【Grant-in-Aid for Transformative Research Areas（A）】

Plant–Climate Feedbacks

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Research Area Information	Number of Research Area : 23A401　Project Period (FY) : 2023-2027 Keywords : phenology; volatile organic compound (BVOCs); ecosystems

Purpose and Background of the Research

●Outline of the Research

The rapid increase in the concentration of CO_2 in the atmosphere and the resulting climate change are having a serious impact on wild plants, animals and agricultural crops. Among the responses of living organisms to climate change, the changes exhibited by plants have gained increasing attention over the last few decades because plants provide essential resources to wild animals and human societies. The most obvious signs are the changes in the timing of recurring seasonal activities (phenology), such as budburst and flowering time.

Climate change not only affects plant phenology, but it is also impacted by it as plants alter atmospheric composition and climatic processes. BVOCs (biogenic volatile organic compounds) emitted by plants produce forest scents, influence solar radiation and rainfall through the production of particles called aerosols, affect ozone production in the troposphere, and have a global cooling effect. Thus, changes in BVOC emissions are expected to have an important impact on the future global environment. However, there is a lack of data to elucidate the dynamic feedback between seasonal plant activity and climate due to the lack of observation system. In addition, the process of atmospheric response from BVOC emission remains unclear.

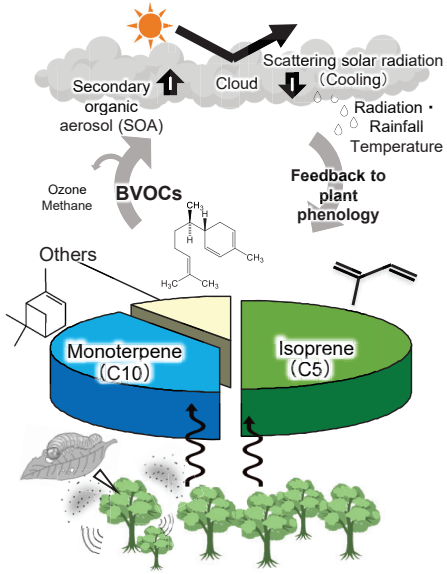

Figure 1. Feedback between plant seasonal activity (phenology) and climate

In this project, we will unravel the dynamic feedback between plant seasonal activity and climate from the genetic level together with experts in diverse fields such as mathematical biology, plant molecular biology, ecology, and atmospheric science, and climate models. To achieve this goal, we will develop models to predict individual plant responses to climate change through the study of molecular mechanisms controlling plant phenology, such as BVOC release, flowering and leaf. In addition, to scale up individual plant level responses to the population and regional levels, develop new climate prediction models by not only acquiring data on a large scale using conventional observation techniques, but also by taking on the challenge of introducing and developing new observation techniques.

Expected Research Achievements

●Three questions to be answered

The primary aim of this field is to unravel the intricate interactions between plant phenology and climate, ultimately leading to the development of predictive models for the future. To accomplish this objective, we have delineated two key research domains, denoted as Area A [BVOC Control Mechanisms] and Area B [BVOC Feedback]. We have also assembled a team of experts to propel research initiatives within each area.
Within Area A, our focus will be on elucidating the genetic control mechanisms governing plant phenology and constructing predictive models to anticipate individual plant responses to climate variations. In Area B, our efforts will concentrate on the development of observational techniques and climate prediction models, extending our insights from individual-level responses to encompass populations and broader geographic scales through the study of BVOC emissions. To bridge the gap between research endeavors targeting different scales and to establish a cohesive framework that integrates observational data and predictive outcomes at genetic, individual, population, and regional levels, we are establishing the Plant Climate Fusion Center. This center will foster interdisciplinary collaboration, bolstered by robust organizational support. Our research will strive to address the following three fundamental questions.

(i) When, where, and to what extent are BVOCs released?
(ii) What are the fundamental genetic control mechanisms responsible for generating diversity in BVOC components and their release quantities?
(iii) Do the BVOCs emitted by plants influence climate conditions and exert feedback effects on ecosystems?

●Three visions

Vision 1: We aim to pioneer a novel field "Plant–Climate Feedback" by amalgamating emerging data from field observations, gene expression, and real-time BVOC monitoring, all facilitated by advanced modeling techniques.
Vision 2: We are dedicated to nurturing a cadre of versatile researchers capable of discerning fresh challenges from a multidisciplinary standpoint.
Vision 3: We strive to advance our global reach by bolstering our international network, focusing on the acquisition of extensive data from diverse ecosystems, modeling environmental responses, and making predictions about the future. This includes the establishment of overseas research centers and the dispatch of young researchers abroad for in-depth studies within this field of research.

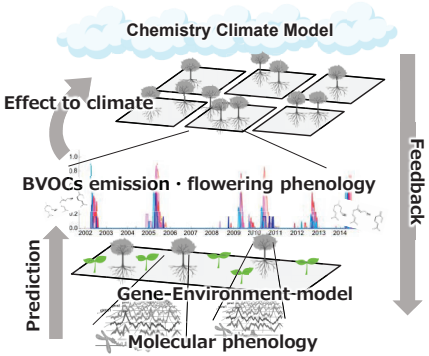

Figure 2. Dynamic feedback modeling

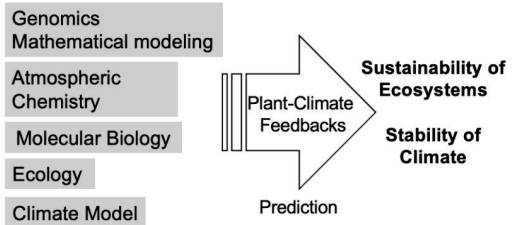

Figure 3. Roadmap to achieve the goals of this project through the integration of different fields.

Homepage Address, etc.	https://www.plant-climate-feedback.com/