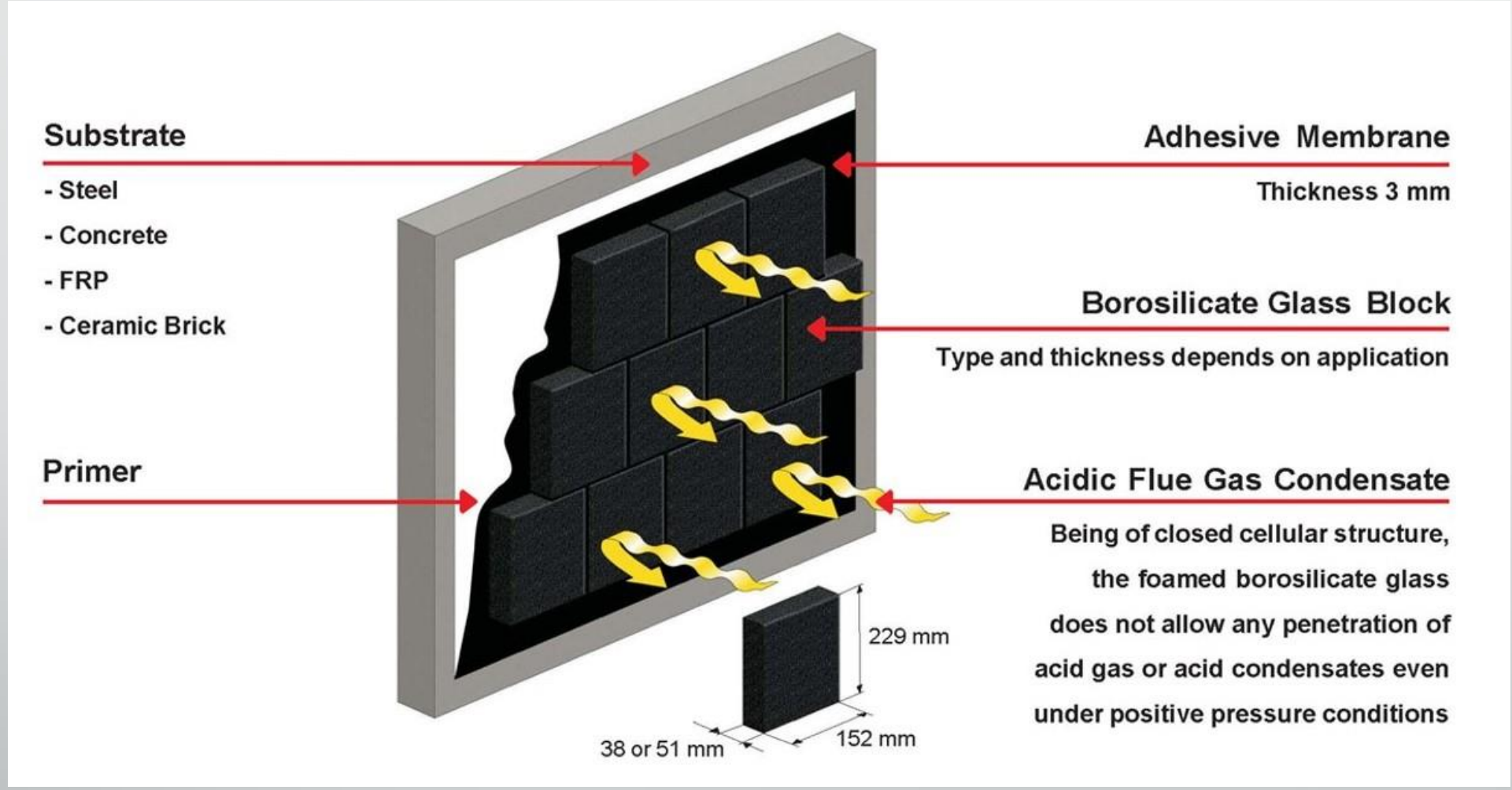
Environmental Benefits of Borosilicate Linings During Plant Start-ups

Paolo Zannetti(*)(#), Giuseppe Bucci(+), Roberto Bellasio(^),
Roberto Bianconi(^), and Frank Freedman(*)

(*) EnviroComp Consulting, Inc. https://www.envirocomp.com/
(+) SINAPSI Innotec Srl http://www.cubics.it/index.html
(^) Enviroware srl https://www.enviroware.com/
(#) Presenter, CICIND Conference Paphos, Cyprus, 21st October 2022
http://booking.cicind.org/files/downloads/TECH-PROG.pdf

