

APPENDIX E2.1. DATA STREAM PLAN: NESDIS COMMON CLOUD FRAMEWORK WITH HF RADAR DATA DISTRIBUTION OF HF RADAR DERIVED HOURLY SURFACE CURRENTS (500M, 2KM, 6KM), JULY 2025

1. DATA AND INFORMATION TYPES

A. Provide a contextual description of the data stream.

The National Environmental Satellite, Data, and Information Service (NESDIS) common cloud data distribution system computes the HF radar-derived surface currents. The service was transitioned from the Coastal Observing Research and Development Center (CORDC) in July of 2025.. The data sets are made available in near real-time through the National Data Buoy Centers (NDBC) THREDDS server. Archived data are available through The National Center for Environmental Information (NCEI) ERDDAP server. Surveys of west coast marine managers, researchers, and general users from both the marine debris and OA communities have expressed interest in a) general information on coastal oceanographic information across seasons and b) specific information on how surface currents move along the West Coast at any given time, to track various components of the water (e.g. floating debris). IOOS HF-Radar Network viewer provides near-real-time information on actual surface currents data off the West Coast. Compared to satellite-based data collection (e.g. SST, SSH), the IOOS HF-Radar Network system provides the advantage of being able to collect data even on cloudy days. The IOOS HF-Radar Network system provides a robust, long-term dataset that can be used for: 1) Studying surface water movements off the West Coast, 2) Identifying persistent eddies and frontal features at various locations, 3) Applications to fisheries tracking/management, and 4) Applications to point-source movements (e.g. debris, contaminants, search and rescue).

In brief, high frequency radio waves are emitted towards the sea surface from HF radar stations near the seashore. Additional stations listen to the scattered return signal, measure the speed of the waves that scatter the signal, and use the return time and location of returned waves to calculate sea surface velocity. See the [IOOS HF-Radar Network document](#) for more technical information.

CeNCOOS maintains a network of 30 HF Radar stations from the Big Sur Coast up to northern California and extending into San Francisco Bay. In 2002, the Coastal Ocean Currents Monitoring Program (COCMP) began creating a California network of high-frequency radar (HFR) instruments to monitor coastal ocean surface currents in real-time and provide surface current forecasting capabilities as mandated by state funding propositions. CeNCOOS worked with COCMP to expand the HFR network in the region, and received funds for operating costs and began creating and distributing products to address stakeholder needs. California State funding for the program ended after 2010.

Current operational funding comes solely from NOAA, with a portion of the overall CeNCOOS grant directed specifically to operating HF Radar stations. This funding covers operations and maintenance for a subset of our original HF Radar stations ranging from the Northern California Border, down to South of Carmel Bay. The Southern California Coastal

Ocean Observing System (SCCOOS) is responsible for maintaining HF Radar stations from San Luis Obispo down to the California-Mexican border. These priority stations are chosen at the federal level and are selected by the economic/commercial importance of surface current measurements.

B. How many station locations are there for this data stream?

CeNCOOS maintains a network of 27 HF Radar stations from the Big Sur Coast up to northern California and extending into San Francisco Bay. See [IOOS HF Radar Station Map](#).

C. What are the specific variables of the data?

High Frequency radar produces hourly calculated surface seawater velocity vectors on a regular grid at 500 m, 2 km, and 6 km depending on the HF Radar Station instrumentation.

D. Provide information about the sampling platform or instrumentation.

The sampling platform includes shore-based HF radar systems. Sea surface current data is measured with SeaSondes, compact HF radars produced by CODAR Ocean Sensors, Ltd. They use patented frequency modulated continuous wave (FMCW) signal processing and crossloop direction finding to measure ocean surface currents and wave variables of the coastal ocean. General instrumentation for each station consists of a transmitter, receiver, 2 antennas, and data acquisition and processing computers. A transmitter broadcasts a frequency modulated radio frequency pulse at 2Hz (two pulses per second). The Doppler shifted return signal, called the sea echo, is detected with a compound cross loop/monopole receive antenna and the signal is processed into estimates of surface current speed and direction.

For example the Bodega Marine Laboratory of University of California, Davis (BML) operates three 12 MHz HF Radar Stations around Bodega Bay, California, and combined, have a spatial resolution of 2 km and create hourly maps of surface currents out to a distance of 30-50 km (20-30 miles) along a 65 km (40 mile) length of shore. This means a total coverage area for the 3-radar array is approximately 2800 km². BML's two 5 MHz stations have a spatial resolution of 5km and create hourly maps of surface currents out to a distance of 90-200 km (55-125 miles).

2. DATA PATHWAY

A. Is a data sharing agreement required?

The data may be used and redistributed for free but is not intended for legal use, since it may contain inaccuracies. Neither the data Contributor, ERD, NOAA, nor the United States Government, nor any of their employees or contractors, makes any warranty, express or implied, including warranties of merchantability and fitness for a particular purpose, or assumes any legal liability for the accuracy, completeness, or usefulness, of this information.

