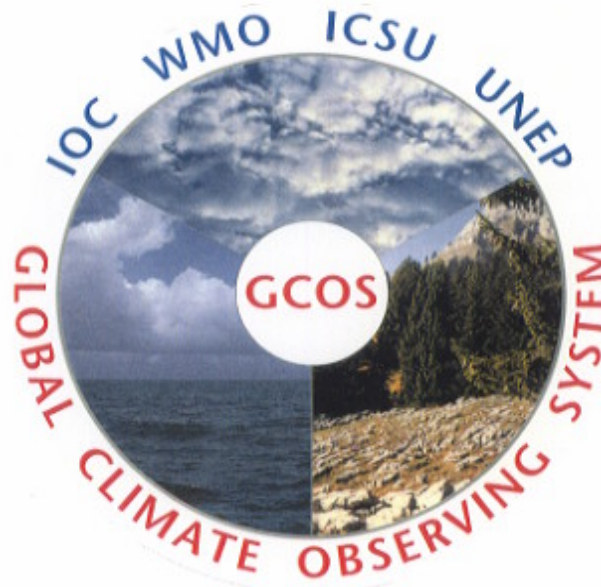




# Overview of GRUAN



*Peter Thorne*

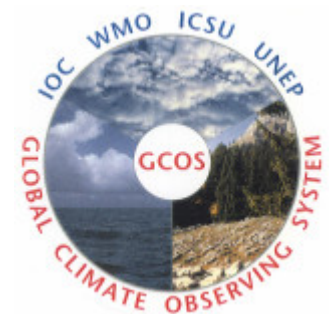
*Chair, GCOS AOPC Working Group on Atmospheric Reference Observations*

*David Goodrich*

*Director, GCOS Secretariat, World Meteorological Organization*

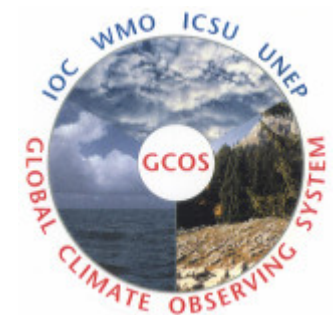
# Outline

- What is GRUAN?
- Why do we need GRUAN?
- How does GRUAN fit in?
- How did we get here?
- Does anyone else think GRUAN is a good idea?
- What do we want out of this meeting?
- What's in it for you?



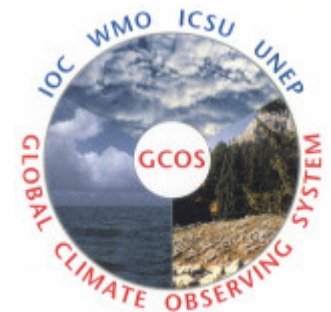
# What is GRUAN?

- GCOS Reference Upper Air Network
- Called for in the GCOS Implementation Plan
- Currently largely an abstract concept, which is the reason why you are all here



# Aims

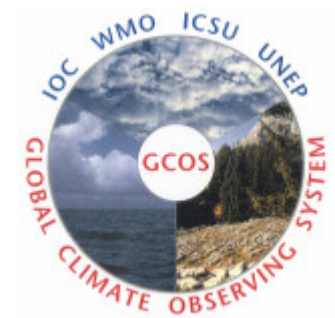
- Order 30-40 sites across the globe
- Providing long-term, high-quality climate records
- Serving to constrain and calibrate data from more spatially-comprehensive global observing systems (inc. satellites)
- Measuring a large suite of co-related climate variables with deliberate measurement redundancy
- Run for climate monitoring



# Common misconceptions

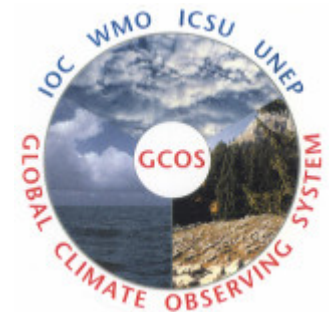
- That it is intended that the GRUAN instrumentation be fixed in perpetuity – managed change!
- That this is an effort to replace GUAN – GUAN is still important
- That it is intended as a resource solely for climate – managed for climate, but available to all
- That GCOS can fund the network, sadly not true

