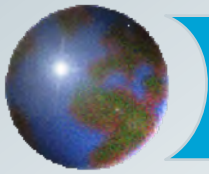


Hurricanes continued
Weather Prediction

GEOG/ENST 2331 – Lecture 18
Ahrens: Chapters 15 and 13



Canadian Weather Service

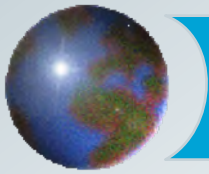
1873

- ❖ "Great Nova Scotia Cyclone"
- ❖ Category 2 hurricane off the Nova Scotia coast
- ❖ Over 500 people killed

1876

- ❖ Telegraph lines set up to every major city in Eastern Canada.





Canadian Hurricanes

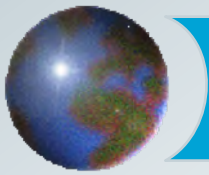
- ✦ Eastern provinces occasionally are hit by tropical storms – as far west as the Great Lakes
 - ✦ Great Lakes – 1 in 5 years

- ✦ Not an issue in the Western provinces

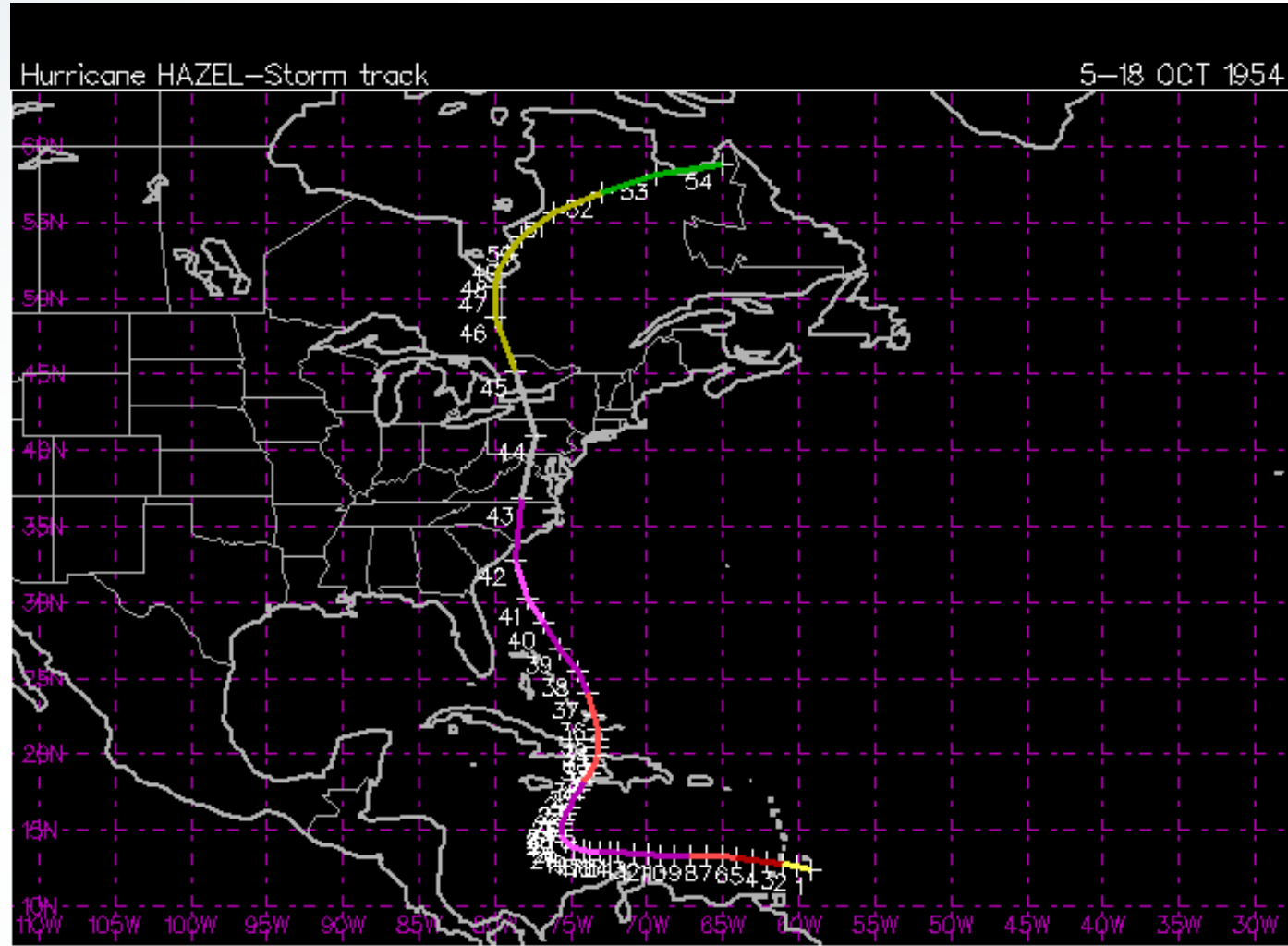
- ✦ Canadian Hurricane Centre
 - ✦ Halifax
 - ✦ Founded in 1986



Igor floods Newfoundland
Source: CTV



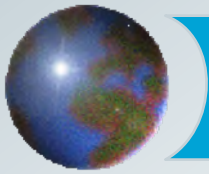
Hurricane Hazel (1954)



October 15, 1954

121.4 mm at Toronto
International Airport

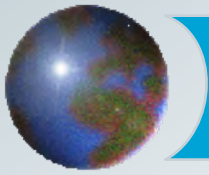
Transitioned storm



"...It was a gigantic flood with smashed houses and uprooted trees bobbing like corks, everything going down the river so fast. Houses crashing into the sides of other houses, people everywhere screaming. And then you couldn't even hear the screams anymore."

