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The Mid-Latitude Mesosphere's Response to Sudden Stratospheric Warmings as Determined from Rayleigh Lidar Temperatures

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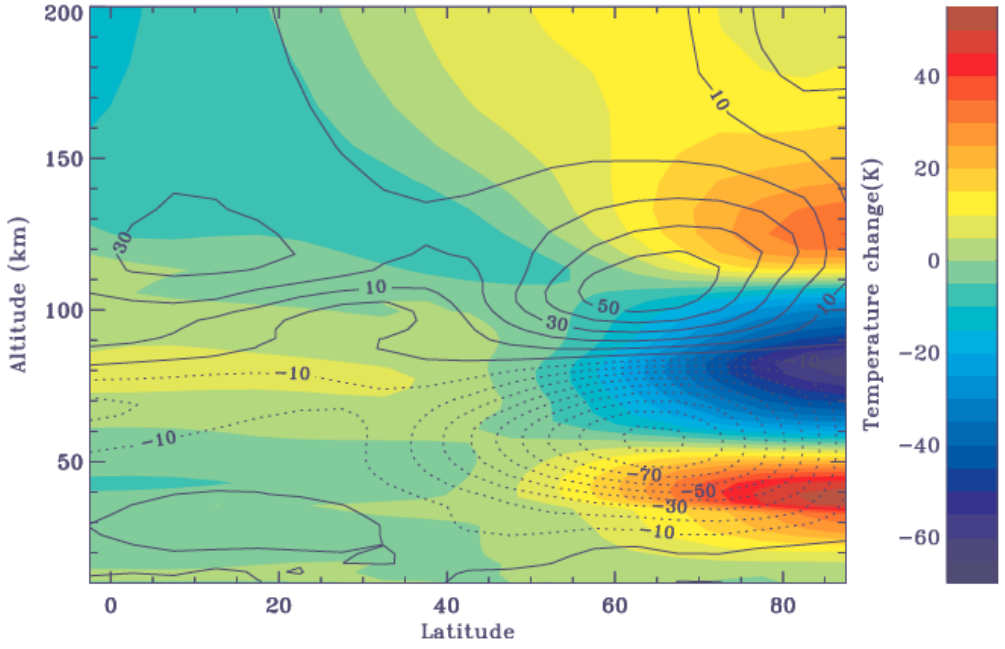
How does the temperature of the Mesosphere at mid-latitudes behave during the full life cycle of a northern hemisphere, major Sudden Stratospheric Warming event?

