

## 1. Introduction

This poster presents the CLIMatology of the Middle Atmosphere temperature and Composition Extended Reference Scenario (CLIMAC-ERS) used during the Phase O/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 is necessary to:

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

For example, CLIMAC-ERS 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-ERS, with CAIRT threshold uncertainty requirement.

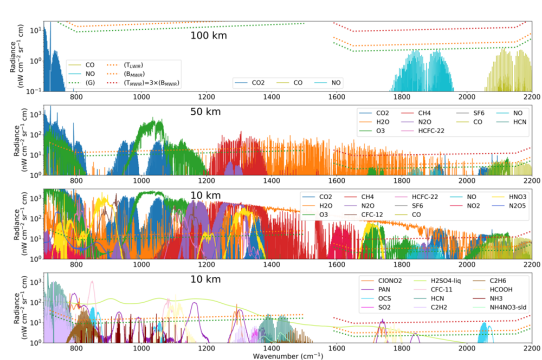
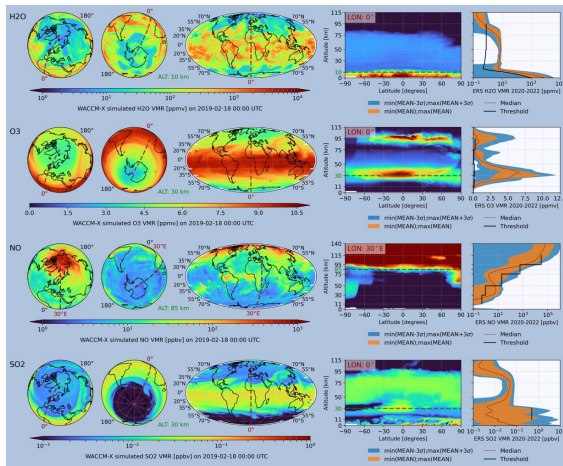
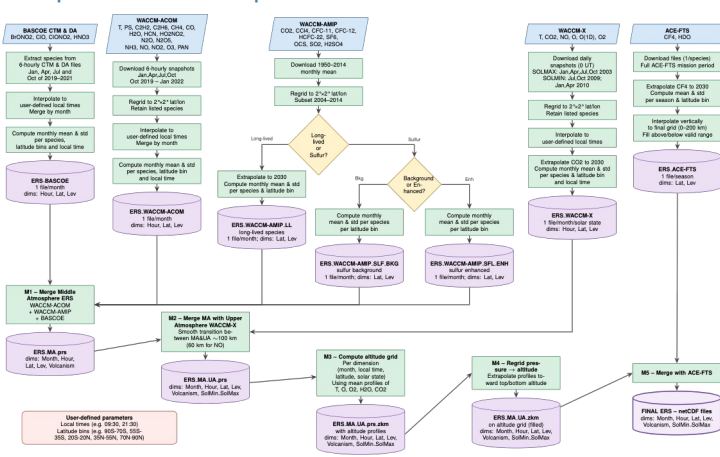


Fig. 2: Radiative Transfer Model calculations of limb spectral radiances at 100 km (row 1), 50 km (row 2) and 10 km (row 3 and 4) tangent point altitudes, for individual trace gases and a CLIMAC daytime atmosphere (45°N, April). Radiometric sensitivity requirements are also shown.

