An Update on the Status of the GCOS Reference Upper Air Network (GRUAN)

Greg Bodeker, Holger Vömel and Peter Thorne

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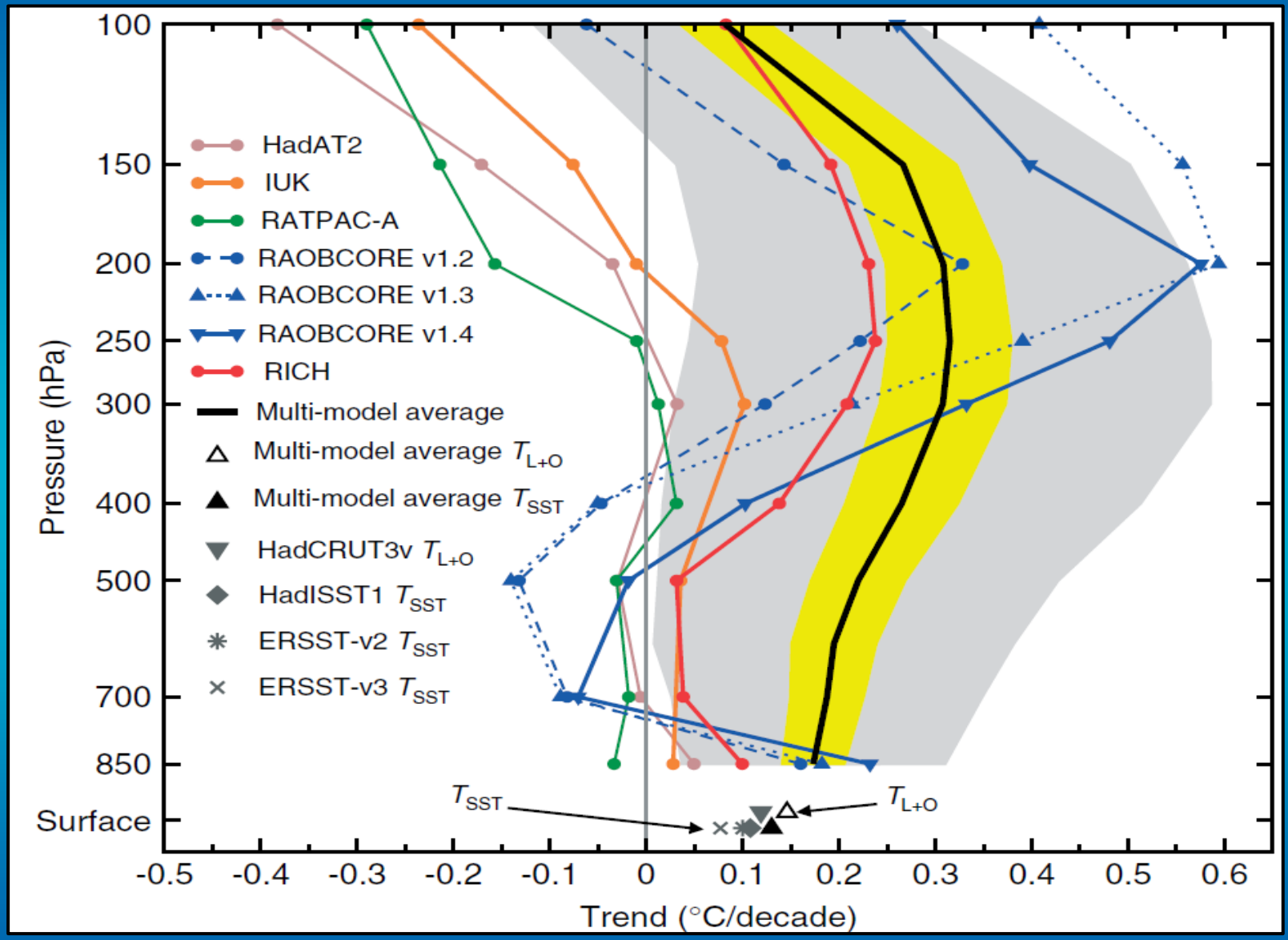
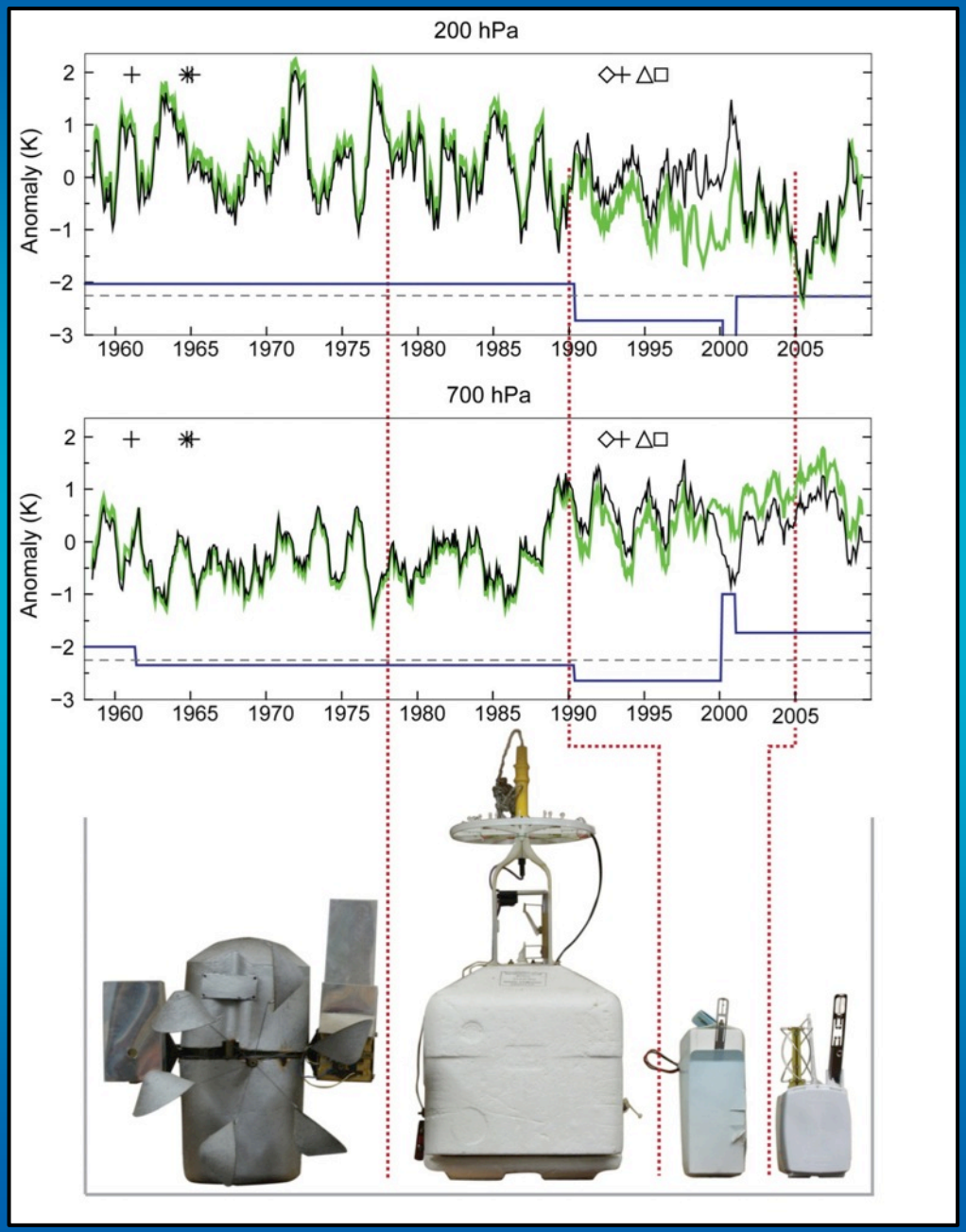
The problem



