

S1 Additional Figures

S1.1 Transects

5 All flights were divided into individual plume transects. For each transect, a Gaussian curve was fitted to both the observations and to all model simulations. Measurements and model values belonging to a given transect were labelled with a unique transect number (tsc) and a not necessarily unique distance number (dst), because sometimes multiple transects were flown at the same distance from the power plant. The following figures show maps and vertical cross-sections of the transect numbering as well as examples of the Gaussian curve fitting procedure.

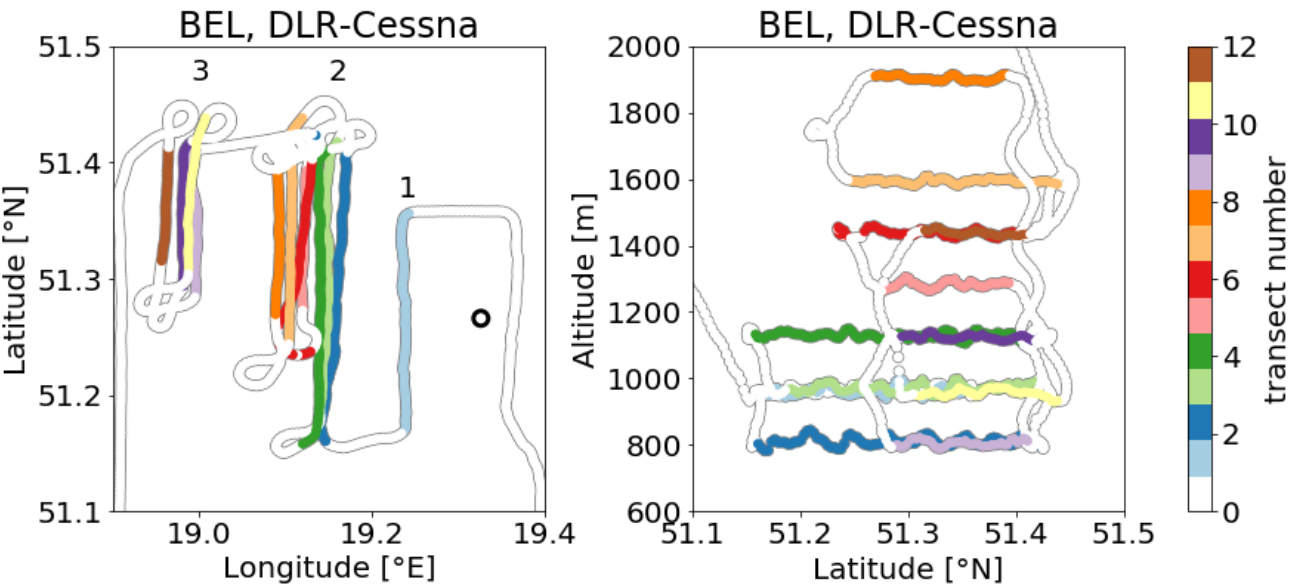


Figure S1. In-situ CO₂ transects from DLR-Cessna aircraft on 7 June 2018 at Belchatow. Left: Latitude versus longitude map of flight track. The open circle denotes the position of the power plant. In total 12 transects were flown at 3 different distances from the power plant (labelled 1,2,3). For better visibility, the flight track is increasingly shifted to the west with increasing altitude. Right: North-south cross-section (altitude versus latitude).

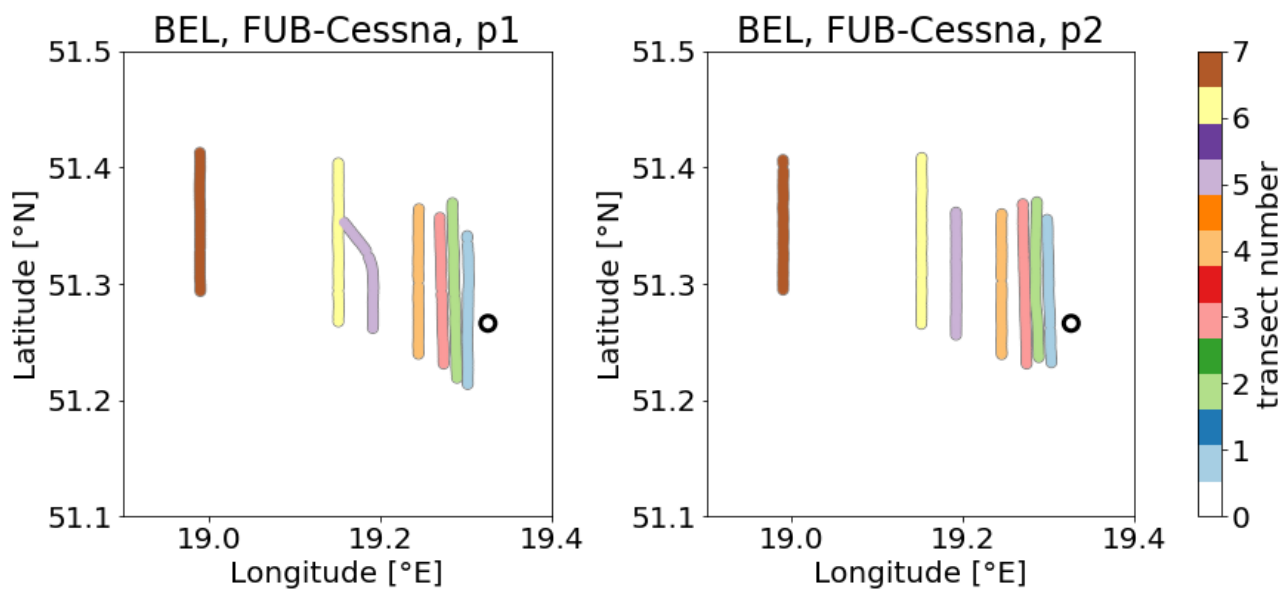


Figure S2. MAMAP total column XCO₂ transects from the FUB-Cessna aircraft on 7 June 2018 at Belchatow. Transects are numbered by increasing distance from the power plant. Left: Latitude versus longitude map of the first flight between 12:20 - 13:27 UTC. Right: Second flight between 13:42 - 14:45 UTC.

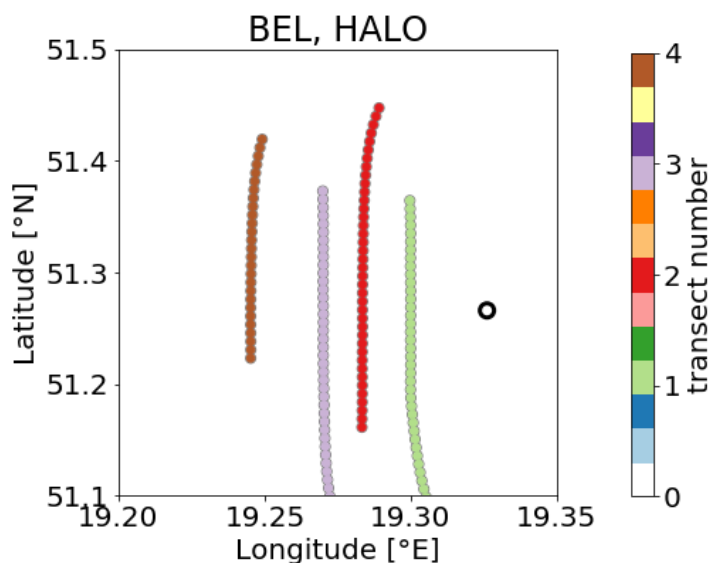


Figure S3. CHARM-F total column XCO₂ transects from the HALO aircraft on 7 June 2018 at Belchatow. Transects are numbered by increasing distance from power plant.

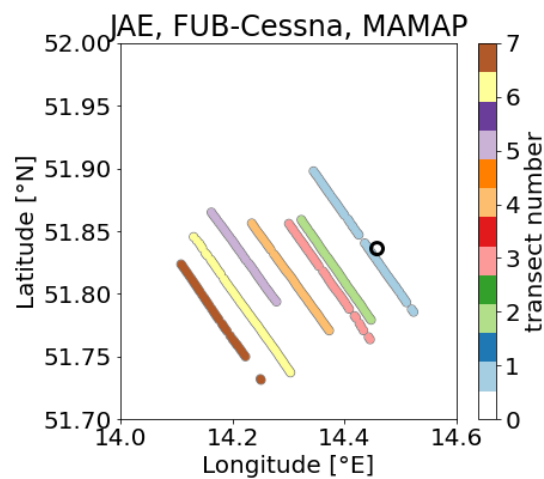


Figure S4. MAMAP total column XCO₂ transects from the FUB-Cessna aircraft on 23 May 2018 at Jämschwalde. Transects are numbered by increasing distance from power plant.

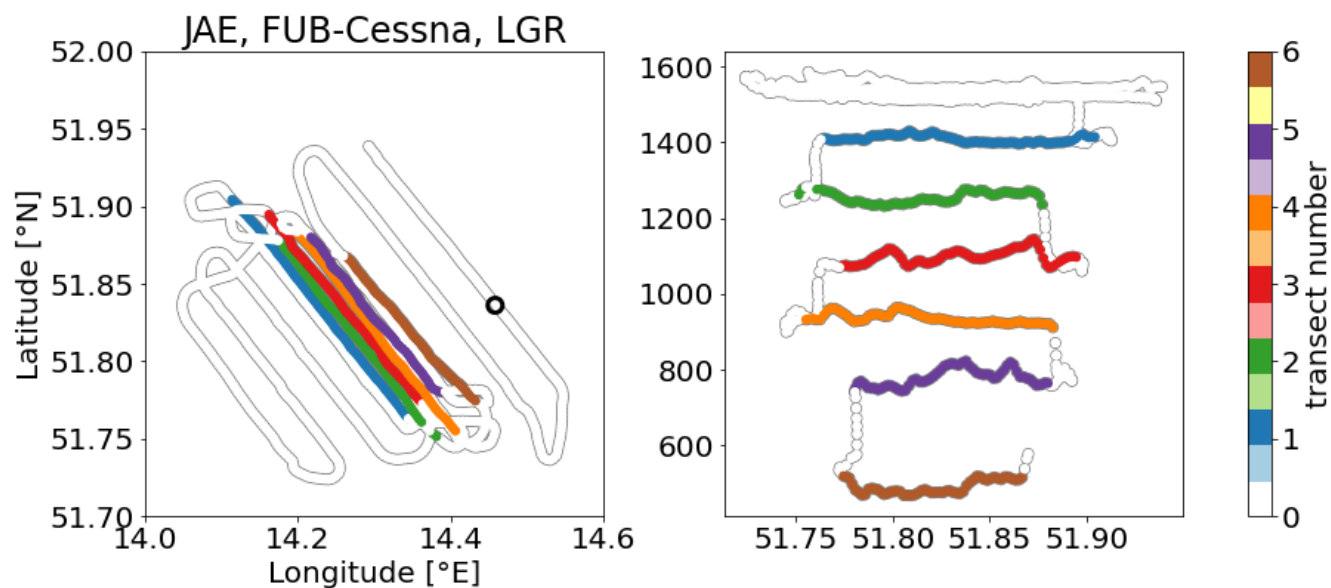


Figure S5. LGR in-situ CO₂ transects from the FUB-Cessna aircraft on 23 May 2018 at Jämschwalde. Transects are numbered by increasing distance from the power plant or by decreasing altitude. Left: Latitude versus longitude map. Right: North-south cross-section (altitude versus latitude).

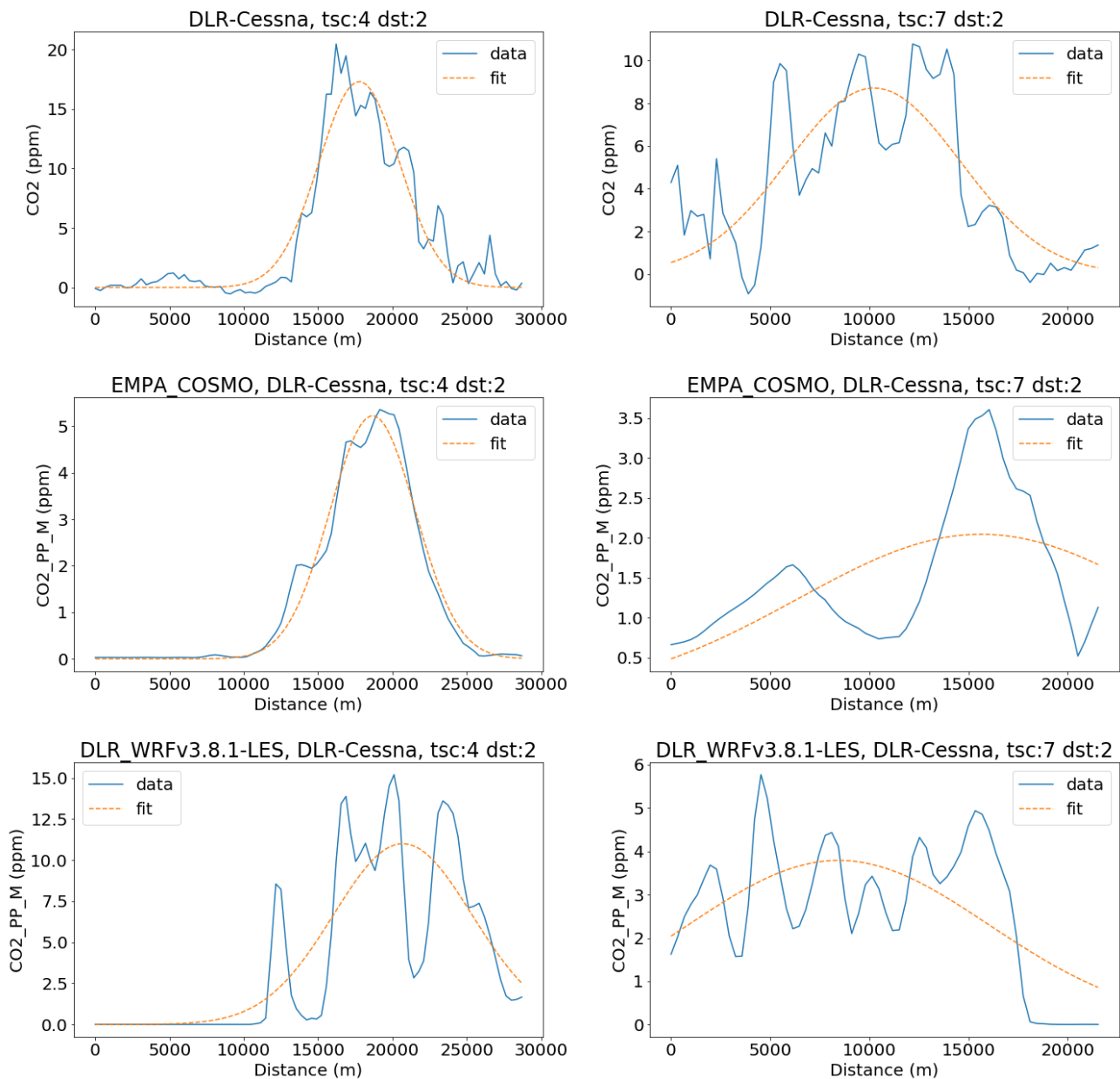


Figure S6. Examples of Gaussian curves fitted to individual transects of CO₂ measurements from the DLR-Cessna aircraft and corresponding fits for two selected models. The individual fit parameters are amplitude, width and horizontal shift of the curve. For each plume transect, a background varying linearly between data points directly before and after the plume is subtracted from the measurements. No background needs to be subtracted from the simulations.

S1.2 Maps of total column XCO₂

10 The following figure shows maps of total column XCO₂ from six model simulations for the power plant Jämschwalde on 23 May 2018, 10:00 UTC. No simulations were performed for Jämschwalde with EULAG and the high-resolution version of WRF-GHG.

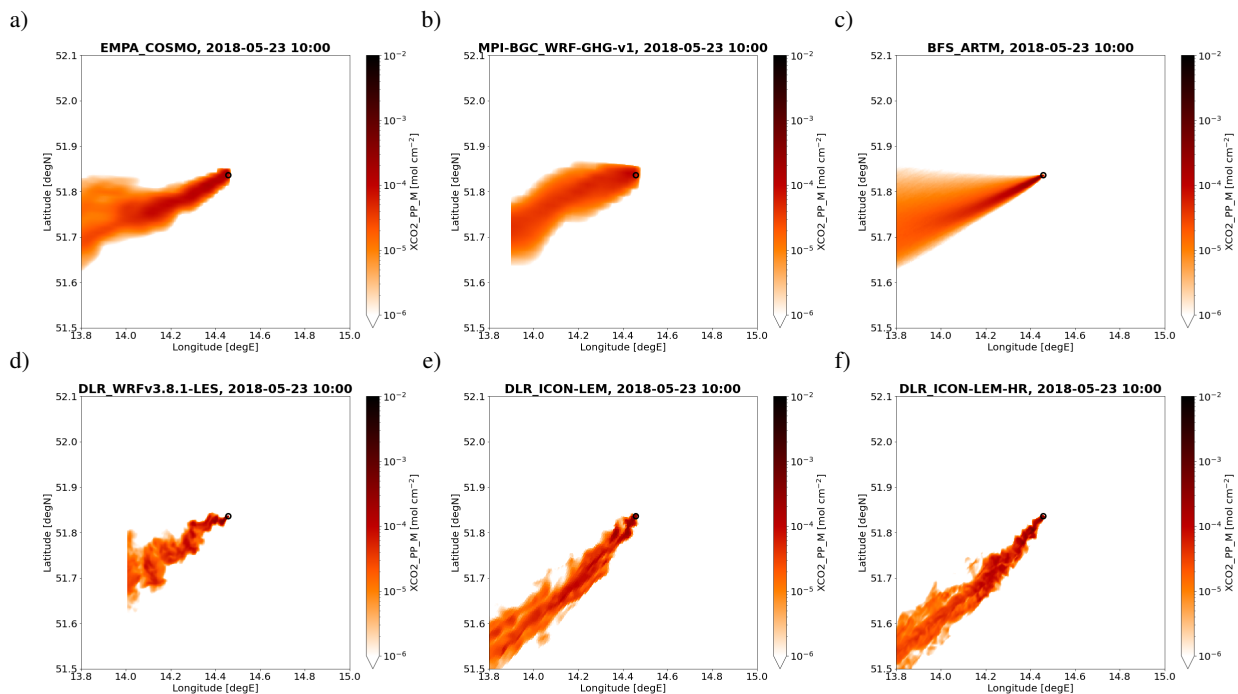


Figure S7. Model simulated total column XCO₂ (tracer CO₂_PP_M) for the Jaenschwalde plume on 23 May 2018 at 10:00 UTC.

S1.3 Curtains of CO₂ and wind speed

For Belchatow, the following figures show curtains of the high (CO₂_PP_H) and low release tracer (CO₂_PP_L) and wind speed (WS) along the DLR-Cessna flight. For Jänschwalde, the figures show curtains of the middle release tracer CO₂_PP_M and potential temperature and wind speed along the second part of the FUB-Cessna flight which was dedicated to in-situ sampling of the plume at multiple levels. Note that no meteorological measurements are available for the FUB-Cessna aircraft.

