Synopsis of the research conducted thus far


Theoritical model
Chiller setup
Temperature acquisition

First trial: code everything from scratch

Antoine equations, Raoult's law

$$x_1 + x_2 = 1$$

$$P_{bub} = x_1 P_1^{sat} + x_2 P_2^{sat}$$

$$P_{dew} = \left(\frac{y_1}{P_1^{sat}} + \frac{y_2}{P_2^{sat}} \right)^{-1}$$

$$P_i^{sat} = 10^{\left(A_i - \frac{B_i}{T + C_i} \right)}$$

Charts for Ai, Bi, Ci

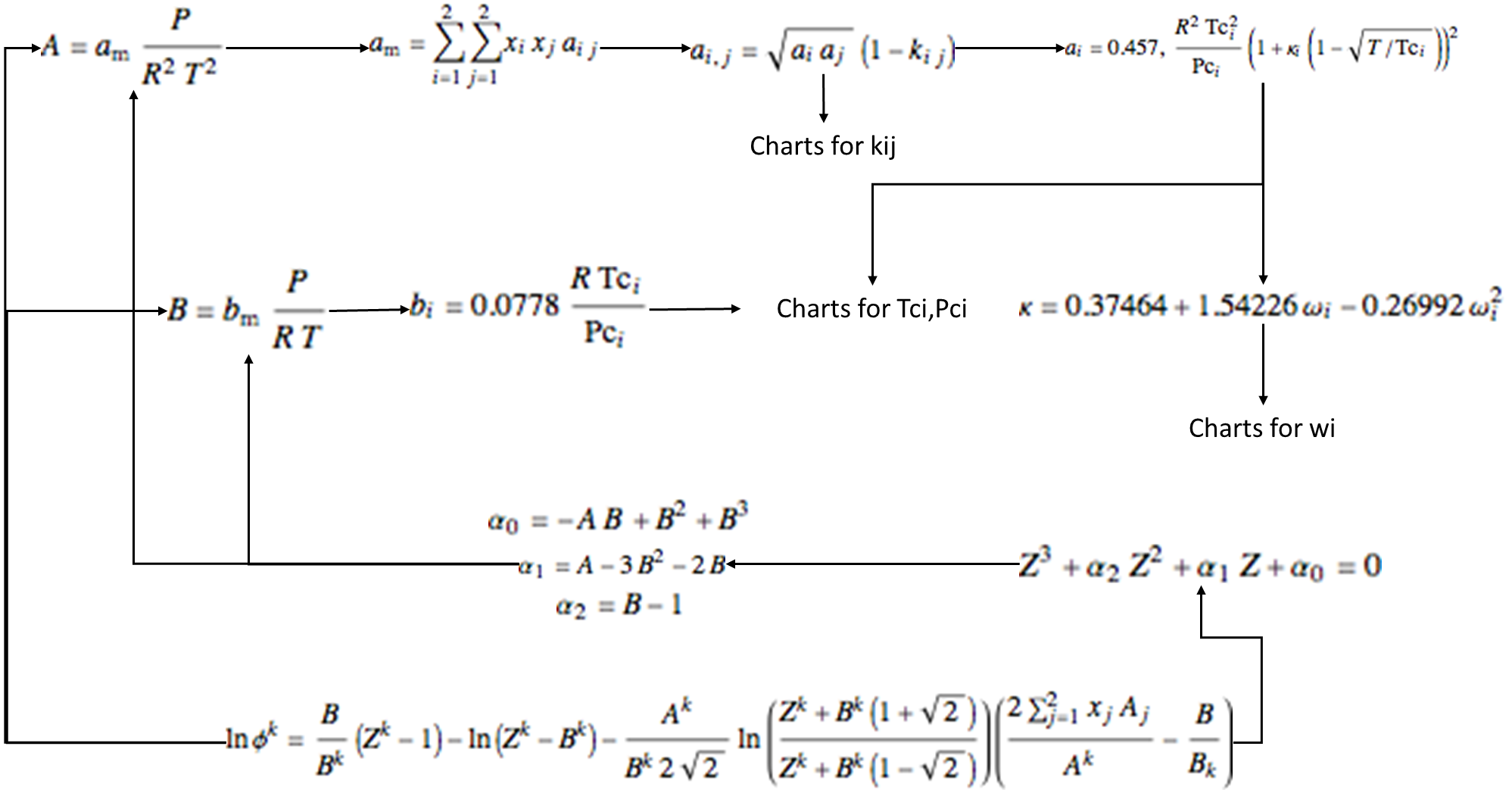
$$K_i = \frac{y_i}{x_i}$$

$$K_i = \frac{\phi_i^L}{\phi_i^V}$$

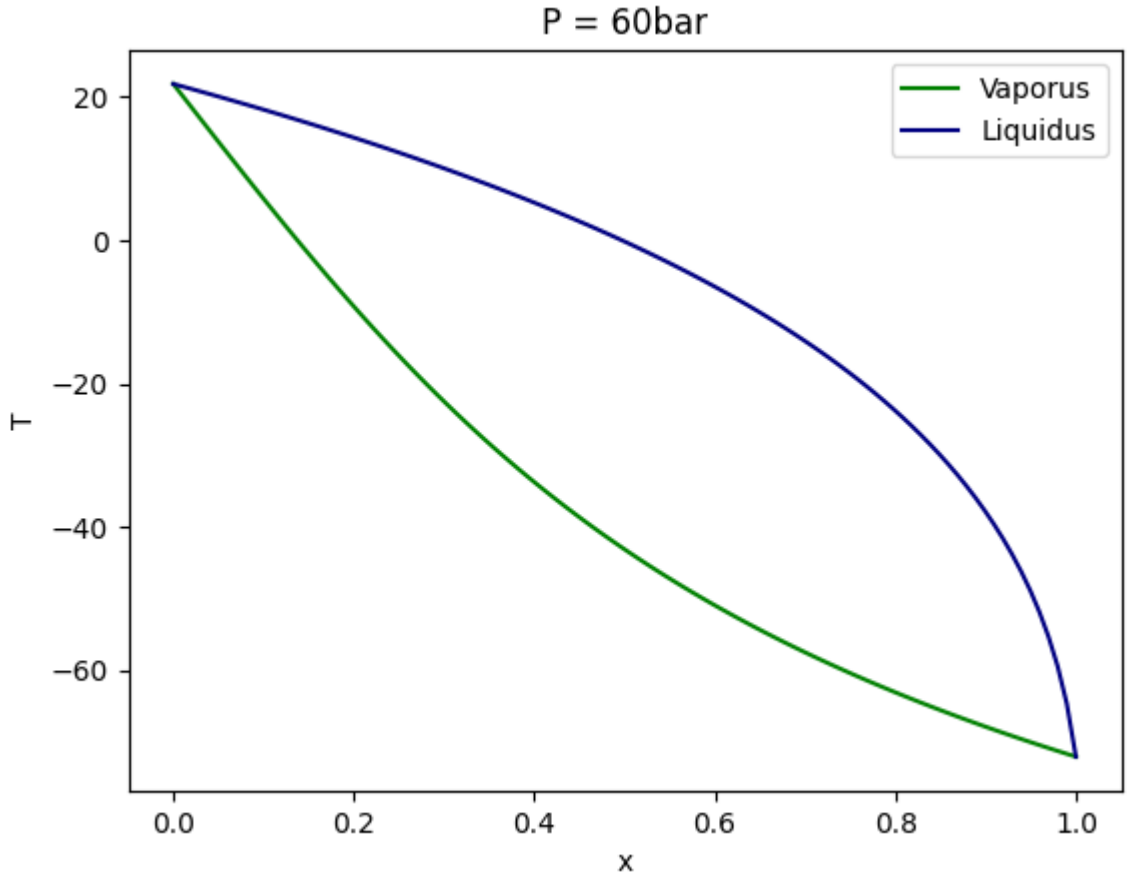
$$\ln \phi^k = \frac{B}{B^k}\left(Z^k - 1\right) - \ln\left(Z^k - B^k\right) - \frac{A^k}{B^k 2\sqrt{2}} \ln\left(\frac{Z^k + B^k\left(1 + \sqrt{2}\right)}{Z^k + B^k\left(1 - \sqrt{2}\right)}\right)\left(\frac{2\sum_{j=1}^{2} x_j A_j}{A^k} - \frac{B}{B_k}\right)$$

