Folkert Boersma, Martin de Graaf, Annabel Chantry, Guido van der Werf, Otto Hasekamp, Marloes Penning de Vries, Anton Vrieling, Nick Schutgens, Gerbrand Koren, Peter van Bodegom, Dimitra Kollia, and Manouk Geurts

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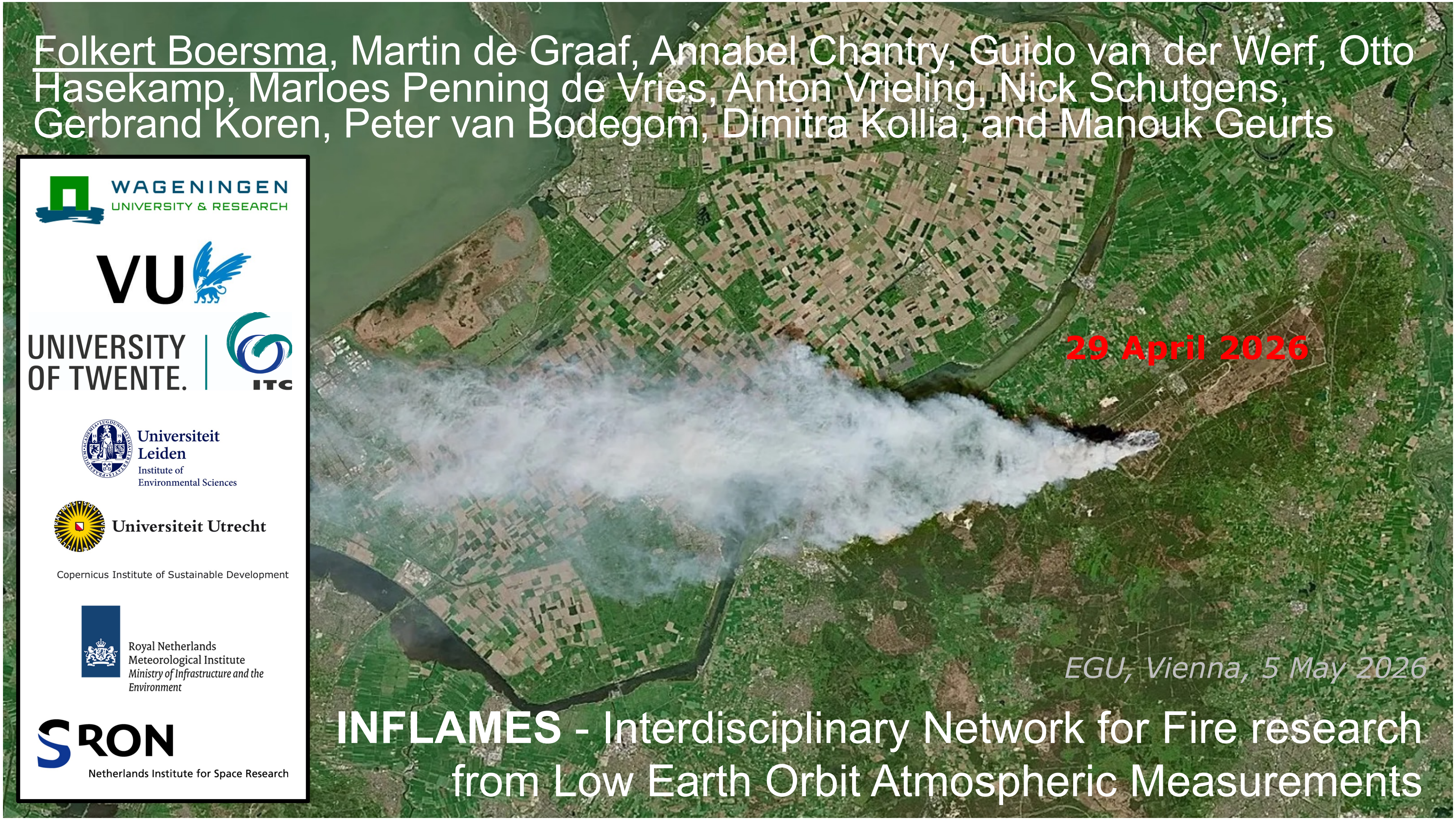
Institute of Environmental Sciences
Universiteit Utrecht
Copernicus Institute of Sustainable Development
Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment
SRON
Netherlands Institute for Space Research

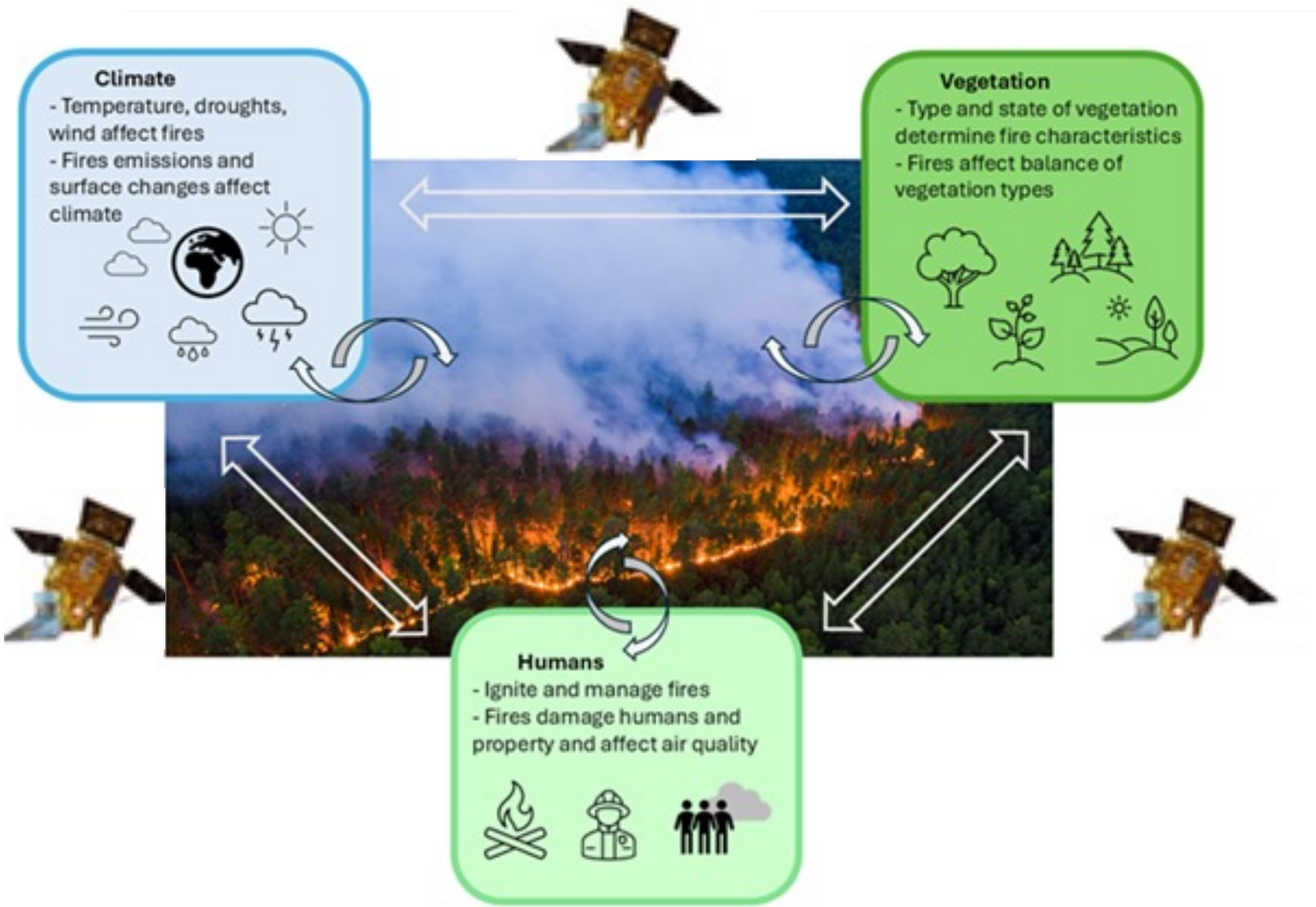


EGU, Vienna, 5 May 2026

INFLAMES - Interdisciplinary Network for Fire research from Low Earth Orbit Atmospheric Measurements


We took a look from the roof of KNMI towards the North
Photo: Igor Nedelovic (KNMI)

