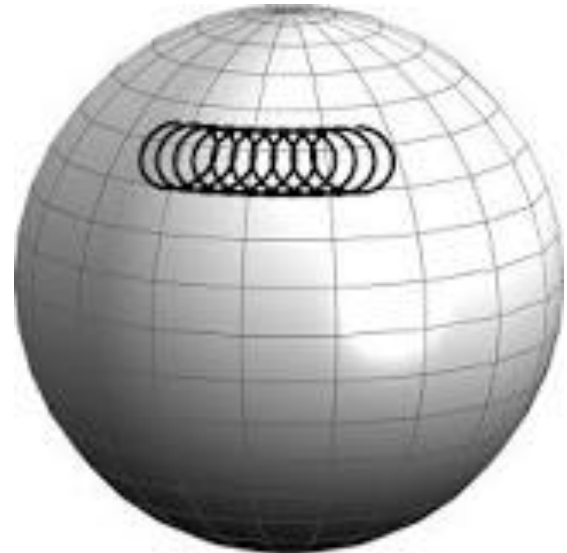


USING REGIONAL OCEAN MODELLING SYSTEMS TO MODEL INERTIAL OSCILLATIONS



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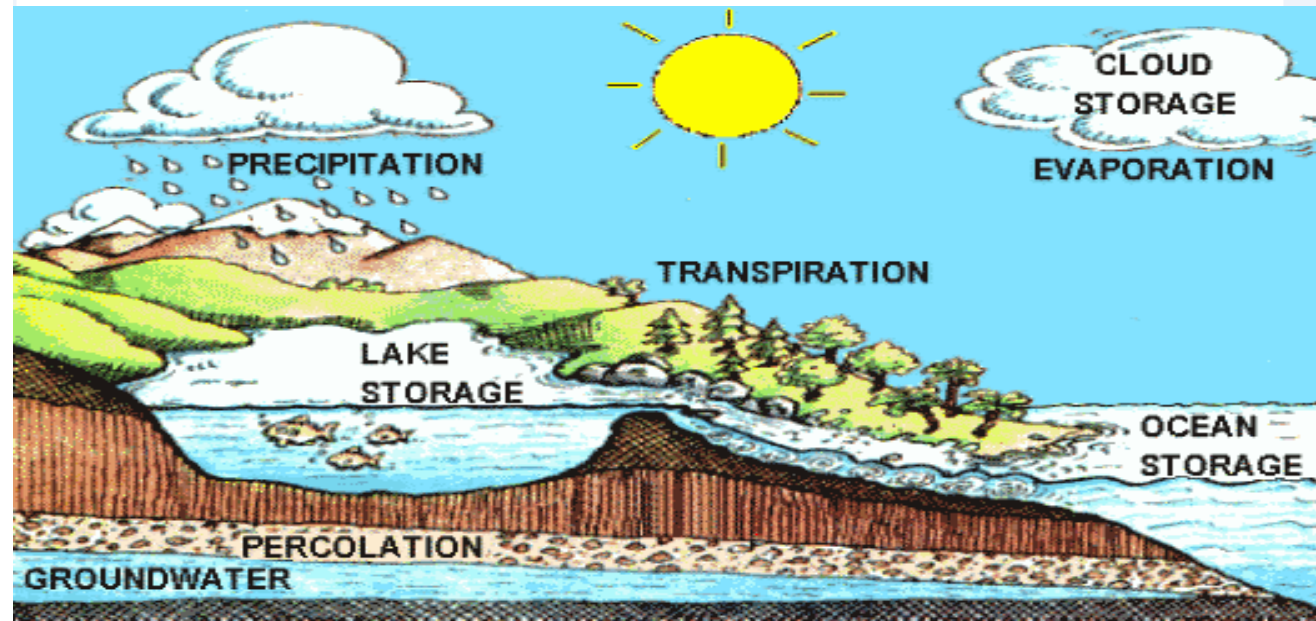
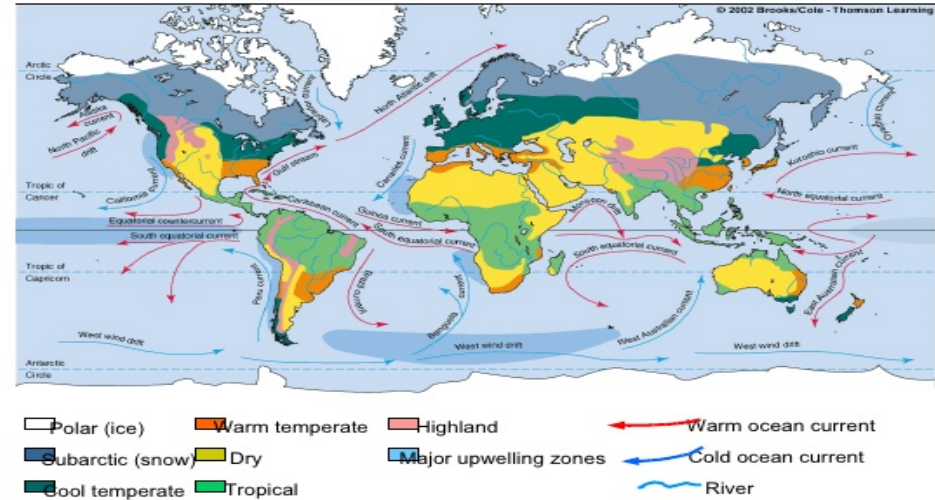
SUPERVISOR DR. JOSEPH ANSONG

