Fluctuation of the South Pacific Albacore Stocks (*Thynnus alalunga*) relative to the Sea Surface Temperature

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Chien-hsiung Wang
Institute of Oceanography
National Taiwan University
Taipei, Taiwan, Republic of China

ABSTRACT

Both of the biomass and production of the south Pacific albacore stocks were estimated by the improved surplus production model. Estimations were based on the catch and effort data of the south Pacific albacore tuna longline fisheries.

Indices of the area and perimeter of the isotherm were measured. They are used as the indices of the sea surface temperature of the south Pacific albacore tuna longline fishing grounds.

The relations between the albacore stocks and the index of the sea surface temperature were examined. The results reveal as follows.

(1) The fluctuations of the south Pacific albacore stocks can not be explained by the distributions of the preferred sea surface temperature.

(2) The fluctuations of the south Pacific albacore stocks mainly depend on the distributions of the over 28°C sea surface temperature.

(3) The heavier El Nino events in 1982/83 and the particular developments of the gill netter in 1989 to 1991 are noticeable.

(4) After adjusting the effects of the heavier El Nino events and the rapid development of gill netters, albacore stocks show remarkable correlation with the index of over 28 °C sea surface temperature.

1、INTRODUCTION

Following the same theory of the surplus production model, Wang (1996) suggested IPM-method (Improved surplus Production Model) for assessing fish stocks. It was applied in the assessing south Pacific albacore stocks (Wang 1997). The parameters, including annual biomass, production, and fishing mortality rate of the south Pacific albacore stocks, were estimated. The estimated maximum sustainable yield of the south Pacific albacore stocks was consistent with the other reports (Skillman 1975; Wetherall *et al.* 1979; Wetherall and Yong 1984, 1987; Wang 1988a; Yeh and Wang 1996). Wang (1988b) tried to describe thc seasonal movements of the south Pacific albacore stocks. As pointed out by Wang (1997), the fluctuations of the south Pacific albacore stocks may mainly depend on the changes of the sea surface temperature. Up to now, I haven't found any paper touched the topic of the relationships between the distributions of the sea surface temperature and the fluctuations of the south Pacific albacore stocks.

This paper tries to describe the relationships between the south Pacific albacore stocks and the distributions of the sea surface temperature.

2、MATERIALS AND METHODS

Annual biomass and production of the south Pacific albacore stocks (Tab-1) were adopted directly from Wang (1996). Those were estimated by the IMP-method (Improved surplus Production Model) based on the catch and effort data of the south Pacific albacore tuna longline fisheries. The fishing efforts were adjusted to the effective efforts by Honma's method.

The isotherms of sea surface temperature (SST) were downloaded from the NOAA-CIRES/Climate Diagnostics Center. The fishing grounds of tuna longline fisheries are assumed to be covered by 120E-70W and 20N-50S.

In order to get the index of the sea surface temperature, the areas and perimeters of the sea surface temperature will be measured along the isotherms. Both of the area and perimeter of the over 28℃ sea surface temperatures were measured as the higher SST index and expressed by A28C and L28C, respectively. Assuming that 15℃-22℃ being the preferred sea surface temperature of the south Pacific albacore stocks (Fishery Handbook, 1974), the preferred SST indices were measured by A15C and L15C, too.

For each index, it was measured at least three times. If any one of the measurements deviated largely than 1%, then this value was discarded and one more measurement was asked. Continuing this process until all the differences of the measurements dropped in 1%. Then, the average value was calculated and used as the SST index in this paper.

The relationships between the albacore stocks and the sea surface temperature will be examined. The effects of the heavier El Nino events and the strongly gill netters will be used as the adjusting factors.

3、 RESULTS

On the basis of the catch and effort data of south Pacific tuna longline fisheries, the effective fishing efforts were estimated by both of Honma's method and generalized linear model, respectively (Yeh and Wang 1996). Simply assumed that all of the albacore catch was exploited by tuna longline fisheries, then total effective fishing effort can be risen directly by the ratio of the total catch and longline catch. Applied the IPM-method (Improved surplus Production Model) in assessing the south Pacific albacore stocks, then annual biomass, production and fishing mortality rate could be estimated (Wang 1997).

Tab-1 shows the estimated annual biomass and production of south Pacific albacore stocks during 1967 to 1995. As shown in Tab-1, annual biomass varied in the ranges of 23-102 thousand metric tons. Mean value maintained in 42526mt. From 1981, the annual biomass has been lower than the mean value. Then, they showed increasing trend from 1989. However, the relative lower biomass appeared in 1989-1991. This period is just the same time of the rapid development of gill netters in this area. Similar trends can be found in the fluctuations of annual productions (Tab-1).

After reviewing the distributions of the daily operating data of Taiwanese tuna longline fisheries, it is reasonably assumed that tuna longline fishing grounds may be covered in the area surrounded by 120E-70W, and 20N-50S.

Downloaded the image from the NOAA-CIRES/Climate Diagnostics Center, distribution of isotherm of sea surface temperature (SST) of fishing grounds can be obtained (Appendix 1982-1997). Two kinds of the index of SST have been measured by these images. One is the higher SST area assuming to be larger than 28℃. The other one is the preferred SST area assuming to be the area surrounded by the isotherms of 15℃-22℃ (Fishery Handbook, 1974). For each one, two indices, i.e., area and perimeter, were measured, respectively. They are expressed by A28C, L28C, A15C and L15C, respectively. The images of the SST isotherms before 1982 are not available.

SST indices of fishing ground in 1982 to 1997 are shown in Tab-2. Variations of the preferred area are comparatively stable than the higher SST area during this period. A15C varied from the ranges of 24.9 to 27.8. The coefficient of variation is CV=0.030. Similarly, L15C varied from the ranges of 37.7 to 41.3. It has lower value of CV=0.023.

Comparatively, the indices of the higher SST area varied violently. A28C varied from the ranges of 26.7 to 39.4. It has larger CV=0.120. L28C varied from the ranges of 33.4 to 49.5. It also has larger CV=0.103. The CV values of the higher SST area are about 4 times of the preferred SST area.

The relationships between the above SST indices and annual biomass and production of the south Pacific albacore stocks are examined.

Reasonably, it is assumed that biomass and production of the south Pacific albacore stocks mainly fluctuate with the distribution of the preferred SST. However, maybe due to the rather stable of the preferred SST, their correlation is very unclear (Fig-1).

For the higher SST area, biomass and production fluctuate roughly with SST index (Fig-2). It seems to have time delay by one year. As shown in Fig-3, the fluctuations of the albacore stocks are fairly consistent with the SST indices of the next year unless in 1982, 1983 and 1990, 1991, 1992.

In 1982/83, there were the heavier El Nino events. Hence, the remarkable deviations in 1982 and 1983 may be considered to be relative to the occurrence of the heavier El Nino events.

If the assumption: "the heavier El Nino event takes much time to form" is acceptable, then it is reasonably considered that fish stocks will be affected continuously in a longer time period under the heavier El Nino event. As an indicator, albacore stocks in 1981 and 1982 should be adjusted in order to truly reflect the relationships between the albacore stock and the SST index.

Base on the above assumptions, 1981's albacore stock might be adjusted to be the average value of 1980 and 1981, and 1982's albacore stock to be the average value of 1980, 1981 and 1982. Then, the correlation between the south Pacific albacore stocks and the A28C SST index are improved but it is yet non-significant (r=0.46355ns with df=13 as shown in Fig-4). Deviations in 1990, 1991, and 1992 are yet remarkable (Fig-5).

As shown in Tab-3, particularly rapid developments of gill netters in 1989 to 1991 are noticeable. Percentages of the catch of gill netters in these three years are particularly high. Especially in 1989, it occupies over half of the total catch of the albacore stocks. In 1991, it is yet higher to 32.722%.

The target species of gill netters are of younger albacore. They are generally of pre-recruit or in recruiting to the tuna longline fisheries. Hence, the particularly high fishing pressure caused by gill netters should be considered as an another important factor effecting the fluctuation of the albacore stocks. Here, the effects of the gill netters are adjusted as follows. It might be assumed that the effects caused by gill netters revealed in the catch composition, and mainly in recruits (given weight one) and prerecruits (given weight two). Then, the catches of the heaviest gill net fishing pressures, 1989 to 1991, should be adjusted as follows by Tab-3.

$R_t = SF_t / (SF_t + LL_t)$

$RA_t = (R_{t-1} + 2 * R_t) / 3$

$B'_t = B_t * (1 + RAt)$

$f'_t = f_t * (1 + RAt)$

Here :

SF=catch of surface fisheries

LL=catch of longline fisheries

R=ratio of the surface fisheries occupied in the total catch

RA=adjusted factor used to adjust the albacore stocks

t=year, 1989-1991

According to the above adjustments, Fig-6 reveals that rather simultaneous fluctuations among the albacore stocks and the indices of the higher SST can be found. However, even adjusted as above, the deviations of some years are yet rather larger.

Compared the deviations (Fig-6) with the percentages of the catch of the surface fisheries occupied (Tab-3), the larger deviations seem to be relative to the unstable fishing pressures caused by the gill netters. As shown if Fig-6 and Tab-3, the relative larger deviations in 1984, 1989, and 1993 to 1996 correspond to the larger variations of the percentage in 1983, 1988, and 1992 to 1995, respectively. They also revealed time delay by one year.

If all of the estimated size of the albacore stocks are adjusted as above, then their correlation are decreased (Fig-7). Anyway, Fig-7 also shows a simultaneous fluctuation trend except in 1989, i.e., between 1988's albacore stocks and 1989's index of SST.

Fluctuations of the fish stocks are always influenced by the biological factors, environmental conditions and human exploitation. Generally, it is not so easy to separate the influential factors and/or to differentiate the strength of the factors. As shown in Fig-8 to Fig-11, the very high correlation coefficients (significant over 1% level) are good enough for explaining that the fluctuations of the south Pacific albacore stocks are mainly depending on the changes of the higher sea surface temperature.

The correlation between A28C and L28C (Fig-12) and between the biomass and production (Fig-13, without adjustment) are very significant. Thus, it implied the conclusions that the fluctuations of the south Pacific albacore stocks highly relate to the distributions of the sea surface temperature over 28°C.

4、DISCUSSIONS

Generally, fish stocks are always affected by the biological factors, environmental conditions and human exploitation.

In the south Pacific Ocean, albacore stocks are mainly exploited by tuna longline fisheries, especially by Taiwanese tuna longline fishery. Reviewing the history of Taiwanese tuna longline fishery in this area, no significant changes of fishing gear and fishing grounds can be detected (Wang 1988a, 1988b; Yeh and Wang 1996). However, there were two noticeable factors in this area. One is the El Nino event occurring in the eastern Pacific Ocean. The other is the gill netters entering the south Pacific Ocean. Excluding the human exploitation, these two factors might be considered to be two most important factors affecting the fluctuations of the south Pacific albacore stocks. It is an interesting topic on the relationships between the albacore stocks and these two factors.

Although this paper can not point out how these two factors affect the south Pacific albacore stocks, it clearly reveals that there is very high correlation between the stocks and the indices of the distributions of the higher sea surface temperature after removing the influences of the heavier El Nino events and the noticeable development of gill netters.

Biomass and production were directly estimated by the IPM-method without considerations of the effects of environmental conditions or gill netters. Isotherms of the sea surface temperature are directly downloaded from the NOAA-CIRES/Climate Diagnostics Center without considerations of the distributions of fishing grounds or fishing pressures of tuna longline fisheries. Hence, it is believed that their high correlation is not simply the "accidental coincidence".

Certainly, the deviations of some years are yet rather large (Fig-6). They may be relative to follow.

(a) The different pressure of the gill netters,
(b) The different strength of the El Nino events,
(c) The different length of time delay caused by El Nino events or gill netters,

(d) How long the influences might be continuous,

(e) The incorrectness of the information of the catch and effort data and/or the sea surface temperature,

(f) The highest sea surface temperature it goes up and the distributed area surrounding by the 28℃ isotherm, and

(g) Another unknown factors affecting the albacore stocks, etc.

