Sensitivity of the solar signal in ozone and temperature to the choice of SSI data set

E. Rozanov[1,2], W. Ball[1,2], T. Egorova[1],T. Sukhodolov[1]

1) Physikalisch-Meteorologisches Observatorium Davos, World Radiation Center, Davos Dorf, Switzerland

2) Institute for Atmospheric and Climate Science, ETH, Zurich, Switzerland

Motivation

- Review of recent SSI data sets is in preparation
- Proper information about their climate related performance is necessary the climate community
- Previous attempts did not cover all relevant aspects of the problem

Review: Heating rates

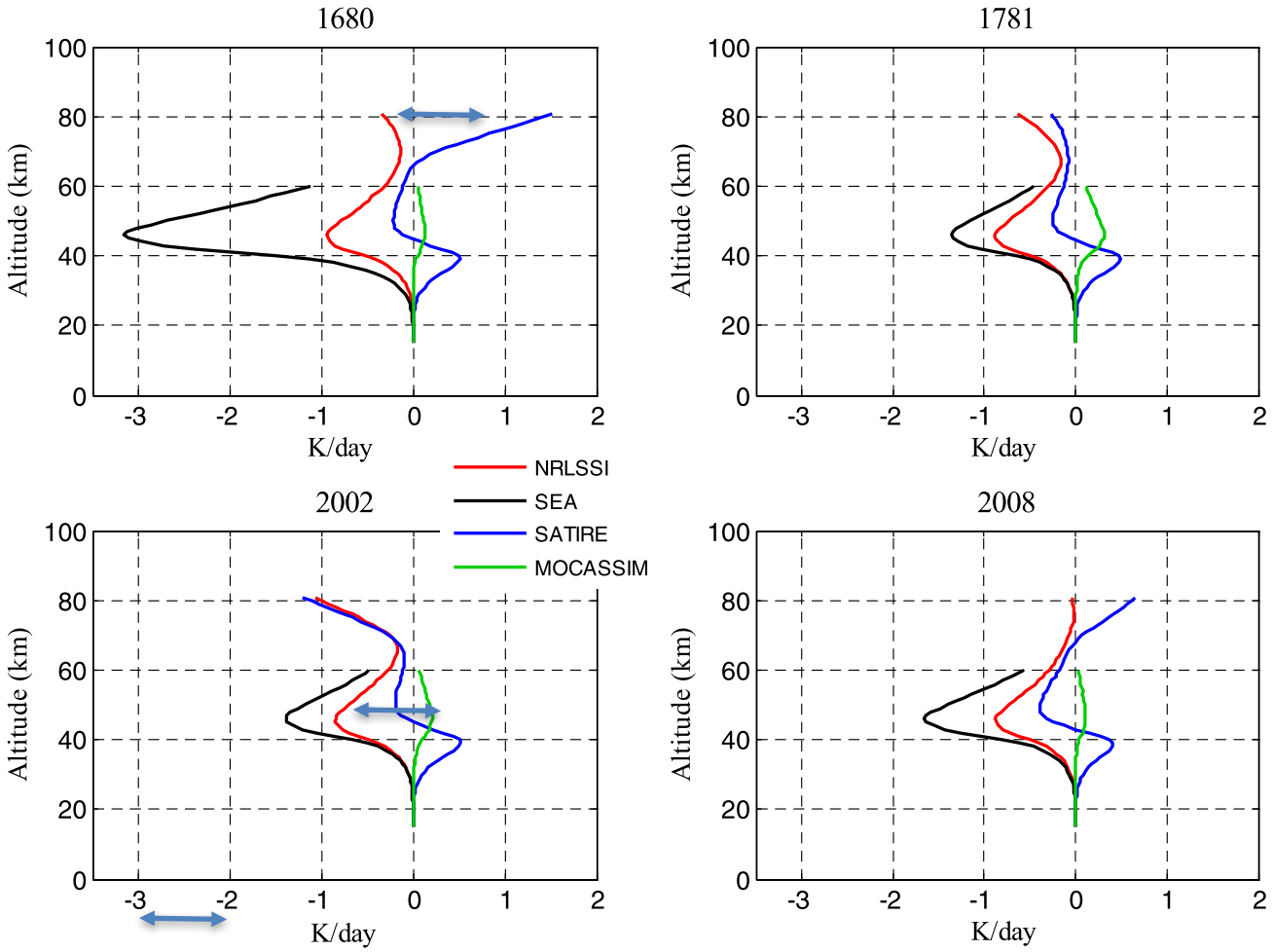
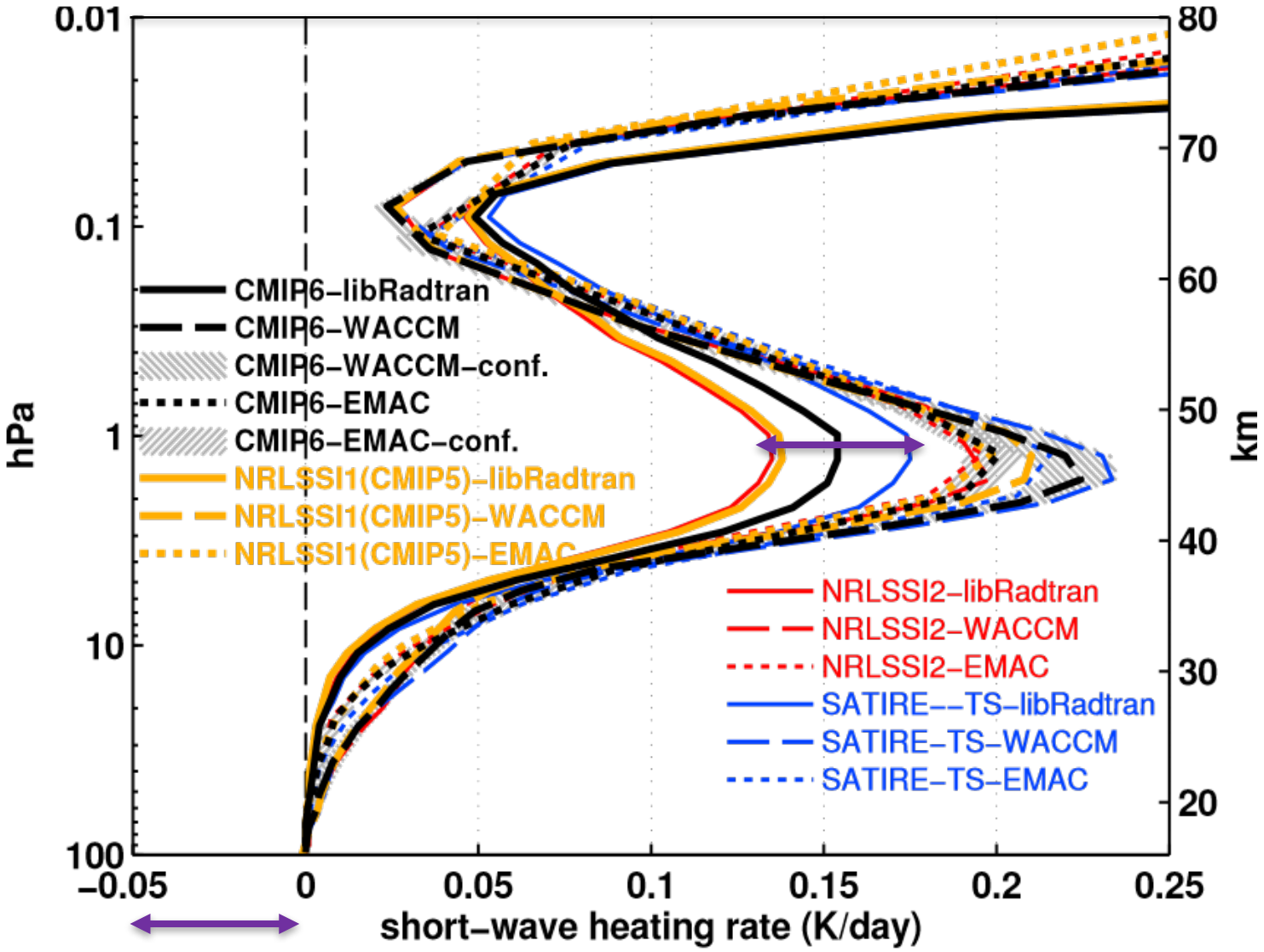


Figure 8 Differences in solar heating rate values calculated for each reconstruction relative to the values obtained using the MGNM. SSI for SEA at wavelengths below 160 nm and for MOCASSIM at wavelengths below 150 nm, are assumed to be zero as they are not provided. A cloudless condition, overhead Sun, and equatorial ozone profile are considered in calculating the solar heating rates.

