How homogeneous are ozonesonde network data?

D. Hubert[1], T. Verhoelst[1], J. Granville[1], A. Keppens[1],
J.-C. Lambert[1], T. Deshler[2], B. J. Johnson[3], F. Posny[4],
R. Querel[5], H. G. J. Smit[6], R. Stübi[7], D. W. Tarasick[8],
A. M. Thompson[9], R. Van Malderen[10]

[1] BIRA-IASB, [2] U Wyoming, [3] NOAA/ESRL, [4] LACy/OSU-Réunion,
[5] NIWA, [6] FZ Jülich IEK-8; [7] MeteoSwiss, [8] ECCC, [9] NASA-GSFC, [10] RMI

BIRA·IASB

QA/validation system : versatile and operational

- Todo: add diagram

How can we evaluate the homogeneity of the ozonesonde network?

Many satellite records provide good quality stratospheric ozone
We considered SAGE II v7.0, OSIRIS v5.07, GOMOS V6, MIPAS V6 and Aura-MLS v3.3.

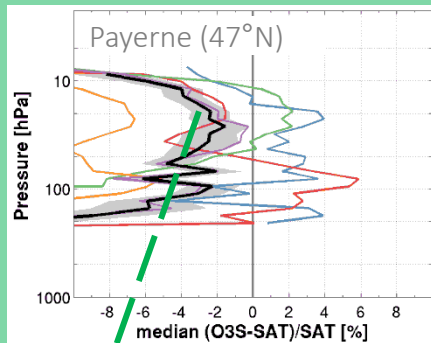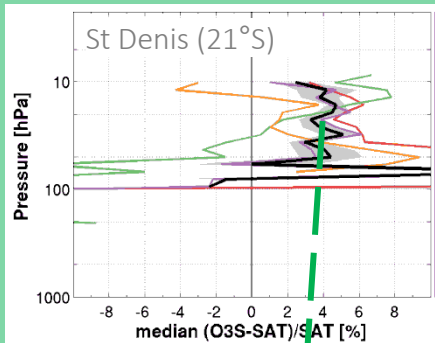**Ensemble approach to determine bias of record at each O3sonde station**

- Satellite-sonde co-location within 500km and up to 6/12h
- Select highest/documented quality satellite data only
- (Weighted) average of bias relative to all satellite records

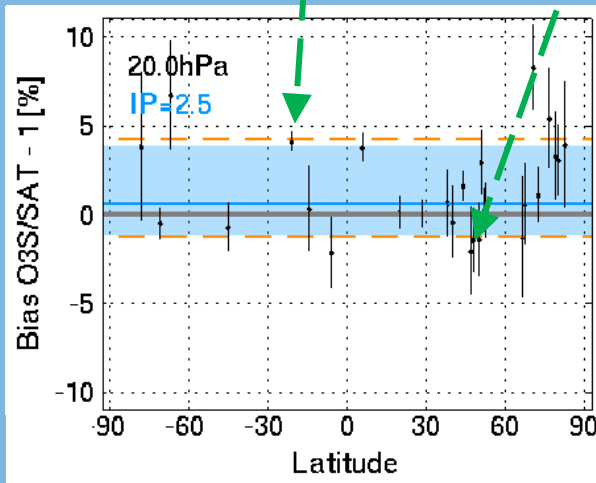**Compare results of site bias across the network**

- Altitude range: above 20km
- Period: 2000-2013
- GAW data archives: NDACC DHF (28 sites) and WOUDC (60 sites)

Illustration of the method

① St Denis (21°S) — Pressure [hPa] vs median (O3S-SAT)/SAT [%]

Payerne (47°N) — Pressure [hPa] vs median (O3S-SAT)/SAT [%]