However, the assumptions of (1) one year time-lag, (2) adjusting 1982 and 1983 albacore stocks by the heavier El Nino events, (3) adjusting 1989, 1990, 1991 albacore stocks by the remarkable developments of the gill netters seem to be reasonable and acceptable. Hence, very high correlation between the albacore stocks and the indices of the higher sea surface temperature are meaningful for explaining the fluctuation of the south Pacific albacore stocks. It is believed that the south Pacific albacore stocks are certainly influenced by the changes of the distributions of the higher sea surface temperature, especially in the area of over 28℃ sea surface temperature.

5、CONCLUSIONS

As mentioned above, the relationships between the albacore stocks and the index of the sea surface temperature were examined. The results can be concluded as follows.

(1) The preferred sea surface temperature can not be used as an indicator of the fluctuations of the south Pacific albacore stocks.

(2) Albacore stocks were varied with one year time delay by the strength of the sea surface temperature over 28℃.

(3) Albacore stocks might be strongly influenced by particularly heavier El Nino events and particularly rapid development of the gill netters.

(4) The correlation between the albacore stocks and the index of higher sea surface temperature were very high if the albacore stocks adjusted the influences caused by the heavier El Nino events, and rapid development of the gill netters.

(5) After the adjustments of the albacore stocks, the deviations of some years are yet rather large. They might be relative to the unknown factors.

(6) Distributions of the sea surface temperature over 28℃ are good enough for explaining the fluctuations of the south Pacific albacore stocks.

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REFERENCES

Fisheries Handbook (1974)
the Appendix Fig 1.12 in page 618 of the "Fisheries Handbook", edited by Y. Sueihiro. Toyo Kesai Hsinboushia, pp731.

Skillman, R.A. (1975)
An assessment of the south Pacific albacore, *thunnus alalunga*, fishery 1953-1972.
Mar. Fish. Rev., 37(3):9-17.

Wang, C. H., M. S. Chang and M. C. Lin (1988a)
Estimating the maximum sustainable yield of south Pacific albacore, 1971-1985.
ACTA Oceanographica Taiwanica, 21:67-81.

Wang, C. H. (1988b)
Seasonal changes of the distribution of south Pacific albacore based on Taiwan's tuna longline fisheries, 1971-1985.
ACTA Oceanographica Taiwanica, 20:13-40.

Wang, C. H. (1996)
Reconsideration of Assessing Fish Stocks with the Surplus Production Model (in Chinese).
ACTA OCEANOGRAPHICA TAIWANICA, 35(4):375-394.

Wang, C. H. (1997)
Research on South Pacific Albacore Stocks (in Chinese).
in the "High Seas Fisheries Research.", No.1, 75-94.
Council of Agriculture, Taiwan, Republic of China,

Wetherall, J. A., F. V. Riggs and M. Y. Y. Yong (1979)
Assessment of the south Pacific albacore stock.
U. S. Nat. Mar. Fish. Serv. Southwest Fish. Center, Admin. Rep., H-79-6, 17pp.

Wetherall, J. A. and M. Y. Y. Yong (1984)
Assessment of the south Pacific albacore stock based on the changes in catch rates of Taiwanese longliners and estimates of total annual yield from 1964 through 1982.
U. S. Nat. Mar. Fish. Serv. Southwest Fish. Center, Admin. Rep., H-84-11, 7pp.

------------------------------ (1987)
South Pacific albacore stock assessment and related issues. U. S. Nat. Mar. Fish. Serv. Southwest Fish. Center, NPALB/87, 14pp.

Yeh, Y. M. and C. H. Wang (1996)
Stock Assessment of the South Pacific Albacore by Using the Generalized Production Model, 1967-1991. ACTA OCEANOGRAPHICA TAIWANICA, 35(2):125-139.

Tab-1. Biomass and production (1967-1995)

Year	Bt	ft
	unit:	1000 mt
1967	102.647	63.908
1968	84.739	68.960
1969	78.291	69.103
1970	83.125	69.079
1971	56.976	63.256
1972	57.552	63.541
1973	47.134	57.282
1974	30.601	42.591
1975	32.748	44.828
1976	42.338	53.621
1977	41.605	53.019
1978	41.283	52.750
1979	32.220	44.287
1980	48.997	58.571
1981	24.769	36.016
1982	28.067	39.823
1983	32.153	44.218
1984	24.263	35.411
1985	28.845	40.688
1986	38.354	50.207
1987	30.995	43.009
1988	31.377	43.411
1989	23.224	34.152
1990	24.816	36.072
1991	26.038	37.508
1992	32.636	44.714
1993	34.924	46.995
1994	37.411	49.349
1995	35.120	47.186
mean	42.526	49.433

Tab-3. Catch composition (1982-1994)

year	albacore LL	catch SF	%
1982	30.235	2.441	7.470
1983	24.653	0.785	3.086
1984	20.936	4.362	17.242
1985	28.041	5.190	15.618
1986	35.523	3.857	9.794
1987	29.091	2.908	9.088
1988	31.122	9.006	22.443
1989	21.681	30.449	58.410
1990	20.847	14.291	40.671
1991	19.068	9.274	32.722
1992	26.475	7.063	21.060
1993	26.875	4.989	15.657
1994	30.105	5.073	14.421
1995			

note: % by SF*100/(SF+LL)

Tab-2. Index of sea surface temperature. (120E-70W, 20N-50S)

year	A28C	L28C	A15C	L15C
1982	36.432	45.646	26.372	40.269
1983	33.690	44.932	24.977	37.712
1984	27.394	40.558	27.059	40.677
1985	25.266	33.440	27.465	40.619
1986	30.279	39.104	27.059	40.033
1987	37.393	48.914	26.554	39.947
1988	30.336	41.049	26.799	41.296
1989	26.756	37.714	27.260	40.972
1990	32.653	46.701	27.729	40.274
1991	34.098	49.460	27.232	40.338
1992	32.618	44.788	26.122	40.342
1993	30.564	47.295	26.322	40.564
1994	33.858	49.256	26.667	40.963
1995	34.349	44.365	26.288	40.911
1996	30.679	43.217	27.075	41.066
1997	39.356	46.446	24.970	38.771
mean	32.233	43.930	26.622	40.297

Fig-1. SST index and Bt, ft

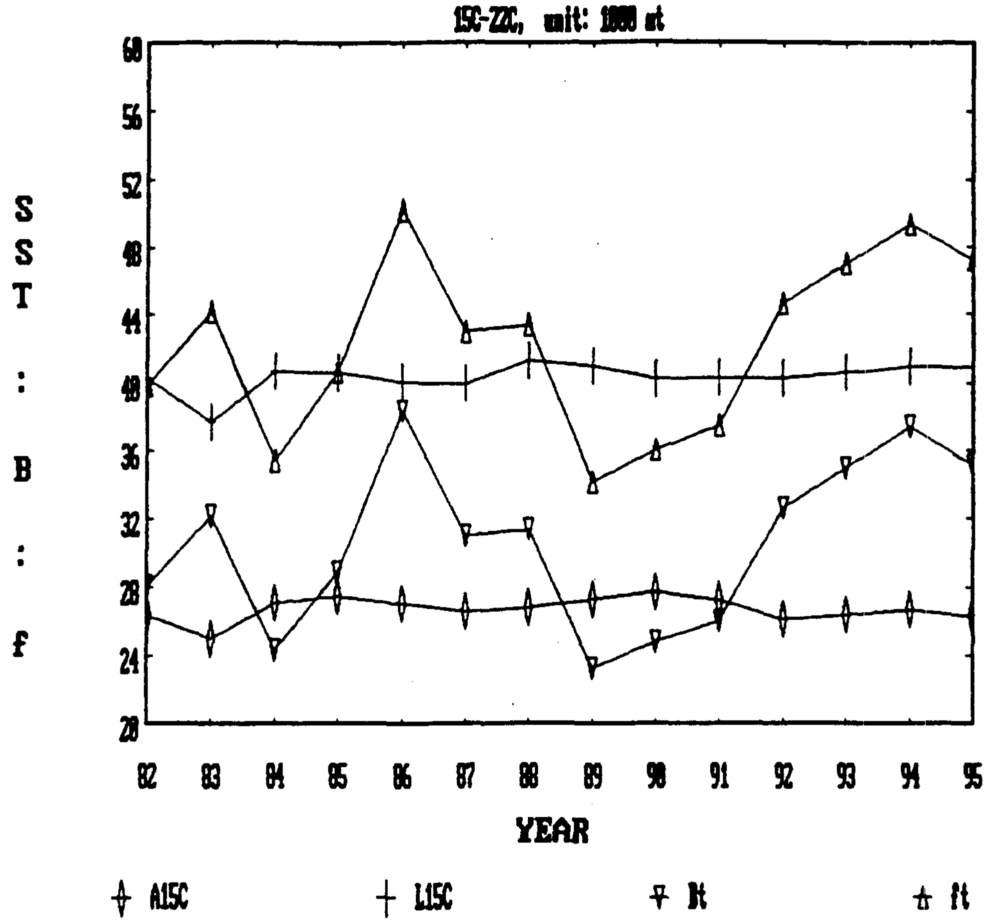


Fig-2. SST index and Bt, ft

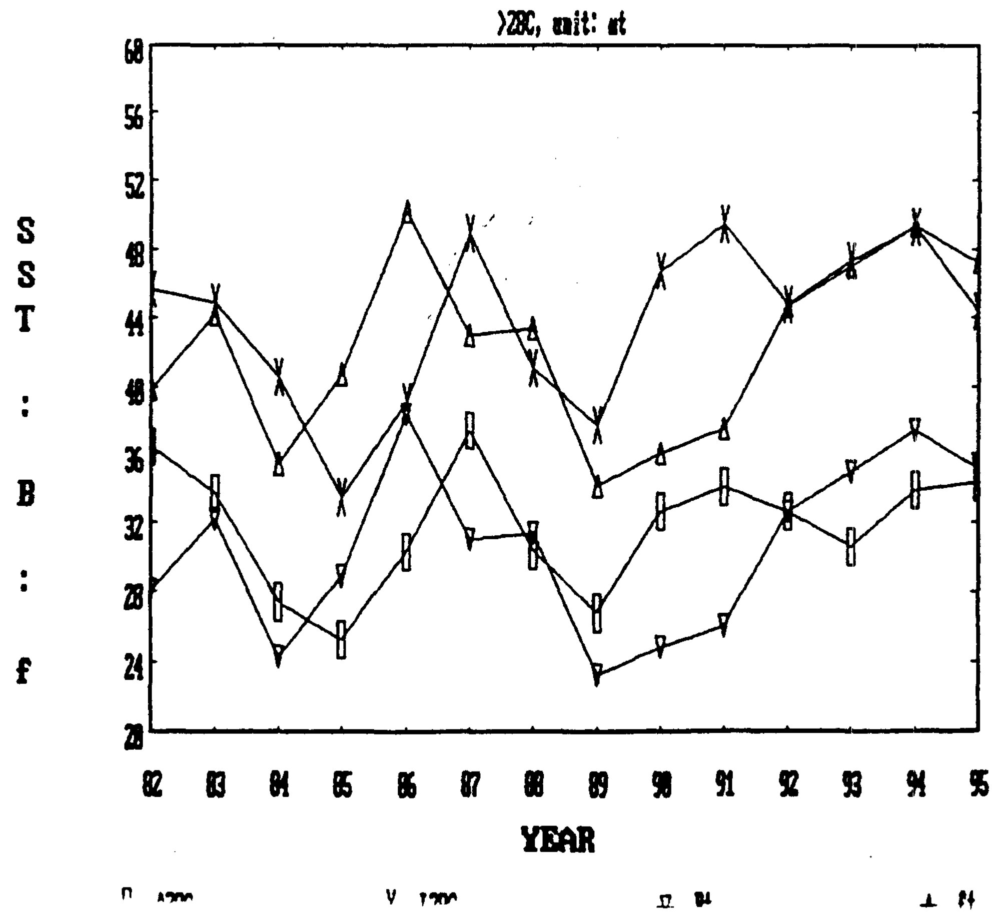


Fig-3. SST index and Bt, ft

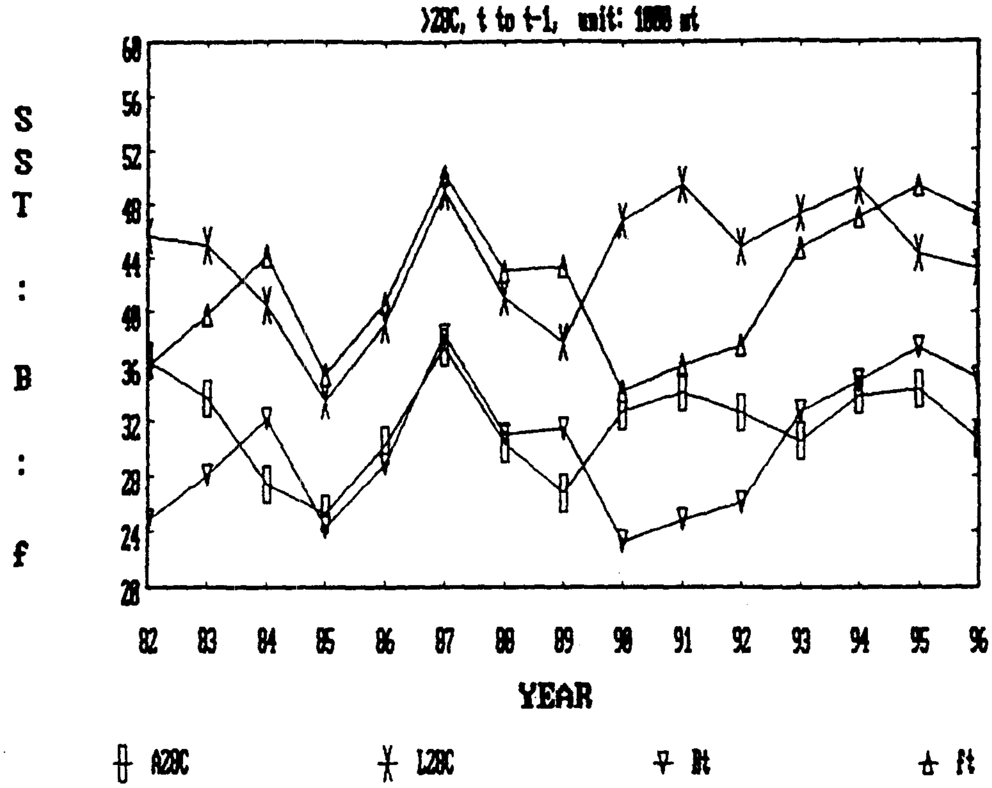


Fig-4. SST index (A28C) and Bt

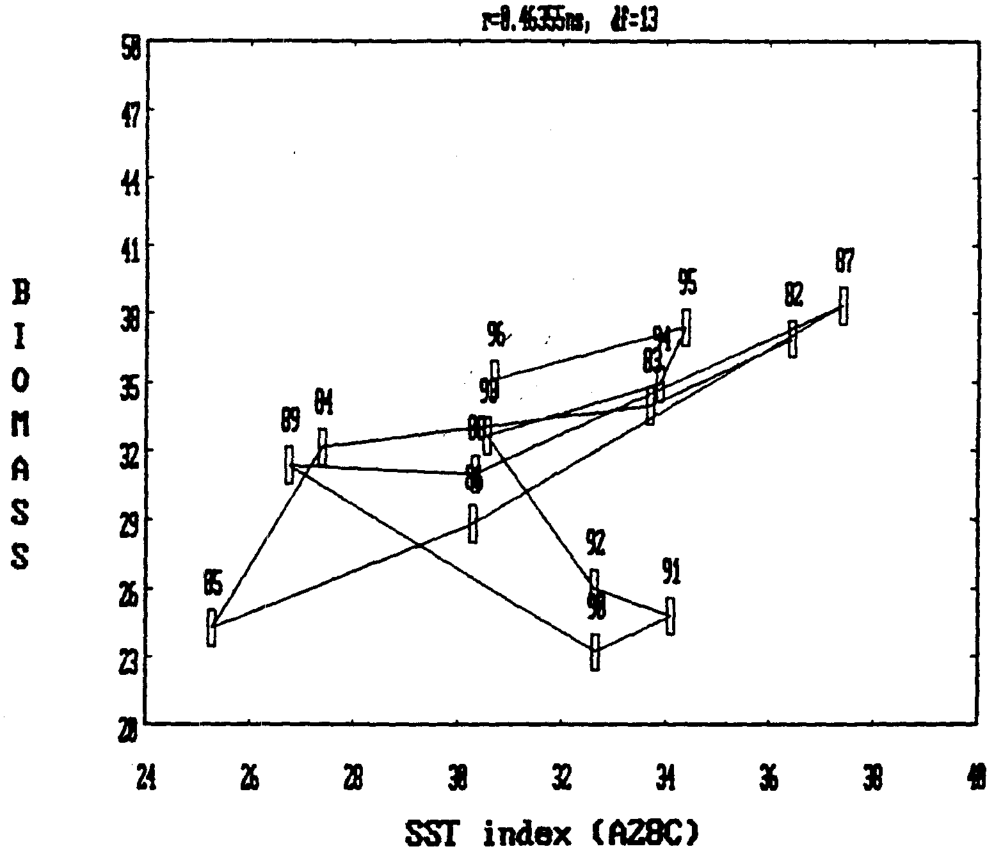


Fig-5. SST index and Bt, ft

82-83's Bt adj-1

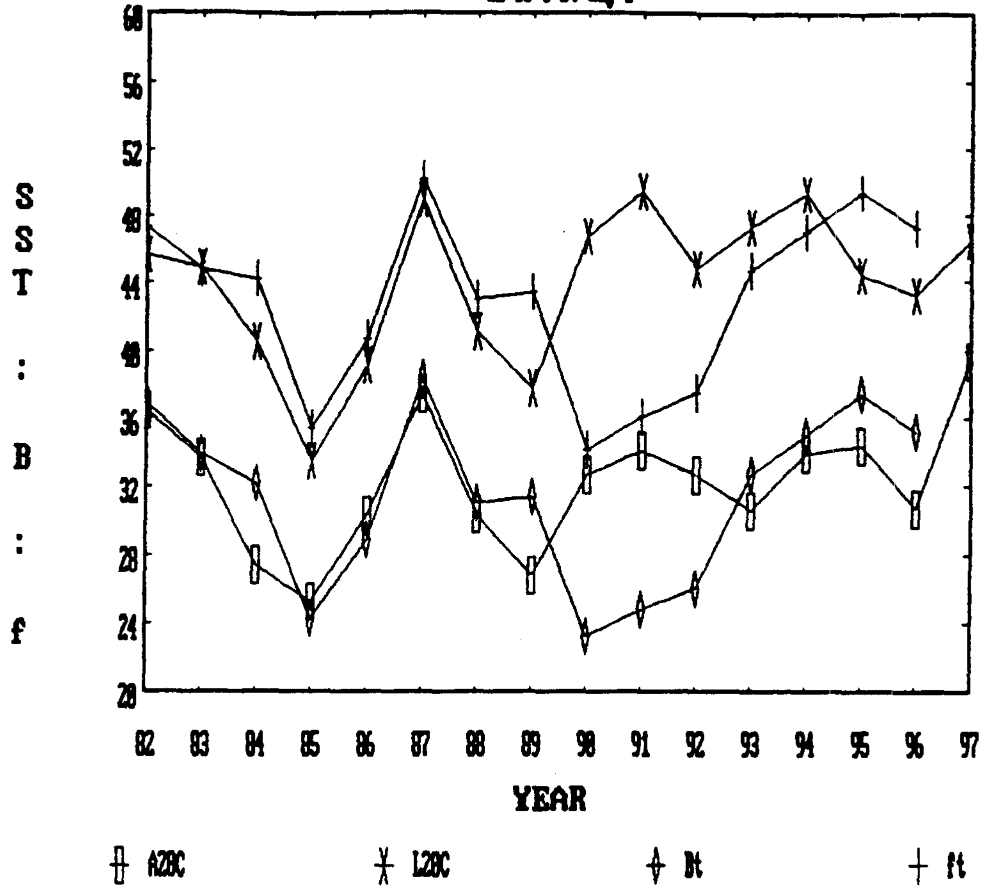


Fig-6. SST index and Bt, ft

82-83's Bt adj-1, 90-92's Bt adj-2

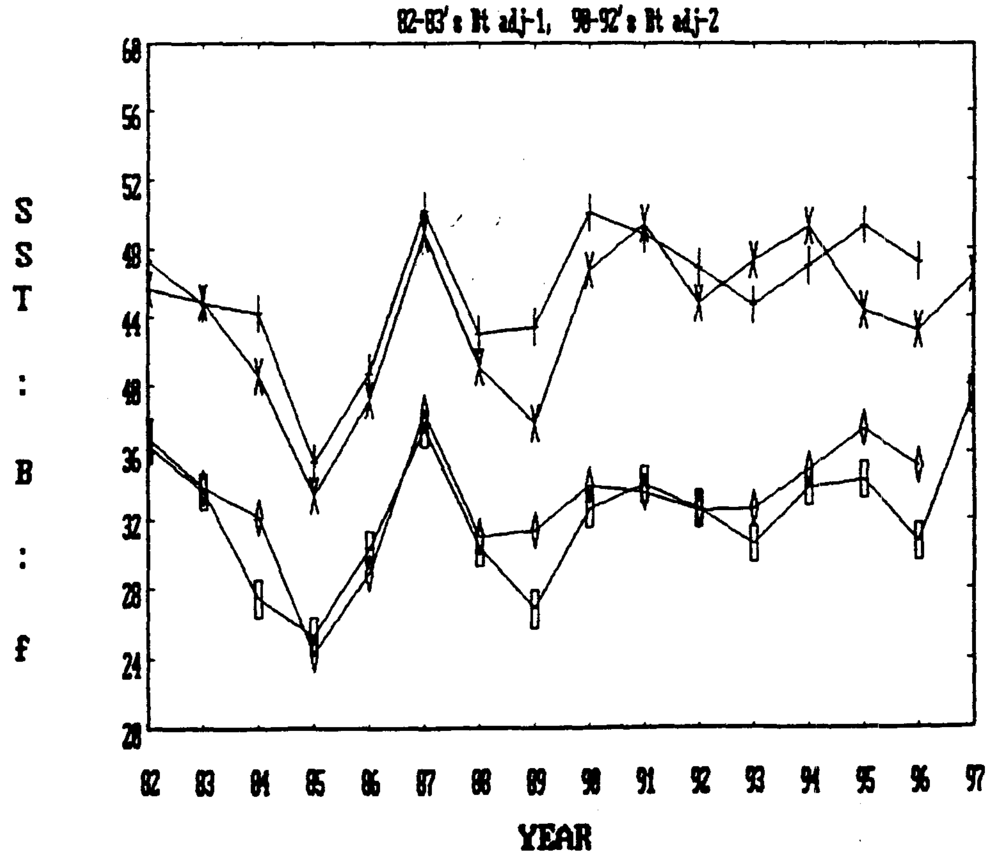


Fig-7. SST index and Bt, ft

82-83's Bt adj-1, all Bt adj-2

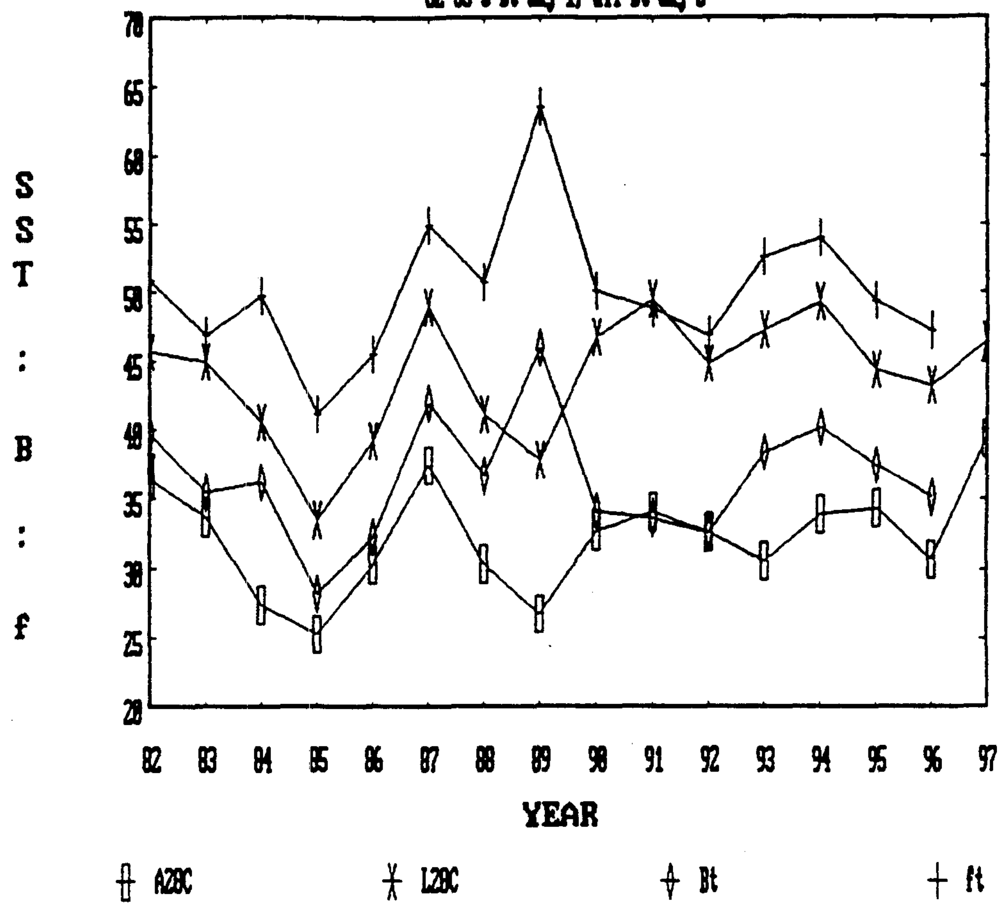


Fig-8. SST index (A28C) and Bt

