ERTH 303 – Weather and Climate

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Weather and Climate are Relevant!

'Dangerous' Hurricane Jimena Threatens Mexico

Hurricane Warning Issued for Mexican Pacific Coast, Including Los Cabos Resort Area

By KIMAE HEUSSIER
Aug. 31, 2008

As Hurricane Jimena spins toward parts of Mexico's Baja peninsula, including the popular resort city of Cabo San Lucas, tourists and local residents are stocking up on food, water and fuel.

Earlier this morning the Mexican government issued a hurricane warning for the southern part of Baja, which means that hurricane conditions are expected in the area within 24 hours.

The storm strengthened over the weekend and, according to the National Hurricane Center, it has sustained winds of nearly 150 mph.

"Jimena is an extremely dangerous Category 4 hurricane on the Saffir-Simpson scale. Some fluctuations in intensity are possible during the next day or two," the center said.
Weather and Climate are Relevant!

The Weather Channel®:
– 3rd most popular cable channel
– 14th most popular site on the web


Intergovernmental Panel on Climate Change

The IPCC is honored with the Nobel Peace Prize

Oslo, 10 December 07

The Intergovernmental Panel on Climate Change
and Albert Arnold (A) Gore Jr
were awarded the Nobel Peace Prize
“For their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change.”
ERTH 303 – Weather and Climate

Syllabus  www.montana.edu/mcwethy/ERTH303

Course Description

Course Requirements

Prerequisites: GEOG 112

Materials: text books, computer access

Desire2Learn: news and dropbox
  (https://ecat.montana.edu/)

Policies and Grading

Calendar
ERTH 303 – Weather and Climate

Expectations

Attendance and Participation

Assignments: readings, weather journal and discussion

Style and format: journals and written material

Exams (3) and Quizzes

Extra credit
Course content –
  • Better understand processes that shape weather/climate
  • Climate change

Lead discussion –

Communication –
  • Oral and written

Peer evaluation –
Assignments this week:

1. Syllabus-
   - Review syllabus and agreement of understanding
     [www.montana.edu/mcwethy/ERTH303](http://www.montana.edu/mcwethy/ERTH303)
   - Prepare questions or sign AOU and turn in

2. Assignment #1 -
   - Find assignment #1 at Desire2Learn website for ERT303
   - Complete and upload to dropbox
ERTH 303 – Weather and Climate

Assignments this week:

3. Hurricane Report
   a) Current storms – Pacific and Atlantic (global)
   b) Forecast
   c) Archive history and context

4. Weather Journal – see grading rubric

5. Extra credit
   a) News
   b) Scientific coverage
   c) Local events

http://www.nhc.noaa.gov
Paleoecology: long-term interactions between humans - climate – vegetation – fire
Paleoecology: humans - climate – fire interactions

Climate and fire in the news:

The wildfire factor

David Schlitz and David Baker

Events such as wildfires, occurring on a tiny area of the globe, have a huge impact on the global carbon cycle. This much is proven by investigation of the terrible fires that affected Indonesia in 1997–98. The growth rate of carbon dioxide in the atmosphere has reached the highest levels recorded. As this increase has been driven by the burning of forests, a significant portion of the carbon fixed by vegetation is lost each year. This carbon enters the atmosphere as carbon dioxide in the smoke from wildfires. In addition, the increase in carbon dioxide in the atmosphere is driven by the burning of fossil fuels. The increase in carbon dioxide is further accentuated by the production of methane, which is also released from fires.

Forests, fires and climate

Cathy Whitlock

In recent decades, forest fires have increased in both the western United States and Australia. In the past 15 years, the western United States has experienced some extreme fires, notable for their size and severity. The annual cost of fire suppression is now exceed $1.6 billion, and the federal government is still not addressing the problem.

Salvage Harvesting Policies After Natural Disturbance


Natural disturbances and the biological legacies produced by them are often poorly understood by policy-makers and natural-resource managers. Recent large-scale natural disturbances include wildfires that burned nearly 10 million ha in Indonesia in 1997–98, 7 million ha in Russia, 54 million ha in Canada, and 4 million ha in Brazil (1–3). In forests, regrowth of economic losses is usually attempted by salvaging large volumes of timber. Major salvage harvesting operations began in Australian wet forests following droughts in 2000. Salvage harvesting operations also follow severe fires in the United States.
Paleoecology: humans - climate – fire interactions

Climate and fire in the news:

P. Higuera
Climate
climate variability, mean state

Fire
(frequency, size, intensity)

Vegetation
(composition, structure)

Humans
(ignition, suppression)
Paleoecology: using lake sediment records to reconstruct vegetation, fire and climate

pollen:

macrofossils:

charcoal:
Paleoecology: historical perspective of human influence
Paleoecology: humans - climate – fire interactions

South Island, New Zealand
Vegetation Change During the Last 1000 yrs.
Paleoecology: humans - climate – fire interactions

**South Island, New Zealand**

Pre-Maori < AD 1280

Native Forest

AD 1280-1850

Bracken/Shrubland

~ AD 1850-present

European Pasture
Paleoecology: humans - climate – fire interactions

South Island, New Zealand
Paleoecology: humans - climate – fire interactions

South Island, New Zealand

New Zealand Charcoal Records from Lake Sediment Cores:
Paleoecology: humans - climate – fire interactions

South Island, New Zealand

Does climate explain increase in fires following Maori arrival?

![Graph showing summer temperature and charcoal accumulation over time](image)

Cook et al., 2006
Paleoecology: climate – vegetation – fire interactions

Rocky Mnt. NP
Ecology: climate and biodiversity in the PNW
Ecology: climate and biodiversity in the PNW

- Coast Range
- Siuslaw National Forest
- Springfield
- Weyerhaeuser and BLM
- Cle Elum
- Plum Creek and Wenatchee National Forest
- Goldfork
- Boise Corp, Payette and Boise National Forests
- Yellowstone
- Targhee and Gallatin National Forests
Climate Change: signs from Antarctica
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Figure 2. Relationship between winter ice duration at the South Orkney Islands and krill density. The longer there is ice, the more krill there are (source: Atkinson et al., 2004).
Climate Change: signs from Antarctica

Figure 2. Relationship between winter ice duration at the South Orkney Islands and krill density. The longer there is ice, the more krill there are (source: Atkinson et al., 2004).
Weather Basics  (ERTH 303, 1 Sep., 2009)

1. Weather & Climate

2. Quantifying “weather”
   a. Atmospheric Pressure and Wind
   b. Temperature
   c. Humidity

3. Reading Weather Maps

4. On-line Weather and Climate Data
1. Weather & Climate

What is weather - What is climate?
- Climate is what you expect
- Weather is what you get

http://www.nhc.noaa.gov
What is “weather”? 
- State of the atmosphere at small scales → a small area over a short time period:

**Meteorology =** 
Study of the atmosphere and the processes that create weather: current values of temperature, pressure, wind, humidity, etc.
1. Weather & Climate

What is “climate”?

- State of the atmosphere at large scales → local to global areas over years, decades, centuries:

<table>
<thead>
<tr>
<th>Climatology for Bozeman MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lat=45.5N Lon=111.1W Elevation=4467 feet</td>
</tr>
<tr>
<td>Number of years available from 1961 to 1990: 30</td>
</tr>
<tr>
<td>Maximum temperature 1961 to 1990: 103 F</td>
</tr>
<tr>
<td>Minimum temperature 1961 to 1990: -46 F</td>
</tr>
<tr>
<td>Mean Annual Precipitation: 14.7 inches</td>
</tr>
<tr>
<td>Mean Annual Snowfall: 44.4 inches</td>
</tr>
</tbody>
</table>

Climatology =

Statistical properties of the atmosphere: means, variability, max, min., etc.

http://www.cdc.noaa.gov/cgi-bin/USclimate/city.pl?state=MT&lane=fast&itypea=1&loc.x=237&loc.y=199&cgfields=itypea
1. Weather & Climate

Weather or Climate?

- Did it snow yesterday in the mountains?
  
  [Link](http://www.wcc.nrcs.usda.gov/snotel/snotel.pl?sitenum=590&state=mt)

- When does Bozeman usually get it’s first snow?

- Was last winter snowier than “normal”? 
  
1. Weather & Climate

Good or Bad Weather?

Good or Bad Climate?
1. Weather & Climate

*Physical science* → uses the Scientific Method

**Scientific Language:**  vs.  **Unscientific Language:**

- Objective description of the world
- Value neutral
- Quantitative

- Subjective
- Value laden
- Qualitative

“High of 82°F, clear skies, dry”

“Good weather!”

“372 in. of snow a year”

“Too snowy!” OR “Awesome!”

