THE SPECIFICS OF TEMPERATURE RETRIEVALS IN THE POLAR SUMMER MESOSPHERE AND LOWER THERMOSPHERE: APPLICATION TO TIMED SABER

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The SABER Instrument Aboard the TIMED Satellite

TIMED: Thermosphere, Ionosphere, Mesophere Energetics & Dynamics
SABER: Sounding of the Atmosphere Using Broadband Emission Radiometry

SABER instrument:

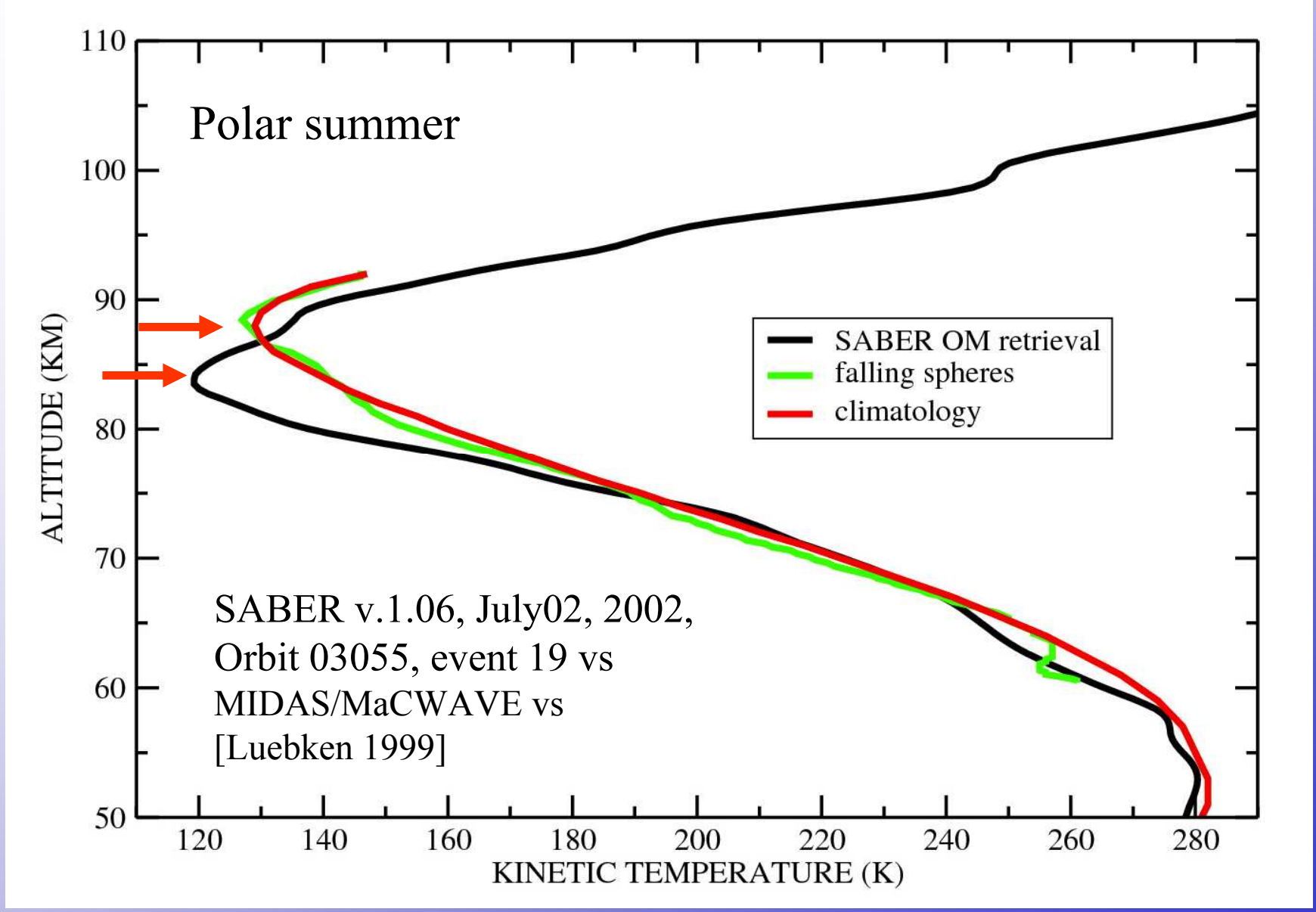
- Designed for studying Mesosphere/Lower Thermosphere
- Limb scanning infrared radiometer
- 10 broadband channels (1.27-17 μm)
- Retrieved data:
  kinetic temperature and CO_2, O_3, H_2O, NO, O_2, OH, NO, O, H

