Reference Upper-Air Observations for GCOS: Requirements, Process, and Plans

Workshop on "Reference Upper Air Observations for the Global Climate Observing System: Potential Technologies and Networks"

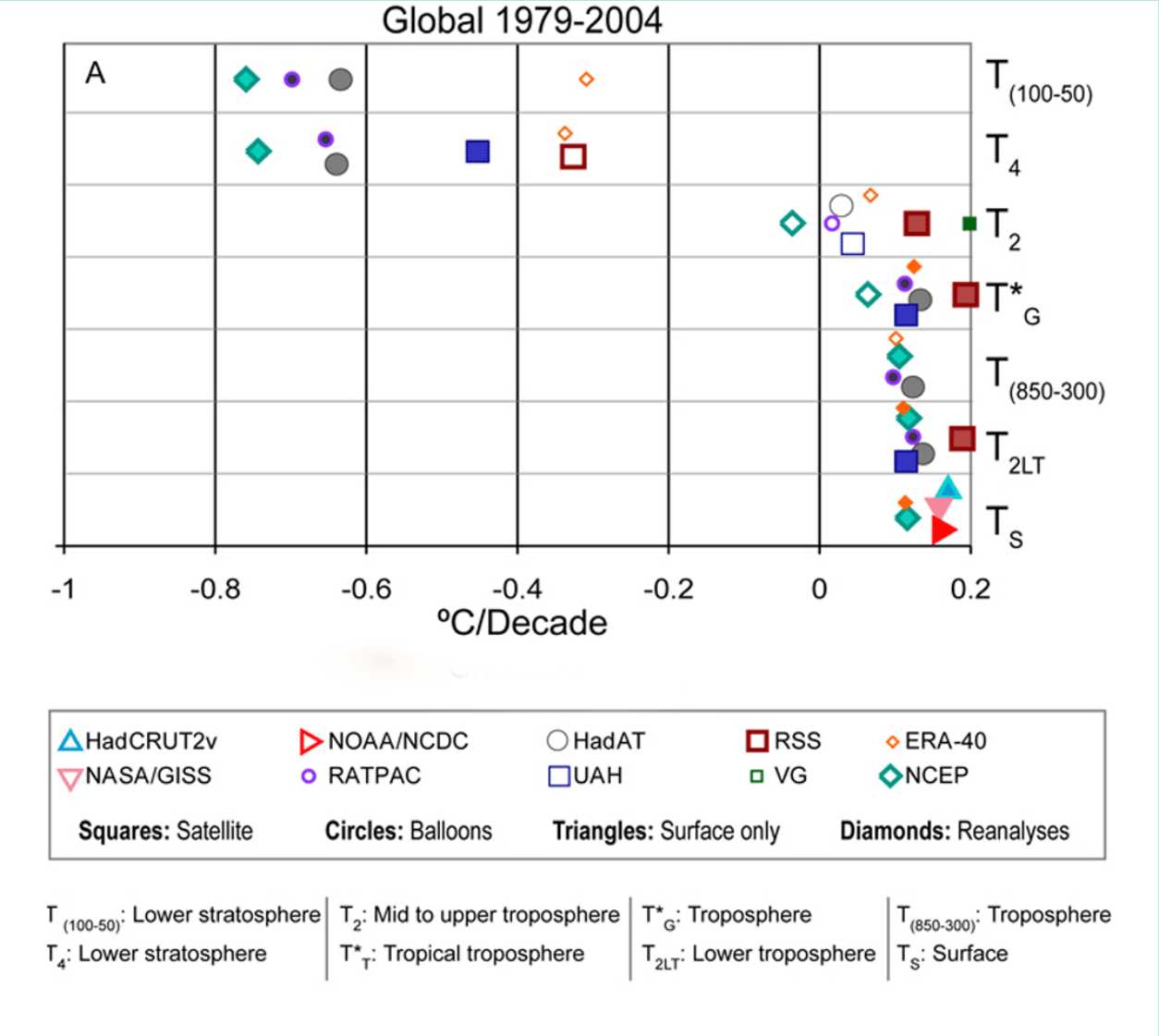
Seattle 22-24 May 2006

Dian Seidel and Peter Thorne

Overarching Concern

- Ensuring that climate monitoring findings, climate projections and predictions, and climate policy decisions are based on reliable observations
- Historical changes above the surface are highly uncertain, we can and must do better in the future.

