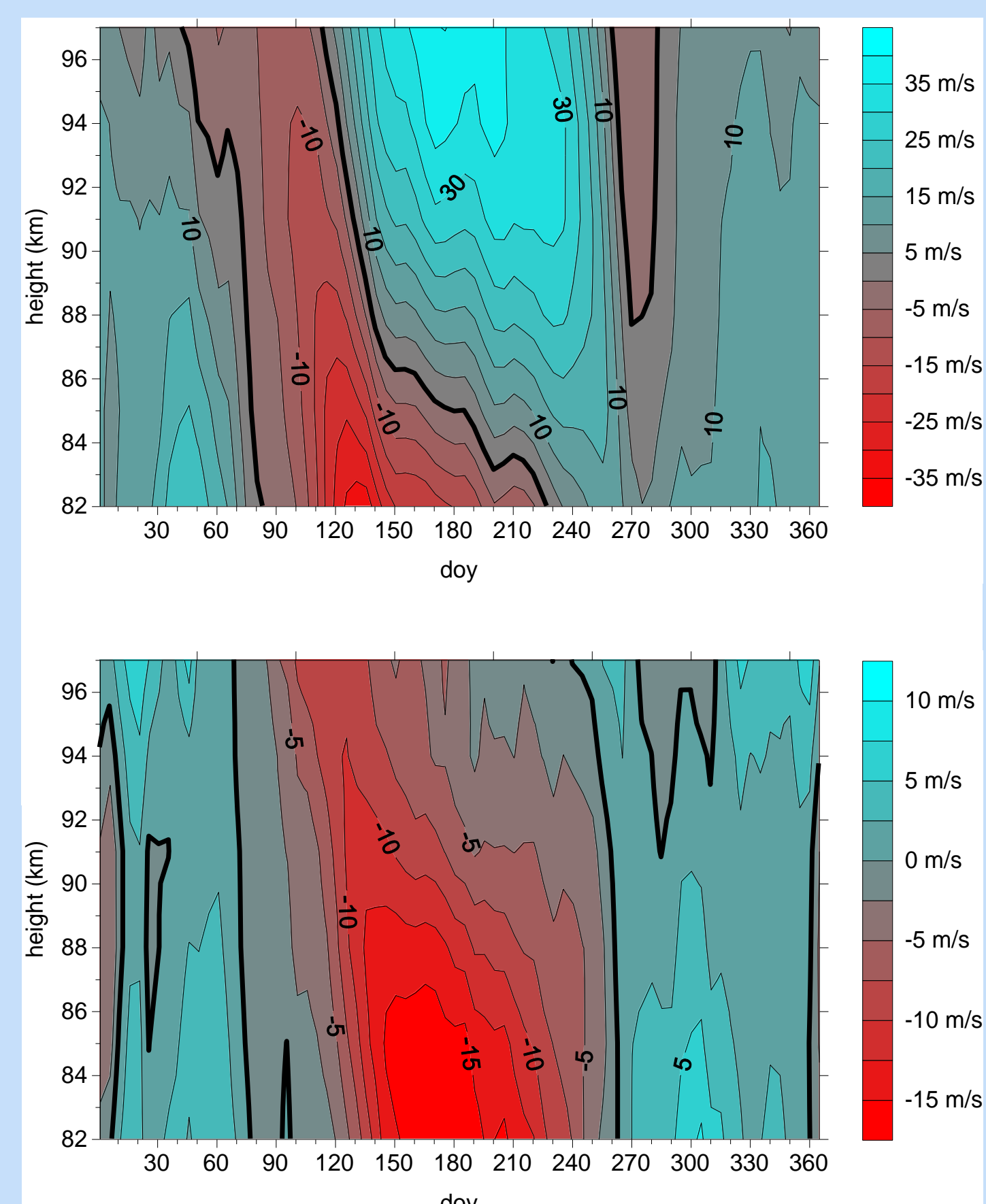


Middle Atmosphere

The middle atmosphere includes the atmospheric region above the tropopause up to the lower thermosphere (10-100 km). The middle atmosphere, mainly through wave coupling, acts as a sensor of lower atmosphere variability. Research at Leipzig mainly aims into two directions:

- VHF radar wind and temperature measurements at 80-100 km
- Numerical modeling of the middle and upper atmosphere and its variability due to natural and anthropogenic forcing



Figures on the left show zonal (upper panel) and meridional (lower panel) prevailing winds at midlatitudes according to measurements.

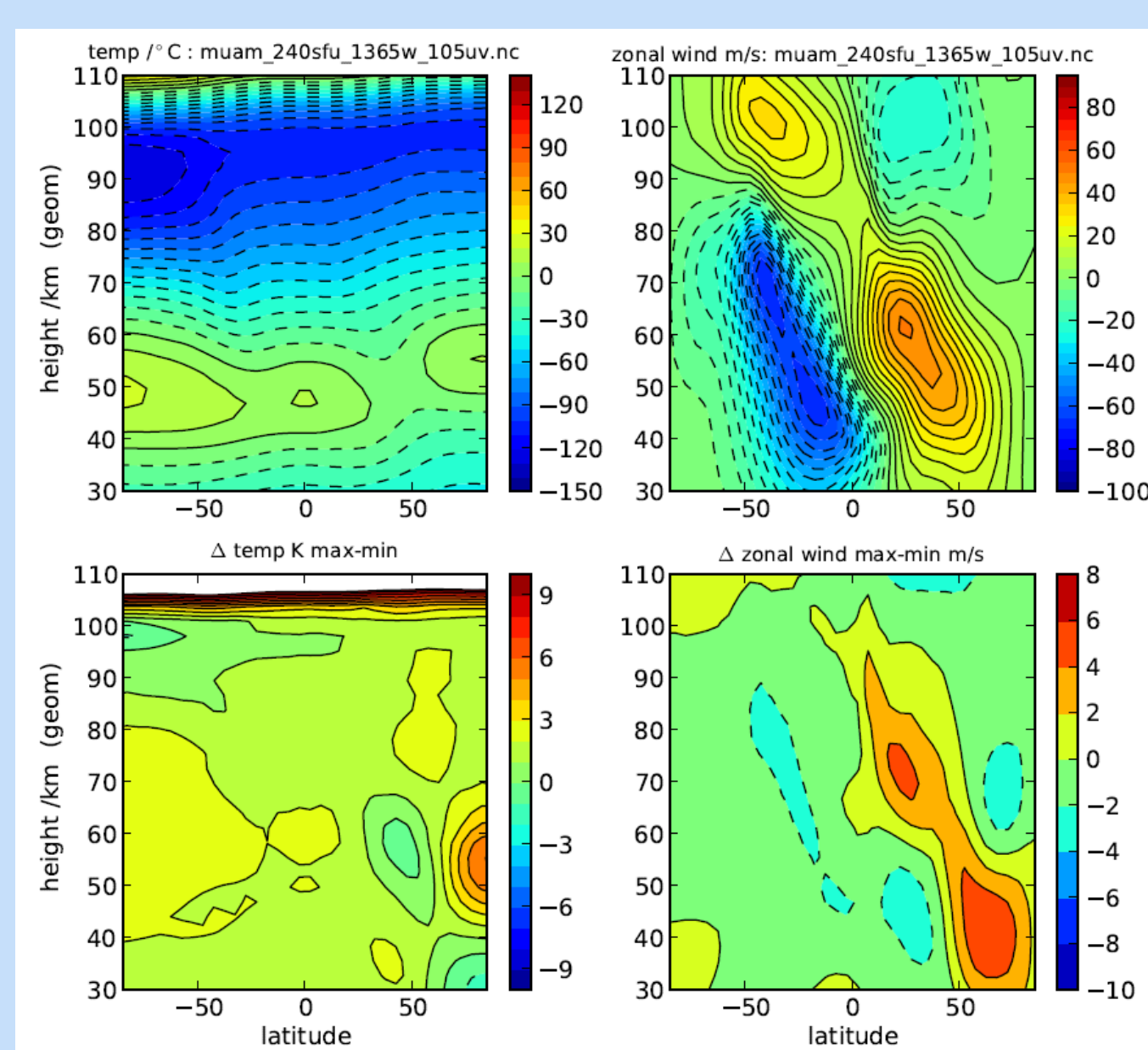
The zonal mean flow is characterized by mesospheric westerlies in winter and easterlies in summer, and a wind reversal in the lower thermosphere.

This reversal is forced by breaking gravity waves that also lead to an equatorward meridional circulation in summer.

Figures on the right show mean temperatures and zonal winds according to numerical model results.

In the lower panels differences between solar maximum and minimum conditions are shown.

