# **CF Standard Names for RADAR and LIDAR data in CfRadial**

## **Introduction**

In order to have the CfRadial format formally recognized by the Cf community, we need to agree upon a list of standard names for RADAR and LIDAR. Thus far, only reflectivity and radial velocity are in the list of standard names.

## **Links**

The CF conventions page is:

<http://cfconventions.org/latest.html>

The guidelines for standard names are provided here:

<http://cfconventions.org/Data/cf-standard-names/docs/guidelines.html>

The CF FAQ is here:

<http://cfconventions.org/faq.html>

## **Standard names for radar/lidar/sonar sensor geometry**

|  |  |  |
| --- | --- | --- |
| **Proposed standard name** | **Description** | **Units** |
| unit\_vector\_component\_x | The component of a unit vector, along the X coordinate axis | unitless (0-1) |
| unit\_vector\_component\_y | The component of a unit vector, along the Y coordinate axis | unitless (0-1) |
| unit\_vector\_component\_z | The component of a unit vector, along the Z coordinate axis | unitless (0-1) |
| platform\_heading\_angle | platform\_heading\_angle is the horizontal angle between the reference direction, which is often due north, and the longitudinal axis of the platform. The angle is measured clockwise positive, starting from the reference direction.  If the reference is not north a comment attribute should be added to specify the reference details.  See also platform\_pitch\_angle and platform\_roll\_angle.  platform\_heading\_angle differs from platform\_azimuth\_angle, in that the former refers to the orientation of the platform itself, while the latter refers to the angle from an observation point to the platform. | degree |
| sensor\_to\_target\_azimuth\_angle | sensor\_to\_target\_azimuth\_angle is the horizontal angle between a reference direction, which is often due north, and the direction of observation from the sensor to the target. The angle is measured clockwise positive, starting from the reference direction.  If the reference is not north a comment attribute should be added to specify the reference details.  sensor\_to\_target\_azimuth\_angle differs from sensor\_azimuth\_angle in that the former is the angle from the sensor to the target, while the latter is the angle from an observation point to the sensor. Because of path distortion (e.g. from refraction) they are not simply 180 degrees apart. | degree |
| sensor\_to\_target\_elevation\_angle | sensor\_to\_target\_elevation\_angle is the vertical angle between the direction from the sensor to the target and a reference plane at the sensor location, which is generally the horizontal plane. The angle is measured upward positive, starting from the reference plane.  If the reference is not the horizontal plane a comment attribute should be to added specify the reference plane details.  A sensor\_view\_angle of 0.0 degrees is equivalent to a sensor\_to\_target\_elevation\_angle of -90.0 degrees. | degree |
| sensor\_to\_target\_rotation\_angle | sensor\_to\_target\_rotation\_angle is the angle between a reference direction and the direction of observation from the sensor to the target. The angle is measured clockwise positive, starting from the reference direction.  A comment attribute should be added to specify the reference direction details.  sensor\_to\_target\_rotation\_angle is intended for use in specialized situations, such as aircraft tail radars. | degree |
| sensor\_to\_target\_tilt\_angle | sensor\_to\_target\_tilt\_angle is the angle between the direction from the sensor to the target and a reference plane at the sensor location. The angle is measured starting from the reference plane.  A comment attribute should be to added specify the reference plane details, as well as the sign of the angle.  sensor\_to\_target\_tilt\_angle is intended for use in specialized situations, such as aircraft tail radars. | degree |

