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

# Upper-air water vapour

## ECV Product: Water Vapour Mixing Ratio in the Upper Troposphere and Lower Stratosphere

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Water Vapour Mixing Ratio in the Upper Troposphere and Lower Stratosphere | | | | |
| **Definition** | 3D field of water vapour mixing ratios in the UTLS. Mixing ratio is the mole fraction of a substance in dry air. | | | | |
| **Unit** | ppm | | | | |
| **Note** | Vertical resolution needed for determining fine layer cirrus and complex tropopause | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km |  | G | 100 |  |
| B | 500 |  |
| T | 1000 |  |
| **Vertical Resolution** | km |  | G | 0.01 |  |
| B | 0.1 |  |
| T | 0.25 |  |
| **Temporal Resolution** | hr |  | G | 3 |  |
| B | 6 |  |
| T | 12 |  |
| **Timeliness** | hr |  | G | 1 |  |
| B | 168 |  |
| T | 720 |  |
| **Required Measurement Uncertainty** | ppm | . | G | 0.1 | Dessler et al. (2013)  Solomon et al. (2010)  Uncertainty requirements are based on interannual variability and data quality needed to study supersaturation and dehydration. |
| B | 0.25 |
| T | 0.5 |
| **Stability** | ppm/decade |  | G | 0.1 | Dessler et al. (2013)  Solomon et al. (2010)  Stability requirements are based on magnitudes of seasonal and  longer-term trends. |
| B | 0.25 |
| T | 0.5 |
| **Standards and References** | Dessler, A. E., Schoeberl, M. R., Wang, T., Davis, S. M., & Rosenlof, K. H. (2013). Stratospheric water vapor feedback. Proceedings of the National Academy of Sciences of the United States of America, 110(45), 18087–18091. doi:10.1073/pnas.1310344110    Solomon, S., Rosenlof, K. H., Portmann, R. W., Daniel, J. S., Davis, S. M., Sanford, T. J., & Plattner, G.-K. (2010). Contributions of Stratospheric Water Vapor to Decadal Changes in the Rate of Global Warming. Science, 327(5970), 1219-1223. doi:10.1126/science.1182488 | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  | Reviewers are invited to suggest answers for these fields | | |
| **Extremes[3]** |  |  | Reviewers are invited to suggest answers for these fields | | |

[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: Bruce Ingleby | Email: bruce.ingleby@ecmwf.int |
| To the extent that UTLS humidity measurements are used from operational radiosondes - and some provide useful humidity data (Nash et al 2011) - attention should be paid to  the vapour pressure equation used, see section 8.2.5 of Nash et al (2011, IOM 107, "WMO Intercomparison of High Quality Radiosonde Systems").  "A brief survey among all manufacturers has shown that the equations by Wexler (1977), Hyland and Wexler (1983) and Sonntag (1994) are the most common equations. These three equations do not differ significantly over the temperature range of interest. It is therefore recommended that only these three equations be used to convert relative humidity over liquid to partial pressure at cold temperatures, ..." BI | |

