

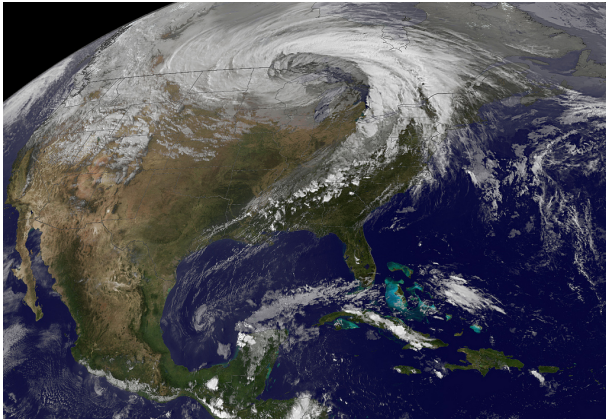
In this course...

- 1 Brief introduction to the atmosphere
- II Overview of the Earth System
- III Survey of the atmosphere:
 - 1 Dynamics
 - 2 Thermodynamics
 - 3 **Weather systems: Extratropical**
 - 4 Chemistry
 - 5 Cloud processes
 - 6 Boundary layer
 - 7 Radiative transfer
 - 8 Remote sensing with radar
 - 9 Weather Systems: High latitude and tropical
 - 10 Numerical weather prediction
 - 11 Climate dynamics
- IV Useful research tools in atmospheric science

Weather Systems Part I: Midlatitude Meteorology

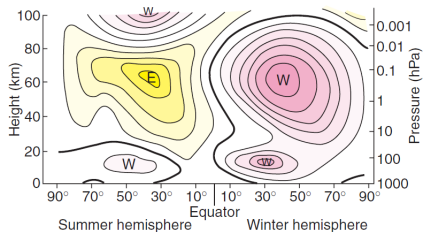
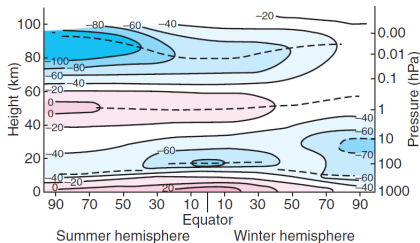
- I Synoptic charts
- II Vorticity and potential vorticity
- III Fronts
- IV Extratropical cyclones

Extratropical cyclone: Snapshot



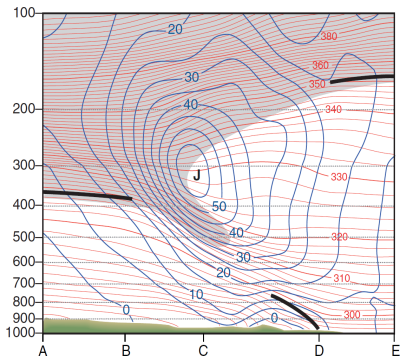
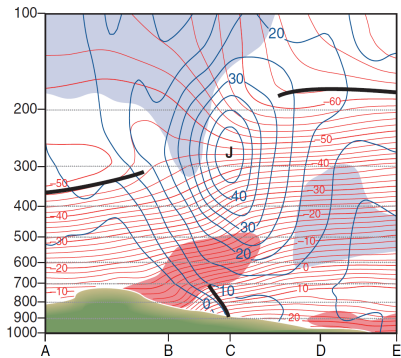
Extratropical cyclone: Snapshot

Meridional structure of atmosphere (December)



