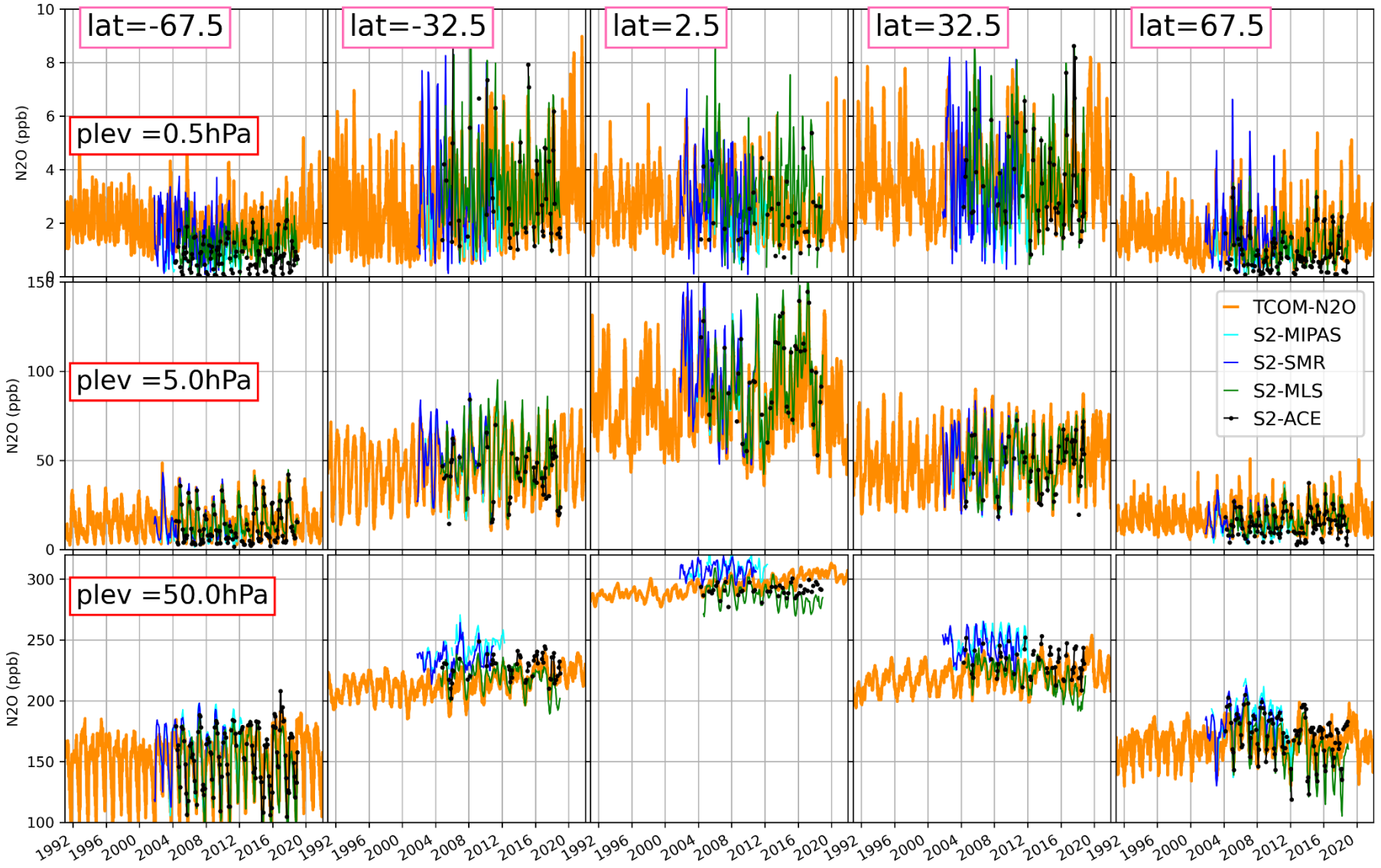
Comparison with SPARC V2 (S2) N2O Data (Hegglin et al., 2021)



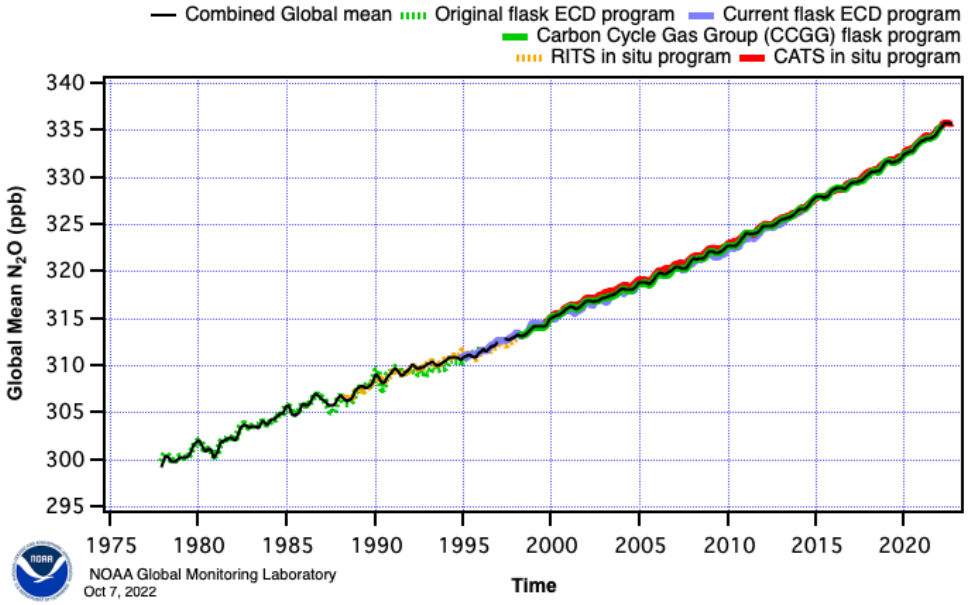
SPARC data files:

- 26 plev, 36 lat bins
- Separate for separate instruments
- No correction/adjustment
- Monthly means are calculated only if there are >5 profile at 5 deg. Latitude bins

