A new method has detected that 78% of plants had shifted to colder regions in Japan during the past 40 years.

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Many studies have shown that the distribution of organisms has also changed in response to global warming, and there are many reviews that integrate them. However, these studies coundn't evaluate the overall trend due to the regional biases.
In order to solve these problems, a different approach is demanded. I propose a method using occurrence data. Using the occurrence data of GBIF, we have detected how Japanese plant species have changed their distribution.
Occurrence data of vascular plants that were collected in Japan were downloaded. The mean temperature of each record was estimated. The number of the records that was analyzed was about 1.3 million.
There is a bias in the occurrence data of GBIF. The average elevation of records had decreased until 1978. From the results of the analysis, it is considered that this decrease is due to a decrease in the elevation of the collection effort by year. In this study, we applied a method that is robust to bias (STI analysis) to all period and a method that is vulnerable to bias but can evaluat in detail (MAT analysis) to datasets after 1978. In STI analysis, species temperature indices (STI) of each species were determined by averaging the annual mean temperature (MAT) at each record collection point. We performed linear regression on a model that used the STI of the record species as a response variable and the MAT of the record and the year as explanatory variables to examine the effect of the year. We also calculated the species elevation index (SEI) by averaging the elevations of each species record to find out what is responsible for the temperature shift, and the species latitude index (SLaI) by averaging the latitudes. Linear regression was carried out with the model using the record species SAI as a response variable and the elevation and year as explanatory variables (SEI analysis) and the model using the record SLaI as a response variable and the latitude and year as explanatory variables (SLaI analysis) to examine the effect of the year.
In the MAT analysis, a liner regression model that has MAT as a response variable and year as an explanatory variable was peformed to every species. And the distribution of the effect of the year was examined.
From the results of the STI analysis, the year effect was 0.011. This suggests that certain sites receive species that prefer 0.011 ˚C warmer climates per year. SEI analysis indicated that the year effect was -1.72 m/year, which means that at a certain point receives the species that prefer 1.72 m lower elevation every year. The result of the SLaI analysis showed that the year effect is -7.8 e-05 deg/yr, or -8.71 m/yr, indicating that at some point receive the species that prefers 8.71 m southward every year. The MAT analysis showed that 78% species had showed negative coefficients, indicating that these species had moved to colder reigon during the past 40 years(Figure). The average speed was 0.021 degrees per year, which was close to the average temperature increasing rate in Japan (0.027deg/year).
The discrepancy between the results of STI analysis and MAT analysis can be explained by the fact that the STI of southern and northern species was underestimated because records were collected only in a limited geographic area . This makes the STI differences among species be small. However, the qualitative value remains robust.
The change in latitudinal direction obtained in this study is remarkably small compared with the change in temperature. Therefore, it is considered that the change to the temperature observed this time was mainly due to the movement to high altitude.

From this,
1.Many Japanese plant had moved to cold direction in response to global warming
2.Its average shifting rate was close to the rate of global warming
3.This movement was primarily due to movement in the elevation direction.
This method can be used if you got the GBIF data, weather data, and elevation data.

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