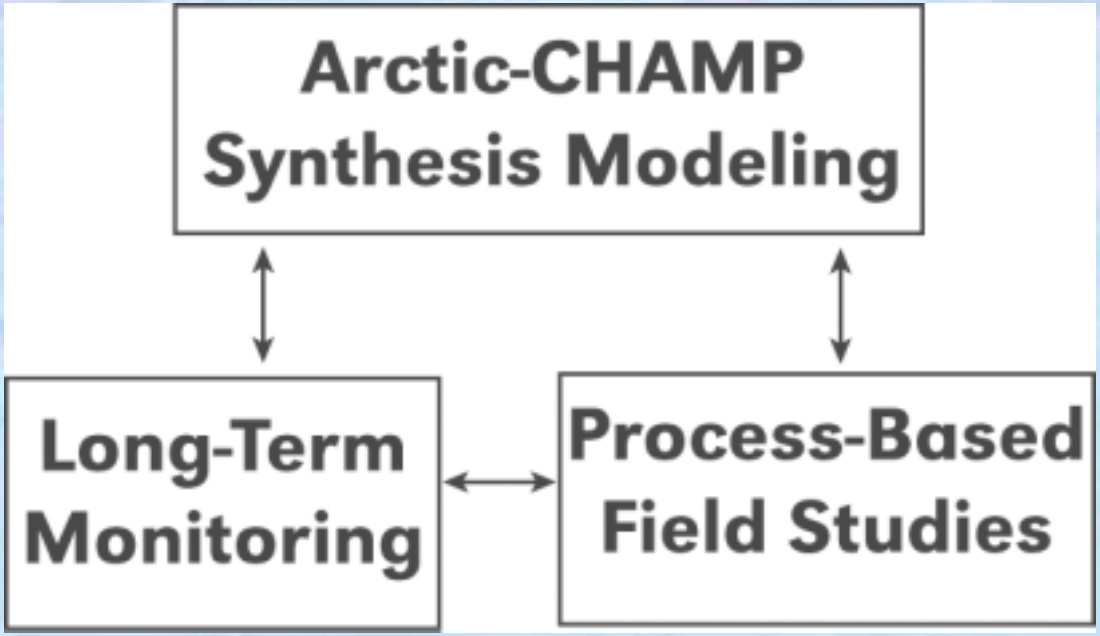
Arctic-CHAMP
Community-wide Hydrologic Analysis and Monitoring Program

Arctic-CHAMP

Integrated research program to study the role of the hydrologic cycle in arctic and global change

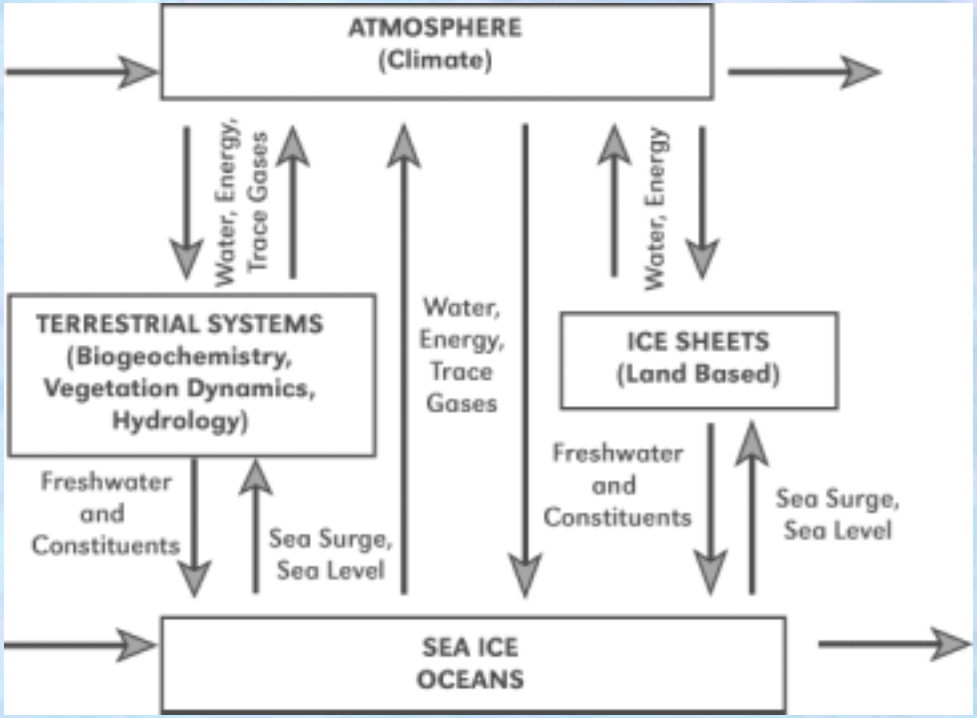


The hydrologic cycle links every major component of the arctic system:

- Physics
- Biology
- Biogeochemistry

…. and central to the analysis of:

- Global change
- Natural variability
- Human vulnerability



Background

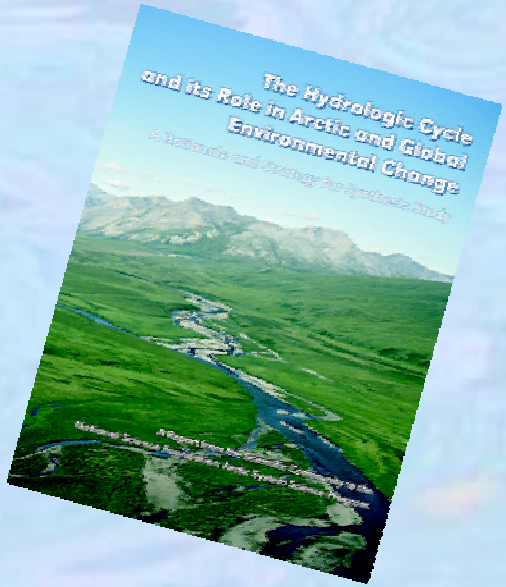
NSF-ARCSS convened a workshop in September 2000, with 34 international arctic researchers representing numerous disciplines, to:

- **assess the state of the art in arctic hydrology**
- **identify research priorities for synthesis study**
- **make recommendations for investments in arctic system science**
- **produce a rationale and strategy document**

The Hydrologic Cycle and its Role in Arctic and Global Environmental Change: A Rationale and Strategy for Synthesis Study

A Report from the Scientific Community to the National Science Foundation Arctic System Science Program

www.arcus.org/ARCSS/hydro/



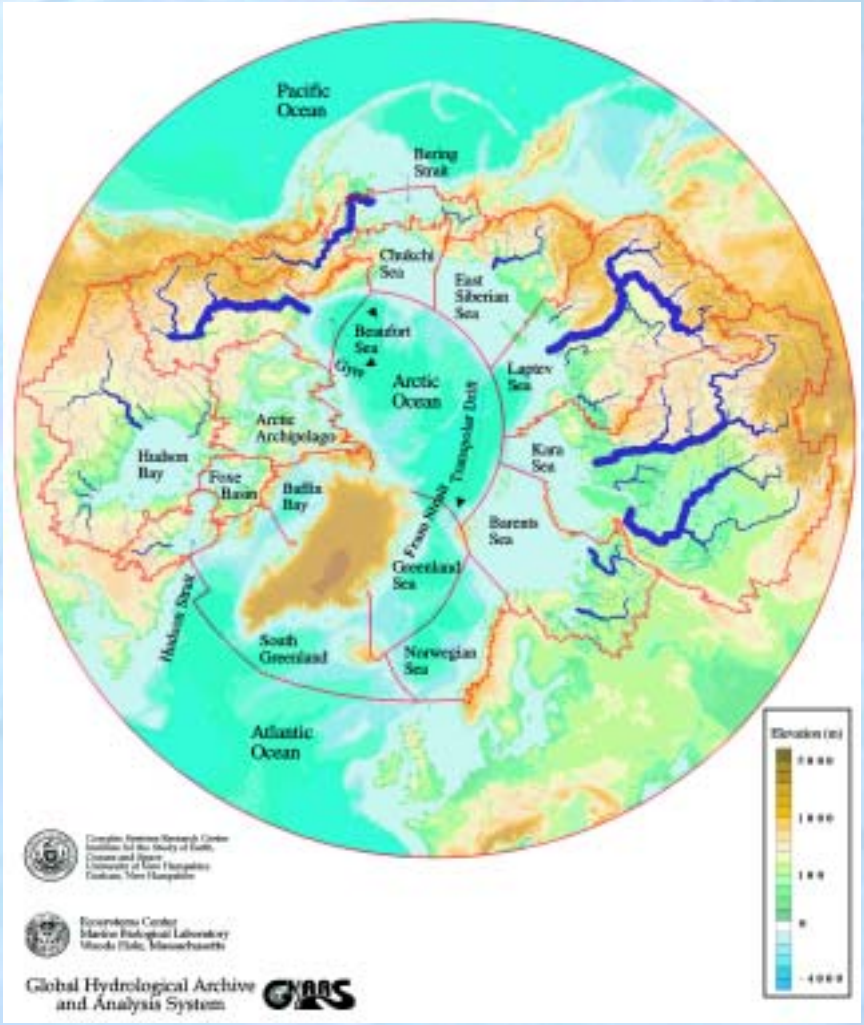
Question: Can we construct a coherent picture of the role of arctic hydrology in the Earth system and in global change, based on current

