ACE-FTS and MLS comparisons of atmospheric trace species

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Outline

- ACE-FTS instrument
- MLS and ACE data being used
- Comparison details
- Comparison results
  - O_3, H_2O, HNO_3, HCl, CO, N_2O, and CH_3Cl
- Summary

ACE-FTS

Atmospheric Chemistry Experiment – Fourier Transform Spectrometer

- Canadian satellite SciSat was launched into a circular, high-inclination orbit in August 2003
  - ACE-FTS and MAESTRO instruments on board
- ACE-FTS is a solar occultation instrument
  - High spectral resolution FTS in the 2.2 to 13.3 µm spectral range
  - 30+ trace species are retrieved, as well as 20+ subsidiary isotopologues
  - Vertical resolution of 3-4 km
- ACE-FTS level 2 version 3.5 data were used in this study
  - Complete dataset currently spans 2004-2013

The data

- MLS v3.3
  - Cloud free data
  - Filtered by quality, convergence, status flags, and precision
  - Using GP heights

- ACE-FTS v3.5
  - Filtered using quality flags
  - Interpolated 1-km grid
  - No vertical smoothing

  - All volume mixing ratios are given in parts per volume

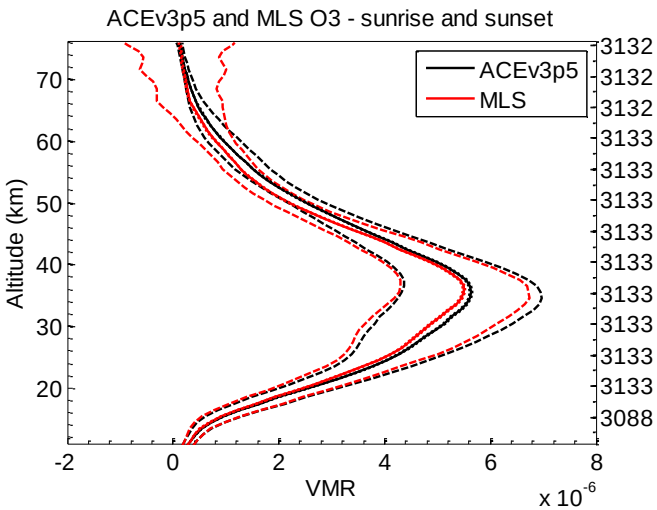
The comparisons

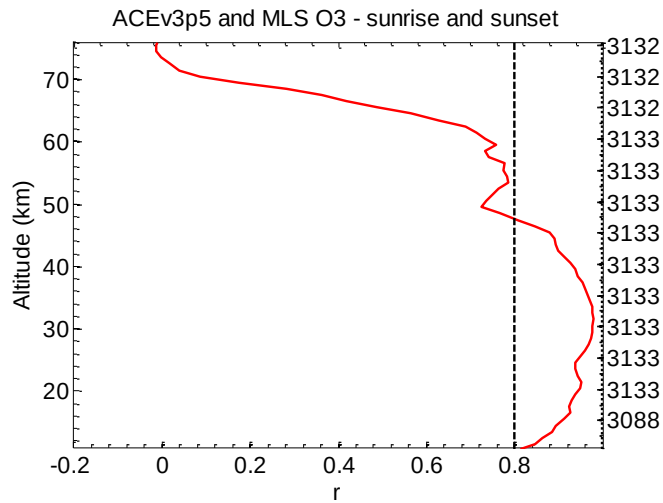
- All comparisons are with respect to ACE-FTS
  - i.e. ACE subtracted by INST
- Comparison criteria
  - ΔUT < 2 hours
  - Δlatitude < 5°
  - Δlongitude < 10°
- Absolute diff:
  - mean of (ACE - INST)
- % diff:
  - 100 * absolute diff / mean of ACE and INST combined

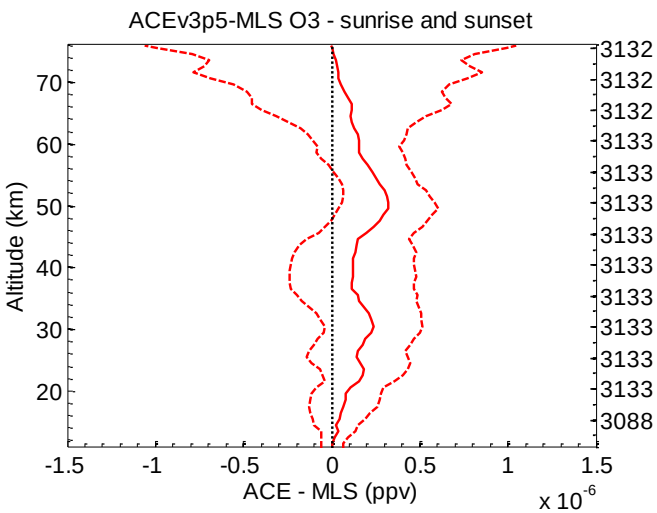
O_3 – what you're about to see

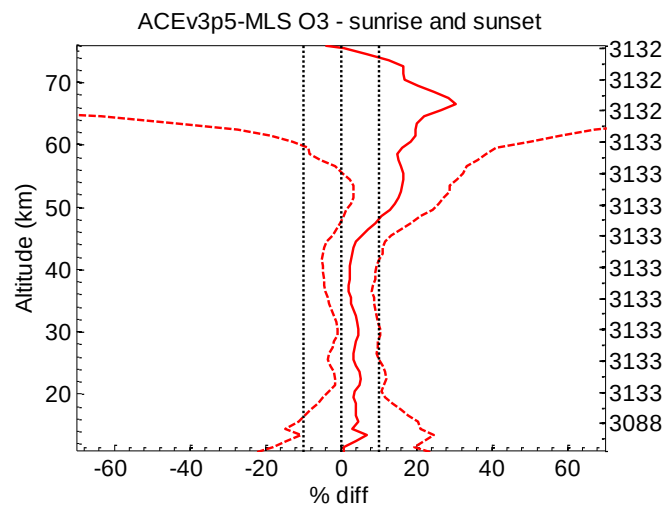
- ACE agrees well with most instruments
  - Slight high bias ~3±7 % in lower-mid stratosphere
  - Higher bias in US/LM, ~10±10 %
- MLS is right in the middle
  - ACE has ~2-5% high bias wrt MLS between 20-45 km
  - ACE has ~5-15% high bias wrt MLS between 45-60 km

O_3 comparisons with MLS (all latitudes)

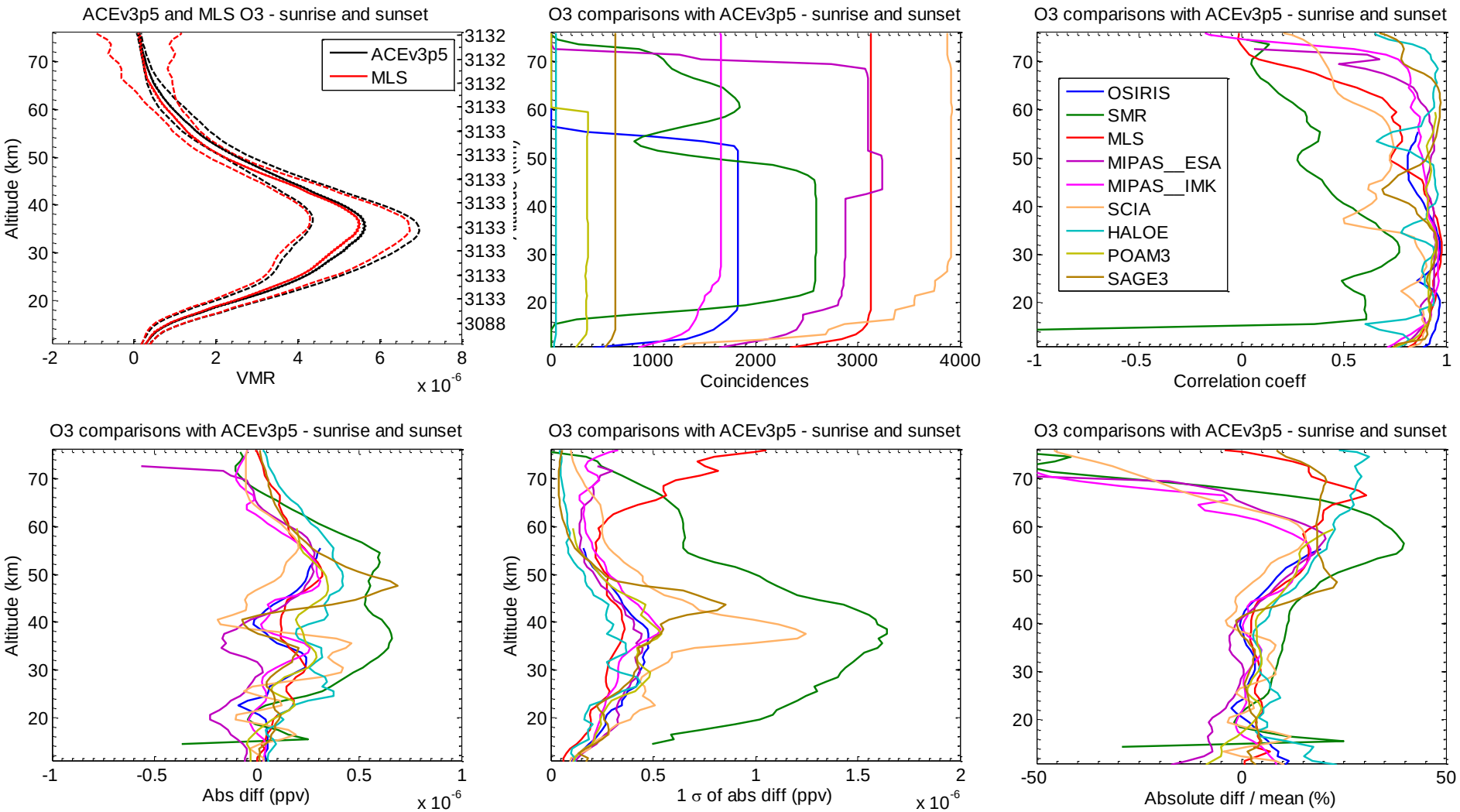








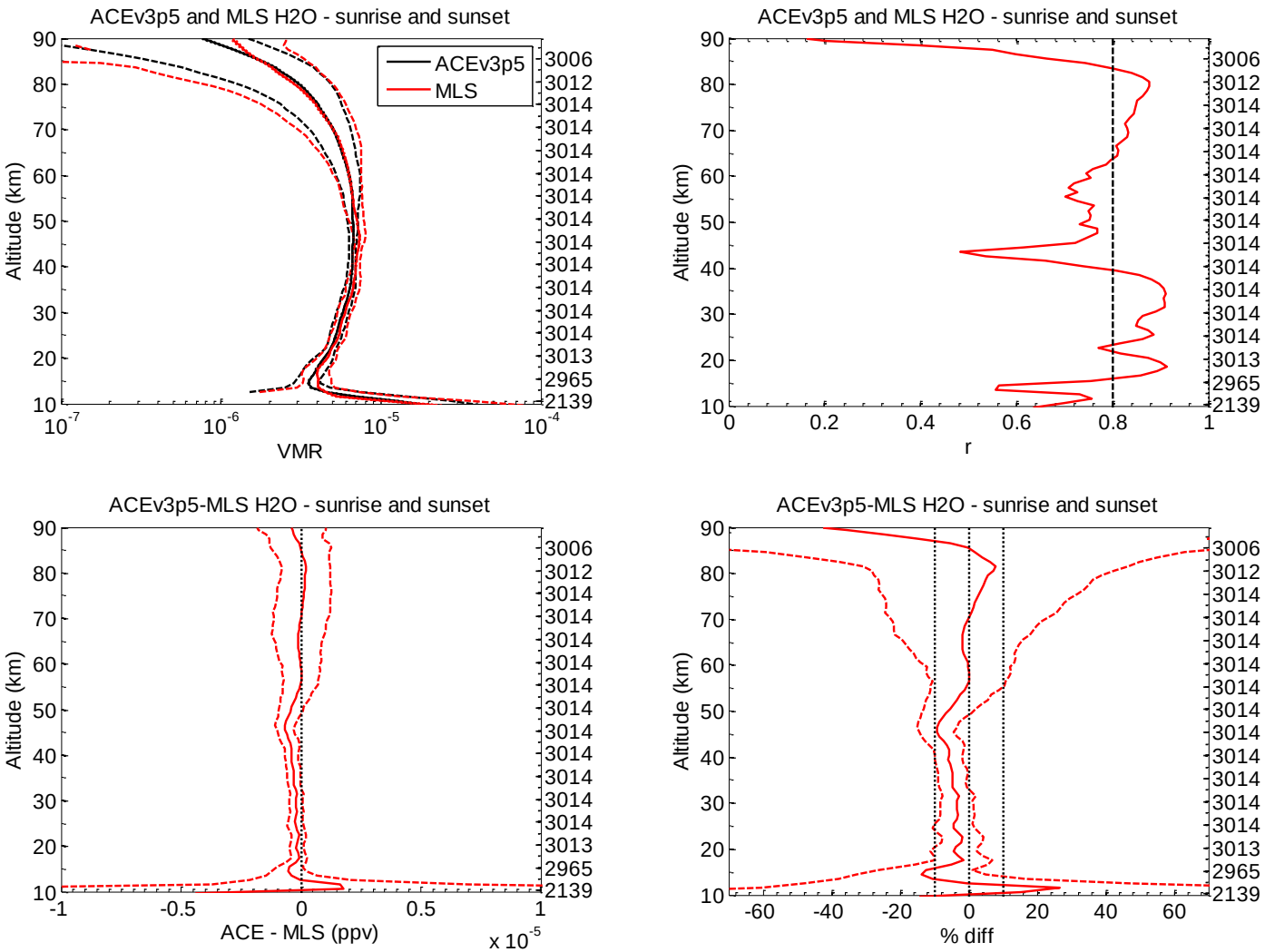
O_3 comparisons with multiple instruments



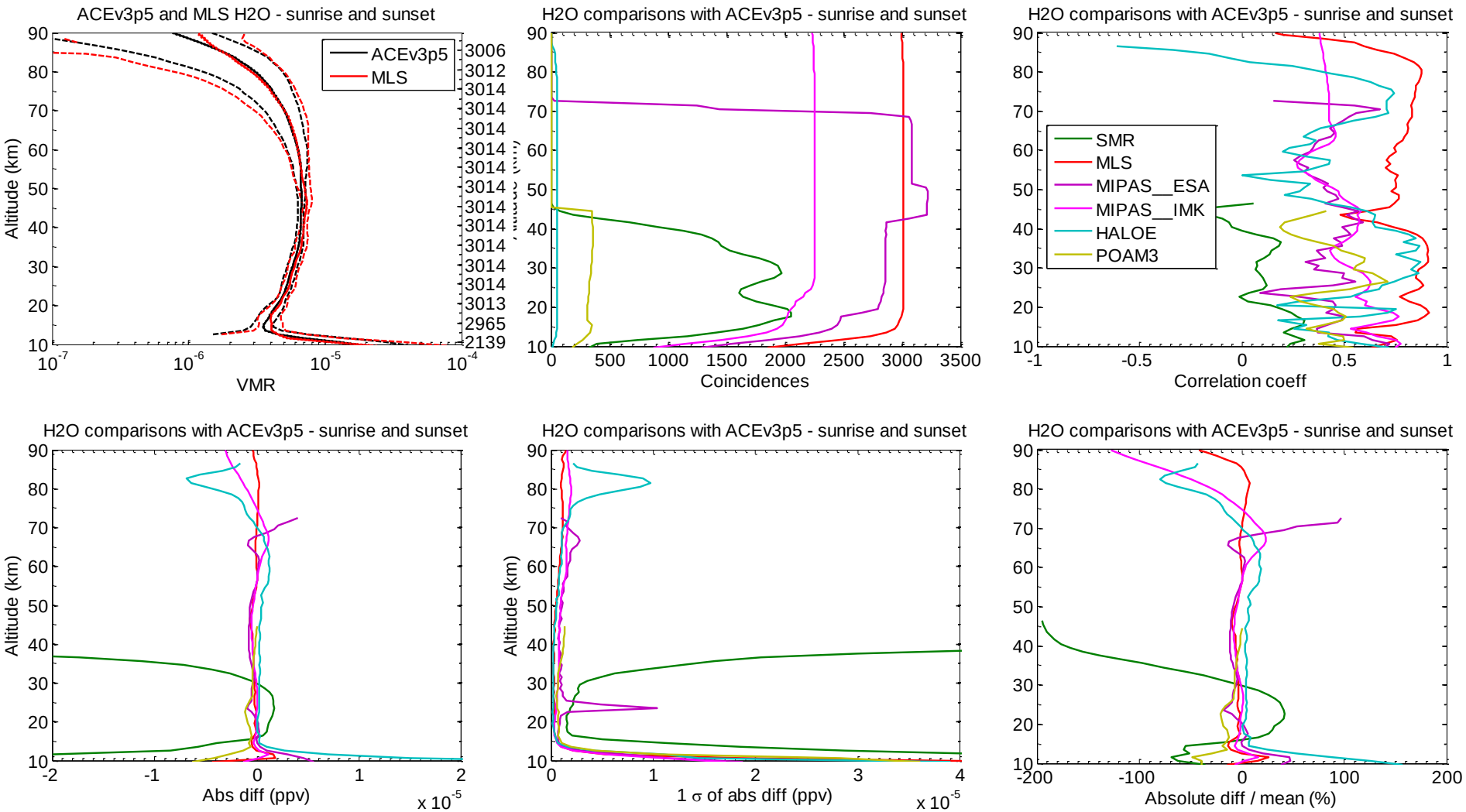
H_2O – what you're about to see

- ACE shows best agreement with MLS
  - Strong correlation throughout 15-80 km
  - 5-10% low bias above hygropause, high bias at lower heights
  - ~0% bias above 50 km, but with greater σ values

H_2O comparisons with MLS (all latitudes)



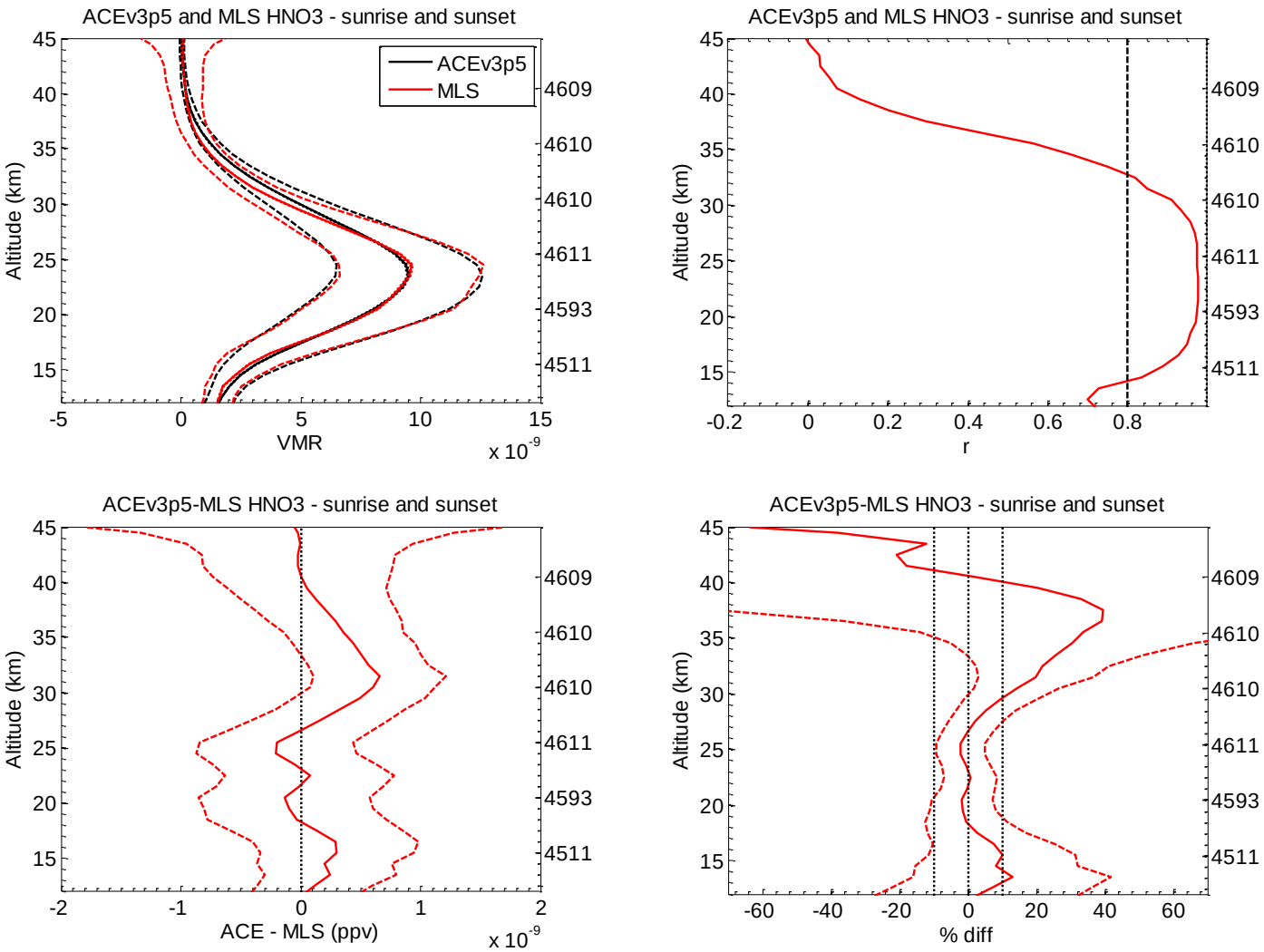
H_2O comparisons with multiple instruments



HNO_3 – what you're about to see

- Almost no bias around peak, 18-28 km
- ACE exhibits high bias wrt MLS outside this altitude region

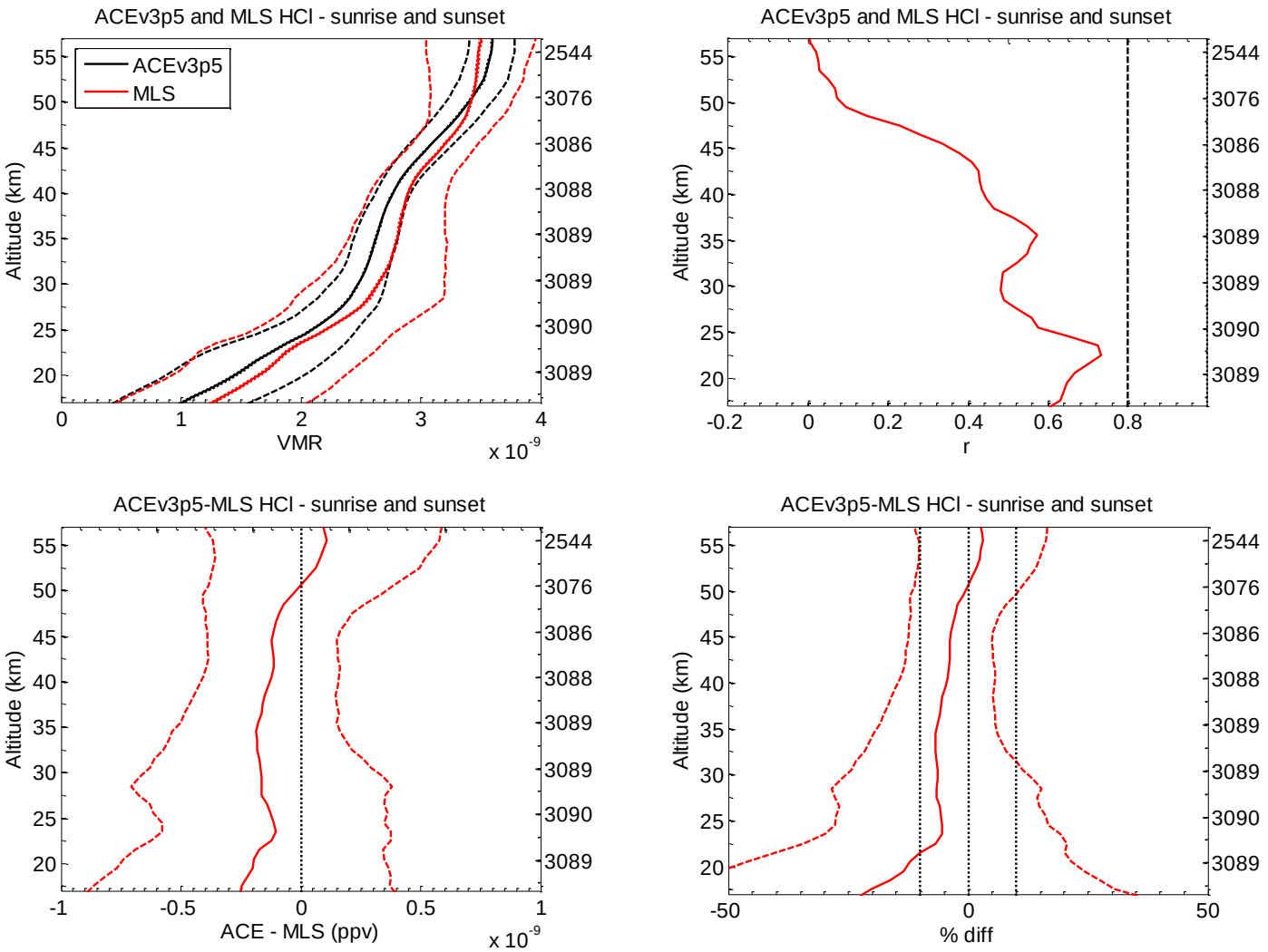
HNO_3 comparisons with MLS (all latitudes)



HCl – what you're about to see

- At most heights, ACE has low bias wrt MLS within 7%
  - However, ACE has high bias wrt HALOE within 10%

HCl comparisons with MLS (all latitudes)

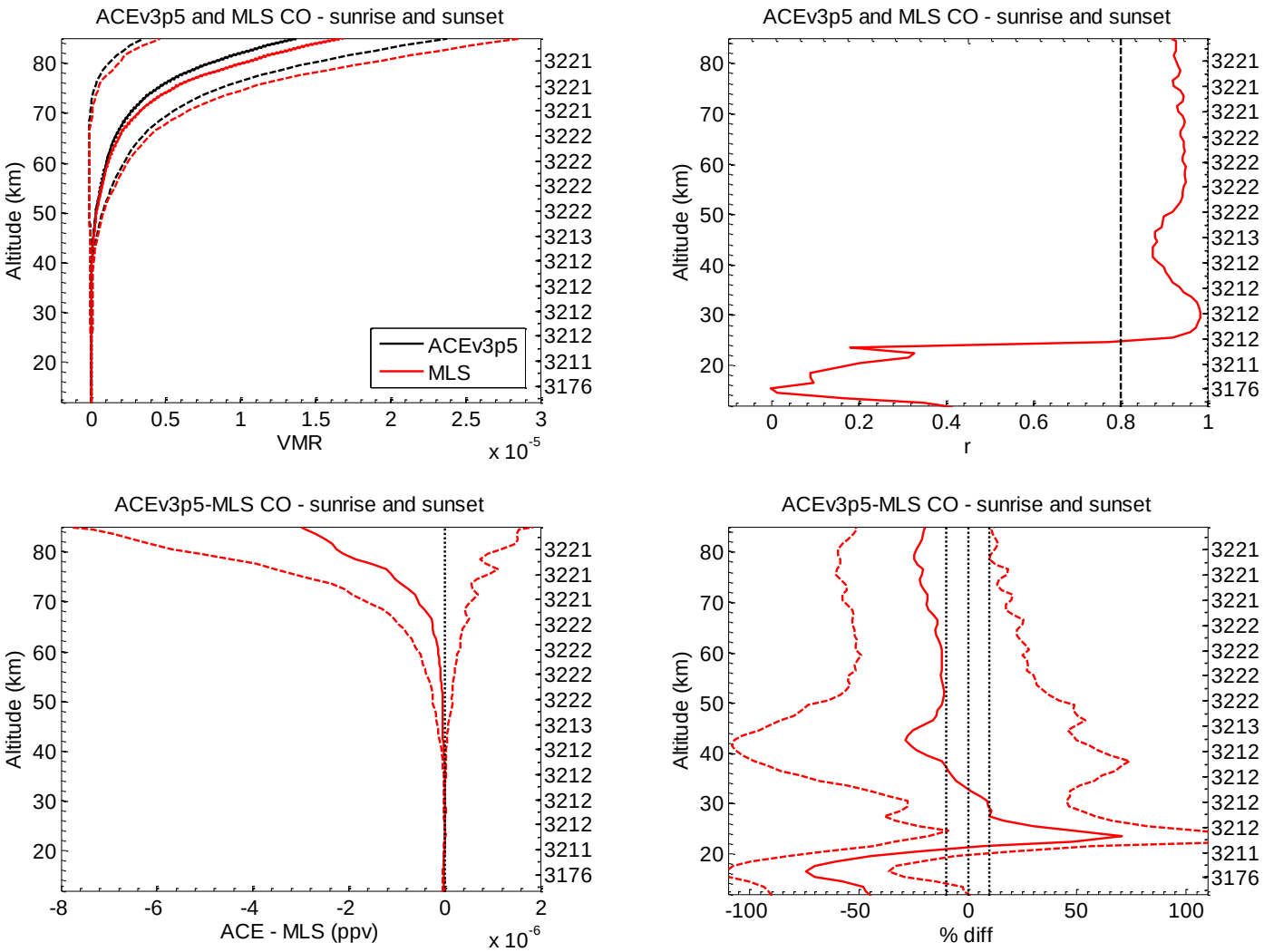


CO – what you're about to see

- ACE agrees well with MLS above 50 km
  - ACE has 10-20% low bias wrt MLS

    (however, ACE has 0-10% low bias wrt MIPAS)

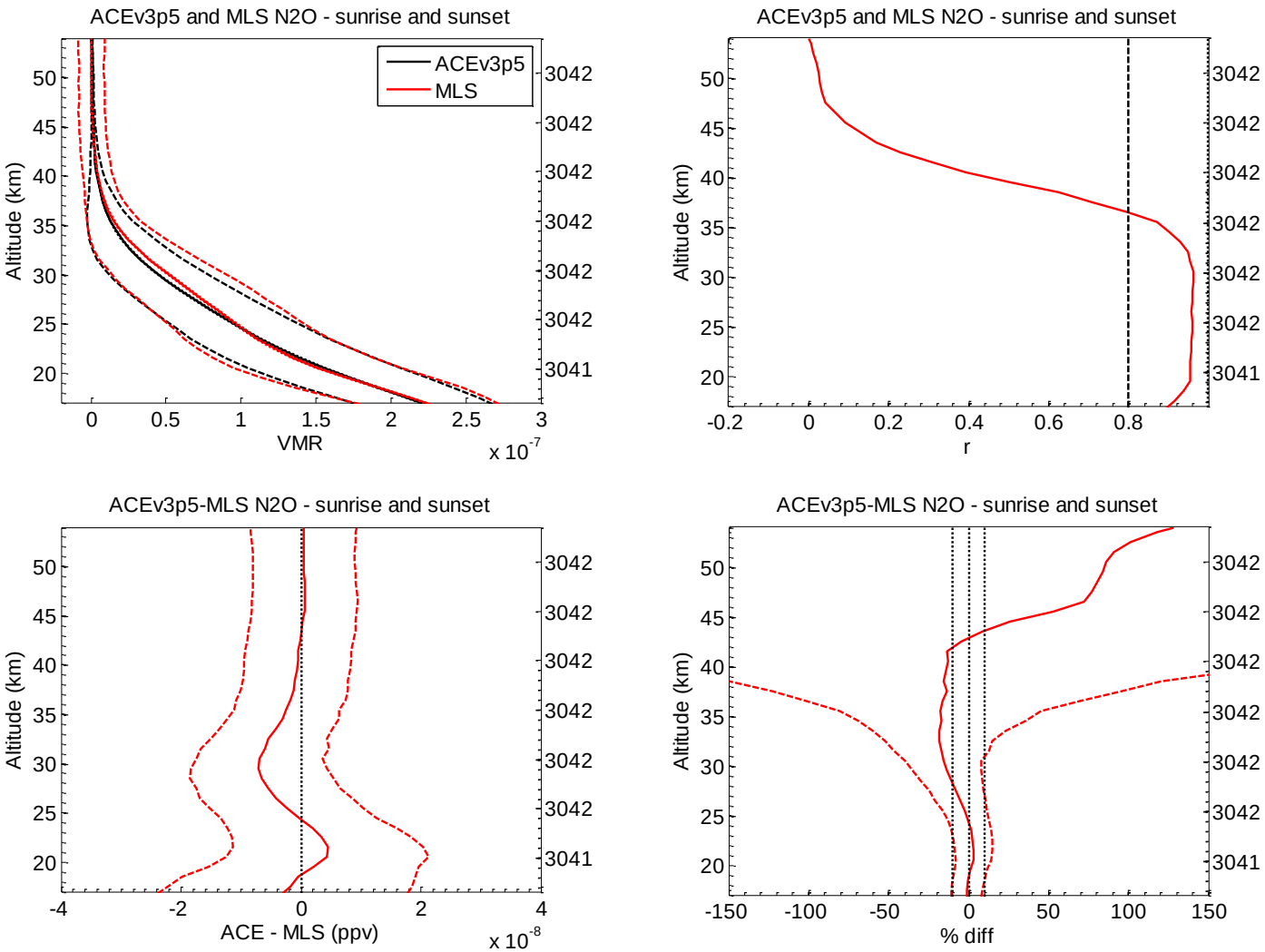
CO comparisons with MLS (all latitudes)



N_2O – what you're about to see

- ACE agrees well with MLS at lower heights; worse agreement at upper heights
  - Agree within 5% up to 25 km
  - Agree within 15% up to 42 km

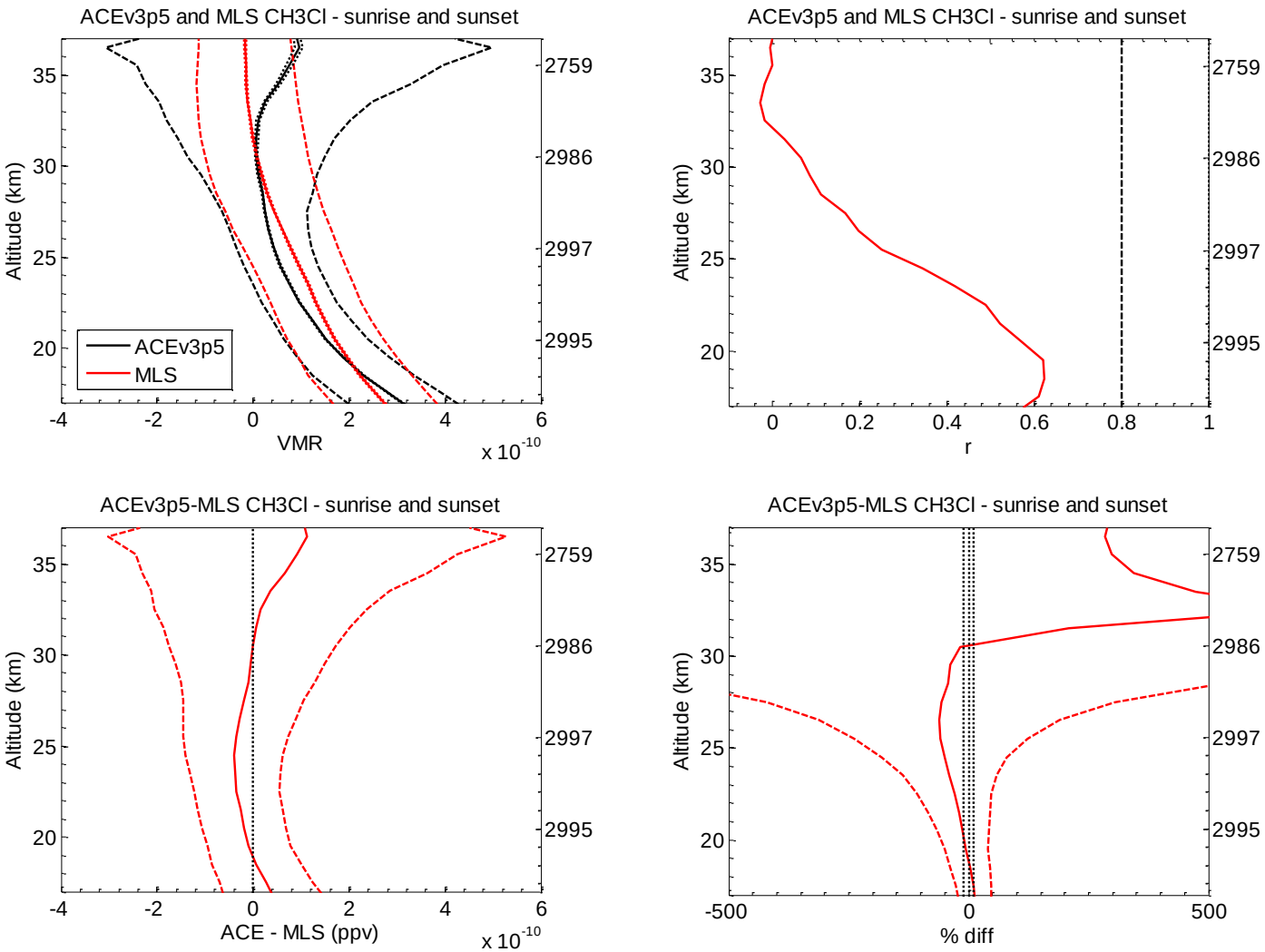
N_2O comparisons with MLS (all latitudes)



CH_3Cl – what you're about to see

- Weak correlation at all heights,
- Large biases between ACE and MLS
- Dissimilar mean profiles
- ACE exhibits much larger variation at upper heights

CH_3Cl comparisons with MLS (all latitudes)



Summary

- ACE-FTS and MLS will be BFFs forever
  - Thousands of coincident profiles to compare

O_3 – ACE bias wrt MLS is near the average difference with other satellite instruments
  - ACE has ~2-5% high bias between 20-45 km
  - ACE has ~5-15% high bias between 45-60 km

H_2O – ACE shows best agreement with MLS
  - ACE has 5-10% low bias above hygropause, high bias at lower heights

N_2O – ACE agrees well with MLS at lower heights; worse agreement at upper heights
  - Agree within 5% up to 25 km, within 15% up to 42 km

HNO_3 – Almost no bias around peak, 18-28 km
  - ACE exhibits high bias wrt MLS outside this altitude region

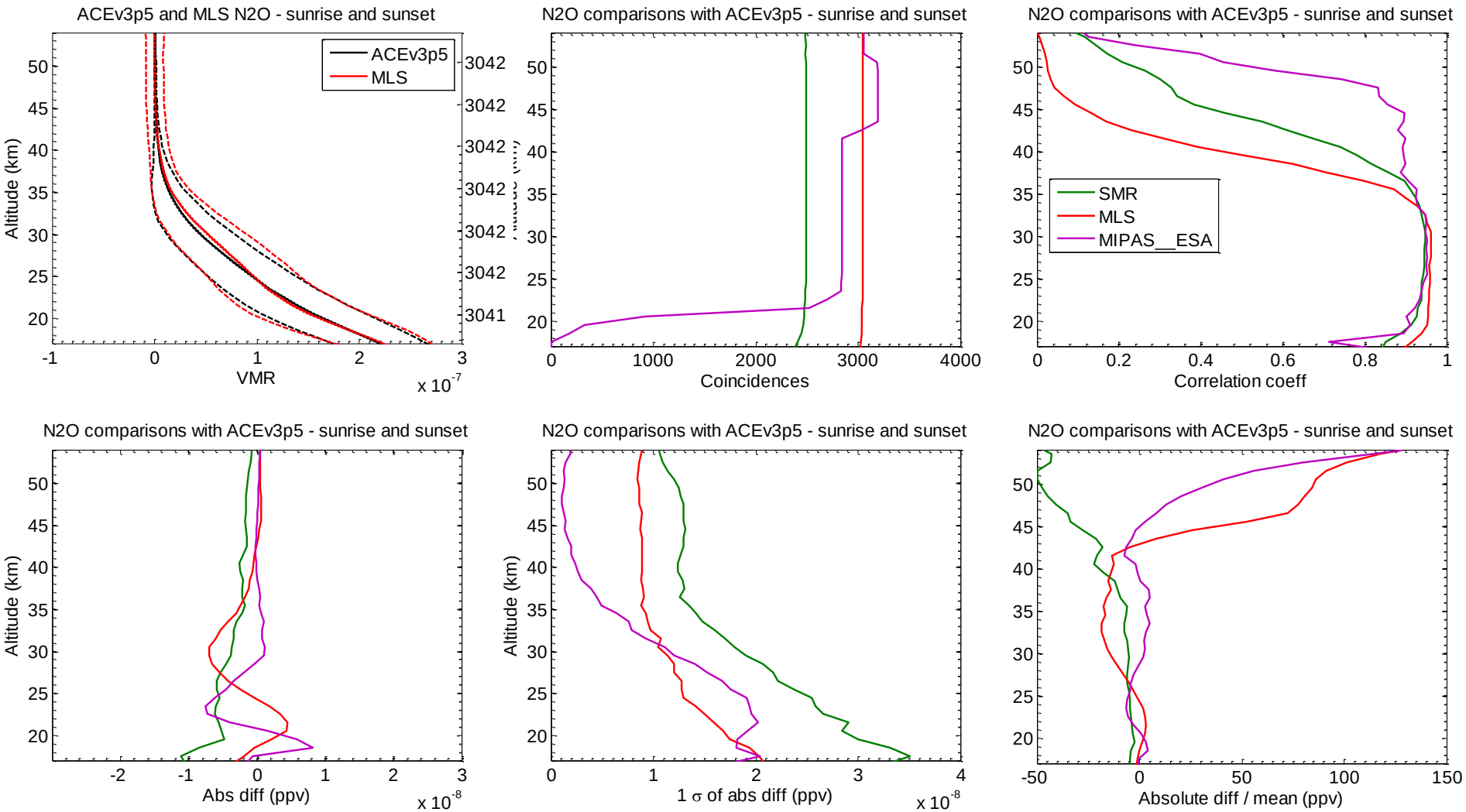
HCl – At most heights, ACE has low bias wrt MLS within 7%
  - However, ACE has high bias, within 10%, with HALOE

CO – ACE agrees well with MLS above 50 km
  - ACE has 10-20% low bias wrt MLS

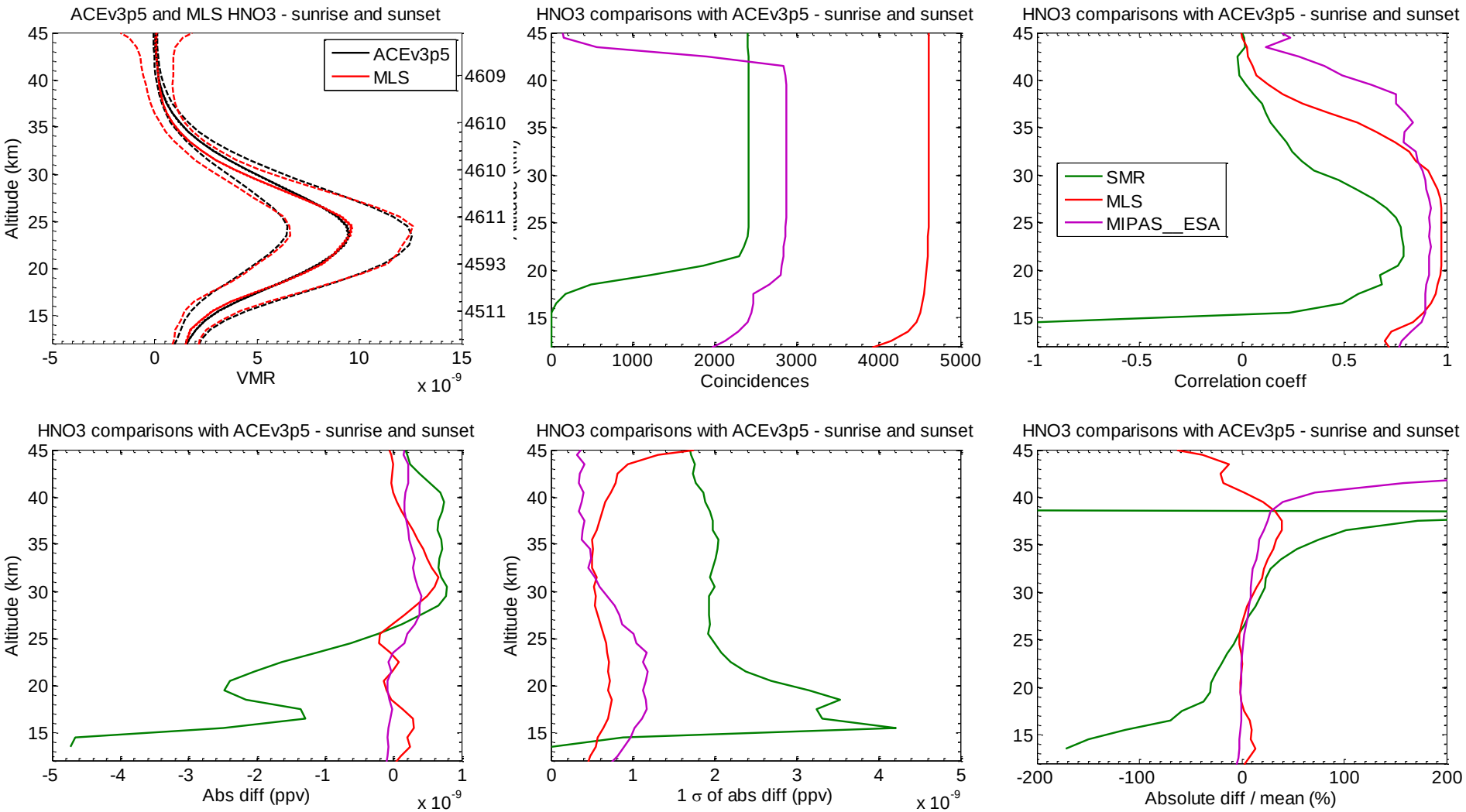
CH_3Cl – ACE and MLS do not compare well

Extra slides

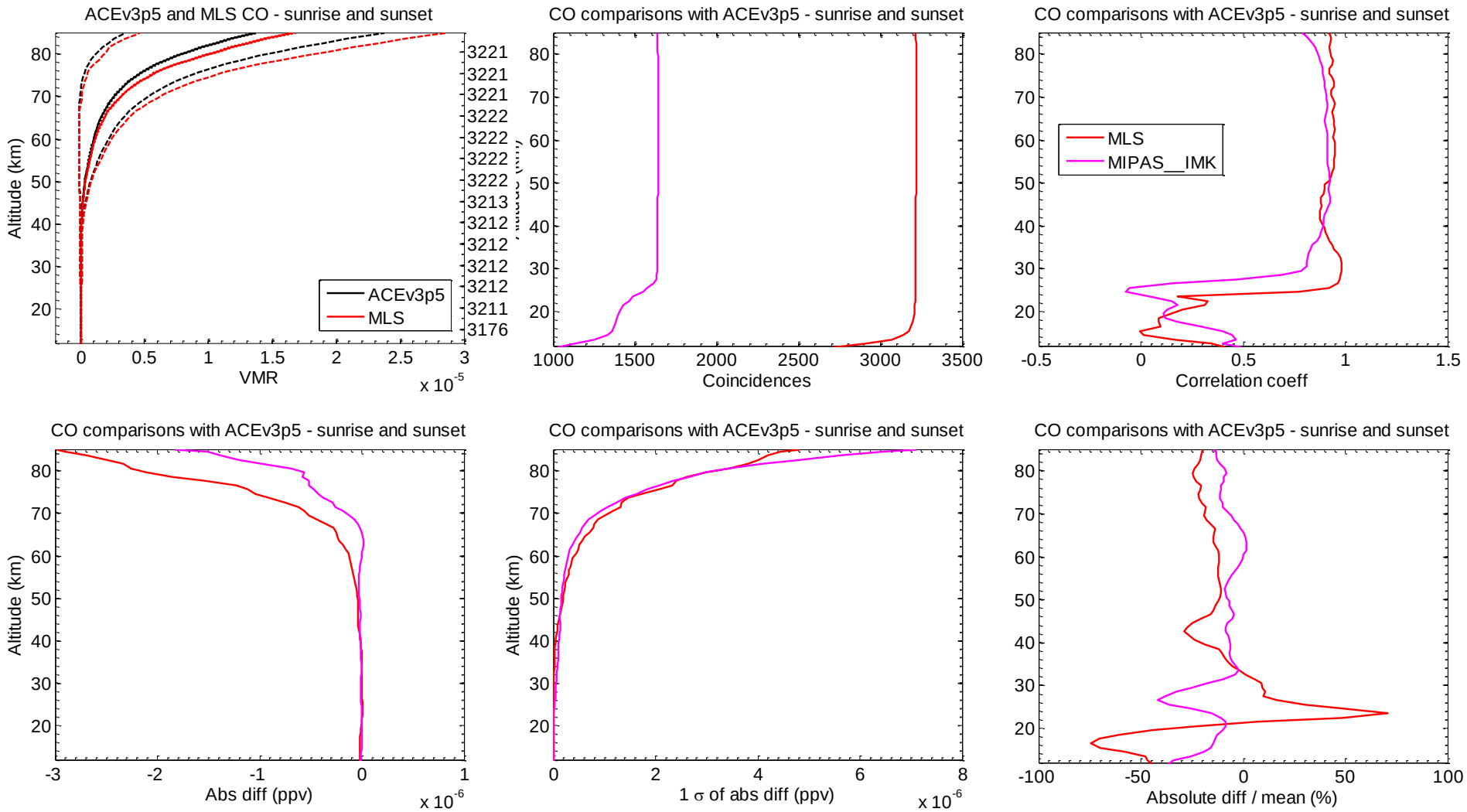
N2O comparisons with multiple instruments



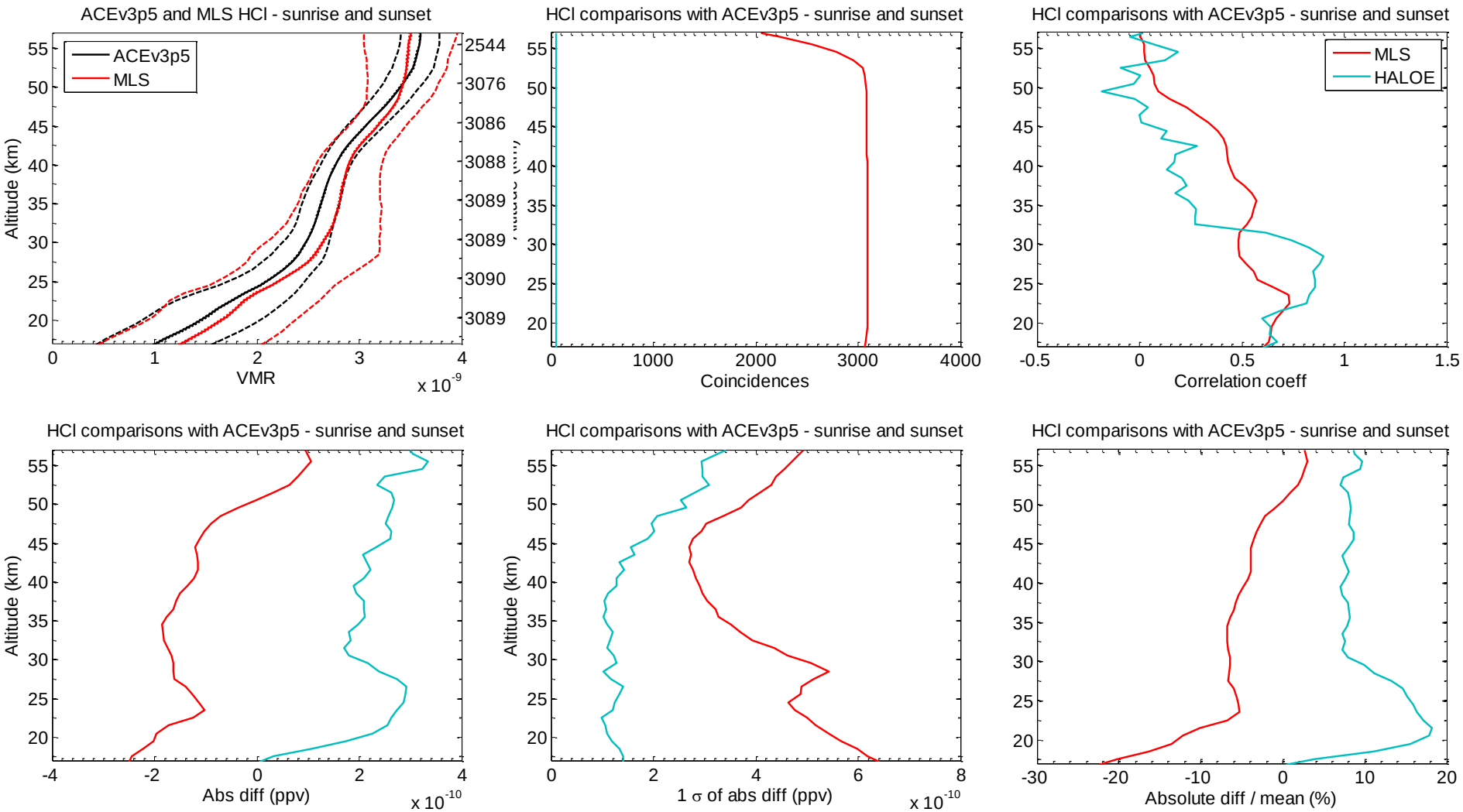
HNO3 comparisons with multiple instruments



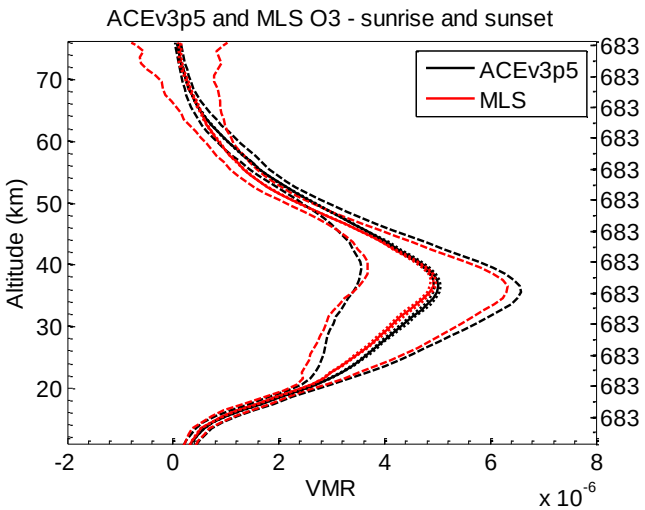
CO comparisons with multiple instruments

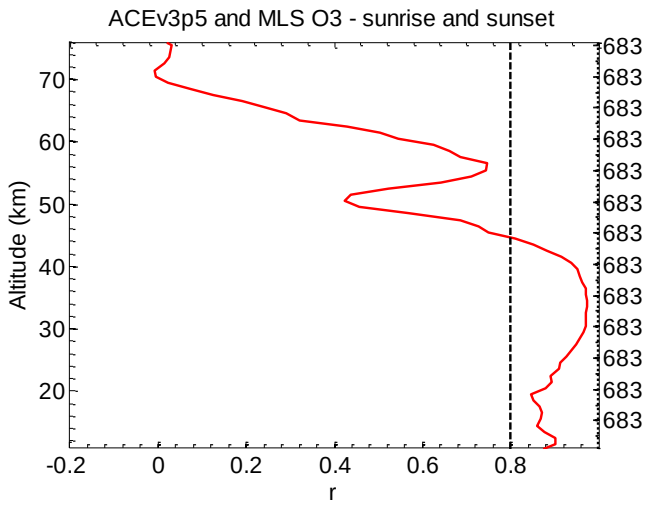


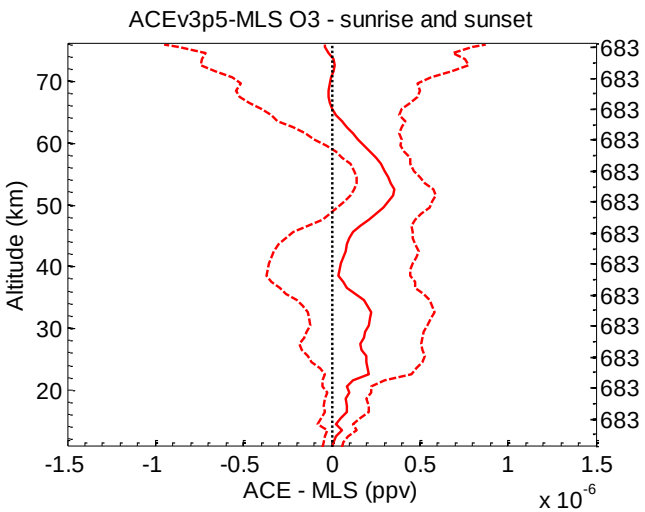
HCl comparisons with multiple instruments

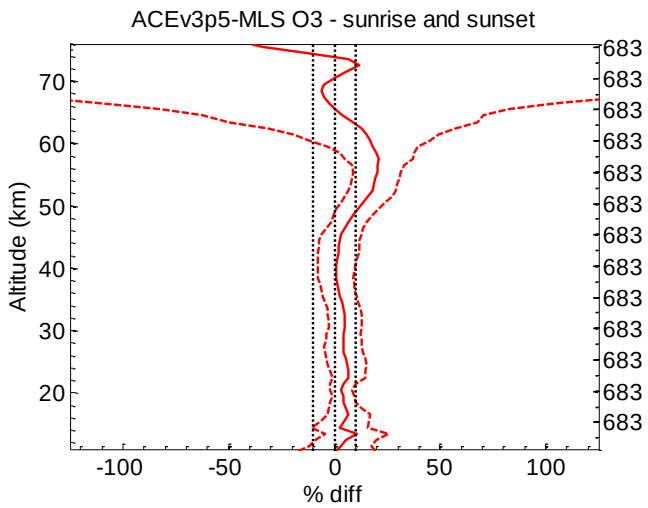


O3 (Arctic)

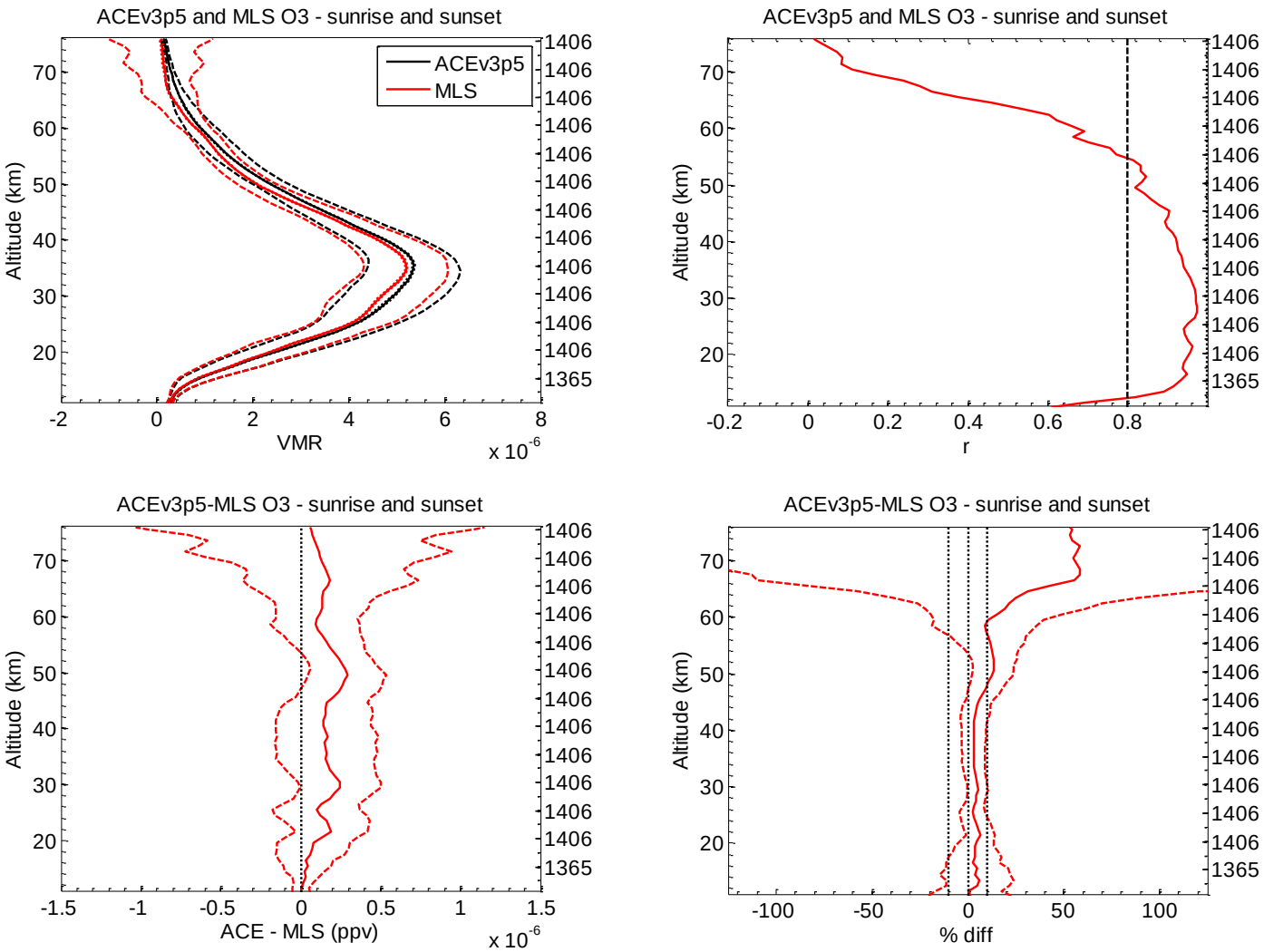

ACEv3p5 and MLS O3 - sunrise and sunset
ACEv3p5
MLS
Altitude (km)
VMR
x 10^-6


ACEv3p5 and MLS O3 - sunrise and sunset
Altitude (km)
r

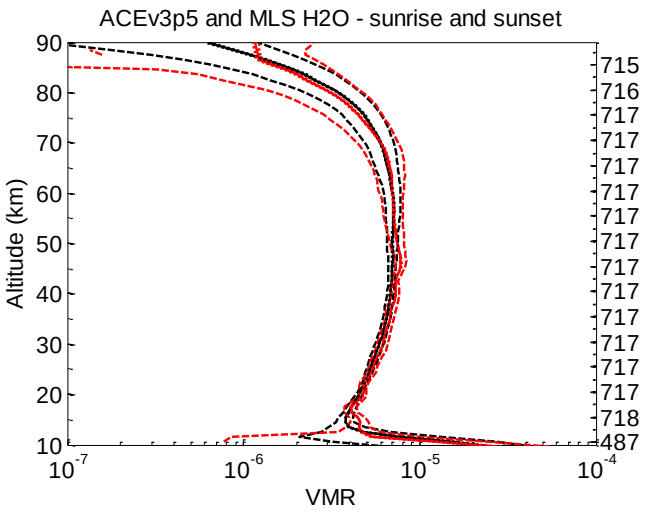

ACEv3p5-MLS O3 - sunrise and sunset
Altitude (km)
ACE - MLS (ppv)
x 10^-6

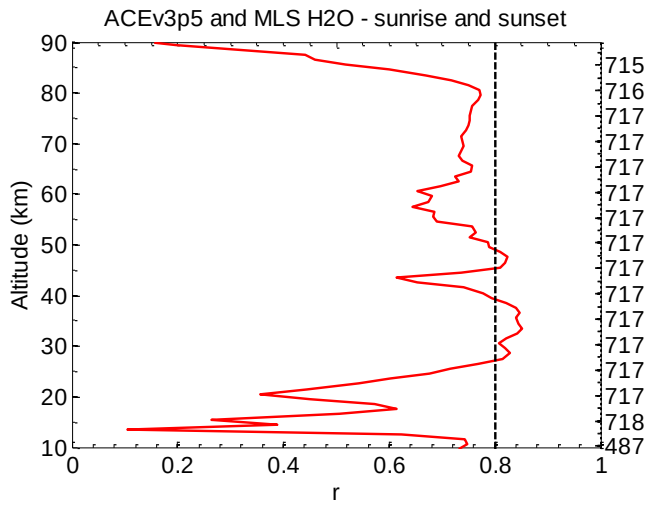

ACEv3p5-MLS O3 - sunrise and sunset
Altitude (km)
% diff

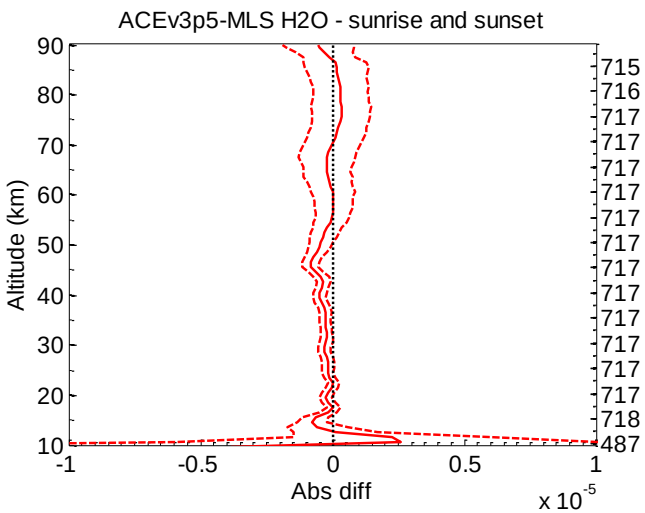
O3 (Antarctic)

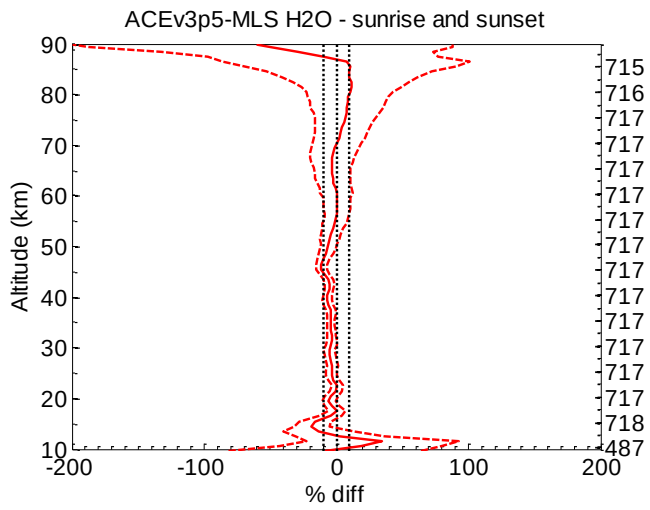


H2O (Arctic)

