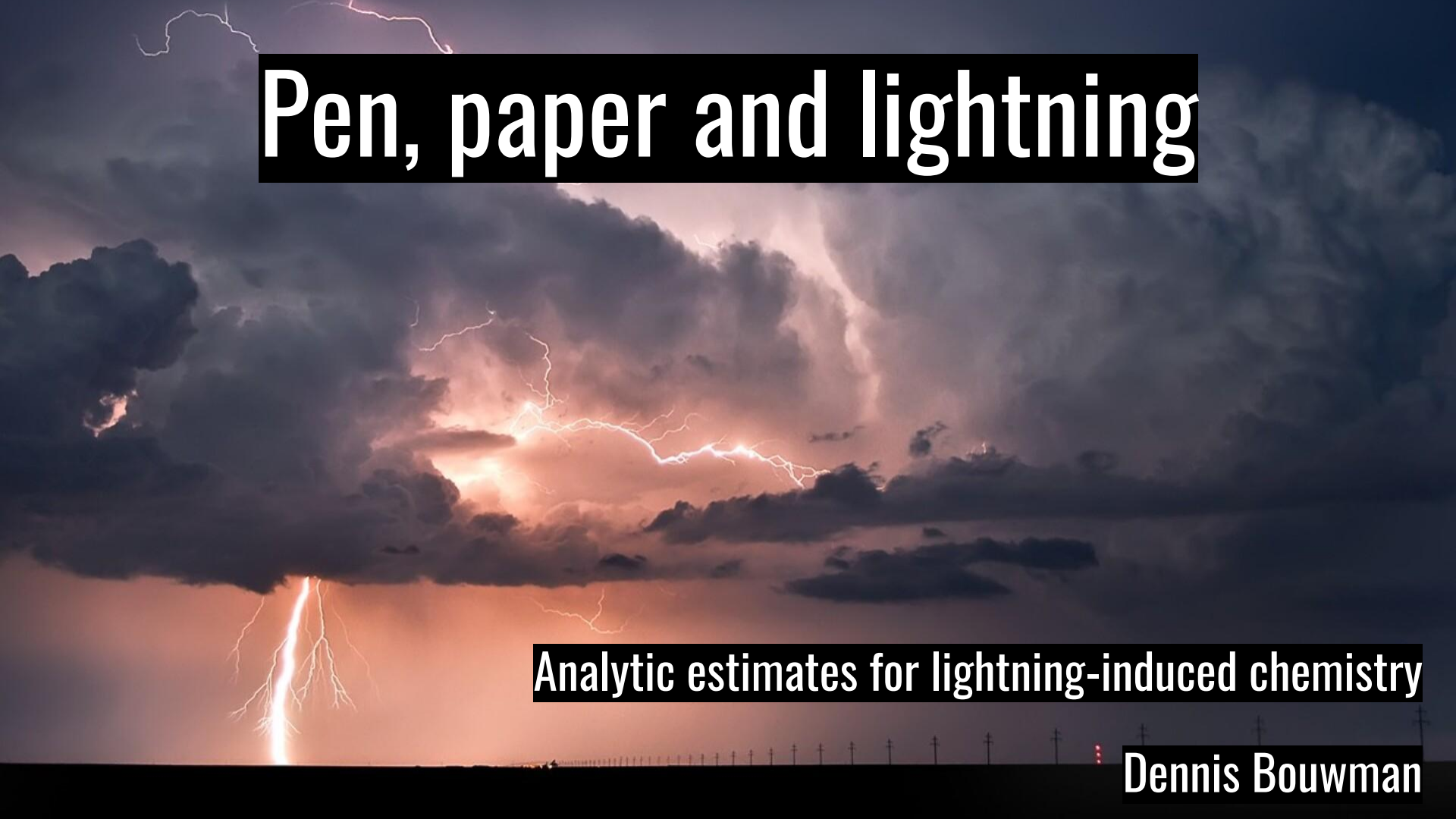
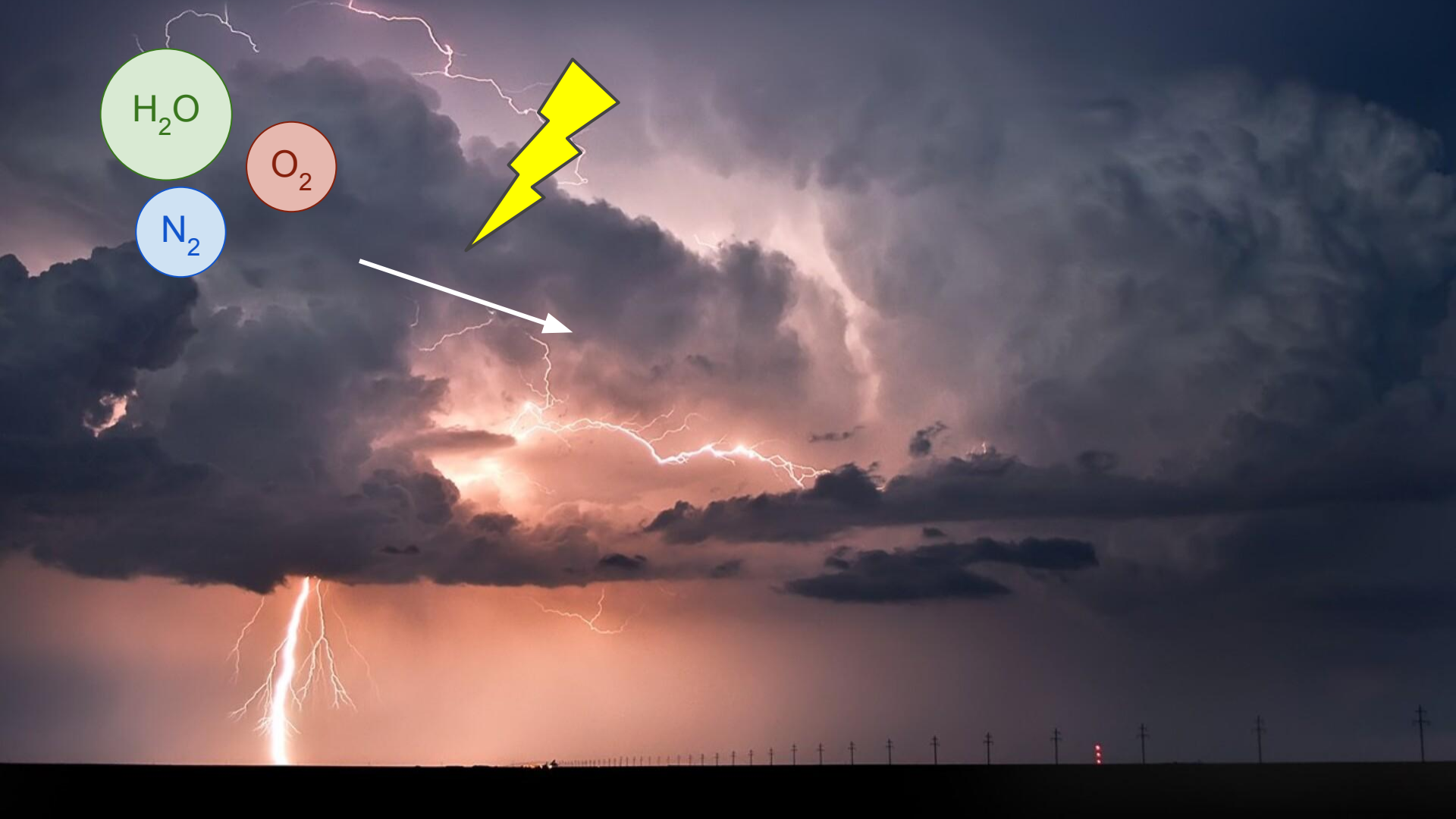


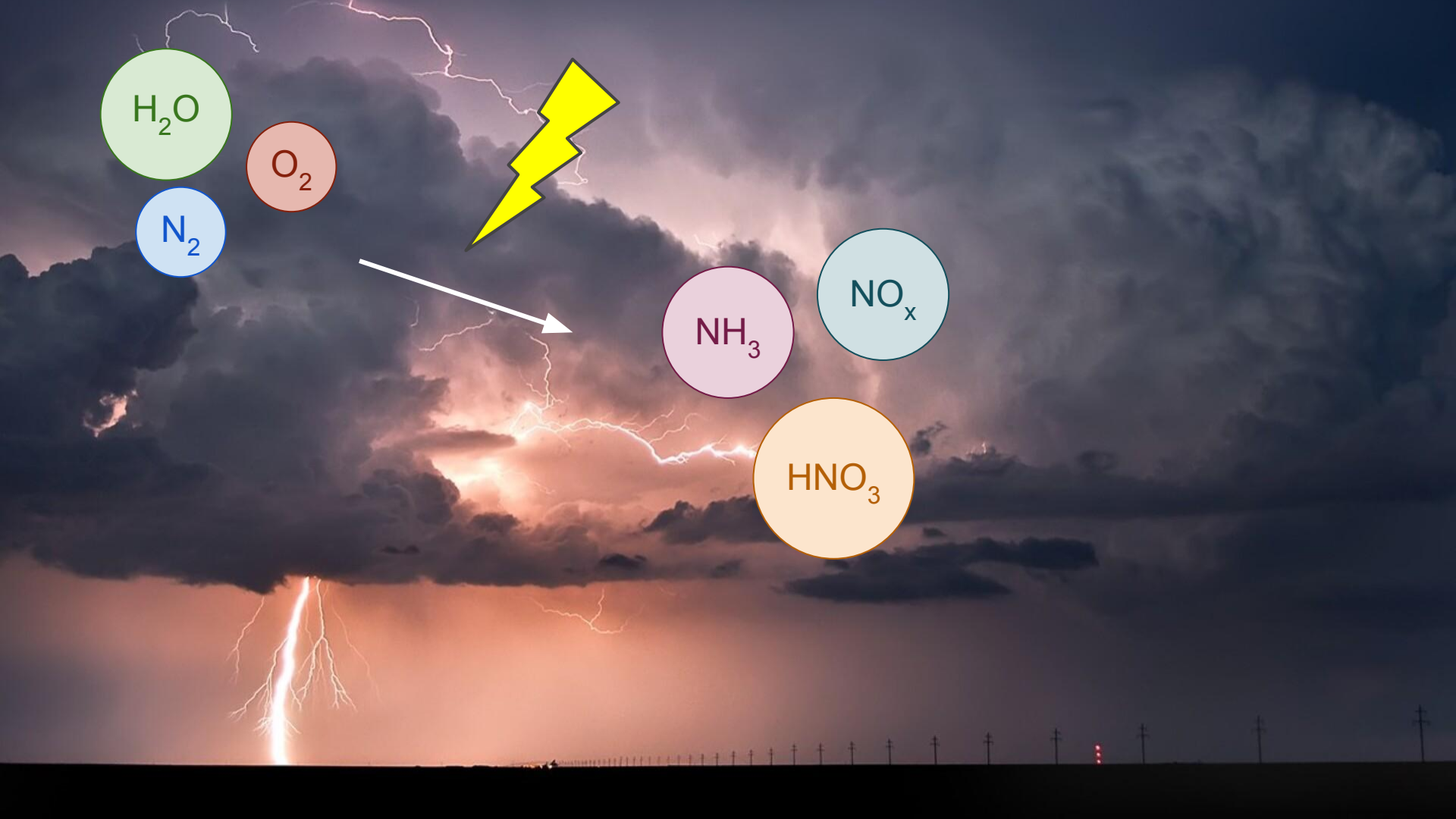
Pen, paper and lightning

