THE LATITUDE EFFECT ON ISOTOPIC COMPOSITION IN PRECIPITATION ACROSS THAILAND

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Abstract

This study investigated the spatial and temporal variation of the isotope precipitation over Thailand in related to climatic and geographic conditions. The 3 years (2013-2015) daily data of stable isotope (δ^2H and $\delta^{18}O$) and climate data were conducted along latitude transect (from 5°37'N to 20°27'N) to determine possible effects of latitude and climatic condition on the δ^2H and the $\delta^{18}O$ signature. To this end, the spatial variability is mainly affected by the latitude effect. the isotopic latitude effect in wet season have negative correlation average -0.23 ‰/°N for $\delta^{18}O$ and -1.59 ‰/°N for δ^2H. Conversely, the event base latitude effect in dry season have positive correlation average +0.12 ‰/°N for $\delta^{18}O$ and +0.81 ‰/°N for δ^2H. These effects are conversely trend depending upon monsoon events and seasonal effect.

I. Introduction

In Thailand, isotope hydrology had been used to assess the hydrogeologic cycle, particularly surface water and ground water interaction. However, the fractionation effect of isotopes in local precipitation separately in dry and wet season have never been analyzed.

Hence, this study considered the raw data of the isotopic composition (δ^2H and $\delta^{18}O$) in precipitation at 26 stations collected during 2013-2015 over Thailand (Fig1), to study possible spatial and temporal correlations between the isotopic composition and latitude effect during wet season (June-October) and dry season (November-May).

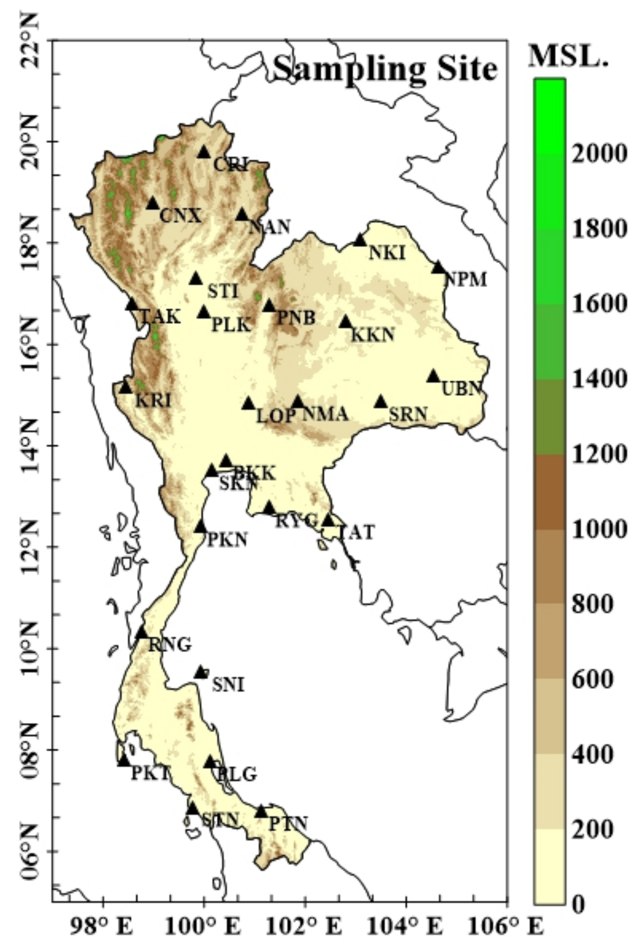

Figure 1 Locations of sampling site

II. Climate Condition

The climate of Thailand is affected by the seasonal characteristics of the southwest (June - October) and northeast monsoons (November - April) including the Intertropical Convergence Zone (ITCZ) and tropical cyclones (Fig 2).

