Title: Improved Temperature Control for Measuring the Humidity Dependence of Aerosol Optical Properties

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Improved Temperature Control for Measuring the Humidity Dependence of Aerosol Optical Properties

EES14 - ACES
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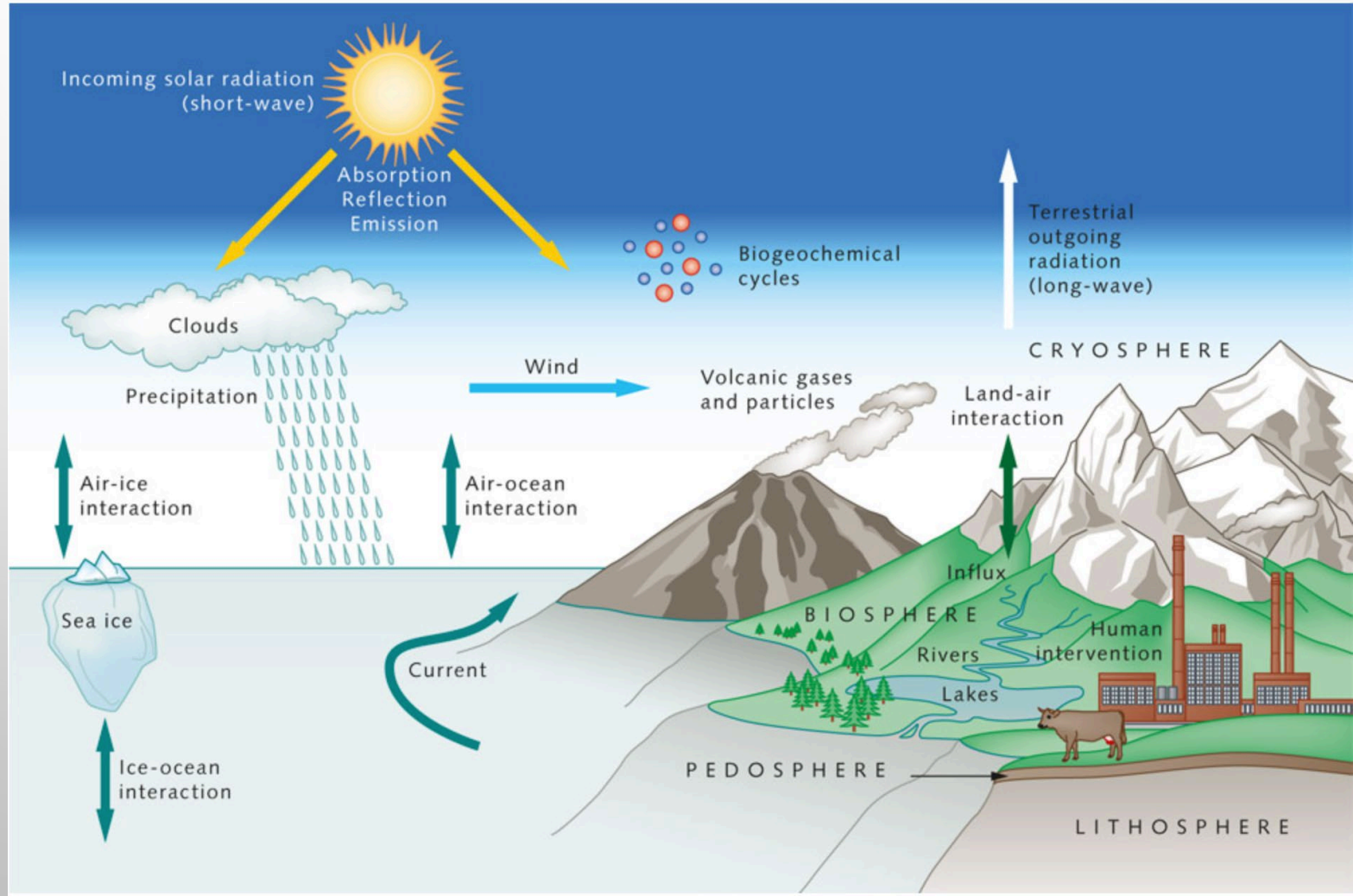
Importance of Measuring Optical Properties of Humidified Aerosols

