

# Convective- and turbulent Scale Evaluation Toolkit, **CSET**

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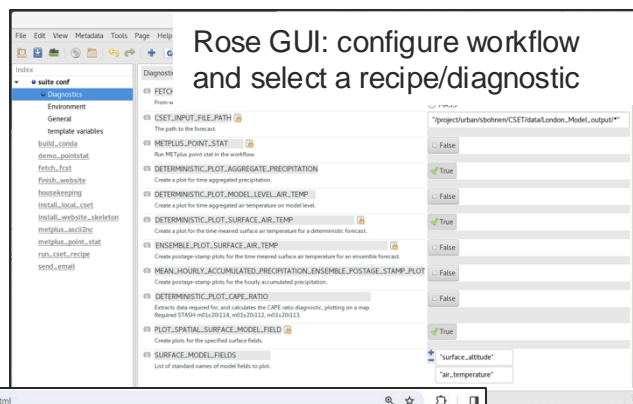
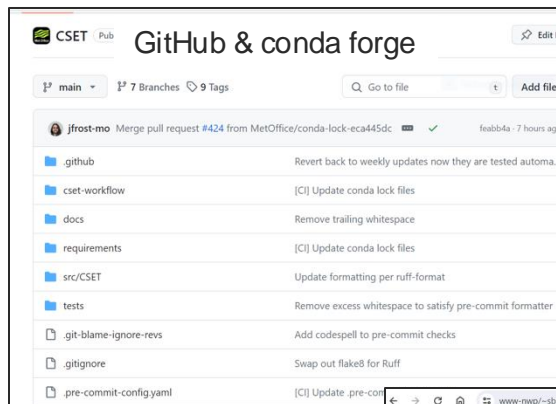
Maalick + wider CSET team

## Thanks to:

Aurore Porson, Stephen Gallagher, Bjoern Fock, Rob Darvell, Keith Williams, David Walters, Marion Mittermaier, Sean Milton, Chris Bridge, Vinod Kumar, Charmaine Franklin, Jin Lee, Scott Wales, Saij Mohandas, Gibies George, A. Jajakumar, Raghavendra Ashrit, Peter Heng, Douglas Boyd, Trevor Carey-Smith, Stuart Moore, Hilary Oliver, Stephanie Landman, Elelwani Phaduli, Małgorzata Melonek, Steven Iack, Evan Kuchera, Hyun-Cheol Shin, Ben Fitzpatrick, Glenn Greed, Stuart Webster, Segolene Berthou, Juan Castillo, Anne McCabe, Mark Weeks, Claudio Sanchez, Richard Jones, Anke Finnenkoetter, Sana Mahmood, Richard Jones, Dasha Shchepanovska, Carol Halliwell, Jon Shonk, Mark Weeks, Lizzie Kendon, Cath Senior, Prince Xavier, Warren Tenant, Clare Bysouth, Nigel Roberts, Alistair Sellar, Christopher Short, Joao Teixeira

# What is CSET?

Community tool for process-oriented evaluation supporting RAL development



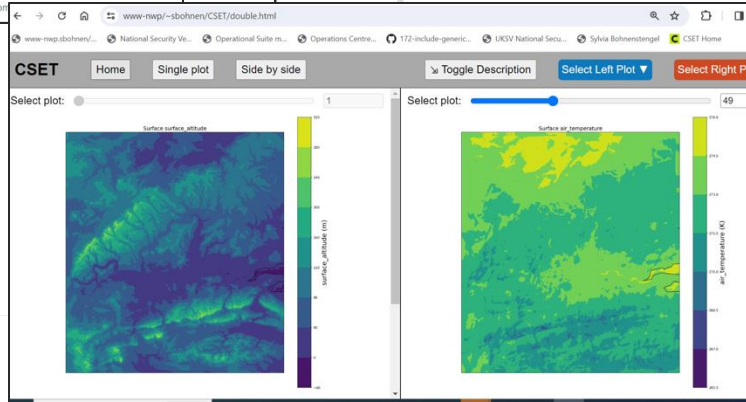
## Library

- Operators
- Recipes
- METplus wrappers (linking to operational verification tools)
- metadata

to (pre-)process analysis of data and generate diagnostics and plots

## Website with

- Diagnostics visualisation
- Ensembles
- download data
- information about diagnostic

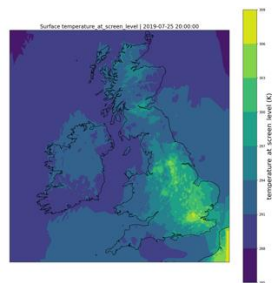


## Workflow (flow.cylc cylc8) orchestrates

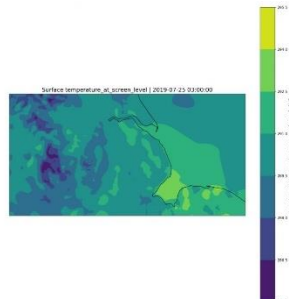
- build conda environment
- install CSET
- fetch data
- run and link of multiple recipes
- run METplus wrappers
- webpage
- cleans
- housekeeping

# Current diagnostics (UM & LFRic)

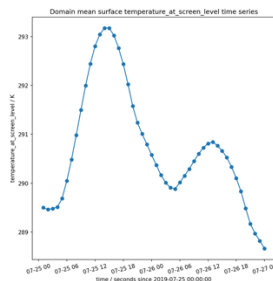
Spatial plots



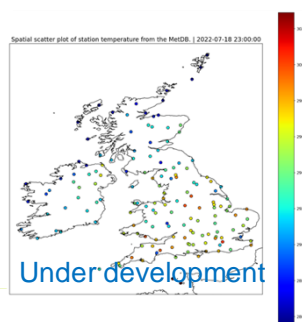
Subset area



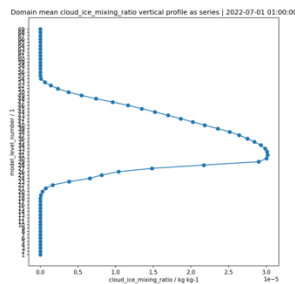
Timeseries domain mean



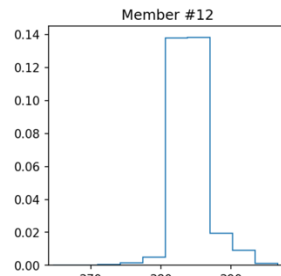
Observations overlay



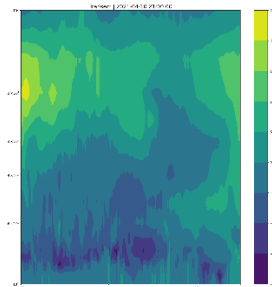
Profiles: mean or at selected points



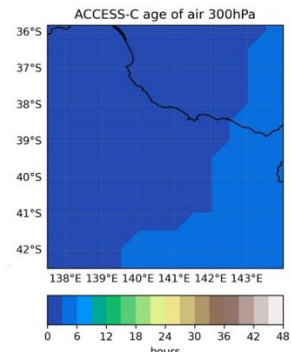
PDF



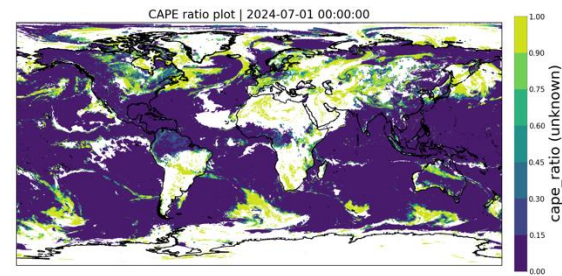
Transects



Age of air



Elevated convection



Focus so far workflow  
infrastructure and progressing  
physical process-based  
diagnostics

