Best Practices for Choosing & Siting Weather Equipment

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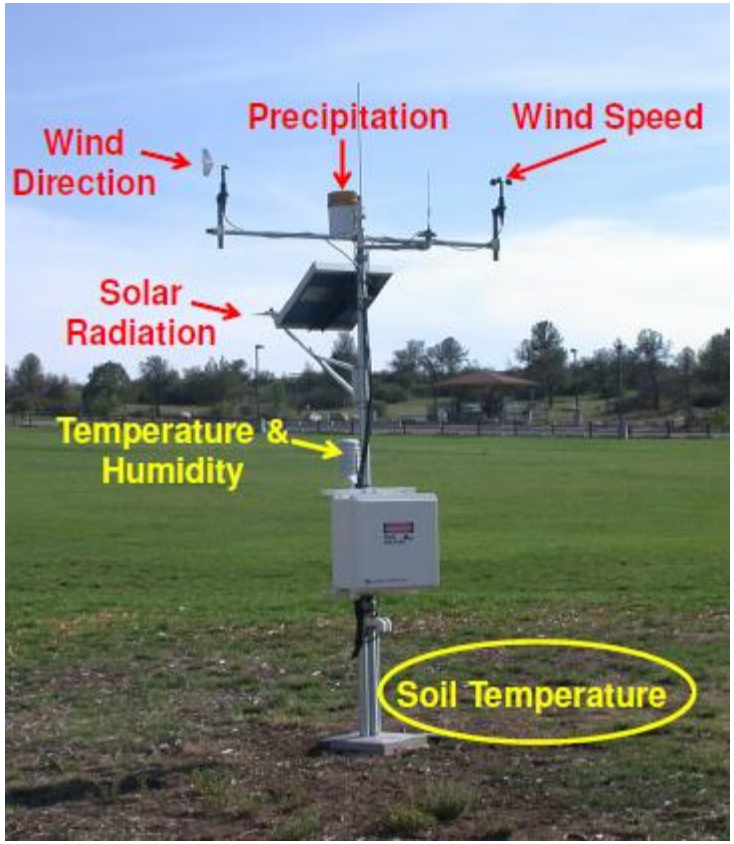
Topics

- General Review of Meteorological Sensors (Ag)
- Automated Weather Stations
- General Siting Recommendations
- Maintenance (If Time Allows)

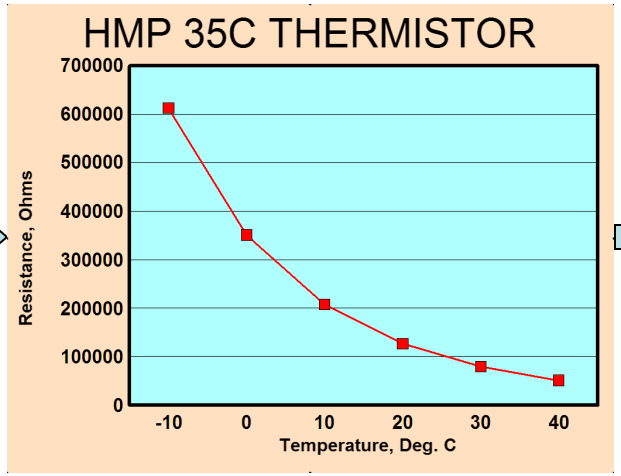
Meteorological Sensors
Agriculture

- Temperature
  - Air & Soil
- Humidity
  - Relative, Dew Point, Wetbulb
- Wind
  - Speed & Direction
- Solar Radiation (ET)
- Precipitation



Temperature (Thermometer)

Thermistors: Measure Air & Soil Temperature



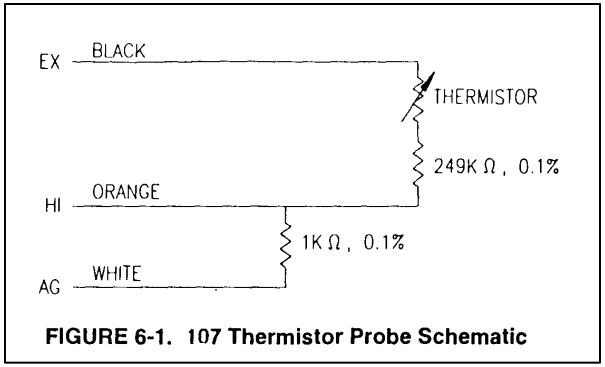
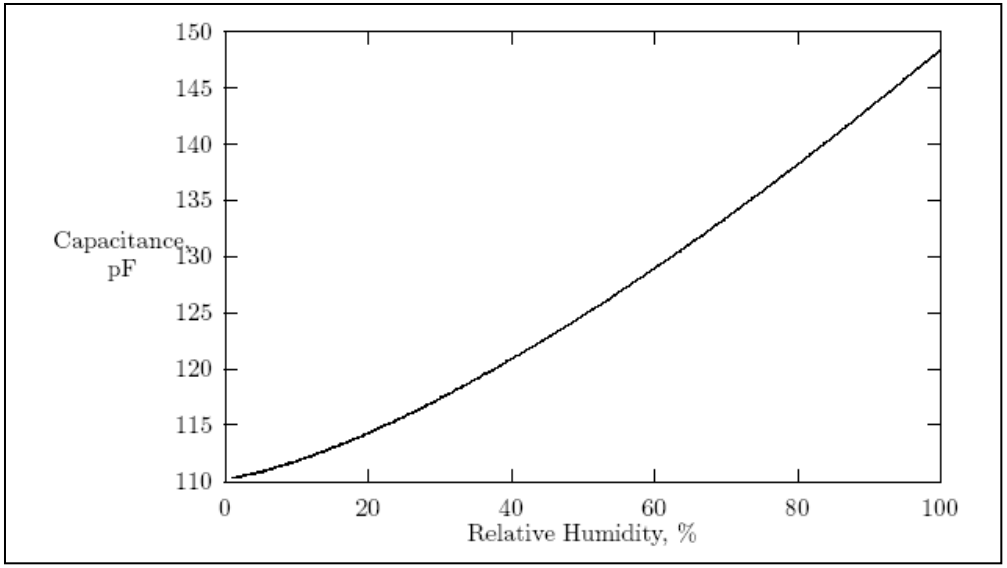


FIGURE 6-1. 107 Thermistor Probe Schematic

Thermistors are temperature sensitive electrical resistors. They are typically placed in a simple half bridge electrical circuit. As the temperature changes, the voltage drop across the thermistor changes and is measured by a data logger or voltmeter.

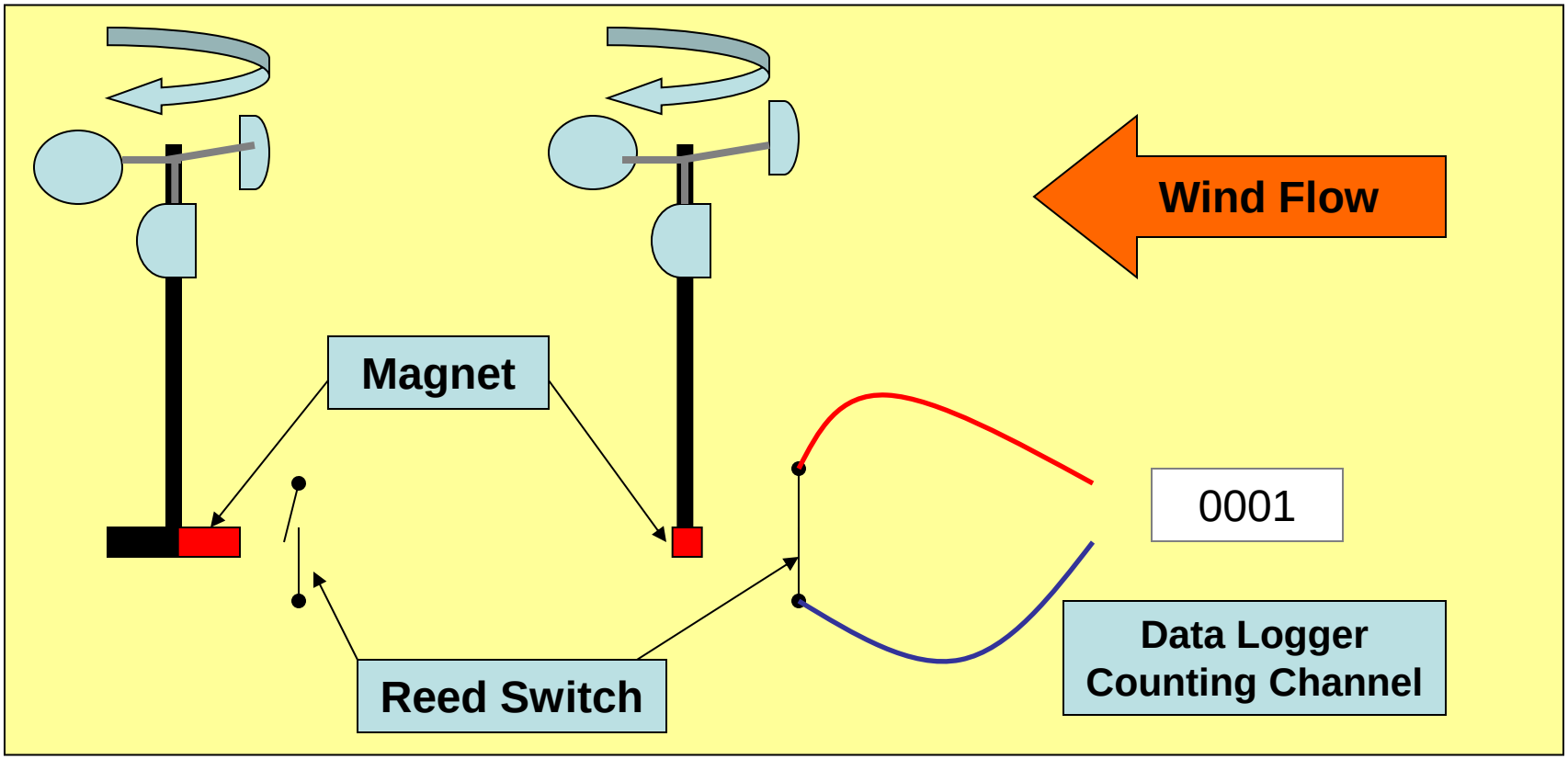
Relative Humidity (Hygrometer)

Preferred: Thin Film Capacitance Sensor



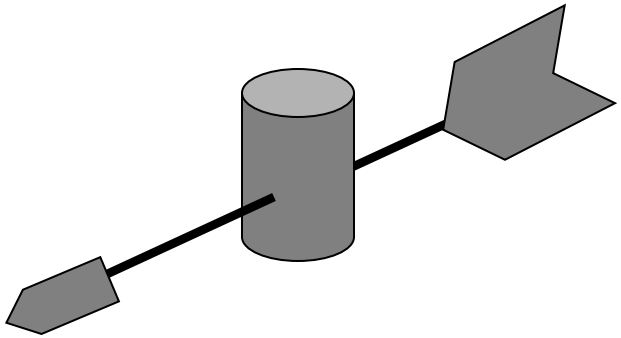
Electrical Capacitance of Sensor Changes With Humidity. When Sensor Is Installed In Proper Electrical Circuit, Voltage Output of Sensor Changes Linearly With Humidity. The Voltage Is Measured With The Data Logger

Wind Speed (Anemometer)

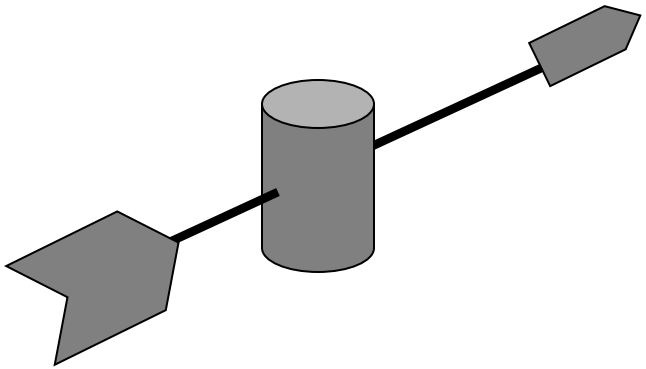


Wind rotates cups and attached magnet which is located adjacent to a reed switch. The rotating magnet opens and closes the switch. The data logger counts the number of switch closures over a defined period of time.

Wind Direction (Wind Vane)

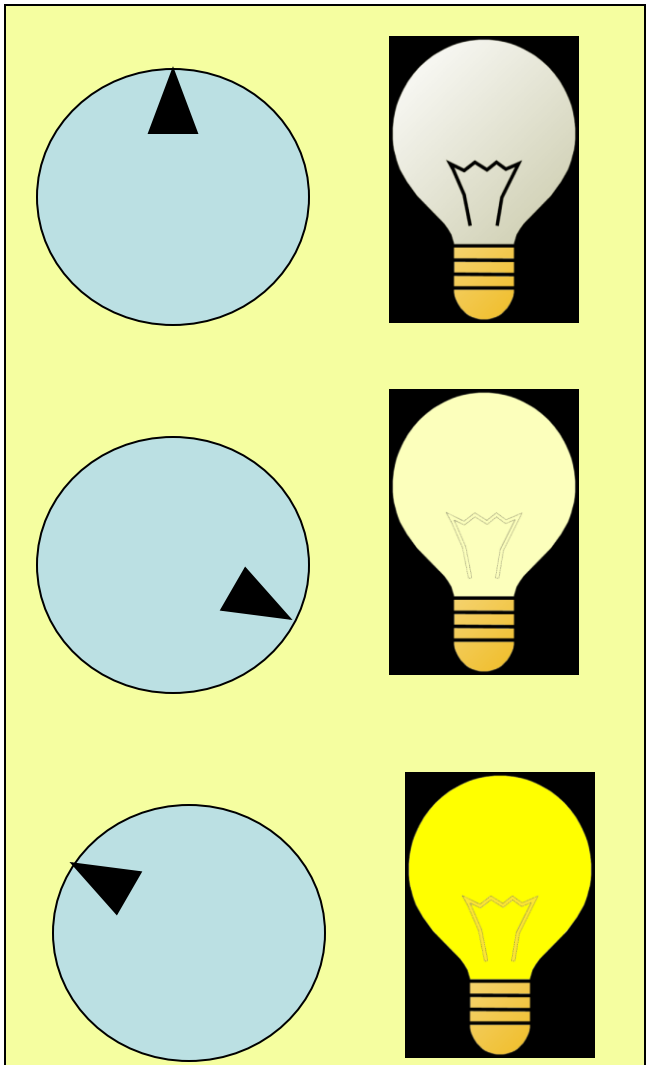


NE Wind (45º):
Low Resistance



SW Wind (225º):
High Resistance

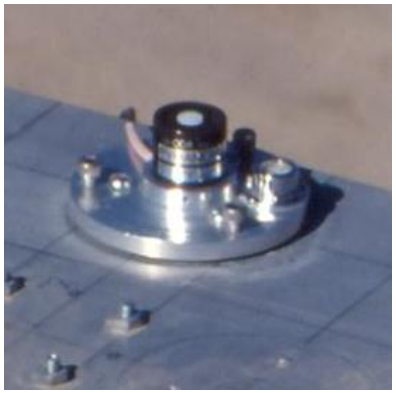
Vane attached to variable resistor (potentiometer) rotates as direction changes, causing change in electrical resistance in a simple voltage divider circuit. Output voltage varies with wind direction & is measured by data logger.

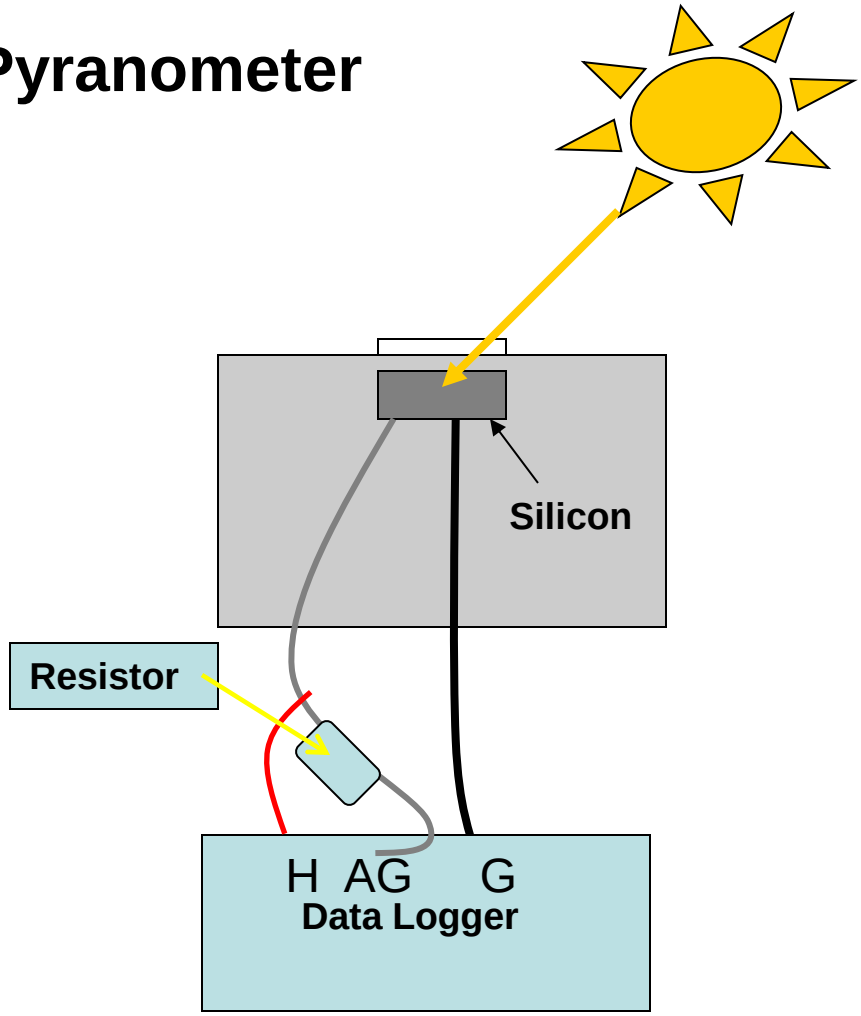


Light Dimmer Switch

Solar Radiation (Pyranometer)

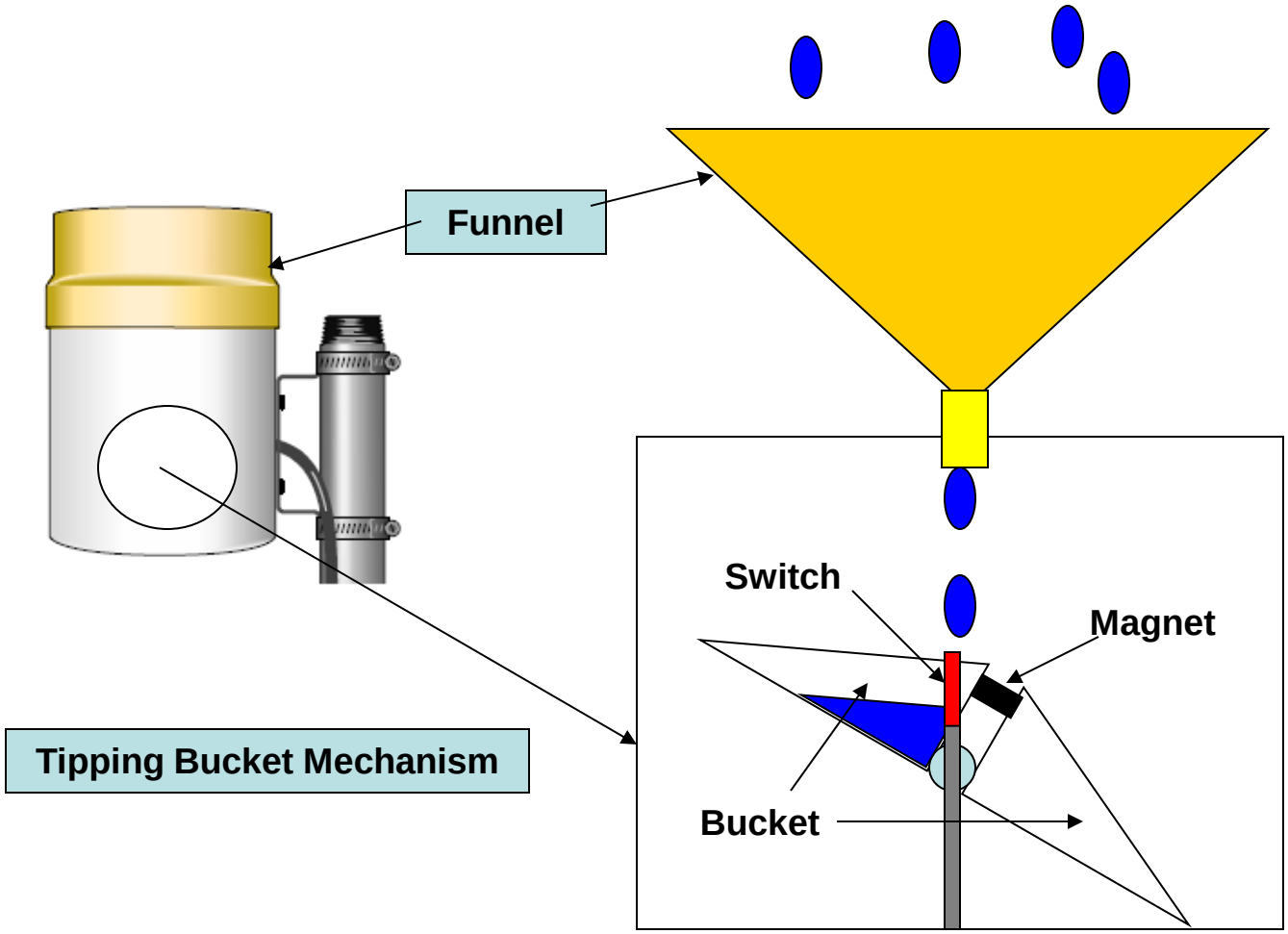
Silicon Cell Pyranometer





Silicon cell converts solar energy into an electrical current. The current is forced across a resistor to generate a voltage drop which is measured by the data logger.

Precipitation (Rain Gauge)



Funnel directs rainfall into tipping bucket mechanism. When one bucket accumulates 0.01" of water, the mechanism tips which causes the magnet to trip a small switch. This switch closure is counted by the data logger as 0.01" of precipitation.

What Equipment Do I Need?

- General Climate Monitoring
    - Temperature & Precipitation
- Frost Management/Monitoring
    - Temperature, Humidity, Wind Speed
    - 2nd Temperature (Inversion Assessment)
- Irrigation Management (ET)
    - Temperature, Humidity, Wind Speed & Solar Radiation

What Equipment Do I Need?

- **Livestock Stress**
  - **Temperature & Humidity**
  - **Wind & Solar Radiation**
    - **More modern stress indices**

- **Insurance**
  - **Temperature, Precipitation, Wind Speed, Hail!!**

Automated Weather Stations

- Data Logger
  - Monitors Sensors
    - How Frequently Are Sensors Scanned (Read)
      - » Impacts Accuracy of High Frequency Events
      - » Peak Wind Gust
  - Often Makes Calculations
    - Dew Point, Degree-Days, ET
    - User Entered Calculations?
  - Stores Data
    - Storage Memory Can Be Important
  - Can Initiate Data Transfer To Base Computer
    - Alarms

Automated Weather Stations

- Telecommunications
  - Hardwire
    - Must connect station to computer with cable
  - Wireless
    - Short Distance RF Transfer
      - ~1000’
      - Line of Site
      - Signal Degraded by Wall/Humidity
  - Cell Phones
    - Machine to Machine Service
    - Verizon, ATT, Etc

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Automated Weather Stations

- Data Management
  - Data Storage
    - More Sensors & Higher Collection Frequency
      - » Equals More Data & Increased Storage Requirements
    - Local Weather Database
    - Format & Ability to Export Data
    - Backup Plan
  - Transfer to Internet
    - Expands Access
      - » NWS
      - » Neighbors

Automated Weather Stations

- Power Supply
  - AC Power
    - Limits Siting Flexibility
    - Power Line to Station
  - DC Power
    - Solar Panels
    - Voltage Regulator
    - Battery for Night Operation
    - Some Maintenance
    - Added Costs
    - Reliable

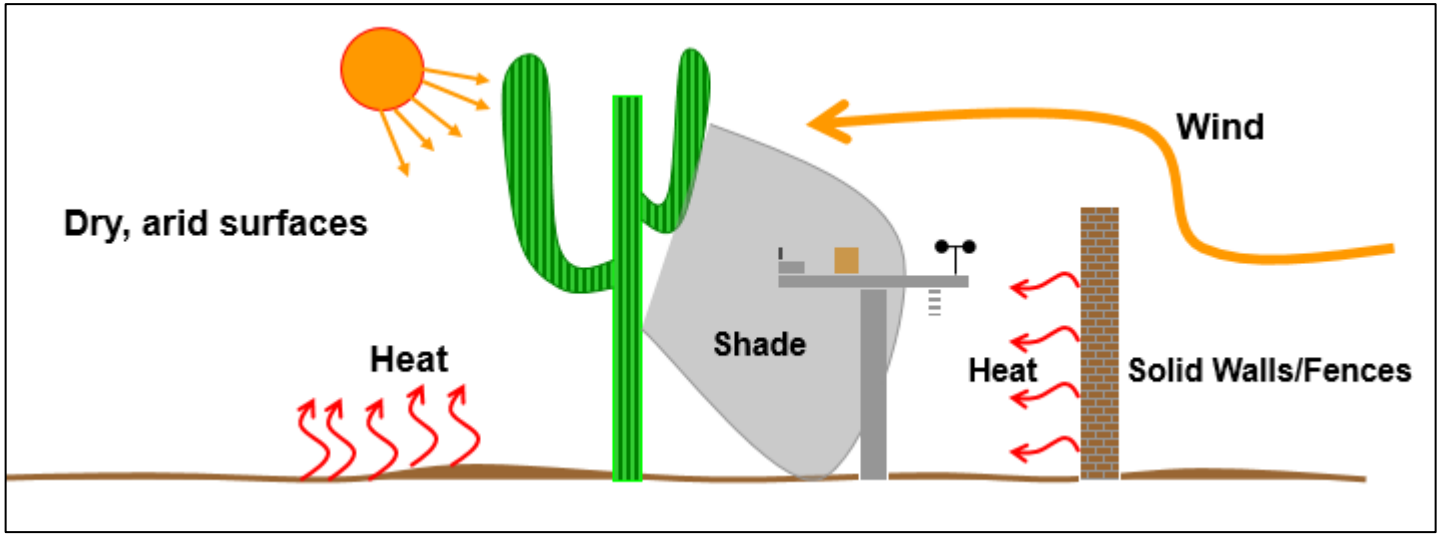
Siting Weather Stations

For Climate & General Weather Monitoring

- **General Recommendation**
  - **Open Areas With Relatively Short Vegetation**
  - **Representative Of Area Of Interest**

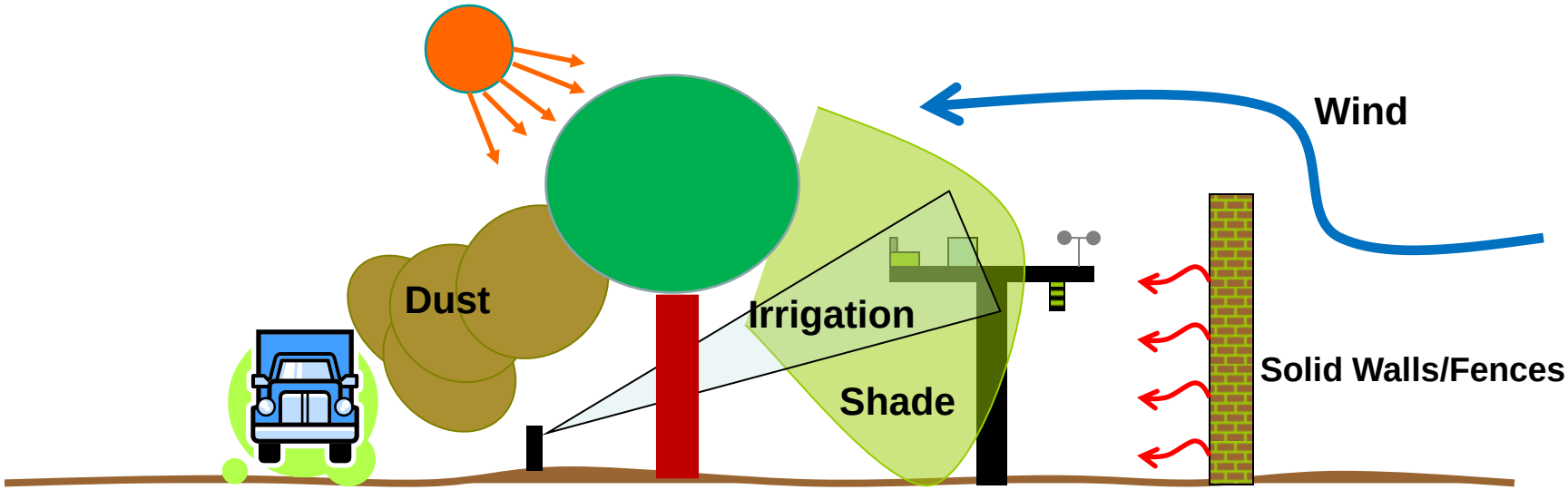
- **Avoid:**
  - large industrial heat sources
  - rooftops
  - steep slopes
  - sheltered hollows
  - high vegetation
  - shaded areas
  - swamps
  - areas where snow drifts occur
  - low places holding standing water after rains

Where You Measure Matters



- **Elevation Above Ground**
- **Underlying Surface**
- **Nearby Obstructions**

Common Siting Problems



Adjacent roads/parking lots generate dust, heat & potential for vandalism.

Shade reduces level of soil radiation measured.

Solid walls & fences reduce wind speed and generate heat.

Irrigation produces higher humidity, cooler temperatures and false rain events.