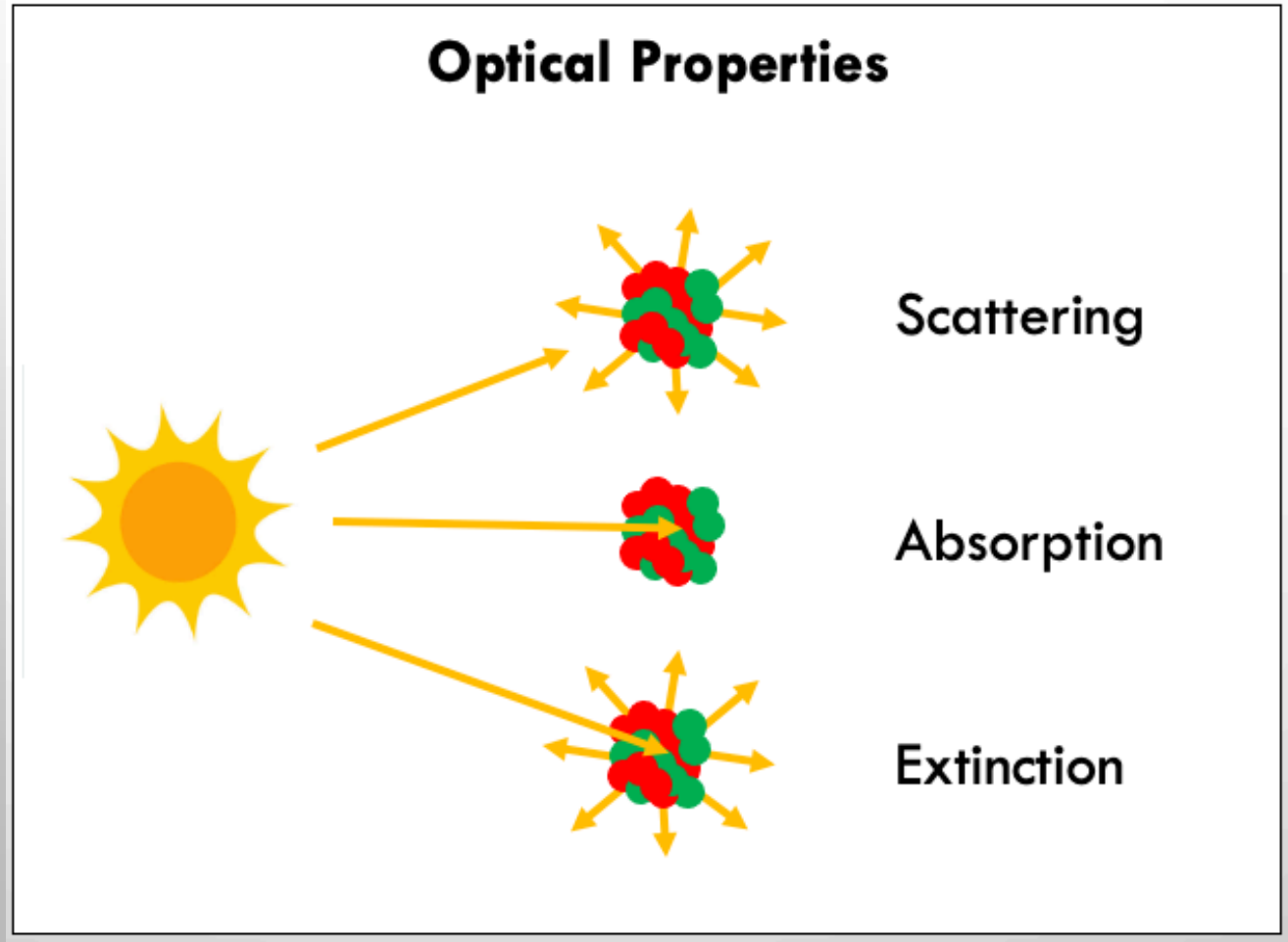
- **Climate Modeling** – quantitative methods to simulate interactions of the important drivers of climate, including atmosphere, oceans, land surface, and ice.

