

Occultation Data Intercomparison & Evaluation

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OUTLINE

- Proposal Summary
- SOLVE-2 Sonde Comparisons
- SAGE III/SAGE II/HALOE/POAM III/POAM II

Proposed Goals & Tasks

Validate SAGE III data

- O_3 , NO_2 , H_2O , and aerosol extinction
- Compare to SAGE II, HALOE, POAM III
- Compare to in-situ measurements
- Evaluate differences

Perform comprehensive occultation data intercomparison

- O_3 , NO_2 , H_2O , and aerosol extinction
- SAGE II & III, POAM II & III, HALOE, ATMOS, ILAS I & II (Also ACE, GOMOS, & MSX)
- Most recent data versions

Produce detailed morphology of the differences in time and space, along with evaluations of any systematic differences found.

A "Unified" Occultation Database

Some Intercomparison Issues

- **Ozone**

- Expect agreement within $\pm 5\%$ from 15-50 km (except HALOE at 25 km).
- Variable and large disagreements below 15 km.
- Disagreements above 50 km - Diurnal variations?

- **NO₂**

- Expect agreement within $\pm 10\%$ from 25-35 km.
- Diurnal variations 20-25 km.
- HALOE aerosol extrapolation error: -5% above 35 km.
- S2-P3 (S2 20-40% low) not consistent with H-P3 & S2-H.
- POAM II 10-15% low bias.

- **Aerosol Extinction**

POAM III - sr/ss bias

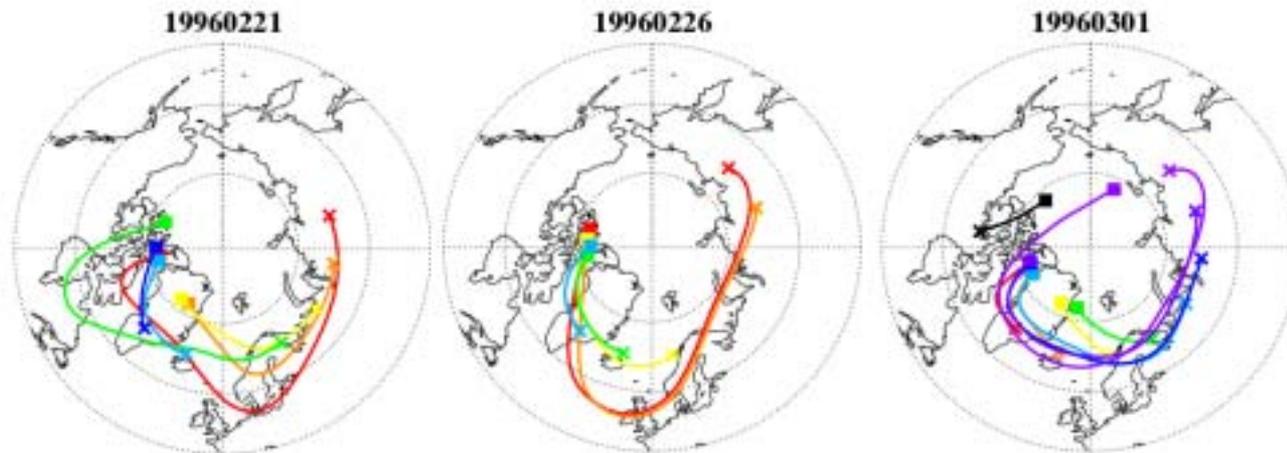
- **Water Vapor**

- SAGE II high bias (20-60% below 30 km)
- HALOE low bias (~10%)

- **Coincidence Criteria**

Equivalent Latitude and Trajectory Matching

- Traditional criteria (space/time) ill-suited for dynamically active regions.
- Equivalent latitude criterion ensures sampling of similar air parcels.
- Trajectory matching increases # “coincidences”.

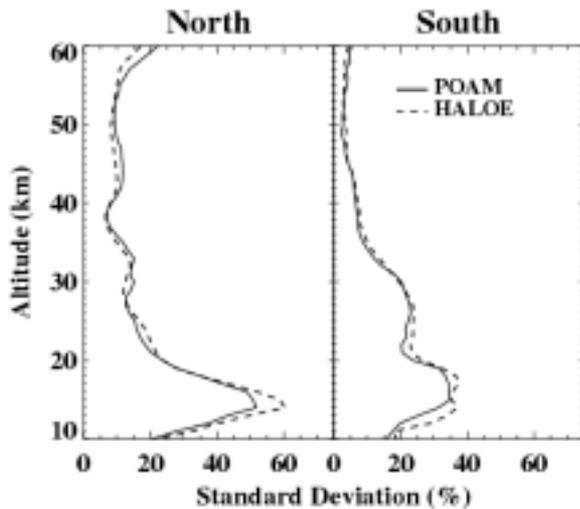


Isentropic (500-K) 5-day back trajectories from POAM III (68°) to SAGE III (78°) using 1996 meteorological conditions.

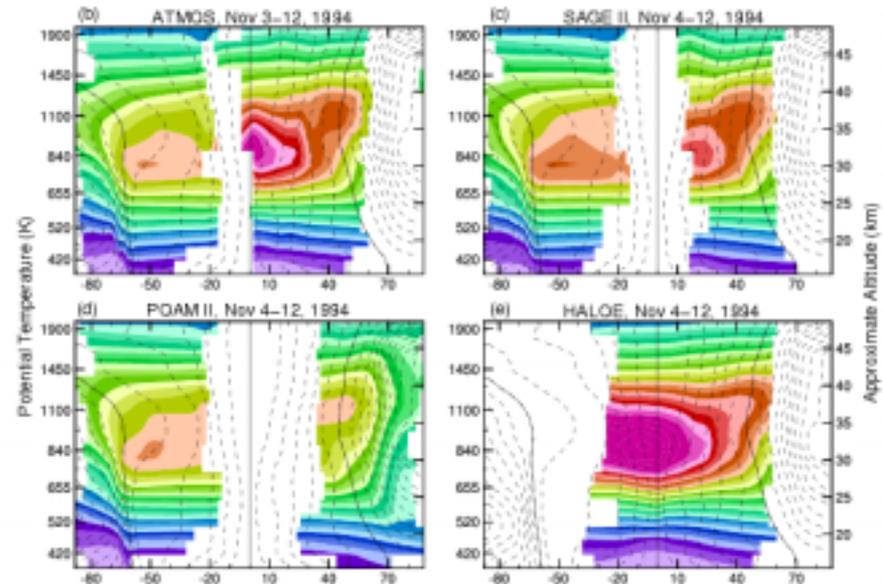
Evaluation of Differences - 1

1. Other correlative data
 - Balloon, aircraft, ground-based
 - Satellite: UARS MLS, Aura MLS/HIRDLS, SS CRISTA
 - Avoid solar occultation systematic errors
2. Compare data precision - Strict coincidence not required
3. Map and compare geophysical variations (e.g., Manney et al., 2001)

