

Climatology of middle atmosphere to support studies of future satellite middle atmospheric missions

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1. Introduction

This poster presents the CLIMAC of the Middle Atmosphere temperature and Composition (CLIMAC) used during the Phase 0/A of the Changing Atmosphere Infra-Red Tomography explorer (CAIRT), proposed to ESA Earth Explorer 11 (EE11). This climatology provides the mean and standard deviation of **37 atmospheric parameters** between **0 and 200 km** in several **latitude bands**, **four seasons** and **several local times**, **background/enhanced volcanic conditions** and **MIN/MAX of the solar cycle** (see 4). Since no single atmospheric model or instrument provides all relevant trace gases across the required vertical domain, this climatology was created by blending outputs of different models or observations (see 3).

2. Motivations

This kind of climatology are necessary to:

- provide initial guesses for the analysis of middle-atmosphere measurements
- simulate middle-atmosphere measurements
- define requirements for future missions

For example, CLIMAC was used to adjust CAIRT measurement objectives (see Fig. 1) and instrumental requirements (see Fig. 2)

Fig. 1: Distributions of selected trace gases targeted by CAIRT for midnight UTC. First four columns: instantaneous horizontal and meridional slices through a WACCM-X simulation (data: HAO/NCAR). Fourth column: profile statistics based on CLIMAC, with CAIRT threshold uncertainty requirement.