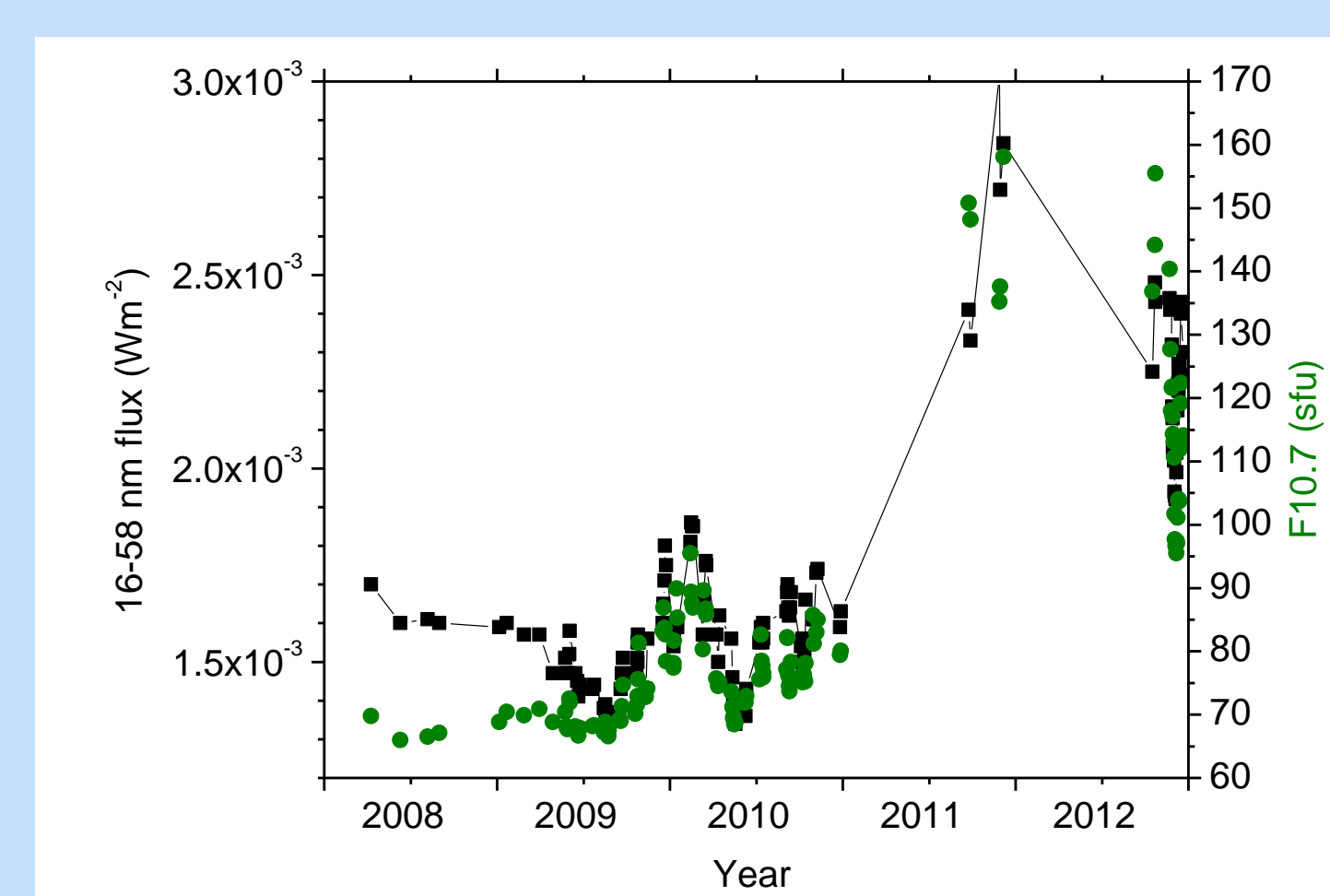
Results refer to Northern Hemisphere winter conditions.



