ITaRS
Initial Training for atmospheric Remote Sensing

MARIE CURIE ACTIONS

Contribution to the study of the humidity effects on aerosol optical properties using Multiwavelength Lidar and Microwave Radiometer

ESR1: Lev Labzovskii

Why humidity is important for aerosols?

Humidity variations can affect aerosol characteristics

- Scattering Properties
- Extinction Properties
- Shape
- Size

Enhancement Factor

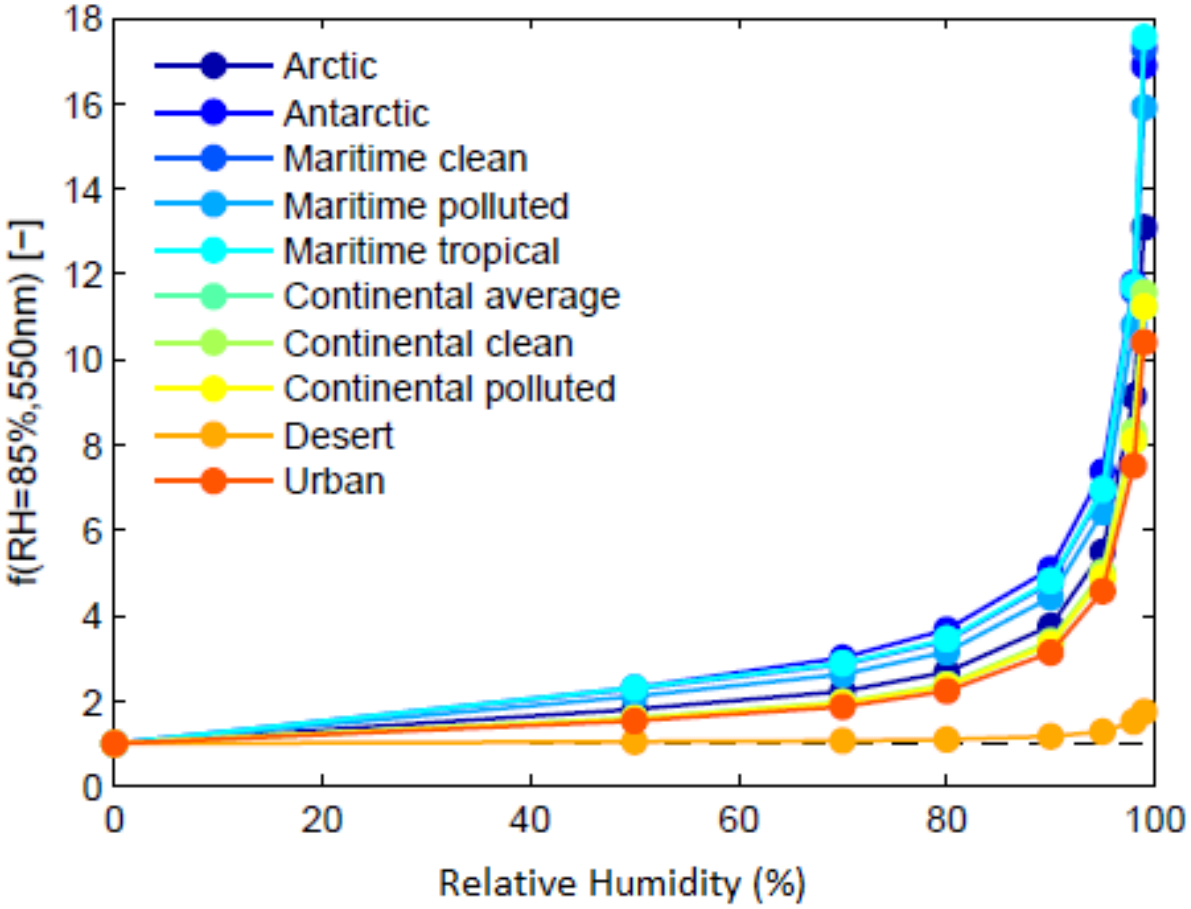
$$f_\zeta(RH) = \left(\frac{1 - RH}{1 - RH_{ref}}\right)^{-\gamma}$$

