



O3S-DQA – Internal consistency of the ozonesonde network in the middle stratosphere using satellite data ensembles as reference

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Ozonesonde PIs

Satellite Science & Processing Teams

Acknowledgements

ESA Multi-TASTE Phase F

Ozonesonde data records are the workhorse for ozone profile validation

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Why?

- In-situ measurements from 0-33km with $\sim 100\text{m}$ vertical resolution
- Networks provide pseudo-global coverage with often weekly soundings
- Data readily available and characterized

[Smit and ASOPOS Panel (2011), WMO Report #201]

But... time and site-specific inhomogeneities may occur in O3sonde records

- Due to changes in **pre-flight preparations**
e.g. O3sonde type & manufacturer, sensing solution type and strength, radiosonde type, ...
- Due to changes in **post-flight data processing**
e.g. corrections for background current, pump flow rate / efficiency, ...
- Bias can amount to a few percent

➤ WMO Ozonesonde Data Quality Assessment (O3S-DQA) initiative

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**

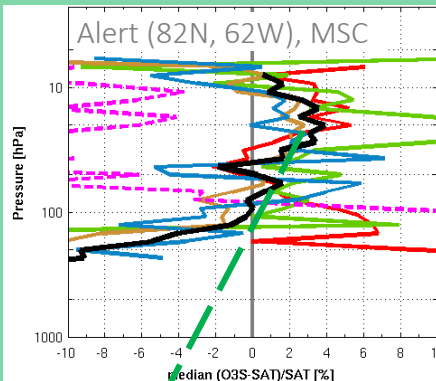
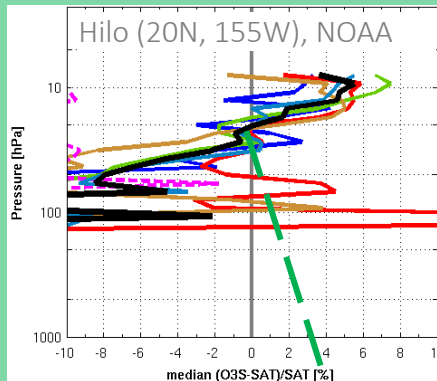
- Satellite-sonde co-location within 500km and up to 6/12h
- Select highest/documented quality satellite data only
- (Weighted) average of bias relative to all satellite records

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

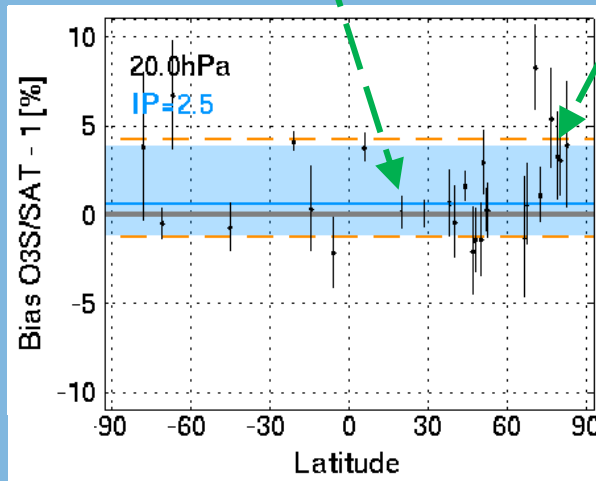
- Altitude range: above 20km
- Period: 2000-2013
- Data archives: NDACC DHF (28 sites) and WOUDC (60 sites)

