MITIMPACT Project : the impacts of ozone on the forest environment

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SUMMARY

- Project Framework and partners involved
- Arpa Piemonte institutional activities on air quality issues
- Ozone levels in the Piedmont region
- Arpa Piemonte in the MITIMPACT Project

INTRODUCTION

- Climate change and air pollution are two important stressors affecting forests health and vitality
- Ozone is the phytotoxic air pollutant and greenhouse gas of most concern to forests; it negatively affects vegetation functionality (e.g. premature leaf senescence, growth reduction, carbon sequestration reduction)
- Mediterranean area has been identified as one of the most prominent “hot-spots” in future climate change projections and is seriously affected by air pollution, in particular ozone (O_3)

THE MITIMPACT PROJECT

The MITIMPACT PROJECT (*Forecast and assessment of climate change and photochemical air pollution impacts on the vegetation in the cross-border areas – Mitigation strategies)* aims at:

- increasing the knowledge of impacts due to climate changes and high ozone levels, both current and future, in the ALCOTRA area;
- identifying solutions and providing effective countermeasures to limit damages and protect the forests

The ALCOTRA area studied in the Project includes:

- the Cuneo province in Italy (Varaita and Stura di Demonte valleys)
- the Côte d'Azur around Nice and the Regional Parc of Mercantour in France

THE MITIMPACT PARTNERSHIP

- IPLA - Institute for wood plants and environment (Project coordinator)
- Arpa Piemonte – Environmental Protecion Agency of the Piemonte Region
- IPSP-CNR - Institute for Plant Sustainable Protection National Research Council
- G.I.E.F.S. – International Group of Studies in the South-European Forests
- GeographR

THE MITIMPACT ACTIVITIES (2017 - 2020)

- WP1: Governance and project administrative management (resp. IPLA)
- WP2: Communication (resp. GIEFS)
- WP3: Measuring and data collection (resp. IPSP-CNR)
- WP4: Ozone concentration and fluxes modelling at micro and macroscale, impact assessment and strategies defining (resp. Arpa Piemonte)

MITIMPACT TECHNICAL ACTIVITIES

- Air quality monitoring in the mountain areas (active samplers powered by solar panels, 5 monitoring campaigns with mobile laboratory, ozone passive samplers at 42 sites)
- Meteorological data measuring and collecting
- Data collection about emissions of ozone precursors from regional emission inventories and cadastres

→ State reference framework (air quality and meteorological conditions) in the studied areas

(IPSP-CNR,GIEFS, IPLA, Arpa)

- Forest health condition data - species monitored:
  - ✓ Pinus halepensis (France)
  - ✓ Pinus sylvestris (Italy and France)
  - ✓ Pinus cembra (Italy and France)
  - ✓ Fagus sylvatica (Italy)

→ Impacts reference framework (vegetation damages) in the studied areas

(GIEFS, IPLA)

MITIMPACT TECHNICAL ACTIVITIES

- Air quality (ozone) and meteorological modelling at regional scale
- Ozone precursors emissions reduction scenario
- Source apportionment for O_3

→ O_3 maps, endogenous and exogenous contribution in the studied area

(Arpa)

- Analysis and climate projections at local scale (years 2035, 2055)

→ Climatological maps

(GeographR)

- Modelling microscale stomatal ozone fluxes

→ Modelling ozone damages to forests

(IPSP-CNR, GIEFS)

- Ecosystem services evaluation

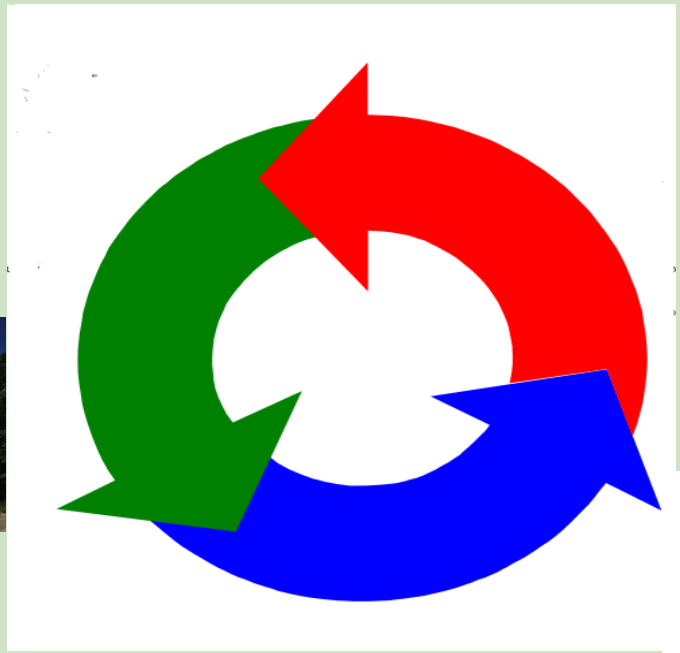
→ Economic evaluation of ecosystem services losses due to ozone pollution

(Arpa)

