Mesosphere/lower thermosphere prevailing winds at northern midlatitudes – long-term tendencies derived from radar observations and modeling

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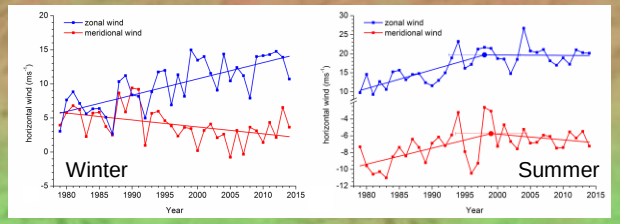

MLT wind measurements at Collm (51.3N, 13E) by LF (to 2006) and MR (since 2004) have been combined to obtain a continuous wind time series from 1979 to date.

Trend analysis shows increase of winds (towards more eastward ones) both in summer and winter.

Linear piecewise fits with a priori unknown breakpoints indicate possible changes of trends in the 1990s during some seasons. This indicates a possible effect of ozone changes.

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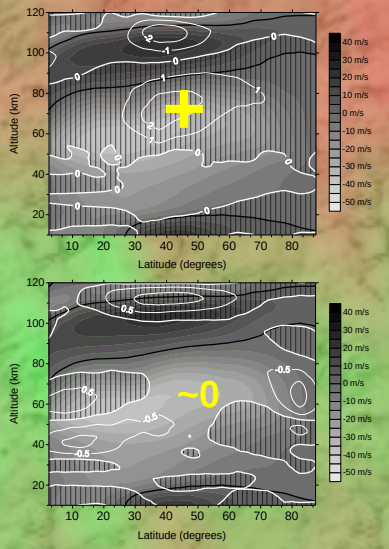

Summer

1995-1980

2005-1995

Model experiments confirm the changes of tendencies before the mid 1990 and after the 1990s.

Figures show background zonal winds (grey) and their changes (white isolines).

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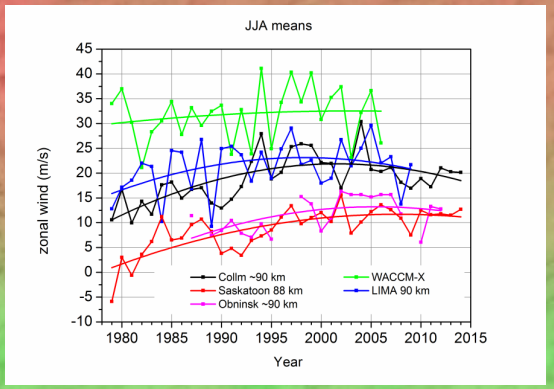


Comparison with MLT winds at Saskatoon/Canada and Obninsk/Russia shows a similar tendency , i.e. positive zonal wind trends, but decreasing with time.

This tendency is robust and also seen in different models (WACCM-X and LIMA).

Absolute wind values differ, owing to SPW, and possible speed biases.

more

close

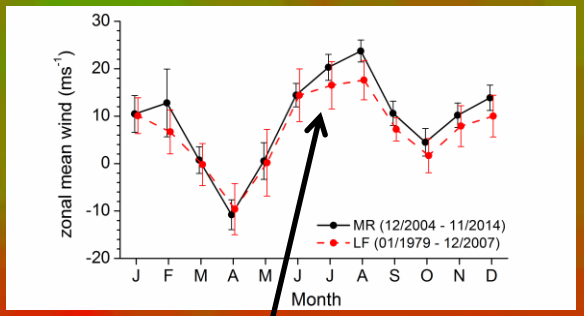
Collm MLT wind time series

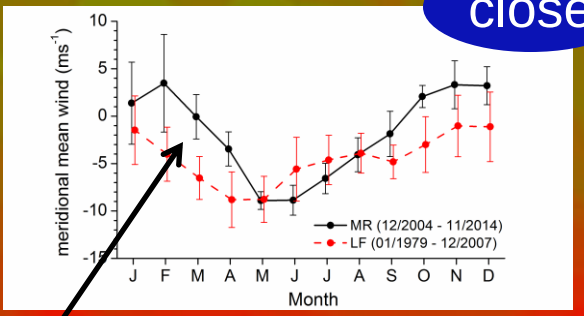
LF windprofiler

Data set:	1979 - 2006
Transmitter:	Zehlendorf, 177 kHz
Reflection point:	52.1°N, 13.2°E
Method:	Similar fades

SKiYMET all-sky meteor radar

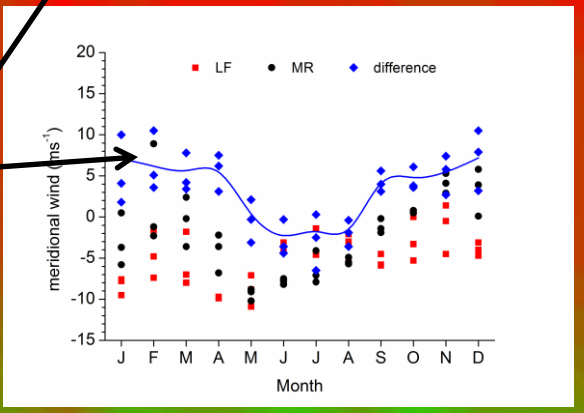
Antenna	3-element Yagi
Position	Interferometer
Frequency	36.2 MHz
Peak power	6 kW
Data set	2004 – date

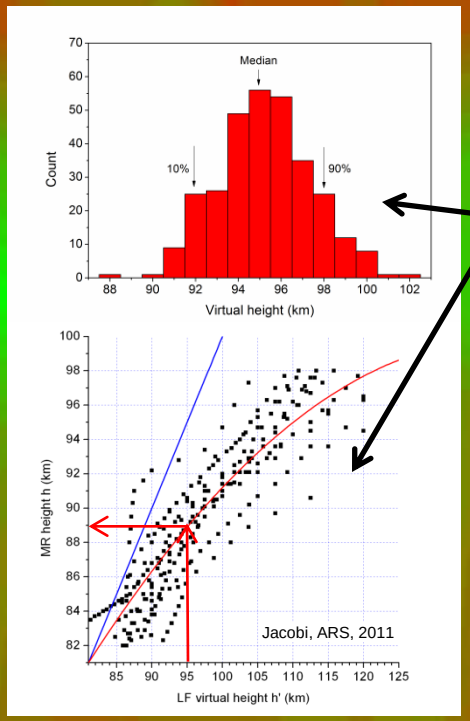




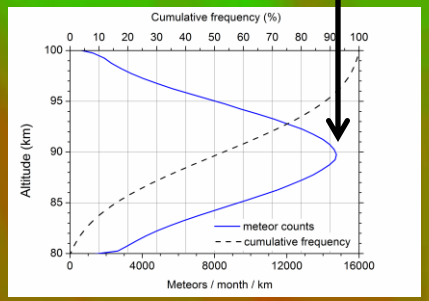
Zonal winds at 90 km agree well.