Motivation

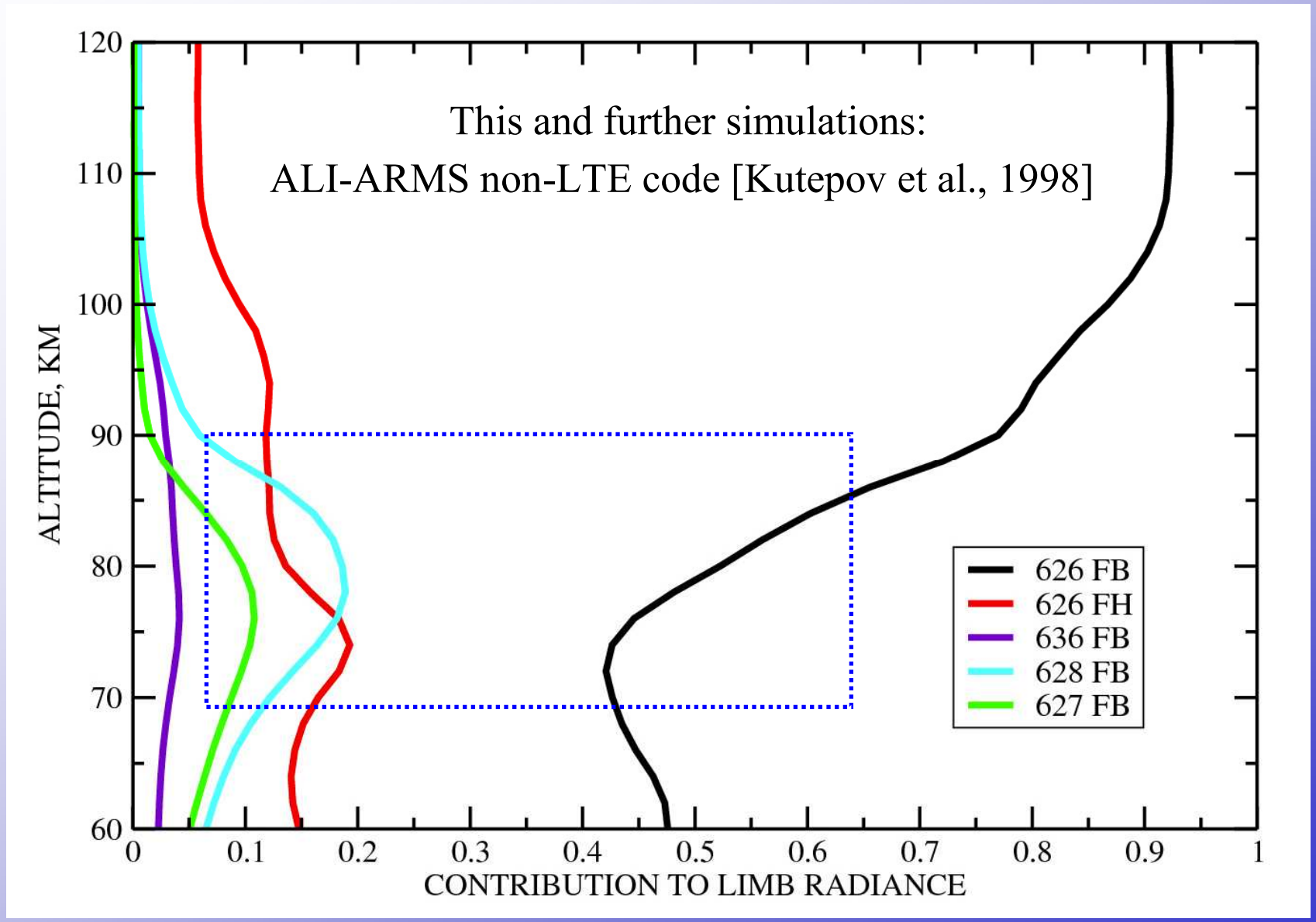
Current SABER (v.1.06) polar summer mesopause is too low both in altitude and temperature compared to:

- falling spheres data [Goldberg et al., 2004]
- climatology [Luebken et al., 1999]
- lidar data [She et al., 2002]
- additionally, SABER temperatures produced NLCs below 80 km in CARMA model [Stevens, 2005]

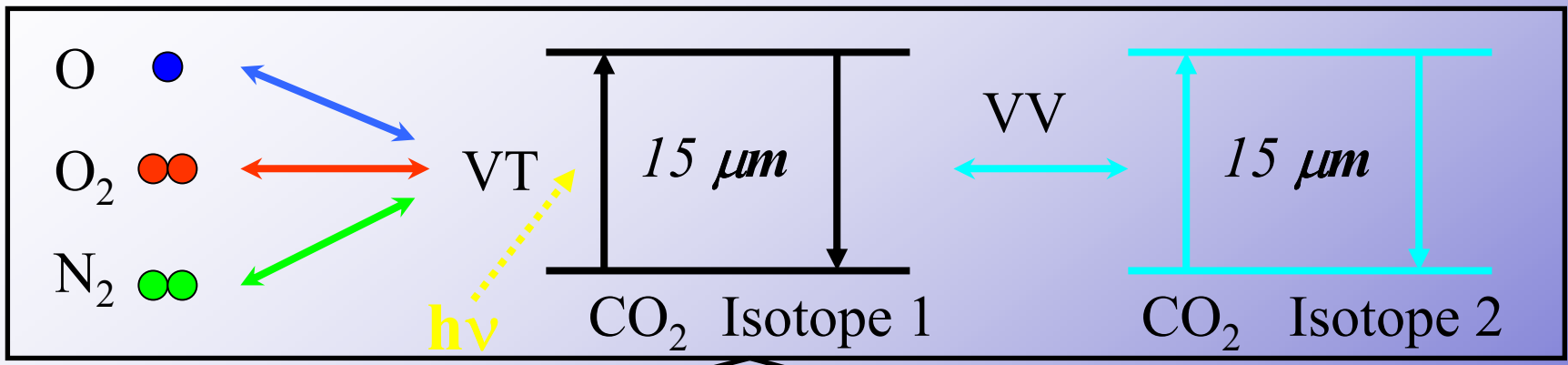
Motivation


Polar summer
SABER OM retrieval
falling spheres
climatology
SABER v.1.06, July02, 2002,
Orbit 03055, event 19 vs
MIDAS/MaCWAVE vs
[Luebken 1999]
ALTITUDE (KM)
KINETIC TEMPERATURE (K)
110
100
90
80
70
60
50
120
140
160
180
200
220
240
260
280

