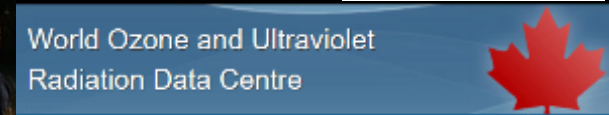
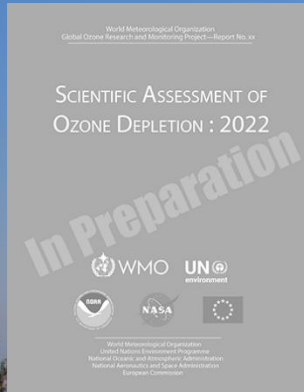


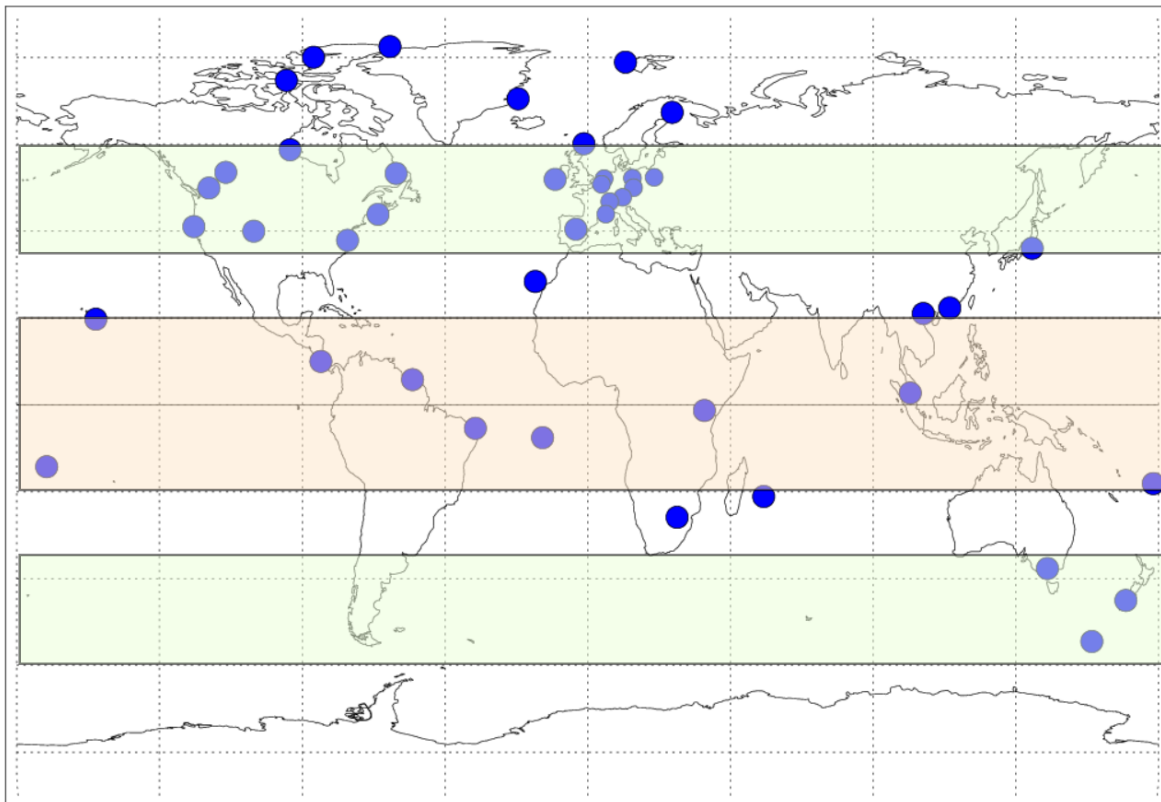
Ozone trends in the lower stratosphere from ozone sondes



W. Steinbrecht, J. Davies, D.W. Tarasick, P. von der Gathen, H. Deckelmann, N. Jepsen, R. Kivi, N. Lyall, B. Kois, P. Oelsner, M. Allaart, A. Piters, M. Gill, R. Van Malderen, A.W. Delcloo, G. Romanens, R. Stübi, G. Ancellet, S. Godin-Beekmann, Johnson, P. Cullis, I. Petropavlovskikh, J.-L. Hernandez, A. Diaz Rodriguez, T. Nakano, M. Tully, R. Querel, R.M. Stauffer, A.M. Thompson, K.-L. Chang, and more !!



