National Central University
Department of Atmospheric Sciences
Radar Meteorology
Homework VI
(2021/11/26 - 2021/12/17)

1. (30 pts.) Let $u = u_0 + u_x x + u_y y$，$v = v_0 + v_x x + v_y y$，$w = w_0$, and it is known that $x = r\cos\alpha\sin\beta$，$y = r\cos\alpha\cos\beta$，$z = r\sin\alpha$ where α is the elevation angle, *r* is the distance from the radar to the observation point, β is the azimuthal angle, starting from due north, and increases clockwise. Please derive the following expression for the radial wind V_r in the VAD method：

$$v_r = w_0 sin\alpha + \frac{1}{2}(u_x + v_y) r cos^2\alpha + u_0 cos\alpha sin\beta + v_0 cos\alpha cos\beta$$
$$+ \frac{1}{2}(v_x + u_y) r cos^2\alpha sin2\beta + \frac{1}{2}(v_y - u_x) r cos^2\alpha cos2\beta$$

2. The TA will send you a data file named “fort.18”, whose format is (1x, f4.0, 1x, f10.6). Inside this file, the first column shows the azimuthal angle, starting from due north, and rotates in the clockwise sense for 360°. The second column is the radar observed radial wind. If the radar’s elevation angle is 1.5°, and the observational range is 25 km. This is a C-band radar with 5 cm wavelength, and the **PRF =** 10^3 s^{-1}. Please do the following:
   (a) (10 pts) Plot a figure to show the distribution of radial wind V_r (on vertical coordinate) with respect to the azimuthal angle (horizontal coordinate).
   (b) (30 pts) Unfold the radial wind data, plot it, then use VAD method to compute *u*, *v*, horizontal convergence/divergence, shear deformation and stretching deformation. (Assuming the vertical velocity *w* can be neglected).
   (c) (30 pts) Use the original folded radial wind data and the gradient VAD technique to compute u, v, and compare the results with those from (b).