What NDACC ozone lidars are telling us about long term satellite measurements

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Lidar ozone measurements

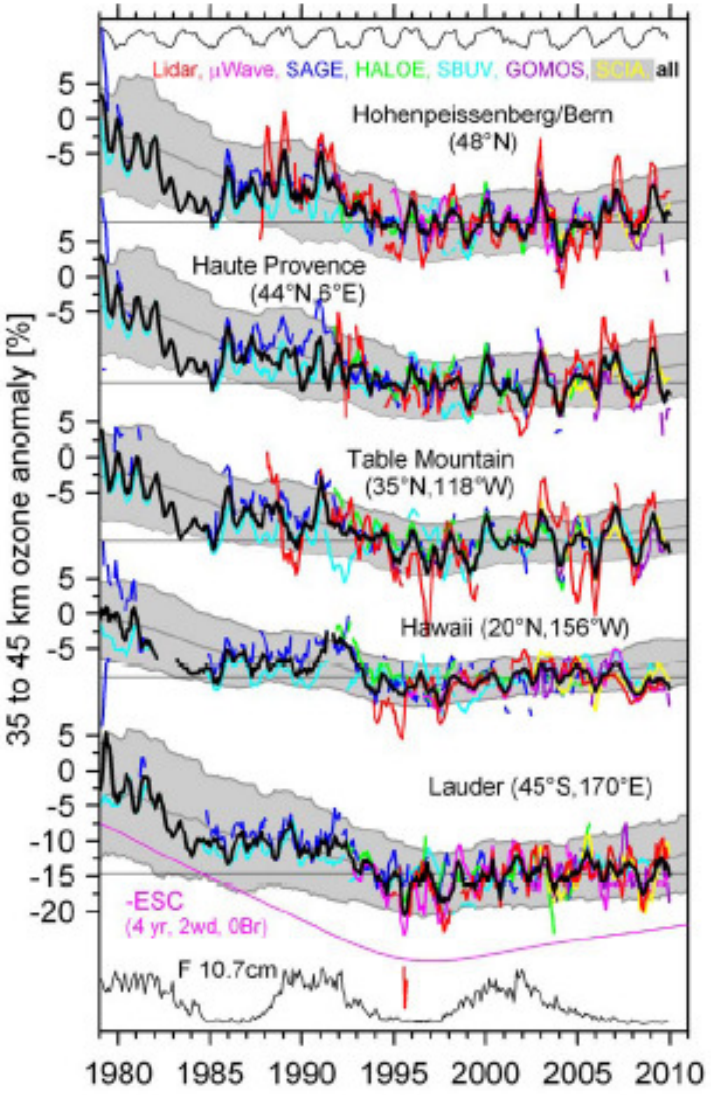
DIAL Method : DIfferential Absorption Lidar

- Emission of 2 laser beams in the UV range ($\lambda_{on,}$, λ_{off}) with different ozone absorption cross-section
- Self calibrated measurements
- Units: ozone nb density vs altitude
- Sensitive to volcanic aerosols: detection of N_2 Raman wavelengths
- Altitude range: 10-50 km, varying altitude resolution (0.3 – 5 km) – profiles noisier above ~40 km
- temporal resolution; 1- 4 hours depending on laser power and rep. rate
- Night-time only and clear skies

Evolution of ozone in the upper stratosphere

Ozone recovery?

- Steinbrecht et al., 2006, Steinbrecht et al., 2009.
- Ozone anomalies in the range 35 – 45 km
- Observed data: 5 month running mean
- Satellite: zonal average
- Grey area: CCMval simulation, 24 month running mean ± 2 σ



Comparision of ozone profile time series at OHP

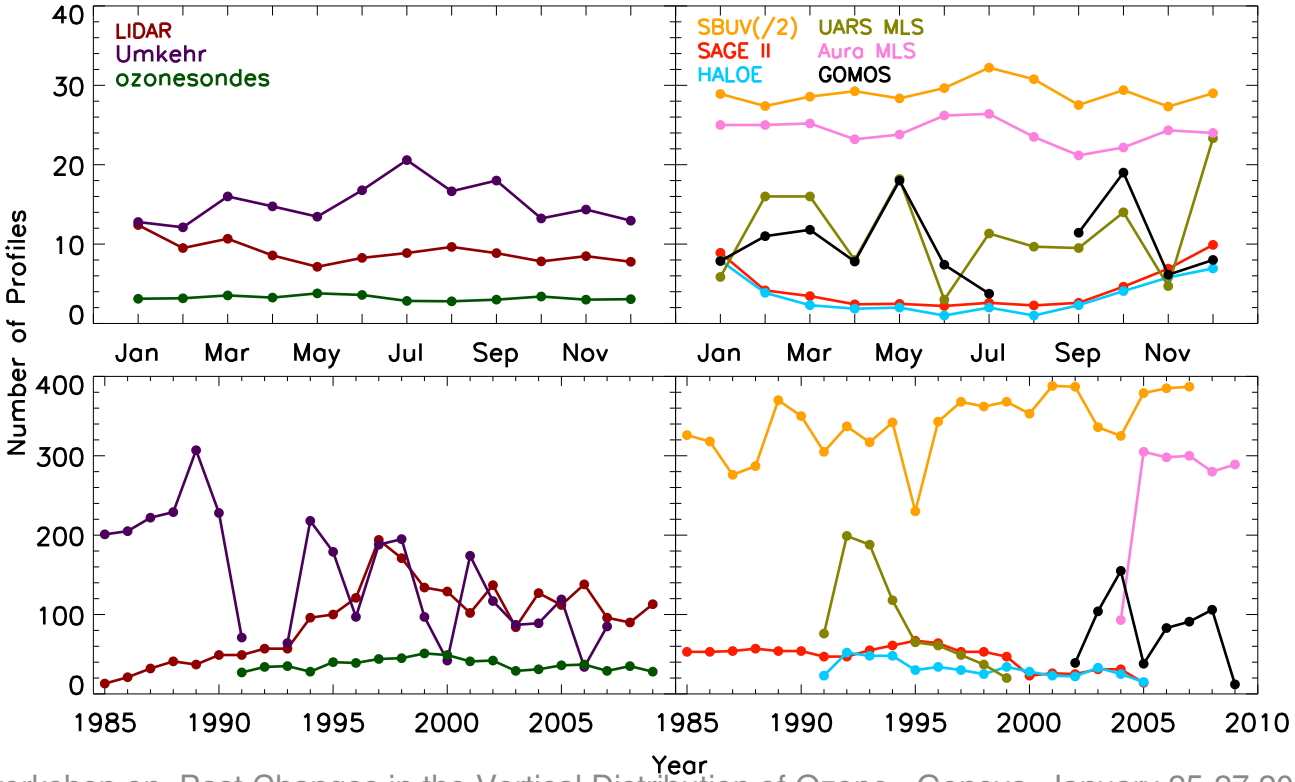
- Ground-based : lidar, Umkehr, ozone sondes
- Satellite: SAGE II, SBUV(/2), HALOE, MLS (UARS & Aura), GOMOS