Thuillier et al., 2014

Review: Heating rates



Matthes et al., GMDD, 2016, annual mean Solar Max – Solar Min

Review: Ozone

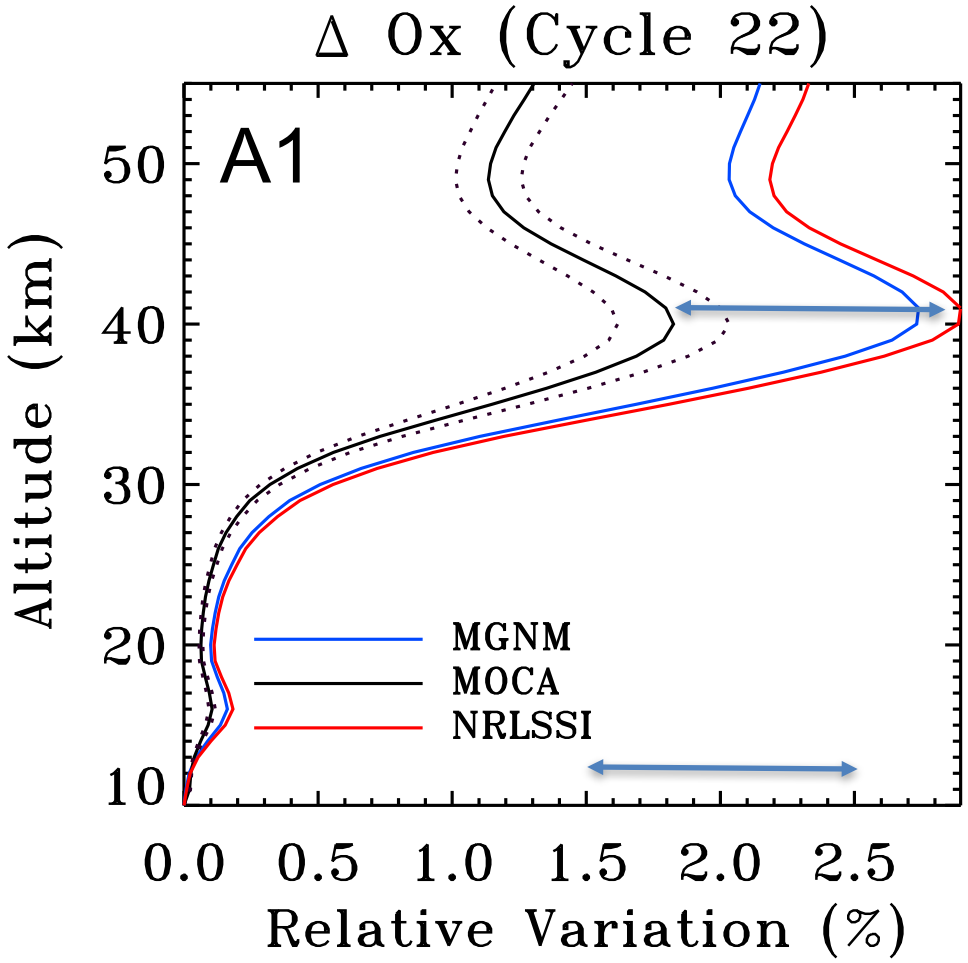
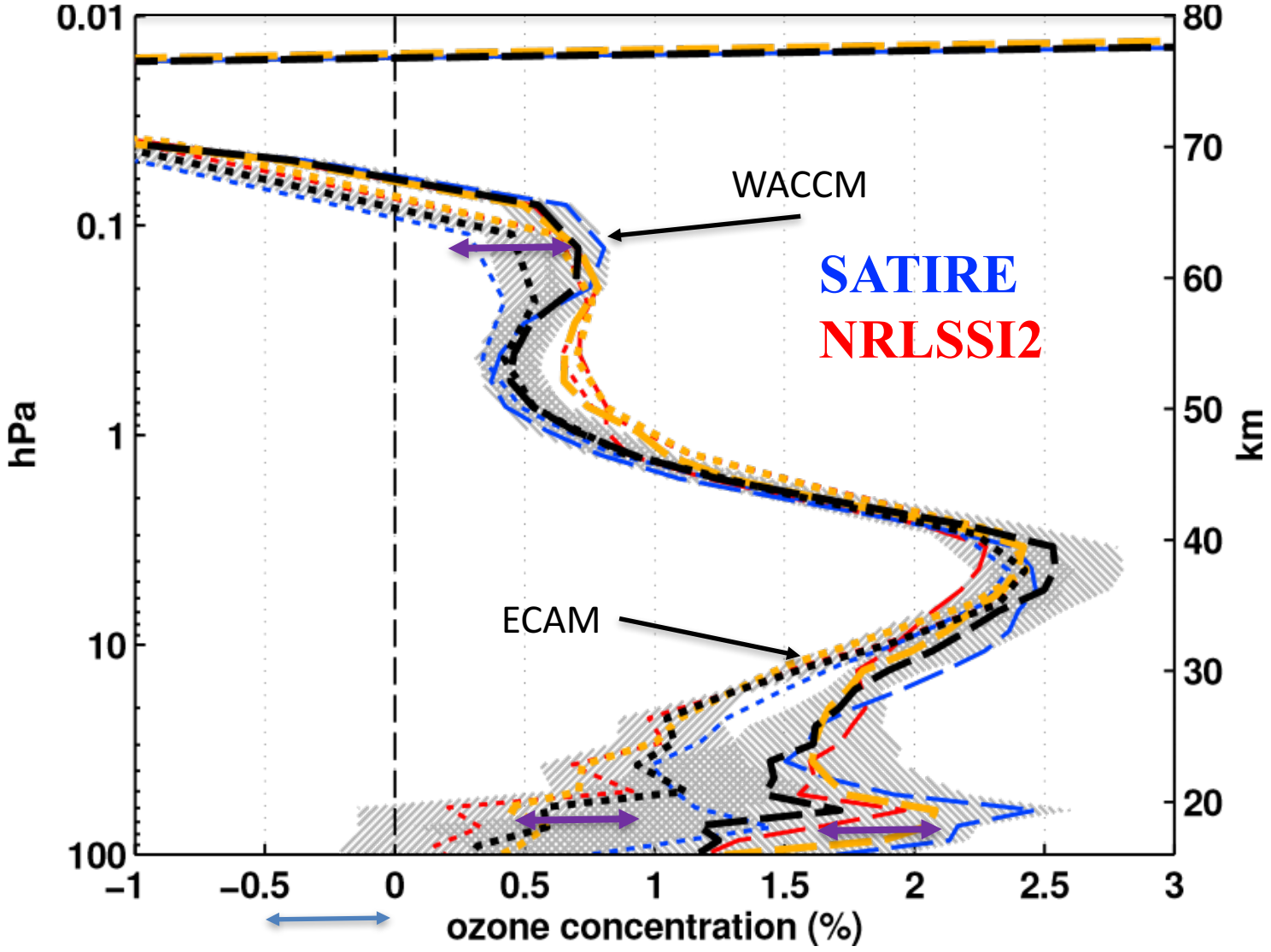


Fig. 6. Relative solar maximum–minimum response in O_x and O at noon, for Cycle 22 (panels A), Cycle 23 (panels B) and 1680 vs March 2009 (panels C).

