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Preliminary view of bycatch hotspot: bycatch distribution in the IOTC area of the southern hemisphere

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Introduction

The problem of seabird bycatch in longline fisheries is thought one of the risks of seabird conservation (Brothers 1994). The necessity to conserve seabirds has led to the development of variety types of bycatch mitigation technologies and they have been actually deployed by commercial pelagic longliners (Kiyota 2002, Yokota & Kiyota 2008). To avoid the seabird bycatch effectively, it is crucial to understand about the location and the nature of the areas where many seabird bycatches have occurred (= bycatch hotspot). There would be multiple ways to define the hotspots of the seabird bycatch, and the well defined hotspots could be used as a beneficial tools from the view points of the scientific study of seabird ecologies and the conservation of seabirds.

Seabird community, abundance and aggressiveness toward pelagic longline operations should be geographically varied. In South African waters, large numbers of albatrosses and petrels aggregate around operating pelagic longline vessels and intensely attack baited hooks, attacks being made mainly by diving seabirds (Melvin et al. 2009). The attacking rate of albatrosses and petrels to the longline baits is much smaller in the North Pacific than in the South African waters, and this could be due to the significant low bycatch rate of diving petrels (Sato et al. 2010). Thus, seabird aggressiveness and the bycatch risk differ among regions. High quality risk analysis, especially for the designation of the bycatch hotspot, should offer valuable information for the introduction of effective mitigation measures with lesser burden on fishermen.

At-sea distribution or foraging activities of seabirds should change seasonally according to phenology; laying an egg, rearing a chick and migrating. For example, during the chick-rearing period, a parent’s foraging range is restricted to the area near their colony in order to return to there for chick provisioning and foraging effort is increased in order to feed the chick. Conversely, non-breeding albatrosses and petrels, including juveniles, may migrate long distances. In addition, the fishing grounds of tuna longline fisheries change by season due to the seasonal changes of migration pattern of tunas, and target species of fishes or seasonal changes in target species. Thus, the actual position of bycatch hotspots will change seasonally. It is important to closely examine seasonal distribution of each seabird species.

At previous tuna RFMO meetings, it was encouraged that the risk analysis of seabird bycatch should be integrated across the southern hemisphere as the distributions of many seabirds by-caught in the Indian Ocean also extend over the Atlantic and Pacific Oceans (WCPFC 2011). Though the risk analysis of seabird bycatches in the pelagic longline fishery conducted by the basin scale (conducted by the ocean) at tuna RFMOs, they should be integrated as albatrosses and petrels caught by the longliners distribute/migrate over the three oceans, they have distorted distribution patterns and their interactions with tuna longliners tend to concentrate in the particular areas. Seabirds, especially albatross species, forage across broad ranges, and some species move from the ocean where there is its colony to another ocean. Thus, it is necessary to discuss the distribution of each species across the whole southern hemisphere in order to define bycatch hotspots.

Our study focuses on seabird species for which CPUEs were high in the Japanese observer data in the IOTC area. Seabird species with high CPUEs in the Japanese observer data with depressed stock levels in the southern hemisphere, and the seabirds bycatches in the IOTC area are discussed from the view point of its status among the three oceans. Examination is made of bycatch distribution using data collected by Japanese observers, longline boats for high school training and chartered research boats in 1992-2010 in the southern hemisphere. According to the results, the hotspots in which effective bycatch mitigation measures should be introduced are discussed for the development of seabird conservation plans.

Methods

Materials

We used seabird bycatch data collected by scientific observers on board commercial tuna longliners, training vessels of high schools, as well as chartered research boats. The majority of the data was collected by the first two data sources on a voluntary basis. The data from observer programs in the southern bluefin tuna operation were obtained during 1997-2009 and the data from high school training vessels and chartered research boats were obtained during 1992-2010. In the majority of cases, the quality of data on seabirds were maintained by giving special lectures to each observer, and species identification was conducted using photos taken by observers in a designated way, and using descriptions in the species identification guide (Nakano 2002). In this study, the older classification system for the species identification of albatrosses was used because of the difficulty to identify some newly described albatross species in the most recent years. Some difficulties exist for species identification of seabirds based on their appearance (external morphology), especially for some albatross species. Though species identification of seabirds in the Japanese observer data was conducted by the scientists in National Research Institute of Far Seas Fisheries (NRIFSF) using photos taken by observers, NRIFSF is now planning to re-check species identifications in the Japanese observer data with specialists of seabird taxonomy.

Data processing

Using these data, the number of seabirds caught and number of hooks observed were summarised into a grid of 5°x5° respectively. The number of seabirds caught was divided by the number of hooks and multiplied by 1000 to obtain average CPUE values of seabirds for each 5°x5° grid cell. The use of seabird bycatch mitigation measures changed by year, area, season and even by vessel and this is likely to have some large influence on the degree of seabird bycatch, but these effects are not taken into account in the calculation of average CPUE for each 5°x5° grid. For the species with higher occurrence in the South Atlantic, and vulnerable species, quarterly CPUE distributions (January-March, April-June, July-September and October-November) are presented.

Results

In the IOTC area, 14,813,680 hooks were observed in Japanese observer data in 1992-2009. Procellariiform seabirds caught by the longline sets monitored by the observers in the IOTC area between 1992-2009 included 3 genus, 9 species and 1730 albatross individuals; 1 genus, 2 species and 177 individuals of giant petrels; and 3 genus, 4 species and 404 individuals of petrels. The total number of by-caught seabirds was 2340 individuals (Table 1). Grey-headed albatross was the species most frequently caught in the IOTC area in 1992-2009 (n=435 / 14,813,680 hooks, Table 1), followed by black-browed albatrosses (n=241 / 14,813,680 hooks, Table 1) and yellow-nosed albatross (n=234 / 14,813,680 hooks, Table 1).

The CPUE for all seabird species combined was the highest off southern African waters in April to September, in southeastern Indian Ocean in September to December and off Chile in July to December (Fig. 1). CPUE of albatrosses was high especially off African waters and in the southeastern Indian Ocean (Fig. 2). The CPUE for giant petrels was lower than that of albatrosses or petrels and occurred in the southeastern Indian Ocean and off African waters but not off Chile (Fig. 3). Bycatch of petrels appeared off African waters, off Chile and in the southeastern Indian Ocean (Fig. 4).

Wandering albatrosses were caught in a number of areas across the Southern Hemisphere, off South Africa, in the southeastern Indian Ocean, the Tasman Sea and off Chile (Fig. 5). Bycatch CPUE for black-browed albatrosses was high off South Africa in April to September and in the southeastern Indian Ocean in September to December (Fig. 6). Shy albatrosses were caught in the southeastern Indian Ocean during July to December and off southern African water during April to September but not off Chile (Fig. 7). Bycatch CPUE for yellow-nosed albatrosses was regionally high off southern African waters and in the south eastern Indian Ocean (Fig. 8). Bycatch of grey-headed albatross occurred below 35 degrees south, off southern African waters, in the southeastern Indian Ocean. None were reported caught in the South East Pacific (Fig. 9). Bycatch of Northern giant petrels appeared mainly off southern Africa and southeastern Indian Ocean and Tasman Sea, and especially included the IOTC conventional area (Fig. 10). Bycatch CPUE of white-chinned petrels was high off South Africa and off Chile, and also occurred in the southeastern Indian Ocean(Fig. 11).

