



Supplement of

**Ammonia in the upper troposphere–lower stratosphere (UTLS):
GLORIA airborne measurements for CAMS model evaluation in the
Asian monsoon and in biomass burning plumes above the South Atlantic**

Sören Johansson et al.

Correspondence to: Sören Johansson (soeren.johansson@kit.edu)

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Introduction

In this document, supplementary information is shown: Spectral micro window boundaries for the NH_3 retrievals (Tab. S1), comparisons of PAN between GLORIA, CAMS reanalysis, and CAMS forecast (Figs. S1-S5), comparisons of IASI total columns and CAMS forecast surface VMRs, and comparisons of AN and clouds between GLORIA and CAMS forecast for the SouthTRAC flights (Figs. S8-S10).

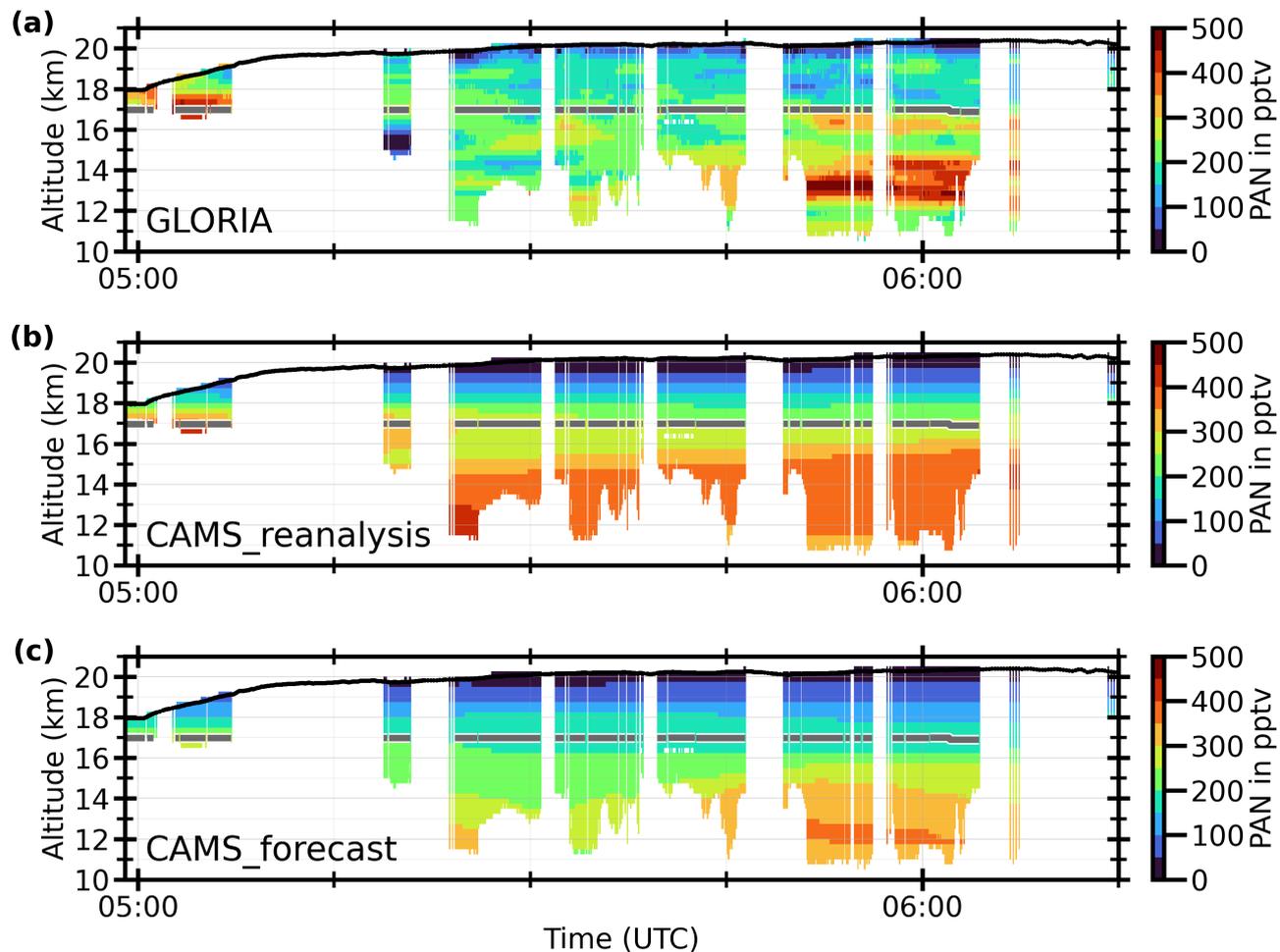


Figure S1: StratoClim flight on 29 July 2017: GLORIA time/altitude cross sections of (a) PAN together with (b) CAMS reanalysis and (c) CAMS forecast simulation results, interpolated onto GLORIA geolocations. GLORIA data is horizontally averaged to match lower horizontal resolutions of CAMS forecast of ≈ 44 km. The black line indicates flight altitudes, the gray line shows the ECMWF analysis 380 K potential temperature as indication of the tropopause location in the Asian Monsoon. Blank spaces indicate regions of high cloud tops, calibration measurements, or aircraft movements.

