CROSS SECTIONS IN METPY

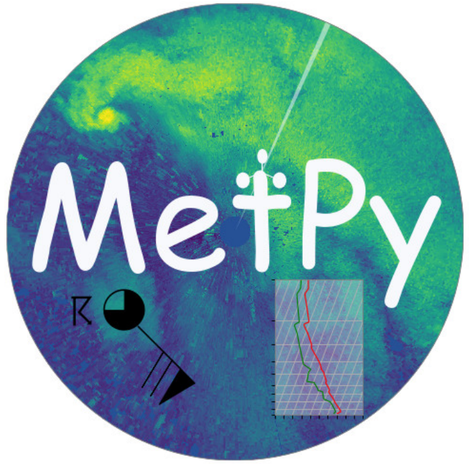
(WITH XARRAY...AND XKCD)

UNIDATA SUMMER INTERNSHIP 2018

JON THIELEN (WITH RYAN MAY AND JOHN LEEMAN)

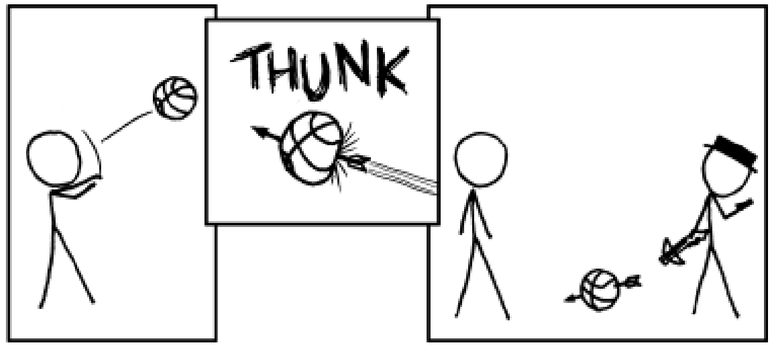
WORKING ON METPY

- STARTED CONTRIBUTING IN NOV 17'
- APPLIED IN JAN 18'
- STARTED INTERNSHIP IN MAY

