Response to Referee Comment (RC1) on

ALADIN laser frequency stability and its impact on the Aeolus wind error

(https://doi.org/10.5194/amt-2021-74)

We thank the reviewer for reading our manuscript and for his positive feedback. Our response to his comment is provided below.

General comment:

The long-term laser frequency stability is first reported for spaceborne high energy solid-state laser. The difference performance between under-ground and in- orbit is implemented. The enhanced frequency noise due to the satellite's reaction wheels is discovered. Two year's global frequency stability of laser is present. It is very significant for future frequency-stability spaceborne laser development. Aeolus wind error in both Mie and Rayleigh Channel due to the enhanced frequency noise is analysed. The wind error can be accepted for the ECMWF mode.

Comment #1:

It is better that the mechanics of the frequency noise enhancement in the master oscillator due to micro-vibration is given.

Response to Comment #1:

We are not sure whether we understand the reviewer's comment regarding the mechanics of the frequency noise enhancement correctly. The underlying mechanical process that causes the enhanced laser frequency noise is explained in line 75ff.:

> "With regard to Aeolus the main susceptibility to micro-vibrations is related to the alteration of the laser cavity length which leads to frequency fluctuations of the emitted light."

Variations in the MO cavity length as being the root cause for frequency fluctuations are also discussed in the description of the ALADIN laser frequency stability in section 3.1, e.g, in lines 280ff:

> "It should be pointed out that, apart from laser frequency variations caused by cavity length changes, the measured Mie response […]".

Additional information on the mechanical and optical layout of the ALADIN laser transmitter, particularly the design of the folded master oscillator, is provided in the ESA Science Report to the Aeolus mission (ESA, 2008), p. 60:

> "The different stages shown in the PLH architecture are divided into two optical benches in the actual laser head: the Upper Optical Bench, and the Lower Optical Bench inside the laser housing. […] The UOB carries the cold plate, which allows cooling of the active components (Master Oscillator and the Pre- and Power Amplifiers). It also carries the isostatic mounts, which fix the PLH onto the ALADIN structure. These isostatic mounts have to maintain alignment of the output beam with respect to the ALADIN optics under the varying forces acting on the cold plate. […] The folding mirrors of the Master Oscillator are mounted on an Invar substructure for additional stability."

For the sake of conciseness, we did not mention these details in the text and referenced the available literature at the beginning of section 2.1.