Simulated SABER signal in the 15μm channel



Energy exchange processes for 15μm levels



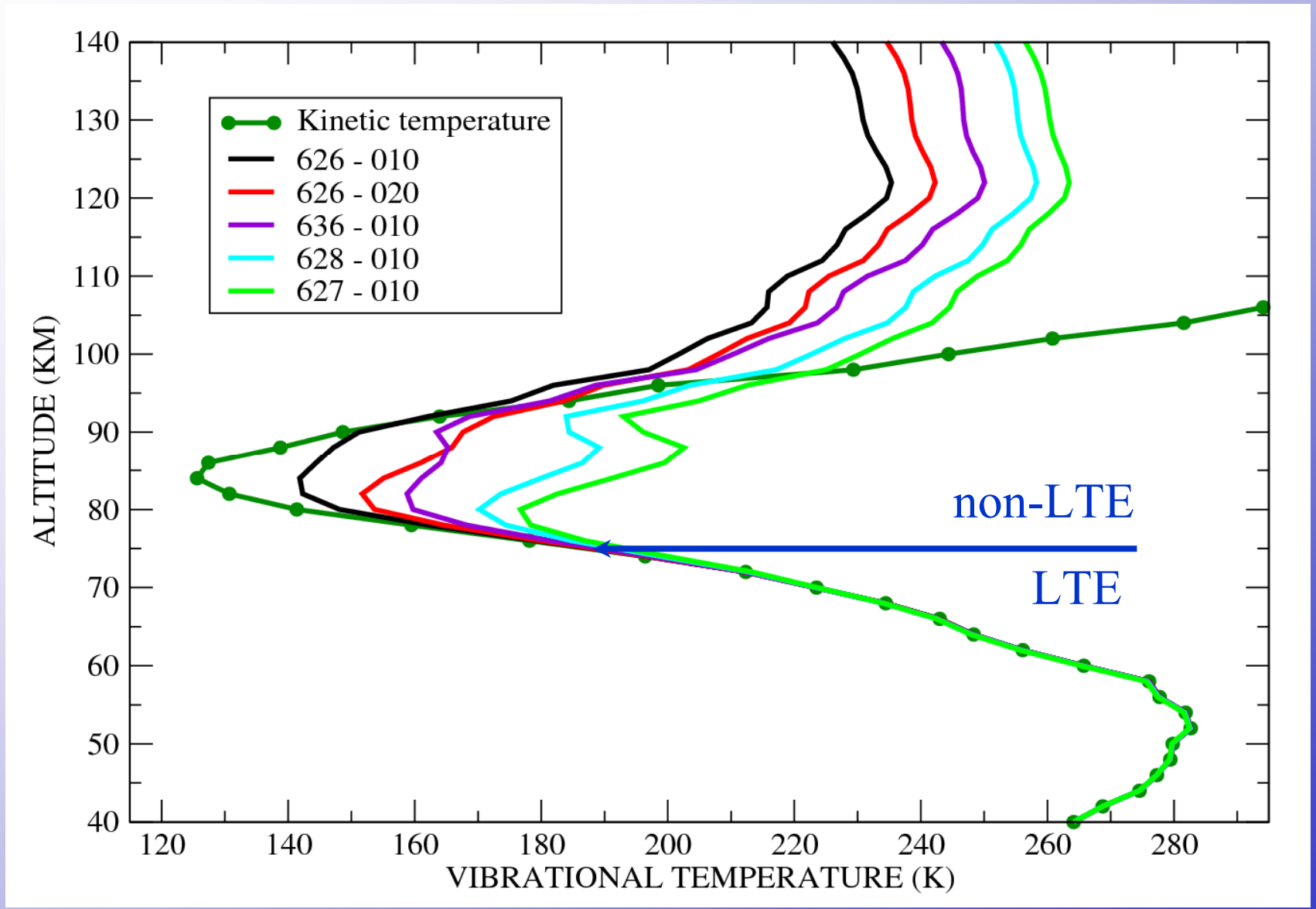
Radiative excitation and de-excitation

Collisional excitation and de-excitation

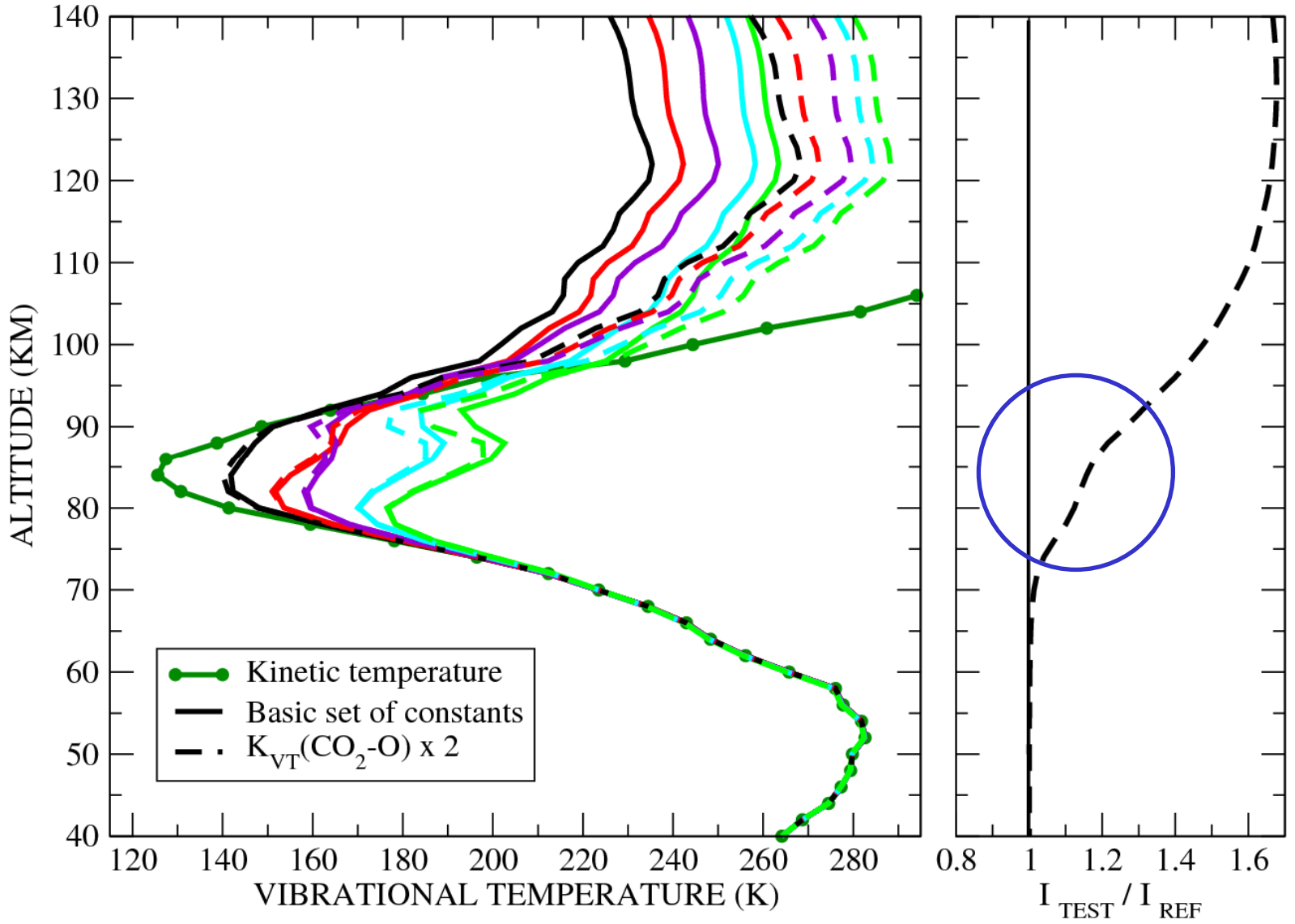
Vibrational-translational (VT) energy exchange (N_2, O_2, O)

Vibrational-vibrational (VV) energy exchange (CO_2)

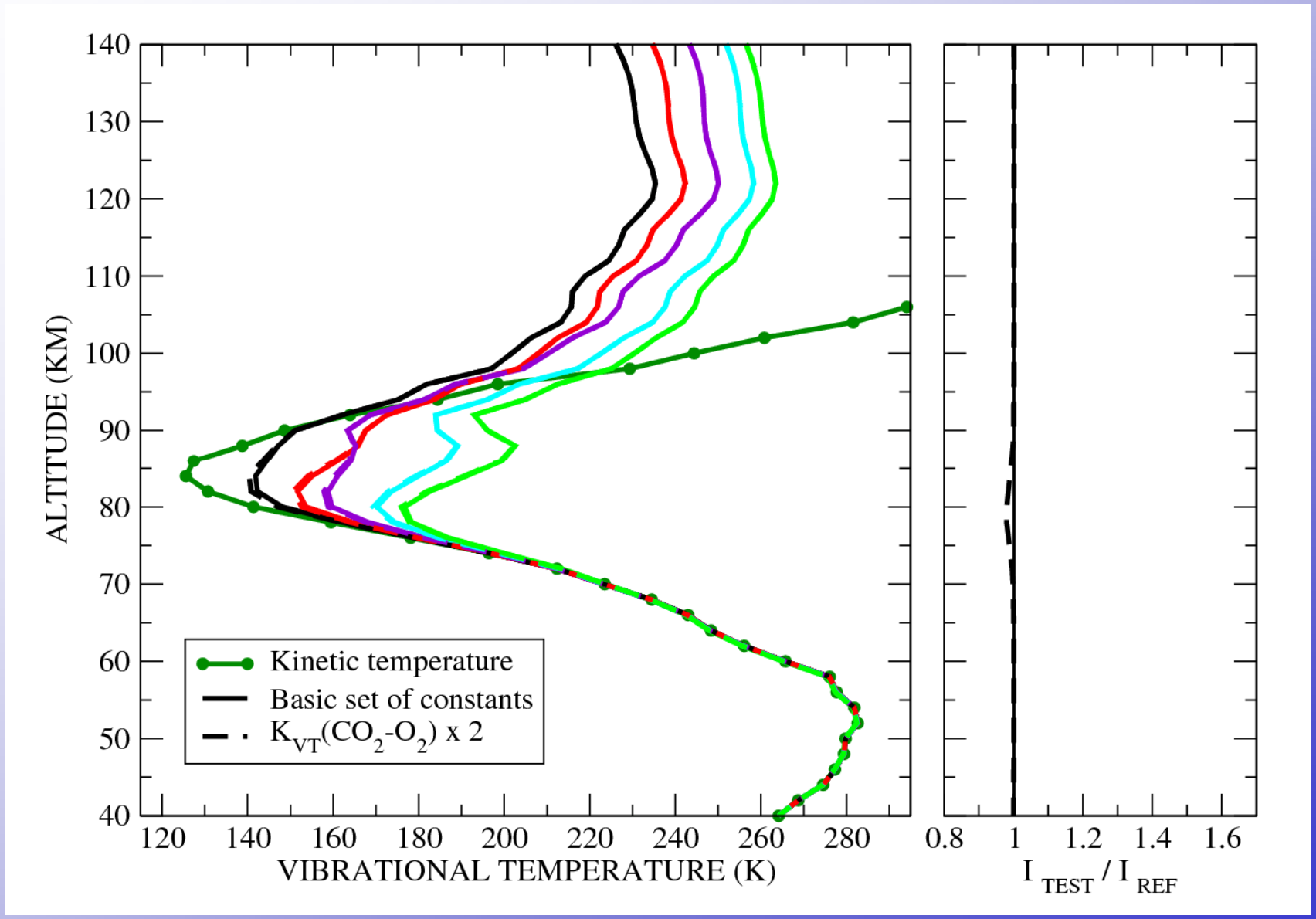
Populations of main contributors



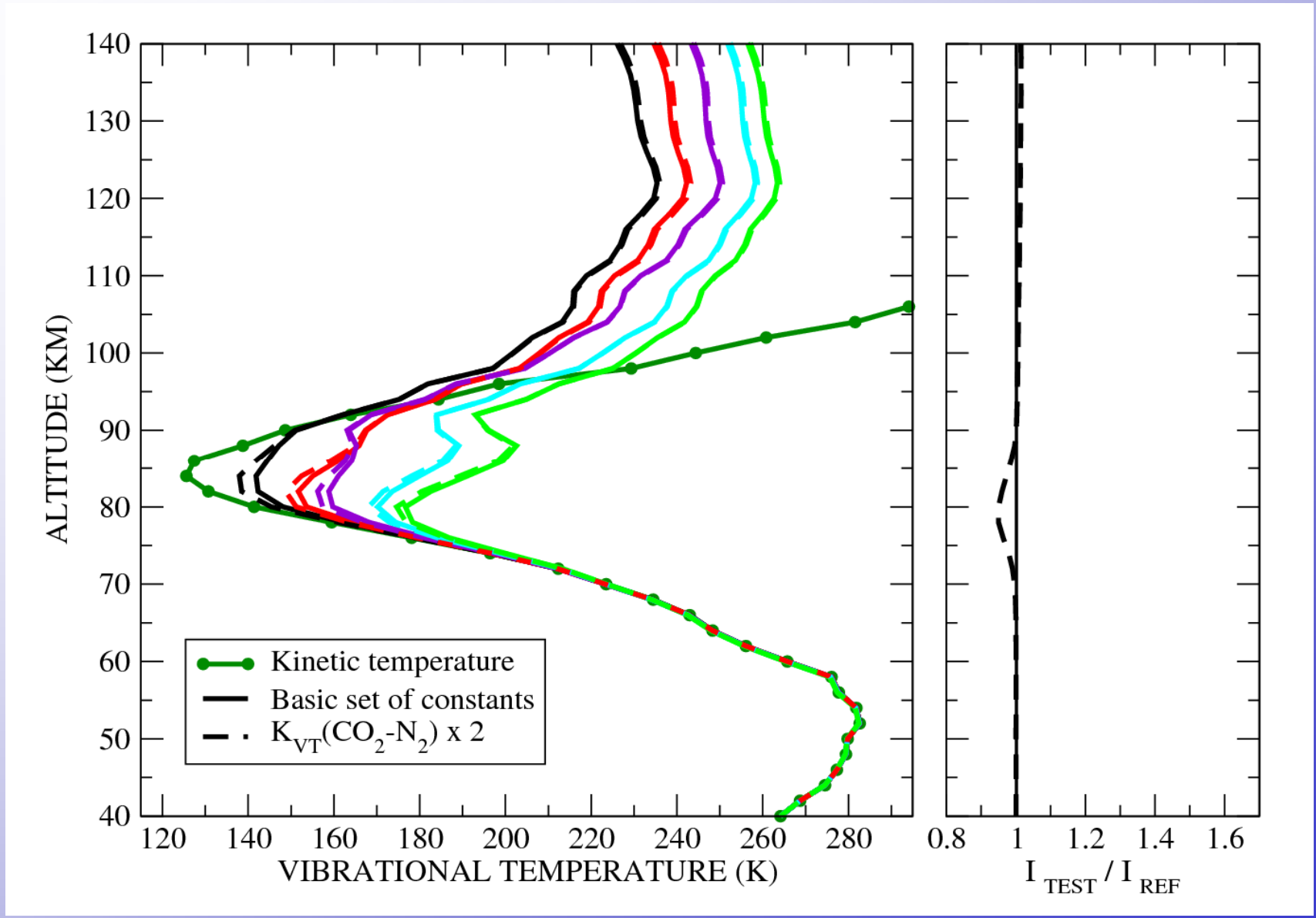