sonde stations and latitude bands



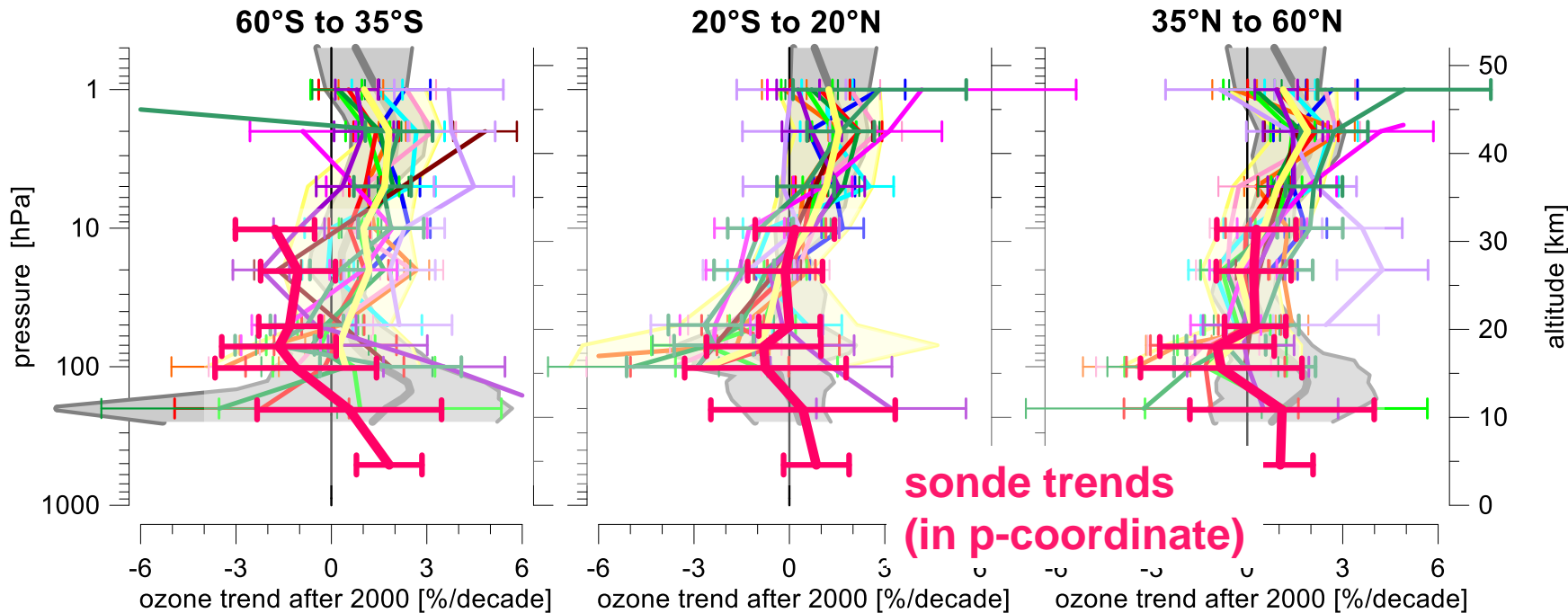
60°N to 35°N

20°N to 20°S

60°S to 35°S

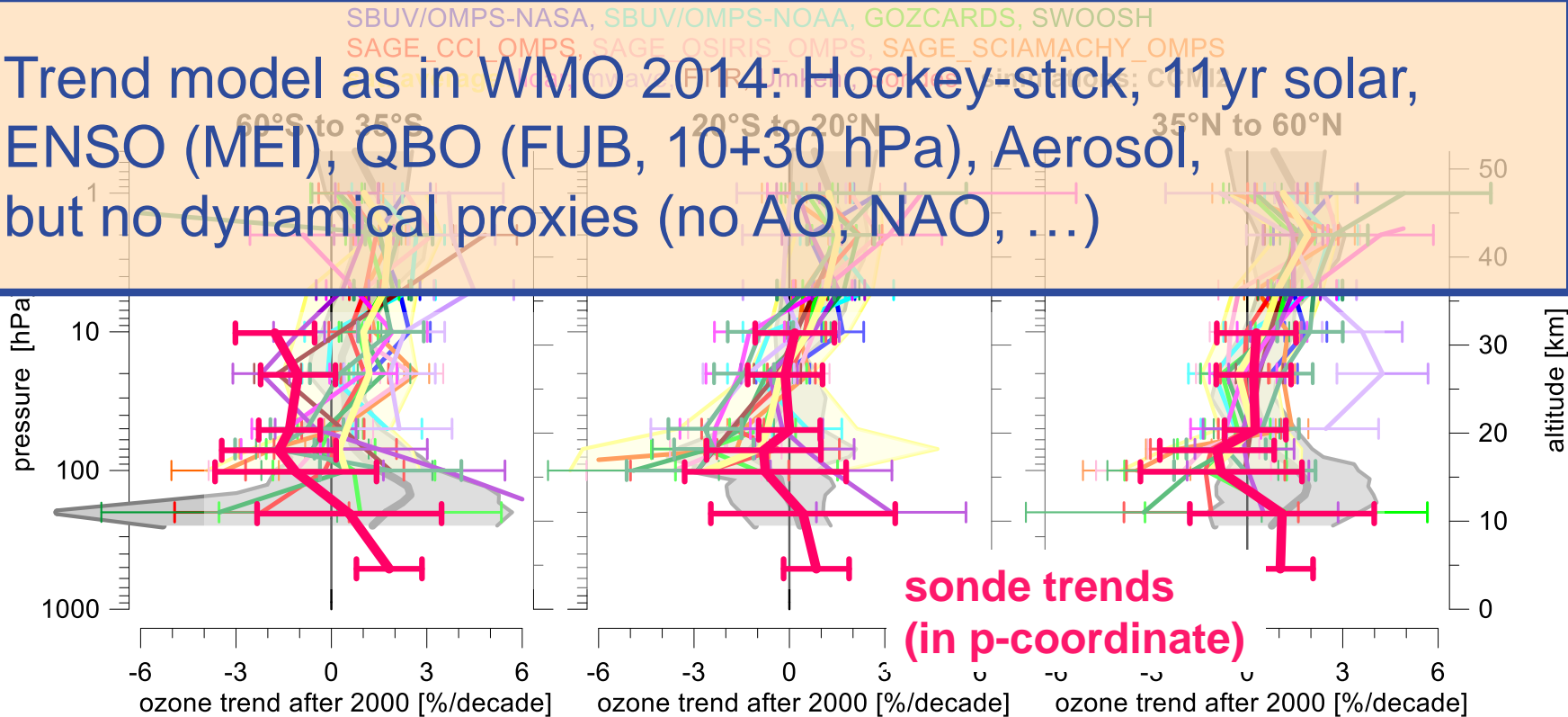
ozone trend profiles, 2000 to 2020/21

SBUV/OMPS-NASA, SBUV/OMPS-NOAA, GOZCARDS, SWOOSH
SAGE_CCI_OMPS, SAGE_OSIRIS_OMPS, SAGE_SCIAMACHY_OMPS
sat. average lidar, mwave, FTIR, Umkehr, Sondes simulations: CCM12

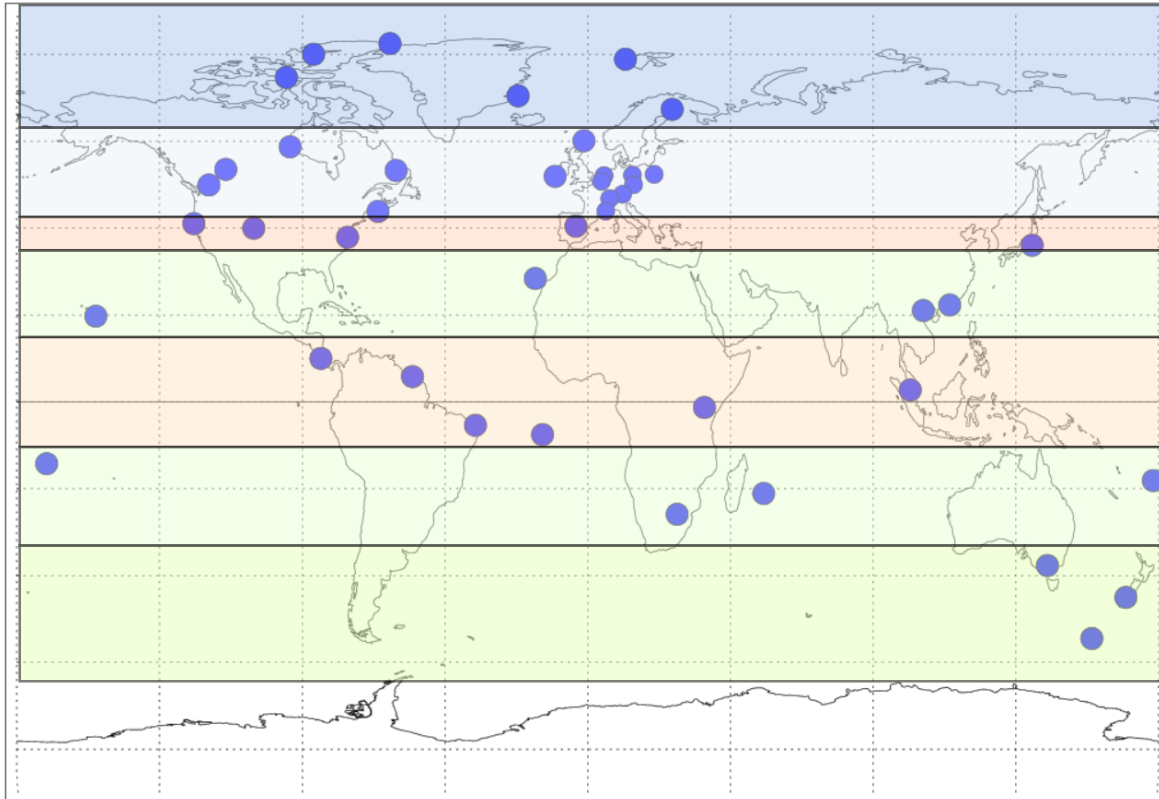


ozone trend profiles, 2000 to 2020/21

Trend model as in WMO 2014: Hockey-stick, 11yr solar, ENSO (MEI), QBO (FUB, 10+30 hPa), Aerosol, but no dynamical proxies (no AO, NAO, ...)



next plots: finer latitude bands, h-coordinate!!



