

Paulo F Penteado

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Summary

I have a PhD and over 20 years experience working at the intersection of science and engineering. I have worked across the spectrum of mission lifecycle, from trade studies and orbit / targeting optimization to operations and data processing pipelines, applied to remote sensing from radio to the UV, including multi- and hyperspectral imagers, SAR and radiometers. I am often brought into a mission to provide software engineering guided by my expertise in data science, astronomy, astrodynamics, and remote sensing, including geometric and radiometric processing and physics-based modeling, such as atmospheric and radiative transfer models.

Key Skills

Instrument planning and data processing, archiving, exploration, mining, visualization and analysis

22 years experience developing algorithms to find what is interesting in existing datasets, process and visualize them. This includes:

- Orbital dynamics applied to observation geometry processing, including complex cases of observation planning optimization (ex: MAIA) and with observer flying through the observed structures (ex: WISPR, SoloHI). Expert in NAIF's SPICE.
- Development, implementation, deployment, and operation of automated pipelines to generate and deliver remote sensing products (AIRS, Parker Solar Probe, STEREO, SMAP, ESCDS, Cassini VIMS), for distribution to scientists, stakeholders, and the public, including through NASA's [Worldview](#), [GIBS](#), and [Eyes on Earth](#).
- Algorithm development in research environments to create and test algorithms and strategies.
- Transition to production environments, needing systematic automated parallelized execution, to enable use of the entire set of available data - both real time streams as observations get downlinked, and entire archives since the beginning of mission.
- Radiative transfer modeling of remote sensing observations, including to derive physical methane abundances. Expert in MODTRAN and Discrete Ordinate algorithms.

Astronomy, Planetary, Earth and Solar Remote Sensing

Since graduate and postdoc research: Planning, acquisition, mining and analysis of astronomical and remote sensing observations: images, spectra and hyperspectral imaging. Experience with planning and acquisition of observations from Keck, Hubble Space Telescope and Cassini, mining Virtual Observatory resources and developing algorithms and databases to handle observations.

Programming:

- Developed projects using IDL, Python, Fortran, MATLAB, C, C++, SQL, Java, Git, Subversion, JIRA, NAIF SPICE, SEXtractor, Astrometry.net, GeoPandas, GDAL, xESMF, rioarray, dask, scikit-image, Polars, scikit-learn, PyTorch, OpenCV, MODTRAN, HITRAN, DISORT, AWS EC2 and Lambda, Docker, CUDA, OpenMP, MPI, Cesium, handling a variety of file formats for ingestion and delivery, including netCDF, HDF, HDF-EOS, shapefile, GeoTIFF, GeoJSON, GeoCSV, KMZ, VICAR, FITS, WMTS, xlsx, and custom proprietary formats.
- Development of pipelines for automated bulk data processing, including parallelized execution and self-contained tool packages for other users to deploy on their environments.

- Expert in IDL, including collaboration the testing and definition of new language features and reviewed books. Curator of the [IDL Coyote](#) website and library, including an archive of the [comp.lang.idl-pvwave](#) newsgroup.
- Always interested in and quick to learn new tools and practices to develop better software solutions. In person training: SPICE (NAIF), MODTRAN (SSI). Online (Coursera): Software Architecture for Big Data, Satellite Formation Relative Orbits (U Colorado Boulder); MLOps (Duke), GIS (UC Davis); ML (Stanford).

Professional Experience

Jet Propulsion Laboratory Science Data and Instrument Visualization Pasadena
(398I)

Geospatial Data Processing and Visualization Developer 2016 – current

- Development of new algorithms and new implementations for [Plume Tracker](#), a tool for both GUI-interactive and pipeline-automated atmospheric retrievals (such as human-made methane and volcanic SO₂ plumes) from radiative transfer modeling of remote sensing observations, both airborne (HyTES) and satellite-based (ASTER, MODIS, VIIRS, AIRS).
- Development and maintenance of the pipeline to create all L2 AIRS products delivered for public access through [Worldview](#), [GIBS](#), including reducing the whole-mission processing time from a year to 3 days.
- Developed the visualizations of the [AIRS volcano monitoring tool](#).
- Creation of new visualizations of AIRS Near-Real-Time data of transient phenomena.
- Maintenance and operation of pipelines for automated generation of products for SMAP and several instrument streams for [Eyes on Earth](#) (AIRS, SMAP, Jason, OCO-2, GRACE-FO, MLS, OMI, GPM).
- Developed software for trade studies, science planning, image simulation and operations for the Multi-Angle Imager for Aerosols (MAIA).
- Developed algorithms and their parallelized implementation for radiometric and geometric mapping, visualization and analysis of solar observations taken by Parker Solar Probe (WISPR) and Solar Orbiter (SoloHI), including automated product generation, published through the [SolarSoft](#) library.
- Software development and data product generation for localization of Mars Exploration Rovers (Spirit and Opportunity) observations.
- Worked in the team developing [OMINAS](#), a versatile toolkit to generate visualization products for Cassini and other planetary imaging missions.
- Development of an online-accessible version of [titanbrowse](#), a geospatial database for hyperspectral observations with integrated visualization tools, which led to the [first discovery of tropical lakes on Titan](#), and [detection of exposed ice-rich bedrock](#), which went unnoticed on data that had been archived and examined for years prior.

