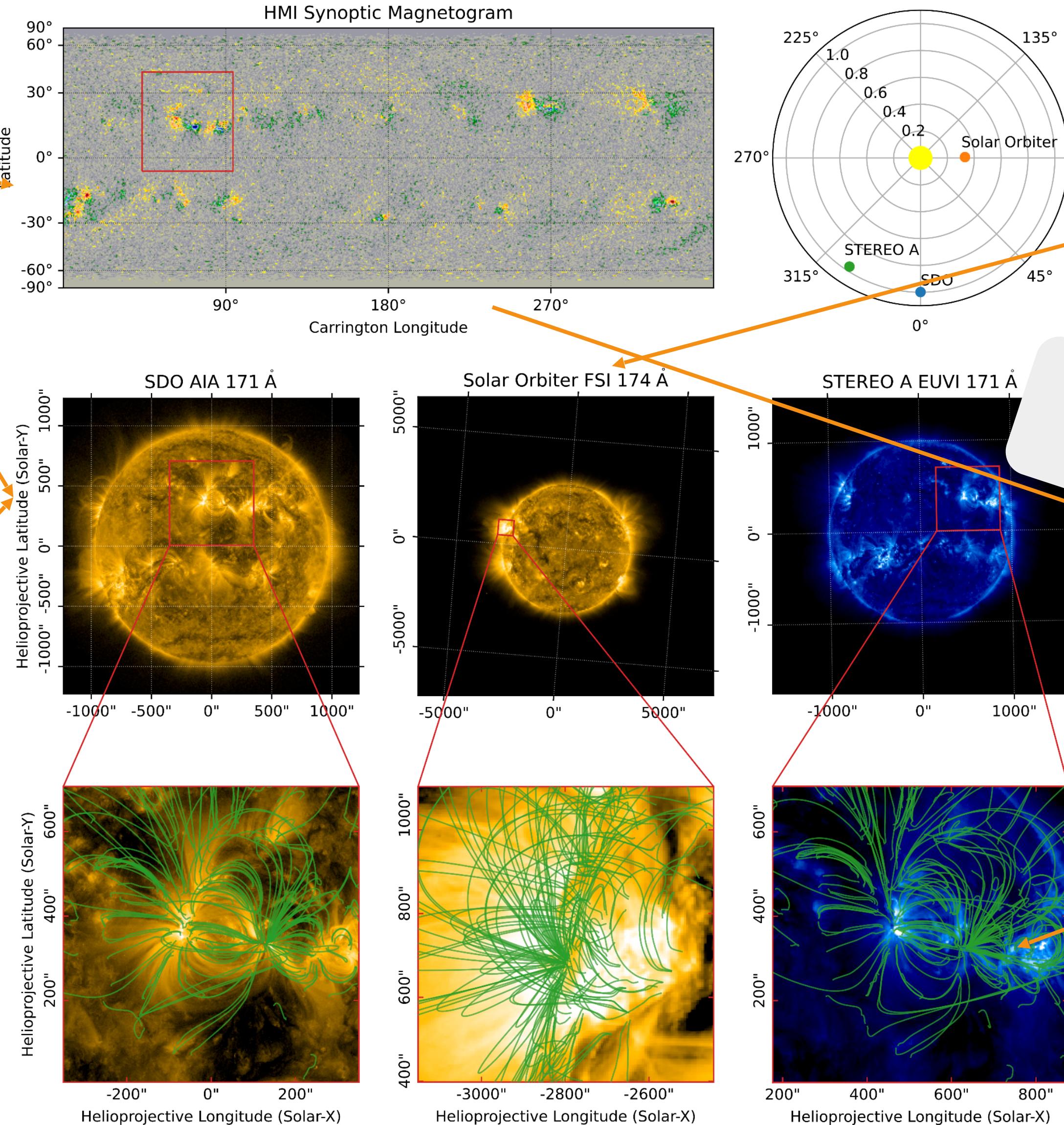
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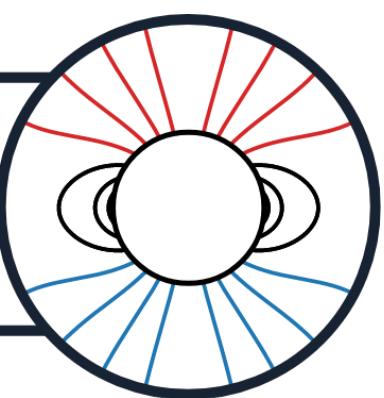