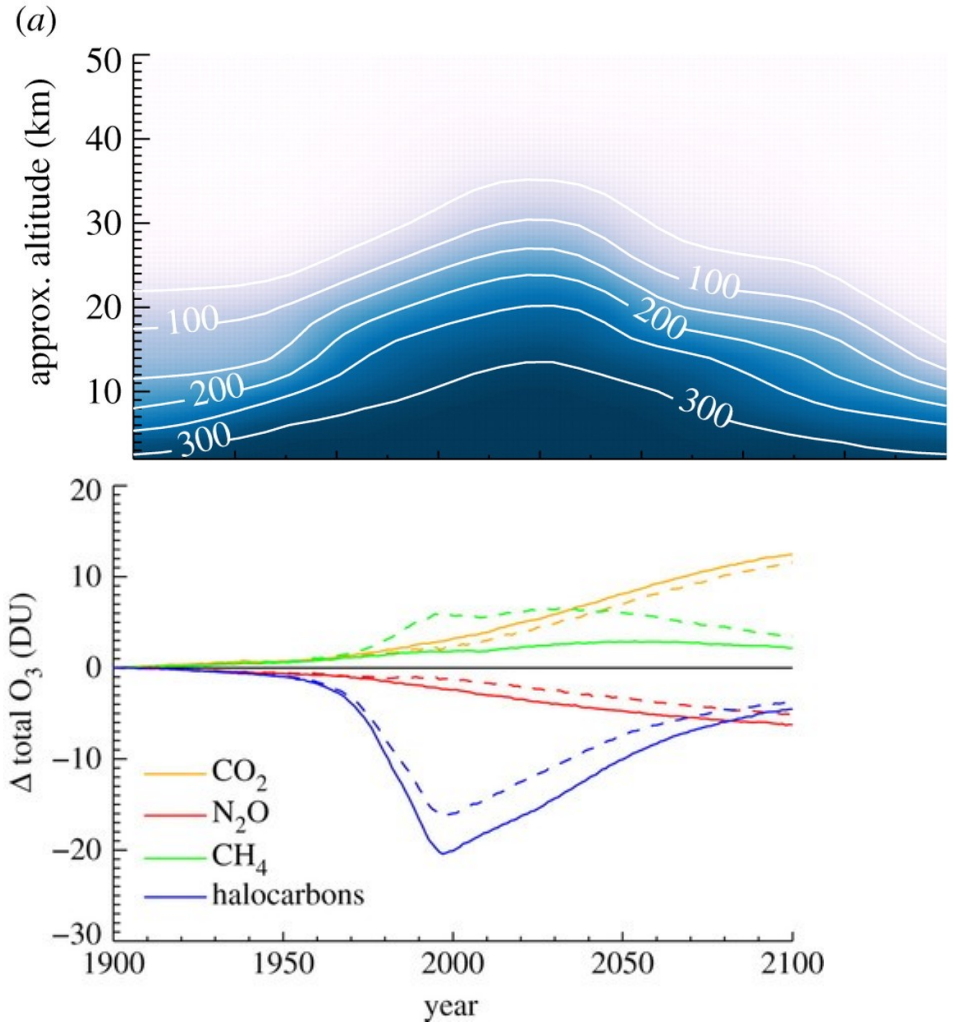
TCOM-N2O: Daily global gap-free N2O profile data based using TOMCAT CTM, Occultation Measurements

Sandip Dhomse

- N2O is an important GHG
- NOy source in the stratosphere – NOx ozone loss cycle
- Long life-time in the stratosphere →~120 yrs
- All the models have biases → parametrisations
- Satellite mea. are sporadic and cover shorter period
- Machine learning model is used to correct the biases → construct new data
- Usage: e.g. evaluate strat. chemistry/dynamics