## **Standard names for radar moments variables**

|  |  |  |
| --- | --- | --- |
| **Proposed standard name** | **Description** | **Units** |
| equivalent\_reflectivity\_factor (already in CF) | A measure of backscattered power, in log units, corrected for range, radar wavelength, operating characteristics and assuming liquid drops | dBZ |
| equivalent\_reflectivity\_factor\_h | Equivalent reflectivity factor, in log units, for horizontal polarization | dBZ |
| equivalent\_reflectivity\_factor\_v | Equivalent reflectivity factor, in log units, for vertical polarization | dBZ |
| linear\_equivalent\_reflectivity\_factor | A measure of backscattered power, in linear units, corrected for range, radar wavelength, operating characteristics and assuming liquid drops | mm6 m-3 |
| linear\_equivalent\_reflectivity\_factor\_h | Equivalent reflectivity factor, in linear units, for horizontal polarization | mm6 m-3 |
| linear\_equivalent\_reflectivity\_factor\_v | Equivalent reflectivity factor, in linear units, for vertical polarization | mm6 m-3 |
| radial\_velocity\_of\_scatterers\_away\_from\_instrument (already in CF) | Doppler velocity measured along a radar radial | m/s |
| radial\_velocity\_of\_scatterers\_away\_from\_instrument\_h | Doppler velocity measured along a radar radial, for horizontal polarization | m/s |
| radial\_velocity\_of\_scatterers\_away\_from\_instrument\_v | Doppler velocity measured along a radar radial, for vertical polarization | m/s |
| doppler\_spectrum\_width | Radial velocity dispersion within the measurement volume | m/s |
| doppler\_spectrum\_width\_h | Radial velocity dispersion within the measurement volume for horizontal polarization | m/s |
| doppler\_spectrum\_width\_v | Radial velocity dispersion within the measurement volume for vertical polarization | m/s |
| differential\_reflectivity\_hv | The ratio of horizontal polarization reflectivity to vertical polarization reflectivity. Commonly referred to as ZDR. | dB |
| linear\_depolarization\_ratio | The ratio of received power from one polarization to received power from an orthogonal polarization, for a pulse transmitted in the orthogonal polarization. Commonly referred to as LDR. | dB |
| linear\_depolarization\_ratio\_h | linear\_depolarization\_ratio for horizontal transmit. That is, the ratio of vertical received power to horizontal received power. Commonly referred to as LDRH. | dB |
| linear\_depolarization\_ratio\_v | linear\_depolarization\_ratio for vertical transmit. That is, the ratio of horizontal received power to vertical received power. Commonly referred to as LDRV. | dB |
| differential\_phase\_hv | The horizontal copolar received phase minus the vertical copolar received phase. Commonly referred to as PHIDP. | degrees |
| specific\_differential\_phase\_hv | The rate of change of differential\_phase\_hv with distance (i.e. range from the instrument). Commonly referred to as KDP. | degrees/km |
| differential\_phase\_copolar\_h\_crosspolar\_v | The horizontal copolar received phase minus the vertical crosspolar received phase. | degrees |
| differential\_phase\_copolar\_v\_crosspolar\_h | The vertical copolar received phase minus the horizontal crosspolar received phase. | degrees |
| correlation\_coefficient\_hv | The complex correlation between the copolar horizontal received signal and the copolar vertical received signal. | unitless (0-1) |
