Chapter 2
Climate

Abstract The climate of Isla de los Estados is strongly influence by the centre of the sub-polar low pressure which develops around the Antarctic Circle. The current climate of Isla de los Estados is cold and humid and corresponds to general classification of Oceanic Insular Cold Climate. Summer has a mean temperature of 8.3 °C, with mean daily extremes of 16.2 and 3 °C. Winter mean temperature is 3.3 °C, with mean daily extremes of 7.4 and −4 °C. Though no reliable records are yet available, rainfall is estimated to be in the range of 2,000 mm/year, but actual precipitation may be highly variable across the island, particularly in altitude. Prevailing winds are from the southwest and the northwest and they are active throughout the year. Isla de los Estados is washed by the western branch of the Malvinas/Falkland current, an arm of the Antarctic Circumpolar Current that brings cold Sub-Antarctic waters.

Keywords Isla de los estados • Magellanice region • climate • Sub-polar low pressure • Antarctic circumpolar current

2.1 Magellanic Region

2.1.1 Winds

The Magellanic Region (Tierra del Fuego and adjacent regions of Patagonia south of 51°S) is situated between the southern edge of the semi-permanent subtropical high pressure cell, the direct influence of which extends up to around 40°S throughout the year, and the centre of the sub-polar low pressure which develops around the Antarctic Circle (Fig. 2.1). These pressure systems have only small seasonal variations and change little in intensity, and the Westerlies prevail in this region all year round (Prohaska 1976; Burgos 1985; Endlicher and Santana 1988; in Tuhkanen 1992).

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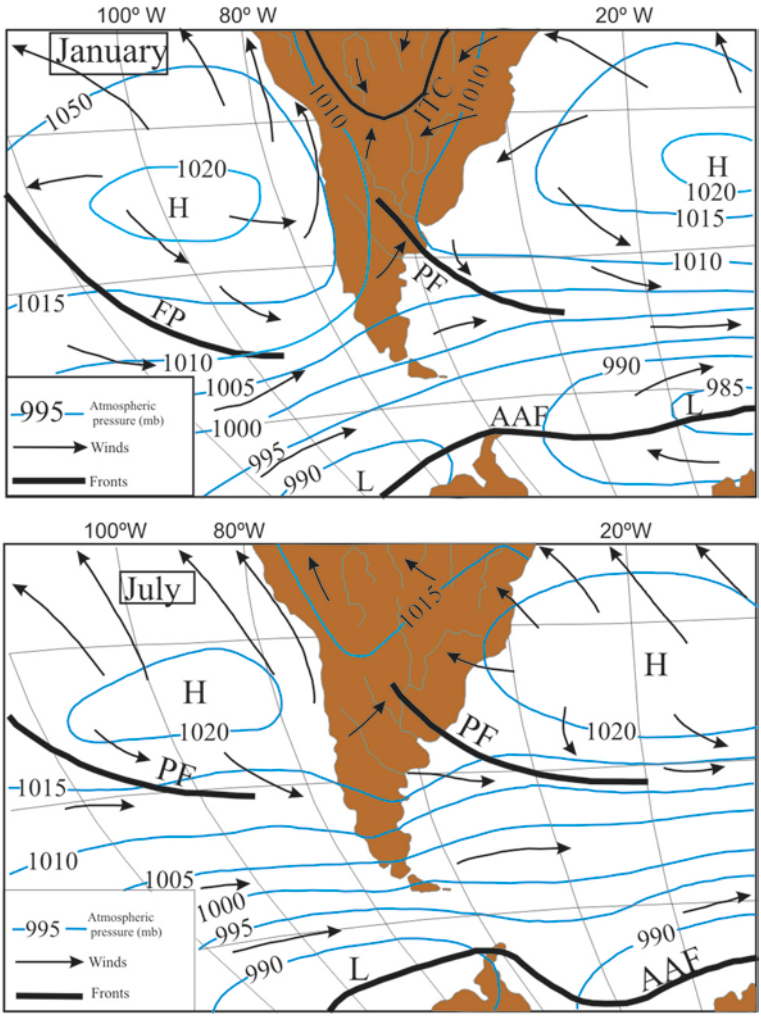

Fig. 2.1 The Magellanic Region is located between the southern edge of the semi-permanent subtropical high pressure cell (H), and the centre of sub-polar low pressure that occurs approximately on the Antarctic *Circle* (L). *ITC* inter-tropical convergence, *PF* polar front, *AF* Antarctic Front. Modified from Tuhkanen (1992)

In the western sector of the Drake Passage north-easterly components slightly dominate. Towards the east of the Passage the westerly and south-westerly components increase such that to the southeast and east of Tierra del Fuego the most frequent wind direction is easterly, with north-easterly and south-easterly being almost equally frequent. The constant south-easterly wind direction in the region of Ushuaia is attributed to diversions caused by relief. The orography also contributes to the existence of a regime of calms significantly higher than that in the

steppe, something that is seen most especially during winter. The winds are in general stronger and more persistent during spring and summer (Tuhkanen 1992).

The average annual wind velocity in the west and southwest of Tierra del Fuego is 12 ms^{-1}, with a maximum that exceeds 30 ms^{-1} for the whole month. Leeward of the mountain range, the obstacle effect reduces the mean annual wind velocity to around 4–6 ms^{-1} (e.g., the city of Punta Arenas, Chile). The effect decreases with increasing distance from the mountains. On the Patagonian coast, the wind velocity reaches an average of 8 ms^{-1} (e.g., Río Grande 8.3 ms^{-1}) (Tuhkanen 1992).

The temporary variations in the directions and intensity of the winds are mainly associated with the passage of cyclonic depressions towards the east and southeast following the line of the continent (Arnett 1958).

The cyclones are formed in the polar front of the South Pacific which occurs between 110° and 120° West, between the two cells of the high pressure belts of the South Pacific. (Taljaard 1972).

The anticyclones manage to cross the continent without major difficulty. The cyclonic depressions, by contrast, disintegrate as they approach the continent and are regenerated to its west. A high percentage of the centres of low pressure cross the South American sector in latitudes south of Tierra del Fuego generating the famous storms of the Drake Passage (Servicio Meteorológico Nacional 1994).

Tierra del Fuego and the south of Patagonia are occasionally, and in particular during the winter, under the influence of stable cold Antarctic air when a line of high pressure develops behind a series of cyclones. This results in a current originating in the Antarctic causing brief sunny periods that are dry, cold and usually windy. Often this Antarctic air is warmed on its journey north and humidified by the surface of the sea. In this way it reaches the region as a damp and unstable current that afterwards joins the western circulation (Zamora and Santana 1979; Burgos 1985; Endlicher and Santana 1988).

The winds coming from the west or "West Wind Drift" that come into the region from the west-southwest exercise a pronounced oceanic trend in winter all along the Pacific Ocean coast. No continuous ice-sheets are seen in the Beagle Channel. The direct oceanic influence penetrates from the east through the Magellan Strait, separating two "cold nuclei" in the south of Patagonia and in the interior of Tierra del Fuego (Tuhkanen 1992).

2.1.2 Temperature and Precipitation

The influence of the Pacific Ocean is more evident in the temperatures during winter. A marked difference is seen between the temperatures on the east and west coasts of Tierra del Fuego. The average temperature of the Pacific coast reflects the temperature of the ocean, which is 4 °C in winter and spring. In particular, the entire coastal area shows average temperatures above freezing point in the coldest months whereas the areas with high mountains are exposed to freezing conditions. In the more inland areas of the island, probably not too far from the coast, the

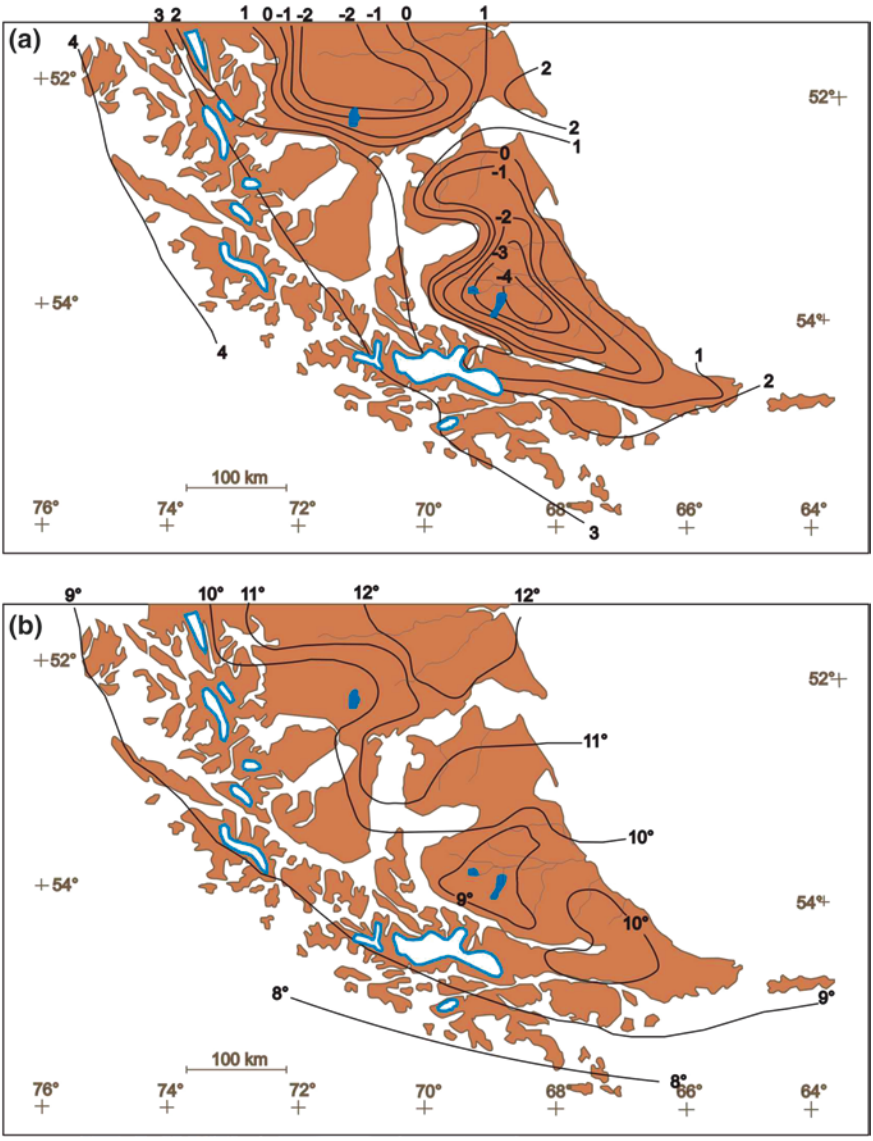

Fig. 2.2 **a** Winter isotherms for the Magellanic Region. Modified from Tuhkanen (1992). **b** Summer isotherms for the Magellanic Region. Modified from Tuhkanen (1992)

average temperature during winter is below freezing in the lowlands (Fig. 2.2a). The temperature gradients around the "cold centres" are relatively steep, but the north–south direction gradients are not evident.

The temperature conditions in summer show a slight continental influence from the Pampas in the north (Fig. 2.2b). The southeast margin of the Fuegian

archipelago has the coldest summers (8–9 °C in the hottest months), reflecting the oceanic temperature, which is 7 °C in summer. The average temperatures in the warmest months of the year show a clear gradient from the west to east following the oceanic gradient and also from north to south, which partially coincides with the oceanic gradient (Tuhkanen 1992).

As regards the vertical temperature gradient, studies carried out by Iturraspe et al. (1989) indicate an average value of 0.55 °C/100 m for the region (0.7 °C in December and 0.4 °C in July).

