

The GCOS Reference Upper-Air Network (GRUAN)

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What is GRUAN?

- Reference Upper-Air Network for ground based climate observation of the free atmosphere in the frame of GCOS (*Global Climate Observing System*)*
- currently largely an abstract concept
- to be implemented within the next years: **Start small, but start!**
- a network of 30-40 sites across the globe (Fig. 1)
- providing long-term, high-quality climate records of upper-air variables
- accurate measurements of the *Essential Climate Variables* at a GRUAN site (Fig. 2):
 - ✓ upper-air temperature (including MSU radiances)
 - ✓ water vapour
 - ✓ wind speed and direction
 - ✓ cloud properties
 - ✓ earth radiation budget (including solar irradiance)

* co-sponsored by WMO, IOC/UNESCO, UNEP, and ICSU

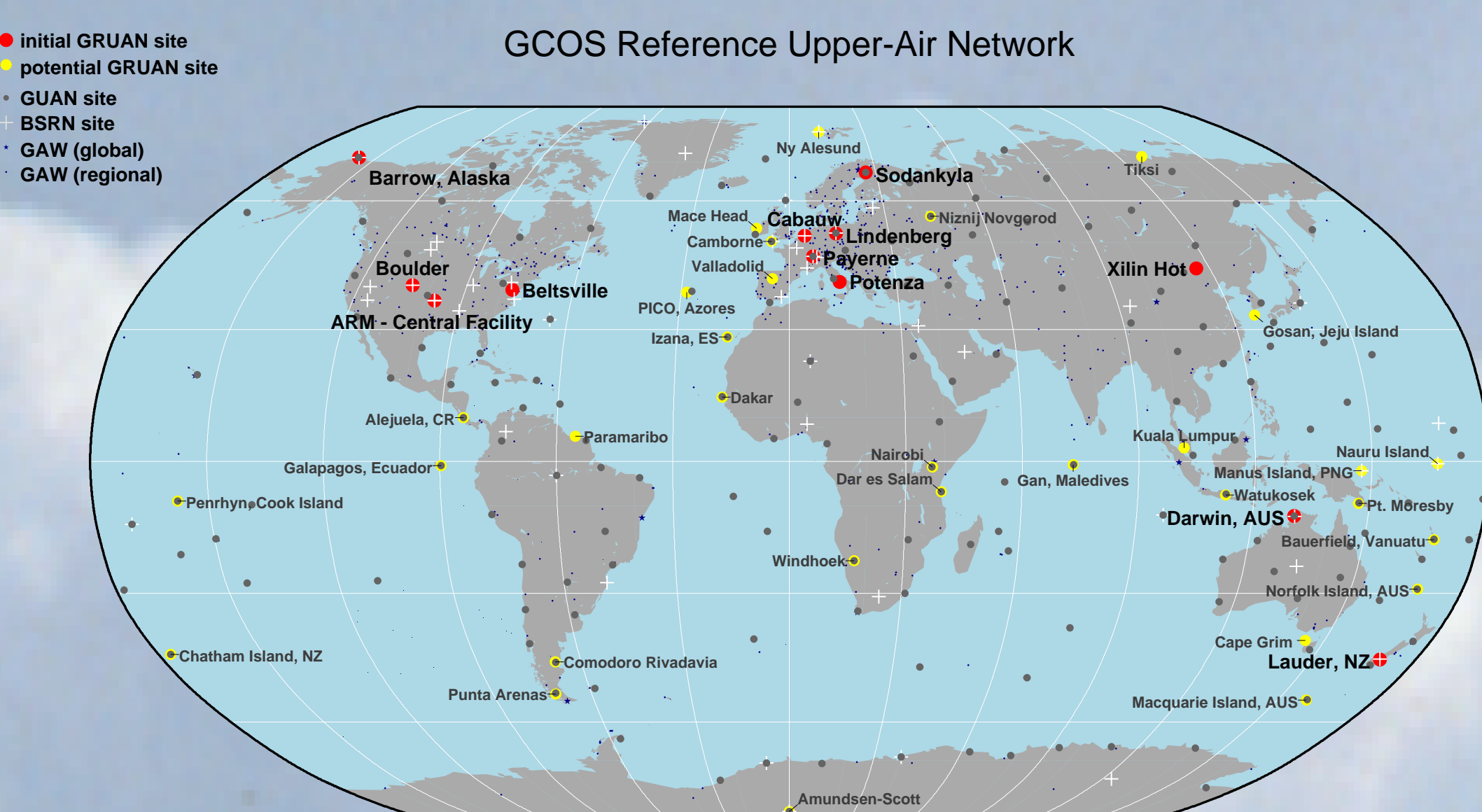


Figure 1: Map of existing observing systems: Global Atmospheric Watch (GAW) Baseline Surface Radiation Network (BSRN) and GCOS Upper-Air Network (GUAN). Red dots mark stations that are foreseen as initial GRUAN sites. Yellow circles show potential additional GRUAN sites.

