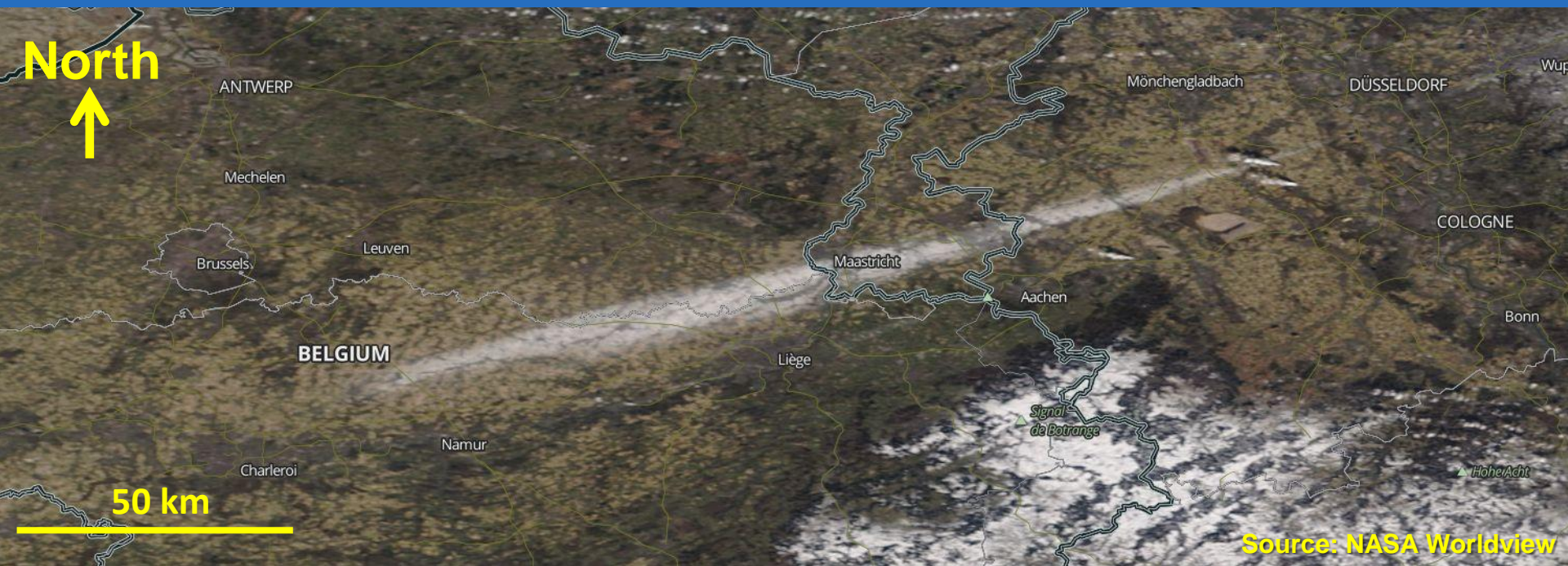


# Observation of narrow bands of heavy snow: two rare cases of snowfall impacted by industrial heat rejection in Europe

by

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The Solar-Terrestrial Centre  
of Excellence

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- Introduction
  - Snow band observation over Belgium
  - Driving processes of the phenomena
- Synoptic conditions
- Snowfall from Neurath and Weisweiler power-plants
- Snowfall from Cattenom power-plant
- Conclusions and Hypothesis

# Introduction

- A narrow band of heavy snow with a length of ~ 150 km was observed on 26 February 2018 in Belgium

- A second narrow band of thin snow cover was also observed (~ 20 km)

- Snow-covered roadways when roads were otherwise clear → **creating hazardous driving conditions**



## Neurath power station (lignite)

- Total capacity of 4211 MW (7 units) with 2 units of 1060 MW (since 2012)
- Natural draft cooling towers

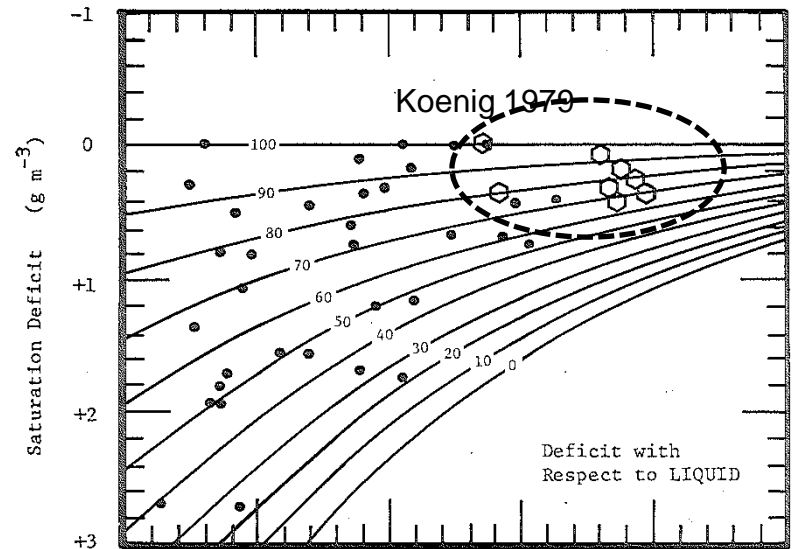
## Weisweiler power station (lignite)

- Total capacity of 1958 MW (4 units)
- Natural draft cooling towers



# Introduction

- Not new but rare enough to forget the driving processes!
- **In U.S.:**
  - Kramer et al. 1976 were the first to report the phenomena.
  - Koenig 1979 and 1981 were the first to analyse in details several cases in U.S. and tried to details the mechanism processes.
- **In Europe:**
  - Only one case in February 1983 (at Dampierre nuclear power plant) documented by Campiston 1986 and Sauvageot 1987
- Under specific atmospheric conditions: water plume from cooling tower may change from supercooled droplets to ice crystal.

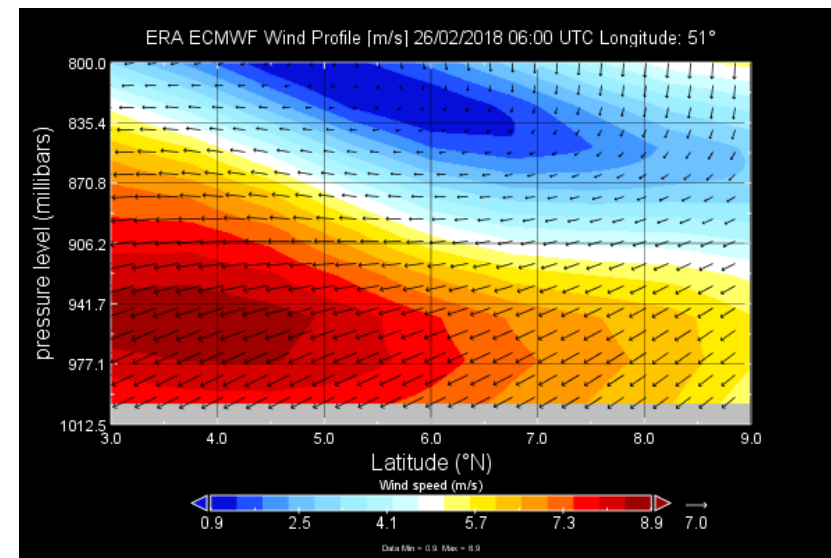
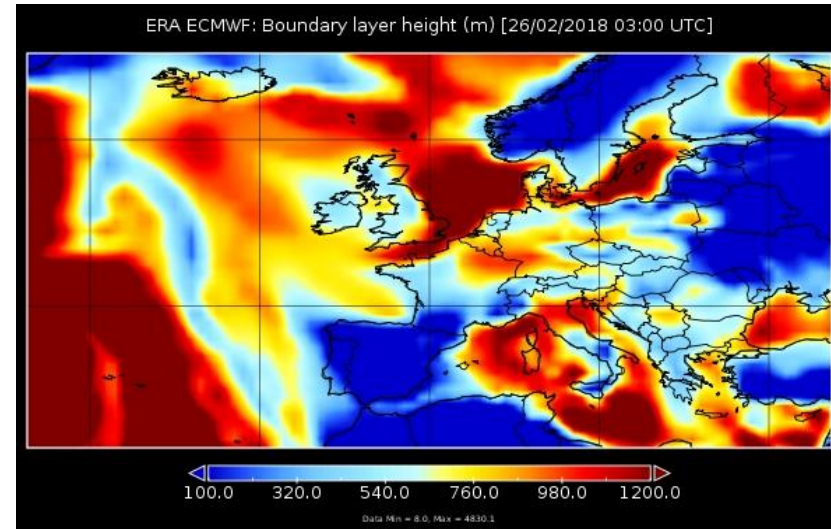
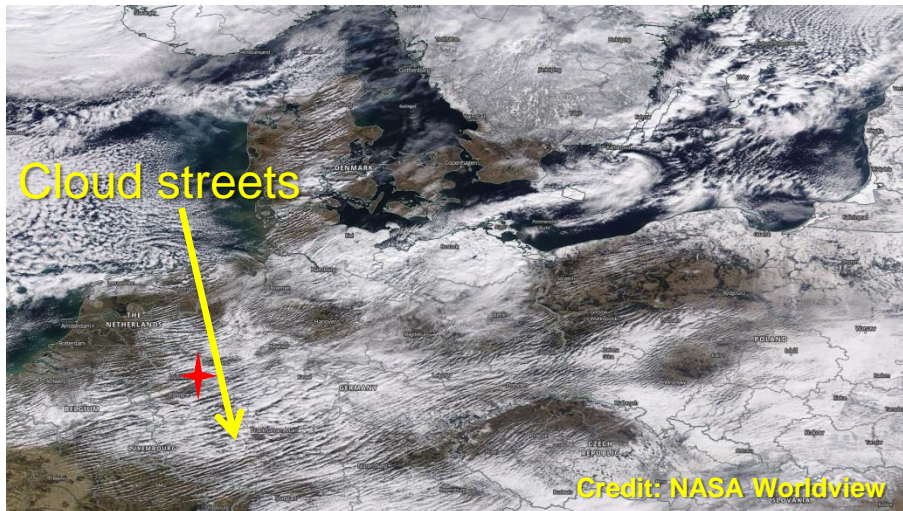


- Close to the saturation, liquid was supersaturated with respect to ice → Bergeron, riming and aggregation → Snowfall



