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

# Evaporation from Land

## ECV Product: Transpiration

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| --- | --- | --- | --- | --- | --- |
| **Name** | Transpiration | | | | |
| **Definition** | The component of the total latent heat flux that corresponds to the vegetation consumption of water. | | | | |
| **Unit** | W/m2 | | | | |
| **Note** | The requirements are analogous to those of the total latent heat flux, because the applications are the same. Several studies have shown, however, that the accuracy of the latent heat flux can still be adequate despite a higher uncertainty in the evaporation components (i.e. bare soil evaporation, transpiration and interception loss) – see e.g. Miralles et al. (2016), Talsma et al. (2018). For that reason, the uncertainty goals have been subjectively relaxed based on expert judgement. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km | Size of grid cell | G | 0.1 | The length scales required to detect spatially heterogeneous responses, particularly if agricultural applications are intended (Fisher et al., 2017; Martens et al., 2018). |
| B | 1 | Scales needed to achieve a realistic partitioning of evaporation into different components considering land cover heterogeneity (Talsma et al., 2019; Miralles et al., 2016). |
| T | 25 | Current spatial resolution of global datasets (McCabe et al. 2016; Miralles et al., 2016), which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Vertical Resolution** | N/A |  | G | N/A | N/A |
| B | N/A | N/A |
| T | N/A | N/A |
| **Temporal Resolution** | hour | time | G | 1 | Water management and agricultural applications require to solve evaporation at timeframes associated with sub-daily irrigation decisions and scheduling (Fisher et al., 2017). |
| B | 6 | Intermediate compromise in which sub-daily processes controlling the evolution of the atmospheric boundary layer can be resolved (McCabe et al. 2016; Miralles et al., 2016). |
| T | 24 | Typical temporal resolution of current global datasets, which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Timeliness** | Days |  | G | 1 | Water management and agricultural applications require data in near real-time (Fisher et al., 2017). |
| B | 30 | Scales needed to make transpiration data useful for early drought diagnostic or to improve seasonal weather forecasts (expert judgement). |
| T | 365 | Current latency for multiple global datasets, which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Required Measurement Uncertainty** | % | relative root mean square error | G | 20 | This will involve an improved differentiation of water use and water stress among different crops, species, and ecosystems, and will enable more efficient water management (Fisher et al., 2017). |
| B | 40 | Intermediate compromise in which datasets can become useful as drought diagnostic or as a water management asset (expert judgement). |
| T | 50 | Current level of relative error (Talsma et al., 2018); this level has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Stability** | W m-2 year-1 |  | G | 0.015 | Approximately half of the current spread in the multi-datasets estimates of the global trend in evaporation (Zang et al., 2016). |
| B | – | – |
| T | 0.03 | Current estimates of the trend in the evaporation, but also the estimates of the spread in the estimates of these trends by different datasets (Zhang et al 2016). |
| **Standards and References** |           Fisher, J. B., Melton, F., Middleton, E., Hain, C., Anderson, M., Allen, R., Mccabe, M. F., Hook, S., Baldocchi, D., Townsend, P. A., Kilic, A., Tu, K., Miralles, D. D., Perret, J., Lagouarde, J.-P., Waliser, D., Purdy, A. J., French, A., Schimel, D., Famiglietti, J. S., Stephens, G. and Wood, E. F.: The future of evapotranspiration: Global requirements for ecosystem functioning, carbon and climate feedbacks, agricultural management, and water resources, Water Resour. Res., 53(4), 2618–2626, doi:10.1002/2016WR020175, 2017.            Martens, B., de Jeu, R., Verhoest, N., Schuurmans, H., Kleijer, J. and Miralles, D.: Towards Estimating Land Evaporation at Field Scales Using GLEAM, Remote Sensing, 10(11), 1720–25, doi:10.3390/rs10111720, 2018.            Mccabe, M. F., Ershadi, A., Jiménez, C., Miralles, D. G., Michel, D. and Wood, E. F.: The GEWEX LandFlux project: evaluation of model evaporation using tower-based and globally gridded forcing data, Geosci. Model Dev., 9(1), 283–305, doi:10.5194/gmd-9-283-2016, 2016.            Miralles, D. G., Jiménez, C., Jung, M., Michel, D., Ershadi, A., Mccabe, M. F., Hirschi, M., Martens, B., Dolman, A. J., Fisher, J. B., Mu, Q., Seneviratne, S. I., Wood, E. F. and Fernández-Prieto, D.: The WACMOS-ET project – Part 2: Evaluation of global terrestrial evaporation data sets, Hydrol. Earth Syst. Sci., 20(2), 823–842, doi:10.5194/hess-20-823-2016, 2016.            Miralles, D. G., Gentine, P., Seneviratne, S. I. and Teuling, A. J.: Land-atmospheric feedbacks during droughts and heatwaves: state of the science and current challenges, Ann. N.Y. Acad. Sci., 8, 469–17, doi:10.1111/nyas.13912, 2019.            Talsma, C., Good, S., Miralles, D., Fisher, J., Martens, B., Jiménez, C. and Purdy, A.: Sensitivity of Evapotranspiration Components in Remote Sensing-Based Models, Remote Sensing, 10(10), 1601–28, doi:10.3390/rs10101601, 2018.            Zhang, Y., Peña-Arancibia, J. L., Mcvicar, T. R., Chiew, F. H. S., Vaze, J., Liu, C., Lu, X., Zheng, H., Wang, Y., Liu, Y. Y., Miralles, D. G. and Pan, M.: Multi-decadal trends in global terrestrial evapotranspiration and its components, Sci. Rep., 1–12, doi:10.1038/srep19124, 2016. | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | Yes | Yes | Transpiration trends are diagnostic of climate changes and their propagation to the global water cycle, and can thus be useful to improve climate adaptation (Fisher et al., 2017). | | |
| **Extremes[3]** | Yes | No | Transpiration plays a key role at regulating drought and heatwaves but data at sub-daily resolution is needed, especially for the latter (Miralles et al., 2019). | | |