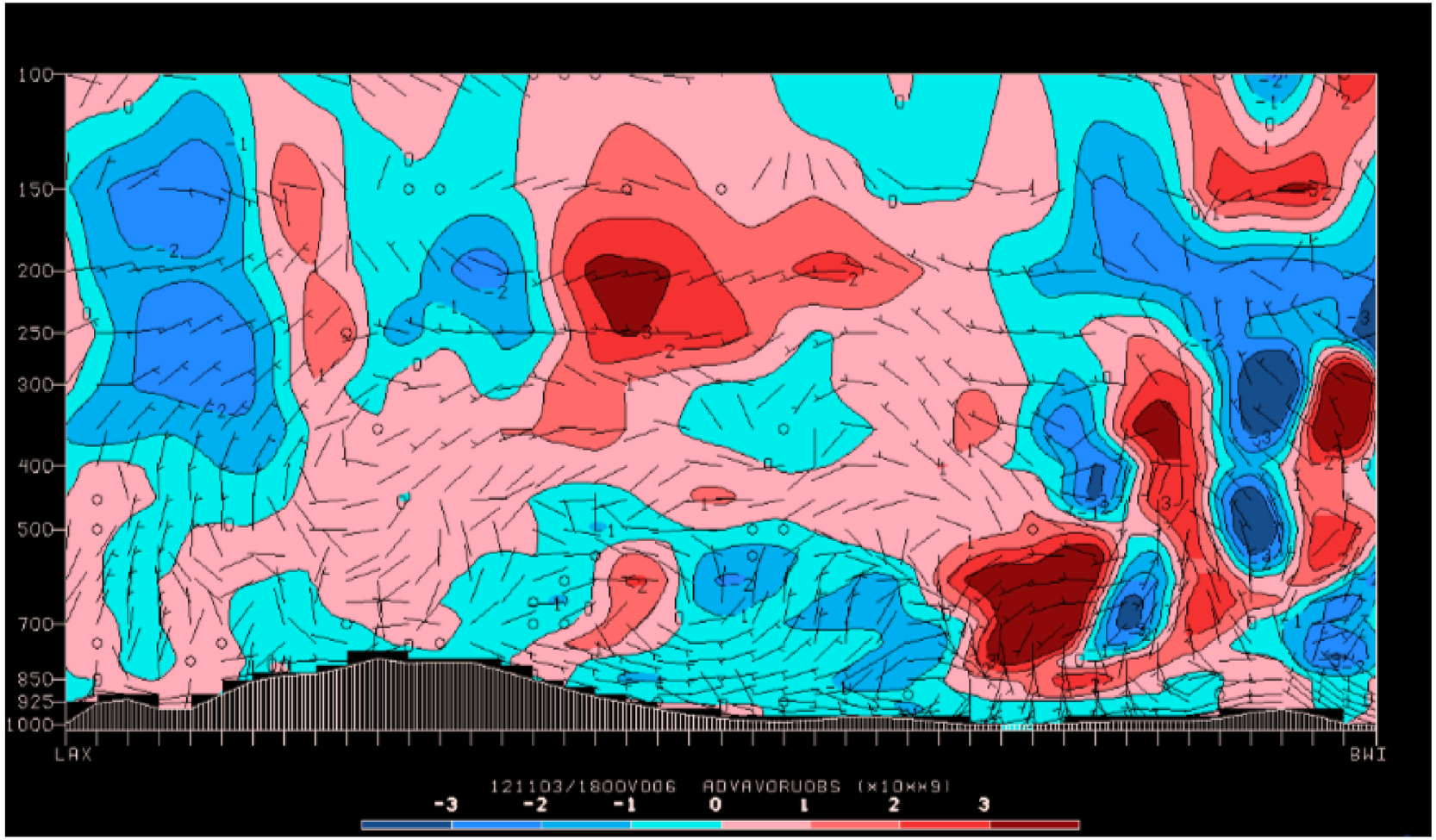


INITIAL PLANS

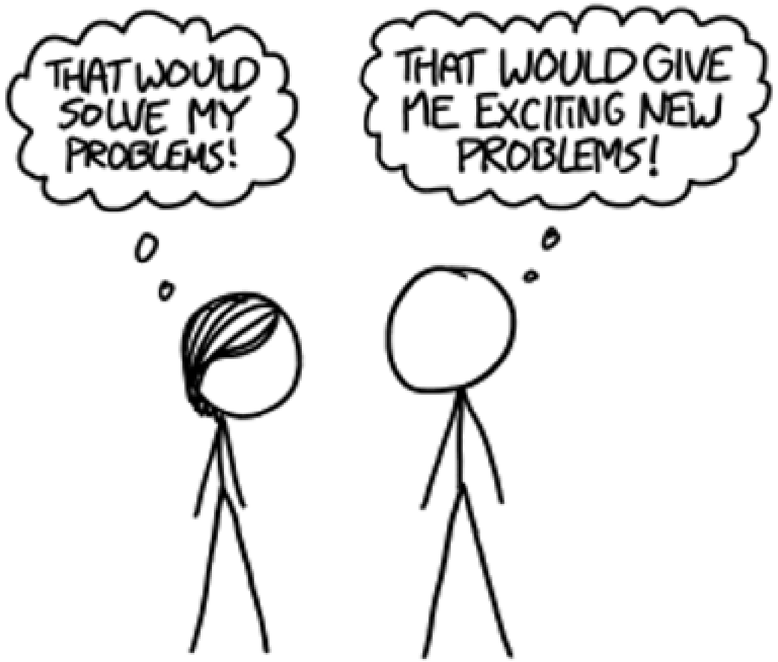
- AUTOMATIC FIELD CALCULATION
- INCOMPLETE STATE OF XARRAY INTEGRATION



ANOTHER PLAN: CROSS SECTIONS…



...WITH XARRAY!


THAT WOULD SOLVE MY PROBLEMS!
THAT WOULD GIVE ME EXCITING NEW PROBLEMS!

WHAT IS XARRAY?