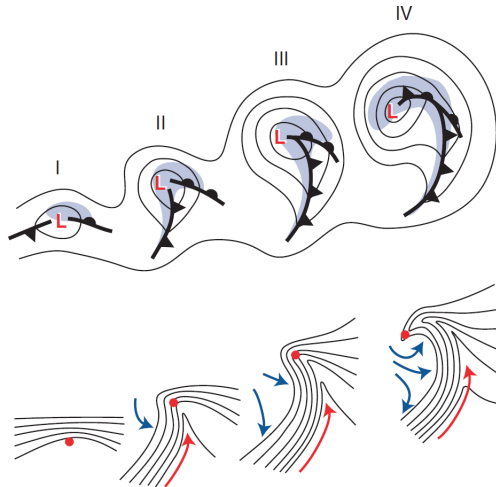
Extratropical cyclone: Snapshot

Jet streams



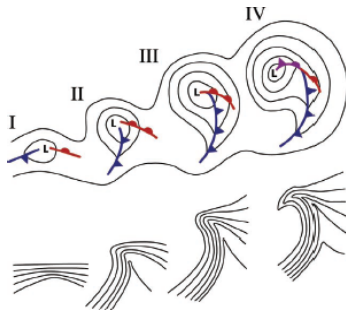
Stages of cyclone development

Norwegian model



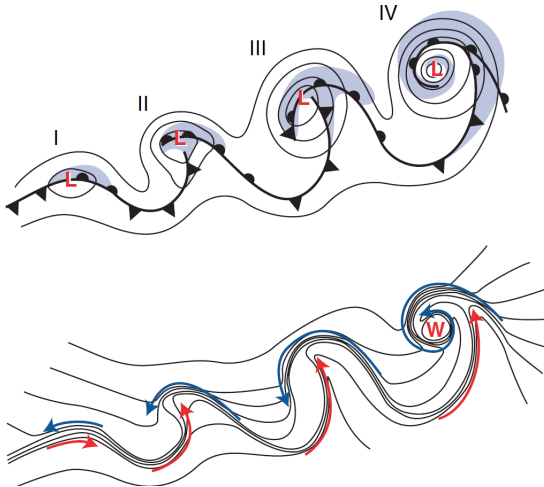
Polar front theory of cyclogenesis (Norwegian Model)

- Developed in 1920's by J. Bjerknes
- Based on surface observations.
- Stages:
 - I: Incipient. Wave forms along existing frontal boundary.
 - II-III: Developing stage (not occluded)
 - IV: Mature stage (occlusion present). Cold front catches up to warm front (cold-type occlusion).
- Cold-type occlusion has never been observed.



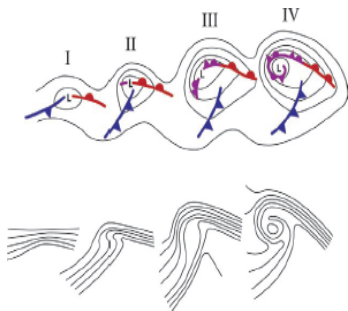
Stages of cyclone development

Shapiro-Keyser model



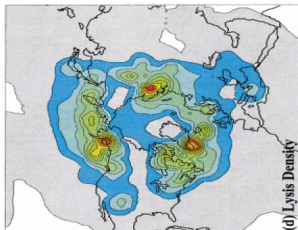
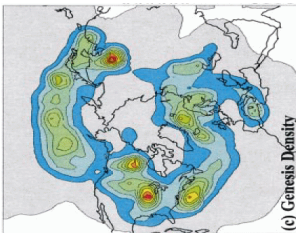
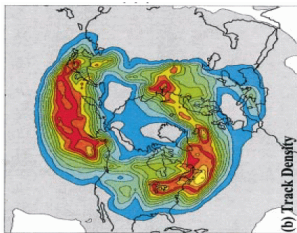
Shapiro-Keyser model of cyclone development

- Developed in 1990
- Based on airplane observations over the ocean.
- Stages:
 - I: Incipient. Wave forms along existing frontal boundary.
 - II: Frontal fracture ('T-Bone')
 - III: Bent-back warm front
 - IV: Warm air seclusion
- Since these were based on observations over the ocean, it is not always observed.



Extratropical cyclone climatology

Cyclone Climatology



Notes:

- tracks near jet stream
- originate:
 - east of mountains
 - western oceans
- decay:
 - northern oceans.
 - Siberia.

Extratropical cyclone tracks

Primary Cyclone Tracks

