Ancillary Data Products for *Progressive Science*

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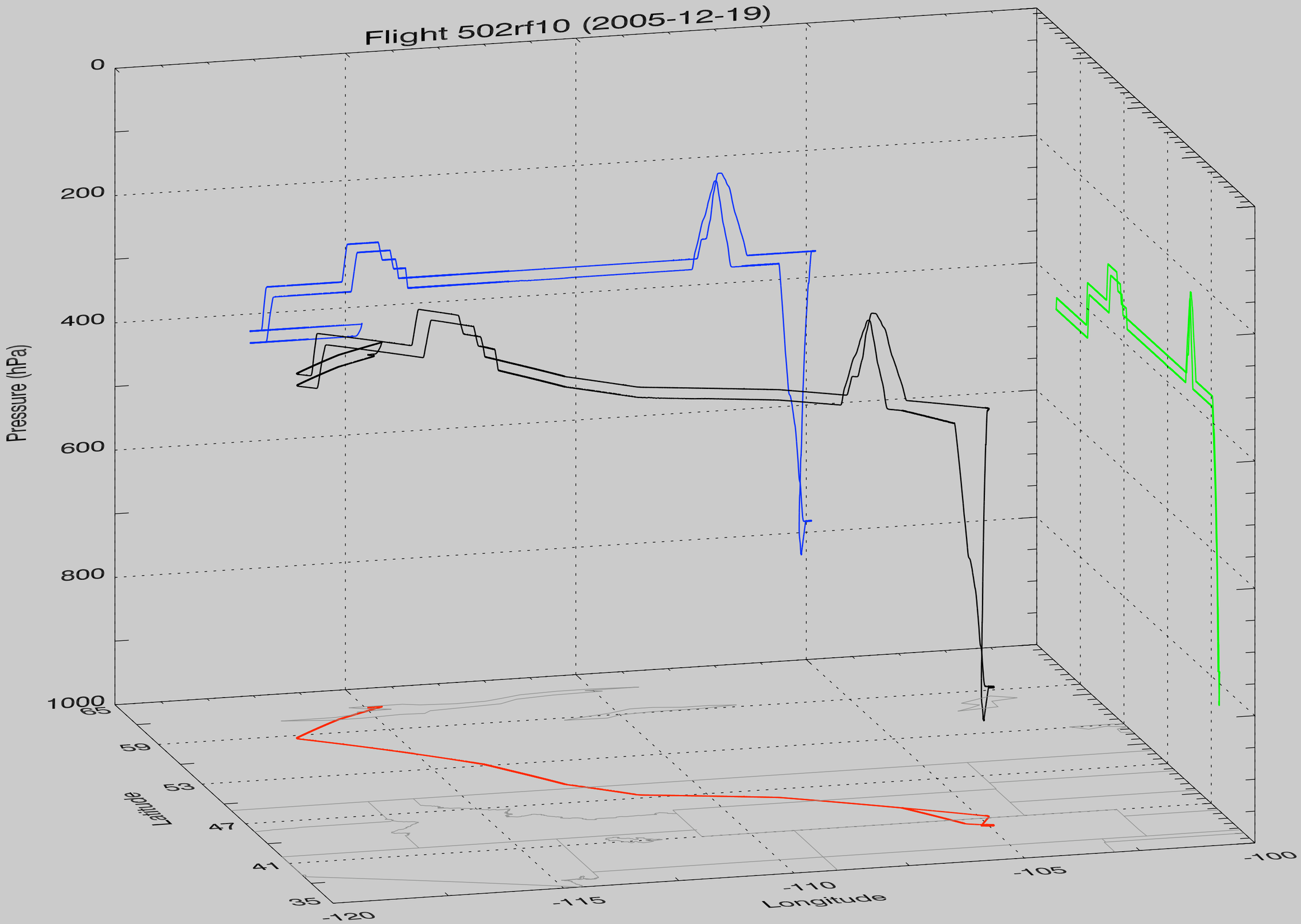
Ancillary Data Products

- GFS data: gridded global analyses from the NCEP Global Forecast System
- GFS data interpolated to the HIAPER flight tracks
- Forward and backward trajectories from points along the HIAPER flight tracks
- Basic visualizations

Basic Plots


Flight 502rf10 (2005-12-19)
Pressure (hPa)
0
200
400
600
800
1000
65
59
53
47
41
35
Latitude
-120
-115
-110
-105
-100
Longitude