- PYTHON PACKAGE FOR N-DIMENSIONAL LABELED ARRAYS
- "AN IN-MEMORY REPRESENTATION OF A NETCDF FILE"
- THE FUTURE OF METPY (FROM A DATA MODEL POINT-OF-VIEW)

```
import xarray as xr
data = xr.open_dataset('irma_gfs_example.nc')
print(data)
```

```
<xarray.Dataset>
Dimensions:                                    (isobaric1: 21, isoba
Coordinates:
  * time1                                      (time1) datetime64[ns
    reftime                                    datetime64[ns] ...
  * latitude                                   (latitude) float32 50
  * isobaric3                                  (isobaric3) float64 1
  * isobaric1                                  (isobaric1) float64 1
  * longitude                                  (longitude) float32 2
Data variables:
    Vertical_velocity_pressure_isobaric        (time1, isobaric1, la
    Relative_humidity_isobaric                 (time1, isobaric3, la
    Temperature_isobaric                       (time1, isobaric3, la
    u-component_of_wind_isobaric               (time1, isobaric3, la
    v-component_of_wind_isobaric               (time1, isobaric3, la
```

```
heights = data['Geopotential_height_isobaric']
heights.sel(time1='2017-09-06T00:00Z',
            isobaric3=50000.)
```

```
<xarray.DataArray 'Geopotential_height_isobaric' (latitude: 81
array([[5880.9595, 5878.8394, 5876.5195, ..., 5807.9194, 5809.
       [5884.5596, 5882.3994, 5879.9194, ..., 5821.2393, 5822.
       [5888.4395, 5885.7993, 5883.2393, ..., 5833.3193, 5834.
       ...,
       [5871.679 , 5871.719 , 5871.5996, ..., 5894.8394, 5894.
       [5871.2393, 5871.159 , 5871.159 , ..., 5892.8794, 5893.
       [5870.5195, 5871.119 , 5870.7993, ..., 5891.119 , 5891.
      dtype=float32)
Coordinates:
    time1       datetime64[ns] 2017-09-06
    reftime     datetime64[ns] ...
  * latitude    (latitude) float32 50.0 49.5 49.0 48.5 48.0 47.
    isobaric3   float64 5e+04
  * longitude   (longitude) float32 250.0 250.5 251.0 251.5 252
```

```
data['Temperature_isobaric'].mean(
    ('time1', 'latitude', 'longitude'))
```

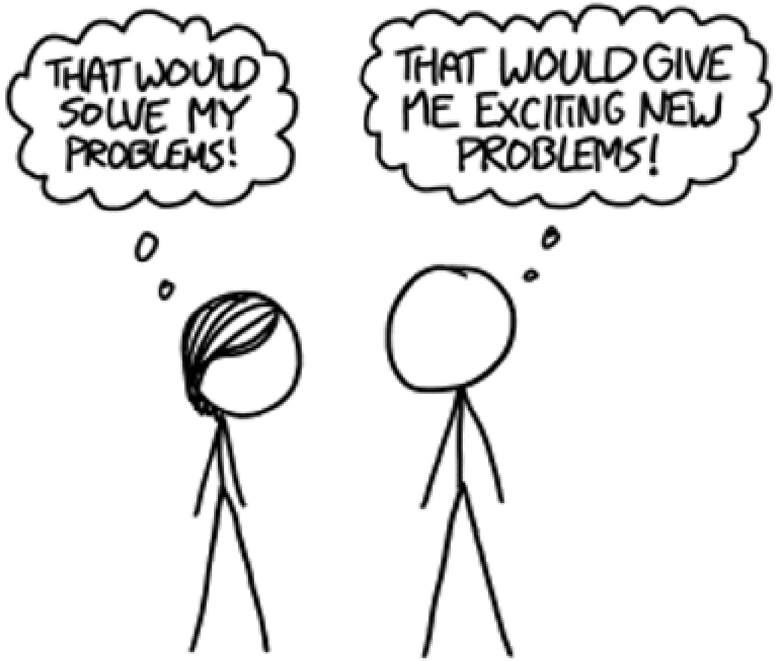
```
<xarray.DataArray 'Temperature_isobaric' (isobaric3: 31)>
array([259.4611 , 255.66313, 248.79195, 240.33334, 235.54622,
       223.24205, 218.46536, 213.04253, 208.66364, 204.48088,
       219.08775, 229.3075 , 238.7891 , 247.04654, 253.94908,
       264.77377, 269.32214, 273.50998, 277.24646, 280.57074,
       286.40454, 289.0842 , 291.59814, 292.82648, 294.26868,
       297.45053], dtype=float32)
Coordinates:
    reftime    datetime64[ns] ...
  * isobaric3  (isobaric3) float64 100.0 200.0 300.0 500.0 700
```

```
(data['Temperature_isobaric'] -
 data['Temperature_isobaric'].mean(
     ('time1', 'latitude', 'longitude')))
```

```
<xarray.DataArray 'Temperature_isobaric' (time1: 9, isobaric3:
array([[[[ -1.46109 , ...,  -1.161102],
         ...,
         [  1.738922, ...,  -1.161102]],

        ...,

        [[ -7.250519, ..., -10.750519],
         ...,
         [  1.749481, ...,   1.849457]]],


       ...,
```

