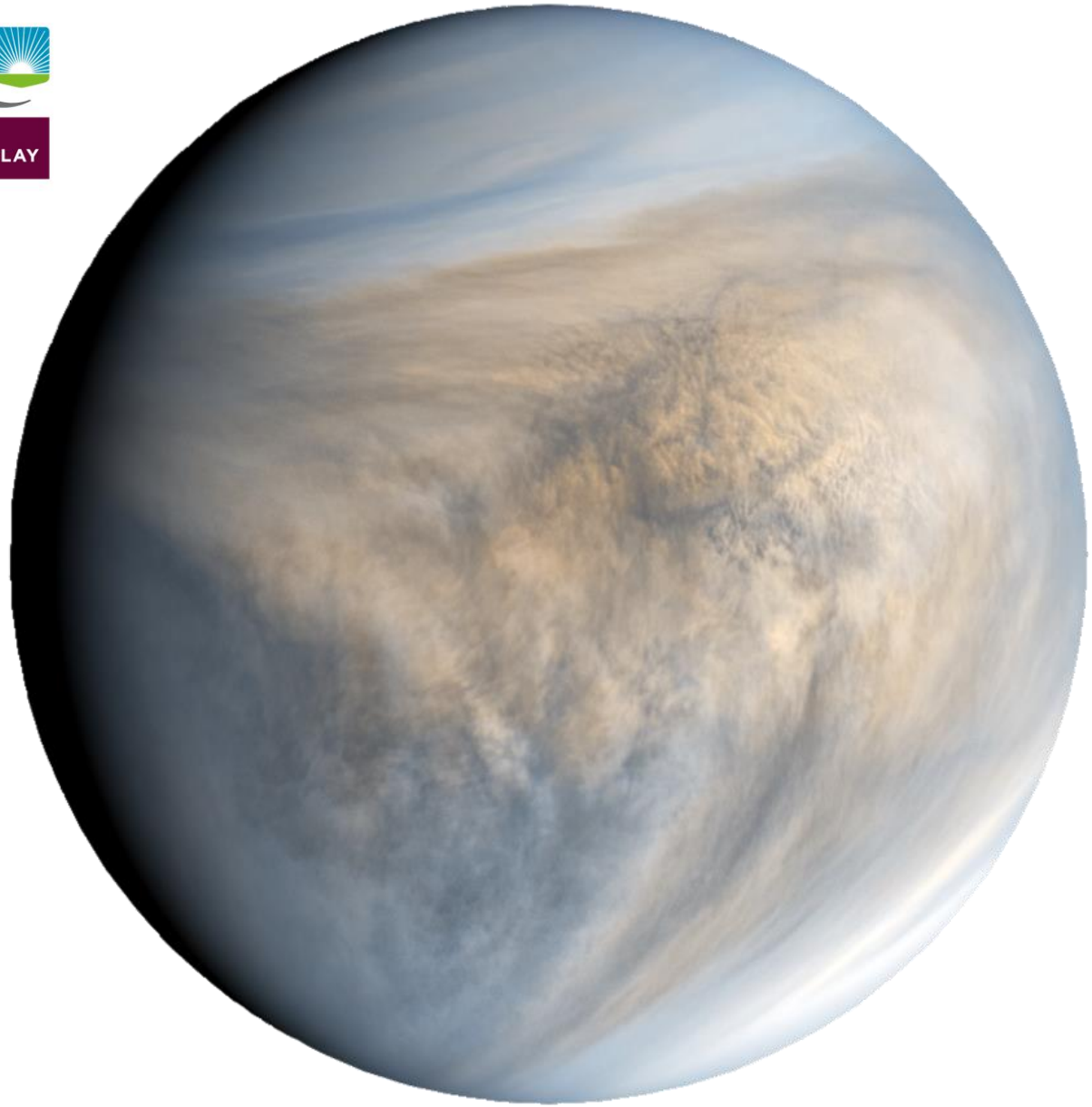
Update on NO nightglow and preliminary microphysics results lookup



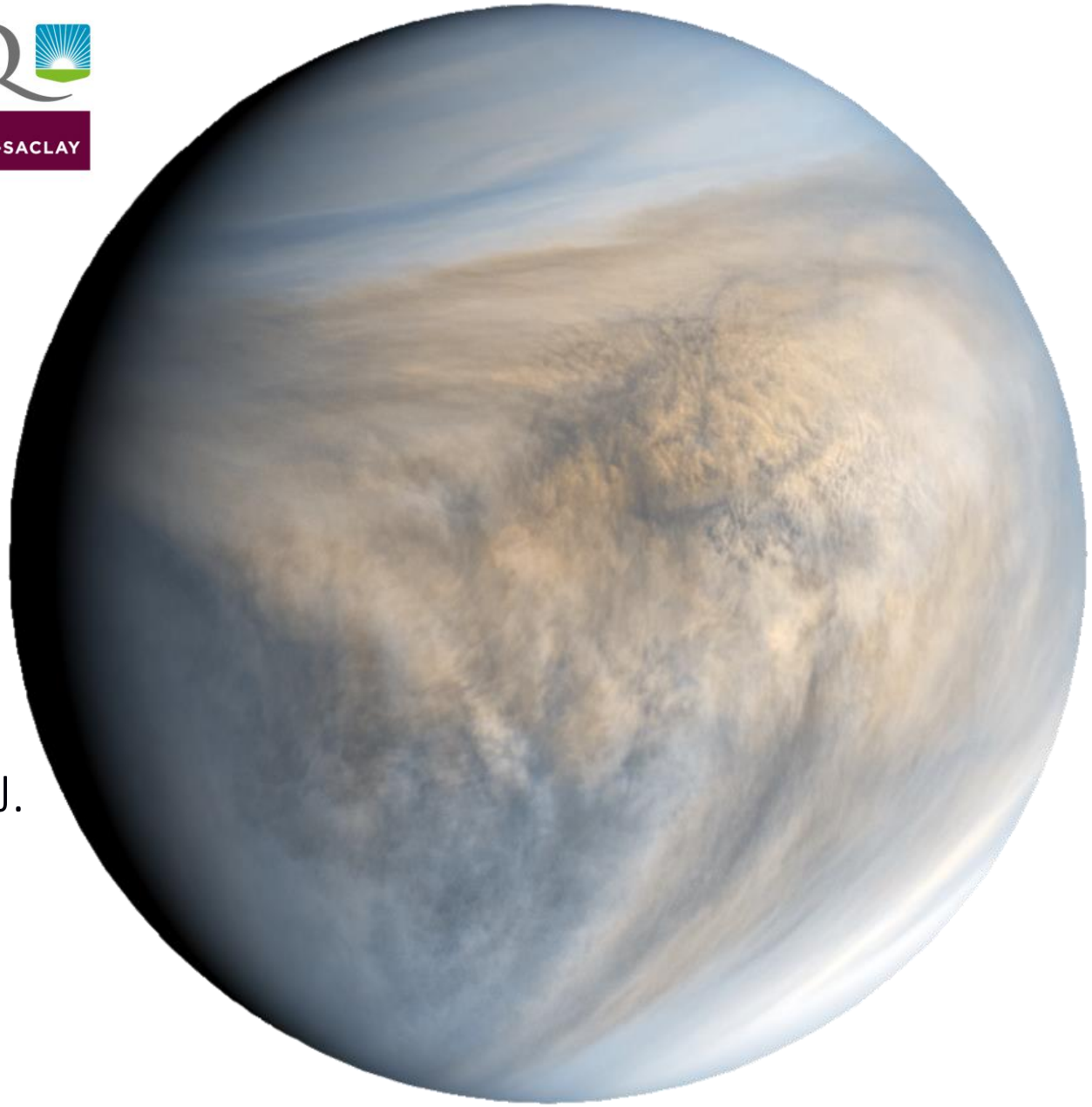
N. Streel[1] , A. Määttänen[1], F. Lefèvre[1] , [1]LATMOS (Paris)

With the help of S. Lebonnois[2] , [2]LMD (Paris)

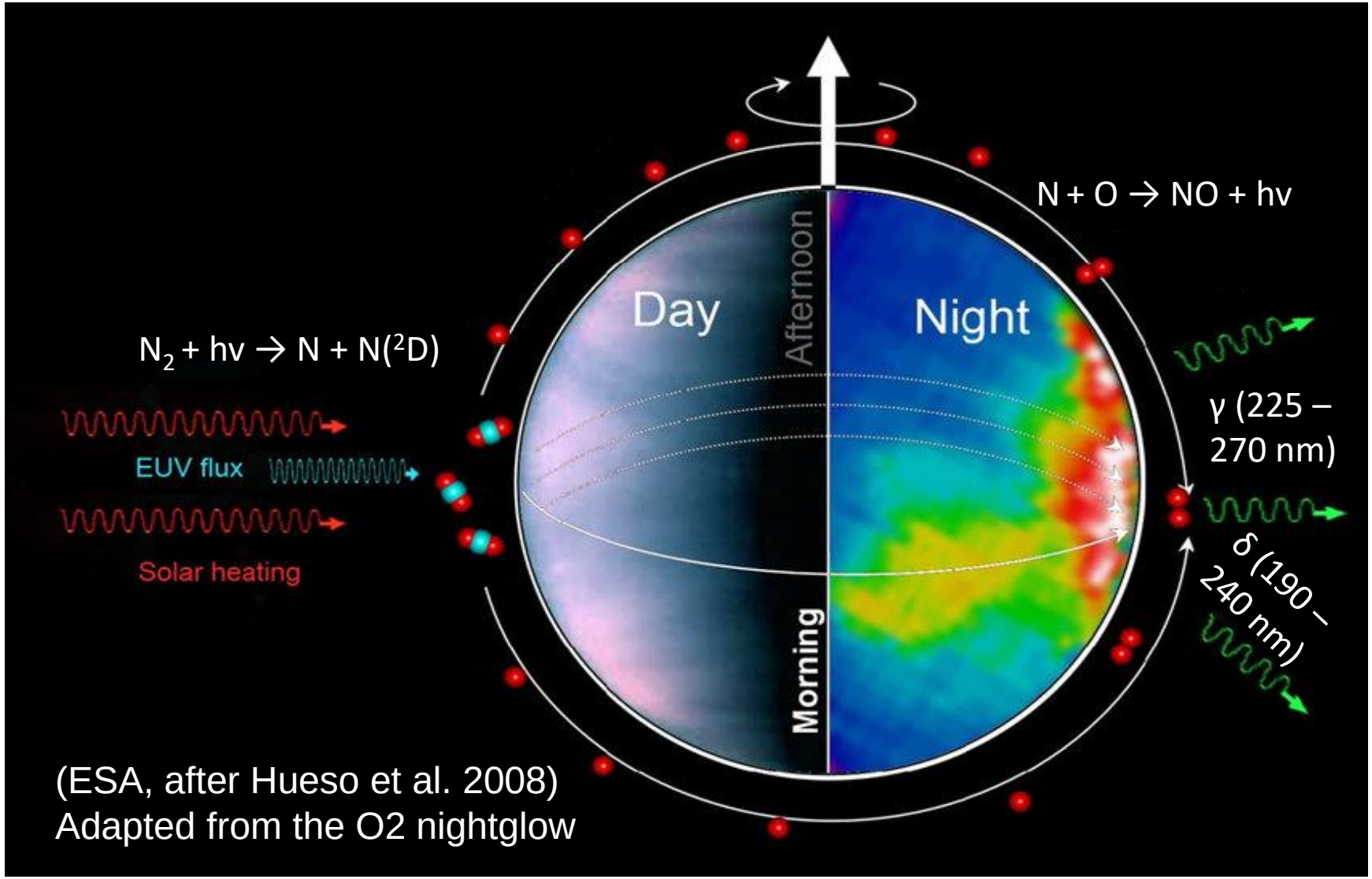
Nicolas.streel@latmos.ipsl.fr

The nitric oxide nightglow simulated by the Venus PCM

N. Streel[1], F. Lefèvre[1], A. Martinez[2,3], A.Stolzenbach[1,2], A. Määttänen[1], S. Lebonnois[3], J. C. Gérard[4], and L. Soret[4], [1]LATMOS (Paris), [2]Instituto de Astrofísica de Andalucía (Granada), [3]LMD (Paris), [4]LPAP (Liège)



Origin of the ultraviolet NO nightglow



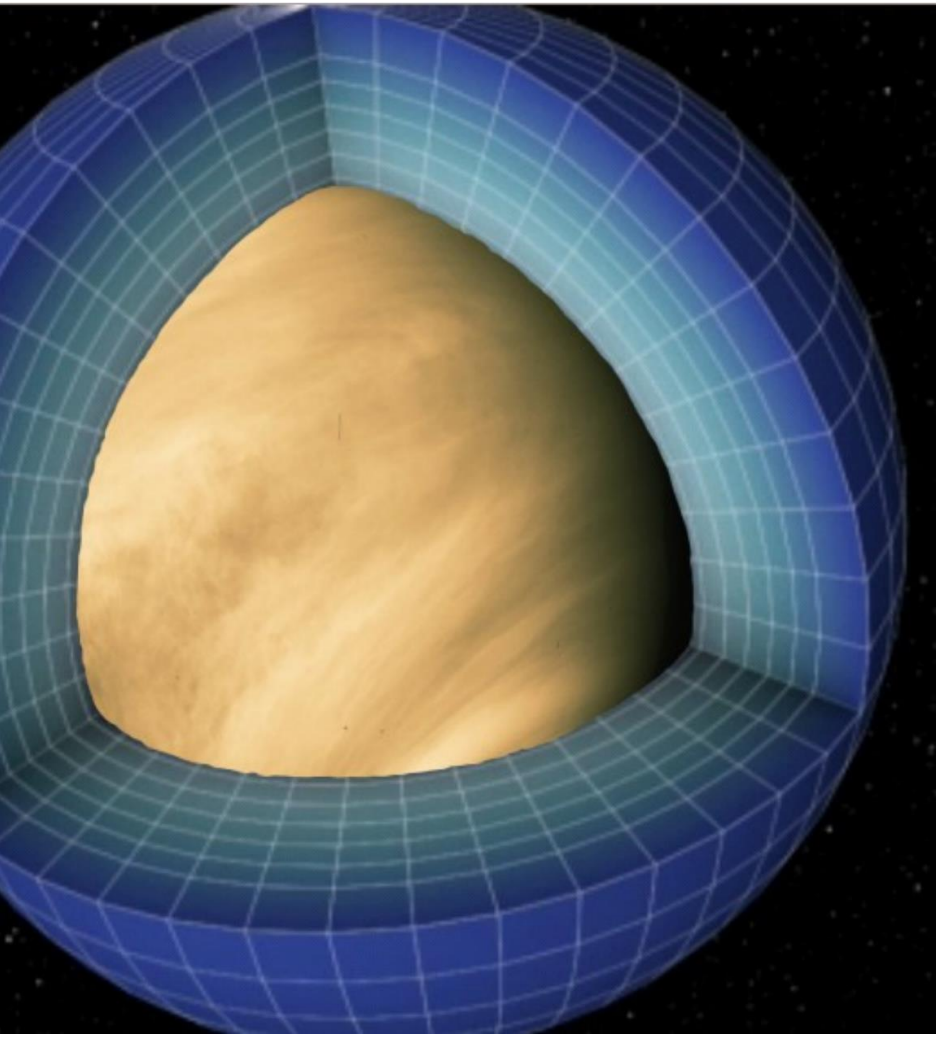
(ESA, after Hueso et al. 2008)
Adapted from the O2 nightglow