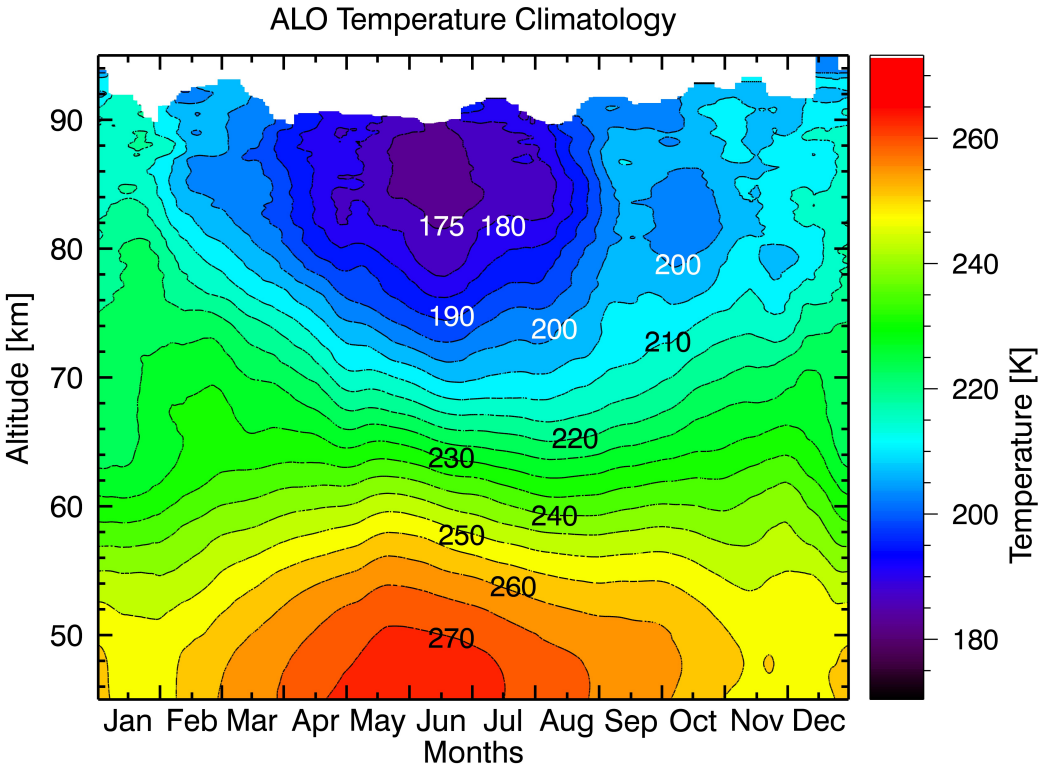
Previous Studies

- *Whiteway and Carswell (1994), Von Zahn, et al. (1998), Walterscheid, et al. (2000),* and *Liu and Roble (2002)* report coolings in the upper mesosphere (~60-80 km), warmings in the lower meosphere (around 50 km) at high latitudes
- *Yuan et al. (2012),* reported coolings of ~20 K from 80-90 km at mid-latitudes



(*Liu and Roble, 2002*)

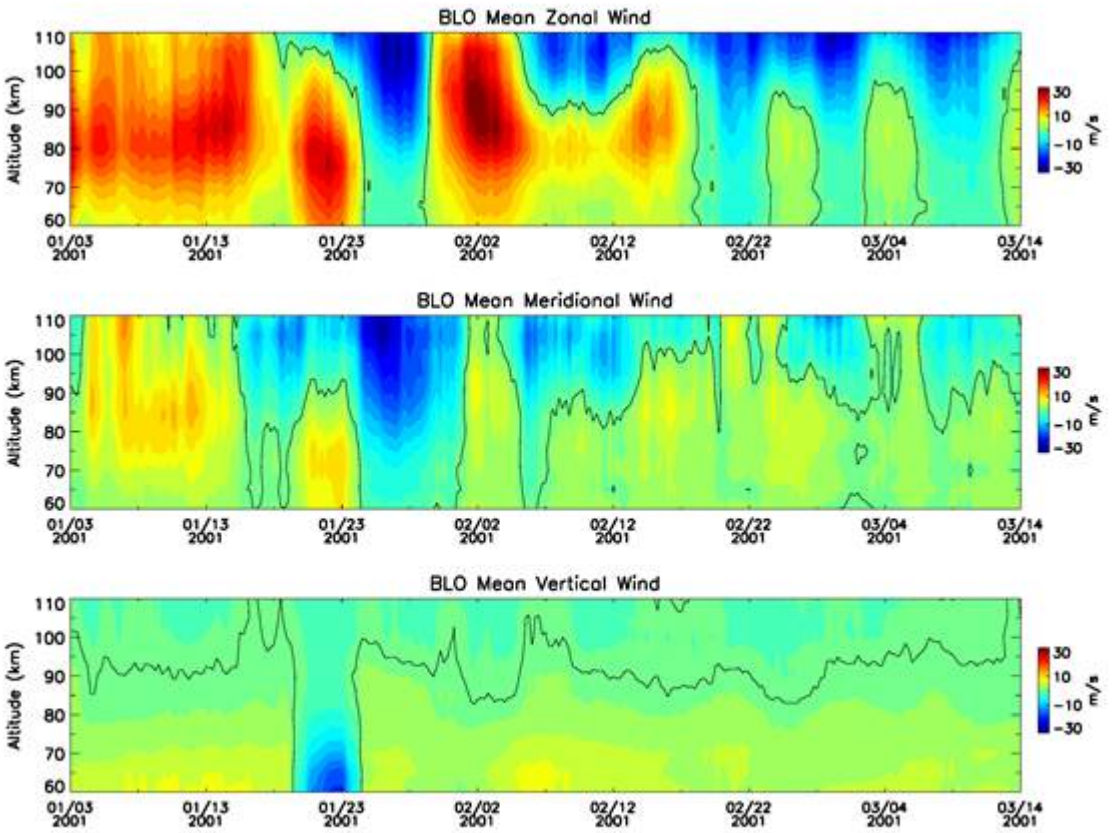
ALO Rayleigh Lidar 1993-2004



- Located at the Atmospheric Lidar Observatory (ALO; 42°N, 112° W)
- 900 nights of temperature data taken over 11 years in climatology (*Herron, 2007*)
- Climatological composite year averaged 31 days across and 11 years deep

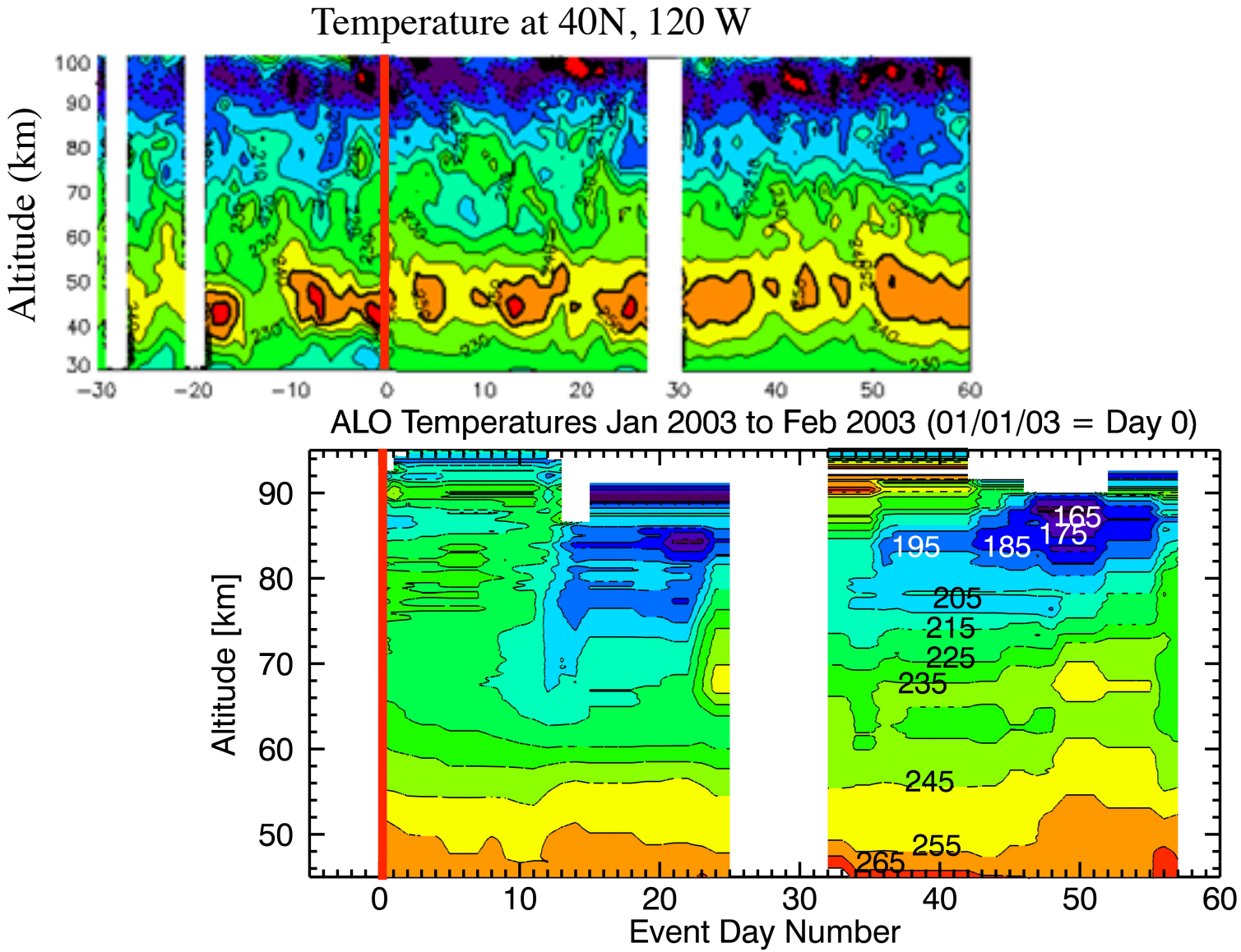
ALO/BLO Mid-latitude Study

- Instruments at ALO and the Bear Lake Observatory (BLO) include: Imaging Doppler Interferometry (IDI) data from a dynasonde, a meteor wind radar, a Na lidar from Colorado State University (now at ALO), and the SABER instrument aboard the TIMED satellite



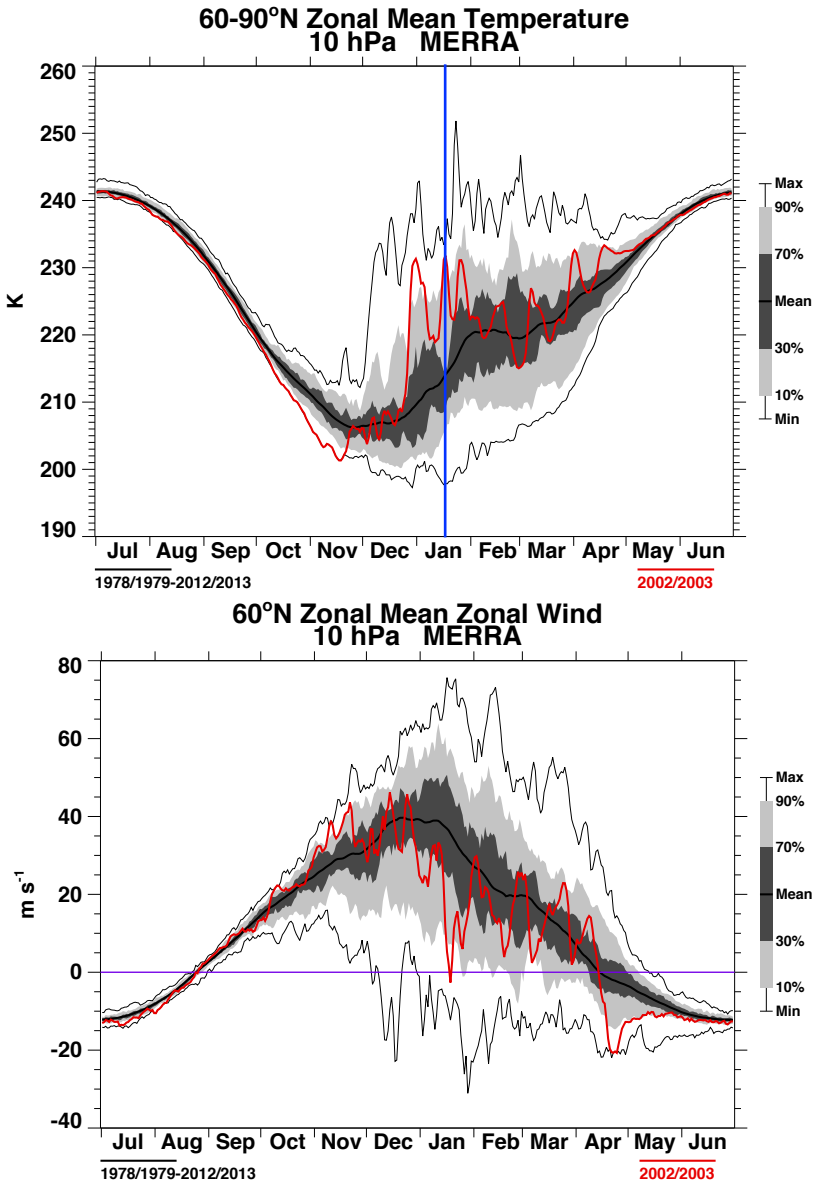
(See Fish, et al.,2.5-16 Monday 16:40)

Comparison with SABER Temperatures



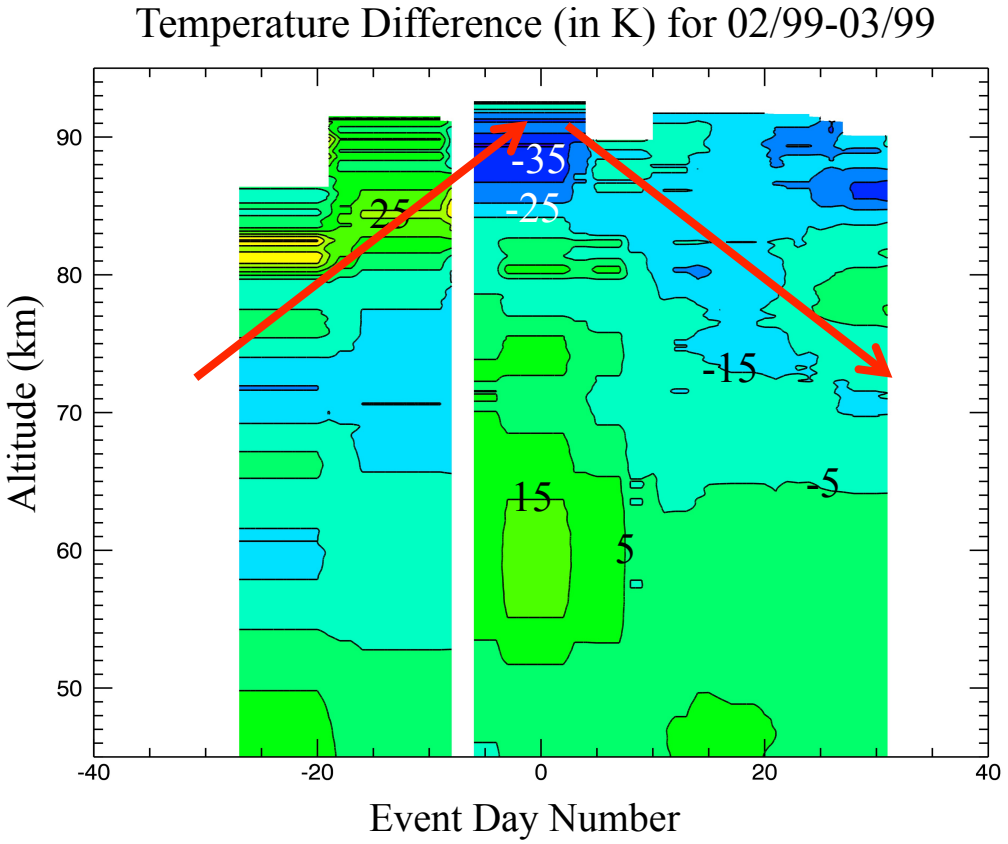
Analysis Method

- Found 8 periods where Rayleigh lidar data overlapped with a SSW event
- MERRA zonal mean temperature and wind data at 60°N and 10 hPa used to define events and their life cycles
- Only looked at major SSWs for this study