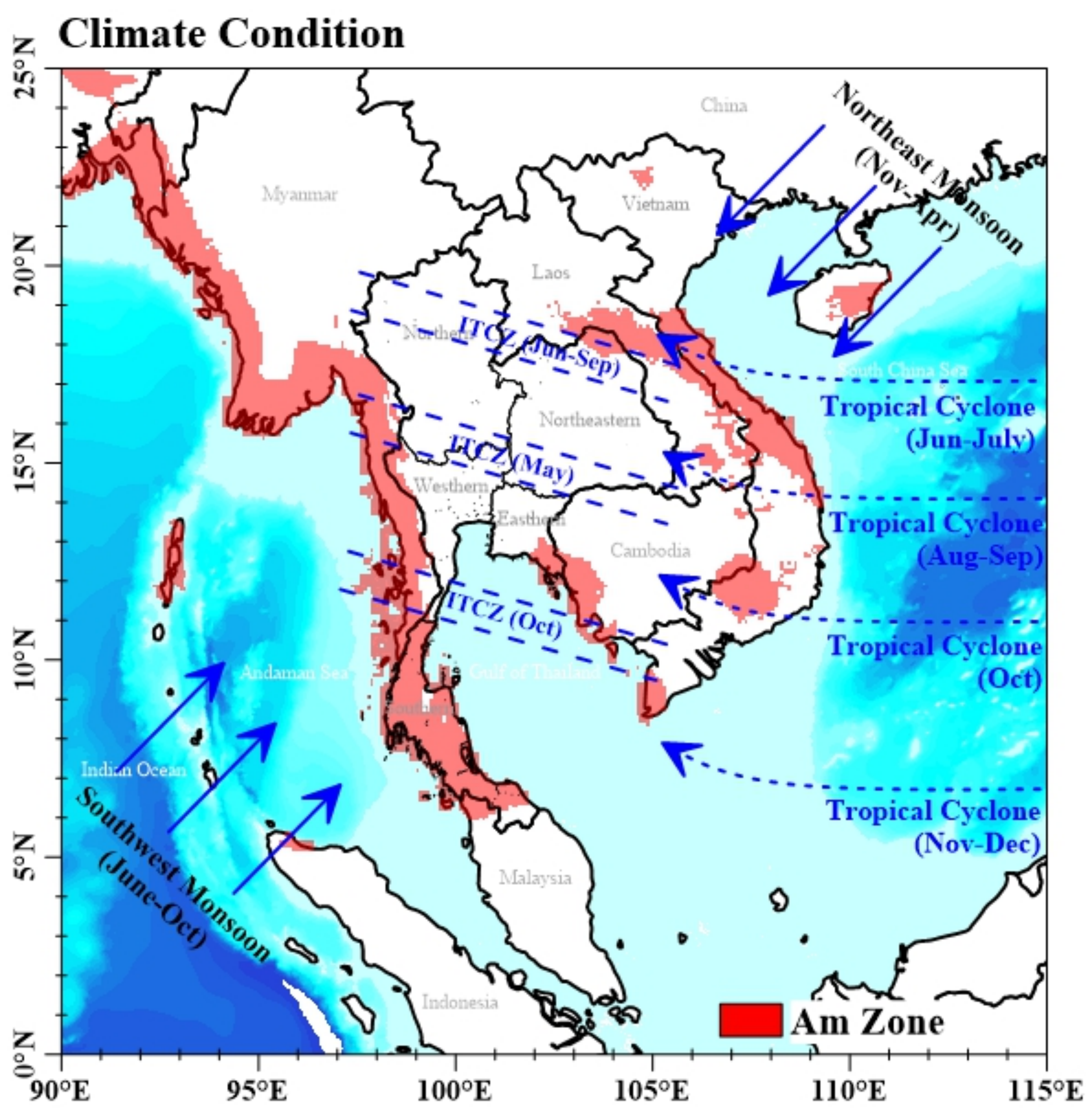

Figure 2 Local climate and Köppen climate classification zones of Thailand, comprising a tropical monsoon climate zone (Am) and a tropical savanna climate zone (Aw).

III. Data Analysis

Daily precipitation samples were collected (2013-2015) in 26 sites as standard rain gauge at 07:00 local time (if rainfall had occurred). Temperature and relative humidity were also made at same time. All samples were analyzed as soon as possible after collection using Cavity Ring-Down Spectroscopy (Picarro L2130-i Analyzer) at Thailand Institute of Nuclear Technology (TINT). Analytical precision was 0.55‰ for δ^2H and 0.16‰ for $\delta^{18}O$. These data were fitted by using least square regression method to report and discuss the latitude effect on the isotopic composition in precipitation during wet and dry seasons.