## 3. Input datasets and processes used to create CLIMAC-ERS



## 4. CLIMAC-ERS 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; hourly for v09                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Volcanism   | Yes, for SO <sub>2</sub> , OCS and H <sub>2</sub> SO <sub>4</sub> c                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Solar cycle | Yes, for CO <sub>2</sub> , NO, O( <sup>1</sup> D), O, O <sub>2</sub> , pT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Parameters  | BrO, BrONO <sub>2</sub> , C <sub>2</sub> H <sub>2</sub> , C <sub>2</sub> H <sub>6</sub> , CCl <sub>4</sub> , CF <sub>4</sub> , CFC11, CFC12, CH <sub>4</sub> , CO <sub>2</sub> , CO, ClO, ClONO <sub>2</sub> , H <sub>2</sub> O, H <sub>2</sub> SO <sub>4</sub> c, HCFC22, HCN, HCl, HD, HNO <sub>3</sub> , HO <sub>2</sub> NO <sub>2</sub> , N <sub>2</sub> O <sub>s</sub> , N <sub>2</sub> O, NH <sub>3</sub> , NO <sub>2</sub> , NO, O( <sup>1</sup> D), O <sub>2</sub> , O <sub>3</sub> , OCS, O, PAN, SF <sub>6</sub> , SO <sub>2</sub> , Surface Pressure, pT |

Fig. 3: Time series of SO<sub>2</sub> and liquid H<sub>2</sub>SO<sub>4</sub> from WACCM-AMIP simulation as a function of pressure and zonally averaged in 20°S-20°N. In CLIMAC-ERS, background/enhanced volcanic conditions are identified at low/high values of these species.

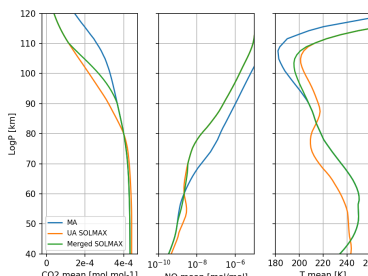
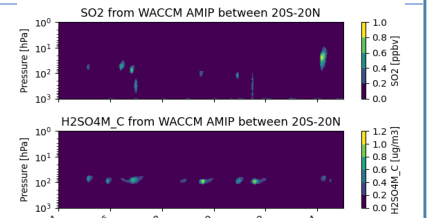
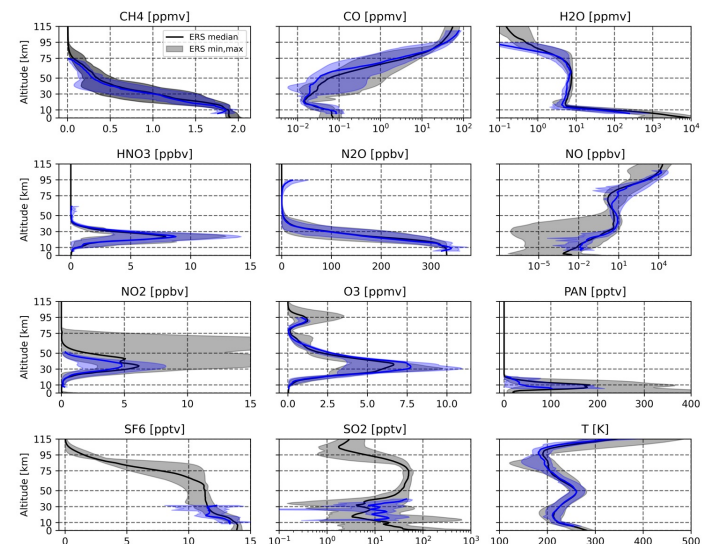


Fig. 4: Vertical merging of WACCM-ACOM and WACCM-X for CO<sub>2</sub>, NO and T at North Pole during January at SOLMAX. Vertical transition from WACCM-ACOM and WACCM-X is done between 90 and 110 km for CO<sub>2</sub> and T, between 50 and 70 km for NO.

## 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

ERS v07 ([doi.org/10.5281/zenodo.10022129](https://doi.org/10.5281/zenodo.10022129)) is the one used during CAIRT PhO/A. ERS v08 is solving several issues in v07, and v09 is provided at hourly local time. ERS v08 and v09 will be made publicly available.

## 6. Reference

Q. Errera, J. Flunger, B. Funke, A. Hoffmann, M. Höpfner, M. Op de beeck, P. Raspollini, B.-M. Sinnhuber, and K. Walker, Climatology of the Middle Atmosphere Temperature and Composition to Support Future Limb Satellite Instrument Studies, to be submitted in ESSD.

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