



LLUV File Format

111.01.1609.FF

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LLUV Format for Totals, Radials & Ellipticals

LLUV (Lat,Lon,U,V) is the file format common to SeaSonde **Totals**, **Radials**, and **Ellipticals**. The LLUV format is built upon the **Columnar Table Format (CTF)** which is covered in a separate document which you should be familiar with before reading this document. With Release 8, it possible that these normally text base files have been compressed with gzip and extensions will append a 'z', which need to be unzipped before reading. SeaSonde readers automatically handle this.

Totals contain the total current vectors combined from two or more SeaSonde Sites.

Radials contain the radial current component towards a SeaSonde Radial Site.

Ellipticals contain the Elliptical current component from a SeaSonde Radial Site with Elliptical Processing.

Identification

The first keyword of the file will typically be '%CTF: <version>' describing the version of the CTF file. Before version 1.00, the file will be missing this key; however, it is still readable with this standard. If the CTF version is 2 or greater then the file will not likely be readable by current readers that expect 1.x

Within the first **ten** lines of the file will must be a keyword of:

%FileType: <type> <subtype> <name>

The <type> must be **LLUV** to identify it as a current map.

The <subtype> identifies one of the three variations.

rdls for Radial Current Vectors.

elps for Elliptical Current Vectors.

tots for Total Current Vectors.

To determine if the file is a **LLUV** type, you should read the first ten lines looking for the '%FileType:' keyword. The <type> value will be **LLUV**. The <subtype> value tells you which variation it is.

File Naming

File name should be use for archiving the data, not as a software determination of whether the file is a valid **LLUV** file, date stamp or contents.

The filenames follow the time-stamped CTF naming convention
TTTS_XXXX_YYYY_MM_DD_HHMM.ext'

'TTTS' is the type of file where 'S' is the type of processing used:

RDLi Radials from Ideal Antenna Pattern.

RDLm Radials from Measured Antenna Pattern.

RDLx Short-time Radials from Ideal Antenna Pattern

RDLy Short-time Radials from Measured Antenna Pattern

ELTi Ellipticals from Ideal Antenna Pattern

ELTm Ellipticals from Measured Antenna Pattern

TOTL Total Current Vectors.

'XXXX' is the four character site name.

'YYYY' is the year

'MM' is the two character month from 01 to 12

'DD' is the two character day from 01 to 31

'HH' is the two character 24 hour from 00 to 23

'MM' is the two character minute from 00 to 59

'**.ext**' is the file type extension. This is used in OS X to assign icons and the default opener for the files. It should not be used to determine if the file is a LLUV or what type of LLUV it is.

.ruv for radial files.

.tuv for total files.

.euv for elliptical files.

.ctf for generic ctf file. Could be a LLUV file or something else. Always read for %FileType: key to be sure.

Keywords

%CTF: 1.00

Identifies the file as a Columnar Table Format. The 1.00 version will change in the future if any major changes are needed in reading the format. If the CTF version is 2 or greater then the file will not be readable by current readers that expect 1.x

%FileType: LLUV <subtype> <name>

LLUV Identifies the file as a LonLatUV file. The <subtype> identifies whether is a Radial, Elliptical or Total Vector Current Map.

<subtype>

rdls for Radials.

elps for Ellipticals

tots for Totals

%LLUVSpec: <version> <yyyy> <mm> <dd>

LLUVSpec is used to when the fundamental LLUV data changes meaning, or indicates resolved problems that specific versions might need a data correction. The LLUV 1.00 version has each vector of longitude, latitude, u,v, vector flag where u,v is the current velocity towards East and North at the location of each vector. [See LLUVSpec Version History section far below.](#)

%UUID: 1DDC51D1-1F3A-11DC-8B42-001451AA6464

As of LLUVSpec 1.04, the SeaSonde LLUV files are being tagged with a UUID Universal Unique Identifier. This key is created using Mac OS X call CFUUIDCreate. Each UUID key has a very, very high chance of being unique. This key will change if the file is reprocessed. Search the Internet for more information on UUIDs.

%Manufacturer: CODAR Ocean Sensors. SeaSonde.

Identifies that the file came from SeaSonde. If you create the LLUV, please put your identity here.

%Site: XXXX ""

Contains the four-character site code followed by an optional user-friendly site name/info.

%TimeStamp: 1999 08 16 13 00 00

Identifies the center time in year, month, day, hour, minute, second of the data collected in the file.

%TimeZone: "PST" -8.00 0

Identifies the time zone of the TimeStamp. The first parameter is the time zone abbreviation in quotes. The second is the hours from UTC to the time zone. The

third is an indicator, if not zero, indicating that daylight savings is in effect.

%TimeCoverage: 60 Minutes

Identifies the coverage time in minutes of the data collected in the file. The time the LLUV data covers is represented by the timestamp minus half the coverage time to timestamp plus half the coverage time

%Origin: 28.033333 -90.016667

Is the <latitude> <longitude> in fractional degrees (positive East and North) of where all Easting Distance(x), Northing Distance(y), Range, and Bearing data is relative to.

Typically the origin is the SeaSonde Radial Site for radials and ellipsicals. For total vectors, the origin comes from the grid file origin, which was selected by the user when creating the combining grid.

%ReceiverOrigin: 28.033333 -90.016667

Is the <latitude> <longitude> in fractional degrees (positive East and North) where the receiver antenna was located. This will typically be the same for radials and for ellipsicals. In a normal radial file this is always the same as the %Origin, but during combine processing, the %Origin is temporarily moved to the grid's origin in order to properly align all combining candidates to the same x,y referencing.