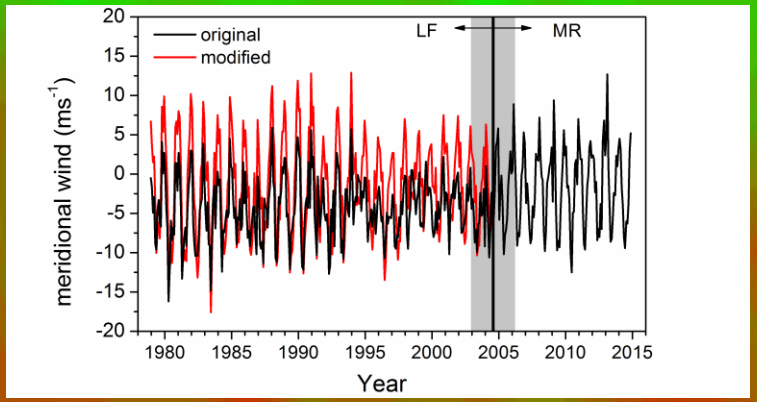
LF meridional wind correction based on 3 years of overlapping measurements.





Nighttime LF virtual height is 95 km on an average. This corresponds to a real height of ~89 km, which is close to the meteor peak flux height.





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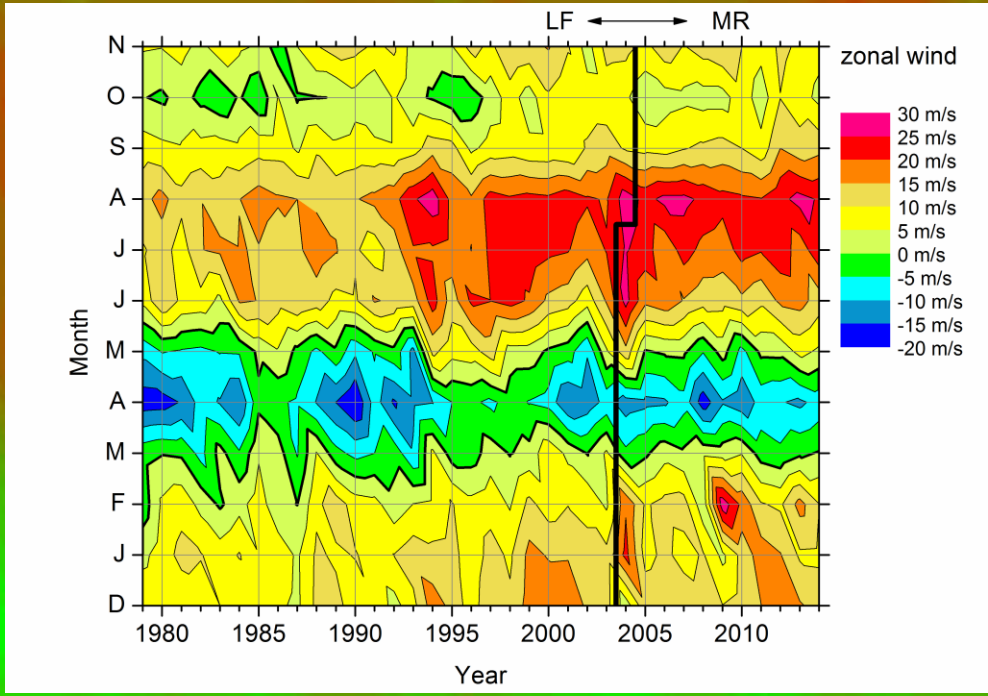
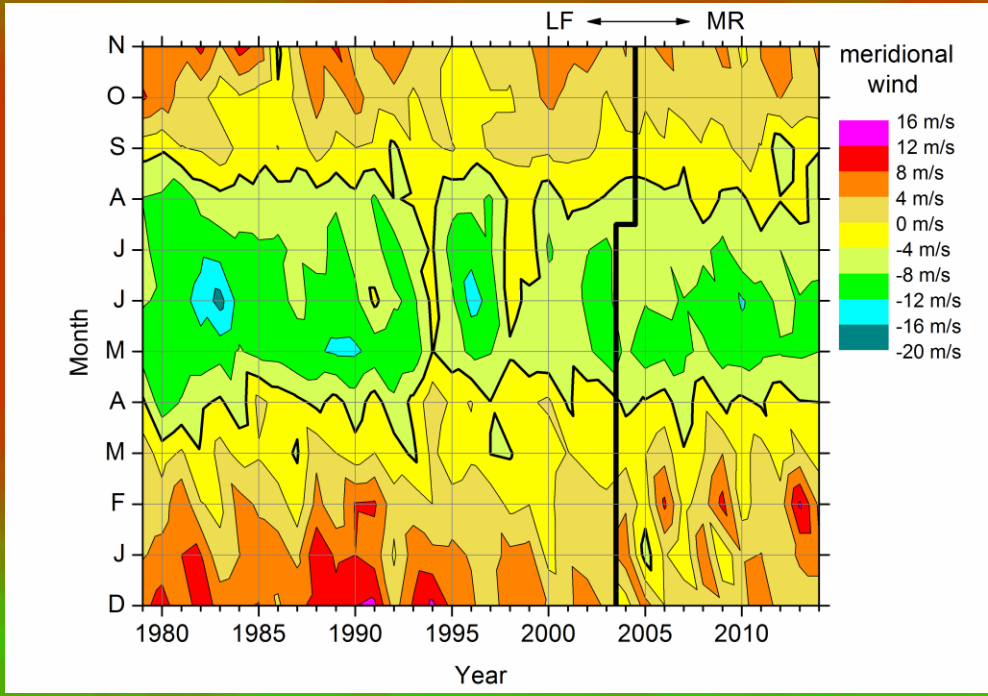
Collm MLT wind time series

close

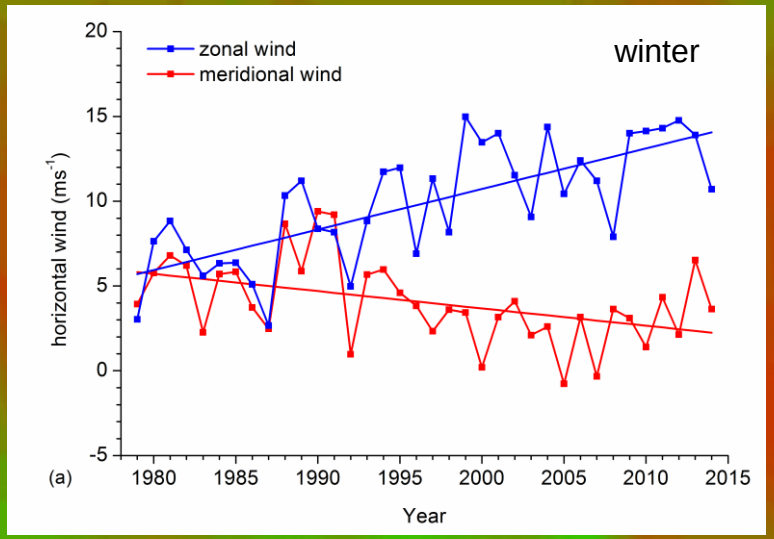


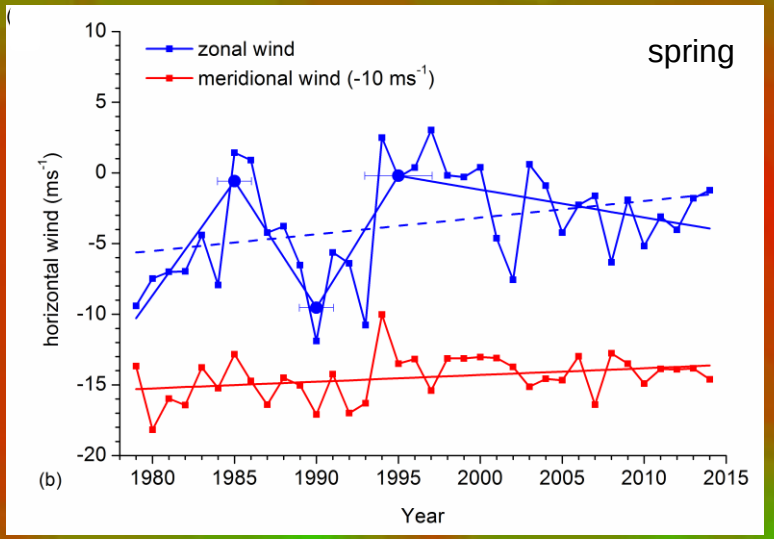


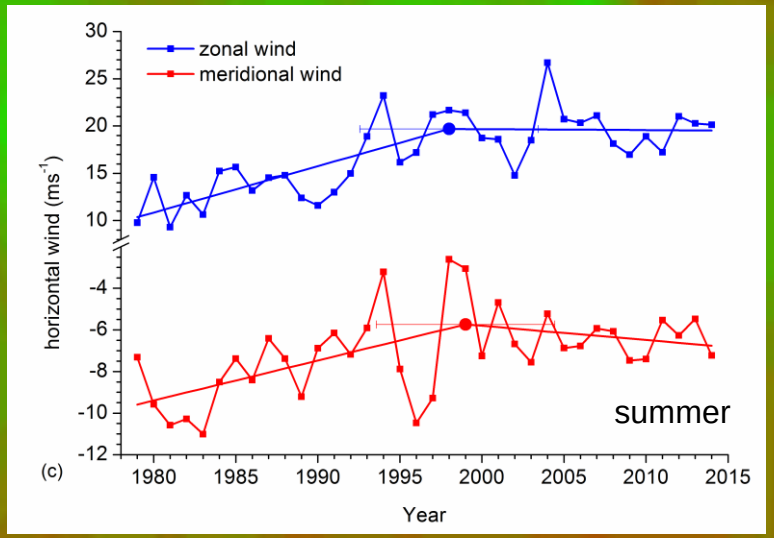
close

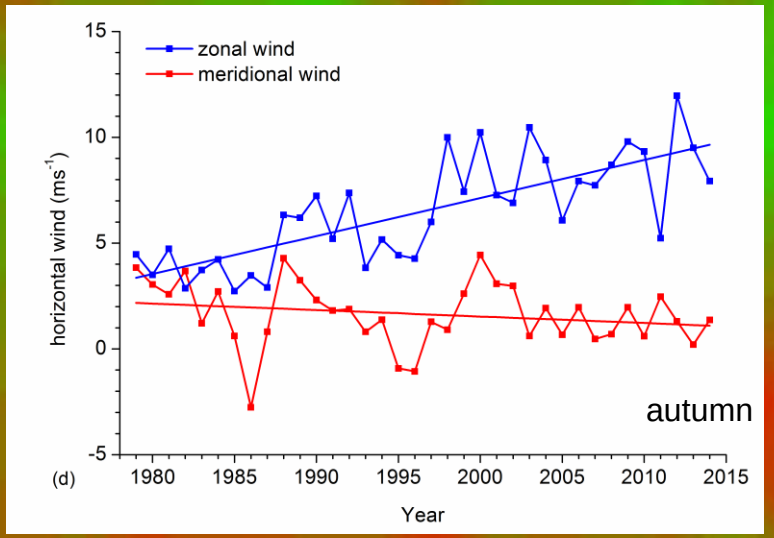
Collm MLT wind time series

Piecewise linear fits with a priori unknown number of breakpoints







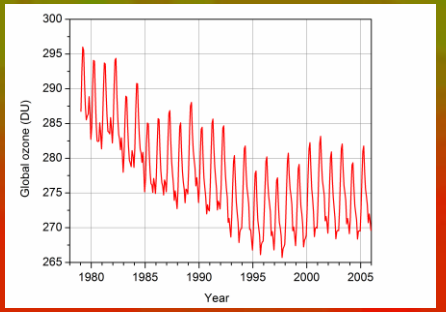


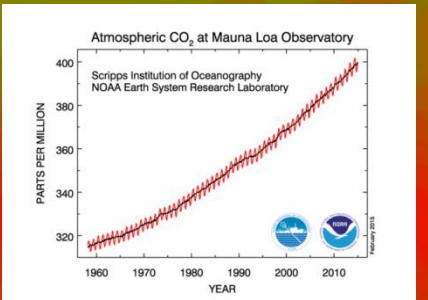
close

MUAM middle atmosphere model

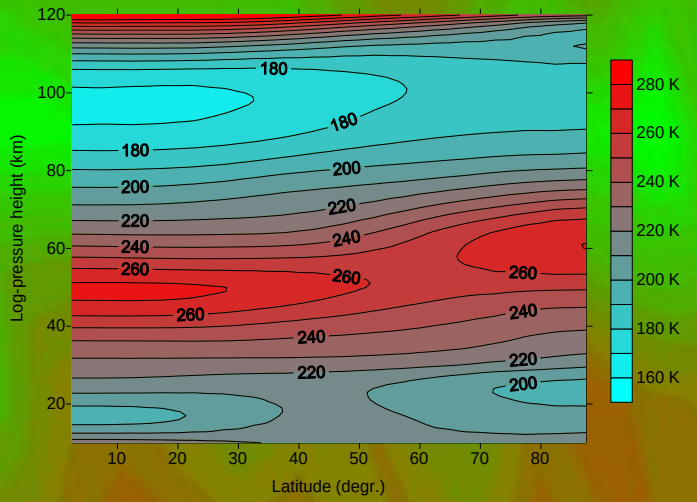
3D primitive equation model
56 layers × 0.4·ln p/p_s
Model top ~160 km in log-pressure coordinates
5° × 5.625° horizontal grid
ERA-Interim fields assimilated below 30 km
Linear GW parameterization scheme
Solar and IR radiation schemes

Prescribed ozone field, water vapor, CO_2

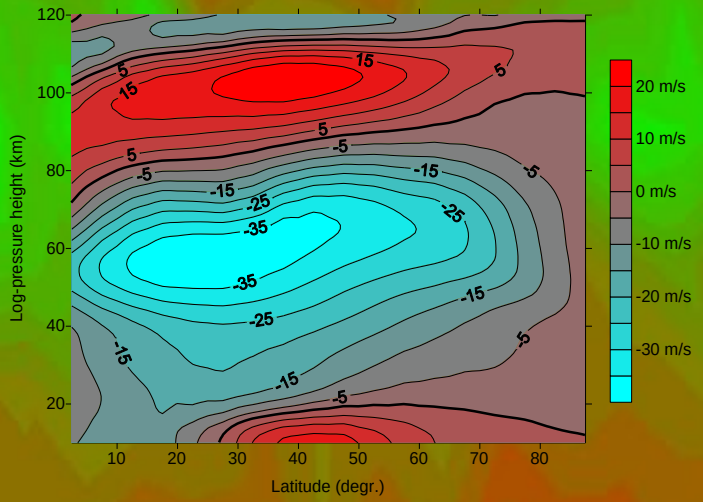




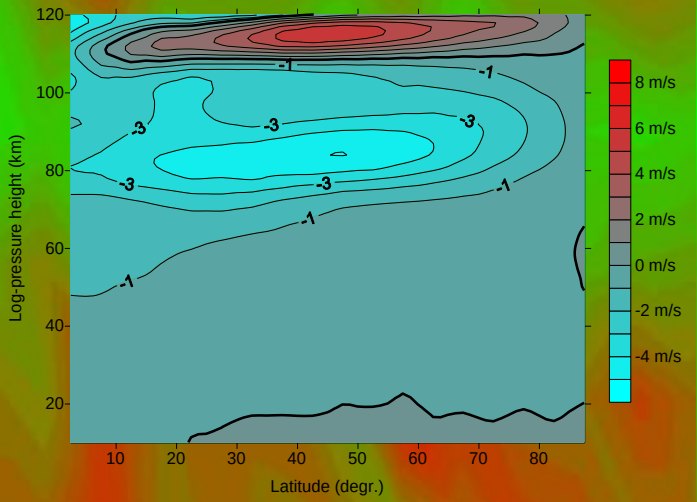
temperature



zonal wind



meridional wind

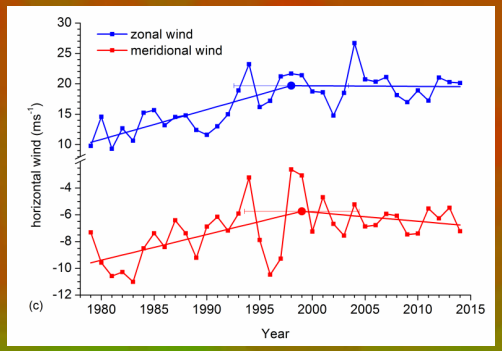


close

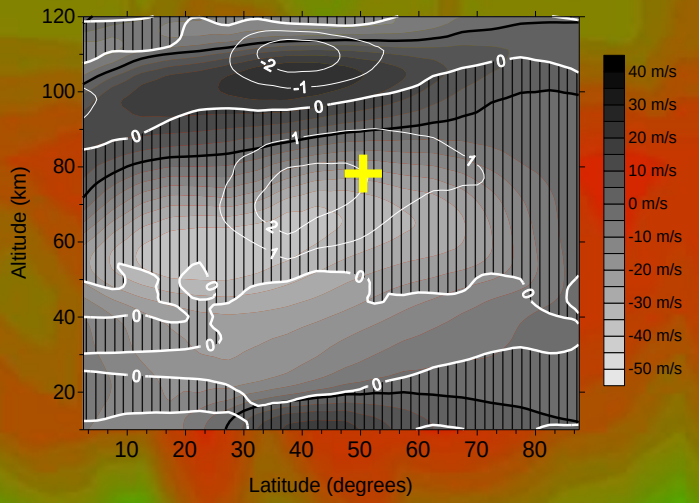
lower boundary kept constant

MUAM middle atmosphere model

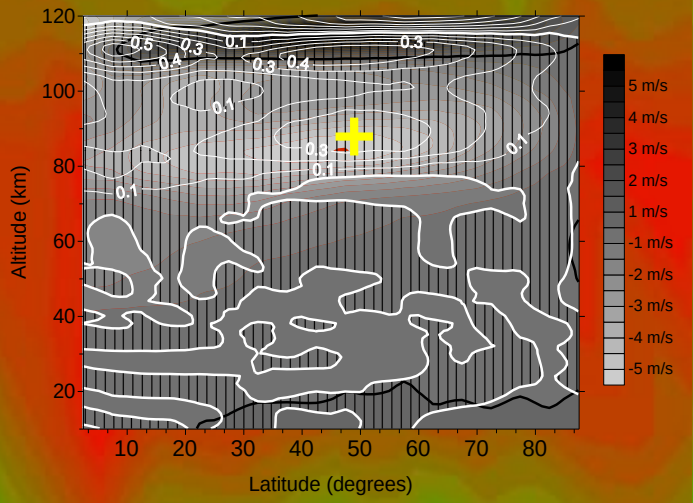
1995 - 1980



zonal wind

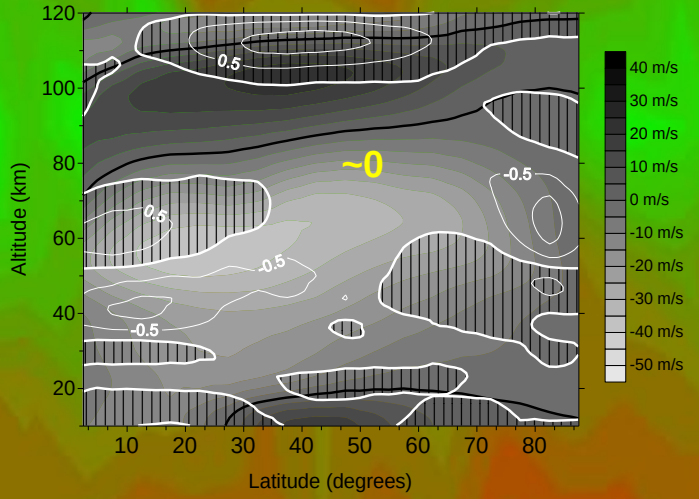


meridional wind

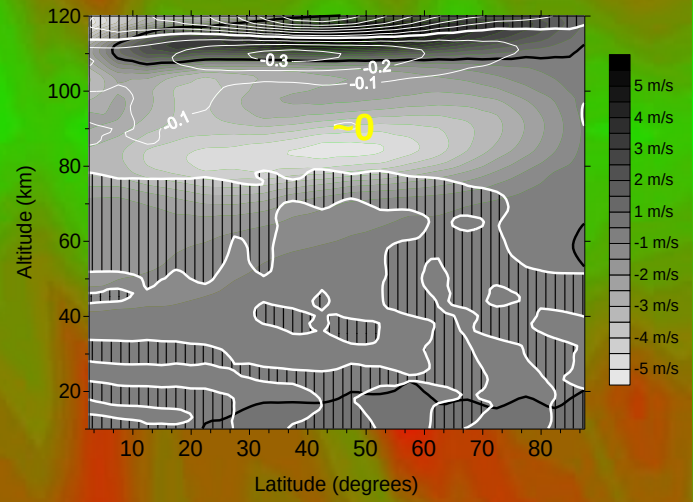


2005 - 1995

zonal wind



meridional wind



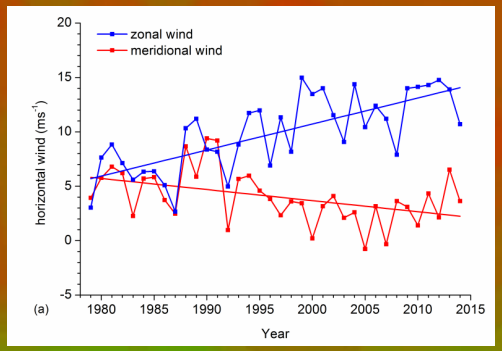
Summer trends and their changes qualitatively reproduced by O_3 and CO_2 trends

close

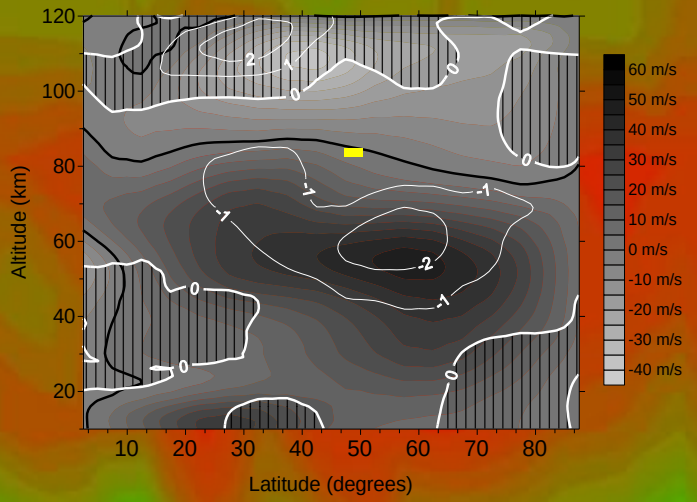
lower boundary kept constant

MUAM middle atmosphere model

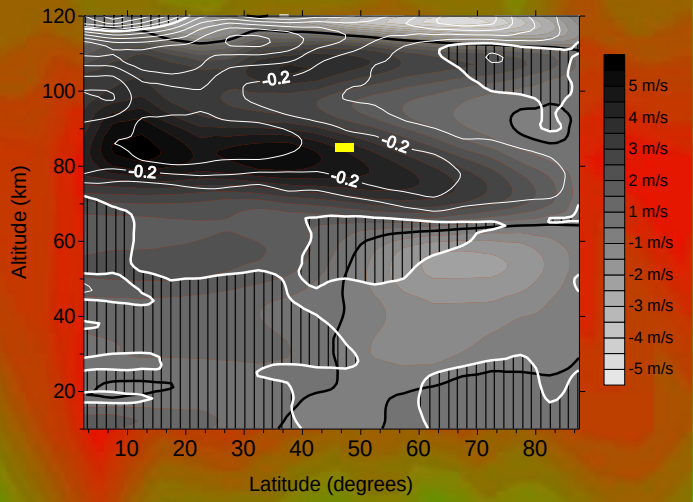
1995 - 1980



zonal wind

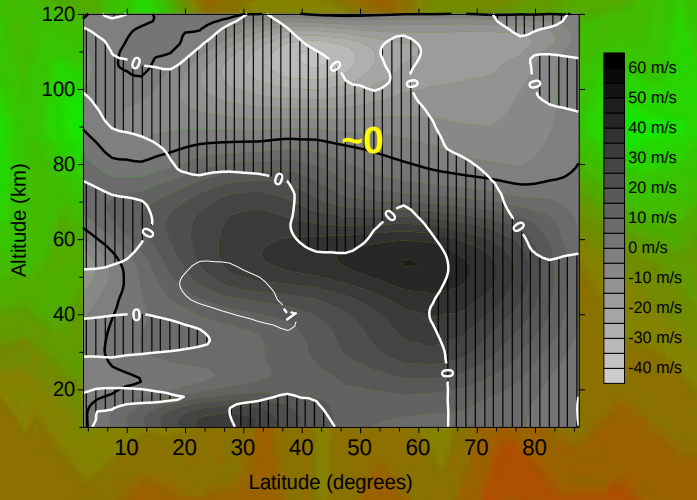


meridional wind

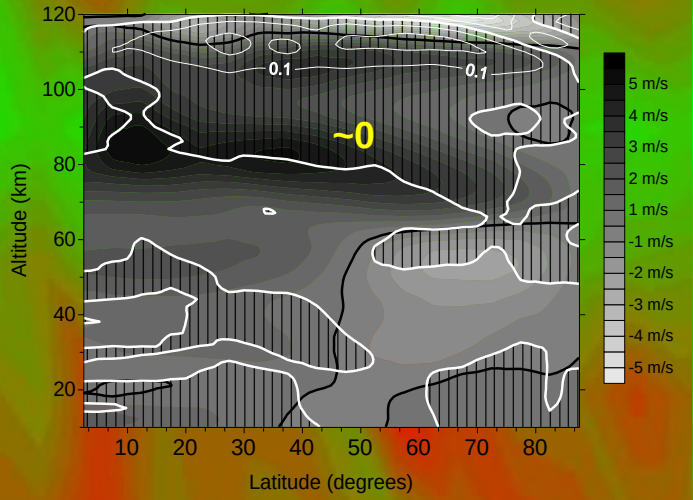


2005 - 1995

zonal wind



meridional wind



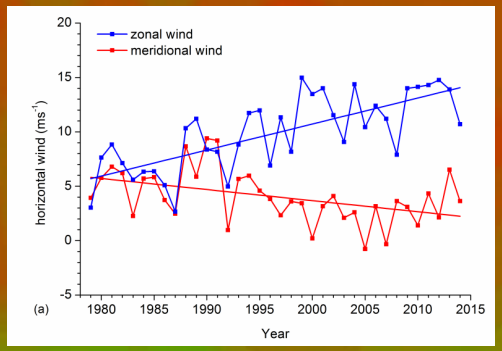
Winter zonal wind
trends and their changes not reproduced by O_3 and CO_2 trends

close

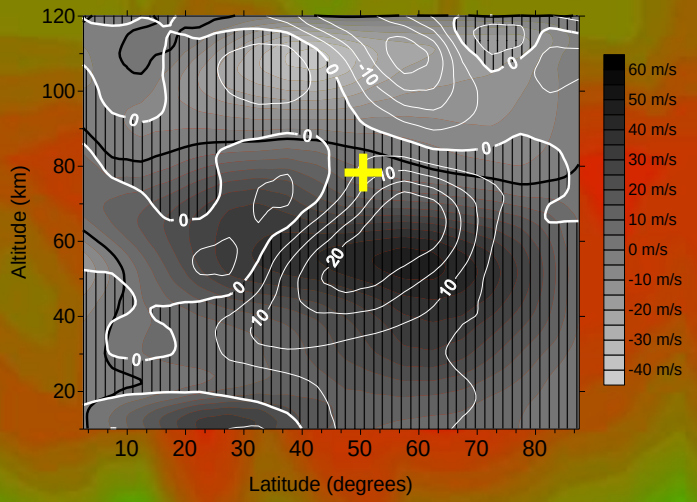
lower boundary taken from ERA

MUAM middle atmosphere model

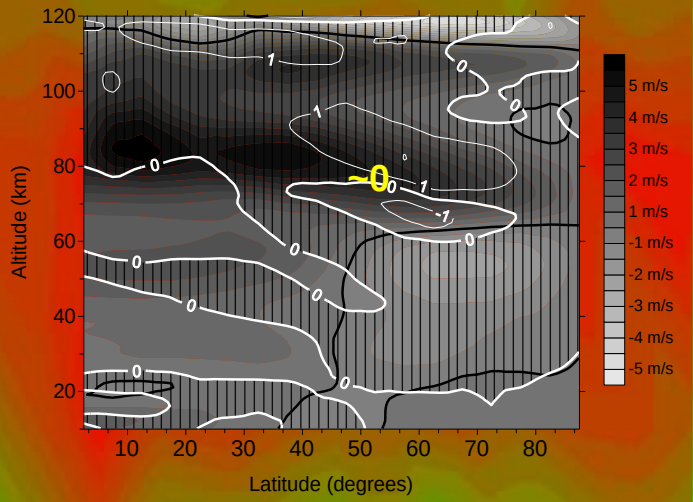
1995 - 1980



zonal wind

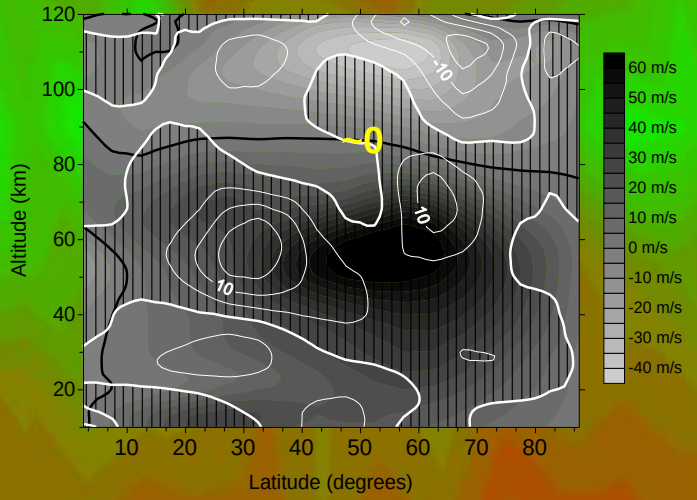


meridional wind

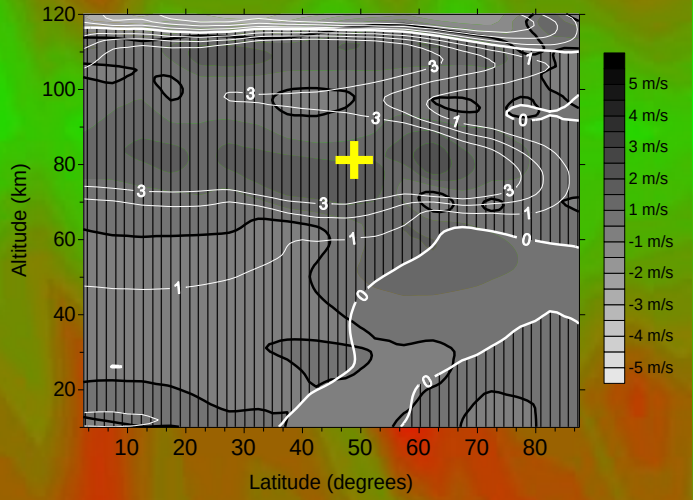


2005 - 1995

zonal wind



