Outline

• Present
  - What is the nature of climate in western Colorado?
  - Where are we now?

• Past  Temperature and Precipitation Trends
  - for the last 100 years
  - for the last 5 years

• Future
  - El Nino Southern Oscillation (ENSO)
  - Climate Prediction Center’s Outlook into 2017
    (new CPC outlooks were issued today!)
What is Climate Normal?

- Answer: 30 Year Average, updated every 10 years.
- The latest climate normal is 1981-2010.
- Now we are half way to a new climate normal period that will be 1991-2020.
What is Normal?
Grand Junction Precipitation - 30 Year Average
What is Normal?
Grand Junction Precipitation - 30 years and 2015

Monthly Precipitation Inches

- 1981-2010
- 1981
- 1982
- 1983
- 1984
- 1985
- 1986
- 1987
- 1988
- 1989
- 1990
- 1991
- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

1982 1997 2015
Colorado Precipitation Patterns

Average Annual Precipitation
Colorado

Valleys: 8-15"
- Grand Junction 9.38"

Mountain valleys: 25"
Mountains: 30-58"

Legend (in inches):
- Under 10
- 10 to 15
- 15 to 20
- 20 to 25
- 25 to 30
- 30 to 35

Period: 1961-1990
Western Colorado Climate

- Colorado has a continental, semi-arid climate.
  - Experiences large temperature and precipitation variation at all time scales.
- Our precipitation falls mainly in the high country.
  - Snowpack is a natural reservoir.
  - All Colorado rivers, but the Green, originate here and flow out of state.
-Seven Snow Study Sites-
Chosen for their long climate records

Valley Coop Sites, Not Ski Areas

Telluride*  Up to 2008

Steamboat Springs  Winter Park

Aspen  Breckenridge

Crested Butte  Silverton

*Telluride data up to 2008
Colorado Mountain Sites Monthly Snowfall

Monthly Snowfall Inches

- 1981-2010
- 2015-2016
Colorado

SNOTEL Current Snow Water Equivalent (SWE) % of Normal

Feb 17, 2016

Drier than normal

Current Snow Water Equivalent (SWE) Basin-wide Percent of 1981-2010 Median

- unavailable *
- <50%
- 50 - 69%
- 70 - 89%
- 90 - 109%
- 110 - 129%
- 130 - 149%
- >=150%

* Data unavailable at time of posting or measurement is not representative at this time of year.

Provisional Data Subject to Revision

The snow water equivalent percent of normal represents the current snow water equivalent found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

Prepared by:
USDA/NRCS National Water and Climate Center
Portland, Oregon
http://www.wcc.nrcs.usda.gov
Westwide SNOTEL Current Snow Water Equivalent (SWE) % of Normal

Feb 17, 2016

Drier than normal

Wetter than normal

Provisional data subject to revision

USDA NRCS

The snow water equivalent percent of normal represents the current snow water equivalent found at selected SNOTEL sites in or near the basin compared to the average value for those sites on the day. Data based on the first reading of the day (typically 0600).
• Colorado has enjoyed a wet year.
• What about the previous five years?
  • How does 2011-2015 compare to the current 30 year average 1981-2010?
• What about the last 100 years?
### Changes in Monthly Average (1981 to 2010)-(2011 to 2015)
in degrees F or inches of Precipitation
(positive values mean 2011-2015 years are warmer/wetter)