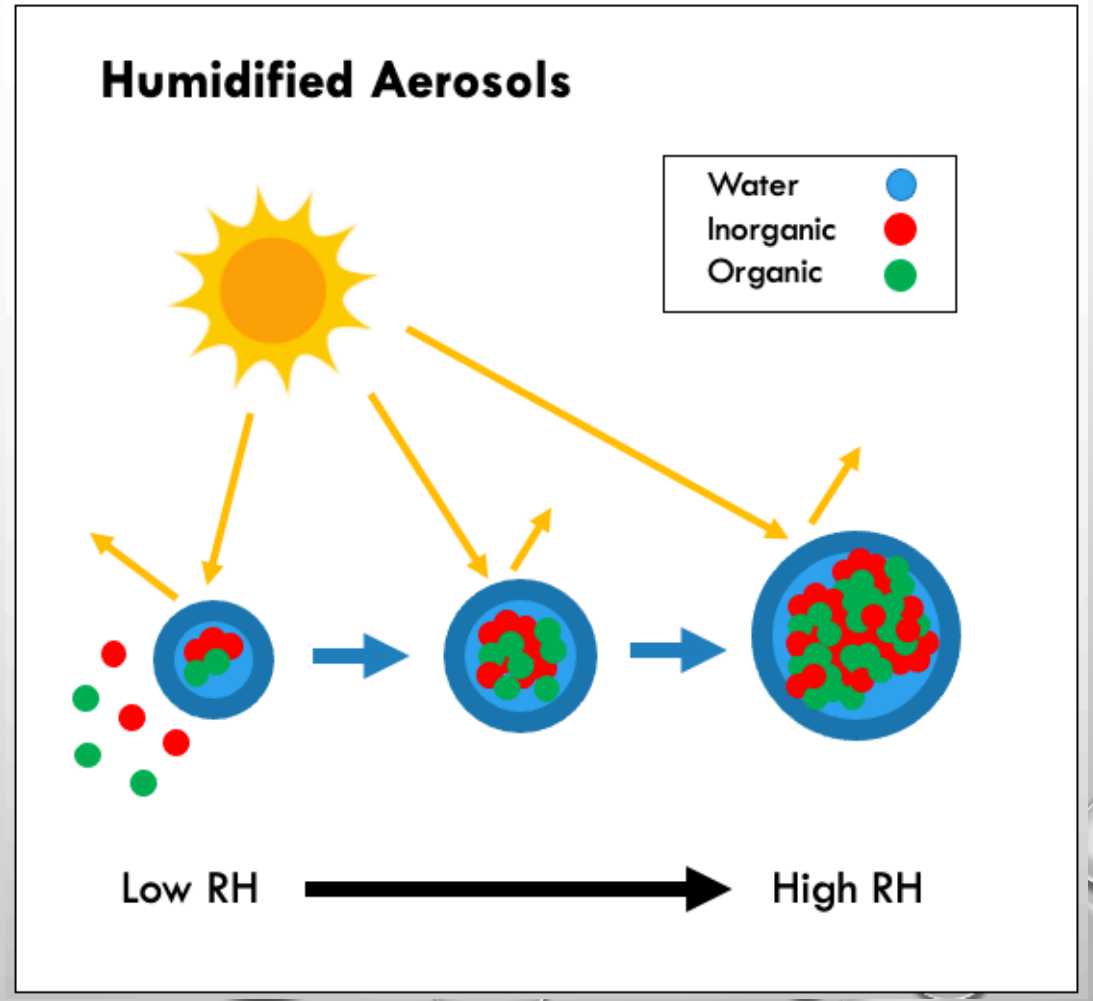
- **Climate Forcing** – the physical process of affecting the climate on Earth through different forcing factors. (variations in solar radiation levels, volcanic eruptions, changing albedo, changing greenhouse gases, etc.).

- **Cloud Formation** – water vapor in the air condenses into visible water droplets or ice crystals through condensation of saturated parcels of air.



