



Resolution SFCG 21-2R4

**REQUIREMENTS, PERFORMANCE, AND PROTECTION CRITERIA
FOR EESS (PASSIVE) SENSORS**

The SFCG,

CONSIDERING

- a) that due to the continuous technological and scientific development, the requirements, performance and protection criteria for Earth exploration-satellite service (EESS) (passive) sensors must be periodically reviewed;
- b) that the basic parameters related to requirements, performance and protection criteria for EESS (passive) sensors are contained in Recommendations ITU-R RS.515 and RS.2017;
- c) that any revision to these Recommendations requires a consensus and a coherent approach in the parameters definition across all the passive bands;
- d) that three main categories of passive sensors can be identified for the use of these bands:
 - 1. 3-dimensional vertical atmosphere sounders requiring very high data reliability and medium resolution over multiple channels,
 - 2. imaging radiometers requiring high data reliability, medium resolution, integration over relatively large bandwidth single channels,
 - 3. atmospheric limb sounders requiring medium data reliability at very high resolution over many small bandwidth channels.
- e) that any performance requirement has to be based on known scientific requirements for the measurement; the data resolution and availability levels must therefore be scientifically meaningful with respect to the applications for which they are used (e.g. forecasting, surface observations and climate monitoring);
- f) that the implementation and orbiting of instruments capable of achieving the performance requirements should be met within a 10-year timeframe;

- g) that the resulting values in these Recommendations will not be applied retro-actively;

RESOLVES

1. that the values given in Table 1 represent the requirements and performance criteria and can be used to derive appropriate protection criteria for spaceborne passive sensors;
2. that Member Agencies submit to the SFCG contributions to update the values contained in Table 1, with a view to future updating of the ITU-R Recommendations listed in CONSIDERING b).

TABLE 1

Requirements and Performance criteria for satellite passive remote sensing

Frequency Band⁽⁶⁾ (GHz)	Total BW required (MHz)	Reference BW (MHz)	Measurement(s)	Required ΔT_e (K)	Data availability (%)³	Scan Mode (N, C, L)⁽⁴⁾
1.370-1.400s, 1.400-1.427P	100	27	Vegetation biomass, soil moisture, snow morphology, sea ice thickness; salinity	0.05	99.9	N, C
2.640-2.655s, 2.655-2.690s, 2.690-2.700P	45	10	Vegetation biomass, soil, moisture, snow morphology; salinity	0.1	99.9	N
4.200-4.400s, 4.950-4.990s	200	200	Soil moisture, sea surface temperature	0.3/0.05*	99.9	N, C
6.425-7.250	200	200	Soil moisture, sea ice thickness, sea surface temperature	0.3/0.05*	99.9	N, C
10.60-10.68p, 10.68-10.70P	100	100	Snow and ice morphology, precipitation over oceans, sea surface temperature	1.0/0.1*	99.9	N, C
15.200-15.350s, 15.350-15.400P	200	50	Rain, background channel ⁽⁷⁾ for 22 GHz water vapor	0.1	99.9	N, C
18.600-18.800p	200	200	Precipitation, Background channel ⁽⁷⁾ for 22 GHz water vapor	1.0/0.1*	95/99.9*	N, C
21.200-21.400p	200	100	Integrated vapor content	0.2/0.05*	99/99.9*	N
22.210-22.500p	300	100	Integrated vapor content	0.4/0.05*	99/99.9*	N
23.600-24.000P	400	200	Integrated vapor content	0.05	99.99	N, C
31.30-31.50P, 31.50-31.80p	500	200	Water vapor, snow and sea ice morphology; atmospheric window channel	0.2/0.05*	99.99	N, C
36.000-37.000p	1 000	100	Rain, snow, lake and sea ice morphology, oil slicks; light rain over oceans	1.0/0.1*	99.9	N, C
50.200-50.400P	200	200	Surface emissions necessary for accurate temp profiles from 52.6-59.3 GHz	0.05	99.99	N, C
52.60-54.25P, 54.25-59.30p	6 700 ⁽¹⁾	100	Temperature profiles, cloud liquid water, snow and lake ice morphology, oil slicks	0.3/0.05*	99.99	N, C
86.00-92.00P	6 000	100	Surface emissions for temperature profiles from 115.25-122.25 GHz; cloud liquid water, snow and ice morphology, oil slicks	0.05	99.99	N, C
100.0-102.0P	2 000	10	NO and O ₃ , precipitation	0.005	99	L
109.5-111.8P	2 000	10	Temperature, O ₃ , CO ₂ , NO	0.005	99	L
114.25-116.00P	1 750	10	Temperature, O ₃ , CO ₂ , NO	0.005	99	L