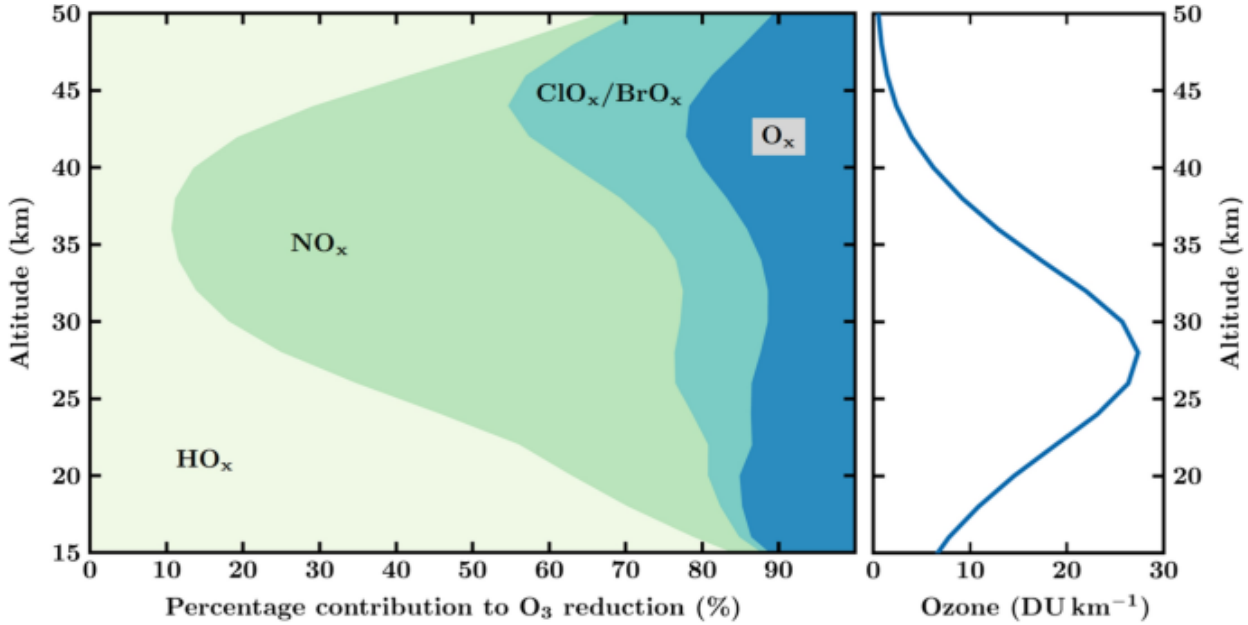


N2O & Ozone loss



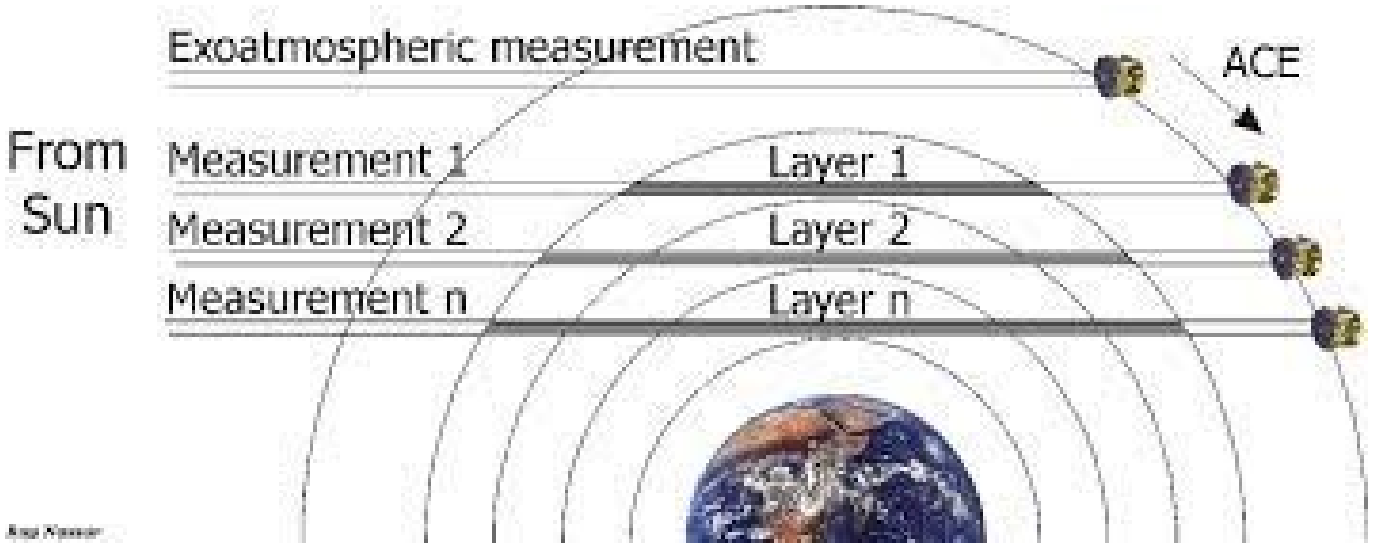
Portman et al, 2012

NOx cycle would control future ozone loss



Muller, 2021

Satellite instrument: ACE-FTS

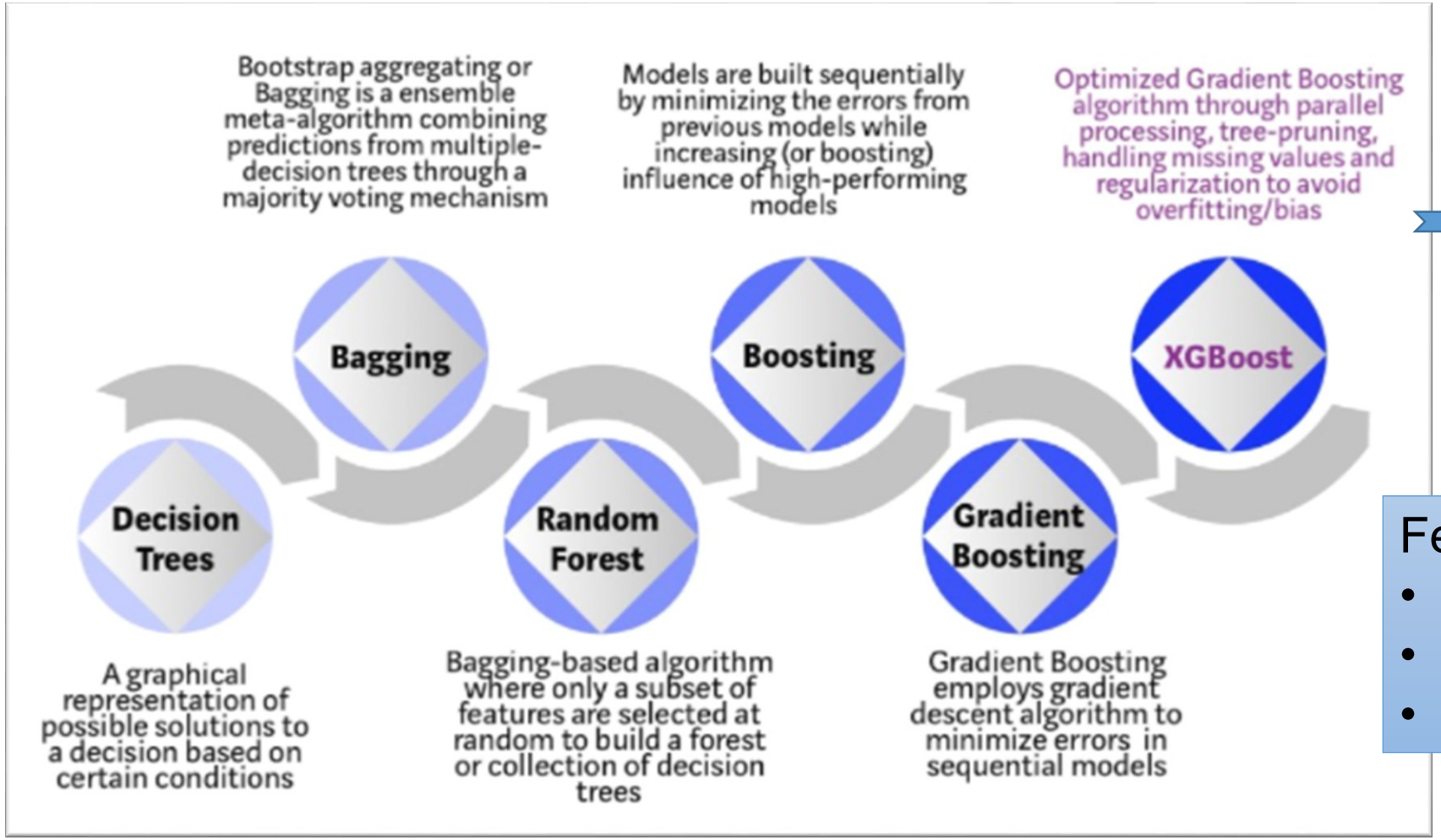


N2O is retrieved using 62 spectral microwindows ranging between 829 and 2241 cm^{-1}