%TransmitterOrigin: 28.033333 -90.016667

Is the <latitude> <longitude> in fractional degrees (positive East and North) where the transmit antenna was located. This key is typically only included for ellipsicals.

%GreatCircle: "WGS84" 6378137.000 298.257223562997

Identifies the model used to represent the Earth's surface as an ellipsoid. WGS84 is the world geodetic since 1984. 6378137 meters is the equator circumference, and the 298.2572 value is the 1/f roundness ratio.

%GeodVersion: "CGEO" 1.00 2005 03 23

Identifies the distance calculation for geo-location used. The first parameter is the name of the method. The second is the version number, followed by the year, month, and day timestamp. The CGEO is a c++ method which makes use of T. Vincenty's Great Circle calculation based upon NOAA Aug 9, 2002 FORTRAN source. This calculation measures the distance and bearings from/to any two points on the Earth using a great circle between the two points. A great circle is a circle on the globe, centered at the globe's center, and is the minimum distance between any two points. Because the SeaSonde is a surface based (follows the curvature of the Earth) the radial bearings also follow a great circle.

Another known method for this calculation is %GeodVersion: "PGEO" 0.902 2005 11 04 which is a perl module also based upon the Great Circle calculation from NOAA source. This method is currently being used by UCSD to convert classic radials and totals.

%LLUVTrustData: all %% all lluv xyuv rbvd

Indicates which LLUV data to trust when reading. Note the %% is a comment followed by the possible values for this key.

The Codar LLUV Reader will use this key to determine which LLUV data to use and then regenerate the rest. This is very useful if you want to alter the origin and/or rotation of all the data or if you want to create/edit a file for xyuv or rbvd data only and

all - indicates to accept all the LLUV data in the file.

lluv - indicates that just the lon,lat,u,v data is valid. x,y and r,b,v,d will be regenerated from this data. (Trick: One could edit the LLUV setting this key to lluv and change the origin, then run it through the utility LLUVRepair, the output LLUV will have new x,y and r,b,v,d data relative to the new origin.)

xyuv - indicates that just the x,y u,v data is valid. Lon,lat and r,b,v,d will be regenerated from the x,y from the origin and u,v. (Trick: One could move the vector to a new location by editing the LLUV and setting this key to xyuv plus changing the origin, then run it through the utility LLUVRepair, the output LLUV will have new lon,lat and r,b,v,d data relative to the new origin.)

rbvd - indicates that just the r,b,v,d (range,bearing velocity,direction) is valid. Lon,Lat, u,v and x,y will be regenerated from the origin plus the %ReferenceBearing: (Trick: One could rotate the entire set of vectors by editing the LLUV and setting this key to rbvd plus changing the reference bearing, then run it through the utility LLUVRepair, the output LLUV will have new lon,lat u,v x,y & rbvd data rotated by the edited reference bearing.)

(Note: These "tricks" also work with SeaDisplay when viewing the vectors. This can be useful when trying to compare two very close vectors that would normally be plotted right on top of each other. By offsetting one slightly in distance or rotation it is much easier to see the differences between the two.)

%RangeResolutionKMeters: 1.500

This key is the range resolution in km of a SeaSonde Radial Site and is necessary to convert the LLUV to the older 'Rad' file format. This key will only be in radial and elliptical formats.

%RangeResolutionMeters: 5.000

This key is the range resolution in meters of a RiverSonde Site or Hi-Resolution. This key will only be in radial and elliptical formats.

%AntennaBearing: 295.0 True

This key is the Receive Antenna bearing alignment.

%ReferenceBearing: 0 True

This key is used only to convert older classic radial format to/from LLUV or by %TrustData: rbvd to rotate the vectors.

%AngularResolution: 1 Deg

This key indicates the Radial or Elliptical bearing resolution.

%SpatialResolution: 5 Deg

This key indicates the Radial or Elliptical Spatial quality coverage over bearing.

%PatternType: Measured

This key indicates type of antenna pattern used to create a radial or elliptical. If Measured, a measured pattern was used for the Radial or Elliptical result. If Ideal, an ideal pattern was used for the Radial or Elliptical result.

%PatternDate: 2009 09 11 00 20 30

The time stamp of the antenna pattern used.

%PatternResolution: 1.0 deg

The bearing resolution of the antenna pattern used.

%PatternSmoothing: 10.0 deg

The bearing smoothing applied to the antenna pattern used.

%PatternUUID: E6DFDF10-D170-4DC3-86F2-E0DA6317FBC6

The UUID of the measured pattern used. Does not exist currently for Ideal patterns.

%TransmitCenterFreqMHz: 4.537183

This key is the center transmit frequency used in megahertz of the SeaSonde. This key will only be in radial and elliptical formats.

%DopplerResolutionHzPerBin: 0.000976563

This key is the Doppler bin resolution of the cross spectra used. It is use to determine current velocity. It is a calculation of the SeaSonde waveform sweep rate divided by number of Doppler cells used. This key will only be in radial and elliptical formats.

The following keys describe first order parameters. When multiple first order options are used, then there will be multiple sets of these keys where each one is preceded by %FirstOrderMethod:.

%FirstOrderMethod: <method> <start range cell> <stop range cell>

Precedes each set of multiple first order options. This optional key only appears when there are multiple first order options. The method type will typically be 0. Optionally followed by start and stop range cells for the options to be applied to. If start and stop are missing then indicates that all ranges are used. Note that Multiple First Order Options will use the last one of these where the range cell is within the start,stop.

