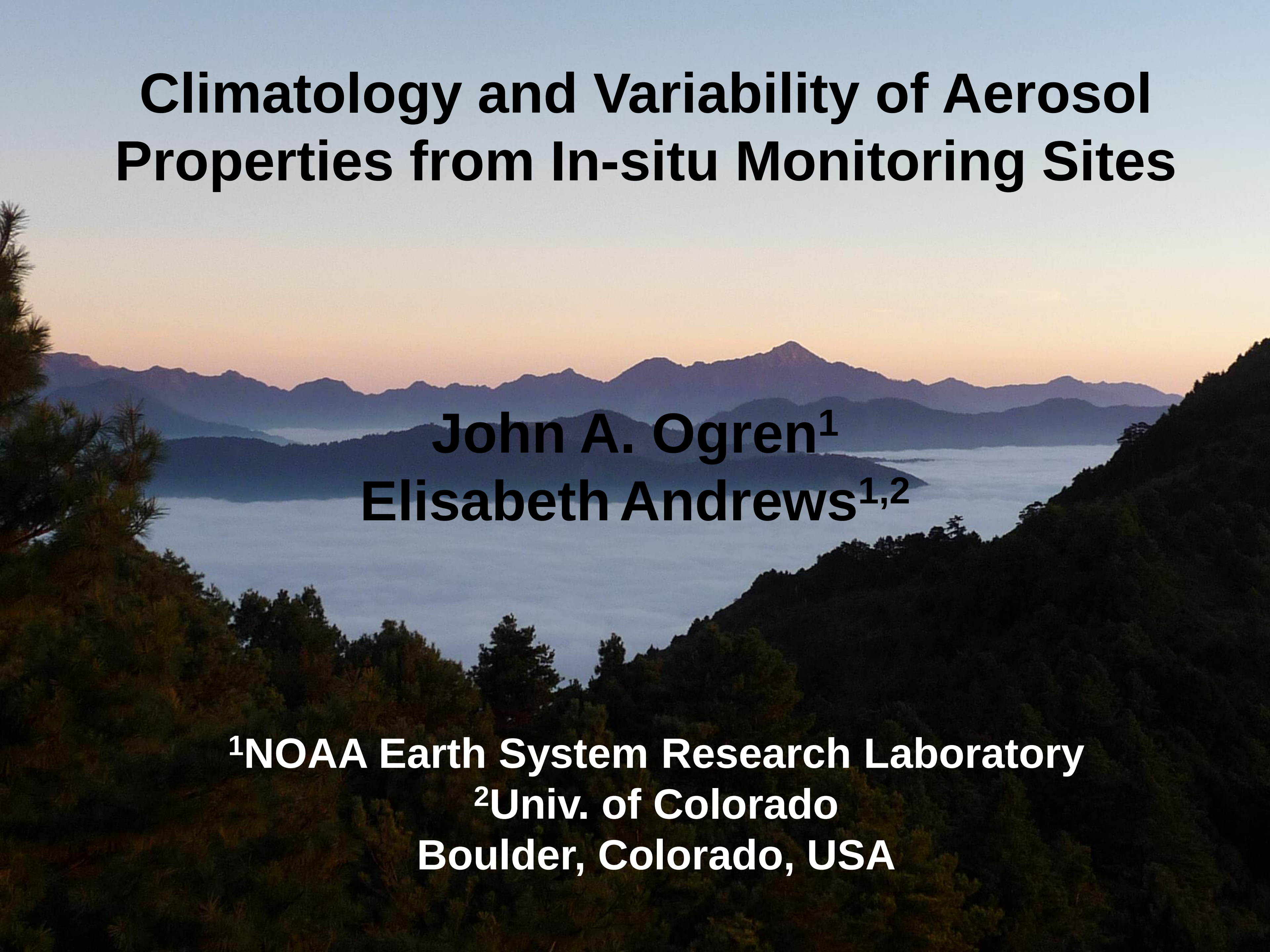

Climatology and Variability of Aerosol Properties from In-situ Monitoring Sites

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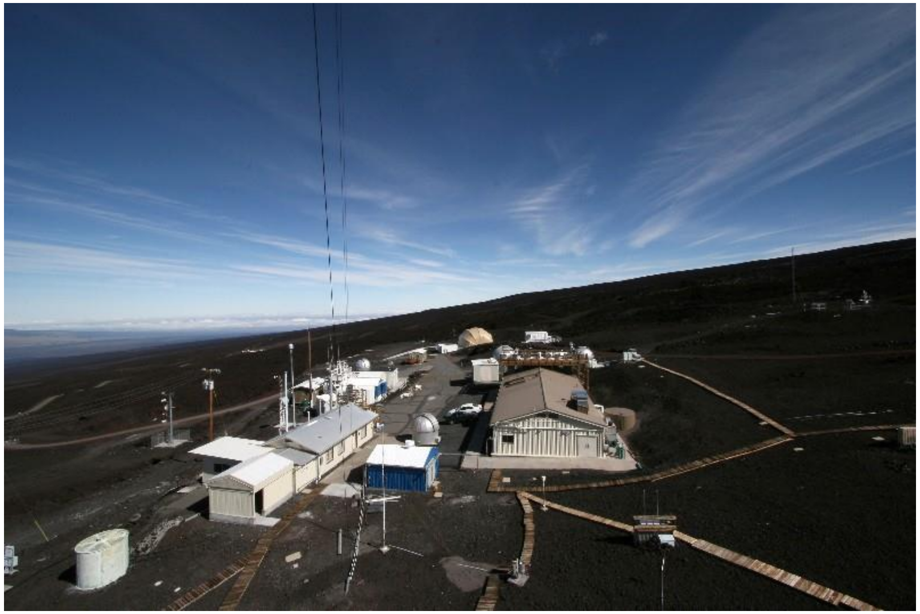
Motivation