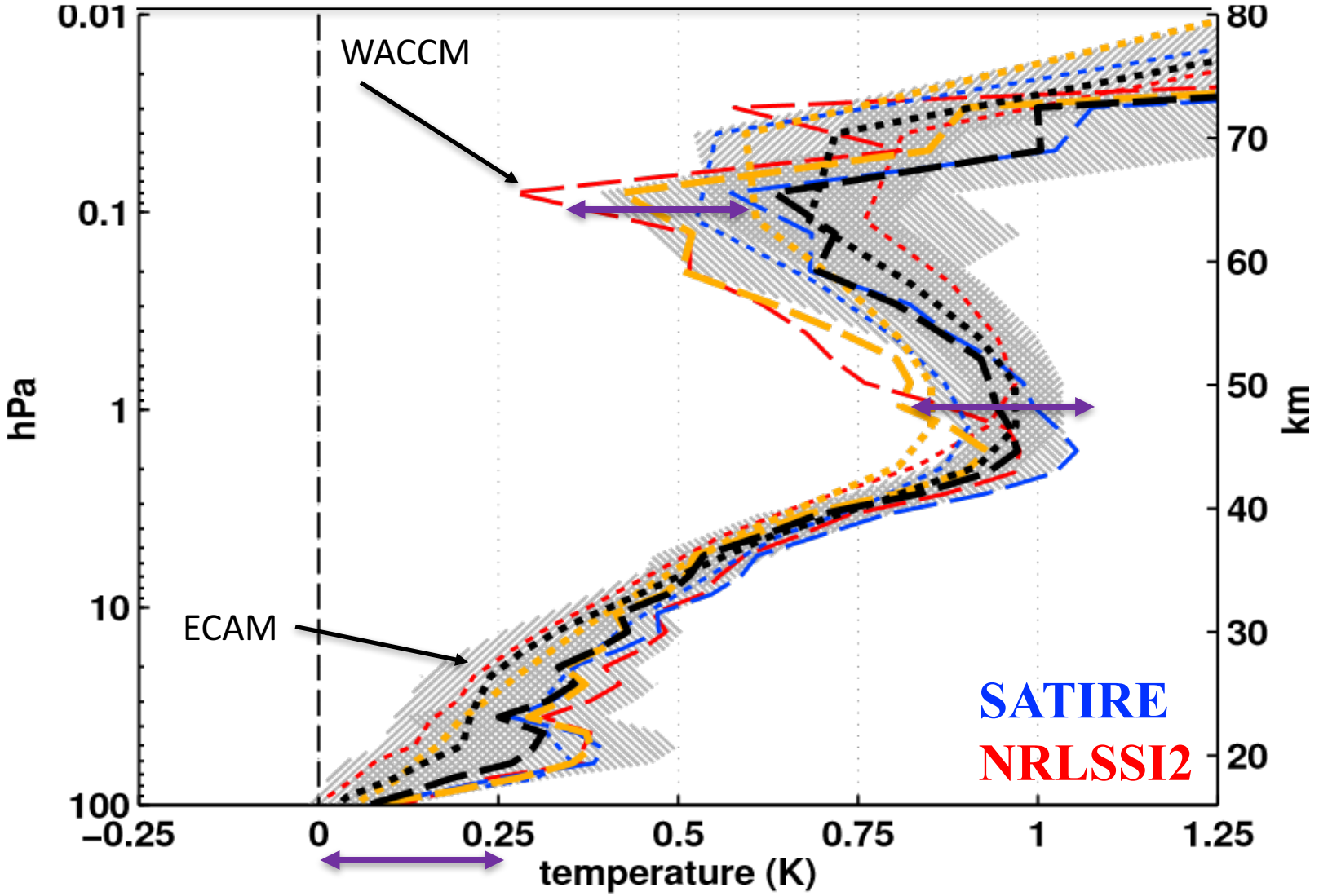
Bolduc et al., 2015

Review: Ozone



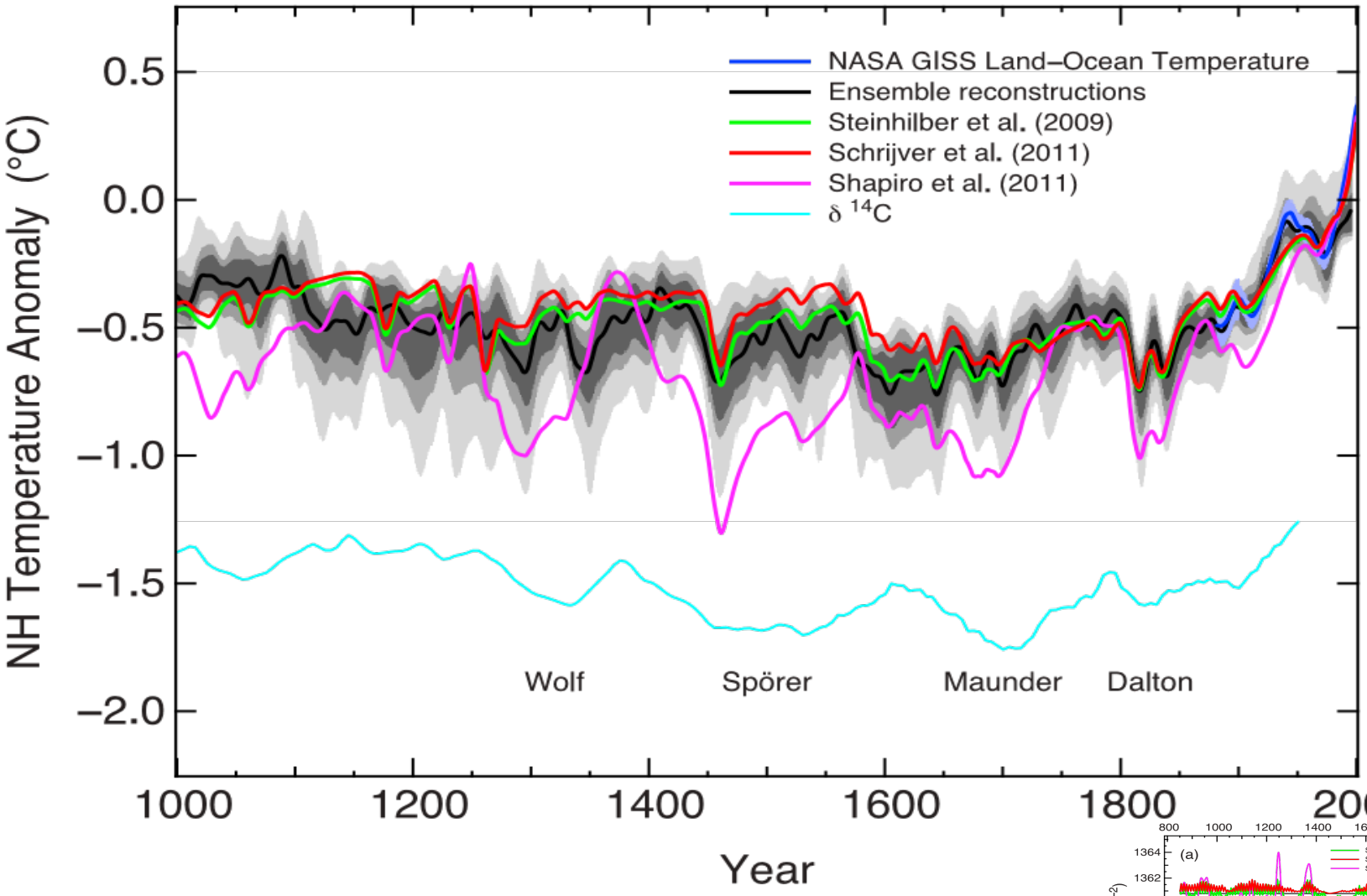
Matthes et al., GMDD, 2016, annual mean Solar Max – Solar Min

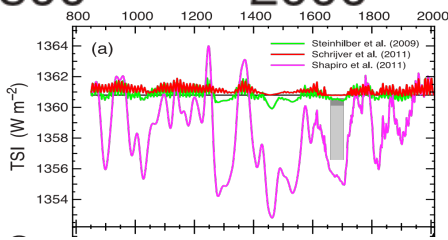
Review: Temperature



Matthes et al., GMDD, 2016, annual mean Solar Max – Solar Min

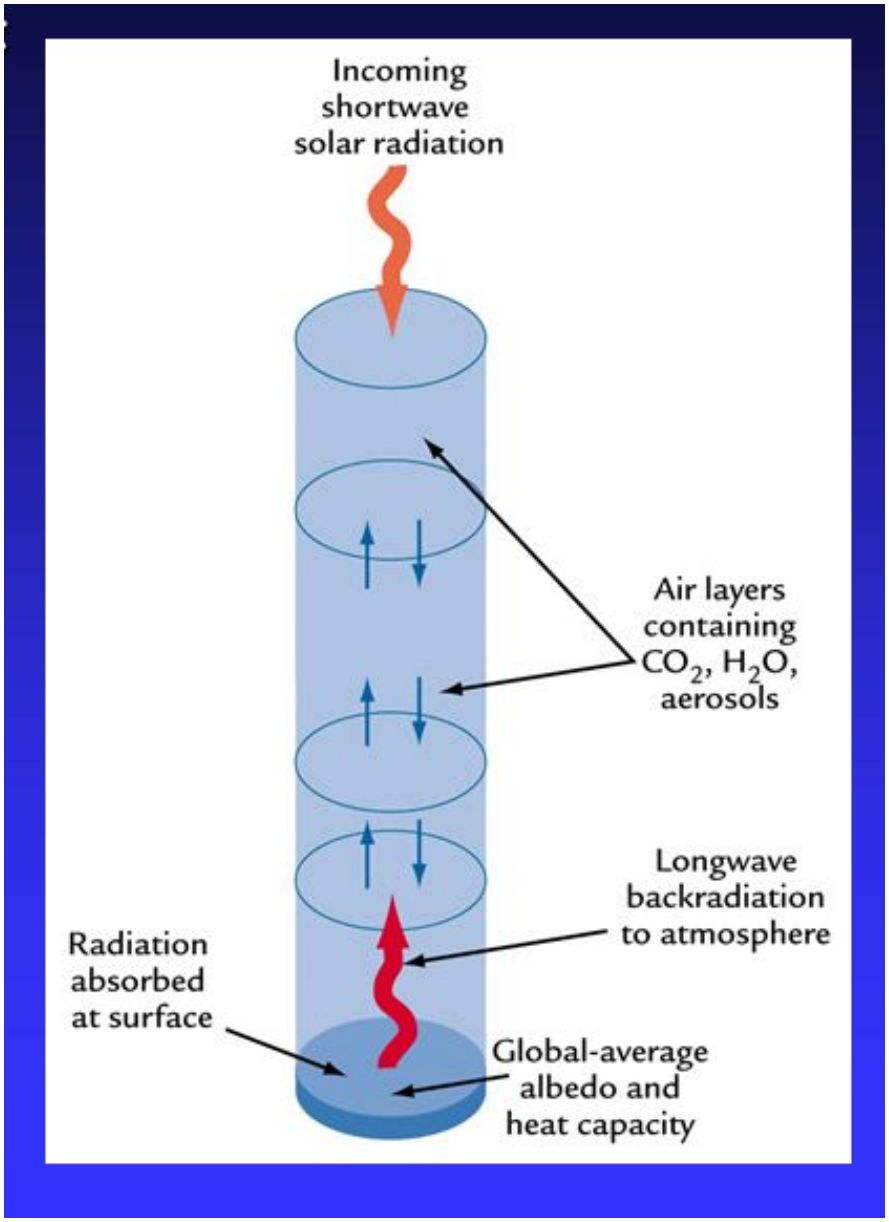
Review: Surface air temperature





Feulner, GRL, 2011

1-D framework and runs



Radiative-convective model with photochemistry, mixed layer ocean and major climate feedbacks.

$dT_{2x} = 2.5K$

SSI affects

↓

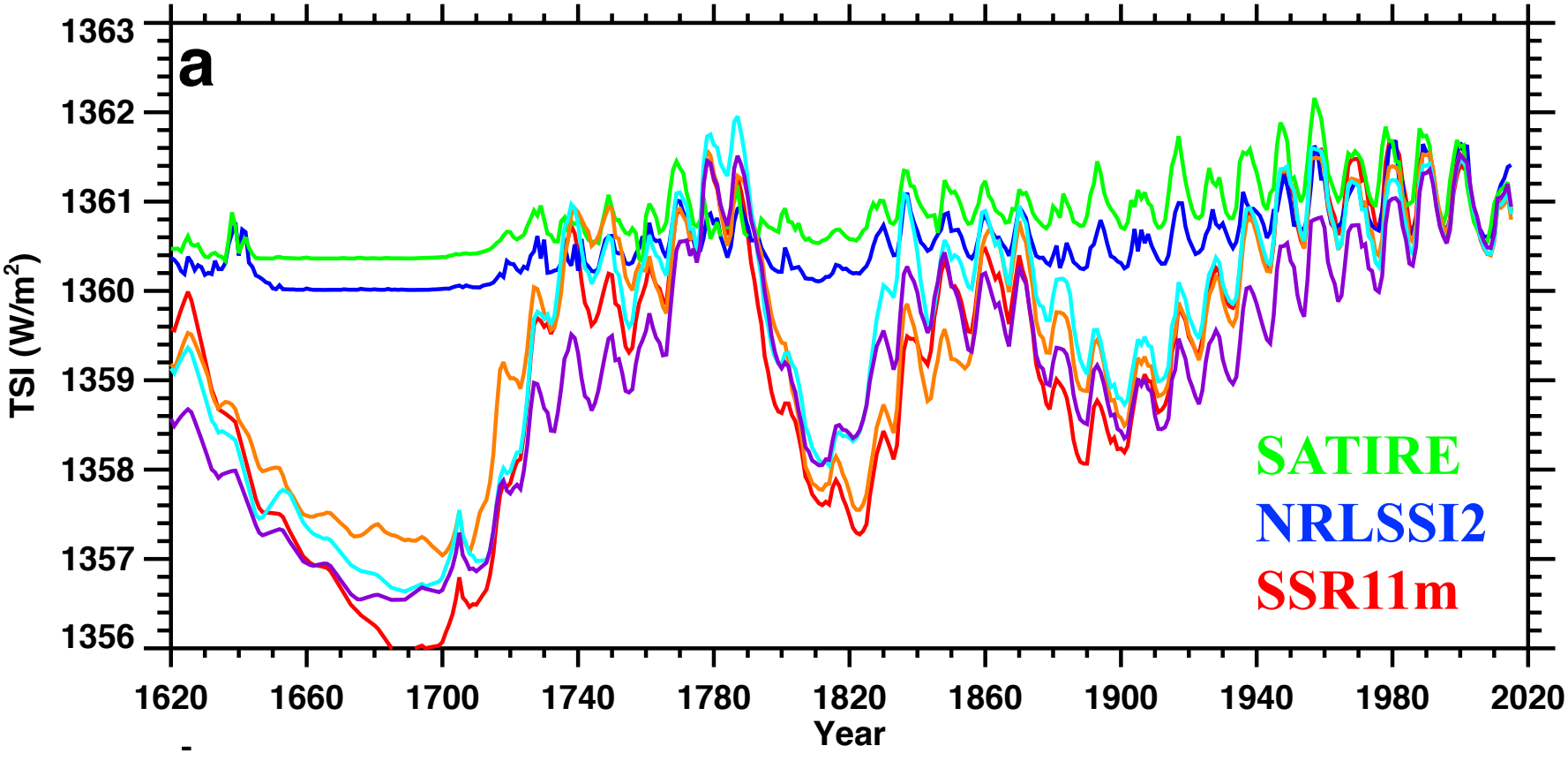
Heating rates
Photolysis rates
Surface energy balance

