Status of SAGE III Water Vapor Retrieval

Presented at
Solar Occultation Satellite Science Team Meeting

May 6-7, 2003

ER-WOON CHIOU

Science Applications International Corporation
Hampton, VA 23666

Outline

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I. Simulation studies

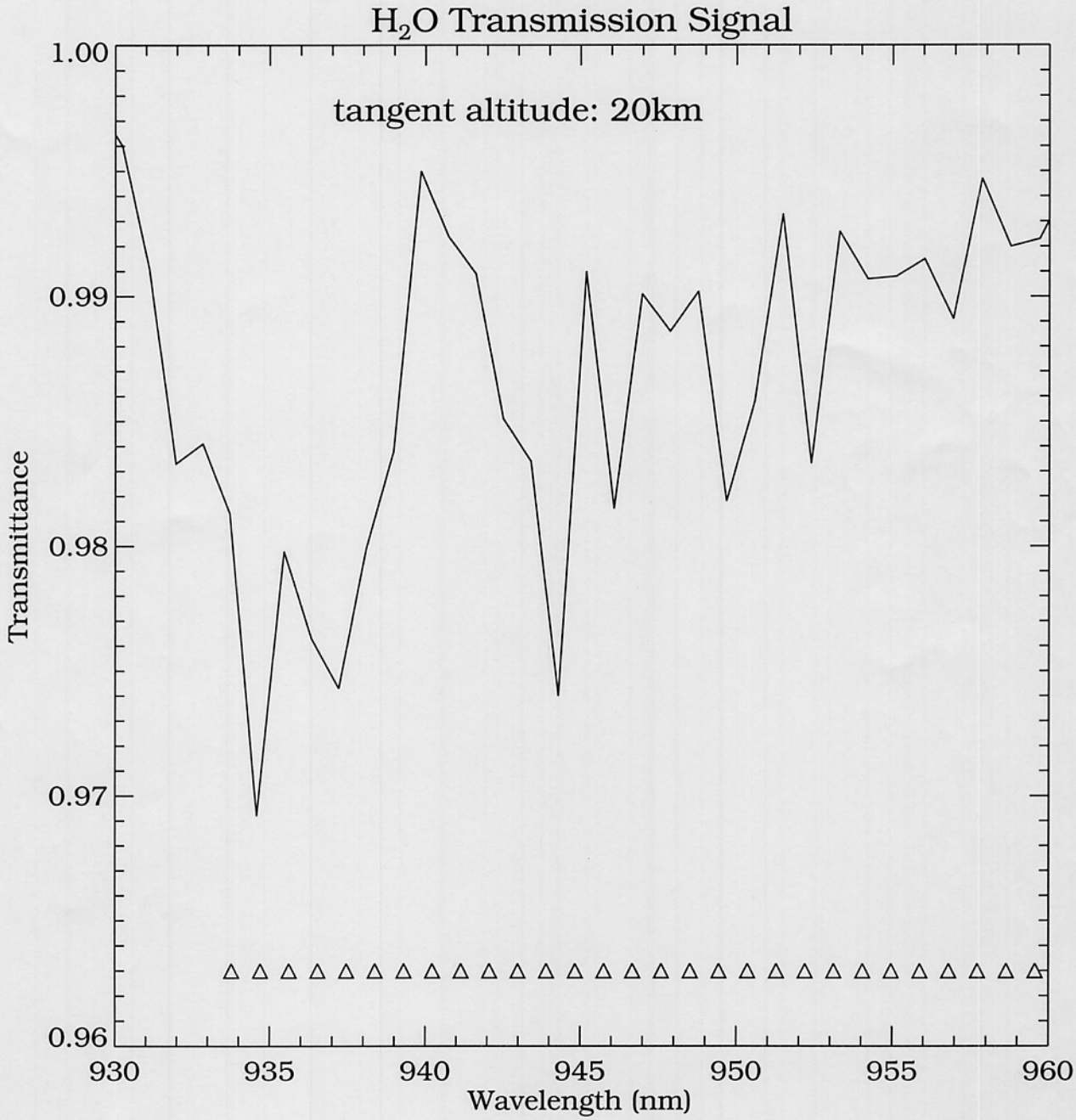
II. Pre-launch retrieval algorithm

III. Instrument performance
(Issues related to unexpected exoatmospheric transmissions and etaloning noise)

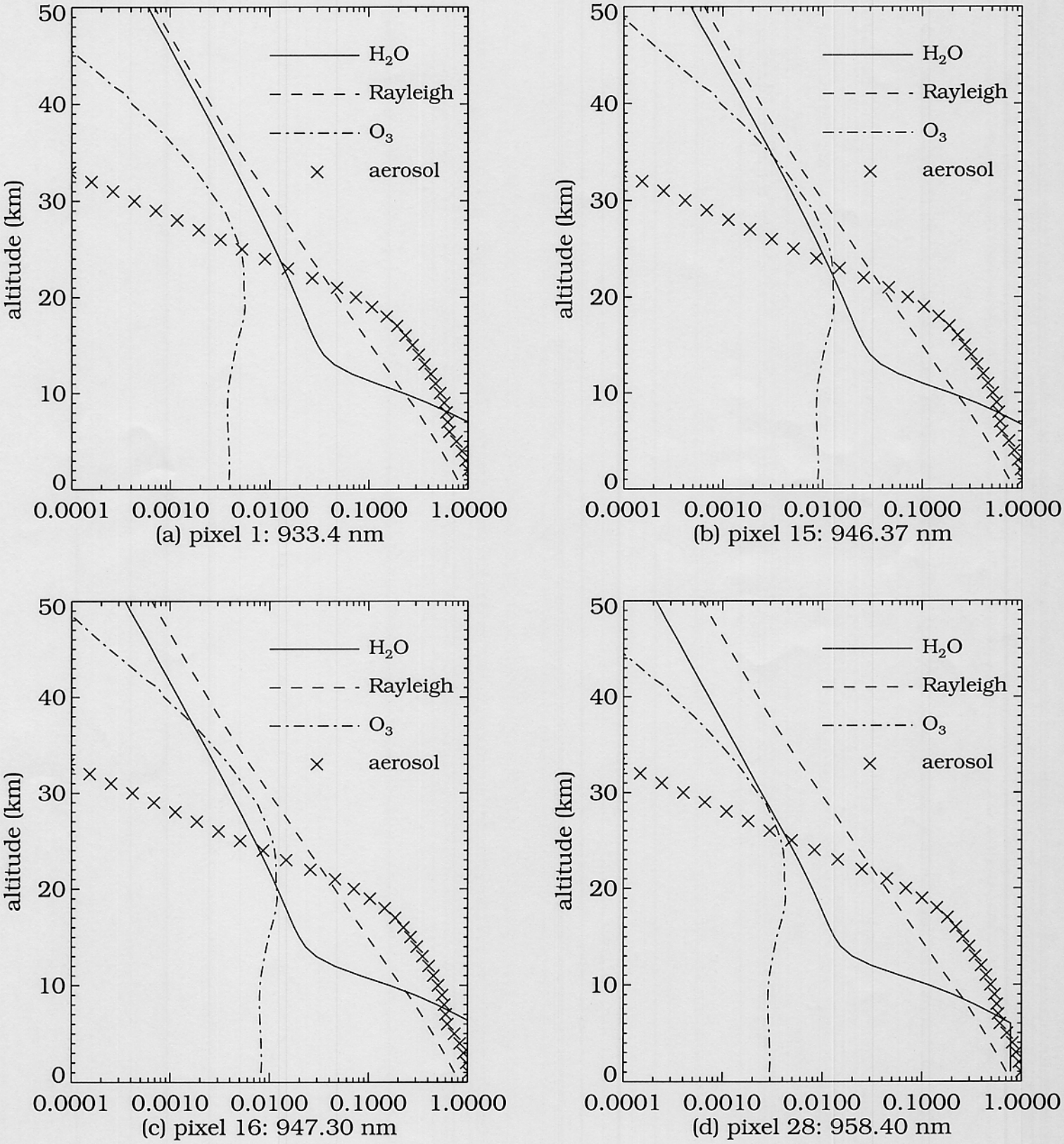
IV. Revised algorithm

V. Preliminary results of retrieved water vapor data products

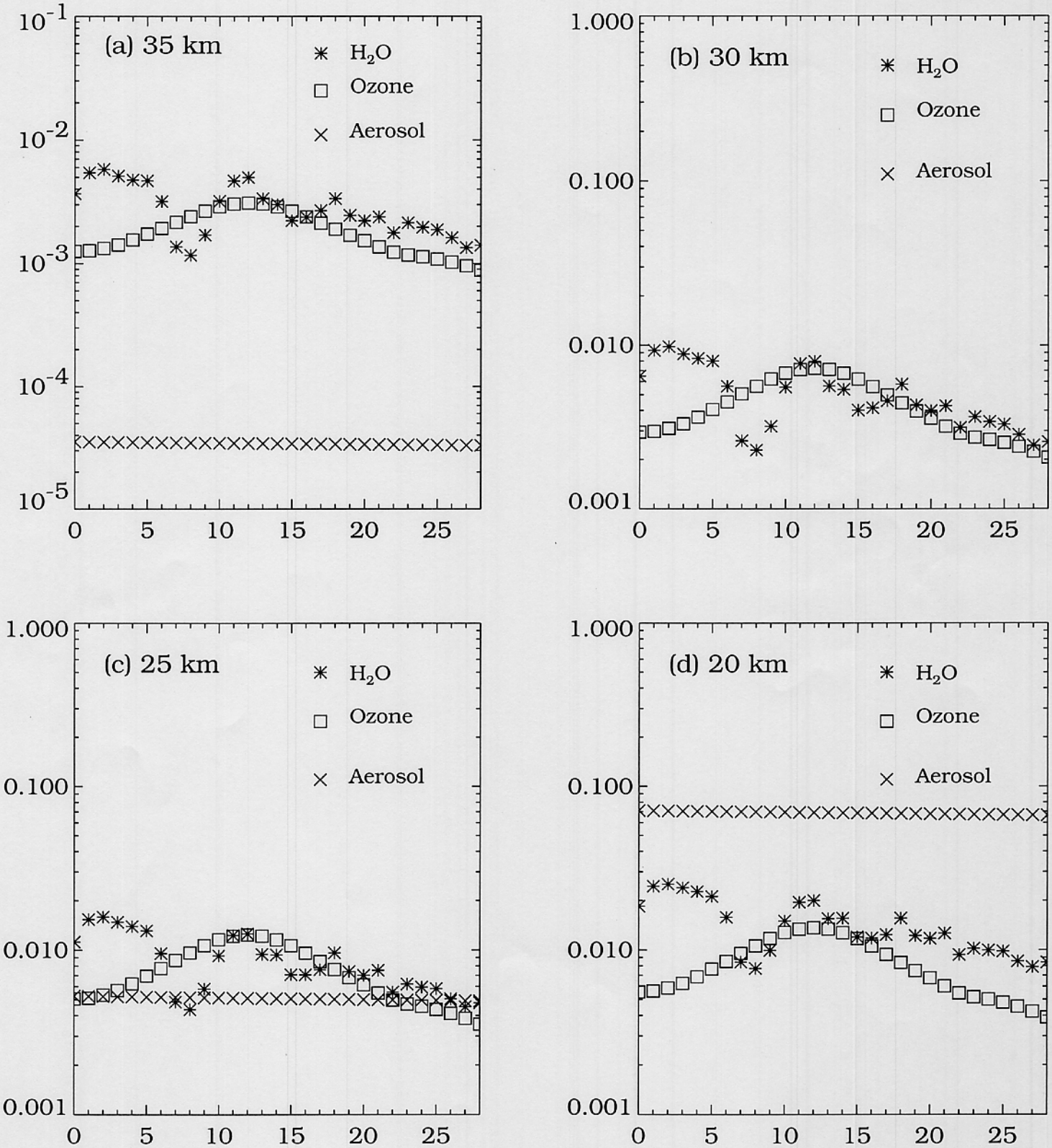
VI. Further research

