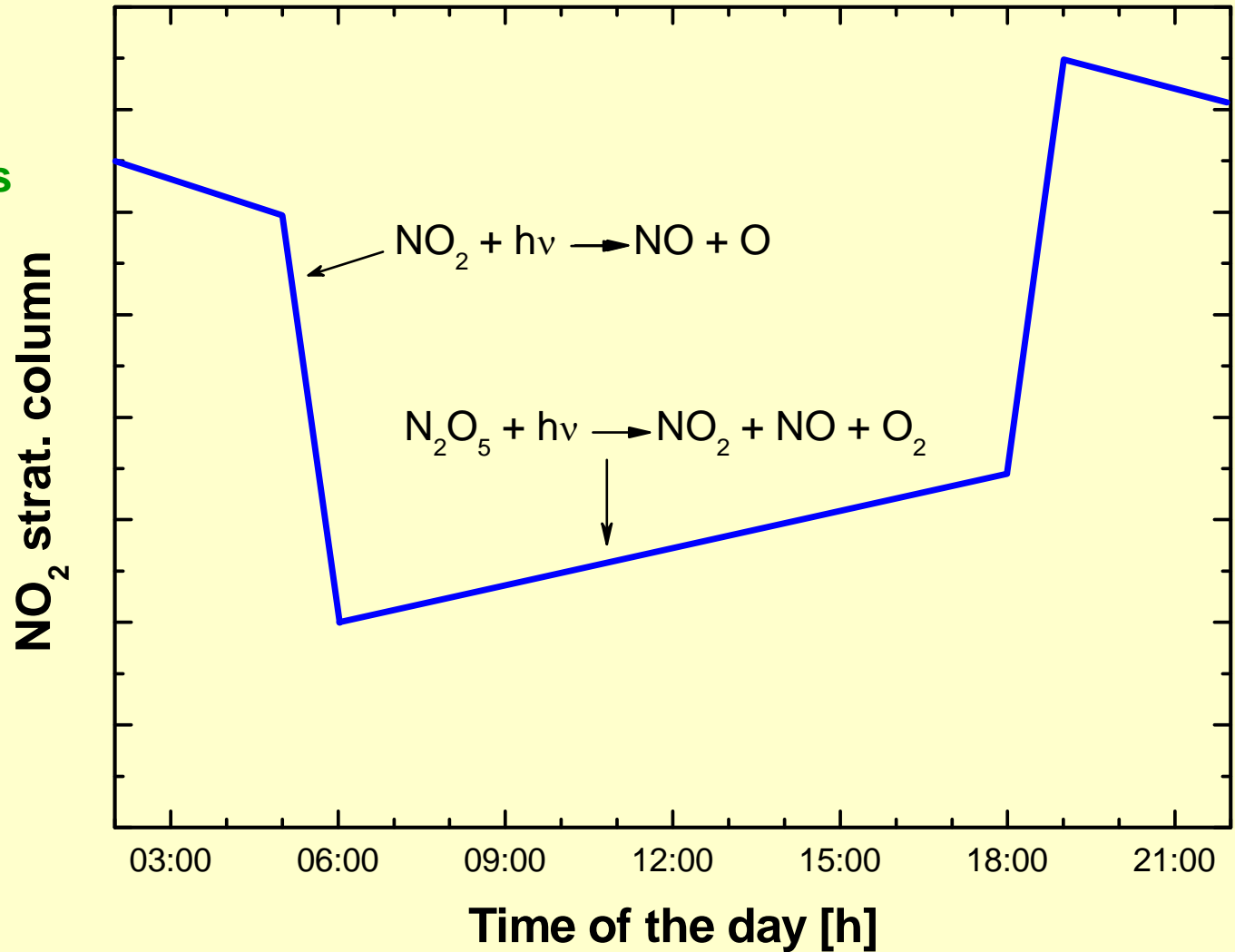


Retrieving the diurnal increasing rates of stratospheric NO₂ on global scale: joint NDACC activity?

basic behavior
described by various
photochemical models



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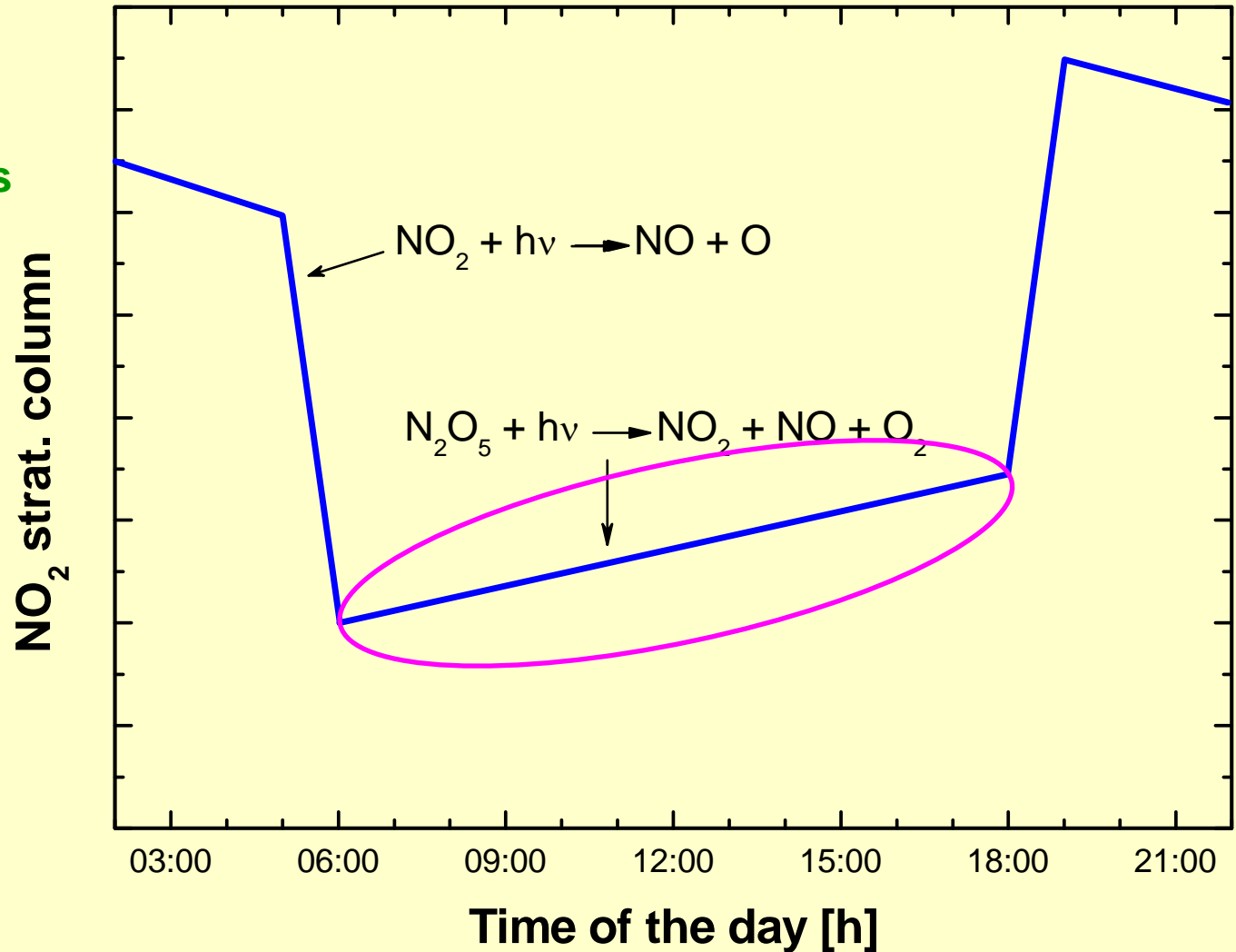
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Retrieving the diurnal increasing rates of stratospheric NO₂ on global scale: joint NDACC activity?

basic behavior
described by various
photochemical models

But: how does offset
and slope of diurnal
increase depend on

- season
- latitude
- other factors
(dynamics, PSCs)?



Motivation: Why are diurnal increasing rates of stratospheric NO₂ interesting?

- accurate knowledge of strat. NO₂ column is required for satellite retrievals of trop. NO₂
- the stratospheric NO₂ diurnal cycle hinders a direct comparison between satellite and g-b FTIR measurements, which are recorded not exactly at the same time (Lambert et al., 1999; 2004)
- correction of time-mismatch *via* photochemical models introduces unknown (model) errors to the validation
- g-b FTIR is able to retrieve itself diurnal increasing rates (probably the only way to measure the diurnal increasing rates of the strat. NO₂ column?)
- FTIR can validate photochemical models

References

Flaud et al., GRL, 10, 1983 (strat. photochem. model)

Sussmann, Stremme, Burrows, Richter, Seiler, Rettinger, ACP, 5, 2657-2677, 2005: Tropospheric NO₂ from combined SCIAMACHY and Zugspitze FTIR retrieval

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Diurnal increasing rates of strat. NO₂

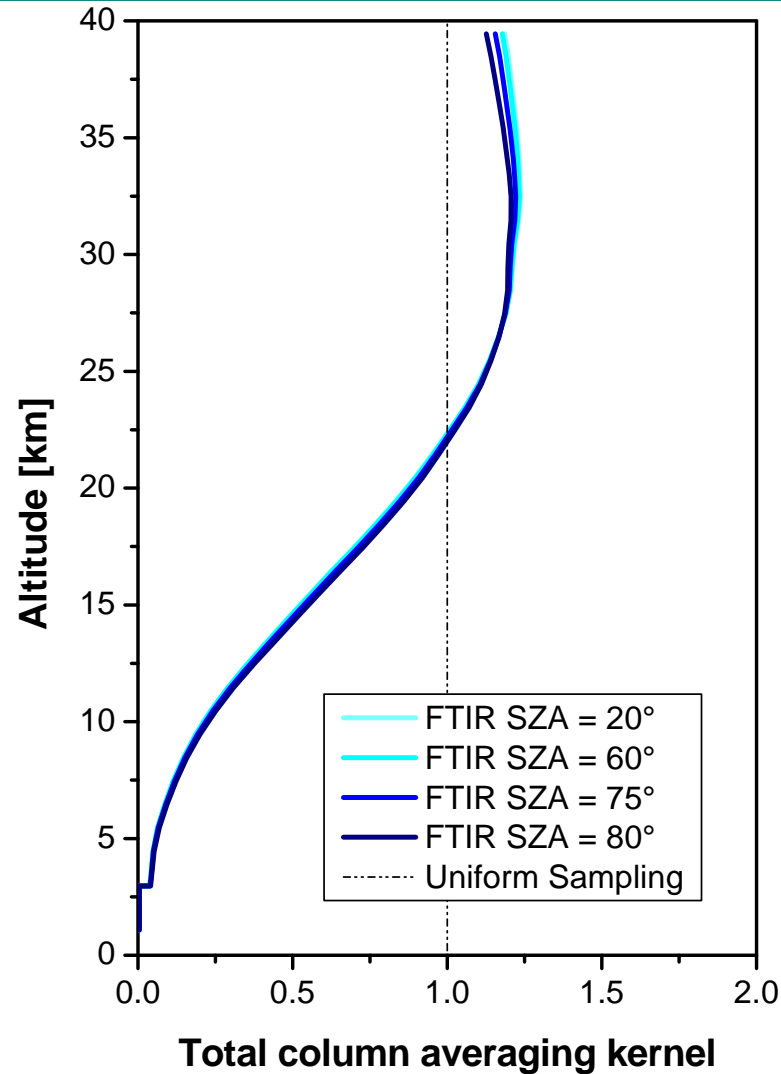
Solar FTIR retrieval of “total“ NO₂

First solar FTIR retrieval of total NO₂ (2914 cm⁻¹):
Camy-Peyret et al., GRL, 10, 1983