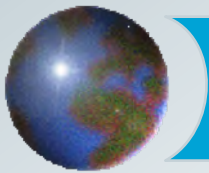
Volunteer fireman Bryan Mitchell (Toronto Star, October 14, 1984)





Humber River flood situation





Humber River Watershed

Geologic Model

Cross-section Locations



Legend

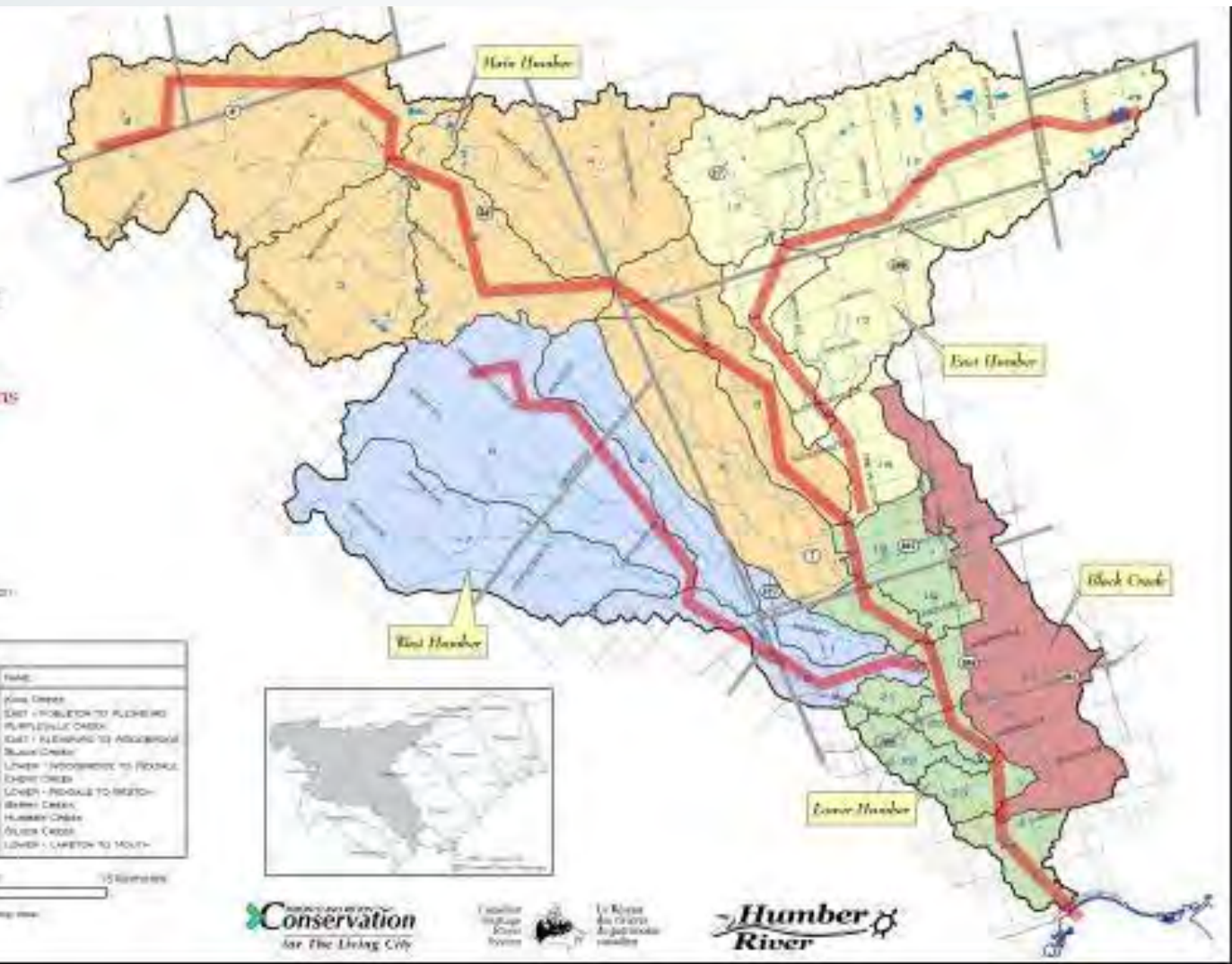
- Regional Boundary
- Municipal boundary
- Road
- Pond & Lake
- Watercourse
- Geologic Model Cross-section Location

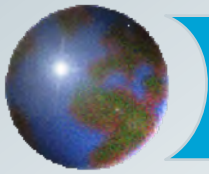
SECONDARY SUBWATERSHED UNITS*			
#	NAME	#	NAME
1	WEST - UPPER	13	WIND CREEK
2	WEST - BRIDGE TO BOUTER	14	EAST - PROBLECK TO FLEMING
3	CENTREVILLE CREEK	15	PURVISVILLE CREEK
4	COLD CREEK	16	EAST - FLEMING TO ASHBRIDGE
5	WEST - BOUTER TO WINDERMERE	17	SHANNON CREEK
6	WESTERN CREEK	18	LOWER - WINDERMERE TO FORDALE
7	WEST - WEST BRANCH	19	UPPER CREEK
8	WEST - MAIN BRANCH	20	LOWER - FORDALE TO BRANTON
9	WEST - EAST BRANCH	21	BRANTON CREEK
10	WEST - LOWER BRANCH	22	HUMBER CREEK
11	ALBION CREEK	23	OLIVER CREEK
12	EAST - UPPER BRANCH	24	LOWER - LAMPTON TO MOUTH



*Secondary subwatershed units are not necessarily based on the Humber River Planning Study. Changes may occur.

