Topic 4: Quantifying the Value of Complementary Observations

Research Question: How much is measurement uncertainty reduced by having redundant or complementary measurements of a given variable?

Approach: Using data from a highly-instrumented location (e.g., ARM site, Lindenberg), and looking at vertical profiles of both temperature and moisture, estimate uncertainty of typical profiles based on individual profiling systems separately, and in various combinations. Quantify error reduction with increasing redundancy of measurements. A model for this approach may be the ARM Value Added Products.

Previous Relevant Work: Wang and Young (2005)

Team Lead: To be determined

Possible Collaborators: ARM scientists

Start Date and Estimated Project Duration: Future project – to be determined

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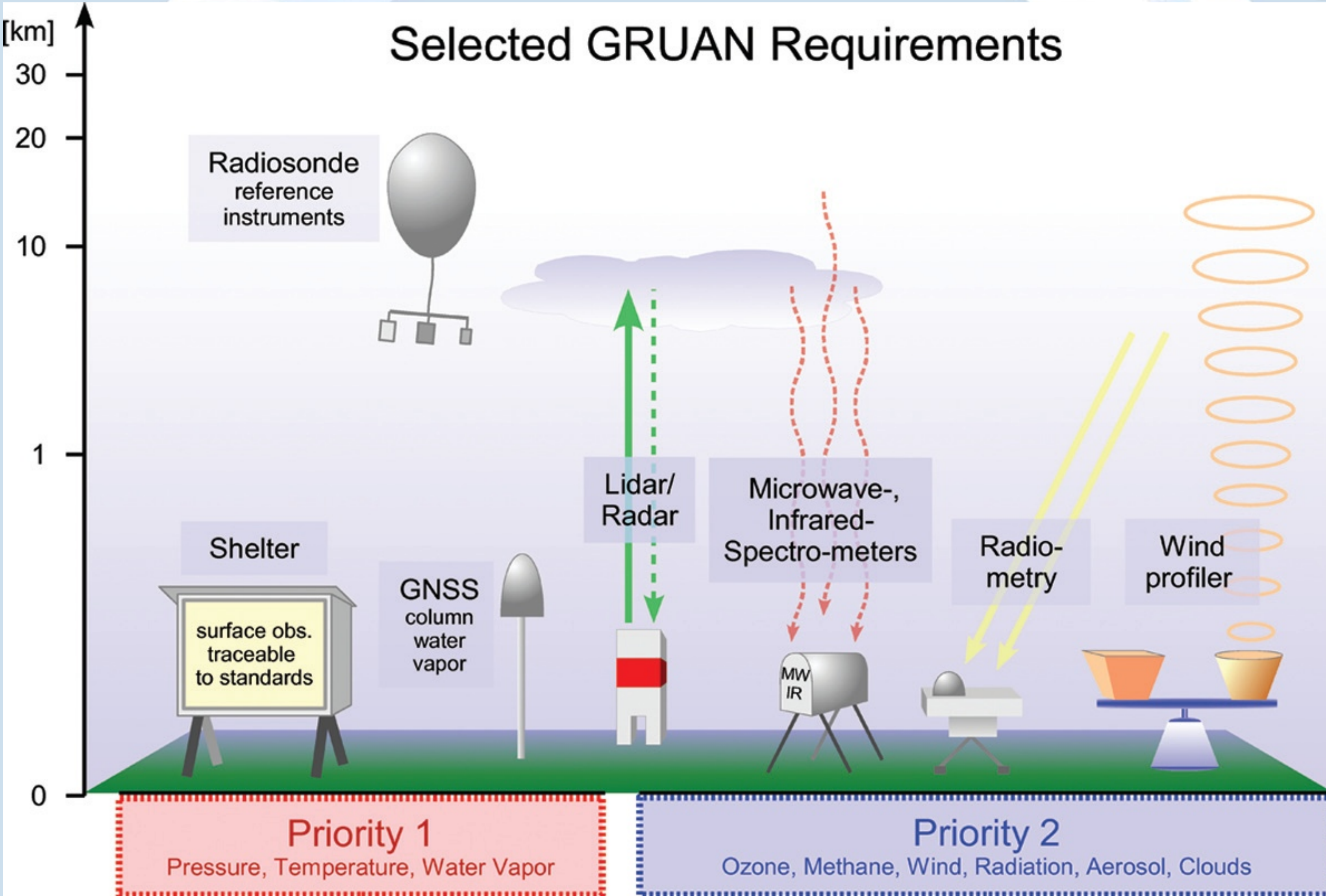
GRUAN instruments

- Focus on priority 1: Pressure, temperature, water vapor
- Focus on upper troposphere and stratosphere
- Focus on reference observations for climate research



Value of Complementary Observations

1. To help identify and quantify changes
2. To help correct errors/biases of individual instrument
3. To reduce uncertainties in measurements (how and by how much???)

References:

Toohey and Strong: Estimating biases and error variances through the comparisons of coincident satellite measurements. JGR, 2007.

Richner and Phillips: The radiosonde intercomparison SONDEX Spring 1981, Payerne. Pure and Appl. Geophys., 1982.

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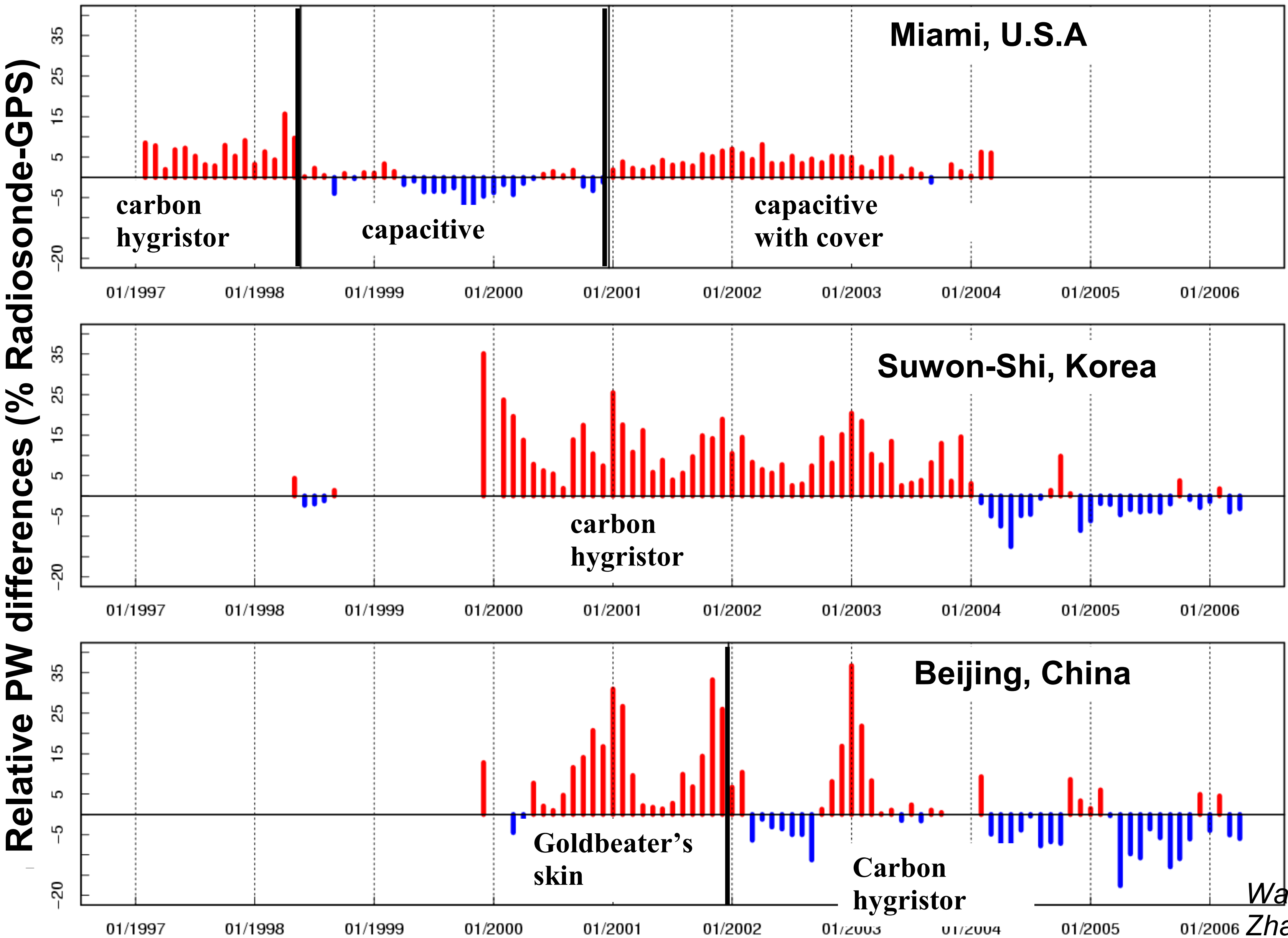
Temporal inhomogeneity of radiosonde PW data



Wang and Zhang (2008)

Estimation of Instrument Error Variances

$$x_l = x_M + \bar{x}_l + \delta x_l$$

$${}_x\sigma_l = \left[\frac{1}{n-1}\sum \delta x_l^2\right]^{1/2}$$

$$x_{lk} = x_l - x_k = x_M - x_M + \bar{x}_l - \bar{x}_k + \delta x_l - \delta x_k$$
$$= \bar{x}_l - \bar{x}_k + \delta x_l - \delta x_k$$

$$\bar{x}_{lk} = \overline{x_l - x_k} = \frac{1}{n_{lk}}\sum(\bar{x}_l - \bar{x}_k + \delta x_l - \delta x_k)$$
$$= \frac{1}{n_{lk}}\sum(\bar{x}_l - \bar{x}_k)$$

