

Total Deposition at Clingmans Dome, TN in the Great Smoky Mountains National Park

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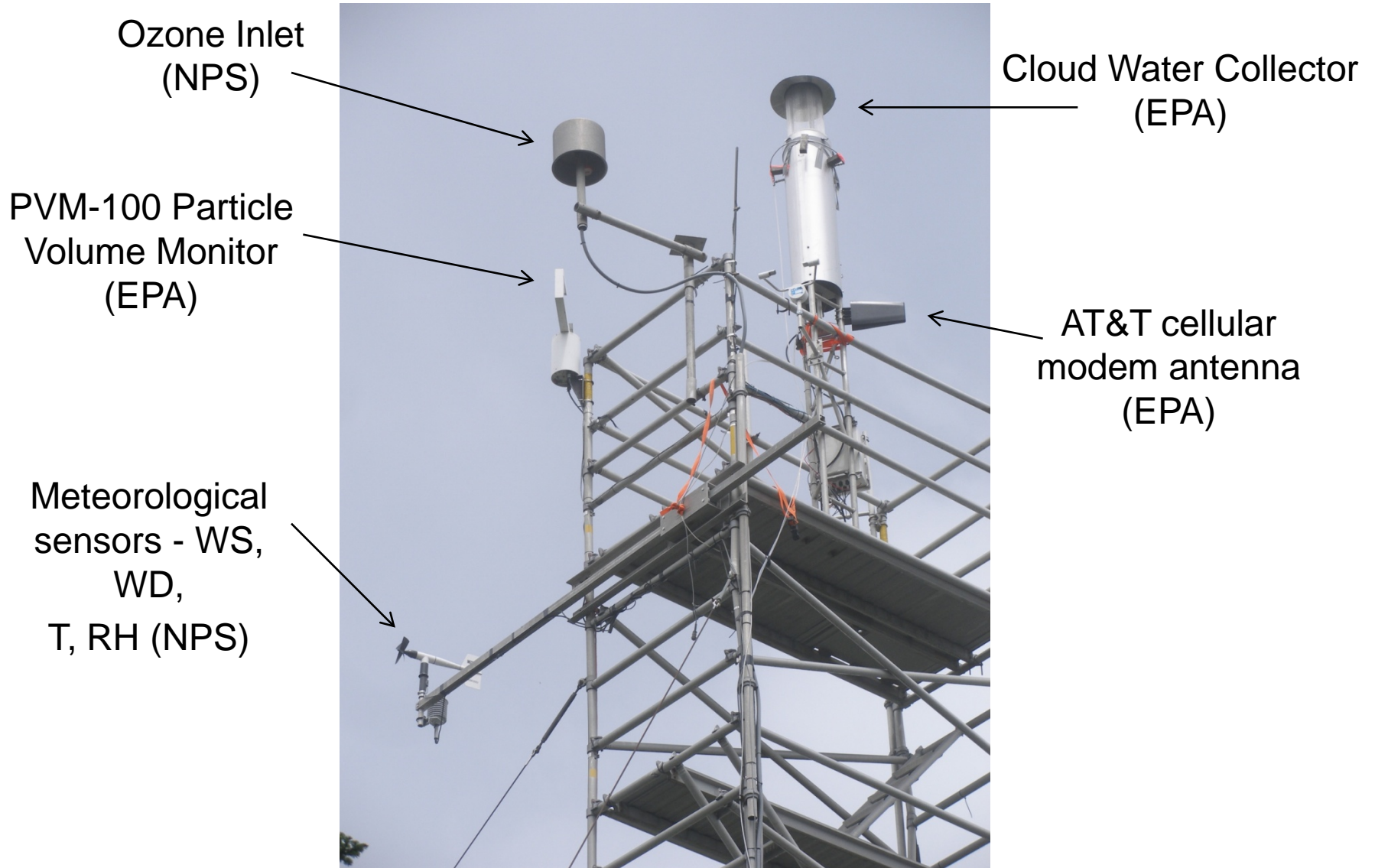
The CASTNET Mountain Acid Deposition Program (MADPRO):



- **Monitors cloud water and its chemical constituents.**
- **High-elevation sites (typically higher than 800 meters).**
- **Ecosystems at these elevations subject to substantial levels of acid deposition from clouds that originate in polluted areas.**
- **Depositions enhanced by frequent cloud immersion, orographically increased precipitation, high wind speeds, and the large leaf areas typical of mountain tree species.**
- **Collecting at Clingmans Dome, TN (CLD303) in the Great Smoky Mountains National Park since 1994.**