Retrieval	Micro windows 8.0 cm MOPD	Micro windows 2.5 cm MOPD
NH ₃	951.625 - 952.000	951.600 - 952.000
	965.125 - 965.625	965.000 - 965.600
	966.625 - 967.500	966.600 - 967.600

Table S1: Definition of spectral micro windows for NH₃ retrievals for both MOPDs used in this work.

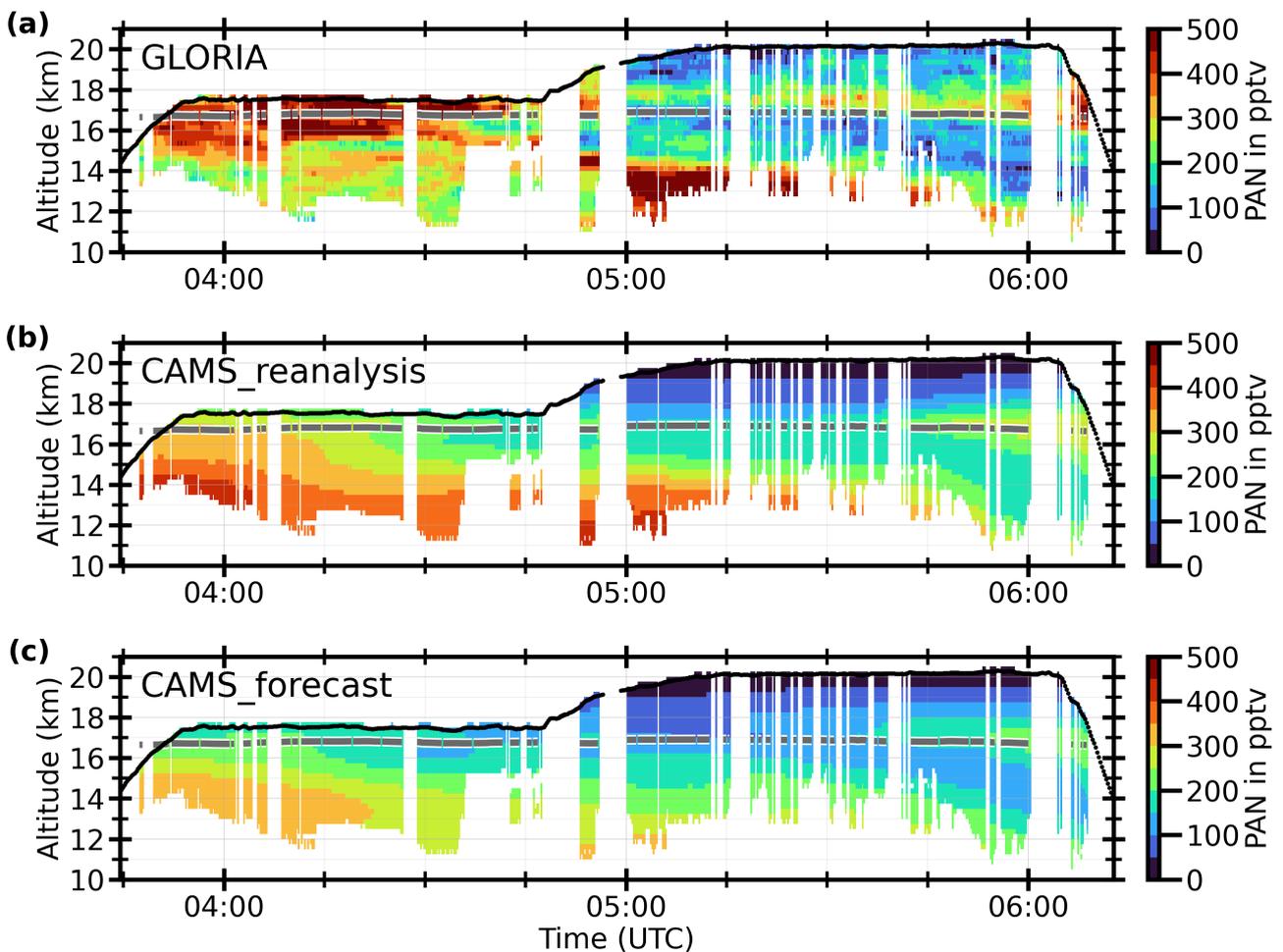


Figure S2: Same as Fig. S1, but for StratoClim flight on 31 July 2017.