② 20.0hPa IP=2.5 — Bias O3S/SAT − 1 [%] vs Latitude

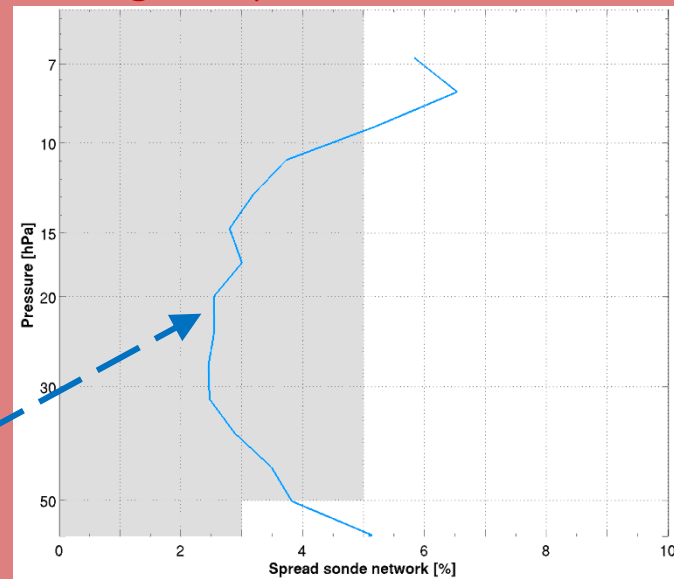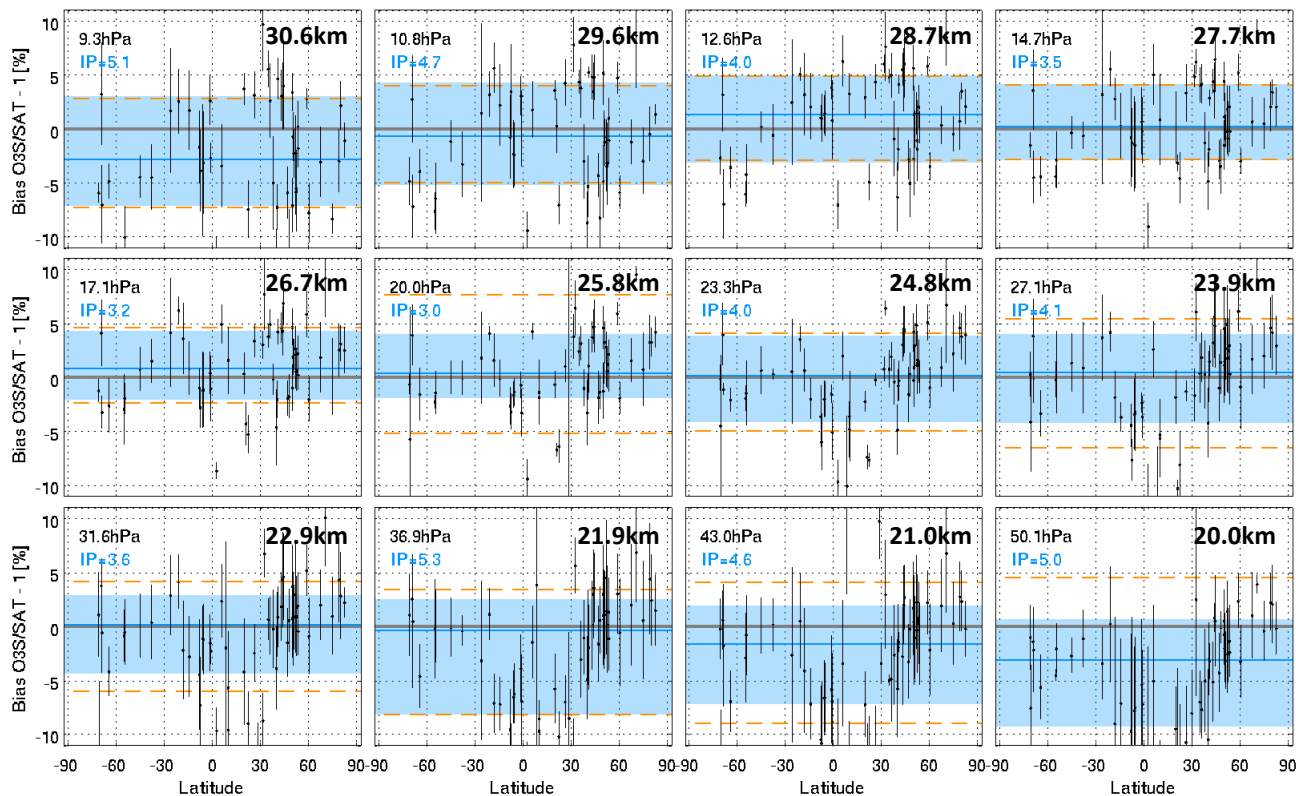③ Vertical structure of network homogeneity — Pressure [hPa] vs Spread sonde network [%]