Sensitivity study - collisions with oxygen atoms



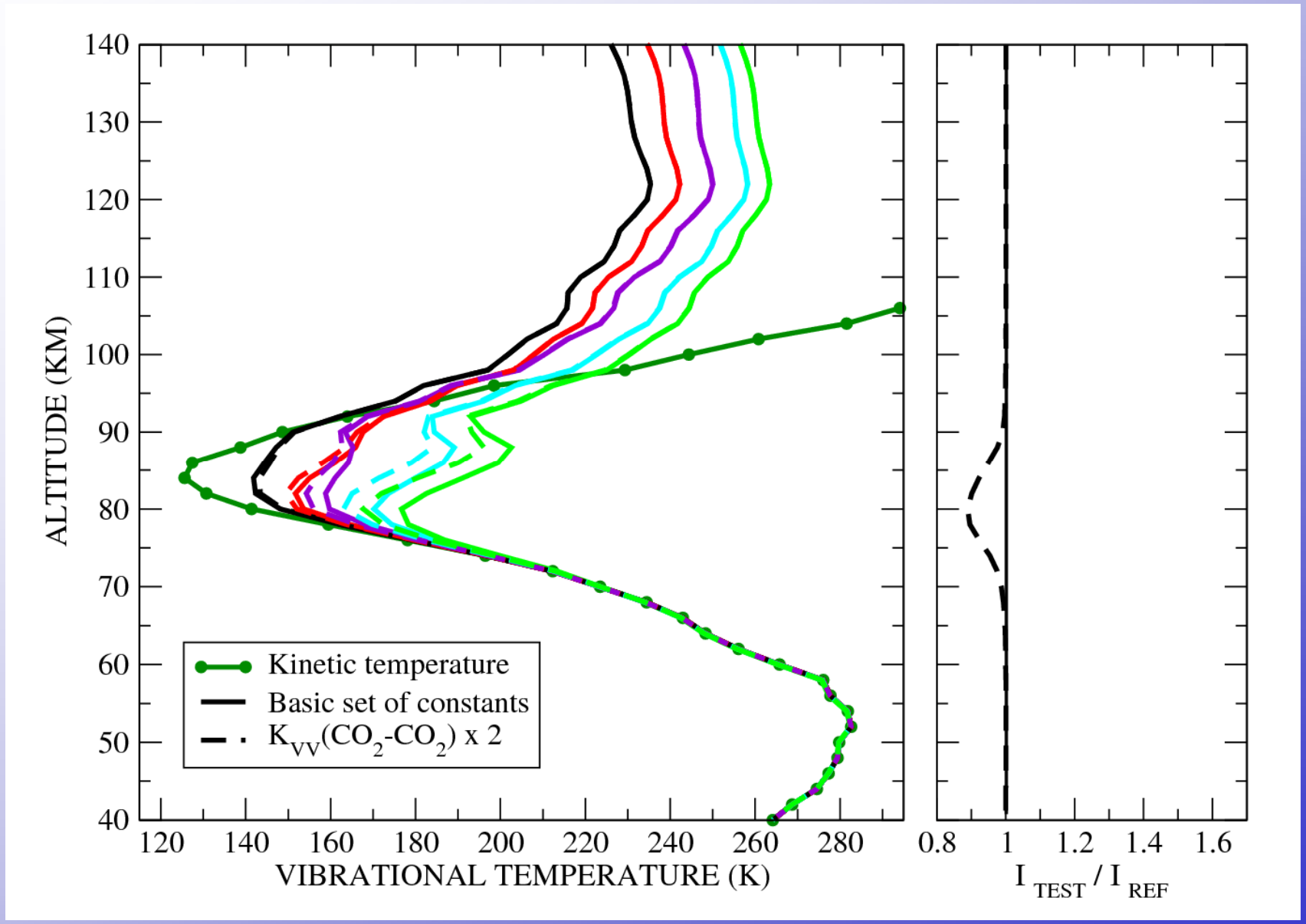
Sensitivity study - collisions with oxygen molecules