| correlation\_coefficient\_copolar\_h\_crosspolar\_v | The complex correlation between the copolar horizontal signal and the crosspolar vertical signal, for a horizontal transmit pulse. | unitless (0-1) |
| correlation\_coefficient\_copolar\_v\_crosspolar\_h | The complex correlation between the copolar vertical signal and the crosspolar horizontal signal, for a vertical transmit pulse | unitless (0-1) |
| received\_signal\_power | Received power, in log units. | dBm |
| received\_signal\_power\_copolar\_h | received\_signal\_power for copolar horizontal receive, from a horizontal polarization transmit pulse. | dBm |
| received\_signal\_power\_copolar\_v | received\_signal\_power for copolar vertical receive, from a vertical polarization transmit pulse. | dBm |
| received\_signal\_power\_crosspolar\_h | received\_signal\_power for crosspolar horizontal receive, from a vertical polarization transmit pulse. | dBm |
| received\_signal\_power\_crosspolar\_v | received\_signal\_power for crosspolar vertical receive, from a horizontal polarization transmit pulse. | dBm |
| linear\_received\_signal\_power | Received power, in linear units. | mW |
| linear\_received\_signal\_power\_copolar\_h | linear\_received\_signal\_power for copolar horizontal receive, from a horizontal polarization transmit pulse. | mW |
| linear\_received\_signal\_power\_copolar\_v | linear\_received\_signal\_power for copolar vertical receive, from a vertical polarization transmit pulse. | mW |
| linear\_received\_signal\_power\_crosspolar\_h | linear\_received\_signal\_power for crosspolar horizontal receive, from a vertical polarization transmit pulse. | mW |
| linear\_received\_signal\_power\_crosspolar\_v | linear\_received\_signal\_power for crosspolar vertical receive, from a horizontal polarization transmit pulse. | mW |
| signal\_to\_noise\_ratio | The ratio of the received power to the system noise, in log units | dB |
| signal\_to\_noise\_ratio\_copolar\_h | signal\_to\_noise\_ratio for copolar horizontal receive, from a horizontal polarization transmit pulse. | dB |
| signal\_to\_noise\_ratio\_copolar\_v | signal\_to\_noise\_ratio for copolar vertical receive, from a vertical polarization transmit pulse. | dB |
| signal\_to\_noise\_ratio\_crosspolar\_h | signal\_to\_noise\_ratio for crosspolar horizontal receive, from a vertical polarization transmit pulse. | dB |
| signal\_to\_noise\_ratio\_crosspolar\_v | signal\_to\_noise\_ratio for crosspolar vertical receive, from a horizontal polarization transmit pulse. | dB |
| normalized\_coherent\_power  plus the alias: signal-quality-index | The magnitude of the lag1 covariance of the received signal, divided by the lag0 power of the received signal | unitless (0-1) |
| normalized\_coherent\_power\_copolar\_h | normalized\_coherent\_power for copolar horizontal receive, from a horizontal polarization transmit pulse | unitless  (0-1) |
| normalized\_coherent\_power\_copolar\_v | normalized\_coherent\_power for copolar vertical receive,  from a vertical polarization transmit pulse | unitless (0-1) |
| radar\_estimated\_precipitation\_rate | Precipitation rate based estimated by radar | mm/hr |
| radar\_scatterer\_classification | Dominant scatterer type in a radar return | unitless (0-255) |