[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: ECMWF | Email: ecresgcosreqs@gmail.com |
| Global transpiration (as well as all other components of total land evaporation ECV) at 1km resolution and 6-hourly frequency are adequate for verification purposes of climate reanalysis. Interconsistency of evaporation components with land-use land-cover dataset and biomass disturbances can provide further robustness to these datasets for use in integrated Earth system modelling. | |

### Comment 2

|  |  |
| --- | --- |
| Author: Françoise Meulenbergh | Email: francoise.meulenberghs@meteo.be |
| Name: Latent Heat – Transpiration part  Comment: name should agree with the suggested unit that corresponds to energy flux and not to water flux like evaporation  Comment: see my other comments posted for latent heat flux (e.g. uncertainty, stability). | |

## ECV Product: Interception Loss

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Interception Loss | | | | |
| **Definition** | The component of the total latent heat flux that corresponds to the precipitation that is intercepted by vegetation and evaporated directly. | | | | |
| **Unit** | W/m2 | | | | |
| **Note** | The requirements are analogous to those of the total latent heat flux, because the applications are the same. Several studies have shown, however, that the accuracy of the latent heat flux can still be adequate despite a higher uncertainty in the evaporation components (i.e. bare soil evaporation, transpiration and interception loss) – see e.g. Miralles et al. (2016), Talsma et al. (2018). For that reason, the uncertainty goals have been subjectively relaxed based on expert judgement. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km | Size of grid cell | G | 0.1 | The length scales required to detect spatially heterogeneous responses, particularly if agricultural applications are intended (Fisher et al., 2017; Martens et al., 2018). |
| B | 1 | Scales needed to achieve a realistic partitioning of evaporation into different components considering land cover heterogeneity (Talsma et al., 2019; Miralles et al., 2016). |
| T | 25 | Current spatial resolution of global datasets (McCabe et al. 2016; Miralles et al., 2016), which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Vertical Resolution** | N/A |  | G | N/A | N/A |
| B | N/A | N/A |
| T | N/A | N/A |
| **Temporal Resolution** | hour | time | G | 1 | Water management and agricultural applications require to solve evaporation at timeframes associated with sub-daily irrigation decisions and scheduling (Fisher et al., 2017). |
| B | 6 | Intermediate compromise in which sub-daily processes controlling the evolution of the atmospheric boundary layer can be resolved (McCabe et al. 2016; Miralles et al., 2016). |
| T | 24 | Typical temporal resolution of current global datasets, which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Timeliness** | Days |  | G | 1 | Water management and agricultural applications require data in near real-time (Fisher et al., 2017). |
| B | 30 | Scales needed to make interception loss needed to (e.g.) improve seasonal weather or hydrological forecasts (expert judgement). |
| T | 365 | Current latency for multiple global datasets, which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Required Measurement Uncertainty** | % | relative root mean square error | G | 20 | This will enable more efficient water management (Fisher et al., 2017). |
| B | 30 | Intermediate compromise in which datasets can become useful as a water management asset (expert judgement). |
