# USING MODIS LAND PRODUCTS TO ESTIMATE REGIONAL EVAPOTRANSPIRATION

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**Abstract**

## I. INTRODUCTION

Evapotranspiration (ET) is a key component for terrestrial ecosystem not only for its energy balance, but also for its mass balance. Since surface energy and water exchange are two key processes that can determine the characters of environment to a large extent, researches on ET are focused by scientists around the world.

Due to the fact that estimation of daily ET may unavailable as a result of the quality of the satellite data, e.g., clouds, or the cost to obtain daily ET may expensive. From this point of view, MODIS products are ideal data to calculate ET for a period, because they are designed to represent the certain parameters of land surface, which are fundamental ones in commonly adopted ET retrieving algorithm, and they have been processed and can be used directly. In addition, they are freely.

Therefore, a methodology is proposed to estimate regional actual ET for a period by using MODIS products and routine meteorological data.

## II. METHODOLOGY

In the proposed methodology, ET was calculated by inversing the energy balance equation:

$$LE = R_n - H - G \tag{1}$$

Where $LE$ is the latent heat flux, of which $L$ is the latent heat of vaporization with a value of $2.49\times10^6$ W /(m$^2$ mm) and $E$ is evapotranspiration in mm; $R_n$ is the net radiation, $G$ is the soil heat flux, $H$ is the sensible heat flux, both in W/m$^2$.

In Eq. (1), algorithms to calculate net radiation, soil heat flux and sensible heat flux in the right side are mature. Usually two kinds of parameters are necessary in these algorithms: one is land surface parameters such

as normalized difference vegetation index (NDVI), land surface temperature and emissivity; another is meteorological data (e.g. air temperature and wind speed). The former can be extracted directly or retrieved indirectly from MODIS products, while the latter can be obtained from metereological observations.

When MODIS products are used as inputs to calculate parameters for Eq. (1), the results represent a mean value for a certain period according to the time resolution of the MODIS products, and since the MODIS products are produced by using the best quality data (cloudless) in the combination period, it is necessary to multiply the mean ET value with the temporal granularity of MODIS products to obtain the total ET for that period as well as considering the cloud effects. Therefore, the following equation is proposed to calculate the total actual ET for a given period:

$$LE_t = a\left(n\overline{LE}\right) \tag{2}$$

Where $LE_t$ is the total actual latent heat flux; $\overline{LE}$ is the mean latent heat flux of a given period; $n$ is the temporal granularity of MODIS product; $a$ is cloudless day and defined as:

$$a = \frac{D_{clear} + (365 - D_{clear})(1 - C)}{n} \tag{3}$$

Where $D_{clear}$ is the clear day in one year; $C$ is the mean annual total cloud amount. Since $D_{clear}$ and $C$ are routine observational items of meteorological station, they can be obtained easily.

## III. CASE STUDY

A case study was carried out in Jinghe River Basin, which is located in the southern part of the loess Plateau, China (Fig. 1). 8-day MOD11A2, 16-day MOD13A2 and MCD43B3 in 2003 as well as daily observational values of air temperature, precipitation, relative humidity and wind speed were adopted.

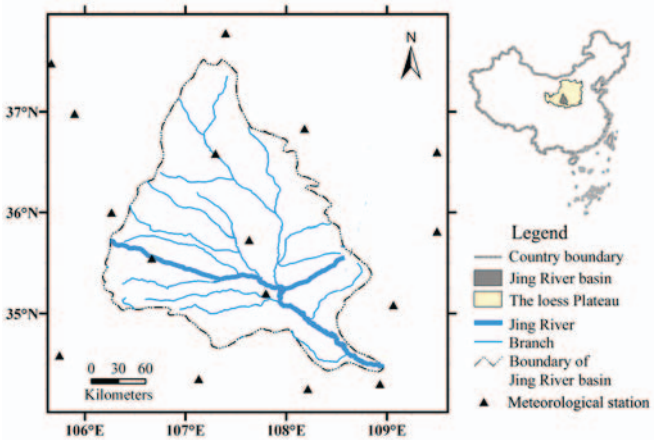


Figure 1 Location of the study area

By using the proposed method, mean ET of each 16-day in 2003 was estimated (Fig. 2), and the annual ET was 711 mm by summing all the 16-day ET value and considering the cloud effects. The modeled yearly ET was validated by using the water balance equation and the absolute error between the two methods was only 42 mm/a. The results are shown in Table 2.

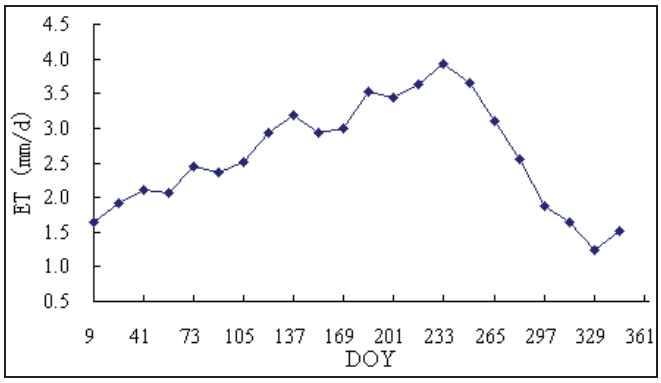


Figure 2 Mean ET of each 16-day in 2003 estimated by the proposed method

Table 2 Validation result

| year | Observation | | | Modeled | Absolute error |
|---|---|---|---|---|---|
| | ***P*** | ***R*** | $ET_o$ | $ET_m$ | |
| **2003** | 716 | 47 | 669 | 711 | 42 |

Note: both parameters are in mm; $ET_o$ means observed evapotranspiration (calculated from water balance equation); $ET_m$ means modeled evapotranspiration by the proposed method.

## IV. CONCLUSION

This study provided a methodology to estimate the regional evapotranspiration by using MODIS products. After comparing with the water balance equation, it was concluded that the proposed method had a high accuracy of 42 mm/a.