Des données spectroscopiques à la modélisation d'exoplanètes

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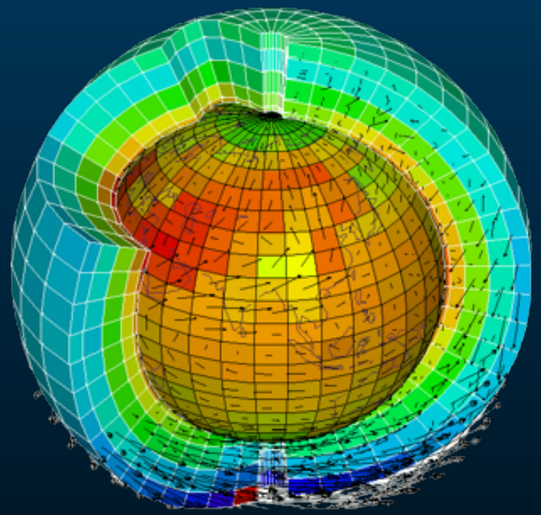
Radiative transfer calculation



Generic-PCM

Longitude -> 64
Latitude -> 48
Altitude -> 30

} 3072 cells

90 physical steps per day (every 16min)

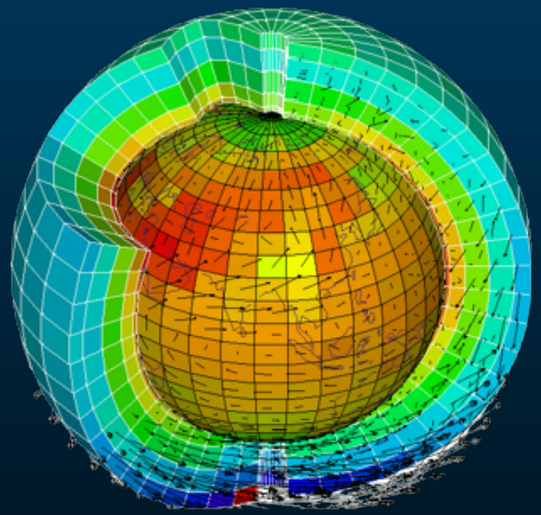
Radiative transfer is called every
4 physical time steps

73728 radiative transfer calculations per day

Line-by-Line spectra

Opacity data

Radiative transfer calculation



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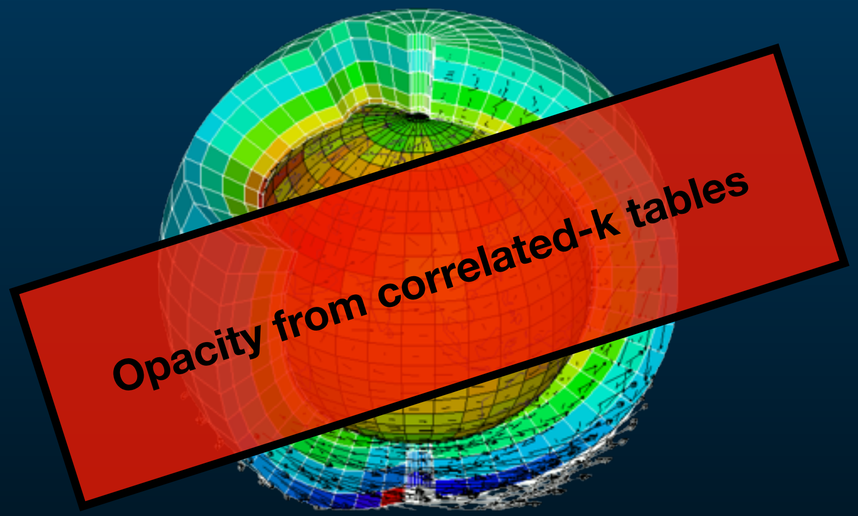
Correlated-k table

Line-by-Line spectra

e.g. Ding & Wordworth (2019)

