GLOBAL PRECIPITATION MISSION

Rainfall patterns and potential changes in these patterns are crucial to understanding climate, and the impact of climate changes upon man. GPM is designed to address both the understanding of rainfall systems, and the impact of rainfall on climate variables and Earth's habitability.

US Perspective on GPM Science Program - Chris Kummerow

CORE SATELLITE

- Dual frequency radar
- Multifrequency radiometer
- Non-sun synchronous orbit
- ~ 70° inclination
- ~ 400 - 500 km altitude
- ~ 4 km horizontal resolution
- 250 m vertical resolution

MISSION: Understand the horizontal and vertical structure of rainfall and its microphysical elements. Provide training for constellation radiometers.

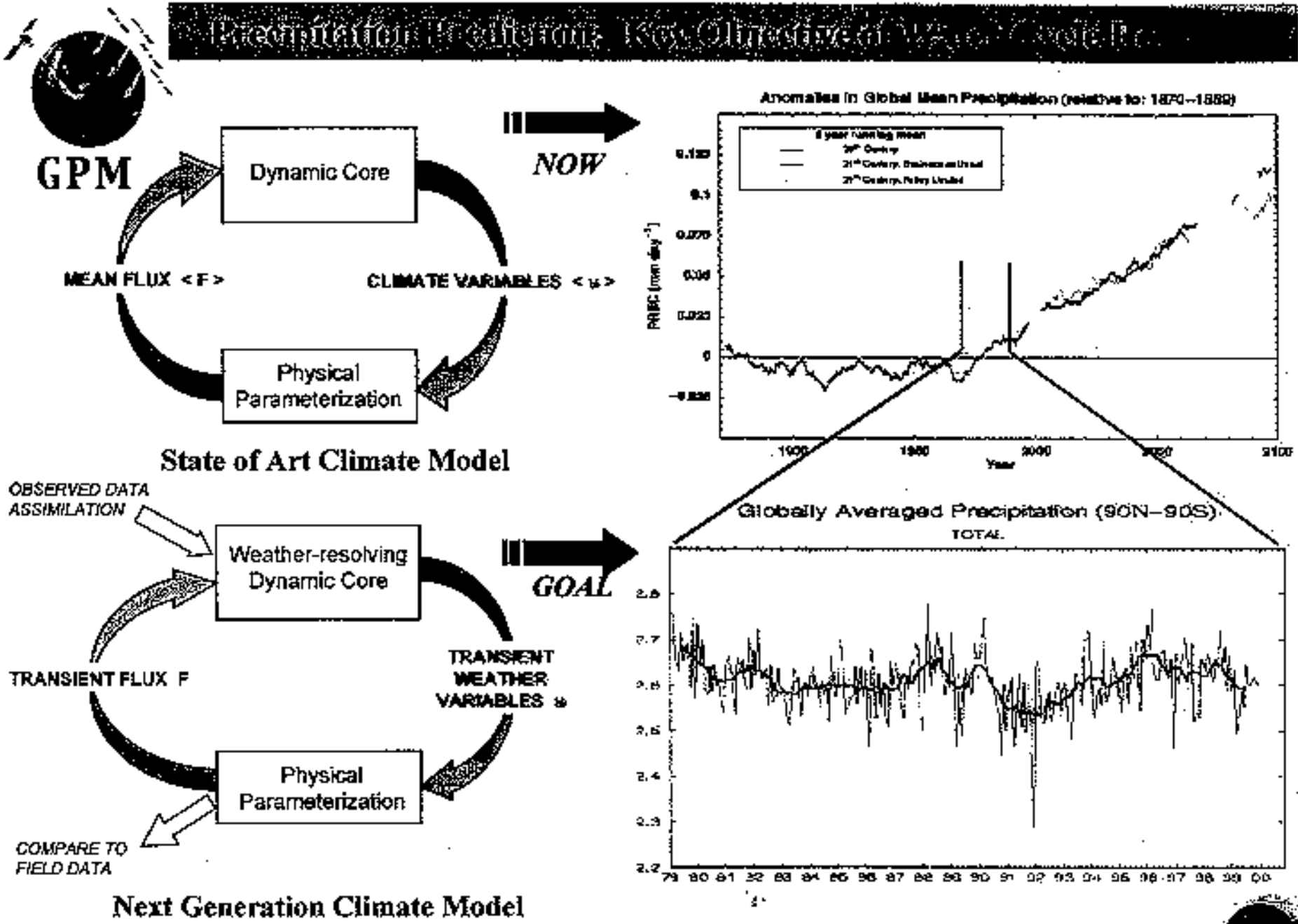
CONSTELLATION SATELLITES

- 8 small satellites with microwave radiometer only*
- 3 hr revisit time
- Sun-synchronous polar orbit
- ~ 600 km altitude

*Some of the 8 small satellites may be replaced by existing radiometers (e.g., SSM/Is, AMSR, etc.)

MISSION: Provide enough sampling to reduce uncertainty in short-term rainfall accumulations. Extend scientific and societal applications.

Precipitation Prediction: Key Objective of Water Cycle Pr...



State of Art Climate Model

Next Generation Climate Model

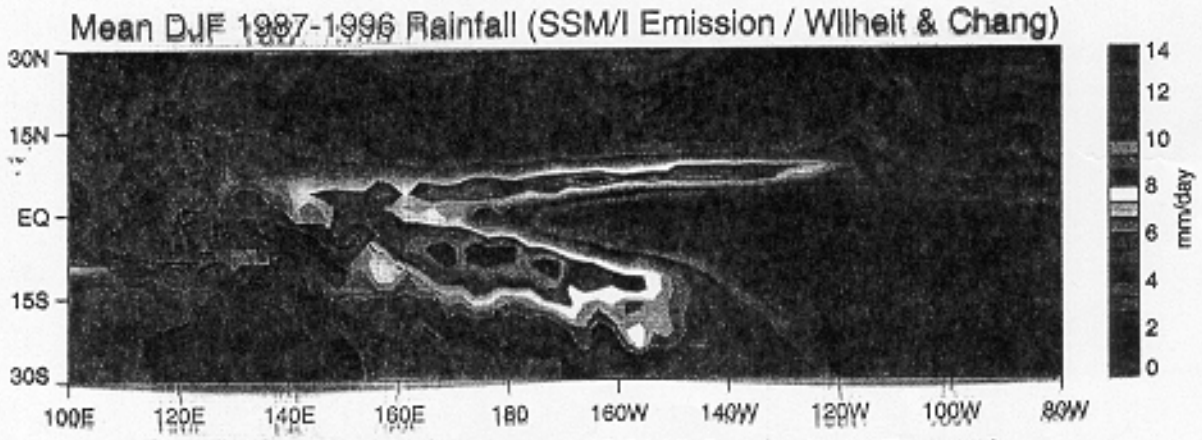
Is the Global Water Cycle Accelerating?