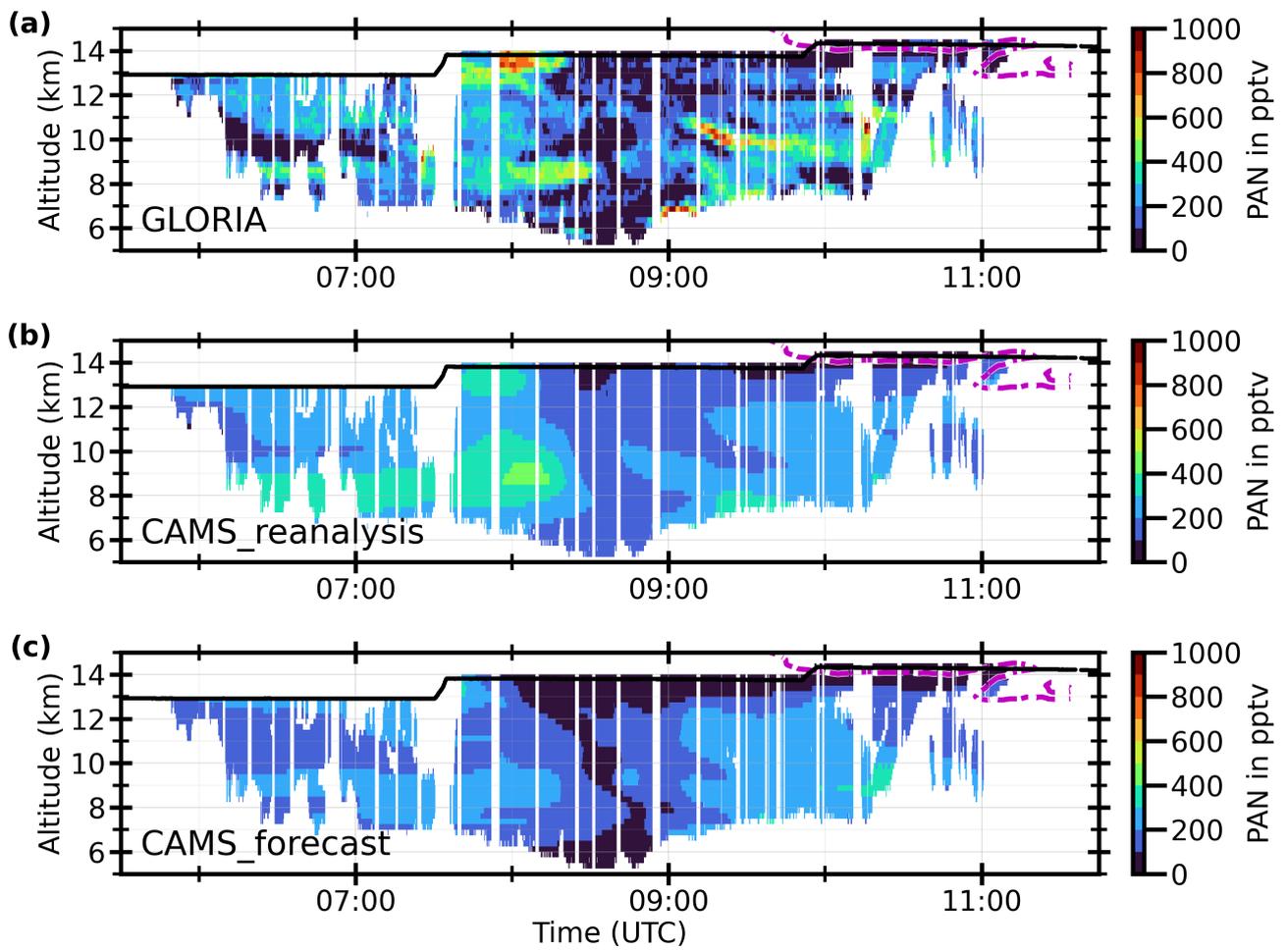


Figure S3: Same as Fig. S1, but for SouthTRAC flight on 8 September 2019. Note that color bars have changed compared to previous plots.

