High concentrations of ozone over the sea: experimental results and numerical simulations

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Results partially obtained in the frame of the project iMONITRAF!

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Why this presentation?

I do not know if there is a communication problem, but session of conferences devoted to “communication affairs” are almost always crowded

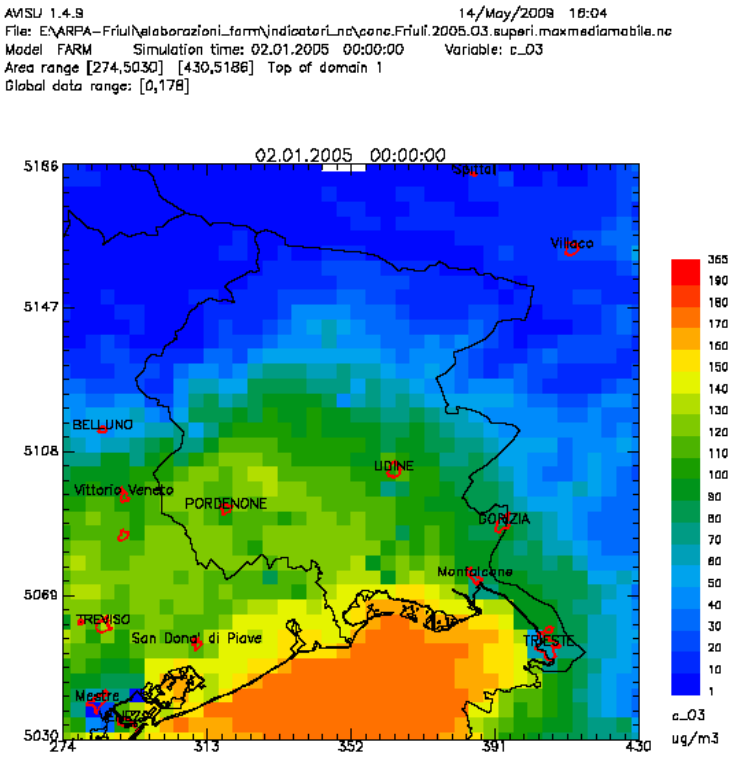
I personally enjoyed all the EMS sessions devoted to communication and communication problems. In Zurich (last EMS meeting) the proposed paradigm was that of a communication “short and sexy”

I tried to face the question of the “Communication problem” with a “physicist approach”

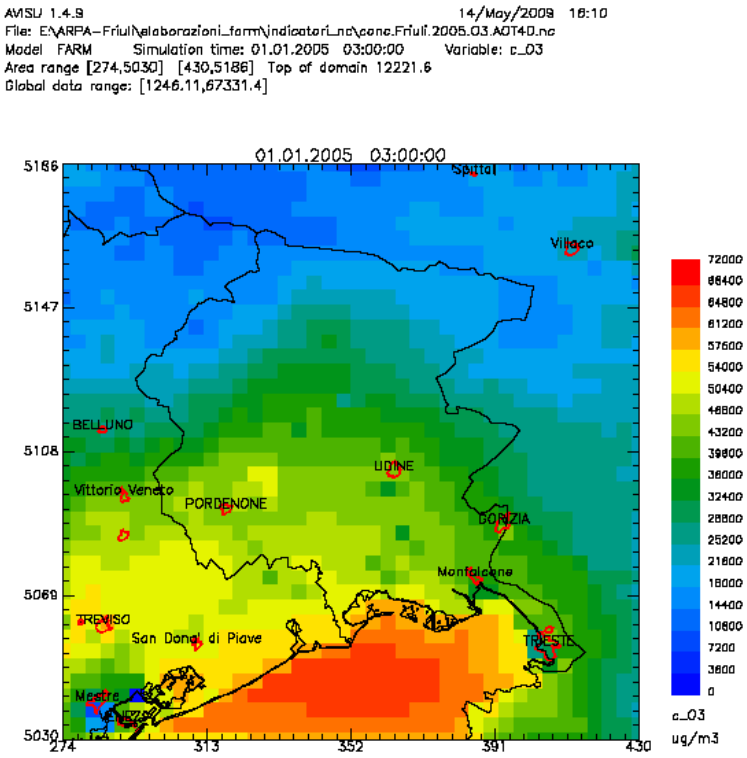
Split the question “is there a communication problem” in elemental constituents, trying to quantify (if possible) each element

Who cares about ozone over the sea?

The starting point: numerical models show high O3 values on the sea



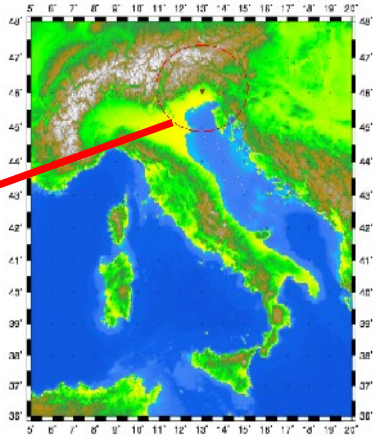
exceedances 120 ug/m3/8h

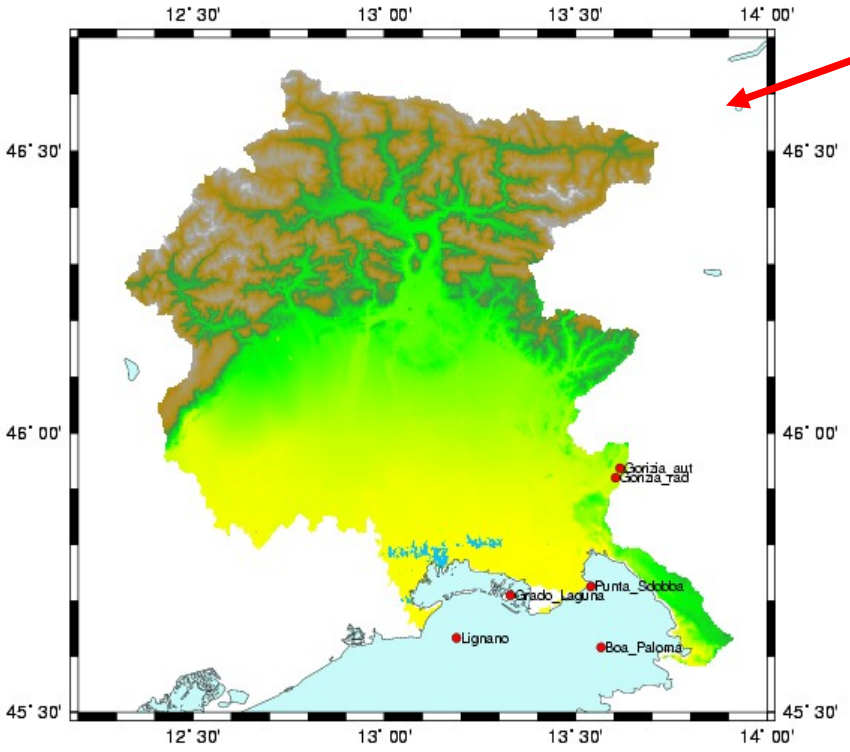


AOT40 (ppb)

Is this likely to happen?		**Yes because...**
Mixing height is lower on sea than on land	→	Once O3 is formed, it is less vertically dispersed
Sunshine duration is higher on sea than on land	→	Photochemical reactions are sustained by high (UV) solar radiation
Sea is far (but not too much) from the most polluted Italian/Slovenian/Croatian areas	→	NOx and CO which are the bricks for the formation of O3 are released by the Adriatic surroundings and only slightly diluted
.....	→	.....

The monitoring campaign (involving even voluntaries)





Haute Ozone sur la MERe

Two years project carried out on a voluntary basis

Only material costs for Arpa (passive samplers and analysis)

Free collaboration of other private and public actors

Two buoys (Paloma and Lignano);
One site on the lagoon (Casone di Grado);
One site on the shore (P.ta Sdobba);
One site on the land (Dept. Gorizia);

Passive samplers to monitor ozone

Haute Ozone sur la MERe

Passive samplers (RADIELLI) which are exposed for a “relatively) fixed period of time;

A substance contained inside the passive samplers changes its status according to average ozone concentration and to average temperature;

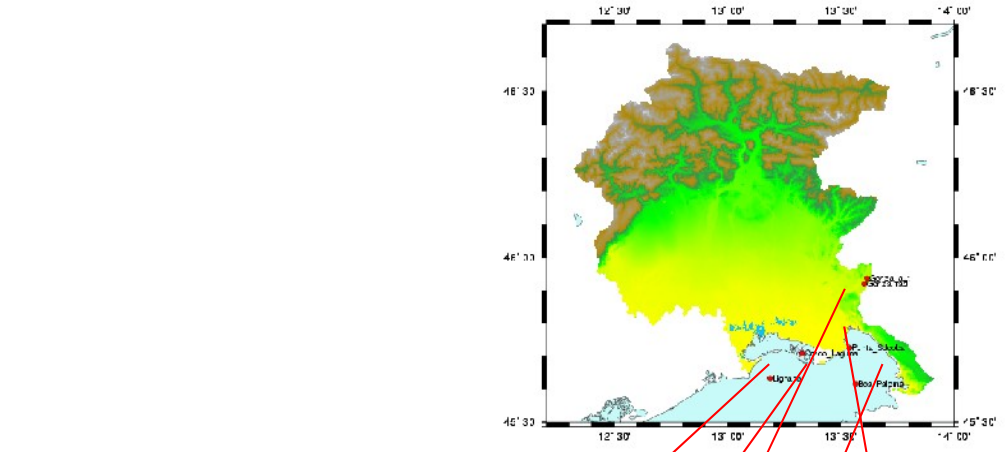
Two passive samplers are exposed at the same time to increase robustness of the estimate.