Northern Arizona University Department of Physics and Astronomy Flagstaff
Postdoctoral researcher 2013 – 2015

Universidade de São Paulo Departamento de Astronomia São Paulo
Postdoctoral researcher 2008 – 2013

Education

University of Arizona Ph.D. in Planetary Sciences <i>Thesis title: "Study of Titan's methane cycle"</i>	Tucson 2003 – 2008
Observatório Nacional M.Sc. in Astronomy <i>Thesis title: "Study of the angular momentum after the fragmentation of a rubble-pile asteroid"</i>	Brazil 2002 – 2003
Universidade Federal do Rio de Janeiro B.Sc. in Astronomy, <i>Magna cum Lauda</i> <i>Thesis title: "Interacting Ellipsoids: a model for the fragmentation of a rubble-pile asteroid"</i>	Brazil 1998 – 2002

Publications

- Google Scholar profile: <http://scholar.google.com/citations?user=QWxVqrYAAAAJ>
- 1. *Synthetic Remote-sensing and In-situ Observations of Fine-scale Structure in a Pseudostreamer Coronal Mass Ejection through the Solar Corona.* BJ Lynch, PF Wyper, E Palmerio, L Casillas, JT Dahlin, LKS Daldorff, SE Guidoni, AK Higginson, P Kumar, A Liberatore, PC Liewer, O Panasenco, **P Penteado**, M Velli. arXiv preprint (2025) <http://arxiv.org/pdf/2501.17298>
- 2. *Analysis of CME Interactions in Solar Corona Combining Coronagraphic Observations with Wide-field Imagers from Solar Orbiter and Parker Solar Probe.* A Liberatore, PC Liewer, M Temmer, GM Cappello, Y De Leo, **P Penteado**. The Astrophysical Journal (2025) [doi:10.3847/1538-4357/adbffd](https://doi.org/10.3847/1538-4357/adbffd)
- 3. *Structure of the Plasma near the Heliospheric Current Sheet as Seen by WISPR/Parker Solar Probe from inside the Streamer Belt.* PC Liewer, A Vourlidas, G Stenborg, RA Howard, J Qiu, **P Penteado**, O Panasenco, CR Braga. The Astrophysical Journal (2023). [doi:10.3847/1538-4357/acc8c7](https://doi.org/10.3847/1538-4357/acc8c7)
- 4. *Extracting the Heliographic Coordinates of Coronal Rays Using Images from WISPR/Parker Solar Probe.* PC Liewer, J Qiu, F Ark, **P Penteado**, G Stenborg, A Vourlidas, JR Hall, P Riley. Solar Physics (2022). [doi:10.1007/s11207-022-02058-6](https://doi.org/10.1007/s11207-022-02058-6)
- 5. *Evolution of a streamer-blowout CME as observed by imagers on Parker Solar Probe and the Solar Terrestrial Relations Observatory.* PC Liewer, J Qiu, A Vourlidas, JR; Hall, **P Penteado**. Astronomy & Astrophysics (2021). [doi:10.1051/0004-6361/202039641](https://doi.org/10.1051/0004-6361/202039641)
- 6. *Tracking solar wind flows from rapidly varying viewpoints by the Wide-field Imager for Parker Solar Probe.* A Nindos, S Patsourakos, A Vourlidas, PC Liewer, **P Penteado**, .JR Hall. Astronomy & Astrophysics (2021). [doi:10.1051/0004-6361/202039414](https://doi.org/10.1051/0004-6361/202039414)
- 7. *Trajectory Determination for Coronal Ejecta Observed by WISPR/Parker Solar Probe.* PC Liewer, J Qiu, **P Penteado**, JR Hall, A Vourlidas, RA Howard. Solar Physics (2020). [doi:10.1007/s11207-020-01715-y](https://doi.org/10.1007/s11207-020-01715-y)
- 8. *Near-Sun observations of an F-corona decrease and K-corona fine structure.* RA Howard, A Vourlidas, V Bothmer, RC Colaninno, CE DeForest, B Gallagher, JR Hall, P Hess, AK Higginson, CM Korendyke, A Kouloumvakos, PL Lamy, PC Liewer, J Linker, M Linton, **Penteado**, **P**, SP Plunkett, N Poirier, NE Raouafi, N Rich, P Rochus, AP Rouillard, DG Socker, G Stenborg, G. AF Thernisien, A. F, NM Viall. Nature (2019). [doi:10.1038/s41586-019-1807-x](https://doi.org/10.1038/s41586-019-1807-x)

