

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 Network Common Data Form (NetCDF). 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 from [Unidata](#).

Two conventions are used for organizing and describing surface currents stored in NetCDF. The [Climate and Forecast \(CF\) Metadata Convention](#) provides the majority of the framework for describing both the data and associated metadata including standardized attributes, units, and variable names. The [Attribute Convention for Dataset Discovery \(ACDD\)](#) is also followed in order to make data available to discovery systems such as the [Thematic Real-time Environmental Distributed Data Services \(THREDDS\)](#).

The following features have been added in product version 2.0.00:

- Updates for current versions of CF & ACDD metadata standards
- Updates to processing metadata
- Updates to contributing radial metadata
- Added depth as a scalar coordinate vertical variable
- Added time and depth bounds as cell boundaries
- Added the grid geoid
- Added the horizontal dilution of precision (HDOP)
- Added the number of sites and radials contributing to each total solution

Questions and comments should be directed to [HFRNet administrators](#).

Appendix A: Sample file header

```
netcdf \202103091200_hfr_uswc_6km_rtv_uwls_SIO {
dimensions:
    time = UNLIMITED ; // (1 currently)
    lat = 367 ;
    lon = 234 ;
    nv = 2 ;
variables:
    int time(time) ;
        time:standard_name = "time" ;
        time:units = "seconds since 1970-01-01" ;
        time:calendar = "gregorian" ;
        time:bounds = "time_bnds" ;
    float lat(lat) ;
        lat:standard_name = "latitude" ;
        lat:units = "degrees_north" ;
    float lon(lon) ;
        lon:standard_name = "longitude" ;
        lon:units = "degrees_east" ;
    int time_bnds(time, nv) ;
    float depth ;
        depth:standard_name = "depth" ;
        depth:units = "m" ;
        depth:bounds = "depth_bnds" ;
        depth:comment = "Nominal depth (and corresponding bounds) based on contributing radars" ;
    float depth_bnds(nv) ;
    byte wgs84 ;
        wgs84:grid_mapping_name = "latitude_longitude" ;
        wgs84:longitude_of_prime_meridian = 0.f ;
        wgs84:semi_major_axis = 6378137.f ;
        wgs84:inverse_flattening = 298.257223563 ;
    short u(time, lat, lon) ;
        u:standard_name = "surface_eastward_sea_water_velocity" ;
        u:units = "m s-1" ;
        u:_FillValue = -32767s ;
        u:scale_factor = 0.01f ;
        u:grid_mapping = "wgs84" ;
        u:coordinates = "depth" ;
        u:cell_methods = "depth: mean time: mean" ;
        u:ancillary_variables = "dopx" ;
    short v(time, lat, lon) ;
        v:standard_name = "surface_northward_sea_water_velocity" ;
        v:units = "m s-1" ;
        v:_FillValue = -32767s ;
        v:scale_factor = 0.01f ;
        v:grid_mapping = "wgs84" ;
        v:coordinates = "depth" ;
        v:cell_methods = "depth: mean time: mean" ;
        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 radial geometry to uncertainty in the eastward \n",
            "velocity estimate (u)." ;
        dopx:_FillValue = -32767s ;
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dopx:scale_factor = 0.01f ;
dopx:grid_mapping = "wgs84" ;
dopx:coordinates = "depth" ;
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 radial geometry to uncertainty in the northward \n",
    "velocity estimate (v).";
dopy:_FillValue = -32767s ;
dopy:scale_factor = 0.01f ;
dopy:grid_mapping = "wgs84" ;
dopy:coordinates = "depth" ;
short hdop(time, lat, lon) ;
hdop:long_name = "horizontal dilution of precision" ;
hdop:comment = "The horizontal dilution of precision (hdop) is the vector length \n",
    "(magnitude) of the eastward (dopx) and northward (dopy) dilution of \n",
    "precision. It represents the contribution of radial geometry to the \n",
    "overall uncertainty in the total velocity (u and v) estimate." ;
hdop:_FillValue = -32767s ;
hdop:scale_factor = 0.01f ;
hdop:grid_mapping = "wgs84" ;
hdop:coordinates = "depth" ;
hdop:ancillary_variables = "dopx dopy" ;
byte number_of_sites(time, lat, lon) ;
number_of_sites:long_name = "number of contributing radars" ;
number_of_sites:units = "count" ;
number_of_sites:comment = "Number of radars contributing radials to the total solution" ;
number_of_sites:_FillValue = -127b ;
number_of_sites:grid_mapping = "wgs84" ;
number_of_sites:coordinates = "depth" ;
short number_of_radials(time, lat, lon) ;
number_of_radials:long_name = "number of contributing radials" ;
number_of_radials:units = "count" ;
number_of_radials:comment = "Number of radials contributing to the total solution" ;
number_of_radials:_FillValue = -32767s ;
number_of_radials:grid_mapping = "wgs84" ;
number_of_radials:coordinates = "depth" ;
byte processing_parameters ;
processing_parameters:long_name = "Methods and parameters used to compute total solutions" ;
processing_parameters:combine_method_name = "Unweighted Least Squares" ;
processing_parameters:combine_method_description = "Method used to compute total solutions from radial velocities" ;
processing_parameters:grid_search_radius = 10.f ;
processing_parameters:grid_search_radius_units = "km" ;
processing_parameters:grid_search_radius_description = "Search radius used for finding contributing radial velocities" ;
processing_parameters:max_radial_speed = 100 ;
processing_parameters:max_radial_speed_units = "cm s-1" ;
processing_parameters:max_radial_speed_description = "Maximum radial speed allowed to contribute to total solutions" ;
processing_parameters:max_rtv_speed = 100 ;
processing_parameters:max_rtv_speed_units = "cm s-1" ;
processing_parameters:max_rtv_speed_description = "Maximum allowed total speed" ;
processing_parameters:min_radar_sites = 2s ;
processing_parameters:min_radar_sites_description = "Minimum number of radar sites required to make a total solution" ;
processing_parameters:min_radials = 3s ;
processing_parameters:min_radials_description = "Minimum number of radials required to make a solution" ;
processing_parameters:max_hdop = 1.25f ;
processing_parameters:max_hdop_description = "Maximum allowed HDOP" ;

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byte radial_metadata ;
  radial_metadata:long_name = "Metadata on radial velocities used to compute total solutions" ;
  radial_metadata:number_files_loaded = 62s ;
  radial_metadata:number_files_loaded_description = "Number of radial files loaded" ;
  radial_metadata:files_loaded = "RDL_m_BML_BML1_2021_03_09_1200.ruv\n",
    "RDL_m_BML_BRAG_2021_03_09_1200.ruv\n",
    "RDL_m_BML_PAFS_2021_03_09_1200.ruv\n",
    "RDL_m_BML_PBON_2021_03_09_1200.ruv\n",
    ...
    "RDL_m_ONC_VATK_2021_03_09_1200.ruv" ;
  radial_metadata:files_loaded_description = "Radial file names loaded" ;

// global attributes:
:Conventions = "ACDD-1.3,CF-1.7" ;
:id = "202103091200siohfrwlsrtvuswc6km" ;
:date_created = "2021-03-09T15:22:36Z" ;
:source = "surface ocean velocity field from hf-radar" ;
:program = "Integrated Ocean Observing System (IOOS)" ;
:title = "Near-Real Time Surface Ocean Velocity, U.S. West Coast, 6km Resolution" ;
:summary = "Surface ocean velocities estimated from HF-Radar are representative \n",
  "of the upper 2.4 meters of the ocean. The main objective of \n",
  "near-real time processing is to produce the best product from \n",
  "available data at the time of processing. Radial velocity \n",
  "measurements are obtained from individual radar sites through the \n",
  "U.S. HF-Radar Network. Hourly radial data are processed by unweighted \n",
  "least squares on a 6km resolution grid of the U.S. West Coast to \n",
  "produce near real-time surface current maps." ;
:instrument = "Earth Remote Sensing Instruments, Active Remote Sensing, \n",
  "Profilers/Sounders, Radar Sounders, Doppler RADAR" ;
:keywords = "Earth Science, Oceans, Sea Surface, Coastal Processes, Marine \n",
  "Environment Monitoring, Ocean Circulation, Ocean Currents, \n",
  "Wind-Driven Circulation, Tides, Tidal Currents, Pacific Ocean, North \n",
  "Pacific Ocean" ;
:geospatial_lat_min = 30.25f ;
:geospatial_lat_max = 49.99204f ;
:geospatial_lon_min = -130.36f ;
:geospatial_lon_max = -115.8056f ;
:processing_level = "Near real-time dataset with automated data acquisition and processing \n",
  "quality control" ;
:history = "2021-03-09T12:53:22Z hfrnet rtvMergeData: Saving 4 new solutions\n",
  "2021-03-09T13:23:02Z hfrnet rtvMergeData: Saving 1787 solutions; 1787 \n",
  "new or updated, 0 unmodified from previous run(s)\n",
  "2021-03-09T13:53:05Z hfrnet rtvMergeData: Saving 2678 solutions; 1886 \n",
  "new or updated, 792 unmodified from previous run(s)\n",
  "2021-03-09T14:22:41Z hfrnet rtvMergeData: Saving 5017 solutions; 4340 \n",
  "new or updated, 677 unmodified from previous run(s)\n",
  "2021-03-09T14:52:43Z hfrnet rtvMergeData: Saving 9704 solutions; 7298 \n",
  "new or updated, 2406 unmodified from previous run(s)\n",
  "2021-03-09T15:22:36Z hfrnet rtvMergeData: Saving 9704 solutions; 7 \n",
  "new or updated, 9697 unmodified from previous run(s)\n",
  "2021-03-09T15:22:36Z hfrnet rtvSaveNetcdf: Removed 1530 solutions \n",
  "exceeding HDOP threshold of 1.25" ;
:references = "Terrill, E. et al., 2006. Data Management and Real-time Distribution \n",
  "in the HF-Radar National Network. Proceedings of the MTS/IEEE Oceans \n",
  "2006 Conference, Boston MA, September 2006." ;
:institution = "Coastal Observing Research and Development Center, Scripps Institution of Oceanography" ;

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:creator_type = "group" ;
:creator_name = "HFRNet Administrators" ;
:creator_email = "hfrnet.administrators@sio.ucsd.edu" ;
:creator_url = "http://cordc.ucsd.edu/projects/mapping/" ;
:naming_authority = "edu.ucsd.cordc" ;
:standard_name_vocabulary = "CF Standard Name Table, Version 51" ;
:keywords_vocabulary = "Global Change Master Directory (GCMD) Keywords, Version 8.6" ;
:instrument_vocabulary = "Global Change Master Directory (GCMD) Keywords, Version 8.6" ;
:format_version = "1.1.00" ;
:product_version = "2.0.00" ;
```

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}
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