Due to the forced orographic ascent of the maritime air masses on the western slopes of the mountain range, very high precipitation is produced in the islands at the foot of mountains in the order of 4,000 mm per year, up to approximately 53°S (Fig. 2.3) (Servicio Meteorológico Nacional 1994). Beyond this latitude the mountain range definitively changes its N–S direction to a more W−E one, so reducing its influence on the general flow. Consequently, the amount of annual precipitation falls dramatically to 2,000 mm, around Santa Inés Island at 54°S and 1,000 mm annually on Hoste Island (Servicio Meteorológico Nacional 1994).

Between 69° and 68° 34′W an appreciable change is seen in the height of the mountains generating a regional leeward effect which manifests itself in the reduction of precipitation to 500 mm in the Beagle Channel and Navarino Island. The said effect loses intensity in the far west of Tierra del Fuego where the precipitation increases to 1,000 mm per year and it is non-existent on Isla de los Estados in whose eastern sector 1,400 mm of precipitation are registered annually (Servicio Meteorológico Nacional, unpublished, period 1982–1986).

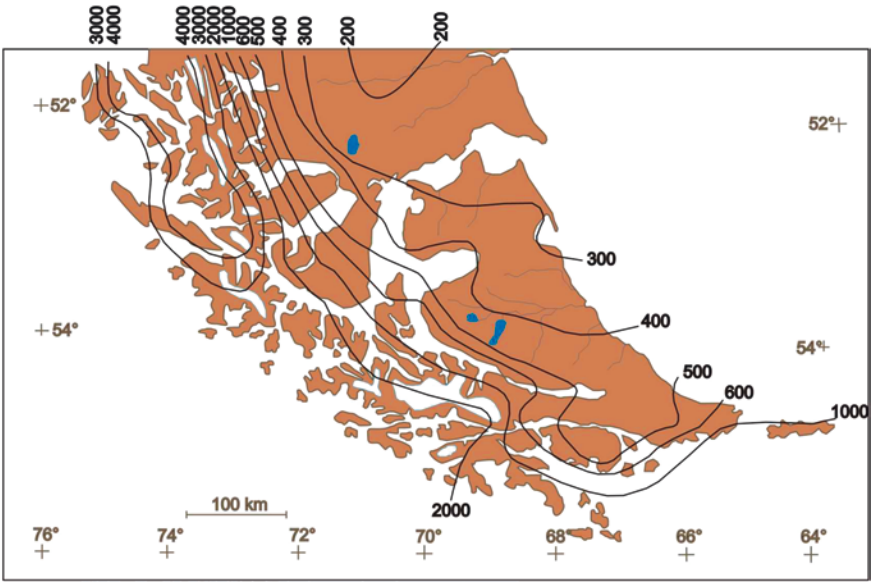

Fig. 2.3 Annual precipitation (mm) for the Magellanic Region. Modified from Tuhkanen (1992)

2.2 Isla de los Estados

The climate of Isla de los Estados is cold and wet. The numerous and rapid daily variations in the weather conditions create a constant situation of instability just as in the rest of Tierra del Fuego. Following the climatic classification of Köppen (1936) it may be classified as a Ef climate, that is to say a cold climate in which the mean temperature of the warmest month is below 10 °C and wet during the whole year. According to García (1986), this climate corresponds to the general classification of Cold Insular Oceanic. When considering the climatic scale of Knoche and Borzacov (1947), two types of climate can be deduced: "Moderate Cold" if you consider the average annual temperature, but taking into account the absolute maxima and minima, classifies it as "Temperate" and "Cold" respectively.

2.2.1 Temperature

In Isla de los Estados the air temperatures are low, but without extreme minima. In contrast to the west of the archipelago of Tierra del Fuego, the island has greater seasonal differentiation. In summer, the mean temperature is 8.3 °C, with mean extremes of 16.2 and 3.0 °C. The mean temperature in winter is 3.3 °C with mean extremes of 7.4 and −4 °C. This average is less than in Tierra del Fuego although the absolute minima are more moderate due to the influence of the ocean. The seawater has a mean temperature that varies between 5 and 7 °C (Dudley and Crow 1983).