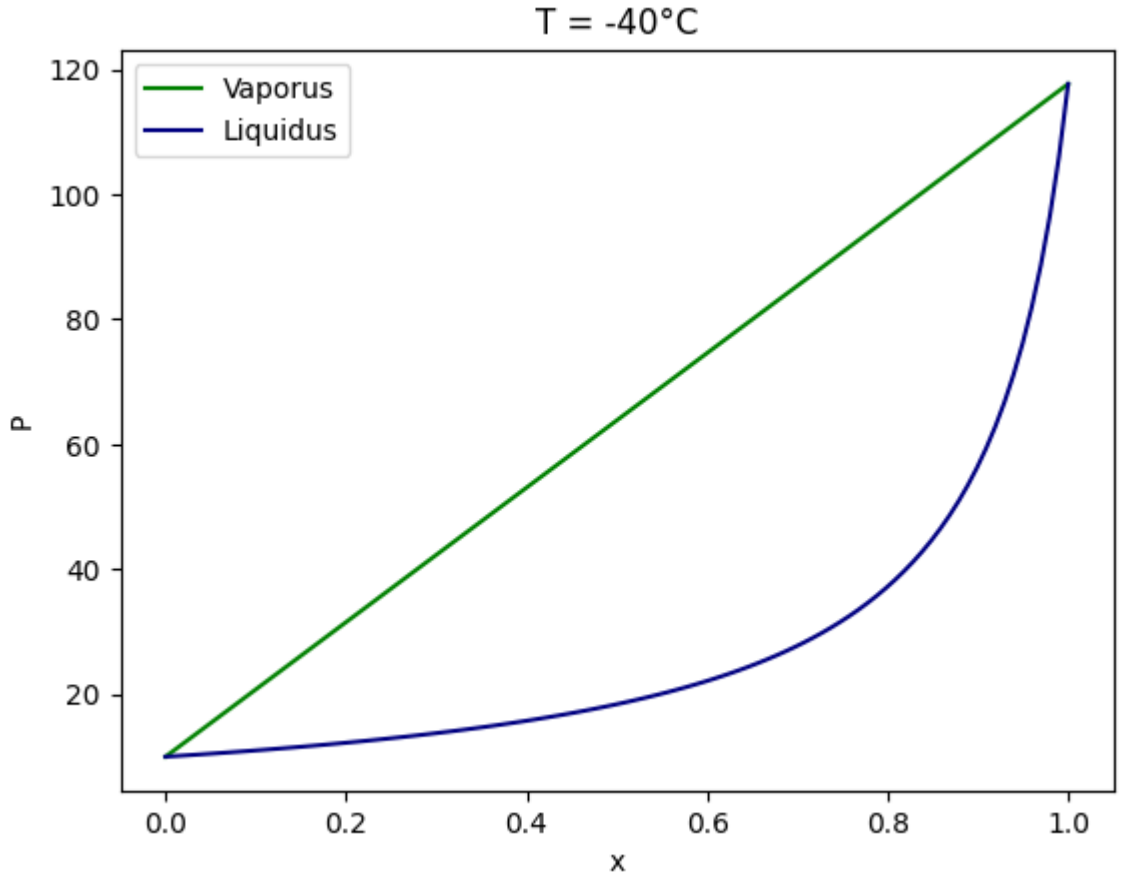
First trial: code everything from scratch