SO WHAT'S MISSING?

- PROJECTION HANDLING
- SYSTEMATIC IDENTIFICATION OF VARIABLES/COORDINATES
- UNITS
- METEOROLOGICAL CALCULATIONS


THAT WOULD SOLVE MY PROBLEMS!
THAT WOULD GIVE ME EXCITING NEW PROBLEMS!

XARRAY AND METPY

PROJECTION HANDLING

```
temperature = data.metpy.parse_cf('Temperature_isobaric')
temperature.metpy.cartopy_crs
```

```
<cartopy.crs.PlateCarree object at 0x7f86c780e3b8>
```

Xarray + CF + CartoPy Projection Handling #786

Edit

Merged **jrleeman** merged 10 commits into `Unidata:master` from `dopplershift:xarray-projections` on May 14

Changes from **all commits** Jump to… +683 −31

Diff settings Review changes

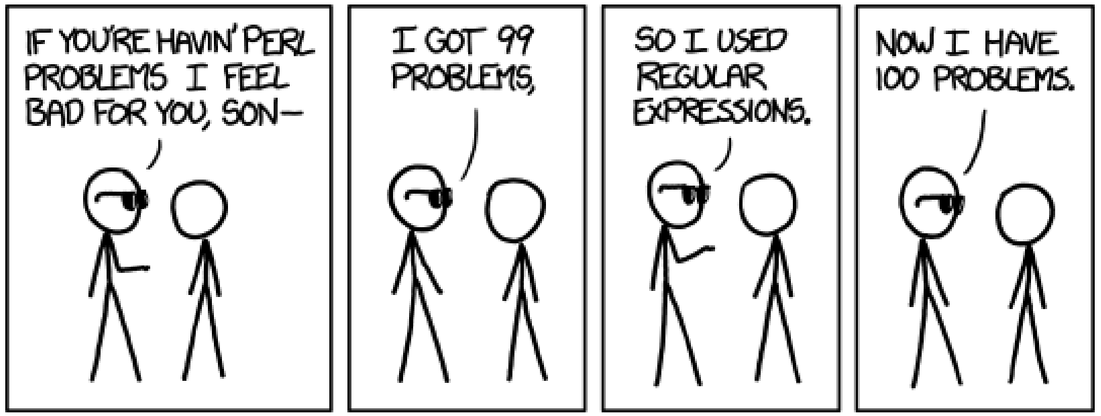
3 .codeclimate.yml View

```
@@ -9,6 +9,9 @@ checks:
    argument-count:                          |    argument-count:
      config:                                |      config:
        threshold: 10                        |        threshold: 10
                                             |  +   method-complexity:
                                             |  +     config:
                                             |  +       threshold: 15
                                             |
  plugins:                                   |  plugins:
```

SYSTEMATIC IDENTIFICATION OF COORDINATES

```
temperature = data.metpy.parse_cf('Temperature_isobaric')
temperature.metpy.vertical
```

```
<xarray.DataArray 'isobaric3' (isobaric3: 31)>
array([   100.,    200.,    300.,    500.,    700.,   1000.,
         5000.,   7000.,  10000.,  15000.,  20000.,  25000.,
        40000.,  45000.,  50000.,  55000.,  60000.,  65000.,
        80000.,  85000.,  90000.,  92500.,  95000.,  97500., 1
Coordinates:
    reftime    datetime64[ns] 2017-09-05T12:00:00
    crs        object Projection: latitude_longitude
  * isobaric3  (isobaric3) float64 100.0 200.0 300.0 500.0 700
Attributes:
    units:     Pa
    positive:  down
    axis:      Z
```


IF YOU'RE HAVIN' PERL PROBLEMS I FEEL BAD FOR YOU, SON—
I GOT 99 PROBLEMS,
SO I USED REGULAR EXPRESSIONS.
NOW I HAVE 100 PROBLEMS.