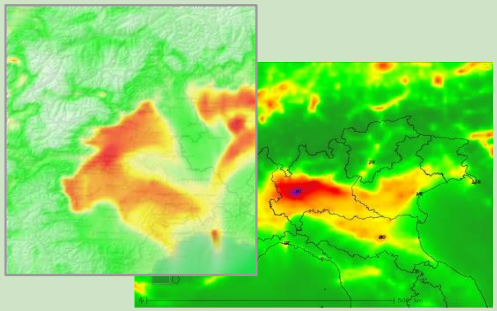
ARPA AIR QUALITY INTEGRATED SYSTEM

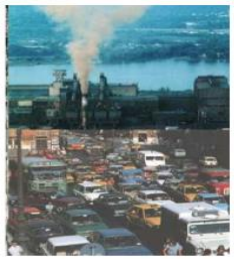
Integration between information from air quality measurements, meteorology and emission inventories, by means of air quality dispersion modelling

Air quality monitoring network



Air quality models

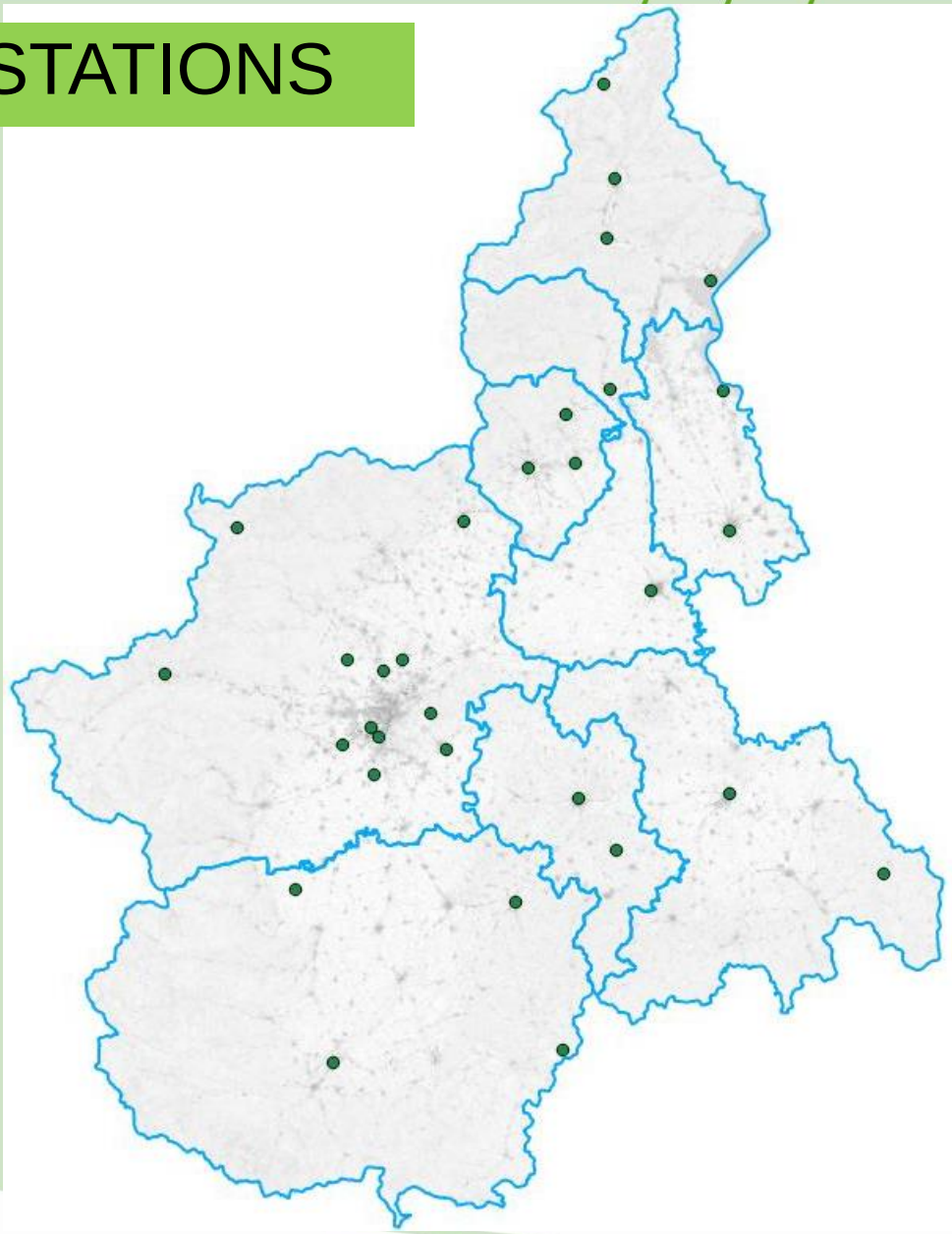




Emission inventories