Illustration of the method

①



②

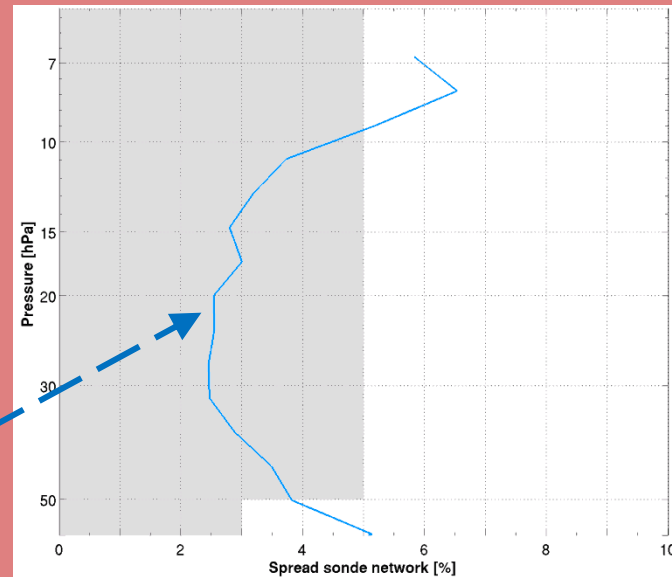


spread across network
=

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

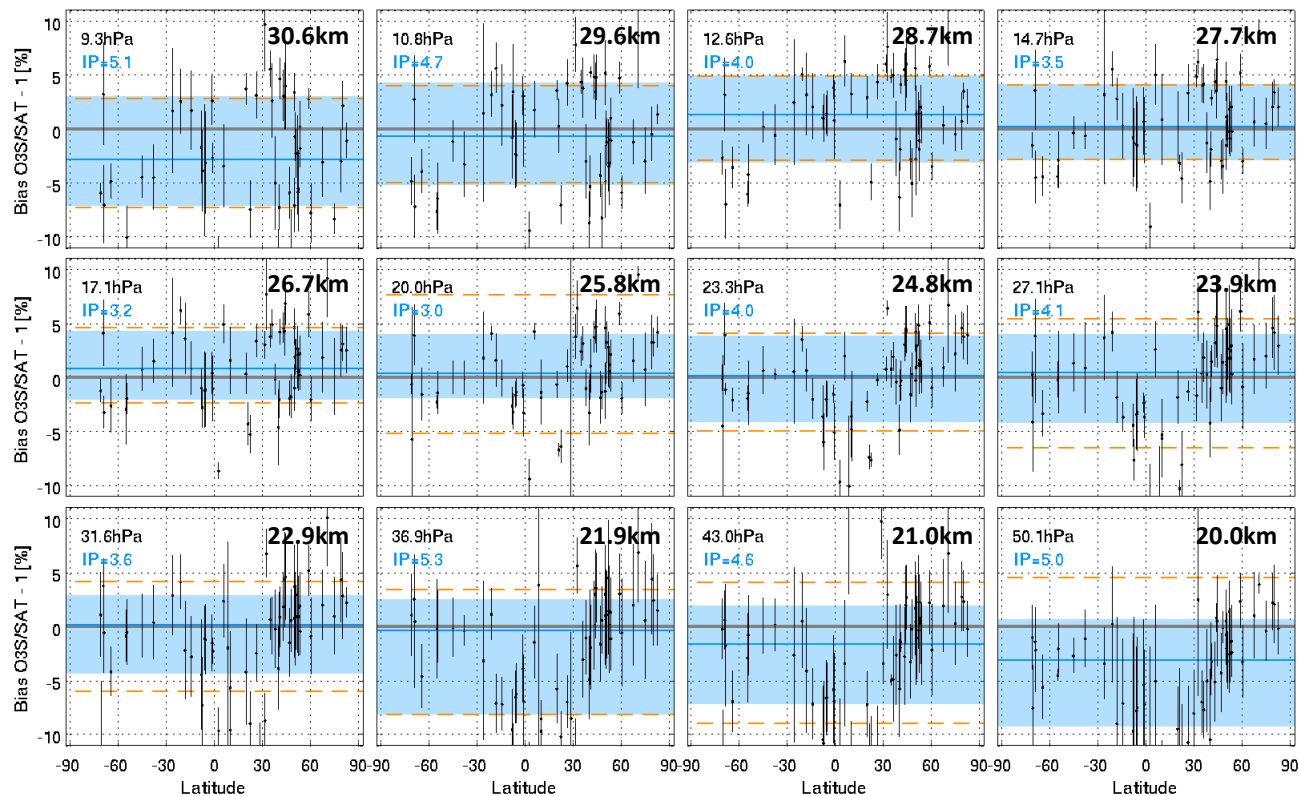
③

Vertical structure of network homogeneity



Meridian cross-section of archived ozonesonde data

