SOEE3151/5680 Report

2024/2025

“A Report on Weather and Forecasting”

This assessment counts for 50% of the final mark for SOEE3151 and 33.33% of the final mark for SOEE5680.

Objective:

Choose a topic from the list below together with the teaching team for the module or suggest your own topic by **Thursday the 24th of October 2024**. Produce a scientific report on your topic.

Some general guidelines:
(Details applying to every specific topic will be given individually.)

- Write an overview and introductory explanation, or historical outline.
- Provide a summary and conclusions at the end.
- Find relevant references to use and include them in a list of references at the end.
- Use examples and illustrations.
- Discuss the relevance, similarity/differences, or applications of your topic to other situations or science fields.
- You need to demonstrate your understanding of the topic and that your report is more than a literature review.
- If your topic is a meteorological case study, you can add your own interpretations by collecting met charts, tephigrams, and satellite pictures etc. either from the web or through the module lecturer. Make sure you do not only focus on the effects of the event but on the underlying dynamics.
- If your topic is about idealised models (e.g. Eady model, Lorenz model), you can perform your own modelling experiments and include some sensitivity experiments.

Assessment:

You will be assessed in terms of correctness and comprehensiveness of content, clarity of explanations, structure, choice of figures, plots and examples. The reports are expected to be partly based on peer-reviewed publications. Links should be made to contents covered in the SOEE3151/5680 course where possible.

In some cases you will be able to make your own contribution (e.g. in form of case studies, chart analysis, or modelling results). It is expected that you describe your topic in a scientific manner, i.e. use scientific references (e.g. from the ISI Web of Knowledge).

When a case study is chosen, then focus on the dynamics and predictability of these events and make links to similar events. What makes these events so remarkable?

For all topics keep in mind that this is a module on dynamics of weather systems and that you need to link your chosen topic to the content of this module. Do not just give a general overview of the topic and do not only base it on textbooks. You need to show that you critically engage with the literature.

Plagiarism: Even though a lot of material will be available on the Internet, the usual rules about sources, referencing etc. apply (Harvard system). **Your essay should go beyond a mere repetition from a paper or websites. Original work is expected in terms of interpretation and combination of scientific information.**

The word limit is 1500 words for SOEE 3151 and SOEE 5680.

Students need to demonstrate that their report is more than a literature review. There are many ways to do that, and it is up to the student to choose their preferred format (e.g. analyse observation, reanalysis or model data, compute a simple model and include the results, conduct sensitivity tests).

You can find further details on the assessment criteria in the feedback sheets for SOEE3151 and for SOEE5680.

The deadline to submit the report is on **Thursday the 28th of November 2024 at 2 p.m**. The submission will take place through a Turnitin link.

List of topics (or you can suggest your own):

Theoretical models:

1) The Eady model

This mathematical description of the development of atmospheric cyclones was developed in the 1940's and remains the basis for much of our understanding of how upper-level and lower-level Rossby waves combine to produce rapid cyclonic development. Exact mathematical solutions exist describing the wave structure, and could be plotted to illustrate your work.

Refs: Hoskins MacIntyre and Robertson, 1985; Davies and Bishop, 1993. Textbooks: e.g. Carlson, Hoskins.

2) Baroclinic instability

Baroclinic instability is the fundamental mechanism of growth of mid-latitude frontal cyclones. It relies on the existence of temperature gradients, which provide available potential energy for cyclogenesis.

Refs: Thorncroft, Hoskins and MacIntyre; Davies, Schaer and Wernli Carlson's textbook

3) The shallow-water system

An approximation to the equations of motion whereby it is assumed that the fluid is homogeneous and that horizontal scales of interest are much larger than the depth of the fluid.

4) Semi-geostrophic theory

A more accurate alternative to quasi-geostrophic theory that involves the geostrophic momentum approximation to the quasi-static primitive equations. In semigeostrophic theory the full effects of ageostrophic advection are included. Atmospheric structures such as fronts, small strong low-pressure cells, and broad weak high-pressure cells are more accurately represented in semigeostrophic theory than in quasigeostrophic theory.

