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Assessment of 16 years of satellite temperature profiles from SABER and MLS using lidar temperature profiles from OHP

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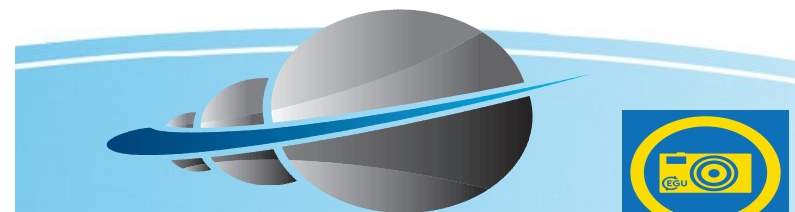
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CANDAC

Canadian Network for the Detection of Atmospheric Change



LATMOS



GORDIEN STRATO



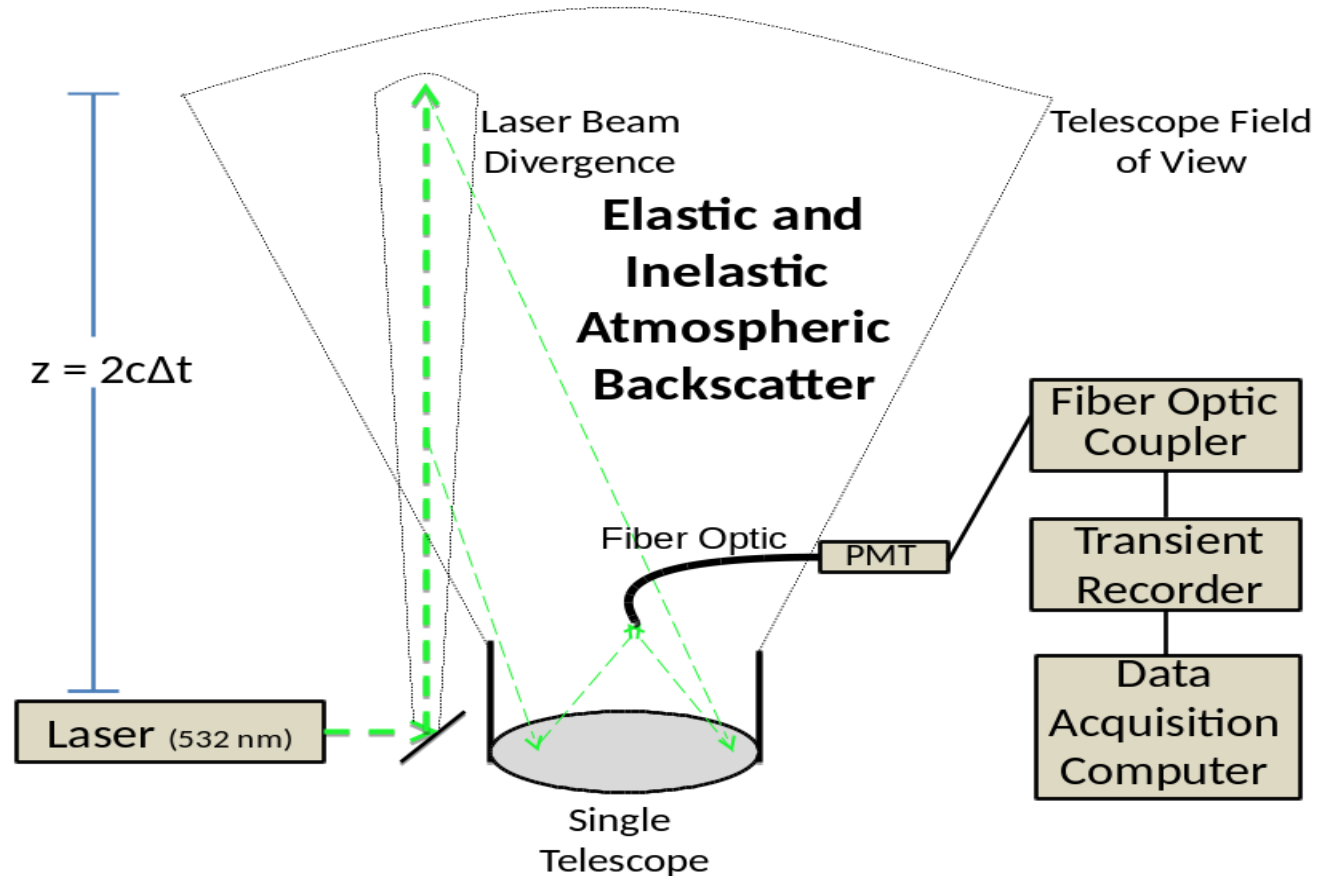
Photography
encouraged

The Instruments



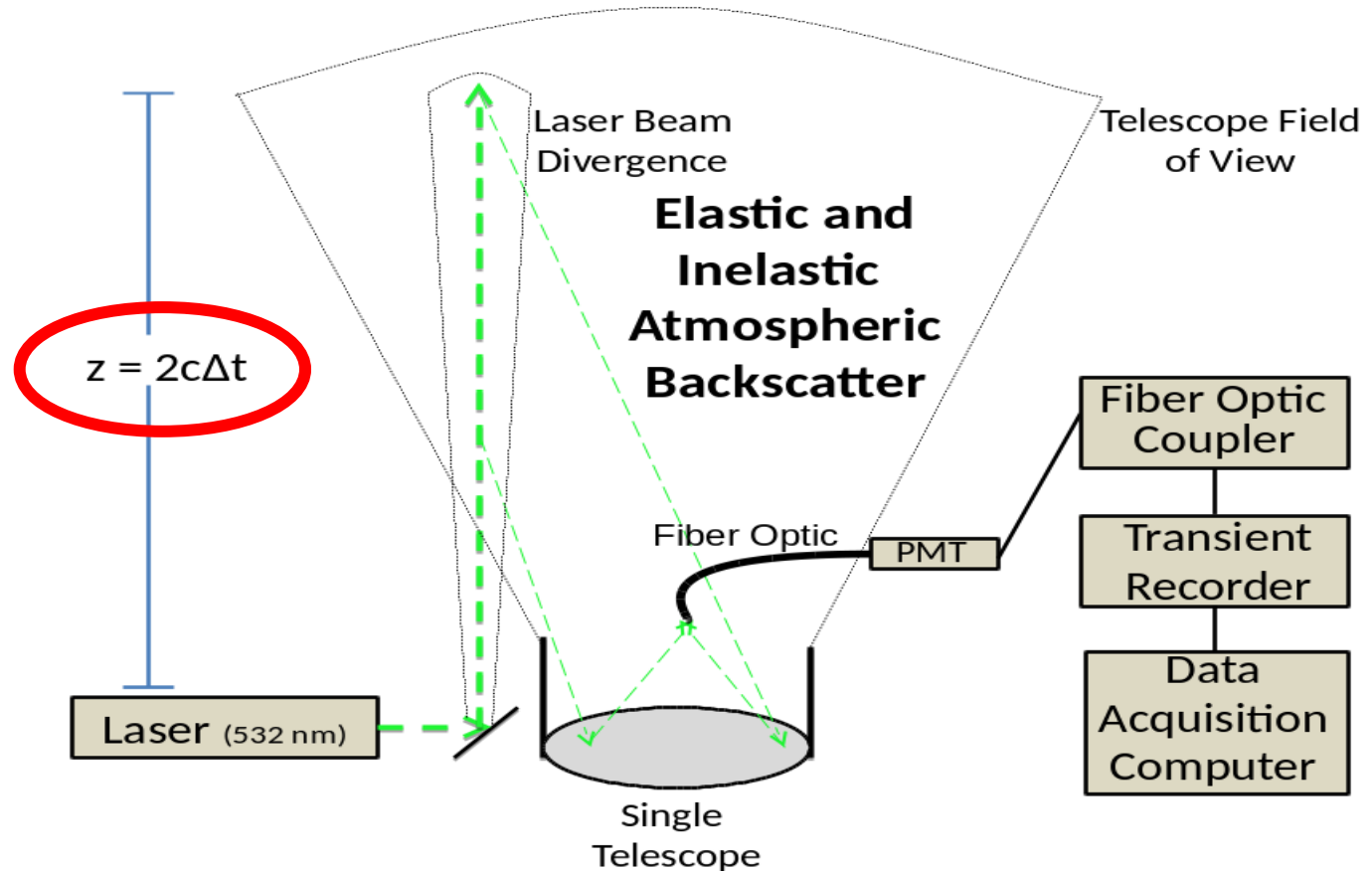
Lidar Basics

- **Pulsed laser light is directed to the sky**
- **Small probability of molecular backscatter into the FoV of telescope**
- **Returned photons are detected and digitized**