%BraggSmoothingPoints: 2

This key is the number of smoothing points applied to the cross spectra in order to determine the first order region. This key will only be in radial and elliptical formats.

%CurrentVelocityLimit: 100.0

This key is the maximum allowed current velocity cm/s in processing the cross spectra or combining into a total vector. You will not find any LLUV vector in this file with a larger velocity.

%BraggHasSecondOrder: 0

This key is a flag if one used to tell radial processing whether to expect the cross spectra to contain second order. If no second order is expected then it is zero. This key will only be in radial and elliptical formats.

%RadialBraggPeakDropOff: 15.000

This key is a factor used by radial processing to determine the first order region. This key will only be in radial and elliptical formats.

%RadialBraggPeakNull: 7.500

This key is a factor used by radial processing to determine the first order region. This key will only be in radial and elliptical formats.

%RadialBraggNoiseThreshold: 5.000

This key is a factor used by radial processing to determine the first order region. This key will only be in radial and elliptical formats.

(End of first order options keys)

%PatternAmplitudeCorrections: 1.00 1.00

This key contains factors used by radial processing to adjust antenna pattern. This key will only be in radial and elliptical formats.

%PatternPhaseCorrections: 65.0 75.0

This key contains phases used by radial processing to adjust antenna pattern. This key will only be in radial and elliptical formats.

%PatternAmplitudeCalculations: 0.65 0.29

This key contains factors calculated by radial processing from Bragg in last CSS. This key will only be in radial and elliptical formats.

%PatternPhaseCorrections: 72.0 64.0

This key contains phases calculated by radial processing from Bragg in last CSS. This key will only be in radial and elliptical formats.

%RadialMusicParameters: 40.000 20.000 2.000

This key contains the Music algorithm parameters used by radial processing. This key will only be in radial and elliptical formats.

%MergedCount: 5

This key is the number of short-time radials merged into the final output. This key will only be in radial and elliptical formats or by LLUVMerger tool.

%RadialMinimumMergePoints: 2

This key is used by the radial processing merge to set a minimum threshold of the number of points that must exist for each range and bearing in order to merge into a final radial vector. This key will only be in radial and elliptical formats.

%ReferenceBearing: 0 DegNCW

This key is the reference angle in degrees clockwise from true North to use when converting the LLUV to the classic 'Rad' file format. This is also used by %LLUVTrustData: rbvd to rotate vectors.

%RangeStart: 1

This key identifies the first cross spectra range cell used by SeaSonde Radial Sites. It is needed when converting the LLUV to the older 'Rad' file format.

%RangeEnd: 10

This key identifies the last cross spectra range cell used by SeaSonde Radial Sites. It is needed when converting the LLUV to the older 'Rad' file format.

%TransmitSweepRateHz: 1.00000

Is the cross spectra sweep rate used a SeaSonde Radial Site.

%TransmitBandwidthKHz: -25.634758

Is the cross spectra bandwidth used a SeaSonde Radial Site. A negative value indicates a down sweep.

%SpectraRangeCells: 128

Is the number of range cells in the last cross spectra on a SeaSonde Radial Site.

%SpectraDopplerCells: 1024

Is the number of doppler cells in the last cross spectra on a SeaSonde Radial Site.

%GridVersion: 2 2004 07 16 16 16 13

Is the SeaDisplay Grid Version number and date stamp for the grid used by the Total vector

%GridAxisOrientation: 0.0 degNCW

Is the vertical (positive y) axis of the total vector source grid from north clockwise)

Note that previous to %LLUVSpec: 1.03 this was value was reported as NCW but was actually CCW from East.

%GridSpacing: 3.000 km

Is the xy separation of total vector source grid points.

%AveragingRadius: 4.000 km

Is the radius distance surrounding each grid point to include source radial/elliptical vectors into a total vector.

%DistanceAngularLimit: 20.0

Is the required minimum angular difference between source radial/elliptical vectors, in order to combine into a total vector. See Geometric Dilution Of Precision.

%CurrentVelocityLimit: 400.0 cm/s

Is the maximum total vector current limit allowed in the output. Result above this value were filtered out because they were considered to be cause from noise or spurious.

%XYUnits: "km" 1000.

This key when it is present before the LLUV table, will override the default assumption of kilometers for distance columns. The affected columns are XDST, YDST, and RNGE. The first parameter "km" is the label used for the scale. The second column is a scalar to multiple the column distance value by to get meters.

%UVUnits: "cm/s" .01

This key when it is present before the LLUV table, will override the default assumption of cm/s for velocity columns. The affected columns are VELU, VELV, VELO, VMAX, and VMIN. The first parameter "cm/s" is the label used for the scale. The second column is a scalar to multiple the column velocity value by to get meters per second.

%ProcessedTimeStamp: 2005 12 09 15 59 40

The time the LLUV file was created/processed in standard Year month day hour minute seconds.

Typically near the end of the file.

%ProcessingTool: "RadialsToCurrents" 10.1.7

The processing application and version used on this file. There may be multiple entries of this key for every application involved with the data.

Typically near the end of the file.

%End:

Marks the end of the file.

Currently this is an indicator marker to show that the file was completed successfully. In the future this may indicate an end of the main section and any further data might be something other than what you were expecting. So unless you are expecting more, you should stop reading the LLUV at this point. In the future, if there is more data then a new %FileType: key will follow.

