GWSP Activities Regarding Asian Regions

アジア地域のGWSP活動について

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GWSP SSC / Chinese Academy of Sciences

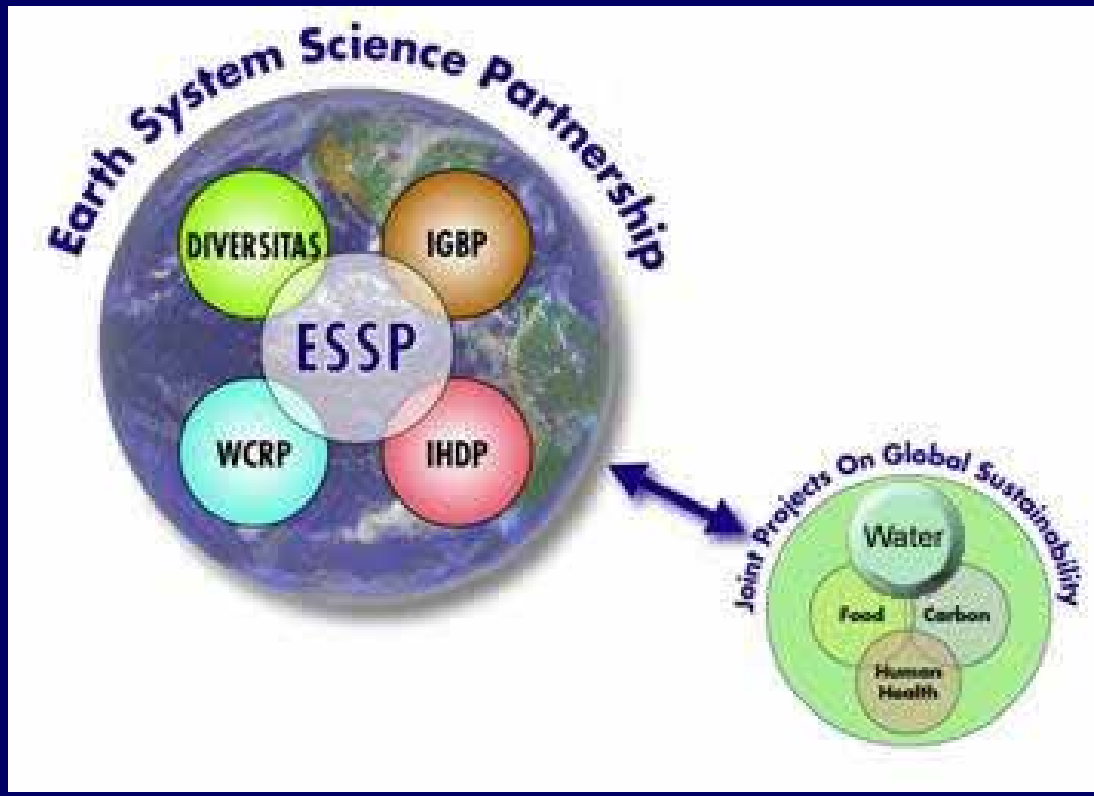
Global Water System Project

Chinese National Committee

GWSP was initiated by ESSP

The Global Water System Project (GWSP) is a newly established joint project by

- **DIVERSITAS,**
- **IGBP**
- **IHDP**
- **and WCRP.**



Mission of Global Water System Project (GWSP/ ESSP)

The mission of the GWSP is to understand the ways in which the humans influence dynamics of the global water system and to inform decision makers on how environmental and socioeconomic consequences of these impacts can be mitigated.

Mission of Global Water System Project (GWSP/ ESSP)

Getting better understanding to answer:

- **What are the impacts of human activities on GWSP?**
- **What are the impact mechanism incl. magnitude and direction?**
- **What are the consequences and how do decision-makers mitigate the consequences?**

GWSP Asia Network initiatives

- GWSP Asia Network was established in 2005, in Japan with first workshop;
- Second Workshop of GWSP Asia Network was held in Guanzhou,China, June 2006

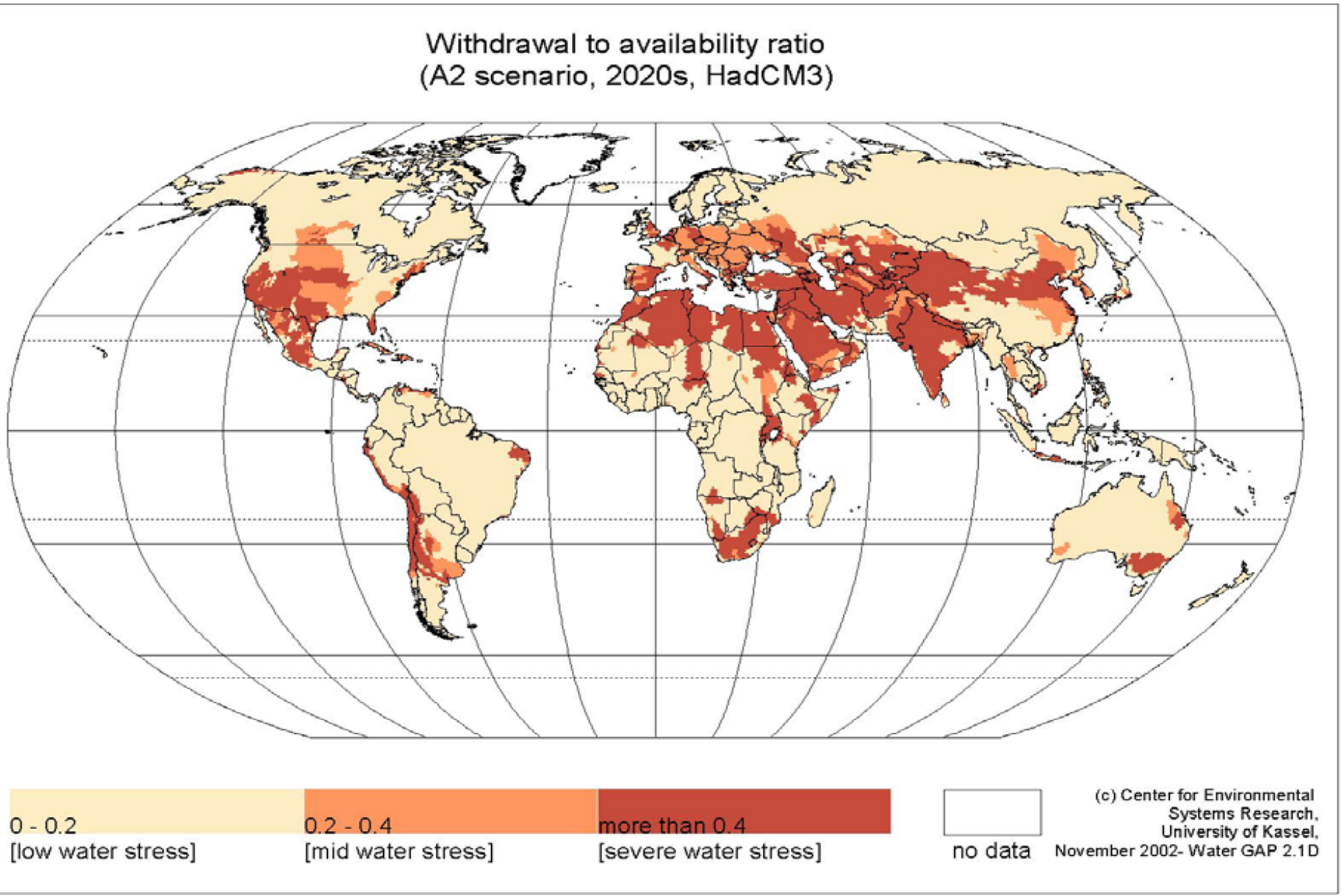
GWSP Asia Network Foci:

- Mega-city / Urbanization impacts on water systems;
- Dams / Hydro-structures on water systems;
- Land cover / use impacts on water systems;
- Others such as coastal region / islands

