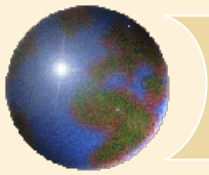


Introduction to Climatology

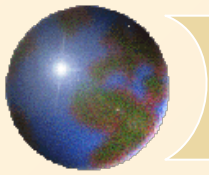
GEOG/ENST 2331: Lecture 1



Us

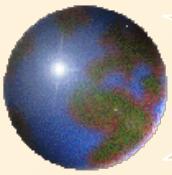
- ✦ **Graham Saunders (RC 2006C)**
graham.saundersl@lakeheadu.ca

- ✦ **Jason Freeburn (RC 2004)**
jtfreebu@lakeheadu.ca

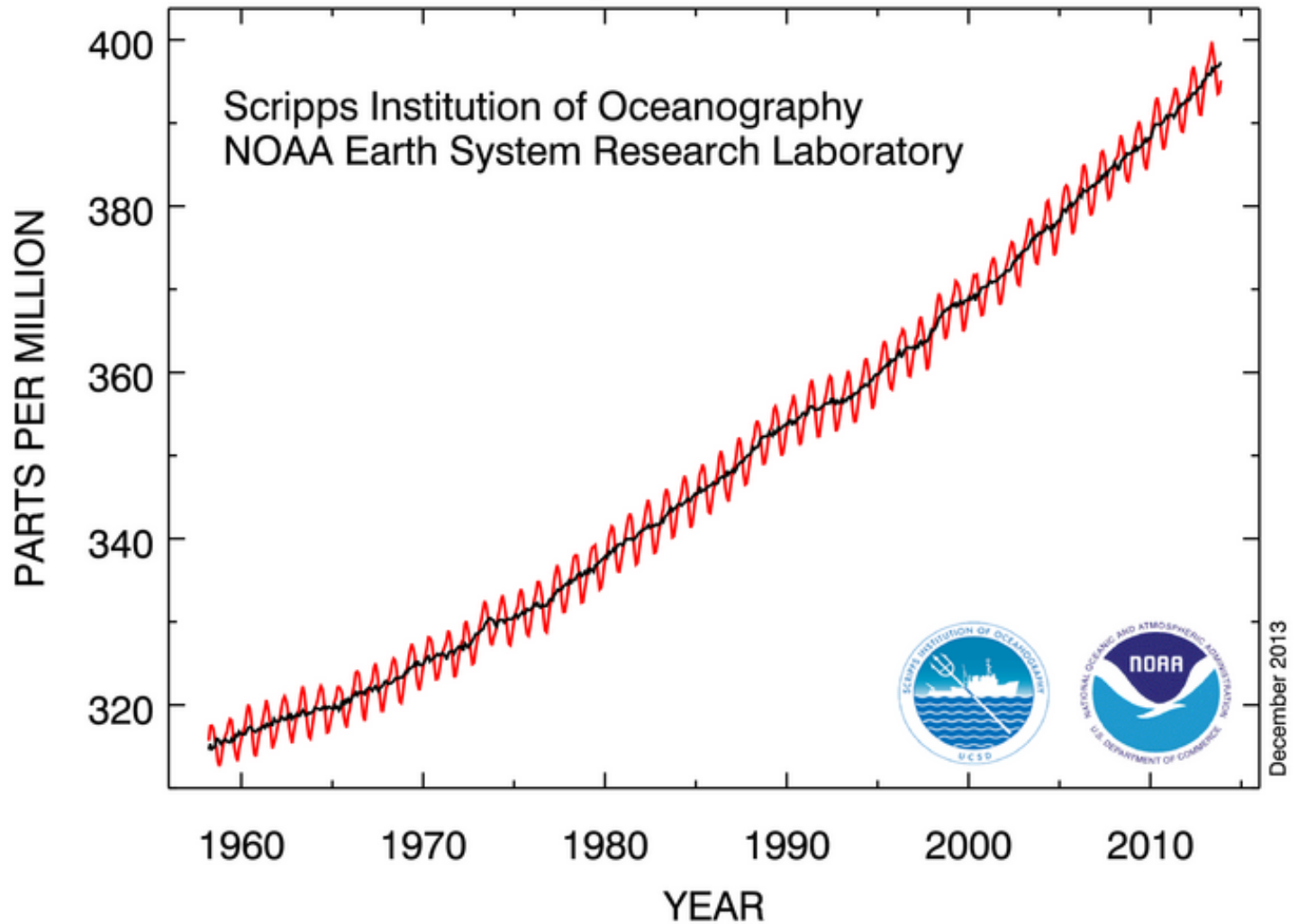


Graham Saunders

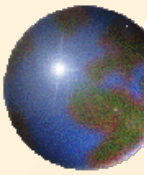
- ✚ Australian Weather Bureau
- ✚ Environment Canada
- ✚ Ministry of Natural Resources
- ✚ M.Sc. in Forestry and Climatology
- ✚ Teaching at LU since 1995
 - Climate Change Research – boreal forest
 - Severe Weather adaptation
 - Pricing carbon
- ✚ Decades of writing about weather, climate and related policy issues.