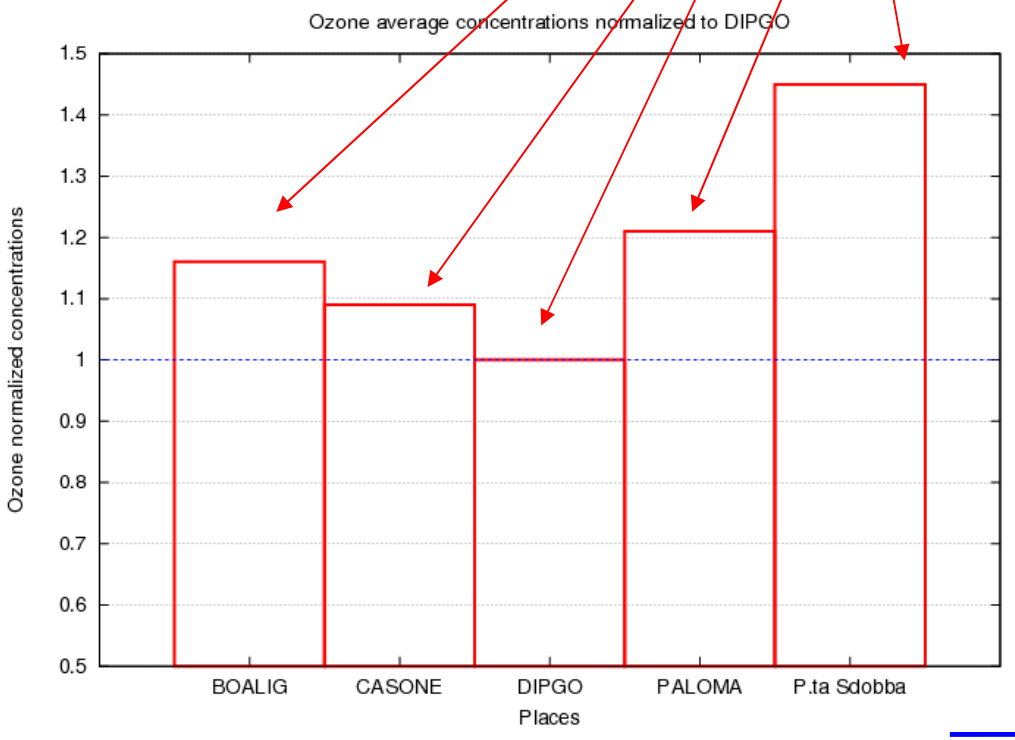
Preliminary results

Near to the sea and shore O3 concentrations are higher than on land

Differences among sea ad land are of the same order of magnitude of those revealed by numerical models

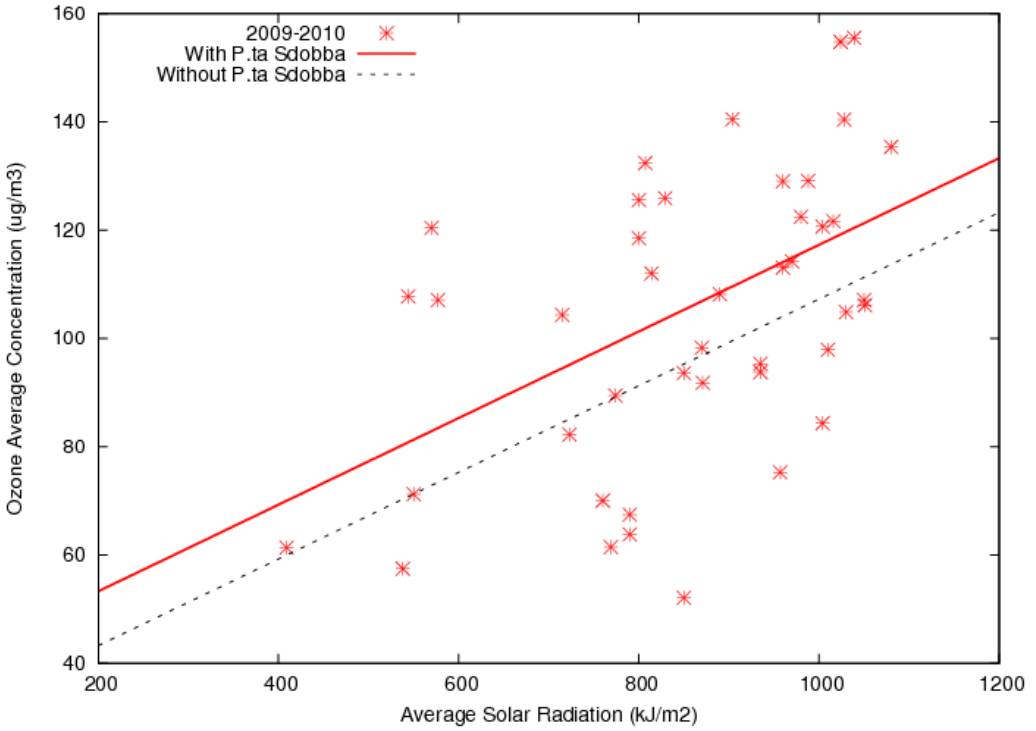
P.ta Sdobba's O3 concentrations are the highest observed on FVG plain and sea





