Measurement needs for automated site characterization

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Background

Justifications for automated measurements are well established

- Automated sites can combine accuracy of in situ with flexibility of invariant scene
- Automated ground systems are always collecting so results are available when the on-orbit sensor needs them
- Questions that still exist are
  - What are the measurements needed
  - What is the trade between cost and accuracy
  - Are a few highly-instrumented sites better than more sites with less instrumentation

RadCaTS

Radiometric Calibration Test Site is the UofA's autonomous, reflectance-based site

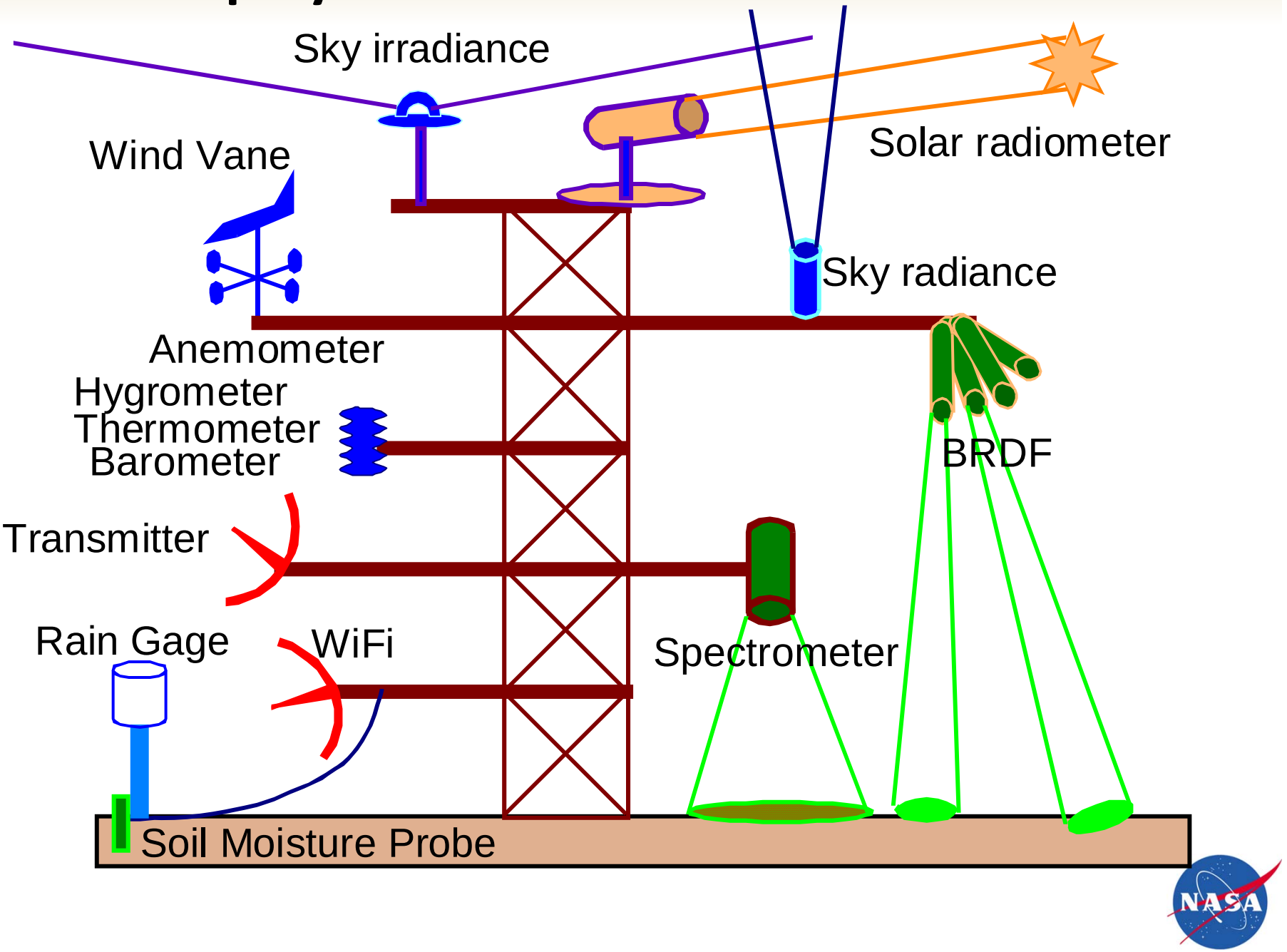
- Original proposed approach relied on a central core site
  - Highly instrumented for maximum spatial and spectral detail
  - Used for high-spatial-resolution sensors (< 4 m)
- Node sites
  - Smaller instrument suite
  - Designed to give spatial information
  - Used for low-spatial-resolution sensors (> 250 m)
  - Combine the two for moderate resolutions

Automated site data product

Goal should be to develop a model image of the test site

- Effort is to calibrate the site
- Model image provides at-sensor radiance for a given sun- sensor geometry
  - Hyperspectral - 10-nm intervals from 350-2500 nm
  - Moderate spatial - 20-m spatial resolution
  - Large spatial extent - 20 by 20 km size derived in part through other image data
- A standard image could be produced for selected bands at specified times during the day
- On-demand product based on user preference for sun- sensor geometry

Core site deployment



Unlimited budget approach

Fully instrumented suite with modest redundancy would be ~$1.6M for startup

- Costs are those for purchase and deployment including planned redundancy of key components and to examine spatial aspects of the validation problem

Portable tower for deployment including costs to incorporate equipment	$50K
6 Digital camera systems for sky and ground monitoring including remote operation setup	$15K
6 Multispectral, sky irradiance monitor	$100K
6 Multispectral ground monitor radiometer	$100K
3 Field spectrometer for continuous deployment	$200K
3 Multispectral thermal-infrared radiometers	$100K
Enclosure and hardware for field spectrometers	$100K
Microwave profiler	$100K
3 GPS water vapor retrieval systems	$150K
Cimel Sun Photometer	$100K
MPL net capable lidar system	$100K
Sky imager	$30K
BRDF imager	$40K
Metorological station	$10K
Wireless data connectivity	$100K
3 Feld calibration sources for spectrometers	$150K
Field references of varying sizes including Spectralon panels and field tarpaulins	$100K
Power generation	$50K

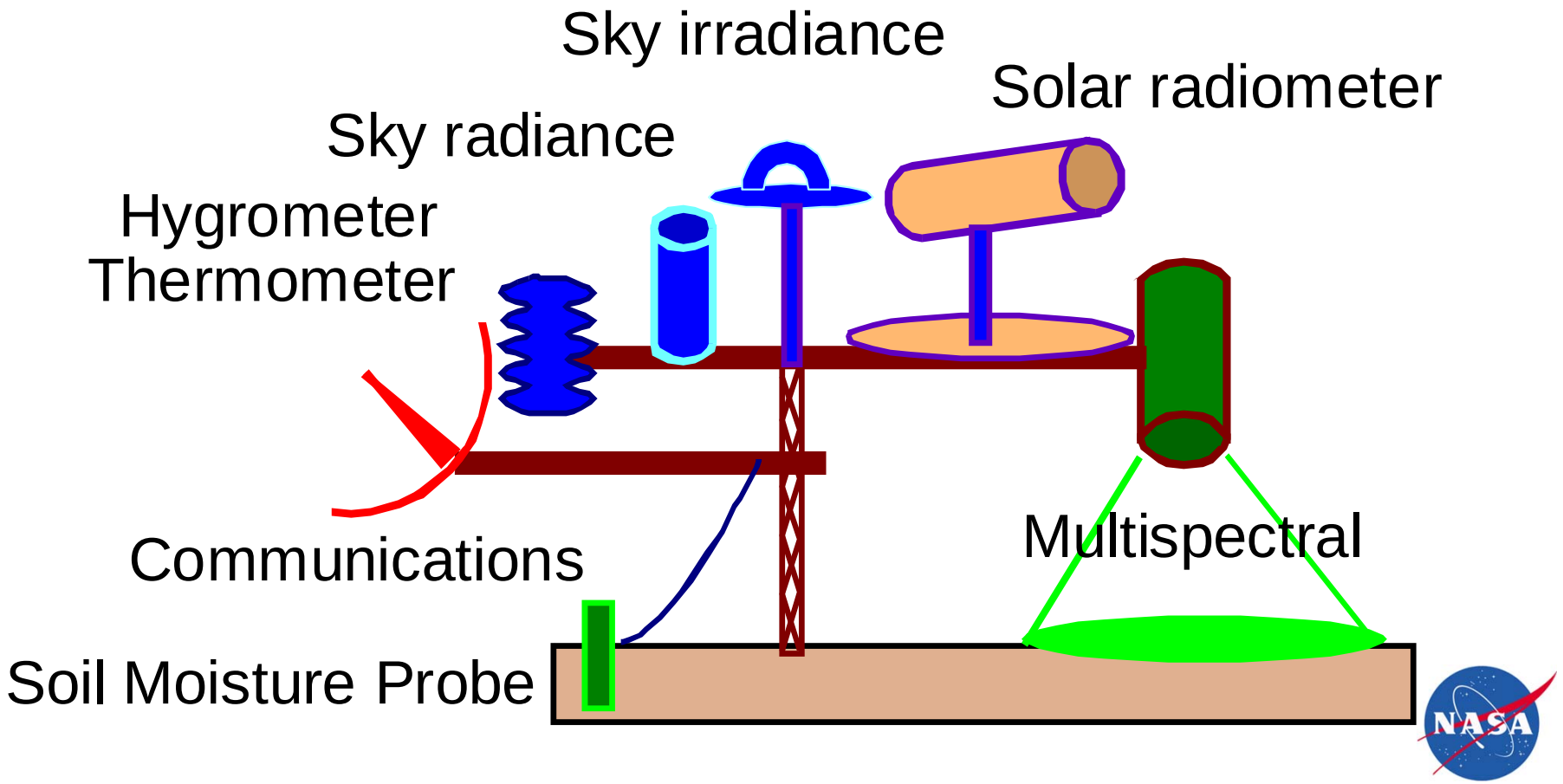
- Maintenance costs would be additional on a year-to-year basis

Minimum set of measurements needed for a reflectance-based approach

- Impact of assumptions on uncertainties must be evaluated
- Numbers of data collections is key factor
- Sites with reflectance > 0.2
  - Site reflectance is most important
    - BRDF
    - Spectral
    - Spatial
    - Temporal
  - Aerosol effects can be viewed as random
    - Aerosol absorption changes with time

Original node site design

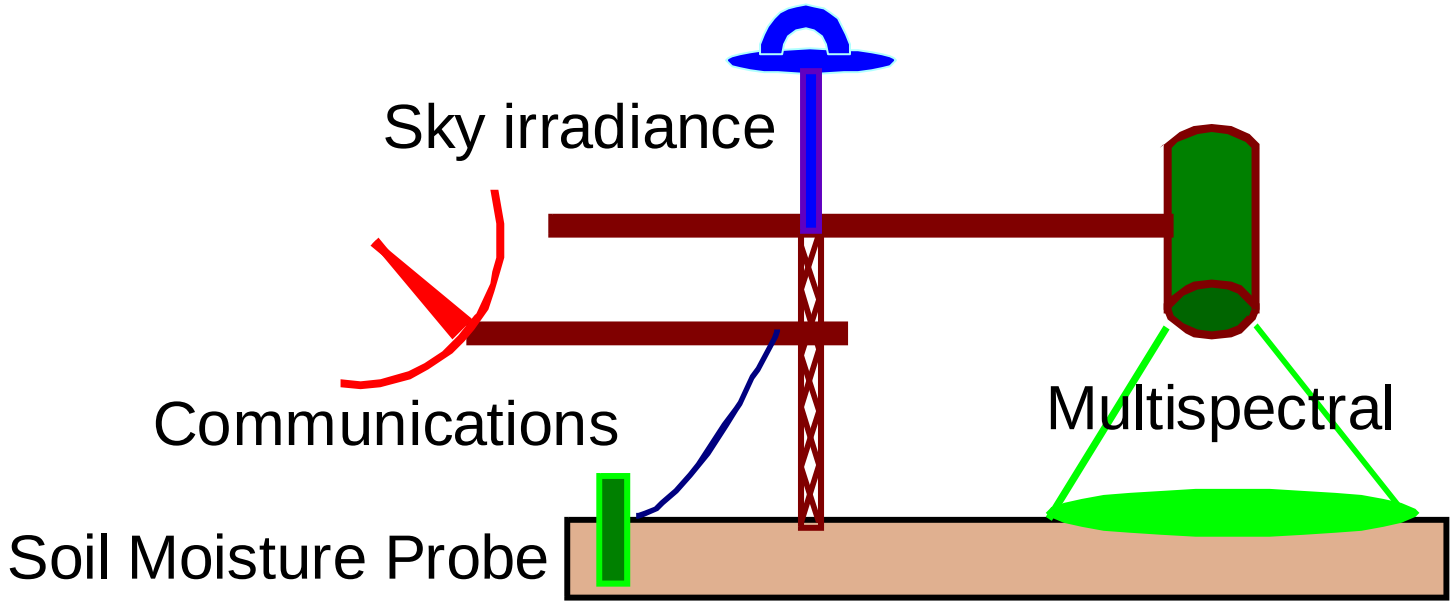
Original node approach was standalone with minimum measurements



Further scaled node

Many sites could omit the atmospheric aerosol measurements

- Sky irradiance still desired for reflectance retrieval
- Soil moisture probe replaces weather station



Minimal budget

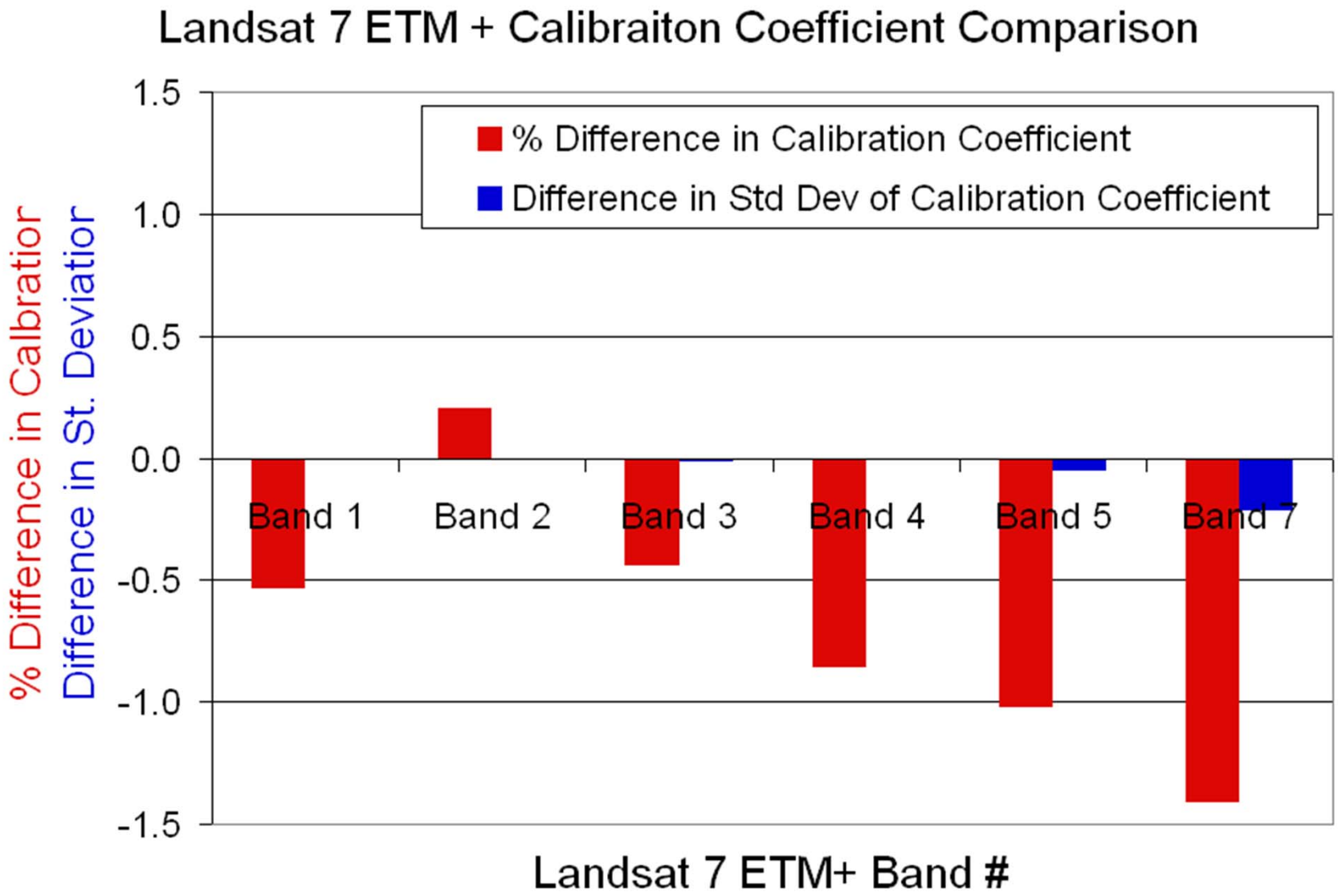
Costs for minimum set of measurements would be $50K

- Portable tower for deployment including costs to incorporate equipment $5K
- 2 Digital camera systems for sky and ground monitoring including remote operation setup $5K
- 1 Multispectral, sky irradiance monitor $15K
- 1 Multispectral ground monitor radiometer $15K
- Soil moisture probe and data logger $5K
- Power generation $5K