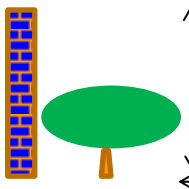
Nearby Obstructions

Obstructions disrupt flow and can generate microclimates

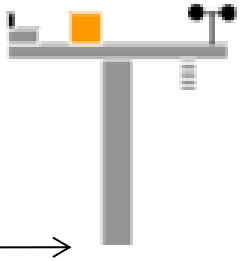
Large Obstructions

Separation: 7-10x Height

Small Obstructions



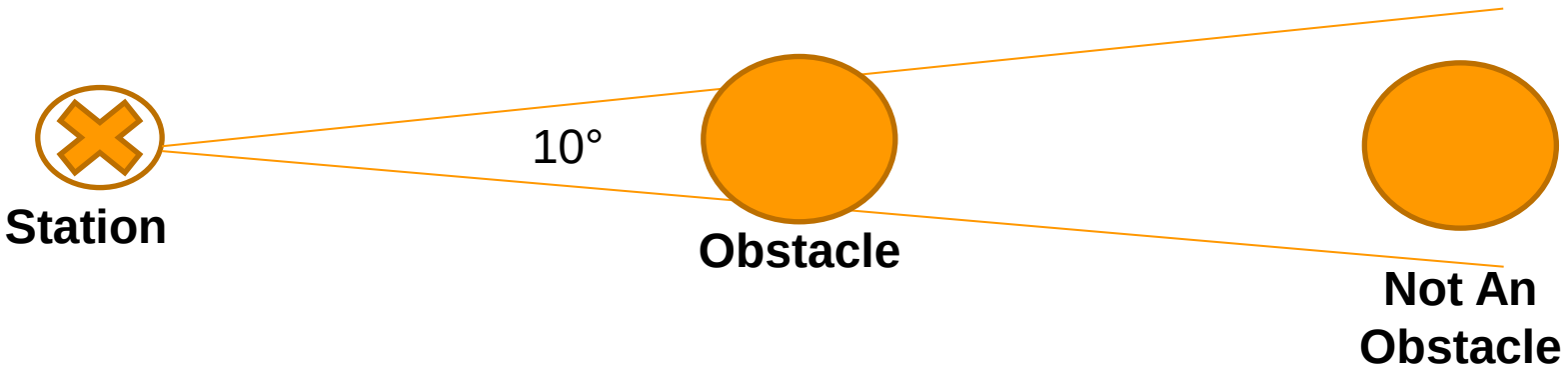
Height



Separation: 3-5x Height

NWS Obstacle Definition

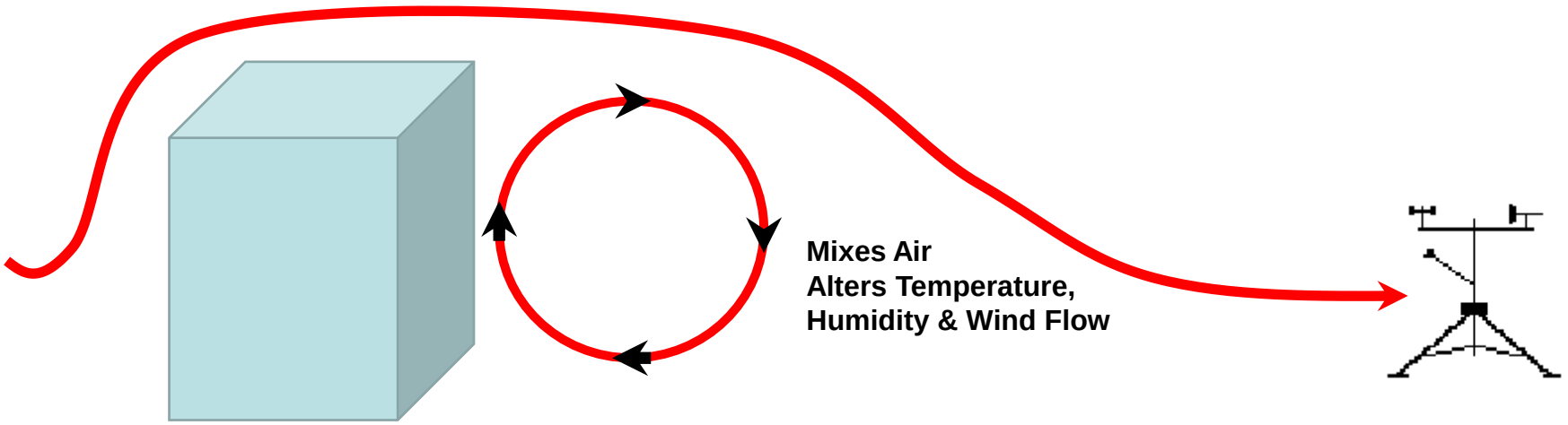
Greater Than10° Horizontal Arc



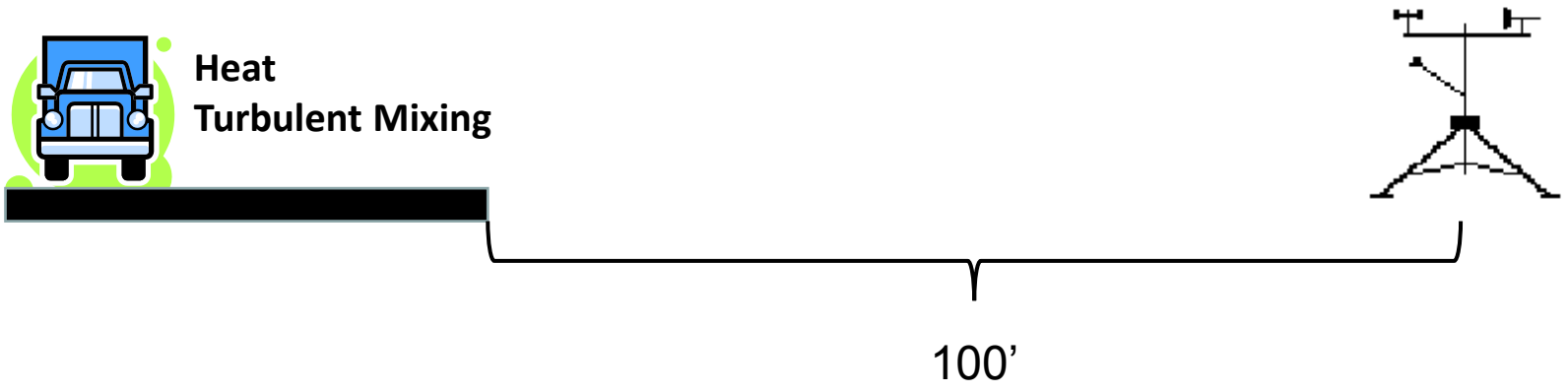
Plan View (Looking Down)

Reason for Separation Distance

Allows Wind, Temperature & Humidity to Readjust to Surface

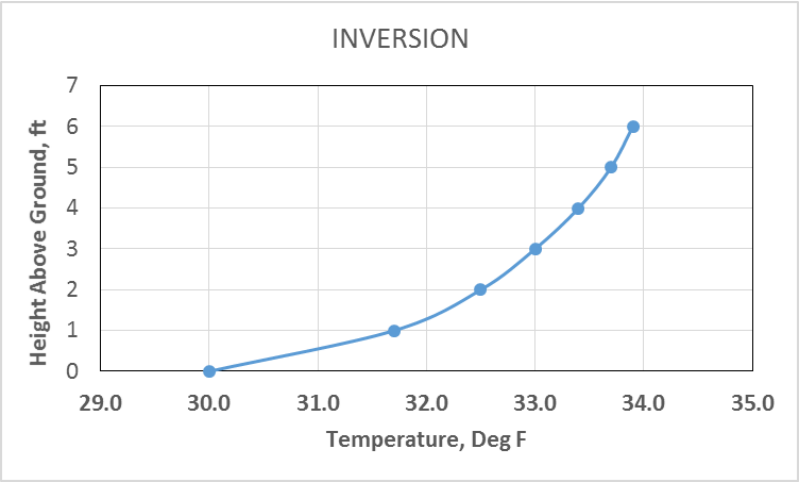


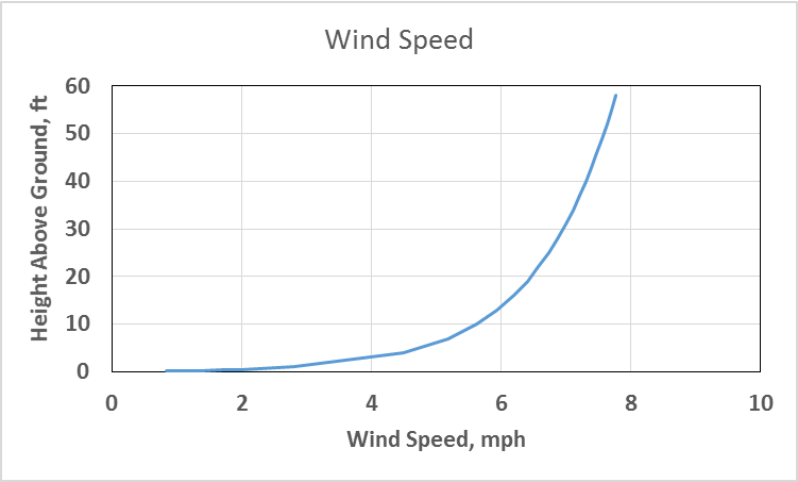
Separation From Concrete/Paved Roads



Heat from concrete/asphalt can be advected downwind to station. Passing vehicles create turbulence and create effects similar to wind machines

Height Above Surface





Meteorological parameters often change quickly over short distances near the surface.