Richner and Philips (1982)

"The Radiosonde Intercomparison SONDEX"

$${}_x\sigma_{lk} = \left[\frac{1}{n_{lk}-1}\sum(\delta x_l - \delta x_k)^2\right]^{1/2}$$

$${}_x\sigma_{lk} = \left[\frac{(n_{lk}-1)({}_x\sigma_l^2 + {}_x\sigma_k^2)}{2n_{lk}-1}\right]^{1/2}$$

Wang and Young (2005)

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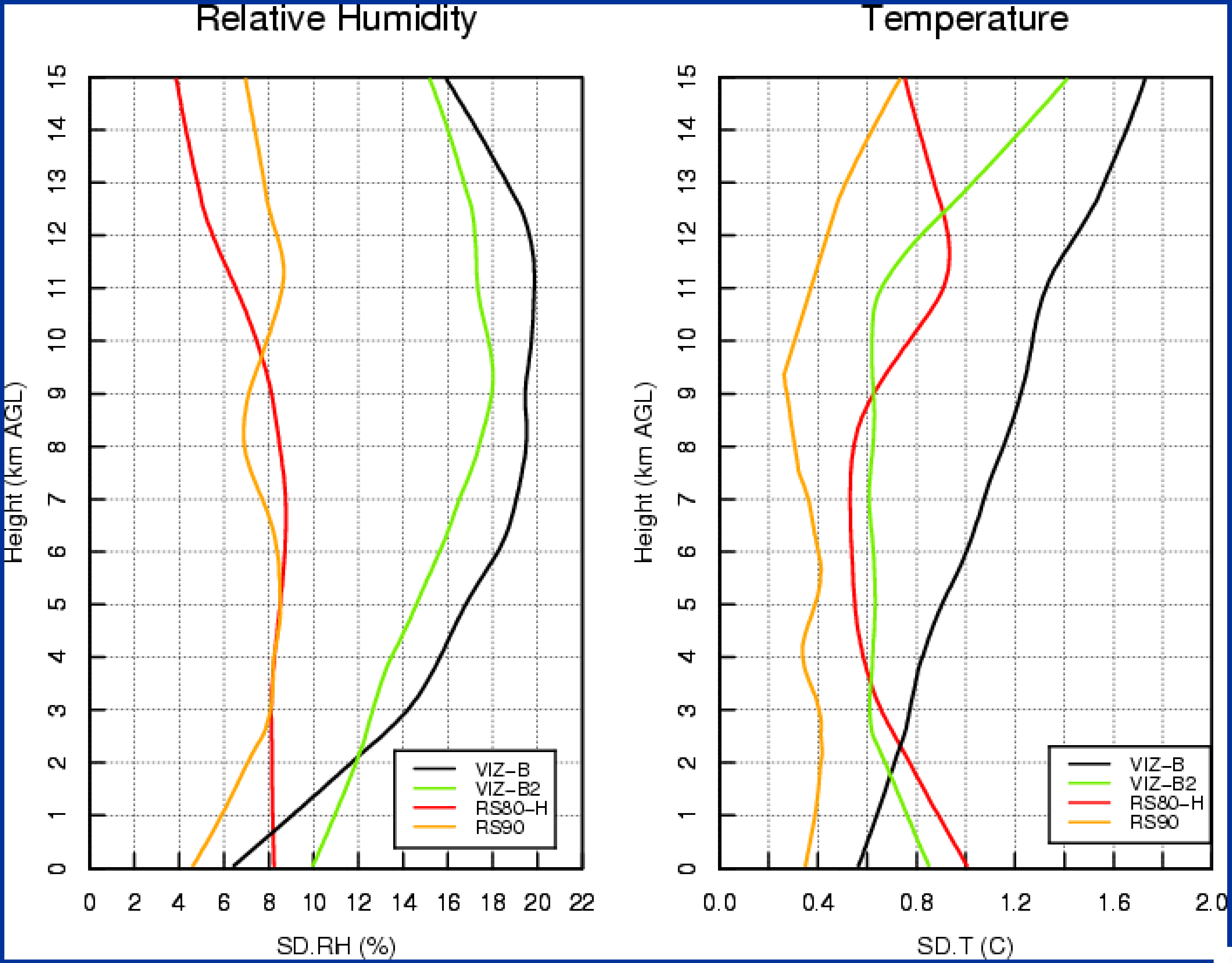
Estimation of Instrument Error Variances



Wang and Young (2005)

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