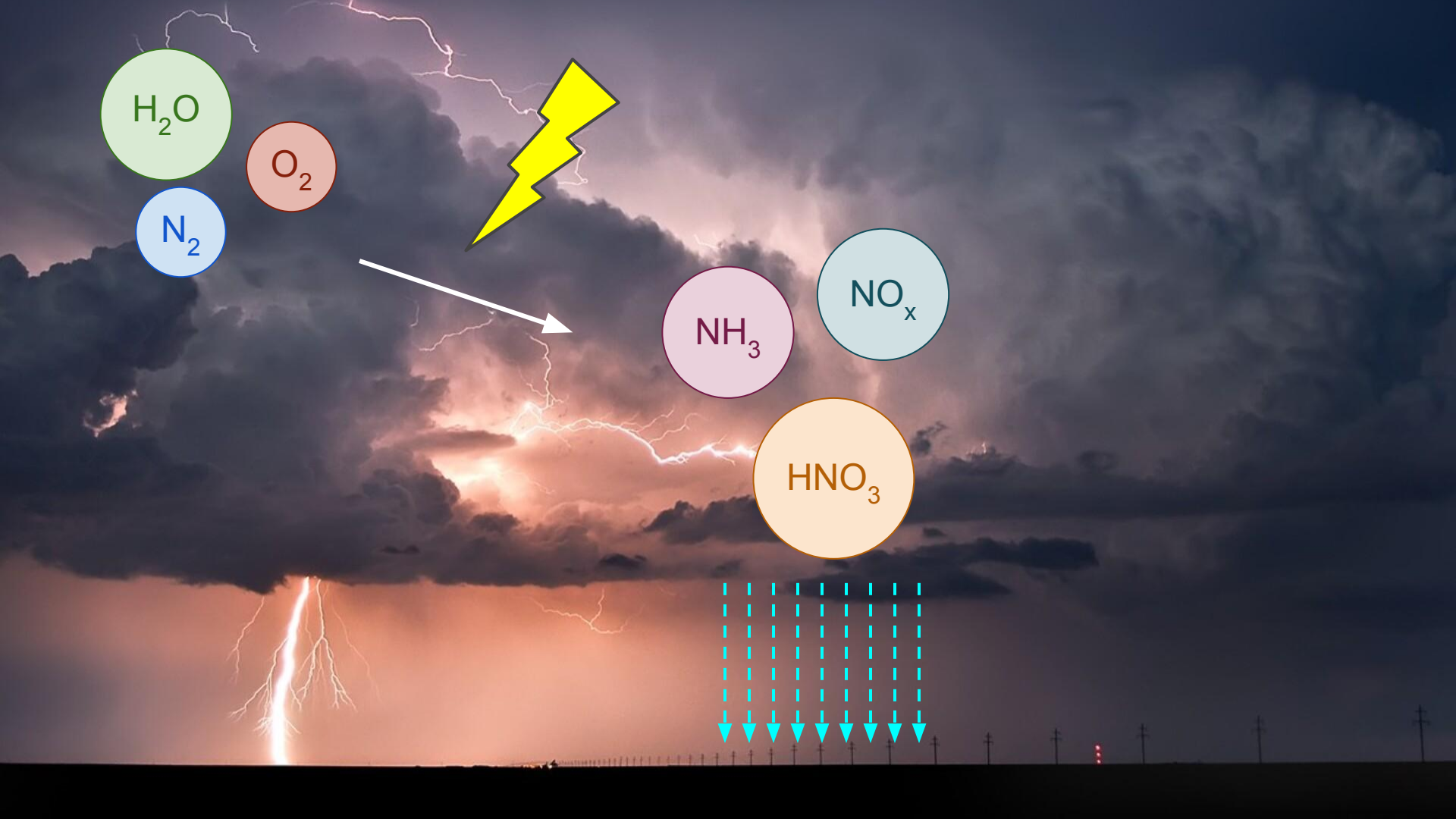
Analytic estimates for lightning-induced chemistry