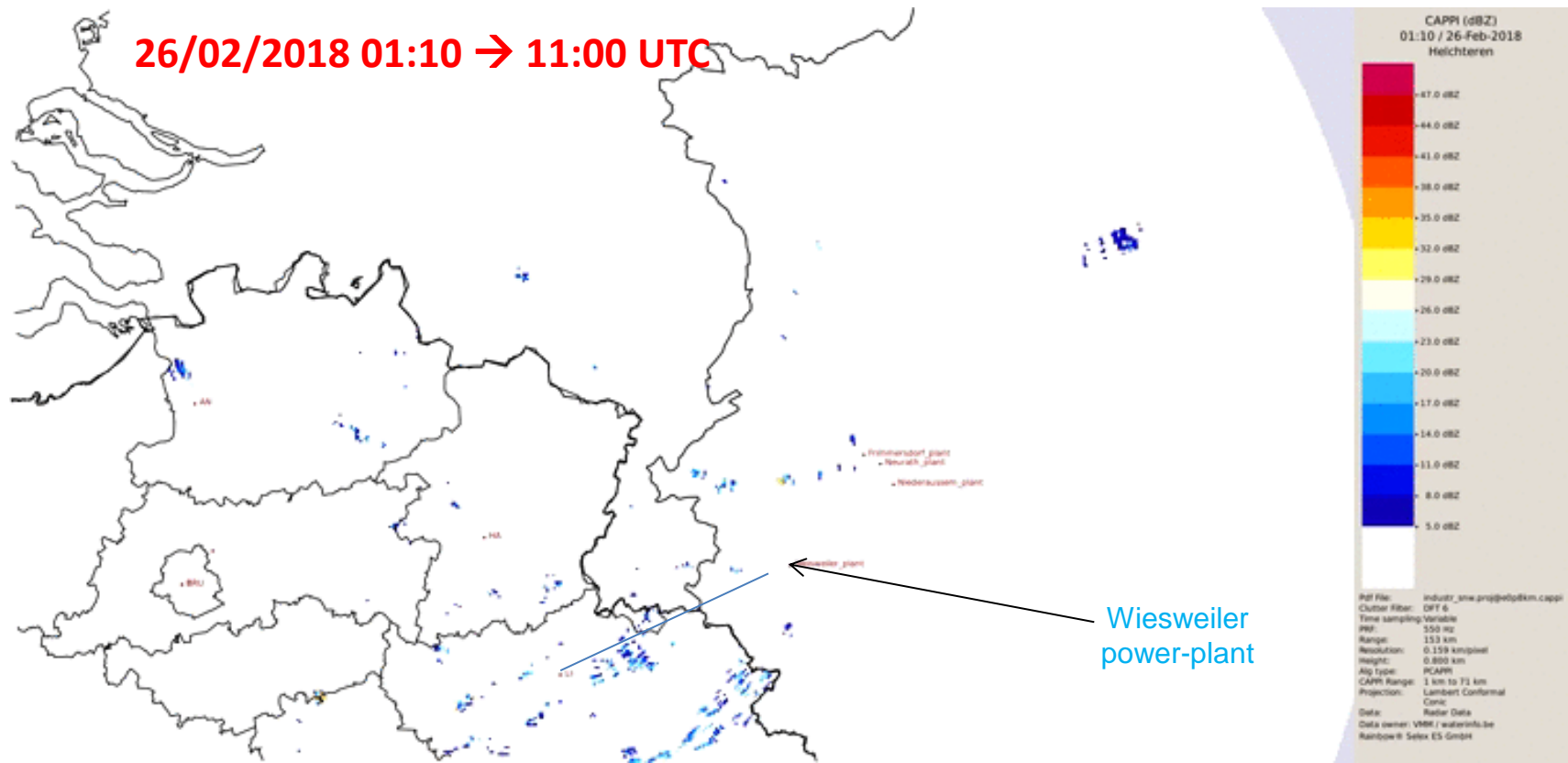
# Boundary layer conditions: 26 February 2018

- Atmospheric boundary layer was high:  $\sim 1200$  m and unstable.
- Wind speed was maximum in the middle part of the boundary layer.
- Vertical directional wind shear:  $\sim 20$ - $30^\circ$  in the boundary layer.
- Cloud Streets generated locally light snowfalls.





# Weather radar (CAPPI: 800m) observations

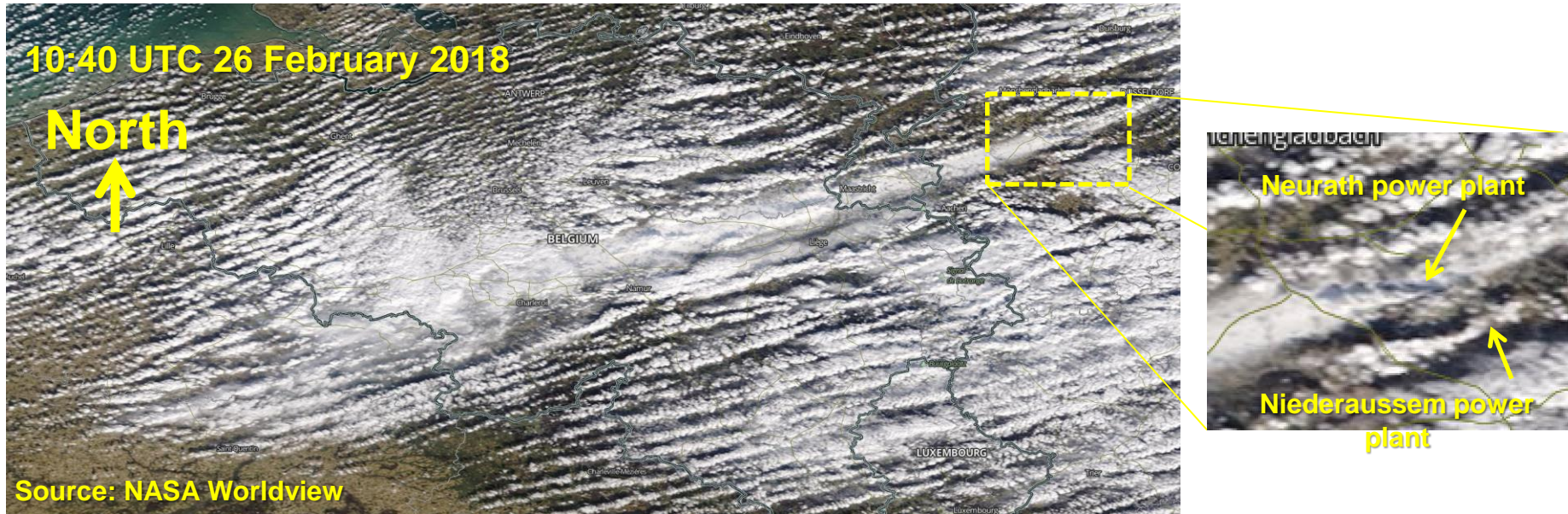


- In front of the weak precipitations area, activation of a narrow band of weak precipitation located downwind (at ~ 10km) from Wiesweiler power-plant likely related to the water plume of cooling towers
- Weak precipitations area was slightly activated on a narrow axis but far away of 10 km from the power-plant



# Satellite observations (MODIS)

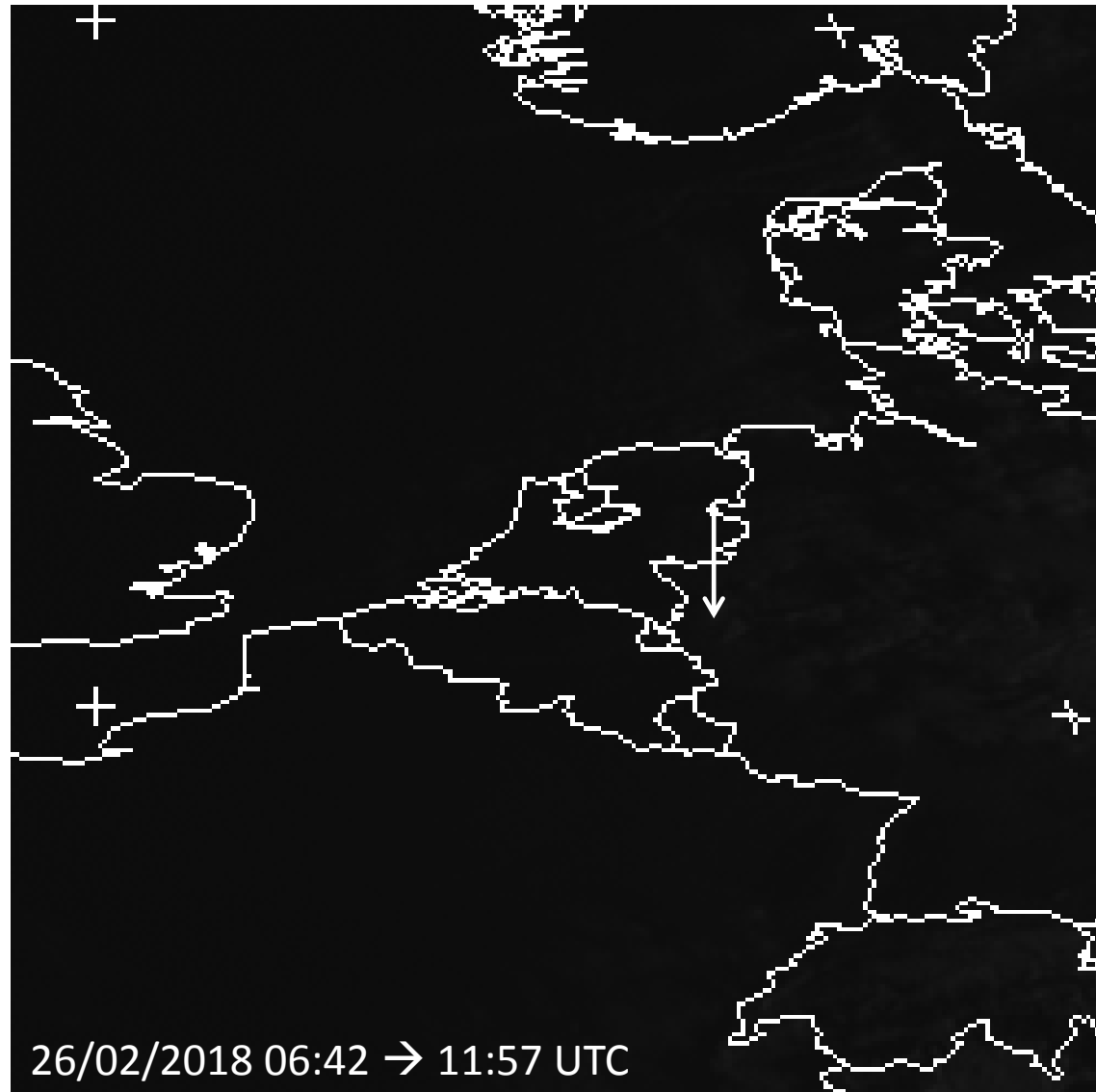
- No data about the height of the water plume



- Following the power capacity and satellite observation, water plume of Neurath was likely higher than the water plume of Weisweiler
- Fuzzy appearance of clouds suggests that the clouds contained ice particles due to its interaction with the water plume of Neurath

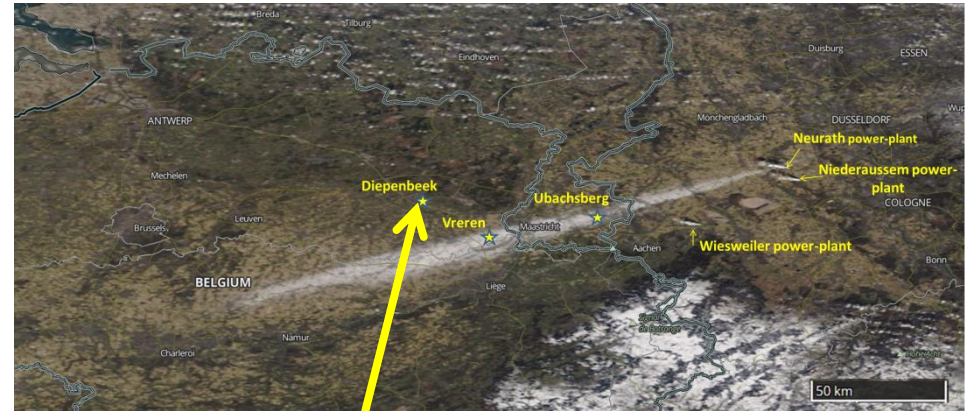
# Satellite observations: SEVIRI (Eumetsat)

- SEVIRI (NIR 1.6 $\mu\text{m}$ ): ice particles (in darker) located downwind from the Neurath power-plant likely related to the water plume of the power-plant.
- SEVIRI captured only the end of the snowfall.