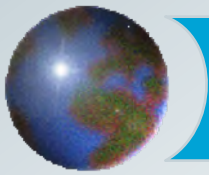
2007 (Rev. 2008)



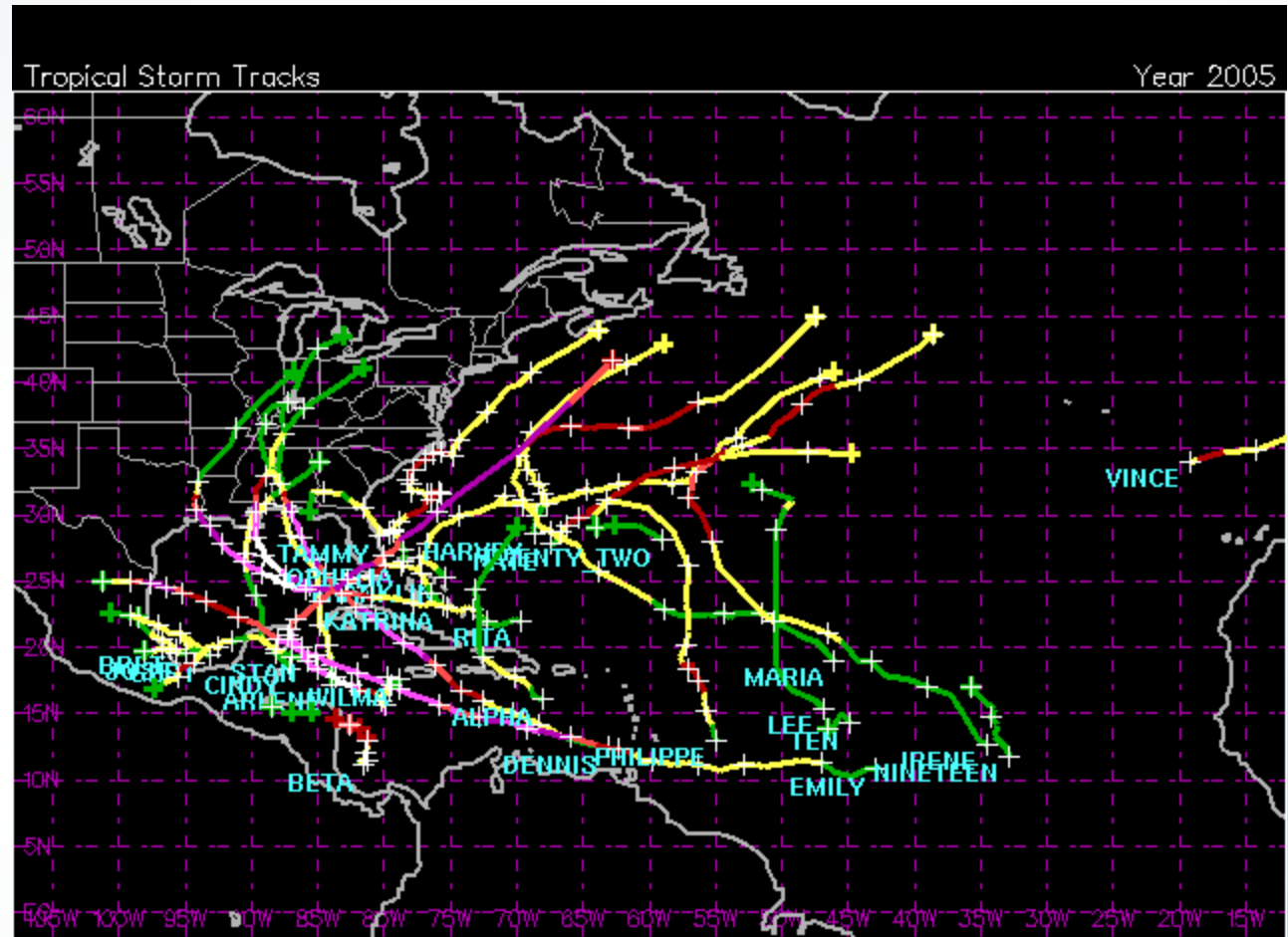


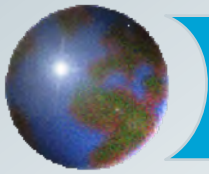
CSU: ATLANTIC BASIN SEASONAL HURRICANE FORECAST FOR 2005

	Dec	April	June	2005
Named Storms (9.6)	11	13	15	27
Hurricanes (5.9)	6	7	8	15
Intense Hurricanes (2.3)	3	3	4	7



2005 Hurricane season





CSU Forecasting

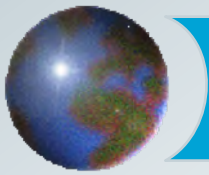
- ❖ 2005 – poorest forecast on record for Atlantic tropical storms
 - ❖ NOAA forecast was similarly poor
- ❖ 2006 – forecast number was far too *high*
- ❖ 2013 – too high again; “biggest bust” in CSU history



2019 Forecasts

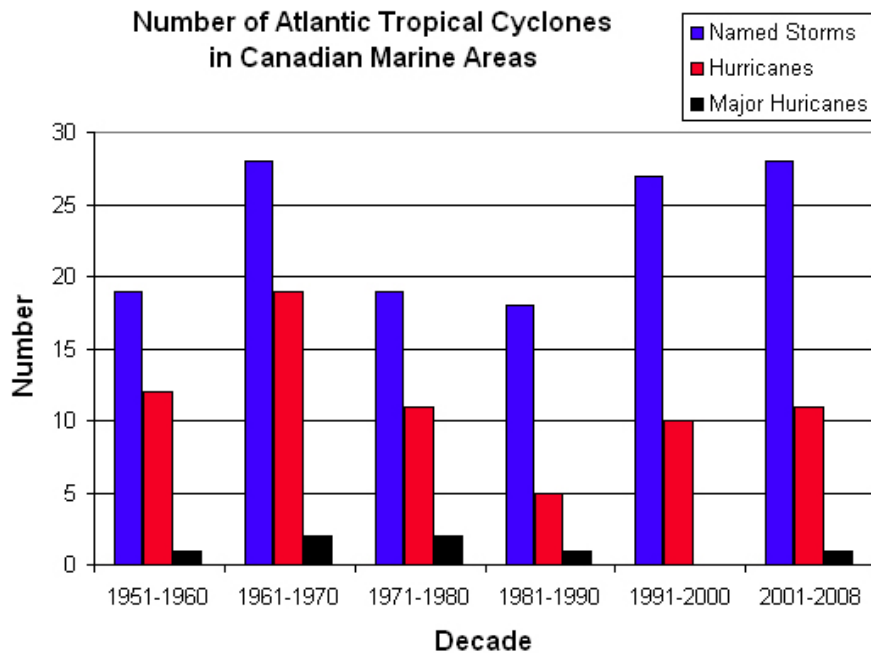
		Named Storms	Hurricanes	Major Hurricanes
Climatology	1950-2000	9.6	5.9	2.3
Climatology	1981-2010	12.1	6.4	2.7
TSR*		12	5	2
Observed	2019	16	5	3