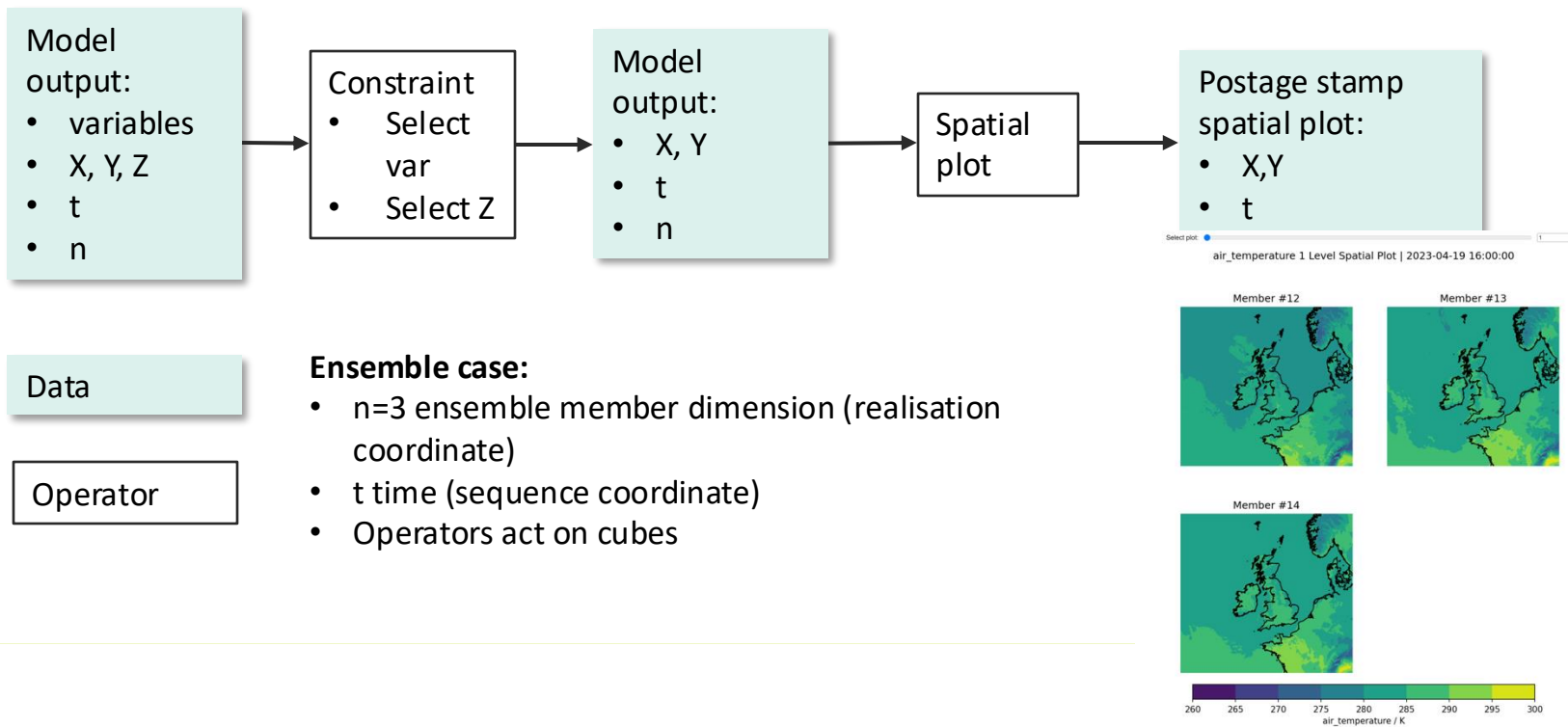
# CSET concept and definitions

<b>CSET Operator</b>	The smallest CSET unit. E.g., read data, write data, filter data, stratify data Act on cubes
<b>CSET Recipe</b>	Consists of a combination of CSET Operators that gives i.e. temperature bias. This can be written and plotted or processed further. Defined with YAML. Act on files. Can produce a diagnostic.
<b>METplus Wrapper</b>	The smallest METplus unit. Aligned with operational verification. Act on files.
<b>Diagnostic</b>	Stepping through a series of CSET Recipes and/or METplus Wrappers resulting in a data file that is plotted. Each diagnostic is a single final output.