(ref Fig-6), r=0.83460**, df=13

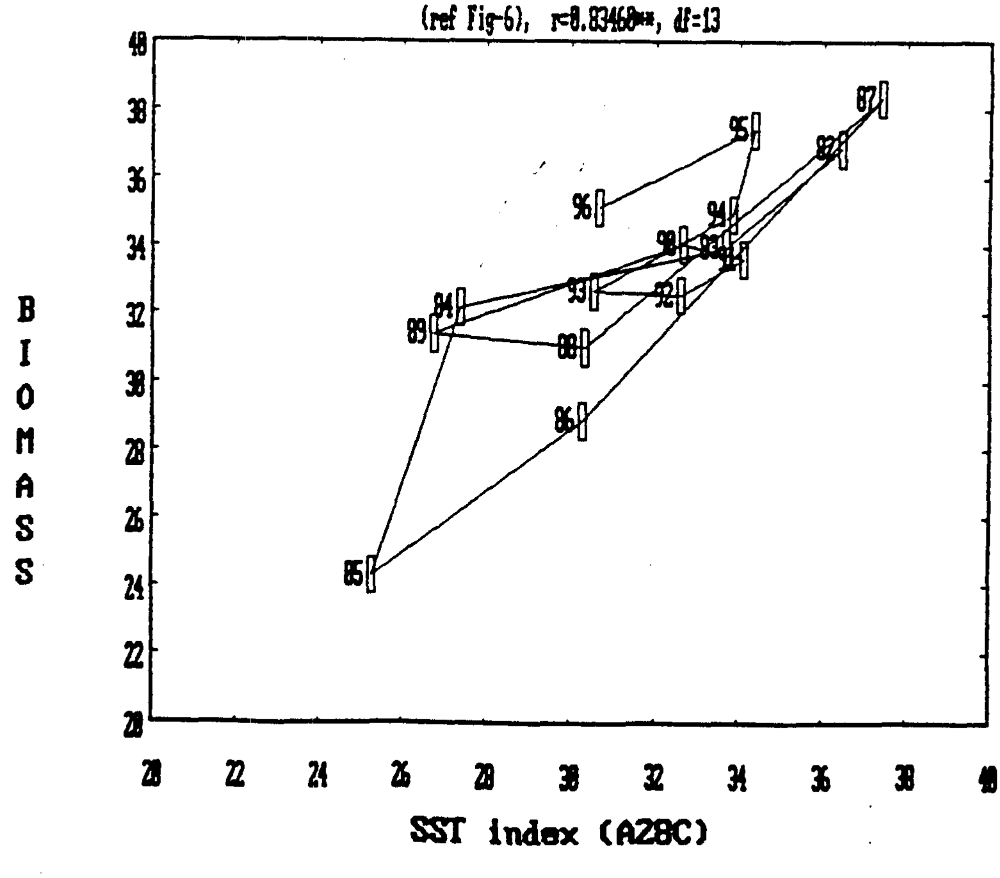


Fig-9. SST index (A28C) and Bt

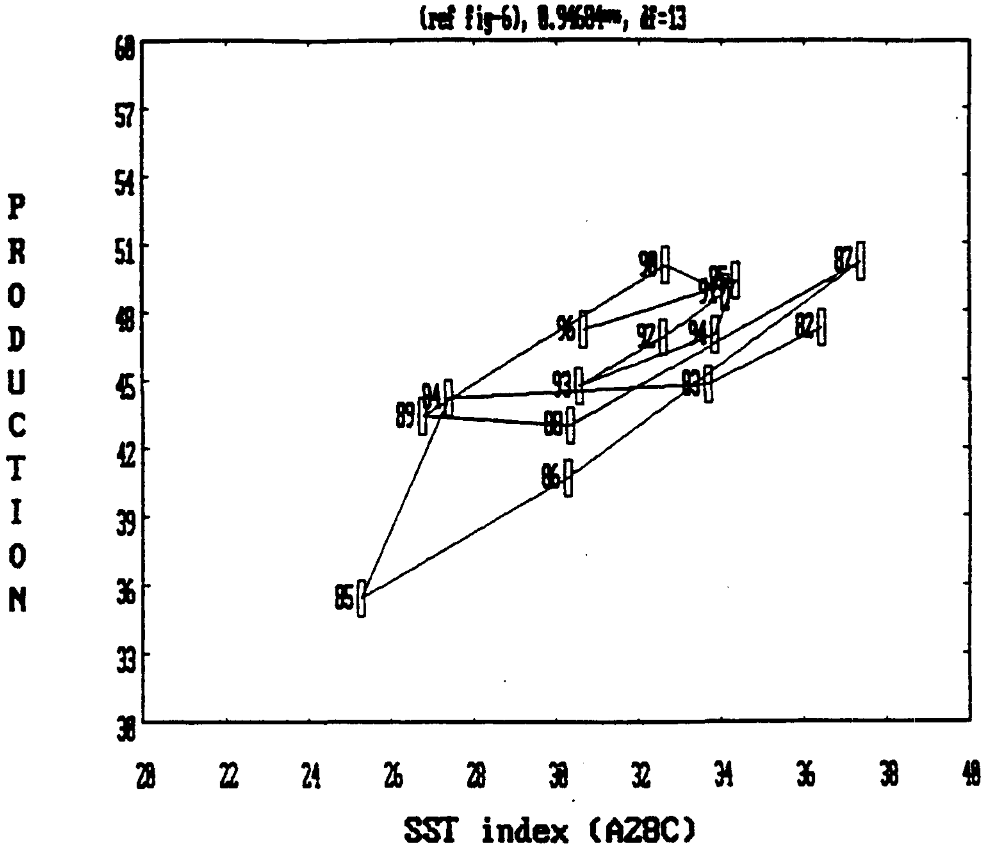


Fig-10. SST index (L28C) and Bt

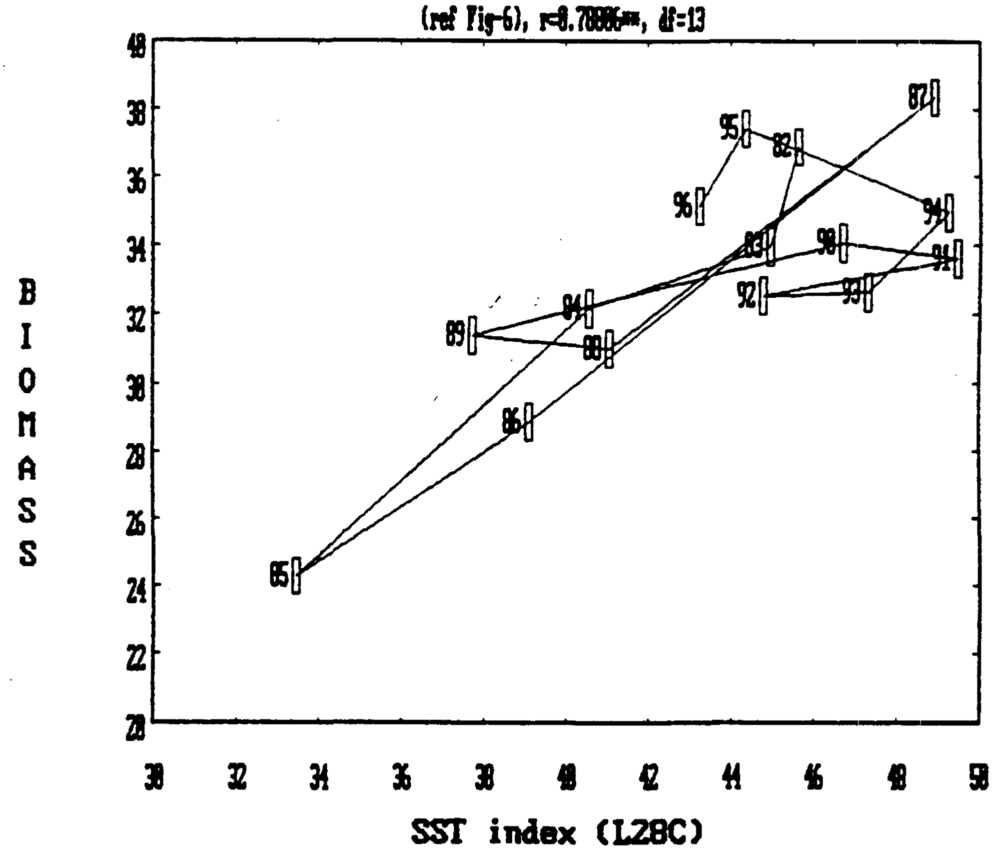


Fig-11. SST index (L28C) and ft

(ref Fig-6), r=0.85232**, df=13

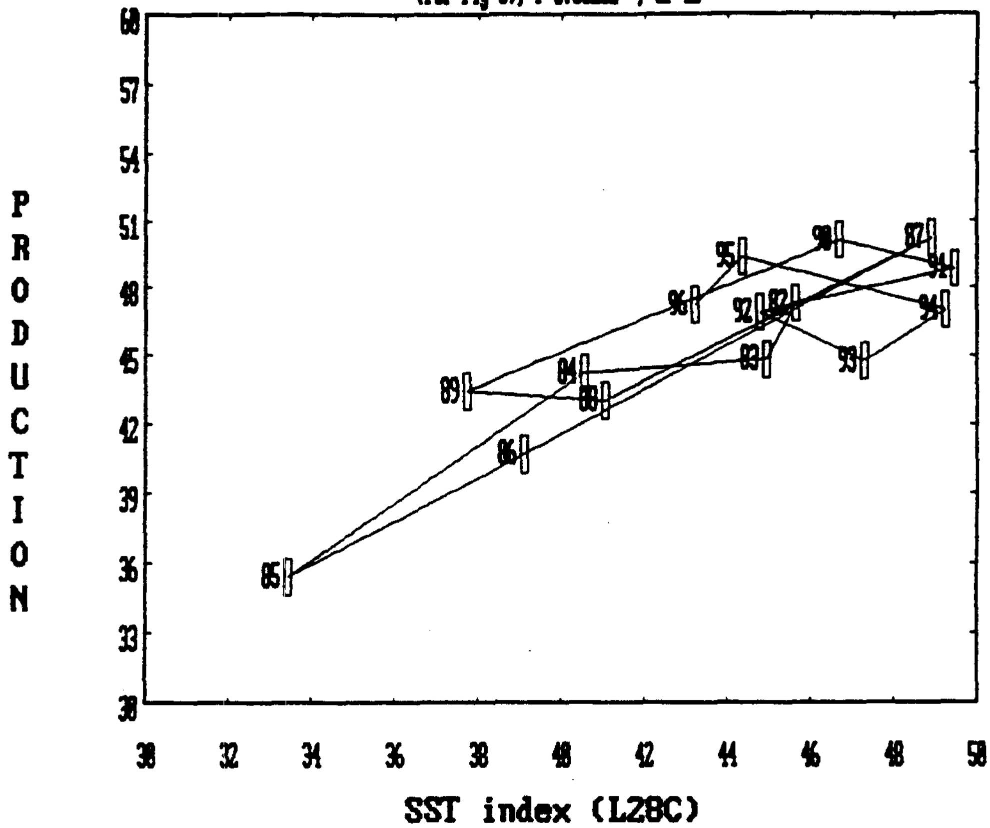


Fig-12. SST index: area and perimeter

A28C to L28C, r=0.83888**, df=13

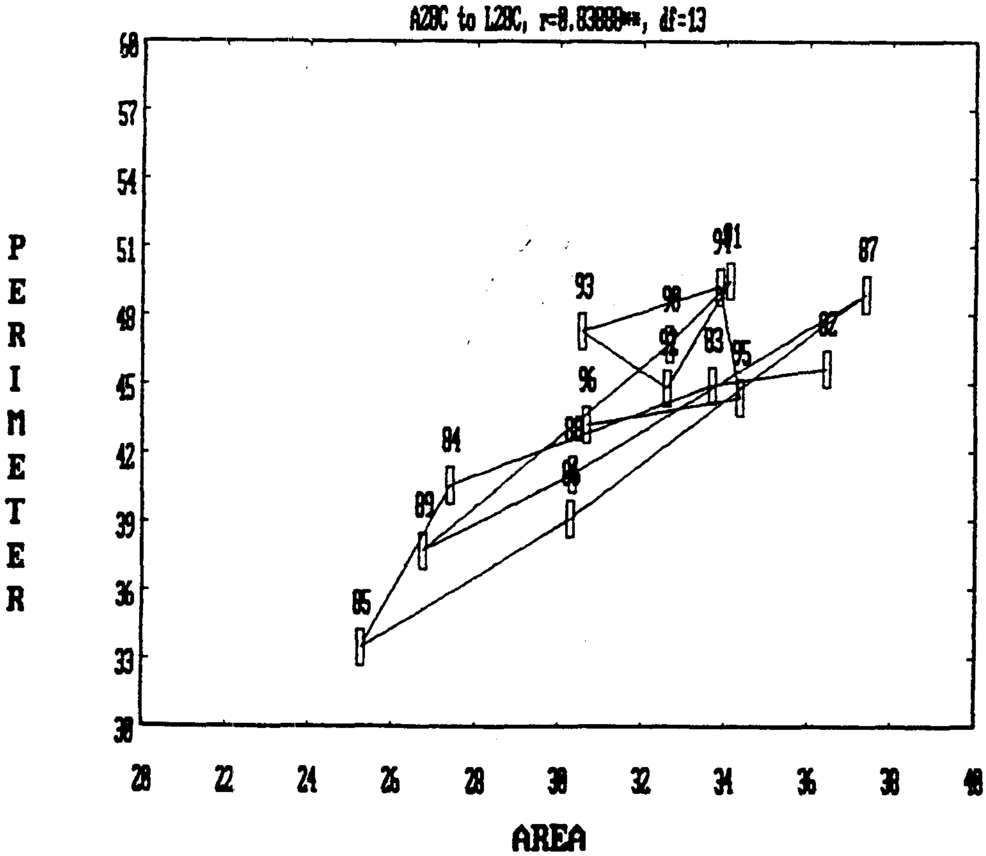
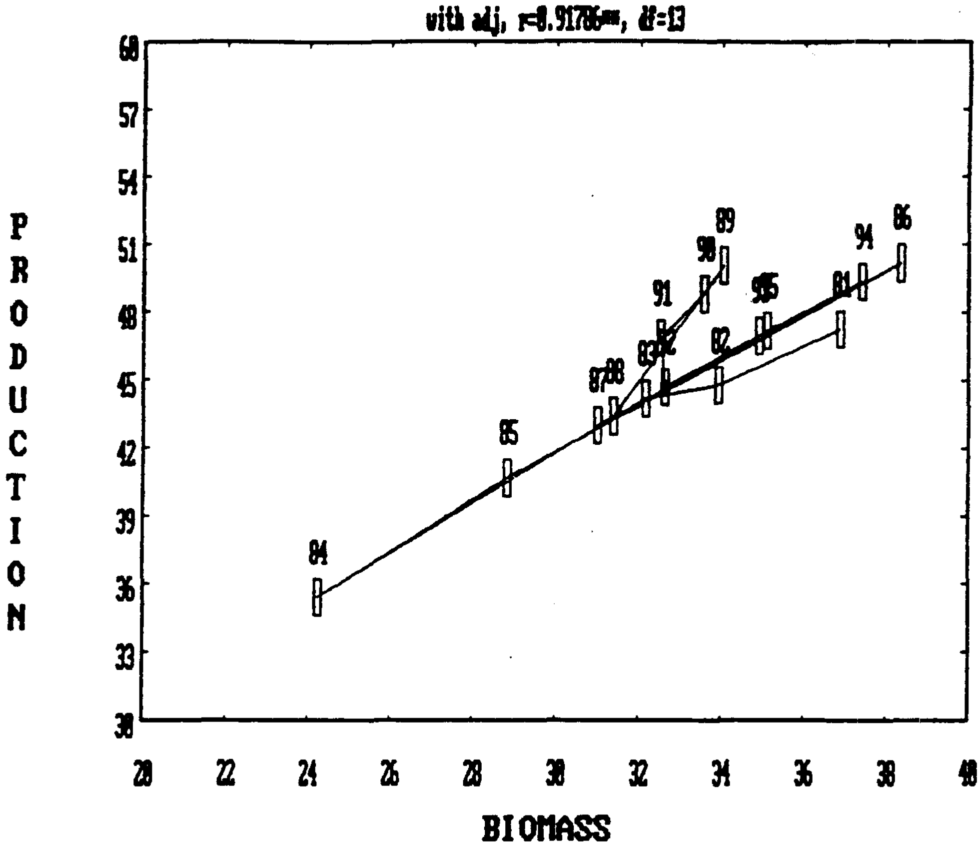


Fig-13. Biomass and production



Appendix

Fig-A1: Distribution of the Isotherm in 1982.

Fig-A2: Distribution of the Isotherm in 1983.