Atmospheric CO₂ at Mauna Loa Observatory

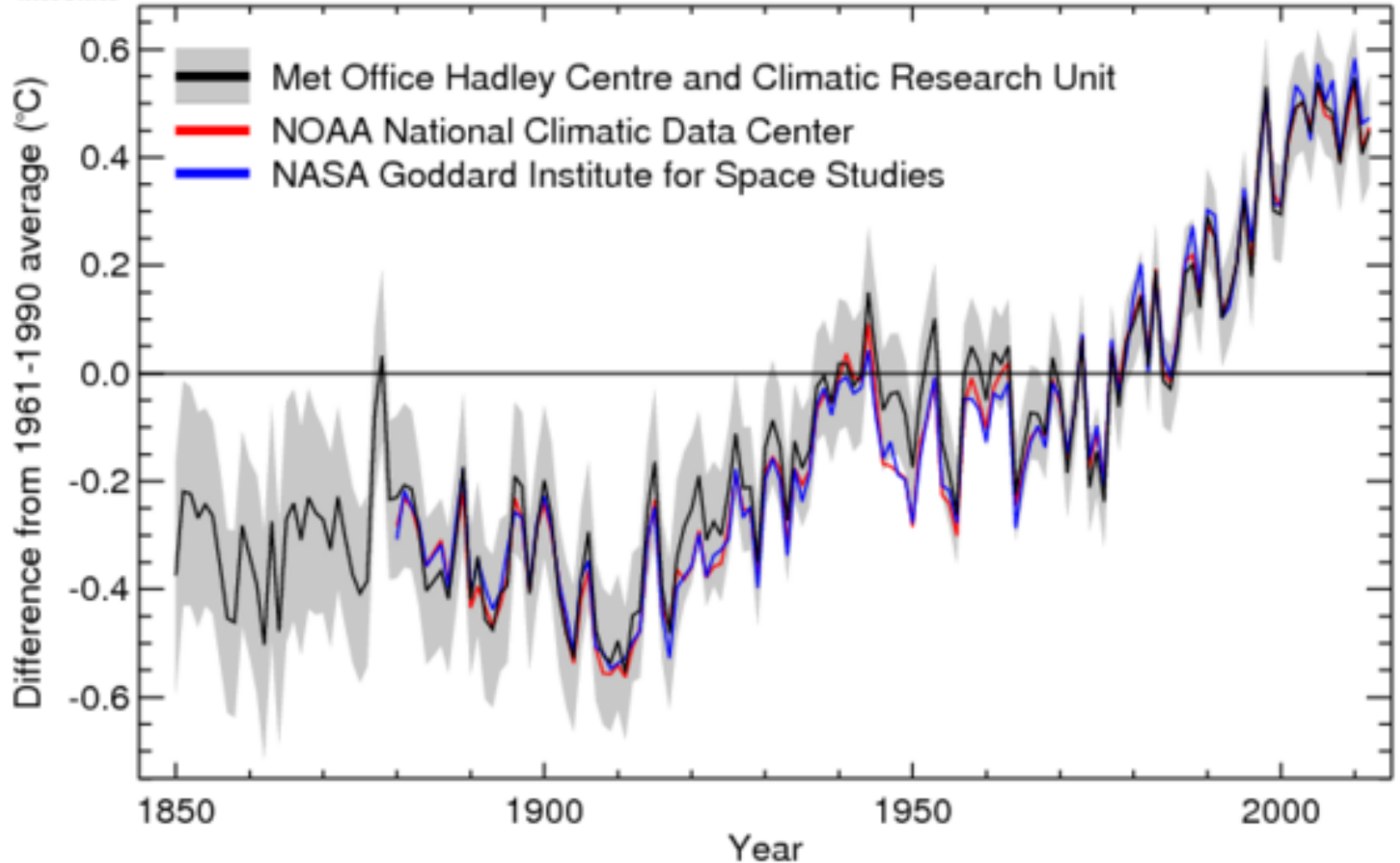


Source: NOAA



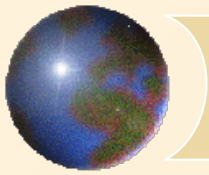
Met Office

Global average temperature anomaly (1850-2012)



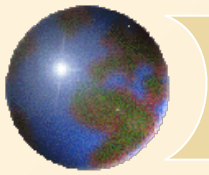
UK Met Office

Bars are annual difference from 1961-1990 average.



Course Objectives

- ✦ Understand the physics that drive weather systems
- ✦ Examine the features that create climatic patterns at small (micro) and large (macro) scales
- ✦ Consider the impacts that climate and weather have on human systems – and vice versa!



Course structure

- ✦ Lectures

 - ▣ Courselink

- ✦ Labs

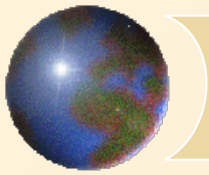
 - ▣ Lab Manual

 - ▣ Jason

- ✦ Attendance

- ✦ Bulletin Board, Office Hours, email response

- ✦ Tour of Weather Station



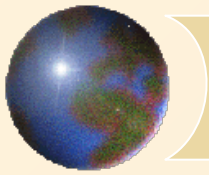
Explore Your Resources

✦ **Text:**

