SAGE III/ISS Validation Methods

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Abstract

Spatiotemporal collocation of measurements between instruments is an essential yet challenging component of the data validation process. Traditional methods of collocation may simply consider length of time and physical distance between measurements. However, the distribution of atmospheric constituents may change rapidly over time and space, so care must be taken to ensure that matched measurements represent the same environment and will not introduce unnecessary bias. More advanced collocation methods may consider additional physical parameters to minimize inappropriate matches with large differences caused by local circulation. We report results from SAGE III/ISS validation with ground-based measurements using advanced collocation methods, and assessments are performed on the quality and presence of trends in both datasets.

Methods

Data Collection:

SAGE III/ISS event types: Solar occultation events (sunrise + sunset)

Ozonesonde stations:

- Boulder, US (39.9, -105.2)
- Lauder, NZ (-45.0, 169.7)
- Payerne, FR (46.8, 6.9)
- Hohenpeissenberg, DE (47.8, 11.0)
- Uccle, BE (50.8, 4.4)

Time period:

- June 2017 - Oct 2023

Data Pre-processing:

SAGE ozone quality filter:

- > 1 km above tropopause altitude
- < 100% uncertainty

Sonde profile preparation:

- Interpolation to SAGE altitude grid
- Removal of outliers and erroneous profiles