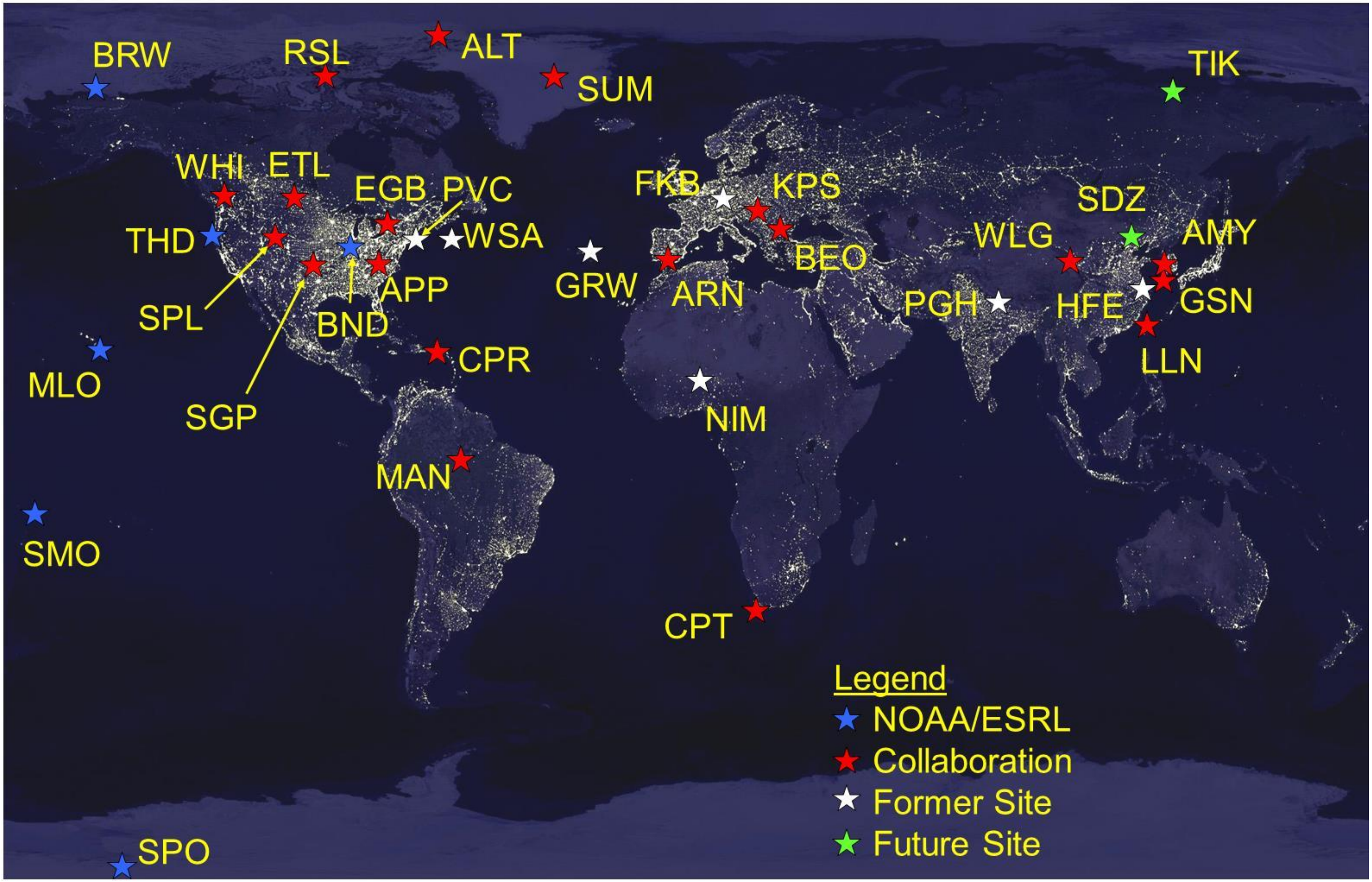
- Evaluation of models with average aerosol properties is necessary, but insufficient to establish that the models correctly represent aerosol processes
- A variety of statistical comparisons allows a more rigorous evaluation of model performance
- Comparison with high time-resolution data sets allows evaluation of sub-grid scale effects

Scientific questions

- What are the time scales of variability of aerosol properties?
- How does the aerosol persistence differ as a function of site types (e.g., mountain, coastal, continental, polar)?
- Can models reproduce lag autocorrelations observed in in-situ data?



Expanded Long-term Aerosol Network



→**Wide range of environments and aerosol types**

Measurements and Data

Aerosol light scattering,
- 3λ nephelometer
- total and hemispheric backscattering

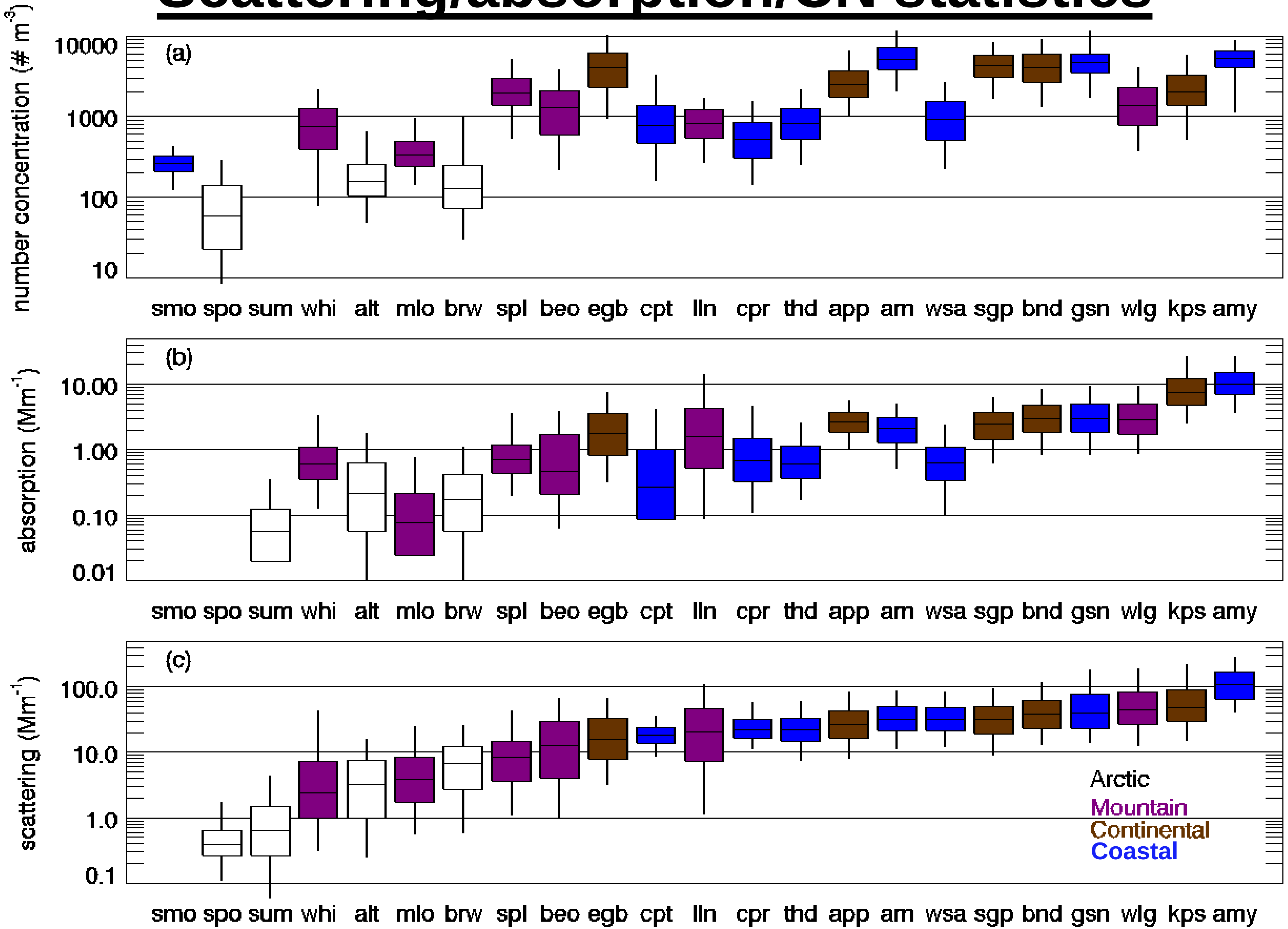
Aerosol light absorption
- Filter-based instruments (PSAP, CLAP)
- Single and multi-wavelength

