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探索棲蘭雲霧森林水循環

Exploring the Water Cycle in Chi-Lan Cloud Forest

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摘要

雲霧森林 (Mmontane Ccloud-fog Fforest) 的特色為時常起霧，其霧水影響當地的能量、水及碳循環，且與氣候息息相關。其水文氣候中一重要環節為蒸發散 (evapotranspiration)，亦即蒸發及蒸散量，可以潛熱通量代表之。本研究分析 2008 年至 2011 年棲蘭通量塔所獲得的觀測資料，以不同程度的能見度代表霧的濃淡，重新檢視能量通量在不同程度能見度之變化，得知在能量潛熱通量部分，隨能見度的變化，其整體似乎為非線性的變化。若探討 WMO 以能見度 1,000 公尺區分有霧、無霧狀態是否適用於棲蘭當地本研究場所，可見於 1,000 公尺前後的潛熱通量數值高低起伏，有原被視為無霧狀態的數值高於有霧狀態者，故此原則較不適合。另外也分析由低至高的能見度高於 2,500 公尺者潛熱通量隨之呈現一指數上升的趨勢趨；勢，而能見度介於 500 至 低於 2,500 公尺者由低至高之潛熱通量變化整體雖是上升，但有較多起伏，；能見度低於 500 公尺者可視為霧氣較濃，潛熱通量皆偏低，根據上述可以推測能見度與全年潛熱通量有非線性之關係。又將資料分別用四個季節觀察之，可發現特別在夏天（六至八月）能見度與潛熱通量較有正向的高的正相關性上升關係，而有其他季節則起伏變動甚大，尤其冬天（十二至二月）之變化幾乎無趨勢，推測原因為並非霧的濃淡影響整體潛熱通量，其他通量亦是如此。將本次數據之年平均資料分成有明顯區別的三種能見度：500 公尺以下、500 至 2,500 公尺及 2,500 公尺以上，以前三年各季節資料分別進行曲線擬合，並以最後一年資料訓練之，得判定係數皆不高，原因為年際之間變動大，故未來若欲分析並預測需要更多年的資料，且水文氣候可能受影響之因素也當考慮在不同季節的狀況。

關鍵字：雲霧森林、潛熱通量、霧、能見度、年平均、季節平均

Abstract

There is frequent fog formation in montane cloud-fog forest. Fog water regulates the energy, water and carbon cycle, and it is important to the local climatological system. A significant part of hydro-climatological cycle in fog forest is evapotranspiration, which can be represented by latent heat flux. The study uses 2008 to 2011 observations from Chi-Lan flux tower to explore the variation of energy flux under different degrees of visibility. The degree of visibility is regarded as the fog thickness here. The results show that the overall change of energy flux which seems to have non-linear relationship with the visibility. WMO defines that visibility less than 1 km as fog condition, but there is fluctuation around 1 km in the research site. Some LH flux values of non-fog state is higher than the value of foggy state. The LH flux shows an exponential increase as visibility above 2,500 m, respectively low below 500 m, while increasing with non-negligible variation as visibility between 500 to 2,500 m. There is a non-linear relation between visibility and annual LH flux, so the criteria isn't suitable. In addition, it can be found that visibility and LH flux have a positive correlation in JJA while large fluctuations in another season especially DJF. There is almost no trend. It is inferred that not only the thickness of fog may affect overall LH flux. The data is divided into three visibility levels , including below 500 m, 500 to 2,500 m, and above 2,500 m. Each season of the previous three years data are respectively curve-fitted and the last year data is for training. The values of coefficient of determination are pretty low because of large variation between years. Therefore, more years data is needed for the research in Chi-Lan, as well as the factors that may impact the hydro-climatological system should also be considered in different seasons.

Key words: Montane Cloud Forest, latent heat flux, fog, visibility, annual mean, seasonal mean