%MergerMethod: 1 MedianVectors

This key when present in radial and elliptical files is a reference to how RadialMerger 10.3.0 or later tool merges multiple vectors at the same range and bearing across the short-time radial list. The first parameter is the method type used followed a textual descriptor. If the method type is 0 or 1 MedianVectors, then RadialMerger picked the median velocity vector for the output radial; the quality valued will come from the median vector selected. If the method type is 2 AverageVectors, then RadialMerger averages the vectors. Previous to RadialMerger 10.3.0, the median method was always used and is implied when this key is missing.

%PatternMethod: 1 PatternVectors

This key when present in radial and elliptical files is a reference to how SpectraToRadial 10.5.0 or later handles the pattern (Ideal and Measured) and angseg (Angular Area filter). The first parameters is the method type used followed a textual descriptor. If the method type is 0 or 1 PatternVectors then SpectraToRadial will place vectors using the pattern and remove those beyond the angseg area. If the method type is 2 OverwaterVectors then SpectraToRadial will force vectors to best fit within pattern and angseg area. If method type is 3 AnywhereVectors then SpectraToRadial will ignore the angseg area.

SpectraToRadial 10.3.9 and earlier places vectors using the pattern and cutout those beyond the angseg.

SpectraToRadial 10.4.0 to 10.4.9 place vectors using the pattern and force outliers beyond the angseg to fit with the pattern.

%FirstOderCalc: 0

This key when present in radial and elliptical files is a reference to how

SpectraToRadial handled the First Order Bragg boundary calculations. The first parameter is the method type used. If the method type is 0 then SpectraToRadial uses its standard method. If the method type is 1, then SpectraToRadial uses external results from an alternate FirstOrderLimits tools which does the standard method plus uses alternate settings for specific range cells. If the method type is 2, then external limits are used from the temporary processing folder, which can come from anywhere.

%LLUVDataQuality: Nominal

This key when present is an indicator of whether the LLUV data quality. Possible values are:

Nominal	Normal.
Suspect	Data quality is suspect. Use at your own risk.
Flawed	Data quality is known to be flawed and should not be used.

%LLUVDataMethod: RealTime

This key when present is an indicator of how the LLUV Data was processed. Possible values are:

RealTime	Processed real-time on the SeaSonde Site.
Reprocessed	The data was recreated by reprocessing.

%LLUVSiteState: Nominal

This key when present is an indicator of the condition of the site. Possible values are:

Nominal	Normal
NewSite	Site is flagged as recent new site.
Restarted	Site is flagged as having been down for a long time then started back up.

%LLUVSiteComment: "operator comment"

This key when present is an added maintenance comment about the site.

Columnar Table Data

The first table in the file should be preceded by a %TableType: key.

LLUV files can have more than one table. Typically the extra tables are more information about the data processing. Radials and Ellipticals will contain diagnostic that cover their processing time. Totals add a table of the sources used. So, be sure to read only tables you recognize and only the LLUV table(s) contain the main LLUV data.

%TableType: <type> <subtype>

<type> when 'LLUV', indicates that the first four columns are always lon,lat,u,v
<subtype> helps to identify the extra columns for the various current maps.

The current subtypes are:

'**TOT4**' for total vector data of lon, lat, u, v, flag, eu, ev, cov, E Dist, N Dist, Range, Bearing, Velocity, Direction, nSite1, nSite2, nSite3, nSite4, nSite5, nSite6

'**RDL8**' for radial data of lon, lat, u, v, flag, Spatial, Temporal, Max Vel, Min Vel, Spatial count, Temporal count, X Dist, Y Dist, Range, Bearing, Velocity, Direction, Spectra Range cell

'**ELP8**' for elliptical data of lon, lat, u, v, flag, Spatial, Temporal, Max Vel, Min Vel, Spatial count, Temporal count, X Dist, Y Dist, Range, Bearing, Velocity, Direction, Spectra Range cell, Angle of Arrival

LLUV type will always contain a minimal of the first four columns of lon, lat, u, v (The CODAR LLUV Readers will allow for a %LLUVTrustData: rbvd with a table that contains only rbvd data.)

If there is no subtype and no %TableColumnsKeys then the data is assumed to contain only lon, lat, u, v and any extra columns will not be read.

Future major changes or additions to the data will increment the last digit of the subtype and will also change the '%TableColumnTypes:' keys.

Using the keys in column types to read the columns will give the best result for handling future versions. CODAR LLUV Reader use this so that it possible for the data columns to be in any order and allow for redundant data to be missing or even extra unknown columns inserted.

After the table type key is the **%TableColumnTypes:** key which describes the datum for each column. Using this key (extremely recommended) will provide compatibility with future unknown **%TableType** <subtype> which allows for the future insertion, removal, or rearrangement of columns. The **%TableColumnTypes:** contains a list of four character codes describing each column of the table data in order.

The known column codes are:

LOND is the current vector longitude in fractional degrees with positive East

LATD is the current vector latitude in fractional degrees with positive North.

VELU is the current vector velocity eastern component in cm/s

VELV is the current vector velocity northern component in cm/s

VFLG is a vector indicator flag. Indicates status of the vector like near coastline, **ADCP** location, interpolated value, and more. See the Vector Indicator Flag document for the complete information on use of this flag.

STDV is a radial or elliptical standard deviation of current velocity over coverage period. (outdated use **ETMP**)

SCDV is a radial or elliptical standard deviation of current velocity over the scatter patch. (outdated use **ESPC**)

SCMX is a radial or elliptical maximum change of current velocity over the scatter patch.

XDST is the current vector easting distance in km from the origin key.

YDST is the current vector northing distance in km from the origin key.

RNGE is the current vector range in km from the origin key.

BEAR is the current vector bearing in degrees clockwise from true North from the origin key.