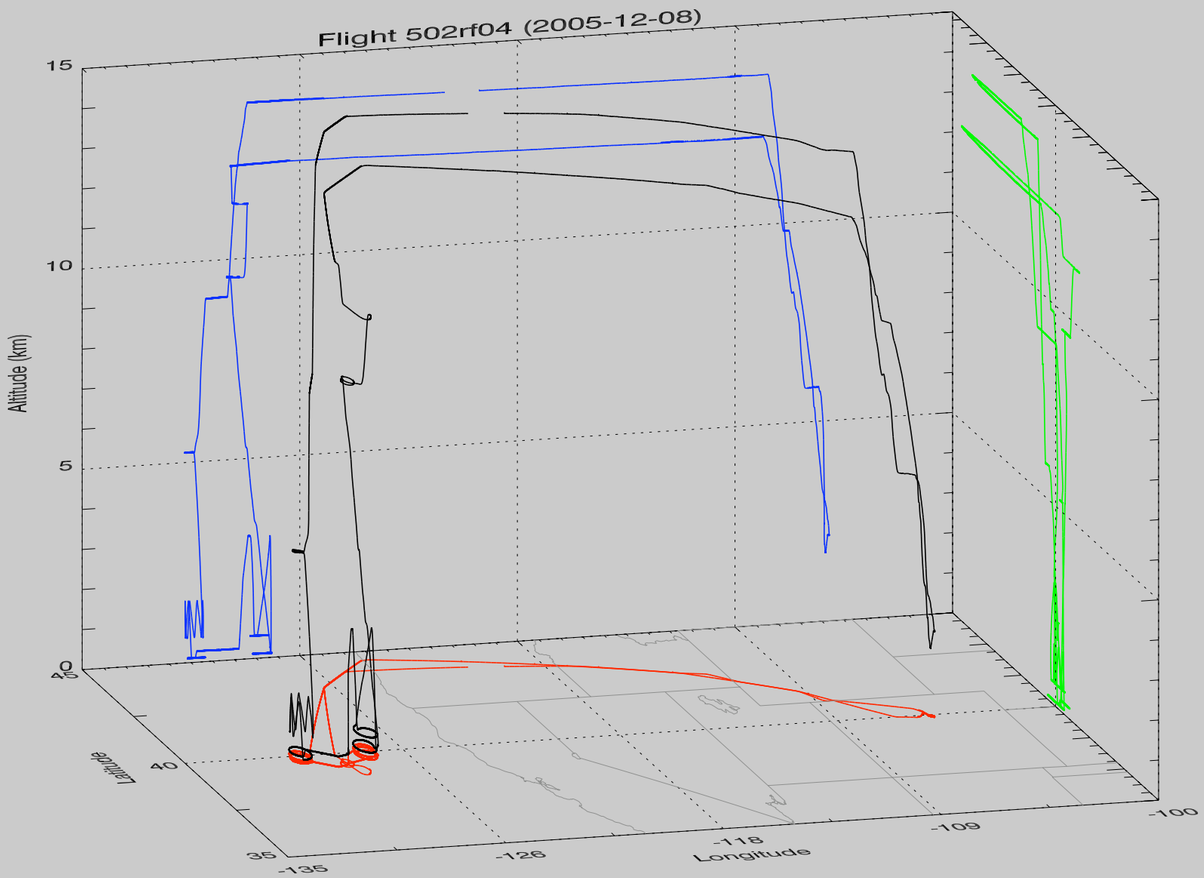
GFS Gridded Data

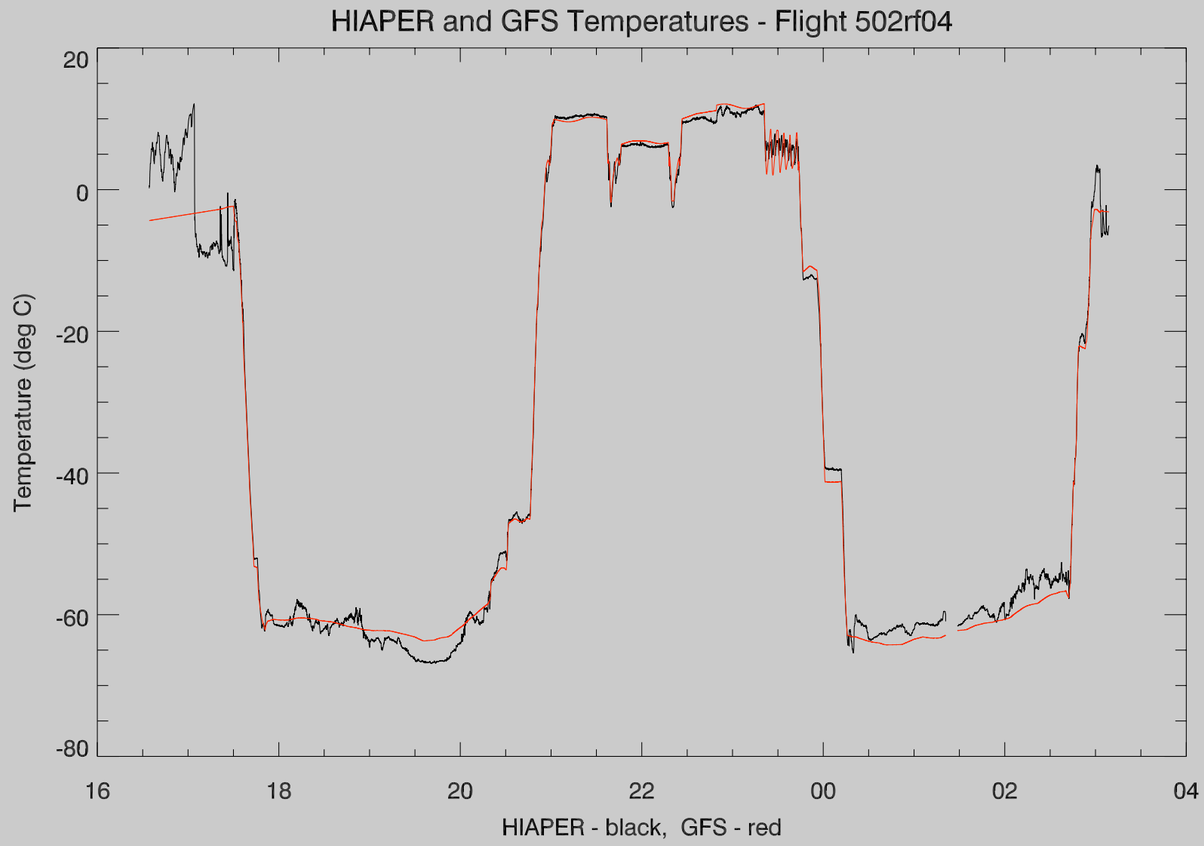
- 6-hourly global operational analyses on 1° x 1° lon-lat grids
- Converted from GRIB to netCDF files (GRIB files available)
- 3-D Variables: *u*, *v*, *w*, *Z*, *T*, *RH*, *vorticity*
- Tropopause variables: *u*, *v*, *Z*, *p*
- Surface variables: *p*, *Z*
- IDL library for reading GFS netCDF files, computing potential temperature and PV, interpolating in space and time, etc.