- ✦ Ahrens, Jackson and Jackson, 2012. *Meteorology Today, 1st Canadian Edition* (Toronto: Nelson Education Ltd.).

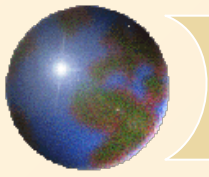
✦ **Manual:**

- ✦ Cornwell, Freeburn, and Saunders 2015. *Climatology Manual* (Thunder Bay: Lakehead University, Department of Geography).



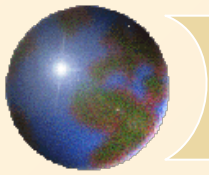
Schedule and Mark Allocation

Lab 0	Sep. 22/23	0
Lab 1	Sep. 29/30	4
Lab 2	Oct. 13/14	4
Lab 3	Oct. 20/21	4
Lab 4	Oct. 27/28	4
Midterm	Oct. 28	15
Lab 5 – Lab Quiz	Nov. 3/4	7
Lab 6 – Group Project*	Nov. 10/11 & 17/18	8
Lab 7	Dec 1/2	4
Final Examination	TBA	50



Group Project

- ⊕ Nov. 10/11 and 17/18
- ⊕ ATAC 3009 Computer Lab



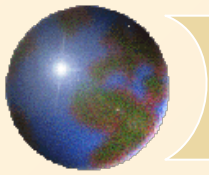
First Half of the Course

I. AIR

- ✦ **Composition and Structure of the Atmosphere.**
- ✦ **Solar Radiation and the Seasons**
- ✦ **Energy Balance and Temperature**
- ✦ **Atmospheric Pressure and Wind**