First remark on **possible strong a-priori-contribution**:
Rinsland et al., JGR, 108, 2003

NO₂ total column averaging kernels: FTIR

dofs \approx 1
⇒ use VMR-profile scaling retrieval



taken from:
Sussmann, Stremme,
Burrows, Richter, Seiler,
and Rettinger,
Atmos. Chem. Phys., 5,
2657-2677, 2005.

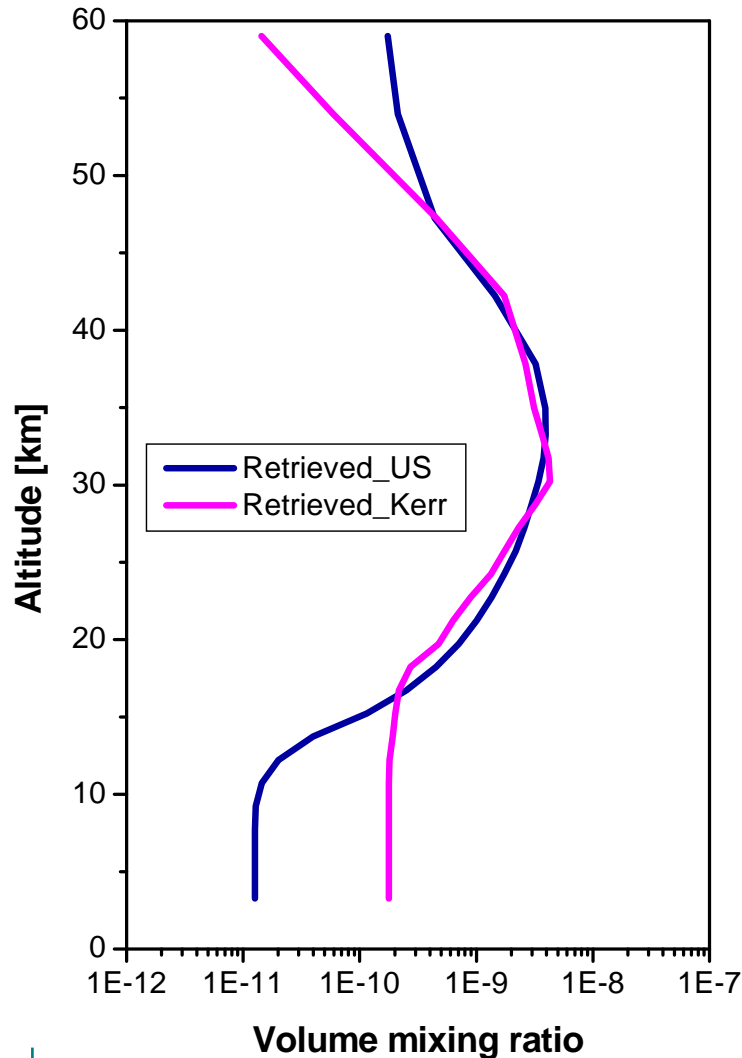
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Diurnal increasing rates of strat. NO₂

Retrieved from the same Zugspitze FTIR spectrum using differing a priori profiles