Peng-Robinson EOS

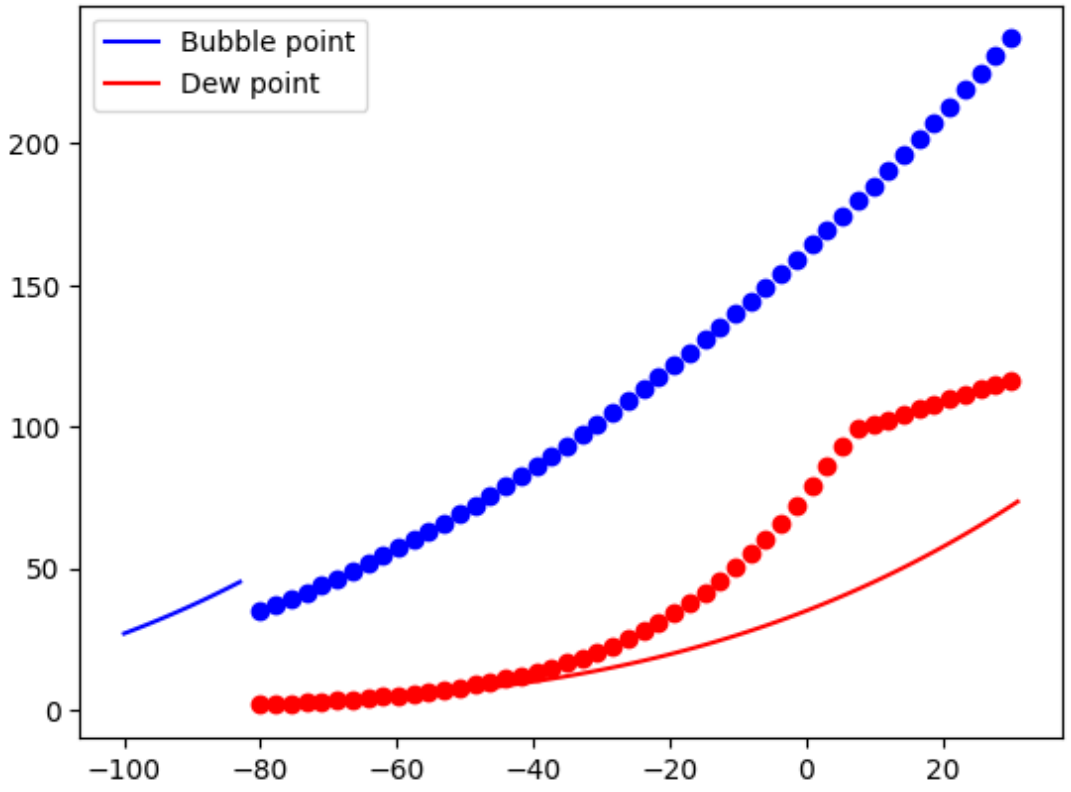


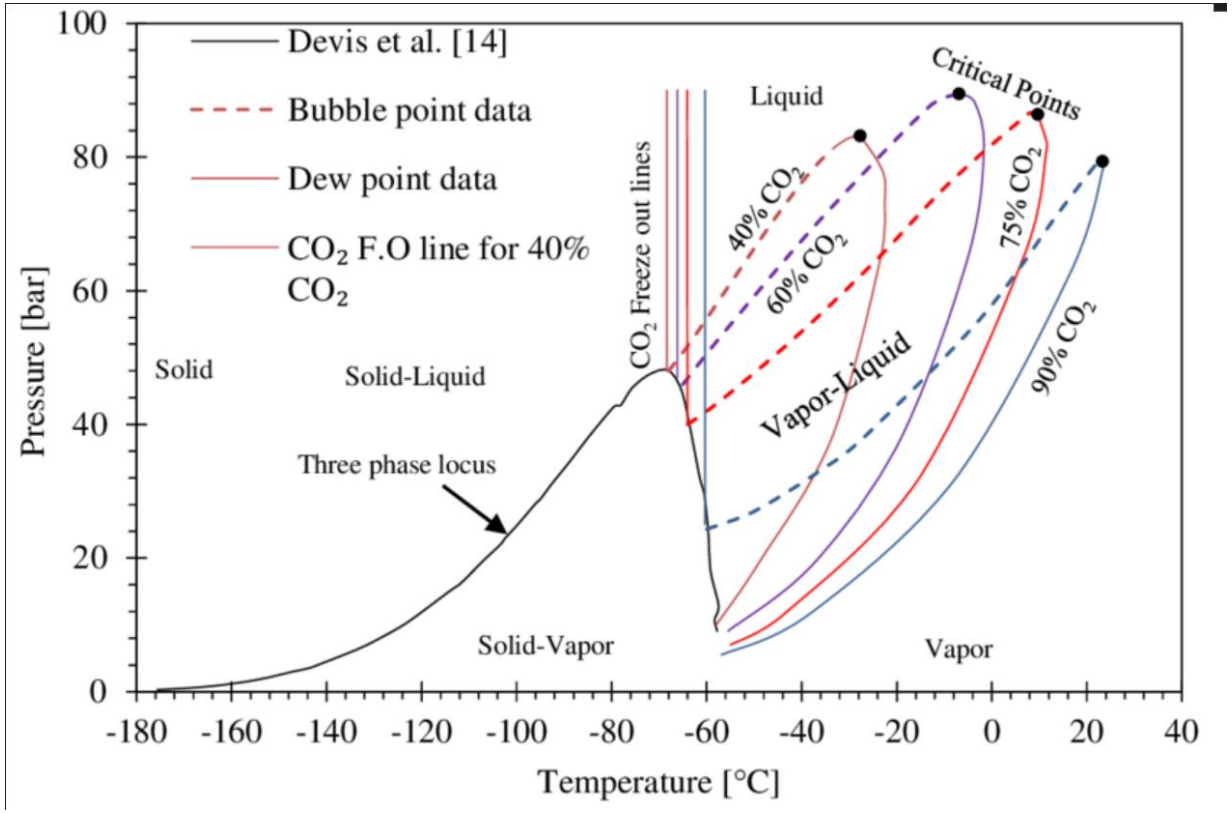
Success: plot Pxy and Txy curves





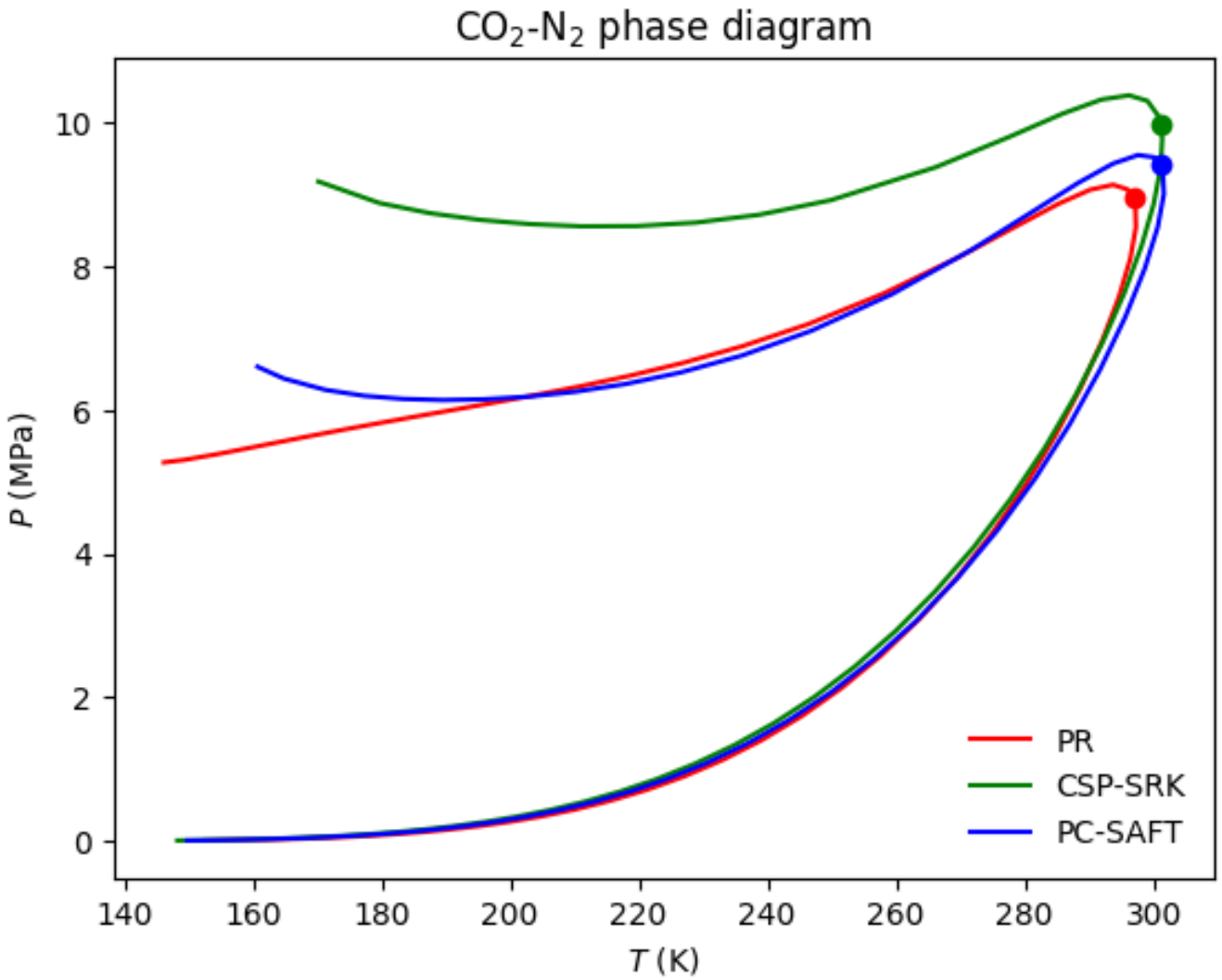
Failure: plot PT curves





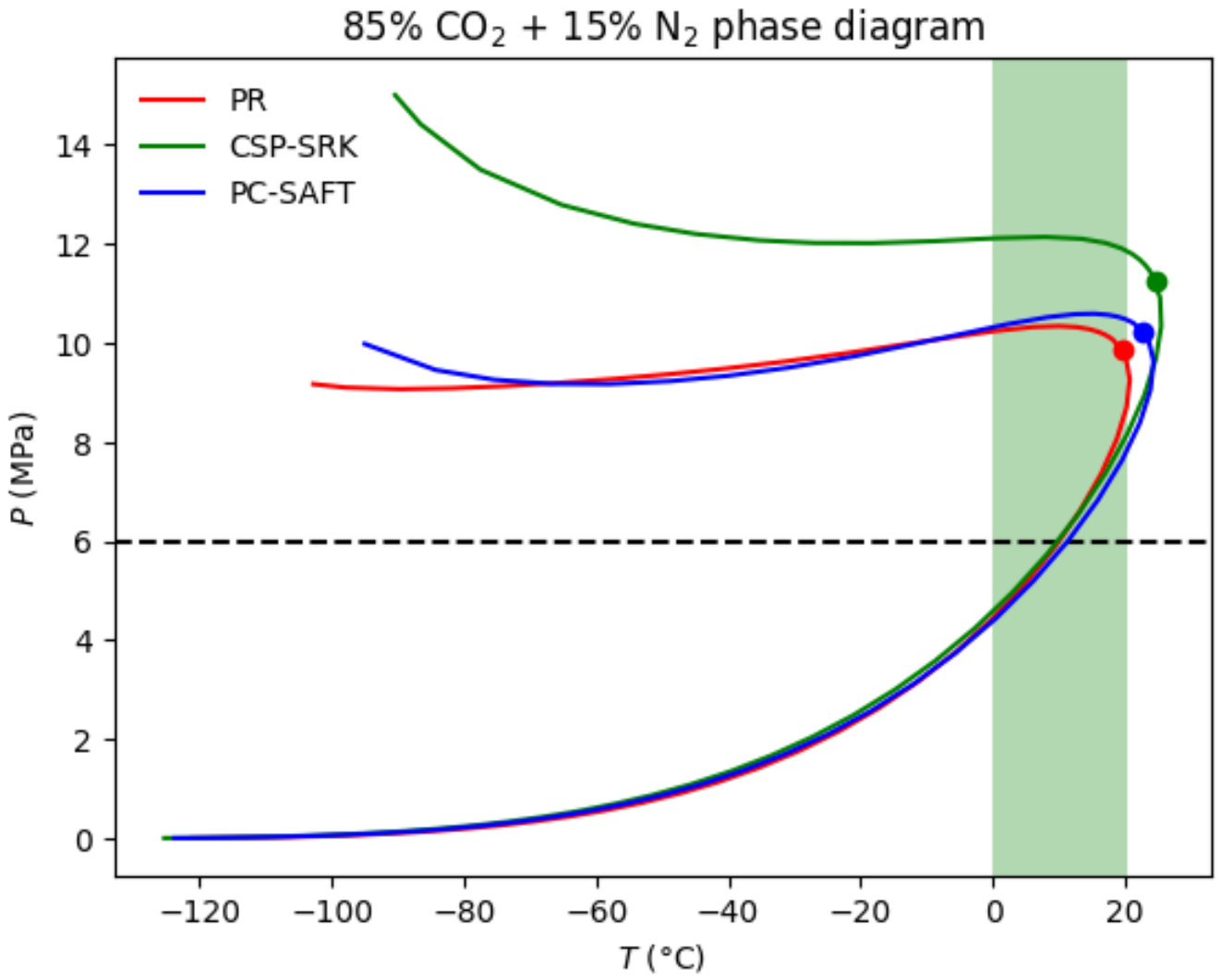
Second tentative: use Thermopack library

Thermopack is a thermodynamics library for multi-component and multi-phase thermodynamics developed at SINTEF Energy Research and NTNU Department of Chemistry.