The Argentine Meteorological Service maintained a meteorological station on Observatorio Island in the Año Nuevo group for several years and another in Puerto San Juan del Salvamento (Fig. 1.1). Their average temperature values are 6–8 °C for both meteorological stations for the warmest month (January) and 0 to −2 °C in Año Nuevo and 2–4 °C in San Juan del Salvamento for the coldest month (July).

El Derrotero Argentino (1962) (i.e., The Argentine Log) registered different temperature values for the "Año Nuevo Station", indicating a maximum mean of 11 °C for summer (December, January, February) and a minimum mean of 1 °C for the months of June, July, August and September. The maximum extremes are 16–18 °C in summer and −6 to −8 °C in winter.

Isla de los Estados has an average of 30 days of frost per year (Servicio Meteorológico Nacional, unpublished, period 1982–1986).

2.2.2 Precipitation

The precipitations are very frequent on Isla de los Estados but the absolute total values are not very high. De Fina (1972) indicates values of precipitation of 200–350 mm and 100–200 mm for the meteorological stations of San Juan de Salvamento and Año Nuevo Islands respectively during the summer months. In

Fig. 2.4 Snow in Colnett Bay (Photo: J. F. Ponce 2005)

the winter season the values are 350–500 mm for San Juan del Salvamento and 100–200 mm on the Año Nuevo Islands.

A map made by L.J. Scabella included in De Fina (1972) showed the isohyets, expressed in millimetres per year, of the mean annual precipitation. On this map, the 500 mm isohyet corresponds with the western extreme of Tierra del Fuego, whereas Isla de los Estados is included in the 1000 m isohyet.

Dudley and Crow (1983) showed that the annual mean of numbers of days with precipitation was 251.5 days with 1,447 mm, those of greater importance occurring in the winter months. June was the wettest month and October the driest.

The greatest frequency of snow in the region is claimed by Isla de los Estados with 60 days with snow per year (Fig. 2.4). The greatest number of days with snowfall frequently occur during the winter months, with a mean of 33 days (Dudley and Crow 1983). Autumn and spring also have precipitation in the form of snow but to a lesser degree. Apart from the months of May and June, in the lower lying areas the snow probably does not persist on the ground for long periods.

2.2.3 Cloud

The amount of cloud is high in this zone, occasionally a covering of cloud virtually sits on Isla de los Estados, obscuring the hilltops (Fig. 2.5). The estimation of annual cloudy days is 74 %. Although these conditions are quite well distributed throughout the year, they reach a maximum of 80 % in June and a minimum of 68 % in October (Dudley and Crow 1983). The visibility in general terms is good and there is usually little fog. An average of 16 days with fog are registered annually.

Fig. 2.5 Low cloud on the southern edge of Lake Lovisato, central area of Isla de los Estados (Photo: J. F. Ponce 2005)

The relative humidity is very high and remains fairly uniform throughout the year, with a maximum of 87 % in June and a minimum of 76 % in December and January. The weather patterns change quickly and unpredictably in this region (Dudley and Crow 1983).

2.2.4 Winds

The winds are constant and strong, predominantly from the northwest and southwest (Kühnemann 1976). They are heavily laden with humidity. The storms are strong (strength greater than 8 for 73 days a year) and frequent (Fig. 2.6). The greatest intensity of wind is achieved in winter with an average of 37 km/h for the month of August and 24 km/h in December (Dudley and Crow 1983).

2.2.5 Electrical Storms

This type of phenomenon is not very common in the Tierra del Fuego and South Atlantic Islands zone. In the majority of the stations that the National Meteorological Service possesses, less than 10 days with electrical storms were registered in 10 years, with the exception of Isla de los Estados and the Evangelistas islet that registered 15–20 days each 10 years respectively (Servicio Meteorológico Nacional, unpublished, period 1982–1986).