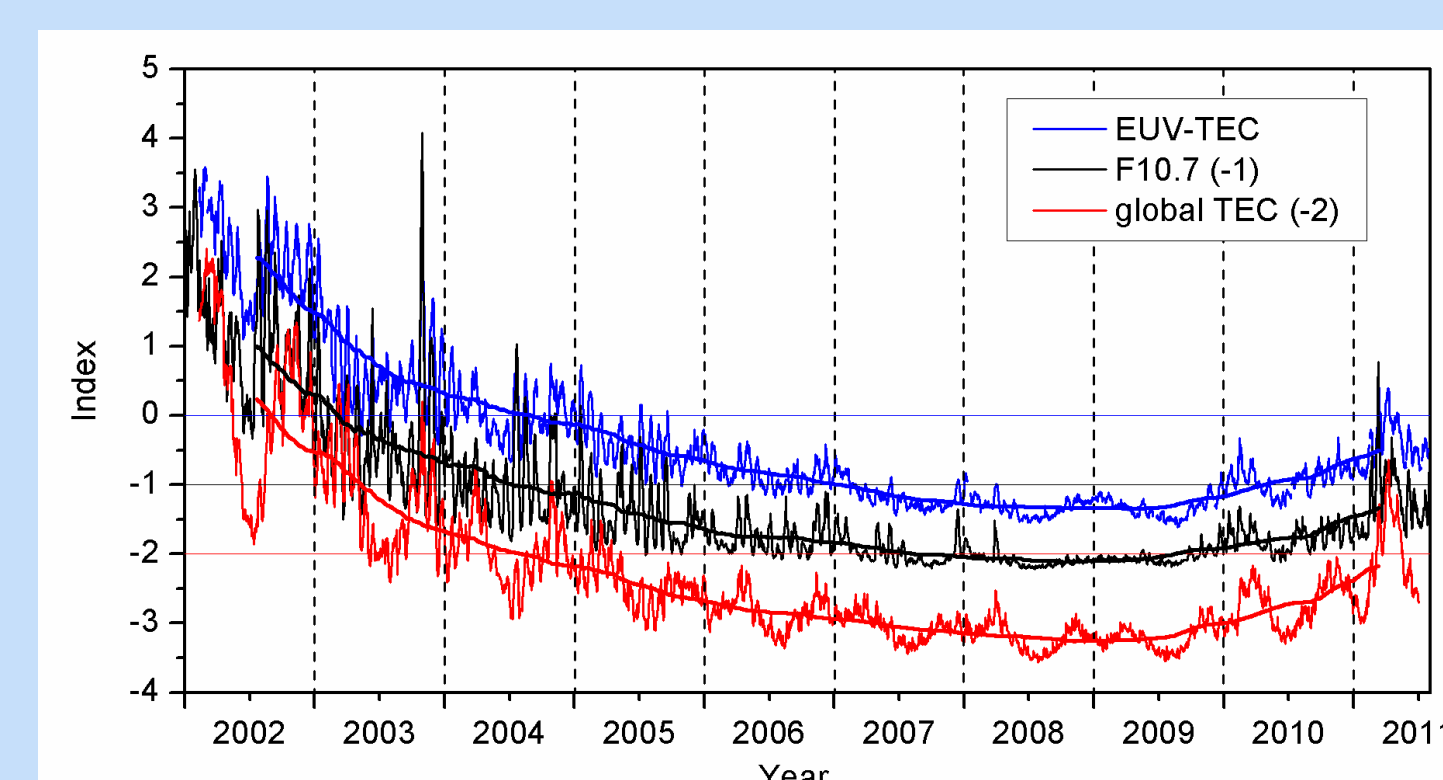
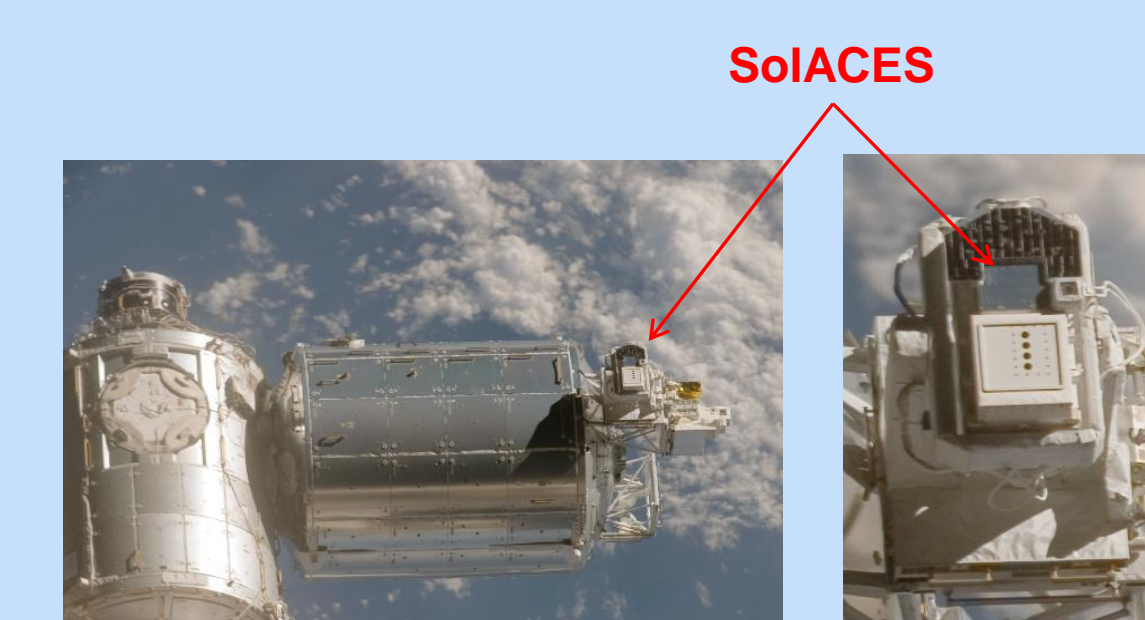
Thermosphere/Ionosphere