Frequency Band ⁽⁶⁾ (GHz)	Total BW required (MHz)	Reference BW (MHz)	Measurement(s)	Required ΔT_e (K)	Data availability (%) ³	Scan Mode (N, C, L) ⁽⁴⁾
115.25-116.00P 116.00-122.25p	7000 ⁽¹⁾	200/10 ⁽⁵⁾	Temperature profiles; cloud liquid water, precipitation	0.05/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, L
148.5-151.5P	3 000	500/10 ⁽⁵⁾	NO, Window Channel for 183 GHz	0.1/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, L
155.5-158.5p ⁽²⁾	3 000	200	Window Channel for 183 GHz	0.1	99.99	N, C
164.0-167.0P	3 000 ⁽¹⁾	200/10 ⁽⁵⁾	Water vapor profile; precip over land, snowfall	0.1/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, C, L
174.8-182.0p, 182.0-185.0P, 185.0-190.0p, 190.0-191.8P	17 000 ⁽¹⁾	200/10 ⁽⁵⁾	O ₃ , NO; snowfall, cloud ice, water profile retrieval	0.1/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, C, L
200.0-209.0P	9 000 ⁽¹⁾	3	NO, Atmospheric constituent	0.005	99	L
226.0-231.5P	5 500	200/3 ⁽⁵⁾	Atmospheric constituent, window for 325 GHz water vapor channel	0.2/ .005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, L
235.0-238.0p	3 000	3	NO, O ₃ , CO ₂	0.005	99	L
250.0-252.0P	2 000	3	NO	0.005	99	L
275-285.4	10 400	3	N ₂ O, ClO	0.005	99	N, L
296-306	10 000	200/3 ⁽⁵⁾	Wing channel for temperature sounding OXYGEN, HNO ₃ , HOCl, N ₂ O, O ₃ , O ¹⁷ O,	0.2/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, L
313.5-355.6	42 100	200/3 ⁽⁵⁾	Water vapour profiling, cloud, Wing channel for temperature sounding HDO, ClO, HNO ₃ , H ₂ O, O ₃ , HOCl, CH ₃ Cl, O ¹⁸ O, CO, BrO, CH ₃ CN, N ₂ O, HCN	0.3/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, C, L
361.2-365	3 800	200/3 ⁽⁵⁾	Wing channel for water vapour profiling O ₃	0.3/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, L
369.2-391.2	22 000	200/3 ⁽⁵⁾	Water vapour profiling H ₂ O	0.3/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, L
397.2-399.2	2 000	200/3 ⁽⁵⁾	Water vapour profiling	0.3/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, L
409-411	2 000	3	Temperature sounding	0.005	99	L
416-433.46	17 460	200/3 ⁽⁵⁾	Oxygen, temperature profiling	0.4/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, L
439.1-466.3	27 200	200/3 ⁽⁵⁾	Water vapour profiling, cloud HNO ₃ , H ₂ O, O ₃ , N ₂ O, CO	0.4/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, C, L
477.75-496.75	19 000	3	Oxygen, temperature profiling	0.005	99	L
497-502	5 000	200/3 ⁽⁵⁾	Wing channel for water vapour profiling BrO, N ₂ ¹⁸ O, O ₃	0.5/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, L
523-527	4 000	200	Wing channel for water vapour profiling	0.5	99.99	N