Systematic Coordinate Identification #871

Edit

Merged **dopplershift** merged 3 commits into `Unidata:master` from `jthielen:xarray-coord-id` on Jul 2

Changes from **all commits** Jump to… +815 −22

Diff settings Review changes

8 metpy/plots/mapping.py View

```
@@ -81,6 +81,14 @@ def __getitem__(self, item):
        """Return a given attribute."""
        return self._attrs[item]

    def __eq__(self, other):
        """Test equality (CFProjection with matching attrs)."""
        return self.__class__ == other.__class__ and self.to_dict() == other.to_dict()

    def __ne__(self, other):
```

SYSTEMATIC IDENTIFICATION OF COORDINATES

Systematic identification of variables from an xarray Dataset #886

Edit New issue

Open **jthielen** opened this issue on Jul 10 · 4 comments

jthielen commented on Jul 10 Member

Corresponding to #860, it would seem useful to also be able to systematically identify variables from an xarray `Dataset`. A simple use-case would be something like what motivated this issue, #662, where we want to identify each of the components of the 3D wind field and then do some calculations on those. This also would likely be a prerequisite for #3 (whenever enough pieces are in place for that to be implemented).

A initial approach could be simply searching for the `standard_name` attribute and strictly adhering to the CF Standard Name list, while giving some option to the user to supply a dictionary to fill standard names where they are missing. However, would there be cases where we don't have a CF standard name for the quantity we want? Or, should there be some kind of automatic processing to fill in for missing `standard_name` attributes? But, then again, anything too much more flexible/complex would likely become even messier than systematic coordinate identification ended up being

Assignees

No one—assign yourself

Labels

Area: Xarray

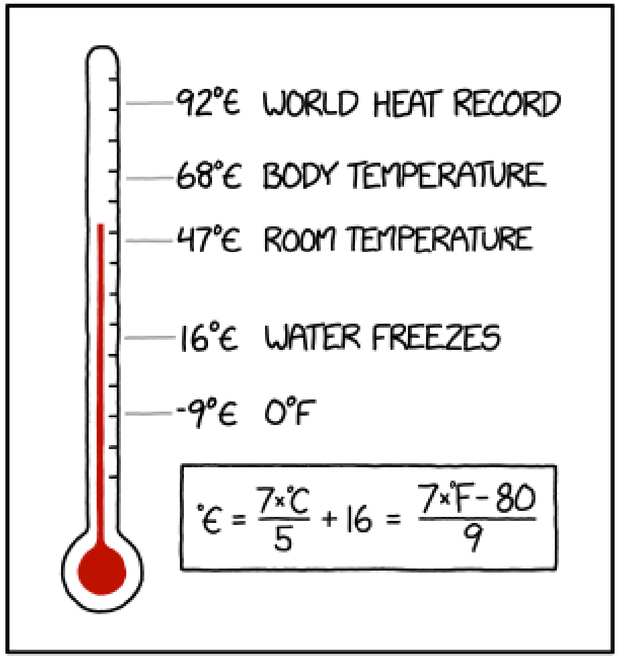
Type: Feature

Projects

None yet

Milestone

UNITS



SINCE THE CELSIUS VS FAHRENHEIT DEBATE HAS PROVEN SURPRISINGLY HARD TO RESOLVE, AS A COMPROMISE I'VE STARTED USING FELSIUS (°€), THE AVERAGE OF THE TWO.

```
temperature[0, -1].metpy.unit_array
```

```
[[290.2 289.7 289.2 ... 286.6 286.6 286.7]
 [289.7 289.7 289.6 ... 286.5 286.2 286.1]
 [289.6 289.4 289.6 ... 286.2 286.  286. ]
 ...
 [299.5 299.5 299.4 ... 299.9 300.  300.1]
 [299.2 299.2 299.1 ... 299.9 299.5 299.7]
 [299.2 298.9 298.8 ... 299.9 299.5 299.3]] kelvin
```