| T | 50 | Current level of relative error (Talsma et al., 2018); this level has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Stability** | W m-2 year-1 |  | G | 0.015 | Approximately half of the current spread in the multi-datasets estimates of the global trend in evaporation (Zang et al., 2016). |
| B | – | – |
| T | 0.03 | Current estimates of the trend in the evaporation, but also the estimates of the spread in the estimates of these trends by different datasets (Zhang et al 2016). |
| **Standards and References** |           Fisher, J. B., Melton, F., Middleton, E., Hain, C., Anderson, M., Allen, R., Mccabe, M. F., Hook, S., Baldocchi, D., Townsend, P. A., Kilic, A., Tu, K., Miralles, D. D., Perret, J., Lagouarde, J.-P., Waliser, D., Purdy, A. J., French, A., Schimel, D., Famiglietti, J. S., Stephens, G. and Wood, E. F.: The future of evapotranspiration: Global requirements for ecosystem functioning, carbon and climate feedbacks, agricultural management, and water resources, Water Resour. Res., 53(4), 2618–2626, doi:10.1002/2016WR020175, 2017.            Martens, B., de Jeu, R., Verhoest, N., Schuurmans, H., Kleijer, J. and Miralles, D.: Towards Estimating Land Evaporation at Field Scales Using GLEAM, Remote Sensing, 10(11), 1720–25, doi:10.3390/rs10111720, 2018.            Mccabe, M. F., Ershadi, A., Jiménez, C., Miralles, D. G., Michel, D. and Wood, E. F.: The GEWEX LandFlux project: evaluation of model evaporation using tower-based and globally gridded forcing data, Geosci. Model Dev., 9(1), 283–305, doi:10.5194/gmd-9-283-2016, 2016.            Miralles, D. G., Jiménez, C., Jung, M., Michel, D., Ershadi, A., Mccabe, M. F., Hirschi, M., Martens, B., Dolman, A. J., Fisher, J. B., Mu, Q., Seneviratne, S. I., Wood, E. F. and Fernández-Prieto, D.: The WACMOS-ET project – Part 2: Evaluation of global terrestrial evaporation data sets, Hydrol. Earth Syst. Sci., 20(2), 823–842, doi:10.5194/hess-20-823-2016, 2016.            Miralles, D. G., Gentine, P., Seneviratne, S. I. and Teuling, A. J.: Land-atmospheric feedbacks during droughts and heatwaves: state of the science and current challenges, Ann. N.Y. Acad. Sci., 8, 469–17, doi:10.1111/nyas.13912, 2019.            Talsma, C., Good, S., Miralles, D., Fisher, J., Martens, B., Jiménez, C. and Purdy, A.: Sensitivity of Evapotranspiration Components in Remote Sensing-Based Models, Remote Sensing, 10(10), 1601–28, doi:10.3390/rs10101601, 2018.            Zhang, Y., Peña-Arancibia, J. L., Mcvicar, T. R., Chiew, F. H. S., Vaze, J., Liu, C., Lu, X., Zheng, H., Wang, Y., Liu, Y. Y., Miralles, D. G. and Pan, M.: Multi-decadal trends in global terrestrial evapotranspiration and its components, Sci. Rep., 1–12, doi:10.1038/srep19124, 2016. | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | Yes | Yes | Interception loss trends are diagnostic of climate changes and their propagation to the global water cycle, and can thus be useful to improve climate adaptation (Fisher et al., 2017). | | |
| **Extremes[3]** | Yes | No | Interception loss prevents a large percentage of incoming precipitation (20–40%) from reaching the ground, and as such it can be important to buffer the propagation of intense precipitation periods into river floods. | | |

[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

|  |  |
| --- | --- |
| Author: Françoise Meulenbergh | Email: francoise.meulenberghs@meteo.bef |
| Name: Latent Heat – part from evaporation of intercepted water  Comment: name should agree with the suggested unit that corresponds to energy flux and not to water flux like evaporation  Comment: see my other comments posted for latent heat flux (e.g. uncertainty, stability). | |