Model runs cover

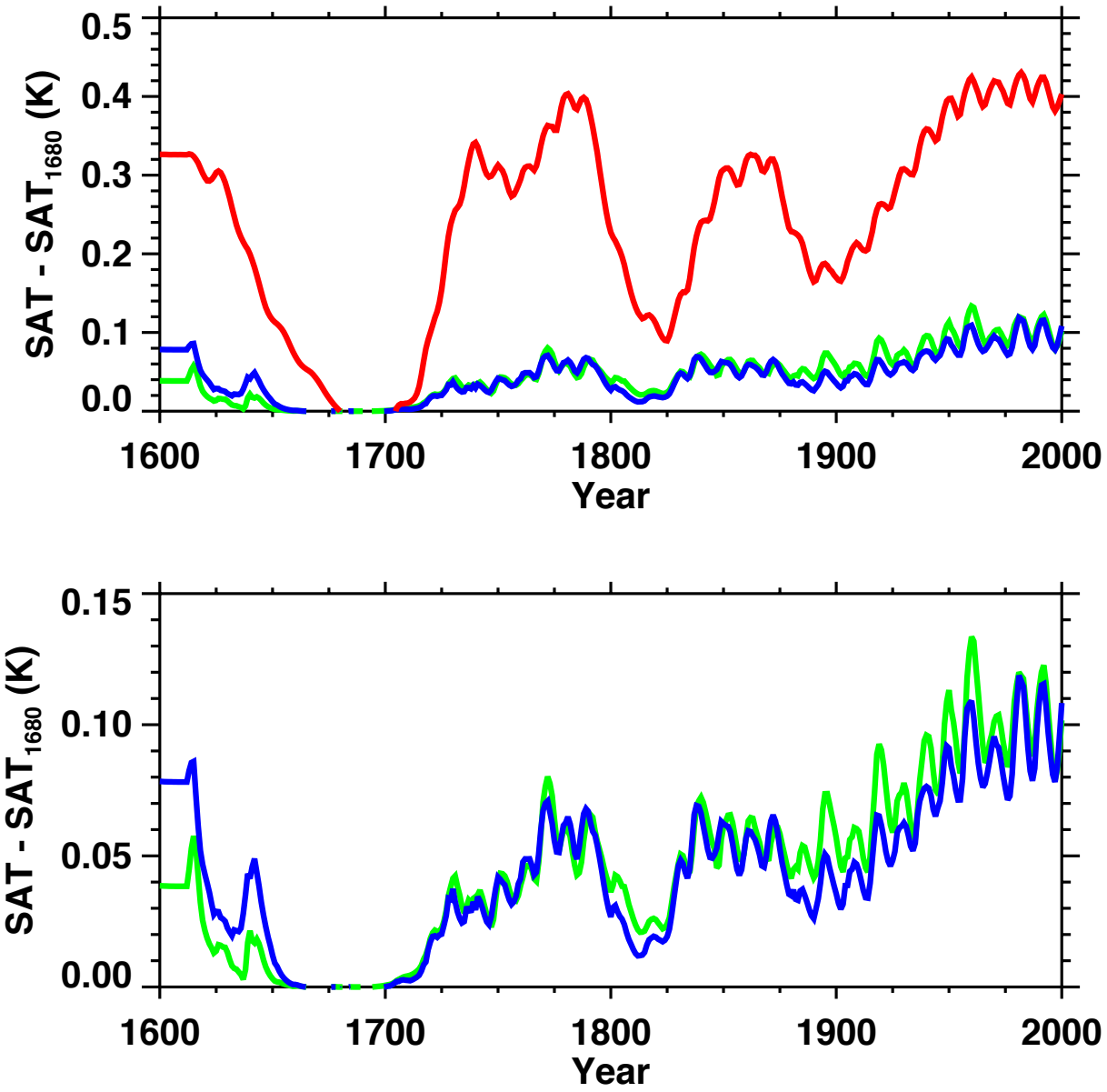
1600-2000
Using SSI from

SATIRE
NRLSSI2
SSR11m

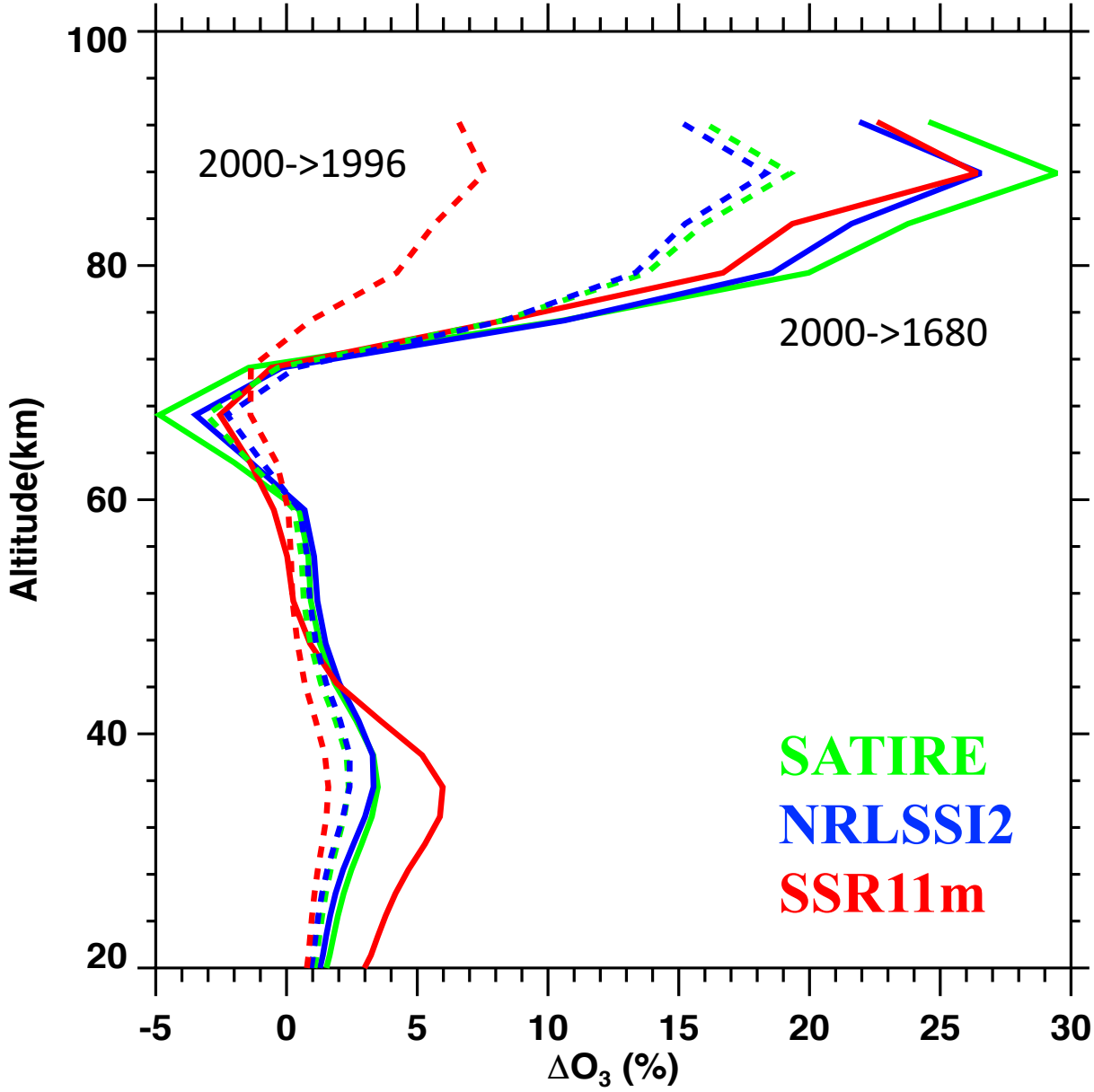