northern polar

northern mid-latitudes

northern mid-latitudes 2

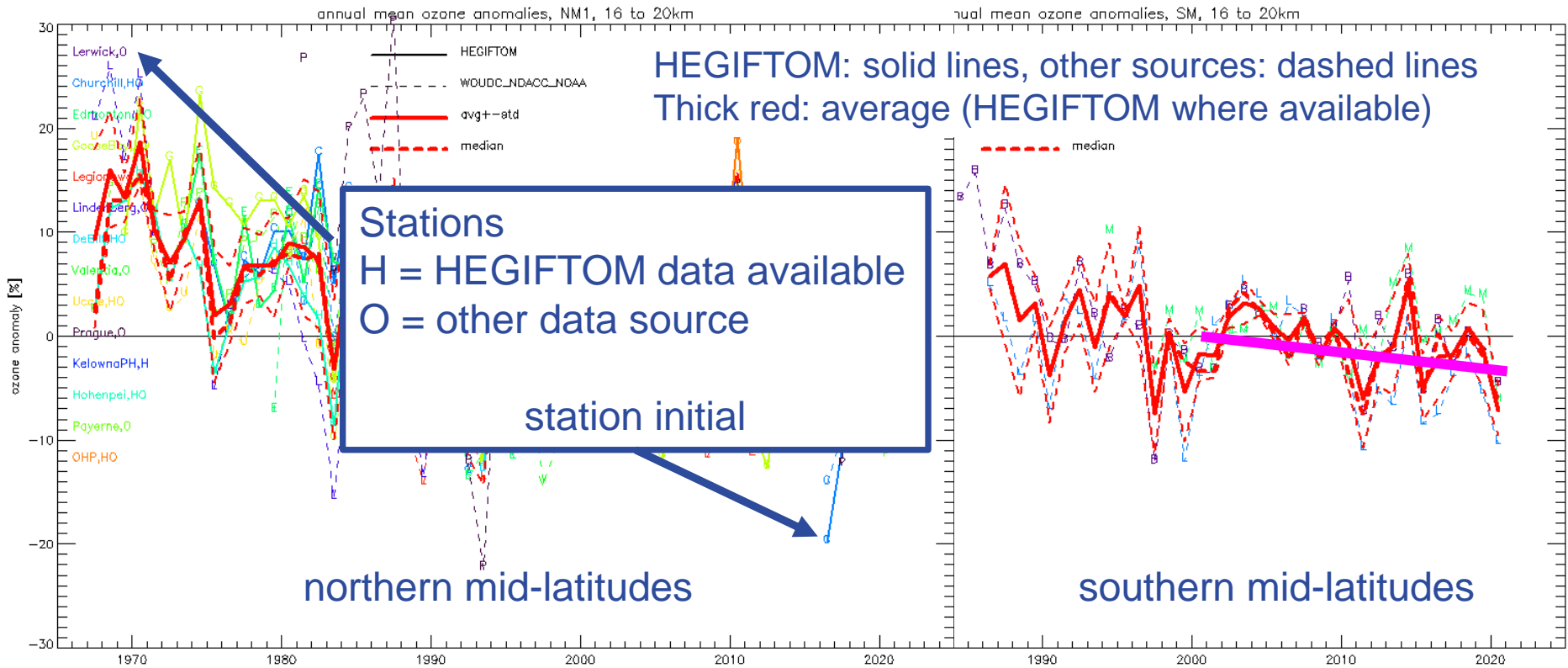
northern extratropics

tropics

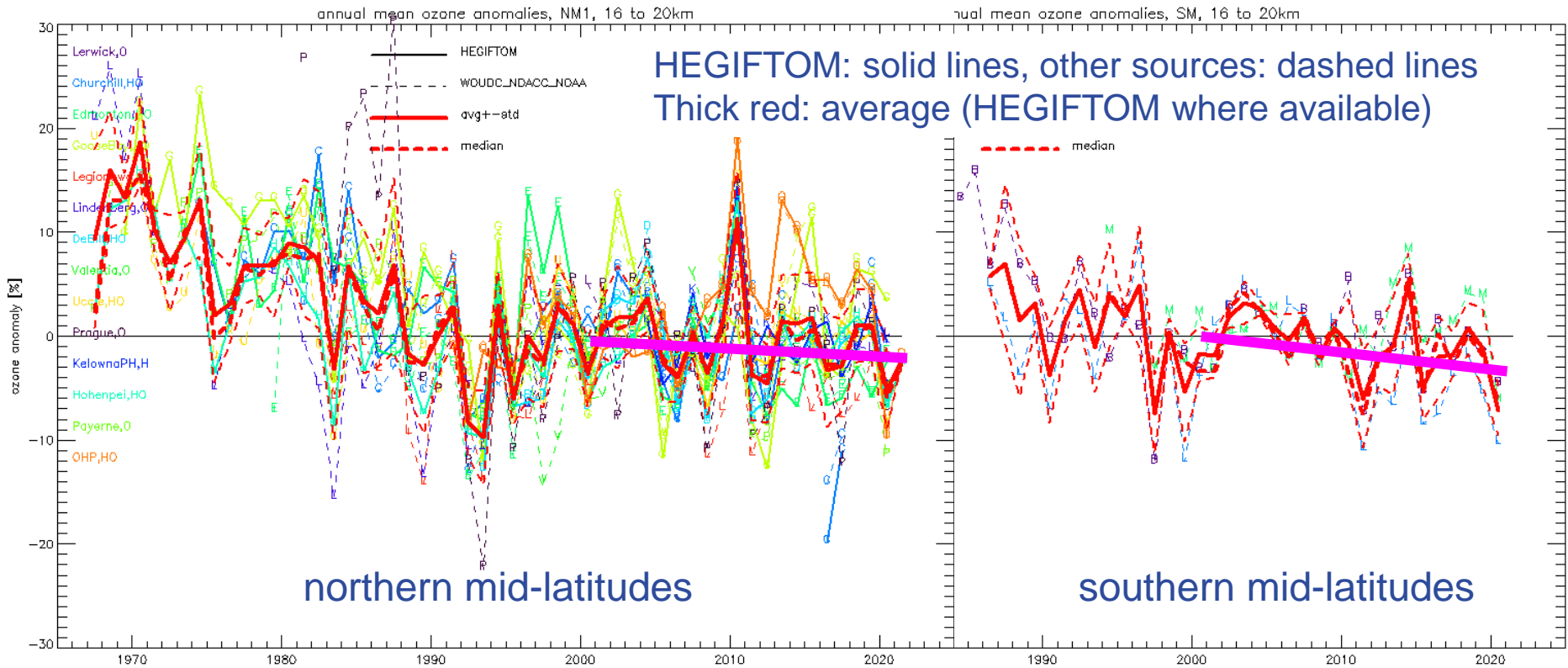
southern extratropics

southern mid-latitudes

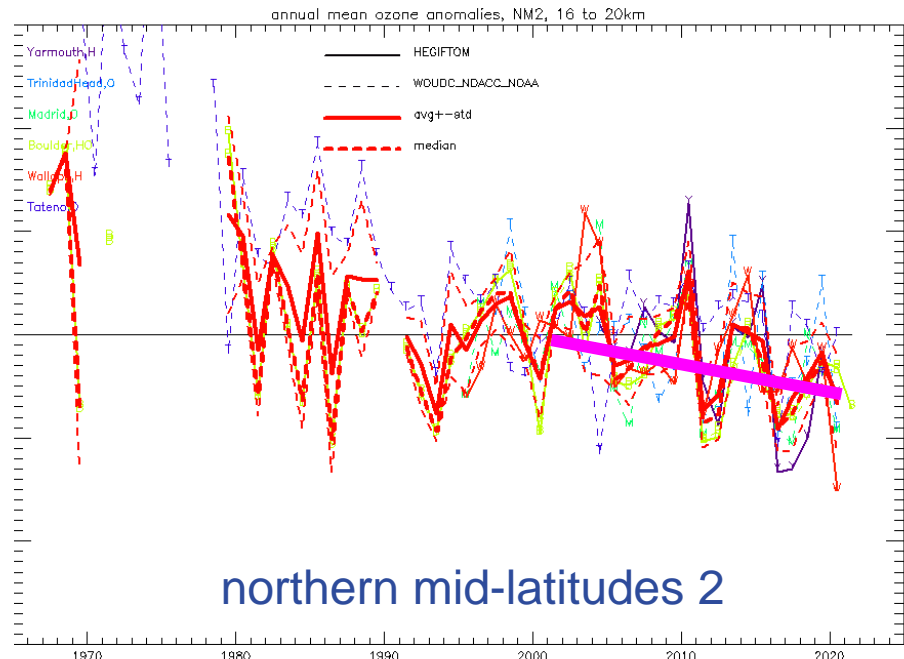
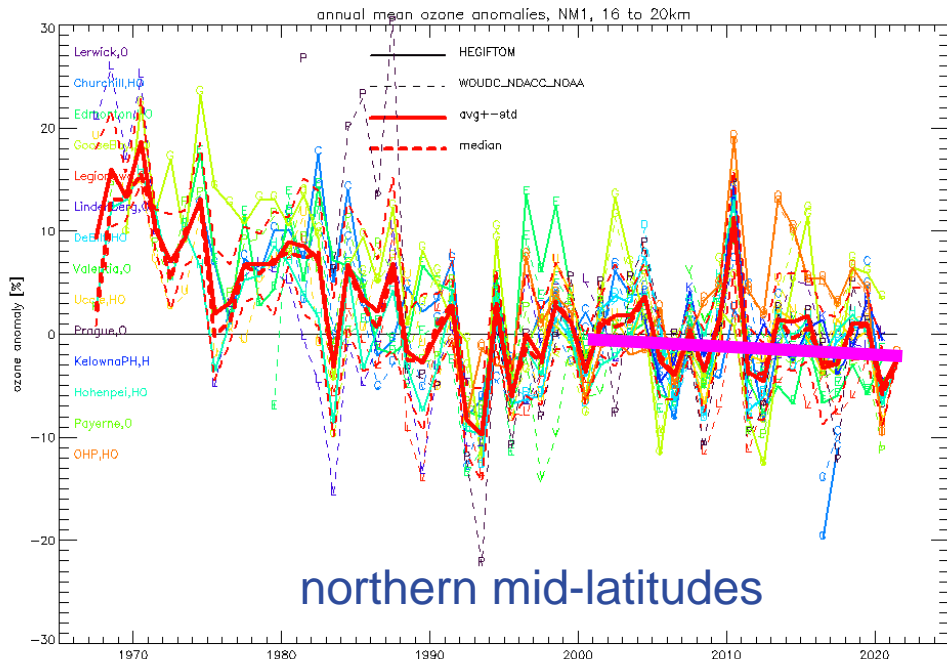
time series, annual means, 16 to 20 km



