ENVIRONMENTAL AND LAND SURFACE PROCESSES STUDY ON THE TIBETAN PLATEAU—A TEN YEAR PLAN

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Abstract

The Tibetan Plateau is often called the "Third Pole" Because of its significance parallel with Antarctica and the Arctic. As a unique geological and geographical unit, the Tibetan Plateau dramatically impacts the world's environment and especially controls climatic and environmental changes in Asia or even in the Northern Hemisphere. The Tibetan Plateau, therefore, provides a field laboratory for studying global change. The Institute of Tibetan Plateau Research (ITP) of the Chinese Academy of Sciences (CAS) is establishing a Field Monitoring and Research Platform (FMRP) on the Tibetan Plateau.

1. Introduction

The goal of the FMRP consists of three parts: Environment, Ecology and Geodynamics. The goal of Environment Part of the FMRP is to study the characteristics of the Plateau's climate and its interactions with global change; to determine the effects of global warming on the glaciers, lakes, and frozen soils and other processes on the Tibetan Plateau, and the ways these changes feedback to global climate change; to understand the roles of glaciers, lakes, rainfall, and soil moisture with respect to greenhouse gasses and aerosols; to establish relationships between modern climate and physical, chemical, and biological proxies by using remote sensing data and the high resolution records; to reveal (eventually model) the processes and mechanisms in the atmosphere, the hydrosphere, the cryosphere, the biosphere and the lithosphere, especially the interface processes between cryosphere and atmosphere, and between hydrosphere and cryosphere.

2. Long-term Plan

On a long-term time scale (10 years), the FMRP is to be combined with the construction of the CAS station network and integrated with the construction of national stations, and coordinated with international monitoring program. The FMRP is intended to cooperate internationally with all monitoring and research programs on the Tibetan Plateau, especially CEOP.

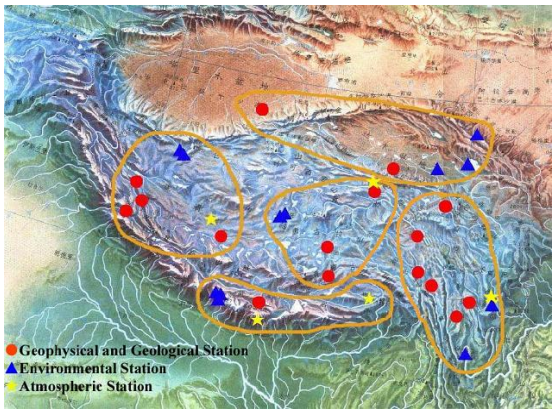

Fig.1 Long-Term Plan – Monitoring Stations on the Tibetan Plateau

In this Long-term Plan, Five first-order monitoring bases will be constructed for geophysical, environmental, and atmospheric research, covering the major regions of the Tibetan Plateau.

2.1 Environment and land surface monitoring bases

Five monitoring bases will be located in different zones. The north base includes glaciological, meteorological and hydrological observation on the Dunde Ice Cap, Qiyi Glacier, Malan Glacier, the Qinghai Lake, Taiyang Lake, Zhalin Lake and Erlin Lake, and Delingha. The south base includes glaciological, meteorological and hydrological observation on the Ronbuk Glacier, Kangwure Glacier, Dasuopu Glacier, Yangzhuoyong Glacier in Mt. Qomolangma (Everest), Mt. Xixiabangma, the Yangzhuoyong Lake, the Pumoyongco lake (or Peikuco Lake), Dingri and Nienamu. The middle base includes glaciological, meteorological and hydrological observation on the Puruogangri Icefield

Tanggula Glacier, Yangbajin Glacier, Donghu Lake, Namuco Lake, Selinco Lake and Coer Lake. The west base includes glaciological, meteorolgical and hydrological observation on the Guliya Ice Cap, Daxiong (or Dajiaco) Glacier, Bange Lake, Kalashi Lake, Guozhaco Lake and Bangda Lake. The east base includes glaciological, meteorological and hydrological observation on the Zepu Glacier, Ranwu Glacier, Aza Glacier, Gonggashan Glacier, Ranwu Lake, and Linzhi, and ecological observation on Mt. Sejila. These five bases will implement the following environment and process monitoring and research:

(1) Land surface monitoring.

These observations include changes taking place in glaciers, snow, lakes, rivers, rare or endangered vegetation, and the thickness of frozen soil. Snow changes include cover area, volume, and mass. Lake changes include lake level, area, evaporation, discharge, etc. Typical rivers include the Changjiang (Yangtze) River and the Huanghe (Yellow) River. Rare and endangered vegetation will be surveyed by remote sensing. The thickness of frozen soil will be plotted along the path of the new Tibetan Plateau Railway.

(2) Process monitoring.

This research includes hydro-chemical studies (such as salinity and conductance), biological studies (such as diatoms and TOC), and observations of life processes under extreme condition, deposition of spores and pollens, precipitation of stable isotopes, and sedimentation rates.

(3) Interface reaction studies.

This study includes aerosols, sand storms, chemical deposition processes from air, origin and sedimentation features of heavy metals and particulates, properties of soil at the base of the trees, and growth processes of tress.