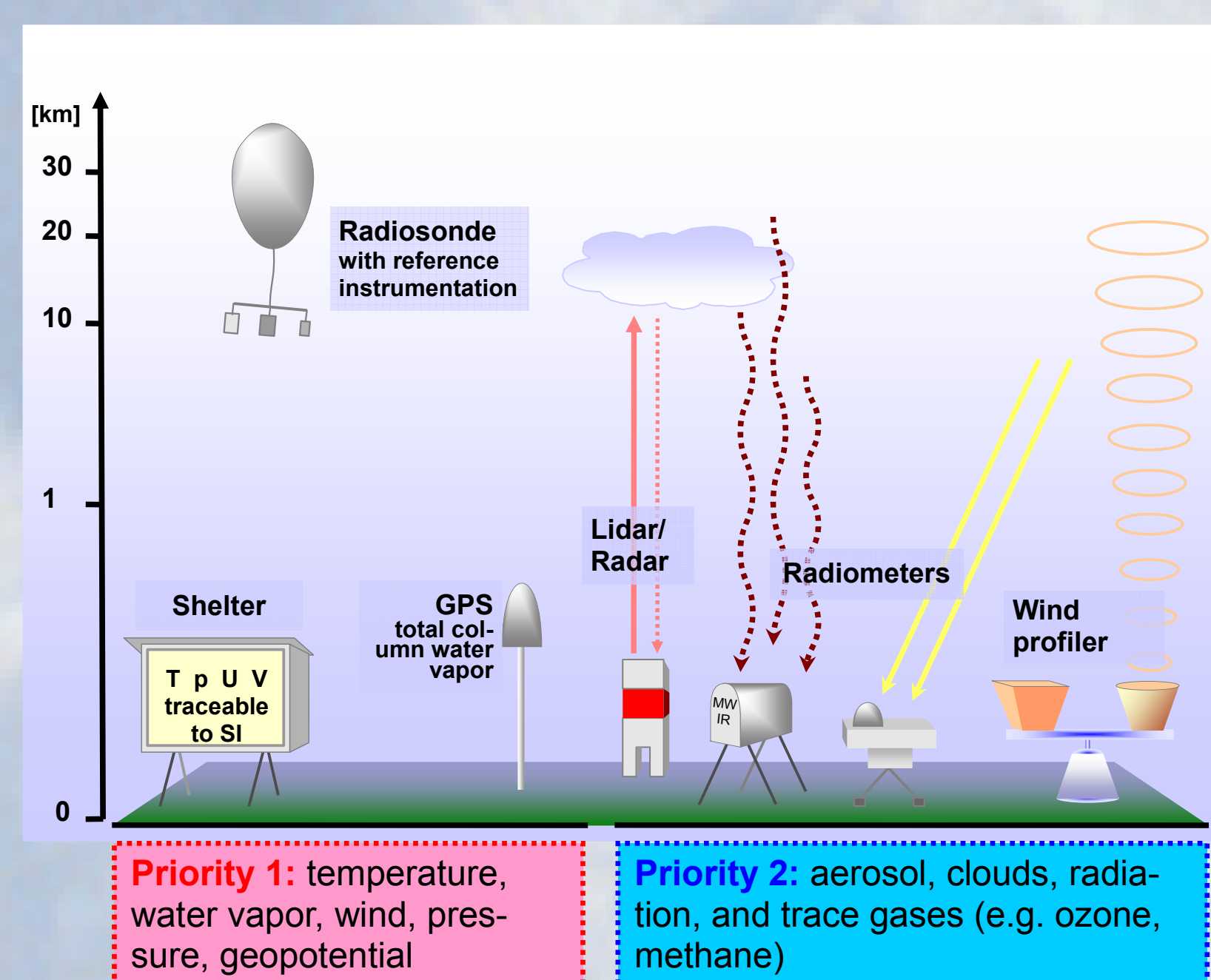


Figure 2: Schematic set-up of a GRUAN station

Priority 1: temperature, water vapor, wind, pressure, geopotential
Priority 2: aerosol, clouds, radiation, and trace gases (e.g. ozone, methane)

Why do we need GRUAN?