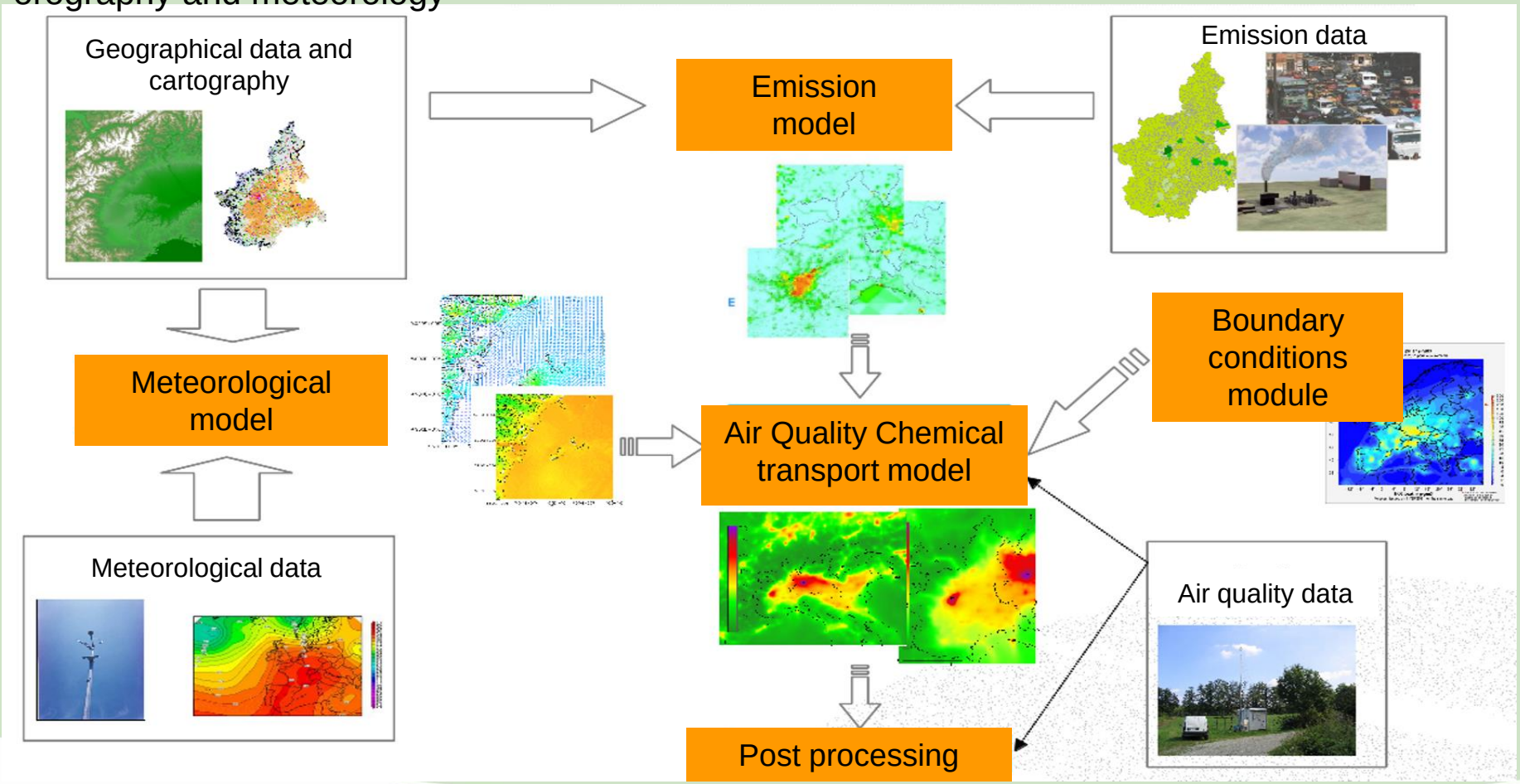
OZONE MONITORING STATIONS

31 air quality monitoring sites for O_3



ARPA MODELLING SYSTEM

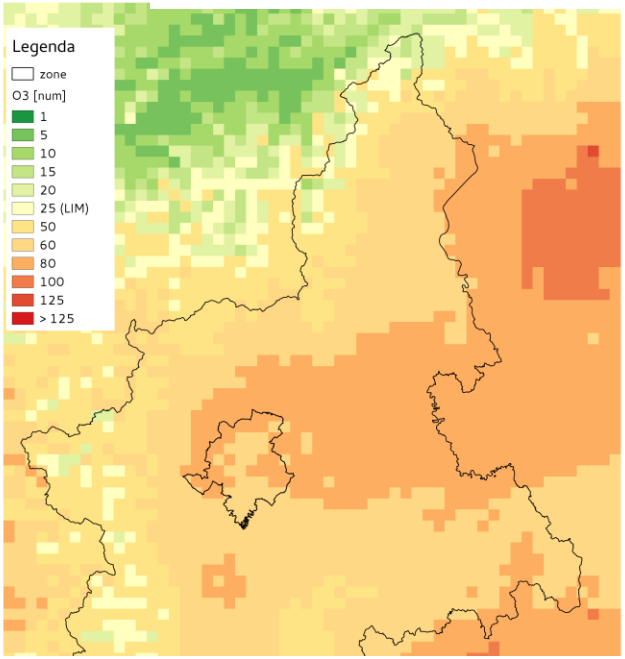
The modelling system used by Arpa Piemonte is based on 3D meteorological, emission e dispersion models to estimate primary and secondary pollutant concentrations in complex orography and meteorology