Interest :

- Tracer of the dynamics on the nightside (solar-to-antisolar circulation & zonal super-rotation)
- Tracer of the nitrogen chemistry

Altitude of the peak : ~115 km range

The Venus PCM



Main characteristics :

Developed at the IPSL (Lebonnois et al 2010/2016)

It includes :

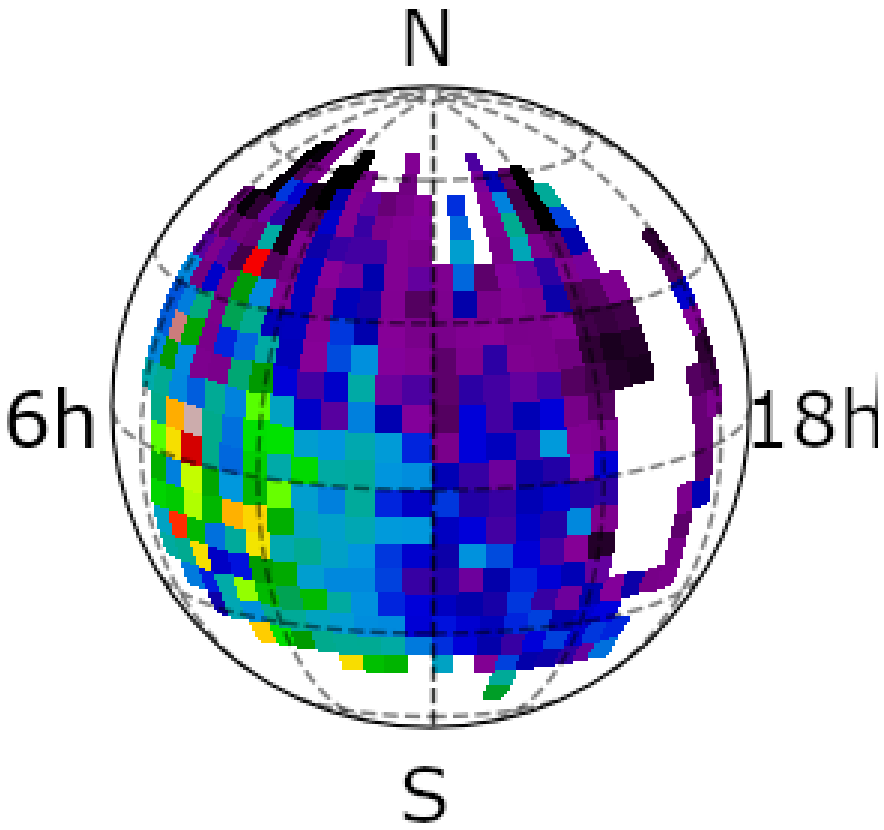
- Dynamics
- Radiative model
- A comprehensive chemical model
- **Clouds parametrization**

Model resolution :

- horizontally : 96x96 → 1.875° of latitude | 3.75° of longitude

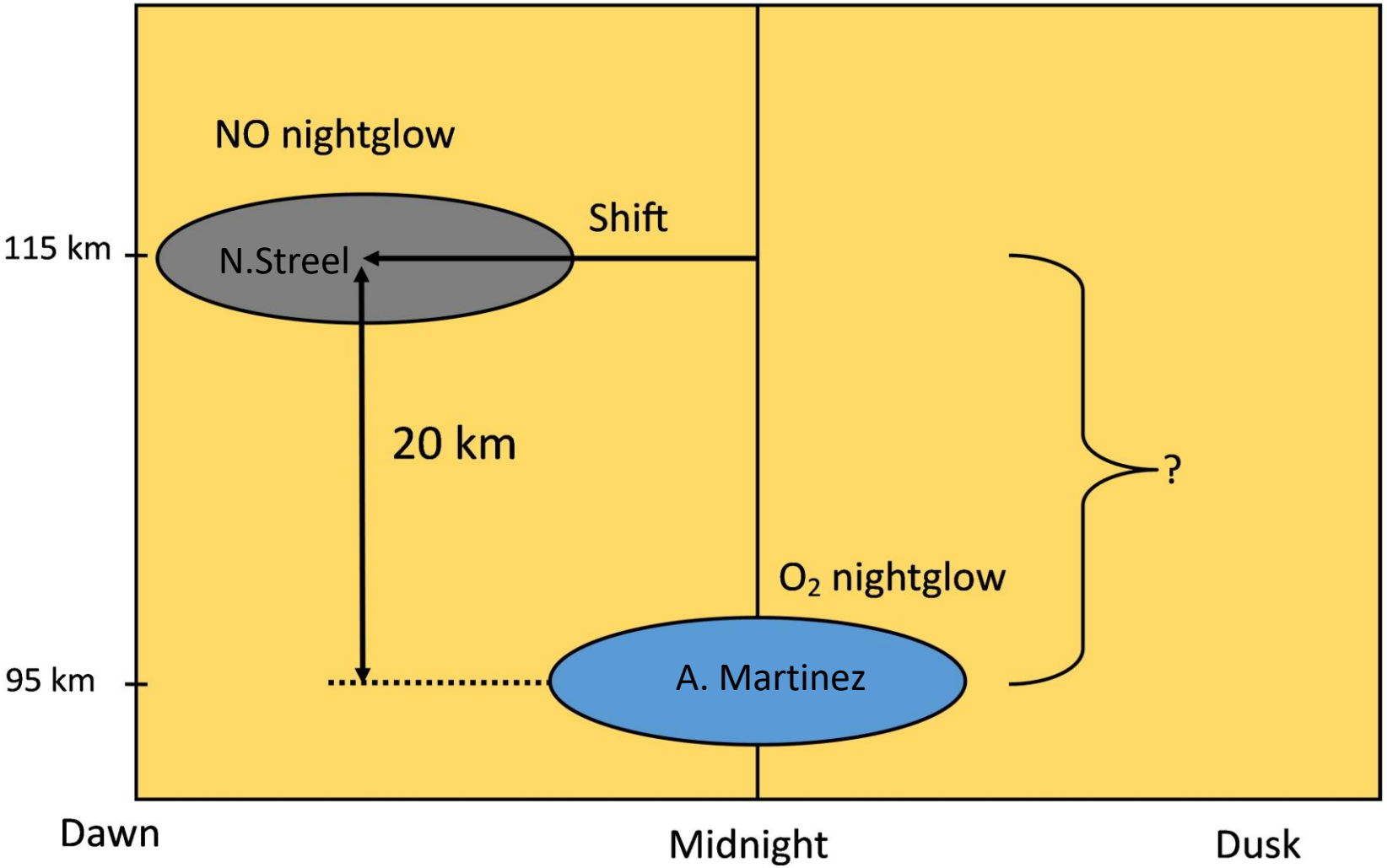
- vertically : 90 levels of pressure → up to 250 km of altitude

Why?

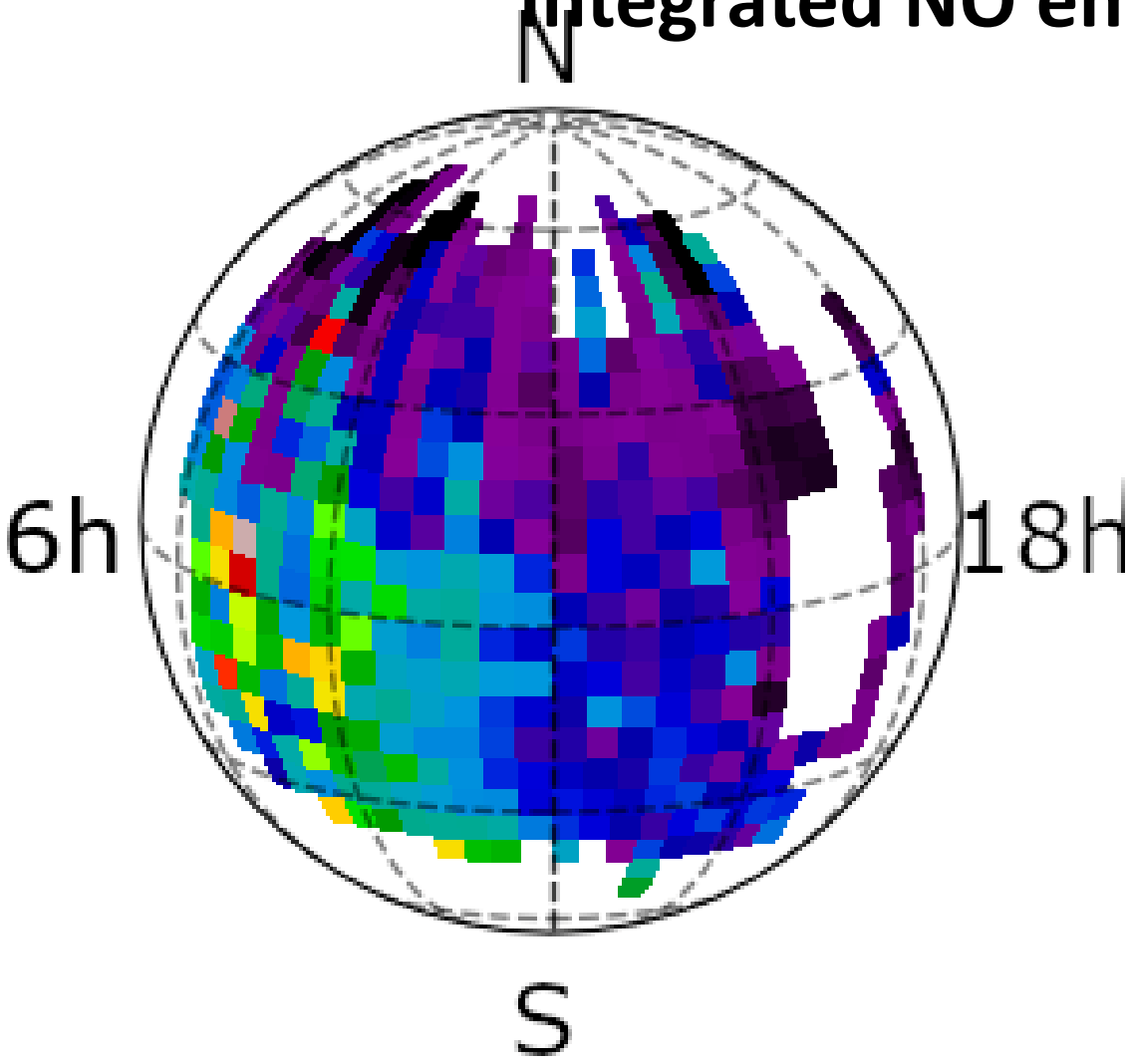


SPICAV nadir observations

Stiepen et al, 2012



Integrated NO emission (kR)