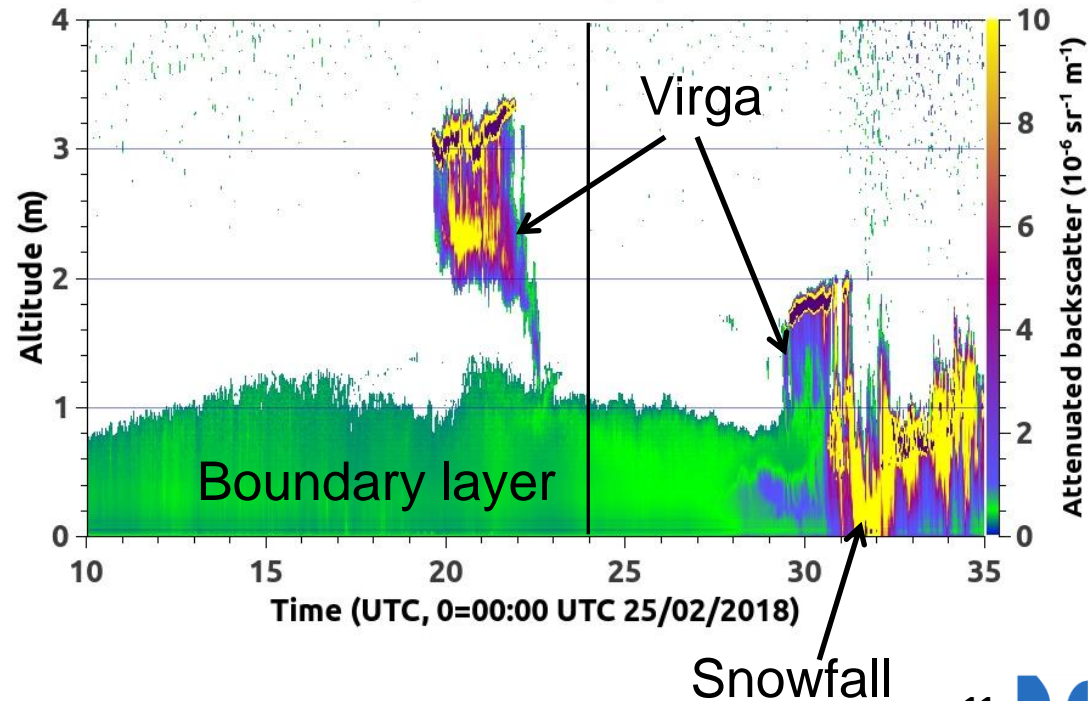


# Ceilometer observations

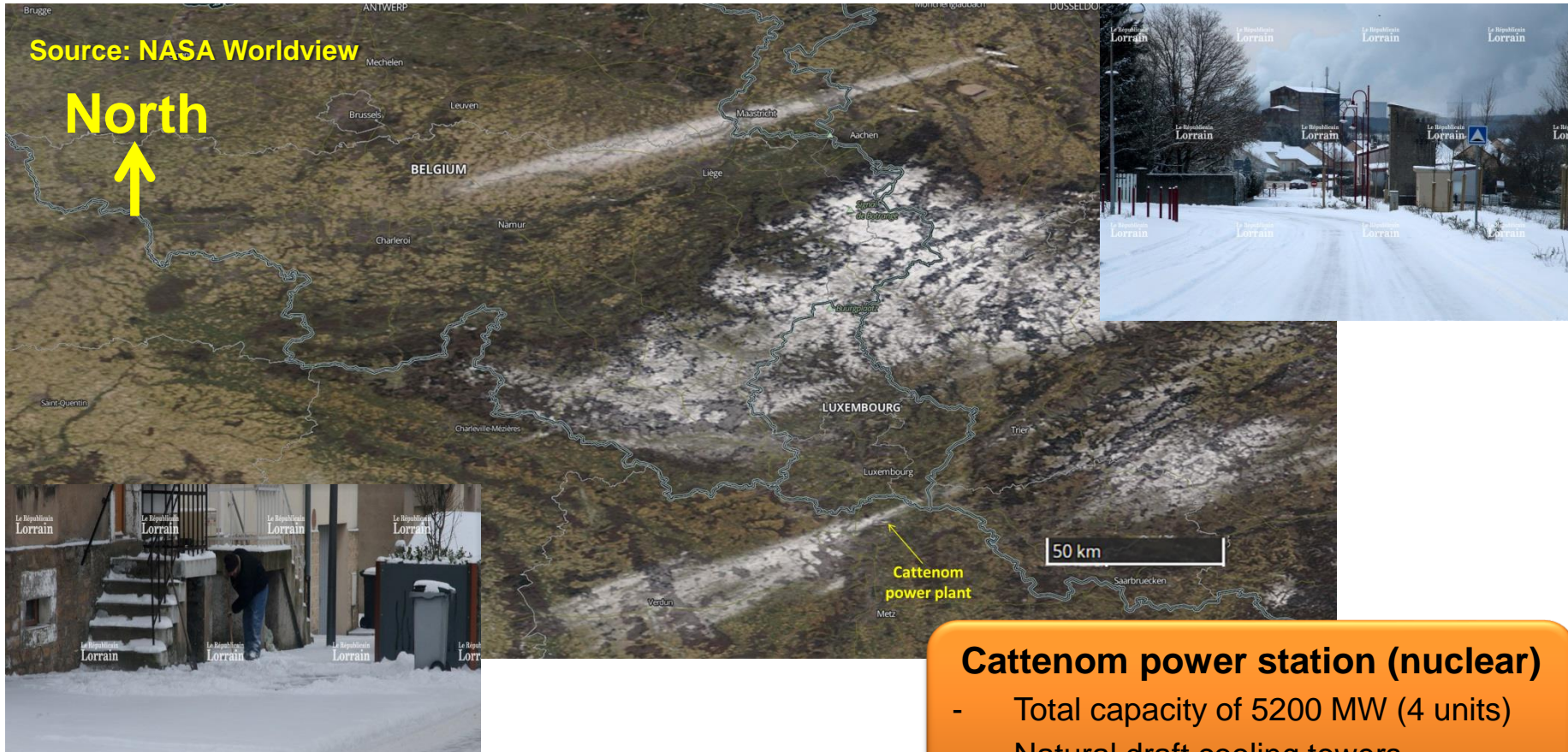
- No precipitation of the plume before the arrival of the weak precipitation area due to the presence of dry air layer in altitude (virga observations) → efficient to disperse the water plumes before its glaciation
- Clouds bring humidity promoting long-lasting plume.
- The longer the plume is, the more likely it is to glaciate.



