Gradients and 2D Visualization of Multiple Variables

CS137 Assignment #2

1. Dates

Out	Thursday, September 24, 2015
Part A Due	Tuesday, September 29, 2015
Part B Due	Tuesday, October 6, 2015
Questions Due	Tuesday, October 6, 2015

2. Goals

1. Gain an understanding of the sources of experimental and computational data.
2. Learn about scientific data and identify relationships among variables in scientific data.
3. Learn to create a visualization showing overlaid variations in the relationships among multiple variables in a dataset.
4. Explore and experiment with color and shape gradients, layering, metaphorical reading of visual elements, and legend design.

3. Readings

- For Part A:
  - *Color and Information, ch. 3 of Envisioning Information* by Edward Tufte
  - *Visual Thinking for Design* by Colin Ware, chapters:
    - 2: *What We Can Easily See*
    - 3: *Structuring Two-Dimensional Space*
  - *Loose, Artistic Textures for Visualization* by David H. Laidlaw. IEEE Computer Graphics and Applications, 21(2):6-9, March/April 2001.
  - *Patterns in Nature* by Peter Stevens, pp.53–71. pp.53–67 are in the linked PDF; see the book in the Cave room for the additional pages.
- For Part B:
  - *World of Science Encyclopedia*, Volume 14, pp.119-128. Motion Of Fluids [2]
  - *Comparing 2D vector field visualization methods: A user study*, by David H. Laidlaw, Michael Kirby, Cullen Jackson, J.Scott Davidson, Timothy Miller, Marco DaSilva, William Warren, and Michael Tarr. TVCG, 11(1):59-70, January 2005.
  - *Strategies for the Visualization of Multiple 2D Vector Fields*, by Timothy Urness, Victoria Interrante, et al. IEEE CG&A, 26(4):74-82, July 2006.

4. Assignment

4.1 Part A: Gradient Design

A gradient is defined for this assignment as any gradually changing visual element or visual quality: a color blend or fade, a morphing texture, a thickening line or accumulation of lines, a gradual change in orientation of a line, form, or pattern. Begin the design process for a 2D visualization of a **synoptic weather map** (Part B) by generating a **resource library** of as many different kinds of gradients as you can imagine. A list of some possible qualities or characteristics follows.

Consider the legibility of each gradient; its change should be easily perceivable. Ideally, there should only be one varying visual aspect per gradient, but you can experiment also with marks that contain two or more separately varying qualities. This is fine as long as the two varying qualities can be adjusted independently of each other. Consider also its legibility in a complex "layered" situation, in the company of other gradients. Not only should the gradient be legible in "mixed company" but also it should not interfere with the legibility of its neighbors. You can highlight the "combinability" of your gradients by showing them in tandem usage with others. Finally, consider the "intuitive reading" of your various gradients: the possible interpretation a viewer might have of the coded meaning shown by the change that takes place in the gradient: intensification of force; increase/decrease of velocity; temperature etc.

There are three sets of compositions that you have to make for this assignment:

1. Make a "library" chart with at least 15 different visual gradients, showing the full range of the variation of each. Each gradient should be depicted by itself, not in conjunction with anything else.
2. Consider each gradient's legibility in a complex layered situation with other gradients. Each gradient should be legible when layered and should not interfere with the legibility of its neighbors. Make a new chart with 10 combinations of **two or more gradients** from your library. Try to mix gradients that have easily discernible difference in terms of their associative character.
3. Finally, make **five gradient compositions,** each with five or more layered gradients, adjusted for co-legibility, as described above. Imagine a 2D field with forces playing across it, each represented by a different, clearly legible gradient.

Possible materials:

- Line:
  - vine charcoal
  - Soft Pencil
  - Ballpoint pen
  - nib pen
  - reed pen
  - felt tip
  - chalk
  - dipped thread, string or yarn
  - ink and brush.
- Color:
  - watercolor
  - oil paint
  - gouache
  - ink
  - dye
  - marker
  - pastel

Possible gradient types:

- Color change:
  - Value—light to dark
  - Hue—compliment blend, temperature change
  - Saturation—neutral to intense
  - Transparency/Opacity
- Linear shape:
  - Thickness
  - Length
  - Orientation
  - Curve/straight
  - Zig zag or wave form: tighter or looser interval
- Shape:
  - Size
  - Round/angular
  - Simple/complex

    - crayon
    - conte crayon
    - autumn leaves
    - food stain
    - flower petals.
- 2D Textures:
    - Any object inked and stamped
    - crumpled paper sprayed or rubbed with paint at an angle
    - wet into wet diffusion of ink or watercolor
    - heavily textured papers (like cold-press watercolor paper)
- Physical Textures:
    - crumpled paper or fabric (inked and printed or drawn on directly)
    - tape or foil or ribbon (pasted down)
    - glue with sand, dirt or dry pigment
    - twigs
    - leaves, grass etc. acrylic modeling paste, gel or medium (also good to use as glue)
    - Geometric/amoebic
    - Orientation
    - Flat/volumetric
- Pattern:
    - Density
    - Size of unit
    - Direction/orientation
- Texture:
    - Contrast
    - Opacity
    - Rough/smooth

4.2 Part B: 2D Graphing of Multiple Variables

For this assignment you must create a **synoptic weather map**: a summation of various conditions related to weather in a composite image, using various gradients and icons of your own choosing to legibly show the overlapping variables in the data.
Attached are 21 different maps showing a variety of conditions for a particular date in the continental U.S. The data is shown through color gradients, numerical indications, graphic icons or photographic imagery. Keys or legends are provided where necessary. Some data is shown in more than one map, or in different combinations.
You should not simply duplicate any of the maps, but make a new visualization based on data selected from a number of different maps. Your map should show a **minimum of six different data variables** selected from the list below, with a **minimum of 4 from Group A**.

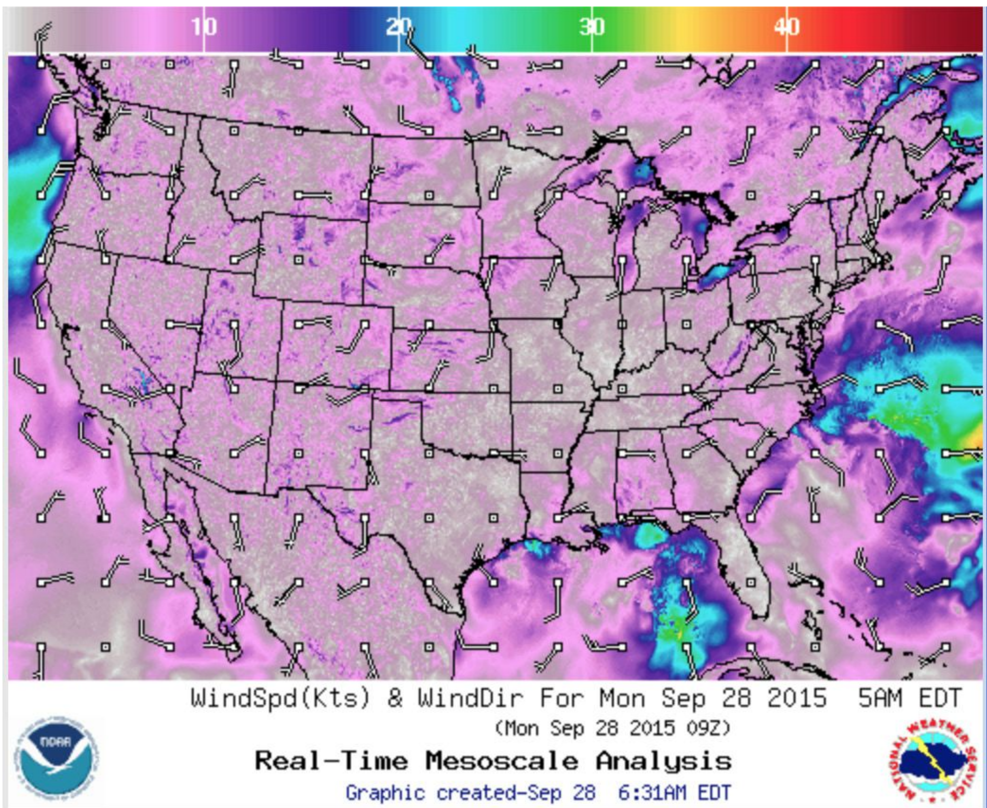
<u>Group A</u>
Wind Speed
Wind Direction
Barometric Pressure Pattern
Water Vapor
Cloud Temperature