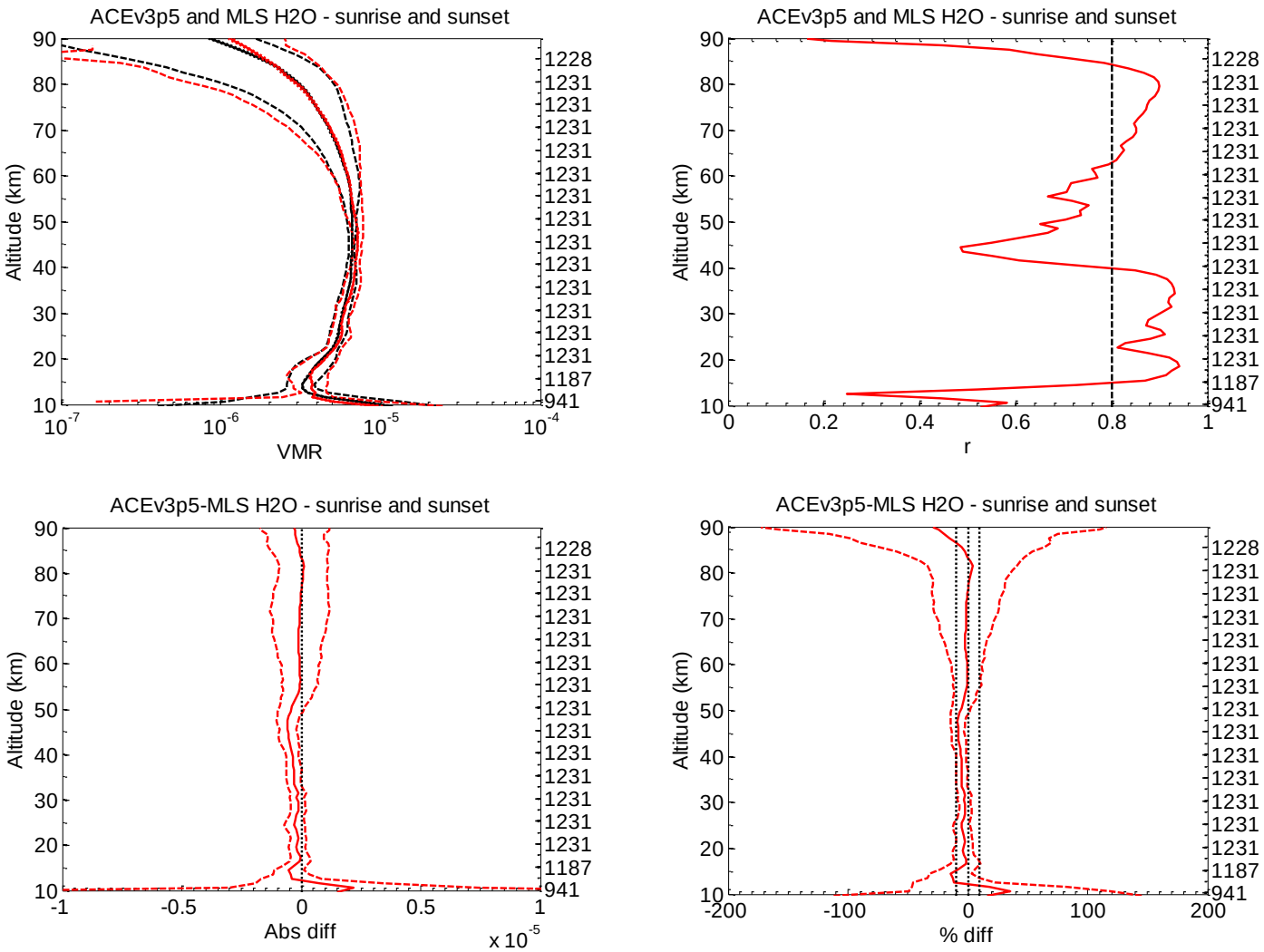

ACEv3p5 and MLS H2O - sunrise and sunset
Altitude (km)
VMR
715
716
717
718
487


ACEv3p5 and MLS H2O - sunrise and sunset
Altitude (km)
r
715
716
717
718
487

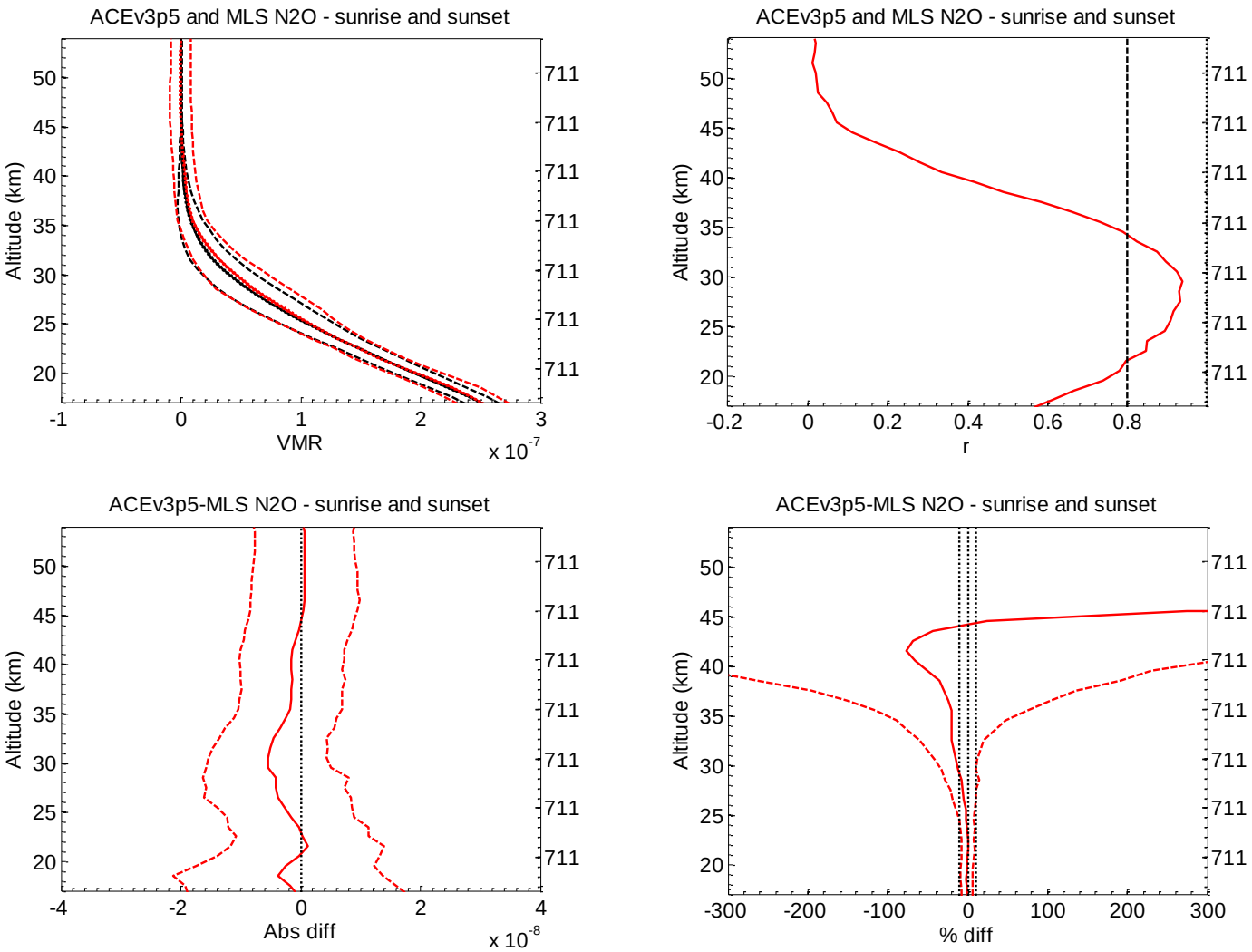

ACEv3p5-MLS H2O - sunrise and sunset
Altitude (km)
Abs diff
x 10^-5
715
716
717
718
487


ACEv3p5-MLS H2O - sunrise and sunset
Altitude (km)
% diff
715
716
717
718
487

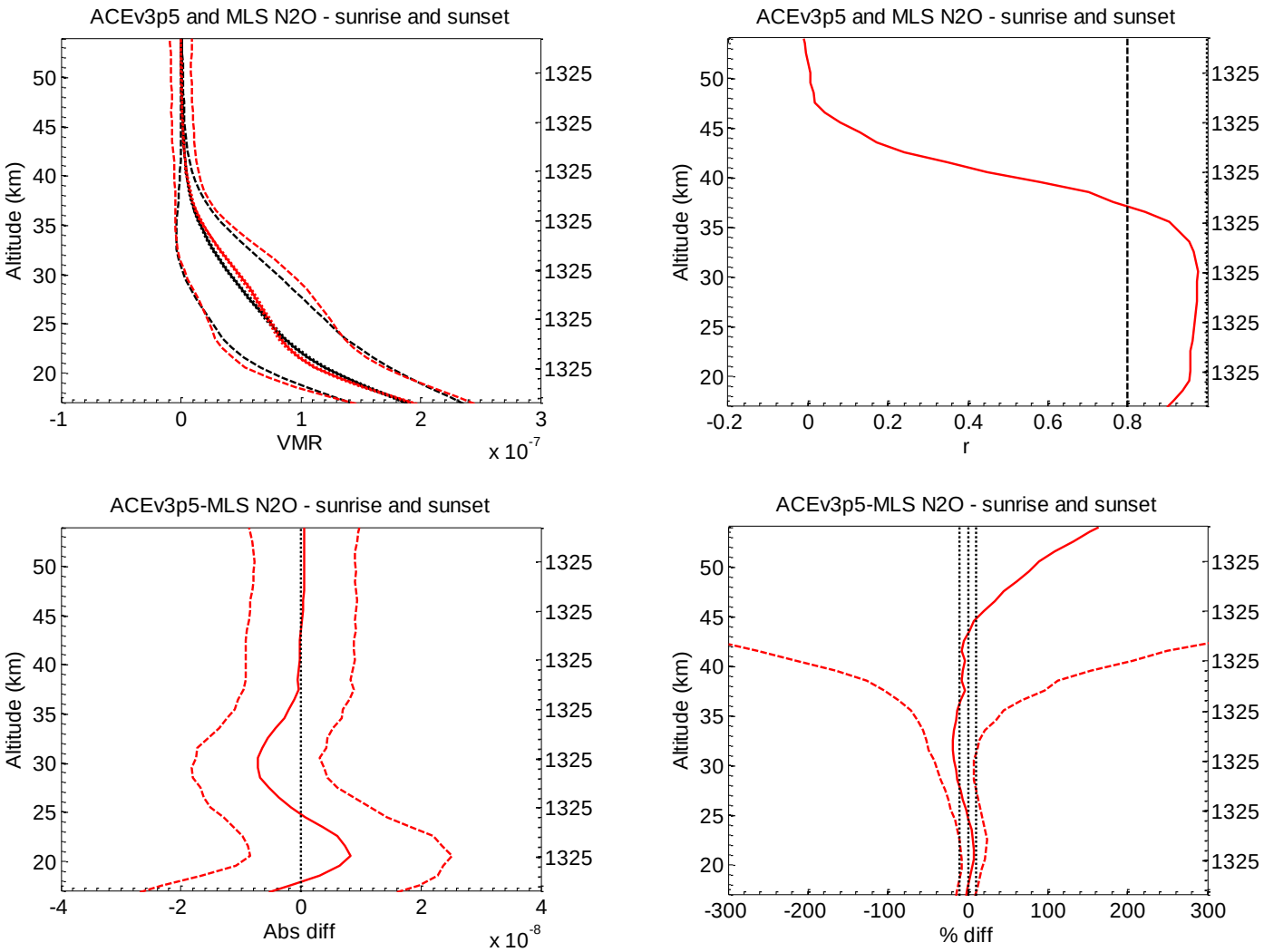
H2O (Antarctic)



