Harmonica v0.7.0: Forward Modeling, Inversion, and Processing Gravity and Magnetic Data

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Abstract

This document describes Harmonica v0.7.0, a software package for gravity and magnetic data processing, forward modeling, and inversion. It is part of the Fatiando a Terra project and is available on Zenodo.

1 Introduction

Harmonica is a Python library for processing and modeling gravity and magnetic data. It includes common processing steps, like calculation of Bouguer and terrain corrections, reduction to the pole, upward continuation, equivalent layers, and more. There are forward modeling functions for basic geometric

shapes, like spheres, prisms, polygonal prisms, and tesseroids. The inversion methods are implemented as classes with an interface inspired by scikit-learn (like Verde).

2 Changelog for Version 0.7.0

Breaking changes:

- Update the gravitational constant (412).
- Remove the `harmonica.test()` function (482).
- Remove `depth_type` from `EquivalentSources` (468).
- Change default value for `depth` in `EquivalentSourcesGB` (515).
- Change default for window size in `EquivalentSourcesGB` (487).

Bug fixes:

- Make `reduce_to_pole` work for arbitrary dimension names (509).
- Fix inverted sign in upward derivative filter (479).
- Fix coordinate rounding errors in FFT (398).

New Features

- Remove horizontal coordinates when ditching thin prisms (394).
- Raise error for zero depth value in equivalent sources (524).
- Merge magnetic forward functions for prisms (448).
- Merge magnetic forward functions for dipoles (453).
- Magnetic field of dipoles in Cartesian coordinates (414).
- Forward models of prisms gravity fields with Choclo (400).
- Drop null prisms when converting a prism layer to pyvista (393).
- Add total gradient amplitude transformation (478).
- Add `total_field_anomaly` function (510).
- Add progressbar to tesseroid forward modelling (430).
- Add new `tilt_angle` transformation function (486).
- Add magnetic field forward modelling of rectangular prisms (369).
- Add function to convert magnetic vector to inclination and declination (402).

- Add Euler Deconvolution of a single window (493).
- Add covariance, change fit data, more docs to Euler Deconvolution (519).
- Add associated Legendre function calculations (505).

Maintenance

- Use Dependabot to update GitHub Actions workflows (455).
- Use Choclo functions for forward modelling point sources (422).
- Use Burocrata to check and add license notices (469).
- Use a text field for license in `pyproject.toml` (442).
- Specify `nopython=True` on jit functions (435).
- Setup Trusted Publisher deployment to PyPI (477).
- Run serial vs parallel test on prisms without Numba (434).
- Rewrite check for point inside tesseroid with Numba (419).
- Fix `prism_layer` test when accessing PyVista cells (409).
- Fix broken ICGEM file loader test (457).
- Extend support to Python 3.12 (484).
- Extend support for Numpy 2.0 (514).
- Drop support for Python 3.8 (497).
- Drop support for Python 3.7 (404).
- Ditch `setup.cfg` and use only `pyproject.toml` (438).
- Decorate tests for Legendre functions (521).
- Continue running doctests after failure (411).
- Add Yago M Castro to `AUTHORS.md` (489).
- Add India Uppal to `AUTHORS.md` (500).
- Add Gelson to `AUTHORS.md` (520).

Documentation

- Update versions of Sphinx and its plugins (472).
- Update how to pip install dev version in `install.rst` (444).
- Set hinge to zero in gallery example plot (408).

- Replace sphinx napoleon for numpydoc (492).
- Replace color for fill in examples using PyGMT (495).
- Minor typo in eq sources parameter estimation docs (389).
- Minor edits to grid transformations guides (391).
- Make gravity units more explicit (421).
- Improve installation instructions in the docs (483).
- Improve docstrings of prism gravity functions (429).
- Improve docstring of `prism_magnetic` function (481).
- Improve coordinates description in forward functions (413).
- Fix wrong citations of Cordell (1992) (518).
- Fix visualization test using deprecated PyVista method (433).
- Fix typo in user guide (475).
- Fix typo in Installing (416).
- Fix spelling of "Gaussian" in transformations guide (464).
- Fix prism and tesseroid layer in API Reference (428).
- Fix multiple typos on `DatasetAccessorPrismLayer` (494).
- Fix missing PyGMT images in user guide (474).
- Download User Guides as scripts and notebooks (405).

3 Citation

Please cite this software as:

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Harmonica offers implementations of some methods that have been published in scientific journals. We appreciate citations of these publications as well in case you made use of them.

- `harmonica.EquivalentSources` with `block_size` set (block-averaged sources):
  Soler, S. R. and Uieda, L. (2021). *Gradient-boosted equivalent sources*, Geophysical Journal International. `doi:10.1093/gji/ggab297`

- `harmonica.EquivalentSourcesGB` (Gradient-boosted equivalent sources):
  Soler, S. R. and Uieda, L. (2021). *Gradient-boosted equivalent sources*, Geophysical Journal International. `doi:10.1093/gji/ggab297`

- `harmonica.tesseroid_gravity` (forward modelling of tesseroids with constant and variable density):
  Soler, S. R., Pesce, A., Gimenez, M. E., & Uieda, L. (2019). *Gravitational field calculation in spherical coordinates using variable densities in depth*, Geophysical Journal International. `doi:10.1093/gji/ggz277`