TORINO PM 2024

SAPERI: una catena modellistica per la simulazione della dispersione di inquinanti in atmosfera in situazioni emergenziali

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UPO
UNIVERSITÀ DEL PIEMONTE ORIENTALE

simularia

SAFERI

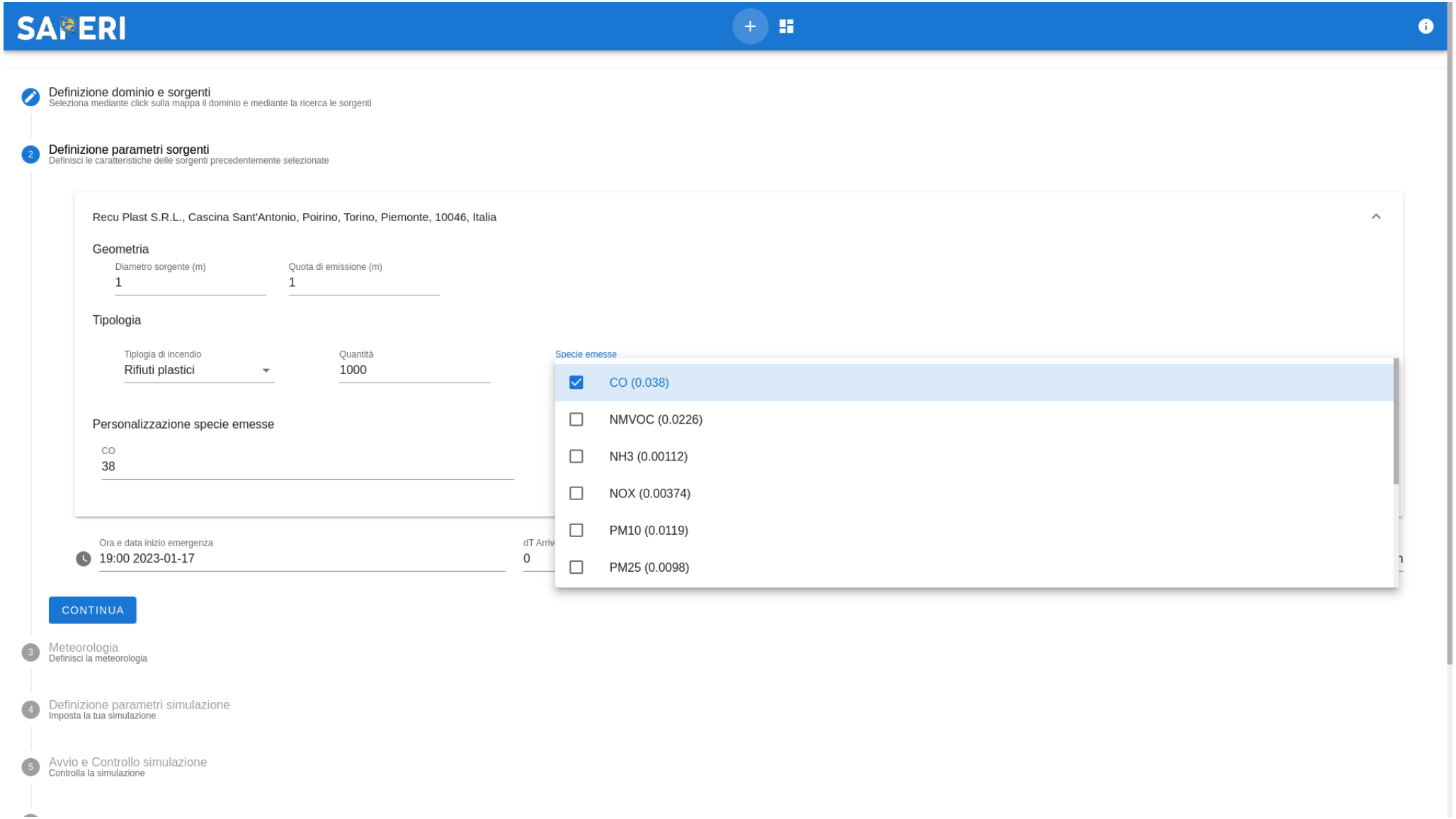
Simulazione Accelerata su Piattaforme Eterogenee di Rilasci Incidentali in atmosfera

Progetto cofinanziato POR FESR 2014/2020 - Asse I - Azione I.1b.1.2 - Bando PRISM-E, Regione Piemonte

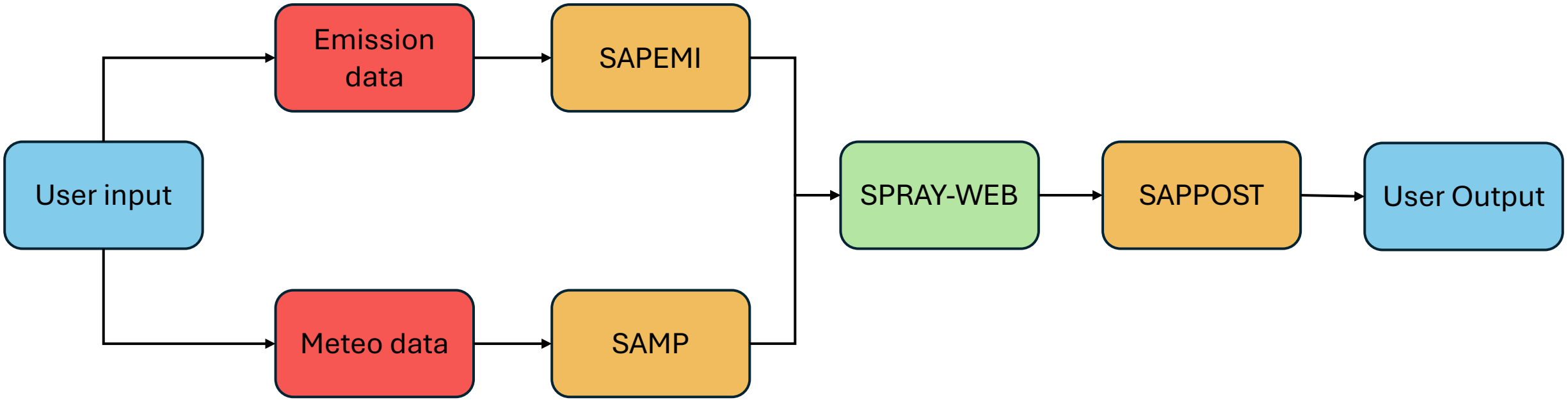
Emergency situations

- Efficient → Modelling chain
- Fast → Code parallelization on GPU
- User-friendly → Easy-to-use graphical interface for non-expert users

SAFERI


SAFERI
Definizione dominio e sorgenti
Seleziona mediante click sulla mappa il dominio e mediante la ricerca le sorgenti
2
Definizione parametri sorgenti
Definisci le caratteristiche delle sorgenti precedentemente selezionate
Recu Plast S.R.L., Cascina Sant'Antonio, Poirino, Torino, Piemonte, 10046, Italia
Geometria
Diametro sorgente (m)
1
Quota di emissione (m)
1
Tipologia
Tipologia di incendio
Rifiuti plastici
Quantità
1000
Specie emesse
CO (0.038)
NMVOC (0.0226)
NH3 (0.00112)
NOX (0.00374)
PM10 (0.0119)
PM25 (0.0098)
Personalizzazione specie emesse
CO
38
Ora e data inizio emergenza
19:00 2023-01-17
0
CONTINUA
3
Meteorologia
Definisci la meteorologia
4
Definizione parametri simulazione
Imposta la tua simulazione
5
Avvio e Controllo simulazione
Controlla la simulazione

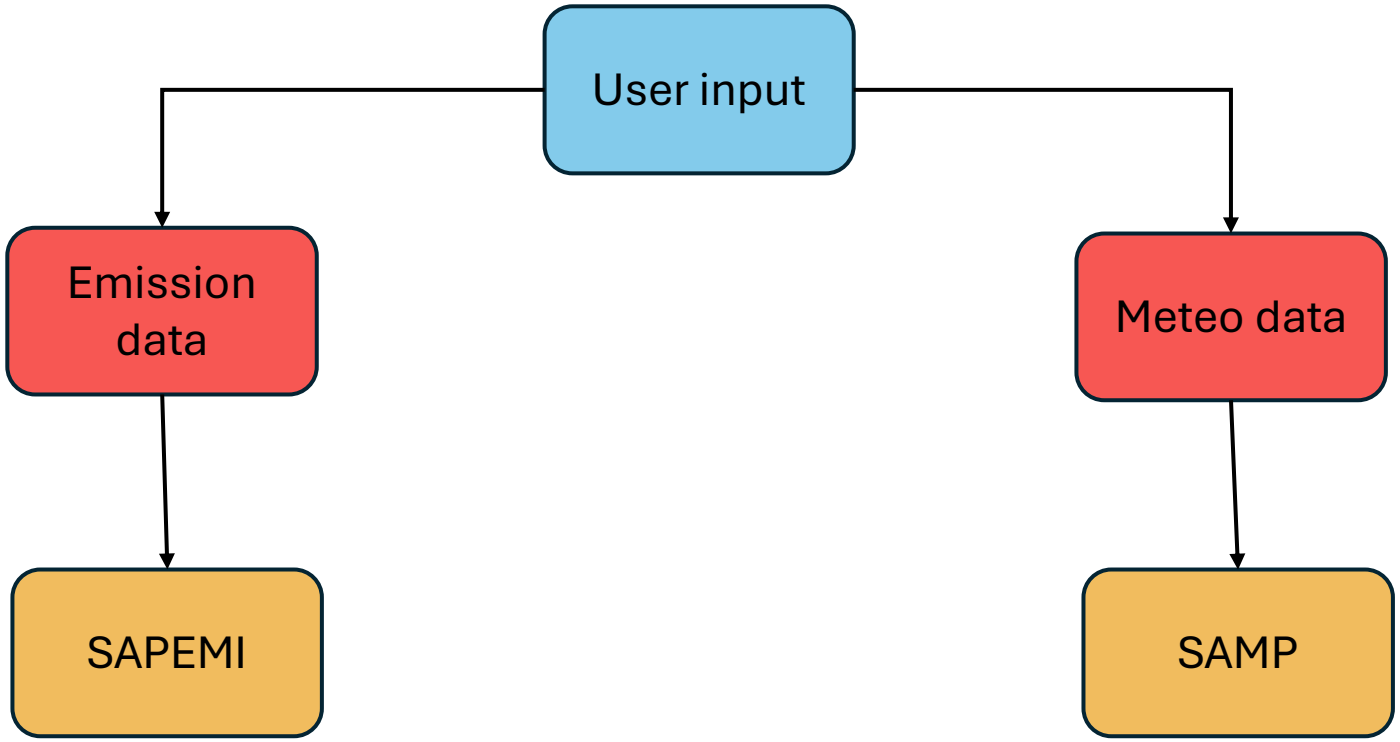
Modelling chain



Modelling chain

- Start hour
- Quantity and type of burning material
- Emergency services arrival
- End time

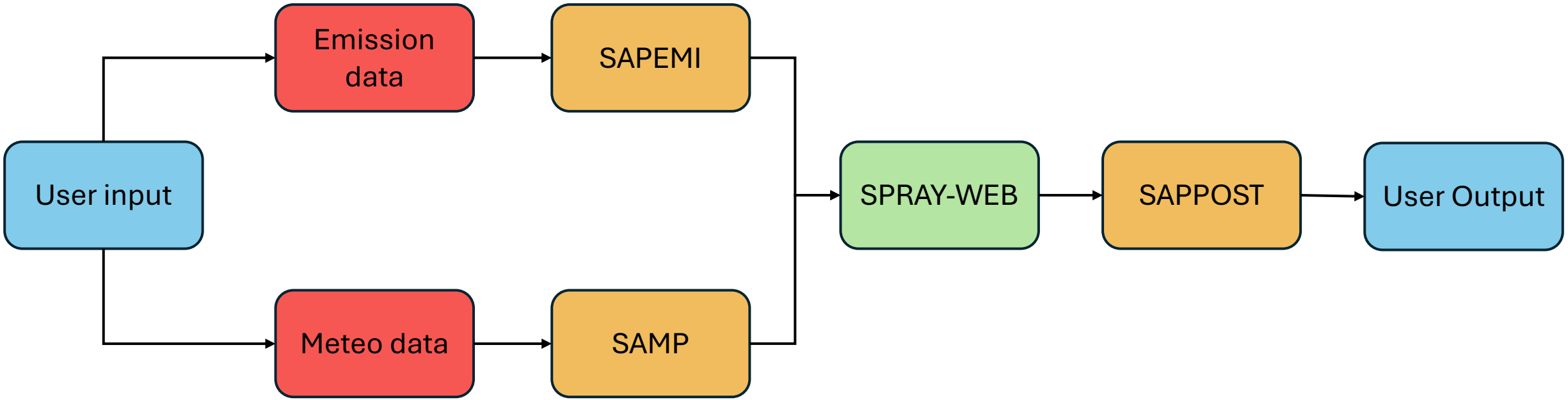
- Emission profile
- Buoyancy flux



- Mistral (COSMO)
- 2.2 km resolution
- 49 hours forcast
- 3D and 2D fields

- Turbulence variables (Hanna, 1982)
- Monin-Obukhov length
- Friction velocity
- Mixing layer height