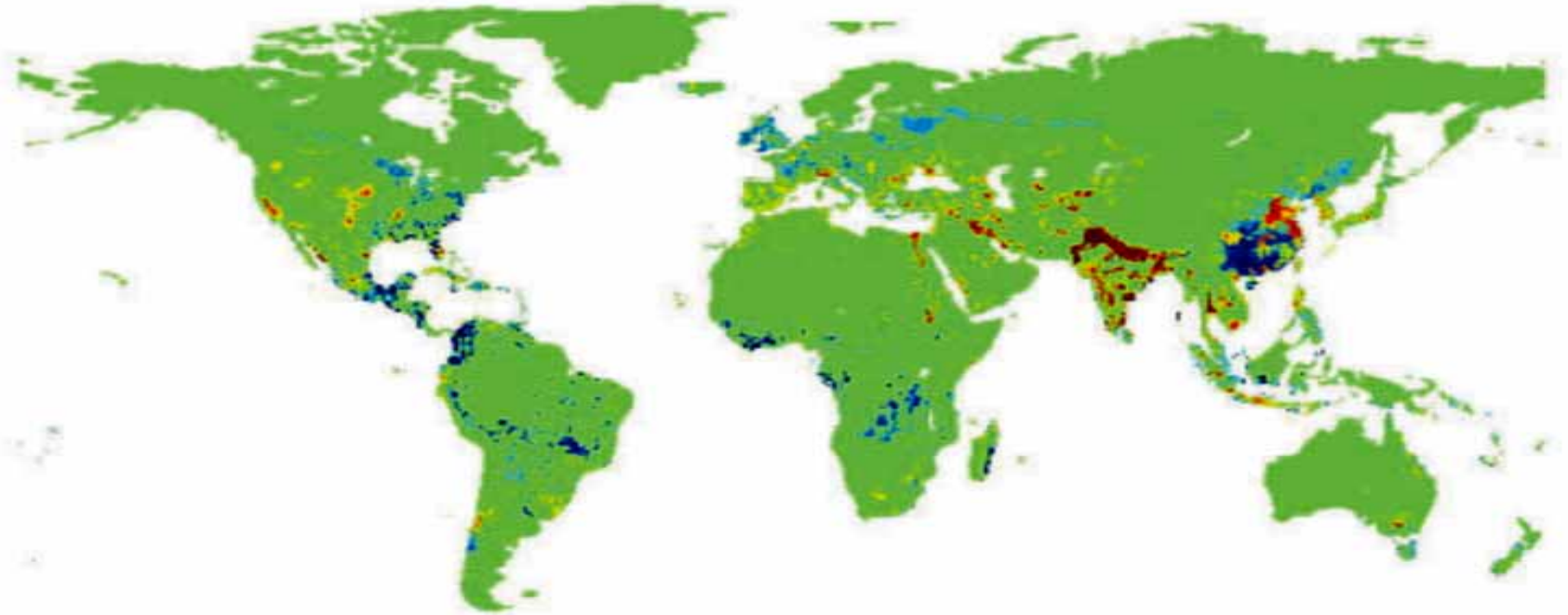
MAJOR CONCERN OF GWSP

- Water withdraw implications
- Virtual water in world socio-economy
- Land cover and land use implication
- Urbanization implications
- Dams and hydraulic structures implications

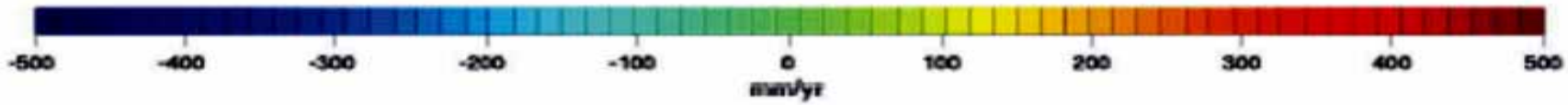
Water Exploitation Ratio Scenario Estimated



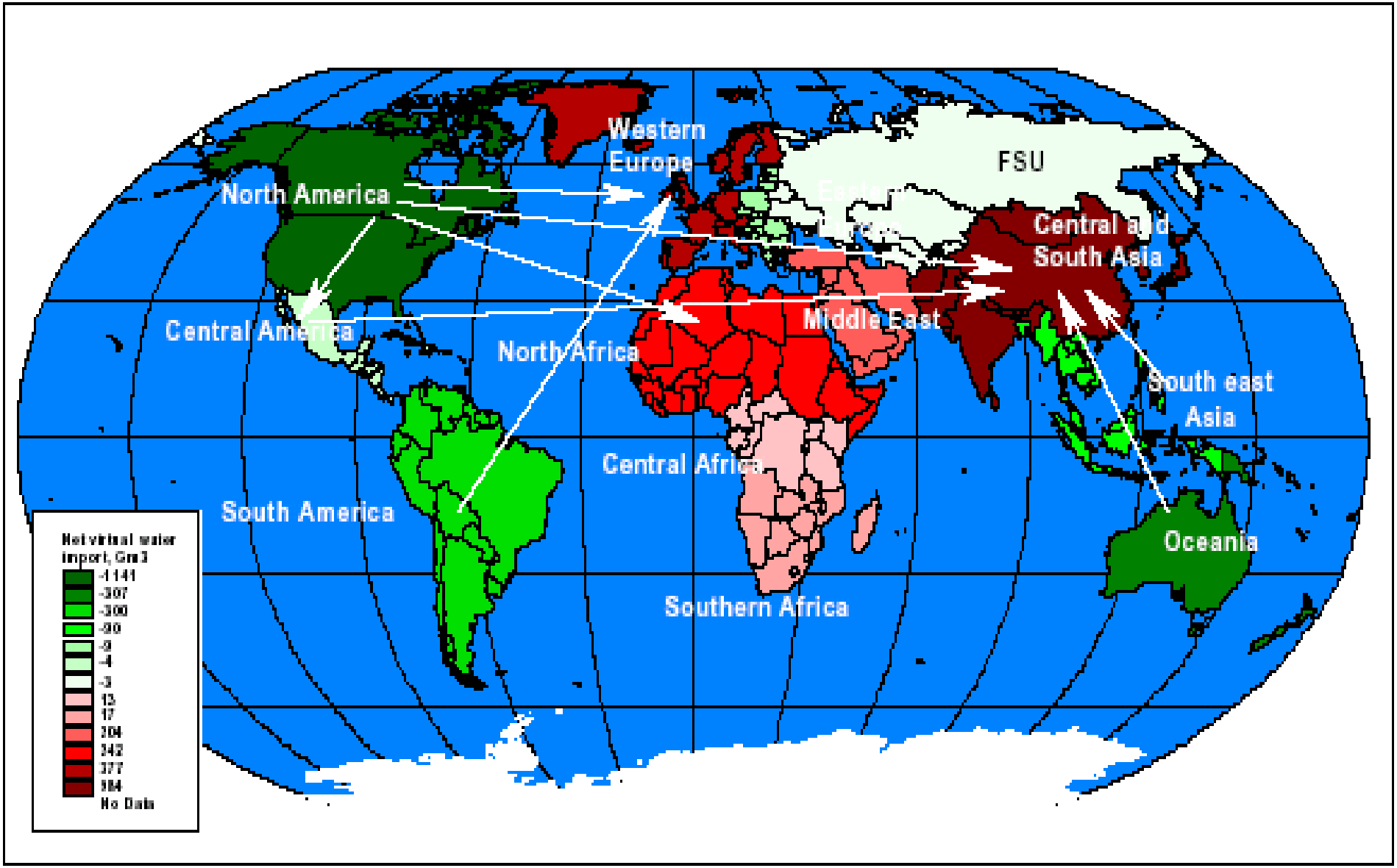
Water Stress Scenario for 2020



Changing ET from deforestation & irrigation (Gordon 2003)



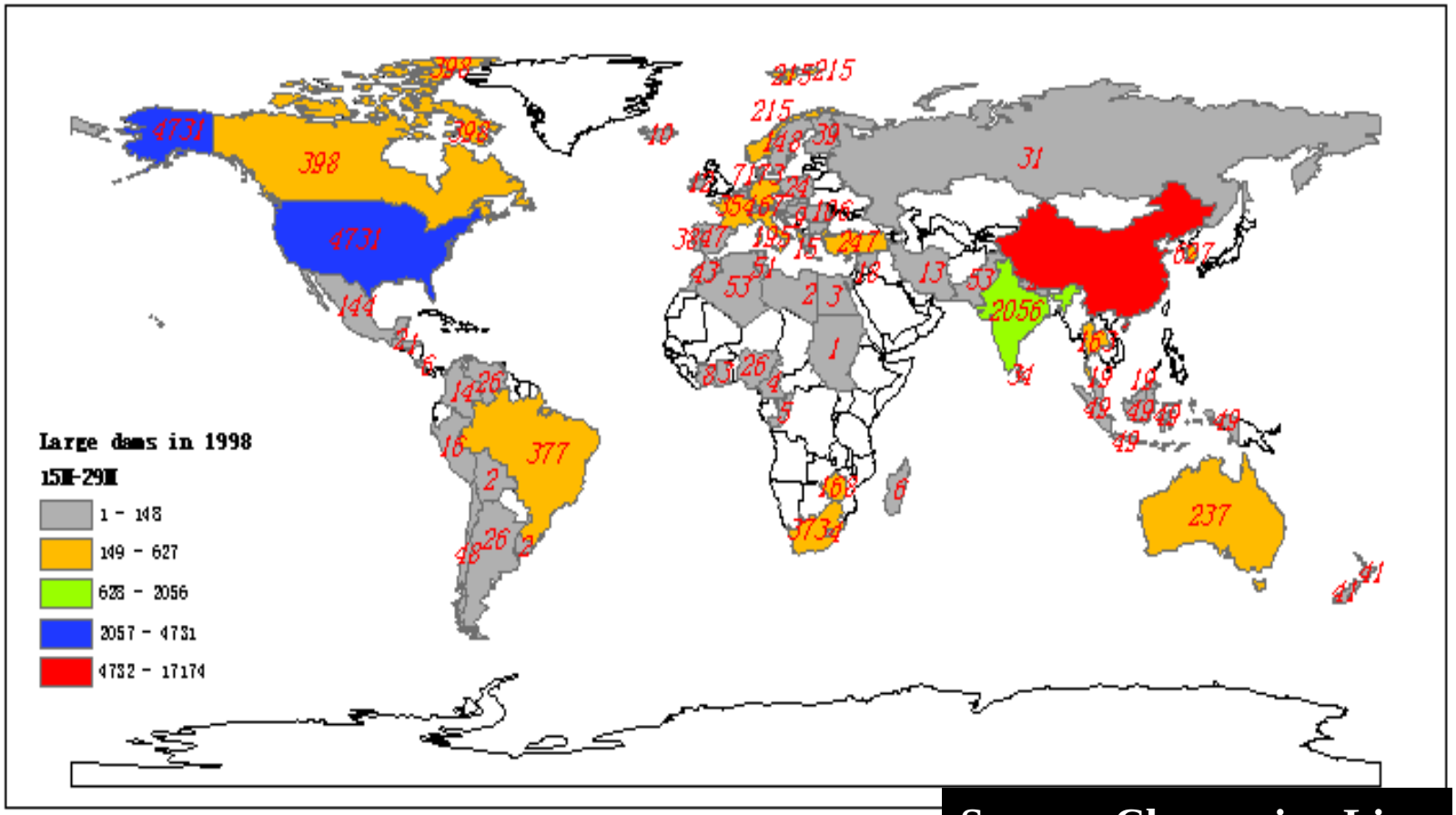
Virtual Water Trade: The socio-economic impacts



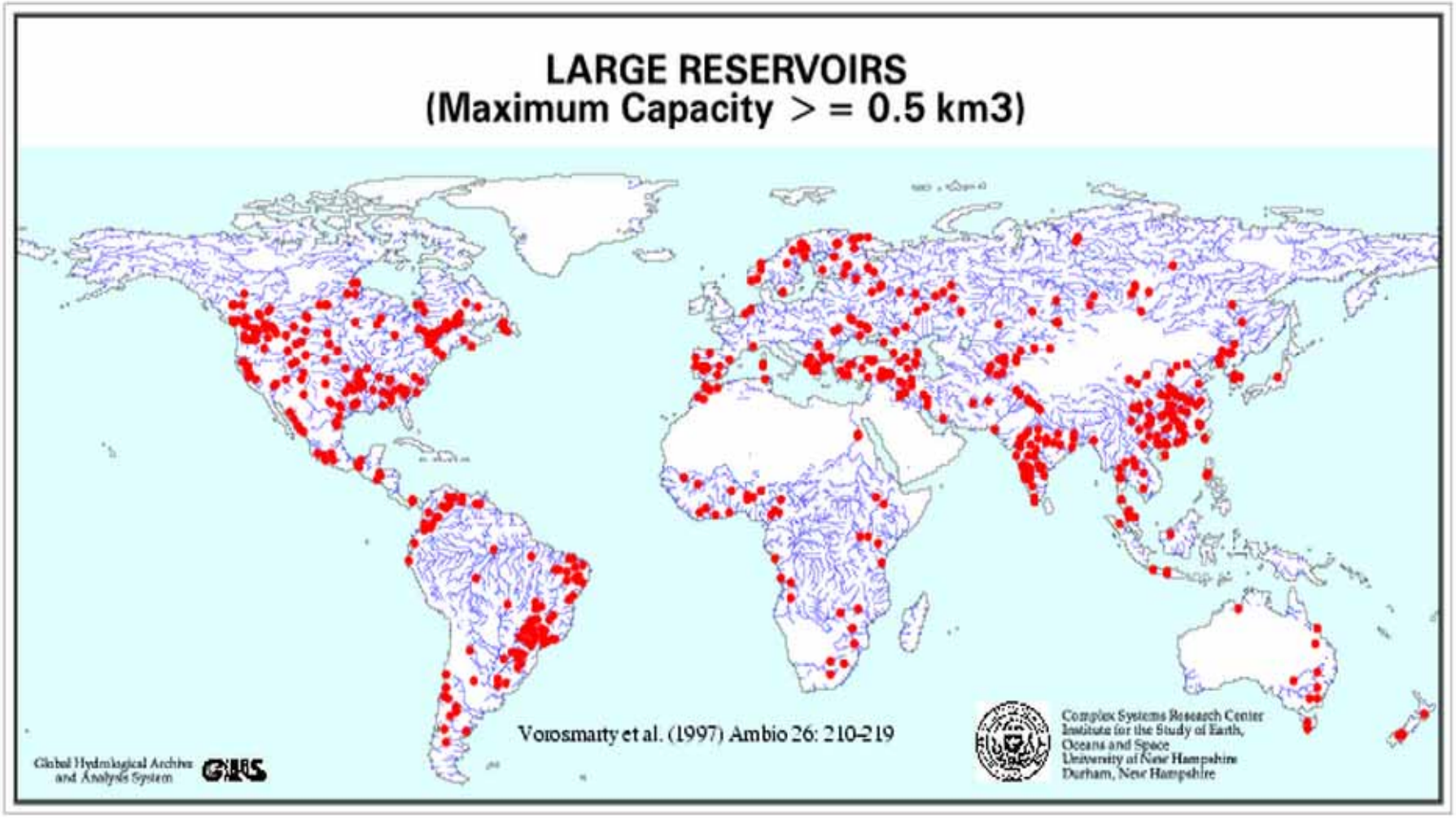
Urban sewage resulting in pollution of water bodies (China)

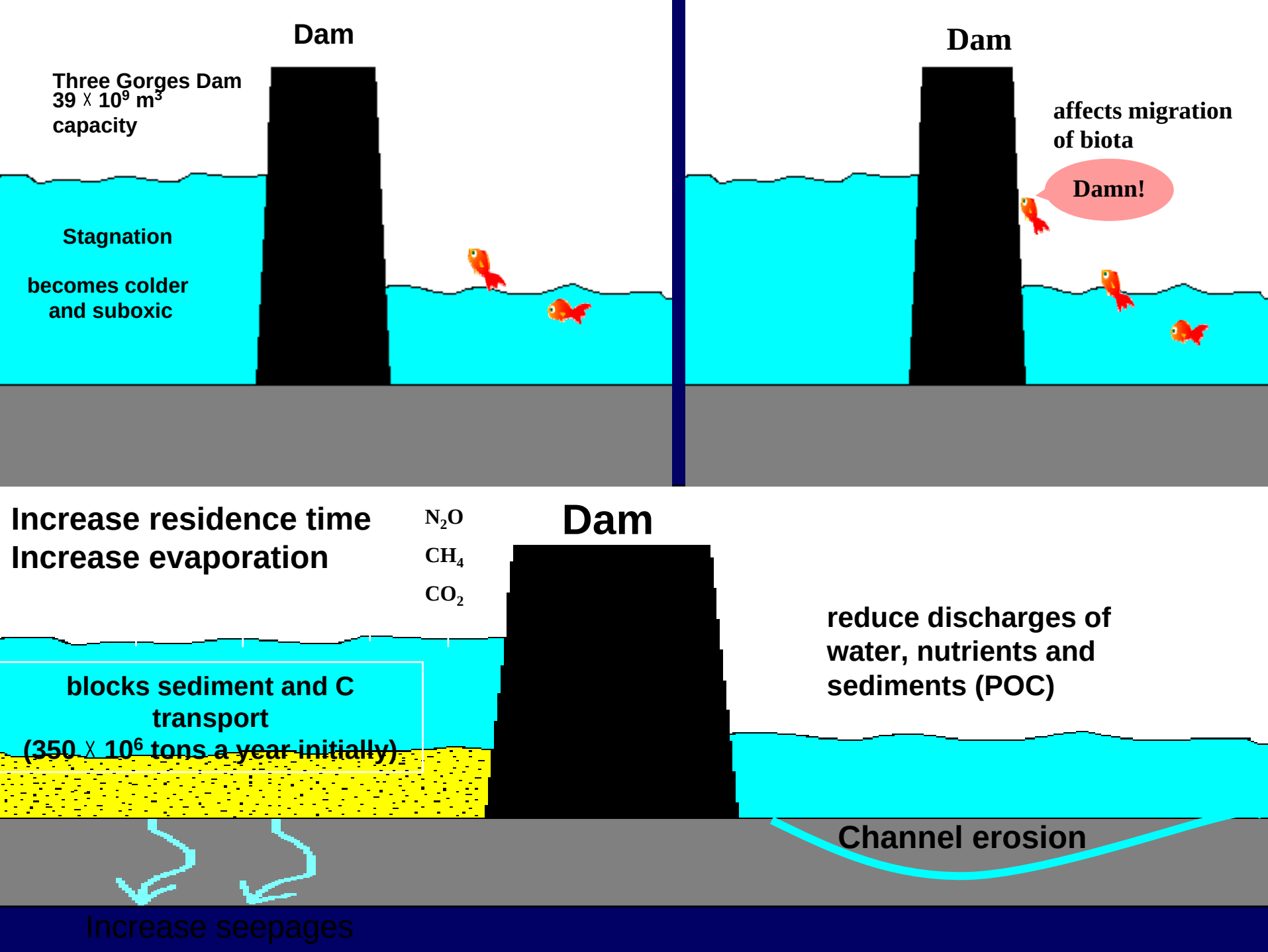
Dams have developed rapidly in the world

What are the consequences?



Distribution of world large reservoirs




Dam
Three Gorges Dam
39 X 10^9 m^3
capacity
Stagnation
becomes colder
and suboxic
Dam
affects migration
of biota
Damn!
Increase residence time
Increase evaporation
N2O
CH4
CO2
Dam
reduce discharges of
water, nutrients and
sediments (POC)
blocks sediment and C
transport
(350 X 10^6 tons a year initially)
Channel erosion
Increase seepages

Establishing Database for GWSP Asia Network

Geo-referenced Database

- Geo-referenced database is able to contribute to new database of GWSP and GWSP-Asia (WG-1).
- For scientific analysis, geospatial information is needed to use the model, such as Global river network, distributed hydrological model.
- In order to develop consistent database, we need to collaborate to develop database and share the information.

Suggested by Jun Magome et al

GWSP Data Strategy suggested by GWSP SSC Co-chair *Charles Vörösmarty* :

(1) Identify the Major "Data-Hungry" Science and Policy Targets
(2) Execute a Data Needs Assessment
(3) Execute a Technology Needs Assessment
(4) Identify a Blueprint for GWSP Data Support
(5) Apply Data to Address GWSP Framework Goals
(6) Producing the GWSP Information Products

Global Dam-DB Effort

- First workshop in April 2006
- Consolidation of existing efforts
- Setting geographical location to dams
- Currently involved
  - Greifswald Univesity Dam Database
  - NOAA DB on Californian Dams
  - Umea University/TNC Dam Database
  - Global Lakes and Wetlands (GLWD)
  - FAO African Dams Database
  - University of Yamanashi, Global Dam & Reservoir Database
  - Eldred2 (European Lakes and Reservoirs database)
  - UNH and UNH/NEWS Dam Database

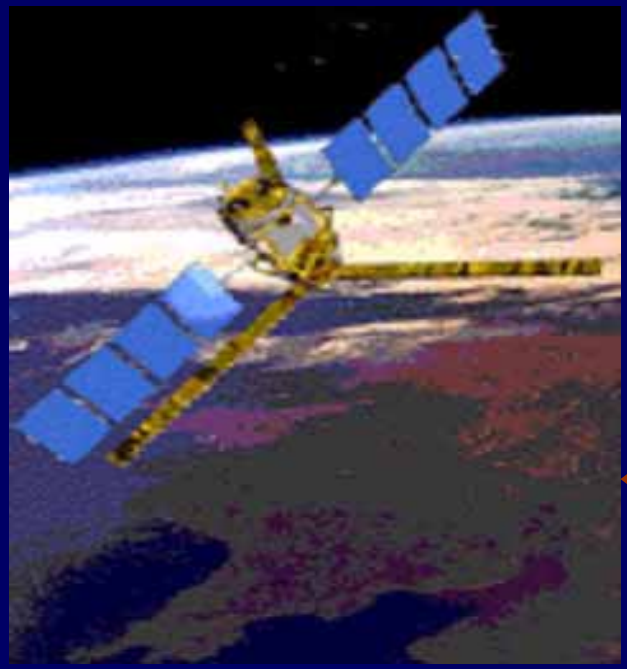
(Marcel Endejan)

Land cover/use change database

"Land cover/use changes alter the water and material cycles in Asia"

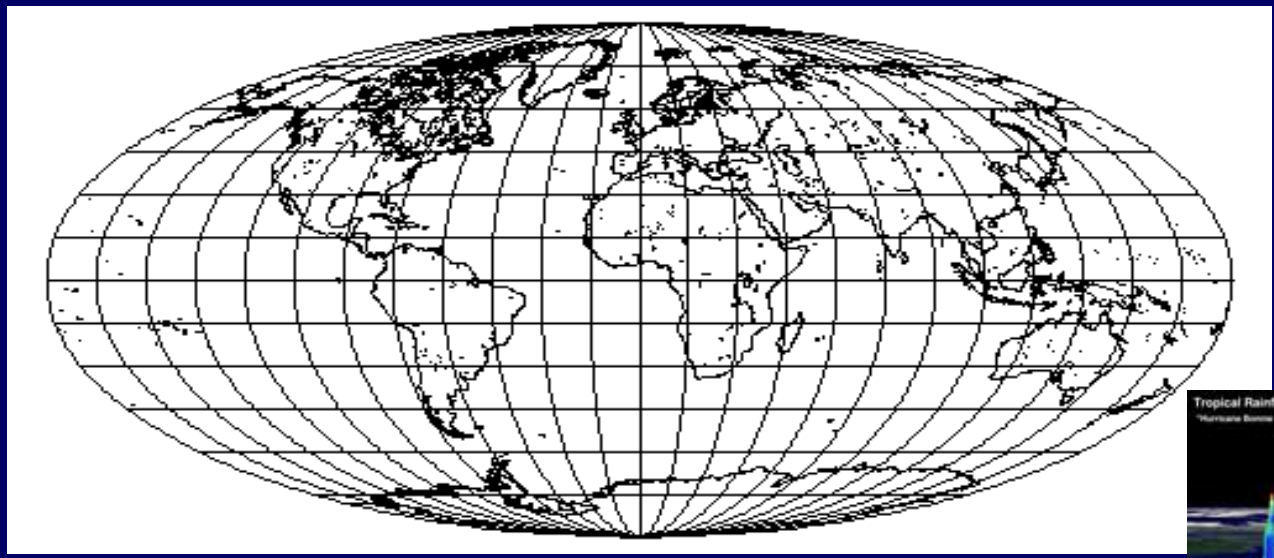
- How much land cover/use changes do alter the evapotranspiration ?
- How much land cover/use changes do alter the river discharge ?
- How much land cover/use changes do alter the groundwater flow system (groundwater recharge, storage, discharge)?
- How much land cover/use changes do alter the ecosystem ? **(Suggested by Makoto Taniguchi)**

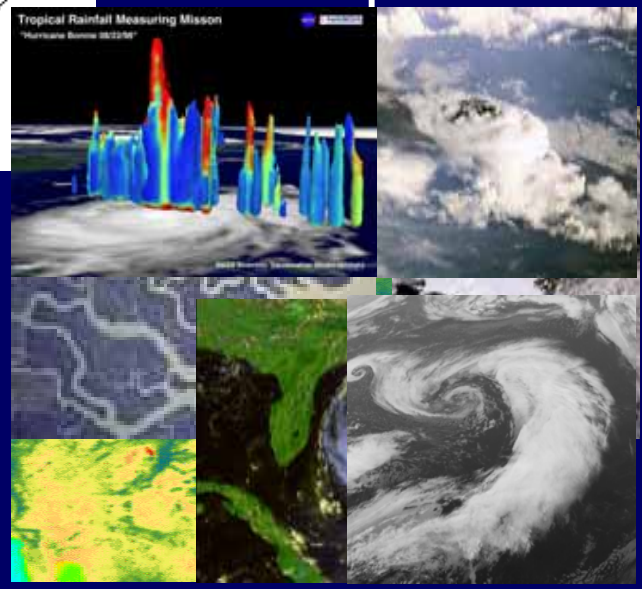
A Research Plan on Water Cycle Studies Associated with GWSP



Need: Advance Understanding & Model Physics
Importance to study Multi-scale Process

Climate models' grid-box representation of Earth's processes... Each grid-box can only represent the "average" conditions of its area.