OZONE CONCENTRATIONS IN PIEDMONT

HUMAN HEALTH PROTECTION

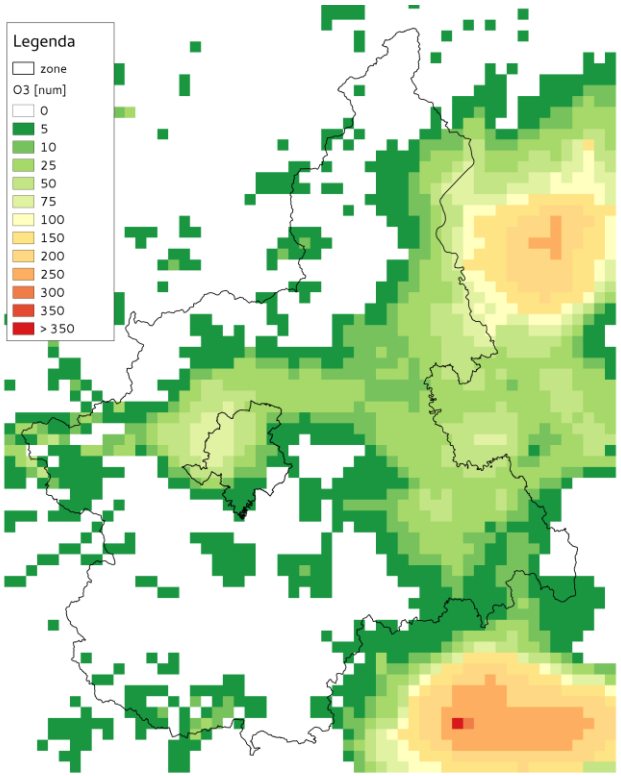
Maximum daily eight-hour mean number of exceedances (120 µg/m³)



Target value exceedances

Sistema modellistico diagnostico di chimica e trasporto con assimilazione dei dati di qualità dell'aria misurati dalle stazioni SRRQA

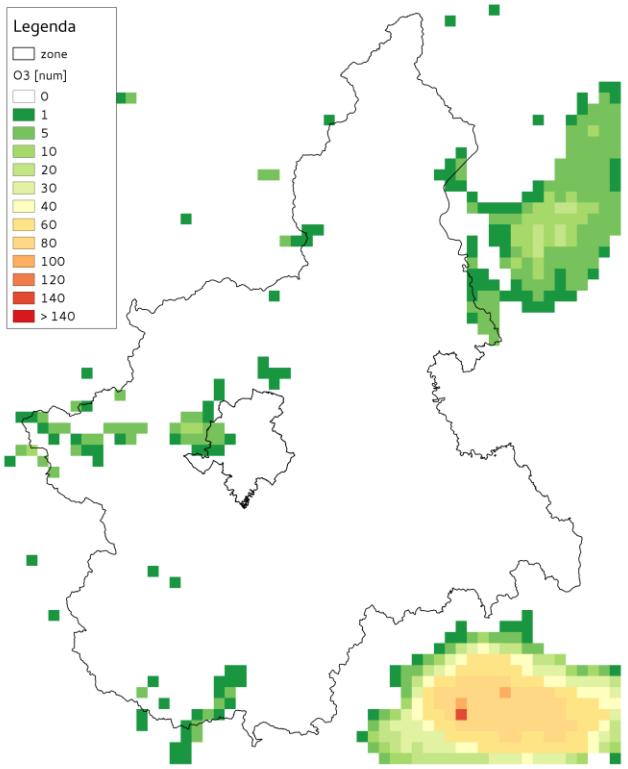
One hour information threshold number of exceedances (180 µg/m³)



Sistema modellistico diagnostico di chimica e trasporto con assimilazione dei dati di qualità dell'aria misurati dalle stazioni SRRQA

Information thresholds exceedances

One hour alarm threshold number of exceedances (240 µg/m³)



Alert thresholds exceedances

RAQP– year 2015

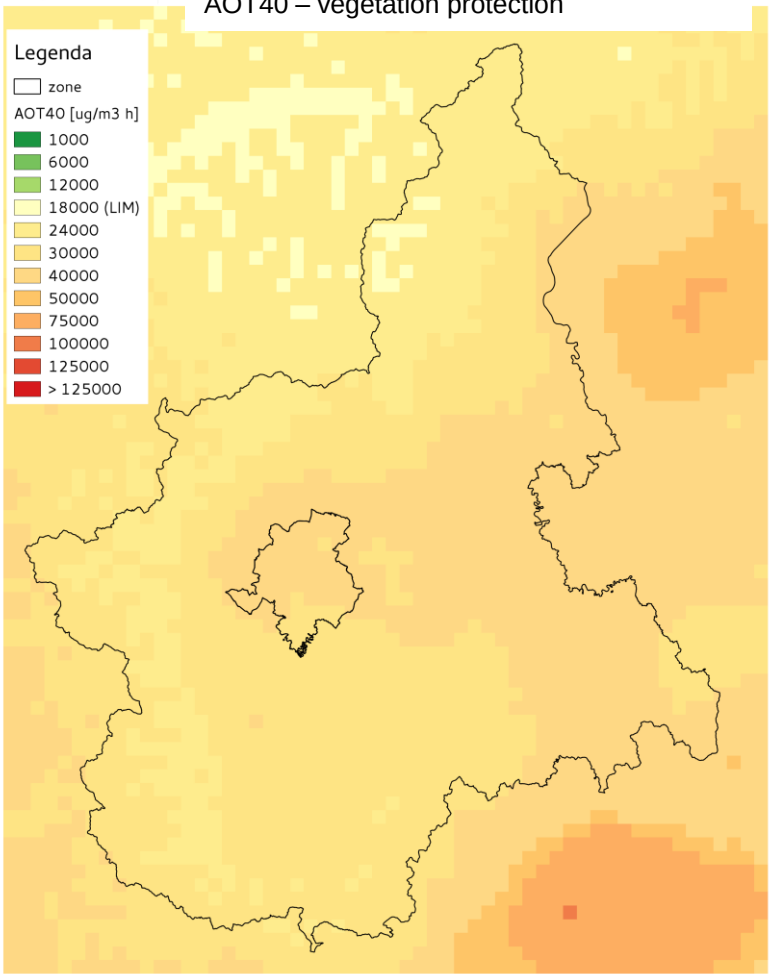
Interreg ALCOTRA
Fonds européen de développement régional
Fondo europeo di sviluppo regionale