II. WATER IN THE ATMOSPHERE

- ✦ **Atmospheric Moisture**
- ✦ **Cloud Development and Precipitation Processes**



Second Half of the Course

III. DISTRIBUTION AND CIRCULATION

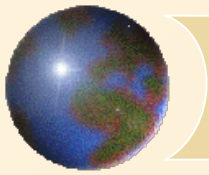
- ✦ **Atmospheric Circulation and Pressure Distributions**
- ✦ **Air Masses and Fronts**

IV. DISTURBANCES and SEVERE WEATHER

- ✦ **Mid-Latitude Cyclones**
- ✦ **Lightning, Thunder, and Tornadoes**
- ✦ **Tropical Storms and Hurricanes**

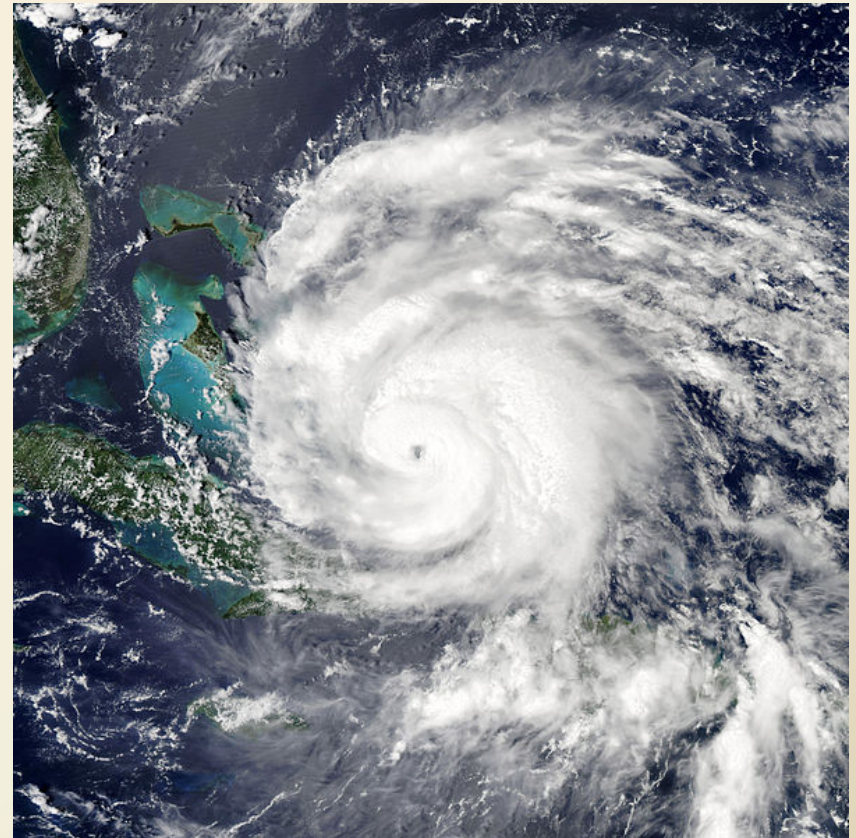
V. CLIMATE CHANGE AND VARIABILITY

- ✦ **Global Climate Classifications**
- ✦ **Global Climate Change**

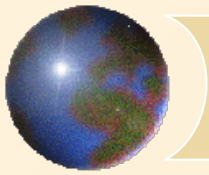


Definitions

- ✦ Weather
- ✦ Climate
- ✦ Meteorology
- ✦ Climatology
- ✦ Climate variability
- ✦ Climate change