ACE-FTS : SCISAT satellite (2004- present)

Occultation instruments – 30 measurements per day

Extreme-Gradient Boosting (XGBoost) – Supervised ML



Training: 1992-2018

Evaluation: 2019-2021

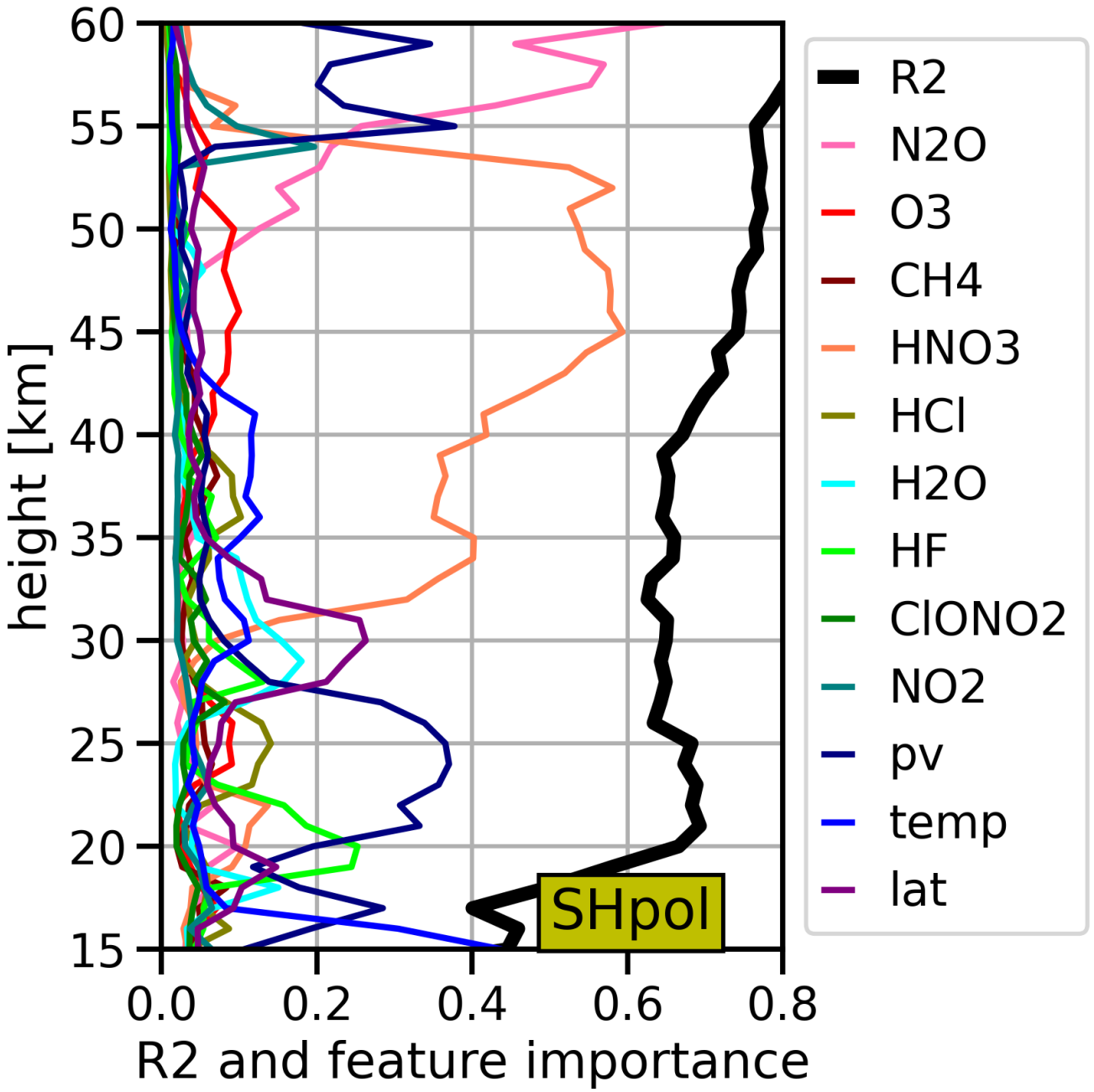
Features:

- CH4, O3, N2O, HCl, HNO3,
- temp.., potential vorticity
- Latitude, time, ..