<table>
<thead>
<tr>
<th>Station</th>
<th>Elevation (ft)</th>
<th>Tmax</th>
<th>Tmin</th>
<th>Tave</th>
<th>Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dinosaur N.M.</td>
<td>5900</td>
<td>-0.7</td>
<td>1.6</td>
<td>0.5</td>
<td>-2.56</td>
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<tr>
<td>Steamboat Springs</td>
<td>6960</td>
<td>-0.1</td>
<td>1</td>
<td>0.4</td>
<td>0.37</td>
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<tr>
<td>Colorado N.M.</td>
<td>5660</td>
<td>-0.7</td>
<td>2.4</td>
<td>0.9</td>
<td>0.47</td>
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<tr>
<td>Grand Junction</td>
<td>4858</td>
<td>-0.4</td>
<td>-1.1</td>
<td>-0.8</td>
<td>1.01</td>
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<tr>
<td>Paonia</td>
<td>5645</td>
<td>-0.3</td>
<td>-0.4</td>
<td>-0.4</td>
<td>0.15</td>
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<tr>
<td>Crested Butte</td>
<td>8860</td>
<td>1.3</td>
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<td>0.9</td>
<td>-3.43</td>
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<td>Montrose</td>
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<td>0.8</td>
<td>1.3</td>
<td>1.1</td>
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<tr>
<td>Gunnison</td>
<td>7640</td>
<td>0.2</td>
<td>0.4</td>
<td>0.2</td>
<td>-1.1</td>
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<tr>
<td>Silverton</td>
<td>9320</td>
<td>0.8</td>
<td>0.6</td>
<td>0.5</td>
<td>-2.2</td>
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<tr>
<td>Hovenweep N.M.</td>
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<td>1.8</td>
<td>1.3</td>
<td>0.11</td>
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<tr>
<td>Cortez</td>
<td>6153</td>
<td>1.7</td>
<td>2</td>
<td>1.8</td>
<td>-0.26</td>
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<tr>
<td>Mesa Verde N.P.</td>
<td>7115</td>
<td>0.9</td>
<td>2.1</td>
<td>1.5</td>
<td>-2.21</td>
</tr>
<tr>
<td>Flaming Gorge N.R.A.</td>
<td>6040</td>
<td>0.7</td>
<td>2.9</td>
<td>1.9</td>
<td>-2.52</td>
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<tr>
<td>Vernal</td>
<td>5278</td>
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<td>2.1</td>
<td>0.7</td>
<td>-0.54</td>
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<tr>
<td>Moab</td>
<td>4026</td>
<td>-1.1</td>
<td>0.3</td>
<td>-0.4</td>
<td>0.35</td>
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<tr>
<td>Canyonlands The Neck</td>
<td>5930</td>
<td>0.2</td>
<td>1.6</td>
<td>0.9</td>
<td>0.48</td>
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<td>Canyonlands The Needles</td>
<td>4998</td>
<td>-0.4</td>
<td>0</td>
<td>-0.2</td>
<td>-0.21</td>
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<tr>
<td>Natural Bridges N.M.</td>
<td>6500</td>
<td>0.3</td>
<td>0.3</td>
<td>0.4</td>
<td>-0.82</td>
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<td>Blanding</td>
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<td>-0.6</td>
<td>2</td>
<td>0.7</td>
<td>-2.02</td>
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<td>Mexican Hat</td>
<td>4130</td>
<td>1.2</td>
<td>1.1</td>
<td>1.1</td>
<td>-0.56</td>
</tr>
<tr>
<td><strong>Total Average</strong></td>
<td><strong>6101</strong></td>
<td><strong>0.2</strong></td>
<td><strong>1.1</strong></td>
<td><strong>0.7</strong></td>
<td><strong>-0.8</strong></td>
</tr>
</tbody>
</table>

- In the last 5 years, the region has been drier and warmer, especially in our low temperatures.
- Grand Junction, wetter and cooler.
Changes in Monthly Average (1981 to 2010)-(2011 to 2015) in degrees F or inches of Precipitation (positive values mean 2011-2015 years are warmer/wetter)

For 2011-2015, the drying trend has been stronger in higher elevations.
Study Sites with Climate Data back to 1911

Eleven sites, average elevation 6558 feet
Problems with Climate Sites (Grand Junction Example)

- The site could have moved
Problems with Climate Sites (Grand Junction Example)

- Urbanization can create local warming
Problems with Climate Sites (Grand Junction Example)

- Instrumentation has changed
Where Are These Site Problems Minimized?