Fig-A3: Distribution of the Isotherm in 1984.

Fig-A4: Distribution of the Isotherm in 1985.

Fig-A5: Distribution of the Isotherm in 1986.

Fig-A6: Distribution of the Isotherm in 1987.

Fig-A7: Distribution of the Isotherm in 1988.

Fig-A8: Distribution of the Isotherm in 1989.

Fig-A9: Distribution of the Isotherm in 1990.

Fig-A10: Distribution of the Isotherm in 1991.

Fig-A11: Distribution of the Isotherm in 1992.

Fig-A12: Distribution of the Isotherm in 1993.

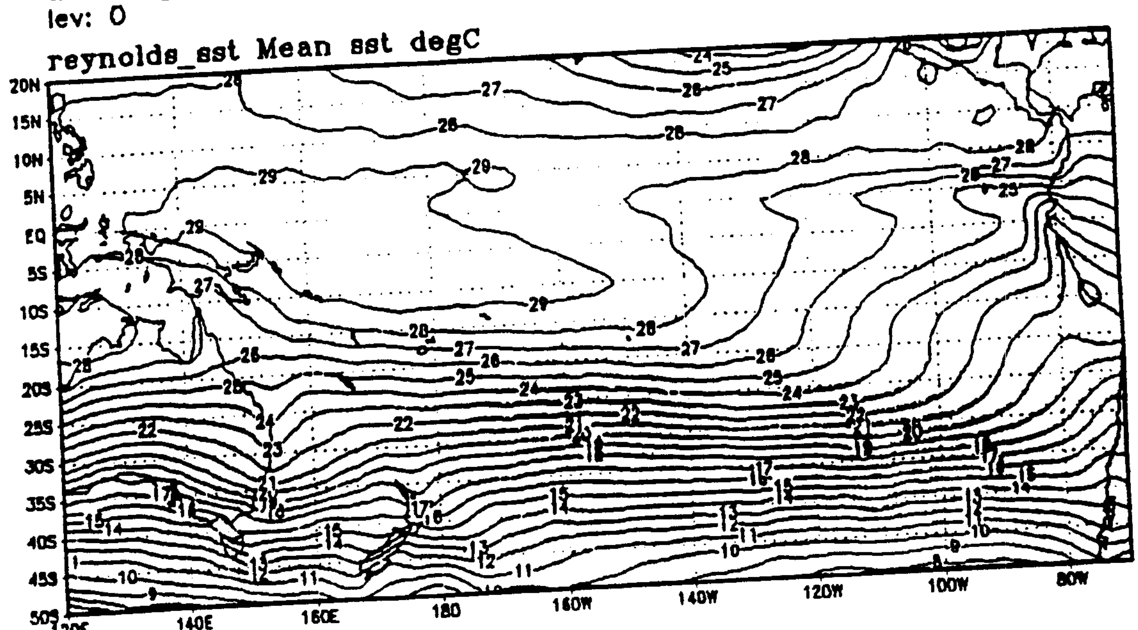
Fig-A13: Distribution of the Isotherm in 1994.

Fig-A14: Distribution of the Isotherm in 1995.

Fig-A15: Distribution of the Isotherm in 1996.

