University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath

SEMESTER II EXAMINATION 2012/2013

ACM 40540

Synoptic Meteorology II

External examiner: Professor Peter A Clark

Head of School: Dr Patrick Murphy

Module Coordinator: Dr Conor Sweeney

Lecturer: Professor Peter Lynch*

Time Allowed: 2 hours

Instructions for Candidates

Answer **all four (4)** questions.
All questions carry equal marks.
Total: 80 marks.

Instructions for Invigilators

Colour versions of Figs 1 and 2
will be distributed at the examination.

Question 1 (20 marks)

You have been given two separate charts, labelled Chart No. 1 and Chart No. 2.

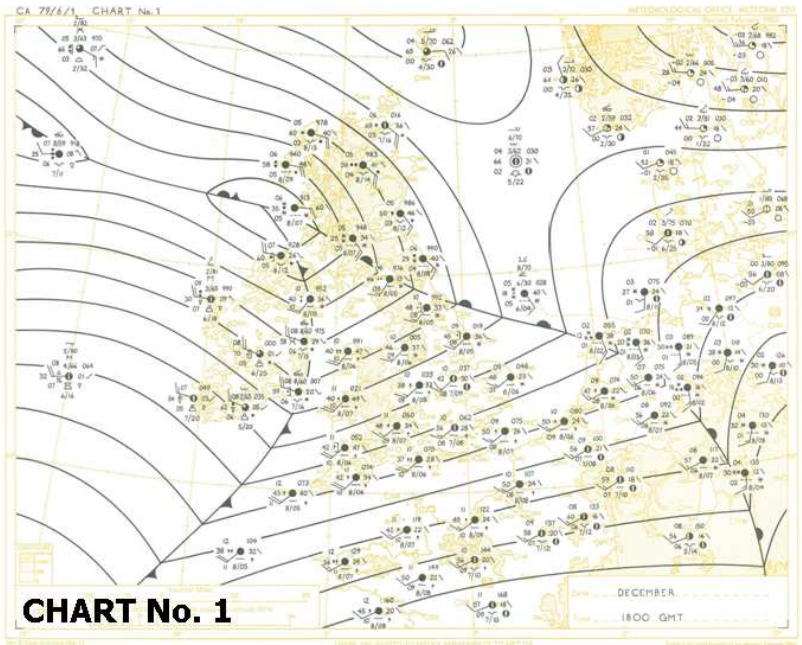
(a) Consider Chart No. 1, which has already been analysed, and answer the questions below.

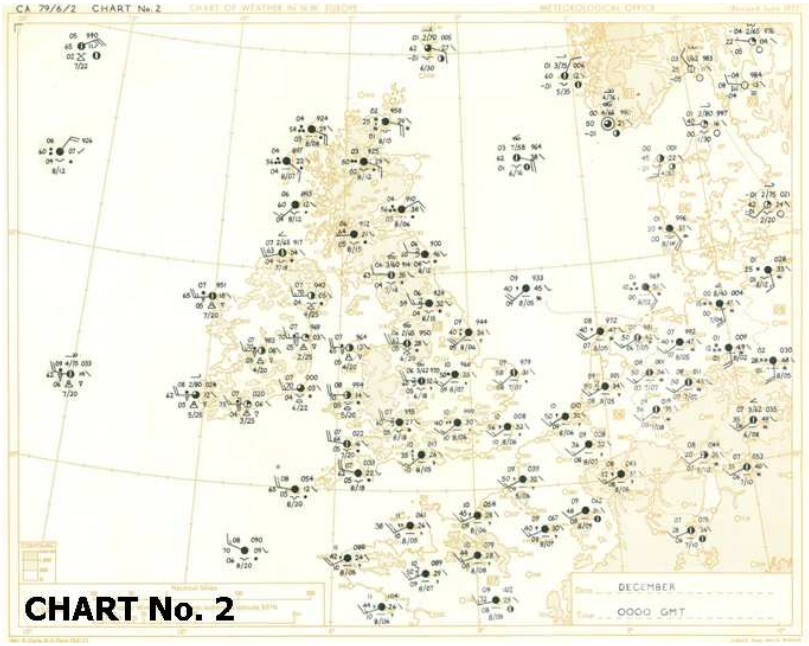
1. Describe the synoptic situation over the British Isles.
2. What kind of airmass is over Ireland? What kind of airmass is over England and Wales?
3. Describe the weather conditions at Holyhead at 1800 GMT.

