

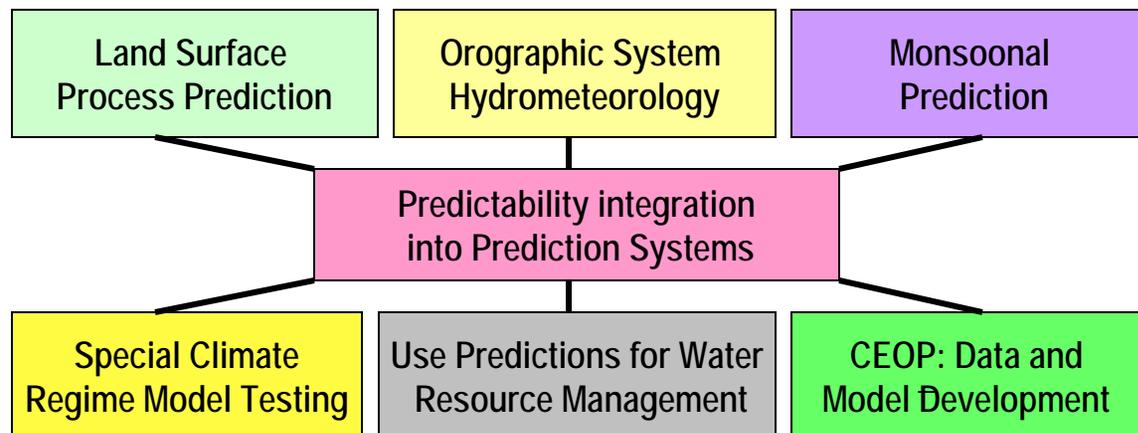
# GEWEX Americas Prediction Project (GAPP)

The **mission** of GAPP is to demonstrate skill in predicting changes in water resources over intraseasonal-to-interannual time scales, as an integral part of the climate system.

## Science Objectives:

- (i) Prediction: Develop and demonstrate a capability to make **reliable monthly to seasonal predictions of precipitation and land-surface hydrologic variables** through improved understanding and representation of land surface and related hydrometeorological and boundary layer processes in climate prediction models.
- (ii) Decision support: **Develop application products for resource managers** by interpreting and transferring the results of improved climate predictions for the optimal management of water resources.