Fig-A16: Distribution of the Isotherm in 1997.

lon: plotted from 120.00 to 290
lat: plotted from −50 to 20.00
t: averaged over Jan 1982 to Dec 1982
lev: 0
reynolds_sst Mean sst degC



MAX=29.9266
MIN=5.39772

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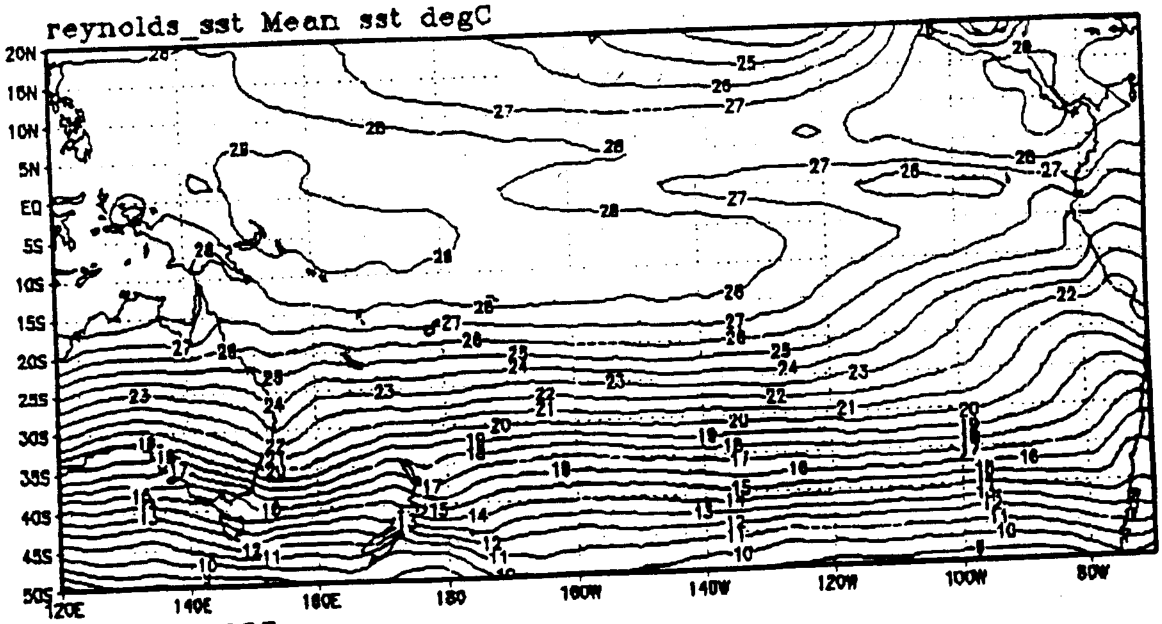
lat: plotted from −50 to 20.00
t: averaged over Jan 1983 to Dec 1983
lev: 0
reynolds_sst Mean sst degC



MAX=29.4833
MIN=6.1238

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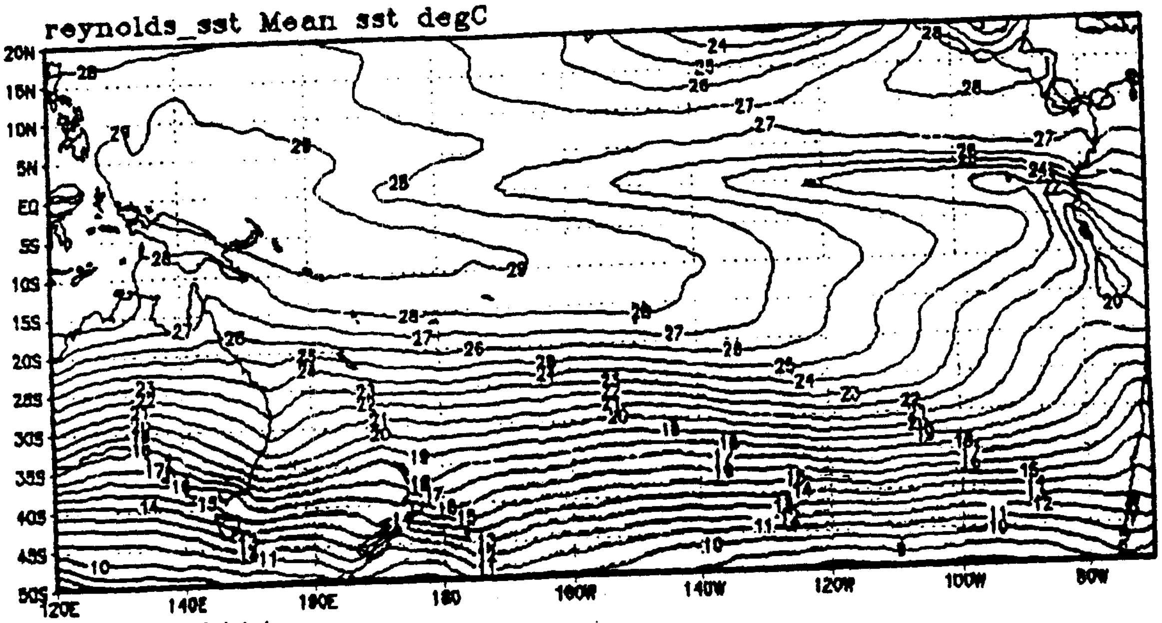
reynolds_sst Mean sst degC



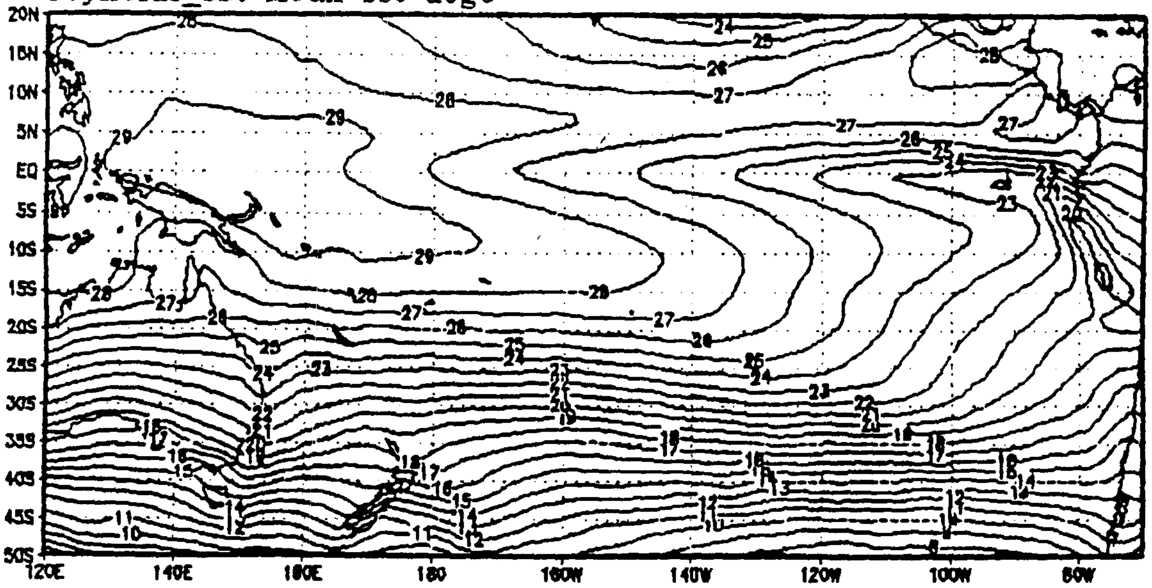
MAX=29.6104
MIN=5.99989

NOAA–CIRES/Climate Diagnostics Center

01/04

lon: plotted from 120.00 to 290
lat: plotted from −50 to 20.00
t: averaged over Jan 1985 to Dec 1985
lev: 0

reynolds_sst Mean sst degC



MAX=29.7113
MIN=5.82489

NOAA–CIRES/Climate Diagnostics Center

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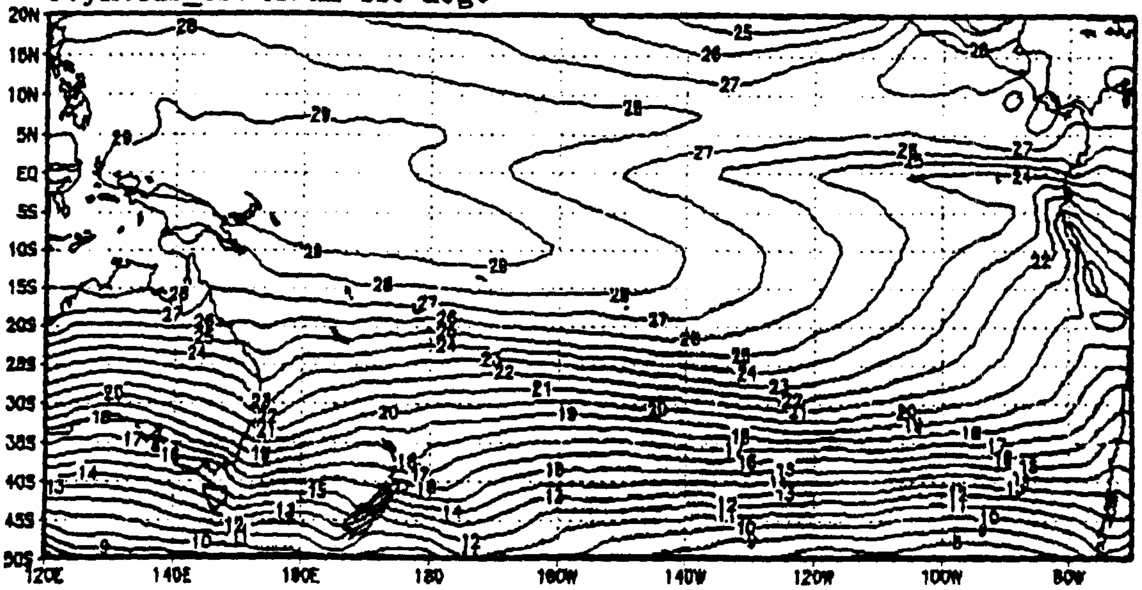
t: averaged over Jan 1986 to Dec 1986
lev: 0

reynolds_sst Mean sst degC

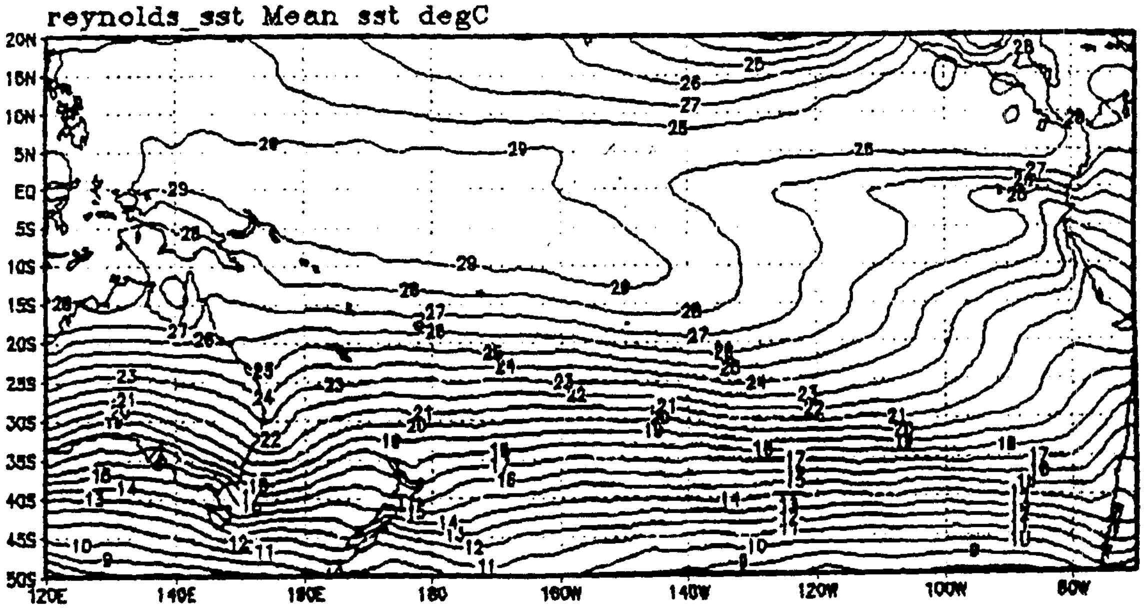


MAX=29.8258
MIN=5.80015

NOAA-CIRES/Climate Diagnostics Center

lon: plotted from 120.00 to 290
lat: plotted from -50 to 20.00
t: averaged over Jan 1987 to Dec 1987
lev: 0