View of Radio and Cloud Water Sampling Towers





Cloud Event



View of the PVM



Close-up of Cloud Water Collector



Cloud Water Collector



Cloud Definition

Minimum conditions for activation of cloud collector

LWC > or = 0.05 g/m³

Temperature = 2°C

No precipitation

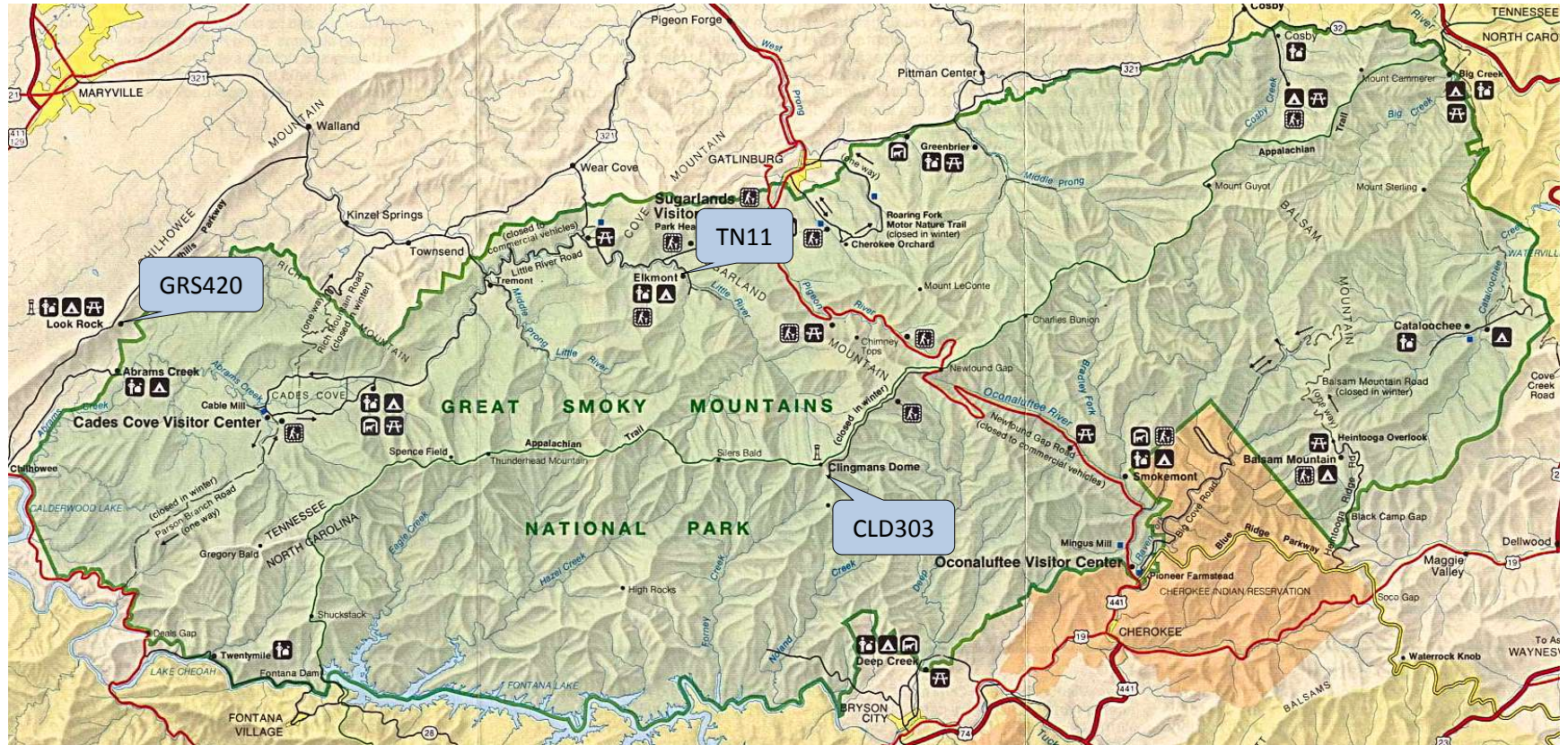
ETI Precipitation Monitor



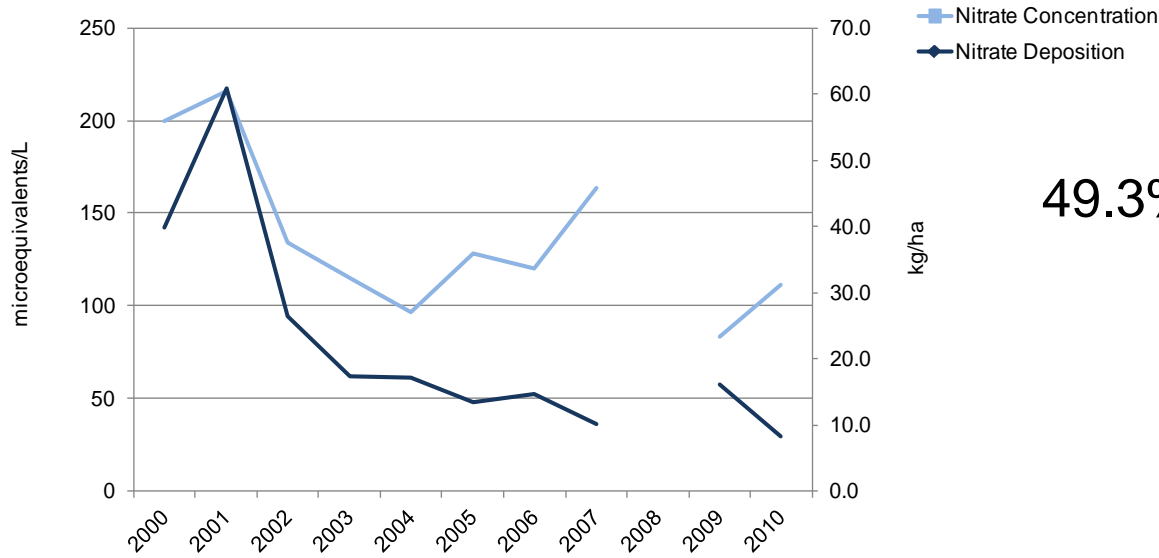
Installation while Site in Cloud



Locations of Dry, Wet and Cloud Monitoring Sites in the Great Smoky Mountains National Park (GRSM)

