Cold Region Studies in CEOP (CRS)

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WCRP Climate and Cryosphere Project: CliC Goal and Themes

Principal Goal:

To assess and quantify the impacts that climatic variability and change have on components of the cryosphere and the consequences of these impacts for the climate system.

In addressing this aim, CliC also seeks to determine the stability of the global cryosphere

CliC focuses its activities through the following **themes** (previous CPAs):

1. ***Terrestrial cryosphere and hydro-climatology of cold regions***
2. ***Ice Masses and Sea Level***
3. ***Marine Cryosphere and Climate***
4. ***Global Prediction of the Cryosphere***

（From SSG presentation(Goodison) 2007）

Past and future

(1) Initiated in 2004, under the collaboration activity between CEOP and CliC. Four overall collaboration topics were defined and started.

(2) Members of JAMSTEC and Univ. Tokyo developed plan, and has continued collaboration work under their separate research funds.

(3) From 2008 to 2009, discussions on the change on framework and has started and still under discussion.

Main members of collaboration

Univ. Tokyo: Toshio KOIKE, Yasutaka TSUTSUI

JAMSTEC: Tetsuo OHATA, Konosuke SUGIURA, Hironori YABUKI, Hotaek PARK

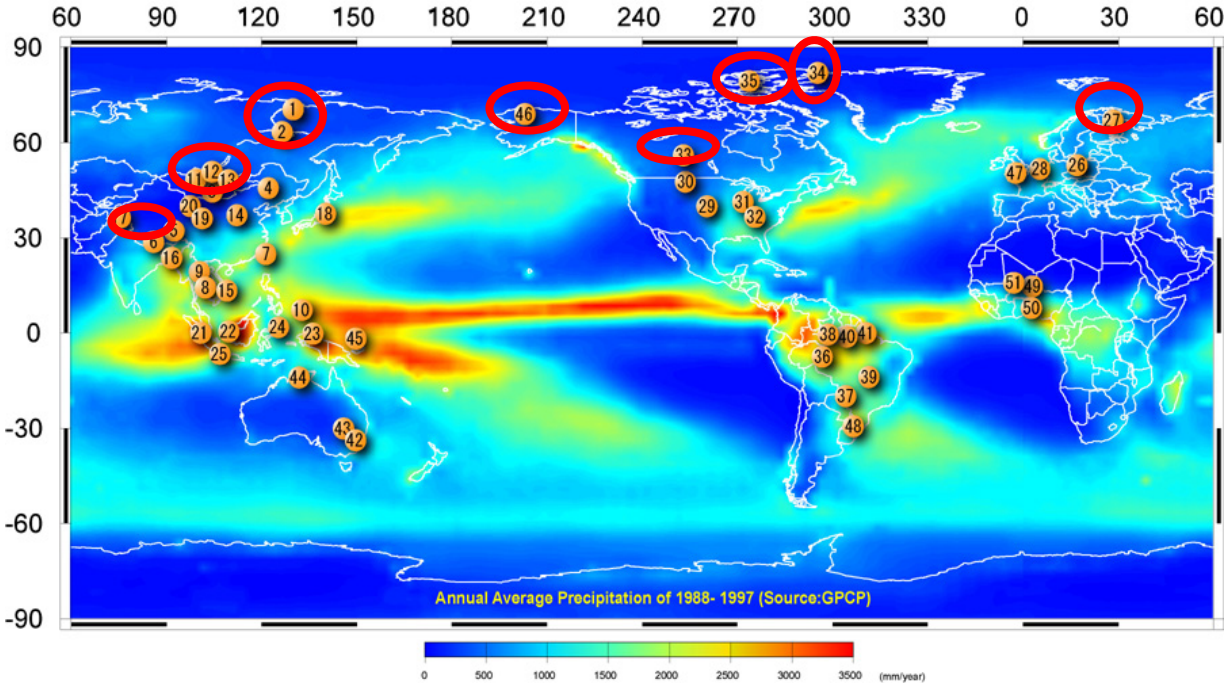
(CliC Project Office: YANG Daqing)

Four Overall Collaboration Topics

1. Convergence of observation and data integration.
2. Long-term variation of snow distribution in northern regions and Its Impact on atmospheric circulation
3. Water and energy budgets (WEBs)
4. High mountain hydrology Including glaciers

CEOP Ⅱ：
reference sites.

Sites with annual average temperature below 0 ℃



1. Convergence of Observation and Data Integration

Targets:

- Reference site/basin network in cryosphere
- Integrated satellite/in-situ products in cold regions

Strategy:

- Sophistically integrated in-situ observation (super site) including isotope, new sites (location, number, standard)
- Common metadata, data quality check, archiving system, and data policy
- Integrated satellite products and validation by in-situ data: snow, snowfall, soil moisture, canopy snow, vegetation
- Long-term, comprehensive, high-quality observation at different spatial scales (regional-point) in Northern Eurasia
- Precipitation data applying various methods

2. Long-term Variation of Snow Distribution in the Northern High Latitude Region and Its Impacts on Atmospheric Circulation

Targets:

- Seasonal and Inter-annual variation of hydrological conditions

Strategy: (Research based on long-term data)

- Long-term snow (SWE) and soil moisture by the SSM/I: product, validation, impact analysis concerning atmosphere and hydrology
- Model analysis and inter-comparison
- Land surface model improvement for regional climate modeling: better inclusion of frozen ground including permafrost

Topic 1

Development of supersites for monitoring and land surface process study, satellite product retrieval, and data rescue.

(1) 3 supersites in Siberia and northern Mongolia maintained. (CEOP Reference site)

(Longest being 11 years of complete towe data)

(2) New supersite planned in Alaska

IARC/JAMSTEC collaboration

(snow/ice, water, vegetation, GHG)

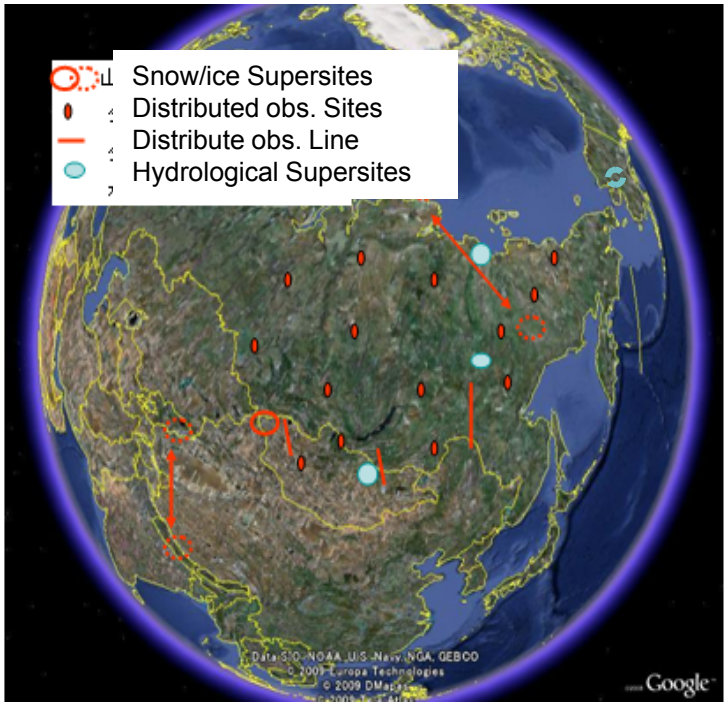
(3) Observation transect and routes in Siberia (and Alaska)

(4) Asian cryosphere data archive project.

Workshop: March 30-April 1, 2009, Lanzhou

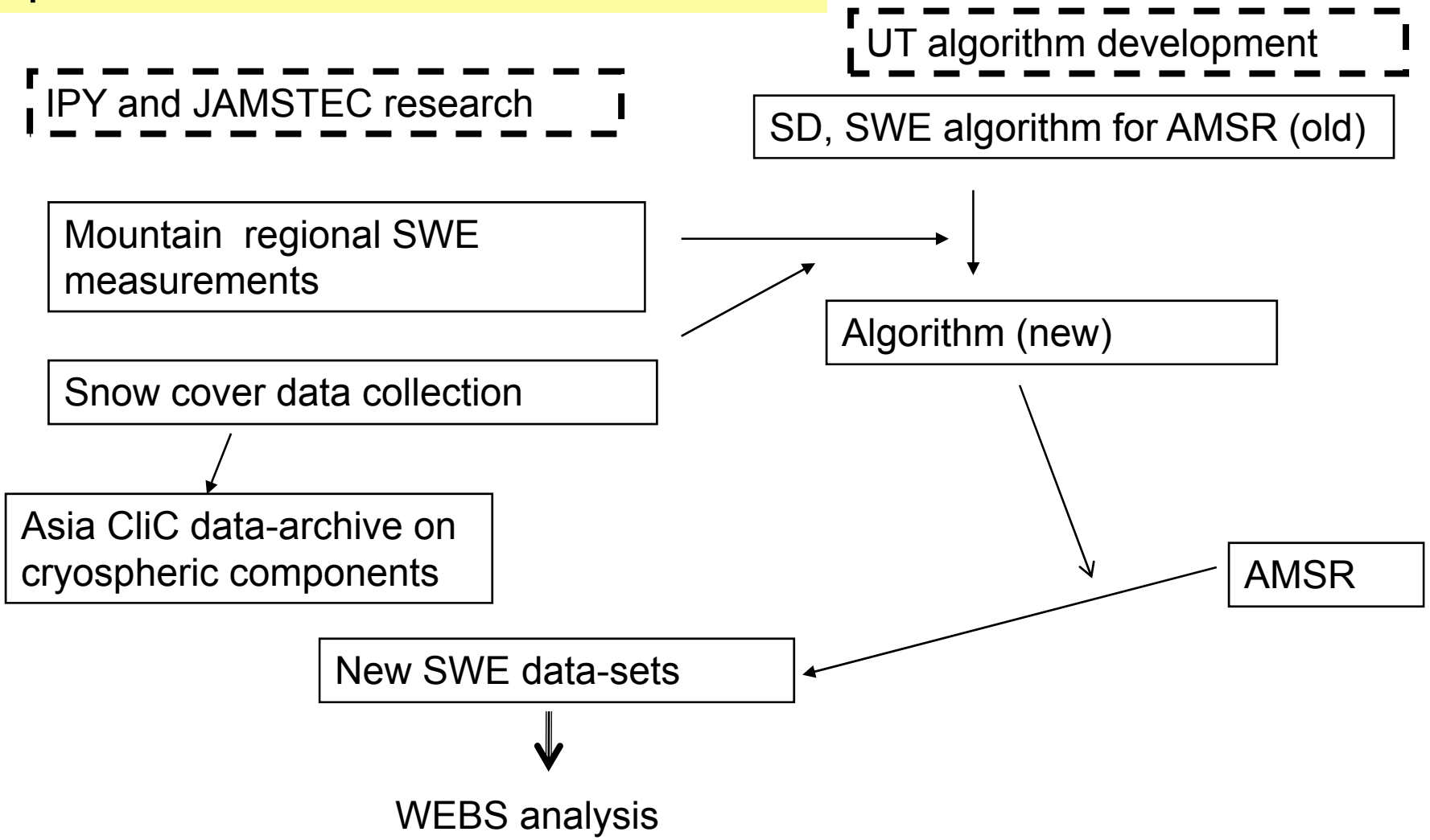
9 countries, 15 participants.

