Airborne Radiation Measurements: State-of-the-Art and Problems

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Techniques

Broadband

Spectral(Solar)

Meas. - Model

Problems

Optical Inlet

Horiz. Leveling

Collocation

EUFAR initiative to compile a textbook on

"Airborne Measurements: Methods and Instruments"

1. Introduction

PART 1: In-Situ Measurements

2. Basic Meteorological Parameters
3. Gas Phase Measurements
4. Clouds and Precipitation
5. Aerosol Particles

PART 2: Remote Sensing

6. Radiation Measurements
7. Passive
8. Active

Airborne Radiation Measurements: Pyranometer / Pyrgeometer State-of-the-Art and Problems

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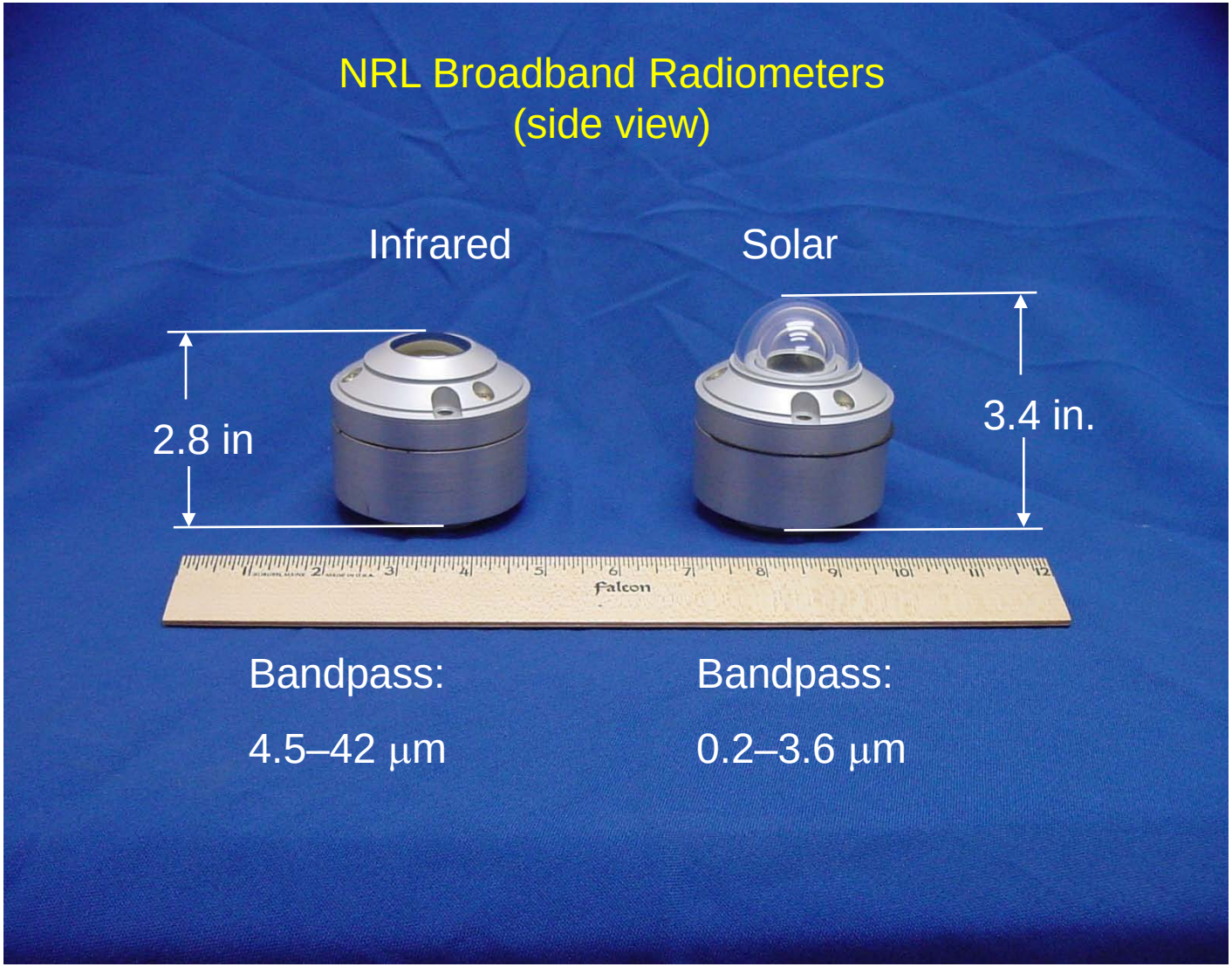

Pyranometer / Pyrgeometer

- **Off-the-shelf commercial radiometers (e.g. Eppley or Kipp & Zonen).**
  - Instruments made for surface measurements
  - Millivolt signals can be noisy in research aircraft environment
- **Modifications for aircraft use:**
  - **Amplification** and **A/D conversion** at sensor
  - **Amplification** of signal at sensor and run in current-loop mode to minimize **noise** in long cables
  - Interior of sensor **evacuated** to prevent condensation/frosting
  - Consider temperature effects, internal misalignments …

General Setup

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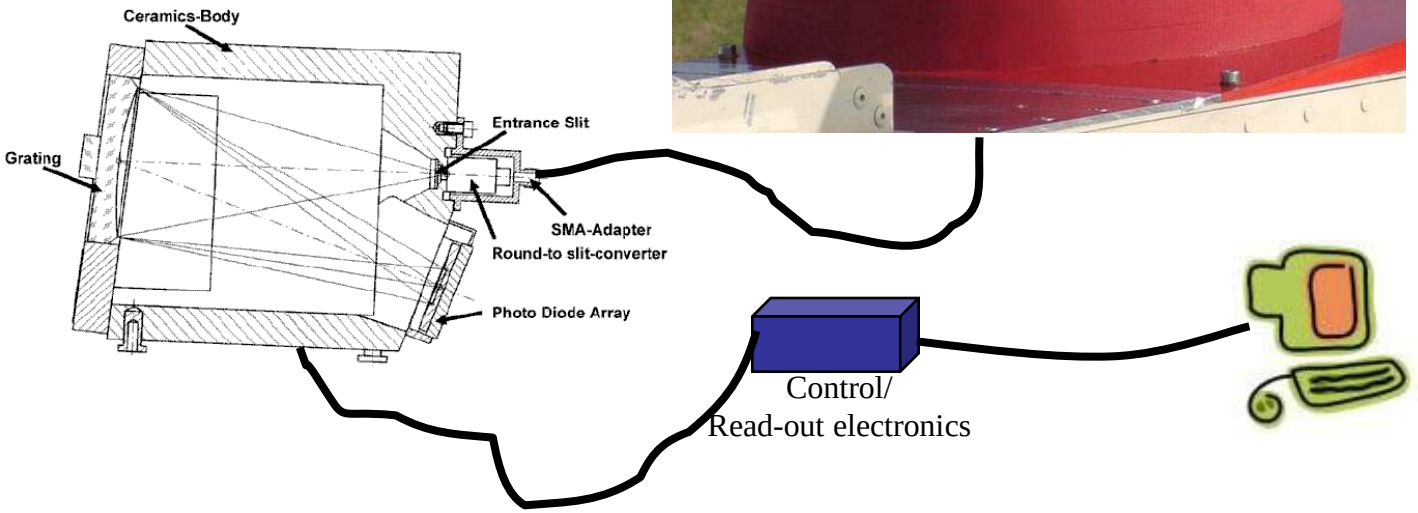
Grating Spectrometer
PDA or CCD, Zeiss