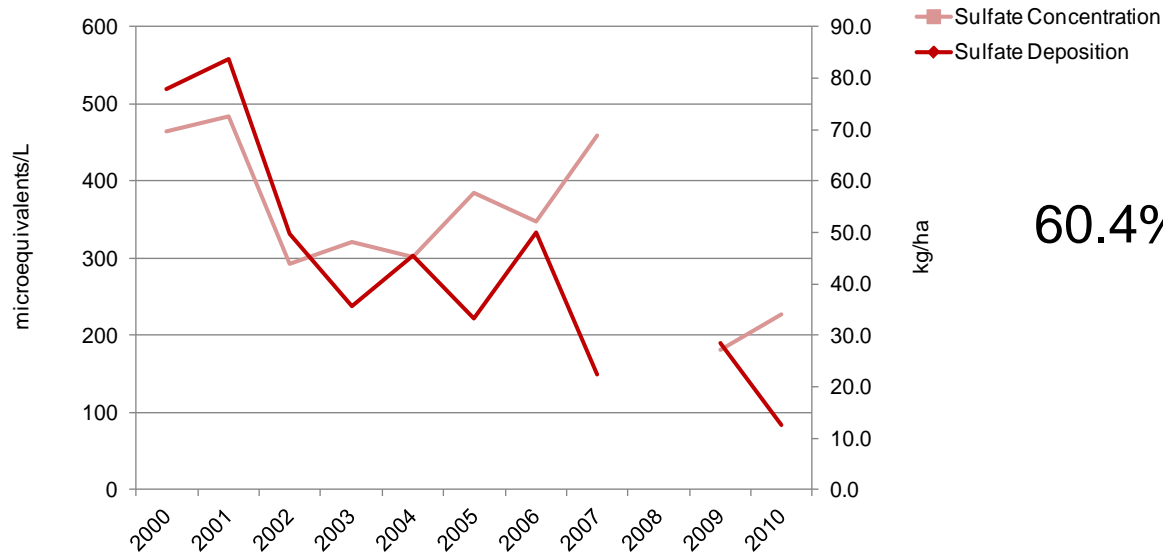


Seasonal Cloud Water Nitrate Concentrations and Depositions, 2000-2010



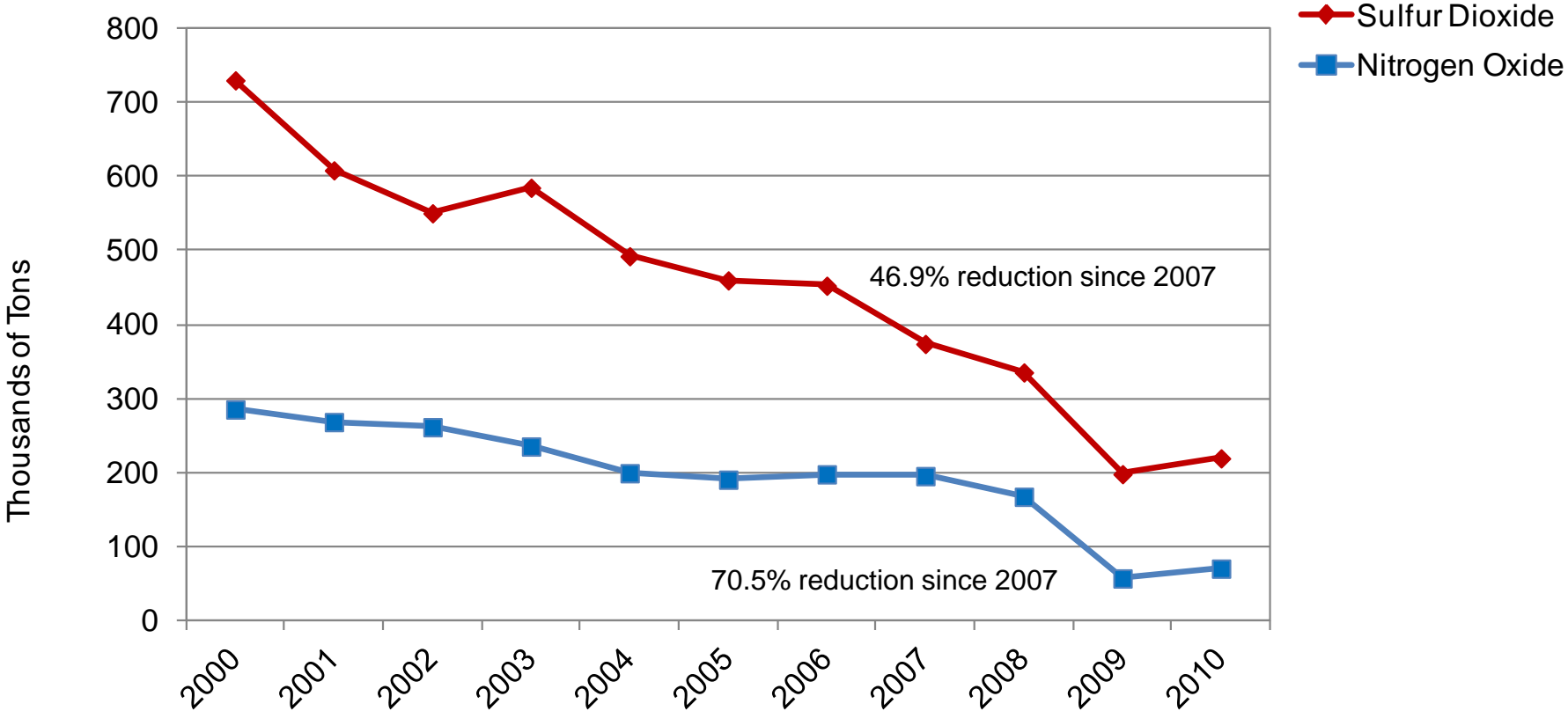
49.3% decrease from 2007

Seasonal Cloud Water Sulfate Concentrations and Depositions, 2000-2010

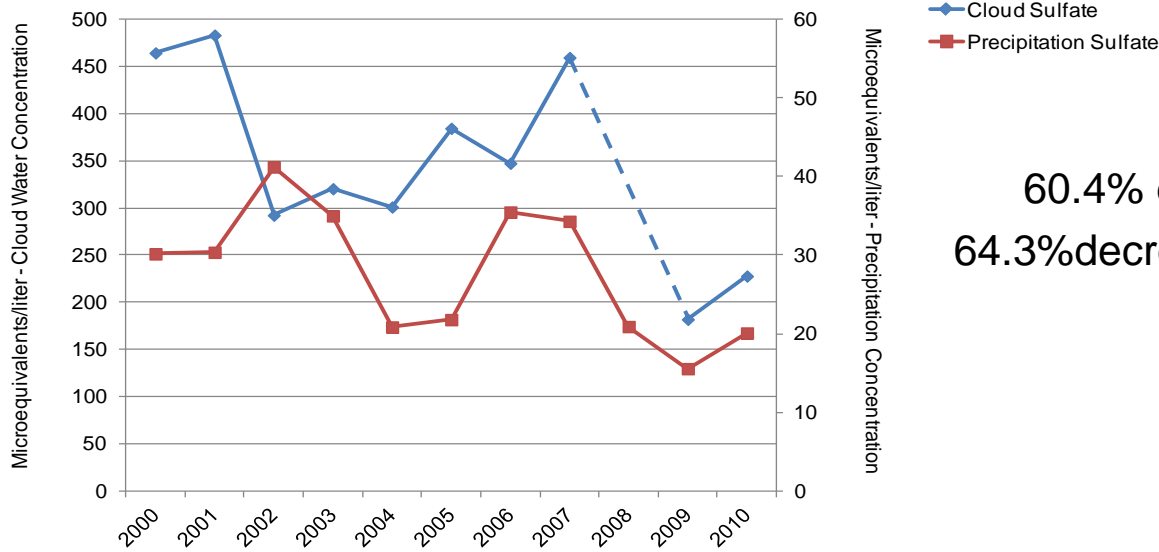


60.4% decrease from 2007