# Why do we need GRUAN?

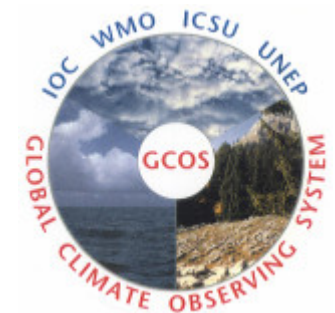
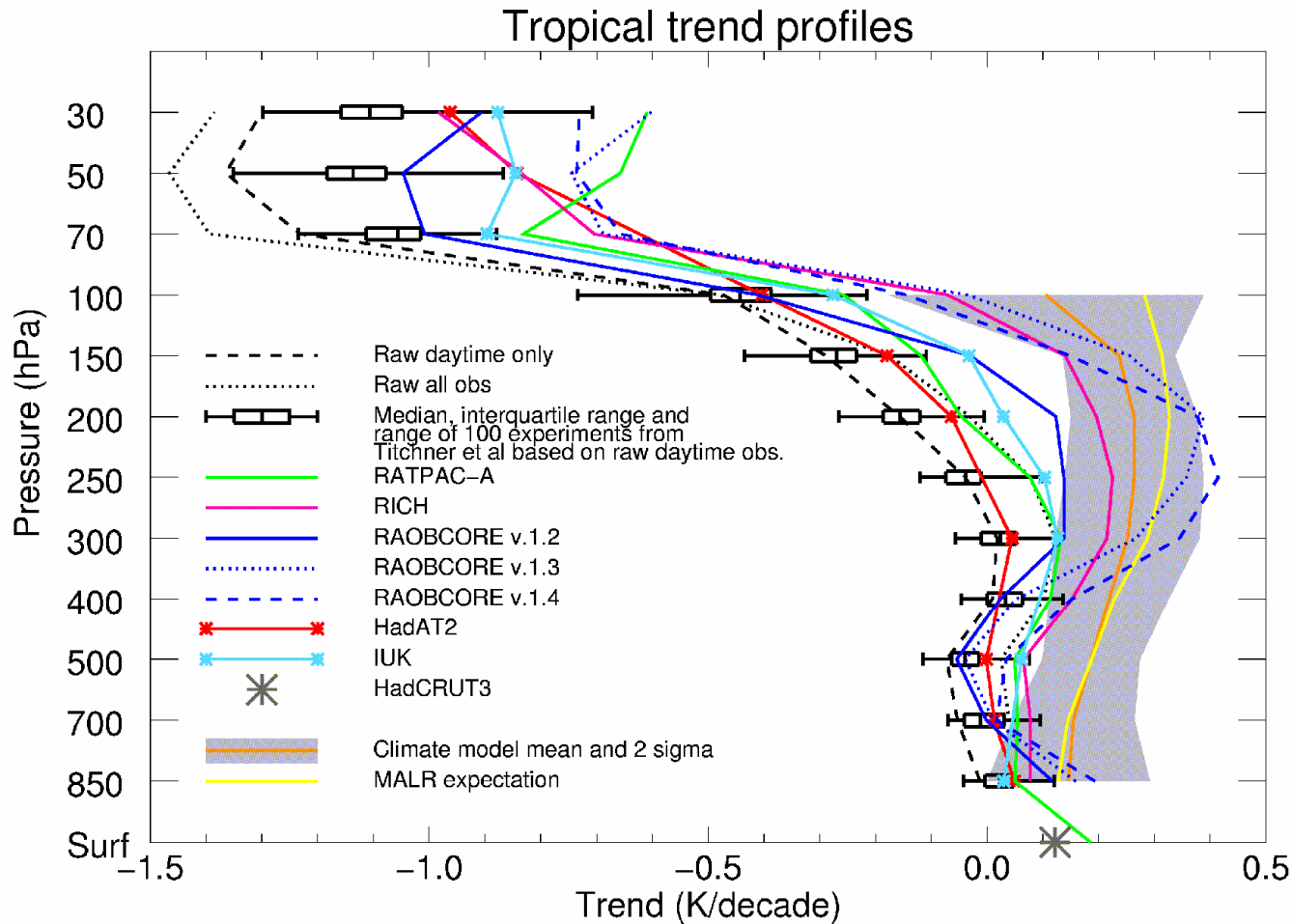


# Historical records are not as good as we'd like

- Changes in tropospheric temperatures are very poorly constrained
- Changes in humidity understood even less, especially in the radiatively important upper troposphere
- Changes in other variables generally worse still.
- Primary reason: the observations were never made for climate and we had no climate “insurance policy”