Discussion

Quantity and season of bycatch in the Indian Ocean

In the Indian Ocean, bycatch of albatrosses mostly occurred in the third quarter (July - September) and fourth quarter (October - December). It is difficult to discuss bycatch in the first quarter (January - March) and second quarter (April - June) because of data gaps. In July to September, the black-browed albatrosses, grey-headed albatrosses and yellow-nosed albatrosses, of which CPUE was high in our study, were likely to be non-breeding individuals, given that their eggs are laid in

September-October and hatch in December-March (Brooke 2002). According to the likely high bycatch of non-breeding individuals, it would be crucial to discuss whether the age (mature-immature) or experience would affect vulnerability to bycatch.

Relationship between colonies in Indian Ocean and quantity of seabird bycatch

Because there are several colonies of seabirds in the Indian Ocean such as Iles Kerguelen, Iles Crozet and Prince Edward Island (Table 2), it is anticipated that the CPUE of those seabird species with colonies in the Indian Ocean would be high. However, in fact shy albatrosses which do not have a colony in the Indian Ocean were by-caught more than some albatross species which have a colony in the Indian Ocean (Table 2). This indicates bycatch of non-breeding individuals or/and such mobility of broad range in albatrosses. From this result, it would be reasonable to integrate three Oceans (Indian, Pacific and Atlantic) for discussing seabird bycatch hotspots.

Difference of vulnerability between species

Bycatch CPUE differs substantially between albatross species which have colonies in the Indian Ocean. For example, many wandering albatrosses were recorded caught while sooty albatrosses and light-mantled albatrosses were caught less (Table 2). This does not reflect differences in the total number of birds of each species, since the number of pairs of wandering albatrosses is similar to that of sooty albatrosses and light mantled albatrosses. Light-mantled albatrosses are not likely to follow ships and it has been suggested that both albatrosses feed nocturnally (ACAP 2011). This behavior might promote the difference of vulnerability to tuna longline fisheries between species.

Preliminary view of bycatch hotspots

Some tuna RFMOs meetings discussed the validity of an integrated approach for the analysis of bycatch distribution patterns in the Southern Hemisphere, covering the Atlantic, Indian and Pacific Oceans (WCPFC 2011). Data available by Japanese longliners identify bycatch of albatrosses in the southern hemisphere concentrated off southern African waters, especially in the SE Atlantic between April to September, and in the southeastern Indian Ocean in April to December. Bycatch of petrels was concentrated in the south east Pacific. According to Inoue et al. (2011), based on the interaction maps combined black-browed albatrosses, sooty albatrosses, Tristan albatrosses, wandering albatrosses, Atlantic yellow-nosed albatrosses, grey-headed albatrosses and white-chinned petrels, it was revealed that probability of overlap between fishery and seabird is high in the SW Atlantic. Consequently, off southern African waters, in the southeastern Indian Ocean, and the SW Atlantic are considered risk areas for seabird bycatch, and it is necessary to introduce appropriate mitigation measures there.

Distribution pattern of white-chinned petrels and mitigation measures

CPUE of white-chinned petrel was high off South African waters in April to June, and in the southeastern Indian Ocean in October to December, and varied seasonally. Compared with the distribution range of white-chinned petrel in other oceans, it was broadly distributed in Indian Ocean so the white-chinned dominant system (Mervin 2009) would be broadly occurring in the Indian Ocean. Because white-chinned petrels bring baited hooks to the sea surface by diving to deep water and increase the interactions of albatrosses with baited hooks (Mervin 2009), it is necessary to introduce mitigation measures to decrease bycatch of diving seabirds such as to sink the bait to deep water before the petrels can catch the bait.

Future issues

The occurrence of bycatch will be affected by several factors. In discussing bycatch hotspots of seabirds, it is necessary to understand the factors affecting the occurrence of bycatch such as behavior of each species against longliners, composition of by-caught species and their age, as well as differences between bycatch hotspots and ecological hotspots. And also, it was revealed that the degree of bycatch CPUE does not necessarily agree with the percentage of seabird distribution calculated with tracking data (Inoue et al. 2011). It is also necessary to understand the reason why the difference is occurred.

Conservation and management measures for seabirds

In this paper, the areas off South Africa (east of 0 degree and west of 50E, south of 25S) and Southeast Indian Ocean (east of 90E and west of 140E, south of 25S and north of 55S) are tentatively identified as by catch hotspots. The actual areas are subject to further review and modification, taking into account the new data to be collected.

Considering quantity and season of bycatches of albatrosses and petrels, the traditional seabird mitigation approach (one from Colum A and another from Colum B) should be replaced with more stringent mitigation measures for these hotspots. When selecting measures, effectiveness, safety and practicability of measures should be taken into account.

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Table 1 Bycatch seabirds in IOTC area during 1992-2009

Species	Number
Wandering albatross	117
Royal albatross	51
Black-browed albatross	241
Buller's albatross	3
Shy albatross	191
Chatham albatross	5
Yellow-nosed albatross	234
Grey-headed albatross	435
Sooty albatross	25
Light-mantled sooty albatross	37
Other albatrosses	391
Northern giant petrel	113
Southern giant petrel	43
Other macronectes	21
Cape petrel	4
Grey petrel	69
White-chinned petrel	147
Flesh-footed shearwater	60
Other petrels	124
South polar skua	6
Roseate tern	1
Other seabirds	22
Albatrosses	1730
Macronectes	177
Petrels	404
Total Seabirds	2340
Observed hooks	14,813,680

Table 2 Number of bycatch from 1992-2009, number of pairs in 2009(IUCN 2009), and colonies of by-caught species(ACAP 2011).

	Number of bycatch	Number of pairs	Iles Kerguelen	Iles Crozet	Prince Edward Island
Wandering albatross	117	22,437	o	o	o
Black-browed albatross	241	600,852	o	o	x
Shy albatross	191	13,000	x	x	x
Yellow-nosed albatross	234	41,580	o	o	o
Grey-headed albatross	435	99,000	o	o	o
Sooty albatross	25	19,000	o	o	o
Light-mantled albatross	37	24,000	o	o	o
Northern giant petrel	113	11,500	o	o	o
White-chinned petrel	147	-	o	o	o

"o" represent that there is a colony there, "x" represent there is not a colony there.

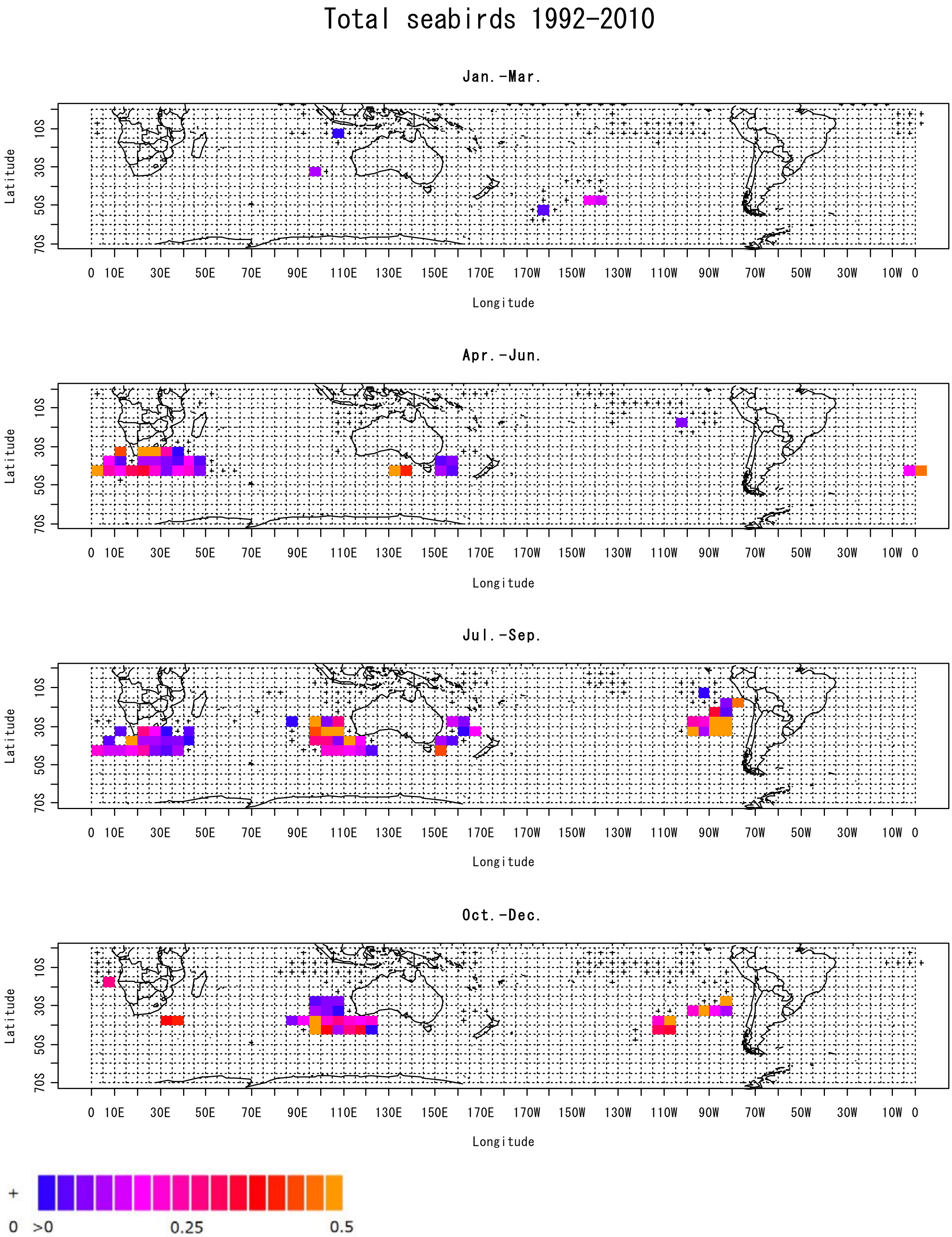

Figure 1 CPUE distribution in the southern hemisphere of observer data of total seabirds used in this study by quarter of year during 1992-2010

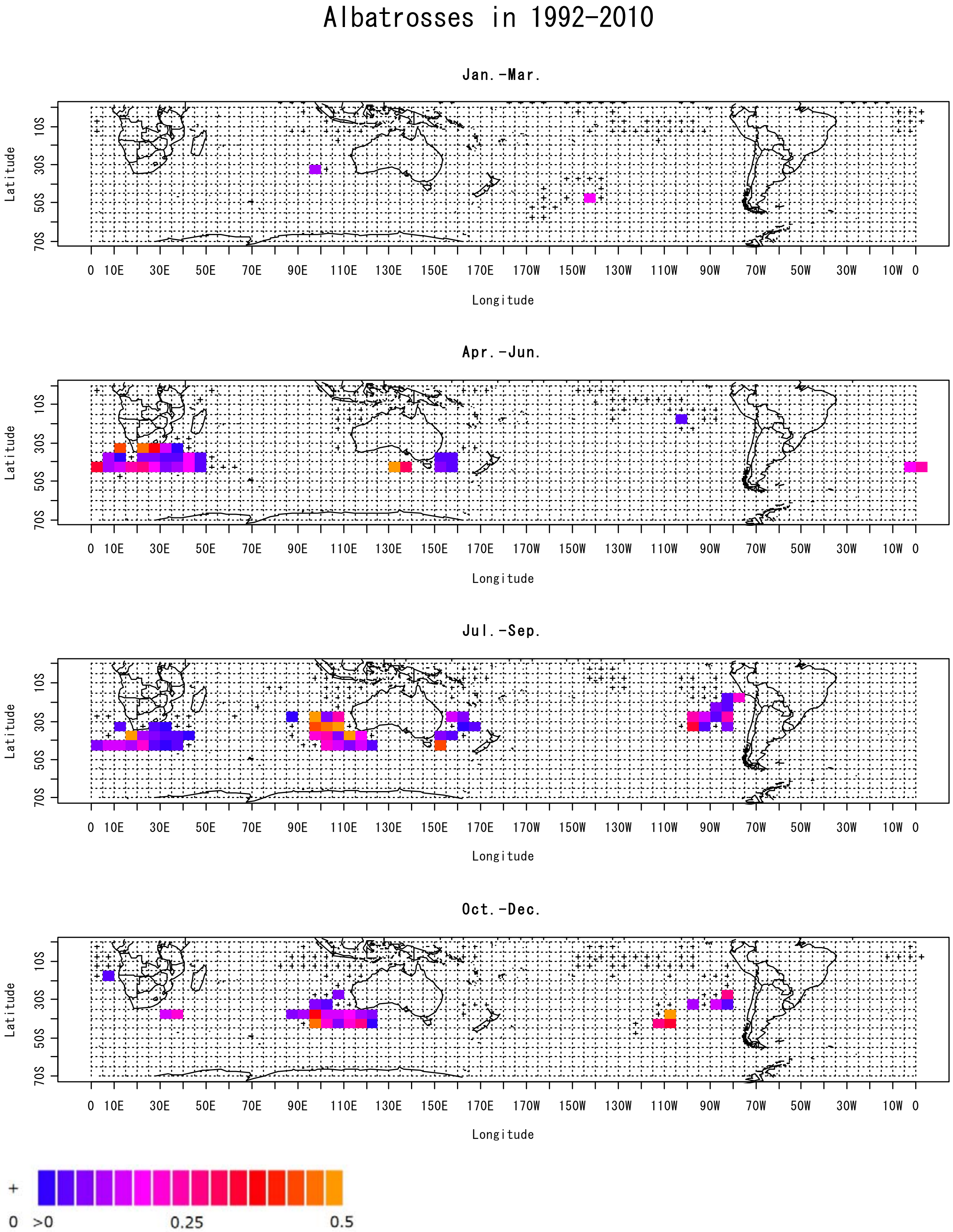

Figure 2 CPUE distribution in the southern hemisphere of observer data of albatrosses used in this study by quarter of year during 1992-2010

