A comparison of wet-deposition data from new NTN site TX43 "Cañónceta" with nearby historical trends using three spatial interpolation techniques

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Introduction

Wet deposition occurs when a particle or gas molecule is collected from the air and carried to the earth's surface by precipitation. Reactive species of nitrogen (N) in the atmosphere such as nitrogen oxides, nitrate (NO_3^-) and ammonia (NH_3) are relatively soluble in water. They may be subjected to wet deposition through precipitation as nitrate (NO_3^-) and ammonium (NH_4^+). The primary, national network of wet deposition monitors is the National Atmospheric Deposition Program/National Trends Network (NADP/NTN). In July 2007, the NADP/NTN added monitoring site TX43 "Cañónceta" in the southern High Plains of Texas, a region known for its intensive production agriculture (Figure below). We are interested in knowing how the first year of wet-deposition data at TX43 aligns with the spatial trends in the historical data from the surrounding NTN sites. Spatial interpolation techniques were used to evaluate wet deposition data in the region from a set of nearby monitoring sites.

Methodology

Three different interpolation schemes, inverse distance weighted (IDW), spline, and kriging were used to obtain the wet-deposition maps of the pollutants in the region.

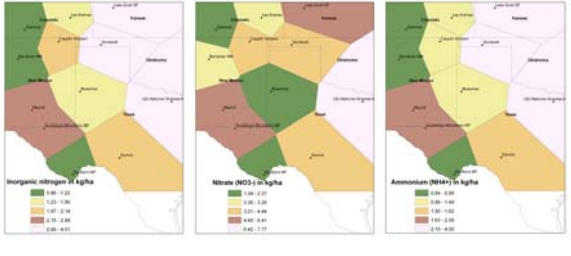
Inverse Distance Weighted (IDW): A linearly weighted combination of a set of deposition sample points, in which the weight is a function of inverse distance, determine the cell values and the interpolated surface. Parameters: cell size=1, number of neighbors=12, power=2.

Spline: A mathematical function that minimizes overall surface curvature. This results in a smooth surface that passes exactly through the input points. Here, the parameters for the method used were: cell size=1, number of points=12, type=thin plate.

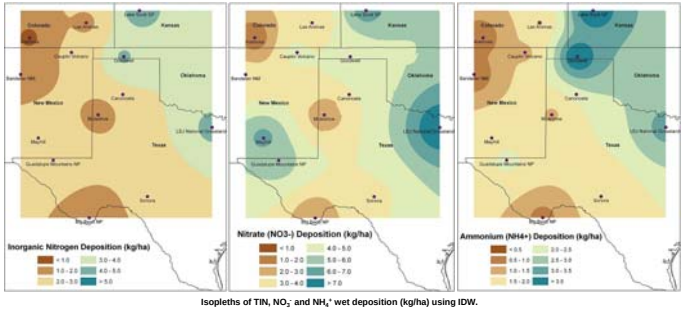
Kriging: A classical weighted linear interpolation method and satisfies the same conditions as the Lagrange or the least squares interpolation method. In this study, ordinary kriging method was used under both isotropy (non-directionality) and anisotropy (directionality) options. Anisotropy (directionality) option was based on *a priori* information on influence of rainfall associated with prevailing wind direction in the study area. The rainfall takes place mostly during the months of June-August during which winds are predominantly from the south and southwest.

For spatial analyses, five-year (2002-06) annual deposition data of total inorganic nitrogen (TIN), nitrate (NO_3^-) and ammonium (NH_4^+) from twelve neighborhood points were used in the study. The calculation algorithm, spatial analyses, and maping were done using ArcGIS Ver.9.2 (ESRI, 2008).

Voronoi Diagram



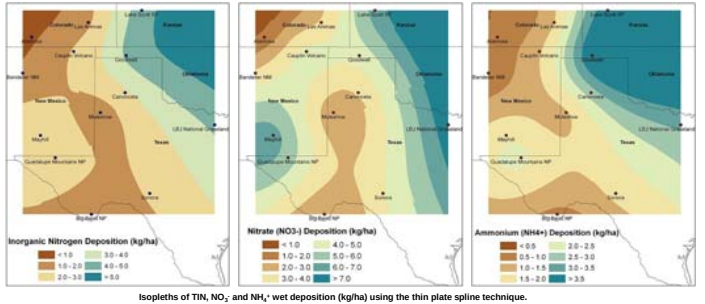
Inverse Distance Weighted (IDW)



Isopleths of TIN, NO_3^- and NH_4^+ wet deposition (kg/ha) using IDW.

