Trajectory calculations

Trajectory calculations solve for the future *x* and *y* positions of air parcels as they are transported by the wind field. To accomplish this, the vector equation:

$$\frac{D\vec{s}}{Dt} = \vec{V}(x,y,t)$$

must be rewritten as:

$$\frac{Dx}{Dt} = u(x,y,t)$$

$$\frac{Dy}{Dt} = v(x,y,t)$$

and solved using a Runga Kutta method. (Notice we've simplified the problem by ignoring the *z* component. In situations where there is ascent or descent, $\frac{Dz}{Dt} = w(x,y,z,t)$ must also be considered, and *u* and *v* will be functions of *(x, y, z, t)* as well.)

The RK order 2 equations become:

$$x_{guess} = x^{\tau} + \Delta t\, u_o$$

$$x^{\tau+1} = x^{\tau} + \Delta t(\frac{u_o + u_1}{2})$$

$$y_{guess} = y^{\tau} + \Delta t\, v_o$$

$$y^{\tau+1} = y^{\tau} + \Delta t(\frac{v_o + v_1}{2})$$

where u_o and v_o are the winds at the initial positions x_o and y_o, while u_1 and v_1 are the winds at x_{guess}, y_{guess}, and $t_o + \Delta t$. Since much interpolation in time and space is needed to solve these equations, a RK Order 4 technique would be too slow on computers, therefore Order 2 is often used instead. This is the technique described in Draxler's paper (see equation 3 in the handout), and it is used in NOAA's HY-SPLIT trajectory model.