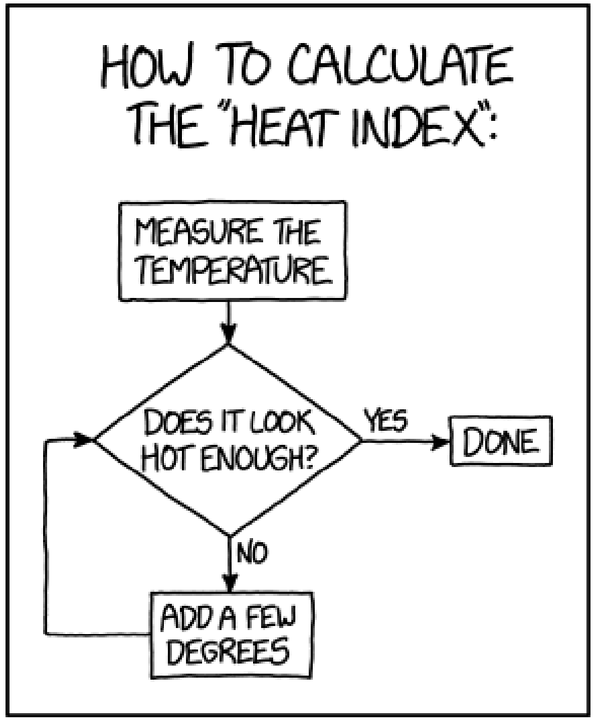
```
dew_point = mpcalc.dewpoint_rh(
    data['temperature'][0, -1],
    data['relative_humidity'][0, -1]
).to('degF')
print(dew_point)
```

```
[[32.106335 34.216534 37.958862 ... 54.41962  54.06663  53.707
 [37.16378  37.290783 39.498154 ... 54.56085  53.85064  53.439
 [36.5536   37.554565 39.08699  ... 54.3687   53.896233 53.551
 ...
 [73.24063  73.3862   73.355545 ... 70.961296 70.89378  71.066
 [72.96811  73.04029  73.04425  ... 70.720695 70.78227  70.853
 [73.148285 72.76404  72.409294 ... 69.40728  70.028336 70.317
```

```
(data['height'].sel(isobaric3=500) -
 data['height'].sel(isobaric3=1000))
```

```
<xarray.DataArray 'height' (time1: 9, latitude: 81, longitude:
array([[[5643.725 , 5635.4604, ..., 5619.6846, 5617.981 ],
        [5639.421 , 5635.045 , ..., 5630.989 , 5629.373 ],
        ...,
        [5778.173 , 5778.397 , ..., 5761.6445, 5763.4287],
        [5777.149 , 5776.445 , ..., 5760.085 , 5760.773 ]],

       [[5654.589 , 5647.1167, ..., 5637.925 , 5636.581 ],
        [5649.821 , 5645.093 , ..., 5646.637 , 5645.485 ],
        ...,
        [5776.485 , 5775.877 , ..., 5766.0366, 5766.7407],
        [5775.261 , 5774.6606, ..., 5764.285 , 5764.565 ]],

       ...,
```

METEOROLOGICAL CALCULATIONS



BUT WHAT ABOUT CROSS SECTIONS?

- CROSS SECTIONS—A FORM OF INTERPOLATION
- METPY'S INTERPOLATION WAS PREVIOUSLY
  - METPY.GRIDDING
  - A FEW FUNCTIONS IN METPY.CALC
- SO…

Changing gridding to interpolate #872

Edit

Merged **dopplershift** merged 2 commits into `Unidata:master` from `jthielen:gridding-to-interpolate` on Jul 2

Conversation 14 Commits 2 Checks 0 Files changed 33 +2,084 −1,541

jthielen commented on Jun 12 Member

This PR is a major API change: it deprecates the `gridding` subpackage in favor of a more general `interpolate` subpackage, and brings over the current single-axis interpolation functions now in `calc` as well. This is motivated by the soon-to-arrive cross section implementation, as cross sections require more general point-/path-based horizontal interpolation, rather than strictly grid-based (what is currently implemented in the `gridding` subpackage).