VELO is the current vector velocity in cm/s. (Negative velocity implies 180deg direction change)

HEAD is the current vector direction in degrees clockwise from true North.

UQAL is the current vector u-component standard deviation.

VQAL is the current vector v-component standard deviation.

CQAL is the current vector covariance.

S1CN is the number of radial/elliptical vectors from site1, which contributed to the total vector

S2CN is the number of radial/elliptical vectors from site2, which contributed to the total vector

S3CN is the number of radial/elliptical vectors from site3, which contributed to the total vector

S4CN is the number of radial/elliptical vectors from site4, which contributed to the total vector

S5CN is the number of radial/elliptical vectors from site5, which contributed to the total vector

S6CN is the number of radial/elliptical vectors from site6, which contributed to the total vector

SPRC is the cross spectra range cell the data came from for Radials and Ellipticals

ESPC is a radial or elliptical Spatial standard deviation of current velocity over the scatter patch.

ETMP is a radial or elliptical Temporal standard deviation of current velocity over coverage period.

MAXV is the maximum current velocity found over the coverage time.

MINV is the minimum current velocity found over the coverage time.

EDVC is the number of doppler velocities at the same range and bearing that went into the selecting the output velocity.

ERSC is the number of velocities at the same range and bearing that went into

the Spatial value for Radial/Elliptical velocity.

ERTC is the number of velocities at the same range and bearing that went into the Temporal value for Radial/Elliptical velocity.

RSVD is a reserved column. The value will typically be zero. This is a placeholder column to sometimes make different table formats semi-compatible in columnar order.

Example for Radial:

%TableColumnTypes: LOND LATD VELU VELV VFLG ESPC ETMP MAXV MINV EDVC ERTC XDST YDST RNGE BEAR VELO HEAD SPRC

%TableRows: <count>

tells reader software how many vectors to expect. Typically you should not count on this number being exact as the file might have been hand edited after its creation.

%TableColumns: <count>

can be used with the table type and subtype to determine if all the expected columns are in the file. This will always match the number of columns but you should rely on the TableColumnTypes key for column content.

The table data should then be preceded by a

%TableStart: <tablenumber>

<tablenumber> will be missing for the first table.

Before the table data starts two comments are added to help visually identify the data columns

Example:

```
%% Longitude Latitude U comp V comp VectorFlag
%% (deg) (deg) (cm/s) (cm/s) (GridCode)
```

Followed by a line for each Table Row of data. Each line is preceded by a space. Spaces (no Tabs) are used between columns.

Followed by a **%TableEnd:** key after the data.

A table might look like this:

(Note: LLUV files are best viewed by a text editor that doesn't wrap long lines.)

```
%TableType: LLUV RDL4
%TableColumns: 16
%TableColumnTypes: LOND LATD VELU VELV VFLG ETMP ESPC MAXV MINV XDST YDST RNGE BEAR VELO HEAD
SPRC
%TableRows: 627
%TableStart:
%% Longitude Latitude U comp V comp VectorFlag Temporal Spatial Velocity
Velocity X Distance Y Distance Range Bearing Velocity Direction Spectra
```

%	(deg)	(deg)	(cm/s)	(cm/s)	(GridCode)	Quality	Quality	Maximum
Minimum	(km)	(km)	(km)	(deg NCW)	(cm/s)	(deg NCW)	RngCell	
-74.1183403	39.6834934	-0.630	-36.145	0	5.550	999.000	-30.770	
-43.690	-0.1021	-5.8501	5.851	181.0	-36.15	1.0	1	
-74.1123923	39.6836137	2.689	-38.486	0	2.970	0.270	-37.230	
-40.460	0.4082	-5.8368	5.851	176.0	-38.58	356.0	1	
-74.1064805	39.6841337	7.334	-46.343	0	1.030	0.000	-46.920	
-46.920	0.9153	-5.7790	5.851	171.0	-46.92	351.0	1	
-74.1006496	39.6850496	5.488	-22.027	0	5.540	1.610	-21.090	
-21.090	1.4155	-5.6772	5.851	166.0	-22.70	346.0	1	
-74.0949440	39.6863544	-1.051	3.054	0	1.930	999.000	4.950	
1.510	1.9049	-5.5322	5.851	161.0	3.23	341.0	1	

%TableEnd:

As of SeaSonde Release 3u3, the RadialArchiver tool will add two extra tables containing part of the radial and hardware diagnostic status files whose time entries time are within the Radial coverage time. These extra tables have their row data prefixed with “% ” so that a MatLab blind matrix read will ignore these rows. The file documents on Radial and Hardware diagnostics have detail information on these tables.

Vector Description

Each line in the LLUV table describes a single current vector. The main component of the vector is the Lon,Lat,U,V data. We also supply x, y, range, bearing, velocity, and direction data as redundant reference information about the vector that helps to provide diagnostics when examining the data.

Longitude, Latitude.

The first two columns are the geo location in fractional degrees of each current vector. This is the data that should be used to plot the current vector with. A positive longitude is East and a positive latitude is North.

U, V Components.

The third and fourth columns show the ocean current vector’s velocity and direction. These are in a x,y style in which U is the Easting/Zonal velocity component and the V is the Northward/Meridonal velocity component in centimeters per second. These components are always oriented from True North at the location of each vector. For Total LLUV files this is the actual ocean current vector. For Radial LLUV files this is a radial component of the actual ocean current vector. For Elliptical LLUV files this is an elliptical component of the actual ocean current vector.