9. *Simulating White Light Images of Coronal Structures for WISPR/ Parker Solar Probe: Effects of the Near-Sun Elliptical Orbit*. P Liewer, A Vourlidas, A Thernisien, J Qiu, P Penteado, G Nisticò, R Howard, V Bothmer. *Solar Physics* (2019). doi:10.1007/s11207-019-1489-4
10. *A corridor of exposed ice-rich bedrock across Titan's tropical region*. CA Griffith, **P Penteado**, JD Turner, CD Neish, G Mitri, N Montiel, A Schoenfeld, RMC Lopes. *Nature Astronomy* (2019). doi:10.1038/s41550-019-0756-5
11. *Current paradigms in parallelization: a comparison of vectorization, OpenMP and MPI*. **P Penteado**. *Journal of Computational Interdisciplinary Sciences* (2015). doi:10.6062/jcis.2012.03.03.0057
12. *Software and cyber-infrastructure development to control the Observatorio Astrofísico de Javalambre (OAJ)*. A Yanes-Díaz, JL Antón, S Rueda-Teruel, L Guillén-Civera, R Bello, D Jiménez-Mejías, S Chueca, NM Lasso-Cabrera, O Suárez, F Rueda-Teruel, AJ Cenarro, D Cristobal-Hornillos, A Marin-Franch, R Luis-Simoes, G López-Alegre, MAC Rodríguez-Hernández, M Moles, A Ederoclite, J Varela, H Vazquez Ramió, MC Díaz-Martín, R Iglesias-Marzoa, N Maicas, JL Lamadrid, A Lopez-Sainz, J Hernández-Fuertes, L Valdivielso, C Mendes de Oliveira, **P Penteado**, W Schoenell, A Kanaan. *Proceedings of the SPIE*, 9152, id. 915215 (2014). doi:10.1117/12.2054944
13. *Goals and strategies in the global control design of the OAJ Robotic Observatory*. S Rueda-Teruel, A Yanes-Díaz, JL Antón, F Rueda-Teruel, M Moles, AJ Cenarro, A Marín-Franch, A Ederoclite, N Gruel, J Varela, D Cristobal-Hornillos, S Chueca, MC Díaz-Martín, L Guillén, R Luis-Simoes, N Maicas, JL Lamadrid, AL López-Sainz, J Hernández-Fuertes, L Valdivielso, C Mendes de Oliveira, **P Penteado**, W Schoenell, A Kanaan. *Highlights of Spanish Astrophysics VII*, pp. 954-954. (2013). 2013hsa7.conf..954R
14. *Possible tropical lakes on Titan from observations of dark terrain*. Caitlin A. Griffith, Juan Lora, Jake Turner, **Paulo F. Penteado**, Robert H. Brown, Martin G. Tomasko, Lyn Doose, Charles See. *Nature* 486, pp. 237-239 (2012). doi:10.1038/nature11165
15. *Goals and strategies in the global control design of the OAJ Robotic Observatory*. A. Yanes-Díaz, S. Rueda-Teruel, J.L. Antón, F. Rueda-Teruel, M. Moles, A.J. Cenarro, A. Marin-Franch, A. Ederoclite, N. Gruel, J. Varela, D. Cristobal-Hornillos, S. Chueca, M.C. Díaz-Martín, L. Guillen, R. Luis-Simoes, N. Maicas, JL. Lamadrid, A. Lopez-Sainz, J. Hernández-Fuertes, L. Valdivielso, C. Mendes de Oliveira, **P. Penteado**, W. Schoenell, A. Kanaan. *Observatory Operations: Strategies, Processes, and Systems IV*. *Proceedings of the SPIE*, Volume 8448, id. 84481B-84481B-14 (2012). doi:10.1117/12.925665
16. *Radiative transfer analyses of Titan's tropical atmosphere*. Caitlin A. Griffith, Lyn Doose, Martin G. Tomasko, **Paulo F. Penteado**, Charles See. *Icarus* 218, 2, pp. 975-988 (2012). doi:10.1016/j.icarus.2011.11.034
17. *Latitudinal variations in Titan's methane and haze from Cassini VIMS observations*. **Paulo F. Penteado**, Caitlin A. Griffith, Martin G. Tomasko, Steffi Engel, Charles See, Lyn Doose, Kevin H. Baines, Robert H. Brown, Bonnie J. Buratti, Roger Clark, Phillip Nicholson, Christophe Sotin. *Icarus* 206, 1, pp. 352-365 (2010). doi:10.1016/j.icarus.2009.11.003
18. *Ground-based measurements of the methane distribution on Titan*. **Paulo F. Penteado**, Caitlin A. Griffith. *Icarus* 206, 1, pp. 345-351 (2010). doi: 10.1016/j.icarus.2009.08.022
19. *VIMS spectral mapping observations of Titan during the Cassini prime mission*. Jason W. Barnes, Jason M. Soderblom, Robert H. Brown, Bonnie J. Buratti, Christophe Sotin, Kevin H. Baines, Roger N. Clark, Ralf Jaumann, Thomas B. McCord, Robert Nelson, Stéphane Le Mouélic, Sebastien Rodriguez, Caitlin Griffith, **Paulo Penteado**, Federico Tosi, Karly M. Pitman, Laurence