Map

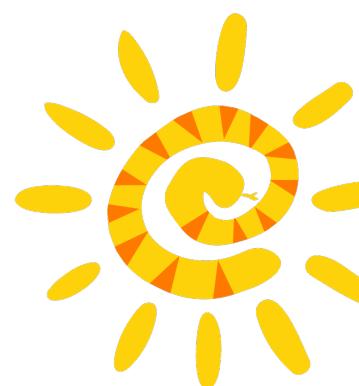


Map

pfsspy



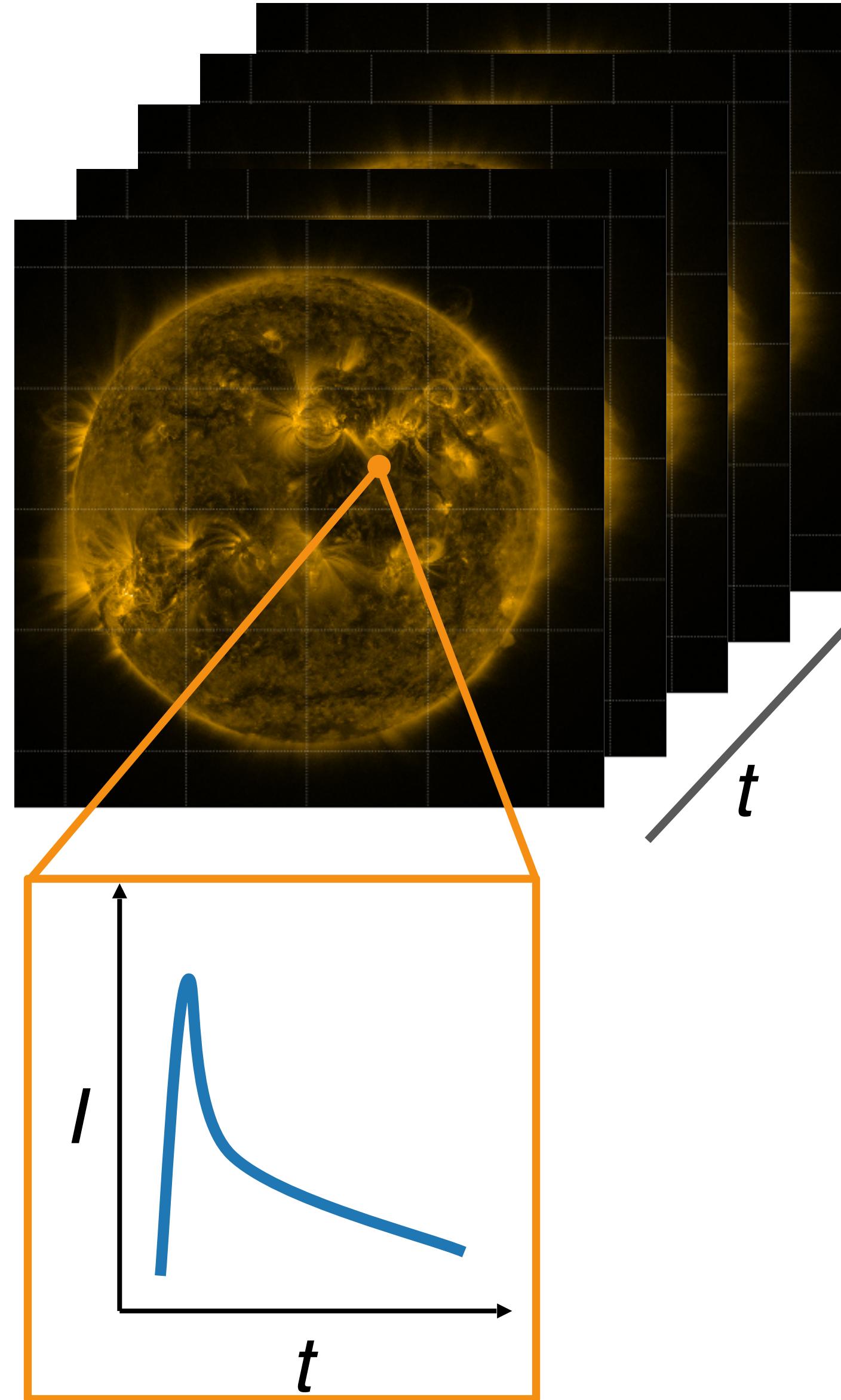
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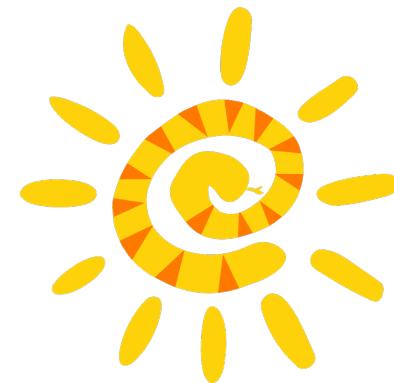
# Future: Multi-dimensional data