POAM-HALOE Precision

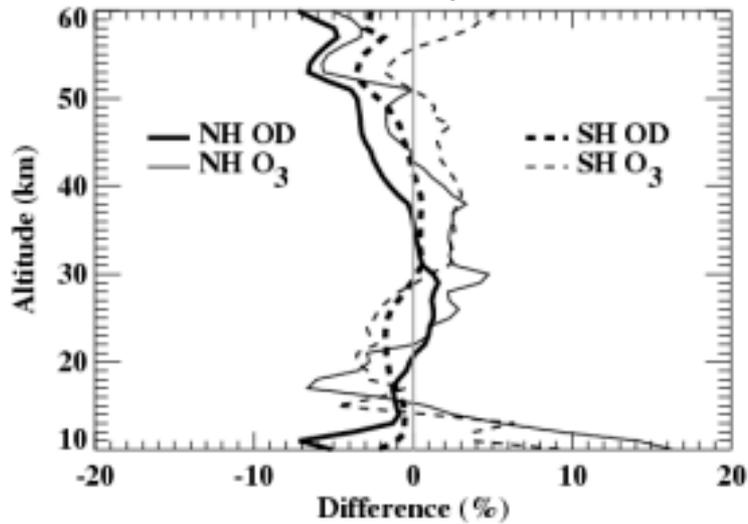


Geophysical Variations

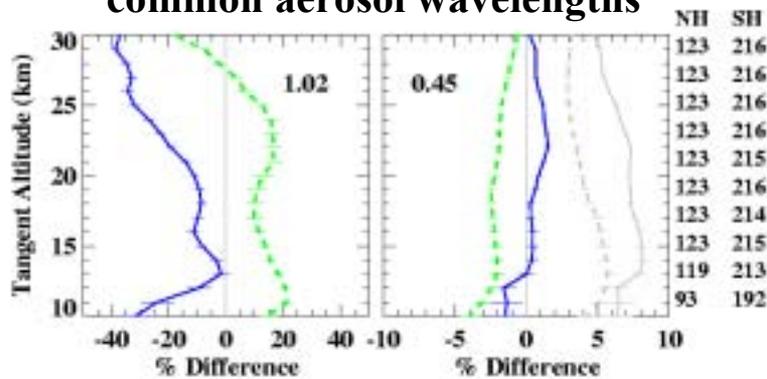


Evaluation of Differences - 2

POAM III-SAGE II O₃ & 600-nm ΔOD



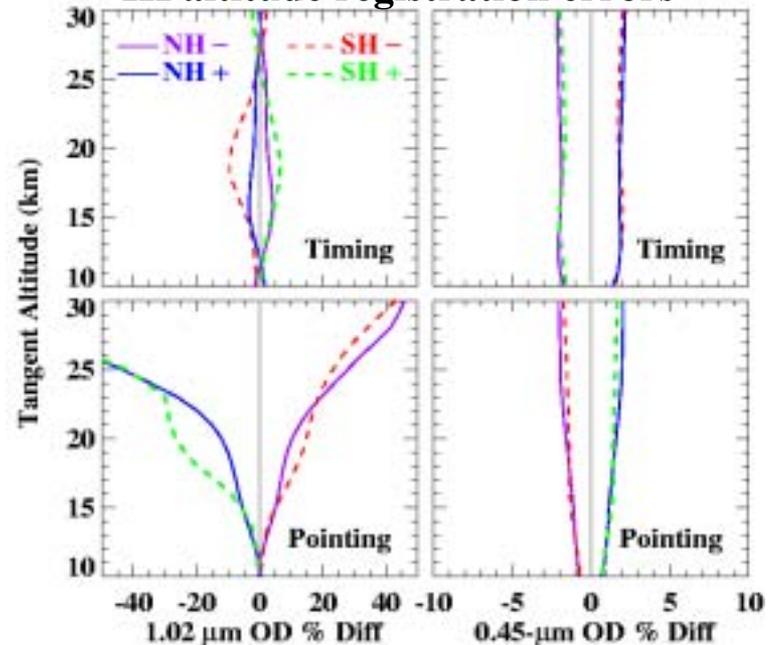
POAM III-SAGE II ΔOD at common aerosol wavelengths



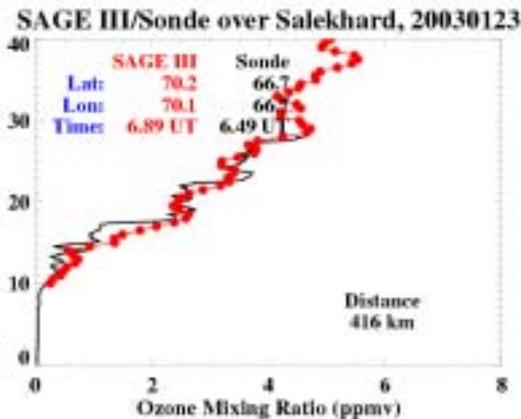
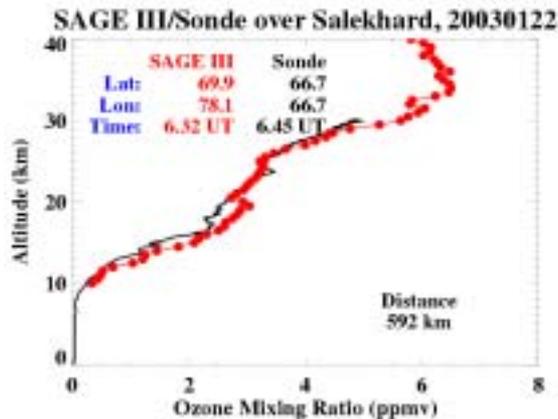
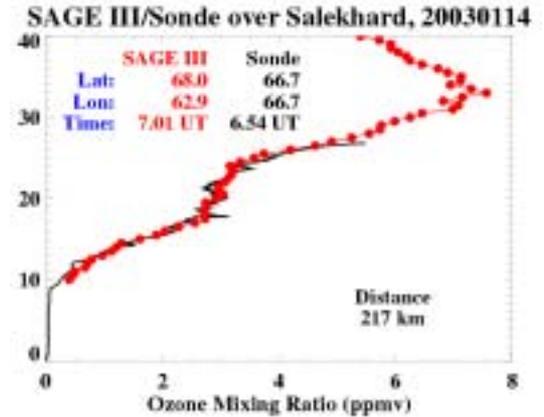
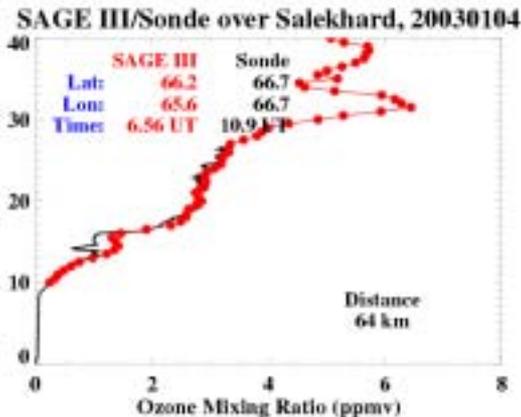
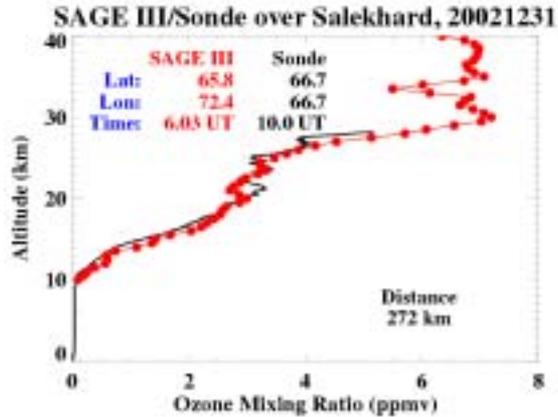
4. Slant path optical depth comparisons

