**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Exam#2**

**Applied Numerical Weather Prediction Due: 3:00 pm, 4 May 2022**

***NOTE: All work is to be completed individually, without consulting any other person.***

**Project#21**

**(21.1)** Utilize your weather forecast model from Activity#8 (using **periodic** boundary conditions, p. 103) and predict the zonal wind at a future time under the conditions…





,

{for +1000 km ≤ x ≤ +2000 km, 0.0 m s-1 otherwise}

where ***A***, ***k***, and ***ω*** are equal to 5 m s-1, π /(1x106 m), and 3.14x10-5 s-1, respectively, as ***x*** varies from 2000 km to +2000 km using 1001 grid points, with dt=60 seconds, with *forward-in-time differencing* and *centered-in-space differencing*. Note that the analytic expression for the zonal wind component applies **only at the initial time** (*t* = *t0* = 0) and applies only for the weather stations located at grid points numbered 1, 111, 235, 374, 427, 589, 633, 787, 852, 987, and 1001.

You must use the inverse distance squared weighting data assimilation scheme to create the *ensemble control* initial conditions at the 1001 grid points given the zonal wind observations at the 11 station locations given above (already done in Activity#8). You’ll create a positive perturbation (P+) initial condition by everywhere adding the scaled perturbations to the ensemble control initial conditions and you’ll also create a negative perturbation (P-) initial condition by everywhere subtracting the scaled perturbations from the ensemble control initial conditions. The initial *perturbations* are determined by subtracting the ensemble control initial conditions from the analytic expression at the initial time. You scale the perturbations by dividing them by the greatest initial *perturbation* magnitude over the entire 1001 grid points. Hence, the scaled perturbation at the grid point having the maximum disagreement between the ensemble control initial condition and the analytic initial condition **magnitude** will be equivalent to one. All other grid points will have a scaled perturbation **magnitude** less than one.

Run your forecast model for each ensemble member (ensemble control, P+, and P-) out to a 6-hour forecast and plot the zonal wind component forecast for each ensemble member at the 0-, 3-, and 6-h forecasts. Include on each of the plots the actual (analytic) solution at the 0-, 3-, and 6-h forecasts. Also, create a trajectory plot of each member (three ensembles and actual solution) by tracking the x-location and amplitude of the zonal wind minimum located initially near x = +1500 kilometers. The trajectory will consist of the x-location as the X-variable and the amplitude of the zonal wind max as the Y-variable with data points plotted at the 0-, 1-, 2-, 3-, 4-, 5-, and 6-h forecast times.

**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Exam#2**

**Applied Numerical Weather Prediction Due: 3:00 pm, 4 May 2022**

***NOTE: All work is to be completed individually, without consulting any other person.***

**Project#21 (continued)**

[q21.2.1] Based on the results of your trajectory plot, would you conclude that the ensemble system was “good” or “bad” at predicting the evolution of the zonal wind maximum that starts near x = +1500 kilometers. Give reasons supporting your conclusion.

[q21.2.2] What feature of the sinusoidal zonal wind field is not handled well by the control forecast and isn’t accounted for in the simple perturbation ensemble methodology such that the results of our ensemble system might be less-than-desirable? Give reasons supporting your conclusion.