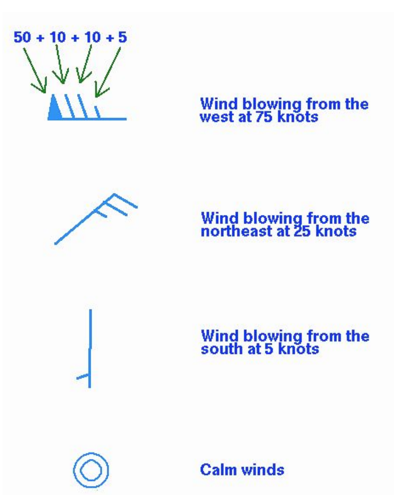
Group A cont.
Temperature
Cloud Cover
Weather Fronts

Group B
Drought Conditions
Precipitation Amounts
Dust Condtions
Flight Rules
Jet Stream
Smoke Conditions
Wind Gusts

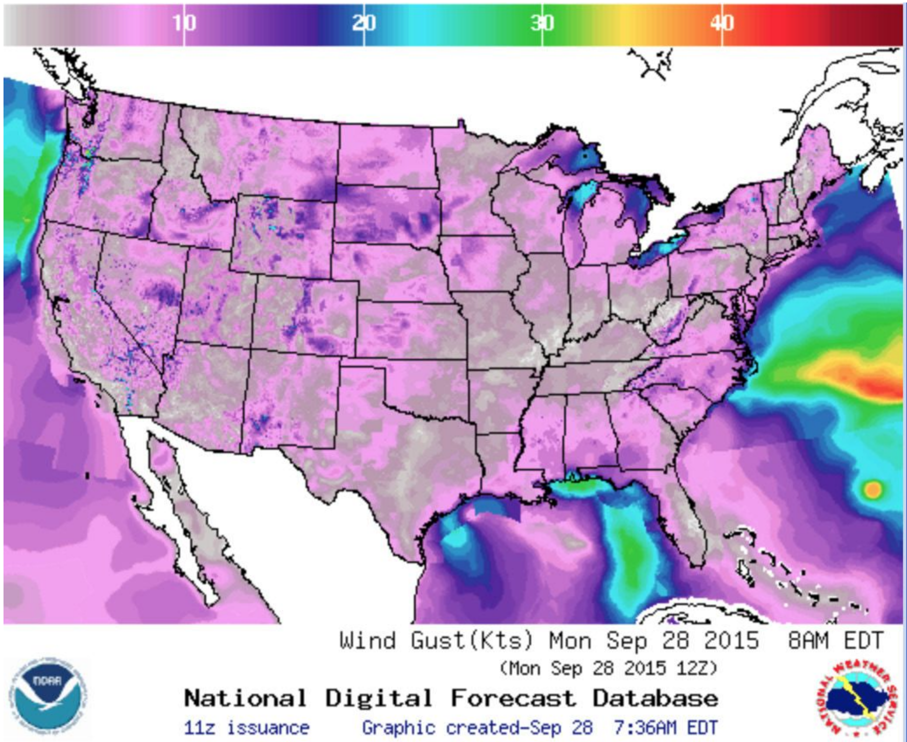
Begin by assessing the data, researching weather terminology and principles to cement your understanding where necessary. Then consult your gradient library for possible visual representation of each variable in the data. Ideally, the gradient you choose for a specific variable should have an **intuitive reading** connected with your understanding of the variable: e.g. your gradient for barometric pressure should evoke barometric pressure in some way. You can invent new variables if your library doesn't contain anything suitable.
If your combined map is organized around making a certain point, for example that flight conditions are being affected by wind and rain and dust, that would be excellent, but it is not necessary.
Your gradient choices should take layering into account: the gradients should not interfere with each other in combination. Visual simplicity of the whole will enhance the legibility of individual values and of data interconnection.
Do not use letters, text or numbers, but find gradient or iconic replacements. Design a **clear, well-organized legend with a key for each of your gradients or icons**, detailing visual change in relation to the changing value of each data variable. Label the axes of the keys with numeric data values, based on the maps.
The emphasis in your completed map should be on simultaneous legibility: all the aspects of the data should be easily understandable, and the variations in the data should be as specifically shown as possible. For example, it's important that the temperature gradient be separately legible from overlapping gradients showing wind speed, barometric pressure etc. but also that the increments of temperature change be as discernible as specifically as possible. To achieve this specificity, make sure to choose a visual variable that will allow you to **differentiate between the incremental change in the data**. Temperature, for example, may require a more finely differentiated visual gradient than cloud cover.
Your map should be on paper or cardboard or other flat surface, at a size large enough to be visible to the whole class during the crit. You may use physical or digital media, or a combination. A limited degree of three-dimensional texture or icons is fine , but the map should be able to hang easily on the wall. You can use actual, removable layers for each variable (on acetate, mesh or other transparent materials, for example) that will allow you to separate or

change the order of the layers. However, the map should be fully legible with all overlapping layers in place.
Finally, import your weather map into the Yurt, to test the visibility of the various gradients in those conditions. **We will look at your map as a physical object in daylight, and as a Yurt display**. If it's possible for you to isolate the six variable and import then as separate layers for toggling overlaying in the Yurt, please do so, but it is not required.