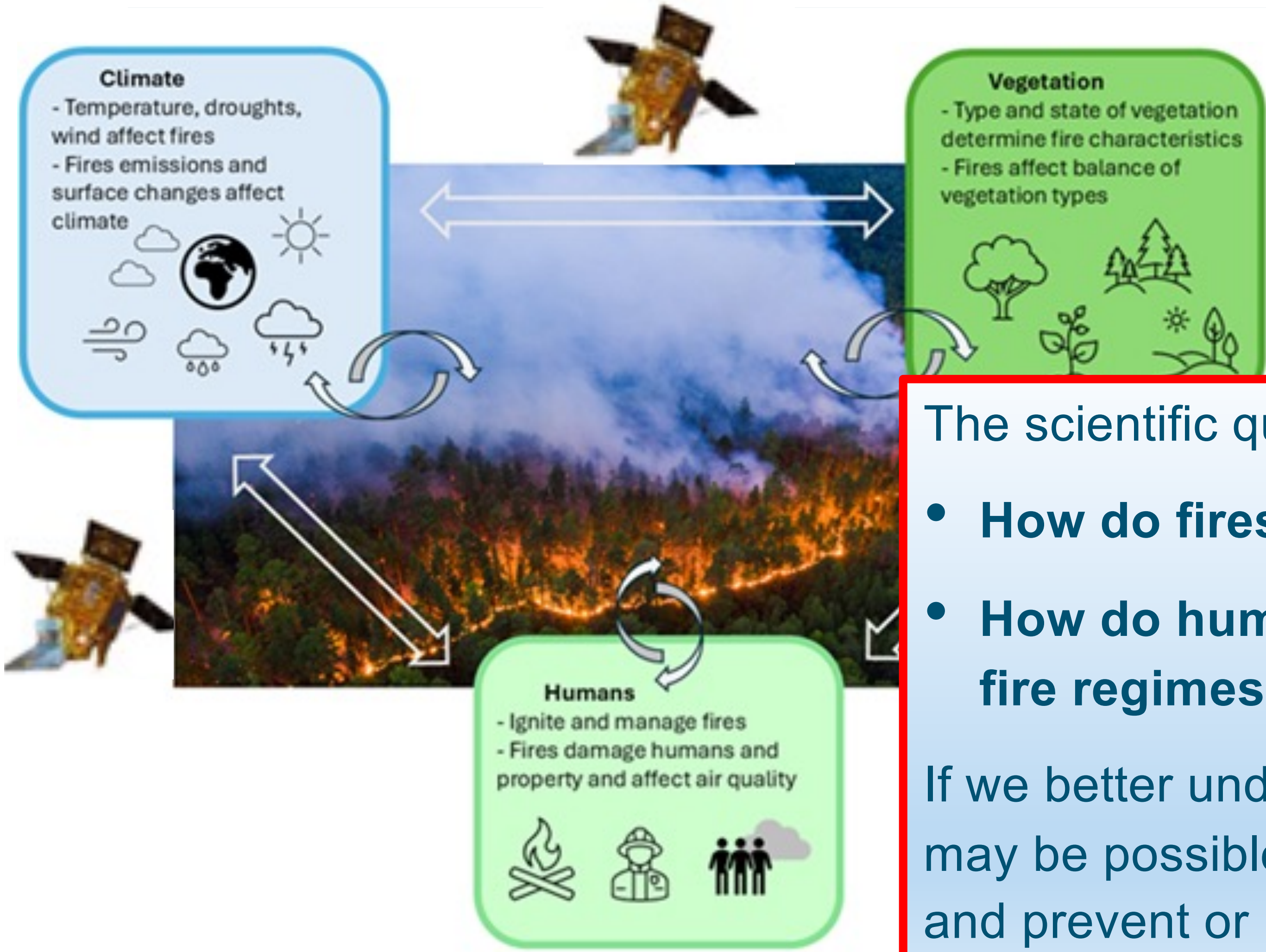
Fires are difficult to predict



The interactions between climate-vegetation and humans determine fire occurrences and impacts.

New (Dutch) satellite measurements allow the synergistic study of these interactions and allow making predictions

Fires are difficult to predict



The interactions between climate-vegetation and humans determine fire occurrences and impacts.

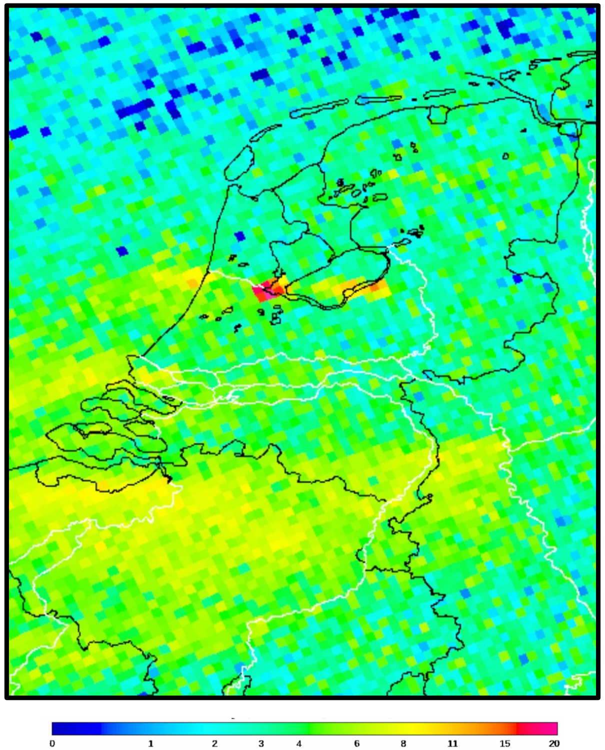
The scientific questions are:

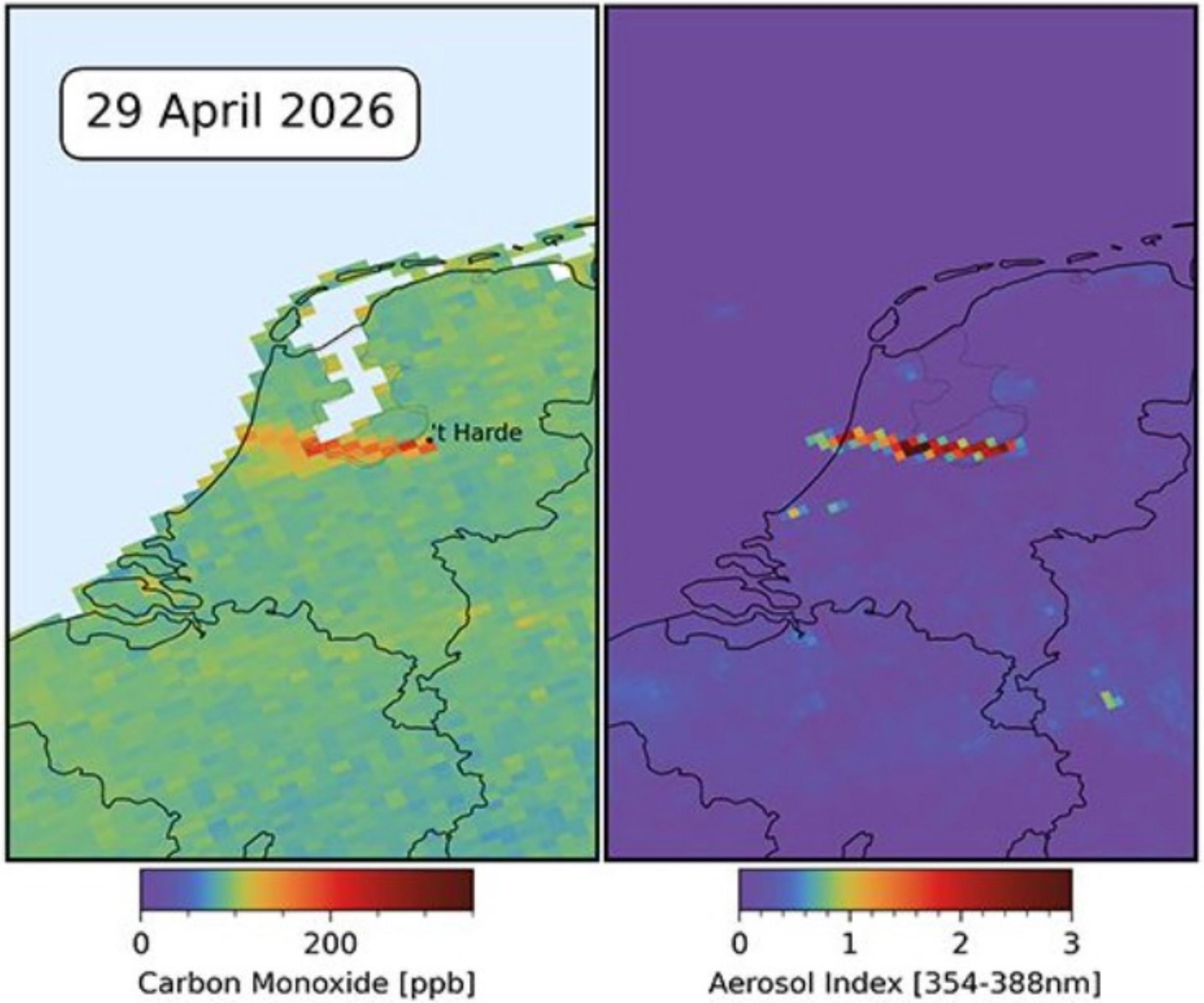
- **How do fires alter air quality and climate?**
- **How do humans and vegetation influence fire regimes?**

If we better understand these interactions, it may be possible in the future to better predict and prevent or mitigate fires and their impacts.

INFLAMES takes the look from space with new sensors

TROPOMI NO_2



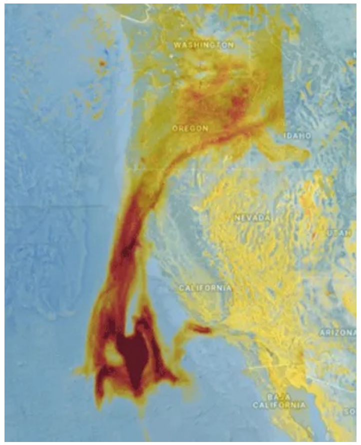


New opportunities from Dutch satellite instruments

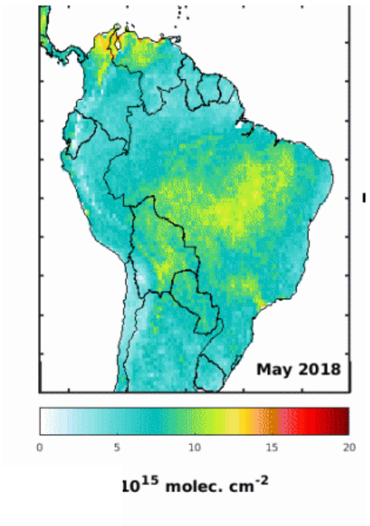
TROPOMI

- CO, NO2, HCHO, HONO
- Aerosol:AOD, AAI, ALH
- Surface albedo, SIF

TROPOMI CO



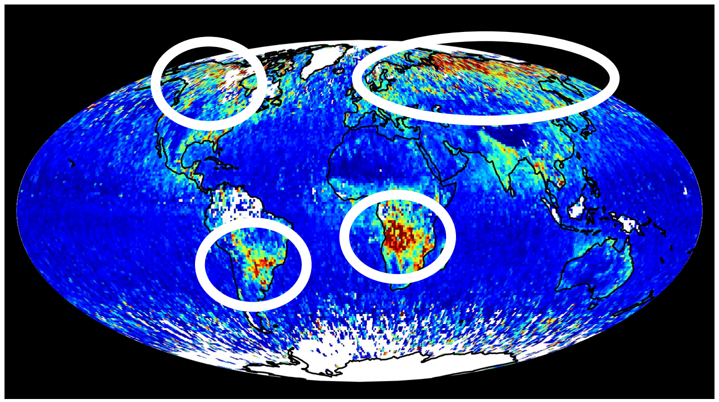
TROPOMI HCHO



SPEXone

- Optical properties (AOD, SSA, AE)
- Composition (BrC, BC, Sulfate)
- Cloud Condensation Nuclei (CCN)
- ALH

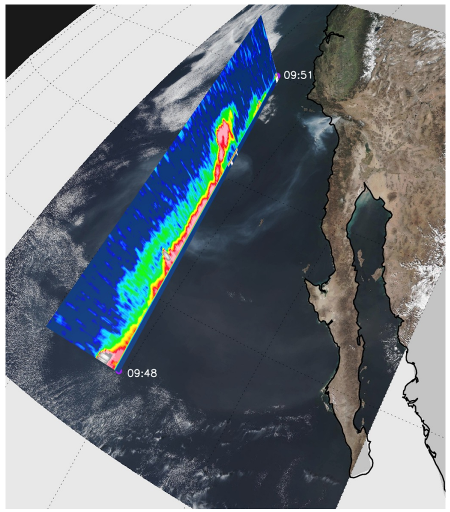
SPEXone Black&Brown Carbon



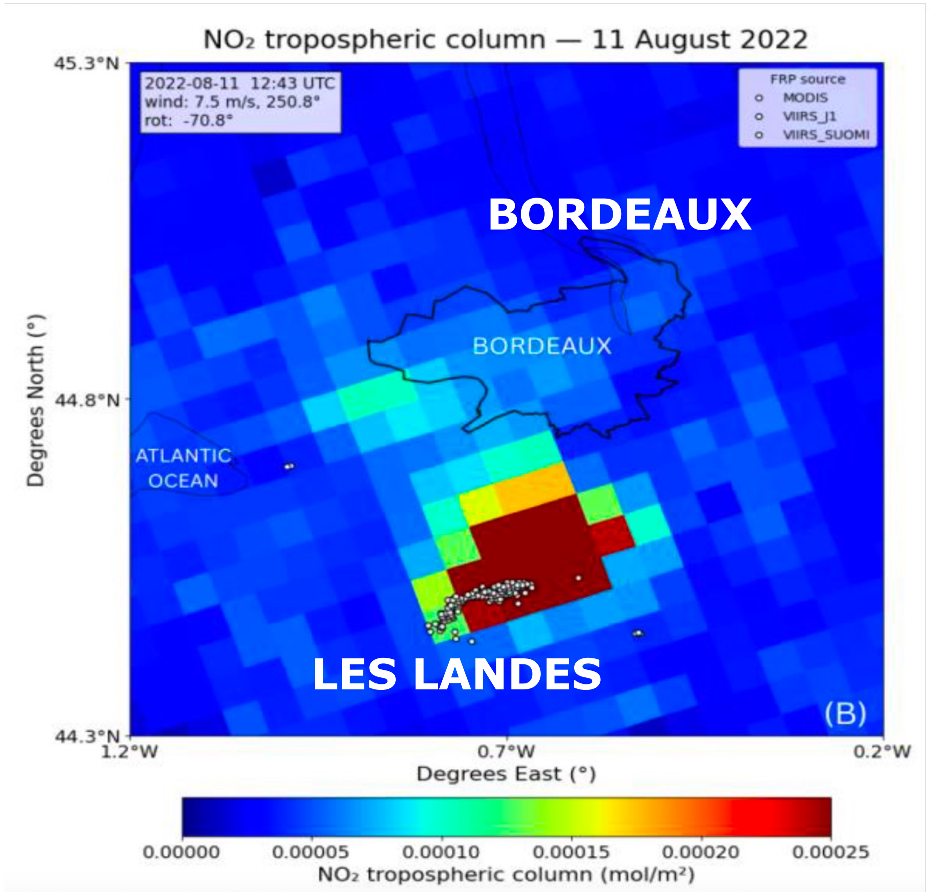
Earthcare

- Vertical exctinction
- Heating rates
- vertical velocity, cloud profile

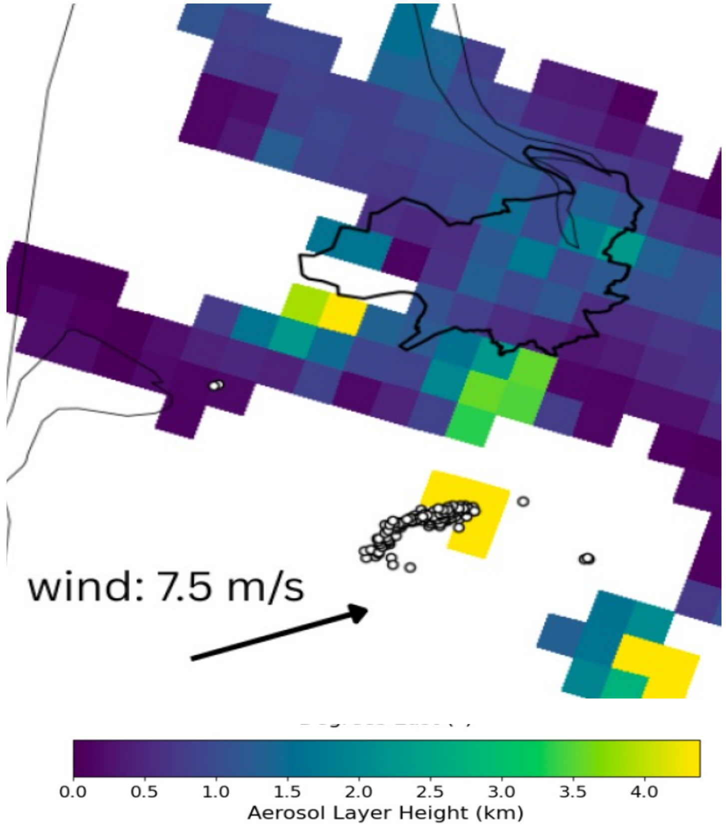
ATLID attn. backscatter



Example: estimating NO_x emissions from Les Landes fire

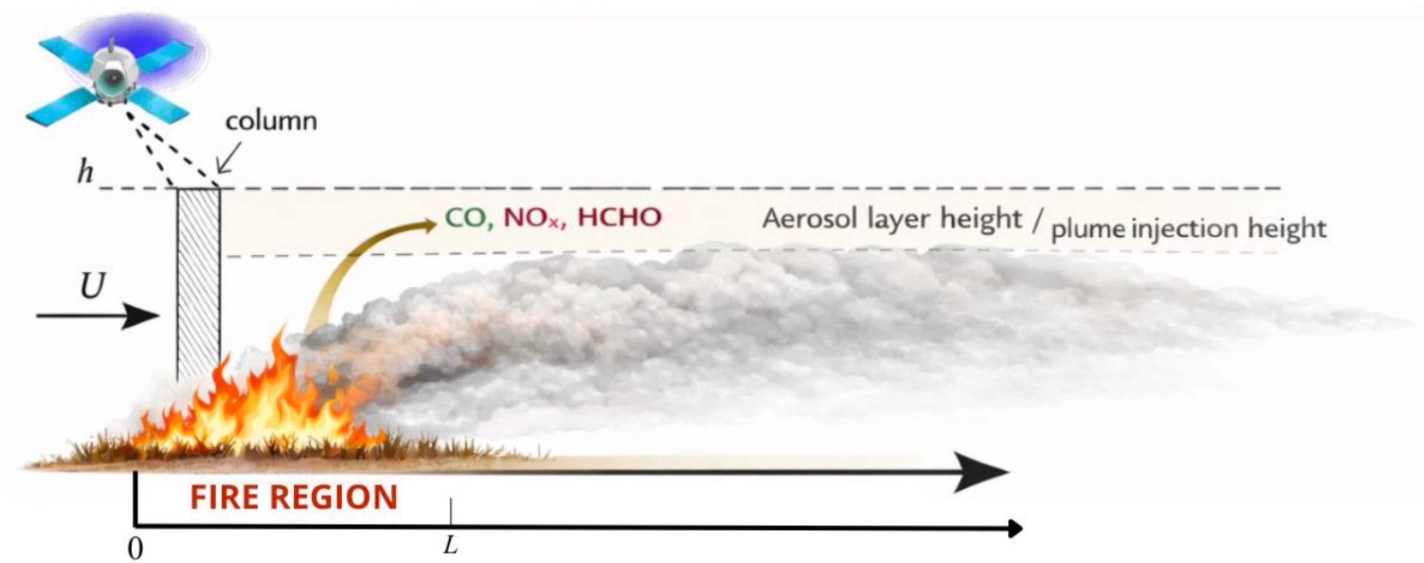


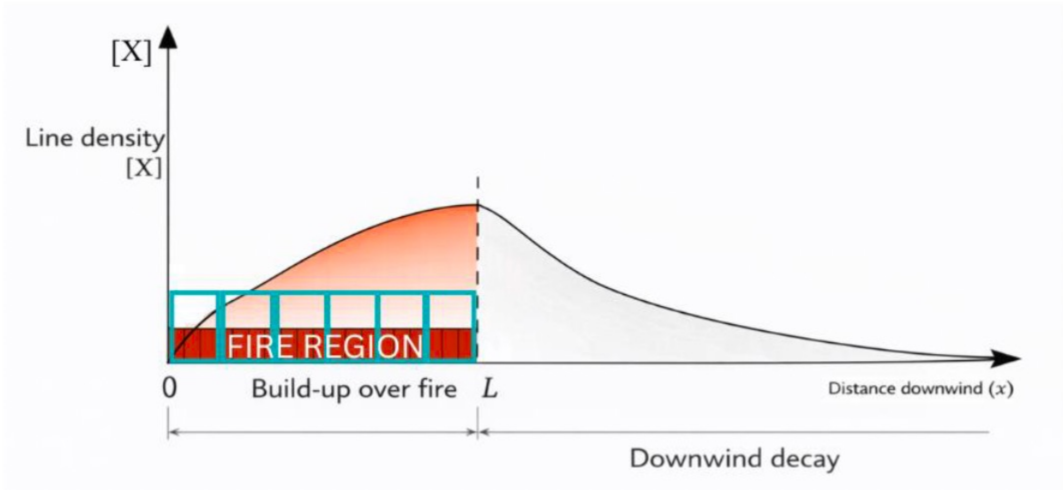
TROPOMI detects strong NO_2 plume northeast of VIIRS fires