Particle number concentration
- Multiple instruments
- Different lower size cuts

Data Processing
- Hourly averaged, edited and corrected
- Absorption and scattering adjusted to and presented at STP and 550 nm

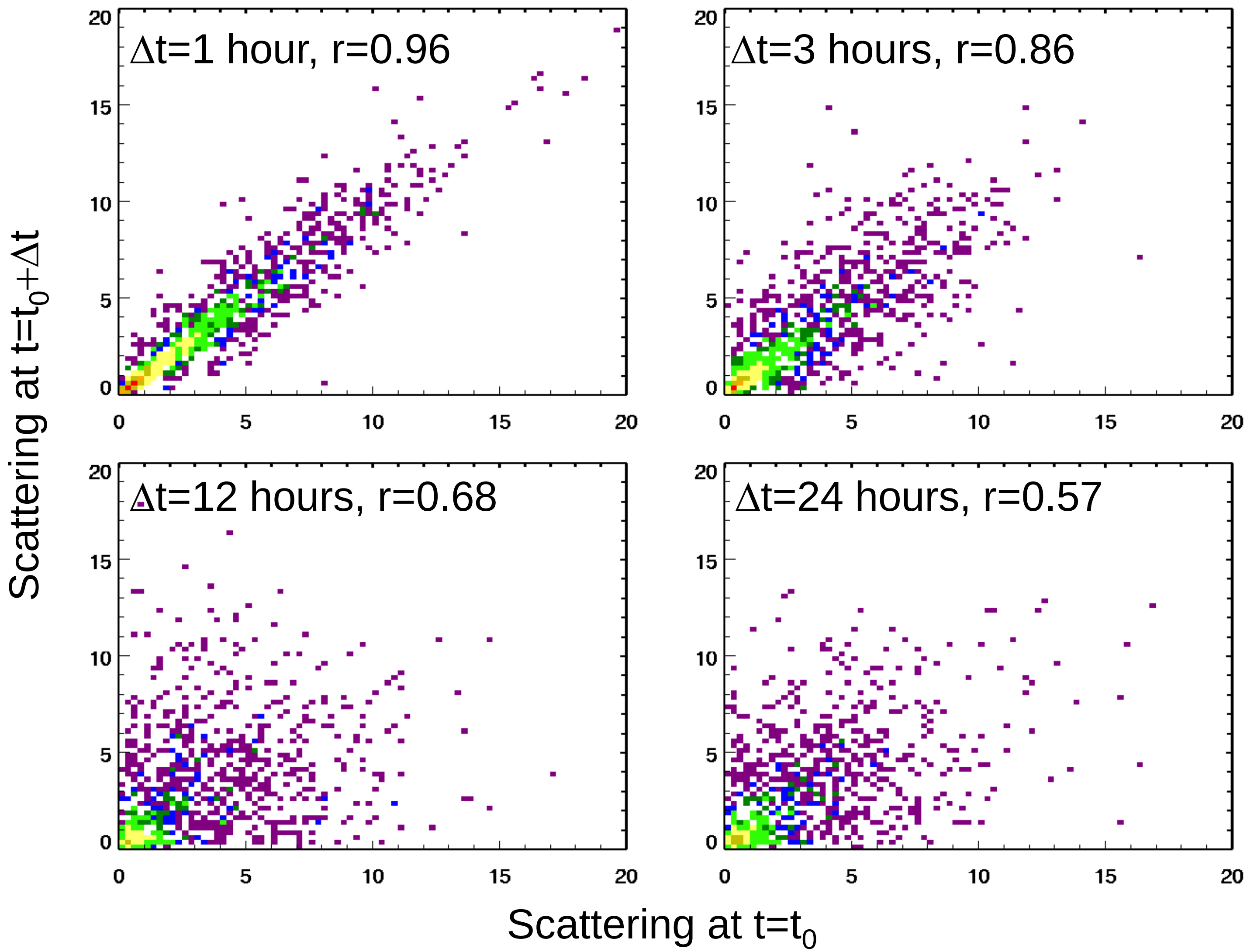
(Bond et al., 2005)

Scattering/absorption/CN statistics



Aerosol Persistence

How well does a measurement at time ‘t’ represent a measurement at time t+Δt?

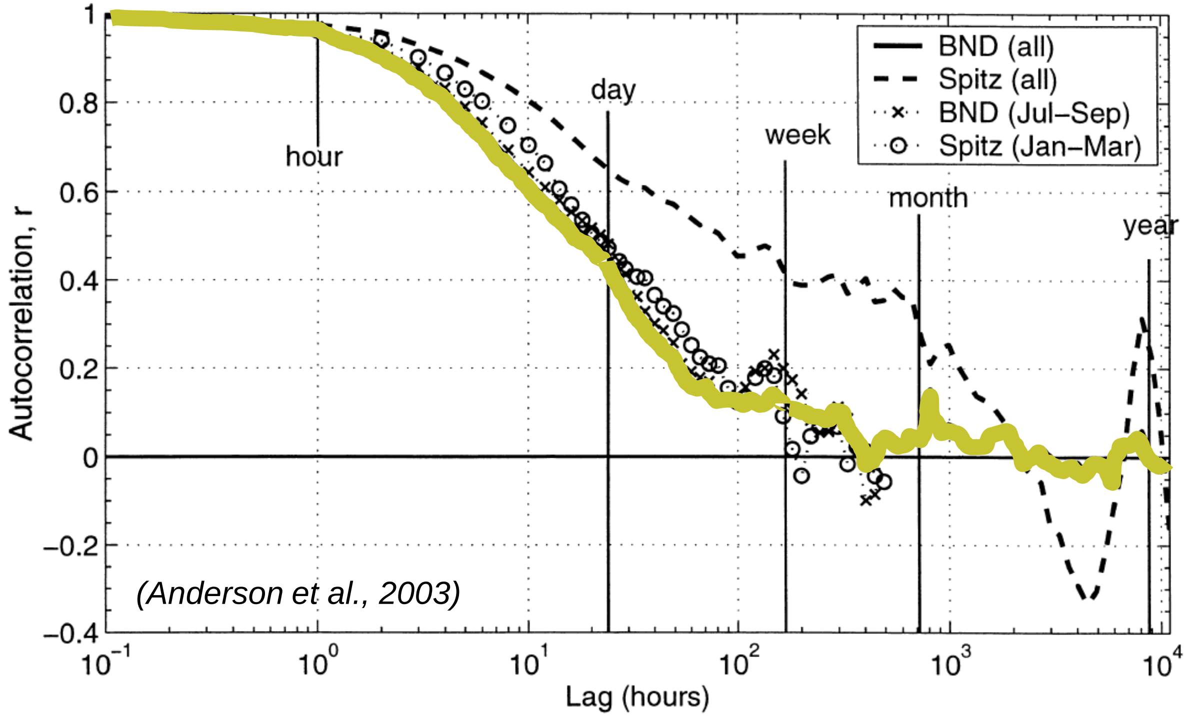


Colors represent density of points

IZA scattering

Autocorrelation Analysis

Lag autocorrelation relationships for aerosol light scattering at Bondville, IL (continental site) and Spitzbergen (polar site)



