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Author(s)	CHEVOORUVALAPPIL, CHANDRAN BAJISH
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学 位 論 文 内 容 の 要 旨

博士 (環境科学)

氏 名 Chevooruvallappil Bajish Chandran

学 位 論 文 題 名

Decadal variability of Antarctic sea ice variability revealed by satellite observation and coupled general circulation model.

(衛星観測と結合大循環モデルにより得られた南極海海氷の十年規模変動)

In the last 30 years, contrary to the Arctic sea ice rapid decrease, the Antarctic sea ice extent has been showing an increasing trend, with significant regional scale increase at the Ross Sea sector and decrease at Bellingshausen Sea. This long-term Antarctic sea ice variability (~10-30 years) is difficult to examine due to the limitation in the satellite observation record and its mechanism has not been sufficiently addressed yet. In order to study the decadal variability in the Antarctic sea ice and the processes driving it, this study examined the relationship between ice, ocean and atmosphere using a high resolution coupled ocean-atmosphere-ice model (CFES) along with observational data derived from satellite.

The observational records of sea ice have revealed a circumpolar variability of sea ice edge (SIE) on decadal time scale (11-16 years). Sea surface temperature (SST) observations and southern annular mode (SAM) record also showed variation on similar timescales with warm (cool) anomaly corresponding to retreat (extension) of SIE at negative (positive) SAM. These coupled relationships are also confirmed from our model study where the leading modes of sea ice concentration (SIC) is circumpolar pattern with a dominant time scale of 12-17 years and the leading mode of SST also has similar pattern with SIC showing a high degree of inverse correlation. The modeled SAM significantly correlates with the leading modes of both SIC and SST. The model and observation also showed a good quantitative with 1°C decrease (increase) of model SST corresponding to 1.4 degree extension (retreat) of SIE which is slightly larger than the observation.

The oceanic variability especially in the SST sets the decadal variability in the Antarctic sea ice. The atmosphere, especially SAM, initiates the decadal sea ice variability with related wind anomalies induce Ekman currents in the mixed layer which produce SST anomalies with the upwelling of the warmer subsurface water at a decadal time scale (14-18 years). The decadal SAM and oceanic variability are coupled through dynamic and

thermodynamic feedback. Therefore, the natural oceanic decadal variability its impact to the atmosphere is the key in the coupled ice-ocean-atmosphere system.