Something similar to multivariate regression model (minimise residuals but using multiple decision trees

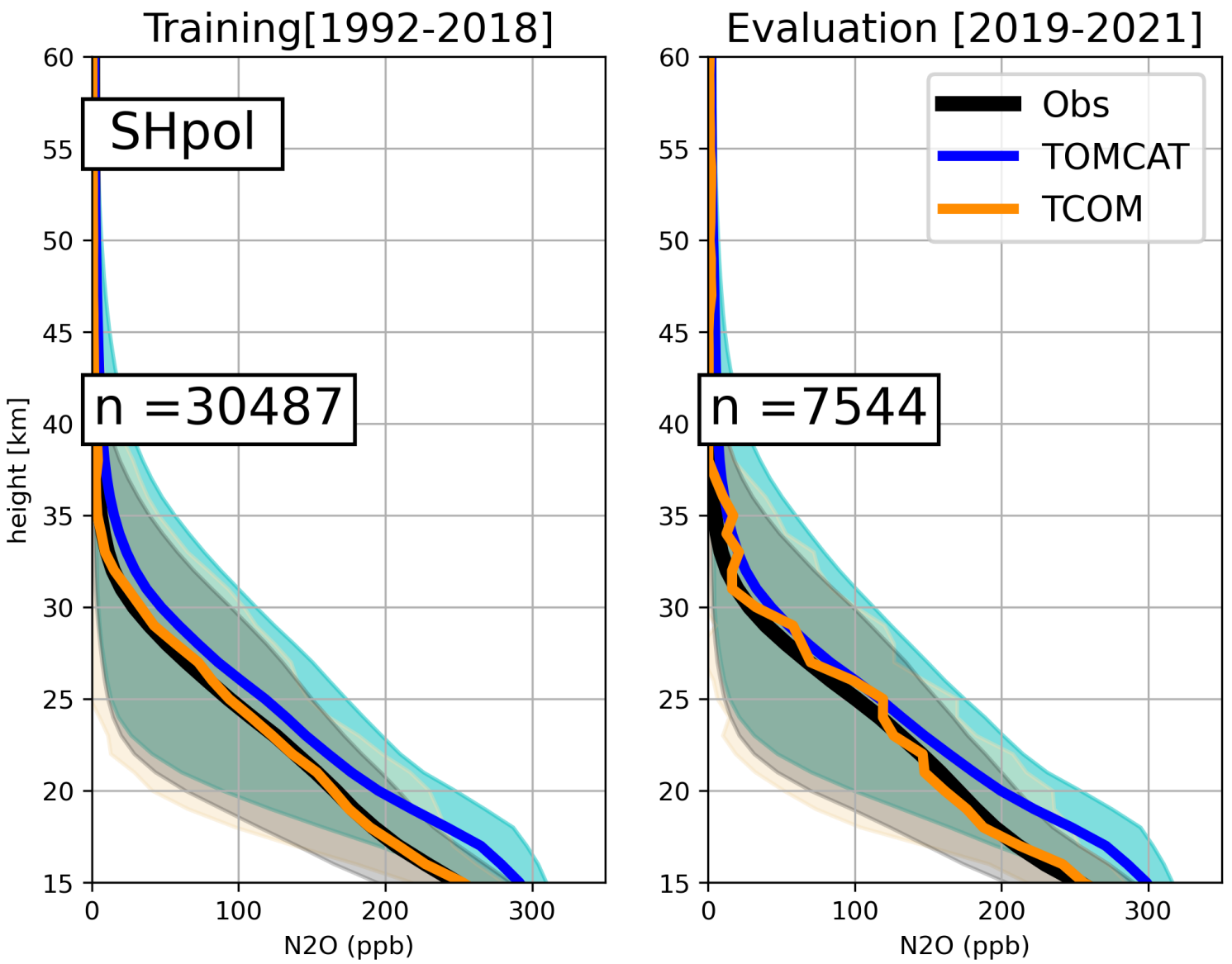
dN2O = temp + potential vorticity + latitude + time + ozone+ methane + N2O + HCl+…..

dN2O = observation minus TOMCAT (about 1.2 million observation profiles)