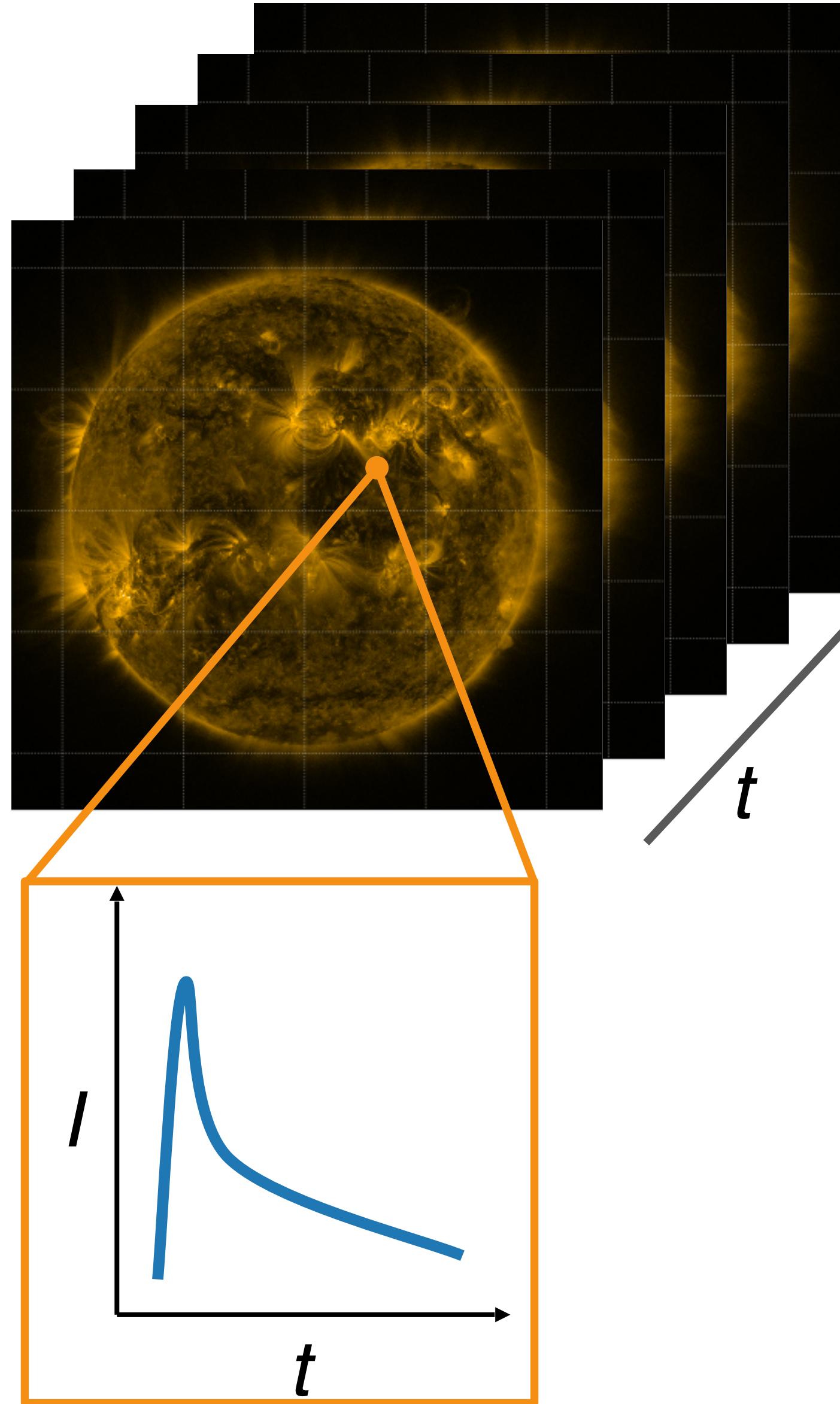
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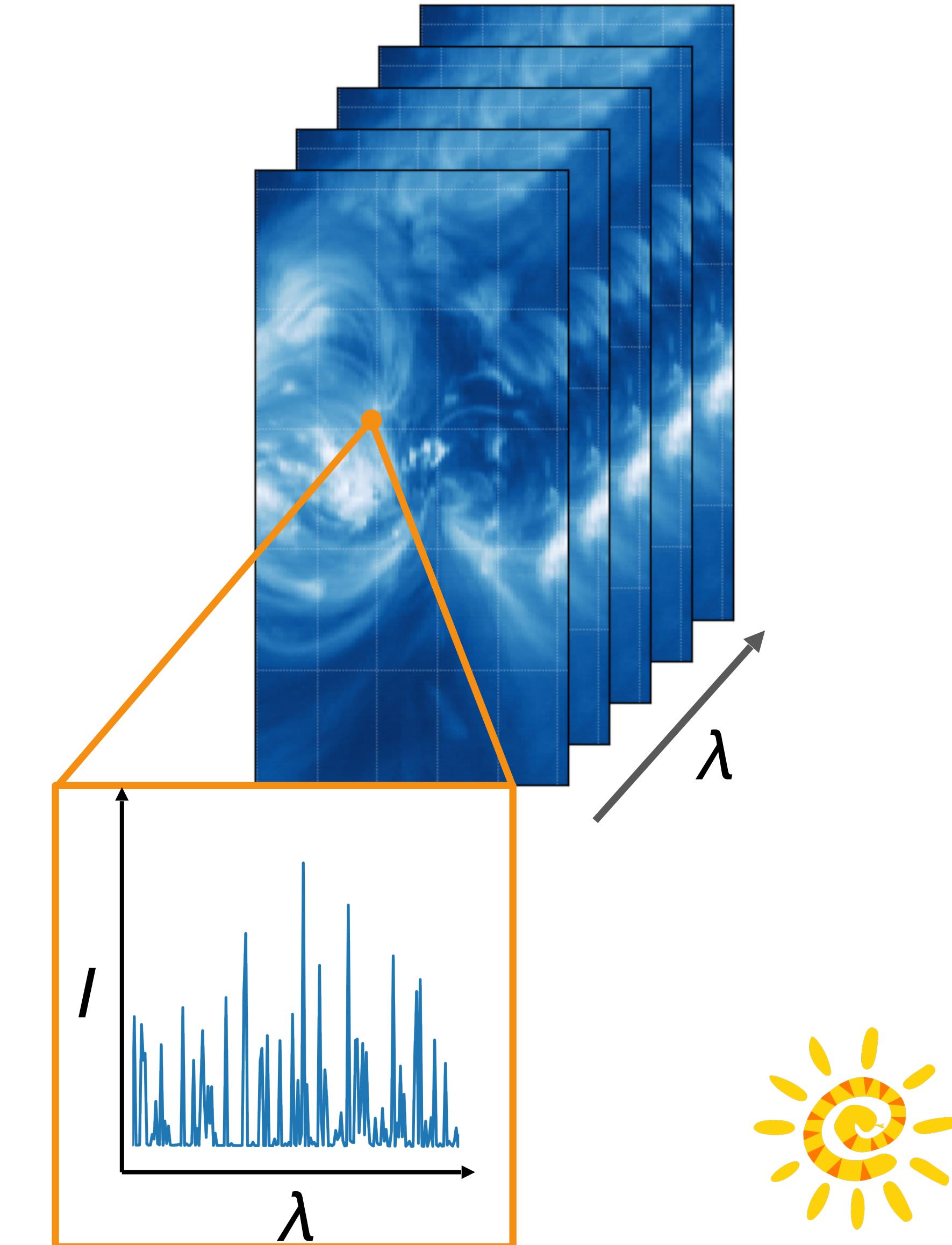
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- **Improved support for multi-  
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- Using ndcube, generalize Map  
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# Future: Multi-dimensional data



- Current limitation of Map: limited to two spatial dimensions
- **Improved support for multi-dimensional data**, including stacking images in time
- Using ndcube, generalize Map to  $> 2$  dimensions



- **Improved support for data with spectral coordinates** (e.g. EIS, IRIS)
- Current efforts in sunraster ([sunraster.readthedocs.io](https://sunraster.readthedocs.io))



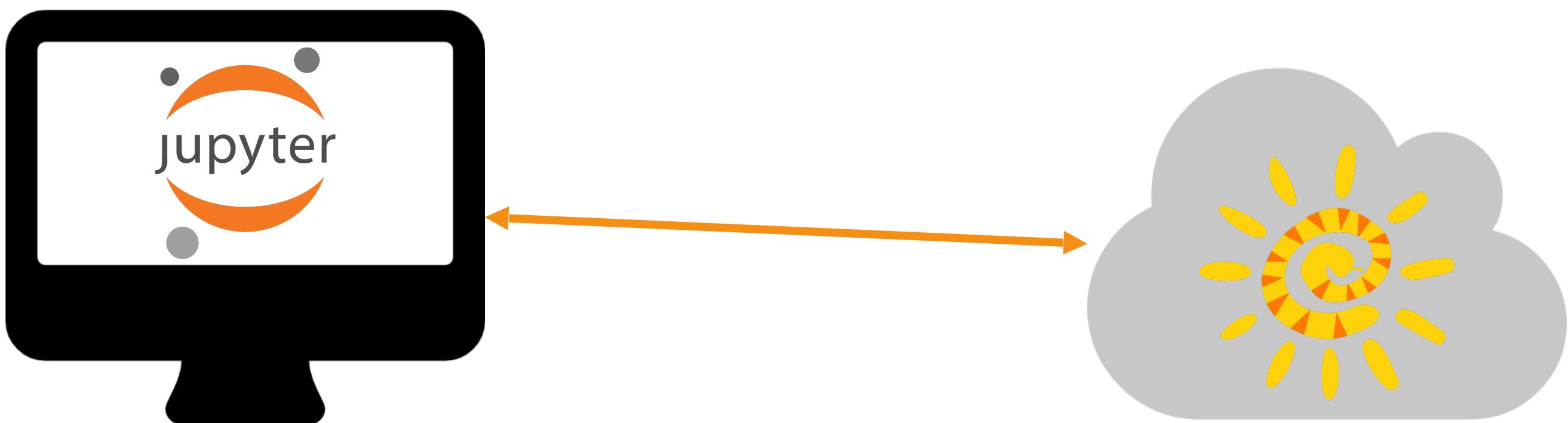
# Future: sunpy at scale

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- Dask helps to scale Python to many cores, nodes
- **Improve support for applying sunpy functionality at scale (e.g. cloud, HPC)**



