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

# Leaf Area Index

## ECV Product: Leaf Area Index

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| --- | --- | --- | --- | --- | --- |
| **Name** | Leaf Area Index | | | | |
| **Definition** | Effective Leaf Area Index;  True Leaf  Area  Index  (LAI)  of  a  plant  canopy  or  ecosystem is  defined  as  one  half  of  the  total  green  leaf  area  per  unit  horizontal  ground  surface  area and  measures  the  area  of  leaf  material  present  in  the  specified  environment. (Projection to the underlying ground along the normal to the slope). | | | | |
| **Unit** | m2/m2 | | | | |
| **Note** | The  conversion  of  data  measurements to true values is an essential step and requires additional information about the structure  and  architecture  of  the  canopy,  e.g.  gap  size  distributions,  at  the  appropriate  spatial  resolutions.  LENGTH OF RECORD: Threshold: 20 years; Target: >40 years | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | m |  | G | 10 | Leaf Area Index  controls  important  mass and energy exchange processes, such as radiation and rain  interception,  as  well  as  photosynthesis  and  respiration,  which  couple  vegetation  to  the  climate  system.  Application at 10 m: Climate Adaptation, Agricultural monitoring  Best practices published here:  <http://www.qa4ecv.eu/sites/default/files/D4.2.pdf> |
| B |  |  |
| T | 250 | Scale needed for regional and global climate modeling. |
| **Vertical Resolution** | N/A |  | G |  |  |
| B |  |  |
| T |  |  |
| **Temporal Resolution** | days |  | G | 1 | When assimilated by model, this value corresponds to the climate model temporal resolution. In order to derive a better phenology accuracy. |
| B |  |  |
| T | 10 | When using for crops or ecosytems modeling |
| **Timeliness** | days |  | G | 1 | In order to be useful in climate change services. |
| B |  |  |
| T | 5 | In order to be useful in environmental change services. |
| **Required Measurement Uncertainty** | m2/ m2 | One standard deviation or error covariance matrix with associated PDF shape (functional form of estimated error distribution for the term). | G | 10% when values are higher than 0.5;  0.05 for smaller values. | The goal value of uncertainties were assessed through literature review of impact of climate change on Leaf Area Index using various earth system models (see Mahowald, et. al., 2016; <https://www.earth-syst-dynam.net/7/211/2016/>)    They show impact on LAI deviation at global scale using various RCP scenarios. If we take the models ensemble results, we demonstrate that the uncertainties should be less than Delta\_LAI ~**0.20 for a 2 deg. C deviation for an annual average LAI**, that can be approximated to  ~**1.5**.  This means that the uncertainties should be smaller than **10% (~0.20/1.87\*100.)**. |
| B |  |  |
| T | 20% when values are higher than 0.5;  0.10 for smaller values. | Same as above but with Delta\_LAI ~**0.25** |
| **Stability** | rate of change of LAI over the available time period (m2/m2 per decade) | A factor of uncertainties to demonstrate that the ‘error’ of the product remains constant over the period, typically a decade or more (see background information). | G | < 3% per decade | ‘The required stability is some fraction of the expected signal’ (see Ohring, et. al. 2005. <https://journals.ametsoc.org/doi/pdf/10.1175/BAMS-86-9-1303>).  “It may represent a requirement on the extent to which the error of the product remains constant over a long period, typically a decade or more. It can be defined by the mean of uncertainties over a month …”.  In the case that we have data over **10** years (= one decade)  N=**10** and U=**10%**  S=sqrt(sum(U^2))/N.  Assuming U constant along the period  It means S=SQRT(N\*U^2)/N=SQRT(N)\*U/N  **S=0.3\*U = 0.31 \* 10./100.0 = 3 %**  This number should be smaller than expected Leaf Area Index trend.  Reference:  C. Y. Jiang, Y. Ryu, H. Fang, R. Myneni, M. Claverie, Z. Zhu, Inconsistencies of interannual  variability and trends in long-term satellite leaf area index products. *Glob. Chang. Biol.***23**,  4133–4146 (2017).) |
| B |  |  |
| T | < 6% per decade | Same as above but with threshold uncertainty. |
| **Standards and References** | LENGTH OF RECORD: Threshold > 20 years; Goal >40 years | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | yes | yes | The Leaf Area Index also indicates the state and the amount of vegetation canopies meaning that the impact on adaptation policies toward ‘GreenCities’ or/and agricultural change management can be assessed. | | |
| **Extremes[3]** | yes | yes | Impact on extreme event, such as drought, can be monitor by this ECV. | | |

[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: Click here to enter text. | Email: debhem@hotmail.co.uk |
| See in table below | |