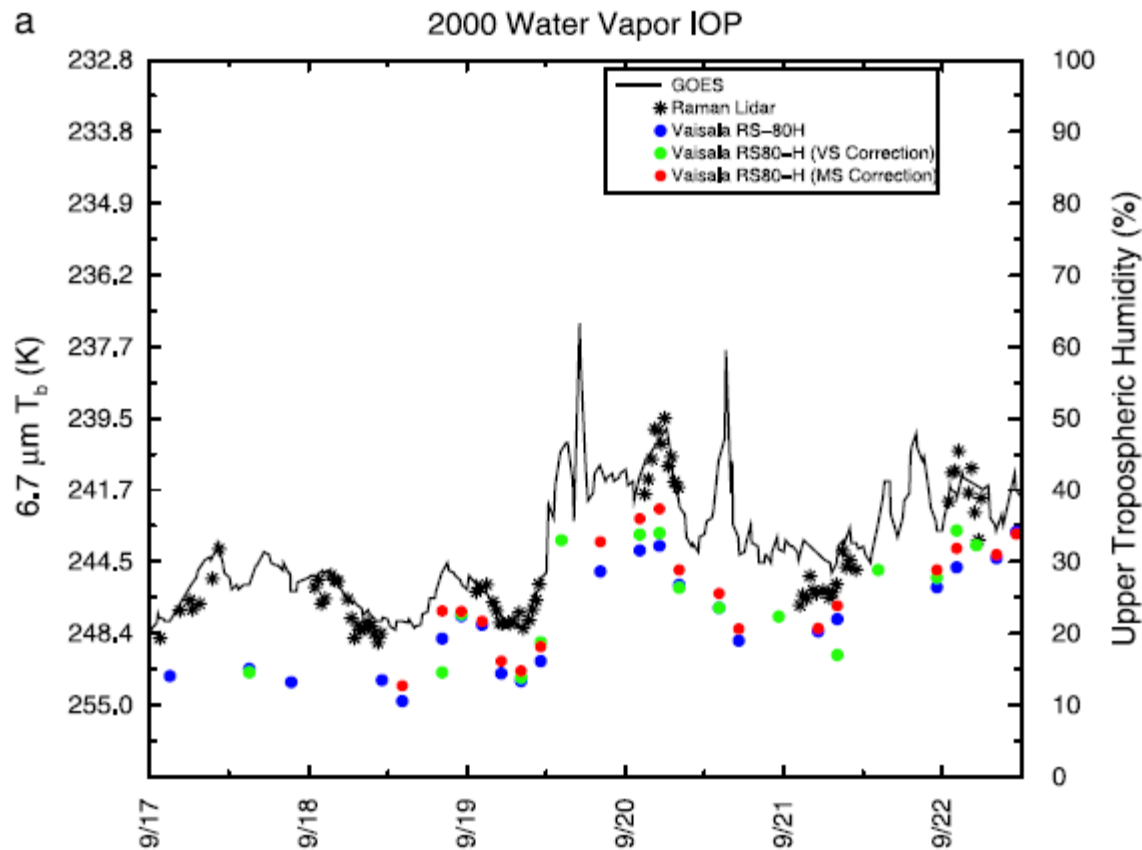


# Where's the real temperature trend?





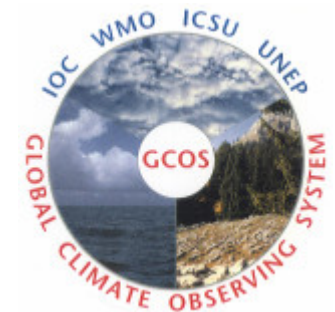
# Troubles with upper-tropospheric moisture



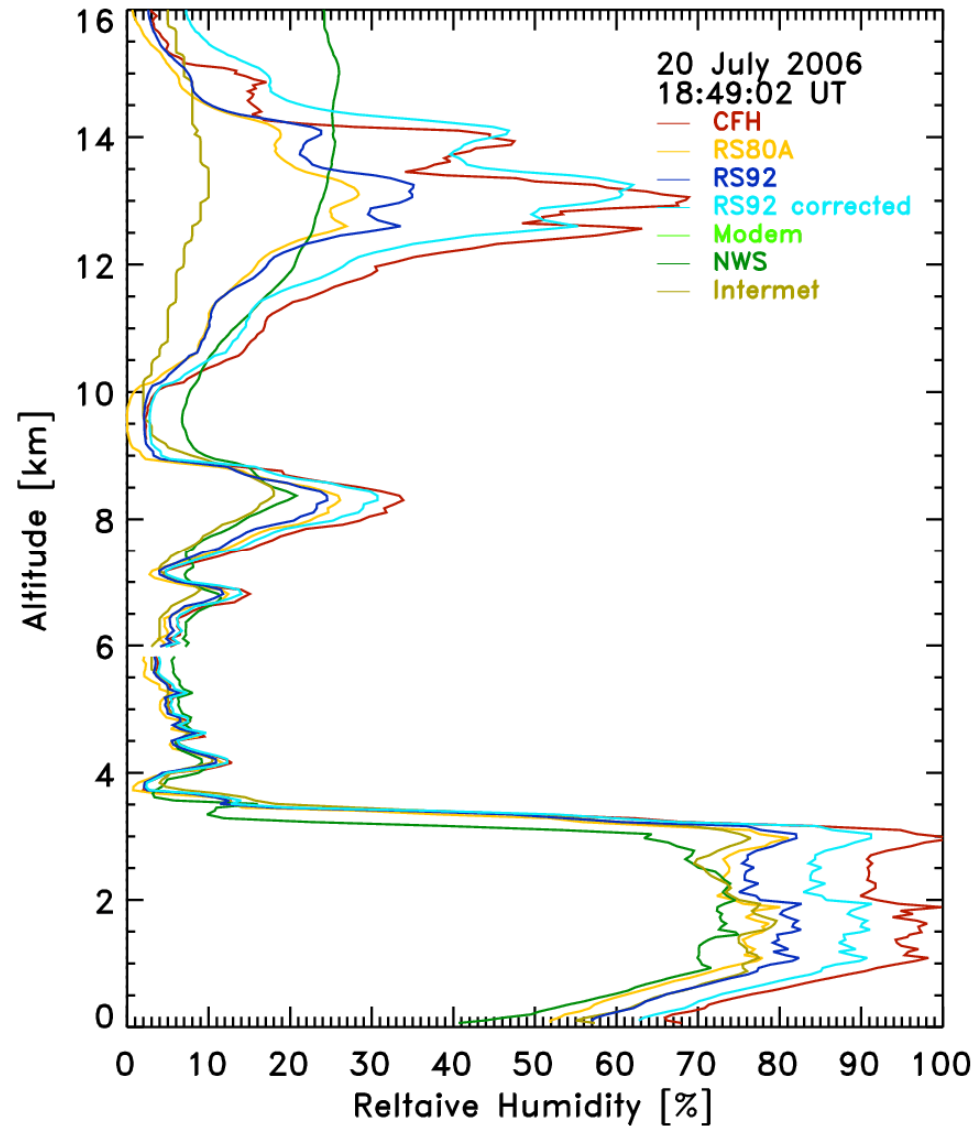
Soden et al.,  
2004.