## ECV Product: Water Vapour Mixing Ratio in the Middle and Upper Stratosphere

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Water Vapour Mixing Ratio in the Middle and Upper Stratosphere | | | | |
| **Definition** | 3D field of water vapor mixing ratios in the middle and upper stratosphere. Mixing ratio is the mole fraction of a substance in dry air. | | | | |
| **Unit** | ppm | | | | |
| **Note** |  | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km |  | G | 100 |  |
| B | 1000 |  |
| T | 2000 |  |
| **Vertical Resolution** | km |  | G | 0.5 |  |
| B | 1 |  |
| T | 2 |  |
| **Temporal Resolution** | hr |  | G | 3 |  |
| B | 6 |  |
| T | 24 |  |
| **Timeliness** | hr |  | G | 1 |  |
| B | 168 |  |
| T | 720 |  |
| **Required Measurement Uncertainty** | ppm | . | G | 0.1 | Dessler et al. (2013)  Solomon et al. (2010)  Uncertainty requirements are  based on observed seasonal and interannual variability. |
| B | 0.25 |
| T | 0.5 |
| **Stability** | ppm/decade |  | G | 0.1 | Dessler et al. (2013)  Solomon et al. (2010)  Stability requirements are  based on magnitudes of longer-term trends. |
| B | 0.25 |
| T | 0.5 |
| **Standards and References** | Dessler, A. E., Schoeberl, M. R., Wang, T., Davis, S. M., & Rosenlof, K. H. (2013). Stratospheric water vapor feedback. Proceedings of the National Academy of Sciences of the United States of America, 110(45), 18087–18091. doi:10.1073/pnas.1310344110    Solomon, S., Rosenlof, K. H., Portmann, R. W., Daniel, J. S., Davis, S. M., Sanford, T. J., & Plattner, G.-K. (2010). Contributions of Stratospheric Water Vapor to Decadal Changes in the Rate of Global Warming. Science, 327(5970), 1219-1223. doi:10.1126/science.1182488 | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  | Reviewers are invited to suggest answers for these fields | | |
| **Extremes[3]** |  |  | Reviewers are invited to suggest answers for these fields | | |

[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: Water Vapour Mixing Ratio in the Mesosphere

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Water Vapour Mixing Ratio in the Mesosphere | | | | |
| **Definition** | 3D field of water vapour mixing ratios in the mesosphere. Mixing ratio is the mole fraction of a substance in dry air. | | | | |
| **Unit** | ppm | | | | |
| **Note** |  | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km |  | G | 100 |  |
| B | 1000 |  |
| T | 2000 |  |
| **Vertical Resolution** | km |  | G | 0.5 |  |
| B | 1 |  |
| T | 2 |  |
| **Temporal Resolution** | hr |  | G | 3 |  |
| B | 6 |  |
| T | 24 |  |
| **Timeliness** | hr |  | G | 1 |  |
| B | 168 |  |
| T | 720 |  |
| **Required Measurement Uncertainty** | ppm | . | G | 0.1 | Dessler et al. (2013)  Solomon et al. (2010)  Uncertainty requirements are  based on observed seasonal and interannual variability. |
| B | 0.25 |
| T | 0.5 |
| **Stability** | ppm/decade |  | G | 0.1 | Dessler et al. (2013)  Solomon et al. (2010)  Stability requirements are  based on magnitudes of longer-term trends. |
| B | 0.25 |
| T | 0.5 |
| **Standards and References** | Dessler, A. E., Schoeberl, M. R., Wang, T., Davis, S. M., & Rosenlof, K. H. (2013). Stratospheric water vapor feedback. Proceedings of the National Academy of Sciences of the United States of America, 110(45), 18087–18091. doi:10.1073/pnas.1310344110    Solomon, S., Rosenlof, K. H., Portmann, R. W., Daniel, J. S., Davis, S. M., Sanford, T. J., & Plattner, G.-K. (2010). Contributions of Stratospheric Water Vapor to Decadal Changes in the Rate of Global Warming. Science, 327(5970), 1219-1223. doi:10.1126/science.1182488 | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  | Reviewers are invited to suggest answers for these fields | | |
| **Extremes[3]** |  |  | Reviewers are invited to suggest answers for these fields | | |

[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: Relative Humidity in the Upper Troposphere and Lower Stratosphere

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Relative Humidity in the Upper Troposphere and Lower Stratosphere | | | | |
| **Definition** | 3D field of the relative humidity in the UTLS. Relative humidity is the amount of water vapor in air divided by the temperature-dependent amount of water vapor in saturated air. RH can be expressed relative to water or ice saturation (to be specified in the metadata). | | | | |
| **Unit** | % | | | | |
| **Note** | Vertical resolution needed for determining fine layer cirrus and complex tropopause | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km |  | G | 100 |  |
| B | 500 |  |
| T | 1000 |  |
| **Vertical Resolution** | km |  | G | 0.01 |  |
| B | 0.1 |  |
| T | 0.25 |  |
| **Temporal Resolution** | hr |  | G | 3 |  |
| B | 6 |  |
| T | 12 |  |
| **Timeliness** | hr |  | G | 1 |  |
| B | 168 |  |
| T | 720 |  |
| **Required Measurement Uncertainty** | % | . | G | 1 | Dessler et al. (2013)  Solomon et al. (2010)  Uncertainty requirements are based on interannual variability and data quality needed to study supersaturation and dehydration. |
| B | 2.5 |
| T | 5 |
| **Stability** | %/decade |  | G | 1 | Dessler et al. (2013)  Solomon et al. (2010)  Stability requirements are based on magnitudes of seasonal and  longer-term trends. |
| B | 2.5 |
| T | 5 |
| **Standards and References** | Dessler, A. E., Schoeberl, M. R., Wang, T., Davis, S. M., & Rosenlof, K. H. (2013). Stratospheric water vapor feedback. Proceedings of the National Academy of Sciences of the United States of America, 110(45), 18087–18091. doi:10.1073/pnas.1310344110    Solomon, S., Rosenlof, K. H., Portmann, R. W., Daniel, J. S., Davis, S. M., Sanford, T. J., & Plattner, G.-K. (2010). Contributions of Stratospheric Water Vapor to Decadal Changes in the Rate of Global Warming. Science, 327(5970), 1219-1223. doi:10.1126/science.1182488 | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  | Reviewers are invited to suggest answers for these fields | | |
| **Extremes[3]** |  |  | Reviewers are invited to suggest answers for these fields | | |

[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: Shinya Kobayashi | Email: shn.kobayashi@gmail.com |
| \* Horizontal Resolution  Same as RH in the FT. | |

### Comment 2

|  |  |
| --- | --- |
| Author: Elisabath Good | Email: elizabeth.good@metoffice.gov.uk |
| The requirements outlined below are mostly based on the results of an online survey with global reach that was issued in 2019 by the CM SAF (https://www.cmsaf.eu/) to gather user requirements for upper tropospheric humidity (UTH) and free tropospheric humidity (FTH). The results are described in the CM SAF document SAF/CM/DWD/RR/3.6 v1.1 that is available on request by emailing contact.cmsaf@dwd.de. In total, 47 responses were received, although most respondents did not complete every question. We recommend GCOS take the results of the CM SAF survey into consideration when defining the requirements for UTH and FTH.  The suggestions below have been agreed by the CM SAF team working on UTH and FTH and we have posted the same response for both ECVs.  The results suggest UTH and FTH data are used in a wide range of applications. The four most popular application areas are climate variability, climate modelling, climate monitoring, and comparing with models or observations.  Horizontal resolution: The results of the survey indicate a threshold requirement of 1°, breakthrough requirement of 0.5°, and goal requirement of <0.25°.  Vertical resolution: no data collected in the survey  Temporal resolution: The results of the survey indicate a threshold requirement of 12-hourly, breakthrough requirement of 3-hourly resolution, and objective requirement of <1-hourly.  Timeliness: This was not a question in the survey, but for climate monitoring, we would suggest threshold 2 months (this is similar to what is currently achieved for many monitoring data sets and matches that defined in Copernicus), breakthrough 5 days (useful for close to real time monitoring) and goal <24 hours (more useful for real time monitoring).  Note for the following two requirements (uncertainty and stability), survey respondents were asked for values representing fraction of saturation, not the fractional accuracy of the measurement.  Uncertainty: The results of the survey suggest values of 6%, 2% and <2% for threshold, breakthrough and goal, respectively. This is based on adding the results for accuracy and precision gathered in the CM SAF survey in quadrature, rounded up to the closest integer (requirements for ‘uncertainty’ were not explicitly collected in the survey). The threshold, breakthrough and objective requirements for accuracy (“theoretical degree of conformity of the measurement to the unknown ‘true’ value”) from the survey are respectively 5 %, 1 % and 1 %. The threshold, breakthrough and objective requirements for precision (“closeness of agreement between independent measurements of a quantity under the same conditions”) from the survey are respectively 2 %, <1 % and <1 %. However, we recognise that these requirements are quite stringent.  Stability: The threshold, breakthrough and objective requirements obtained in the survey are 1 %/decade, 0.1 %/decade and <0.1 %/decade, respectively. However, we recognise that these requirements are quite stringent. | |

