Plugin Development

Atmospheric retrievals are not an isolated science. We regularly use different codes and models from various fields and contributors to better characterise exoplanetary systems. Often repetitive steps are needed to make use of an external code, and frequently, these are difficult to share or distribute to a broader audience. Plugins are a new feature in TauREx 3.1 that allows developers to simplify the distribution and usage of their profile/models/chemistry etc., to other users for their retrievals. The plugin system can be used to add the following new components:

- `TemperatureProfile`
- `Chemistry`
- `Gas`
- `PressureProfile`
- `Star`
- `Planet`
- `ForwardModel`
- `Contribution`
- `Opacity`
- `Priors`
- `Optimizer`
- `Mixin`

Refer to the Developers guide on how to build each individual component. This guide will outline how to package your new components into a TauREx plugin.

Anatomy of a Plugin

Plugins are installable python packages that TauREx will integrate automatically into its pipeline. Plugins can come from existing python libraries or dedicated packages. Dedicated packages only contain TauREx components and generally have the name like `taurex_something`. For example, a package that provides wrappers to the GGchem chemistry code would be called `taurex_ggchem` (which exists btw if you need it).

Importantly, open-source plugins should be registered to PyPI installable with a single command:

```
> pip install taurex_myplugin
```

If they rely on an external FORTRAN/C++ code then they should be packaged into a binary wheel distribution. We recommoned cibuildwheel for building these wheels. After install the plugin will be automatically detected by TauREx:

```
> taurex --plugins
Successfully loaded plugins
---------------------------
myplugin
```

A plugin, in its most basic form, points TauREx to the place where your components exist in your package. This is accomplised through the `entry_point` parameter in `setup.py` of the plugin package:

```
entry_points = {'taurex.plugins': 'myplugin = taurex_myplugin'}

setup(name='taurex_myplugin',
      ..
      entry_points=entry_points,
      ..)
```

What this does is allow TauREx to access `taurex_myplugin` under `taurex.plugins.myplugin`

Plugins can also be defined in existing packages as well. If you have a `coolscience` python library and have built some TauREx components under `coolscience.taurex` then you can add to your `entry_point`:

```
entry_points = {'taurex.plugins': 'coolscience = coolscience.taurex',
                # ... other entrypoints
                }

setup(name='coolscience',
      ...
      entry_points=entry_points,
      ...)
```

The package will still be installable without TauREx. If later on someone installs TauREx then they automatically get the plugin for free! Neat!

TauREx Hello World!

Lets create a first plugin `taurex_helloworld` where we will define a new component: a randomized temperature profile. First we setup our folder structure:

```
taurex_helloworld/
    __init__.py
    randomtemp.py
LICENSE
README.md
setup.py
```

setup.py

The most essential part is the `setup.py` file to install the package and plugin. The following is something you can work with:

```
#!/usr/bin/env python
import setuptools
from setuptools import find_packages
from setuptools import setup

packages = find_packages(exclude=('tests', 'doc'))
provides = ['taurex_helloworld', ]

requires = []

install_requires = ['taurex', ]

entry_points = {'taurex.plugins': 'helloworld = taurex_helloworld'}

setup(name='taurex_helloworld',
      url='http://example.com/taurex_helloworld',
      license='BSD',
      author='Your Name',
      author_email='your-email@example.com',
      description='Very short description',
      long_description=__doc__,
      packages=packages,
      entry_points=entry_points,
      provides=provides,
      requires=requires,
      install_requires=install_requires)
```

randomtemp.py

This is our random temperature profile, we will steal the implementation from Custom Types and change it a little:

```python
from taurex.temperature import TemperatureProfile
from taurex.core import fitparam
import numpy as np


class RandomTemperature(TemperatureProfile):

    def __init__(self, base_temp=1500.0,
                 random_scale=10.0):
        super().__init__(self.__class__.__name__)

        self._base_temp = base_temp
        self._random_scale = random_scale

    # -----Fitting Parameters--------------

    @fitparam(param_name='rand_scale',param_latex='rand')
    def randomScale(self):
        return self._random_scale

    @randomScale.setter
    def randomScale(self, value):
        self._random_scale = value

    @fitparam(param_name='base_T',param_latex='$T_{base}$')
    def baseTemperature(self):
        return self._base_temp

    @baseTemperature.setter
    def baseTemperature(self, value):
        self._base_temp = value

    # -------Actual calculation -----------

    @property
    def profile(self):
        return self._base_temp + \
                    np.random.rand(self.nlayers) * self._random_scale

    BIBTEX_ENTRIES = [
        """
        @article{myart,
            title={School of Life},
        """
    ]

    # -----Plugin related------------------

    @classmethod
    def input_keywords(cls):
        return ['helloworld', 'helloearth', 'hello-world',]
```

As before a terrible temperature profile we now include two extra parameters. The class method `input_keywords` informs TauREx on how this temperature profile is selected in the input file. It must return a list and can include more than one keyword. If this plugin is installed we can use the profile through one of those keywords:

```
[Temperature]
profile_type = helloworld    # Valid keyword RandomTemperature
# profile_type = helloearth  # Also valid
# profile_type = hello-world # Also valid
```

The `BIBTEX_ENTRIES` parameter is used by TauREx to list relevant publications involved with the atmospheric compoenent. See Basics for more information.