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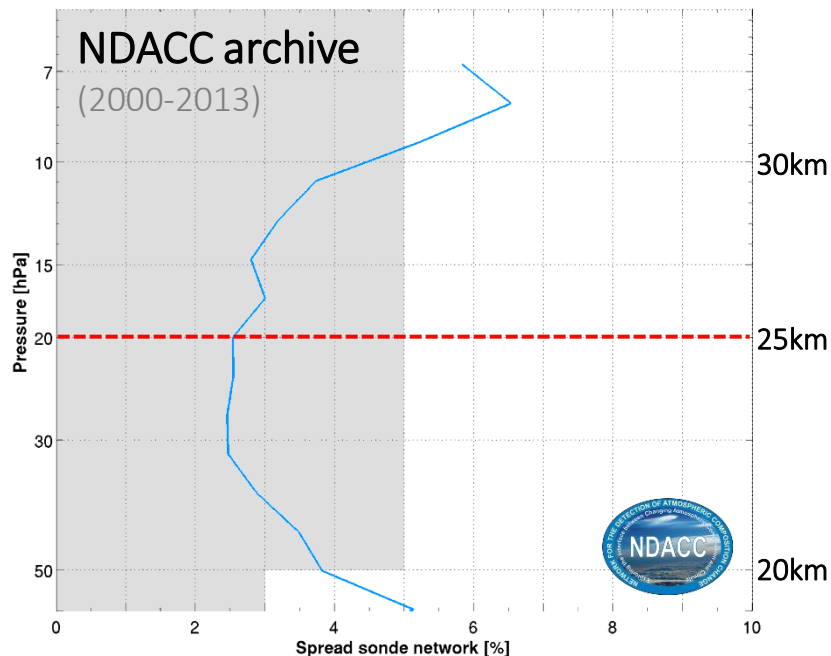


There is a clear altitude dependence of the spread in site bias across the network

Vertical structure of NDACC homogeneity

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



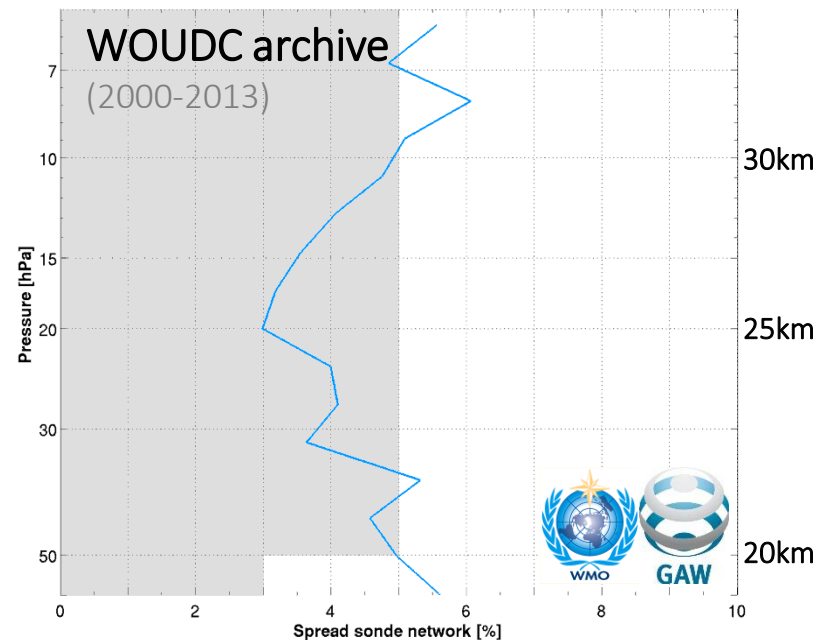
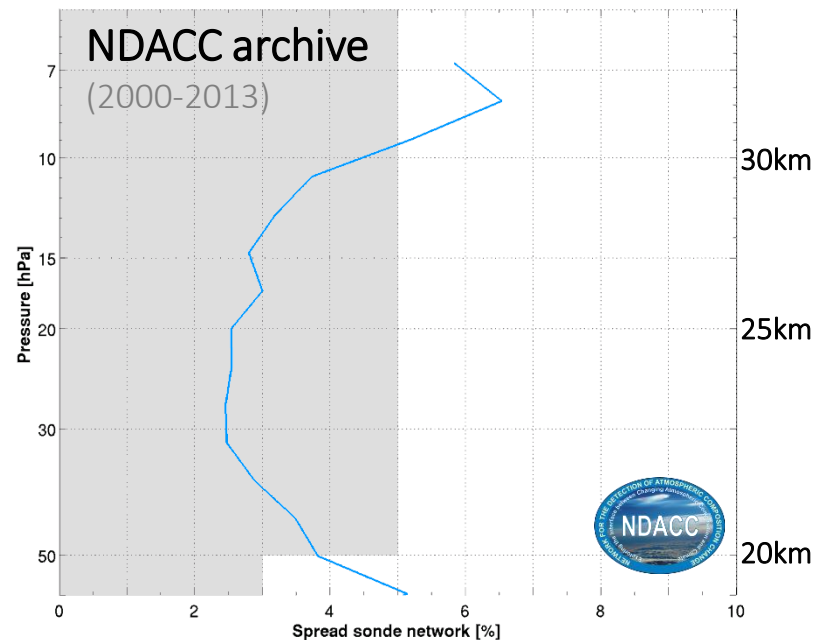
Key points