UV (CCD)	UV – Visible	Visible	Near Infrared
532 pixel	512 pixel	1024 pixel	512 pixel
λ = 260–680 nm	λ = 280–700 nm	λ = 290–1000 nm	λ = 900–2300 nm

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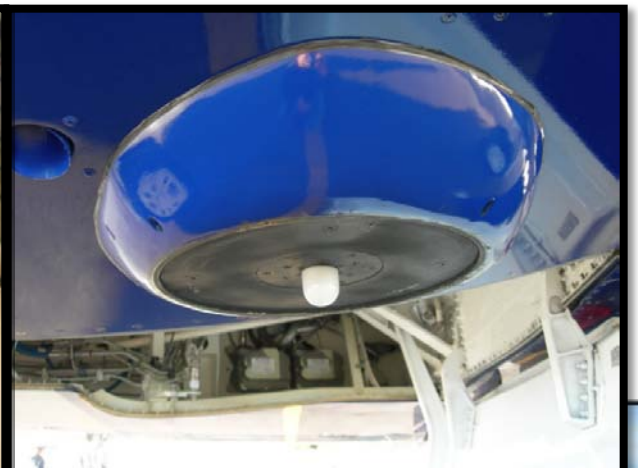
Available Systems (list may not be complete)

- **SSFR** *Pilewskie*
  (**S**olar **S**pectral **F**lux **R**adiometer)
  → Irradiance, Radiance

- **SMART-Albedometer** *Wendisch*
  (**S**pectral **M**odular **A**irborne **R**adiation Measurement Sys**t**em)
  → Irradiance, Radiance, Actinic Radiation

- **HARP** *Shetter*
  (**H**IAPER **A**irborne **R**adiation **P**ackage)
  → Irradiance, Actinic Radiation



Comparison Measurements - Model

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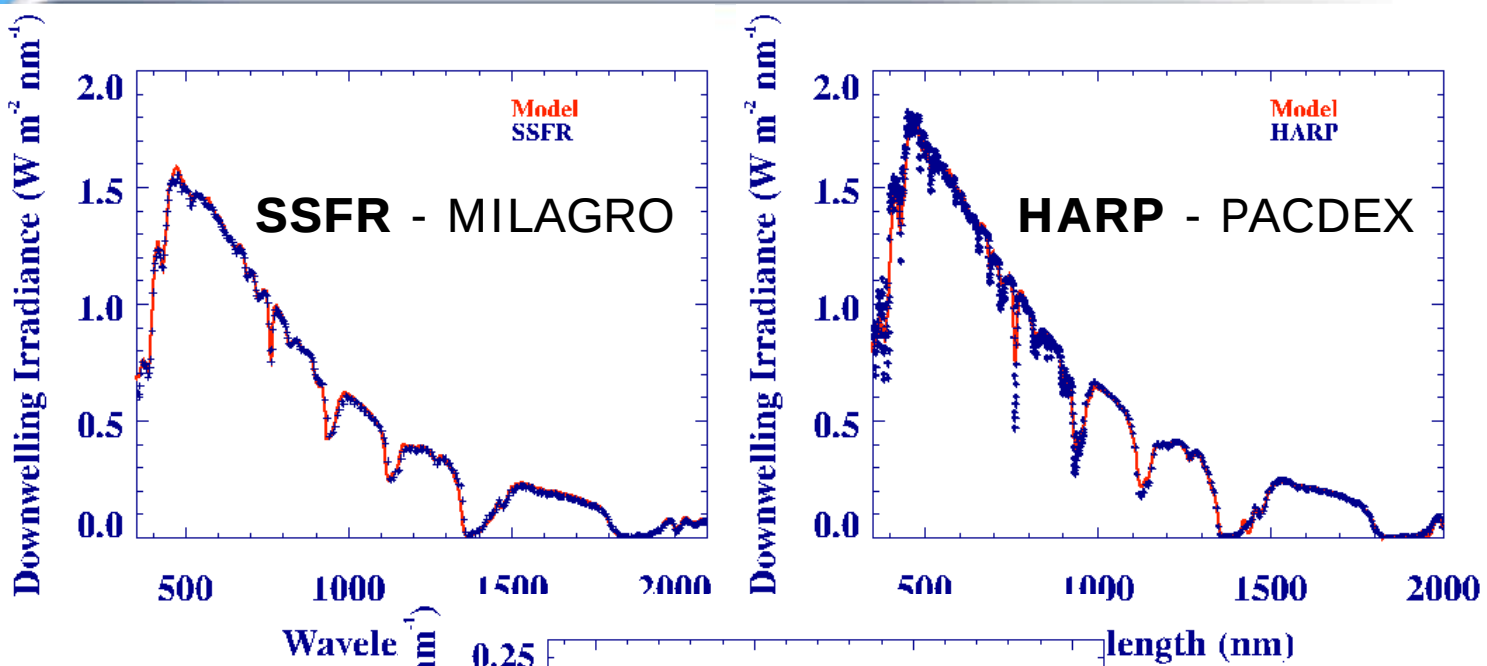

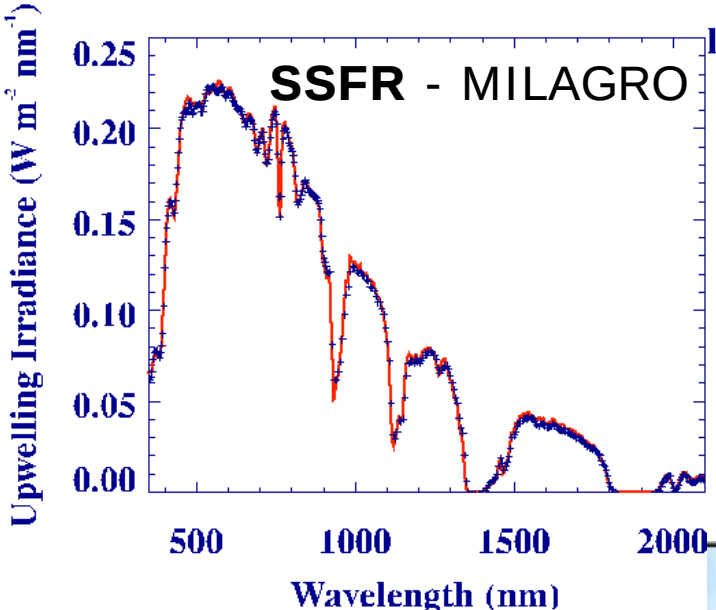

Pilewskie et al. [2008]