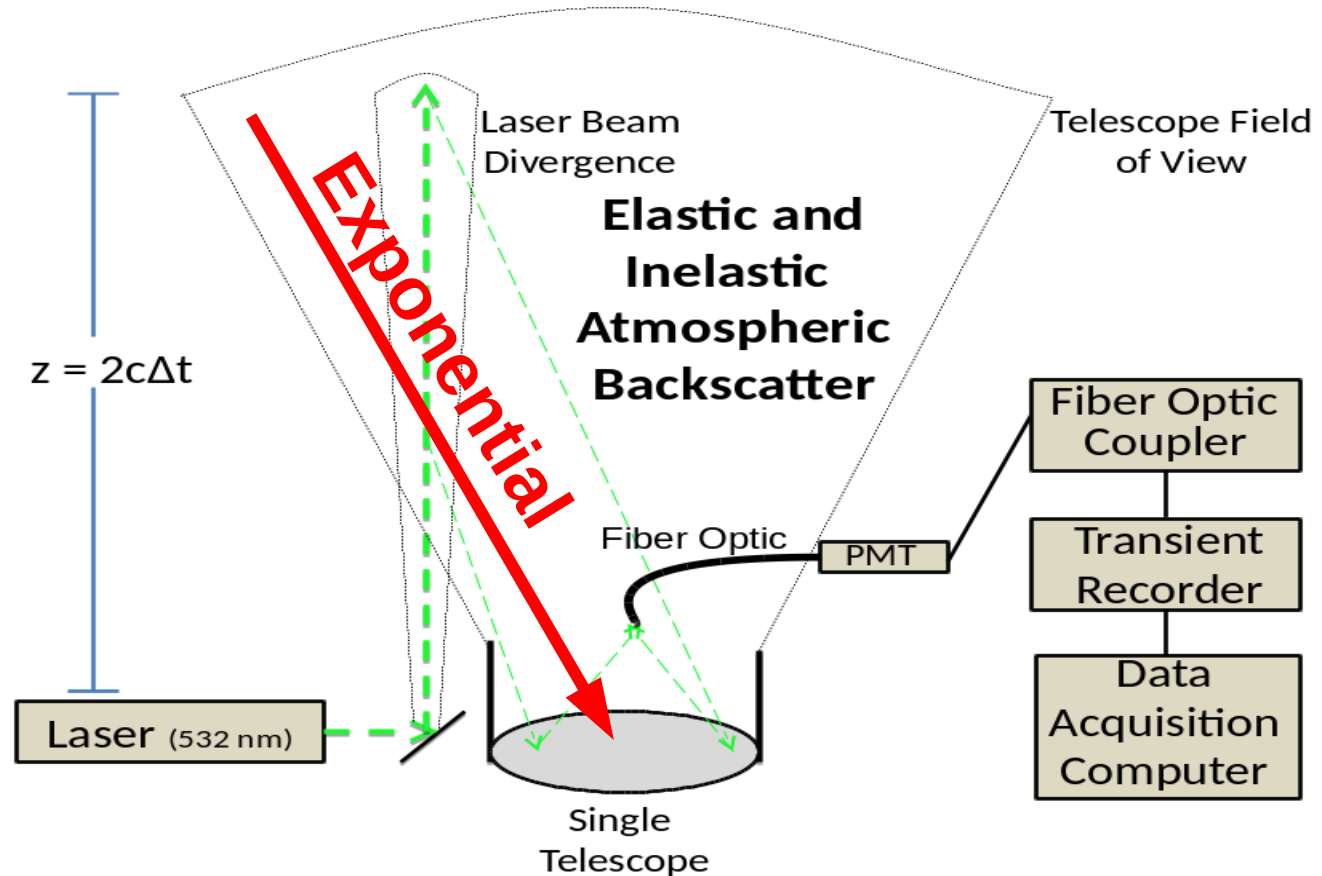
Lidar Take Away

- **Very accurate and precise vertical information**



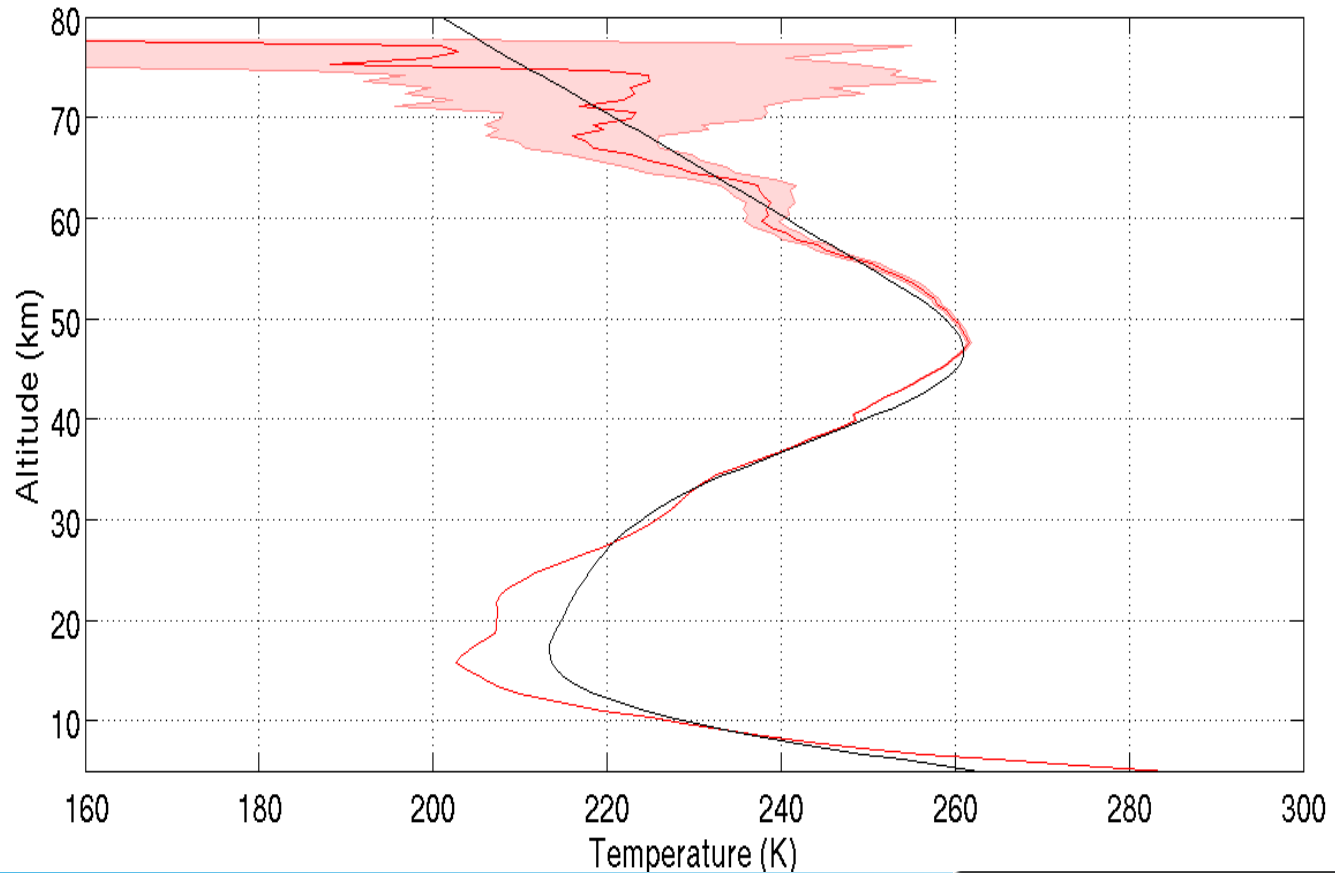
Lidar Take Away

- Very accurate and precise vertical information
- Probability of measuring a photon \propto density



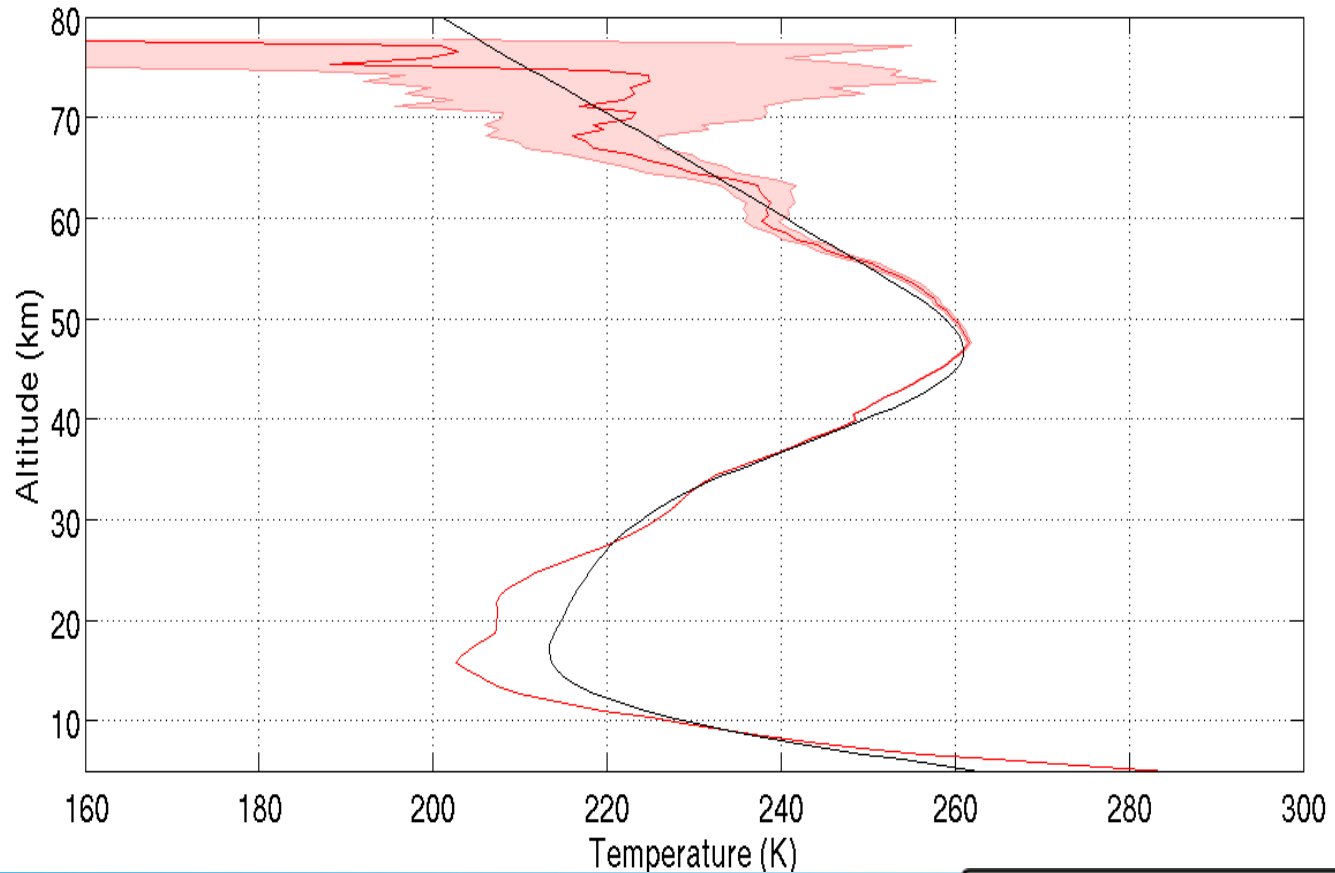
Lidar Take Away

- **Very accurate and precise vertical information**
- **Probability of measuring a photon \propto density**
- $T(z) \propto \int \frac{d\rho(z)}{dz}$