## **Standard names for covariance variables**

This section lists the proposed standard names for radar covariance variables, derived from the I/Q time series.

These are the fundamental quantities from which many of the radar moments are computed.

Lag0 covariances for a single channel (e.g. horizontal copolar to horizontal copolar) are real.

All other covariances are complex. These must be stored either as (real, imaginary) parts, or as (power, phase) pairs.

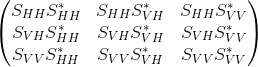
For this standard, we choose (log-power, phase) as the best way to store these complex variables.

|  |  |  |
| --- | --- | --- |
| **Proposed standard name** | **Description** | **Units** |
|  |  |  |
| **Lag-0 powers** | | |
| covariance\_lag0\_copolar\_h\_copolar\_h | Lag-0 covariance for horizontal copolar signal. This is received horizontal copolar power. | dBm |
| covariance\_lag0\_copolar\_v\_copolar\_v | Lag-0 covariance for vertical copolar signal. This is received vertical copolar power. | dBm |
| covariance\_lag0\_crosspolar\_h\_crosspolar\_h | Lag-0 covariance for horizontal crosspolar signal. This is received horizontal crosspolar power. | dBm |
| covariance\_lag0\_crosspolar\_v\_crosspolar\_v | Lag-0 covariance for vertical crosspolar signal. This is received vertical crosspolar power. | dBm |
|  |  |  |
| covariance\_lag0\_copolar\_h\_crosspolar\_v\_power | Lag-0 covariance horizontal copolar to vertical crosspolar signal, power | dBm |
| covariance\_lag0\_copolar\_h\_crosspolar\_v\_phase | Lag-0 covariance horizontal copolar to vertical crosspolar signal, phase | degree |
| covariance\_lag0\_copolar\_v\_crosspolar\_h\_power | Lag-0 covariance vertical copolar to horizontal crosspolar signal, power | dBm |
| covariance\_lag0\_copolar\_v\_crosspolar\_h\_phase | Lag-0 covariance vertical copolar to horizontal crosspolar signal, phase | degree |
|  |  |  |
| **Lag-1 complex values, stored as log-power and phase** | | |
| covariance\_lag1\_copolar\_h\_copolar\_h\_power | Lag-1 covariance for horizontal copolar signal, power | dBm |
| covariance\_lag1\_copolar\_h\_copolar\_h\_phase | Lag-1 covariance for horizontal copolar signal, phase | deg |
| covariance\_lag1\_copolar\_v\_copolar\_v\_power | Lag-1 covariance for vertical copolar signal, power | dBm |
| covariance\_lag1\_copolar\_v\_copolar\_v\_phase | Lag-1 covariance for vertical copolar signal, phase | deg |
|  |  |  |
| covariance\_lag1\_copolar\_h\_copolar\_v\_power | Lag-1 covariance for horizontal to vertical copolar signals, power | dBm |
| covariance\_lag1\_copolar\_h\_copolar\_v\_phase | Lag-1 covariance for horizontal to vertical copolar signals, phase | deg |
| covariance\_lag1\_copolar\_v\_copolar\_h\_power | Lag-1 covariance for vertical to horizontal copolar signals, power | dBm |
| covariance\_lag1\_copolar\_v\_copolar\_h\_phase | Lag-1 covariance for vertical to horizontal copolar signals, phase | deg |
|  |  |  |
| covariance\_lag1\_crosspolar\_h\_crosspolar\_v\_power | Lag-1 covariance for horizontal to vertical crosspolar signals, power | dBm |
| covariance\_lag1\_crosspolar\_h\_crosspolar\_v\_phase | Lag-1 covariance for horizontal to vertical crosspolar signals, phase | deg |
| covariance\_lag1\_crosspolar\_v\_crosspolar\_h\_power | Lag-1 covariance for vertical to horizontal crosspolar signals, power | dBm |
| covariance\_lag1\_crosspolar\_v\_crosspolar\_h\_phase | Lag-1 covariance for vertical to horizontal crosspolar signals, phase | deg |
|  |  |  |
| covariance\_lag1\_copolar\_h\_crosspolar\_v\_power | Lag-1 covariance for horizontal copolar to vertical crosspolar signal, power | dBm |
| covariance\_lag1\_copolar\_h\_crosspolar\_v\_phase | Lag-1 covariance for horizontal copolar to vertical crosspolar signal, phase | deg |
| covariance\_lag1\_crosspolar\_v\_copolar\_h\_power | Lag-1 covariance for vertical crosspolar to horizontal copolar signal, power | dBm |
| covariance\_lag1\_crosspolar\_v\_copolar\_h\_phase | Lag-1 covariance for vertical crosspolar to horizontal copolar signal, phase | deg |
|  |  |  |
| covariance\_lag1\_copolar\_v\_crosspolar\_h\_power | Lag-1 covariance for vertical copolar to horizontal crosspolar signal, power | dBm |
| covariance\_lag1\_copolar\_v\_crosspolar\_h\_phase | Lag-1 covariance for vertical copolar to horizontal crosspolar signal, phase | deg |