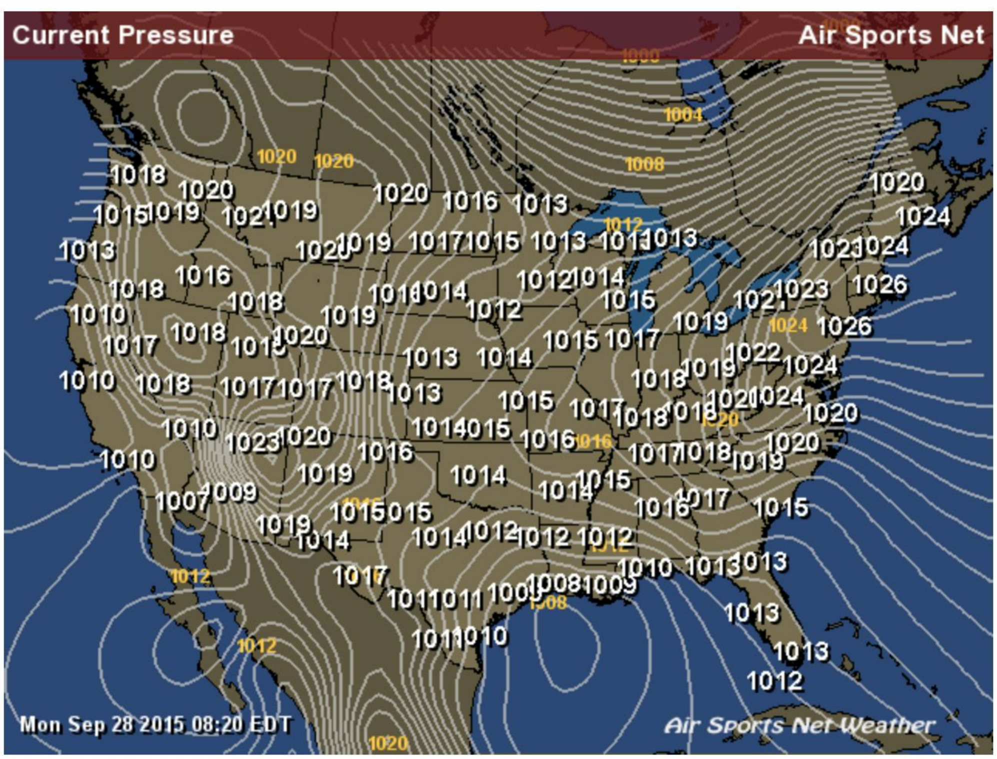




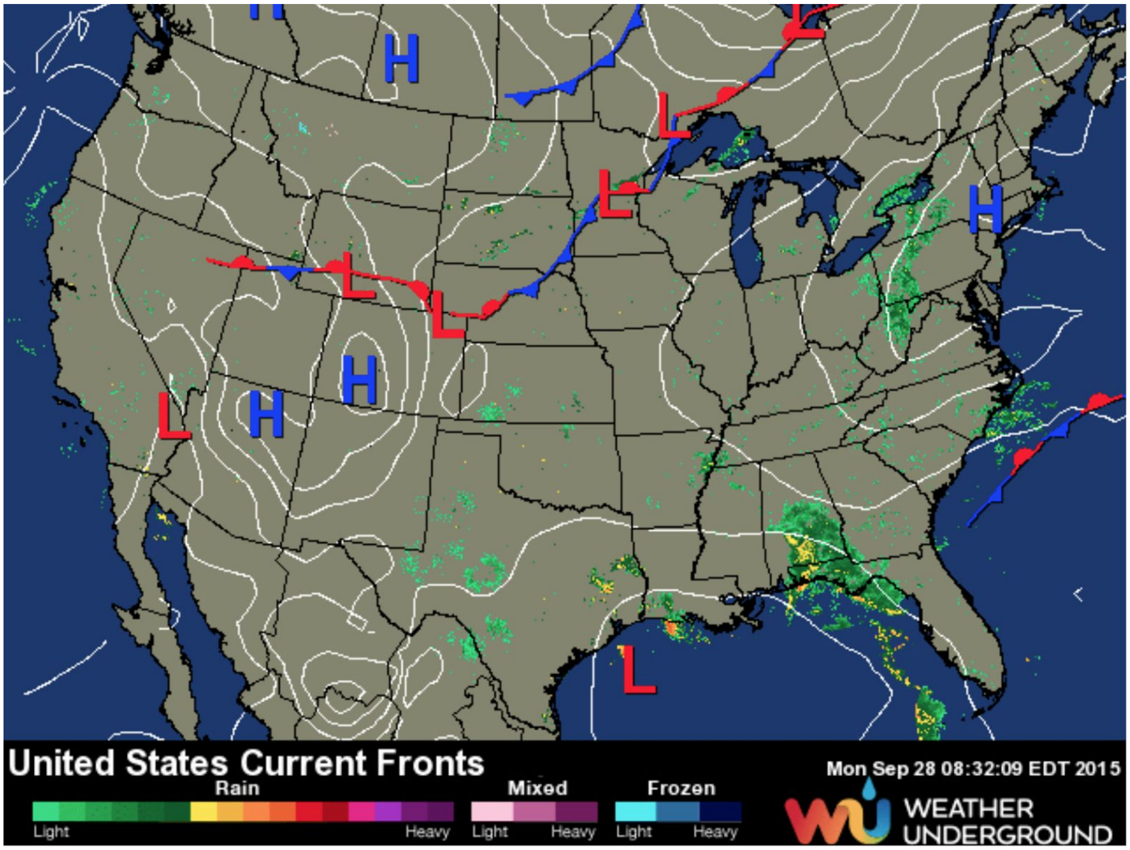
Wind Speed (color) and Wind Direction (icons)

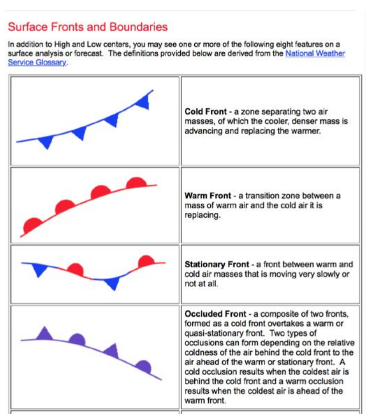


Wind Gusts (Color)



Barometric (Atmospheric) Pressure (numbers and isobars)