NASA: Hurricane Irene, 2011

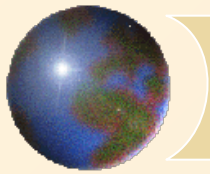


Weather

✪ *The state of the atmosphere at a given time and place*

- ✪ Temperature
- ✪ Humidity
- ✪ Wind velocity
- ✪ Pressure

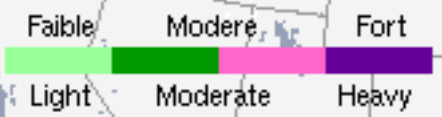
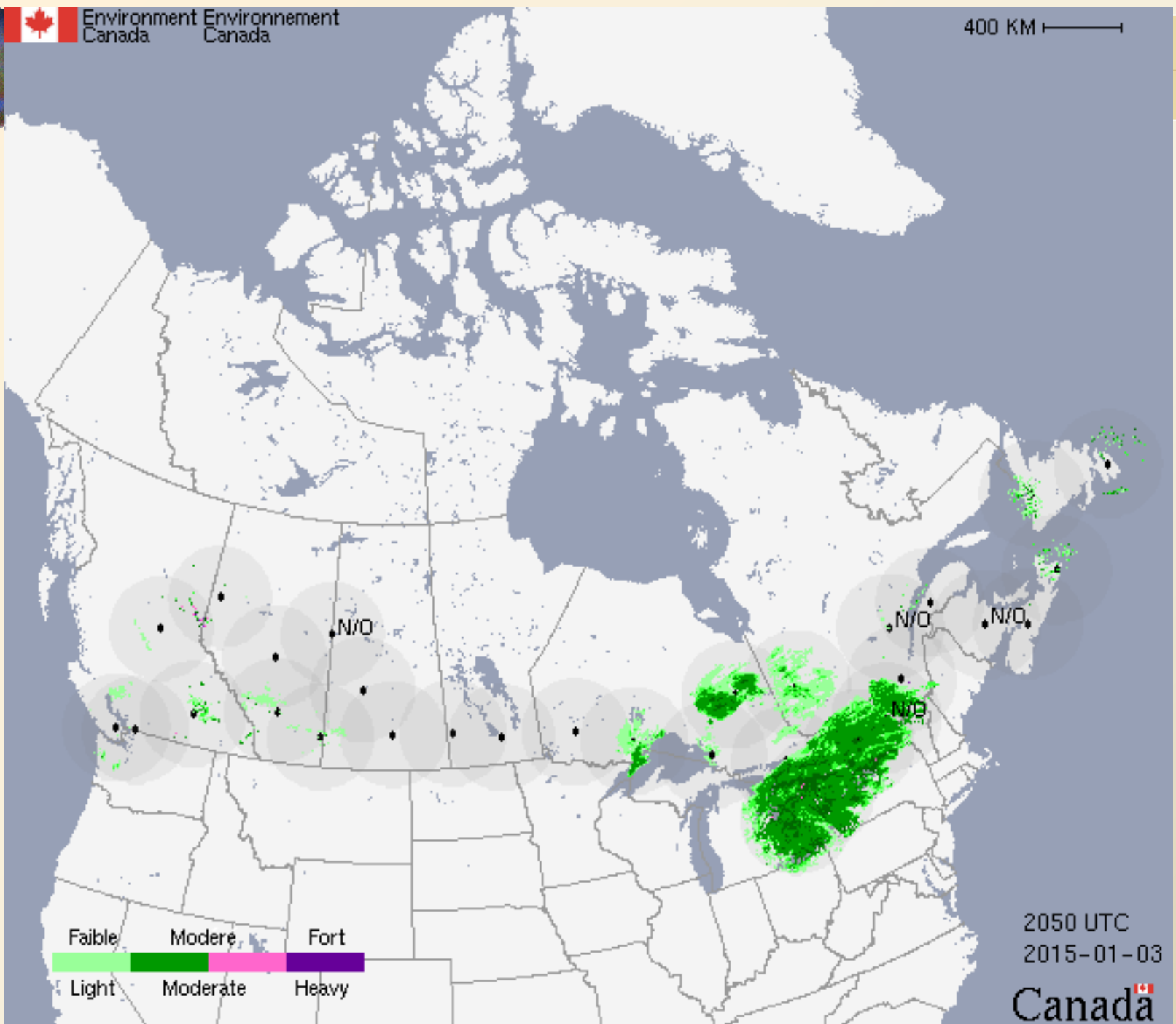