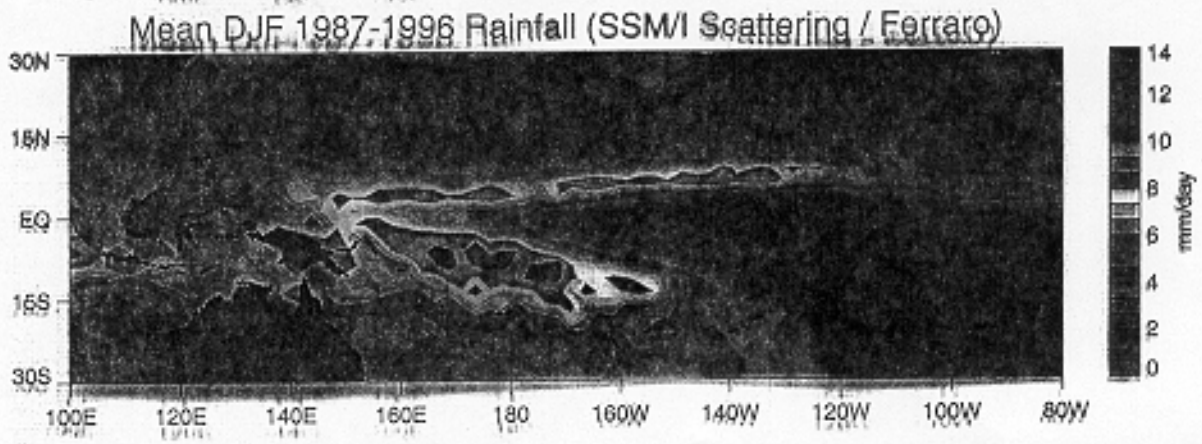
- This issue matters, because the rate of water cycling may be directly related to the frequency and intensity of storms, and the amount of rainfall.

- We have conflicting evidence from climate models, e. g. NCAR Climate System Model:

  <http://www.cgd.ucar.edu/~tls/CSM/tables.html>

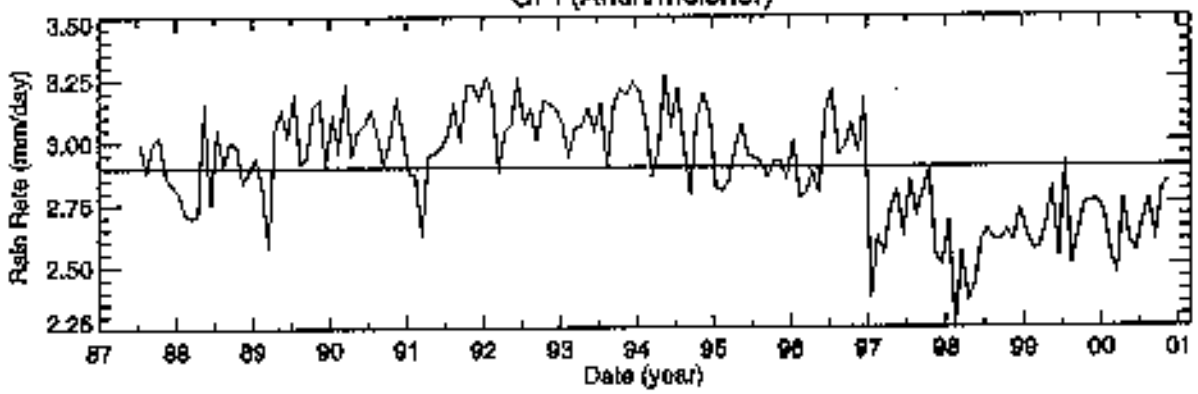
  and from observation, e. g. international Global Precipitation Climatology Project: <http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/FTP_SITE/INT_DIS/readmes/gpcp_global_precip.html>


Mean DJF 1987-1996 Rainfall (SSM/I Emission / Wilheit & Chang)
30N
15N
EQ
15S
30S
100E
120E
140E
160E
180
160W
140W
120W
100W
80W
14
12
10
8
6
4
2
0
mm/day

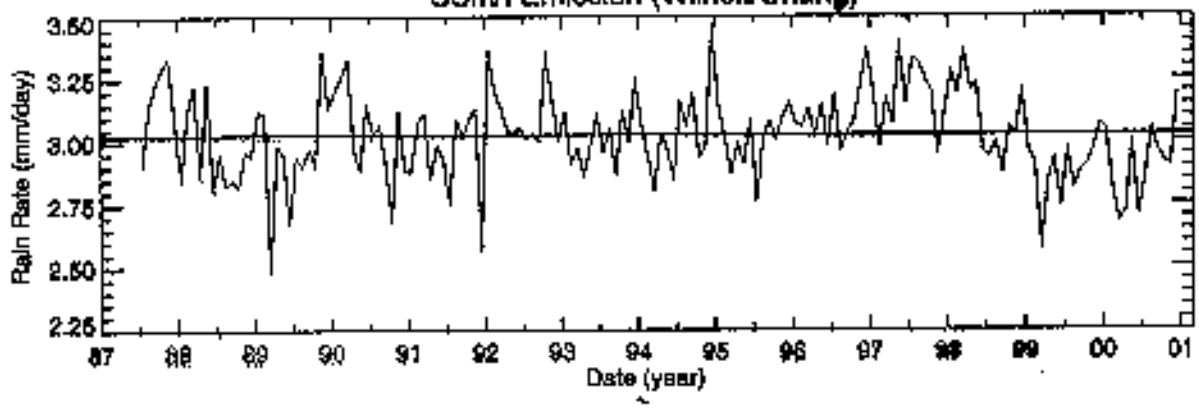

Mean DJF 1987-1996 Rainfall (SSM/I Scattering / Ferraro)
30N
15N
EQ
15S
30S
100E
120E
140E
160E
180
160W
140W
120W
100W
80W
14
12
10
8
6
4
2
0
mm/day

Global Oceanic Rainfall (30S - 30N)

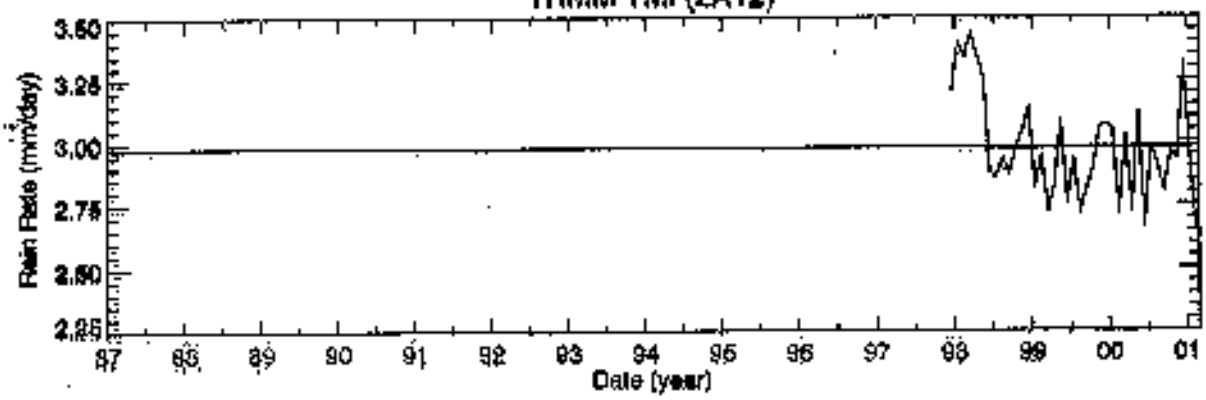
GPI (Arkin/Meisner)



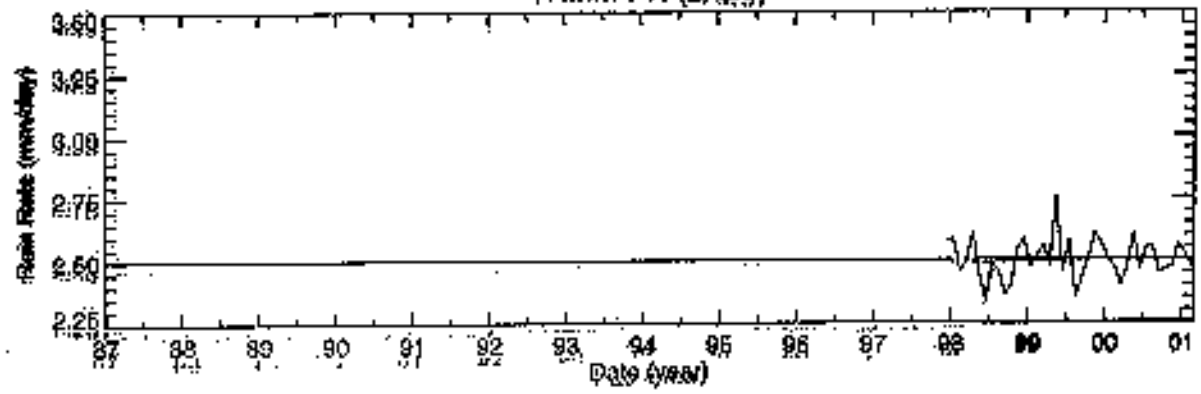
SSM/I Emission (Wilheit/Chang)



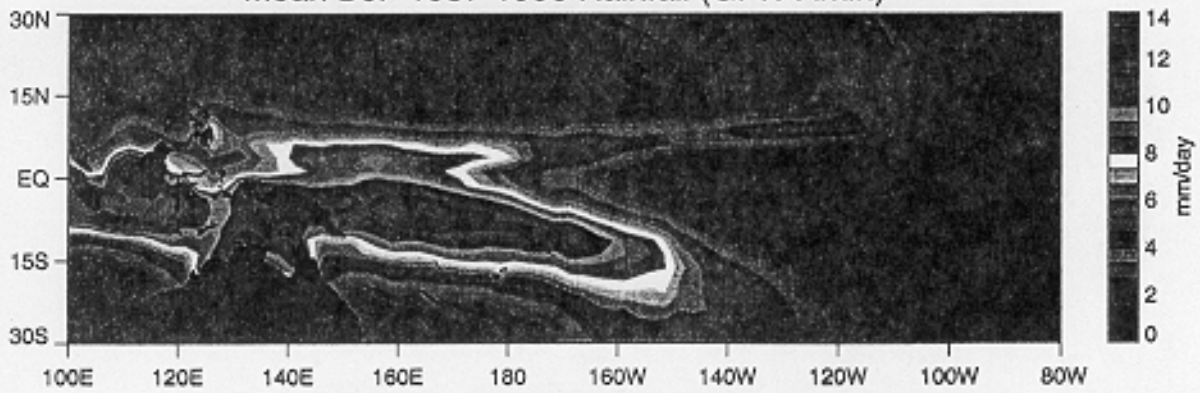
TRMM TMI (2A12)



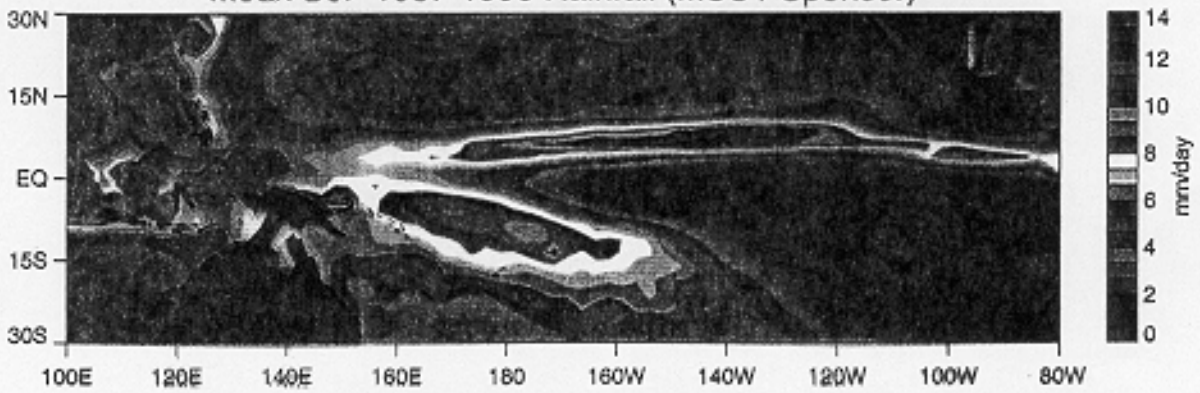
TRMM PR (2A25)