Sulfur Dioxide and Nitrogen Oxides Emissions at TVA Power Plants

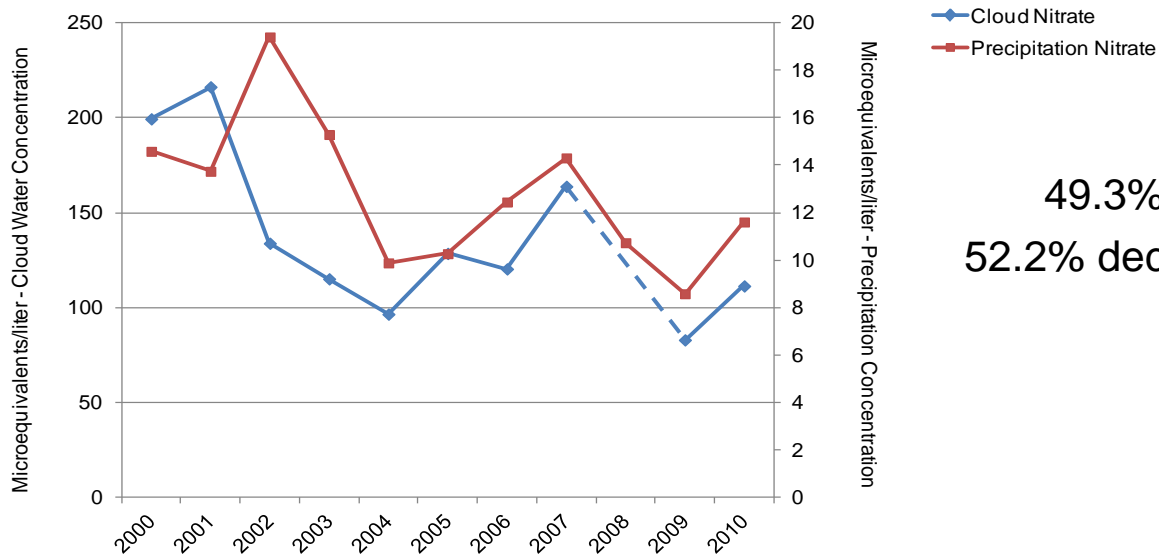


Mean Seasonal Cloud Water versus Mean Seasonal Precipitation Sulfate Concentrations, 2000–2010



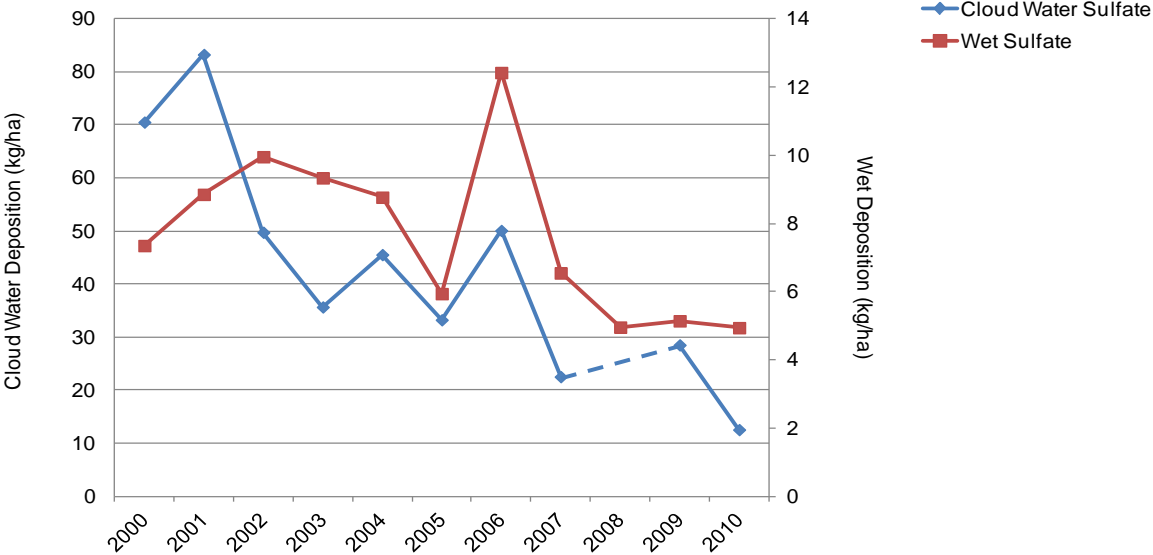
60.4% decrease in CW Sulfate
64.3% decrease in precipitation sulfate

