AATSR

Advanced along track Scanning Radiometer

Absolute uncertainty

An uncertainty given in the same unit as the measured value. This is generally written as the standard uncertainty $u(x_i)$.

Accuracy

A qualitative term describing the (lack of) systematic uncertainties. A measurement said to be “higher accuracy” would have smaller uncertainties associated with systematic effects. Note that it is possible to have a high accuracy measurement in the presence of large random effects.

AEROCOM

The AEROCOM-project is an open international initiative of scientists interested in the advancement of the understanding of the global aerosol and its impact on climate

AERONET

(AErosol RObotic NETwork) program is a federation of ground-based remote sensing aerosol networks

AIRS

Atmospheric Infrared Sounder

AMSU-B

Advanced Microwave Sounding Unit

AOD

Aerosol Optical Depth

AVHRR

Advanced Very High Resolution Radiometer

Bias

An offset (additive) or scaling factor (multiplicative) that affects all measurements by a particular instrument. The bias may be estimated, in which case it can be corrected for (a correction), or may be an unknown error.

BRF

Bi-directional Reflection Factors

Calibration

Calibration is the process of converting the raw signal recorded by the satellite to the measurand. Examples include converting raw AVHRR counts to a radiance or brightness temperature. The calibration process is normally defined by an algorithm and a set of calibration coefficients.

CCCS

Copernicus Climate Change Service

CCI

(ESA) Climate Change Initiative

CDR

Climate Data Record

CDS

Climate Data Store

CEOS WGISS

Committee on Earth Observation Satellites (CEOS) Working Group on Information Systems and Services

CF

Climate and Forecast (metadata convention)

Common errors

Common errors are constant (or nearly so) across the satellite image, and may be shared across the measured radiances for a significant proportion of a satellite mission. Common errors might typically be referred to as biases in the measured radiances.

Correction

An adjustment made to correct for a known bias. This may have a functional form (e.g. a straight line) with multiple correction parameters (e.g. an offset and slope). Note that even after correction there will always be a residual, unknown error.

ECMWF

European Centre for Medium Range Weather Forecasts

ECV

Essential Climate Variables

ERA-CLIM2

European Reanalysis of Global Climate Observations -2

Error

The unknown difference between the measured value and the (unknown) true value. The error is a specific draw from the probability distribution function described by the uncertainty.

Expanded uncertainty

Expanded uncertainty is the standard uncertainty multiplied by a coverage factor, k. The coverage factor is chosen to obtain a desired level of confidence. Most commonly a 95 % confidence interval is chosen. For a Gaussian distribution this is achieved with a coverage factor k = 2. (Note that strictly this provides a 95.45 % confidence interval).

FCDR

Fundamental Climate Data Record. The project's working definition of FCDR is:

An FCDR consists of a long, harmonised record of uncertainty-quantified sensor observations that are calibrated to physical units and located in time and space, together with all ancillary and lower-level instrument data used to calibrate and locate the observations and to estimate uncertainty.

Geo-location (or navigation)

This term refers to the process by which the geographical coordinates (e.g., latitude and longitude) of each satellite measurement are determined. The precise determination of geographical coordinates requires information on the time, satellite orbit, the satellite attitude parameters, and the Geoid. In the case of absence of this information, geographical coordinates are often determined by techniques that use landmarks and control points. The result of geo-location is a geo-referenced satellite measurement without a change in the original geometry of the measurement.

Geo-rectification

This term refers to the process by which a geo-located or navigated satellite measurement is transformed into the grid of a known coordinate system or type of projection. This process requires interpolation techniques such as cubic-spline or nearest neighbour. Geo-rectification results in gridded satellite measurements. Geo-rectification is synonymous to gridding for satellite measurements.

Geo-referenced

This term refers to satellite measurements that have been geo-located or navigated.

Gridding

This term refers to the process that assigns a geo-referenced satellite measurement to the appropriate cell in a predefined grid. This step is used to aid the visualisation of satellite imagery as a map in which one grid-cell can be interpreted as one image pixel. Gridding results in gridded satellite measurements. Gridding is synonymous to geo-rectification for satellite measurements.

GRUAN

GCOS Reference Upper Air Network

GSICS

Global Space-based Inter-calibration System

Harmonisation

A harmonised satellite series is one where all the calibrations of the sensors have been made consistent with (a) to reference dataset(s) which can be traced back to known reference sources, in an ideal case back to SI. Each sensor is calibrated to the reference in a way that maintains the characteristics of that individual sensor such that the calibration radiances represent the unique nature of each sensor. This means that two sensors which have been harmonised may see different signals when looking at the same location at the same time where the difference is related to known differences in the responses of each sensor such as differences in the sensors spectral response functions. Harmonisation can be achieved to within an uncertainty that should be estimated, and the uncertainty contributes to the component of uncertainty that is common across the whole record of a given sensor.

HIRS

High-resolution Infrared Radiation Sounder

Homogenisation

Unlike harmonisation, homogenisation is where all satellites are forced to look the same such that when looking at the same location at the same time they would (in theory) give the same signal. In reality the signals from different sensors would be different and homogenisation is adding in corrective terms to each satellite to make them look the same. It is likely that these corrective terms will not be 100% effective and that the process of homogenisation will add in scene dependent errors to the uncertainty budget which may be difficult to assess.

IASI

Infrared Atmospheric Sounding Interferometer

Independent

Independent errors arise from random effects causing errors that manifest independence between any pair of measured values m' and m, such that the error in m' is in no degree predictable from knowledge of the error in m (were that knowledge available). In an image, independent errors therefore arise from random effects operating at the image pixel level, the classic example being detector noise. The *independent component of uncertainty* (or, loosely, independent uncertainty) is the uncertainty contributed by the independent errors.

Intercalibration

Intercalibration is the process of cross comparing one satellite with another dataset used as a reference. Often the reference dataset is another satellite whose calibration is better characterised and/or updated relative to the satellite of interest and so can be used to recalibrate and/or provide information on problems/biases in the satellite of interest.

IR

Infra-red

LAC

Local Area Coverage

Level 0

(CEOS definition)

Reconstructed unprocessed instrument data at full space and time resolution with all available supplemental information to be used in subsequent processing (e.g., ephemeris, health and safety) appended.

Level 1A

(CEOS definition)
Reconstructed, unprocessed instrument data at full resolution, time-referenced, and annotated with ancillary information, including radiometric and geometric calibration coefficients and georeferencing parameters (e.g., platform ephemeris) computed and appended but not applied to Level 0 data.

Level 1B

Level 1A data that have been processed to sensor units and contains acquisition time and satellite pixel location with associated uncertainties. (Note this is the satellite raw grid). Data processing is performed in a consistent manner for the entire data set.

Level 1C

Level 1B data that have been georeferenced in a standard georeferenced grid.

Level 2

Derived geophysical variables at the same resolution and location as Level 1 source data.

Level 3

Variables mapped on uniform space-time grid scales, usually with some completeness and consistency.

Locally correlated

Where measured values obtained together (having small separations in time and space) have highly correlated errors, whereas errors in measurements separated by longer space-time scales are independent and uncorrelated.

Match up

A sensor "point" measurement that is matched with another sensor's "point" measurement sufficiently close in space and time.

In a more practical context, a match up consists of two or more sensor pixels (with optional surrounding pixels) that have been acquired at almost the same time and cover almost the same location. Time and spatial difference allowed are defined by the scientific aim. The match up data consists of all data variables at the location and all metadata for each sensor.

Measurand

The quantity that is being measured (e.g. radiance, reflectance, temperature).

Measured value

The number and unit obtained from a measurement of a measurand.

Measurement

The process of experimentally obtaining a result. The act of measuring.

Measurement Uncertainty

A non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used (VIM). Usually, the standard uncertainty is the quoted parameter unless otherwise stated. The concept is that the measurement uncertainty characterises the degree of doubt remaining about the value of the measurand after measurement.

Measurement result

The number, unit and uncertainty of a measurand that comes from measurement

MMS

Multi Sensor Match up system

MVIRI

Meteosat Visible Infra-Red Imager

MW

Microwave

NetCDF

NetCDF (network Common Data Form) is a set of software libraries and machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data

NMI

National Metrology Institutes

NWP

Numerical Weather Prediction

Precision

A qualitative term describing the spread of obtained measured values. A high precision data set has small uncertainties associated with random effects. This says nothing about uncertainties associated with systematic effects. Quantitative information is provided by the associated uncertainty.

Projection

This term refers to a systematic transformation of the latitudes and longitudes of locations on the surface of a sphere or an ellipsoid into locations on a plane. Different transformations have been developed and they vary in terms of the priorities they assign on the conservation of angles, area, or distance and on the region of the globe they are optimized for. Projection results in gridded satellite measurements in a specific type of projection.