From: Santer et al., Consistency of modelled and observed temperature trends in the tropical troposphere, International Journal of Climatology, DOI: 10.1002/joc.1756, 2008.

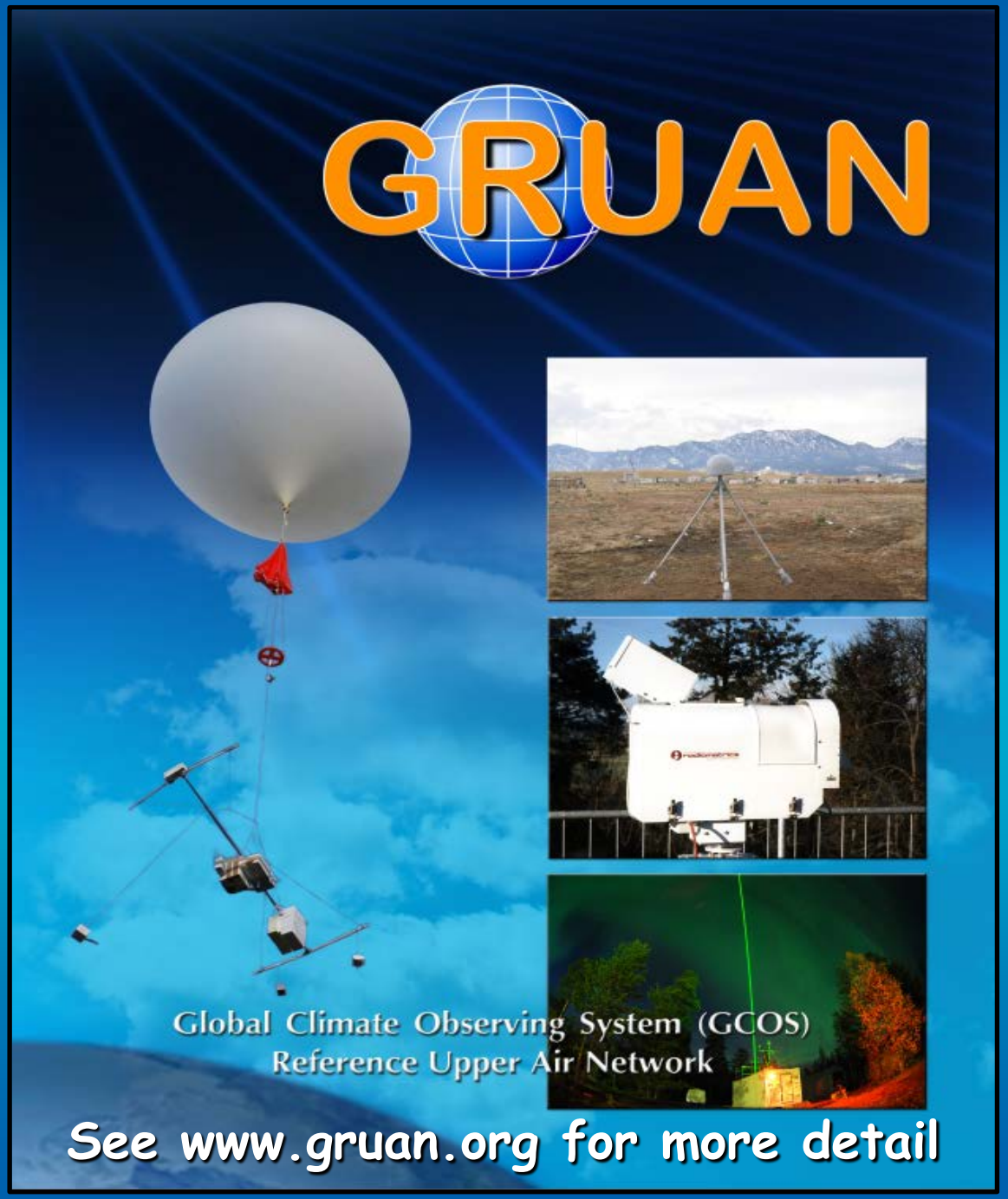
What caused the problem



- Historical observations made primarily for operational monitoring purposes.
- Ubiquitous change – impacts very rarely adequately quantified for climate trend determination.
- Ambiguity in the rate and details of climatic changes.
- Significant impediment to understanding climate change and its causes.

The solution

- The GCOS Reference Upper Air Network (GRUAN)
- Network for ground-based reference observations for climate in the free atmosphere in the frame of GCOS
- Initially 15 stations, envisaged to be a network of 30-40 sites across the globe when GRUAN becomes fully operational.