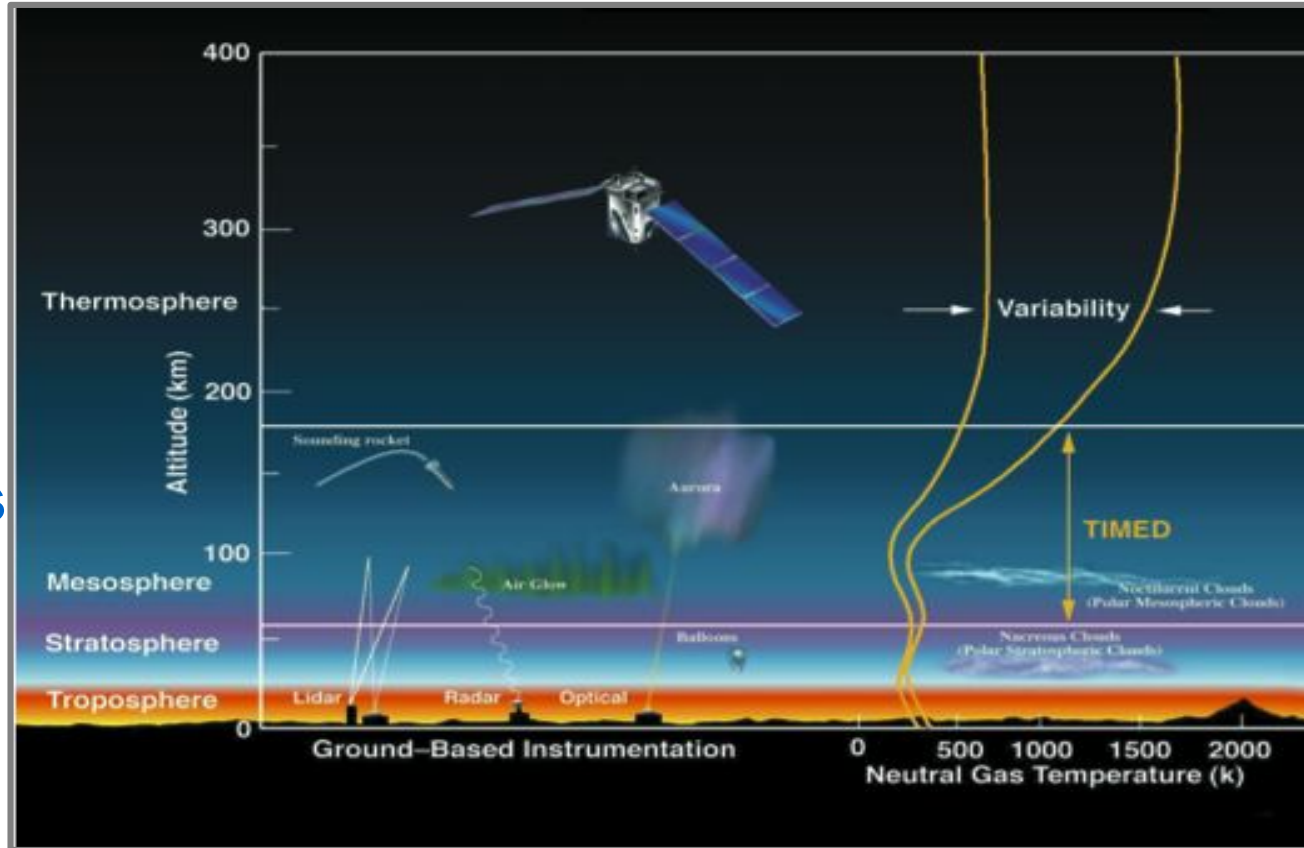
Lidar Take Away

- **Very accurate and precise vertical information**
- **Probability of measuring a photon \propto density**
- $T(z) \propto \int \frac{d\rho(z)}{dz}$
- **Statistical errors**



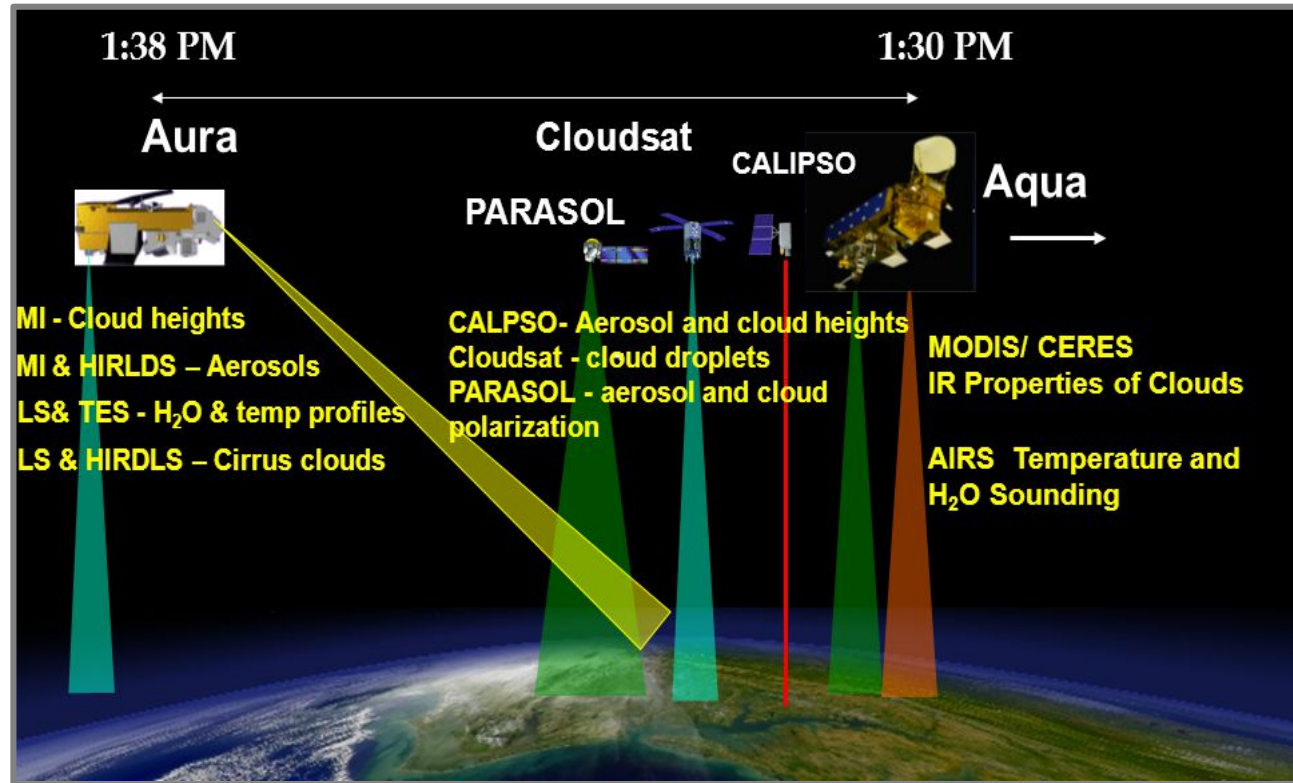
SABER/TIMED

- **S**ounding of the **A**tmosphere using **B**roadband **E**mission **R**adiometry
- Measurements from CO_2 thermal emissions
- Not sun synchronous



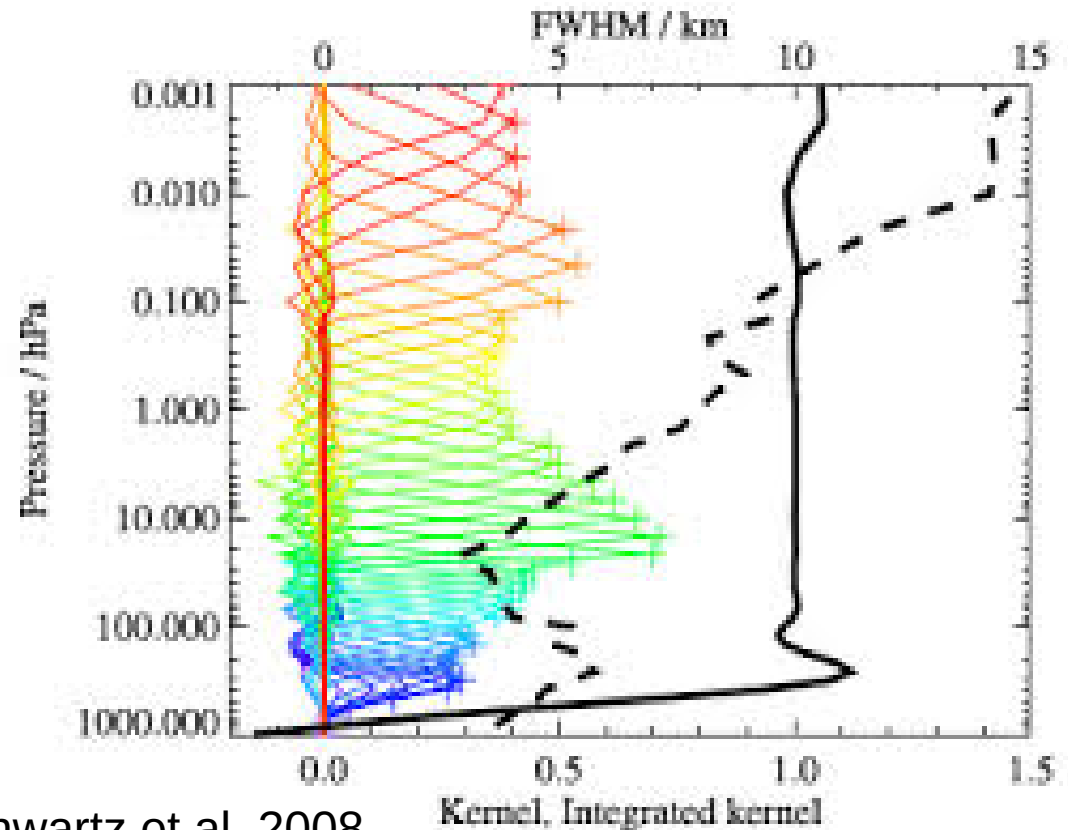
MLS/Aura

- **M**icrowave
Limb scanning
Spectrometer
- Measurements from O_2 emissions
- Sun synchronous orbit
- Passes OHP around 1h45 UTC