PRESENTATION OUTLINE

- ✓ Ocean models
- ✓ ROMS
- ✓ Inertial Oscillations
- ✓ Conclusion

Ocean models are numerical models with a focus on the properties on the oceans and their circulation.

Ocean models play a large role in aiding our understanding of the oceans influence on weather and climate



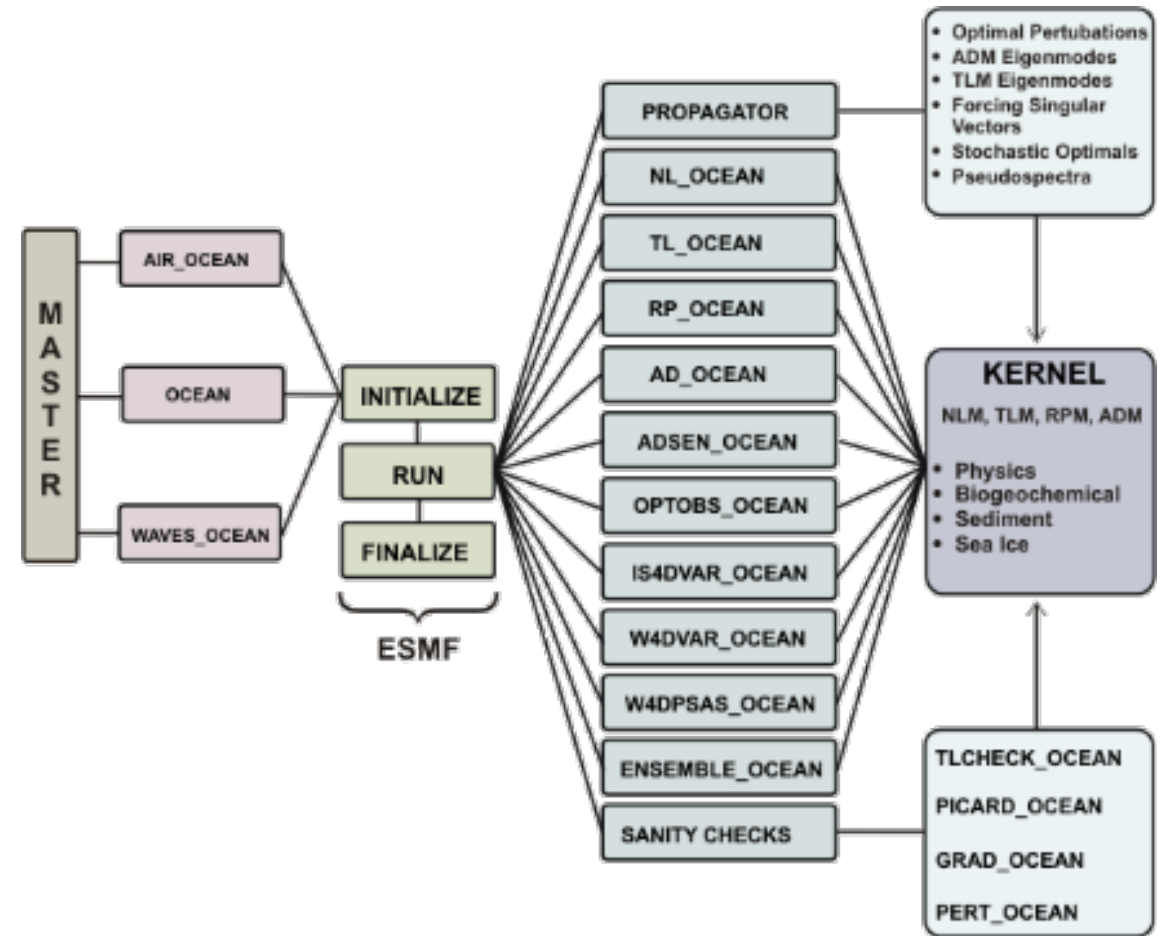
EXAMPLES OF OCEAN MODELS

- Regional Ocean Modelling Systems (ROMS)
- Modular Ocean Model (MOM)
- Parallel Ocean Program (POM)
- MIT General Circulation Model (MITGCM)
- Hybrid Coordinate Ocean Model (HYCOM)
- ...

THE REGIONAL OCEAN MODELLING SYSTEMS (ROMS)