(4) Studies of proxies that can be used to reconstruct pre-historical record of modern process.

These studies include the relationship between tree ring records and climate, between stable oxygen isotopes and temperature, and between intensity of photosynthesis and plant respiration.

2.2 Atmospheric monitoring stations

Four stations will be built for atmospheric monitoring: named Wudaoliang station at the north base, Mt. Qomolangma station at the south base, Gaize station at the west base, and Linzhi station at the east base.

They all monitor stratosphere, troposphere, boundary layer, atmospheric radiation, precipitation, soil moisture, and other ground surface processes. Two stations, at Mt. Qomolangma and Numco will also monitor aerosols, atmospheric chemistry, and the vertical distribution of ozone.

(1) Observations of the stratosphere and troposphere.

GPS air sounding: to monitor the atmospheric structure and movement. Observed parameters are air temperature, humidity, pressure, and wind. Spatial resolution is 30 meter, daily monitoring.

(2) Vertical distribution of ozone.

Ozone sounding: weekly monitoring of the vertical distribution of ozone from 0-30 km, 3 to 4 times each week during the change of seasons.

(3) Observation in the surface layer.

Five level meteorological survey towers: to monitor air exchange near land surface, and determine lower boundary parameters, such as five levels of air temperature, humidity, pressure, and wind at 0-20 m.

(4) Boundary layer observations

Wind temperature profiler: to continually monitor structure and exchange features, including wind, temperature, and structure within the boundary layer, from 300 m to 3 km.

(5) Observations of atmospheric radiation

Observation system for sunlight and radiation: to continually monitor atmospheric radiation, including long wave radiation, short wave radiation, scattered waves radiation, and reflected waves radiation.

(6) Soil thermal flux observations

Sensors for temperature, humidity, and soil heat flux: to continually monitor heat exchange between soil and the atmosphere, which including heat exchange gradient, soil temperatures, humidity and evaporation, at depths from 0-10m.

(7) Precipitation observations

Precipitation observation system: including automatic precipitation monitoring gauges and manual rainfall records.

(8) Atmospheric chemistry observations

Atmospheric chemistry sampling and analysis system:

including optical ozone abundance, real-time analysis of CO_2, NO_X, SO_2, and ground CO_3. Experimental analysis of CO_2, CH_4, N_2O, CO, POPs, VOCs, CFCs by weekly sampling.

(9) Aerosol observation

Atmospheric sampling and analysis system: including aerosols, and particulates, large flow sampling and experimental analysis.

3. Short-term Plan

On a Short-term time scale (3-5years), the FMRP will be promoted by the CAS Knowledge Innovation Project.

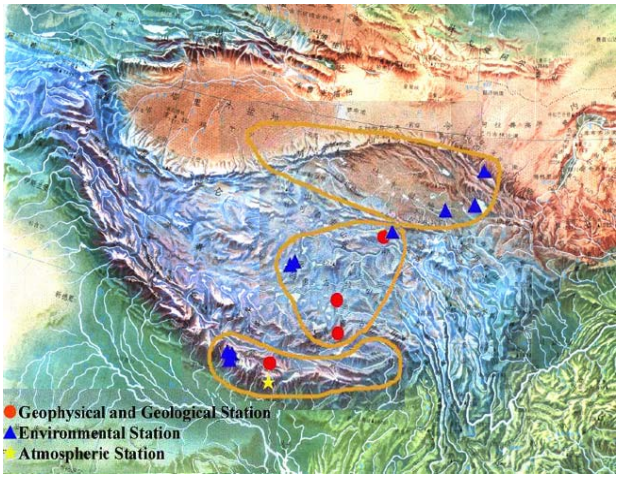

Fig.2 Short –Term Plan – Monitoring Stations on the Tibetan Plateau

The FMRP is intended to internationally link with CEOP and DFG. This Project will facilitate efficient support for international research and cooperation, and create a better research environment for the long term monitoring.

The main topics of the monitoring and research are as follows:

(1) Land surface monitoring.

To observe the changes of glaciers, snow, lake, river, vegetation, and meteorology in Mt. Qomolangma regions.

(2) Process monitoring

To observe atmospheric environment processes (such as aerosols, sand storms, initial and derivative air pollutants), atmospheric chemistry, hydrochemistry, concentrations of stable isotopes in precipitation, physicochemical processes under glaciers, distribution of glacier topography, and sediment grain size and concentration in melt water.

(3) Interface reaction monitoring

This study includes chemical reactions and concentration changes of greenhouse gases (CO_2, CH_4, N_2O), carbon particulates, POPs, SO_4^{2-}, NO^{3-}, Ca^{2+}, Na^+, heavy metals, and particulates, snow and glacier chemistry effected by high ultraviolet radiation in high altitude areas, processes of mass and energy transfer, flux monitoring, properties of soils, and the growth of trees.

(4) relationships between climate proxies and modern process

Including the relationship between radial growth of tree rings and climate, between temperature, precipitation and stable isotopes, between intensity of photosynthesis and respiration, between glacial fluctuation and global change.

