


## DR. MARLOES PENNING DE VRIES



- Level-0, 1, and 2
- Radiative Transfer Models
- Exercise
- Questions on discussion board
  - Irradiance, radiance, reflectance, reflectivity and their units
  - Relationship between brightness and whiteness of clouds
- Q&A




# LEVEL-0, 1, AND 2

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- Level-0 : uncalibrated, "raw" data [photon counts, detector units]
- Level-1 : geo-referenced, calibrated radiances [ $\text{Wm}^{-2}\text{sr}^{-1}$ ] or TOA reflectances [-]
- Level-2 : atmospherically corrected BOA reflectances [-] or other products
- More information: <https://www.earthdata.nasa.gov/engage/open-data-services-and-software/data-information-policy/data-levels>

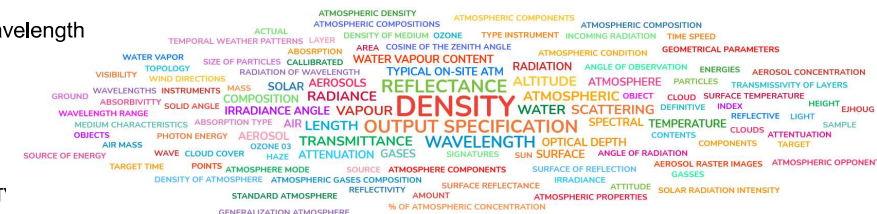


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- Calculate TOA reflectances (or radiances)
- Need input on:
  - Atmosphere (temperature & density profile, aerosols, gases ( $O_3$ ,  $H_2O$ ,  $CO_2$ , ...))
  - Surface (reflectivity, topology)
  - Angles of Sun and instrument w.r.t. surface normal
  - Solar irradiance
  - Wavelength



## EXERCISE

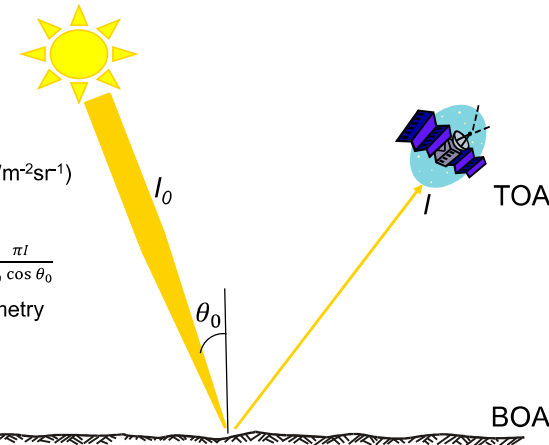
- Trouble with linear algebra? Look at: <https://www.khanacademy.org/math/algebra-basics/alg-basics-graphing-lines-and-slope/alg-basics-solutions-to-two-var-equations/v/2-variable-linear-equations-graphs>



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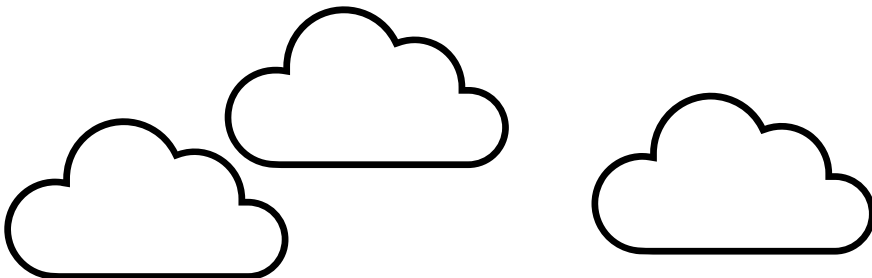
## IRRADIANCE, RADIANCE, REFLECTANCE, REFLECTIVITY

- Irradiance  $I_0$ 
  - flux per unit area (in  $\text{Wm}^{-2}$ )
- Radiance  $I$ :
  - flux per unit area and solid angle (in  $\text{Wm}^{-2}\text{sr}^{-1}$ )
- TOA Reflectance  $R_{TOA}$ :
  - Equal to radiance/irradiance:  $R_{TOA} = \frac{\pi I}{I_0 \cos \theta_0}$
  - Property of surface, atmosphere, geometry
  - NOT equivalent to reflectivity!
- BOA Reflectance  $R_{BOA}$ :
  - $R_{TOA}$  minus Atmospheric influence
  - Property of surface - equivalent to reflectivity (for all practical purposes)



## WHY DO CLOUDS LOOK THE WAY THEY DO?

- Clouds are bright because liquid water does not absorb visible radiation
- Clouds are white because cloud droplets are larger than the wavelengths of visible radiation and therefore scatter all colours with the same probability



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