CLIMATE AS A BASIS FOR INTEGRATING BETWEEN THEMES

MARCH 2. 2005
TOKYO, JAPAN

IN ADDRESSING CLIMATE ISSUES, DATA ARE NEEDED:

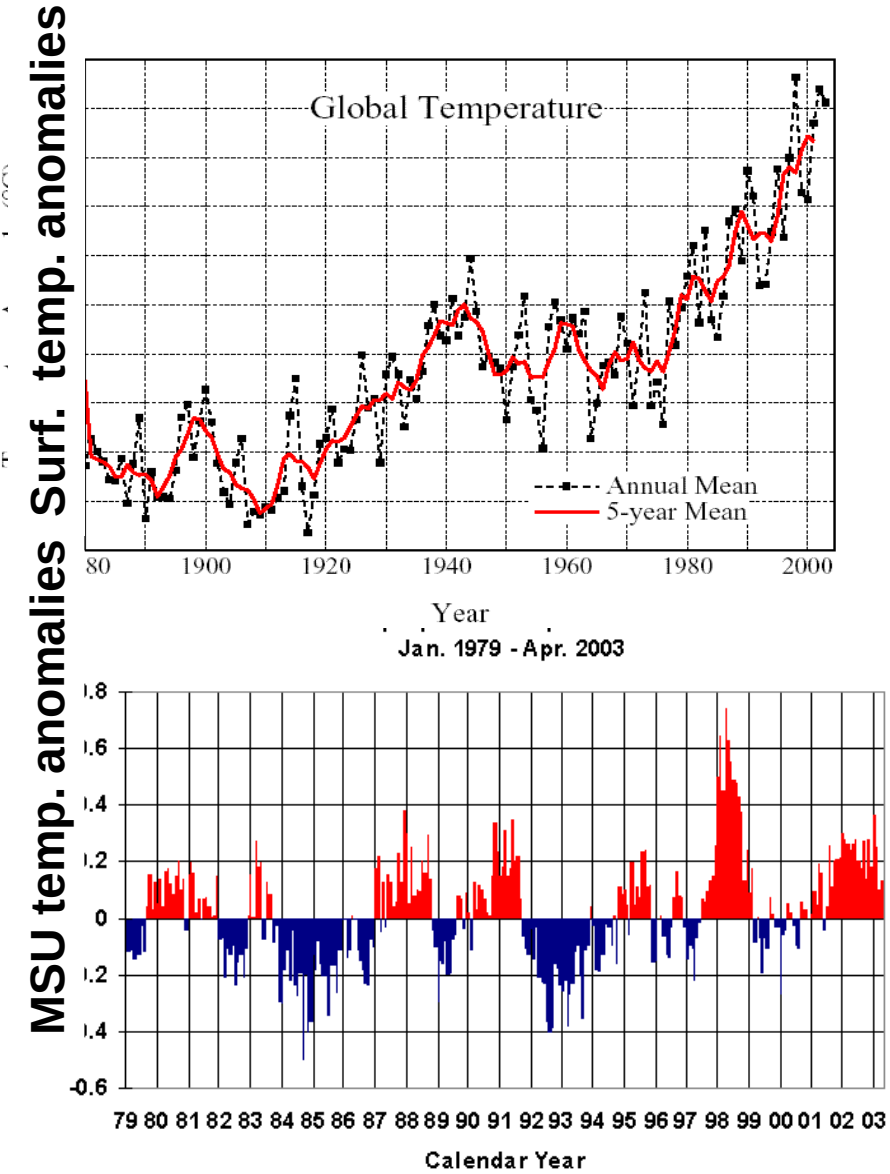
1) TO ASSESS THE EXISTENCE OF CLIMATE TRENDS. IN PARTICULAR LONG TERM CONSISTENT RECORDS OF CLIMATE VARIABLES ARE NEEDED. (TREND ANALYSIS).

2) TO ASSESS THE RELATIONSHIP BETWEEN CHANGES IN CLIMATE VARIABLES AND THEIR INFLUENCE ON OTHER PHYSICAL, BIOLOGICAL AND SOCIECONOMIC VARIABLES. (IMPACT ASSESSMENT).

3) TO DEVELOP THE PROCESS UNDERSTANIDNG NEEDED TO BUILD MODELS (CLIMATE (AND EARTH SYSTEM) MODEL DEVELOPMENT).

4) TO ESTABLISH A BASELINE DESCRIPTION OF CLIMATE FOR USE IN EVALUATING MODELS AND ASSESSING CHANGE.

HOW SHOULD WE CHARACTERIZE AND ANALYZE UNCERTAINTIES IN DATA SETS?



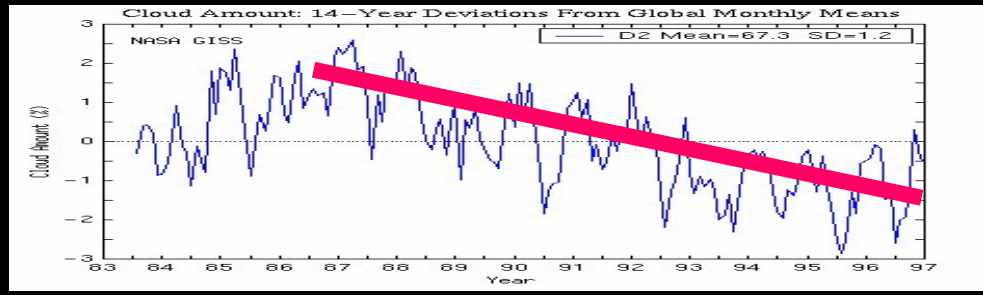
Why are the trends different?
Analysis of dataset's uncertainties