spread across network
=

upper limit to "ground network homogeneity"
satellite, sampling and smoothing uncertainties
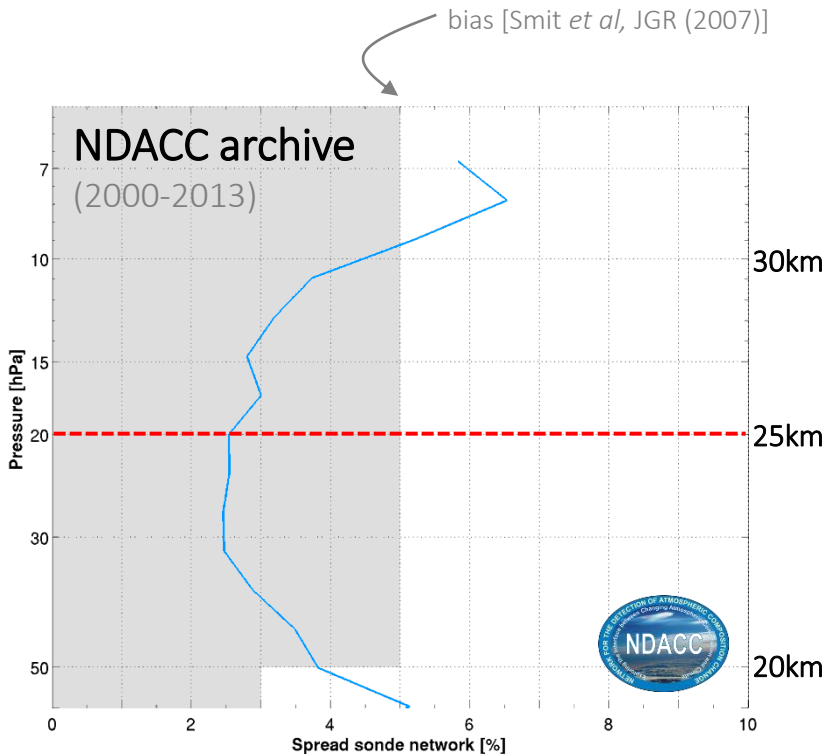are part of the random error budget

Meridian cross-section of archived ozonesonde data

There is a clear altitude dependence of the spread in site bias across the network

Vertical structure of NDACC homogeneity

bias [Smit *et al*, JGR (2007)]

NDACC archive
(2000-2013)

Key points

- Most homogeneous around 25km (~20hPa)

- Worsens by 1-2% below
  poorer satellite precision, less ozone
  & increased natural variability
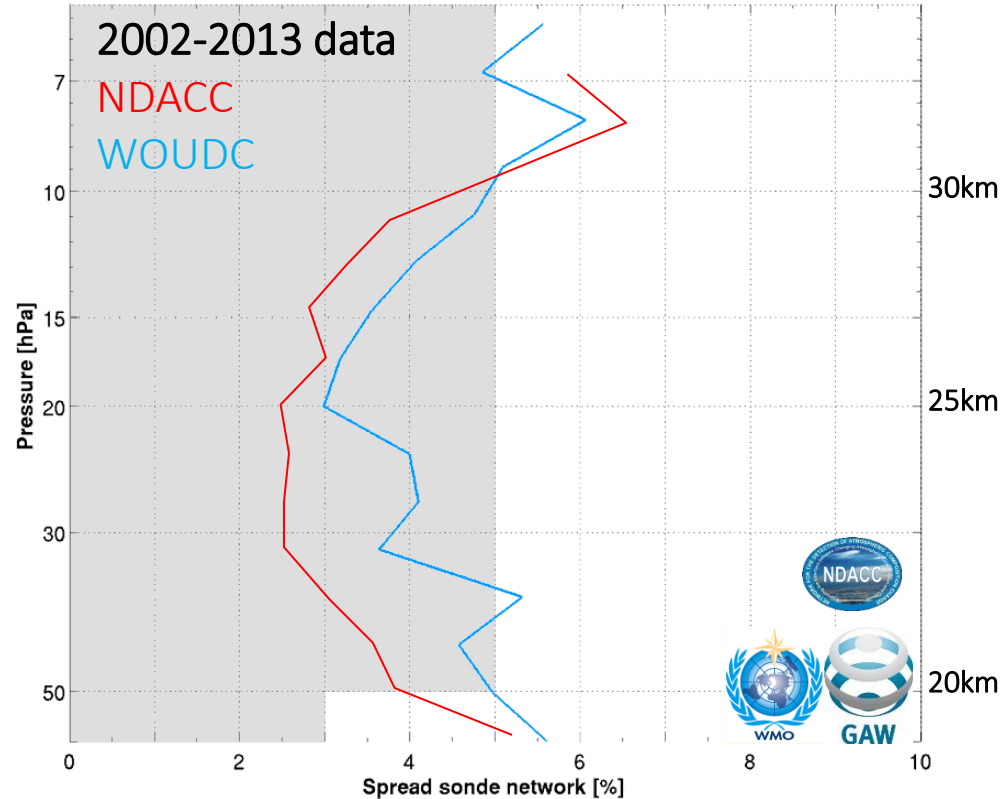
- Worsens by 1-2% above
  poorer sonde data quality