4.The first three stations in the Short-term Plan

Three integrated all-the-year-round monitoring and research stations including Namcuo, Linzhi and Qomolangma are under constructing in addition to temporary stations on the whole Tibetan Plateau during this period. They are:

(1) Namcuo Station:

Namcuo Station is built on the shore of the second largest Chinese salt lake – the Namcuo Lake. The station covers 0.5ha. including observation site and living services area. There will be one Atmosphere Observation Tower (30m) for the normal weather monitoring, precipitation measurement and aerosol observation. And the change of the thickness of frozen soil will be recorded. Along and inside the Lake, hydrology and limnology and ecosystem will be studied. Some observation instruments will be sited on the Mt. Nyangqentangula to monitoring the changes of the glaciers on the top of the mountain.

(2) Qomolangma Station

This station will be located on the north slope of Mt. Qomolangma (Everest), .

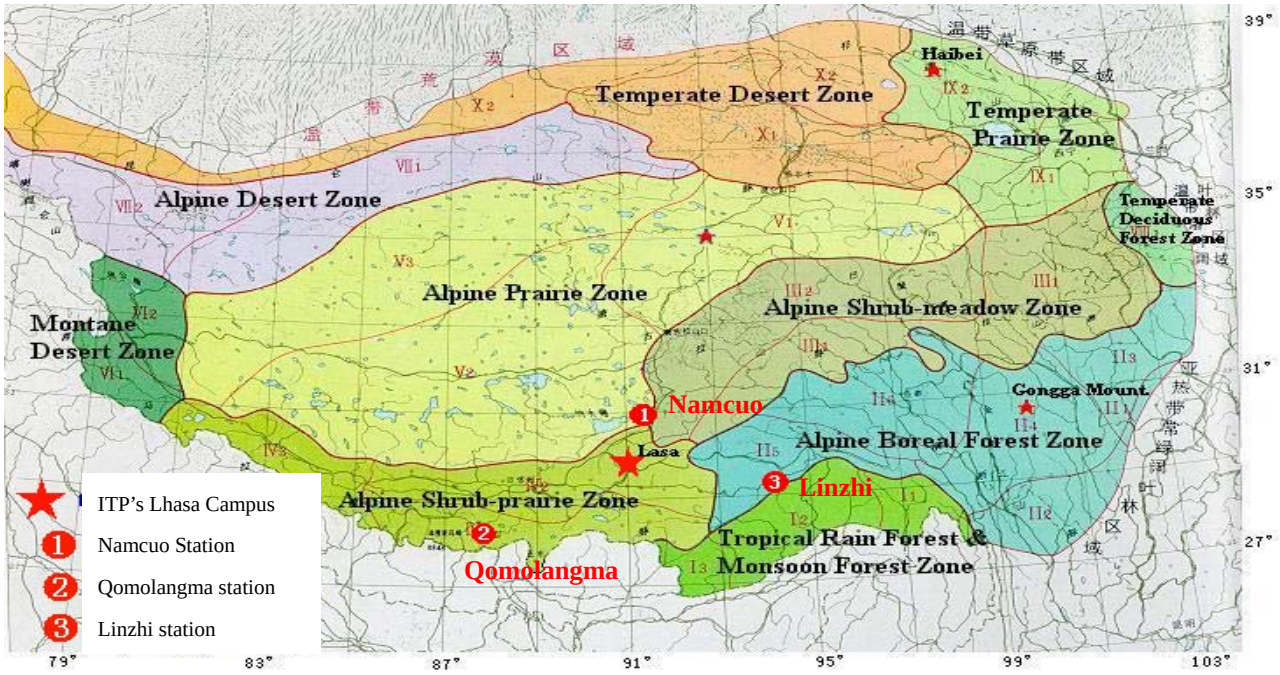

Fig.3 The first three stations on the Tibetan Plateau in the short –term Plan

Qomolangma Station will focus on the observation of relationship between Himalayas atmosphere system and global atmosphere cycle, which will involve studying the exchange processes of ground layer, troposphere and stratosphere, monitoring the vertical distribution of ozone, soil thermal flux observation and atmospheric chemistry observations. This station is intend to monitoring the environment changes of the Himalayas area, find out the cause, and measure the effect of this changes brings to the surrounding regions.

(3) Linzhi Station

Linzhi station is composed of meteorology, glaciology, hydrology and vegetation observation. This station will emphasize the monitoring of forest growth in cold high Tibetan Plateau. The observation site is divided into two parts, separately located on the sun and sunless slope of Mt. Sejila. Each part includes several sample quadrates of forest, shrub and meadow. Radial growth of tree rings will be measured to build the relationship between tree growth and climate factors. The temperature, precipitation and stable isotopes in the sample quadrates will be monitored, and causes for the form of tree line will be studied based on this station's observation data.

In situ and remote-sensing observation, and laboratory analyses are essential for the FMRP on the Tibetan Plateau. The FMRP is to create a comprehensive, reliable and continuous data bank, which will produce long-term, reliable criteria, high-quality, high-resolution (both in time and space) and homogeneous data set.

Keyword: Tibetan Plateau, FMRP, Environment