## GAPP Components



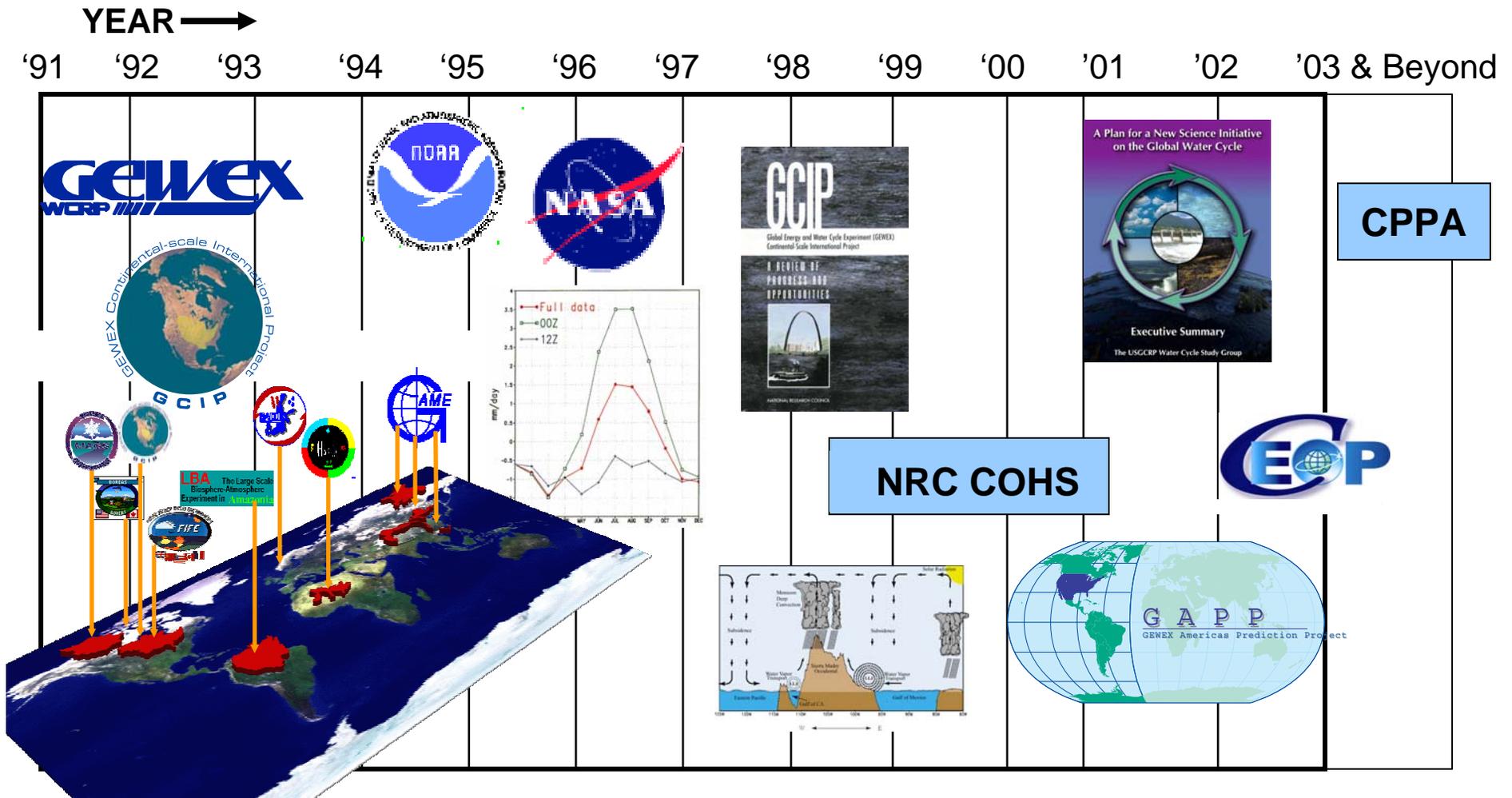
# GAPP Background:

GAPP has a successful history rooted in *international* and *interagency* cooperation, scientific advisement, and operational relevance.

*International:* WCRP-UNESCO-IGOS-IAHS-IGBP

*Interagency:* NOAA-NASA-BoR-USGS-USDA-DOE-USACE

*Research Community:* ~50 university, federal, state, and private researchers



## 2. Land Memory and Variability Studies

### *Scientific Rational*

- Multi-month land-memory mechanisms: (i) the storage of water near the surface as soil moisture (ii) its storage on the surface as snow and ice, and (iii) nature and seasonal progression of growing vegetation.
- Understanding the strength of these relationships for different geographical regions and seasons, and their robustness over time and models remains a challenge

### *Activities:*

1. Quantifying the strength of land memory processes
  - using existing data including NARR, Retroactive LDAS, satellite data
2. Understanding the spatial and temporal extent of the land memory signal
3. Quantifying the role of land memory in climate variability and prediction
4. Understanding land memory and variability across modeling scales

# 3. Hydrometeorology of Orographic Systems

## *Scientific Rational*

- In regions with marked topography, climate conditions such as temperature, precipitation, and snow can be significantly modulated by orographic features.
- Major gaps remain in our understanding of the natural evolution of clouds and precipitation in mountainous terrain, especially at horizontal scales less than 100 km.

## *Activities:*

1. Diagnostic analyses of existing hydrometeorological data
2. Investigation of the mean seasonal cycle and predictability of its variability
3. Integrate atmospheric elements with surface hydrologic components
4. Carry out hydrometeorological model experiments
5. Apply climate and hydrologic models in seasonal climate forecasting for basins with complex terrain

## 4. Warm Season Precipitation

### *Scientific Rational*

- Documenting the major elements of the NAMS regime and its variability, within the context of the evolving land surface-atmosphere-ocean annual cycle, is fundamental for improving warm season precipitation prediction
- The relative importance of land and ocean influences on North American precipitation changes with the seasons.
- The land surface has many memory mechanisms beyond soil moisture, such as snow extent, vegetation, and aerosols that must be understood.

