Vertical Interpolation in MetPy: Sigma to Isobaric to Isentropic

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Introduction

Vertical coordinate interpolation is commonly desired functionality of meteorological analysis software for research, teaching, and operational applications. The Python language has gained popularity among atmospheric scientists due to its relative ease of use, numerous community maintained packages, and modern graphics capabilities. Vertical coordinate interpolation support does not currently exist within common, actively maintained packages, and has been a highly requested feature by users of the MetPy package. Therefore, it is necessary that support for these calculations be added to the MetPy suite while maintaining a user interface that is both powerful and flexible while remaining simple to understand and use.

Objectives

1. Develop user-friendly functions for vertical coordinate interpolation of gridded fields.
   - Sigma to isobaric and isobaric to isentropic coordinate conversions are commonly requested features for the MetPy package.
   - Similar software can calculate these conversions, but contain older graphics engines than is available within the Python language.
   - Users have requested an easy to use method for vertical coordinate interpolation in MetPy.
2. Implement these calculations through accepted, peer-reviewed methods.

Sigma to Isobaric

Sigma coordinates are often used within numerical weather prediction models since they are terrain-following and thus defined over the entire domain. However, since sigma coordinates are not at a constant pressure or height, interpolation to isobaric coordinates is often conducted during post-processing to allow for easier interpretation of model forecasts.

Isobaric to Isentropic

Isentropic coordinates are often used in synoptic and dynamic meteorology in a complementary view to the traditional Quasi-Geostrophic theory, as well as for Potential Vorticity analysis. Interpolation to isentropic coordinates requires an iterative process, which becomes very slow when written with the traditional for-loop methods of compiled languages. Isentropic interpolation has been desired functionality for the Python scientific community, and now becomes possible with the aid of vectorized calculations in NumPy.

Sample Code

```python
# Sigma to Isobaric
isentropic_interpolation(isentlevs, lev, relh)

# Isobaric to Isentropic
log_interp(plevs, pres, hgt, axis=1)
```

Conclusion

Added functionality for sigma to isobaric and isobaric to isentropic coordinate conversions.

- Code available in MetPy ≥ 0.6. Examples can be found in the Unidata Python Gallery (unidata.github.io/python-gallery) and the MetPy documentation (unidata.github.io/MetPy/latest).
- Future improvements:
  - Improve interpolation to be more flexible regarding input data types
  - Conduct additional testing against other software

New MetPy Features

- Support for the following has been added to MetPy:
  - Sigma to Isobaric interpolation
  - Isobaric to Isentropic interpolation
  - 1-D linear interpolation for N-D arrays
  - Calculation of Montgomery Streamfunction

References


Acknowledgements

This work funded primarily by the National Science Foundation (Grant NSF-1344155).