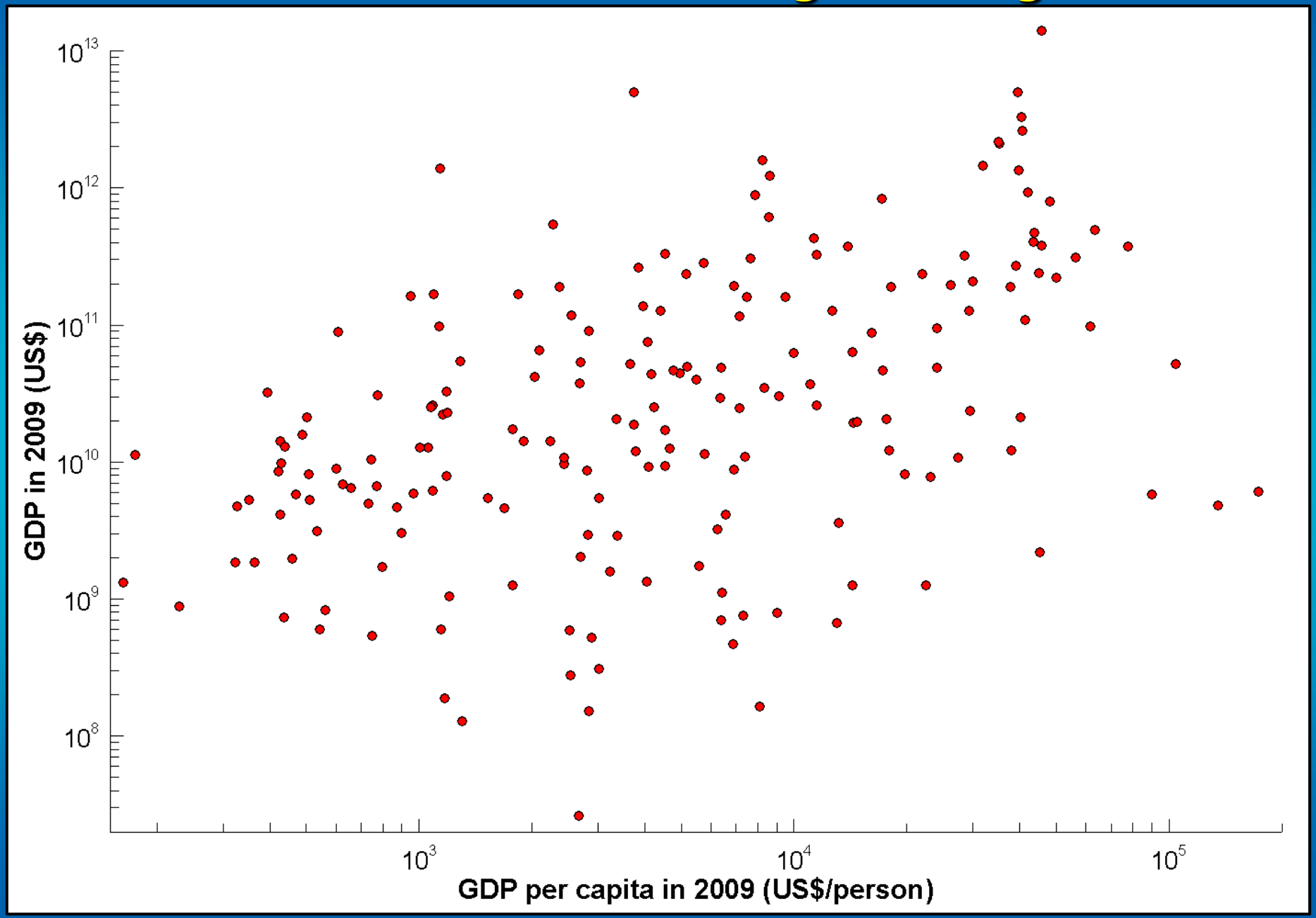
GRUAN sites

- Currently no sites in South America, Africa or Antarctica. Only one south of 12.5°S.
- GRUAN Network Expansion Workshop held in June 2012, in Berlin.

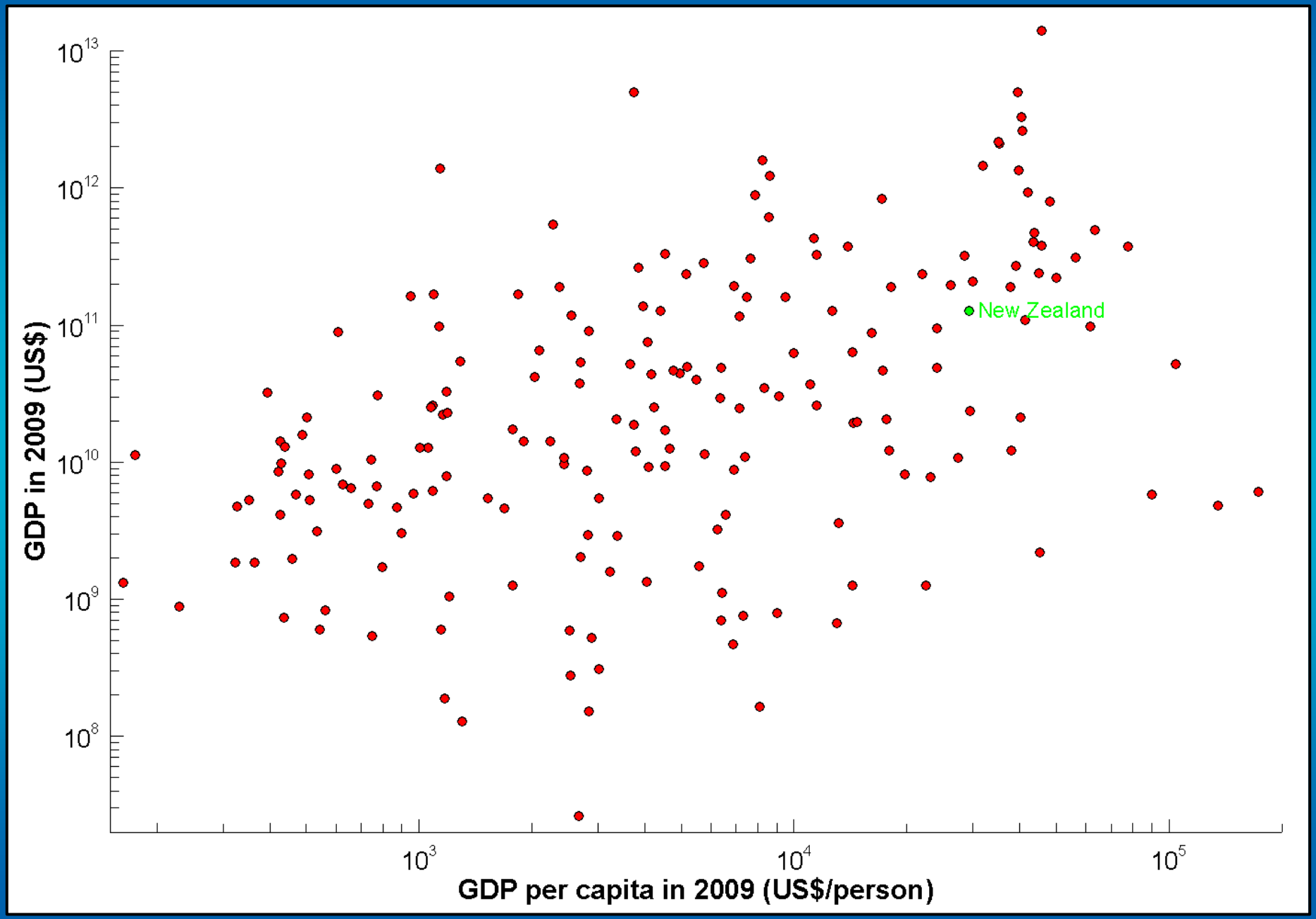
The goals of the workshop

- Define the scientific basis to guide the expansion of GRUAN from its then 15 sites (Ny Ålesund now added), to the expected 35-40 over the next few years.
- The emphasis was on defining the criteria by which network expansion should occur and to consider prospective sites. Little or no consideration given to what they should measure or how they should measure it.
- Bring the workshop white papers to a nearly completed state.
- Entrain additional expertise into GRUAN.
- Use quantitative & objective approach to determine how to augment the current GRUAN network with additional sites and to provide recommendations for new sites identified during the workshop & in the resultant White Papers.

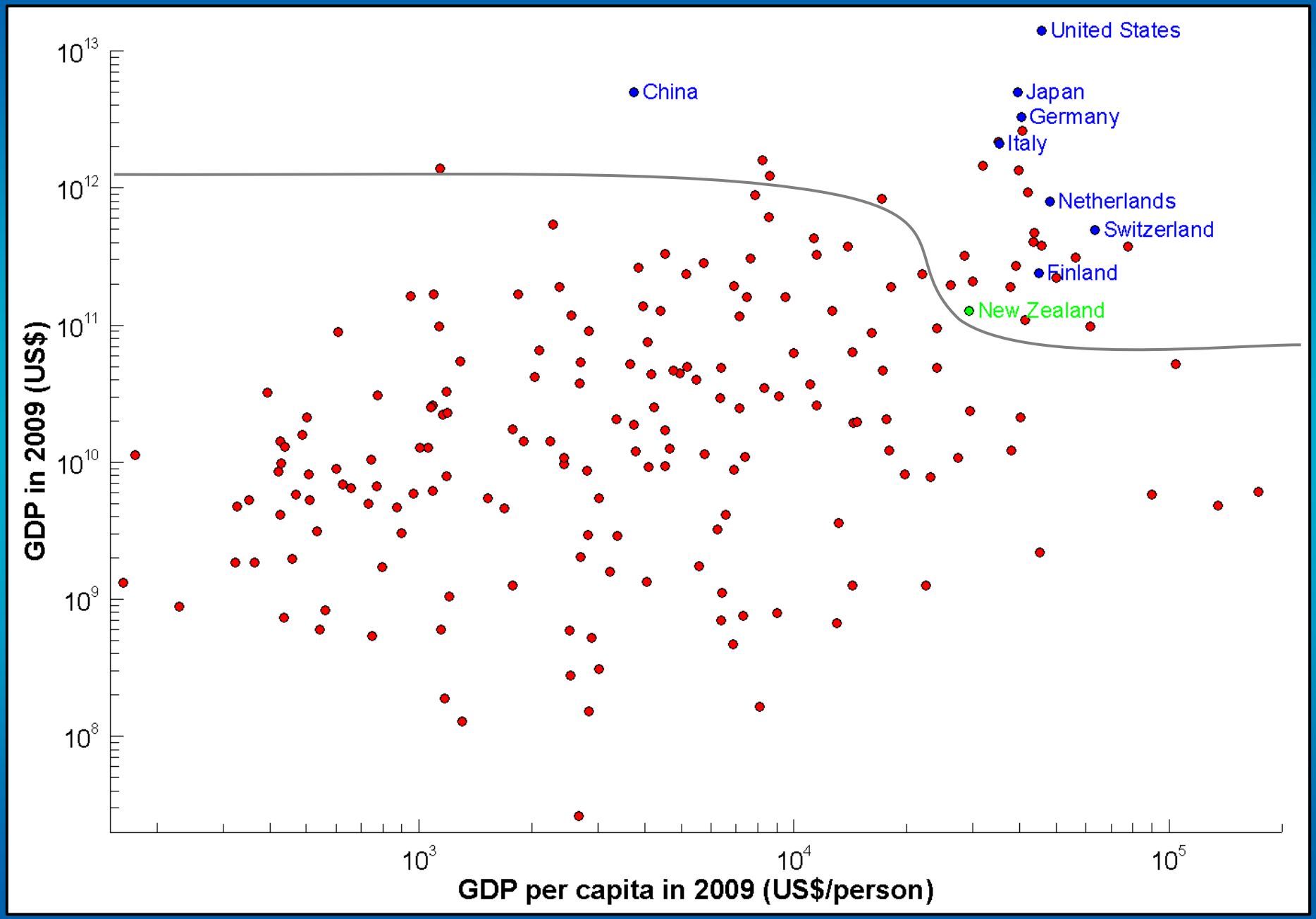
The Global Monitoring challenge



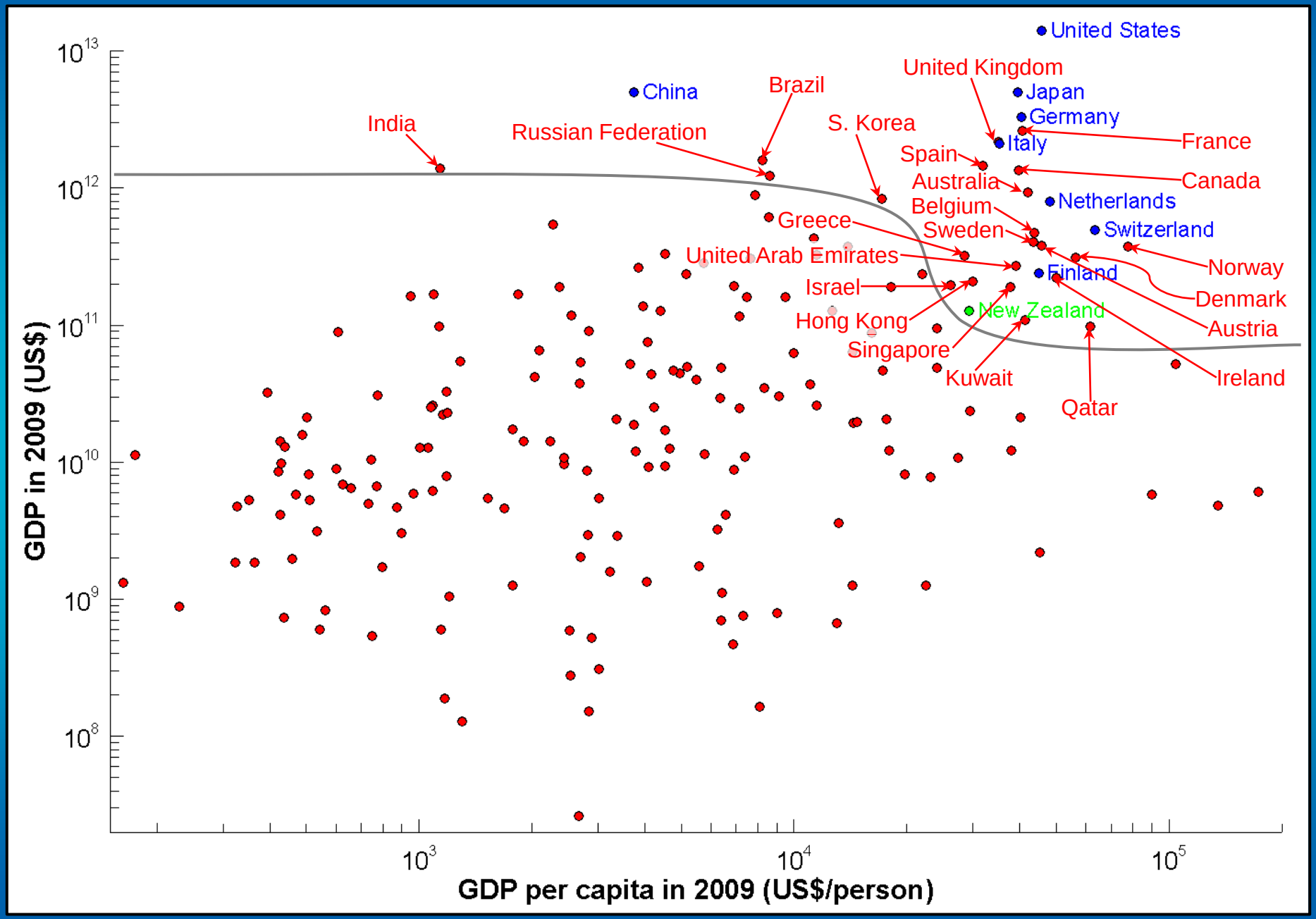
