Fire Information Observed by Satellite in North India

*Yuki Kurogi[1], Sachiko Hayashida[1]

1. Nara Womens University

Background and Objective

Spices released by biomass burning have a significant impact on air pollution, global warming, and human health all over the world. It is estimated that the agricultural burning accounts for about a quarter of the world’ s biomass burning. The Indian states of Punjab and Haryana (referred to as the Punjab region) are highly agriculturally productive regions in India, and, mostly, farmers burn agricultural residues from September to November, after the rice harvesting.

Biomass burning has been monitoring by satellite measurements using infrared wavelength bands. The main satellite sensors acquiring fire information are MODerate resolution Imaging Spectroradiometer (MODIS) and Visible Infrared Imaging Radiometer Suite (VIIRS). These observation results (active fire products) are widely available on the website (https://firms.modaps.eosdis.nasa.gov). Although detections of crop residue burning are considered to be underestimated due to the small and short duration of fires, and the fact that the fires are hidden by smoke and clouds, satellite observations have the advantage of being able to obtain long-term records over a wide area.

In this study, our objective is to reveal the long-term changes of crop residue burning in Indian Punjab region using MODIS and VIIRS data and to obtain information about the burning time in a day. The time of satellite observations is limited by the satellite orbit, therefore some fires may not be detected depending on the burning time. On the other hand, the information of burning time is essentially required to simulate air pollutions.

Data

MODIS is onboard EOS-Terra launched in December 1999 and EOS-Aqua launched in 2002. They observe fire information twice a day (Terra crosses the equator at approximately 10:30am/pm and Aqua at 1:30pm/am) with a spatial resolution of 1 km. VIIRS is onboard the Suomi NPP launched in October 2011 and NOAA-20 launched in November 2017. They have spatial resolution of 375 m, and can observe also twice a day (Suomi NPP crosses the equator at approximately 1:30am/pm and NOAA-20 at 0:40pm/am).

Method and preliminary results

In this study, fires located in the Punjab region were collected using active fire products by MODIS and VIIRS for the period from September to November when crop residue burning occurs. Values of Fire Detection Count (FDC) and Fire Radiation Power (FRP) were integrated daily to investigate the long-term trend. The number of FDC increased in 2020, which could be due to the impact of COVID-19.

Furthermore, the burning time was estimated using the MODIS Terra/Aqua FRP ratio (10:30 and 13:30 ratio) (Vermote et al., J. Geophys. Res. Atmos., 2009). They inferred that small T/A ratio indicates a rapid increase in fire radiative energy with a short duration of fire activity such as slash-burning. The T/A ratio approaching to 1.0 would represent a constant fire radiative energy as observed in forest fires. It was calculated the T/A ratios in Punjab; T/A ratios were 0.20 and 0.10 for October and November, respectively (Vadrevu et al., Environ. Pollut., 2011). The VIIRS observations are expected to provide more detailed information on the burning time because of its improved spatial resolution and the close observation times of the two satellites, 12:40 and 13:30. In this study, we analyze T/A ratios as in Vadrevu et al. (2011) using VIIRS. As an initial analysis, we collected cases that were considered to be the same fire observed by both NOAA-20 and Suomi NPP in the Punjab region in 2020 and 2021 and derived the T/A ratios, which showed a large variability.

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