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Introduction of Huaihe River Basin Energy and Water Cycle Experiment and Research

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Huaihe River Basin Energy and Water Cycle Experiment and Research (HUBEX), as one of the Ninth Five-Year Plan (1996-2000) Major Programs supported by the National Natural Science Foundation of China (NSFC), successfully passed the check-up and won high appraisement from the experts. Huaihe River Basin, located in the inland of the eastern Asia monsoon area, is the key base for rice-cotton production and suffers from the frequent drought and flood. In order to investigate the climate problem of Huaihe River Basin area, we must understand the energy and water cycle mechanism which have a crucial effect upon the climate. The goal of HUBEX is to gain a better understanding of the energy and hydrological processes. It is also an important component of the Global Energy and Water Cycle Experiment Program/GEWEX Asian Monsoon Experiment (GEWEX/GAME) held in the East Asian semi-humid subtropics. Its field experiment was listed among the top ten news on basic research in China in 1998 by the Ministry of Science and Technology of China.

1 The Background

1.1 GEWEX projects

The energy and water cycle plays a dominant role in nearly all aspects of the earth's climate system. For this reason the Global Energy and Water Cycle Experiment (GEWEX,1989-2005) was initiated in 1989 by the World Climate Research Program (WCRP) to observe, understand and model the hydrological cycle and energy fluxes in the atmosphere, at land surface and in the upper oceans. GEWEX is an integrated program of research, observations, and science activities ultimately leading to the prediction of global and regional climate change.

The goal of the GEWEX is to reproduce and predict, by means of suitable models, the variations of the global hydrological regime, its impact on atmospheric and surface dynamics, and variations in regional hydrological processes and water resources and their response to changes in the environment. GEWEX projects have the following five experiment areas: GEWEX Continental-Scale Experiment in Mississippi River Basin, Mackenzie GEWEX Study, Baltic Sea Experiment, Large-scale Biosphere-Atmosphere Experiment in Amazonian, GEWEX Asian Monsoon Experiment.

As a part of the GEWEX, the GEWEX Asian Monsoon Experiment (GAME) is to understand the role of the Asian monsoon in the global energy and water cycle and to improve the simulation and seasonal prediction of Asian monsoon patterns and regional water resources. It has four regional experimental studies including GAME-Siberia, GAME/HUBEX, GAME-Tibet and GAME-Tropics.

1.2 The beginning of HUBEX

Since 1991, HUBEX have been initiated and organized by scientists from China and Japan, and some preliminary studies were carried out. The GAME/HUBEX committee was established in China and Japan, respectively. International workshops and Working Group meetings were held in order to make unified experimental implementation plans and scientific research plan. In 1997, confirmed formally by the National Natural Science Foundation of China (NSFC), Huaihe River Basin Energy and Water Cycle Experiment (HUBEX) became one of the major projects of the Ninth Five-Year Plan of NSFC.

2 Brief Introduction of HUBEX

The aims of HUBEX are to, use the intensive field observations and the special observations data including meteorological observations, hydrological observa-

tions, digital and Doppler radars, satellite remote sensing, etc, study the process of the energy and water cycle of meso-scale precipitation system in eastern Asia monsoon area (mainly focus on Meiyu area), set up the regional climate/hydrology numerical model and date assimilation system so as to improve the abilities of climate simulation and forecasting. There were four sub-projects in HEBEX: Observational Experiment of the Energy and Water Cycle Processes, the Studies between Energy and Water Cycle Processes with regional climate, the Studies on Regional Hydro-climate Numerical Model and the Studies on HUBEX Data Set and Four-dimensional Assimilation Schemes. In 1998, HUBEX was listed among the top ten news on basic research in China by the Ministry of Science and Technology of China.

2.1 Domain of field experimental region

Huaihe River Basin, located between Yangtze River and Yellow River, is a closed basin extending 5 degrees in latitude and 9 degrees in longitude. It belongs to warm temperate semi-humid monsoon climate region, which is the climate transition zone between the North and South China. As a typical climate representative of the East Asian monsoon areas with less effects from human activities and dense meteorological and hydrological observation network, Huaihe River Basin is an ideal field experimental site. Both Chinese and Japanese scientists have investigated the spot more than ten times since 1991 in order to implement the experiment. Considering the special characteristics of natural geography, the hydrological and meteorological network within the basin, the γ scale observational sub-region was set up in the area of $140\times150km^2$. The β ($700\times500km^2$)and α ($1200\times1500km_2$)scale observational sub-regions were nested outside of the γ scale sub-region.

All necessary preparations, such as instrumentations, were finished in year of 1997. In the summer of 1998 and 1999, the intensive and special observation of surface, upper-air, hydrology, radar, boundary, surface flux, radiation and satellite remote sensing were put into practice. Meteorology and hydrology observation data with different sources were collected.