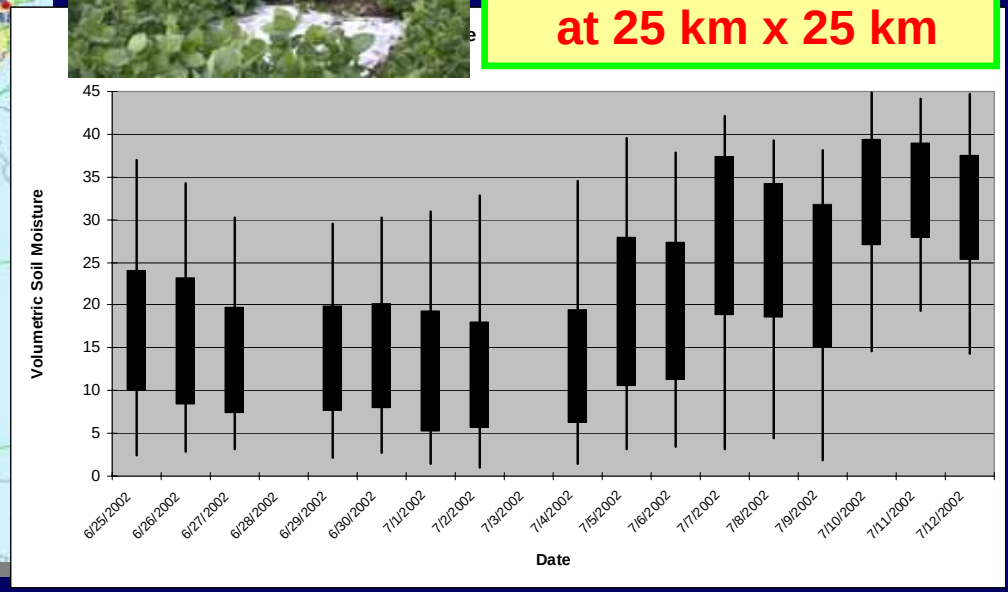


However, controlling processes of the water cycle (e.g. precipitation) vary over much smaller areas.

Problems Current Observation System

- In situ sampling in soil moisture is far too sparse and monitoring on global scale infeasible without remote sensing
- Are these point observations relevant to that at scales of the prediction models?

Example：ground soil moisture distribution Measurements at 25 km x 25 km



Large Spatial Variability in Soil Moisture

Applications require spatial and temporal distributed information ← remote sensing measurements

Suggestions to Research Focus

Purpose: Prediction Model

Model vs. Observations - not only a parameter or a process but also each physical process of all components in climatic system

Regional responses:

Connection to national managements

Key to success - Important Controlling Process

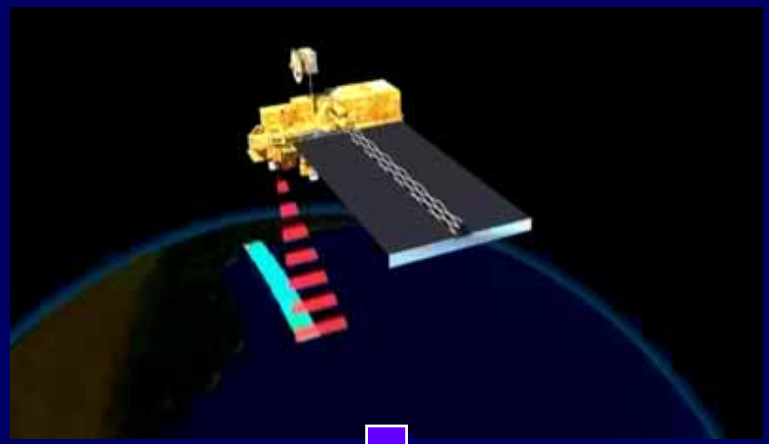
Modeling - multi – scales – systems: Up/Down scaling to catch up the important controlling processes

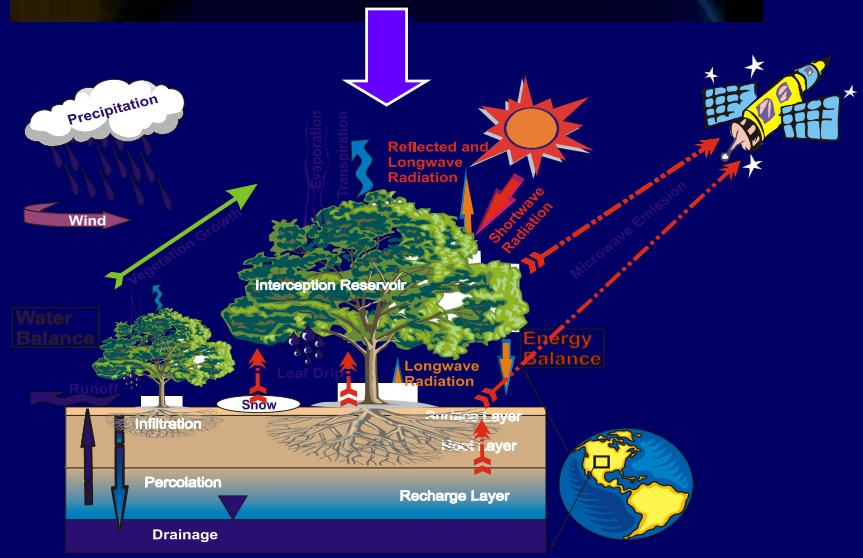
Key to success - Improving Observation System

Satellite remote sensing + tradition systems for model initialization, parameterization, updating, and calibrating

Why Remote Sensing?

Remote Sensing +tradition measurements → more accurate spatial and temporal distribution information → new observation system



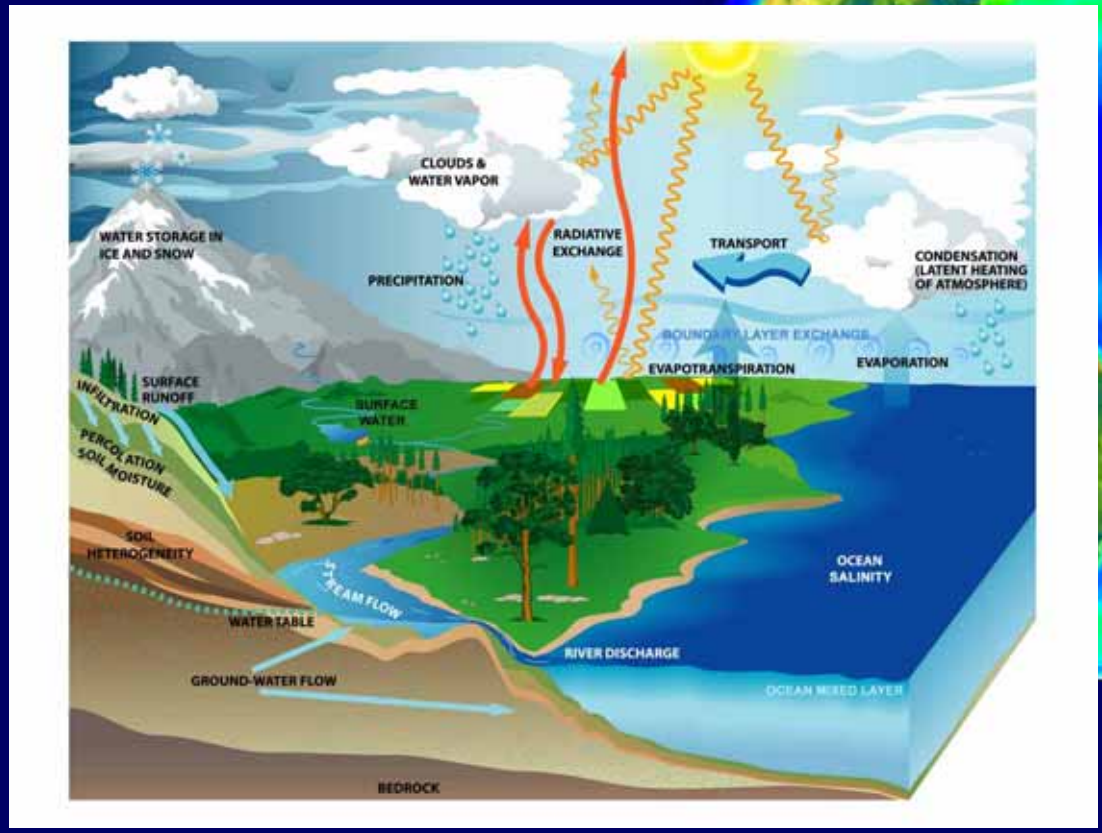


New Observation System

Advance new understanding on earth system science

Earth Climate - Major Cycles

1. carbon cycle through atmosphere, terrestrial vegetation, oceans sediments, and lithosphere
2. Water cycle through atmosphere, rivers, and ocean
   - ✓ Precipitation
   - – Evaporation
   - ✓ Soil moisture
   - ✓ Snow, glacier
   - ✓ Runoff
   - ✓ Ground water
   - Water vapor
   - Polar ice
3. Radiation cycle



Land Surface Observations

Land Surface Parameters	Remote Sensing
Precipitation	SSM/I, TRMM, AMSR-E, GOES, AVHRR
Radiation	MODIS, GOES, AVHRR
Surface temprature	AVHRR, MODIS, SSM/I, GOES
Soil moisture	TRMM, SSM/I, AMSR-E, HYDROS, ESTAR, NOHRSC, SMOS
Ground Water	GRACE
Snow cover, depth & water	AVHRR, MODIS, SSM/I, AMSR-E, GOES,NWCC, NOHRSC
Streamflow	Laser/Radar, Altimeter
Vegetation	AVHRR, TM, VCL, MODIS, GOES
Others: Soils, Latent & Sensible heat fluxes, etc	MODIS ….

