

Pollutant Deposition Maps and Analysis



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1. Introduction

The deposition of atmospheric nitrogen has increased dramatically over the past few decades. Changes in nitrogen deposition can cause a shift in forest ecosystems, which concerns the U.S. National Park Service. Models that simulate meteorology, pollutant emissions, and atmospheric chemistry can help park officials quantitatively determine trends in deposition over protected ecosystems.

2. Objective

This research project has two main goals:

- 1) Use model-predicted results from AIRPACT-3 to develop a series of pollutant deposition maps. These maps will show the total deposition for selected species in gas phase and in aerosol phase, and also for total nitrogen, total sulfur and total mercury. This will show the dry and wet deposition separately on a monthly accumulative basis.
- 2) Develop a series of meteorological maps on a monthly accumulative basis. These represent convective precipitation events (thunderstorms), non-convective precipitation events, fog events, and ice events (freezing fog).

Overall, this study seeks to determine the relationship between pollutant deposition and meteorological variables while analyzing the differences in nitrogen deposition during winter and summer months.

3. Deposition

Deposition decreases the concentration of particles in the air. There are two types of deposition: dry deposition and wet deposition.

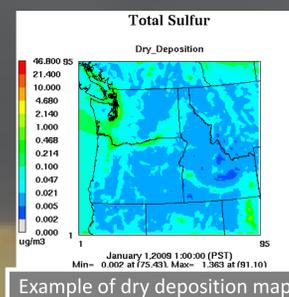
Dry deposition: Particle deposition caused by gravity, dry wind interception, or turbulent transport to the surface. For small particles, turbulent transport is the primary deposition mechanism.

Wet deposition: Particles are captured by atmospheric water in fog, clouds, rain and snow.

Wet deposition dynamics are different in convective rain (thunderstorms) and non-convective rain events.

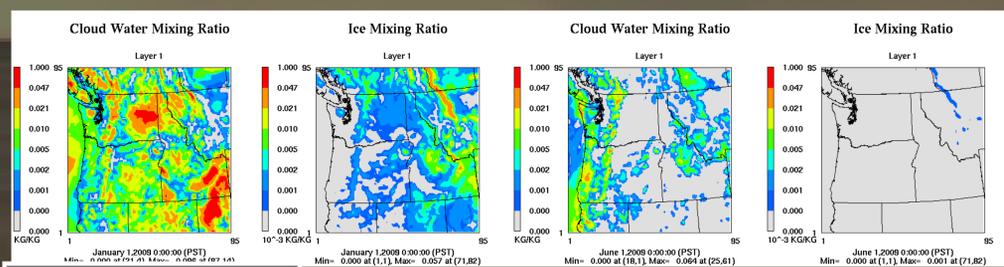
In this research, we studied dry and wet deposition for the species listed below:

Species	Gas Phase	Aerosol
Nitrogen	NO ₂ , NO, NO ₃ , N ₂ O ₅ ,	
	HNO ₃ , HONO, RNO ₃ , NH ₄ ,	
	PAN, PAN2, PBZN, NO ₃	
	MA_PAN, NH ₃	
Sulfur	SO ₂ , SO ₄	SO ₄
Mercury	HG, HGIIGAS	HG



4. Meteorology

Meteorology is one of the most important aspects of pollutant deposition. Besides convective rain and non-convective rain, there are several meteorological variables that affect the dry and wet deposition. There is also interest in understanding how fog or ice events change deposition. In order to study the variation of the deposition, the maps of these variables are plotted on a monthly cumulative basis.