Dynamical concepts:

5) Potential-vorticity inversion as a diagnostic tool in meteorology

6) Waves in the atmosphere (just one)
   a. Large-scale (planetary) waves

b. Vertical propagation of waves
c. Gravity waves

7) Role of moisture (just one)

a. Diabatic Rossby waves

- This is a wave phenomenon where cyclogenesis is strongly supported by latent heating, which can lead to explosive developments.

b. Air-sea interaction in synoptic systems

- Fluxes of sensible and latent heat into the atmosphere, waves, spray etc.

8) The life cycle of cyclones (theories and paradigms)

a. The classical Norwegian model versus the Shapiro-Keyser model
b. Idealized model experiments (Thorncroft, Davies)

9) Mesoscale circulations at fronts

10) Warm conveyor belts (Carlson, Browning, Wernli, Eckhardt)

11) Slantwise convection

A form of convection driven by a combination of gravitational and centrifugal forces. Slantwise convection can occur in baroclinic flows in which the slantwise-upward displacement of air parcels, elongated in the direction of the thermal wind, results in a vector combination of buoyancy and Coriolis (or centrifugal) and pressure-gradient accelerations that drive the parcel in the same direction as the displacement.

12) On the use of tropopause maps (Morgan & Nielsen-Gammon, 1998).

Case studies:

13) Case studies of weather events (just choose one)

a. The Presidents Day Storm (Feb 22, 1979)
b. The October 1987 storm in the UK (See Weather special issue)
c. The Burns Day storm Jan 1990 (UK, Denmark, Holland, Belgium)
d. The 1993 super-snowstorm in the US
e. The “surprise” snow storm of 24-25 Jan 2000
f. The Boscastle storm of August 2004 (See Weather special issue)
g. European heat wave of 2003 (See Weather special issue)
h. The Ohio Valley wave-merger cyclogenesis event of 25-26 January 1978. (Hakim, G. J., L. F. Bosart, and D. Keyser, 1995).
i. The central European windstorm Lothar (Wernli)
j. The Elbe flood August 2002

14) Fronts (e.g. publications on case studies by F. Sanders, D. Schulz)

Weather and climate phenomena:

15) Orographic phenomena (just one)
    a. Flow regimes over mountains
    b. Flow phenomena (Foehn, Bora etc.)
    c. Tip jets (e.g. Greenland)
    d. PV banners and vortex shedding
       When a strong low-level wind field impinges upon a mountain range, elongated potential vorticity banners develop downstream of high topography. Individual pairs of banners can be attributed to flow splitting and gravity wave breaking.

16) African Easterly waves (AEWs) and convection

AEWs are the typical synoptic weather patterns in West Africa, which modify the distribution and timing of rainfall to the water-stressed countries in this region. A large proportion of hurricanes begin their lives as AEWs crossing the West African coast. (e.g. Kiladis et al. 2006)

17) Nocturnal jets

18) Dynamics of heat lows

19) Dynamics of tornadoes

20) Meso-scale convective systems (MCSs)

21) Hurricanes from a PV perspective

22) Hurricane transitions into the extratropics from a PV wave-vortex perspective

23) The Blocking phenomenon

24) The quasi-biennial oscillation (QBO)

25) Madden-Julian Oscillation (MJO)

Modelling and prediction:

26) Data assimilation (Optimum interpolation, 3D-Var, 4D-Var)

27) Ensemble forecasting

28) Forecast verification

29) Nowcasting

Variability, Predictability and Uncertainty:

30) The Lorenz model and chaos

31) Inter-annual variability of synoptic systems

32) Teleconnection patterns

33) Seasonal prediction

34) Predictability and ensemble forecasts

35) Climate models and scenarios

36) Synoptic systems in climate predictions

37) Uncertainty and predictability in climate predictions

Links to chemistry, exchange and transport:

38) The permeability of the tropopause (e.g. chemical tracers) and link to synoptic systems

39) Long-range transport (e.g. of dust, soot, pollutants) in dynamical systems

40) Weather systems and air quality