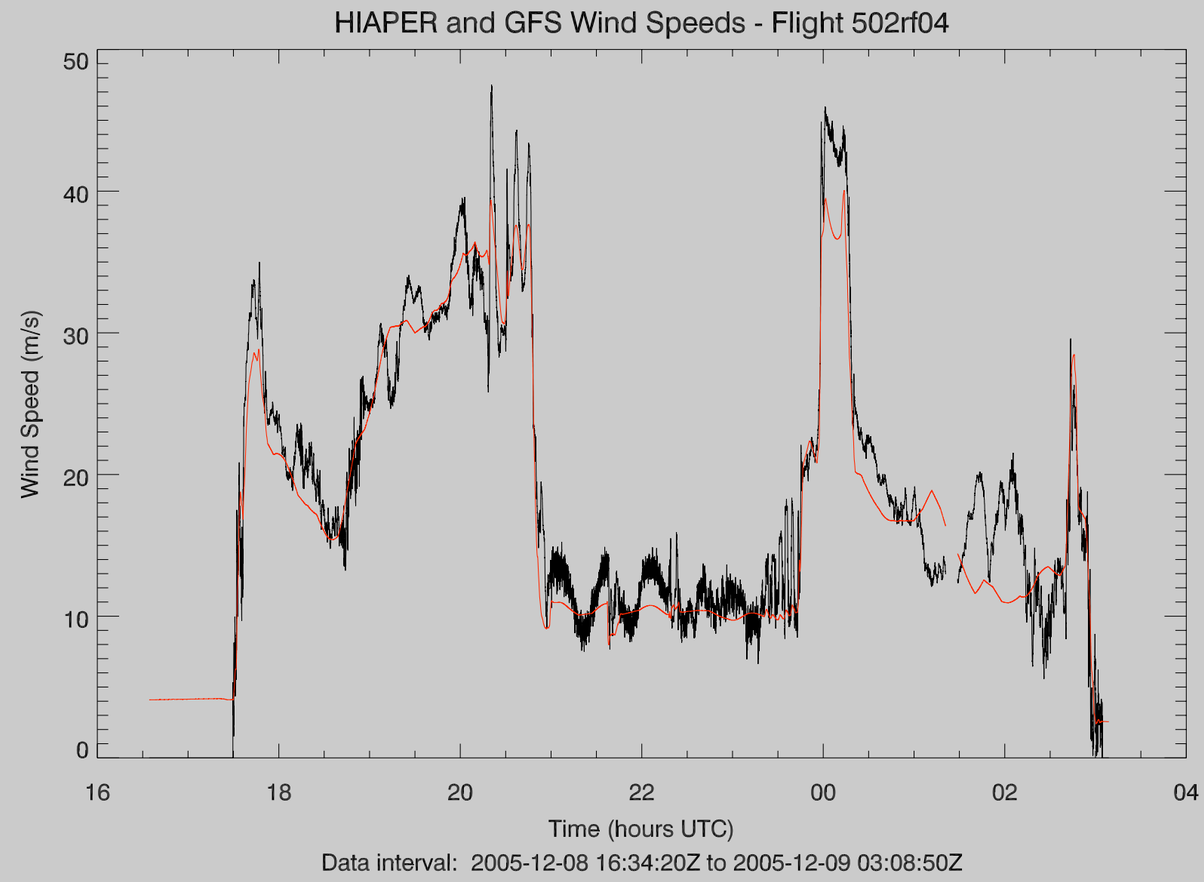
GFS Data Interpolated to Flight Tracks

- netCDF files that match the RAF file structure and include the following variables:
  - Selected RAF variables: *GGLON*, *GGLAT*, *GGALT*, *PSXC*, *PALTF*, *UI*, *VI*, *ATX*, *THETA* (other variables could also be included)
  - GFS variables interpolated to aircraft location: *u*, *v*, *w*, *T*, *Z*, *PV*, tropopause *p* and *Z*, *O3* (when available)

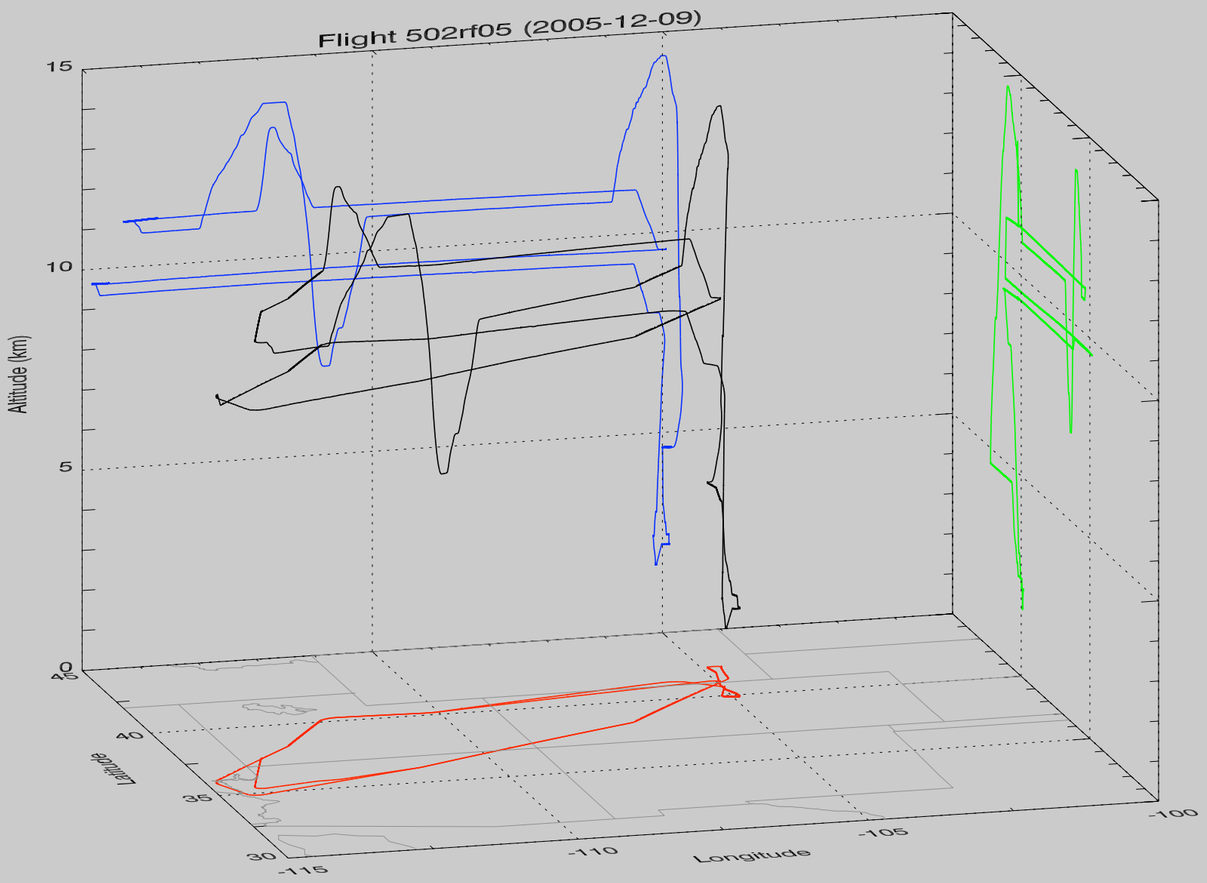
GFS/HIAPER Comparisons - Flight 4

