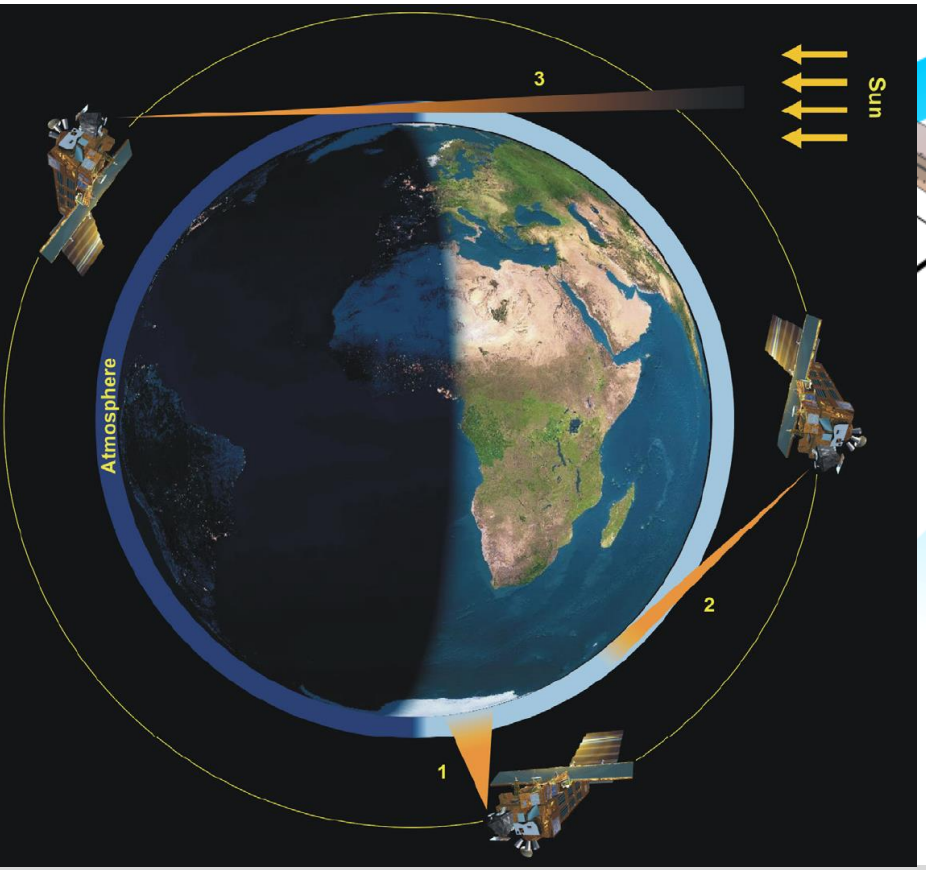
Stratospheric Aerosol Extinction from SCIAMACHY

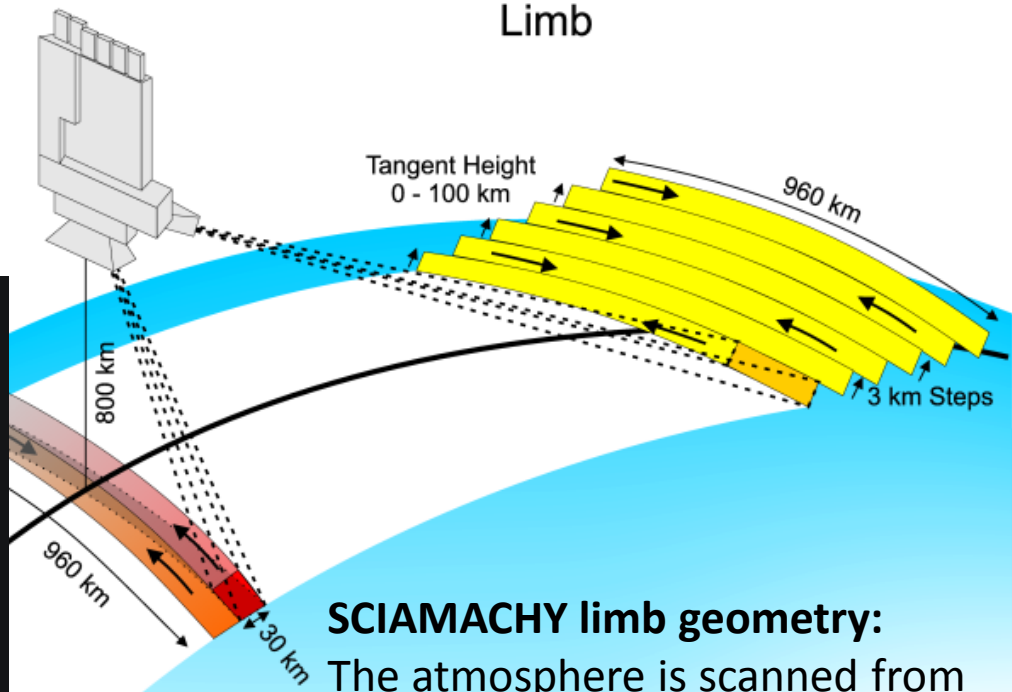
L. A. Brinkhoff[1], A. Rozanov[1], F. Ernst[1],
R. Hommel[1], C. von Savigny[2], C. Gebhardt[1],
H. Bovensmann[1], and J. P. Burrows[1]

1. Institute of Environmental Physics and Remote Sensing, University of Bremen, Bremen, Germany
2. Institute of Physics, Ernst-Moritz-Arndt-University of Greifswald, Greifswald, Germany

SCIAMACHY/Envisat limb measurements

Operating time: March 2002 – April 2012
Orbit information: sun-synchronous, ~800 km altitude





SCIAMACHY limb geometry:
The atmosphere is scanned from 0 km to ~93 km with tangent height steps of 3.3 km, measuring scattered solar radiation.

Spatial resolution:
[4 × 240 × 400] km
(vert. × across × along flight dir.)

Data processing and data product

MEASUREMENT

Vertical profiles of the **scattered solar radiation** between 230-2380 nm (spectral sampling between 0.11-0.74 nm)

RETRIEVAL

- **Measurement vector**:
  1. tangent height normalization,
  2. wavelength pairing, 470 and 750 nm (Bourassa et al., 2007)
- **Solving the inverse problem**: SCIATRAN + optimal estimation method (Rodgers, 2000)
- **Product**: vertical aerosol extinction coefficient profile at 470 and 750 nm

LEVEL 3 DATA

- Aerosol extinction coefficient profiles [1/km] at 470 nm and 750 nm
- **Grid**: monthly mean, 1 km altitude, 5° latitude, 5° longitude

Current product version: **V1.1**

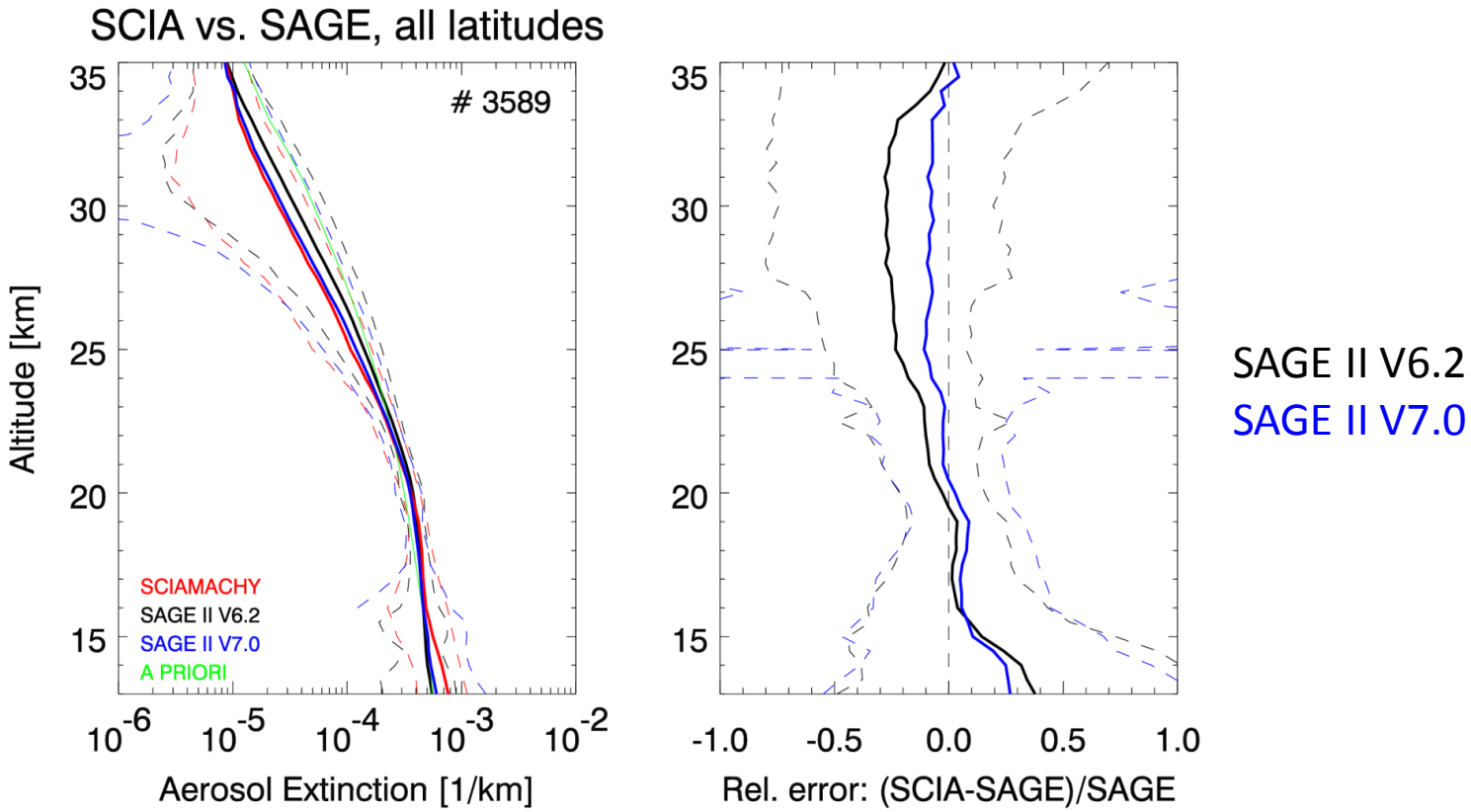
Validation with SAGE II

Comparison with SAGE II V6.2 and V7.0 (occultation geometry) at co-located measuring points.