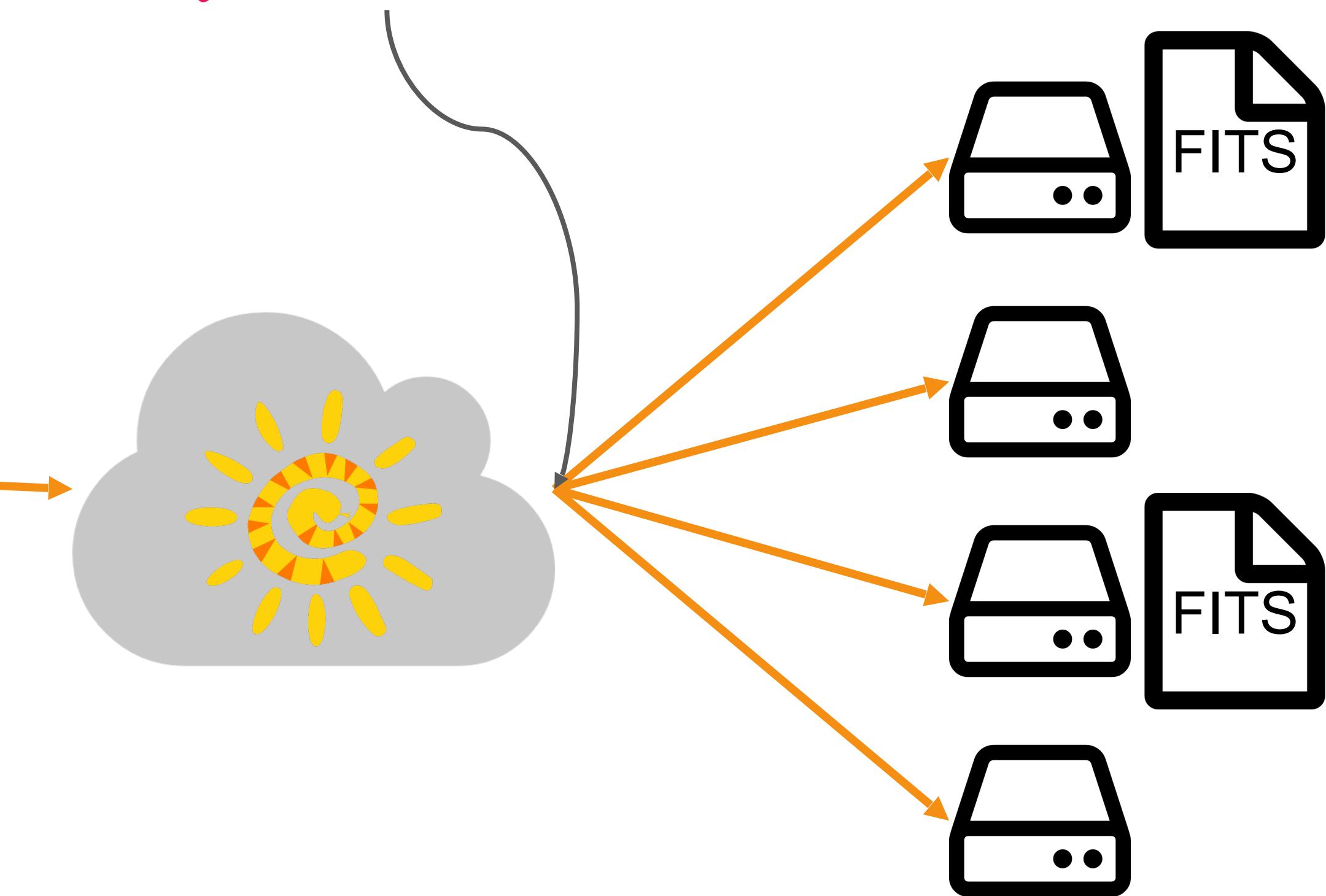
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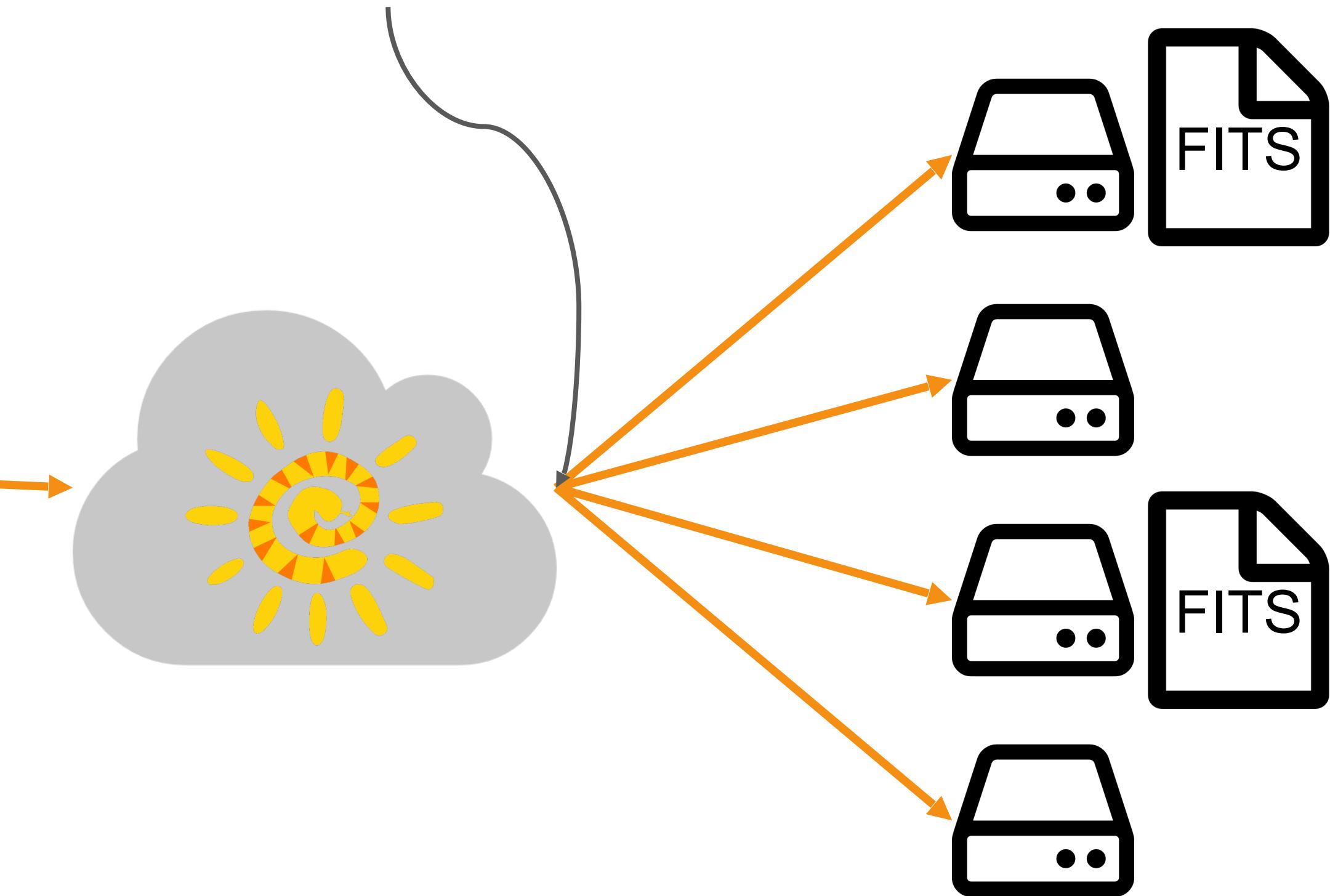
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\* Funding from NASA OSTFL