| covariance\_lag1\_crosspolar\_h\_copolar\_v\_power | Lag-1 covariance for horizontal crosspolar to vertical copolar signal, power | dBm |
| covariance\_lag1\_crosspolar\_h\_copolar\_v\_phase | Lag-1 covariance for horizontal crosspolar to vertical copolar signal, phase | deg |
|  |  |  |
| **Lag-2 complex values, stored as log-power and phase** | | |
| covariance\_lag2\_copolar\_h\_copolar\_h\_power | Lag-2 covariance for horizontal copolar signal, power | dBm |
| covariance\_lag2\_copolar\_h\_copolar\_h\_phase | Lag-2 covariance for horizontal copolar signal, phase | deg |
| covariance\_lag2\_copolar\_v\_copolar\_v\_power | Lag-2 covariance for vertical copolar signal, power | dBm |
| covariance\_lag2\_copolar\_v\_copolar\_v\_phase | Lag-2 covariance for vertical copolar signal, phase | deg |
|  |  |  |
| **Lag-3 complex values, stored as log-power and phase** | | |
| covariance\_lag3\_copolar\_h\_copolar\_h\_power | Lag-3 covariance for horizontal copolar signal, power | dBm |
| covariance\_lag3\_copolar\_h\_copolar\_h\_phase | Lag-3 covariance for horizontal copolar signal, phase | deg |
| covariance\_lag3\_copolar\_v\_copolar\_v\_power | Lag-3 covariance for vertical copolar signal, power | dBm |
| covariance\_lag3\_copolar\_v\_copolar\_v\_phase | Lag-3 covariance for vertical copolar signal, phase | deg |
|  |  |  |
|  |  |  |
|  |  |  |
| **Lag-0 powers for staggered PRT** | | |
| covariance\_lag0\_copolar\_h\_copolar\_h\_short\_power | Lag-0 covariance for horizontal copolar signal for short PRT. | dBm |
| covariance\_lag0\_copolar\_v\_copolar\_v\_short\_power | Lag-0 covariance for vertical copolar signal for short PRT. | dBm |
| covariance\_lag0\_crosspolar\_h\_crosspolar\_h\_long\_power | Lag-0 covariance for horizontal copolar signal for long PRT. | dBm |
| covariance\_lag0\_crosspolar\_v\_crosspolar\_v\_long\_power | Lag-0 covariance for vertical copolar signal for long PRT. | dBm |
|  |  |  |
| **Lag-1 complex values for staggered PRT, stored as log-power and phase** | | |
| covariance\_lag1\_copolar\_h\_copolar\_h\_short\_power | Lag-1 covariance for horizontal copolar signal for short PRT, power | dBm |
| covariance\_lag1\_copolar\_h\_copolar\_h\_short\_phase | Lag-1 covariance for horizontal copolar signal for short PRT, phase | deg |
| covariance\_lag1\_copolar\_v\_copolar\_v\_short\_power | Lag-1 covariance for vertical copolar signal for short PRT, power | dBm |
| covariance\_lag1\_copolar\_v\_copolar\_v\_short\_phase | Lag-1 covariance for vertical copolar signal for short PRT, phase | deg |
|  |  |  |
| covariance\_lag1\_copolar\_h\_copolar\_h\_long\_power | Lag-1 covariance for horizontal copolar signal for long PRT, power | dBm |
| covariance\_lag1\_copolar\_h\_copolar\_h\_long\_phase | Lag-1 covariance for horizontal copolar signal for long PRT, phase | deg |
| covariance\_lag1\_copolar\_v\_copolar\_v\_long\_power | Lag-1 covariance for vertical copolar signal for long PRT, power | dBm |
| covariance\_lag1\_copolar\_v\_copolar\_v\_long\_phase | Lag-1 covariance for vertical copolar signal for long PRT, phase | deg |
|  |  |  |
| covariance\_lag1\_copolar\_h\_copolar\_h\_short\_to\_long\_power | Lag-1 covariance for horizontal copolar signal for short\_to\_long PRT, power | dBm |
| covariance\_lag1\_copolar\_h\_copolar\_h\_short\_to\_long\_phase | Lag-1 covariance for horizontal copolar signal for short\_to\_long PRT, phase | deg |
| covariance\_lag1\_copolar\_v\_copolar\_v\_short\_to\_long\_power | Lag-1 covariance for vertical copolar signal for short\_to\_long PRT, power | dBm |
| covariance\_lag1\_copolar\_v\_copolar\_v\_short\_to\_long\_phase | Lag-1 covariance for vertical copolar signal for short\_to\_long PRT, phase | deg |
|  |  |  |
| covariance\_lag1\_copolar\_h\_copolar\_h\_long\_to\_short\_power | Lag-1 covariance for horizontal copolar signal for long\_to\_short PRT, power | dBm |
| covariance\_lag1\_copolar\_h\_copolar\_h\_long\_to\_short\_phase | Lag-1 covariance for horizontal copolar signal for long\_to\_short PRT, phase | deg |
| covariance\_lag1\_copolar\_v\_copolar\_v\_long\_to\_short\_power | Lag-1 covariance for vertical copolar signal for long\_to\_short PRT, power | dBm |
| covariance\_lag1\_copolar\_v\_copolar\_v\_long\_to\_short\_phase | Lag-1 covariance for vertical copolar signal for long\_to\_short PRT, phase | deg |
|  |  |  |