TROPOMI Aerosol Layer Height indicates injection at 4-5 km

Example: estimating NO_x emissions from Les Landes fire





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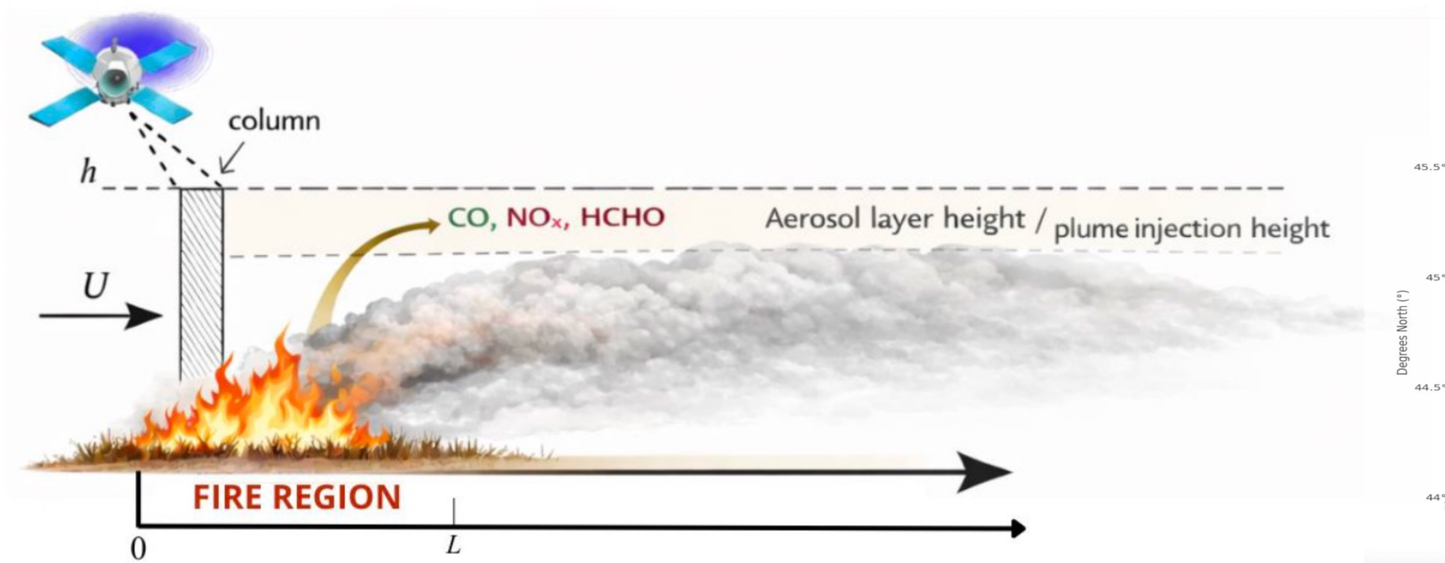
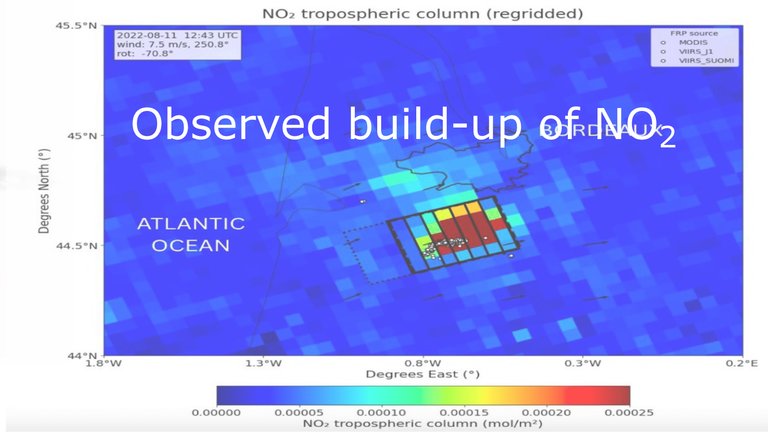
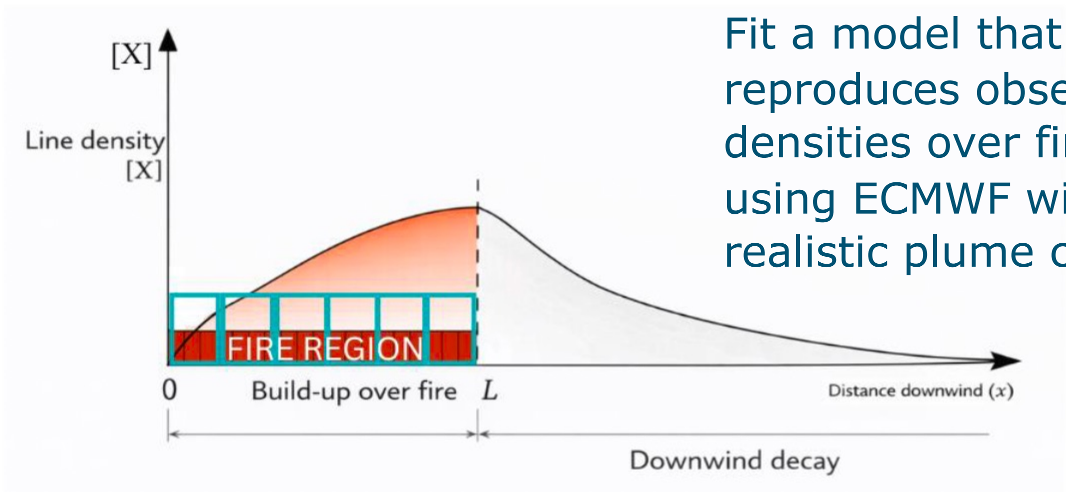
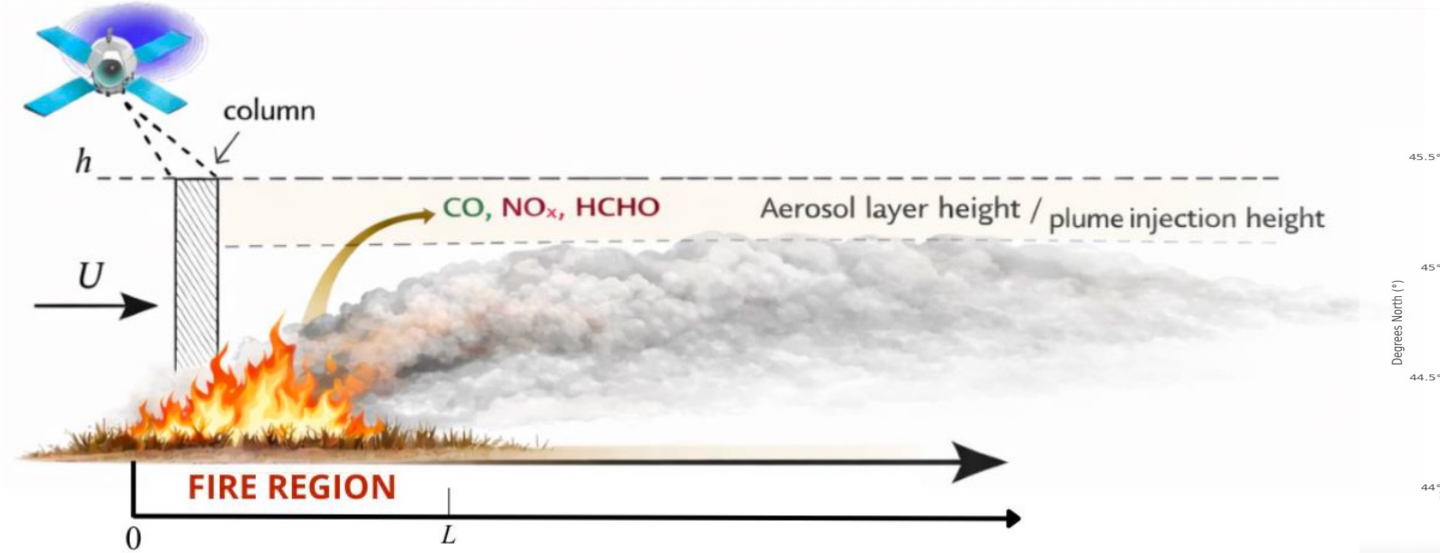