Southern Hemisphere countries supporting a GRUAN site



All countries supporting a GRUAN site



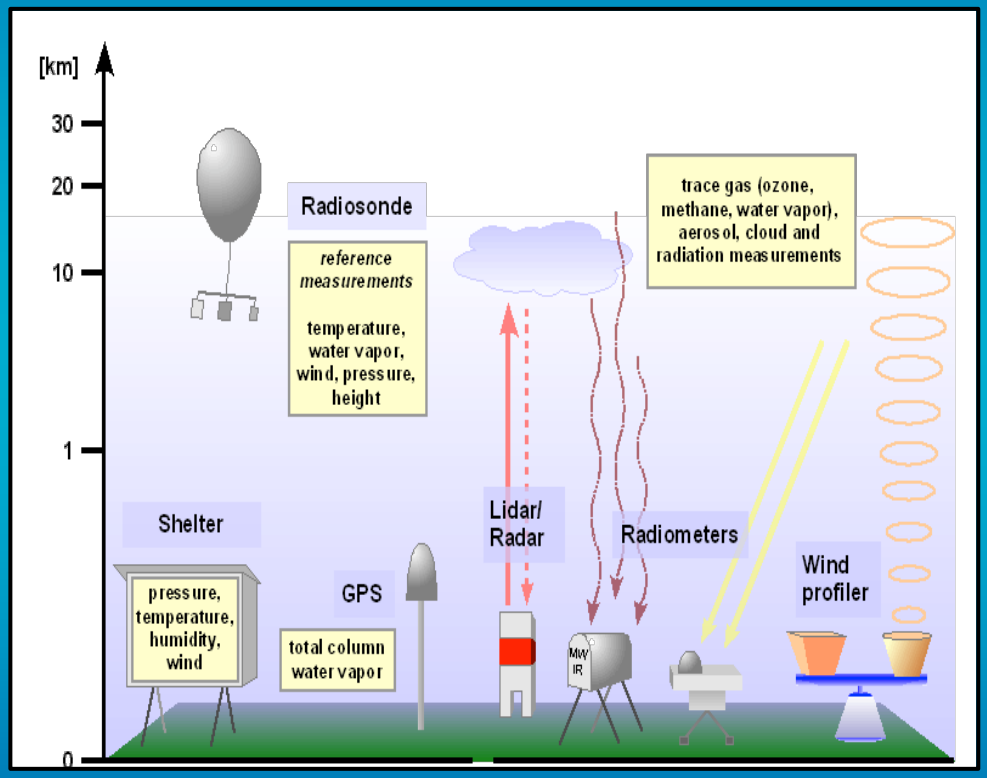
Who is missing?