Mean Seasonal Cloud Water versus Mean Seasonal Precipitation Nitrate Concentrations, 2000–2010

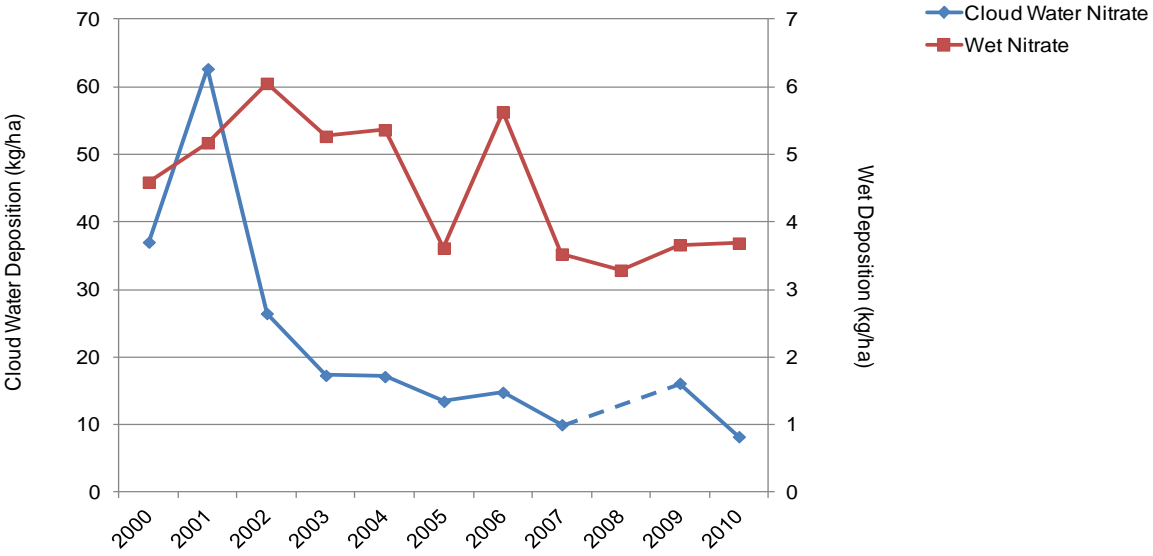


49.3% decrease in CW nitrate
52.2% decrease in precipitation nitrate

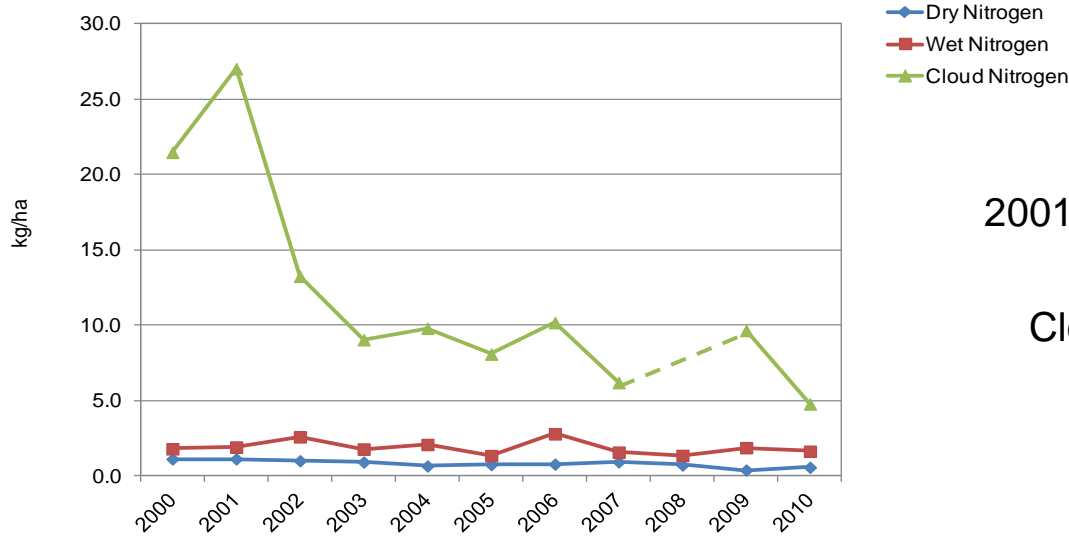
Cloud Water and Wet Sulfate Deposition Estimates (June through September), 2000-2010



Cloud Water and Wet Nitrate Deposition Estimates (June through September), 2000-2010

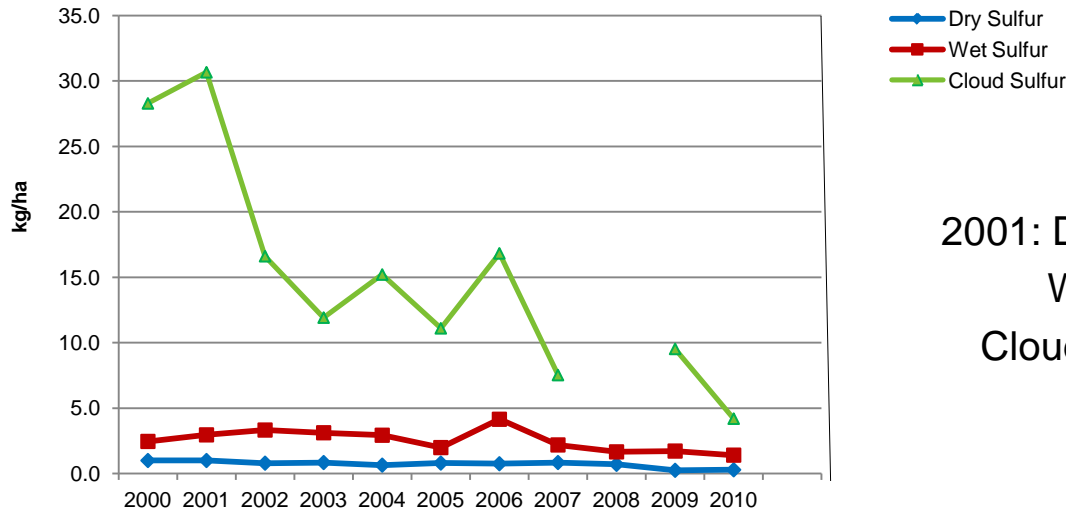


Seasonal CLD303 Total Nitrogen Deposition Components, 2000-2010



2001: Dry Dep 3.8% 2010: 8.3%
 Wet Dep 6.4% 2010: 23.5%
 Cloud Dep 89.8% 2010: 68.2%