(Hänel 1976)

$$\Delta F = -\frac{1}{2} S \overline{T^2} (1 - \overline{A_c})(1 - \overline{R_c})^2 * \beta_{au(SO4)} f(RH) * Q_{SO2} Y_{SO4} \tau_{SO4}$$

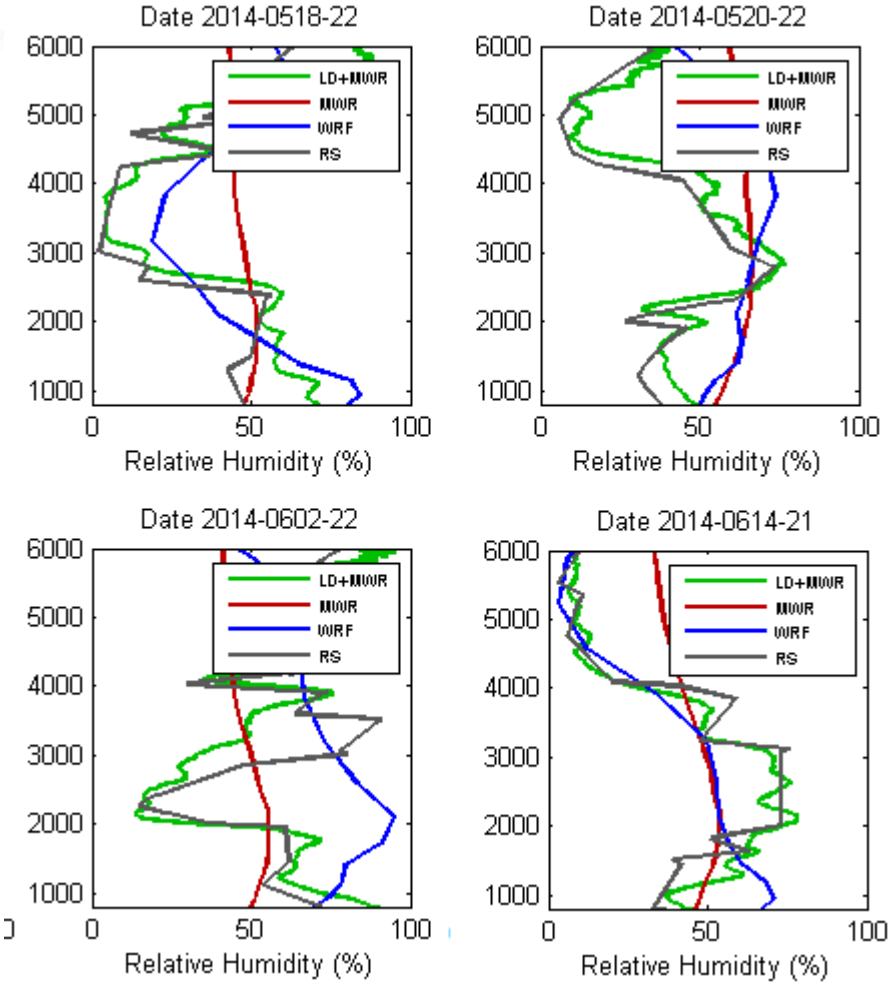
Aerosol contribution to radiative forcing (example – sulphate aerosol)

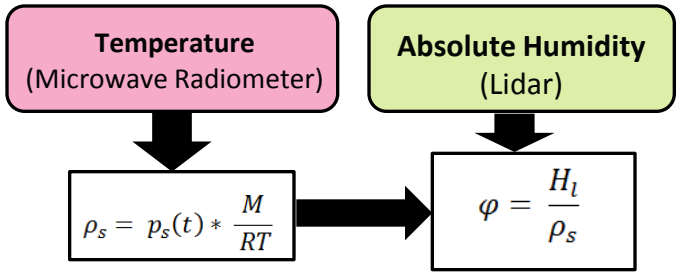
Why humidity is important for aerosols?