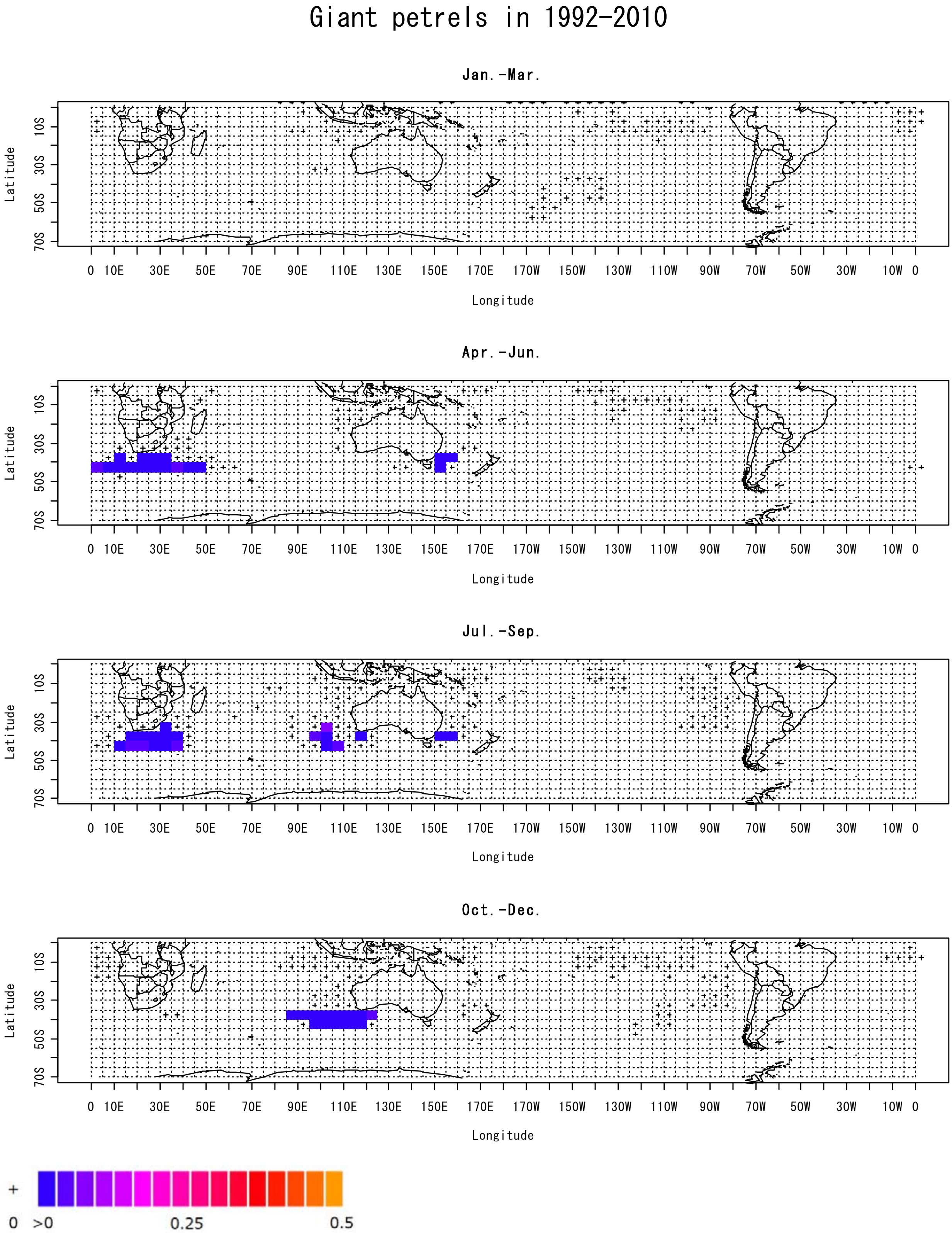

Figure 3 CPUE distribution in the southern hemisphere of observer data of giant petrels used in this study by quarter of year during 1992-2010

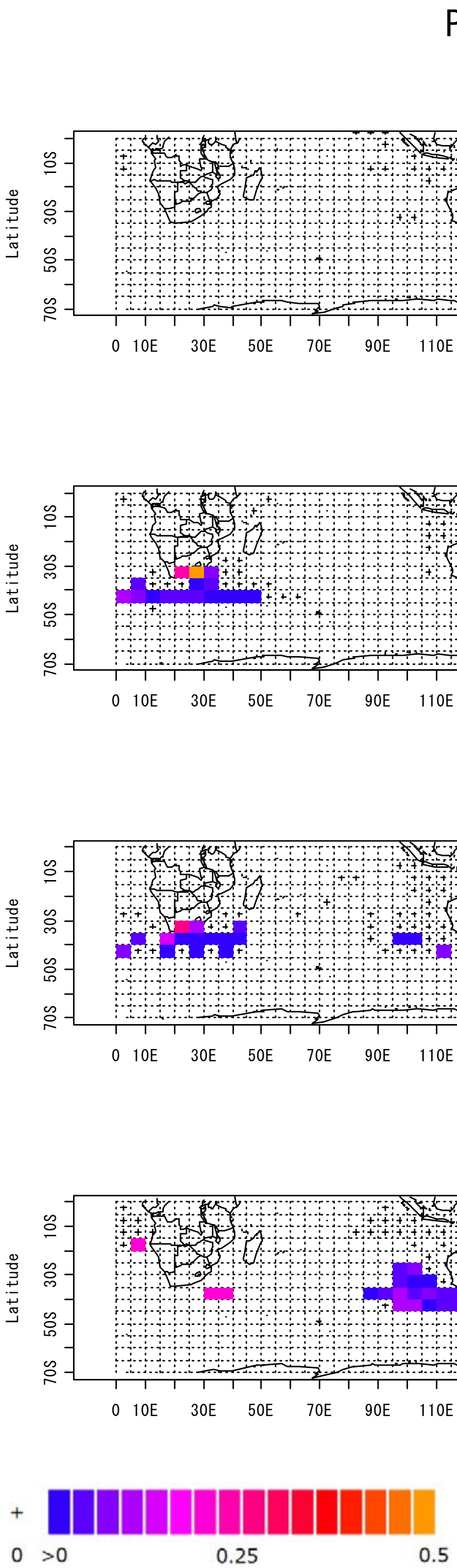

Figure 4 CPUE distribution in the southern hemisphere of observer data of petrels used in this study by quarter of year during 1992-2010