Soderblom, Katrin Stephan, Paul Hayne, Graham Vixie, Jean-Pierre Bibring, Giancarlo Bellucci, Fabrizio Capaccioni, Priscilla Cerroni, Angioletta Coradini, Dale P. Cruikshank, Pierre Drossart, Vittorio Formisano, Yves Langevin, Dennis L. Matson, Phillip D. Nicholson, Bruno Sicardy. *Planetary and Space Science* 57, 14-15, pp. 1950-1962 (2009). [doi:10.1016/j.pss.2009.04.013](https://doi.org/10.1016/j.pss.2009.04.013)

20. *Characterization of Clouds in Titan's Tropical Atmosphere*. Caitlin A. Griffith, **Paulo Penteado**, Sebastien Rodriguez, Stéphane LeMouélic, Kevin H. Baines, Bonnie Buratti, Roger Clark, Phil Nicholson, Ralf Jaumann, Christophe Sotin. *The Astrophysical Journal Letters* 702, 2, pp. L105-L109 (2009). [doi:10.1088/0004-637X/702/2/L105](https://doi.org/10.1088/0004-637X/702/2/L105)
21. *Evidence for a Polar Ethane Cloud on Titan*. C. A. Griffith, **P. Penteado**, P. Rannou, R. Brown, V. Boudon, K. H. Baines, R. Clark, P. Drossart, B. Buratti, P. Nicholson, C. P. McKay, A. Coustenis, A. Negrao, R. Jaumann. *Science*, 313, 5793, pp. 1620-1622 (2006). [doi:10.1126/science.1128245](https://doi.org/10.1126/science.1128245)
22. *The Evolution of Titan's Mid-Latitude Clouds*. C. A. Griffith, **P. Penteado**, K. Baines, P. Drossart, J. Barnes, G. Bellucci, J. Bibring, R. Brown, B. Buratti, F. Capaccioni, P. Cerroni, R. Clark, M. Combes, A. Coradini, D. Cruikshank, V. Formisano, R. Jaumann, Y. Langevin, D. Matson, T. McCord, V. Mennella, R. Nelson, P. Nicholson, B. Sicardy, C. Sotin, L. A. Soderblom, R. Kursinski. *Science* 310, 5747, pp. 474-477 (2005). [doi:10.1126/science.1117702](https://doi.org/10.1126/science.1117702)
23. *Observations of Titan's Mesosphere*. C. A. Griffith, **P. Penteado**, T. K. Greathouse, H. G. Roe, R. V. Yelle. *The Astrophysical Journal*, 629, 1, pp. L57-L60 (2005). [doi:10.1086/444533](https://doi.org/10.1086/444533)
24. *Measurements of CH₃D and CH₄ in Titan from Infrared Spectroscopy*. **P. F. Penteado**, C. A. Griffith, T. K. Greathouse, C. de Bergh. *The Astrophysical Journal*, Volume 629, Issue 1, pp. L53-L56 (2005). [doi:10.1086/444353](https://doi.org/10.1086/444353)
25. *Interacting ellipsoids: a minimal model for the dynamics of rubble-pile bodies*. F. Roig, R. Duffard, **P. Penteado**, D. Lazzaro, T. Kodama. *Icarus*, 165, 2, p. 355-370 (2003). [doi:10.1016/S0019-1035\(03\)00216-1](https://doi.org/10.1016/S0019-1035(03)00216-1)