## ECV Product: Relative Humidity in the Free Troposphere

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Relative Humidity in the Free Troposphere | | | | |
| **Definition** | 3D field of the relative humidity in the free troposphere. Relative humidity is the amount of water vapor in air divided by the temperature-dependent amount of water vapor in saturated air. RH can be expressed relative to water or ice saturation (to be specified in the metadata). | | | | |
| **Unit** | % | | | | |
| **Note** | McCarthy, 2007 notes significant spatial heterogeneity related to latitude of the observation. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km |  | G | 100 | McCarthy, 2007 |
| B | 1000 | McCarthy, 2007 |
| T | 2000 | McCarthy, 2007 |
| **Vertical Resolution** | km |  | G | 0.1 |  |
| B | 0.5 |  |
| T | 1 |  |
| **Temporal Resolution** | hr |  | G | Sub-hourly |  |
| B | 1 |  |
| T | 3 |  |
| **Timeliness** | hr |  | G | 1 |  |
| B | 24 |  |
| T | 720 |  |
| **Required Measurement Uncertainty** | % | . | G | 0.1 |  |
| B | 0.5 |
| T | 1 |
| **Stability** | %/decade |  | G | 0.1 |  |
| B | 0.5 |
| T | 0.1 |
| **Standards and References** | McCarthy, 2007 <https://doi.org/10.1002/joc.1611> | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  | Reviewers are invited to suggest answers for these fields | | |
| **Extremes[3]** |  |  | Reviewers are invited to suggest answers for these fields | | |

[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: Shinya Kobayashi | Email: shn.kobayashi@gmail.com |
| \* Horizontal Resolution  Taking account of the spatial correlation of humidity, I think that the requirements should be the same as or more stringent than those for temperature and wind. | |

### Comment 2

|  |  |
| --- | --- |
| Author: Toshinori AOYAGI (JMA) | Email: aoyagi.toshinori@gmail.com |
| \* Stability  Threshold value "0.1" seems to be a typo. | |

### Comment 3

|  |  |
| --- | --- |
| Author: Elisabeth Good | Email: elizabeth.good@metoffice.gov.uk |
| The requirements outlined below are mostly based on the results of an online survey with global reach that was issued in 2019 by the CM SAF (https://www.cmsaf.eu/) to gather user requirements for upper tropospheric humidity (UTH) and free tropospheric humidity (FTH). The results are described in the CM SAF document SAF/CM/DWD/RR/3.6 v1.1 that is available on request by emailing contact.cmsaf@dwd.de. In total, 47 responses were received, although most respondents did not complete every question. We recommend GCOS take the results of the CM SAF survey into consideration when defining the requirements for UTH and FTH. The suggestions below have been agreed by the CM SAF team working on UTH and FTH and we have posted the same response for both ECVs.  The results suggest UTH and FTH data are used in a wide range of applications. The four most popular application areas are climate variability, climate modelling, climate monitoring, and comparing with models or observations.  Horizontal resolution: The results of the survey indicate a threshold requirement of 1°, breakthrough requirement of 0.5°, and goal requirement of <0.25°.  Vertical resolution: no data collected in the survey  Temporal resolution: The results of the survey indicate a threshold requirement of 12-hourly, breakthrough requirement of 3-hourly resolution, and objective requirement of <1-hourly.  Timeliness: This was not a question in the survey, but for climate monitoring, we would suggest threshold 2 months (this is similar to what is currently achieved for many monitoring data sets and matches that defined in Copernicus), breakthrough 5 days (useful for close to real time monitoring) and goal <24 hours (more useful for real time monitoring).  Note for the following two requirements (uncertainty and stability), survey respondents were asked for values representing fraction of saturation, not the fractional accuracy of the measurement.  Uncertainty: The results of the survey suggest values of 6%, 2% and <2% for threshold, breakthrough and goal, respectively. This is based on adding the results for accuracy and precision gathered in the CM SAF survey in quadrature, rounded up to the closest integer (requirements for ‘uncertainty’ were not explicitly collected in the survey). The threshold, breakthrough and objective requirements for accuracy (“theoretical degree of conformity of the measurement to the unknown ‘true’ value”) from the survey are respectively 5 %, 1 % and 1 %. The threshold, breakthrough and objective requirements for precision (“closeness of agreement between independent measurements of a quantity under the same conditions”) from the survey are respectively 2 %, <1 % and <1 %. However, we recognise that these requirements are quite stringent.  Stability: The threshold, breakthrough and objective requirements obtained in the survey are 1 %/decade, 0.1 %/decade and <0.1 %/decade, respectively. However, we recognise that these requirements are quite stringent. | |