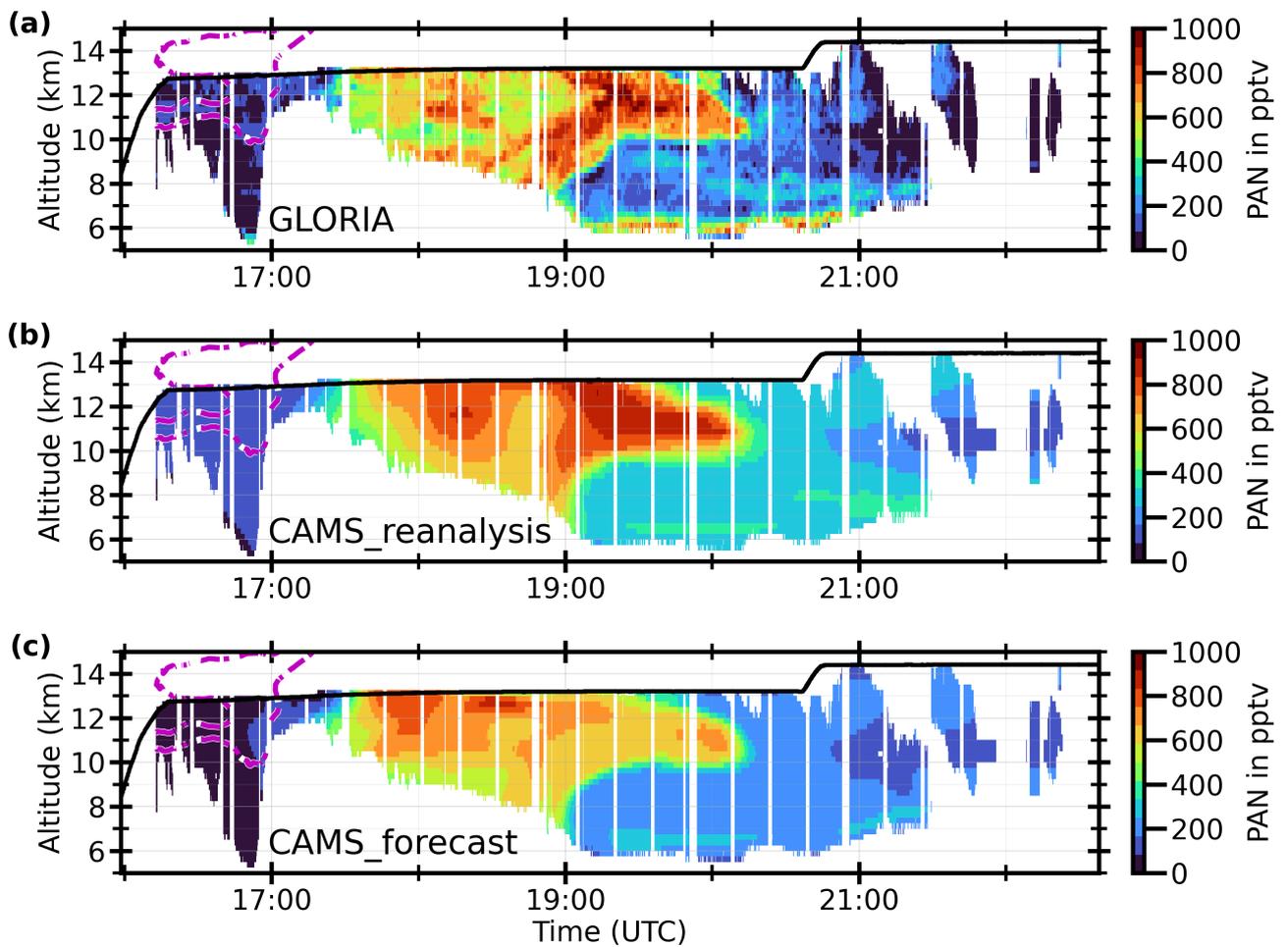


Figure S4: Same as Fig. S1, but for SouthTRAC flight on 7 October 2019.