- 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



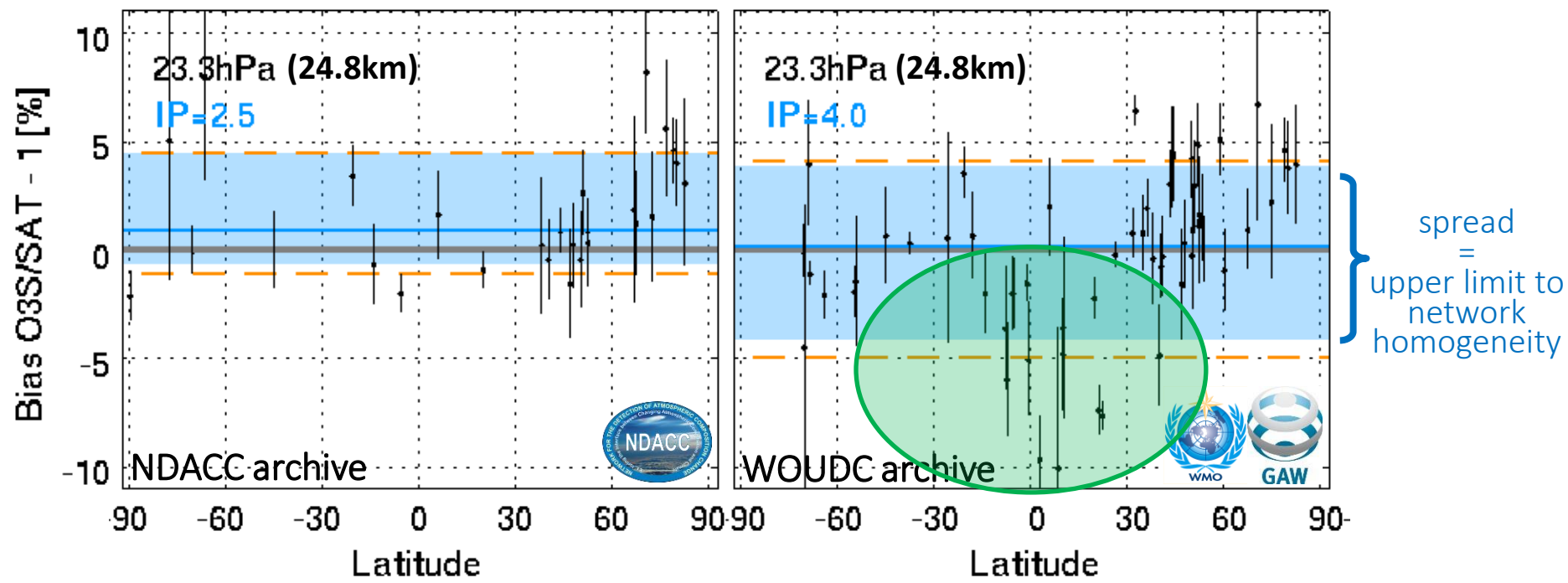
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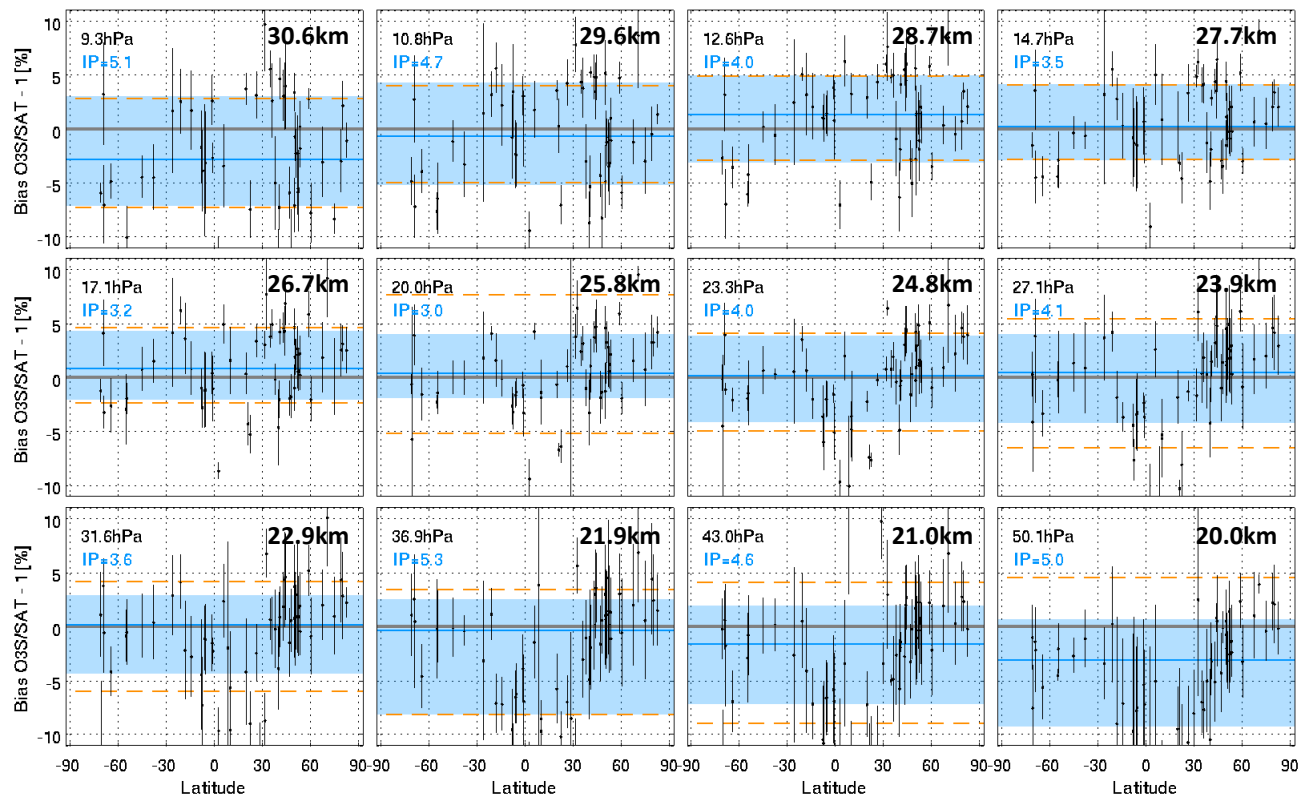
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We can even go one step further...