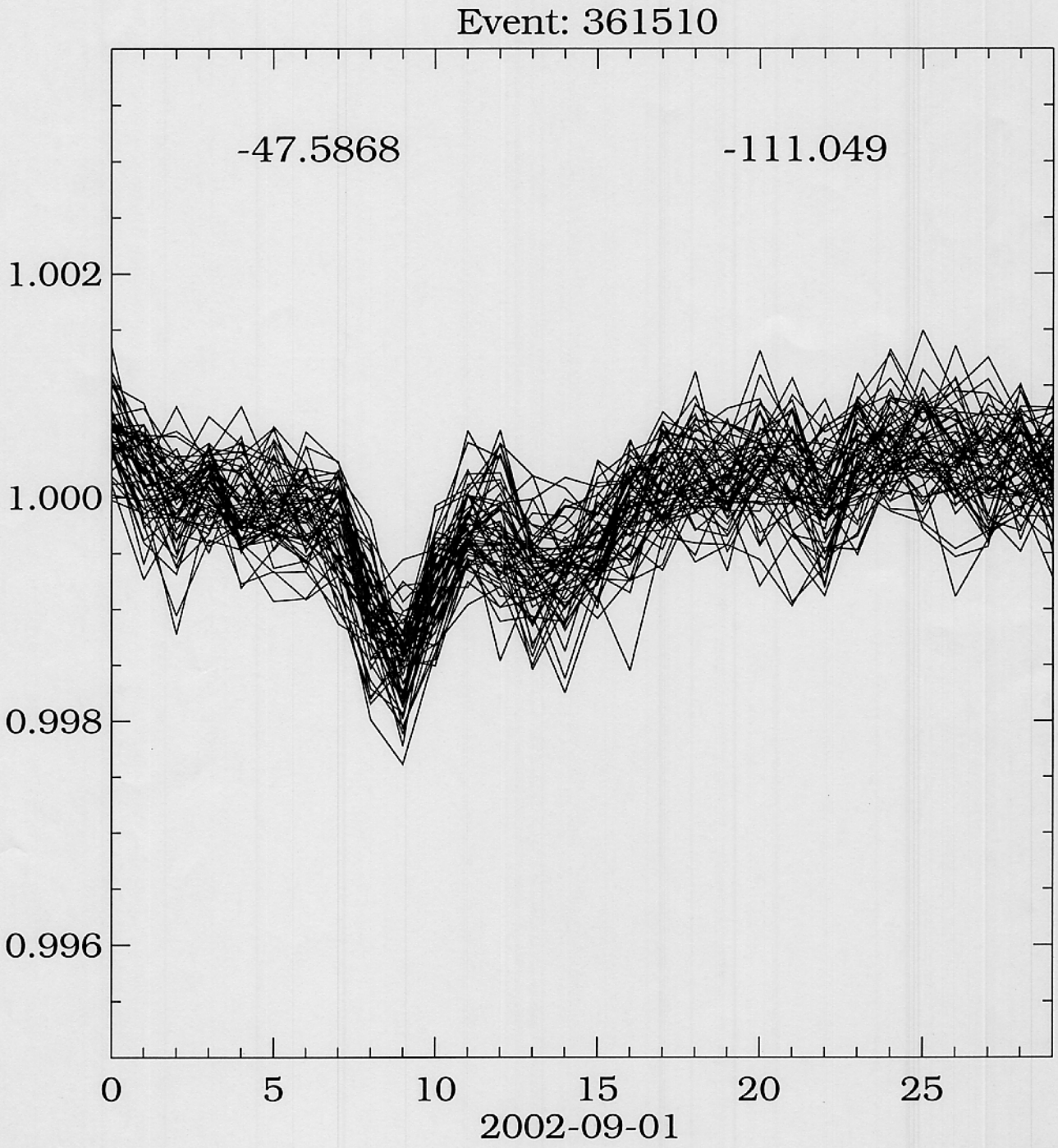

H2O Transmission Signal
tangent altitude: 20km
Transmittance
1.00
0.99
0.98
0.97
0.96
930
935
940
945
950
955
960
Wavelength (nm)

slant path optical depths due to aerosol, Rayleigh, H_2O , and O_3



Slant path absorptions due to aerosol, O_3 , H_2O

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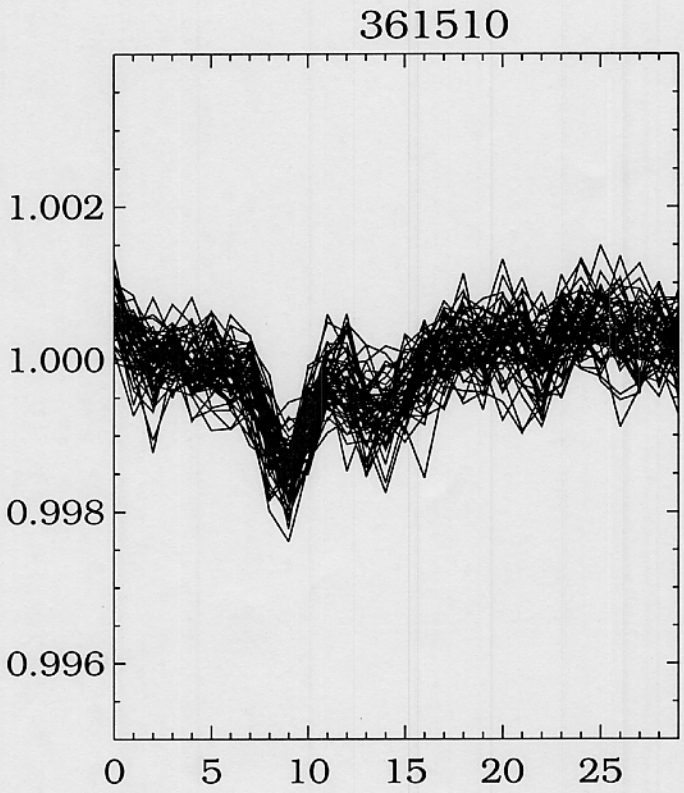
-47.5868
-111.049
1.002
1.000
0.998
0.996
0
5
10
15
20
25
2002-09-01


361510
1.002
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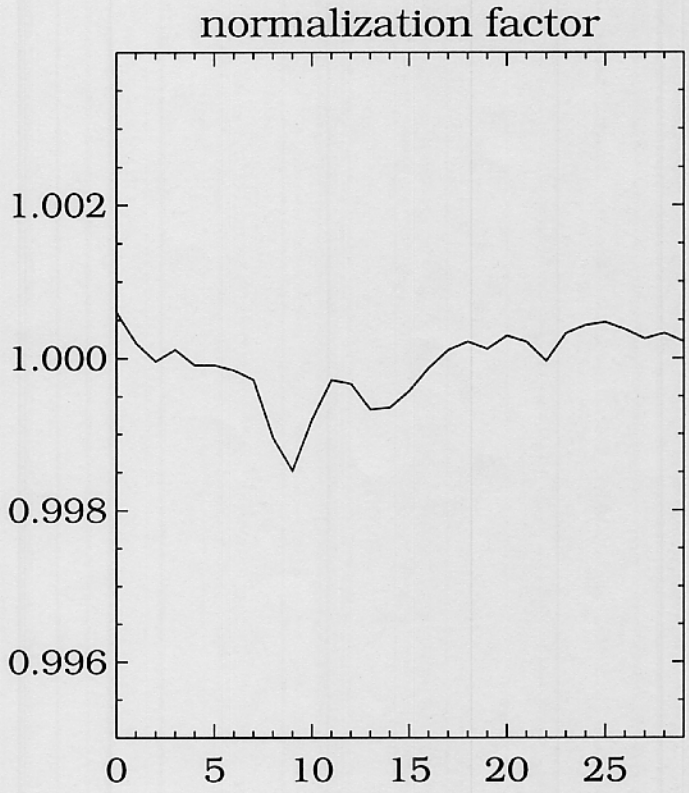
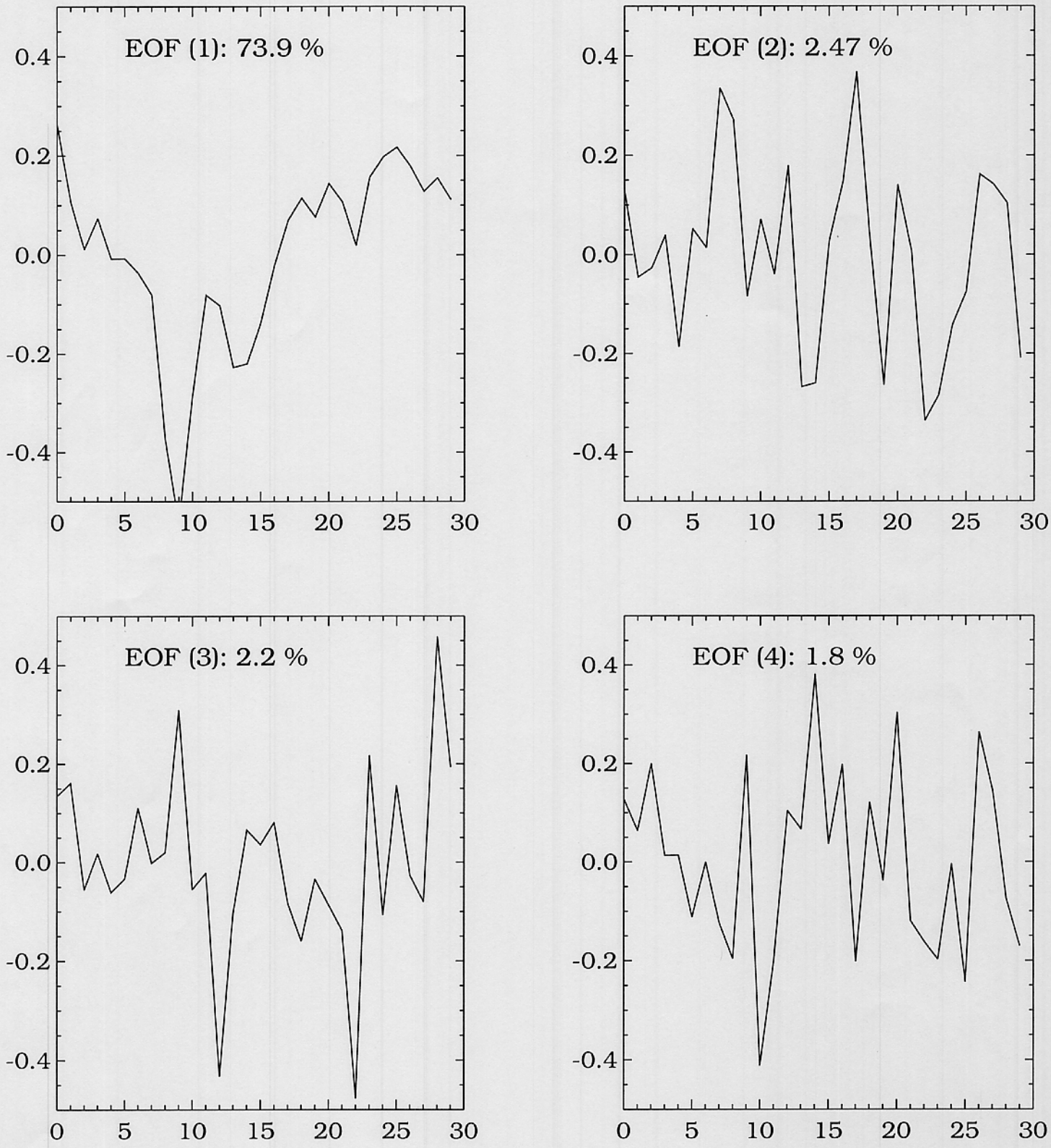
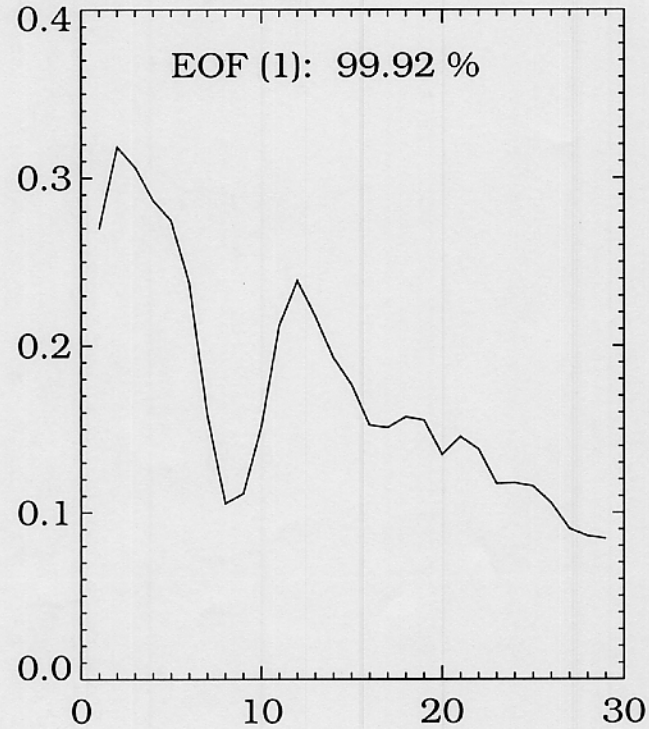
0.996
0
5
10
15
20
25