Modelling chain



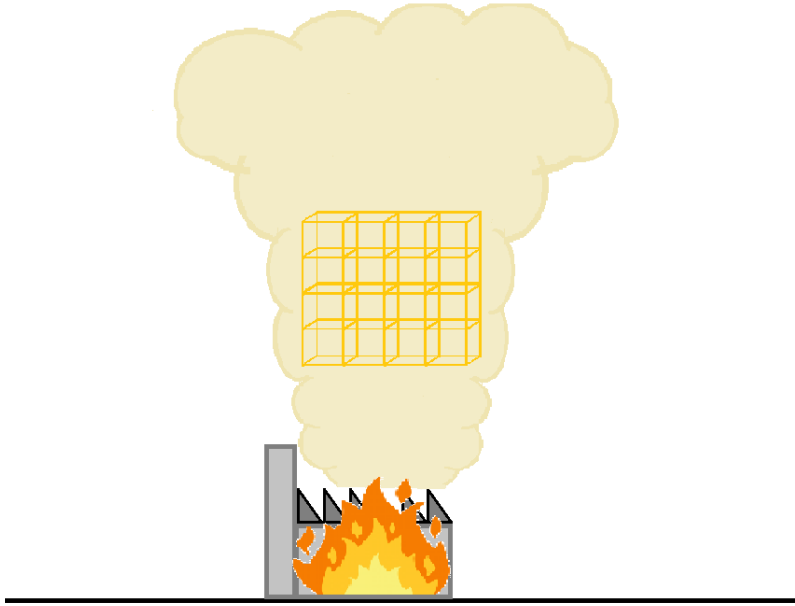
SPRAY-WEB

https://sprayweb.isac.cnr.it/

- Every time particle emission occurs, ΔT_p and w_p are initialized depending on buoyancy flux computed by SAPEMI.
- Cell temperature differences and velocities (ΔT_c and w_c) are computed by summing the contribution of the particles inside
- Cell quantities are updated according to the following equations:

$$\Delta T_c(t_1) = \Delta T_c(t_0) + \Gamma(z_c) w_c(t_0) \Delta t - 0.0098 w_c(t_0) \Delta t$$

$$w_C(t_1) = w_C(t_0) + \frac{\Delta T_c(t_1)}{\Delta T_c(t_1) + T_a(z_c)} g \Delta t - \frac{0.5 C_D S w_c^2(t_0) \rho_a}{\rho_P V_c} \Delta t$$

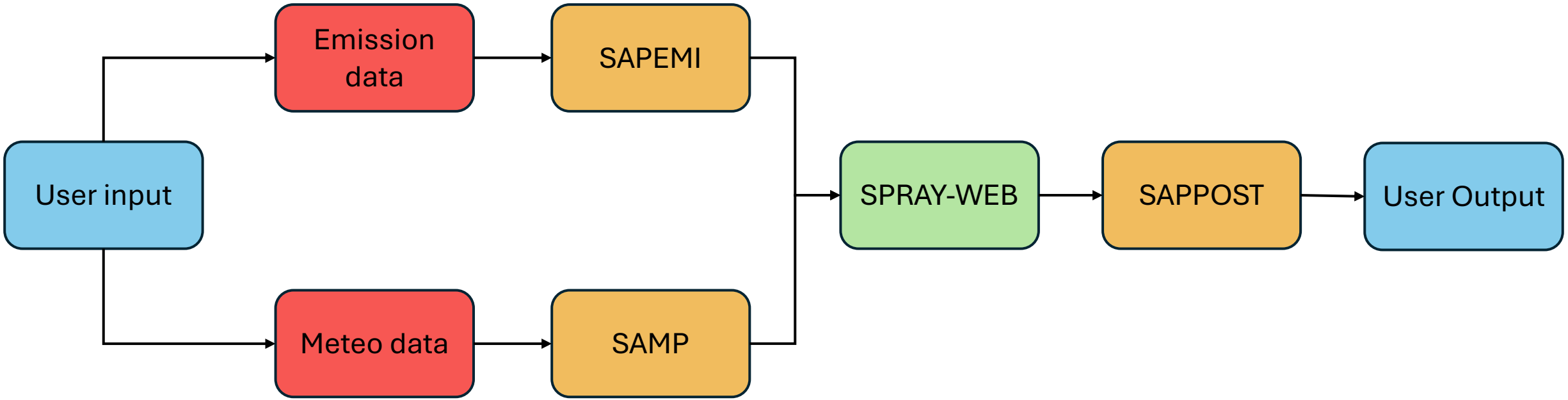


- Cell quantities are redistributed to particles and the plume rise is calculated as

$$\Delta z_p = w_p \Delta t$$

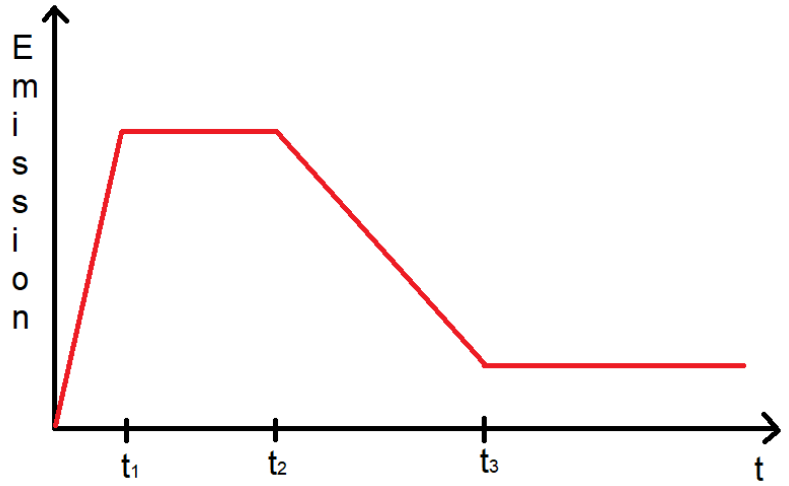
(Alessandrini et al., 2013)

Modelling chain

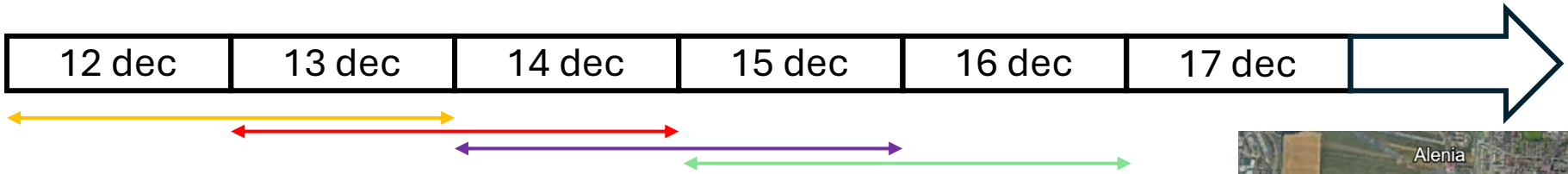


Case study: DEMAP fire

- 12/12/2021, 15:30, Beinasco (TO)
- 65m diameter
- 2’000’000 Kg of PET burned
- 34 MJ/kg (Hazrat et al., 2019) of energy released
- Benzene, emission factor 0.9 g/kg (Woodallen et al.)
- Emission profile modulated according to extinguishing operations



Case study: DEMAP fire

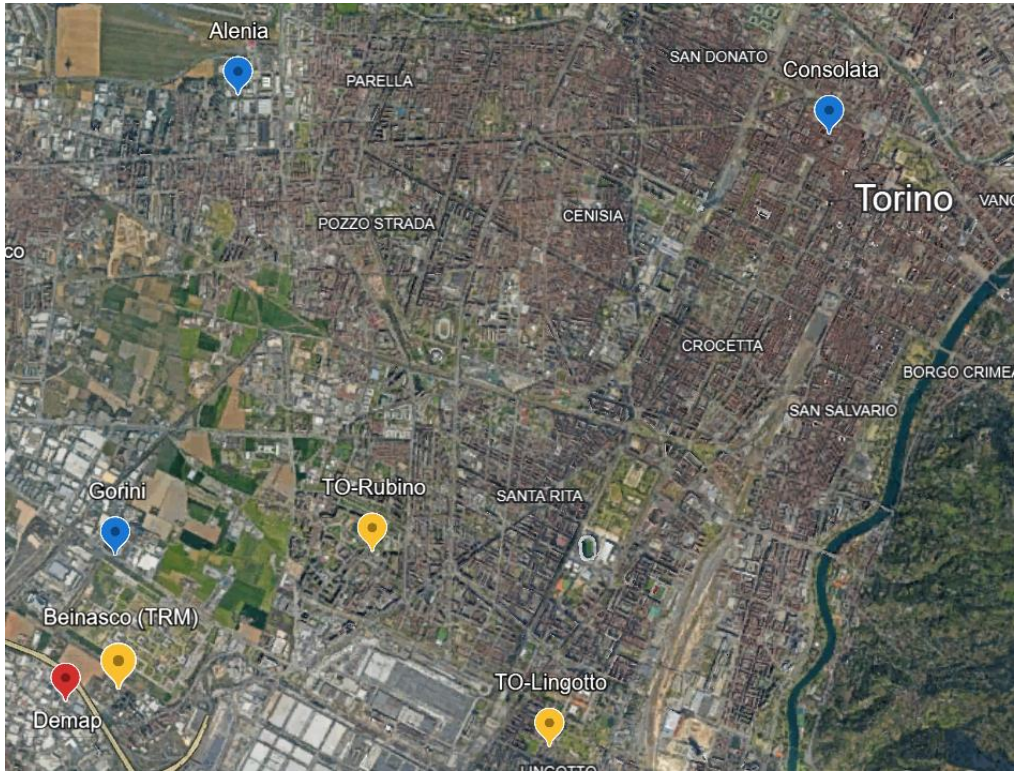


4 simulations, 48h each:

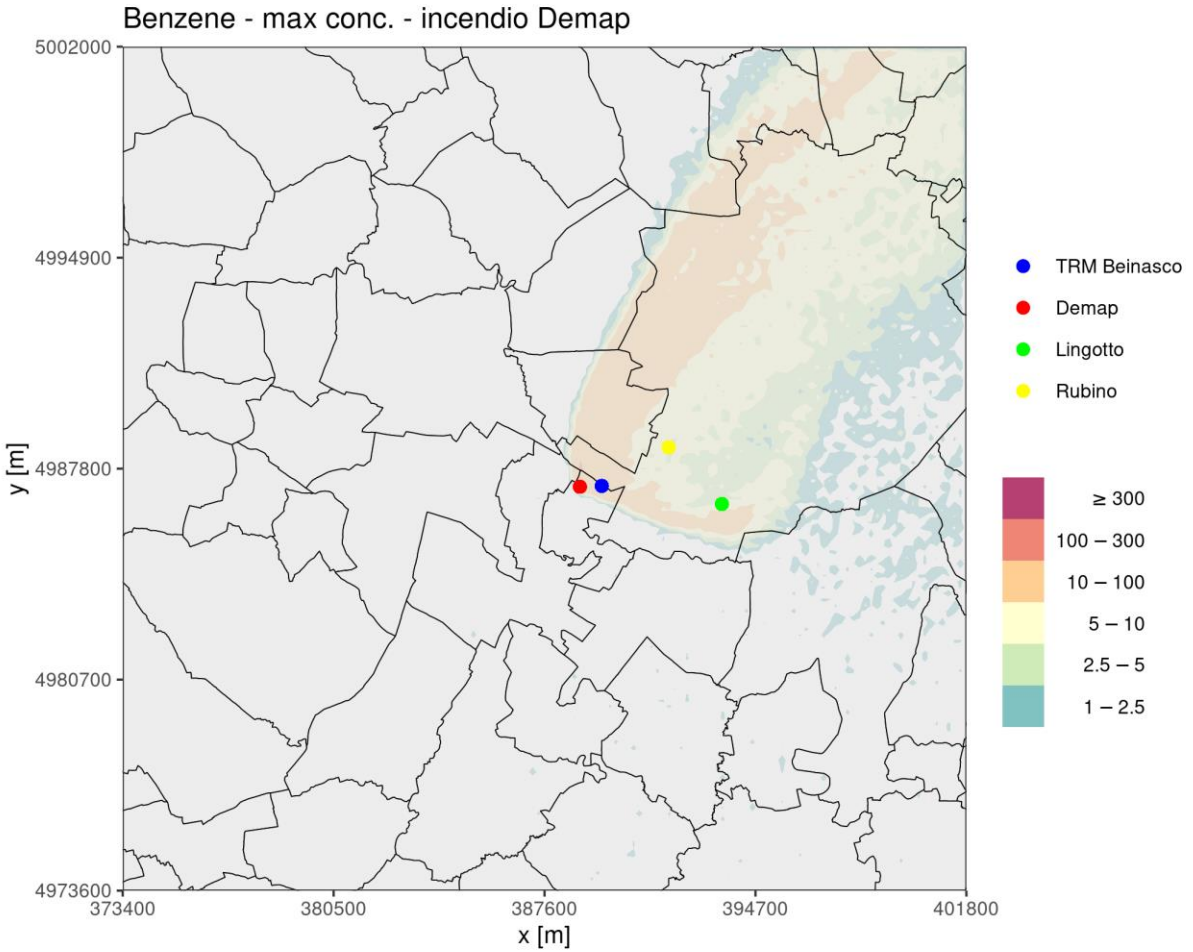
- 12-14 December
- 13-15 December
- 14-16 December
- 15-17 December

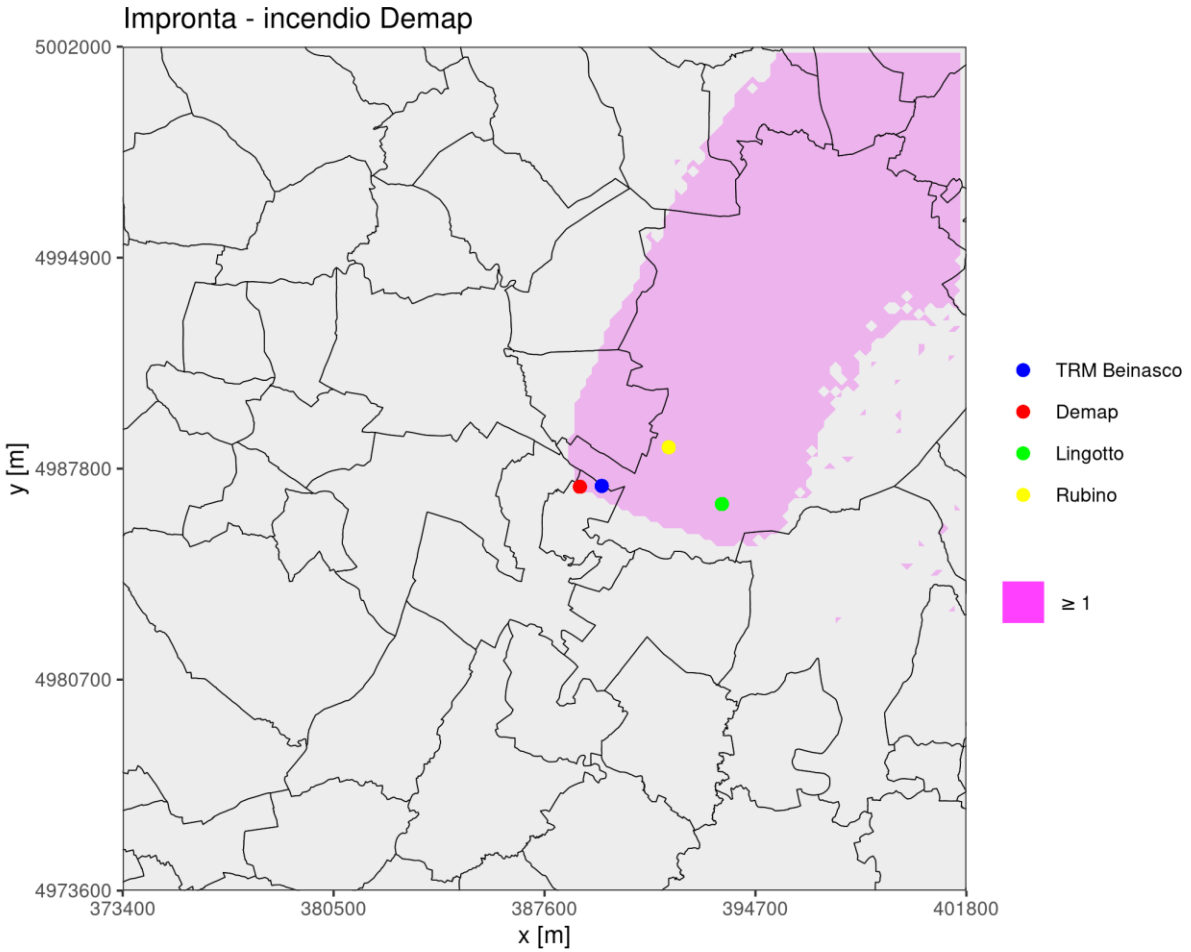
28.6x28.6 km domain at 2.2km horizontal resolution

200x200 m concentration grid resolution



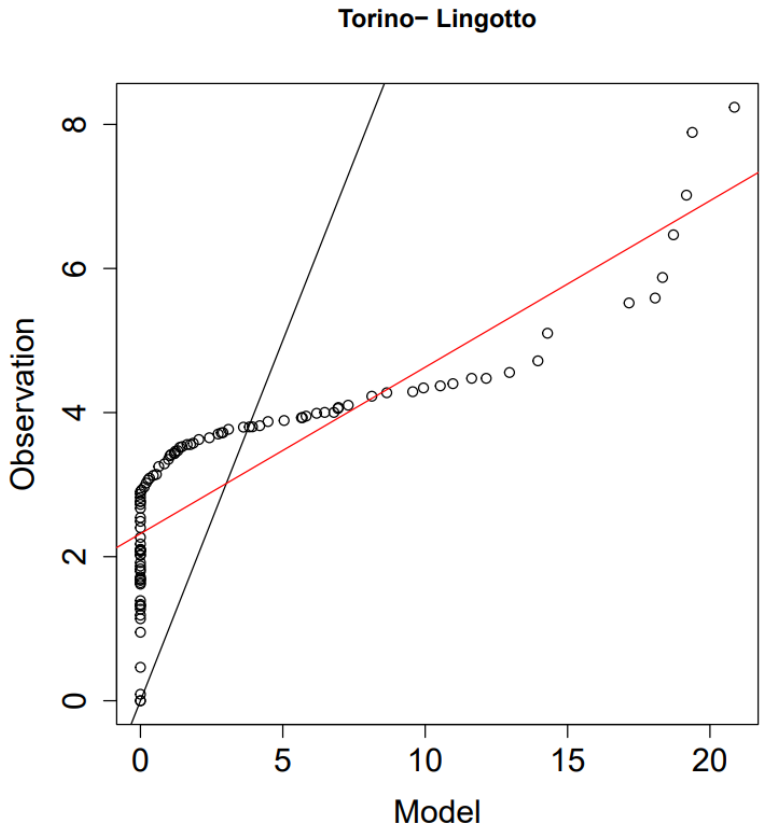
Output SAPERI (12-14 Dec)





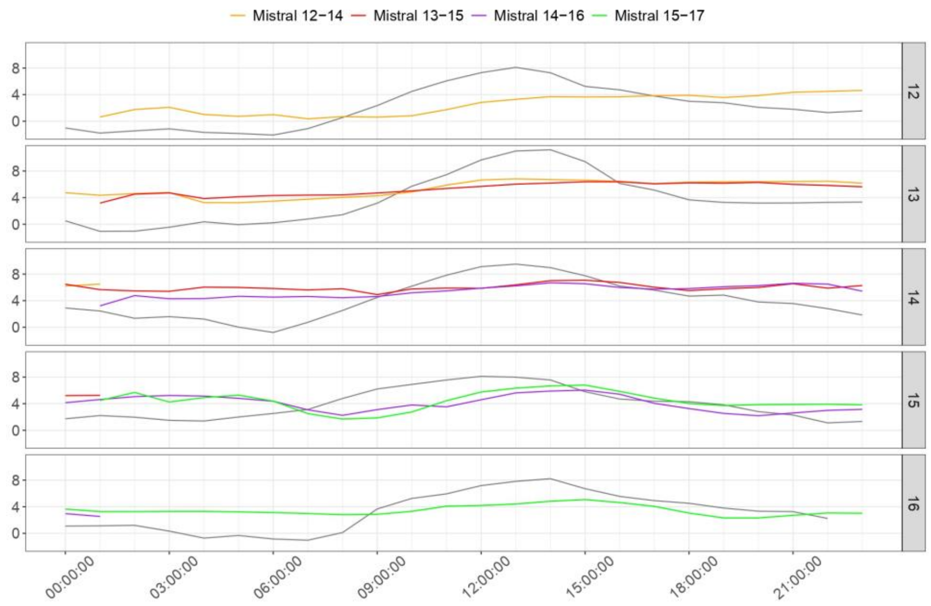
Case study: DEMAP fire, validation

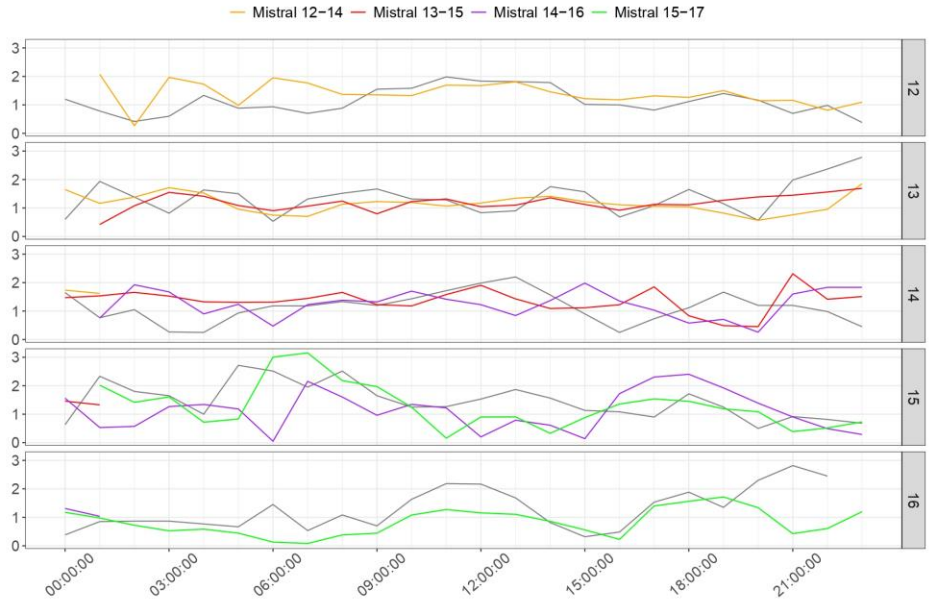
- Wind direction: angular correction for concentrations
- Background: hourly mean DJF 2018-2019 for each station
- Model uncertainties: correction based on angular coefficient and intercept of the best fit for qq-plot of observation vs modeled data