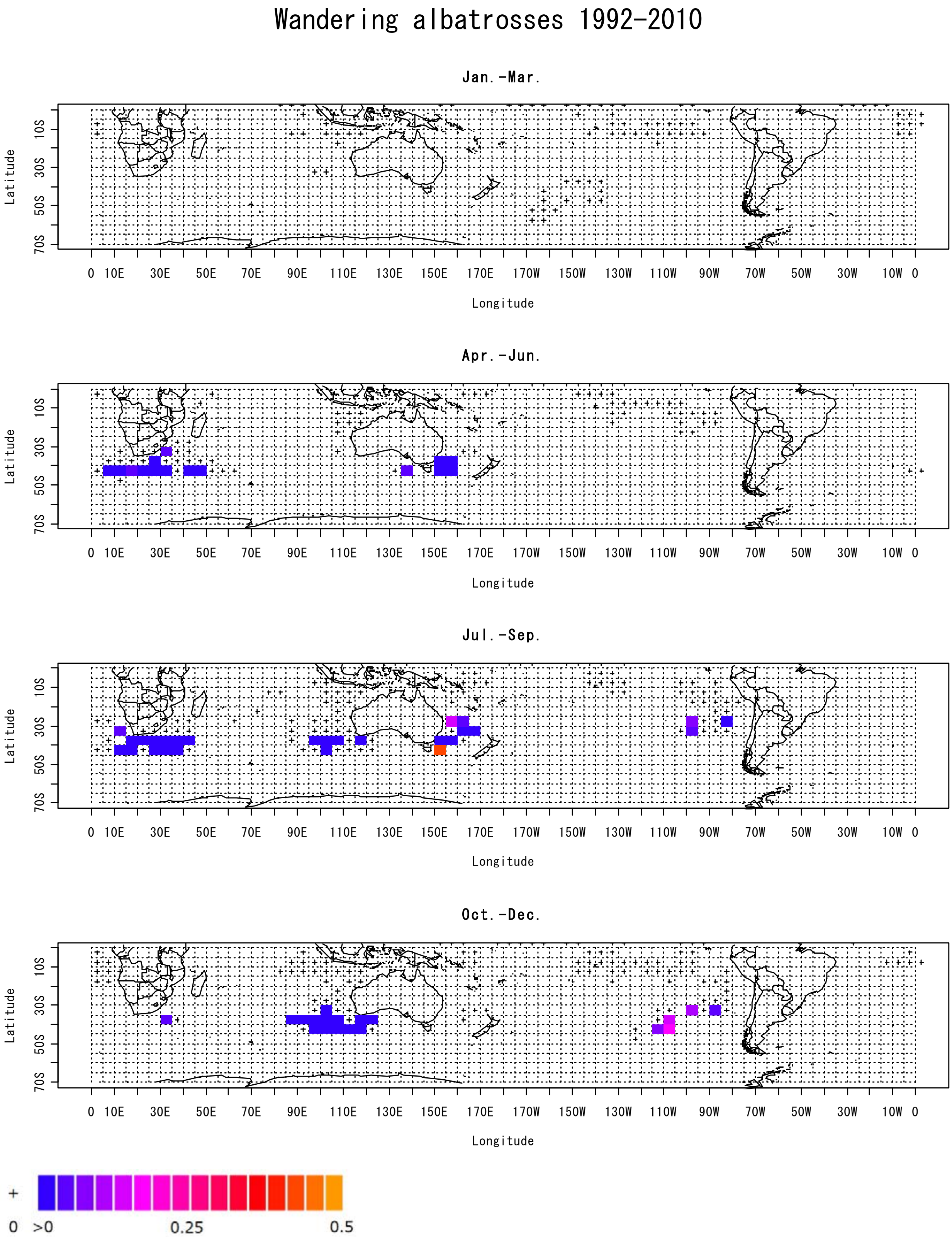

Figure 5 CPUE distribution in the southern hemisphere of observer data of wandering albatrosses used in this study by quarter of year during 1992-2010