### *Activities:*

1. improved convective parameterization in climate/forecasting models
2. the North American monsoon system, with participation in NAME
3. utilizing GAPP research to enhance the operational skill in warm season precipitation forecasting.

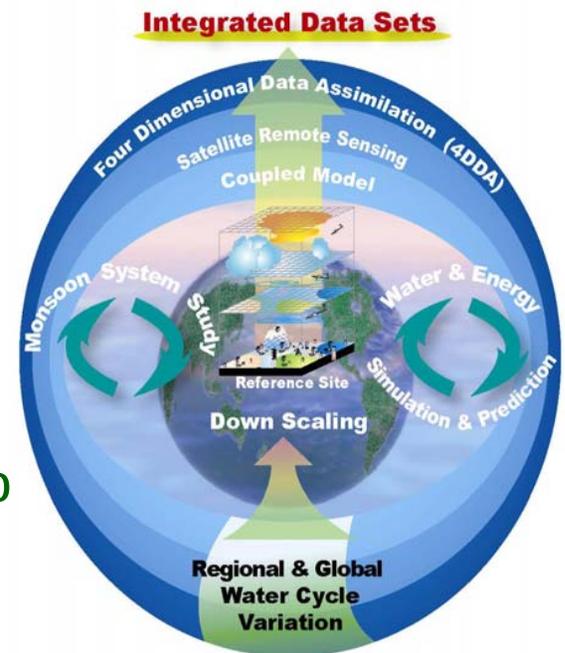
# 5. Coordinated Enhanced Observing System CEOP

## *Scientific Rational*

- Focused on the measurement, understanding, and modeling of water and energy cycles within the climate system.
- Motivated by the synchronism of the new generation of Earth observing satellites and GEWEX-CSEs.
- Primary goal to develop a consistent data set for 2001-2004 to support research objectives in climate prediction and monsoon system studies.

## *Activities:*

1. Provide data (in-situ, remote sensing, and model output) to CEOP and data management
2. Demonstrate the utility of satellite data in research and climate prediction
3. Evaluate the performance of global and regional models across climate regimes and time scales.
  - Water and Energy Simulation and Prediction (WESP)
  - Monsoon Studies



## 6. Operational Seasonal Climate Prediction: Components from GAPP

### *Scientific Rational*

- This section describes the infrastructure for constructing and achieving a multi-scale, multi-model, end-to-end, ensemble seasonal prediction system – to be first demonstrated in hindcast mode and then secondly transitioned into operations.

### *Activities:*

1. **Land surface model improvements:** Providing improved land-model components for the coupled land/atmosphere prediction models
2. **Land Data Assimilation Systems:** Developing and implementing global and regional land data assimilation systems
3. **Regional Climate Modeling:** Developing, demonstrating and implementing regional climate models.
4. **Ensemble Hydrologic Prediction**

## 7. Hydrology and Water Resource Applications

### *Scientific Rational*

- Improvements in seasonal climate prediction obtained have the potential to improve management of water resources systems.
- Hydrologic forecast technologies are now emerging that can provide reliable forecasts with lead times of weeks or months.
- We must translate information on seasonal to interannual variations in climate into information on the probability of future streamflow conditions
- Water managers must understand the nature of probabilistic forecasts, and adapt management decision making for such information.

### *Activities:*

1. Applications activities (demonstration projects) to evaluate and understand issues operational implementation of seasonal forecasting through partnering with NWS and other non-GAPP water users and agencies.

## 8. GAPP Remote Sensing Applications

### *Scientific Rational*

- Advances in continental and regional precipitation, surface soil-moisture, snow, surface soil freezing and thawing, surface inundation, river flow, and total terrestrial water-storage remote sensing provide the basis for a remote sensing research effort.
- Satellite data sets provide a valuable extension to conventional in-situ ground-based observations by providing continuous spatial coverage and repeat temporal coverage, which simplifies their use in modeling and assessment studies.