Sensor Heights

National Weather Service

- **Air Temperature**
  - **4-6’ Above Surface**
    - **Use 5’ If Possible**
    - **Use 6’6” (2m) if Computing ET**
- **Relative Humidity**
  - **Co-Located With Air Temperature**
    - **Better Computation of Dew Point & Wet Bulb**

Sensor Heights

National Weather Service

- **Wind Speed & Direction**
  - **NWS: 30-33’ Above Surface**
    - **Difficult to Install and Maintain**
  - **Agricultural Recommendations**
    - **6’6” (2m) Especially for ET**
    - **10’ (3m) Better for Tall Vegetation Areas**
  - **Co-Locate Anemometer & Wind Vane**

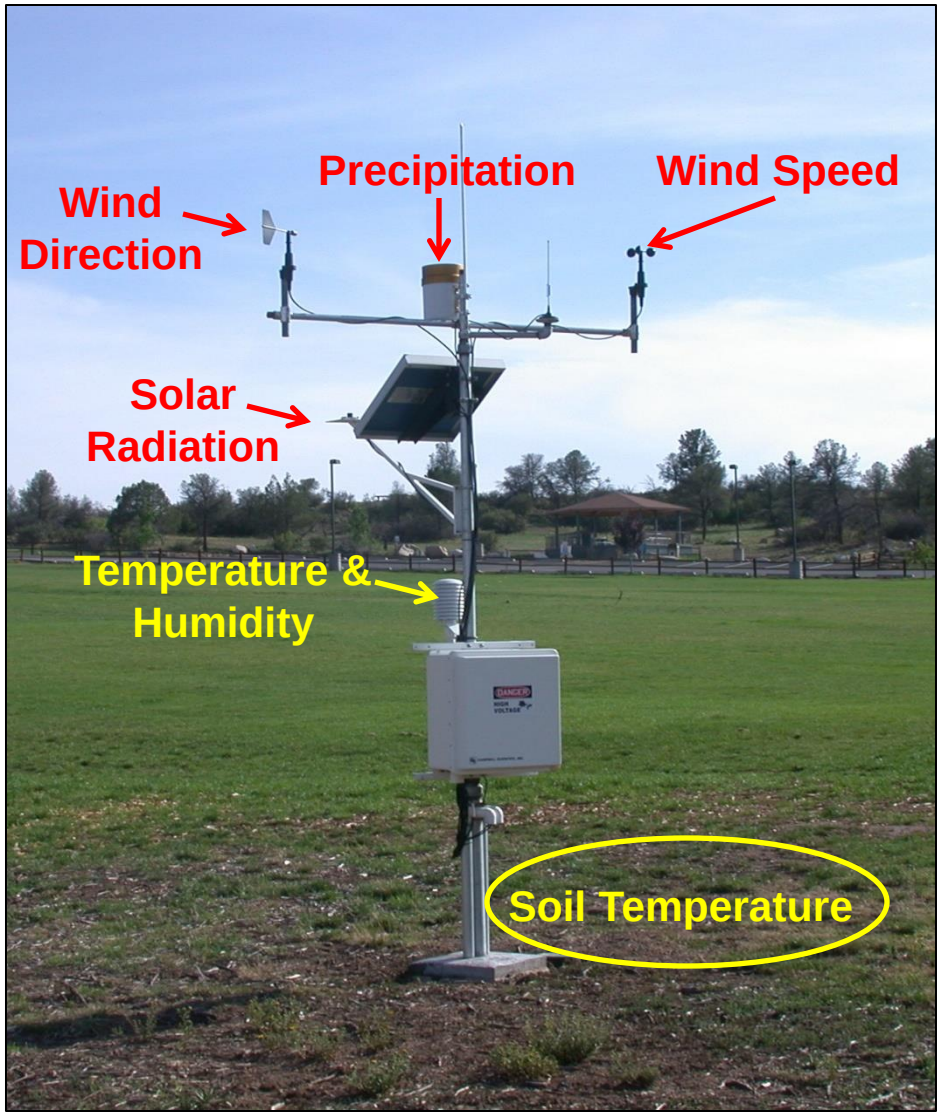
Sensor Heights

National Weather Service

- **Precipitation**
  - 3-5’ Above Surface (Higher in Deep Snow Areas)
    - Close to Ground as Possible
      - Higher Installation Under Report Precipitation
    - Avoid Tall Adjacent Obstacle that can Block Rain
- **Solar Radiation**
  - Any height that avoids shading
    - Adjacent obstacles

More Expensive Stations

Increased Flexibility in Siting



Lower Cost Stations

Less Flexibility on Sensor Height

- **Weather/Climate Stations**
  - Install Temperature at 5’ Above Surface
- **ET Stations**
  - Install Anemometer at 6’6” (2m)
  - Over/Downwind of Green Vegetation

What About In-Field Monitoring?

- **Great Idea for Farm/Crop Management**
  - **Frost Management/Damage Assessment**
  - **Crop Development Models/Projections**
  - **Pest Management**
  - **ET??**
- **Less Optimal For Climate Monitoring/Forecasting**
  - **Climate & Forecasting Datasets**
    - **Assume Open Sites**
  - **Seasonal Vegetation Changes & Nearby Obstacles**
    - **Impact Wind, Temperature, Humidity**

ET Stations

- Ideal World
  - Over or Downwind of Short Green Reference Crop
    - Pasture or Alfalfa Preferred
- Reality/Best Option
  - Over Surface With Short Vegetation (<1.5')
  - Away From Obstacles Impacting Wind Flow
  - Near Production Areas of Interest
- Poor Sites May Require Aridity Adjustments
  - Hot, Dry Isolated Locations May Overestimate ET