MITIMPAC

OZONE CONCENTRATIONS IN PIEDMONT

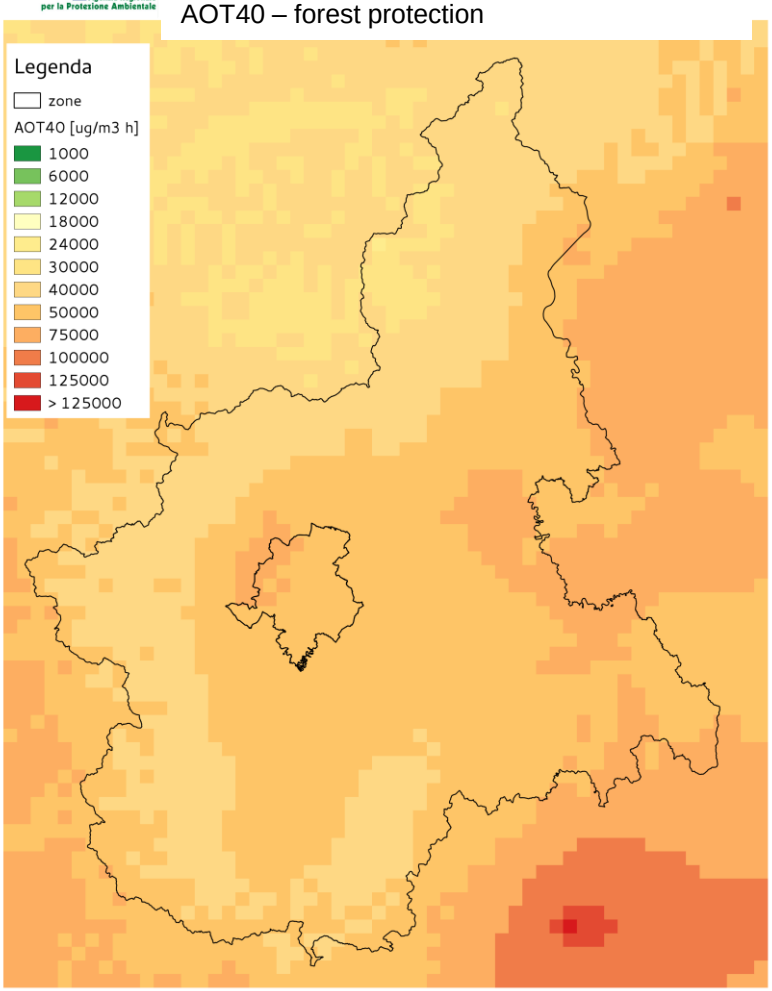
VEGETATION PROTECTION

Sum of hourly values exceeding 80 µg/m³
between 8:00 and 20:00, may-july
AOT40 – vegetation protection



AOT40 – vegetation protection (may-july)

Sum of hourly values exceeding 80 µg/m³
between 8:00 and 20:00, april-september
AOT40 – forest protection



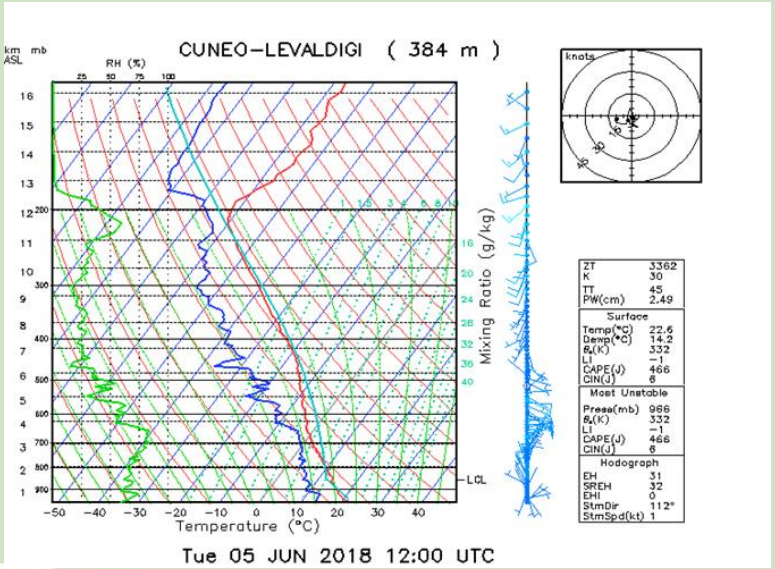
AOT40 – forest protection (april-september)