- scientific understanding?
- institutional support and infrastructure?

Answer: No.

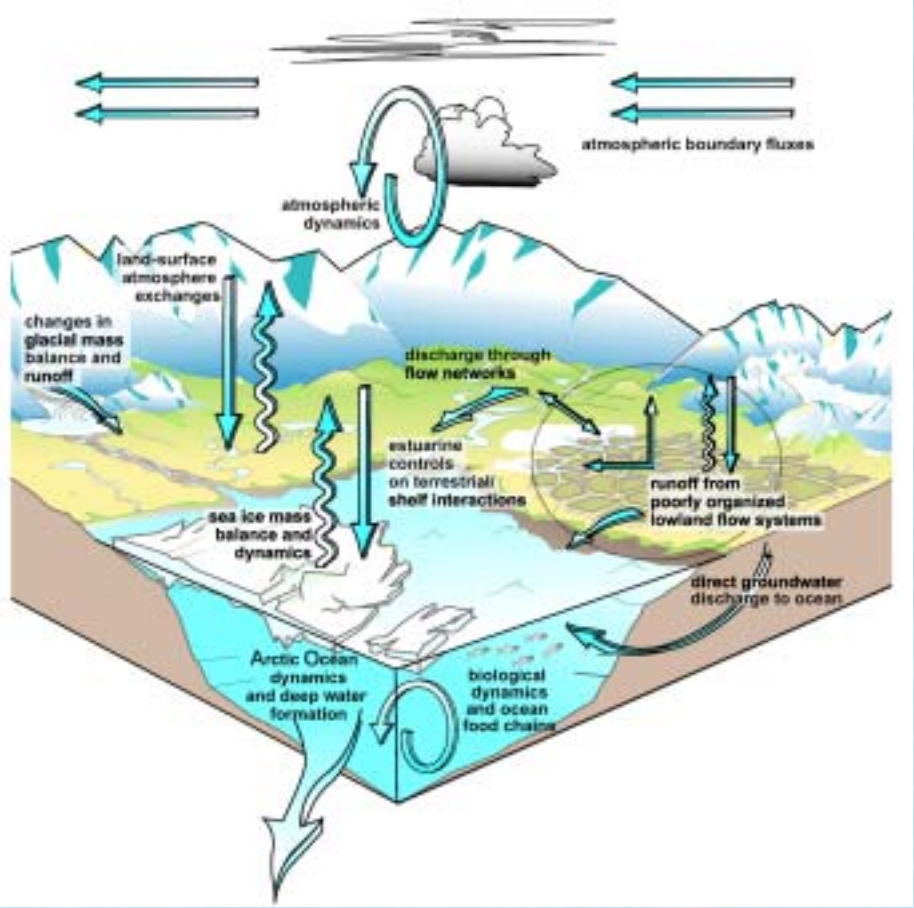
The Water Cycle of the Arctic

- organizing framework is the full pan-arctic drainage basin
- a well-bounded component of the larger Earth system
- the most land-dominated of all ocean basins
- has clear connections to the global ocean and climate systems