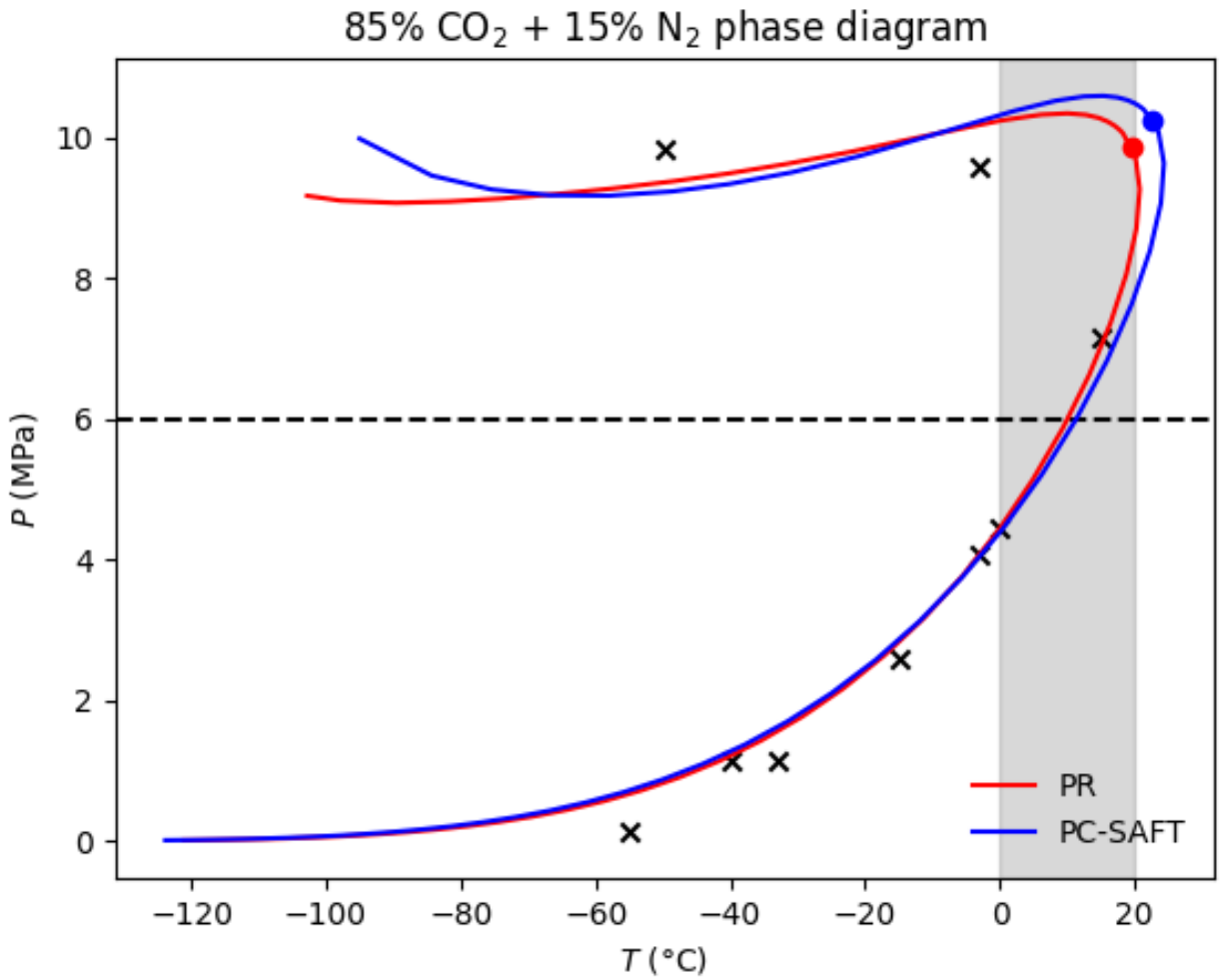


Focus on our range

Our domain: 6MPa, 0°C to room temperature (20°C), 85% CO2 + 15% N2.



Comparison with real data



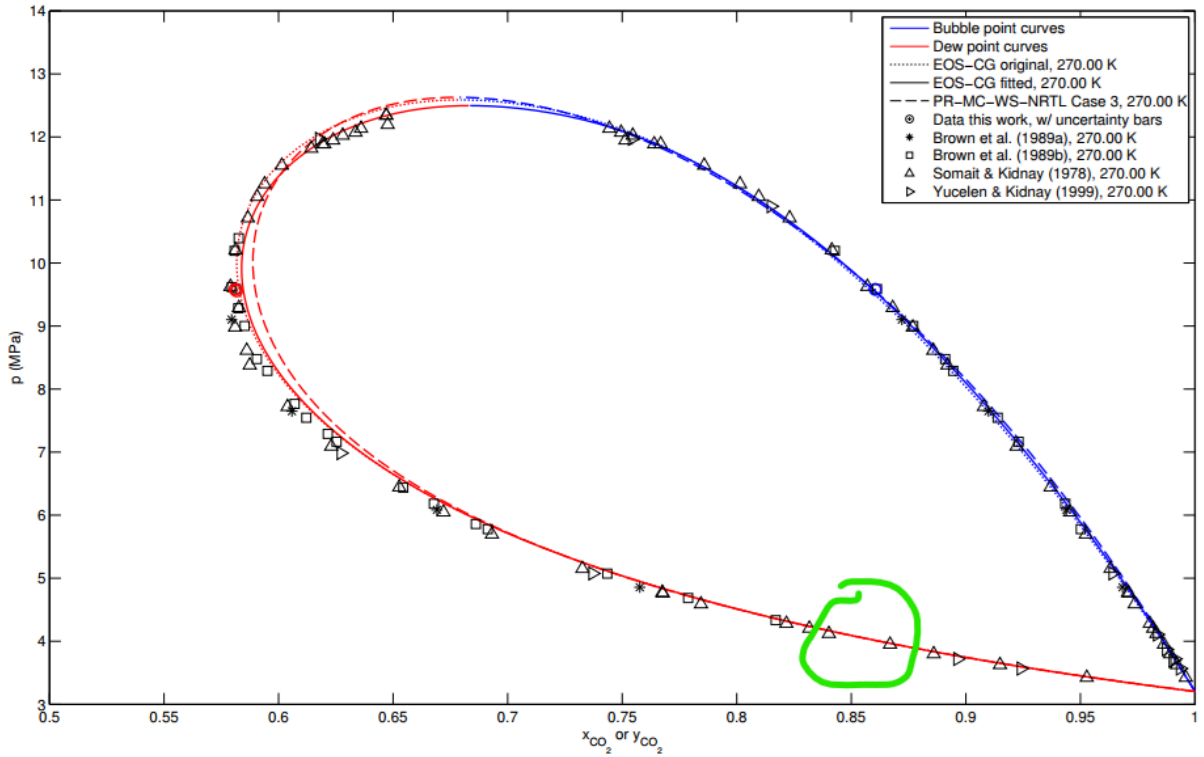
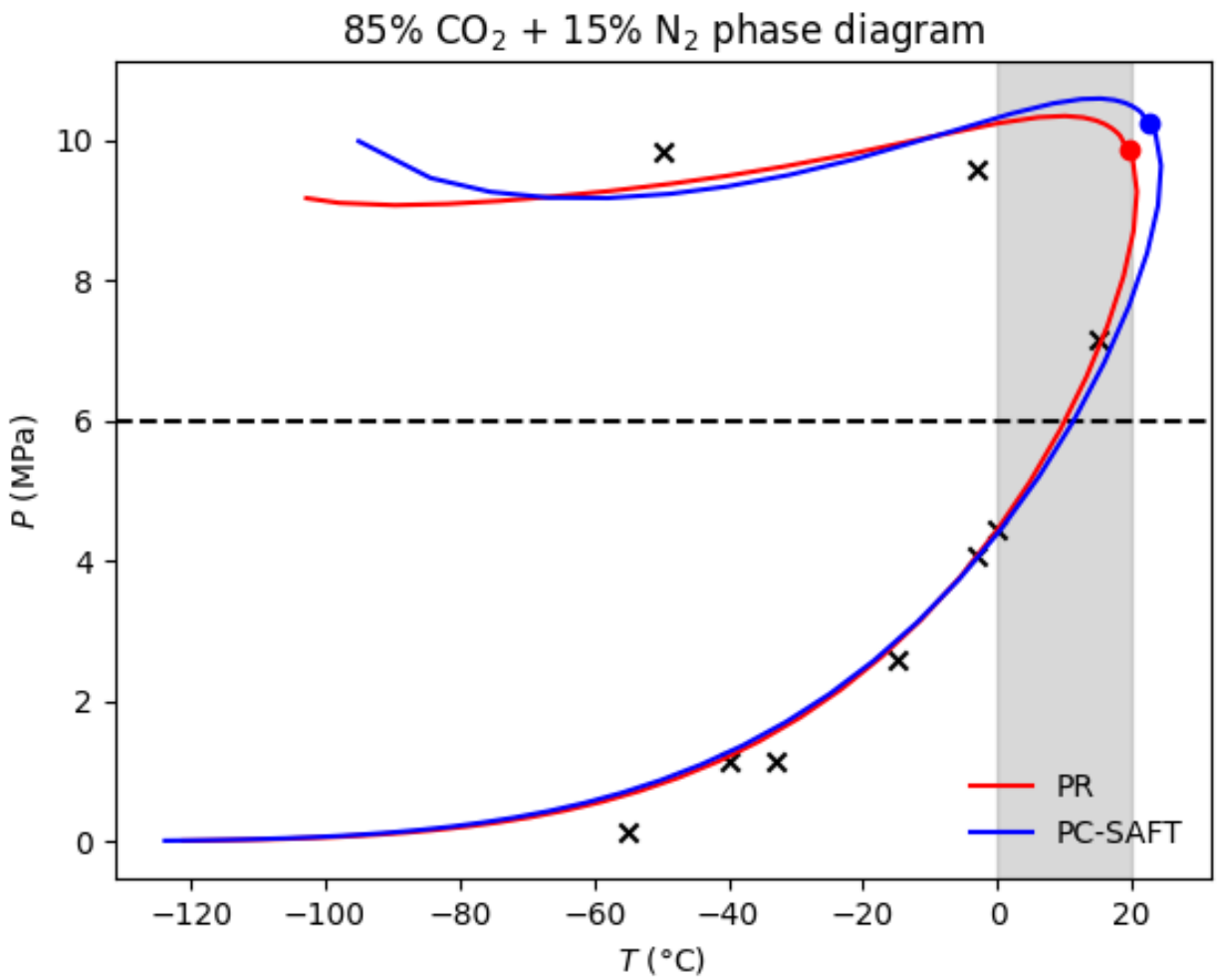
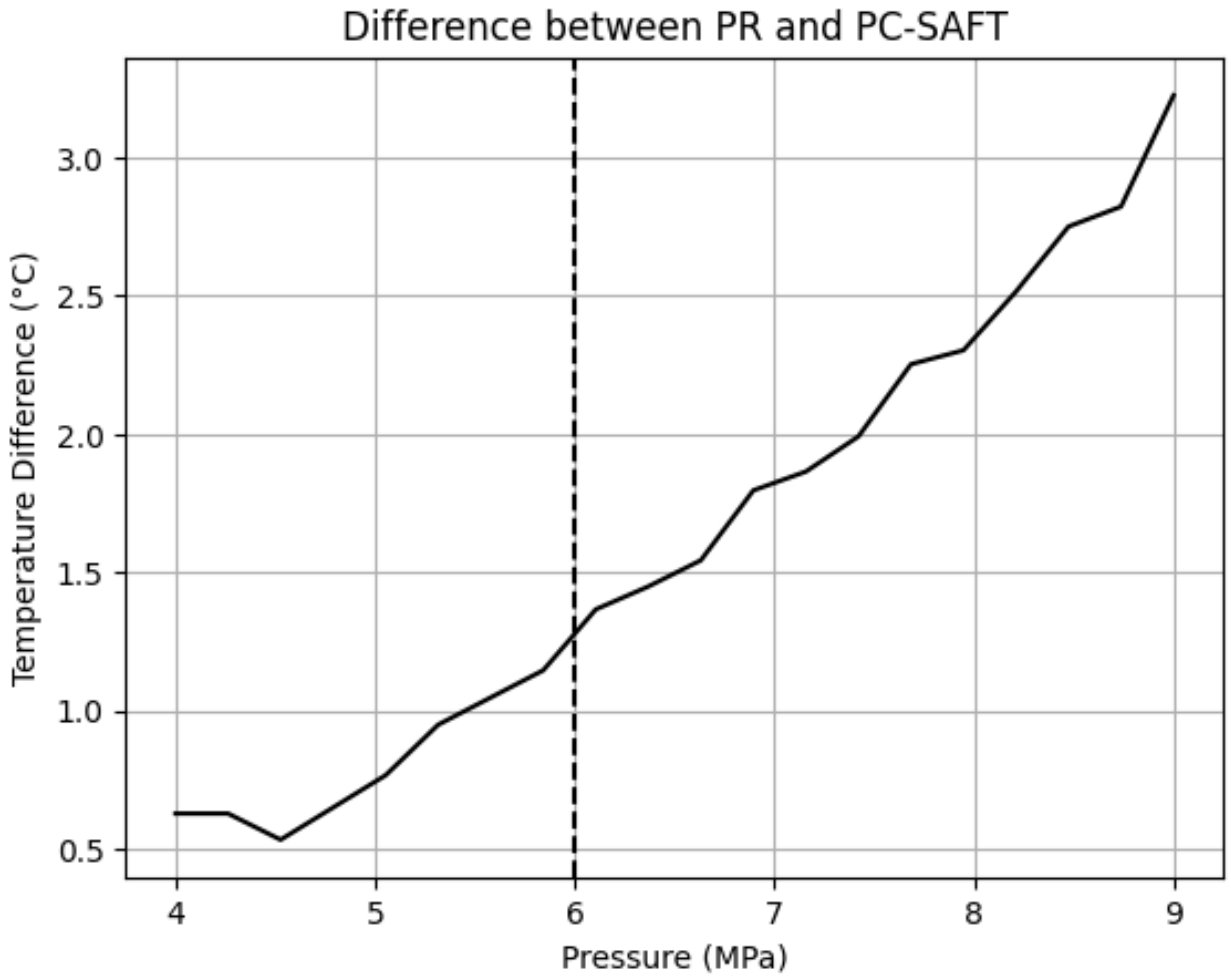


