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学 位 論 文 内 容 の 要 旨/Dissertation Abstract

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学 位 論 文 題 名/Title of Dissertation

A conceptual model for a vortex-pair-driven western boundary current extension jet: background flow effects on the extension jet and implementation into the real environment
（渦対強制による西岸境界流続流ジェットの概念モデル：
続流ジェットに対する背景流の効果と現実環境への適用）

In simple numerical ocean models, a western boundary current jet initially separates from the shore and flows eastward south of the inter-gyre boundary. This premature separation is caused by positive vorticity which is paired with negative vorticity. In this study, a conceptual model is proposed to conceive as a mechanism for the formation of the western boundary current extension jet, with vortex pair forcing on the western boundary. This conceptual model has been successfully validated, as it accurately reproduces an extension jet in a wind-driven two-layer quasi-global equilibrium model.

The physical structure of the jet reproduced by vortex pair forcing is compared with that reproduced by conventional inflow and outflow models. The role of turbulent eddies in the follow-on jet was discussed based on the balance of the potential vorticity equation and the turbulent enstrophy equation. In the downstream region of the jet, turbulent eddies formed flows that move away from the jet and towards recirculation; this feature is shared with the jet reproduced by inflow and outflow models. The author introduced R_{eddy} as an indicator of the contribution of the eddy to the driving of the recirculation jet. An inspection of spatial distribution in R_{eddy} revealed that the effect of the eddy was small in the upstream region of the extension jet, and that the intrusion of vortex pairs due to forcing is the dominant factor.

The conceptual model's unique capability to independently handle flow locally driven by large-scale wind and the extension jet driven by a vortex pair is a significant advancement. This feature of the conceptual model allowed us to investigate the effect of the background flow on the jet. The results revealed that an eastward background flow extends the jet structure to the east, while a southward background flow shortens the jet. These findings were confirmed both theoretically and empirically. Notably, the influence of the background flow is more pronounced for the meridional component than the zonal one.

Furthermore, as a bridge from the idealized theory of the jet due to the vortex pair forcing up to the real-world western boundary current extension jet, an analysis using eddy-resolving ocean general circulation model (OFES) data was carried out. The author provided the values of R_{eddy} by arranging the form of the equation to be easily used with OFES data, offering practical and informative insights into the behavior of the real-world western

boundary current extension jet. The terms in the potential vorticity equation in the OFES data are, to some extent, similarly distributed to those in the vortex pair experiments in the Kuroshio extension. However, the analysis of OFES data shows that the western boundary current extension jet in other oceans, such as the Gulf Stream and the Brazilian Current, also shares common characteristics with the Kuroshio extension.

In the Kuroshio extension, it is known that the extension jet has an elongation phase and a contraction phase. The jet in the OFES data was divided into these two phases from the volume transport of the jet, and the characteristics of the elongation and contraction phases were confirmed from other physical quantities. As assumed from the snapshots of the jet, the effect of turbulent eddies was smaller in the elongation phase than in the contraction phase, indicating that the intrusion of vortex pairs is essential for enhancing the follow-on jet.