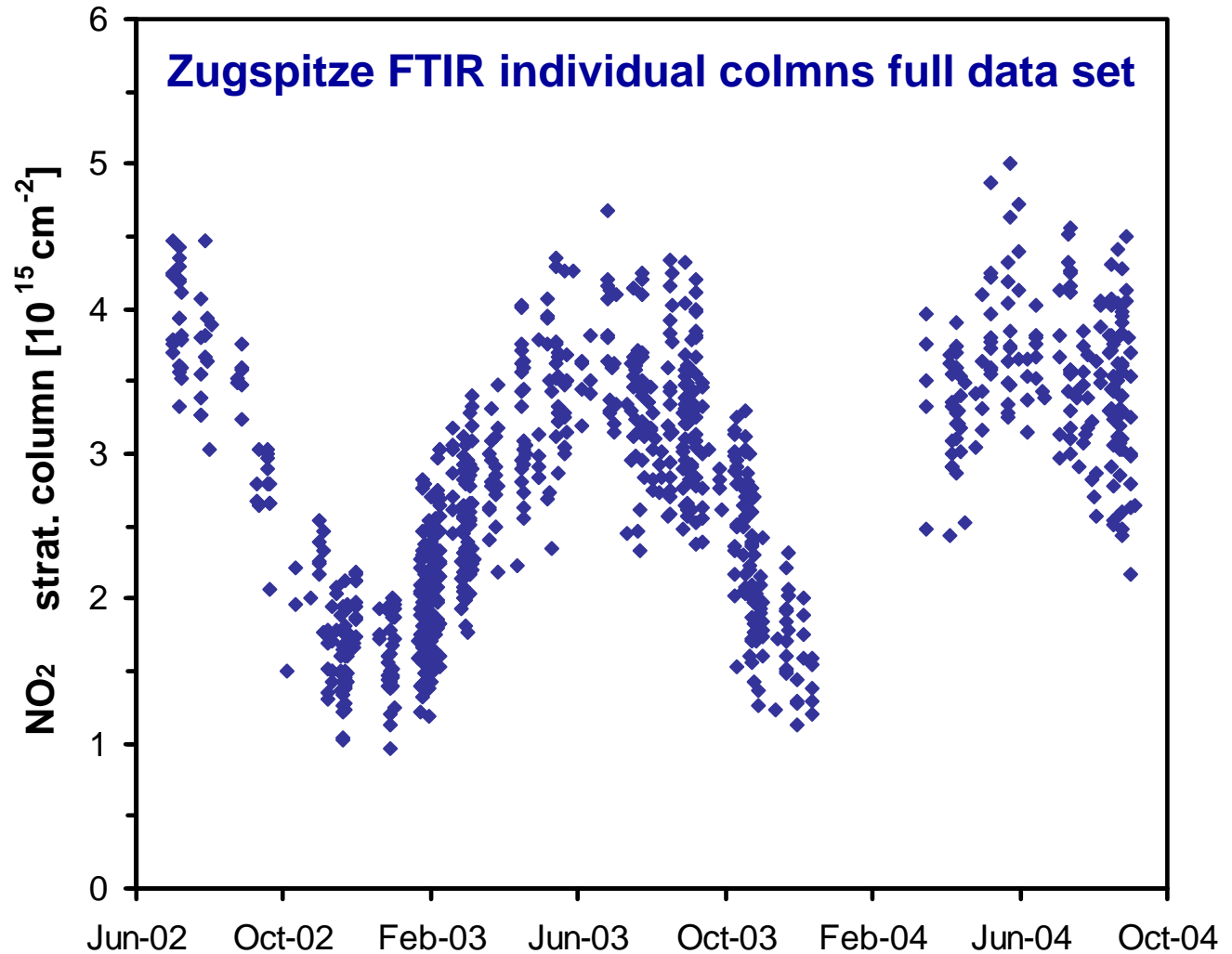


Solar FTIR retrieval not sensitive in the troposphere, can only retrieve strat. column



- use US Standard profile with **VMR = 0** in the troposphere as a priori
- or read out only the stratospheric part of the retrieval

Strat. NO₂ from Zugspitze FTIR: annual cycle + diurnal increase



taken from:
Sussmann, Stremme,
Burrows, Richter, Seiler,
and Rettinger,
Atmos. Chem. Phys., 5,
2657-2677, 2005.

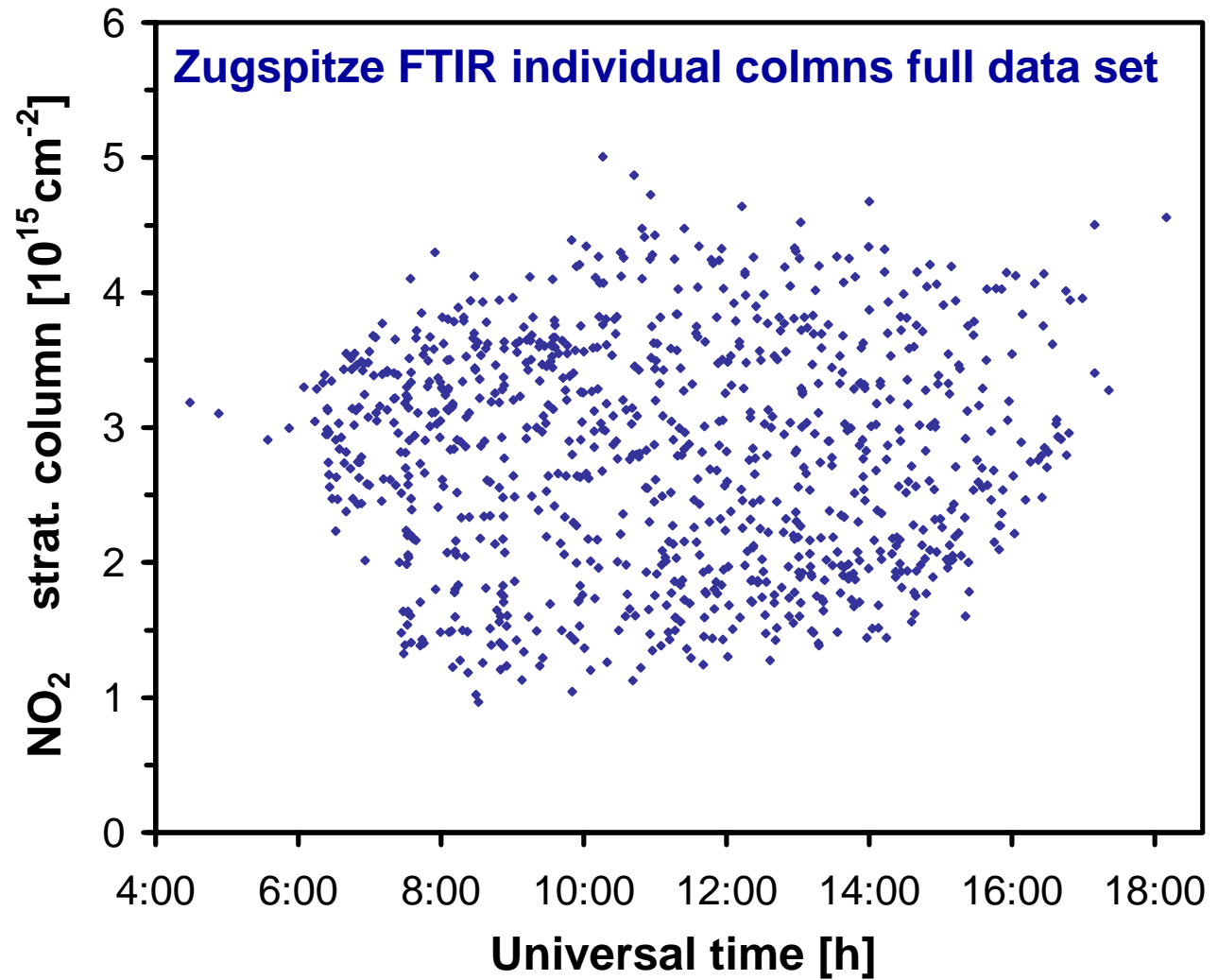
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Diurnal increasing rates of strat. NO₂