Below is the list of changes I've made at this point:

- The internal module structure of `gridding` has been updated for the `interpolate` package (so that users using non-public functions from `gridding` will have to change more than just the subpackage name)

Reviewers

jrleeman

stickler-ci

dopplershift

Assignees

No one—assign yourself

Labels

Area: Calc

WITH THAT OUT OF THE WAY...

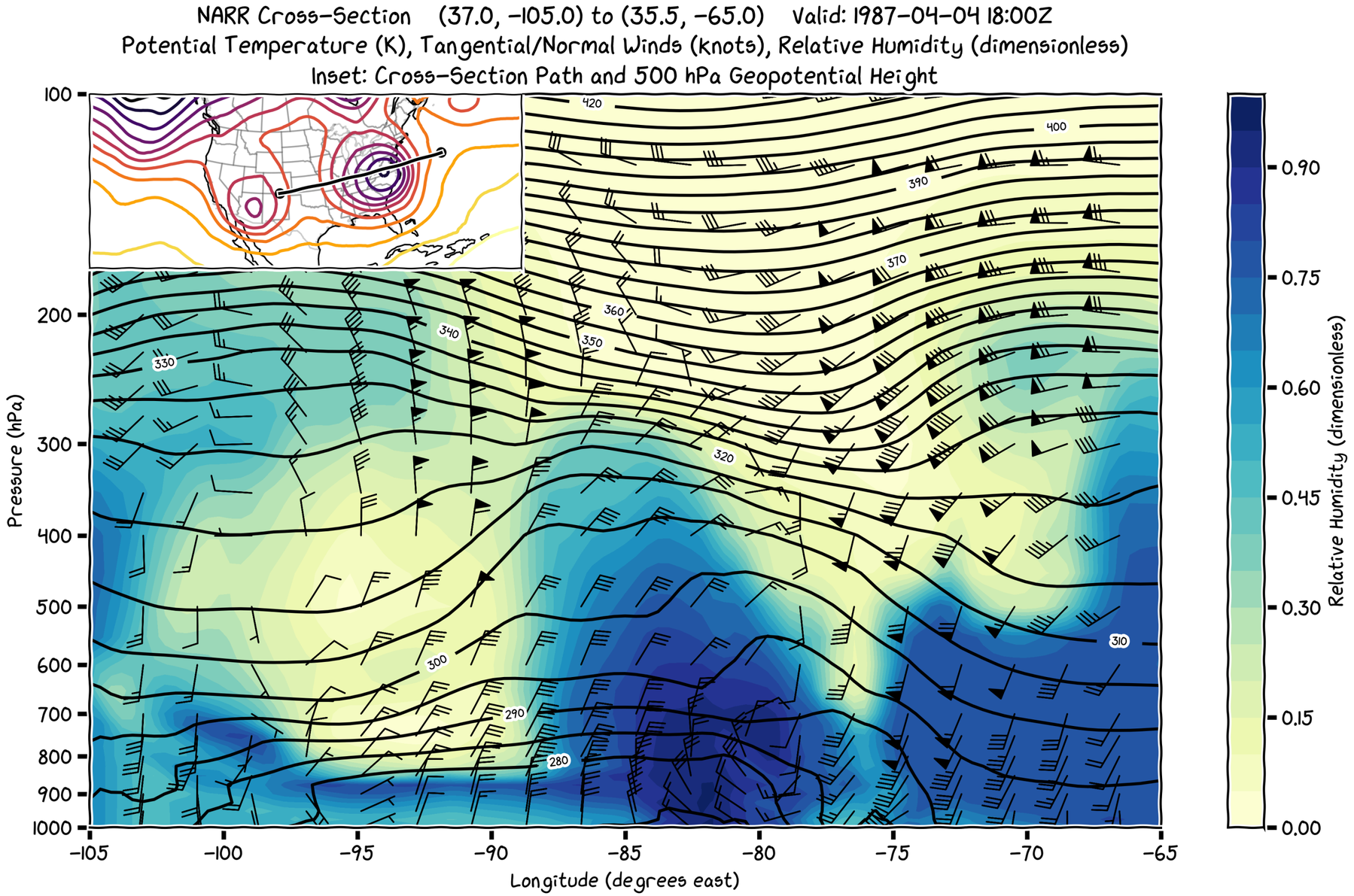
CROSS SECTIONS!

