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!**

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- **Co-authors**
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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

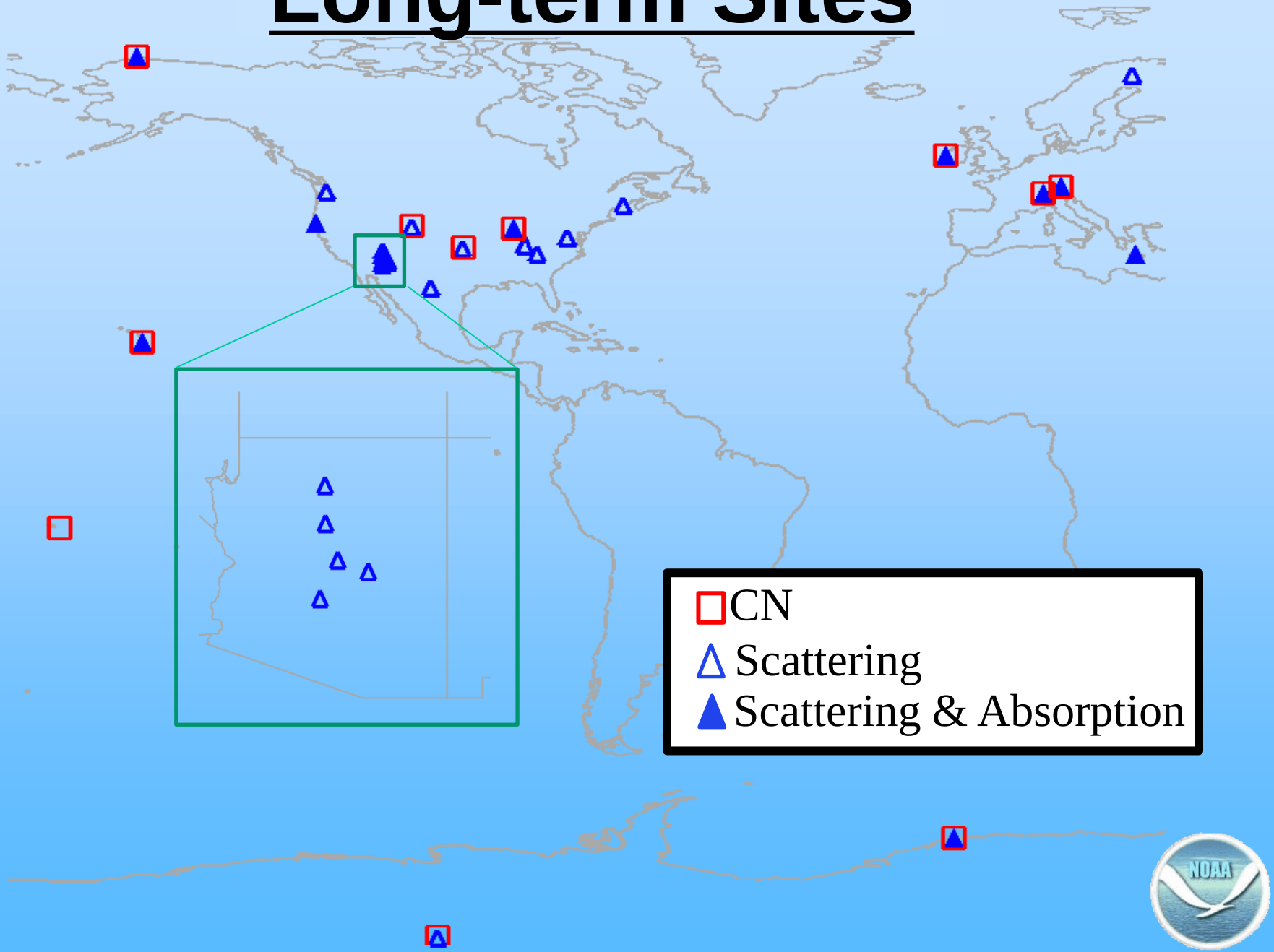
Objectives

- **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**

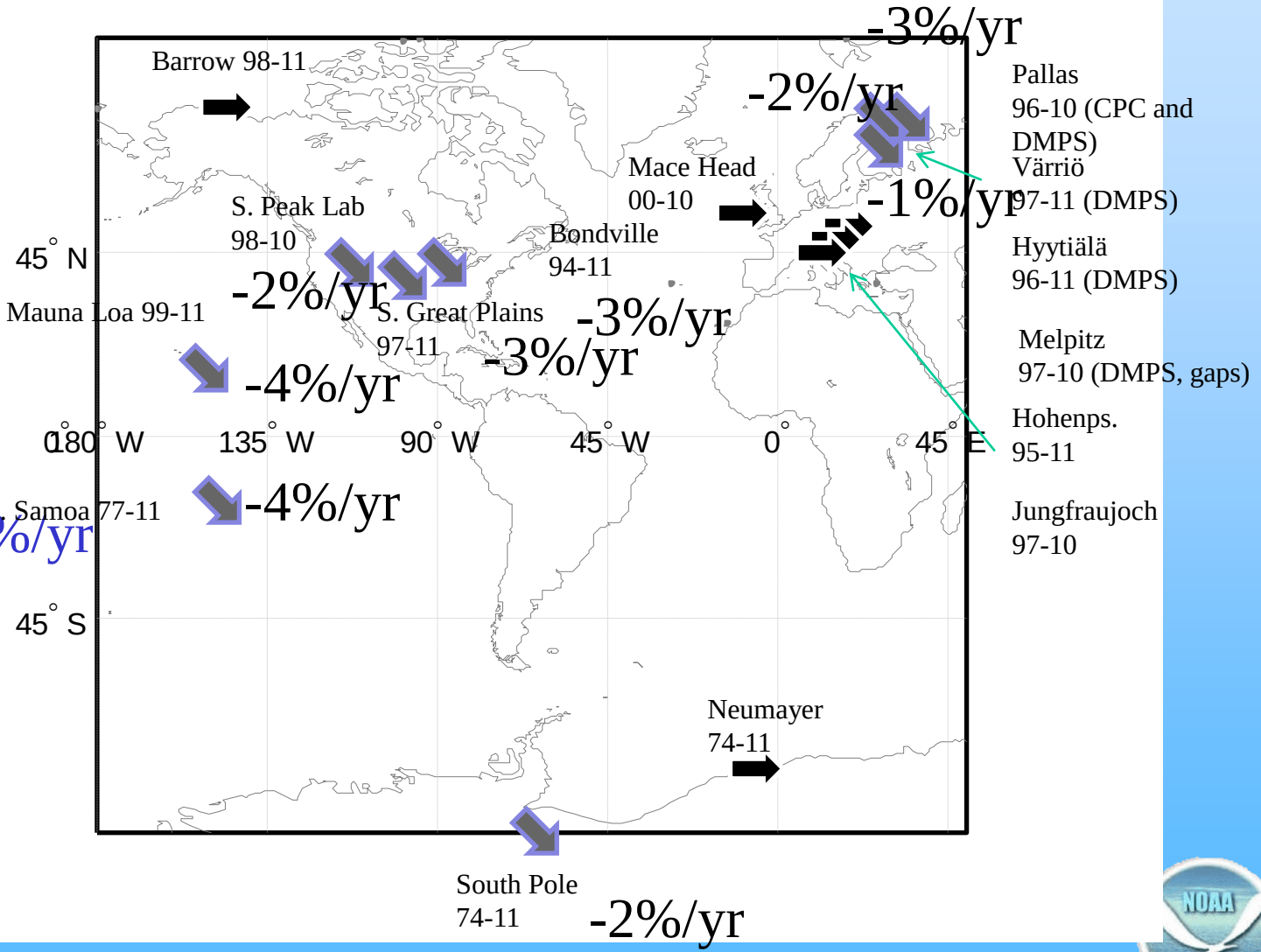
Statistical Analyses

- **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**

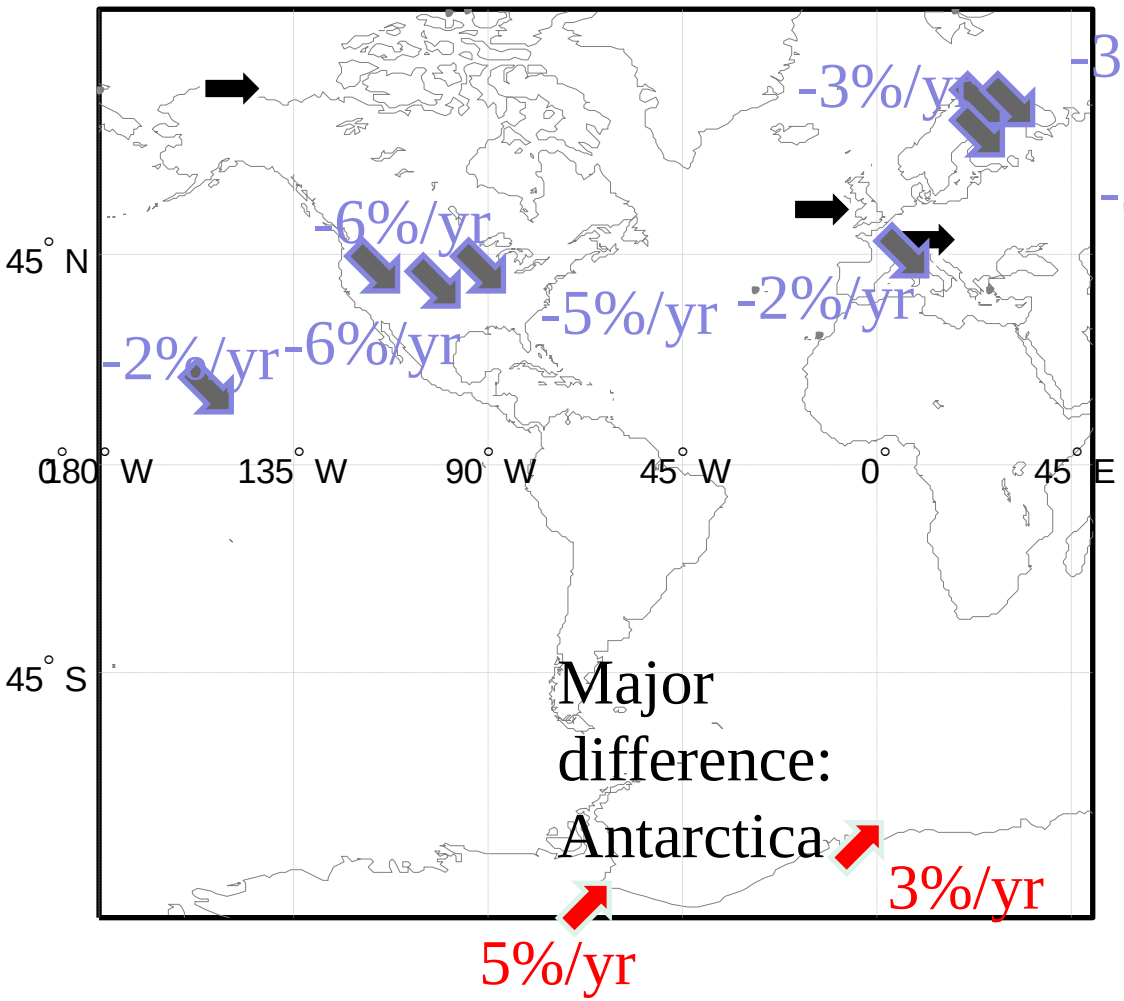
CN Trends (all data)

Overall: decreasing or staying the same

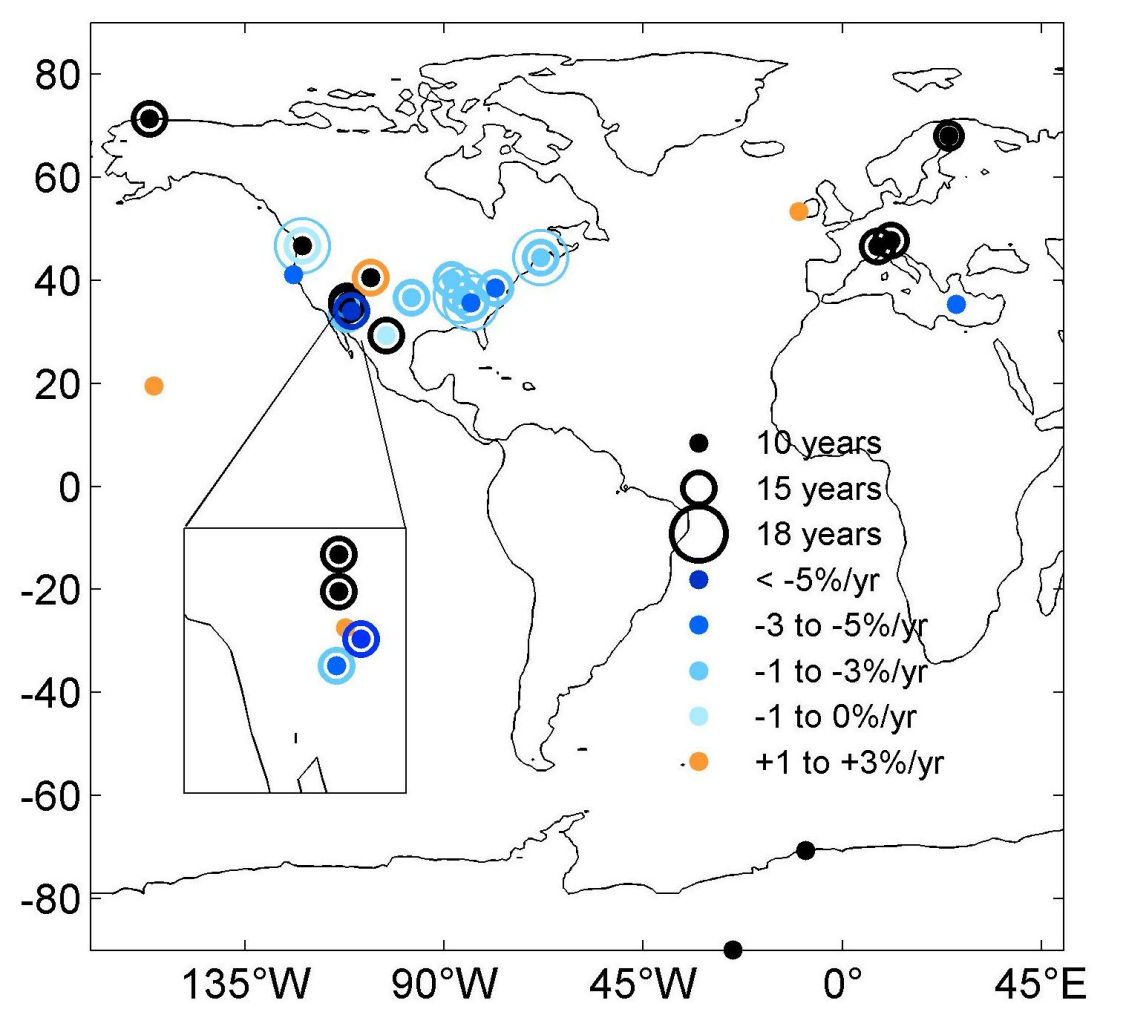
magnitude ~1-4%/yr



CN Trends 2001-2010

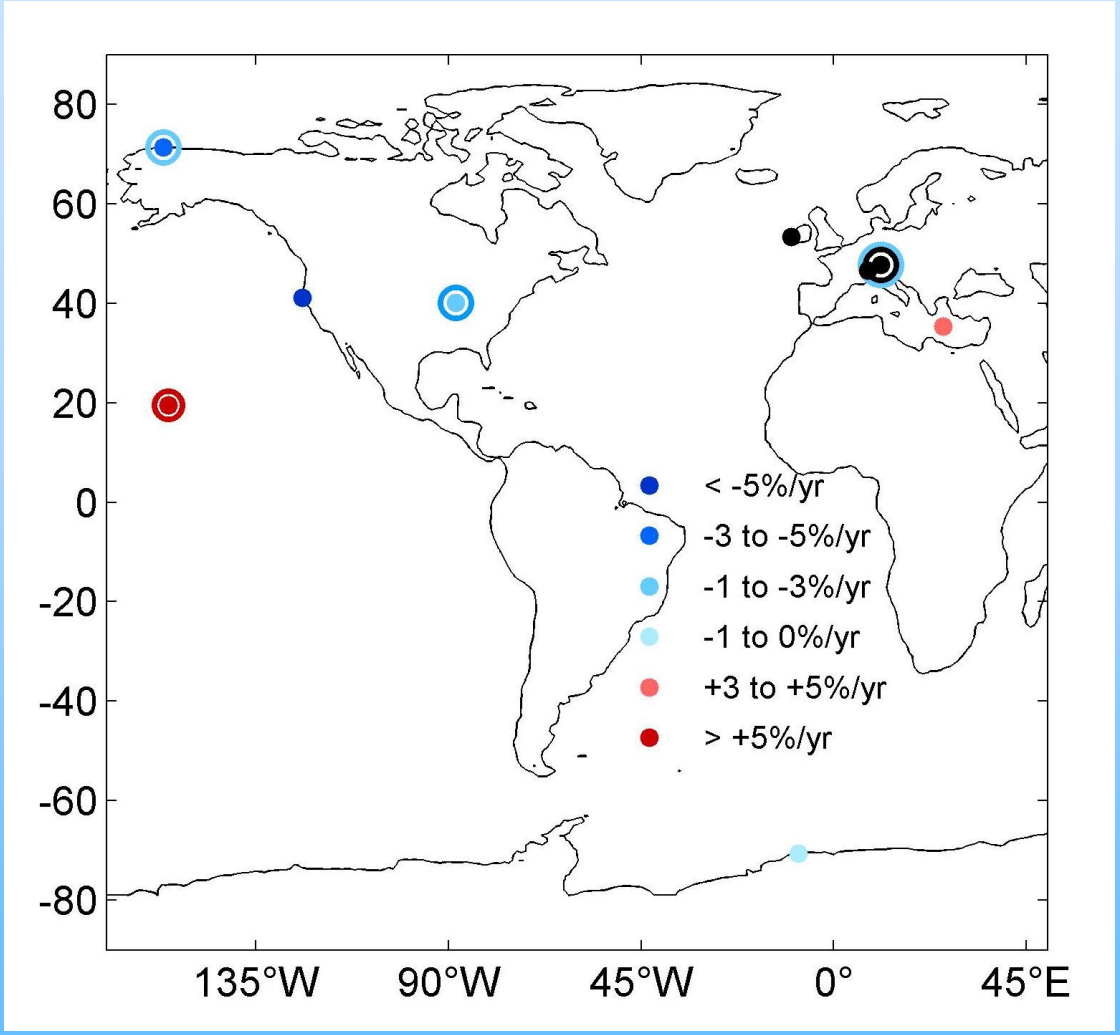


Trends in Scattering Coefficient



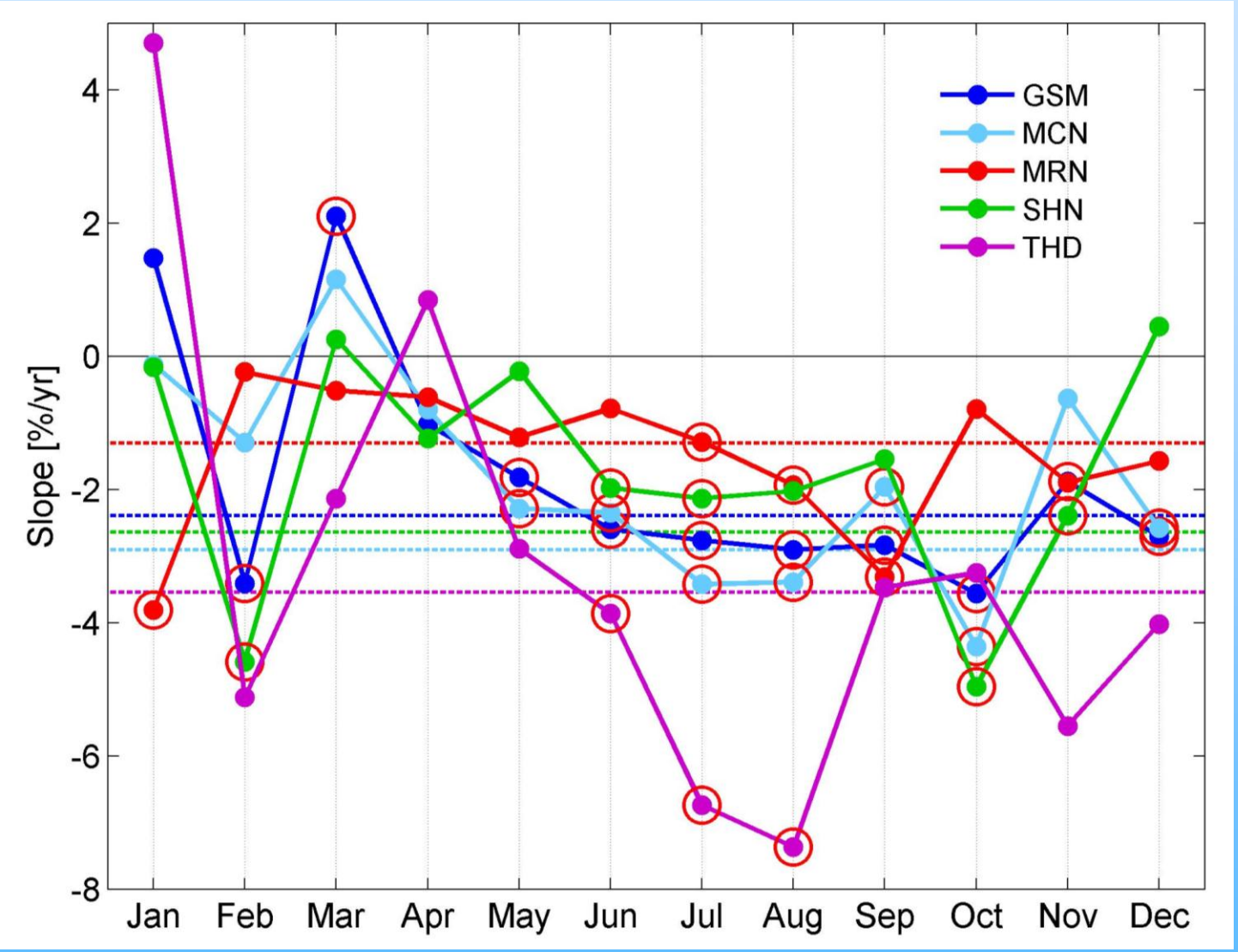
Black symbols: trends not statistically significant.
Colored symbols: statistically significant trends

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