Vector Flag

The Vector Indicator Flag (**VFLG**) in the fifth column is a composite value used by the Combine Grid and the LLUV files to indicate extra information about individual current vectors.

- Bit0 (+1) disabled grid point and not outputted in LLUV files.
- Bit1 (+2) grid point is near the coastline.
- Bit2 (+4) grid point contains a point measurement like an ADCP.
- Bit4 (+16) current vector was the result of interpolating across a baseline area.
- Bit5 (+32) vector result exceeded the Maximum current limit.
- Bit7 (+128) vector is out of bounds. For radial vectors this means that the vector was outside the Angular filter area. Not used for Total Vectors.
- Bit8 (+256) Total vector does not have enough angular resolution from the contributing radials.
- Bit9 (+512) vector is marked as hidden and should not be normally displayed.
- Bit11(+2048) vector was created by interpolation.
- Bit12(+4096) vector is of dubious quality and should not normally be used or displayed.

SeaDisplay will not normally display the vectors with these flags

Bits (0,3,5,6,7,8,9,10)

Values (+1,+8,+32,+64,+128,+256,+512,+1024)

Combining will not use radial vectors with these flags

Bits (0,3,5,6,7,8,9,10)

Values (+1,+8,+32,+64,+128,+256,+512,+1024)

X, Y Distance.

The x,y distances are given as a reference from the %Origin: keyword. They are the cos,sin of the range and bearing great circle distance from the %Origin location. This makes x an Easting distance and y a Northing distance. (Easting and Northing are terms to describe traveling in an Eastward or Northward direction but not necessarily directly traveling exactly East or North). The x,y coordinate can be thought of as a tangential plane to the earth at the location of the %Origin:. You should not compare or add x,y distances from different origins as orientation of their planar data will be different. For Total vector files, these x,y points will typically be the same as the created combine grid file x,y distances. To find the lat,lon position convert this to range,bearing and apply the Great Circle calculation.

Range, Bearing

Range and Bearing is a reference location of the vector from the %Origin: keyword. The location is found by navigating a great circle from the %Origin starting with Bearing direction degrees clockwise from True North and traveling the Range in kilometers. For radial LLUV files, this the radial spoke measured by the SeaSonde.

Velocity, Direction

Velocity and Direction is the ocean current vector. This is the same info as the U, V data except that it is in magnitude of centimeters per second and direction degrees clockwise from True North at the location of the vector. For radials, the Direction will be close to 180 degrees from the Bearing but will vary depending on the latitude and the difference in the longitude from the %Origin. Also for radials and ellipticals, the sign of the velocity indicates whether the velocity is towards (positive) or away (negative) from the site which also indicates when negative that the current direction is a 180 degrees from the Direction value given (always take the velocity sign into account when examining the vector direction.)

Uncertainties/Quality Factors

There are three to six columns for Quality Factors. Their usage is dependent on the type of LLUV: radial, elliptical or total.

While we typically call these Quality Factors, it's really a misnomer; they are really measurement uncertainties but it is simpler to label them as quality. They indicate measurement uncertainty due to noise, a changing surface current pattern, and/or horizontal shear over each measured area. They represent a lower bound on the actual uncertainty in the current velocity. For example, errors due to contaminated radar spectra or incorrect first-order region boundaries will not be included in the estimate. We believe that most spatial uncertainty is due to horizontal current shear and most temporal uncertainty is due to the current pattern changing over time.

A resulting Quality Factor of 999 indicates a non-calculable result.

For Radials & Ellipticals, there are 7 possible columns: Temporal (**ETMP**), Spatial (**ESPC**), Maximum Velocity (**MAXV**), Minimum Velocity (**MINV**), Velocity Doppler Count (**EDVC**), Spatial Count (**ERSC**), and Spatial Count (**ERTC**)

Radial Processing starts with calculating temporary intermediate radials from a series of cross spectra(CSS). We refer to these intermediate radials as the Short-Time Radials. The CSS files are typically created every 10 minutes for a Standard Range SeaSonde and 30 minutes for a Long Range SeaSonde. This also applies to Elliptical Processing.

Short-Time Radials are temporary by default. They can be saved and later examined if a switch in configuration file AnalysisOptions.txt Line 10 is set from 0 to 1. This saves the Short-Time Radials into folder Data/RadialShorts. Short-Time Radials created with ideal pattern radials will start with 'RDLx' and Short-Time Radials created with a measured pattern radials will start with 'RDLy'.

Short-Time Radial Qualities:

The Quality Factors for Short-Time Radial are calculated for each vector from a list of different velocities found in the cross spectra doppler resulting in the same range and bearing as follows:

As for Release 6, Spatial Quality Factors are always calculated over 5deg while the vector bearing might be 1,2 or 5 degree resolution.

Spatial Quality (**ESPC**) is the standard deviation of the velocity list.

Velocity Doppler Count (**EDVC**) is the number of velocities that went into the Spatial Quality and also the radial velocity result. The naming is in reference to the source doppler bins used from the cross spectra to determine the radial velocity.

Spatial Count (**ERSC**) is the number of velocities that went into the Spatial Quality. The naming is in reference to the source doppler bins used from the cross spectra to determine the radial velocity.

Minimum Velocity (**MINV**) is the lowest velocity found in the velocity list.

Maximum Velocity (**MAXV**) is the highest velocity found in the velocity list.

Radial Processing continues to collect Short-time Radials over the configured output time coverage and merges them into the Final Output Radial using the median of the radial velocities at the same range and bearing (default method).

Merged or Final Output Radial Qualities:

The Quality Factors for the Final Output Radial are calculated using the Short-Time Radials as follows:

Spatial Quality (ESPC) is selected from the Short-Time Radial Spatial Quality corresponding to the radial velocity selected.