R2 & feature Importance's

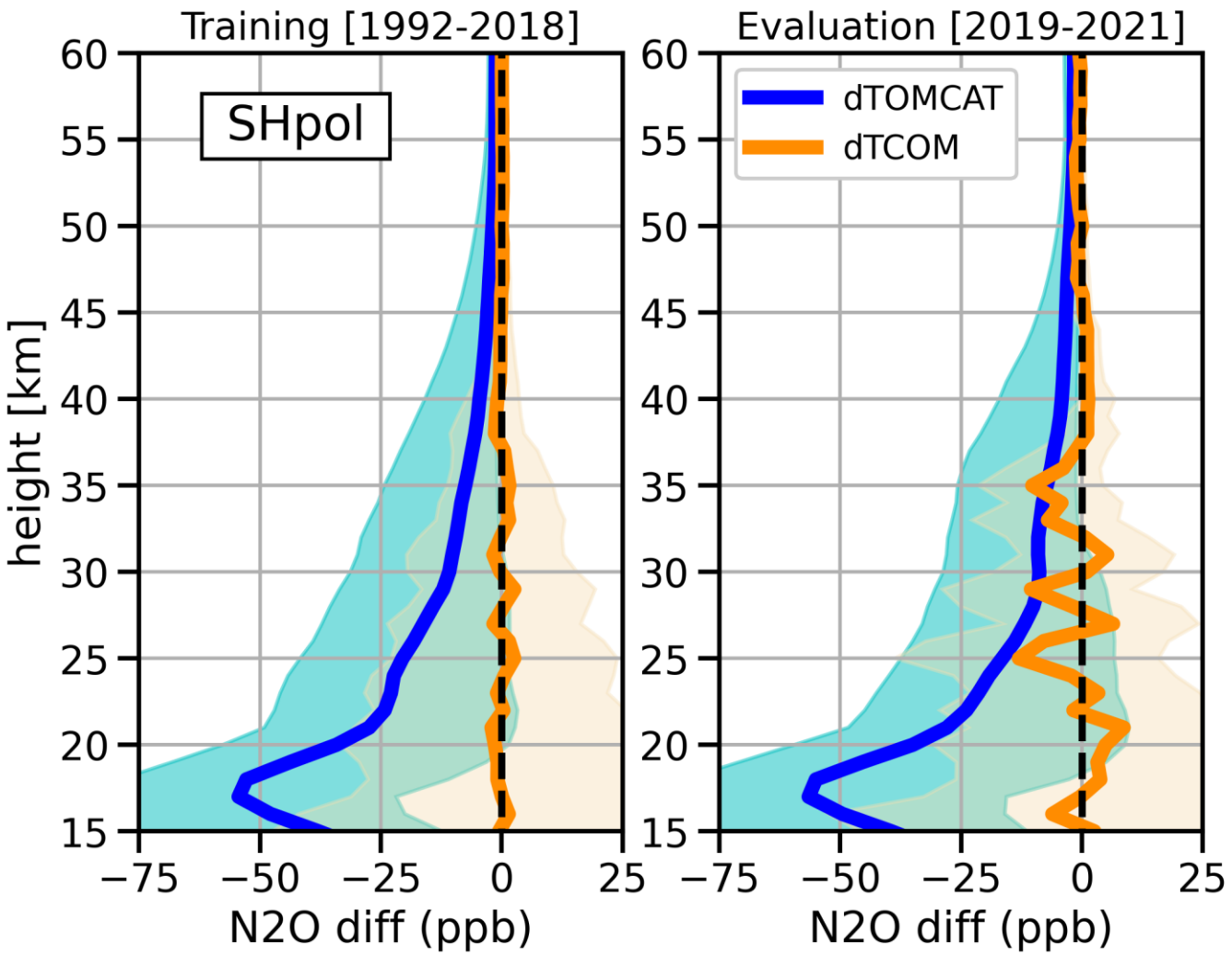
R2 is calculated for 30% testing data



Evaluation: Absolute values

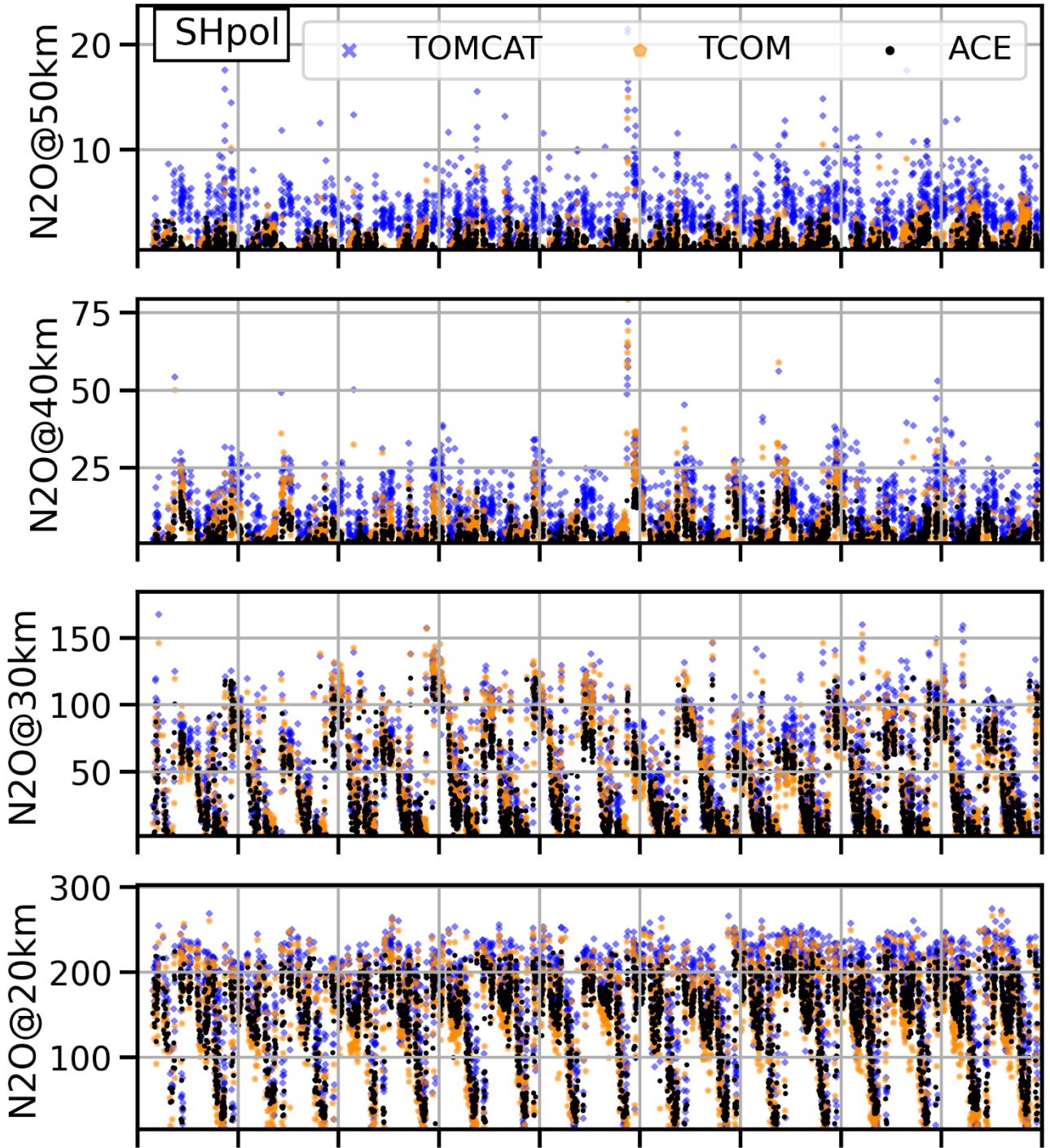
Shaded – 10 & 90 percentiles

Evaluation: Absolute differences



Shaded – 10 & 90 percentiles