meridional wind



Winter zonal wind
trends and their changes qualitatively reproduced by lower boundary changes

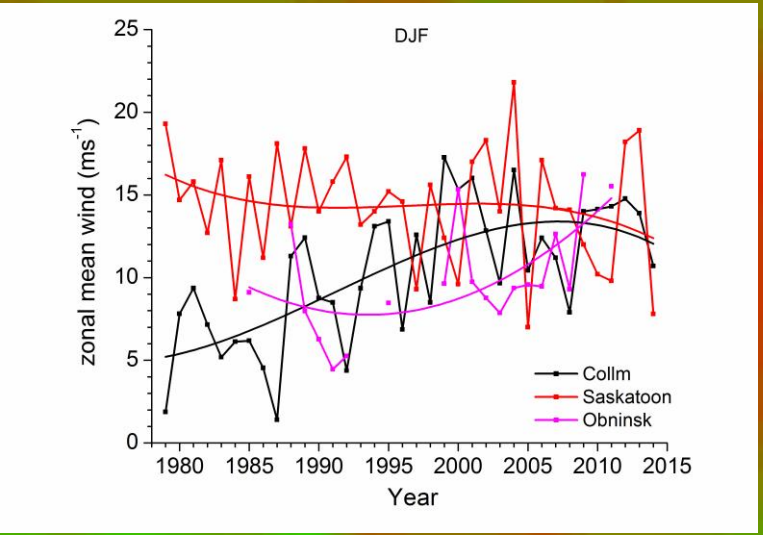
close

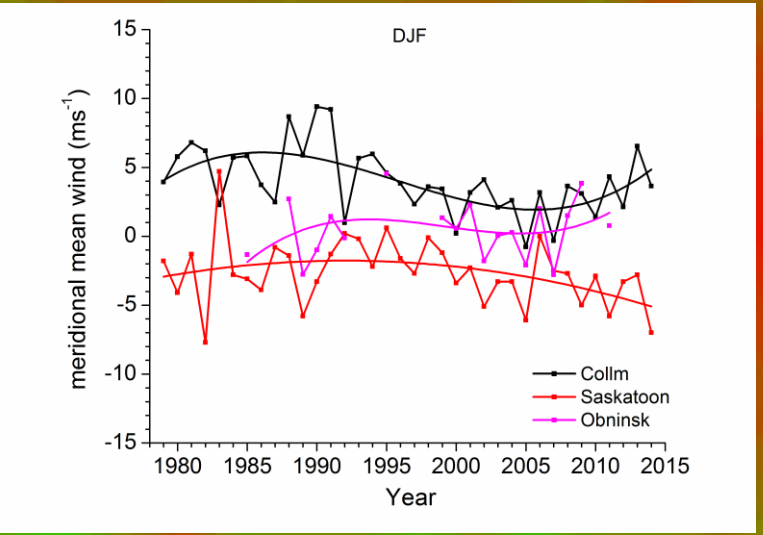
MLT wind time series

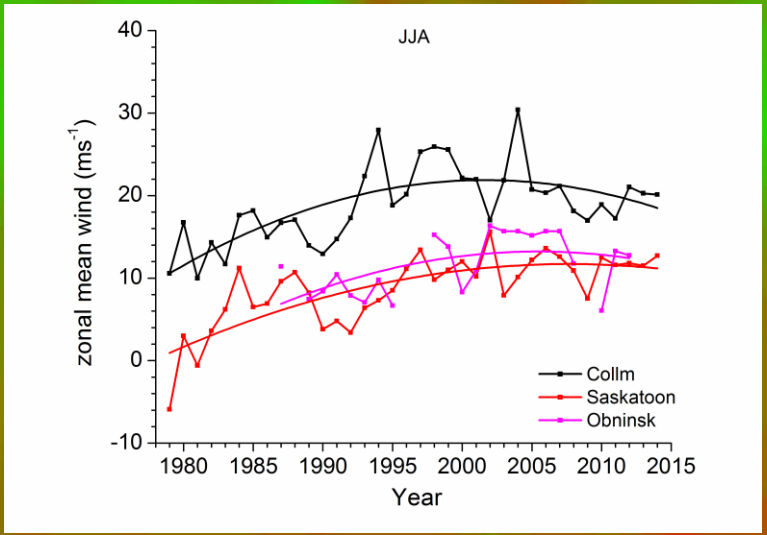
Saskatoon (107W), Collm (13E), Obninsk (37E)