Satellite Temperatures

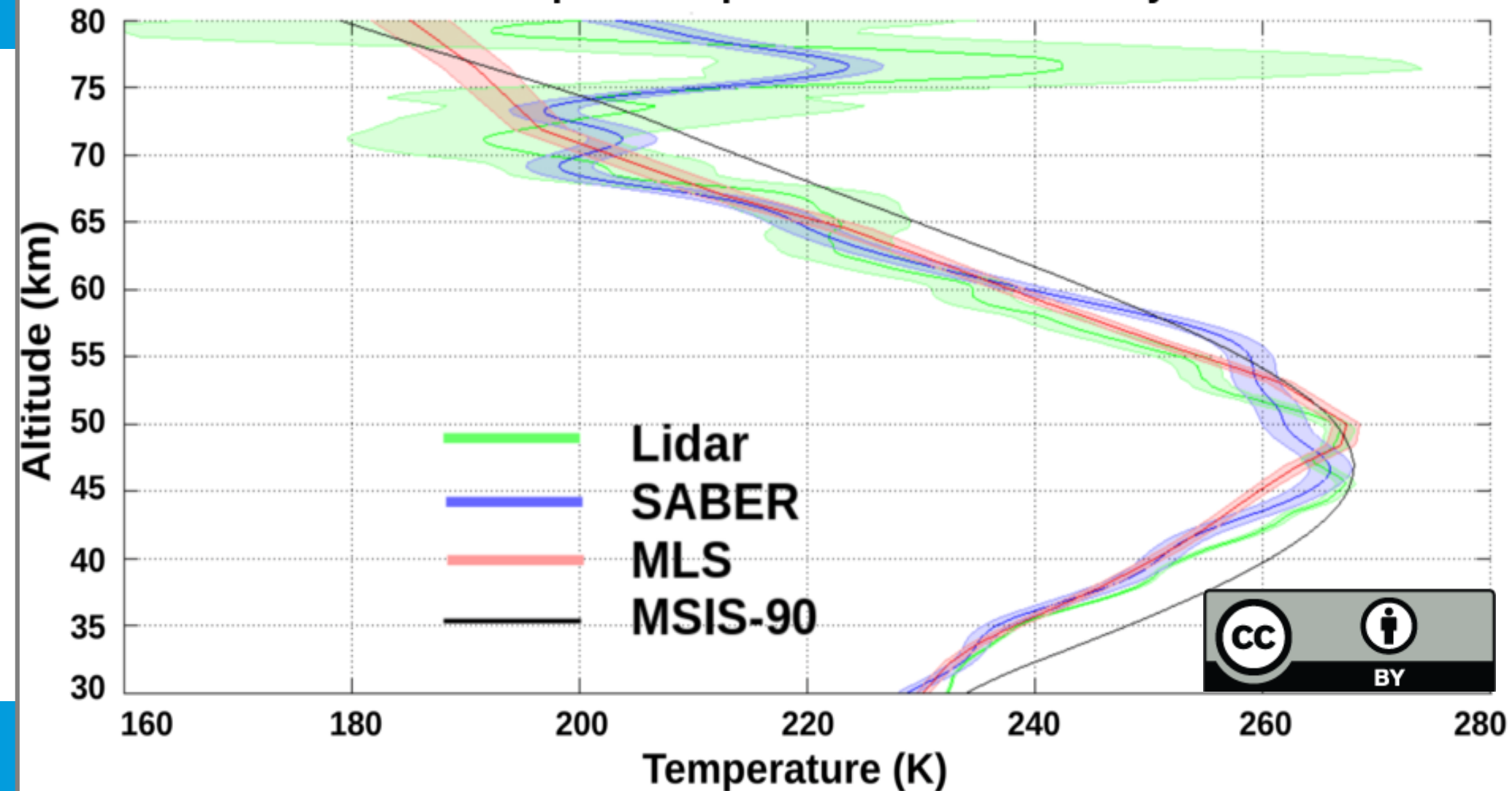
- **Passive measurements**
- **Solve inverse problems to turn radiance into pressure/GPH and into temperatures**
- **Extensive use of models as a priori given no other measurements**
- **Very complex**