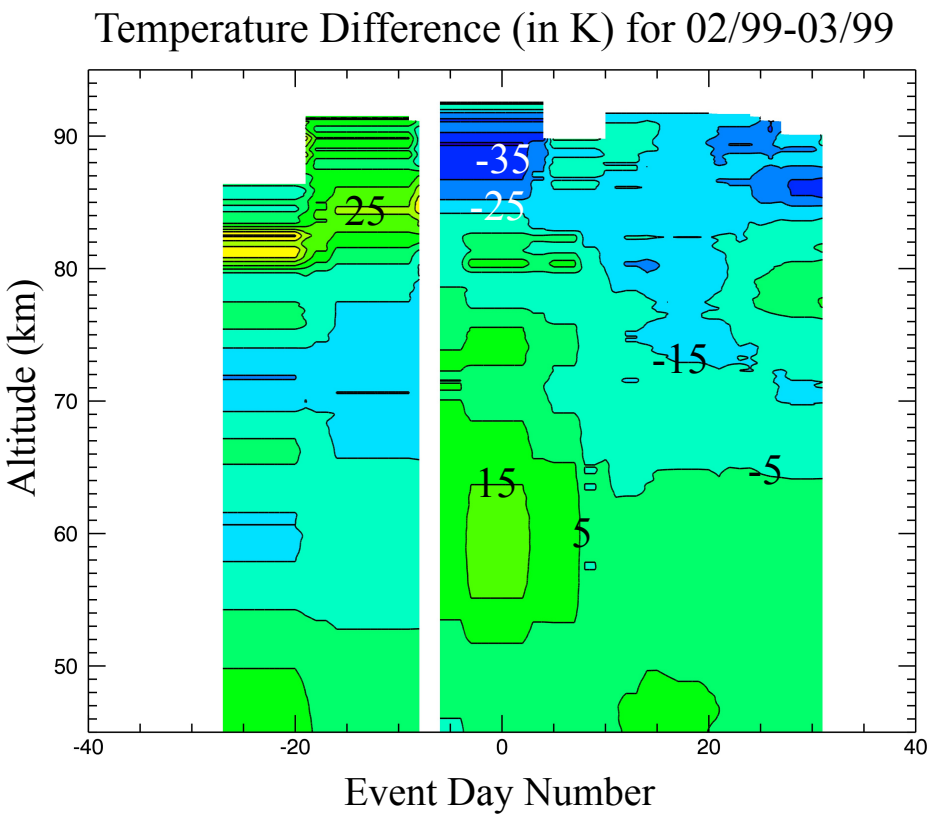


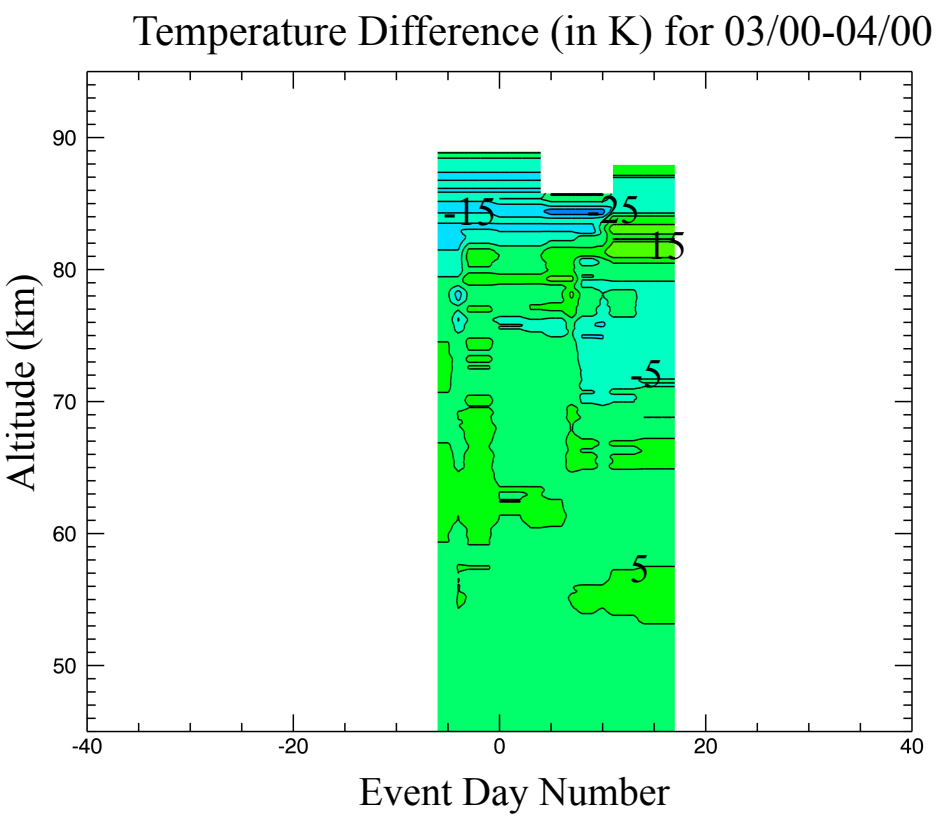
Results-1 of 3

- Coolings and warmings defined by the difference between nightly averaged temperatures and climatological temperatures for that day of the year
- Coolings between -15 and -45 K
- Coolings start at about 70-80 km before peak day, rise to 80-90 km during peak and lower again to 70-90 km afterward
- Warmings between 15 and 25 K
- Warmings stationed in lower mesosphere from 50-70 km