Strat. NO₂ diurnal increasing rate: Retrieval from Zugspitze FTIR



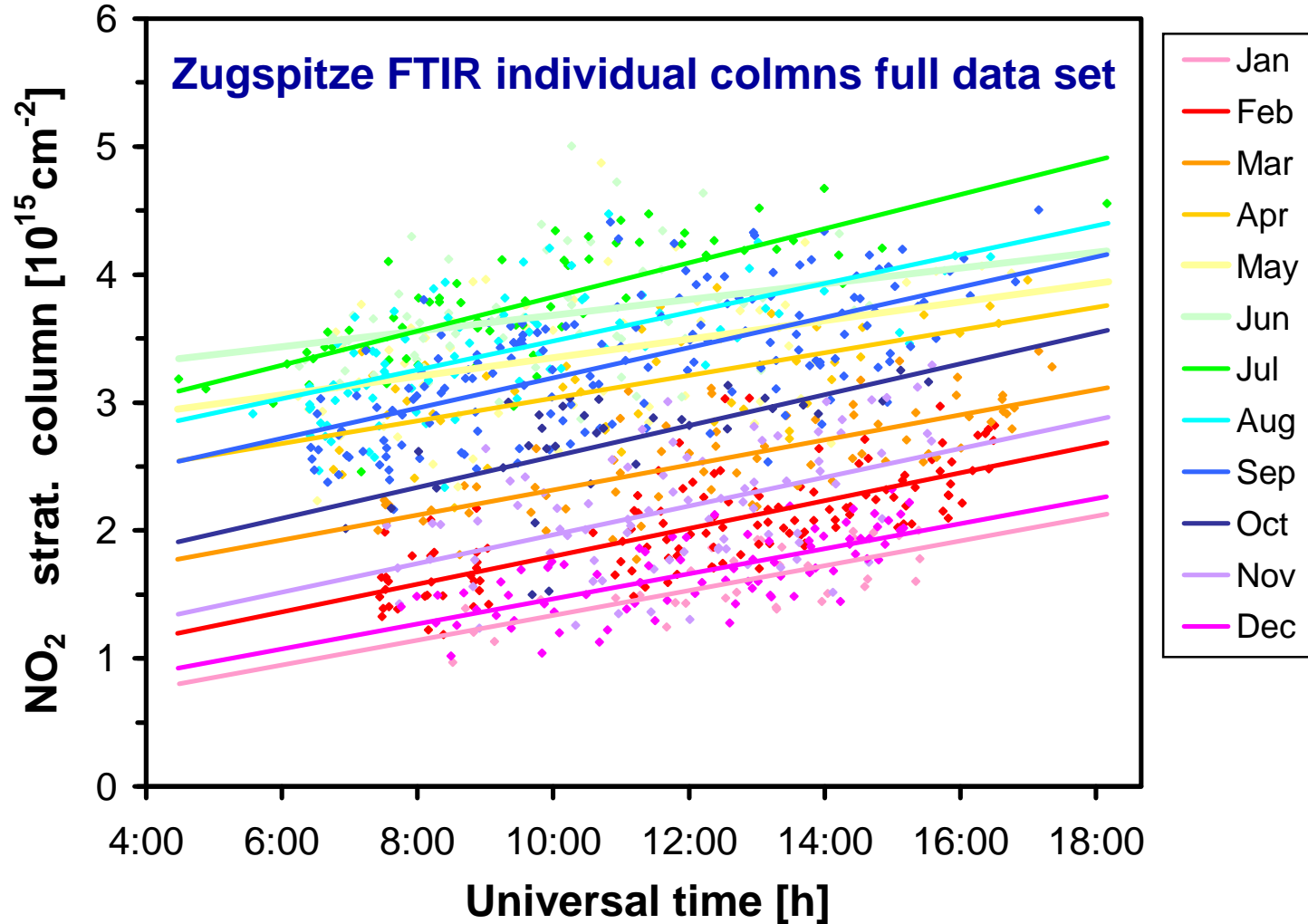
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Diurnal increasing rates of strat. NO₂

Strat. NO₂ diurnal increasing rate: Retrieval from Zugspitze FTIR



taken from:
Sussmann, Stremme,
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Diurnal increasing rates of strat. NO₂