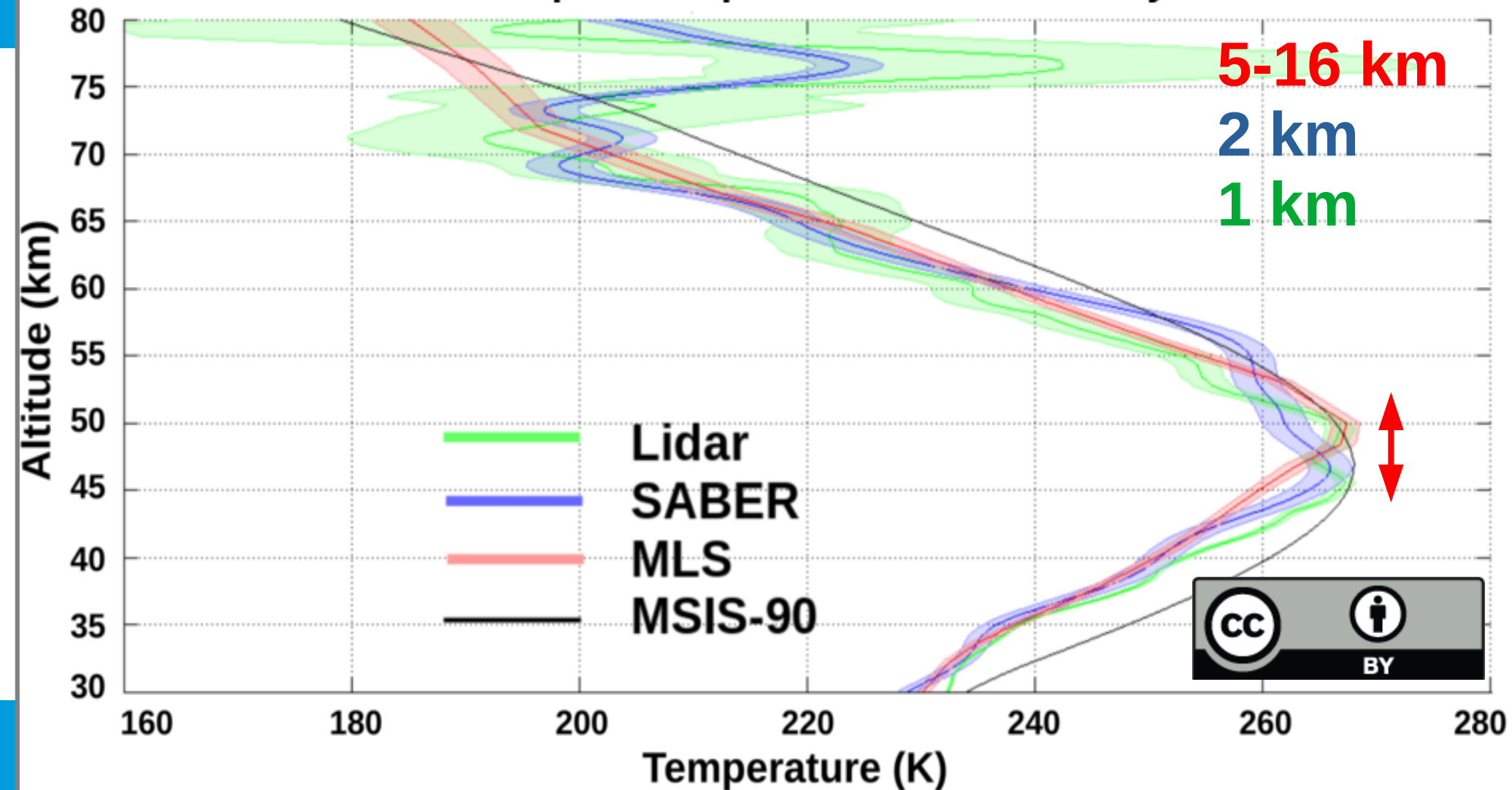
Schwartz et al. 2008

An Example Comparison

Vertical temperature profiles for OHP 25 July 2012



Vertical temperature profiles for OHP 25 July 2012

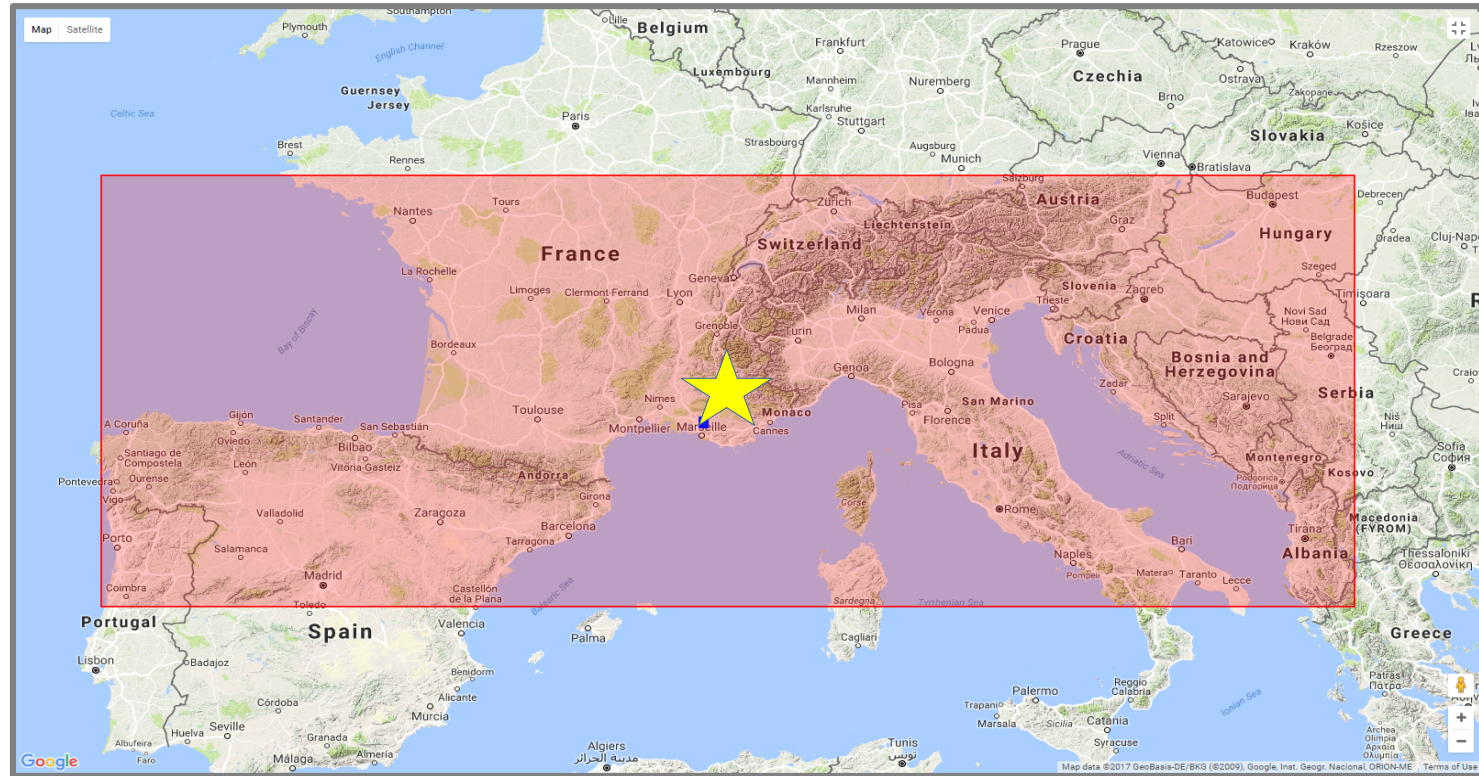


The 16 Year Comparison



Comparison Parameters

- **OHP (44N, 6E)**
- **$\pm 4^\circ$ lat**
- **$\pm 15^\circ$ long**
- **Saber ± 4 hours of lidar**
- **MLS nearest pass approx. 1h45 UTC**