Heterogeneous data sampling

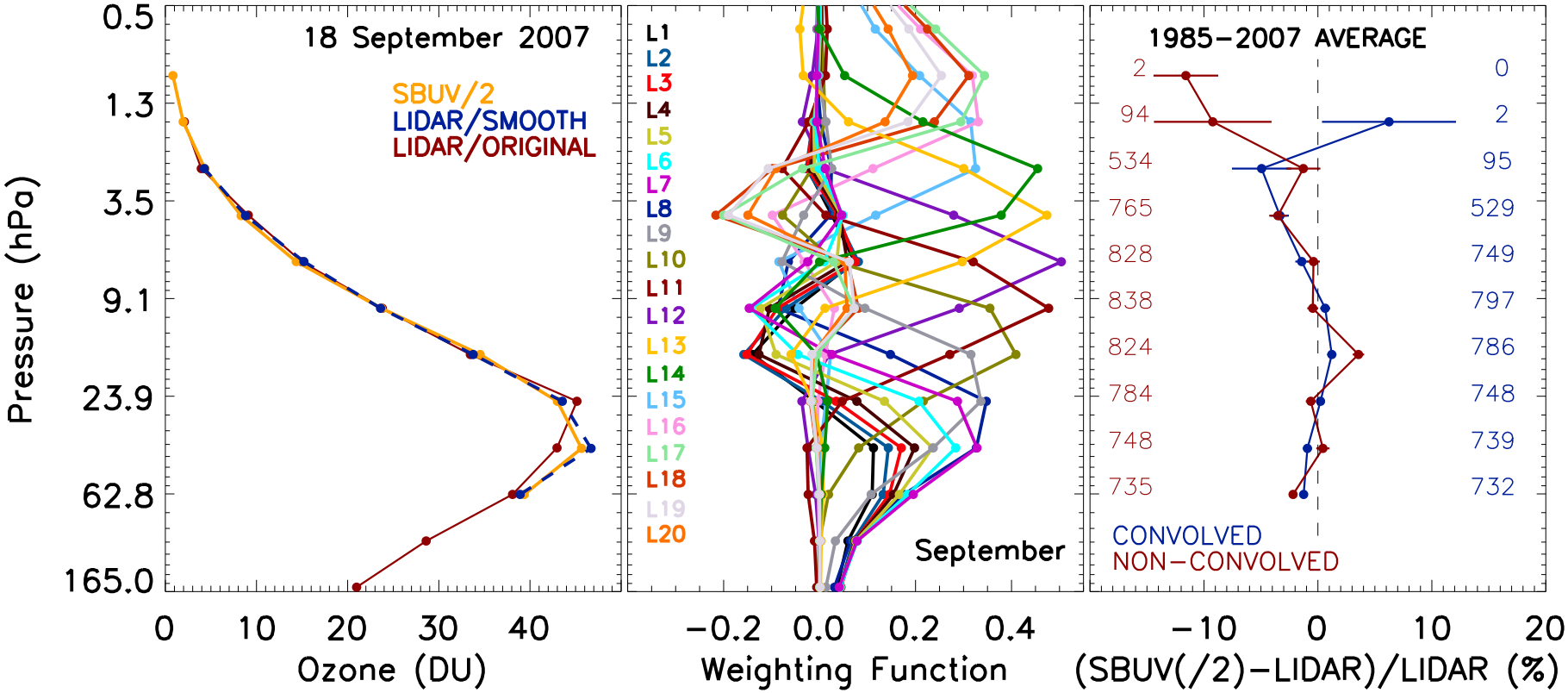
± 2.5° or 5° lat

± 5° or 10° long

Nair et al., ACPD, 2010

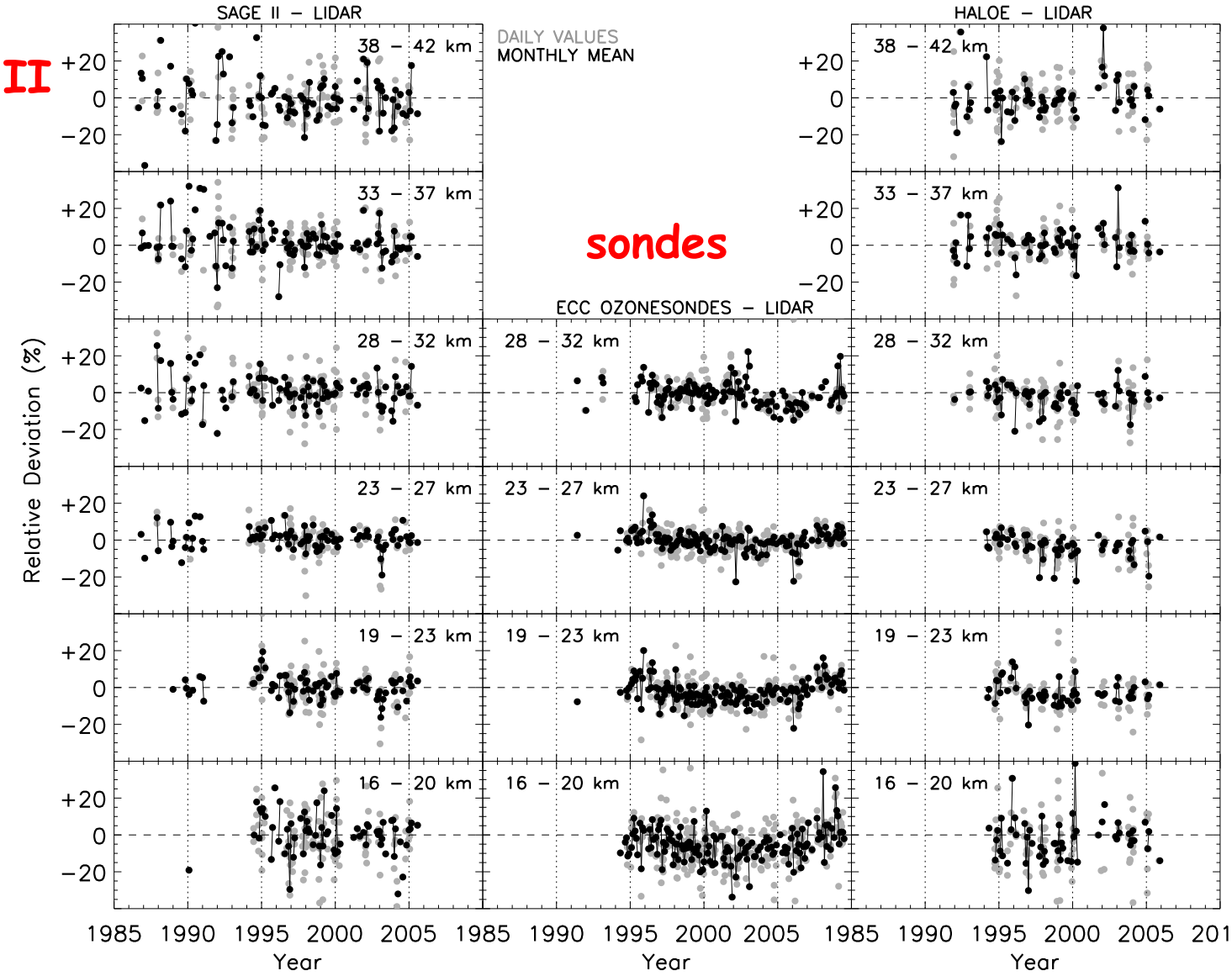


Data Conversion: Averaging Kernel issue



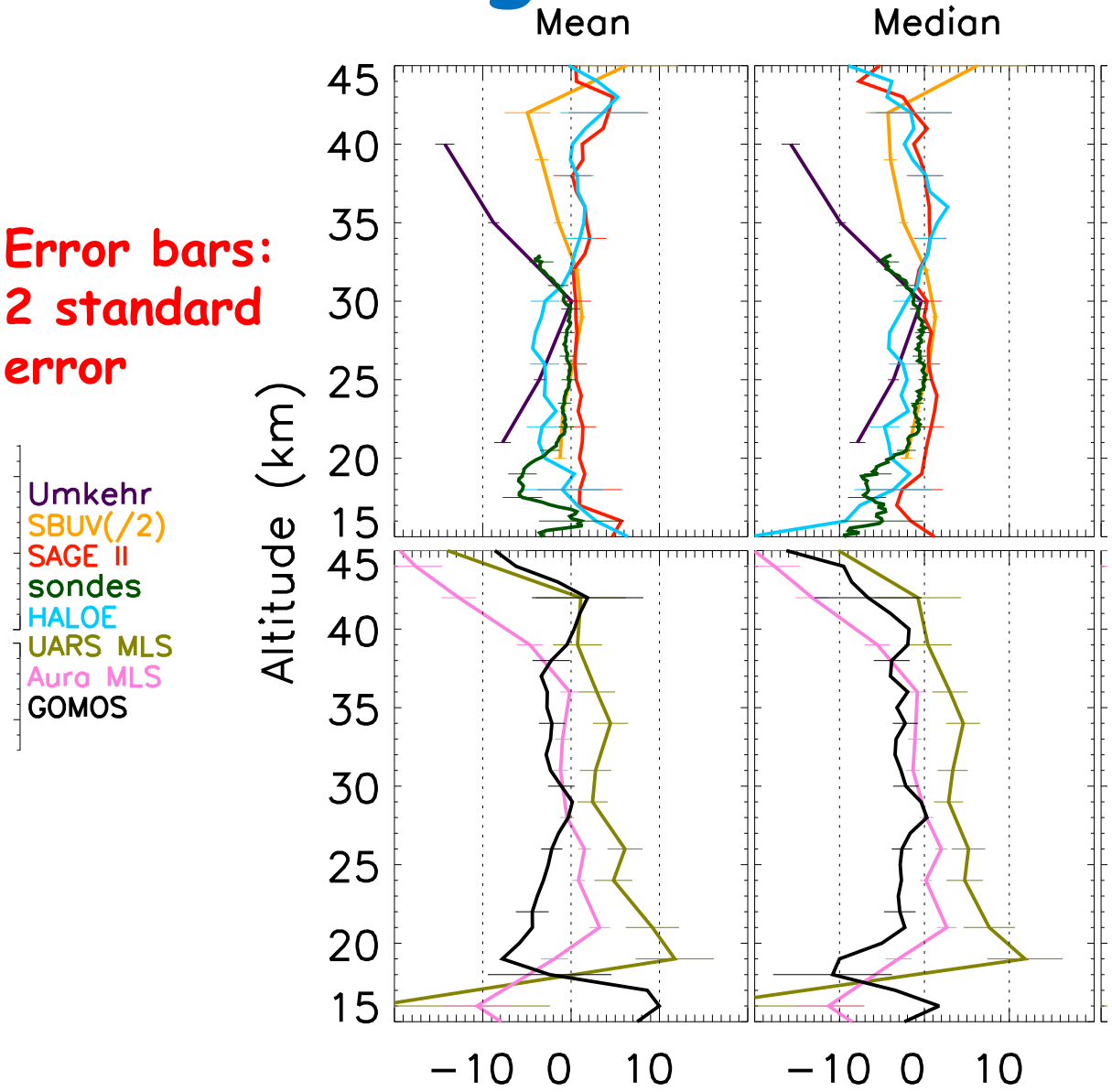
SBUV(/2), lidar and the lidar profile convolved using SBUV/2 averaging kernels (left) SBUV/2 averaging kernels (middle) and the average relative difference (right panel) at OHP.

Example of coincident data series



Average biases at OHP

Error bars:
2 standard error

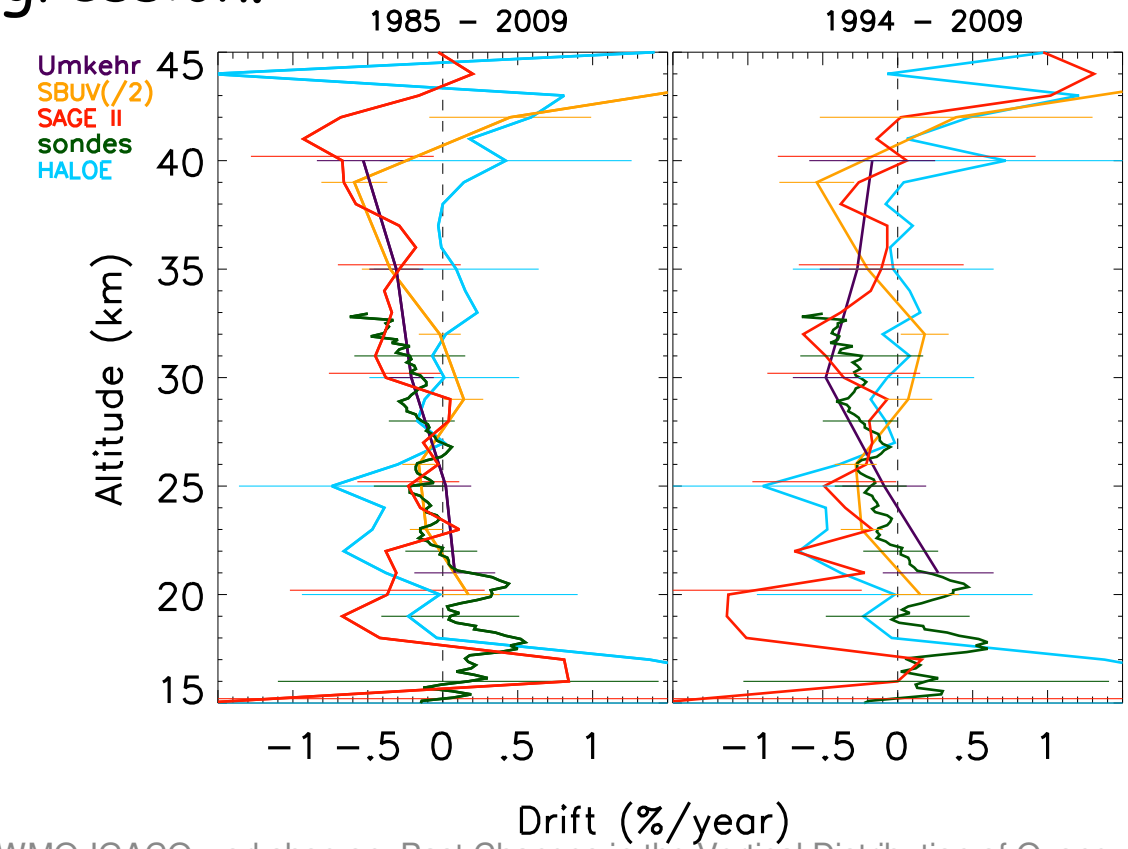


> 15 years data sets

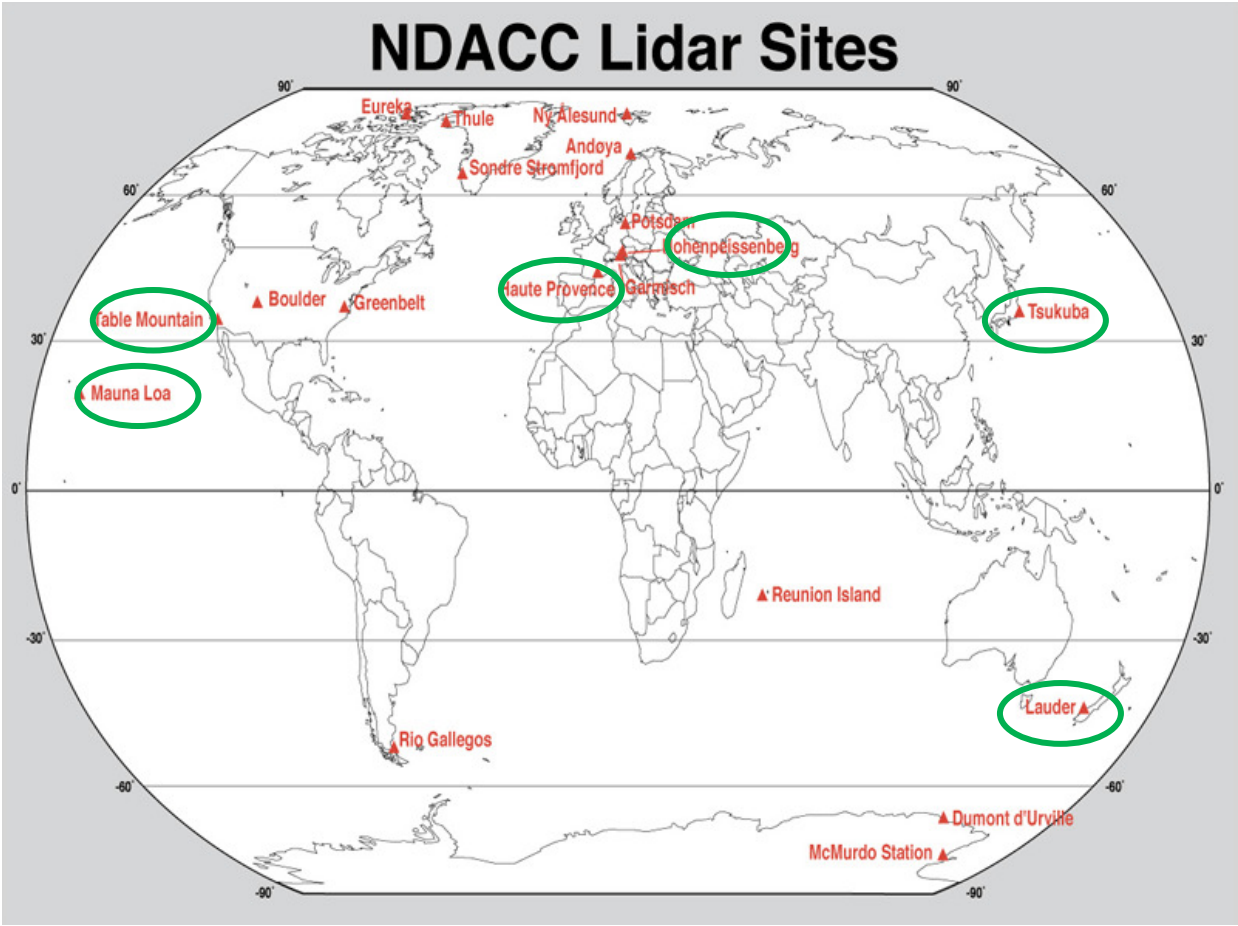
< 15 years data sets

Drifts of ozone time series as compared to the OHP lidar

The drifts are derived from the time series of monthly averages of the relative differences of ozone using simple linear regression.

