Sunny Patagonia?

Climbing in a Changing Climate

LIFE IN EL CHALTEN, a small town in Southern Patagonia, revolves around the weather forecast. Waiting for elusive weather windows is an exciting and sometimes frustrating way to live.

When I first came to climb in El Chaltén, ten years ago, a friend taught me to interpret weather charts to make predictions for the next few days. Some years later, I started looking at Pacific Ocean weather maps to track weather systems coming toward South America, and at times I was able to forecast good weather as much as three weeks in advance.

Soon I wanted to know what the next season might be like, so I dove into the uncertain world of seasonal forecasts. Over time this took me even further, into trying to understand the bigger picture—how the climate has changed over the past decades and what to expect for the future.

In 2003, El Chaltén got Internet service for the first time, and soon Web-based weather forecasts began having a big impact on climbing in the area. Forecasts spared climbers the physical and mental energy of false starts and allowed them to choose objectives closer to the upper limits of their ability; it also encouraged them to take advantage of even the shortest weather windows. Along with increased climber visitation, a general increase in skill levels, and a wealth of communal know-how, the availability of weather forecasting could well account for the stunning jump in quality ascents over the last decades. And yet there seems to be something else going on.

A number of climbers that were active in the 1970s are convinced that today's climbers are also benefiting from better weather. Do they have a point? The Chaltén Massif was once known for its unrelenting bad weather. After yet another unsuccessful visit to the area, German alpinist Reinhard Karl famously wrote in early 1980, "Just as well I could hide inside my fridge at home and burn 100 Deutsche Mark bills." Then, sometime in the early 2000s, climbers started returning from Patagonia with tales of weeklong periods of good weather lining up one after the other.

There's no question that environmental changes in the Chaltén Massif in recent years have been dramatic and would seem to point to a change in climate. Glaciers are receding at incredible speed, moraines are collapsing, big rock features are falling off, and vegetation is advancing. Is the climate in Patagonia actually changing, improving the weather and making climbing easier?

To answer this question in a scientific manner, we first have to define "good" climbing weather in meteorological terms. The key variables are precipitation and wind. No long-term records exist for either of these for the Chaltén area. Luckily, however, in 1990 the U.S. National Centers for Environmental Prediction (NCEP) and National Center for Atmospheric Research (NCAR) started the "Reanalysis" project to fill the needs of climate researchers for a retroactive record of global atmospheric circulation. It covers the period from 1948 to the present, combining observational data with state-of-the-art numerical models.

The NCEP/NCAR Reanalysis has some limitations. For the period before satellite observations started, in 1979, the Southern Hemisphere reanalysis results are less reliable because of insufficient observational data. Further, the project's 2.5° latitude/longitude grid lacks the precision to accurately deduce localized phenomena such as precipitation, which in the southern Andes varies dramatically in a very short distance. The most reliable data set that occurs on a big enough spatial scale and is a good indicator of regional weather is "sea level pressure." Relatively high atmospheric pressure at sea level is generally associated with little precipitation and wind. Pressure observations have been used for centuries to predict weather conditions.

From the NCEP/NCAR Reanalysis, I extracted the monthly mean sea level pressure (MSLP) and the "standardized monthly MSLP anomaly" since 1949 and analyzed the data. First, I wanted to answer one frequently asked question: Which is the best month to go climbing in the Chaltén Massif? Surprisingly, September is the month with the highest MSLP (suggesting likely good weather). In September, however, there is usually too much snow left over from the austral winter for good climbing conditions, plus it is very cold. During the summer season, the month with the highest MSLP is February, which usually also provides dry rock climbing conditions and higher temperatures.

Next I looked at long-term trends, using time series of both annual and summer (averaging December, January and February) data, focusing mainly on summer because of its greater interest to climbers and because, as I learned during my research, the relevant changes are most pronounced then.

The summer MSLP shows a long-term trend toward higher values, with the strongest increases between the 1970s and the '80s—an increase in mean values of approximately 1 millibar (mb). (See Chart 1.) Although 1mb may seem like a small increase, its significance becomes more apparent when you consider the average summer MSLP in El Chaltén is approximately 1003mb to 1010mb. A rising average means high MSLP occurrences are more frequent. Could this explain the many dry summers we've experienced in recent years?

Next I looked at the "best" and "worst" summer seasons, those with the highest and lowest MSLP. To select them, I used +/-1.28 standard deviations as a threshold, to identify summers below the 10th and above the 90th percentile of the data distribution. Beginning again with 1949, I found eight "worst" and 11 "best" summers.

The first thing that stands out is that of those 11 "best" summers, nine happened in the last 30 years and only two in the 30 years prior. (See Chart 2.) Furthermore, seven have come since the year 2000. On the contrary, only one of the eight "worst" summers happened in the last 30 years, while the other seven happened in the 30 years before. This points to a marked trend toward more frequent "best" and less frequent "worst" summer periods.

When comparing the "best" summers to a list of important ascents in the area, there appears to be a strong relationship. One notices a clear uptick of ascents during "best" summers after 1980, compared to average or "worst" summers. (This analysis applies also to the pre-forecast era, taking into account the number of climbers that visited the area at the time.) The "best" summers are related to long periods of good weather and thus favorable climbing conditions (dry, ice-free rock), which, for many objectives, can be as important as the weather for climbing success.