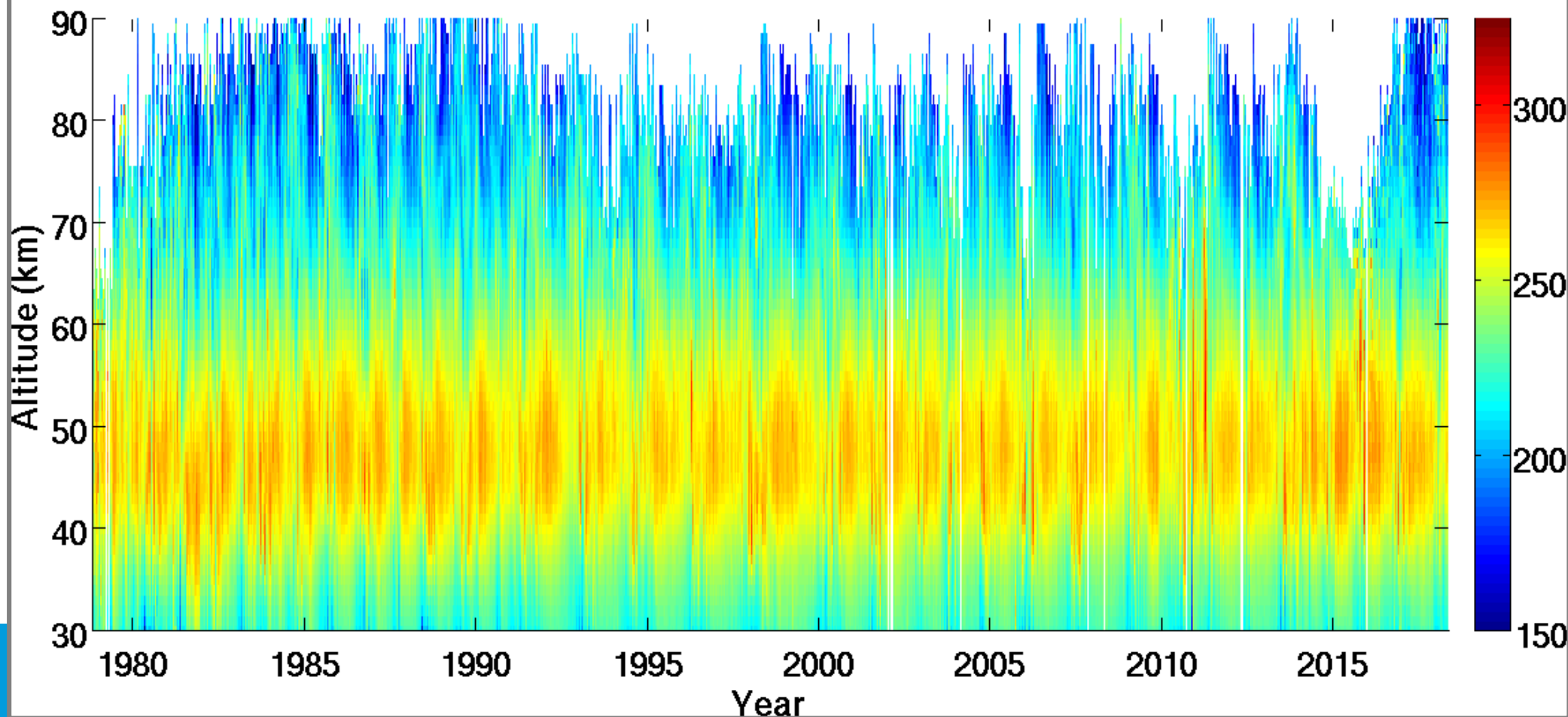


40 year OHP data series



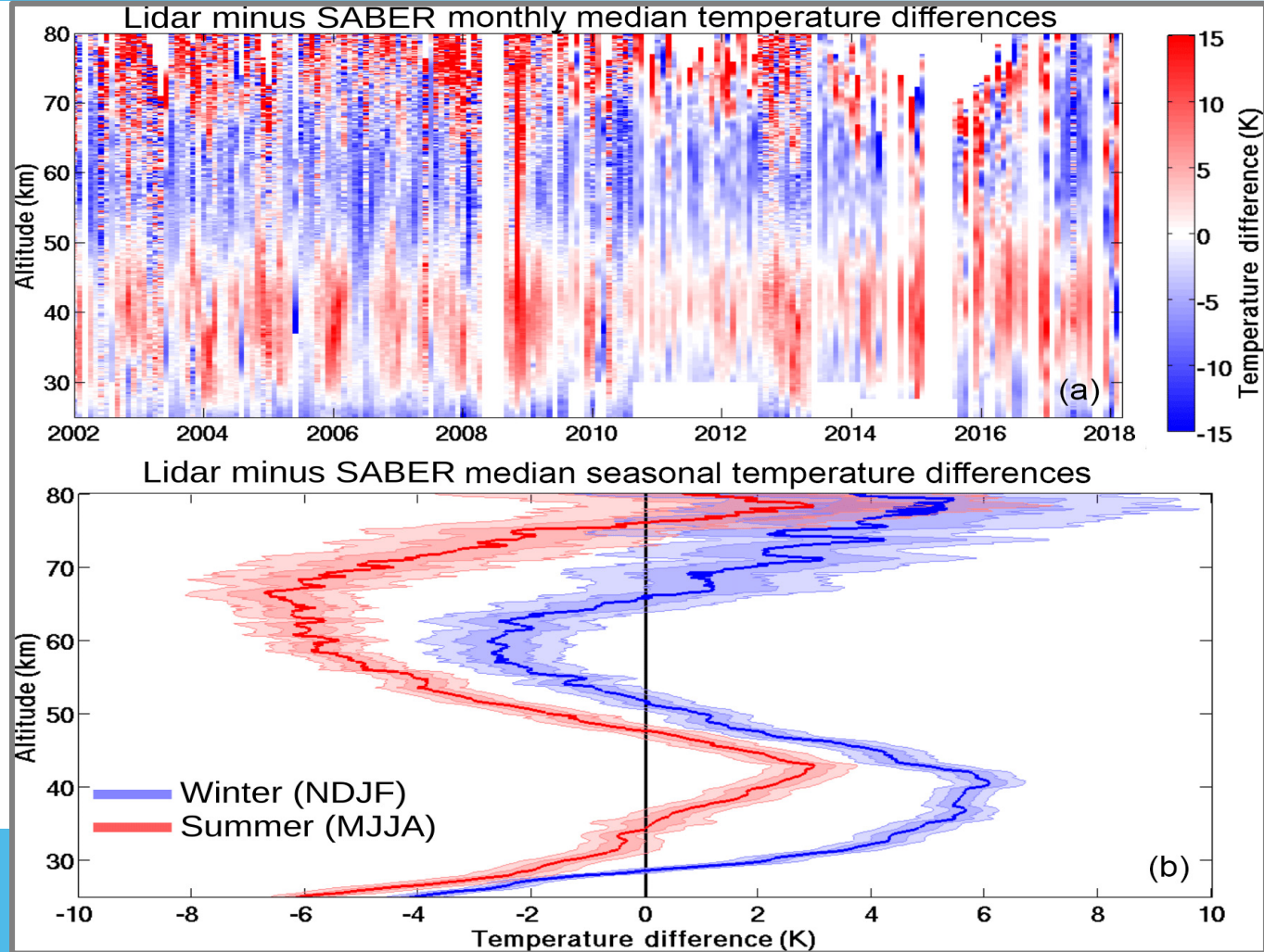
BY

LTA Temperatures 1978-2018



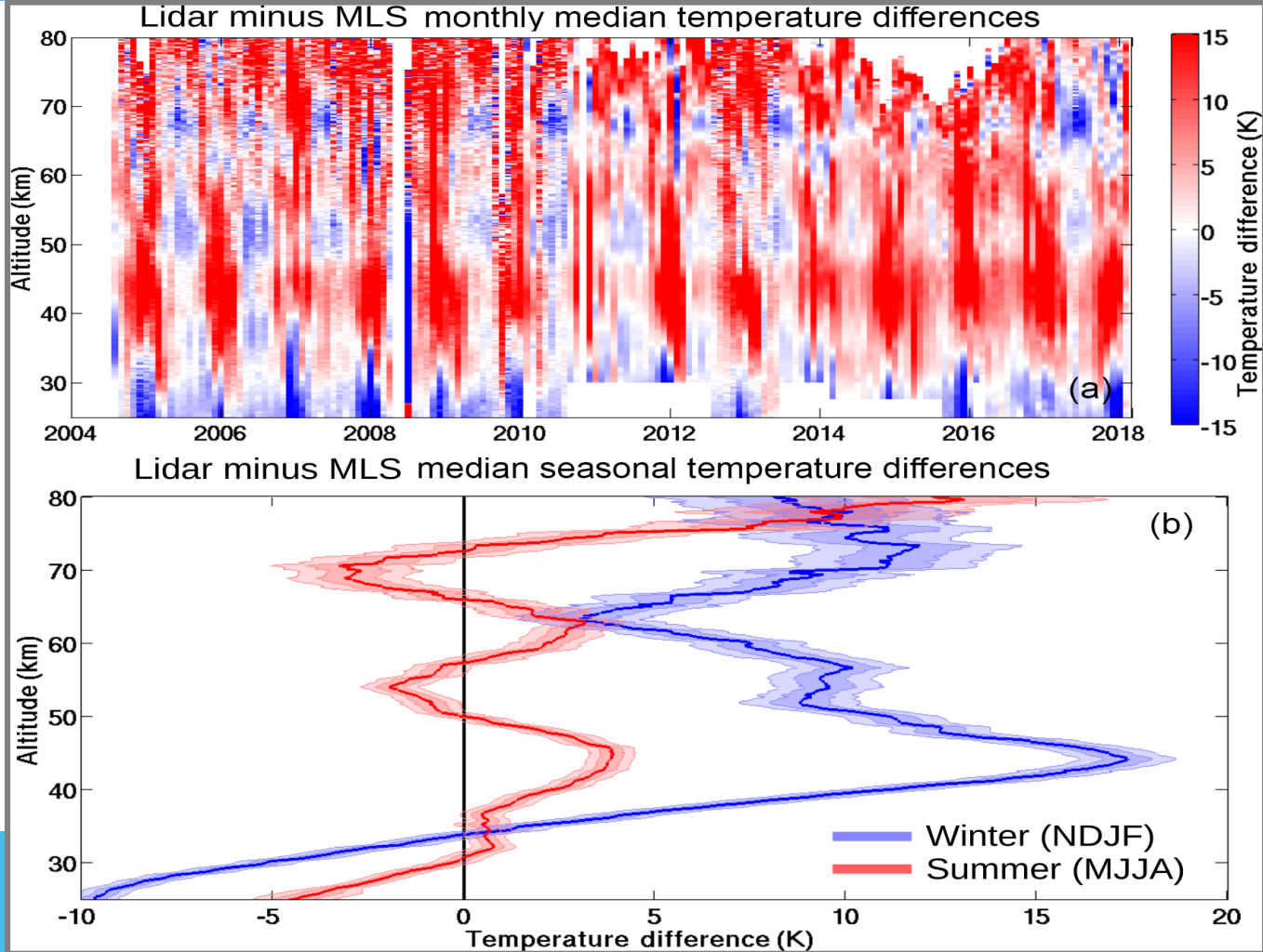
Lidar minus SABER

- **1100 coincident nights from 2002 to 2018**
- **Monthly medians of nightly temperature differences**
- **S-shaped altitude dependence**
- **Winter/Summer seasonal variation**



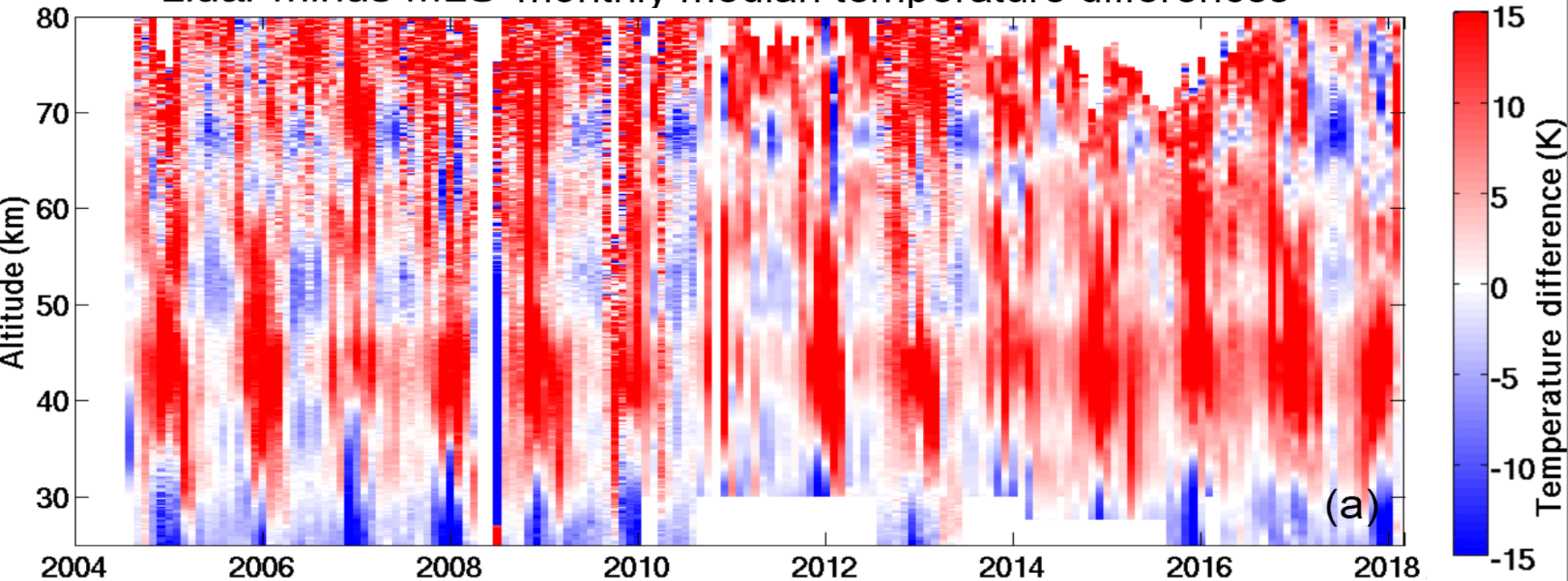
Lidar minus MLS

- **1741** coincident nights from **2004** to **2018**
- Monthly medians of nightly temperature differences
- Clear annual cycle and non-linear altitude dependence
- Winter stratopause!



