

You are allowed ten minutes before the start of the examination to acquaint yourself with the instructions below and to read the question paper.

Do not write anything until the invigilator informs you that you may start the examination. You will be given five minutes at the end of the examination to complete the front of any answer books used.

January 2010

Answer Book

Data Sheet

Figures 1 and 2 (for use with Q2)

Any bilingual English language dictionary permitted

Calculators and programmable calculators are permitted

UNIVERSITY OF READING

Final Examination for MSc

Course in Applied Meteorology

MTMA39

Operational Forecasting Systems and Applications

Two hours

Answer **ANY TWO** questions

The marks for the individual components of each question are given in [] brackets. The total mark for the paper is 100

1.

- (a) In an NWP computer model, the equations of motion, the thermodynamic equation and the moisture equation all contain source and sink terms. List the physical processes which will act as sources or sinks of atmospheric momentum, heat and moisture in these equations.

[11 marks]

- (b) By referring to the concept of *parametrization*, describe how sub-grid scale physical processes are dealt with in an NWP model.

[20 marks]

- (c) A major national weather forecasting centre has many customers who require site-specific weather forecasts, at locations around the country, for up to 48 hours into the future. Discuss the issues that the forecasting centre would need to consider when designing and building an NWP system in order to satisfy the requirements of its customers.

[19 marks]

Turn over

2.

- (a) Some weather forecasting centres run *ensemble prediction systems* as well as producing deterministic forecasts from a single run of an NWP model. Discuss briefly the 2 main reasons why a forecasting centre might wish to use such a system.

[10 marks]

Describe how the European Centre for Medium-range Weather Forecasts (ECMWF) generates the initial conditions for the 51 ensemble members within its ensemble prediction system.

[15 marks]

- (b) Attached to this paper are 2 “EPSgrams” generated by the ECMWF EPS system (figures 1 and 2). Explain the meaning of the “box-and-whisker” figures shown on these diagrams.

Which of the 2 locations appears to have the more predictable weather over the period shown? State briefly why you think this might be.

[8 marks]

- (c) Probability-based weather forecasts allow users to make economic decisions. By using a simple example of your choice, show how a business could use probability forecasts to ensure that it does not lose out financially when conducting a weather sensitive business activity. State any assumptions you make in your example.

[17 marks]

Turn over

3.

- (a) List 3 types of prediction model which might be “driven” by the output of an NWP forecast. For each model chosen, list the variables which would be needed to drive the model, the types of output information the model could produce and a potential customer for this output.

[21 marks]

- (b) When performing statistical validation of NWP forecasts, a common measure of forecast performance is the “RMSE” skill score against persistence for a particular variable.

Describe briefly what is meant by

- (i) RMSE
- (ii) Skill score
- (iii) Persistence

Describe a circumstance in which comparing NWP model performance to persistence might result in a spurious apparent lack of skill from the model.

[13 marks]

- (c) Several major forecasting centres use NWP models to produce forecasts for the monthly to seasonal time range. Describe the main modifications that would need to be made to a standard global NWP model in order to use it to make predictions at this longer time range.

[16 marks]

(End of Question Paper)