	SCIRoCCo Scatterometry Glossary	Ref:	SCI-SPU-14-0001-v02
		Issue:	1.2
		Date:	20/12/2016
		Proj:	**SCIRoCCo** Scatterometer Instrument Competence Centre

Prepared by:

The SCIRoCCo Team:

Change register

Version/Rev.	Date	Reason for Change	Changes
1.0	08/05/2014	First Release. Preliminary version	
1.1	20/02/2015	4th bi-monthly Report Review	Contributions from ECMWF merged. Ordered and format cleaned
1.2	20/12/2016	Removed duplicates, refined some descriptions	U10N, Scirocco, Linear Freq. Modulation, ...

Document Approval

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1. Introduction

1.1   Scope

This Glossary defines the commonly agreed terminology to use in all the documents generated by the SCIRoCCo Consortium

The Scatterometer Instrument Competence Centre (SCIRoCCo, http://scirocco.sp.serco.eu) is a Project established by ESA, in 2014, an interdisciplinary cooperation of international scatterometry experts aimed at promoting the continuing exploitation of ESA's unique 20 years' worth of ERS Scatterometer data (ESCAT) at medium (25Km, 50 Km) spatial resolution, and improving the quality of available and future scatterometry data.

ESA's Sensor Performance, Products and Algorithms (SPPA) Portal (earth.esa.int/web/sppa) is the main access point to EO data quality-related information, dealing with all Envisat and ERS data.

1.2   Applicable and Reference Documents

Applicable Documents

ID	Reference	Document Title	Issue	Date
AD-1	IT-1211-941	Scatterometer Instrument Competence Centre (SCIRoCCo) – Technical and Management Proposal.	3	09/06/2014
AD-2	SCI-MOM-14-0001-v02	SCIRoCCo KO Minute of Meeting	2	25/07/2014

Reference Documents

The following documents provide further reference information:

RD-1	N/A	List of reference documents		

2. Glossary

Term	Description
Absolute calibration	Process of determining the relationship between the raw instrument recordings and the physical quantity of interest.
Absorptance	A measure of the ability of a material to absorb electromagnetic energy at a specific wavelength.
Active Microwave Instrument (AMI)	Part of ERS-1 and ERS-2 payload, incorporating image (SAR, Synthetic Aperture Radar), wind (scatterometer), and wave (imagette) modes.
Active remote sensing	Remote sensing methods that provide their own source of electromagnetic radiation to illuminate the Earth's surface.
Active transponder	Artificial point target with a well-established radar cross section used for absolute calibration of scatterometers
Advanced Scatterometer (ASCAT)	Space-borne scatterometer as part of the MetOp satellites payload operated by EUMETSAT
Advanced Scatterometer Processing System (ASPS)	Scatterometer processing framework specifically designed to process ERS-2 AMI scatterometer data in Zero Gyro Mode (ZGM)
Along-track resolution	On-ground spatial resolution of a microwave instrument in direction of the satellite orbit.
Ambiguity removal (AR)	Spatial filtering method to obtain a spatially consistent and unambiguous wind vector field over the scatterometer swath.
Amplitude	Measure of the strength of a signal, and in particular the strength of an electromagnetic wave
Analysis	The process of approximating the true state of a (geo)physical system at a given time
Angular beam width	Angle subtended in the horizontal plane by the radar beam.
Angular field of view	Angle subtended by lines from a remote sensing system to the outer margins of the strip of terrain that is viewed by the system.
Antenna	Device that transmits and/or receives microwave energy in radar systems.
Antenna aperture	Measure of effectiveness of an antenna to transmit or receive power of an