Seasonal CLD303 Total Sulfur Deposition Components, 2000-2010

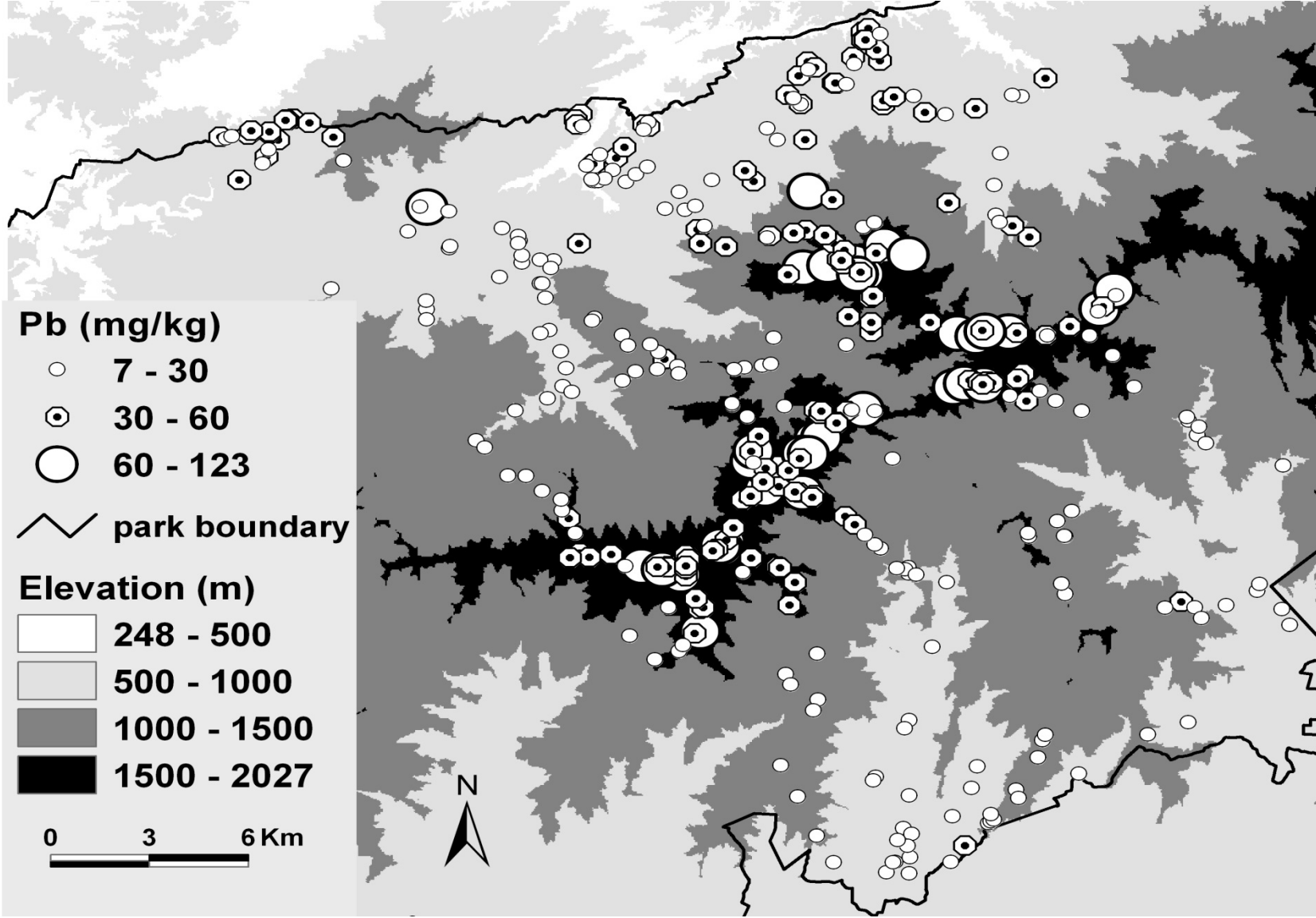


2001: Dry Dep 2.9% 2010: 4.8%
 Wet Dep 8.5% 2010: 23.9%
 Cloud Dep 88.6% 2010: 71.3%