Satellite, lidar  
and sonde  
measurements at  
ARM sites

**Figure 8.** (a) Time series of the  $T_{6.7}$  and UTH and (b and c) corresponding profiles of relative humidity for 17–22 September 2000. The time series of  $T_{6.7}$  and UTH are shown for the GOES, Raman lidar, and both corrected and uncorrected radiosondes (Figure 8a). Figures 8b and 8c display profiles from uncorrected radiosondes and the Raman lidar, respectively.

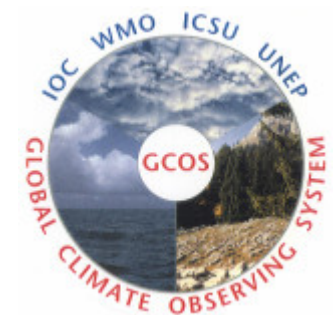


# Water vapor: Polymer sensors



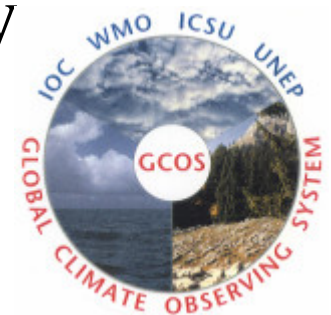
WAVES 2006  
Howard University  
Beltsville, MD

From Holger Voemel

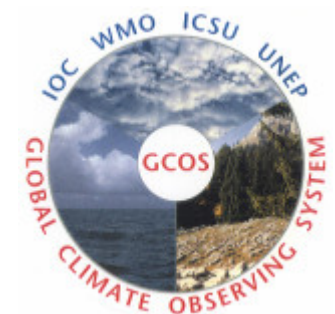
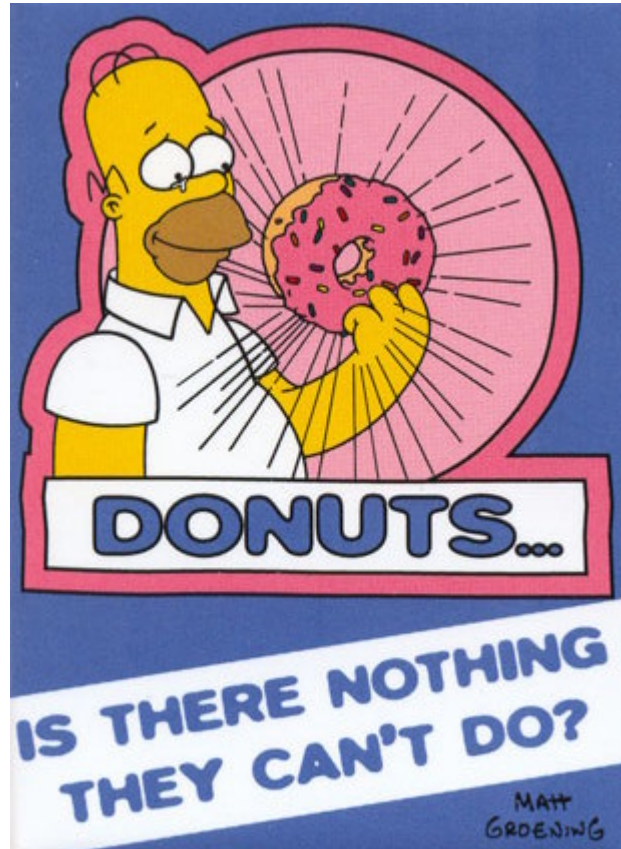


# GRUAN is that insurance policy

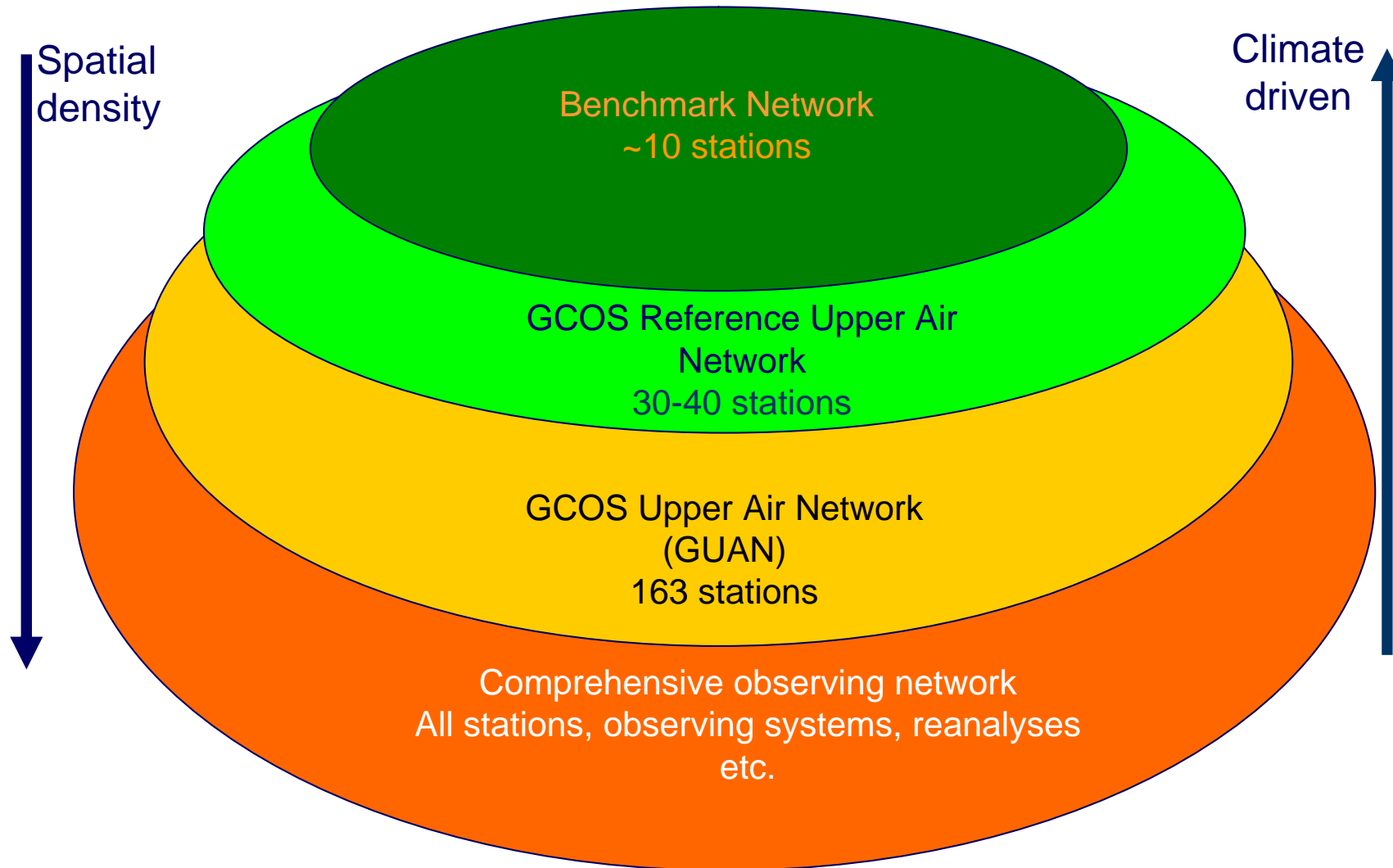
- We know that the global observing system will continue to evolve and improve
- We need a way of separating the true signal from the inevitable non-climatic effects that will be imparted into the record
- GRUAN would provide islands of certainty in an ever evolving ocean of uncertainty