Co-location criteria: spatial diff. < 500 km, temporal diff. < 6h

SCIAMACHY orbits: 4382-18119, 01/01/2003-08/17/2005

# of co-locations: N = 3589 (for all latitudes between 80°N and 80°S)

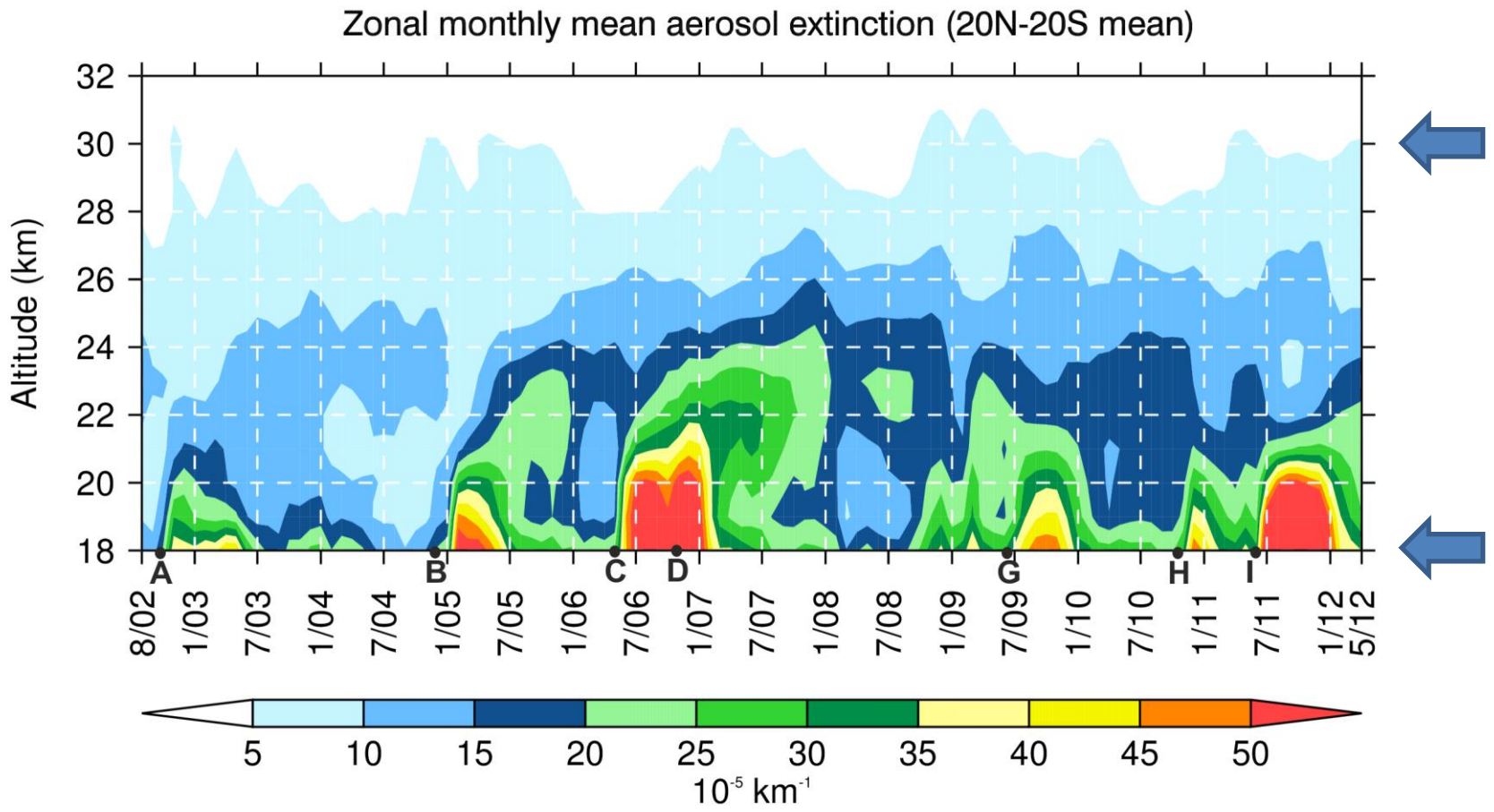


From F. Ernst (PhD Thesis, 2013), Paper in prep.

SCIAMACHY stratospheric aerosol record V1.1

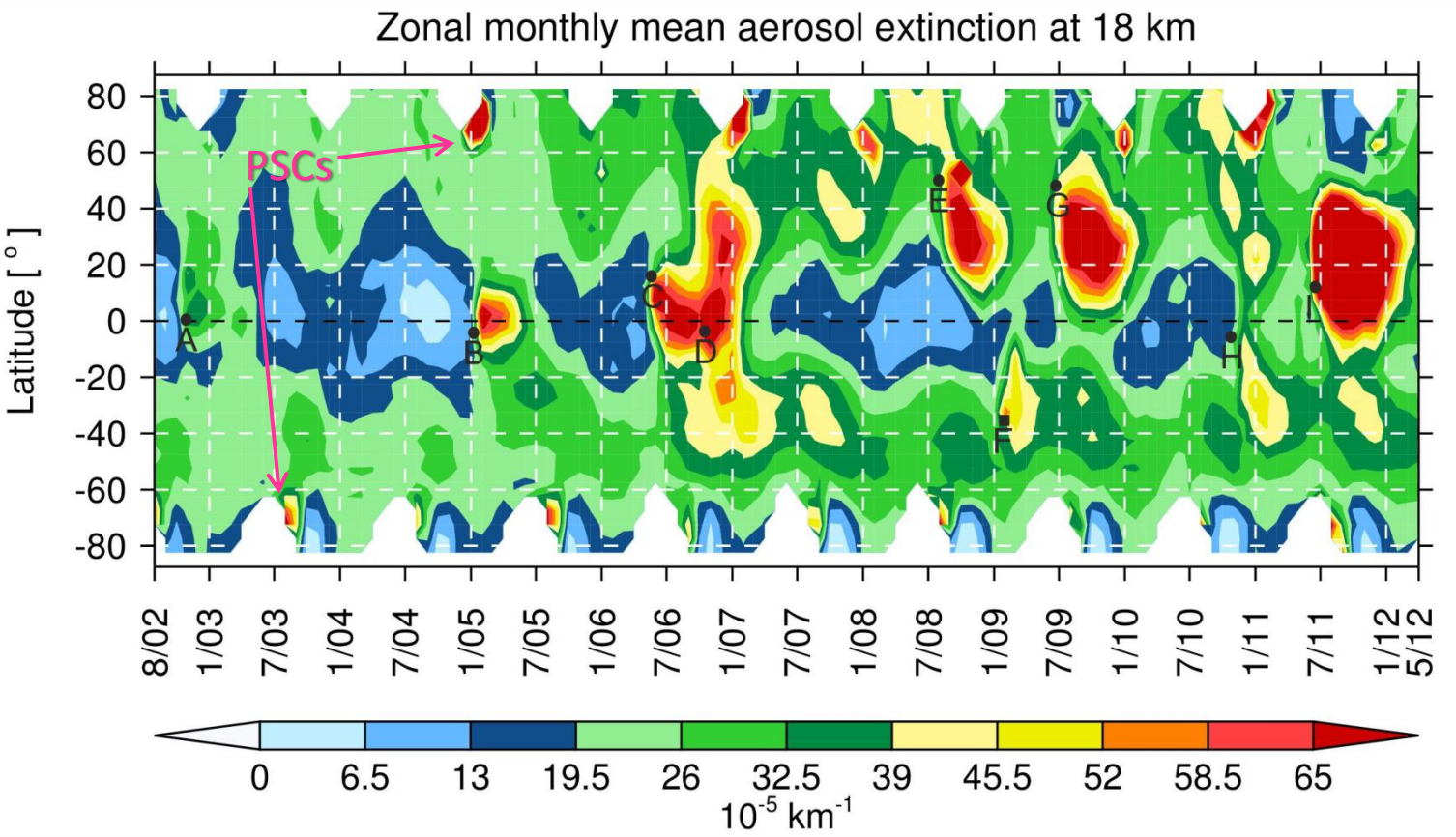
in zonal monthly mean extinction coefficients at 750 nm