5. Simulation of suspected systematic errors.

Simulation of possible POAM III altitude registration errors

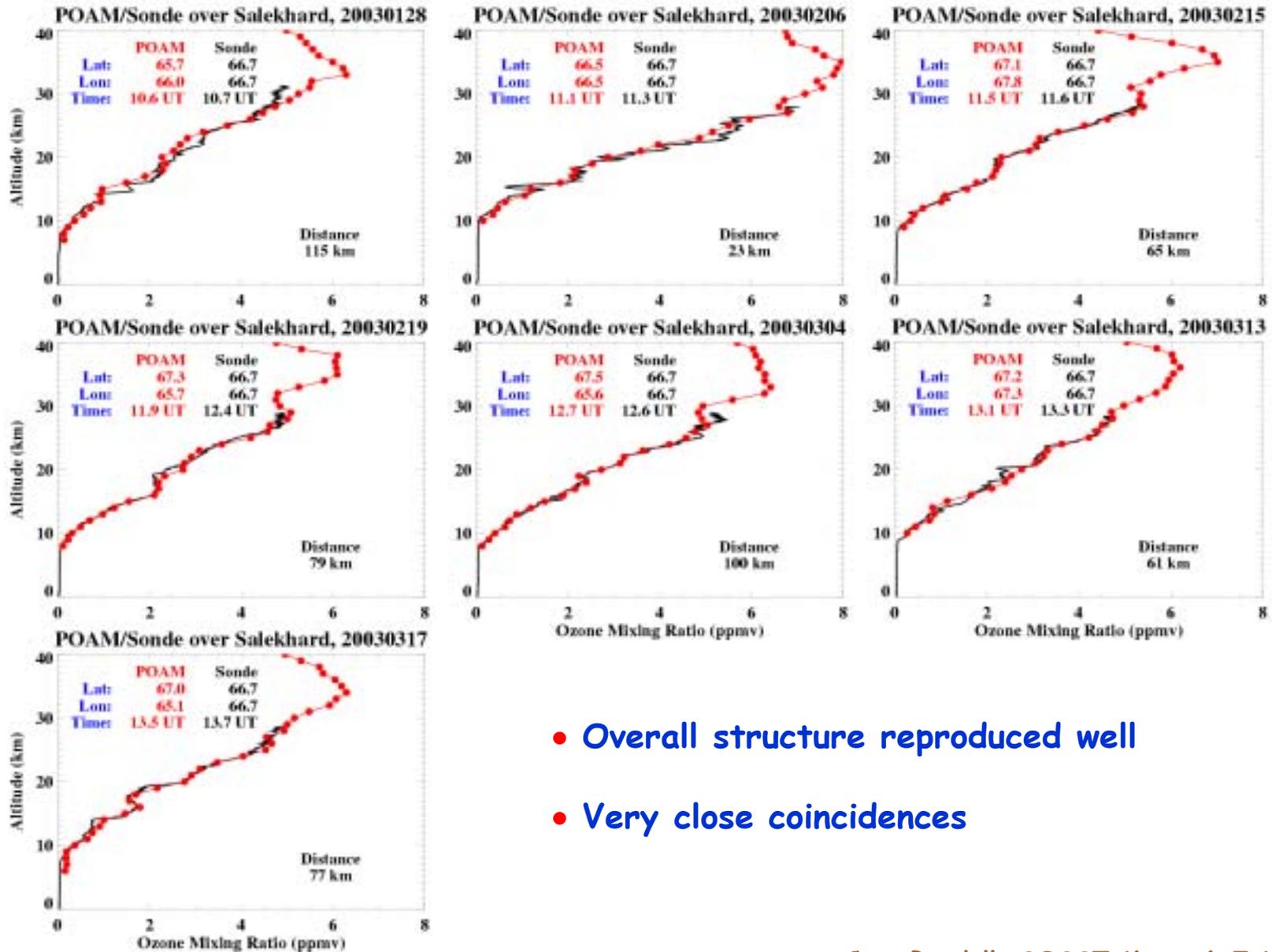


SOLVE-2: SAGE III vs. Salekhard Sonde



- Overall structure reproduced well
- Not particularly close coincidences

SOLVE-2: POAM III vs. Salekhard Sonde

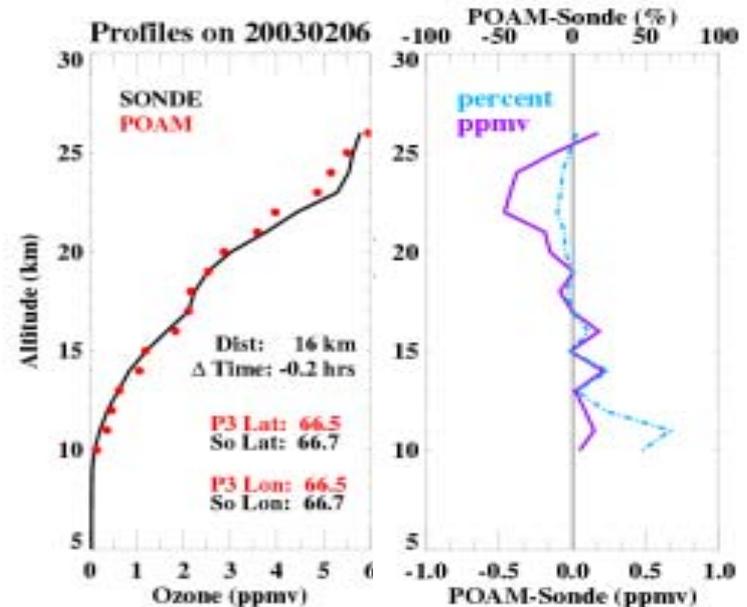
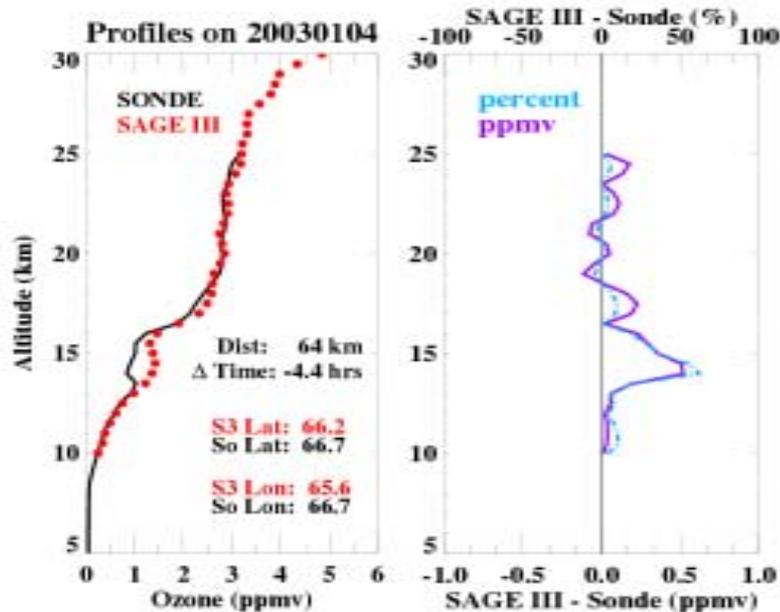


- Overall structure reproduced well
- Very close coincidences

SOLVE-2: Salekhard Sondes - Average Differences (1)