## **Standard names for SPECTRA variables**

This section lists the proposed standard names for spectra field variables. After assuming reciprocity there are 6 unique elements of the covariance matrix and the following names reflect those combinations. In the short name, the notation due to Bringi and Chandrasekar where SVH refers to the backscattering element where horizontal polarization is transmitted, but vertical polarization is received. The \* denotes complex conjugate.

The covariance matrix elements are given as



Elements below the diagonal are conjugate symmetric to elements above the diagonal.

The diagonal terms are real, and the off-diagonal terms are complex.

In spite of reciprocity, it may be desirable to compute both the Hx and Vx terms. The following table shows the unique elements not assuming reciprocity:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Hco\*** | **Hx\*** | **Vx\*** | **Vco\*** |
| **Hco** | HcoHco\* | HcoHx\* | HcoVx\* | HcoVco\* |
| **Hx** |  | HxHx\* | HxVx\* | HxVco\* |
| **Vx** |  |  | VxVx\* | VxVco\* |
| **Vco** |  |  |  | VcoVco\* |

The standard names for these spectra are given below.

|  |  |  |
| --- | --- | --- |
| **Standard name** | **Description** | **Units** |
| spectrum\_of\_copolar\_h\_to\_copolar\_h | Real |  |
| spectrum\_of\_crosspolar\_h\_to\_crosspolar\_h | Real |  |
| spectrum\_of\_crosspolar\_v\_to\_crosspolar\_v | Real |  |
| spectrum\_of\_copolar\_v\_to\_copolar\_v | Real |  |
|  |  |  |
| spectrum\_of\_copolar\_h\_to\_crosspolar\_h\_real | Complex – real part |  |
| spectrum\_of\_copolar\_h\_to\_crosspolar\_h\_imaginary | Complex – imaginary part |  |
|  |  |  |
| spectrum\_of\_copolar\_h\_to\_crosspolar\_v\_real | Complex – real part |  |
| spectrum\_of\_copolar\_h\_to\_crosspolar\_v\_imaginary | Complex – imaginary part |  |
|  |  |  |
| spectrum\_of\_copolar\_h\_to\_copolar\_v\_real | Complex – real part |  |
| spectrum\_of\_copolar\_h\_to\_copolar\_v\_imaginary | Complex – imaginary part |  |
|  |  |  |
| spectrum\_of\_crosspolar\_h\_to\_crosspolar\_v\_real | Complex – real part |  |
| spectrum\_of\_crosspolar\_h\_to\_crosspolar\_v\_imaginary | Complex – imaginary part |  |
|  |  |  |
| spectrum\_of\_crosspolar\_h\_to\_copolar\_v\_real | Complex – real part |  |
| spectrum\_of\_crosspolar\_h\_to\_copolar\_v\_imaginary | Complex – imaginary part |  |
|  |  |  |
| spectrum\_of\_crosspolar\_v\_to\_copolar\_v\_real | Complex – real part |  |
| spectrum\_of\_crosspolar\_v\_to\_copolar\_v\_imaginary | Complex – imaginary part |  |

## **Standard names for LIDAR field variables**

|  |  |  |
| --- | --- | --- |
| **Standard name** | **Description** | **Units** |
|  | Atmospheric temperature profile (e.g., imported from sonde) |  |
|  | Atmospheric pressure profile (e.g.,imported from sonde) |  |
| od | Optical depth |  |
| extinction | Total derived extinction | m^-1 |
| od\_aerosol | Aerosol optical depth |  |
| extinction\_aerosol | Aerosol or cloud extinction | m^-1 |
| llinear\_depolarization\_aerosol |  |  |
| backscatter\_coefficent\_aerosol | Aerosol backscatter coefficient | m^-1 sr^-1 |
| backscatter\_coefficent\_aerosol\_std | Uncertainty in aerosol backscatter coefficient due to shot noise | m^-1 sr^-1 |
| time |  |  |
| range/altitude |  | m |