reynolds_sst Mean sst degC

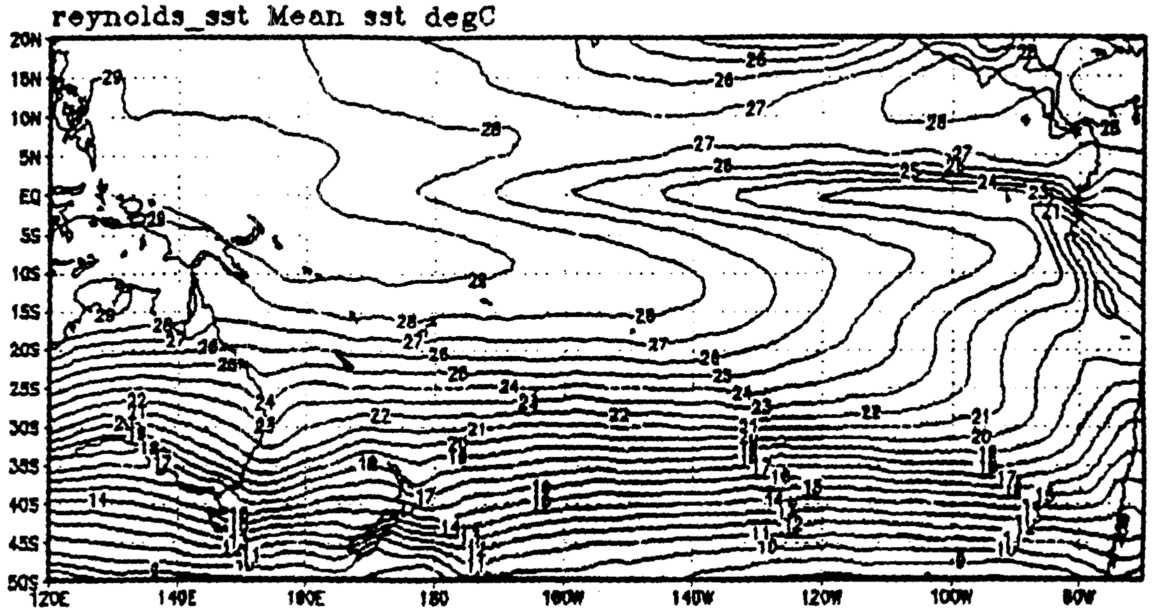


MAX=29.8745
MIN=5.7538

NOAA-CIRES/Climate Diagnostics Center

lon: plotted from 120.00 to 290
lat: plotted from -50 to 20.00
t: averaged over Jan 1988 to Dec 1988
lev: 0

reynolds_sst Mean sst degC

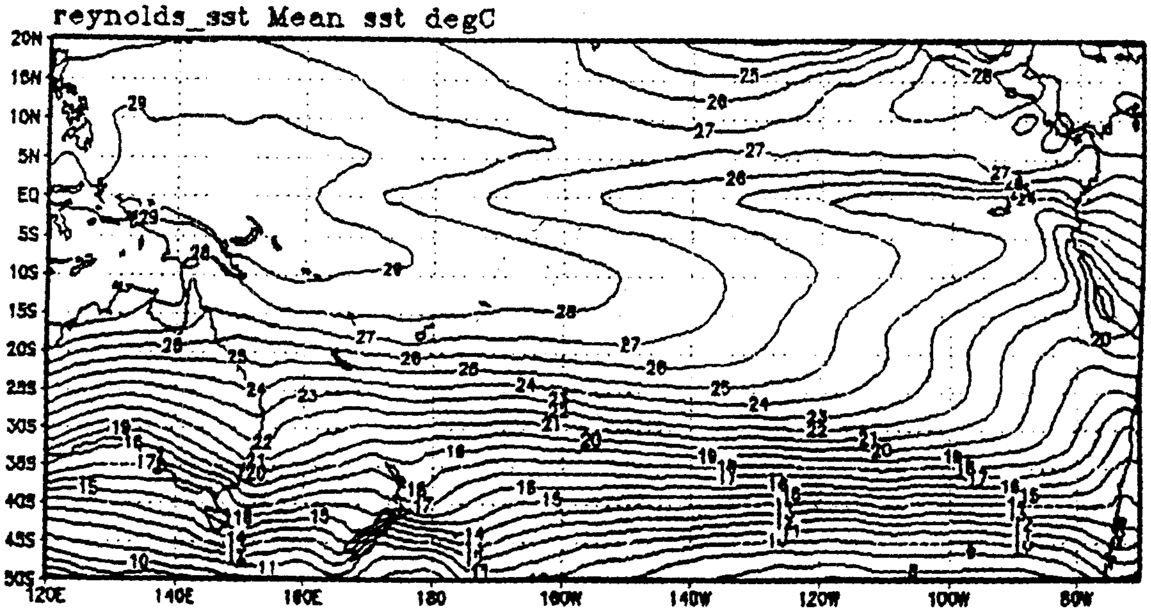


MAX=29.6991
MIN=6.1871

NOAA-CIRES/Climate Diagnostics Center

lon: plotted from 120.00 to 290
lat: plotted from -50 to 20.00
t: averaged over Jan 1989 to Dec 1989
lev: 0

reynolds_sst Mean sst degC

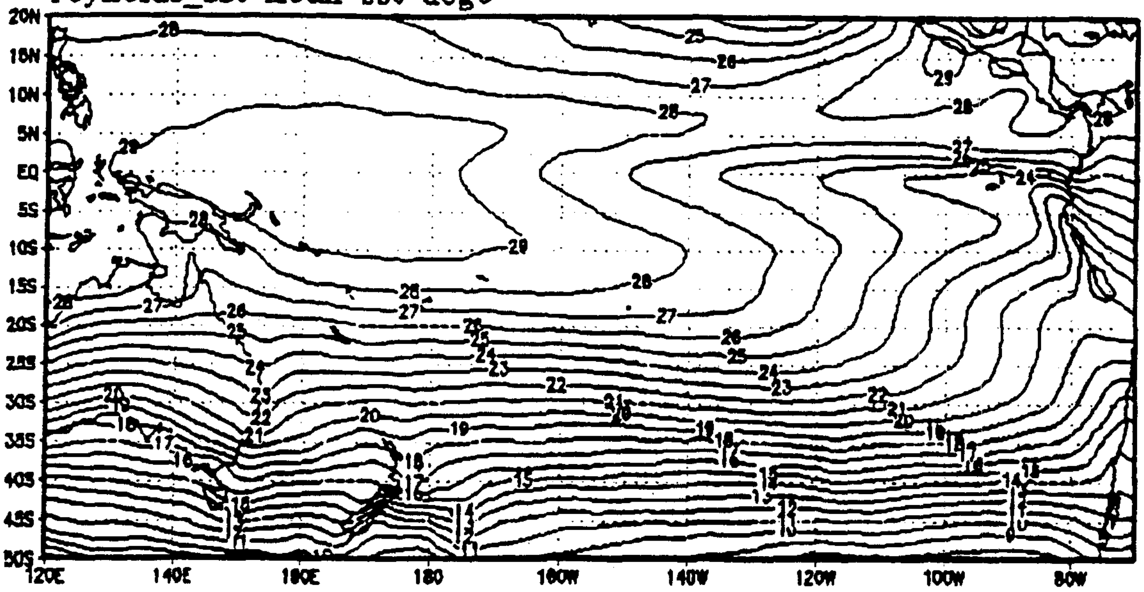


MAX=29.7434
MIN=6.06199

NOAA-CIRES/Climate Diagnostics Center

lon: plotted from 120.00 to 290
lat: plotted from −50 to 20.00
t: averaged over Jan 1990 to Dec 1990
lev: 0

reynolds_sst Mean sst degC

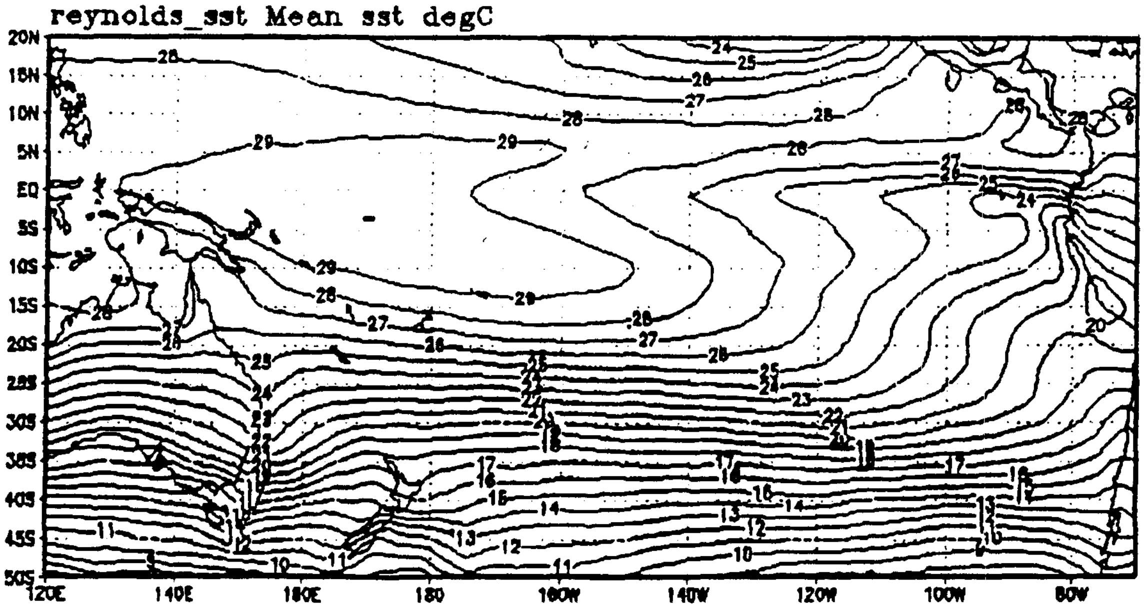


MAX=29.8415
MIN=6.15272

NOAA–CIRES/Climate Diagnostics Center

lon: plotted from 120.00 to 290
lat: plotted from −50 to 20.00
t: averaged over Jan 1991 to Dec 1991
lev: 0

reynolds_sst Mean sst degC

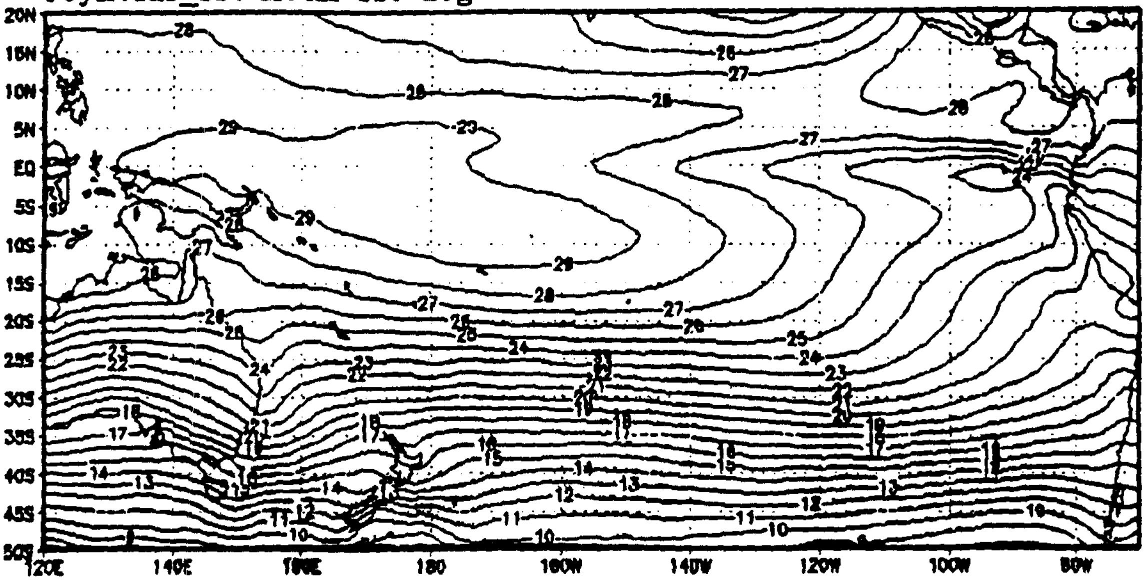


MAX=30.0013
MIN=5.97967

NOAA–CIRES/Climate Diagnostics Center

lon: plotted from 120.00 to 290
lat: plotted from -50 to 20.00
t: averaged over Jan 1992 to Dec 1992
lev: 0

