NetCDF Description for Near Real-Time Surface Currents Produced by the HF-Radar Network

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In order to promote data distribution and interoperability, sea surface velocities computed in near real-time by the HF-Radar Network (HFRNet) are stored in a portable and self-describing format called NetCDF (Network Common Data Form). NetCDF is a data format with supporting software libraries and conventions that enable the creation, access, and sharing of scientific data. A full description of NetCDF including documentation, conventions and software is available through Unidata at http://www.unidata.ucar.edu/software/netcdf/index.html.

Two conventions are used for organizing and describing surface currents stored in NetCDF. The Climate and Forecasting (CF) Metadata Convention (http://cf-pcmdi.llnl.gov/) provides the majority of the framework for describing both the data and associated metadata including standardized attributes, units and variable names. Although still in draft form (and thereby not explicitly stated in the NetCDF file), the Attribute Convention for Dataset Discovery (http://www.unidata.ucar.edu/software/netcdf-java/formats/DataDiscoveryAttConvention.html) has been adopted to anticipate support for data discovery through applications such at THREDDS (Thematic Real-time Environmental Distributed Data Services, http://www.unidata.ucar.edu/projects/THREDDS/).

Additional attributes beyond those prescribed by the CF Metadata Convention and Attribute Convention for Dataset Discovery are described below (see Appendix A for example entries):

netcdf_library_version	NetCDF library version used to create the file
format_version	HFRNet NetCDF format version
product_version	HFRNet product version
grid_resolution	Nominal grid resolution
grid_projection	Projection used to generate the grid
regional_description	Regional description of grid coverage

Topics under consideration for future versions of NetCDF format datasets include:

- Addition of a vertical dimension with appropriate qualifiers indicating a nominal depth
- Refine contributing site and network representation so that it is compatible with aggregation

- Add the number of radials, contributing site names and an error estimate for each solution (velocity)

HFRNet surface currents have been formatted for NetCDF by the Coastal Observing Research and Development Center at Scripps Institution of Oceanography with valuable insight and contributions from Steve Hankin (NOAA), John Wilkin (Rutgers) and Eoin Howlett (ASA). Questions and comments should be directed to Mark Otero (motero@mpl.ucsd.edu).

Appendix A: Sample file header (produced by ncdump –h)

```
netcdf 200812011100_HFRadar_USWC_6km_rtv_SIO {
dimensions:
        time = UNLIMITED ; // (1 currently)
        lat = 367 ;
        lon = 234 ;
        nSites = 55 ;
        nSites_maxStrlen = 25 ;
        nProcParam = 7 ;
variables:
        int time(time) ;
                time:standard_name = "time" ;
                time:units = "seconds since 1970-01-01" ;
                time:calendar = "gregorian" ;
        float lat(lat) ;
                lat:standard_name = "latitude" ;
                lat:units = "degrees_north" ;
        float lon(lon) ;
                lon:standard_name = "longitude" ;
                lon:units = "degrees_east" ;
        short u(time, lat, lon) ;
                u:standard_name = "surface_eastward_sea_water_velocity" ;
                u:units = "m s-1" ;
                u:_FillValue = -32768s ;
                u:scale_factor = 0.01f ;
                u:ancillary_variables = "DOPx" ;
        short v(time, lat, lon) ;
                v:standard_name = "surface_northward_sea_water_velocity" ;
                v:units = "m s-1" ;
                v:_FillValue = -32768s ;
                v:scale_factor = 0.01f ;
                v:ancillary_variables = "DOPy" ;
        short DOPx(time, lat, lon) ;
                DOPx:long_name = "longitudinal dilution of precision" ;
                DOPx:comment = "The longitudinal dilution of precision (DOPx) represents the\n",
                        "contribution of the radars\' configuration geometry to\n",
                        "uncertainty in the eastward velocity estimate (u). DOPx is a\n",
                        "direct multiplier of the standard error in obtaining the\n",
                        "standard deviation for the eastward velocity estimate from the\n",
                        "least squares best fit. DOPx and DOPy are commonly used to\n",
                        "obtain the geometric dilution of precision\n",
                        "(GDOP = sqrt(DOPx^2 + DOPy^2)), a useful metric for filtering\n",
                        "errant velocities due to poor geometry." ;
```

```
            DOPx:_FillValue = -32768s ;
            DOPx:scale_factor = 0.01f ;
        short DOPy(time, lat, lon) ;
            DOPy:long_name = "latitudinal dilution of precision" ;
            DOPy:comment = "The latitudinal dilution of precision (DOPy) represents the\n",
                "contribution of the radars\' configuration geometry to\n",
                "uncertainty in the northward velocity estimate (v). DOPy is a\n",
                "direct multiplier of the standard error in obtaining the\n",
                "standard deviation for the northward velocity estimate from the\n",
                "least squares best fit. DOPx and DOPy are commonly used to\n",
                "obtain the geometric dilution of precision\n",
                "(GDOP = sqrt(DOPx^2 + DOPy^2)), a useful metric for filtering\n",
                "errant velocities due to poor geometry." ;
            DOPy:_FillValue = -32768s ;
            DOPy:scale_factor = 0.01f ;
        float site_lat(nSites) ;
            site_lat:long_name = "Contributing radar site latitudes" ;
            site_lat:standard_name = "latitude" ;
            site_lat:units = "degrees_north" ;
        float site_lon(nSites) ;
            site_lon:long_name = "Contributing radar site longitudes" ;
            site_lon:standard_name = "longitude" ;
            site_lon:units = "degrees_east" ;
        char site_code(nSites, nSites_maxStrlen) ;
            site_code:long_name = "Contributing radar site code" ;
        char site_netCode(nSites, nSites_maxStrlen) ;
            site_netCode:long_name = "Contributing radar site network affiliation code" ;
        float procParams(nProcParam) ;
            procParams:long_name = "RTV processing parameters" ;
            procParams:comment = "\n",
                "01) Maximum GDOP threshold\n",
                "02) Maximum speed threshold (cm s-1)\n",
                "03) Minimum number of sites required\n",
                "04) Minimum number of radials required\n",
                "05) Maximum angular gap to interpolate radial\n",
                "    data over (degrees, 0 = no interpolation)\n",
                "06) Maximum gap in range to interpolate radial\n",
                "    data over (range-resolution, 0 = no interpolation)\n",
                "07) Spatial search radius for radial solutions (km)" ;

// global attributes:
            :netcdf_library_version = "netcdf library version \"3.6.3\" of Aug 14 2008 22:45:23 $" ;
            :format_version = "HFRNet_1.0.0" ;
            :product_version = "HFRNet_1.1.04" ;
            :Conventions = "CF-1.1" ;
            :title = "Near-Real Time Surface Ocean Velocity" ;
            :institution = "Scripps Institution of Oceanography" ;
            :source = "Surface Ocean HF-Radar" ;
            :history = "01-Dec-2008 23:28:05:  NetCDF file created" ;
            :references = "Terrill, E. et al., 2006. Data Management and Real-time\n",
                "Distribution in the HF-Radar National Network. Proceedings\n",
                "of the MTS/IEEE Oceans 2006 Conference, Boston MA,\n",
                "September 2006." ;
            :creator_name = "Mark Otero" ;
            :creator_email = "motero@mpl.ucsd.edu" ;
            :creator_url = "http://cordc.ucsd.edu/projects/mapping/" ;
```

```
        :summary = "Surface ocean velocities estimated from HF-Radar are\n",
            "representitive of the upper 0.3 - 2.5 meters of the\n",
            "ocean.  The main objective of near-real time\n",
            "processing is to produce the best product from\n",
            "available data at the time of processing.  Radial\n",
            "velocity measurements are obtained from individual\n",
            "radar sites through the HF-Radar Network and\n",
            "processed to create near-real time velocities\n",
            "(RTVs)" ;
        :geospatial_lat_min = 30.25f ;
        :geospatial_lat_max = 49.99204f ;
        :geospatial_lon_min = -130.36f ;
        :geospatial_lon_max = -115.8056f ;
        :grid_resolution = "6km" ;
        :grid_projection = "equidistant cylindrical" ;
        :regional_description = "Unites States, West Coast" ;
}
```