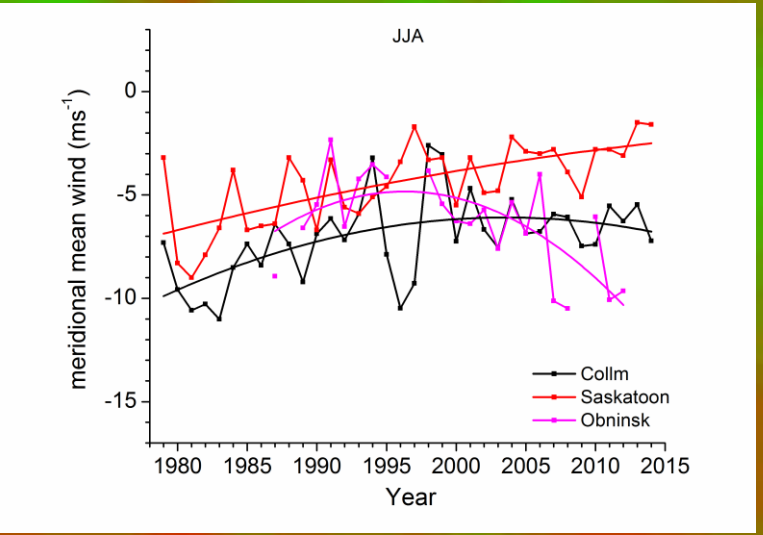
Winter zonal winds behave different at different sites.

Summer winds show mostly similar tendencies.









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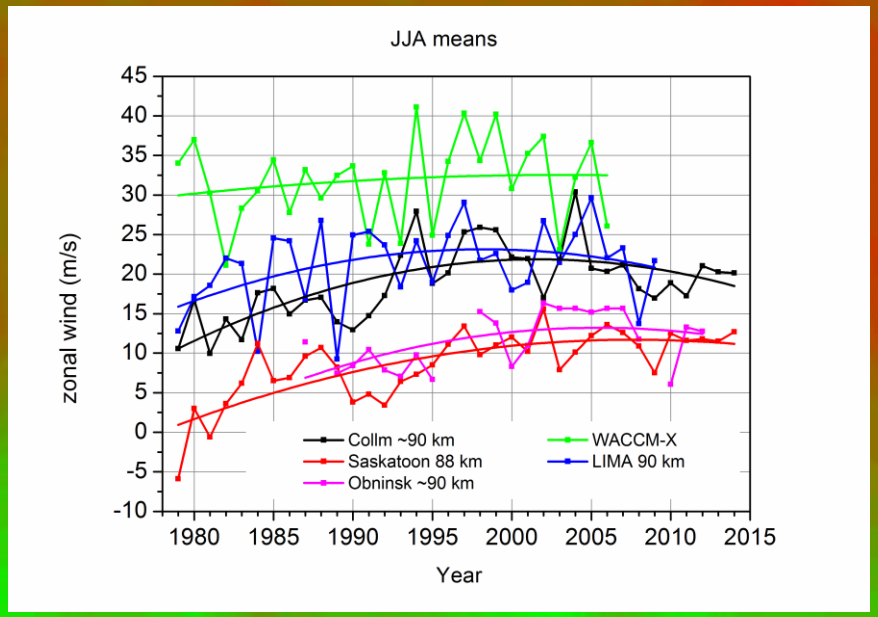
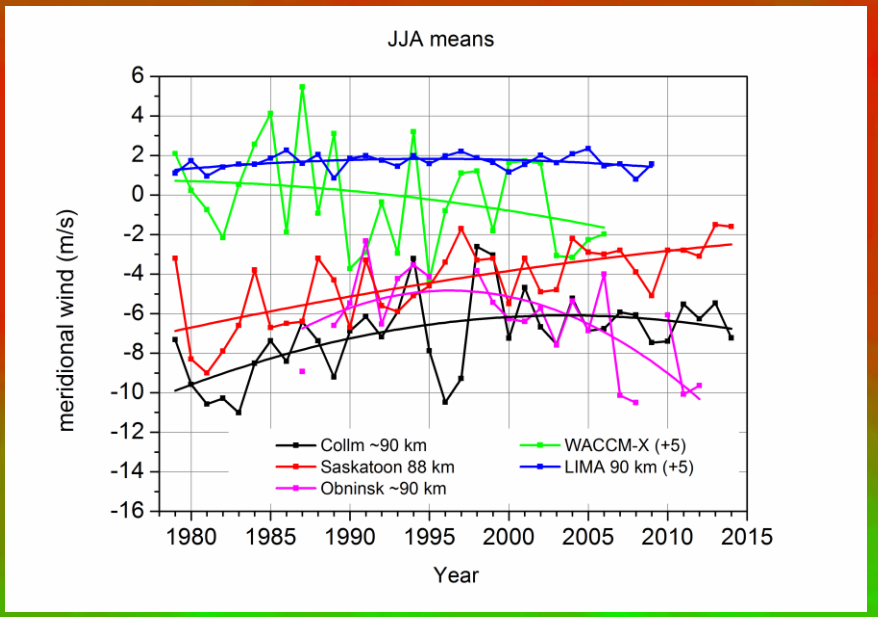
close

MLT wind time series

Saskatoon (107W), Collm (13E), Obninsk (37E)





Tendencies of the zonal wind reproduced in models. Summer meridional winds show different tendencies both over different sites and in models.