SAGE III - Sonde

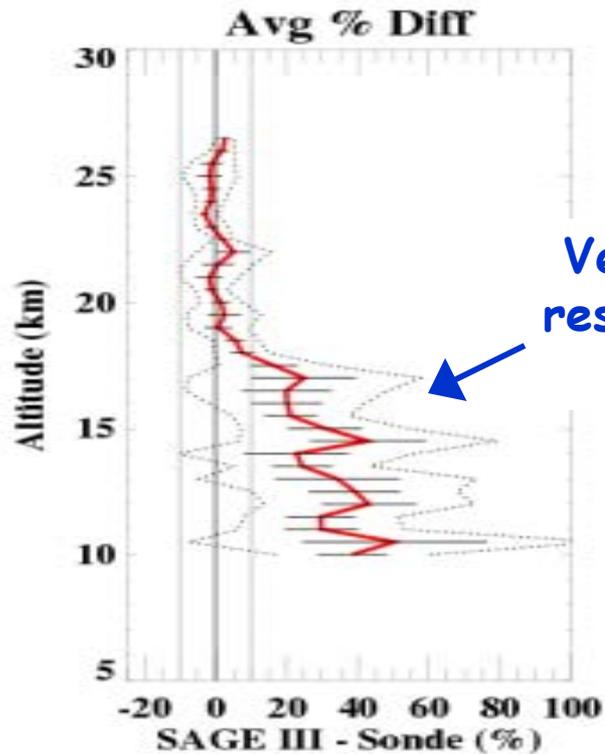
POAM III - Sonde



Sonde is convolved with occultation vertical resolution before calculating differences

SOLVE-2: Salekhard Sondes - Average Differences (2)

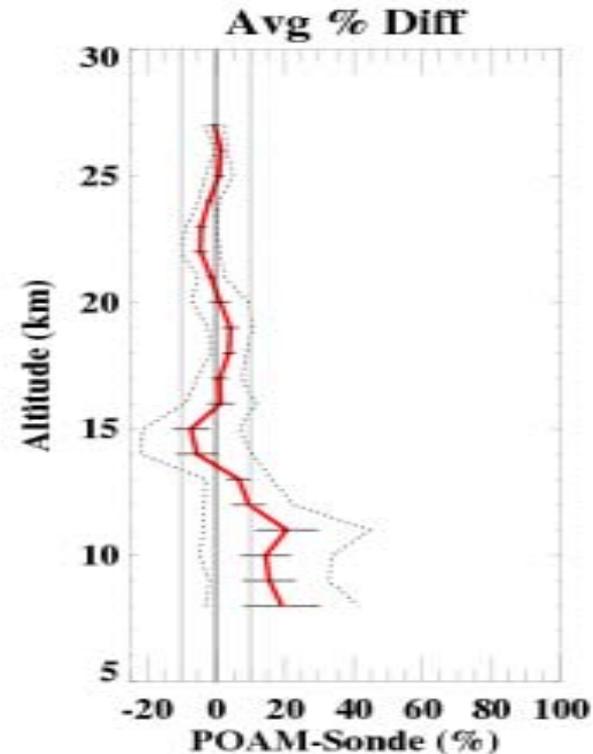
SAGE III: 5 Events



Vertical resolution ???



POAM III: 7 Events



Occultation Intercomparisons Including SAGE III

SAGE II v6.1

POAM II v6.0

SAGE III v2.00
(Ozone = "Composite")

POAM III v3.0

HALOE v19

Traditional Coincidences

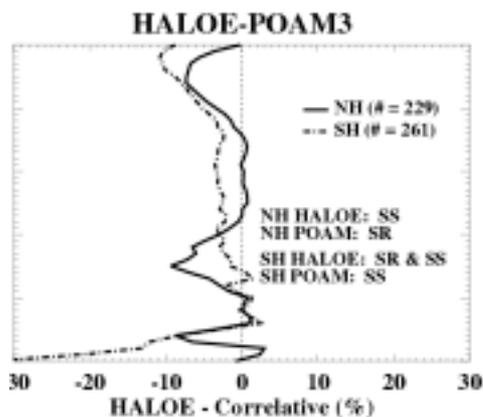
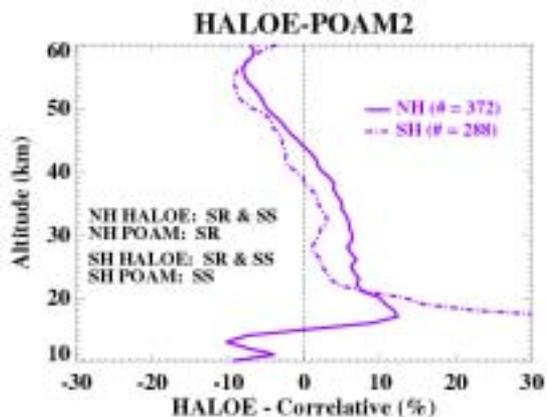
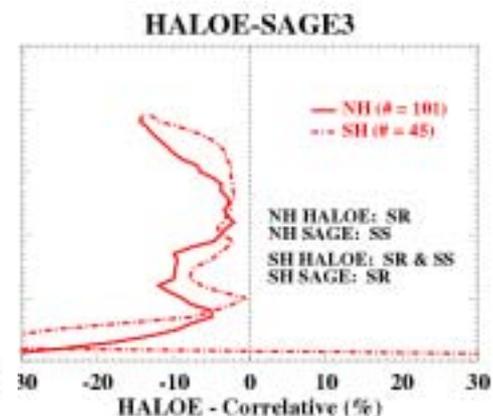
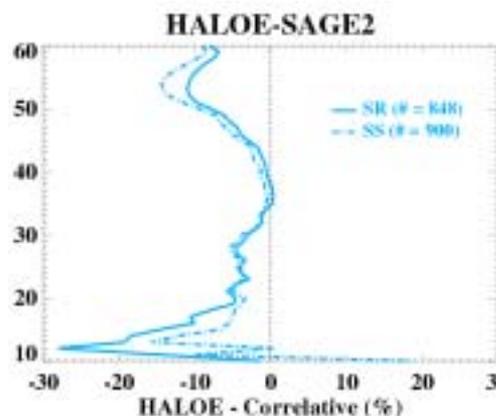
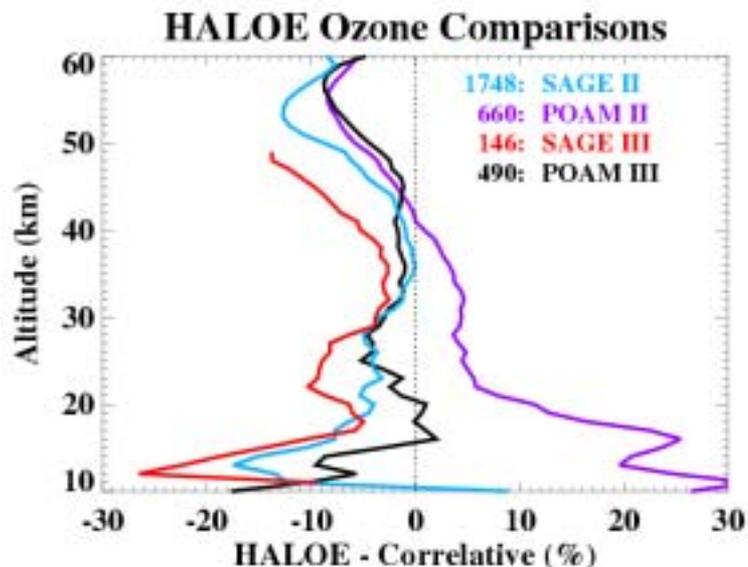
Distance = 500 km unless otherwise stated