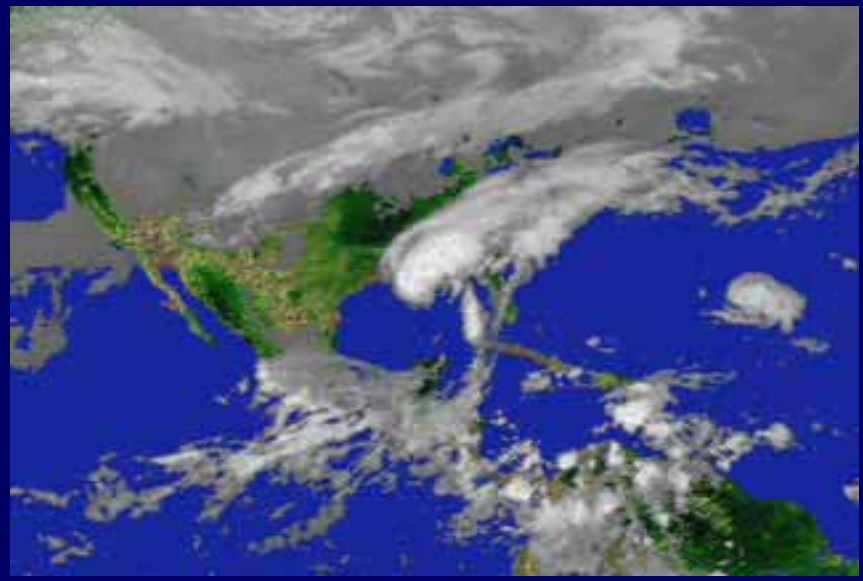
Remote Sensing Precipitation

- **Current available sensors**

1. **Passive Microwave: SSM/I, SSMR, TOPEX/Poseidon, AMSR-E, TMI, and WINSAT**
2. **Active Microwave: PR on TRMM**

- **Future observing system: GPM**

- **TRMM is providing insight into the complex atmospheric processes that influence rainfall patterns**

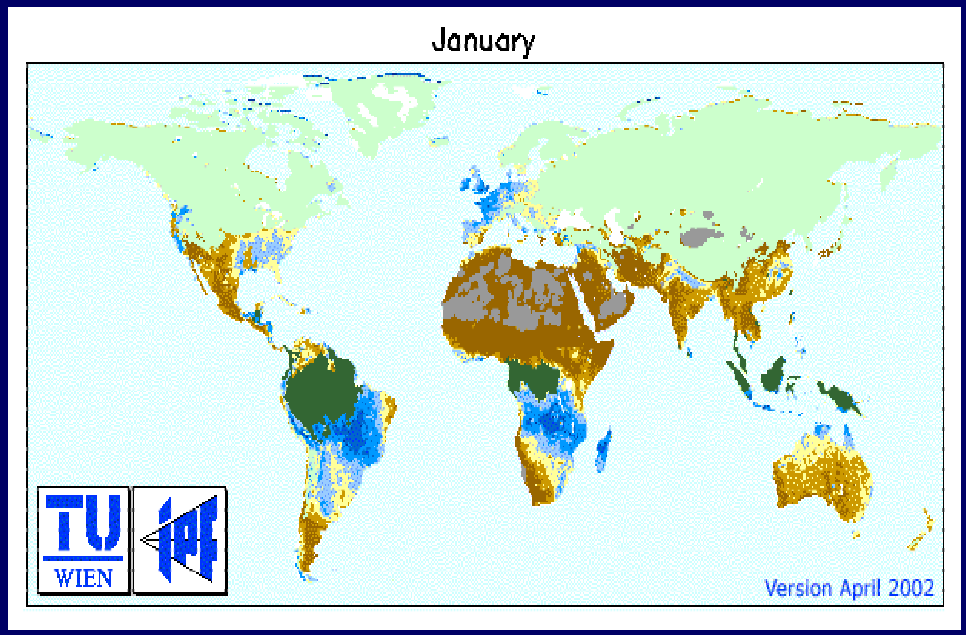


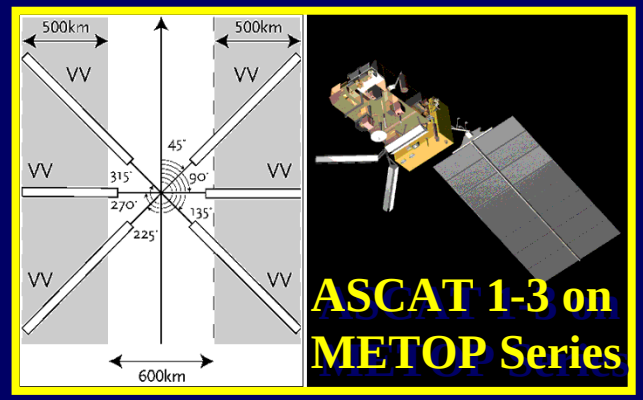
Current /Future Sensors for Soil Moisture

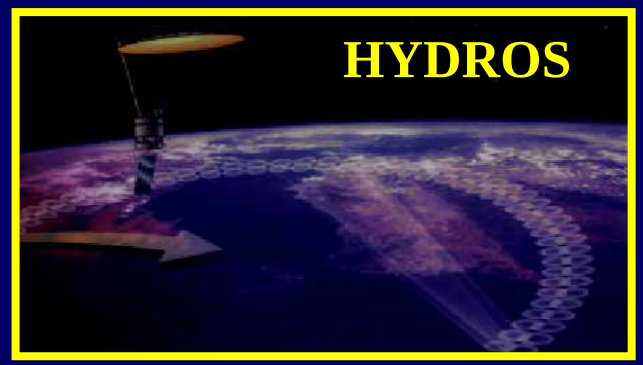
Current sensors:

- SSM/I(R) 1978 – current
- TMI since 1998
- AMSR-E since 2002
- ERS-1/2 scatterometers since 1991

10 years Global Monthly Mean Soil Moisture

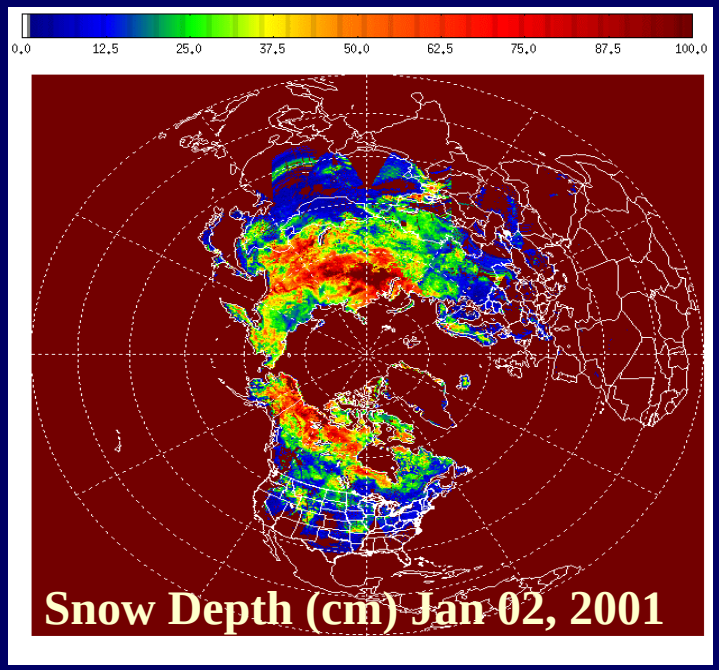






Remote Sensing Of Snow Properties

- **Optical Sensors**
  - Radiation balance (albedo)
  - Snow extent
- **Microwave Remote Sensing**
  - Snow wetness
  - Snow water equivalent
  - Snow extent



Energy and Mass balance calculations

Runoff / Surface Water

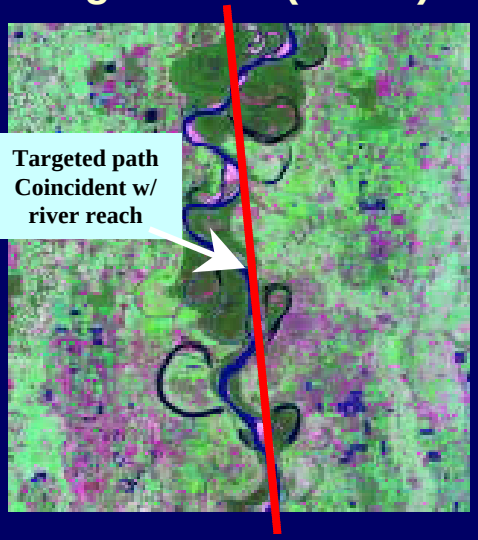
Stream Discharge and Surface Water Height from Space

