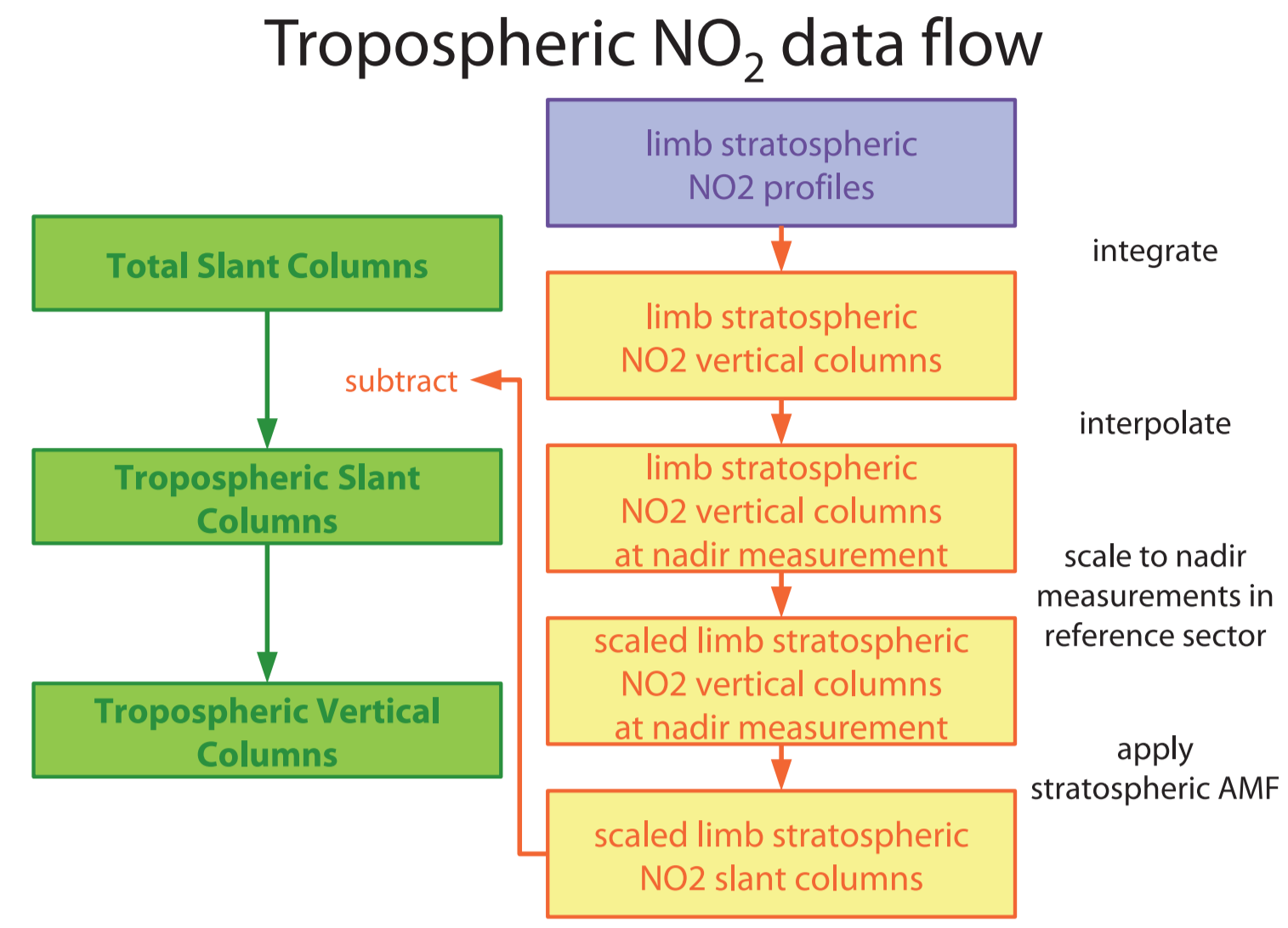# Tropospheric NO$_2$ from SCIAMACHY limb/nadir matching