- Irradiance and ground monitor costs are optimistic based on custom builds – no commercial product is currently available

- **Data connectivity and year-to-year maintenance not included**

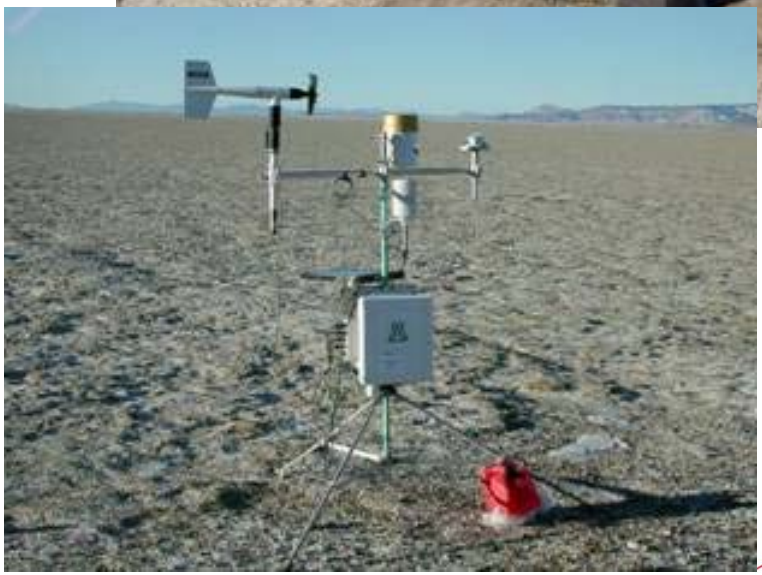
Impact of using average atmospheric conditions



Current instrumentation

Currently a suite of instruments to obtain atmospheric and surface information

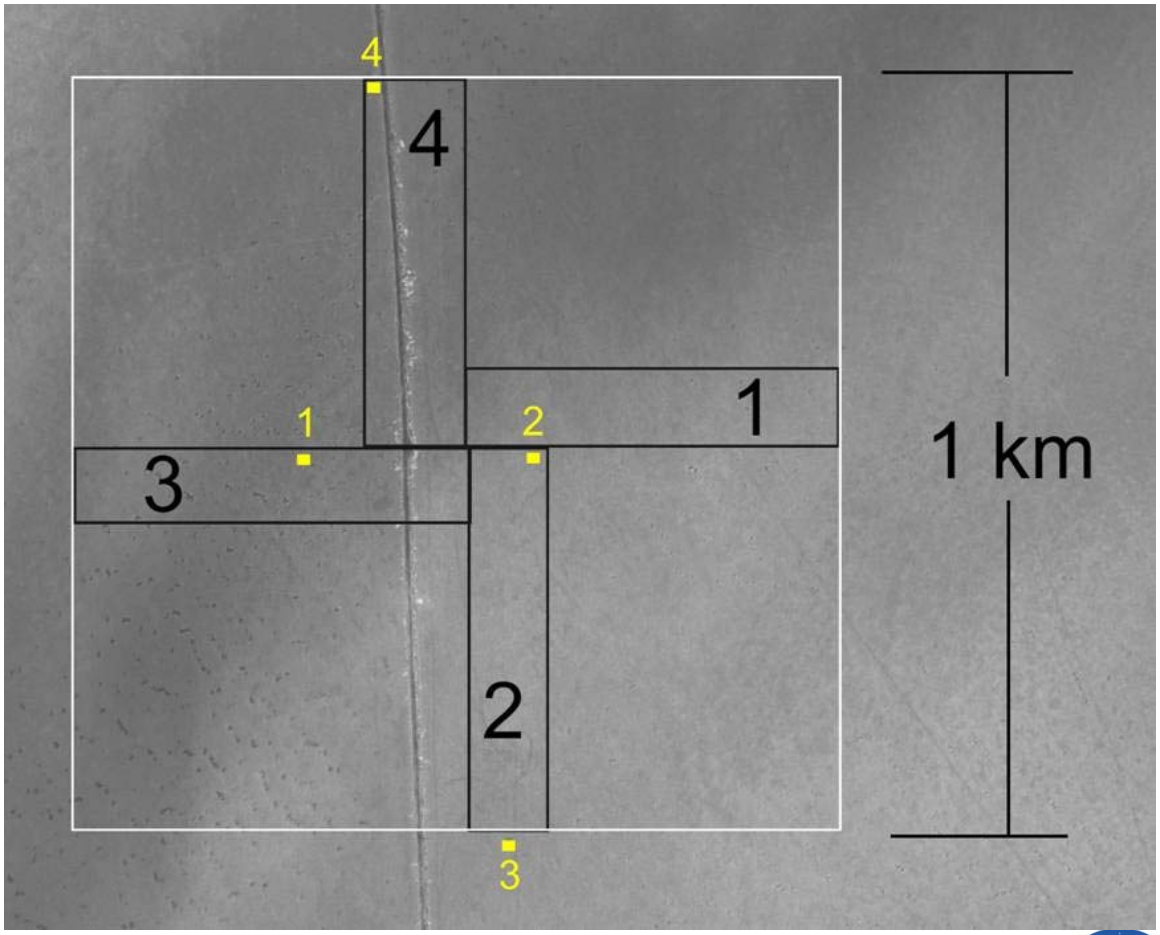
- Atmospheric data from Cimel sun photometer
  - Atmospheric optical depth
  - Angstrom exponent
  - Water vapor
- Weather information from meteorological station
  - Temperature
  - Pressure
  - Precipitation



Spatial sampling impact

A big issue with the large-footprint results is the number of spatial samples needed

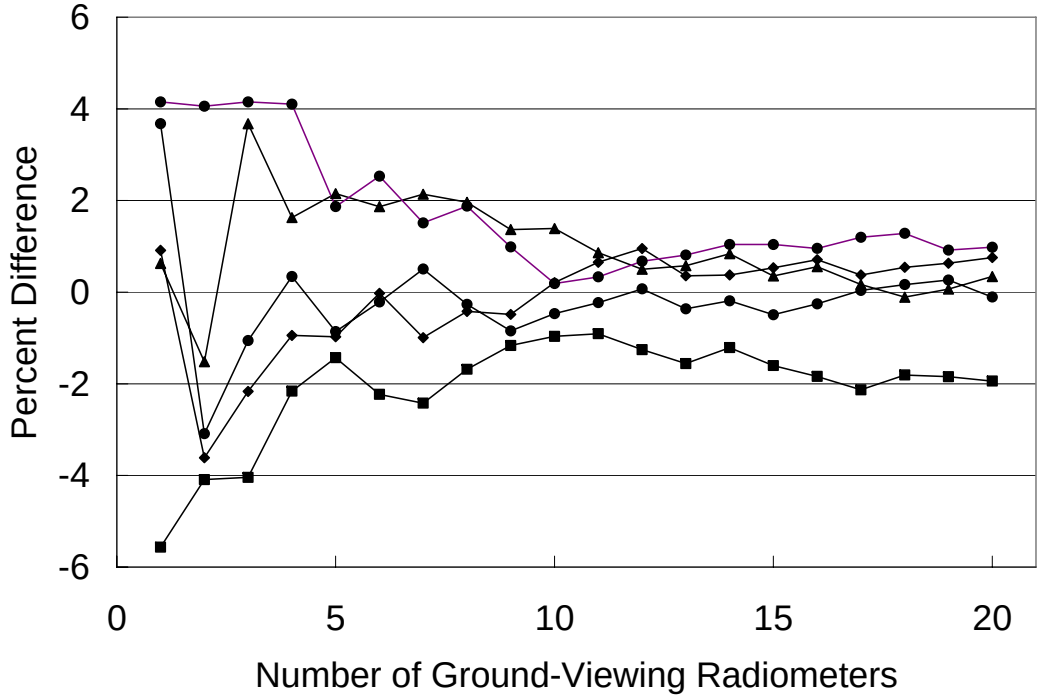
- Cost limited deployment of more radiometers
- Use of high-resolution imagery can assess number of radiometers needed
- Single scene evaluated at this point



Optimal radiometer number

Vary number of radiometer locations from 1 to 20

- Randomly selected pixel agrees with entire site to better than 10%
- Four radiometers produces the same uncertainty as 20 radiometers
- Evaluation only examined the panchromatic band
- Further work with more scenes and multispectral data



Summary

Automated ground measurement approaches are a useful means for radiometric calibration

- Groups have also succeeded in developing sites
  - Stennis Space Center facility
  - JPL facility at Lake Tahoe and Frenchman Flat
  - UofA at RRV Playa
  - High and low spatial resolution
  - BRDF correction
- Vicarious calibration data can be collected at the convenience of the sensor scheduler
- Allows intercomparisons between sensors without need for coincident data collections
- Costs are driven by desired level of site understanding and year-to-year maintenance