Weather patterns on a global scale can be predicted in an extended range due to periodic phenomena, mainly occurring in the tropics and near the poles. The tropical region is particularly important because the latent heat of condensation released during the formation of deep, convective clouds is a source of energy for global atmospheric circulation. In other words: the activity and organization of thunderstorms, as well as their variability, affect weather patterns on a global scale. It includes predictability of weather in mid-latitudes (e.g., in Europe).

The Maritime Continent - a region composed of islands and seas, located between Australia and South-East Asia, is the area with the highest global precipitation, typically exceeding 10 mm per day. This is why the Maritime Continent is considered a critical region for the variability in atmospheric circulation and predictability of weather patterns on a global scale. Such a high average rainfall also means that extreme rain events, with their adverse societal effects, occur frequently and regularly. The vulnerability of inhabitants of the Maritime Continent region to hazardous weather is expected to intensify along with climate change.

Thunderstorm activity, and rainfall resulting from it, in the Maritime Continent, are characterized by a very strong diurnal cycle - it usually rains at the same time of the day: in the afternoon over land, while after midnight and in the early morning offshore. The basic mechanism behind this difference is known - it is an effect of differences in diurnal warming of land and water areas during daytime and circulation that develops as a result of that imbalance. However, specific processes that govern days-to-weeks variability in activity and spatial organization of thunderstorms remain unclear. But we know that large-scale atmospheric and oceanic conditions influence the amount of rainfall over the Maritime Continent region.

The main goal of this project is to broaden our knowledge and understanding of the physical processes that govern variability in thunderstorm activity and organization on a subseasonal (weeks to months) time scale. We will focus on three types of phenomena, each associated with extreme precipitation events: enhanced diurnal convection over land, mesoscale convective systems, and tropical cyclones. We will identify large-scale conditions in atmospheric and oceanic circulations, associated with tropical waves (type of weather systems in the equatorial band) and atmosphere-ocean interactions, that best explain variability in thunderstorm activity. To that end, we will analyze existing in-situ, remote sensing (satellite and radar), and modeling (atmospheric and oceanic reanalysis) data and identify enhanced thunderstorm activity events. We will calculate trajectories of tropical weather systems to analyze their impact on extreme precipitation and identify critical predictors of extreme precipitation. We will establish and utilize a regional surface monitoring network in Sumatra, that will collect unique observational data that will allow the study of feedbacks between cloud organization, local flow in the lower troposphere, and large-scale conditions. The monitoring network will be maintained in collaboration with the Indonesian partner (Andalas University). Finally, we will assess the skill of forecasts of extreme precipitation events based on identified processes and regional predictions

The project involves novel theoretical and observational research at the frontiers of tropical dynamics and atmosphere-ocean interactions. The project's scope, hypothesis, and objectives are within the interests of the international community exemplified by the international Years of the Maritime Continent program. Identification of physical mechanisms triggering extreme rainfall will benefit the inhabitants of the Maritime Continent region. However, given global teleconnections, the project will improve the predictability of weather patterns in other areas of the globe, e.g., in Europe. This project will be executed in an international collaboration between scientists from the USA, Europe, and Indonesia.