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Understanding snow/glacier change and its causality in the high mountain Asia region

The overall objective of this project is to study the spatio-temporal characteristics and changes of typical factors dominating water and energy cycles in the HMA region, such as, clouds, surface radiation, precipitation, atmospheric water vapor, snow, and glacier, as well as the possible driving mechanism of these changes by coupling high-resolution satellite products and hydrological model.

To this end, the tasks of the whole project are broken down into four parts:

(1) Cloud detection /cloud microphysical parameters retrieval
Clouds play a key role in HMA's water and energy cycles. They seriously impact the precipitation, temperature and surface energy distribution. Considering the fact that proper cloud products with relatively higher spatial and temporal sampling and with satisfactory accuracy are serious shortage in HMA region, except accurate cloud mask, we intend to develop new types of cloud microphysical parameters, such as cloud optical thickness, cloud effective radius, liquid/ice water content and cloud top height jointly based on measurements of Himawari-8, FY-2 series and MODIS. These data are then used to derive all-sky surface radiation and served as auxiliary data for water vapor and precipitation estimation.

(2) Precipitation and total precipitable water (TPW) estimation
In this project, we attempt to retrieve high-resolution precipitation areas, intensity and the phase of the precipitation over the HMA region using passive microwave, visible/infrared bright temperatures and the precipitation measured by the Dural-frequency Precipitation Radar (DPR). In addition, we will take advantage of optical sensor aboard geostationary satellite, passive microwave radiometer and ground observations to obtain high resolution TPW under all-sky conditions. First, we will further improve the algorithm of retrieving TPW using passive microwave radiometer over the area with complex surface condition. Then a fusion method will be developed to merge the TPW derived from geostationary satellite, passive microwave radiometer and ground observations into an improved TPW product. At the same time, a comprehensive analysis regarding long-term variation of TPW and precipitation at the HMA area is carried based on the generated datasets.

(3) All-sky surface radiation estimation with high-resolution

Surface radiation is a very important energy source in perturbating HMA's evapotranspiration, snow and glacier melting, thus a controlling factor in the energy and water cycles in the HMA region.

All currently available radiation products in this area are not suitable for regional scale study of water and energy exchange and snow/glacier melting due to their coarse resolution and low accuracies. Our goal is to produce high-resolution (< 2km, half-hour) short- and long-wave radiation (downward and net components) to drive high-resolution hydrological models. The big improvement of these products is the full consideration of the effect of clouds and topography on derived radiation.

(4) Hydrological simulation and snow/glacier change analysis

Based on existing work, we develop a proper hydrological model that can work well over high and cold mountain areas. Among development, we focus on the issue of how to couple the remote sensing data and hydrological model. Based on the high-resolution driving data mentioned above, an extensive simulation can be carried out to study the snow/glacier melting and runoff at HMA region. At the same time, to investigate the influence of change of snow and glacier on local climate change.