Sensitivity study - collisions with nitrogen molecules



Sensitivity study - vibrational-vibrational exchange



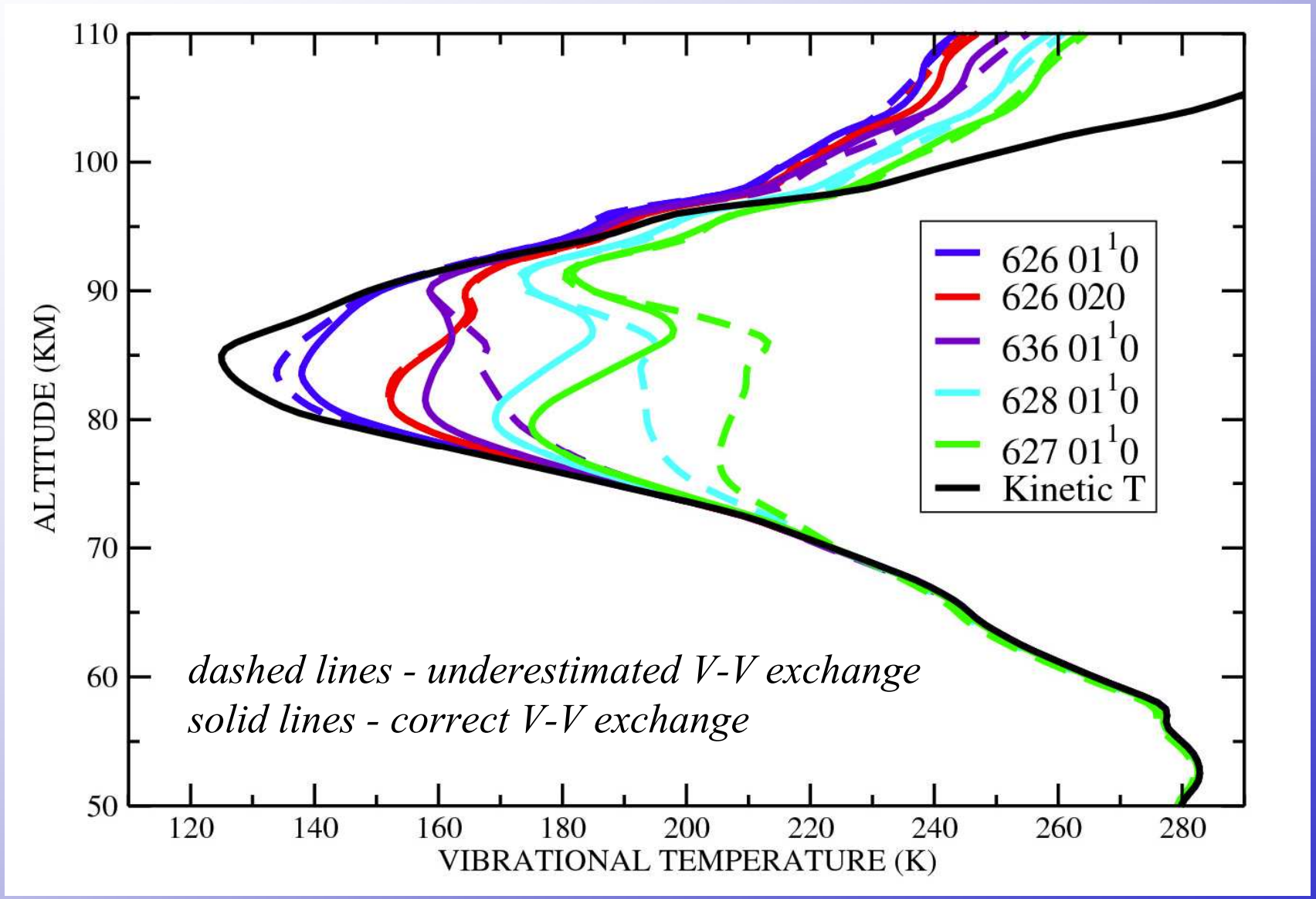
Possible sources of mesopause altering

- VT (CO_2-O): the effect starts below the mesopause but dramatically increases with the altitude;
- VT (CO_2-O_2) and VT (CO_2-N_2): mesopause region, possible candidates
- VV (CO_2-CO_2): mesopause region, possible candidate