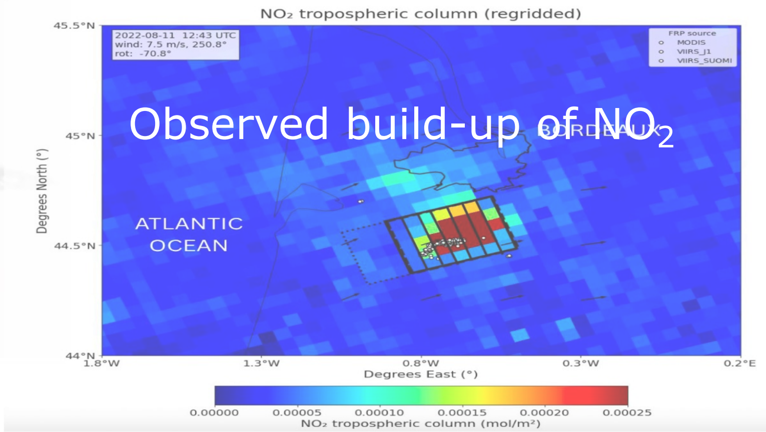


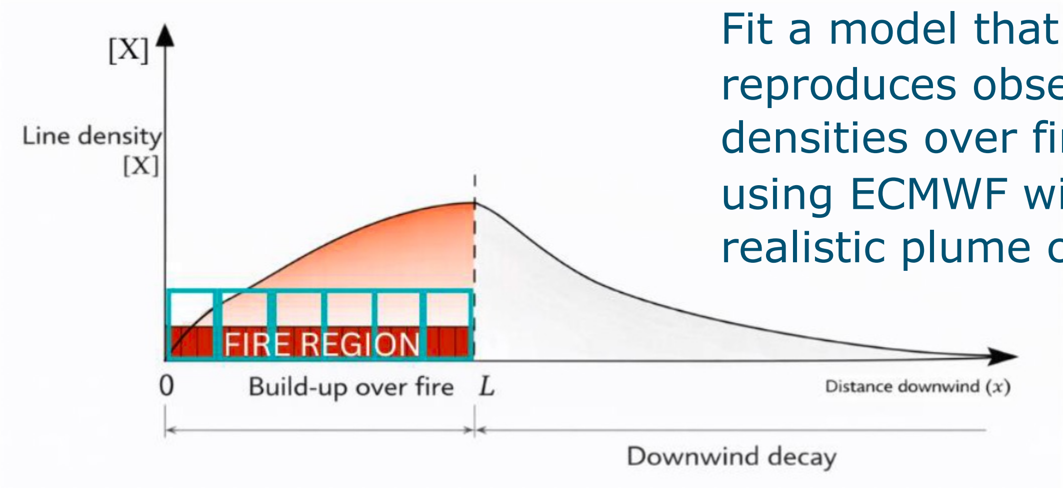


Fit a model that best reproduces observed line densities over fire region using ECMWF wind and realistic plume chemistry

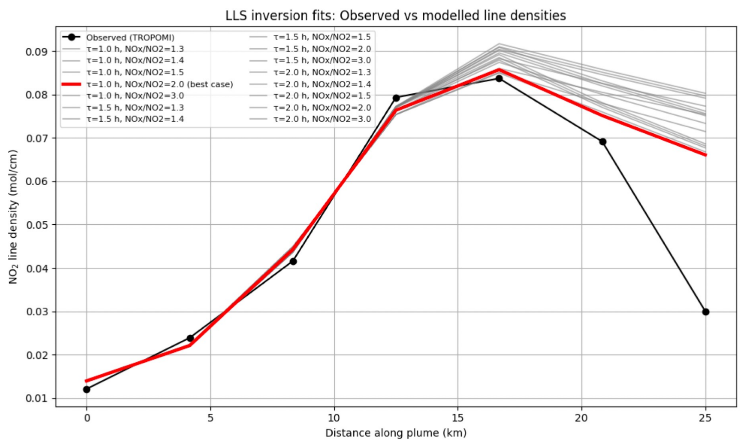
Example: estimating NO_x emissions from Les Landes fire







Fit a model that best reproduces observed line densities over fire region using ECMWF wind and realistic plume chemistry



Example: estimating NO_x emissions from Les Landes fire

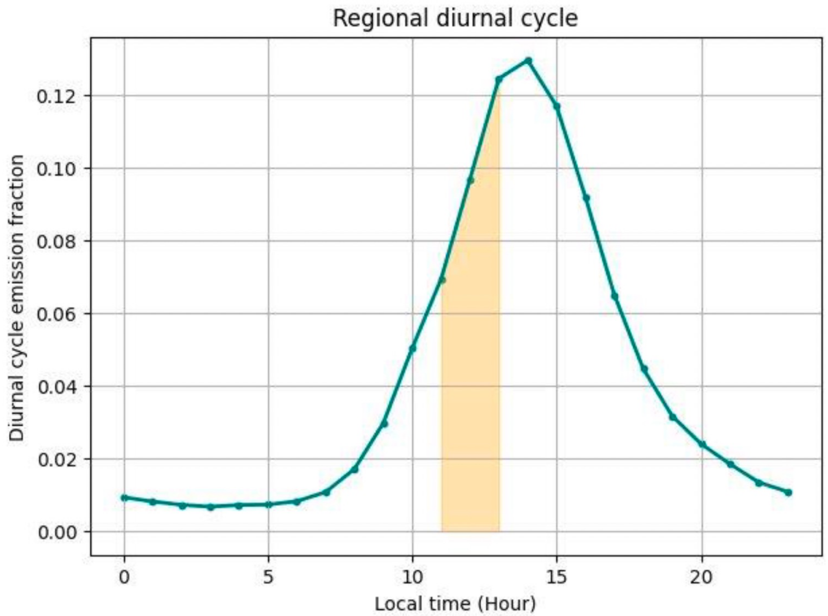
Result:

τ_{NOx} = 1 hr

NO_x/NO_2 = 2

146 mol/s in hours before overpass

Much higher than 40 mol/s predicted by GFEDv5



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INFLAMES objectives and approach

O1 Quantify and assess how (changing) fires impact air quality

O2 Understand how humans influence fire dynamics

O3 Reveal how climate change drives fire dynamics

O4 Quantify and project fire impacts on climate

Satellite observations

- Emissions and concentrations (AQ)
- Smoke and clouds (climate)
- Surface albedo, SIF (vegetation)

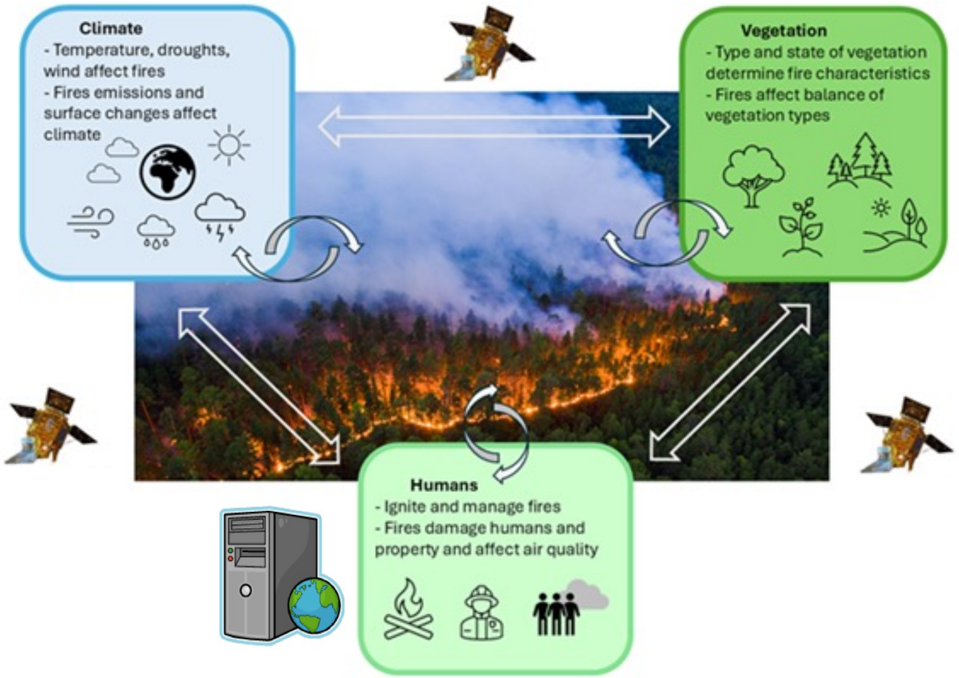
Models

- microHH (local air pollution)
- LOTOS-Euros (regional)
- JSBACH (dynamic vegetation)
- ECHAM-HAM (climate model)

Socio-ecological input

- Land-use change
- Population - ignition
- Landscape fragmentation
- Interviews on the ground