Comparing NDACC DHF and WOUDC homogeneity

Very similar vertical structure of homogeneity
differences are within 0.5-1%

The NDACC DHF archive seems slightly more homogeneous than the WOUDC archive
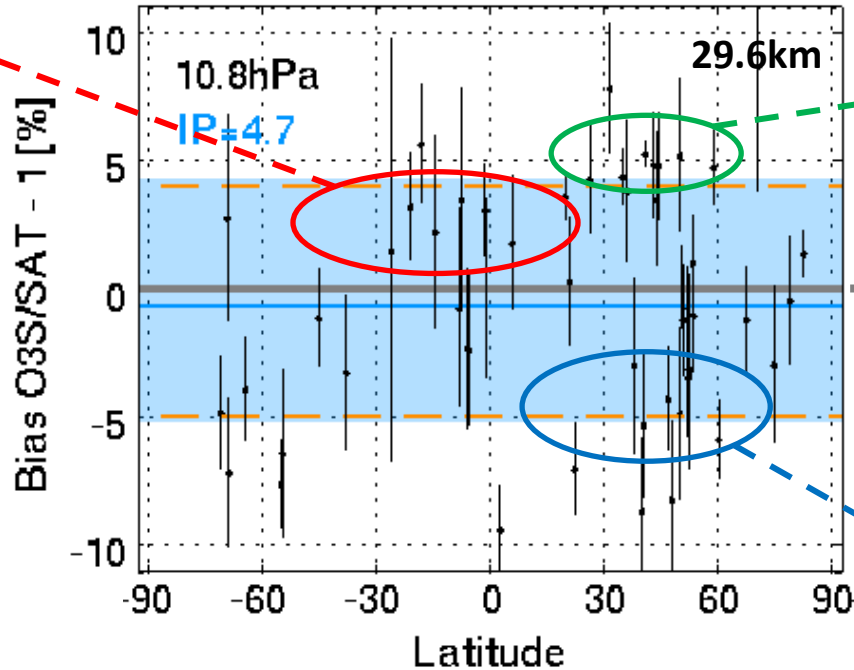likely as a result of fewer stations, especially in the tropics

Comparing NDACC DHF and WOUDC homogeneity

Very similar vertical structure of homogeneity
differences are within 0.5-1%

The NDACC DHF archive seems slightly more homogeneous than the WOUDC archive
likely as a result of fewer stations, especially in the tropics