Fig. 8. Isothermal VLE data from literature [49, 28, 50, 48], EOS calculations at mean temperature $T = 270.00\,K$, and measurements with estimated uncertainties from present work: $\tilde{x}_{CO_2}$, $\tilde{y}_{CO_2}$, $\tilde{p}_f$, $u_c\left(\tilde{x}_{CO_2}\right)$, $u_c\left(\tilde{y}_{CO_2}\right)$ and $u_c\left(\tilde{p}_f\right)$ from Tables 4 and 5.

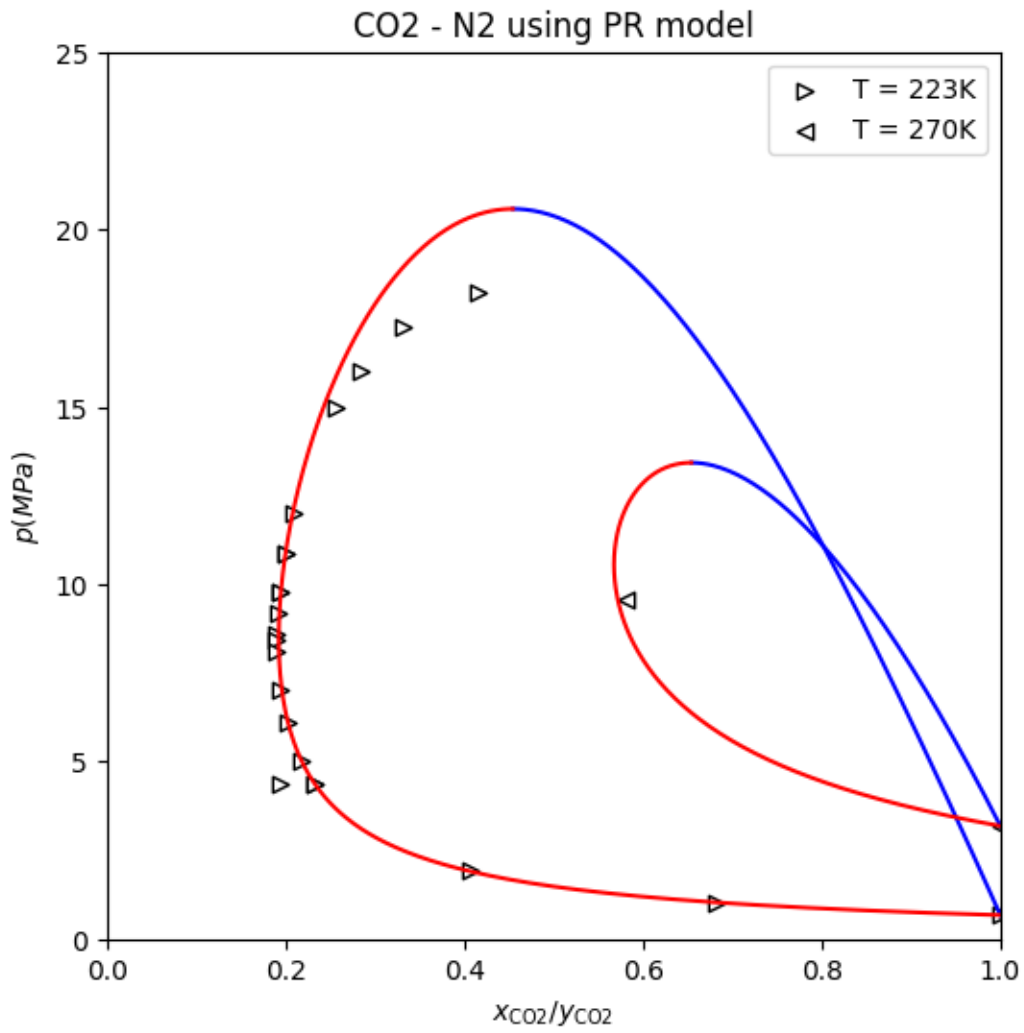
Experimental data from: S. F. Westman, H. G. J. Stang, S. W. Løvseth, A. Austegard, I. Snustad, S. Ø. Størset, and I. S. Ertesvåg, Vapor–Liquid Equilibrium Data for the Carbon Dioxide and Nitrogen (CO2 + N2) System at the Temperatures 223, 270, 298 and 303 K and Pressures up to 18 MPa, Fluid Phase Equilibria 409, 207 (2016).