Velocity Doppler Count (EDVC) is from older LLUV radial and indicate the velocity count of the short-time radial used.

Temporal Quality (ETMP) is the standard deviation of the velocities at the same range and bearing across the Short-Time Radials. The maximum number of velocities used here is the number of merged Short-Time Radals. This can be found with the key '%MergedCount: 5'. The count for the Temporal might be less than this as there might not be a vector for the same range and bearing across all of the Short-time radials used.

Temporal Count (ERTC) is the number of velocities that went into the Temporal calculation. This is also the number of short-time radial found at the same bearing and velocity to merger. This value will be between the AnalysisOptions minimum radial vectors and the %MergedCount: in the LLUV file, inclusive.

Note that if the alternate configuration setting in AnalysisOptions.txt Line13 Merging method is set to 1, then the merging will average the radial velocities at the same range and bearing. The Spatial Quality will be an average of the

Short-Time Radials Spatial Qualities. Velocity Doppler Count will be the total of the Short-Time Radial Velocity Doppler Counts. The Minimum Velocity and Maximum Velocity will be the Minimum and Maximum found over the Short-Time Radial Minimum Velocity and Maximum Velocity.

Total Vector Qualities:

For Totals, there are 3 columns of U Quality, V Quality, and Covariance. These are derived using linear error propagation along with Temporal Quality from the radials and/or ellipticals.

For more information, read the Velocity Uncertainties document.

Contributors

The contributor columns are strictly for total LLUV files. They indicate the number of contributing radial or elliptical vectors from each site that went into the total vector calculation. These are used for diagnostic purposes to help identify coverage problems.

Known Table Subtypes and Their Data Column Types

Latest Total:

TOT4 LOND LATD VELU VELV VFLG UQAL VQAL CQAL XDST YDST RNGE BEAR VELO HEAD S1CN S2CN S3CN S4CN S5CN S6CN

Latest Radial:

RDL9 LOND LATD VELU VELV VFLG ESPC ETMP MAXV MINV ERSC ERTC XDST YDST RNGE BEAR VELO HEAD SPRC

Latest Elliptical

ELP9 LOND LATD VELU VELV VFLG ESPC ETMP MAXV MINV ERSC ERTC XDST YDST RNGE BEAR VELO HEAD SPRC

Shorttime Radial

RDL8 LOND LATD VELU VELV VFLG ESPC ETMP MAXV MINV EDVC ERSC XDST YDST RNGE BEAR VELO HEAD SPRC

Shorttime Elliptical

ELP8 LOND LATD VELU VELV VFLG ESPC ETMP MAXV MINV EDVC ERSC XDST YDST RNGE BEAR VELO HEAD SPRC

Previous Radial where EDVC is velocity count (If 5deg resolution, is also spatial count)

RDL7 LOND LATD VELU VELV VFLG ESPC ETMP MAXV MINV EDVC ERTC XDST YDST RNGE BEAR VELO HEAD SPRC

Previous Elliptical where EDVC is velocity count (If 5deg resolution, is also spatial count)

ELP7 LOND LATD VELU VELV VFLG ESPC ETMP MAXV MINV EDVC ERTC XDST YDST RNGE BEAR VELO HEAD SPRC

Older Elliptical without Temporal Count ERTC

ELP6 LOND LATD VELU VELV VFLG ESPC ETMP MAXV MINV EDVC XDST YDST RNGE BEAR VELO HEAD SPRC

Older Radial without Temporal Count ERTC

RDL6 LOND LATD VELU VELV VFLG ESPC ETMP MAXV MINV EDVC XDST YDST RNGE BEAR VELO HEAD SPRC

Older Radial without Spatial Count EDVC

RDL5 LOND LATD VELU VELV VFLG ESPC ETMP MAXV MINV XDST YDST RNGE BEAR VELO HEAD SPRC

Older Radial where ETMP and ESPC should be swapped when read.

RDL4 LOND LATD VELU VELV VFLG ETMP ESPC MAXV MINV XDST YDST RNGE BEAR VELO HEAD SPRC

Older Radial

RDL3 LOND LATD VELU VELV VFLG SCDV SCMX STDV XDST YDST RNGE BEAR VELO HEAD

Older Total where HEAD should be read as CCWE instead of label CWN.

TOT3 LOND LATD VELU VELV VFLG UQAL VQAL CQAL XDST YDST RNGE BEAR VELO HEAD S1CN S2CN S3CN S4CN S5CN S6CN

LLUVSpec SeaSonde version history

%LLUVSpec: 1.25 2016 04 27

Supports RiverSonde profile data which contains velocity components from a strip out from the site and perpendicular to the river for which the velocity components are relative to (down and across stream) instead of u,v from True.

%LLUVSpec: 1.24 2015 12 01

Supports XYUV version 8 for totals with angular spread column

%LLUVSpec: 1.23 2014 08 25

Supports bathymetry contoured polygons defined as lon,lat points. These files can be found in new SeaDisplay 8 site maps.

%LLUVSpec: 1.22 2014 07 17
Supports reading Target Association 1 files.

%LLUVSpec: 1.21 2013 12 14
Supports reading new bathymetry depth files where data is defined as lon,lat,depth. These files can be found in new SeaDisplay 8 site maps.

%LLUVSpec: 1.20 2013 12 06
Fixed a Total contributor bug where column 10 is missing and column 11 cannot be read.