OR: $\Delta \text{LAT} = \pm 4^\circ$, $\Delta \text{Lon} = \pm 12^\circ$

$\Delta \text{Time} = \pm 2$ hrs unless otherwise stated

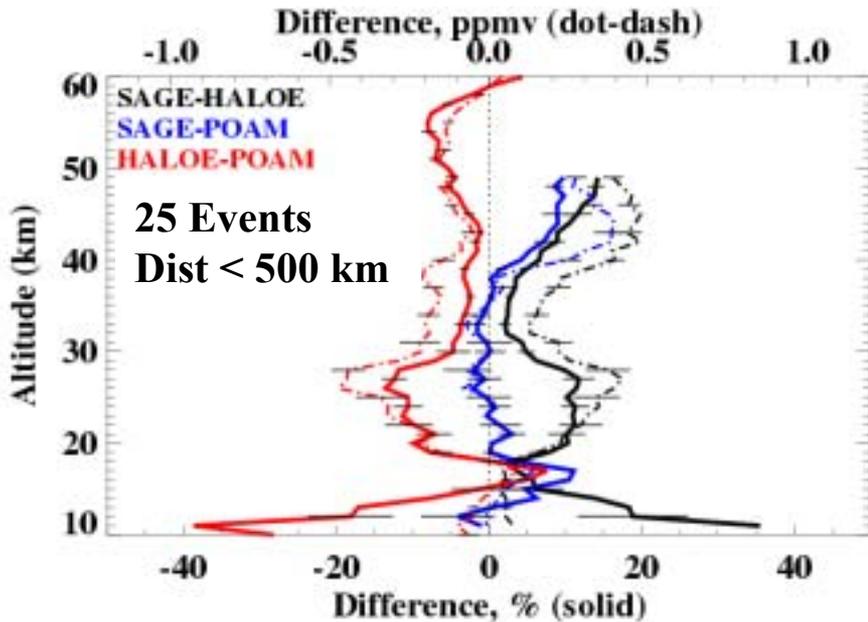
(Still to include: ACE, ILAS I/II, ATMOS, MkIV, GOMOS, MSX)

SAGE II/III, HALOE, POAM II/III: Ozone



- S2, S3, P3 show similar comparisons.
- Significant correction needed for P2.
- P2, P3 & S3 SR/SS biases must be examined further.

S3/H/P3 Triple Coincidences, 67°N, 9-16 Sept. 2002



SAGE-HALOE Distance = 157 \pm 89 km
 SAGE-POAM Distance = 278 \pm 71 km
 HALOE-POAM Distance = 201 \pm 93 km

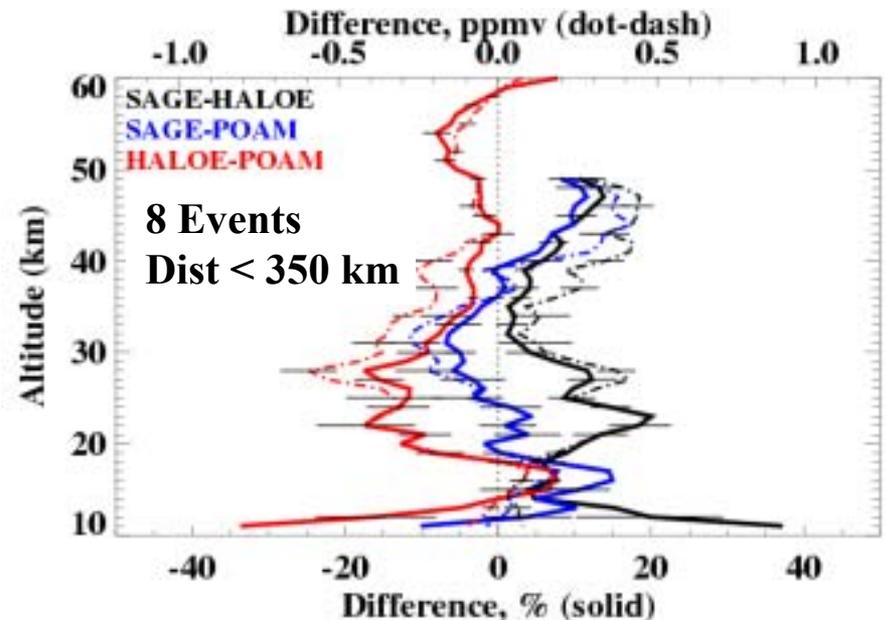
SAGE-HALOE Δ Time = -10. \pm 0.14 hrs
 SAGE-POAM Δ Time = 0.04 \pm 0.02 hrs
 HALOE-POAM Δ Time = 10.8 \pm 0.16 hrs

SAGE-HALOE Δ Lat = 0.36 \pm 0.66
 SAGE-POAM Δ Lat = 1.44 \pm 0.39
 HALOE-POAM Δ Lat = 1.07 \pm 0.28

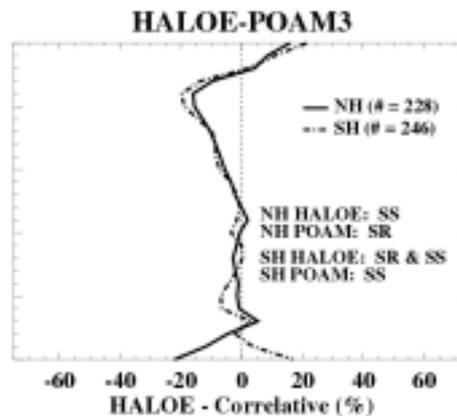
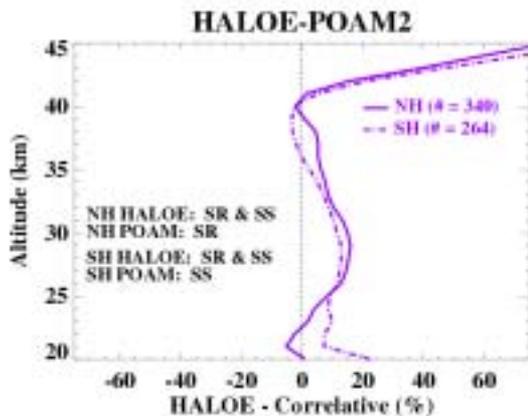
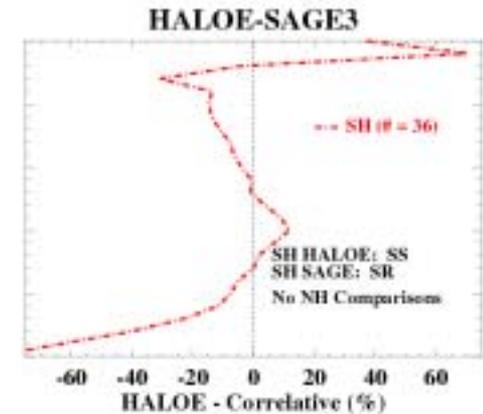
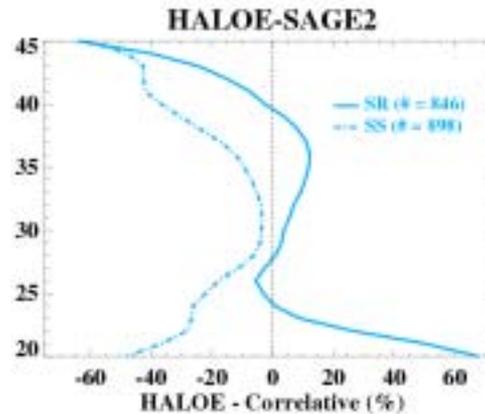
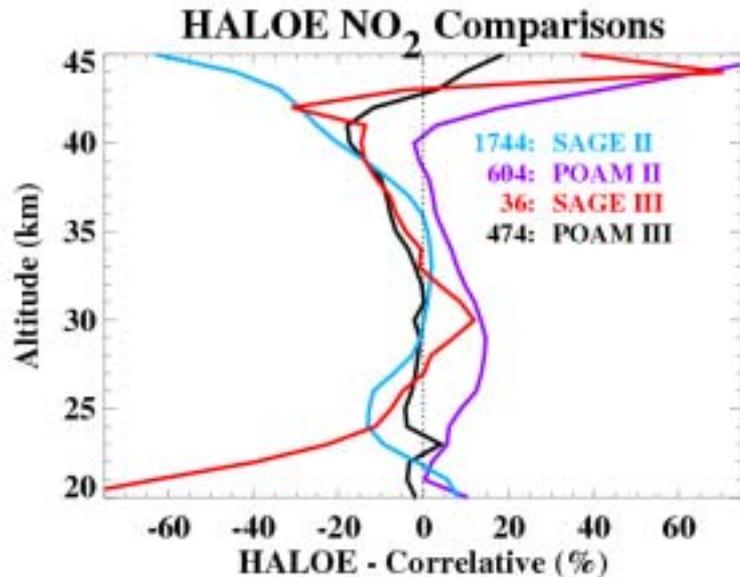
SAGE-HALOE Distance = 216 \pm 153 km
 SAGE-POAM Distance = 362 \pm 80 km
 HALOE-POAM Distance = 238 \pm 108 km