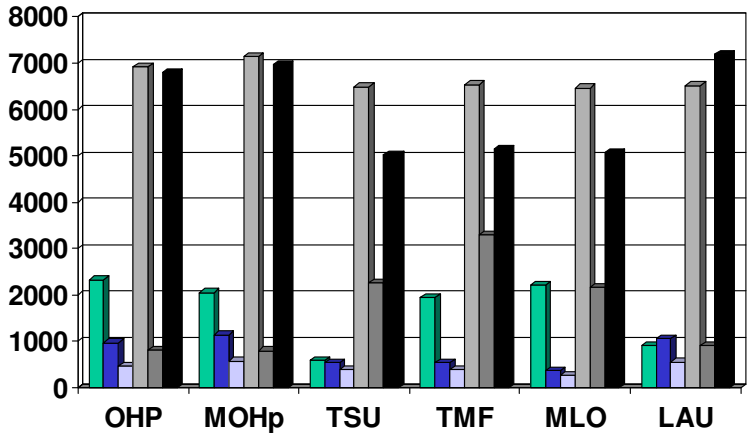


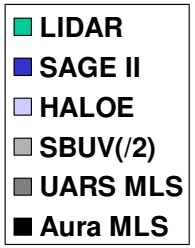
Study at 6 NDACC lidar stations



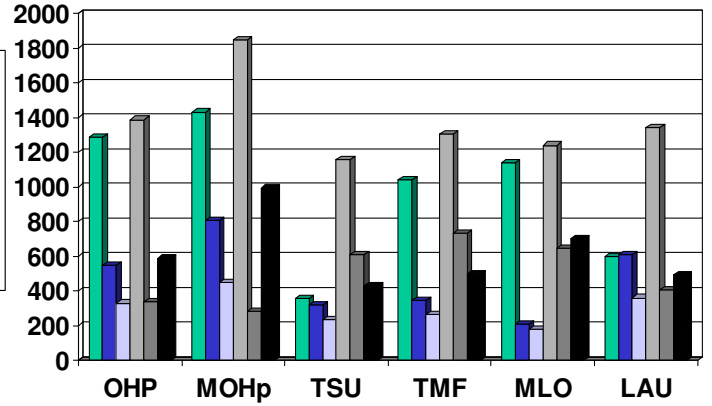
Data sampling

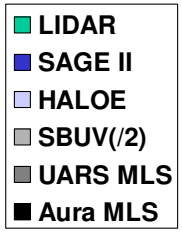
Total number of profiles

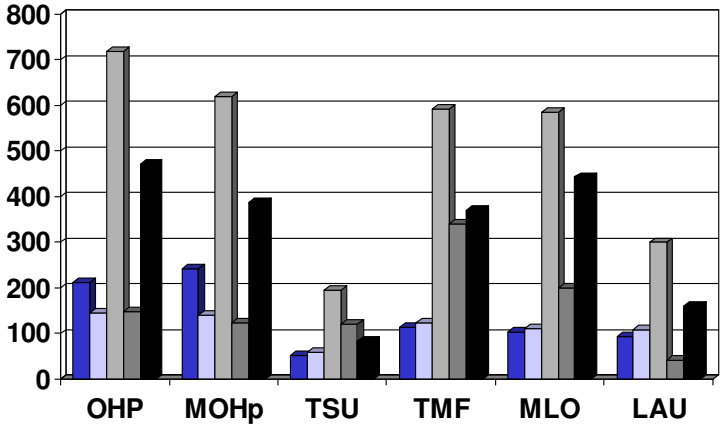


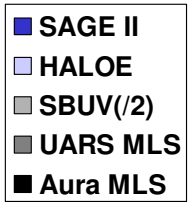


number of coincidences with any of the measurements





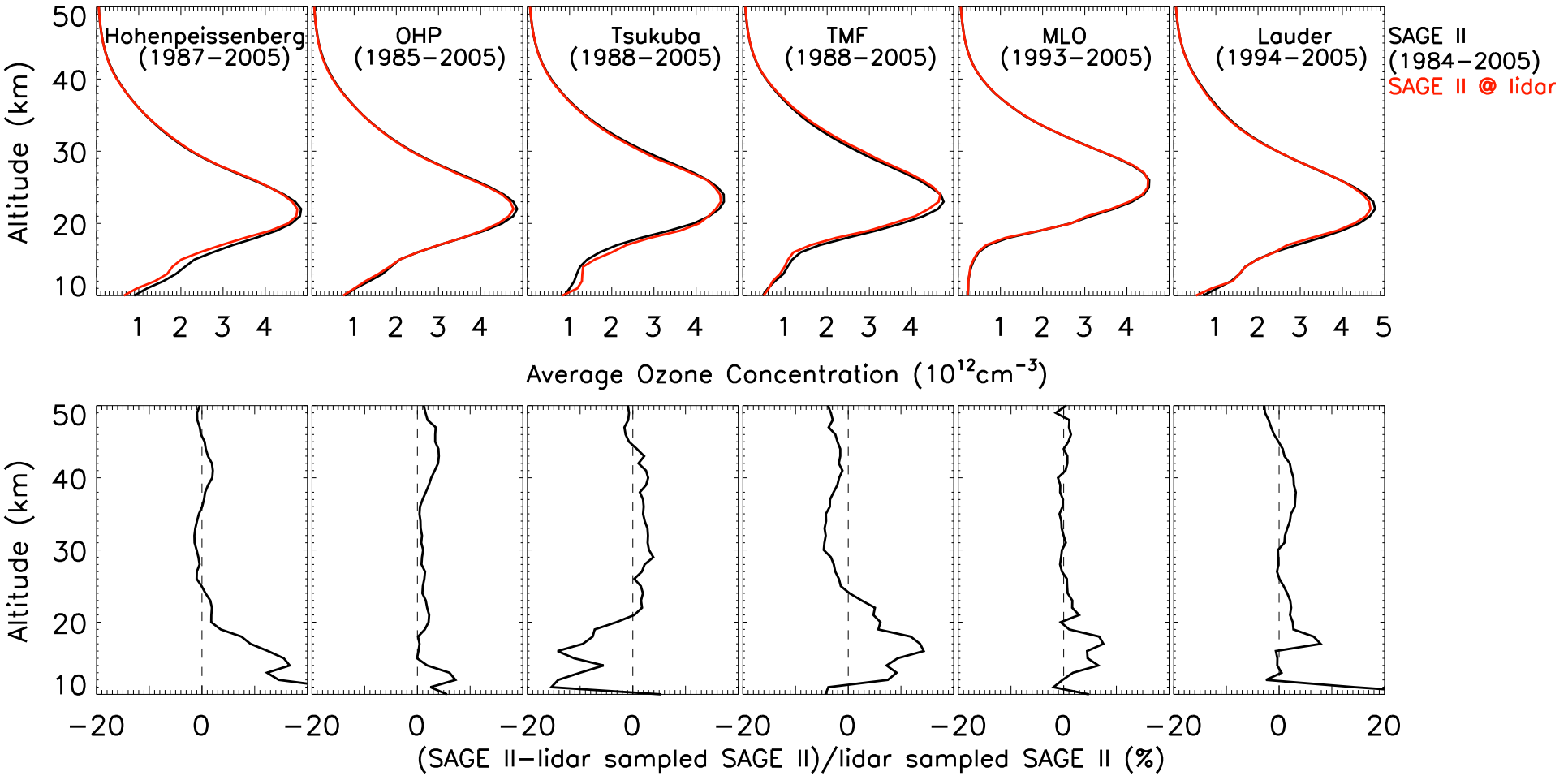




number of coincidences with lidar measurements

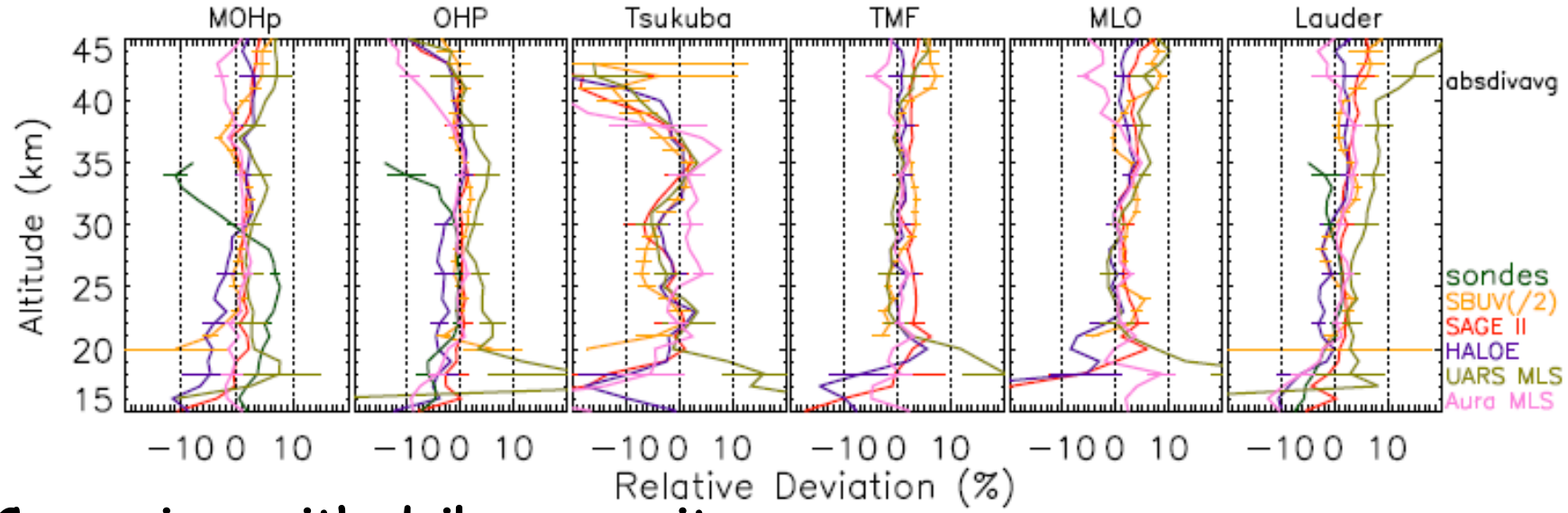
Clear sky bias

Average ozone concentration of SAGE II ozone profiles for the non-coincident and coincident days with lidar and relative deviation