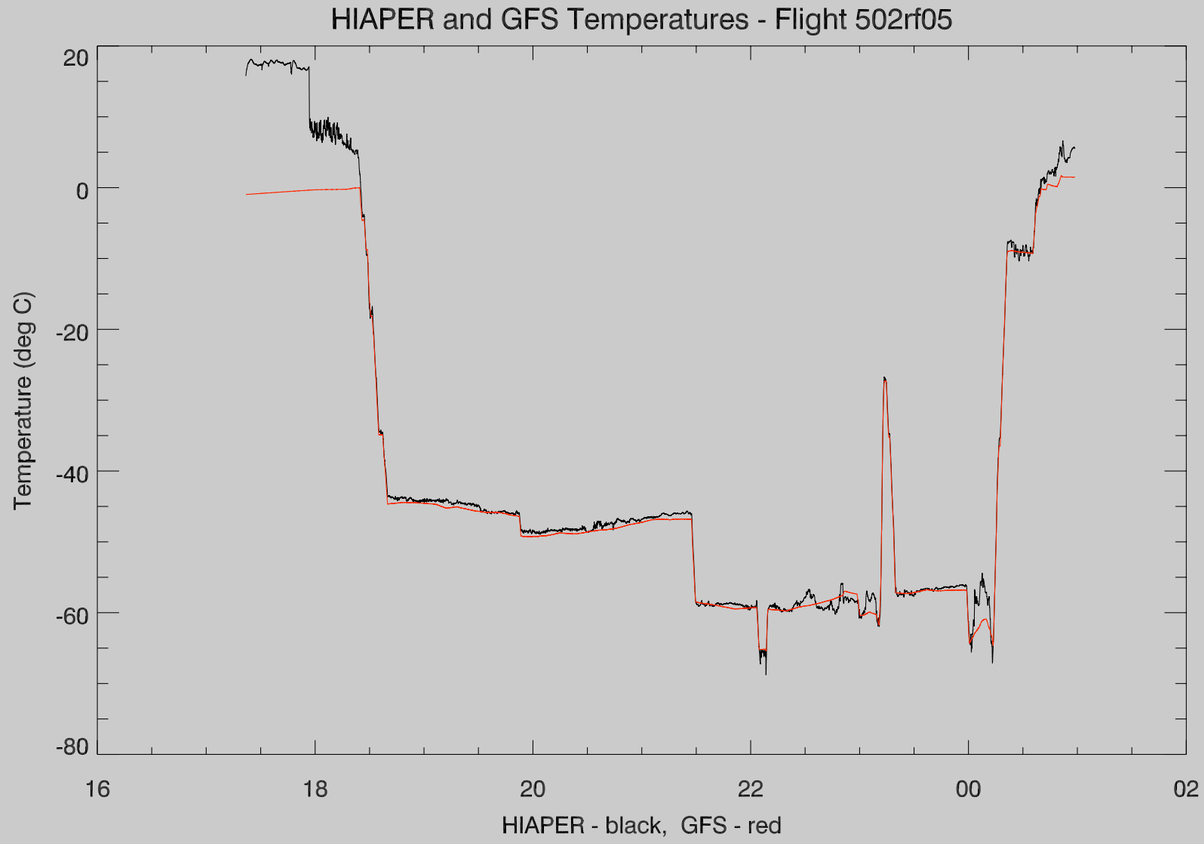


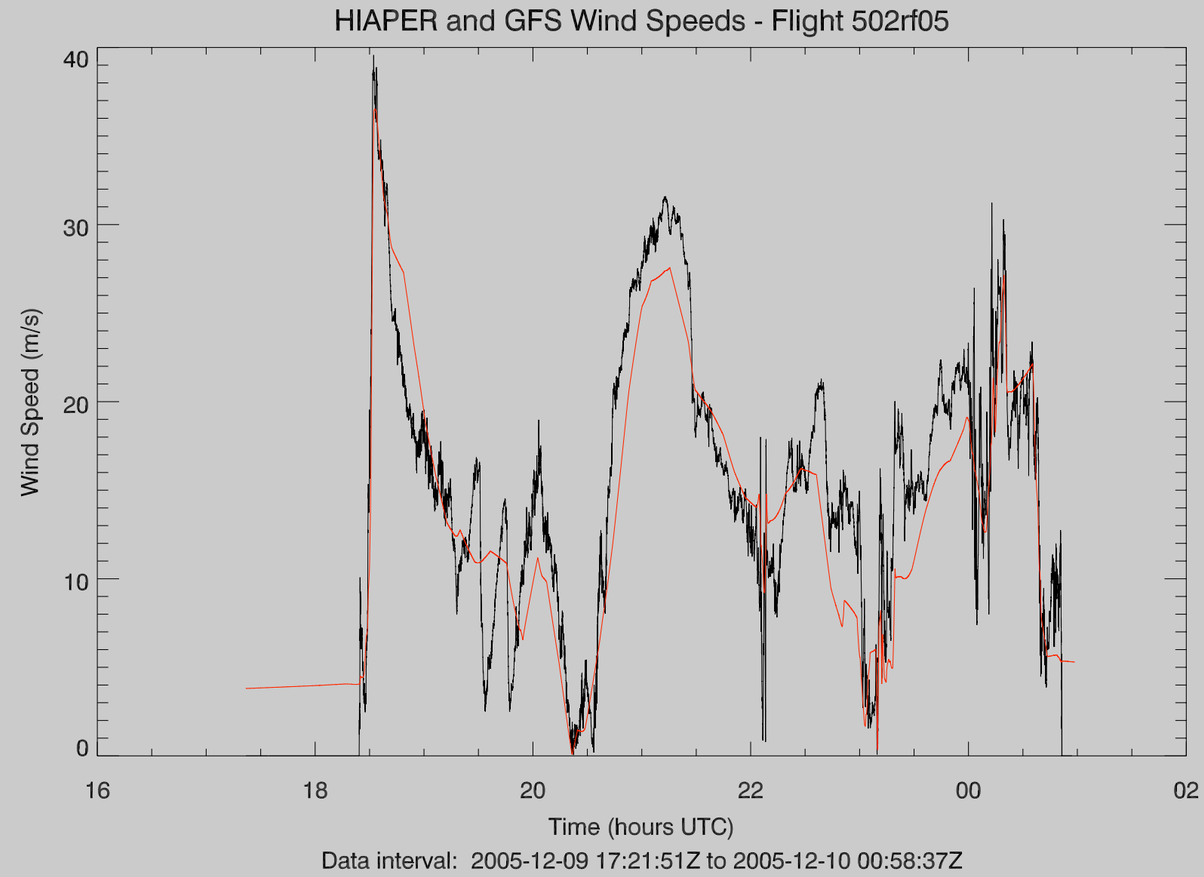




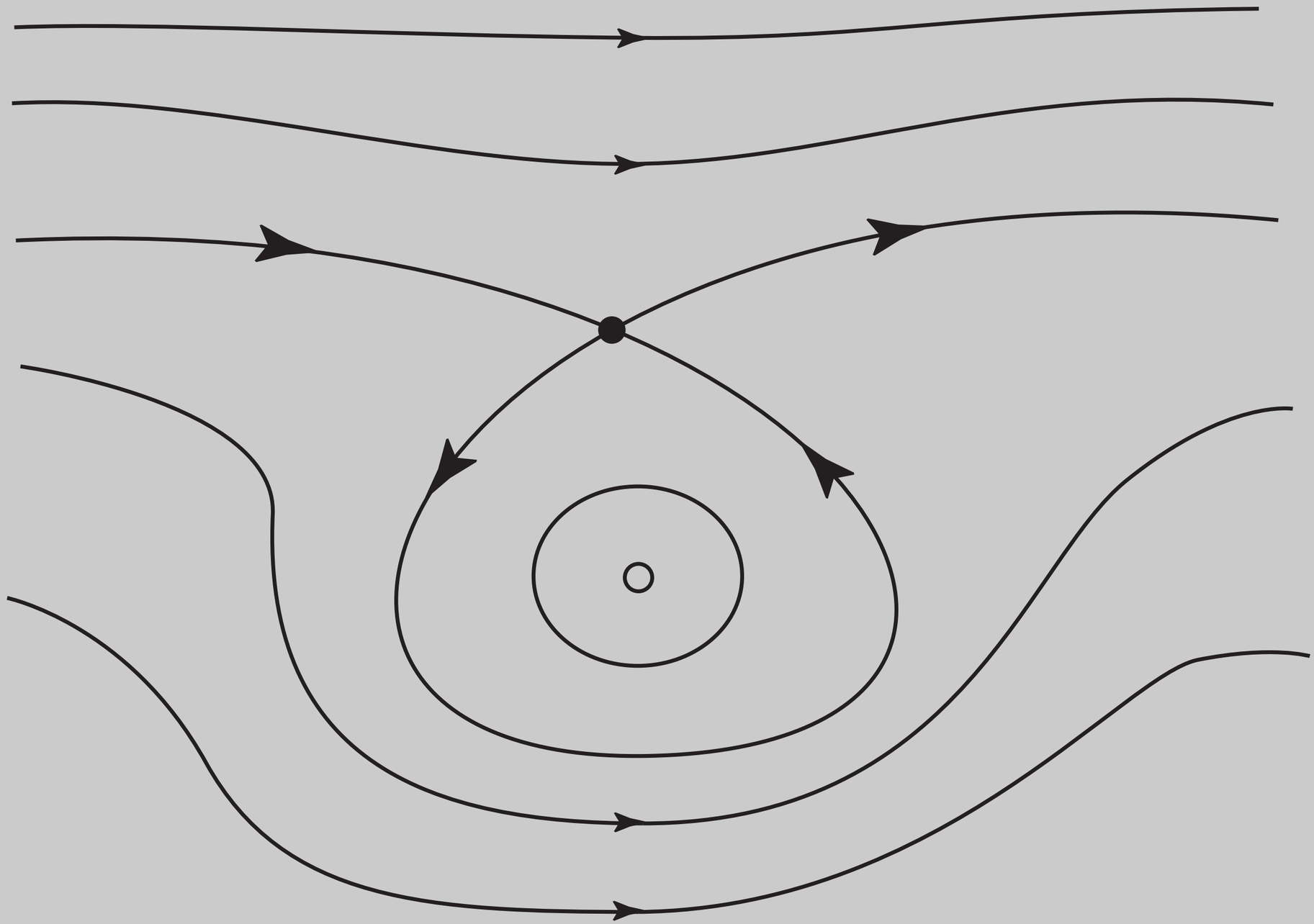