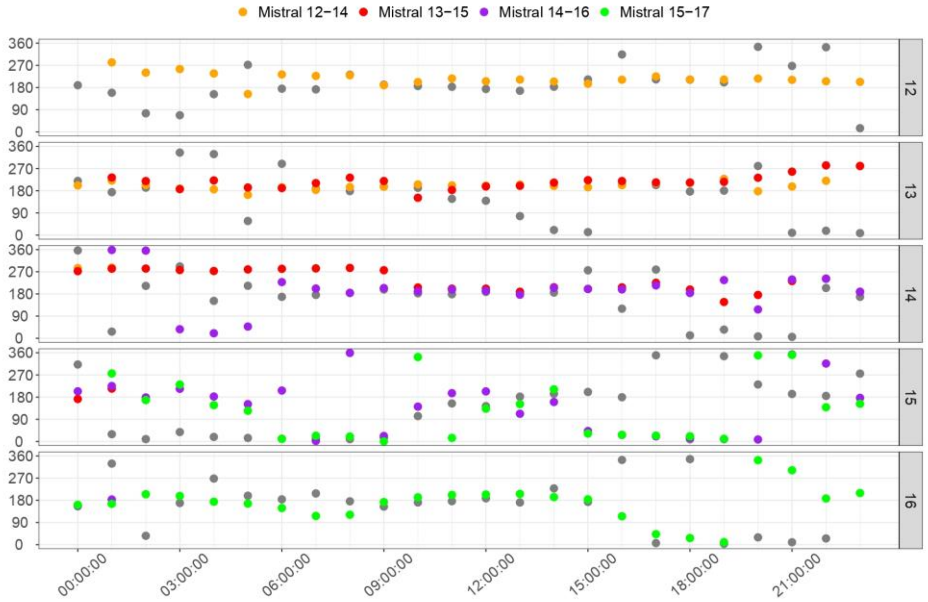
Case study: DEMAP fire

METEO VALIDATION





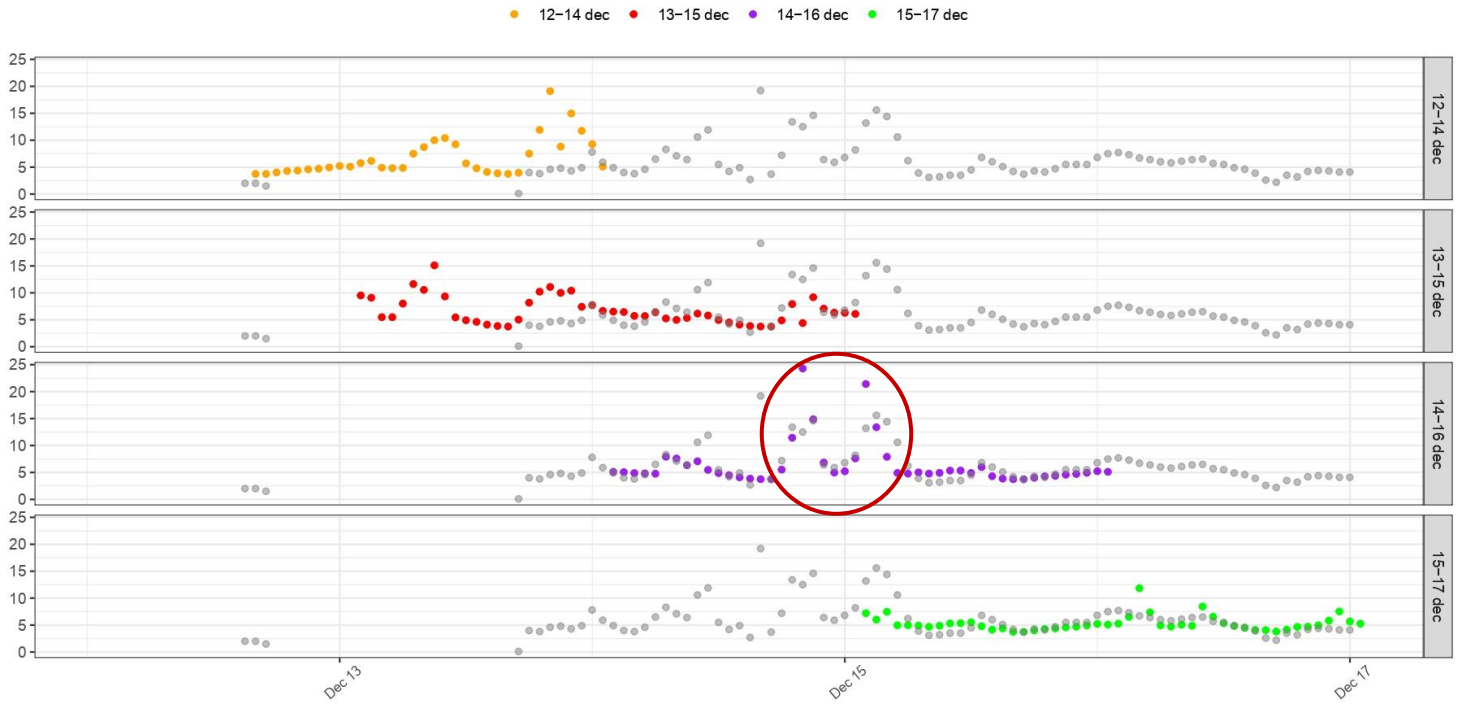
Gorini

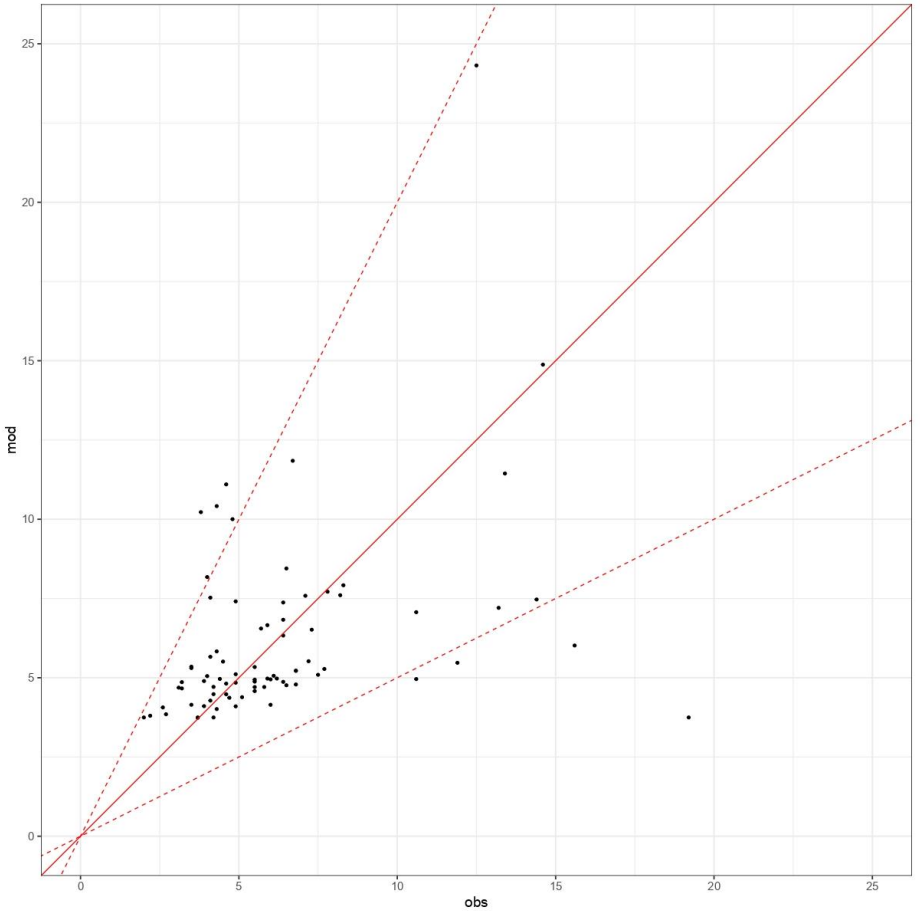


Simulation	MAE	Angle
12-14	56.94	114
13-15	67.03	134
14-16	57.25	114
15-17	64.14	128