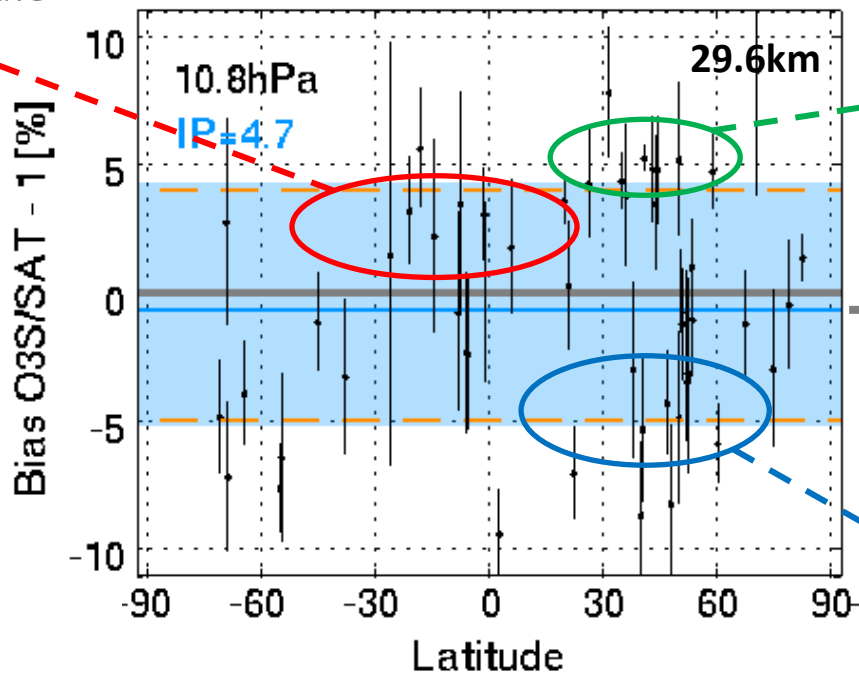
What happens at mid Northern latitudes?