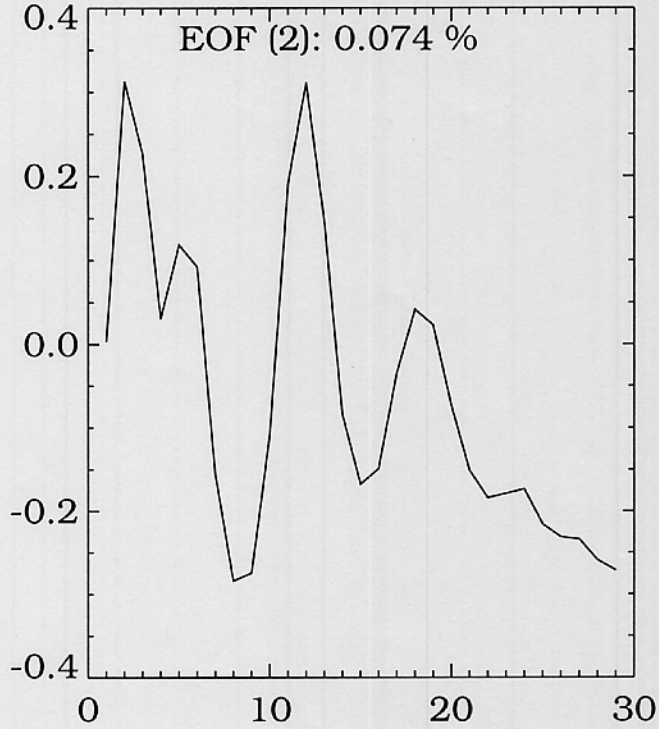

normalization factor
1.002
1.000
0.998
0.996
0
5
10
15
20
25

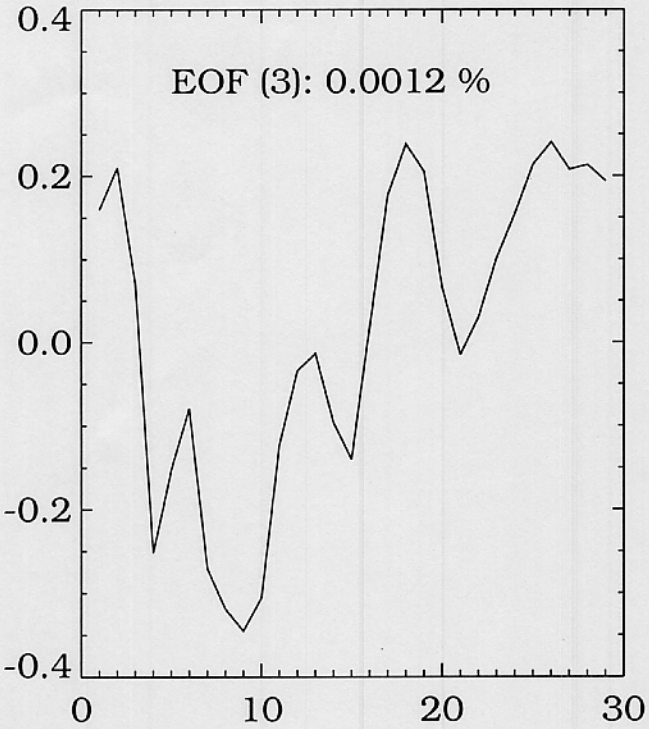
EOF basic vectors for Etaloning Noise



EOF basic vectors for H_2O spectra







$$T_i^{measured} = T_{i,aer}^{computed} * T_{i,ozn}^{computed} * T_{i,wat}^{computed}$$

where i=1 to 29.

$$T_{i,aer}^{computed} = e^{-(x_1+(i-1) * x_2)}$$

$$T_{i,ozn}^{computed} = e^{-x_3 * \chi_i}$$

$$T_{i,wat}^{computed} = 1.0 - A_{i,x_4}^{computed}$$

χ_i represents ozone cross sections and the four parameters are:

$x_1 + (i-1) * x_2 =$ the slant path optical depth due to aerosols;

$x_3 =$ slant column density of ozone;

$x_4 =$ water vapor mixing ratio; and $A_{i,x_4}^{computed}$ are the slant path absorptions due to water vapor computed from the EGA forward model.

Multiple Linear Regression (MLR)

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$$\delta_i = C_1 \chi_i + \sum_{m=1}^{M} k_m(f_m^i) + \sum_{n=1}^{N} K_n(F_n^i) + C_2 \left[\frac{i}{30}\right]$$

Pre-launch Algorithm and Subsequent Modification

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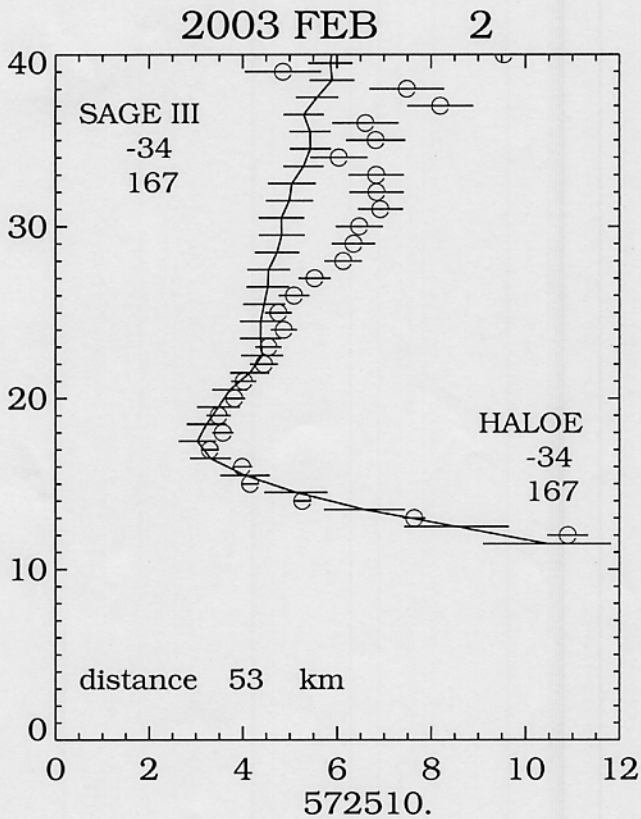
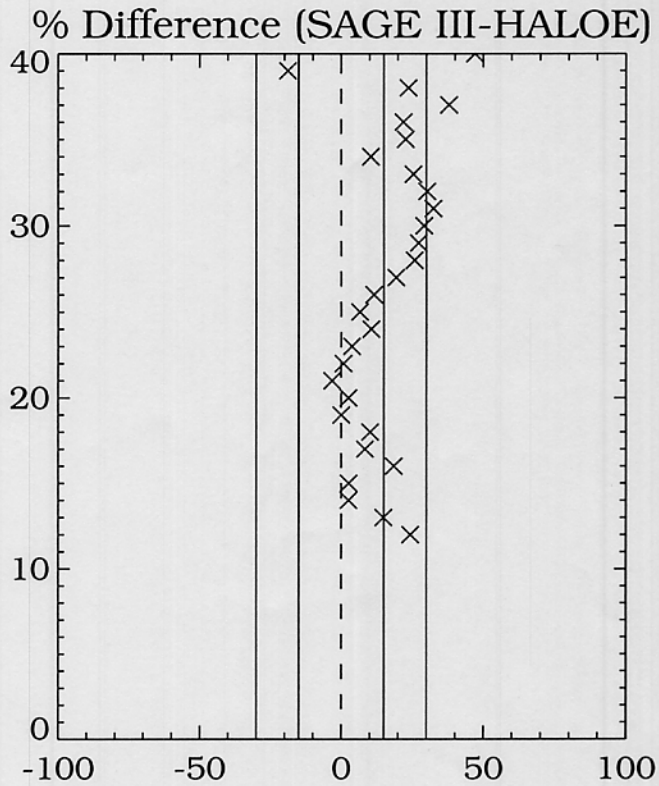
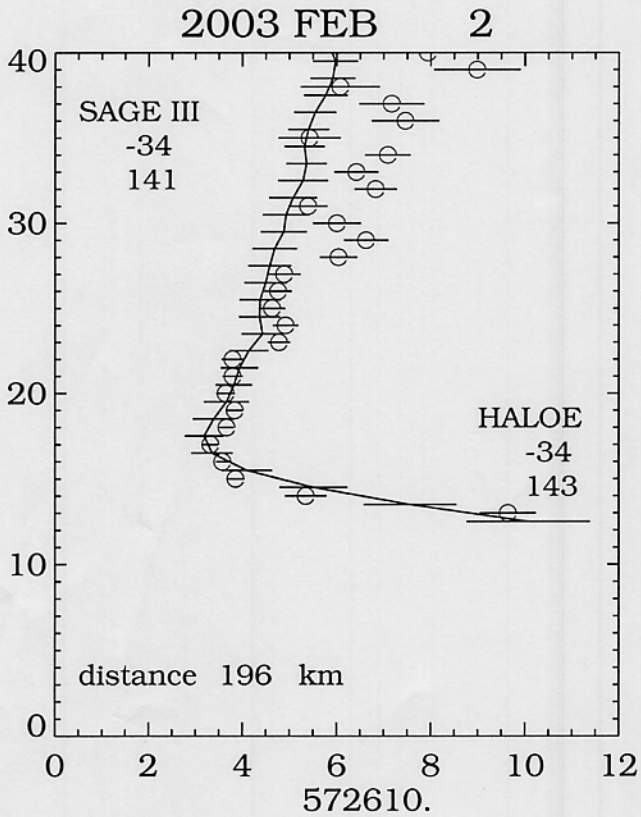
I. Non-linear Optimization Iterative Algorithm
(Solving for 4 parameters following a top-down approach; Inputs are the total slant path transmissions, without removing the contributions of aerosols and ozone)

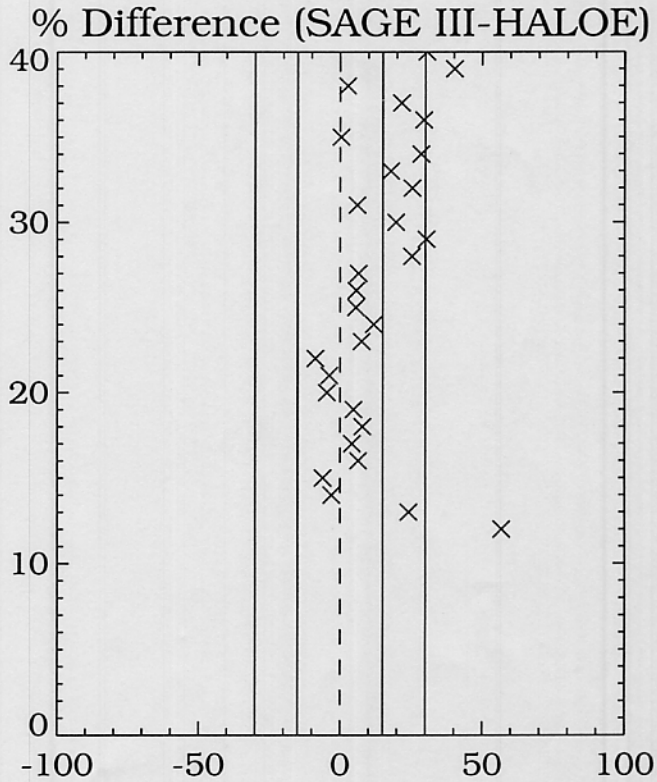
II. Two-stage Algorithm
(a) Multiple Linear Regression (MLR) to separate the contributions from interfering species and etaloning noise
(b) Non-linear Optimization Iterative Procedure to solve for water vapor mixing ratios following a top-down approach