- **Analyze differences in these datasets**
- **Collocate multiple records consistent time series**
- **Derive atmospheric state & circulation data**
- **Seek improvements in divergent wind field analysis**
- **Reprocess historical data cooperation with partners**
- **Assemble a complete description of WEC within 15%**

from GISS & GHCC

DETECTING CLIMATE TRENDS FROM SATELLITE DATA

WHILE IT IS TEMPTING TO USE SATELLITE PRODUCTS TO ARGUE FOR CERTAIN CLIMATE TRENDS,

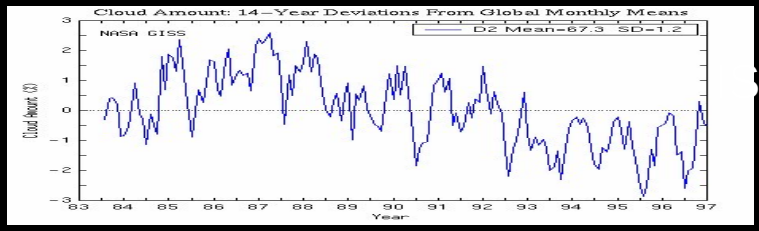


GEWEX RECOMMENDS CAUTION BECAUSE:

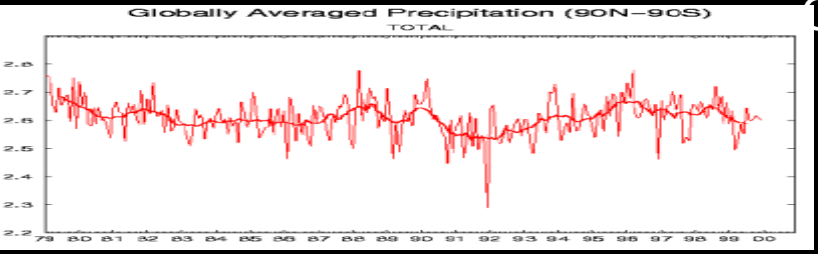
- THE ERROR BARS ON THE SATELLITE PRODUCTS ARE LARGE AND THE “TRENDS” ARE STILL WITHIN THE NOISE.
- THE “TRENDS” ARE VERY SENSITIVE TO CHANGES IN SATELLITES AND THEIR ORBITS AND TO ANALYSIS TECHNIQUES.
- TRENDS IN A VARIABLE SHOULD BE CONFIRMED BY DIFFERENT DATA SETS

A RECENT GEWEX/ IGWCO/UNESCO WORKSHOP ON TRENDS IN THE GLOBAL WATER CYCLE RECOMMENDED A REANALYSIS OF SATELLITE WATER CYCLE DATA PRODUCTS.

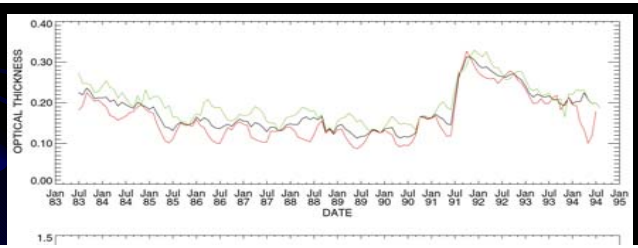
HOW MUCH PROCESSING SHOULD BE DONE BY THE PROVIDERS OF IGWCO CLIMATE DATA SETS?



