Summary of the Skywatch Suite of Instruments

http://skywatch.colorado.edu/

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Introduction

The **Skywatch** suite is composed of radiation/remote sensing instruments and precipitation instruments located on the roof of the Duane Physics building. Two broadband **Radiometers** measure downwelling solar and infrared radiation that is sensitive to clouds, aerosols, and water vapor. A **Ceilometer** determines cloud base altitude and the boundary layer height. A **Sun Photometer** measures the directly transmitted solar irradiance in narrow spectral bands which can be used to determine aerosol loading. A **Solar Spectral Flux Radiometer** measured hyperspectral radiance and irradiance, complementary to the broadband radiation measurements. It will be operated in two modes: zenith pointing and sky-scanning to derive aerosol properties.

The **Disdrometer** is the instrument of choice for the in situ measurement of drop size distributions, while the **Micro-Rain Radar** is used as the remote sensing profiler. The **Rain Gauge** is the absolute rain amount detector.

Purpose

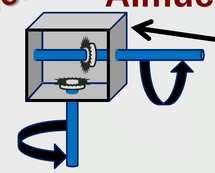
- **Teaching tool** for undergraduates and graduates alike.
- Information source for present weather and sky conditions
- Cloud/aerosol/precipitation remote sensing.
- **Develop** novel instrumentation and **retrieval** methods for **aerosol optical thickness**, **size**, and **composition** using hyperspectral radiance
- Integration and merging of data from multiple instruments

My Research Goals:

Using: Solar Spectral Flux Radiometers

- Dual head, hyperspectral full hemispheric radiometer
- Wavelengths range from 300 to 1700 nm
  - Si and InGaAs solid state Linear diode array
  - 9 to 12 nm resolution
  - 366 mm^{-1} and 179 mm^{-1} flat field grating

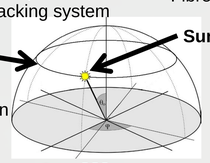
Develop: Almucantar Tracking System



Development of 2-axis tracking system
- **Construct** active sun-tracking method with 4-quadrant photodiode
- Test and calibrate Tracking system

Fibre optics Heads

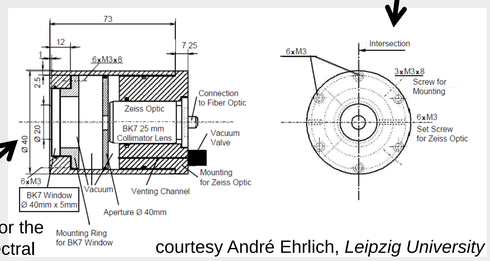
Solar Almucantar



Uses:
- Aerosol optical thickness determination
- Hyperspectral abilities for aerosol size distribution
- Possible particle shape determination by use of polarization

Narrow field of View Collimator

- Construction of a narrow field of view fore optics
- Will give a factor of 10^6 stray light rejection
- Change SSFR from hemispheric irradiance detector to **radiance** measurements
- Use in **CALNEX** for spring of 2010



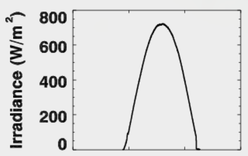
- **Potential design** for the collimating hyperspectral fore optic

courtesy André Ehrlich, *Leipzig University*

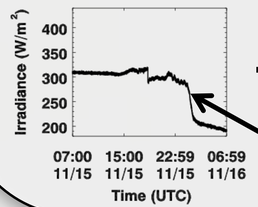
Current Instruments

Radiometers

Pyranometer Irradiance for 10/17/09 to 10/18/09



Pyrgeometer Irradiance for 11/15/09 to 11/16/09



Pyranometer

- Broadband Shortwave Irradiance (310 to 2800 nm)

← Clear sky on 10/17 to 10/18 Irradiance only depends on sun angle

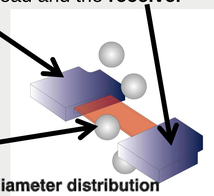
Pyrgeometer

- Longwave Irradiance (4.5 μm to 42 μm)

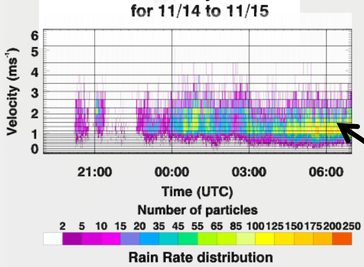
Overcast to clear on 11/15 to 11/16

Disdrometer

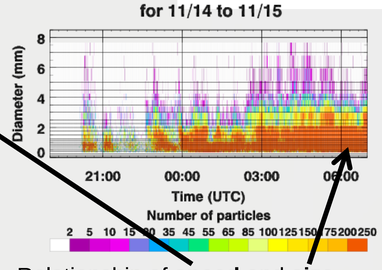
- Active 2D laser beam sensing
- **Hydrometeor** detection by shadow size
  - particle partially blocks the laser path, between the **emitter** head and the **receiver** head.
- Hydrometeor speed detection by amount of time blocking the laser beam