Borosilicate Glass Block Lining System (BGBLS)



Borosilicate Glass Block Lining System (BGBLS)

- Commonly used by owners of large industrial chimneys for protection against acid dewpoint corrosion
- Additional benefit of BGBLS is their strong insulating property
- **Our study**: Focus on possible air quality benefits of BGBLS
  - warmer plume in the start-up phase ➔ higher plume rise ➔ lower ground level concentrations ➔ possible health benefits

Focus on start-up scenarios

- Our study places great emphasis on start-up scenarios ➔ highest concentration impacts
- Fossil-fueled plants are becoming, more and more, back-up systems for wind and solar electricity generation plants ➔ frequent start-ups are needed (typically 200 or more per year)

Technical Approach

1. Computational Fluid Dynamics (CFD) software (Solidworks) to simulate the motion of gasses inside a chimney during start-up
   - with BGBLS lining
   - without BGBLS lining
2. Air Quality Dispersion Models to simulate the concentration impact at ground level of the pollutants emitted from the chimney

Examples of CFD Simulation Videos

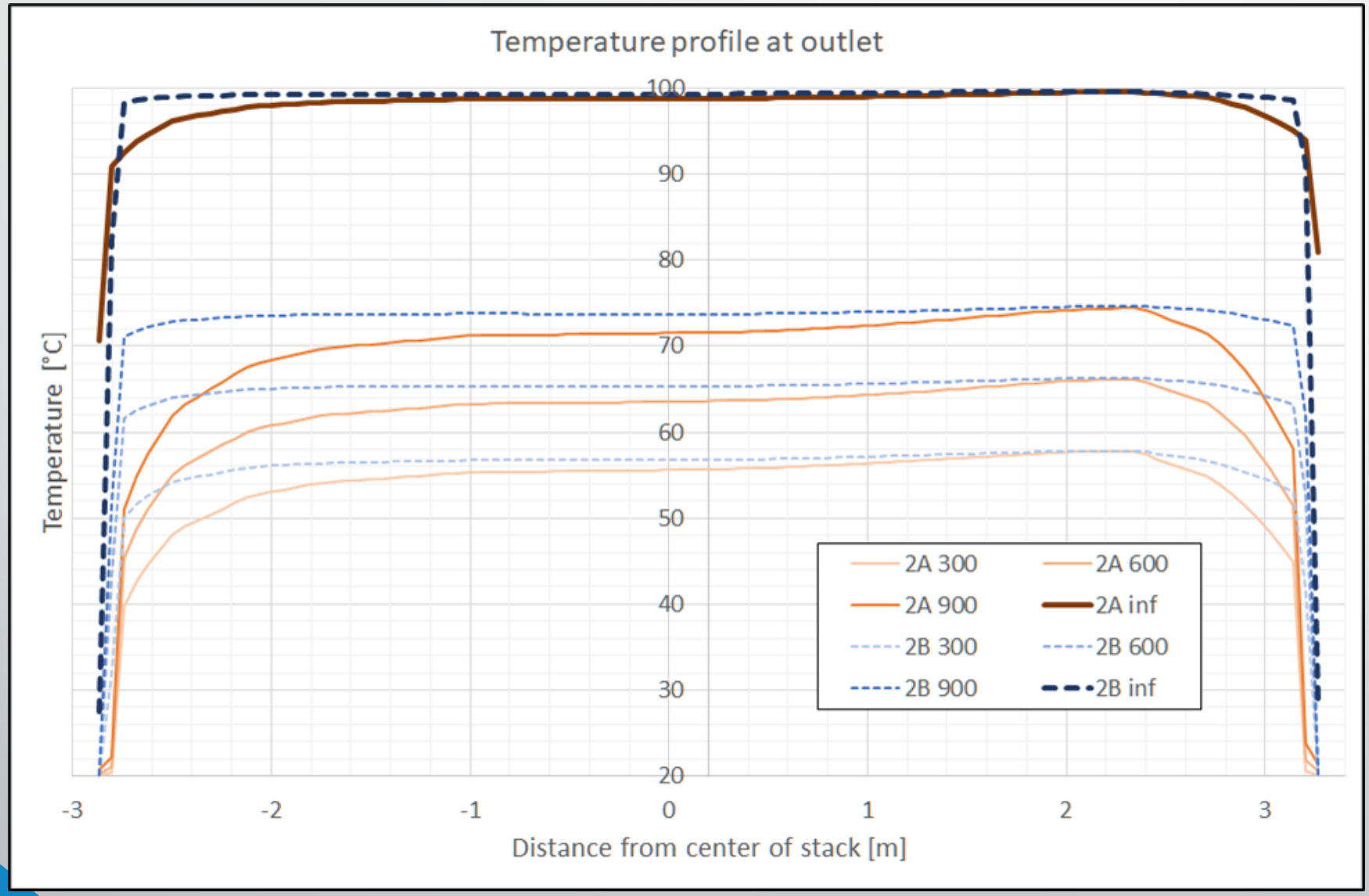
Case 1B (150 m brick chimney)