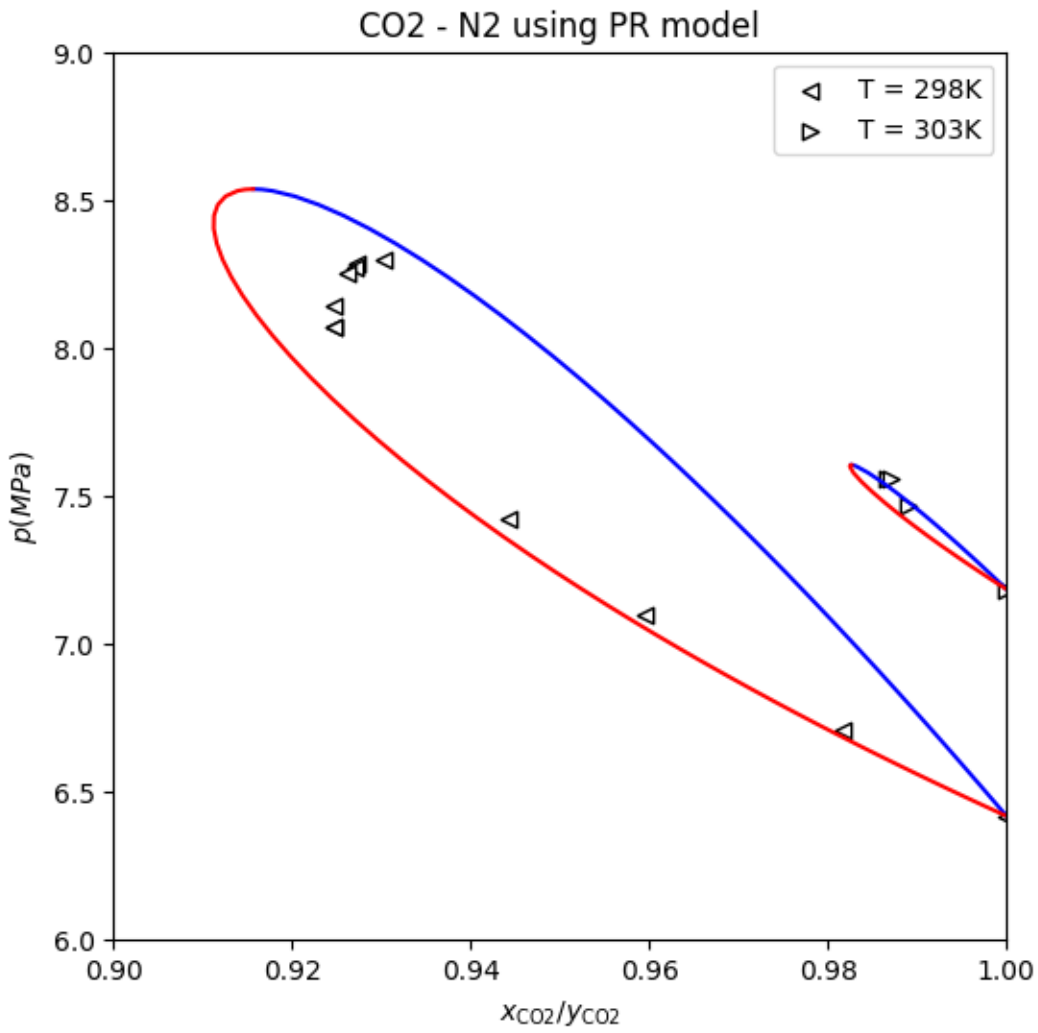
Comparison between models



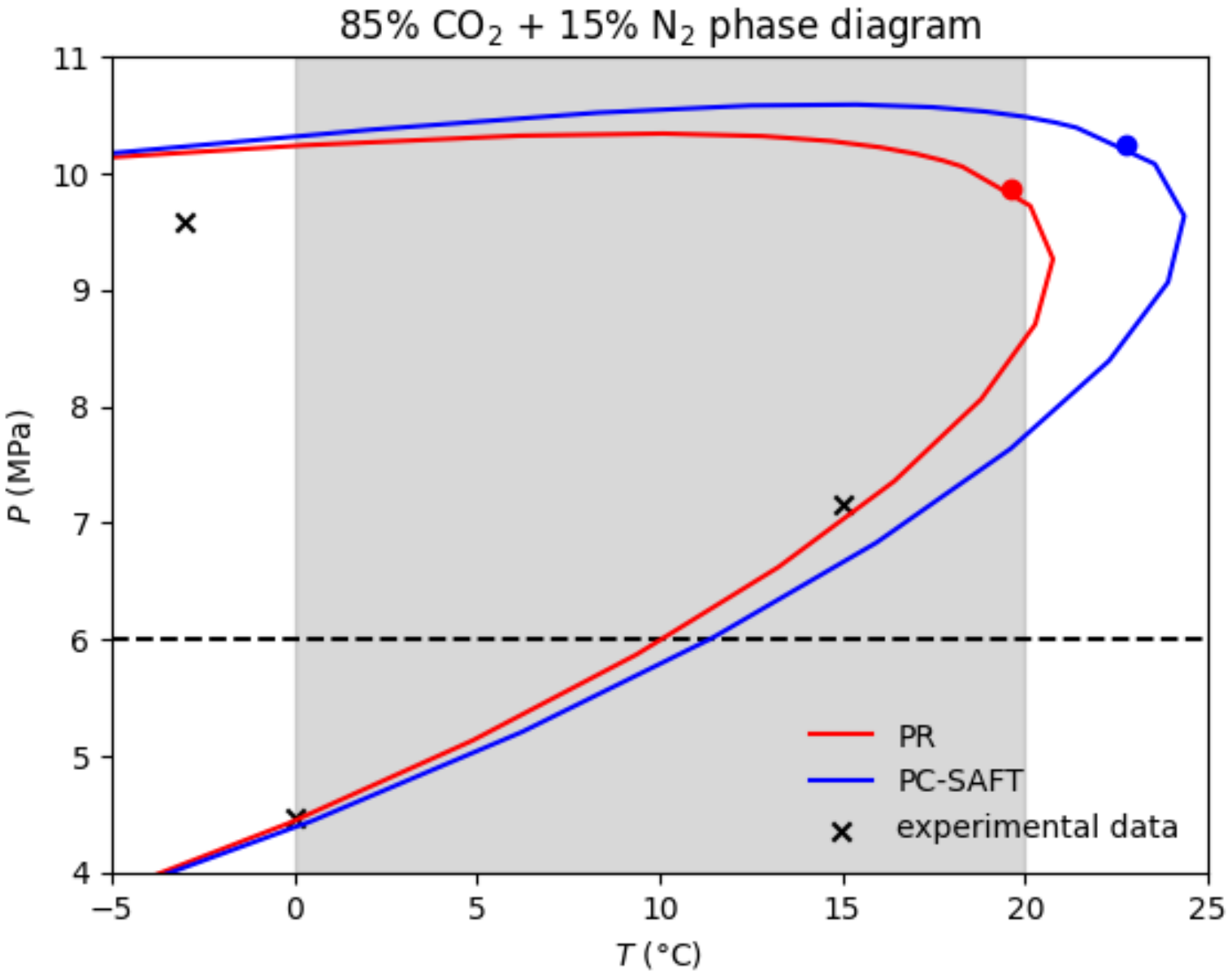


Real data in the vicinity of our domain





To sum up


85% CO_2 + 15% N_2 phase diagram
11
10
9
8
7
6
5
4
P (MPa)
−5
0
5
10
15
20
25
T (°C)
PR
PC-SAFT
experimental data

