

Recommendation ITU-R P.310-11

(09/2025)

P Series: Radio-wave propagation

Definitions of terms relating to propagation in non-ionized media

Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

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Series of ITU-R Recommendations

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Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	Radio-wave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R P.310-11

Definitions of terms relating to propagation in non-ionized media

(1951-1959-1966-1970-1974-1978-1982-1986-1990-1992-1994-2019-2025)

Scope

This Recommendation provides definitions of terms relating to propagation in non-ionized media as used in ITU-R P-series Recommendations.

Keywords

Vocabulary, non-ionized RF propagation, ground propagation, tropospheric propagation

Related ITU-R Recommendations

Recommendation ITU-R P.453 – The radio refractive index: its formula and refractivity data

NOTE – In every case the latest edition of the Recommendation in force should be used.

The ITU Radiocommunication Assembly,

considering

that it is important to have agreed definitions of propagation terms used in the texts of ITU-R Study Groups,

recommends

that the list of definitions annexed hereto should be adopted for incorporation in the vocabulary.

Annex**Vocabulary of terms used in radio propagation in non-ionized media**

	Term	Definition
A.	<i>Terms related to radio waves</i>	
A1.	<i>Cross-polarization</i>	The appearance, in the course of propagation, of a polarization component which is orthogonal to the expected polarization.
A2.	<i>Cross-polarization discrimination</i>	For a radio wave transmitted with a given polarization, the ratio at the reception of the power received with the expected polarization to the power received with the orthogonal polarization. <i>Note 1</i> – The cross-polarization discrimination depends both on the characteristics of the antenna and on the propagation medium
A3.	<i>Cross-polarization isolation</i>	For two radio waves transmitted with the same frequency with the same power and orthogonal polarization, the ratio of the co-polarized power in a given receiver to the cross-polarized power in that receiver.

	Term	Definition
A4.	<i>Depolarization</i>	A phenomenon by virtue of which all or part of the power of a radio wave transmitted with a defined polarization is transferred to another polarization.
A5.	<i>Co-polarization</i>	The appearance, in the course of propagation, of a polarization component which is identical to the expected polarization.
A6.	<i>Polarization mismatch loss</i>	The ratio of: a) the power received by an antenna from a given plane wave of arbitrary polarization to b) the power that would be received by the same antenna from a plane wave of the same power flux density and propagation direction, whose polarization has been adjusted for maximum received power.
B.	<i>Terms related to ground effects on radio-wave propagation</i>	
B1.	<i>Free-space propagation</i>	Propagation of an electromagnetic wave in a homogeneous ideal dielectric medium which may be considered of infinite extent in all directions.
B2.	<i>Line of sight propagation</i>	Propagation between two points for which the direct ray is sufficiently clear of obstacles for diffraction to be of negligible effect.
B3.	<i>Radio horizon</i>	The locus of points at which direct rays from a point source of radio waves are tangential to the surface of the Earth. <i>Note 1</i> – As a general rule, the radio and geometric horizons are different because of atmospheric refraction.
B4.	<i>Penetration depth</i>	The depth within the Earth at which the amplitude of a radio wave incident at the surface falls to a value $1/e$ (0.368) of its value at the surface.
B5.	<i>Smooth surface; specular surface</i>	A surface separating two media which is sufficiently large and the irregularities of which are sufficiently small to cause specular reflection. <i>Note 1</i> – In practice, the minimum size of the surface corresponds to the first Fresnel zone and the importance of irregularities is estimated using the Rayleigh criterion.
B6.	<i>Rough surface</i>	A surface separating two media which does not fulfil the smooth surface conditions and the irregularities of which are randomly located and cause diffuse reflection.
B7.	<i>Diffuse reflection coefficient</i>	The ratio of the amplitude of the incoherent wave reflected from a rough surface to the amplitude of the incident wave.
B8.	<i>Measure of terrain irregularity; Δh</i>	A statistical parameter which characterizes the variations in ground height along part or all of a propagation path. <i>Note 1</i> – For example, Δh is often defined as the difference between the heights exceeded by 10% and 90% respectively of the terrain heights measured at regular intervals (the interdecile height range) along a specified section of a path.
B9.	<i>Obstacle gain</i>	The enhancement in field strength, which can occur at one end of a transmission path including an isolated obstacle, with respect to the field strength which would occur at the same point if this obstacle were removed.
B10.	<i>Site shielding</i>	The reduction in the level of interference radio signals reaching an antenna situated near the ground, due to natural or artificial obstacles in the vicinity of the antenna.