QA4ECV

Quality Assurance for Essential Climate Variables

Random

Random errors are errors manifesting independence: the error in one instance of a quantity is in no way predictable from knowledge of the error in another instance: the error in each instance is considered to be an independent draw from an underlying probability distribution; "random" implies in this context both "unpredictable" and "uncorrelated between measured values" (within a given processing level); random errors therefore tend to "average out" across many measured values, and the uncertainty in the average of the measured values decreases with more measurements; random effects may be operating at the same time as other types of effect, in which case only a component of the total error is random; an example of a random effect (an effect giving rise to random errors) is electronic noise in an amplifier circuit.

A complication arises in a chain of processing in which a quantity subject to random errors at a one level then influences many values in a higher level of processing: the originating effect may be random (or, "aleatoric") but at the higher level the resulting errors across many values are not independent. For this reason, we use "random" to discuss the nature of an effect, and "independent" to signify "uncorrelated across measured values".

Random effects

Random effects are those causing errors that cannot be corrected for in a single measured value, even in principle, because the effect is operates by chance, i.e., is aleatoric. Random effects for a particular measurement process vary unpredictably from (one set of) measured values(s) to (another set of) measured values(s), and produce random errors in those measured values.

Re-gridding

This term refers to the process of transforming the information represented in one grid into another grid.

Re-projection

This term refers to the process of transforming the information represented in one type of projection into another type of projection.

Recalibration

A recalibrated dataset is one where the calibration coefficients and/or the calibration algorithm has been updated relative to the operational calibration used to create the original satellite Level 1 datasets. The operational calibration is normally derived from pre-launch measurements and there are many instances where the pre-launch data/algorithm is insufficient to calibrate the sensor in orbit either due to changes in the satellite response while in orbit or due to problems with the pre-launch data/algorithm itself or both.

Relative uncertainty

An uncertainty given in relative units (per cent, parts per million, fractions, etc). This is generally written $u(x_i)/x_i$

Scene Normalisation

Scene normalisation is a process which attempts to remove some of the variance seen in EO data to create values that are independent of view angle or atmospheric state or observing time etc. to give a uniform measure of a given variable across an image. It can be considered as a method to give what would have been observed by the same instrument under viewing identical conditions.

SCOPE-CM

Sustained Coordinated Processing of Environmental Satellite Data for Climate Monitoring

Sensor Bias Correction

Some Level 1 correction schemes involve determining corrections to already calibrated radiances based on some defined reference. These sensor bias corrections can then be applied to correct for gross errors in the original calibration. One example of this are the corrections provided by the GSICS (Global Space-based Inter-Calibration System) consortium for a number of sensors. Note that the terms “Harmonisation” and “Homogenisation” can be applied to this form of correction.

SEVIRI

Spinning Enhanced Visible Infra-Red Imager

SI

International sytem of units

SI-Traceability

SI-Traceability is traceability where the “stated metrological reference” is formally calibrated within the International System of Units (SI) through a National Metrology Institute that participates in the Mutual Recognition Arrangement and whose measurement for this parameter is thus audited through formal international comparison and peer review.

SLSTR

Sea and Land Surface Temperature Radiometer

SNO

Simultaneous **N**adir **O**verpass – a location on the planet where the nadir tracks of two satellites intersect within a given spatial and time distance. Both distance measures can vary, depending on the context. This is a special case of a match up as defined above.

SRF

Spectral Response Function

SSCC

SEVIRI Solar Channel Calibration

SSM/T2

Special Sensor Microwave/Temperature-2

SST

Sea Surface Temperature

Standard uncertainty

Standard uncertainty describes the standard deviation of the probability distribution describing the spread of possible values.

Structured errors

Structured errors are a concept introduced to characterise certain errors in satellite imagery. Structured errors arise from effects that influence more than one measured value in the image, but are not in common across the whole image. The originating effect may be random (aleatoric) or systematic (but acting on a subset or locality of pixels), but in either case the resulting errors are not independent, and may even be perfectly correlated across the affected pixels. Since the sensitivity of different pixels/channels to the originating effect may differ, even if there is perfect error correlation, the error (and associated uncertainty) in the measured value can differ in magnitude. Structured errors are therefore complex, and, at the same time, important to understand, because their error correlation properties affect how uncertainty propagates to higher-level data. The *uncertainty from structured effects* (or, loosely, structured uncertainty) is the part of the uncertainty contributed by structured errors. A *structured random effect* would refer to an effect that is unpredictable in terms of origin while leading to a predictable pattern of correlated errors across measured values in an image.