spread = upper limit to network homogeneity
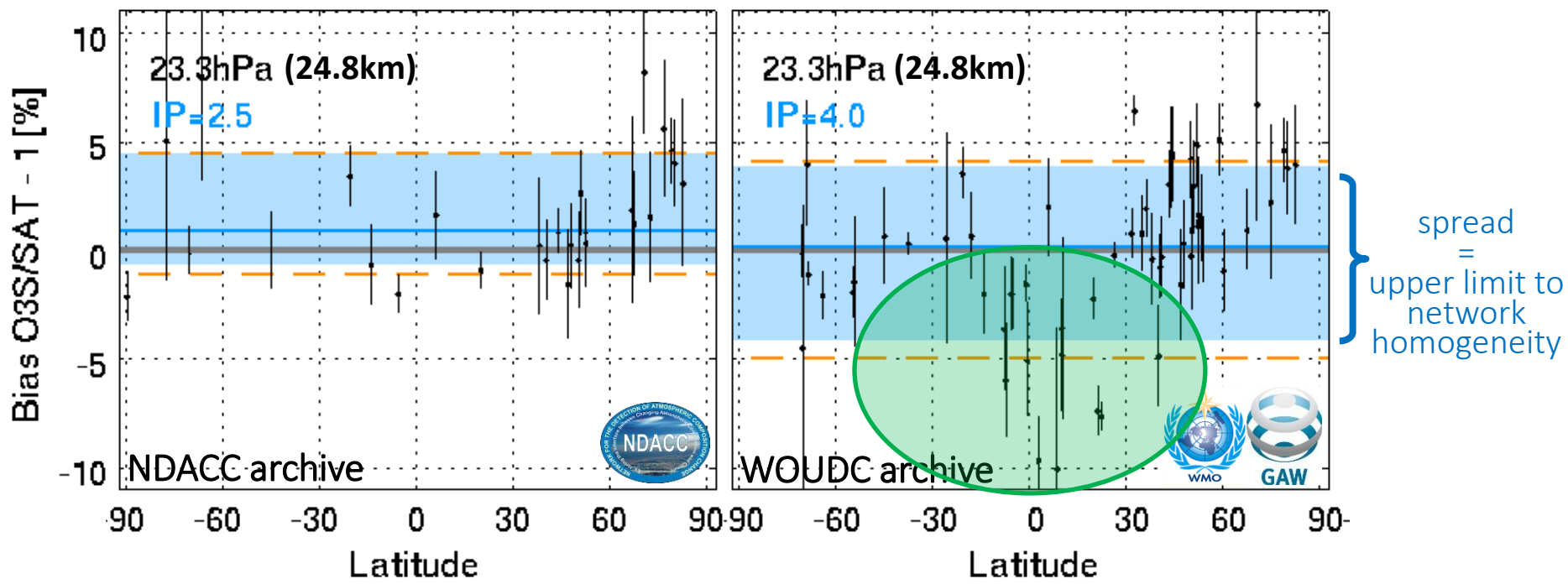
We can even go one step further…
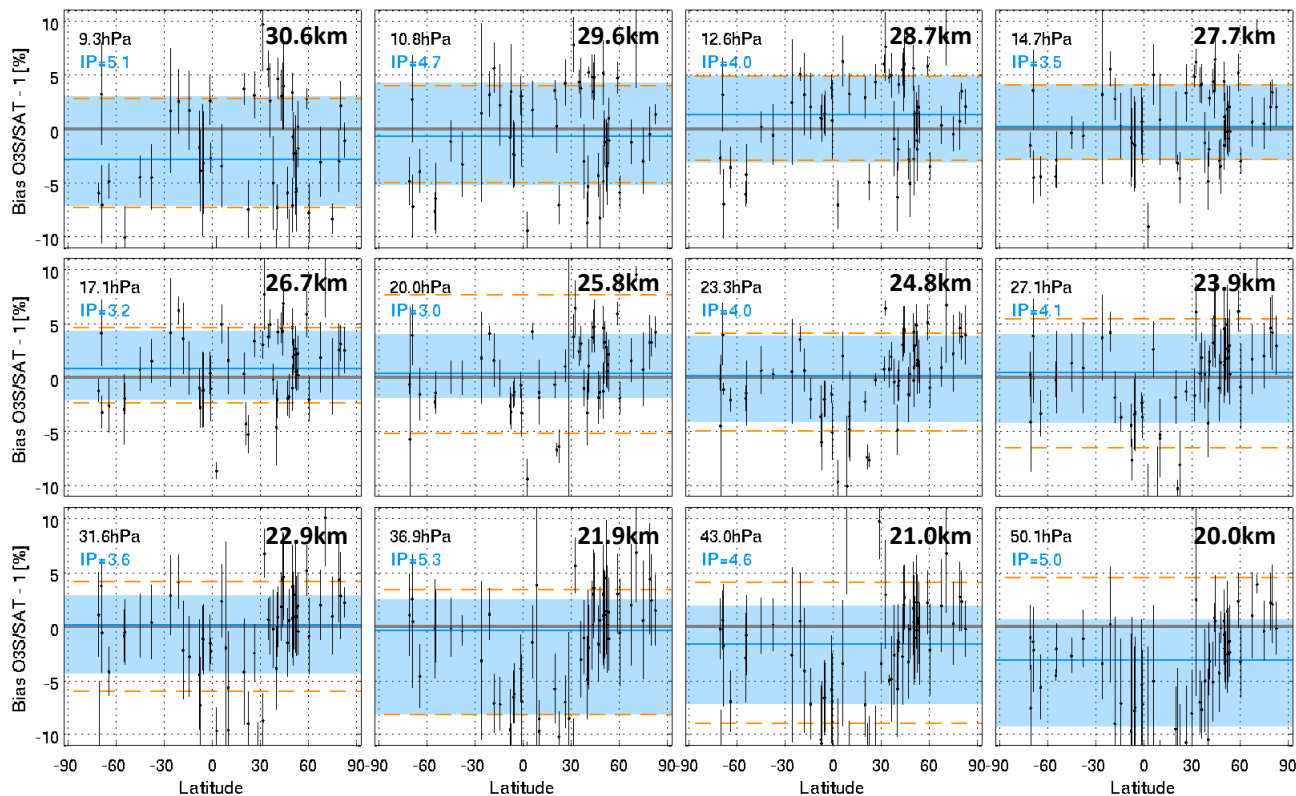
What happens at mid Northern latitudes?

We can even go one step further…

Network inhomogeneity at least partially caused by ozonesonde type

Bias differences due to ozonesonde type/model?