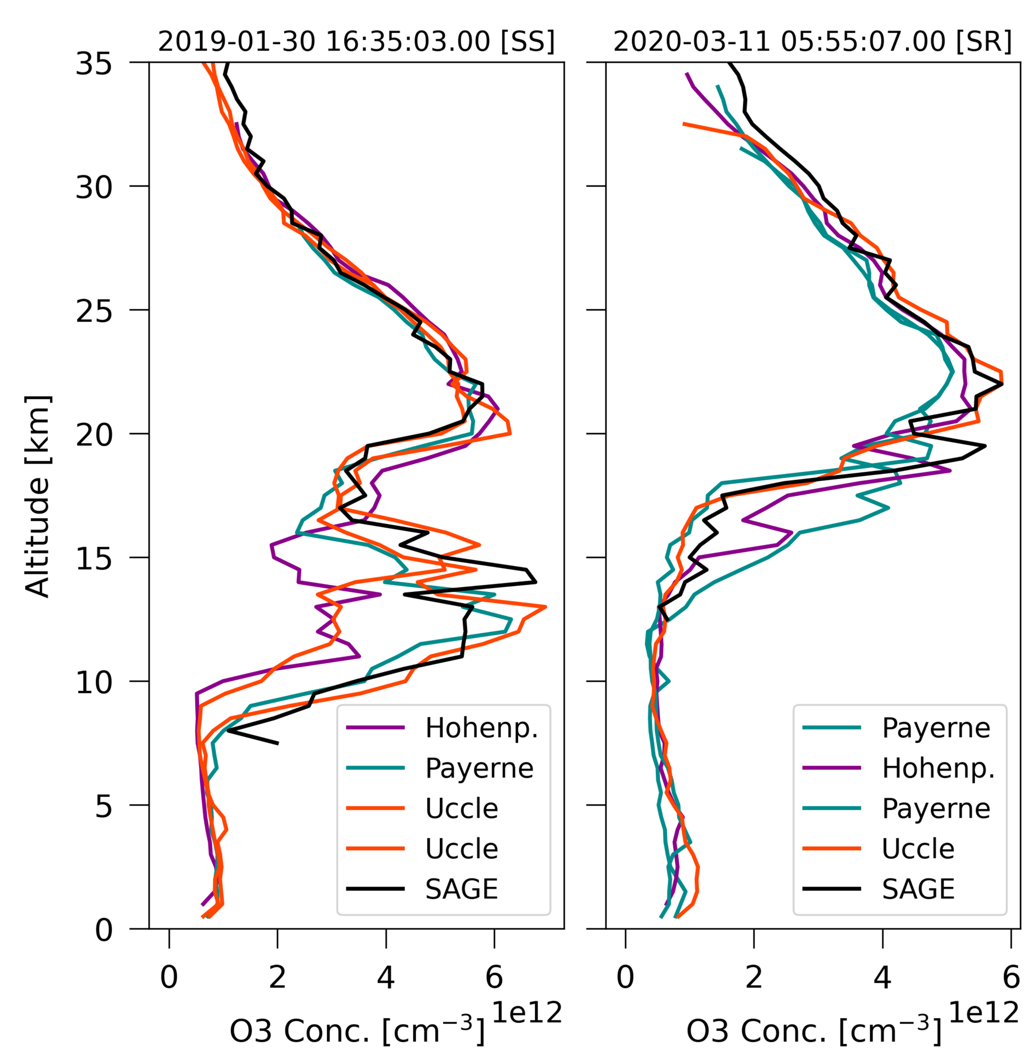
Collocation Criteria

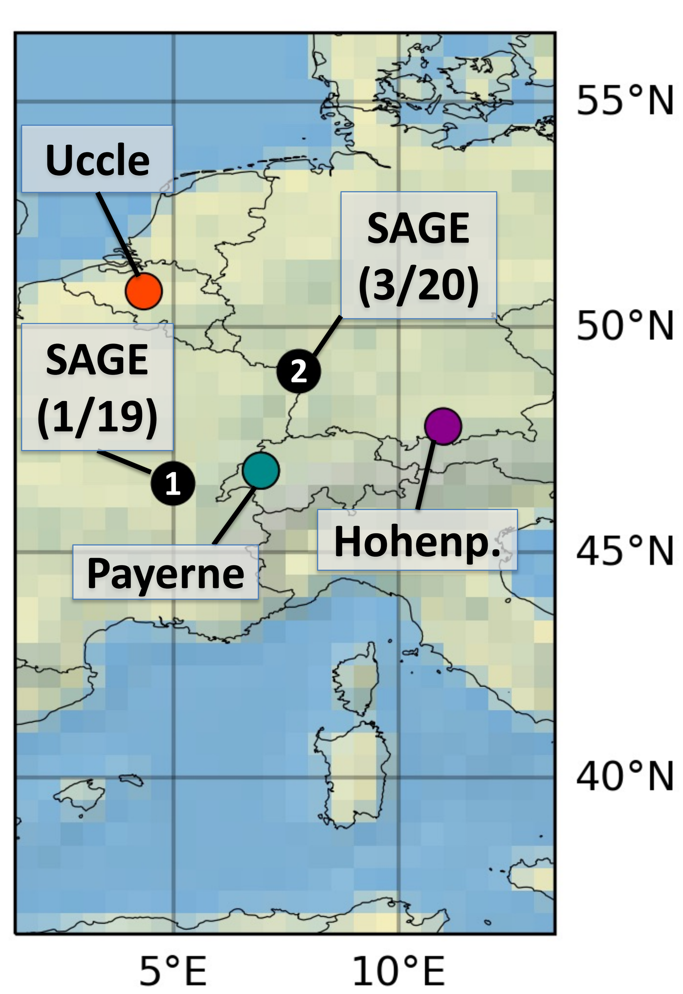
Collocation criteria serve as the guidelines that define the permissible separation in space and time between coincident events, forming the basis for a meaningful comparison between satellite and ozonesonde measurements.

- **Distance Criteria:** Informed by the horizontal resolution of the satellite instrument
- **Temporal Criteria:** Accounts for the typical temporal scale of ozone fluctuations
- **Quality vs. Quantity:** Strive to maintain balance between a.) obtaining a large enough number of matches for robust statistical analysis and b.) reducing noise and number of mismatched events due to high ozone variability over time and space
- **Geophysical Variability:** Consider additional metrics to quantify the similarity between measured airmasses, including long-lived atmospheric tracers, pressure/temperature gradients between measurement locations, and atmospheric models
- **Multiple Matches:** Methods to compute comparisons on datasets which include multiple matches per event may include scoring or weighing matches by likelihood of environmental similarity

Multiple Match Example:

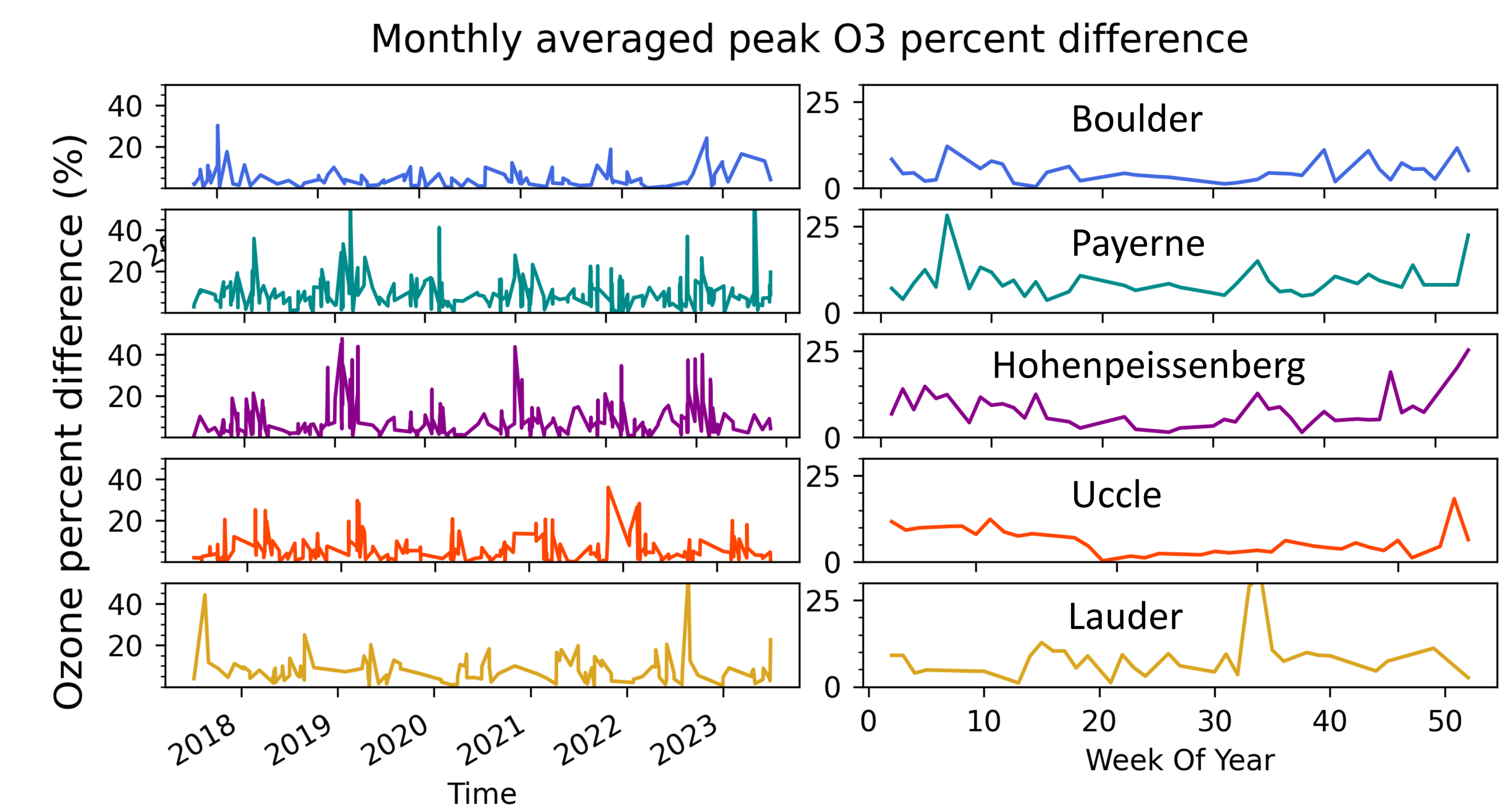
Collocation criteria: ± 24 hours, ± 5 degrees latitude, ± 10 degrees longitude

