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drops, ice crystals and graupel. Pressure was calculated diagnostically by solving the Poisson equation which was derived from the continuity equation and dynamic equation.

3. Result. We calculated two cases, (A) set updraft as initial wind and (B) set no wind as initial. Comparing rainfall intensity of (A) with that of (B), heavier and wider rainfall is seen in the case (A) than (B). Updraft had an effect on the developing stage of a cumulus. It made bigger and denser initial cumulus. This powerful initial cumulus matured and stored more water and ice drops. On the dissipating stage, stored rain drops fell all at once. This became heavy rainfall.

REFERENCE. Takahashi, T.(1976): Hail in an Axisymmertric Cloud Model, J. Atmos. Sci., 33, pp.1578-1601

H12A-5 1535h

Characteristics of Spatial Distribution of Surface Soil Moisture in Bare Fields

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Active microwave remote sensing (AMRS), including spaceborne and airborne remote sensing, must be one of the most powerful technique for observing soil moisture content at the land surface in regional and global scale. For the purpose of proposing a certain spatial resolution of an AMRS sensor for monitoring surface soil moisture in suitable scale, it is necessary to understand characteristics of spatial distribution of surface soil moisture in conditions of various kinds of land use. In this study, the characteristics of surface soil moisture in bare fields were discussed statistically by using the field data obtained by the direct soil sampling. This study is divided into three parts as follows.

At first, the method of surface soil sampling itself was examined for getting a rational and effective way of field measurements. The volumetric water content and the mass wetness were mainly used to express the condition of soil-water constituents. Relation between sampling conditions, such as size of sampler, depth and number of sampling at a point, and extent of error of the measurements were investigated. In the next, temporal and spatial variations of soil moisture in cases of dry and wet conditions in several agricultural fields were summarized. One result shows that range of distribution of soil moisture tends to be large in dry condition. In order to validate the AMRS data, detail measurements synchronized with the satellite remote sensing, SAR of EERS-1 (European Remote Sensing Satellite-1) and JERS-1 (Japan -Earth Resources Satellite-1), were also carried out in some same fields. At last, the spatial scale of distribution of soil moisture content in the relatively wide area of paddy fields was discussed by using the spatial auto-correlation function of the moisture content. The characteristics of spatial distribution of surface soil moisture were also compared to that of dry bulk density.

H12A-6 1600h

TEMPORAL SCALE EFFECTS ON MODELLED CATCHMENT HYDROLOGICAL PROCESSES IN RESPECT OF GLOBAL CLIMATE CHANGE

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The effects of the temporal scale of mountainous catchment modelled runoff and soil moisture were analyzed in respect of global climate change. For this purpose, two approaches with different time resolutions were adopted for the same catchment size (in this instance, the medium sized Mesochora catchment in Central Greece). The first approach was a monthly water balance model including a snowmelt variable quantified empirically according to monthly temperature. Inputs to this model were the monthly precipitation and temperature. The second one was the coupling of the snowmelt and the soil moisture accounting models of the US National Weather Service River Forecast System (US (NWSRFS) with such inputs as the ambient air temperature and precipitation, both at six-hourly-time-step.

The global climate change, which was indexed to CO_2 doubling scenarios, was simulated by a set of hypothetical scenarios of temperature increases by 1,2, 4°C and precipitation changes by 0,±10,±20%. All combined scenarios produced similar winter runoff increases for the both two hydrological approaches and lesser spring snowmelt and summer runoff decreases on US NWSRFS models. Nevertheless the combined scenarios of 4°C temperature increase yielded the largest spring runoff reductions for US NWSRFS models Under the alternative climate scenarios, the changes of the soil moisture contents were erratic among modelling approaches and the various climate cases. Yet the largest soil moisture content reductions were simulated from the monthly water balance model during the summer months.

Although the calibrated US NWSRFS models had finer time resolutions and higher value of Nash parameter NTD as an accuracy criterion than those of water balanced model, the aforesaid erratic hydrological differences among the climate scenarios and models strongly suggest that there is need for better representation of the catchment hydrology modelling before, materialising the hydrological modelling at the land-surface-atmosphere interface.

H12A-7 1625h

Three-Parameter Lognormal Distribution Model for Soil Water Retention

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Soil moisture plays important roles in the energy and water exchange processes at the interface of the land surface and atmosphere. The moisture characteristic of soil is represented by the relationship between the volumetric water content θ and the soil capillary pressure ψ and is referred to as the soil water retention curve. It is based on the soil pore structure, and is necessary for modeling water movement in unsaturated soil.

Many models for soil water retention curve have been proposed. However, most of these models are curve-fitting equations and do not emphasize the physical significance of their empirical parameters. A new retention model (the LN model) was developed by applying three-parameter lognormal distribution laws to the pore radius distribution function $f(r)$ and to the water capacity function, which was taken to be the pore capillary pressure distribution function $f(\psi)$. The LN model contains three parameters that are closely related to the statistics of $f(\psi)$: the bubbling pressure ψ_c, the mode ψ_0 of $f(\psi)$, and the standard deviation σ of transformed $f(\psi)$. The accuracy of the LN model was tested for 100 sets of observed retention data of both disturbed and undisturbed soils. Results showed that the LN model exhibits great flexibility. By comparing the LN model with three existing models, it was shown that the van Genuchten model is analogous to the LN model under the restriction $\psi_c = 0$, the Brooks-Corey model is similar to the LN model when $\psi_c \to \psi_0$, and the modified Tani model is analogous to the LN model when σ is restricted to $\sigma \approx 0.62$. As a result, it was concluded that ψ_c, ψ_0 and σ are all essential for a general retention model.

