System upgrade of the Na Lidar at Tromso for the thermospheric Na observation

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An Nd:YAG laser-based sodium temperature/wind lidar was developed for the measurement of the northern polar mesosphere and lower thermosphere at Tromsø (69.6N, 19.2E), Norway (Nozawa et al. 2014; Kawahara et al. 2017). The highly stable laser system is first of its kind to operate virtually maintenance-free during the observation season (from late September to March) since 2010. Recent resonance lidar observations report very thin distribution of metallic atoms such as Na or Fe in the thermosphere between 120 km and 170 km. To measure thermospheric wind and temperature, low signal should be extracted from the background signal. Using an Na Faraday filter (magneto-optical filter) is one of the best candidate to reject the background light (Liu et al., 2016). The faraday filter was originally developed as an ultra-narrow bandpass filter for the daytime observation. The dificulty of using the filter is to keep its transmission stable under a high temperature condition of the Na cell. A pyrex-glass cell wall is potentially sensitive to the high-temperature (~200 degree Celsius) atomic Na vapor. So the atomic Na density in the cell changes, leading to the unstable transmission. The possible solution of this problem is to use chemically stable material. Mono-crystal sapphire is one of the best candidates. We try to use sapphire both for the cell body and the windows that are attached by optical contact method. In this talk, we present the idea of sapphire cell, the problems to solve, and a new Faraday filter design.

References

Nozawa, S., T. D. Kawahara, N. Saito, C. M. Hall, T. T. Tsuda, T. Kawabata, S. Wada, A. Brekke, T. Takahashi, H. Fujiwara, Y. Ogawa, and R. Fujii, Variations of the neutral temperature and sodium density between 80 and 107 km above Tromso during the winter of 2010-2011 by a new solid state sodium LIDAR. *J. Geophys. Res., 119*, doi:10.1002/2013JA019520, 441-451, 2014.

Kawahara, T.D., S. Nozawa, N. Saito, T, Kawabata, T.T. Tsuda, and S. Wada, Sodium temperature/wind LIDAR based on laser-diode-pumped Nd:Yag lasers deployed at Tromsø, Norway (69.6°, 19.2°), *Optics Express, 25*, A491-A501, 2017.

Liu, A. Z., Y. Guo, F. Vargas, and G. R. Swenson, First measurement of horizontal wind and temperature in the lower thermosphere (105–140 km) with a Na Lidar at Andes Lidar Observatory, *Geophys. Res. Lett.*, *43*, doi:10.1002/2016GL068461, 2016.