Applied SSI data sets



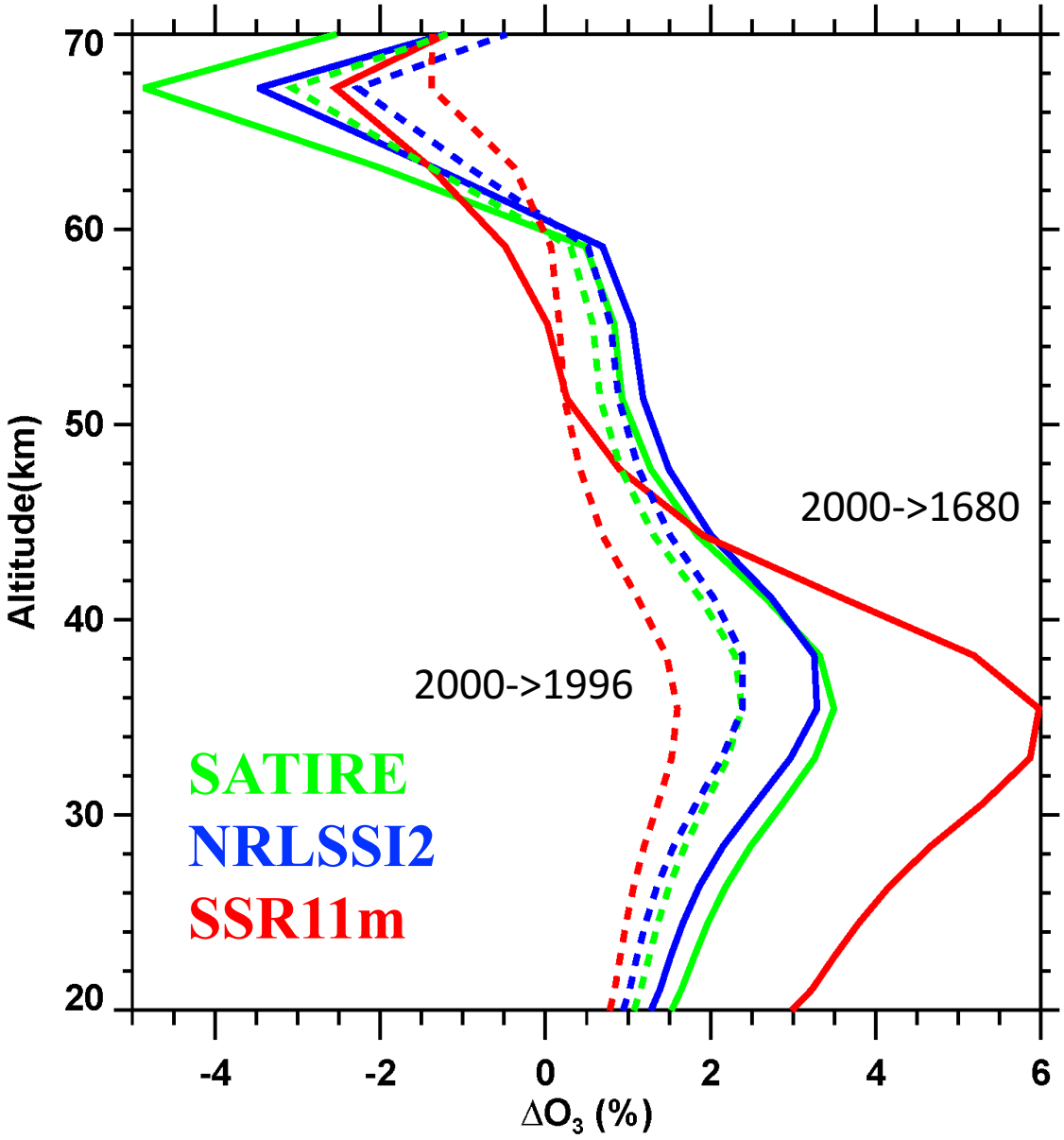
Surface air temperature response



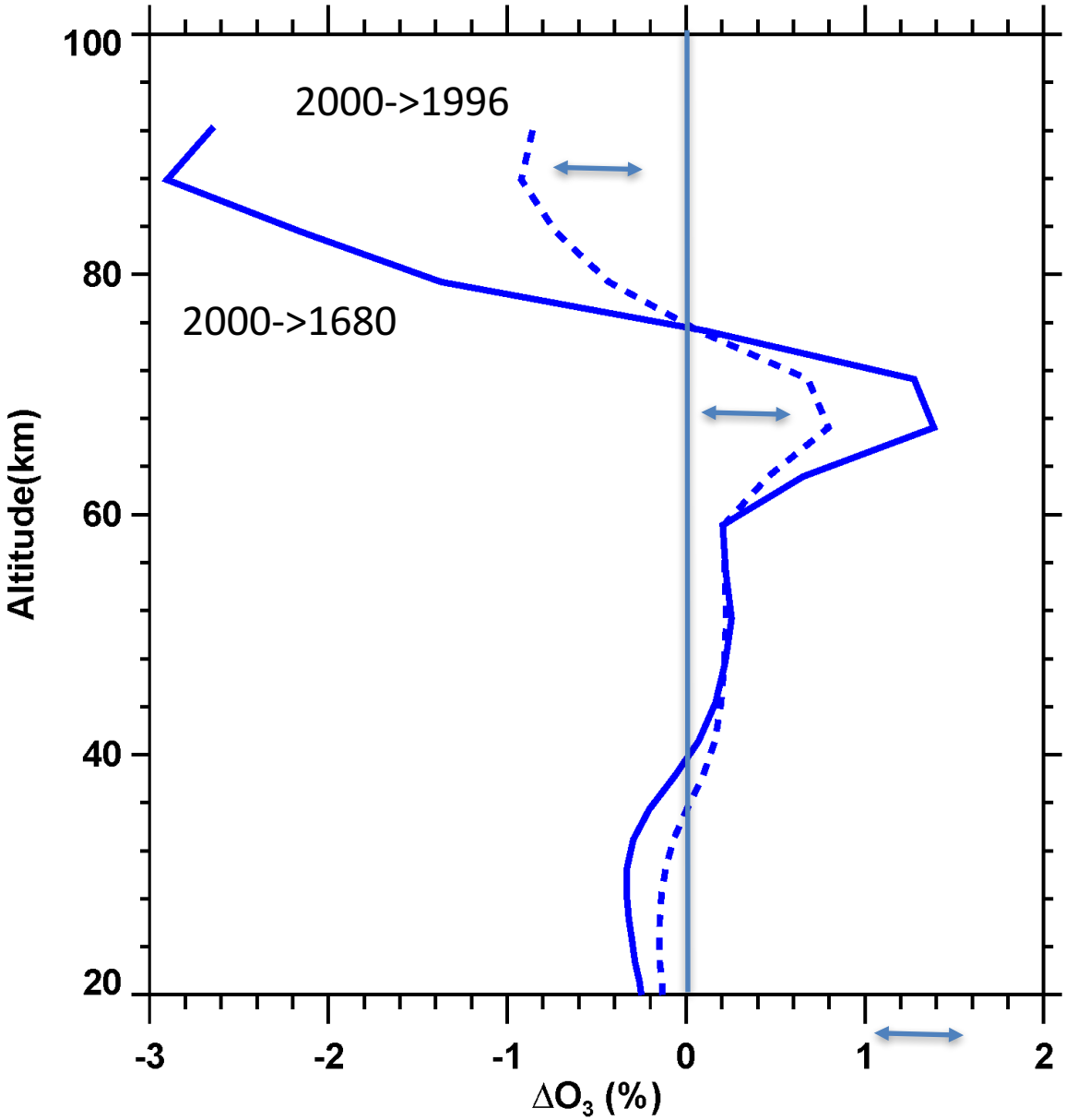