Lag is the time between measurements being compared (Δt).
'r' is the lag autocorrelation statistic.

Autocorrelation analysis can be used to quantify aerosol persistence.

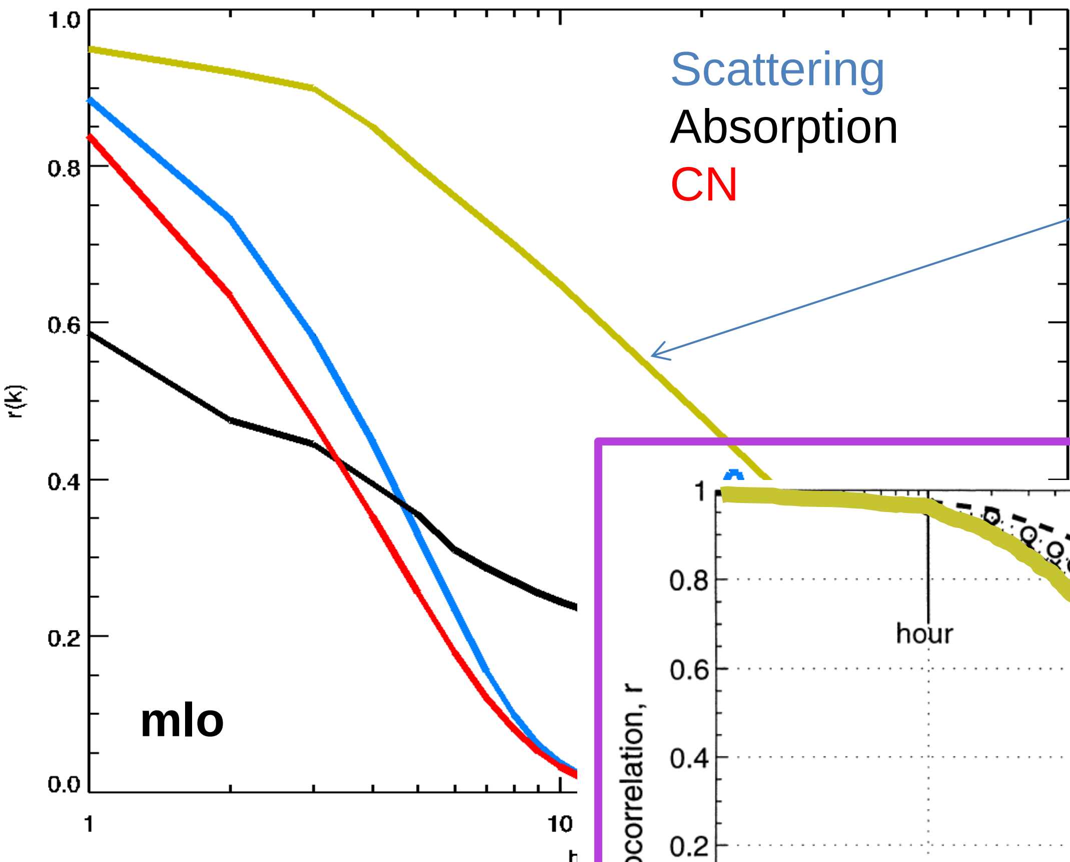
Sources/processes

Lag-autocorrelation analysis can help identify whether aerosol properties co-vary.

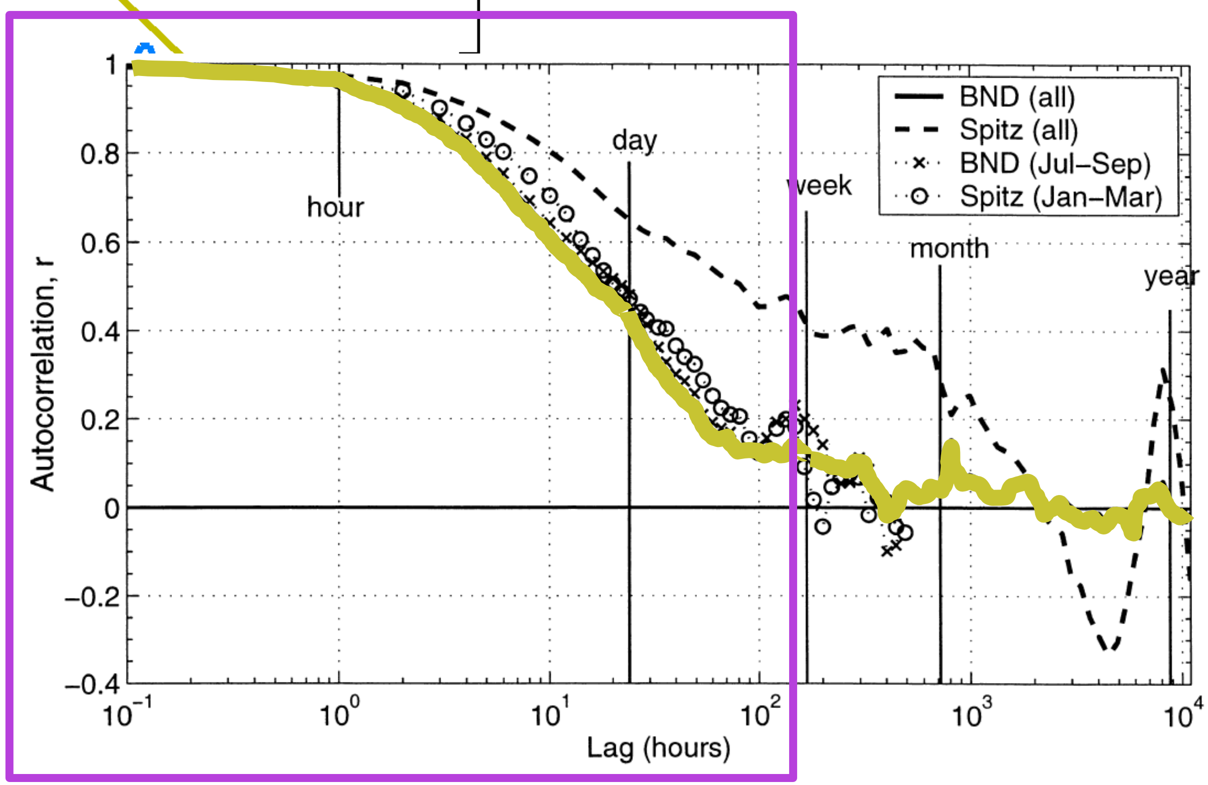
Similar patterns for different aerosol properties could indicate similarities in:
→source and/or transport
→atmospheric processes