Data record



A) Ruang, Sep `02, 2°N, Reventador, Nov `02, 0°
B) Manam, Jan `05, 4°S
C) Soufriere Hills, May `06, 16°N
D) Tavurvur, Oct `06, 4°S
E) Kasatochi, Aug `08, 52°N
F) Black Saturday Australia, Feb+March `09, 37°S ?
G) Sarychev Peak, June `09, 48°N
H) Mount Merapi, Oct `10, 7°S
I) Nabro, June `11, 13°N

Aerosol observations in the lower stratosphere



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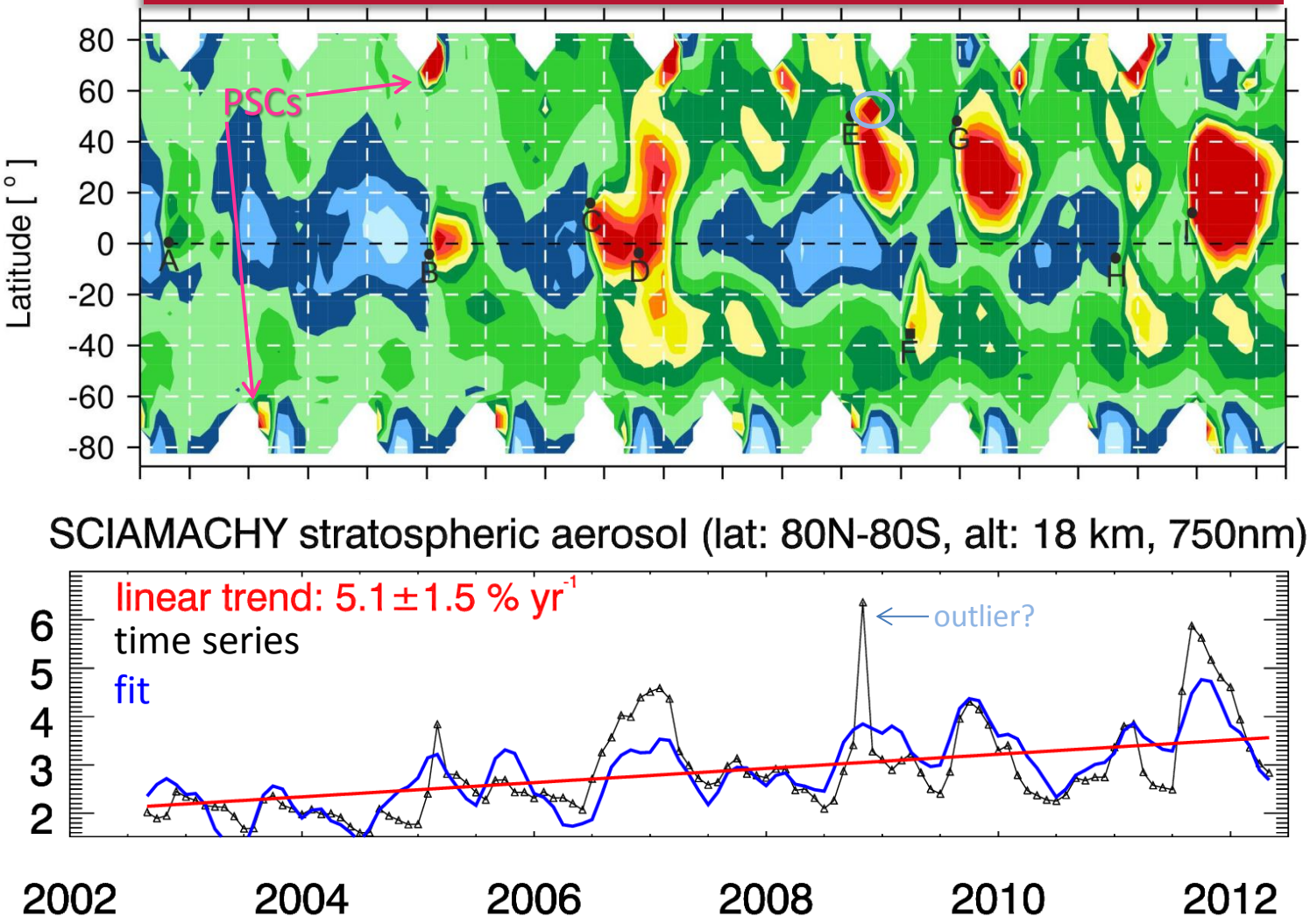
Trend estimates

… with a multivariate linear regression analysis

2002-2012: Increase in the aerosol load at 18 km



A volcano proxy has to be included.