	electromagnetic wave.
Antenna gain pattern	Directional (angular) dependence of the strength of transmitted or received microwave energy of an antenna.
Azimuth angle	Geographic orientation of a line given as an angle measured in degrees clockwise from north (sometimes from south).
Azimuthal anisotropy	Directional, with respect to the azimuth angle, dependent properties of a surface or medium, as opposed to isotropy (uniformity in all directions)
Background field	In objective analysis and data assimilation, an a priori estimate of the atmospheric state. In most data assimilation systems, the background field is a forecast from the previous analysis time. Sometimes the term "First Guess" is also used for the background field.
Backscatter	In microwave remote sensing, the portion of the microwave energy scattered directly back towards the antenna by the Earth's surface.
Backscatter coefficient	In microwave remote sensing, a quantitative measure of the intensity of energy scattered back to a radar antenna from an area on the Earth's surface.
Backscatter noise	Uncertainty measure of the backscatter measurement.
Backscatter-triple	A number of three independent backscatter coefficients, observing an identical region on the Earth's surface almost simultaneously in time, but at different measurement configurations (azimuth and incidence angles).
Beam	A focused pulse of electromagnetic energy.
Bistatic radar equation	Radar equation in case of physically separated transmitter and receiver antenna.
Boresight direction	Direction of the maximum power emitted, appearing as a single main lobe in the antenna gain pattern.
Calibration	The process of quantitatively defining the instrument response to known, controlled input signals.
Calibration target	In microwave remote sensing, natural or artificial targets on the Earth's surface utilised for calibration purposes.
C-band	A microwave band with a wavelength (frequency) interval ranging from 7.5 - 3.8 cm (4 - 8 GHz) in the electromagnetic spectrum.
Change-detection algorithm	An algorithm ascertaining the changes of specific features within a certain time interval.
Coherent radiation	Electromagnetic radiation whose waves are equal in direction, amplitude and phase, so that they are capable of exhibiting interference.

Corner reflector	Cavity formed by two or three smooth planar surfaces intersecting at right angles. Electromagnetic waves entering a corner reflector are reflected directly back toward the source.
Cross-over angles	In the TU Wien soil moisture retrieval algorithm, particular incidence angles at which the backscatter coefficient is unaffected by vegetation changes.
Curvature	In the TU Wien soil moisture retrieval algorithm, the second derivative of the backscatter coefficient as a function of the incidence angle. Used in a second order Taylor polynomial approximation to normalise the backscatter value to a reference incidence angle of 40 degrees.
Data assimilation	The purpose of data assimilation is to determine a best possible atmospheric state using observations and short range forecasts. Data assimilation is typically a sequential time-stepping procedure, in which a previous model forecast is compared with newly received observations, the model state is then updated to reflect the observations, a new forecast is initiated, and so on. The update step in this process is usually referred to as the analysis; the short model forecast used to produce the analysis is called the background.
Depolarised	Refers to a change in polarisation of a transmitted radar pulse as a result of various interactions with the terrain surface.
Depression angle	The angle between the imaginary horizontal plane passing through the antenna and the line connecting the antenna and the target.
Dielectric constant	Electrical property of matter given as a factor by which the electric field between charges is decreased or increased relative to vacuum.
Discrete Global Grid (DGG)	A regular tessellation of a manifold or 2-D surface that divides it into a series of contiguous cells, which can then be assigned unique identifiers and used for spatial indexing purposes.
Distributed targets	In radar, extensive target made-up of several individual small-sized targets.
Doppler shift	Change in the observed frequency of a electromagnetic wave caused by the relative motion between transmitter and receiver.
Dry backscatter reference	In the TU Wien soil moisture retrieval algorithm, the backscatter coefficient corresponding to the driest observed soil condition.
Dry cross-over angle	In the TU Wien soil moisture retrieval algorithm, cross-over angle used for the determination of the dry backscatter reference.
Electromagnetic radiation	Energy propagated in the form of and advancing interaction between electric and magnetic fields. All electromagnetic radiation moves at the speed of light.