## ECV Product: Bare Soil Evaporation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Bare Soil Evaporation | | | | |
| **Definition** | The component of the total latent heat flux that corresponds to the direct evaporation of soil moisture into the atmosphere. | | | | |
| **Unit** | W/m2 | | | | |
| **Note** | The requirements are analogous to those of the total latent heat flux, because the applications are the same. Several studies have shown, however, that the accuracy of the latent heat flux can still be adequate despite a higher uncertainty in the evaporation components (i.e. bare soil evaporation, transpiration and interception loss) – see e.g. Miralles et al. (2016), Talsma et al. (2018). For that reason, the uncertainty goals have been subjectively relaxed based on expert judgement. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km | Size of grid cell | G | 0.1 | The length scales required to detect spatially heterogeneous responses, particularly if agricultural applications are intended (Fisher et al., 2017; Martens et al., 2018). |
| B | 1 | Scales needed to achieve a realistic partitioning of evaporation into different components considering land cover heterogeneity (Talsma et al., 2019; Miralles et al., 2016). |
| T | 25 | Current spatial resolution of global datasets (McCabe et al. 2016; Miralles et al., 2016), which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Vertical Resolution** | N/A |  | G | N/A | N/A |
| B | N/A | N/A |
| T | N/A | N/A |
| **Temporal Resolution** | hour | time | G | 1 | Water management and agricultural applications require to solve evaporation at timeframes associated with sub-daily irrigation decisions and scheduling (Fisher et al., 2017). |
| B | 6 | Intermediate compromise in which sub-daily processes controlling the evolution of the atmospheric boundary layer can be resolved (McCabe et al. 2016; Miralles et al., 2016). |
| T | 24 | Typical temporal resolution of current global datasets, which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Timeliness** | Days |  | G | 1 | Water management and agricultural applications require data in near real-time (Fisher et al., 2017). |
| B | 30 | Scales needed to make bare soil evaporation data useful for early drought diagnostic or to improve seasonal weather forecasts (expert judgement). |
| T | 365 | Current latency for multiple global datasets, which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Required Measurement Uncertainty** | % | relative root mean square error | G | 20 | This will enable more efficient water management (Fisher et al., 2017). |
| B | 30 | Intermediate compromise in which datasets can become useful as drought diagnostic or as a water management asset (expert judgement). |
| T | 50 | Current level of relative error (Talsma et al., 2018); this level has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Stability** | W m-2 year-1 |  | G | 0.015 | Approximately half of the current spread in the multi-datasets estimates of the global trend in evaporation (Zang et al., 2016). |
| B | – | – |
| T | 0.03 | Current estimates of the trend in the evaporation, but also the estimates of the spread in the estimates of these trends by different datasets (Zhang et al 2016). |
| **Standards and References** |           Fisher, J. B., Melton, F., Middleton, E., Hain, C., Anderson, M., Allen, R., Mccabe, M. F., Hook, S., Baldocchi, D., Townsend, P. A., Kilic, A., Tu, K., Miralles, D. D., Perret, J., Lagouarde, J.-P., Waliser, D., Purdy, A. J., French, A., Schimel, D., Famiglietti, J. S., Stephens, G. and Wood, E. F.: The future of evapotranspiration: Global requirements for ecosystem functioning, carbon and climate feedbacks, agricultural management, and water resources, Water Resour. Res., 53(4), 2618–2626, doi:10.1002/2016WR020175, 2017.            Martens, B., de Jeu, R., Verhoest, N., Schuurmans, H., Kleijer, J. and Miralles, D.: Towards Estimating Land Evaporation at Field Scales Using GLEAM, Remote Sensing, 10(11), 1720–25, doi:10.3390/rs10111720, 2018.            Mccabe, M. F., Ershadi, A., Jiménez, C., Miralles, D. G., Michel, D. and Wood, E. F.: The GEWEX LandFlux project: evaluation of model evaporation using tower-based and globally gridded forcing data, Geosci. Model Dev., 9(1), 283–305, doi:10.5194/gmd-9-283-2016, 2016.            Miralles, D. G., Jiménez, C., Jung, M., Michel, D., Ershadi, A., Mccabe, M. F., Hirschi, M., Martens, B., Dolman, A. J., Fisher, J. B., Mu, Q., Seneviratne, S. I., Wood, E. F. and Fernández-Prieto, D.: The WACMOS-ET project – Part 2: Evaluation of global terrestrial evaporation data sets, Hydrol. Earth Syst. Sci., 20(2), 823–842, doi:10.5194/hess-20-823-2016, 2016.            Miralles, D. G., Gentine, P., Seneviratne, S. I. and Teuling, A. J.: Land-atmospheric feedbacks during droughts and heatwaves: state of the science and current challenges, Ann. N.Y. Acad. Sci., 8, 469–17, doi:10.1111/nyas.13912, 2019.            Talsma, C., Good, S., Miralles, D., Fisher, J., Martens, B., Jiménez, C. and Purdy, A.: Sensitivity of Evapotranspiration Components in Remote Sensing-Based Models, Remote Sensing, 10(10), 1601–28, doi:10.3390/rs10101601, 2018.            Zhang, Y., Peña-Arancibia, J. L., Mcvicar, T. R., Chiew, F. H. S., Vaze, J., Liu, C., Lu, X., Zheng, H., Wang, Y., Liu, Y. Y., Miralles, D. G. and Pan, M.: Multi-decadal trends in global terrestrial evapotranspiration and its components, Sci. Rep., 1–12, doi:10.1038/srep19124, 2016. | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | Yes | Yes | Bare soil evaporation trends are diagnostic of climate changes and their propagation to the global water cycle, and can thus be useful to improve climate adaptation (Fisher et al., 2017). | | |
| **Extremes[3]** | Yes | No | Bare soil evaporation plays a key role at regulating drought and heatwaves but data at sub-daily resolution is needed, especially for the latter (Miralles et al., 2019). | | |

[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

|  |  |
| --- | --- |
| Author: Françoise Meulenbergh | Email: francoise.meulenberghs@meteo.bef |
| Name: Latent Heat - bare soil part  Comment: name should agree with the suggested unit that corresponds to energy flux and not to water flux like evaporation  Comment: see my other comments posted for latent heat flux (e.g. uncertainty, stability). | |

## ECV Product: Sensible Heat Flux

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Sensible Heat Flux | | | | |
| **Definition** | The land surface (terrestrial) sensible heat flux represents the conduction of heat from the land surface into the atmosphere. | | | | |
| **Unit** | W/m2 | | | | |
| **Note** | Current sensible heat flux datasets based on satellite data are often derived as a residual from the energy balance equation based on estimated latent heat fluxes. Due to their analogous use to that of latent heat fluxes by the climate and meteorology community, their user requirements are similar. However, giver their lower immediate value for the agricultural and water management community, some differences in the targeted goals are considered. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km | Size of grid cell | G | 1 | Scales needed to achieve a realistic estimation considering land cover heterogeneity that may be useful to determine the role of sensible heat fluxes during extreme events (Miralles et al., 2019). |
| B | – | – |
| T | 25 | Current spatial resolution of global datasets, which has so far been deemed sufficient for climatological applications. |
| **Vertical Resolution** | N/A |  | G | N/A | N/A |
| B | N/A | N/A |
| T | N/A | N/A |
| **Temporal Resolution** | hour | time | G | 1 | Sub-daily processes are needed to represent the evolution of the atmospheric boundary layer during flash droughts or heatwaves (Miralles et al., 2019). |
| B | – | – |
| T | 24 | Typical temporal resolution of current global datasets, which has so far been deemed sufficient for climatological applications. |
| **Timeliness** | Days |  | G | 1 | Accurate forecasting of short-term droughts and heatwaves requires data in near real-time (Miralles et al., 2019). |
| B | 30 | Scales needed to make sensible heat fluxes data useful for early drought diagnostic or to improve seasonal weather forecasts (expert judgement). |
| T | 365 | Current latency for multiple global datasets, which has so far been deemed sufficient for climatological applications. |
| **Required Measurement Uncertainty** | % | relative root mean square error | G | 10 | This will involve an improved differentiation among ecosystems, and enable more efficient weather forecasts of extreme events (expert judgement). |
| B | 20 | Intermediate compromise at which datasets can become useful as drought diagnostic (expert judgement). |
| T | 40 | Current level of relative error that has so far been deemed sufficient for climatological applications. |
| **Stability** | W m-2 year-1 |  | G | 0.015 | Due to the scarcity of studies of sensible heat flux trends (Siemann et al., 2018), we refer to the same stability thresholds as for latent heat fluxes (and in the same units). |
| B | – | – |
| T | 0.03 | – |
| **Standards and References** |           Siemann, A. L., Chaney, N. and Wood, E. F.: Development and Validation of a Long-Term, Global, Terrestrial Sensible Heat Flux Dataset, J. Climate, 31(15), 6073–6095, doi:10.1175/JCLI-D-17-0732.1, 2018.            Miralles, D. G., Gentine, P., Seneviratne, S. I. and Teuling, A. J.: Land-atmospheric feedbacks during droughts and heatwaves: state of the science and current challenges, Ann. N.Y. Acad. Sci., 8, 469–17, doi:10.1111/nyas.13912, 2019. | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | Yes | Yes | Sensible heat flux trends are a useful diagnostic of climate changes and can thus be useful to improve climate adaptation. | | |
| **Extremes[3]** | Yes | No | Sensible heat fluxes play a key role at regulating drought and heatwaves but data at sub-daily resolution are needed, especially for the latter (Miralles et al., 2019). | | |

[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

|  |  |
| --- | --- |
| Author: Françoise Meulenbergh | Email: francoise.meulenberghs@meteo.bef |
| Comment: see also my comments done for latent heat flux (e.g. about uncertainty)  Definition: "heat between the land surface and the atmosphere". Comment: direction is a convention; both positive and negative values are possible.  Note: “Current sensible heat flux datasets based on satellite data are often derived” -- > “Some sensible heat flux datasets based on satellite data are derived”  Comment: as LE and H are driven by same processes and as the partition of energy fluxes is of interest for climate applications, I suggest to consider similar requirements for both (e.g. spatial and temporal resolutions).  Uncertainty: see 2 comments provided for LE  Stability: see comment provided for LE | |

## ECV Product: Latent Heat Flux

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Latent Heat Flux | | | | |
| **Definition** | The land surface (or terrestrial) latent heat flux is the evaporation occurring over land surfaces, and it may comprise three main sources or individual components: bare soil evaporation (direct evaporation of water from soils), interception loss (evaporation of water from wet canopies) and transpiration (plant water consumption), each of which are considered as sub-products. | | | | |
| **Unit** | W/m2 | | | | |
| **Note** | – | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km | Size of grid cell | G | 0.1 | The length scales required to detect spatially heterogeneous responses, particularly if agricultural applications are intended (Fisher et al., 2017; Martens et al., 2018). |
| B | 1 | Scales needed to achieve a realistic partitioning of evaporation into different components considering land cover heterogeneity (Talsma et al., 2019; Miralles et al., 2016). |
| T | 25 | Current spatial resolution of global datasets (McCabe et al. 2016; Miralles et al., 2016), which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Vertical Resolution** | N/A |  | G | N/A | N/A |
| B | N/A | N/A |
| T | N/A | N/A |
| **Temporal Resolution** | hour | time | G | 1 | Water management and agricultural applications require to solve evaporation at timeframes associated with sub-daily irrigation decisions and scheduling (Fisher et al., 2017). |
| B | 6 | Intermediate compromise in which sub-daily processes controlling the evolution of the atmospheric boundary layer can be resolved (McCabe et al. 2016; Miralles et al., 2016). |
| T | 24 | Typical temporal resolution of current global datasets, which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Timeliness** | Days |  | G | 1 | Water management and agricultural applications require data in near real-time (Fisher et al., 2017). |
| B | 30 | Scales needed to make evaporation data useful for early drought diagnostic or to improve seasonal weather forecasts (expert judgement). |
| T | 365 | Current latency for multiple global datasets, which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Required Measurement Uncertainty** | % | relative root mean square error | G | 10 | This will involve an improved differentiation of water use and water stress among different crops, species, and ecosystems, and will enable more efficient water management (Fisher et al., 2017). |