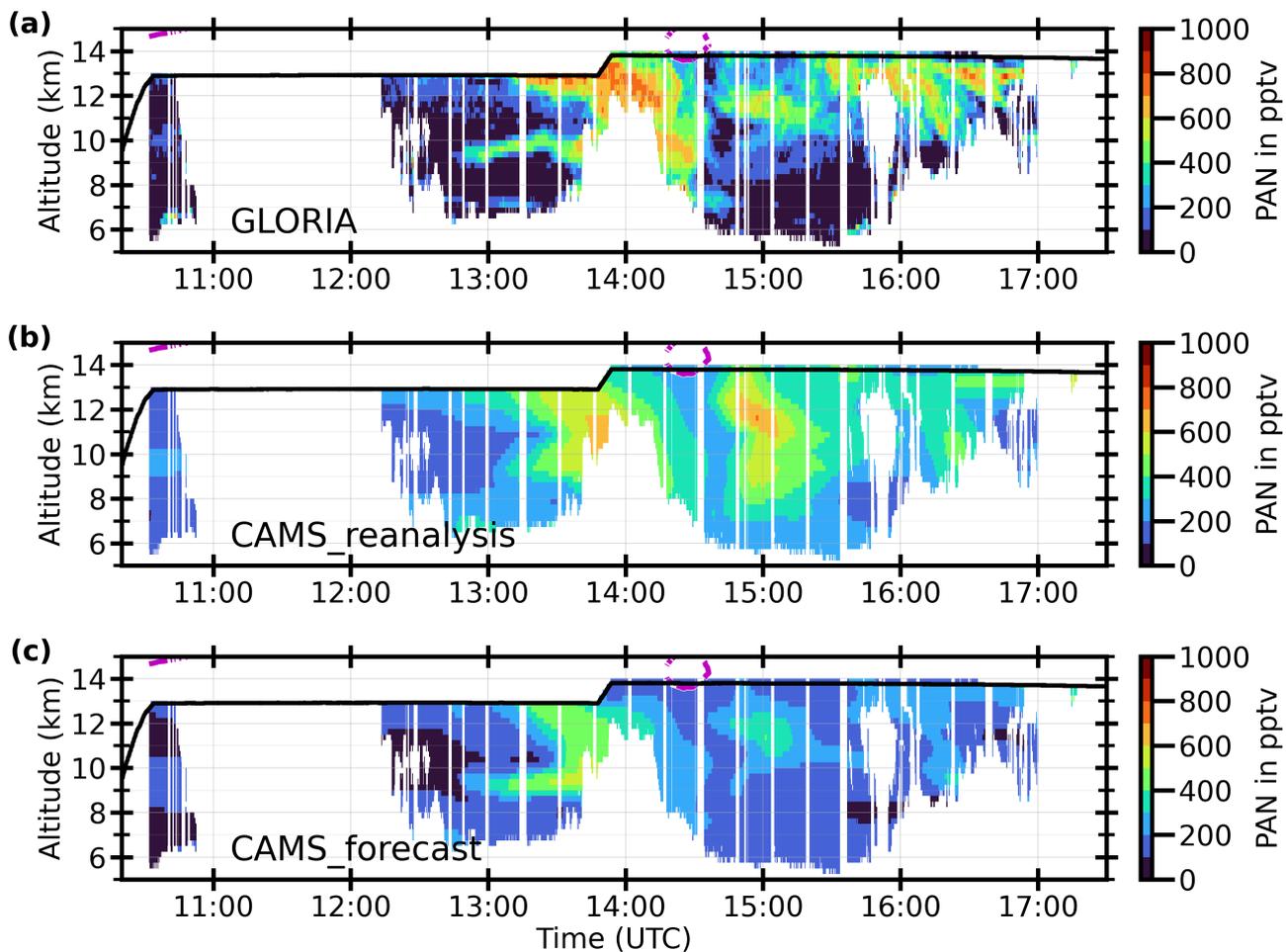


Figure S5: Same as Fig. S1, but for SouthTRAC flight on 4 November 2019.

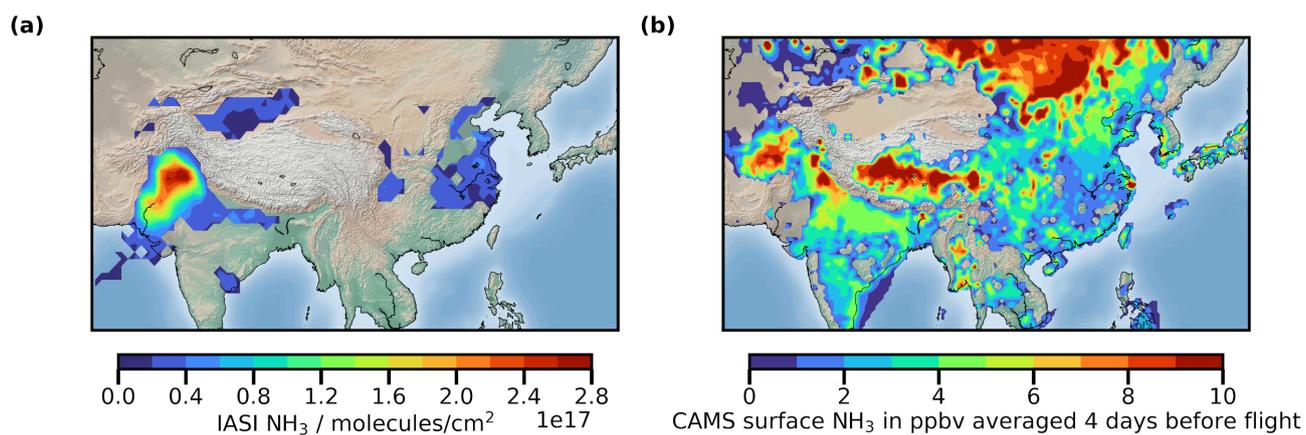


Figure S6: (a) IASI (METOP-A+B) total column NH_3 , averaged over 5 days (26-30 July 2017) before the StratoClim flights. Averaged columns smaller than 1.4×10^{16} molecules/ cm^{-2} (5% of the maximum of the color bar) are filtered out to focus on maximum columns. (b) CAMS forecast surface VMR, averaged as in (a). Surface VMRs smaller than 0.05 ppbv (5% of the maximum of the color bar) are filtered out to focus on maximum VMRs.