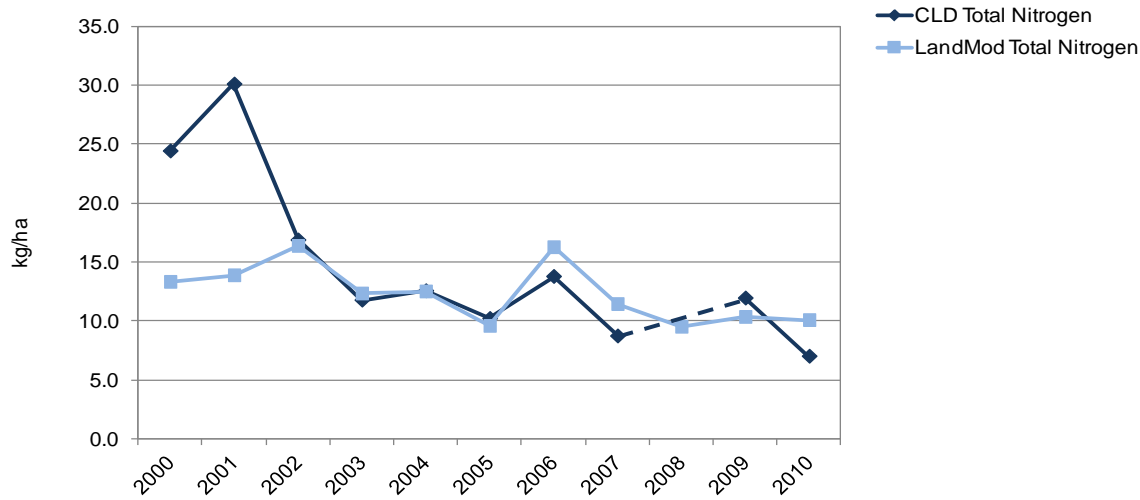
View from Top of Collection Tower



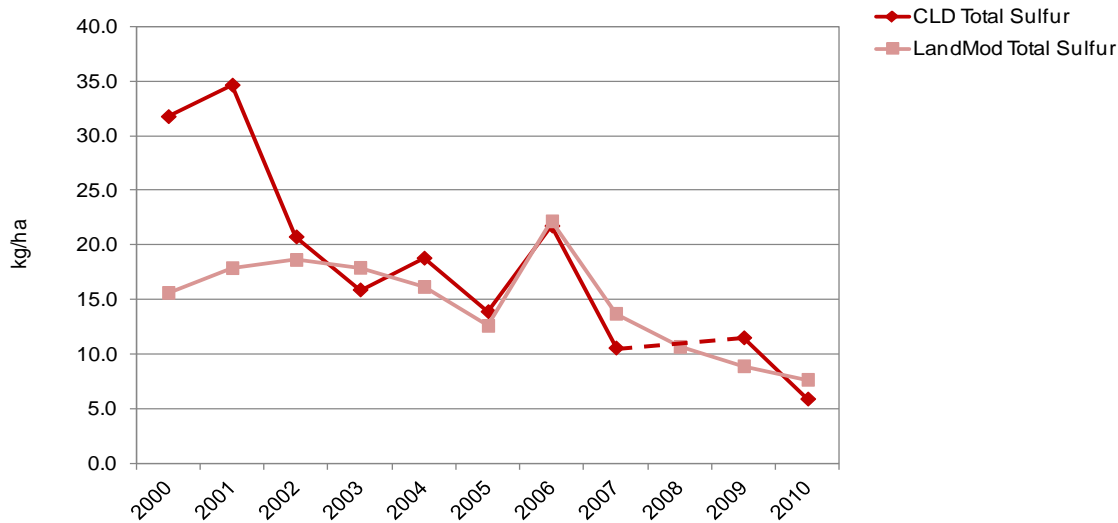
Spatial Distribution of Measured Deposition Indices for Forest-floor Lead Concentrations in GRSM (Weathers, et. al., 2006)



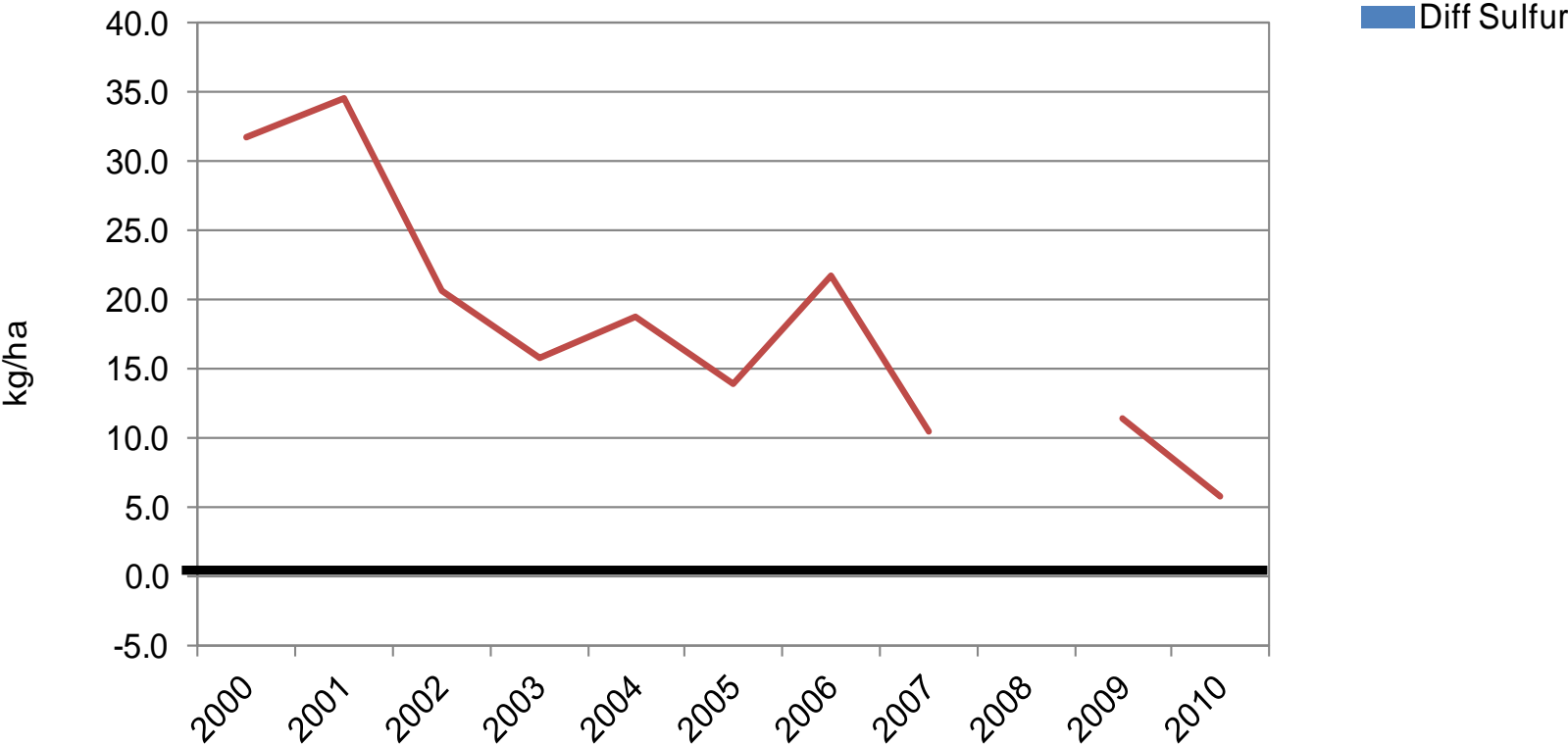
Seasonal Total Nitrogen Deposition: CLD303 versus LandMod, 2000-2010