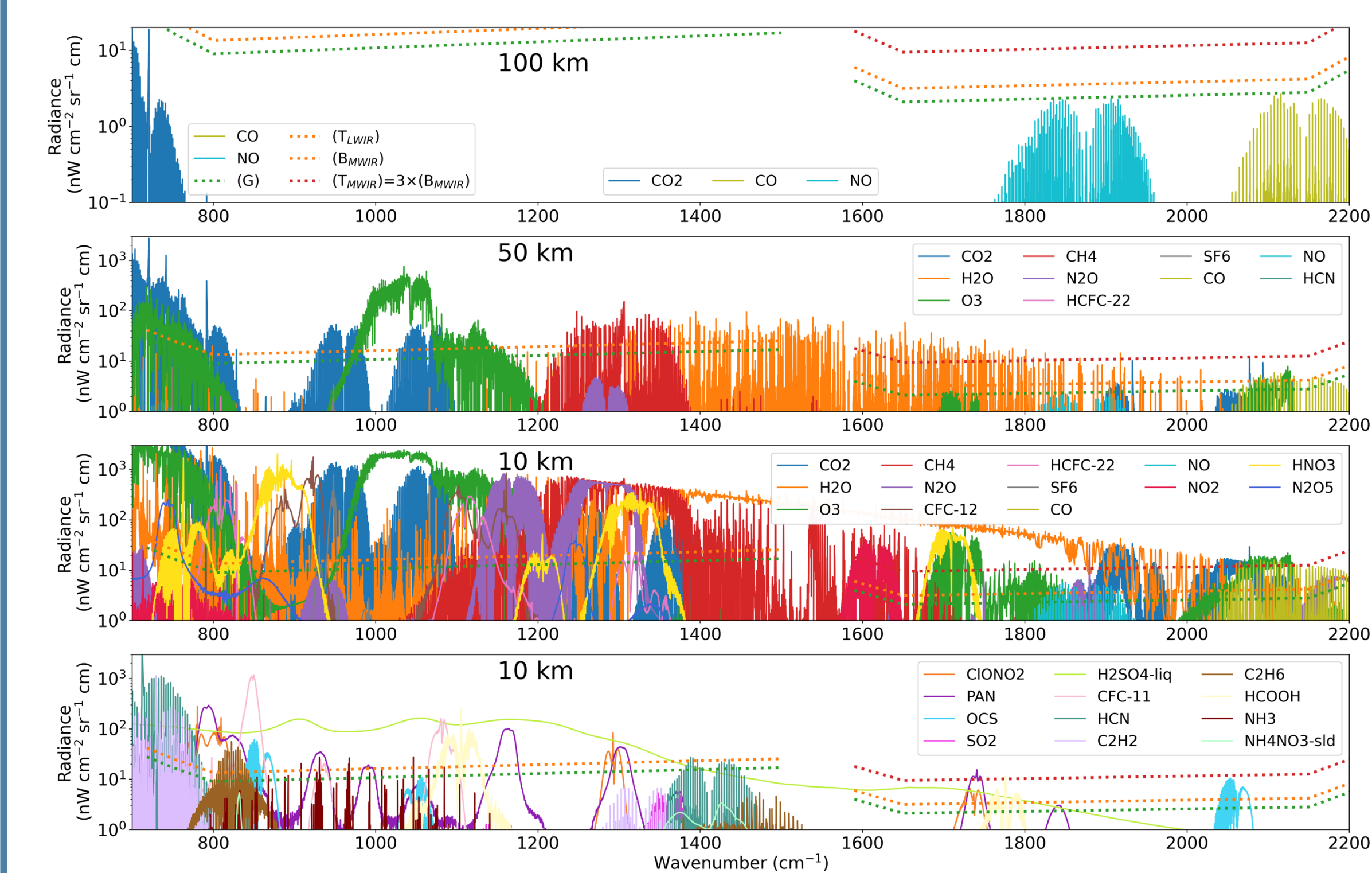
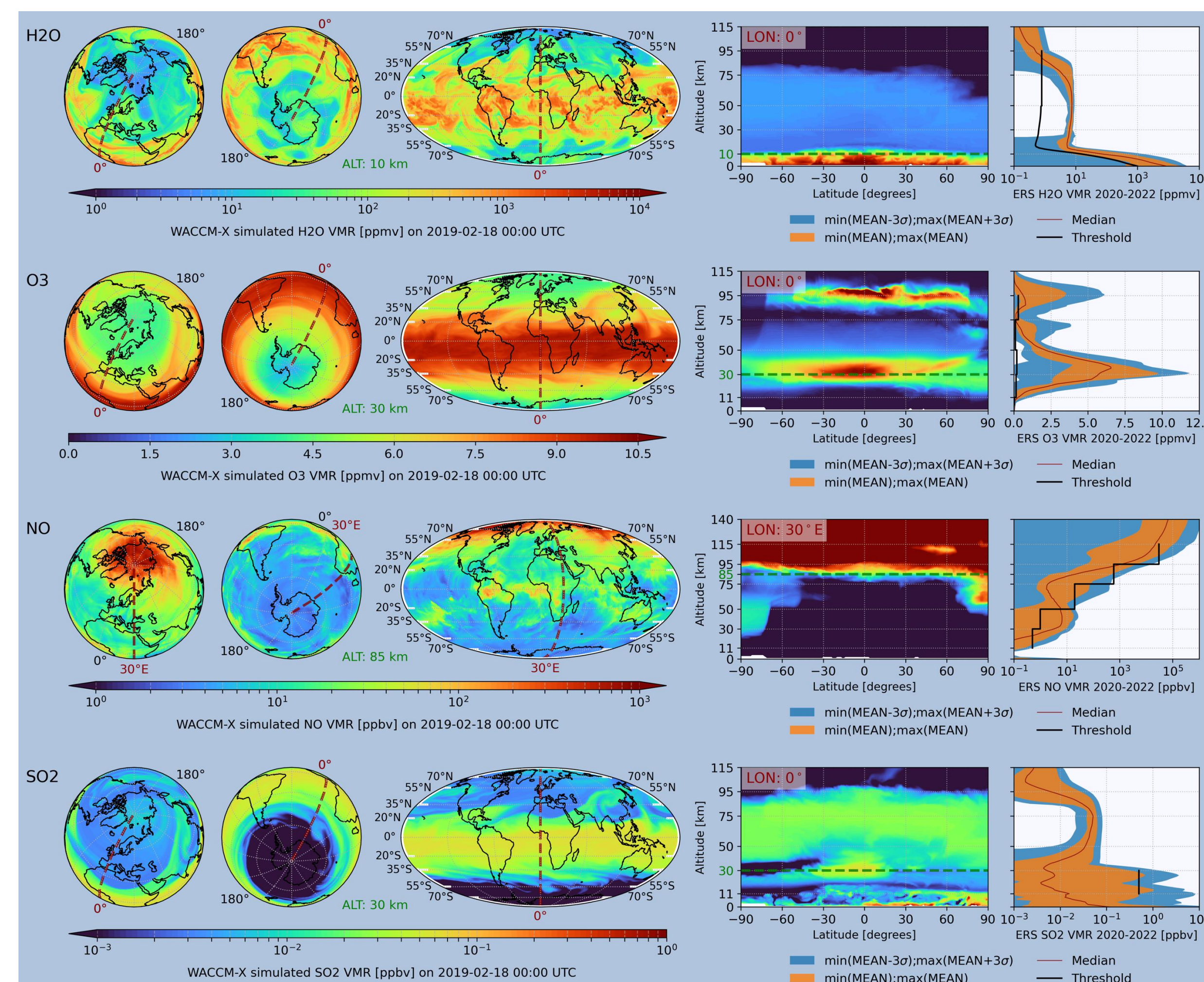
