Numerical Matsuno-Gill Model

This model is based on the works of Matsuno (1966) and Gill (1980). 3 prognostic variables u,v and p on a 2-dimensional spatial domain are integrated in time forced by a convective heating Q.

$$ \frac{\partial u}{\partial t} + \epsilon u - \frac{1}{2} y v = - \frac{\partial p}{\partial x} \\ \frac{\partial v}{\partial t} + \epsilon v + \frac{1}{2} y u = - \frac{\partial p}{\partial y} \\ \frac{\partial p}{\partial t} + \epsilon p + \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = Q $$

The prognostic variables can be interpreted as horizontal winds and column height in a shallow water model, or wind shear and layer thickness in a 2-layer model, or boundary layer winds and pressure and probably other interpretations. Read Matsuno (1966), Gill (1980), Neelin (1989) and others for more information. The model is non-dimensionalised, which can be done in different ways depending on the interpretation you choose to apply. Often the horizontal length scale is approximately 10 degrees and the timescale a couple of hours. Note that here the sign of the forcing is reversed compared to Gill 1980, so that a postive heating induces a posive geopotential or layer thickness anomaly (in contrast to negative anomalies corresponding to a low pressure system at the surface).

The model can be found here: https://github.com/pkeil7/numerical_gill . The code runs on the Julia language on your local machine or on levante. Read this page on how to install Julia and a Julia kernel for jupyterhub on levante. Then download the repository or clone it:

```
git clone https://github.com/pkeil7/numerical_gill.git
```

Open a Julia console and activate the project:

```
using Pkg
Pkg.activate("path/to/this/project")
Pkg.instantiate()
```

This will install all necessary packages listed in the `Project.toml` file for you.

Check out notebooks/showcase.ipynb for more information and a demonstration of how to reproduce the solution to idealised forcing from Gill 1980. Of course, you can specify your own forcing Q and play around with it. In case of questions contact Paul Keil: `paul.keil [at] mpimet.mpg.de`

References

- Matsuno, Taroh. “Quasi-geostrophic motions in the equatorial area.” Journal of the Meteorological Society of Japan. Ser. II 44.1 (1966): 25-43.
- Gill, Adrian E. “Some simple solutions for heat-induced tropical circulation.” Quarterly Journal of the Royal Meteorological Society 106.449 (1980): 447-462.
- Neelin, J. David. “On the interpretation of the Gill model.” J. Atmos. Sci 46.15 (1989): 2466-2468.