Korean Journal of Polar Research
Vol.2, No.1(Spec. Issue), p.189~192, June 1991

Meridional Changes of Sea Surface Temperature along 135°E on the Southern Ocean

Sangbok D. Hahn

Korea Oceanographic Data Center
National Fisheries Research and Development Agency of Korea
Kijang-up, Yangsan-gun, Kyungsangnam-do, 626-900 KOREA

Abstract : Based on monthly mean sea surface temperature (SST) for 7 years (1979-1985) along 135° E on remote Southern Ocean, SST meridional effect was studied. Three variables were given as functions of southern latitude between 35°S and 65°S. They were linearly decreasing tendencies with increasing latitude. Decreasing rates per southern latitude in degree are 0.11℃ for annual SST range, 0.56℃ for annual mean SST and 2.8 kcal cm^{-2} yr^{-1} for radiation balance, respectively.

Key words : sea surface temperature(SST), meridional change, Southern Ocean, annual SST, annual mean SST, radiation balance

Introduction

The Southern Ocean has the land mass of the Antarctic continent to form a southern boundary but has no clear land boundary to its north except the Australian continent and is continuous with the other major oceans, forming a circular ocean. Of all the oceanic regions it is this which most nearly approaches the ideal case of an ocean which completely covers the earth.

However, the Southern Ocean is the least known area in the world beyond British *Discovery* and American *Eltanin*'s historical scientific activities. During and since the International Geophysical Year (IGY, 1957-58), a great number of hydrographical observations have been made aboard numerous ships engaged in the replenishment and relief of scientific bases installed on the Antarctic continent by many nations. Some nations are involved in oceanographic observations in relation to krill fisheries experiments. Korea has been working in oceanographic observation since 1978 in the Southern Ocean. Up to now, this is still a remote area to study ocean climate because of a lack of time series data.

Knowledge of high technology is being applied to determine sea surface temperatures and to disseminate the results. The National Oceanic and Atmospheric Administration (NOAA) of the USA produces weekly maps of the world's sea surface temperature deduced from satellite observations giving weekly time series data in this remote ocean.

It is of interest to establish ocean climatic base data as well as understanding meridional sea surface temperature change in the Southern Ocean. As a pilot study, one typical meridional line has been selected based on a geographical concept. The Australian sector of the Southern Ocean is the only area well bounded by lands between Antarctica and Australia, and a meridional section along 135°E has been selected for this study, as a central zone of the Australian sector of this ocean.

Data and Analysis

Based on weekly mean sea surface temperature (SST) charts for 7 years (1979-1985, GOSSTCOMP SST Charts SH 090E and SH 135E) published by NOAA (1979−1985), each monthly mean SST for 5 degree latitude intervals from 35°S to 65°S along 135°E was obtained. This monthly mean SST was considered as climatic base data and was applied for various simple statistical treatments. However, inter-yearly variation was not considered because of relatively short time series data.

The radiation balance (RB) in kcal cm^{-2} yr^{-1} unit as a radiation flow of heat is defined by RB $=Qs-Qb$, where Qs is the incoming solar radiation and Qb is the outgoing back radiation, can be obtained by $RB=L\times E+Qh+Qv$ where L is the latent heat of vaporisation, E the rate of evaporation, Qh the heat flow from sea surface to atmosphere and Qv the heat flow from sea surface to lower layer respectively. RB values for this study are calculated from the Budyko's geographical distribution of energy balance (Budyko, 1980).

Results

1. Seasonal Variation

Monthly mean SST values for each 5 degree latitude intervals between 35°S and 65°S are computed from a 7-years period (1979−85) and are shown in Fig. 1, indicating Sub-tropical and Antarctic Convergence zones are not clear along 135°E section. However, there is not a relatively small temperature change zone between 50°S and 55°S, approximately 4℃ change per 300 nautical miles.

SST reaches its maximum value in February (austral summer) and minimum in August (austral winter) in general. At 35°S, annual maximum is 19.4℃ with standard deviation 0.90℃ in February, and annual minimum 14.4℃ with standard deviation 0.64℃ in August. At 65°S, annual maximum is 1.0℃ with standard deviation 0.45℃ in August.

Standard deviation, as a simple variability index, is 1℃ in summer and 0.7℃ in winter in general, however, it has shown 1.75℃ in January at 45°S for the highest value, and 0.26℃ in October at 65°S as the lowest value. Within ±1℃ uncertainty, Figure 1 may be used to estimate SST at a particular time and latitude along 135°E.

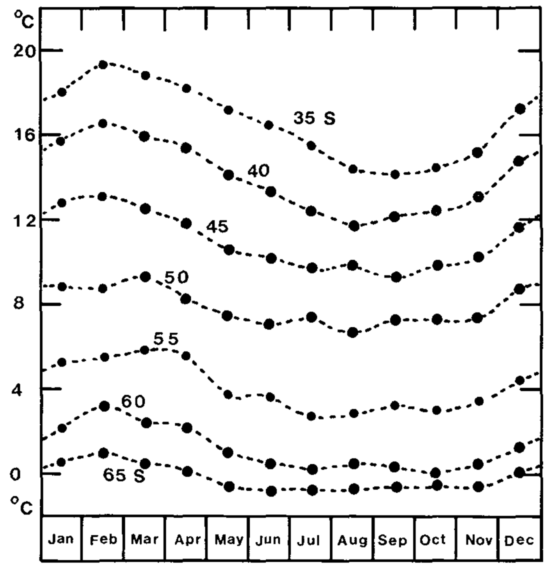

Fig. 1. Seasonal and meridional changes of SST along 135°E (1979−1985).