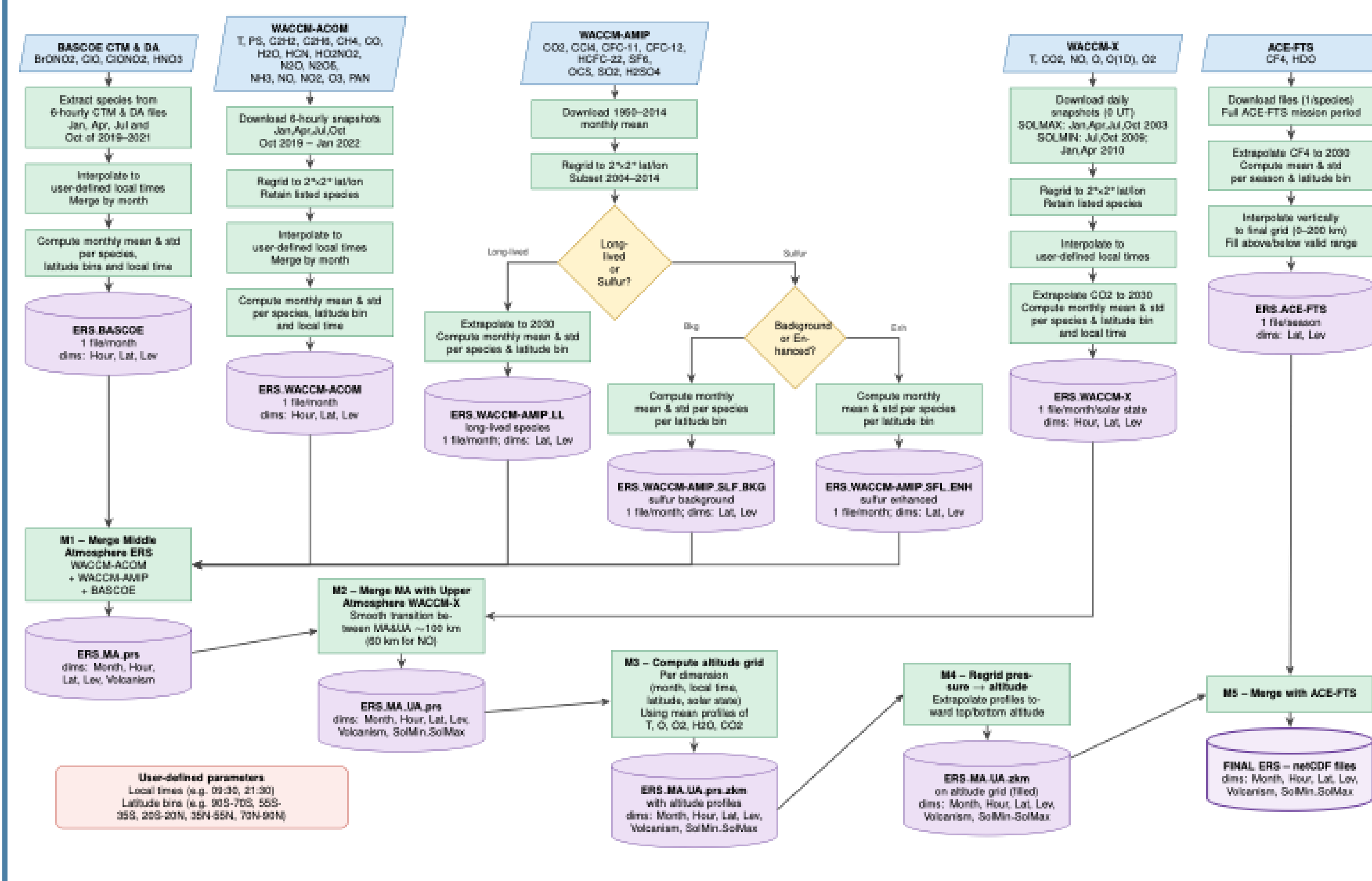