Motivation:

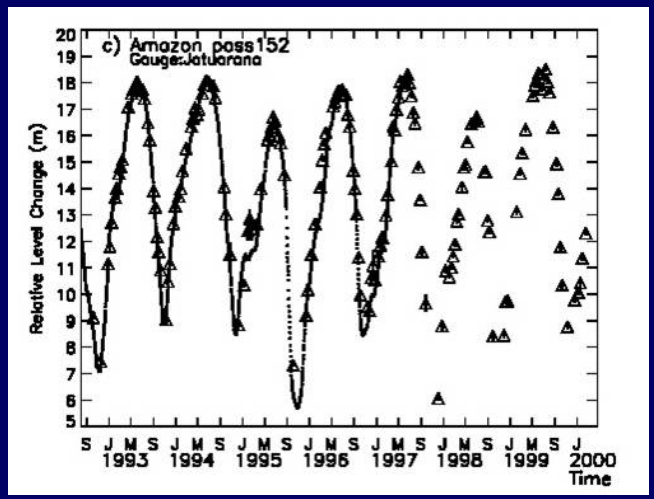
- **critical water cycle component**
- **essential for water resource planning.**
- **stream discharge and water height data are difficult to obtain**

Mission Concepts:

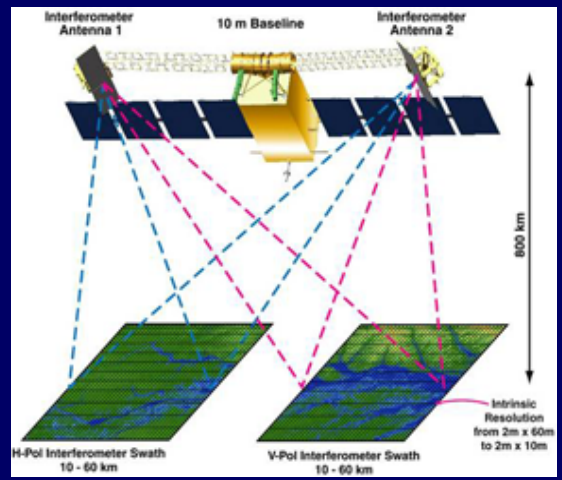
Laser Altimetry Concept
e.g. ICESat (GSFC)



Radar Altimetry Concept
e.g. Topex/Poseidon over Amazon R.



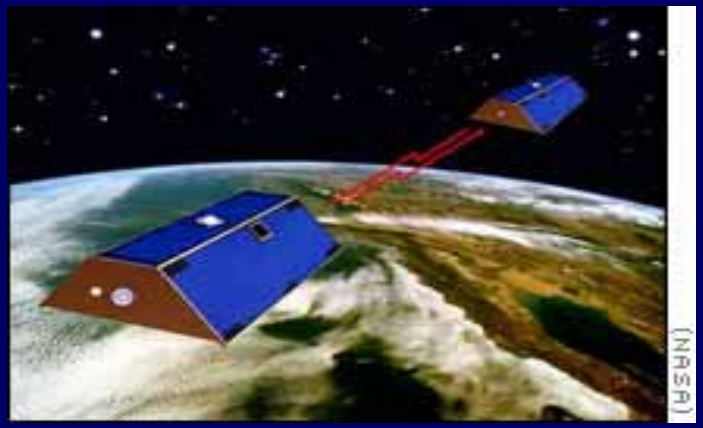
Interferometer Concept
(JPL)