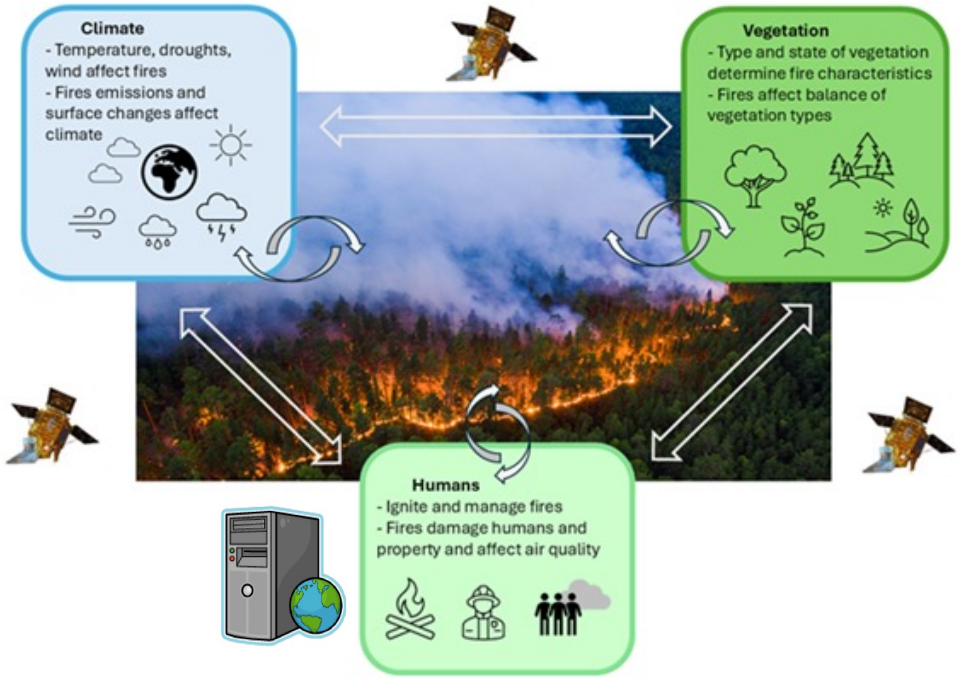
Expected outcomes and interdisciplinary value



<u>Scientific impact:</u>

- Key model improvements
- Better Dutch satellite products
- New generation of RS scientists

Expected outcomes and interdisciplinary value



A new ecological-climate-human fire framework

- Includes human influences on vegetation and fires
- Couples dynamic vegetation modelling (JSBACH) with fire emissions
- Links ecosystem changes to air quality and climate impacts
- Integrated into global climate model ECHAM-HAM

Empowered by new NL satellite sensors

- Uses SPEXone, EarthCare, TROPOMI for aerosols, clouds, radiative forcing, SIF
- Satellite observations inform model updates

Scientific impact:

- Key model improvements
- Better Dutch satellite products
- New generation of RS scientists

Truly interdisciplinary

- Combines ecology, climate modelling, human behaviour & remote sensing
- Aligns with UN SDG 3 & 11 – health and resilient cities

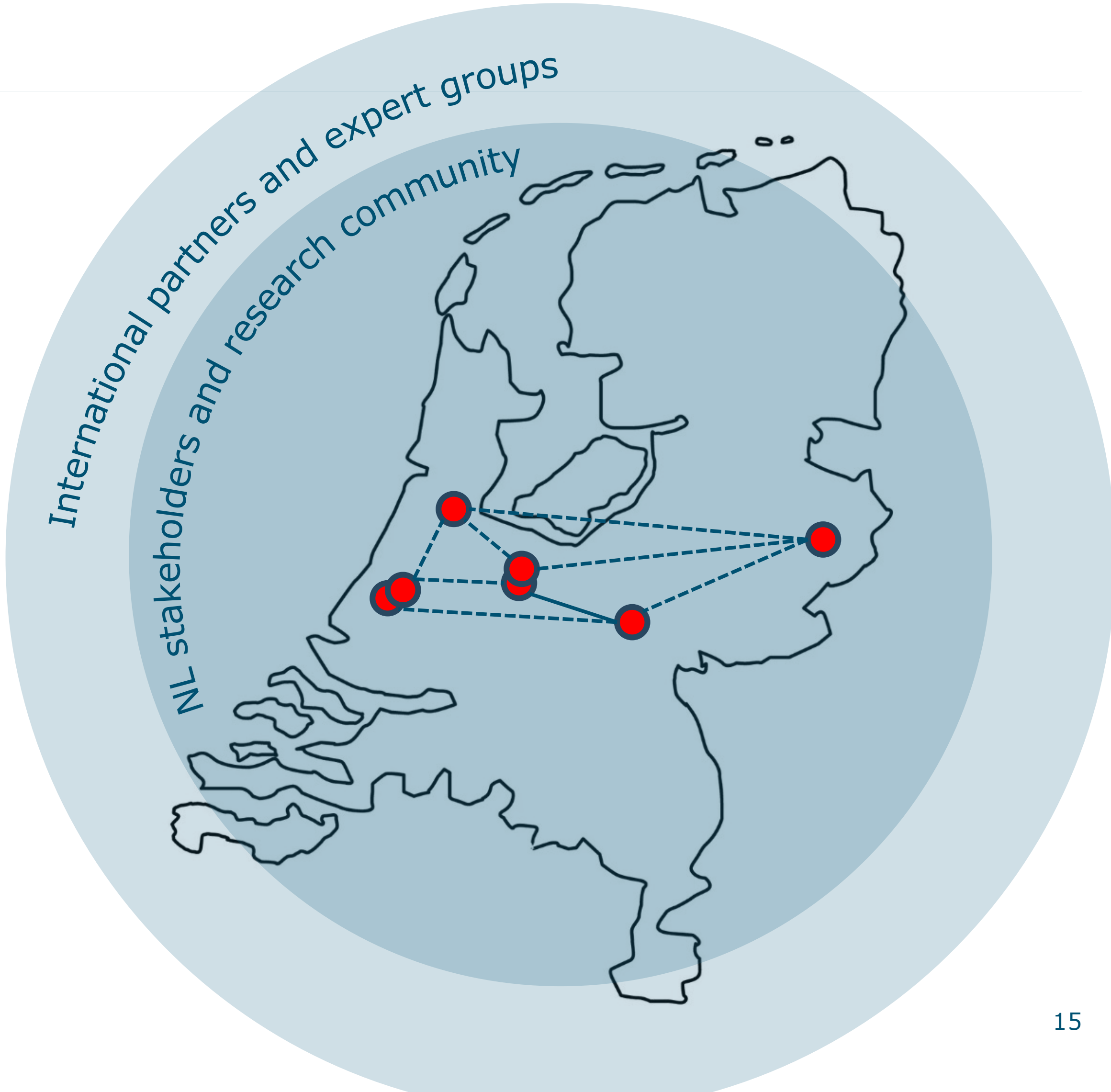
Networking activities

Activities:

- Early-career scientists in Earth Observation networking events
- National networking events with societal stakeholders
- International Summer School on use of EO for fire research
- User workshops with international networks

Goals:

- Strengthening the NL remote sensing community
- Connecting with international efforts
- Empowering early career researchers



Fire cases – from tropical to boreal

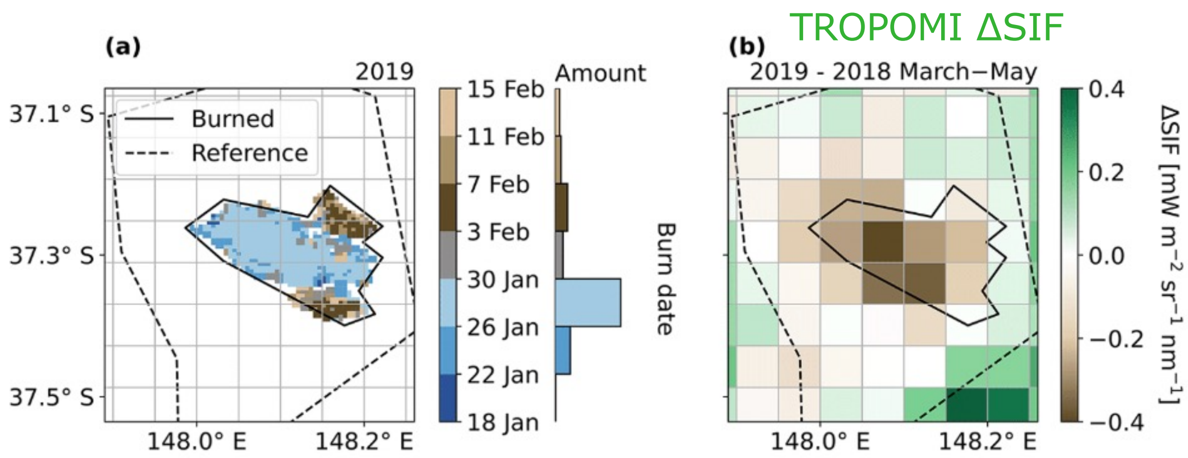
WP3.1 will produce the observational package

WP1-2: Well-observed fires in Europe (2018 Sweden, 2022 Les Landes, 2024 Pantanal)
Capture short-term effects of emissions and variability in regimes
Europe, India, and Africa in sequence from best-observed to least-observed

WP3-4: Fires with strong radiative effects (Africa → Atlantic)
Fires with strong effects on the surface (Boreal, Australia)

WP5: Fires in region with strong changes in vegetation traits (Africa)

WP6: Fires with different mgmt strategies (Europe, Africa)



INFLAMES addresses fires at different scales

Local and regional fire characteristics captured in WP1 & WP2 which study contrasting fire regimes

emissions

parameterizations (injection, transformation, fire mgmt)

Consolidation in global models
JSBACH (WP5)
GFED (WP1)
ECHAM-HAM (WP4)

and regional model
LOTOS-Euros (WP2)

Emission factor for temperate coniferous forest

Emission Factors for temperate coniferous forests

Source	NOx EF (g NO kg⁻¹ DM)
Andreae & Merlet (2001)	3.0
Akagi et al. (2011)	2.51
Jin et al. (2021)	1.36
Liu et al. (2017)	0.49
Yokelson et al. (2007)	7.44
GFED5	1.65