More about goals of GRUAN

- Multi-decade measurement programmes.
- Characterize observational biases.
- Robust, traceable estimates of measurement uncertainty.
- Ensure traceability through comprehensive meta-data collection and documentation.
- Ensure long-term stability by managing measurement system changes.
- Tie measurements to SI units or internationally accepted standards.

Priority 1: Temperature, pressure, water vapour
Priority 2: Ozone, methane …



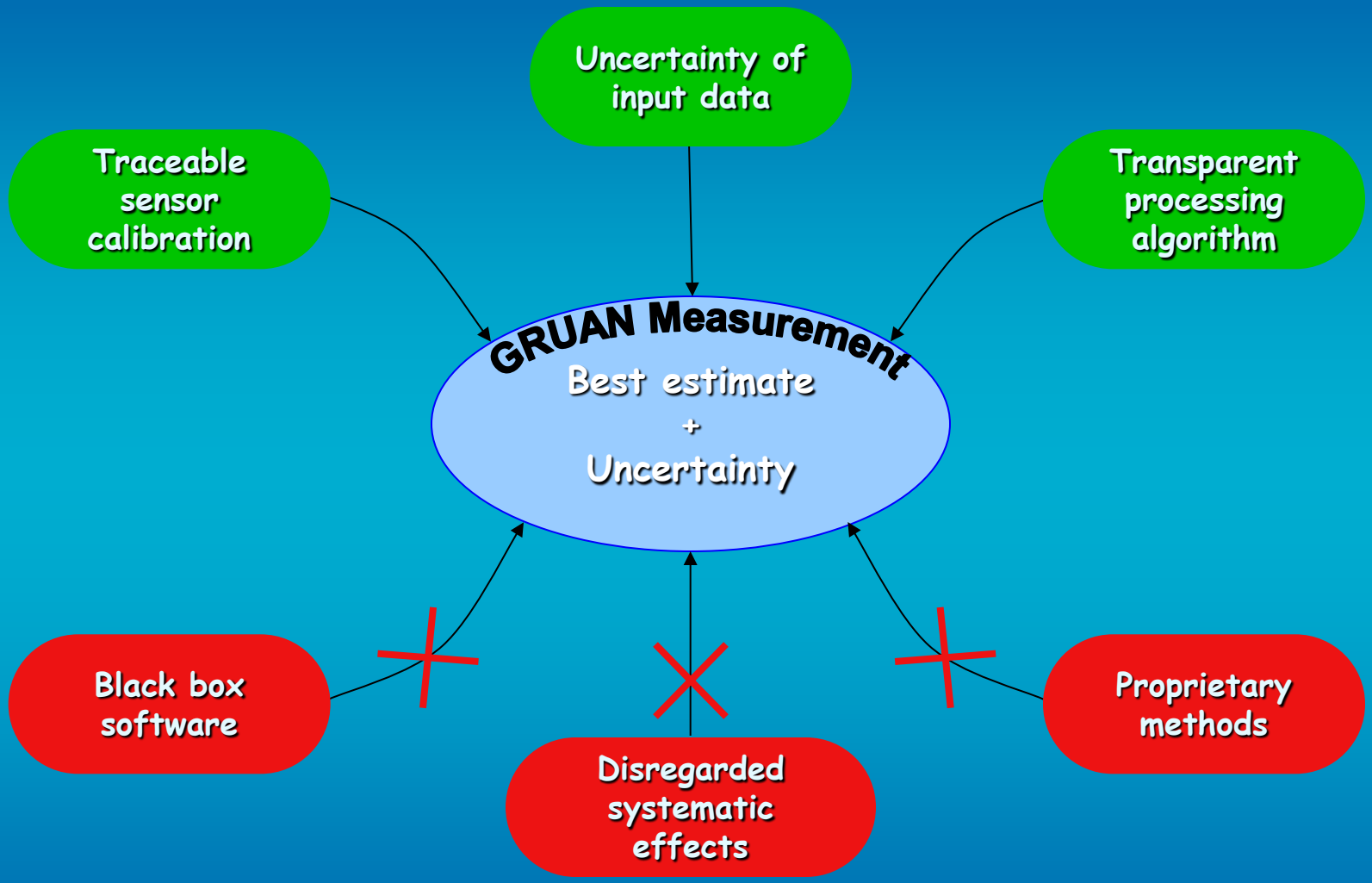
- Measure a large suite of co-related climate variables with deliberate measurement redundancy

Focus on reference observations

A GRUAN reference observation:

- ✓ Is traceable to an SI unit or an accepted standard
- ✓ Provides a comprehensive uncertainty analysis
- ✓ Is documented in accessible literature
- ✓ Is validated (e.g. by intercomparison or redundant observations)
- ✓ Includes complete meta data description

Establishing reference quality



Literature:

- Guide to the expression of uncertainty in measurement (GUM, 1980)
- Reference Quality Upper-Air Measurements: Guidance for developing GRUAN data products, Immler et al. (2010), Atmos. Meas. Techn.

Uncertainty, redundancy and consistency

Understand the uncertainties:

- Analyze sources - identify, which sources of measurement uncertainty are systematic (calibration, radiation errors), and which are random (noise, production variability …). Document this.