Fig. 2: Radiative Transfer Model calculations of limb spectral radiances at 100 km (row 1) and 50 km (row 2) and 10 km (rows 3 and 4) tangent point altitudes, for individual trace gases and a CLIMAC daytime atmosphere (45°N, April). Radiometric sensitivity requirements are also shown.

3. Input datasets and processes used to create CLIMAC



4. CLIMAC domain

Vertical	0-200 km
Seasons	Four months (January, April, July and October)
Latitudes	Five latitude bands ([-20°, 20°], ±[35°, 50°], ±[70°, 90°]) in v07, v07b, v08
Local times	9:30 and 21:30 in v07, v07b, v08
Volcanism	Yes, for SO ₂ , OCS and H ₂ SO ₄ c
Solar cycle	Yes, for CO ₂ , NO, O(¹ D), O, O ₂ , pT
Parameters	BrO, BrONO ₂ , C ₂ H ₂ , C ₂ H ₆ , CCl ₄ , CF ₄ , CFC11, CFC12, CH ₄ , CO ₂ , CO, ClO, ClONO ₂ , H ₂ O, H ₂ SO ₄ c, HCFC22, HCN, HCl, HDO, HNO ₃ , HO ₂ NO ₂ , N ₂ O ₅ , N ₂ O, NH ₃ , NO ₂ , NO, O(¹ D), O ₂ , O ₃ , OCS, O, PAN, SF ₆ , SO ₂ , Surface Pressure, pT

Fig. 3: Time series of SO₂ and liquid H₂SO₄ from WACCM-AMIP simulation as a function of pressure and zonally averaged in 20°S-20°N. In CLIMAC, background/enhanced volcanic conditions are identified at low/high values of these species.