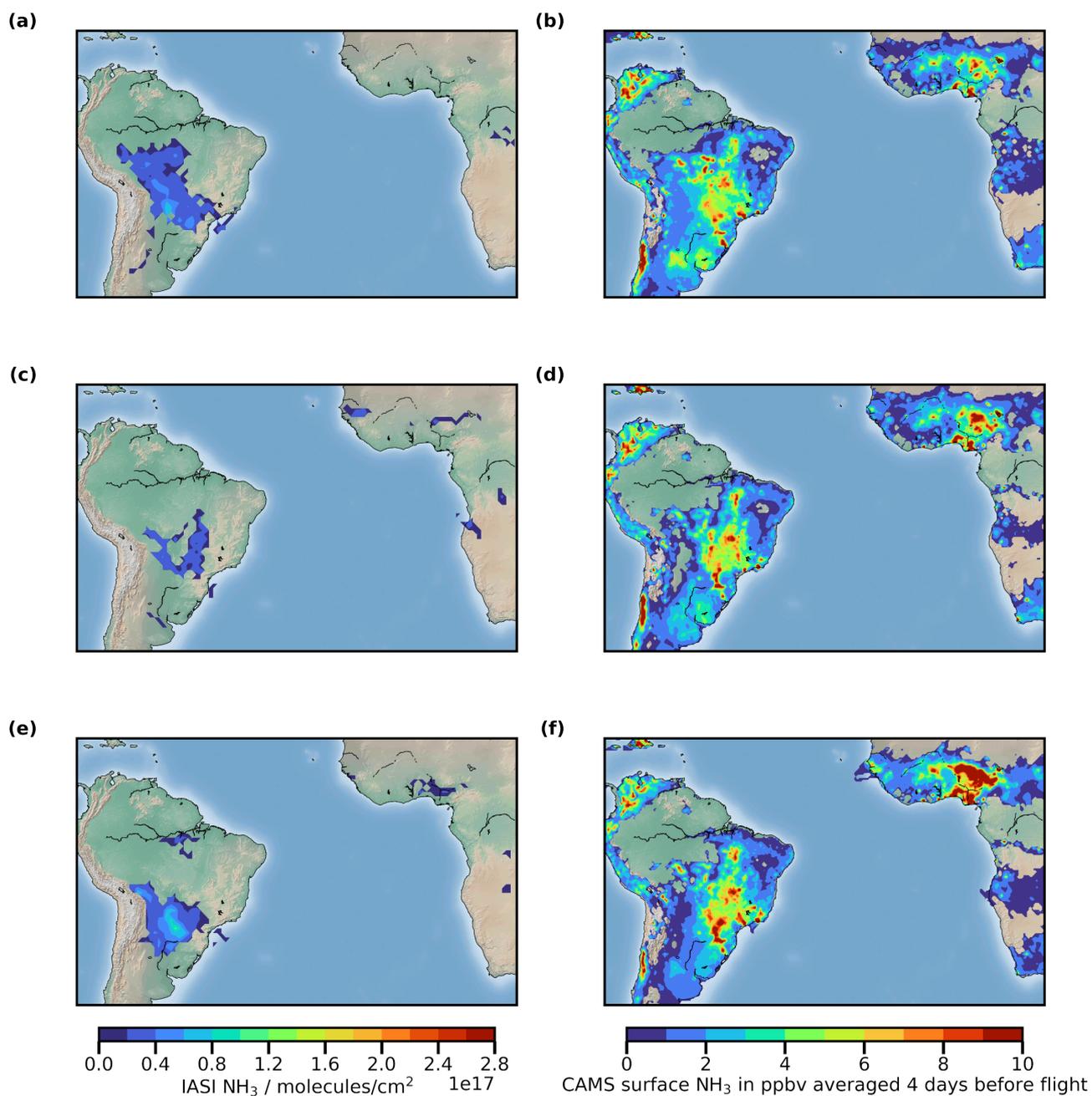


Figure S7: Same as Fig. S6, but for SouthTRAC flights on (a-b) 8 September 2019, (c-d) 7 October 2019, (e-f) 4 November 2019.