SAGE-HALOE Δ Time = -10. \pm 0.18 hrs
 SAGE-POAM Δ Time = 0.03 \pm 0.02 hrs
 HALOE-POAM Δ Time = 10.7 \pm 0.20 hrs

SAGE-HALOE Δ Lat = 0.27 \pm 0.58
 SAGE-POAM Δ Lat = 0.91 \pm 0.67
 HALOE-POAM Δ Lat = 0.64 \pm 0.81



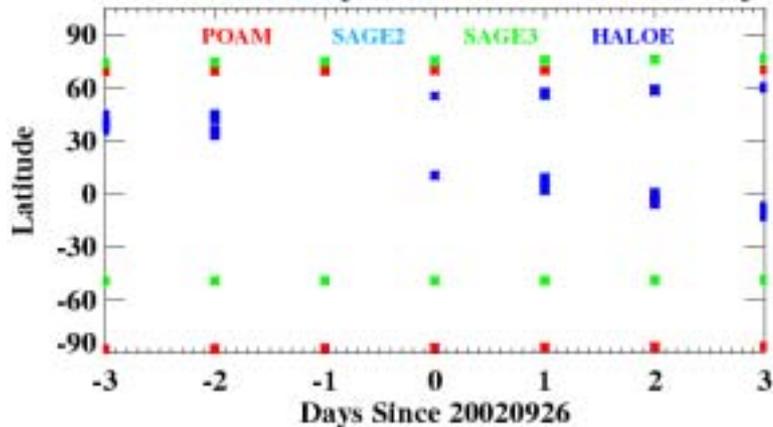
SAGE II/III, HALOE, POAM II/III: NO₂



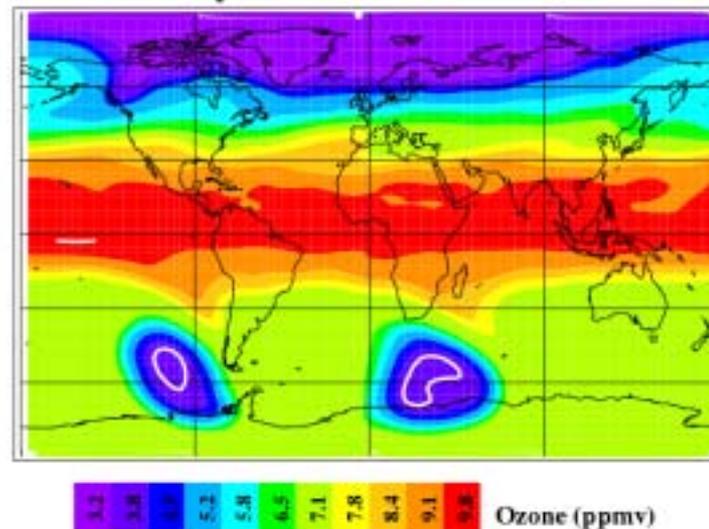
- Qualitatively similar from 25-40 km.
- Large disagreements at 45 km.
- S2 SR/SS bias must be examined further.
- Line-of-sight correction at 20 km.

Combining Occultation Data for Global Studies: 20020926

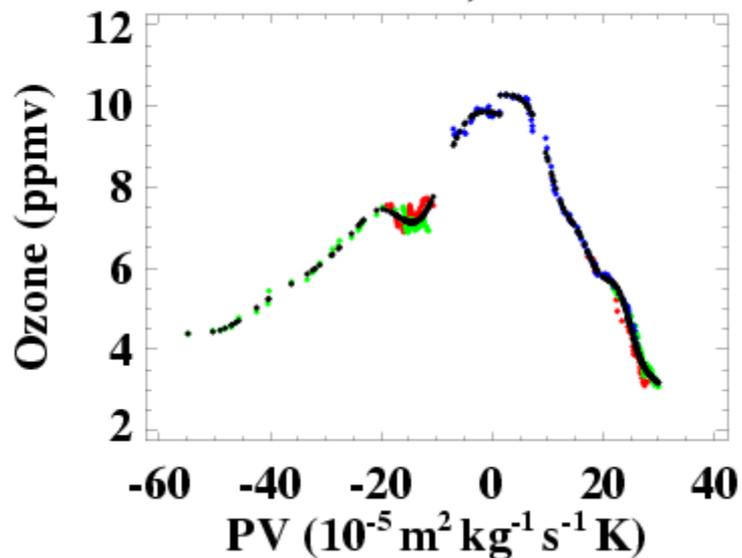
Occultation Day/Lat: 20020926 +/- 3 Days



