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AN INTRODUCTION TO THE  
PACIFIC AND THE THEORY  
OF ITS SETTLEMENT

The exploration of the vast Pacific Ocean and the settlement of its hundreds of remote islands were remarkable episodes in human prehistory. They seem all the more so because the methods and motives of the first Pacific settlers are not well understood. Early sea-going explorers had no prior knowledge of Pacific geography, no documents to record their route, no metal, no instruments for measuring time and evidently none for navigation. But this book, which reviews indigenous navigation and the archaeology of early settlement, suggests that the first exploration of the remote Pacific was rapid and purposeful; that it was more systematic and involved less loss of human life than conventionally thought; that navigation methods continued to improve as colonisation spread to more distant islands.

There are rich ethnographic and historic accounts of traditional navigation methods, but these have had millennia in which to elaborate and change. Sailing in a sea that is mapped in the mind is very different from sailing in an unknown one. There have been many experimental voyages by various rafts, replica canoes and Western vessels, but they cannot fully duplicate conditions of the first voyages. There have been computer simulations. Added to this are the results of 40 years of modern archaeology.

After more than 200 years of debate about how the Pacific was settled, the literature on the subject is now very large and, interestingly, many of the early themes are still alive. In all of this discussion, most attention has been given to whether voyaging was accidental or deliberate, what routes it took through the regions and islands of the ocean, when it happened, and who did it. In popular belief, the people involved have ranged from mythical hero navigators able to sail the ocean, discover new land and return home with sailing directions to find it again, to accidental travellers or exiles who made lucky (and unlucky) one-way passages in an ocean they could not map, leaving behind islands to which they could not return. The modern view is that they were competent sailors. However, many prehistorians believe they may have suffered high losses at sea, that their range of return voyaging was restricted, that they may have harboured unrealistic ideas about their island world, and may have been transported

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across parts of the ocean by conditions beyond their understanding or control. These views follow from uncertainty about the methods and circumstances of colonisation.

There are many other issues of interest to prehistorians. One concerns the kind of ancient navigation needed to settle the chains of large and often intervisible islands between mainland Southeast Asia, the Pleistocene continent of New Guinea and Australia (Greater Australia or Sahul), and its near neighbours in the west of Melanesia, which are known to have been reached by 40,000 to 30,000 years ago.

Other questions concern the much later, very rapid, exploration of the vast expanse of the remote Pacific farther to the east, which began after 3500 years ago. For instance, what was the origin of the first deep-sea navigators? To what extent was navigation a matter of chance or technological competence? Was discovery by one-way or return voyaging? How could navigators fix the positions of new islands in order to find them again? How many explorers may have survived or died at sea? Was there anything systematic about the order of colonisation and the elapsed time it took? How did navigation change as colonisation proceeded? How and why did the main thrust of colonisation take place against the prevailing easterly winds when that was the most difficult way to go?

Current models of early voyaging confuse issues of method with motive. Romantic notions about early navigators are often a sign that gaps in the argument are glossed over. A common assumption is that people did not choose to go, they were forced to, but there is no evidence as yet which says so. Another example is the presumption that explorers were so set on finding new land that they were equally willing to die at sea in the attempt. One objective of this book is to avoid much of the mystery by looking carefully at what was feasible in navigation, and then inspecting archaeological data for evidence of what happened.

A review of theories of voyaging and Pacific settlement (Irwin 1989) and a yacht voyage across its western part have led to the suggestion that the general pattern of colonisation implies developing methods of directed exploration, which allowed, not the fastest rate of advance, but the highest chance of survival. This predicts in a general way the order in which island groups should be settled and variations in the time this should take and, as such, it can be weighed against archaeological evidence. As a second level of testing, and also to find out about the detail of changes to navigation methods, a new computer simulation of voyaging is described.

Many difficulties arise. Firstly, while there is a wealth of information on surviving traditional navigation systems in parts of the Pacific, in crucial respects they do not represent the original ones. While there are many unknowns about navigation, there is a set of parallel issues in the archaeology of early settlement. The evidence itself is patchy, subject to sampling error and subject to change. Experience has shown that theories that are closely data-driven change as quickly as the data. Much can be gained from considering wider probabilities as well. Secondly, while archaeology and historical linguistics have been of mutual assistance in tracking prehistoric settlement, the expectations of the one have sometimes unnecessarily restricted the other, and biological data are still too few to produce detailed patterns. A third general problem is that some diversity in culture, language

and biology, which has been attributed to colonisation, may result instead from the contacts of post-settlement voyaging, and it seems there were systematic patterns in both. Such difficulties have resulted in particular disputes in prehistory, concerned with the time and order of island settlement, the location and nature of 'homelands' for settlers, and the extent to which there were pauses in colonisation to allow cultural changes to take place.

Perhaps the most unsatisfactory thing about the current view of Pacific settlement is its context. It is not concerned with the practicalities of deep-sea sailing, with details of weather and the relative accessibility of different island targets. It has little to say about how new communities might be established. At the core of the problem is the lack of an explicit navigational theory of colonisation. The consequence is that, in reconstructions of past events, colonising populations have not been moved by considerations that might have made sense to them, but by the exigencies of a rather narrow prehistory of artifacts, settlement patterns, proto-languages and biological traits, which retrospectively require them to go, sometimes to stop, and then to take one route rather than another. This context is actually more suited to the end of prehistory, when the age of discovery was long past, ocean voyaging had declined, and when island populations had changed.

## THE SCOPE OF THIS BOOK

This book is concerned with two distinct episodes of voyaging and colonisation. The first began some 50,000 years ago in the tropical region of Island Southeast Asia, the continent of Australia and its Pleistocene outliers. This was the first voyaging of its kind in the world. The second episode began after 3500 years ago and was a burst of sophisticated maritime and neolithic settlement in the remote Pacific. Apart from some isolated islands in other oceans which were left to be discovered much later by Europeans, this virtually completed the human settlement of the world apart from its ice-caps. Interestingly, the origins of the second episode are to be found in the region of the first.

Pleistocene voyaging was remote in time, and no navigational materials or methods survive for our inspection. Our knowledge of early island and coastal archaeology is fragmentary, and much of what can be said about colonisation is circumstantial and follows from investigation of the navigational and geographical conditions of the region. The first part of the book offers a view of Pleistocene voyaging realities and is largely a background to what follows.

The evidence of Pacific prehistory fills out with time and has a rich context of ethnography at the end. There is much more to be said about navigation in the remote Pacific and a new theory of colonisation is presented. The ancestors of the people involved appear to be identifiable as an archaeological category. The cultural sequences of many of the islands settled are substantially known, and the colonists themselves approach an ethnic entity as they go.

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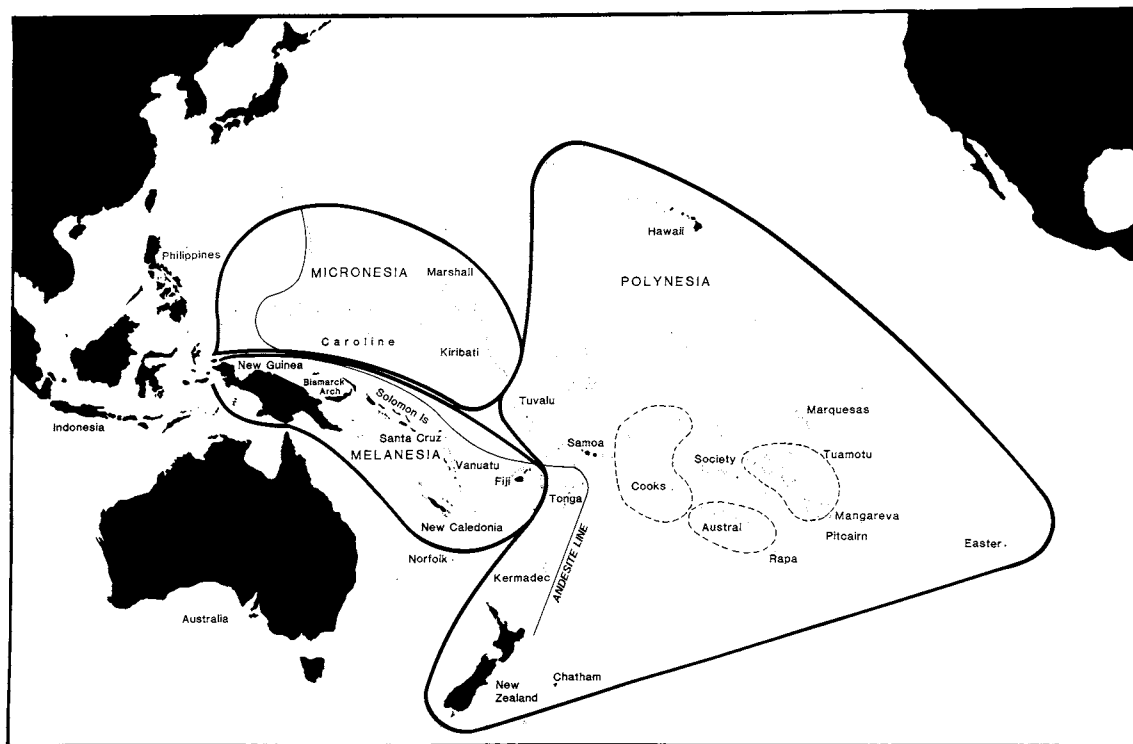
The emphasis of this book follows available information, such as it is. Archaeological evidence is presented in detail in so far as it relates to colonisation. The book is not intended to be a general work on Pacific prehistory, but is rather concerned with Pacific navigation and the archaeology of early settlement. However, in two important respects its scope goes beyond that. The final chapters present results of the computer simulation designed to examine previous conclusions about the settlement of the remote Pacific. It tells us more about people's methods and motives in exploration. There is also a study of the pattern of inter-island voyaging in the remote Pacific, after colonisation, and how this contact systematically affected the patterns of development that followed. We learn something about the context of cultural and biological diversification.

The rest of this chapter provides a background sketch of Pacific islands and the prehistory of their settlement, a summary of arguments about navigation, exploration and colonisation, a description of Pacific weather patterns, and a brief account of the main themes of 200 years of previous debate on these matters. It ends with a description of the contents of the chapters which follow.

## A SKETCH OF THE PACIFIC AND ITS SETTLEMENT

Full accounts are available elsewhere (e.g. Bellwood 1978; Jennings 1979; Irwin 1980; Kirch 1984b; Terrell 1986), but to summarise briefly, the islands of the Pacific offer diverse habitats for humans. One distinction is between the islands of the continental regions in the western Pacific and those on the Pacific Plate, east of the 'Andesite Line', where volcanic mountains penetrate the surface to form volcanic islands or show their presence underwater with a crown of coral (Fig. 1). Large high islands in the west are geologically diverse and rich in resources for settlement; on the Pacific Plate there are many high, basaltic islands, which offer a rather more restricted range. Sometimes these have a windward/leeward distinction in rainfall; large, deep valleys with alluvial soils; fringing reefs or barrier reefs offshore. There are many low islands on coral reefs near sea-level and others raised by volcanic activity; some are short of good soil and water. The most extreme habitats are atolls, which have a reef enclosing a lagoon without a central island; along it are islets of sand and coral rarely more than a few metres above the sea, but people have lived successfully on some for 2000 years or more. Pacific settlement accommodated tropical, sub-tropical, temperate and near sub-Antarctic climates. There were seasonal changes and natural hazards, such as droughts, cyclones and *tsunami*. Human settlements, although constrained by their environments, actually transformed them, sometimes again and again.

Pacific islands occur alone and in groups. They become more isolated, with distance east in the Pacific, and their natural flora and fauna increasingly impoverished, although marine food remains abundant where there are reefs. Traditional economies included a diverse range of portable



1. The regions and island groups of the Pacific. The background to Pacific colonisation lies in mainland and Island Southeast Asia, which includes Indonesia and the Philippines. Melanesia, Micronesia and Polynesia are the conventional divisions of Oceania. The Andesite Line marks a geological division between continental islands in the west from the volcanic islands of the Pacific Plate.

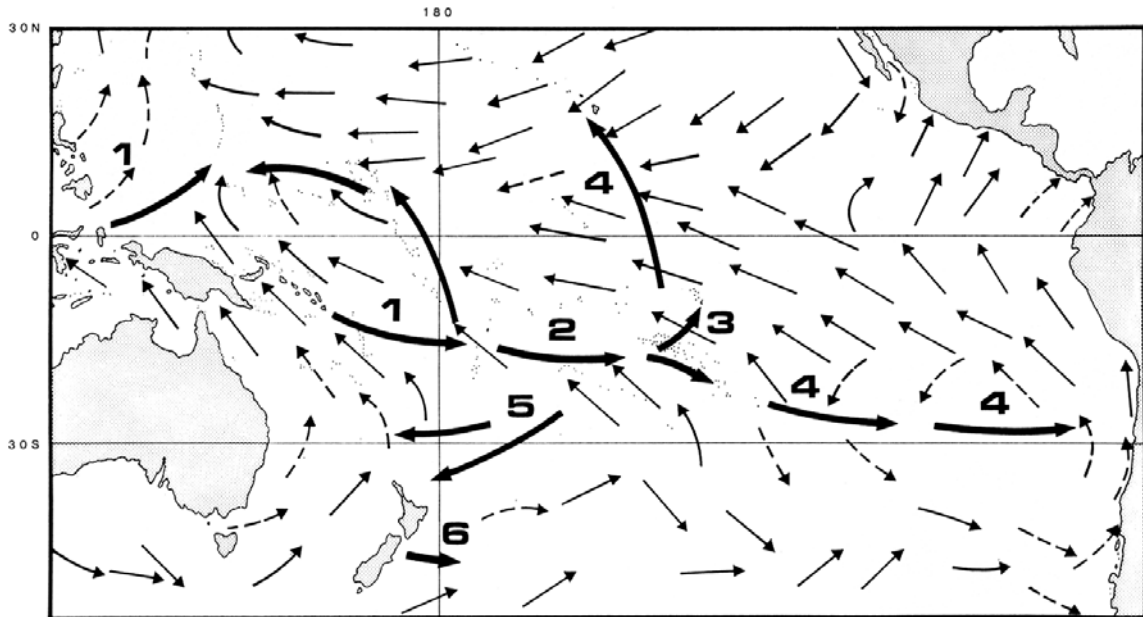
garden plants and tree crops. Pigs, dogs and fowls were sometimes kept, and seafood was important. In many islands, agriculture, aborigiculture and even aquaculture were intensified. Traditional settlement patterns ranged from dispersed households to socially differentiated villages. Society was integrated by exchange relations, which occurred locally and over wider areas. There was a great variety of forms of leadership. Society ranged from small-scale and egalitarian, without much formal hierarchy, to large-scale, stratified and with hereditary chieftainship, which was especially developed in parts of Polynesia.

To turn to the question of first settlement. Greater Australia (Sahul), the Pleistocene continent of Australia and New Guinea, was already colonised 40,000 years ago. By 30,000 B.C., the Bismarck Archipelago was settled, and the then-larger islands of the Solomons either already settled or about to be. Early inhabitants were diverse hunter-gatherers in varied habitats. There is evidence for emerging agriculture in New Guinea even before its separation from Australia by rising seas in the early Holocene.

An easy 'voyaging corridor' stretched from mainland Southeast Asia to the end of the Solomon Islands. Seasonal and often sheltered conditions favoured early movement of simple craft, and the routes they took were influenced by the distance and size of island targets, patterns of intervisibility and favourable winds and currents.

Beyond the Solomons, islands are much farther apart and usually smaller, too, and conditions were different enough to arrest further settlement for 25,000 years, or for as long as it took people to learn how to sail offshore and survive. However, the voyaging corridor offered safe sailing conditions

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APPROXIMATE YEARS BEFORE PRESENT

(1) 3500-3000 (2) 3000-2500 (3) 2500-2000 (4) 2000-1500 (5) 1000 (6) 500

2. The colonisation of the remote Pacific led first against the prevailing winds, then across and down them and, finally, beyond the tropics. The direction of advance offered the highest chance of survival.

for such skills to be learned and to which the first, tentative offshore trips could return.

The broad pattern of settlement of the remote Pacific is shown in Figure 2, together with the prevailing winds of the southern winter. Deep-sea colonisation began after 3500 years ago probably with the rapid spread of an archaeological culture called Lapita through the islands of Melanesia to reach Fiji and West Polynesia by 1000 B.C., or before. This coastal and maritime adaptation carried its own portable economy of plants and animals, and engaged in long-distance exchange. Available radiocarbon dates now indicate that the Marquesas Islands in far East Polynesia may have been settled by A.D. 0, and some prehistorians hold the view that earlier sites, between 3000 and 2000 years old, are still to be found among closer groups such as the Cook and Society islands. In the centuries following A.D. 0, settlement reached Hawaii, distant Easter Island and probably South America. Cool and more difficult sailing conditions delayed settlement south of the tropics, but by approximately A.D. 1000, colonists reached New Zealand. The very remote Chatham Islands to the southeast appear to have been the final settlement of Polynesia.