%LLUVSpec: 1.19 2013 09 14
Support new Combine Total version 5 with GSPC (Degrees between sources)

%LLUVSpec: 1.18 2012 05 07
Corrected reading to not clear column types on %TableColumns: key. If Read does not resolve vector format full is used (LLUV, RBVD)

%LLUVSpec: 1.17 2011 06 20
Support PeakPicker Target files.

%LLUVSpec: 1.16 2011 05 12
Support adding an extra Table for Combine totals and LLUVMreger sources.

%LLUVSpec: 1.15 2010 11 23
Support for extra optional tag value which could be extra column 'VTAG' or separate LLUV Tables.

%LLUVSpec: 1.14 2010 07 18
Tsunami Detection strip support.

%LLUVSpec: 1.13 2010 04 20
Support Radial and Elliptical multiple first order options where each set is preceded by key %FirstOrderMethod:. Added velocity contributor count Radials.

%LLUVSpec: 1.12 2009 11 05
Support new optional time stamp each vector. See LLUVPointExtractor for create a time series of LLUV vectors.

This version indicates new %SpatialResolution: metadata to indicate was resolution the radial or elliptical spatial calculations are using.

This version adds new Quality column for radial & ellipticals of number of vectors used to calculate the spatial quality. Previous to Radial Release 6, the

EDVC column count was the count of the number of doppler velocities found and equalled the number used for Spatial quality. In Release 6 and Release 6 Update 1, EDVC column is the doppler velocity count for the short-time radial contribution which is always 1deg while the Spatial quality always uses 5 deg coverage. Final radials will have a new ERSC instead of EDVC indicating the Spatial count and a ERTC for temporal count. Short-time Radial will have EDVC velocity count and a ERSC spatial count.

%LLUVSpec: 1.11 2009 09 02

This version indicates new %AngularResolution: metadata to indicate was resolution the radial or elliptical is using.

%LLUVSpec: 1.10 2009 06 23

This version indicates support for new site metric keys.

%LLUVSpec: 1.09 2009 05 26

LLUV are allowed to have more than one table of the main type of data. If the LLUV is an Radial, then all tables containing LLUV and subtypes that start with "RD" will be read in as radial data. If the LLUV is a Total, then all tables containing LLUV and subtypes that start with "TO" will be read in as total vector data so that if radials source tables are attached they will typically be ignored when reading.

Note, having more than one LLUV table of the main type of data is not common. SeaSonde still currently outputs just one table for LLUV vectors and some secondary tables of diagnostic information.

%LLUVSpec: 1.08 2009 05 14

This version indicates increased support for LLUV Grid variant.

%LLUVSpec: 1.07 2009 03 13

This version indicates support for new LLUV variant of the set of grid points used for combining.

%LLUVSpec: 1.06 2008 11 01

This version indicates support for new key %LLUVTrustData: which indicates whether all the LLUV columns should be trusted or just some of them. This is to support hand and or partial programatic editing which modifies some metadata or data columns but not others. The CODAR LLUV readers will use this key to update portions of the data if needed. See the %LLUVTrustData: key below for more.

%LLUVSpec: 1.05 2007 06 14

This version indicates support for new tsunami detection wave map which does not conform fully to LLUV data as u,v is encoded as time-from-shore and angle of arrival. A future document will describe this new format in more detail.

%LLUVSpec: 1.04 2007 06 01

This version indicates support for new LLUV Radial column ERTC, which is number of vectors that went into the Temporal Quality. This column is inserted after the Spatial Count, and the table subtype is updated to 'RDL7'

%LLUVSpec: 1.03 2006 10 05

This version indicates support for two new LLUV variations. Existing SeaSonde LLUV files remain the same as previous version 1.02

The first variant is new optional keywords %XYUnits: and %UVUnits: to describe the scalar of the distance and velocity vector table data. If these keys are missing, then the implied distance of kilometers and velocities of cm/s are used. The main reason for these new keys are to support RiverSonde radials, which require distance in meters and velocities in m/s. These keys don't currently exist in SeaSonde LLUV outputs.

The second variant is support for a wave vector map, which does not fully conform fully to the LLUV as u,v is encoded as wave period and wave direction. A future document will describe this new format in more detail.

The reference key %GridAxisOrientation: was reported as NCW but was actually CCW from East. The value will now actually be NCW.

%LLUVSpec: 1.02 2006 01 11

This version indicates two fixes to the format.

The first fix is that in LLUV Total Vectors files only, the vector Direction 'HEAD' column was actually CCW East. This has been fixed to be CW North. The table subtype TOT4 was updated to also indicate the fix %TableType: LLUV TOT4. Previous versions 'TOT3', 'TOT2', 'TOT1' are all CCW from East for the HEAD column only the other bearing columns are still CW North.

The second fix is that for Radial LLUV only, the Spatial and Temporal columns were swapped. This means that the 'ETMP' is really Spatial and the 'ESPC' column is really Temporal. In the fixed version, just the columns %TableColumnTypes: ids are swapped ETMP EPSC marking the data correctly, but keeping the same column order for the data as the incorrect version. The table subtype was updated to %TableType: LLUV RDL5. Reader of previous version 'RDL4' should swap the Temporal/Spatial data. Table subtype 'RDL3' and earlier contains only Temporal values which were labeled as standard deviation 'STDV'

%LLUVSpec: 1.01 2005 12 30

There are no LLUV 1.01 files.

This would have marked the fix to the total vector Direction column, but didn't happen.

%LLUVSpec: 1.00 2005 03 25

This is first time the LLUVs are marked with this version key.

Revision History

First Draft Sep 24, 2016

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