Norwegian Cyclone Model
Fall 2015
Mid-Latitude Cyclones

• What?
  – Low pressure located between 30° and 60° latitude.

• Impact?
  – Cause of most of the stormy weather in U.S., especially during the winter season.

• Why?
  – Crucial for predicting significant weather phenomena such as blizzards, flooding, rains, and severe weather.
Stages of Development

• Initial Setup

• Initiation*

• Development*

• Mature or Occluded*

• Dissipation
Initial Setup

- Front exists separating warm air to south and cold air to north.
- The front is often stationary.
- Can be just about any boundary.
  - Differential heating
Initiation

- Weak surface wave develops.
- Usually the effect of some upper level forcing.
  - PVA from short-wave.
  - Jet streak
Initiation cont.

- Closed circulation around low is able to produce temperature advections.

- Precipitation begins to develop with the heaviest occurrence along the front.
Development

- Both warm and cold front become organized.
- Low pressure becomes stronger (surface pressures fall in the low).
- Winds intensify around the low.
- Temperature advections become large.
Temperature Advections

• Warm air advection: upward motion
  – Lowers surface pressure.

• Creates surface forcing in addition to the upper level forcing.

• Systems can intensify rapidly.
Temperature advections cont.

• Low-level temperature advections also alter the upper-level fields.

• Warm advection: Upper level heights increase.

• Cold advection: Upper level heights decrease.

• Advections intensify the upper level disturbance or trough that initially cause the disturbance.

• As trough deepens, forcing from PVA increases.
  – Positive feedback.
Development

- Both warm and cold front become organized.
- Low pressure becomes stronger (surface pressures fall in the low).
- Winds intensify around the low.
- Temperature advections become large.
Mature or Occluded

- Cold front “catches up” with warm front.
- Occlusion forms.
- Temperature advections are intense at low levels.
Mature cont.

- Warm sector gets cut-off from the low.
- Low no longer has a supply of warm, moist air.
- Begins to dissipate.
Mature cont.

- Heights fall so much aloft due to cold air advection that an upper-level low develops.
- Low becomes closed aloft (complete circulation around it).
Mature cont.

- Vorticity isopleths tend to become parallel to the flow (course notes).
- Upper level forcing weakens and eventually dissipates.
- Lows become “stacked”.
- System no longer intensifies.
Dissipation

- System begins to dissipate.
- A new low may form at the triple point.
- Triple point: point where cold, warm, and occluded fronts come together.
“Textbook” case
March “super-storm” of 1993

• More than a foot of snow from Alabama to Maine.

• Tornados ripped through Florida.

• Hurricane force winds and barometric pressure followed by record cold over eastern United States.
Storm of Century
Storm of the Century
Other models

(a) Norwegian Model

(b) Shapiro–Keyser Model