SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year	2025
Project Title:	Alternative schemes to accelerate seamless weather prediction
Computer Project Account:	spgbmong
Principal Investigator(s):	Beatriz Monge-Sanz
Affiliation:	University of Oxford, Physics Department
Name of ECMWF scientist(s) collaborating to the project (if applicable)	Matthew Chantry, Peter Dueben, Antje Weisheimer, Antje Inness
Start date of the project:	2023
Expected end date:	2025

Computer resources allocated/used for the current year and the previous one

(if applicable)
Please answer for all project resources

		Previous year		**Current year**	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	27,000,000	30,000,000	57,000,000	36,000,000
Data storage capacity	(Gbytes)	10,000	2,500	10,000	5,500

Summary of project objectives (10 lines max)

The new generation of Earth System Models (ESMs) required to answer pressing questions on weather extremes under climate change needs to be developed in ways that allow seamless prediction across a wide range of resolutions and timescales.

The role of stratospheric chemistry in ESMs and numerical weather prediction (NWP) is still an open question. Monge-Sanz et al. (2022) demonstrated the benefits of improving stratospheric ozone models for NWP at multiple timescales, from medium-range to seasonal and decadal. For this they used a fast linear ozone model that superseded existing linear models as shown by Monge-Sanz et al. (2011). In this project we assess the role of stratospheric key radiative species through ECMWF model experiments with different configurations and different approaches to incorporate the interaction between meteorological fields, radiation and stratospheric species.

Summary of problems encountered (10 lines max)

None

Summary of plans for the continuation of the project (10 lines max)

The simulations we plan to carry out include:

i) Medium-range 10-day forecast experiments covering different periods of time, up to one year, mainly focused on NH winter/spring events. This allows assessment of feedbacks along the annual cycle, as well as under different atmospheric conditions and relevant meteorological patterns, such as SSWs and polar vortex breaking events.

ii) Medium-range 10-day assimilation and forecast experiments with CAMS configuration, covering different periods of time, up to three months, mainly focused on NH winter/spring events.

iii) Seasonal runs with 7-month integration range and typically two start dates. These runs will cover decadal periods, allowing us to assess the evolution of stratospheric interannual variability.

List of publications/reports from the project with complete references

Not applicable yet – publications are in preparation.

Summary of results

Simulations have been performed with the latest cycle version 49r1, horizontal resolution T511 and full vertical resolution L137, and covered NH recent winter/spring periods after 2020. We have also assessed the role of stratospheric ozone with experiments using the CAMS model configuration. Several 3-month assimilation experiments have been run in which the contribution of ozone datasets from key instruments to meteorological fields has been quantified.

The relevance of the Microwave Limb Sounder (MLS) O_3 dataset has been identified of potential benefit for improving meteorological fields in numerical weather prediction (NWP) system forecasts. The assimilation of this dataset causes differences in the mean temperature field of up to 0.2 K in forecast lead times between day 0 and day 5 (Figure 1). Complementary results have been obtained with MLS H_2O assimilated in 49r1 (Semane and Bonavita, 2025). This provides consistent proof of benefits that MLS observations of stratospheric species can bring to weather forecasting. Our results show the need for new observations that will continue to provide similar or improved information for key stratospheric species once the MLS instrument will be decommissioned. We are therefore showing the relevance that data provided by the ESA Earth Explorer 11 CAIRT candidate mission would have to improve NWP.

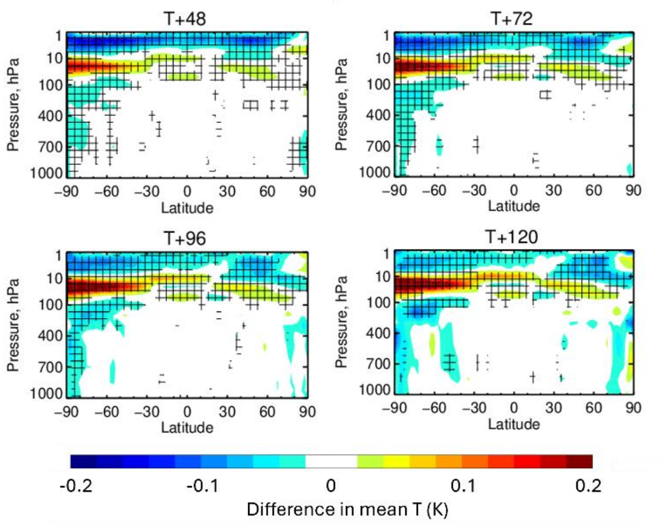

Figure 1. Cross sections for the change of mean Temperature (K) for forecast lead times from 48 to 120 h, for the period December 2020–March 2021, for two analysis experiments with and without MLS ozone. Hatched regions indicate where results are statistically significant to the 95% confidence interval. From Monge-Sanz et al. (*in prep*).

We have also presented results related to this project at several international conferences and invited seminars this year, including the 13th Atmospheric Limb Workshop and the RMetS Annual Conference 2025.

References:

Monge-Sanz, B. M., Bozzo, A., Byrne, N., Chipperfield, M. P., Diamantakis, M., Flemming, J., Gray, L. J., Hogan, R. J., Jones, L., Magnusson, L., Polichtchouk, I., Shepherd, T. G., Wedi, N., and Weisheimer, A.: A stratospheric prognostic ozone for seamless Earth System Models: performance, impacts and future, Atmos. Chem. Phys., https://doi.org/10.5194/acp-22-4277-2022, 2022.

Monge-Sanz, B. M., Chipperfield, M. P., Cariolle, D., and Feng, W.: Results from a new linear O_3 scheme with embedded heterogeneous chemistry compared with the parent full-chemistry 3-D CTM, Atmos. Chem. Phys., 11, 1227–1242, https://doi.org/10.5194/acp-11-1227-2011, 2011.

Semane, N., and Bonavita, M.: Reintroducing the analysis of humidity in the stratosphere, ECMWF Newsletter 183 - Spring 2025, 28-31, doi: 10.21957/ns41h80kl3, 2025.