Summary Report for APN Project 2000-05: RMIP for Asia (2000.4-2001.3)

I. Background

The research challenge of regional scale estimate, analysis and impact assessment of global change is stated in IPCC reports as follows:
(1) An important long term goal is the accurate projection of regional climate change so that potential impacts can be adequately assessed. (IPCC 1995)
(2) RCMs consistently improve the spatial detail of simulated climate compared to GCMs. RCMs driven by observed boundary conditions shows area-averaged temperature biases (regional scales of 10^5 to10^6 km^2) generally within 2 C and precipitation biases within 50% of observations. (IPCC 2001)

Currently a few case studies have demonstrated that the RCM can reproduce the seasonal evolution of monsoon rain-belts over Asia which very often is not captured by the GCM. However most systematic analysis of the RCM performance in Asia is needed.

Under the joint support of Chinese Academy of Sciences (CAS), START and APN, the TEACOM project "Regional Modelling of the Changes in the General Monsoon System in Asia under Anthropogenic Forcing", with primary goal of addressing this important research challenge, has stepped into a new stage of evaluating the advantages and disadvantages of RCM so as to provide better projection of regional climate change, through the inter-comparison study of the performance of an ensemble of RCMs regarding their capacity of simulating the regional climate of Asia.

II. Objectives

The objectives of the inter-comparison project on the whole are as follows:
(1) To further improve the RCMs for application in Asia
(2) To develop an ensemble of the results from a group of RCMs
(3) To provide higher confident scenarios of regional climate change in Asia

The designed tasks include three phases to be implemented in four years since 2000.

Phase	Simulation periods	Inter-comparison topics	Implementation years
Phase one	18 months	Full annual cycle and two extreme cases	2000-2001
Phase two	10 years	Statistical behavior	2001-2003
Phase three	scenarios	Projection for the 21st century	2003-2004

III. Expected Products

The whole inter-comparison project expects to produce the following products.

(1) Assessment report of RCMs' performance in Asia
(2) Research papers to journals
(3) Proceedings of two workshops
(4) Regional climate change scenarios for Asia in 21st century

IV. Participating groups

This project combines into the inter-comparison study the work of ten participating research groups working on the RCM application for Asia. These groups are the leading groups with a focus on regional climate modeling in Asia.

(1) START TEA Regional Center, Institute of Atmospheric Physics, Chinese Academy of Sciences, China.
(2) Global Change Research Center, Department of Atmospheric Sciences, Nanjing University, China
(3) Commonwealth Scientific and Industrial Research Organization (CSIRO) Atmospheric Research, Australia
(4) Atmospheric Environment Division, National Institute for Environmental Studies (NIES), Japan
(5) Department of Atmospheric Science, Central Research Institute of Electric Power Industry (CRIEPI), Japan
(6) Meteorological Research Institute/JMA, Japan
(7) Atmospheric Sciences Program, School of Earth and Environmental Sciences, Seoul National University (SNU), Korea
(8) Department of Atmospheric Sciences, Yonsei University (YU), Korea
(9) Department of Geological and Atmospheric Sciences, Iowa State University, USA.
(10) Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, USA

V. Major activities of phase one(00.4-01.3)

(1) An inception meeting was held in Yonsei University, Seoul, Korea in June 26-29, 2000. We mainly agreed on the simulation period, domain, topography, and land cover types, initial driving fields, lateral boundary fields, data for validation, model outputs for the first step and preliminary assessment of simulated surface climate. Enclosed please find the minutes of this meeting.
(2) Preparation and running of models by the participating groups were conducted from June to December, 2000. Data for model validation were also collected from this period.
(3) A preliminary analysis of simulation results of the models were conducted in January, 2001.
(4) A summary workshop was held in Beijing in February 27-March 1, 2001 to review the advances of intercomparison and discuss the future work plan for the next phase. Please find attached the minutes of the workshop.

VI. List of major products in phase one

(1) A collection of models' information (please see attachment)

(2) A collection of station and grid data (please see attachment)
(3) Outputs of 18 months run of each model (stored at START TEA Regional Center)
(4) Preliminary analysis products of each model (stored at START TEA Regional Center)
(5) Preliminary products of the inter-comparison of 10 models against observation. (available at http://riems.tea.ac.cn/rmip/meeting/default.html)

VII. List of products for each model
(1) Seasonal mean fields of T_{mean}, T_{max}, T_{min}, R_{total} and P_{sea}
(2) Correlation fields between Model and observation.
(3) Seasonal variation of area means for 12 regions
(4) Evolution of rain belts
(5) Variation of Bias in different regions and seasons

VIII. List of inter-comparison products
(1) Maps of T_{mean}, T_{max}, T_{min}, SLP and R_{total} for winter and summer from different models and observation
(2) Seasonal evolution of area mean for above variables from different models and observation.
(3) Extreme events
i. Hot summer of 1997
Spatial distribution of grids with $T_{max} > 35$ or 38C
Number of days with $T_{max} > 35$ or 38C
ii. Dry summer of 1997
Anomalous rainfall in summer of 1997 (model/observation)
iii. Flood in summer of 1998
Spatial distribution of rainfall in summer of 1998 (model/observation)
Evolution of daily rainfall over three regions
@ Mid and upper reaches of Yangtze valley
@ Lower reaches of Yangtze valley
@ Songhuajiang river basin
Number of days with heavy rain (> 50mm and >100mm)

