ASEN 6519. Lidar Remote Sensing

HW #4 – Temperature Lidar Technologies

1. **Integration technology**: Derive the equations of integration technology for temperature measurements in step-by-step fashion. Then derive the temperature errors for this technology. From this error analysis aspect, where should we start the integration with a seeding temperature, from the top or from the bottom? Explain why.
2. **Boltzmann technology**: Explain with equation derivations why Fe-resonance Boltzmann lidar or other lidars utilizing the Boltzmann distribution law can employ broadband lasers, but not limited to narrowband lasers. What are the pros and cons if narrowband lasers are used in Boltzmann lidar technologies?
3. **Doppler technology**: When sending real lidar pulses to the atmosphere, the return signals (regardless resonance fluorescence, elastic or inelastic scattering) are the convolution of the pure scattering signals with the laser lineshape. Let's take Fe absorption and fluorescence as an example. The laser bandwidth could be much larger (several to 10 GHz), comparable (~1 GHz), narrower (100-200 MHz), and significantly narrower (10s MHz) than the Fe absorption linewidth itself (you may compute the linewidth determined by the Doppler broadening). If we assume both the laser lineshape and the absorption lineshape are Gaussians, determine how the laser linewidth affects the effective cross-section. Then explain with equation derivations or error analyses why Doppler lidars demand narrowband lasers.
4. **Temperature lidar technologies versus altitude**: If you are tasked to measure the atmospheric temperature from the surface to the thermosphere up to ~150 km with ground-based lidars, what lidar technologies will you use to achieve such a goal? Please state your reasons and point out 1) the challenges of temperature measurements in each altitude region, and 2) the advantages and disadvantages of the lidar technologies you choose.

HW #4 is due on March 2nd, 2016 in class.