Comments from Public Consultation on ECV Requirements 13/01 – 13/03 2020 for:

# Lightning

## ECV Product: Schumann Resonances

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| **Name** | Schumann Resonances | | | | |
| **Definition** | Extremely Low Frequency (ELF) magnetic and electric field of the three first resonance modes (8 Hz, 14 Hz, 20 Hz). | | | | |
| **Unit** | picoTesla2/Hz (magnetic field); volt2/m2/Hz (electric field) | | | | |
| **Note** | Regular measurements of two horizontal magnetic field components at a location are enough to monitor globally Schumann Resonances. The magnetic field should be monitored at a level of  ~0.1 picoTesla2/Hz.  Additionally to the magnetic measurements, one vertical electric measurement would document the full transverse electromagnetic (TEM) waveguide component at any given location. Note the estimate of the electric intensity assumes the wave impedance is half that of free space (377 ohms). In this context, the electric field should be monitored at a level of ~2.3 x 10-9 V2/m2/Hz.). Note also that the electric field should be monitored at 2.3 x 10-9 V2/m2/Hz. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | N/A |  | G |  | . |
| B |  |  |
| T |  |  |
| **Vertical Resolution** | N/A |  | G | N/A | N/A |
| B | N/A | N/A |
| T | N/A | N/A |
| **Temporal Resolution** | day |  | G | 1/24 | Suitable for investigation of the strong diurnal variation of tropical “chimney” regions and for use in multi-station inversion methods for global lightning activity |
| B | 1 | Suitable for investigation of intraseasonal variations (5 day wave; MJO) |
| T | 30 | Suitable for investigation of the global seasonal and annual variation, and the interannual ENSO variation |
| **Timeliness** | day |  | G | 1 | For use in building a representative monthly estimate for climate purposes |
| B | - |  |
| T | 30 | For climate-related studies;  responsiveness of lightning to long-term temperature changes |
| **Required Measurement Uncertainty** | femtoTesla2/Hz |  | G | 1 | Absolute coil calibration is feasible at the 1% level/  (Calibration of the vertical electric field is difficult, but possible) |
| B | - |  |
| T | 5 | Absolute coil calibration  at the 5% level |
| **Stability** | femtoTesla2/Hz |  | G | 1 | Given lightning sensitivity to temperature at the 10% per K level, one needs absolute calibration and stability at the 1% level to see fraction of 1K temperature changes |
| B | - | – |
| T | 5 | Coil calibration should be checked and maintained to at least this level |
| **Standards and References** | Nickolaenko, A.P. and M. Hayakawa, Resonances in the Earth–ionosphere cavity. Kluwer Academic Publisher, Dordrecht, London, 2002.  Nickolaenko, A.P. and M. Hayakawa, Schumann Resonance for Tyros: Essentials of Global Electromagnetic Resonance in the Earth–ionosphere Cavity. Springer, Tokyo/Heidelberg/New York/Dordrecht/London, 2014.  Polk, C., Schumann Resonances, in CRC Handbook of Atmospherics. Volume 1, Ed., H. Volland, CRC Press, Boca Raton, Florida, 1982.  Sátori G, V. Mushtak, and E. Williams, Schumann resonance signature of global lightning activity. In: Betz, HD, U. Schumann and P. Laroche (eds), Lightning: Principles, Instruments and Applications: Review of Modern Lightning Research. Springer, Berlin, pp 347–386. 2009.  Sentman, D.D., Schumann Resonances. In Volland, H., Ed., Handbook of Atmospheric Electrodynamics, CRC Press, Boca Raton, 267-296, 1995. | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | no | N/A |  | | |
| **Extremes[3]** | yes | yes | This product is relevant for global statistics of storms and current requirement cover this | | |

[1]Goal (G); Breakthrough (B) (not mandatory, more as one possible); Threshold (T), for definitions see [Guidelines](http://tiny.cc/ecv-review)

[2] Is the ECV Product directly relevant to support Climate Adaptation?

[3] Can the ECV Product be used to monitor climate extremes or aspects of extremes?