GFS/HIAPER Comparisons - Flight 5



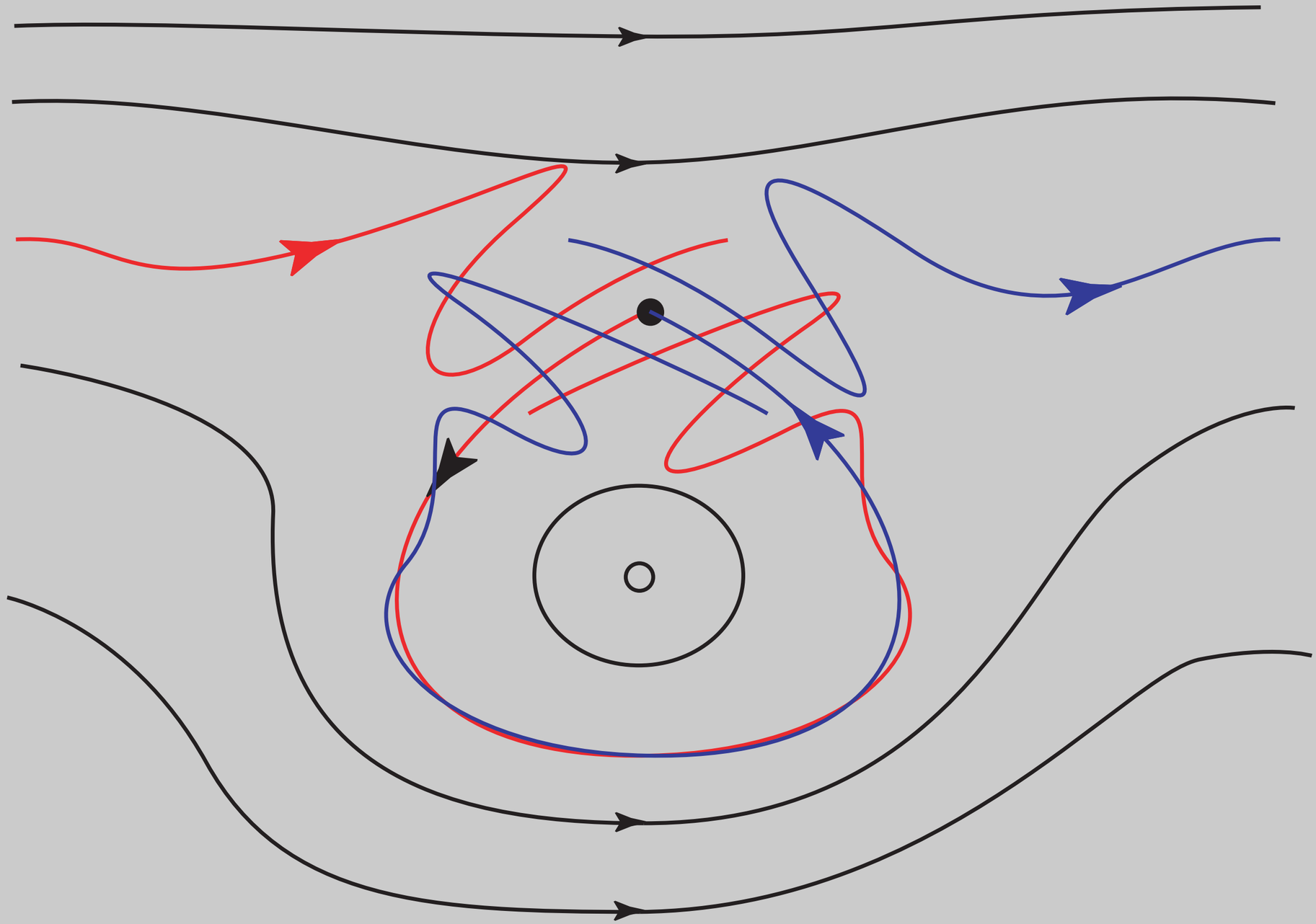