Optical Properties and Humidified Aerosols

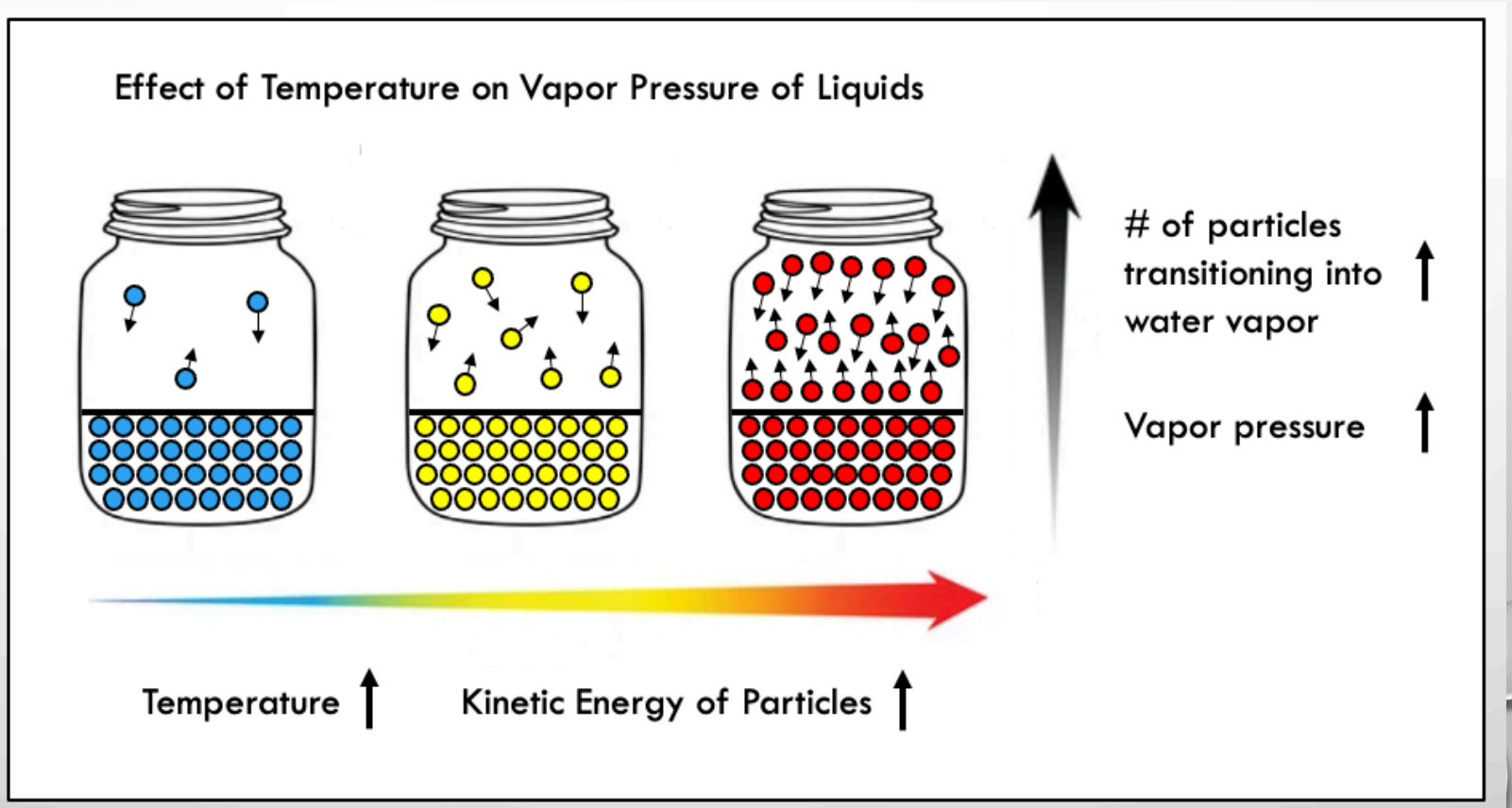




Relative Humidity and Temperature

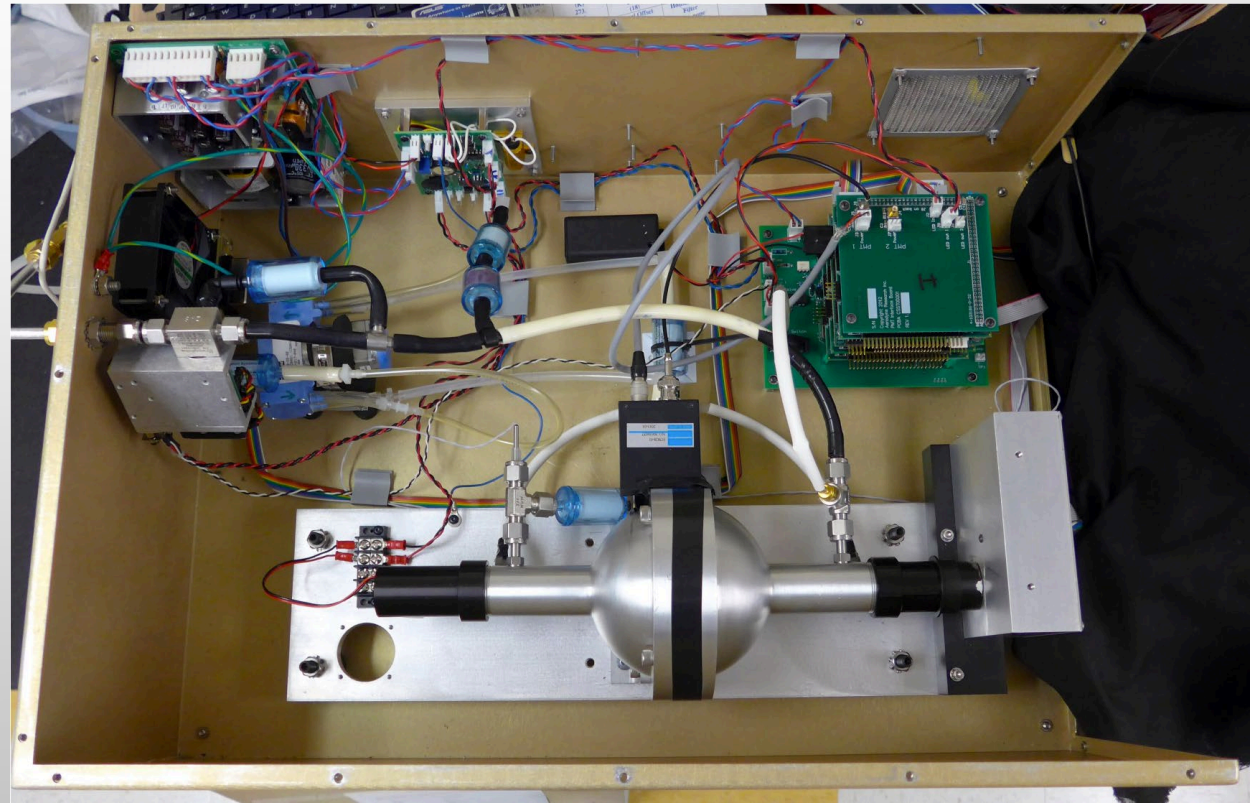
$$Relative\ Humidity\ (RH) = \frac{partial\ pressure\ of\ water\ vapor}{\text{equilibrium vapor pressure of water}}$$

- As the temperature of water increases, the kinetic energy of its molecules increases and the number of molecules transitioning into water vapor also increases, thereby increasing the vapor pressure.



