

Figure 6 Diagram of MODIS data processing at the NIES Data Analysis Center

The MODIS Surface Reflectance product (MOD 09) is computed from the MODIS Level 1B land bands 1, 2, 3, 4, 5, 6, and 7 (648 nm, 858 nm, 470 nm, 555 nm, 1240 nm, 1640 nm, and 2130 nm, respectively). The product is an estimate of the surface spectral reflectance for each band as it would have been measured at ground level if there were no atmospheric scattering or absorption.

LST and Emissivity (MOD 11) information is retrieved from MODIS data at spatial resolutions of 1 km over land surfaces under clear-sky conditions. A physically based day–night LST algorithm has been used to simultaneously retrieve surface band emissivity and temperatures from a pair of daytime and night-time MODIS observations in bands 20, 22, 23, 29, and 31–33 over all types of land cover.

Land cover and its changes (MOD 12), which affect many aspects of the environmental system such as energy balance, biogeochemical cycles, hydrological cycles, and climate, are considered to be critical elements of global change studies. MOD 12 will be produced at a 1-km resolution on a quarterly basis. The land cover parameter identifies 17 categories of land cover following the IGBP global vegetation database, which defines nine classes of natural vegetation, three classes of developed land, two classes of mosaic land, and three classes of unvegetated land (snow or ice, bare soil or rocks, and water).

The product of vegetation indices (MOD 13) will provide consistent spatial and temporal comparisons that will be used to monitor terrestrial photosynthetic vegetation activity in support of change detection and phenologic and biophysical interpretations. Vegetation index maps depicting spatial and temporal variations in vegetation activity are derived at 8-day,

16-day, and monthly intervals for precise seasonal and inter-annual monitoring. A time-series dataset of the normalized difference vegetation index (NDVI) derived from NOAA/AVHRR, SPOT/VEGETATION, TERRA, or AQUA/MODIS is useful for the extraction of reliable information on land cover change at the global, continental, and large regional scales, because the dataset can cover large areas and long periods from 1980 to the present, with high temporal resolution and at low cost. In light of the above need, we have developed a new land-cover-change detection method based on an NDVI dataset (Fig. 7). It includes three stages: image-to-image geometric registration; reconstruction of high-quality NDVI time-series by use of a Savitzky–Golay filter; and land-cover-change detection by cross correlogram spectral matching (CCSM). The new method is based on the assumption that different land cover types have different NDVI temporal profiles (Fig. 8).