Key Processes and Linkages

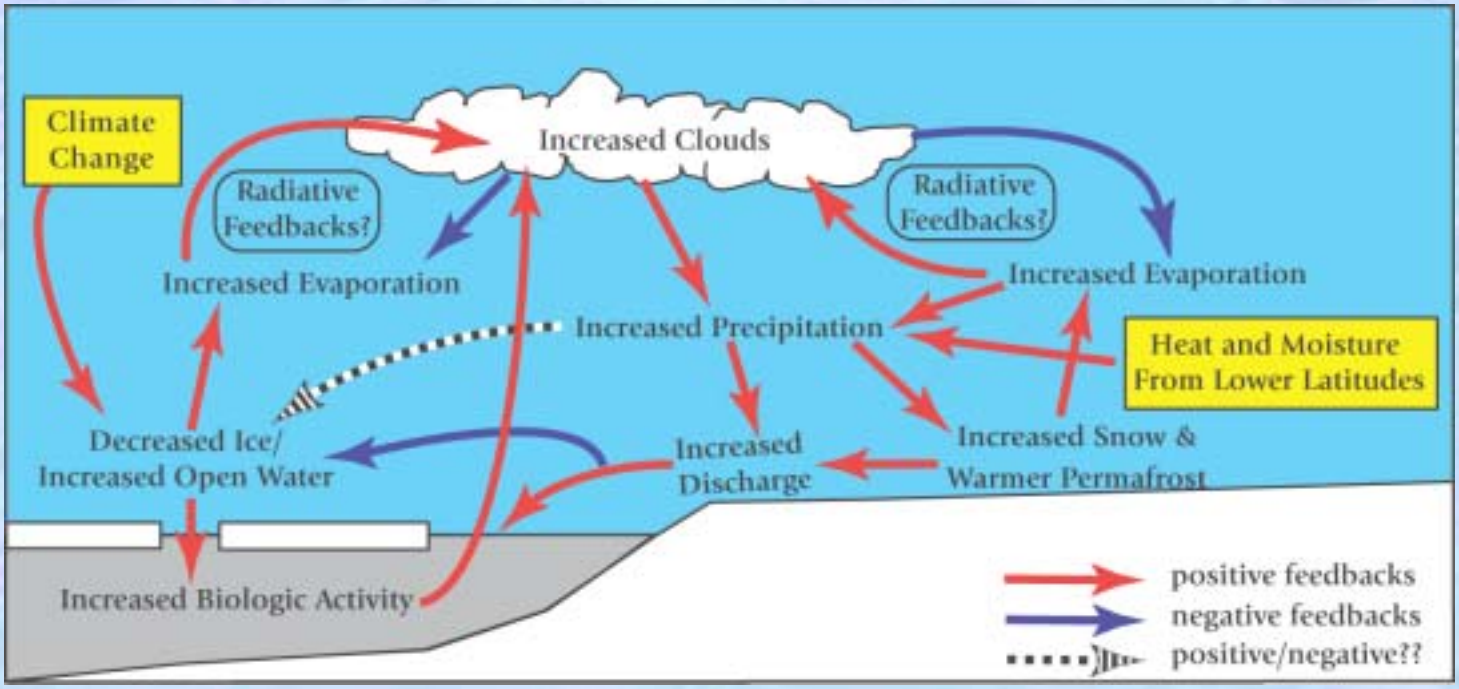
- Disciplinary research has studied many individual elements of the arctic water cycle
- These processes are linked and inter-dependent
- Major shortcoming of current science is lack of integrative analyses, including human dimensions



Arctic System Change

- Change is an inherent property of the Arctic
- Strong historical and paleo evidence for major, abrupt shifts in state
- The Arctic is experiencing an unprecedented rate of change in modern times:
  - –temperature increases
  - –timing of rainfall and snowmelt
  - –freeze/thaw of lakes and rivers
  - –intensity of seasonal storm activity
  - –melting of glaciers
  - –thawing of permafrost
  - –reduction of hemispheric snowcover

What Feedbacks Will These Changes Cause?



The unknowns and uncertainties are many, and the hydrological cycle figures prominently in each.

Key Unresolved Questions

(1) What are the stocks and fluxes of the pan-arctic water balance and how do they vary over time and space?
(2) How will the arctic hydrologic cycle respond to natural variability and global change?
(3) What are the direct impacts of arctic hydrology changes on nutrient biogeochemistry and ecosystem structure and function?
(4) What are the water-related feedbacks to the oceans and atmosphere in the face of natural variability and global change? How do these influence human systems?