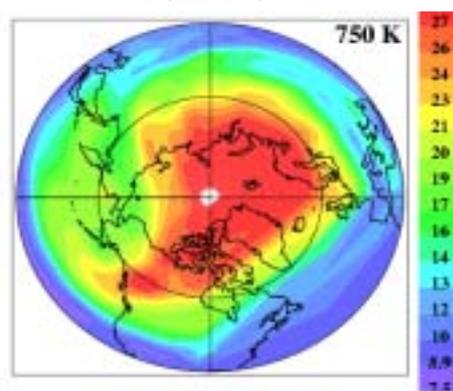
PV Proxy Ozone at 750 K on 20020926



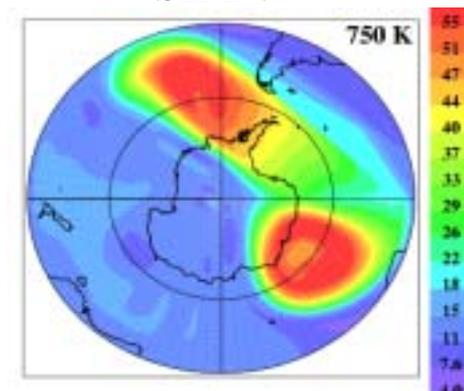
20020926, 750 K



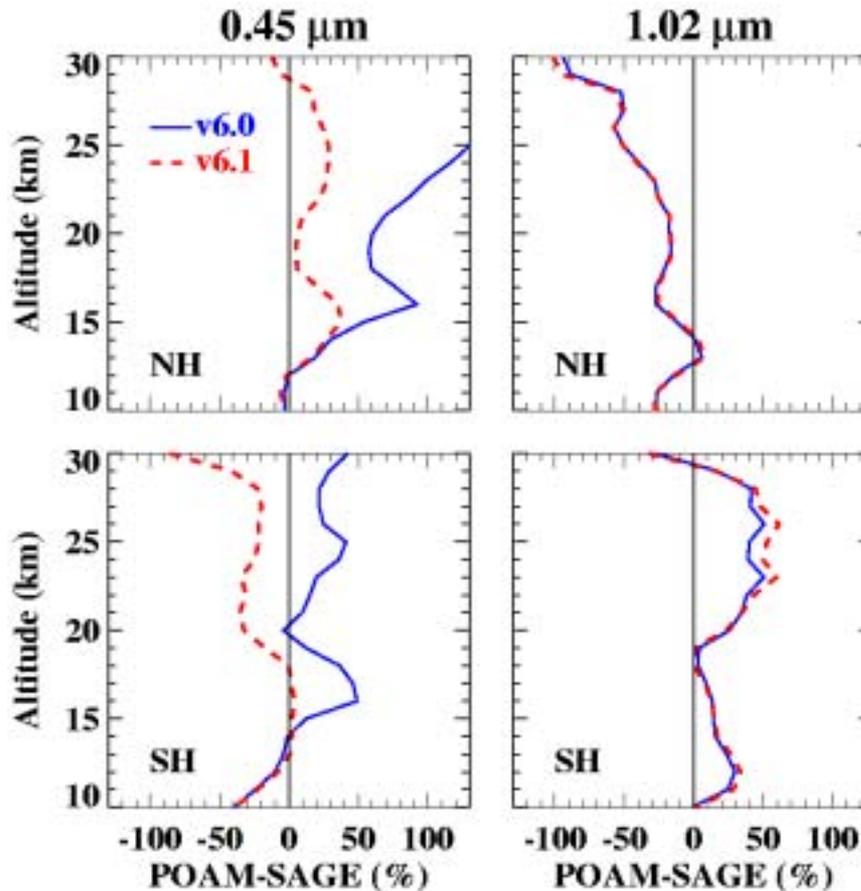
NH PV



SH PV



Some Intercomparison Issues: POAM III Aerosol Extinction

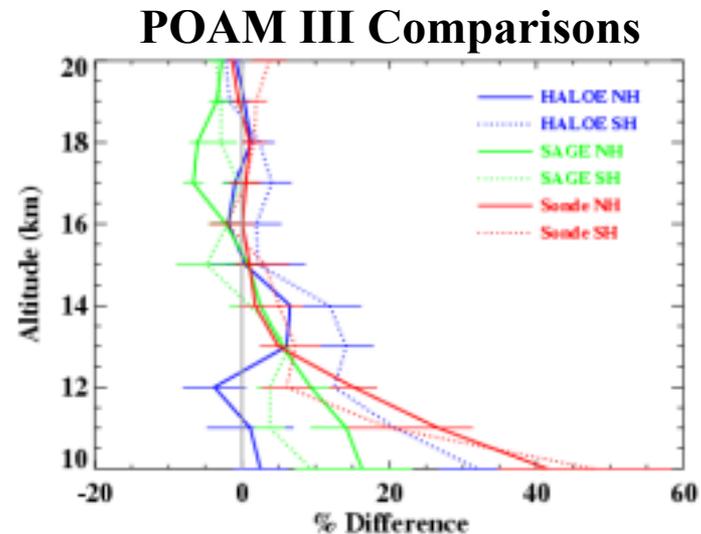
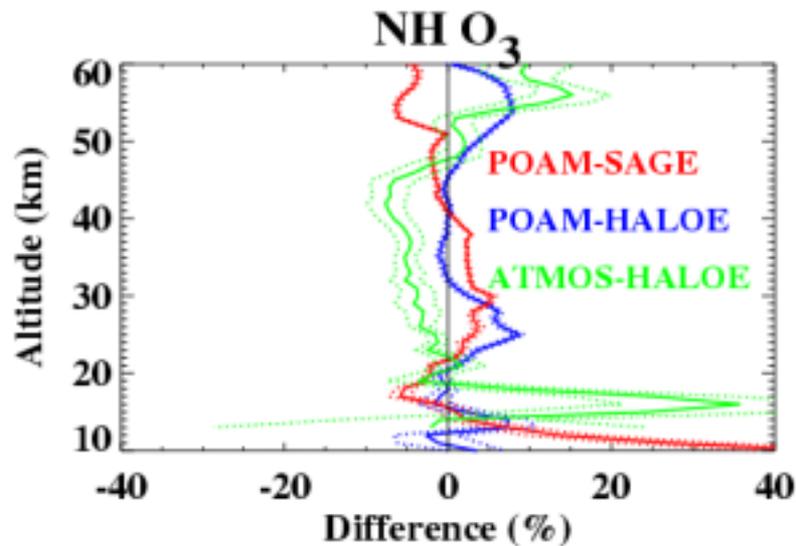


- NH/SH asymmetry in POAM III - SAGE III aerosol extinction comparisons.

- Opposite direction in red and blue channels.

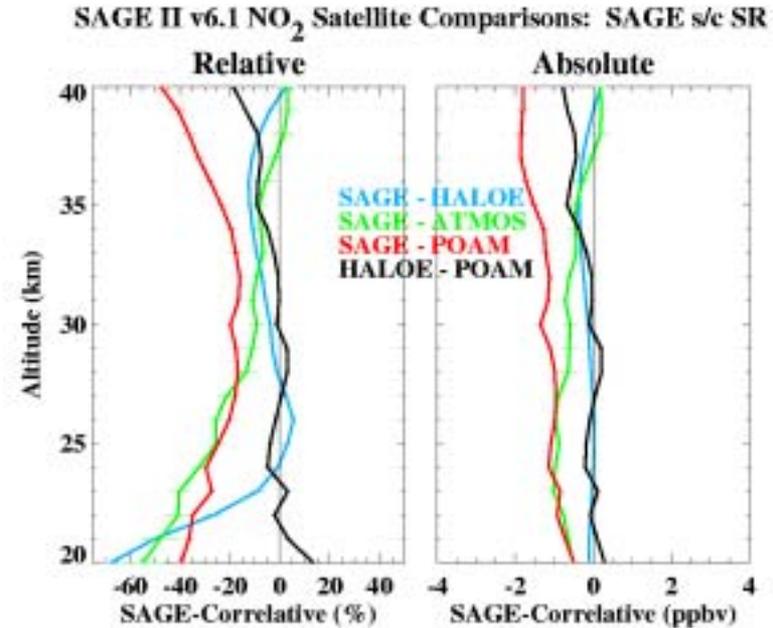
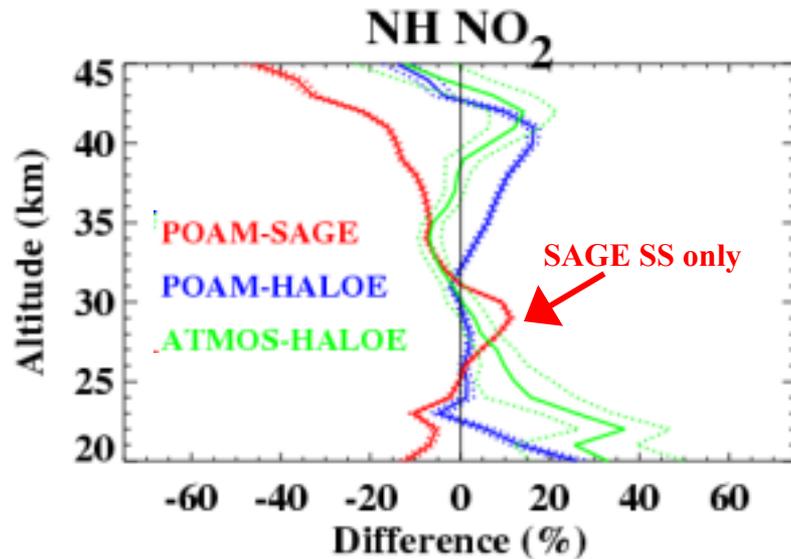
Indicative of a POAM III Hemispheric (SR/SS) Bias ??