Spatial Distribution

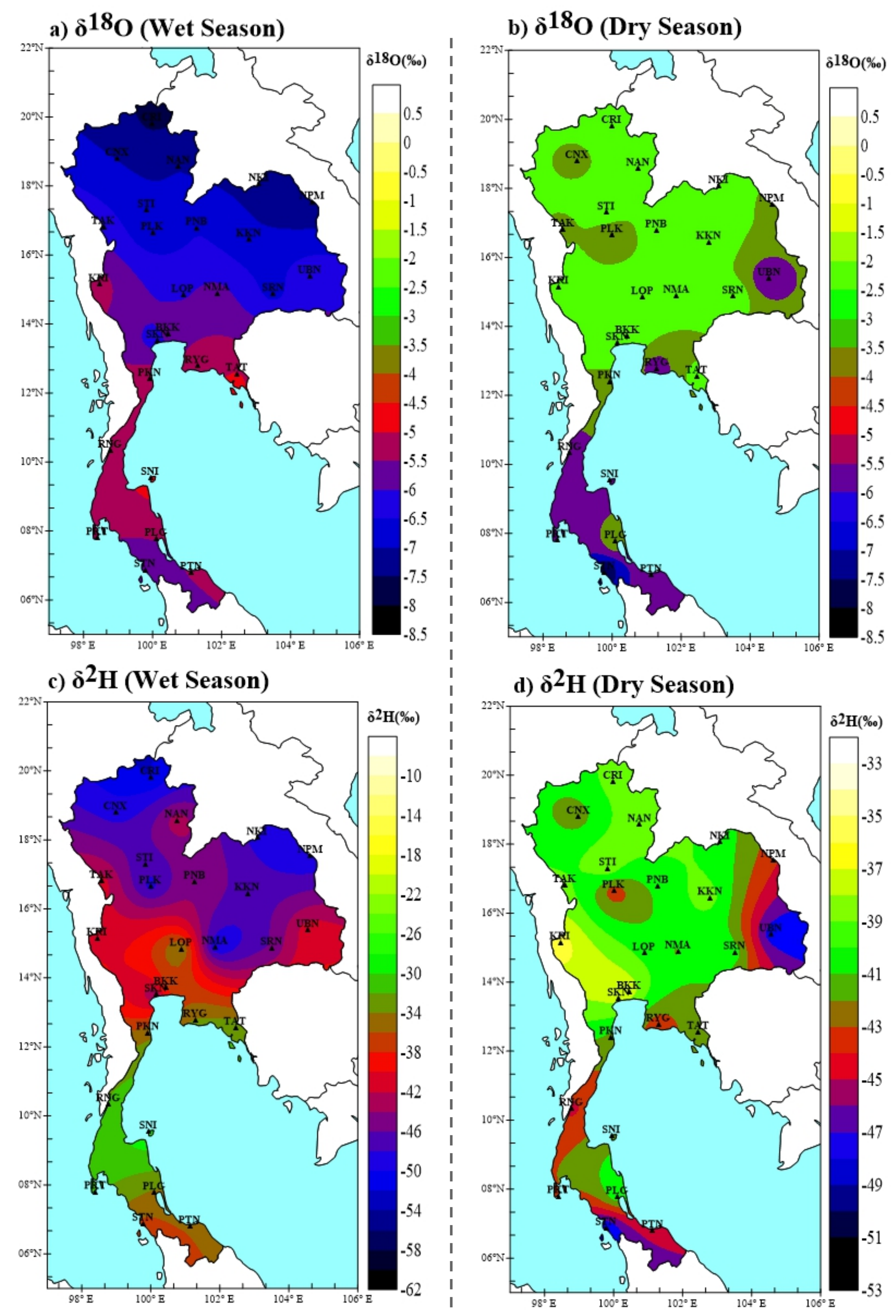

Figure 3 Spatial distributions of $\delta^{18}O$ and δ^2H , wet season and dry season values based on data acquired during 2013–2015, respectively.