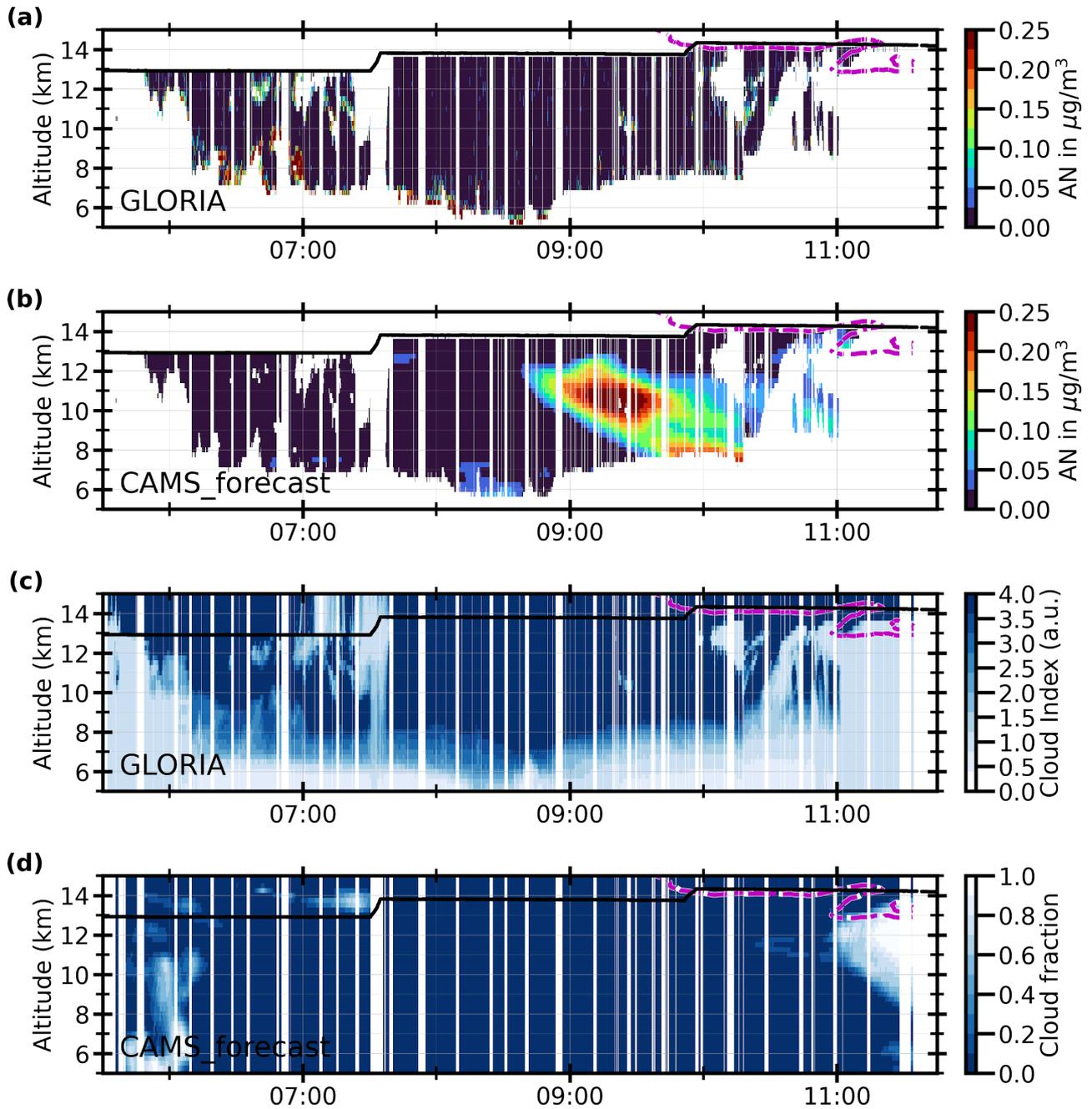


Figure S8: SouthTRAC flight on 8 September 2019: GLORIA time/altitude cross sections of (a) solid ammonium nitrate (AN) together with (b) CAMS forecast simulation results for ammonium aerosol, interpolated onto GLORIA geolocations, and scaled to ammonium nitrate mass, for a better comparison with GLORIA measurements. (c) GLORIA cloud index, which is an established ratio of radiances (see Spang et al. (2004)), in which lower values mean more cloud contamination along the line of sight. (d) CAMS forecast cloud fraction, interpolated on GLORIA tangent points. Please note that clouds along the GLORIA line of sight, which are not necessarily on the tangent point but still can give a signal in the GLORIA cloud index, are likely to be underestimated in this representation.