MSC/SNC-CMC GOES 2015-01-03 20:30 UTC IR





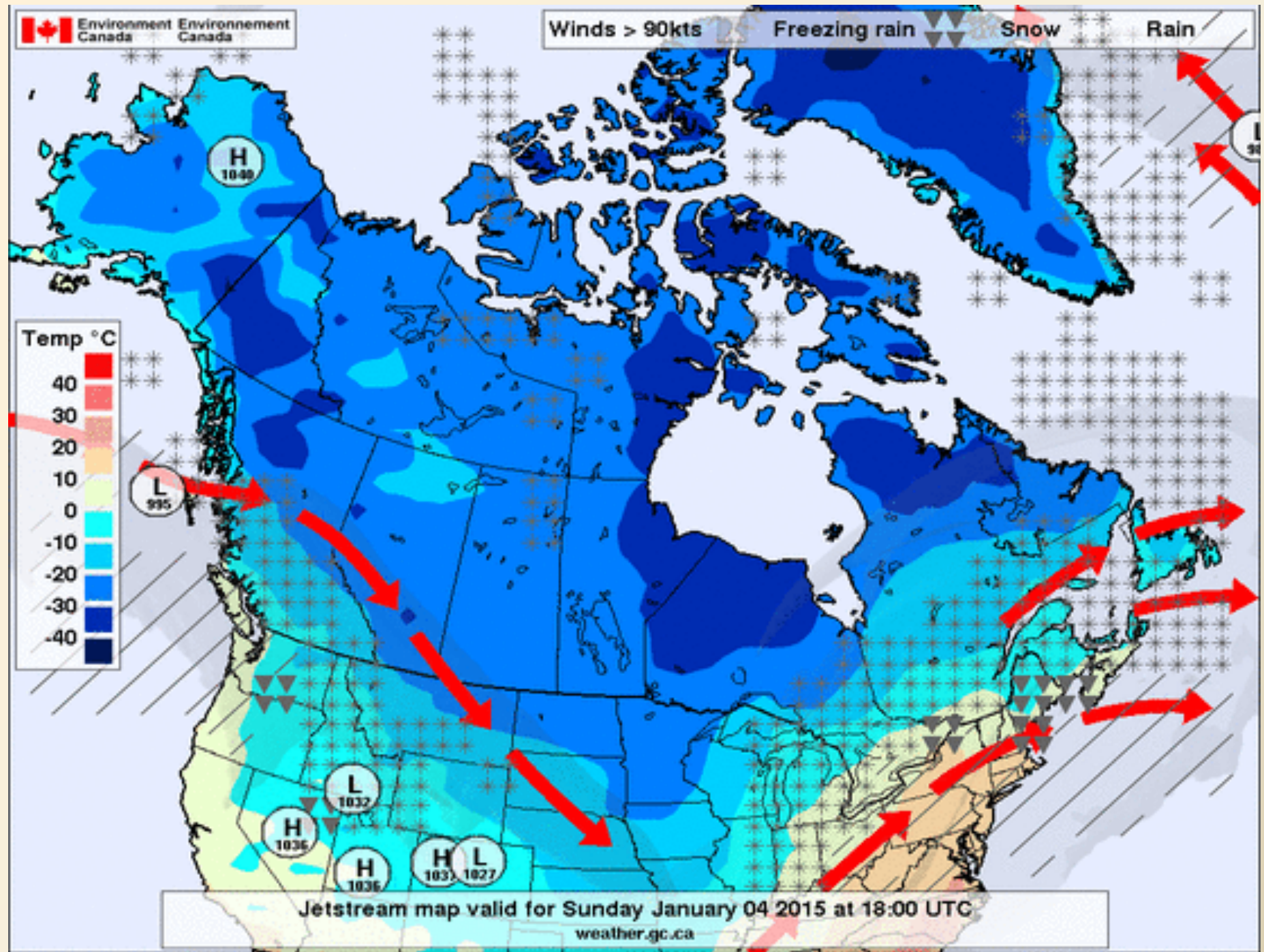
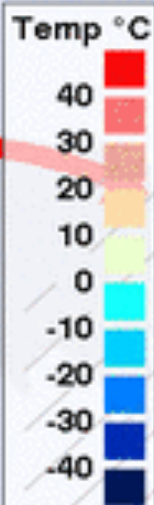
2050 UTC
2015-01-03