| B | 20 | Intermediate compromise in which datasets can become useful as drought diagnostic or as a water management asset (expert judgement). |
| T | 40 | Current level of relative error (McCabe et al. 2016); this level has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Stability** | W m-2 year-1 |  | G | 0.015 | Approximately half of the current spread in the multi-datasets estimates of the global trend in evaporation (Zang et al., 2016). |
| B | – | – |
| T | 0.03 | Current estimates of the trend in the evaporation, but also the estimates of the spread in the estimates of these trends by different datasets (Zhang et al 2016). |
| **Standards and References** |           Fisher, J. B., Melton, F., Middleton, E., Hain, C., Anderson, M., Allen, R., Mccabe, M. F., Hook, S., Baldocchi, D., Townsend, P. A., Kilic, A., Tu, K., Miralles, D. D., Perret, J., Lagouarde, J.-P., Waliser, D., Purdy, A. J., French, A., Schimel, D., Famiglietti, J. S., Stephens, G. and Wood, E. F.: The future of evapotranspiration: Global requirements for ecosystem functioning, carbon and climate feedbacks, agricultural management, and water resources, Water Resour. Res., 53(4), 2618–2626, doi:10.1002/2016WR020175, 2017.            Martens, B., de Jeu, R., Verhoest, N., Schuurmans, H., Kleijer, J. and Miralles, D.: Towards Estimating Land Evaporation at Field Scales Using GLEAM, Remote Sensing, 10(11), 1720–25, doi:10.3390/rs10111720, 2018.            Mccabe, M. F., Ershadi, A., Jiménez, C., Miralles, D. G., Michel, D. and Wood, E. F.: The GEWEX LandFlux project: evaluation of model evaporation using tower-based and globally gridded forcing data, Geosci. Model Dev., 9(1), 283–305, doi:10.5194/gmd-9-283-2016, 2016.            Miralles, D. G., Jiménez, C., Jung, M., Michel, D., Ershadi, A., Mccabe, M. F., Hirschi, M., Martens, B., Dolman, A. J., Fisher, J. B., Mu, Q., Seneviratne, S. I., Wood, E. F. and Fernández-Prieto, D.: The WACMOS-ET project – Part 2: Evaluation of global terrestrial evaporation data sets, Hydrol. Earth Syst. Sci., 20(2), 823–842, doi:10.5194/hess-20-823-2016, 2016.            Miralles, D. G., Gentine, P., Seneviratne, S. I. and Teuling, A. J.: Land-atmospheric feedbacks during droughts and heatwaves: state of the science and current challenges, Ann. N.Y. Acad. Sci., 8, 469–17, doi:10.1111/nyas.13912, 2019.            Talsma, C., Good, S., Miralles, D., Fisher, J., Martens, B., Jiménez, C. and Purdy, A.: Sensitivity of Evapotranspiration Components in Remote Sensing-Based Models, Remote Sensing, 10(10), 1601–28, doi:10.3390/rs10101601, 2018.            Zhang, Y., Peña-Arancibia, J. L., Mcvicar, T. R., Chiew, F. H. S., Vaze, J., Liu, C., Lu, X., Zheng, H., Wang, Y., Liu, Y. Y., Miralles, D. G. and Pan, M.: Multi-decadal trends in global terrestrial evapotranspiration and its components, Sci. Rep., 1–12, doi:10.1038/srep19124, 2016. | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | Yes | Yes | Evaporation trends are diagnostic of climate changes and their propagation to the global water cycle, and can thus be useful to improve climate adaptation (Fisher et al., 2017). | | |
| **Extremes[3]** | Yes | No | Evaporation plays a key role at regulating drought and heatwaves but data at sub-daily resolution is needed, especially for the latter (Miralles et al., 2019). | | |