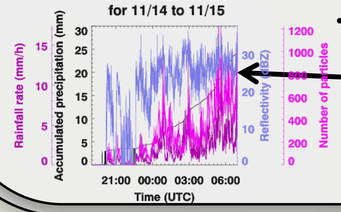
Particle Velocity distribution for 11/14 to 11/15



Particle diameter distribution for 11/14 to 11/15



Rain Rate distribution for 11/14 to 11/15

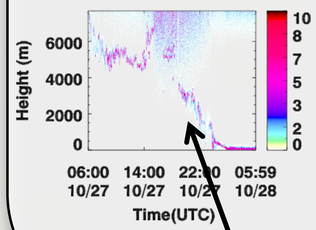


- Relationship of **speed** and **size**, gives the **rain rate**(R), and the **Radar Reflectivity**(Z), can be used to find the correct Z-R relationship

Ceilometer

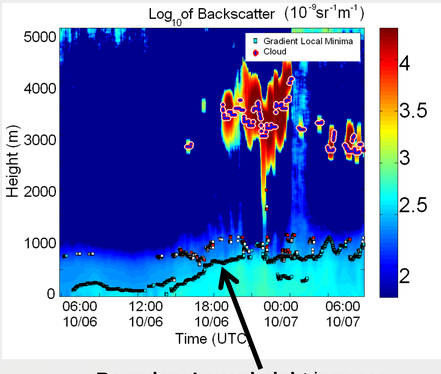
- Active cloud base height sensing system
- LIDAR-like mode (905nm wavelength laser)
- Determines up to 3 cloud base heights
- Measures backscatter from cloud droplets
- Atmospheric Boundary layer determination
  - Using the minimum negative gradient of the backscatter to determine the boundary layer height

Ceilometer Reflectivity for 10/27/09 to 10/28/09



Cloud base descends with rain event

Log_{10} of Backscatter ($10^{-9} sr^{-1} m^{-1}$)

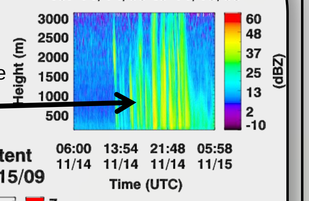


Boundary Layer height increase with daytime heating

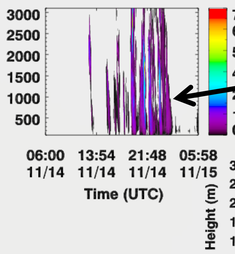
Micro Rain Radar

- Zenith pointing Doppler radar (24.1 GHz)
- **Reflectivity** and Velocity gives the drop size distribution

Reflectivity for 11/14/09 to 11/15/09

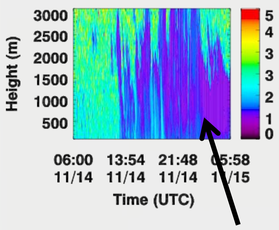


Liquid Water Content for 11/14/09 to 11/15/09



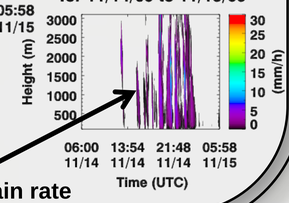
- **Liquid water content** determination

Fall Velocity for 11/14/09 to 11/15/09



- Particle **Fall Velocity** determination (64 doppler frequency bins)

Rain Rate for 11/14/09 to 11/15/09



- Profiling **rain rate**

Future Instruments

Rain Gauge

- Weighing system measures total liquid water content of precipitation
- Automated absolute amount measurements
- Antifreeze combination for subzero temperatures

Sun Photometer

- Passive sun-tracking system
- Grating spectrometer with 2048 channel Si CCD
- 350 – 1050 nm Wavelength range
- Will help determine atmospheric aerosol loading
- 1° degree half angle field of view

References

- Löffler-Mang, M., and J. Joss, 2000:*An optical disdrometer for measuring size and velocity of hydrometeors*. J. Atmos.Ocean. Tech., vol.17, pp.130-139.
- Kurt Nemeth and Martin Löffler-Mang, 2006: *OTT PARSIVEL® - Enhanced Precipitation Identifier for present Weather, Drop Size Distribution and Radar Reflectivity,* OTT MESSTECHNIK GmbH & Co. KG
- Jacqueline Gordon, 1985:*New Uses for the Solar Almucantar,* Applied optics, vol.24, No. 20, pp.3381-3389

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