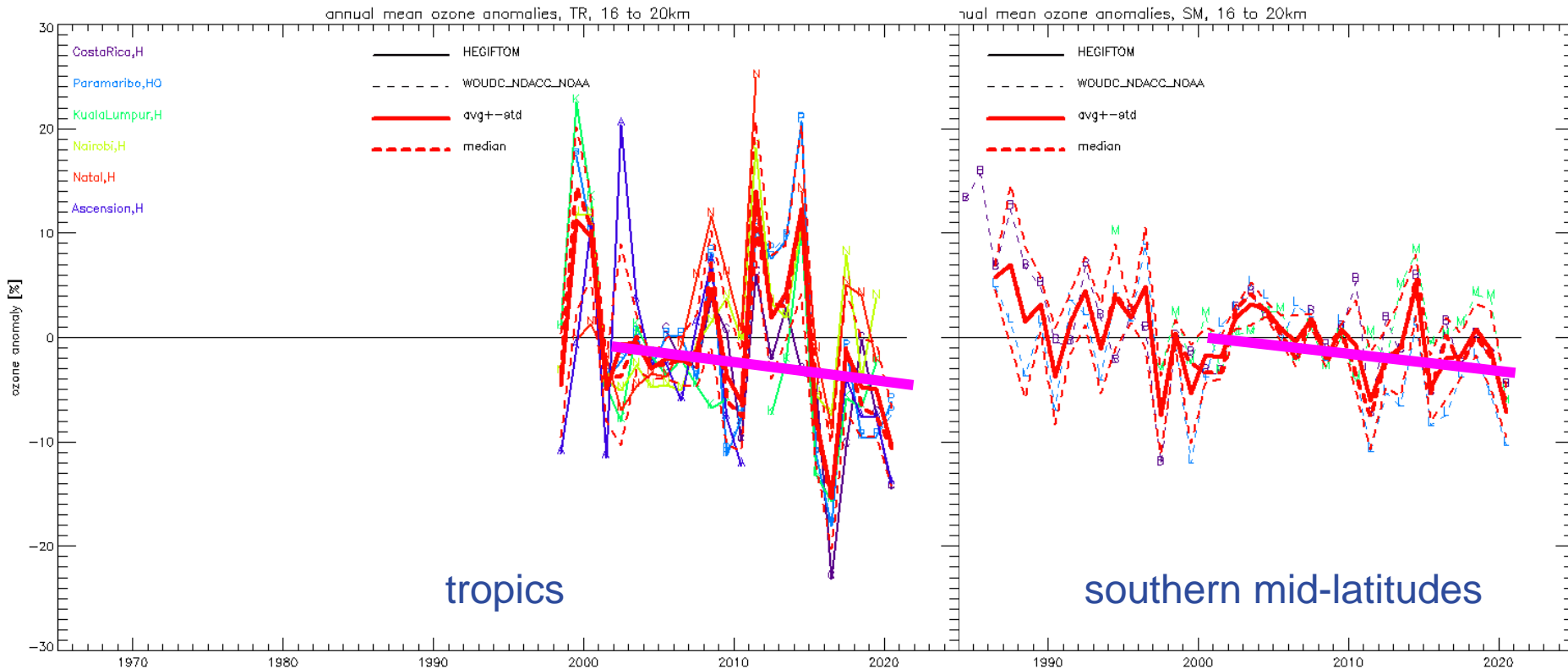
time series, annual means, 16 to 20 km



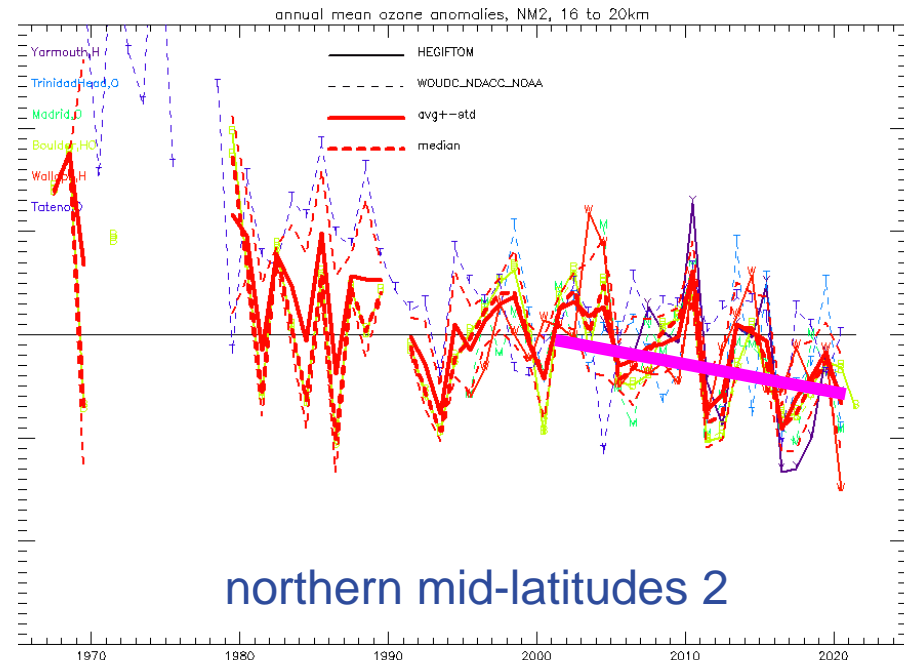
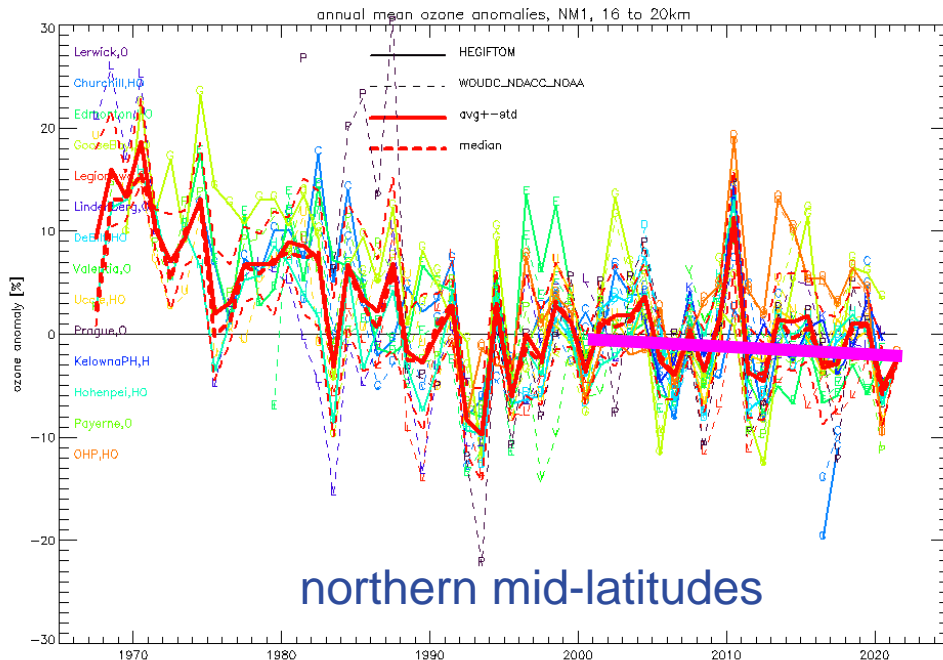
time series, annual means, 16 to 20 km



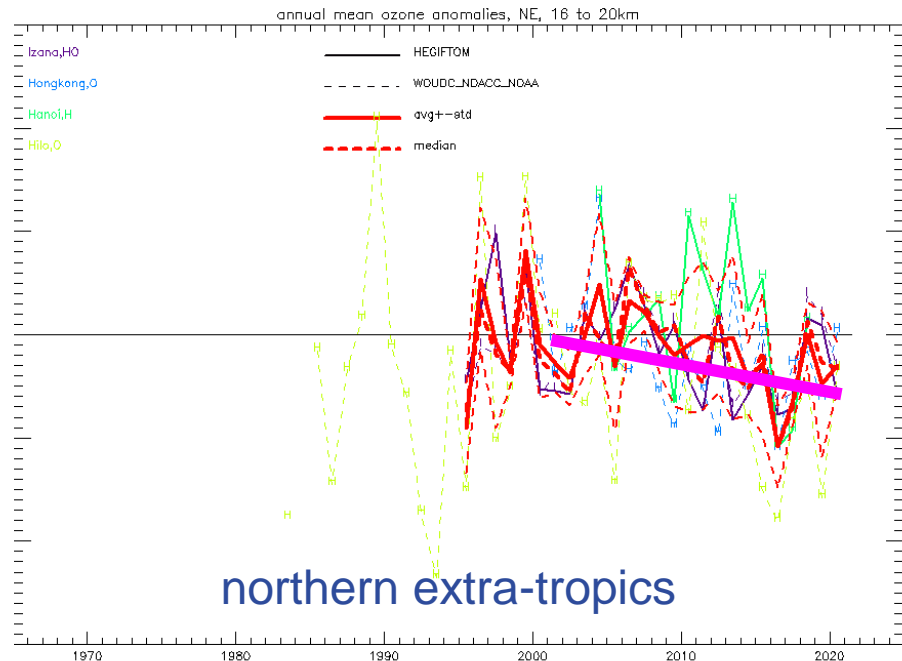
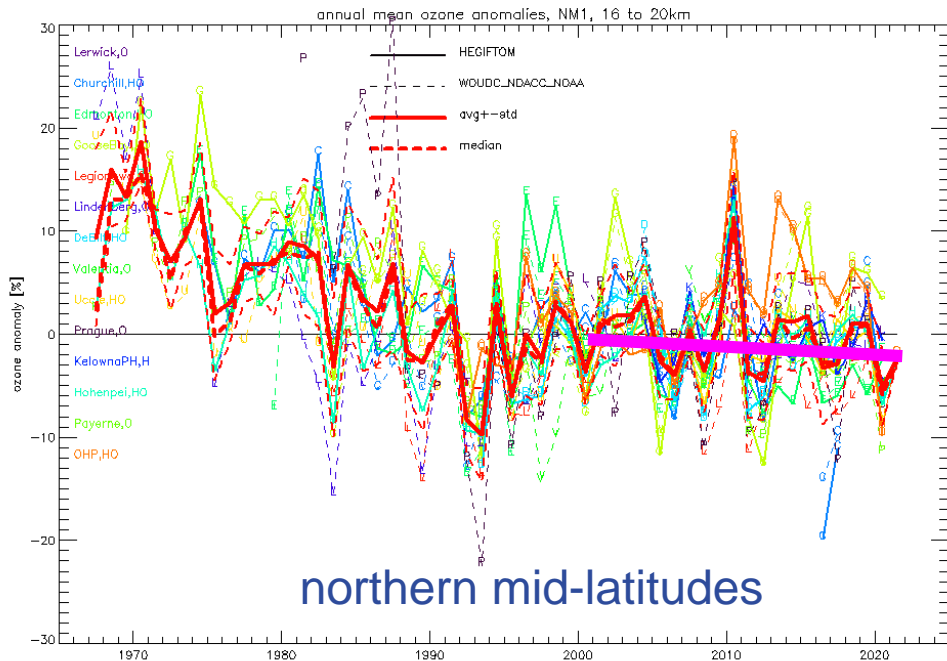
time series, annual means, 16 to 20 km