jthielen Fixes based on CI, code coverage analysis, and review 5646050 22 days ago

1 contributor

159 lines (127 sloc) | 5.58 KB | Raw | Blame | History

```
1   # Copyright (c) 2018 MetPy Developers.
2   # Distributed under the terms of the BSD 3-Clause License.
3   # SPDX-License-Identifier: BSD-3-Clause
4   """Tools for interpolating to a vertical slice/cross section through data."""
5
6   import cartopy.crs as ccrs
7   import numpy as np
8   import xarray as xr
9
10  from ..package_tools import Exporter
11  from ..xarray import CFConventionHandler
12
13  exporter = Exporter(globals())
```

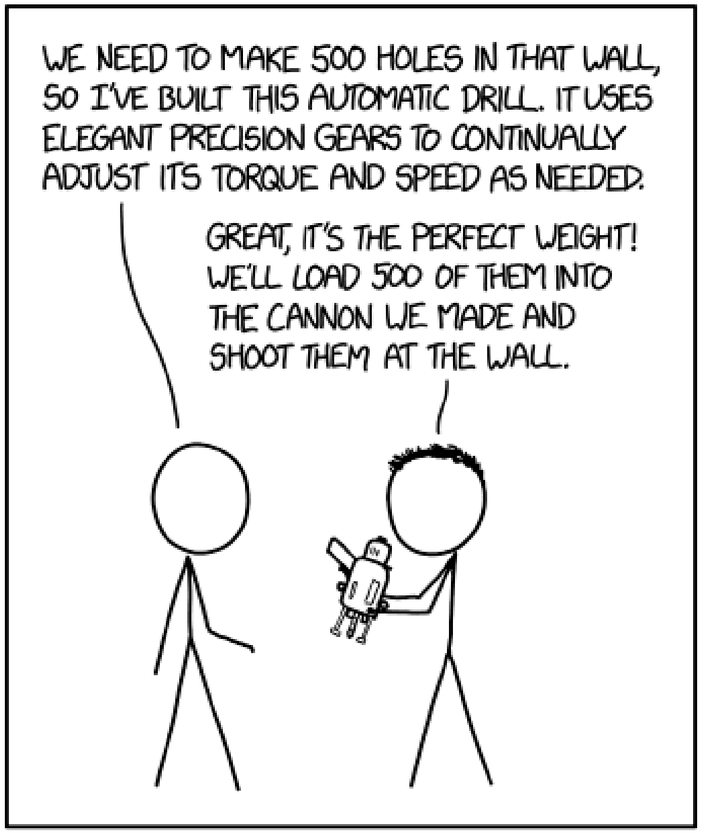

NARR Cross-Section (37.0, -105.0) to (35.5, -65.0) Valid: 1987-04-04 18:00Z
Potential Temperature (K), Tangential/Normal Winds (knots), Relative Humidity (dimensionless)
Inset: Cross-Section Path and 500 hPa Geopotential Height
Pressure (hPa)
100
200
300
400
500
600
700
800
900
1000
420
400
390
370
360
350
340
330
320
310
300
290
280
-105
-100
-95
-90
-85
-80
-75
-70
-65
Longitude (degrees east)
Relative Humidity (dimensionless)
0.90
0.75
0.60
0.45
0.30
0.15
0.00

LIVE DEMO TIME!

THANK YOU!

- RYAN AND JOHN
- HAILEY
- SEAN
- INKEN AND SHERI
- MATT
- ETHAN
- EVERYBODY!

XKCD COMICS (BY RANDALL MUNROE) USED WITH MODIFICATION UNDER CC BY-NC 2.5



HOW SOFTWARE DEVELOPMENT WORKS