ISCCP

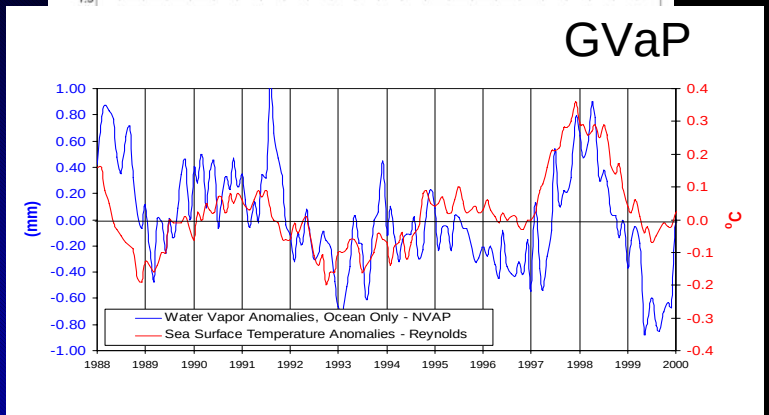


GPCP



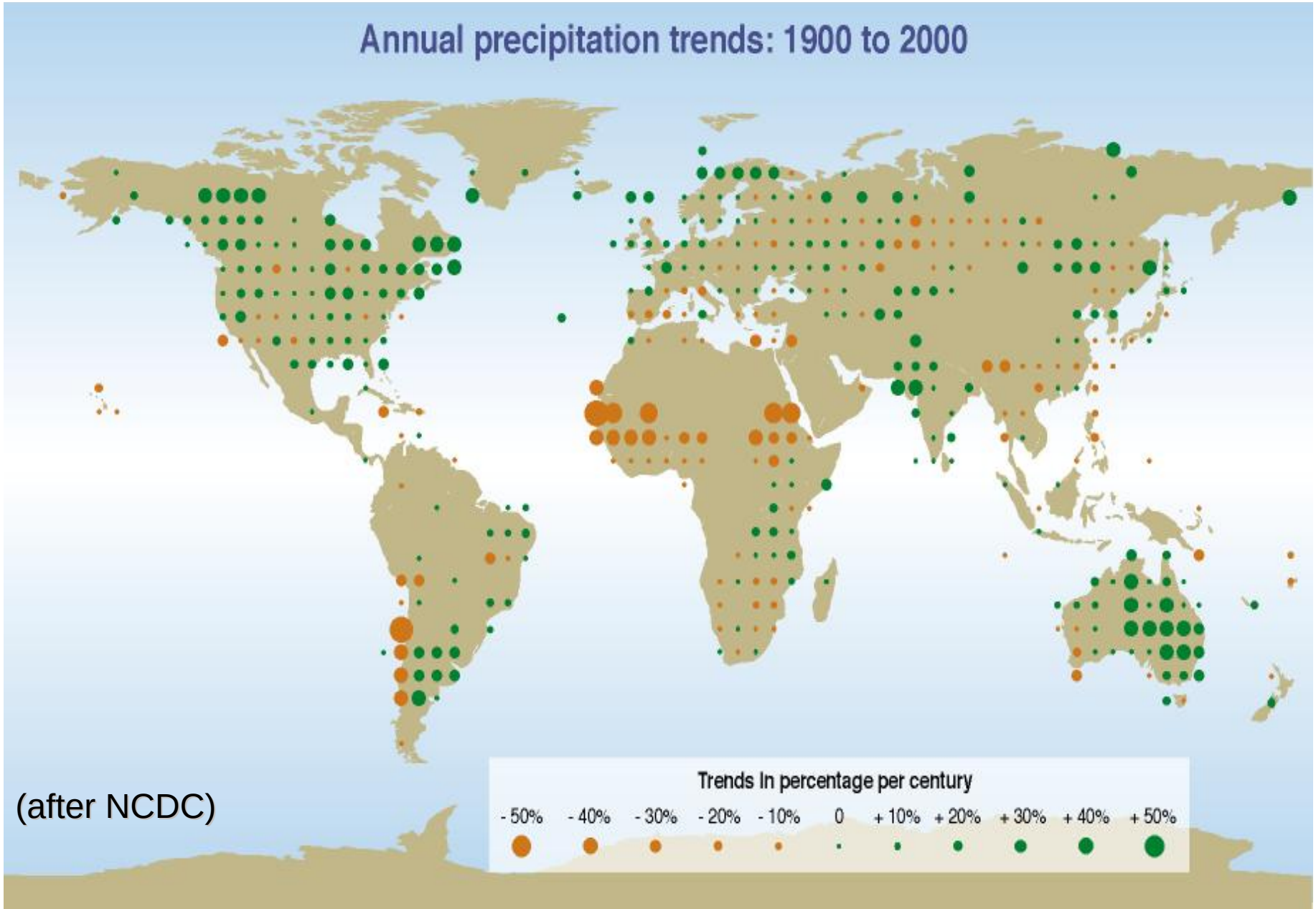
GACP

GVaP



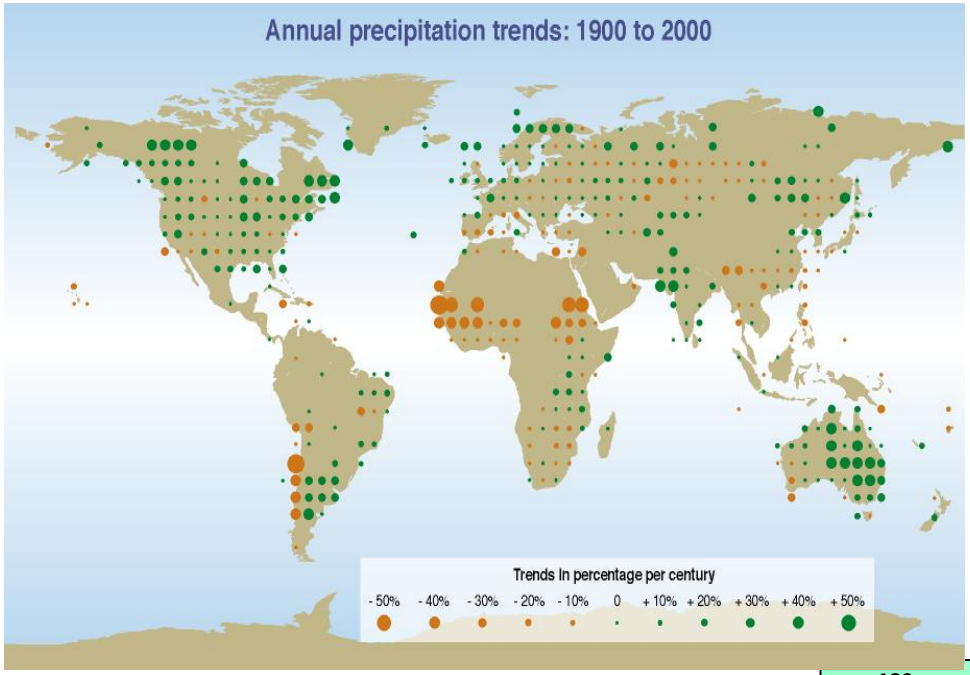
MANY SCIENTISTS WISH TO LOOK AT SATELLITE DATA IN THEIR BASIC FORM. HOWEVER, OTHER USERS WISH TO HAVE ALL OF THE EFFECTS OF SATELLITE OPERATIONS REMOVED. THIS IS PARTICULARLY TRUE WHEN LONG-TERM TRENDS ARE BEING ASSESSED. THIS MEANS A GREAT DEAL OF WORK BECAUSE ALGORITHMS MUST BE ADJUSTED WHENEVER SATELLITES ARE MOVED, OR THEIR ORBITS CHANGE, OR AN INSTRUMENT CALIBRATION BEGINS TO DRIFT. TO WHAT EXTENT SHOULD THE DATA PROVIDER BE RESPONSIBLE FOR MAKING HIGHLY PROCESSED LONG-TERM DATA SETS?

Precipitation patterns have changed



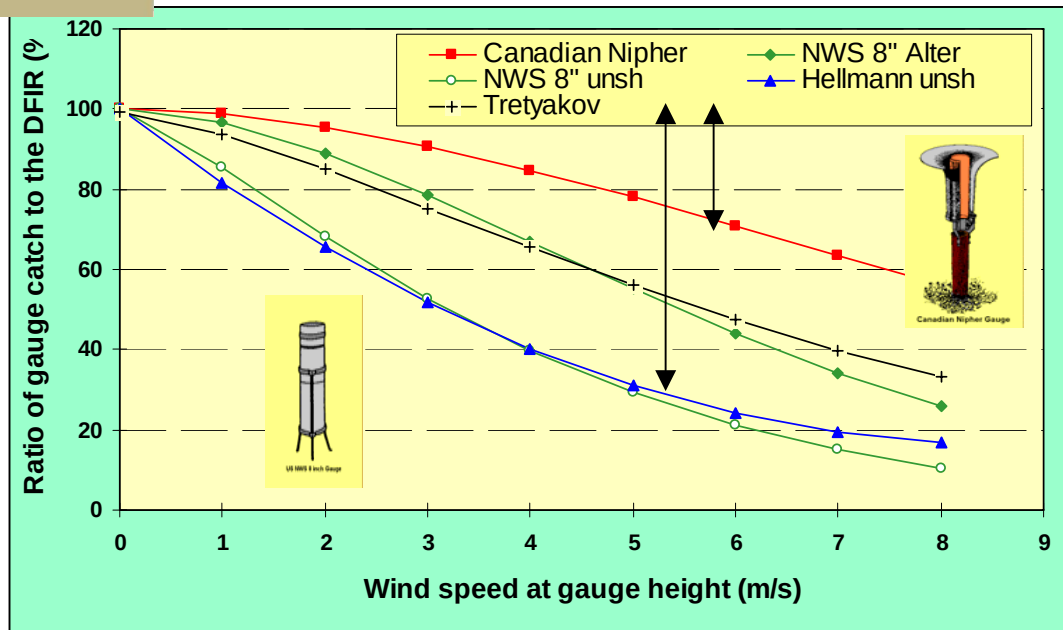
(after NCDC)