# How does GRUAN fit in?

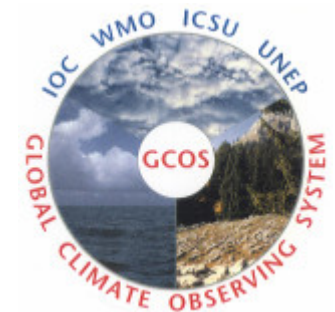


# Vision of a cascade of networks (or donuts!)



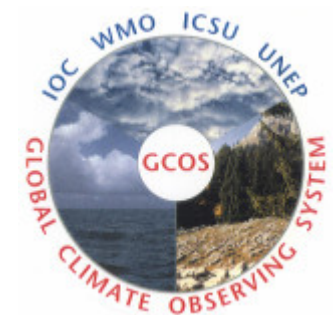
# Benchmark Network

- Problem: Current observations have both known and unknown biases that are very difficult to correct
- Solution: Continuous, stable observations whose accuracy is traceable to international standards, e.g. “Keeling curve”
- How to get there: A research question.
- Not the focus of this workshop



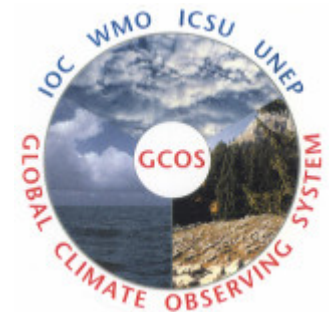
# GCOS Upper-Air Network (GUAN)

- Mandated to provide continuity and global coverage of radiosonde measurements
- A subset of the operational network
- Subject to on-going efforts to improve reporting frequency and quality
- Not the focus of this workshop



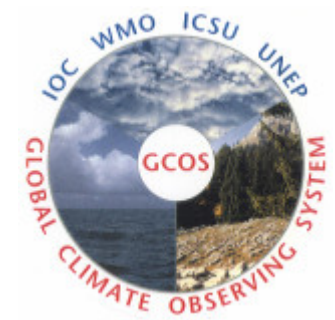
# Comprehensive Network

- Provides the detailed spatial resolution necessary to relate climate change and variability to human activities and the environment
- Includes multiple data types, including satellite data
- Relies not only on network measurements, but also on assimilation and analysis of the observations
- Answers mainly to other (non-climate) requirements
- Not the focus of this workshop



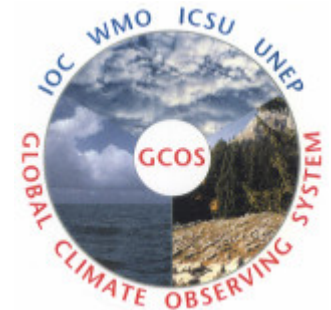


# How did we get here?



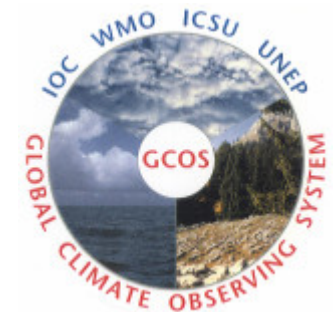
# Boulder, Feb 2005

- Workshop jointly organised by NOAA and GCOS and hosted by NOAA
- Discussed measurement requirements based on full range of climate applications
- Contributions and review from a wide cross-section of the climate community on defining reference network requirements
- Requirements differ by variable – absolutely key are Temperature and Humidity.
- Final report at [http://www.oco.noaa.gov/docs/ua\\_workshopreport\\_v7.pdf](http://www.oco.noaa.gov/docs/ua_workshopreport_v7.pdf)