## ECV Product: Relative Humidity in the Boundary Layer

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Relative Humidity in the Boundary Layer | | | | |
| **Definition** | 3D field of the relative humidity in the PBL. Relative humidity is the amount of water vapor in air divided by the temperature-dependent amount of water vapor in saturated air. RH can be expressed relative to water or ice saturation (to be specified in the metadata). | | | | |
| **Unit** | % | | | | |
| **Note** | Vertical resolution is required for calculation of fluxes in the lowermost boundary layer.  McCarthy, 2007 notes significant spatial heterogeneity related to latitude of the observation. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km |  | G | 10 | McCarthy, 2007 |
| B | 100 | McCarthy, 2007 |
| T | 1000 | McCarthy, 2007 |
| **Vertical Resolution** | m |  | G | 10 |  |
| B | 50 |  |
| T | 100 |  |
| **Temporal Resolution** | hr |  | G | Sub-hourly |  |
| B | 1 |  |
| T | 3 |  |
| **Timeliness** | hr |  | G | 1 |  |
| B | 24 |  |
| T | 720 |  |
| **Required Measurement Uncertainty** | % | . | G | 0.1 |  |
| B | 0.5 |
| T | 1 |
| **Stability** | %/decade |  | G | 0.1 | Assumption that stability is per measurement system  leads to partial cancellation across a network of sites performing measurements. |
| B | 0.5 |
| T | 0.1 |
| **Standards and References** | McCarthy, 2007 <https://doi.org/10.1002/joc.1611> | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  | Reviewers are invited to suggest answers for these fields | | |
| **Extremes[3]** |  |  | Reviewers are invited to suggest answers for these fields | | |

[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: Shinya Kobayashi | Email: shn.kobayashi@gmail.com |
| \* Horizontal Resolution  Taking account of the spatial correlation of humidity, I think that the threshold requirement should be the same as or more stringent than that for temperature and wind.  \* Stability  I was wondering if the stability requirements (Goal and Breakthrough) are intentionally set to the same as the uncertainty requirements. Should they be set to one tenth of the uncertainty requirements as done for the Specific Humidity? | |

## ECV Product: Specific Humidity in the Upper Troposphere and Lower Stratosphere

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Specific Humidity in the Upper Troposphere and Lower Stratosphere | | | | |
| **Definition** | 3D field of the specific humidity in the UTLS. The specific humidity is the ratio between the mass of water vapour and the mass of moist air. | | | | |
| **Unit** | g/Kg | | | | |
| **Note** | Vertical resolution needed for determining fine layer cirrus and complex tropopause. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km |  | G | 100 |  |
| B | 1000 |  |
| T | 2000 |  |
| **Vertical Resolution** | km |  | G | 0.01 |  |
| B | 0.1 |  |
| T | 0.25 |  |
| **Temporal Resolution** | hr |  | G | Sub-hourly |  |
| B | 1 |  |
| T | 3 |  |
| **Timeliness** | hr |  | G | 1 |  |
| B | 24 |  |
| T | 720 |  |
| **Required Measurement Uncertainty** | g/Kg | . | G | 0.01 | Dessler et al. (2013)  Solomon et al. (2010) |
| B | 0.05 |
| T | 0.1 |
| **Stability** | g/Kg/decade |  | G | 0.01 | Dessler et al. (2013)  Solomon et al. (2010) |
| B | 0.02 |
| T | 0.05 |
| **Standards and References** | Dessler, A. E., Schoeberl, M. R., Wang, T., Davis, S. M., & Rosenlof, K. H. (2013). Stratospheric water vapor feedback. Proceedings of the National Academy of Sciences of the United States of America, 110(45), 18087–18091. doi:10.1073/pnas.1310344110    Solomon, S., Rosenlof, K. H., Portmann, R. W., Daniel, J. S., Davis, S. M., Sanford, T. J., & Plattner, G.-K. (2010). Contributions of Stratospheric Water Vapor to Decadal Changes in the Rate of Global Warming. Science, 327(5970), 1219-1223. doi:10.1126/science.1182488 | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  | Reviewers are invited to suggest answers for these fields | | |
| **Extremes[3]** |  |  | Reviewers are invited to suggest answers for these fields | | |