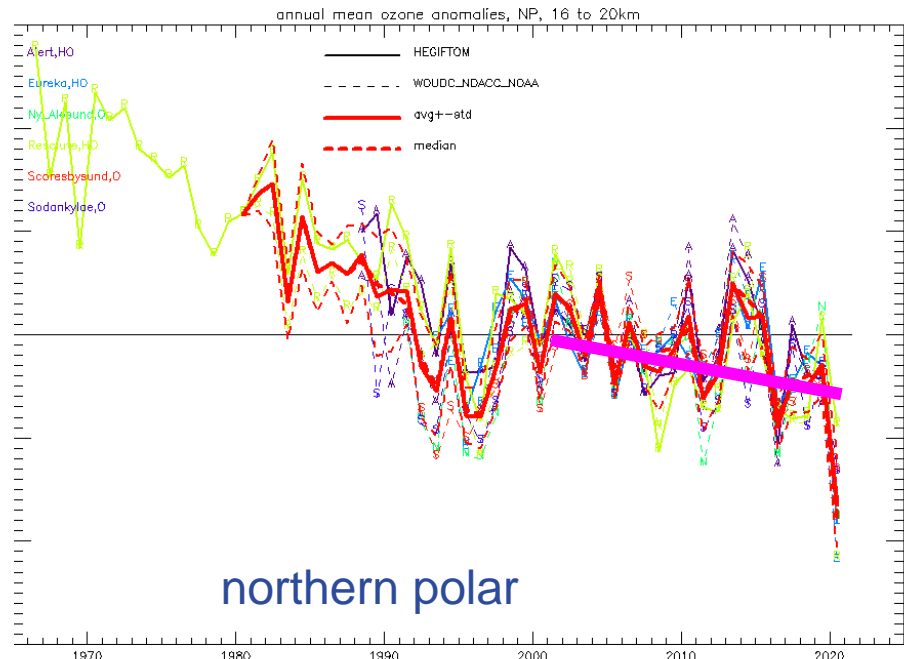
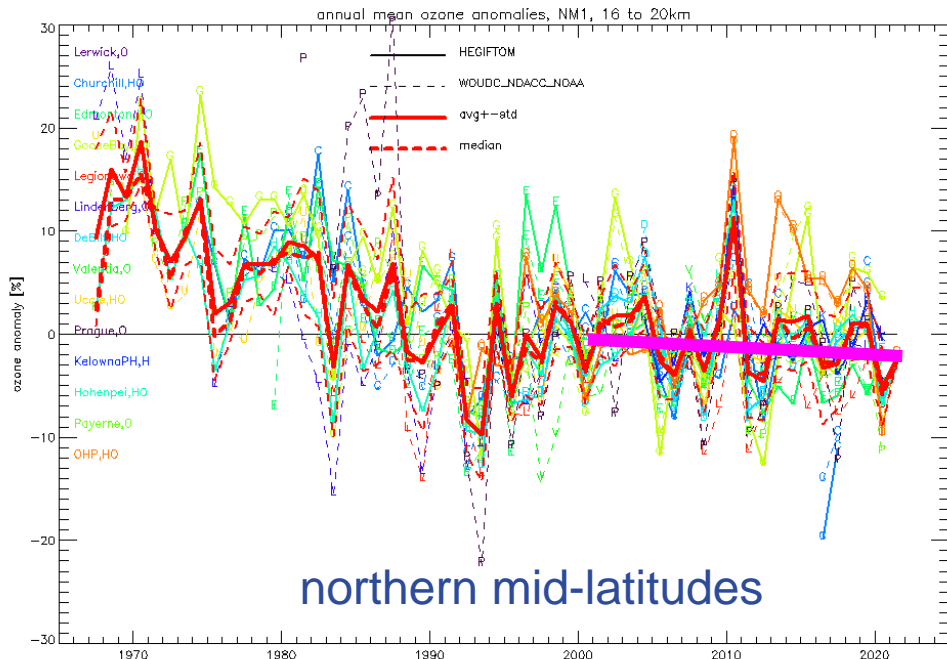
time series, annual means, 16 to 20 km



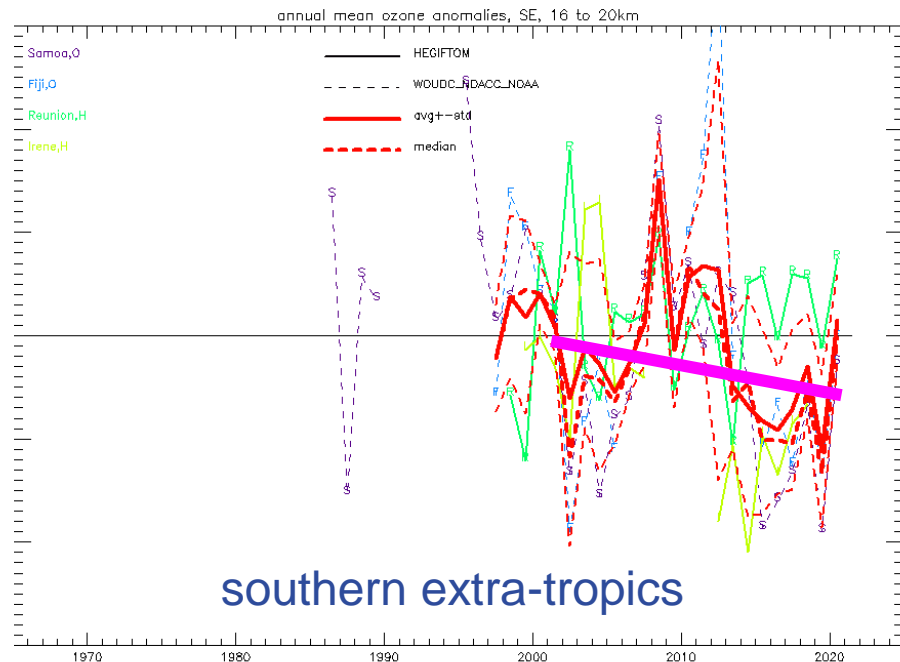
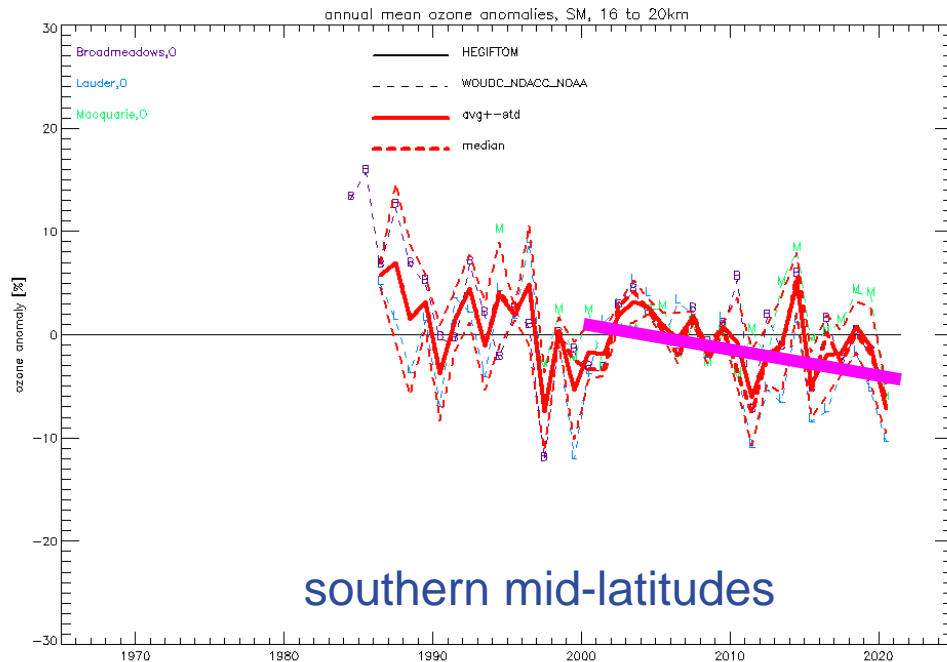
time series, annual means, 16 to 20 km