Case 2B (50 m steel chimney)

Main Results of CFD Simulations

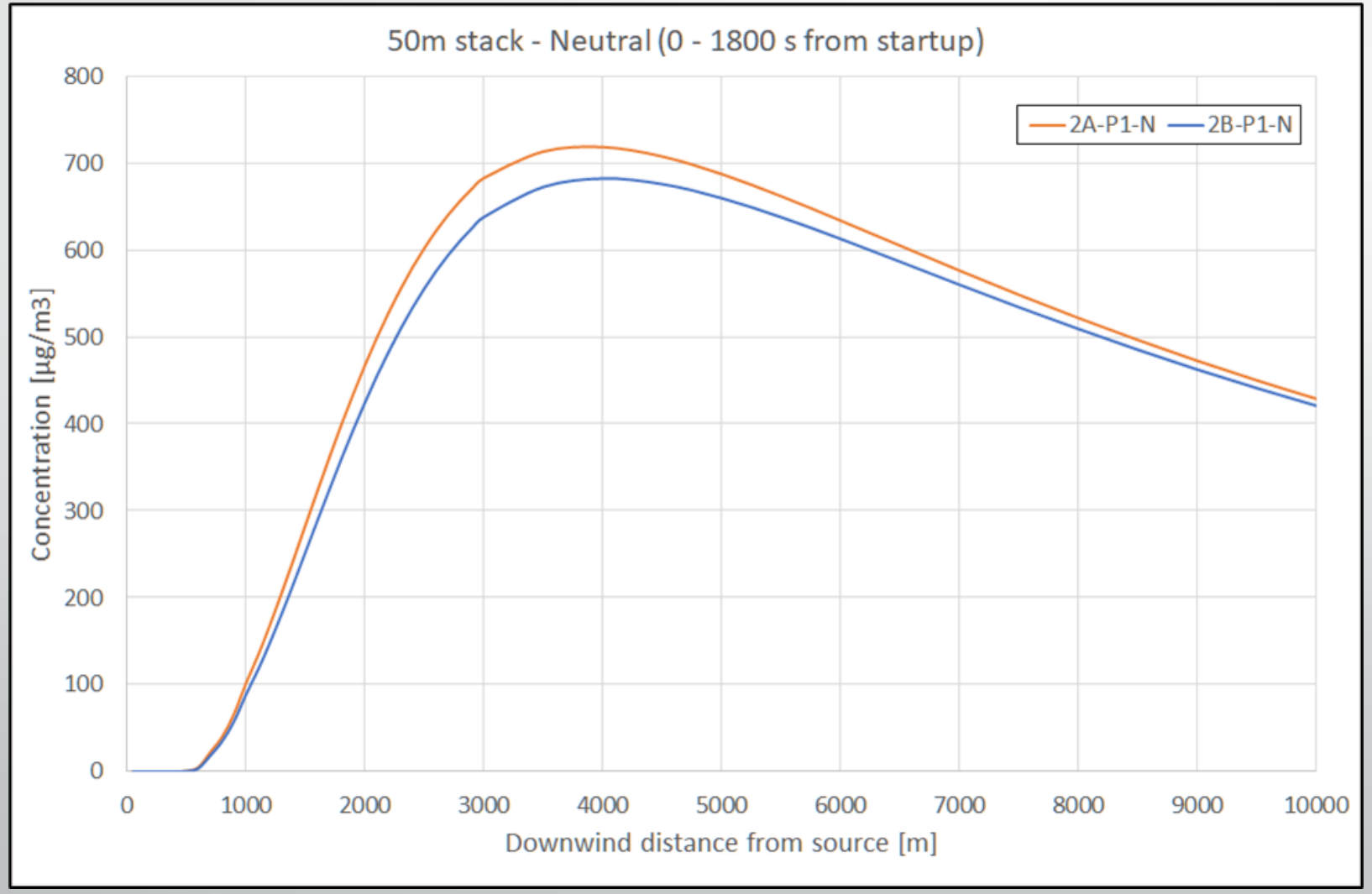
- Without BGBLS lining, a substantial fraction of the plume – the fraction emitted from a circular ring near the internal wall of the stack – is much colder than the plume emitted from the center
- This fraction is about 19% of the entire volumetric flow from the stack
- The presence of BGBLS lining substantially increases the gas temperature of this circular ring fraction ➔