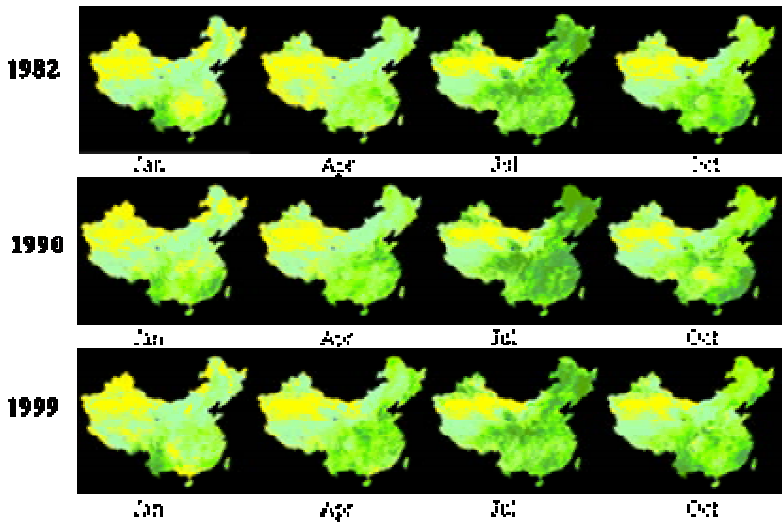


Figure 7 NDVI dataset from NOAA/AVHRR for the period 1982–1999

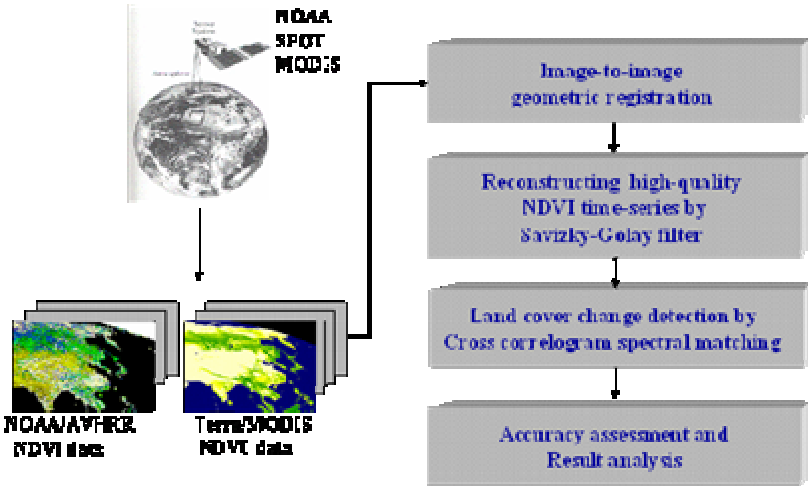


Figure 8 A new method of detecting long-term land cover change

LAI and FPAR (MOD 15) are 1-km-resolution products provided on a daily and an 8-day basis. LAI defines an important structural property of the plant canopy, namely the one-sided leaf area per unit ground area. FPAR measures the proportion of available radiation in the photosynthetically active wavelengths (400 to 700 nm) that a canopy absorbs. The two indices are very useful for monitoring crop growth.

The PSN and NPP product (MOD 17) is a Level 4 product consisting of 8-day net PSN and NPP. Annual NPP is the time integral of the PSN product over a year, and is a very important index for measuring plant productivity. Seasonal changes in some MODIS high-order products are shown in Figure 9.

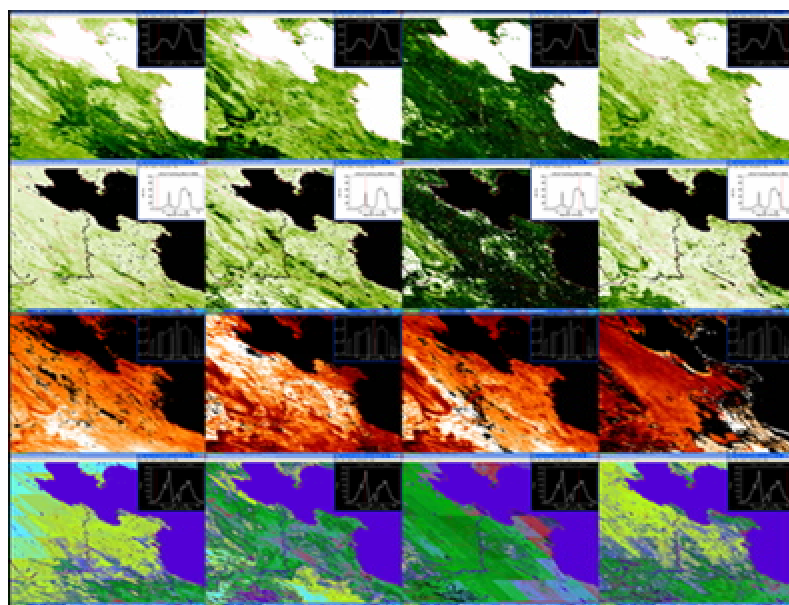


Figure 9 Seasonal changes in some MODIS high-order products on the North China Plain

(From top to bottom: MOD 13 – Vegetation Index; MOD15 – Leaf Area Index; MOD 11 – Land Surface Temperature; and MOD 17 – Net Primary Productivity)

Although we can produce MODIS high-order products by a data processing system, most of them have not yet been calibrated or validated by ground-truth data in various ecological systems, and this validation is the next step in our project. Figure 10 shows the annual changes in FPAR and LAI at each of five validation stations, and Figure 11 shows the results of validation; such results indicate that the MODIS products must be validated before they are put into use.