Total inorganic nitrogen wet deposition at TX43 was found to be between 2.0 and 3.0 kg/ha. Wet deposition of NO_3^- and NH_4^+ at the same site were in the range 3.0-4.0 and 2.0-2.5 kg/ha, respectively.

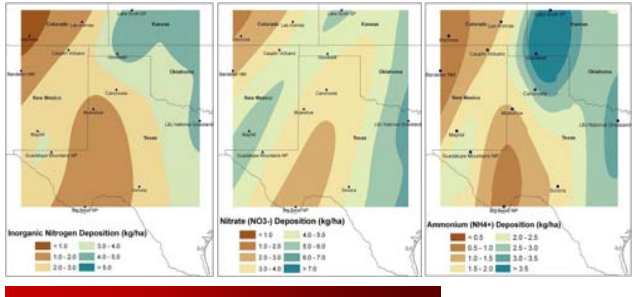
Thin Plate Spline



Isopleths of TIN, NO_3^- and NH_4^+ wet deposition (kg/ha) using the thin plate spline technique.

Wet deposition of inorganic nitrogen at TX43 was in the range 2.0 and 3.0 kg/ha, and for NO_3^-, wet deposition was on upper range of 3.0-4.0 kg/ha. Ammonium (NH_4^+) wet deposition at TX43 was between 2.5-3.0 kg/ha.

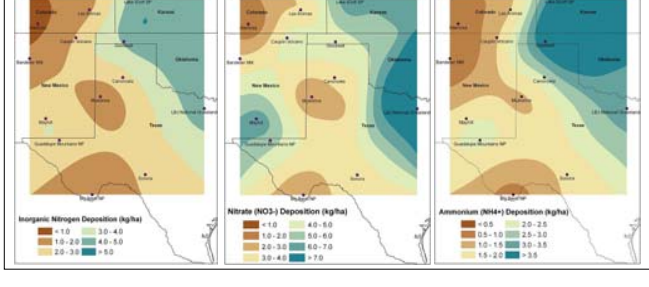
Kriging with Anisotropy (directionality)



Isopleths of TIN, NO_3^- and NH_4^+ wet deposition (kg/ha) using the kriging technique with anisotropy.

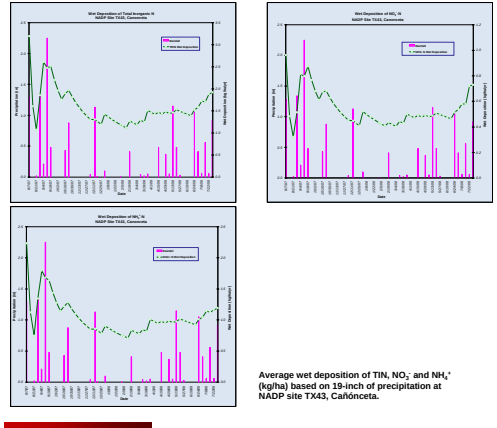
Inorganic nitrogen wet deposition at TX43 was found to be in the range of 2.0 and 3.0 kg/ha. Wet deposition of NO_3^- and NH_4^+ at the same site was in the range 3.0-4.0 and 2.5-3.0 kg/ha, respectively. Nitrate wet deposition was mostly influenced by sites to the south and southwest of TX43, and NH_4^+ by the sites north of TX43.

Kriging with Isotropy (non-directionality)



Isopleths of TIN, NO_3^- and NH_4^+ wet deposition (kg/ha) using the kriging technique with isotropy.

Total inorganic nitrogen wet deposition at TX43 was found to be between 2.0 and 3.0 kg/ha. Wet deposition of NO_3^- and NH_4^+ at the same site were in the range 3.0-4.0 and 2.0-2.5 kg/ha, respectively. Deposition trends are similar to IDW.



Average wet deposition of TIN, NO_3^- and NH_4^+ (kg/ha) based on 19-inch of precipitation at NADP site TX43, Cañónceta.

Conclusion

- Wet deposition of inorganic nitrogen from nitrate (NO_3^-) and ammonium (NH_4^+) in 2006 in the southern High Plains of Texas was in the range of 2.0-3.0 kg/ha (NADP, 2006).
- NO_3^- and NH_4^+ wet deposition for 2006 was in the range 4.0-6.0 and 2.5-3.0 kg/ha, respectively.
- Above values compared well across all three interpolation schemes.
- Our first year (July 2007-08) wet deposition data of TIN and NO_3^- at TX43, based on 19-inch precipitation shows 1.9 and 0.7 kg/ha, respectively. NH_4^+ wet deposition at TX43 is 1.2 kg/ha.
- Kriging can be the best suited interpolation method in the case of data showing anisotropy.

Acknowledgement

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