time series, annual means, 16 to 20 km

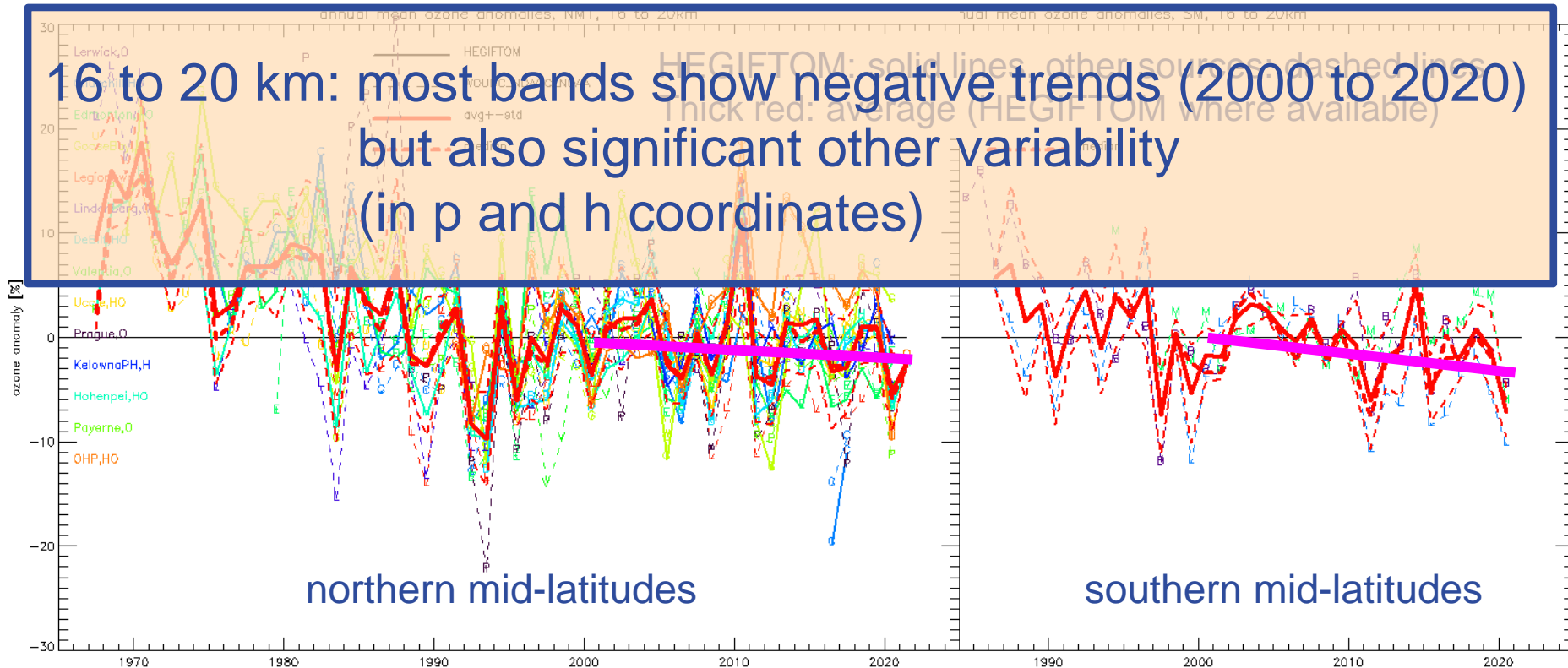


time series, annual means, 16 to 20 km

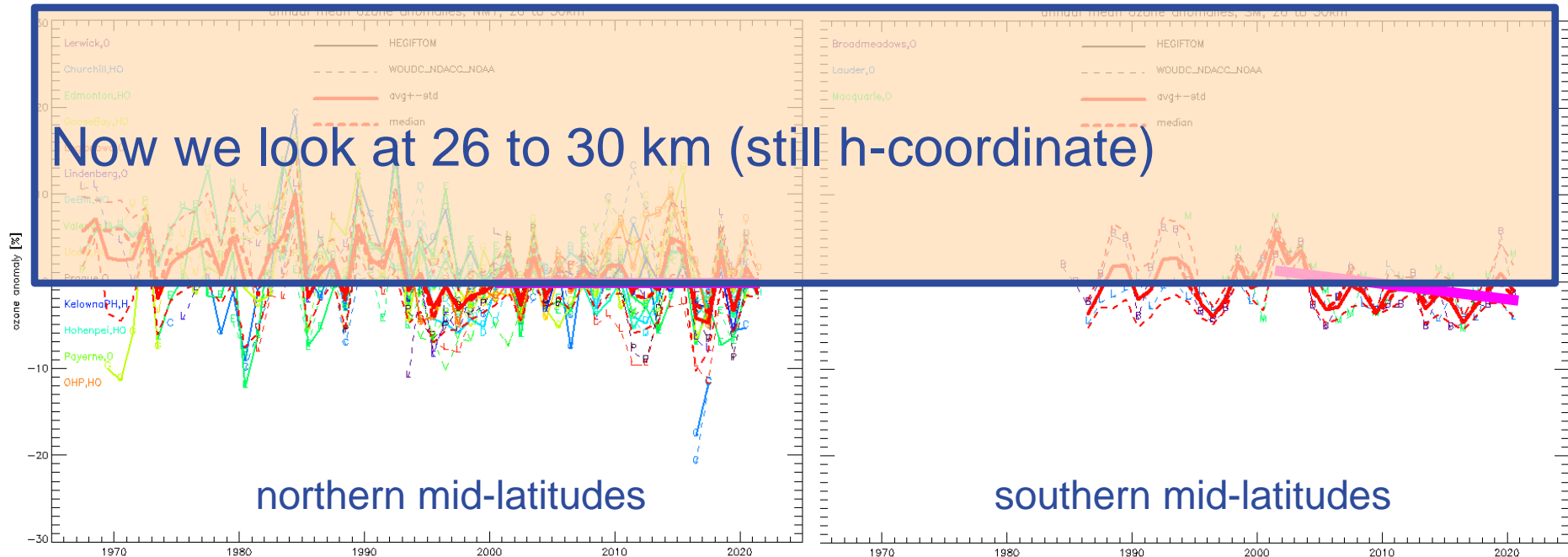


time series, annual means, 16 to 20 km

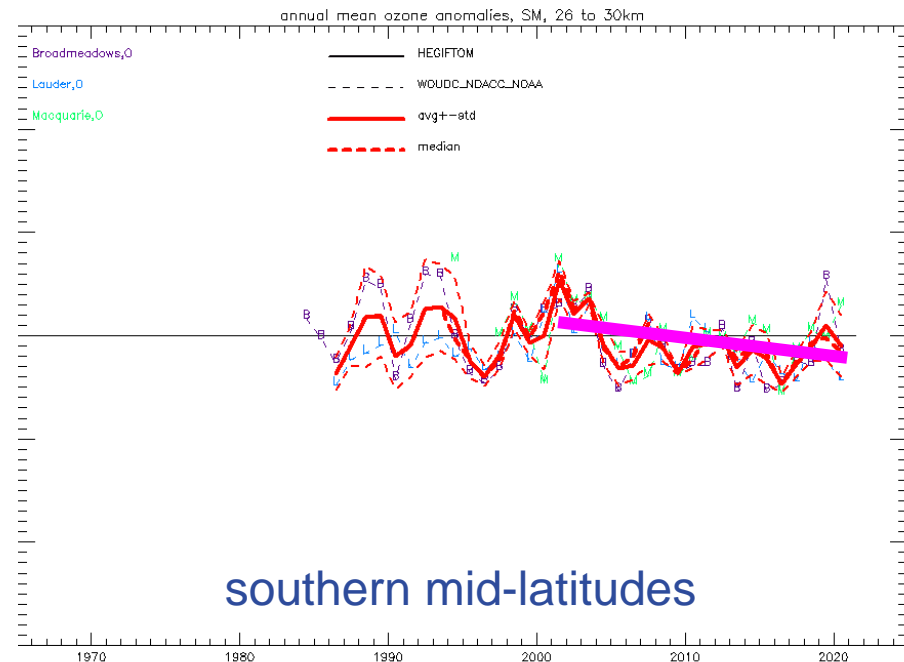
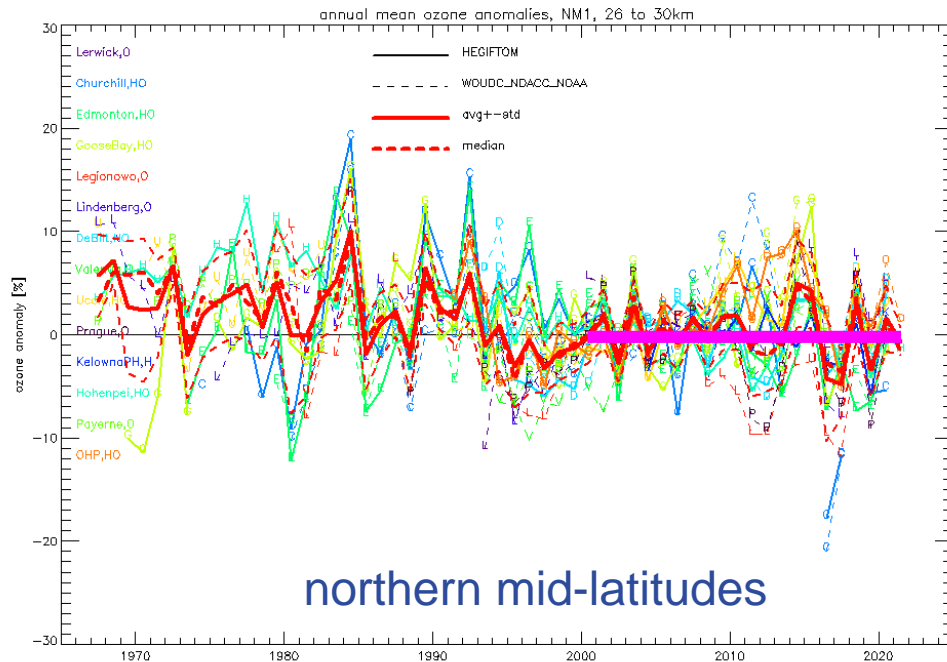
16 to 20 km: most bands show negative trends (2000 to 2020)
but also significant other variability
(in p and h coordinates)



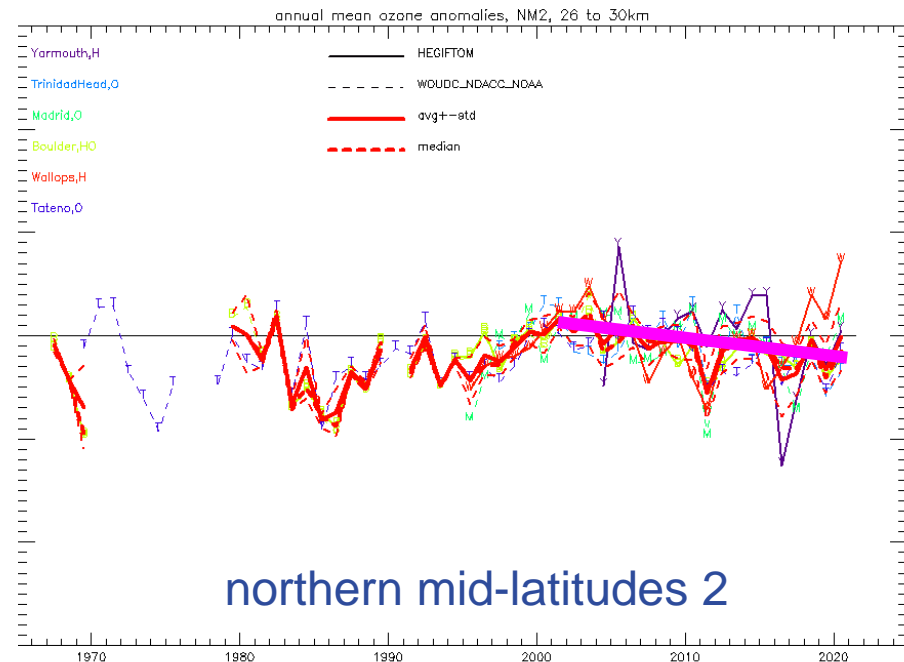
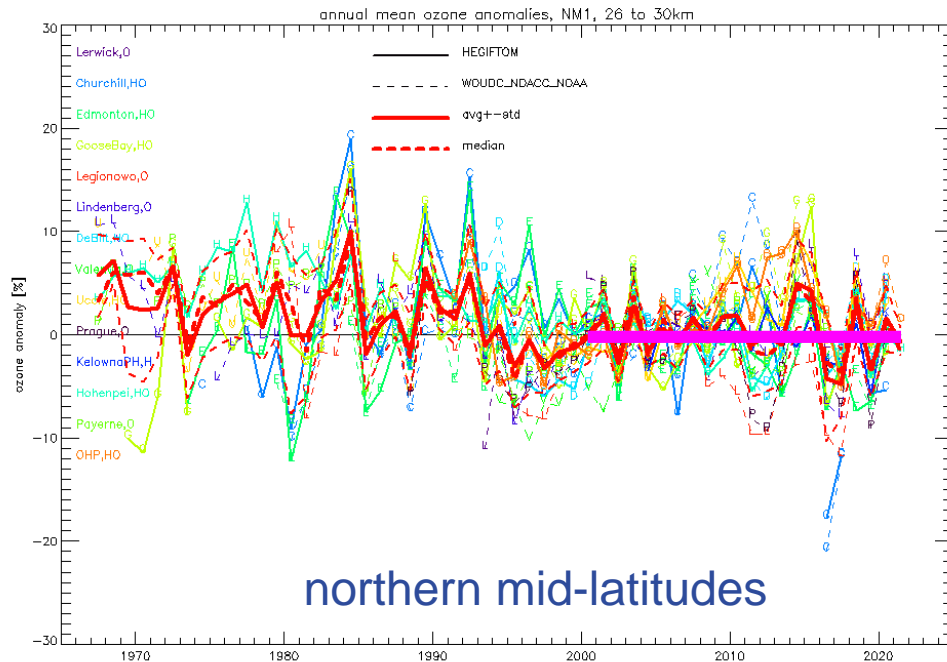
time series, annual means, 26 to 30 km