Precipitation patterns have changed – but are some actual changes or effects of temperature on the snow to rain ratio?



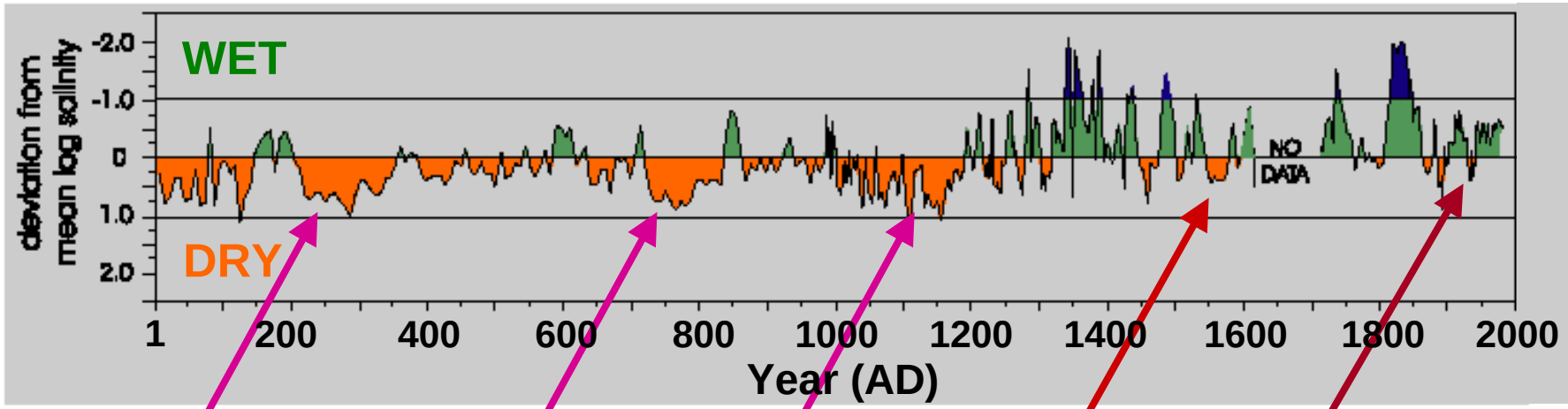
Undercatch from some gauges can lead to large underestimates of snow amounts. For a given amount of precipitation, where the relative amount of snow decreases the amount of precipitation measured would increase because rain has much smaller undercatch errors.

What impact does this have for the interpretation of the trend towards higher annual precipitation at mid-latitudes.? Is this the result of a change that has made gauges more efficient (larger rain/snow ratios) or physical changes?



AT WHAT TIME SCALE DOES LONG-TERM CLIMATE VARABILITY BECOME CLIMATE CHANGE?

Northern US High Plains Paleodrought
(Reconstructed from Lake Sediments)



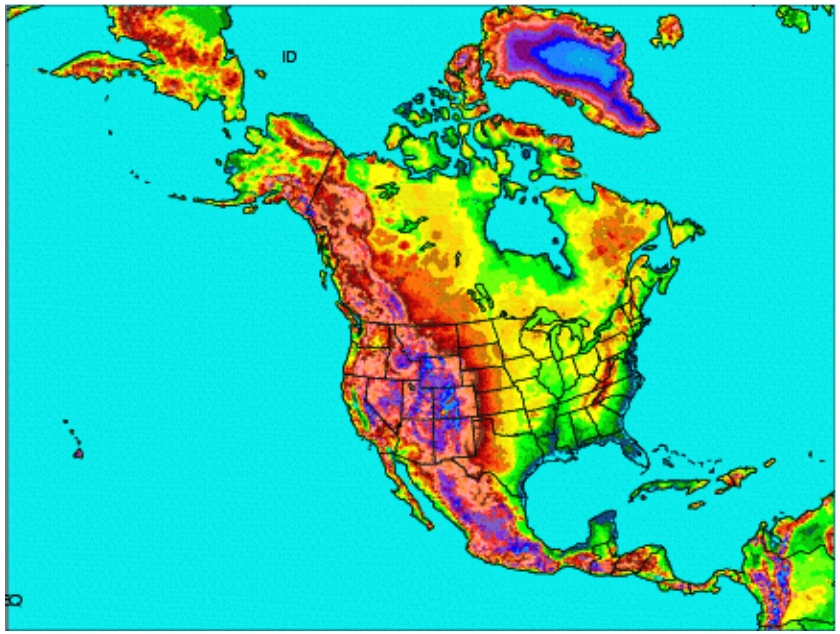
1930's dustbowl

16th century "megadrought"

>100 year "megadroughts"

(From Woodhouse and Overpeck, 1998, After Laird et al., 1996, Nature)