Airborne Radiation Measurements: Angular Response: Cosine (Irradiance) State-of-the-Art and Problems

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- **Two Options: Transmissive – Reflective Diffusers**
- **Problematic: Transmissive Diffusers**
  - Flashed opal (glass) becomes transparent beyond 1000 nm
  - Teflon and delrin (plastics) diffusers have spectral absorption features

Pilewskie et al. [2008]

Transmissive Diffusers

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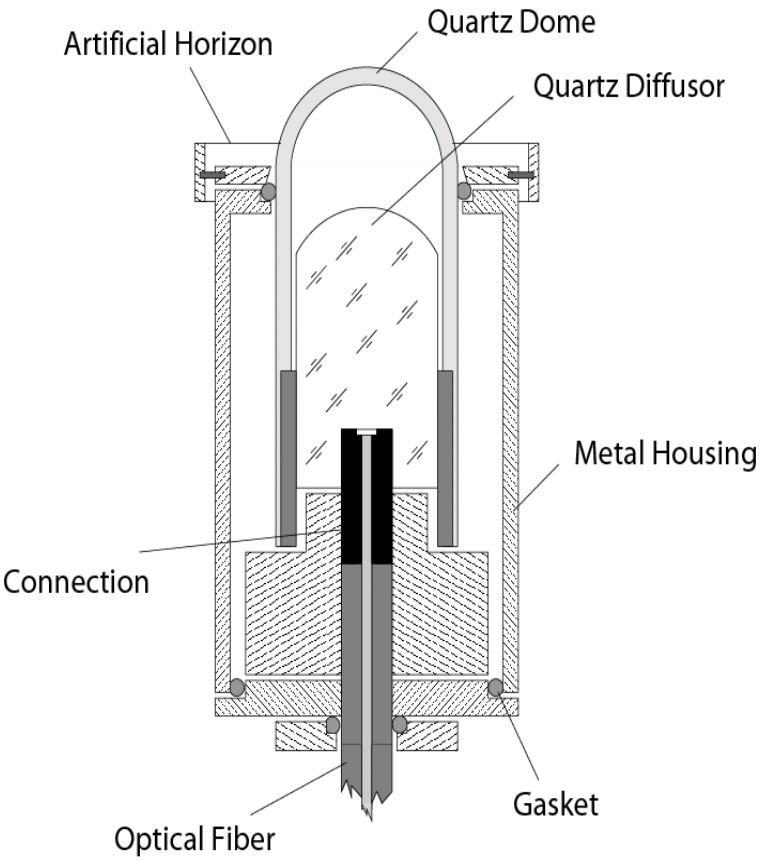

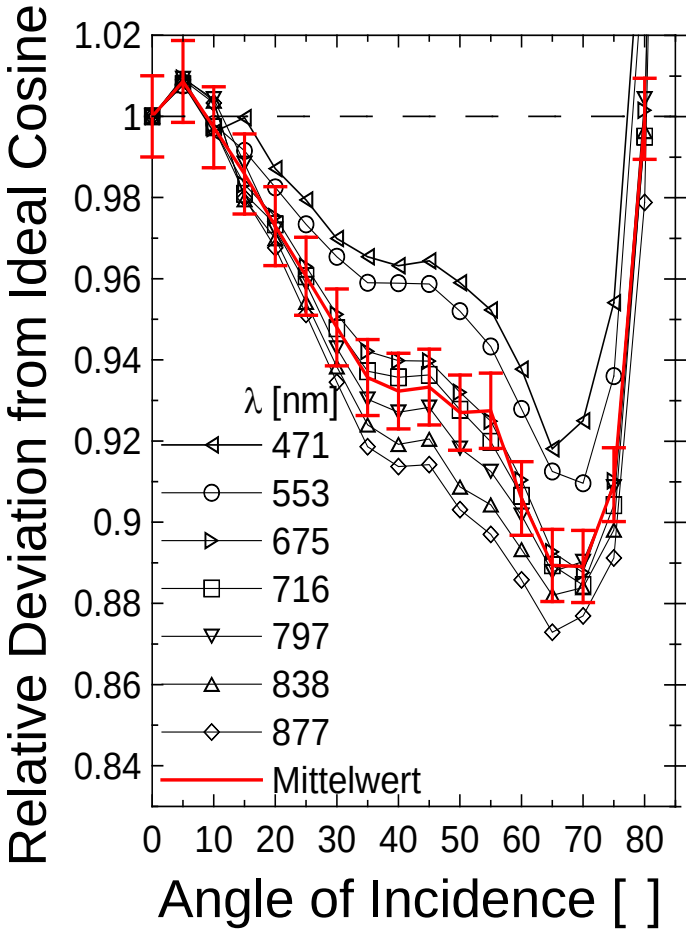

Meteorologie Consult GmbH

Wendisch [2004]

Angular Response: Cosine (Irradiance)

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- **Two Options: Transmissive – Reflective Diffusers**
- **Problematic: Transmissive Diffusers**
  - Flashed opal (glass) becomes transparent beyond 1000 nm
  - Teflon and delrin (plastics) diffusers have spectral absorption features
- **Solution: Reflective Integrating Sphere**
  - Based on design by *Crowther* [1999]
  - Hollow spectralon sphere
  - Fiber optic bundle at exit 180° from entrance aperture
  - Conical baffle between entrance and exit

***Pilewskie* et al. [2008]**

Reflective Integrating Sphere

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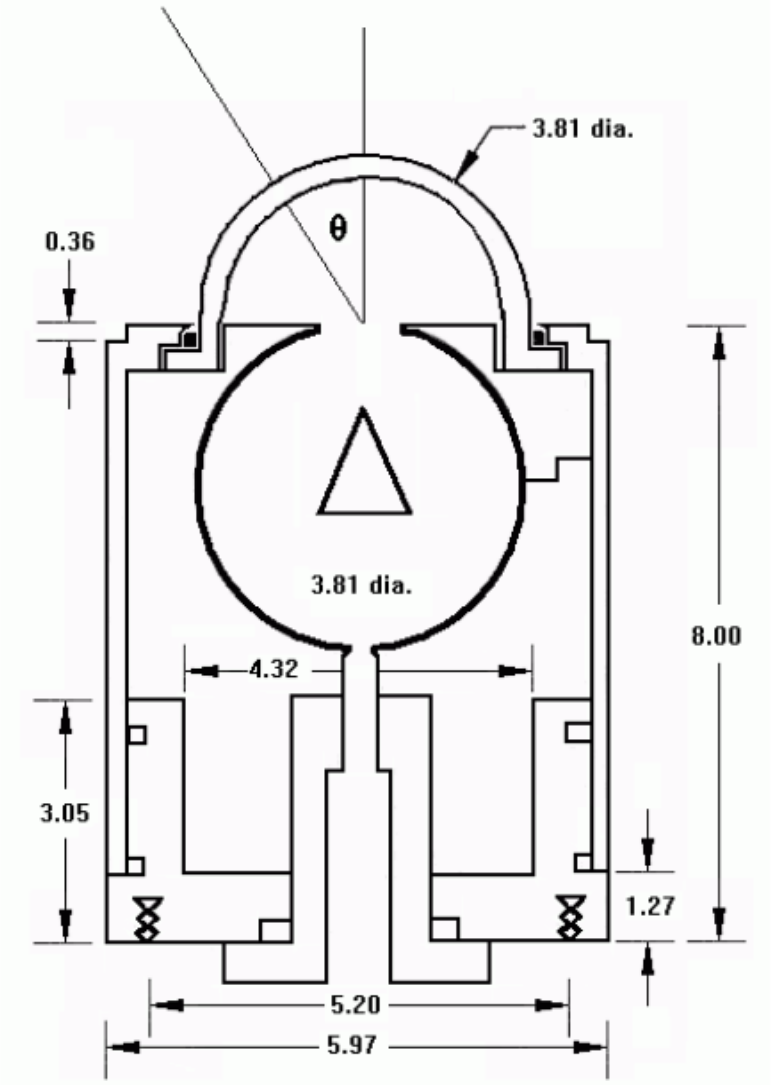
Trades:

- Very good response at low incident angles
- Uniform spectral response
- “hot spot” between 10°-30° from normal incidence.
- Correctable to better than 3%.



Pilewskie et al. [2008]

Reflective Integrating Sphere

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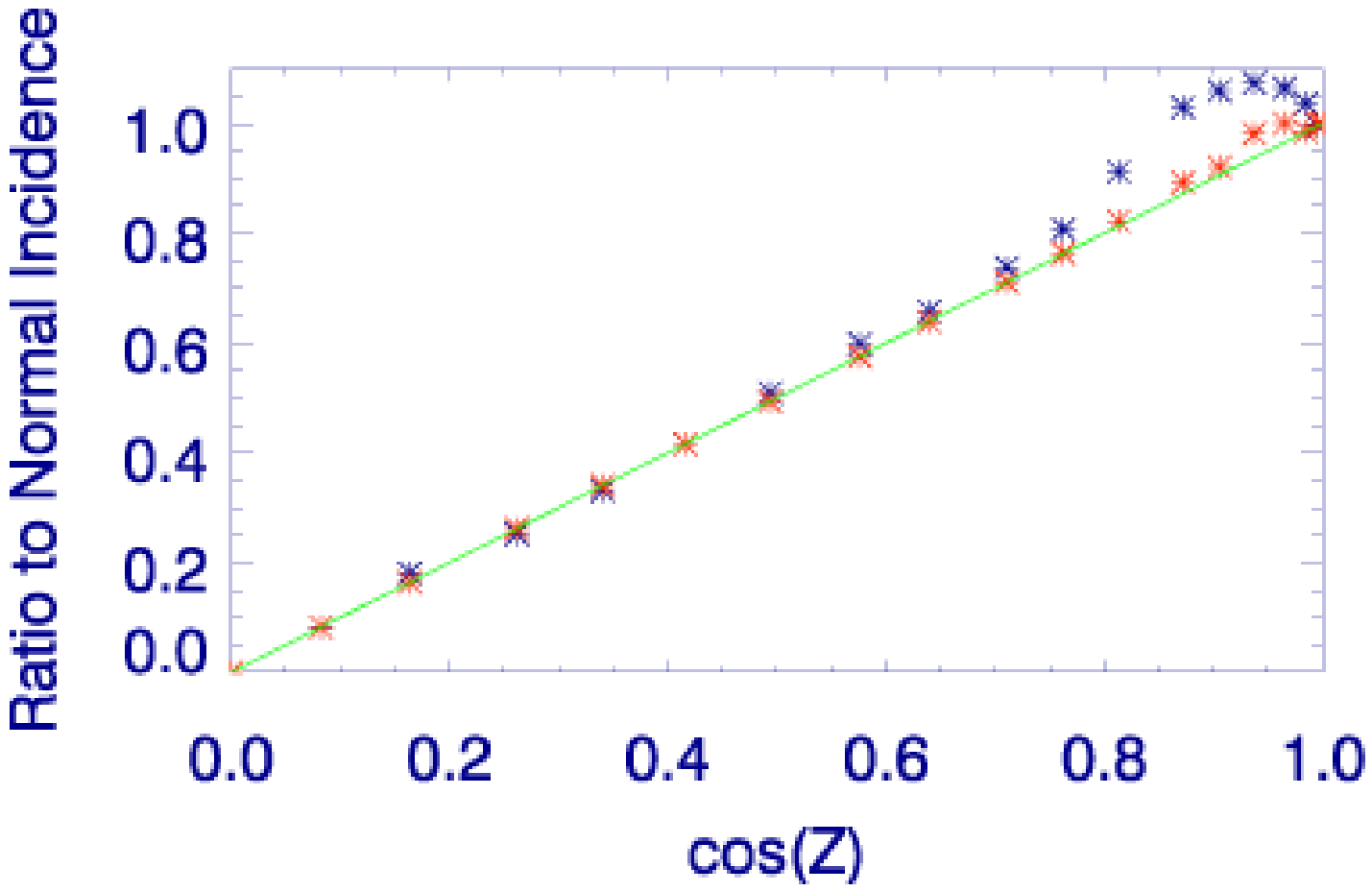
New design has reduced “hot spot”.



Pilewskie et al. [2008]

Airborne Radiation Measurements: Measured Deviations, State-of-the-Art and Problems

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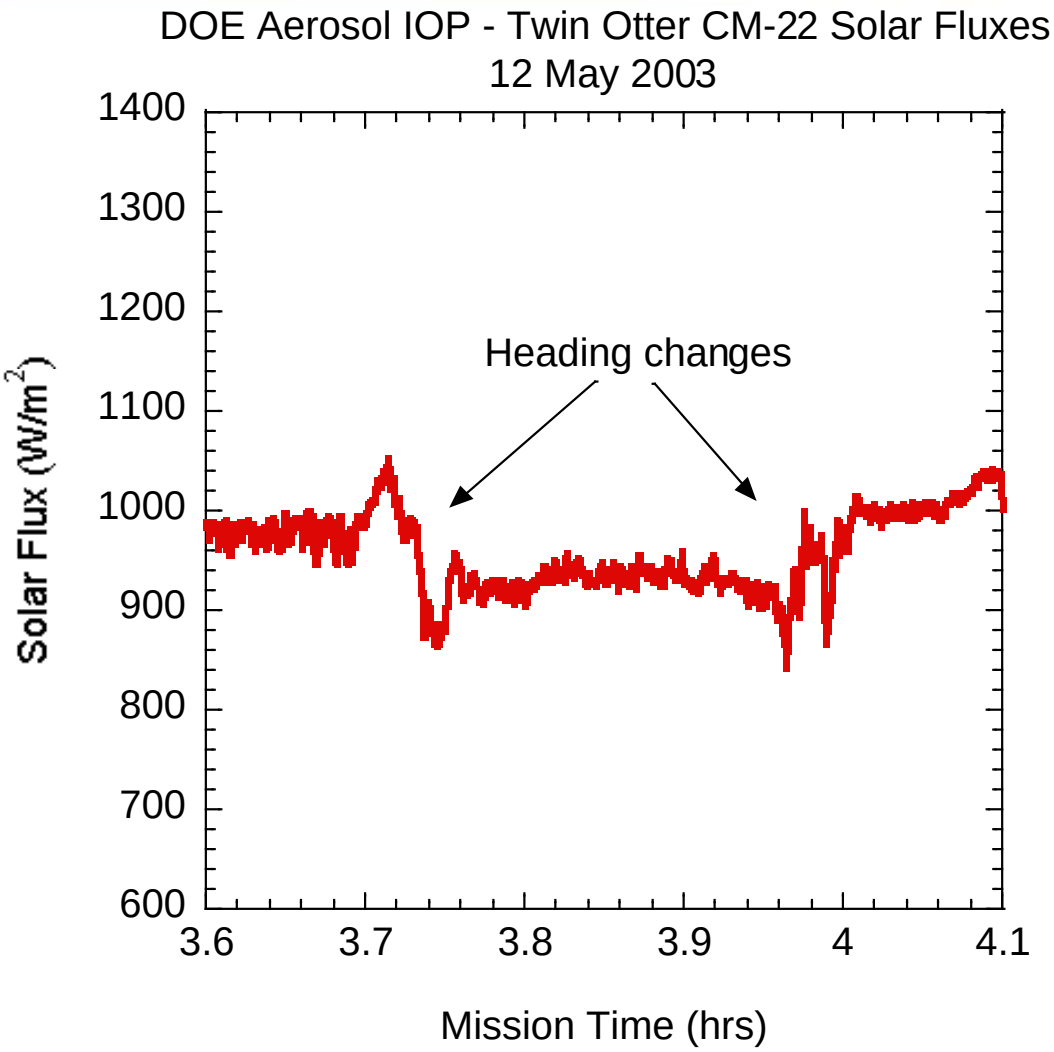

Bucholtz et al. [2008]

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Simulated Deviations

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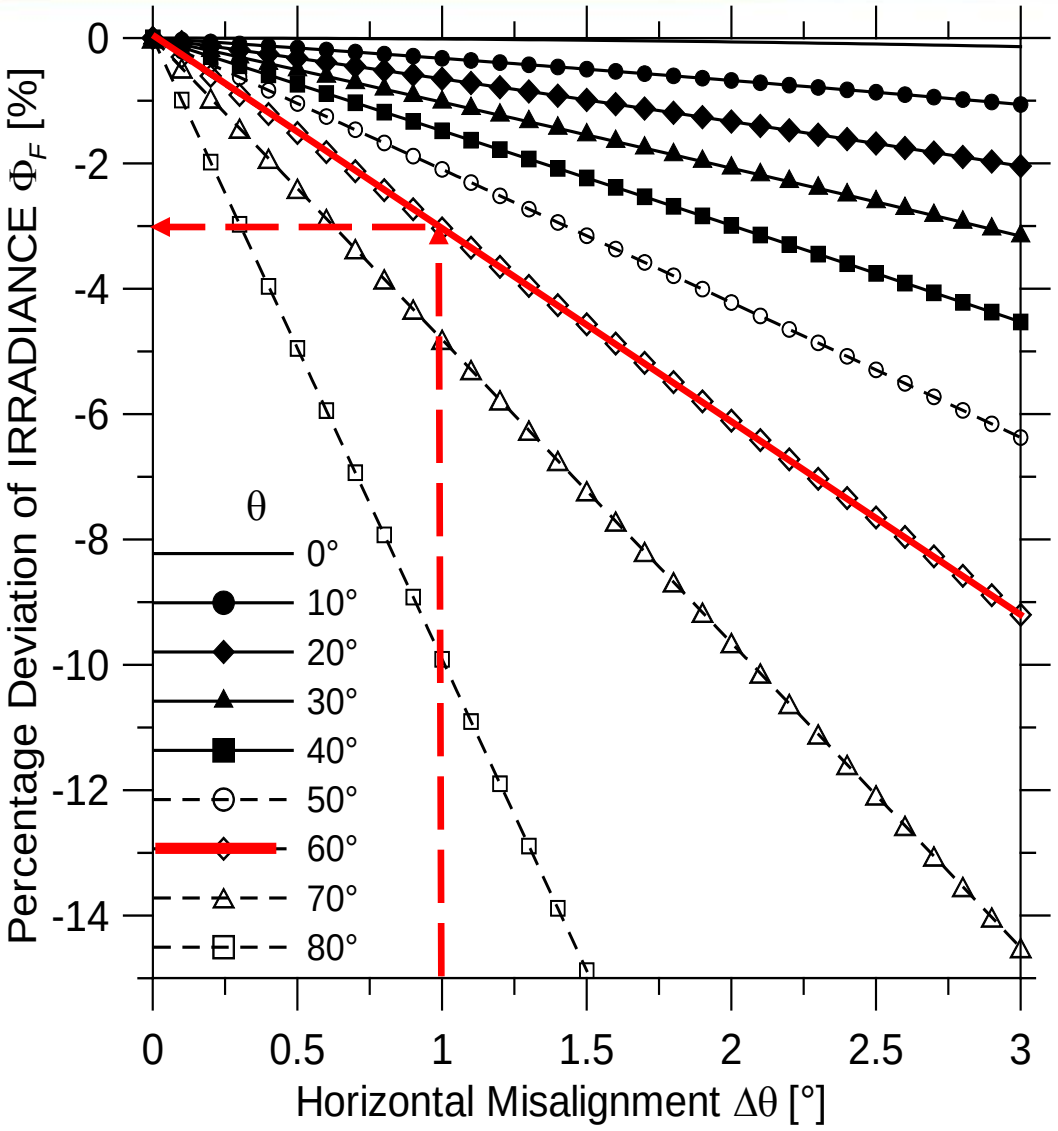

Wendisch et al. [2001]

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- SPARM (Stabilized Platform for Airborne Radiation Measurements)
- STRAP (STabilized RAdiometer Platform)

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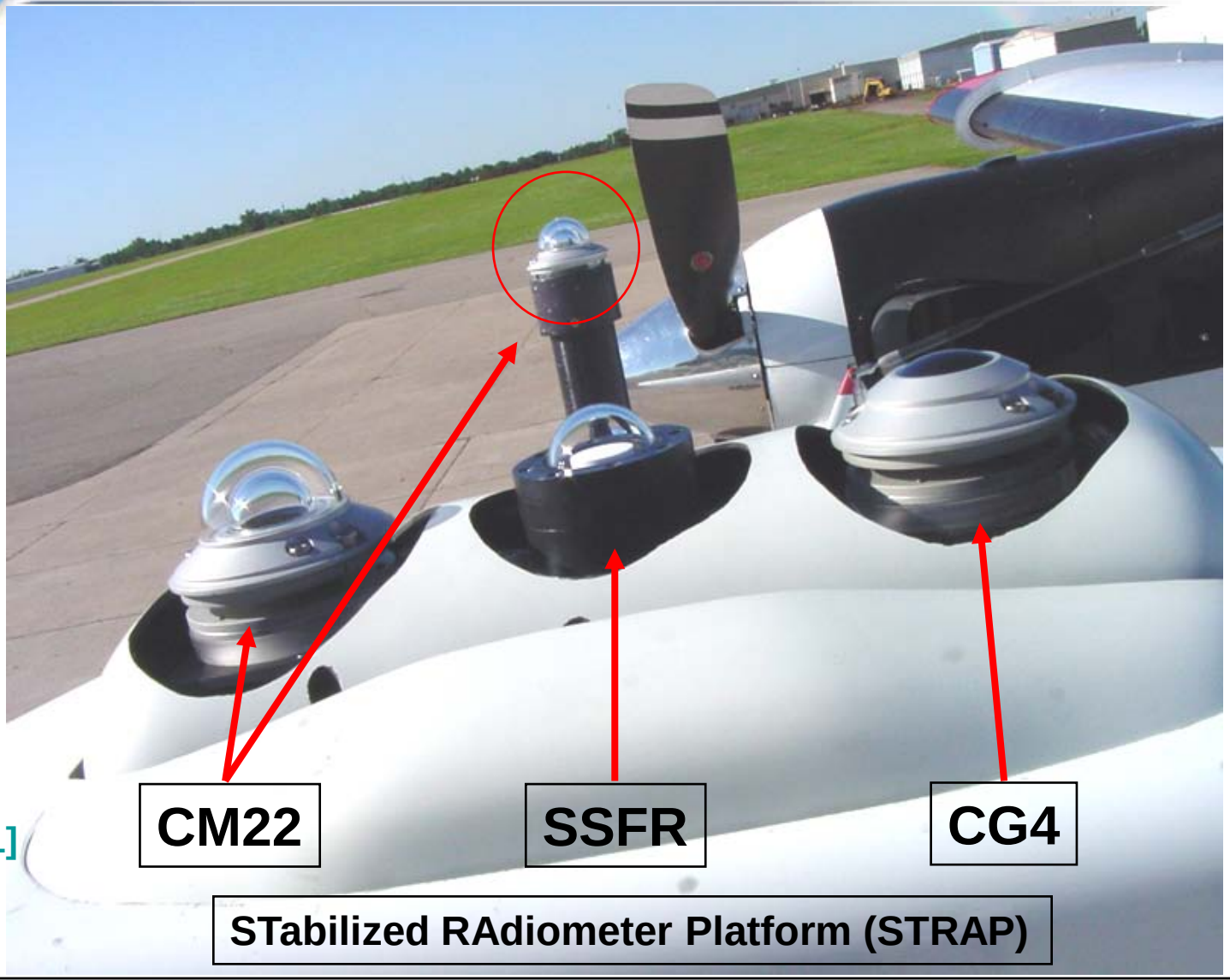
SPARM:
Enviscope GmbH
Wendisch et al. [2001]

STRAP:
Bucholtz et al. [2008]



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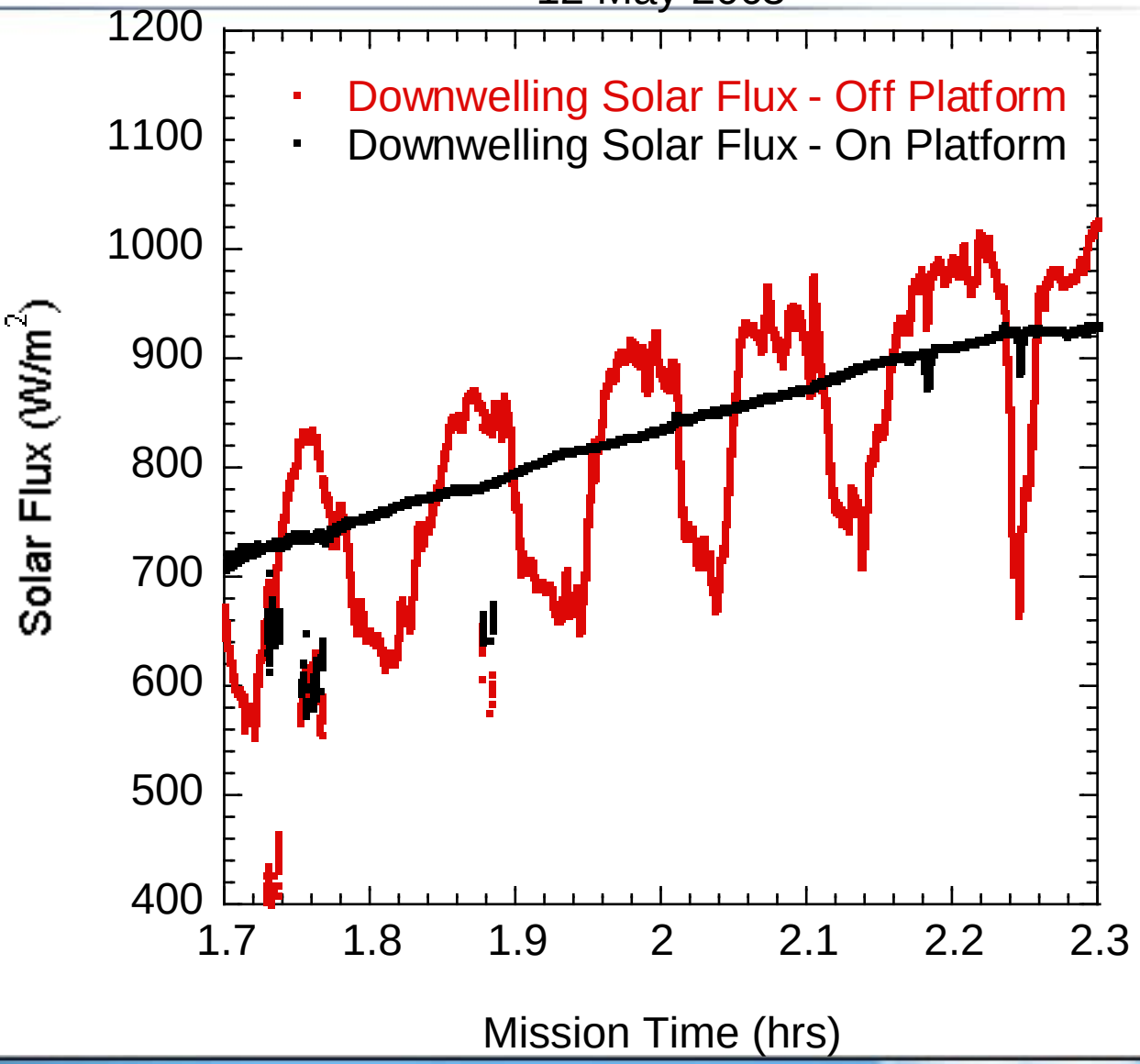

Bucholtz et al. [2008]

Airborne Radiation Measurements: Airborne State-of-the-Art and Perspectives

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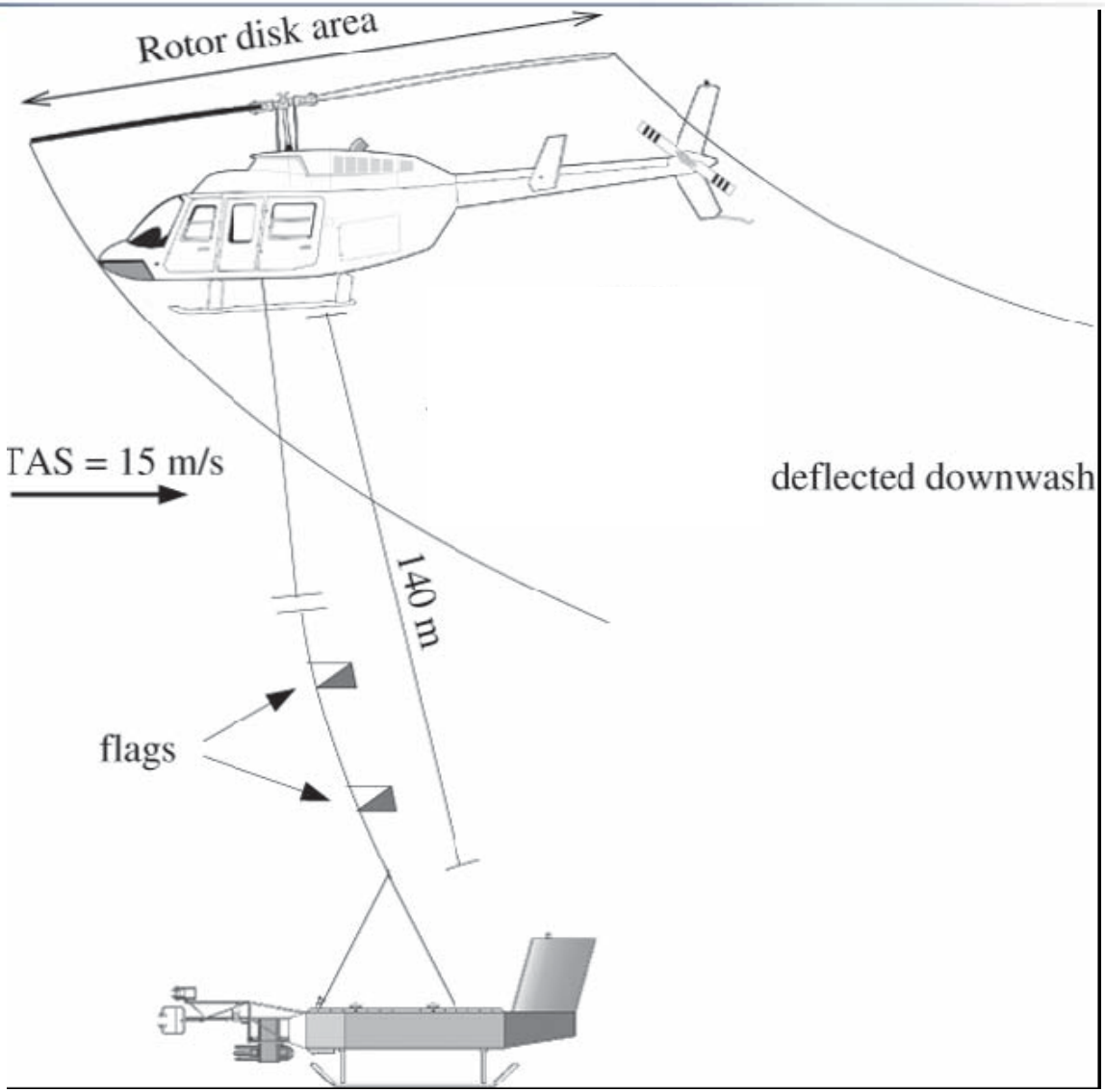

Siebert et al. [2006]

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ACTOSS
Airborne Cloud Turbulence Observation System

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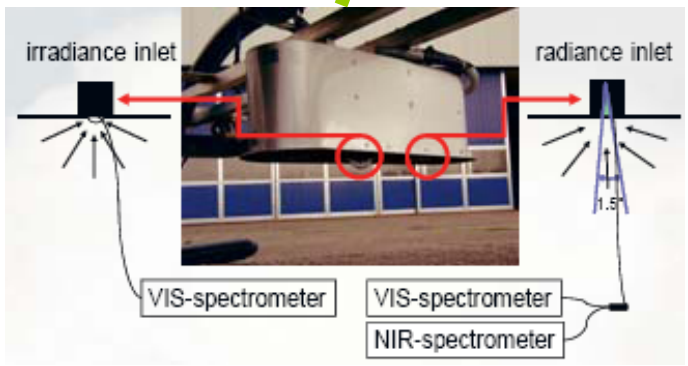
Come and see our poster ...



Siebert et al. [2006]

AIRTOSS
Aircraft TOwed Sensor Shuttle

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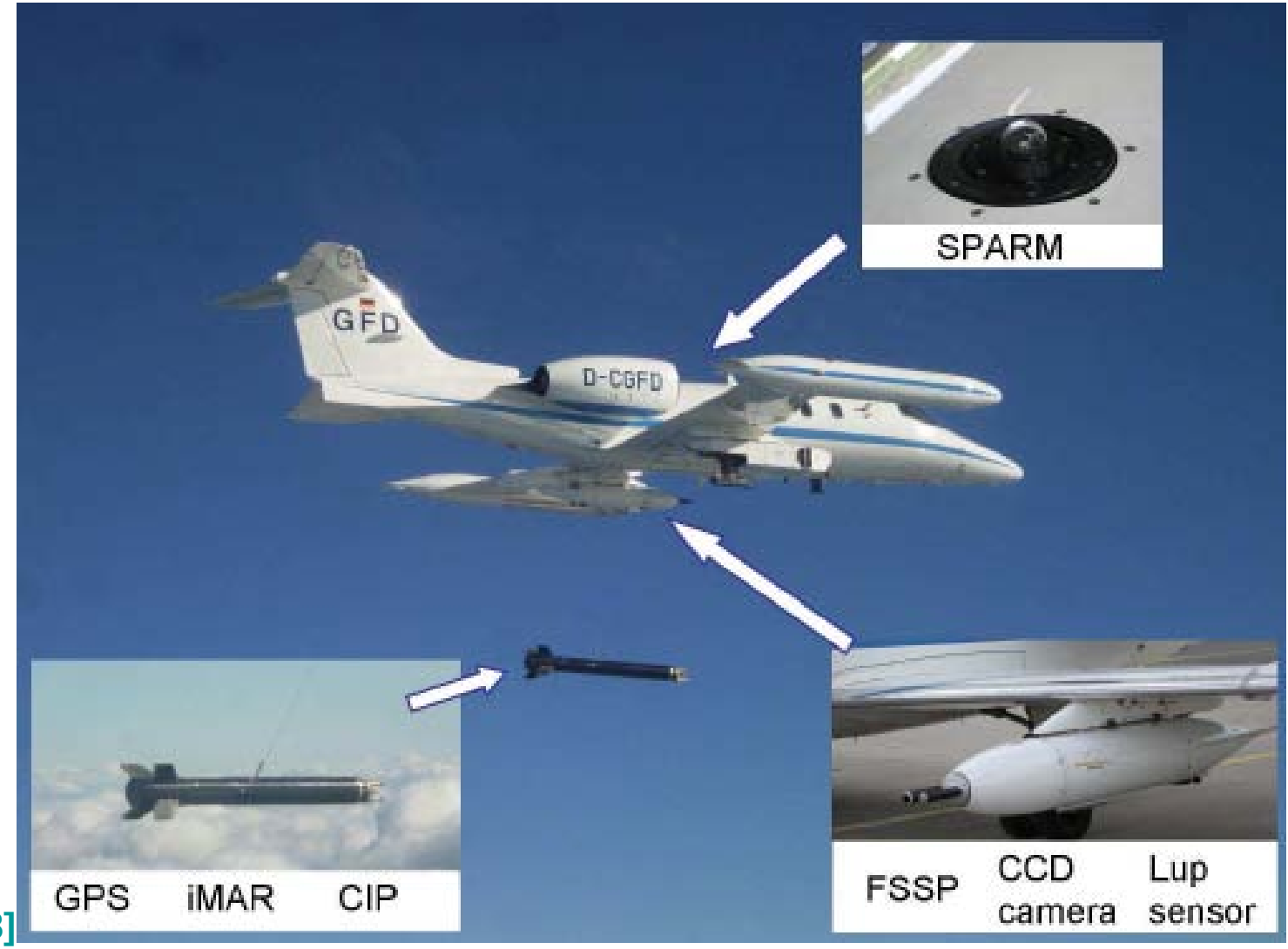

Frey et al. [2008]
Borrmann et al. [2008]

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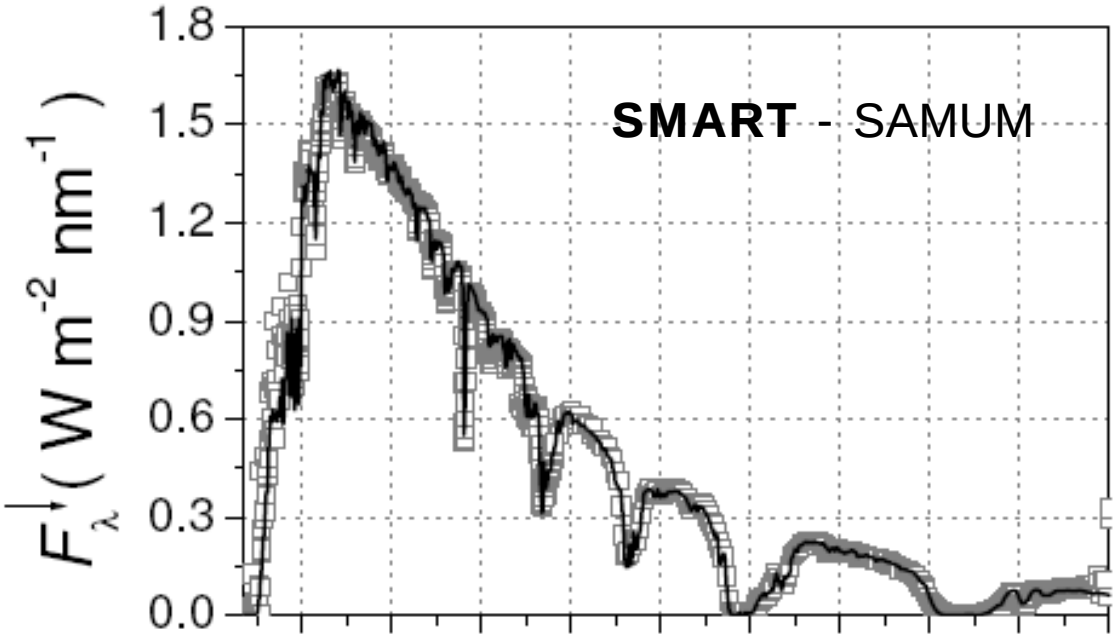

Bierwirth et al. [2009]