[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

|  |  |
| --- | --- |
| Author: Françoise Meulenbergh | Email: francoise.meulenberghs@meteo.bef |
| See below table | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Latent Heat Flux | | | | |
| **Definition** | The land surface (or terrestrial) latent heat flux is the energy flux associated to the evaporation occurring over land surfaces, and it may comprise three main sources or individual components: bare soil evaporation (direct evaporation of water from soils), interception loss (evaporation of water from wet canopies) and transpiration (plant water consumption), each of which are considered as sub-products. | | | | |
| **Unit** | W/m2 | | | | |
| **Note** | – | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit SI?** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km | Size of grid cell | G | 0.1 | The length scales required to detect spatially heterogeneous responses, particularly if agricultural applications are intended (Fisher et al., 2017; Martens et al., 2018). |
| B | 1 | Scales needed to achieve a realistic partitioning of evaporation into different components considering land cover heterogeneity (Talsma et al., 2019; Miralles et al., 2016). |
| T | 25 | Current spatial resolution of global datasets (McCabe et al. 2016; Miralles et al., 2016), which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Vertical Resolution** | N/A |  | G | N/A | N/A |
| B | N/A | N/A |
| T | N/A | N/A |
| **Temporal Resolution** | hour**ent: SI** | time | G | 1 | Water management and agricultural applications require to solve evaporation at timeframes associated with sub-daily irrigation decisions and scheduling (Fisher et al., 2017). |
| B | 6 | Intermediate compromise in which sub-daily processes controlling the evolution of the atmospheric boundary layer can be resolved (McCabe et al. 2016; Miralles et al., 2016). |
| T | 24 | Typical temporal resolution of current global datasets, which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Timeliness** | Days |  | G | 1 | Water management and agricultural applications require data in near real-time (Fisher et al., 2017). Comment: is NRT needed / useful for climate applications ? |
| B | 30 | Scales needed to make evaporation data useful for early drought diagnostic or to improve seasonal weather forecasts (expert judgement). |
| T | 365 | Current latency for multiple global datasets, which has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Required Measurement Uncertainty** | % | relative root mean square error ? Comment: relative to what ? | G | 10 | This will involve an improved differentiation of water use and water stress among different crops, species, and ecosystems, and will enable more efficient water management (Fisher et al., 2017). |
| B | 20 Comment: percentages are not appropriate in case of small values. | Intermediate compromise in which datasets can become useful as drought diagnostic or as a water management asset (expert judgement). |
| T | 40 | Current level of relative error (McCabe et al. 2016); this level has so far been deemed sufficient for climatological applications (Fisher et al., 2017). |
| **Stability** | W m-2 year-1 |  | G | 0.015 . Comment: the proposed values look unrealistically small. e. g. 0.12 | Approximately half of the current spread in the multi-datasets estimates of the global trend in evaporation (Zang et al., 2016). |
| B | – e.g.4 | – |
| T | 0.03 e.g. 9 in case of CM SAF HOAPS v4.0 for ocean LE | Current estimates of the trend in the evaporation, but also the estimates of the spread in the estimates of these trends by different datasets (Zhang et al 2016). |
| **Standards and References** | ·          Fisher, J. B., Melton, F., Middleton, E., Hain, C., Anderson, M., Allen, R., Mccabe, M. F., Hook, S., Baldocchi, D., Townsend, P. A., Kilic, A., Tu, K., Miralles, D. D., Perret, J., Lagouarde, J.-P., Waliser, D., Purdy, A. J., French, A., Schimel, D., Famiglietti, J. S., Stephens, G. and Wood, E. F.: The future of evapotranspiration: Global requirements for ecosystem functioning, carbon and climate feedbacks, agricultural management, and water resources, Water Resour. Res., 53(4), 2618–2626, doi:10.1002/2016WR020175, 2017.  ·          Martens, B., de Jeu, R., Verhoest, N., Schuurmans, H., Kleijer, J. and Miralles, D.: Towards Estimating Land Evaporation at Field Scales Using GLEAM, Remote Sensing, 10(11), 1720–25, doi:10.3390/rs10111720, 2018.  ·          Mccabe, M. F., Ershadi, A., Jiménez, C., Miralles, D. G., Michel, D. and Wood, E. F.: The GEWEX LandFlux project: evaluation of model evaporation using tower-based and globally gridded forcing data, Geosci. Model Dev., 9(1), 283–305, doi:10.5194/gmd-9-283-2016, 2016.  ·          Miralles, D. G., Jiménez, C., Jung, M., Michel, D., Ershadi, A., Mccabe, M. F., Hirschi, M., Martens, B., Dolman, A. J., Fisher, J. B., Mu, Q., Seneviratne, S. I., Wood, E. F. and Fernández-Prieto, D.: The WACMOS-ET project – Part 2: Evaluation of global terrestrial evaporation data sets, Hydrol. Earth Syst. Sci., 20(2), 823–842, doi:10.5194/hess-20-823-2016, 2016.  ·          Miralles, D. G., Gentine, P., Seneviratne, S. I. and Teuling, A. J.: Land-atmospheric feedbacks during droughts and heatwaves: state of the science and current challenges, Ann. N.Y. Acad. Sci., 8, 469–17, doi:10.1111/nyas.13912, 2019.  ·          Talsma, C., Good, S., Miralles, D., Fisher, J., Martens, B., Jiménez, C. and Purdy, A.: Sensitivity of Evapotranspiration Components in Remote Sensing-Based Models, Remote Sensing, 10(10), 1601–28, doi:10.3390/rs10101601, 2018.  ·          Zhang, Y., Peña-Arancibia, J. L., Mcvicar, T. R., Chiew, F. H. S., Vaze, J., Liu, C., Lu, X., Zheng, H., Wang, Y., Liu, Y. Y., Miralles, D. G. and Pan, M.: Multi-decadal trends in global terrestrial evapotranspiration and its components, Sci. Rep., 1–12, doi:10.1038/srep19124, 2016. | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | Yes | Yes | Evaporation trends are diagnostic of climate changes and their propagation to the global water cycle, and can thus be useful to improve climate adaptation (Fisher et al., 2017). | | |
| **Extremes[3]** | Yes | No | Evaporation plays a key role at regulating drought and heatwaves but data at sub-daily resolution is needed, especially for the latter (Miralles et al., 2019). | | |

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