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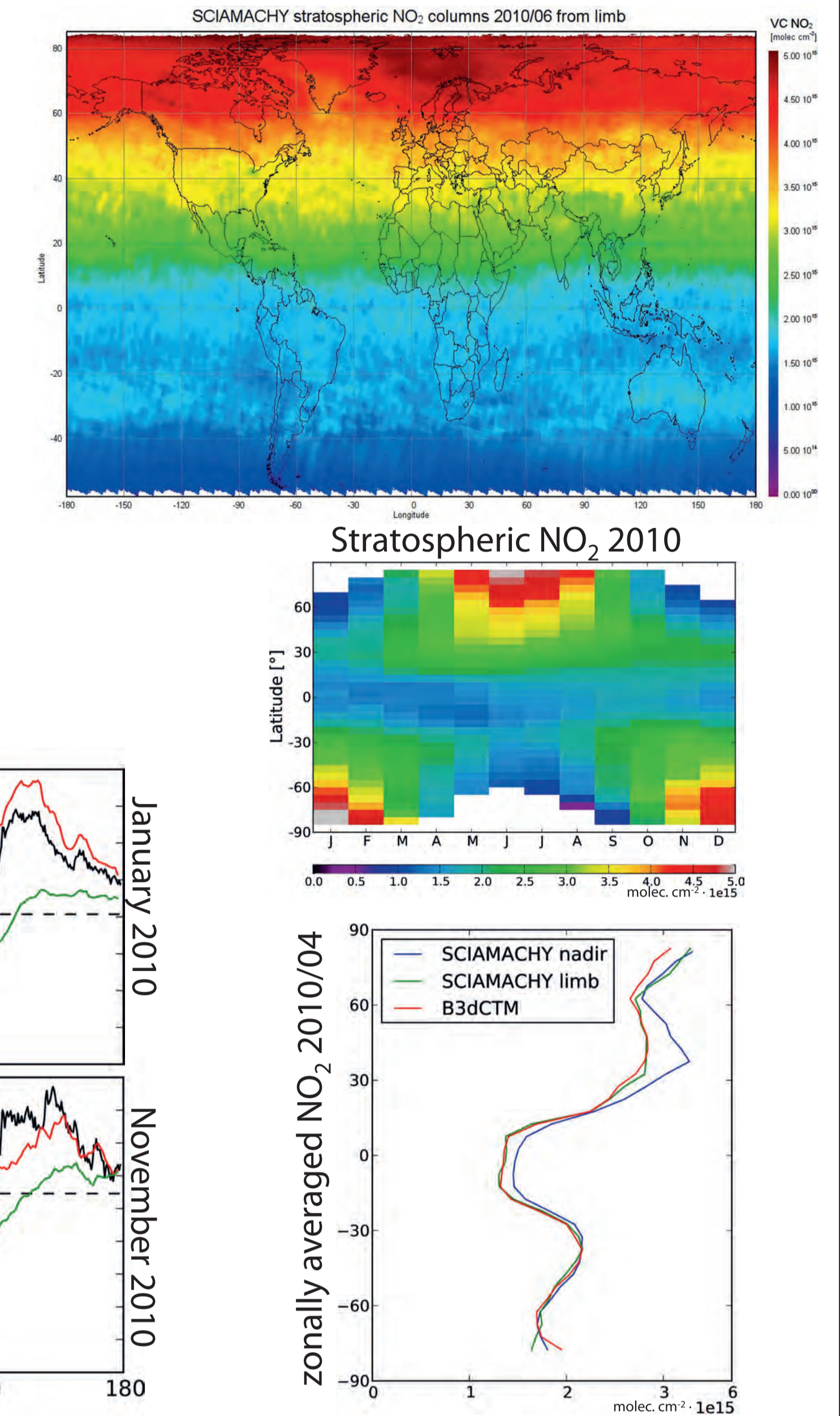Institute of Environmental Physics, University of Bremen, FB 1, P.O. Box 330 440, D-28334 Bremen

Introduction

- NO$_2$ is an important tropospheric pollutant: O$_3$ smog, acid rain
- Global measurements are available from satellite instruments, e.g. SCIAMACHY
- When measuring tropospheric pollution: must account for stratospheric NO$_2$ layer
- Traditionally, Pacific Ocean was defined as *"clean"* and taken as strat. signal
- SCIAMACHY offers additional measurements in limb geometry
- These have been used to calculate global smoothed fields of strat. NO$_2$
- Here we use limb measurements to determine the actual stratospheric NO$_2$ content for each nadir measurement

Tropospheric NO$_2$ data flow

Calculating strat. vertical columns

- Integrate limb-profiles (12km - 40km)

- Consider each limb state individually
- For each limb state, interpolate in latitude
- For each nadir measurement, interpolate one value per limb state, using latitude
- For each latitude, consider the limb state's line-of-sight
- For each nadir measurement, interpolate stratospheric column using the pixel's line-of-sight