Winds > 90kts

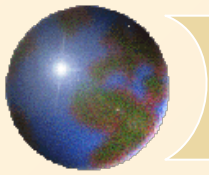
Freezing rain

Snow

Rain



Jetstream map valid for Sunday January 04 2015 at 18:00 UTC

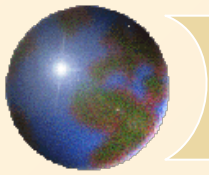


Thunder Bay: September 14 Averages

- ☉ T_{max} : 17° C
- ☉ T_{min} : 5° C
- ☉ Precipitation: 40 per cent chance
within 24-hour period

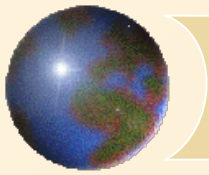
Thunder Bay: September 14 Forecast

- T_{max} : 25° C
- ☉ T_{min} : 12° C
- ☉ Precipitation: None forecast



Climate

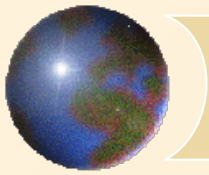
- ✦ *A description of the weather in some location over a long period of time*
 - ▣ Averages, variabilities, and extremes
 - ▣ Typically at least 30 years of data are used



Thunder Bay climate for September

Extremes

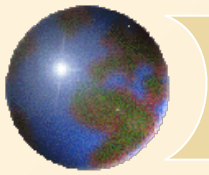
- ⊕ Average T_{max} : 11.0° C
 - ⊕ Average T_{min} : 1.3° C
 - ⊕ Average rain: 87.5 mm
 - ⊕ Average snow: 0.5 cm
 - ⊕ Days with precipitation: 12 (of 30)
 - ⊕ T_{max} : 34.0° C (Sept. 11, 2005)
 - ⊕ T_{min} : -8.3° C (Sept. 29, 1945)
 - ⊕ Daily* rain: 131.2 mm (Sept. 8, 1977)
 - ⊕ Daily* snow: 9.2 cm (Sept. 30, 1985)
 - ⊕ Daily* prec: 131.2 mm (Sept. 8, 1977)
 - ⊕ Max snow depth: 9 cm (1985)
- * 24-hour period



Climate vs. Weather

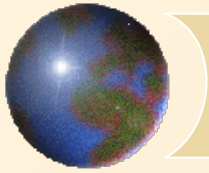
Weather is the condition of the atmosphere at any particular time and place.

Climate is "averaged weather", the long term averages of weather events (typically 30 years or more). It includes the compilation of weather statistics such as central tendencies, variability, and extremes.



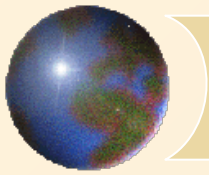
Meteorology

- ✦ The science dealing with phenomena of the atmosphere; especially weather processes and weather forecasting
- ✦ 350 BCE: the text *Meteorology* was written by Aristotle



Climatology

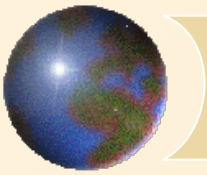
- ✚ The science of climate,
phenomena and causes