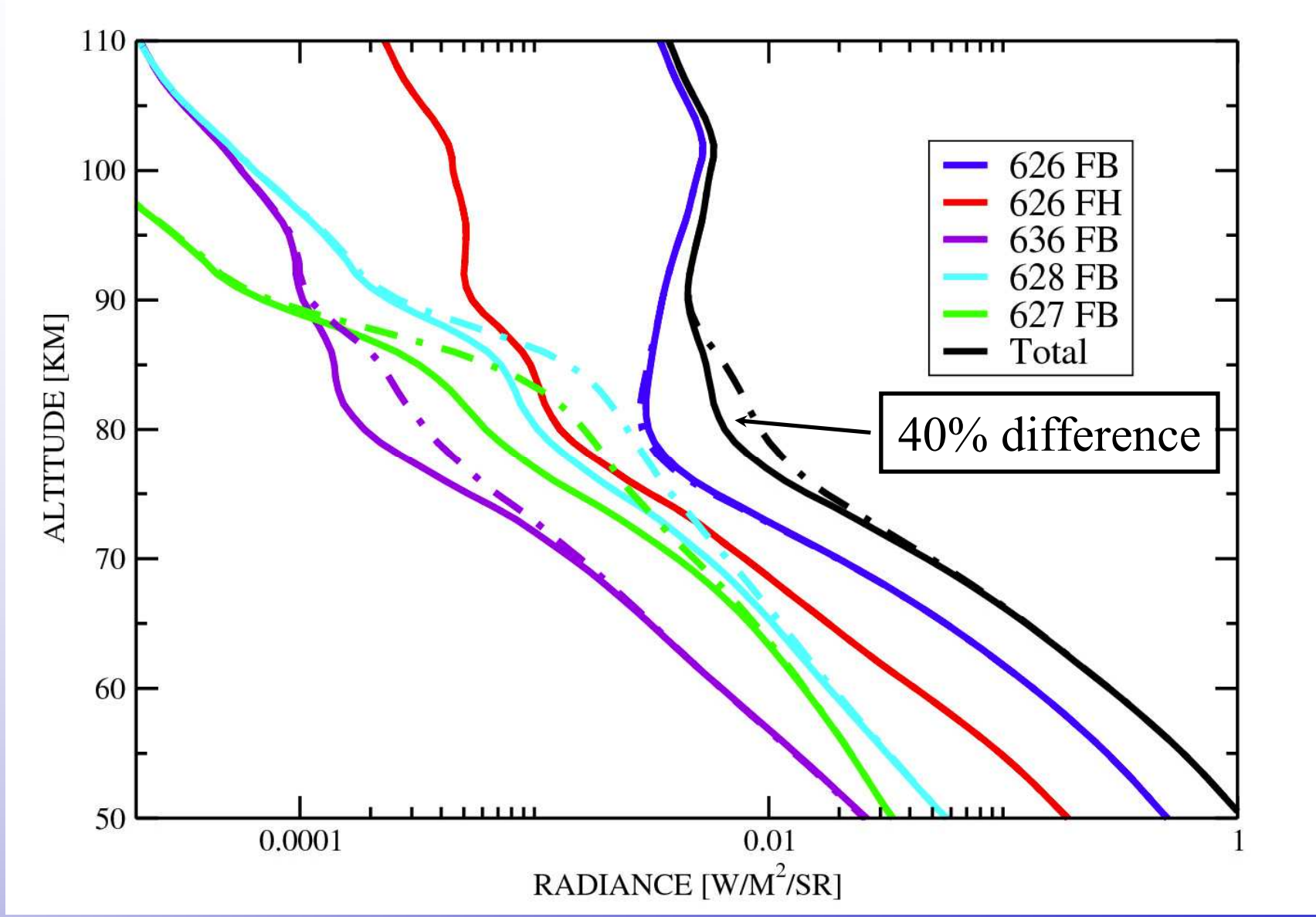
An examination of the SABER OM revealed that

- VT exchanges were described correctly;
- VV within the isotopes functioned properly;
- VV between the isotopes was neglected.

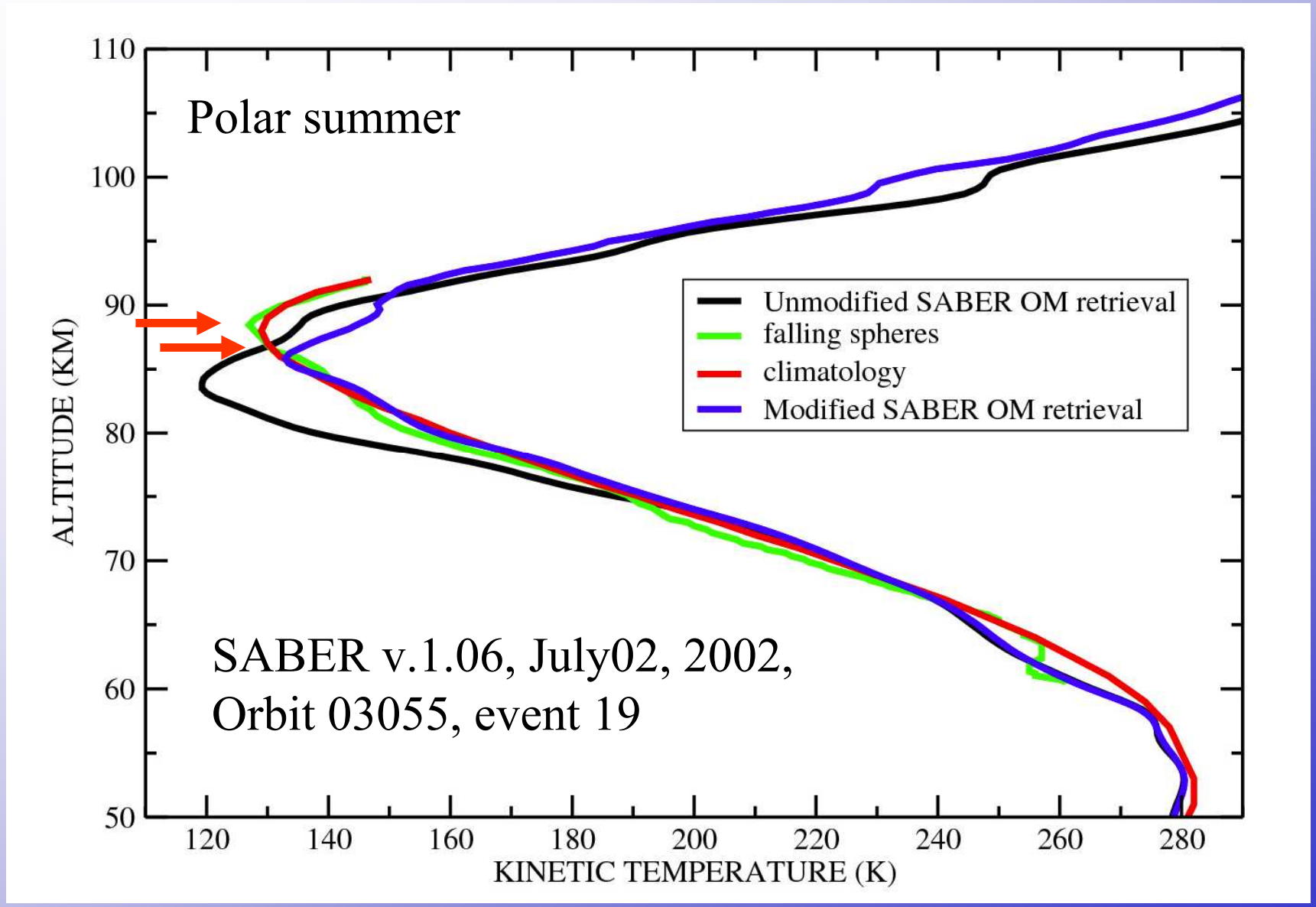
Correct accounting for V-V exchange with the isotopes



