Introduction to Climatology

GEOG/ENST 2331: Lecture 1
Us

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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 CO$_2$ at Mauna Loa Observatory

Scripps Institution of Oceanography
NOAA Earth System Research Laboratory

Source: NOAA
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:**

**Manual:**
## Schedule and Mark Allocation

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<thead>
<tr>
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<th>Date</th>
<th>Mark</th>
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<tbody>
<tr>
<td><strong>Lab 0</strong></td>
<td>Sep. 22/23</td>
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<tr>
<td><strong>Lab 1</strong></td>
<td>Sep. 29/30</td>
<td>4</td>
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<td><strong>Lab 2</strong></td>
<td>Oct. 13/14</td>
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<td><strong>Lab 3</strong></td>
<td>Oct. 20/21</td>
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<td><strong>Lab 4</strong></td>
<td>Oct. 27/28</td>
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<td><strong>Midterm</strong></td>
<td>Oct. 28</td>
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<td><strong>Lab 5 – Lab Quiz</strong></td>
<td>Nov. 3/4</td>
<td>7</td>
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<td><strong>Lab 6 – Group Project</strong></td>
<td>Nov. 10/11 &amp; 17/18</td>
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<td><strong>Lab 7</strong></td>
<td>Dec 1/2</td>
<td>4</td>
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<td><strong>Final Examination</strong></td>
<td>TBA</td>
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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
Thunder Bay: September 14 Averages

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

Thunder Bay: September 14 Forecast

- $T_{\text{max}}$: 25° C
- $T_{\text{min}}$: 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

- Average $T_{\text{max}}$: 11.0° C
- Average $T_{\text{min}}$: 1.3° C
- Average rain: 87.5 mm
- Average snow: 0.5 cm
- Days with precipitation: 12 (of 30)

Extremes

- $T_{\text{max}}$: 34.0° C (Sept. 11, 2005)
- $T_{\text{min}}$: -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

![Graph showing temperature trends in Toronto, Ontario](image-url)
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