Seasonal Total Sulfur Deposition: CLD303 versus LandMod, 2000-2010

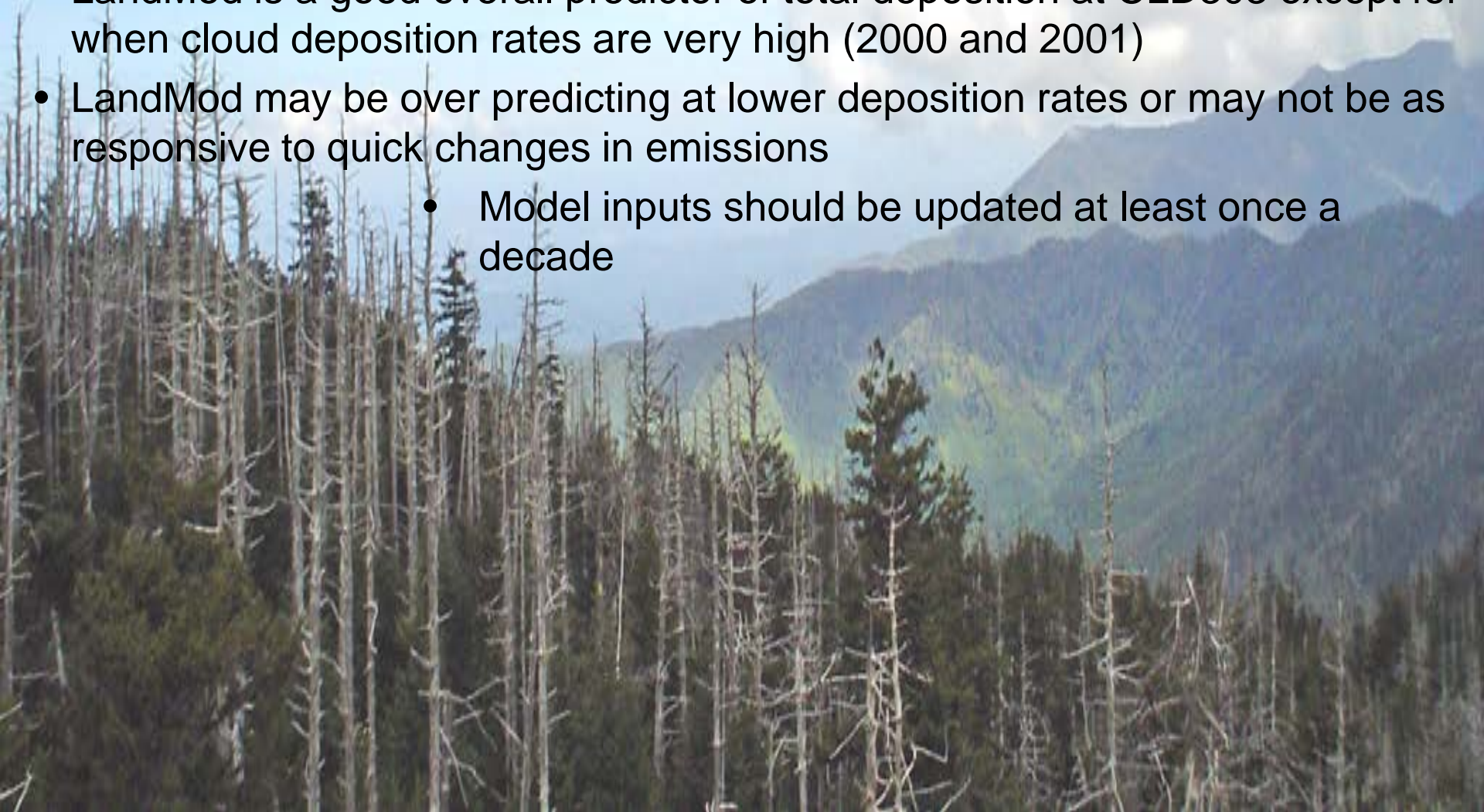


CLD303 Total Seasonal Sulfur Deposition and Difference in kg/ha from LandMod Total Seasonal Sulfur



Conclusions

- Cloud deposition is the largest contributor to total deposition at high elevation sites that experience cloud impaction
- LandMod is a good overall predictor of total deposition at CLD303 except for when cloud deposition rates are very high (2000 and 2001)
- LandMod may be over predicting at lower deposition rates or may not be as responsive to quick changes in emissions
 - Model inputs should be updated at least once a decade



Recommendations

- Continue monitoring at CLD303 to help refine predictability of models
- Update inputs to CLOUD and LandMod
- Install NADP precipitation collector and CASTNET filter pack to get improved total deposition estimate as site specific data are necessary for calculation of inputs to highly sensitive high elevation ecoregions
- www.epa.gov/CASTNET

A Murky Future



The End