The thermosphere / ionosphere region is mainly forced by solar variability, but also reacts on the variability of lower regions. Research focuses on solar variability, and long-term changes of the thermosphere and ionosphere system.

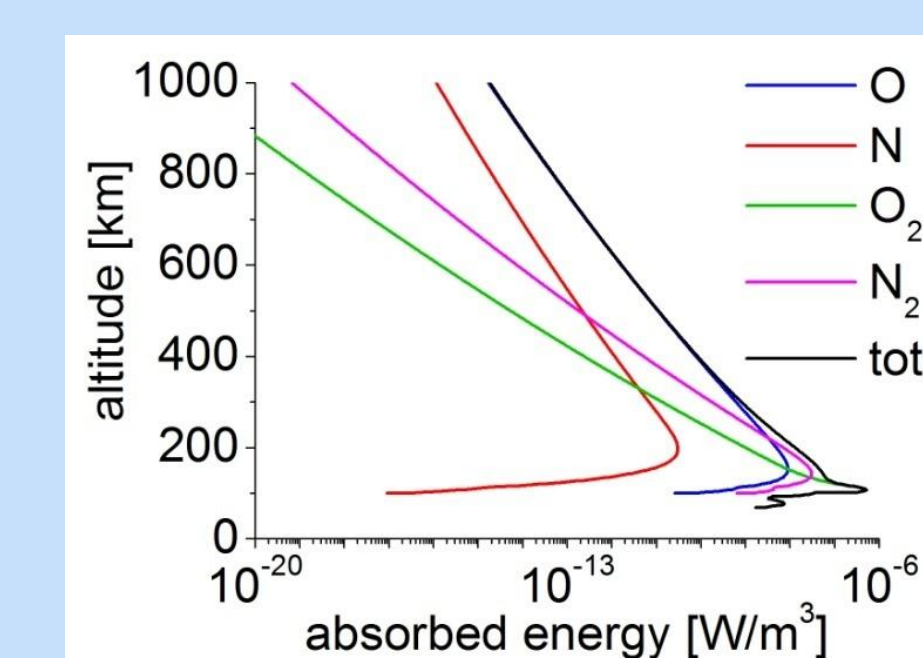
- EUV measurements on board ISS, and ionization from measured EUV spectra
- Planetary waves in ionospheric electron density
- Lower E-region variability



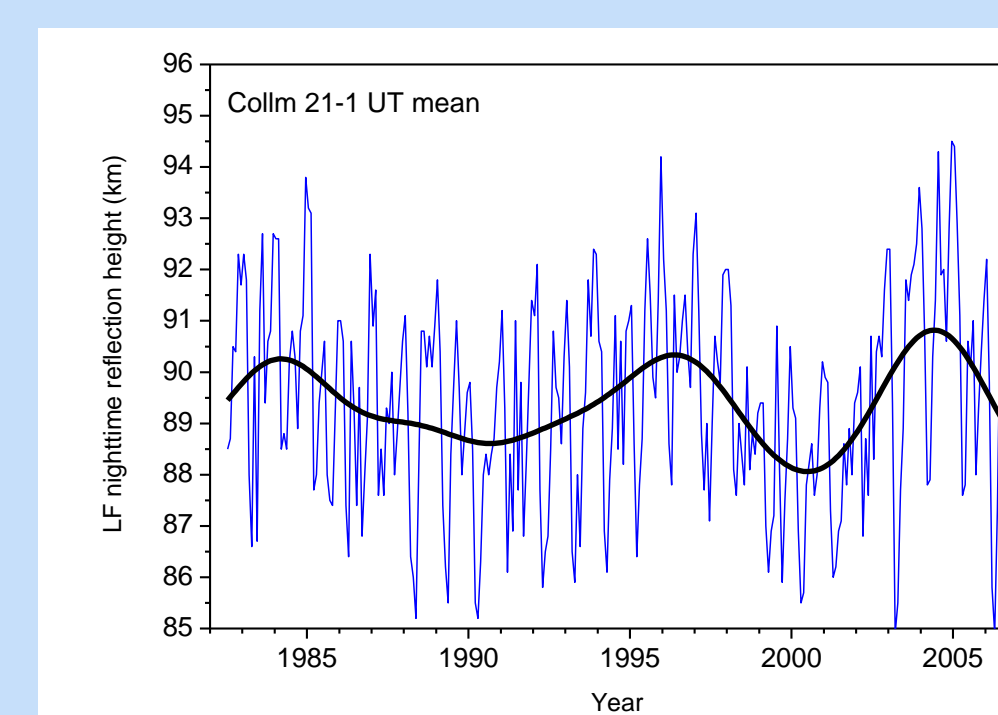
Left: The figure shows solar EUV fluxes as measured with the SolACES spectrometer on board ISS (see figures below).