“This was a low-probability event”

“We were unlucky!”
2. Quantifying Weather

**Atmospheric pressure**

- Air moves from areas of high to low pressure, creating **wind**
- Air rises in areas of low pressure
- Air descends in areas of high pressure

**Units:**

- millibars (mb)
- kilopascals (kPa)
- 1 mb = 0.1 kPa

[Link to Global Sea Surface Pressure Animation: http://geography.uoregon.edu/envchange/climAnimations/flash/mslp.html](http://geography.uoregon.edu/envchange/climAnimations/flash/mslp.html)
2. Quantifying Weather

Temperature

- Degrees Fahrenheit (°F)
  °F = 9/5 °C + 32
- Degrees Celsius (°C)
  °C = 5/9 (°F – 32)
- Degrees Kelvin (°K)
  °K = °C + 273.16

- A Celsius increment is larger than a Fahrenheit increment: 1 Celsius degree is 1.8 Fahrenheit degrees

http://www.magnet.fsu.edu/education/tutorials/magnetacademy/superconductivity101/images/superconductivity-temperature.jpg
Humidity

- **Relative humidity** – amount of water vapor in the air, relative to the maximum possible, thus %

- **Dew point** – higher the dew point, the greater amount of water vapor in the air
  - > 15°C (59°F) = humid
  - < 5°C (41°F) = dry
3. Reading Weather Maps

- **Fronts** – boundaries between air masses of different temperatures

![Diagram of weather fronts](image)
3. Reading Weather Maps

- Isobars = areas of equal (sea level) pressure
- UTC = Coordinated Universal Time = Greenwich Mean Time + 6 hr (as of 2 Sep. 2008)
3. Reading Weather Maps
3. Reading Weather Maps
3. Reading Weather Maps – station data
3. Reading Weather Maps – station data

**Weather:**

- Rain (light, moderate, heavy)
- Snow (light, moderate, heavy)
- Thunder (with rain, snow, no precipitation)
- Shower (rain, snow)
- Drizzle
- Freezing rain, Freezing drizzle
- Ice pellets/Sleet
- Fog (shallow, deep)
- Haze

**Sky Conditions:**

- Clear
- Scattered clouds (approximately 25% cloud cover)
- Partly cloudy (approximately 50% cloud cover)
- Mostly cloudy (approximately 75% cloud cover)
- Overcast
- Sky Obscured
- Sky Cover Missing
3. Reading Weather Maps – station data

Wind:
- Wind blowing from the west at 75 knots
- Wind blowing from the northeast at 25 knots
- Wind blowing from the south at 5 knots
- Calm winds

Pressure Trend:
- Continuously falling
- Falling, then steady
- Falling before a lesser rise
- Rising before a greater fall
- Continuously rising
- Rising, then steady
- Falling before a greater rise
- Rising before a lesser fall
- Steady
3. Reading Weather Maps

Hurricane Gustav: 06 UTC September 1, 2008
4. Reading Weather Maps – online data

Few subjects within Earth Sciences are as far reaching as the study of weather (meteorology) and climate (climatology). We plan our days based on the current weather, plant food supplies based on seasonal forecasts, and develop economies based on regional climate. Weather and climate also explain major biogeographic patterns and influence physical processes shaping the landscapes we inhabit. With unprecedented climate changes likely inevitable in our lifetimes, the study of weather and climate has taken on added importance in recent decades.

In this course we will build a physical understanding of how Earth systems interact to create the weather we see on a daily basis and the climatic patterns that emerge at larger spatial and temporal scales. The last 1/3 of the course focuses on understanding the current predictions for global and regional climate change based on the Intergovernmental Panel on Climate Change’s fourth assessment.

Objectives

By the end of the course, students will be able to:

1. Analyze, describe, and plot the major atmospheric processes controlling weather and climate, including radiation budgets, pressure gradients, frontal movement, and air masses.
2. Make use of on-line weather and climate resources to assist in planning daily activities.
3. Describe the methods used to reconstruct past climates and predict future climates.
4. Develop and express an informed opinion on the causes, likelihood, and consequences of human-caused global climate change.

Structure

The course consists of weekly lectures and class activities focused on the reading for that day. You need to be comfortable with basic math (i.e. algebra) and statistics (distributions and probabilities) for the homework assignments and in-class exercises, and you will need access to the Internet throughout the semester.