Flow Visualization
MCEN 5151

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1st Cloud Assignment

3/3/11

A Variety of Clouds above San Francisco on 02/20/2011.

Image Purpose: The goal of this image was to capture several different clouds at drastically different elevations, giving the picture a layered appearance. The first and closest layer is the profile of the buildings and trees. This layer grounds the picture while giving it direction and perspective. The next layer is composed of the dark cumulus clouds. These clouds are at a very low elevation so they feel very close, complimenting the building and tree profile nicely. Behind the cumulus are the cirrus clouds. These are wisp-like and thin, giving a very open and spacious feel at the higher elevations. The image transitions from a confined feel, near the ground, to a very open feel high in the sky.

Image Location & Orientation: This picture was taken in San Francisco on 2/20/2011 at approximately 2:00pm. The camera was facing west by north west. The houses seen as a profile sit on a hill, the camera was aimed up at about 40 degrees from horizontal.

Clouds Types: There are three distinct cloud types seen in this image.

1. Cumulus Humilus Radiatus: These clouds are located mainly on the lower left and right corners just above the profile of the buildings and trees. Cumulus humilis radiatus describes heap cloud formations with cotton (or cauliflower) like textures, which develop at lower elevations. [1]
2. Cirrus Fibratus Duplicatus: These clouds are the white streaks flowing from the lower left to the upper right of the picture. Cirrus fibratus duplicatus are high elevation cloud formations which appear to be multiple layers of threads or fibers. [1]
3. Cirrus Uncinus duplicatus: Examples of this type of cloud can be seen on the right side of the picture where the white streaks originate. Similar to cirrus fibratus duplicatus the cirrus uncinus duplicatus are high, thread-like clouds with the addition of curved or “hooked” ends. [1]

Figure 1, The location of the three cloud types.

Atmospheric Events:

Weather: Three days prior to taking the picture San Francisco experienced constant rain. A cold front was sweeping through the area initially causing hail and rain storms. This violent weather then eased to rain showers with little to no wind. Sunday was the first day, in several, that the sky poked through the clouds. The image, and the skew-T plots (discussed below) both suggest the atmosphere is stable. The wind was stronger than the day before, however it was relatively light in nature. The fact that the atmosphere is stable suggests that there was nice weather for the next couple of days. In fact, San Francisco did experience nice mild temperatures and blue skies for the next few days.

Skew-T Plots: Below in figure 2 are two skew-T plots. Both plots are formed by data collected by weather balloons launched from Oakland. The right plot shows data collected from a balloon launched at 5:00am Pacific Standard Time, where the left plot shows data collected from a balloon launched at 5:00pm PST. Both plots support that the atmosphere was stable. This is because both plots show a CAPE number close to zero and air temp line (the right heavy black line) remaining on the right side of the air parcel temp line (the light black line). Notice the dew point line (the left heavy black line) and the air temp line touch in the left plot and come very close in the right plot at an elevation of approximately 1400m. When the touch we know the balloon traveled through a cloud. In the left plot one may say that there is a cloud at 1400m and vertically spans several hundred meters. This cloud was probably similar to the cumulus clouds seen in the photo. Judging from the right plot one cannot say for certain weather the balloon traveled through air that was recently a cloud, air that will soon be a cloud, or air within the proximity of a cloud. However since the heavy black lines approach each other at similar elevation for both plots one may say that there are likely to be clouds seen elsewhere in the sky at that elevation throughout the day. It is apparent that the weather balloon went through the cirrus clouds seen in the image since the heavy black lines nearly touch at higher elevations. [2]