Left: EUV-TEC index, defined as normalized primary ionization calculated from TIMED SEE solar EUV spectra. Also shown is global total electron content (TEC) and F10.7 solar proxy. The figure below shows energy absorbed by different species.



Left: Long-term measurements of LF reflection heights in the lower ionosphere. The time series show a decadal change due to the 11-year solar cycle.



Collm Observatory

Collm Observatory, about 50 km east of Leipzig, was founded in 1932 by Ludwig Weickmann, the former Director of the Geophysical Institute.



At Collm, since the 1950 remote sensing instruments are operated especially for the investigation of the upper and middle atmosphere, which form the basis for the middle and upper atmosphere research:

- VHF meteor radar
- LF receiver
- GPS receiver



Figures show transmitting antenna (right), and transmitter and receiver units (above) of the meteor radar.

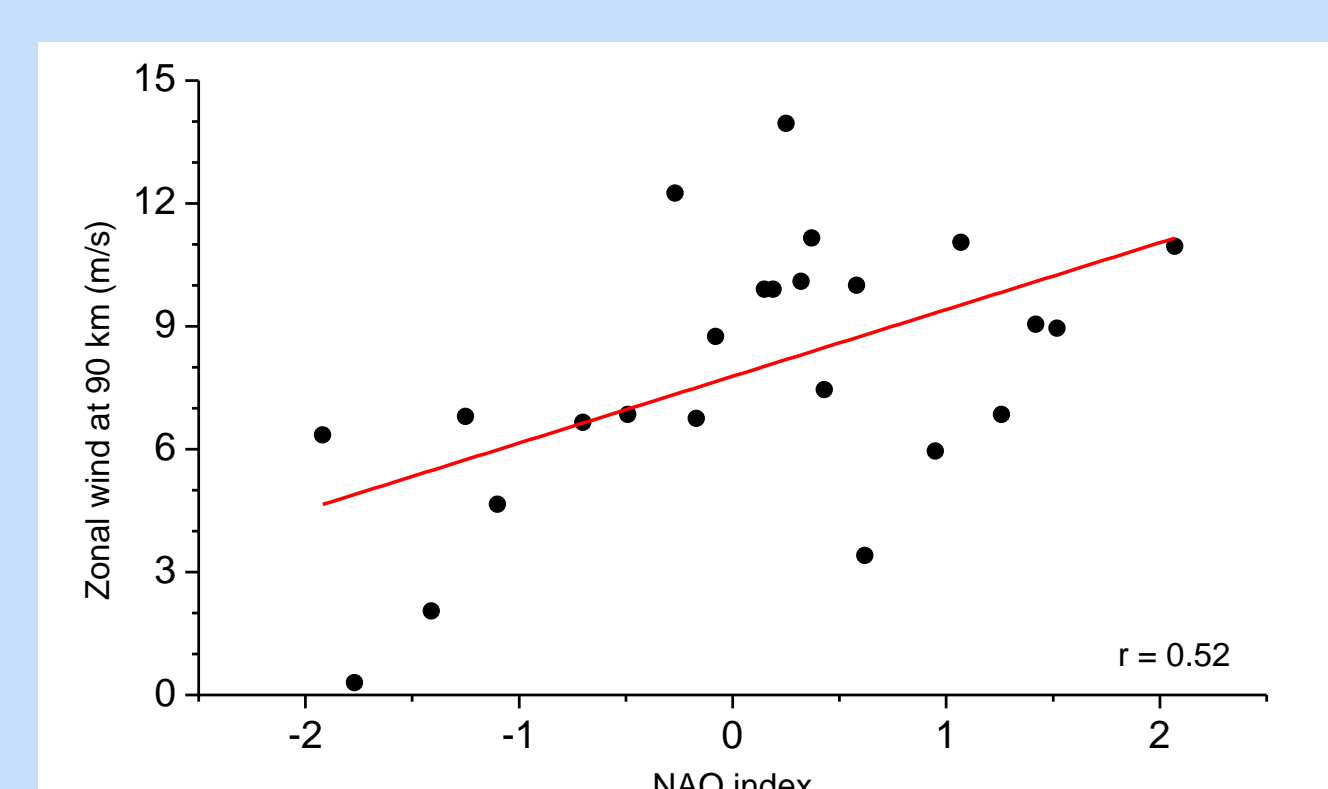


At Collm, also seismic measurements are run by the Institute of Geophysics and Geology of the University of Leipzig.

Information and contact: <http://www.uni-leipzig.de/~jacobi/collm>
jacobi@uni-leipzig.de