At much the same time as Lapita left the east of the voyaging corridor, other groups with a different archaeological signature, but probably with some element of contact in their histories, sailed out from somewhere to the west of New Guinea into the high islands of western Micronesia. The Mariana Islands were settled c.1000 B.C. and the much closer islands of Belau and Yap were possibly discovered at much the same time, although there is no evidence for this. The eastern groups of Micronesia, which are nearly all atolls, were settled by A.D. 0, but a longer period of settlement is a distinct possibility. The source of eastern Micronesian settlement,

somewhere between eastern Melanesia and West Polynesia, is as vague as that for western Micronesian settlement, somewhere in the Philippines or eastern Indonesia.

## NAVIGATION

We know colonisation was deliberate, because explorers took with them the plants and animals, women and men necessary to establish viable settlements. As for navigation, it has been shown by a major computer simulation by Levison, Ward and Webb (1973), which took account of actual conditions of wind and current in the Pacific, that the major voyages of settlement could not have occurred by drift and were the result of some kind of directed navigation. Detailed ethnographic research on traditional Pacific canoes and navigation, which included experimental voyages at sea (Gladwin 1970; Lewis 1972; Finney 1977; Siers 1977), established that voyaging canoes were large, fast and safe, with double hulls (like catamarans) or with single hull and outrigger. Practical skills widespread in the Pacific were to steer an accurate course at sea, to maintain a running fix of position by dead-reckoning, and to detect destination islands from beyond sighting range by the use of sea-signs and, where possible, create broad overlapping target-island screens. Esoteric skills most probably included estimating a conceptual equivalent of latitude by the night sky without instruments. While longitude could not be controlled as such without time-pieces, it is both possible and likely that the position of new islands could be fixed by a combination of astronomy and an extension of geographical knowledge by dead-reckoning (Irwin 1989). In just a few millennia a large part of the world's surface was explored, but what remains to be inferred, here, are the kinds of sailing methods that were used by these oceanic explorers as the Pacific was crossed.

### Exploration and survival

No sailing boat can sail into the wind, and the problem is that the prevailing wind in the tropical Pacific is from the east, against the direction of settlement. The similarities of Oceanic people, especially in language, with others to the west was obvious from early historical times, but did not always match the force of the contrary wind in theories of origin. An American source for Polynesians was an early idea, and its modern exponent is Thor Heyerdahl. Yet, in spite of the difficulty, eastward voyages were recorded in the tropics from early historic times, and it was understood then that the means to do so arise from seasonal interruptions in the easterly trade winds.

Sailing between known and unknown islands has its risks, but sailing into empty ocean is fatal. Some theories of Pacific colonisation prefer many explorers to die at sea, but there is nothing to show Pacific explorers were unconcerned about their lives. Without a doubt, it is safest to sail first in the direction that is normally upwind because one can expect

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the fastest trip back. The hard way is really the easy or safe way and this simple paradox is one of the keys to explaining the trajectory of human settlement. Practically every radiocarbon date in the remote Pacific supports the view that colonisation went first against the prevailing winds and only then across and down them.

Sailing upwind also provides the means to find the way home by latitude sailing. This was probably developed at some point in the settlement of the Pacific, and simply involves returning to the latitude of one's origin island, while still upwind of it, and then running with the wind along the latitude. Experimental evidence shows that the error in estimating latitude from the stars, without instruments, is matched by the ability to detect the presence of land from offshore.

To sail with some safety across the prevailing wind requires a knowledge of islands to leeward of the starting island, in case that cannot be reached on the return journey. Sailing downwind, on the other hand, usually requires returning by a different route. The circumstances of exploration changed in the remote Pacific as geographical knowledge was added to navigational knowledge, and the range of feasible options increased. Increasing experience and skill were needed to manage the long exploratory probes eventually made into the difficult higher-latitude extremities of Polynesia, and to South America.