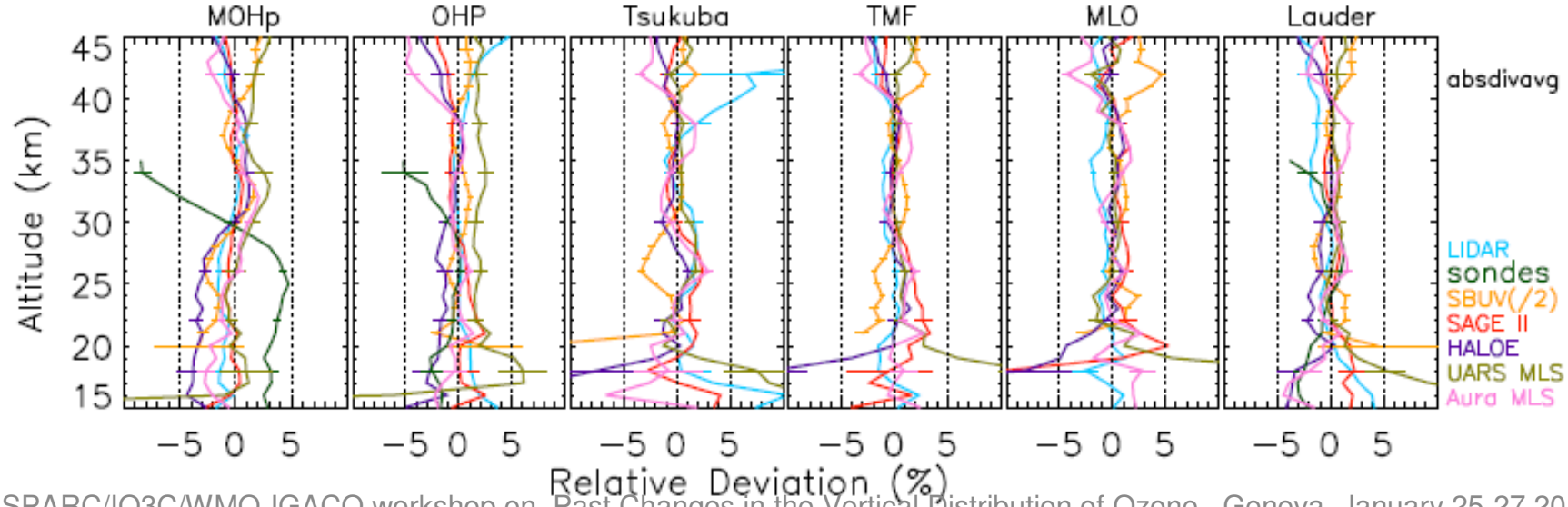


Average differences

Comparison with lidar measurements

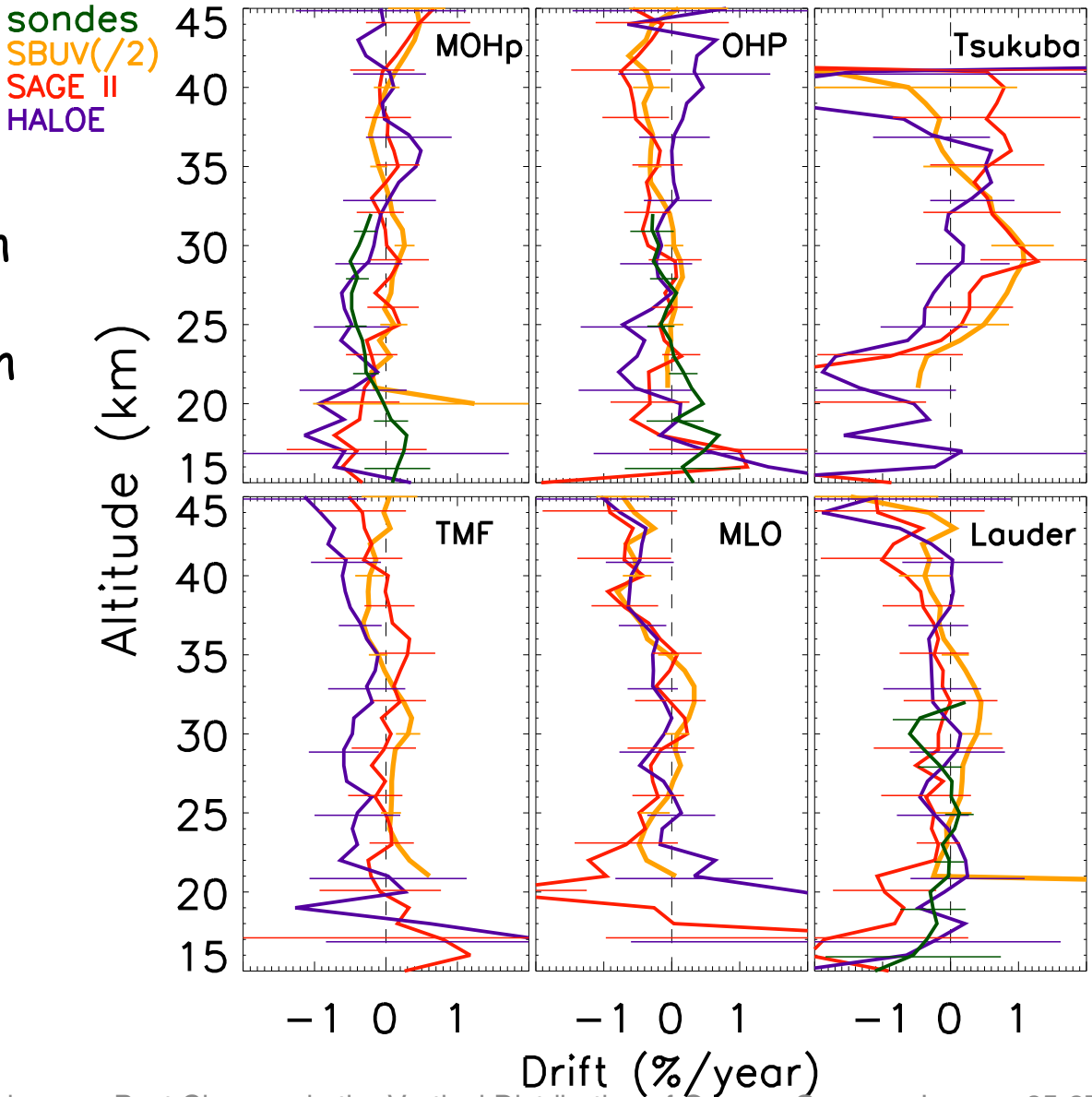


Comparison with daily composite average

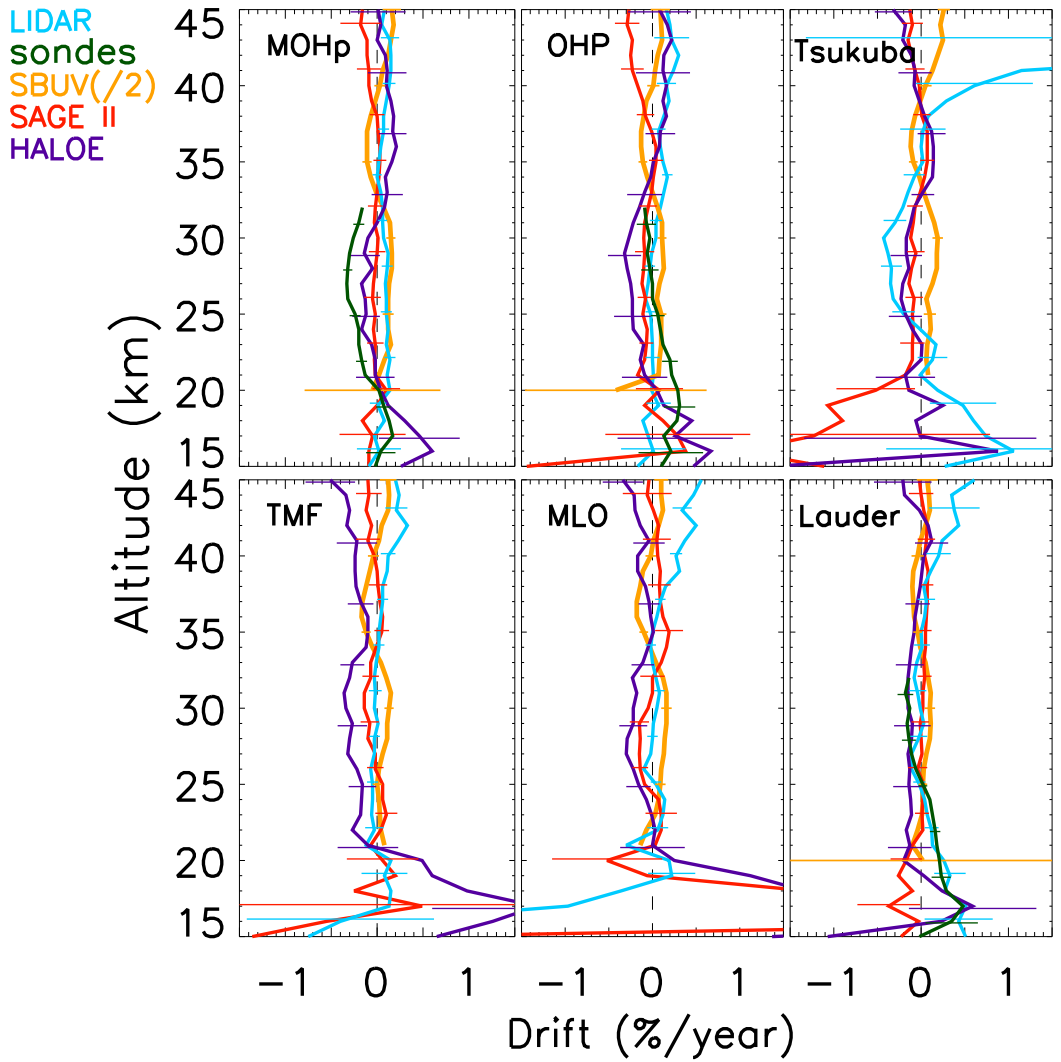


Drift with lidar measurements

Vertical distribution of drifts estimated from the comparison with the lidar measurements at various stations.



Drift with all measurements daily average



Deasonalised time series

Time series of 5 month running average of ozone anomaly at OHP and Hohenpeissenberg