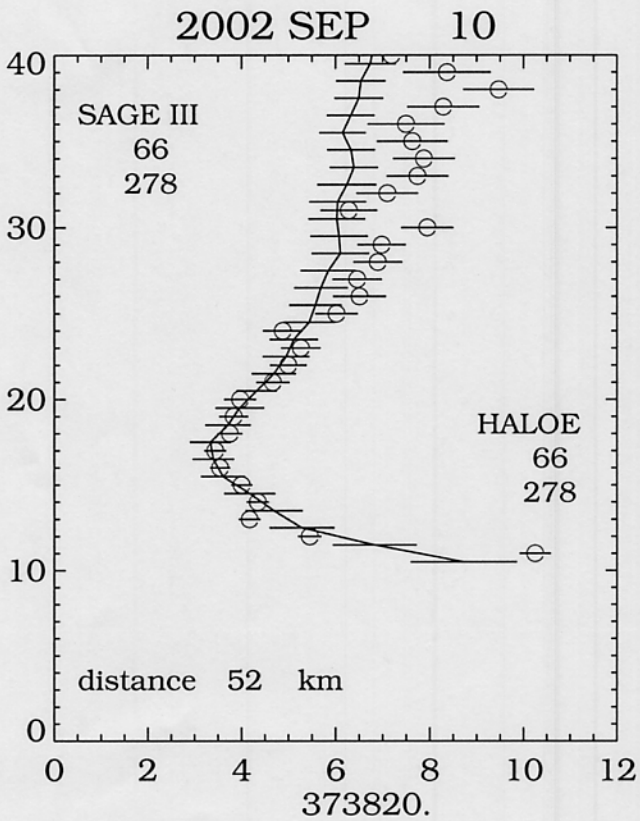
III. Modified Two-stage Algorithm
(a) Derive (Total optical depth - etaloning optical depth) from MLR process
(b) Non-linear Optimization Iterative Procedure to simultaneously retrieving water vapor and removing contributions from aerosols and ozone

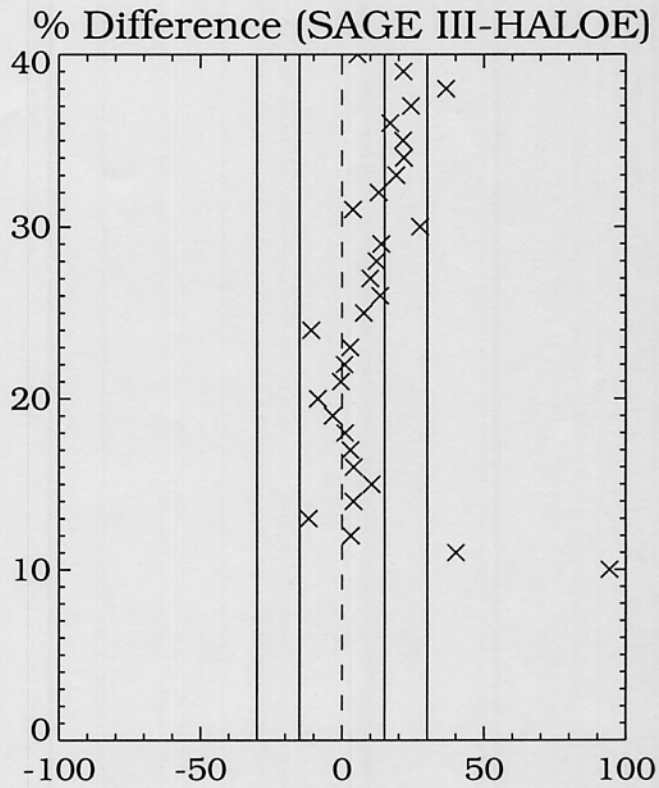

2003 FEB 2
SAGE III
-34
167
HALOE
-34
167
distance 53 km
572510.


% Difference (SAGE III-HALOE)


2003 FEB 2
SAGE III
-34
141
HALOE
-34
143
distance 196 km
572610.


% Difference (SAGE III-HALOE)


2002 SEP 10
SAGE III
66
278
HALOE
66
278
distance 52 km
373820.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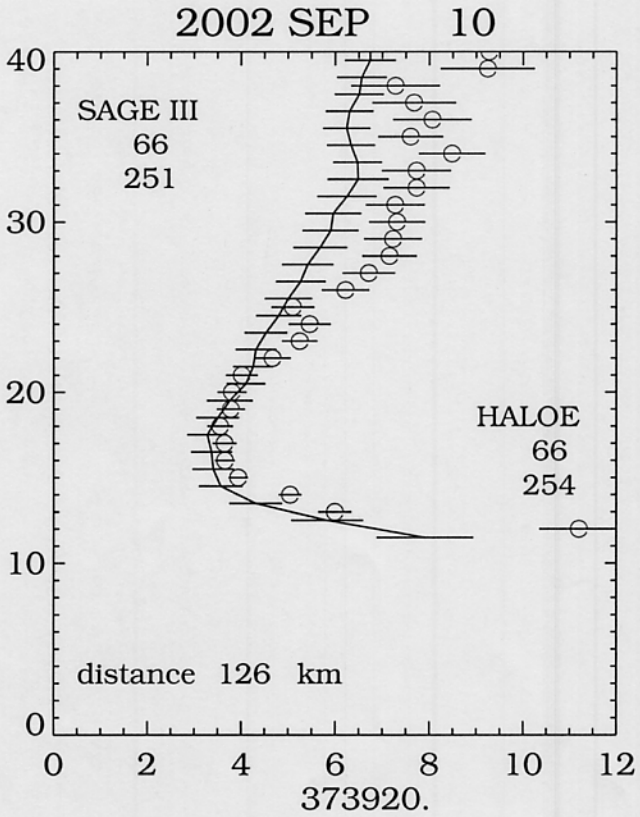
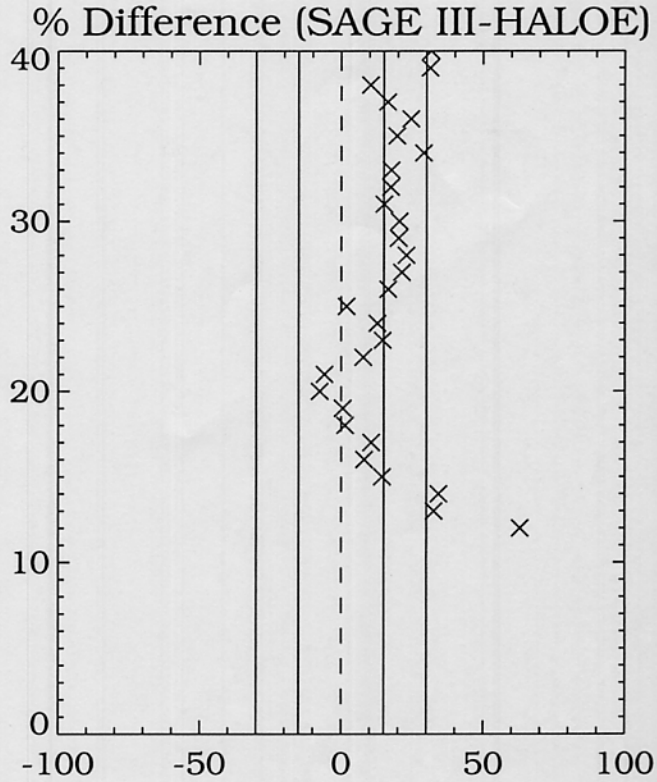

2002 SEP 10
SAGE III
66
251
HALOE
66
254
distance 126 km
373920.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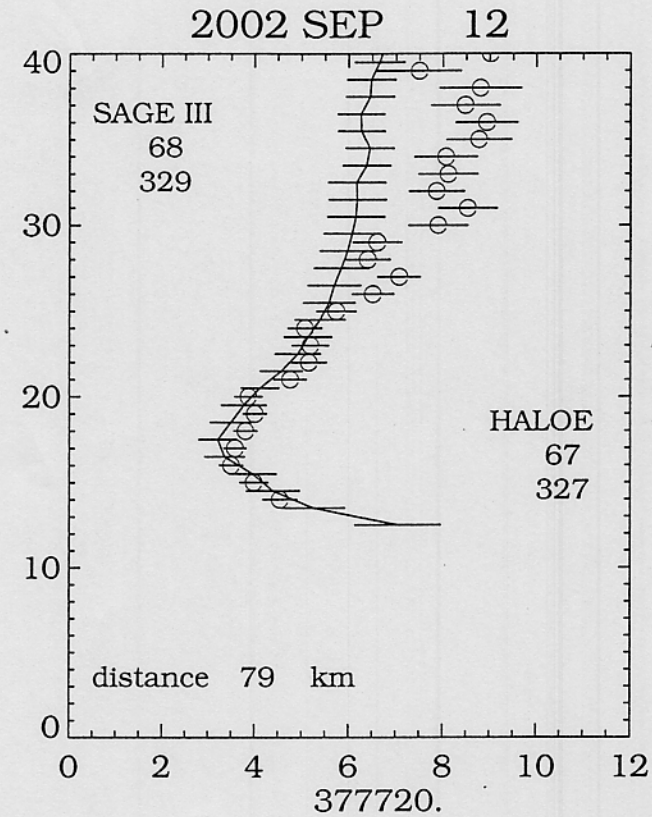
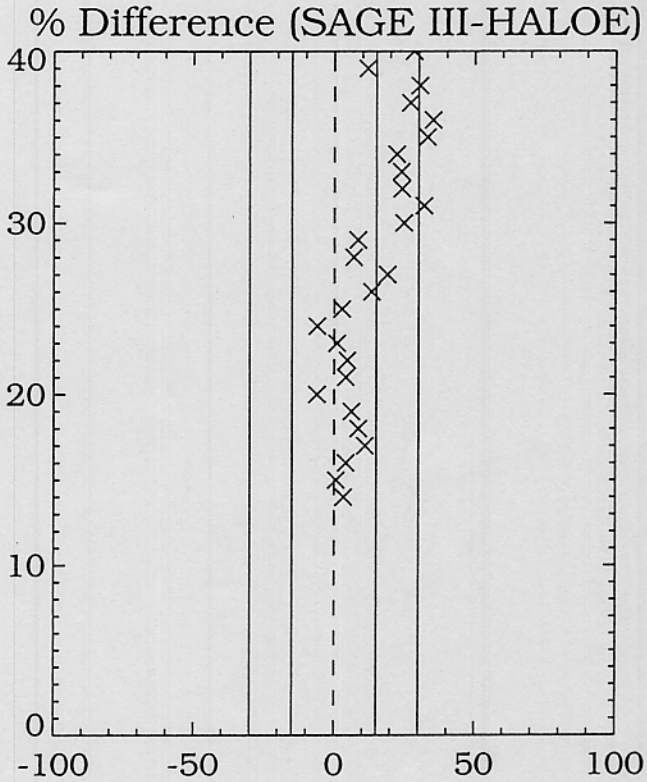