(b) Using Chart No. 1 as a guide, draw up Chart No. 2 putting on *fronts* and *isobars*. Draw isobars every 2 hPa as in Chart No. 1.

(c) Comparing Chart No. 2 with Chart No. 1, answer the questions below.

1. How quickly is the cold front moving in the vicinity of Wales?
2. Is the Low west of Scotland deepening or filling? By how much?
3. Describe the weather conditions at Holyhead at 0000 GMT.





(Large format copies of the charts will be provided).

Question 2 (20 marks)

Hurricane Katrina struck New Orleans in August, 2005. Between 1500 UTC on 26 August and 1500 UTC on 28 August, the hurricane intensified rapidly, the central pressure dropping from 981 hPa to 907 hPa.

(a) Calculate the *relative vorticity* of the hurricane at 1500 UTC on 26 August, when the maximum winds were observed to be $36\,\mathrm{m\,s^{-1}}$ at a distance of 12 km from the centre of the hurricane.

(b) Calculate the *relative vorticity* of the hurricane at 1500 UTC on 28 August, when the maximum winds had increased to $77\,\mathrm{m\,s^{-1}}$ at a distance of 18 km from the centre of the hurricane.

[Hint: You are asked for the *mean* vorticity within the core of maximum winds. Remember that the mean vorticity is the circulation per unit area. Assume that the hurricane is axisymmetric.]

Question 3 (20 marks)

The simplified vorticity equation may be written

$$\frac{\mathrm{d}}{\mathrm{d}t}(\zeta + f) + (\zeta + f)\nabla \cdot \mathbf{V} = 0$$

where the notation is standard.

(a) Consider a typical extra-tropical baroclinic wave, whose axis tilts westward with decreasing pressure. Explain how this equation may be interpreted to make a link between changes in absolute vorticity and divergence.

(b) Write the continuity equation in pressure coordinates. Interpret it in terms of the relationship between (horizontal) divergence and vertical velocity.

(c) Using the Dines two-level model, draw the charactistic vertical structure of a mid-latitude depression, indicating the connection between divergence and vertical velocity. Explain how the upper-level divergence is associated with the intensification of extra-tropical weather systems.

Question 4 (20 marks)

(a) Describe the distinction between deterministic and probabilistic weather forecasting. Indicate circumstances in which each is more appropriate.

(b) What are the sources of uncertainty in numerical weather forecasts? List at least three specific sources of uncertainty.

(c) Breifly describe the phenomenon of "sensitive dependence on initial conditions". Comment on its implications for short-range and for medium-range weather forecasting. Which elements are more predictable and which are less predictable at medium range?

(d) Consider the EPS-gram in Figure 1. Using only the evidence in this diagram, describe the probable weather conditions in Dublin for Easter 2010. Comment specifically on the probable weather conditions on:

(i) Easter Sunday, 4 April 2010

(ii) Easter Monday, 5 April 2010

What is your confidence in the predictions, based on the ensemble forecasts?