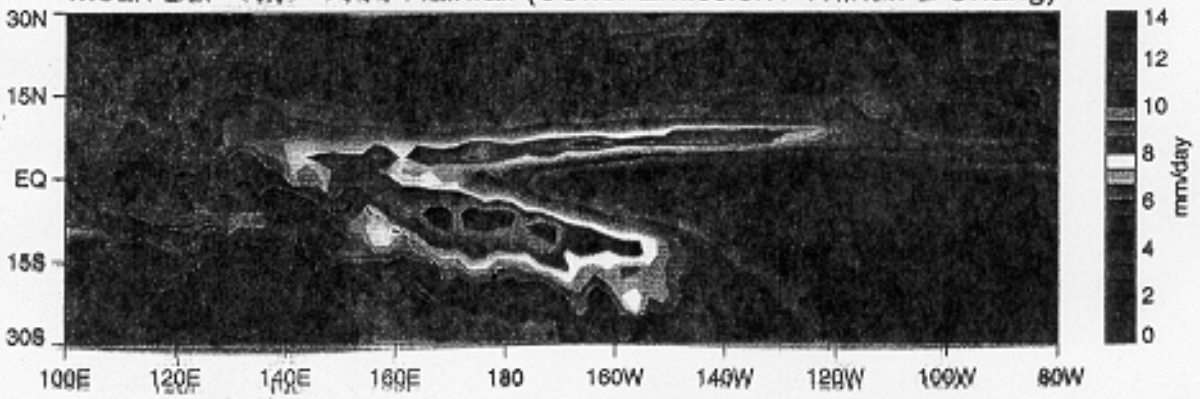
Mean DJF 1987-1996 Rainfall (GPI / Arkin)



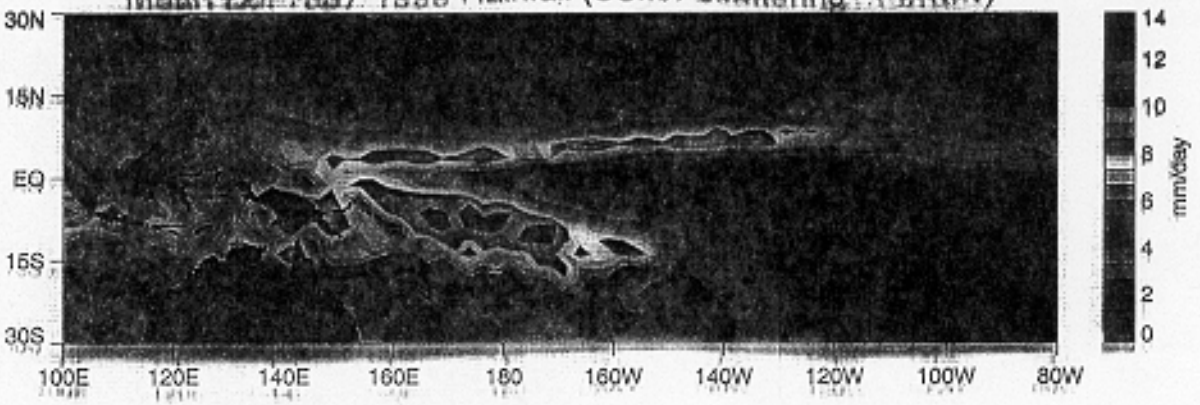
Mean DJF 1987-1996 Rainfall (MSU / Spencer)



Mean DJF 1987-1996 Rainfall (SSM/I Emission / Wilheit & Chang)



Mean DJF 1987-1996 Rainfall (SSM/I Scattering / Ferraro)



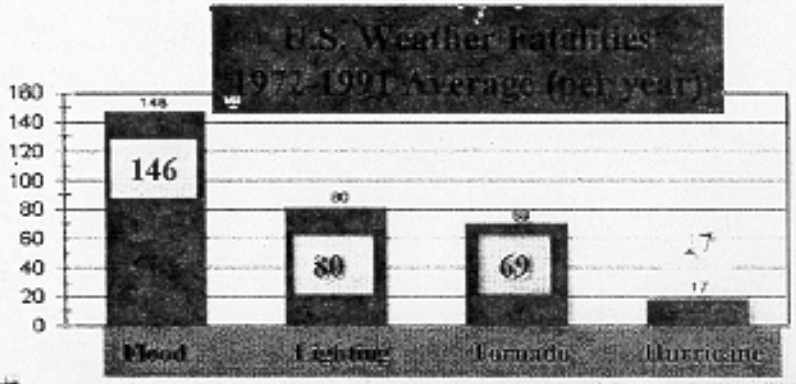
How can knowledge of water cycling be used to improve water system management?

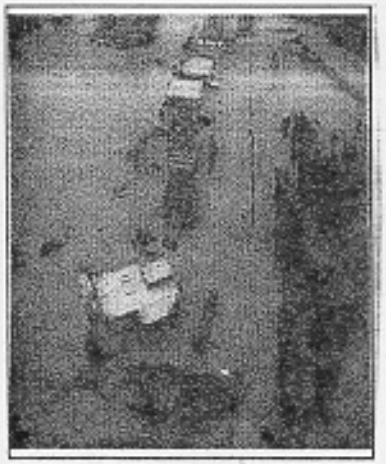
- The challenge is that of merging information from satellite measurements, ground-based weather radar observations, and rain-gauges, to deliver optimal estimates of area-averaged rainfall rate and accumulation.

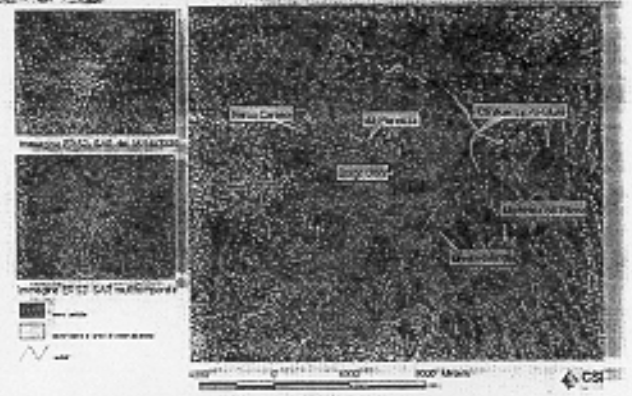
- The goal is to eventually provide reliable (statistical) prediction of area-averaged precipitation on time-scales that most matter for strategic water system management.

Floods Remain Greatest Threat to Human Life

GPM







GPM

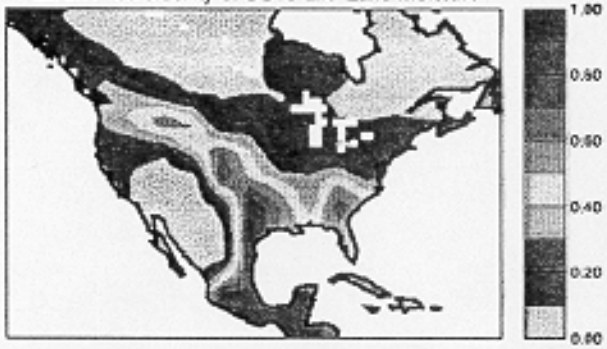
Synergy with Soil Moisture Missions

Understanding Impact of Soil Moisture on Flood/Drought Prediction, Weather Forecasting, & Agriculture is Scientifically Compelling

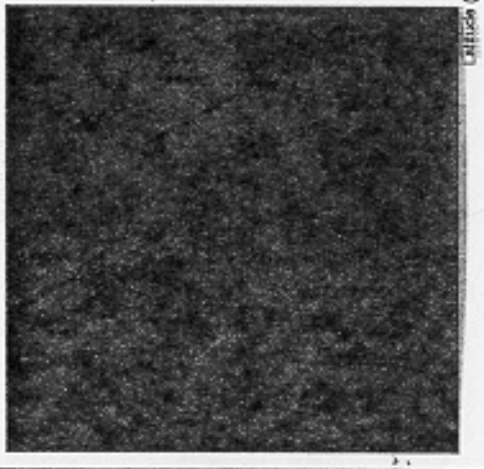
Index of Precipitation Predictability (JJA):

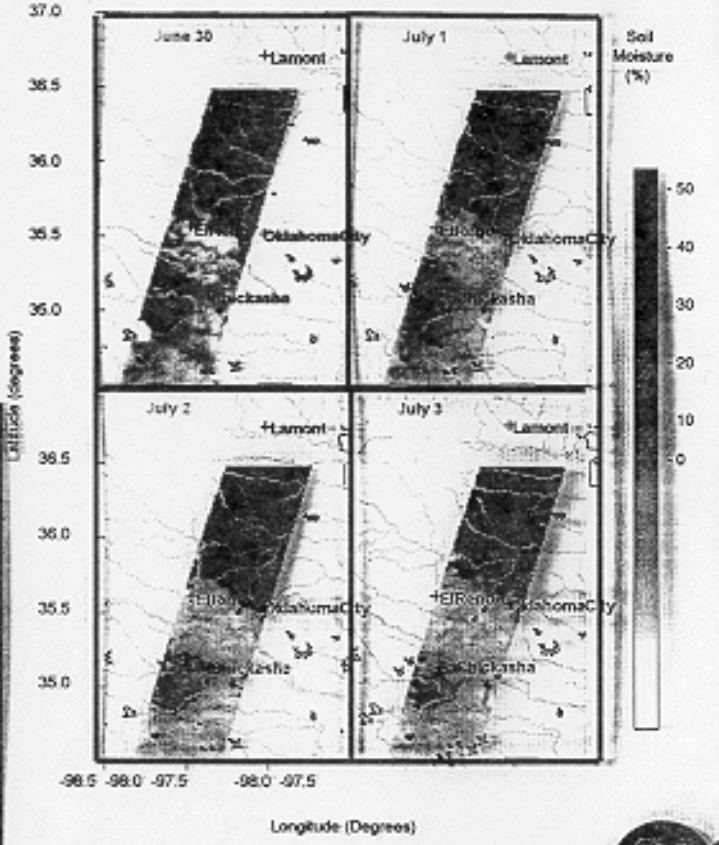
Given Predictability of SSTs

Given Predictability of SSTs and Land Moisture



GLOBAL SOIL MOISTURE OBSERVATION USING MICROWAVE RADIOMETER



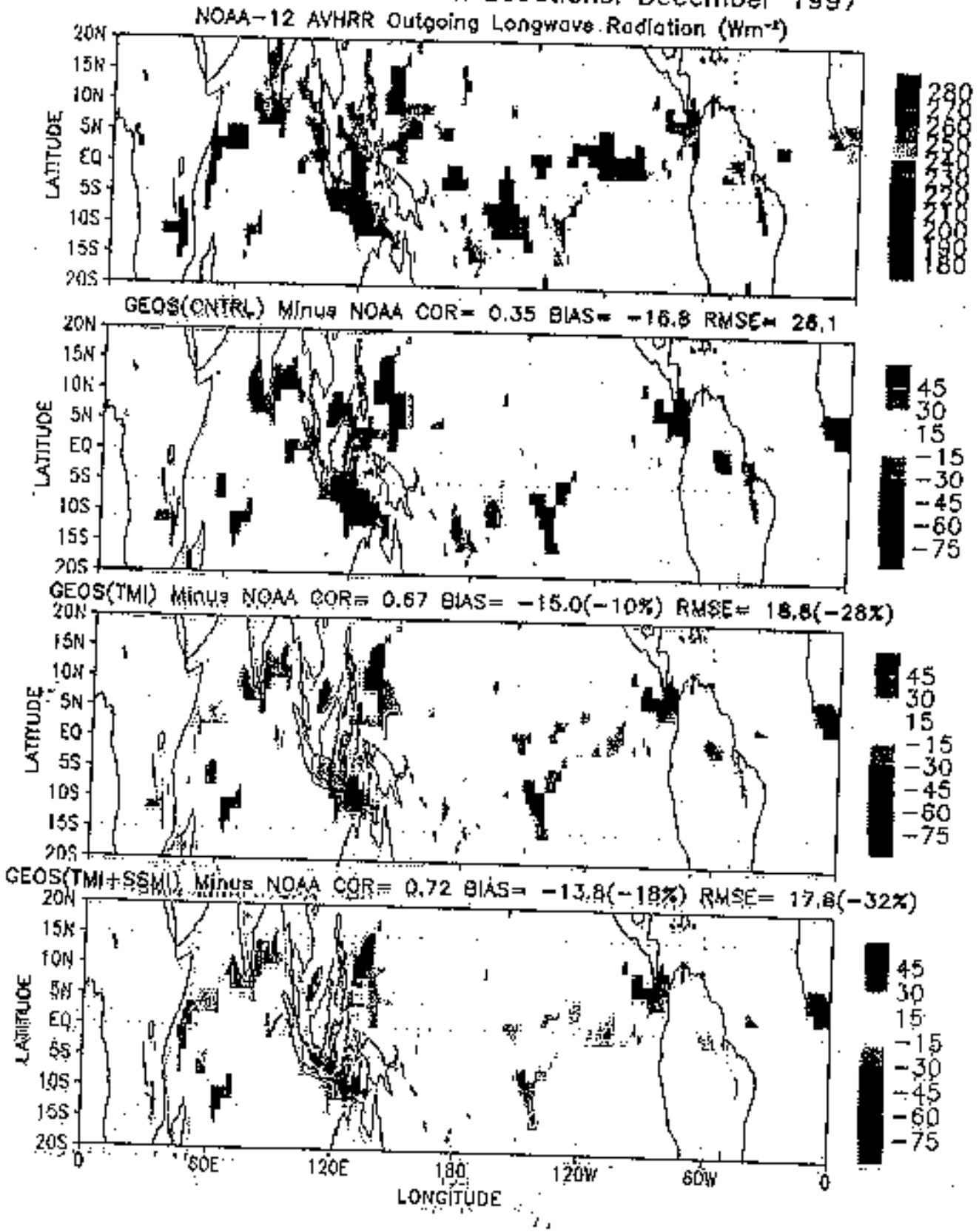


Can weather forecasts be improved by assimilation of global precipitation data?

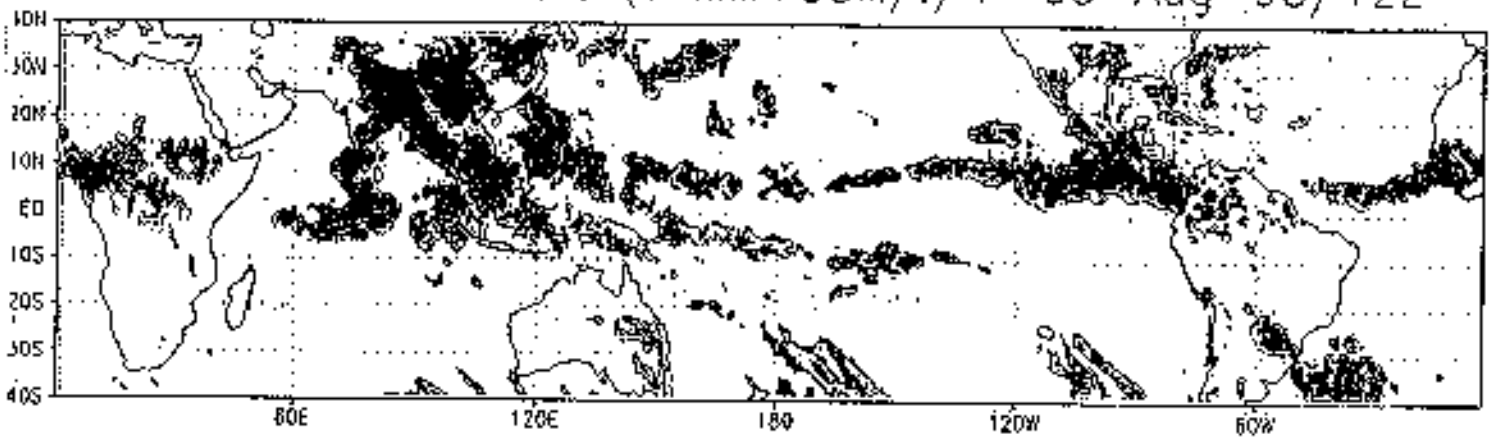
- Comparing model predictions with observed precipitation globally is a powerful diagnostic research tool for improving model formulations of "wet processes" throughout the Earth system (i. e. evaporation and transformation, not just condensation processes).

- Assimilation of observed precipitation and latent heat release provides augmented predictability of future weather developments, a valuable result for NWP applications.

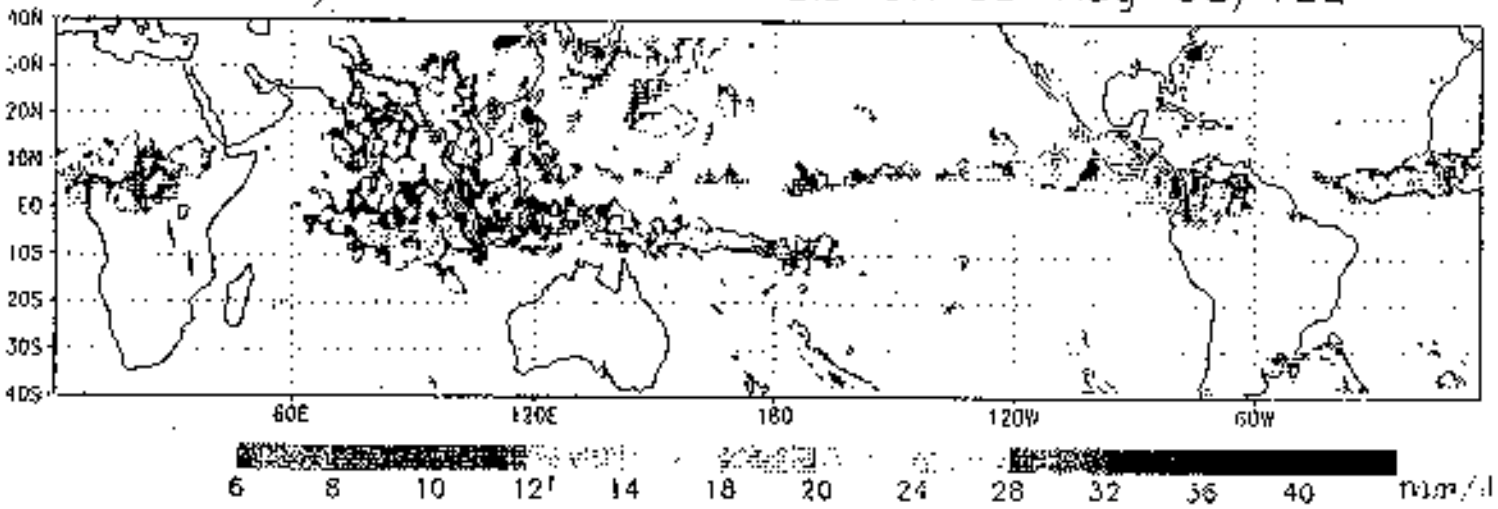
OLR Improvement Associated with Rainfall Changes (> 2 mm d^{-1}) at TMI+SSMI Observation Locations: December 1997