IX. Preliminary assessment of the models' capacity in reproducing the surface climate over Asia in the 18-month run
The assessment is classified into three catogories:
(1) Common features which most of the models have captured
e.g.
a. Most models can reproduce the spatial patterns of seasonal mean surface temperature (including T_{mean}, T_{max}, T_{min})
b. Most models can reproduce the annual variations of T_{mean}, T_{max}, T_{min}, especially the amplitude over most of the sub-regions.
c. Most models can reproduce the hot summer of 1997 over the large part of Asia continent
d. Nearly 50% of the models can reproduce the spatial pattern of seasonal total precipitation. The agreement between models and observation in winter is better than in summer.
e. Most models can reproduce the annual variation of precipitation over most of sub-regions.

f. Part of the models have captured the flood over Yangtze in summer of 1998 reasonably well.
(2) Common problems of model simulations
e.g.
a. Northward shift of rain belts in summer in most of the models.
b. There is an overall cold bias over south and warm bias over north in almost all seasons
Etc.
(3) Questions raised from the preliminary assessment
e.g.
a. Problems in simulation of precipitation are related to: convection schemes? Lateral boundary treatment? Simulation of low level jet? Soil moisture initialization? Microphysics of precipitation? etc. It was suggested that the precipitation patterns can be improved by introducing the gravity wave drag, and/or including stratospheric levels in the models.
b. Warm bias over northern regions are related to: cloud simulation? Long wave radiation? Snow and sea ice treatment? etc.
c. Cold bias over western Pacific in some models are perhaps due to use of an inappropriate scheme to diagnose the air temperature at 2m height from the model.

X. Plan for 2001- 2002
As agreed at the summary workshop, the future work will be focused on the following four aspects:
(1) Further analysis of 18-months run, including:
a. Inter-comparison of the components of land surface energy and water balances, cloudiness, the atmospheric circulation including summer and winter monsoon, low level jet and jet stream over the upper troposphere etc.
b. Influence of different physical parameterization schemes: land surface scheme, convection scheme and radiation scheme, etc.

(2) Drafting scientific papers related to RMIP by participating groups for discussion at the workshop in Kobe.

(3) Workshop in Kobe
A workshop aimed to summarize the complete set of achievements from the 18-month simulation and discuss a detail plan for 10-year simulation (1989-1998) will be held at APN Secretariat, Kobe, Japan, September 2001. The START TEA-SC will give the presentation on the further comparison results of 18-month simulation, while each participating group would give the related presentation of its own research. The paper from participating groups related to RMIP will be submitted in the workshop and one or two scientific papers of RMIP will be discussed during the workshop for publication and distribution.

(4) Preparation for 10 years run
As a follow-up to the Kobe workshop, we will begin the preparation of the necessary data for the 10-year simulation.

Minutes for the Inception Meeting of APN Project #2000-05: Regional Modeling Inter-comparison Project (RMIP) for Asia

Congbin Fu, Project Leader

1. Time, venue and attendance

The inception meeting of APN Project #2000-05: Regional Modeling Inter-comparison Project (RMIP) for Asia was held on June 26-29, 2000 at Allen Hall of Yonsei University, Korea.

The meeting was chaired by Prof. Congbin Fu, the Project leader, and hosted by Prof. Jeong-Woo Kim, member of steering committee of RCM for TEACOM. Other representatives from the participating groups of the project include:

Dr. S. Emori (NIES, Japan)
Prof. J. McGregor (CSIRO, Australia)
Dr. H. Kato (CRIEPI, Japan)
Dr. M. Lal (IIT, India)
Prof. D.K. Lee (SNU, Korea)
Prof. Y.N. Pan (NJU, China)
Mr. Z. Xiong (TEA-RC, China)
Mr. L.Z. Wang (DIS of TEA-RC, China)

Prof. W. Gutowski, co-chair of Project to Inter-compare Regional Climate Simulations (PIRCS), was invited as a special guest scientist.

Mr. Z.B. Wan attended the meeting as liaison officer of APN

Dr. F. Giorgi, co-chair of the steering committee, and Dr. W.L. Wu, representative of the participating group from CIRES/CU, were not able to attend the meeting due to schedule conflicts or unforeseen reason.

A number of professors and students from Yonsei University and Seoul National University also attended the meeting as observers. The total number of participants is around 20.

2. Scientific presentations

The meeting was divided into two parts. The first part is to exchange the latest progress of regional climate modeling. Most of scientific presentations were about different modeling experiences in simulating monsoon Asia by different RCMs. Prof. Gutowski introduced the PIRCS project and some lessons from his experience and made a number of suggestions for the RMIP project for Asia.

3. The discussion of implementation plan

The second part is allocated to discuss the implementation plan of the project. The group agreed upon the following issues:

a. The integration period: from March, 1997 to September, 1998.

This period consists of a complete annual cycle and two extreme climate events in East Asia, including a hot and drought summer in 1997 and a severe flood disaster in 1998.

b. The integration and analysis domain

The center of modeling domain is located at 35N, 105E. The map project is Lambert conformal project. The two true latitudes are 35N and 35.01N respectively. The model grids at 60km resolution are 151(longitude) X 111(latitude). The buffer zone is 10 grids. The analysis domain is the one subtracting the buffer zone from each side of the integration domain. The analysis domain is divided into 12 sub-regions in order to assess the performance of the different RCMs in simulating the regional climate. The division of sub-regions in modeling domain is as follows:

1) Central East China
2) North China
3) Southwest China
4) Northeast China
5) Western arid/semi-arid regions
6) Eastern arid/semi-arid regions
7) Korea peninsula
8) Japan islands
9) Indian sub-continent
10) South China and Indo-China peninsula
11) Tibetan Plateau
12) Siberia

c. Driving fields

The 6-hourly NCEP reanalysis data in the integration period will be used. The SST data will also be from NCEP reanalysis. Surface variables are replaced in sigma 0.995 of NCEP reanalysis. The snow cover data at 1.875X1.875 Gaussian grid of NCEP reanalysis will be used. Since the soil moisture initialization depends on different land surface schemes, each group will decide his own method according to his own land surface scheme.

d. Land cover data and topography data

The land cover data to be used is from the Global Datasets for Land-Atmosphere Models International Satellite Land Surface Climatology Project (ISLSCP) initiative 1: 1987-1988

vol. 1-5 (B.W. Meeson, et al).

The topography data to be used is the $0.5^0 \times 0.5^0$ topography data from the National Center for Atmospheric Research (NCAR).

e. Data for model validation

The station data of 5 variables will be used for model validation, including daily maximal (T_{max}) and minimal (T_{min}) and mean (T_m) 6-hourly temperature at 1.5m height, daily total precipitation (P) and sea level pressure which is deduced from the model's surface pressure and model's lowest temperature, plus OLR data from satellite.

f. Model outputs for the first step

- daily $T_{max,}$ $T_{min,}$ T_m 6-hourly average temperature at 1.5m height
- daily total precipitation , convective precipitation
- daily outgoing long wave radiation (OLR)
- daily sea level pressure

g. Storage of other model outputs

Each participating group will be responsible to store other parameters of the model outputs for further study.

At least the upper air wind, temperature, humidity and geo-potential high would be requested to be stored as standard outputs. The variables related to surface energy and water budgets from land surface model outputs are also requested to be stored, though they will not be used in the first step analysis.

h. Model validation analysis for the first step

- seasonal cycle of $T_{max,}$ $T_{min,}$ T_m for each sub- region
- seasonal cycle of total precipitation for each sub-region
- seasonal patterns of sea level pressure
- evolution of main rain belts
- The extreme climate events
  Drought in summer, 1997
  Flood in summer, 1998
  Extreme warmth in summer, 1997

i. Participating groups and models

1) START Regional Center for Temperate East Asia, P.R. China (the TEA center): Regional Integrated Environmental Model System (RIEMS) will be used. This model is developed in

the TEA Center. Its dynamic component is the Penn/NCAR Meso-scale Model version 5 (MM5). Some important physical parameterization schemes include the Biosphere-Atmosphere Transfer Scheme (BATS), the high-resolution boundary layer scheme, the Athens-Kuo cumulus parameterization scheme, and the revised CCM3 radiative transfer scheme with aerosol effect. This model has been applied to the simulation of climate in East Asia.

2) Atmospheric Sciences Program, School of Earth and Environmental Sciences, Seoul National University, R.O. Korea: a. Regional Climate Model Version 2 (RegCM2) will be used. It is developed in the U. S. National Center for Atmospheric Research. Its dynamic component is the Penn/NCAR Mesoscale Model version 4 (MM4). Some important physical parameterization schemes are the same as those of the RIEMS except that the radiative transfer scheme is from CCM2. b. The Penn/NCAR Meso-scale Model (MM5) coupled with NCAR/LSM will also be used.

3) Central Research Institute of Electric Power Industry, Japan: Regional Climate Model Version 3 (RegCM3) is developed and will be used. Its dynamic component is the same as the RegCM2 but its radiative transfer scheme is from CCM3. A new land surface scheme model (LSM) is coupled into the model in place of BATS. It has been used to simulate both winter and summer climate in East Asia.

4) Atmospheric Environment Division, National Institute for Environmental Studies, Japan: Regional Atmospheric Model System (RAMS) will be used. This model is developed in Colorado State University by R.A. Pielke. Its basic equations are the non-hydrostatic compressible equations. Some important physical parameterization schemes are K-distribution radiation scheme, an Arakawa-Schubert type cumulus scheme, and Mellor-Yamada level turbulence closure boundary scheme, MATSIRO land-surface scheme is coupled in this model. It has been applied to simulate the climate in East Asia for the period from January to December of 1994.

5) Division of Atmospheric Research, Commonwealth Scientific and Industrial Research Organization, Australia: Limited Area Model (DARLAM) has evolved from a semi-Lagrangian model proposed by J. McGregor. Its physical parameterization includes a canopy scheme with 6 soil layers for temperature and moisture, the Geophysical Fluid Dynamics Laboratory radiation scheme, interactive diagnosed clouds, mass-flux cumulus parameterization, shallow convection and stability-dependent surface scheme. It is used in the simulation of climate in Australia, New Zealand and South Africa. Compared to GCM. It shows great improvement in the precipitation pattern.

6) Cooperative Institute for Research in Environmental Sciences, University of Colorado: Arctic Regional Climate System Model (ARCSYM) has been developed. It is a limited-area meso-scale climate model that incorporates representation of the atmosphere, land surface, sea ice and ocean. Its dynamic component is the same as RegCM2, some relevant physical parameterizations include the treatment of cloud process, sea ice thermodynamics and

NCAR land surface model (LSM). Model validation and simulation has been finished in Alaska for the impact of tundra ecosystems on the surface energy budget.

7) Nanjing University, P.R. China: The Regional Climate Model (RCM) is originated form RegCM2. A near surface layer was added to its planetary boundary so that the flux exchanges between surface and atmosphere can be described more reasonably.

8) Yonsei University, R.O. Korea: Regional Atmospheric Model System (CRU/RAMS 3B) will be used.

9) International Institute of Theoretical and Applied Physics, Iowa state University, US: The Penn/NCAR Meso-scale Model version 5 (MM5) will be used.

10) Meteorological Research Institute, Japan: MRI regional climate model. This group and model may participate this project after some conditions are examined. It is composed of three models. The outer model is the MRI-CGCM. The intermediate is the Fine-mesh Limited-area Model (FLM). The inner model is the Japan Spectral Model (JSM). The modified FLM has 16 layers and level-2 closure mode is applied to represent the vertical turbulent diffusion. Calculation of the surface flux is based on the Monin-Obukoo similarity theory.

j. Fellowships

- Per invitation of Prof. J. McGregor, Ms. S.Y. Wang will visit CSIRO for around 6 months to run DARLAM and to undertake other RMIP related activities.
- Visitor to CIRES/CU group will be arranged after further discussion.

4. Actions to be taken and timetable

a. Most of the groups will directly access the NCEP data through NCAR and create the driving fields according to the agreed domain and horizontal resolution, but with the features of each model being taken into account. W. Gutowski will send, by July 10, 2000, a tape of such data at standard pressure levels to TEA-RC. For those who can not directly access this data set, the TEA-RC can send copies to them upon request.

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b. The TEA –RC will send a CD-ROM of land cover and topography data at 60km resolution to each participating group by July 15, 2000. A list of dynamic parameters for each land cover type will be included as standard.

c. Following individuals will response to the surface data for validation
   Z. Xiong (China): 160 stations or more (of China)
   D.K.Lee (Korea): 72 stations (of Korea)
   H.Kato (Japan): 113 stations (of Japan)

A list of stations for each country will be sent to the TEA-RC by July 28 and the actual data in Microsoft-excel format will be sent to TEA-RC through E-mail by September 28, 2000.

M.Lal (India) will also provide station data from India and OLR data for validation use. However, the deadline needs be clarified. The TEA-RC DIS will also be responsible to try to get station data from Mongolia, N. Korea and Russia

d. Model run

Each participating group will finish their model run and send the model outputs as listed in 3(f) in NETCDF format to the TEA-RC by the end of November, 2000.

e. Preliminary model validation

The TEA-RC will prepare a preliminary validation report by the third week of January, 2001, and send it to each group to review.

f. A summary workshop will be held at TEA-RC, on February 19-21, 2001.

g. A project summary will be submitted to APN by the end of February, 2001.

A Table of model description

Model			
Top level pressure			
Vertical Levels			
Dynamics structure			
Dynamics			
Lateral boundary condition			
physics	Cumulus Convective scheme		
	Land Surface Process		
	Planet Boundary Layer		
	Radiation scheme	Long wave	
		Long wave	

An example of model description

Model	RIEMS
Top level pressure	100hpa

Vertical Levels			σ coordinate 17 levels
Dynamics structure			PSU/NCAR MM5(V.2)
Dynamics			Hydrostatic
Lateral boundary condition			Linear Relaxation
Physics	Cumulus Convective scheme		Kuo-Anthes
	Land Surface Process		Bats 1e
	Planet Boundary Layer		Holtslag
	Radiation scheme	Long wave	CCM3
		Short wave	CCM3+aerosol

Draft Agenda for the Inception Meeting of APN Project #2000-05:
Regional Modeling Inter-comparison Project for Asia (RMIP)
June 27-29, 2000, Yonsei University, Seoul, R. Korea.

Day 1: June 26 (Monday)

Arrival and informal discussion of the agenda
(6:00pm during reception)

Day 2: June 27 (Tuesday)
Morning (9:00-12:00)

Opening (9:00-10:00)

(1) Welcome remarks (Jeong-Woo Kim)
(2) Approval of meeting agenda
(3) Introduction of the approved APN project on RMIP (Congbin Fu)

Reports on the latest scientific progress of regional climate modeling research from participating groups and invited participants
(open to public) (10:00-12:00)
(Each report has 15 minutes oral presentation and 5 minutes discussion)

(1) W.J. Gutowski (USA): Project to Intercompare Regional Climate Simulations (PIRCS): Lessions and Suggestions for an Asian RMIP
(2) Jeong-Woo Kim (Korea)
(3) Congbin-Fu (China): Potential Impact of changing vegetation on East Asia Summer Monsoon

Coffee Break (11:00-11:20)

(4) John McGregor (Australia): Recent regional climate modelling research in Australia
(5) Murari Lal (India): Regional Climate Modelling for Monsoon Asia

Afternoon (1:30-5:30)

Continuation of progress report (open to public) (1:30-3:30)

(6) Dong-Kyou Lee (Korea): Regional Climate Modeling at SNU for the East Asian Summer Monsoon
(7) Hisashi Kato (Japan): Climate change in and around Japan caused by global warming - Numerical experiment using RegCM2.5 nested in NCAR-CSM
(8) Seita Emori (Japan): Regional climate modeling of East Asian region based on CSU-RAMS
(9) Wanli Wu (USA) (cancelled)
(10) Yinong Pan (China)

(11) Zhe Xiong (China): Preliminary Analysis of 10-year run of RegCM2 in East Asia

Coffee Break (3:30-3:50)

Discussion of the implementation plan (3:50-5:30)

(1) Modeling domain and period
(2) Preparation of data of initial and lateral boundary condition
- Driving fields and buffer zone
- Topography
- Land cover, etc.

Day 3: June 28 (Wednesday)
Morning (9:00-12:00)

Continuation of the discussion of the implementation plan

(3) The data and sources for inter-comparison validation:
   i. Monthly averaged data for maximal and minimal temperature, surface air temperature and precipitation (from the observation stations in the modeling domain).
   ii. The daily precipitation and temperature data in summer from June to August in 1997 and 1998 (from observation stations)
   iii. Upper field data (from NCEP reanalysis data)
(4) The division of sub-region in the modeling domain (range, longitude and latitude)
   i. Central China,
   ii. South China,
   iii. North China,
   iv. Northeast China,
   v. Northwest China,
   vi. Korea peninsula
   vii. Mongolia
   viii. Japan islands
(5) Analysis
   i. To study the average monthly to seasonal condition for surface air temperature, precipitation, maximal and minimal temperature.
   ii. To study the evolution of monsoon.
   iii. To study the extreme climate events.
      * Drought in Summer, 1997
      * Flood in Summer, 1998

Afternoon (1:30-5:30)

Discussion of follow-up actions and timetable

(1) TEA-RC provides all groups with the data of lateral boundary and initial fields (by July 15, 2000).

(2) All groups run their own models and implementation of fellowships (from Early August to early November, 2000).
(3) All groups send the model results to TEA-RC. The requirement for data exchange and timetable is as follows
    i. Using 8MM 8500 tape or 650M CD-ROM. As for the 8MM tape, please send two same copies for back-up.
    ii. Data should have three parts: the first is the observed and simulated dataset, the second is a readme file, the last is the source code for reading the dataset. For the simulated dataset, please output all the variables in the Sigma coordinate, and at 850, 500hpa in pressure coordinate. In the readme file, please list the operating system and chip, because there are different integer format in different chips
    iii. For observed dataset, please prepare them and arrive at TEA-RC by the end of October, 2000, better formatted; For simulated dataset, please prepare them and arrive at TEA-RC by the end of November, 2000, better unformatted.
(4) The TEA-RC prepares the report of preliminary analysis results and send to all groups (by January 31, 2001)
(5) All groups review and modify the results report (by February 18, 2001)
(6) Summary workshop (at TEA-RC, tentatively on February 19-21, 2001)

Day 4: June 29 (Thursday)
Morning (9:00-)

Other business and conclusion

List of Participants for RMIP Inception Workshop

June 27-29, 2000, Yonsei University, Seoul, R. Korea.

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Minutes for the Summary Workshop of APN Project #2000-05: Regional Modeling Inter-comparison Project (RMIP) for Asia

Congbin Fu, Project Leader

1. Time, venue and attendance

The summary workshop of APN Project #2000-05: Regional Modeling Inter-comparison Project (RMIP) for Asia was held from February 27 through March 1, 2001 at Jing Min Hotel, Beijing, China, hosted by START TEA Regional Center. The workshop received auspicious funding support from APN and in-kind support from START TEA Regional Center.

The workshop was attended by scientists of the participating groups, members of the steering committee of RCM for TEACOM, invited guest scientists, local funding agency officials and journalist. (See attachment 1)

The agenda of the workshop was adopted as attachment 2.

2. Report of project status

Prof. Congbin Fu, Leader of the RMIP Project, introduced the status of the project, including its background, objectives, tasks, participating groups, expected products, major activities in this APN fiscal year, major products of inter-comparison, and the plan for the next fiscal year. The information of participating models, the station data and grid data is included in attachment 3.

3. List of products regarding surface climate from 8 models' run

The START TEA Regional Center processed the outputs of the 8 participating models, and produced a series of graphic products which include about 180 figures and 6 tables. They are classified as following:

(1) Maps of T_{mean}, T_{max}, T_{min}, SLP and R_{total} for winter and summer from different models and observation

(2) Seasonal evolution of area mean for above variables from different models and observation.

(3) Extreme events

i. Hot summer of 1997

Spatial distribution of grids with $T_{max} > 35$ or 38C

Number of days with $T_{max} > 35$ or 38C

ii. Dry summer of 1997

Anomalous rainfall in summer of 1997 (model/observation)

iii. Flood in summer of 1998

Spatial distribution of rainfall in summer of 1998 (model/observation)

Evolution of daily rainfall over three regions

@ Mid and upper reaches of Yangtze valley

@ Lower reaches of Yangtze valley

@ Songhuajiang river basin

Number of days with heavy rain (> 50mm and >100mm)

4. Report of inter-comparison results

Based on the preliminary analysis, models' capacity in reproducing the surface climate over Asia in the 18-month run was assessed preliminarily. The results are shown as following:

(1) Common features which most models have captured

e.g.

a. Most models can reproduce the spatial patterns of seasonal mean surface temperature (including T_{mean}, T_{max}, T_{min})

b. Most models can reproduce the annual variations of T_{mean}, T_{max}, T_{min}, especially the amplitude over most of the sub-regions.

c. Most models can reproduce the hot summer of 1997 over the large part of Asia continent

d. Nearly 50% of the models can reproduce the spatial pattern of seasonal total precipitation. The agreement between models and observation in winter is better than in summer.

e. Most models can reproduce the annual variation of precipitation over most of sub-regions.

f. Some of the models have captured the flood over Yangtze in summer of 1998 reasonably well.

(2) Common problems of model simulations

e.g.

a. Northward shift of rain belts in summer in most of the models.

b. There is an overall cold bias over south and warm bias over north in almost all seasons

Etc.

(3) Questions raised from the preliminary assessment

e.g.

a. Problems in simulation of precipitation are related to: convection schemes? Lateral boundary treatment? Simulation of low level jet? Soil moisture initialization? Microphysics of precipitation ? … It was suggested that the precipitation patterns can be improved by introducing the gravity wave drag, and/or including stratospheric levels in the models.

b. Warm bias over northern regions are related to: cloud simulation? Long wave radiation? Snow and sea ice treatment?…

c. Cold bias over western Pacific in some models are perhaps due to use of an inappropriate scheme to diagnose the air temperature at 2m height from the model.

5. Scientific presentations by invited guest scientists

During this workshop, in addition to the presentation given by TEACOM about the preliminary analysis results for 8 participating groups, Dr. John McGregor from CSIRO, Australia, Dr. Dong-Kyou Lee from SNU, Korea, Dr. Shinji Kadokura from CRIEPI, Japan, Dr. Yasuo Sato from Atmospheric Environment and Applied Meteorology Research Department, Japan, Dr.

Charles Hakkarinen from EPRI, USA, Dr. Zhuguo Ma from TEACOM, China presented the their own research results. Dr. McGregor introduced his Conformal-Cubic Model and demonstrated model's different simulation features other than those of regional model. Dr. Ma presented a new way to retrieve soil moisture using surface temperature and precipitation and showed that the retrieved soil moisture is in good agreement with observation. This scheme will be used in regional climate modeling for soil moisture initialization. Dr. Lee, Dr. Kadokura and Dr. Sato gave the presentations of their own analysis of model's outputs respectively, and Dr. Hakkarinen demonstrated the CSM simulation results for current and future climate.

6. Discussion of the outline of project summary to APN

The draft outline was agreed upon based on the report of project status and the inter-comparison results. (see attachment 4)

7. Actions to be taken and timetable

Activity one:

1. In order to understand the questions raised in the preliminary assessment, we plan to further analyze the 18-month simulation results, including diurnal cycle of surface flux, surface energy budget, water budget, atmospheric circulation, low level jet, upper level jet, etc. To prepare for this work, each group is expected to send:
    a) the upper air wind, temperature, humidity and geo-potential high in all vertical levels with time interval of less than 12 hours;
    b) 6-hourly net radiative flux at surface, soil temperature at surface and subsoil, net absorbed solar flux, sensitive heat flux, latent heat flux, water content of total soil layers, water content in upper soil layer, water content in rootzone soil layer, total runoff, convective precipitation;
2. With regard to the fact that the some groups have difficulty to simulate the right rain belt position, we will take monsoon rain belt evolution in East China as a specific topic and discuss the potential impacts of gravity wave drag, model top level, large scale jet, lower level jet on the summer monsoon rain belt position and rainfall intensity;
3. The groups who prefer to re-run the 18-month simulation or do the sensitivity studies in order to better understand and improve the model performance are encouraged;
4. Dead lines of outputs are as following:
    a) Each group is expected to send the outputs of last 18-month run listed in above for further analysis by the end of March, 2001;
    b) The model outputs for re-run, continuous run and sensitivity studies are due the end of May, 2001;

Activity two:

Further processing of the newly arrived model outputs from each group will be undertaken in START TEA Regional Center which need nearly 200GB disk of storage in computer. The Center is searching for additional funds to support this work other than APN.

START-TEA will be exploring the potential value of using a web-based data retrieval system such as Ferret (http://ferret.wrc.noaa.gov/Ferret/), which would allow participants to store output from their own models at their home site while simultaneously making it available to START-TEA for analysis. This could enhance the efficiency of START-TEA's data storage, provided packages like Ferret are not hindered by bandwidth limitations on the web. It would also broaden the community that could analyze RMIP output and help give greater perspective on the capabilities of the models.

Activity three:
A workshop aimed to summarize the complete set of achievements from the 18-month simulation and discuss a detail plan for 10-year simulation (1989-1998) will be held at APN Secretariat, Kobe, Japan, September 2001. The START TEA-SC will give the presentation on the further comparison results of 18-month simulation, while each participating group would give the related presentation of its own research. The paper from participating groups related to RMIP will be submitted in the workshop and one or two scientific papers of RMIP will be discussed during the workshop for publication and distribution.

Activity four:
As a follow-up to the Kobe workshop, we will begin the preparation of the necessary data for the 10-year simulation.

Attachment 1:

List of Participants for RMIP Summary Workshop

Jingmin Hotel, Beijing, China, February 27-March 1, 2001

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Attachment 2

Agenda for the Summary Workshop of APN Project #2000-05:

Regional Modeling Inter-comparison Project for Asia (RMIP)

February 27- March 1, 2001, Jing Min Hotel, Beijing, China.