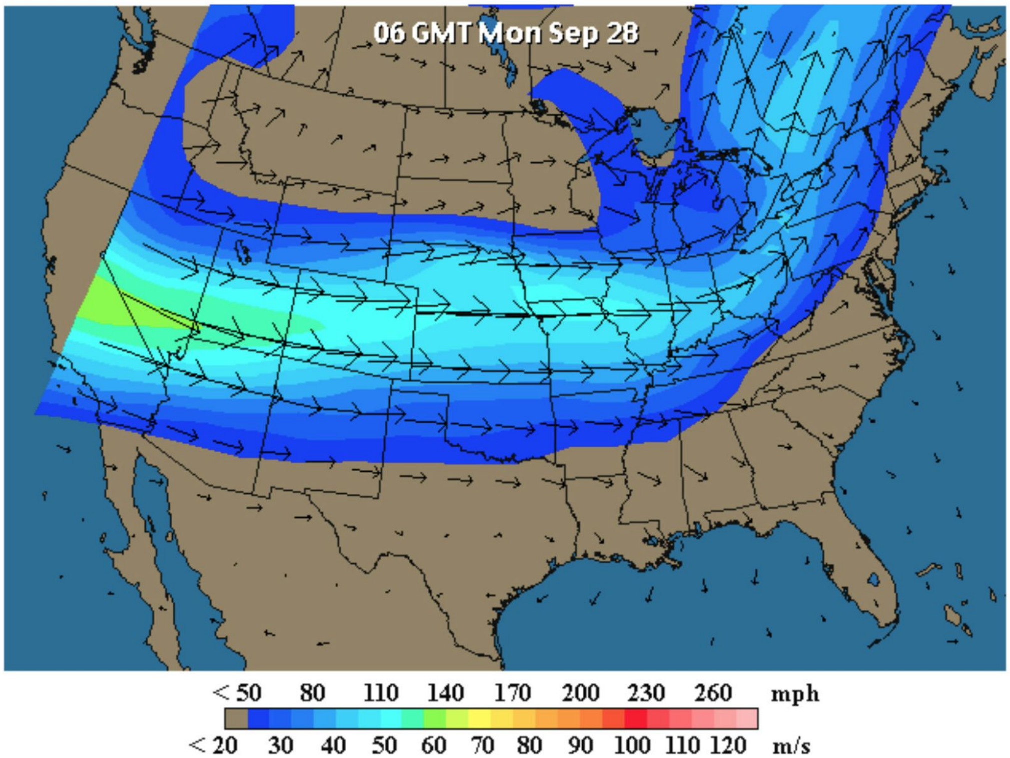


Surface Fronts and Boundaries

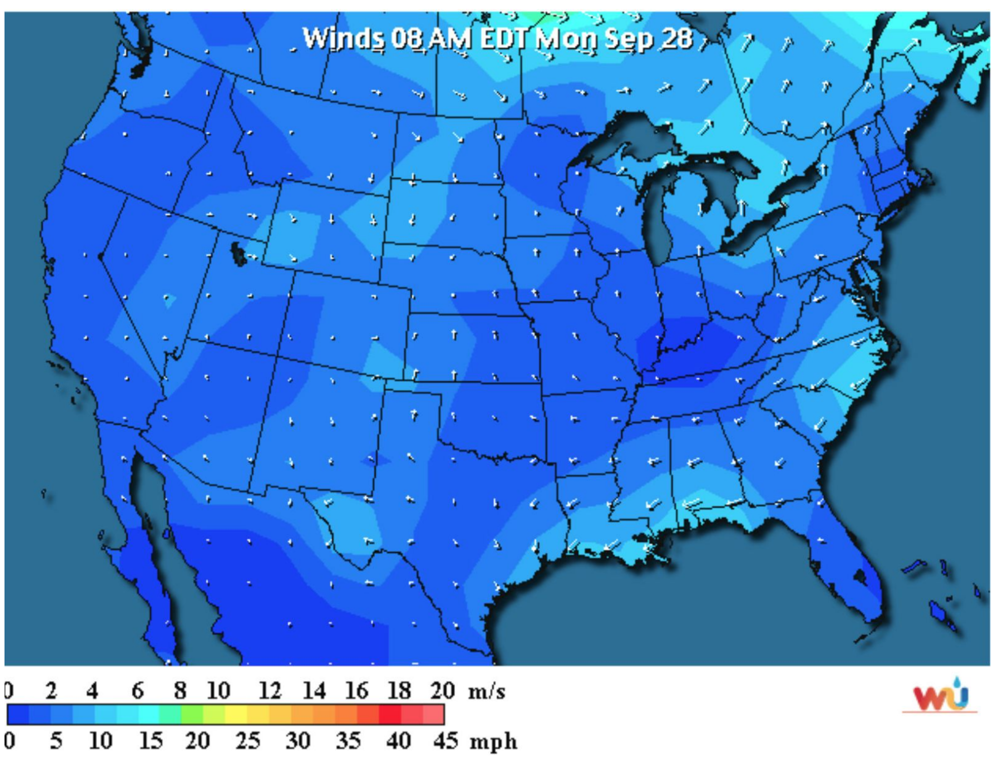
In addition to High and Low centers, you may see one or more of the following eight features on a surface analysis or forecast. The definitions provided below are derived from the National Weather Service Glossary.

	Cold Front - a zone separating two air masses, of which the cooler, denser mass is advancing and replacing the warmer.
	Warm Front - a transition zone between a mass of warm air and the cold air it is replacing.
	Stationary Front - a front between warm and cold air masses that is moving very slowly or not at all.
	Occluded Front - a composite of two fronts, formed as a cold front overtakes a warm or quasi-stationary front. Two types of occlusions can form depending on the relative coldness of the air behind the cold front to the air ahead of the warm or stationary front. A cold occlusion results when the coldest air is behind the cold front and a warm occlusion results when the coldest air is ahead of the warm front.

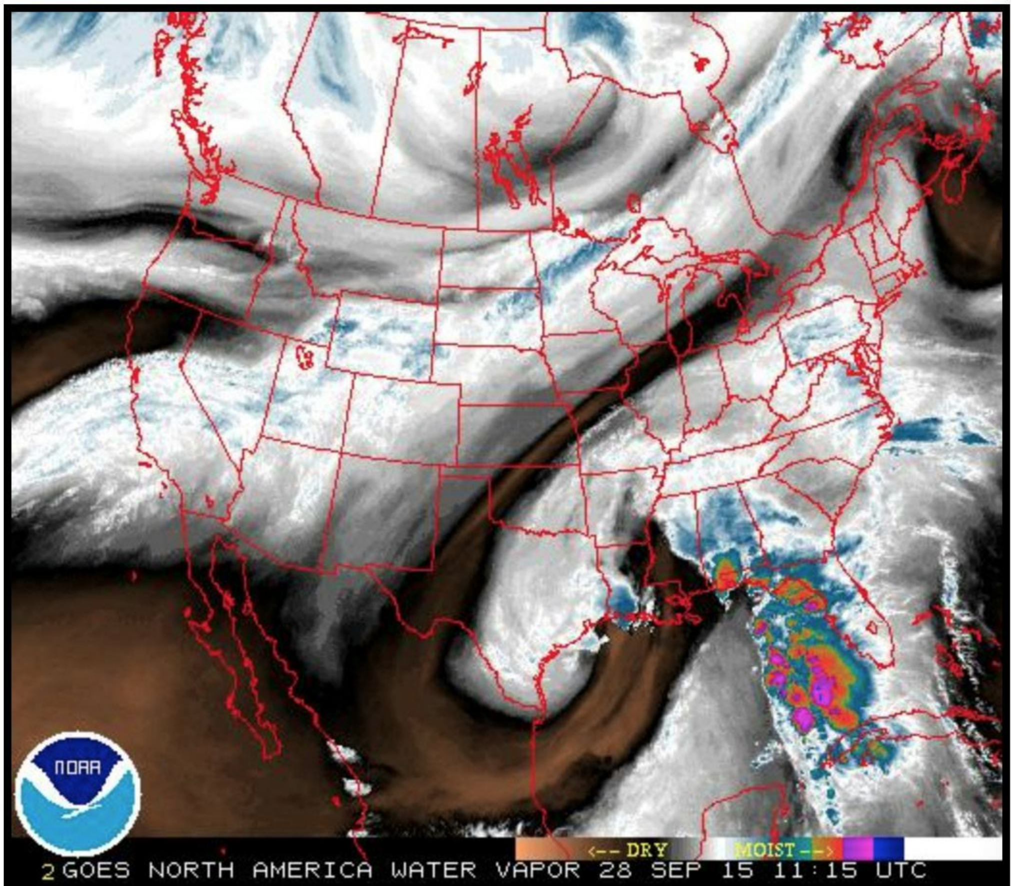
Barometric Pressure Systems (Isobars) Weather Fronts (Letters and Icons)
Precipitation (Color)



Jet Stream Speed and Direction (Colors and Icons)