ROMS is a numerical ocean model widely used by the scientific community for a diverse range of applications.

The model was developed and is supported by researchers at the Rutgers University of California and contributors worldwide.

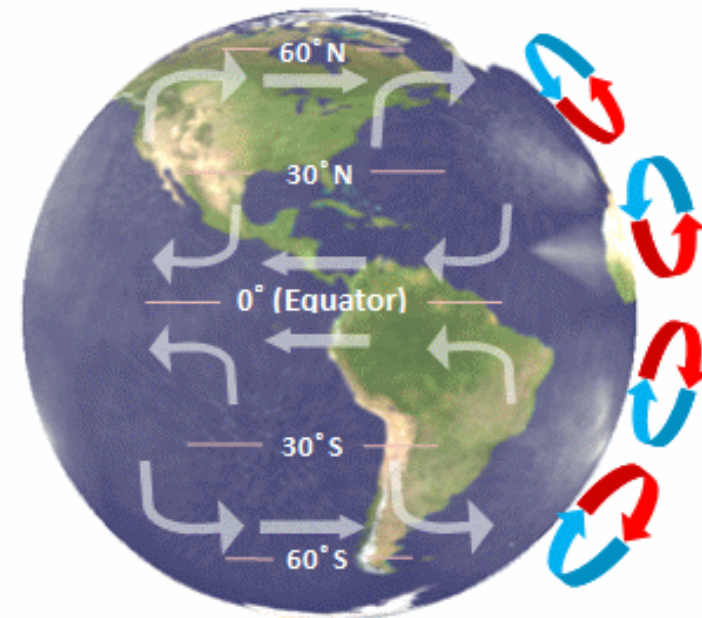


Framework of ROMS

INERTIAL OSCILLATION

Inertial oscillations which are also referred to as inertial waves are types of mechanical wave possible in rotating fluids.

They are the simplest type of time dependent motion caused by Coriolis force, which arises as a result of the rotation of the earth.



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INERTIAL OSCILLATION *CON'T*

