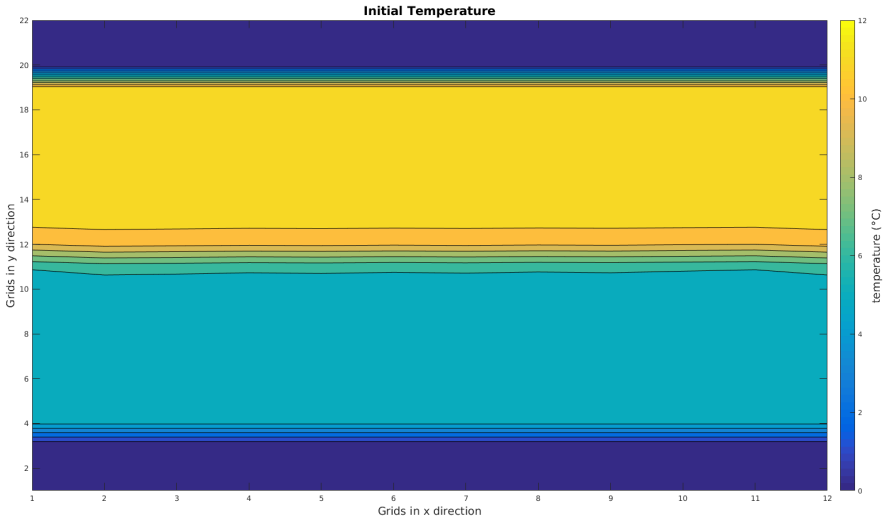
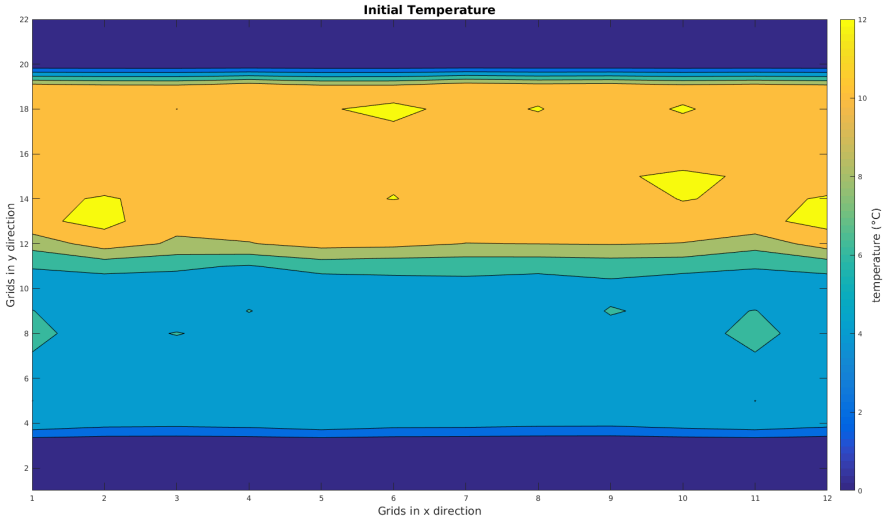
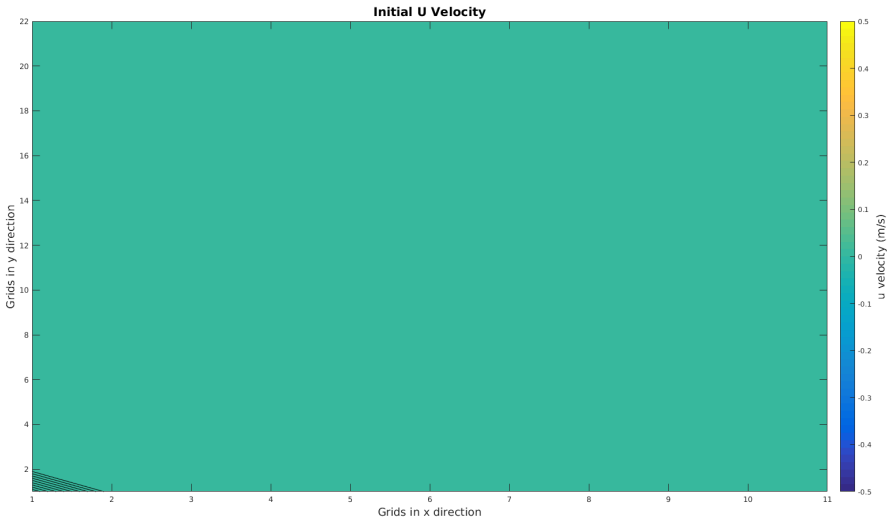
Simple Nudging with ROMS on a system with smaller size