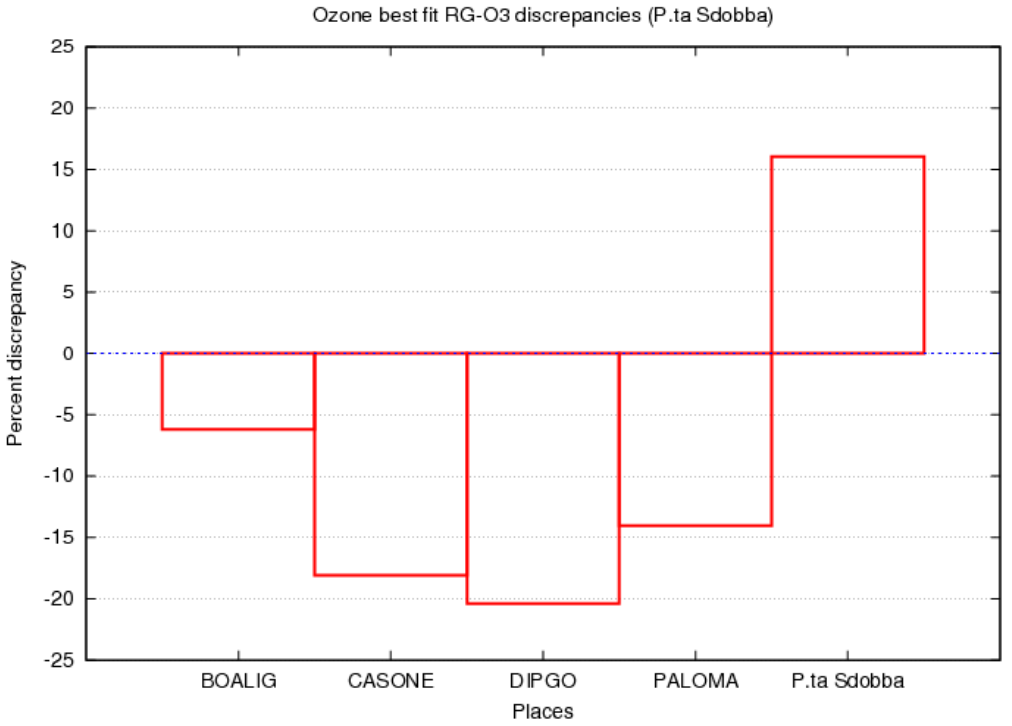
Preliminary results

Linear regression between average solar radiation and average O3 concentrations is statistically significant (99.5%)



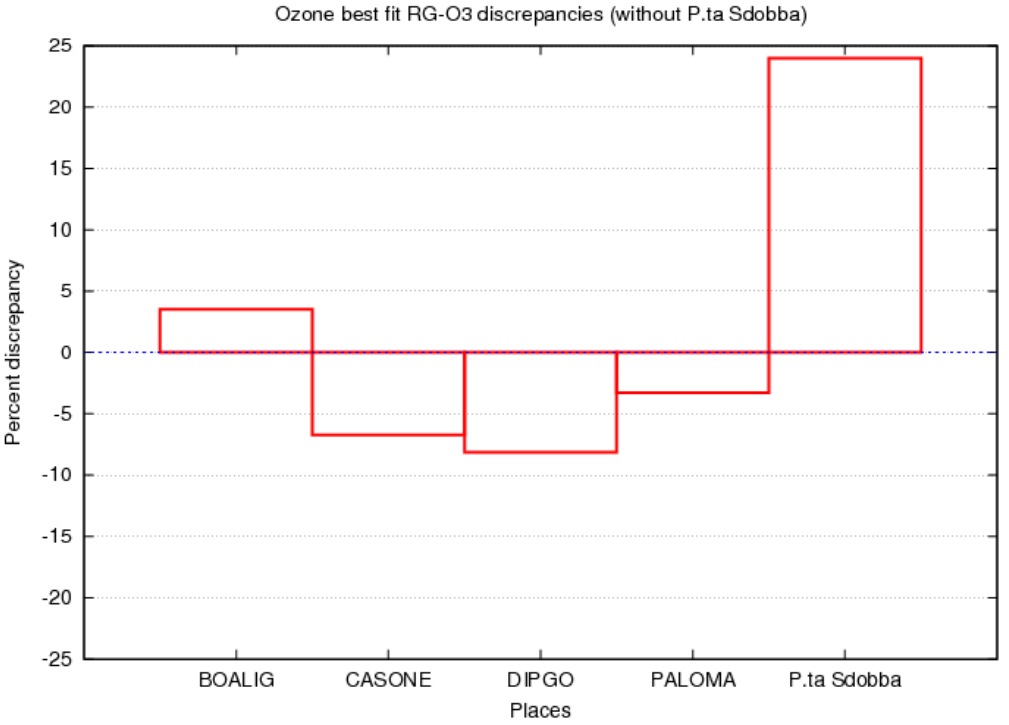
Preliminary results

P.Ta Sdobba's O3 concentrations are completely different from those observed in the other monitoring stations