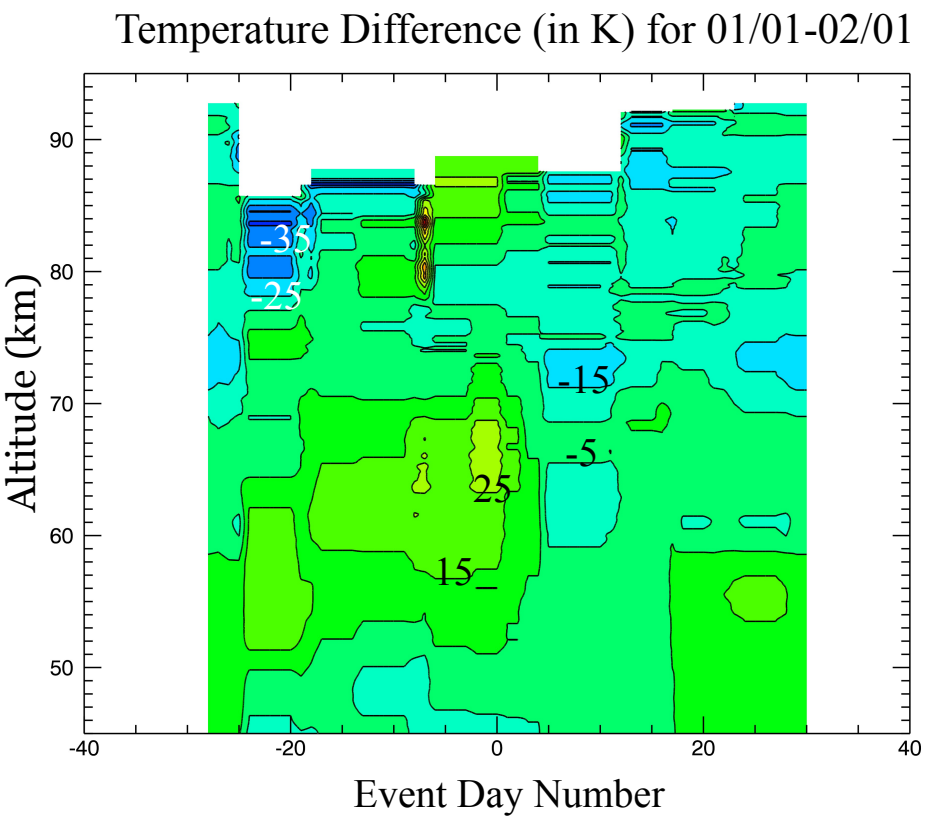


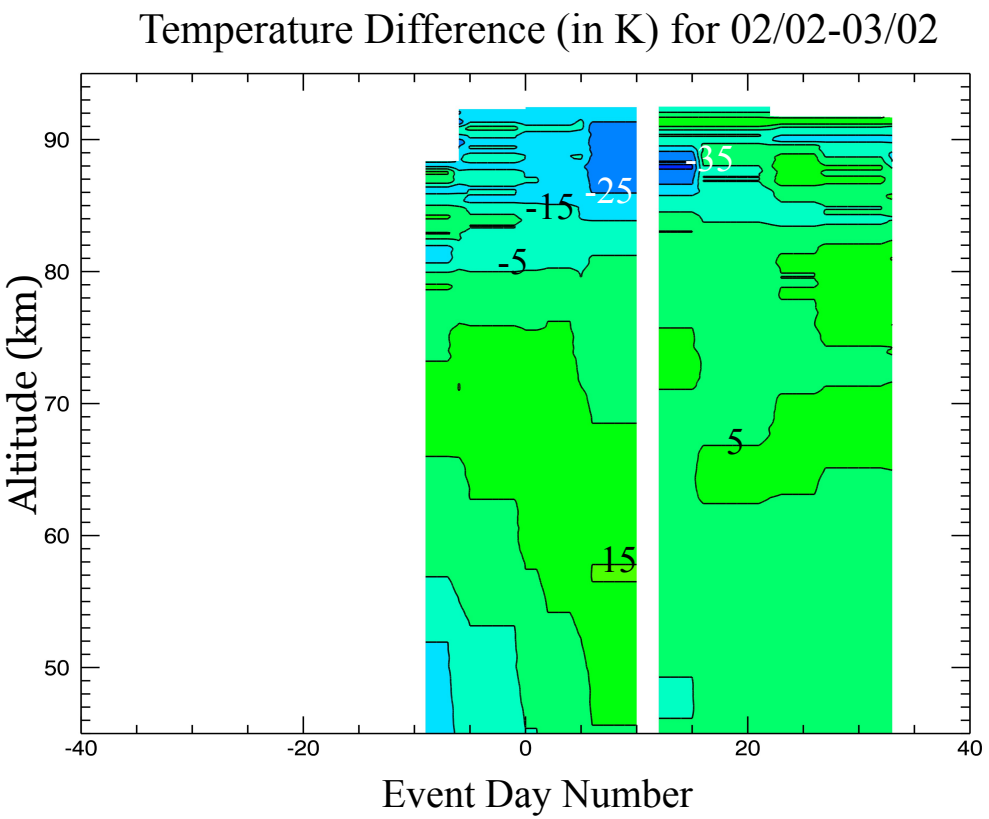
Results-1 of 3



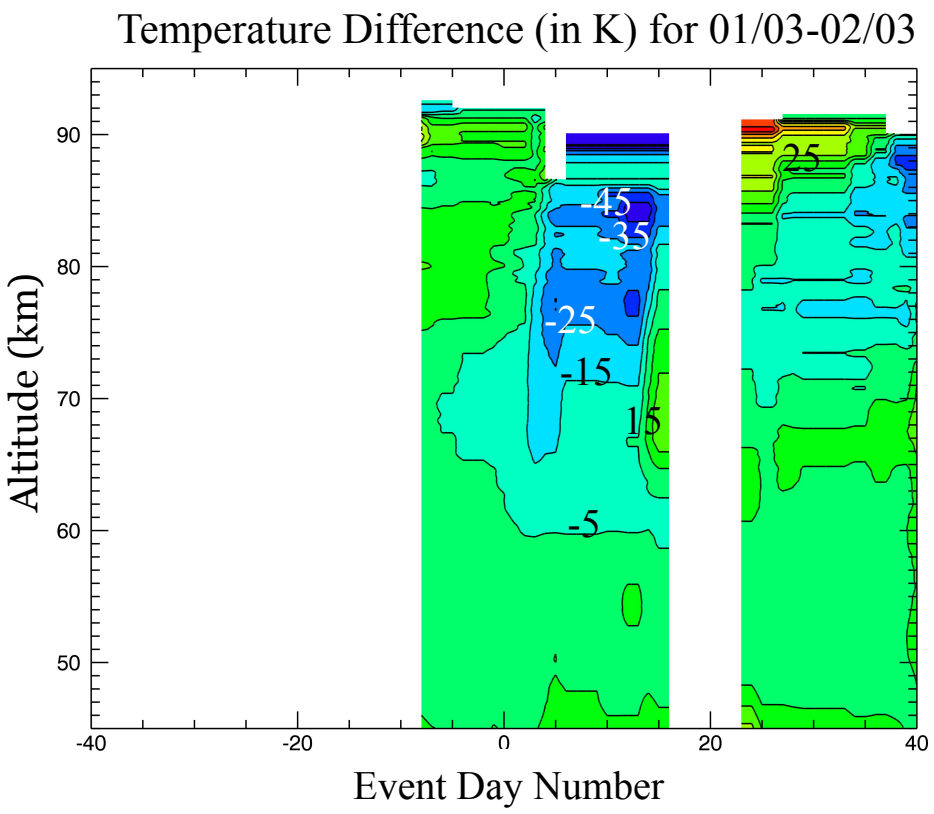


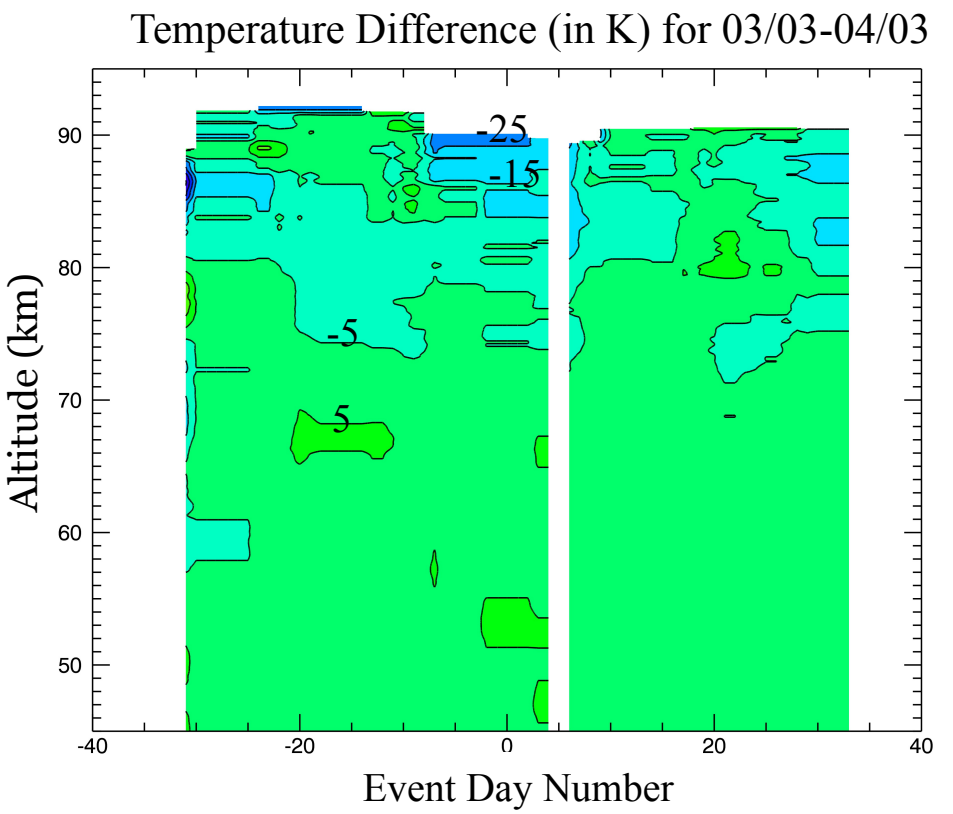
Results-2 of 3





Results-3 of 3





Conclusions

- A general cooling pattern was found in the upper mesosphere using mid-latitude rayleigh lidar data acquired during six major, Northern Hemisphere SSWs
- The coolings had magnitudes of 15-45 K.
- The temporal evolution of this phenomena showed coolings at altitudes of 70-90 km that then rise to 80-90 km while becoming colder near the peak of the SSW and finally descend back to 70-90 km while lessening in strength as the SSW descends from its peak.
- Similar coolings were shown at high latitudes previously, whereas these coolings happened at mid latitude

New Questions

- With new lidar capabilities **(Wickwar, et al., 2.5-20, Tuesday 10:30)**, what sort of temperature pattern will we observe in the lower Thermosphere (100-120 km)?
- What is the behavior of the mesosphere during minor SSWs?
- What else is happening during the SSW periods when the mesospheric temperatures do not follow the observed pattern (i.e. change in vertical winds)?
- How will new Rayleigh lidar data analysis techniques (*Khanna, 2012*) modify the current SSW pattern?

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