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IMPLEMENTATION OF IMAPP/IDEA-I OVER THE PO VALLEY REGION, NORTHERN ITALY, FOR AIR QUALITY MONITORING AND FORECASTING

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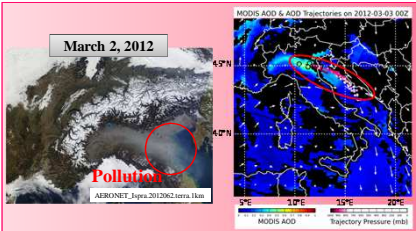
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PO VALLEY: AREA OF INTEREST

Po valley, in the northern part of Italy, is the area with the most severe air pollution problems in the country as it is the largest industrial, trading and agricultural area with a high population density. Torino has one of the main industrial centers in Italy, within a heavily urbanized metropolitan area, and pollutants often cloud the skies overhead. The Alpine chain at the North and West sides of the valley, and the Apennines to the South, act as a barrier to winds blowing from Northern Europe and the Mediterranean, favoring the stagnation of pollutants. Ground-based observations represent point measurements and do not have the necessary coverage to map the distribution of aerosols all over the Po valley.

IMAPP IDEA-International APPLICATION

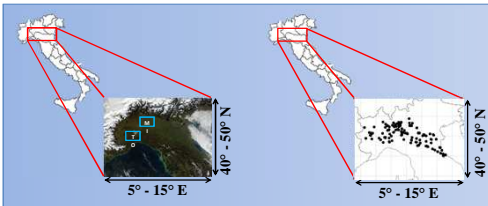


As an example, we considered March 2, 2012 characterized by a polluted area on Eastern side of the valley, as shown above (left). In the right figure we show IDEA-I aerosol trajectory forecasts over Italy. IDEA-I result shows venting of aerosol to South-East.

Over the Po valley domain, regional Italian Regional Agency for Environmental Protection (ARPA) uses forecasting systems for air quality but such systems do not use satellite data. The use of satellite data allows having a more complete coverage over the studied domain, but most of all having air quality information in real time. The application of IMAPP IDEA-International over the Po Valley domain was the first step of investigation on the existing PM₁₀-AOD (Aerosol Optical Depth) correlation.

As Terra or Aqua MODIS AOD retrievals are available daily, the use of these products by IDEA-I permits real-time air quality forecasts. For our specific purpose, IDEA-I was installed at University of Modena and Reggio Emilia, (Italy). A larger European area was chosen as the domain for IDEA-I to look for regional transport patterns that could influence the Po valley.

DATA AND METHODS



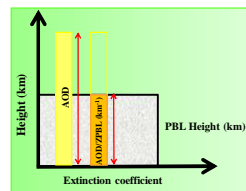
The Po Valley (left), where Turin (TO) and Milan (MI) are the largest industrial areas with high population densities. On the right, the distribution of 126 air quality ground monitoring stations of ARPA network for PM₁₀ measurements.

- PM₁₀ in μg m⁻³, has been considered over 126 air quality monitoring stations of the ARPA network. Since each administrative division (region) of Italy has its own ARPA network, we considered four different regions covering the Po valley: Piemonte (27 stations), Lombardia (59 stations), Emilia Romagna (37 stations) and Veneto (3 stations).
- MODIS Terra Level 2 Aerosol Products, collection 5.1 have been used, which provides AOD data at 0.55 μm with a spatial resolution of 10 km² (MOD04, LAADS Web - NASA).
- The spatial co-location of MODIS pixels with PM₁₀ stations has been determined by calculating the distance between the MODIS pixel and PM₁₀ station. All the MODIS pixels within a distance of 0.25° (about 20-25 km) are averaged for each PM₁₀ station.
- One year (2012) of coincidence data of PM₁₀ mass, MODIS AOD obtained over four regions of the Po valley has been used to establish and study a relationship between PM₁₀ and AOD.

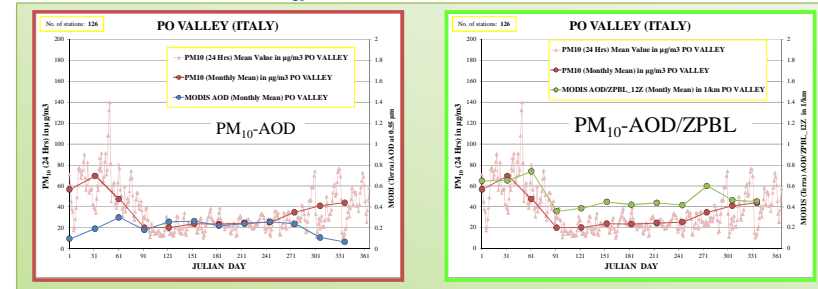
AEROSOL VERTICAL DISTRIBUTION

Since the majority of aerosol abundance resides in the boundary layer, the thickness of boundary layer has direct impacts on the correlation between AOD and PM. For this reason, we consider the correlation between PM₁₀-AOD and PM₁₀-AOD /ZPBL over the Po Valley.

We assume that the aerosols are confined and mixed homogeneously with boundary layer. So, the values of AOD normalized by Planetary Boundary Layer height (ZPBL) may be regarded as mean PBL extinction in km⁻¹ (see schematic on right).



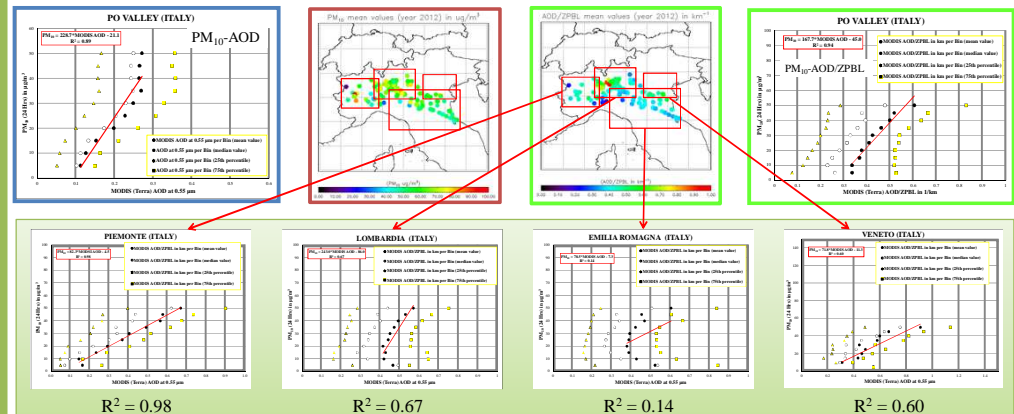
ZPBL IMPACT ON PM₁₀ – MODIS CORRELATION: PO VALLEY RESULTS



By analyzing the seasonal trend for all stations, a much stronger correlation between PM₁₀ and MODIS appears if AOD normalized PBL is considered. The PM₁₀-AOD that were not comparable for the fall and winter seasons (on the left), are much more correlated when PM₁₀-AOD /ZPBL is considered (on the right). The ZPBL trend over the Po Valley (not shown) has a direct impact on the PM₁₀ – MODIS correlation and has low values during the winter and high values during the summer.

ZPBL IMPACT ON PM₁₀ – AOD CORRELATION REGIONAL RESULTS

Linear regression equation is derived by dividing PM₁₀ (24Hrs) into 10 bins of 5 μg m⁻³



Normalizing by ZPBL improves the PM₁₀-MODIS AOD correlation for the Po Valley as a whole (upper left vs upper right). If we consider each administrative division separately (lower panels), the correlation decreases significantly except for Piemonte, which maintains a high R². The worst correlation is found for Emilia Romagna, which has ARPA sites near the Southern Apennines chain where there is the least polluted region within the Po Valley. The correlation is also reduced within the highly industrialized Lombardia region.

CONCLUSION

- IMAPP IDEA-I aerosol forecasts heightens the comprehension of air quality within the Po Valley
- MODIS AOD and AOD/ZPBL has been co-located ground-based PM₁₀ concentration measurements at 126 stations over the Po Valley
- The correlation between PM₁₀ and AOD/ZPBL (R²=0.94) is found to be superior to the correlation between AOD and PM₁₀ (R²=0.89) within the Po Valley. However, the correlations for each region are generally not as high.