[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: Shinya Kobayashi | Email: shn.kobayashi@gmail.com |
| I was wondering if the requirements are intentionally made different from those for RH and Mixing Ratio.  \* Horizontal Resolution (Breakthrough and Threshold)  \* Temporal Resolution  \* Timeliness (Breakthrough) | |

### Comment 2

|  |  |
| --- | --- |
| Author: Richard Forbes (ECMWF) | Email: richard.forbes@ecmwf.int |
| The Goal of 10m vertical resolution is stated as being needed "for determining fine layer cirrus and complex tropopause.", but the Goal horizontal resolution is 100km in comparison seems rather coarse for a complex tropopause which may also have significant horizontal structure (e.g. small scale dry intrusions). The B and T horizontal resolutions are also rather large scale for the proposed vertical resolution and temporal resolution. We suggest increasing the horizontal resolution and/or decreasing the vertical resolution. Goal would ideally be <25km, but may be this is too ambitious?  It makes sense to have the same requirements for both "Specific Humidity" and "Mixing ratio" in the UTLS ECVs, but we could also question the need for both as they will be very similar. | |

## ECV Product: Specific Humidity in the Free Troposphere

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Specific Humidity in the Free Troposphere | | | | |
| **Definition** | 3D field of the specific humidity in the free troposphere. The specific humidity is the ratio between the mass of water vapour and the mass of moist air. | | | | |
| **Unit** | g/Kg | | | | |
| **Note** | McCarthy, 2007 notes significant spatial heterogeneity related to latitude of the observation. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km |  | G | 100 | McCarthy, 2007 |
| B | 1000 | McCarthy, 2007 |
| T | 2000 | McCarthy, 2007 |
| **Vertical Resolution** | km |  | G | 0.1 |  |
| B | 0.5 |  |
| T | 1 |  |
| **Temporal Resolution** | hr |  | G | Sub-hourly |  |
| B | 1 |  |
| T | 3 |  |
| **Timeliness** | hr |  | G | 1 |  |
| B | 24 |  |
| T | 720 |  |
| **Required Measurement Uncertainty** | g/Kg | . | G | 0.1 |  |
| B | 0.5 |
| T | 1 |
| **Stability** | g/Kg/decade |  | G | 0.01 |  |
| B | 0.05 |
| T | 0.1 |
| **Standards and References** | McCarthy, 2007 <https://doi.org/10.1002/joc.1611> | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  | Reviewers are invited to suggest answers for these fields | | |
| **Extremes[3]** |  |  | Reviewers are invited to suggest answers for these fields | | |

[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: Specific Humidity in the Boundary Layer

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Specific Humidity in the Boundary Layer | | | | |
| **Definition** | 3D field of the specific humidity in the PBL. The specific humidity is the ratio between the mass of water vapour and the mass of moist air. | | | | |
| **Unit** | g/Kg | | | | |
| **Note** | Vertical resolution is required for calculation of fluxes in the lowermost boundary layer.  McCarthy, 2007 notes significant spatial heterogeneity related to latitude of the observation. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km |  | G | 10 | McCarthy, 2007 |
| B | 100 | McCarthy, 2007 |
| T | 1000 | McCarthy, 2007 |
| **Vertical Resolution** | m |  | G | 1 |  |
| B | 50 |  |
| T | 100 |  |
| **Temporal Resolution** | hr |  | G | Sub-hourly |  |
| B | 1 |  |
| T | 3 |  |
| **Timeliness** | hr |  | G | 1 |  |
| B | 24 |  |
| T | 720 |  |
| **Required Measurement Uncertainty** | g/Kg | . | G | 0.1 |  |
| B | 0.5 |
| T | 1 |
| **Stability** | g/Kg/decade |  | G | 0.01 |  |
| B | 0.05 |
| T | 0.1 |
| **Standards and References** | McCarthy, 2007 <https://doi.org/10.1002/joc.1611> | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  | Reviewers are invited to suggest answers for these fields | | |
| **Extremes[3]** |  |  | Reviewers are invited to suggest answers for these fields | | |