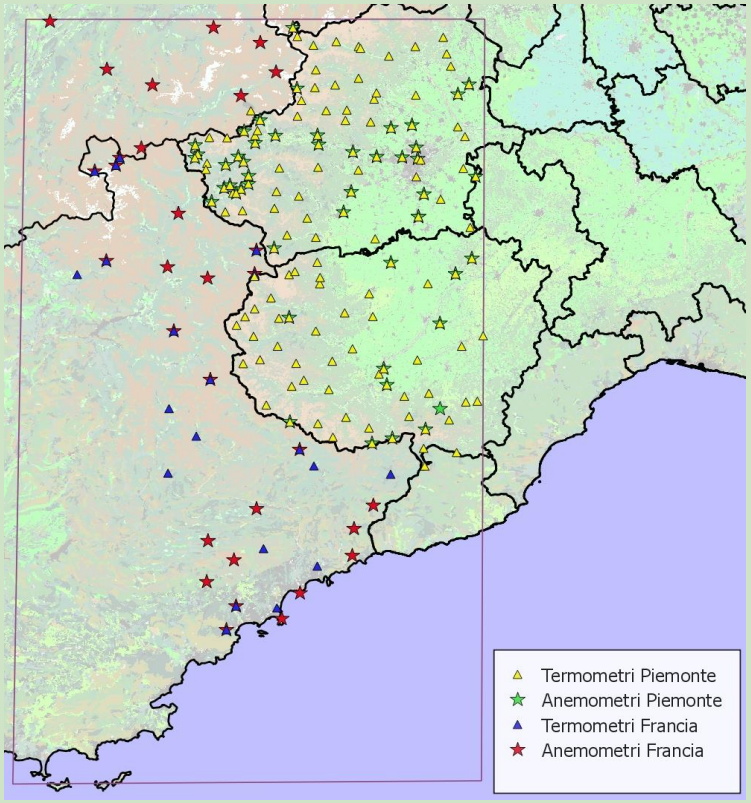
RAQP – year 2015

ARPA ACTIVITIES IN THE MITIMPACT PROJECT

METEOROLOGICAL DATA

- Ground stations: data collection from Arpa Piedmont and Météo France meteorological monitoring networks
- Vertical profiles from Cuneo-Levaldigi radiosoundings (twice a day)



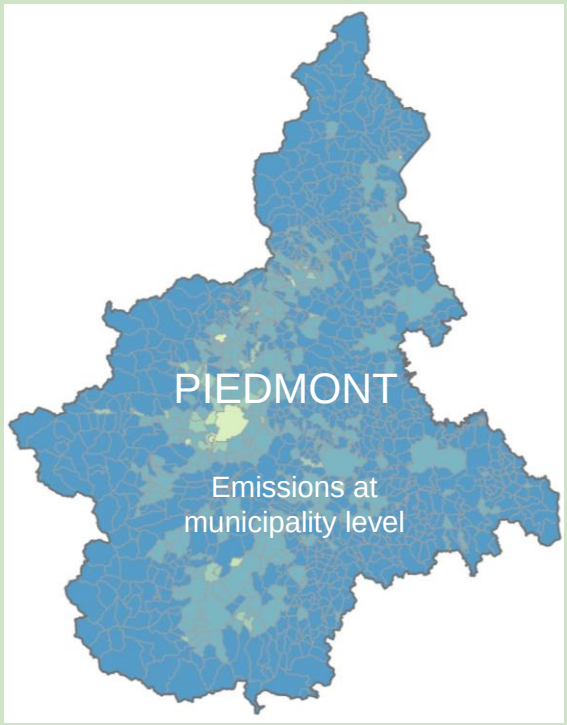


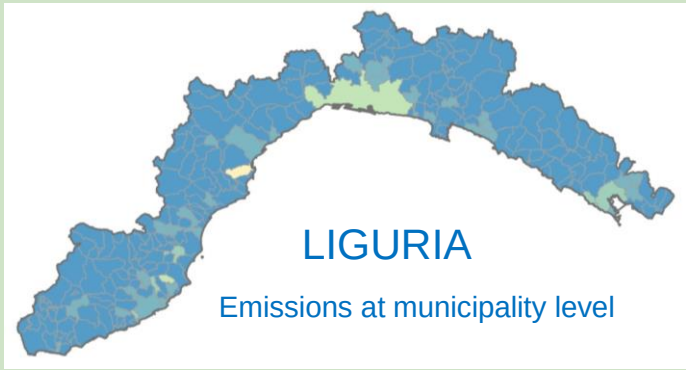
CHEMICAL DATA

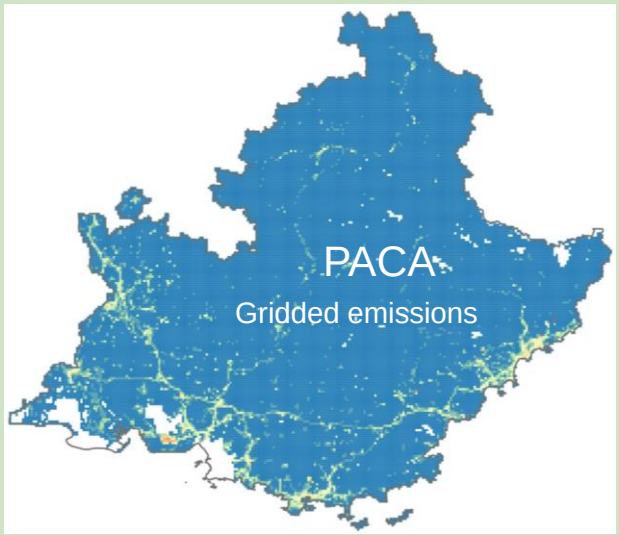
Ozone concentration data: Arpa has carried out 3 monitoring campaigns at high altitude with mobile laboratory during summer 2018, 2 will be made during summer 2019