Vertical Integrated Moisture Flux

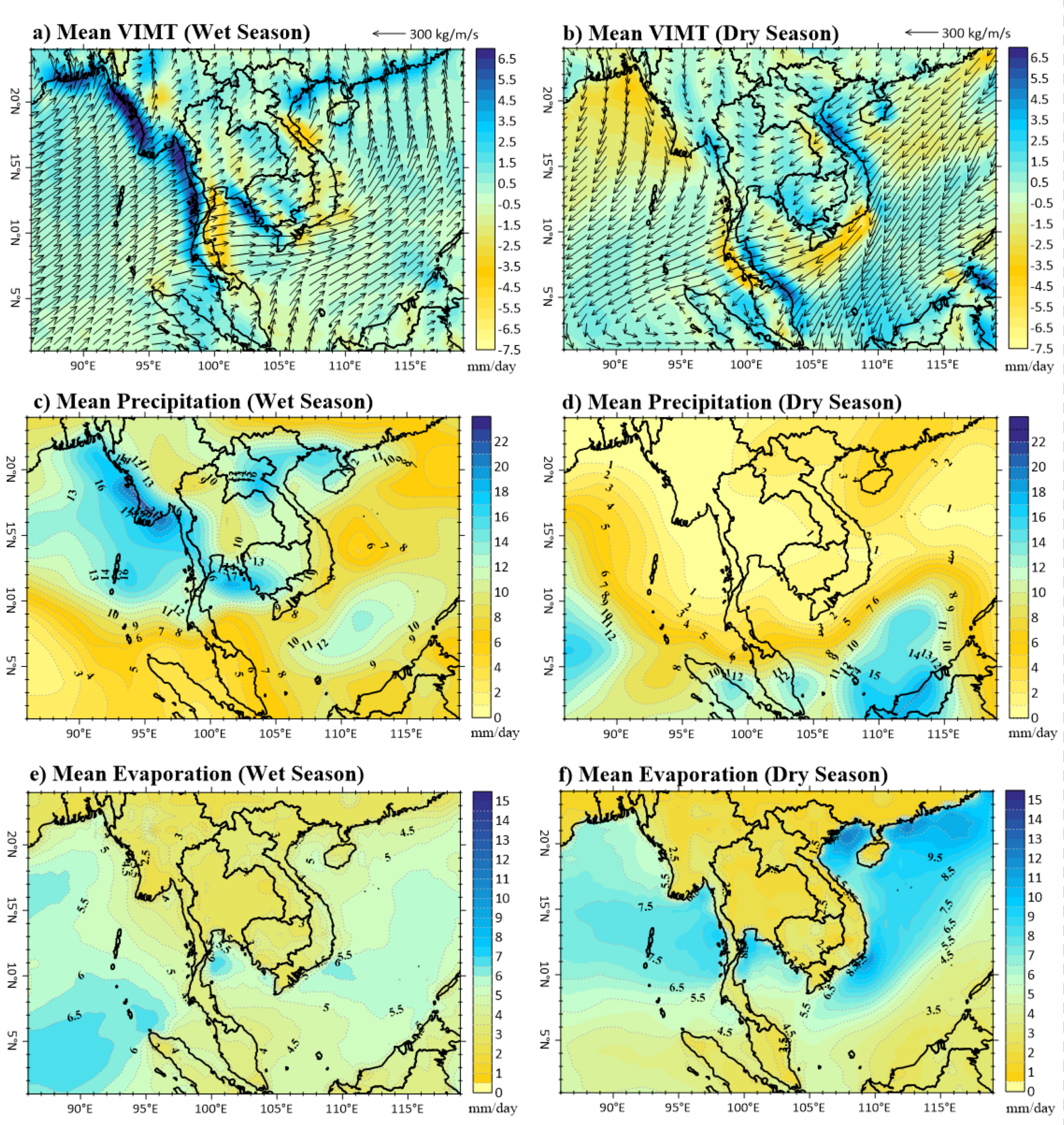

Figure 4 Vertically integrated moisture transport, mean precipitation and mean evaporation, wet season and dry season values based on reanalysis data acquired during 2013–2015, respectively.

IV. Results

The isotopes in the precipitation generally depletes with increasing latitude in wet season, associated to southwest monsoon which brings air originated from Indian Ocean toward Thailand (Fig 4a). On average, the $\delta^{18}O$ latitude effect is -0.23 ‰/°N (R^2=0.75), and for δ^2H it amounts to -1.59 ‰/°N (R^2=0.71) exposed negative correlation. Conversely, the isotope value enriches with increasing latitude throughout dry season. This is happened because the effect of northeast monsoon over northern Thailand, which brings cool moisture with enriched isotopes from the South China Sea (Fig 4b). At the same time, the southern Thailand is affected by the ITCZ and easterly winds that contain supersaturated air from the Gulf of Thailand towards the coast of Thailand, producing heavy rain. Therefore, the heavy isotopes were depleted during November until February in lower latitude area. On average, the latitude effect in dry season is +0.12 ‰/°N for $\delta^{18}O$ (R^2=0.34), and +0.81 ‰/°N for δ^2H (R^2=0.27) exposed positive correlation (Fig 5).

