Surface Flux Observations during RAISE Intensive Observation and Estimation of Regional Energy/Water Fluxes over Kherlen River Basin

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Introduction

Network of the surface flux stations and automatic weather stations (AWSs) will be constructed over the Kherlen river basin and they will be operated during the intensive observation periods in 2003. Main target of these observations will be for the estimation of the regional energy/water fluxes as well as providing the fundamental meteorological observations to the RAISE-Mongolian community. In this document, the planned observations as well as the prospective research with the obtained data are outlined

Observation

A) Surface Flux Stations

Flux stations will be constructed at three sites: 1)in the forested area over the hill to the north of the Mongonmorit village, 2)over the grassland in the vicinity of Kherlenbayan-Ulan, 3) over the grassland within the protecting fence in the vicinity of Kherlenbayan-Ulan. Table 1 lists the specification and the planned measurements at each station.

B) AWS Stations

Light-weighted and solar-powered AWS are used at four sites: Baganuur, Jagalthaan, Underhaan and Darhan. They are collocated with the operational meteorological post/station for the comparison and maintenance purpose. The measurement system is fully-automatic, fully stand-alone and it is powered by solar panel. The planned measurements are list in Table 2.

Research Plan

A) Regional Heat Budget Estimates using Satellite Remote Sensing and Surface Heat Budget Model

Regional estimates of surface heat/water flux will be computed by applying satellite data and surface meteorological observations to the surface heat budget model. The model is the surface heat budget equation linearlized with bulk transfer methods and can be solved forward in the temporal direction (Matsushima and Kondo. 1995). Thermodynamic property of the vegetation and the surface, the major input to the model, can be given from the satellite images: Thermal thermalinfrared images give the radiometric surface temperature, while the vegetation indices and the snow indices can be taken from ADEOS II/GLI and MODIS (Saito and Yamazaki, 1999).

For the validation of satellite information and in order to acquire the albedo distribution, the aircraft observation will be performed along with the seasonal march. The resulted surface energy components will be validated through the comparison with the surface flux measurements and AWS observations.

B) Scintillometer measurements of regional sensible heat flux.

Scintillometer (see e.g., de Bruin, 2002) is a optical device that measures "scintillation" of the atmosphere due to the density fluctuation of the air, with the infrared or red light passing through a horizontal path. Recent technology enables one to put the light source and the receiver more than 1km upto 5km apart each other, which, in turn, enables us to measure "path-averaged" regional sensible heat flux. The measurement with this large aperture scintillometer (LAS) will be done in the vicinity of the Kherlenbayan-Ulan.

C) Surface heat budget over different landcover and surface conditions

The RAISE surface flux measurements spans from the northern forest to the southern steppes in the Kherlen river basin. This enables a comparative study of the surface heat budget components over different surface conditions and landcover in the basin.

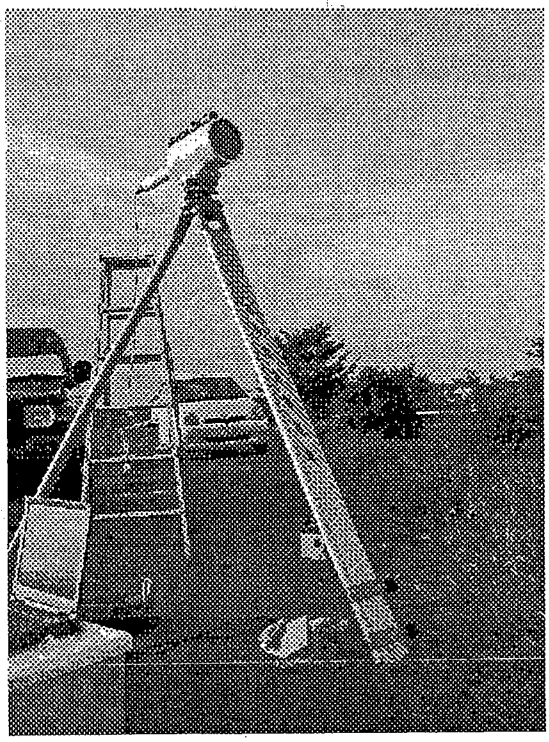

Figure 1: Receiver of the large aperture scintillometer

D) Variance methods with aircraft observation

Thermometer and humidity meter onboard of the aircraft will be used to estimate the variance (in the sense of turbulence) of these quantities. These variances can be converted to the corresponding surface fluxes, i.e. sensible and latent heat flux using well-known variance methods (Asanuma and Brutsaert, 1999). With the aircraft flown over the Kherlen river basin, the distribution of the variance, henceforth the surface fluxed can be obtained.

E) Investigation of heat/water transport characteristics

Turbulence transport of the heat and water vapor transport will be investigated in the framework of time-scale analysis using the wavelet transform (e.g. Daugechies, 1992). Emphasis will be given on the similarity between heat and water vapor transport and the characteristics of the transport at larger time scale.

References

Asanuma, J, Brutsaert, W: Turbulence Variance Characteristics of Temperature and Humidity in the Unstable Atmospheric Surface Layer Above Variable Pine Forest, *Water Resour. Research*, Vol. 35, No. 2., 1999

Daugechies, I: *Ten Lectures on Wavelets*, SIAM, 1992

De Bruin, H: Introduction: Renaissance of Scintillometry, *Boundary-layer Meteor.*, Vol. 105, 2002

Matsushima, D. and J. Kondo: An estimation of the bulk transfer coefficients for a bare soil surface using a linear model, *J. Appl. Meteor.*, Vol. 34, 927-940, 1995.

Saito, A. and T. Yamazaki: Characteristics of spectral reflectance for vegetation ground surfaces with snow-cover; Vegetation indices and snow indices, *J. Japan Soc. Hydrol. & Water Resour.*, Vol.12, 28-38, 1999.

Table 1: Specification and measured parameters of each flux station

site name	Forest A	Grassland A-1	Grassland A-2
location	north of Mongonmorit	Kherlenbayan-Ulan	Kherlenbayan-Ulan
vegetation	forest	grassland	grassland (inside of the protecting fence)
measurement plat home	tower (upto 30m height)	mast (upto approx. 3m)	mast (upto approx. 3m)
measured parameters			
radiation	4 components	4 components	4 components
wind speed	3 components (sonic anemometer)	3 components (sonic anemometer)	3 components (sonic anemometer)
fluxes	sensible/latent heat flux, CO2 flux, eddy correlation	sensible/latent heat flux, CO2 flux, eddy correlation	sensible/latent heat flux, CO2 flux, eddy correlation
other meteorological variables	temperature, humidity, air pressure, precipitation, surface temperature	temperature, humidity, air pressure, precipitation, surface temperature	temperature, humidity, surface temperature
soil parameters	soil heat flux, soil temperature, soil moisture, soil water potential	soil heat flux, soil temperature, soil moisture, soil water potential	soil heat flux, soil temperature, soil moisture,

Table 2: Measured items with AWS

variables	detail
radiation	4 components
wind	wind direction and wind speed
meteorological variables	temperature, humidity, air pressure, precipitation
soil	soil moisture