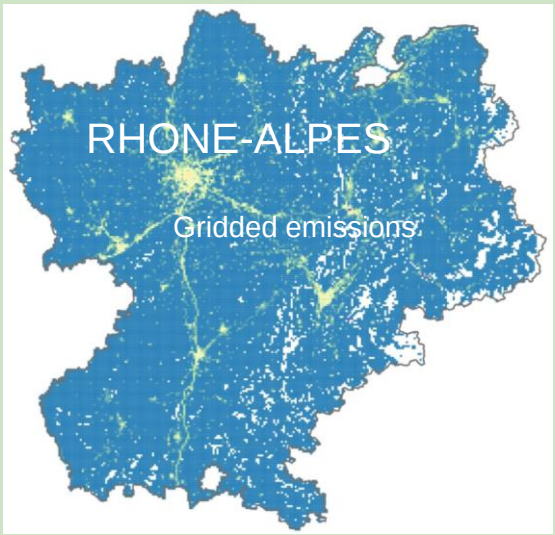
- ***Pietraporzio (Valle Stura - Italy):*** 28 may – 27 june 2018 (1334 m a.s.l.)
- ***Isola2000 (France):*** 27 june – 27 july 2018 (2100 m a.s.l.)
- ***Pontechianale (Valle Varaita):*** 17 august – 25 september 2018 (1607 m a.s.l.)

EMISSION DATA





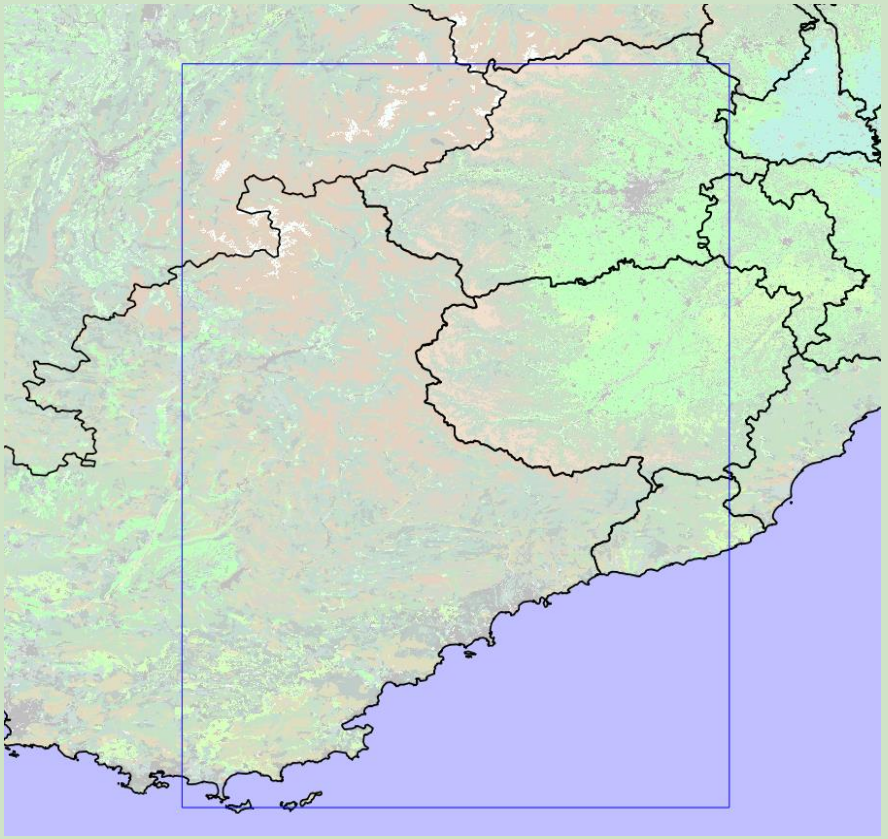




Emissions about: volatile organic compounds (NMVOC), nitrogen oxydes (NO_x), ammonia (NH_3), carbon monoxyde (CO), sulfur dioxyde (SO_2), particulate matter (PM_{10} and $PM_{2.5}$) + greenhouse gases (N_2O, CH_4 and CO_2)

METEOROLOGICAL AND CONCENTRATION DOMAINS

METEOROLOGICAL DOMAINS



OZONE TARGET AREA

METEOROLOGICAL MODELLING

- **Meteorological modelling** will supply – at each grid point in the cross-border domain (horizontal resolution 3 km x 3 km) – information about meteorological parameters (humidity, solar radiation, temperature) that can be correlated with ozone damages;
- The meteorological modelling will be carried out with the **meteorological model at limited area WRF**, developed at *National Center for Atmospheric Research* (NCAR), which has been recently integrated in the Arpa air quality modelling system; the model is suitable both for operational activities (such as air quality forecasts and *near real time* analysis) and studies on previous long term periods (seasonal/yearly simulations). The code is widely used by the scientific community both for operational and research activities.
- Capitalization: the integration of WRF in the Arpa modelling system will allow its use in a wide range of applications both at regional and local scale

AIR QUALITY MODELLING

- **Air quality dispersion, transport and chemical transformation of pollutants** (ozone and its precursors) will be carried out with **FARM,** a *Chemical Transport Model (CTM)*: starting from the results of meteorological modelling – together with ozone emission precursors, geographyc and land use information for the studied area – the simulation (horizontal resolution 3 km x 3 km) will produce hourly concentrations of the main pollutants, **ozone** included;
- Meteorological and chemical data collected in the project will be used to optimize the modelling system configurations and to evaluate its performance in correctly reproducing measured data (both meteorological and chemical);
- Modelling results will be used to produce ozone maps in the cross-border domain; measured ozone concentrations will be integrated in the modelling results by means of *data fusion* techniques;
- The ozone concentrations produced by Arpa will be shared with the MITIMPACT partners to be used for the different activities in the project framework.