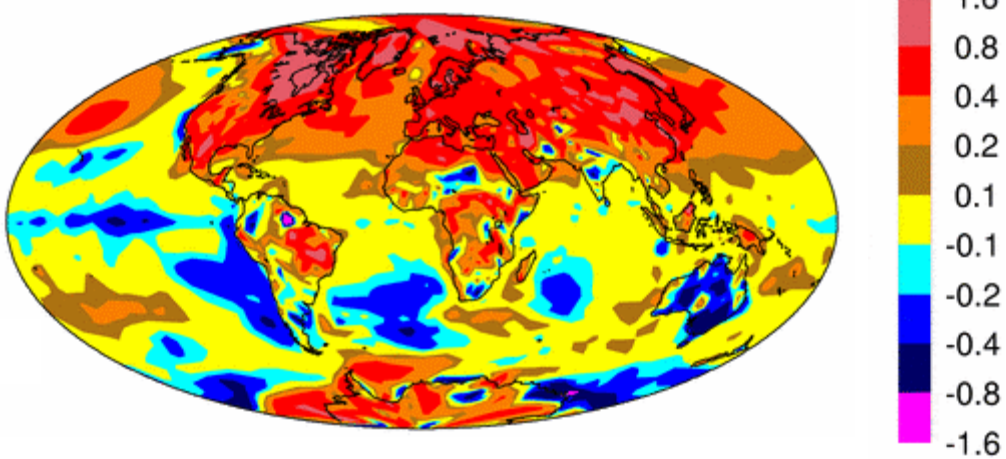
HOW VALID ARE TREND AND VARIABILITY ESTIMATES DERIVED FROM MODEL REANALYSIS?



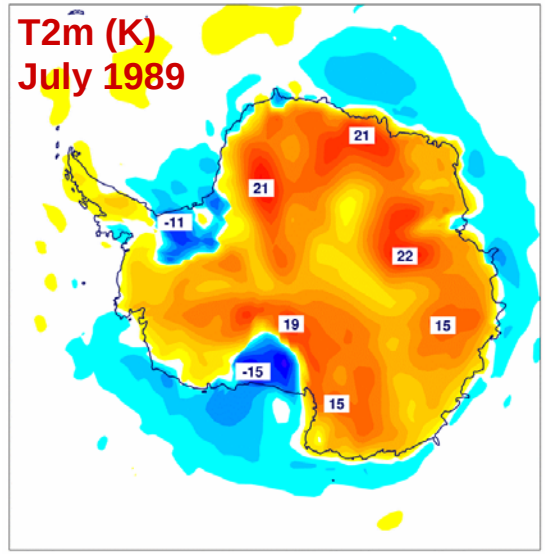
REANALYSIS PRODUCTS HAVE COARSE RESOLUTION (REGIONAL: 32 KM). HOW DOES RESOLUTION AND MODEL PERFORMANCE AFFECT THE RELIABILITY OF TIME SERIES FOR DIFFERENT VARIABLES?

Linear trends 1979-2001 (°C/decade)

ERA-40 2m T analysis



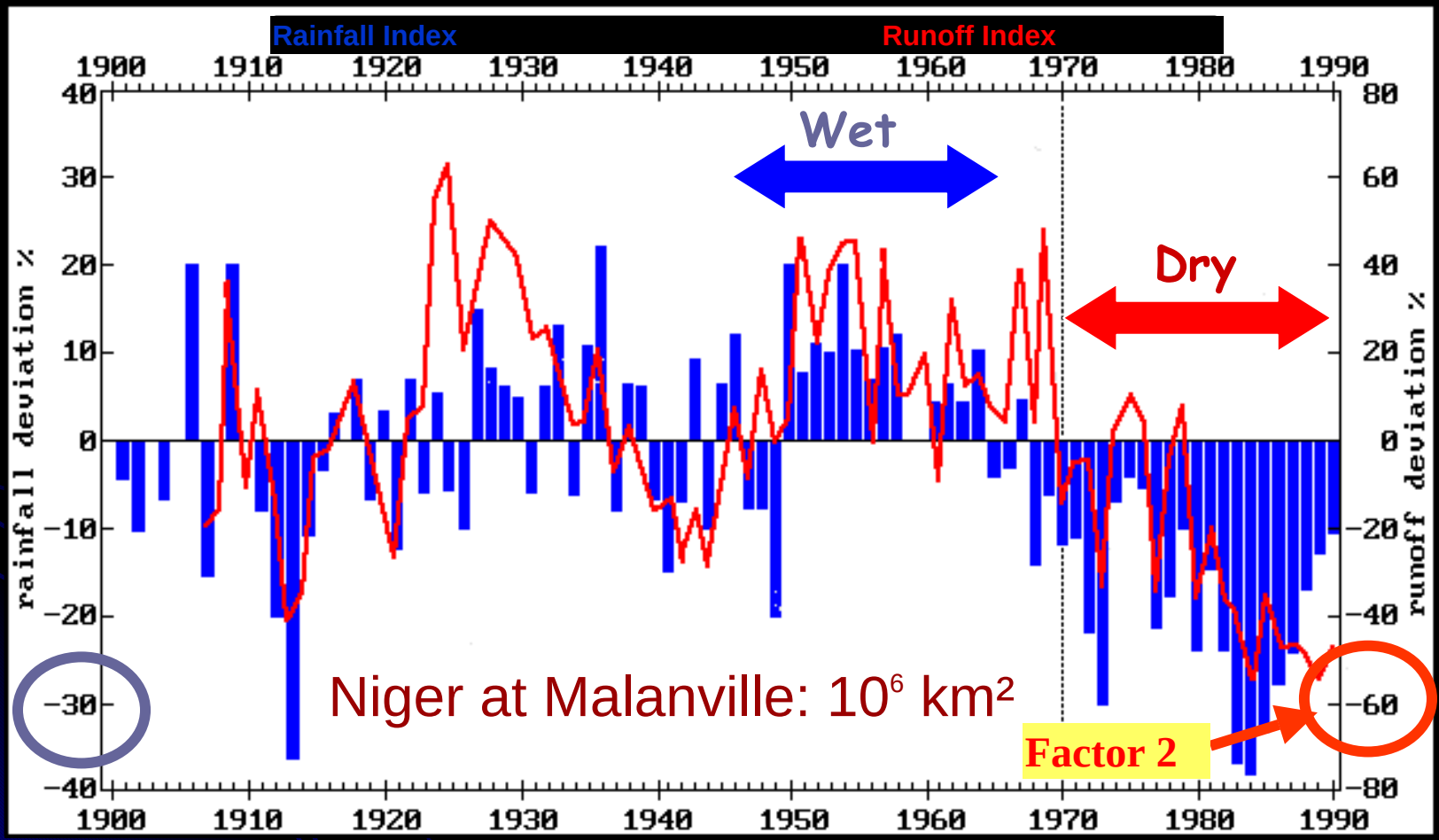
Mean differences between ERA-40 and ERA-15