We can even go one step further...

Network inhomogeneity at least partially caused by ozonesonde type

ECC ENSCI sonde

biased positive



KC sonde

biased positive

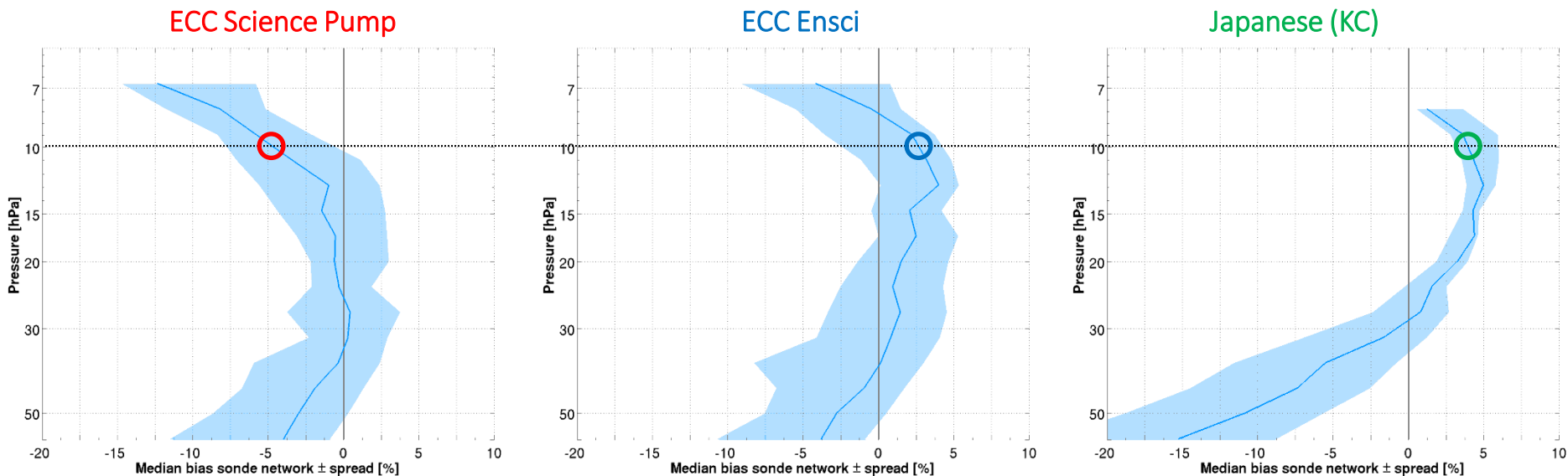
bias entire network

ECC SPC sonde

biased negative

Bias differences due to ozonesonde type/model?

There are notable differences...