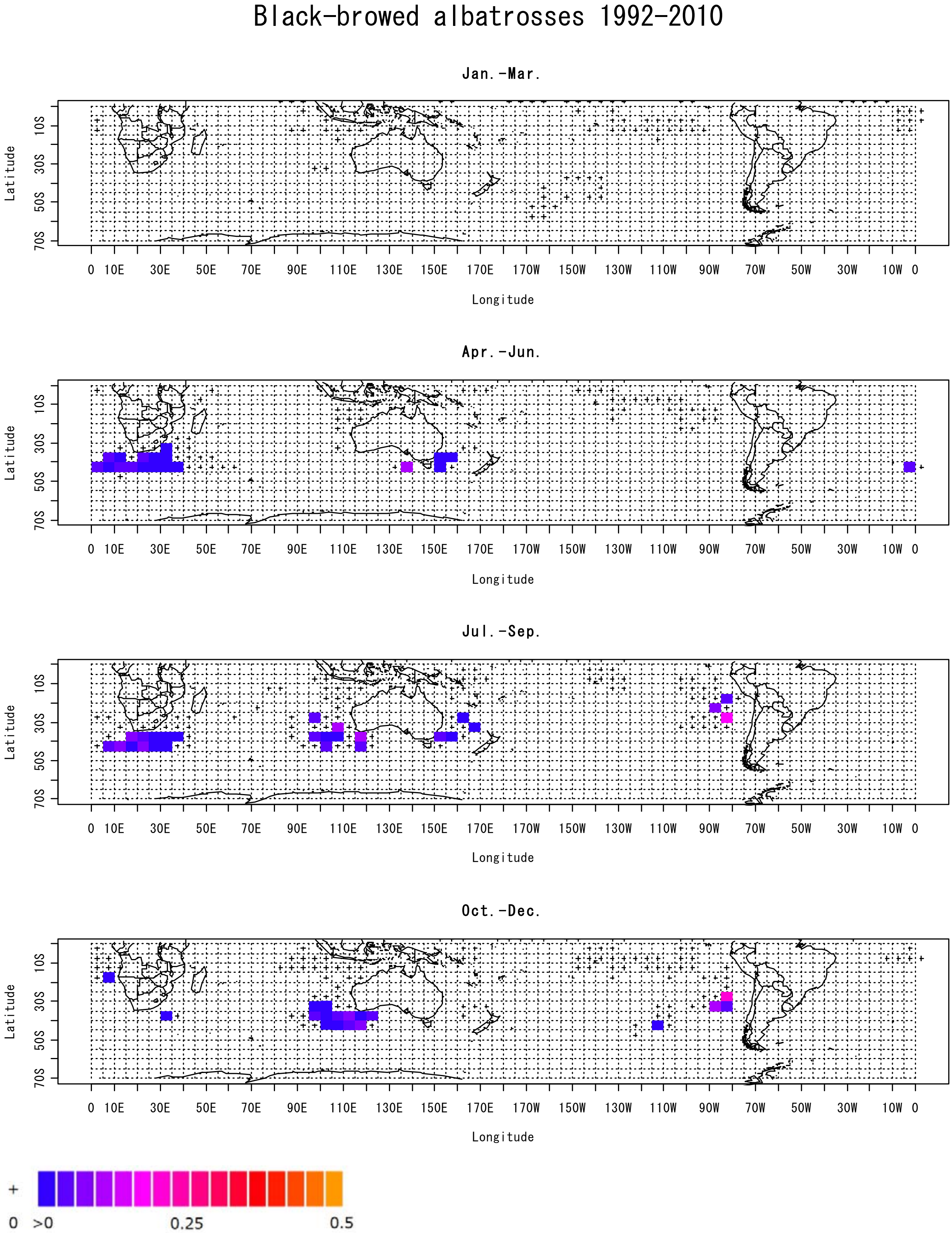

Figure 6 CPUE distribution in the southern hemisphere of observer data of black-browed albatrosses used in this study by quarter of year during 1992-2010

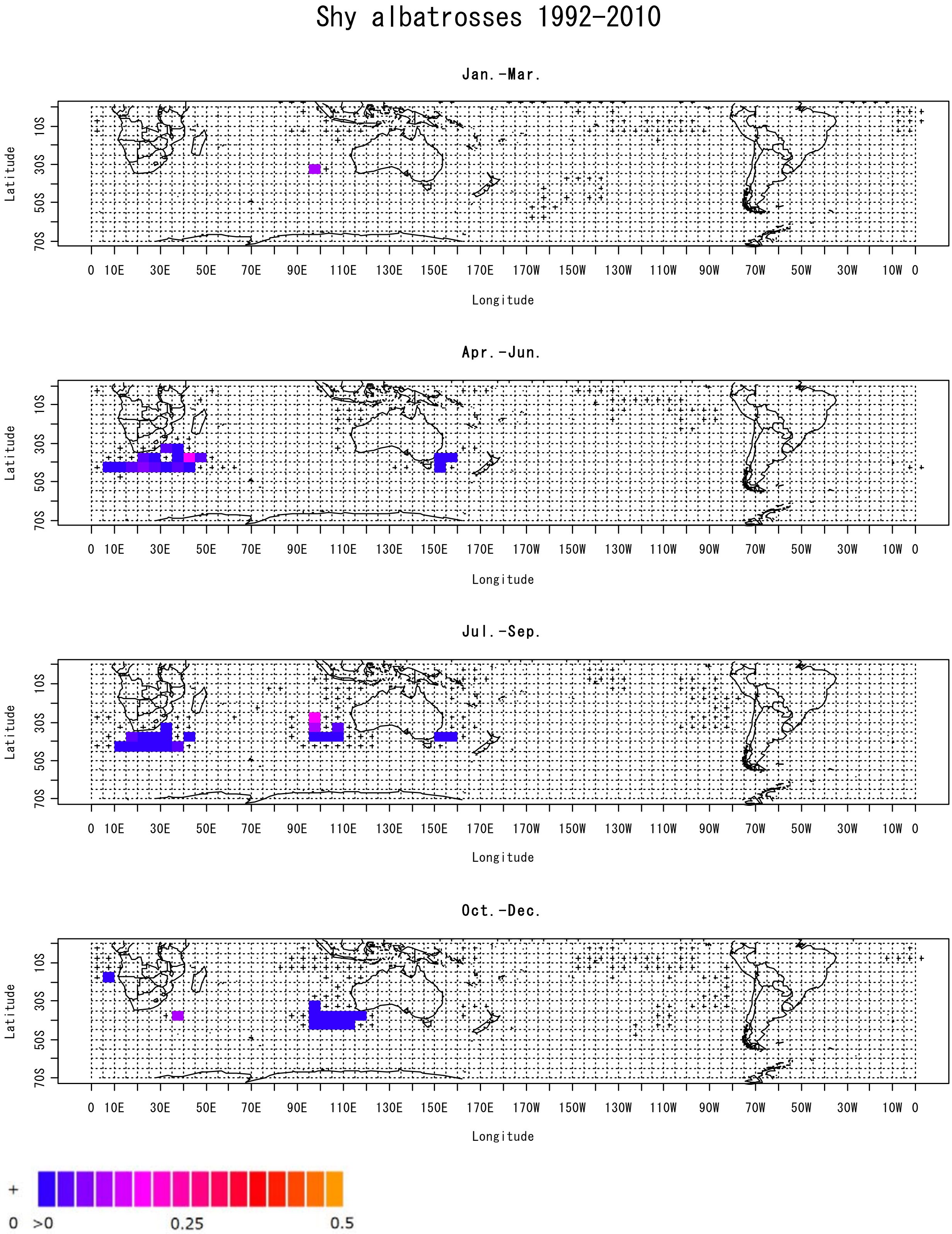

Figure 7 CPUE distribution in the southern hemisphere of observer data of shy albatrosses used in this study by quarter of year during 1992-2010 This data include bycatch of Tristan albatrosses.