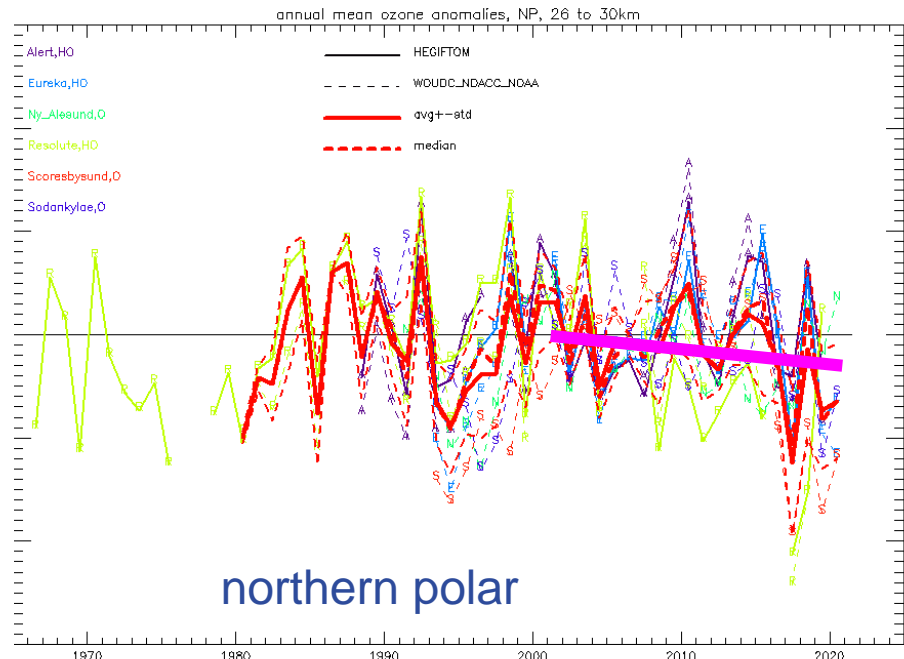
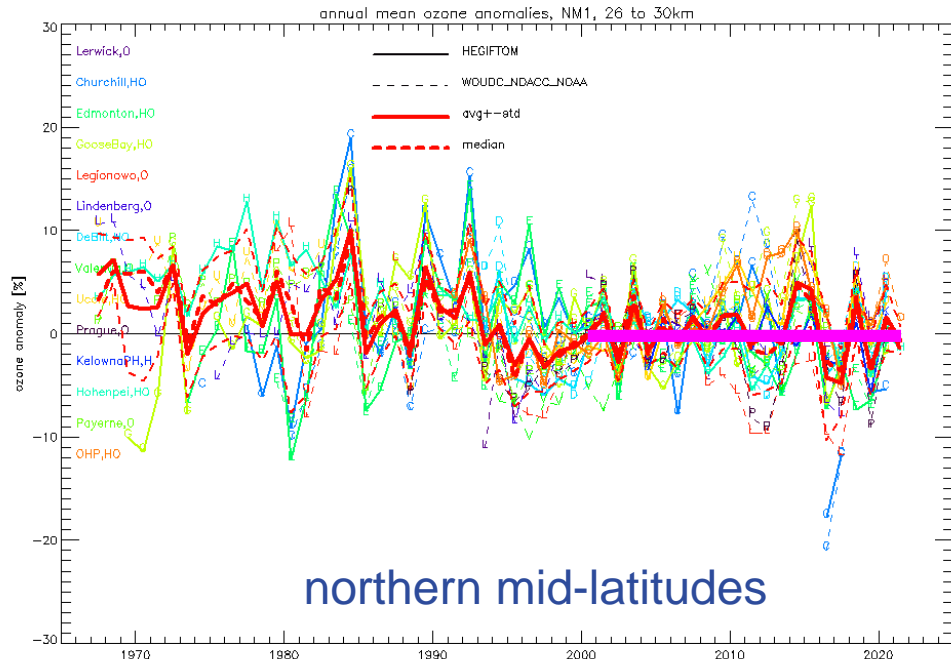
time series, annual means, 26 to 30 km



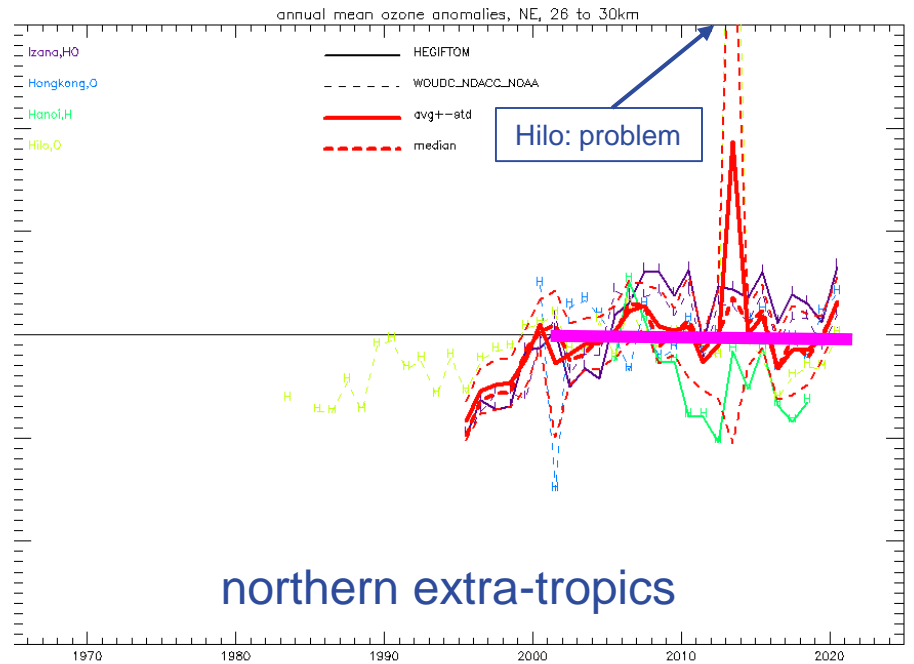
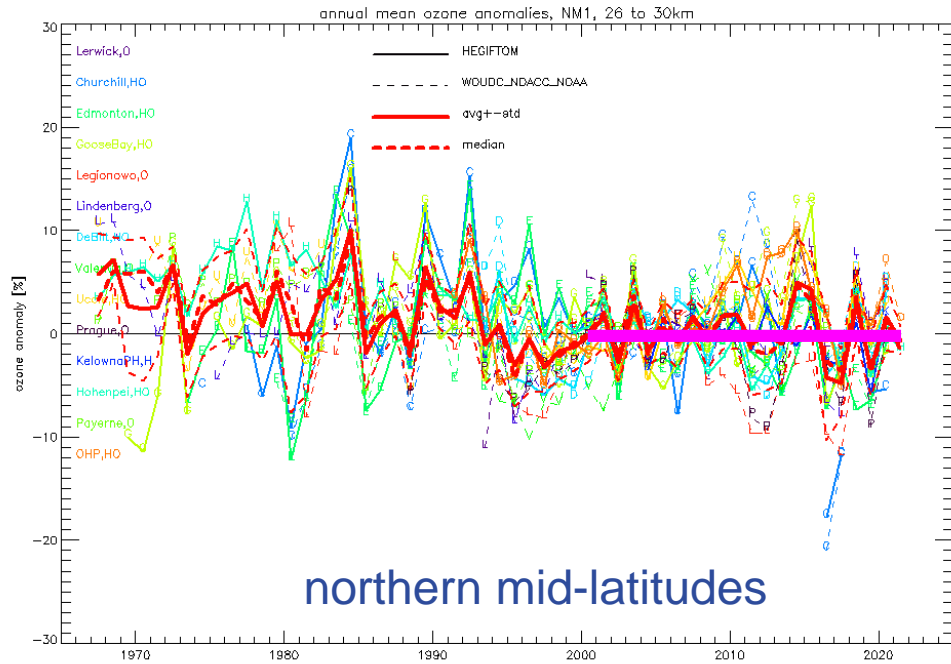
time series, annual means, 26 to 30 km