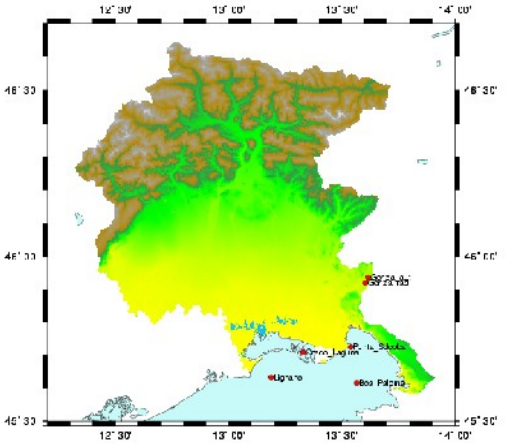


Preliminary results

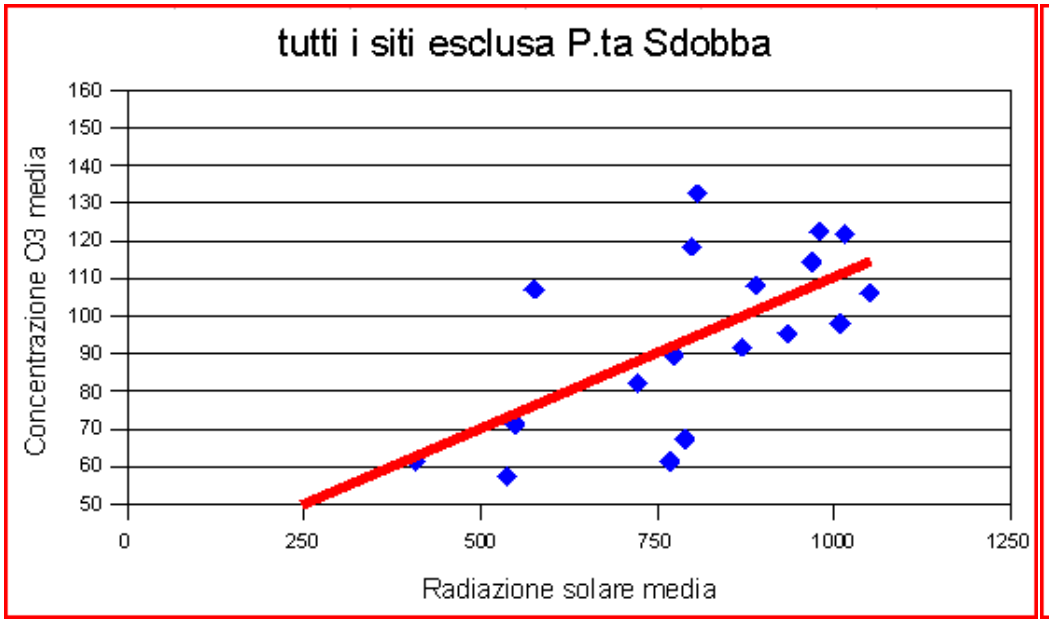
RG-O3 statistical relationship obtained without P.ta Sdobba's data reduces the percent differences among the other monitoring stations and shows that O3 concentrations at P.ta Sdobba are larger than expected by more than 20%
(effects of a near source of precursors?)