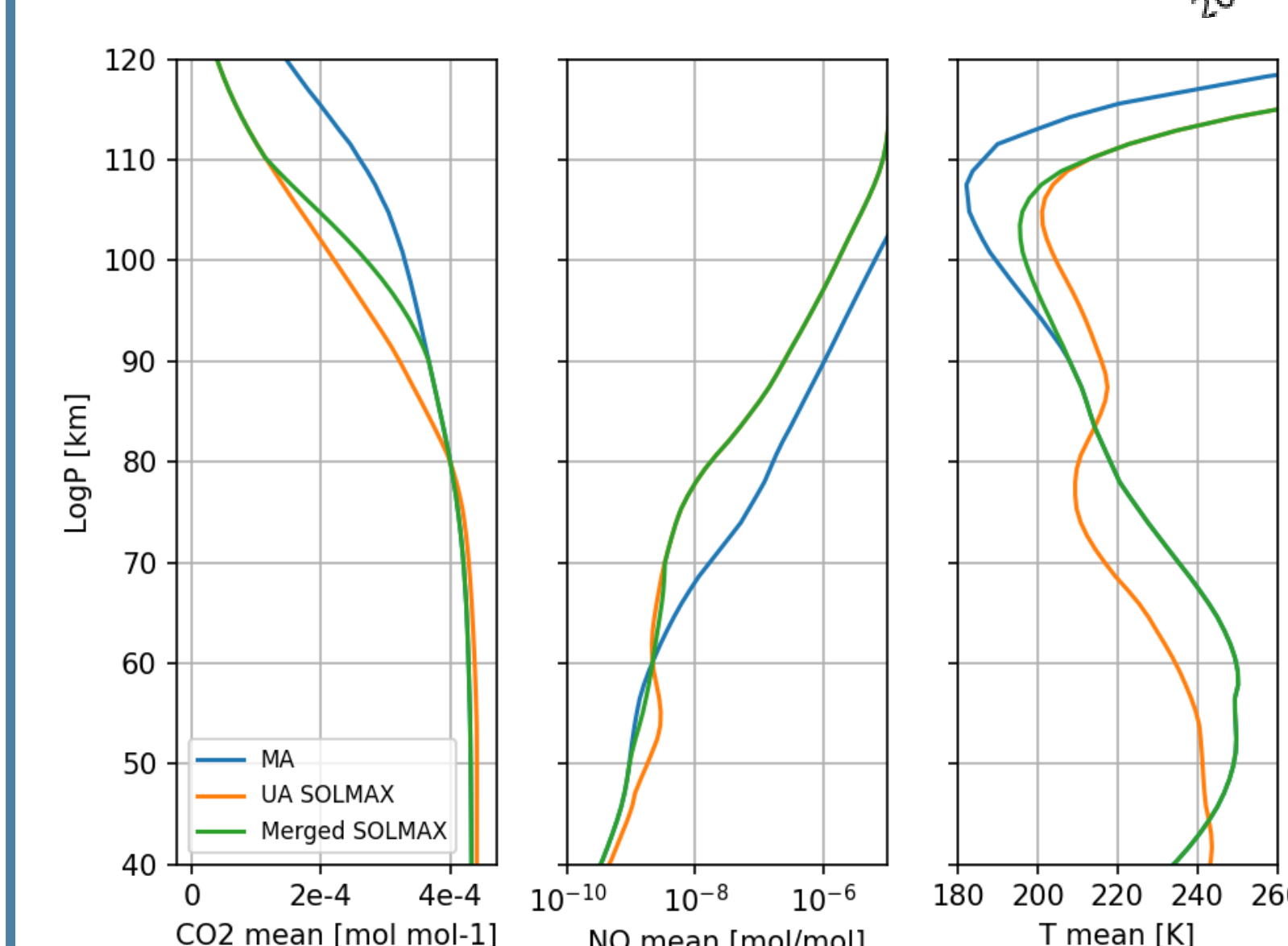
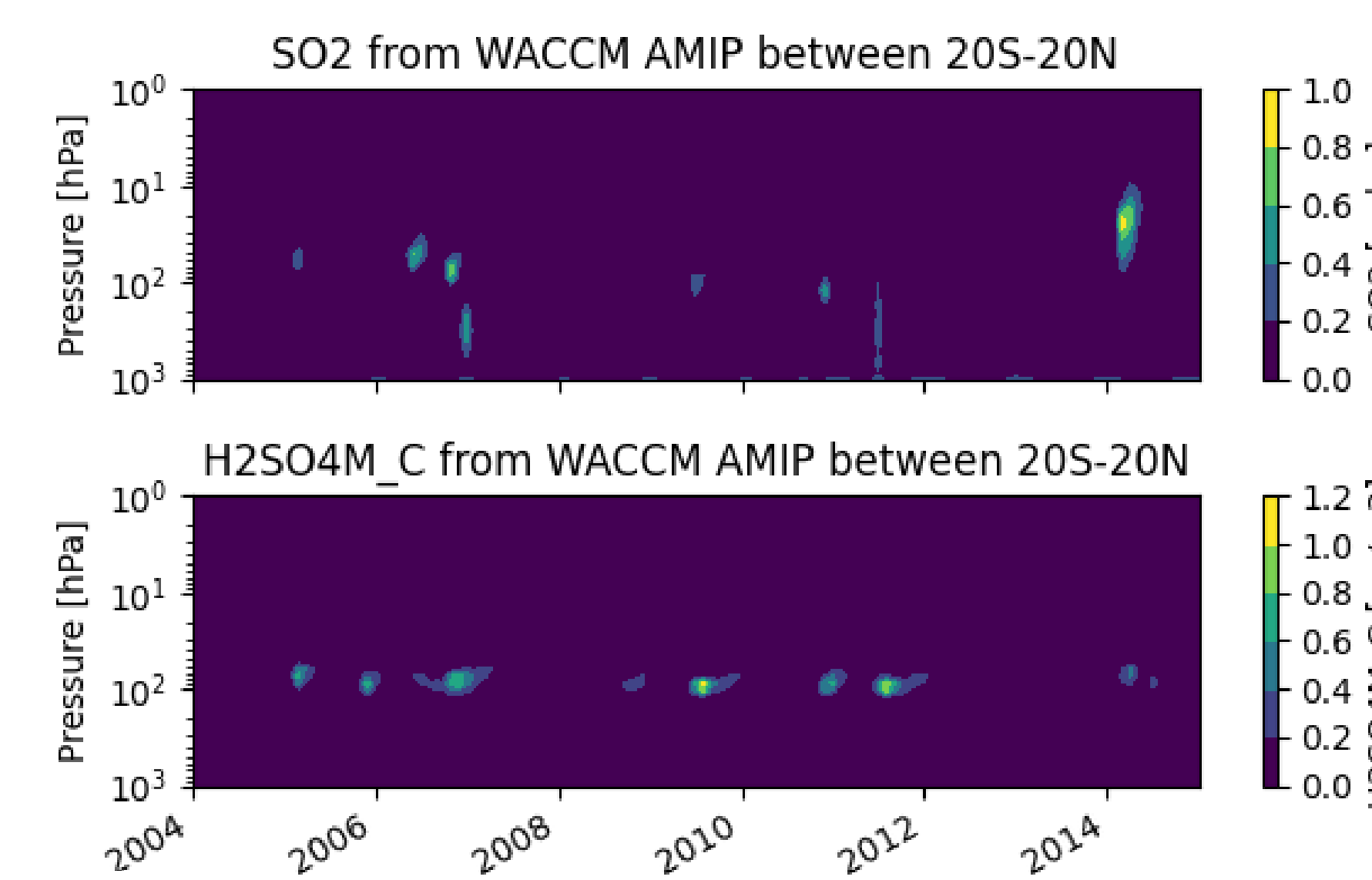