Electromagnetic spectrum	Continuous sequence of electromagnetic energy arranged according to wavelength or frequency.
Emission	Process by which a body radiates electromagnetic energy. Emission is determined by kinetic temperature and emissivity.
Emissivity	Ratio of radiant flux from a body to that from a blackbody at the same kinetic temperature and emissivity.
Error propagation	Effect of the uncertainties of a set of variables on the uncertainty of a function based on them.
Estimated Standard Deviation (ESD)	In the TU Wien soil moisture retrieval algorithm, a static estimated of the backscatter noise at a given location on the Earth's surface.
European Remote Sensing Satellite (ERS)	European earth observation satellite with a payload of various instruments operated by ESA.
European Space Agency (ESA)	Intergovernmental organisation of European countries, dedicated to the exploration of space.
External calibration	Calibration process utilising calibration targets/references outside the instrument itself.
Fan-beam antenna	A directional antenna producing a main beam with a narrow beamwidth in one dimension and a wider beamwidth in the other dimension.
Far range	The portion of a radar beam farthest from the spacecraft flight path.
Foreshortening	A distortion in radar images causing the lengths of slopes facing the antenna to appear shorter on the image than on the ground.
Frequency	The number of wave oscillations per unit time or the number of wavelengths that pass a point per unit time.
Frequency band	A wavelength interval in the electromagnetic spectrum.
Gamma nought ($\gamma 0$) backscatter coefficient	Representation of the backscatter dedicated for volume scatterer which is proportional to the projected area of the incident energy.
Geocentric latitude	A geographic coordinate that specifies the north-south position of a point on the Earth's surface. Defined as the angle between the radius, from centre to the point on the reference ellipsoid surface, and the equatorial plane.
Geodetic latitude	A geographic coordinate that specifies the north-south position of a point on the Earth's surface. Defined as the angle between the reference ellipsoid surface normal and the equatorial plane.

Geophysical Model Function, GMF	Functional relationship between NRCS and U10N, wind direction, radar beam azimuth angle, incidence angle, radar wavelength and polarization.
Geophysical noise	Noise induced by IFOV differences in the multiplet of WVC NRCSs. IFOV differences in combination with geophysical variability cause NRCS inconsistencies between the different views, called geophysical noise. Geophysical noise generally dominates over other noise contributions at low winds.
Goddard Earth Model (GEM)	Geopotential model of the Earth used in theoretical analysis of measuring and calculating the effects of the Earth's gravitational field.
Grid Point Index (GPI)	Unique identifier used for spatial indexing purposes of a Discrete Global Grid.
Grid spacing / sampling	Spacing between different grid point indices of a Discrete Global Grid, given as a distance or angle measure with respect to a sphere or ellipsoid.
Ground range	The distance from the ground track of the satellite to an object.
Gyroscope	A device for measuring or maintaining orientation, based on the principles of angular momentum.
Half-power beamwidth	The angle between the -3 dB points of the antenna main lobe, when referenced to the peak effective radiated power of the main lobe.
Hamming window	A taper formed mathematical function based on a weighted cosine that is zero-valued outside of some chosen interval with applications in spectral analysis, filter design and beamforming.
Incidence angle	Angle between an electromagnetic wave incident on a Earth's surface and the line perpendicular to the point of incidence.
Integrated Field Of View (IFOV)	Backscatter area of a number of contributions of a given wavelength, polarization and azimuth assigned to a particular WVC.
Internal calibration	Calibration process utilising calibration targets/references inside the instrument itself.
Inversion	Bayesian inference of the wind PDF, given a multiplet of NRCS values in a WVC, its noise properties and the GMF. The wind PDF obtained is generally multi-modal and therefore the wind vector information is ambiguous.
Ka-band	A microwave band with a wavelength (frequency) interval ranging from 1.1 - 0.75 cm (27 - 40 GHz) in the electromagnetic spectrum.
K-band	A microwave band with a wavelength (frequency) interval ranging from 1.7 - 1.1 cm (18 - 27 GHz) in the electromagnetic spectrum.
Ku-band	A microwave band with a wavelength (frequency) interval ranging from 2.5 - 1.7