Asia-CliC ativity. Refer to CliC Newsletter.

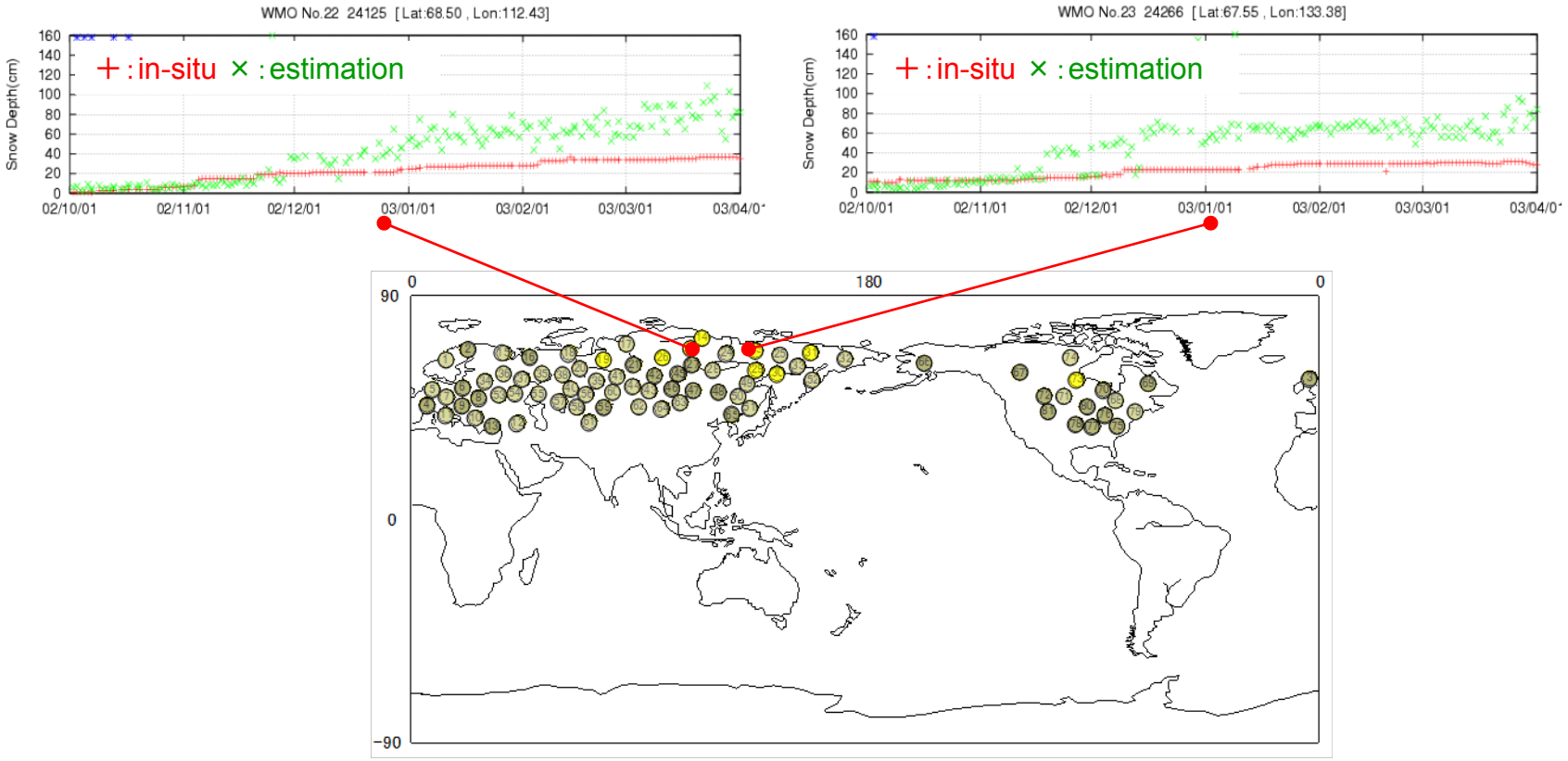


Existing and planned observation network of JAMSTEC

Topics 1 and 2: SWE satellite issue



Present status of Satellite retrieval of Snow depth, AMSR-E

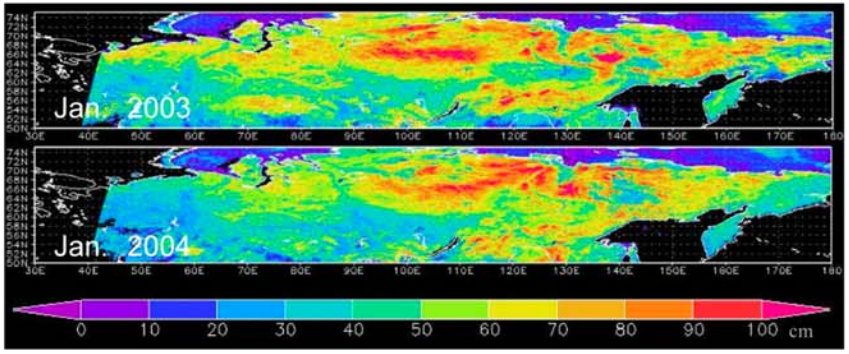


Not good !

(From Tsutsui, UT)

PROBLEM

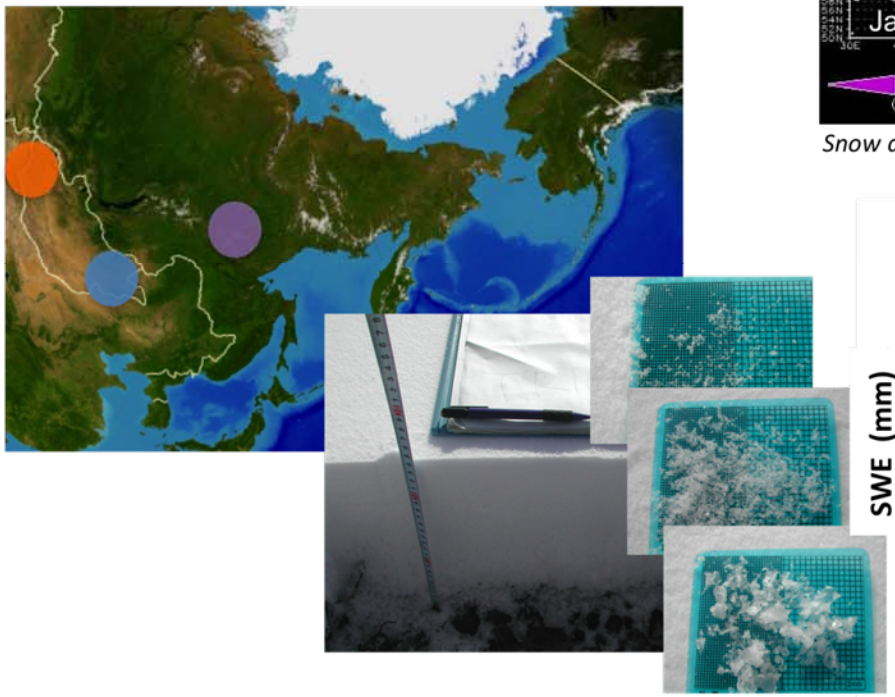
➢*Overestimation of snow depth based on the current retrieval algorithm for snow by frozen ground in the permafrost region*

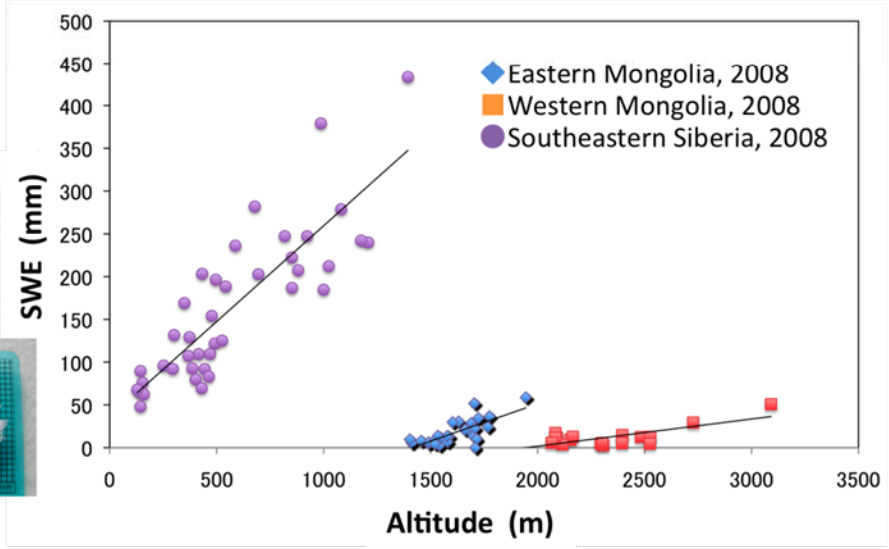


Snow depth based on the current retrieval algorithm for snow by using AMSR-E

Ground truth data

➢*Observation in the permafrost region*





Modification of the algorithm by using the ground truth data

➢*Introduction of the effect of frozen ground into the algorithm*

➢*Evaluation and improvement of the snow grain growth estimation process in the algorithm*

3. Water and Energy Budgets (WEBs)

(Research for CEOP2 period)

Targets:

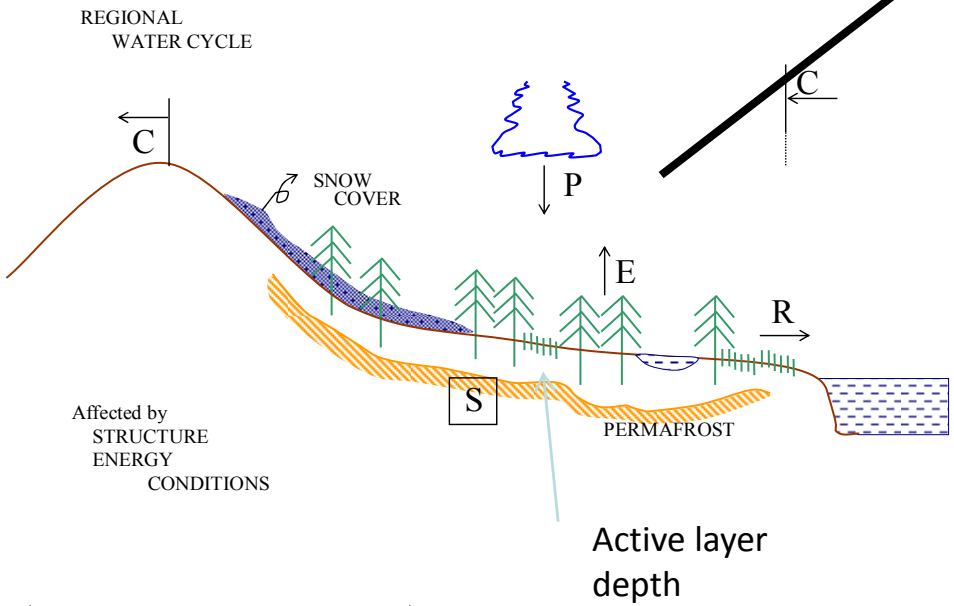
- Intercomparison among the large rivers flowing to Arctic ocean, such as *Lena, Obi, Yenisey, and Mackenzie*
- Impacts of the WEB variation on atmospheric circulation

Strategy:

- Data integration
- Atmosphere-land interaction land processes: snow, permafrost, soil moisture, vegetation, fluxes, land water.
- Predictability Improvement of GCMs coupled with LDAS
- Down-scaling and A-L coupled DAS
- Large Arctic draining River Runoff and its change
  <Existing project: IPY Arctic-HYDRA>
- Stable isotope budget

Topics 3: Application of Land hydrological model for WEBS study in Siberia

Question to answer– runoff variability and increase trend



Land hydrological model

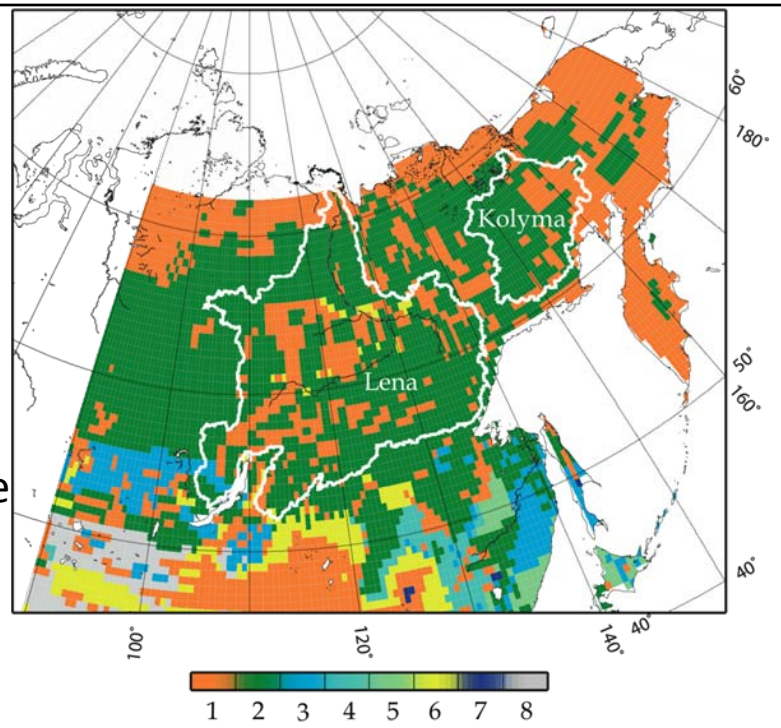
Forcing – grid data based on station data

Model Ⅰ（2LM＋runoff processes）:

- Simple land surface、
- Vegetation expressed by fixed LAI

Model Ⅱ（CHANGE）:

- Growth of vegetation
- Classification of land types、
- Detail description of sub-surface (soil moisture, soil temp.)



＜Water budget＞

P（Precip）

＝E(Evapotranspiration）＋R（Runoff ）＋ΔS（Storage change）

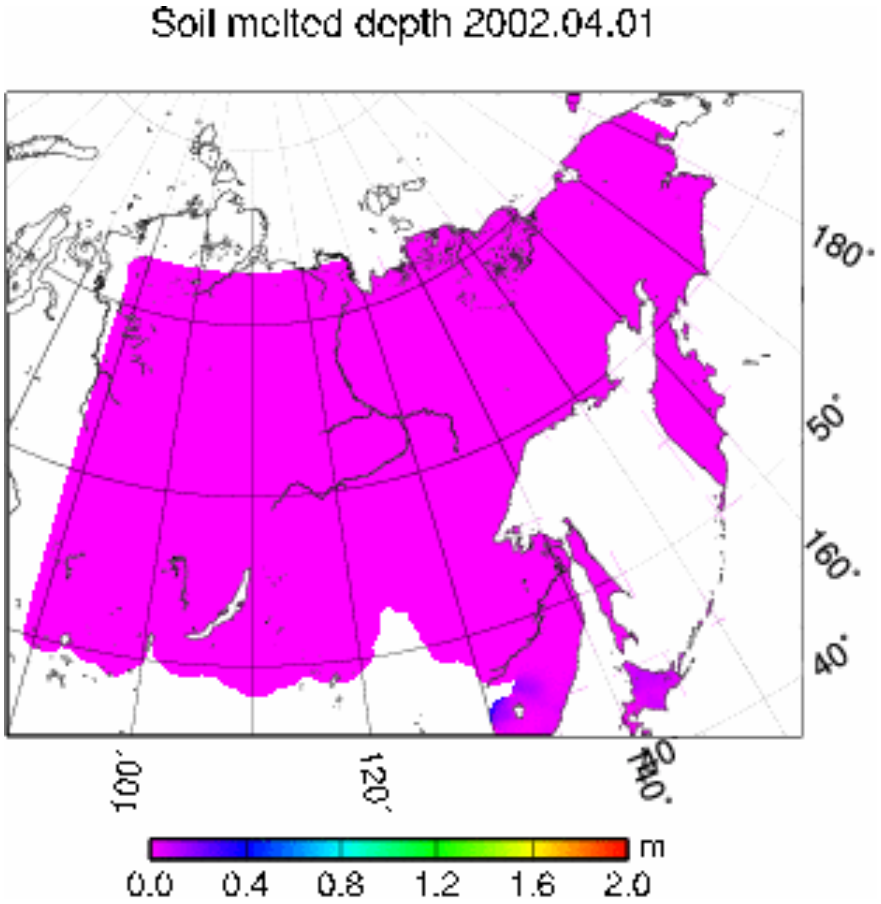
E＝transpiration＋Intercepted evap.＋ground evap.

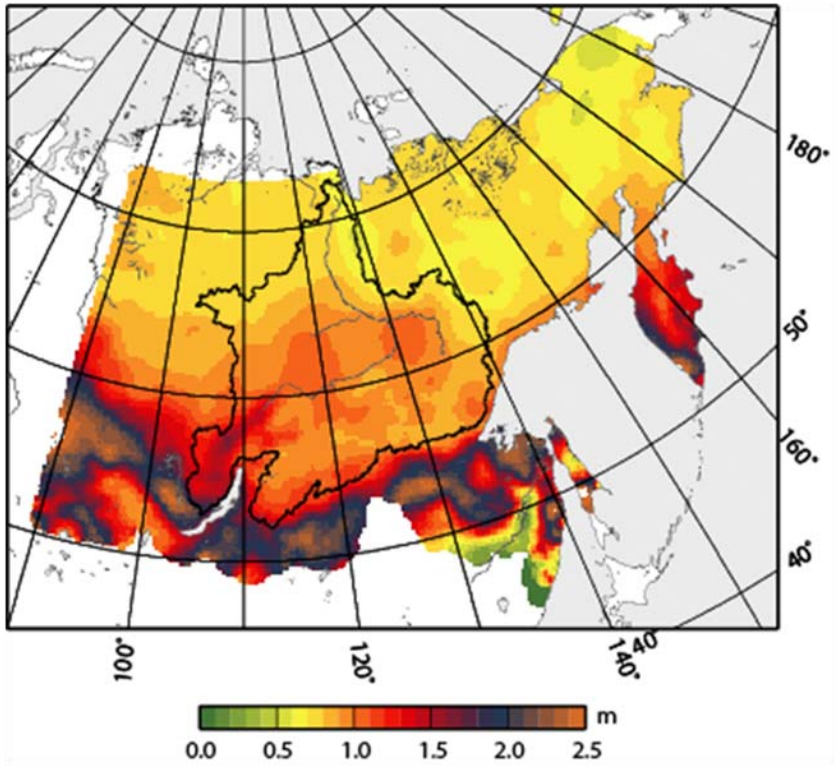
Preliminary results: (Park et al., 2008)

Simulation results (park et al., 2008)

Seasonal variation of thawed depth (left)

Active layer depth (ALD) (right)

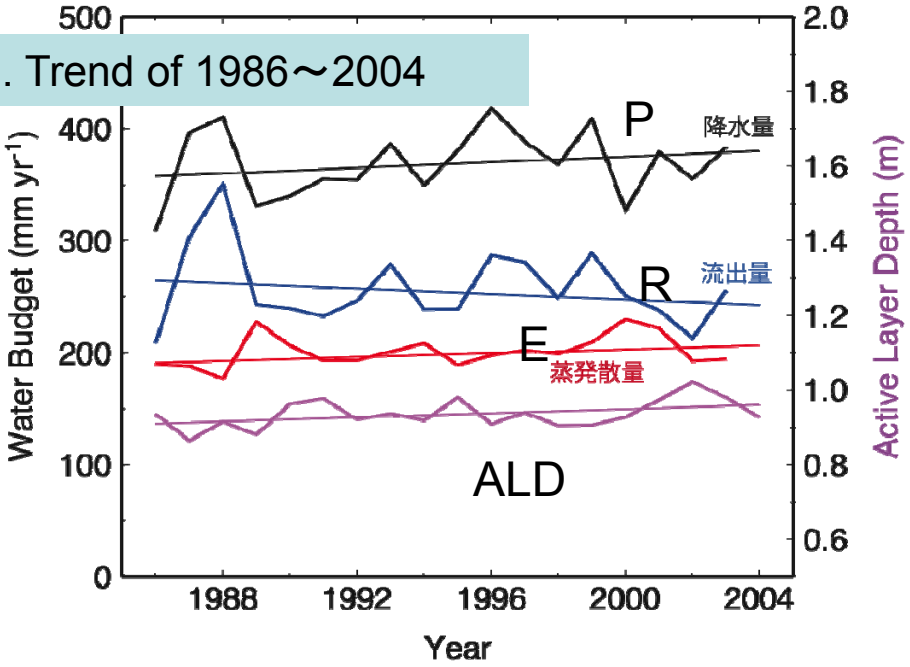




Results for Lena basin

Relation of Hydrological components, active layer depth（Model Ⅰ）

1. Trend of 1986～2004

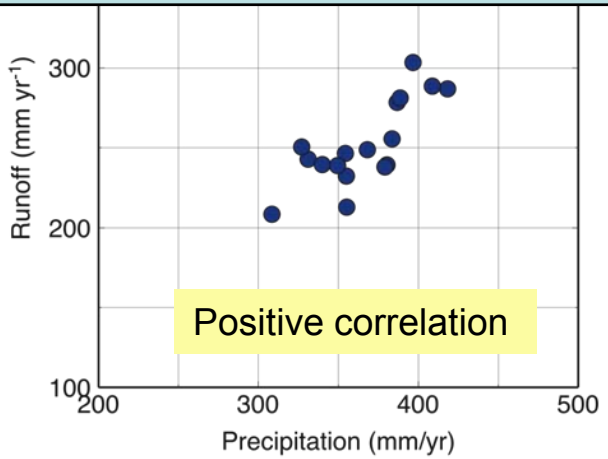


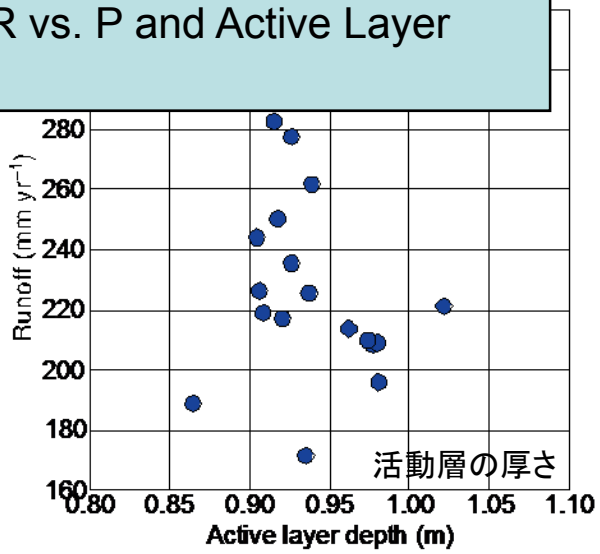
(1)Slight increase in P

(2)Slight increase in E and Active layer depth

(3)Runoff show decrease trend

2. Correlation of Annual values (R vs. P and Active Layer Depth





・High P year, corresponds to high R year.

but,

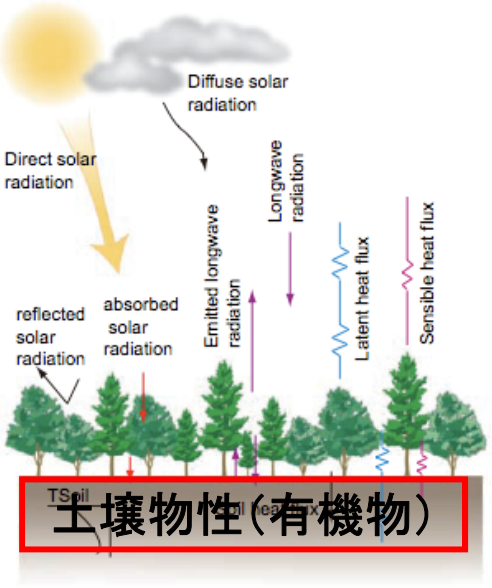
Long-term trend is opposite for P and R.

→some other factor than P determines trend of R.

Model Ⅱ

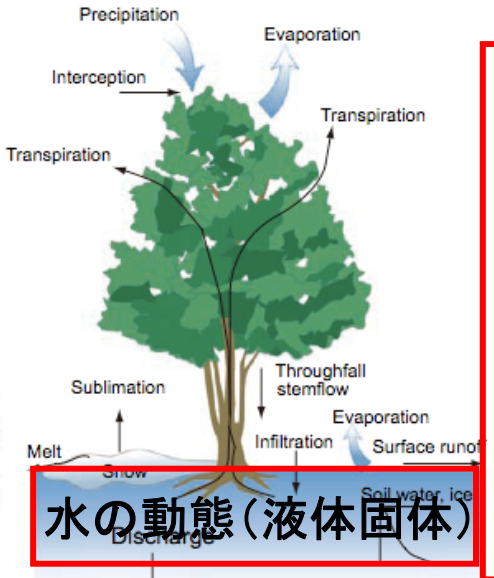
Coupled Hydrological and Biogeochemical Model (CHANGE)

Energy fluxes



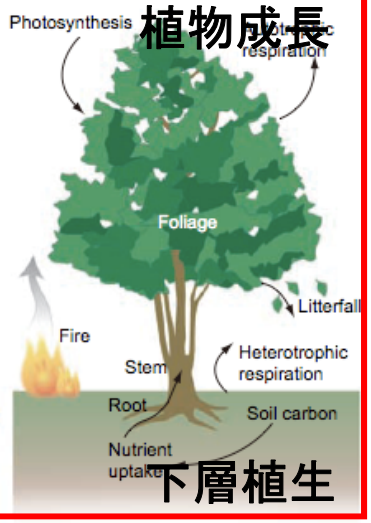
土壌物性（有機物）

Hydrology



水の動態（液体固体）

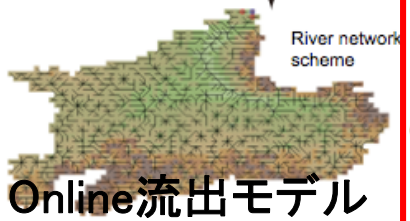
Carbon cycle



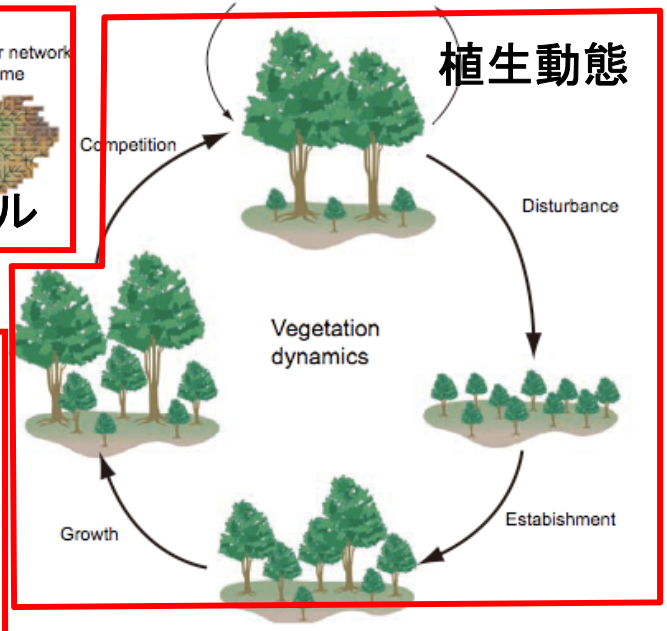
植物成長

下層植生

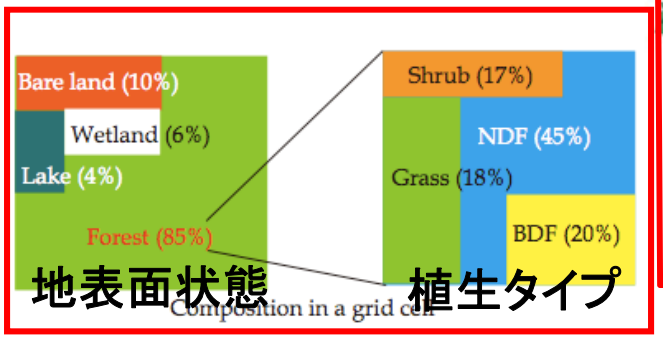
- Daily forcing data (7 variables)
- Hourly time step
- Spinup running for 500 yrs
- 16 vegetation types (not required as input data)
- Albedo effect following surface change on the processes
- Seperation of soil water and ice



Online流出モデル



植生動態

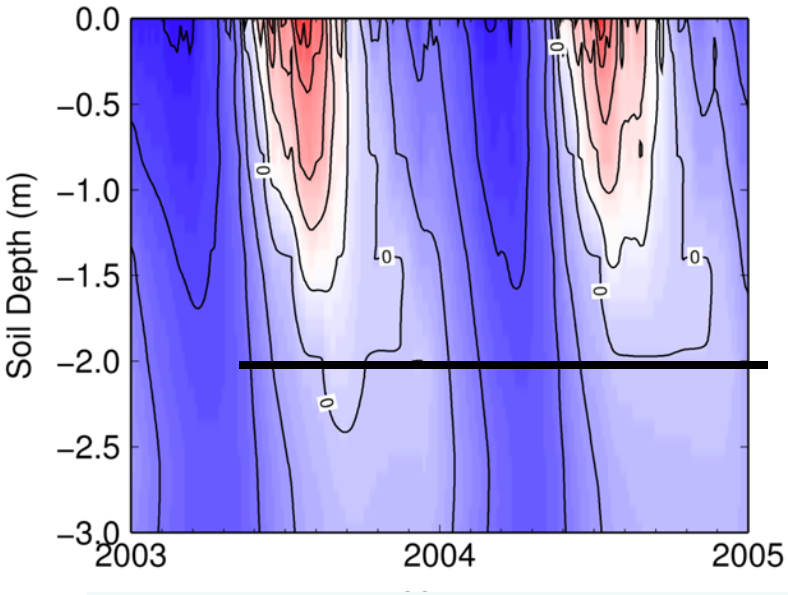


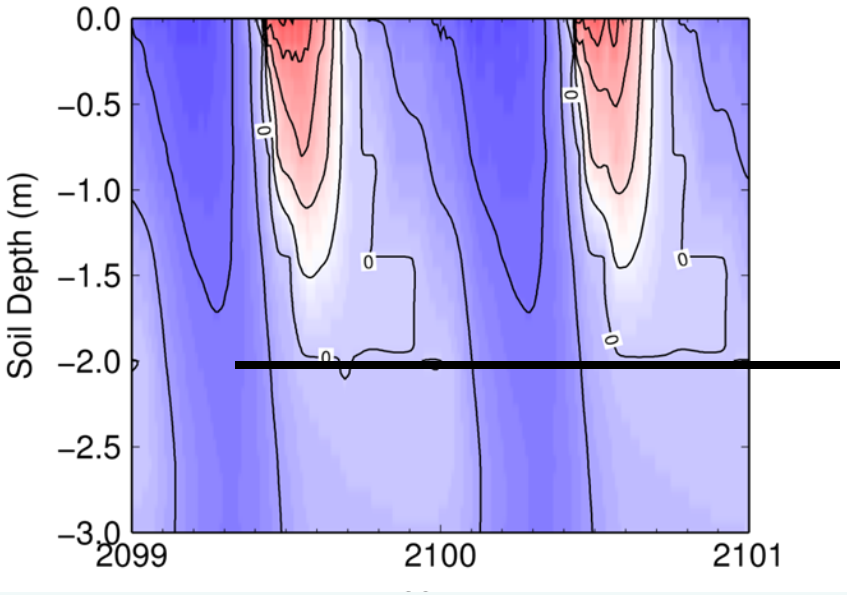
地表面状態

植生タイプ

Preliminary results for Model Ⅱ。

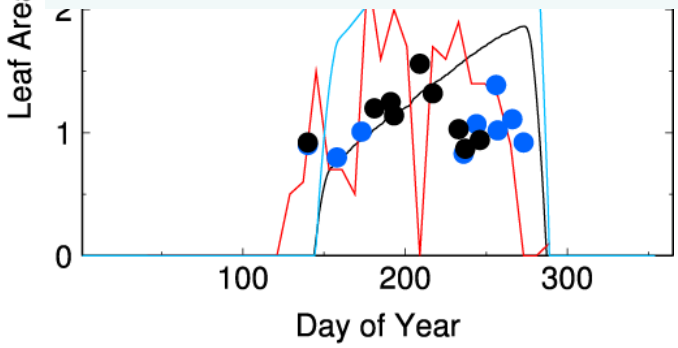
For Yakutsk site　Thawed depth present and 2100





→ Result show that no degdradation of frozen ground.
Development of vegetation affects.

→ This model will be applied to longer-term（1950～2007) by applying integrated data including CEOP data. Hope to clarify the long-term trend in the increase of Large Northern Rivers.



CO2濃度（ppm）　入力	300	700
純生産量 (gC m^{-2} y^{-1})	458.6	660.6
葉面積指数	1.6	3.4
土壌有機物量 (kgC m^{-2})	20.1	32.3

Future of Topics 3:

Hydrological Issues of WEBS

<Present>

Grid data from land observation stations (BMDS)

Global data-sets.

Land hydrological model

Model Ⅱ（CHANGE）:

- Growth of vegetation
- Classification of land types、
- Detail description of sub-surface (soil moisture, soil temp.)

will be developed/modified further, including

lake and reservoirs

forestfire.

Satellite products will be developed /applied (UT Group) <Topic 1>

<Future issues>

CEOP frozen ground assimilation

→ WEBS characheristics of northern rivers. Long-term trend of runoff from Large Northern Rivers.

As for atmospheric application: New group in JAMSTEC will consider (related also to Theme 2)

4. High Mountain Hydrology Including Glaciers

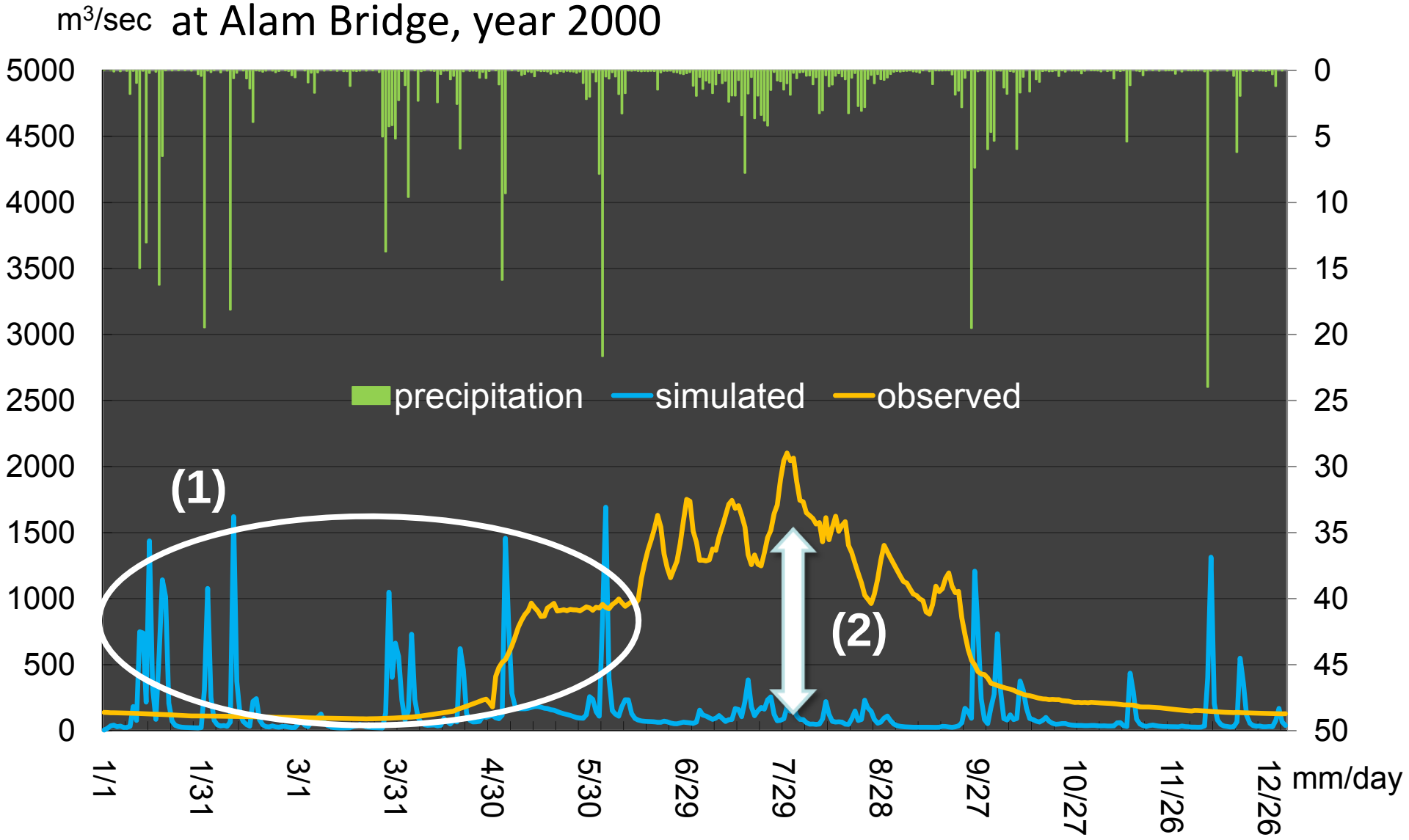
Targets:

- From process study to application to water resources management

Strategy:

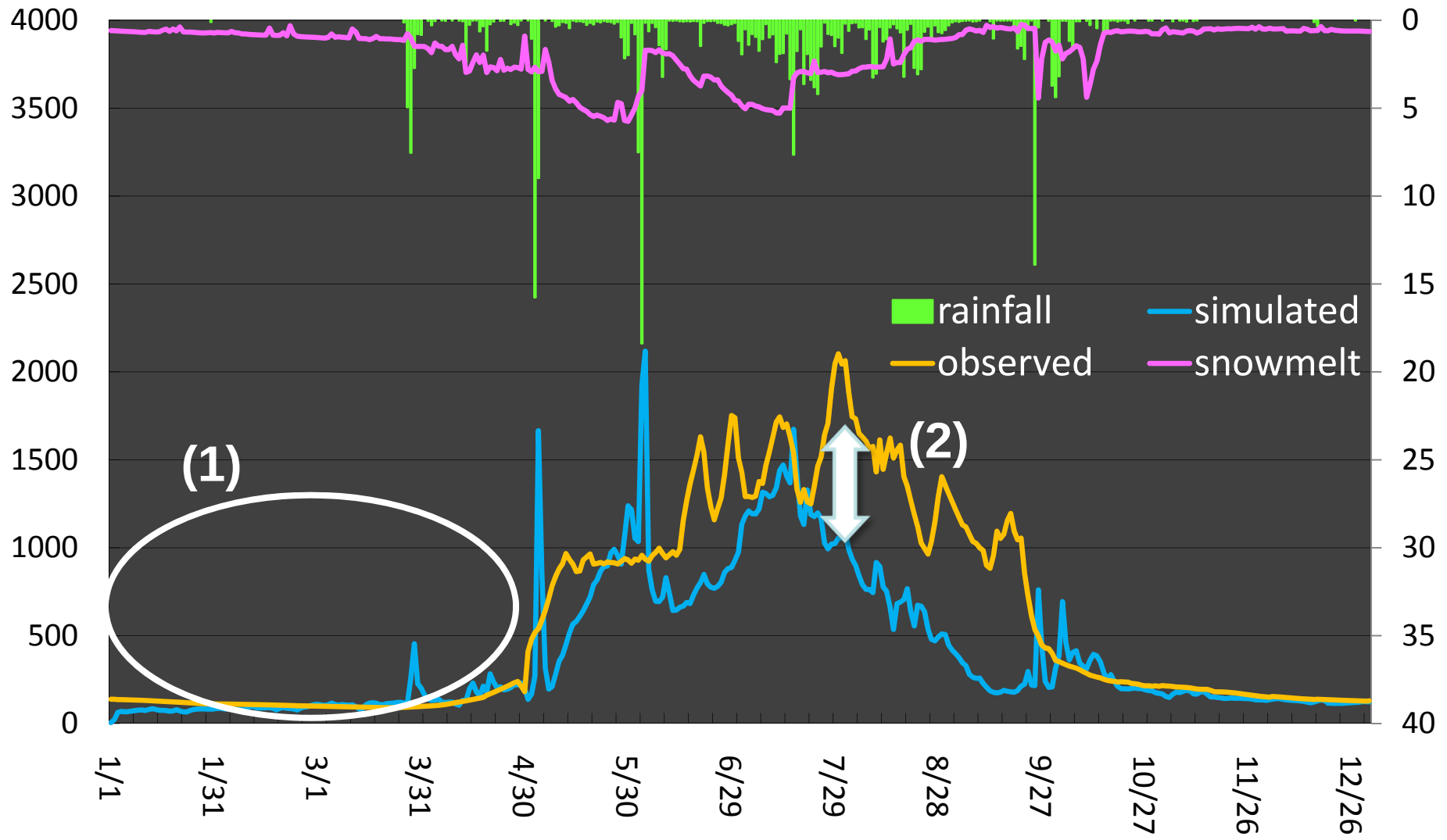
- Enhanced collaborative research in reference basins
- Intercomparison of impacts of climate change on water resources
- Cooperation with “Semi-arid region study”
  - Planned Project: IHACY- International High Asia Cryosphere Year, CliC related project, China core.

Pakistan dainage: Simulation with WEBDHM (UT Group)



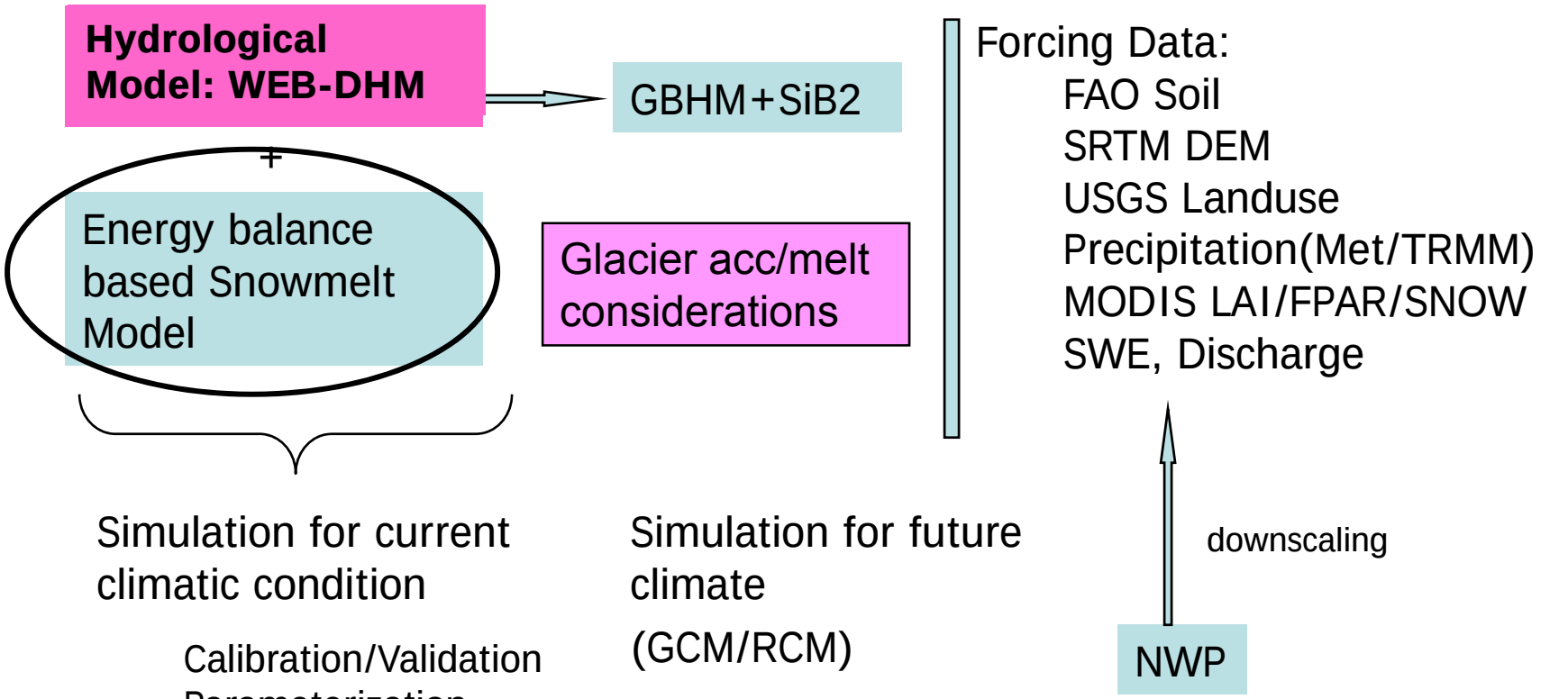
Coupled model result

Energy balance based Snowmelt Model added.



Snowmelt modeling under Climate Change Conditions

Overall Strategy



Glacier variation study in Altai Mountains, Mongolia by JAMSTEC group

In-situ observation

(1) Glacier dynamics

(2) Mass/heat balance

(3) Mountain climate

(4)Snow cover

Heat balance

Boundary layer

Glacier wind

Application of models and station data

・Reanalysis data and application of RCM (long-term)

・Surface met. Station data (long-term)

Developement of long-term climate change data-sets

Simulation applying Glacier Model

Applicability of glacier models, verification, driving data

・Evaluation of mountain snow

・Verification of satellite derivation

Improvement of large-scale snow cover

Glacier change

Satellite・Map・Aerial photo、Analysis data

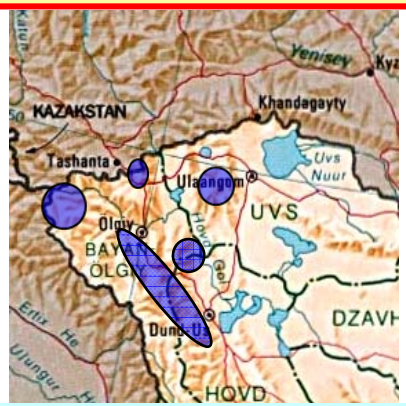
Glacier model, Yamaguchi et al. (2008)

Understanding the dominating climate factor for glacier changes

In the recent decades.

How is anthropogenic element affecting glacier loss.

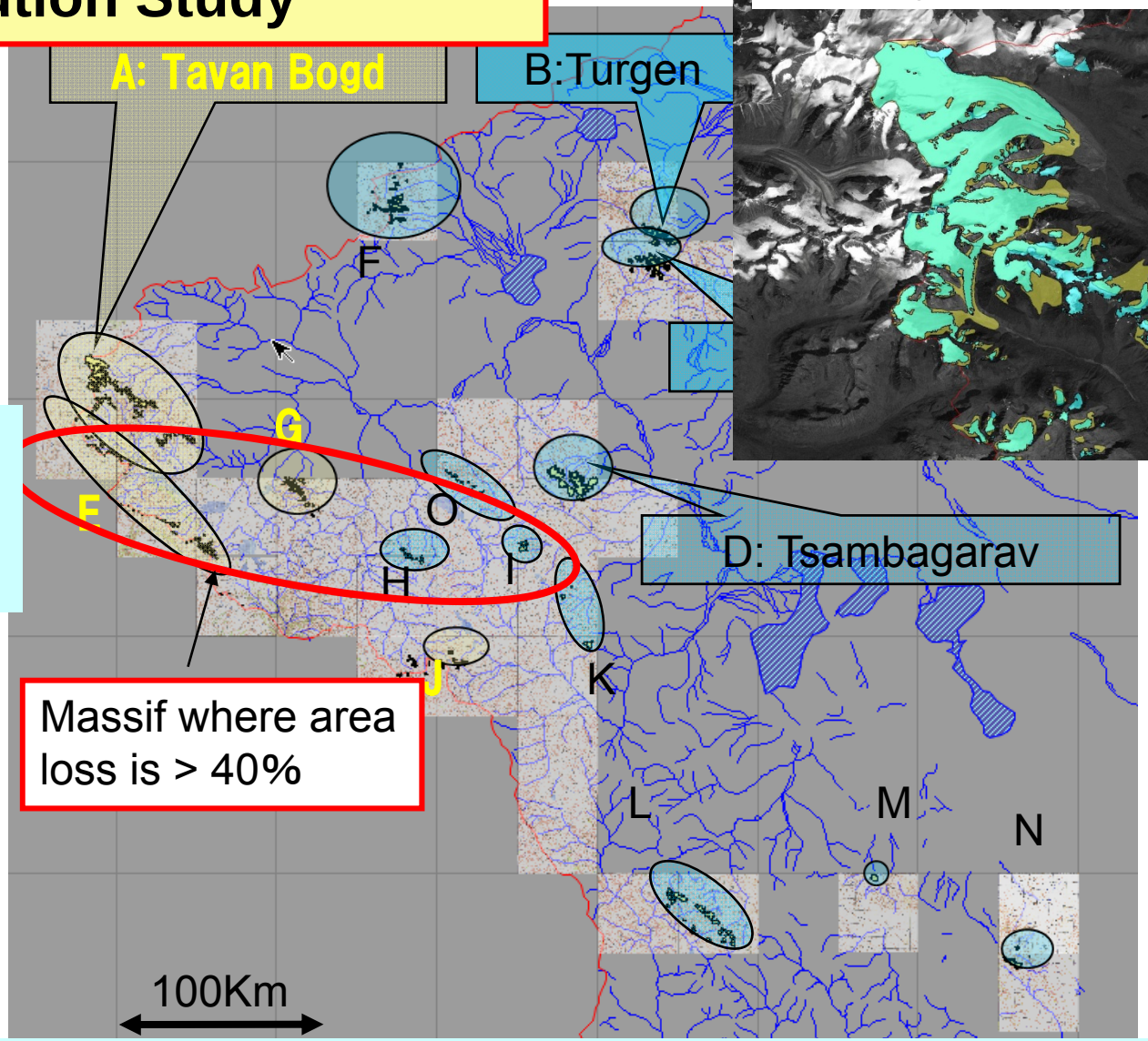
Glacier distribution Study



Distribution of glaciers in the Altai Mountains, Mongolia district. **Do not exist in World Inventory**

Method:
Topographical map (1950) and Satellite data (2000), GIS

Result: <u>Glacier Area decreased 31% in about 50 years.</u> However, the range is 10—57%.