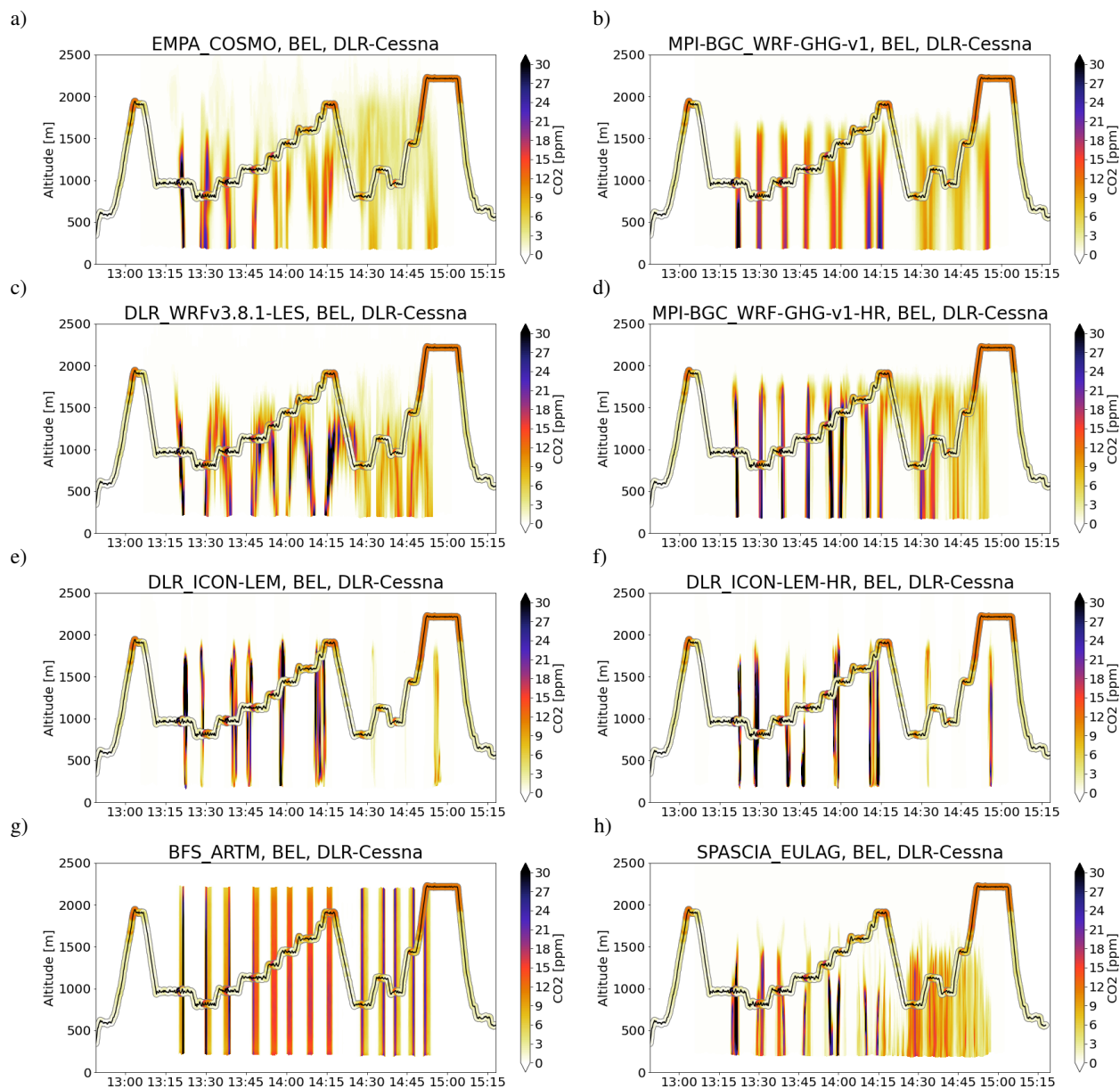


Figure S8. Curtains of the Belchatow CO₂ plume along the DLR-Cessna flight on 7 June 2018. Figures for high release tracer CO₂_PP_H.

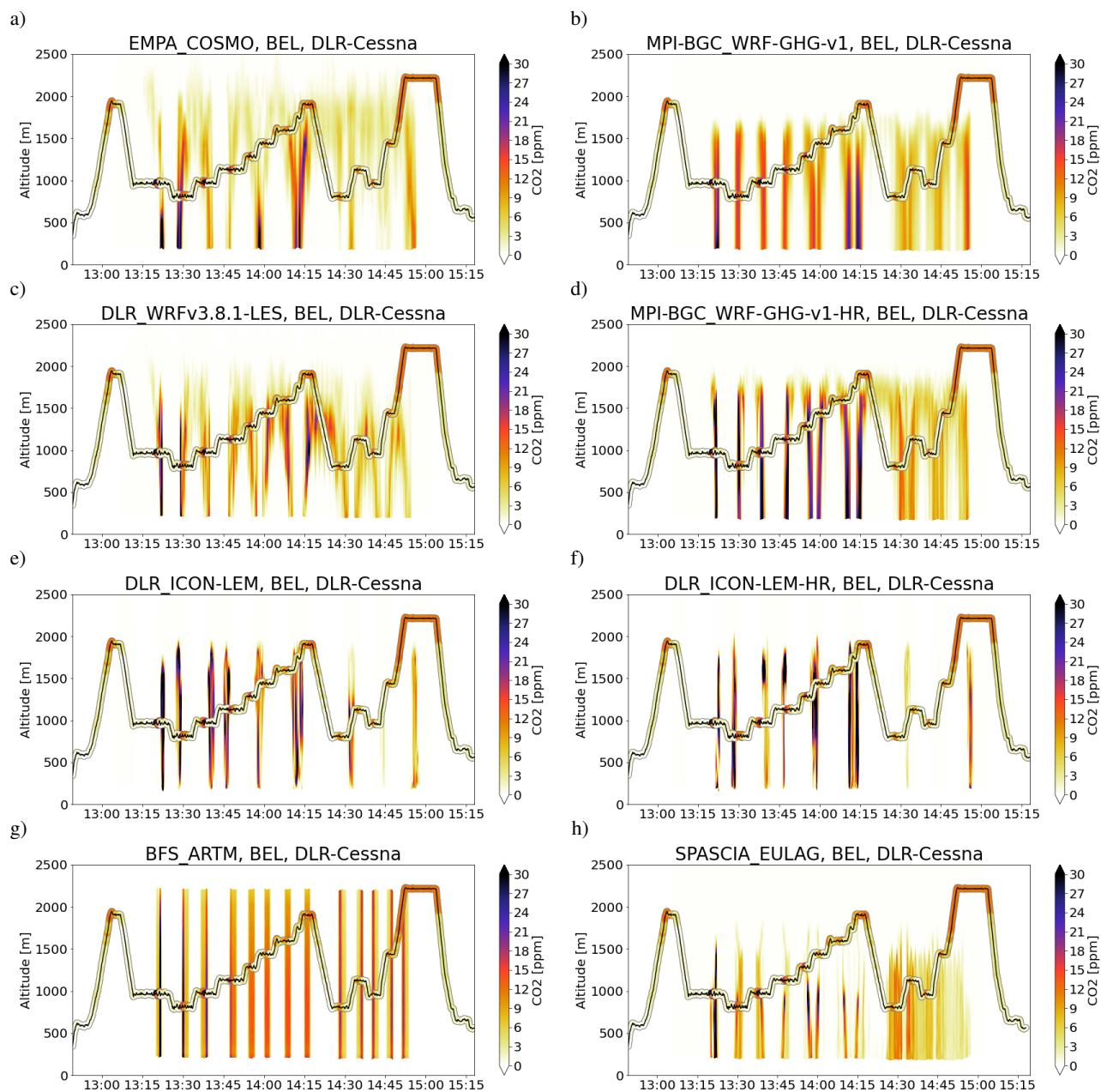


Figure S9. Curtains of the Belchatow CO₂ plume along the DLR-Cessna flight on 7 June 2018. Figures for low release tracer CO₂_PP_L.

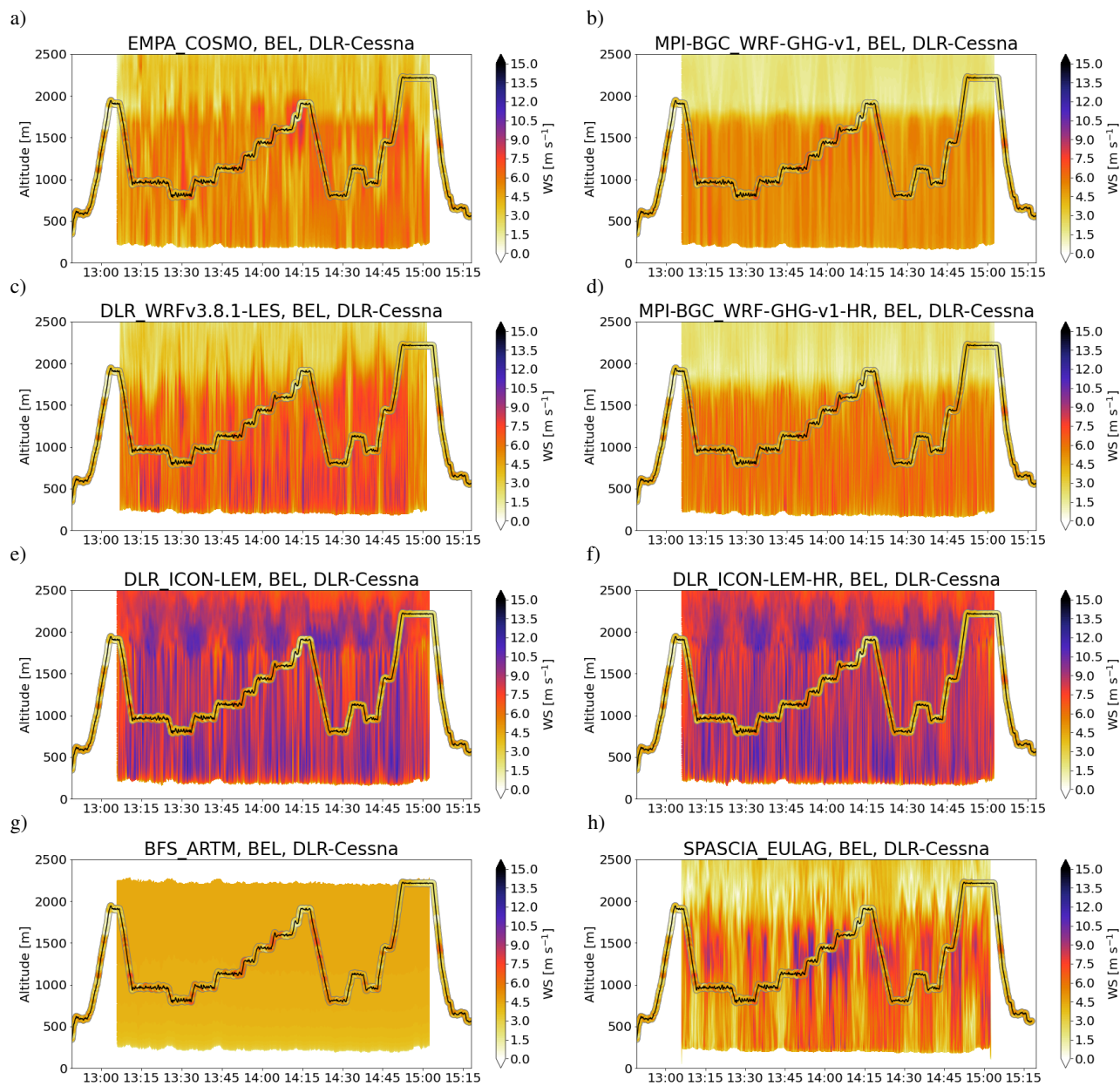


Figure S10. Curtains of wind speed along the DLR-Cessna flight on 7 June 2018.

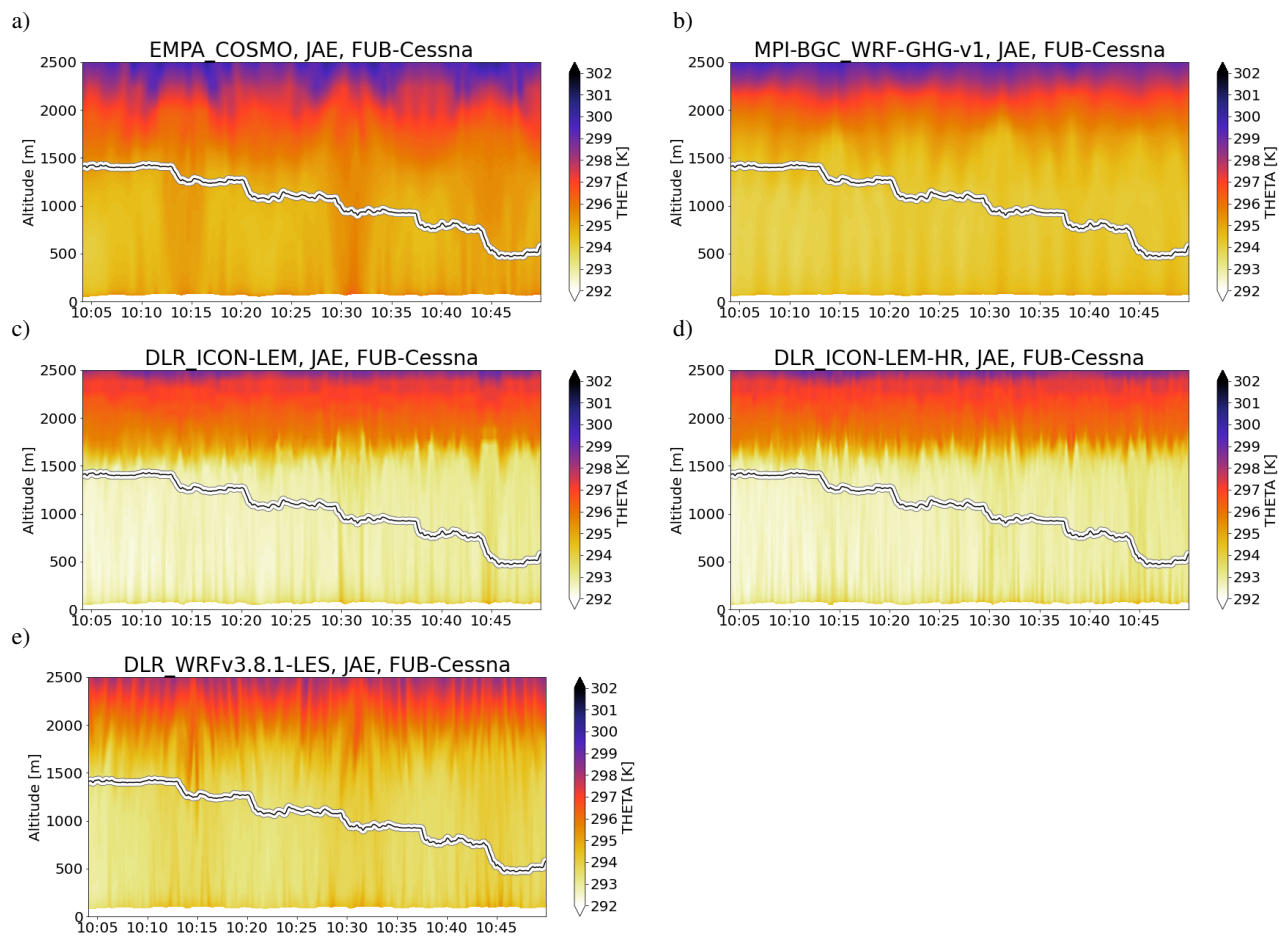


Figure S11. Curtains of potential temperature along the FUB-Cessna flight on 23 May 2018.