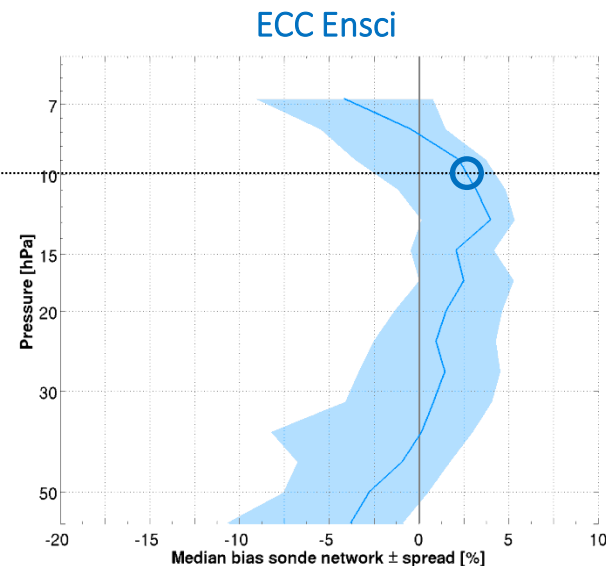
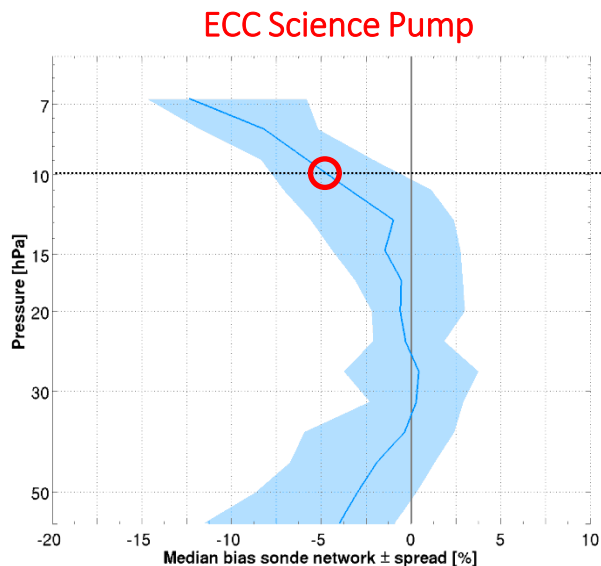
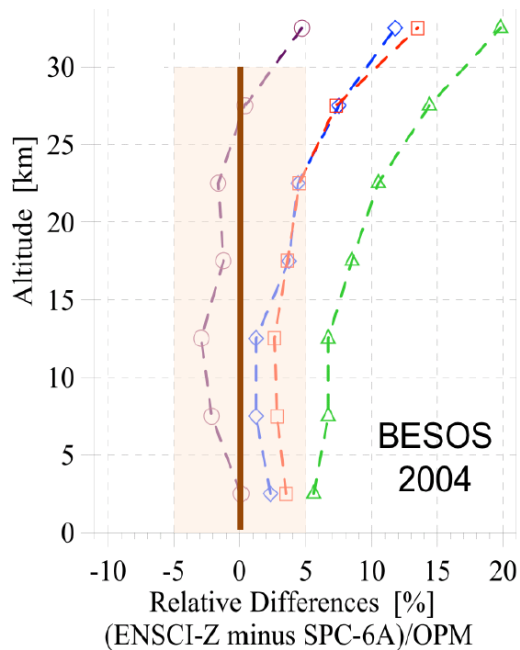


➤ These results are consistent with dedicated O3sonde field and laboratory campaign results

Results from laboratory and field campaigns

Changing ECC manufacturer and sensing solution strength

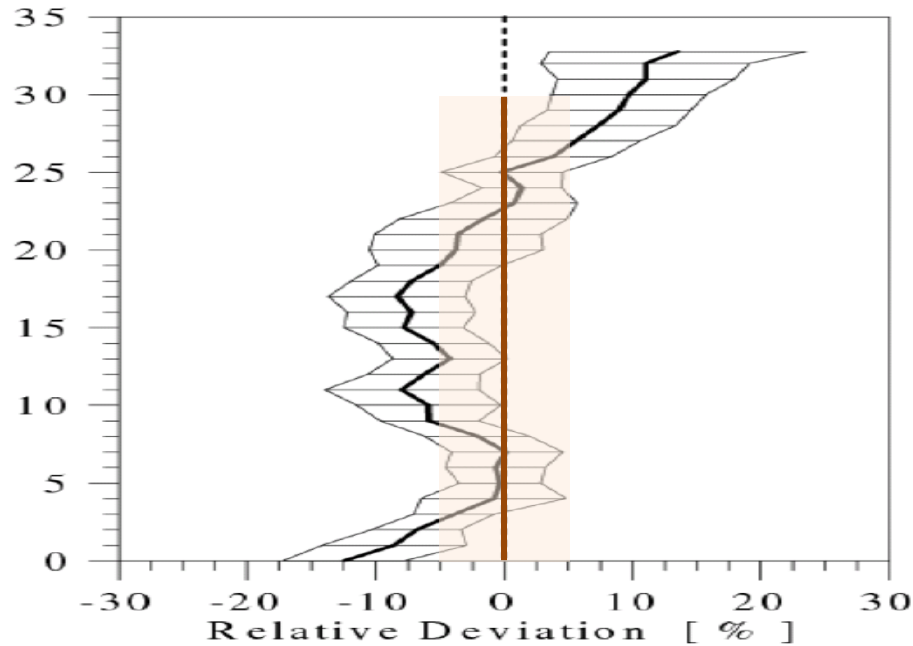
[Smit and ASOPOS Panel (2011), WMO Report #201]