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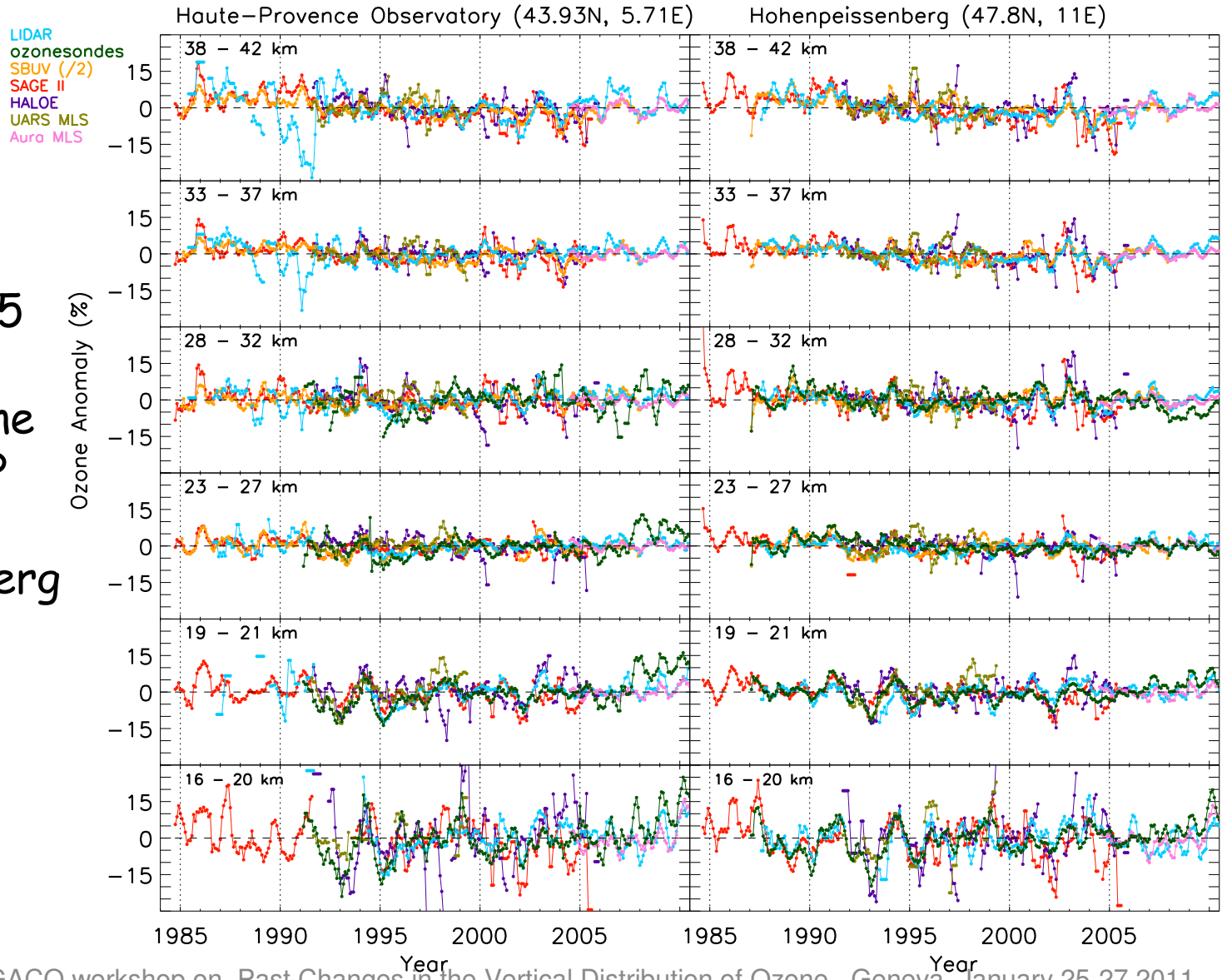
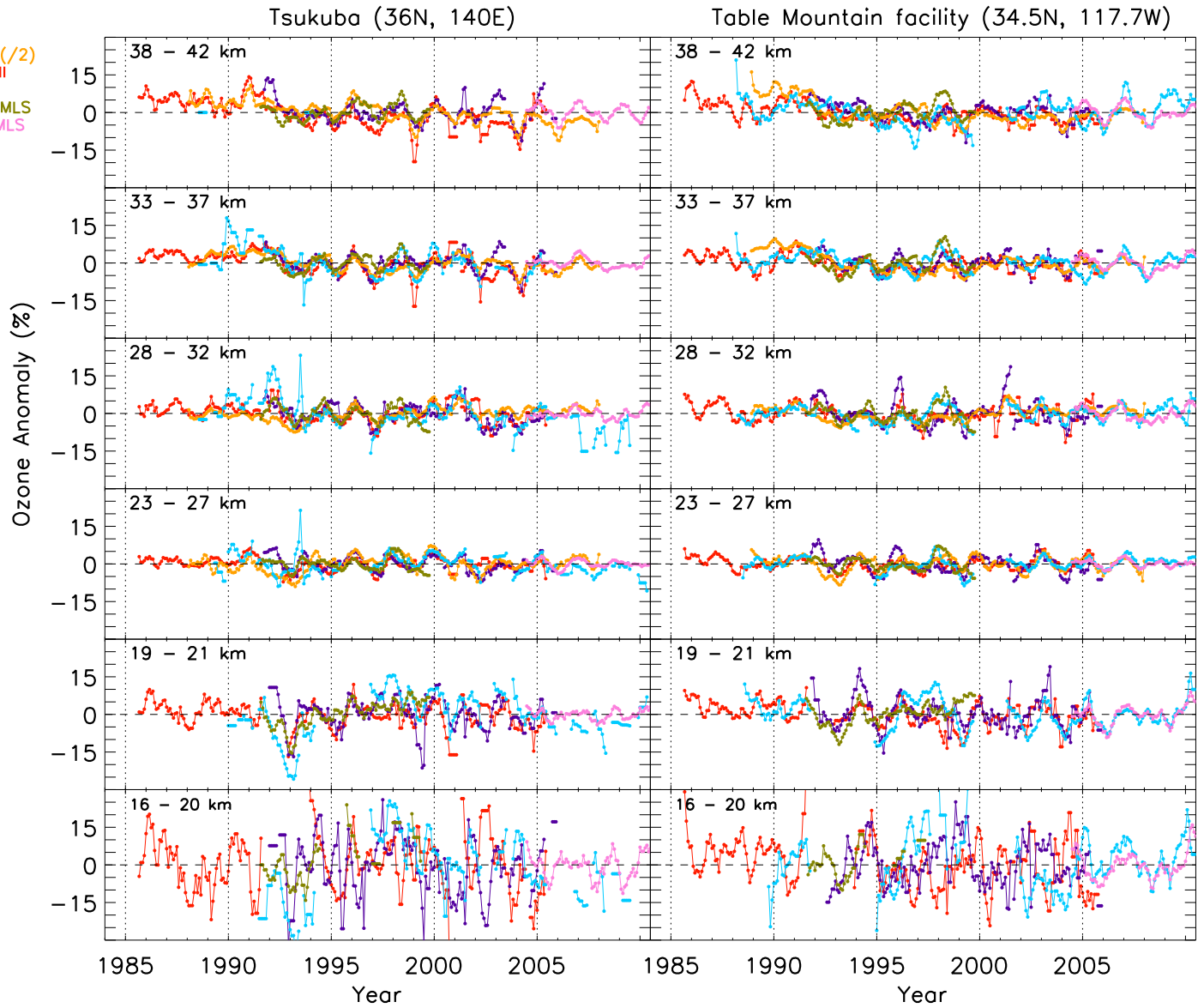