- historical upper-air records are not as good as required for studying climate change (Fig. 3)
- standard upper-air radiosondes do not provide sufficient accuracy for climate related research (Fig.4)
- we need a way of separating the true signal from the inevitable non-climatic effects that will be imparted into the record
- provide long-term, high quality upper-air climate records, with complete estimates of measurement accuracy
- fully characterize the properties of the atmospheric column and their changes
- constrain and adjust data from more spatially comprehensive global observing systems (including satellites and current radiosonde networks)
- ensure that potential gaps in satellite programs do not invalidate the long-term climate record

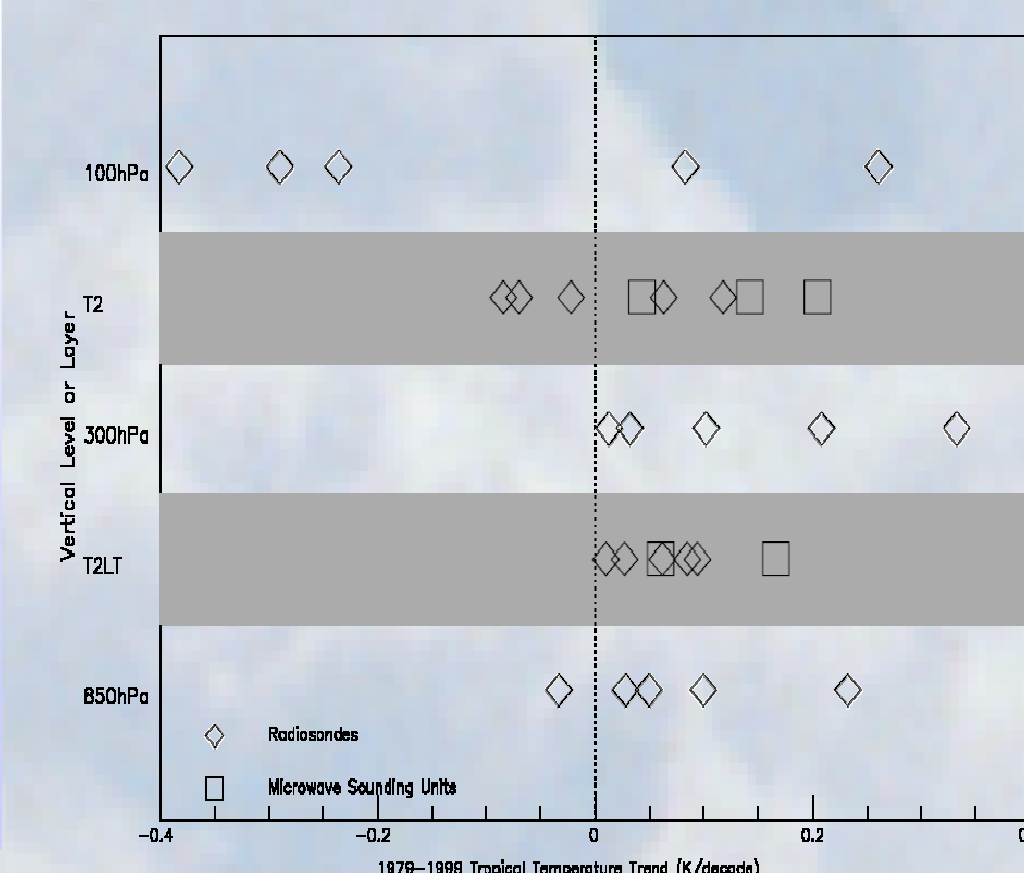


Figure 3: Comparison of upper-air temperature trends for 1979-1999 in the Tropics for selected vertical levels (adapted from Santer et al. 2008).