Contour interval 2K
Yellow/red indicates ERA-40 warmer than ERA-15

HYDROLOGICAL RESPONSES TO RAINFALL ARE NON-LINEAR (IMPLICATIONS FOR CLIMATE CHANGE)

Two periods : 50's-60's versus 70's-80's

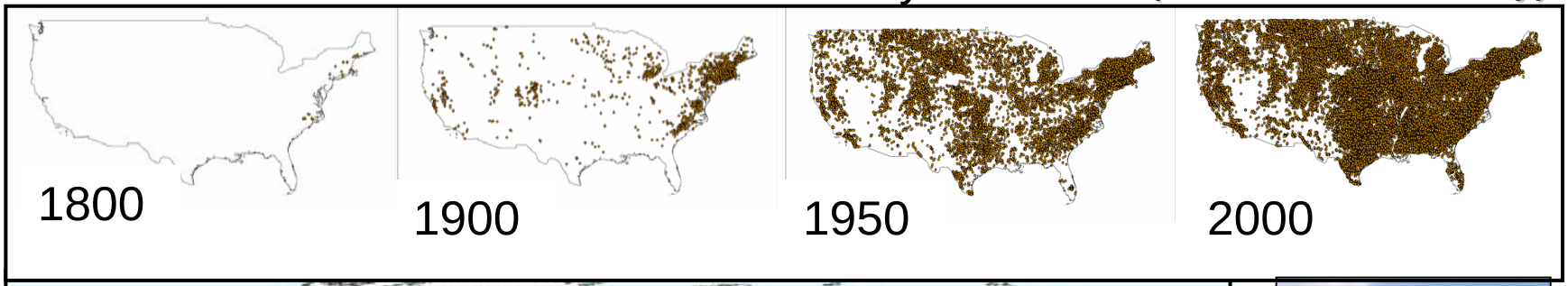


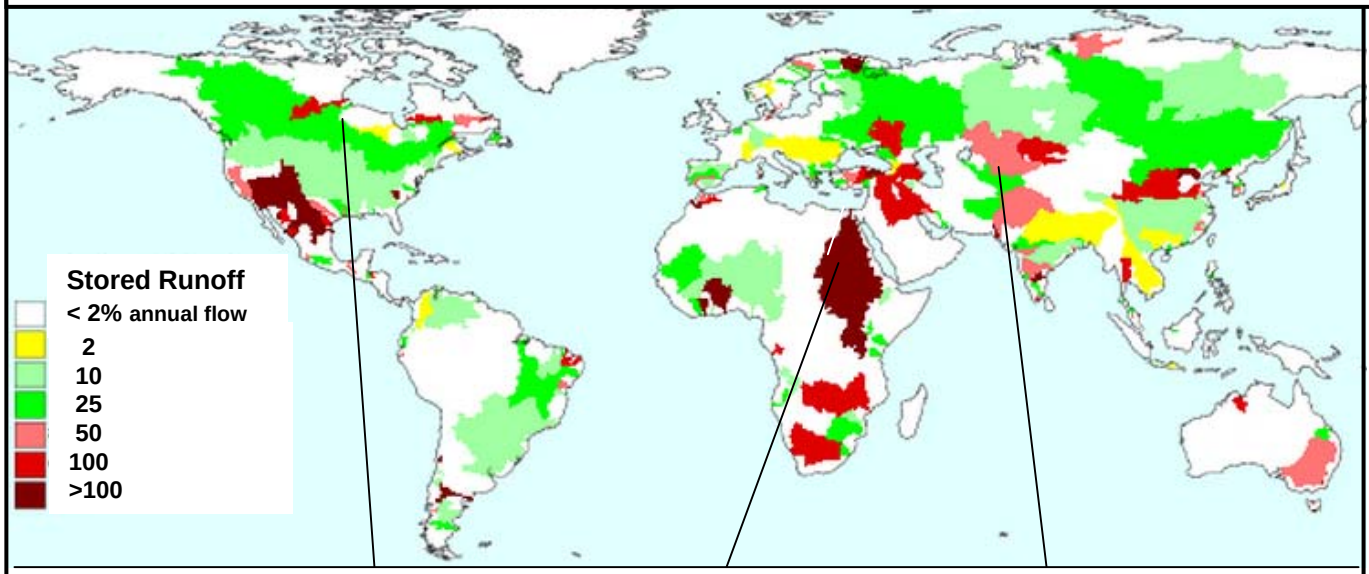
A Factor 2 when looking at the streamflow

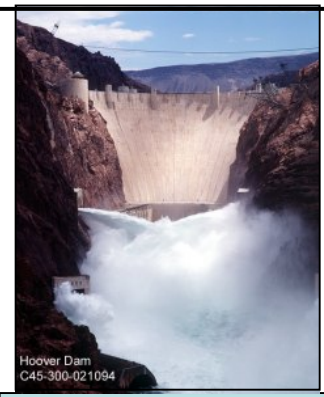
(courtesy of T. Lebel)

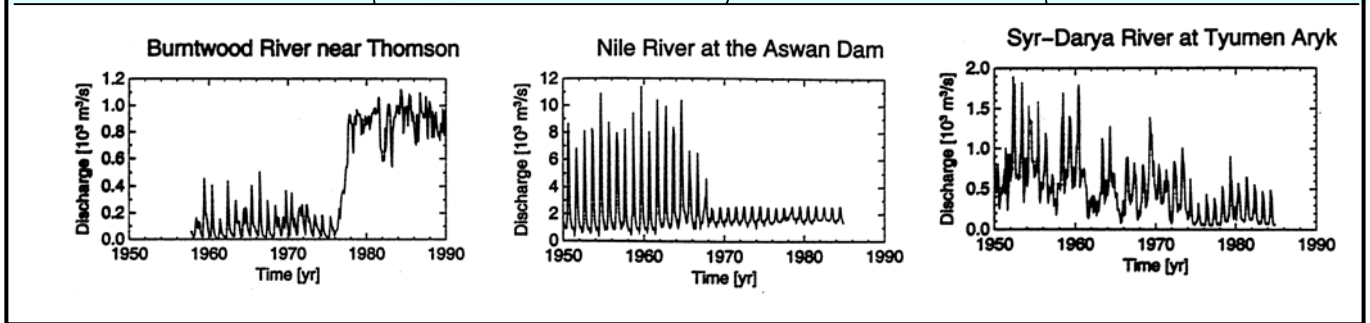
THE CONTRIBUTIONS OF WATER AND LAND USE CHANGES IN OBSERVED TRENDS MUST BE ANALYZED