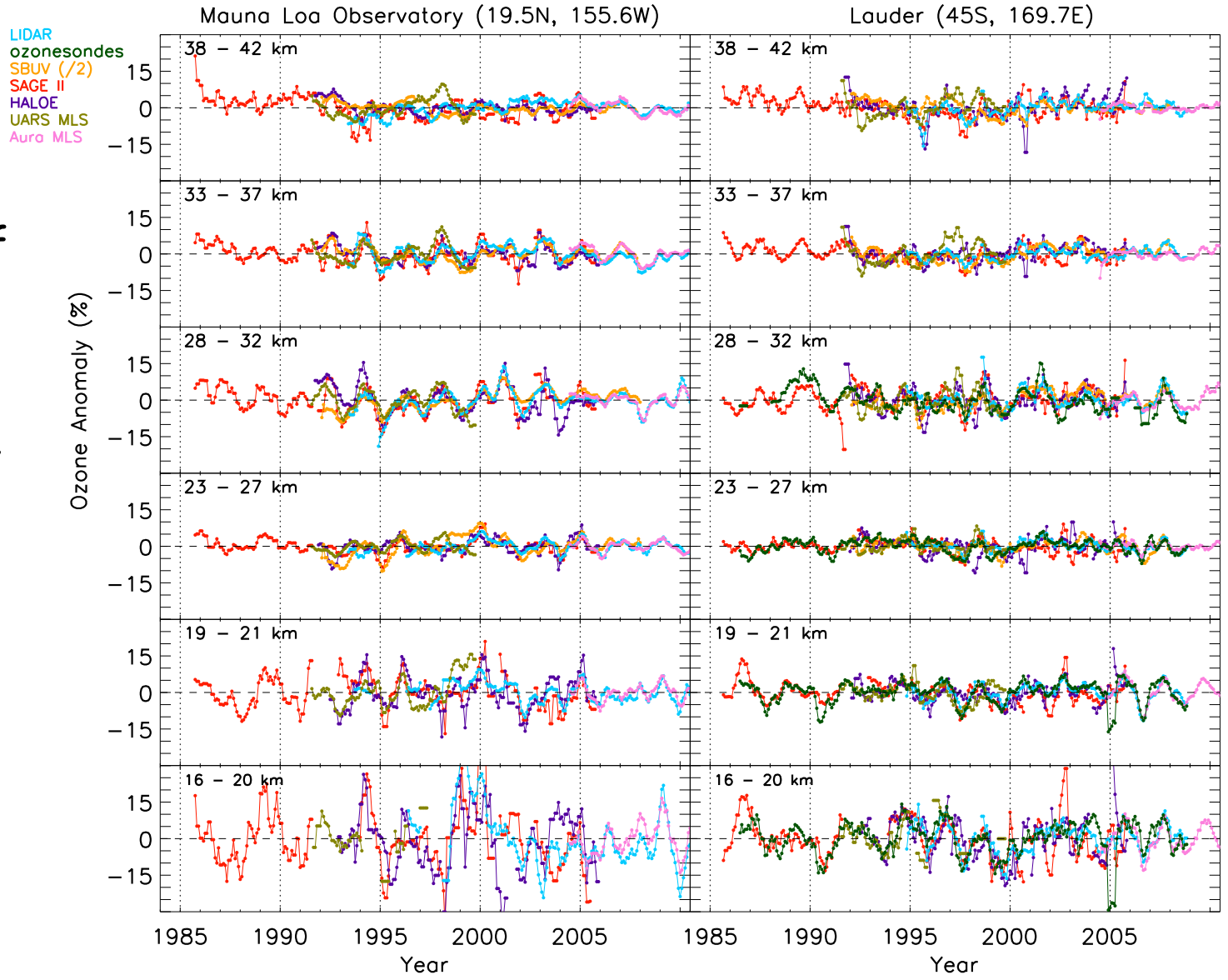
Deasonalised time series (2)

Time series of 5 month running average of ozone anomaly at Tsukuba and Table Mountain