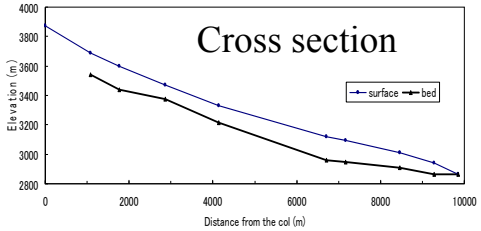
A: Tavan Bogd, B: Turgen, C: Kharkhiraa, D: Tsambagarav

<Yabuki, Kadota and Konya>

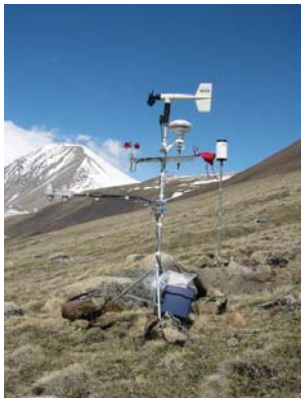
<Kadota et al., 2007>

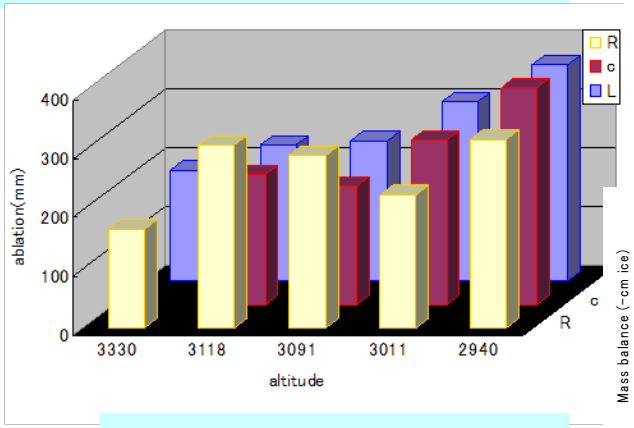
In-situ study: Potanin Glacier, Tavanbogd Massif, Alatai Mountains.

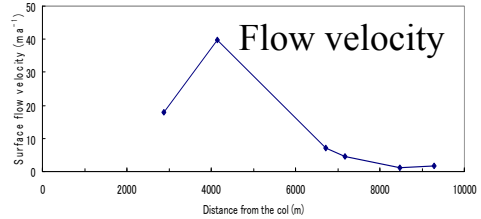
（June-September, 2007） IPY Study , Preliminary obs. 2003-2006, 2007-2009.

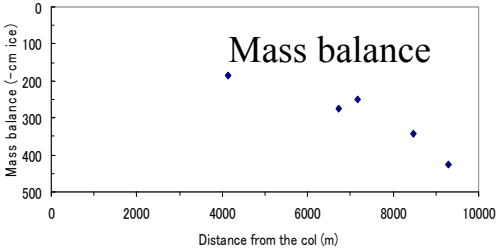


Research glacier：Potanin Glacier。Photo from left bank（Length, 10km）









Along the center stakes(Dynamic

On the glacier, surface lowering was measured in addition to the basic heat balance components (air temp., humidity, wind, air pressure, shortwave/longwave radiation。Outside station was set to obtain general condition on ground surface（Right, **3010m.a.s.l.**）

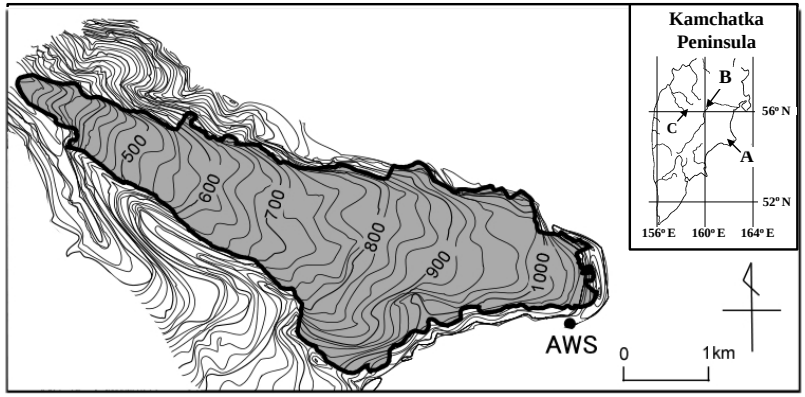
■**Surface lowering** of glaciers（June 27 to Sept 7, 2007）

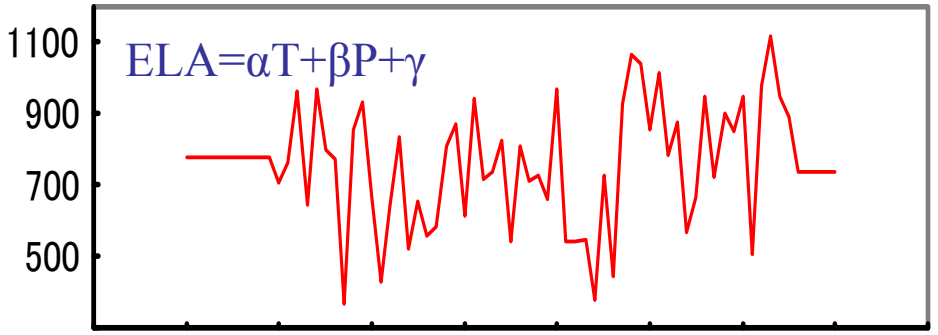
Thickness and dynamics of Potanin glacier. These will be used for examining shrinking process

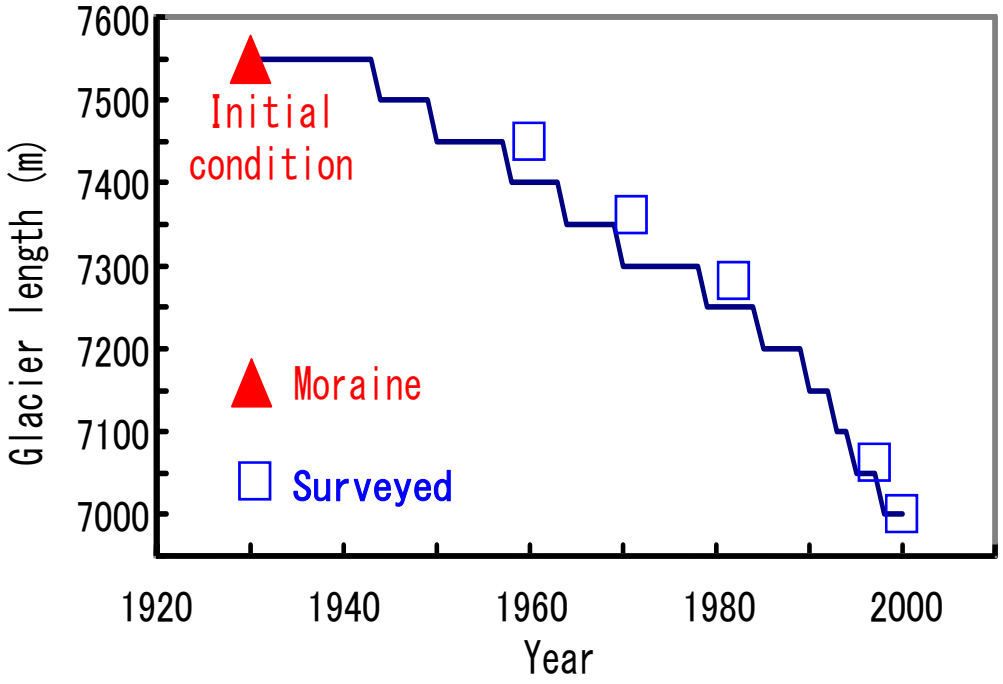
Results:

1) Identified as Continental type glacier.
2) Seem to be in rather strong negative mass balance.

Application of glacier model. (Yamaguchi et al., 2008) for Model applied to Koryto Glacier, Kamchatka.