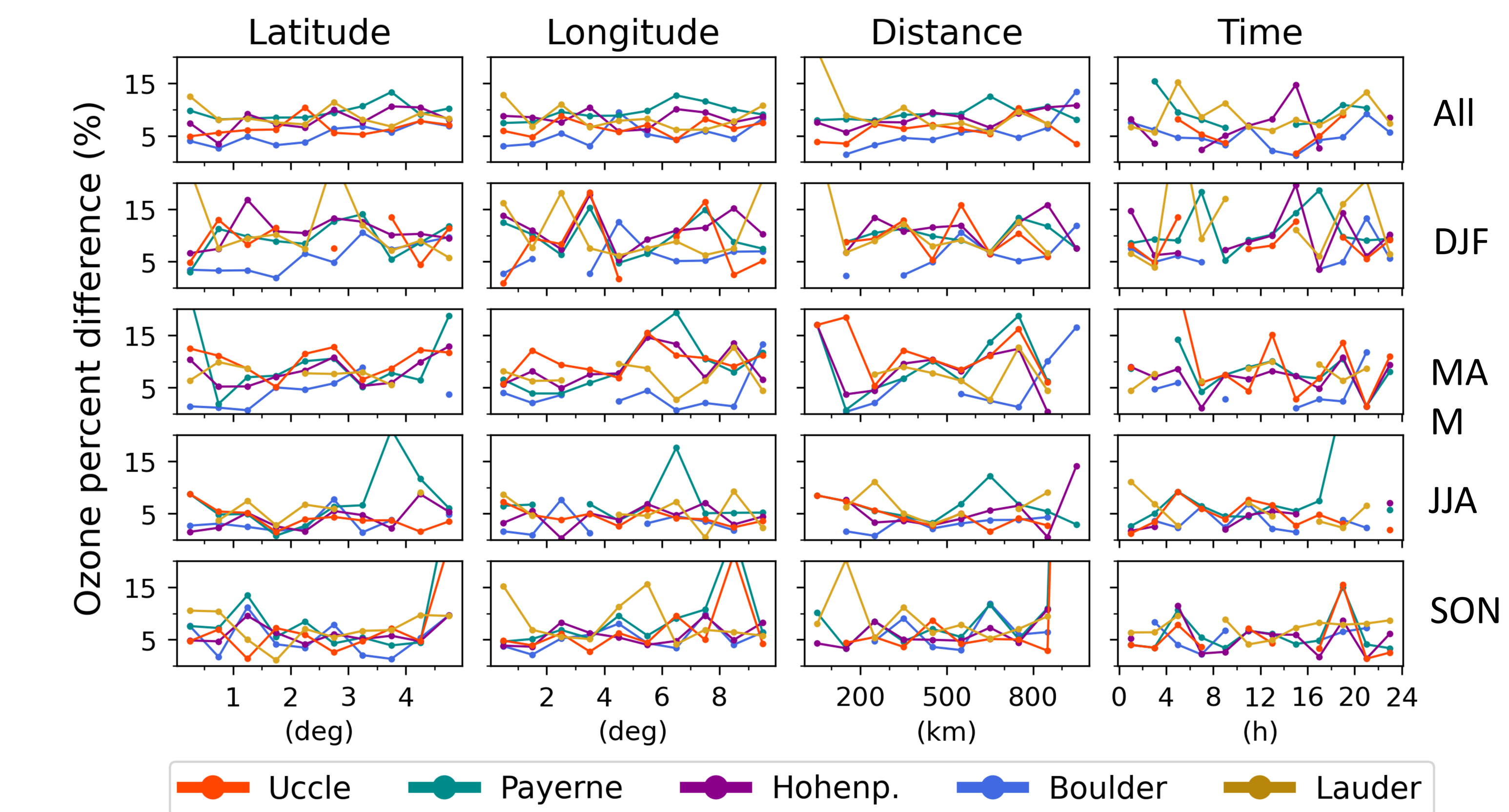




SAGE time	O3 [%]	Lat [deg]	Lon [deg]	Dist [km]	Time [h]	Station
2019-01-30 16:35:03	4.2	1.3	6.0	475.8	10.0	Hohen.
2019-01-30 16:35:03	10.4	0.3	2.0	153.3	5.0	Payerne
2019-01-30 16:35:03	3.3	4.3	0.6	475.7	5.0	Uccle
2019-01-30 16:35:03	19.6	4.3	0.6	475.7	18.0	Uccle
2020-03-11 05:55:07	6.9	2.2	0.8	254.2	18.0	Payerne
2020-03-11 05:55:07	6.8	1.2	3.2	274.7	0.0	Hohen.
2020-03-11 05:55:07	9.1	2.2	0.8	254.2	5.0	Payerne
2020-03-11 05:55:07	0.9	1.8	3.4	314.0	5.0	Uccle

Seasonality





- Higher variability of O3 difference during late winter/early spring months
- Similar response from all stations to each metric during each season

Conclusions + Future Work

Many uncertainties and biases can be introduced during the process of validating data from independent sources, especially considering the highly variable behavior of the quantities being measured. These issues may be mitigated by utilizing advanced collocation methods, including:

- Triple Collocation method for error evaluation
- Evaluating local geospatial variability with equivalent latitude, potential vorticity, or other derived meteorological products or models
- Scoring and weighting of matches to minimize collocation uncertainties
- Account for differences in vertical resolution (averaging kernel)
- Correction of biases related to altitude, latitude, season, hemisphere, drift, etc.