	cm (12 - 18 GHz) in the electromagnetic spectrum.
Latitude	A geographic coordinate that specifies the north-south position of a point on the Earth's surface.
Layover	In radar images, the geometric displacement of the top of objects toward the near range relative to their base.
L-band	A microwave band with a wavelength (frequency) interval ranging from 30 - 15 cm (1 - 2 GHz) in the electromagnetic spectrum.
Linear frequency modulation (chirp)	The fact that the frequency of a wave increases linearly with time. The frequency excursion is usually centered around a carrier frequency and limited to a certain bandwidth. The main use in radar, is the spreading of the (transmitted) energy of the radar pulse over time, thus permitting to transmit a much higher energy for the same peak power. See also pulse compression.
Local slope	In the TU Wien soil moisture retrieval algorithm, intermediate model parameter used for a robust estimation of the parameters slope and curvature to normalised the backscatter coefficient to a reference incidence angle.
Longitude	A geographic coordinate that specifies the east-west position of a point on the Earth's surface.
Look angle	The angle between the vertical plane containing a radar antenna and the direction of radar propagation. Complementary to the depression angle.
Look direction	Direction/angle defined in the horizontal plane with reference to north, in which pulses of microwave energy are transmitted or received by a radar system.
Look-Up Table (LUT)	A mathematical formula expressed as a table used to convert one distribution of data to another.
Low Earth Orbit (LEO)	Satellite orbit around the Earth with an appr. altitude between 160 km and 2000 km and a orbit period between 88 min. and 127 min.
Maximum likelihood estimator, MLE (distance)	Inversion residual. The multiplet of backscatter data is inverted to 3 parameters: wind speed, wind direction and the inversion residual measuring the distance to the model. When the Maximum Likelihood Estiamator is used, that distance is colloquially referred to as "MLE". Therefore, the MLE measures the difference of the measured backscatter multiplet and the multiplet given by the solution wind speed and direction in the given satellite geometry of the WVC, according to the GMF. Hence, the MLE is a measure of the inconsistency of the measured backscatter multiplet with the GMF.
Microwave spectrum	Region of the electromagnetic spectrum in the wavelength range of 0.1 to 30 cm.

Mie scattering	Scattering mechanism taking place if the target size is similar to the wavelength resulting in resonant effects.
Monostatic radar equation	Radar equation in case of a single physically antenna acting as transmitter and receiver.
Nadir	Point on the ground directly in line with the remote sensing system and the centre of the earth.
Near range	Refers to the portion of a radar data closest to the satellite flight path.
Noise	Random or repetitive events that obscure or interfere with the desired information.
Normalised radar cross section, NRCS, σ^0	Effective backscattering area of a surface in case of plane microwave radiation incident on a scattering object or a scattering medium. It is computed as the ratio of the intensity scattered back in the direction toward the source and the incident irradiance from the source.
Orbit	Path of a satellite around a body such as the earth, under the influence of gravity.
Orbit duration	Time elapsed for one complete satellite path around a body such the Earth.
Passive microwave remote sensing	Remote sensing of microwave energy naturally reflected or radiated from the Earth's surface.
Pencil-beam antenna	A directional antenna producing a main beam with a narrow beamwidth in along and across track direction.
Pitch	Rotation of a satellite about the horizontal axis normal to its longitudinal axis that causes a nose-up or nose-down attitude.
Point targets	A single target having small dimensions compared to the resolution of a radar.
Polar orbit	An orbit that passes close to the poles, thereby enabling a satellite to pass over most of the Earth's surface, except the immediate vicinity of the poles themselves.
Polarisation	The direction of orientation in which the electrical field vector of electromagnetic radiation circulate.
Polarised radiation	Electromagnetic radiation in which the electrical field vector is contained in a single plane, instead of having random orientation relative to the propagation vector.
Post-launch calibration	Calibration process performed after the launch of a space-borne instrument utilising artificial and/or natural calibration targets.
Pre-launch calibration	Calibration process performed before the launch of a space-borne instrument to characterise the performance of individual instrument sub-systems.