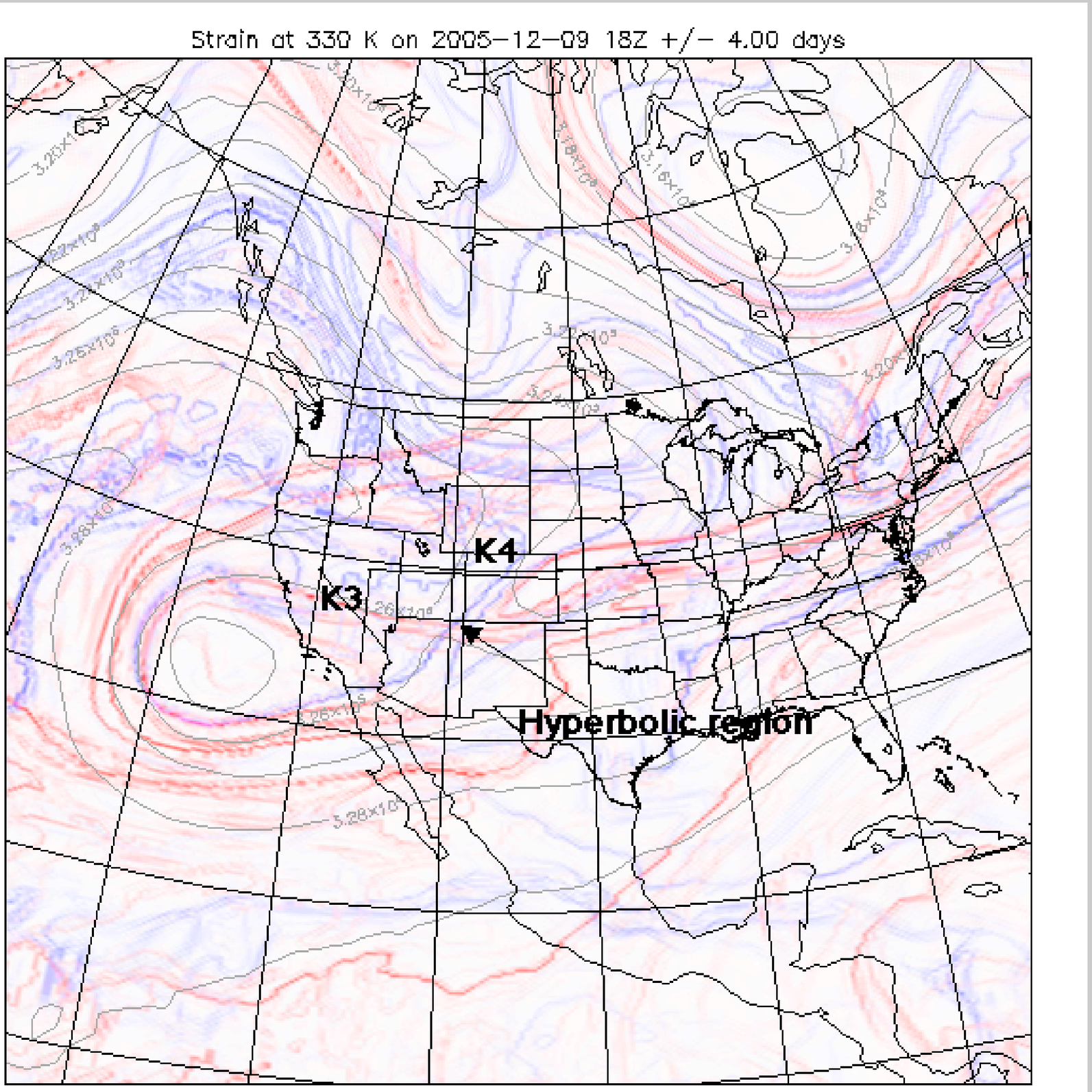
Horizontal Transport
steady flow around a cut-off low