An example of a structured random effect is the impact of a random error in the measurement of signal while viewing a calibration target, which causes unpredictable but inter-related errors in all measured values which use that calibration cycle.

Swath data

This term refers to the data that a satellite collects by scanning the area below its current location, i.e., the swath or the width of this area perpendicular to the satellite's flight direction.

Systematic

Systematic errors are those that could in principle be corrected for if we had sufficient information to do so: that is, they arise from unknowns that could in principle be estimated; they are epistemic rather than aleatoric. Systematic errors influence many measured values, including, but are not limited to, effects that give rise to constant error for a significant proportion of a satellite mission—i.e., biases, for which the structure is a simple error in common. In terms of correlation properties across an image, therefore, effects that are systematic in origin give rise to either structured or common errors.

Systematic errors therefore "average out" slowly or not at all across many measured values; systematic effects may be operating at the same time as other types of effect, in which case only a component of the total error is systematic; an example of a systematic effect is a mis-characterised calibration target.

Systematic effects

Effects for a particular measurement process that do not vary (or vary coherently) from (one set of) measurement(s) to (another set of) measurement(s) and therefore produce systematic errors that cannot be reduced by averaging.

TOA

Top of Atmosphere

Traceability (Metrological)

Traceability is defined by the Committee of Earth Observation Satellites (CEOS) as:

Property of a measurement result relating the result to a stated metrological reference through an unbroken chain of calibrations of a measuring system or comparisons, each contributing to the stated measurement uncertainty.

Traceability involves both an unbroken chain to that reference – a clear link of "A was calibrated against B, which was calibrated against C and so on to the reference" and the documentary evidence that each step was performed in a reliable way, with clear uncertainty analysis in the form of an uncertainty budget for each step which includes the previous step as input as well as the uncertainties introduced by the current step. Ideally this documentation is reviewed through peer review or formal audit.

Note that there are other common uses of the term "traceability" including that it is possible to "trace" the origin of all the input data sets and that there are appropriate algorithmic documents (e.g. ATBDs) and that software is formally checked. These are all important aspects of a quality system. Metrological traceability includes all this, and also the unbroken chain of calibration and uncertainty analysis.

Type A evaluation of uncertainty

The GUM distinguishes Type A and Type B methods for evaluating uncertainty. A Type A method uses statistical analysis of repeated observations. Usually this is used to estimate the uncertainty associated with random effects. It is possible to use Type A methods to estimate the uncertainty associated with effects that are systematic for the measurement of interest but consciously randomised for the purposes of uncertainty evaluation (e.g. by realigning an instrument that would normally not be realigned, or varying a temperature that would normally be constant). In Earth Observation Type A methods are generally used to estimate noise statistics – a random effect process.

Type B evaluation of uncertainty

The GUM describes Type B methods for evaluating uncertainty as using “other methods”. This may include prior knowledge (e.g. from a calibration certificate or the behaviour of similar instruments), it may include performing theoretical modelling.

UERRA

Uncertainties in Ensembles of Regional Re-analyses

Uncertainty

The GUM defines uncertainty as:

A parameter, associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand.

Uncertainty is a measure of the spread of the distribution of possible values.

Uncertainty-quantified Climate Data Record (CDR)

A record of satellite observations of a geophysical quantity (such as sea surface temperature) in which estimates of total uncertainty (or error covariance) and/or dominant components of uncertainty (or error covariance) are provided or characterised at pixel-level (and potentially larger) scales. The CDR should be provided with all relevant auxiliary information for the data to be meaningful, including, e.g. time of acquisition, longitude and latitude, solar and viewing angles.

Uncertainty-quantified Fundamental Climate Data Record (FCDR)

A record of calibrated, geolocated, directly measured satellite observations in geophysical units (such as radiance) in which estimates of total uncertainty (or error covariance) and/or dominant components of uncertainty (or error covariance) are provided or characterised at pixel-level (and potentially larger) scales. The FCDR should be provided with all relevant auxiliary information for the data to be meaningful, including, e.g. time of acquisition, longitude and latitude, solar and viewing angles, sensor spectral response.

UTH

Upper Tropospheric Humidity

Vicarious Calibration

Vicarious calibration is a method that makes use of “invariant” natural targets of the Earth for the post-launch calibration of a sensor. This is most commonly used for reflectance channels where there is no on-board calibration source available to track changes in the instrument response.

WCRP

World Climate Research Programme