February 26 (Monday)

14:30pm-10:00pm Arrival and Registration

February 27 (Tuesday)

8:30-9:00am	Registration
9:00-12:00am	Opening remarks
	Approval of agenda
	Report of project status
	Report of inter-comparison results
12:00-13:30pm	Working lunch
13:30-17:00pm	Discussion of the results
17:00pm-18:00pm	Meeting with officials from Minstry of Science and Technology (MOST), Chinese Academy of Sciences (CAS), China Natural Science Foundation (CNSF)
18:00pm-20:00pm	Welcome dinner

February 28 (Wednesday)

9:00-12:00, 13:30-17:00	Continuation of discussion of the results
	Presentations by participating groups
	Presentations by invited scientists
	Discussion of the outline of summary report to APN

March 1 (Thursday)

9:00-12:00, 13:30-17:00	Discussion of the next-step work plan
	Closing

March 2 (Friday)

Departure

Attachment 3

List of model information

Model	Investigator	Institution	Model frame	Model output	Remark
RIEMS	Fu Congbin(China)	TEA-Center	Yes	Yes	
Regcm3	Hisashi Kato(Japan)	CRIEPI	Yes	Yes	
NIES/CCSR RAM	Seita Emori(Japan)	NIES	Yes	Yes	
JSM_BAIM	Yasuo Sato(Japan)	MRI/JMA	Yes	No	
DARLAM	John McGregor (Australia)	CSIRO	Yes	Yes	
MM5/LSM	William J. Gutowski (USA)	IOWA state Univ.(ISU)	Yes	12 month	
ARCSyM	Wu wanli (USA)	Univ. Colorolado (CU)	Yes	Yes	In cooperation with NJU
NJU RCM	Su Bingkai (China)	Nanjing Univ.(NJU)	Yes	Yes	
MM5/LSM	Dong-Kyou Lee (korea)	SNU	Yes	Yes	
ReGCM	Jeong-woo Kim (Korea)	Yonsei Univ.	Yes	Yes	

Model	RIEMS Congbin Fu China	Regcm3 Hisashi Kato Japan	DARLAM J. McGregor Australia	NIES/CCSR RAMS Seita Emori Japan	ARCSyM Wanli Wu U.S.A	NJU RCM Bingkai Su China	JSM_BAIM Yasuo Sato Japan	MM5/LSM W. Gutowski U.S.A	MM5/LSM D. Lee Korea	RegCM J. Kim Korea
Vertical levels	σ-17 levels	σ-14 levels	σ-18 levels	Z – 21 levels	σ-17 levels	σ- 17 levels	σ-23 levels	σ-23 levels	σ-23 levels	σ-15 levels
Dynamics	hydro	hydro	hydro	n-hydro	Hydro	hydro	hydro	n-hydro	n-hydro	Hydro
LBC	LR	ER	ER	ER	ER	ER	ER+Spectral coupling	LR	ER	ER
Convective scheme	K/A	K/A	Arakawa[1)]	A/S	K/A	K/A[2)]	Moist convective adjustment	Betts-Miller	Grell	Grell
Land surface	BATs	LSM	Kowalczyk	MATSIRO	NCAR LSM	BATs[3)]	BAIM	LSM	LSM	BATs
PBL scheme	Holtslag	Holtslag	Louis	Mellor-Yamada	Holtslag	Holtslag	Yamada Level 2 Louis scheme	MRF	MRF	Holtslag
LW radiation scheme	CCM3	CCM3	GFDL	Nakajima	RRTM	RRTM	Sugi	CCM2	CCM2	CCM3
SW radiation scheme	CCM3+ aerosol	CCM3	GFDL	Nakajima	CCM2	CCM3+ aerosol	Lacis& Hansen	CCM2	CCM2	CCM3+ aerosol
LW radiation scheme	CCM3	CCM3	GFDL	Nakajima	RRTM	RRTM	Sugi	CCM2	CCM2	CCM3
SW radiation scheme	CCM3+ aerosol	CCM3	GFDL	Nakajima	CCM2	CCM3+ aerosol	Lacis& Hansen	CCM2	CCM2	CCM3+ aerosol

* hydro : hydrostatic
* n-hydro: non-hydrostatic
* LR : linear relaxation
* ER: exponential relaxation
* A/S : Arakawa-Schubert
* K/A: Kuo-Anthes

1) modified by McGregor, et al.

2) with Zhao's amendments to Kuo-Anthes

3) considering the influence of scalar roughness in BATs

List of station data information

	Investigator	Station number	Daily Mean temperature	Daily Maximal temperature	Daily Minimal temperature	Daily precipitation	Daily mean sea level pressure	OLR
China	Xiong zhe	193	Yes	Yes	Yes	Yes	Yes	
Japan	Hisashi Kato	155	Yes	Yes	Yes	Yes	Yes	
South Korea	Dong-Kyou Lee	72	Yes	Yes	Yes	Yes	Yes	
North Korea	Kang Bom Jin	6	Yes	Yes	Yes	Yes	Yes	
Mongolia	Gombolu udev Purevjav	73	Yes	Yes	Yes	Yes	Yes	
India	Murari Lal	15	Yes	Yes	Yes	Yes	Yes	Yes

List of grid data information

	Source
Monthly precipitation	Xie Pingping and Arkin
Monthly mean maximal temperature	NCEP/NCAR reanalysis
Monthly mean minimal temperature	NCEP/NCAR reanalysis
Monthly mean temperature	NCEP/NCAR reanalysis
Monthly mean sea level pressure	Japan Meteorological Agency(JMA)

Attachment 4

Outline of summary report for APN project 2000-05: RMIP for Asia (2000.4-2001.3)

I. Background - RCM in IPCC reports

(1) An important long term goal is the accurate projection of regional climate change so that potential impacts can be adequately assessed (IPCC 1995)

(2) RCMs consistently improve the spatial detail of simulated climate compared to GCMs. RCMs driven by observed boundary conditions shows area-averaged temperature biases (regional scales of 10^5 to10^6 km^2) generally within 2 C and precipitation biases within 50% of observations. (IPCC 2001). A few case studies have demonstrated that the RCM can reproduce the seasonal evolution of monsoon rain-belts over Asia which very often is not captured by the GCM. However most systematic analysis of the RCM performance in Asia is needed.