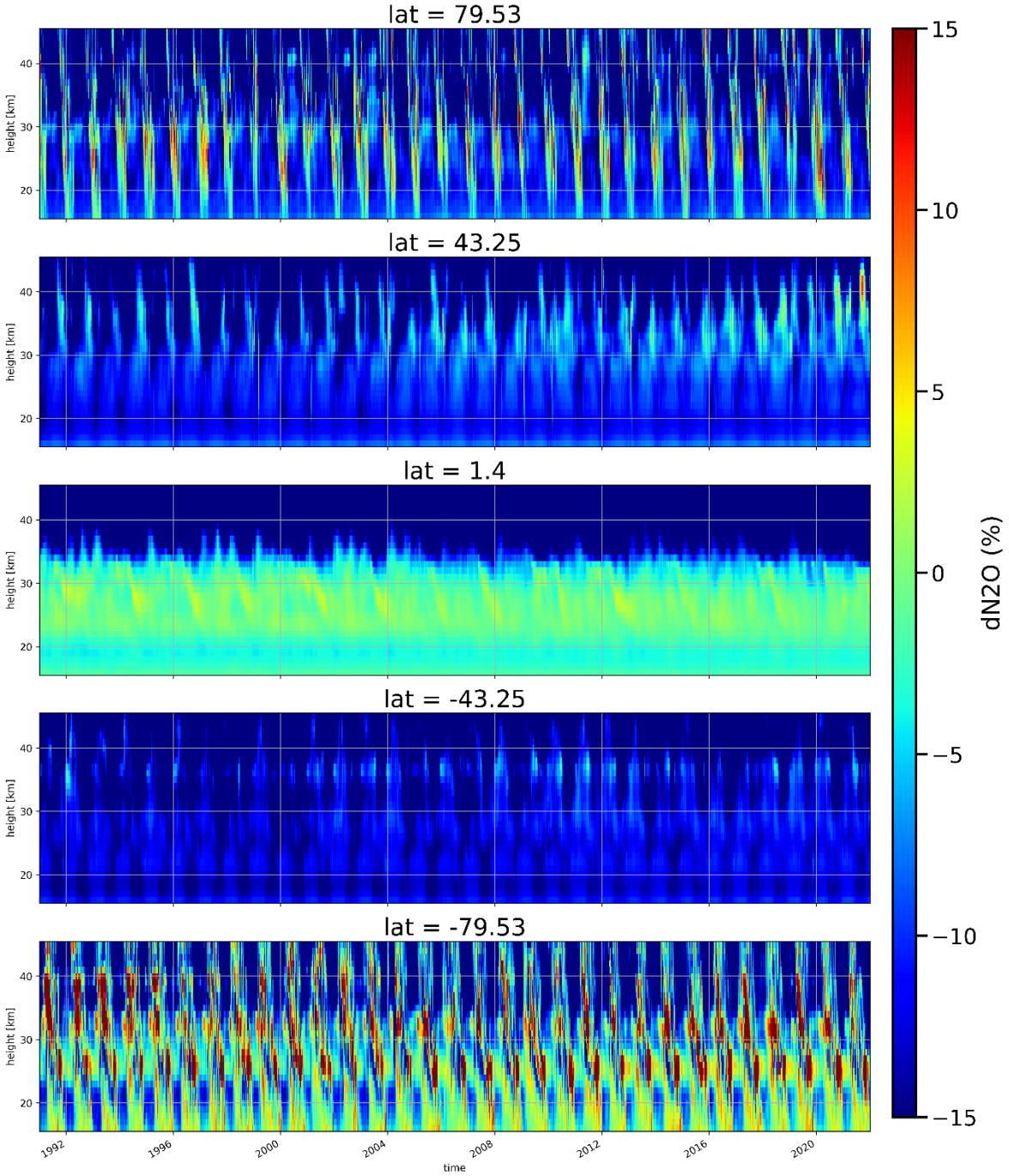
Note that recently there is sharp increase in methane



Comparison: SH polar lats

Only 10% points are plotted

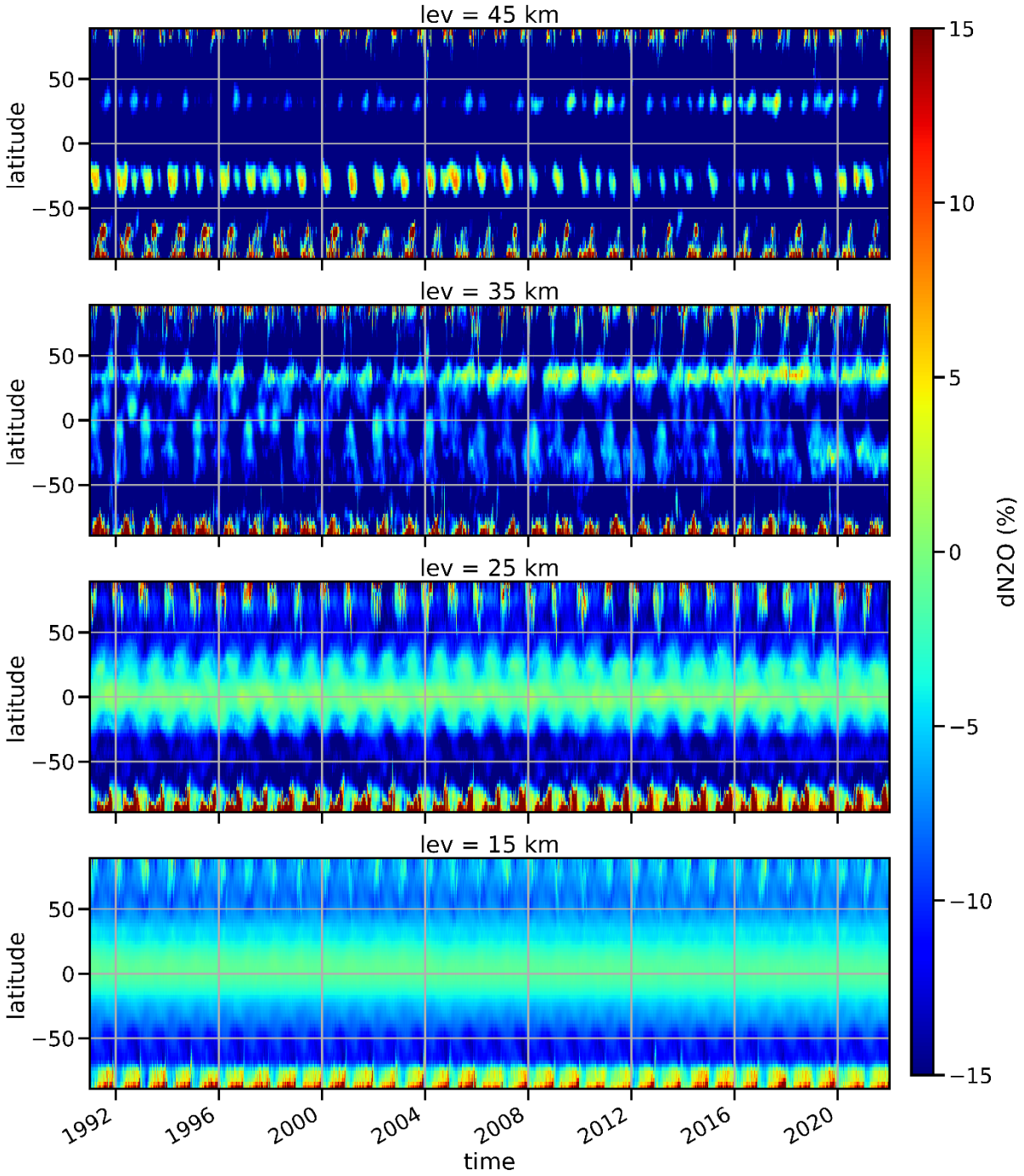
- Black dots : ACE-FTS
- Blue : TOMCAT
- Orange : TCOM