SPICAV nadir observations

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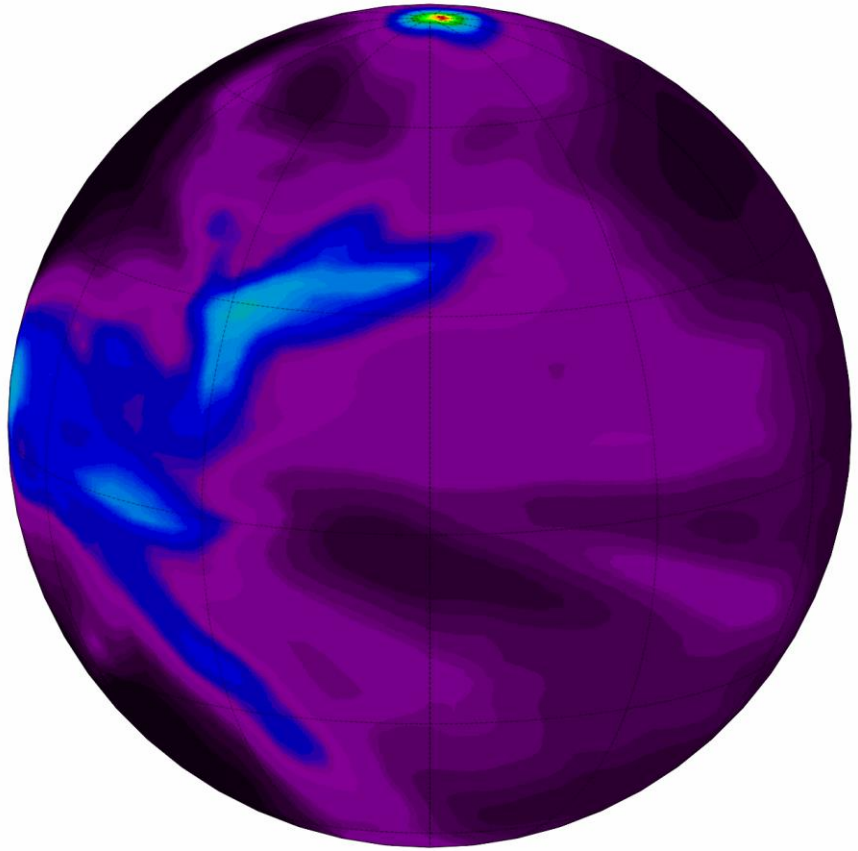
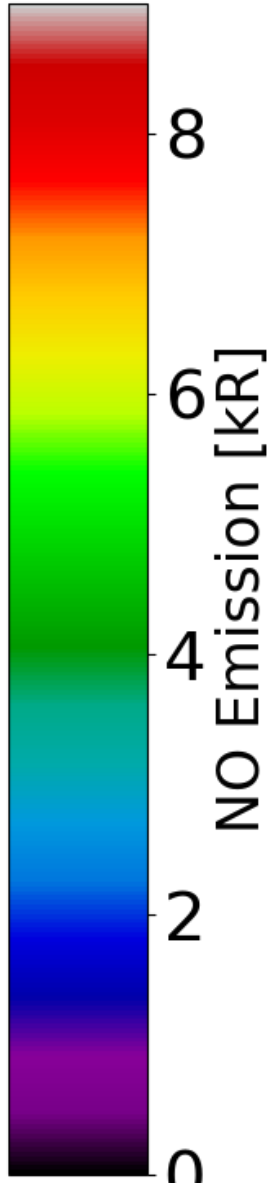
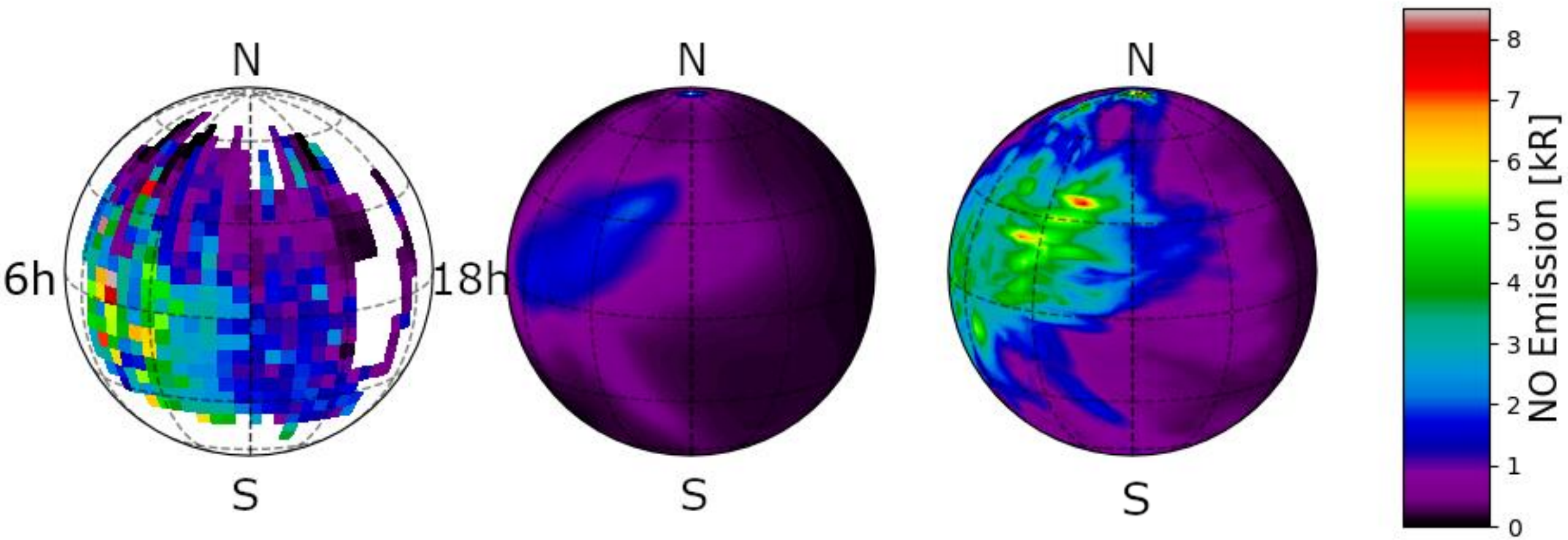


Venus PCM



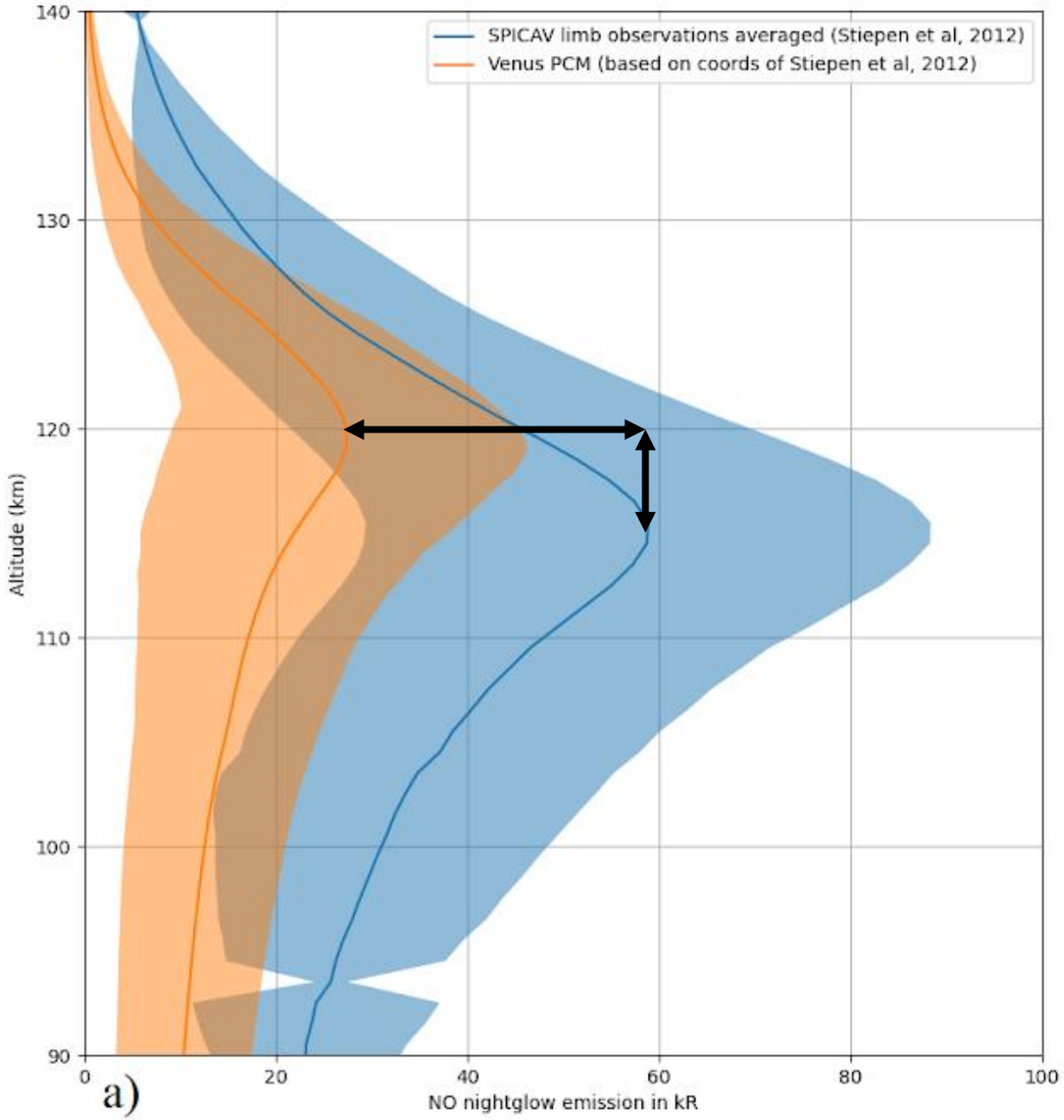
Integrated NO emission (kR)



SPICAV nadir observations

Venus PCM (1day avg)

Venus PCM (max over 1 day)



NO nightglow vertical distribution

- Vertical shift of about 5km
- Intensity of half it should be

What now ?

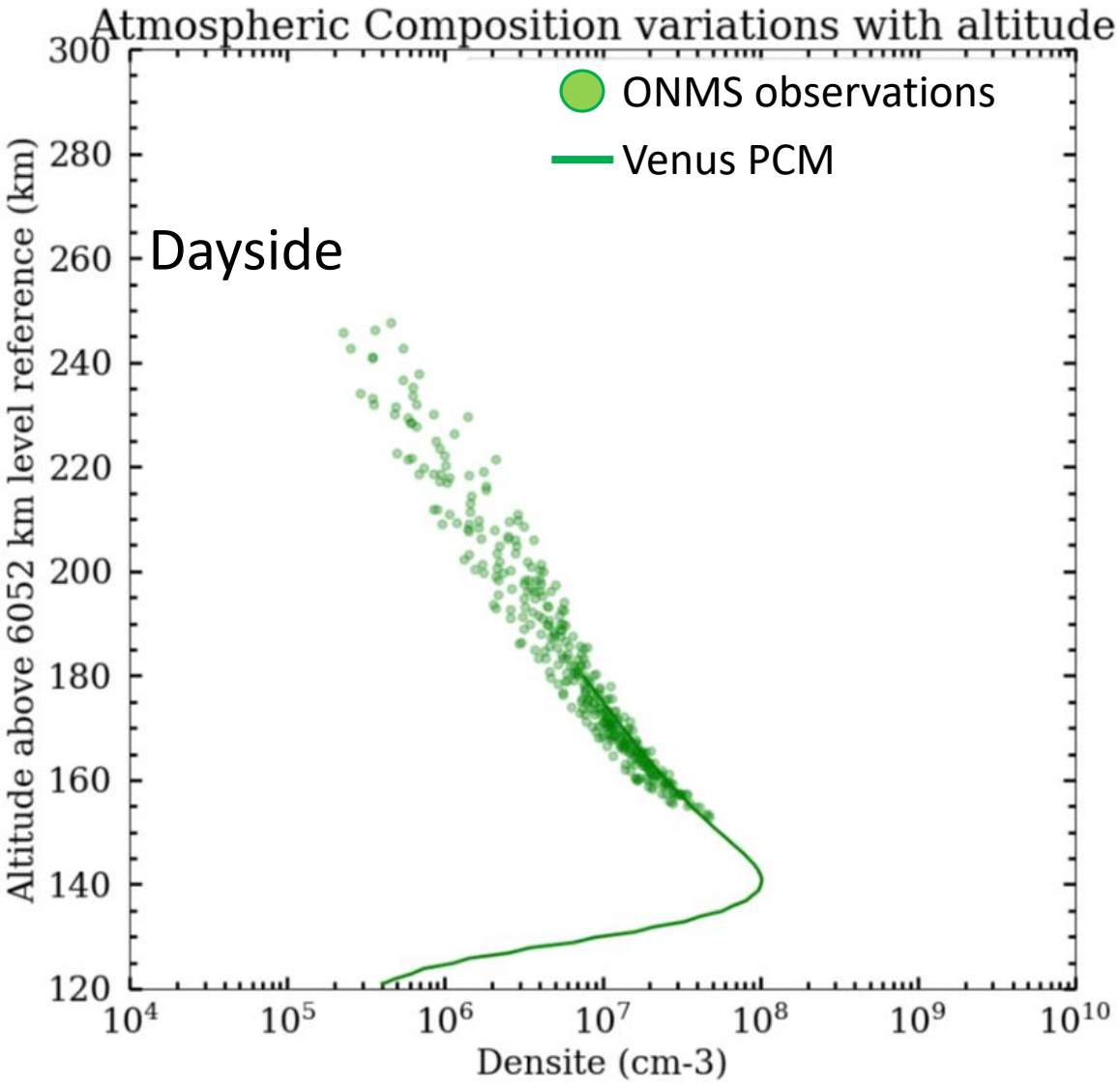
There is 2 possibilities :

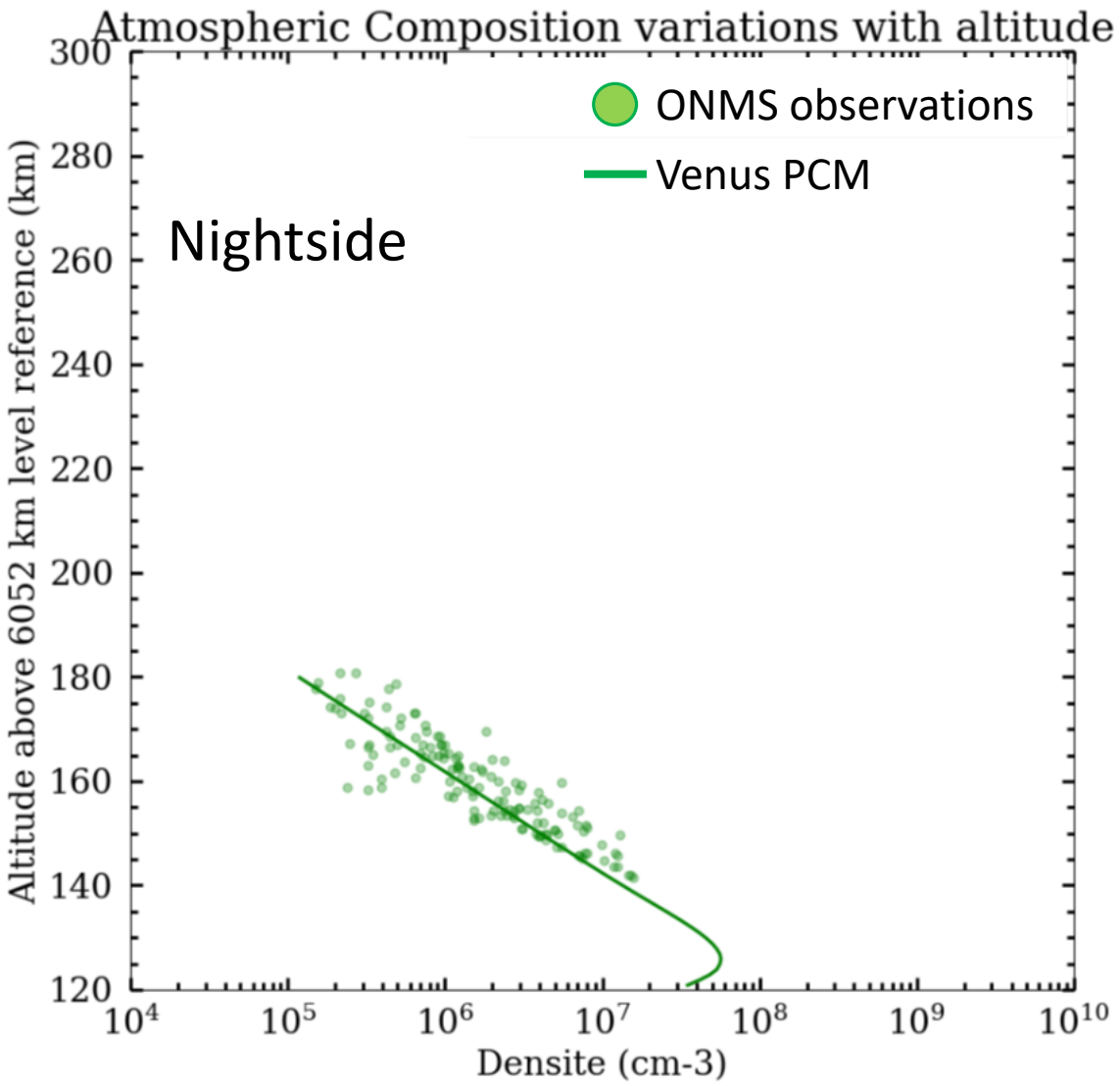
- The chemistry is missing some reactions or misevaluate them