Historical Temperature Changes from Non-Reference Observations



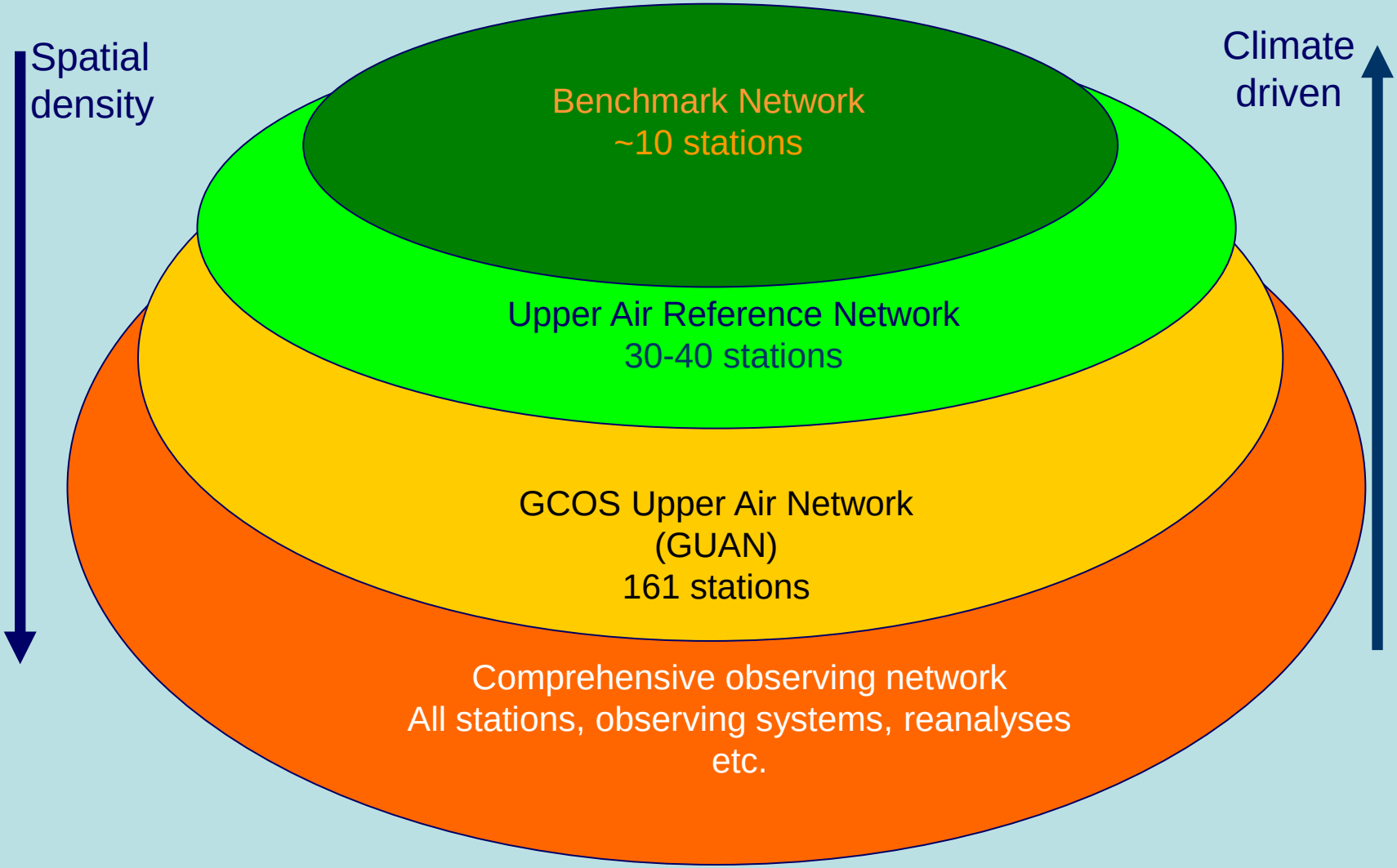
Uncertainty increases with altitude and is of the same order of magnitude as the climate change signal for many layers.

Source: CCSP S&A1.1

Key Climate Science Drivers

- Monitoring and detecting climate variability and change
- Understanding the vertical profile of temperature trends
- Understanding the climatology and variability of water vapor, particularly in the upper-troposphere and lower stratosphere
- Understanding and monitoring tropopause characteristics
- Understanding and monitoring the vertical profile of ozone, aerosols and other constituents
- Prediction of climate variations
- Reliable reanalyses of climate change
- Understanding climate mechanisms and improving climate models

Cascade of Upper-Air Observations



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.
- How to get there: A research question.
- <u>Not</u> 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.
- <u>Not</u> 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.
- Meets other (non-climate) requirements.
- <u>Not</u> the focus this workshop.

Reference Network

- Establishing a reference network as part of GUAN (GCOS Upper Air Network) is articulated in the GCOS Implementation Plan (2004)
- Goals:
  - Provide long-term, high-quality climate records
  - Serve to constrain and calibrate data from more spatially-comprehensive global observing systems (inc. satellites)
  - Measure a larger suite of co-related climate variables than can be provided as benchmark observations

3-Phase Plan

1. Boulder workshop Feb 2005 discussed requirements based on full range of climate applications
   - http://www.oco.noaa.gov/docs/ua_workshopreport_v7.pdf
2. This workshop
3. Workshop on data management issues and network protocols

Then … assemble a set of proposed options for implementation by governments and agencies.

Requirements

- Developed at 2/2005 Boulder workshop and in subsequent months of report-writing and review
- 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.

Terms Used in Requirements Tables

- Priority - Ranking from 1 to 4, with 1 as highest priority for GCOS. Based on GCOS “Essential Climate Variables” concept.
- Precision – repeatability; standard deviation of random errors
- Accuracy – systematic error; measured minus actual value
- Long-Term Stability – Maximum tolerable change in systematic error over time (multiple decades)

Purpose of This Workshop

- To identify technological and scientific options to meet the requirements set out in the Boulder report.
  - Instrumentation options (both current and planned) including rough costs, set-up, cal-val and maintenance issues.
  - Network location issues
- Final product is a report summarizing technologies and their ability to meet the stated requirements and siting guidelines.

Key Aspects of Reference Network

- Redundant measurements and analyses
- Long-term continuity of observing system
- Stability of observations and their accuracy
- Complete metadata
- As complete as feasible measurement of atmospheric column characteristics
- Ongoing data quality control and analysis
- Strong data management, archival and dissemination commitment

Key Questions

- How to ensure instruments are performing as required/expected?
- Are operational measurement systems / research systems / a mix most useful?
- Whether to address all variables from the outset?
- Should all sites across the network be identical?
- How to maximise the benefits of multi-instrument redundancy?
- What expertise would site managers / observers require for different options?
- How can we make sites useful to non-climate applications?
- Any other questions???

Topics Outside Our Scope

- Financial details of each option – we want a “big picture” report of what is possible.
- When or from whom funds should be sought – this will be better discussed later.
- Data archival and network management issues – these will be discussed in a subsequent workshop.

QUESTIONS