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| --- | --- | --- | --- | --- | --- |
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| **Unit** | m2/m2 | | | | |
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| B |  |  |
| T | 250 | Scale needed for regional and global climate modeling. Land surface and Earth System Model evaluation of LAI is often completed at 1km spatial resolution for global assessments, so it would be useful to include these coarser resolution data. |
| **Vertical Resolution** | canopy thickness |  | G | 0.1 | Every 1/10th of the canopy thickness to improve evaluation of vegetation LAI within Land surface/Earth System Models |
| B |  | Any specified level through the canopy |
| T | 1 | Canopy mean |
| **Temporal Resolution** | days |  | G | 1 | When assimilated by model, this value corresponds to the climate model temporal resolution. In order to derive a better phenology accuracy. |
| B |  |  |
| T | 10 | When using for crops or ecosytems modeling, or Land Surface / Earth System Model evaluation. |
| **Timeliness** | days |  | G | 1 | In order to be useful in climate change services. |
| B |  |  |
| T | 5 | In order to be useful in environmental change services. Can be longer (~months) for historic climate/environmental change assessments. |
| **Required Measurement Uncertainty** | m2/ m2 | One standard deviation or error covariance matrix with associated PDF shape (functional form of estimated error distribution for the term). | G | 10% when values are higher than 0.5;  0.05 for smaller values. | The goal value of uncertainties were assessed through literature review of impact of climate change on Leaf Area Index using various earth system models (see Mahowald, et. al., 2016; <https://www.earth-syst-dynam.net/7/211/2016/>)    They show impact on LAI deviation at global scale using various RCP scenarios. If we take the models ensemble results, we demonstrate that the uncertainties should be less than Delta\_LAI ~**0.20 for a 2 deg. C deviation for an annual average LAI**, that can be approximated to  ~**1.5**.  This means that the uncertainties should be smaller than **10% (~0.20/1.87\*100.)**. |
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| **Extremes[3]** | yes | yes | Impact on extreme event, such as drought, can be monitor by this ECV. | | |

### Comment 2

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| --- | --- |
| Author: Andy Wiltshire | Email: andy.wiltshire953@gmail.com |
| To have real value for the climate and earth system community the LAI data needs to related to the landcover class information. | |

### Comment 3

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| --- | --- |
| Author: ECMWF | Email: ecresgcosreqs@gmail.com |
| Definition: (to add)  Effective Leaf Area Index(LAIeff): The LAI value that would produce the same indirect ground measurement as that observed assuming random foliage distribution. ( LAIeff=LAItrue x canopy clumping index ) (Fang et al., 2019)  True Leaf Area Index (LAItrue) ....  Note: (to add): LENGTH OF RECORD: Threshold: 20 years; Target: >40 years (Spatially and temporally consistent and gap filled, with provision of the related Land use/land cover background)  Horizontal/temporal Resolutions: 1km global spatial resolution with 10-daily (or less) temporal resolution is of crucial importance for NWP applications  Standards and References (to add):  Fang, H., Baret, F., Plummer, S., & Schaepman‐Strub, G. ( 2019). An overview of global leaf area index (LAI): Methods, products, validation, and applications. Reviews of Geophysics. 57, 739– 799. https://doi.org/10.1029/2018RG000608  Boussetta S., Balsamo G., Dutra E., Beljaars A., Albergel C. (2015) Assimilation of surface albedo and vegetation states from satellite observations and their impact on numerical weather prediction, Remote Sensing of Environment, pp. 111-126. DOI:10.1016/j.rse.2015.03.009  Adaptation[2]: (add a reference to the ImagineS EU project: http://fp7-imagines.eu/)  Extremes[3]: (add a reference to Boussetta el al., 2015 ) | |

### Comment 4

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| Author: Nic Bax | Email: nic.bax@csiro.au |
| This would seem to be an important point as linking this ECV with landcover would provide an idea of the quality of the different landcover caetgories, crucial for adaptation work. | |

### Comment 5

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| Author: Marie Weiss | Email: mariewc84@gmail.com |
| Additional Reference:  Best practices  Fernandes, R., Plummer, S., Nightingale, J., Baret, F., Camacho, F., Fang, H., Garrigues, S., Gobron, N., Lang, M., Lacaze, R., LeBlanc, S., Meroni, M., Martinez, B., Nilson, T., Pinty, B., Pisek, J., Sonnentag, O., Verger, A., Welles, J., Weiss, M., & Widlowski, J.L. (2014). Global Leaf Area Index Product Validation Good Practices. Version 2.0. In G. Schaepman-Strub, M. Román, & J. Nickeson (Eds.), Best Practice for Satellite-Derived Land Product Validation (p. 76): Land Product Validation Subgroup (WGCV/CEOS), doi:10.5067/doc/ceoswgcv/lpv/lai.002 | |