Dennis Bouwman

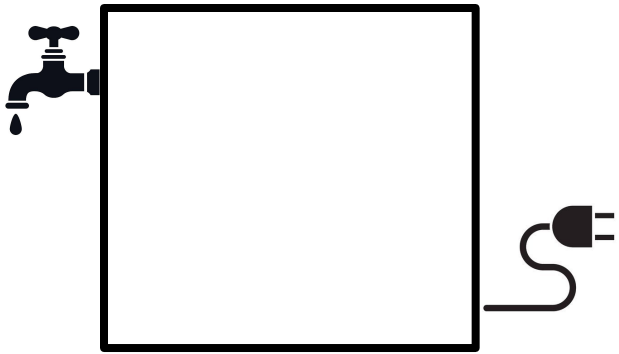

H_2O
O_2
N_2


H_2O
O_2
N_2


H_2O
O_2
N_2
NH_3
NO_x
HNO_3

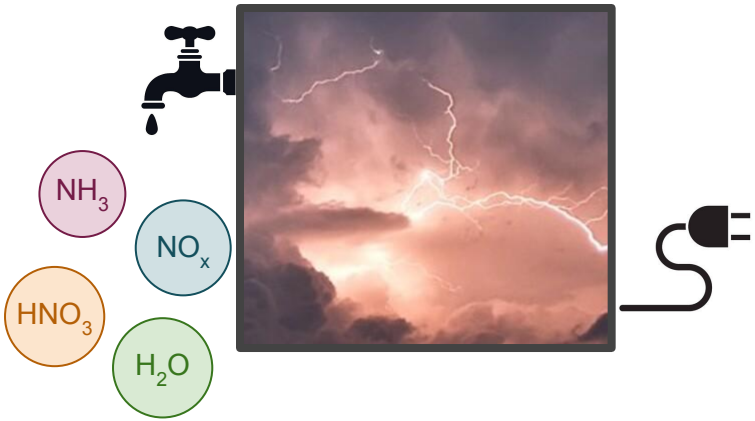

H_2O
O_2
N_2
NH_3
NO_x
HNO_3

Imitate lightning to make *electric fertilizers*

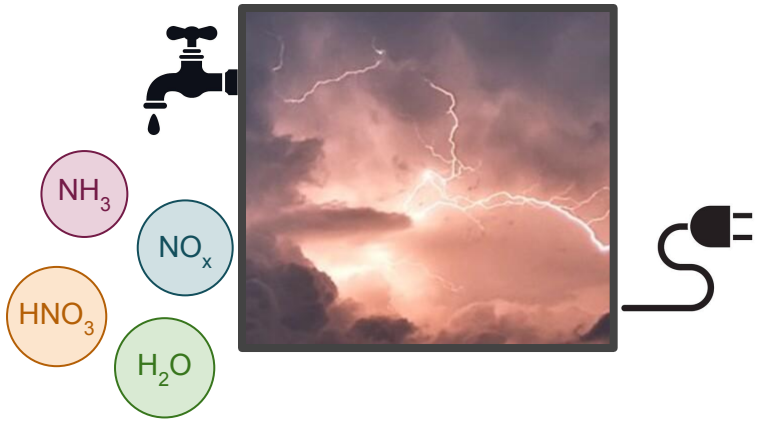


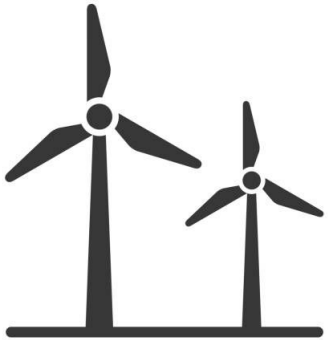
Imitate lightning to make *electric fertilizers*

Imitate lightning to make *electric fertilizers*

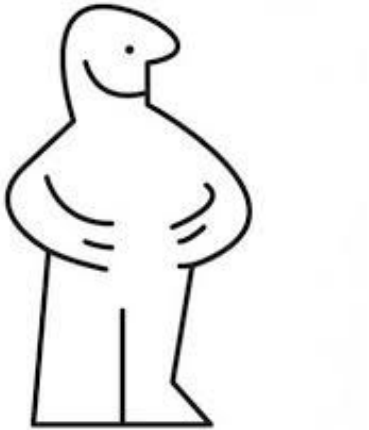


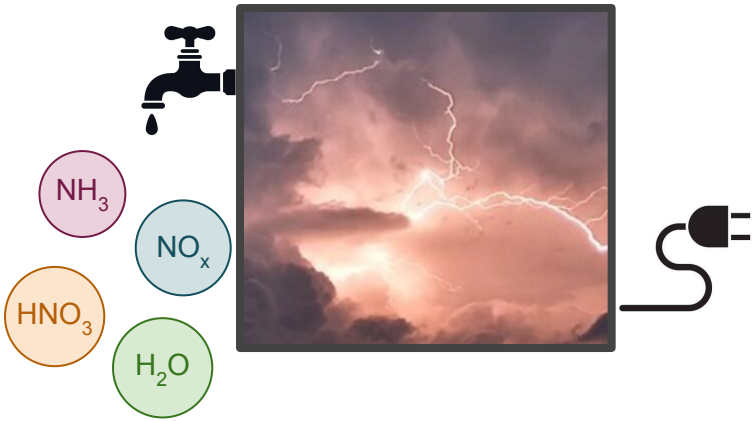
Imitate lightning to make *electric fertilizers*