Lidar minus MLS – a closer look

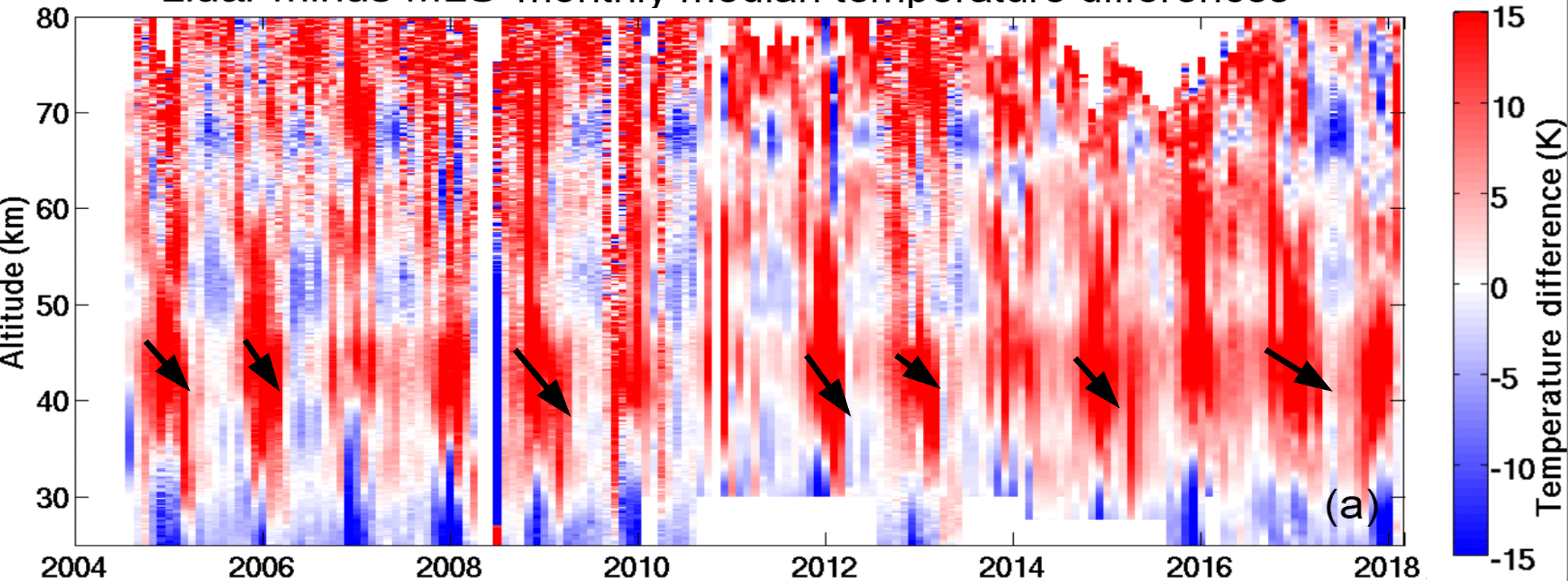
Lidar minus MLS monthly median temperature differences



Lidar minus MLS median seasonal temperature differences

Lidar minus MLS – a closer look

Lidar minus MLS monthly median temperature differences



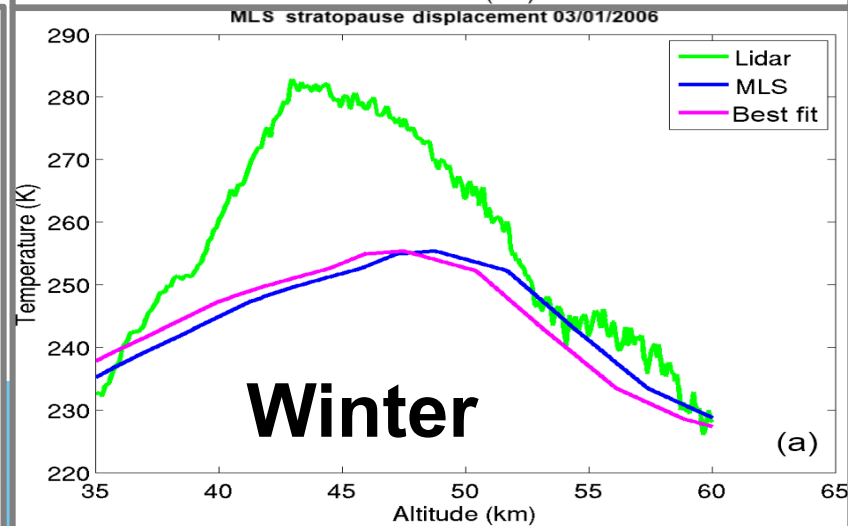
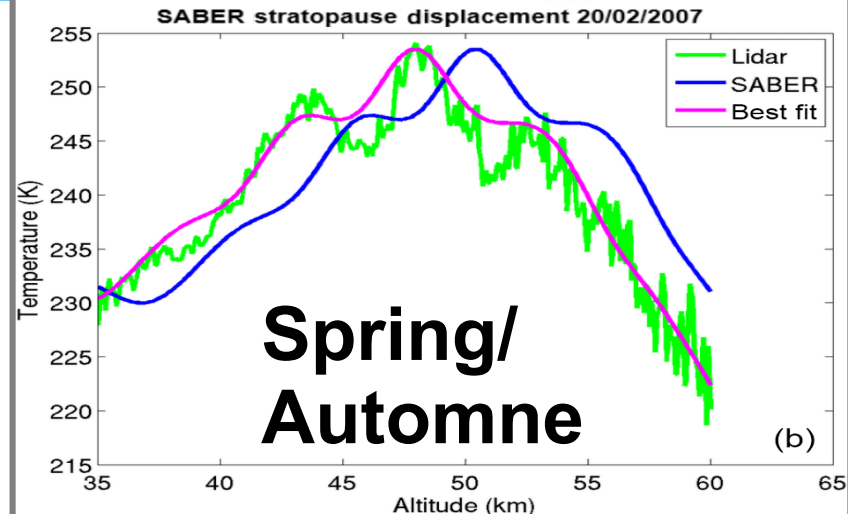
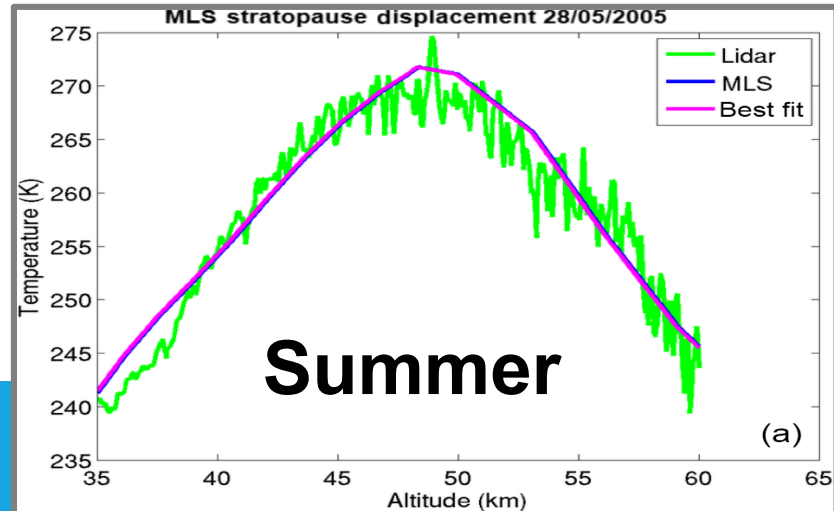
Lidar minus MLS median seasonal temperature differences

Using the Lidar for a simple Offset Correction

Empirical Correction



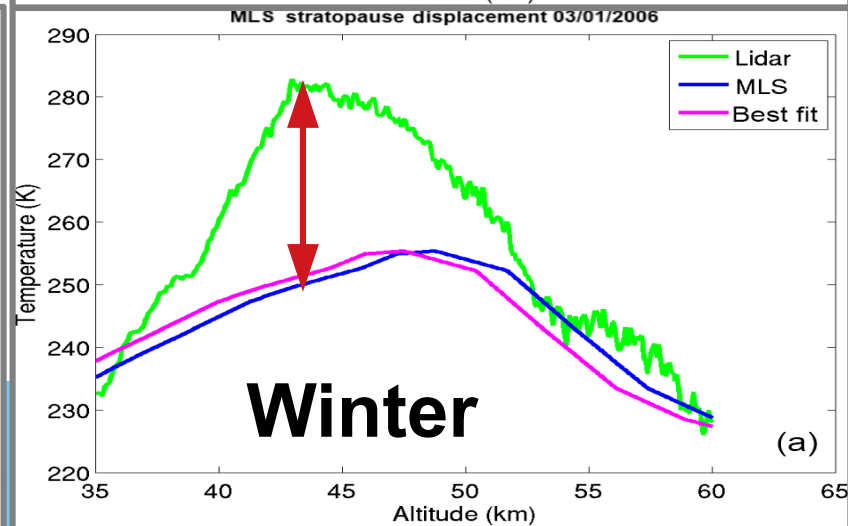
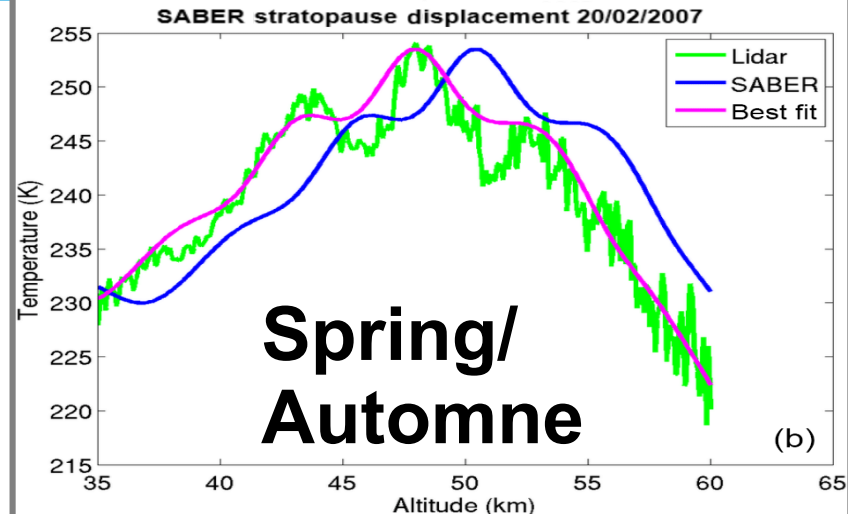
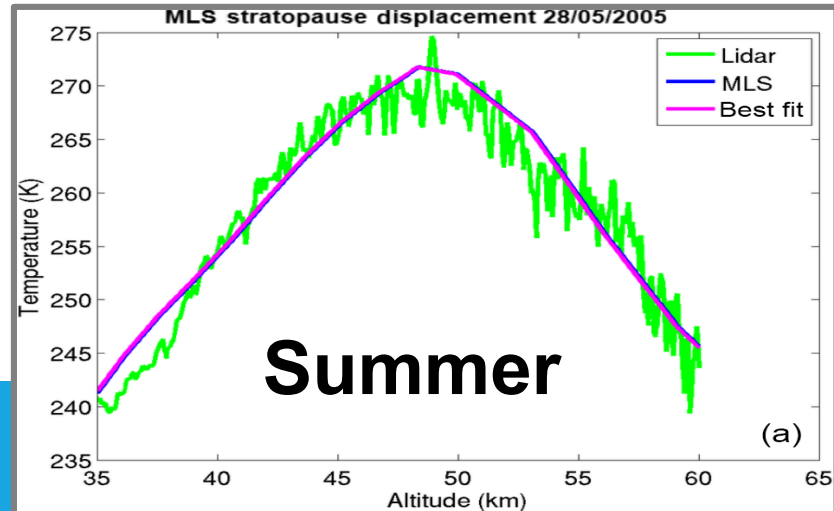
- Shifted the satellite profile based on the lidar stratopause height
- Lidar, satellite, corrected satellite