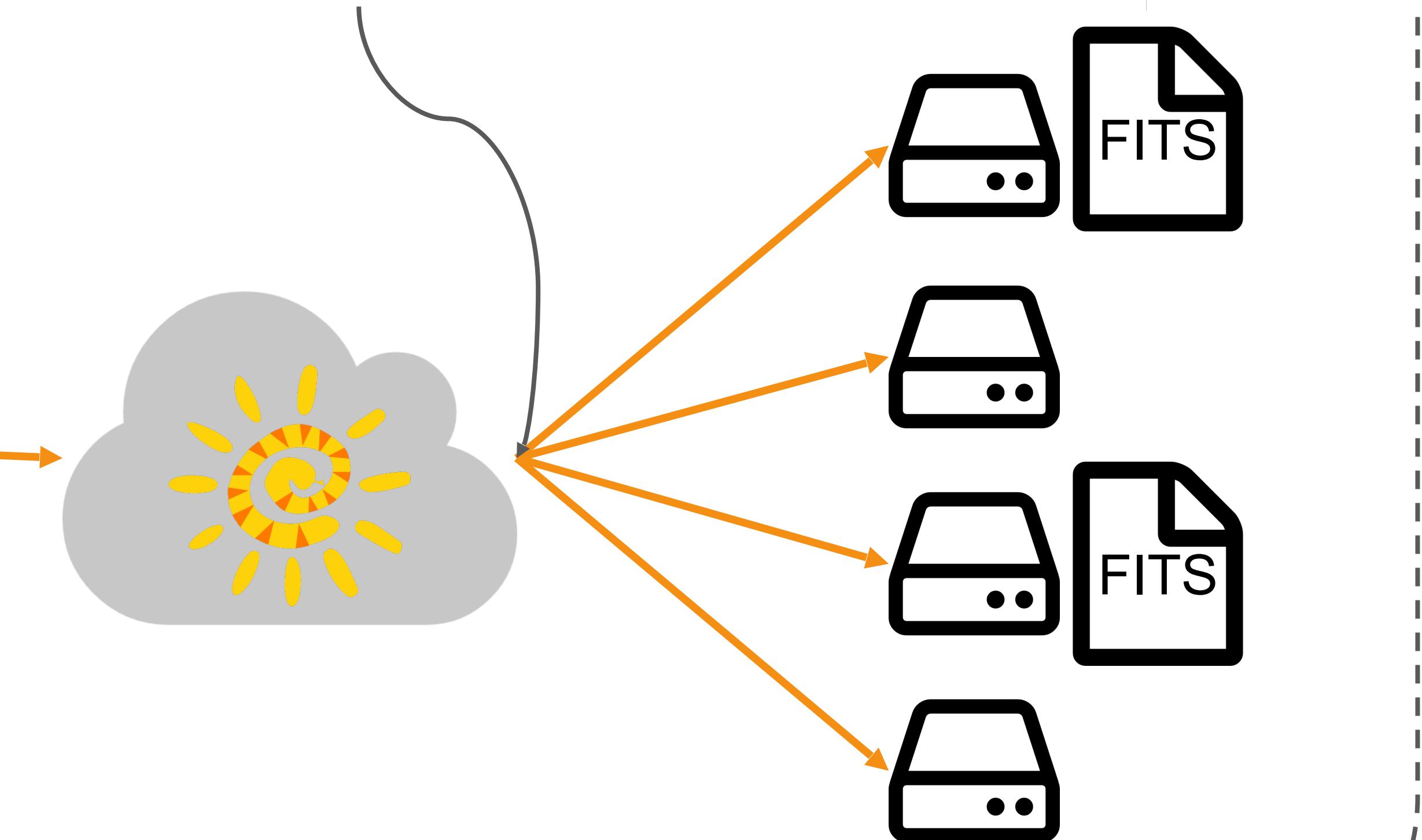
# Future: sunpy at scale

- Increasingly large data requires compute co-located with data
- Dask helps to scale Python to many cores, nodes
- **Improve support for applying sunpy functionality at scale (e.g. cloud, HPC)**



# dask

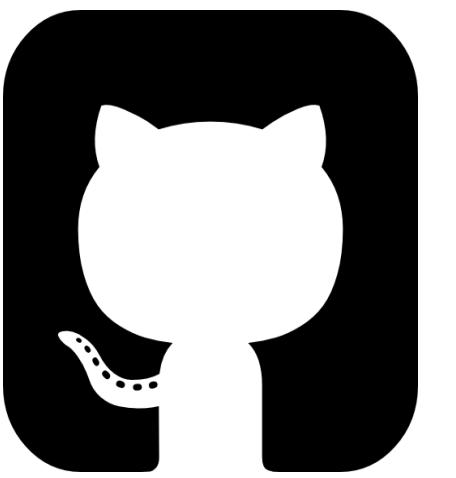
\* See talk by Sandy Antunes



\* Funding from NASA OSTFL



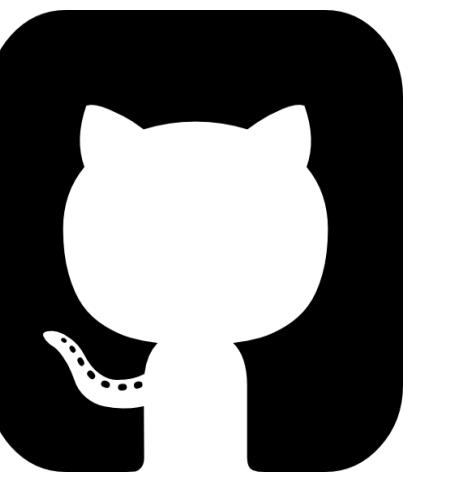
# Getting in Touch



[github.com/sunpy/sunpy](https://github.com/sunpy/sunpy)



# Getting in Touch



[github.com/sunpy/sunpy](https://github.com/sunpy/sunpy)

SunPy Python for Solar Physics - <https://sunpy.org> - +sunpy:openastronomy.org for other channels

09:28 samaloney ah ok

09:29 samaloney is there status page I should be checking or something?

09:30 emansky yes, the VSO FB page is one place, Alisdair may have others, I'll get him to post the status

09:32 samaloney ok great thanks, and good luck with making the DB happy again, they can be so needy

09:57 Cadair I don't really understand the warning

09:57 1 WARNING: SunpyUserWarning: VSO-C500 :soap:Server.Transport : 200 OK

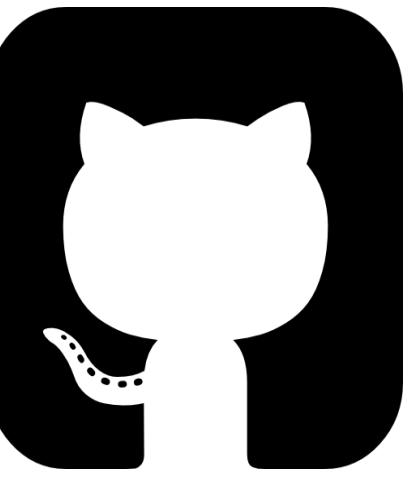
09:57 or at least that warning is somewhat useless

09:57 what's a VSO-C500?

10:04 emansky similar to HTTP status code 500 (Internal Server Error). Either a problem in the Perl script itself, or something the Perl script depends upon. If we're talking the AIA NRT, the DB is not running, so the query that's run by the Data Provider code for AIA NRT fails. And yes, the 500 isn't too specific or helpful. Part of the problem is getting the SOAP:Lite to bubble up a real error from the User code, thru the SOAP layer, to Apache.



# Getting in Touch

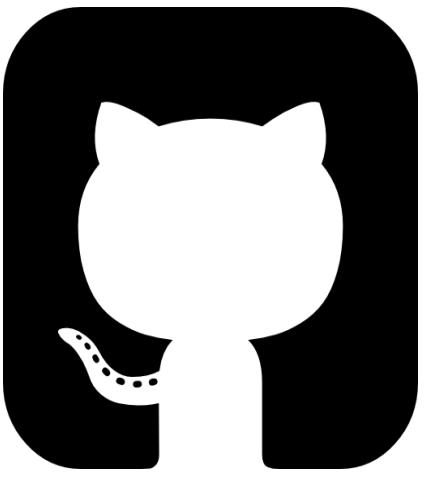


[github.com/sunpy/sunpy](https://github.com/sunpy/sunpy)

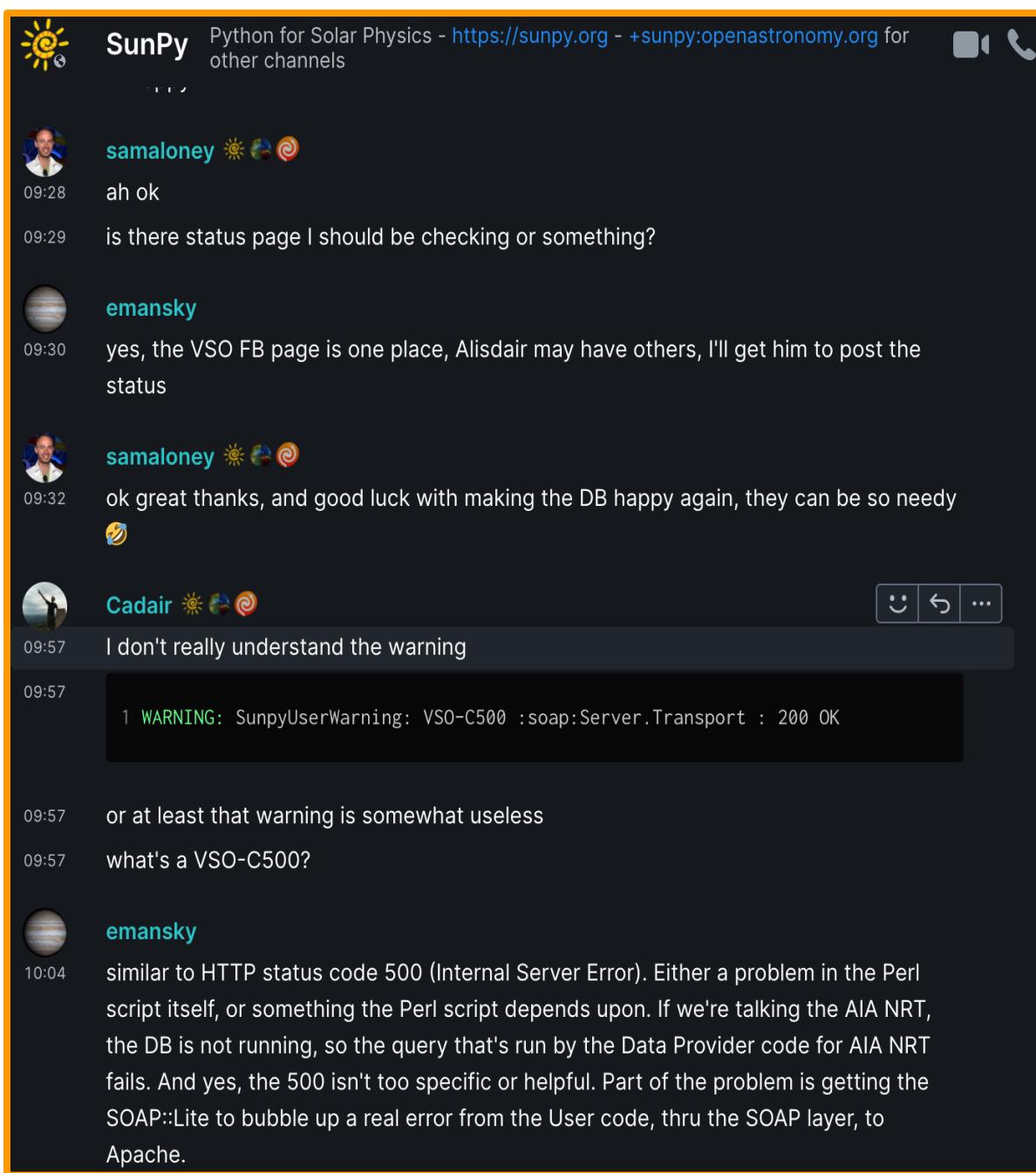
A screenshot of a Slack channel named "SunPy". The channel has a dark theme with light-colored text. A user named "samaloney" asks if there is a status page to check. Another user, "emansky", responds that the VSO FB page is one place, and they will get Alasdair to post the status. "samaloney" thanks "emansky" for great work. "Cadar" expresses confusion about a warning message. "emansky" explains that the warning is similar to an HTTP 500 error and provides context about the code flow from Perl scripts to Apache.

A screenshot of a forum topic page for the "SunPy" category on [community.openastronomy.org](https://community.openastronomy.org/c/sunpy/5). The page shows two posts: "SunPy core 3.0 Released" and "About the SunPy category". The first post is an announcement from the "Announcements" tag. The second post is a general category information post. The forum interface includes navigation buttons for "SunPy", "all", "all tags", "Latest", and "Top", as well as filters for "Replies", "Views", and "Activity".

# Getting in Touch

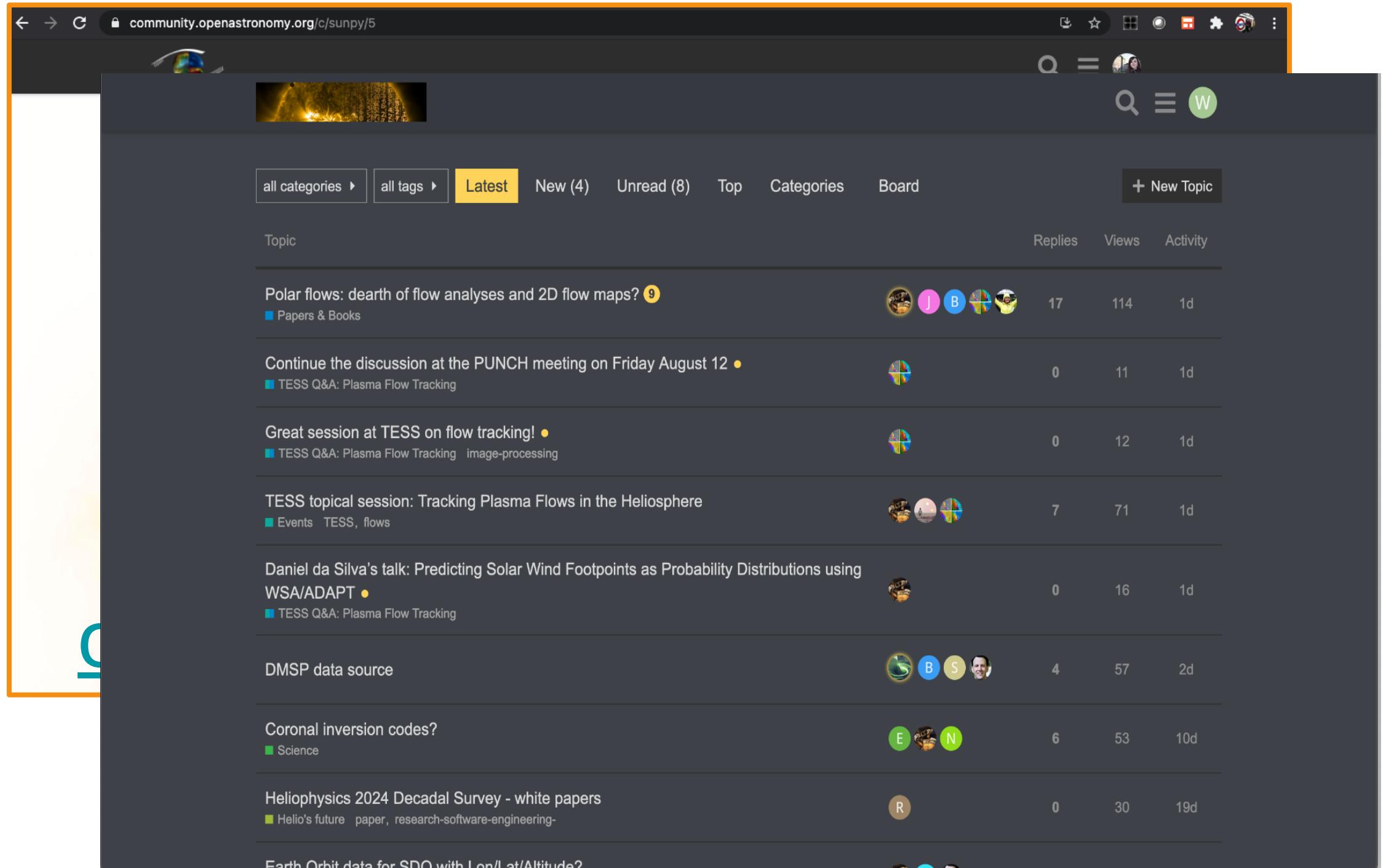


[github.com/sunpy/sunpy](https://github.com/sunpy/sunpy)