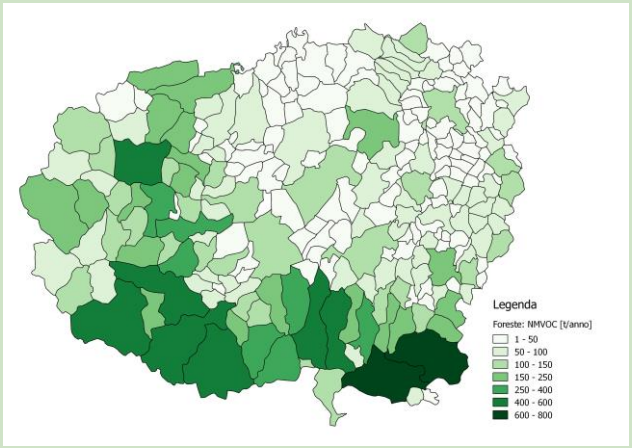
AIR QUALITY MODELLING

- The ***source apportionment*** method ***in atmospheric dispersion modelling*** – already applied by Arpa in the framework of the Alcotra project SH'AIR – will allow the estimation of internal and external contribution to ozone production due to emission sources located inside and outside the studied area

BIOGENIC EMISSION REDUCTION SCENARIO

- A **modelling scenario** aimed at estimating the **variation of ozone concentrations** due to a **reduction of ozone emission precursors** will be carried out; **the reduction in emission precursors** can be obtained assuming a change of the present **plant coverage in the forested areas** in terms of different distribution and frequence of plant species each with a specific emission profile.
- Climatic changes in medium and long period will change the distribution and frequency of vegetal species, each of them characterized by specific emission profile for the ozone precursors.
- One of the aims of the project will be to identify strategies for the mitigation of ozone impacts: a scenario producing a change – by means of management techniques – of the specific composition of the forest will be carried out.

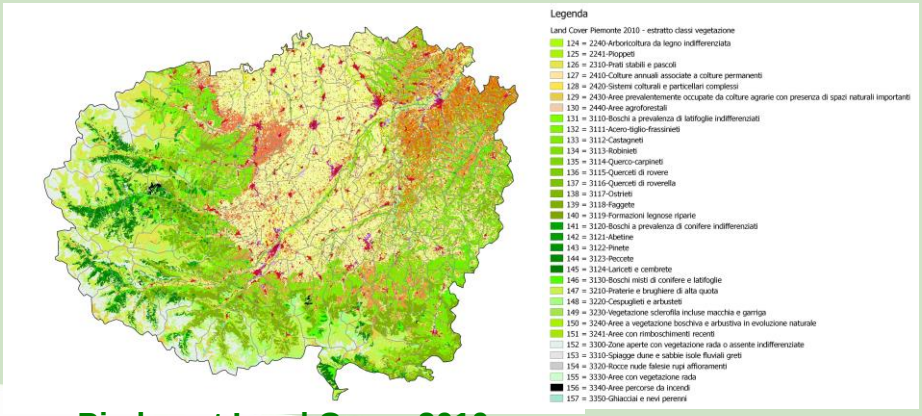
BIOGENIC EMISSION REDUCTION SCENARIO



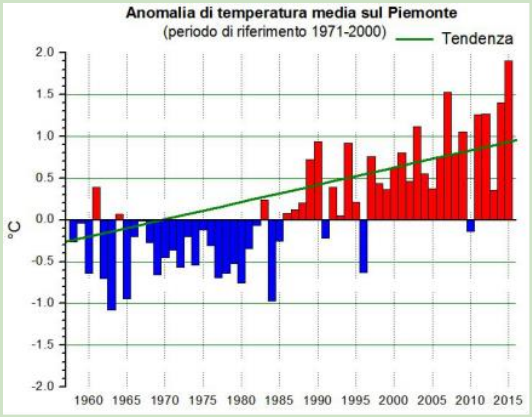
Ozone precursors: NMVOC for FORESTS (tons/year/municipality) (IREA)

Key point: identification of species to be included in the change according to the following criterios:

- Lower NMVOC emissions
- Higher spatial representativity
- Lower sensibility to meteorological parameters



Piedmont Land Cover 2010



Piedmont average temperature trend

ECONOMICAL EVALUATION OF OZONE IMPACTS

Objective of the project is the economic evaluation of costs variation for ecosystemic services due to ozone pollution impact in the studied areas, taking into account different social and economic contexts (such as forestry activities, health, agriculture).

Ozone impact on forests and the whole ecosystem are increasing and there is hazard of a further increase due to the expected climate changes effects.

The methodology for the economical evaluation of ozone impacts will be developed assessing the impacts on plants and their functionality, as well as the consequences on the different ecosystemic services.