Pulse	Short burst of electromagnetic radiation transmitted by a radar antenna.
Pulse compression	Signal processing technique used to increase the range resolution as well as the signal to noise ratio of a radar. See also Linear Frequency Modulation.
Pulse duration	Interval between the time, during the first transition, that the pulse amplitude reaches a specified fraction (level) of its final amplitude, and the time the pulse amplitude drops, on the last transition, to the same level.
Pulse repetition frequency	Number of pulses transmitted by a radar per unit time interval.
Radar	Acronym for radio detection and ranging. Radar is an active form of remote sensing that operates in the microwave wavelength regions.
Radar cross section	A measure of the intensity of backscattered radar energy from a point target. Expressed as the area of a hypothetical surface which scatters radar equally in all directions and which would return the same energy to the antenna.
Radar equation	Mathematical representation of the dependency between the transmitted to the received electromagnetic power of a radar.
Radar scattering coefficient	A measure of the back-scattered energy from a target with a large area. Expressed as the average radar cross section per unit area in decibels (dB). It is the fundamental measure of the radar properties of a surface.
Radiometric accuracy	Closeness to which the result of a measurement conforms to the correct value of a physical quantity of interest.
Radiometric calibration	Determination of the relationship between the raw instrument recordings and the physical quantity of interest with its noise related uncertainty.
Radiometric resolution	Ability of a radar to discriminate very slight differences in energy scattered back to the instrument.
Range	In radar, this is the distance in the direction of radar propagation, usually to the side of the platform.
Range binning	Received backscatter energy is binned according to the time delay of transmission and reception to achieve sub-beamwidth resolution.
Range direction	see look direction
Range resolution	Spatial resolution in the range direction, which is determined by the pulse length of the transmitted microwave energy.
Rayleigh criterion	In radar, the relationship between surface roughness, depression angle, and wavelength that determines whether a surface will respond in a rough or smooth fashion to the radar pulse.

Rayleigh scattering	Scattering mechanism taking place if the target size is much smaller than the wavelength resulting in resonant effects.
Reflectivity	Ability of a surface to reflect incident energy.
Refraction	Bending of electromagnetic rays as they pass from one medium into another when each medium has a different index of refraction.
Relative calibration	Determination of the relative bias of an instrument to a defined standard.
Remote sensing	Group of techniques for collecting and interpreting information about an distant object without being in physical contact with the object.
Repeat cycle	Fixed time interval after that a satellite repeats its path on the ground.
Roll	Rotation of an aircraft that causes a wing-up or wing-down attitude.
Roughness	In radar, the average vertical relief of a small-scale irregularities of the terrain surface. Also called surface roughness.
Satellite	An object in orbit around a celestial body.
Scattering	Multiple reflections of electromagnetic waves by particles or surfaces.
Scatterometer	Radar system that emits microwave signals to measure the power received from surface backscattering to infer earth's surface properties by measuring a multiplet of backscattering cross sections. The multiplet of signals typically includes different azimuth views and/or microwave polarizations at wavelengths on the cm scale. Satellite microwave scatterometers are mainly launched to obtain ocean vector winds, but other geophysical variables, such as soil moisture, sea ice and snow parameters, or vegetation are also obtained.
SCIRoCCo	THe SCatterometer InstRument Competence Centre Established by the European Space Agency in 2014 in support of the activities of the Sensor Performance and Product Assessment and Algorithm section (SPPA earth.esa.int/web/sppa) for the ERS-2 Scatterometer mission Phase-F. See scirocco.sp.serco.eu. SCIRoCCo aims at promoting the continuing exploitation of ESA's unique 20 years' worth of ERS Scatterometer data (ESCAT) at medium (25Km, 50 Km) spatial resolution, and improving the quality of available and future scatterometry data.
Sensor	Device that receives electromagnetic radiation and converts it into a signal that can be recorded and displayed as either numerical data or an image.
Sensor inter-calibration	Calibration of two or more sensors with respect to a common reference.
Sensor intra-calibration	Calibration of a single sensor to a sensor dependent reference.