In the southern winter of 1985, with four others, I took my 11.2 m yacht *Rhumblin* from New Zealand north to Fiji, and then across the island groups of the western Pacific to New Guinea. The trip was to survey the Louisiade Archipelago, but at the same time I was nursing my dissatisfaction with the subject of Pacific colonisation. All the way to the west I was noting conditions as they would have been for a canoe sailing without charts in the opposite direction, and checking the progress of yachts going that way. We slipped easily downwind with the rhythm of trade wind sailing. There was usually a clear view of much of the sky at night and, relying as we were on sextant and satellite navigation, it was still easy to tell by eye from the altitude of the stars that we were maintaining our approximate latitude. We could see clouds overtake us from behind knowing they could bring more wind. We usually saw line squalls before they arrived. It was hard to get weather forecasts, and when low pressure troughs arrived they took us as much by surprise as an early voyager would have been. But it was just a question of reducing sail and waiting for them to pass through, which in the trade wind season they do fairly quickly.

What we were experiencing was the other side of the coin of colonisation. It was what any canoe could choose to do, which had sailed upwind, whether it found land or not. The ease of sailing west is what made sailing east possible! *Rhumblin* is about as fast as a sailing canoe off the wind. It took us under six days to cross the 500 sea miles from Fiji to Vanuatu. We had the *Pacific Pilot* and charts to show us what lay ahead, whereas a returning early navigator would have had known seamarks and landmarks of another kind. Not even we could miss the peak of Erromanga, more than 50 nautical miles south of us, when our destination, Efate, still lay below the horizon but closer ahead. The trip to the Solomon Islands took another six days, and so did the voyage across the Solomon Sea to New Guinea. Later on, it took just three and a half days to cross the



Coral Sea to the Queensland coast, on a broad reach across the wind. Australia and America are implicated in Pacific colonisation, as we shall discuss later.

Return voyaging is a natural and conventional part of any maritime settlement, and just because people were involved in an episode of colonisation, they were not restricted to one-way traffic. Strategic use of weather systems is conventional too. I have been lucky enough to sail with Mailu people in southeast coastal New Guinea in essentially the same 11–15 m long, stable, seaworthy and fast, double-hulled sailing canoes as were used in prehistory. Traditional trading still takes them some hundreds of kilometres into the Massim region; they sail east with the monsoon and return at the beginning of the trade wind season. If they go west, they take the last of the trades and have variables or monsoonal north-westerlies to come home on. On short trips along the Papuan coast, even during the trade wind season, a canoe can make some progress east in the early morning, when wind from the land holds the trades a mile or so offshore; but later in the day there is always a fresh southeasterly to return on. In the Louisiade Archipelago, small and medium-sized outrigger canoes can often be seen coming and going about their inter-island business, and people watch the weather and use it to advantage. The situation is typical of the parts of the Pacific where sailing survives.

A number of issues arise from this discussion of navigation, and several propositions require further investigation (Irwin 1989). One is that there was a general direction of exploration, which led first upwind. Secondly, the order of discovery was generally in the order of ease of return, and voyages were conventionally two-way. Thirdly, methods that began the settlement of the remote Pacific did not complete it as inter-island distances increased, areas of ocean expanded, and sailing outside of the tropics became harder. Further, there may have been geographical reasons for variations in the order and elapsed time of island settlement, but we should be wary of pauses that follow from the hindsight of prehistorians' reasoning.

## WEATHER PATTERNS IN THE PACIFIC

Details of the weather are important to some of the arguments that follow, so a general outline is provided here. The weather in the Pacific is affected by global patterns of air movement. Warmed air rises at the equator, flows poleward and cools, descending to the surface in the regions of latitude 30°N. and 30°S., and some flows back towards the lower pressure tropics. Cold, dense air from the poles flows towards the equator, meets the air flowing from around latitude 30°, and there is another ascendance, which occurs around latitude 60°. The Coriolis Force, caused by the earth's rotation, deflects air flow to the left in the Southern Hemisphere, so air flowing towards the pole gives winds from the west and air flowing towards the equator gives winds from the east. In the Northern Hemisphere air is deflected to the right giving similar east and west winds (Brierly 1985:17–18). The general flow of air around the earth is divided into

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