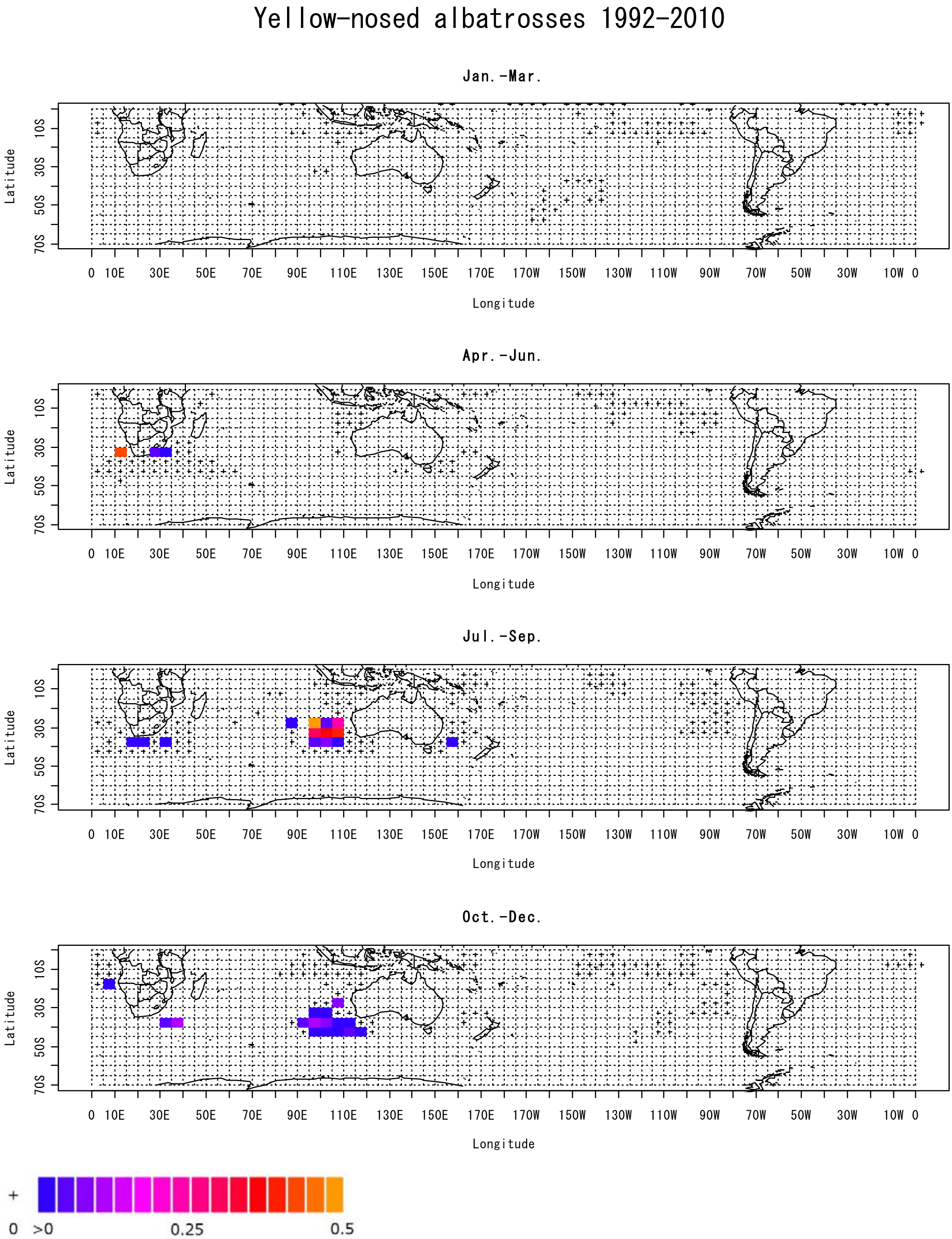

Figure 8 CPUE distribution in the southern hemisphere of observer data of yellow-nosed albatrosses used in this study by quarter of year during 1992-2010

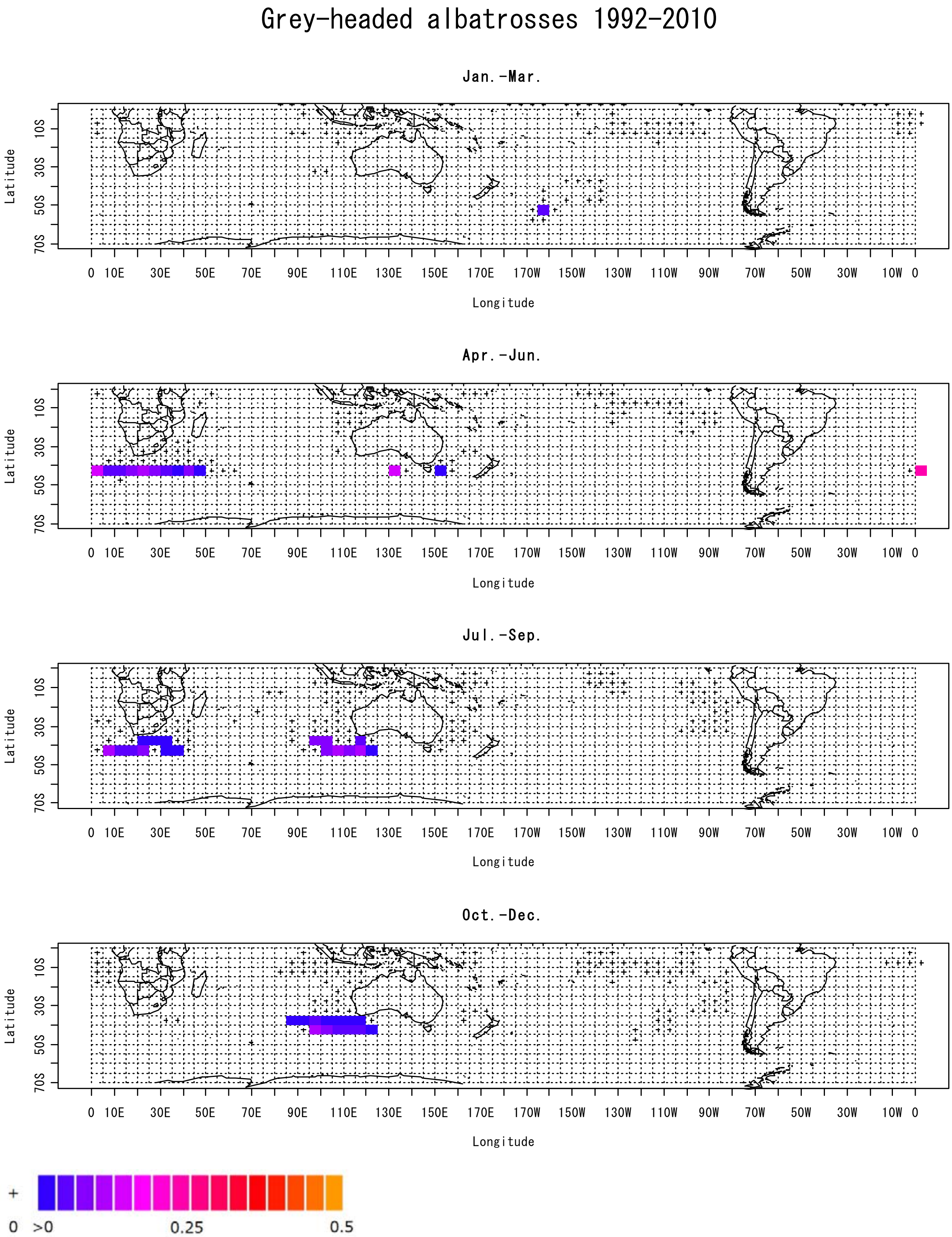

Figure 9 CPUE distribution in the southern hemisphere of observer data of grey-headed albatrosses used in this study by quarter of year during 1992-2010