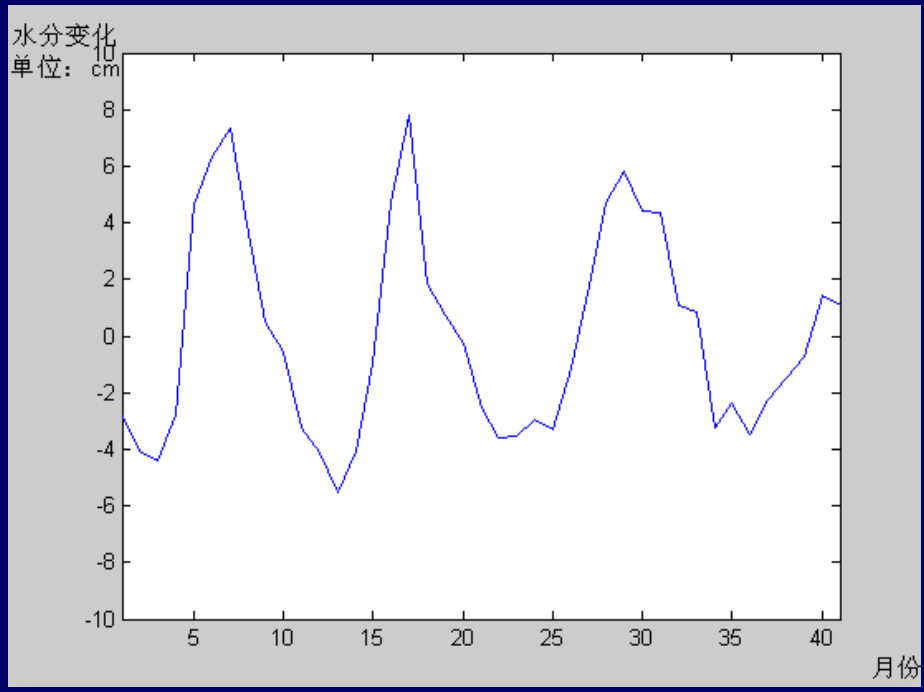


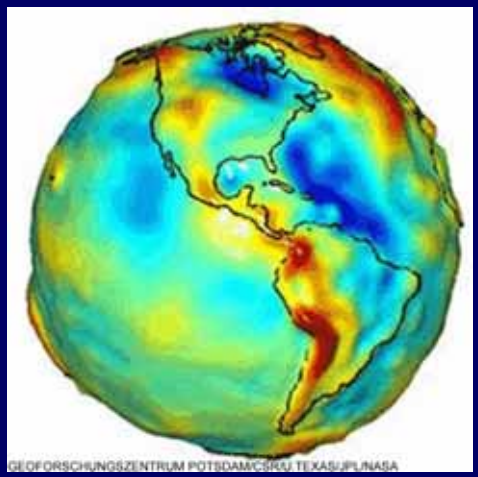
Observing the Global Water Cycle

GRACE: *groundwater, soil moisture, snow, surface water*

GRACE senses water storage changes as variations in the Earth's gravity field

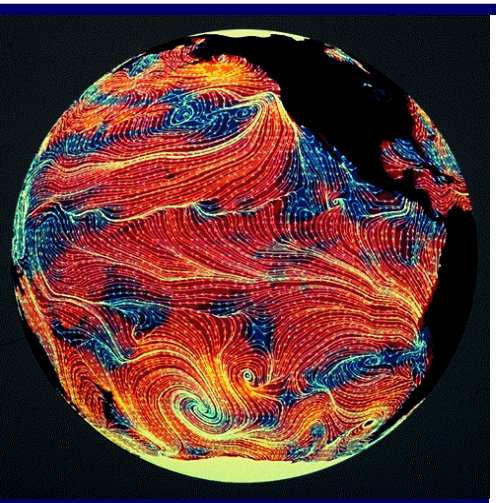




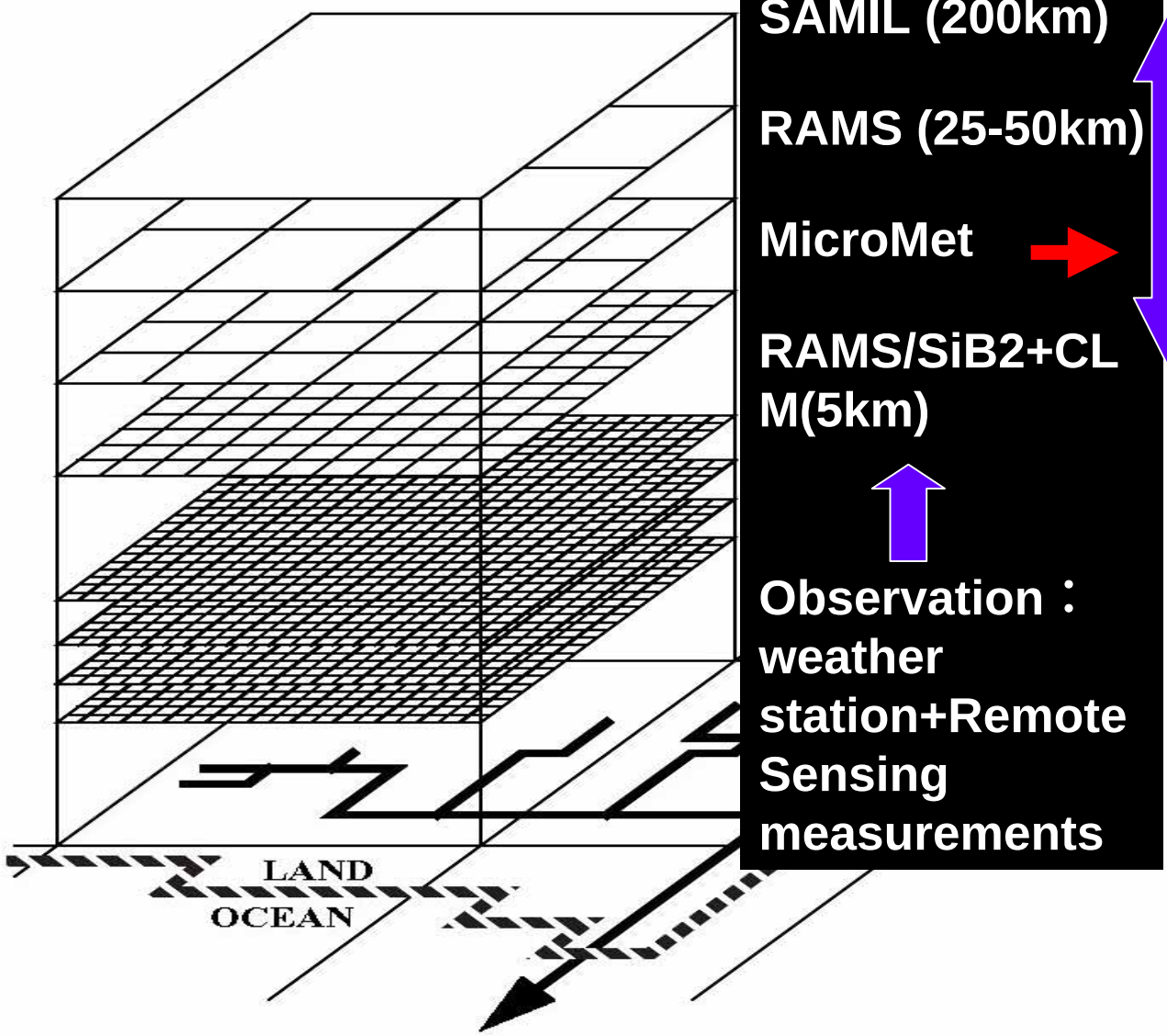


The variation of monthly terrestrial water storage measured from GRACE over Tibet Plateau , Feb. 2003-Aug. 2006

Concept Of Two-Way Nesting Model System From Global, To Regional, To Local Spatial Scales



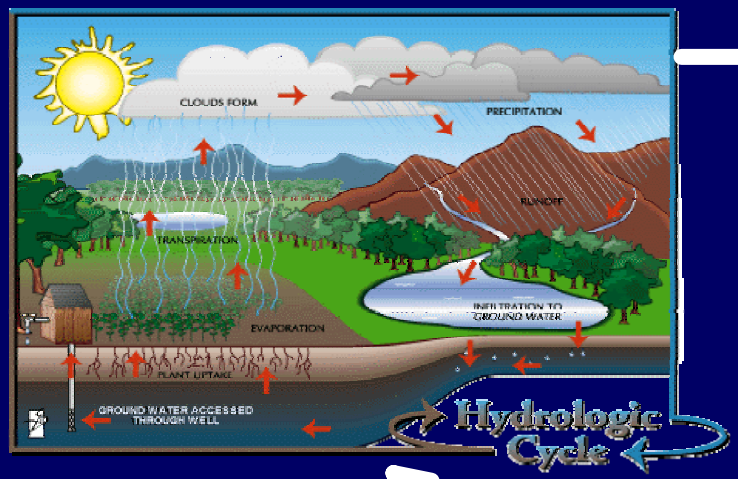
Schematic of two-way nesting model system from global, to regional, to local spatial scales



Data Assimilation System With Satellite Observation

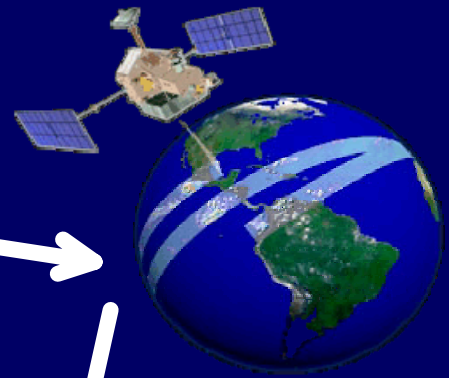
Atmospheric forcing

Land Surface Model



Satellite Data Simulation System

Satellite Observation



Data Analysis System

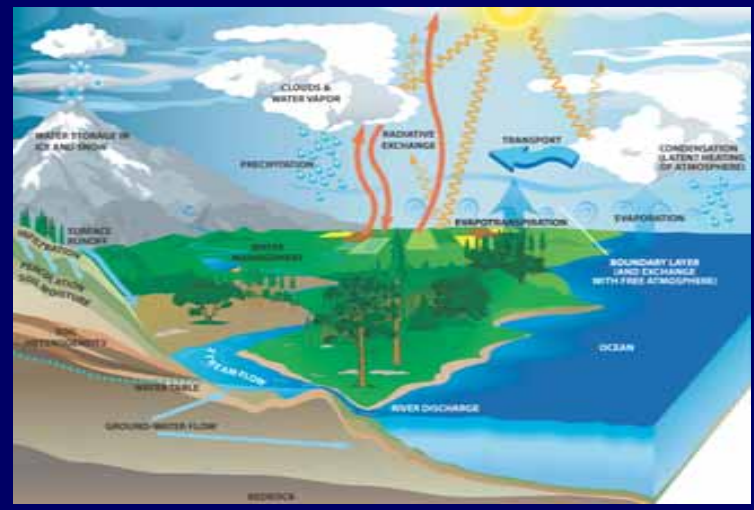
Data Assimilation System

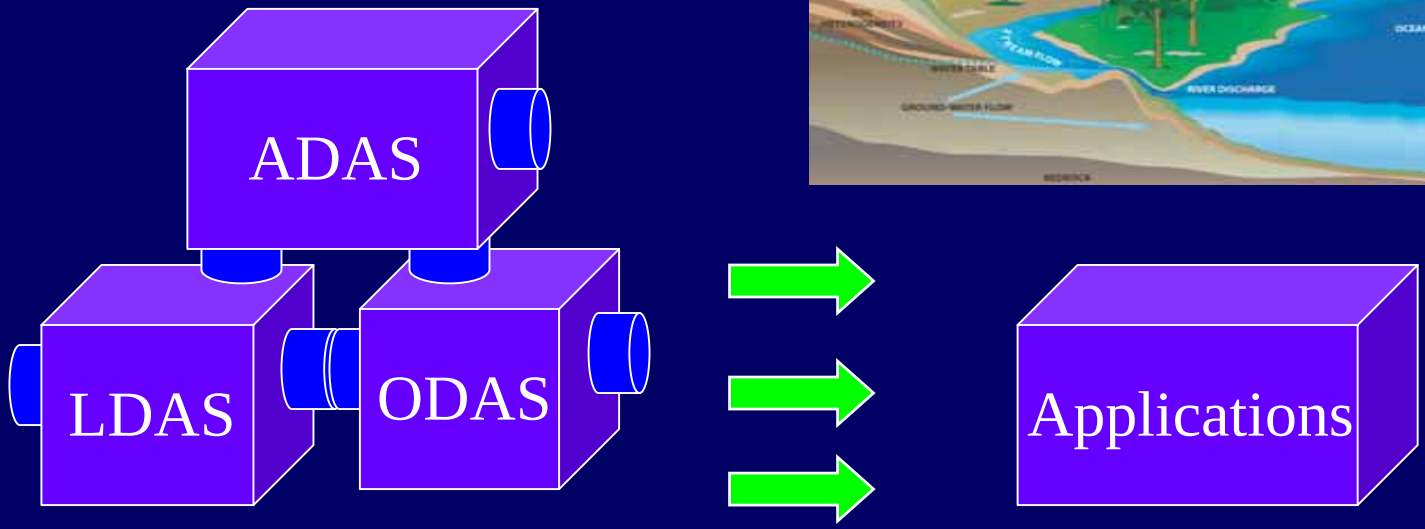
Climate, Meteorology, Land Surface data Assimilation

Long Term Research Objective

Improved Observing System

\+ Stationary observations





Long term Objective: Coupled Earth System Model with

1) Atmospheric, Land and Ocean Data Assimilation and prediction
2) Improved observing system for model initialization, input forcing parameters, and calibration functions

Global Water System Project