Differences between TCOM & TOMCAT profiles for various lat bins (%)

- Tropics – QBO & vertical velocities
- Mid-lats : isentropic transport + BD circulation
- Polar lats : mixing near polar vortex

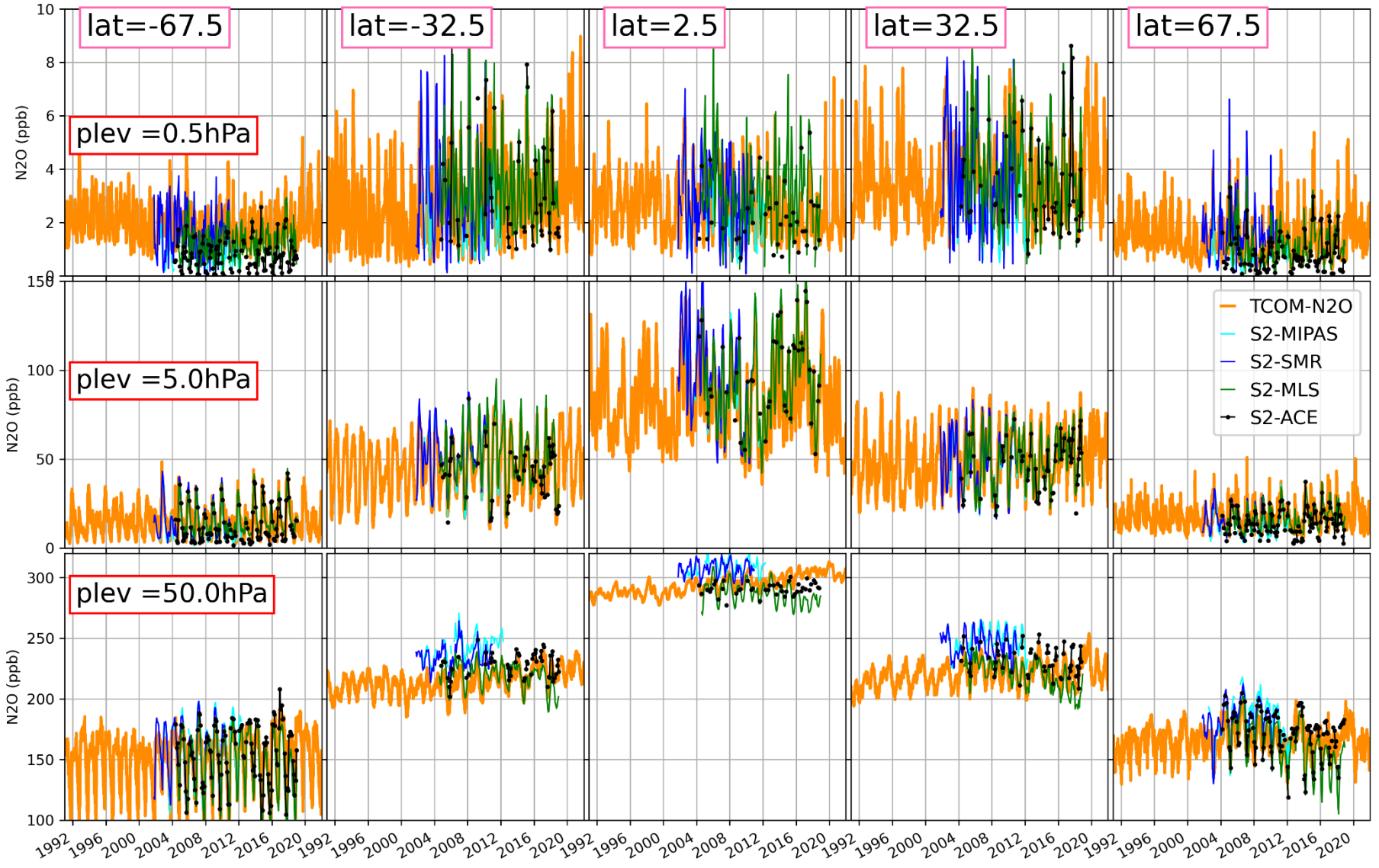
ACE has fewer profiles at low-latitudes



Differences between TCOM & TOMCAT profiles for various levels (%)

Can be used to identify inhomogeneities in ERA5 are non-uniform

Comparison with SPARC N2O Data (Hegglin et al., 2021)



SPARC data files:

- 26 plev, 36 lat bins
- Separate for separate instruments
- No correction/adjustment
- Monthly means are calculated only if there are >5 profile at 5 deg. Latitude bins
- Drifts in MLS data are clearly visible

Summary &Outlook

- Successfully constructed daily global gap-free N2O profile data sets using CTM output & Obs. → biases with 20 ppb
- Ideal to study changes in the stratosphere, model evaluation, satellite retrievals algorithms,…
- XGBoost regression performs better than other machine learning based regressions
- Twice daily (day/night) data on height and pressure level would be available on request
- Zonal mean daily mean files are uploaded on Zenodo
- For daily 3D fields contact s.s.dhomse@leeds.ac.uk