Some Intercomparison Issues: Ozone in Lower Stratosphere



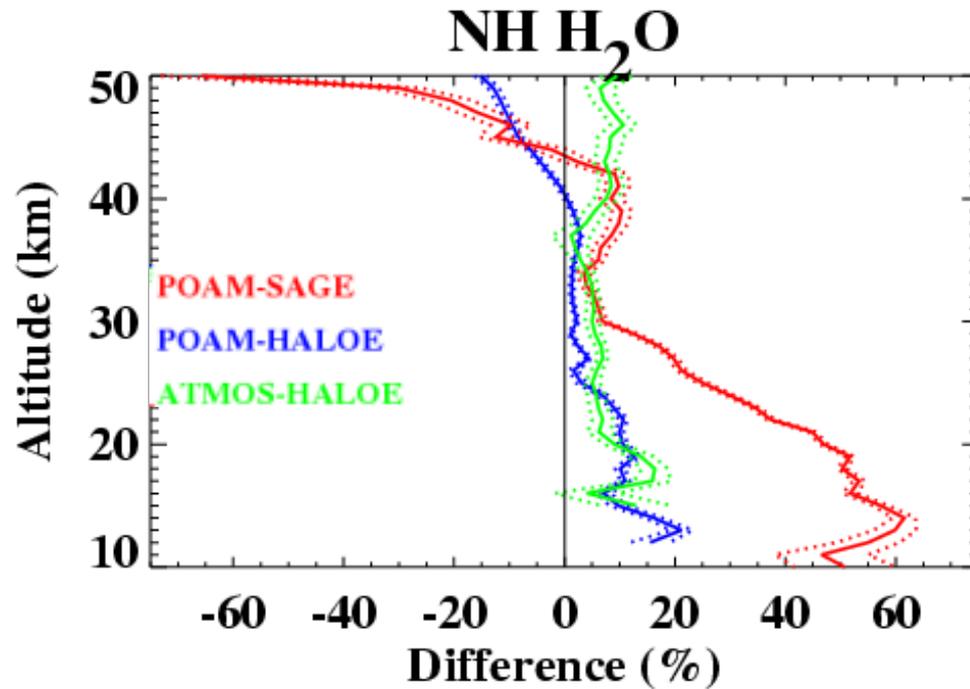
- Agreement within $\pm 10\%$ above 20 km.
- Variable and large disagreements below 20 km.
- ATMOS questionable.
- POAM III high bias below 12 km.

Some Intercomparison Issues: NO₂



- 4-Instrument agreement only within about $\pm 20\%$.
- Diurnal variations along line-of-sight near 20 km.
- HALOE aerosol extrapolation error: 5% of P-H diff above 35 km.
- ?? SAGE II SS above 35 km (left panel) ??
- SAGE II SR comparisons with HALOE and POAM not consistent with HALOE-POAM comparisons.

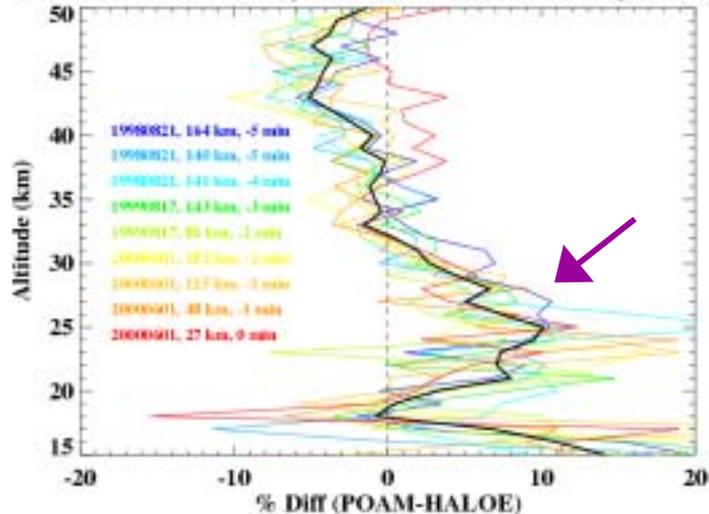
Some Intercomparison Issues: H₂O



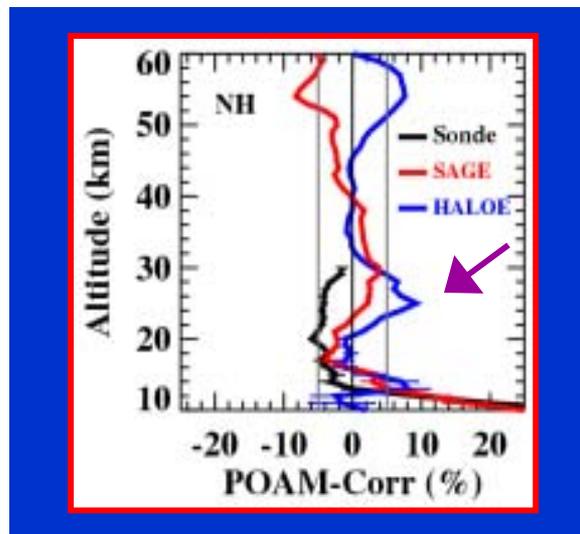
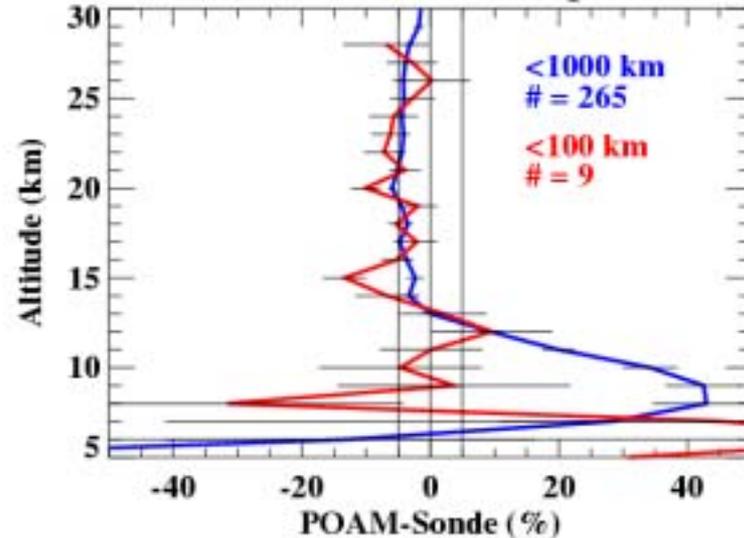
- ATMOS-HALOE & POAM-HALOE remarkably consistent below 40 km.
- Variable disagreements above 40 km.
- SAGE II bias (fix in progress).

Some Intercomparison Issues: Distance Coincidence Criterion

NH POAM-HALOE, 9 Closest Coincidences (< 200 km)



POAM III - Sonde Comparisons



- 25-km POAM/HALOE differences apparent even in closest coincidences.
- POAM/Sonde comparisons < 100 km are similar to < 1000 km above 12 km.
- POAM/Sonde comparison character changes for closest coincidences below 12 km.