Abu Dhabi Polytechnic
Meteorology Department

MET-324 NWP & Num. Analysis
(CRN: 2302)

Mid Examination
2nd Semester (2020-21)

Date: 03.03.2021 (10 -11.30 AM)

Instructor: Dr. Nageswara Rao G.

This test includes 10 questions (multiple choice, multiple blanks, short answer, calculations and short derivations). Answer all the questions in the space provided for each question, in your own words to make explanations.

(Max. Points: 100)

1. _____ equations are more accurate.

a. Quasi geostrophic
b. Basic hydrodynamic
c. Non-hydrostatic
d. Hydrostatic

Answer: _____

2. To study the land-sea breeze circulation, _____ can be used.

a. Spectral model
b. Hydrostatic model
c. Non-hydrostatic model
d. Primitive equation model

Answer: _____

3. Explain the following NWP concepts:
a) Initialization, b) Data Assimilation and c) Parameterization

Answer:

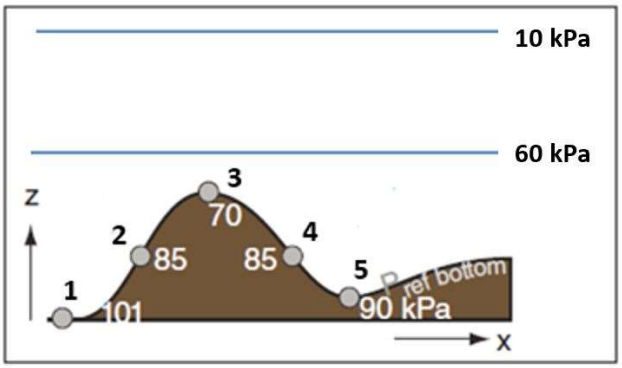
4. Calculate the number of time steps required to give a one-day forecast by a grid point model with a horizontal resolution of $\Delta x = 5\ km$, a) if sound waves are allowed (c = 320 m/s) and b) if sound waves are not allowd (c = 80 m/s) in the model.
From the above, explain the need for the filtering of sound waves from the model equations.

Answer:

5. Why hydrostatic assumption cannot be used in mesoscale models? Explain what other assumptions can be used in these models to filter out sound waves?

Answer:

6. Calculate the sigma (σ) values for the model reference pressure of 60 kPa for the given 5 locations, as shown in the diagram given below. Model top pressure is given as 10 kPa. Surface pressures are given in kPa. Write your results in the table given below the diagram.

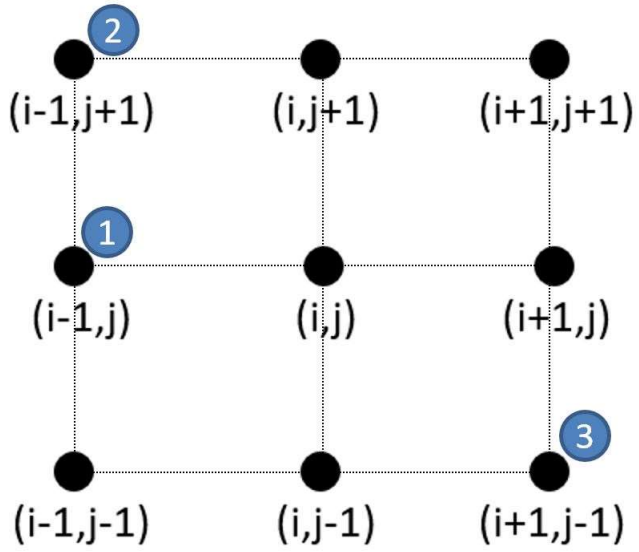


Location	Surface Pressure (kPa)	sigma (σ_{60kPa})
1	101	
2	85	
3	70	
4	85	
5	90	

7. How you calculate the pressure gradient force (PGF) on level isobaric surfaces? Why the PGF calculation on sigma coordinates introduces errors? How you correct the error?

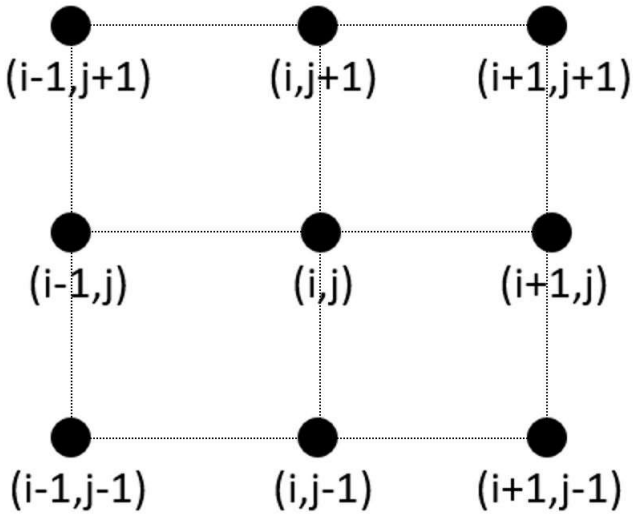
Answer:

8. Write the Taylor expansion series (upto 2nd derivative) for u(i-1,j), u(i-1,j+1) and u(i+1,j-1) at the three grid points (1,2 and 3 colored in blue circles) in the 9-point stencil as shown in the diagram given below. Assume the same grid space in x and y directions $(\Delta x = \Delta y = \Delta)$.



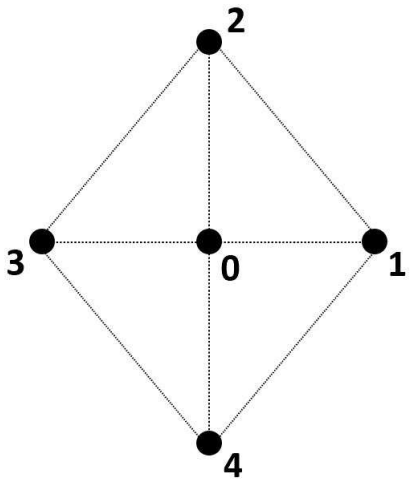
Answer:

9. With the help of a 9-point square stencil (given in the diagram below) and centered difference formula for the derivatives, obtain a finite difference expression for the mixed 2nd derivative at the central grid point (i,j).



Answer:

10. What the Jacobian, $J(\psi,\zeta)$ expresses? Give the mathematical formula for formula for $J(\psi,\zeta)$ and obtain the finite difference expression using centered difference formula for the derivatives, with the help of the 5-point diamond stencil, given in the diagram below. Assume $\Delta x = \Delta y = \Delta$.



Answer: