Global Climate Observing System (GCOS) Reference Upper Air Network (GRUAN)

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History
1970s – ARL pioneers monitoring upper-air climate and stratospheric ozone, primarily using radiosonde and ozonesonde data archives.
1990s – Recognition of data quality and continuity problems, particularly for humidity but also for temperature and ozone, by ARL and others
2000s – ARL and others advocate for reference upper-air instruments and a reference upper-air climate network

Accomplishments
- Foundational Workshops to Define GRUAN (2005-2008)
  - Feb 2005 Boulder, CO - identified the climate observation requirements of a reference upper-air network
  - May 2006 Seattle, WA - explored potential technologies and networks that could meet the stated requirements
- Establishment of GRUAN Lead Centre at Lindenberg (2008)
- Development of Reference Radiosondes by Commercial Manufacturers
- Growth of the Network (2008-2011)

ARL Leadership in GRUAN
- GCOS Working Group on Atmospheric Reference Observations, which provides oversight and guidance to GRUAN (Member 2006-2011)
- GRUAN Analysis Team for Network Design and Operations Research (Chair 2009 -2011)
- GRUAN Task Team on Site Evaluation (Member 2010-2011)

GRUAN Goals
- Develop and sustain an international reference network designed specifically to meet climate requirements
- Provide long-term, high-quality, upper-air climate records, with complete estimates of measurement error
- Constrain and adjust data from more spatially comprehensive global observing systems (including satellites and radiosonde networks)
- Fully characterize the atmospheric column and its changes
- Ensure that potential gaps in satellite programs do not invalidate the long-term climate record

ARL Research in Support of GRUAN
- Trend Error Rate (%) Due to Changing Observing Schedule
- The importance of consistent methods of observation
- The use of reference observations to characterize uncertainty

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Uncertainty in global upper-air temperature trends due to lack of reference observations. Plots compare radiosonde-derived temperature trends from different datasets and research teams. The wide spreads and large error bars are prime arguments for establishing a reference upper-air network.

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