2002 SEP 12
SAGE III
68
329
HALOE
67
327
distance 79 km
377720.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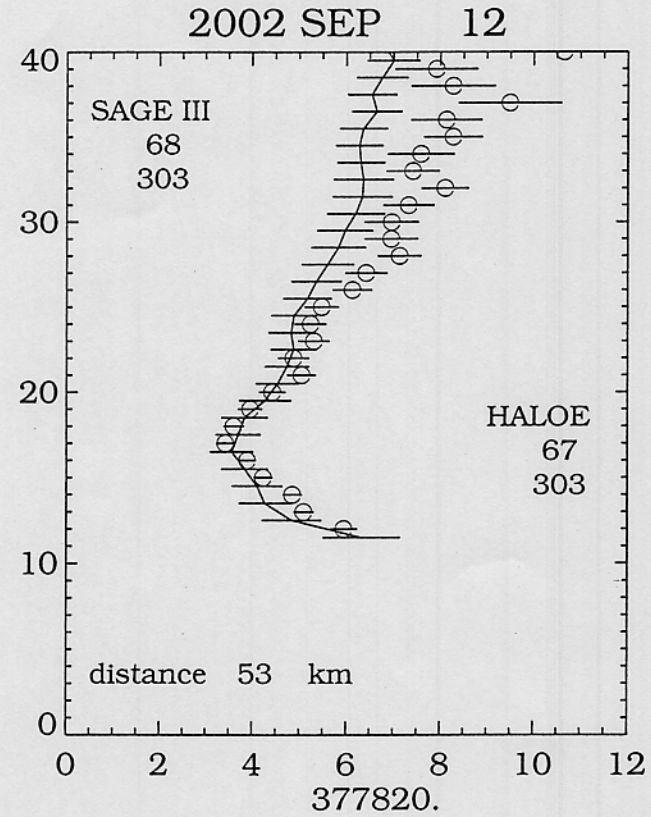
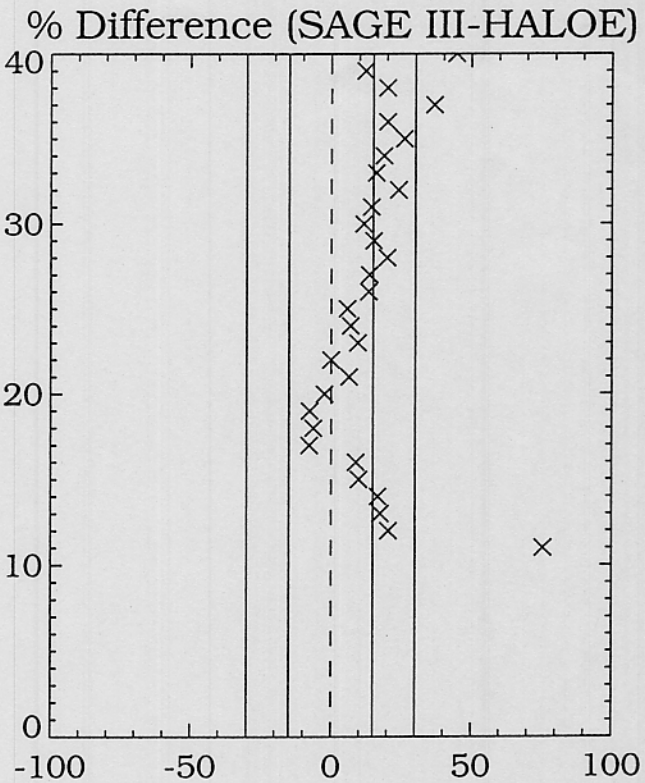
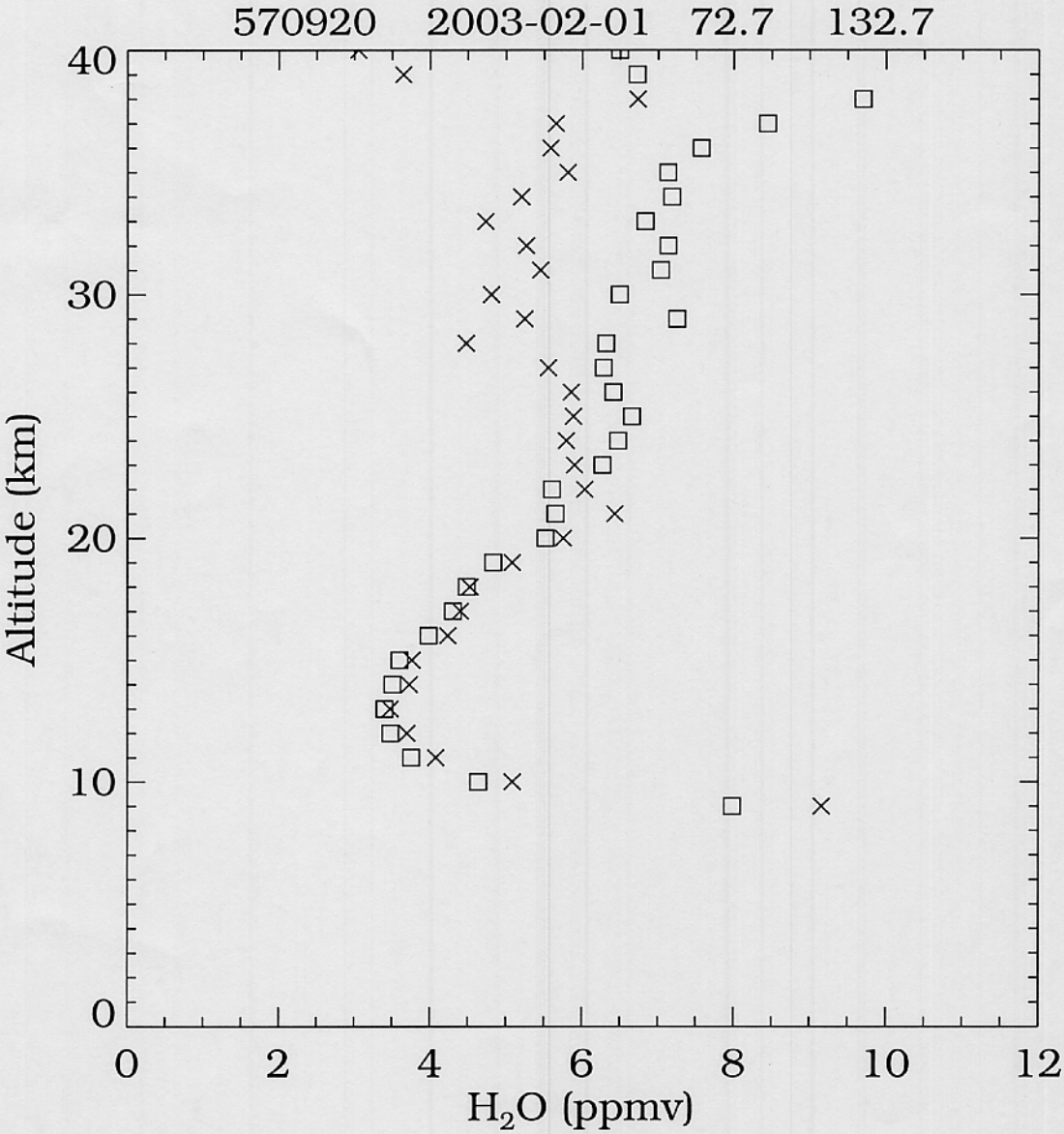
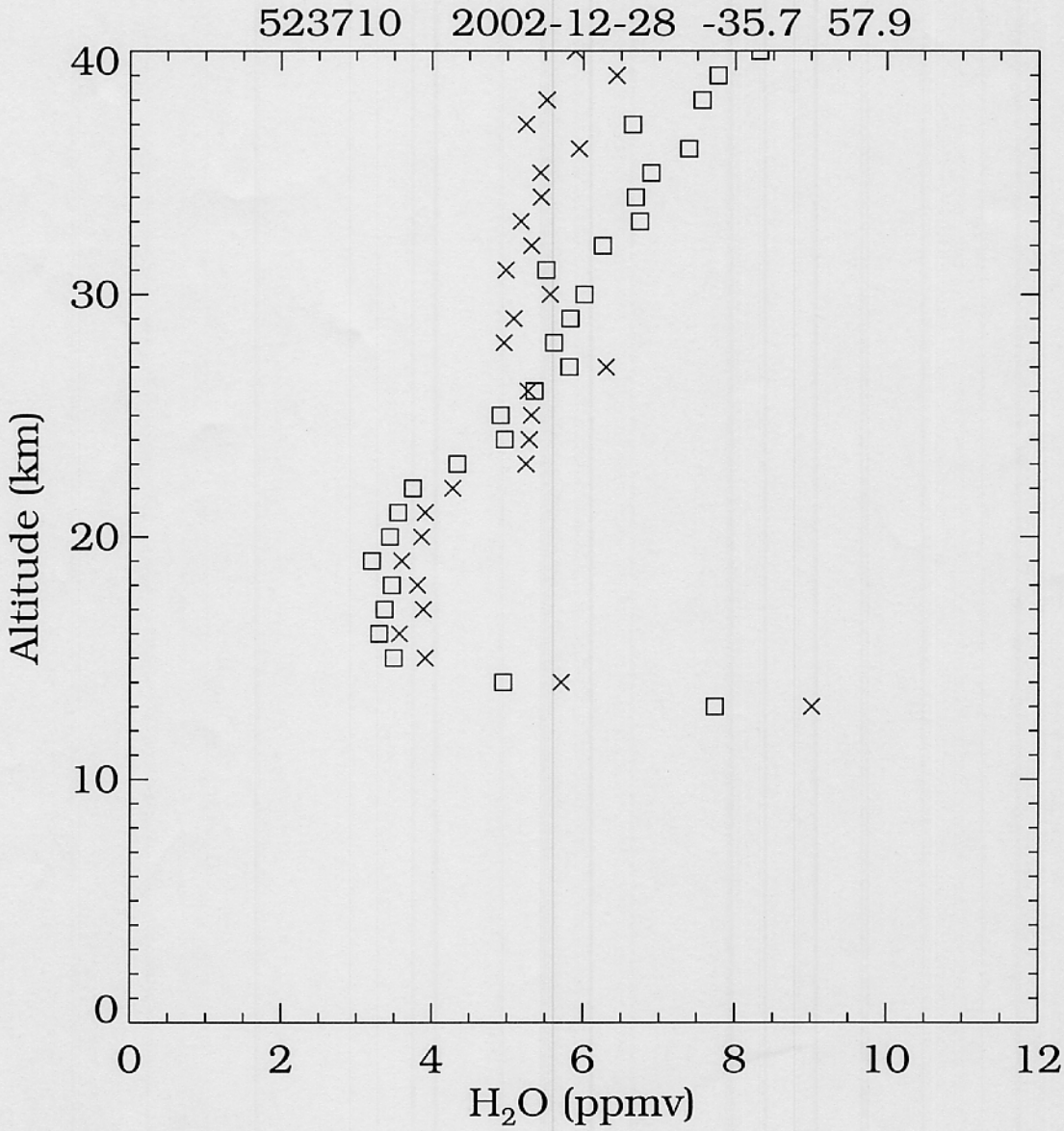
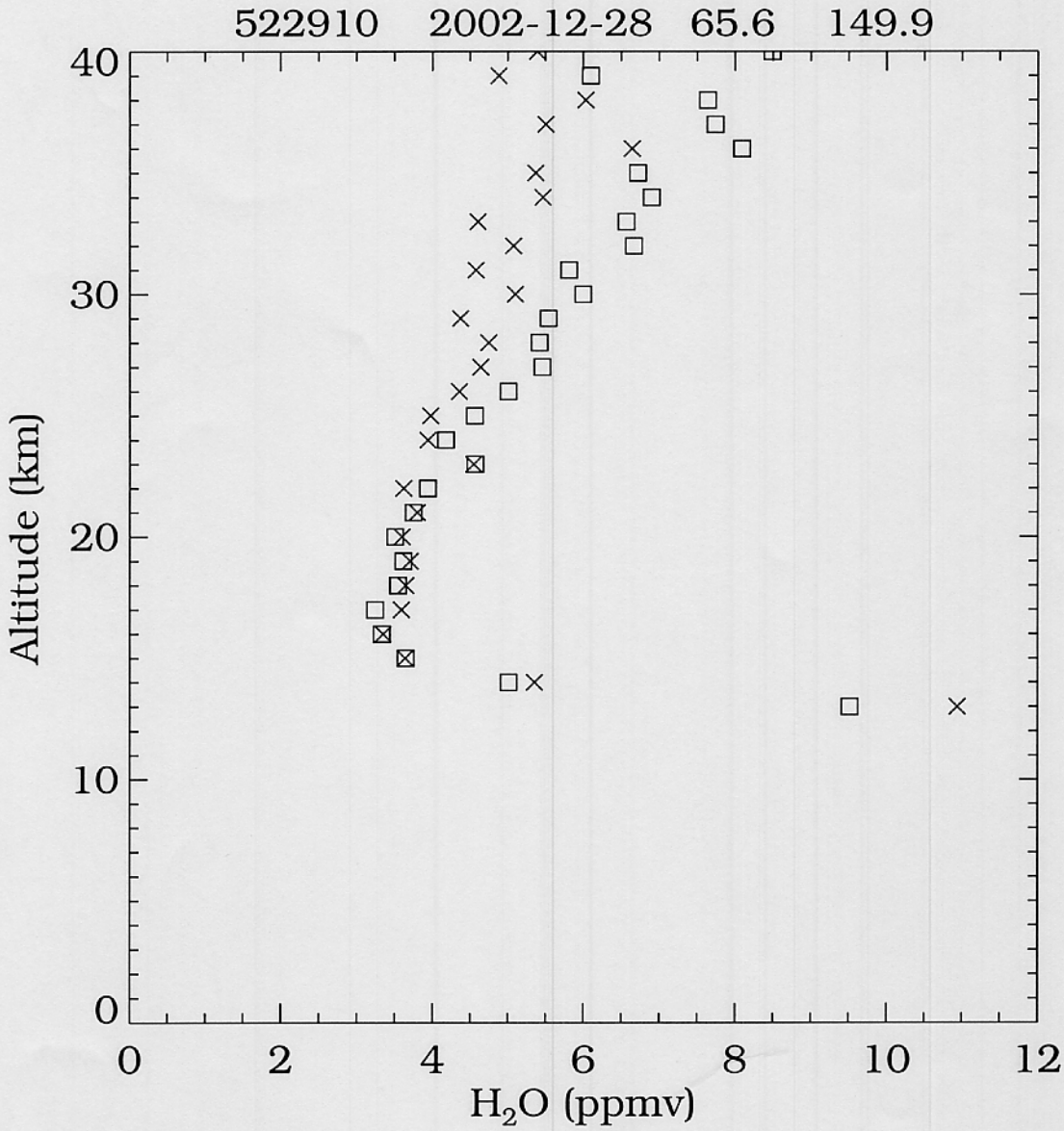
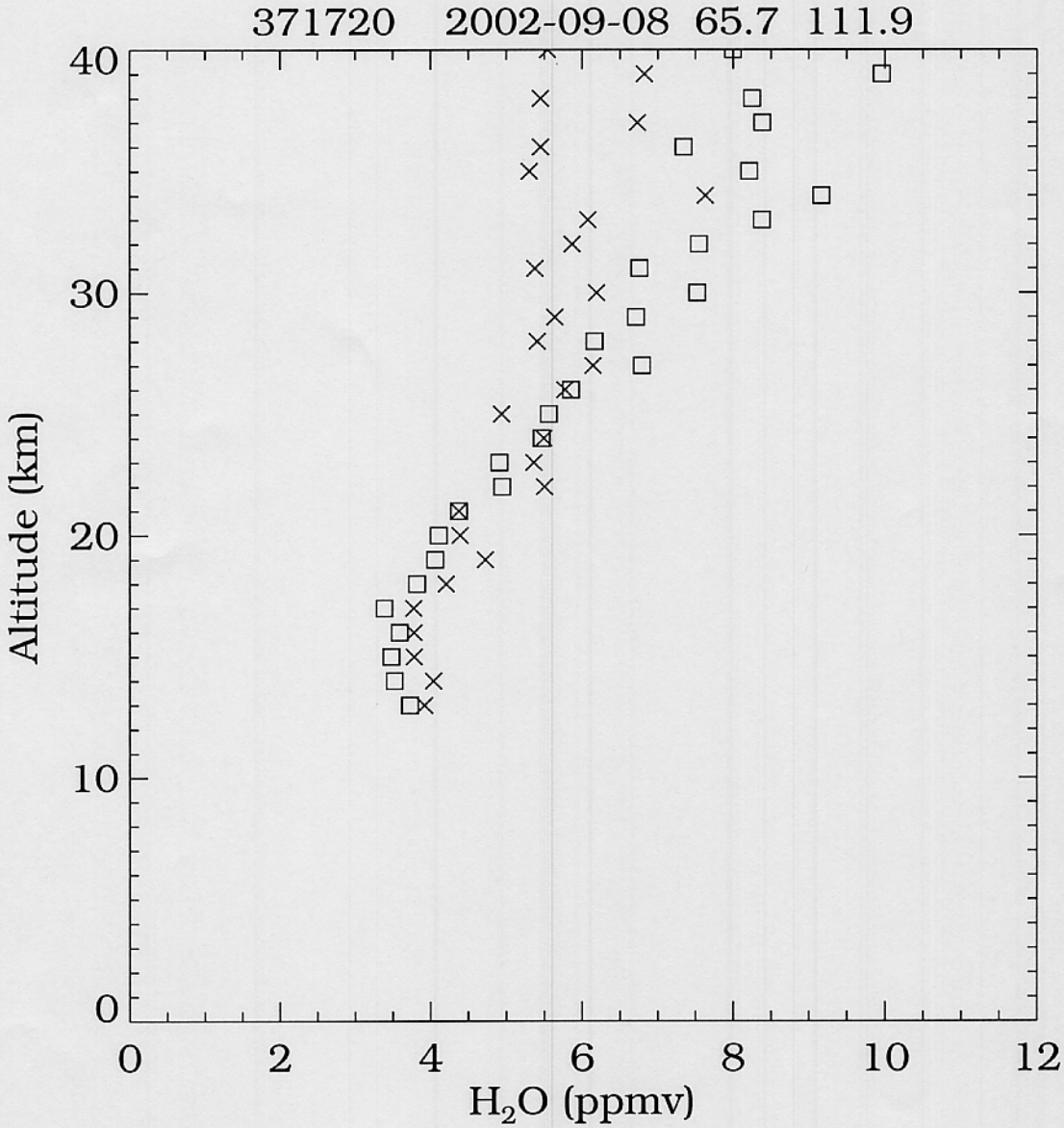