• National Parks and Monuments
  • Faming Gorge NWR 1958
  • Dinosaur NM 1964
  • Ouray NWR 1956
  • Colorado NM 1940
  • Canyonlands (Neck and Needles) 1965
  • Natural Bridges NM 1965
  • Hovenweep NM 1957
  • Mesa Verde NP 1924
National Parks and Monuments with Climate Data back to 1961

Nine sites, Average elevation: 5839 feet
Maximum Temperatures per Decade since 1911

Western Colorado and Eastern Utah
Maximum Temperatures 10 Year Average

Forecast Area
Forecast Area 2011-15
Parks Monuments
Parks Monuments 2011-15
Minimum Temperatures per Decade since 1911

Western Colorado and Eastern Utah
Minimum Temperatures 10 Year Average
Western Colorado and Eastern Utah
Precipitation 10 Year Average
Western Colorado Climate History

- The last five years have showed a drying and partial warming trend.
- The last 100 years have shown large variations in precipitation.
- The last 100 years have shown little change in maximum temperatures.
- Minimum temperatures have shown a warming trend since the 1970s.
Climate Future

- A climate outlook for the El Niño spring season.
- Who knows for summer!
- An outlook into a La Niña winter.
- El Niño Southern Oscillation
El Niño Southern Oscillation (ENSO)

- Simple Definition: variance from normal sea surface temperatures (and sea level pressure and winds) in the eastern **equatorial** Pacific Ocean.
  - El Niño: a warm change (+ENSO)
  - La Niña: a cold change (-ENSO)

- ENSO changes the jet streams (winds aloft) which changes the storm track with resulting predictable effects

- ENSO effects are felt mainly in the cold season
- ENSO: primary winter outlook tool
Current Pacific Conditions:

Current Ocean Niño Index 2.3 (strong), this week 2.5,
Current Pacific Decadal Oscillation 1.53 (also quite warm)
### ENSO Events Since 1950

<table>
<thead>
<tr>
<th>El Nino (22 events)</th>
<th>La Nina (23 events)</th>
<th>ENSO Neutral (21 events)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009-2010</td>
<td>2010-2011</td>
<td>2013-2014</td>
</tr>
<tr>
<td>1994-1995+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1991-1992+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1951-1952</td>
<td>1954-1955</td>
<td></td>
</tr>
<tr>
<td>1950-1951+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

La Niña tend to follow El Niño
- **El Niño**
  - Dry and Warm
  - North of Colorado
  - Wet and Cool
  - South of Colorado

- **La Niña**
  - Wet and Cold
  - North of Colorado
  - Dry and Warm
  - South of Colorado
Seven Colorado Mountain Sites

La Niña: a wet December-January (northern mountains)

El Niño Fall and Spring (southern mtns)

Monthly Snowfall Inches

- El Nino Average
- La Nina Ave
- 30 Year Average 1981-2010
ENSO Review

• ENSO is an important part of long-range national forecasts
• Colorado precipitation is highly variable and has some subtle cold season response to ENSO
• El Niño tends to produce a wetter spring and fall.
• El Niño years are wetter south, drier north.
• La Niña produces a snowier heart of winter, centered on January, wetter north, drier south.
• The ENSO dividing line is roughly the I-70 corridor.
Climate Prediction Center’s Outlook
For Spring Season March-April-May

Temperature

Precipitation
Climate Prediction Center’s Outlook
For Summer Season June-July-August
Climate Prediction Center’s Outlook
For Fall Season Sep-Oct-Nov
Climate Prediction Center’s Outlook
For Winter Season Dec-Jan-Feb
Climate Outlook Review

- El Niño has produced a wet winter season for Colorado so far.
- El Niño springs are typically wet.
- Summer climate signals are weak for precipitation, but with a shift towards warmer than normal.
- La Niña may develop next fall and winter.
- La Niña tends to produce a dry autumn.
- La Niña tends to produce a snowy heart of winter mainly across northwest Colorado.
Questions?