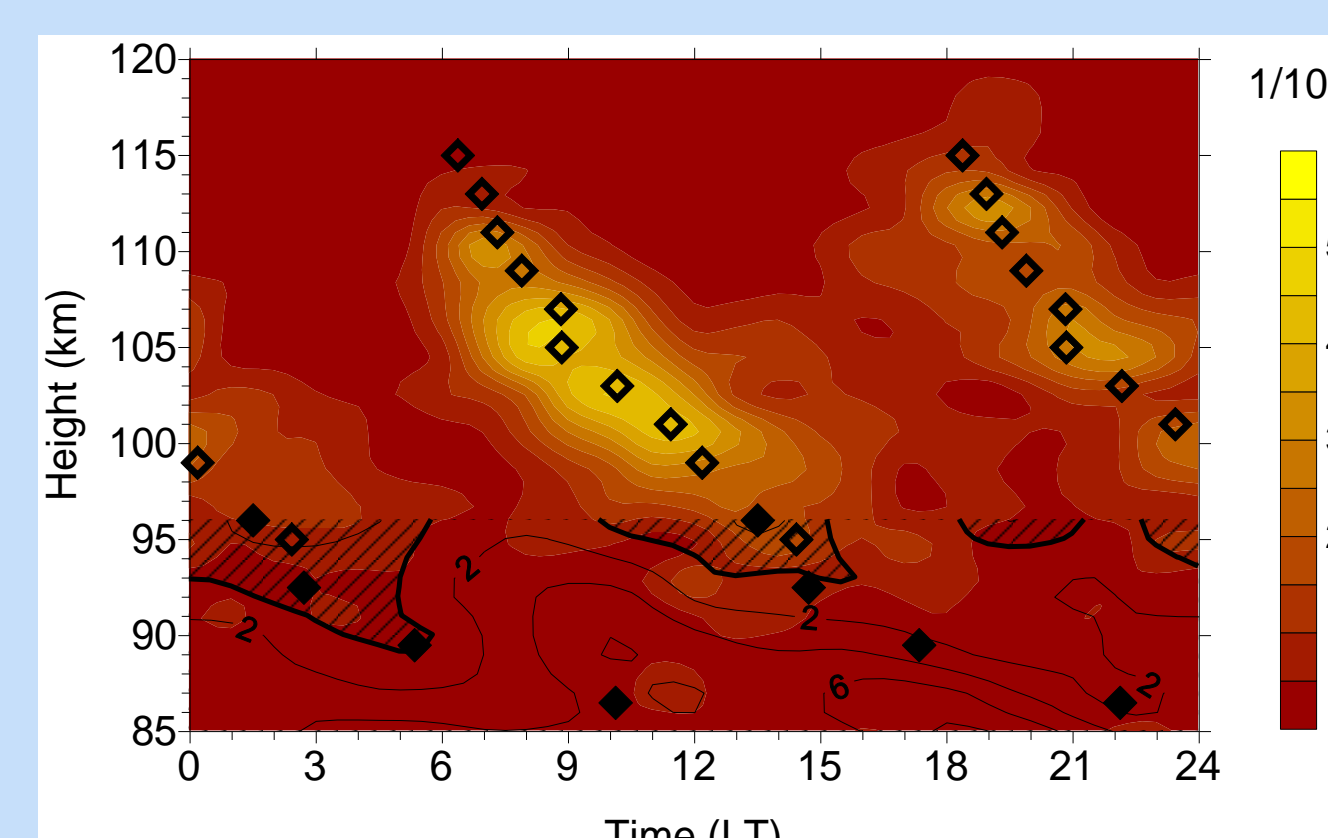
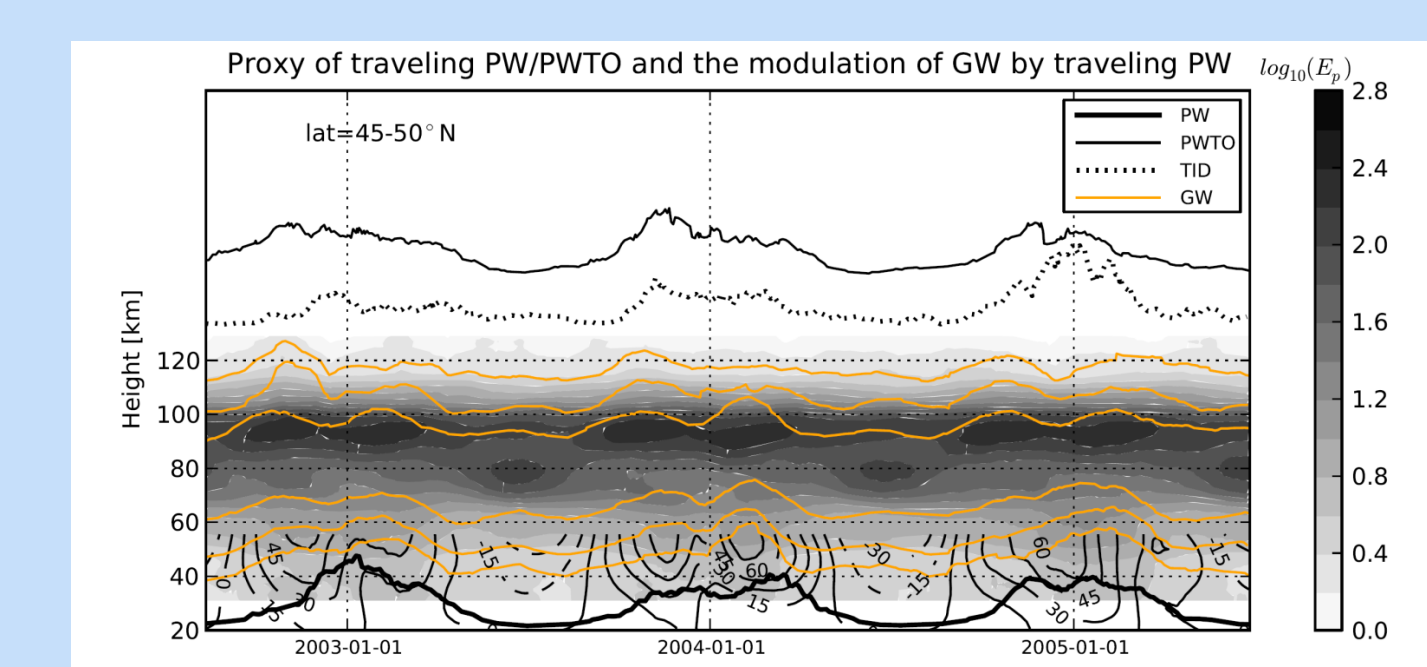
Vertical Coupling

Middle and upper atmosphere dynamics is, besides solar forcing, also determined by forcing from below. We look for forcing mechanisms that couple the lower and the upper atmosphere, as well as the neutral and ionized part.



Left: The figure shows mesopause region zonal winds vs. NAO indices. The correlation shows that there is a coupling throughout the winter atmosphere via the strength of the polar vortex.

Right: Modulation of gravity waves by planetary wave (yellow lines) shows the same seasonal cycle as planetary wave-type oscillations (upper line) in the ionosphere do. This shows that the signature of planetary waves in the ionosphere is probably due to modulation of gravity waves.



Left: Sporadic E layers in the lower ionosphere (colors) show a semidiurnal signature, which is owing to wind shear variability (contours) in the neutral atmosphere. The figure shows GPS measurements together with Collm radar wind data. The symbols denote the phases of the semidiurnal signature.

Right: The equatorial lower ionosphere shows a wave 4 signature (colors), owing to neutral atmosphere dynamics (contours). The figure shows GPS sporadic E occurrence rates together with satellite temperature anomalies.