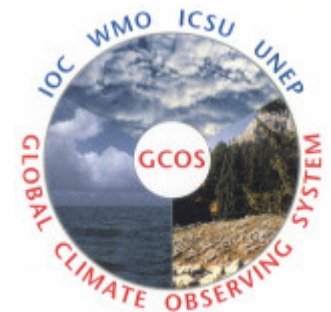
# Seattle, May 2006

- Sponsored by NOAA and GCOS and hosted by University of Washington Applied Physics Laboratory
- Focussed on identifying technological options to meet the requirements
- Some tweaking of previously defined requirements
- Much discussion of issues surrounding radiosondes



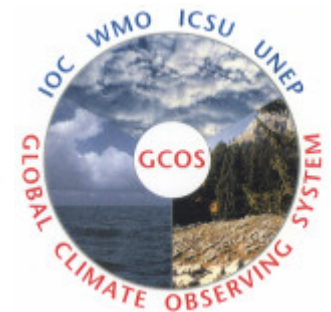
# The GRUAN Report

- GCOS Reference Upper-Air Network: Justification, requirements, siting and instrumentation options
- Summary of progress from Boulder and Seattle.
- Subject to open review
- Gives us the starting point for this meeting
- <http://www.wmo.int/pages/prog/gcos/Publications/gcos-112.pdf>



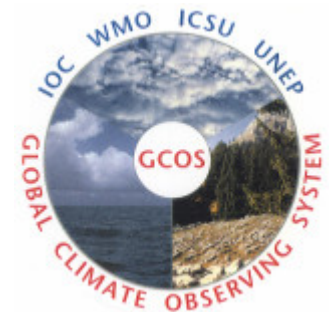
# AOPC Working Group on Atmospheric Reference Observations

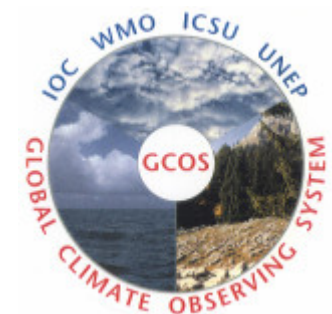
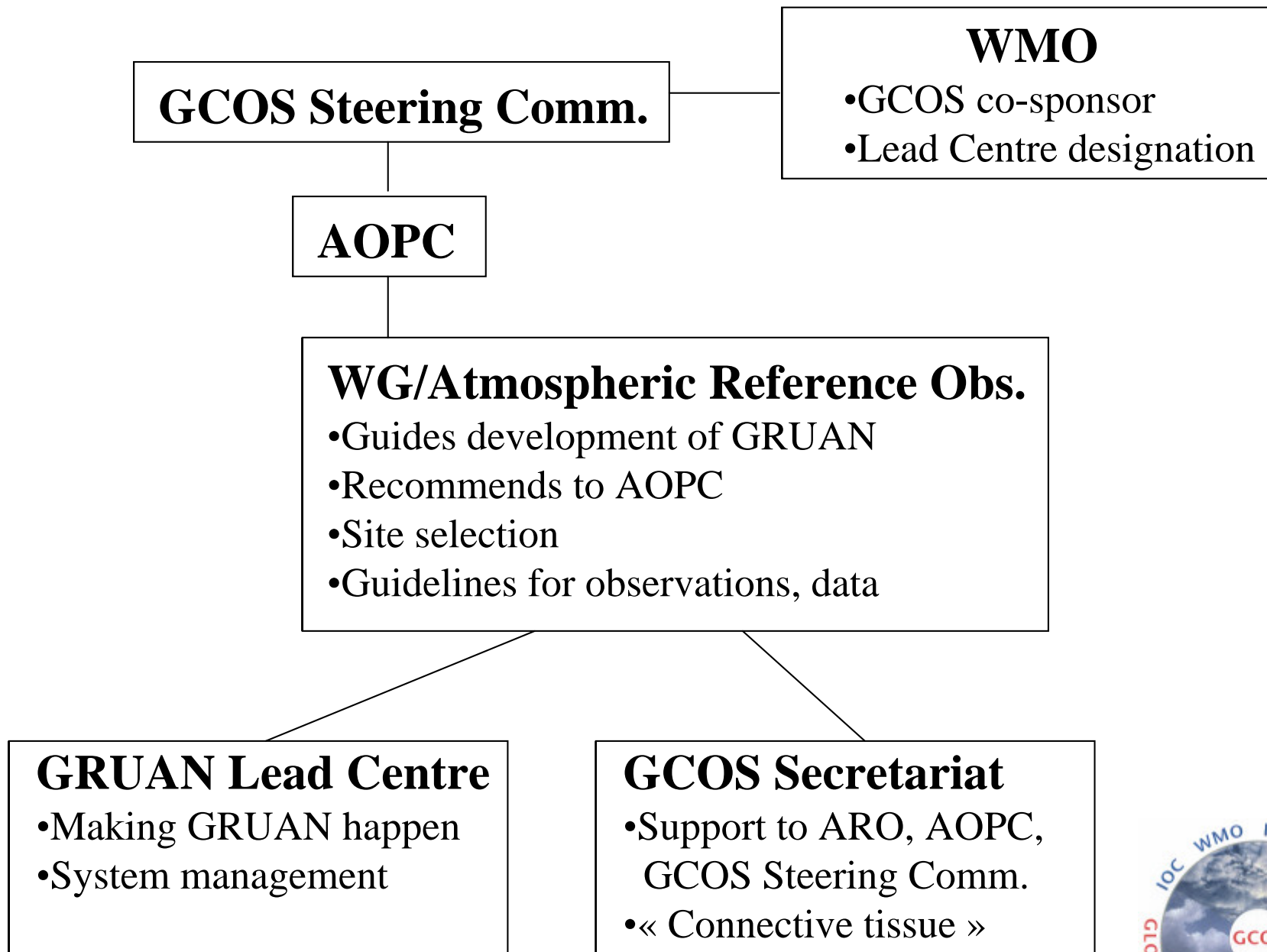
- Initiated call for expressions of interest in lead centre
- Organised this workshop
- Wrote the GCOS report
- Spread the word – drafting a BAMS article
- Kept its chair busy with homework assignments ...