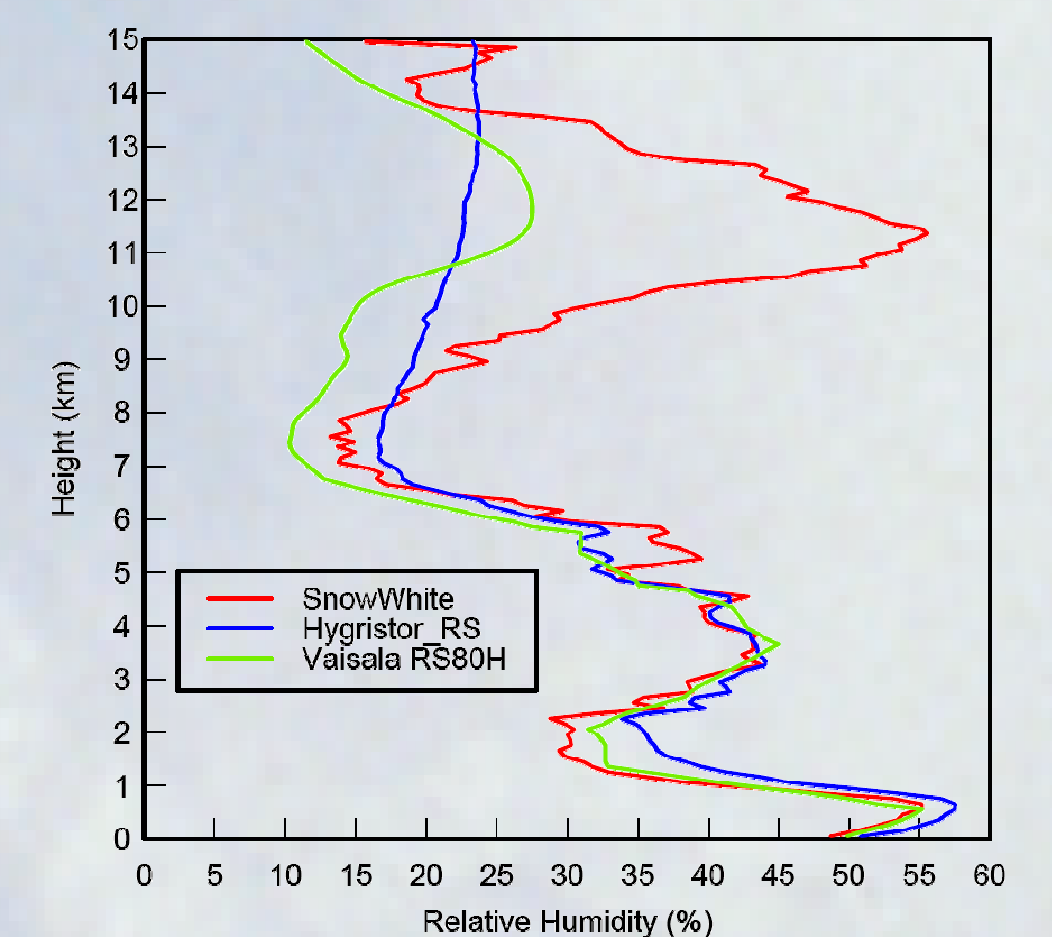


Figure 4: Comparison of mean relative humidity profiles (from six soundings) measured by a reference-quality humidity sensor (Snow White, red curve) and by two types of operational humidity sensors.

The guiding principles for GRUAN observations

GRUAN will require establishing uncertainties for all measured parameters. These uncertainties will in part be based on the manufacturer's information and will additionally use evaluations of the uncertainties in the published literature as well as uncertainties established as part of GRUAN by:

- making redundant measurements of a given atmospheric variable
- calibrating sensors with references traceable to SI standards whenever possible
- following the ISO Guidelines for calculating and expressing Uncertainty in Measurements (GUM).

Instruments for which a meaningful uncertainty cannot be established or for which the scientific basis for the uncertainty estimation cannot be documented may be of lesser importance within GRUAN.