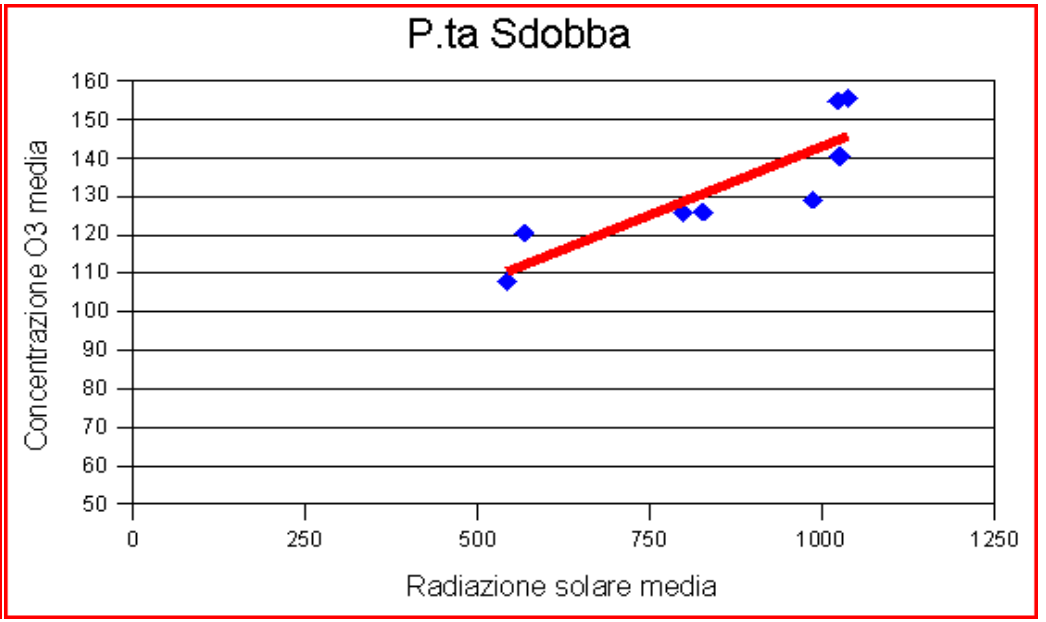


Preliminary inerpretation of the results



P.ta Sdobba's ozone sees to have a behaviour different from that of all the other areas





Same linear coefficient (0.08 ug/m3/kJ)
but different intercept (ca. 30 ug/m3 all the places and ca 80 ug/m3 P.ta Sdobba)

Preliminary interpretation of the results

Campaign of measurements seem to confirm the excess of ozone over the sea. This seems to be related to the high solar radiation over the sea

There is one area which does not follow the relationship between solar radiation and ozone concentration.

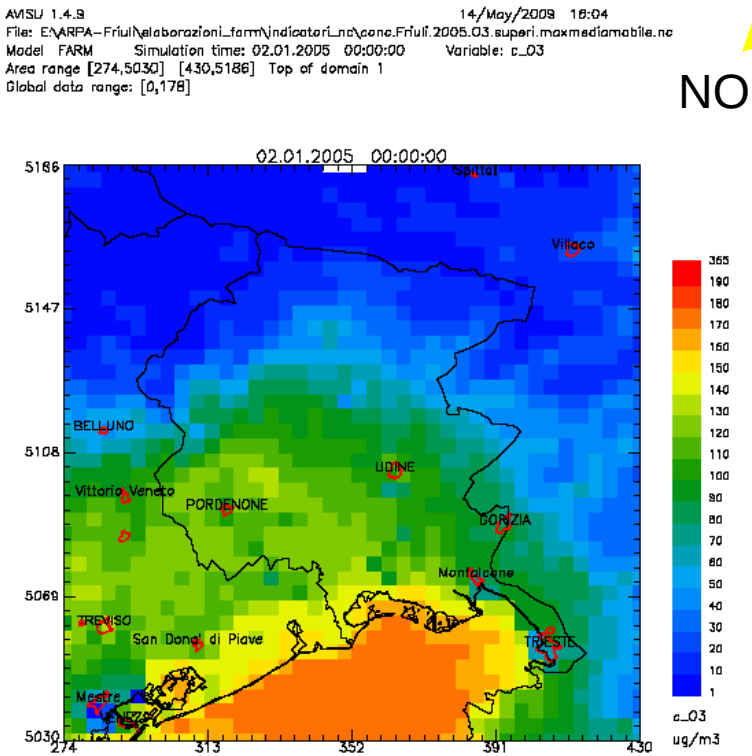
Where are coming from the ozone precursors for the high concentrations observed over the sea?
Why there is an area (p.ta Sdobba) which does not follow the general rule?

Numerical modelling is used to answer to the above questions:

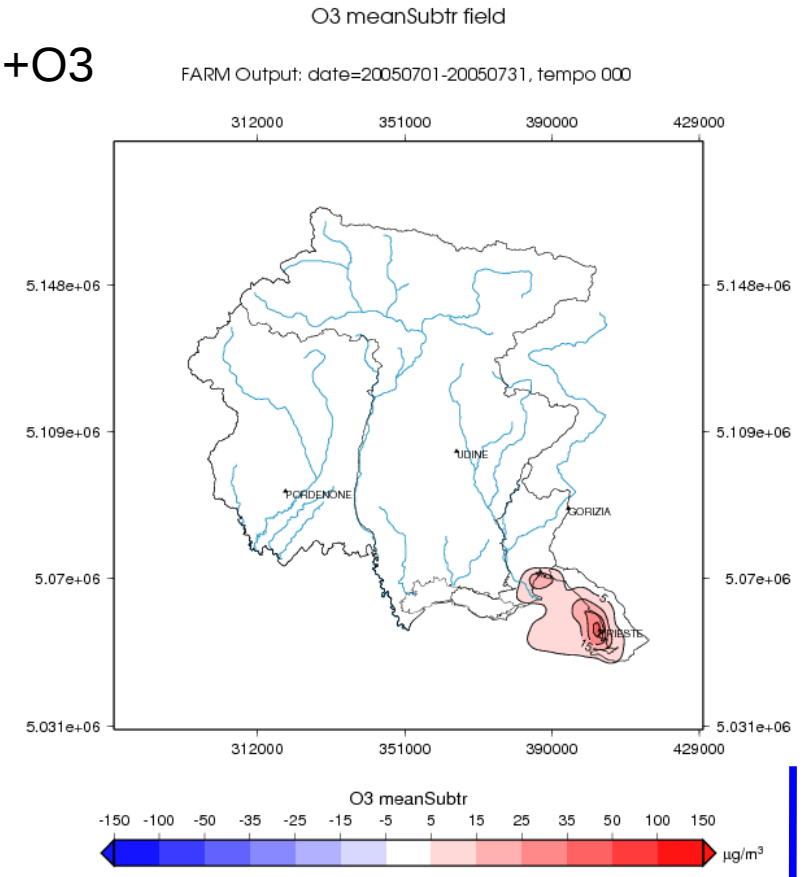
1) a photochemical Eulerian numerical model with a local emission inventory
2) a puff Lagrangian numerical model for the behaviour of p.ta Sdobba