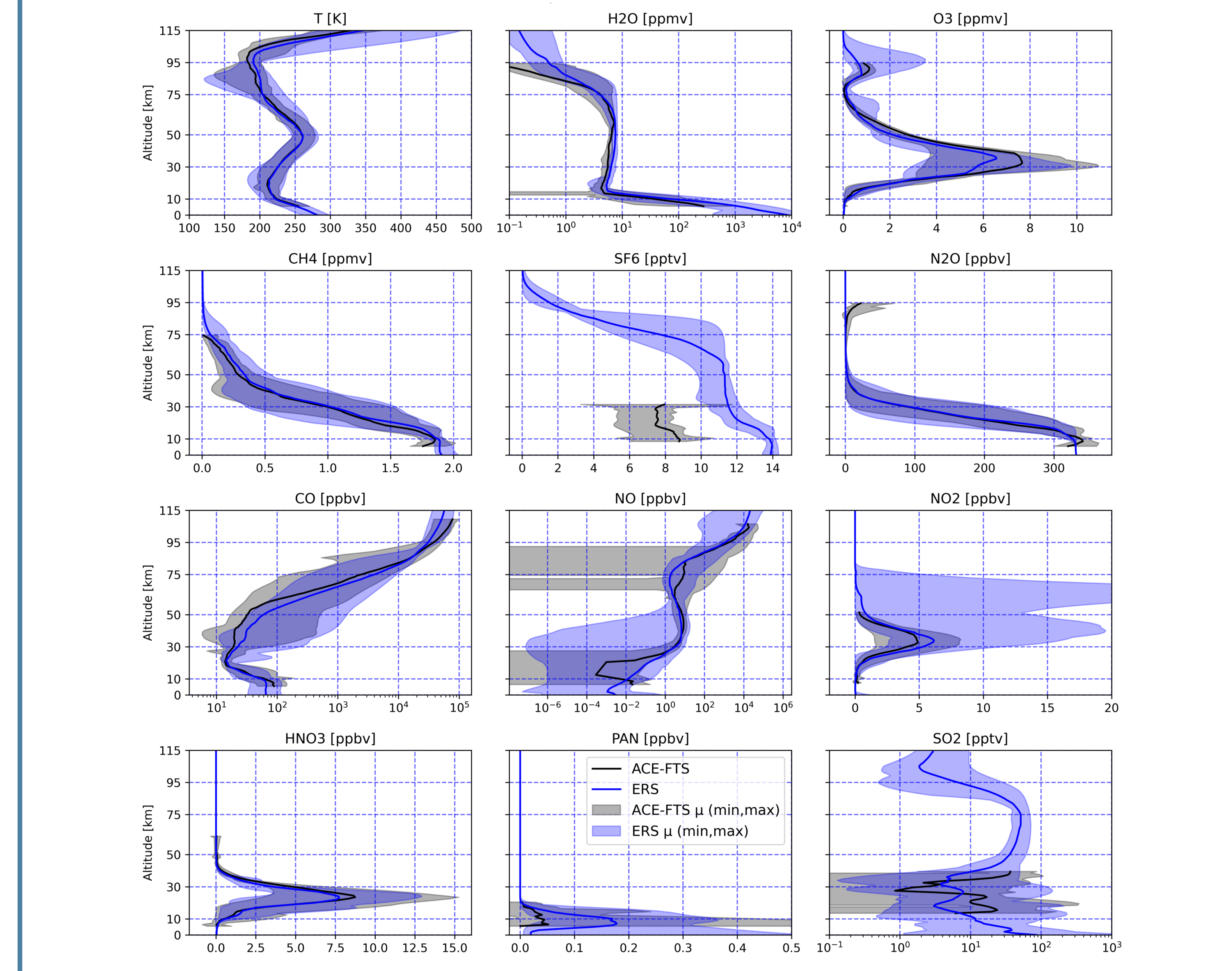