Frequency Band ⁽⁶⁾ (GHz)	Total BW required (MHz)	Reference BW (MHz)	Measurement(s)	Required ΔT_e (K)	Data availability (%) ³	Scan Mode (N, C, L) ⁽⁴⁾
538-581	43 000	200/3 ⁽⁵⁾	Water vapour profiling HNO ₃ , O ₃ , H ₂ O, ClO	0.5/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, L
611.7-629.7	18 000	3	Water vapour profiling, OXYGEN, H ₂ O, ClO ₂ , SO ₂ , HNO ₃ , BrO, CH ₃ CN, (H ³⁷ Cl), H ₂ O ₂ , HOCl, O ₃ , HO ₂ , H ³⁵ Cl, CH ₃ Cl, O ¹⁸ O	0.005	99	L
634-654	20 000	200/3 ⁽⁵⁾	Wing channel for water vapour profiling HOCl, H ₂ ¹⁸ O, SO ₂ , ClO, HO ₂ , BrO, HNO ₃ , O ₃ , NO, N ₂ O	0.6/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, L
656.9-692	35 100	200/3 ⁽⁵⁾	Water vapour profiling, cloud H ₂ O, HO ₂ , ClO, CH ₃ Cl, CO	0.6/0.005 ⁽⁵⁾	99.99/99(5)	N, C, L
713.4-717.4	4 000	3	Oxygen	0.005	99	L
729-733	4 000	3	Oxygen HNO ₃ , O ¹⁸ O	0.005	99	L
750-754	4 000	3	Water	0.005	99	L
771.8-775.8	4 000	3	Oxygen	0.005	99	L
823.15-845.15	22 000	200/3 ⁽⁵⁾	Oxygen	0.8/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, C, L
850-854	4 000	3	NO	0.005	99	L
857.9-861.9	4 000	3	Water	0.005	99	L
866-882	16 000	200	Cloud, window	0.8	99.99	N, C
905.17-927.17	22 000	200/3 ⁽⁵⁾	Water	0.9/0.005 ⁽⁵⁾	99.99/99 ⁽⁵⁾	N, L
951-956	5 000	3	Oxygen NO, O ¹⁸ O	0.005	99	L
968.31-972.31	4 000	3	Water	0.005	99	L
985.9-989.9	4 000	3	Water	0.005	99	L

(1) This bandwidth is occupied by multiple channels.

(2) This band is needed until 2018 to accommodate existing and planned sensors.

(3) Data availability is the percentage of area or time for which accurate data is available for a specified sensor measurement area or sensor measurement time. For a 99.99% data availability, the measurement area is a square on the Earth of 2,000,000 km², unless otherwise justified; for a 99.9% data availability, the measurement area is a square on the Earth of 10,000,000 km², unless otherwise justified; for a 99% data availability, the measurement time is 24 hours, unless otherwise justified.

(4) N: Nadir, Nadir scan modes concentrate on sounding or viewing the Earth's surface at angles of nearly perpendicular incidence. The scan terminates at the surface or at various levels in the atmosphere according to the weighting functions. L: Limb, Limb scan modes view the atmosphere "on edge" and terminate in space rather than at the surface, and accordingly are weighted zero at the surface and maximum at the tangent point height. C: Conical, Conical scan modes view the Earth's surface by rotating the antenna at an offset angle from the nadir direction.

(5) First number for nadir or conical scanning modes and second number for microwave limb sounding applications

(6) P = Primary allocation, shared only with passive services (RR No. 5.340); p = primary allocation, shared with active services, and s = secondary allocation

⁽⁷⁾ Background channel: channel used in combination with others in order to extract individual physical parameters

* First number for sharing conditions circa 2008; second number for scientific requirements that are technically achievable by sensors within the next 10 years