Climate Variability

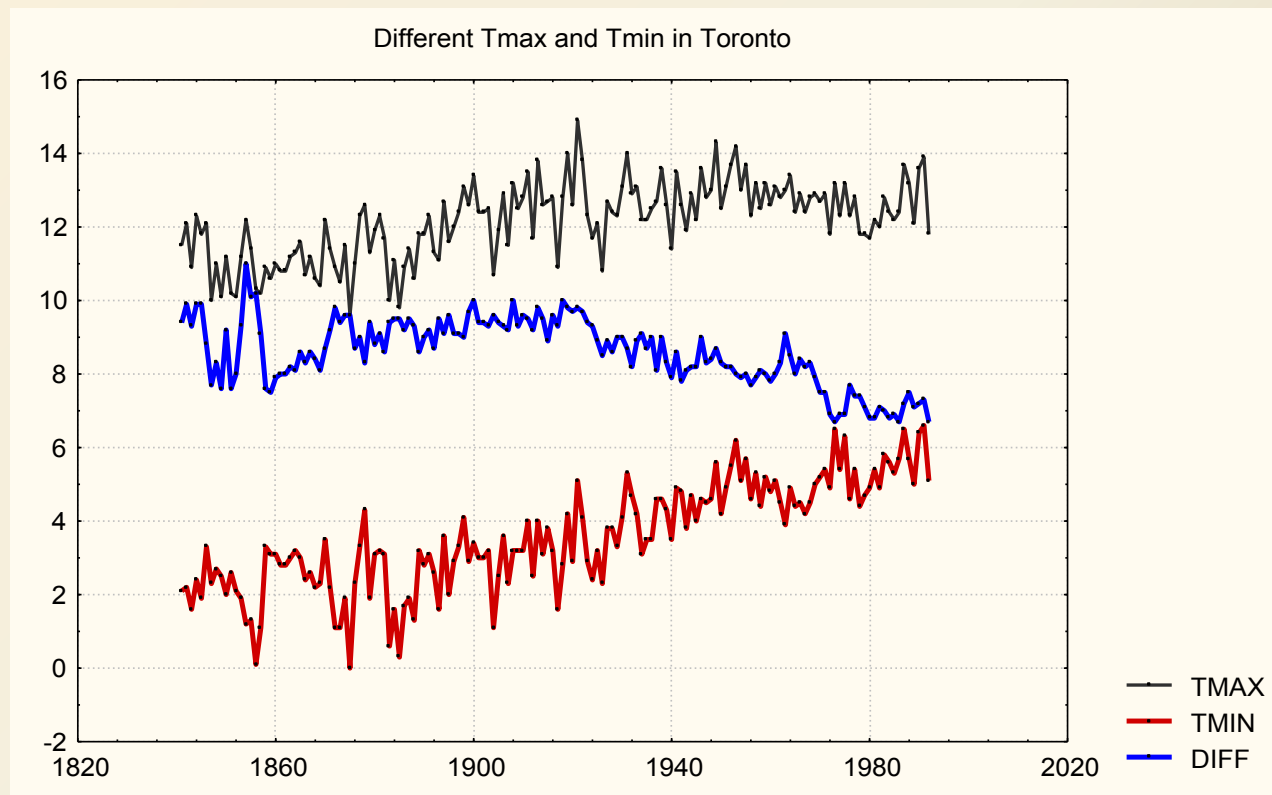
- ⊕ The variation about the mean, typically expressed as a standard deviation or extreme

- ⊕ Sources include:
 - ⊞ Persistent local conditions
 - ⊞ Slowly changing factors such as sea surface temperature (SST)
 - ⊞ Long term cycles in climate such as the El Niño / Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO)
 - ⊞ More

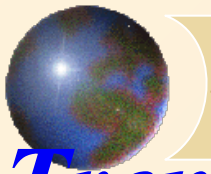


Climate Change

- ✪ A net change in climate characteristics such as the mean and/or standard deviation and/or extremes



Toronto, Ontario



Trends vs. variability

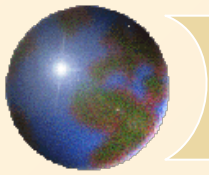
Temperature and precipitation departures from normal vary greatly on a daily, monthly and annual basis

Some examples

Some weather events or large departures from normal can be used to analyze weather effects on wildlife, habitat disturbances, such as fires or floods.

Discussion

Seasonal trends in Northern and Southern Ontario



Next Lecture

- ⊕ Composition and structure of the atmosphere
- ⊕ Ahrens: Chapter 1