- Limb columns differ from nadir columns over clean regions (Pacific Ocean)
- When assuming no tropospheric NO$_2$ over Pacific, we need to apply linear offset to vertical limb columns
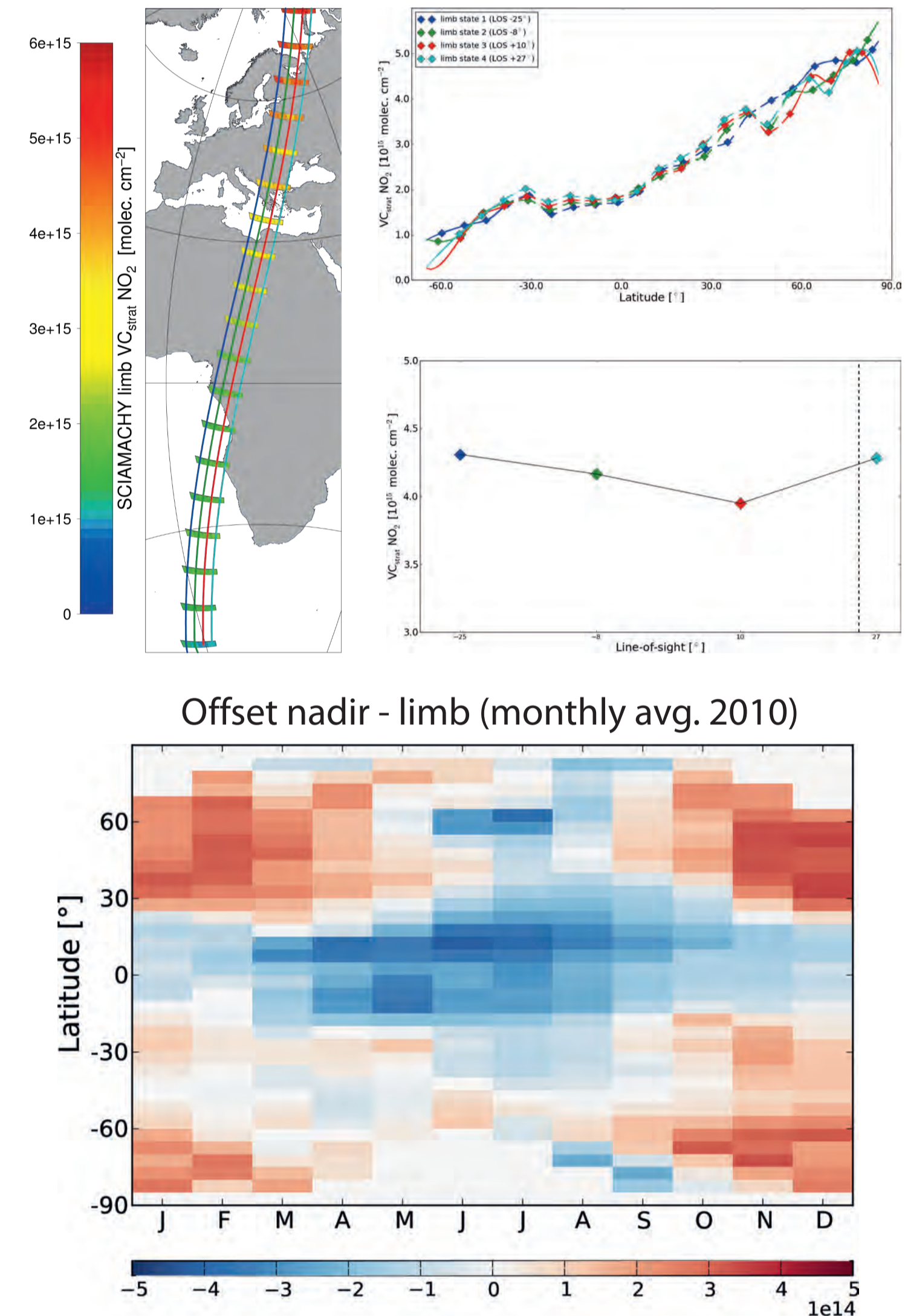
Offset nadir - limb (monthly avg. 2010)

Stratospheric NO$_2$ columns from limb

- limb columns show expected patterns: high values in summer, low values in winter
- scaled limb columns in excellent agreement with nadir measurements:
  - virtually no difference in clean regions
  - NH pollution (betw. 25°N and 60°N) and African biomass burning visible in nadir - limb
- SCIAMACHY limb stratospheric NO$_2$ in better agreement with nadir than B3dCTM model data