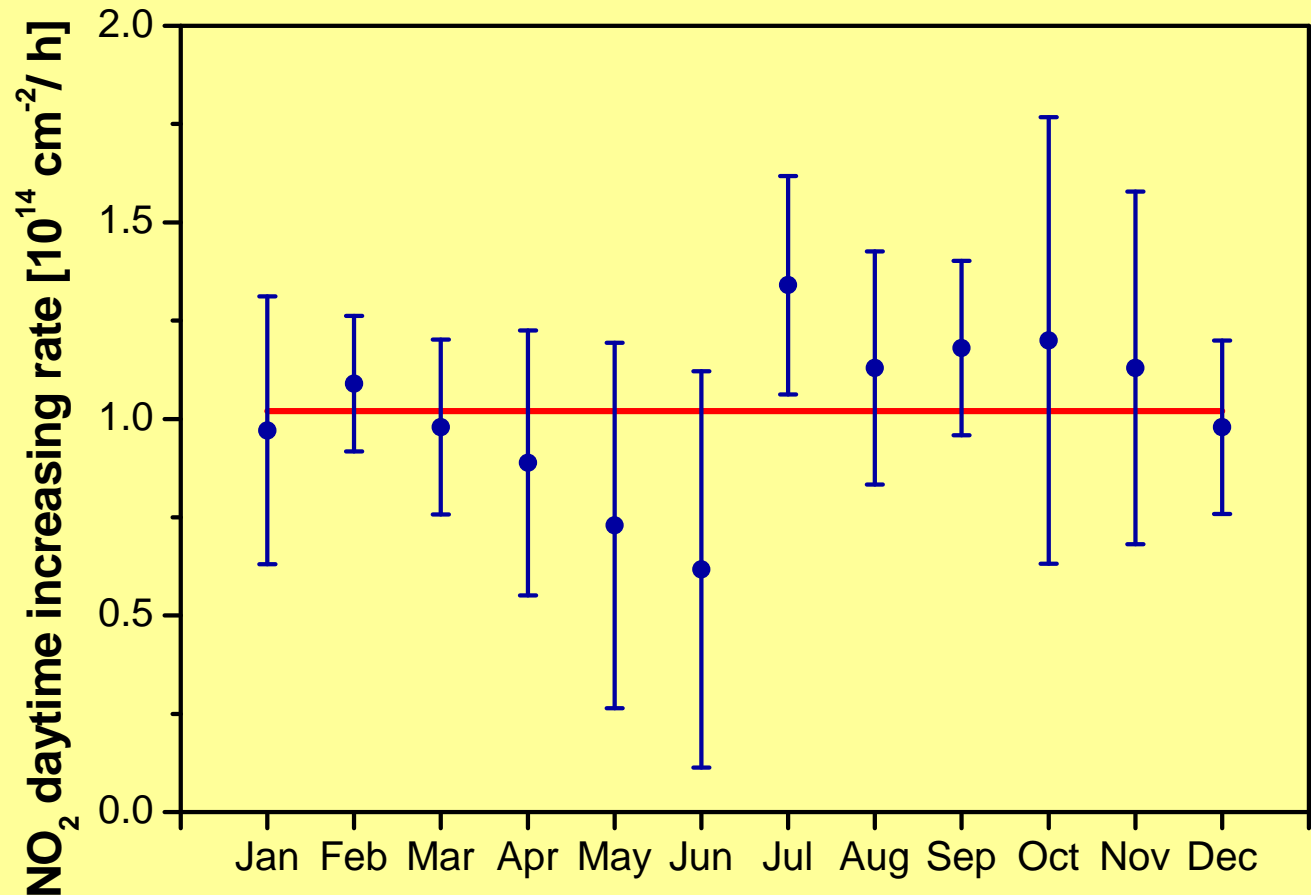
Strat. NO₂ diurnal increasing rate: Does it depend on season?

Flaud et al., GRL, 10, 1983 (strat. photochem. model):

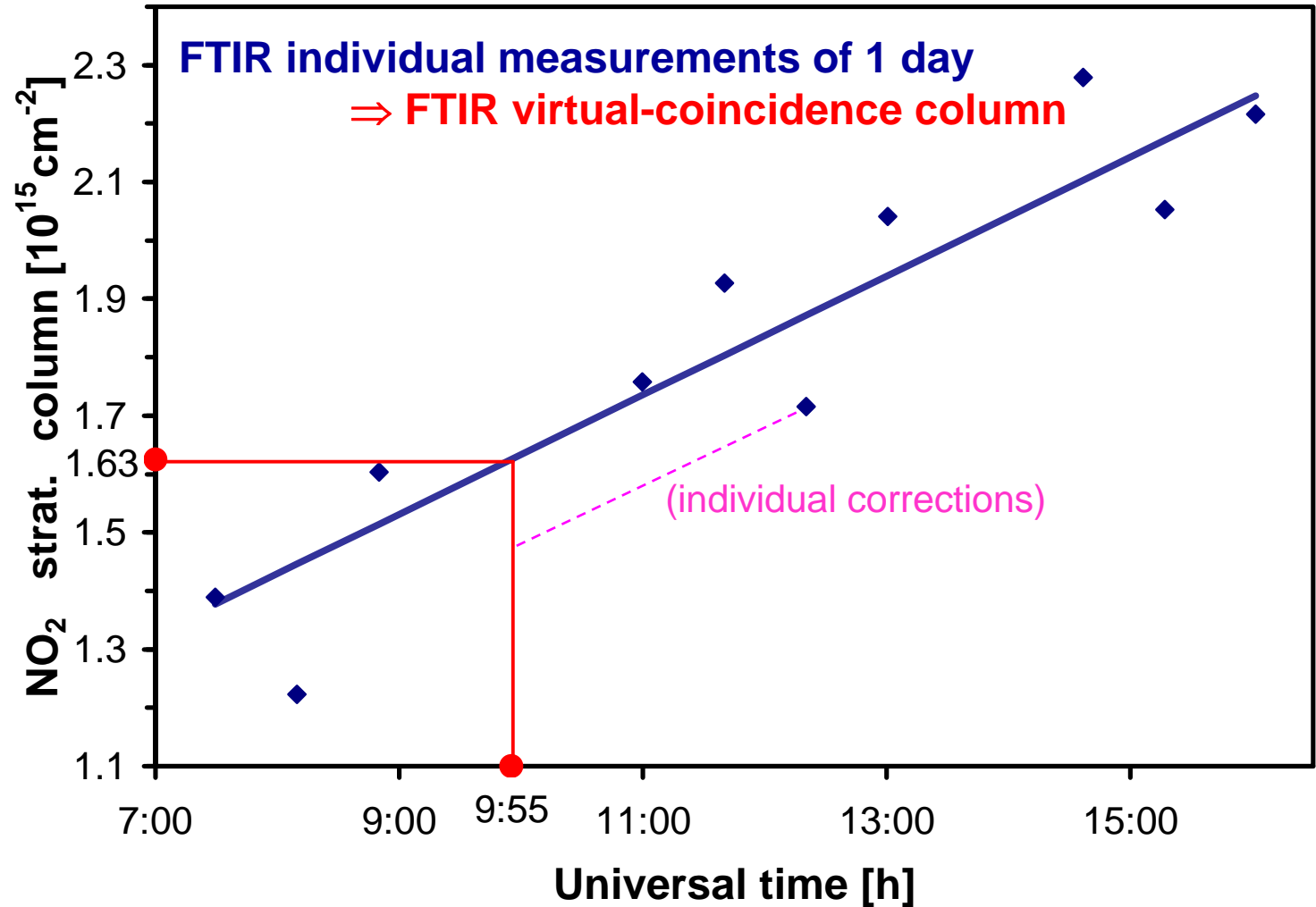
“diurnal increasing rate should be a function of the season” since the build up of N₂O₅ depends on the length of the night and because its rate of photo dissociation varies with solar elevation.“