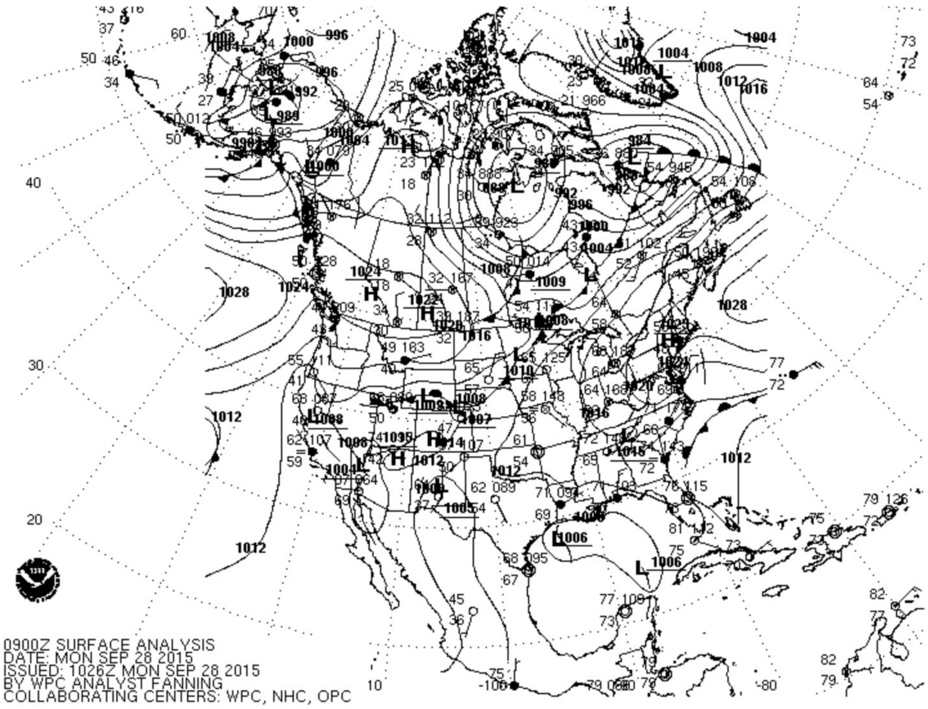
Wind Speed (Color) and Direction (Icons)



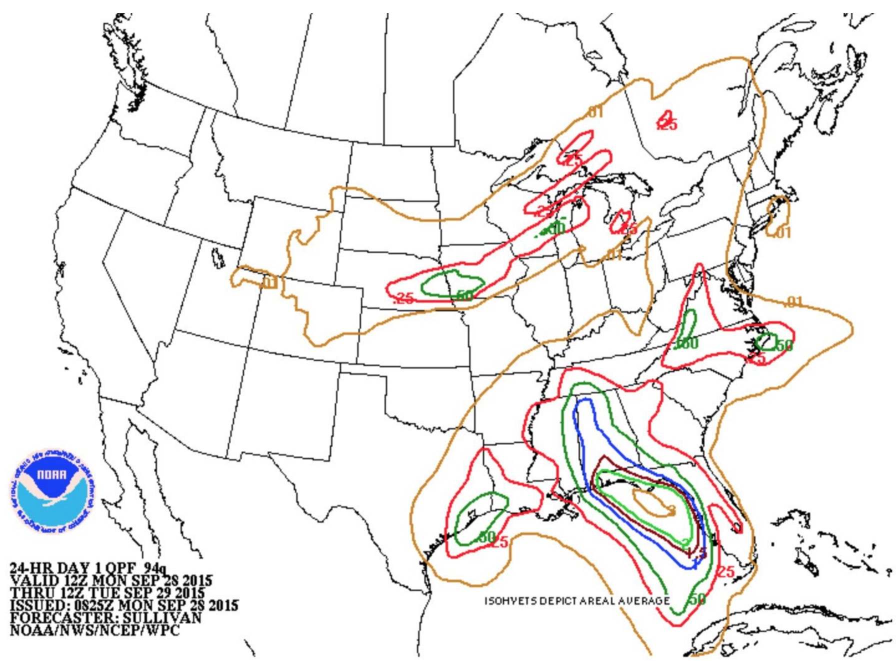
Water Vapor

This image is taken using a wavelength sensitive to the content of water vapor in the atmosphere. Bright and colored areas indicate high water vapor (moisture) content (colored and white areas indicate the presence of both high moisture content and/or ice crystals). Black and brown areas indicate little or no moisture present. Water vapor imagery is useful for both determining locations of moisture and atmospheric circulations.

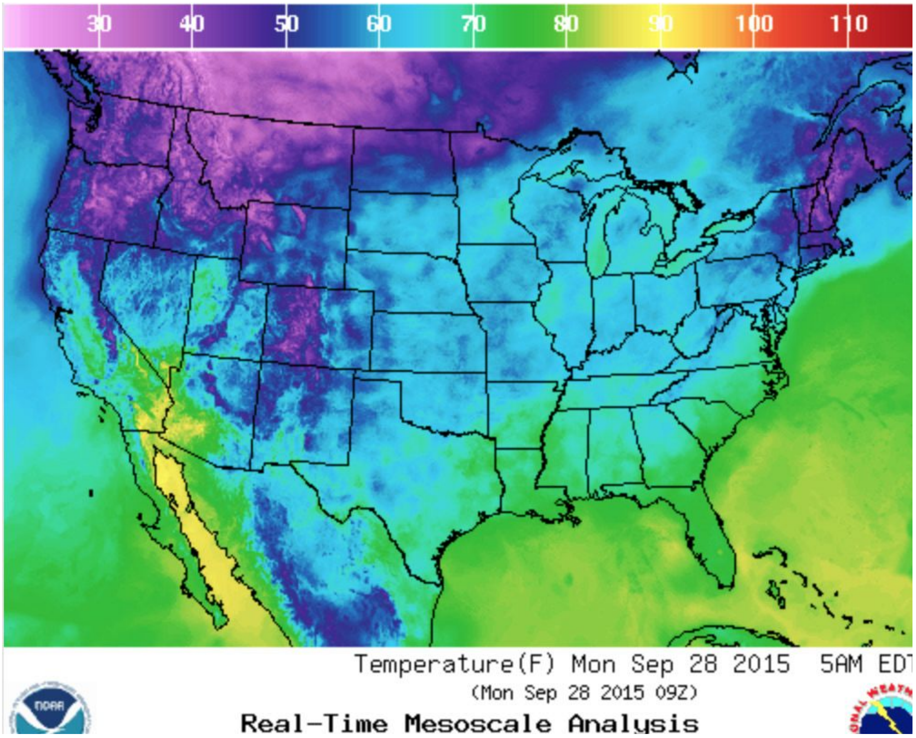
Satellite Image with color enhancements



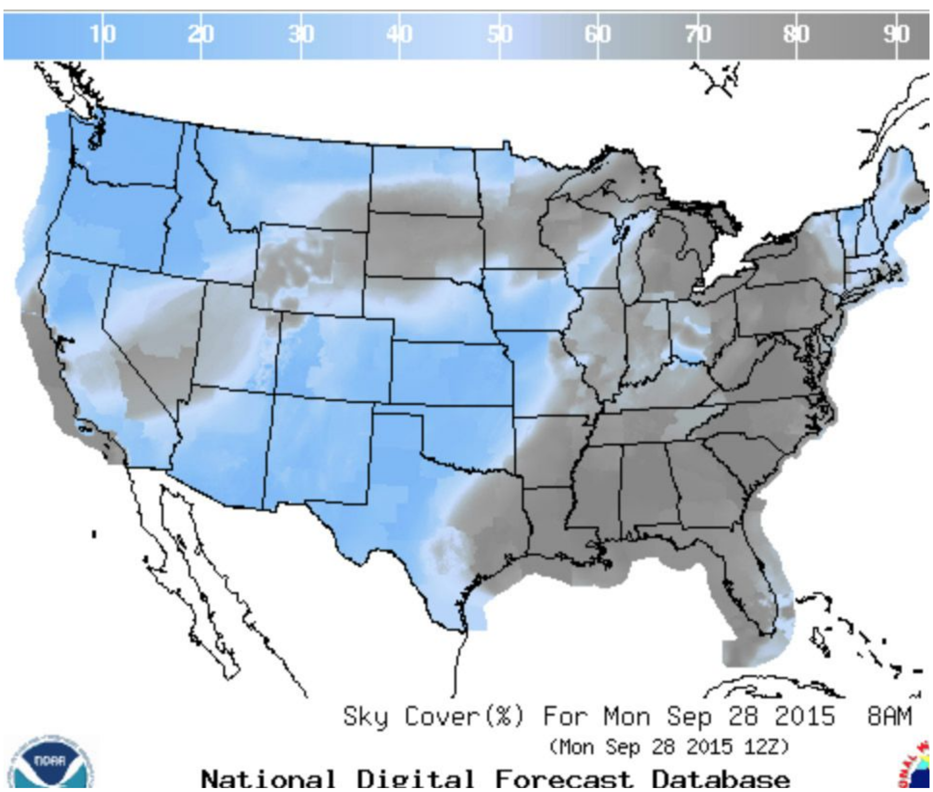
Surface Analysis (Barometric Pressure and Patterns, Weather Fronts, Wind, Temperature)