2.2 Data analysis and numerical simulation

EI Nino event occurred in May 1997 reached its peak by the end of 1997, which was the strongest warming case in the twentieth century. In 1998 all the Yangtze valley suffered from floods. El Nino's counterpart, La Nina occurred in 1999, and the lower reaches of the Yangtze River suffered from floods. Observational data obtained in the above climatic backgrounds were very helpful to reveal how climate changes influence water resources, and how changes of regional energy and water cycle influence East Asia monsoon and global change. Therefore, after the experiment were conducted, a series of related research in the calculation analysis, diagnosis and numerical simulation, etc. was carried out by using the intensive observational data, such as, the comprehensive research on the relationship between energy and water cycle during the Meiyu and regional climate based on historic observational and satellite remote sensing data; test and simulation of the regional climate-hydrological model developed by project using observational data; the establishment of the regional data assimilation system and four-dimensional assimilation data system, etc.

3 Significant Achievements

In this project, there were more than fifty experts from Peking University, Institute of Atmospheric Physics, Chinese Academy of Sciences, National Meteorological Center, National Satellite Meteorological Center, HuaiHe River Commission, Ministry of Water Resources, Informational Center, Ministry of Water Resources, and so on. By the end of this project in 2003, 101 papers including 23 SCI and 3 EI had been published, accompanied with a plenty of field observational data. About 3 post-doctor, 36 doctor, and 46 master dissertations were involved, and four international scientific conferences were held. The main achievements are summarized as follows.

3.1 Conducting large hydro-meteorological joint experiments

Abundant quantitative field observations at first hand for two years have been obtained. It was first in China that the meteorological and hydrological data were obtained for semi-humid monsoon zone in eastern Asia. The data were of great application value in studying land-surface process and improving hydrology model.

3.2 Depicting physical images of energy and water balance

On the basis of using observational data, the stud-

ies on the energy and water cycle over the Huaihe river basin were accomplished through diagnose analysis and numerical modeling. The pictures of energy and water balance in Huaihe River basin were presented. And the data depicting earth-atmosphere exchange with quantitative parameters had been used in the improvement and forecast for climate model.

3.3 Providing the feature of the meso-scale cloud/precipitation structure

By using the new observational satellite data such as TRMM and radar data, the project inversed and provided the feature of the meso-scale cloud/precipitation structure in the Meiyu frontal system over Huaihe River Basin, provided important physical basis for the further understanding of formative mechanism of Meiyu frontal rainstorm and rainstorm prediction, and had good effect on rainstorm numerical simulation experiment and real time forecast implemented in the meso-scale short-term rainstorm prediction.

3.4 Coupling study on the regional climate model and hydrology model

By using the obtained observational data, the regional climate model was improved, new land surface process model and hydrology model were developed, and regional climate model and hydrology model were coupled. It had very obvious effects on the hydro-meteorological prediction during the Meiyu and flooding season over the Huaihe River Basin, especially in the forecast of torrential rain and floods in 2003.

3.5 Establishing regional data assimilation system and four-dimensional assimilation data set

The regional data assimilation system and four-dimensional assimilation data set were established, which were used by domestic and foreign scientists. The data set is of great value to the diagnostic analysis of East Asian monsoon and Meiyu frontal system and the mechanism studies.

3.6 Promoting international cooperation

Successful international cooperation was the project's feature. Since both the climates in China and Japan are commonly affected by Meiyu, the governments paid great attention and gave strong support to HUBEX. Therefore, HUBEX was also a cooperative project between China and Japan. The experiment promoted the cooperation and exchanges between the scientists of the two countries greatly, and got very good responses in the international society.

4 Brief Conclusions

Global Energy and Water Cycle Experiment is a new discipline, and particular emphasis will be put on the linking of disciplines such as coupled atmospheric and land surface models, and cross-disciplinary studies. It not only attracts many scientists from the above areas, but also brings along the development in these areas. HUBEX, as a bridge for Chinese scientists to enter this new discipline, promotes the cooperation between the meteorologists and hydrologists who work independently in their own area for a long time and plays a positive role in pushing forward the intersection between each other, infiltration and coordinative development of multi-disciplines.

HEBEX data set and land surface process model, hydrology model based on the data set are very important to short-term climate and hydrology simulation and forecast, meanwhile, it will have an effect on drought and flood forecast and water resource management.

In terms of the management of NSFC, there are some enlightening conclusionsas follows. (1) Providing support to new, multi-disciplinary intersecting field can help Chinese scientists stand in the forefront of international academia; (2) Observational experiments are a part of basic research and sources of atmospheric science. So we must pay great attention to these observational experiments, especially those belonging to the International Experiment; (3)The post-project management must be strengthened to ensure scientists to use observational data better.