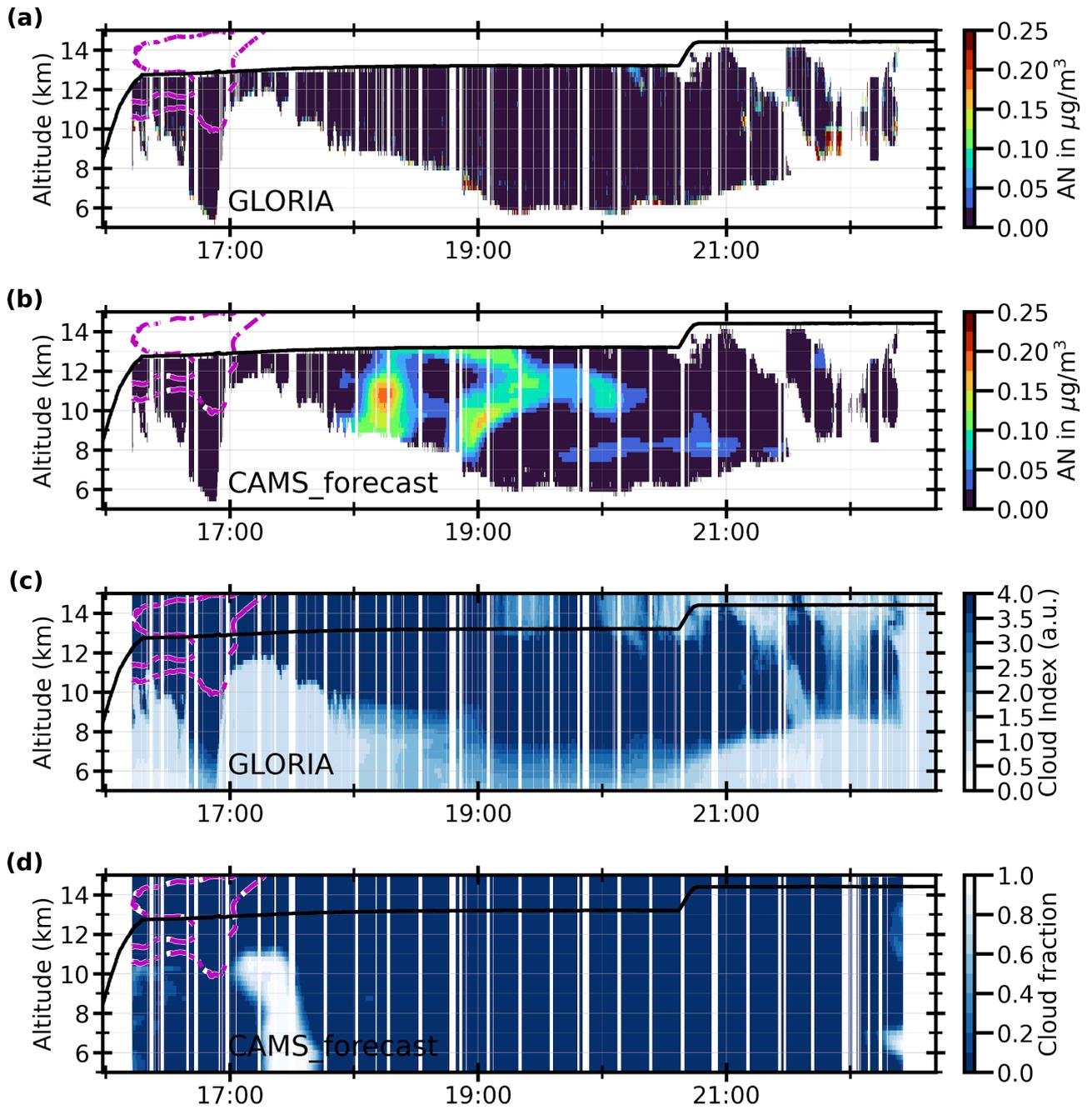


Figure S9: Same as Fig. S8, but for SouthTRAC flight on 7 October 2019.

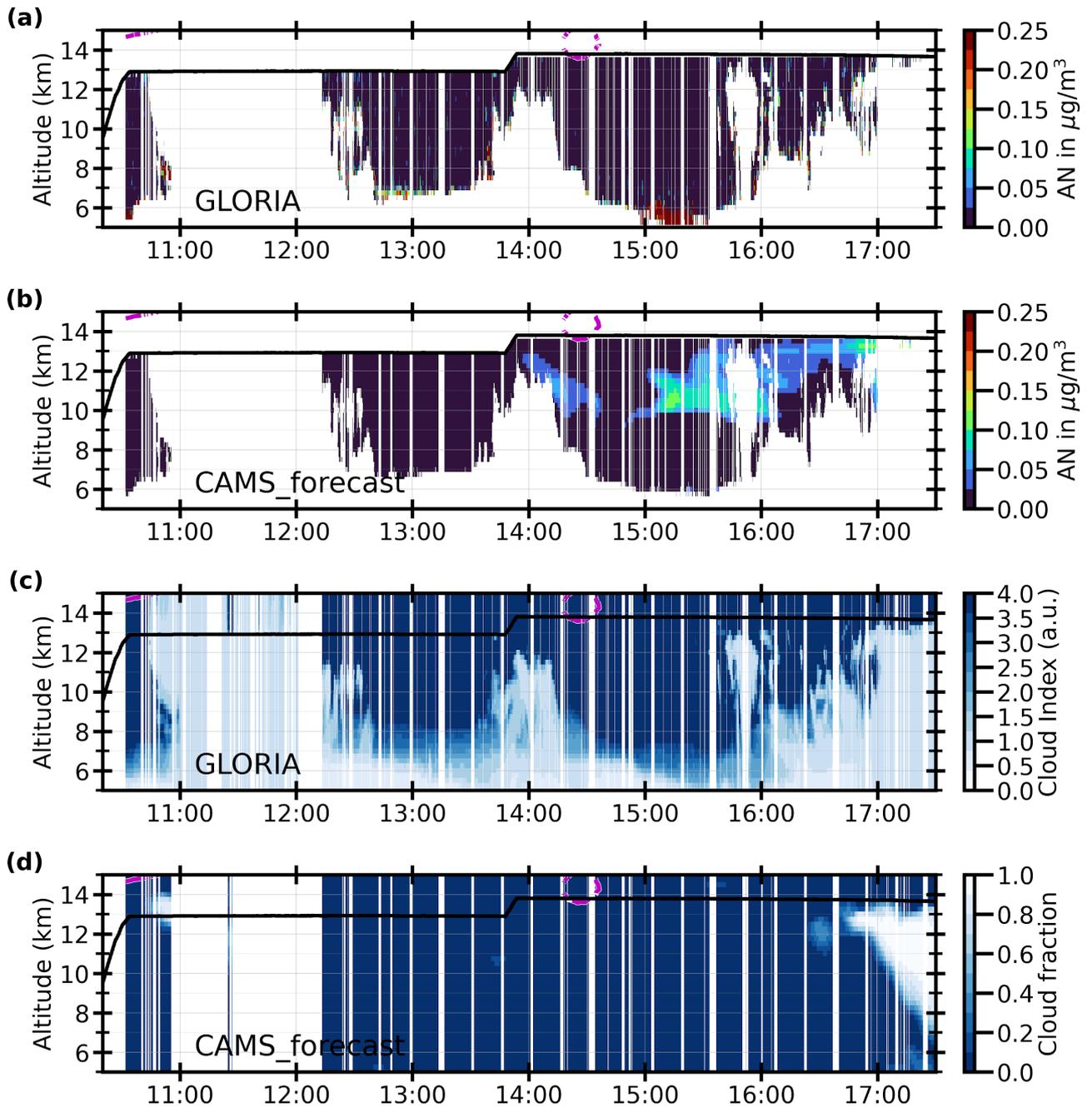


Figure S10: Same as Fig. S8, but for SouthTRAC flight on 4 November 2019.