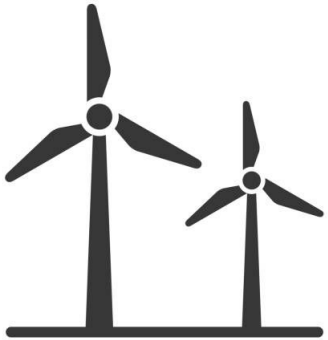




Imitate lightning to make *electric fertilizers*

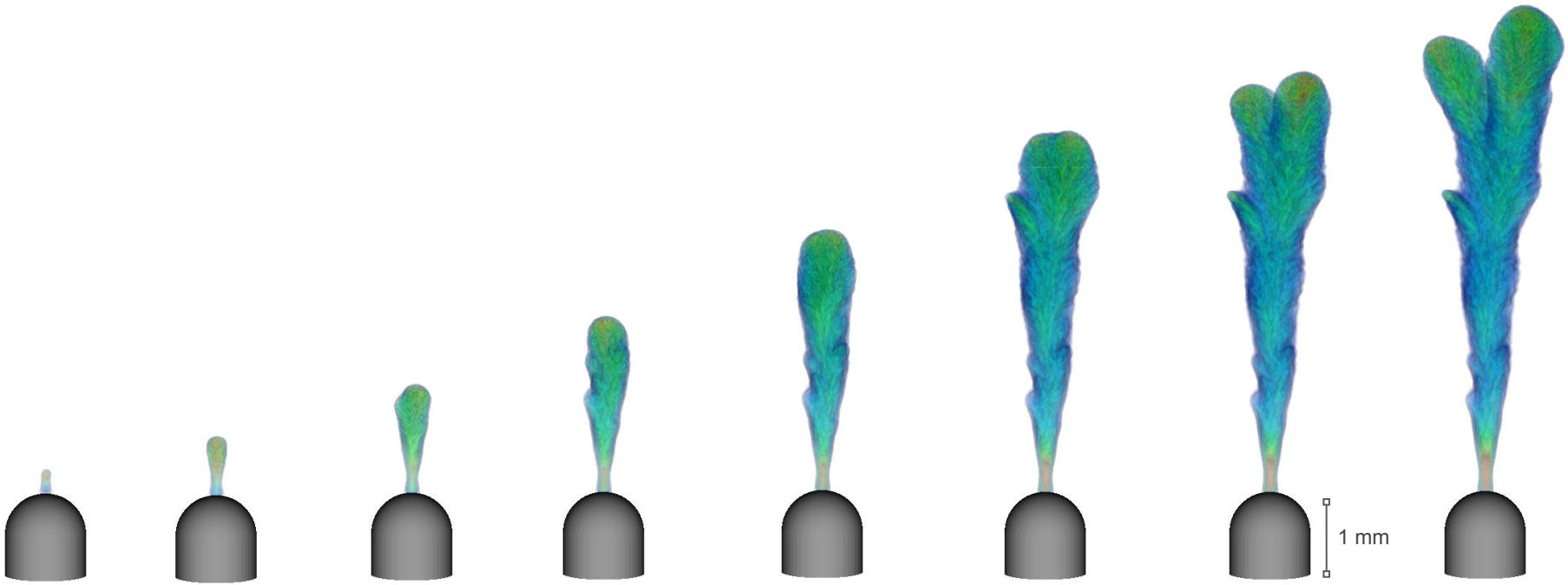






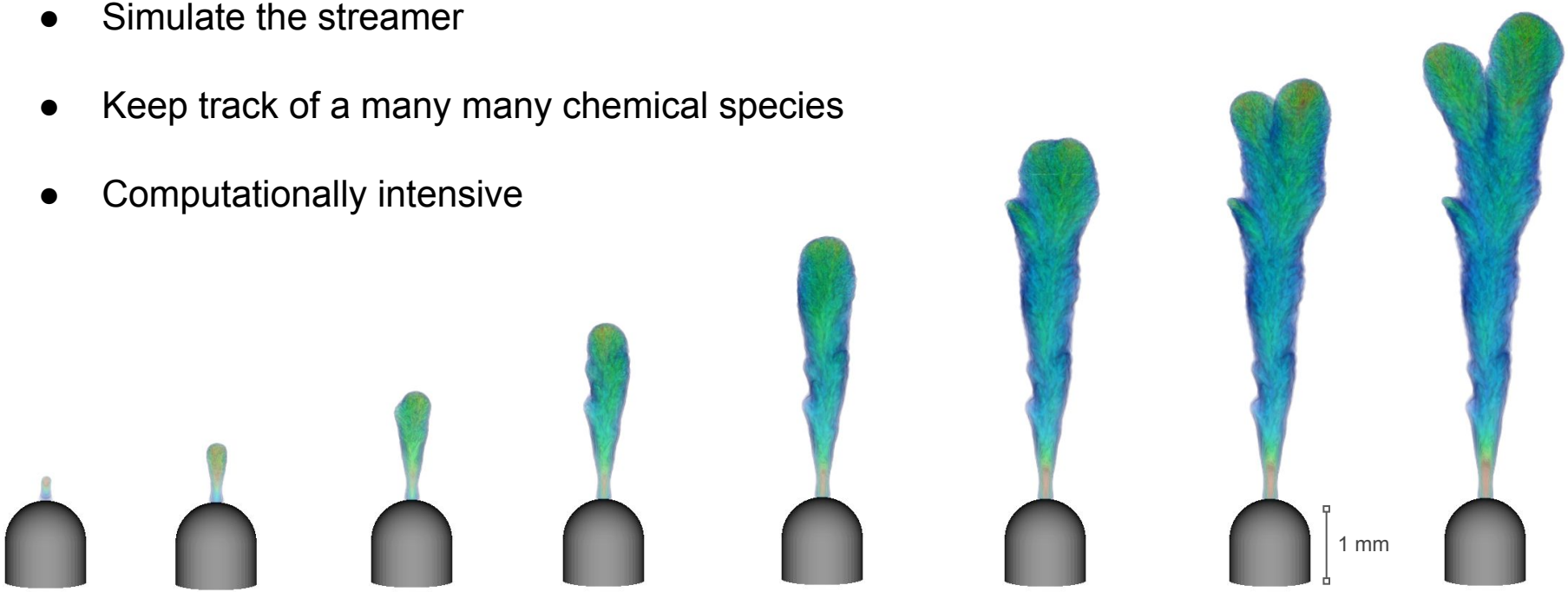
Lightning makes plants happy too!

We study *streamers* by numerical simulation



We study *streamers* by numerical simulation