Synthesize best uncertainty estimate:

- Uncertainties for every data point, i.e. vertically resolved

Use redundant observations:

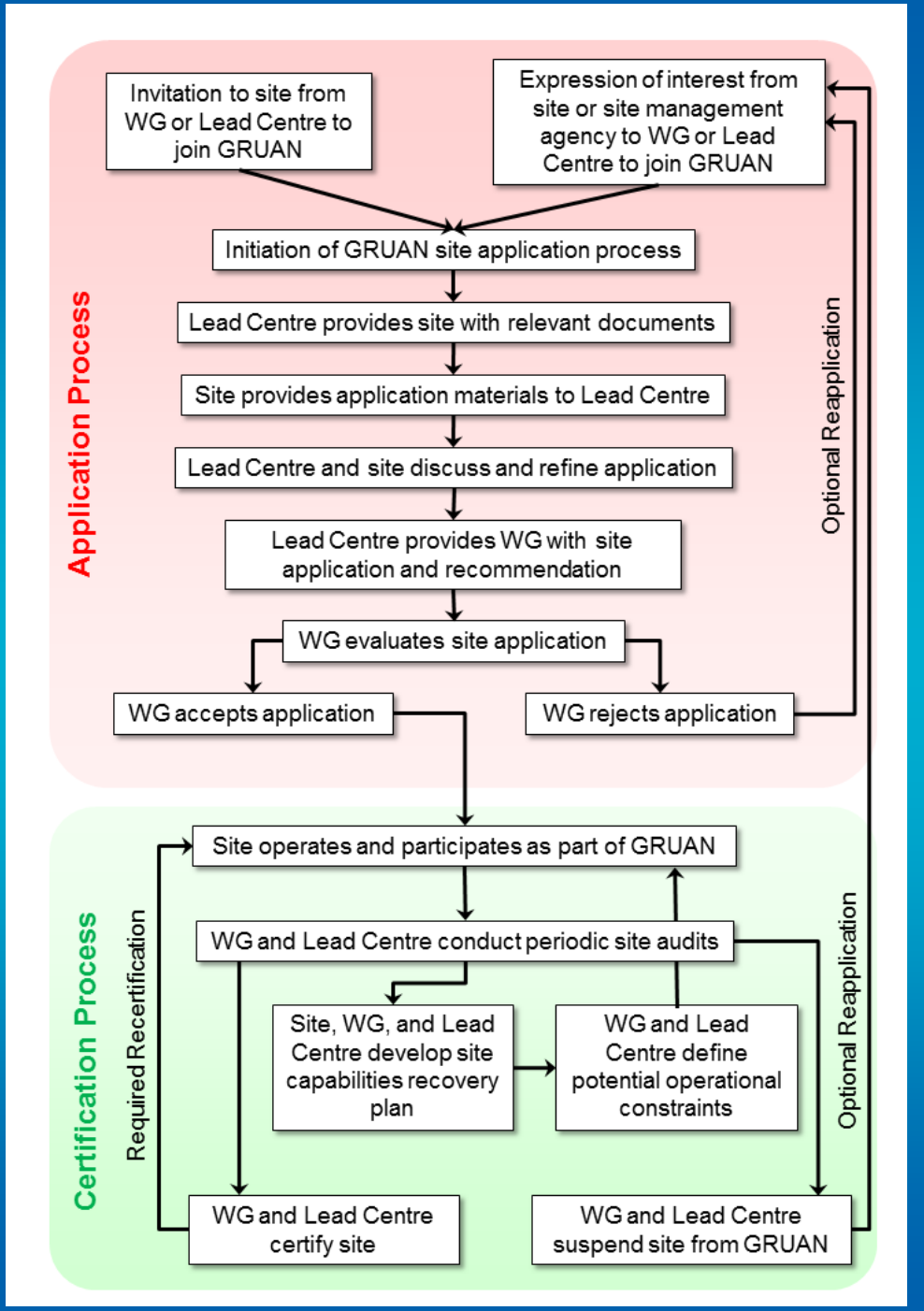
- to manage change
- to maintain homogeneity of observations across network
- to continuously identify deficiencies

GRUAN achievements 2012-13

- Network expansion workshop (June 2012, Germany)
- First data stream reprocessing completed (RS-92 data to v2)
- Manual and Guide signed off by all WG-GRUAN members and also all contributing sites representatives → includes GRUAN site assessment and certification process.
- New Implementation Plan covering 2013-2017 horizon
- 5th Implementation and Coordination Meeting hosted by KNMI
- Partner network agreement signed with NDACC

Site assessment and certification

- At least 4 sites to be certified per year.
- Formalize outcomes of the Network Expansion Workshop (2013) and solicit expressions of interest from identified top target stations (by 2015)
- Periodic review of the network composition to ensure we are still meeting stakeholder needs (2016 and thereafter)



Conclusions

- GRUAN is up and running.
- Data are flowing and being used.
- New data products are in development.
- New sites are being identified and are being invited to join GRUAN.
- Comprehensive implementation plan is in place.
- GRUAN Manual and Guide have been written.
- We need to work closely with the climate research community to ensure that GRUAN meets users needs.