The tropical stratospheric aerosol distribution at 30 km …

Biennial variation

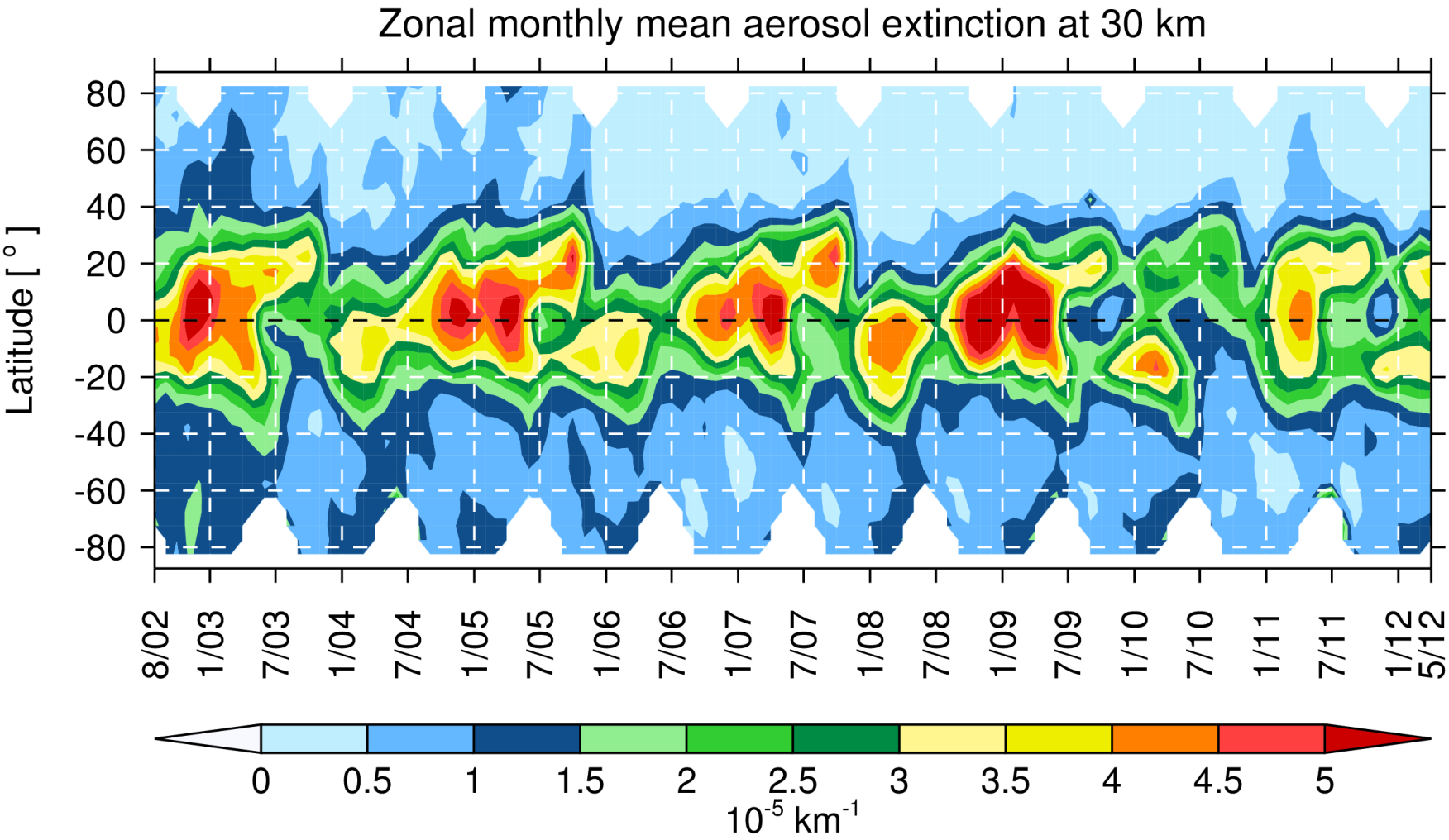


Figure 1: ERA-Interim QBO in zonal mean zonal wind (3N-3S mean)