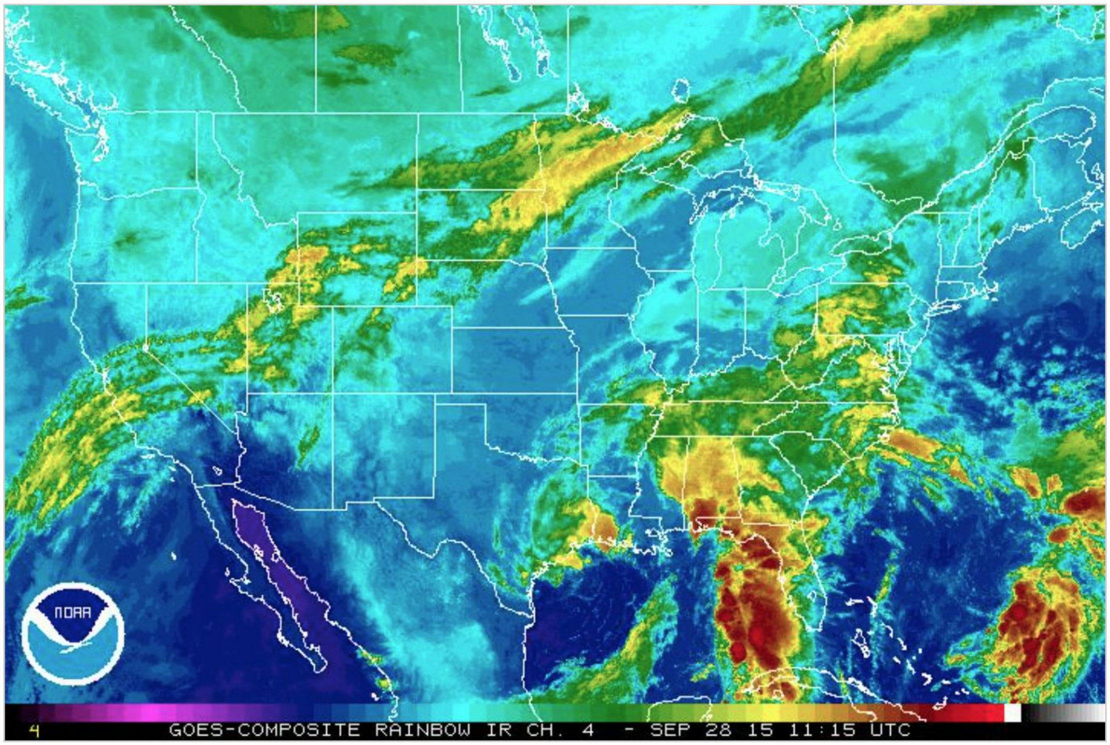
Precipitation Amounts (Colored Lines, Numbers)



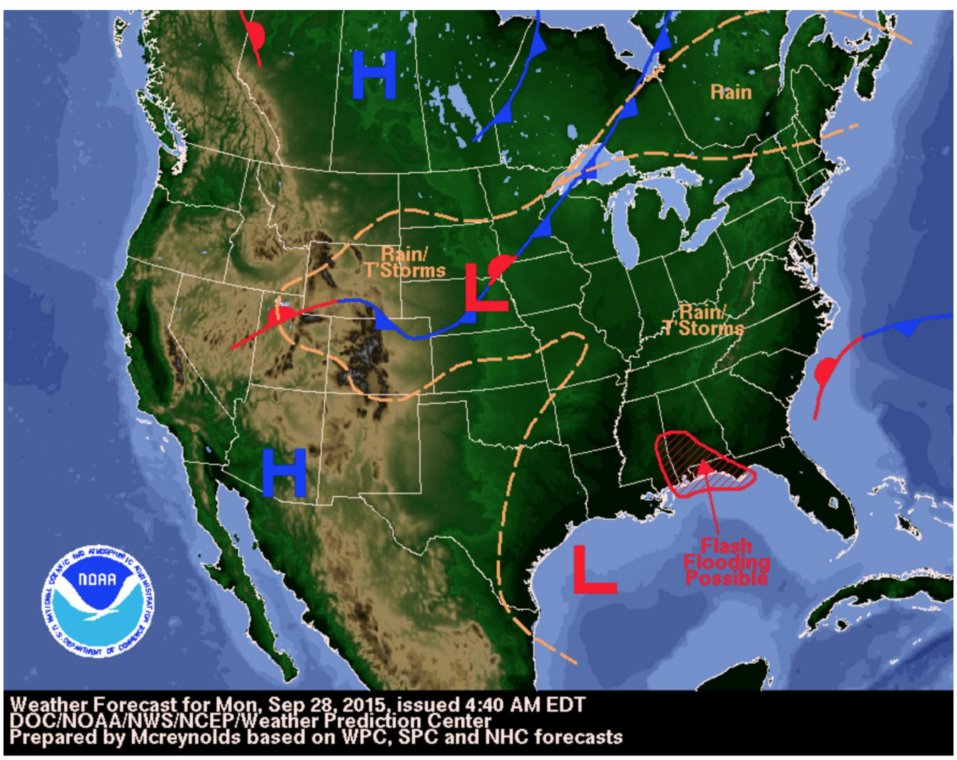
Temperature (Color)