Not for Zugspitze:

⇒ 1 Mean diurnal increasing rate for mid-latitudes =
+ 1.02(6)E+14 cm⁻²/h



Matching FTIR to satellite overpasses: Concept of „virtual coincidences“



taken from:
Sussmann, Stremme,
Burrows, Richter, Seiler,
and Rettinger,
Atmos. Chem. Phys., 5,
2657-2677, 2005.

FTIR precision for strat. NO₂ < stdv of retr. strat. columns rel. to linear increase

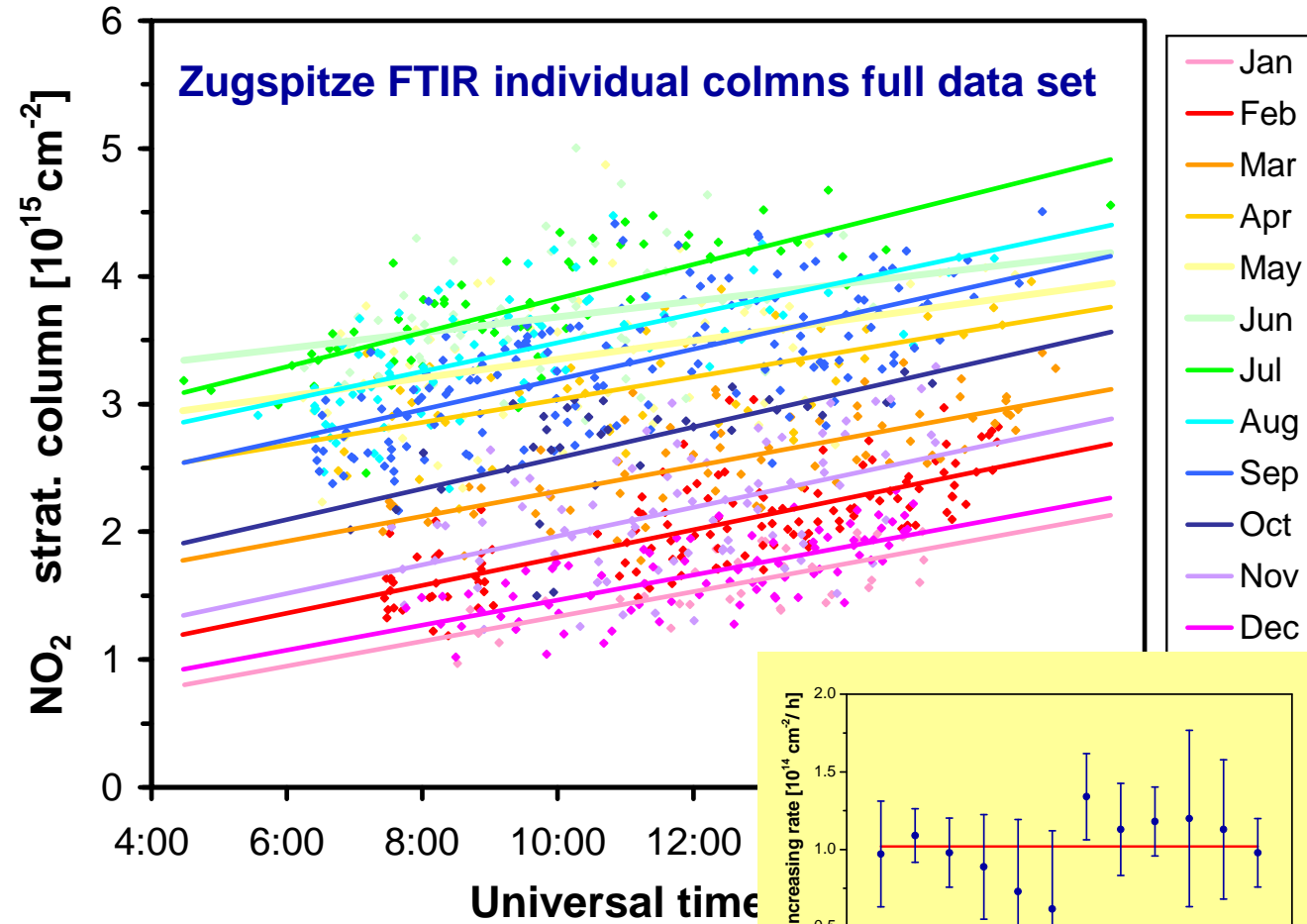
	$AV_i(n_i)$	$AV_i(\sigma_i)$	$AV_i(\sigma_i/\text{sqrt}(n_i))$
Zugspitze FTIR	4.6	8.8 %	4.3 %