Stratospheric NO$_2$ 2010

Longitudinal variation 60°N - 65°N


A glance at the trop. slant columns
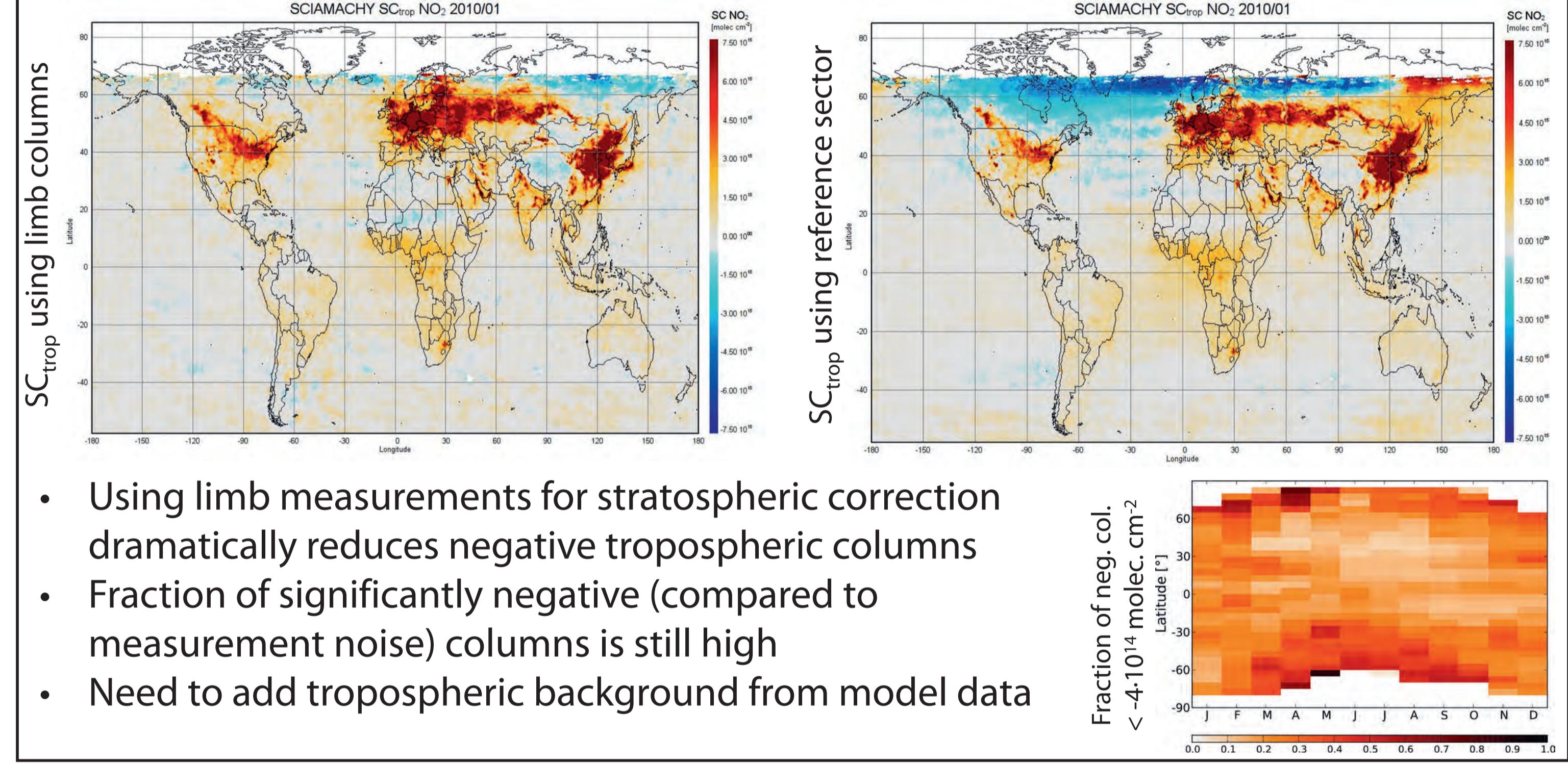
- Using limb measurements for stratospheric correction dramatically reduces negative tropospheric columns
- Fraction of significantly negative (compared to measurement noise) columns is still high
- Need to add tropospheric background from model data

Error analysis

- Error in nadir slant columns: 2-4·10^{14} molec. cm^{-2}
- Error in limb profiles from noise and smoothing: 15-20%
- Error from lightpath uncertainty: up to 20%

- Tropospheric reference sector not perfectly clean: need to add trop. columns from model

- Stratospheric a-priori for nadir zonally constant
- Nadir-columns not T-corrected (243K)
- No limb measurements lower than 12km and above 40km: need to account for missing and tropospheric parts of profile

These errors are partially accounted for by scaling limb columns to nadir columns over the Pacific Ocean. Only their zonal variability contributes to the total error.