The GRUAN Lead Centre, Lindenberg, DWD

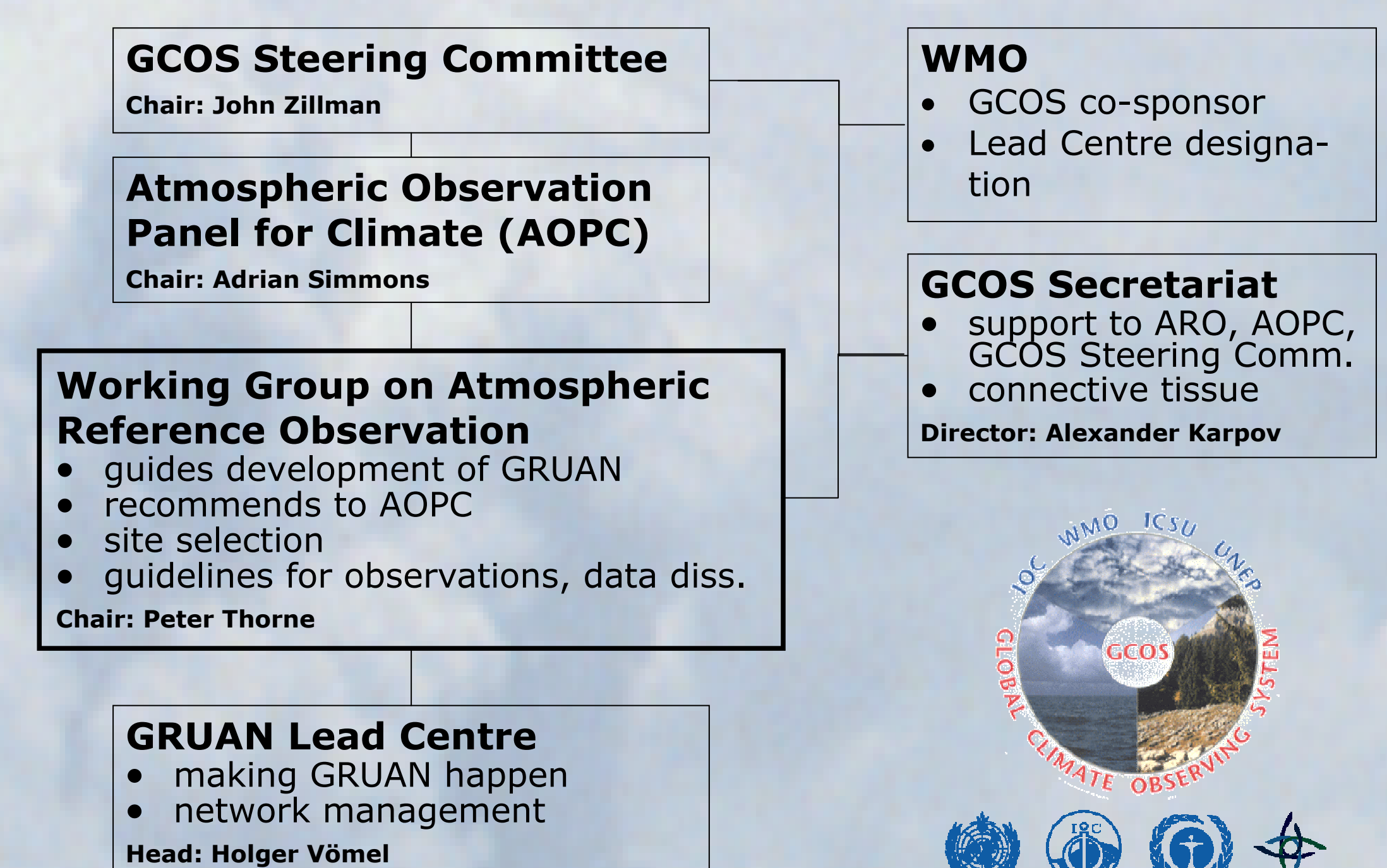
- designated as lead centre by WMO
- four full time staff (scientists and technicians) recruited
- additionally open visiting scientist position
- supervision and coordination of the network
- characterisation/definition of reference instruments:
 - ✓ quantification of statistical errors and biases
 - ✓ training of staff



Next steps to make GRUAN happen:

- initiation meeting hold in Lindenberg, Feb 2008
- invitation of initial sites by GCOS / WMO (10/2008)
- initial network operating in 2009
- additional sites join in by a phased approach
- LUAMI campaign, Lindenberg, November 2008
 - ✓ Lindenberg campaign regarding an Upper-Air Methods Intercomparison (LUAMI)
 - ✓ 03 November - 24 November 2008
 - ✓ inter-comparison of upper-air remote sensing systems and reference radiosondes

Who will steer, manage, and operate GRUAN?



Important partners

- national contributors
 - ✓ Fundamental to success of the enterprise
- WCRP and the climate science community
- Global Space-based Inter-calibration System (GSICS)
- Existing observational networks
 - ✓ NDACC, ARM, GUAN, GAW, BSRN, GSN, ...
- WMO
 - ✓ Commissions: CIMO and CBS
 - ✓ Observations Department
- NMS international departments, development

References

D. Seidel et al, Reference Upper-Air Observations for Climate: Rationale, Progress, and Plans, BAMS, in press.
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Santer, B. D. et al., Consistency of modeled and observed temperature trends in the tropical troposphere. *Int. J. Climatol.*, submitted