## [wmo-im/BUFR4] Revision of E-Profile Sequences (#21)

### Response to reviewers

1. [SibylleK] I do not think that new descriptors are needed to minimize the data width by 1 bit (all "Uncertainty in..")

Agreed - the template has been updated to use the original descriptors 015 066 and 015 068 as they are fit for purpose

1. [SibylleK] 3 01 032 for "Common header sequence" has to be changed, because it already exists. But, it seems to be a typo and should be 3 01 132.

This should read 3 01 132 and has been corrected in latest version

1. [jitsukoh] How to calculate the uncertainty in the ALC template?

Comment

The following brief description provides the roadmap to obtain uncertainty estimates for ALC products. On the E-PROFILE hub, the uncertainty estimation is not yet operationally implemented but is planned to be deployed during the current program phase (until 2023).

Methodology:

* Attenuated backscatter coefficient: for this product, Gaussian error propagation can be applied.
* Higher order products (backscatter and extinction coefficient, depolarization ratio): Monte Carlo simulation

Sources of uncertainty for attenuated backscatter coefficient:

* Measurement noise: In case of analogue detection, analysis of the variability of the measured raw profiles within a time range 5-15 min. Assuming stable atmospheric conditions over such a short time period, profiles of standard deviation indicate the expected uncertainty in the measurements. In case of photon-counting instruments the measurement noise can be calculated directly using Poisson statistics.
* Calibration
  + In case of cloud calibration ([O’Connor et al, 2004](https://doi.org/10.1175/1520-0426(2004)021%3C0777:ATFAOC%3E2.0.CO;2), [Hopkin et al, 2019](https://doi.org/10.5194/amt-12-4131-2019)):
    - Multiple scattering
    - Signal saturation (photon-counting instruments only)
  + In case of Rayleigh calibration ([Wiegner and Geiß, 2012](https://doi.org/10.5194/amt-5-1953-2012))
    - Signal noise
    - Atmospheric transmission due to aerosols (lidar ratio assumption)
* Water vapor absorption ([Wiegner and Gasteiger 2015](https://doi.org/10.5194/amt-8-3971-2015), [Wiegner et al. 2019](https://doi.org/10.5194/amt-12-471-2019)): for instruments in 905-910 nm range
* Overlap-correction ([Kotthaus et al, 2016](https://doi.org/10.5194/amt-9-3769-2016), [Hervo et al. 2016](https://doi.org/10.5194/amt-9-2947-2016))
* Signal artefacts in free troposphere ([Kotthaus et al, 2016](https://doi.org/10.5194/amt-9-3769-2016)): significant mostly in case of analog signal detection

Additional sources of uncertainty for extinction and backscatter coefficient:

* Lidar ratio assumption

Uncertainty in Depolarization Ratio (correct: volume linear depolarization ratio)

Beside statistical uncertainties (comparable to statistical uncertainty of attenuated backscatter), the accuracy of the depolarization ratio can be affected by several sources of systematic uncertainties ([Freudenthaler 2016](https://doi.org/10.5194/amt-9-4181-2016); [Bravo-Aranda et al., 2016](https://doi.org/10.5194/amt-9-4935-2016))

1. Calibration
   1. Rayleigh calibration ([Beherendt and Nakamura, 2002](https://doi.org/10.1364/AO.41.007657)): if filter bandwidth is not known correctly and temperature dependence of Rayleigh scattering is not taken into account, errors can be up to 10%
   2. ∆90 calibration ([Freudenthaler 2016](https://doi.org/10.5194/amt-9-4181-2016))
2. Diattenuation of receiving optics and polarizing beam splitters
3. Retardance of emitting and receiving optics
4. Rotational misalignment between plane of polarization of the laser and incident plane of polarization beam splitter
5. [Marijana Crepulja] I have a question regarding 0 33 002. Does quality information (0 33 002) refer to u, v, w component respectively in the new sequence 3 09 024? Similar in the sequence 3 09 025, quality information (0 33 002) refers to virtual temperature and w component respectively? When comes to sequence 3 09 026, does quality information (0 33 002) refer to entire message or?

|  |  |  |  |
| --- | --- | --- | --- |
|  | 0 11 003 |  | u-component |
|  | 0 11 004 |  | v-component |
|  | 0 33 002 |  | Quality information of u/v horizontal wind components - relates to 3 09 024 |
|  | 0 11 006 |  | w-component |
|  | 0 33 002 |  | Quality information (relates to vertical wind component)relates to 3 09 024 |
|  | 0 12 007 |  | Virtual Temperature |
|  | 0 33 002 |  | Quality information of virtual temperature relates to 3 09 025 |
|  | 0 33 002 |  | Quality information - overall quality flag for all parameters - related to 3 09 026 |

1. [Marijana Crepulja] I agree with [@SibylleK](https://github.com/SibylleK) comments on the new descriptors for the uncertainties, as I believe we can use existing descriptors without introducing new elements for reducing data width. When comes to new descriptors for introducing new reference value, we can use operator 203YYY and existing descriptors for this purpose. However, if there is an issue that 203 operator can cause trouble in some decoding software we can address this with new descriptors.

The use of 203 YYY operator would not be appropriate (and not possible to do using the current E-PROFILE software without a major re-write). This is likely to have a downstream impact and cause issues when we start disseminating the messages.