taken from:
Sussmann, Stremme,
Burrows, Richter, Seiler,
and Rettinger,
Atmos. Chem. Phys., 5,
2657-2677, 2005.

Strat. NO₂ diurnal increasing rate: How would this plot look like for other sites?

Site-dependent factors?

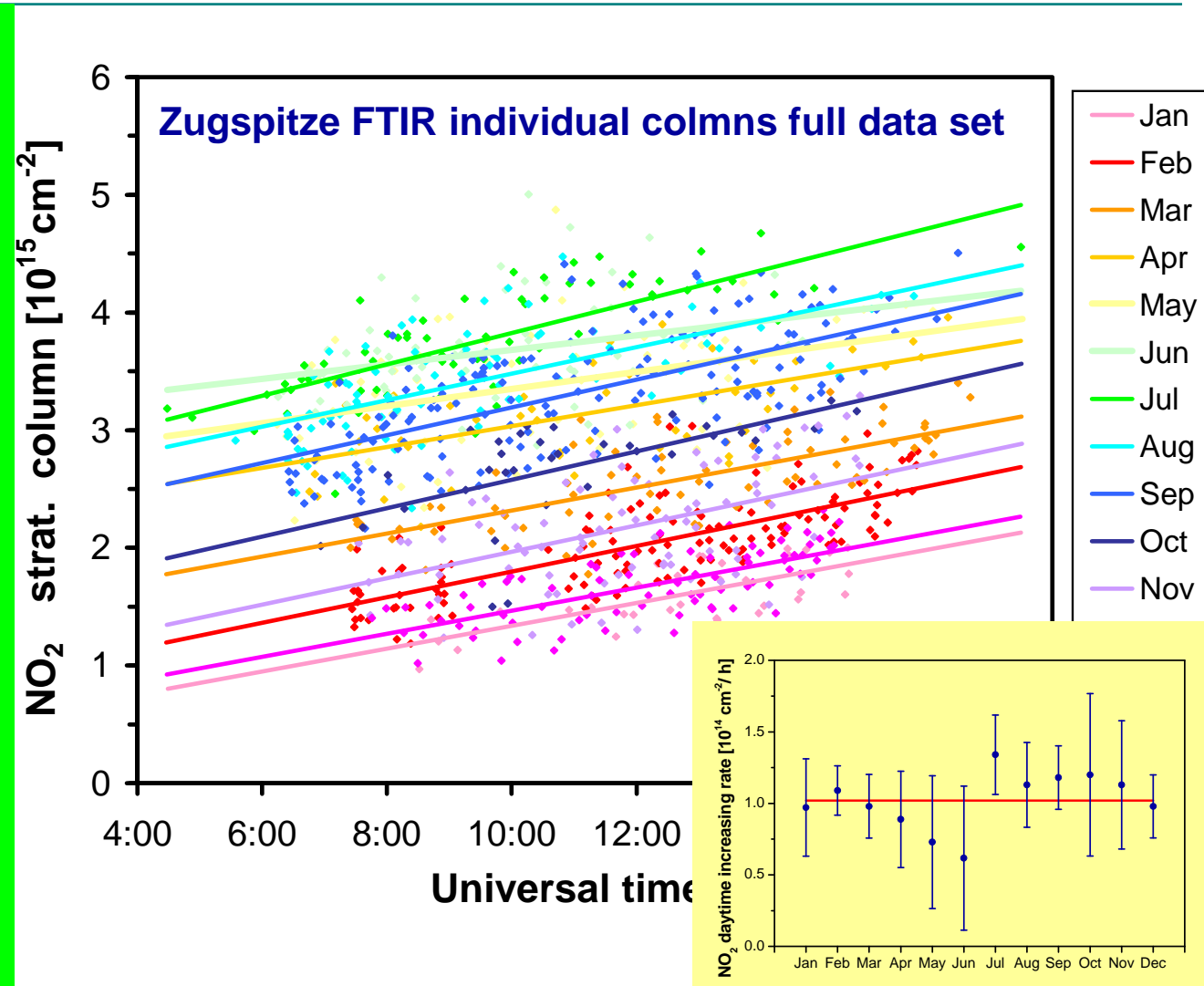
- dependency on latitude?
- dependency on dynamical effects (vortex boundary)?
- dependency on PSCs?



Strat. NO₂ diurnal increase on global scale: Suggestion for a NDACC exercise

Possible action items

- make this kind of plot for your site
- think about /play with intelligent variations of this plot dedicated to your site (separate intra-/extra-vortex conditions, separate days with/without PSCs, ...)
- send me your strat. NO₂ columns if interested in ex.
- help to find an interested modeller to simulate this plot for all sites
- ...?



Wuppertal

Ralf Sussmann

Wuppertal

Diurnal increasing rates of strat. NO₂