US National Inventory of Dams (from C. Vorosmarty)







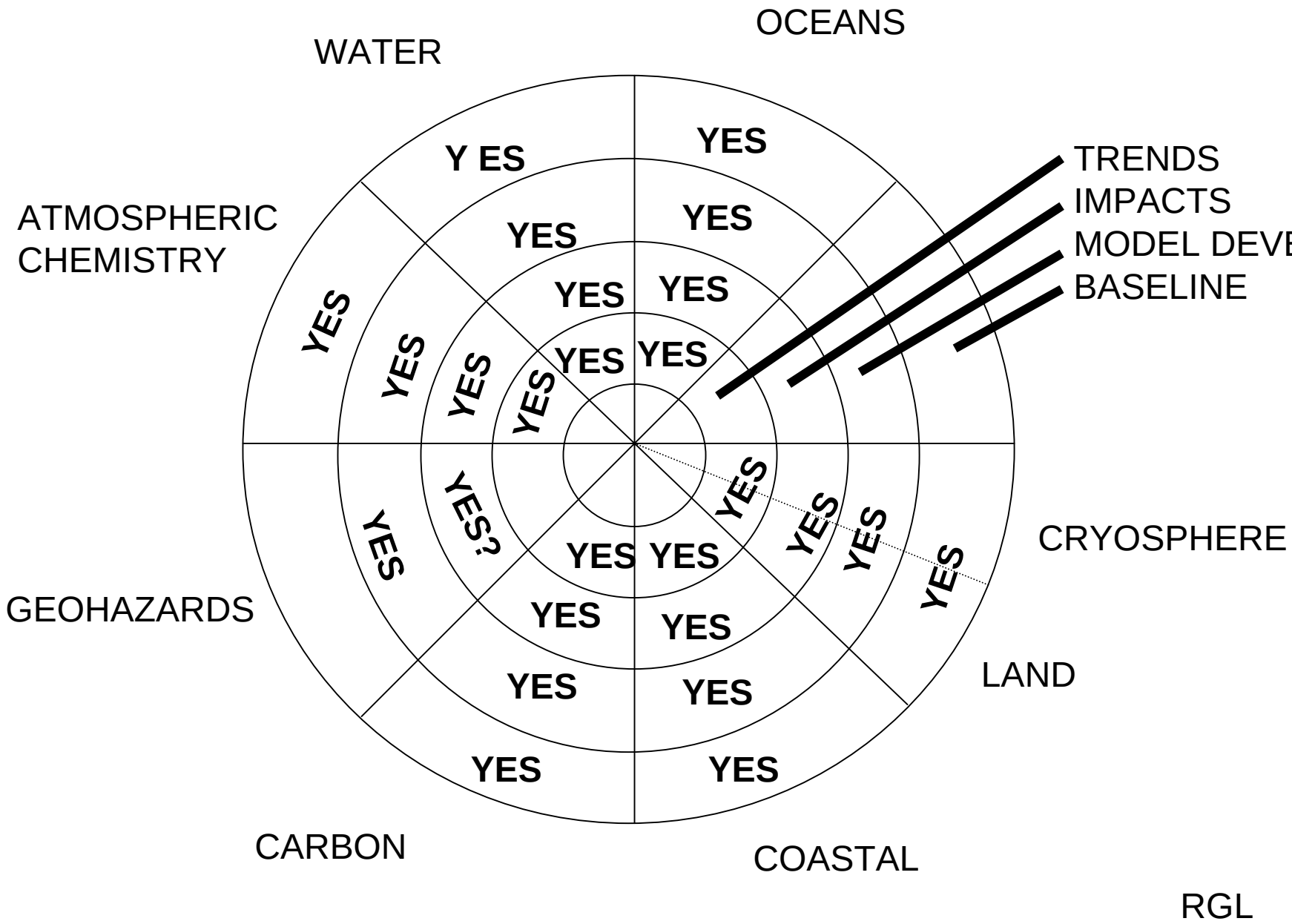


Interactions with:

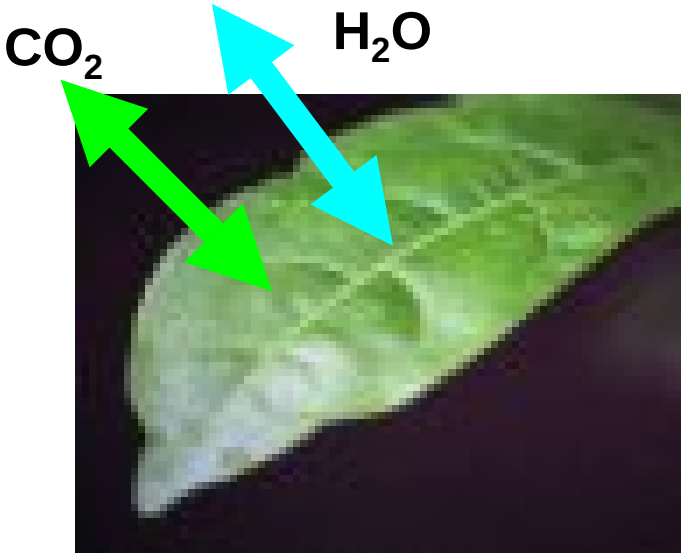
- People
- Aquatic biota
- Agriculture
- Climate
- Navigation
- Energy
- Economics
- Health
- Carbon, BGC