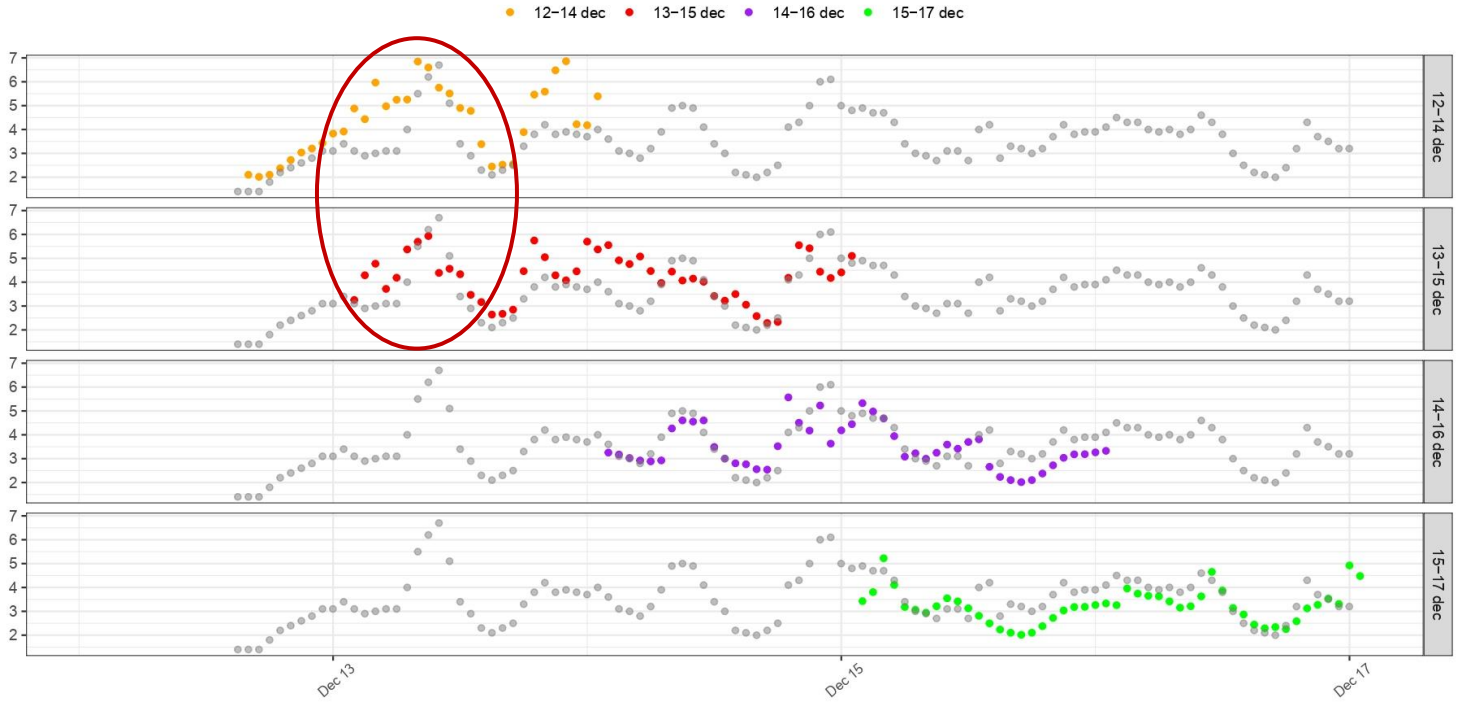
Case study: DEMAP fire

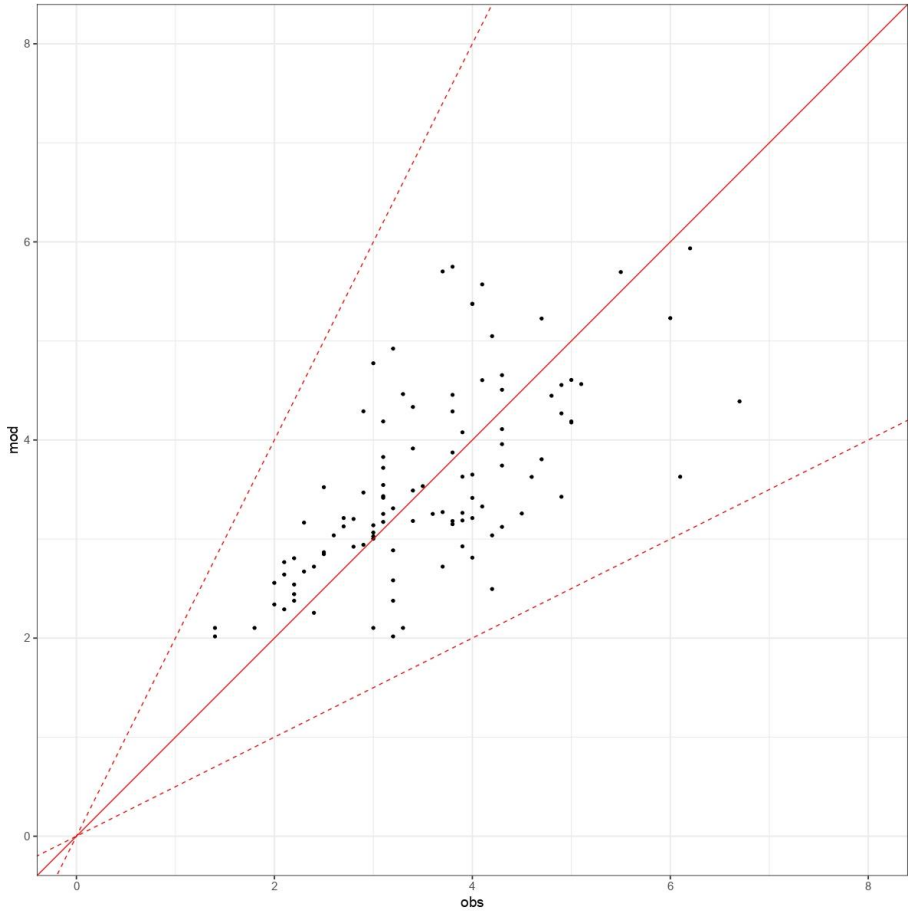
AIR QUALITY VALIDATION



