Turbulence Imaging with the MU Radar

Gernot Hassenpflug[1]

[1] Kyoto University RISH

The MU radar has been upgraded to use 25 digital receivers and 5 transmit frequencies. Imaging is one of the most promising techniques to implement, since it allows the finding of solutions to under-determined problems such as turbulence activity viewed by radar.

In the present study, it is shown how the radar is able to image echo structures at resolutions in range and angle more detailed than the range gate and beam-width. The resolution is dependent on the algorithms implemented: here the Fourier, Capon, MUSIC and MEM (maximum entropy method) are shown. Their performance varies as a function of their complexity, and their consideration of the data at hand. Initial experiments carried out with the simplest method, the Fourer method, were made to test the system, and then an improvement was made by using the Capon method, shown to have a much better performance in theory, and relatively simple to implement.

Imaging allows the display of multiple information. In this case, the brightness in range and angle can be shown, and also the Doppler information for each brightness. to display this information in a manner reasonably understandable to viewers, a movie format is used and the Doppler represented by shades and hues of color: red for approaching Doppler, green for near-zero Doppler, and blue for receding Doppler. The magnitude of the brightness is seen in the hue of the color.

In this way, we can view what is expected to be turbulence in the lower atmosphere, for cases where many variations exist within the radar volume, such that there is visual variation that can be interpreted in terms of turbulence structure. The time resolution of the observations can be varied to detail small-scale time variations at low ranges (less than 10 km) or cover echoes to higher altitudes (about 20 km).

From the visual data presentation, image processing can be used to determine dynamic paramaters of the turbulence, and comparison with models is envisaged as a future step, to gain a better understanding of the generation mechanisms underlying the turbulence.