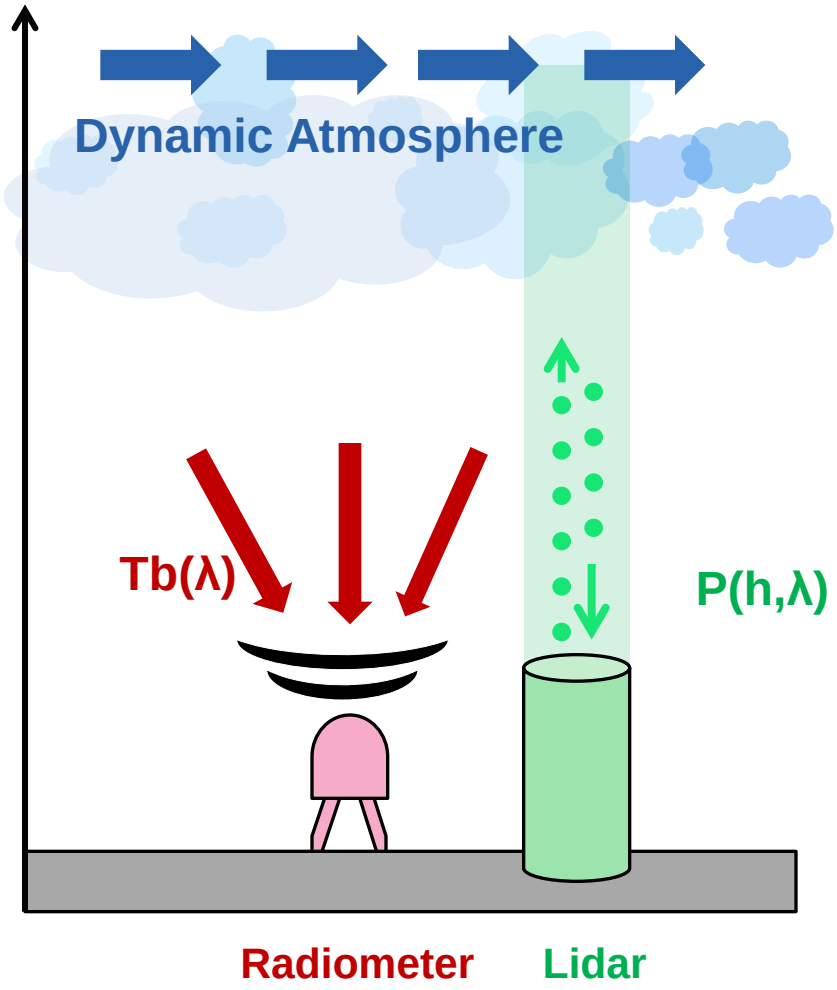


The scattering enhancement factor calculated at 550 nm wavelength for different aerosol classes against relative humidity [Zieger, 2011].

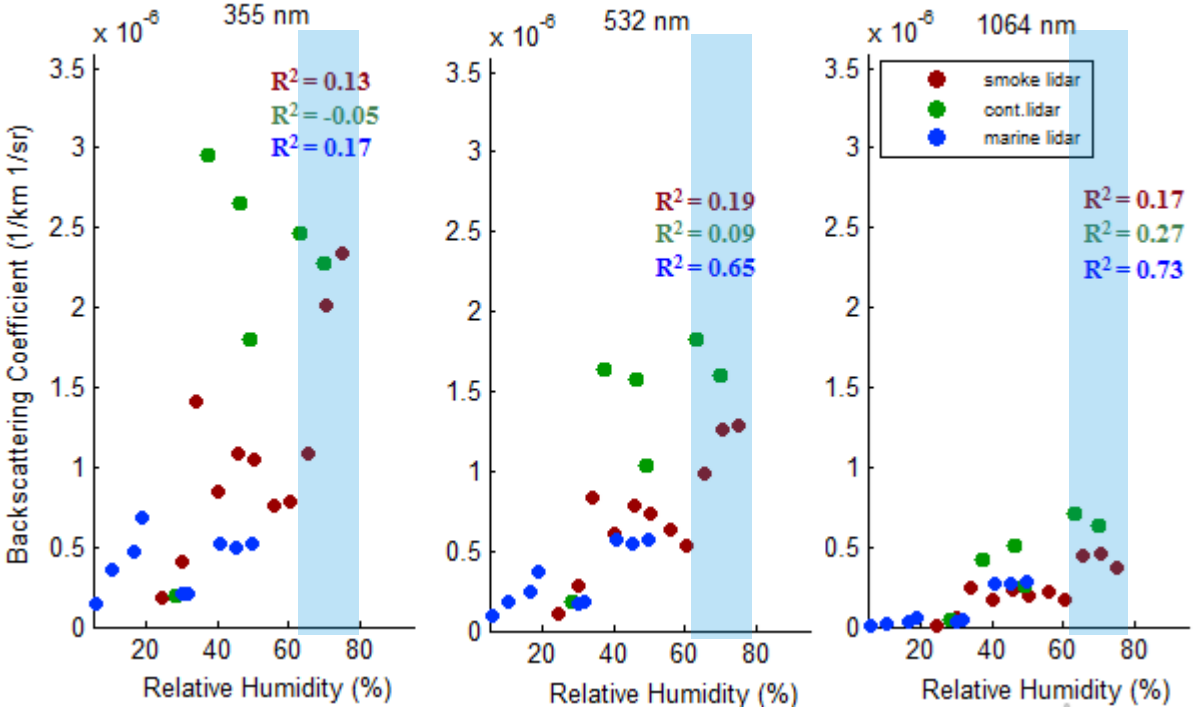
Multiwavelength Lidar and Microwave Radiometer





