Synoptic Scale
Scale Interaction
Tropical-Extratropical Interaction
Jet Streaks/Short Waves

Scale Interaction & High Impact Weather

Two sub-tropical weather systems dropped 470 millimetres -- 18.5 inches -- of rain on some parts of coastal B.C. in a six-day period.

British Columbia - Record breaking heavy rain in Vancouver, Abbotsford and Victoria on October 16. Bridge washout cuts access to Pemberton, BC. "It is being called the worst flood of the past century" in British Columbia.

Washington - Snohomish, Nooksack and Skagit rivers overflowed October 17-18. Seattle broke a one-day rainfall record on October 20. Record levels on Skagit River at Concrete. Record levels on Snohomish River on October 21. Entire town of Hamilton under water. Flood damages have exceeded $160 million.

2003 Northwestern Floods

California Wild Fires

October 2003
California Wild Fires

October 2003

California Mud Slides

November 2003

Time/Longitude: 250-mb Meridional Wind (m s\(^{-1}\)); 55-40N.

Three Interacting Time Scales

Sub-seasonal - Rossby Wave Propagation - on order of weeks to month+ - slow retrogression of wave axis

Medium-range - Rossby Wave Train - downstream wave energy transfer - on order of week(s)

Short-range - storm/jet streak - on order of days
Slow Planetary Waves

Oct. 12

Oct. 18

Oct. 24

Nov. 3

OPERATIONAL DATA
200mb EDDY HEIGHTS (deg)
07-DAY MEAN FOR:
Rossby Wave Trains

6-14+day life cycle
Rossby Wave Trains

250 mb Winds, Isotach (m/s)

21

Synoptic-Scale Cyclogenesis

Oct. 12
Oct. 18
Oct. 24
Nov. 3

Synoptic Waves
Ridge Axes
Trough Axes

Cal.

23

Rossby Wave Trains & High Impact Weather

24

Oct. 12
Oct. 18
Oct. 24
Nov. 3
Three Interacting Time Scales

Lothar Wind Storm

Tropical to Extratropical Interactions

What triggers Rossby Wave Trains?
Energy from tropical convection can propagate into the extratropics to influence predictive skill.

- El Niño and La Niña regimes have significantly different extratropical sensitive regions.
- The Lothar storm may have been influenced by a Madden-Julian Oscillation event over the eastern Pacific ocean 10 days earlier.

Madden-Julian Oscillation

MJO Influence on US Temperature and Precipitation
Tropical to Extratropical Interactions

October 26

Tropical Convection

Northward Propagating Rossby-Wave Train

Figure 4. Schematic view of the dominant changes in the upper troposphere, mainly in the northern hemisphere, in response to increases in SSTs, enhanced convection, and anomalous upper tropospheric divergence in the vicinity of the equator (scalloped region). Anomalously outflow into each hemisphere results in subtropical convergence and an anomalous anticyclone pair straddling the equator, as indicated by the streamlines. A wave train of alternating high and low geopotential and streamfunction anomalies results from the quasi-stationary Rossby wave response (linked by the double line). In turn, this typically produces a southward shift in the storm track associated with the subtropical jet stream, leading to enhanced storm track activity to the south (dark stipple) and diminished activity to the north (light stipple) of the first cyclonic center. Corresponding changes may occur in the southern hemisphere.

Rossby Wave Trains & High Impact Weather Events

QUICKSCAT Surface Winds (knots)

Tropical Cyclone: 9 November 2002

- QUICKSCAT Surface Winds (knots)
Bay of Bengal Tropical Cyclone: 10 November 2002

- ~200 fisherman lost at sea

US Tornado Outbreak: 11 November 2002

12 November 2002

- Poorly forecast rainfall event over Eastern Vancouver Island
- 4-5” in 24 h. Impacts: Mudslides, power outages
Oil Tanker “Prestige” Disaster

- 13-19 November 2002

QUIKSCAT Surface Winds

- 13 November 2002
Alpine Floods: 16-17 November 2002

Swiss-Italian Flooding: 00 UTC 16 November

Eastern Switzerland: 17 November 2002

Austrian-German Alpine Wind Storm

• 17 November 2002
Austrian-German Alpine Wind Storm

Eastern US-Canadian Snow and Ice Storm

November 18/19 2002

• School Gymnasium in Vancouver collapses under heavy rains.

• 16 November 2002

NASA space shuttle Endeavor and crew prepare for liftoff

• Spanish-born, U.S. astronaut Michael Lopez-Alegria, right, waves as he leaves the Operations and Checkout Building at Kennedy Space Center in Cape Canaveral, Fla., Saturday afternoon with fellow crew members, John Herrington, left, the first tribal registered American-Indian astronaut, and Don Pettit, center, for a trip to launch pad 39-A for a planned liftoff onboard the space shuttle Endeavour. (AP Photo)
“Rain in Spain creates liftoff pain”

- NASA fueled space shuttle Endeavor for liftoff Saturday,
- but storms in Spain loomed as a possible show stopper – again”.

Moroccan Flood: 0600 UTC 25 November 2002

Italian Alps: 26 Nov 2002

- Dundee Satellite Image

Flooding in Italian Alps

Northern Italy
28 November 2002

Lago Maggiore:
26 November 2002
Hovmuller Diagram: 250-mb Meridional Wind (m s\(^{-1}\)); 35-60°N
6-28 November 2002

Rossby Wave Trains (on order of weeks)

12 Nov.

18 Nov.

24 Nov.

27 Nov.

All Three Time Scales

9-27 Nov.
Resulting High Impact Weather

Three Interacting Time Scales

Sub-seasonal - Rossby Wave Propagation - on order of weeks to month+ - slow retrogression of wave axis

Medium-range - Rossby Wave Train - downstream wave energy transfer - on order of week(s)

Short-range - storm/jet streak - on order of days

Questions?

European Wind Storm

Lothar

December 1999

0754 UTC 26 December 1999