Ozone response



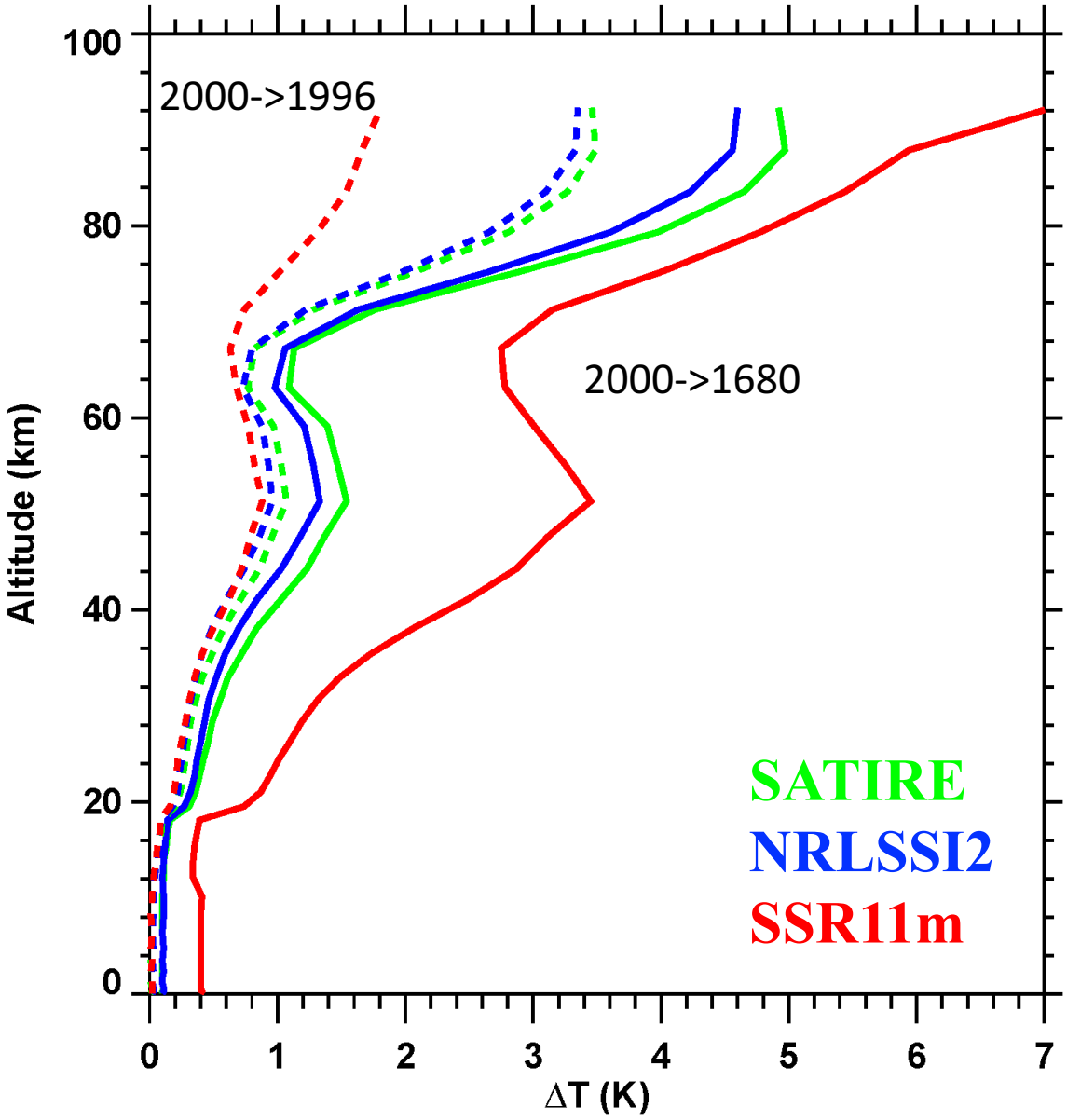
Ozone response



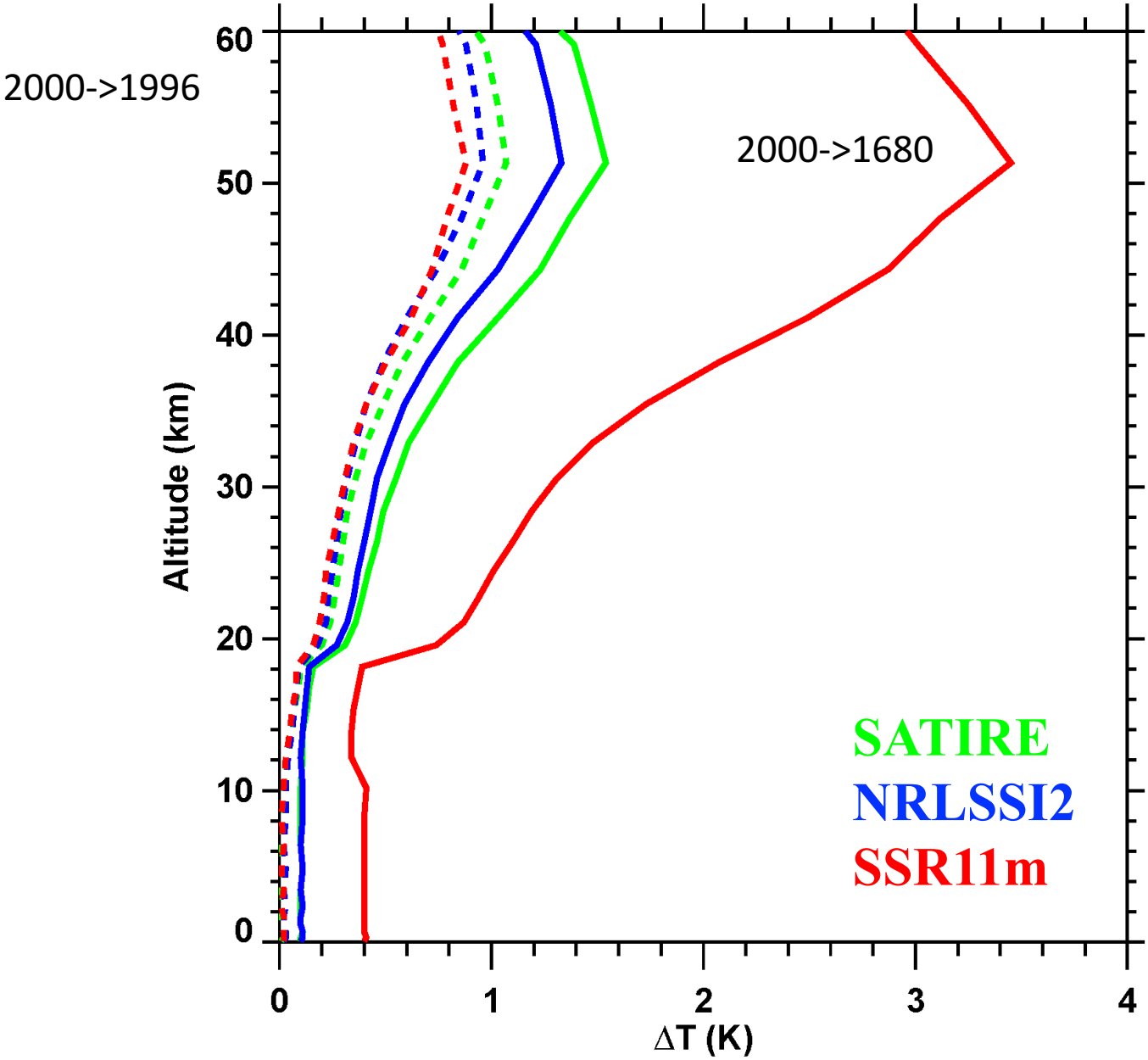
Ozone response (NRL-SATIRE)