Annual SST range at latitude φ, $\triangle T\varphi$, which is derived from maximum monthly mean value minus minimum monthly mean value shows meridional decreasing tendency linearly as following simple equation:

$$\triangle T\varphi = 5 - 0.11\ (\varphi - 35) \quad \cdots\cdots\cdots\cdots(1)$$
$$35 \leq \varphi \leq 65$$

φ : the southern latitude in degree.

Meridional SST annual range is shown in Figure 2 with its general trend.

2. Meridional Changes of Annual Mean SST and Radiation Balance

With annual mean SST for 1979−1985 at each latitude along 135°E, a simple equation can be formed as follow:

$$T\varphi = 16.6 - 0.56\ (\varphi - 35) \quad \cdots\cdots\cdots\cdots(2)$$
$$35 \leq \varphi \leq 65$$

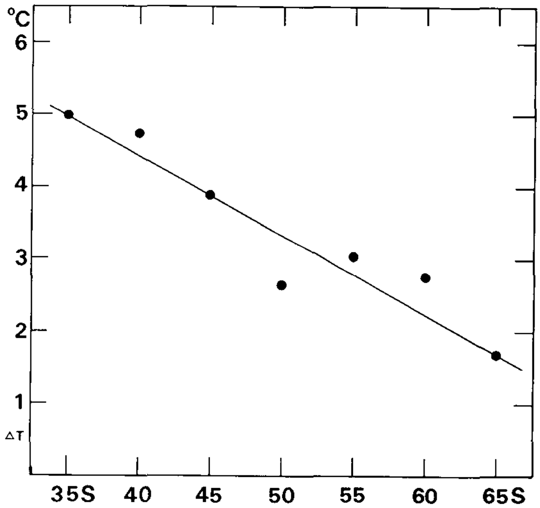

Fig. 2. Meridional change of annual SST range along 135° E (1979–1985).

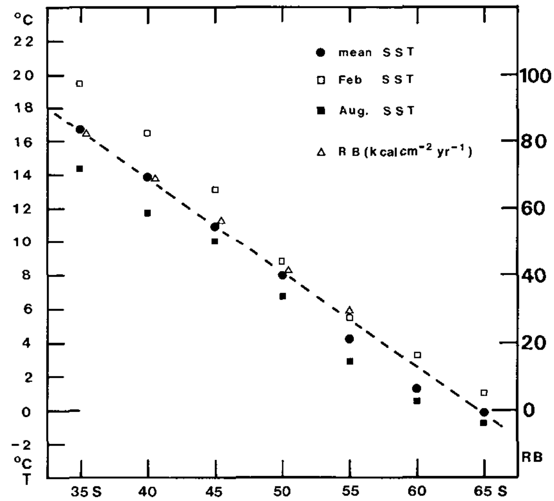

Fig. 3. Meridional changes of annual SST and radiation balance along 135° E.

$T\varphi$: annual mean SST (℃)

In Figure 3, values of February and August are also plotted as well as annual mean SST and radiation balance in kcal cm^{-2} yr^{-1}unit. This radiation balance value is adopted from Budyko (1980).

Radiation balance ($RB\varphi$) is shown some decreasing tendency as the SST, and this can be written as follow:

$$RB\varphi = 83 - 2.8\ (\varphi - 35) \quad \cdots\cdots\cdots\cdots (3)$$
$$35 \le \varphi \le 65$$

From equations (2) and (3), we may understand 1℃ SST drop is equivalent to 5 kcal cm^{-2} yr^{-1} radiation balance decreasing in this section.

Conclusion

Meridional changes of sea surface temperature along 135° E on the Southern Ocean were studied with monthly mean SST time series data from January 1979 to December 1985. At a given latitude, φ, individual SST, its annual range and annual mean, and radiation balance may be simply obtained from the figures (Fig. 1 to 3) in the text.

Sub-tropical Convergence and Antarctic Convergence zones are not significant along this section. Annual SST range ($\triangle T\varphi$), annual mean SST ($T\varphi$) and radiation balance ($RB\varphi$) are shown linear decreasing tendencies toward poleward direction; 0.11℃, 0.56℃ and 2.8 kcal cm^{-2} yr^{-1} respectively, per degree latitude between 35° S and 65° S. They may be given following equations:

$$\triangle T\varphi = 5 - 0.11\ (\varphi - 35)$$

$$T\varphi = 16.6 - 0.56\ (\varphi - 35)$$

$$RB\varphi = 83 - 2.8(\varphi - 35)$$

It is worthwhile to note here that inter-yearly variation of SST is not considered to obtain above conclusions, and GOSSTCOMP SST data are adopted without correction after examined with moored instruments data during 1981–1983, permitting ±0.5℃ uncertainty (Hahn, 1986).

Acknowledgements

The author would like to record his great indebtedness to professor G.W. Lennon and Dr. J. A.T. Bye, both Flinders Institute of Atmospheric and Marine Sciences, Flinders University of South Australia, for their research materials supplied while he has been working at FIAMS from 1981 to 1987.

References

Budyko, M.I. 1980. Global Ecology, Progress Publishers, Moscow. 323p.

Hahn, S.D. 1986. Physical Structure of the Waters of the South Australian Continental Shelf, School of Earth Sciences, Flinders University of South Australia, Adelaide. 284p.

NOAA, GOSSTCOMP Sea Surface Temperature Charts SH 090E and SH 135E for 1979 −1985 (Weekly operational base).