Opacity data

Radiative transfer calculation



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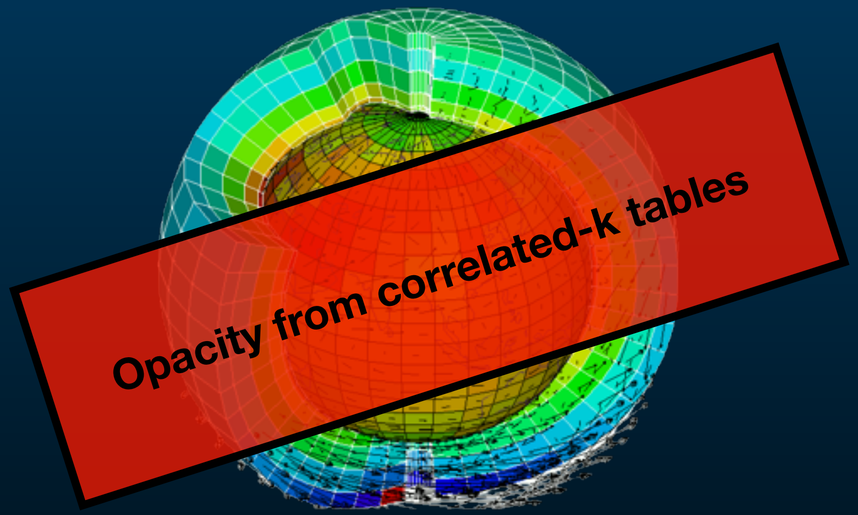

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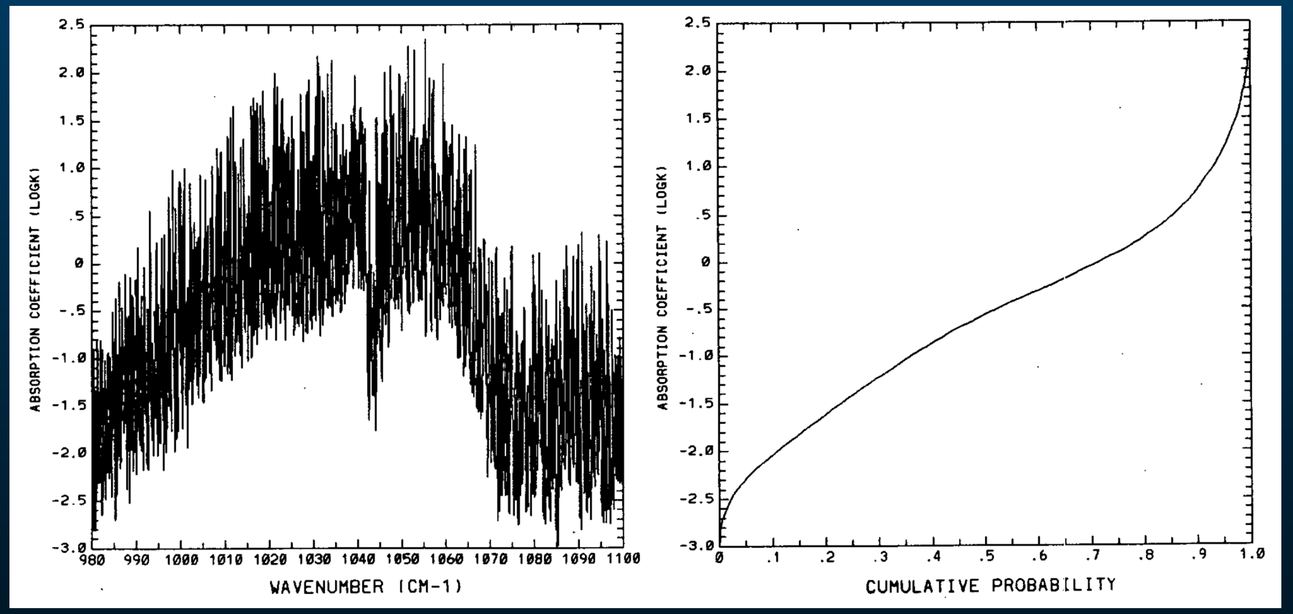
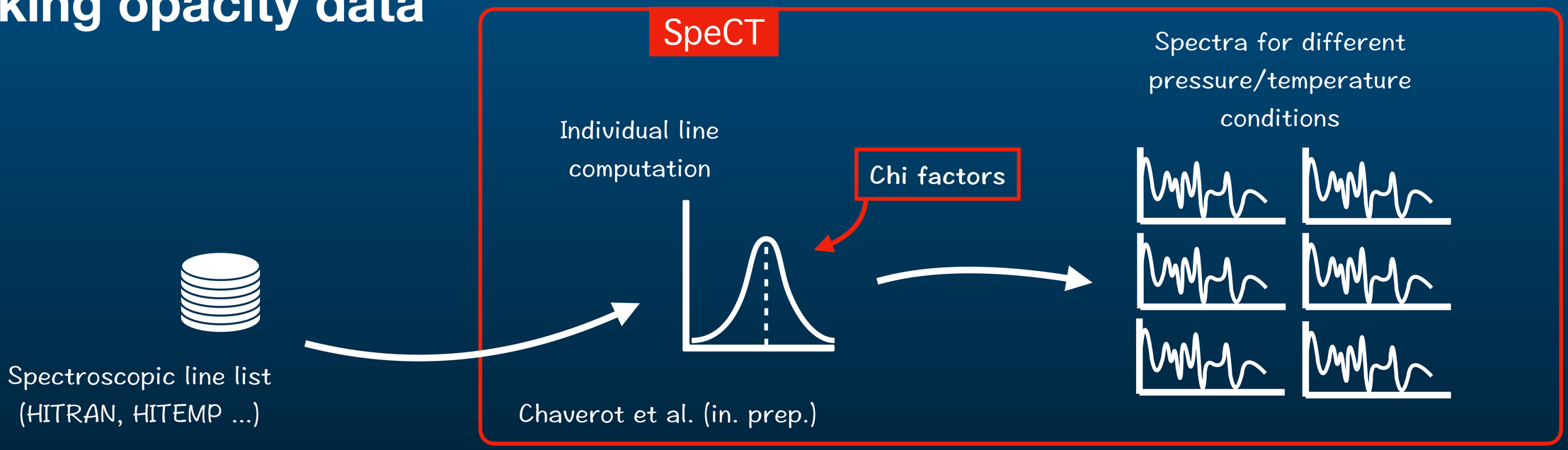


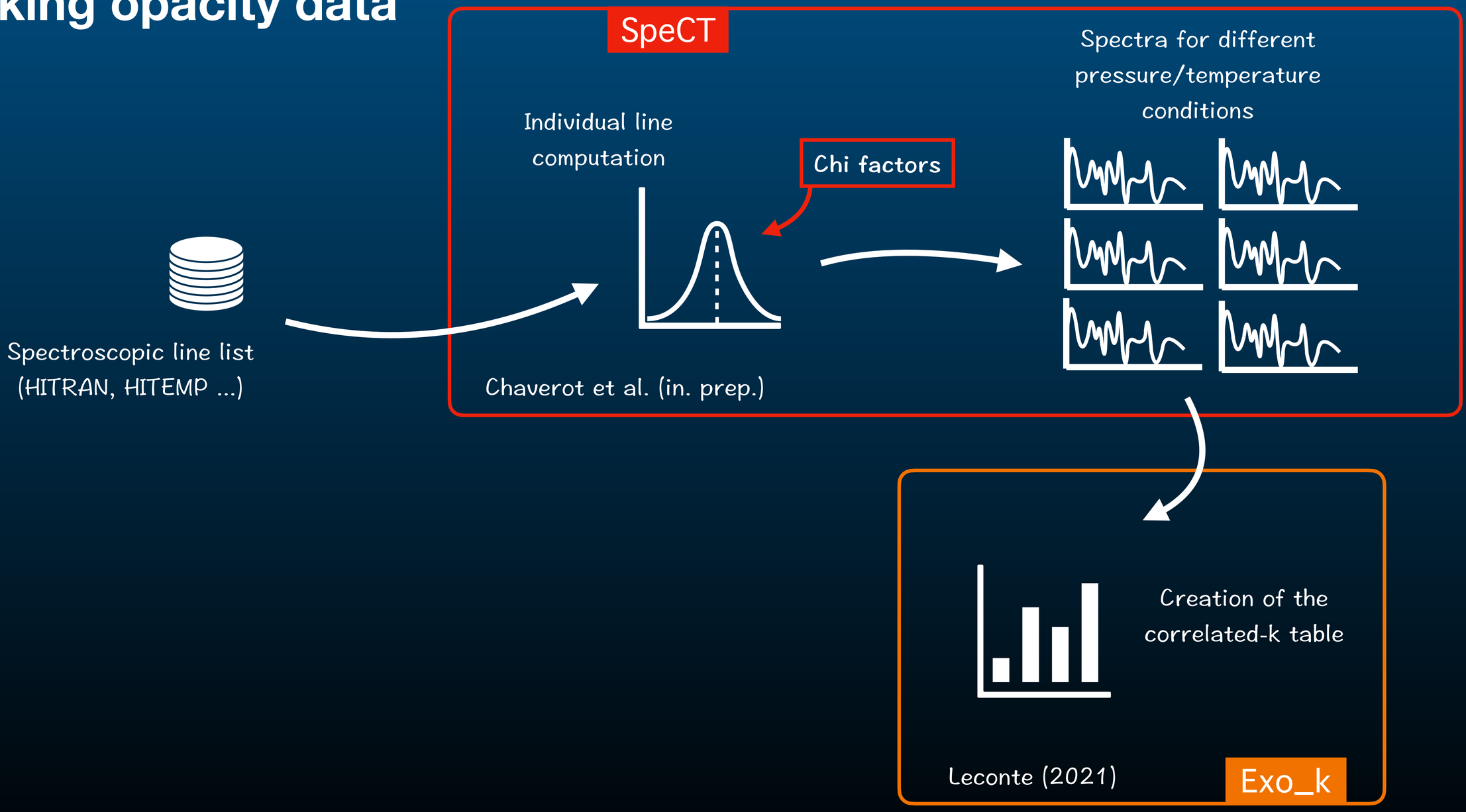
Fu et al. (1992)

Correlated-k table

Making opacity data



Making opacity data



Making opacity data

SpeCT

Spectroscopic line list
(HITRAN, HITEMP ...)

Individual line
computation

Chi factors

Chaverot et al. (in. prep.)

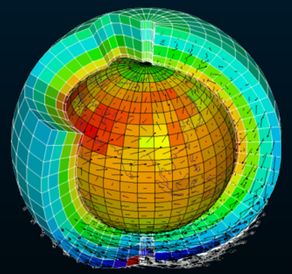
Spectra for different
pressure/temperature
conditions

Creation of the
correlated-k table

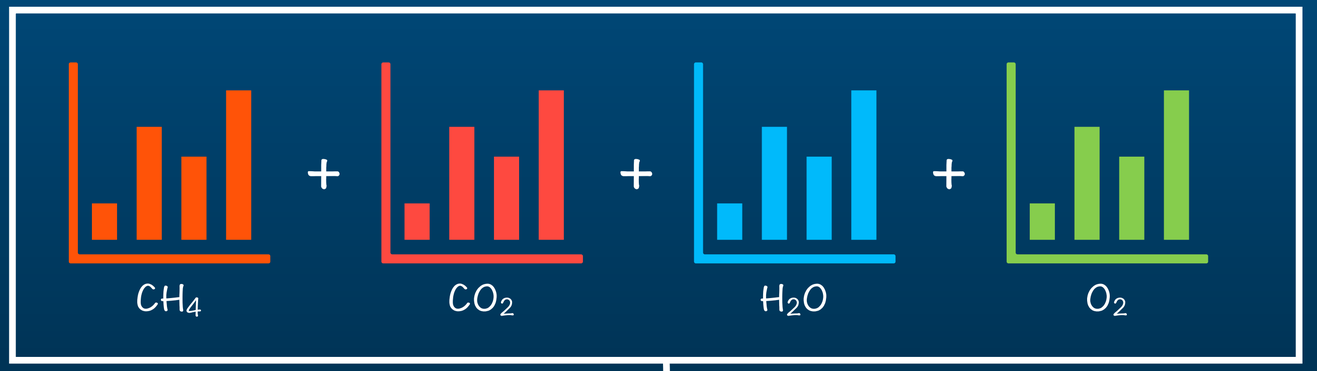
Leconte (2021)

Exo_k

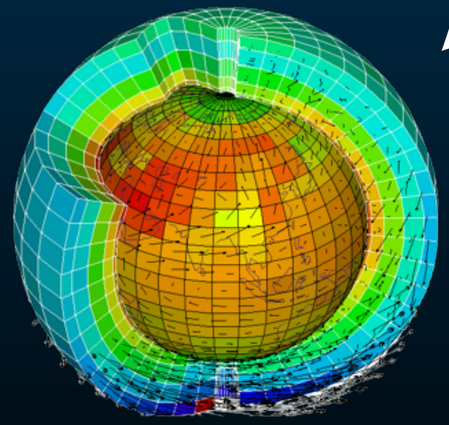
Climate modeling



Challenge of the composition



No interpecies interaction



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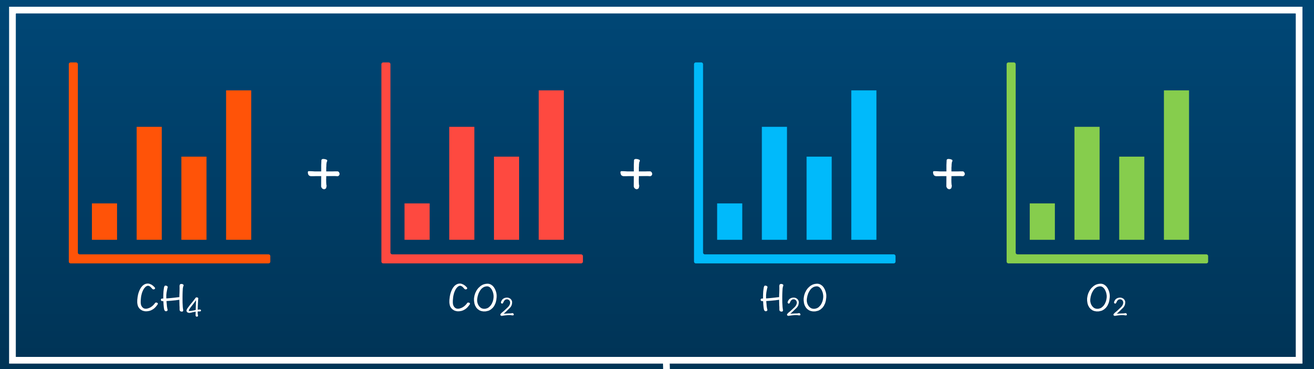
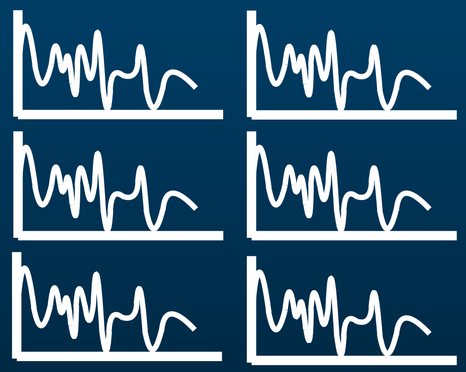


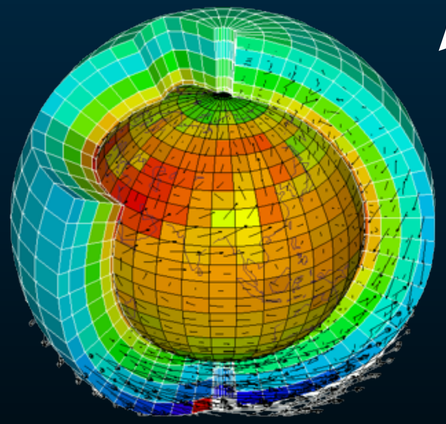


$H_2O + CO_2 + O_2 + CH_4$

$H_2O + CO_2$
$+ O_2 + CH_4$

Accurate opacities but one single composition -> time consuming

No interpecies interaction



Spectra for Correlated-k Tables (SpeCT)