- Due to the anticipated presence of El Niño conditions during the season
- Season so far – 100 fatalities, \$12 billion (US)

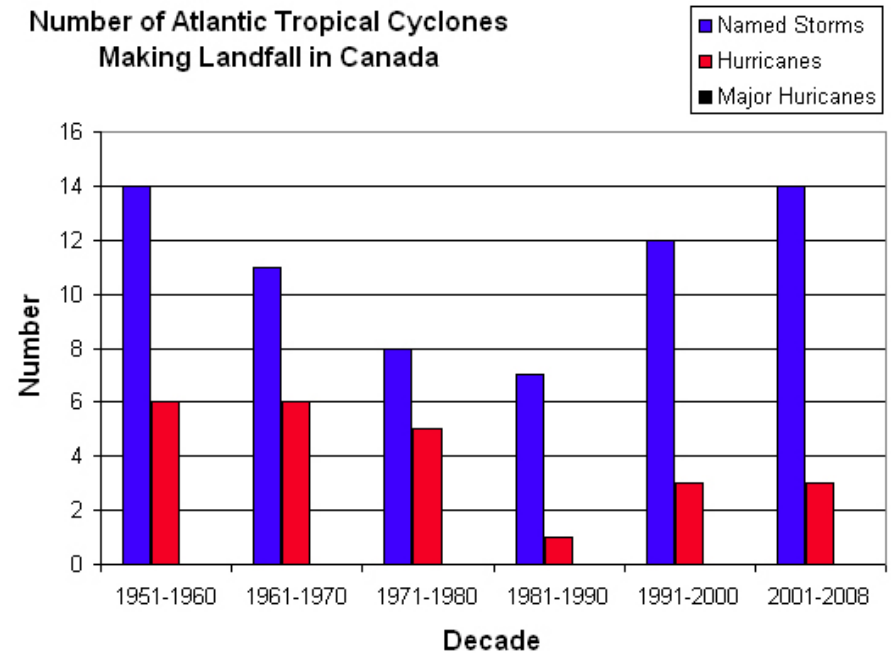


Canadian Hurricanes

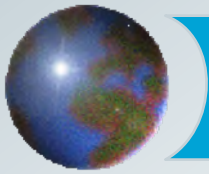
Number of Atlantic Tropical Cyclones
in Canadian Marine Areas



Number of Atlantic Tropical Cyclones
Making Landfall in Canada

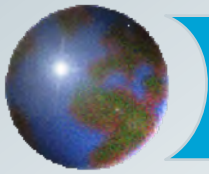


Source: Canadian Hurricane Centre



Hurricanes and climate change

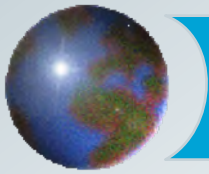
- ✦ 2001-2005 was the most active 5-year period ever for Atlantic Hurricanes
- ✦ Global warming is not predicted to bring increased tropical cyclone incidence
 - ❑ May bring more intense cyclones
 - ❑ May bring longer cyclone seasons



Climate change

- ❖ Opposing factors at work:
 - ❖ Higher SST *should* result in more – and more powerful – cyclones
 - ❖ Greater stability in tropical troposphere *should* result in fewer storms

- ❖ May combine for fewer but more powerful cyclones
 - ❖ Some studies predict greater numbers in the North Atlantic specifically



Hurricane Sandy

📍 October 25, 2013

📍 Sandy peaks at Category 3

📍 Landfall in Cuba

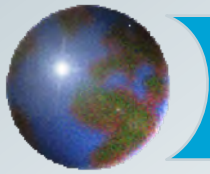
📍 October 30

📍 Tropical storm

📍 Landfall in New Jersey

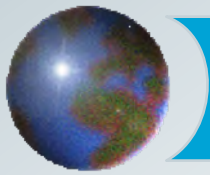


Hurricane Sandy



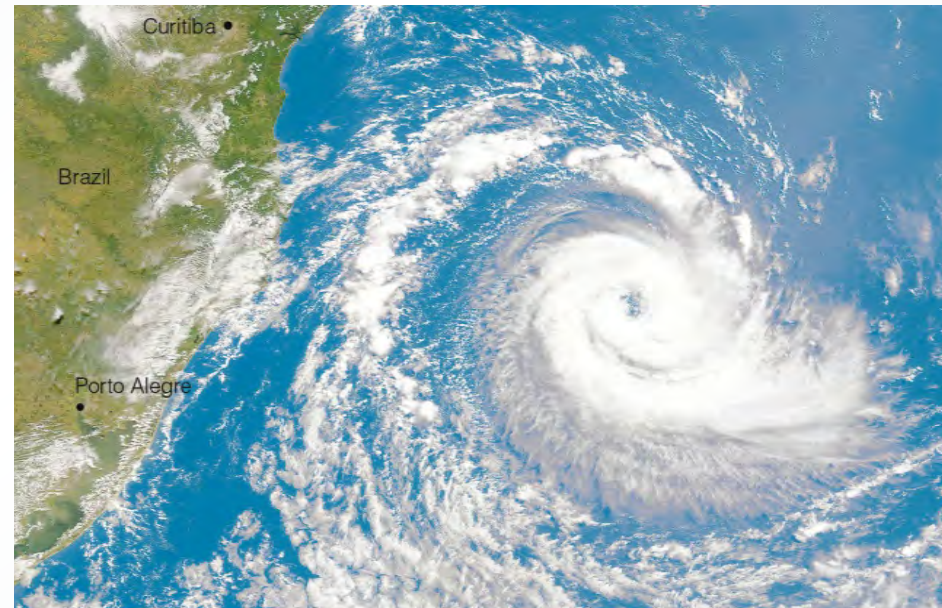
European Centre for Medium-Range Weather Forecasts