- The vertical transport is not enough efficient

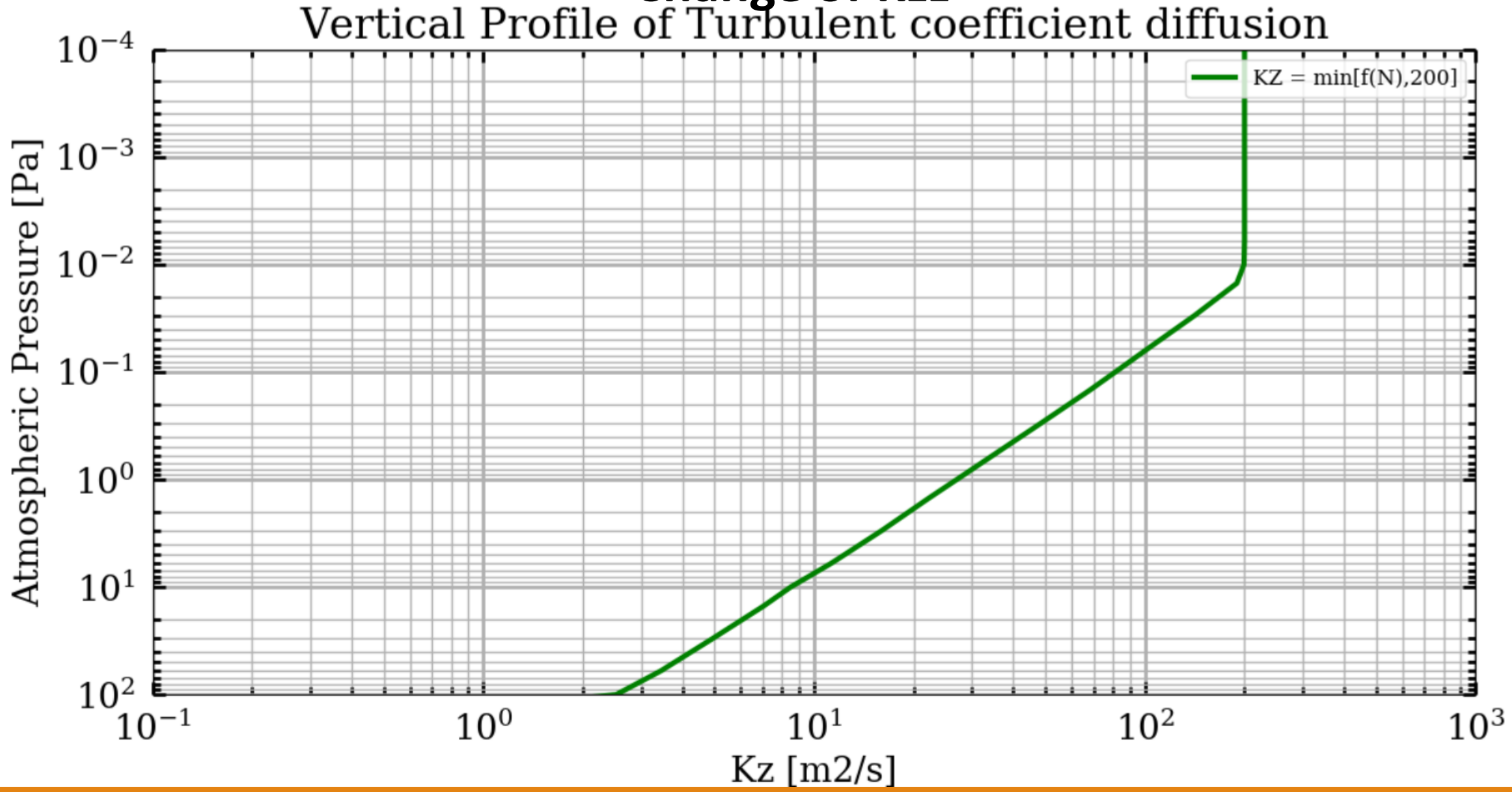
Nitrogen atoms vertical distributions

$$N_2 + h\nu \rightarrow N(2D) + N$$

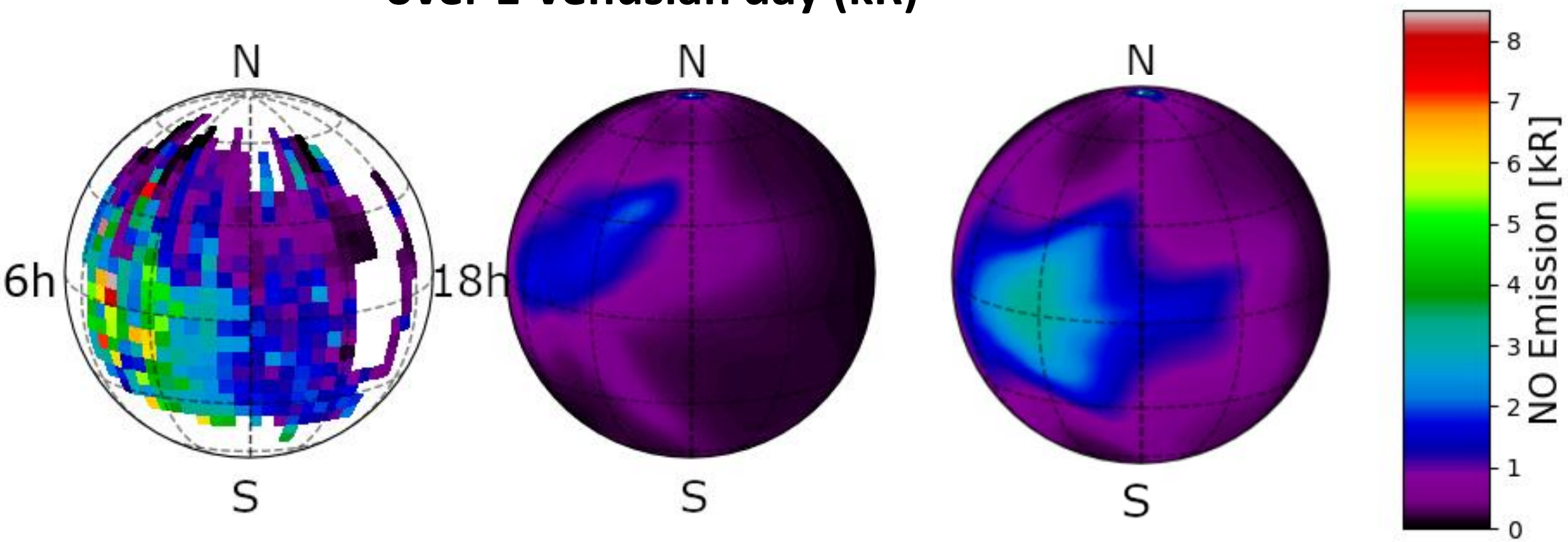




Change of Kzz



Integrated NO emission averaged over 1 Venusian day (kR)

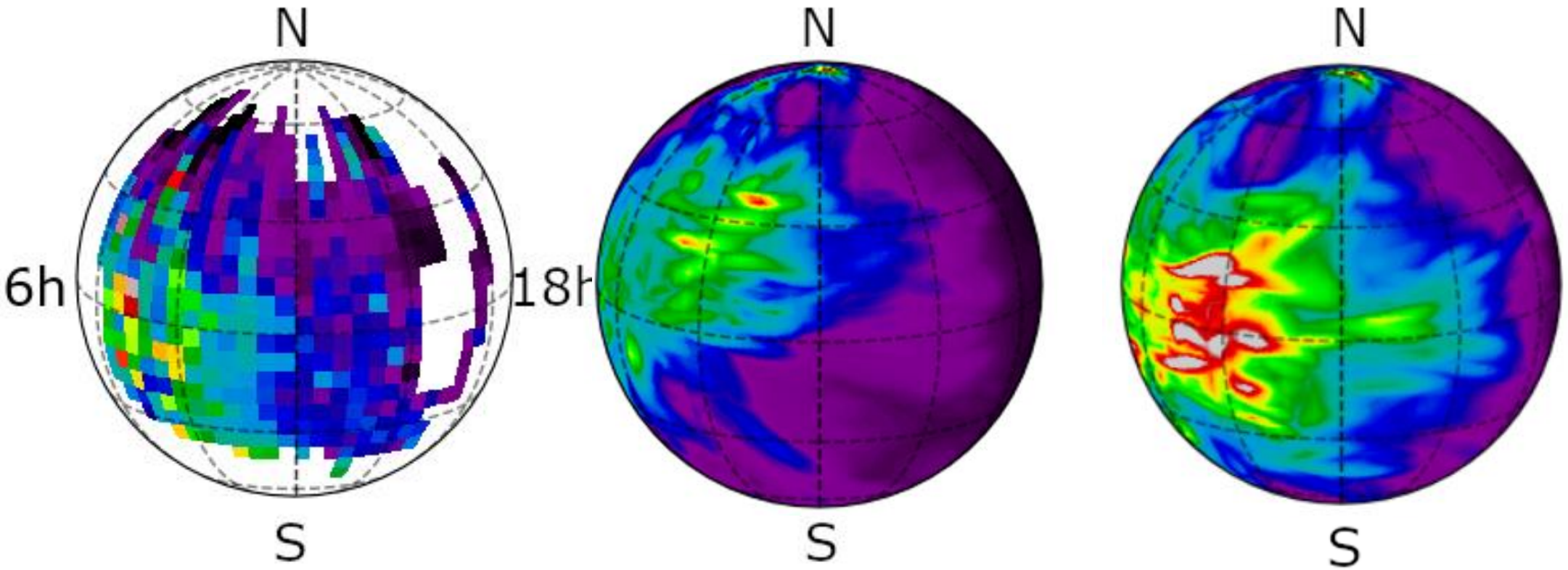


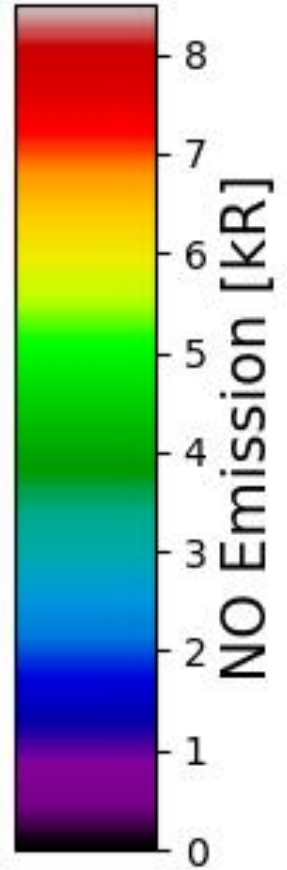
SPICAV nadir observations

Venus PCM with old kzz

Venus PCM with new kzz

Integrated NO emission max values over 1 Venusian day (kR)



