EVAPORATION: A GLOBAL CHALLENGE FOR MONITORING AND MODELING

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EVAPORATION IS A CENTRAL ISSUE BECAUSE:

- IT LINKS THE WATER AND ENERGY CYCLES
- IT PROVIDES THE ATMOSPHERE WITH MOISTURE NEEDED FOR PRECIPITATION
- IT DETERMINES THE RATE OF CARBON SEQUESTRATION IN VEGETATION
- IT DETERMINES PLANT PRODUCTIVITY AND CAN BE RELATED TO CROP YIELD..
- IT IS THE MAIN CAUSE OF WATER STRESS DURING DROUGHT EVENTS.

Operational applications of ET information in Idaho Department of Water Resources:

Estimate aquifer recharge and withdrawals

Document historical volumes of water used by water rights

Buy back Snake River irrigation water to increase flows for salmon

Develop Conservation Plan for fish under Endangered Species Act

Quantify trends in future water demand as irrigated cropland converts to residential and commercial land-uses in rapidly expanding urban areas

Develop water use information for water rights curtailment orders and mitigation plans

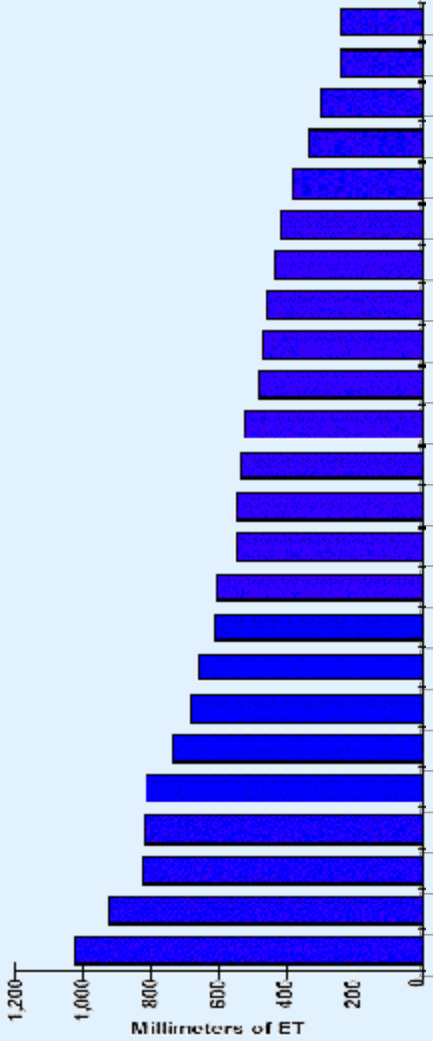
Boise River Valley, Idaho

ET BY LAND USE CLASS

- Benefit:

  Impacts of Land-use Change

(Allen, 2007)

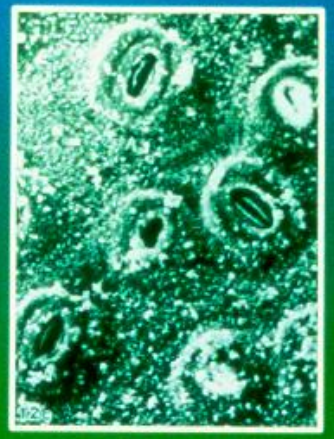


Class Name	ET in mm
Petroleum Tank Yards	237
Rangeland	242
Unclassified	298
Barren	335
Commercial / Industrial	380
Transportation	420
Idle Agriculture	436
Abandoned Agriculture	459
Junk Yard	467
Feedlot	479
Dairy	524
Other Agriculture	536
Public	548
Sewage	552
New Subdivision	606
Farmstead	609
Rural Residential	657
Urban Residential	684
Canal	731
Irrigated Crops	812
Perennial	820
Recreation	826
Water	924
Wetland	1,025

Evaporation processes are active at many scales

Spatial scales

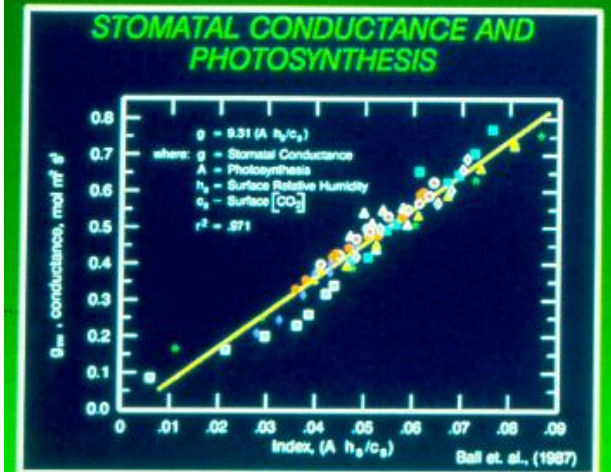
Electron Micrograph of lower sides of leaves showing open stomata (1200x)

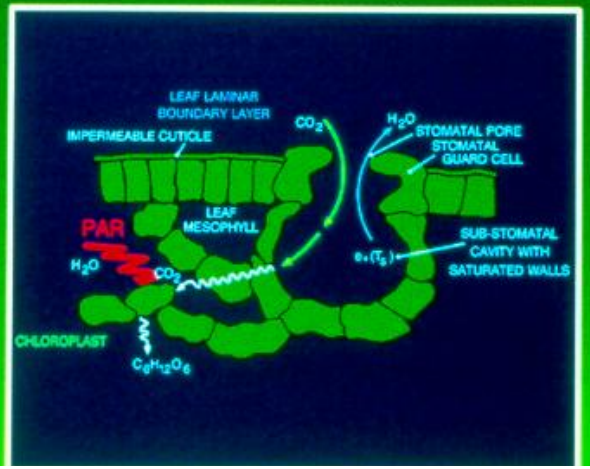


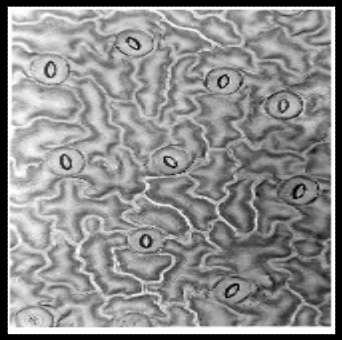
Red Maple

Red Oak

Tree

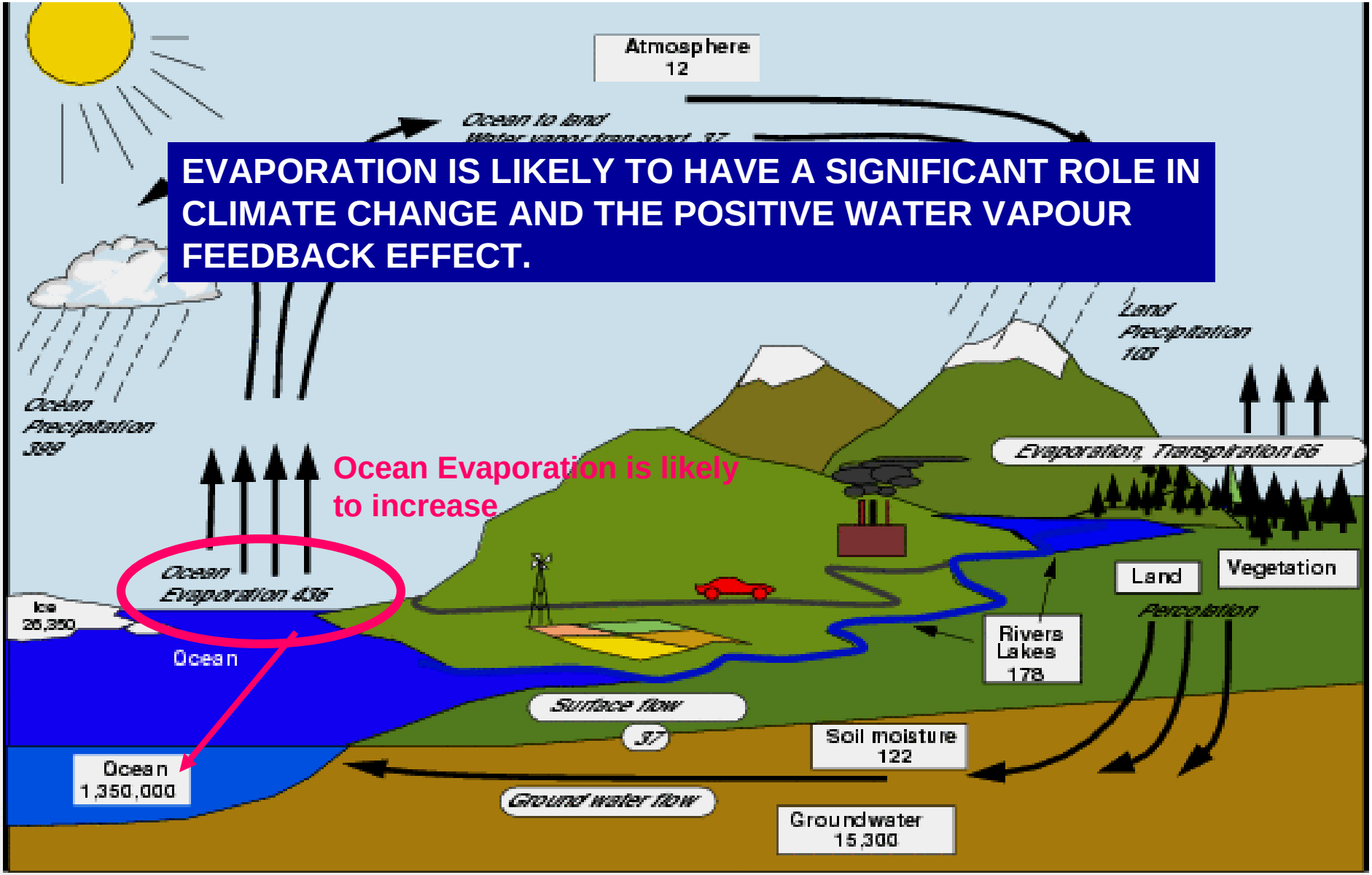






Stomata (10 μm)

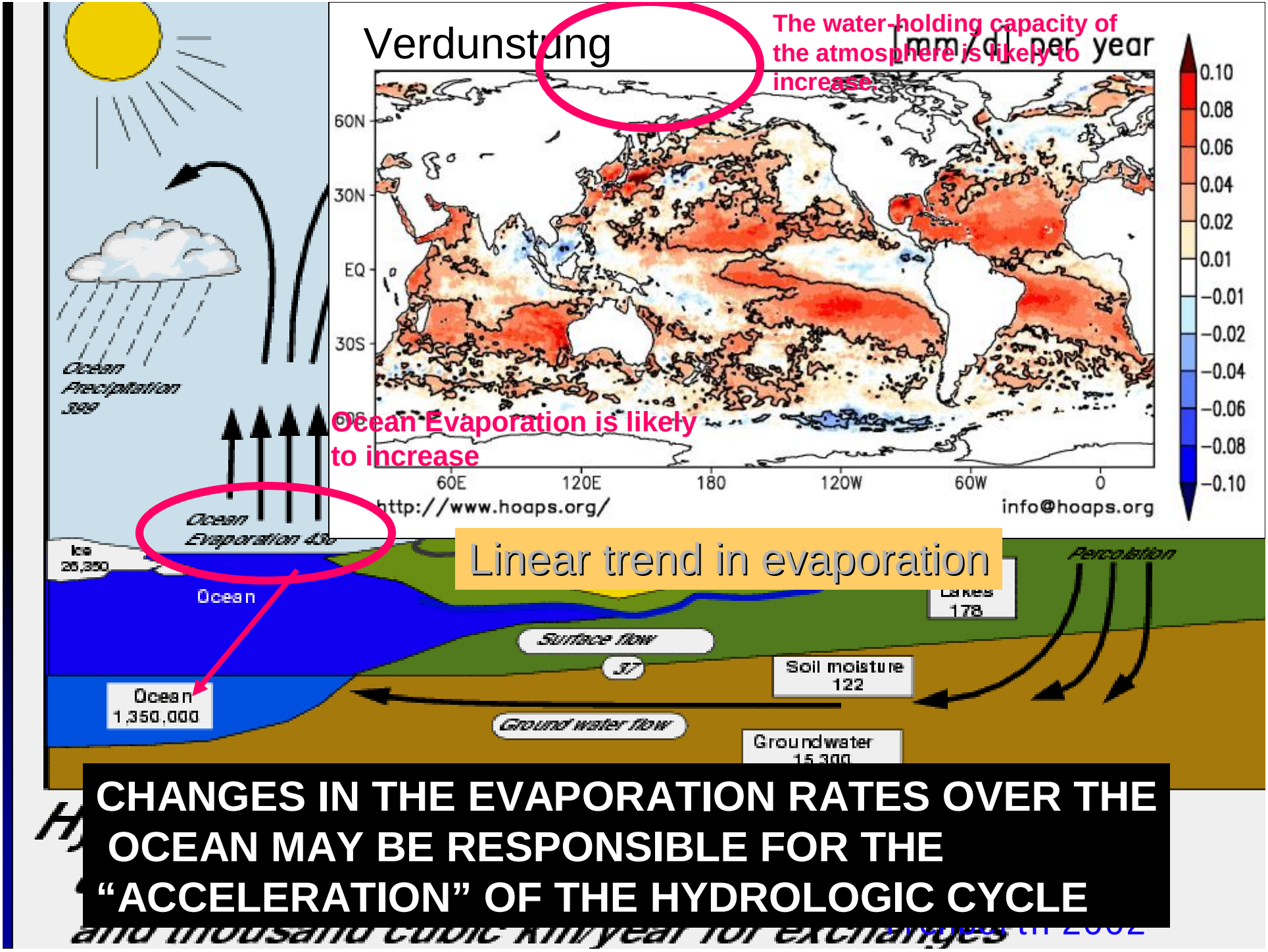
. Katul modified



Hydrological cycle.

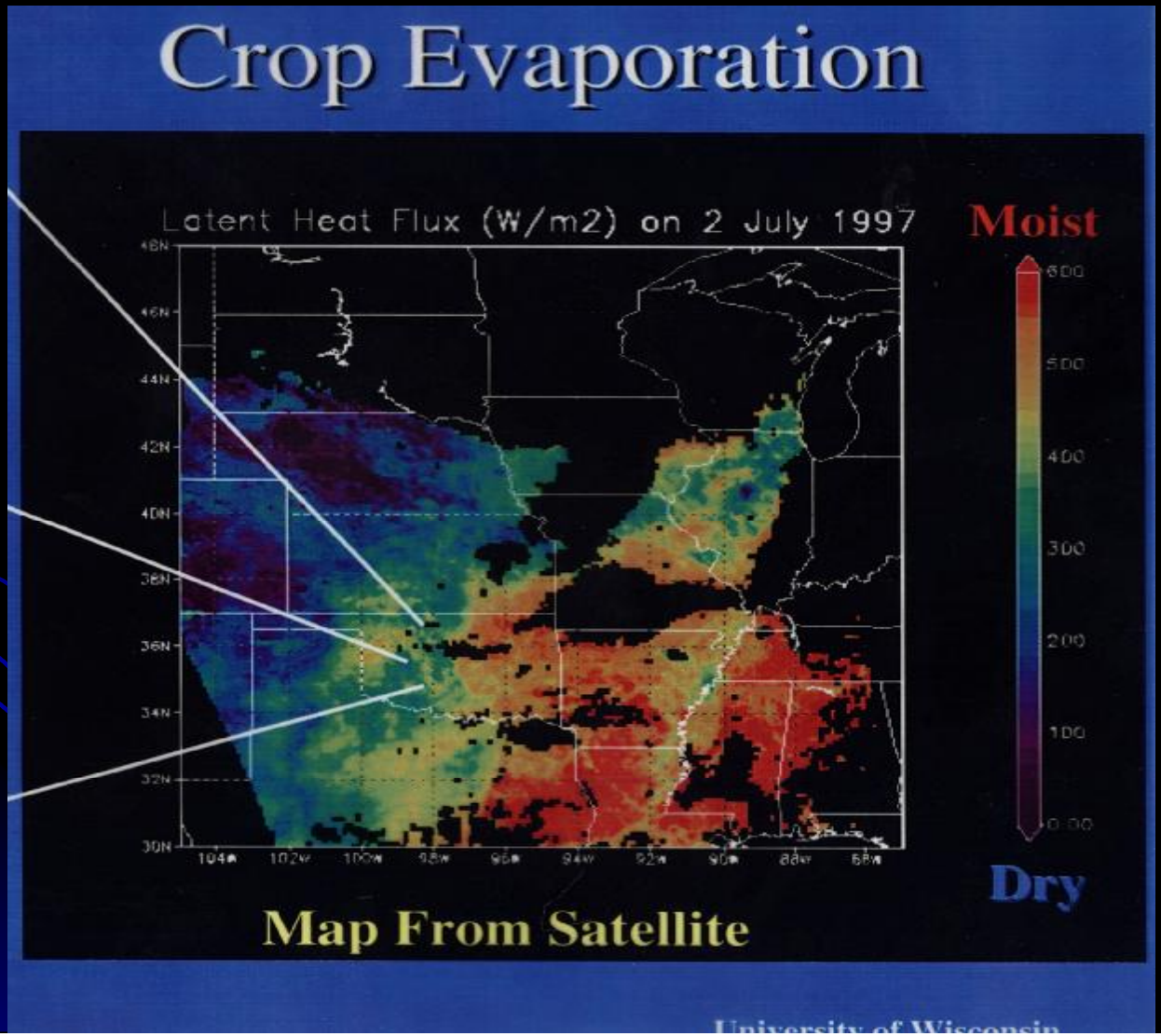
Units are thousand cubic km for storage and thousand cubic km/year for exchanges

(K. Trenberth base map)


Verdunstung
The water-holding capacity of the atmosphere is likely to increase.
[mm/d] per year
0.10
0.08
0.06
0.04
0.02
0.01
−0.01
−0.02
−0.04
−0.06
−0.08
−0.10
60N
30N
EQ
30S
60E
120E
180
120W
60W
0
http://www.hoaps.org/
info@hoaps.org
Ocean Evaporation is likely to increase
Ocean Precipitation
Ocean Evaporation
Ice 26,350
Ocean
Linear trend in evaporation
Percolation
Lakes 178
Surface flow
Soil moisture 122
Ocean 1,350,000
Ground water flow
Groundwater 15,300
CHANGES IN THE EVAPORATION RATES OVER THE OCEAN MAY BE RESPONSIBLE FOR THE "ACCELERATION" OF THE HYDROLOGIC CYCLE

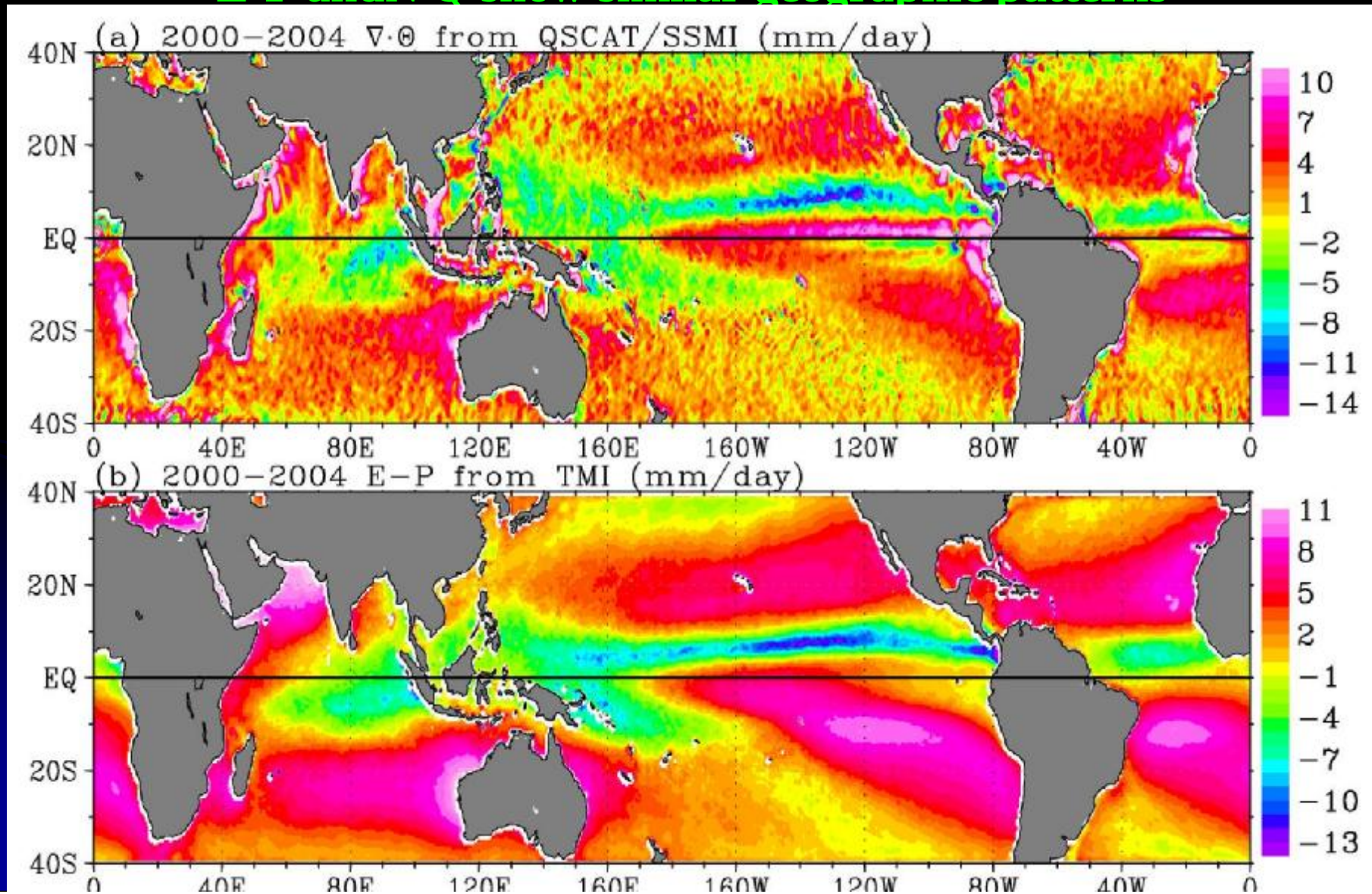
GEWEX AND EVAPORATION

GEWEX STUDIES HAVE INVOLVED THE USE OF SATELLITE DATA TO ESTIMATE EVAPORATION OVER LAND AND OCEANS IN EFFORTS TO CLOSE WATER AND ENERGY BUDGETS.



Through SEAFLUX computations using a modified "Konda" approach estimates of Evaporation (E), precipitation (P), and moisture advection (Q) over ocean are independently derived from satellite data. (after Clayson)

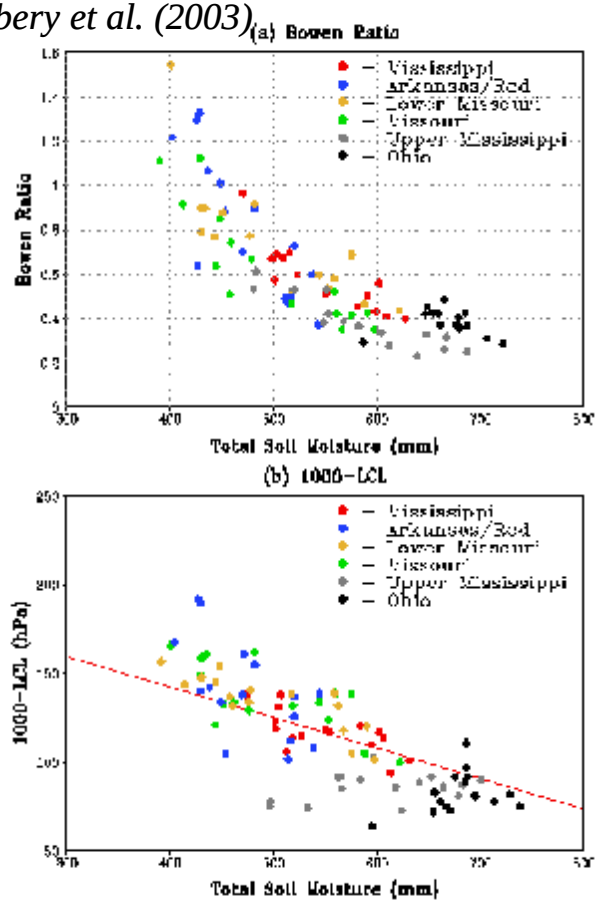
E-P andÑ·Q show similar geographic patterns



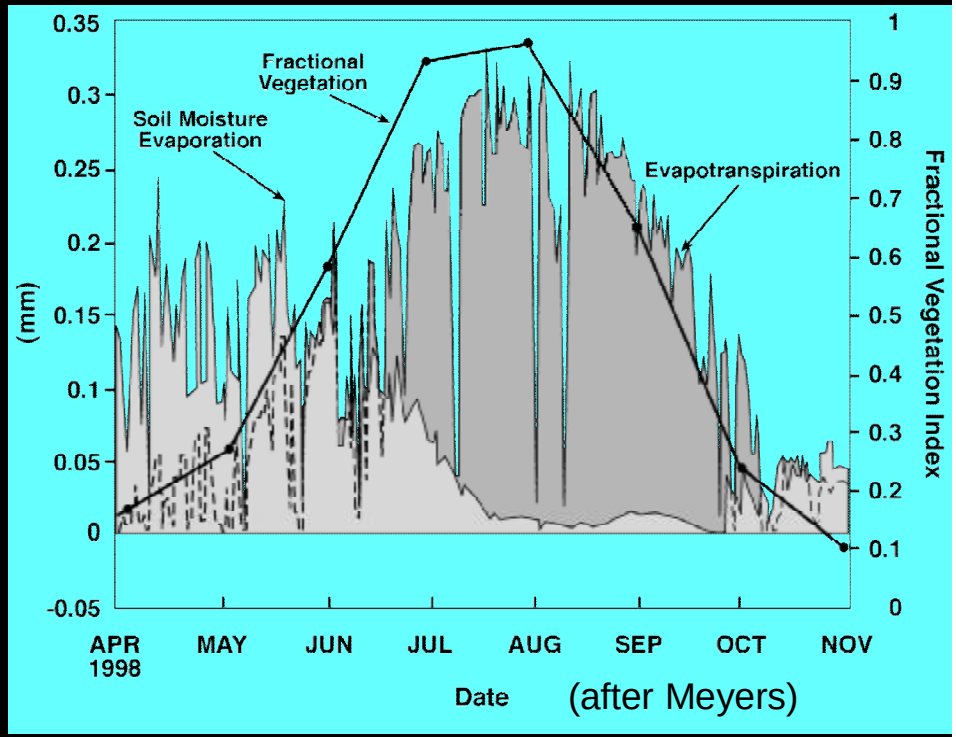
STUDIES IN THE MISSISSIPPI RIVER BASIN HAVE SHOWN THE IMPORTANCE OF SOIL MOISTURE AND SOIL TEMPERATURE ON EVAPORATION.

THE BOWEN RATIO (SH/LH) IS CLOSELY CONNECTED TO THE SOIL MOISTURE

Berbery et al. (2003)

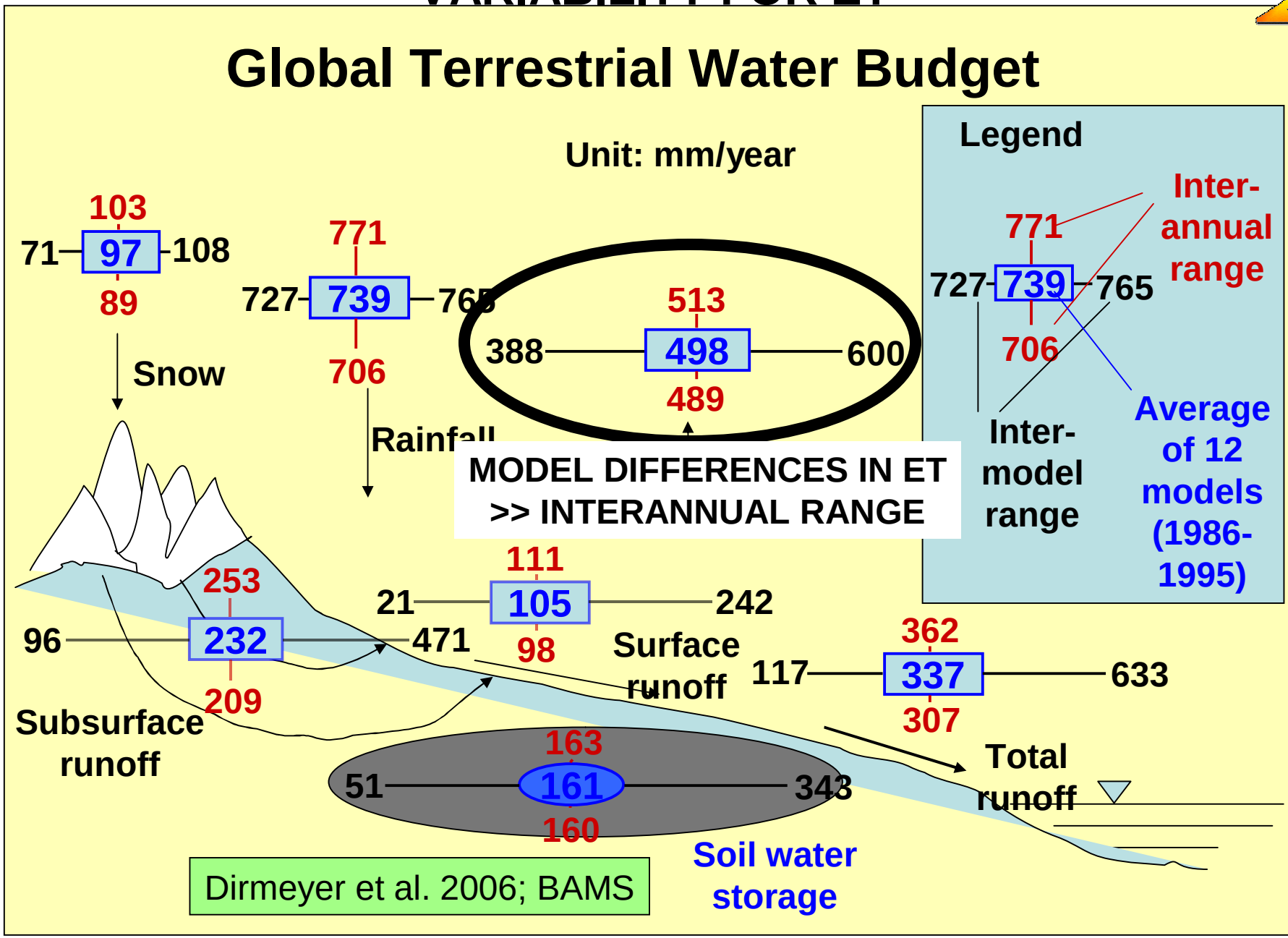


EVAPORATION FROM THE SOIL IS CRITICAL UNTIL VEGETATION GROWTH BECOMES THE DOMINANT FACTOR.

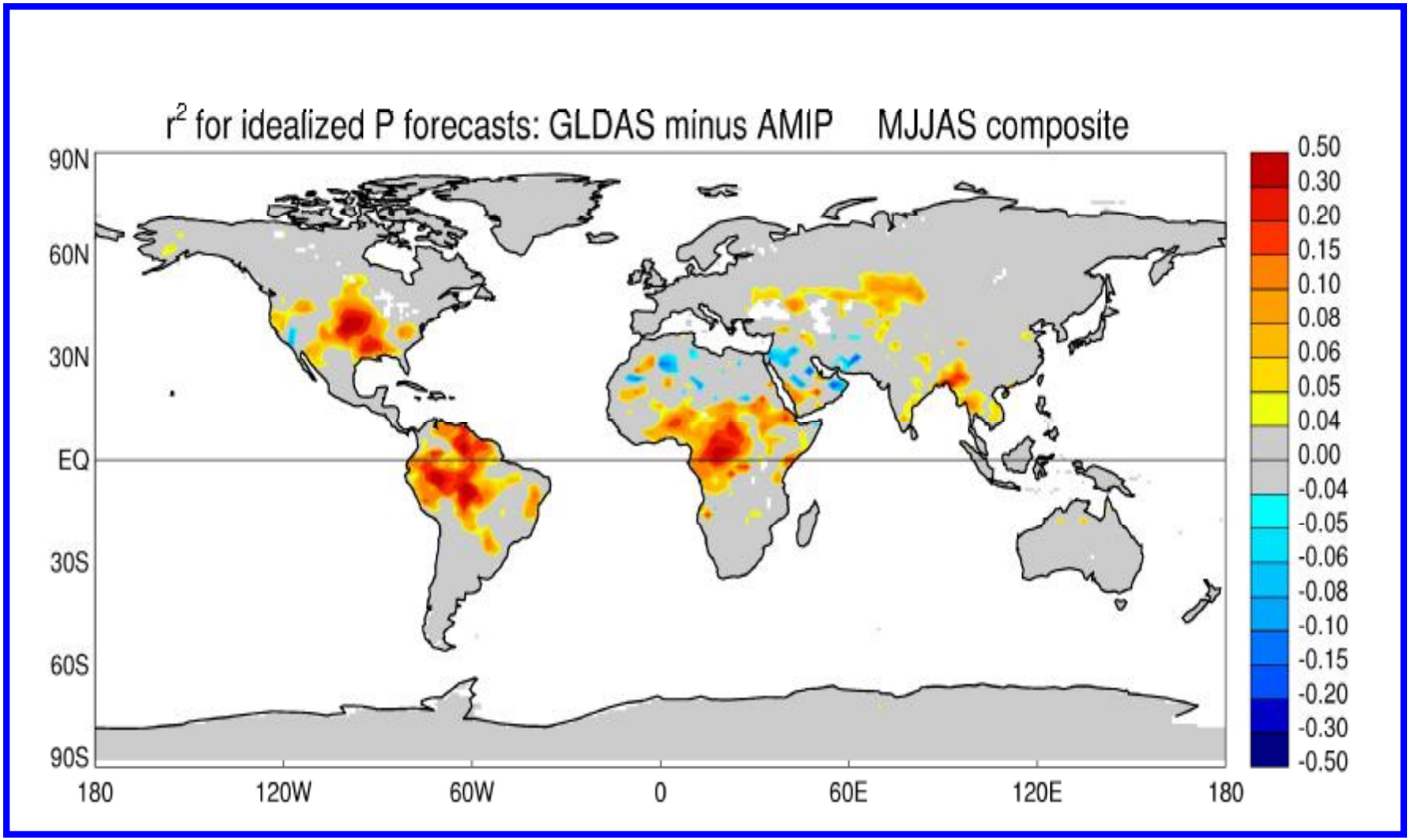


(after Meyers)

GSWP MODELS SHOWED A WIDE RANGE OF VARIABILITY FOR ET



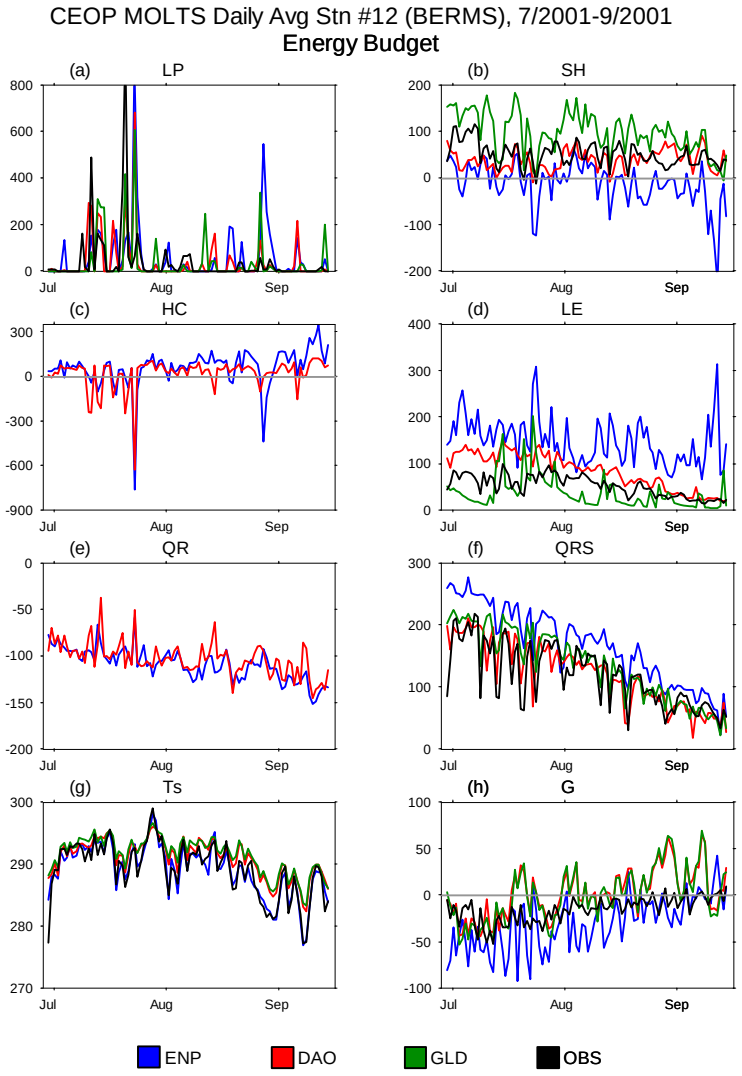
EVIDENCE OF THE ROLE OF ET IN REGIONAL PRECIPITATION PATTERNS

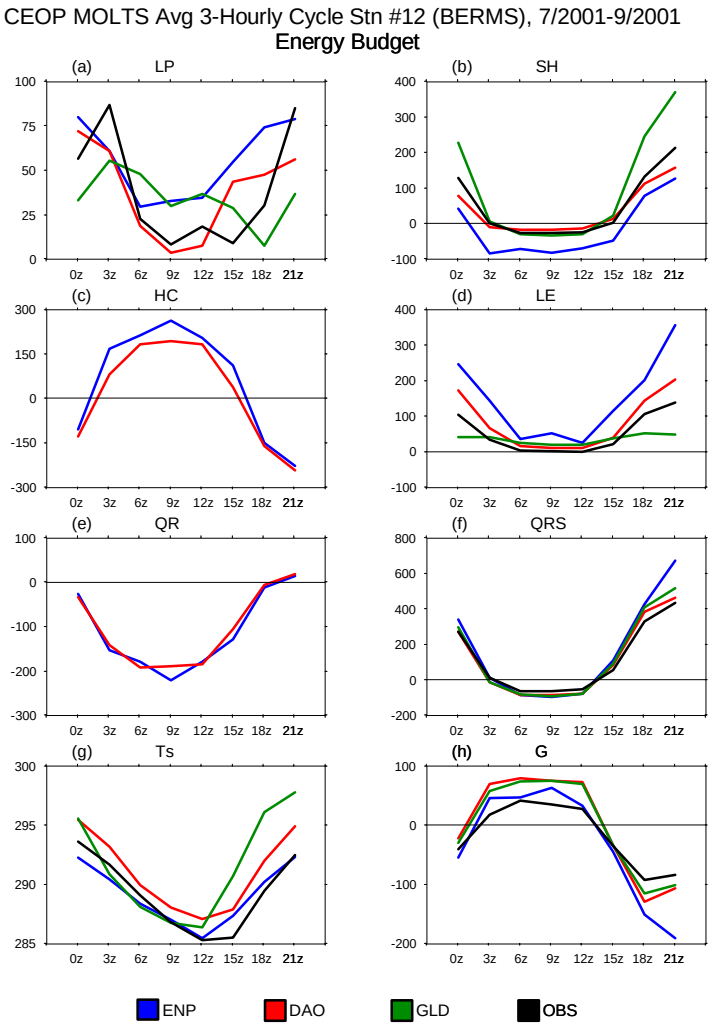


Initial Energy Comparisons

Roads, J., M. Bosilovich, M. Kanamitsu, M. Rodell, 2003: CEOP

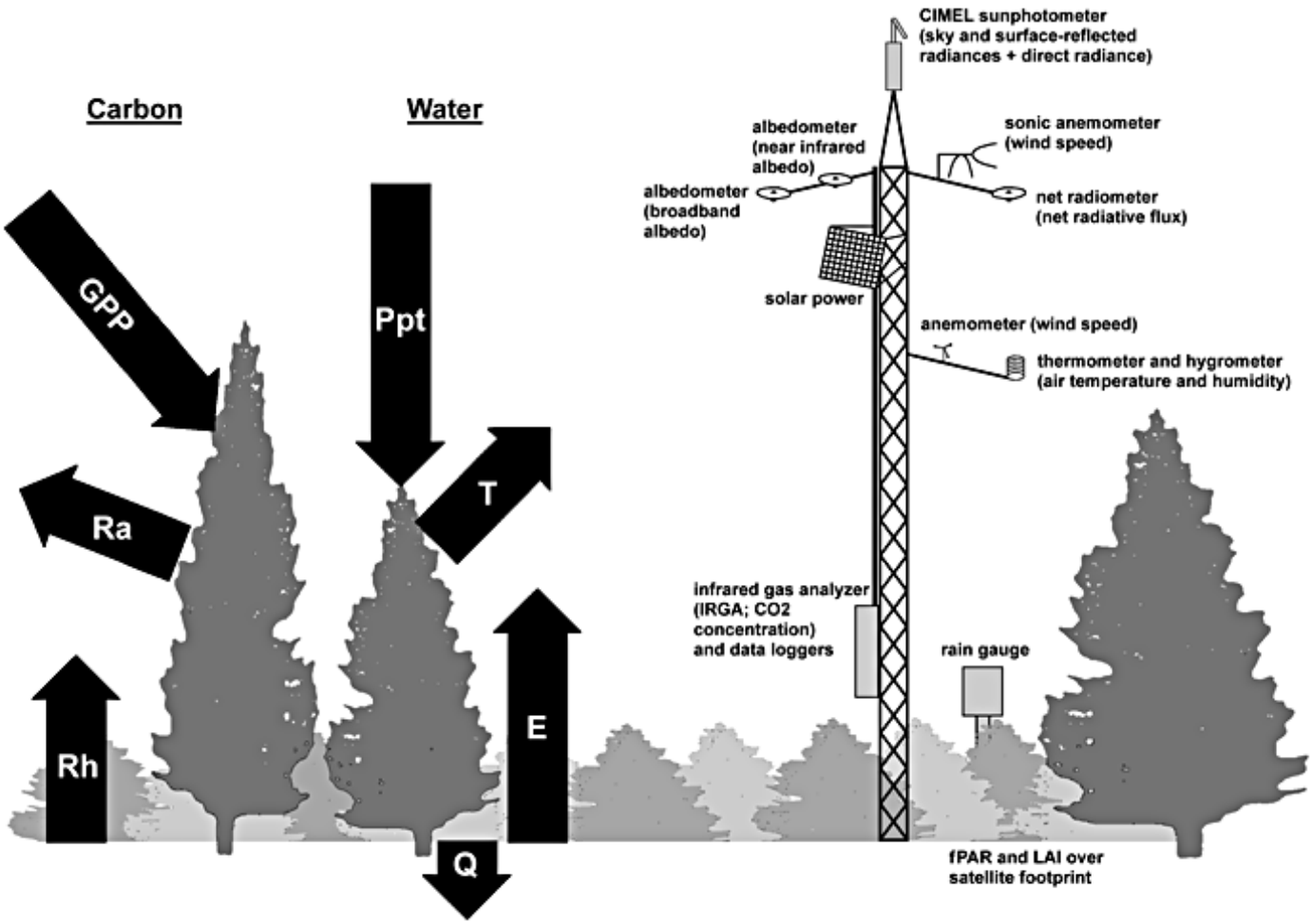
Pilot Data Comparisons. CEOP Newsletter 3.



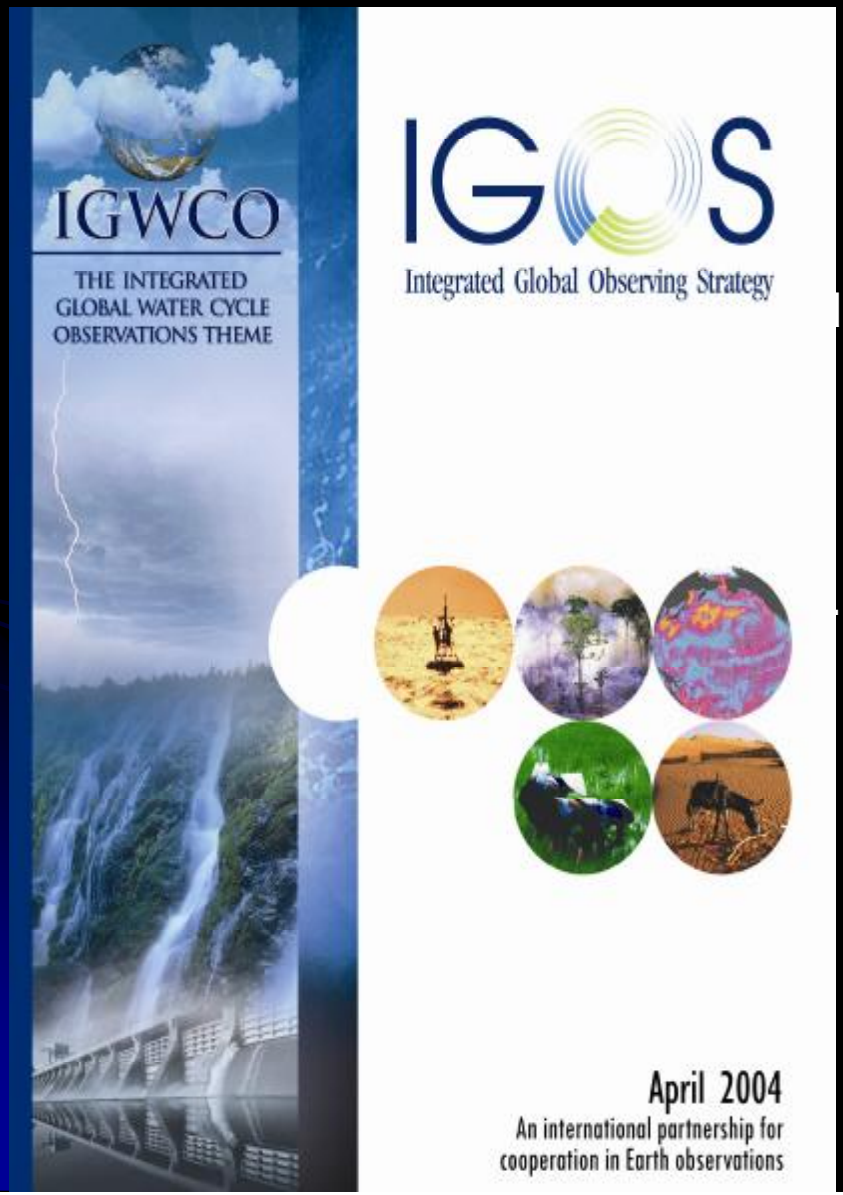


Fluxnet (2003)

FLUXNET CONFIGURATION



THE INTEGRATED GLOBAL WATER CYCLE OBSERVING THEME (IGWCO) HAS THE FOLLOWING OBJECTIVES:



Provide a framework for guiding decisions on priorities and strategies regarding water cycle observations for:

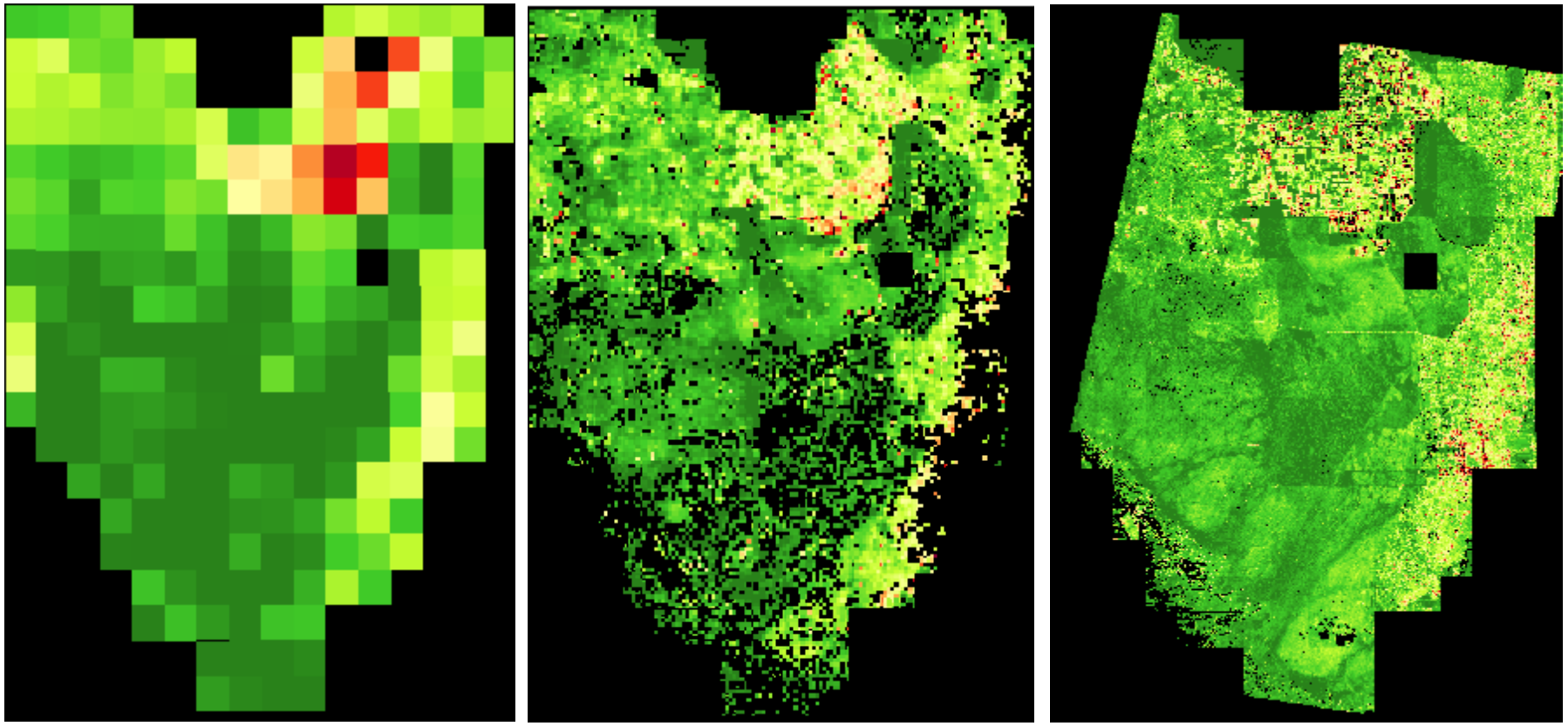
- Monitoring climate variability and change,
- Effective water management and sustainable development of the world's water resources,
- Societal applications for resource development and environmental management,
- Specification of initial conditions for weather and climate forecasts,
- Research directed at priority water cycle questions

Promote strategies that facilitate the processing, archiving and distribution of water cycle data products.

High resolution can provide information on the land area responsible evaporation stress

FLORIDA EVERGLADES

GOES (5km) | MODIS (1km) | L7 (60m)



(hourly) | (daily) | (monthly)

Evaporative stress (high) — (low)

From M.C. Anderson, PI. Multi-scale remote assessment of land-surface hydrological response to natural and anthropogenic stressors - A case study in the Florida Everglades - proposal funded from NRA-03-OES-02 - Earth System Science Research …

Thermal Data Continuity

Land Surface Temperature and Emissivity Earth System Data Record (LSTE-ESDR)

Coverage	Spatial Resolution	Temporal Resolution	Current Data Sources	Future Data Sources
Global	10-20 km	Hourly	AIRS GOES MSG	CrIS GOES MSG
Regional	1-5 km	2-4 times daily	MODIS AVHRR ATSR	VIIRS AVHRR ATSR
Local	30–100 m	Once every 8-16 days	ASTER Landsat	!!

Table from S. Hook et al. 2006. Land Surface Temperature and Emissivity Earth System Data record (LSTE-ESDR) white paper.

DRI CAN ADDRESS EVAPORATION ISSUES BY:

-EVALUATING SATELLITE PRODUCTS TO SEE WHICH ARE MOST USEFUL.

- ASSESSING THE RATE AT WHICH DROUGHT CONDITIONS DEVELOP FOR DIFFERENT LANDSCAPE AND INITIAL MOISTURE CONDITIONS ON THE CANADIAN PRAIRIES.

- UNDERTAKING STUDIES THAT COULD ASSIST IN EVALUATING THE EVAPORATION PARAMETERIZATIONS USED IN MODELS WITH A VIEW TO FINDING BETTER WAYS TO REPRESENT THESE PROCESSES.

- LEADING IN THE DEVELOPMENT OF AN INTEGRATED EVAPORATION PRODUCT.