



# eur PLANET 2024

Research Infrastructure

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## Deliverable D6.7

**Deliverable Title:** Exoplanet atmospheric composition from observations  
**Due date of deliverable:** 30/05/2023  
**Nature<sup>1</sup>:** R  
**Dissemination level<sup>2</sup>:** P  
**Work package:** 6  
**Lead beneficiary:** UCL  
**Contributing beneficiaries:** ObsPARIS  
**Document status:** Final

**Start date of project:** 01 February 2020  
**Project Duration:** 54 months  
**Co-ordinator:** Prof Nigel Mason, University of Kent

1. **Nature:** R = Report, P = Prototype, D = Demonstrator, O = Other

2. **Dissemination level:**

PU	PP	RE	CO
Public	Restricted to other programme participants (including the Commission Service)	Restricted to a group specified by the consortium (including the Commission Services)	Confidential, only for members of the consortium (excluding the Commission Services)

## Executive Summary / Abstract:

This action in VA2: VESPA Task 6 focuses on developing the TauREx 3 software framework and providing a uniform analysis of existing observations of exoplanetary atmospheres; both the code and the results will be made available to users through the VESPA infrastructure. TauREx 3 has been fully rewritten in Python 3 to minimise external runtime library issues and to facilitate ease of maintenance and installation in the existing infrastructure. Using TauREx 3, we have uniformly analysed the entire Hubble Space Telescope exoplanet observation archive and provided results that are fully documented and open-access.

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## 1 TauREx 3 development and implementation

We have finalised the development of the TauREx 3 framework for the analysis and interpretation of exoplanet atmospheres and published the code base as open-access software ([Al-Refaie et al. 2019](#), [Al-Refaie et al. 2022a](#), [Al-Refaie et al. 2022b](#)). In this work package we have focused on improving code complementarity to the existing infrastructures as well as ease of installation, maintenance, and deployment on large-scale high-performance computing clusters (HPC) and database systems. TauREx 3 has been rewritten from scratch as a full Python 3 stack. This avoids any library cross-dependency issues that may often occur on HPC systems. The code base is now easily implementable into any system architecture, either as a stand-alone framework or as Python library and API service. Installation is possible via the PyPi package manager, see below.

TauREx 3 is a permanently evolving framework and we are committed to publishing fully packaged and documented code regularly. The code base is available under a BSD 3 license here:

[https://github.com/ucl-exoplanets/TauREx3\\_public](https://github.com/ucl-exoplanets/TauREx3_public)

Installation instructions can be found here:

<https://taurex3-public.readthedocs.io/en/latest/user/installation.html#installation>

For additional information on how to run the code and its current functionalities, we refer the reader to the documentation:

<https://taurex3-public.readthedocs.io/en/latest/>

In a second step, the feasibility of an on-demand service will be assessed by deploying the code on the OPUS platform, either at UCL or ObsParis.

## 2 Exoplanet atmospheric catalogues

Using the TauREx 3 framework, we were able to publish the largest uniformly analysed catalogue of exoplanet atmospheres observed by the Hubble Space Telescope. The catalogue includes a uniform analysis of 70 exoplanets in transmission spectroscopy ([Edwards et al. 2022](#)) and 25 planets in emission spectroscopy ([Changeat et al. 2022](#)). These publications discuss the first in-depth comparative planetology of extrasolar planets using homogenous data and have led to the resolution of key questions pertaining to planetary chemistries and evolution histories.

Detailed data products and results are published open-sourced for Changeat et al 2022 on github:

[https://github.com/QuentChangeat/HST\\_WFC3\\_Population](https://github.com/QuentChangeat/HST_WFC3_Population)

and are available as a VizieR catalogue (also findable from the EPN-TAP service VizieR\_planets):

<https://cdsarc.cds.unistra.fr/viz-bin/cat/J/ApJS/260/3#>

Similarly, all data products will be provided open-access for Edwards et al. 2022 upon final publication by the journal.

Furthermore, we provide fully documented Jupyter notebooks and example cases, allowing the user to fully reproduce these results as part of the TauREx3 code base. Example scripts and Jupyter notebooks can be found here:

[https://github.com/ucl-exoplanets/TauREx3\\_public/tree/develop/examples](https://github.com/ucl-exoplanets/TauREx3_public/tree/develop/examples)

Owing to the importance of these results, a dedicated EPN-TAP service providing direct access to the spectra is being designed. It will make spectra accessible and searchable from the VESPA portal and other TAP clients, allowing for cross-searches with other services in the field, e.g., the Encyclopedia of Exoplanets or the ARTECS database to come.