Simulation Results and Performance Analysis of Phase Velocity Spectral Analysis Software (M-Transform) for Airglow Imaging Data

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We have developed a user-friendly software based on *Matsuda et al.*, 2014's 3D-FFT method (M-Transform) for airglow data analysis as a function on Interactive Data Language (IDL). Input of this function is 3-D array of a time series of airglow image that have already been converted to geographical coordinate (*x*, *y*, *t*). The user can customize the wave parameters (e.g. horizontal wavelength (λ_h), wave period (τ), phase speed (*c*), image resolution in space (*dx*,*dy*) and time (*dt*)) in one-line command when executing the program, which depends on their analysis purpose. In order to exhibit this new function's performance and the characteristics/interpretation of the spectral analysis, we have run several test cases using artificial wave. The first case is artificial wave with constant speed (40 m/s) and different wave period (8, 15, 30 min) and horizontal wavelength. In second case, we applied Gaussian shape wave-packet with different FWHM (50, 100, 200 km). For the third test case, with a fixed wave packet size (100 km), we changed the wave packet duration (30, 60, 120 min). The results from the various simulations showed reasonable characteristics of the spectral analysis for different scenarios. We showed that the increase of wave period and horizontal wavelength lead to the wider spectrum with total power difference of ~10%. By changing the wave packet size, we showed that the bigger the wave packet size, the sharper and narrower the spectrum became with the total power increase 2x of the increase size of the wave packet. The result of changing the wave packet duration showed that the longer the duration of wave packet, the spectrum becomes sharper and the total power is proportional to the wave packet length. We also examined the aliasing and zero padding effect on the spectral analysis. In order to avoid the aliasing effect, it is recommended to set the period minimum to at least 2 x image interval (*dt*). More detailed analysis will be discussed during the presentation.

Keywords: Airglow, Gravity wave, Analysis software