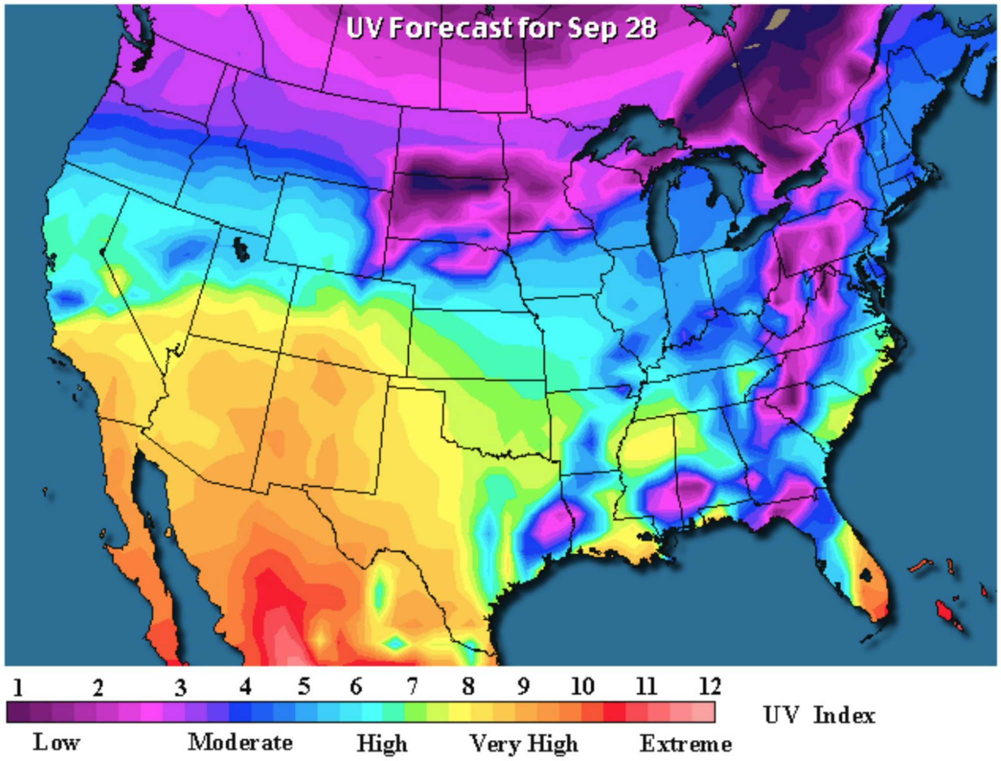
Sky Cover (Color)



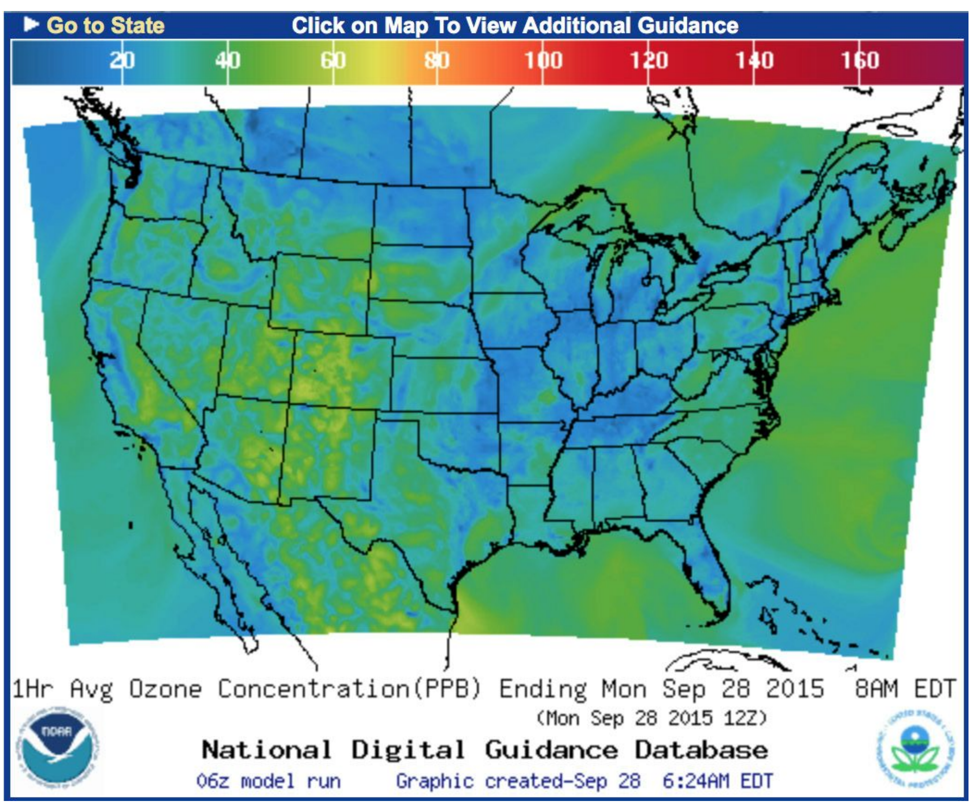
Infrared Photograph: Cloud Temperature (Color Enhanced)



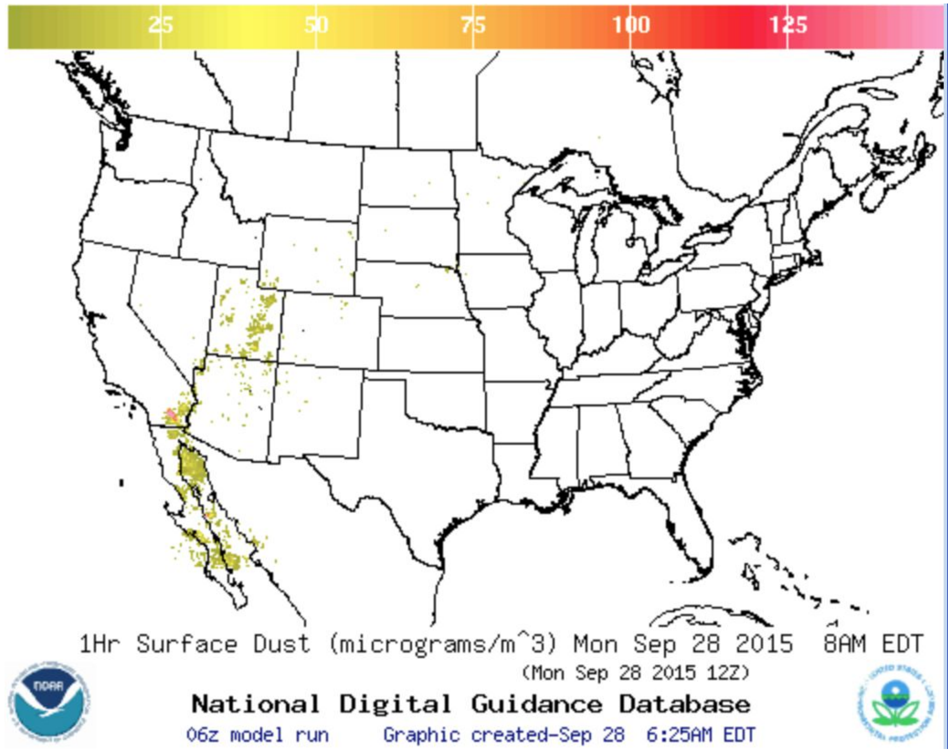
Forecast Composite: Fronts (Letters and Icons)
Precipitation and Flood Risk (Colored Lines and Text)