	Term	Definition
B11.	<i>Site shielding factor</i>	The ratio, generally expressed in dB, of the level of an interfering radio signal which would occur without any site shielding, to the actual level of the interfering radio signal with site shielding.
C.	<i>Terms related to tropospheric effects on radio-wave propagation</i>	
C1.	<i>Troposphere</i>	The lower part of the Earth's atmosphere extending upwards from the Earth's surface, in which temperature decreases with height except in local layers of temperature inversion. This part of the atmosphere extends to an altitude of about 9 km at the Earth's poles and 17 km at the equator.
C2	<i>Temperature inversion (in the troposphere)</i>	An increase in temperature with height in the troposphere.
C3.	<i>Mixing ratio</i>	The ratio of the mass of water vapour to the mass of dry air in a given volume of air (generally expressed in g/kg).
C4.	<i>Refractive index; n</i>	Ratio of the speed of radio waves <i>in vacuo</i> to the speed in the medium under consideration.
C5.	<i>Refractivity; N</i>	One million times the amount by which the refractive index n in the atmosphere exceeds unity: $N = (n - 1) 10^6$
C6.	<i>N-unit</i>	A dimensionless unit in terms of which refractivity is expressed.
C7.	<i>Modified refractive index</i>	The sum of the refractive index n of the air at height h and the ratio of this height to the radius of the Earth, a : $n + \frac{h}{a}$
C8.	<i>Refractive modulus; M</i>	One million times the amount by which the modified refractive index exceeds unity: $M = \left(n + \frac{h}{a} - 1 \right) 10^6 = N + 10^6 \frac{h}{a}$
C9.	<i>M-unit</i>	A dimensionless unit in terms of which refractive modulus M is expressed.
C10.	<i>Standard refractivity gradient</i>	A standard value of vertical gradient of refractivity used in refraction studies; namely -40 N/km. This corresponds approximately to the median value of the gradient in the first kilometre of altitude in temperate regions.
C11.	<i>Standard radio atmosphere</i>	An atmosphere having the standard refractivity gradient.
C12.	<i>Reference atmosphere for refraction</i>	An atmosphere in which $n(h)$ decreases with height as given in Recommendation ITU-R P.453.
C13.	<i>Sub-refraction</i>	Refraction for which the refractivity gradient is greater (i.e. positive or less negative) than the standard refractivity gradient.
C14.	<i>Super-refraction</i>	Refraction for which the refractivity gradient is less (i.e. more negative) than the standard refractivity gradient.
C15.	<i>Beam spreading loss</i>	A non-ohmic loss due to spreading of the antenna beam in the vertical elevation plane due to the variation of the atmospheric refractive index versus height.

	Term	Definition
C16.	<i>Effective radius of the Earth</i>	Radius of a hypothetical spherical Earth, without atmosphere, for which propagation paths are along straight lines, the heights and ground distances being the same as for the actual Earth in an atmosphere with a constant vertical gradient of refractivity. <i>Note 1</i> – The concept of effective radius of the Earth implies that the angles with the horizontal planes made at all points by the transmission paths are not too large. <i>Note 2</i> – For an atmosphere having a standard refractivity gradient, the effective radius of the Earth is about 4/3 that of the actual radius, which corresponds to approximately 8 500 km.
C17.	<i>Effective Earth-radius factor, k</i>	Ratio of the effective radius of the Earth to the actual Earth radius. <i>Note 1</i> – This factor k is related to the vertical gradient dn/dh of the refractive index n and to the actual Earth radius a by the equation: $k = \frac{1}{1 + a \frac{dn}{dh}}$
C18.	<i>Ducting layer</i>	A tropospheric layer characterized by a negative M gradient, which consequently may generate a tropospheric radio-duct if the layer is sufficiently thick compared with the wavelength.
C19.	<i>Tropospheric radio-duct</i>	A quasi-horizontal stratification in the troposphere within which radio energy of a sufficiently high frequency is substantially confined and propagates with much lower attenuation than would be obtained in a homogeneous atmosphere. <i>Note 1</i> – The tropospheric radio-duct consists of a ducting layer and, in the case of an elevated duct, the portion of the underlying atmosphere in which the refractive modulus exceeds the minimum value attained in the ducting layer.
C20.	<i>Ground-based duct (Surface duct)</i>	A tropospheric radio-duct in which the lower boundary is the surface of the Earth.
C21.	<i>Elevated duct</i>	A tropospheric radio-duct in which the lower boundary is above the surface of the Earth.
C22.	<i>Duct thickness</i>	The difference in height between the upper and lower boundaries of a tropospheric radio-duct.
C23.	<i>Duct height</i>	The height above the surface of the Earth of the lower boundary of an elevated duct.
C24.	<i>Duct intensity</i>	The difference between the maximum and minimum values of the refractive modulus in a tropospheric radio-duct. <i>Note 1</i> – The intensity of a duct is the same as that of its ducting layer.
C25.	<i>Ducting</i>	Guided propagation of radio waves inside a tropospheric radio-duct. <i>Note 1</i> – At sufficiently high frequencies, a number of electromagnetic modes of guided propagation can coexist in the same tropospheric radio-duct.

	Term	Definition
C26.	<i>Trans-horizon propagation</i>	Tropospheric propagation between points close to the ground, the reception point being beyond the radio horizon of the transmission point. <i>Note 1</i> – Trans-horizon propagation may be due to a variety of tropospheric mechanisms such as diffraction, scattering, reflection from tropospheric layers. However, ducting is not included because in a duct there is no radio horizon.
C27.	<i>Tropospheric-scatter propagation</i>	Tropospheric propagation due to scattering from many inhomogeneities and discontinuities in the refractive index of the atmosphere.
C28.	<i>Hydrometeors</i>	Concentrations of water or ice particles which may exist in the atmosphere or be deposited on the surface of the Earth. <i>Note 1</i> – Rain, fog, clouds, snow and hail are the main hydrometeors.
C29.	<i>Aerosols</i>	Small particles in the atmosphere (other than fog or cloud droplets) which do not fall rapidly under gravity.
C30.	<i>Precipitation-scatter propagation</i>	Tropospheric propagation due to scattering caused by hydrometeors, mainly rain.
C31.	<i>Multipath propagation</i>	Propagation of the same radio signal between a transmission point and a reception point over a number of separate propagation paths.
C32.	<i>Scintillation</i>	Rapid and random fluctuation in one or more of the characteristics (amplitude, phase, polarization, direction of arrival) of a received signal, caused by refractive index fluctuations of the transmission medium.
C33.	<i>Gain degradation; antenna to medium coupling loss</i>	The apparent decrease in the sum of the gains (expressed in decibels) of the transmitting and receiving antennas when significant scattering effects occur on the propagation path.
C34.	<i>Precipitation rate; rainfall rate; rain rate</i>	A measure of the intensity of precipitation expressed by the increase in the height of water reaching the ground per unit time. <i>Note 1</i> – Rain rate is generally expressed in millimetres per hour.