Burned area EF

$$E_{GFED} = A \times B \times C$$

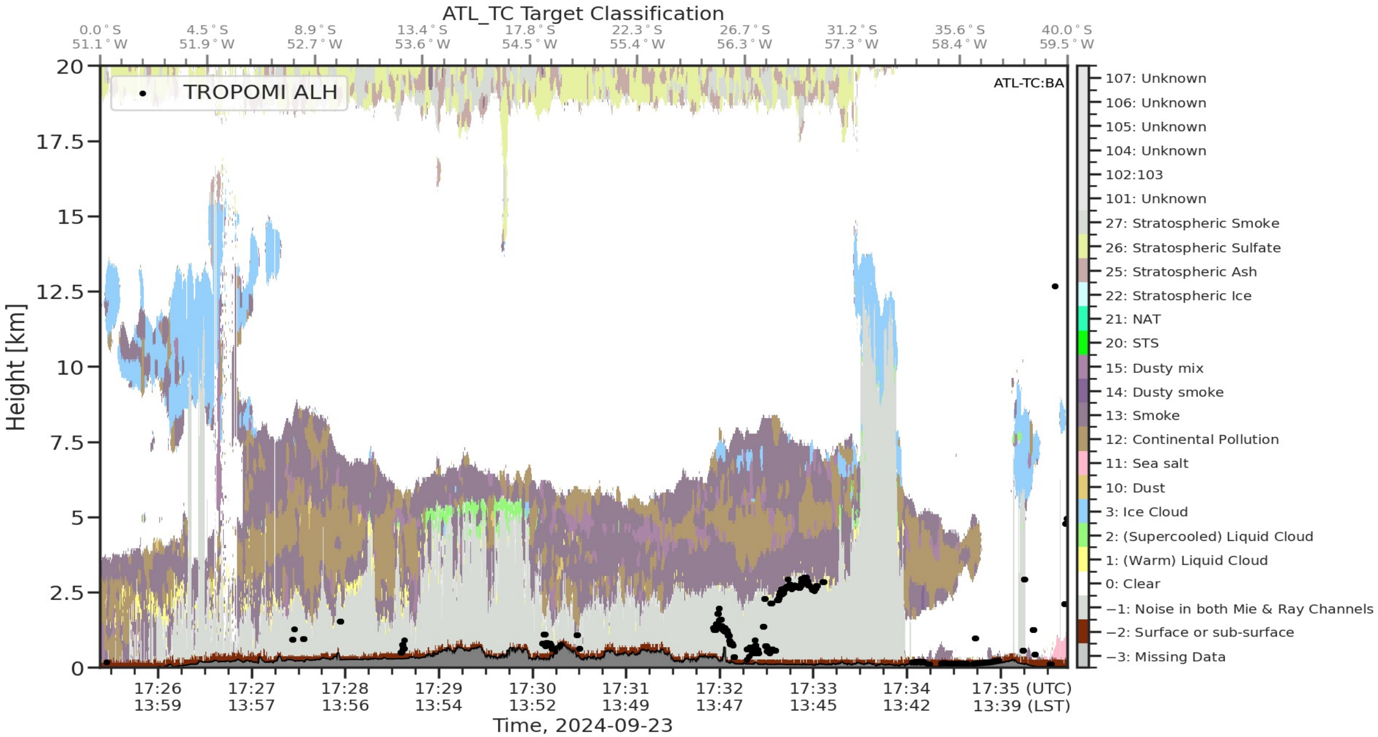
Fuel consumption

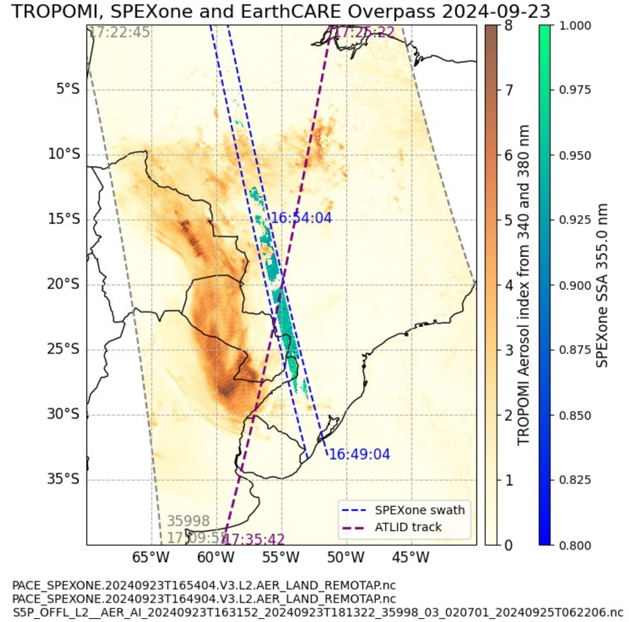
$$EF_X^{sat} = \frac{E_X^{sat}}{A_{GFED} \times B_{GFED}}$$

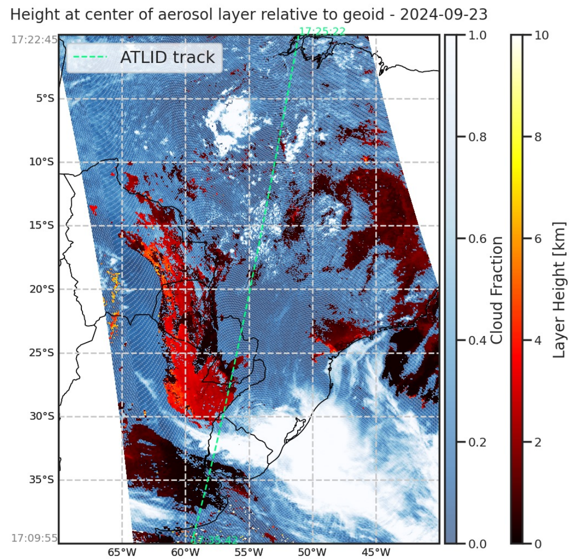
$EF_{TROPOMI}$ = 3.25 g NO kg-1 DM

Close Overpasses 23 September 2024

- Combining observations provides plume extent, height and optical properties at the same time



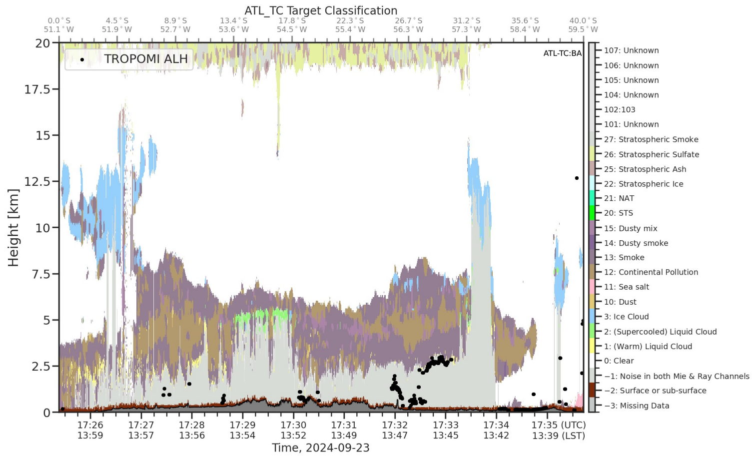




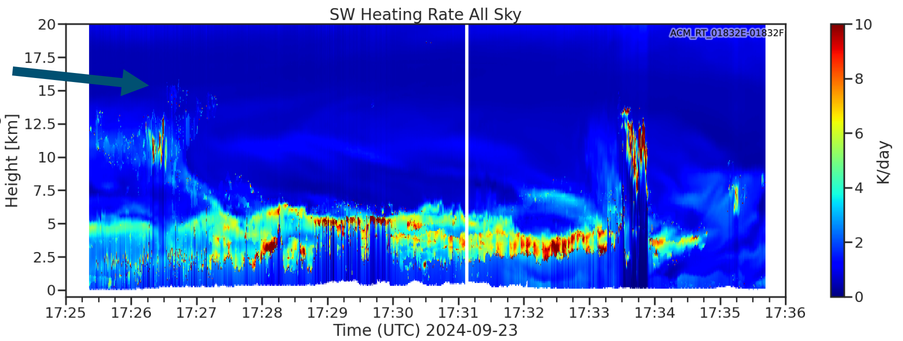
Annabel Chantry, Martin de Graaf

EarthCARE Heating Rates

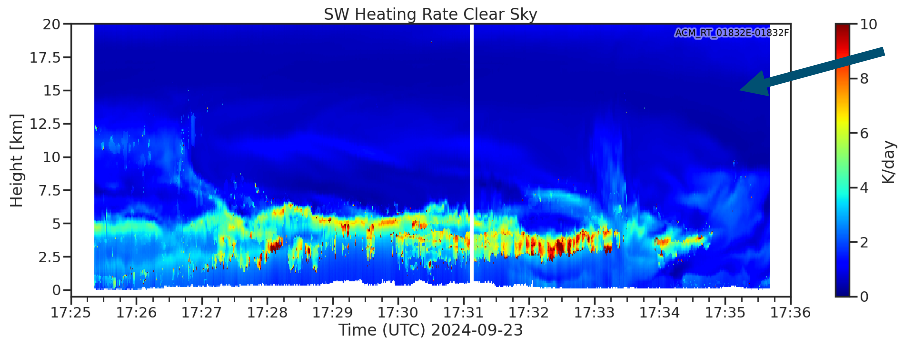
- ACM_RT-EarthCARE L2 product containing simulated heating rates from the reconstructed scene