Eulerian photochemical model

Delete one emission category each time to see what does it happen: **shipping**



$$NO_2 + O_2 \rightleftharpoons NO + O_3$$

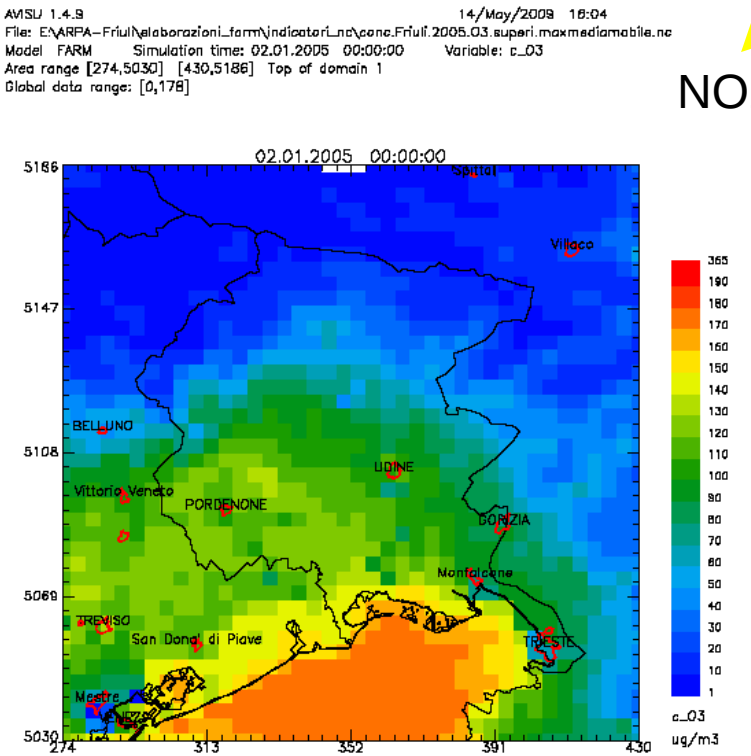


Shipping can explain the lack of O3 near to Monfalcone and Trieste

Results obtained in the frame of the project iMONITRAF!

Eulerian photochemical model

Delete one emission category each time to see what does it happen: **road transport**