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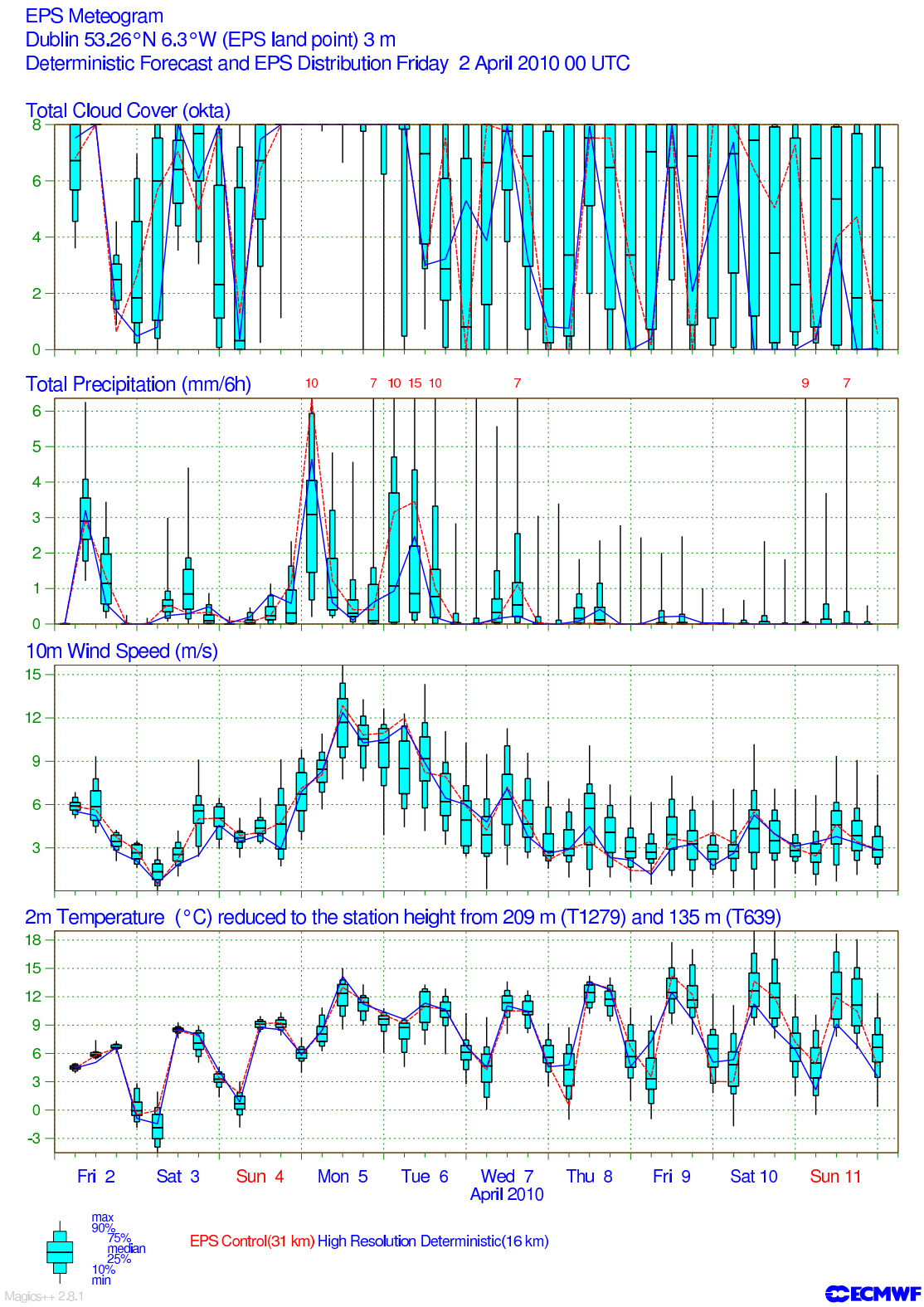
EPS Meteogram
Dublin 53.26°N 6.3°W (EPS land point) 3 m
Deterministic Forecast and EPS Distribution Friday 2 April 2010 00 UTC
Total Cloud Cover (okta)
Total Precipitation (mm/6h)
10 7 10 15 10 7 9 7
10m Wind Speed (m/s)
2m Temperature (°C) reduced to the station height from 209 m (T1279) and 135 m (T639)
Fri 2
Sat 3
Sun 4
Mon 5
Tue 6
Wed 7
April 2010
Thu 8
Fri 9
Sat 10
Sun 11
max
90%
75%
median
25%
10%
min
EPS Control(31 km) High Resolution Deterministic(16 km)
Magics++ 2.8.1
ECMWF

Figure 1: