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Organic, inorganic and total bromine measurements around the extratropical tropopause and lowermost stratosphere

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We report on measurements of organic, inorganic and total bromine (Br^{tot}) in the upper troposphere and lower stratosphere (UTLS) over southern Argentina and surroundings extending down to the Antarctic Peninsula in September and November of 2019. These measurements were recorded from the German High Altitude and Long range research aircraft (HALO) as part of the Transport and Composition of the Southern Hemisphere UTLS (SouthTRAC) research campaign. Br^{tot} is inferred from measured total organic bromine (Br^{org}), i.e., the sum of bromine contained in CH_3Br , the halons and the major very short-lived brominated species, added to inorganic bromine ($\text{Br}_y^{\text{inorg}}$), evaluated from measured BrO and photochemical modelling. Lagrangian transport modelling as well as in situ measured transport (CO and N_2O) and air mass lag-time (SF_6) tracers are used to identify air mass transport pathways into the UTLS and indicate the likely origins of bromine-rich air masses reaching the Southern Hemisphere (SH) lower stratosphere. Additionally, the SH bromine volume mixing ratios are compared with previous measurements from fall 2017 observed in the Northern Hemisphere as part of the Wave-driven Isentropic Exchange (WISE) research campaign, and the long term trend in stratospheric bromine.