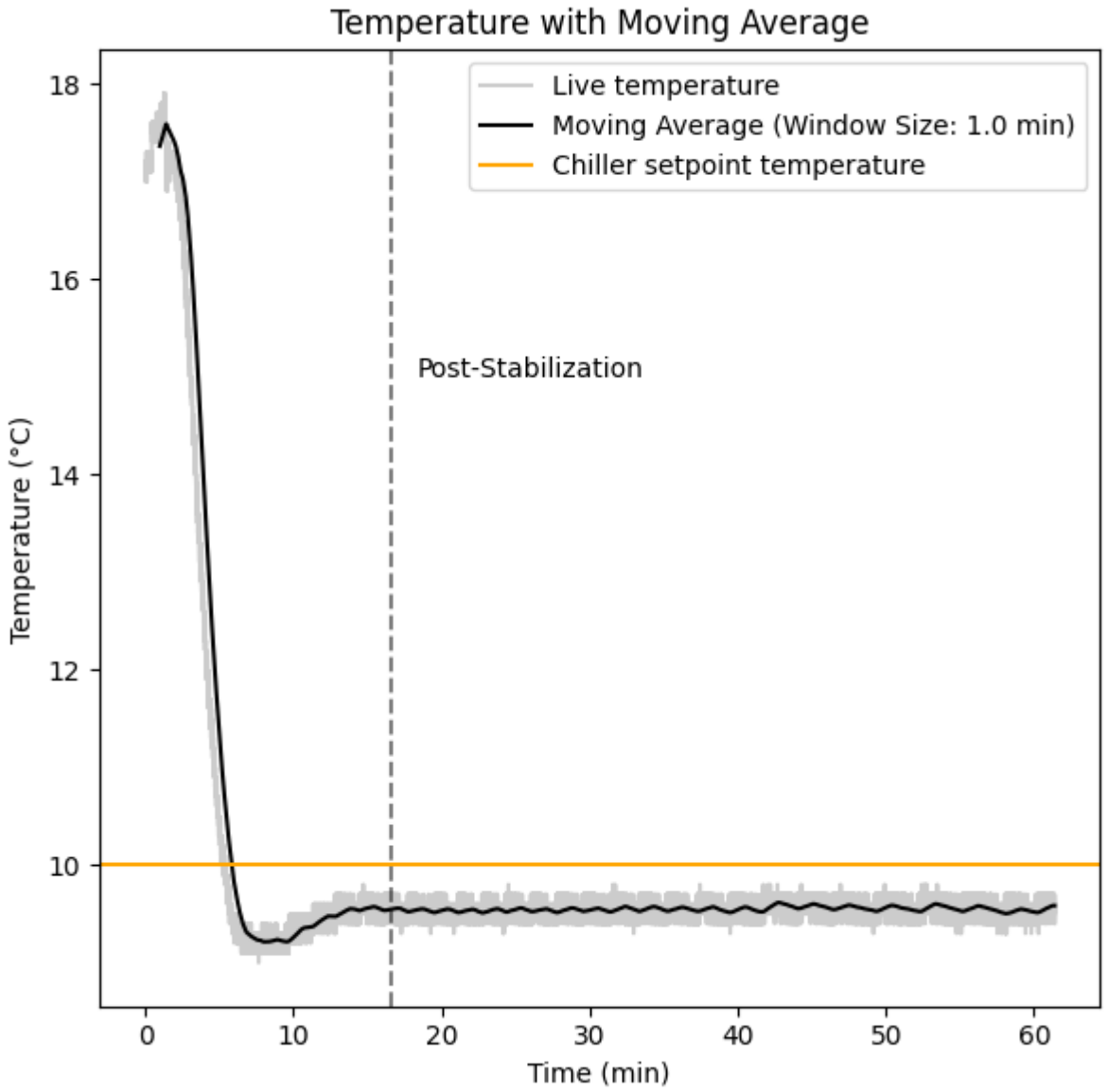

Theoritical model
Chiller setup
Temperature acquisition

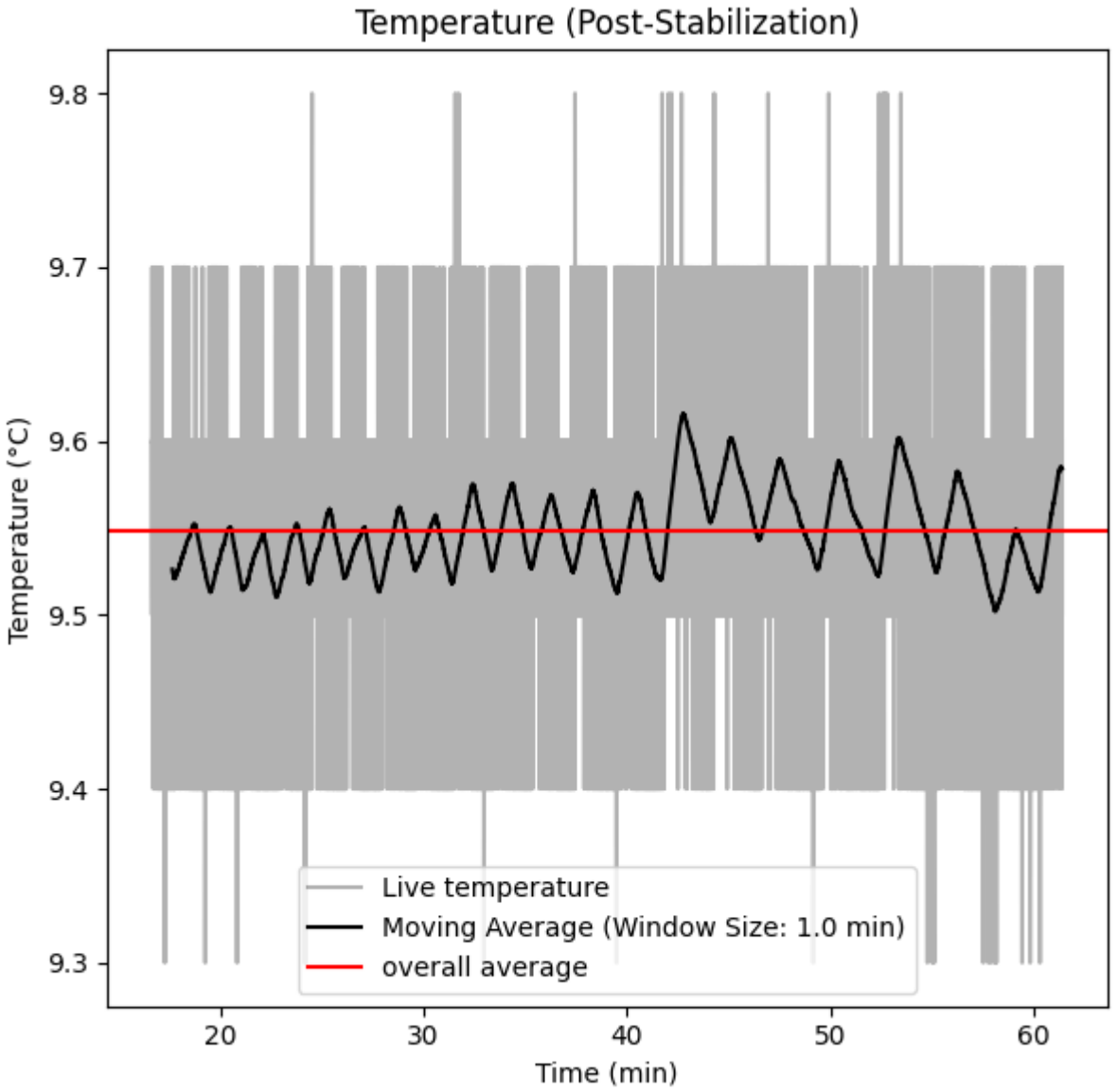
The use of the chiller and preparation of the cooling liquid