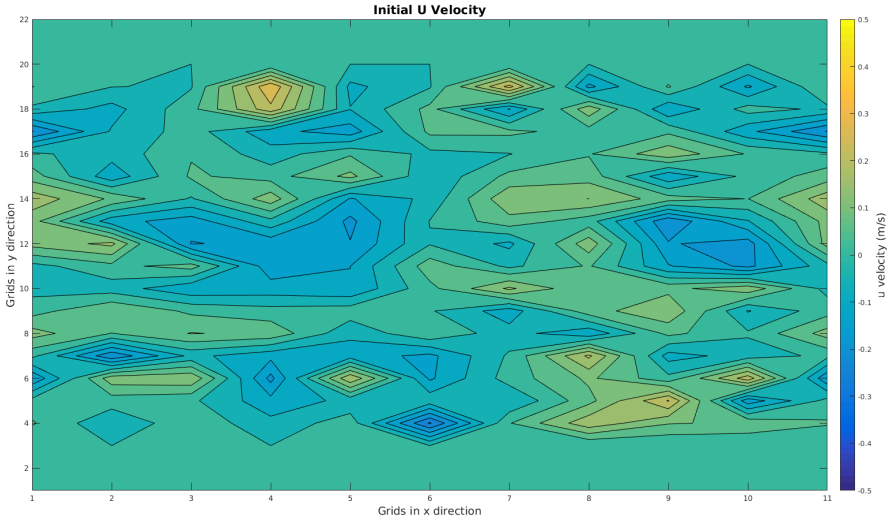
Setup of twin experiments

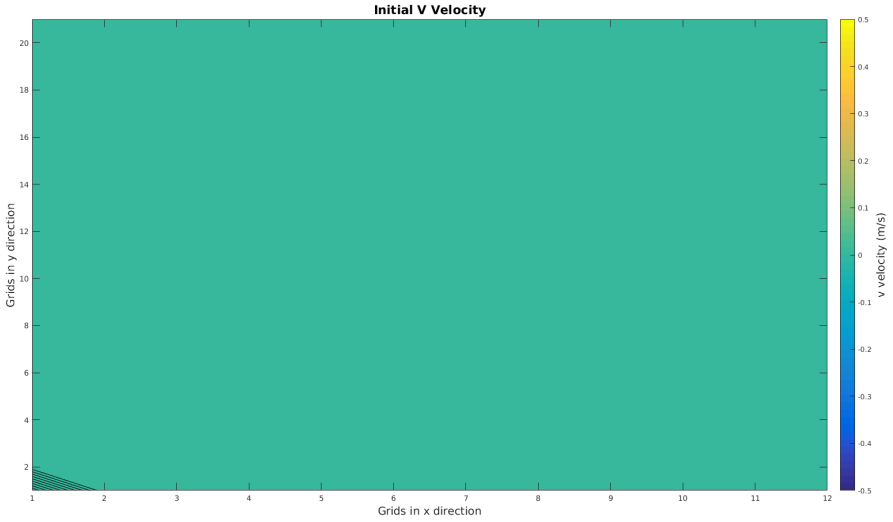
In order to achieve faster computing time, we shall now start with a smaller system. The initial conditions for twin experiments are shown below. A Gaussian noise ($\mu = 0, \sigma = 0.1$ for velocity and $\sigma = 0.5$ for temperature)was added to the syestem shown as the second graph.