Example of Horizontal Temperature Variation at the Top of the Stack



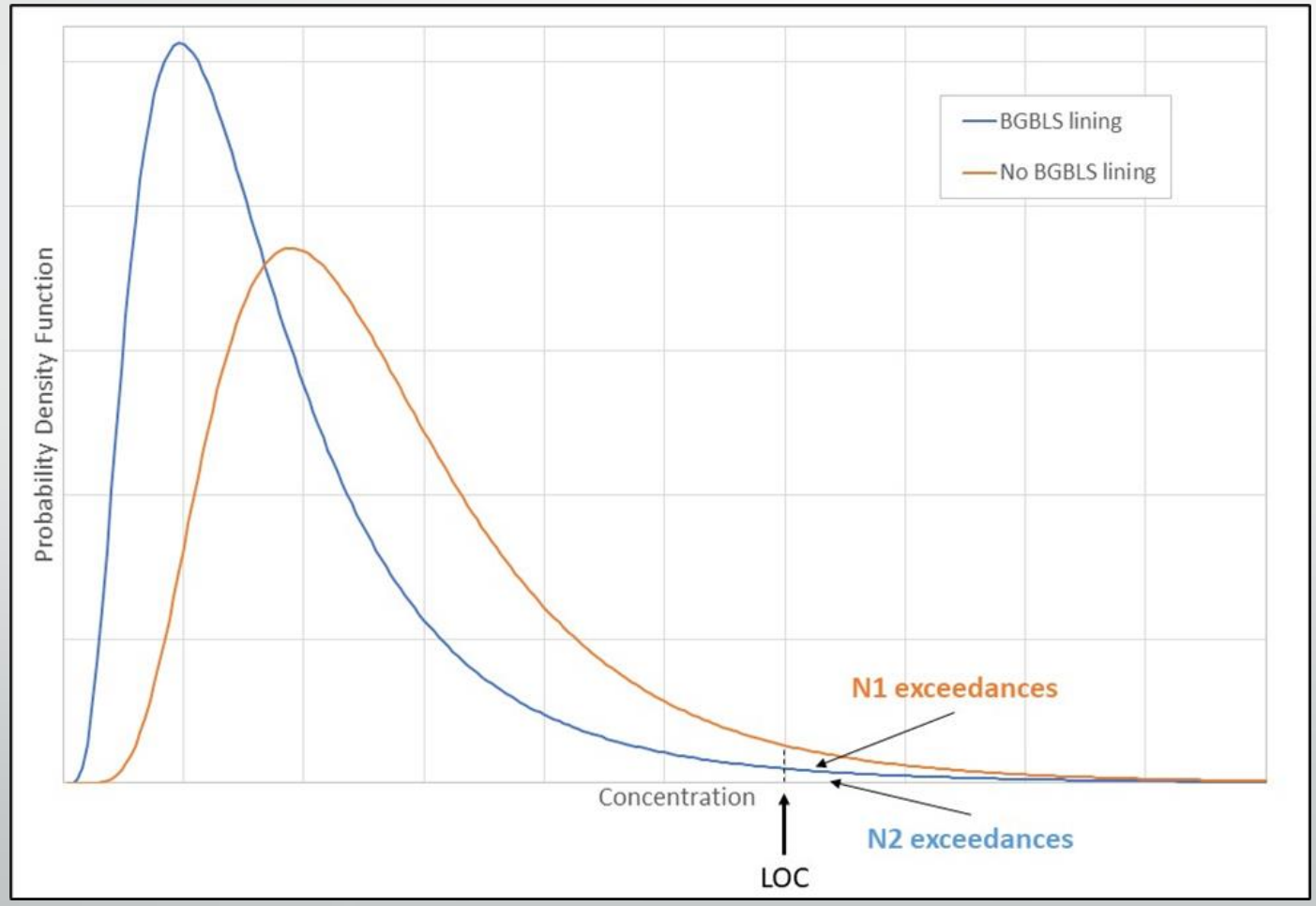
Air Quality Benefits

- Significant only at the beginning of the start-up (first 30 minutes), e.g.:



Yet,

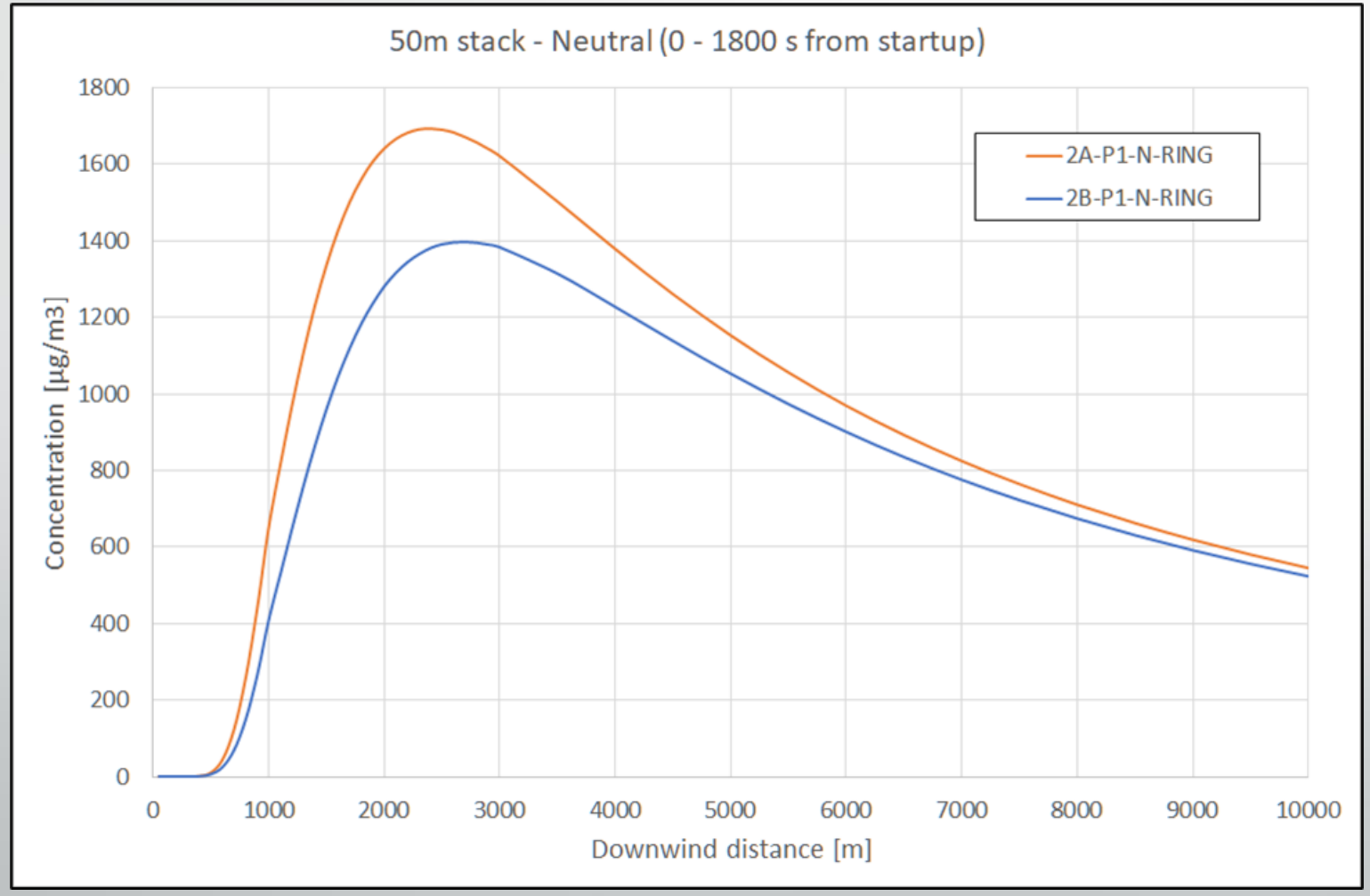
even minor decrease in concentration ➔ significant decrease in exceedances above air quality standards



Future Challenge

- Current dispersion models cannot simulate sections of a plume with different exit temperatures
- Yet, our CFD simulations show:
  - Much lower temperatures (high gradient) near the wall of the stack without BGBLS lining
  - A significant reduction of temperature gradient with BGBLS lining
- We plan to develop a dispersion model capable of accounting for the temperature gradient at the top of the stack ➔ better modeling ➔ possible identification of even larger air quality benefits

In fact, if we focus only on the 19% fractional emission near the chimney's wall ➔



Thanks!

- Acknowledgments: This study was financed by Hadek, a global supplier of internal lining systems for industrial stacks

- For questions, contact:

Dr. Paolo Zannetti, QEP zannetti@envirocomp.com