Conversely, lack of co-variance suggests differences in sources/transport or atmospheric processing

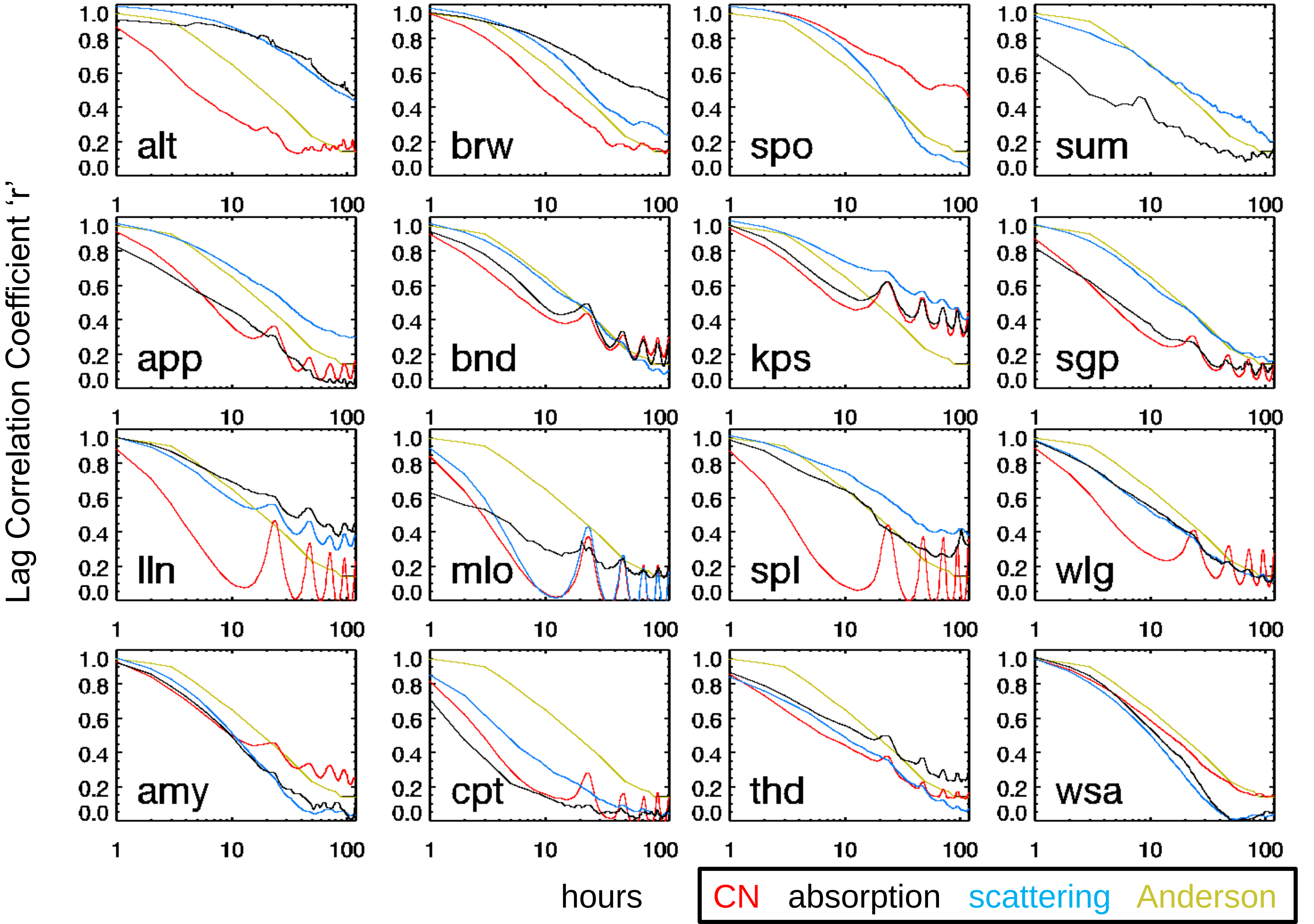
What do we see at the NOAA network sites?



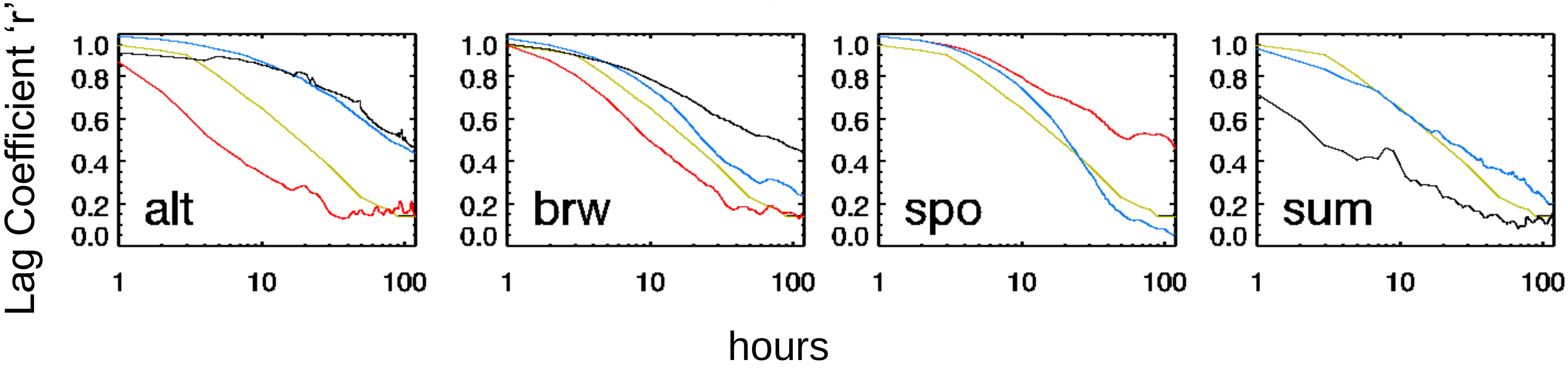
Autocorrelation for light scattering at Bondville (Anderson et al., 2003)



