Remember These?

- Factor 1: Our Energy Source
- Factor 2: Revolution & Tilt
- Factor 3: Rotation!
- Factor 4: Latitude
- Factor 5: Altitude
- Factor 6: Land & Water are Different
The Influence of Water

- Average January / July temperatures for three cities at latitude 40N:

<table>
<thead>
<tr>
<th>Location</th>
<th>January</th>
<th>July</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chico, CA</td>
<td>47.8</td>
<td>80.4</td>
<td>32.6</td>
</tr>
<tr>
<td>Brighton, CO</td>
<td>26.8</td>
<td>72.1</td>
<td>45.3</td>
</tr>
<tr>
<td>Columbus, OH</td>
<td>26.0</td>
<td>74.0</td>
<td>48.0</td>
</tr>
</tbody>
</table>
Factors that Influence Climate

- Which side of the ocean you’re on!

The winds help stir ocean currents. Generally, western shores get cold water from the poles, eastern shores get warm from the equator.
Climate Zones

A - Tropical Climates
Tropical moist climates extend north and south from the equator to about 15° to 25° latitude. In these climates all months have average temperatures greater than 64°F (18°C) and annual precipitation greater than 59°.

B - Dry Climates
The most obvious climatic feature of this climate is that potential evaporation and transpiration exceed precipitation. These climates extend from 20°-35° North and South of the equator and in large continental regions of the mid-latitudes often surrounded by mountains.

C - Moist Subtropical Mid-Latitude Climates
This climate generally has warm and humid summers with mild winters. Its extent is from 30°-50° of latitude mainly on the eastern and western borders of most continents. During the winter, the main weather feature is the mid-latitude cyclone. Convective thunderstorms dominate summer months.

D - Moist Continental Mid-latitude Climates
Moist continental mid-latitude climates have warm to cool summers and cold winters. The location of these climates is poleward of the C climates. The average temperature of the warmest month is greater than 50°F (10°C), while the coldest month is less than -22°F (-30°C). Winters are severe with snowstorms, strong winds, and bitter cold from Continental Polar or Arctic air masses.

E - Polar Climates
Polar climates have year-round cold temperatures with the warmest month less than 50°F (10°C). Polar climates are found on the northern coastal areas of North America, Europe, Asia, and on the landmasses of Greenland and Antarctica.

H - Highlands
Unique climates based on their elevation. Highland climates occur in mountainous terrain where rapid elevation changes cause rapid climatic changes over short distances.
Limitations to “Naming” Climates

- Implies sharp boundary between climate zones
  - in reality there is a gradual transition (Colorado is a great example!)

- Relates too strongly to vegetation
  - useful in areas with little climate data, but it is better to use temp/precip measurements

- Some of the groups (esp. Moist subtropical mid-latitude) are very broad, including what appear to be very different climate types
A WORD ABOUT normals
What is Normal?

- A tool helpful when comparing conditions to the long term
- A 30-year average
- Updated every 10 years
- There are normals for:
  - Days, months and years
  - Temperature, rainfall, snowfall, and more!
September Rainfall: Fort Collins

<table>
<thead>
<tr>
<th>Year</th>
<th>Rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>3.55”</td>
</tr>
<tr>
<td>1972</td>
<td>0.51”</td>
</tr>
<tr>
<td>1973</td>
<td>1.70”</td>
</tr>
<tr>
<td>1974</td>
<td>1.08”</td>
</tr>
<tr>
<td>1975</td>
<td>0.39”</td>
</tr>
<tr>
<td>1976</td>
<td>1.94”</td>
</tr>
<tr>
<td>1977</td>
<td>0.14”</td>
</tr>
<tr>
<td>1978</td>
<td>0.12”</td>
</tr>
<tr>
<td>1979</td>
<td>1.03”</td>
</tr>
<tr>
<td>1980</td>
<td>0.71”</td>
</tr>
<tr>
<td>1981</td>
<td>1.20”</td>
</tr>
<tr>
<td>1982</td>
<td>4.06”</td>
</tr>
<tr>
<td>1983</td>
<td>0.28”</td>
</tr>
<tr>
<td>1984</td>
<td>0.80”</td>
</tr>
<tr>
<td>1985</td>
<td>1.37”</td>
</tr>
<tr>
<td>1986</td>
<td>0.74”</td>
</tr>
<tr>
<td>1987</td>
<td>0.65”</td>
</tr>
<tr>
<td>1988</td>
<td>1.95”</td>
</tr>
<tr>
<td>1989</td>
<td>2.33”</td>
</tr>
<tr>
<td>1990</td>
<td>1.36”</td>
</tr>
<tr>
<td>1991</td>
<td>0.85”</td>
</tr>
<tr>
<td>1992</td>
<td>0.02”</td>
</tr>
<tr>
<td>1993</td>
<td>2.62”</td>
</tr>
<tr>
<td>1994</td>
<td>0.48”</td>
</tr>
<tr>
<td>1995</td>
<td>2.88”</td>
</tr>
<tr>
<td>1996</td>
<td>1.34”</td>
</tr>
<tr>
<td>1997</td>
<td>2.06”</td>
</tr>
<tr>
<td>1998</td>
<td>0.78”</td>
</tr>
<tr>
<td>1999</td>
<td>2.46”</td>
</tr>
<tr>
<td>2000</td>
<td>2.66”</td>
</tr>
</tbody>
</table>

The average of all these numbers is 1.40” – the normal September rainfall at Fort Collins.

The 1st Dirty Secret of Normals:
Normals only tell you the average for a particular month, day or year. They don’t tell you anything about natural variability!
All Normals Work the Same Way

- Fort Collins’…
  - Normal September Rainfall: 1.40”
  - Normal September Temperature: 61.0 degrees
  - Normal September High: 75.3 degrees
  - Normal “First Freeze of Fall”: October 2

- All of these are based on 30 numbers recorded between 1971-2000!
Normal vs. “supposed to”

- A normal is just an average!
- It doesn’t mean “supposed to”
- It’s not “supposed to” rain 1.40” at FTC in September
- It doesn’t “usually” rain 1.40” at FTC in September
- It has never rained exactly 1.40” at FTC during any September dating back to 1889

The 2nd Dirty Secret of Normals:
For rainfall, most months are below-normal!
Normal vs. “Supposed To”

- For the sake of the developers of this material, we will leave this example in 😊

- From 1971-2000, the average OU-OSU score was OU 31, OSU 14.
  - This doesn’t mean OU is “supposed to” win 31-14 each following year.
  - OU never won 31-14!
  - Each year’s score (individual event) was decided by factors other than the 30-year “normal”
So, what’s my point?

- In Colorado, and in much of the U.S., climate values are highly variable.

- Large variability makes “supposed to”, “usually” and even the word “about” pretty meaningless on a month-to-month basis.

- However, for longer-term rainfall (seasonal, annual, and beyond), departures from “normal” mean more.
So, why have normals?

- People adjust their practices (ag, water resources, etc.) based on recent history
- Normals are exactly that: recent history
  - About a generation of history, to be exact
- Normals are a good diagnostic tool to put events in perspective
- Normals are a great planning tool (again: agriculture, water resources, etc.)
COLORADO’S CLIMATE
Let’s Talk About Our Climate!
What’s special about Colorado’s Climate?

- High elevation (highest state in the Union – by far)
- Mid-Latitude location (lively seasonal changes)
- Interior Continental Location far from atmospheric moisture sources
- Complex Mountain topography
We’re caught in the middle

Cool, Dry Air

Warm or cool, Moist or Dry Air

Warm, Moist Air
Generous sunshine and low humidity, i.e. people like it here
Large Seasonal Temperature Variations

Fruita, Colo.
Large diurnal temperature ranges and rapid changes

Kersey, Colo.

Temperature for KSY01 (01-29-2006 - 02-28-2006)

Blanca, Colo.

Temperature for BLA01 (08-08-2002 - 08-27-2002)
Complex patterns due to our topography
Colorado Average Annual Temperature (F)
1971-2000

Elevation is a dominant control for Colorado temperatures, especially during the summer.

Remember ... the Earth’s average temperature is about 58 degrees.

Data from PRISM Group at Oregon State University
Frequent but highly variable precipitation (for every “upslope,” there’s a “downslope”)

Photo by Wendy Ryan
Lots of Snow, sometimes and some places
National Annual Average Snowfall

[Map showing annual average snowfall across the United States with color-coded regions indicating different snowfall ranges.]
Where we fit in the national picture


Precipitation (in.)

- 0
- 16–20
- 36–40
- 80–100
- <4
- 20–24
- 40–50
- 100–120
- 4–8
- 24–28
- 50–60
- 120–140
- 8–12
- 28–32
- 60–70
- 140–160
- 12–16
- 32–36
- 70–80
- 160+

Copyright (c) 2006, PRISM Group, Oregon State University
http://www.prismclimate.org  -  Map created Jun 16 2006
Highly seasonal precipitation patterns with geographic diversity in “seasonality”

Average Precipitation Selected NE Colorado Locations

- Brighton
- Sterling
- Byers
- Holyoke
- Ft Collins
Seasonal Precipitation Averages
I-70 Transect

Water Year Average Precipitation for Selected Stations

- Grand Junction
- Vail
- Vail Pass
- Georgetown
- Denver
- Burlington
Seasonal Precipitation Averages
North-South Transect

North-South Transect Water Year Precipitation Averages

- Durango
- Crested Butte
- Vail
- Steamboat

Precipitation (inches)

0.0 0.5 1.0 1.5 2.0 2.5 3.0

Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep
A few storms contribute a large fraction of the annual precipitation in many years.
Large Year-to-Year Variations in Precipitation
Fort Collins Water Year Precipitation

Fort Collins, CO Water Year Precipitation (in)
Colorado: It’s a great place but we have to be ready for anything

Photo by Lynn Kral, Loveland, January 2006
Colorado Climate Hazards

- Winter Storms

March 2003 Snow Storm aftermath in Fort Collins
Colorado Climate Hazards

- Winter Storms
- Avalanche
Colorado Climate Hazards

- Winter Storms
- Avalanche
- Flash Floods

Fort Collins Flood
July 28, 1997
Fort Collins Flood July 28, 1997
Colorado Climate Hazards

- Winter Storms
- Avalanche
- Flash Floods
- Severe Storms (winds, hail, lightning)
Colorado Climate Hazards

- Winter Storms
- Avalanche
- Flash Floods
- Severe Storms (winds, hail, lightning)
- Tornados
Colorado Climate Hazards

- Winter Storms
- Avalanche
- Flash Floods
- Severe Storms (winds, hail, lightning)
- Tornados
- Drought
48-Month SPI

Fraction of Colorado in Drought

Based on 48 month SPI

(1890 - November 2007)
Colorado Climate Hazards

- Winter Storms
- Avalanche
- Flash Floods
- Severe Storms (winds, hail, lightning)
- Tornados
- Drought
- Wildfires
Colorado Climate Hazards

- Winter Storms
- Avalanche
- Flash Floods
- Severe Storms (winds, hail, lightning)
- Tornados
- Drought
- Wildfires
- Extreme Cold
Colorado Climate Hazards

- Winter Storms
- Avalanche
- Flash Floods
- Severe Storms (winds, hail, lightning)
- Tornados
- Drought
- Wildfires
- Extreme Cold
- Expansive Soils
But all of that...

...makes THIS essential!

Photo Credit: Colorado Climate Center
Good news – It’s Break Time