NO COMMENT

## ECV Product: Total lightning stroke density

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| **Name** | Total lightning stroke density | | | | |
| **Definition** | Total number of detected strokes in the corresponding time interval and the space unit. The space unit (grid box) should be equal to the horizontal resolution and the accumulation time to the observing cycle. | | | | |
| **Unit** | Dimensionless | | | | |
| **Note** | Data sets at the 1-map-per-month level require limited data storage, and thus should be simply posted on a publically accessible website. The larger data sets reaching down to global resolutions of 0.1 degree with time resolution of a few hours should be maintained by the network managers, and provided to the user community as needed. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | Degree pixels |  | G | 0.1x0.1 | Thunderstorms are complex, with different dynamics in different parts of the storm, for example the updraft region and the trailing stratosphere region. Therefore the net influence on global currents and climatology is likely to be very different from different sub-storm scales. |
| B | 0.25x0.25 | This is the convection scale and will help identify climate variability at the storm level |
| T | 1x1 | Ideally these data would be provided as both maps as well as digital files, along with the Metadata with adequate time resolution to address both long term and short term detection efficiency variations within these data sets. |
| **Vertical Resolution** | N/A |  | G | N/A | N/A |
| B | N/A | N/A |
| T | N/A | N/A |
| **Temporal Resolution** | day |  | G | 1/24 | Lifetime of thunderstorm cell, diurnal cycle. For high resolution climatology, also necessary to validate thunder day data in order to extend time series of lightning activity back in time |
| B | 1 | Weather patterns, weekly and intraseasonal patterns like MJO |
| T | 30 | Climate Scale |
| **Timeliness** | day |  | G | 1 | For high resolution climatology. It can be important for special occasions to see direct impacts of events  or mitigation immediately in order to react. |
| B | 30 | Forecasting and model input |
| T | 365 | For lightning climatology studies the provision of yearly data within one year of data collection, and to prepare their data back as far as it is available from their network is necessary. |
| **Required Measurement Uncertainty** | dimensionless |  | G | 1 | For high resolution climatology, also necessary to validate thunder day data in order to extend time series of lightning activity back in time |
| B | - |  |
| T | 15 | For climatologies |
| **Stability** | % |  | G | 1 | For high resolution climatology, also necessary to validate thunder day data in order to extend time series of lightning activity back in time |
| B | - | – |
| T | 10 | For climatologies |
| **Standards and References** | Algorithm Theoretical Basis Document (ATBD) for L2 processing of the MTG Lightning Imager data (Eumetsat, 2014)  Meteosat Third Generation (MTG) End-User Requirements Document (EURD) (Eumetsat, 2010)  Nag et al., 2015 | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | yes | yes | For adaptation, a lightning climatology can be used for example to find a suitable location for infrastructure. The suggested requirements cover this. Lightning observations are widely used for early warning of storms, but this is not considered here. | | |
| **Extremes[3]** | yes | yes | This product is relevant for extremes since it is a proxy for storms. The suggested requirements cover this. | | |

[1]Goal (G); Breakthrough (B) (not mandatory, more as one possible); Threshold (T), for definitions see [Guidelines](http://tiny.cc/ecv-review)

[2] Is the ECV Product directly relevant to support Climate Adaptation?

[3] Can the ECV Product be used to monitor climate extremes or aspects of extremes?

### Comment 1

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| Author: Steven Goodman | Email: Click here to enter text. |
| - Timeliness: the word network is not observing system agnostic as the satellite data are not considered networks.. I would change the sentence to end with "... as far back as possible."  - The required measurement uncertainty only refers to calendar days, but not to other important variables such as peak current or radiance. As we refine our ECV product we should include these. satellite radiance uncertainty is 20%.  - Standards and References does not include the GOES-R and LIS operating space-based instruments.  Please add the following:    Algorithm Theoretical Basis Document (ATBD) for L2 processing of the GOES-R Geostationary Lightning Mapper (GLM, Goodman et al., 2013) and MTG Lightning Imager data (Eumetsat, 2014)  GOES-R Product Definition and Users' Guide (PUG, Rev. 2018) and Data Book (Rev., 2019)  Meteosat Third Generation (MTG) End-User Requirements Document (EURD) (Eumetsat, 2010)  Nag et al., 2015  GOES-R Series, 2018. Product Definition and Users’ Guide. Volume 3: Level 1b Products, 1 November 2018 DCN 7035538, Revision 2.0, available  at https://www.goes-r.gov/users/docs/PUG-L1b-vol3.pdf.  GOES-R Series Data Book, 2019. CDRL PM-14 Rev A. May 2019, NOAA-NASA. Available at https://www.goes-r.gov/downloads/resources/  documents/GOES-RSeriesDataBook.pdf.  Adaption- lightning also used for building protection, safety codes- not just location. What about fires, fire ignition due to drought?  Thanks  steve | |

### Comment 2

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| Author: ECMWF | Email: ecresgcosreqs@gmail.com |
| - It would be useful to obtain additional information from the observations to discriminate  between Cloud-to-Ground (CG) and Cloud-to-Cloud (CC) lightning strokes. This would help  to better document and improve our understanding of the climatological variations of the  CG/CC lightning ratio across the globe. It would also allow a better separation between the  ground-level effects of lightning (e.g. disruptions in power supply and airport activities,  wildfire triggering, threat to populations during outdoor activities) and its upper-air  effects (e.g. on the safety of air traffic).  - Information about instrument's detection efficiency and its variations in space and time  is absolutely paramount to allow the quantitative evaluation of lightning products which  have become available from global forecast models.  - The time resolution of 1/24 day would deserve to be labelled as "Breakthrough", not just "Goal",  since it would help to identify or confirm biases in the diurnal cycle of convection  in global models that are able to predict lightning. I would think that a climate model that wrongly  predicts the diurnal cycle of convection locally is unlikely to correctly predict the  larger scales over that same region.  Philippe Lopez, ECMWF | |