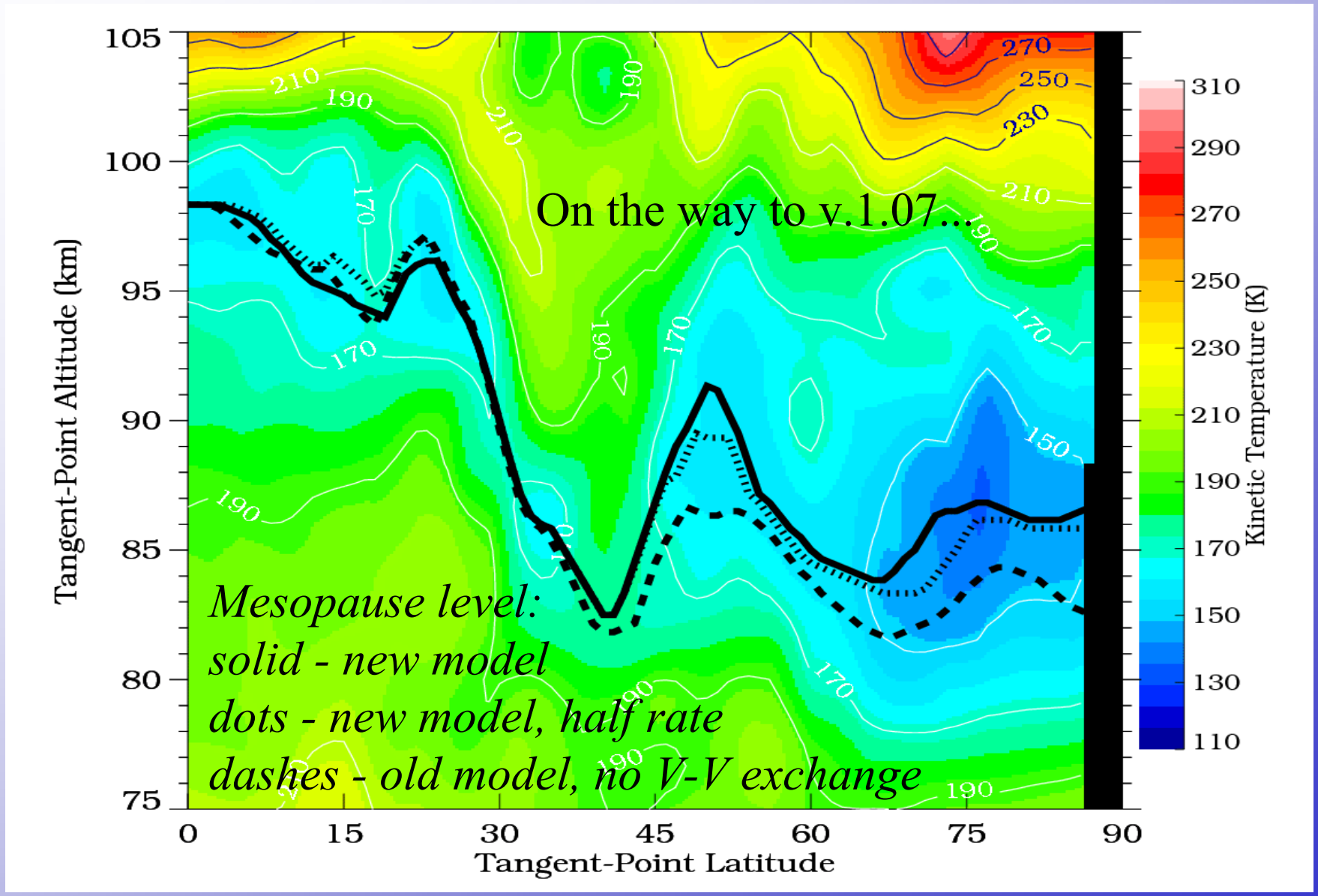
Modified SABER OM vs unmodified SABER OM



Modified SABER OM retrieval



Modified SABER OM retrieval



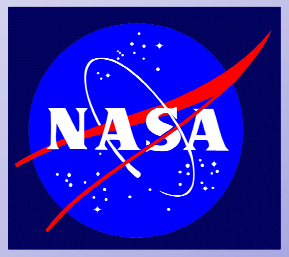
Conclusions

- Polar summer mesosphere demonstrates very strong non-LTE behavior;

- The temperature retrieval in this region is extremely sensitive to the comprehensiveness of the non-LTE model;

- Neglecting the V-V exchange between the CO_2 isotopes can lead to ~10 K error in the mesopause temperature and to ~4 km error in its position;

- Performed investigation has helped to eliminate the inconsistency of polar summer SABER retrievals with in situ measurements.


NASA