- Simulate the streamer
- Keep track of a many many chemical species
- Computationally intensive



In applications we have hundreds of repeated discharges...

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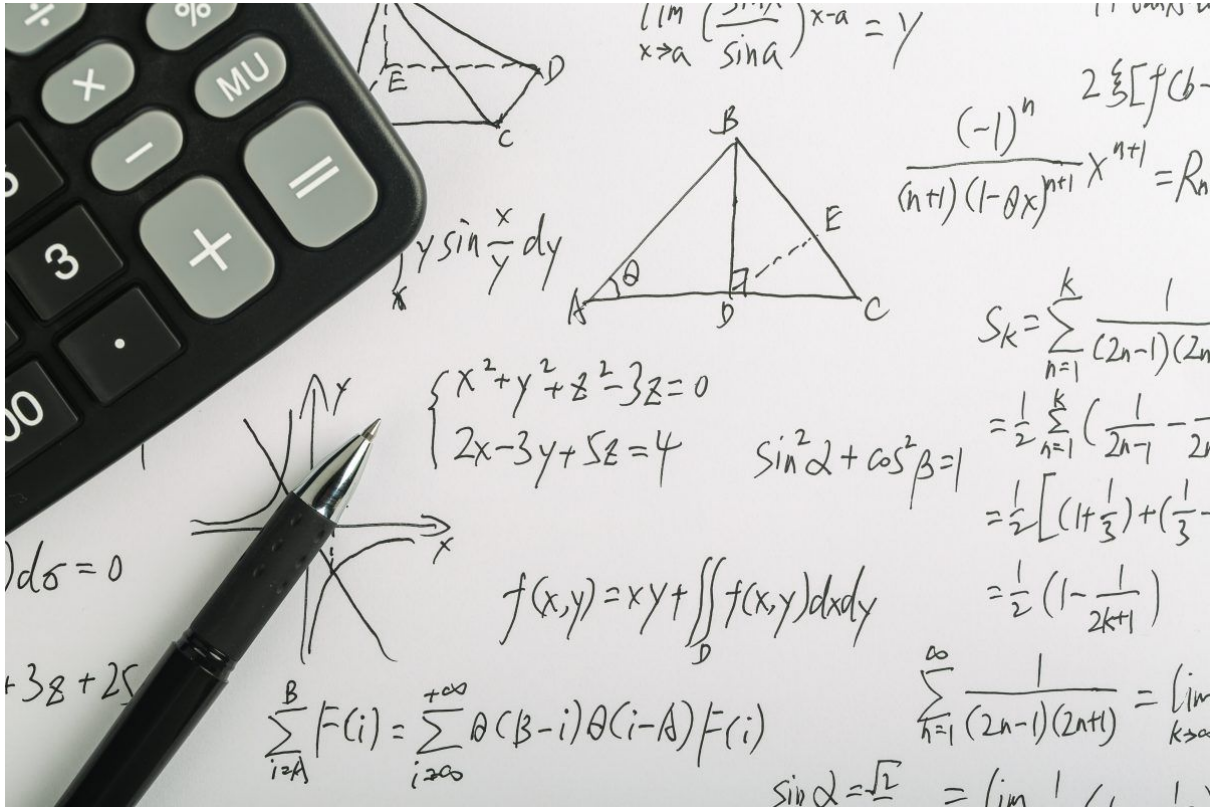
Approach from a different angle