Horizontal Transport
unsteady flow around a cut-off low



Mapping the flow deformation



Trajectory Model

- Solves Lagrangian equations of motion in pressure coordinates (Bowman, *JGR*,1993)

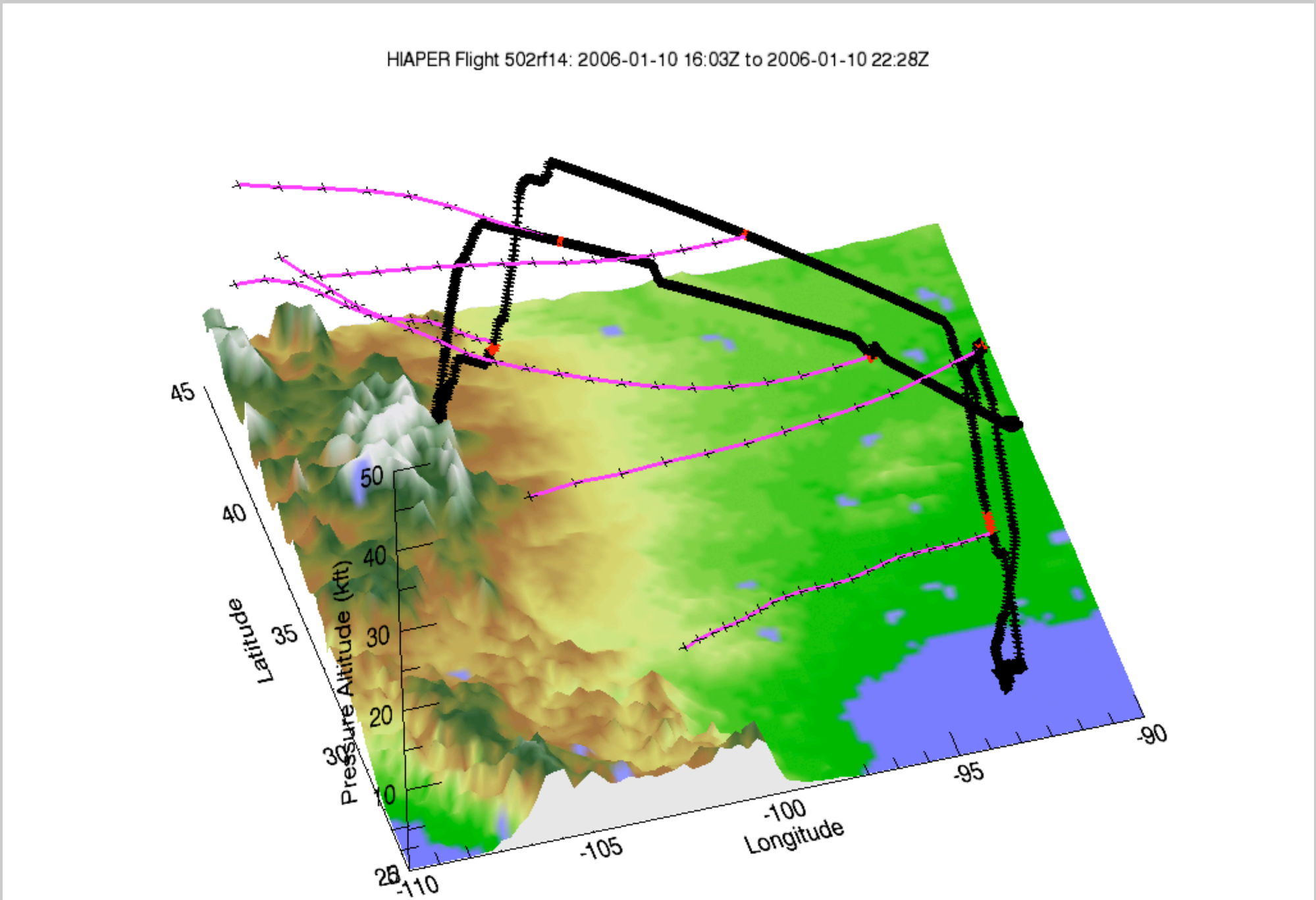
$$\frac{d\mathbf{x}}{dt} = \mathbf{v}(\mathbf{x}, t), \mathbf{x} = (x, y, z), \mathbf{v} = (u, v, w)$$

- 4-th order Runge-Kutta scheme with 30-minute time steps
- Linear interpolation of GFS winds to particle locations
- Errors in wind field should be the dominant source of error

Forward and Backward Trajectories

- 5-day back trajectories computed from initial positions every minute along the flight track (second = 00)
- One trajectory per file
- Particle locations saved at start, end, and on the hour (minute = second = 00)
- Subsets consisting of every 10th and 60th trajectory (10 minutes and 1 hour)
- Particles that go “underground” are set to NaN

Once-Hourly Back Trajectories - Flight 14



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Visualization Tools - GFS variables

Where to Get the Ancillary Data Files

- Data: http://csrp.tamu.edu/hiaper/archive/
- Software: k-bowman@tamu.edu