Signal	Information recorded by a remote sensing system.
Signal to noise ratio	The ratio of the level of the signal carrying real information to that carrying spurious information as a result of defects in the system.
Slant range	In radar, an imaginary line running between the antenna and the target.
Slope	In the TU Wien soil moisture retrieval algorithm, the first derivative of the backscatter as function of the incidence angle
Soil moisture model parameters	In the TU Wien soil moisture retrieval algorithm, parameters driving a model to retrieve surface soil moisture estimates from backscatter coefficient observations by the use of a change detection algorithm.
Spatial resampling	The calculation of new value at a location of interest, based on the values in the local area around the location of interest.
Spatial resolution	Ability of a radar to separate closely spaced objects on the ground.
Speckle	Random constructive and destructive interference from the multiple scattering returns.
Specular reflection	Scattering mechanism at which the angle of the incoming wave is the same as the angle of the outgoing/reflected wave with reference to the surface normal.
Stress-equivalent 10-m-height wind speed, U10S	Wind speed inferred from scatterometer backscatter measurements of the ocean surface at a height of 10 m. Atmospheric stability and density changes the relationship between ocean roughness (radar cross section) and the real wind at 10-m height. Therefore, scatterometer winds are taken at average mass density and an equivalent neutral atmospheric stability, and are compared to NWP or buoy U10S, i.e., winds corrected for atmospheric stability and mass density effects in the lowest 10 m.
Sub-beamwidth resolution	Extraction of target information within an antenna beam by utilising directional information to achieve higher spatial resolutions.
Surface soil moisture (SSM)	In the TU Wien soil moisture retrieval algorithm, representing the water content within the topsoil layer given as degree of saturation in percentage.
Swath	Strip of the Earth's surface from which information is collected by a radar.
Swath grid	Spatial grid defined within the swath of a radar used to geo-reference observations.
Target	Object on the Earth's surface of specific interest in a remote sensing investigation.
Thinning	A procedure to reduce the density of data
Time-series	A series of values of a quantity obtained at successive times not necessarily with

	equal intervals between them.
Transmissivity	Property of a material that determines the amount of energy that can pass through the material.
U_{10N}, U10N	Wind speed at 10m above the surface, adjusted for neutral conditions. See also U10S or Stress-equivalent 10-m-height wind speed.
Validation	Process of confirming the validity of data to a known reference.
Volume scattering	Interaction between electromagnetic radiation and the interior of a material resulting in radiation scattered equally in all directions.
Wavelength	Distance between successive wave crests or other equivalent points in a harmonic wave.
Wet backscatter reference	In the TU Wien soil moisture retrieval algorithm, the backscatter coefficient corresponding to the wettest observed soil condition.
Wet cross-over angle	In the TU Wien soil moisture retrieval algorithm, cross-over angle used for the determination of the wet backscatter reference.
Wet reference correction	In the TU Wien soil moisture retrieval algorithm, a correction applied to the wet reference in climate regions where likely no wettest soil conditions were observed.
Wind Vector Cell (WVC)	Square area in a scatterometer swath, defined by an equidistant across-track range. Each subsequent range is numbered in an order depending on scatterometer swath type. The along-track range is chosen identical to the across-track range such that square cells are defined.
X-band	A microwave band with a wavelength (frequency) interval ranging from 3.7 - 2.5 cm (8 - 12 GHz) in the electromagnetic spectrum.
Yaw	Rotation of an aircraft about its vertical axis so that the longitudinal axis deviates left or right from the flight line.