

Aerosol decadal trends: In-situ measurements of number concentration and optical properties

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Acknowledgments

- **This talk summarizes the results of two papers currently available at ACPD**
 - Coen Collaud and 25 others, Aerosol decadal trends (I): In-situ optical measurements at GAW and IMPROVE stations
<http://www.atmos-chem-phys-discuss.net/12/20785/2012/>
 - Asmi and 25 others, Aerosol decadal trends (II): In-situ aerosol particle number concentrations at GAW and ACTRIS stations
<http://www.atmos-chem-phys-discuss.net/12/20849/2012/>
- **Comments welcome!**



Acknowledgments

- **Lead authors and statistical analysts**
 - Martine Collaud Coen and Ari Asmi
- **Co-authors**
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- **Contributors and data providers**
 - P.P. Aalto, E. Asmi, U. Baltensperger, W. Birmili, N. Bukowiecki, D. Day, M. Fiebig, A.M. Fjaeraa, H. Flentje, A.G. Hallar, A. Hamed, A. Hyvärinen, A. Jefferson, S. G. Jennings, N. Kivekäs, G. Kouvarakis, M. Kulmala, H. Lihavainen, C. Lund Myhre, W. C. Malm, N. Mihapopoulos, J. V. Molenar, C. O'Dowd, B. A. Schichtel, P. Sheridan, A. Virkkula, E. Weingartner, R. Weller, A. Wiedensohler



Background

- **Many publications on trends in AOD, PM mass and chemical species concentrations**
- **Few publications on trends on number concentrations and optical properties**
 - Even fewer publications that examine these trends for multiple stations and regions
- **Global models of aerosol radiative forcing calculate trends of the parameters we measure directly**
 - Light scattering and absorption
 - Number concentration



Objectives

- **Evaluate trends**
- **Compile a high-quality data set for comparisons with models**

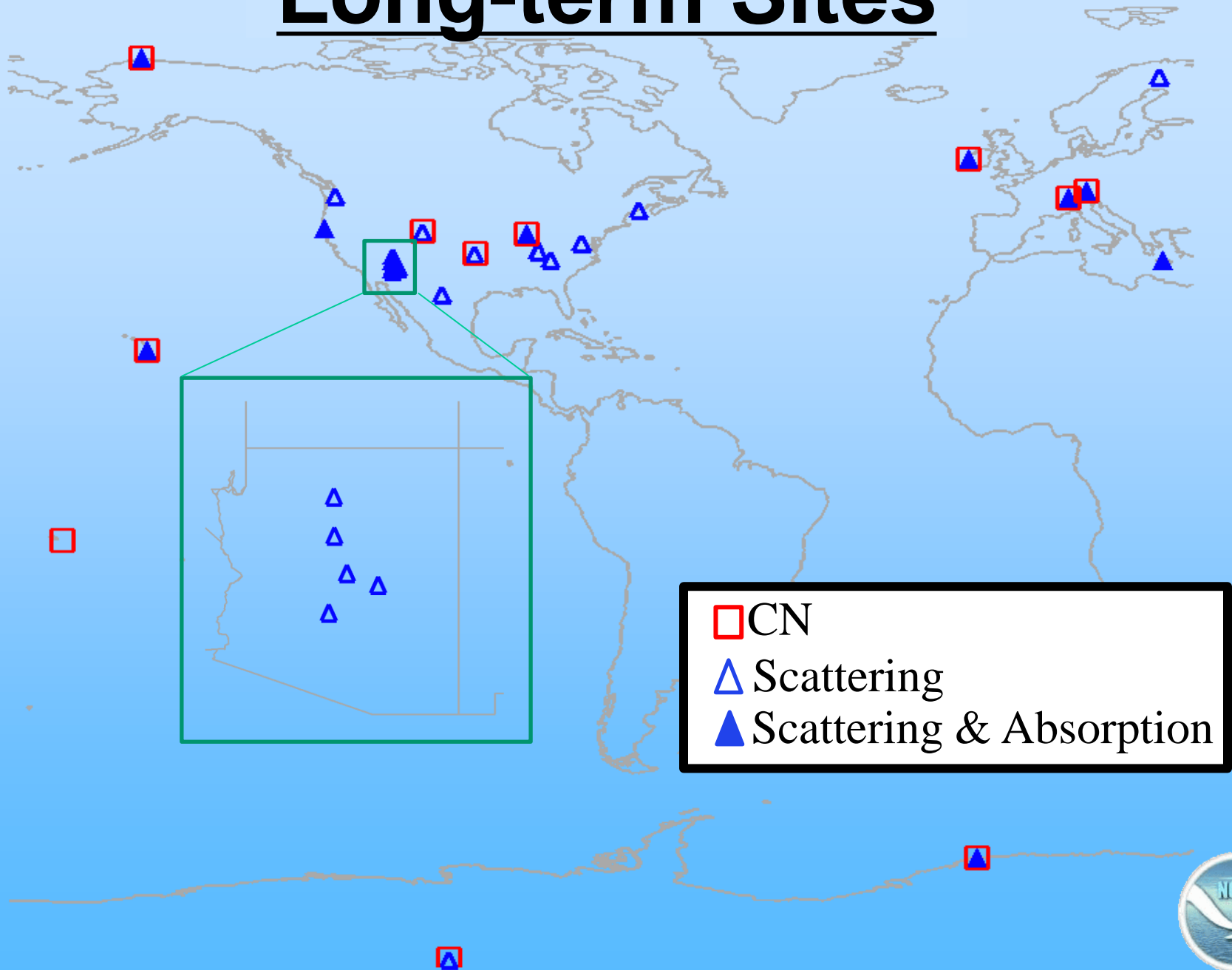


Data Sets

- **Networks and Measurements**
 - IMPROVE (US)
 - Light scattering coefficient
 - ACTRIS (EU) and WMO/GAW
 - Number concentration
 - Light scattering coefficient
 - Light absorption coefficient
- **Minimum length of 10 years was required for inclusion**
 - Some stations have longer records, but with ruptures in the record



Long-term Sites



Data Screening

- **Data sets downloaded from WMO World Data Center for Aerosols (WDCA)**
 - Submitted data were quality screened by data providers
- **Questionnaire sent to data providers**
 - Identify ruptures in the data
 - Inform of relevant site-specific features
- **Additional quality screening done by study authors**
 - Follow-up questions to data providers
- **If necessary, revised data sets submitted to WDCA**
- **One outcome of this study is higher-quality data sets available for future work**



Statistical Analyses

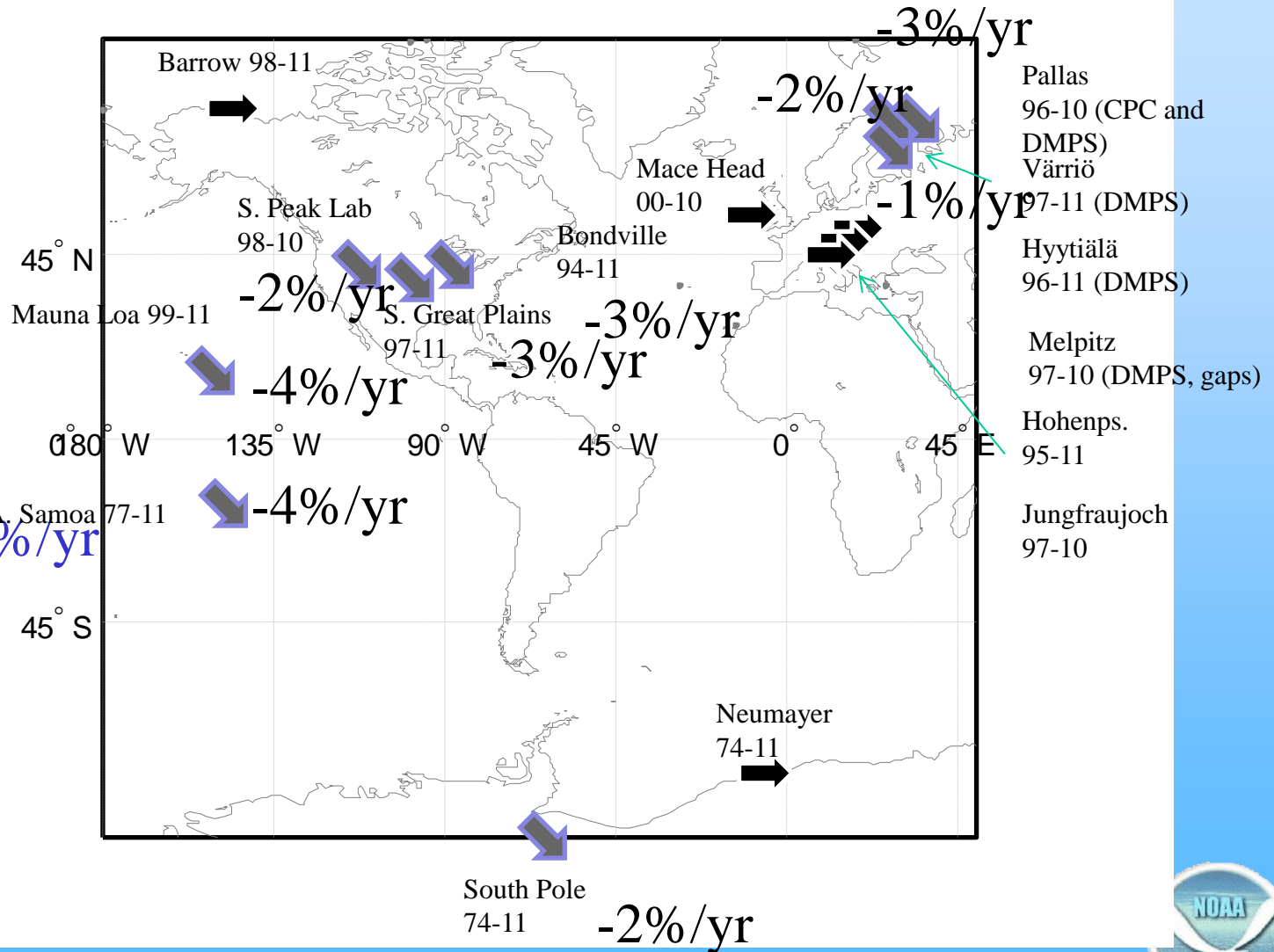
- **Three different analytical methods**
 - Seasonal Mann-Kendall significance test with Sen's slope estimator
 - Generalized least-squares with autoregressive bootstrap algorithm for determining confidence intervals
 - Least-mean square fit to logarithms of data
- **Multiple approaches allow assessment of sensitivity of findings to choice of statistical method**



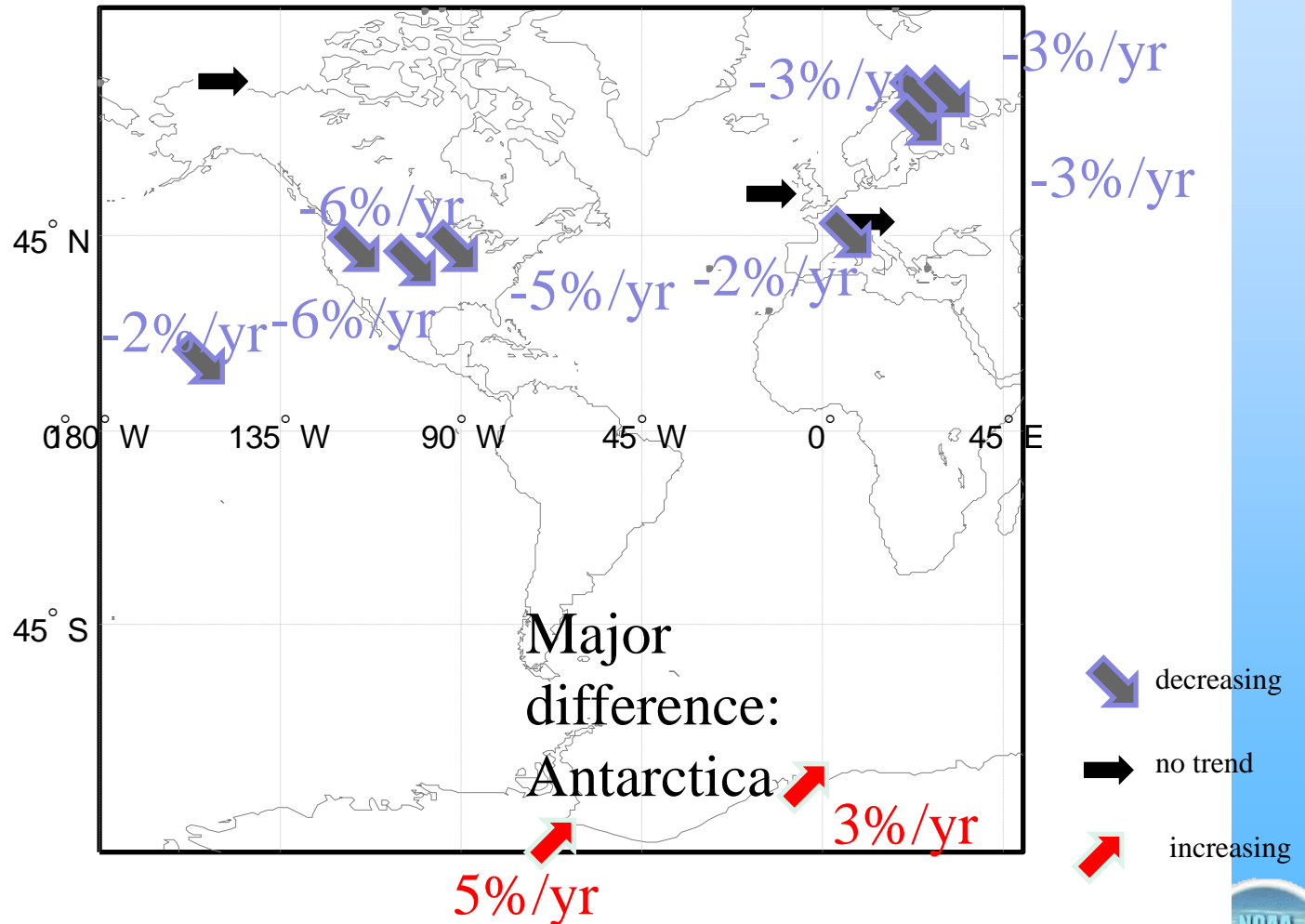
CN Trends (all data)

Overall:
decreasing
or staying the
same

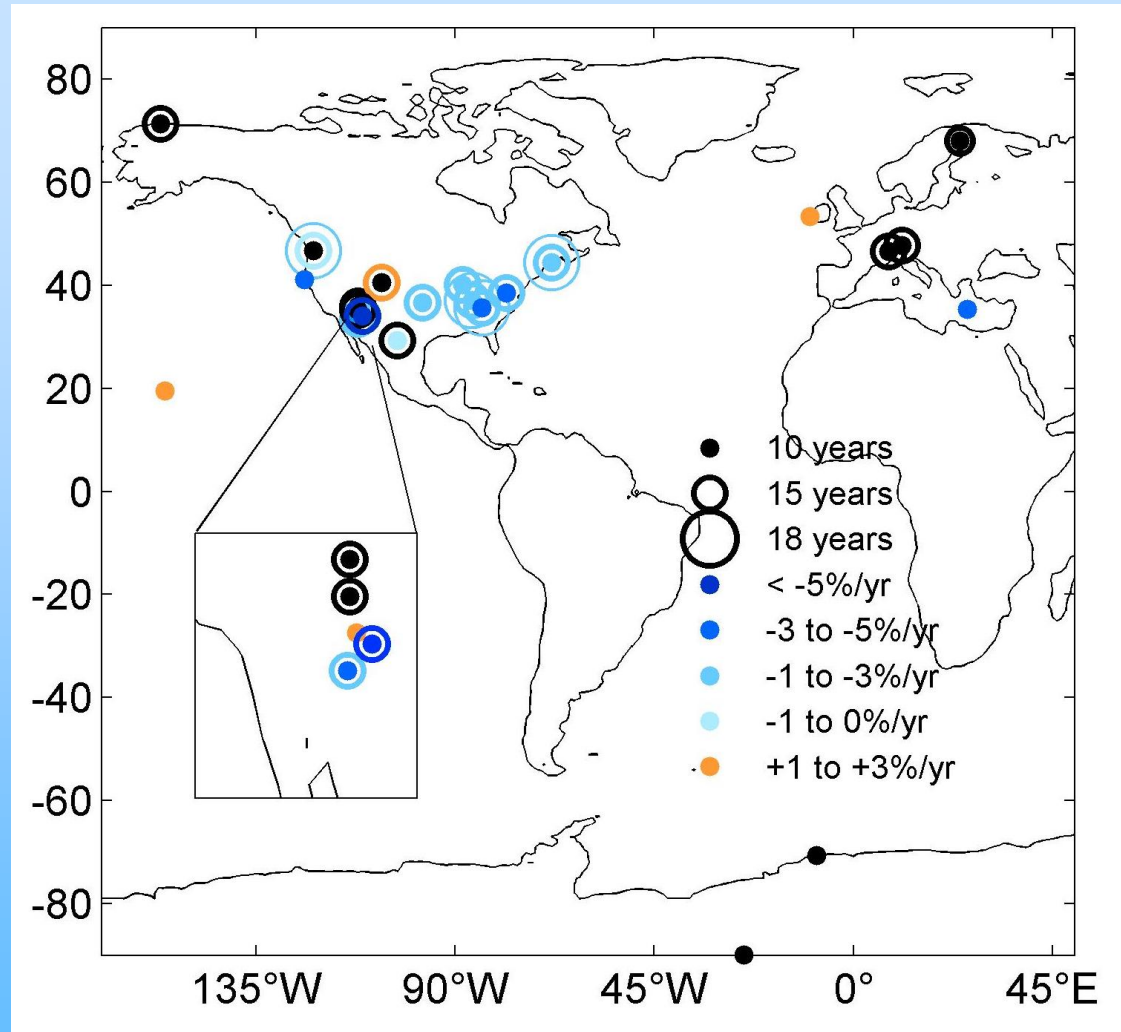
magnitude ~1-4%/yr



CN Trends 2001-2010



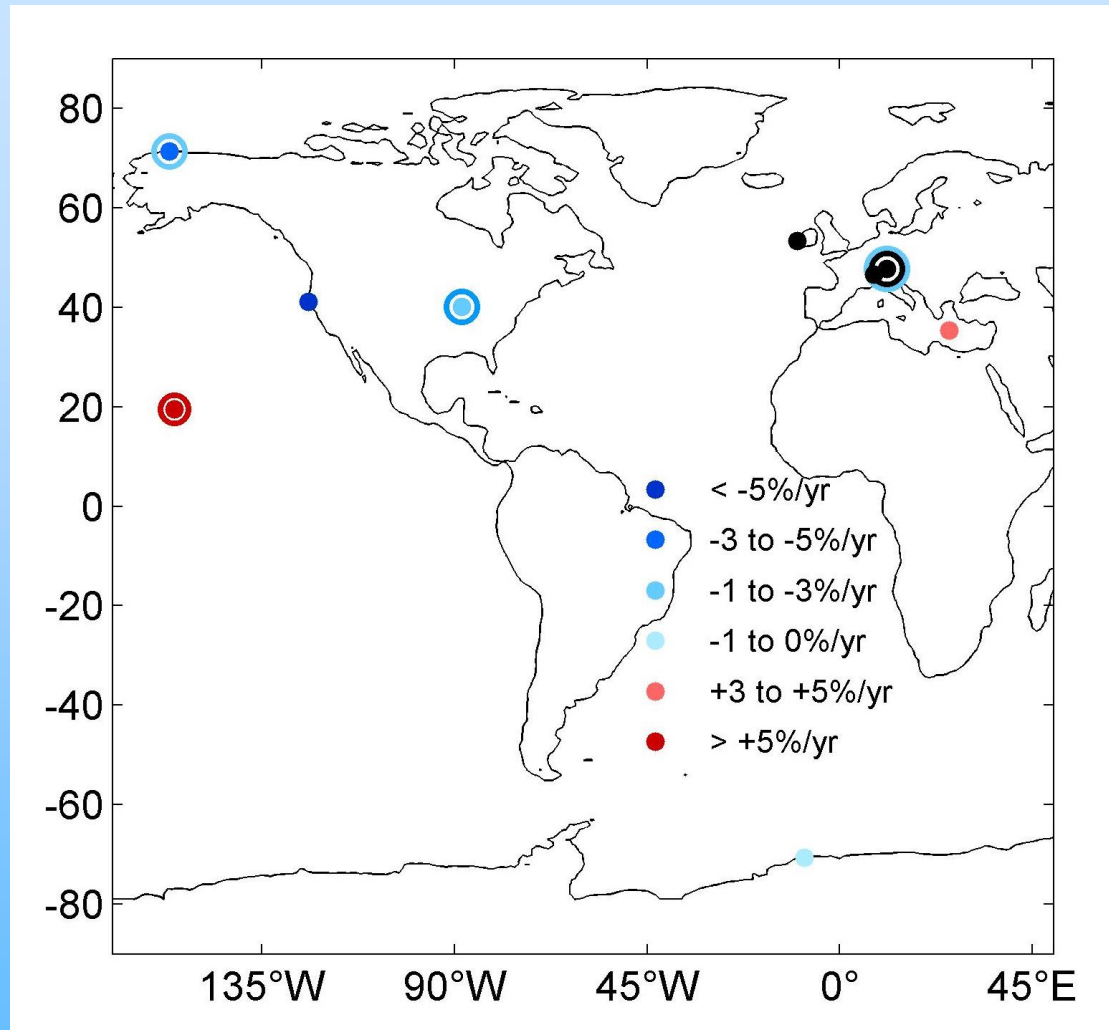
Trends in Scattering Coefficient



Black symbols: trends not statistically significant.
Colored symbols: statistically significant trends

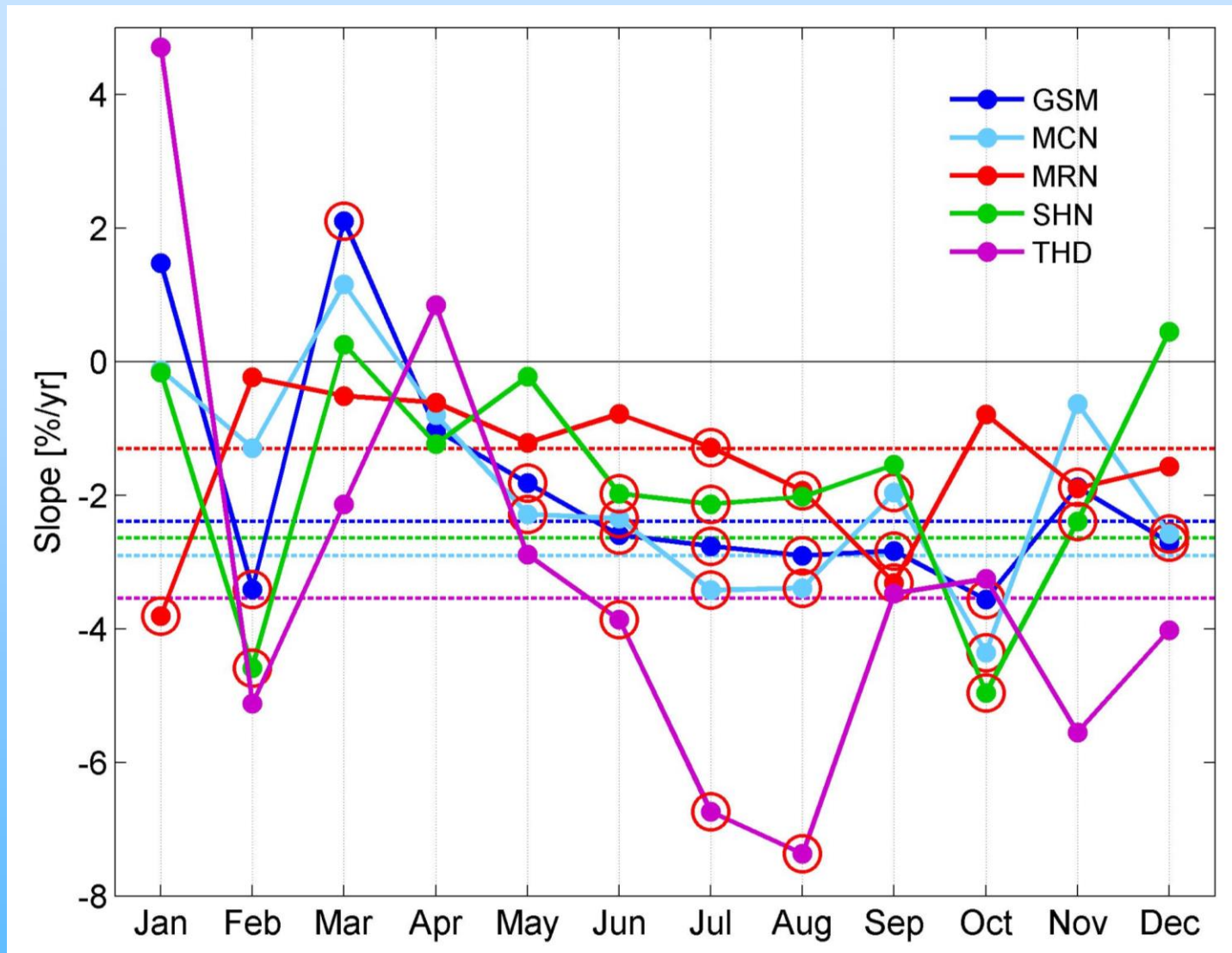


Trends in Absorption Coefficient



Black symbols: trends not statistically significant.
Colored symbols: statistically significant trends

Seasonal Scattering Trends at 5 US Sites



Red circles: statistically significant at 90% confidence level
Dotted lines show the annual trends



Summary of Decadal Trends (pct/yr)

Scattering Coefficient	Mean, all stations	Mean, only s.s. trends
Europe (4/1)	+0.6	+2.6
USA (14/10)	-2.6	-1.8
Mauna Loa (1/1)	+2.7	+2.7
Arctic (1/0)	not s.s.	not s.s.
Antarctic (1/0)	not s.s.	not s.s.
Absorption Coefficient		
Europe (3/0)	not s.s.	not s.s.
USA (1/1)	-2.0	-2.0
Mauna Loa (1/1)	+9.0	+9.0
Arctic (1/1)	-6.5	-6.5
Antarctic (1/1)	-0.07	-0.07

s.s.=“Statistically Significant”

(#/#)=number of stations / number with s.s trends



Summary of Decadal Trends (pct/yr)

Number concentration	Mean, all stations	Mean, only s.s. trends
Europe (7/4)	-1.3	-2.6
USA (3/3)	-6.5	-6.5
Mauna Loa (1/1)	-3.5	-3.5
Arctic (1/0)	not s.s.	
Antarctic (2/2)	+2.7	

s.s.=“Statistically Significant”

(#/#)=number of stations / number with s.s trends



Comparison of CN and Optical Trends

Dataset	CN Trend (MK) (%/yr)	Scattering coeff. (MK) (%/yr)	Abs. Coeff (MK) (%/yr)
Antarctica	NMY 3.7	2.5	-2.5 ✖
Europe	HPB 0.3	1.7	-3.9
Europe	JFJ -1.6	-1.2	-1.0
Europe	MHD 0.9	2.7	-2.0
Europe	PAL -3.0	-0.9	-
US	BND -7.2	-1.9 ✔	-2.0 ✔
US	BRW -1.3	2.4	-6.5
US	SGP -5.3	-2.0 ✔	-
Pacific	MLO -3.5	2.7 ✖	9.0 ✖

No general agreement among trends

Bold: S. significant



Conclusions

- **No consistent global trends**
 - Different monthly trends for same site/variable
 - Different trends for CN and optical properties
 - Different trends in different regions
- **Repeating this analysis in ten years will allow inclusion of many more data sets**
 - Many stations have shorter records
 - Inclusion of long-term data sets with ruptures, where justifiable