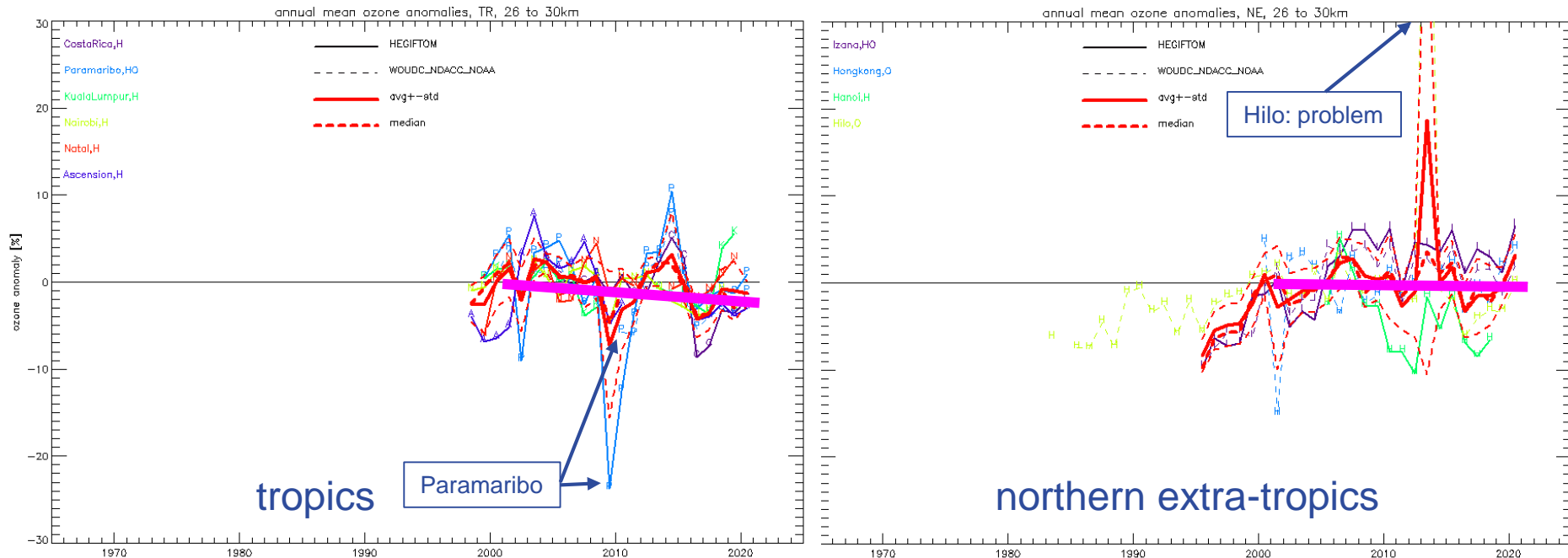
time series, annual means, 26 to 30 km



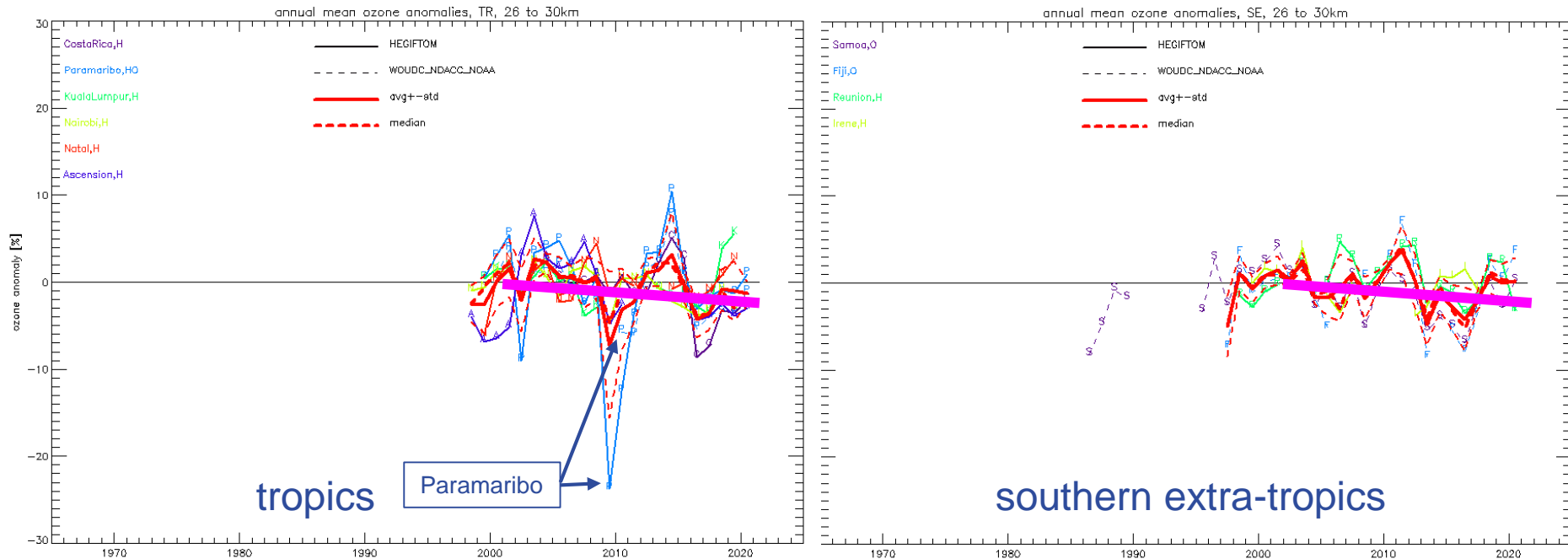
time series, annual means, 26 to 30 km



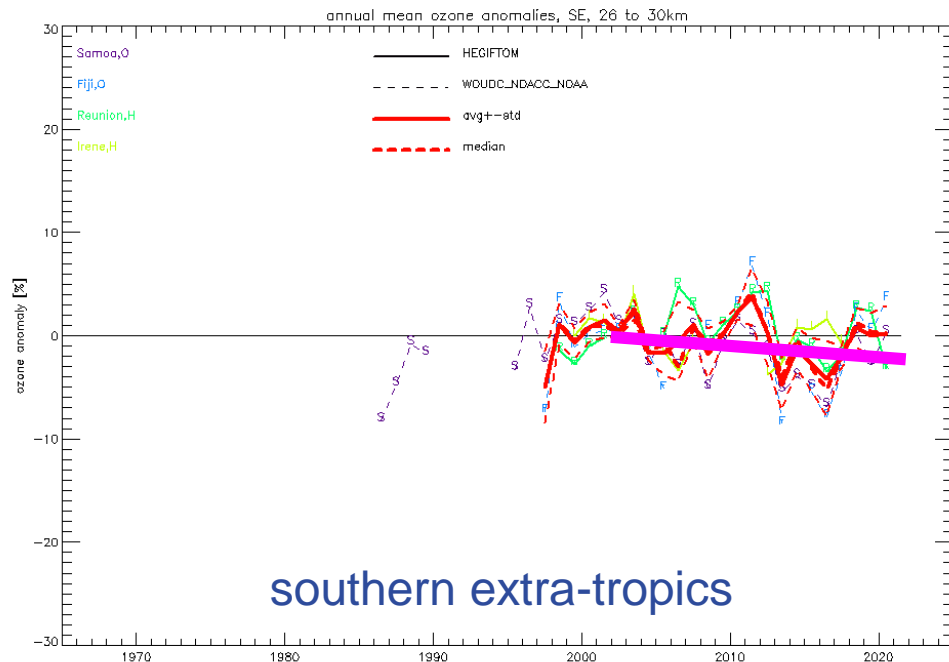
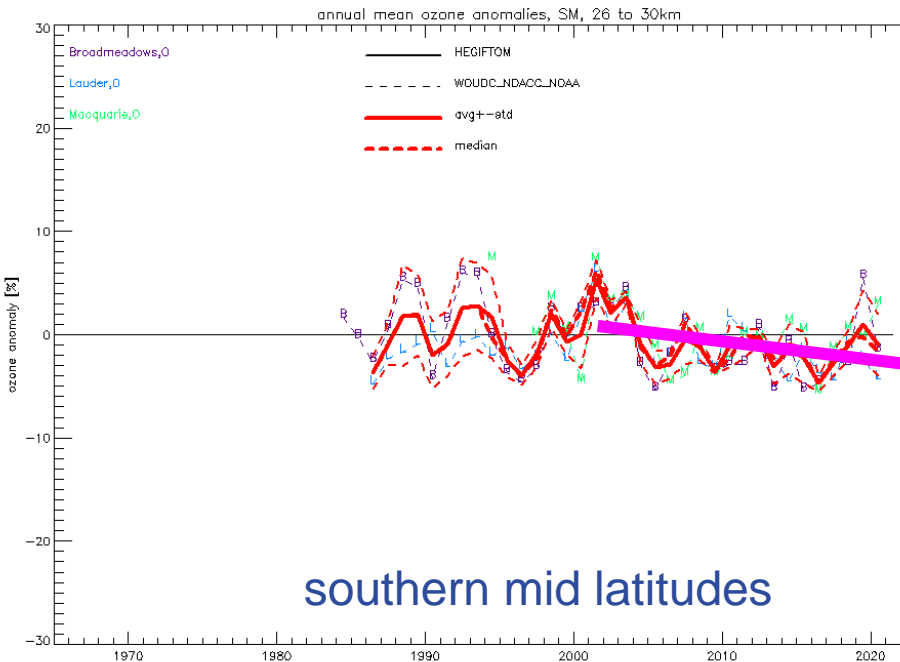
time series, annual means, 26 to 30 km



time series, annual means, 26 to 30 km



time series, annual means, 26 to 30 km



- analysing sonde data from various sources
- best data in northern hemisphere
- tendency to negative trends in (lower) stratosphere
- important other variability (non-trend, dynamics e.g. 2010)
- coordinate system matters! (cooling / shrinking stratosphere)
- t.b.d. look relative to tropopause

- not shown: tropospheric changes