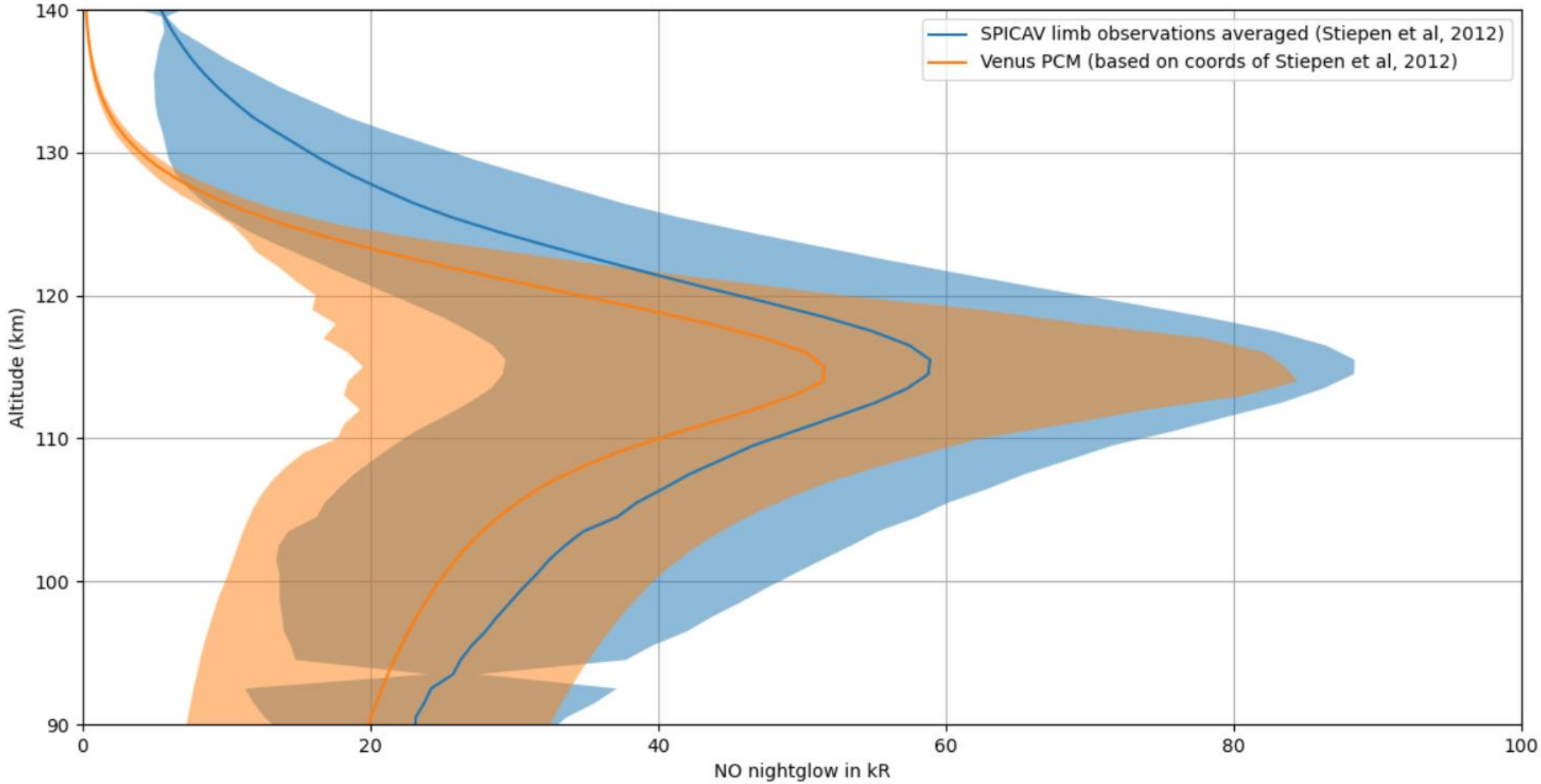


SPICAV nadir observations

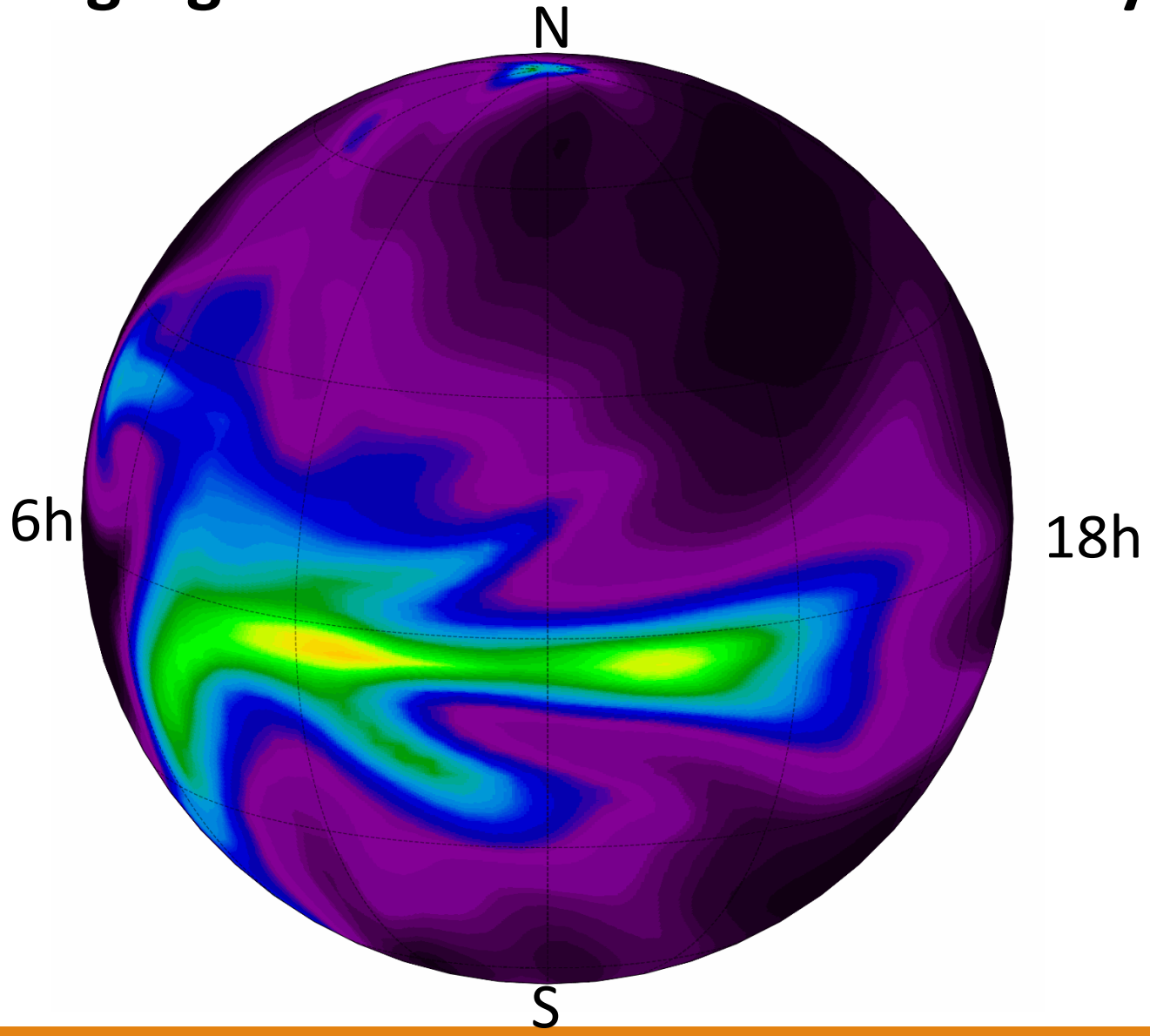
Venus PCM with old kzz

Venus PCM with new kzz

NO nightglow vertical distribution



NO nightglow short timescale variability



Take away message - 1

The Venus PCM is now reproducing very well the NO nightglow

The culprit is probably the dynamics

- Both the spatial distribution and variability are well reproduced
- The intensity is nearly the same as the observations
- The peak altitude is now matching with the observations as well


Venus at Night in Infrared from Akatsuki *(JAXA/ISAS/DARTS/Damia BOUIC)*

Implementing clouds microphysics in the Venus PCM

N. Streel[1] , A. Määttänen[1], F. Lefèvre[1] , [1]LATMOS (Paris)

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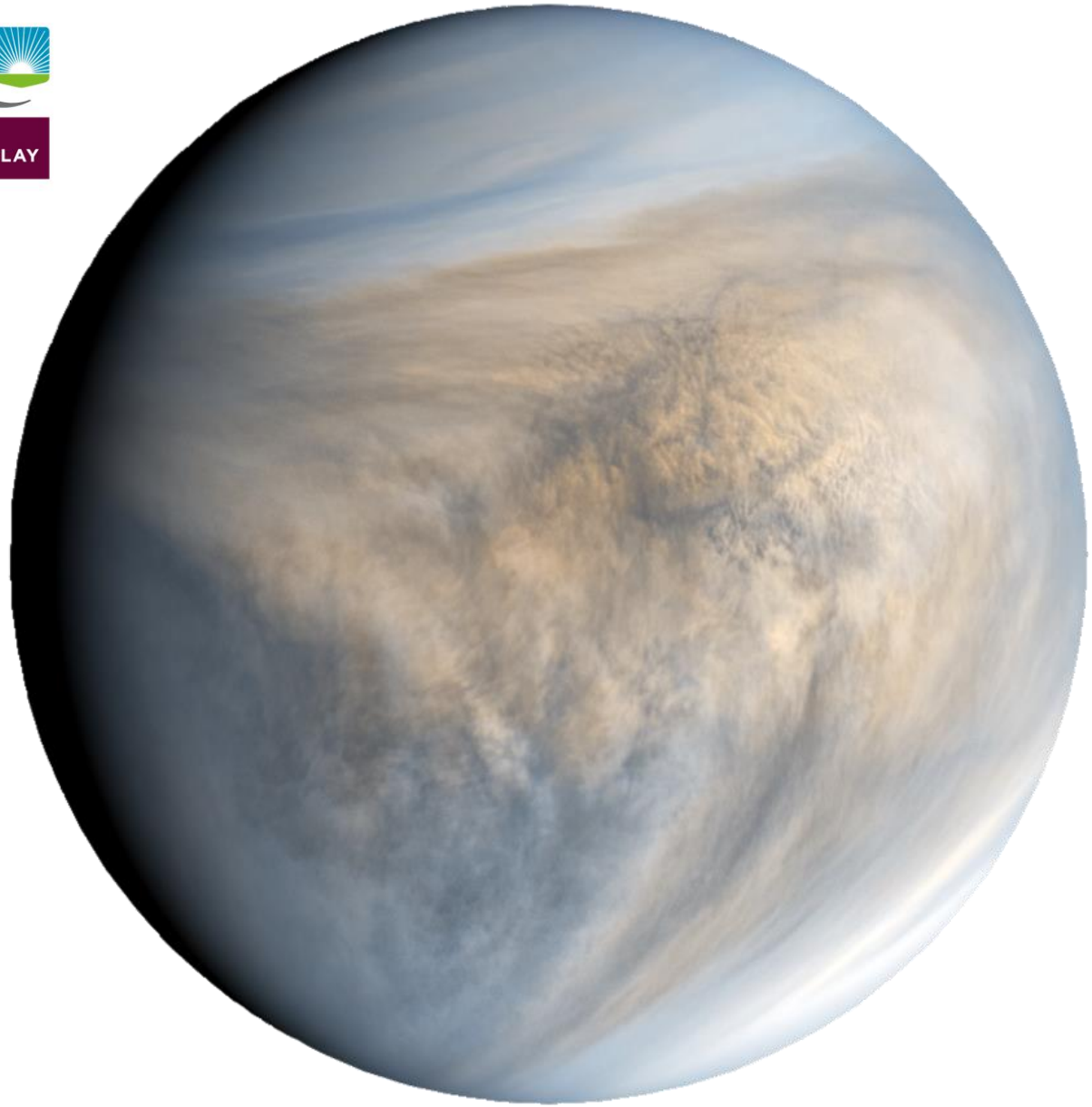
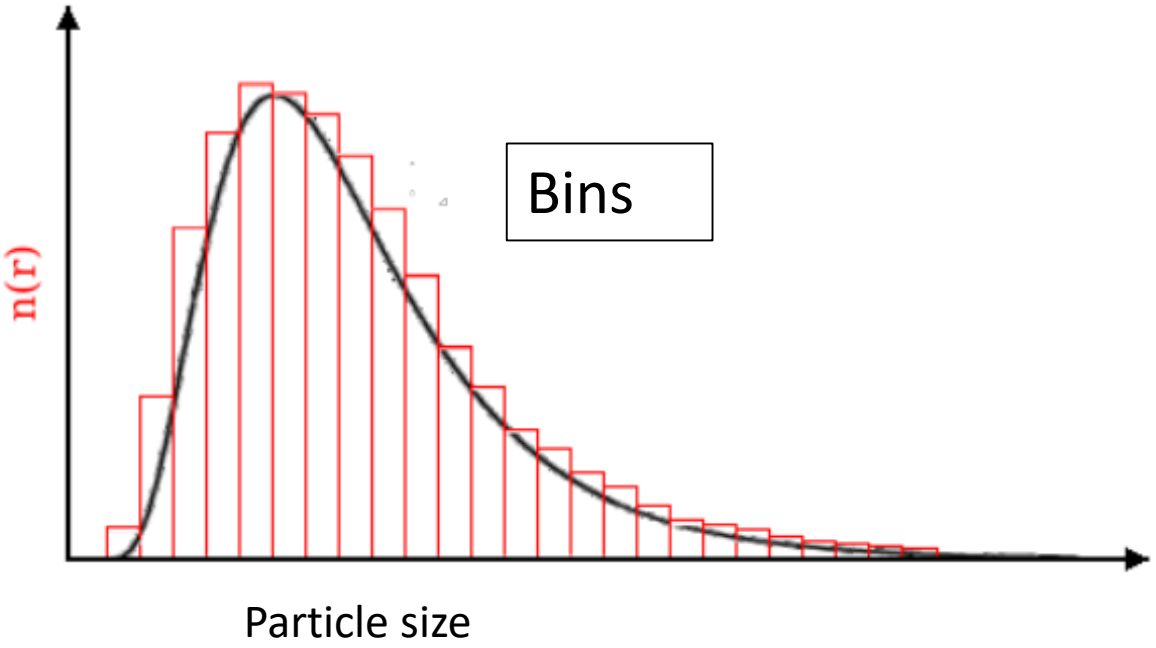
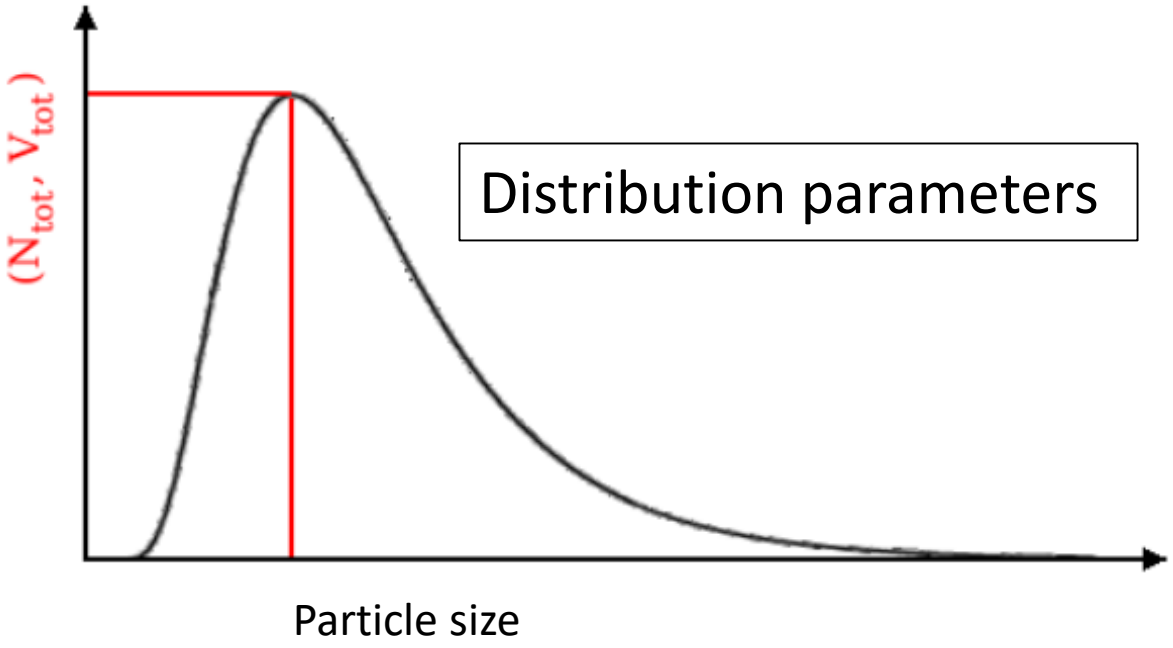


