

Review of radiation variables in WMDR and OSCAR/Requirements

This note responds to questions arising from discussion of WMDR Issue #389.

The original aim of Issue #389 was to introduce into WMDR a set of variables missing in WMDR but present in OSCAR/Requirements (OSCAR/R), along with their definitions, and also to provide some definitions missing in WMDR using definitions in OSCAR/R.

All variables in Issue #389 are related to atmospheric radiation. This note is restricted to analysis of those variables with radiation units (irradiances and radiances, spectrally resolved and spectrally integrated). Dimensionless variables (reflectance, emissivity, albedo) are not analysed, nor is “background luminance”; proposals for these variables have been retained unchanged.

There are also many radiation variables in WMDR relating to solar observations and space weather requirements. These are not addressed here. In principle, there could be some overlap here with atmospheric variables at the top of the atmosphere (TOA). A preliminary check suggests that there are currently no such overlaps.

The other specific radiation variables found in WMDR and OSCAR/R that are not addressed here are:

- Fire radiative power,
- Photosynthetically active radiation (PAR).

Considering, now, the atmospheric variables with radiation units, these can be logically divided as follows:

- (1) short-wave or long-wave or total (= short-wave + long-wave),
- (2) upward or downward fluxes,
- (3) spectrally integrated or spectrally resolved,
- (4) hemispherically integrated fluxes (irradiances) or angle-specific radiances,
- (5) atmospheric level (surface or TOA or, in principle, any other level).

Since it has been agreed not to include atmospheric level as part of the variable name in WMDR, (5) is not considered further here.

There are 12 permutations of (1), (2) and (3). The table below shows how they are currently populated in WMDR (i.e. their current WMDR IDs), or how they are proposed to be populated (by reference to item n in #389.n). (Numbers in brackets give the equivalent ID in OSCAR/R.) The final column in the table shows how the existing/proposed variables divide according to (4).

Short-wave	Integrated	Downward	NEW #389.1 (50,51) 571, 572, 573 [Also see NEW #389.4 (359)]	Irradiance Irradiance Irradiance
		Upward	NEW #389.2 (167) 574	Irradiance Irradiance
	Spectral	Downward	[Also see NEW #389.4 (359)]	Irradiance
		Upward	[Also see NEW #389.3 (168)]	Spectral radiance
Long-wave	Integrated	Downward	566 (52) – needs definition	Irradiance
		Upward	567 (169,170) – needs definition	Irradiance
	Spectral	Downward		
		Upward	[See NEW #389.3 (168)]	Spectral radiance
Total	Integrated	Downward	NEW #389.4 (359)	Irradiance

		Upward		
	Spectral	Downward	NEW #389.4 (359)	Irradiance
		Upward	NEW #389.3 (168) 89 (175)	Spectral radiance Spectral radiance

This analysis shows that:

- #389.1 is unnecessary. We should change the names of 571, 572 and 573 and supply appropriate definitions.
- #389.2 is unnecessary. We should change the names of 574 and supply an appropriate definition.
- We should change the name of 566 and supply an appropriate definition.
- We should change the name of 567 and supply a appropriate definition.
- #389.3 should be retained but modified.
- 89 (water-leaving spectral radiance) could be absorbed under #389.3.
- #389.4 should be split into 2 items: one for spectrally integrated and one for spectrally resolved.
- #389.5-#389.8 (BDRF, LW emissivity, background luminance, surface albedo) should be retained.

Proposed revision of #389

Changes

notation	name	description	tags
566	Longwave radiation (downwelling) → Downward long-wave irradiance	Flux density of upwelling long-wave radiation, measured at a specified level within the atmosphere	radiation
567	Longwave radiation (upwelling) → Upward long-wave irradiance	Flux density of upwelling long-wave radiation, measured at a specified level within or at the top of the atmosphere	radiation
571	Diffuse solar radiation → Diffuse downward short-wave irradiance	Flux density of diffuse downwelling solar radiation, measured at a specified level within the atmosphere	radiation
572	Direct solar radiation → Direct downward short-wave irradiance	Flux density of direct downwelling solar radiation, measured at a specified level within or at the top of the atmosphere	radiation
573	Global solar irradiance (downwelling) → Downward short-wave irradiance	Flux density of downwelling total solar radiation, measured at a specified level within or at the top of the atmosphere	radiation
574	Global solar irradiance (upwelling) → Upward short-wave irradiance	Flux density of upwelling reflected solar radiation, measured at a specified level within or at the top of the atmosphere	radiation
267	Background luminance (no change – add definition only)	Luminous flux received from the background, per unit solid angle and per unit area where the Luminous flux is a quantity derived from radiant flux by evaluating the radiation according to its action upon the International	radiation

		Commission on Illumination standard photometric observer.	
271	Surface albedo (no change – add definition only)	Hemispherically integrated reflectance of the Earth surface in the range 0.4-0.7	radiation

Additions

notation	name	description	tags
new id	Upward spectral radiance	Upwelling radiant power per unit area, per unit solid angle, per unit wavelength interval, measured at a specified level within or at the top of the atmosphere	radiation
new id	Solar spectral irradiance	Spectrally resolved flux density of radiation received from the sun at the top of the atmosphere	radiation
new id	Solar total irradiance	Spectrally integrated flux density of radiation received from the sun at the top of the atmosphere. Also called “Total solar irradiance (TSI)”.	radiation
new id	Earth surface short-wave bidirectional reflectance	Reflectance of the Earth surface as a function of the viewing angle and the illumination angle in the range 0.4-0.7. The distribution of this variable is represented by the Bidirectional Reflectance Distribution Function (BRDF)	radiation
new id	Long-wave earth surface emissivity	Emissivity of the earth surface in the thermal IR, function of the wavelength	radiation

Other issues

- Solar spectral irradiance and solar total irradiance. It is proposed to keep TOA as part of the definitions of these variables, noting the special significance of such measurements. Discussion required.
- Long-wave radiation (direction unspecified). This is WMDR 565. Because the direction is unspecified, it does not fit into the first table above. It probably originates from bolometer measurements at the Earth’s surface including both upwelling and downwelling components. More information needed. Definition needed.