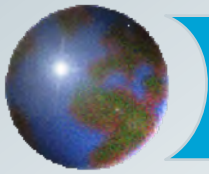
- ✦ Independent intergovernmental organisation
- ✦ Supported by 21 European Member States
- ✦ World's largest archive of numerical weather prediction data
- ✦ Global weather forecasts to 15 days and seasonal forecasts to 12 months
- ✦ prediction of Hurricane Sandy in October 2012 making landfall on the East Coast of the United States seven days before it happened



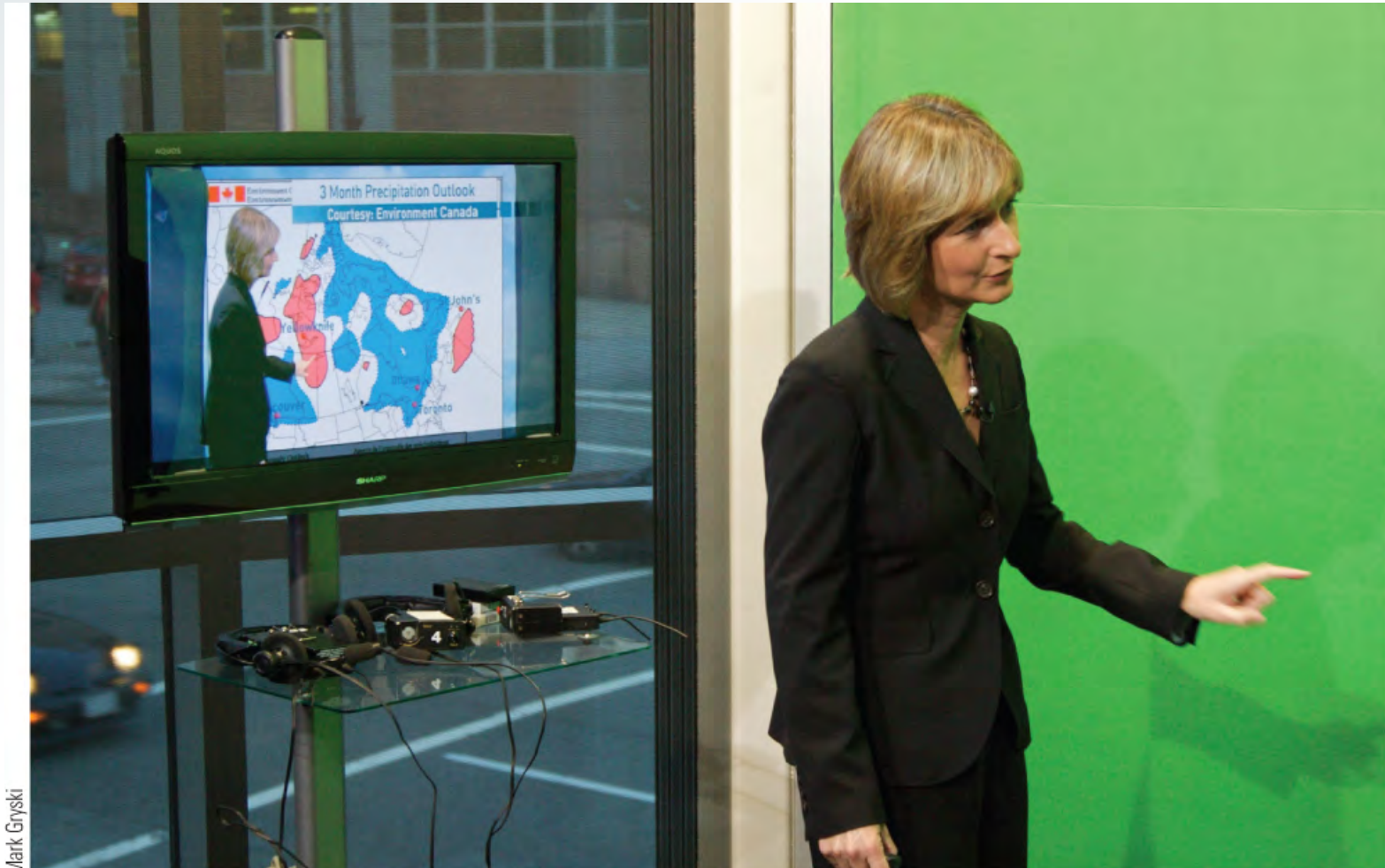
Cyclone Catarina

- ✦ March 26-27, 2004
- ✦ First hurricane-strength storm observed in the South Atlantic
 - ✦ Category 2, 160 km/h
- ✦ Why now?
 - ✦ Combination SSTs and atmospheric flow
- ✦ Four tropical storms over 2010-2019