2002 SEP 12
SAGE III
68
303
HALOE
67
303
distance 53 km
377820.

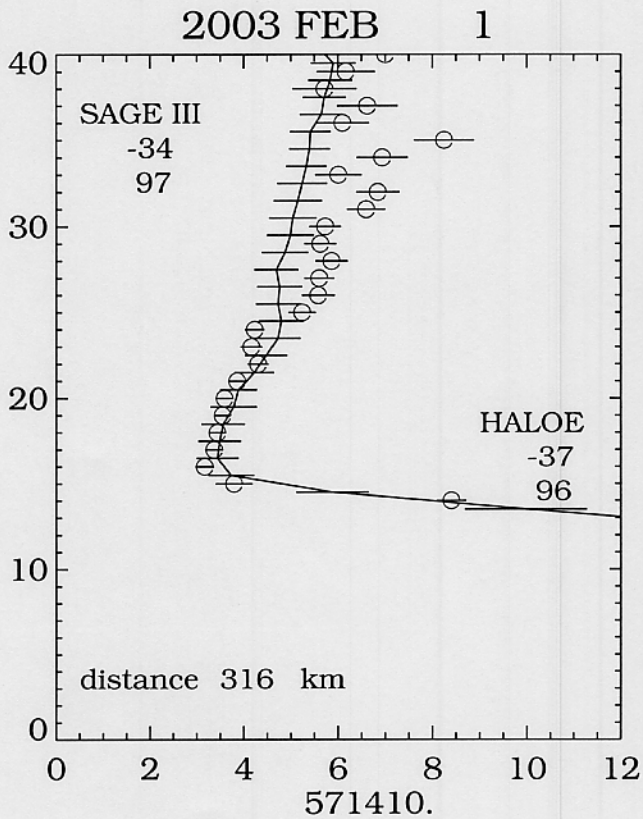

% Difference (SAGE III-HALOE)

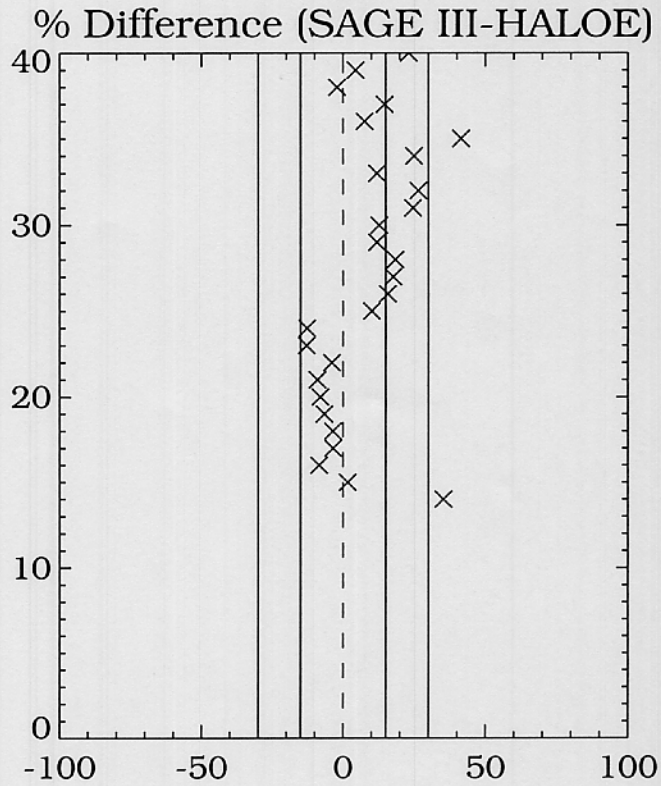

570920 2003-02-01 72.7 132.7
Altitude (km)
0
10
20
30
40
0
2
4
6
8
10
12
H_2O (ppmv)

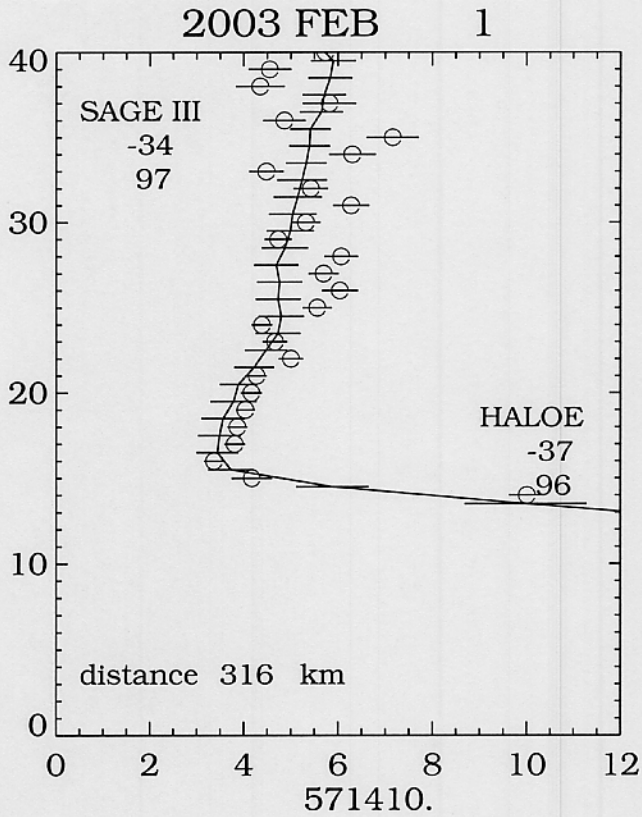

523710 2002-12-28 -35.7 57.9
Altitude (km)
0
10
20
30
40
0
2
4
6
8
10
12
H2O (ppmv)