II. Objectives

(1) To further improve the RCMs for application in Asia

(2) To develop an ensemble of the results from a group of RCMs

(3) To provide higher confident scenarios of regional climate change in Asia

III. Tasks

Phase one	18 months	Full annual cycle and two extreme cases
Phase two	10 years	Statistical behavior
Phase three	scenarios	Projection for the 21st century

IV. Expected Products

(1) Assessment report of RCMs' performance in Asia

(2) Papers to journals

(3) Proceedings of two workshops

(4) Regional climate change scenarios for Asia in 21st century

V. Participating groups

START TEA Center and GCR Center, NJU, China

CSIRO, Australia

NIES, CRIEPI and MRI, Japan

SNU and YU, Korea

ISU and CU, USA

Totally 10 groups

VI. Implementation period

2000-2004 (4 years)

VII. Major Activities in the first year (00.4-01.3)

(1) Planning meeting in Seoul, Jun. 2000, agreed on:
Simulation period, domain, topography, and land cover types
Initial driving fields, lateral boundary fields
Data for validation
Model outputs for the first step
Preliminary assessment of simulated surface climate
Fellowships
(2) Preparation for model run, June -Aug. 2000
(3) Model runs of 10 groups, Sep.-Dec. 2000
(4) Preliminary analysis of simulations, Jan.2001
(5) Summary workshop in Beijing, Feb.2001
(6) Discussion of the plan for 2001.4-2002.3

VIII. Major products
(1) A collection of models' information
(2) A collection of station and grid data
(3) Outputs of 18 months run of each model
(4) Preliminary analysis products of each model
(5) Preliminary products of the inter-comparison of 10 models against observation.

IX. Products for each model
(1) Seasonal mean fields of T_{mean}, T_{max}, T_{min}, R_{total} and P_{sea}
(2) Correlation fields between Model and observation.
(3) Seasonal variation of area means for 12 regions
(4) Evolution of rain belts
(5) Variation of Bias in different regions and seasons

X. Inter-comparison products
(1) Maps of T_{mean}, T_{max}, T_{min}, SLP and R_{total} for winter and summer from different models and observation
(2) Seasonal evolution of area mean for above variables from different models and observation.
(3) Extreme events
i. Hot summer of 1997
Spatial distribution of grids with T_{max} > 35 or 38C
Number of days with T_{max}>35 or 38C
ii. Dry summer of 1997
Anomalous rainfall in summer of 1997 (model/observation)
iii. Flood in summer of 1998
Spatial distribution of rainfall in summer of 1998 (model/observation)
Evolution of daily rainfall over three regions
@ Mid and upper reaches of Yangtze valley
@ Lower reaches of Yangtze valley
@ Songhuajiang river basin
Number of days with heavy rain (> 50mm and >100mm)

XI. Preliminary assessment of the models' capacity in reproducing the surface climate over Asia in the

18-month run

(1) Common features which most of the models have captured

e.g.

a. Most models can reproduce the spatial patterns of seasonal mean surface temperature (including T_{mean}, T_{max}, T_{min})

b. Most models can reproduce the annual variations of T_{mean}, T_{max}, T_{min}, especially the amplitude over most of the sub-regions.

c. Most models can reproduce the hot summer of 1997 over the large part of Asia continent

d. Nearly 50% of the models can reproduce the spatial pattern of seasonal total precipitation. The agreement between models and observation in winter is better than in summer.

e. Most models can reproduce the annual variation of precipitation over most of sub-regions.

f. Part of the models have captured the flood over Yangtze in summer of 1998 reasonably well.

(2) Common problems of model simulations

e.g.

a. Northward shift of rain belts in summer in most of the models.

b. There is an overall cold bias over south and warm bias over north in almost all seasons

Etc.

(3) Questions raised from the preliminary assessment

e.g.

a. Problems in simulation of precipitation are related to: convection schemes? Lateral boundary treatment? Simulation of low level jet? Soil moisture initialization? Microphysics of precipitation ? … it was suggested that the precipitation patterns can be improved by introducing the gravity wave drag, and/or including stratospheric levels in the models.

b. Warm bias over northern regions are related to: cloud simulation? Long wave radiation? Snow and sea ice treatment?…

c. Cold bias over western Pacific in some models are perhaps due to use of an inappropriate scheme to diagnose the air temperature at 2m height from the model.

XII. Plan for 2001- 2002

(1) Further analysis of 18 months run

a. Inter-comparison of the components of land surface energy and water balances, cloudness, the atmospheric circulation including summer and winter monsoon, low level jet and jet stream over the upper troposphere etc.

b. Influence of different physical parameterization schemes: land surface scheme, convection scheme and radiation scheme, etc.

(2) Drafting the scientific papers

Topics, Time table

(3) Workshop in Kobe

Main agenda: Presentation from each group related to 18 month simulation in any topic they are interested in or focus on inter-comparison discussion or both?

Time: September 2001

(4) Preparation for 10 years run

Participating groups, Time table