For temperatures less than 20°C chiller needs a special cooling fluid

50% 50%

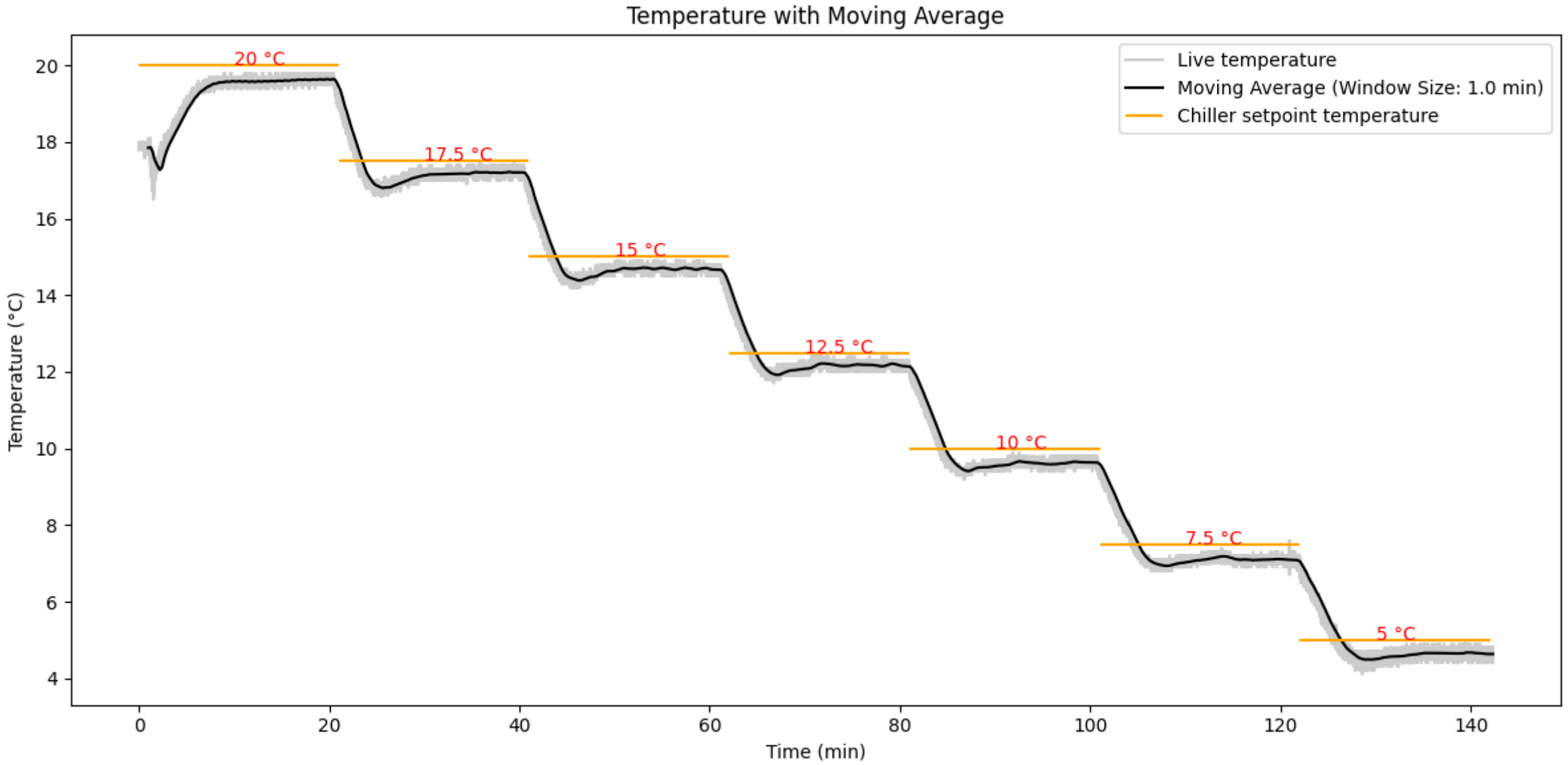
Stability of the Chiller



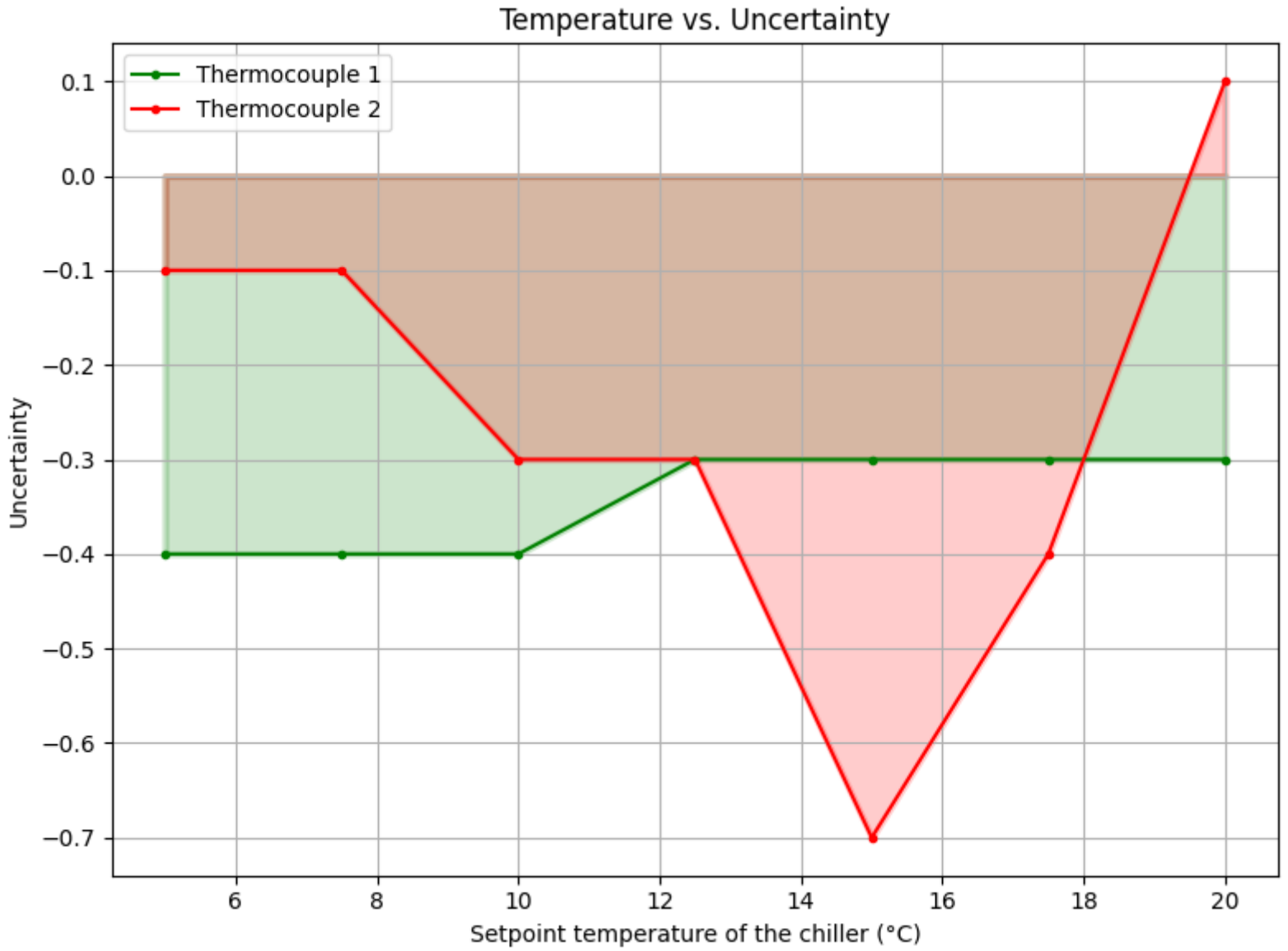



Theoritical model
Chiller setup
Temperature acquisition

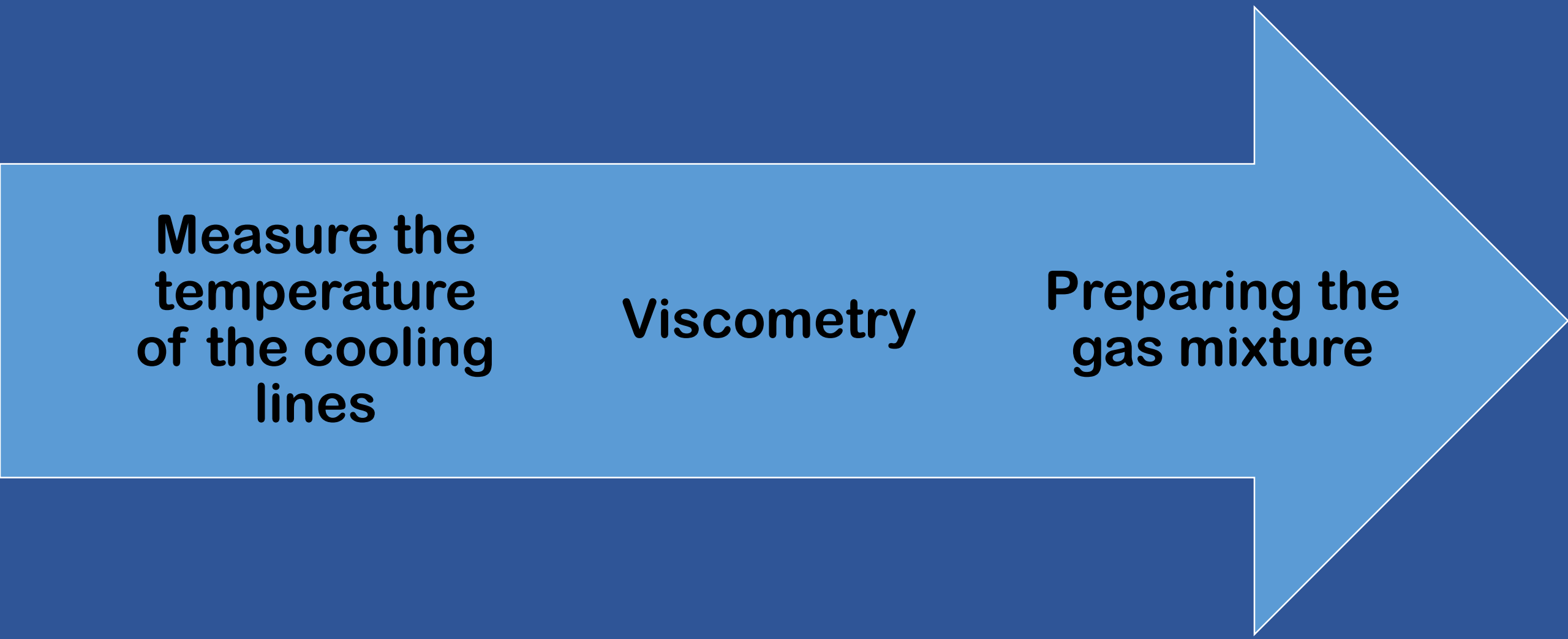
Uncertainty interval of thermocouples



Uncertainty interval of thermocouples



What’s next?


Measure the temperature of the cooling lines
Viscometry
Preparing the gas mixture