Diepenbeek 25-26/02/2018

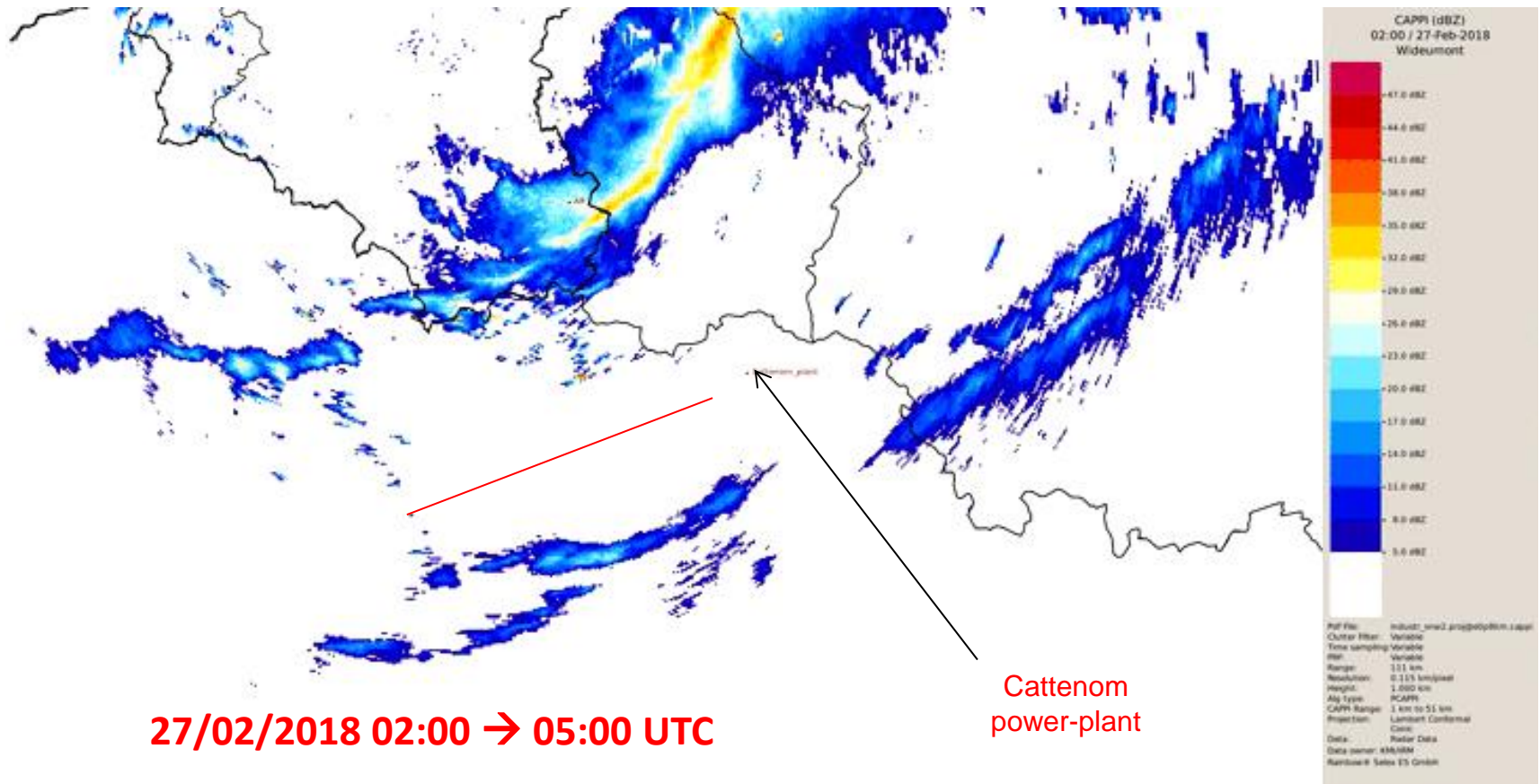


# Cattenom power-plant observations



- 27 February 2018: similar synoptic conditions to the previous day
- Snow band is more spread (wind direction changed slightly during the snowfall) and is shorter (~ 75 km)

# Cattenom power-plant observations

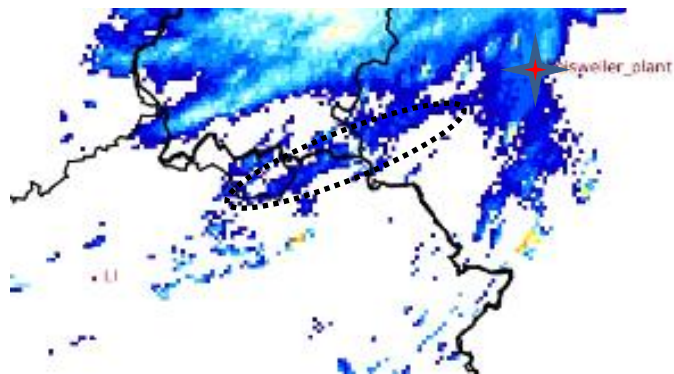


- In front of the weak precipitations area, activation of a narrow band of weak precipitation located downwind (at ~ 5km) from Cattenom power-plant
- Weak precipitations area was significantly activated close to Cattenom power-plant and on narrow axis downwind from power-plant