PRESSURE

From few Pa to tens of bar

TEMPERATURE

From few Kelvin to few thousands

0K > HITRAN > 400K
400K < HITEMP < 3000K

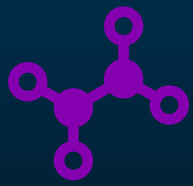
WAVELENGTH

Visible and infrared up to microwave
350nm -> 10mm

High resolution to resolve each individual line

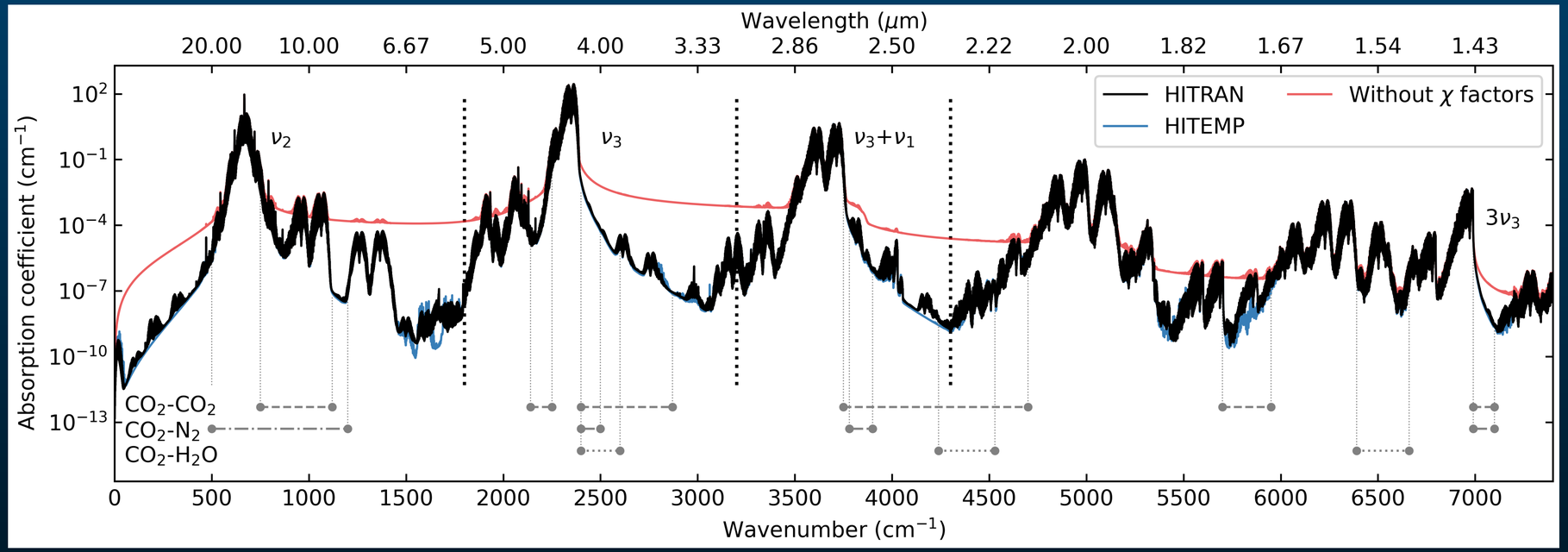
Various gas mixtures

H_2O+N_2
H_2O+CO_2
CO_2+N_2
$H_2O+CO_2+N_2$



Correction factors

Chaverot et al. (in. prep.)