H12A-8 1330h TITLE

The Variation of Annual Rainfall and Surface Temperature Over Chao Phraya River Basin, Thailand

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Sponser's Name : GEWEX, Japan

Climate is never still, it has been varied through out the past and it will be vary in the future. Climate fluctuations may vary from seasonal to inter-annual or even longer time scales depending either on external forces such as solar radiation, earth orbit etc., or on internal interactive processes among various components of the climate system. Moreover, human activities and the consequent injection in the atmosphere of the so called greenhouse gases, land use and alteration of the earth surface etc., may play important role in producing climate variations.

In this study, two important indicators temperature and precipitation have been used to analyze the changes in climate and environments. The observed data of precipitation and temperature from 1952 to 1992 over the Chao Phraya river basin have been used in this analysis. It is found that the changes in precipitation and temperature are not globally uniform since in high latitude the changes in temperature are more significant, while mid latitude the changes are equally important where as changes in precipitation are more significant in low latitudes.

The decreasing trend in the rainfall for the whole period (except 1972 to 1978) occurred over Chao Phraya river basin. There is sharp decrease of annual rainfall from 1978 till 1992.

For the Chao Phraya river basin, annual mean surface temperature rise remarkably above normal since 1978. The mean annual temperature was below normal in between 1971 to 1978.

H12A-9 1330h TITLE

GCIP Continental-Scale Diagnostic Studies

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The continental-scale diagnostic and modeling studies of the GEWEX Continental-Scale International Program (GCIP) will address two priority scientific questions: 1. How does the strength and character of the land surface/atmospheric feedback vary seasonally over the Mississippi Basin? On what scales? 2. What are the relative roles of large-scale land-atmosphere feedback and remote forcing in the development, maintenance and decay of mid-latitude hydrological anomaly regimes?

The GCIP continental-scale diagnostic studies will be based primarily on operational data/analysis/forecast products from the US and Canada. Operational four-dimensional data assimilation systems will provide the daily and time-averaged data/analysis products needed for a broad suite of studies that include precipitation recycling, intense precipitation events, large-scale, long lasting hydrological anomaly regimes, as well as the documentation and study of the annual and diurnal cycles. The primary operational "workhorse" will be a regional mesoscale model with a horizontal grid mesh of 30 km and 50 layers in the vertical.

The major continental-scale research thrusts will be described. The site of GCIP, the Mississippi Basin, offers a rich variety of regional and seasonal hydrological conditions. In order to exploit this diversity for purposes of calibration of parameters and the transfer of GCIP results to other continental regions, the basin has been subdivided into four large subregions with different characteristics. During the first year of the 5-year observational program the focus will be on summertime conditions over the southwest subregion, which more or less corresponds to the combined Red and Arkansas River Basins. During the second year, the focus will expand to the upper Mississippi Basin and studies of cold weather hydrology, notably the effect of snow cover on the thermal condition of the land surface.

H12A-10 1330h TITLE

Rainfall-Runoff and Streamflow Modelling of Chao Phraya River Basin, Thailand

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The Chao Phraya River Basin which has an area of about 160,000 sq.km. is the largest river basin in Thailand. The river basin covers the main part of the northern and central parts of the country . It is well developed in water resources,irrigation,agriculture,hydropower,urbanization and industries. There is forest cover about twenty percent of the basin area.The river basin receives an annual rainfall of about 1300 mm/yr from the southwest monsoon (during July-September)from the Andaman Sea and from tropical revolving stroms or typhoons (during August-October)from the South China Sea.

The streamflow in the Upper Chao Phraya River Basin is simulated by using the SSARR hydrological model developed by U.S. Army Engineers, North Pacific Division, Oregon, U.S.A.. In the 250 km reach of the Lower Chao Phraya River from Chainat to the Gulf of Thailand, the streamflow is influenced by tidal effects and it is simulated by using the Node and Branch Model for channel networks considering overbank flows . The hydrological and hydraulic parameters of the two models are determined by trial and error during model calibration considering the daily and hourly hydro-meteorological data in 1968(dry year), 1971(normal year) and 1975(flood year). The result of the model calibration is found to be satisfactory. The models are verified successfully by using the hydro-meteorological data in 1978 . The two models are later applied for flood forecasting in the river basin.From this study, it can be concluded the hydrological process and daily streamflows in the Chao Phraya River Basin can be accurately described and predicted by the two models. Therefore , the two models may be used as a tool component in the Global Energy and Water Cycle Experiment (GEWEX)/Asian Monsoon Experiment(GAME) in the Chao Phraya River Basin.

H12A-11 1330h TITLE

A Point Heavy Rainfall Model Based on Cloud Physics

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A point heavy rainfall process is physically modeled. It uses meteorological variables at the ground level as its input. The components of the model are parameterized based on well established observations and the previous studies of cloud physics. The water equivalent mass condensed in a cloud column defined over the characteristic area is the model state. Particular emphasis is placed on the efficiency of accretion. The dominant parameters in the formulation are the pressuer at the cloud top, the hight-averaged updraft velocity, the inverse of the average diameter of the hydrometeors at cloud base, and critical hydrometeors diameter of skew-symetric hydrometeor size distribution function. The parameters included in the model are estimated by the optimization technique. The model is tested by heavy storm events observed at Chonju Weather Sevice Station in Korea. The hyetograph is predicted by the model with the medium valus of the estimated parameter. The results show that the moddel is suitable for the heavy raincloud.