Trop. NO$_2$ over Pacific from OsloCTM2, 2004-2007

Still, the resulting tropospheric data product looks remarkably good!
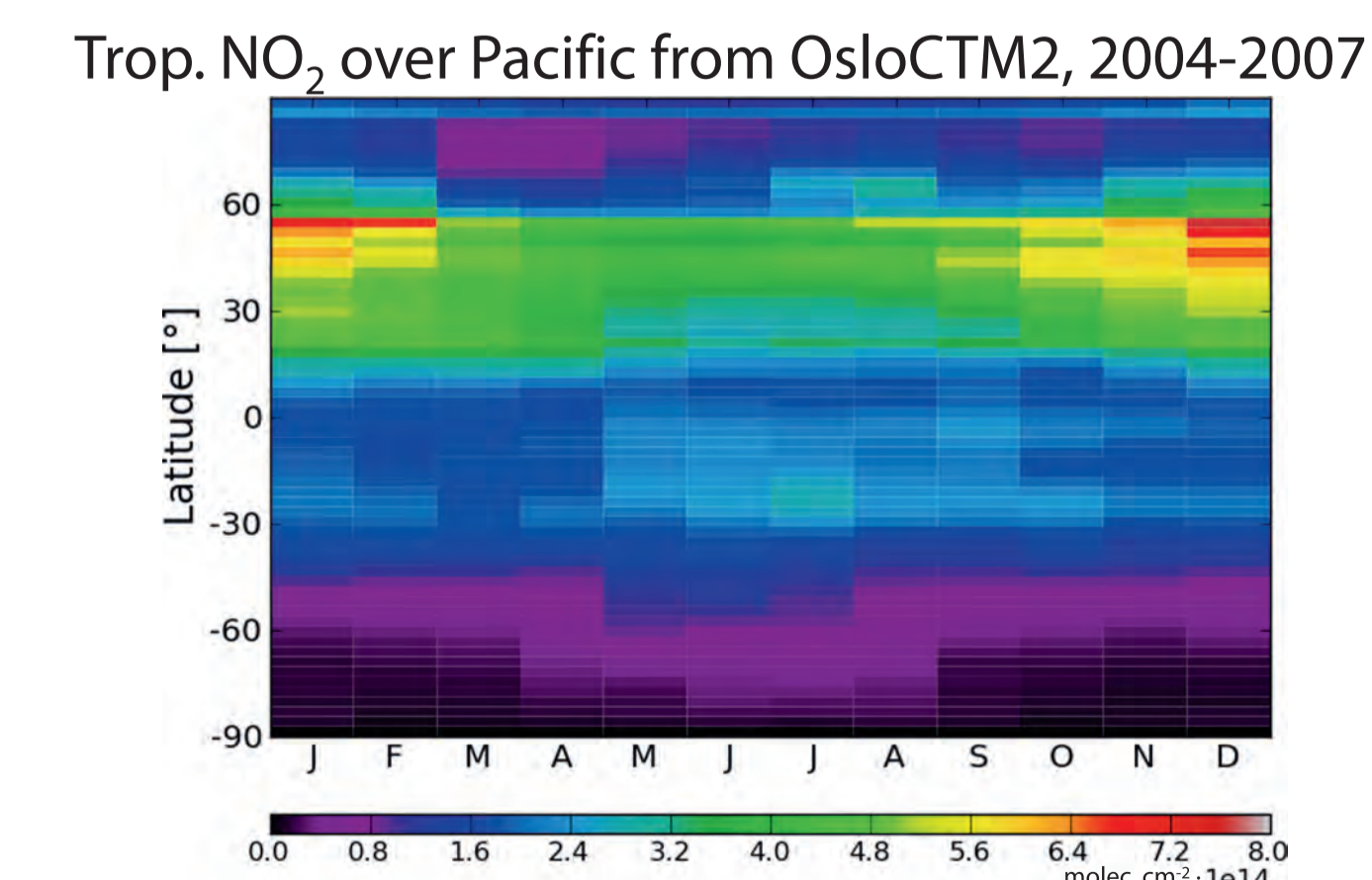
Summary

- Per-pixel calculation of stratospheric NO$_2$ columns using the same instrument as for nadir columns
- Absolute difference between nadir and limb columns accounted for using linear, latitude-dependent offset

- Over clean regions very good agreement between nadir and scaled limb columns
- Most error sources are accounted for in zonal averages; only their zonal variability contributes to total error
- Resulting tropospheric columns show almost no negative values

Selected References

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