Temperature response



Temperature response



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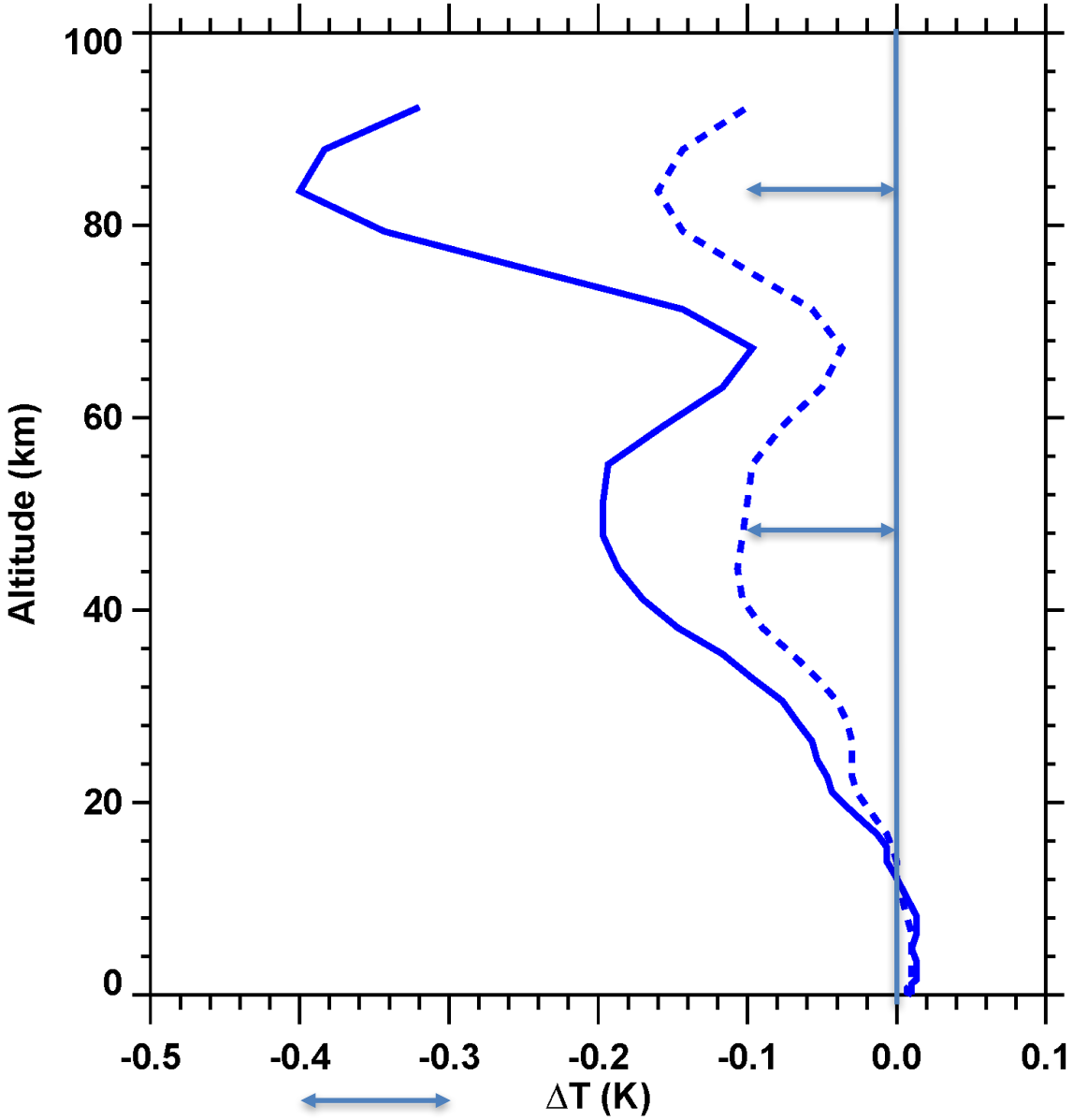
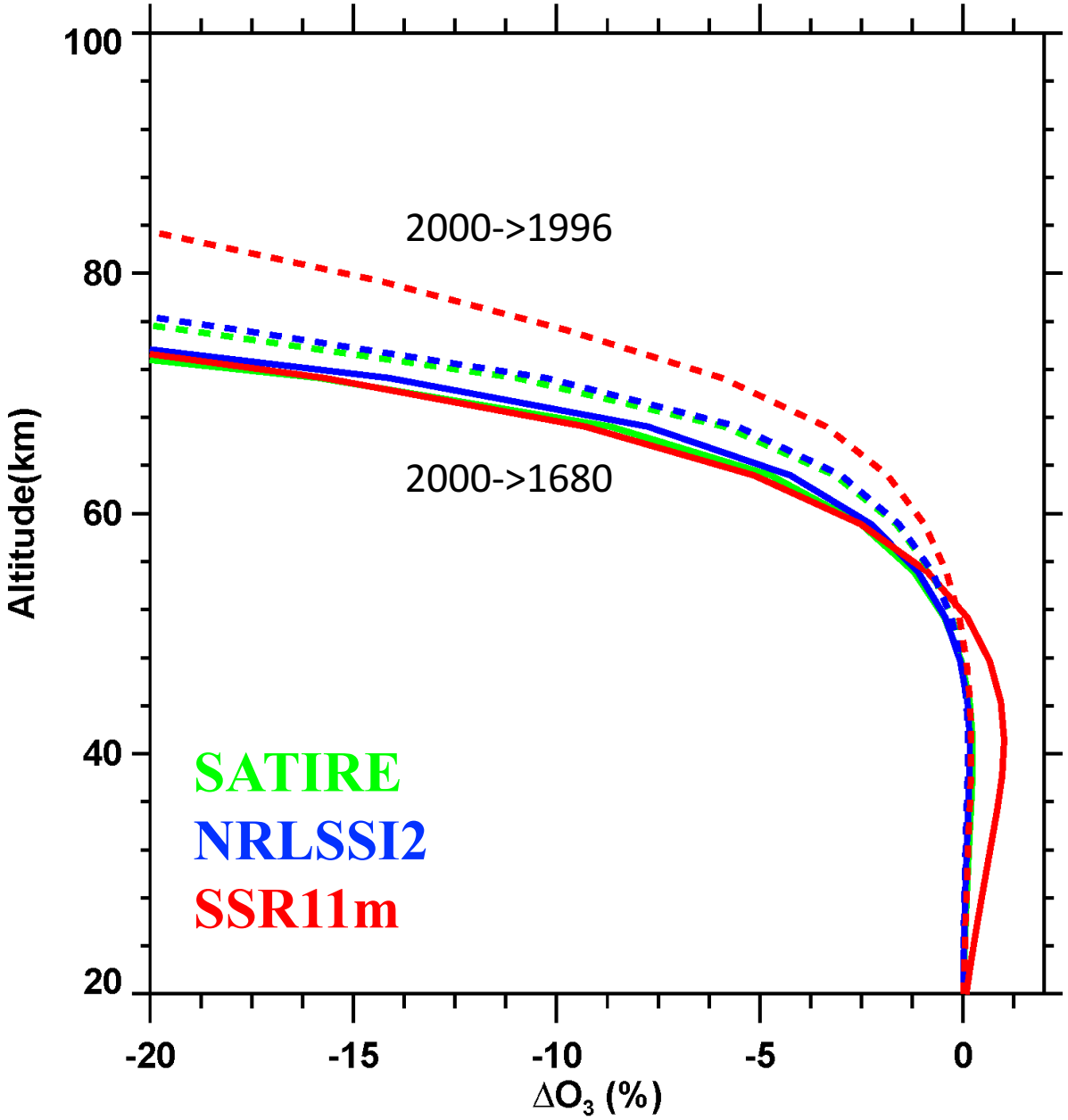


Water vapor response



Conclusions

We compared the ozone, temperature and H_2O responses to solar irradiance variability for NRLSSI2, SATIRE and SSR11m data sets.

The surface temperature responses obtained with NRLSSI2, SATIRE are almost identical. SSR11m data set gives the same decadal scale response, but 4 times larger response on centennial (and longer) time scales.

Stratospheric ozone responses obtained with NRLSSI2, SATIRE differ by 0.2% in the stratosphere and up to 0.5% in the mesosphere on decadal and are twice larger on centennial time scale.

Stratospheric temperature responses obtained with NRLSSI2, SATIRE differ by 0.1 K in the stratosphere and up to 0.2 K in the mesosphere on decadal and are twice larger on centennial time scale.

Stratospheric responses obtained with SSR11m are almost the same at decadal and 4 times larger on centennial time scale. Smaller variability in shortwave SUV in SSR11m is visible.

Early 20th century warming remains unexplained.

Early 20th century warming