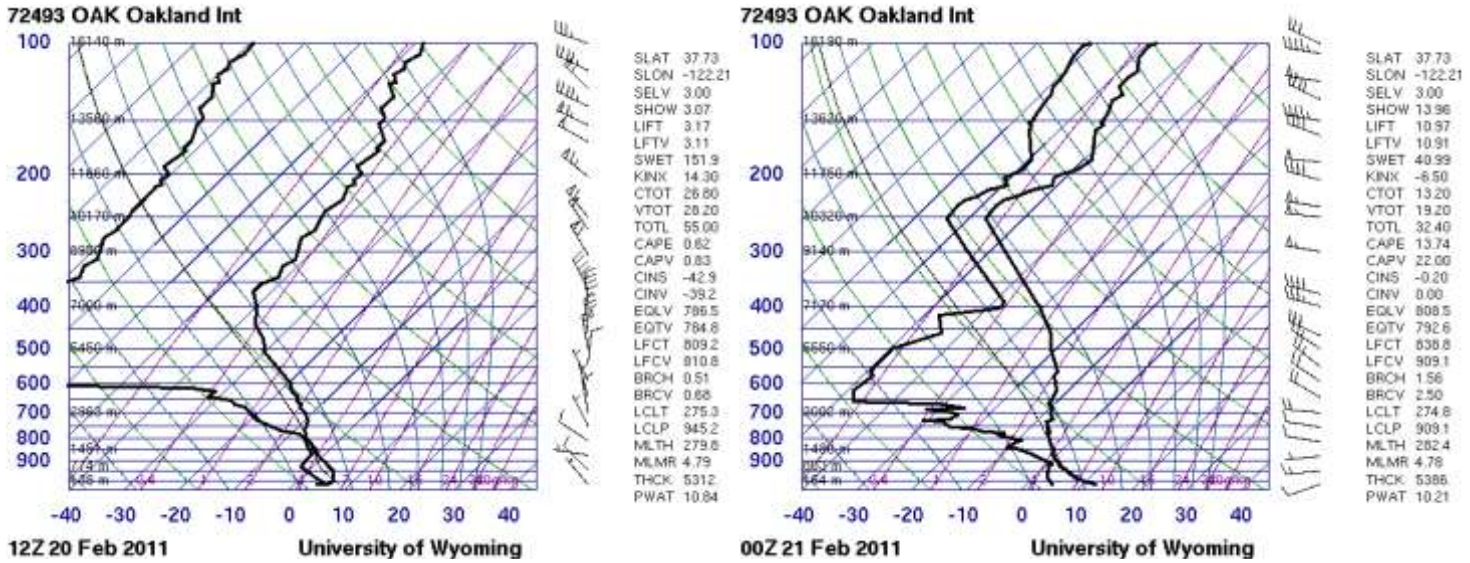

Figure 2, Skew-T plots for Oakland on 02.20.2011 at 12Z and 02.21.2011 at 00Z. [3]

Interesting Fact: The cumulus clouds seen in the image are lower than they would typically be elsewhere in the world. In fact these clouds are part of the phenomena know as the San Francisco fog. These cumulus clouds, or fog are specific to central California's coast. This is because they from the special geography of the San Francisco peninsula and the local ocean currents. Specifically what happens is that warm air from out over the ocean is pushed by easterly winds towards shore [4]. Local coastal currents drag cold water down from the north and cools the air right by the shore [4]. When this warm air from the ocean meets this cold air at the coast it rises and forms low clouds [4]. These clouds are then pushed by the wind across the city and into the bay [4]. The clouds can then rise and continue to move east or they will settle in the bay depending on the bay temperature [5].

Photographic Technique: Figure 3 shows the image pre and post digital enhancement. The pre-edited image is nothing special. In fact I find it rather dull. But the image feels as if something dramatic and artistic is hidden within it. With a little editing the images full features are displayed. This was done with cropping and contrast enhancement in photoshop.

Figure 3, Image before (left) and after (right) digital enhancement.

Table 1, Image Details.

Field of View		
	Building Profile	100m
	Cumulus Cloud Level	13200m
	Cirrus Cloud Level	20000km
Approximate distance to objects		
	Building and Tree Profile	~30m
	Cumulus Clouds	~2000m
	Cirrus Clouds	~6000km
Cameral Type		Cannon PowerShot SX 100IS
Image Specs.		
	Aperture	f/4.0
	Shutter Speed	1/1000
	ISO	80
	Number of Pixels Pre Edit	3264x2448

Conclusion: Unlike capturing specific and confined flow phenomena, imaging clouds allows for so many possibilities. Photographing clouds is very open to artistic freedom. What I enjoy about this photo is the layered effect, it gives the image a unique feel known to everyone. Notice how confined the image feels near the building and tree profile. Then notice how open the image feels when you look at the cirrus clouds. I took artistic liberty to darken the building profile and brighten the blue to enhance this feel. I believe this image reveals how people typically look at the sky, they look up to displace themselves from the trapped lives they live. On a scientific note I this image shows different clouds at various elevations with respect to objects on the ground. This was exactly what I was going for, the artistic feel and interpretation was just a bonus. I would have liked to have a similar image without the pesky cumulus clouds randomly floating in the middle of the image. I think it takes away from the photo's esthetics. Overall I am very fond of this photo.

References:

[1] Clouds Online, Cloud Atlas. Germany. http://www.clouds-online.com/cloud_atlas/cumulus /cumulus.htm

[2] Skew-T plot Application, AIRS Near-Real-Time Server. Jet Propolsion Laboratory. Cal Teck. http://airsnrt.jpl.nasa.gov/SkewT_info. html

[3] University of Wyoming, College of Engineering. Skew-T plots. Oak 12Z 20 Feb 2011, Oak 00Z 21 Feb 2011. http://weather.uwyo.edu/upperair/sounding.html

[4] J. Goodman, "The Microstructure of California Coastal Fog and Stratus," Journal of Applied Meteorology, 16, 1056-1067 (1977)

[5] F. Kong, "An experimental simulation of a coastal fog-stratus case using COAMPS(tm) model ," Atmospheric Research 64 205-215, (2002)