[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: Abdullah Kahraman | Email: kahraman@meteogreen.com |
| This is arguably the most crucial environmental variable in terms of convective storms research. Most of the uncertainty regarding convective available potential energy comes from low level moisture, and its horizontal, vertical, and temporal variability. I would ideally want to see horizontal resolution improvements in both "G", "B" as 1 and 10, respectively. Breakthrough for vertical resolution could be 10 m instead of 50, especially in terms of fog analysis, in addition to convection studies. | |

## ECV Product: Integrated Water Vapour

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | Integrated Water Vapour | | | | |
| **Definition** | Total amount of water vapour present in a vertical atmospheric column over a given location. | | | | |
| **Unit** | Kg/m2 | | | | |
| **Note** | Implicit assumption that IWV is intrinsically linked to boundary layer and surface humidity given the predominance of the water vapour in these regions in contributing to the column total.  Because IWV scales with temperature, uncertainty and stability should be split latitudinally. The applied values here are for mid-latitude locations. They would be stricter (more relaxed) for polar (tropical) locations and in winter than summer. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | km |  | G | 25 |  |
| B | 250 |  |
| T | 1000 |  |
| **Vertical Resolution** | N/A |  | G | N/A |  |
| B | N/A |  |
| T | N/A |  |
| **Temporal Resolution** | hr |  | G | 0.20 |  |
| B | 1 |  |
| T | 24 |  |
| **Timeliness** | hr |  | G | 3 |  |
| B | 24 |  |
| T | 720 |  |
| **Required Measurement Uncertainty** | Kg/m2 |  | G | 0.1 | Vary by latitude  (see notes) |
| B | 0.5 |
| T | 1 |
| **Stability** | Kg/m2/decade |  | G | 0.1 | Vary by latitude  (see notes) |
| B | 0.2 |
| T | 0.5 |
| **Standards and References** |  | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** |  |  | Reviewers are invited to suggest answers for these fields | | |
| **Extremes[3]** |  |  | Reviewers are invited to suggest answers for these fields | | |

[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: Marc Schröder | Email: marcgcossch@gmail.com |
| Within the ESA Water\_Vapour\_cci project a user requirements survey was conducted in 2018. The survey received 34 responses in total and not all questions have been answered comprehensively. The user requirements document is available at: http://cci.esa.int/watervapour. The survey can be summarised as follows (order: threshold, breakthrough, goal):  Horizontal resolution: 100 km, 5 km, <1 km  Temporal resolution: monthly, daily, <6 hourly  Timeliness: was not covered in the survey.  Uncertainty: 14%, 7%, 1.4%  Stability: 5 %/decade, 1 %/decade, <0.5 %/deacde  Note that the survey provides requirements for systematic and random uncertainties separately. These were squared, added and then the square root was taken to come up with the values given above.  The overview of available data records at http://gewex-vap.org/?page\_id=309 reveals quite a few mature data records with horizontal resolutions larger than 100 km. It is thus proposed to keep the original value of 250 km as threshold requirement.  The above values are slightly stricter/less strict than CM SAF requirements for uncertainty and stability. The CM SAF requirements are available in absolute units and were compared here by using the climatological average of an SSM/I-based product to convert absolute into relative units. The document is available on request from contact.cmsaf@dwd.de and was based on a survey of existing requirements.  A comment on timeliness: some aspects of climate analysis, like e.g. trend analysis, may be covered based on a more relaxed timeliness than 1 month.  Finally, it is proposed to delete the second paragraph under „Note“. | |