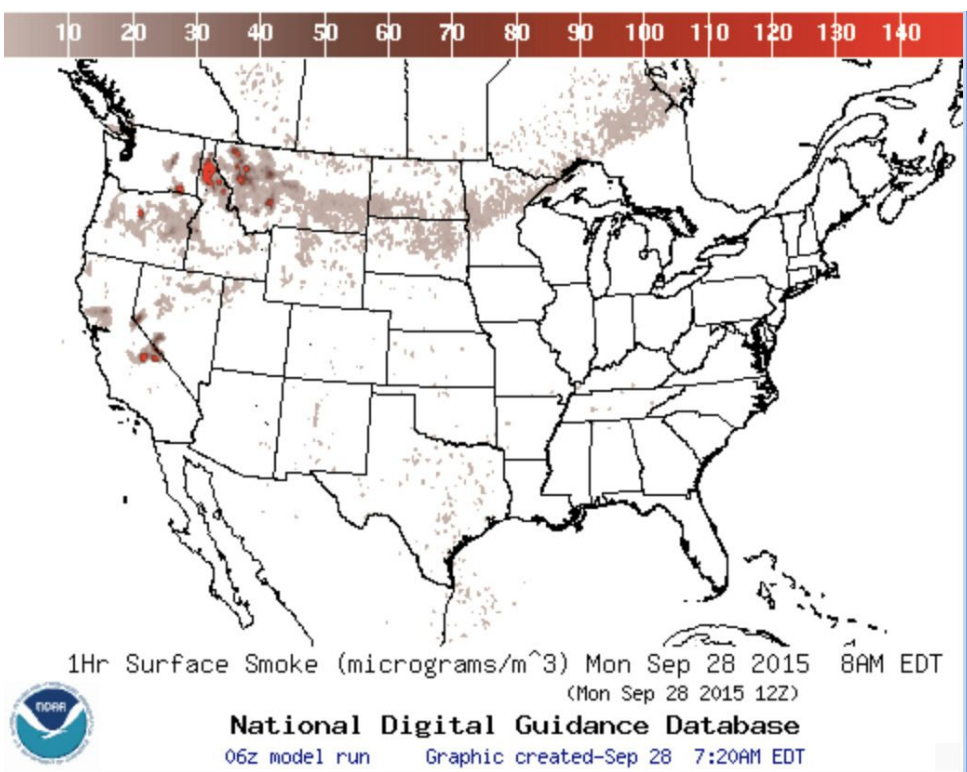
Ultraviolet Radiation (Color)



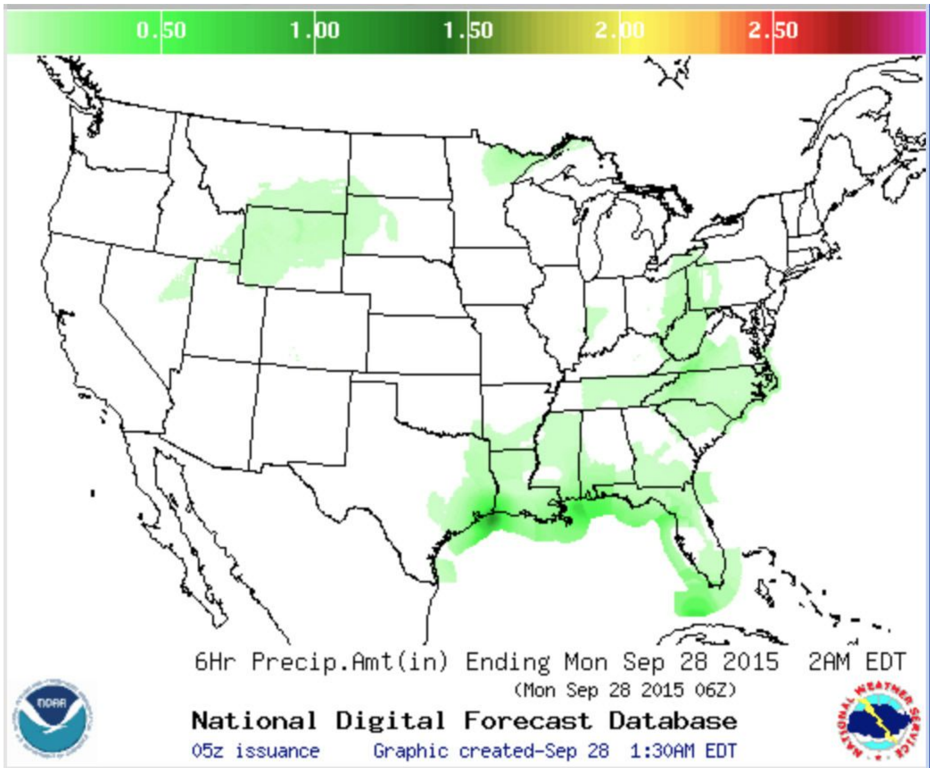
Ozone Concentration (Color)



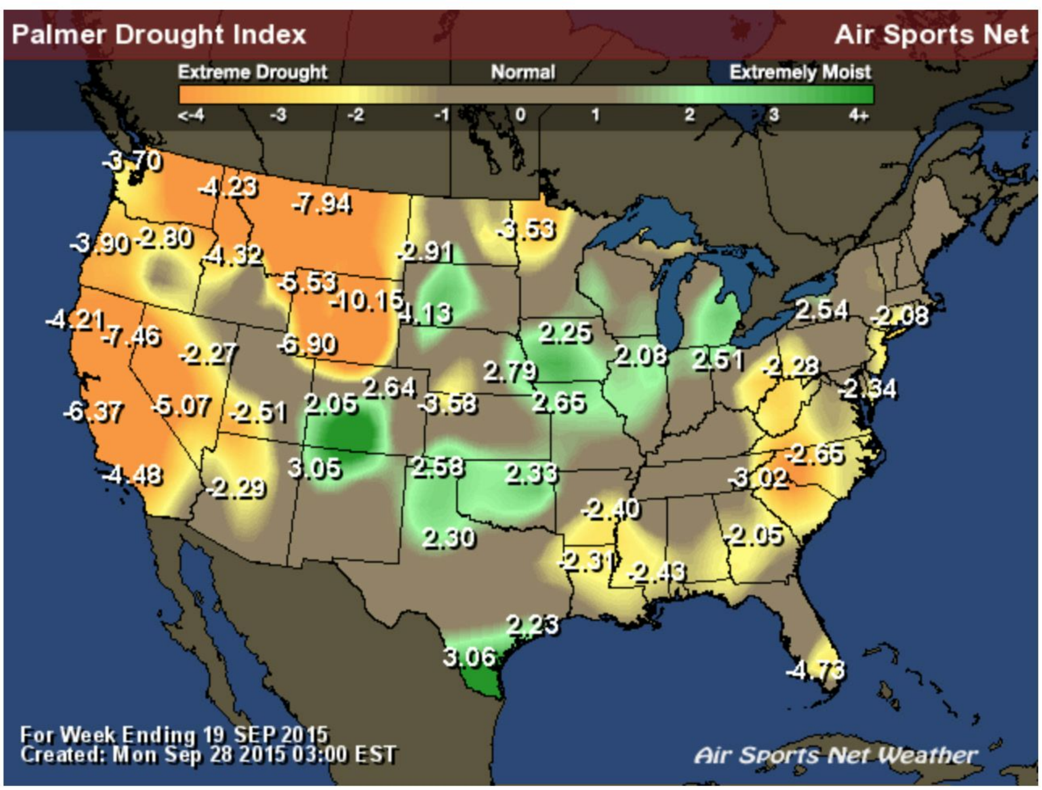
Surface Dust (Color, Texture)



Surface Smoke (Color, Texture)



Precipitation Amounts (Color)



Drought Conditions (Color, Numbers)

5. Questions (answer briefly)

Questions are due, emailed to the TA, by 9am on the due date for part B. Most of these are very short questions intended to help guide you through the assignment. They should not take long to answer. Most of the time, a very brief, one sentence or less, answer is sufficient.

1. How well are data values discernable in your visualization?
2. How well are relationships among data values visualized easily by your design?
3. What are the factors behind your choice of visual characteristics that show gradient?
4. What are additional factors that need to be considered when designing visualization that are different when you think about this problem in 3D in the Cave as opposed to in 2D on paper?