Quick description of MAD-VenLA





MAD-VenLA

Quick description of MAD-VenLA

MAD-VenLA hypothesis :

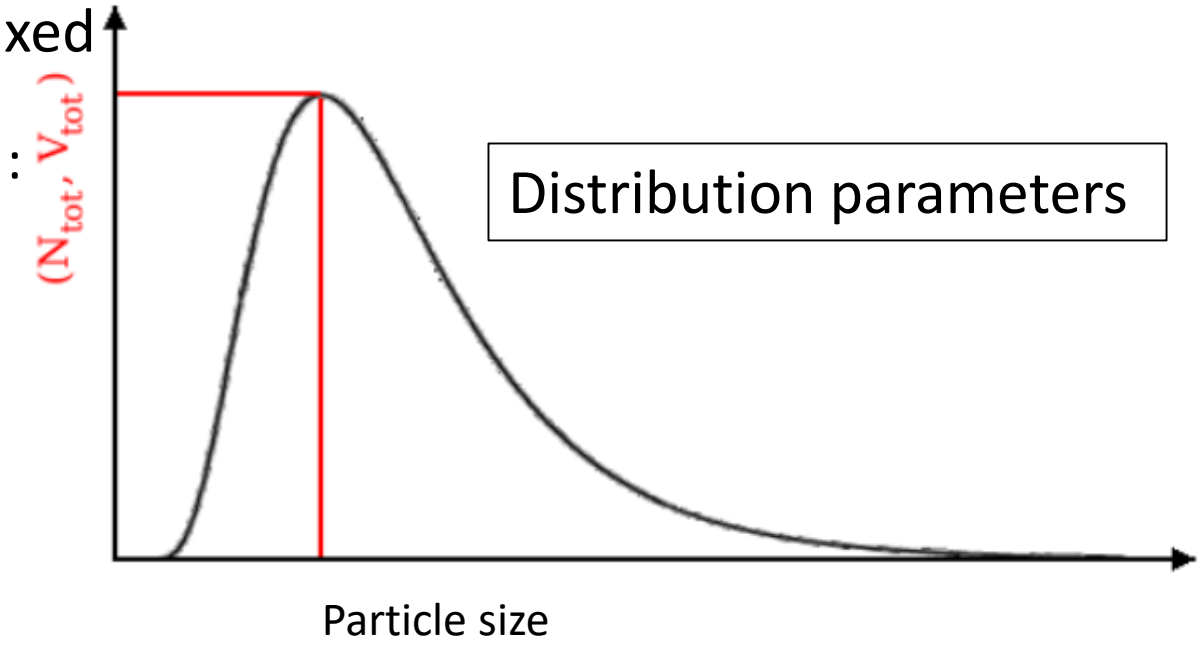
- Only two droplet modes -> (Only mode 1 and 2 particles)
- Shape of the distribution is fixed (log – normal distribution)
- Standard deviation of the distribution is fixed

Moments that follow the evolution of each mode :
M_0 : the total number of particles
M_3 : total volume of particles

And for each of the moments 3 sub moments :

- One for water (liquid)
- One for sulfuric acid (liquid)
- One for condensation nuclei

Total of 12 tracers in the model



MAD-VenLA

Quick description of MAD-VenLA

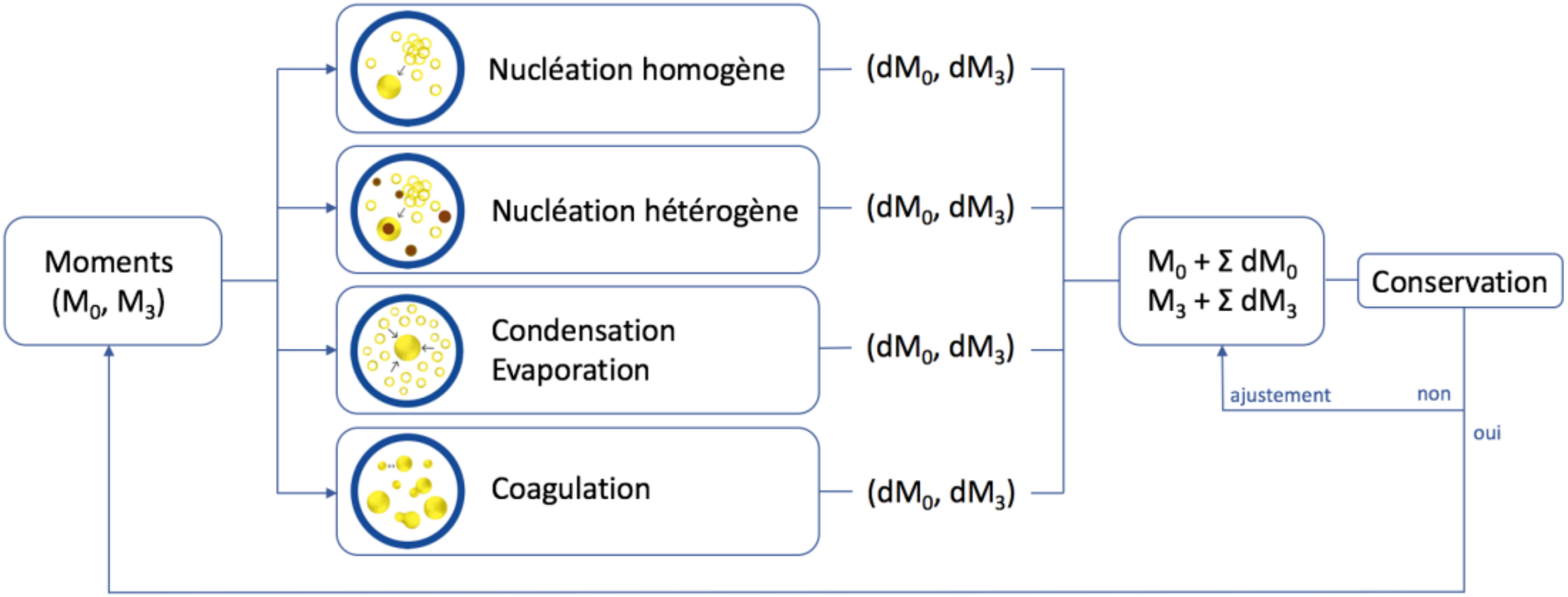
Processes modelled :

- Homogenous nucleation
- Heterogenous nucleation
- Brownian coagulation
- Condensation / evaporation

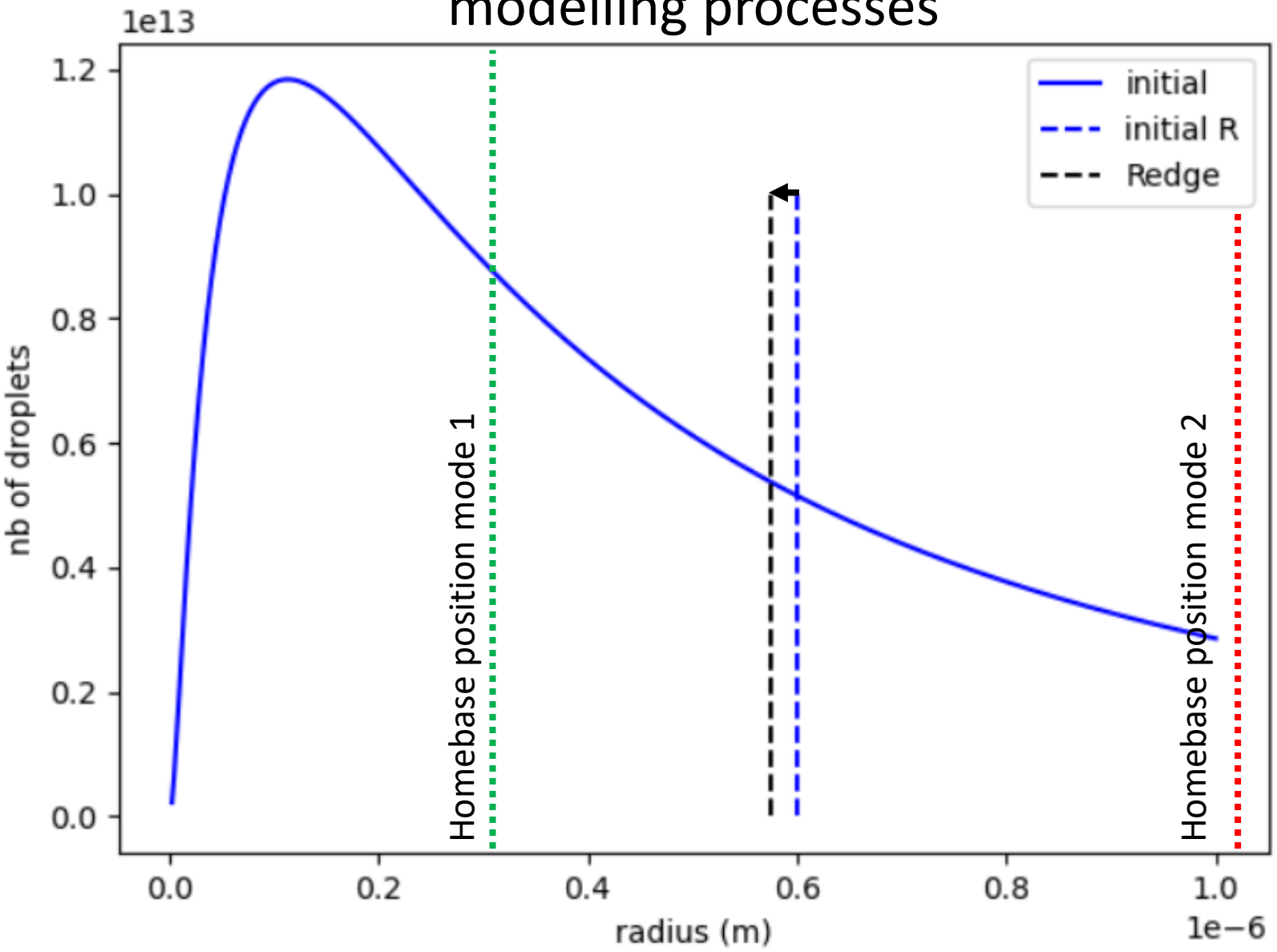
Modelling process:

- Mode merging -> to allow droplets to move from one mode to the other

Quick description of MAD-VenLA : physical processes

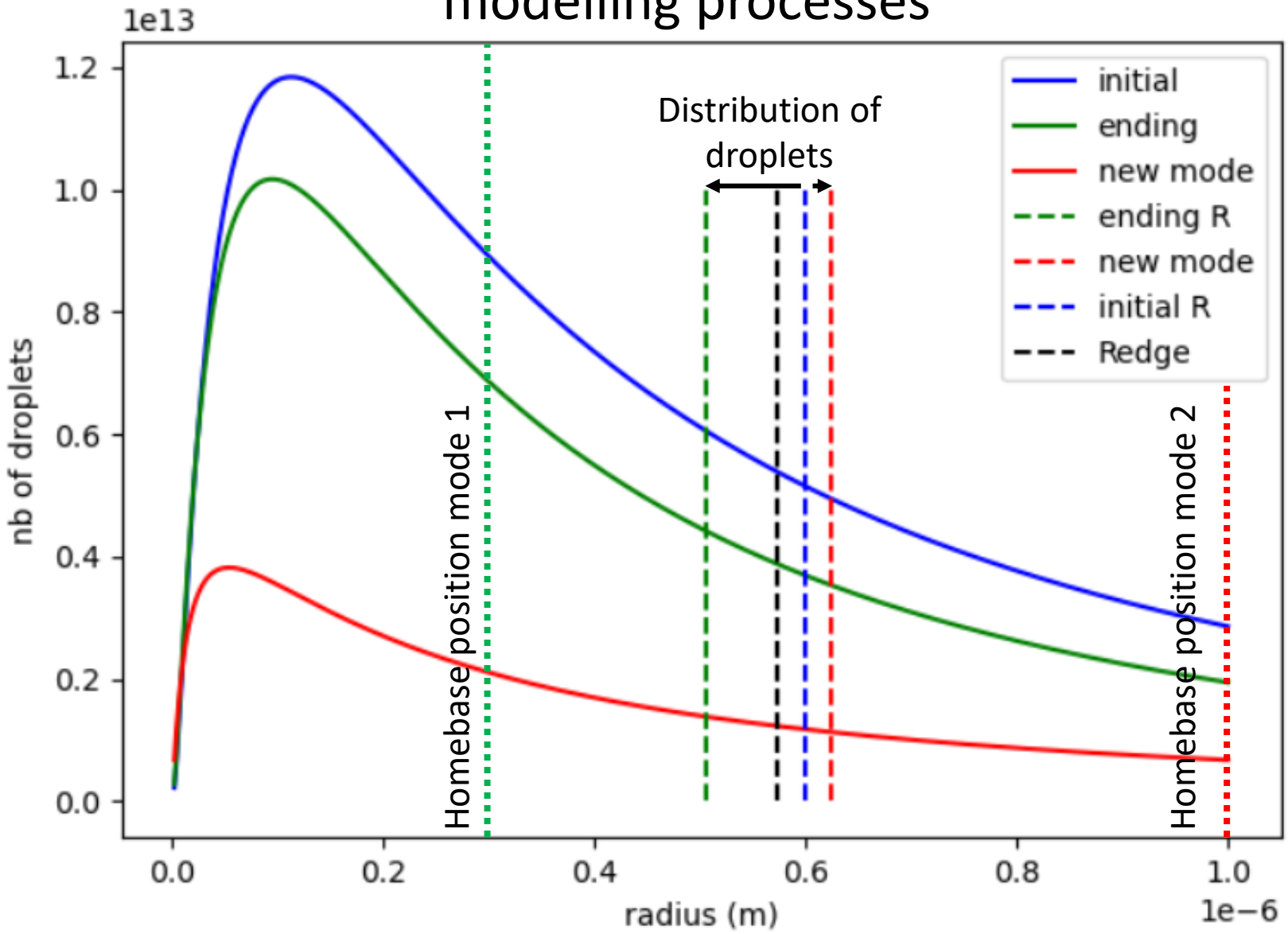


Quick description of MAD-VenLA : modelling processes



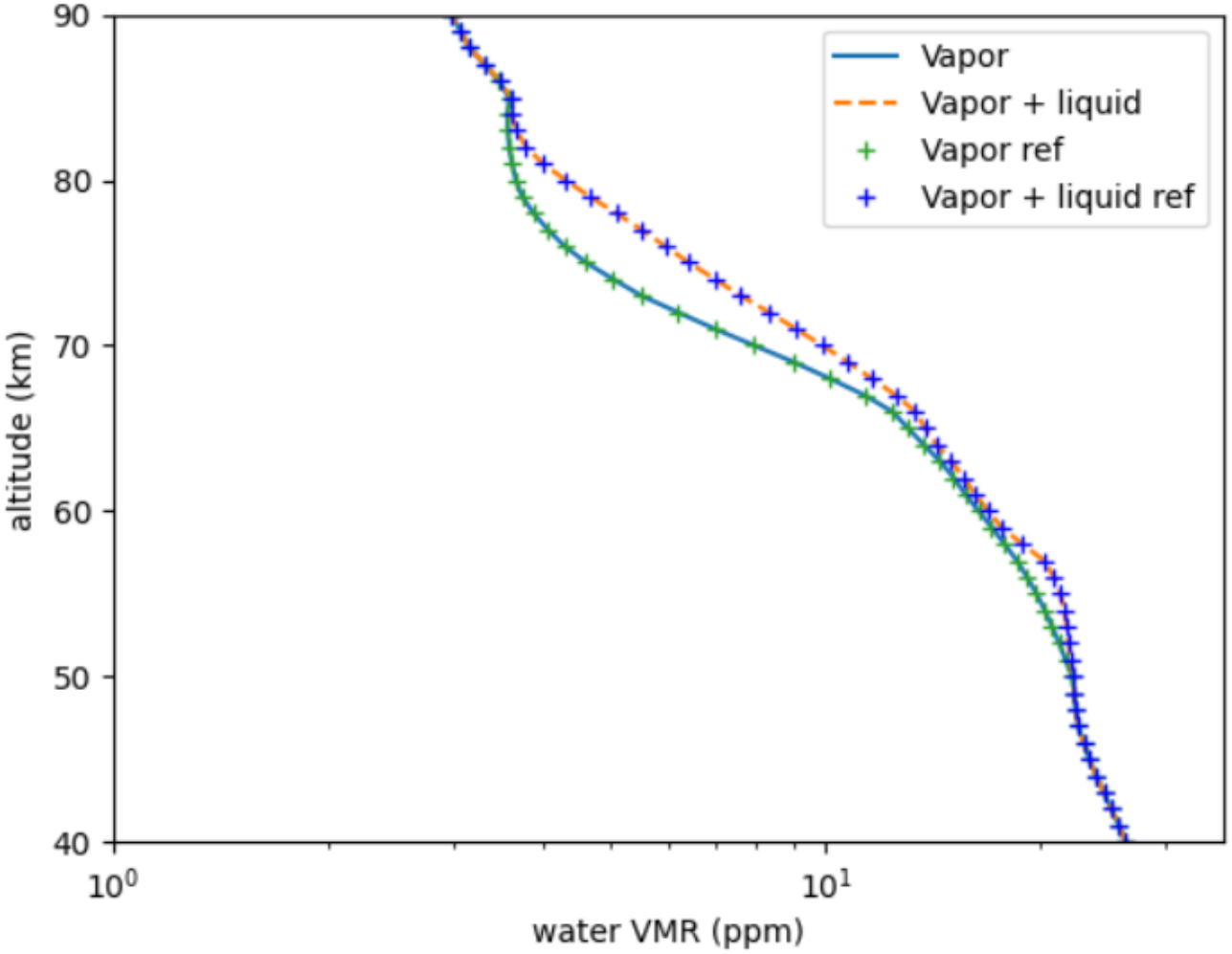
Based on :
Whitby et al, 2002

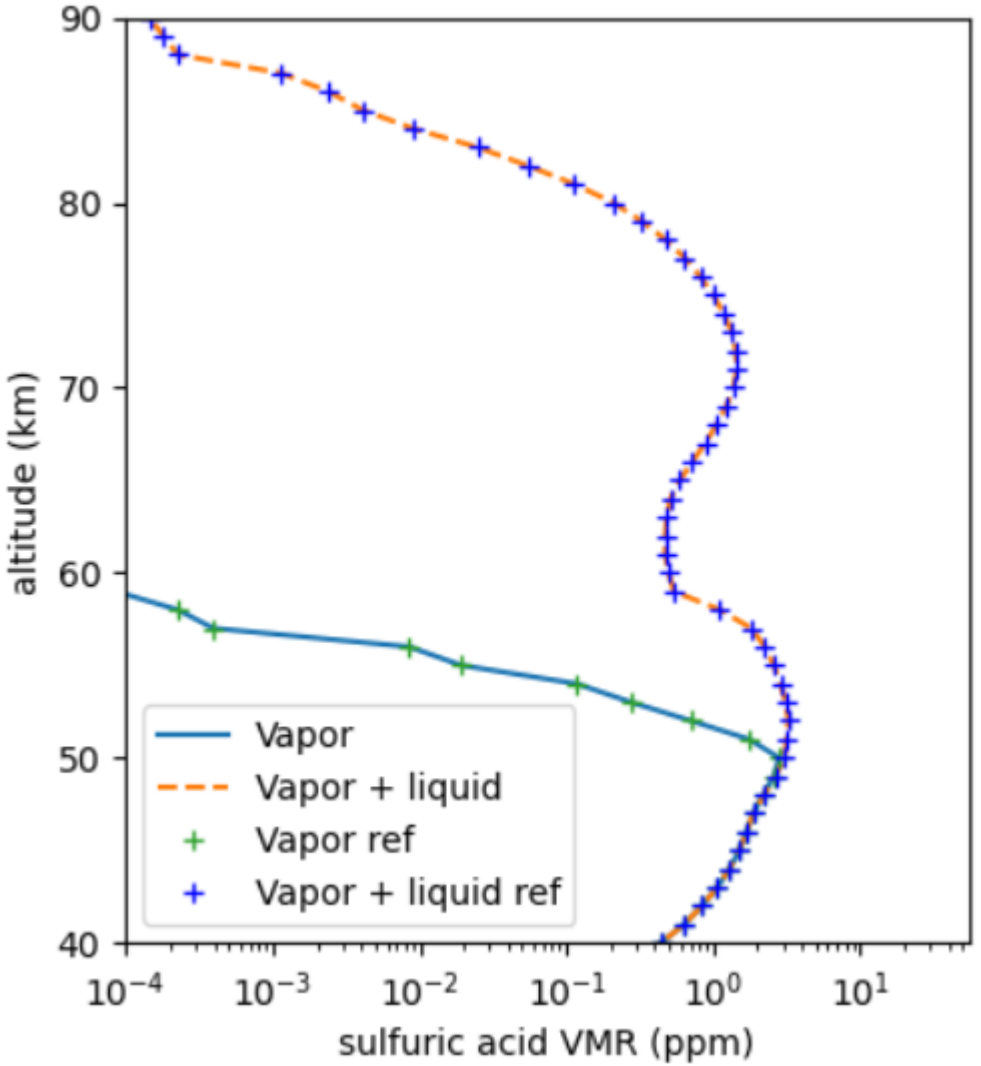
Quick description of MAD-VenLA : modelling processes



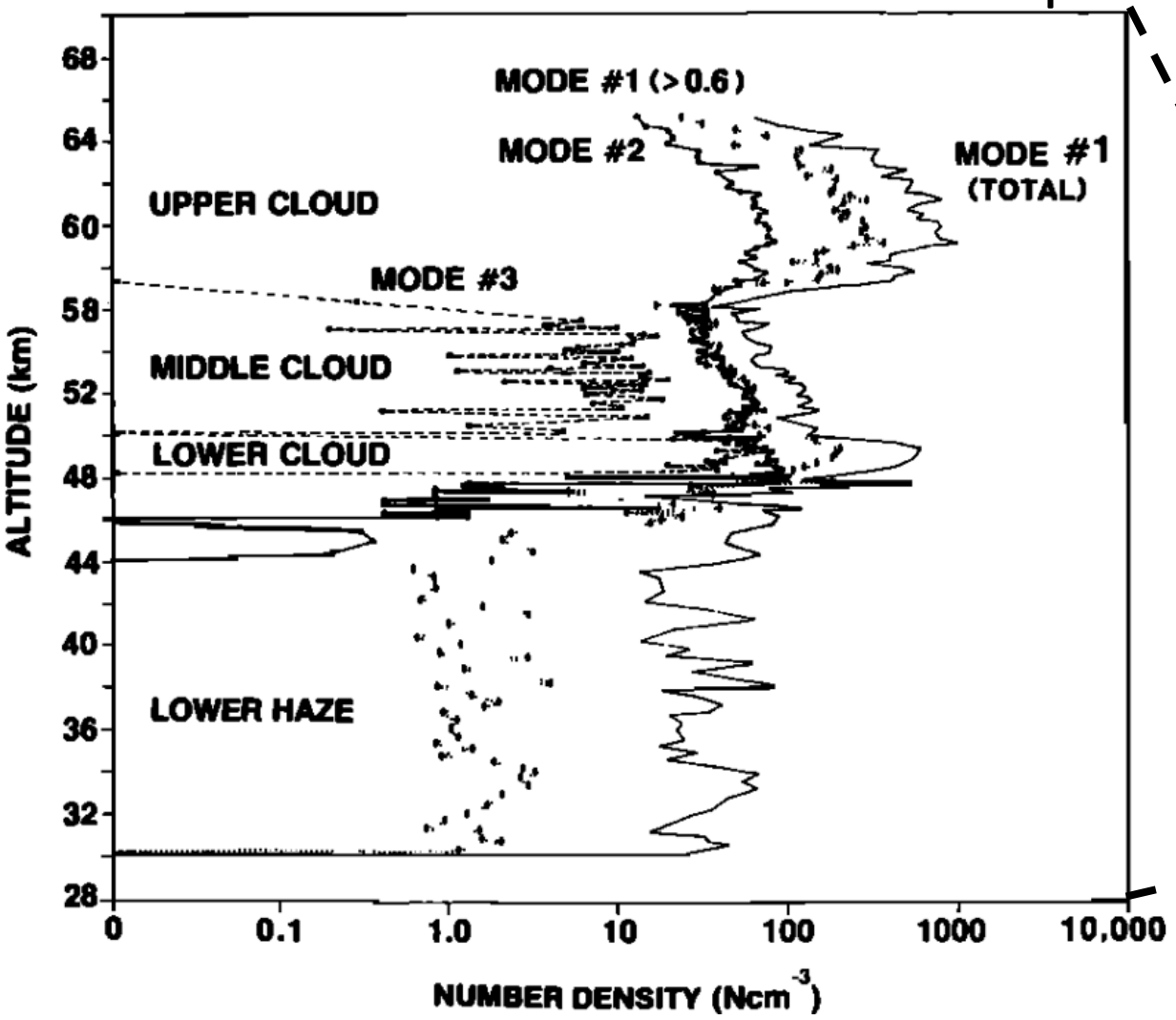
Based on :
Whitby et al, 2002

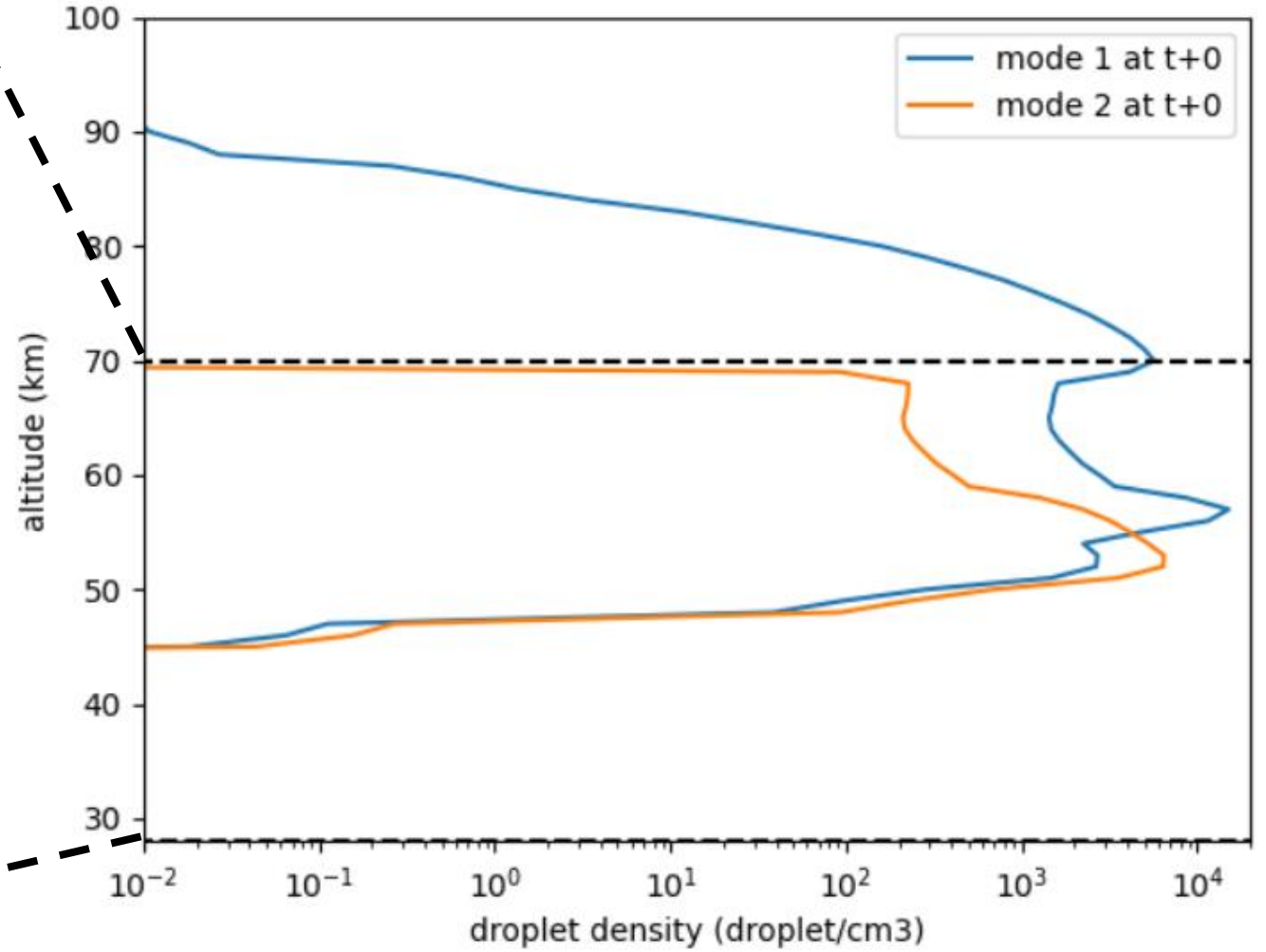
Implementing clouds in the Venus PCM
Chemical profiles