Fig. 2.6 Storm in Colnett Bay, December 2005 (Photo: J. F. Ponce 2005)

2.3 Oceanic Circulation in the Magellanic Region

South America is situated to the north of the Southern Ocean, a circumpolar body of open water from 20° to 30° of latitude in width, occupying the space between the Antarctic continent and the Atlantic, Pacific and Indian Oceans (Hamon and Godfrey 1978). Interrupted only by small islands beyond 50°S, the Southern Ocean is one of the largest and most remote regions of the planet. Its waters, located between 40° and 60° of latitude South, travel predominantly eastwards in the "West Wind Drift", or Antarctic Circumpolar Current, controlled by the strong southern Westerlies. Along the coast of Antarctica, where the Polar drift of the Easterlies ("East Wind Drift") is found, the Antarctic Circumpolar Current moves from east to west. The Humboldt current separates from the "West Wind Drift" and travels towards the Equator along the coast of Chile, producing Sub-Antarctic conditions around 48°S across the Pacific and a cold maritime climate in the low subtropical latitudes (Heusser 2003). A second arm of the Antarctic Circumpolar Current continues towards the west where it is known as the Cape Horn Current (Fig. 2.7) travelling across the south of the Isla Grande de Tierra del Fuego. This current turns towards the north, stretched by the point of South America and the islands of the Scotia Arc and divides into two arms, one passes either side of the Malvinas/Falkland Islands becoming the Malvinas/Falkland Current and the other goes around the South Georgia Islands. Accordingly, Isla de los Estados is washed by the western branch of the Falkland current that brings cold Sub-Antarctic waters. It is a fairly strong current having a mean velocity of 15−20 knots (Kühnemann 1976).

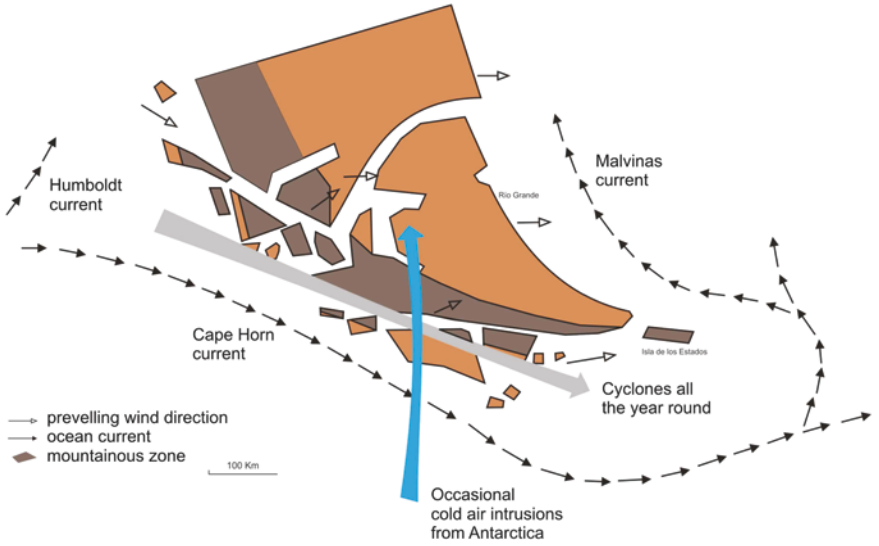

Fig. 2.7 Principal factors that affect the climate in Tierra del Fuego. Modified from Tuhkanen (1992)

According to Deacon (1937, 1960, 1963), the Antarctic Convergence or Polar Oceanic Front is located at around 50°S on average, where the temperature of the surface water falls rapidly towards the pole approximately 2 °C. The Subtropical Convergence is located at 40°S, and here the water temperature falls 4 °C. This front is considered to represent the northern limit of the Southern Ocean. The Antarctic Convergence (Gordon 1967; Gordon and Goldberg 1970) provides a reference to outline the geographical field of the Antarctic and Sub-Antarctic.

