学 位 論 文 審 査 の 要 旨

博士の専攻分野の名称　博　士（食資源学）　氏名 BUAREAL KANOKRAT

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学 位 論 文 題 名

Linking Solar-Induced Chlorophyll Fluorescence to Gross Primary Productivity Across Terrestrial Ecosystems
（陸域生態系における太陽光誘起クロロフィル蛍光と総一次生産量の関係の解明）

This doctoral thesis consists of five chapters, including an abstract, a general introduction, three research chapters, and a general conclusion. It integrates ground-based solar-induced chlorophyll fluorescence (SIF) measurements, eddy covariance observations, and environmental data to evaluate the capability of red (F687) and far-red (F760) SIF to represent gross primary productivity (GPP) across terrestrial ecosystems. The study focuses on three contrasting ecosystems in Japan: a rice paddy field, a cool temperate bog, and a sparse mixed forest dominated by larch (Larix spp.) and understory Sasa bamboo. The main objective was to clarify how SIF–GPP relationships vary with ecosystem type, canopy structure, vertical heterogeneity, and environmental conditions, and to compare the performance of red and far-red SIF across diurnal and seasonal scales.

Chapter 1: General Introduction

This chapter outlines ecosystem-scale carbon cycling and photosynthesis, emphasizing limitations of traditional vegetation indices for estimating GPP. The theoretical basis of SIF and its physiological linkage to photosynthesis are introduced, highlighting key research gaps related to canopy structure and chlorophyll reabsorption.

Chapter 2: Solar-Induced Chlorophyll Fluorescence in a Rice Paddy Ecosystem

This chapter examines SIF–GPP relationships in a rice paddy using ultrafine-resolution ground-based spectroradiometer and eddy covariance data. F687 tracked GPP better than

F760, likely due to low chlorophyll reabsorption and a simple canopy structure. Cloudiness affected SIF magnitude but had limited influence on the SIF–GPP relationship.

Chapter 3: Solar-Induced Chlorophyll Fluorescence in a Cool Temperate Bog Ecosystem

This chapter extends the analysis to a bog ecosystem with moss-dominated vegetation. F687 again showed a slightly stronger relationship with GPP than F760, consistent with low reabsorption conditions. Radiation and moisture were important controls on SIF dynamics.

Chapter 4: Vertical Decoupling of Red and Far-Red SIF in a Sparse Mixed Forest

This chapter analyzes a larch–Sasa mixed forest with pronounced vertical heterogeneity. In contrast to open ecosystems, F760 showed a stronger relationship with GPP than F687, reflecting strong chlorophyll reabsorption of red fluorescence within forest canopies. The contribution of understory vegetation to ecosystem GPP during leaf-off periods was also highlighted.

Chapter 5: General Conclusion

Overall, the SIF–GPP relationship was shown to be ecosystem-dependent and strongly influenced by canopy structure and chlorophyll reabsorption. Red SIF is more suitable for open ecosystems, whereas far-red SIF performs better in forests with complex vertical structures. These findings provide important implications for interpreting ground-based and satellite SIF observations in carbon cycle research.

よって，審査員一同は，BUAREAL KANOKRAT が博士（食資源）の学位を受けるのに十分な資格を有するものと認めた。

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