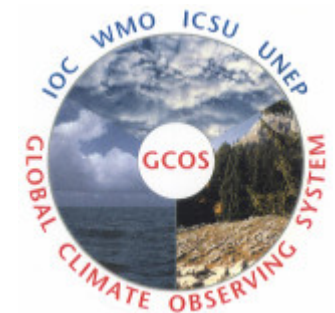
# Lindenberg, DWD

- Designated as lead centre by WMO
- Remit is to act as a focal point and help to resolve remaining issues to make GRUAN a reality.
- Three full time staff now recruited
- Visiting Scientist position
- First GRUAN site





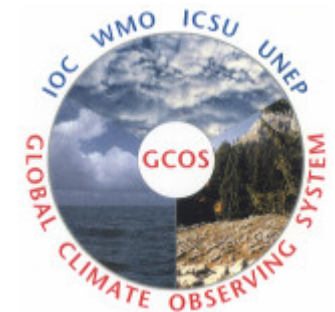
Does anyone else think GRUAN is a  
good idea?





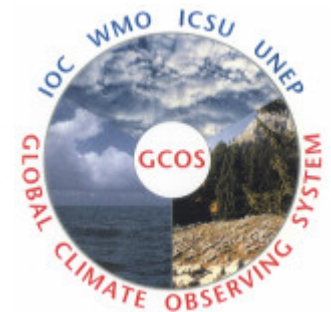
# Advice and support from international bodies

- GCOS Implementation Plan calls for GRUAN
- GCOS Atmospheric Observation Panel for Climate
  - Oversight; advised on Lead Center
- WCRP/Stratospheric Processes and their Role in Climate
  - Endorsed, noted satellite continuity issues
- WCRP Observations and Assimilation Panel
  - Start small, but start
- WMO Executive Council
  - Asks for report at upcoming session
- WMO/CBS
  - Develop operational procedures
- WMO/CIMO
  - Provide required technical guidance

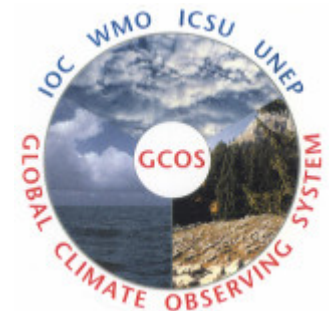


# Some important partners

- National contributors
  - Fundamental to success of the enterprise
- WCRP and the climate science community
- Global Space-based Inter-calibration System
- Current observational research programs
- WMO
  - Commissions: CIMO and CBS
  - Observations Department
- NMS international departments, development agencies
  - Help with developing nations?

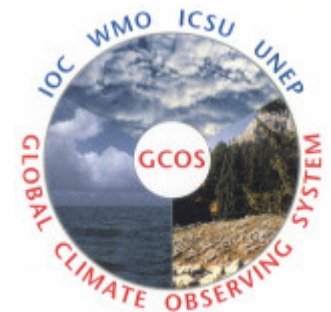


What do we want out of this meeting?



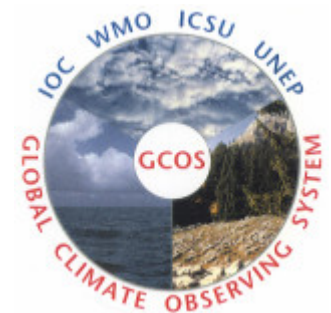
# Firstly, what we don't want

- A 50 page + report
- Lots of arguments about technical nitty-gritty details
- A complete laundry list of things to do with no sign of volunteers to do them.
- Everyone going away with fundamentally different ideas of the pathway forwards



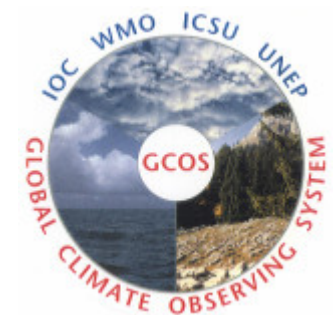
# Health warning

- The following slides are just some initial musings.
- They are not meant to definitively steer the meeting.
- Think of them rather as giving some idea of the kind of outputs that are being hoped for.