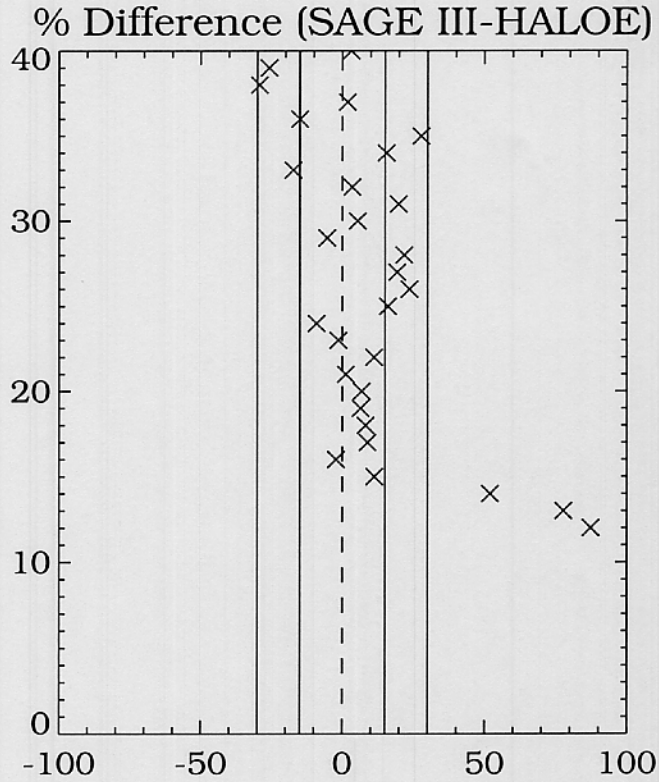

522910 2002-12-28 65.6 149.9
Altitude (km)
0
10
20
30
40
0
2
4
6
8
10
12
H_2O (ppmv)

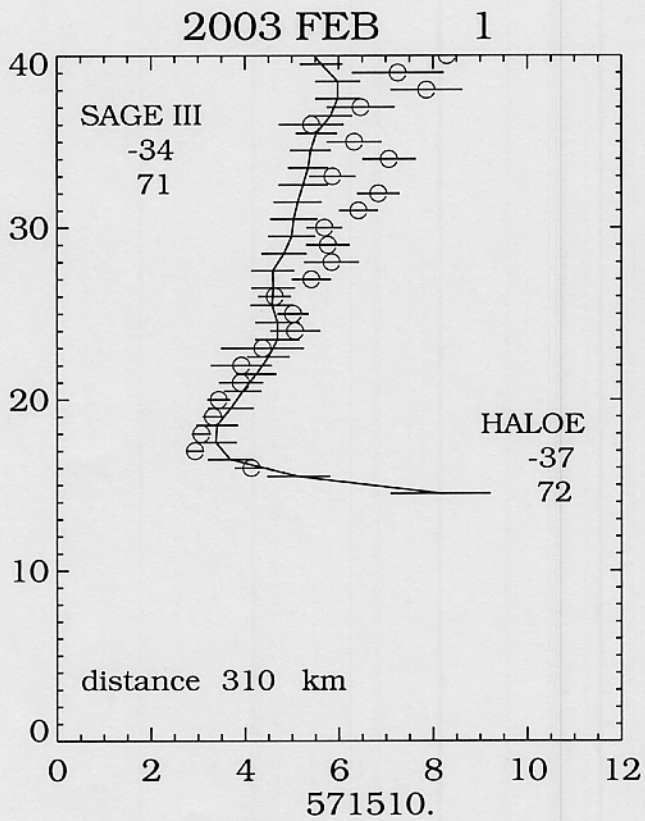

371720 2002-09-08 65.7 111.9
Altitude (km)
0
10
20
30
40
0
2
4
6
8
10
12
H_2O (ppmv)

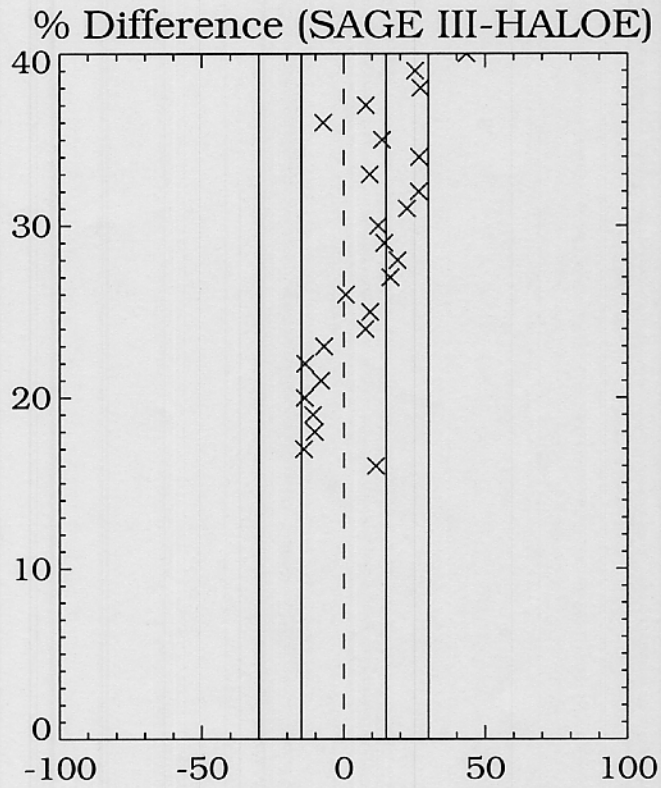

2003 FEB 1
SAGE III
-34
97
HALOE
-37
96
distance 316 km
571410.


% Difference (SAGE III-HALOE)


2003 FEB 1
SAGE III
-34
97
HALOE
-37
96
distance 316 km
571410.


% Difference (SAGE III-HALOE)


2003 FEB 1
SAGE III
-34
71
HALOE
-37
72
distance 310 km
571510.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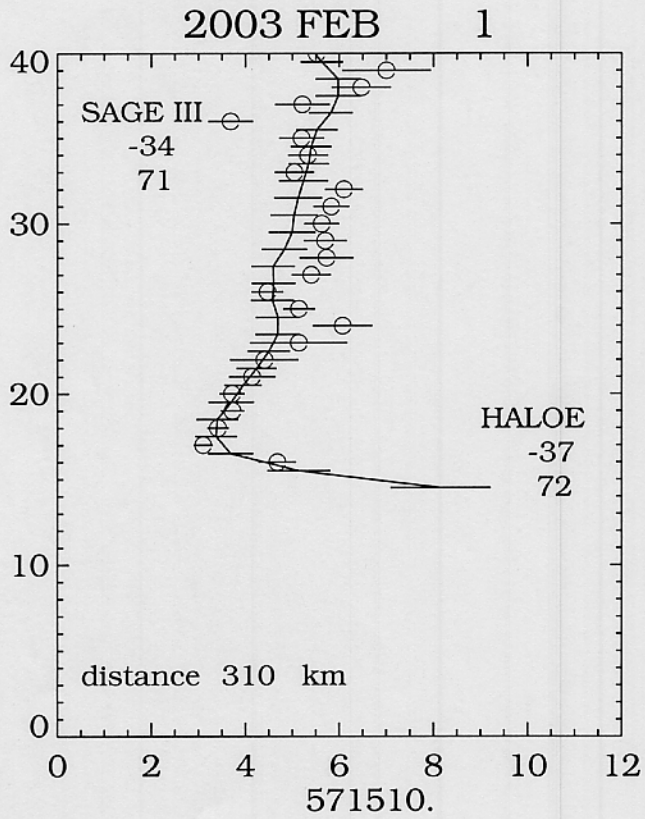
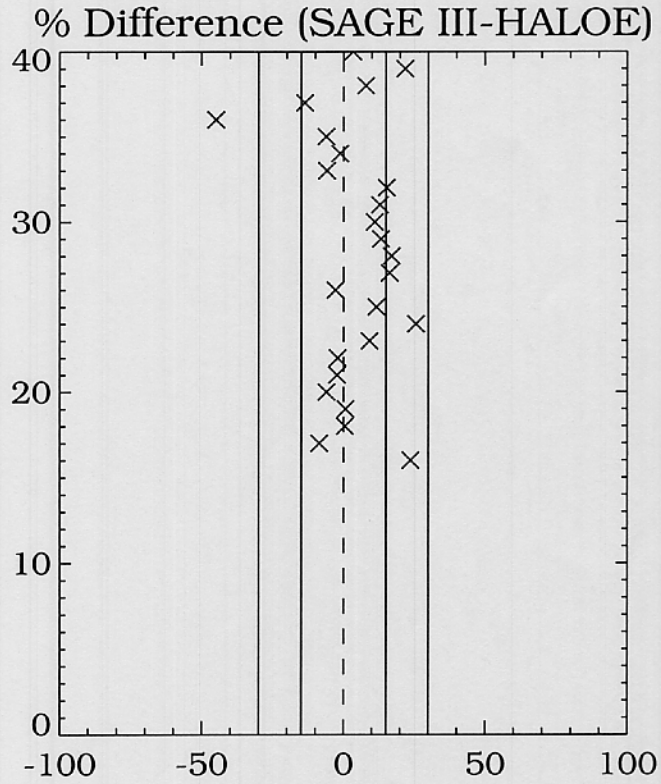