A screenshot of a SunPy Slack channel. The channel name is "SunPy". It shows a message from "samaloney" at 09:28 asking if there's a status page to check. "emansky" replies at 09:29 that the VSO FB page is one place, and Alisdair will post the status. "samaloney" thanks "emansky" at 09:32. "Cadar" at 09:57 asks for help understanding a warning message. "emansky" provides a detailed explanation of the warning at 10:04, mentioning it's similar to an HTTP 500 error and involves Perl scripts and Apache.

```
09:28 samaloney ah ok
09:29 samaloney is there status page I should be checking or something?
09:30 emansky yes, the VSO FB page is one place, Alisdair may have others, I'll get him to post the status
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```

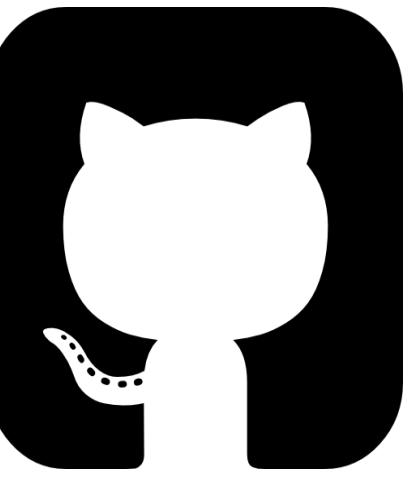


A screenshot of the OpenAstronomy forum. The URL is "community.openastronomy.org/c/sunpy/5". The "Latest" tab is selected. The first post is about polar flows and 2D flow maps, with 17 replies and 114 views. The second post is about continuing the discussion at the PUNCH meeting on Friday August 12, with 0 replies and 11 views. The third post is about a great session at TESS on flow tracking, with 0 replies and 12 views. The fourth post is about a TESS topical session on plasma flows in the heliosphere, with 7 replies and 71 views. The fifth post is about Daniel da Silva's talk on predicting solar wind footprints, with 0 replies and 16 views. The sixth post is about the DMSP data source, with 4 replies and 57 views. The seventh post is about coronal inversion codes, with 6 replies and 53 views. The eighth post is about heliophysics 2024 decadal survey white papers, with 0 replies and 30 views. The ninth post is about Earth Orbit data for SDO with Lon/Lat/Altitude, with 0 replies and 40 views.

Topic	Replies	Views	Activity
Polar flows: dearth of flow analyses and 2D flow maps?	17	114	1d
Continue the discussion at the PUNCH meeting on Friday August 12	0	11	1d
Great session at TESS on flow tracking!	0	12	1d
TESS topical session: Tracking Plasma Flows in the Heliosphere	7	71	1d
Daniel da Silva's talk: Predicting Solar Wind Footpoints as Probability Distributions using WSA/ADAPT	0	16	1d
DMSP data source	4	57	2d
Coronal inversion codes?	6	53	10d
Heliophysics 2024 Decadal Survey - white papers	0	30	19d
Earth Orbit data for SDO with Lon/Lat/Altitude?	0	40	40d



# Getting in Touch



github.com/sunpy/sunpy

Slack channel screenshot showing a conversation between users samaloney, emansky, and Cadair. The messages discuss a VSO-C500 error, its meaning, and the status page.

09:28 samaloney ah ok  
09:29 samaloney is there status page I should be checking or something?  
09:30 emansky yes, the VSO FB page is one place, Alisdair may have others, I'll get him to post the status  
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Forum screenshot showing several topics related to plasma flow tracking and solar physics research.

- Polar flows: dearth of flow analyses and 2D flow maps? (9 replies, 114 views, 1d ago)
- Continue the discussion at the PUNCH meeting on Friday August 12 (0 replies, 11 views, 1d ago)
- Great session at TESS on flow tracking! (0 replies, 12 views, 1d ago)
- TESS topical session: Tracking Plasma Flows in the Heliosphere (7 replies, 71 views, 1d ago)
- Daniel da Silva's talk: Predicting Solar Wind Footpoints as Probability Distributions using WSA/ADAPT (0 replies, 16 views, 1d ago)
- DMSP data source
- Coronal inversion codes? (6 replies, 53 views, 10d ago)
- Heliosphere 2024 Decadal Survey - white papers (0 replies, 30 views, 19d ago)
- Earth Orbit data for SDO with Lon/Lat/Altitude?

element.io group screenshot for SunPy, showing recent messages and an announcement about version 3.0.

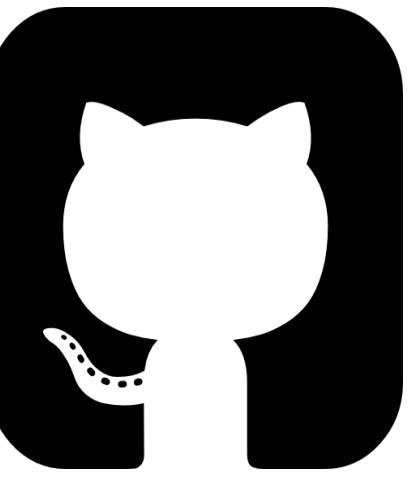
★ SunPy 381 members

Welcome to SunPy, a home to discussions about exploring how to use python for solar data analysis. Code generated by this group is available at GitHub. Join us on IRC at #sunpy on element.io.

richard...@gmail.co..., ... Russell Hewett 5 Creating new map sub-classes — Hi Richard, The Map factory is a bit magic. All you need to do is import the map module and d... May 28 ☆  
tanso...@gmail.... , ... nabil...@gmail.... 7 A question about "Retrieving and analyzing GOES X-Ray Sensor (XRS) data" — Thanks a lot! You help is very useful! 在2021... May 26 ☆  
tanso...@gmail.co..., nabil...@gmail.co... 3 Can SunPy completely replace IDL in the research of solar observation? — Thanks a lot! 在2021年5月25日星期二 UTC+8 下午4:... May 25 ☆  
divyam...@gmail.c..., will.t...@gmail.c... 3 Query regarding the code for deriving temperature of solar plasma using sunpy — Okay. Thank you so much! On Thu, 20 May 2... May 20 ☆  
stu...@cadair.com SunPy core 3.0 Released — The SunPy project is happy to announce version 3.0 of the core package has been released. SunPy's May 14 ☆  
mnana...@gmail.... , ... ays...@gmail.... 15 Sunpy offline mode working — Hi, Anand, > If this is the issue with outdated astropy, then, once I create the Exe file and May 7 ☆



# Getting in Touch



github.com/sunpy/sunpy

A screenshot of a GitHub repository page for SunPy. On the left, there's a dark sidebar with user profiles and a message input field. The main area shows a list of commits and pull requests. A large orange callout bubble points from the center of the image towards the GitHub interface.

[sunpy.org/help](http://sunpy.org/help)

A screenshot of a forum thread on the SunPy help forum. The thread has several posts from users like samaloney, emansky, and Cadair. The posts discuss various topics such as status pages, DB issues, and warning messages. An orange callout bubble points from the center of the image towards the forum interface.

A screenshot of the SunPy group on element.io. It shows a list of members and a feed of messages. One message from Richard Hewett discusses map sub-classes. Another from Russell Hewett announces the release of SunPy version 3.0. An orange callout bubble points from the center of the image towards the element.io interface.