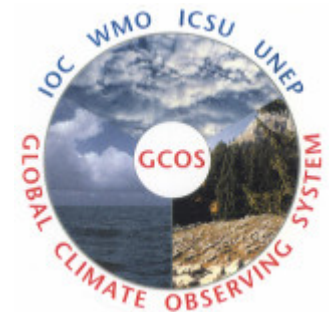
# An initial set of stations

- Lindenberg is first station
- The next section of this workshop will outline other candidates
- Hope to coalesce on an initial station list that is ready to go now with minimal additional effort required.



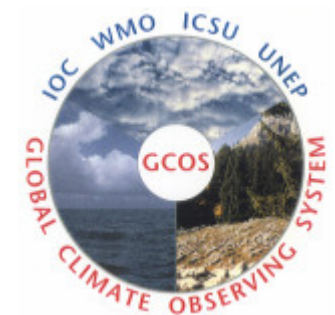
# A way to decide on further stations

- Second list of plausible candidates and locations required in the future (preferably with agents to follow up)
- Idea as to necessary instrumentation and practices that would need to be attained at these sites
- A group analogous to AOPC Advisory Group on GCOS Surface Network and GCOS Upper Air Network?
- Work on defining optimal locations?



# A set of guidelines for observing procedures and instrumentation

- Assuring comparability of observations from constituent sites
- Spreading best practices
- Sharing of lessons learned
- Resolving issues on instrumentation and temporal sampling
- Agreed protocols for instrument replacements and additions.
- Authoritative data sets



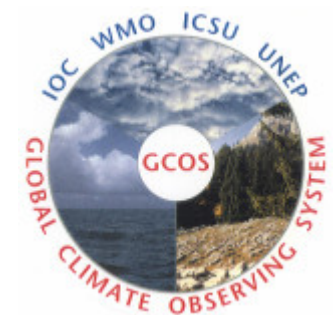


# A set of guidelines for data dissemination and QA/QC

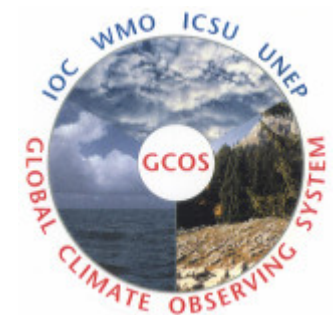
- Data to be made broadly available
- Usable format(s?)
- Metadata as well as data
- Generation of creative peer pressure
- Rapid Quality Control and feedback to the sites to fix problems
- Traceability to SI units or accepted standards wherever possible.

# Finally ...a short report that provides the roadmap forwards

- Focussed on the identification and resolution of major issues that we need to address to make GRUAN “operational”
- Action oriented with clear objectives that are realistic and timebound and have an “owner”
- Agreed, insofar as possible, in the final session.

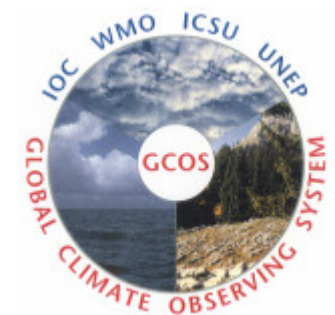


# What is in it for you?



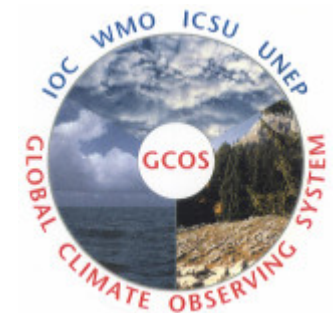
# Better Science

- A network of 30-40 high quality well-maintained sites can only be good for helping our scientific understanding
- Opportunities for undertaking a broad range of synergistic activities
- Improved understanding of climate changes



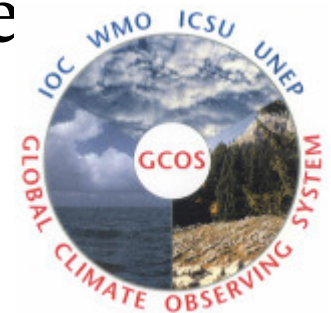
# The opportunity to influence

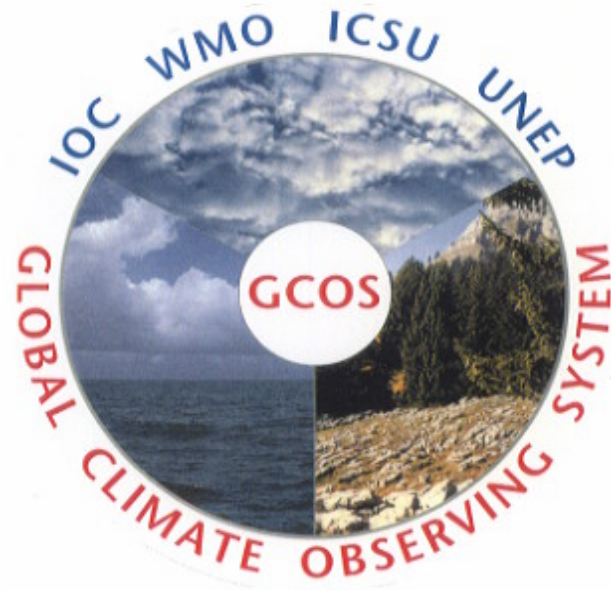
- GRUAN is still at its most formative stages
- You can influence its evolution
- You can help it be a success
- You can be a key player



# Recognition

- GRUAN will only be a success with broad community support
- GCOS will formally recognise all contributions to GRUAN's successful initiation and continuation
- Your contribution will be used by many users of the data for a long time to come





# Questions