There are notable differences…
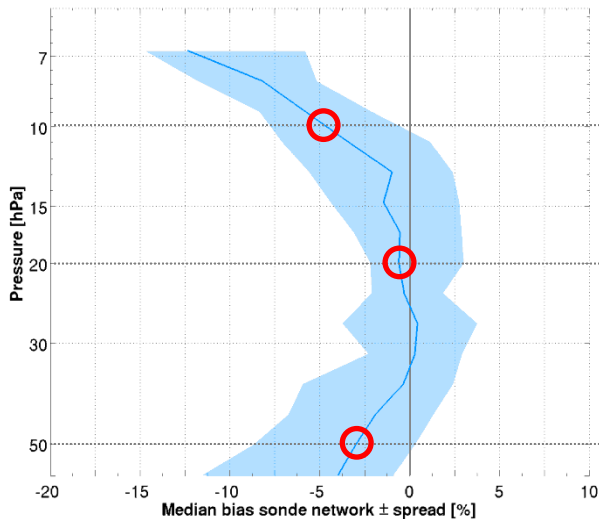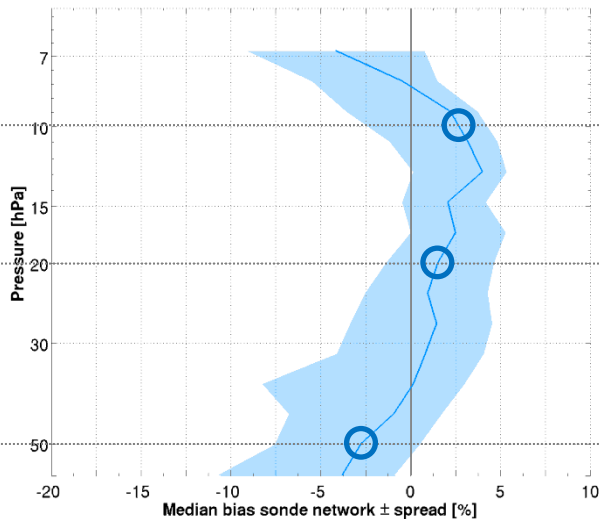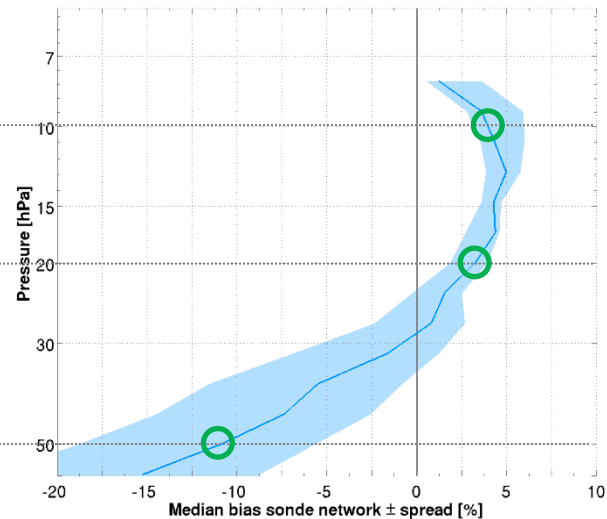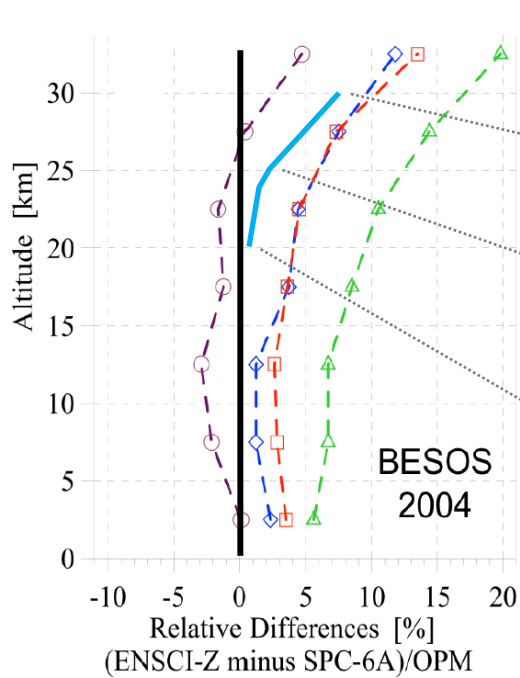

> These results are consistent with dedicated O3sonde field and laboratory campaign results
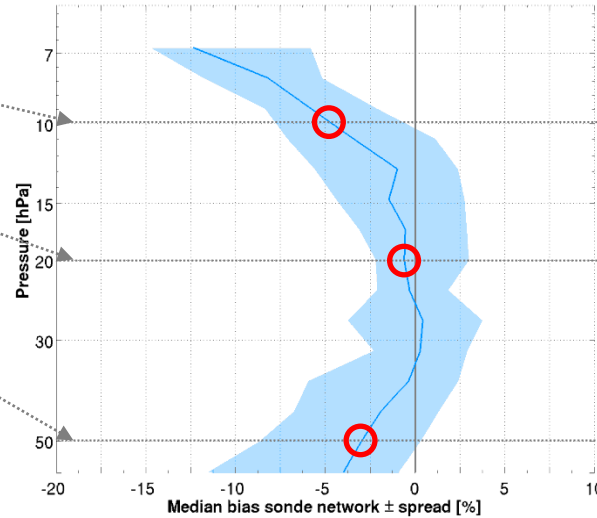
Results from laboratory and field campaigns