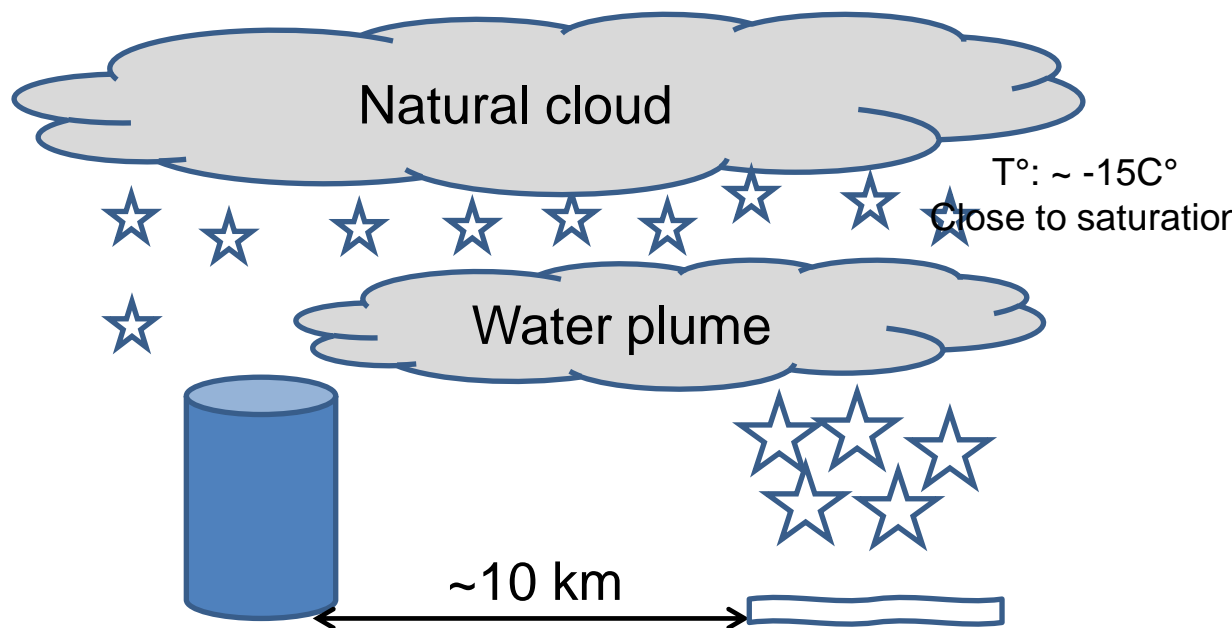
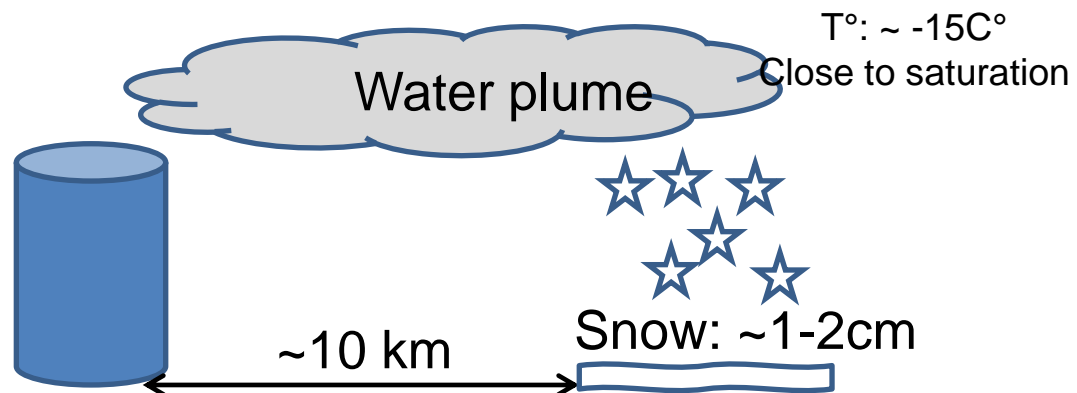
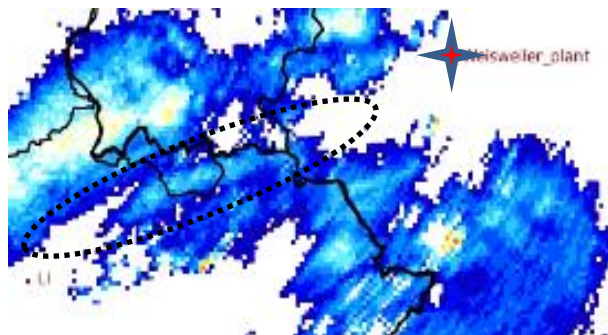
# Conclusions and Hypothesis

## Weisweiler power plant

- Precipitation of the plume



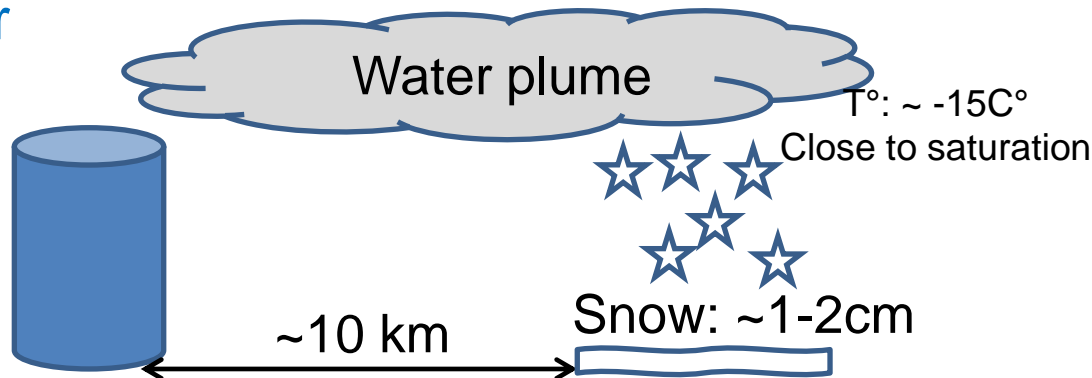
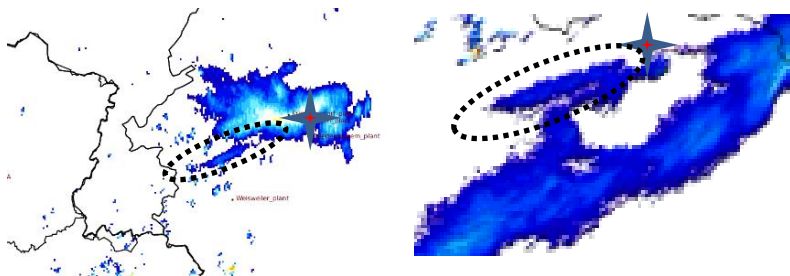
- No interaction with the natural cloud: Seeder-feeder effect