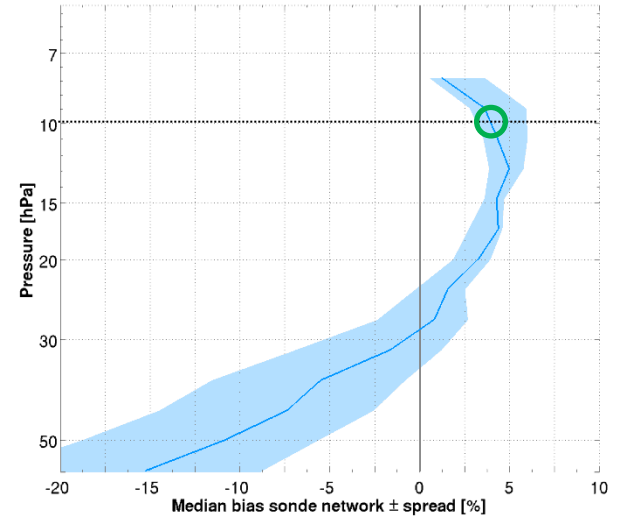
Results from laboratory and field campaigns

Difference between Japanese sonde and photometer

[Smit and ASOPOS Panel (2011), WMO Report #201]



Japanese (KC)



Assessment of ozonesonde network data homogeneity using satellite-based ensemble approach

- Contribution to WMO's Ozonesonde Data Quality Assessment (O3S-DQA)
- Focus here on data of 2000-2013 and between 20-33km

Homogeneity of NDACC DHF and WOUDC ozonesonde data archives

- Use spread in station bias across network as conservative estimate for network homogeneity
- The spread is **smallest at 25km, below ~3%**
- It is **better than ~5% at other altitudes**
- Part of the inhomogeneity is traced to differences between sonde type and manufacturer

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

The O3 Sonde Data Quality Assessment (O3S-DQA)

Objectives

Perform corrections for differences in sonde type & manufacturer, sensing solution type & strength, background current, pump flow rate, ... in a homogenized way at 50 participating stations

- Reduce uncertainty down to 5-10%.
- Document the homogenization process and the quality of ozonesonde measurements to allow the recent record to be linked to the older...

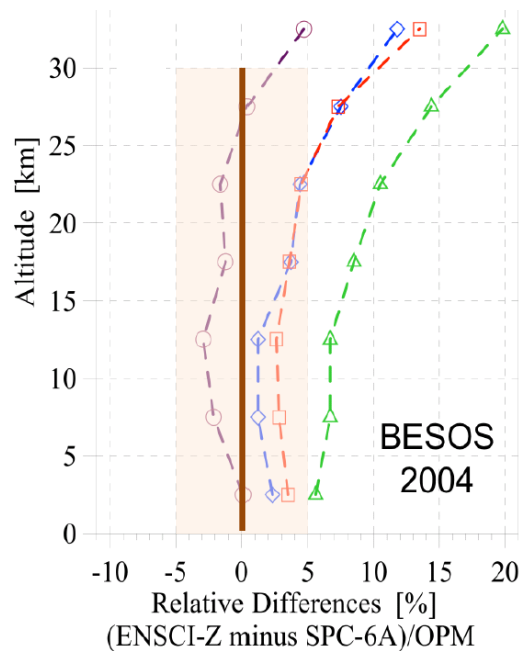
Proposed guidelines to homogenize O3 sonde records should result in

- **Reduced temporal inhomogeneity** at single stations (reduce jumps in time series)
 - important for satellite drift analyses
- **Reduced spatial inhomogeneity** between stations
 - important for satellite bias validation
- **Introduction of uncertainty values** for each measurement level in the profile
 - important for SAT validation

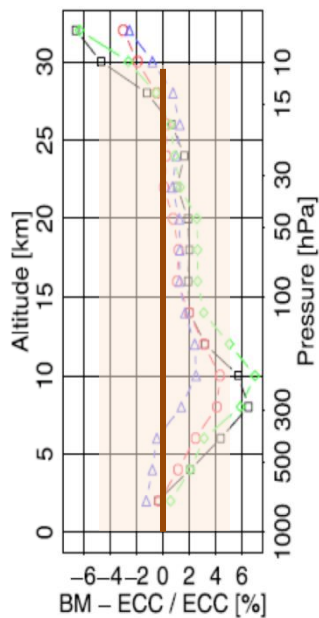
Results from laboratory and field campaigns

[Smit and ASOPOS Panel (2011), WMO Report #201]

a) Changing ECC manufacturer and sensing solution strength



b) Difference between ECC sonde and BM sonde



c) Difference between Japanese sonde and photometer

