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Item 3

Routine Calibration/Validation

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Summary and Purpose of Document

The document contains an outline of a talk which will discuss the important aspects for routine calibration and validation across the GRUAN network, including the estimation of uncertainties.

Routine Calibration/Validation: Outline

I. Conceptual Framework
   1. Robust uncertainty estimates as a science product
      a. community efforts and transparency supporting design, execution and analysis of measurements
   2. Documentary guidelines: the ISO 5725
      a. clearly defines language and principles for establishing the accuracy of a measurement
   3. Lessons from the National Measurement Institutes (NMIs) model
      a. intercomparisons, focused research program, independent methods
   4. Case studies from other areas measurement science
      a. voltage standards: electrochemical cells and the introduction of quantum electrical standards
      b. infrared radiometry: source-based and detector-based methods

II. Motivation
   1. Lessons from stratospheric ozone depletion
   2. International credibility

III. Assembling a cal/val procedure
   1. Identification of appropriate standards
      a. ideally, based on well-defined and reproducible physical quantities, rather than an artifact maintained at a central location
   2. Estimating the uncertainty in the standard over the relevant geophysical dynamic range
      a. variability with time of day, season, climatic oscillations (MJO, ENSO, QBO, NAO, etc.)
   3. Evaluating the universality of standards against uncertainties introduced by varying environmental conditions or operational procedures
      a. Is the standard dependent on local pressure, radiation environment, flow rate, or time history (hysteresis)?
   4. Computing a consensus reference value from an ensemble of standards
      a. combining an ensemble of measurements of the same observable according to their independent uncertainty estimates

IV. GRUAN measurement: temperature
   1. SI/ITS-90 provides robust standards, traceable to fundamental properties of matter, that have proven to be reproducible independent of time and place?
   2. Given a ground-based SI traceable calibration, how do we estimate the uncertainty introduced in situ due to variable radiation environment? Are there other relevant sensitivities?

V. GRUAN measurement: water vapor
   1. What are the community's best standards, and how do we document and critically analyze their uncertainties?
   2. Water vapor has a larger dynamic range than temperature, introducing a more challenging measurement problem

VI. Secondary GRUAN measurement: infrared spectral radiances
   1. Can draw on calibration foundations from remote sensing community

VII. Lessons from the remote sensing community
   1. Efforts to develop sensors with robustly quantified uncertainties for full mission lifetime: COSMIC, CLARREO

VIII. Multi-sensor fusion methods and cal/val
   1. Ground-based remote methods are sensitive to key GRUAN geophysical variables: temperature, water vapor
   2. Self-consistency in trends may offer opportunity to bolster uncertainty estimates and monitor performance over time