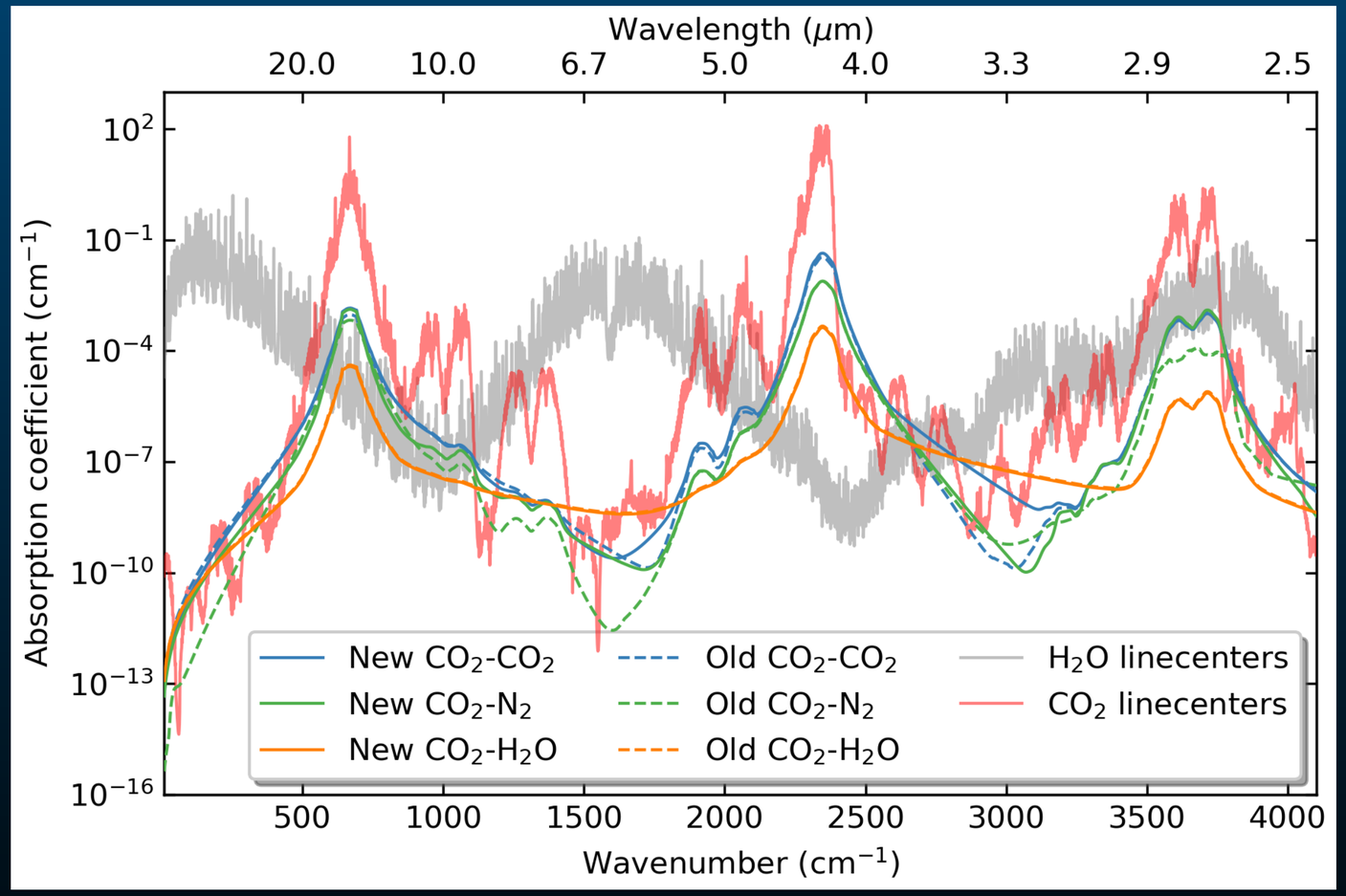
Aims:

1) Propose accurate opacity data for the climate modeling community
2) Calculate CO_2 continua, based on the Chi factor formalism

Correction factors

Updated Chi factors:

- common formalism (Perrin & Hartmann 1989)
- using HITRAN 2020
- new experiment data: pure CO_2, 2600-2900cm^{-1} (Tran et al. 2024)
- Chi factor for a new band: ν_2, CO_2-N_2 (Niro et al. 2004)



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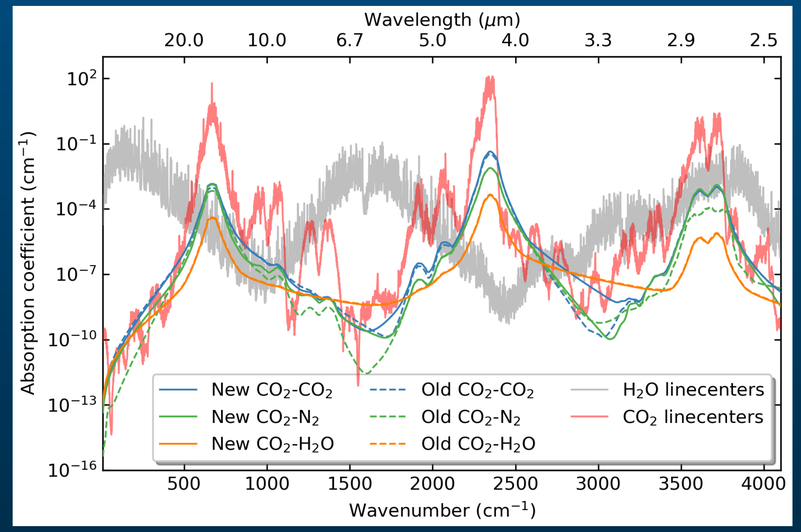
Next steps



Development of SpeCT:

- adding other greenhouse gases (e.g. CH_4)
- adding inter-species broadening for more gases (e.g. H2, O2)
- adding traces gas (CO, SO_2, He, H_2S)

Long term aims:

- creating an open-source database of correlated-k tablen using SpeCT (projet coordinated by M. Turbet)
- producing continua for all the molecules that are relevant for temperate exoplanets