Fig. 4: Vertical merging of WACCM-ACOM and WACCM-X for CO₂, NO and T at North Pole during January at SOLMAX. Vertical transition from WACCM-ACOM and WACCM-X is done between 90 and 110 km for CO₂ and T, between 50 and 70 km for NO.

5. Validation against ACE-FTS

Fig. 5: Comparison between ERS v8 and ACE-FTS for the mean of 12 parameters.



6. Versions, code and data availability

Version	Comments
v07	Initial versions used during CAIRT Phase 0/A
v07b	A version using the consolidated code presents in this paper without significant change w.r.t. v07
v08	Using the consolidated code and solving some issues: <ul style="list-style-type: none"> - Solving a minor bug in time selection in WACCM-AMIP and WACCM-X - Bug fixed in vertical merging of WACCM-ACOM and WACCM-X for CO₂, NO & T - CF₄ now properly extrapolated to 2030 - Using ACE-FTS v5.3 against v4.1.2 in v07 - Using AGAGE datasets from 10.5281/zenodo.18878005 - Include BRO and HCl from BASCOE - Better vertical decrease of H₂SO₄c above the highest observe altitude
v09	In addition to v08, v09: <ul style="list-style-type: none"> - Includes 4 additional latitude bands in ±[55°, 70°] and ±[20°, 35°] - Provide local times between 0:30 and 23:30 every hour

CLIMAC v07 (initially named Extended Reference Scenario – ERS) can be download here: doi.org/10.5281/zenodo.10022129
 Other versions will be made publicly available.
 Code will be made publicly available.

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