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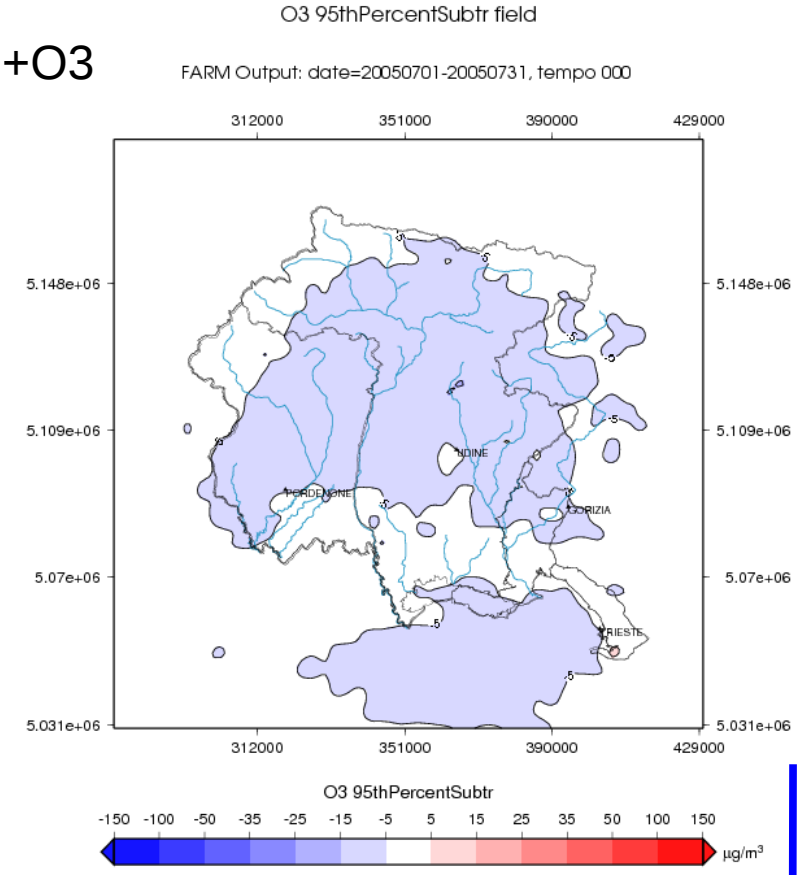
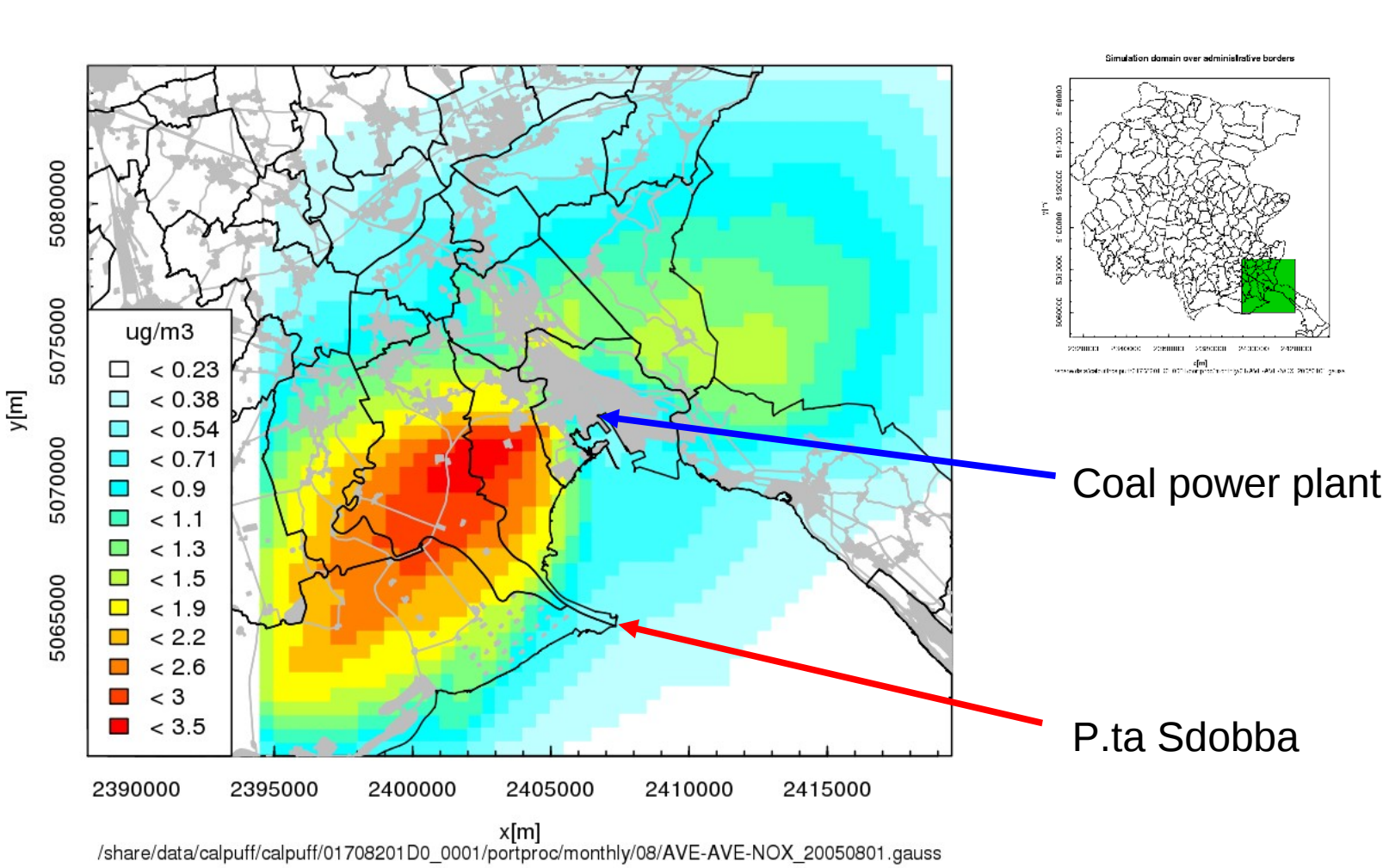


Transports produce a relevant effect on O3 concentrations on the sea

Lagrancian puff model

Estimate the emission of ozone precursors by punctual activities: **coal power plant**



Conclusions

Ozone peaks over the Northern Adriatic Sea seems to be a real effect and not an artefact of the numerical models (at least as an average behaviour)

One of the main driving forces of ozone peaks over the Northern Adriatic Sea seems to be the increased solar radiation (small cloudiness) in presence of abundant concentrations of precursors (in particular of NOx)

Road transport seem to be one of the main sources for the increase of ozone over the Northern Adriatic Sea (high ratio NO2/NOx)
Shipping seems to be one of the main caused of ozone depletion near to the harbours (low NO2/NOx ratio)

Some local effects (however relevant) still do not have an answer

Thank you for your attentions