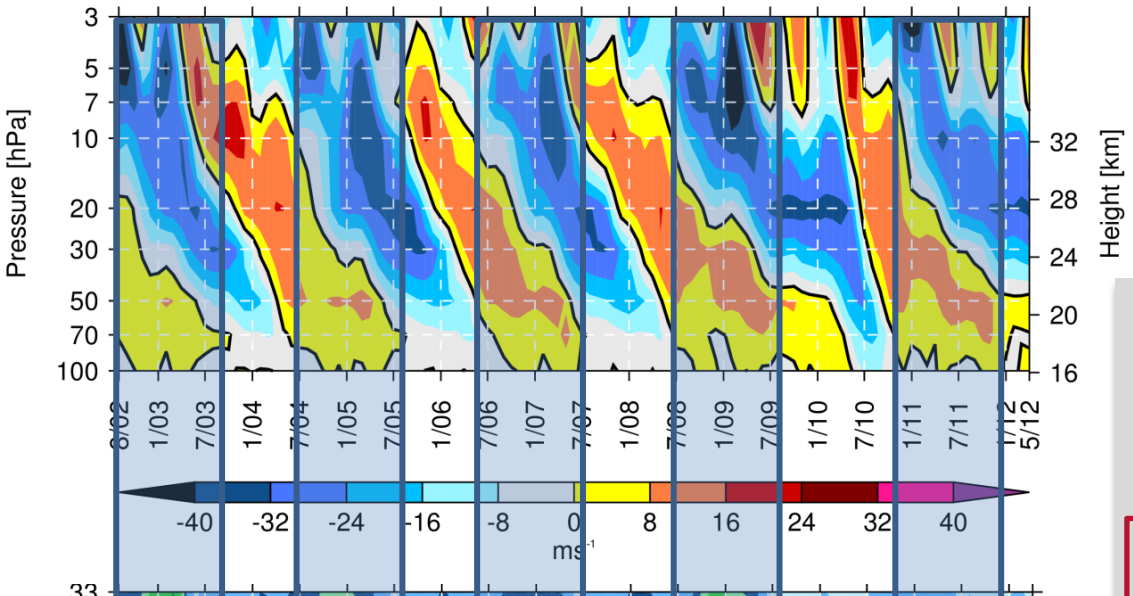


Figure 2: Zonal monthly mean aerosol extinction (3N-3S mean)

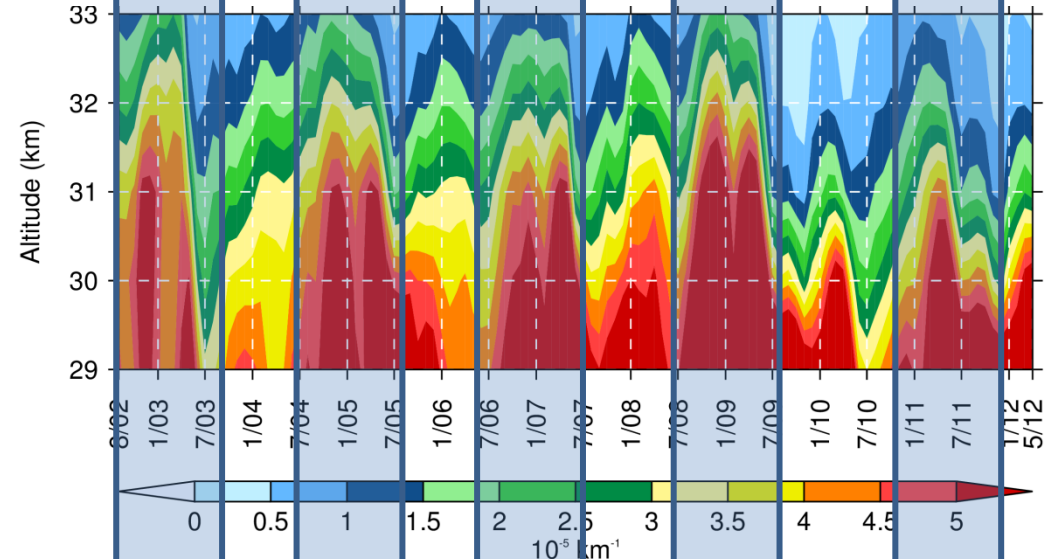
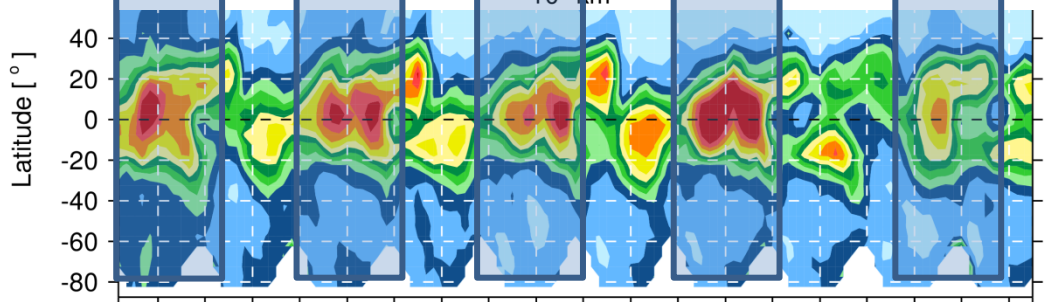