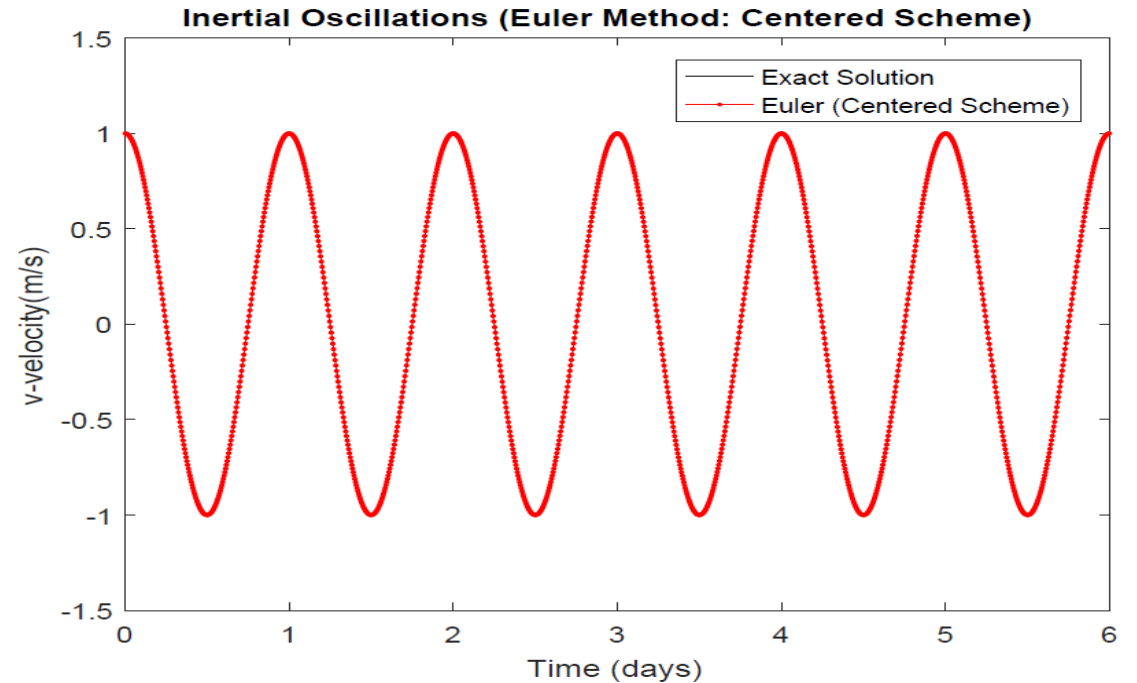
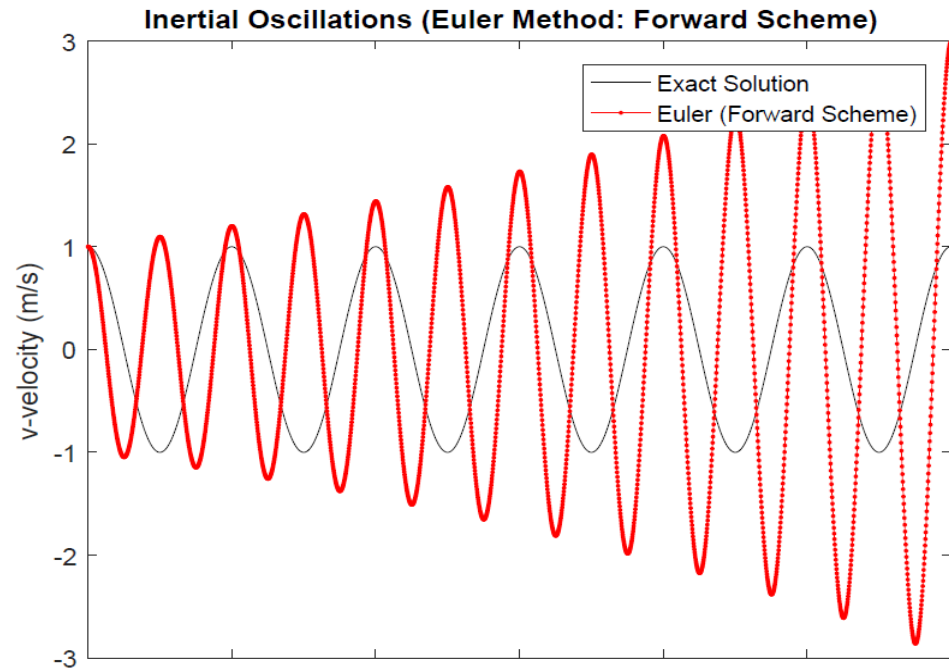
The equations governing purely motions are given by

$$\begin{aligned}\frac{du}{dt} - fv &= 0, \\ \frac{dv}{dt} + fu &= 0,\end{aligned}$$

where u and v are the velocities in the zonal (x-axis) and meridional (y-axis) directions, and f is the Coriolis parameter which is given by $f = 2 \sin(\phi)$.

INERTIAL OSCILLATION *CON'T*

SOLVING INERTIAL OSCILLATION USING OTHER MATHEMATICAL METHODS



INERTIAL OSCILLATION WITH ROMS

ROMS can be used to solve the equations governing the inertial oscillations.

This is done by running scripts for Coriolis scenarios (tweaking the conditions in order to mimic exact situation)

Eg.

- ✓ wind speed
- ✓ Currents
- ✓ Wave heights
- ...