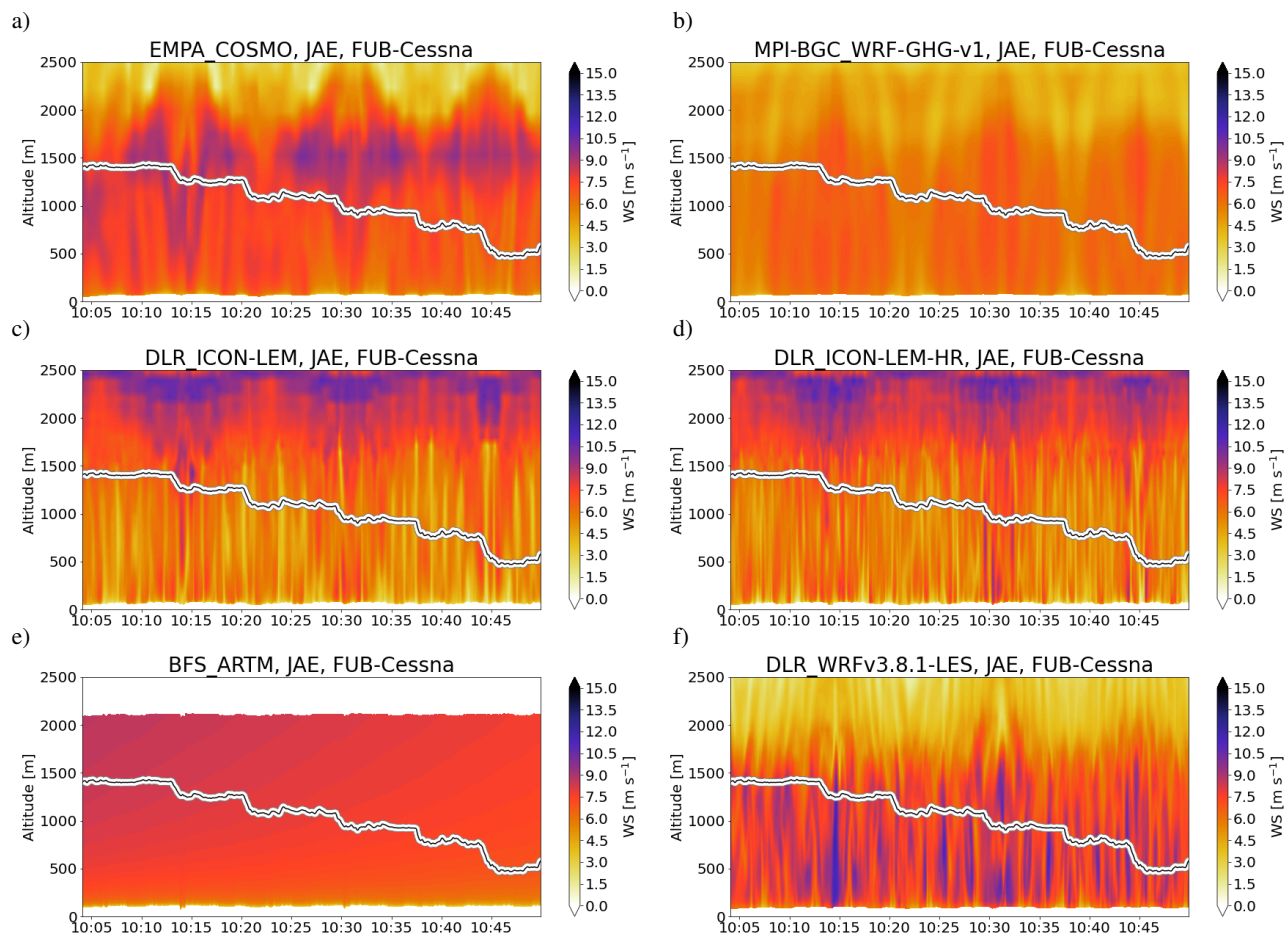


Figure S12. Curtains of wind speed along the FUB-Cessna flight on 23 May 2018.

S1.4 Top view on in-situ CO₂

The following two figures compare in-situ observed and simulated CO₂ along the flight track of the DLR-Cessna aircraft on 7 June 2018 at Belchatow and the FUB-Cessna aircraft on 23 May 2018 at Jänschwalde, respectively.

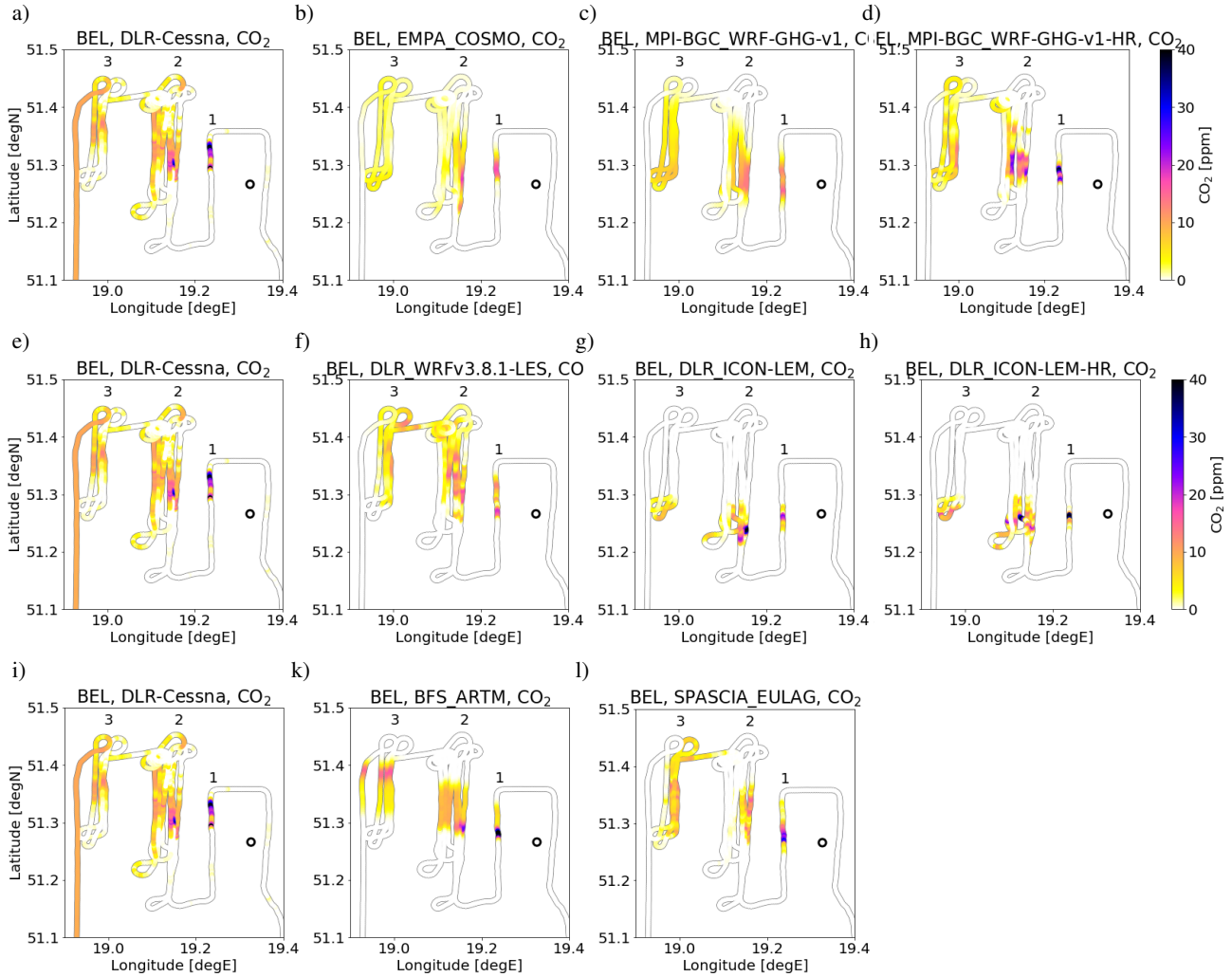


Figure S13. Latitude-longitude projection of in-situ CO₂ along DLR-Cessna flight at Belchatow on 7 June 2018. The left-hand figures in all rows present the observations as reference. The remaining figures show model results for the middle release tracer CO₂_PP_M. For better visibility of the data along overlapping transects, the aircraft longitudes have been shifted towards the west with increasing altitude.