### *Activities:*

1. Demonstrate the usefulness of remote sensing to provide forcing and parameters for land surface hydrological models, model state constraints for data assimilation and prediction systems, and validation data (fluxes and states such as surface temperature and soil moisture content)
2. Demonstrate of terrestrial hydrologic states and fluxes for improved forecasting, and seasonal climate prediction
3. Compare satellite derived land surface products with observations made during field experiments, including NAME (soil moisture) and enhanced data sets from the GEWEX Coordinated Enhanced Observation Period (CEOP) reference sites.

## 9. GAPP Data Management

### *Rational*

- GAPP must development of a comprehensive and accessible database for the Continental-scale GAPP study area and establish an evolving program of model development that will permit observations and analyses to be extended spatially within GAPP or applied globally with new observations.
- These data sets will consist primarily of relevant data from existing in-situ, remote sensing, and model output sources and will also include special (surface, upper air, and satellite) meteorological and hydrological observations with increased spatial and temporal resolution.

### *Activities:*

1. Focus on the development of a comprehensive and accessible database for the Continental-scale GAPP study area that include data sets from existing in-situ, remote sensing, and model output sources, and includes special (surface, upper air, and satellite) meteorological and hydrological observations (e.g. CEOP).

# 10. GAPP Organizational Elements

## *Rational*

- *NOAA and NASA program managers are responsible for overall implementation, but receive scientific guidance and advice from the GAPP Scientific Advisory Group.*
- *The GAPP Data Management Committee coordinates data-related activities*
- *The GAPP Working Groups (WG), coordinate the transfer of research results across the program elements and have the responsibility to produce the GAPP research synthesis products that document the progress of GAPP research to the research goals of CPPA and NTHP.*

## *Activities:*

1. Science Advisory Group (SAG)
2. Data management committee
3. GAPP working groups
  - Predictability
  - Water Resources
  - Data and Observations
  - Joint GAPP-PACS NAME
4. 14 GAPP synthesis products

### ***GAPP Synthesis Products:***

***What are the key factors governing hydrologic predictability, and in particular, the ability to predict streamflow, evapotranspiration, and soil moisture?***

- Quantify the influence of land and ocean states on the seasonal prediction skill of precipitation and temperature within the GAPP domain. 2-4 years

***What is the role of hydrologic prediction in coupled land atmosphere modeling?***

- Quantify the sensitivity of seasonal climate predictions to land states, including soil moisture, snow, orography and vegetation. 2-4 years
- Assess and improve predictions of onset of the North American monsoon. 2-4 years
- Provide a regional reanalysis of the atmospheric and land surface states using state-of-the-science numerical modeling and data assimilation systems. 1-2 years

***How can improved modeling strategies, including land data assimilation and ensemble forecasting, best be implemented in a hydrologic prediction framework?***

- Quantify seasonal climate forecast skill and accuracy requirements for water resources applications. 2-4 years
- Develop and test procedures to assimilate new data products (e.g. satellite data sets) and off-line model outputs (e.g., from LDAS systems) to provide improved weather and seasonal forecasts. 1-3 years
- Quantify the value added to seasonal prediction skill from ensemble regional climate models relative to predictions from their parent global model within the GAPP domain. 2-4 years

***GAPP Science Question: How can the scientific contributions of GAPP, in areas such as coupled land-atmosphere modeling and seasonal forecasting, best be transferred to the operational hydrology and water resources community?***

- Develop and evaluate the usefulness of seasonal hydrologic forecasts systems for water resources applications. 2-4 years
- Develop operational hydrologic forecasts incorporating the use of climate forecasts. 2-4 years

***GEWEX-GAPP Science Question: Can we understand and predict the variations in the regional and global hydrological regime and water resources and its response to changes in the environment?***

- Develop a historical understanding of the water and energy budget and its variability within the GAPP domain based on data and modeling, including Reanalysis-2. 2-4 years
- Develop an understanding of the GAPP water and energy budget, through data analysis and modeling studies, and its relationship to the global water and energy budget, with particular focus on GEWEX CSEs domains. 2-4 years
- Determine the transferability of climate and hydrologic models across different climate/hydrologic regimes. 1-3 years
- Carry out field experiments leading to improved understanding of the North American Monsoon system. 2 years
- Quantify surface fluxes and land-atmosphere climate feedbacks across the North American monsoon domain. 2-4 years