INERTIAL OSCILLATION WITH ROMS

✓ After compiling the code you get an executable file. After that you have to run the file.

✓ After running the file it produces a netCDF file which can then be used to plot a graph or make an animation in matlab or python

```
/cygdrive/c/Users/Owner/Downloads/roms/Projects/Coriolis
2591  5 23:56:40  4.642538E+00  1.477029E+03  1.481672E+03  4.538700E+12
      (05_01_15)  5.442649E-02  2.046209E-01  1.428064E-10  3.176033E+00
2592  6 00:00:00  4.642779E+00  1.477029E+03  1.481672E+03  4.538700E+12
      (05_01_15)  6.038513E-02  2.029442E-01  1.434321E-10  3.175935E+00
WRT_HIS  - wrote history fields (Index=1,1) into time record = 0000145

Elapsed CPU time (seconds):
Thread #  0 CPU:      352.688
Total:              352.688

Nonlinear model elapsed time profile:
Allocation and array initialization .....          0.031 ( 0.0089 %)
Ocean state initialization .....                 0.047 ( 0.0133 %)
Processing of input data .....                  0.084 ( 0.0236 %)
Computation of vertical boundary conditions ..... 0.109 ( 0.0310 %)
Computation of global information integrals ..... 7.844 ( 2.2240 %)
Writing of output data .....                   1.094 ( 0.3101 %)
Model 2D kernel .....                         248.547 (70.4723 %)
Lagrangian floats trajectories .....            0.203 ( 0.0576 %)
2D/3D coupling, vertical metrics .....          3.125 ( 0.8861 %)
Omega vertical velocity .....                 3.125 ( 0.8861 %)
Equation of state for seawater .....           1.359 ( 0.3854 %)
3D equations right-side terms .....            15.469 ( 4.3860 %)
3D equations predictor step .....             25.594 ( 7.2568 %)
Pressure gradient .....                      3.359 ( 0.9525 %)
Corrector time-step for 3D momentum .....      32.062 ( 9.0909 %)
Corrector time-step for tracers .....          6.500 ( 1.8430 %)
Total:                                         348.562  98.8304

All percentages are with respect to total time = 352.688

ROMS/TOMS - Output NetCDF summary for Grid 01:
number of time records written in HISTORY file = 00000145
number of time records written in RESTART file = 00000002

Analytical header files used:
ROMS/Functionals/ana_btFlux.h
ROMS/Functionals/ana_grid.h
ROMS/Functionals/ana_initial.h
ROMS/Functionals/ana_smFlux.h
ROMS/Functionals/ana_stFlux.h

ROMS/TOMS: DONE... Friday - August 3, 2018 - 3:07:17 PM
Owner@Joseph-PC /cygdrive/c/Users/Owner/Downloads/roms/Projects/Coriolis
$ ls
Build coriolis.h files_Advection1 files_Advection3 files_Advection5 input movie ocean_his.nc oceanS.exe
build.bash coriolis.in files_Advection2 files_Advection4 files_NoAdvection matlab_codes ocean_fit.nc ocean_rst.nc python_codes
Owner@Joseph-PC /cygdrive/c/Users/Owner/Downloads/roms/Projects/Coriolis
$ ls *.nc
ocean_fit.nc ocean_his.nc ocean_rst.nc
Owner@Joseph-PC /cygdrive/c/Users/Owner/Downloads/roms/Projects/Coriolis
$
```