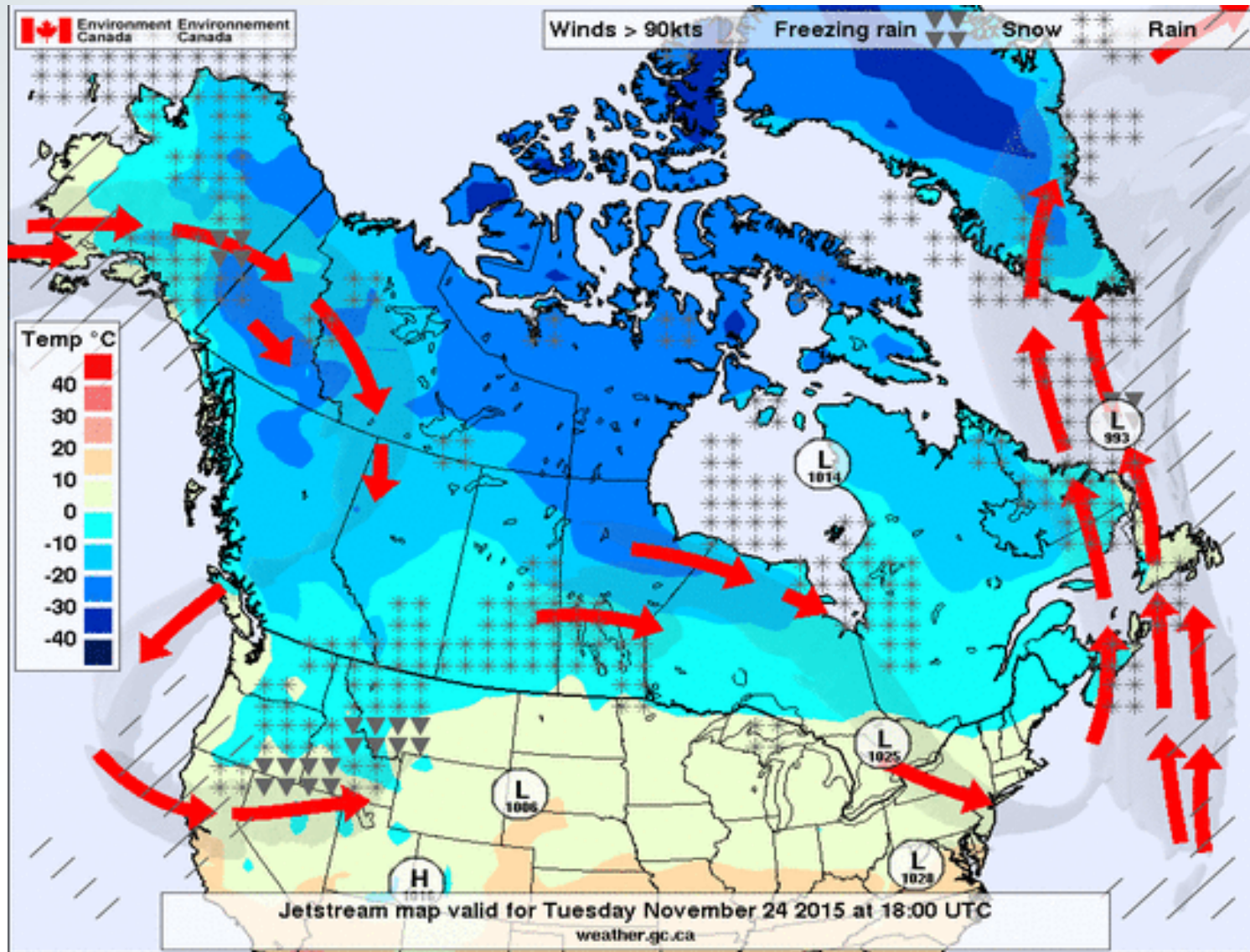
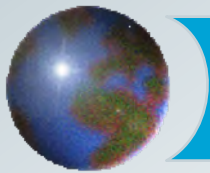


