

The climate of the coast and fog zone in the Tarapacá Region, Atacama Desert, Chile

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Abstract

In the Atacama Desert, the narrow littoral plain and the adjacent mountain range have a unique climate. This area is locally called the “coastal desert with abundant cloudiness”, and extends from the coastline up to an elevation of 1000 m. The climate is designated as being BWn according to Köppen’s Climate Classification as adapted for Chile. In the original classification the acronym (Bn) is used for foggy environments. Toward the east a “normal desert” climate (BW) is found. This is known as one of the most extreme deserts of the world. In the BWn areas there are meteorological differences between low and high elevation zones. The climate of the coastal plains and the mountains is described in this paper in order to show that there is an area where the climate differs from those classified as BWn and BW in the Chilean Climate Classification. This area is located between 650 and 1200 m a.s.l. and contains several fog oases or *lomas* vegetation, rich in biodiversity and endemism.

The weather is warmer near sea level, with an annual average temperature of 18 °C. At high elevation sites like Alto Patache, the temperature decreases at a rate of 0.7 °C for every 100-m increase in altitude. The average annual minimum temperature often approaches 1 °C in winter, while the mean annual temperature range is significant (8.3 °C in Los Cóndores). The mean monthly relative humidity in Alto Patache is over 80%, except during the summer months. During autumn, winter and spring high elevation fog is present in the study area at altitudes ranging from 650 m up to 1060 m, giving annual water yields of 0.8 to 7 L m⁻² day⁻¹. If vegetation is used as an indicator, the foggy zone lies between 650 m a.s.l. and 1200 m a.s.l. About 70% of the mountain range experiences the foggy climate, as opposed to the coastal plains that are characterized by a cloudy climate.

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1. Introduction

The general relief of the Tarapacá Region in the Atacama Desert of Chile exhibits four main features from west to east: a narrow littoral plain that ends in a

steep cliff, a coastal mountain range with 1500-m peaks called *Cordillera de la Costa*, an “Intermediate Depression” that is a longitudinal plain (*pampa*) located at about 1000 m of altitude, and the *Cordillera de los Andes* that ends in a high plateau with peaks over 6,000 m a.s.l. (Fig. 1).

The adaptation of the Köppen Climate Classification to the Chilean territory designates the climate of the coast from sea level up to 1000 m as BWn. Locally, this is called a “coastal desert with abundant cloudiness”. Immediately

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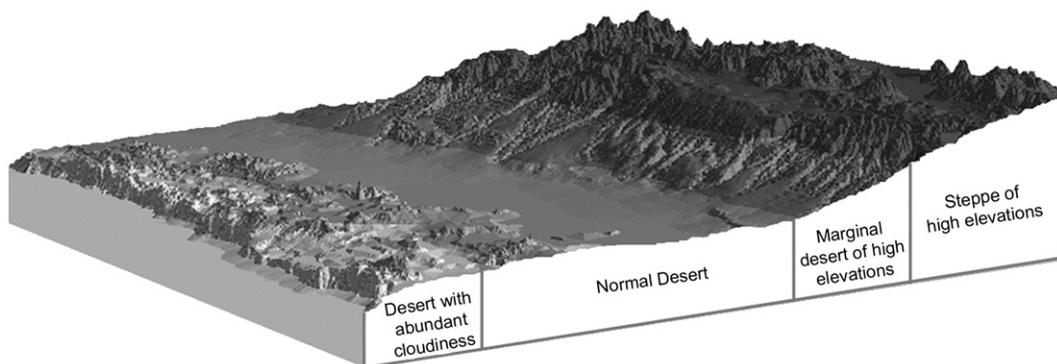


Fig. 1. Relief and climate of southern Tarapacá, Chile.

eastward of this is a zone with a BW climate known as the “normal desert”. Toward the Andes mountains two more climatic types are found, BWk and BWH (Errázuriz et al., 2000). In Tarapacá, the BWn and BW climates have a mean annual rainfall of 1 mm, while in the village of Putre in the high Andes the average annual precipitation is more than 250 mm (Novoa and Villaseca, 1989). In the coastal regions the mean annual temperature range is small, whereas inland it is very extreme. Average relative humidity is high at the coast (around 70%), and low 50 km inland (less than 50%) (Fig. 1). BWn climatic zone has been defined by Fuenzalida (1971) as extending from the coastline up to the 1000-m a.s.l. contour line, and BW zone, from that altitude to 1500 m a.s.l. However, in the Intermediate Depression there are low lands (salt flats and *pampas*) that still have the continental characteristics of the BW climate. The BWn zone has two sectors, one near the coast that is cloudy and another one in the mountain range that is foggy.

The importance of understanding the coastal foggy climates of South America is that in Perú and northern Chile there are important ecosystems of high biodiversity locally called *vegetación de lomas* or fog oases. They are ecologically endangered since the species are very fragile and depend mostly on fog, since annual precipitation is extremely low (Cereceda et al., 1999). Global climate change may be a significant issue for these ecosystems. They can also be good indicators of this planetary change (Rundel et al., 1997; Thompson et al., 2003).

In the past, the *Cordillera de la Costa* was inhabited by people living in small mining villages mainly associated with the exploitation of nitrate, but recently the population has migrated, especially to Iquique, the region’s capital. Over the last 15 years about 50,000 people have moved to Alto Hospicio, a new town located in the upper plateau of this mountain range at about 600 m a.s.l. The majority of the population work in Iquique and hence high traffic

volumes occur on a dangerous road that connects the two cities. This road, through a mega cliff where fog is present, especially during winter and spring, is causing hazardous conditions for traffic.

The objectives of this study were to investigate the climatic variability that occurs within the region as well as the differences in meteorological conditions that prevail at sea level and in the areas influenced directly by the almost permanent stratocumulus clouds of the eastern Pacific. The possibility of identifying and quantifying the spatial extent of the areas involved was also explored.

2. Background

Larrain et al. (2002) reviewed early studies of the coastal climates of the Atacama Desert and reported on fog water collection measured in northern Chile over the last 10 years. Fuenzalida (1971, p. 30) demarcated the extent of the BWn climatic zone as follows: “From the northern limit of the country until approximately the latitude of 30° S, along the littoral, there is a narrow fringe of territory with an altitude less than the height of the tradewinds inversion.” He refers to a stratocumulus (Sc) cloud cover, some hundreds of meters thick, that lies over the littoral during the night and dissipates in the morning, as causing cloudiness with a characteristic diurnal cycle. These clouds generate fog that is sporadic in some sites and frequent in others. Actually, this cycle and the Sc are being studied intensively because of their importance in the climates of the world (Garreaud and Muñoz, 2004).

In Koeppen’s (1948) original classification, the letter “n” is used for fog (*nebel*) with variations in the frequency of occurrence and temperature range denoted as n' , n'' , n''' , n'''' . The author refers mainly to the fog and drizzle events typical of Peru and the foggy areas of Morocco and California, USA.

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