Figure 3: Zonal monthly mean aerosol extinction at 30 km

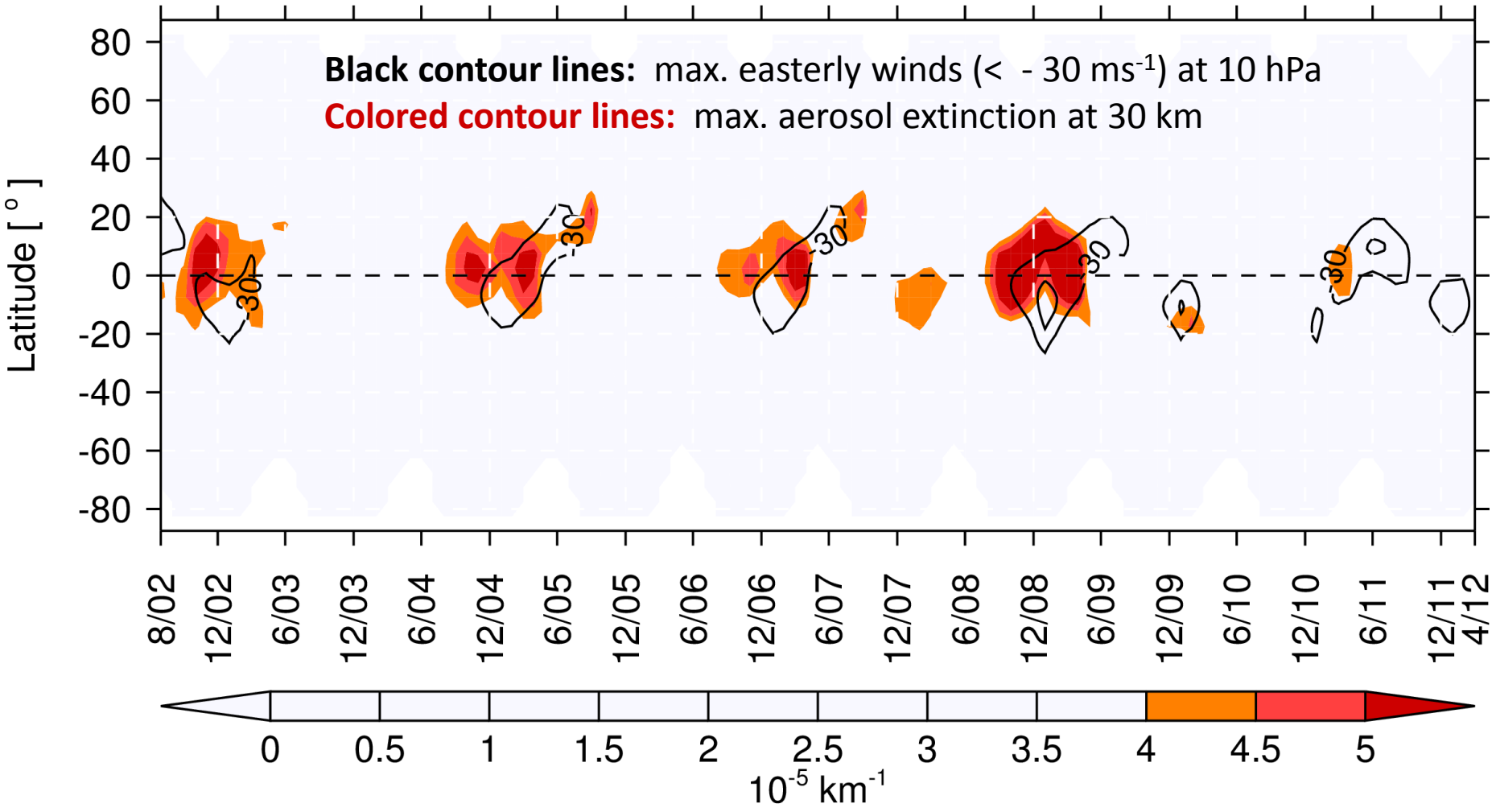


… the biennial variation is due to the QBO in eq. zonal wind.

Maximum vertical extension of the aerosol layer during easterly shear period.

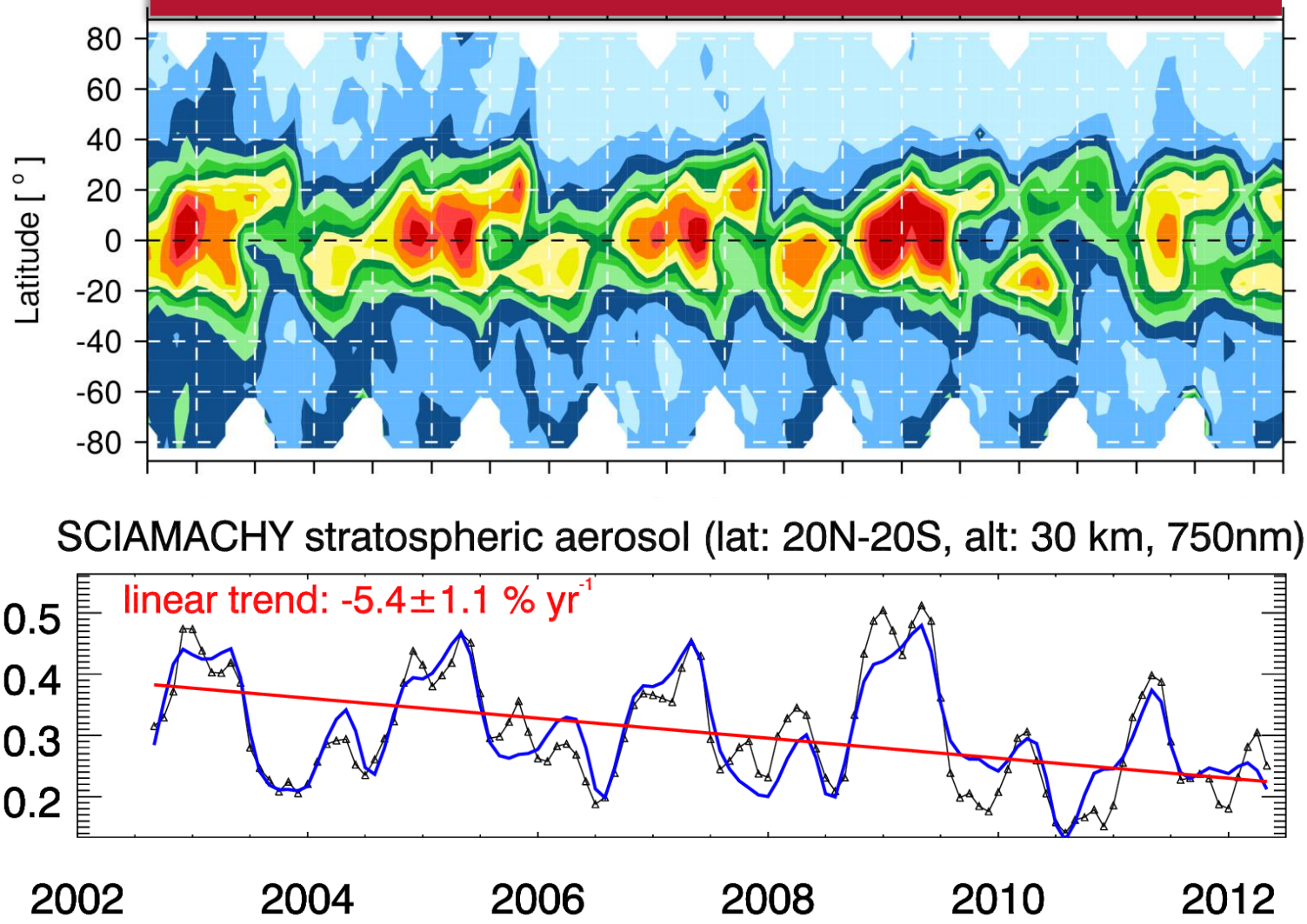
Which coincides with strong easterly winds at ~ 10-5 hPa.

