
xomega Documentation

Release 0.1

Takaya Uchida

Apr 03, 2019

Overview

1	Contents	3
	Python Module Index	5

xomega is a Python package for solving the [generalized omega equation](#) which takes the form

$$N^2 \nabla_h w_b + f_0^2 \frac{\partial^2 w_b}{\partial z^2} = \beta \frac{\partial b}{\partial x} + \nabla_h \cdot \mathbf{Q}(u, v, \theta, \Phi).$$

Given the right-hand side of the equation, the package inverts the vertical velocity fields at each time and depth in wavenumber space, i.e.

$$-\kappa^2 N^2 \hat{w}_b + f_0^2 \frac{\partial^2 \hat{w}_b}{\partial z^2} = ik\beta \hat{b} + (ik\hat{Q}_x + il\hat{Q}_y).$$

where $\kappa = (k, l)$ is the horizontal wavenumber vector. The right-hand side, neglecting the turbulent correlation terms is $\mathbf{Q} = \mathbf{Q}_{tw} + \mathbf{Q}_{da}$ where

$$\mathbf{Q}_{tw} = -2 \left(\frac{\partial \mathbf{u}}{\partial x} \cdot \nabla b, \frac{\partial \mathbf{u}}{\partial y} \cdot \nabla b \right)$$

$$\mathbf{Q}_{da} = f \left(\frac{\partial v}{\partial x} \frac{\partial u_a}{\partial z} - \frac{\partial u}{\partial x} \frac{\partial v_a}{\partial z}, \frac{\partial v}{\partial y} \frac{\partial u_a}{\partial z} - \frac{\partial u}{\partial y} \frac{\partial v_a}{\partial z} \right).$$

where $\mathbf{u}_a (= \mathbf{u} - \mathbf{u}_g)$ is the ageotropic velocity. Assuming the total flow to be in geostrophic balance $\mathbf{u} = \mathbf{u}_g = \frac{\hat{z}}{f} \times \nabla_h \Phi$, the generalized form reduces to the [quasi-geostrophic Omega equation](#).

Note: xomega is at early stage of development and will keep improving in the future. The rigid-lid API should be quite stable, but minor utilities could change in the next version. If you find any bugs or would like to request any enhancements, please [raise an issue on GitHub](#).

1.1 Current limitations

1.1.1 Uniform Vertical Grid

The algorithm used in xomega currently only supports input on uniform vertical grid. Calculation using data on non-uniform grid will give no error but the discretization error may be significant.

1.1.2 Rigid-lid Boundary Conditions

Currently, only rigid-lid boundary conditions are implemented.

1.2 Installation

1.2.1 The quickest way

xomega is compatible both with Python 2 and 3. The major dependencies are [xarray](#) and [dask](#). The best way to install them is using [Anaconda](#):

```
$ conda install xarray dask .
```

1.2.2 Install xomega from GitHub repo

To get the latest version:

```
$ git clone https://github.com/roxyboy/xomega.git
$ cd xomega
$ python setup.py install .
```

Developers can track source code changes by:

```
$ git clone https://github.com/roxyboy/xomega.git
$ cd xomega
$ python setup.py build .
```

1.3 API

1.3.1 xomega

`xomega.xomega.w_rigid(N2, f0, beta, Frhs, kx, ky, dZ, dZ0=None, dZ1=None, zdim='Zl', dim=None, coord=None)`

Inverts the Omega equation given by Giordani and Planton (2000) to get the balanced vertical velocity (w_b) for rigid-lid boundary conditions given the right-hand side fo the equation.

Parameters

N2 [float or xarray.DataArray] The buoyancy frequency.

f0 [float] Coriolis parameter.

beta [float] Meridional gradient of the Coriolis parameter for a beta-plane approximation.

Frhs [xarray.DataArray] The Fourier transform of the right-hand side of the Omega equation.
The last two dimensions should be the meridional and zonal wavenumber.

kx [xarray.DataArray] Zonal wavenumber.

ky [xarray.DataArray] Meridional wavenumber.

dZ [float or xarray.DataArray] Vertical distance between grid. This should take constant value(s) for best numerical percision.

dZ0 [float or xarray.DataArray, optional] Top vertical distance between grids.

dZ1 [float or xarray.DataArray, optional] Bottom vertical distance between grids.

zdim [str, optional] Dimension name of the vertical axis of *Frhs*.

dim [list, optional] List of the xarray.DataArray output.

coord [dict, optional] Dictionary of the xarray.DataArray output.

Returns

wa [xarray.DataArray] The quasi-geostrophic vertical velocity.

X

`xomega.xomega`, 4

W

`w_rigid()` (*in module `xomega.xomega`*), 4

X

`xomega.xomega` (*module*), 4