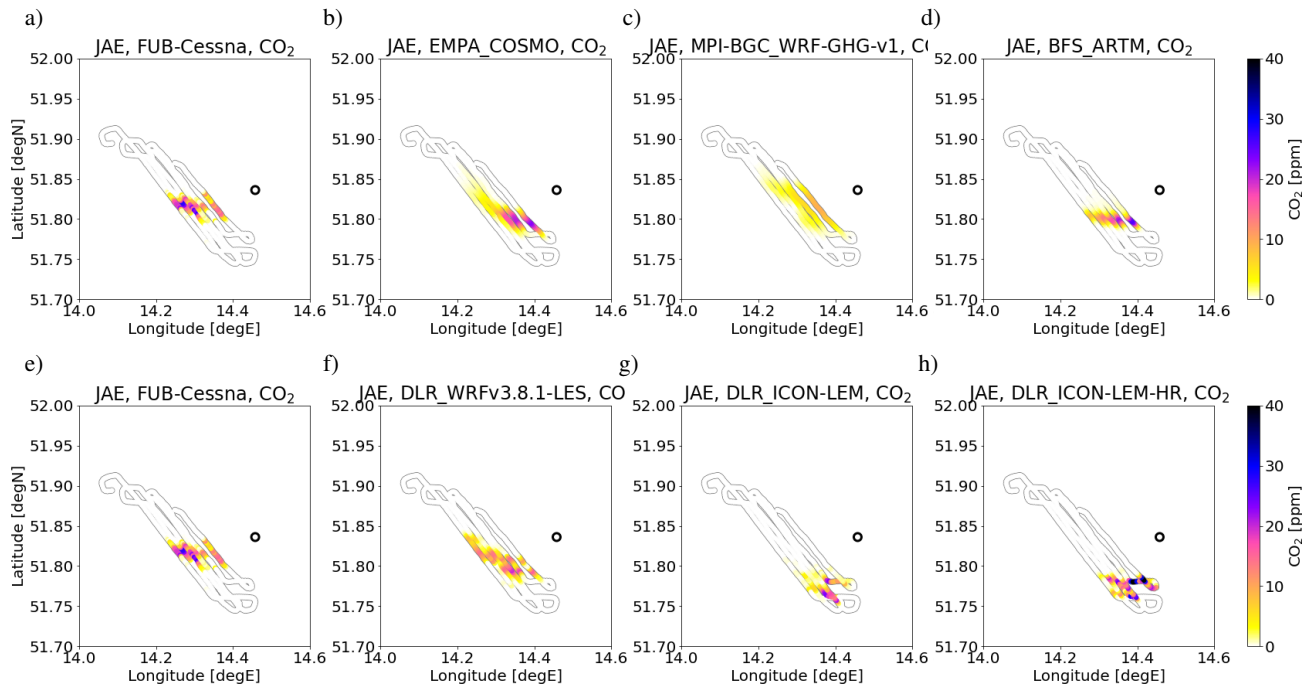


Figure S14. Latitude-longitude projection of in-situ CO₂ along FUB-Cessna flight at Jänschwalde on 23 May 2018. The left-hand figures in both rows show the observations as reference. The remaining figures show simulations for the middle release tracer CO₂_PP_M. For better visibility of the data along overlapping transects, the aircraft longitudes have been shifted towards the west with increasing altitude

20 S1.5 Time series of meteorological parameters

The following figures compare time series of observed and simulated wind speed and potential temperature along the DLR-Cessna flight at Belchatow on 7 June 2018. No meteorological measurements are available for the FUB-Cessna flight at Jänschwalde on 23 May 2018.

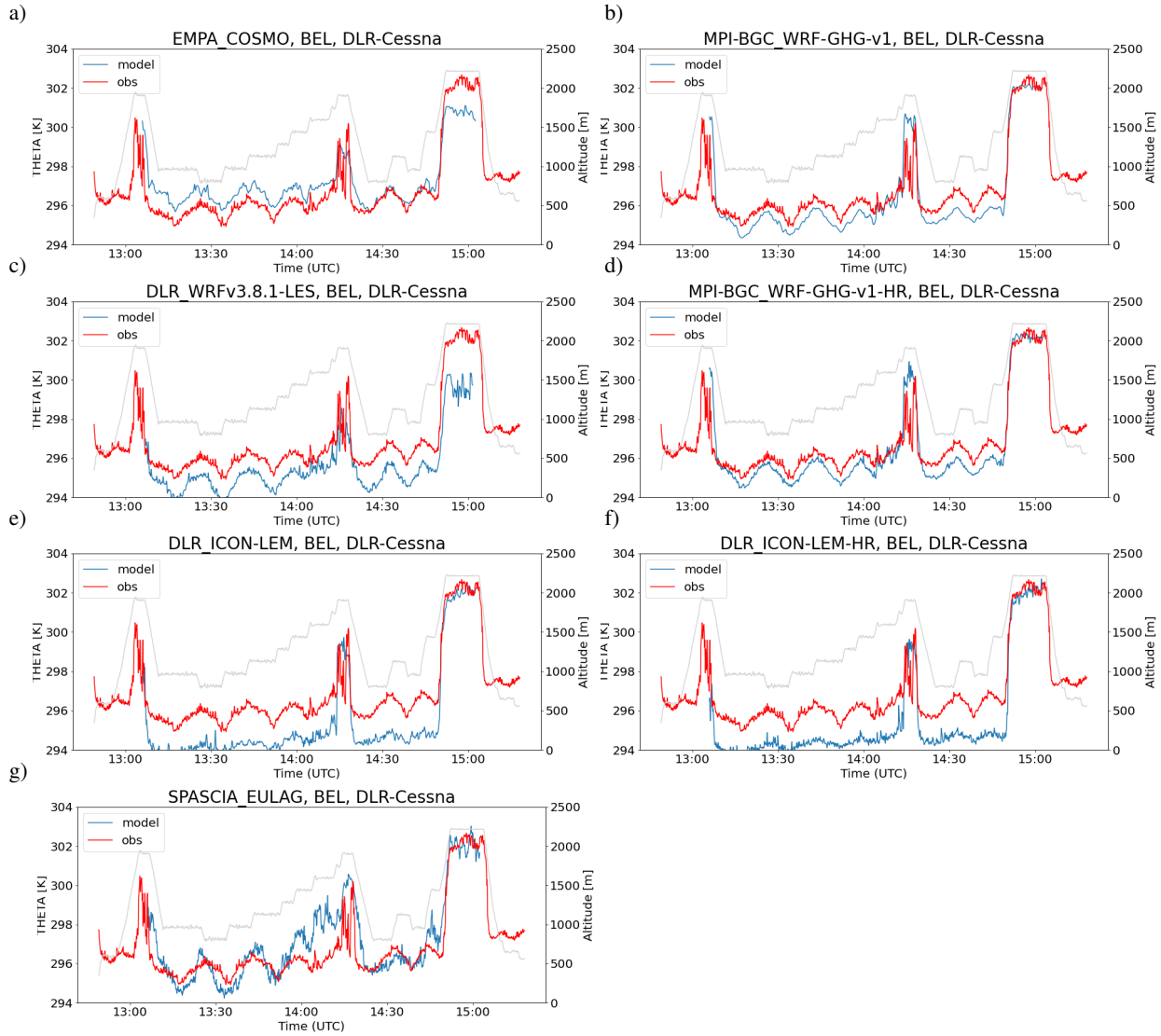


Figure S15. Time series of potential temperature along the DLR-Cessna flight on 7 June 2018.