Correlation between maximum easterly winds and maximum aerosol load

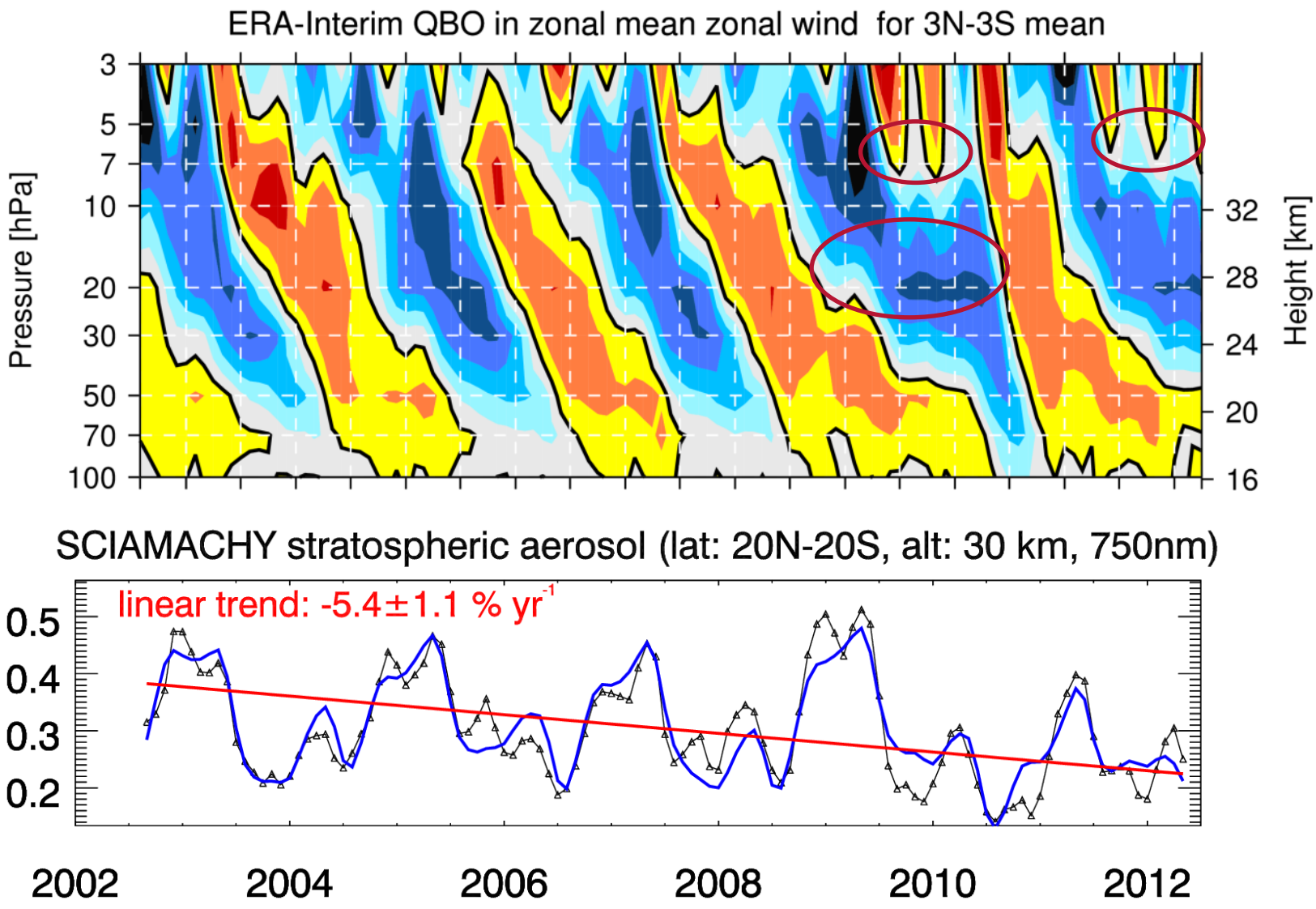


Trend estimates

2002-2012: Decrease in the aerosol load at 30 km



Trend estimates



Summary

- The SCIAMACHY stratospheric aerosol data set (V1.1) agrees within 10% to collocated SAGE II V7.0 measurements for 15-33km (all latitudes) (Ernst et al., in prep.).

- It clearly shows perturbations from volcanic eruptions, directly visible between 18-21 km.

- We see a biennial variation in the eq. aerosol load, predominantly between 29-33 km, as the QBO influences the maximum elevation of the aerosol layer. (This in correspondence with model results, see Wednesday talk by R. Hommel)

- First results on trend estimates indicate

  ... an increase in the lower and central region of the stratospheric aerosol layer (e.g., 20 km, 20N-20S: ~ +5 % yr^{-1}) due to several volcanic eruptions. This is in accordance with work of others (e.g., Hofmann et al. (2009), Neely III et al. (2013), Vernier et al. (2011)).

  ... a decrease between 29-33 km (e.g. 30 km, 20N-20S: ~ -5 % yr^{-1}) likely due to a long east phase of the QBO around the years 2009-10 combined with west phases of the SAO reaching relatively low altitudes in 2009 and 2011-12 .

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… ECMWF for providing ERA-Interim reanalysis data.

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