2003 FEB 1
SAGE III
-34
71
HALOE
-37
72
distance 310 km
571510.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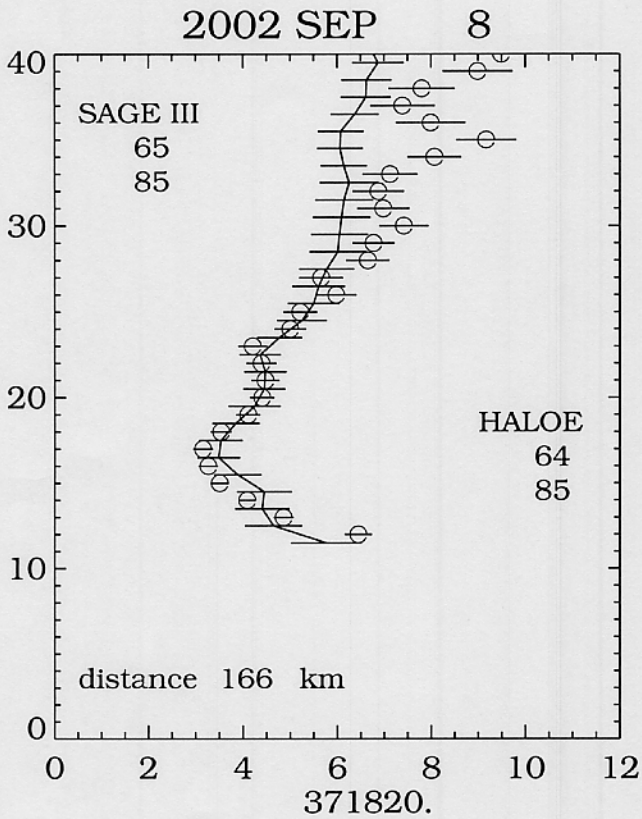
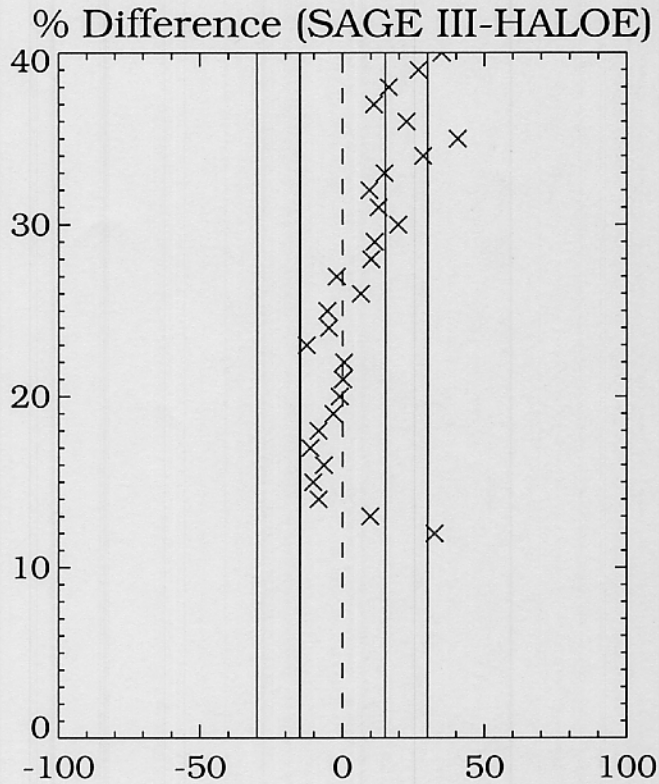
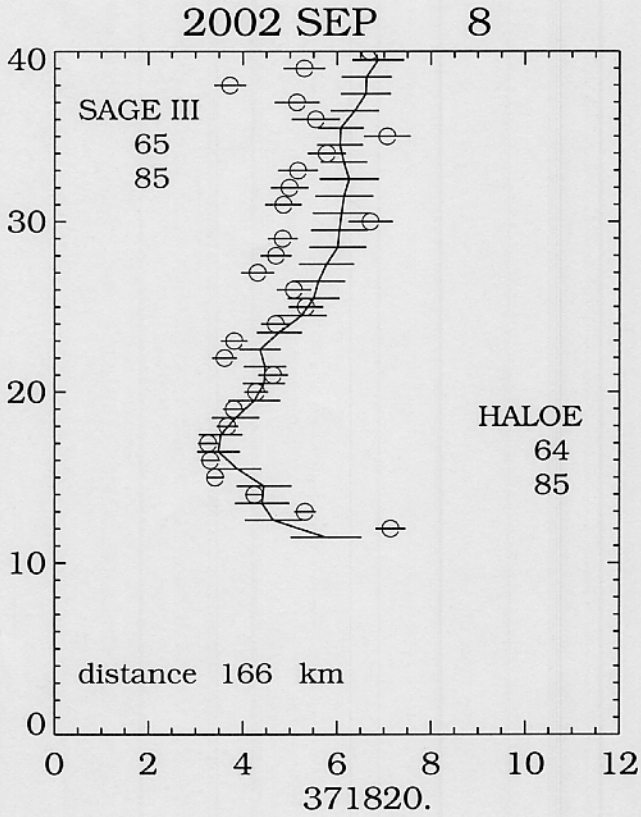
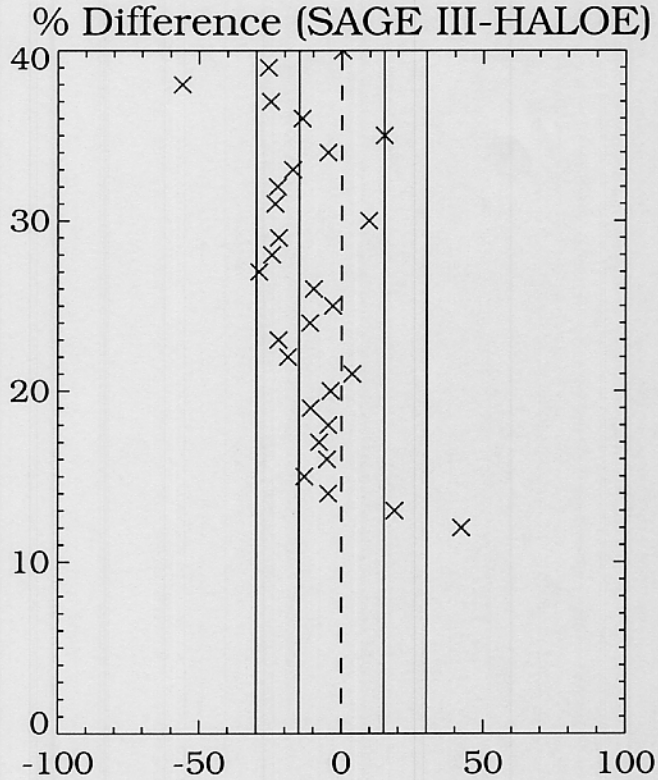
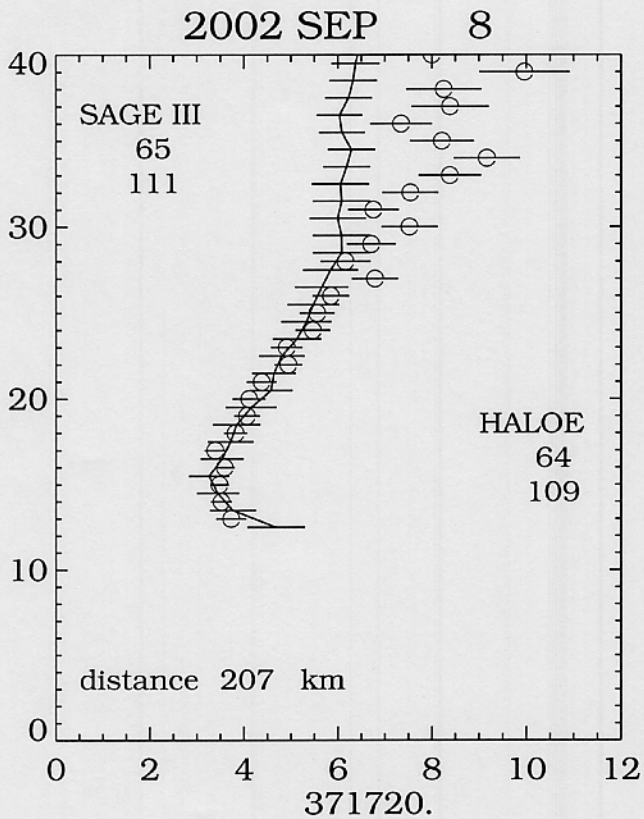
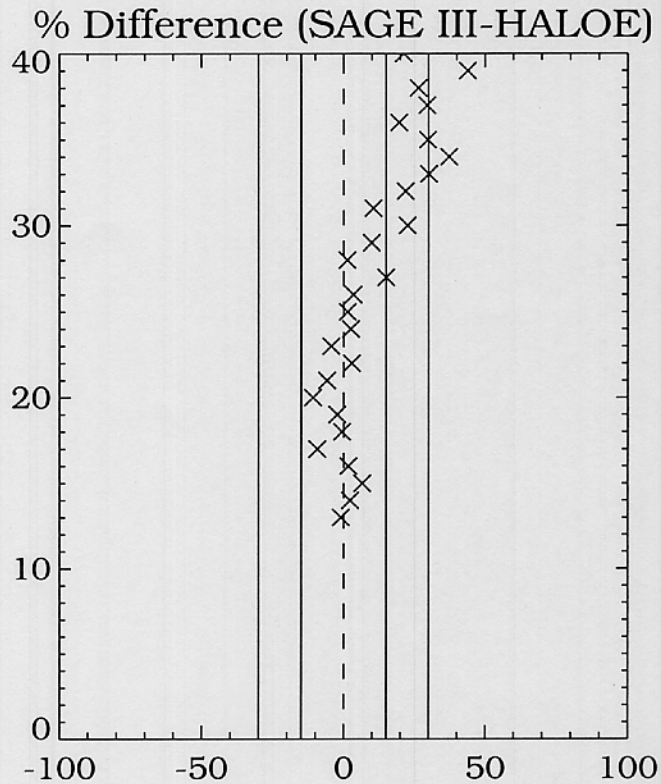

2002 SEP 8
SAGE III
65
85
HALOE
64
85
distance 166 km
371820.

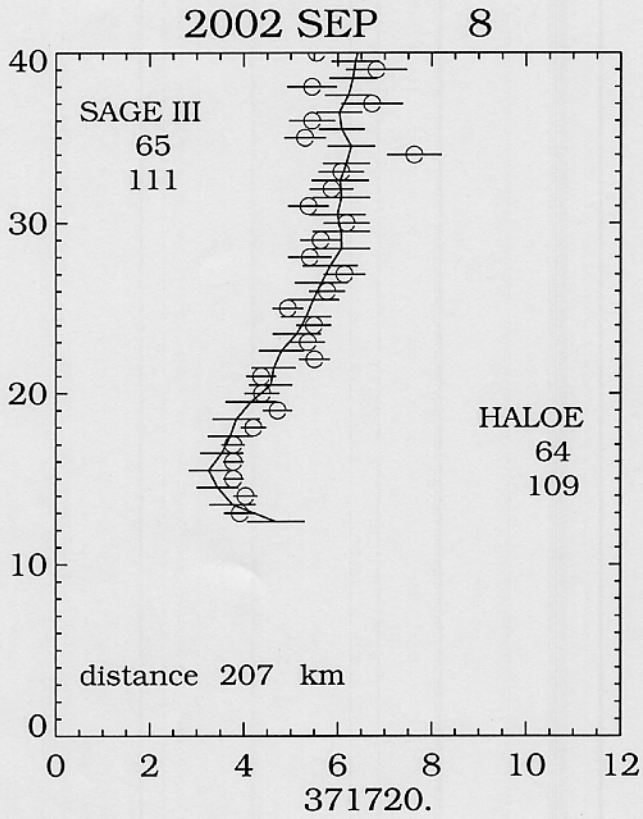

% Difference (SAGE III-HALOE)

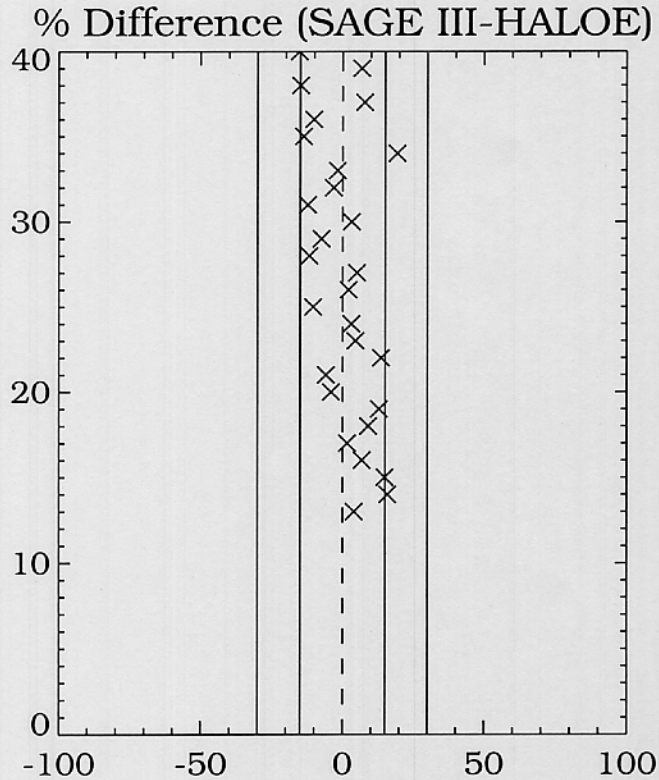

2002 SEP 8
SAGE III
65
85
HALOE
64
85
distance 166 km
371820.


% Difference (SAGE III-HALOE)


2002 SEP 8
SAGE III
65
111
HALOE
64
109
distance 207 km
371720.


% Difference (SAGE III-HALOE)


2002 SEP 8
SAGE III
65
111
HALOE
64
109
distance 207 km
371720.


% Difference (SAGE III-HALOE)

Further Research

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I. Implement and test a new approach for simultaneously retrieving water vapor mixing ratios and removing the contributions of aerosol, ozone and etaloning noise using one-stage non-linear optimization iterative scheme.

II. Re-examine the computation of error bars

III. Investigate the issue of uncertainty in ozone cross sections

IV. Intercomparisons with various coincident measurements (SAGE II, HALOE, POAM III, Frost-point hygrometers etc)

V. Investigate the characteristics of seasonal and spatial (latitudinal, altitudinal) variations in the water vapor data products