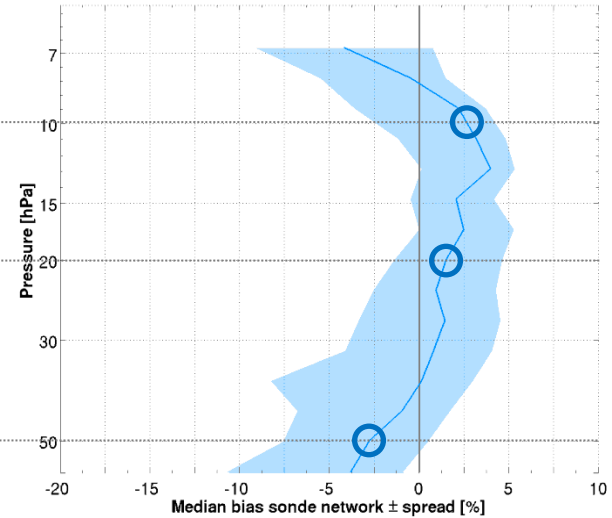## Changing ECC manufacturer and sensing solution strength
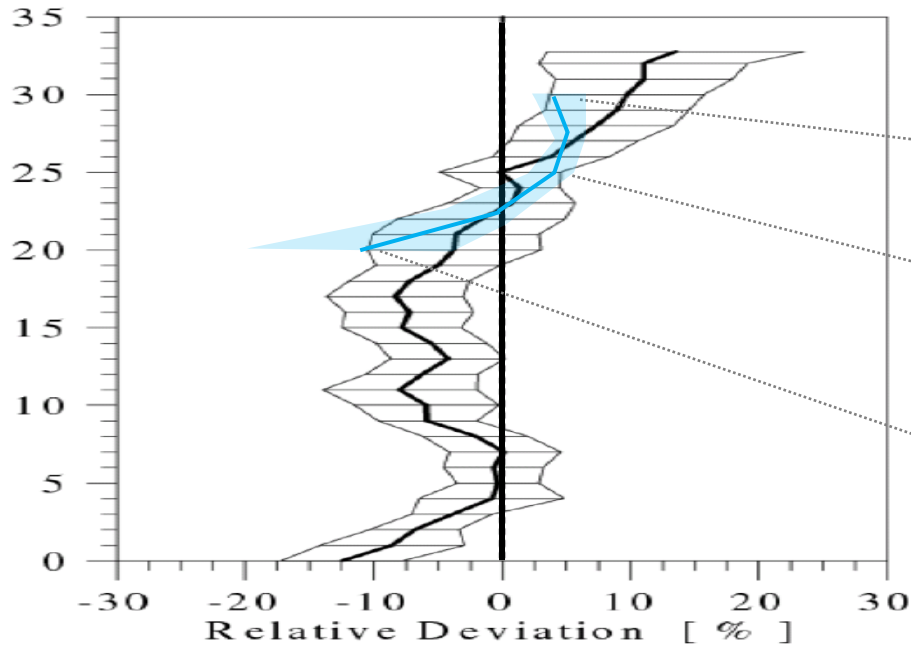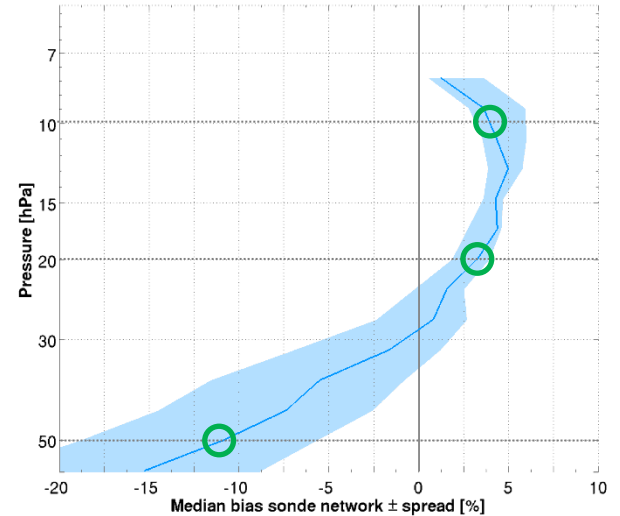[Smit and ASOPOS Panel (2011), WMO Report #201]