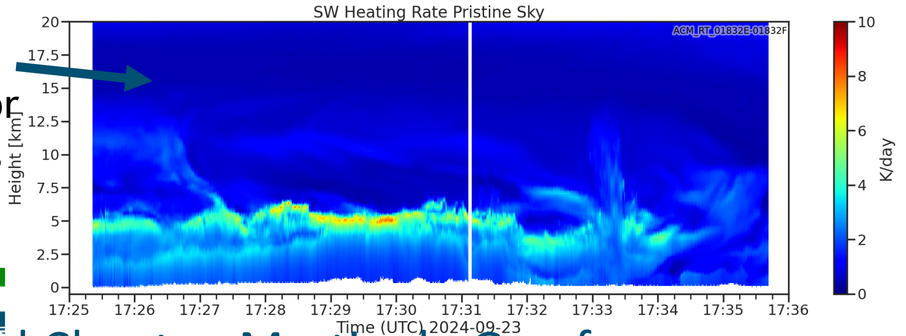
With all features



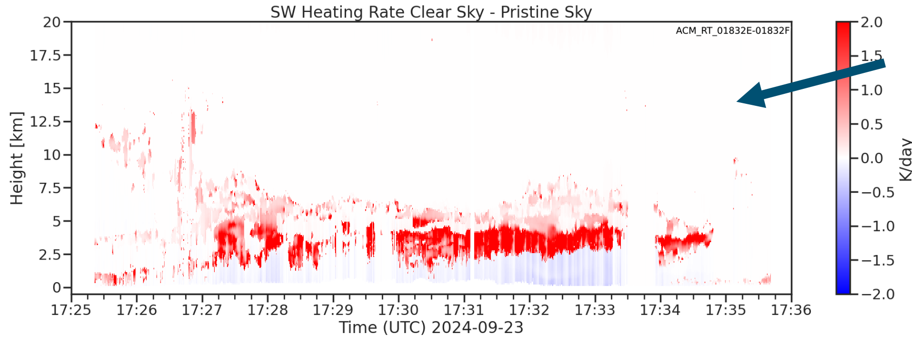
Without clouds but with aerosols



Without clouds or aerosols

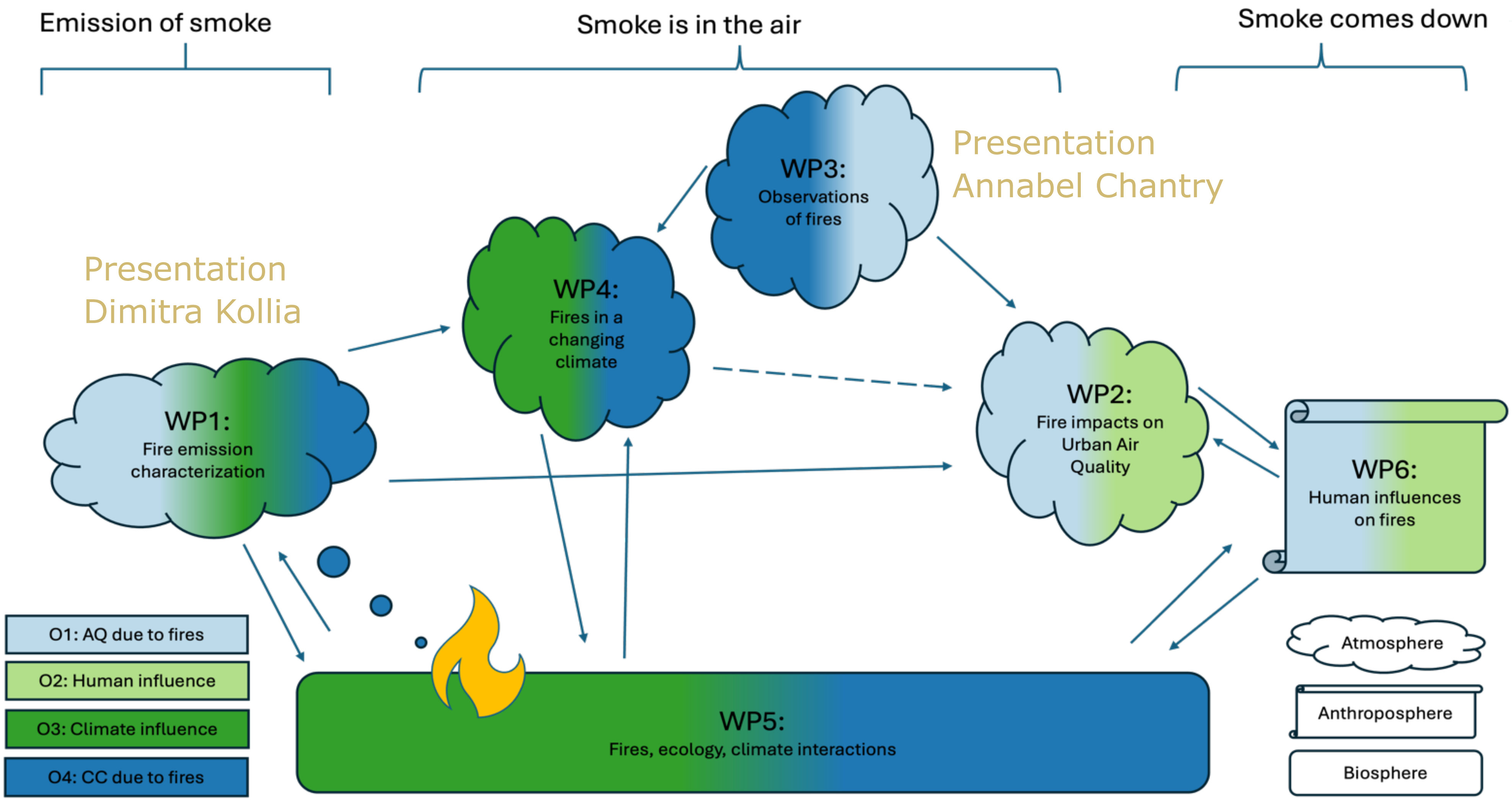


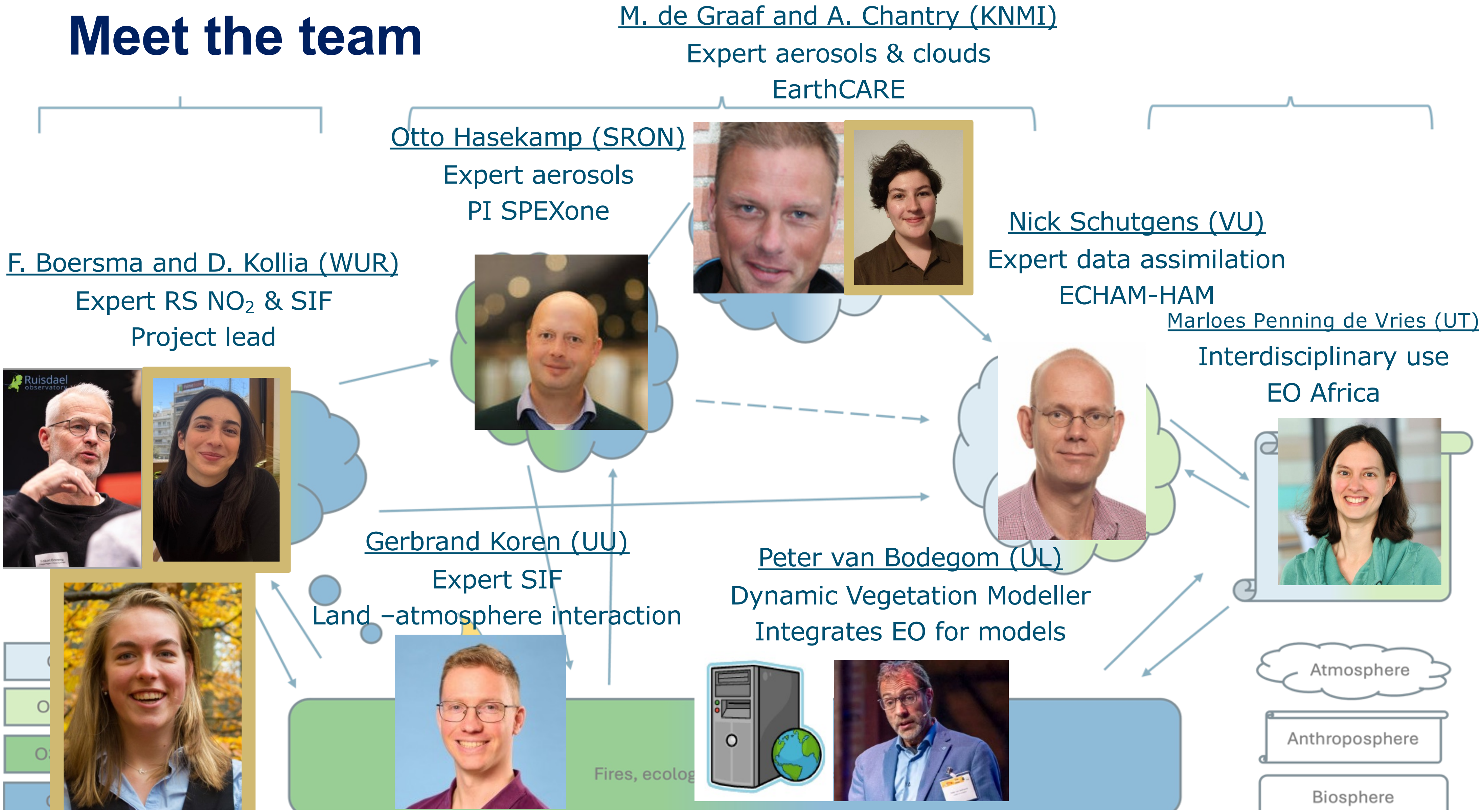
Aerosol effect



Annabel Chantry, Martin de Graaf

Coherence of the project




Meet the team
M. de Graaf and A. Chantry (KNMI)
Expert aerosols & clouds
EarthCARE
Otto Hasekamp (SRON)
Expert aerosols
PI SPEXone
Nick Schutgens (VU)
Expert data assimilation
ECHAM-HAM
F. Boersma and D. Kollia (WUR)
Expert RS NO_2 & SIF
Project lead
Marloes Penning de Vries (UT)
Interdisciplinary use
EO Africa
Ruisdael observatory
Gerbrand Koren (UU)
Expert SIF
Land –atmosphere interaction
Peter van Bodegom (UL)
Dynamic Vegetation Modeller
Integrates EO for models
Fires, ecolog
Atmosphere
Anthroposphere
Biosphere