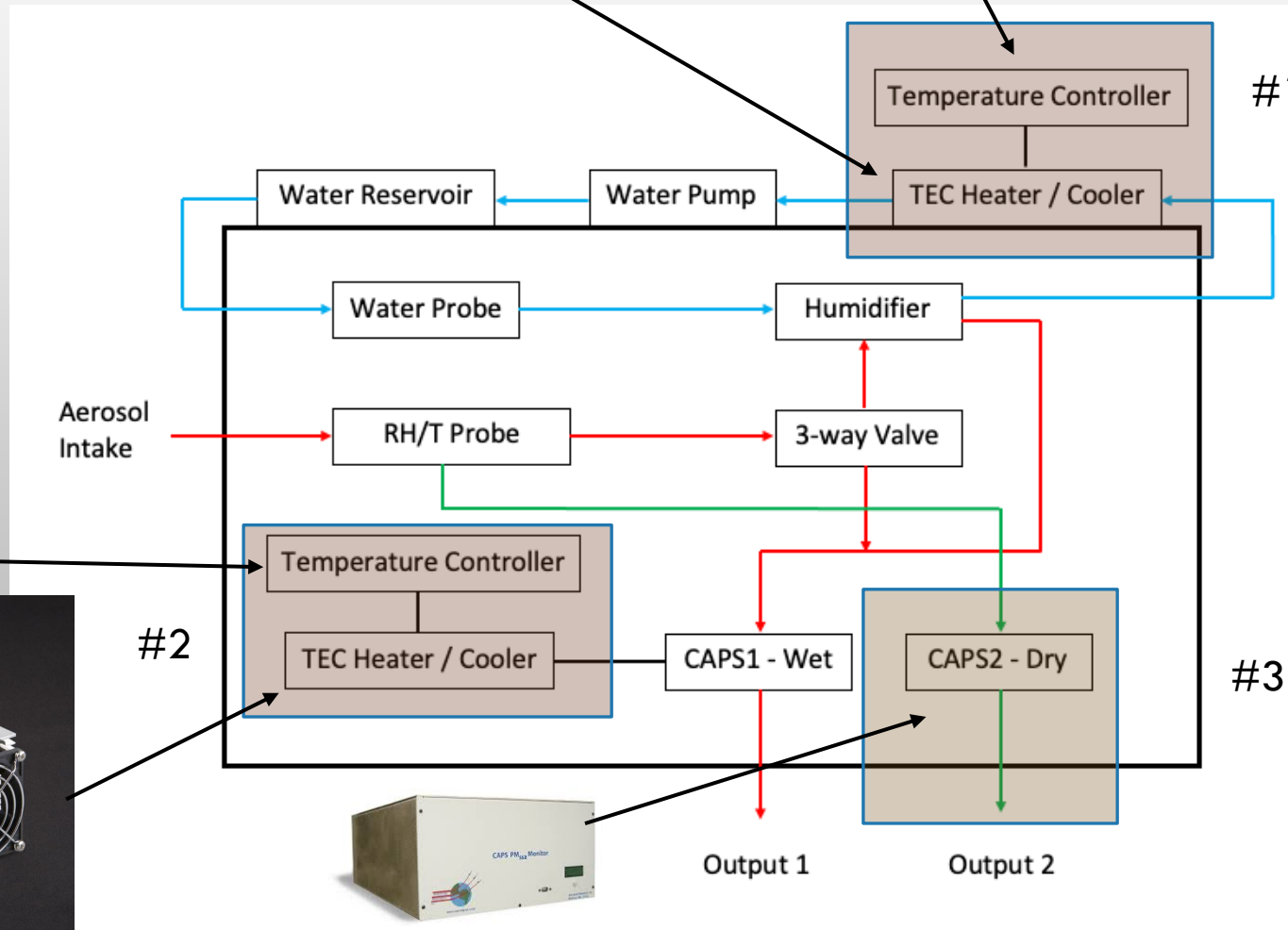
CAPS PMssa Monitor

- Provides simultaneous measurement of both particle-based total optical extinction and scattering.
- Produces a direct measurement of the particle single scattering albedo (SSA), the ratio of scattering to total extinction.
- Laser wavelength blue light 450nm
- Measure ambient aerosol directly in the CAPS monitor but also simulate different levels of humidity to characterize the roll of water uptake on optical properties.



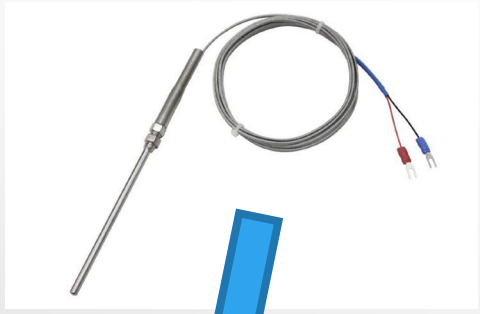
DUAL CAPS DESIGN

1. Temperature Controller and water cooler/heater added to water system.
2. Temperature Controller and air cooler/heater added to the aerosol system.
3. Second CAPS instrument.