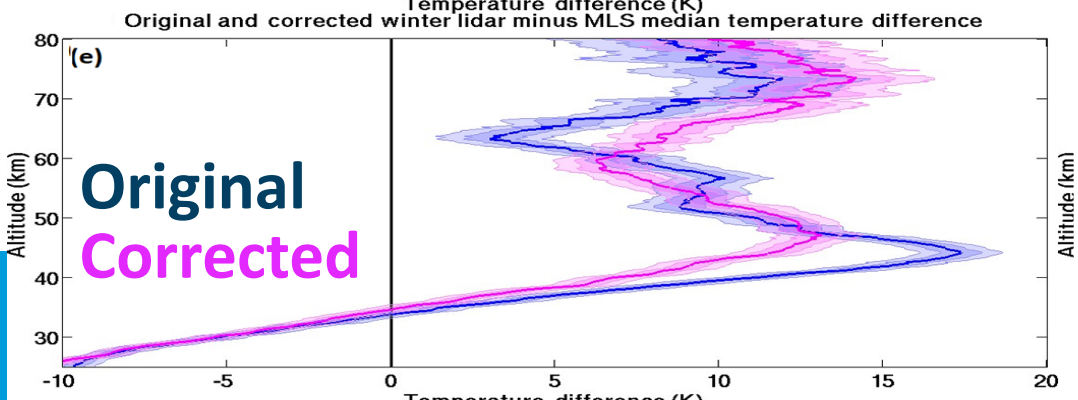
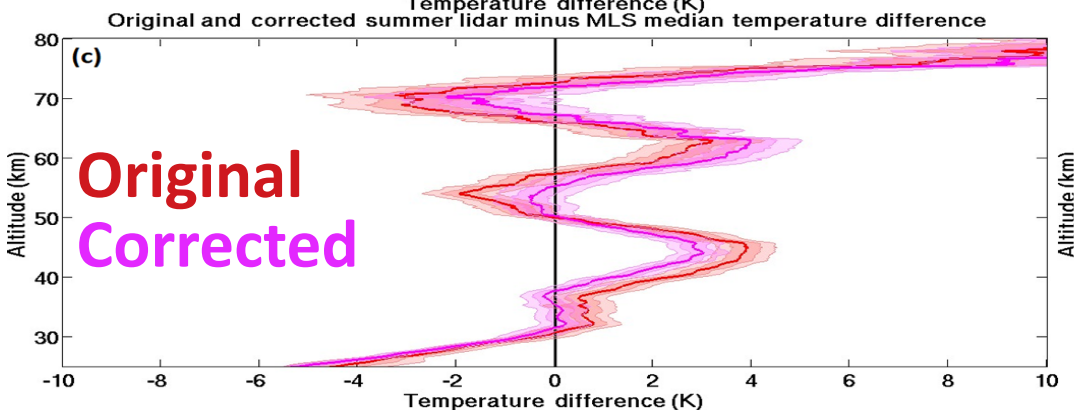
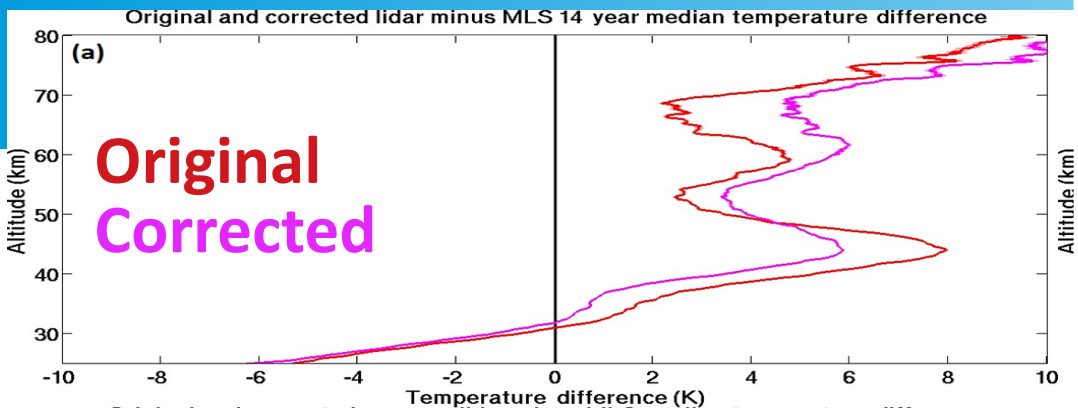
Empirical Correction

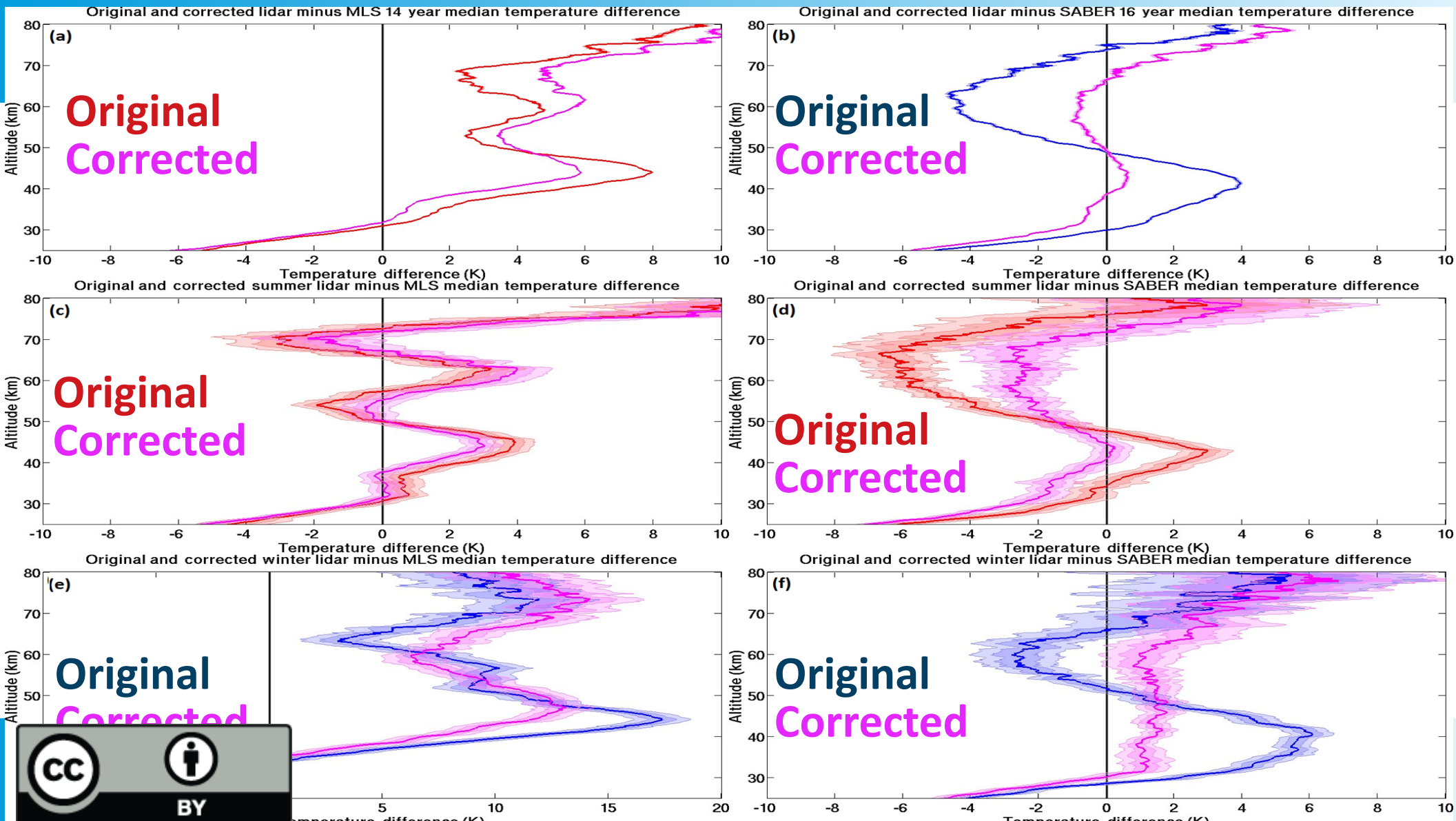


- Shifted the satellite profile based on the lidar stratopause height
- Lidar, satellite, corrected satellite
- Satellite missed a SSW



The Results of the Offset Correction





Some Concluding Thoughts

- Care should be taken when using satellite data to study altitude dependent problems (gravity waves, SSWs, temperature trends etc.)
- Lidar data may be useful to the satellite community for use in calibration and empirical GPH and temperature corrections
- There are several mature lidar stations in the NDACC with long data records. When stitching together successive satellite data sets maybe lidar could be the common thread