Short-term Lag Autocorrelation



Short-term Lag Autocorrelation

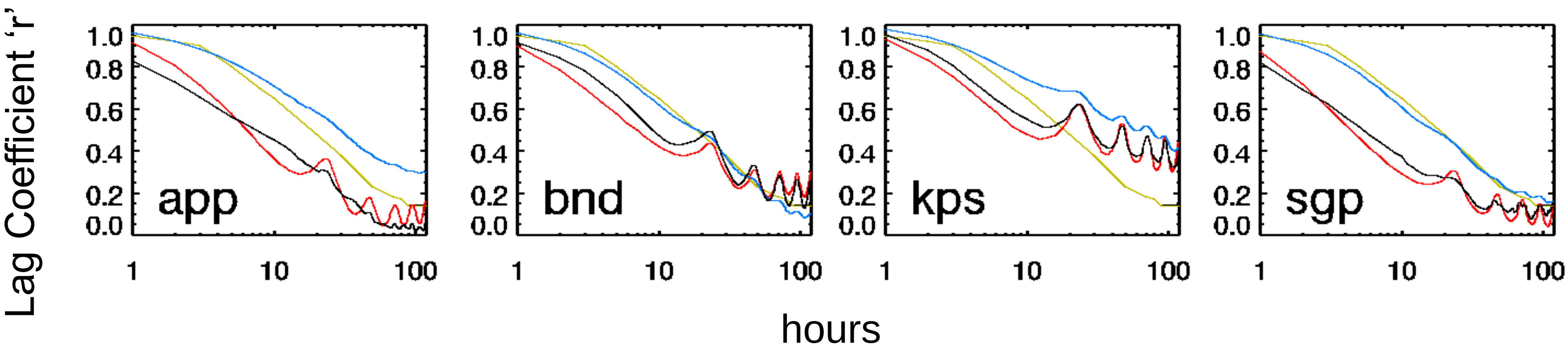


Polar sites:

- very persistent, i.e., above Anderson line (especially scattering, but also absorption at ALT and BRW and CN at SPO)
- no diurnal oscillations in CN

CN absorption scattering Anderson

Short-term Lag Autocorrelation



Continental sites:
→All sites show diurnal behavior in CN, but this may have different causes

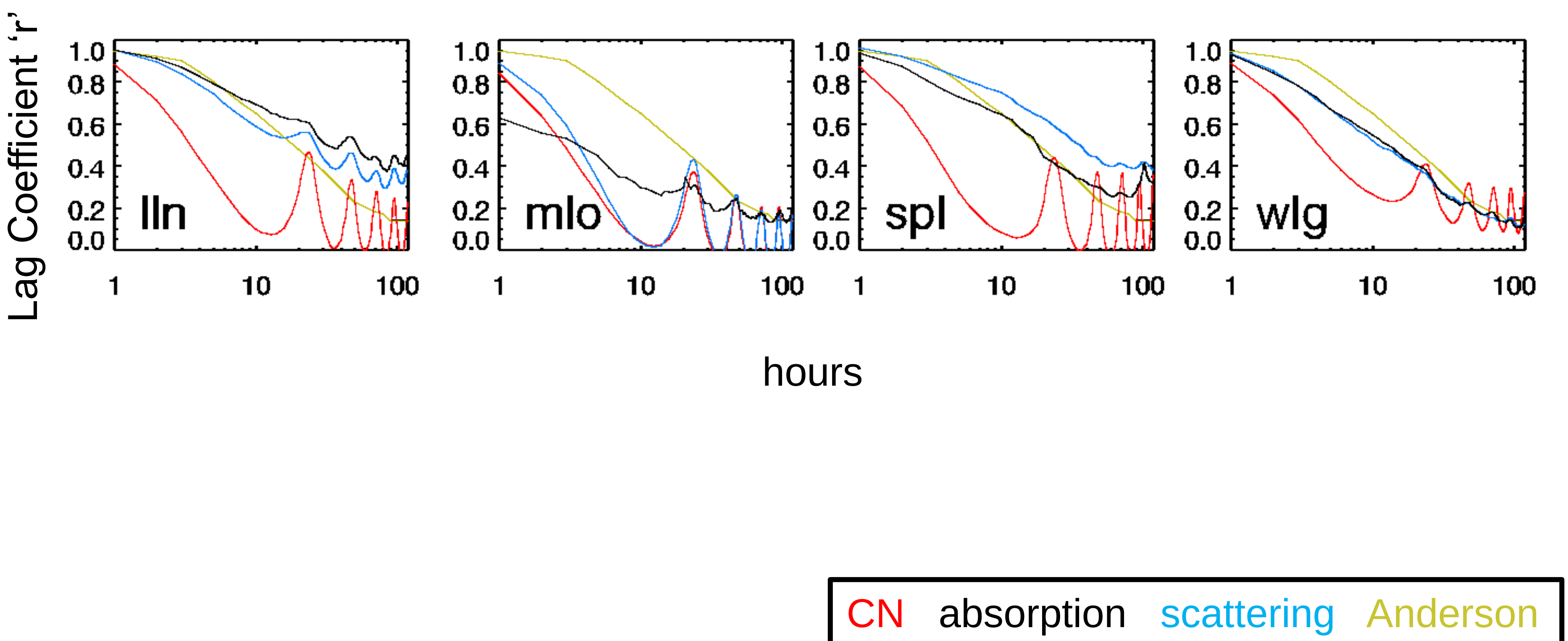
- APP – new particle formation (NPF) – don’t see diurnal cycle in other params
- BND&SGP – source differences – CN and absorption have diurnal cycle, scattering does not
- KPS – Boundary layer dynamics and/or diurnal sources

CN absorption scattering Anderson

Short-term Lag Autocorrelation

Mountain sites:

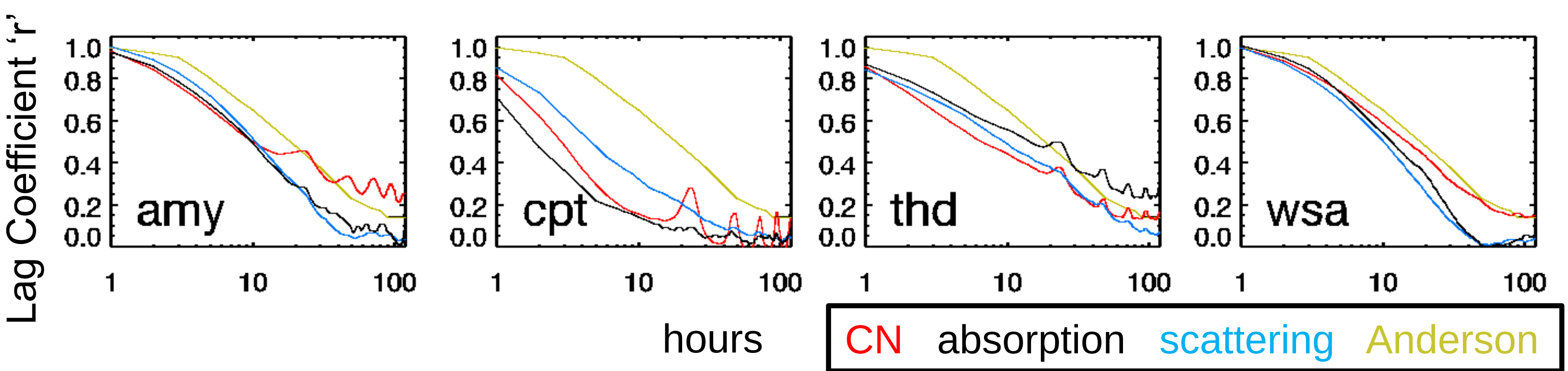
- LLN&MLO – dominated by upslope/downslope flow – all parameters show diurnal cycles
- SPL&WLG – dominated by new particle formation – only CN shows diurnal cycle