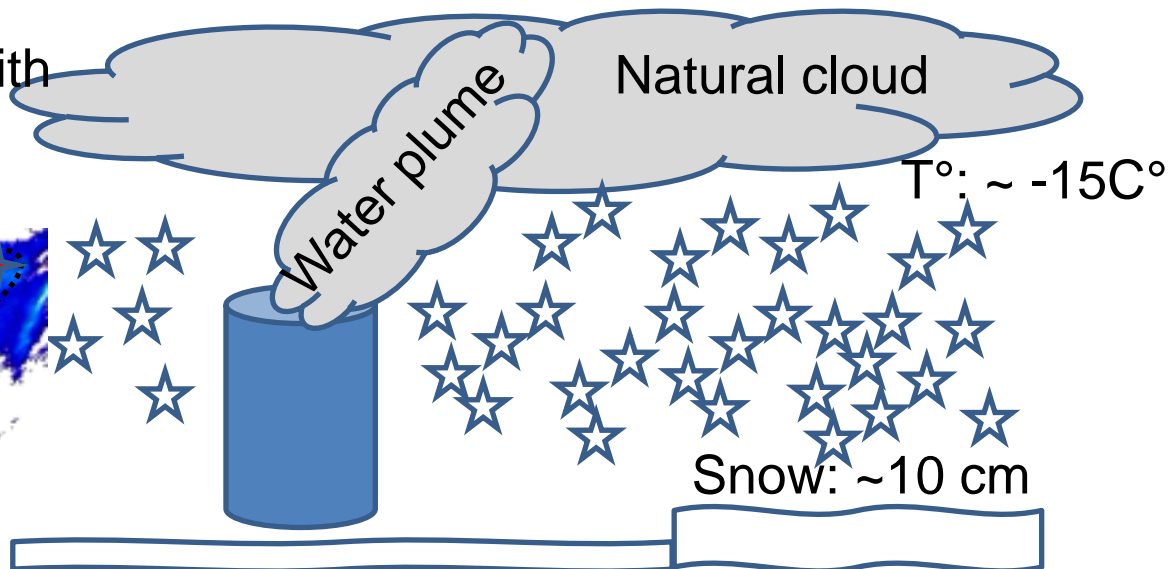
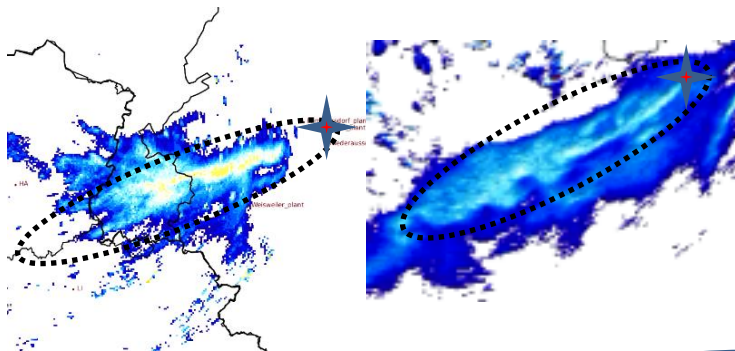
# Conclusions and Hypothesis

## Neurath and Cattenom power plants

- Precipitation of the plume

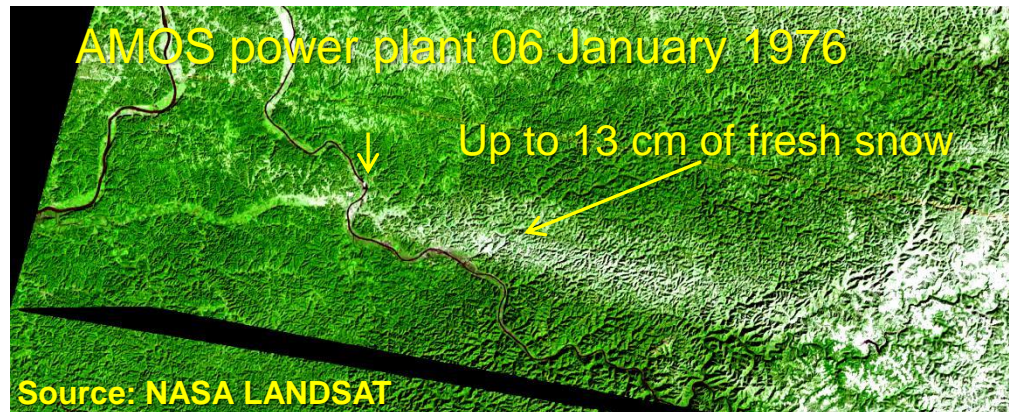
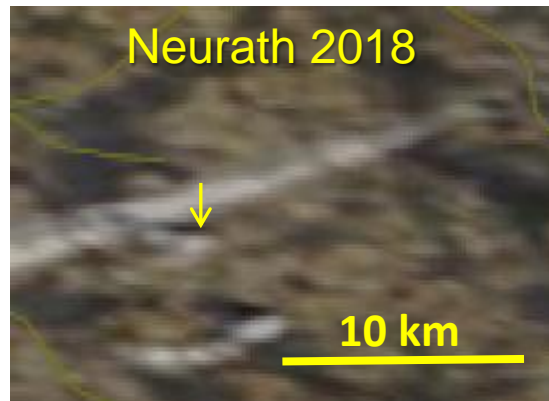


- Interaction of the plume with natural cloud



# Conclusions and Hypothesis

- Potential interaction of water plume with natural cloud induced heavy snowfall downwind.
- But also significant snowfall upwind (up to 10 km) of the power plant? How? More snowfall cases are necessary to strengthen our observations





# Thank You!

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