Temperature Control to Humidify Aerosol

Thermocouple Temperature Sensor



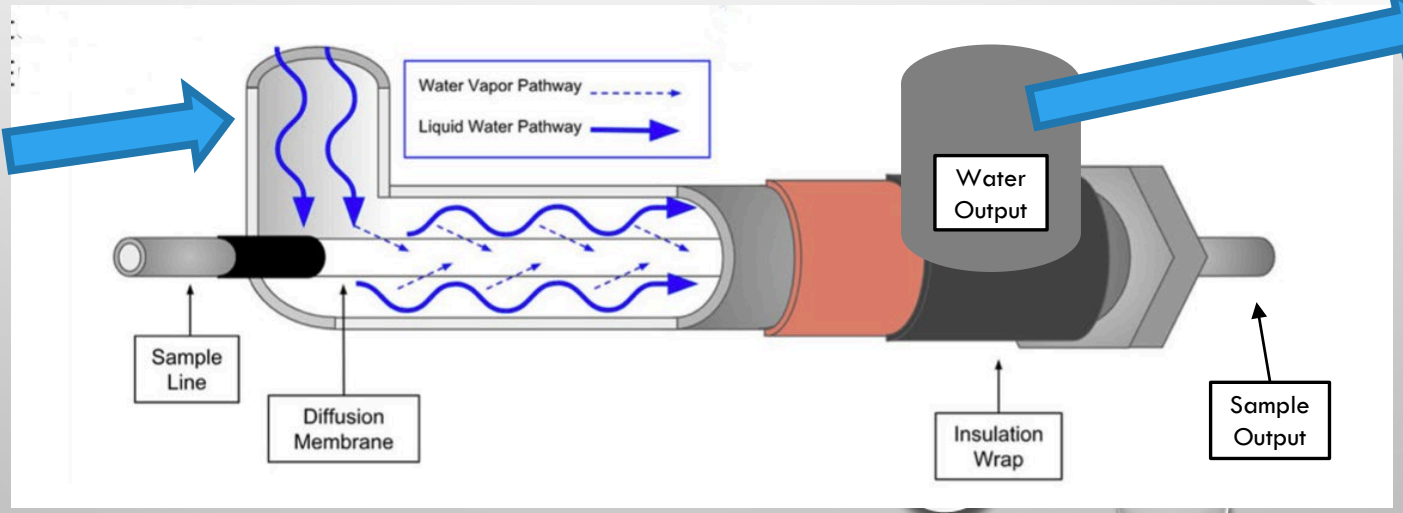
Temperature Controller

Water Reservoir

Water

Water Heater/Cooler

Aerosol Humidifier



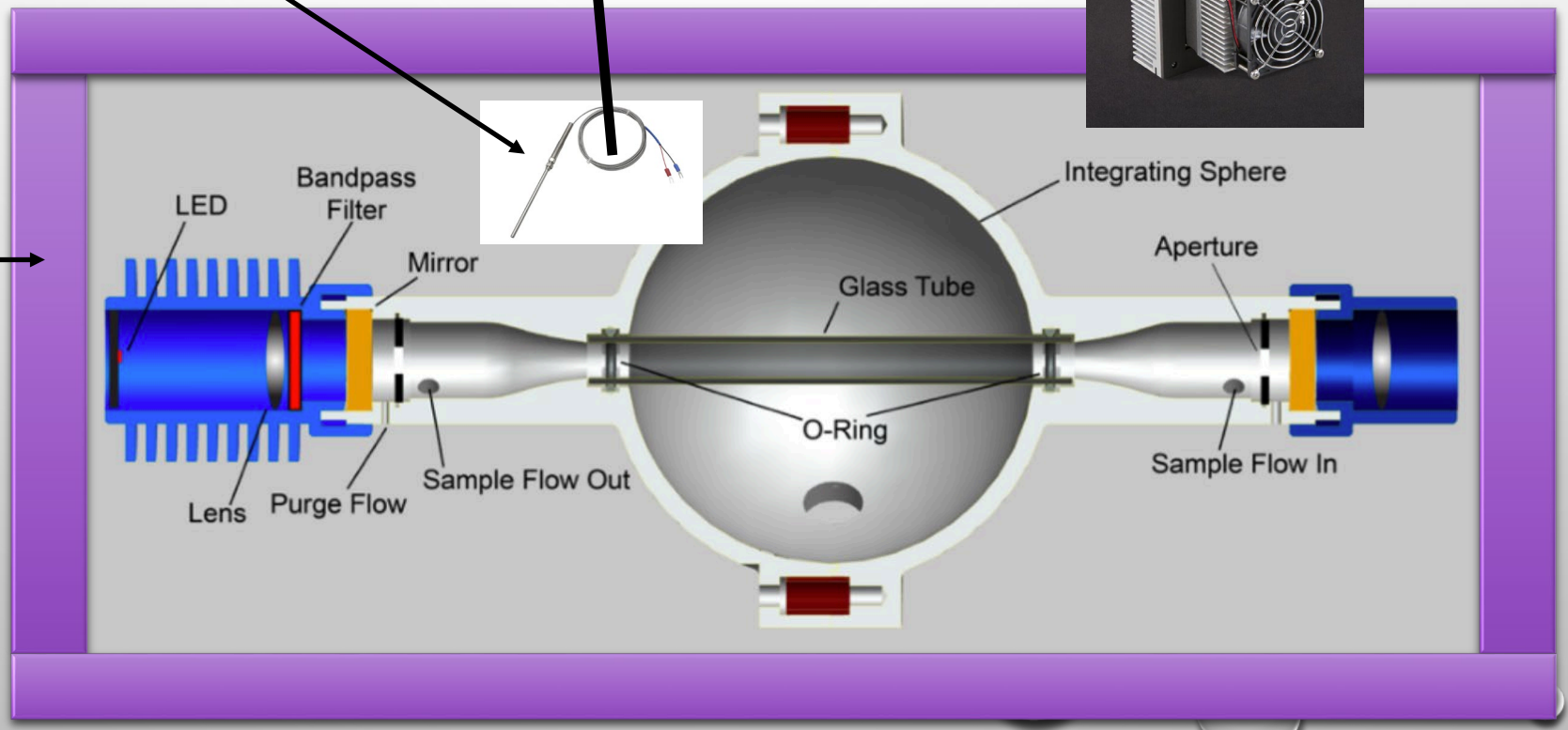
Temperature Control for Aerosols

Thermocouple Temperature Sensor

Air Cooler

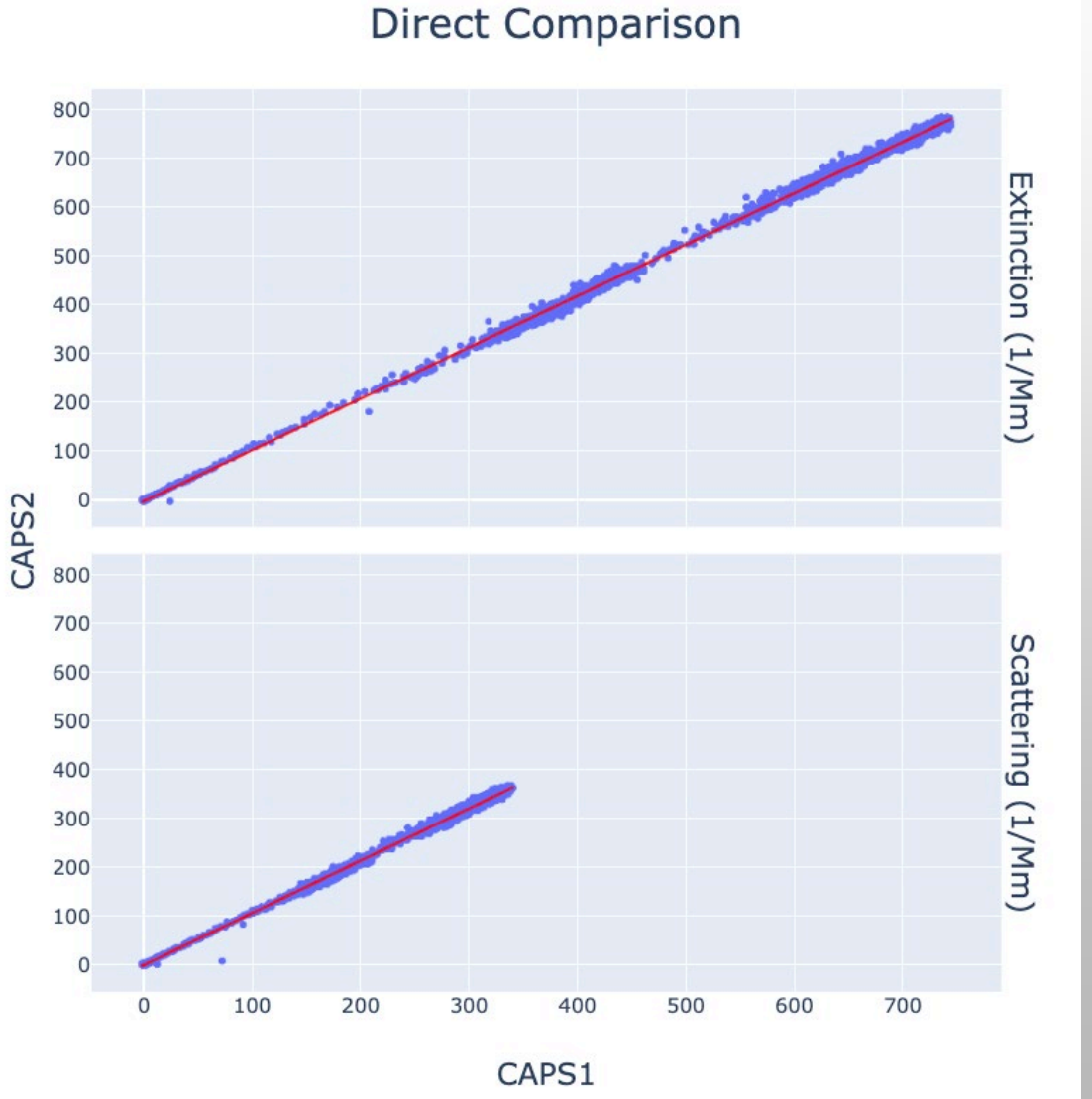