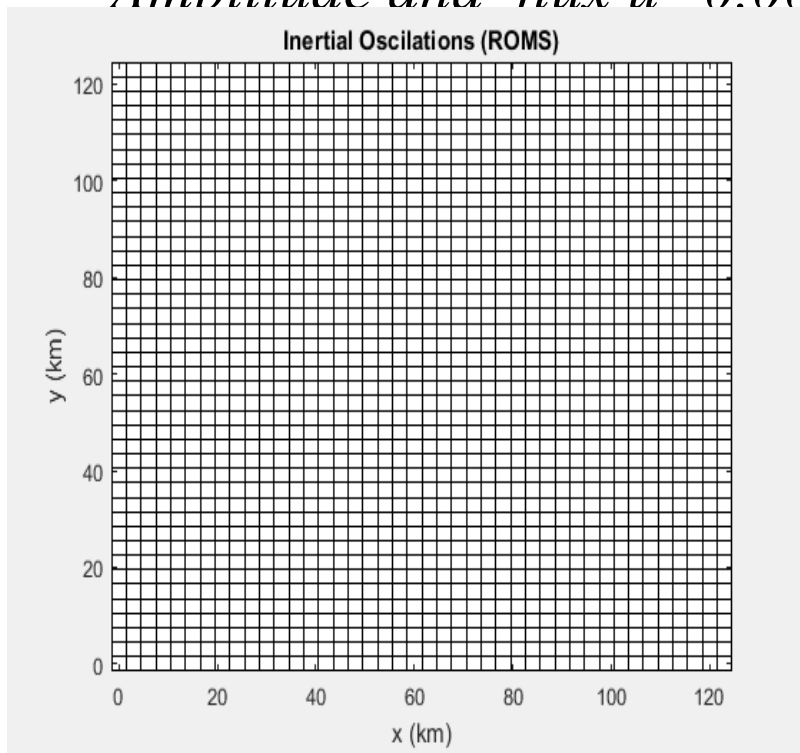
ROMS PROJECT (COESSING 2017)

Mimicking the movement of a float when: *velocity (ana_initial) $u=1\text{m/s}$ and $v=2\text{m/s}$*

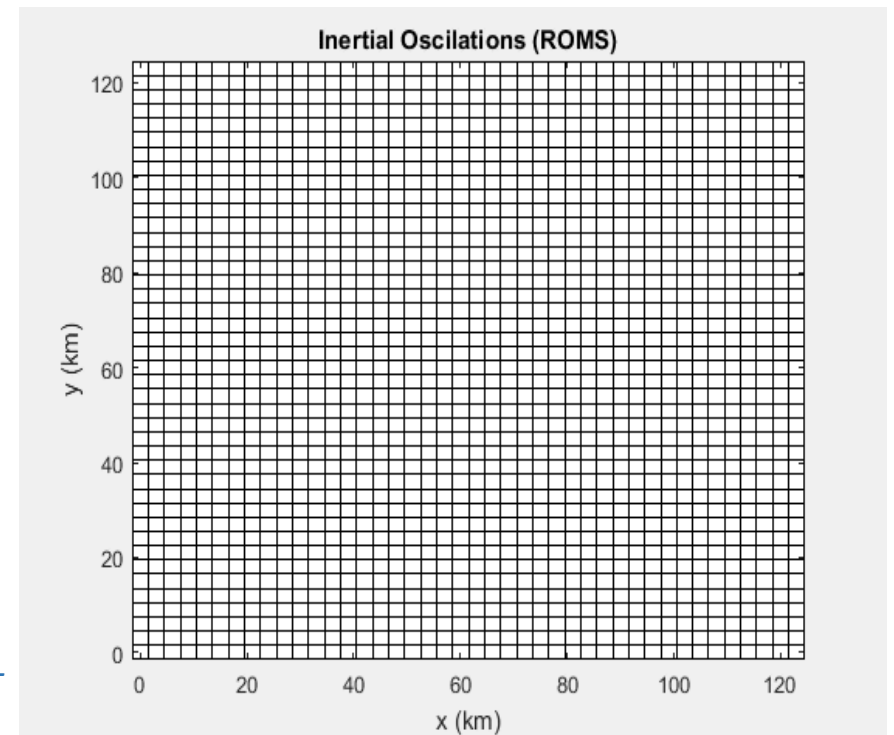
Amplitude ana_flux $u=0.0003\text{N/m}$ $v=0.0001$