REFERENCE EVAPOTRANSPIRATION

Atmospheric or Evaporative Demand

Penman or Penman Monteith Equation

Weather Data

Evaporative Demand

CROP COEFFICIENTS

Converts ETo to Crop Water Use

Crop

Coefficient

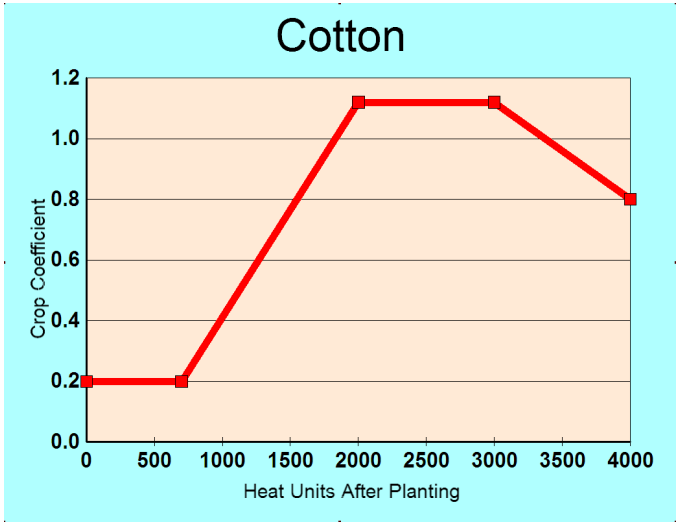
Reference ET

Vegetation or Crop ET

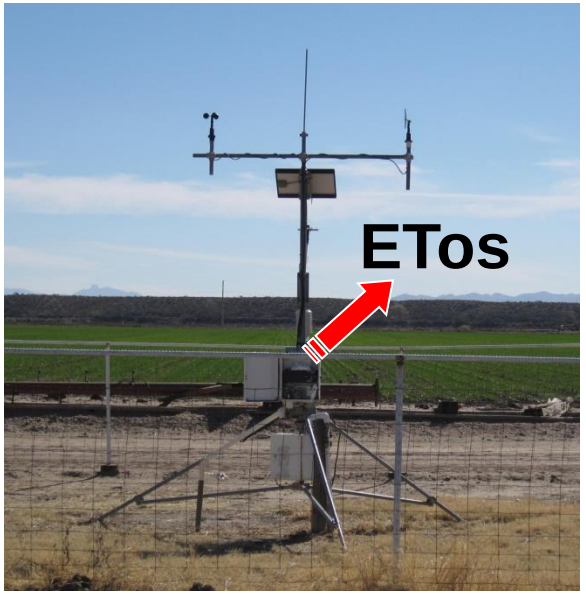
ESTIMATING CROP ET (ETc)

ETc = Kc x ETos

ETc =

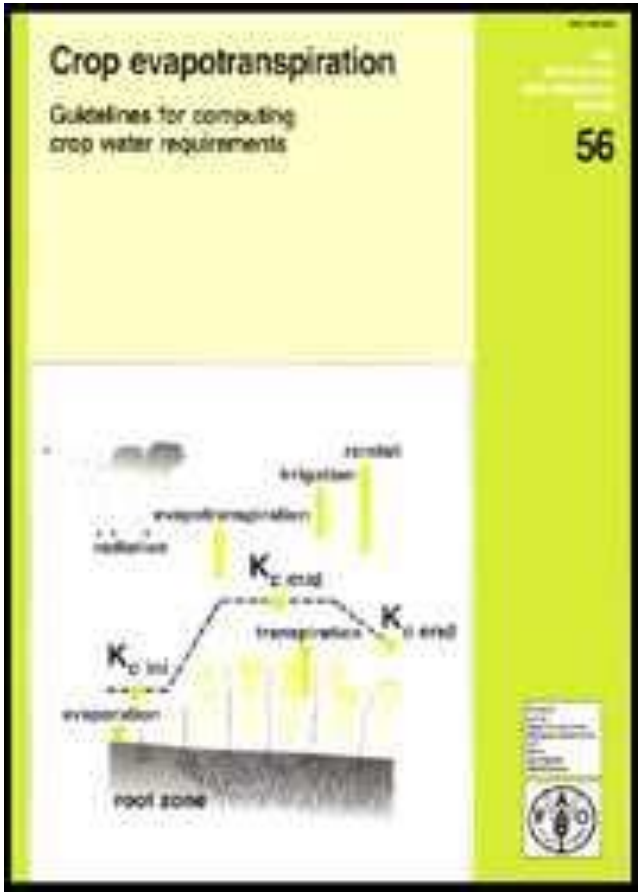


X

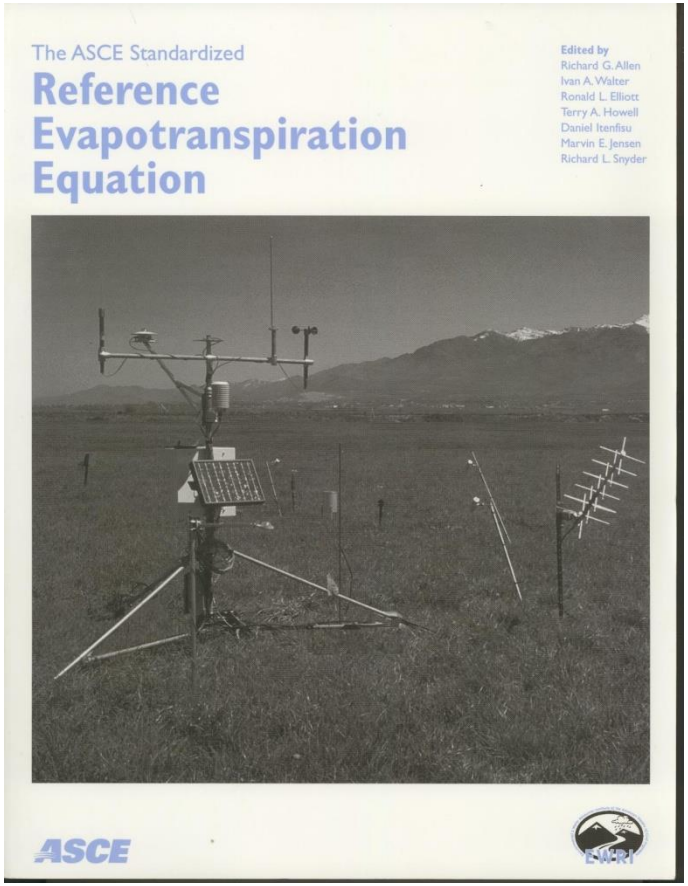


REFERENCE ET

Use A Recommended Computation Procedure!!!



International Standard



U.S. Standard

What Type of Equipment Should You Buy?

- Government Agencies
  - Don’t Make Recommendations
- We Plan To Purchase & Run Several Popular Package Systems
  - Compare Performance
  - Ease of Use
  - Communications
  - Computed Variables
- Report Back To You Next Winter
  - Pros & Cons