Results from laboratory and field campaigns

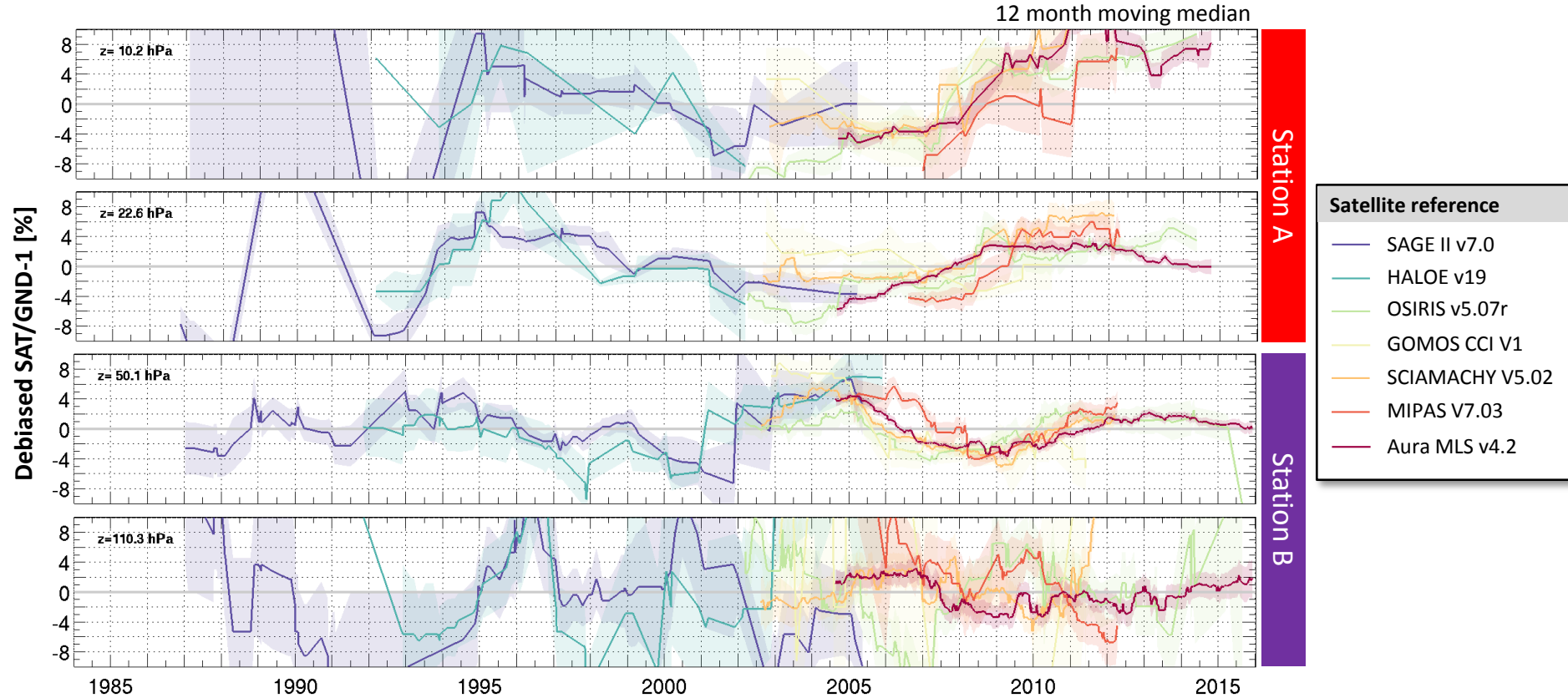## Difference between Japanese sonde and photometer
[Smit and ASOPOS Panel (2011), WMO Report #201]

Japanese (KC)

Diagnostic tool for features in ozonesonde time series

Conclusion

Homogeneity of NDACC DHF and WOUDC ozonesonde data archives
focused on 2000-2013 data between 20-33km

- Use spread in station bias across network as conservative estimate for network homogeneity

- The spread is smallest at 25km, less than ~3%

- It is better than ~5% at other altitudes

- Part of the inhomogeneity is traced to differences between sonde type and manufacturer

The method is also used as a diagnostic tool to identify sonde data quality issues at a single station.

Outlook

WMO's Ozonesonde Data Quality Assessment (O3S-DQA)

- Most stations with long-term records finalised homogenisation

- First internal data release by end of 2016 (30-40 stations)

- Evaluation and intercomparisons early 2017

- Contributes to WMO/UNEP ozone assessment 2018