And velocity when ana_initial $u=2\text{m/s}$ and $v=2\text{m/s}$

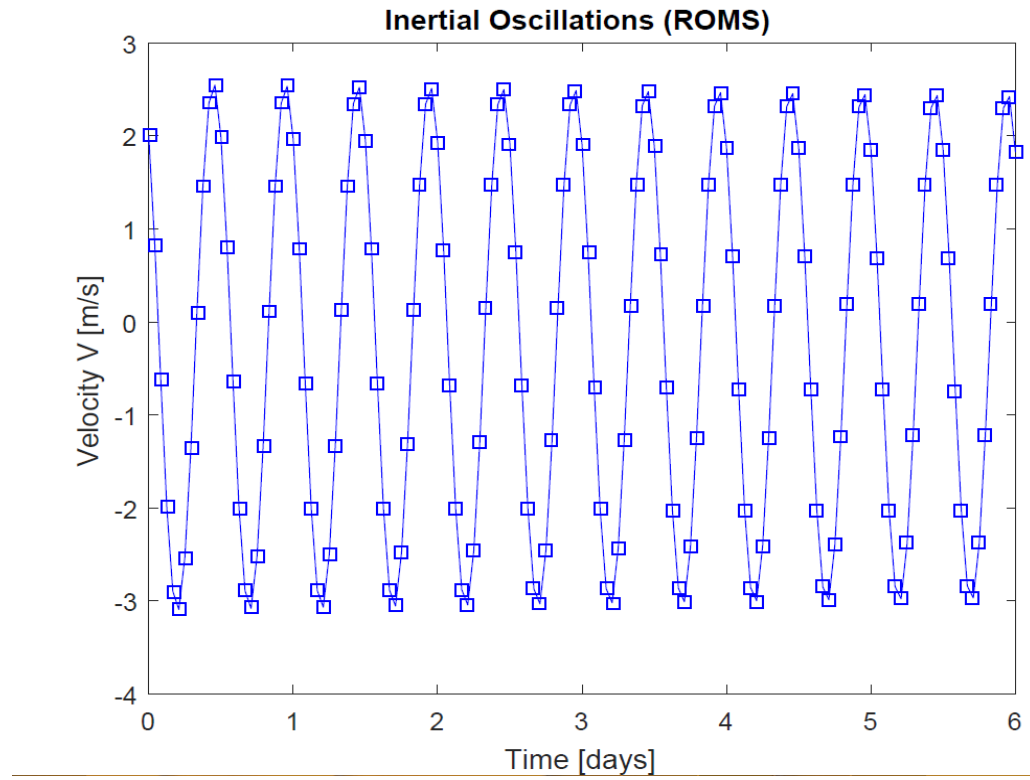
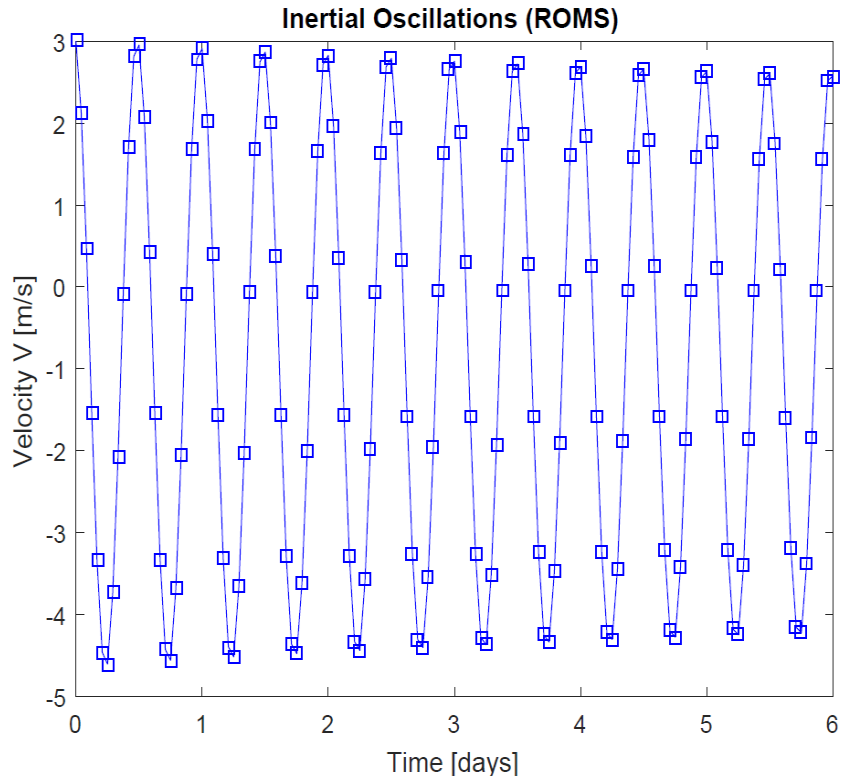
Amplitude ana_flux $u=0.0001$ and $v=0.0001$



COESSING 2018 (USING ROMS FOR INERTIAL OSCILLATIONS)



INERTIAL OSCILLATION WITH ROMS



Thank You



*COESSING 2018 (USING ROMS FOR INERTIAL
OSCILLATIONS)*