Observed Rain Rates (TRMM+SSM/I) : 05-Aug-98/12Z



3-Day SUP-ENS FCST VALID ON 05-Aug-98/12Z



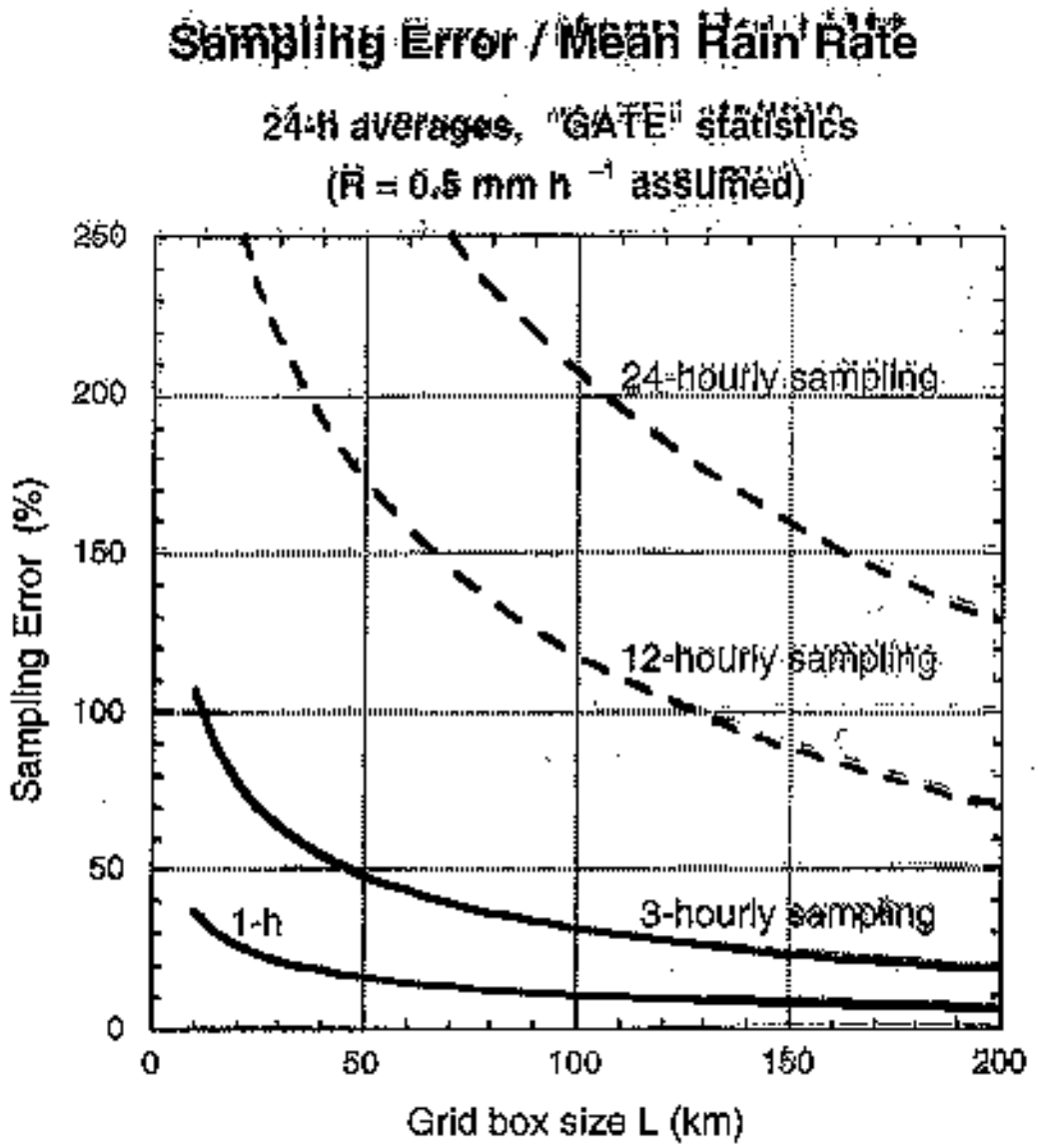
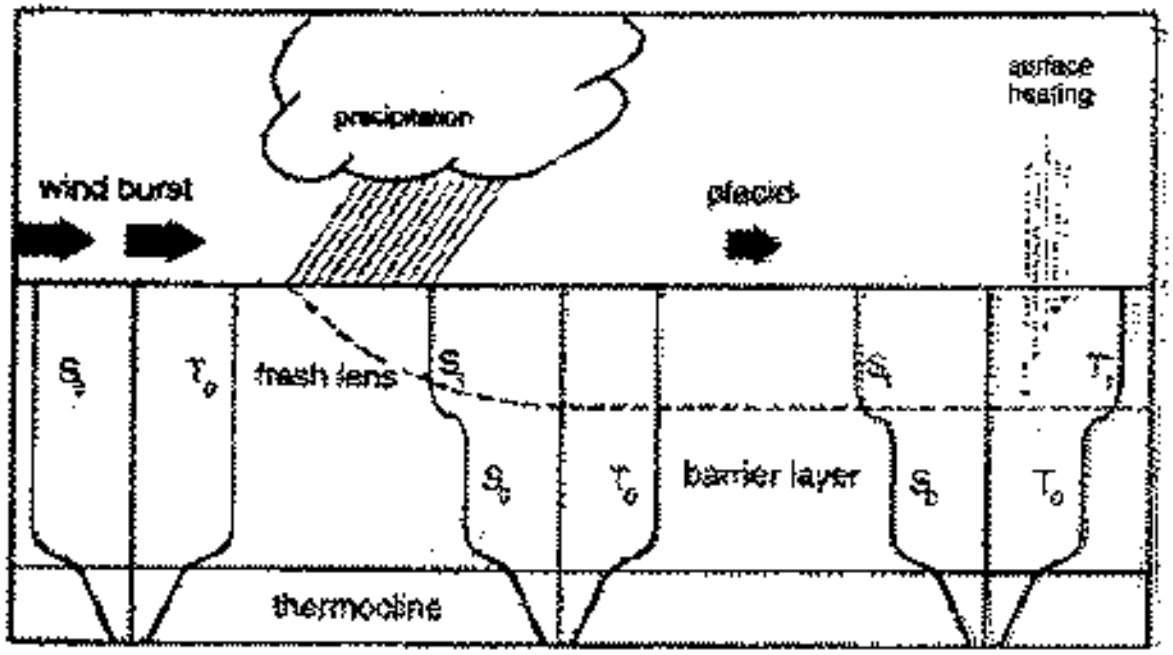


Figure 1. Relative sampling error for daily averages from 1 - 24 satellite observations per day. The area has mean rain rate 0.5 mm/h (i.e., 12 mm/day) with rain statistics like GATE.

GPM

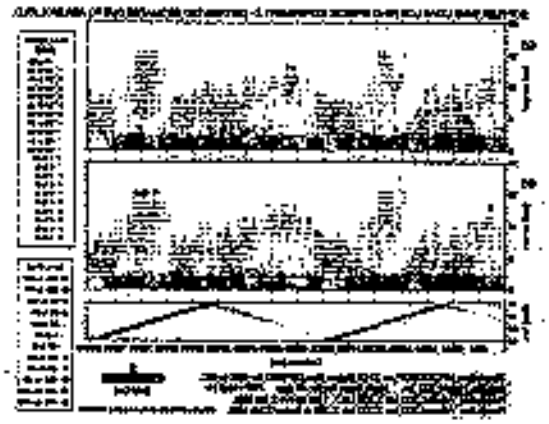
Synergy with Ocean Salinity Missions



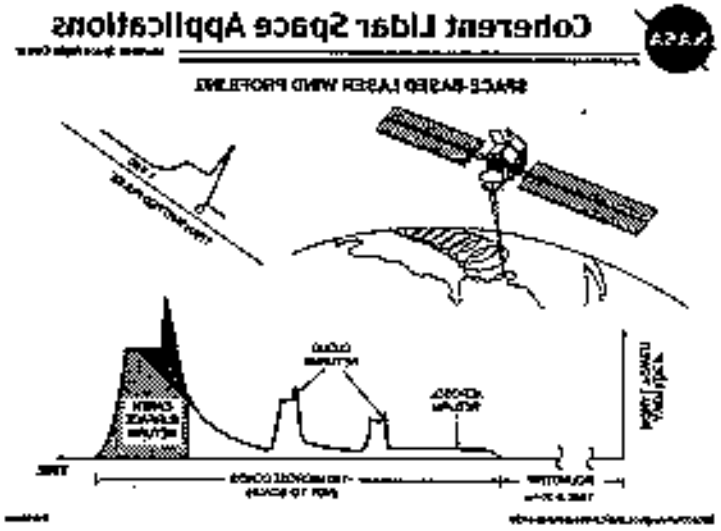
Schematic diagram illustrating Lukas-Lindstrom 'barrier layer' theory. During strong wind burst, surface mixed layer extends down to top of thermocline. Following wind burst, additional buoyancy from precipitation and strong surface heating acts to form relatively warm and fresh thin surface mixed layer. Below thin layer is strong halocline, which effectively decouples surface forcing from deeper water. Further heating is trapped for vertical mixing above barrier formed by halocline.

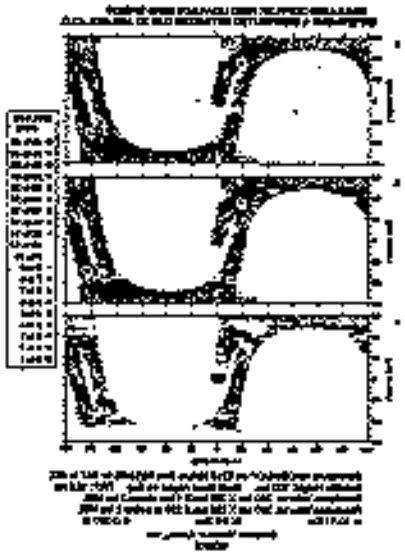
From: Anderson, S. P., R. A. Weller, and R. B. Lukas, 1996: Surface buoyancy forcing and the mixed layer of the western Pacific warm pool: Observations and 1D model results. J. Climate, 9, 3056-3085.

Synergy with Global Wind Lidar Missions



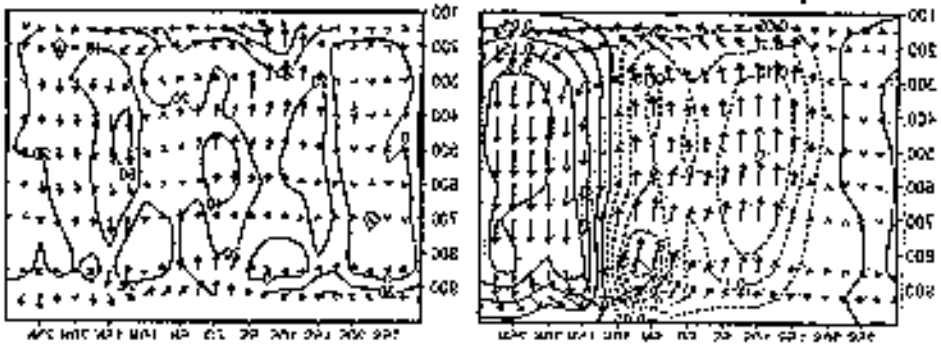
Simulated DWL LOS Winds (D. Emmitt; SWA)



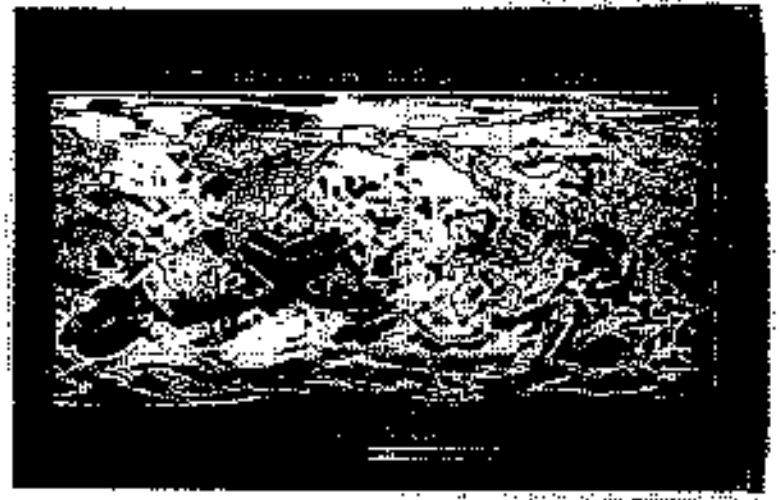


Simulated DWL LOS Winds (D. Emmitt; SWA)

Wind Uncertainties in Global Model Analyses



January mean Hadley circulation (left) for 1985-88 calculated as average of GSFC/DAO & NCEP reanalyses. Vertical motion contoured in μbars s^{-1}. Vector differences (right) between two analyses given with percent differences in vertical motion. Uncertainties exceeding 20% are common.



NCEP-DGMW Wind Speed Differences (R. Atlas; NASA/GSFC)

GPM is an essential step toward systematic observation of global precipitation.

- TRMM has demonstrated the possibility of "training" rainfall retrieval algorithms based on passive microwave observations only, using cloud structure information from microwave Precipitation Radar observations.

- The core GPM mission and other concurrent cloud-research satellites will constitute a powerful tool for investigating cloud and precipitation processes in the global atmosphere, and relating the passive and active signatures of precipitating clouds.

What community must do for GPM

- Must answer questions

- Must have outreach

Challenge: 100 Millions viewers / day

↓

Must have timely rainfall data where not currently available

Must develop rainfall forecast models for public view

GPM is an essential step toward systematic observation of global precipitation.

- The GPM concept includes the seed of a future Global Precipitation Observing System, in the guise of a constellation of research and operational satellites, equipped with passive cloud-sensing microwave imagers.

- The low Earth-orbit constellation is needed to provide both relatively high spatial resolution (beam-filling factor) and frequent observations (3-hourly or better).

What GPM <u>must</u> do for community

1. Provide reliable obs. of rainfall w. uncertainty. Must have continuity

2. Make methods and data available to community – Improve on monolithic data system

3. Validate products

When necessary, see beyond confines of "Mission" to provide data that users really need.

i.e. Merged satellite, radar gauge products

Merged GPM, AMSU, Geo-IR for applications