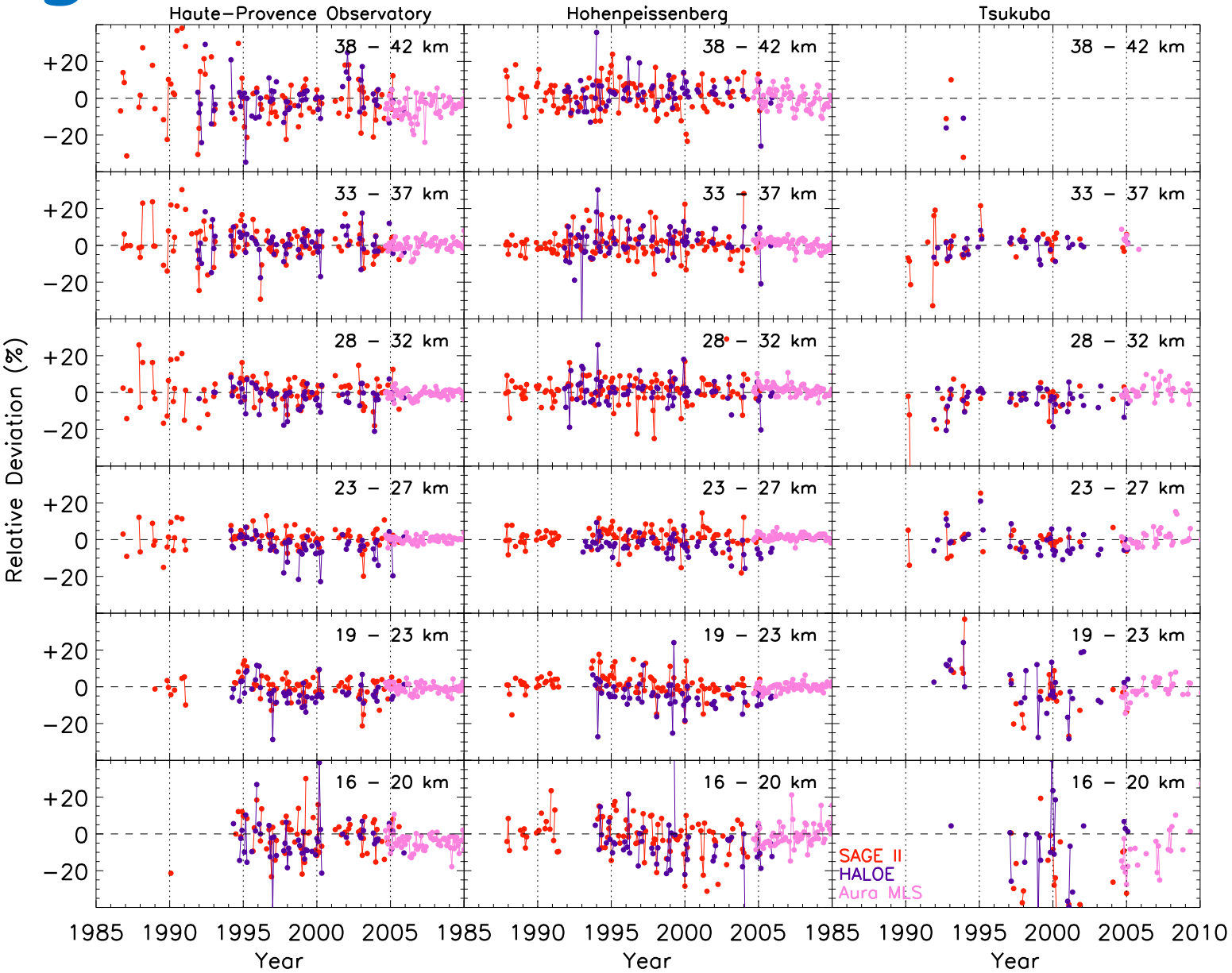


Deasonalised time series (3)

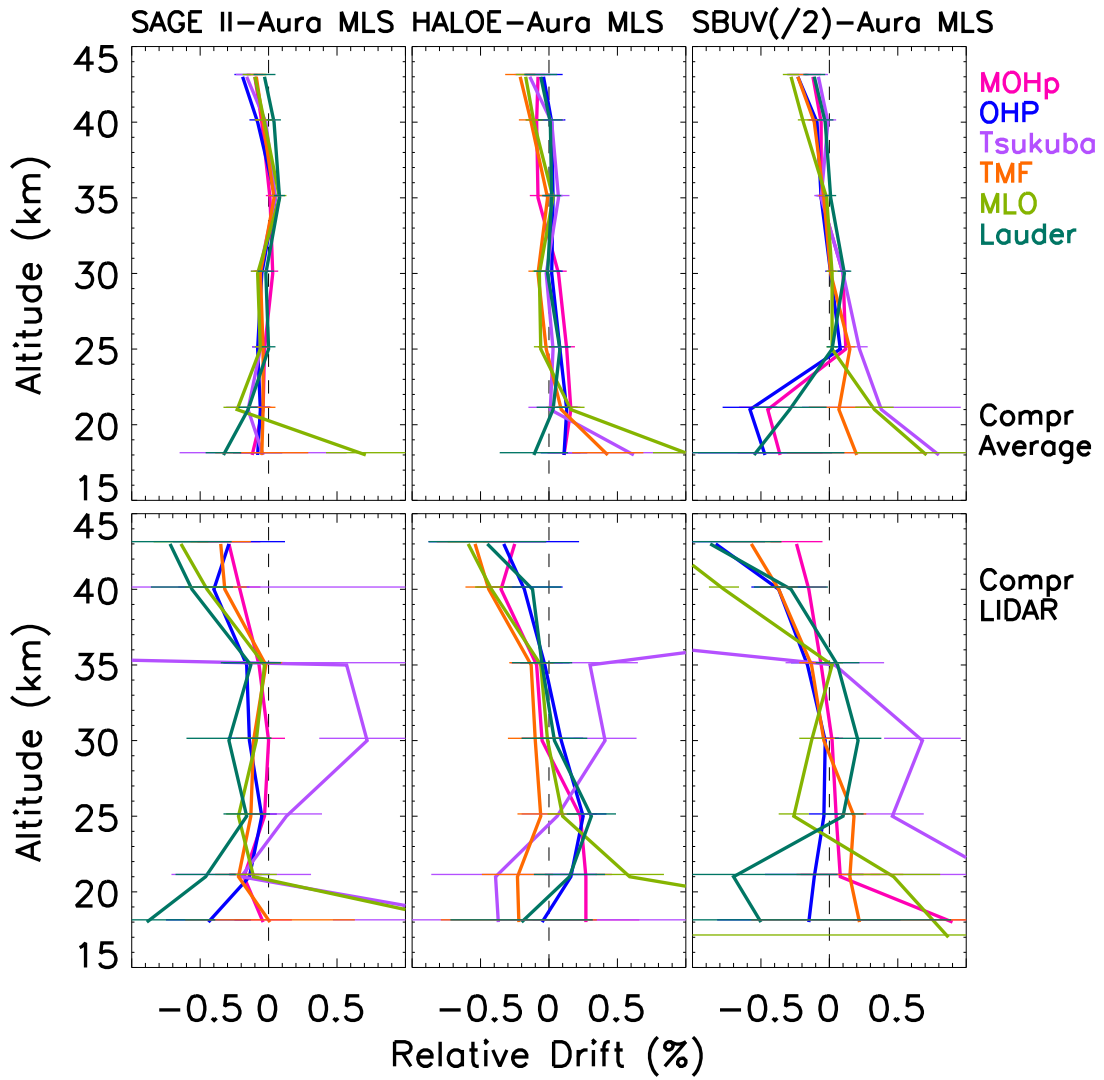
Time series of 5 month running average of ozone anomaly at Mauna Loa Observatory and Lauder.



Long term relative differences



Drift of long term composite time series



Conclusions

- 5 NDACC stations provide lidar ozone profile time series since 1991 or before
- Average differences within ± 5 % at 20-45 km
- Drifts: below ± 1 %/year at 20-45 km
- Smaller average and drifts using daily composite averages
- Comparison of monthly averages also possible
- Issues with continuation of the time series (Tsukuba, Lauder)
- 2010-2011: ISSI team on O3 and T lidar algorithms