Thermocouple Temperature Sensor

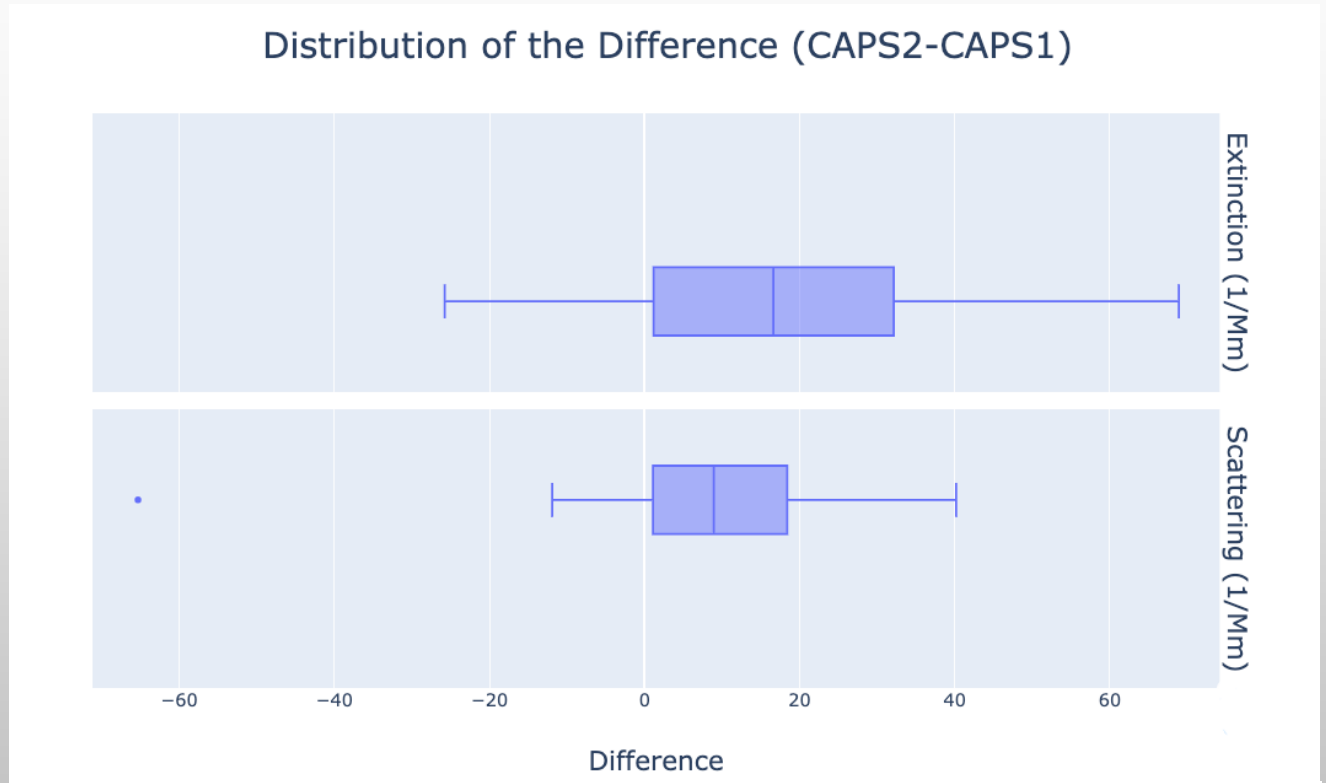
Insulation



CAPS Comparison

Fullerene Soot (Black Carbon Surrogate)
Time Period: 7/22/2021 8:00 – 10:30am





Percentage Error:		Slope:
Extinction:	4.9%	1.054
Scattering:	6.2%	1.072

CONCLUSION

- There aren't significant biases between the CAPS systems so we can directly compare the dry and humidified measurements.
- Temperature control on the dry system creates a more robust and stable measurement.
- On the wet system we now can more precisely control the different levels of humidification.
- Now we can start looking at ambient aerosols to look at their behavior and changes to the optical properties with water uptake.