__init__.py

We can use `__init__.py` to expose the temperature profile to TauREx by importing it like so:

```
from .randomtemp import RandomTemperature
```

Tip

You could also just point the `entry_point` to `taurex_helloworld.randomtemp`. However we recommend either putting it in an `__init__.py` or defining another python file that includes these imports. This allows you to include components from different files and allows you to be selective on what to expose to TauREx

Using our plugin

To use our plugin we can now do:

```
pip install .
```

Running `taurex --plugins` we see:

```
Successfully loaded plugins
---------------------------
helloworld
```

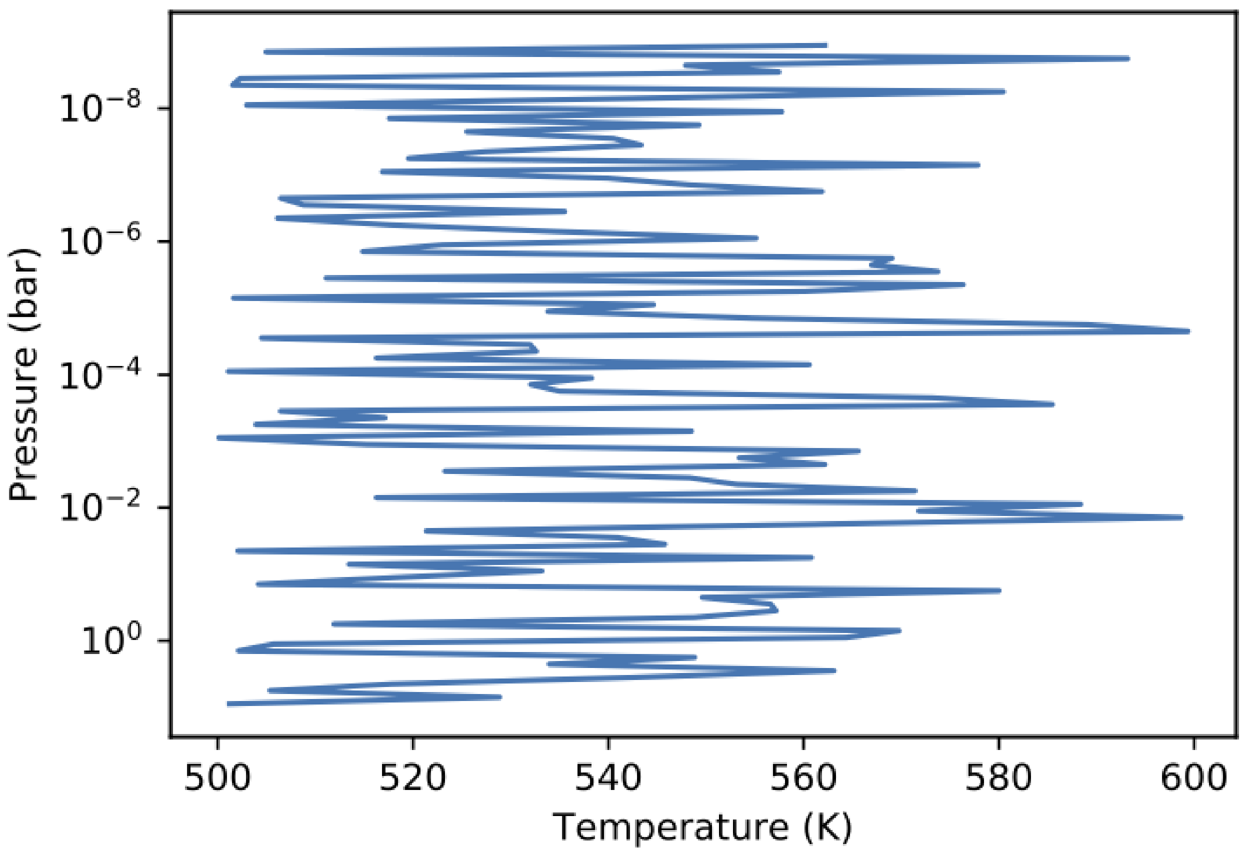
Our plugin has now been loaded into TauREx! We can also see that our temperature profile was detected as well by doing `taurex --keywords temperature`:

profile_type	Class	Source
file / fromfile	TemperatureFile	taurex
isothermal	Isothermal	taurex
guillot / guillot2010	Guillot2010	taurex
npoint	NPoint	taurex
helloworld / helloearth / hello-world	RandomTemperature	helloworld
rodgers / rodgers2010	Rodgers2000	taurex

Now we can write in the input file:

```
[Temperature]
profile_type = helloworld
base_temp = 500.0
random_scale = 100.0
```

Which gives us



Still terrible

This is a minimal guide to developing plugins but we always recommend looking at plugin projects and seeing how they accomplish their tasks.