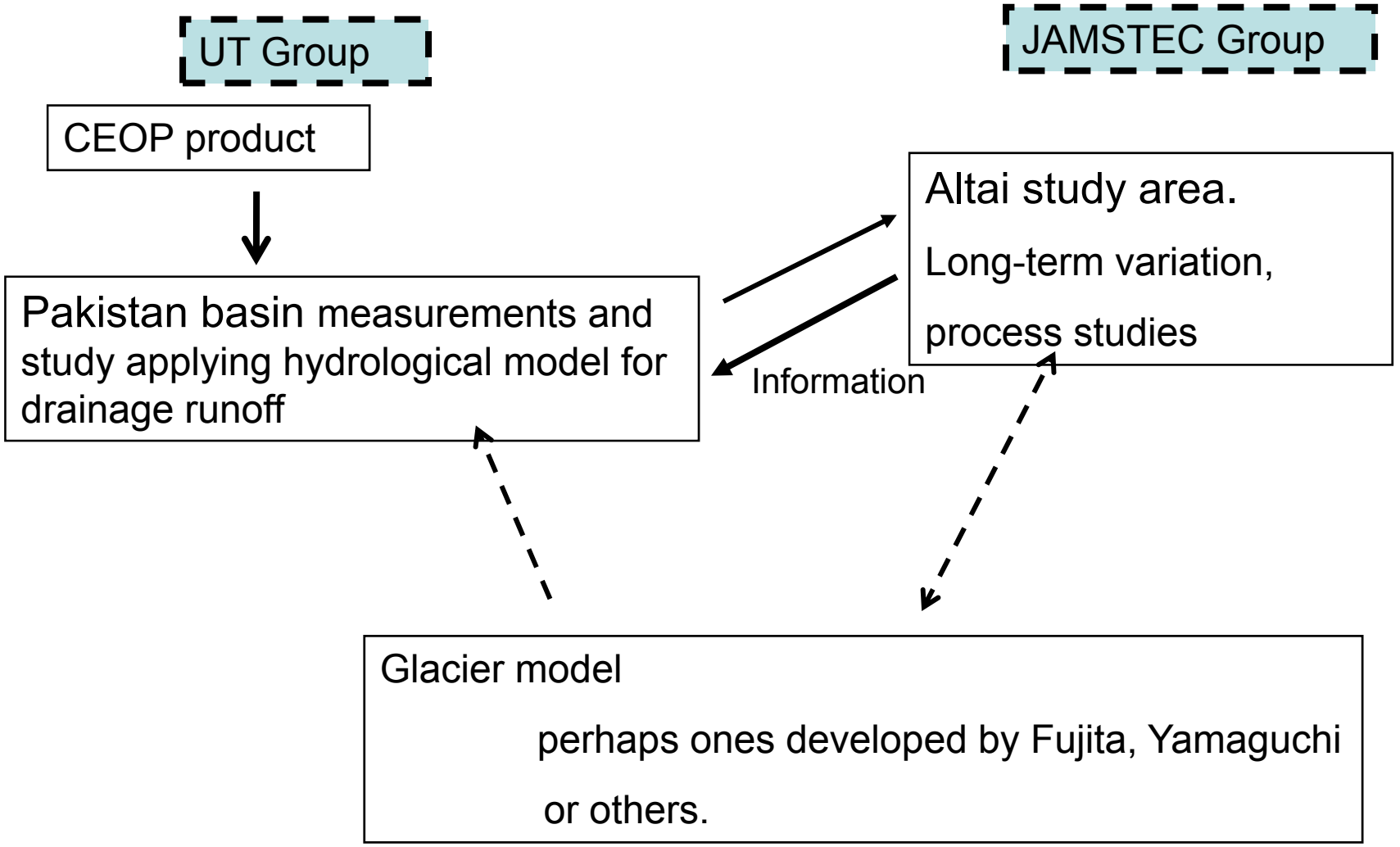


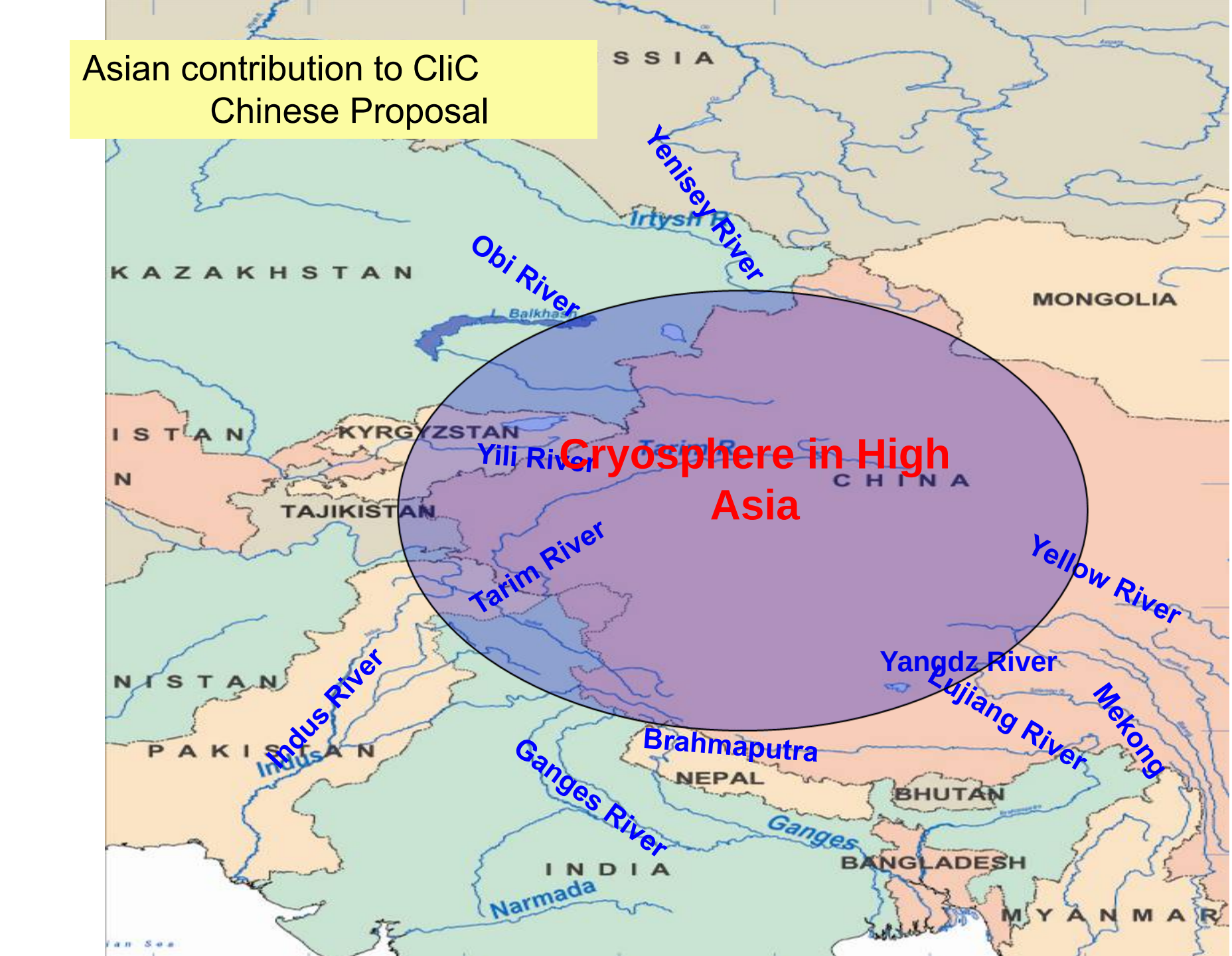




Topic 4:

Glacier basin hydrological study




Asian contribution to CliC
Chinese Proposal
Cryosphere in High Asia
Yenisey River
Obi River
Irtysh R.
KAZAKHSTAN
MONGOLIA
KYRGYZSTAN
TAJIKISTAN
CHINA
Yili River
Tarim River
Yellow River
Yangdz River
Lujiang River
Mekong
Indus River
Brahmaputra
Ganges River
NEPAL
BHUTAN
Ganges
BANGLADESH
INDIA
Narmada
MYANMAR

(Prepared by Yang Daqing)

New topic to be included in Topic 1

Cold Region Precipitation Bias-Correction and Analysis as Related to CEOP/CliC Water Balance Studies

A Proposal Submitted to CEOP

by

Daqing Yang, Barry Goodison, Tetsuo Ohata
WCRP CliC Project

Project Goal

- Address the problem of biases of precipitation measurements in the cold regions (including high latitude and high elevation).
- Use the results from the WMO Solid Precipitation Measurement Intercomparison Project and recent field experiments.
- Evaluate and define the accuracy of precipitation measurements, and implement the appropriate bias correction methodologies in the cold regions.
- Generate an accurate precipitation database and an improved climatology to meet the data needs for GEWEX/CEOP and CliC projects

Necessary Actions

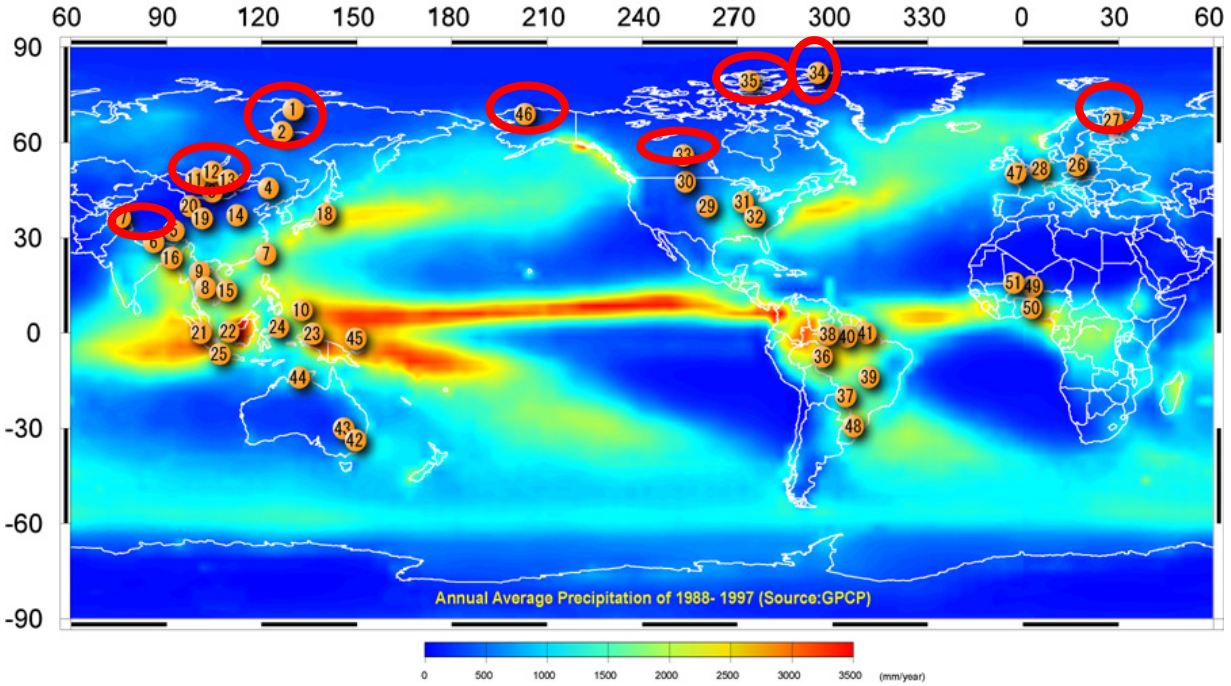
- CEOP and CliC to discuss and formulate a practical plan
- Establish a working group to define specific activities.
- Work out a budget and find funds necessary for the proposed activities over the next 2 years.
- Engage other groups (such as national met. services and data centers) for collaboration
- CliC is ready to work with CEOP….
- IARC may cooperate in implementation of this issue.

Four Overall Collaboration Topics

1. Convergence of observation and data integration.
2. Long-term variation of snow distribution in northern regions and Its Impact on atmospheric circulation
3. Water and energy budgets (WEBs)
4. High mountain hydrology Including glaciers

CEOP Ⅱ：
reference sites.

Sites with annual average temperature below 0 ℃



Summary and future

(1) Contribution to the satellite data product derivation of snow. based on CliC interest and CEOP interest is working.

(2) Development and application of hydrological and glacier model is still limited in cooperation, but has future possibility. It will widen the scope of CliC and CEOP interest.

(3) Application of CEOP product to CliC interest/studies, snow and ice changes, had certain limitation due to short-duration of the data-set, and coverage extent of the data-set.

(4) Snow-atmosphere interaction study may be a topic productive from use of CEOP data, but it is limited at the moment.

(5) Snow-cover, cold region precipitation may be the most fruitful area for collaboration at the moment.

(6) Involvement of wider cryosphere community may be essential. For example, Institutes on cold region studies, such as IARC, Asian groups for High Asia studies lead by China CliC group, may be important for cold region studies in CEOP.