Major Obstacles: Science

- **Numerous gaps in our current understanding of basic scientific principles and processes regarding water cycling in arctic environments**
- **The lack of cross-disciplinary synthesis and modeling to decipher feedbacks on the earth system and on society arising from arctic hydrological change**

Major Obstacles: Institutional

- Sparse observational networks for routine monitoring
- Absence of integrated data sets of spatial and temporal biogeophysical information
- Lack of process-based, long-term, and interdisciplinary field programs
- Lack of an adminstrative structure to achieve understanding of the full pan-arctic water cycle

Recommendations

- **Rescue, maintain, and expand data collection efforts for routine monitoring**
- **Invest in long-term, process-based field studies**
- **Initiate interdisciplinary synthesis studies**
- **Develop a pan-Arctic Community-wide Hydrological Analysis and Monitoring Program (Arctic-CHAMP)**

Arctic-CHAMP

Catalyze and Coordinate Interdisciplinary Research

Goal 1: Assess and better understand the stocks and fluxes which constitute the arctic hydrologic cycle.

Goal 2: Document changes to the arctic water cycle, contributing a hydrological component to U.S. and international arctic research efforts.

Goal 3: Understand the causes of arctic water cycle change and assess their impacts on biological and biogeochemical systems.

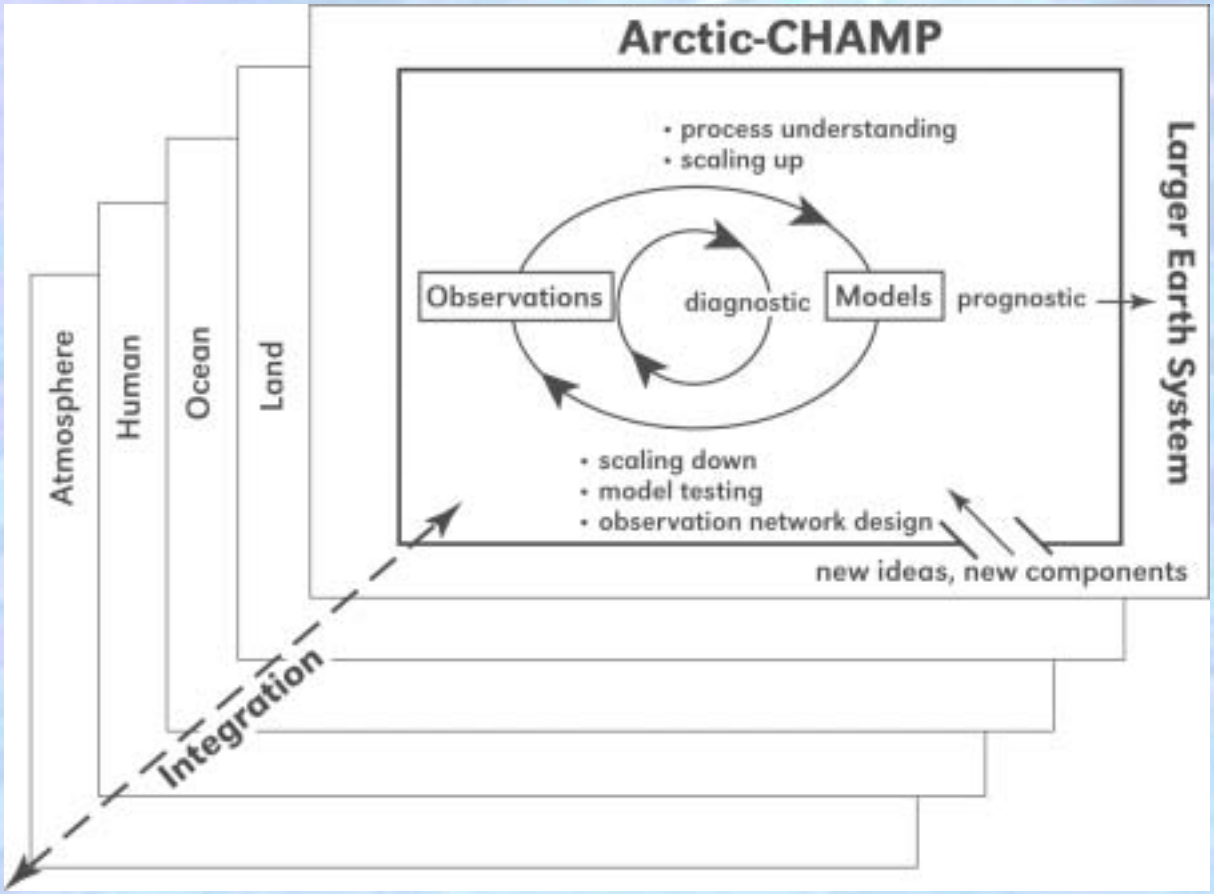
Goal 4: Develop predictive simulations of the response of the earth system and human society to changes in arctic hydrological systems.

Arctic-CHAMP Implementation: Science

- **Expanded monitoring and observations**
- **Multidisciplinary, process-based, long-term catchment studies**
- **Community-based synthesis modeling (Arctic Integrated System Model or ARC-ISM)**

Arctic-CHAMP Implementation: Institutional

- Create Arctic-CHAMP Steering Committee
- Define interdisciplinary implementation plan
- Fund peer-reviewed science projects
- Establish Arctic-CHAMP Synthesis and Education Center (CSEC)
- Convene Arctic-CHAMP Workshop Series and Open Science Meetings
- Integrate with other U.S. and international research initiatives



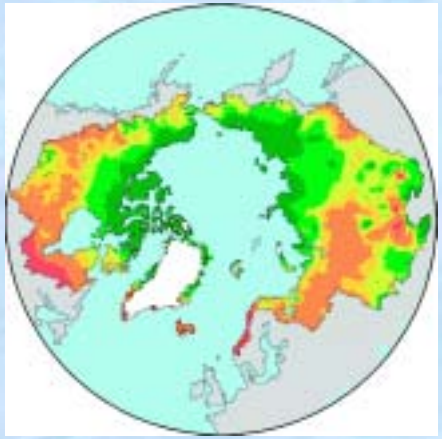
Conceptual framework of the pan-Arctic Community-wide Hydrological Analysis and Monitoring Program (Arctic-CHAMP)

Multiscale Approach to Synthesis

Local

Global/ Regional

Pan-Arctic



Global

Humans and Arctic Hydrology

The interactions between humans and the water cycle are an integral part of the Arctic.

Major Arctic-CHAMP Programmatic Links

- **NSF Biocomplexity in the Environment (BE)**
- **Multi-Agency Study of Environmental Arctic Change (SEARCH)**
- **International Arctic/Subarctic Ocean Fluxes (ASOF) Experiment**

Arctic-CHAMP and Biocomplexity in the Environment (BE)

Two of five BE topical areas most relevant:

- **Dynamics of Coupled Natural and Human Systems (CNH)**
- **Coupled Biogeochemical Cycles (CBC)**

Arctic-CHAMP and Biocomplexity in the Environment (BE)

BE Program Goals

- high degree of interdisciplinarity
- focus on complex environmental systems that include interactions of non-human biota or humans
- focus on systems with high potential for exhibiting non-linear behavior

CHAMP Linkages

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Arctic-CHAMP and SEARCH

SEARCH Program Goals

- Develop long-term observations to detect arctic change
- Modeling and data assimilation
- Process studies
- Impact analysis on ecosystems and society

CHAMP Linkages

- Develop long-term observations to detect arctic change
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Arctic-CHAMP and Arctic/Subarctic Ocean Fluxes (ASOF) Experiment

ASOF Program Goals

- Ocean fluxes and circulation monitoring in the face of warming and freshening of the subpolar seas
- Elucidate the gateways of the Arctic Ocean with subarctic seas
- Define variability of Arctic Ocean dynamics and THC
- Initial emphasis on pan-arctic monitoring

CHAMP Linkages

- Complement circumarctic ocean flux observations with near real-time monitoring of freshwater flux to arctic ocean
- Through process studies, provide understanding of spatial and temporal changes in freshwater flux
- Assimilate ocean information into ARC-ISM synthesis work
- Attribute the role of terrestrial hydrology in recent and potential future freshening of the Nordic Seas


www.arcus.org/ARCSS/hydro/

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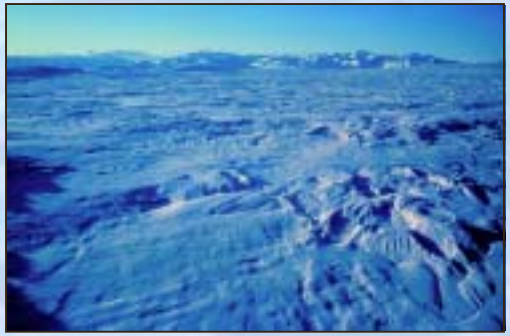


Examples of a permafrost-dominated landscape with sharp contrasts in the state of water cycling between winter and summer.