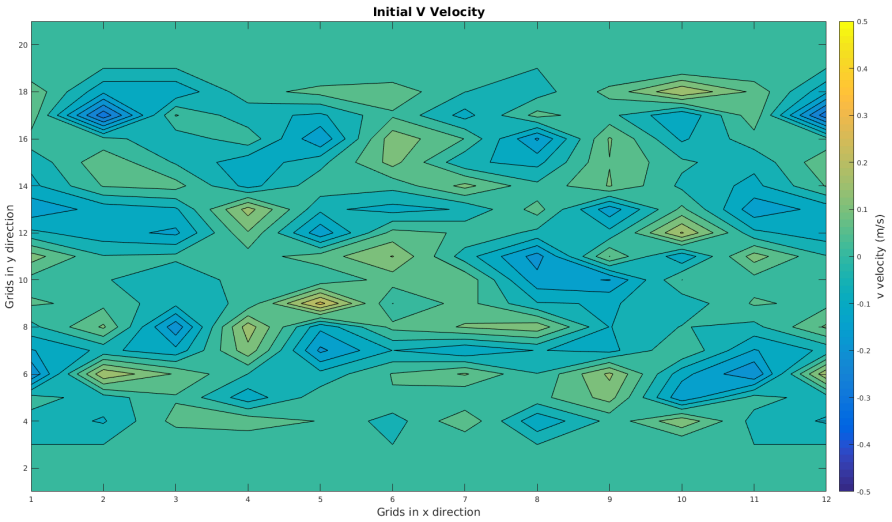





Initial U Velocity
Grids in y direction
Grids in x direction
u velocity (m/s)

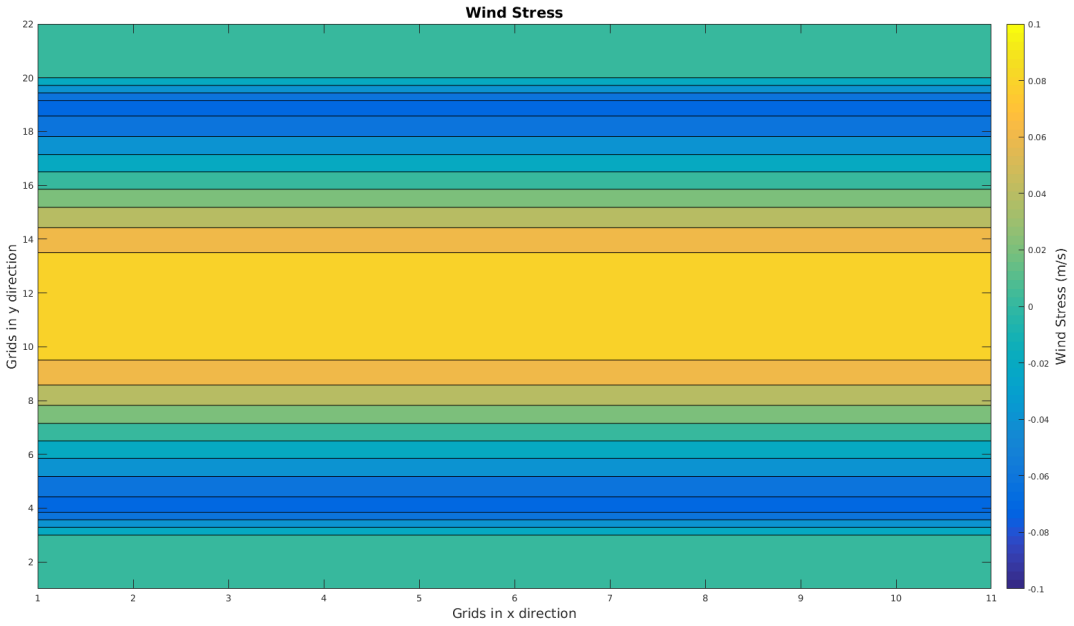

Initial U Velocity
Grids in y direction
Grids in x direction
u velocity (m/s)