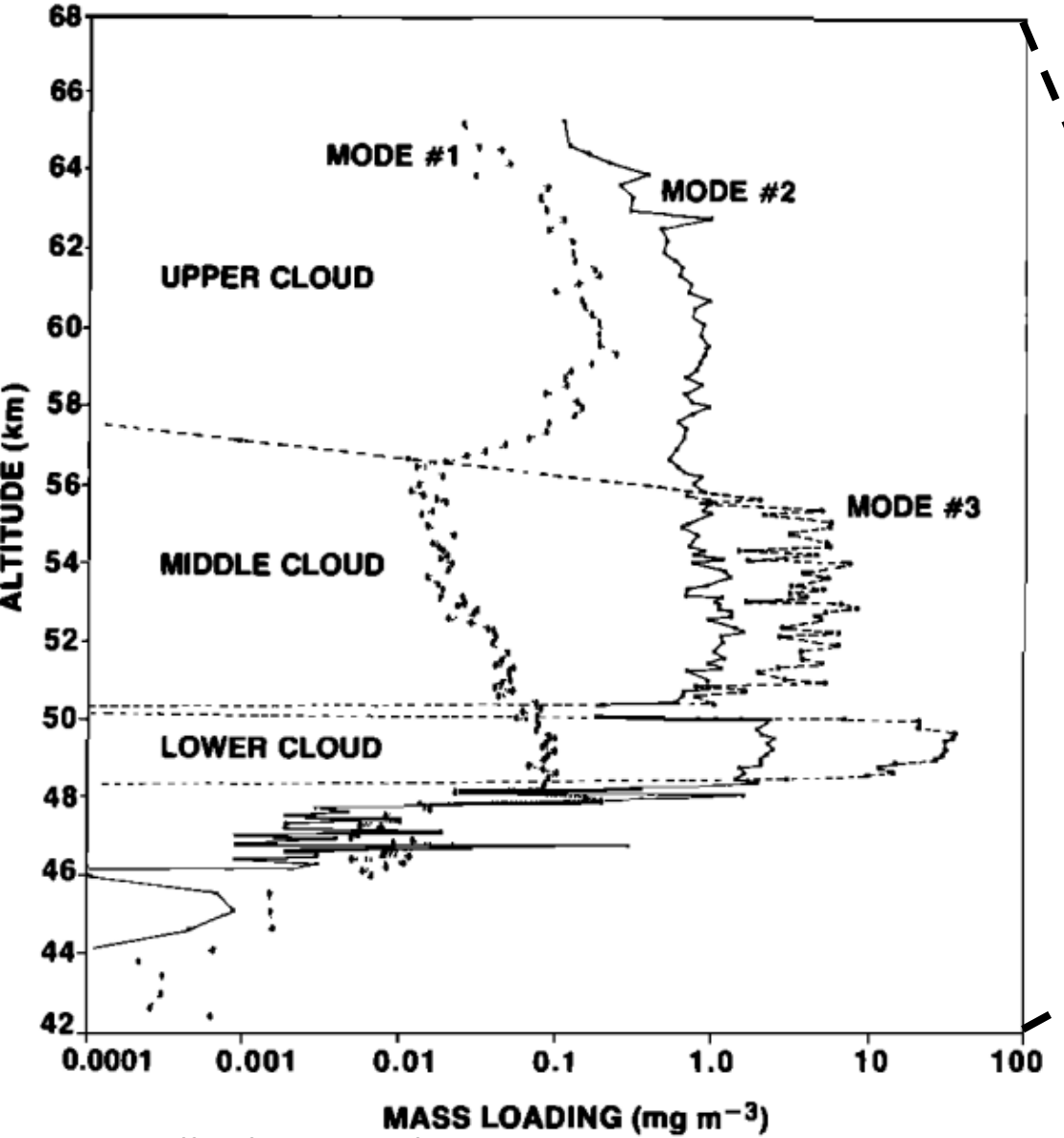
Implementing clouds in the Venus PCM
Droplet distribution



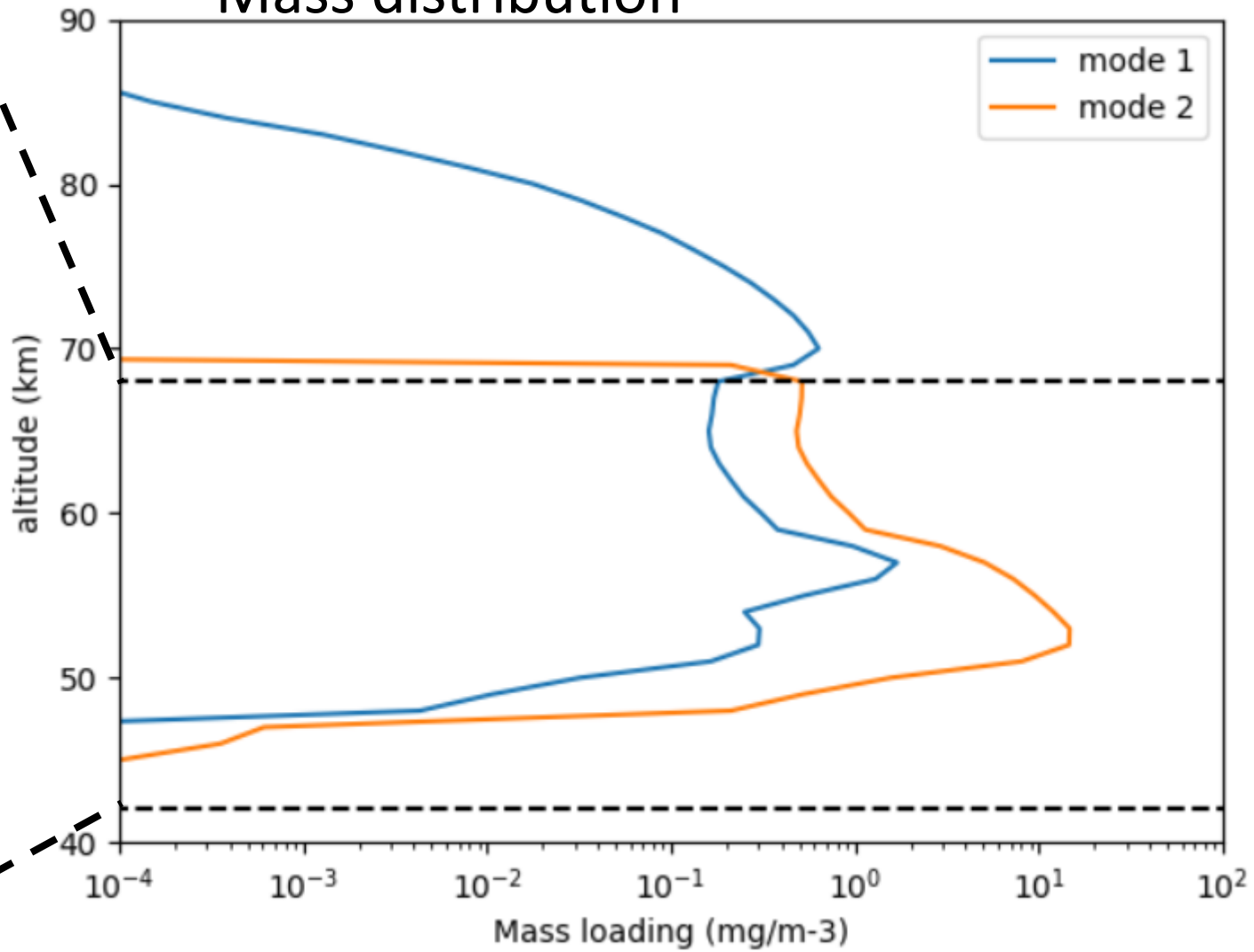


Knollenberg et al, 1980

Implementing clouds in the Venus PCM
Mass distribution

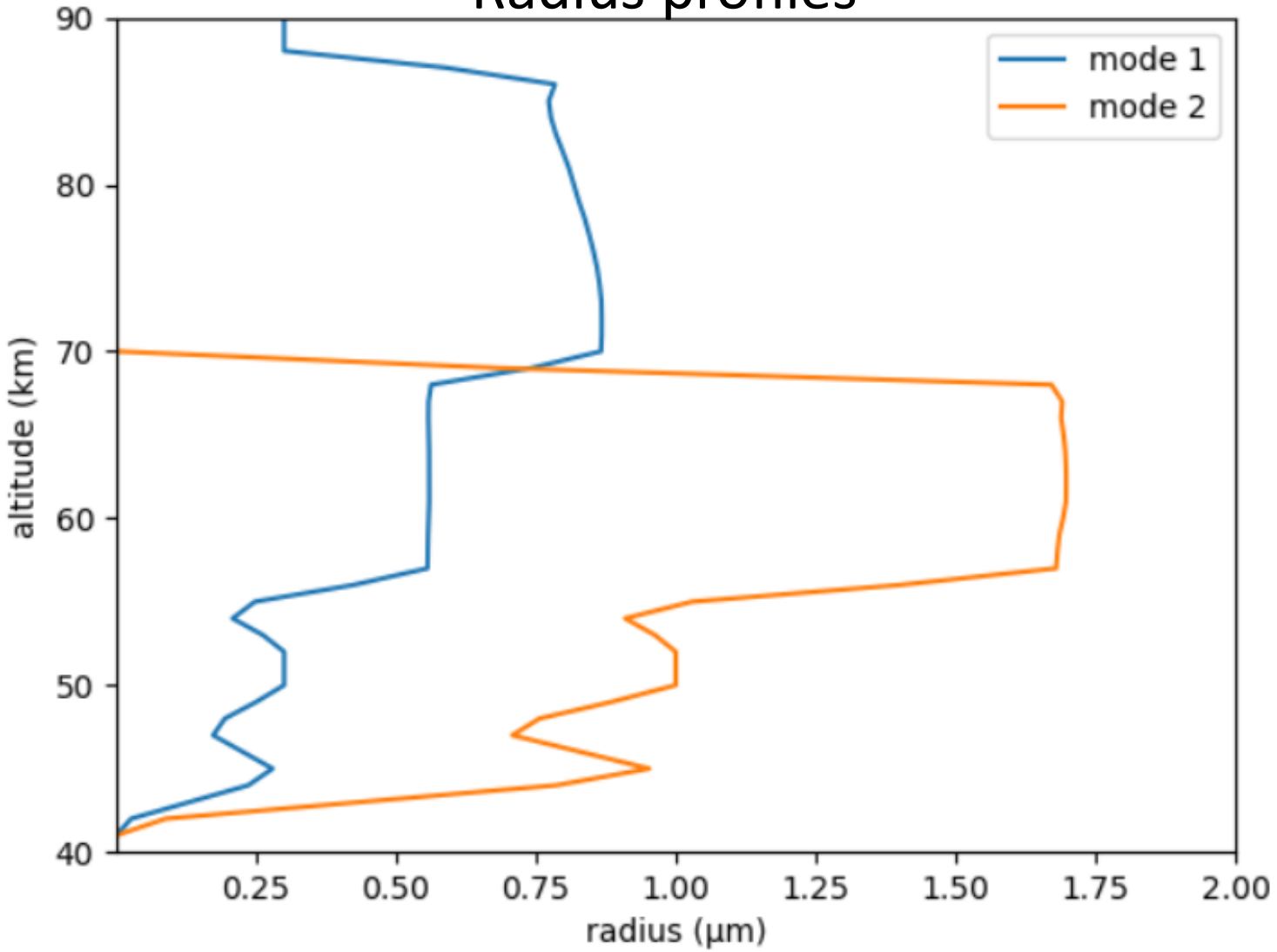


Knollenberg et al, 1980



Venus PCM

Implementing clouds in the Venus PCM
Radius profiles



Take away message - 2

Transition from the old cloud scheme into the microphysical model seems to be smooth

- The total amount of H2O and H2SO4 are respected
- The extension of mode 2 is compatible with the height of the cloud layer.
- Mass distribution is coherent with the expected behaviour
- Radius of mode 1 droplets in the 70/90 km region is too big

Halfway there !

Futur work

Working with the 1D version of the Venus PCM :

- Force some behaviour of the model (eddy diffusion, production of H2SO4…)
  - Ensuring that the evolution of the model is consistent with the expected behaviour

Working with the 3D version of the Venus PCM :

- Make sure it works
  - The behaviour of the coupling of the clouds and dynamic in the cloud distribution
  - Link the microphysics to the photolysis trough optical depth profile
  - Try new species as condensation nuclei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