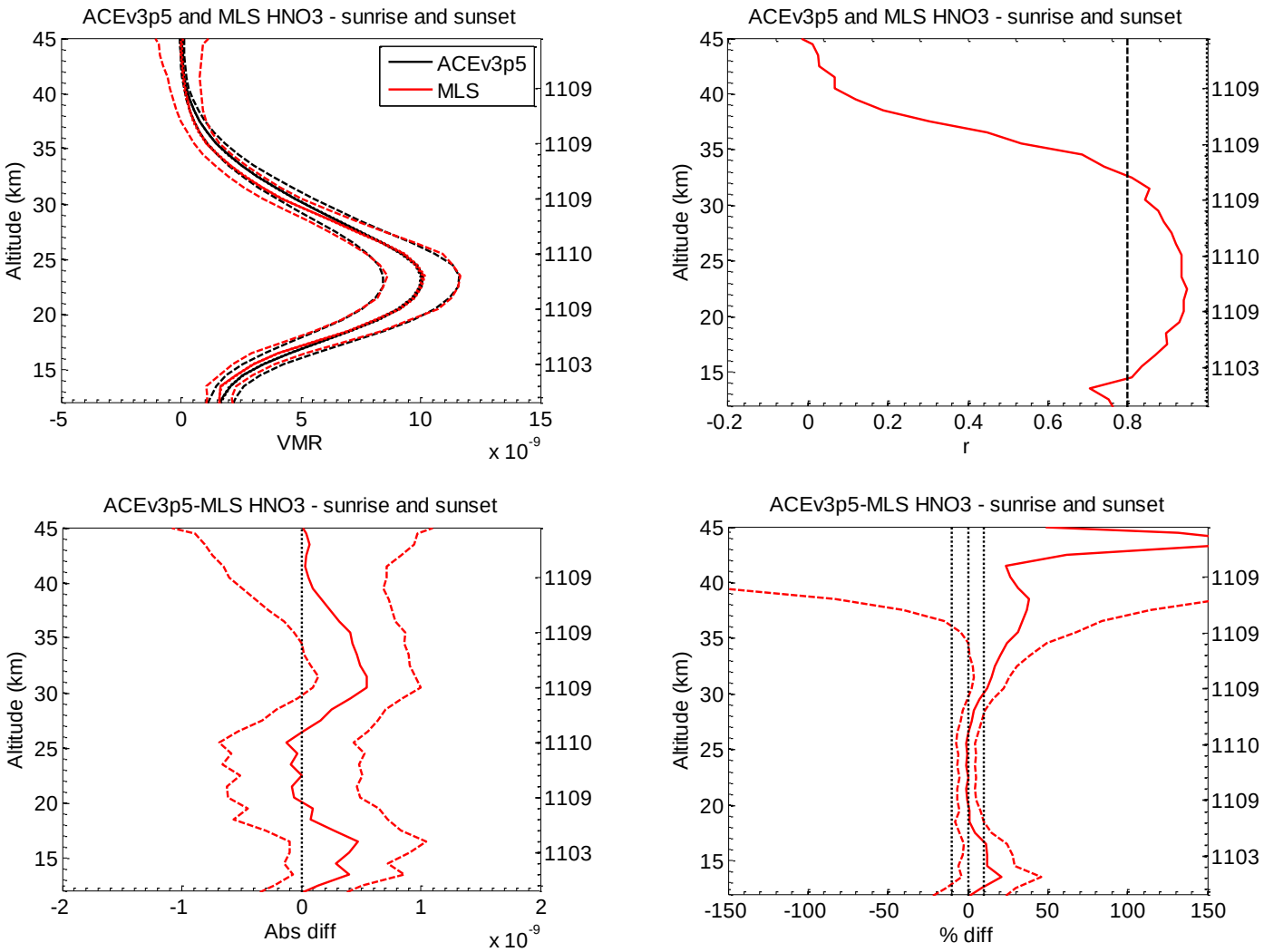
N2O (Arctic)


ACEv3p5 and MLS N2O - sunrise and sunset
Altitude (km)
VMR
x 10^-7
ACEv3p5 and MLS N2O - sunrise and sunset
Altitude (km)
r
ACEv3p5-MLS N2O - sunrise and sunset
Altitude (km)
Abs diff
x 10^-8
ACEv3p5-MLS N2O - sunrise and sunset
Altitude (km)
% diff

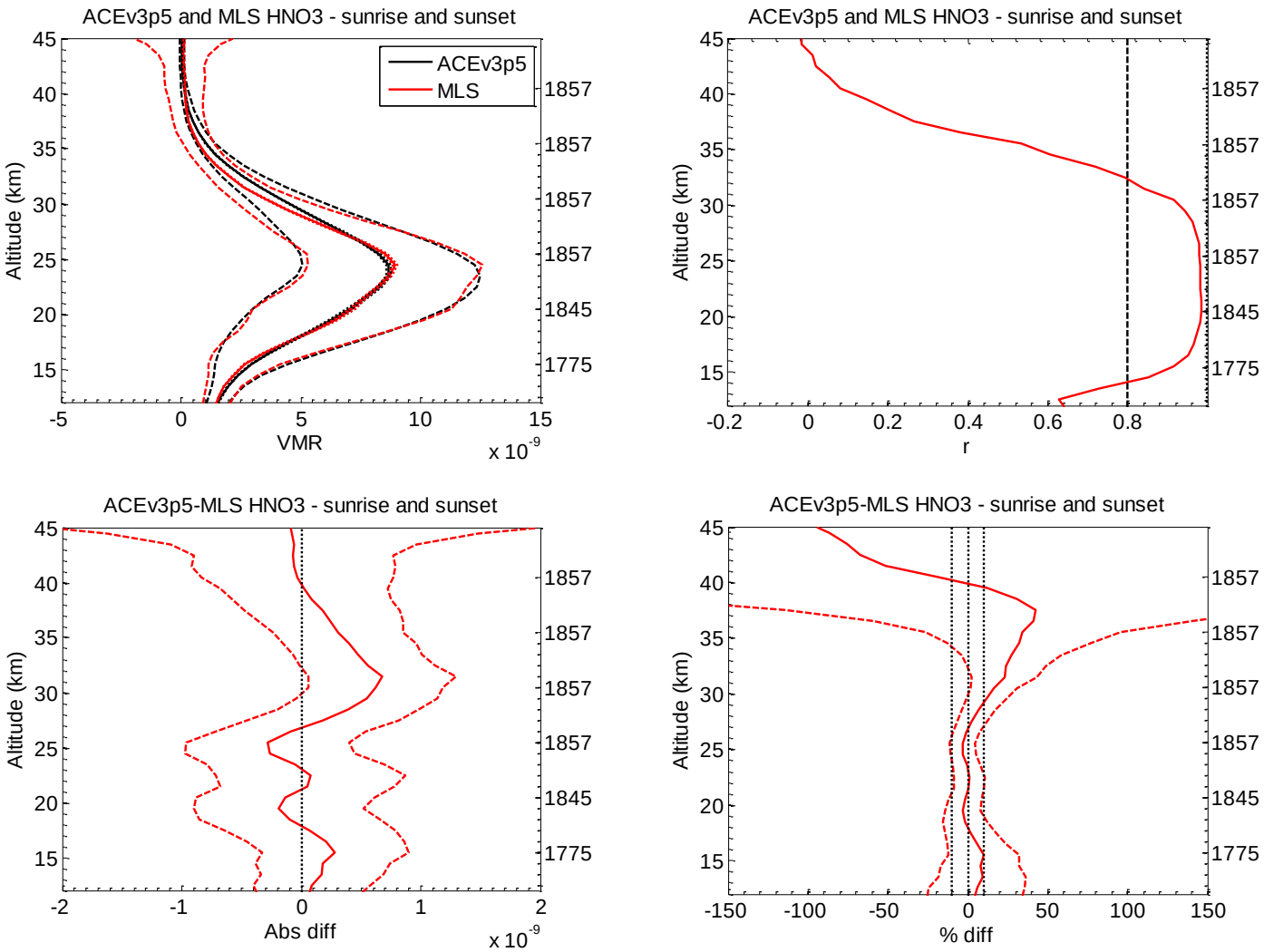
N2O (Antarctic)



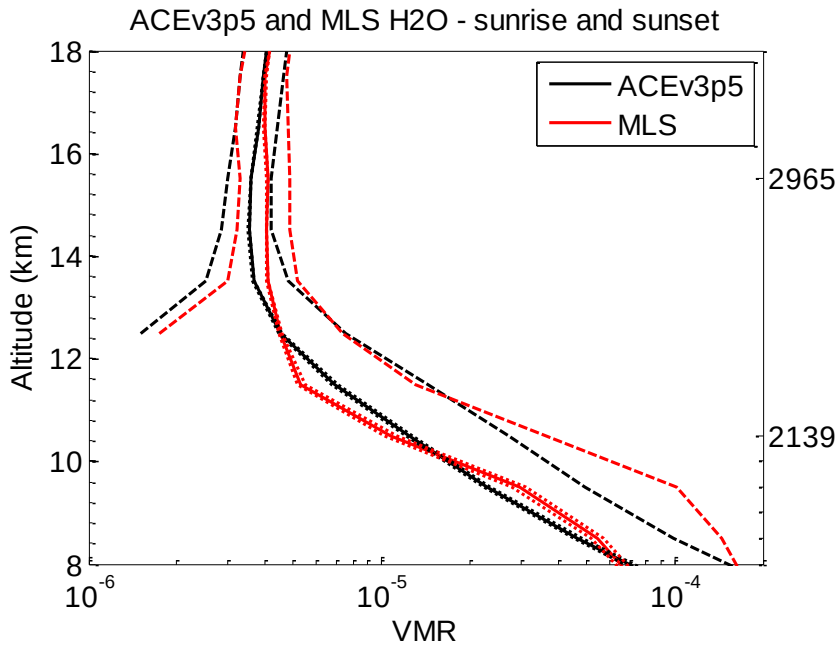
HNO3 (Arctic)


ACEv3p5 and MLS HNO3 - sunrise and sunset
ACEv3p5
MLS
Altitude (km)
VMR
x 10^-9
ACEv3p5 and MLS HNO3 - sunrise and sunset
Altitude (km)
r
ACEv3p5-MLS HNO3 - sunrise and sunset
Altitude (km)
Abs diff
x 10^-9
ACEv3p5-MLS HNO3 - sunrise and sunset
Altitude (km)
% diff

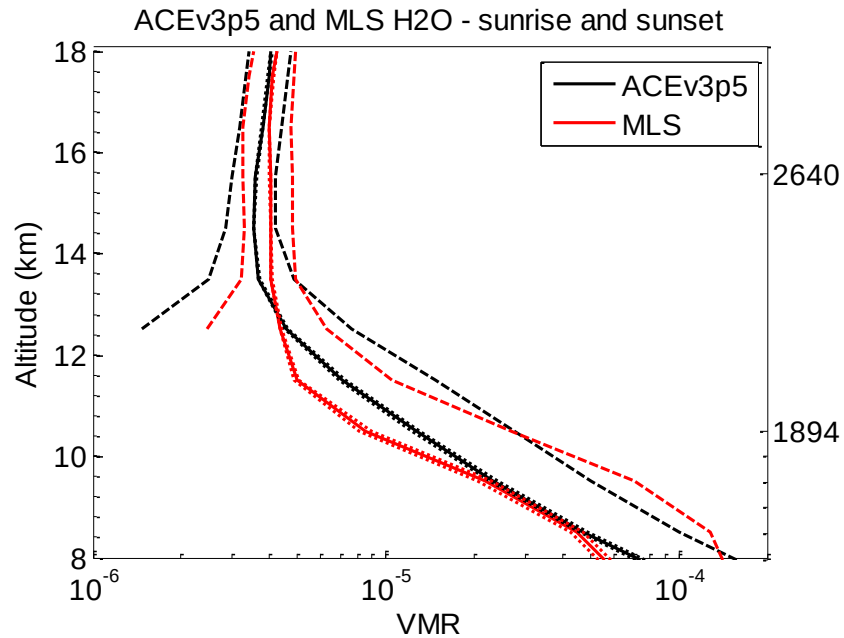
HNO3 (Antarctic)



MLS data interpolated to 1-km grid



MLS data interpolated to ACE 1-km pressure values



All latitudes, Comparison criteria:

ΔUT < 2 hours
Δlatitude < 5°
Δlongitude < 10°