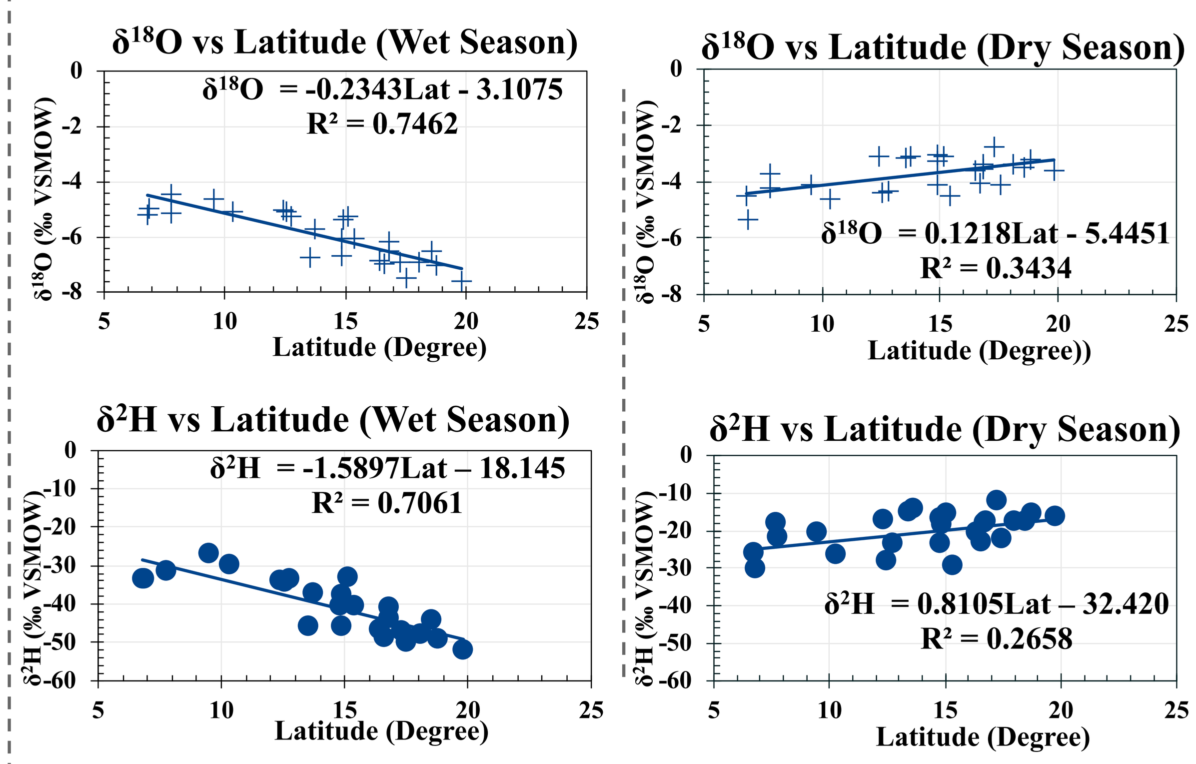

Figure 5 Latitude effect, wet season and dry season values based on data acquired during 2013–2015, respectively.

V. Conclusion

In tropical regions, the latitude effects on an isotopic precipitation can be adequately described in terms of condensation processes ,and the original moisture sources change seasonally. The slope of latitude effect appears to be related to the amount of precipitation, resulted the latitude effect in wet season is greater than dry season.

The regressions of latitude effect have different trend when wet season and dry season are considered separately, related to the moisture transport pattern. The intercept of wet season is higher than in dry season may be involved to the level of humidity. In addition, for the tropical region, the heavy isotope of precipitation is enricher in dry season than in wet season, because it is governed to amount of precipitation and evaporation intensity from their sources.

Acknowledgements

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