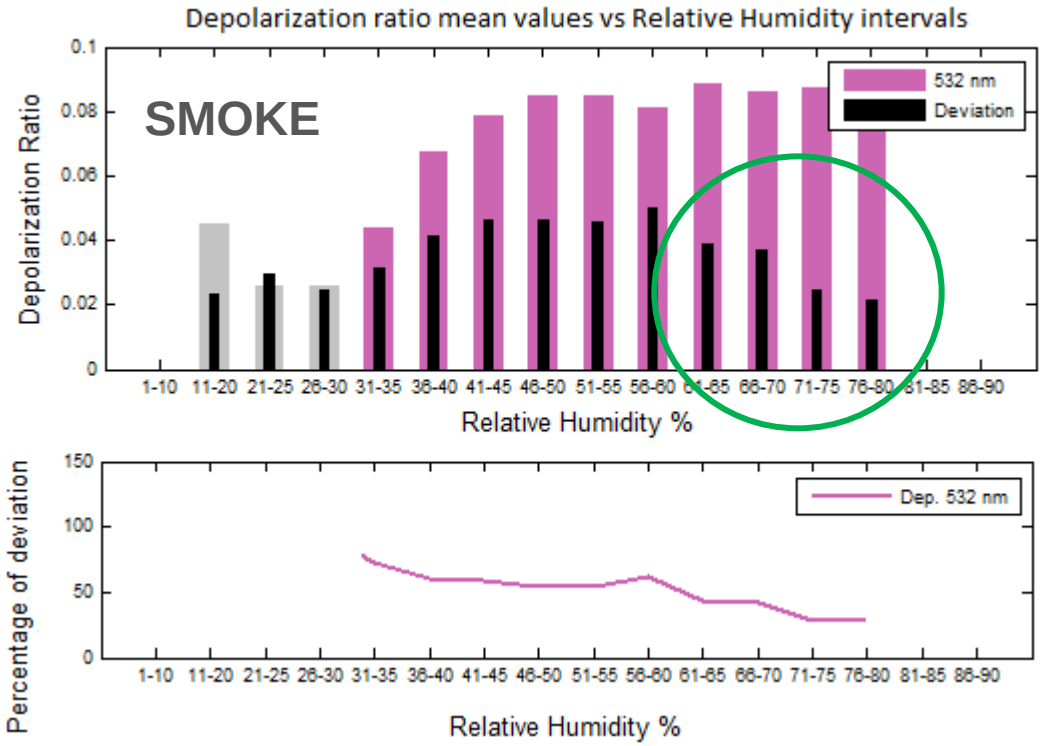


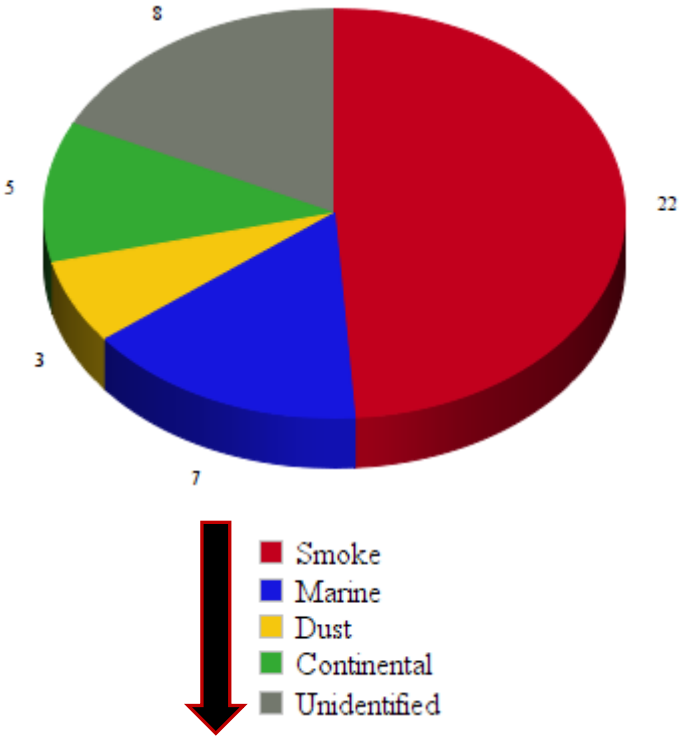
Aerosol optical parameters vs humidity



- ✓ **Marine aerosol – negative forcing contribution (significant)**
- ✓ **Smoke aerosol – negative forcing, more analysis required**
- × **Continental aerosol – undefined effect**

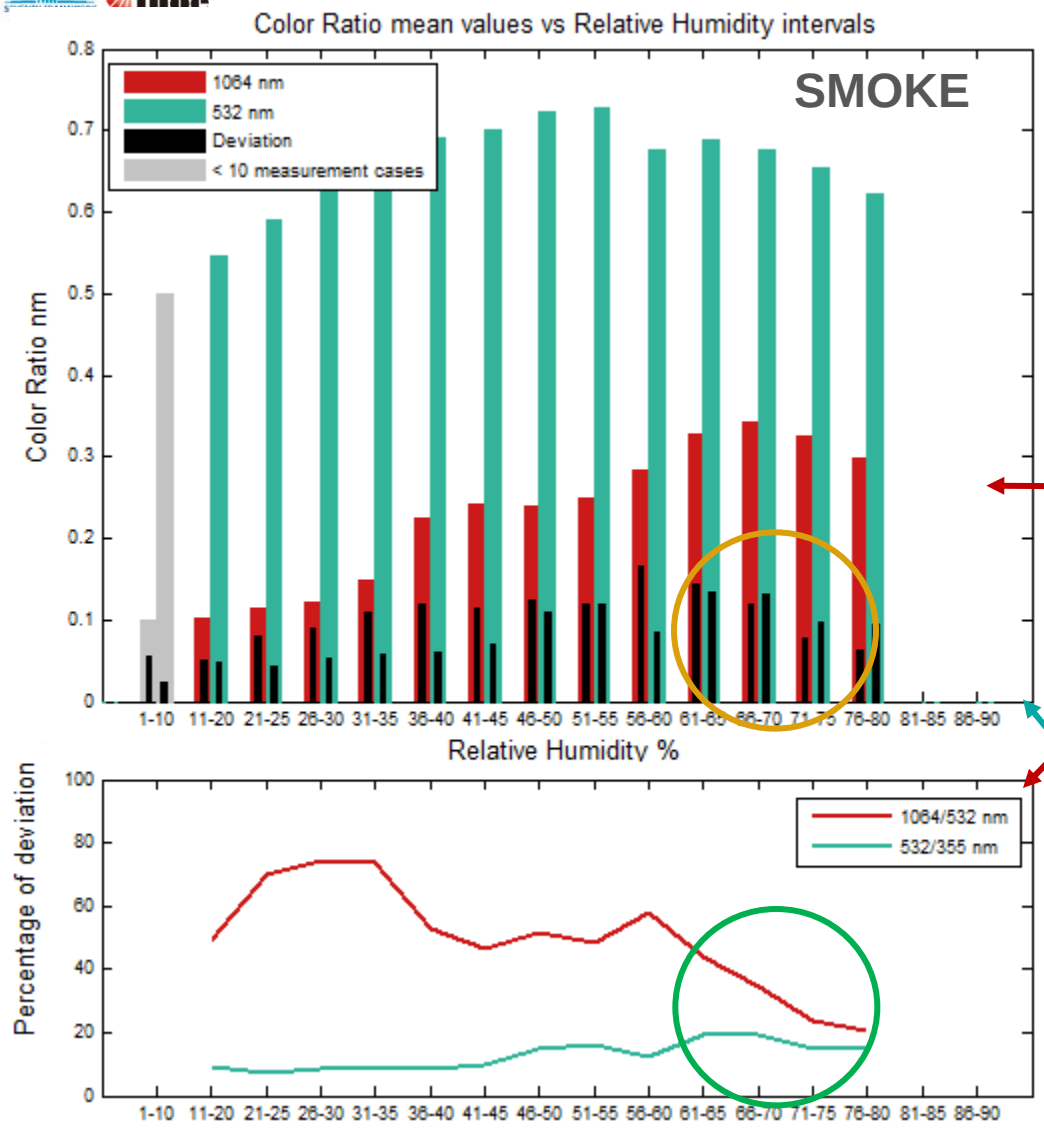
Aerosol optical parameters vs humidity. Smoke.