PROGRAMMATIC RATIONALE FOR CLIMATE AS AN INTEGRATOR:

1) ALTHOUGH IGOS-P CHOSE NOT TO ADOPT CLIMATE AS A THEME, GEO DOES HAVE CLIMATE AS ONE OF ITS NINE SOCIO-ECONOMIC AREAS. BY INITIATING AN INTEGRATIVE ACTIVITY IGOS-P WOULD BE PROVIDING MORE COMPREHENSIVE COVERAGE OF GEO PRIORITIES.
2) CLIMATE WOULD HELP TO PROVIDE A LONGER-TERM PERSPECTIVE ON DATA NEEDS AND PROVIDE STRONGER ARGUMENTS FOR RESEARCH TO OPERATIONS TRANSITIONS AND REANALYSIS.
3) CLIMATE WOULD HELP BROADEN THE COMMUNITY THAT WOULD SUPPORT THE STRENGTHENING OF THEME ACTIVITIES.


OCEANS
WATER
ATMOSPHERIC CHEMISTRY
CRYOSPHERE
GEOHAZARDS
LAND
CARBON
COASTAL
TRENDS
IMPACTS
MODEL DEVEL.
BASELINE
Y ES
YES
YES?
RGL

Cross cutting: IGCO (carbon) and IGWCO



Water and carbon cycles are linked through biology: knowing one cycle improves knowledge of the other

Measuring water and carbon concentrations and fluxes are often related, i.e. satellite measurements, flux towers

It is important that the water and carbon observing system Implementation Plans complement each other

IGCO products which can aid IGWCO

- **Estimates of NPP deduced from NDVI and FAPAR could be used to estimate water fluxes**
- **Eddy covariance flux towers simultaneously measure CO_2 and latent heat fluxes**
- **Atmospheric distributions of CO_2 to aid H_2O satellite retrievals**

IGWCO products required for C cycle studies

Many water cycle fields are needed, in particular as input for process based terrestrial biosphere models:

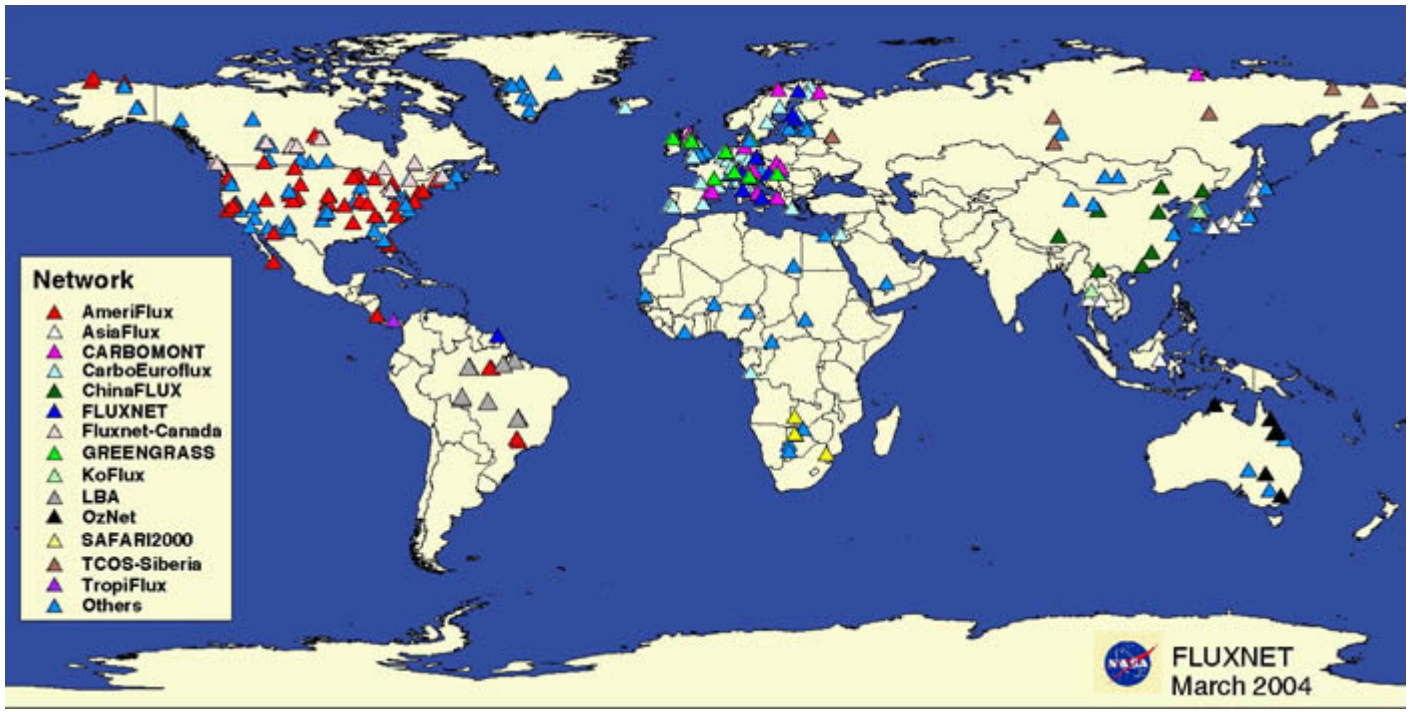
- **precipitation (and evaporation)**
- **soil moisture**
- **cloudiness and the impact on radiation (quantity and ratio of direct and diffuse radiation)**

IGWCO products required for C cycle studies (cont.)

Other water cycle fields would also prove very useful:

- **river runoff (lateral transport of dissolved organic and inorganic C)**
- **^{18}O isotopes in H_2O**
- **wetland distribution for estimating methane emissions**
- **maps of permafrost**

- global network of micrometeorological tower sites measuring
  - carbon dioxide
  - water vapor
  - and energy fluxes
- Over 200 tower sites are operating on a long-term and continuous basis.
- data on site vegetation, soil, hydrologic, and meteorological characteristics also collected



FLUXNET
A Global Network

Will use the 2.6 micron band to estimate CO_2 column concentrations.

This band is also sensitive to H_2O and as such, accurate fields of water vapor will be required.