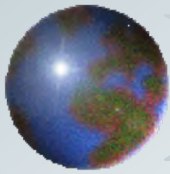


Daily/Seasonal Weather Prediction

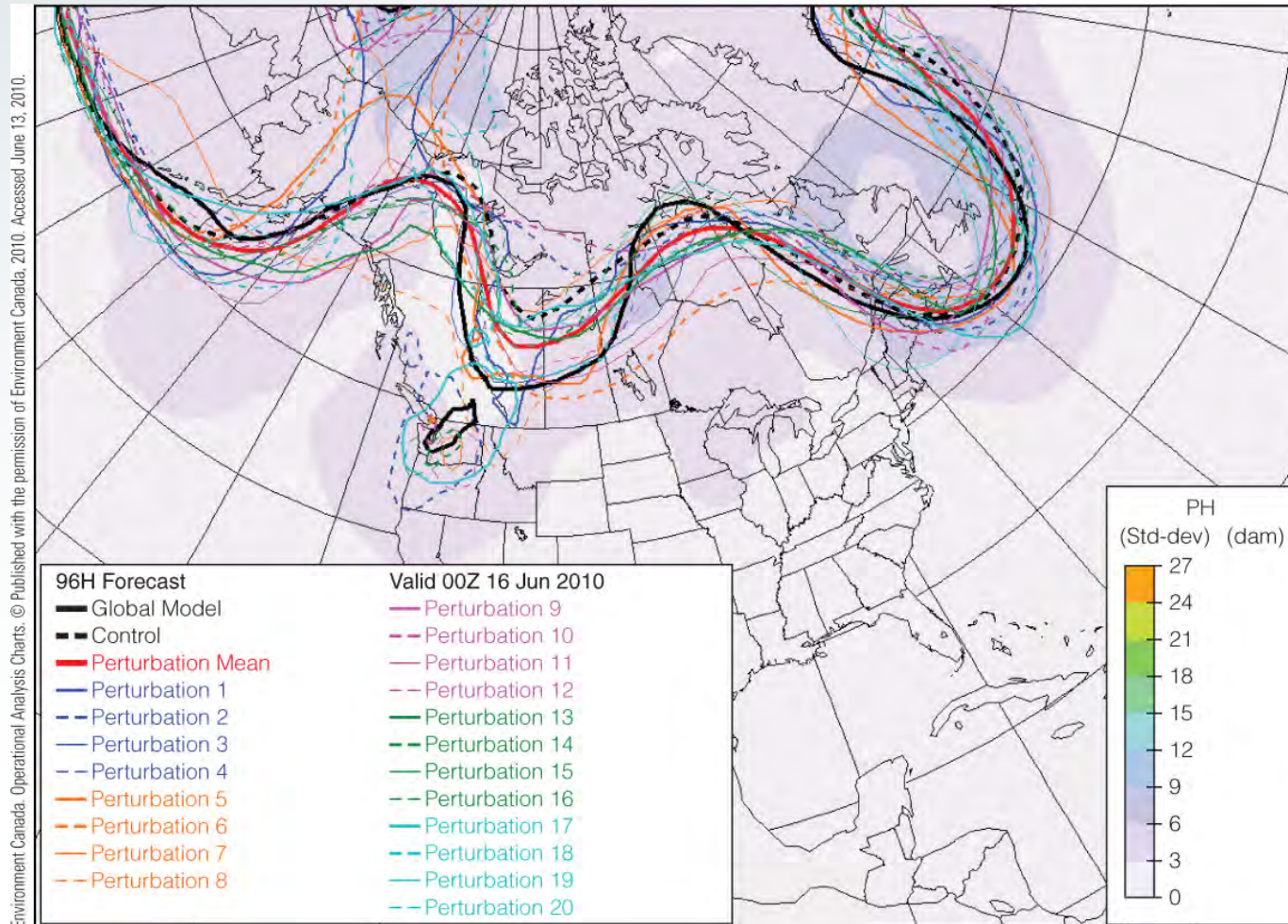


Mark Gryski

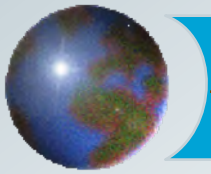




Ensemble 500-mb forecast



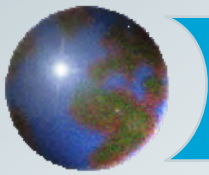
Ahrens: Fig. 13.6, p. 452



Models . . . better agreement overall with slow moving frontal boundary and by 00z Friday have it from NE Ontario through S Wisconsin . . .

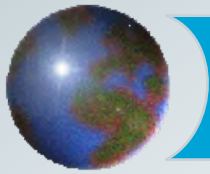
Most models generally agree on precipitation amounts Thursday night . . . the NAM is an outlier with heftier totals. We did not go as low as the GFS/ECMWF/Gem suggest.

There will likely be some lake enhancement . . .



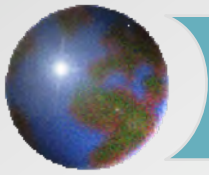
November 14, 2019 0800 EDT





Canadian Weather Service

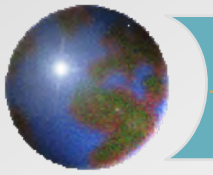
Eastern Canada.

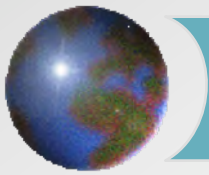


Lecture outline

Polar cyclones

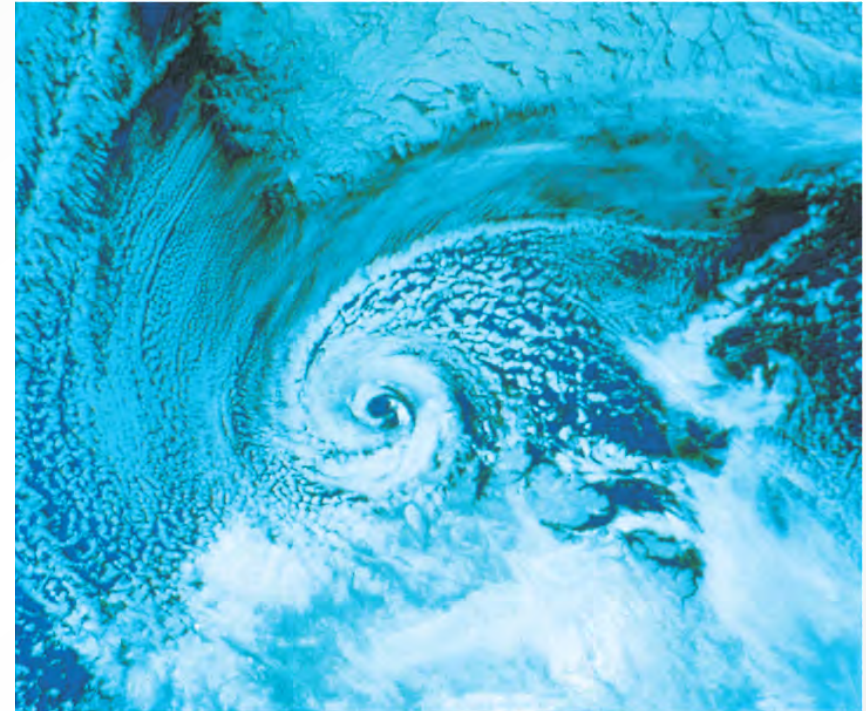
Dynamics



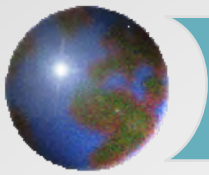


Polar Lows

- ❖ Cyclones forming over the open sea in polar regions
- ❖ Winds must be *gale force*
 - ❑ >60 km/h
- ❖ Several hundred kilometres in diameter
- ❖ Last up to two days