reynolds_sst Mean sst degC

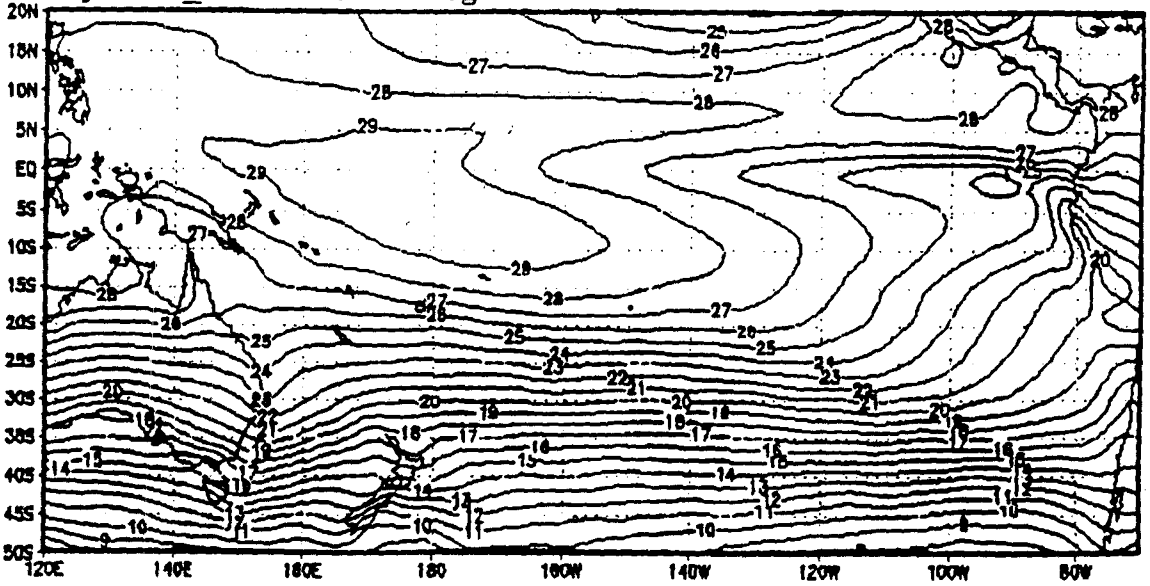


MAX=29.6588
MIN=6.02812

NOAA–CIRES/Climate Diagnostics Center

lon: plotted from 120.00 to 290
lat: plotted from -50 to 20.00
t: averaged over Jan 1993 to Dec 1993
lev: 0

reynolds_sst Mean sst degC

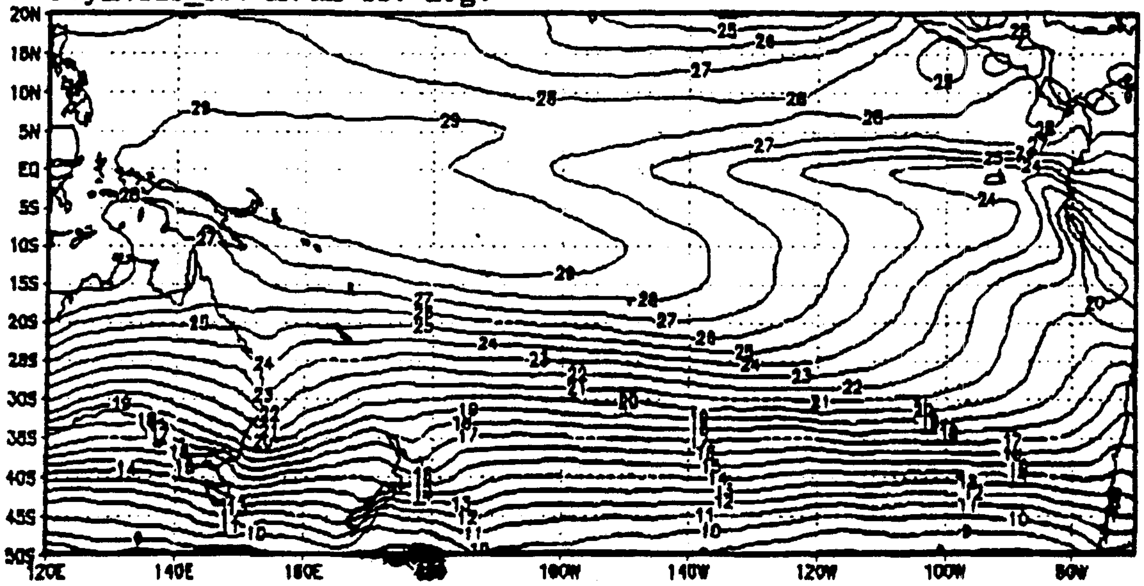


MAX=29.6289
MIN=6.08848

NOAA–CIRES/Climate Diagnostics Center

lon: plotted from 120.00 to 290
lat: plotted from -50 to 20.00
t: averaged over Jan 1994 to Dec 1994
lev: 0

reynolds_sst Mean sst degC

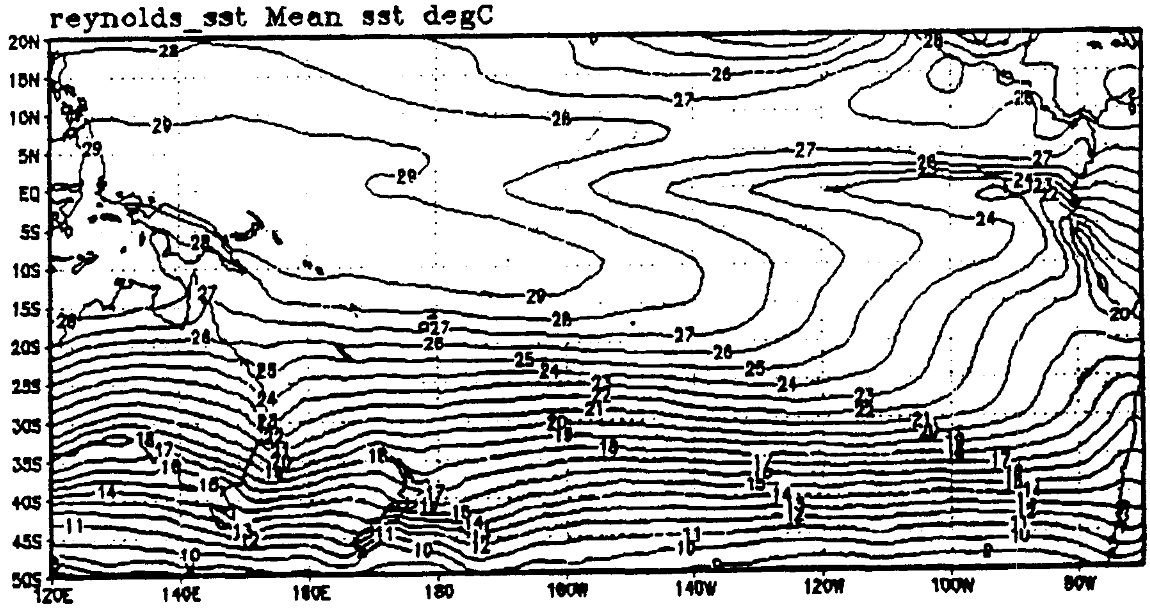


MAX=29.9491
MIN=6.20199

NOAA-CIRES/Climate Diagnostics Center

lon: plotted from 120.00 to 290
lat: plotted from -50 to 20.00
t: averaged over Jan 1995 to Dec 1995
lev: 0

reynolds_sst Mean sst degC

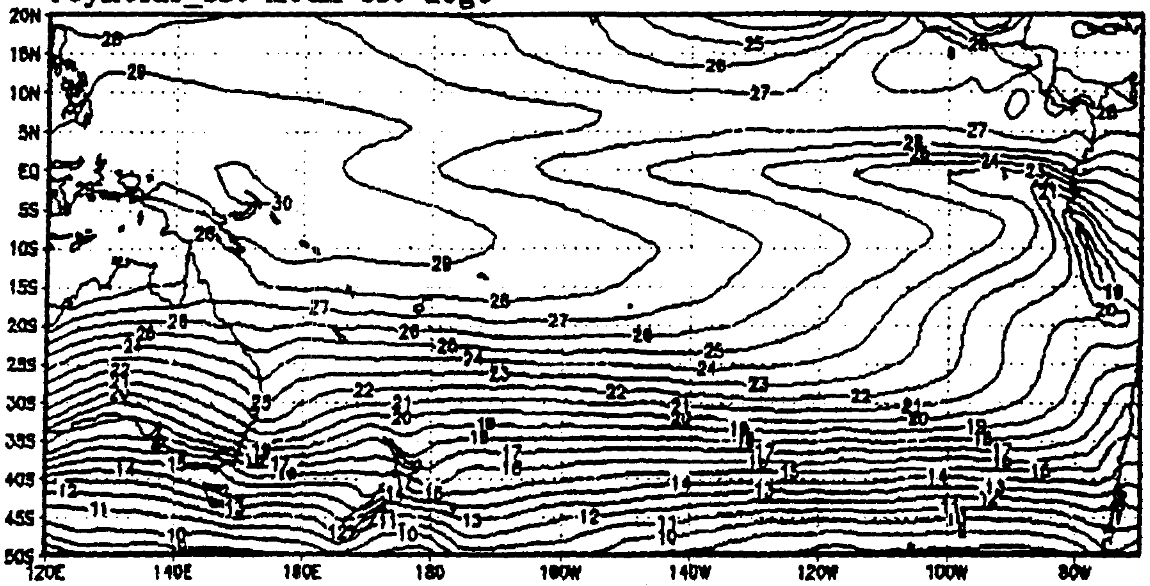


MAX=29.9342
MIN=5.94913

NOAA-CIRES/Climate Diagnostics Center

lon: plotted from 120.00 to 290
lat: plotted from −50 to 20.00
t: averaged over Jan 1996 to Dec 1996
lev: 0

reynolds_sst Mean sst degC

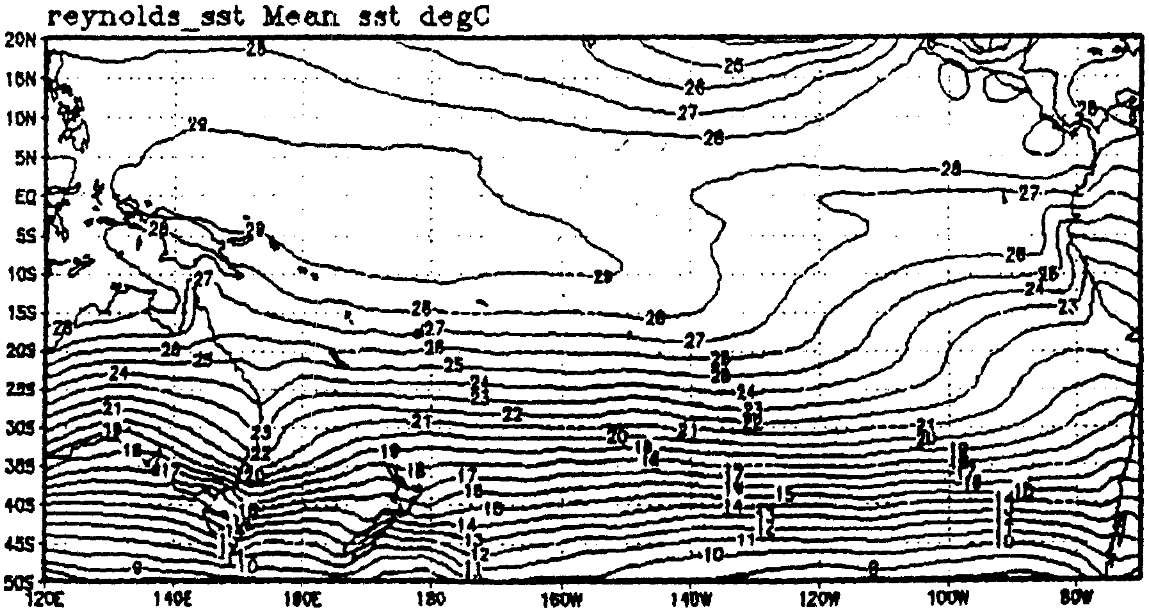


MAX=30.1037
MIN=6.33333

NOAA−CIRES/Climate Diagnostics Center

lon: plotted from 120.00 to 290
lat: plotted from −50 to 20.00
t: averaged over Jan 1997 to Dec 1997
lev: 0

reynolds_sst Mean sst degC



MAX=29.6274
MIN=6.06431

NOAA−CIRES/Climate Diagnostics Center