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
  - ~10 stations
- Upper Air Reference Network
  - 30-40 stations
- GCOS Upper Air Network
  - (GUAN)
  - 161 stations
- Comprehensive observing network
  - All stations, observing systems, reanalyses etc.

Spatial density

Climate driven
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.
• **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.
- Meets other (non-climate) requirements.
- Not 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

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