Study an *idealized* streamer analytically

Study an *idealized* streamer analytically

Study an *idealized* streamer analytically

1.

2.

3.

Study an *idealized* streamer analytically

1. A formula for the density of a reactive species
2.
3.

Study an *idealized* streamer analytically

1. A formula for the density of a reactive species
2. A formula for “macroscopic parameters”
3.

Study an *idealized* streamer analytically

1. A formula for the density of a reactive species
2. A formula for “macroscopic parameters”
3. Solving the system of equations

Result: Electron density in the interior ($n_{e,ch}$)

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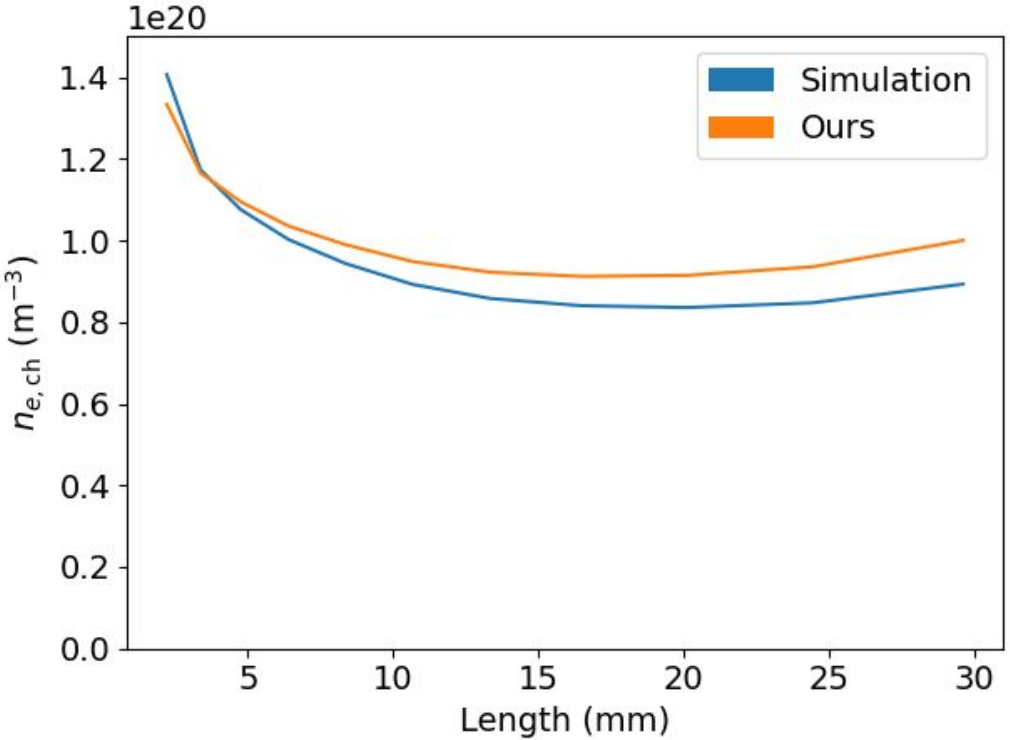

In the future...?