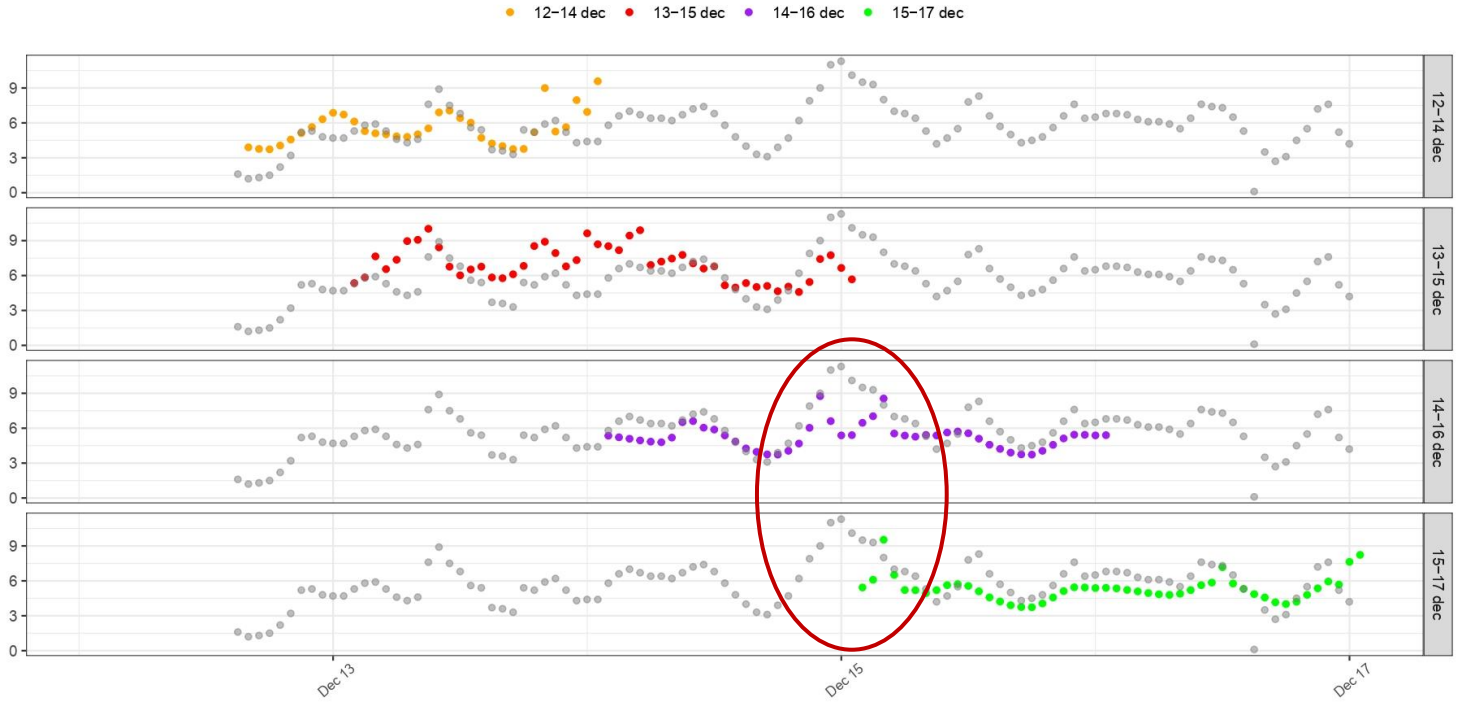


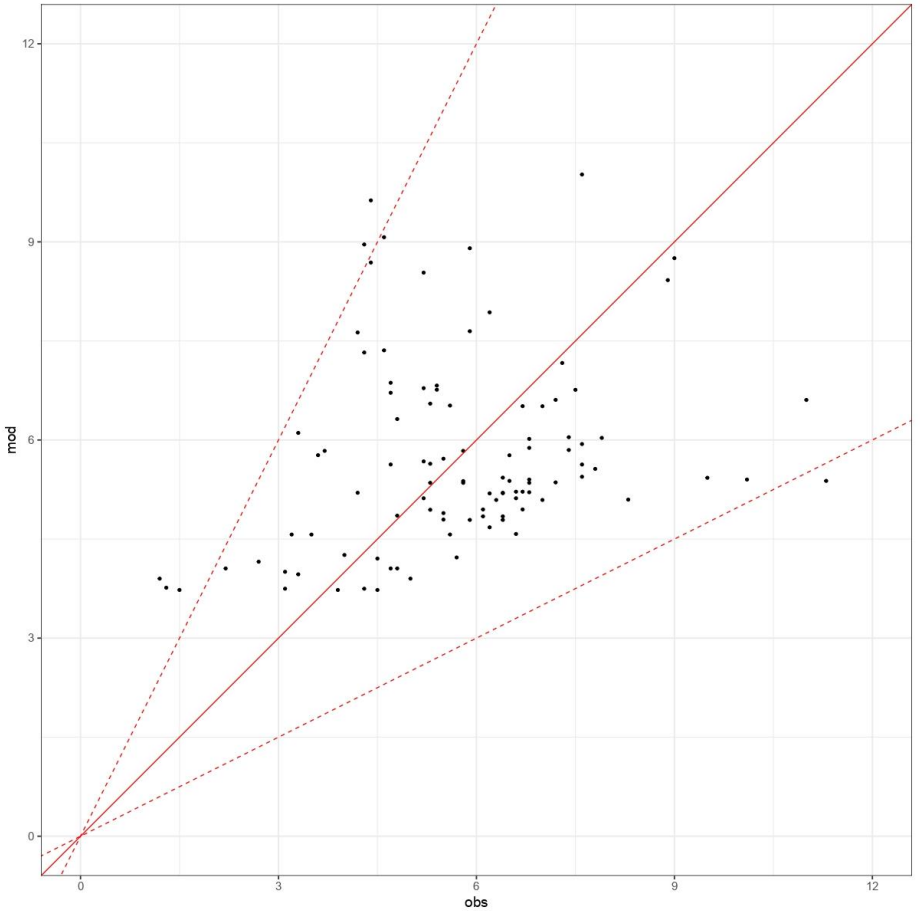
BEINASCO (TRM)





TO - RUBINO





TO - LINGOTTO

Thanks for your kind attention!