Chapter 6
Google Earth Engine (GEE) for Modeling and Monitoring Hydrometeorological Events Using Remote Sensing Data

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ABSTRACT

Google Earth Engine (GEE) has emerged as a powerful platform for modeling and monitoring extreme hydrometeorological events. In recent years, GEE has been used extensively for studying floods, droughts, and other natural disasters. It offers a comprehensive suite of tools that can help researchers and practitioners better understand the complex interactions between weather, climate, and water resources. By providing access to a wealth of satellite imagery, climate data, and geospatial datasets, GEE enables users to model and monitor these events with unprecedented accuracy and efficiency. This book chapter explores the various ways in which GEE can be used for modeling and monitoring extreme hydrometeorological events, understanding hydrometeorological events and their monitoring needs, including case studies and practical examples. It's worth noting that this chapter mainly focuses on using GEE for remote sensing and geospatial data analysis into hydrometeorological modeling and monitoring.

INTRODUCTION

GEE is a cloud-based platform that provides access to a vast collection of global and regional remote sensing datasets for analysis and visualization (Amani et al., 2020). It allows for the analysis of large-scale geospatial data using Google's computing infrastructure. With over 40 years of satellite imagery

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and other geospatial data available, GEE has become an important tool for the analysis of earth systems (Tamiminia et al., 2020), including hydrometeorological modeling and monitoring. This platform is particularly useful in this area, as it provides access to large amounts of historical and real-time data, making it possible to generate models and predictions of hydrometeorological processes.

Hydrometeorology is the study of the interaction between the atmosphere and water on the Earth's surface. This includes processes such as precipitation, evapotranspiration, runoff, and groundwater recharge. Hydrometeorological models are used to simulate and predict these processes, providing important information for water resources management, flood and drought prediction, and climate change adaptation. In recent years, there has been a growing interest in the use of GEE and deep learning for hydrometeorological modeling and monitoring, due to its ability to handle large amounts of data and provide near-real-time analysis (Lee et al., 2021).

In this book chapter, we will review the use of GEE for hydrometeorological extreme events modeling and monitoring. We will begin by discussing the hydrometeorological events and their monitoring needs using GEE data sources available in GEE, including satellite imagery, weather data, and other geospatial data. We will then describe the preprocessing of remotely sensed data for hydrometeorological modeling within GEE. Followed by providing a discussion to understand the time series analysis and machine learning techniques and the integration between ground-based measurements with remotely sensed data for modeling hydrometeorological events using GEE. Then, we will discuss the potential of GEE in improving early warning systems and disaster response strategies for extreme hydrometeorological events. Finally, we provide example case studies for using GEE in studying hydrometeorological extreme events.

UNDERSTANDING HYDROMETEOROLOGICAL EVENTS AND THEIR MONITORING NEEDS

Hydrometeorological events, such as floods, droughts, and extreme weather events, can have significant impacts on water resources, agriculture, infrastructure, and human lives (Matthies-Wiesler and Quevauviller, 2022). Understanding these events and monitoring their occurrence is essential for developing effective management strategies and mitigating their impacts.

One of the primary challenges in understanding hydrometeorological events is the availability of accurate and reliable long-term data. Also, Traditional monitoring methods, such as ground-based observations and manual data collection, can be expensive, time-consuming, and limited in spatial coverage. However, advancements in technology have led to the development of remote sensing tools and data platforms that can provide more comprehensive and accurate data (Hazaymeh and Hassan 2016). Satellite-based remote sensing systems, such as NASA's Earth Observing System (EOS), National Oceanic and Atmospheric Administration's (NOAA) and the European Space Agency's (ESA) Sentinel satellites, provide a wealth of data on various hydrometeorological variables, including precipitation, soil moisture, evapotranspiration, and land surface temperature. These systems use a variety of sensors, such as optical, thermal, radar, lidar, and passive microwave sensors, to measure these variables at different spatial and temporal scales (Petropoulos and Islam, 2017). One of the significant advantages of satellite-based remote sensing systems is their ability to provide data over large areas and in real-time. This capability is particularly important for monitoring hydrometeorological events, such as floods, droughts and dust storms, which can occur over extensive areas and require timely responses (Lopez et