EL CHALTEN IS LOCATED at 49˚S, in the northern half of a zone of eastward-progressing low-pressure weather systems that travel around Antarctica and closely follow the westerly wind belt, with a quasi-stationary high-pressure system to the northwest. The north-south movement of the ring of low-pressure systems is poorly understood, but such shifts dictate the weather in this area. This north-south movement is described by an index called the Antarctic Oscillation (AAO). A positive AAO index corresponds to southward contraction of the low-pressure systems and favors good climbing weather. (In the last decades it has become fashionable to blame any weather pattern on El Niño or La Niña. Although their effects on the southern tip of the American continent are not entirely understood, it is safe to say that the AAO index is a far better indicator of the weather in Southern Patagonia than El Niño or La Niña.)

Since the AAO is the single most important influence on the weather in this region, I next looked at the AAO index provided by G.J. Marshall (1), derived from station data from 1957 to present. I observed a summertime trend toward a positive AAO index, strongly marked from the beginning of the 1980s (2, 4). In 13 of the 19 “best” and “worst” summers I found a direct relationship to the AAO index, while six occurred with a neutral AAO index. (Five of those six were high MSLP anomalies whose center was located too far south geographically for the AAO index to capture them.)

Since wind is such an important factor for climbing in this area, I also looked at the “zonal wind” (wind along latitudinal lines) at 850mb from 1949 to 2018. (Atmospheric pressure levels are often used to express elevation—850mb corresponds to approximately 1,500 meters, the average height of the Andes in this area.) I did not find an observable long-term change in wind speed. However, I did find that the “best summers” are associated with a negative (less than average) 850mb zonal wind anomaly, while the opposite is true for the “worst summers.” Moreover, research suggests that in the Chaltén Massif, and generally south of 40°S, there is a positive correlation of 850mb zonal wind and precipitation in the mountain area (5). This means that a decrease in wind during the “best summers” is associated with a decrease in precipitation.

Together, these findings point to a shift in the climate between the mid-1970s and the 1980s, and an increased occurrence, especially in the last two decades, of high MSLP summer anomalies (characterized by below average winds and precipitation). This has profoundly benefited climbers. Although a multitude of factors have facilitated climbing in recent years, when average MSLP seasons occur hardly anything of note gets done. Conversely, the timing of previously unimaginable ascents seems to relate first and foremost to high MSLP seasonal anomalies. When climbers of old point out that climbing in the Chaltén Massif was harder in their time, they have a point.

So what happened at the beginning of the ’80s that had such a big influence? Researchers agree that the recent changes of the AAO index can be attributed to the Austral summertime depletion of stratospheric ozone over Antarctica (the “ozone hole”), a phenomenon observed since the late 1970s, as well as the cumulative effect of the emission of greenhouse gases (from approximately the 1940s on). The long-term average of the AAO index is at its highest level for the past 1,000 years (2, 4).

State-of-the-art climate models predict that increasing greenhouse gases will lead to a continuing positive trend in the AAO index, dampened somewhat by the opposing effect of ozone hole recovery, initiated by the Montreal protocol agreement in 1987. This dampening effect is expected to end in midcentury with the healing of the ozone hole. After that, if greenhouse gas concentrations increase further, dramatic shifts in climate are expected for southern Patagonia (2, 3).

Regarding the wider arc of the Patagonian Andes, research suggests rather unequivocally that the surface air temperature is expected to rise over the entire area. There is less certainty regarding precipitation. During the summer months, the following trends are hypothesized: Precipitation increases are expected south of the center of the westerly wind belt, strongest at ~60˚S but reaching northward to Tierra del Fuego; only slight precipitation changes are expected close to the center of the westerly wind belt, around ~52˚S (just south of Torres del Paine); and precipitation decreases are expected farther north, strongest at ~45˚S (around the northern Aysén Region) (5, 6).

Regarding the Chaltén Massif, its location just north of the center of the westerly wind belt means that, as the AAO index becomes more positive, we will see an increase in temperature and likely a general decrease in precipitation, again mostly during summer. Also, it seems reasonable to expect a continuation of the more frequent high MSLP summer events of the last two decades. These events result in long windows of good weather, paving the way for long link-ups and hard free climbing. However, as the last two seasons of poor weather have shown, this does not mean that El Chaltén will become a Caribbean beach and that every season will be “awesome.”

Also, it’s important to note that drier, warmer climate leads to a more unstable mountain environment, with more dangerous, difficult approaches and descents, and increased rockfall. The temperature will become a key variable for assessing objectives not only for the days of the planned ascent, but also in the preceding weeks. For example, in early 2016, after weeks of very high temperatures, a large piece fell off the Cerro Torre headwall, and, separately, a climber was killed by spontaneous rockfall on the east face of Cerro Fitz Roy. As often happens in life, when challenges diminish in one area, they increase in others. We won’t get to have both sides of the coin.

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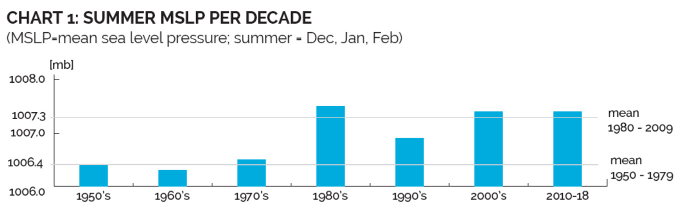
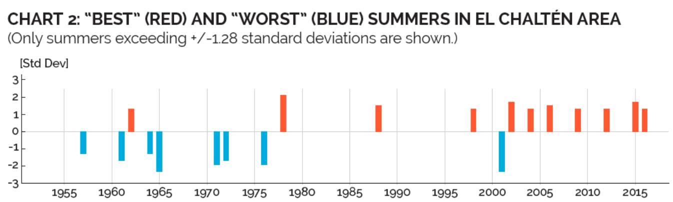
Images



Summer mean sea level pressure (MSLP) in El Chaltén area.



"Best" and "worst" summers in El Chaltén area.

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