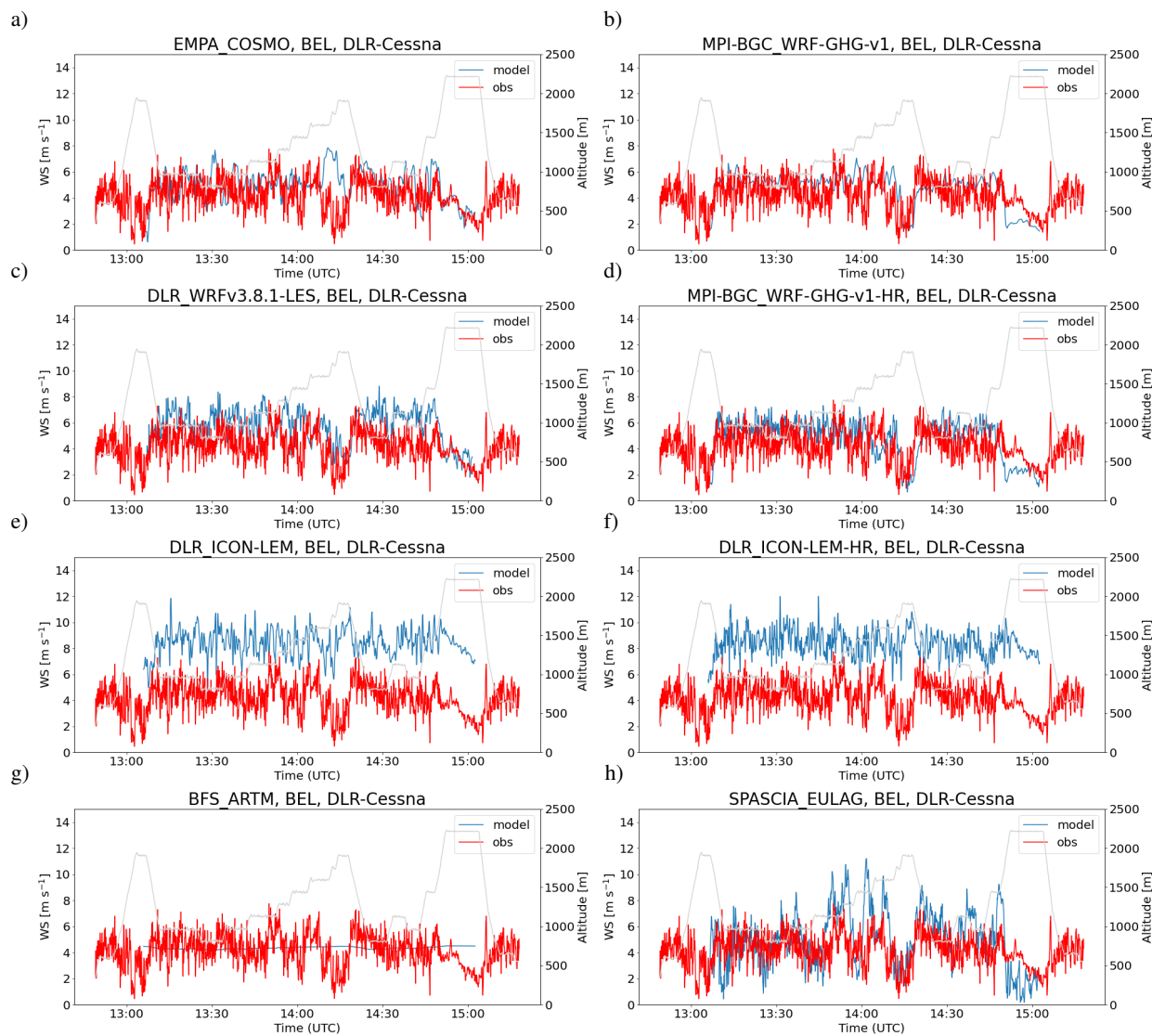


Figure S16. Time series of wind speed along the DLR-Cessna flight on 7 June 2018.

S1.6 Time series of CHARM-F and model simulated column CO₂ at Jänschwalde

- 25 The following figure compares total column CO₂ above background observed with the CHARM-F lidar on the HALO aircraft with corresponding simulated columns.

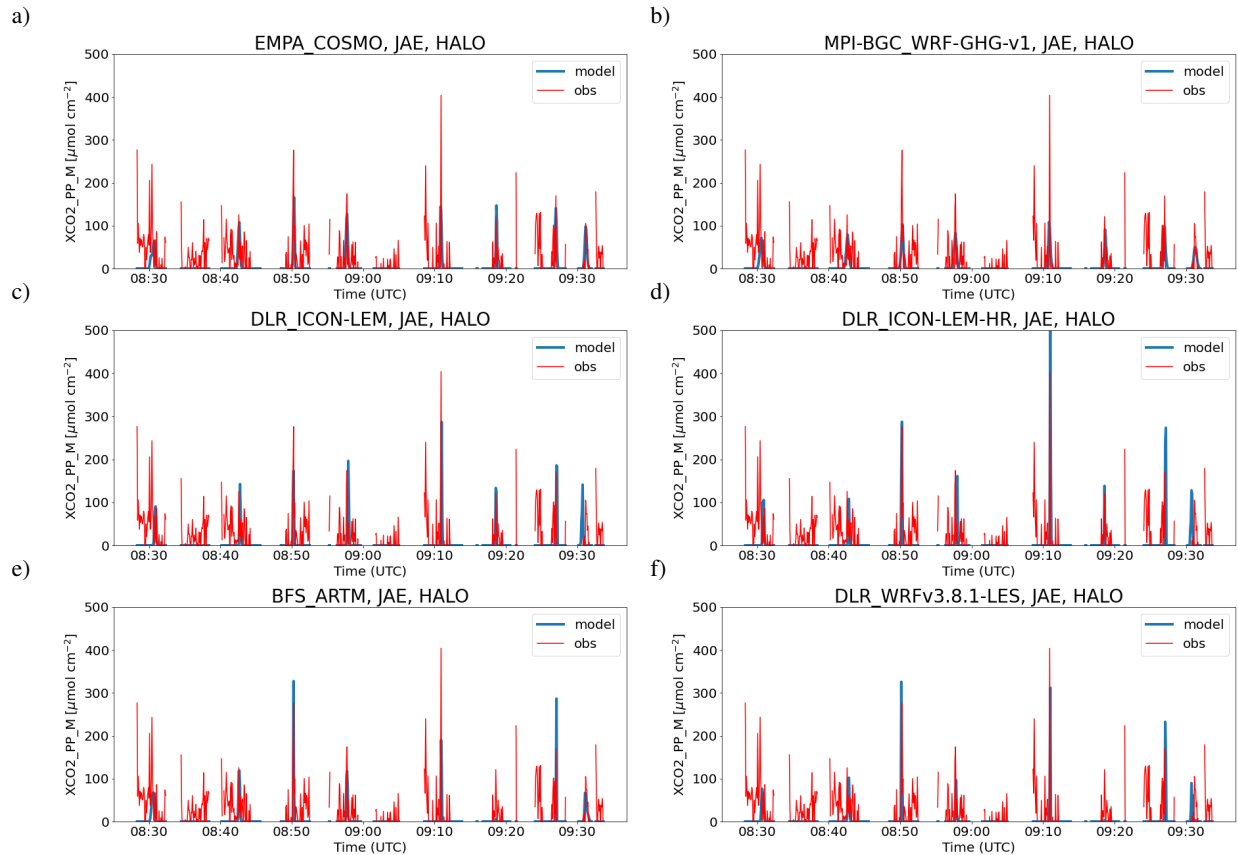


Figure S17. Time series of CO₂ column enhancements simulated and observed by CHARM-F along the HALO flight at Jänschwalde on 23 May 2018.