References

Arnett JS (1958) Principal tracks of southern hemisphere extratropical cyclones. Monthly Weather Rev 86:41–44

Burgos JJ (1985) Clima del extremo sur de Sudamérica. In: Boelcke O, Moore DM, Roig FA (eds) Transecta botánica de la patagonia austral. CONICET, Instituto de la Patagonia and Royal Society, pp 10–40

Bagnati RH Derrotero AP III (1962) Archipiélago Fueguino Islas Malvinas 3° (ed) I. Servicio de Hidrografía Naval p 324

Deacon GER (1937) The hydrology of the Southern Ocean. Discov Rep 15:1–24

Deacon GER (1960) The southern cold temperate zone. In: Proceedings of the Royal Society. Series B 152:441–447

Deacon GER (1963) The Southern Ocean. In: Hill MN (ed) The Sea, Interscience Publisher, London, 2:281–296

De Fina AL (1972) El clima de la región de los bosques Andino-patagónicos argentinos. In: Dimitri M (ed) La región de los bosques andino-patagónicos. Sinopsis general. Colección científica del INTA (Instituto Nacional de Tecnología Agropecuaria) Buenos Aires 10:35–58

Dudley TR, Crow GE (1983) A contribution to the Flora and Vegetation of Isla de los Estados (Staaten Island), Tierra del Fuego, American Geophysical Union, Antarctic Research Series, Argentina, vol 37, Washington DC, pp 1–26

Endlicher W, SantanaA (1988) El clima del sur de la Patagonia y sus aspectos ecológicos. Un siglo de mediciones climatológicas en Punta arenas. Anales del Instituto de la Patagonia, Serie ciencias naturales Punta Arenas, Chile 18:57–86

García MC (1986–87), Estudio de algunos rasgos geomorfológicos de la Isla de los Estados. Unpublished graduation thesis, Universidad Nacional del Centro de la Provincia de Buenos Aires and Centro Austral de Investigaciones Científicas, CONICET, Ushuaia, p 55

Gordon AL (1967) Structure of Antarctic waters between 20° W and 170° W. Antarctic Map Folio Series, USA

Gordon AL, Goldberg RD (1970) Circumpolar characteristic of Antarctic waters Antarctic Map Folio Series. 18, American Geographical Society of New York, New York, 13:1–19

Hamon BV, Godfrey JS (1978) Role of the oceans. In: Pittock AB, Frakes LA, Jenssen D, Peterson JA, Zillman JW (eds) Change and variability: a southern perspective. Cambridge University Press, UK, pp 31–52

Heusser CJ (2003) Ice age southern andes. A chronicle of paleoecological events. Developments in quaternary science 3. series editor: Jim rose. Elsevier, 5–10

Iturraspe R, Sottini R, Shroder C, Escobar J (1989) Generación de información hidro-climática en tierra del fuego. In: Hidrología y variables climáticas en Tierra del Fuego. Inf Básica Contr Cient 7. CADIC, Ushuaia, pp 4–170

Knoche W, Borzacov J (1947) Provincias Climáticas de la Argentina. In: Geografía de la República Argentina (GAEA), Buenos Aires 6:140–174

Köppen W (1936) Das geographische Sistem der Klimate. In: Köppen W, Geiger R (eds) Hadbuch der klimatologie 1C verlag von gebruder borntraeger, Berlin, pp 1–44

Kühnemann O (1976) Observaciones ecológicas sobre la vegetación marina y terrestre de la Isla de los estados (Tierra del Fuego, Argentina). Ecosur, Argentina 3(6):121–248

Prohaska F (1976) The climate of argentina paraguay and uruguay. In: Schwerdtfeger W (ed) Climate of central and south america. World survey of climatology. Elsevier, Amsterdam, 12:13–112

Nacional SM (1982–1986) Unpublished reports, CADIC, Ushuaia, p 87

Nacional SM (1994) El archipiélago de tierra del fuego. Unpublished report, Ushuaia, p 21

Taljaard JJ (1972) Synoptic meteorology of the southern hemisphere. Meteorol Monogr 13:139–213

Tuhkanen S (1992) The climate of Tierra del Fuego from a vegetation geographical point of view and its ecoclimatic counterparts elsewhere. Acta Botanica Fennica, 125:4–17

Zamora E, Santana A (1979) Oscilaciones y tendencias térmicas en Punta Arenas entre 1888 Y 1979. Anales del Instituto de la Patagonia, Punta Arenas, Chile 10:145–154

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