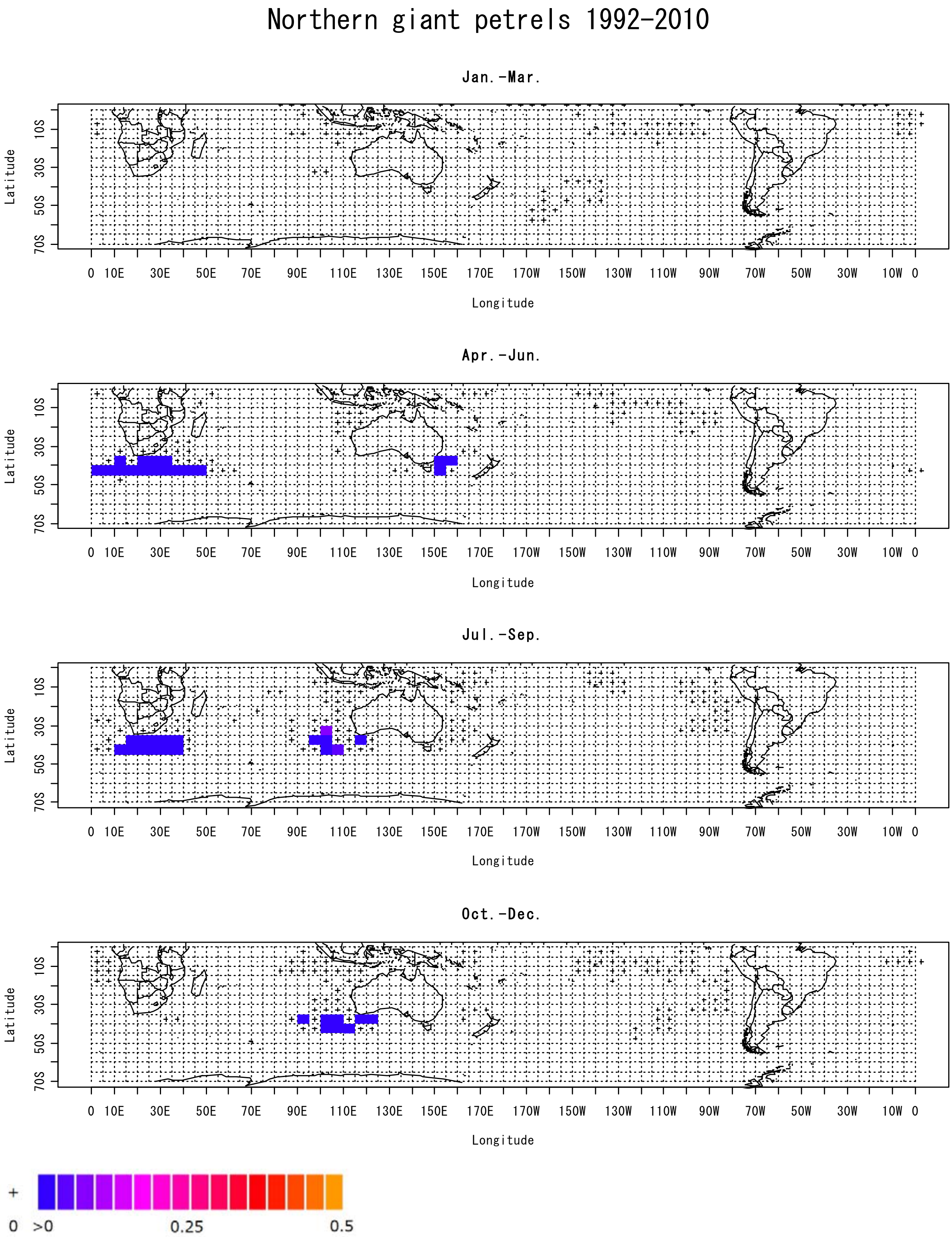

Figure 10 CPUE distribution in the southern hemisphere of observer data of northern giant petrels used in this study by quarter of year during 1992-2010

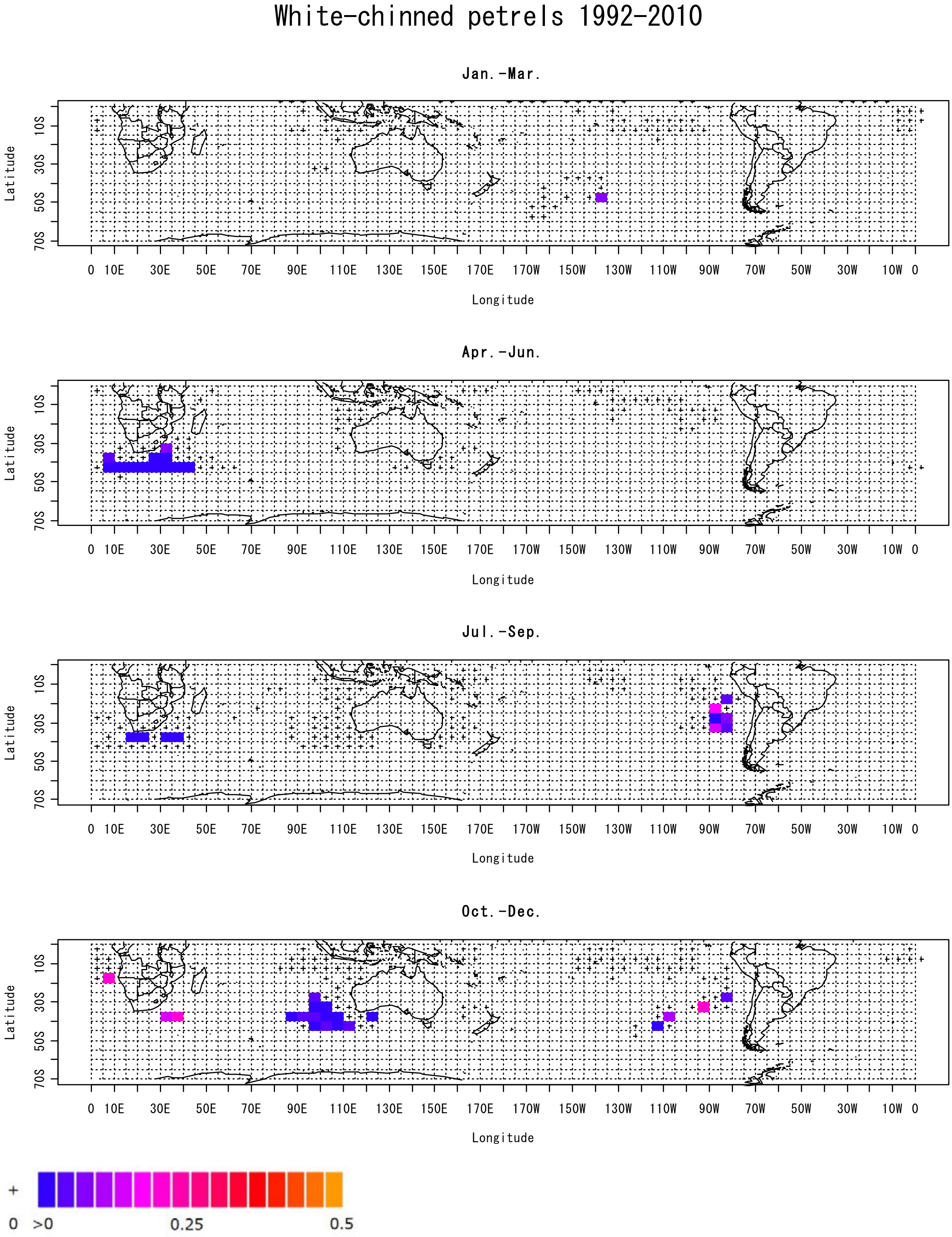

Figure 11 CPUE distribution in the southern hemisphere of observer data of white-chinned petrels used in this study by quarter of year during 1992-2010