B. In which format(s) was data received by CeNCOOS?

Data are ingested into the CeNCOOS data portal directly from the [NDBC Thredds Data Server \(TDS\)](#).

C. How can the information be accessed?

The data are available through the CeNCOOS data portal, where it can be downloaded or explored through interactive visualizations. Specifically the data are available from two unique access points:

- Web Mapping Service (WMS)
- THREDDS (OpENDAP, NetCDF, etc)

D. What file formats will be used for sharing data, if different from original?

Data are shared as WMS and through THREDDS. Data are also available for exploration in the CeNCOOS portals via interactive, graphical visualizations.

E. Describe how the data is ingested(e.g. the flow of data from source to CeNCOOS data portals) and any transformations or modifications made to share data in the CeNCOOS data portal.

Raw data received at shore based computer systems is retrieved by NESDIS, which acts as the national node for IOOS HFR DAC. Here raw radial data is converted into surface current vectors, gridded, and undergoes QC. The data is made available in the NetCDF format through an Open-source Project for a Network Data Access Protocol (OPeNDAP).

The following data types are contained in the columns that comprise each row:

Longitude and Latitude

Current speed and direction vectors (north-south (U) and east-west components)

Error Flags

Statistics (U and V Standard Deviation, Covariance)

X and Y Grid Coordinates

Range, Bearing, Velocity, and Direction

Antenna site that contributed to data

Data are then downloaded from the source to the CeNCOOS storage. Custom Java, Scala, and Python scripts are used to convert data formats suitable for internal and external interoperability services. Data are made available in the CeNCOOS portals through the access points and via graphic displays generated through internal JSON-format data requests from these services.

Graphic displays include a mapping service, customized interactive visualizations, and time-series plots of the unit values wherein each parameter is graphed independently. Back-end scripts handle the conversion of visualized data from CF standards to other, non-CF units that may be requested by the user. Data files may be downloaded by the user from the CeNCOOS data portal. A user request for a CSV file request pulls the data from the server cache. A user request for ERDDAP pulls data from the ERDDAP service using

the same cache. The CF standard names are surface_eastward_sea_water_velocity and surface_northward_sea_water_velocity, or additionally it could be sea_water_speed and sea_water_velocity_to_direction if reported as speed and direction instead of components.

Summary statistics generated within the interactive graphical displays may be requested by the user. Summary statistics may include minimum, maximum and mean values. Seasonal statistics, available on time series longer than 3 years, include mean, and 10th and 90th percentiles. Note: the number of points visually available to interactive users from the source data are limited when necessary using temporal binning, such as daily, weekly, monthly, seasonally and yearly.

F. What metadata or contextual information is provided with the data?

Data are shared in the CeNCOOS portals with descriptive project and file metadata describing the data and accompanying fields. Metadata are also available via ERDDAP: <http://erddap.cencoos.org/erddap/index.html>

G. Are there ethical restrictions to data sharing?

No

a. If so, how will these be resolved?

N/A

H. Who holds intellectual property rights (IPR) to the data?

Data are free and open to all under a CC0 1.0 license

I. Describe any effect of IPR on data access.

None

3. DATA SOURCE AND QUALITY CONTROL

A. Indicate the data source type (i.e. Federal, Non-Federal, University, State Agency, Local Municipality, Military Establishment (branch), private industry, NGO, non-Profit, Citizen Science, Private individual)

University

a. If Federal data source, were changes applied to the data?

No

b. If Yes, describe any changes to the data that require documentation?

N/A

B. Indicate the data reporting type (e.g. real-time, historical).

Near real-time

C. If real-time, list the QARTOD procedures that are currently applied.

All HFR surface current data in the CeNCOOS portal has been through QC applied at the HF Radar Data Assembly Center. Raw radial values are not made available, unless they are specifically requested.

D. If real-time, list the QARTOD procedures that are planned for implementation.

N/A

E. What is the status of the reported data? (e.g. raw, some QC, incomplete, delayed mode processed but not QC'd)

See [IOOS HF Radar QC Practices](#)

F. Describe the data control procedures that were applied by the originator.

See [IOOS HF Radar QC Practices](#) for description of QC tests.

a. Provide a link to any documented procedures.

https://hfradar.ioos.us/hfrnet/documents/HFRNet_QC-RTVproc.pdf

G. Describe the data control procedures that were applied by CeNCOOS.

N/A

a. Provide a link to any documented procedures.

N/A

H. List the procedures taken for data that could not be QC'd as directed.

N/A

4. STEWARDSHIP AND PRESERVATION POLICIES

A. Who is responsible for long-term data archiving?

NESDIS and NDBC are responsible for submitting all CeNCOOS generated HF Radar data to NCEI for archival. For more information see "[A Plan to meet the nation's needs for surface current mapping](#)".

B. Which long-term data storage facility will be used for preservation?

NCEI

C. Describe any transformation necessary for data preservation.

N/A

D. List the metadata or other documentation that will be archived with the data.

N/A