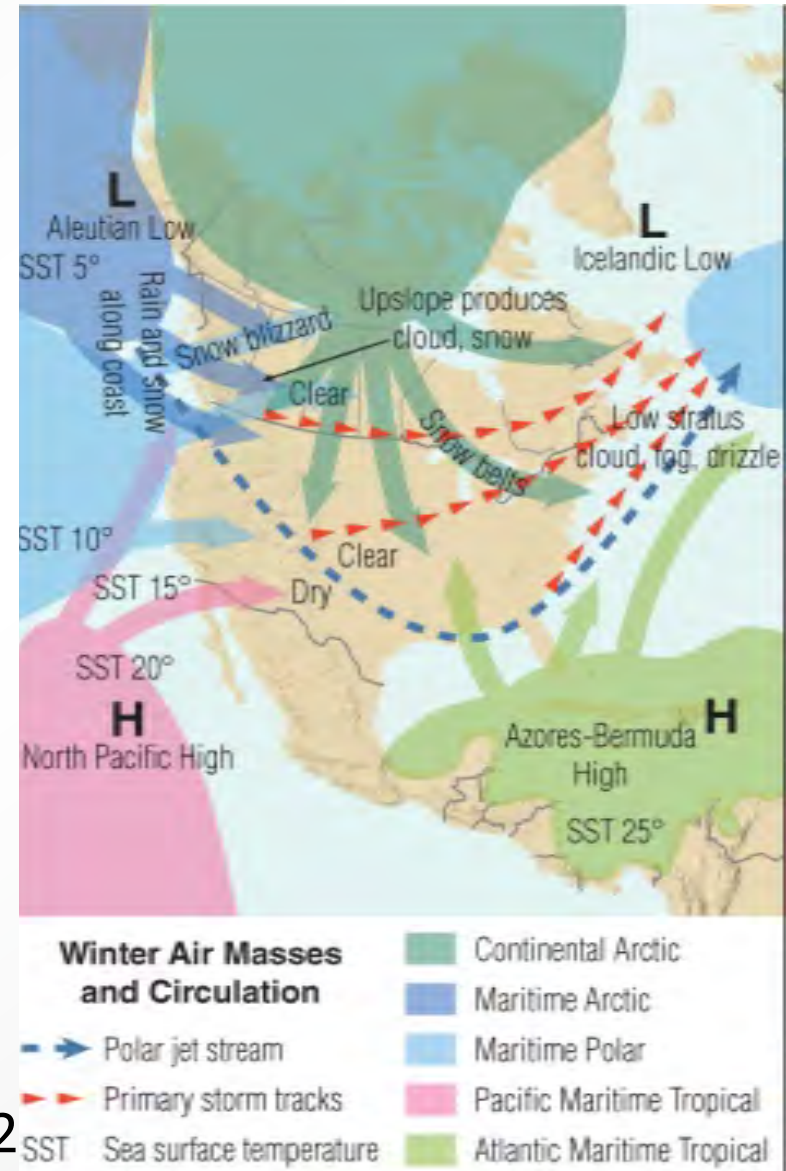


Barents Sea Feb 27 1987
Ahrens: Fig. 12.27

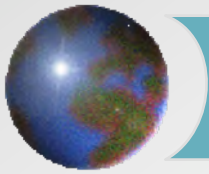


Polar low formation

- ✪ cA air mass moves over open sea water
- ✪ *Arctic front* forms between cA and mP air masses
- ✪ Relative warmth of the open sea fuels the storm



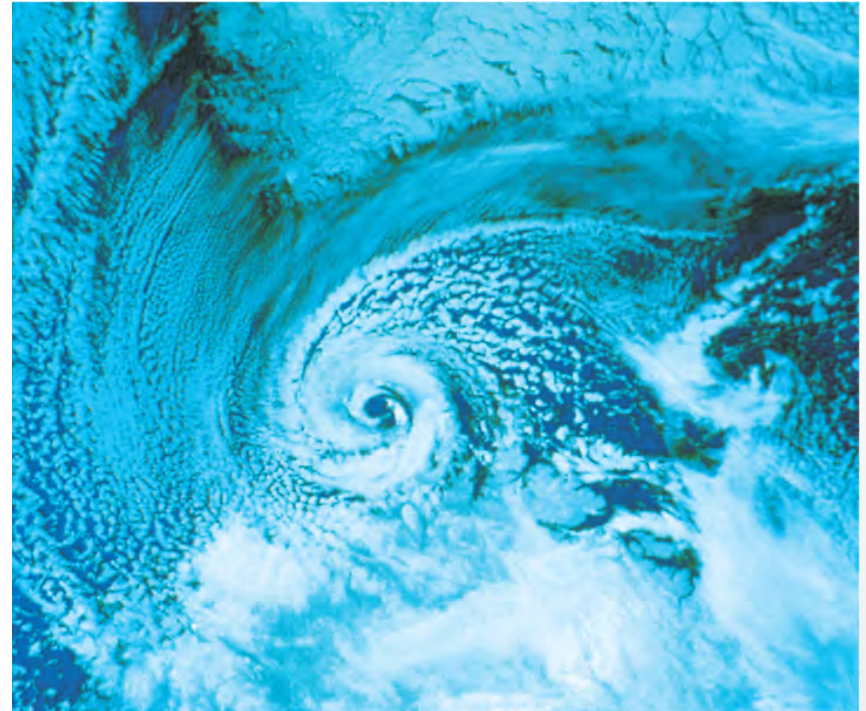
Ahrens: Fig. 11.2

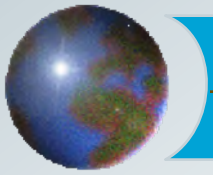


Similarity to tropical cyclones

- ✦ Sea surface temperatures (SSTs) as energy source
- ✦ Eye formation
- ✦ Warm core
- ✦ Dissipate over land (or ice)

- ✦ Differences:
 - ✦ Much weaker winds
 - ✦ Heavy snow instead of rain





Coming up

- ✦ Course evaluations!
- ✦ Weather forecasting continued
- ✦ Climate classification