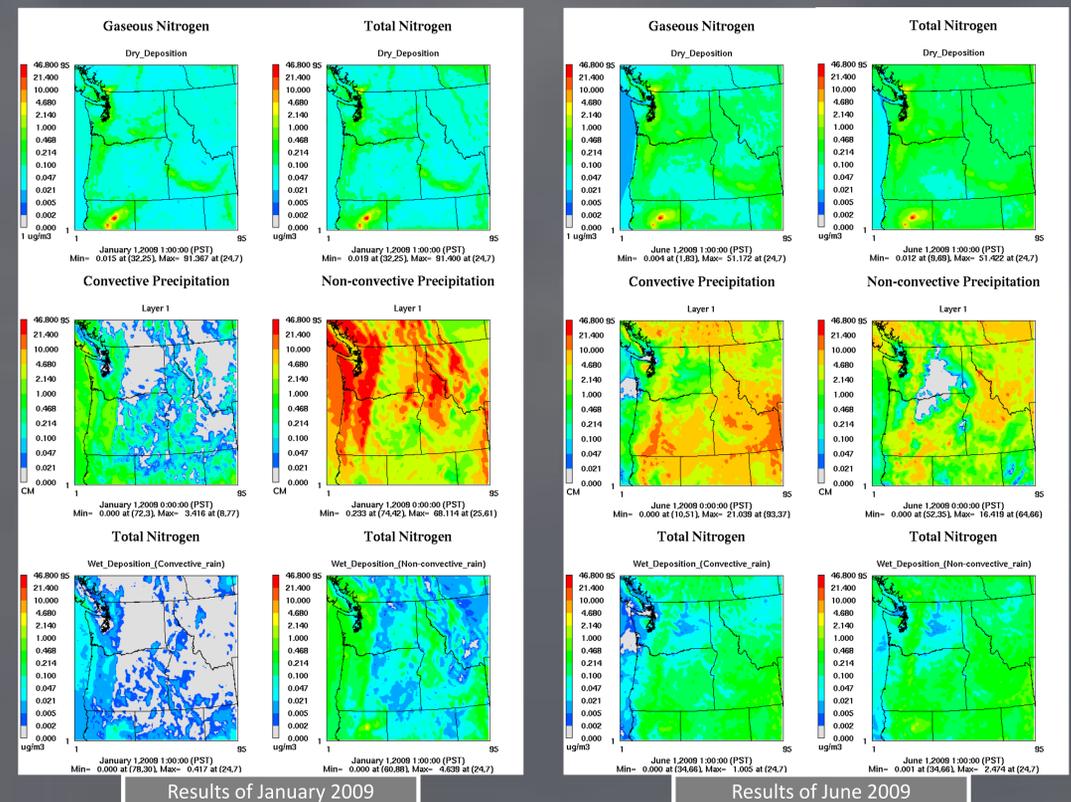


RC	Convective rain
RN	Non-convective rain
QC	Could water mixing ratio

5. Result and Analysis

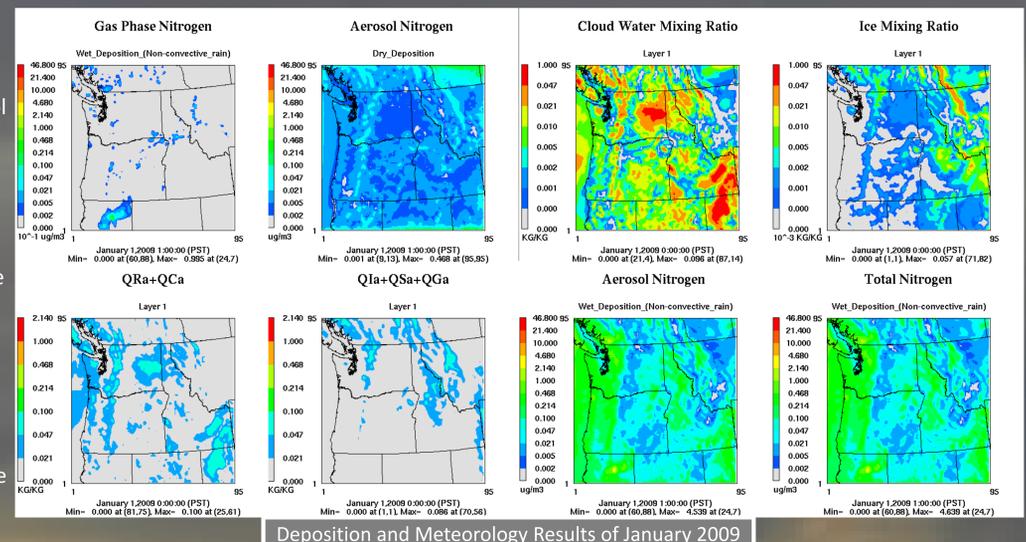
A.) Agreement of the Wet Deposition Maps and Relevant Rain Data

The dry deposition maps shown in the upper panel clearly show that there is generally dry deposition of nitrogen species near the location of their emission sources (i.e. urban, highway, and fire areas). There appears to be no correlation between dry deposition and precipitation. Wet deposition is shown in the bottom panel and rain events are shown in the middle panel. In general, the wet deposition maps with convective rain and non-convective rain agree with the location of convective rain distribution and non-convective distribution rain, respectively. This is to be expected by definition of these wet deposition events.



B.) Contribution of Meteorological Variables in Dry and Wet Deposition

Meteorological and related nitrogen deposition variables for January 2009 are shown in the maps at right. Total wet deposition of nitrogen from non-convective rain clearly depends on the aerosol nitrogen wet deposition as the main source of the total nitrogen deposition. There is a clear correlation between aerosol nitrogen in dry deposition and the ice mixing ratio. However, aerosol nitrogen in dry deposition is anti-correlative to the cloud water mixing ratio because fog turns the dry deposition of aerosol nitrogen into wet deposition events of aerosol nitrogen. However, the level of cloud water mixing ratio is low when compared to the rain distribution and the aerosol nitrogen in dry deposition is low compared to the aerosol nitrogen in wet deposition. Therefore, it is not unusual to see little correlation between the fog events and wet deposition of aerosol nitrogen or total nitrogen.



8. Acknowledgements

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6. Conclusion and Future Plan

The results of dry and wet deposition with both types of rain are consistent. However, there is no significant, direct relationship between fog/ice riming and wet deposition. For a better understanding of the meteorological effect on deposition, a further study on smaller time scales may be needed. Moreover, errors may occur in determining the occurrence of convective rain and non-convective rain. An evaluation of model simulation to the regional monitoring model PRISM (Parameter-elevation Regressions on Independent Slopes Model) is needed.

7. References

Mary Beth Adams, (2003) Ecological issues related to N deposition to natural ecosystems: research needs. Environment International 29 (2003) 189-199