Short-term Lag Autocorrelation

Coastal sites:

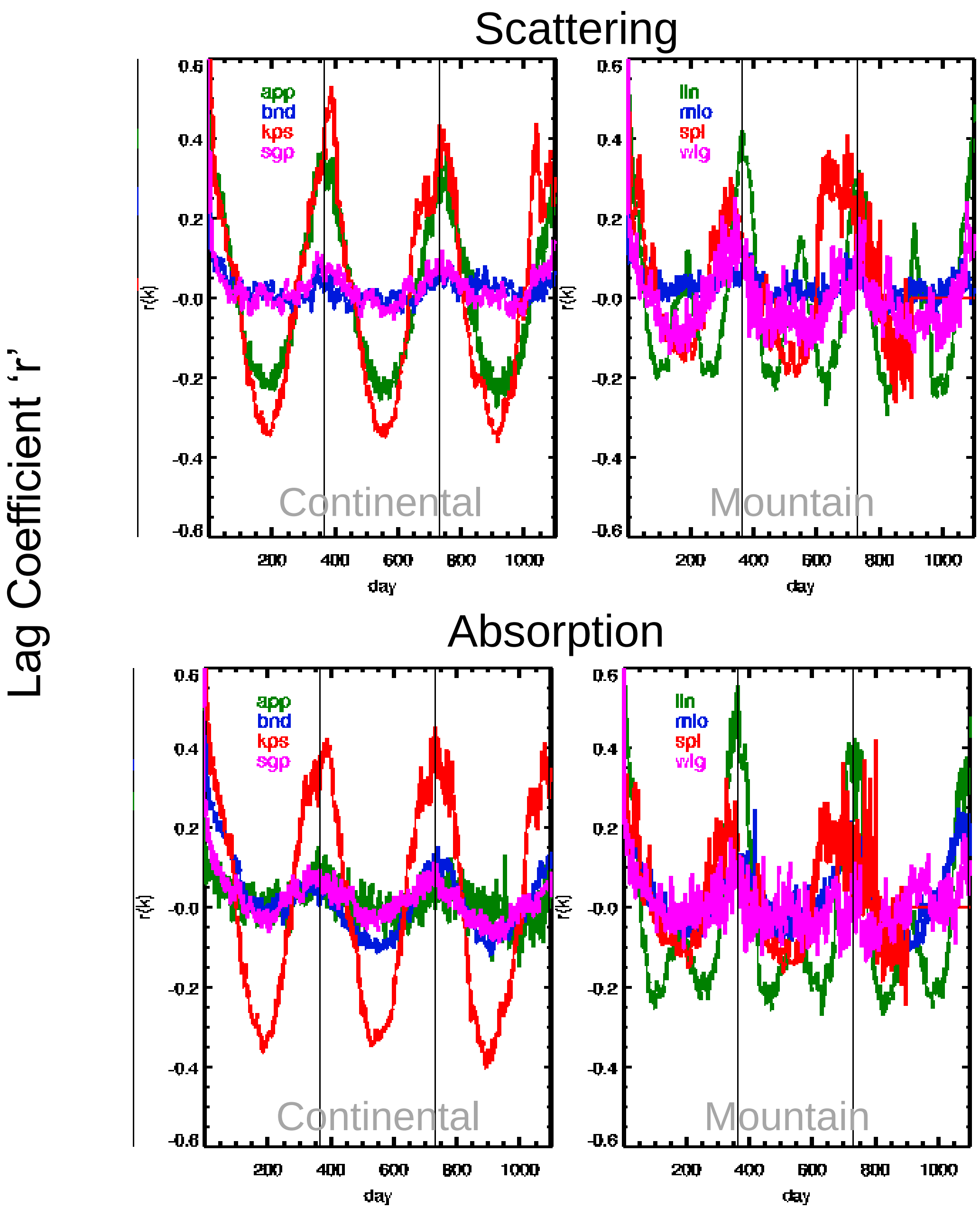
- AMY&CPT – indications of NPF – only CN shows diurnal pattern
- THD – local daily sources (harbor?) and/or onshore/offshore – all parameters have hint of diurnal cycle
- WSA – remote, small island – no significant sources, not enough land mass to instigate onshore/offshore flow.