Initial V Velocity
Grids in y direction
Grids in x direction
v velocity (m/s)



The wind force added has the form $\tau_u(i,j) = -0.1cos(2\pi y(i,j)/L)\ m^2/s^2$, where i,j are the index of grid points in x and y directions respectively, L is the total length in y direction, and subscript u indicates that the wind force is in x direction. The boundary conditions are periodical for y direction and closed for x direction. The bottom is flat. The other relevant parameters are listed below, as well as a plot for the wind stress.

name	Description	Value
N_i	Number of x direction ρ points	20
N_j	Number of y direction ρ points	10
N_σ	Number of vertical layers	5
dt	Time step size	600s (10 min)
N_{time}	Number of time steps	57600 (400 days)
N_{his}	Number of time steps between observation	144 (1 day)
Zo_b	Bottom Roughness	0.02m
θ_s	See Vertical S-coordinate section	7
θ_b	See Vertical S-coordinate section	0.1



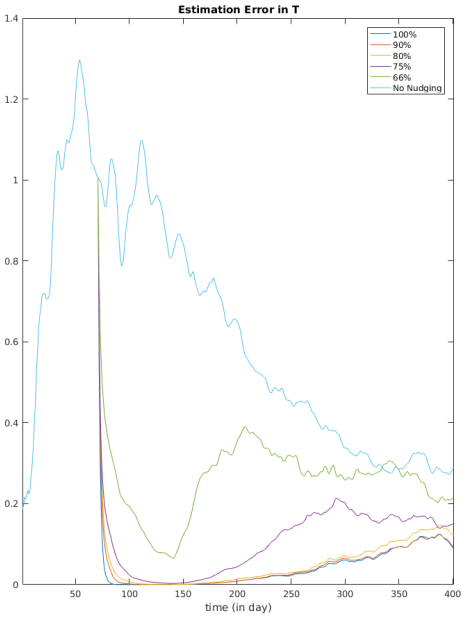
The total number of unknown variables are: 20x10x5x3(u, v, and temperature)+20x10(ζ) = 3200.

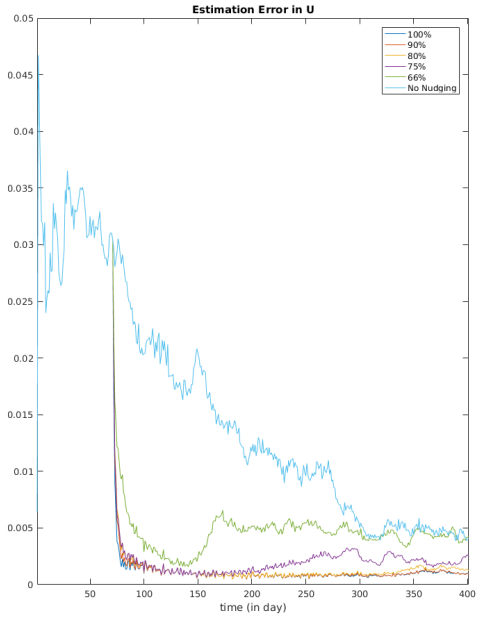
Simple Nudging results

From day 71 to day 140, we applied simple nudging to the system as the first graph, trying to nudge it to the system with Gaussian noises added. After that, we run both systems without nudging until day 400, and compare the two systems. Below is a plot of estimation error vs time, which is defined as

$$Estimation\ Error = \frac{1}{N_i N_j N_\sigma} \sum_{over\ all\ grids} (x_i^2 - y_i^2)$$

The results are plotted below.





From the graph, we can see that we roughly need around 75%-80% of the variables observed to have a good prediction. Next thing we want to do is to increase the forcing and see how the system behaves, and if we get similar result with simple nudging or not.