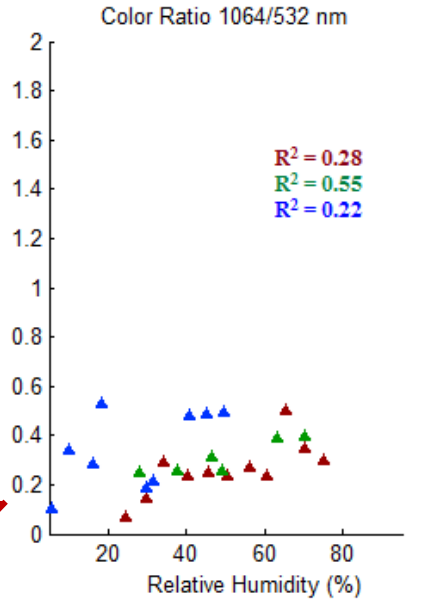


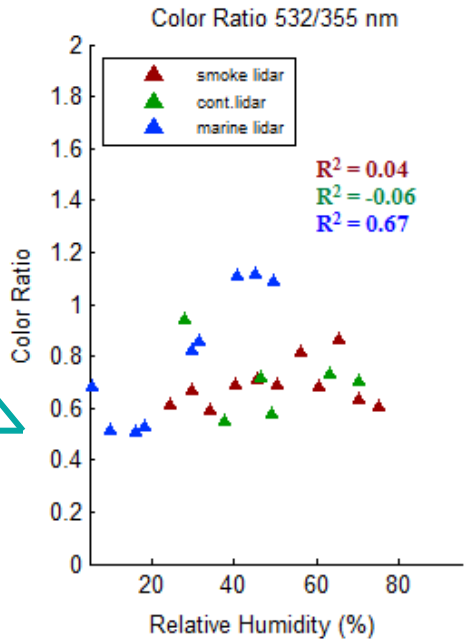


Statistics of aerosol typing.
Bucharest, Sep 2013 – April 2014

Aerosol optical parameters vs humidity. Smoke.







*Color ratio – ratio between backscattering coefficients at different wavelengths (1064/532 nm, 532/355 nm)

Conclusions

Relative humidity retrieval by lidar and radiometer

- Combination of lidar and microwave radiometer ->
  best agreement with radiosounding among other instruments and models
  (HygrA-CD Campaign, Athens + Bucharest measurements)

Humidity effects on aerosols

- All aerosol classes have enhanced backscattering with increased humidity -> Possible negative forcing
- There is strongest statistical dependence between backscattering at 1064 nm and relative humidity
- Smoke aerosol 61-80%: The most stable depolarization ratio -> Low deviations of depolarization ratio
- Smoke aerosol 61-80%: Decreasing of deviations from mean of color ratio 1064/532 -> Stable spectral dependence for backscattering at higher relative humidity
- Lidar ratio analysis: 61-80% deviations of lidar ratio at these humidity conditions become identical -> Stabilization of ratio between absorption and scattering