Summary of short term lag results

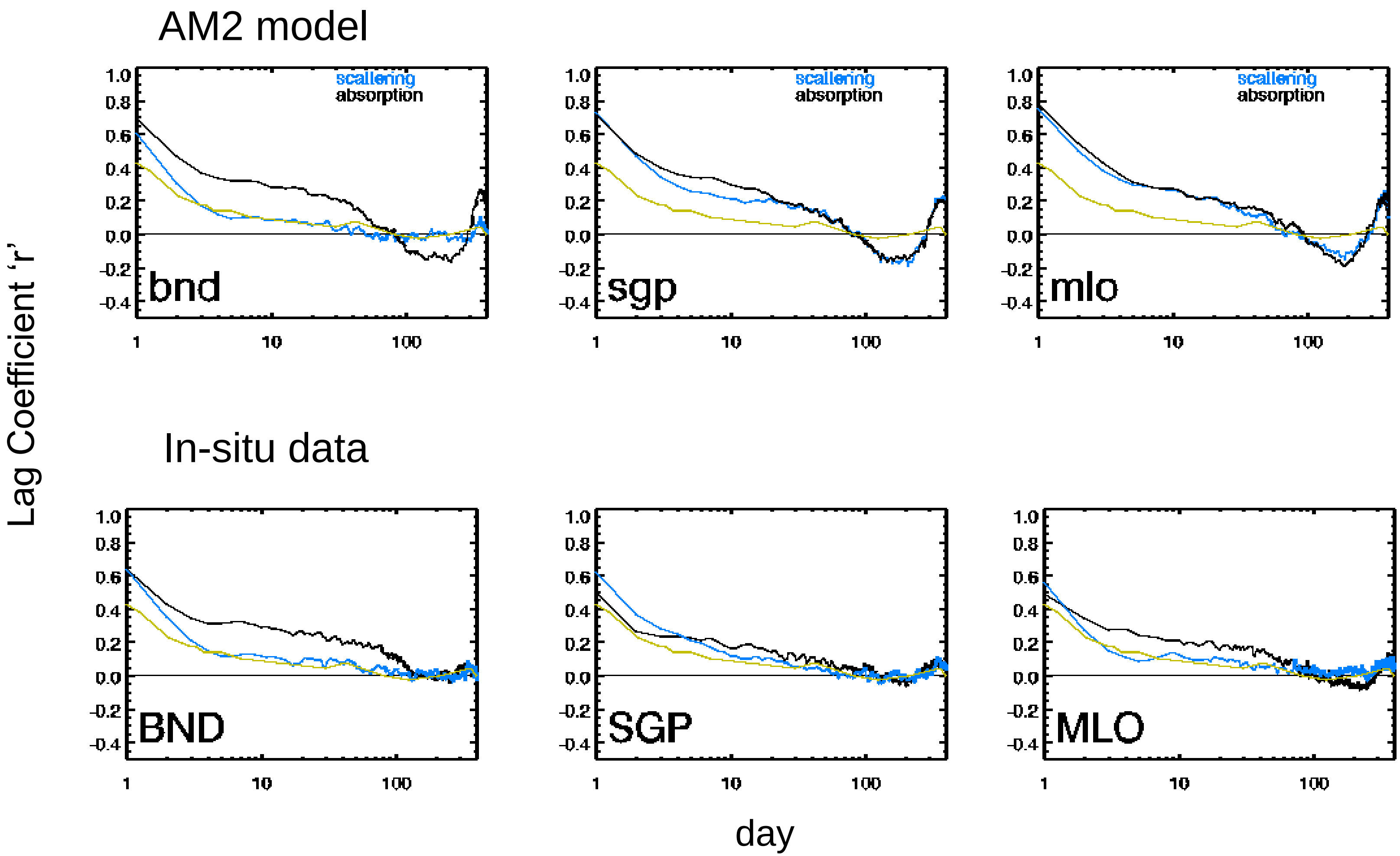
- Optical properties may not have the same diurnal cycle even at the same site
- All continental and mountain sites experience diurnal oscillations in CN. Some coastal sites do as well.
- Strength of diurnal cycle varies at each site and for each parameter
  - →atmospheric processing (NPF)
  - →transport (upslope/downslope; onshore/offshore)
- Lowest persistence (<0.75 at 1h lag) observed for absorption (MLO, SUM)
- At mountain sites, persistence tends to decrease with elevation and increase with latitude (based on 16 mountain sites, not presented here)
- Anderson 2003 autocorrelation curve is good surrogate for some sites and some parameters

Long-term Lag Autocorrelation



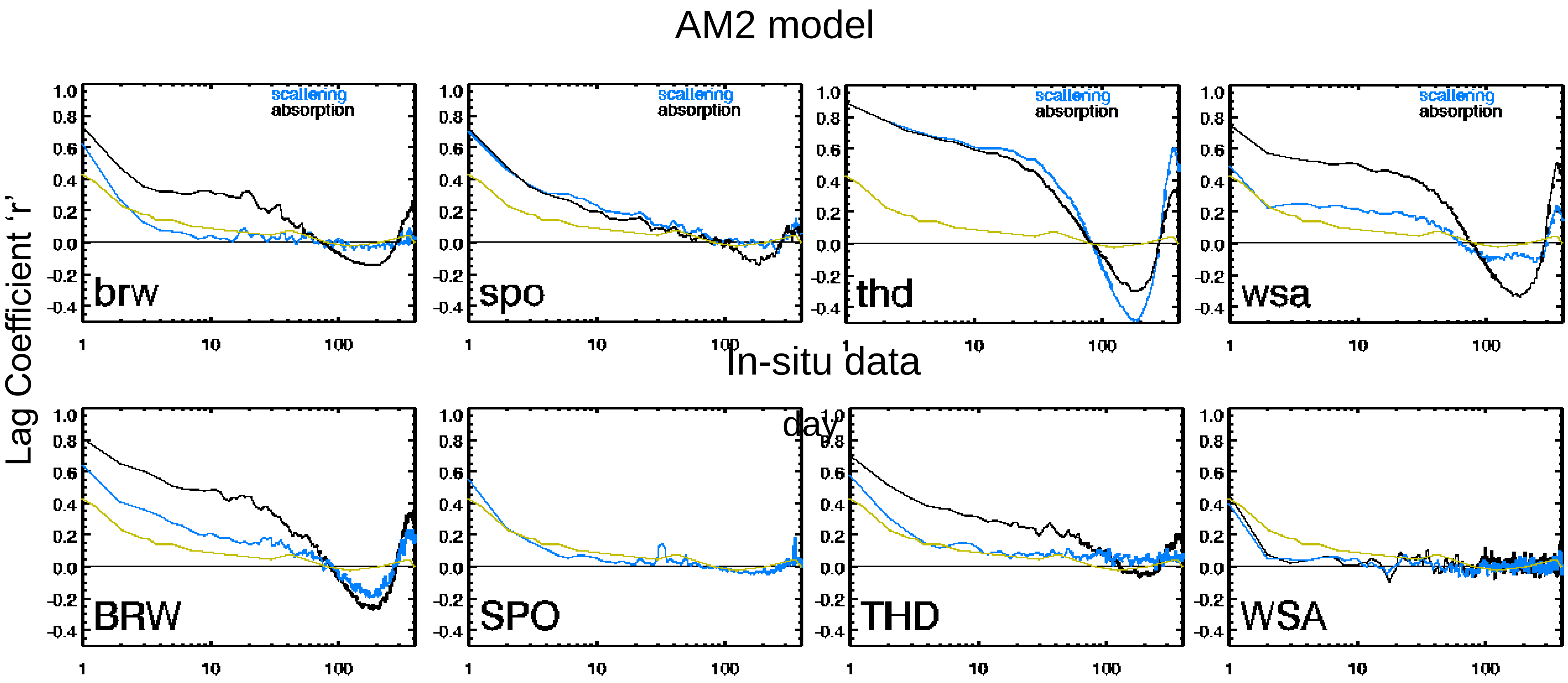
- Large differences in strength of annual cycle within site type. For example, APP and KPS have large annual cycles in scattering while BND and SGP do not.
- Scattering and absorption can have different long term cycles at a given site, e.g., annual absorption cycles at APP and WLG are much weaker than scattering cycles at those sites.
- Bi-modal lag coefficient at LLN reflects different air masses in March and October

Comparison daily lags – data and model



Model annual cycles too strong
Model persistence>surface site persistence (sub-grid variability?)

Comparison daily lags – data and model



Model underpredicts persistence at BRW, including magnitude of annual cycle.
Model over predicts persistence at SPO (but mostly looks good)
Model persistence at coastal sites (THD, WSA) much larger than measured persistence; modelled annual cycle at coastal sites too high.

Acknowledgements

(in order of appearance)

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