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# Recipe

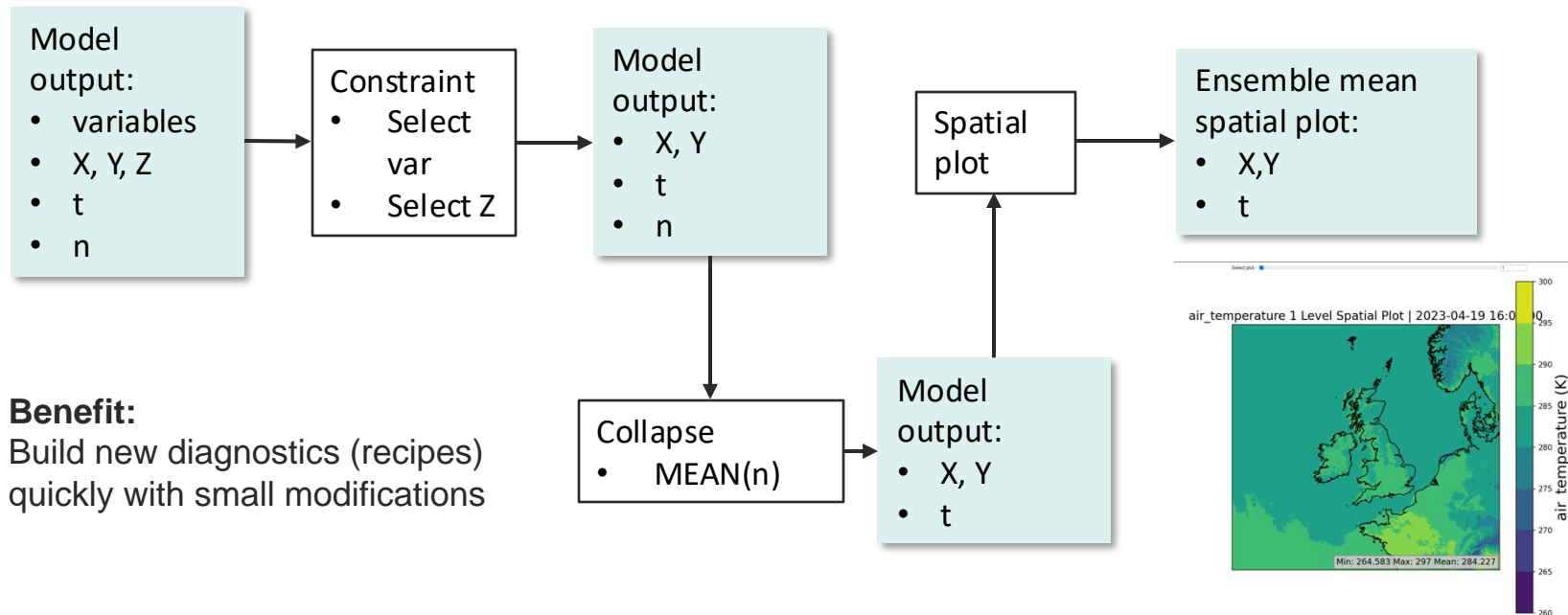
flexibly chain operators to plot **spatial postage stamp** diagnostic





# Recipe

Insert additional collapse operator into recipe to plot **ensemble mean** spatial plot



See James Frost's talk next for the corresponding code change in the recipe

# What are the benefits of using CSET?

Development is supported by our three pillars

## Technical

- Built on modern software
  - Python 3
  - Cylc 8
  - GitHub
  - Builds on Iris and METplus
- Easy to use and contribute
  - Clear documentation incl tutorials
  - Reproduceable
  - Portable
  - Open access
- QA and best practice
  - Automation for testing and docs
  - Scientific peer review

## Science

- Align parametrisation, diagnostics development and evaluation research linked to Regional Atmosphere Land (RAL) suites
- Process based understanding, evaluation, and verification
- Flexible evaluation code
- Aligned with operational verification to support PS and RAL3-LFRic testing
- Ensembles and LFRic supported by default

## Community

- Centralised and documented resource
- Common working practices
- Legacy for diagnostics and observations
- Community development

## GitHub documentation

# Rose GUI documentation

CSET documentation

Search

CSET Documentation
Getting Started
How-to Guides
Technical Reference
Glossary
CLI Usage
Recipe Format
CSET Operators
Internal Functions
Background Information
Developer's Guide
Changelog
GitHub

# Convection Operators

## CSET.operators.convection

A module containing different diagnostics for convection.

The diagnostics are calculated from output from the Unified Model, although precalculated values in the required input form may also be used.

```
CSET.operators.convection.cape_ratio(SBCAPE, MUCAPE, MUCIN, MUCIN_thresh=-75.0)
```

Ratio of two fields, one filtered to allow physical values to be output.

**PARAMETERS:**

- SBCAPE** (*Cube*) – Surface-based convective available potential energy as calculated by the model. If using the UM please use STASH m01z0i114
- MUCAPE** (*Cube*) – Most-unstable convective available potential energy as calculated by the model. If using the UM please use STASH m01z0i112
- MUCIN** (*Cube*) – Most-unstable convective inhibition associated with the most-unstable ascent as calculated by the model. If using the UM please use STASH m01z0i113
- MUCIN\_thresh** (*float, optional, default is -75. J/kg*) – Threshold to filter the MUCAPE by values are realistically realisable.

**RETURN TYPE:**

Cube

NOTES

This diagnostic is based on Clark et al. (2012) [Clarketal2012]. It is based around the idea that for elevated convection the convective instability is not based at the surface. This utilises two flavours of CAPE: the surface-based CAPE (SBCAPE) and the most-unstable CAPE (MUCAPE). The MUCAPE is filtered by the MUCIN associated with that parcel's ascent to ensure that any CAPE can at least theoretically be released. The default value is set at -75 J/kg but it can be changes depending on location and users requirements.

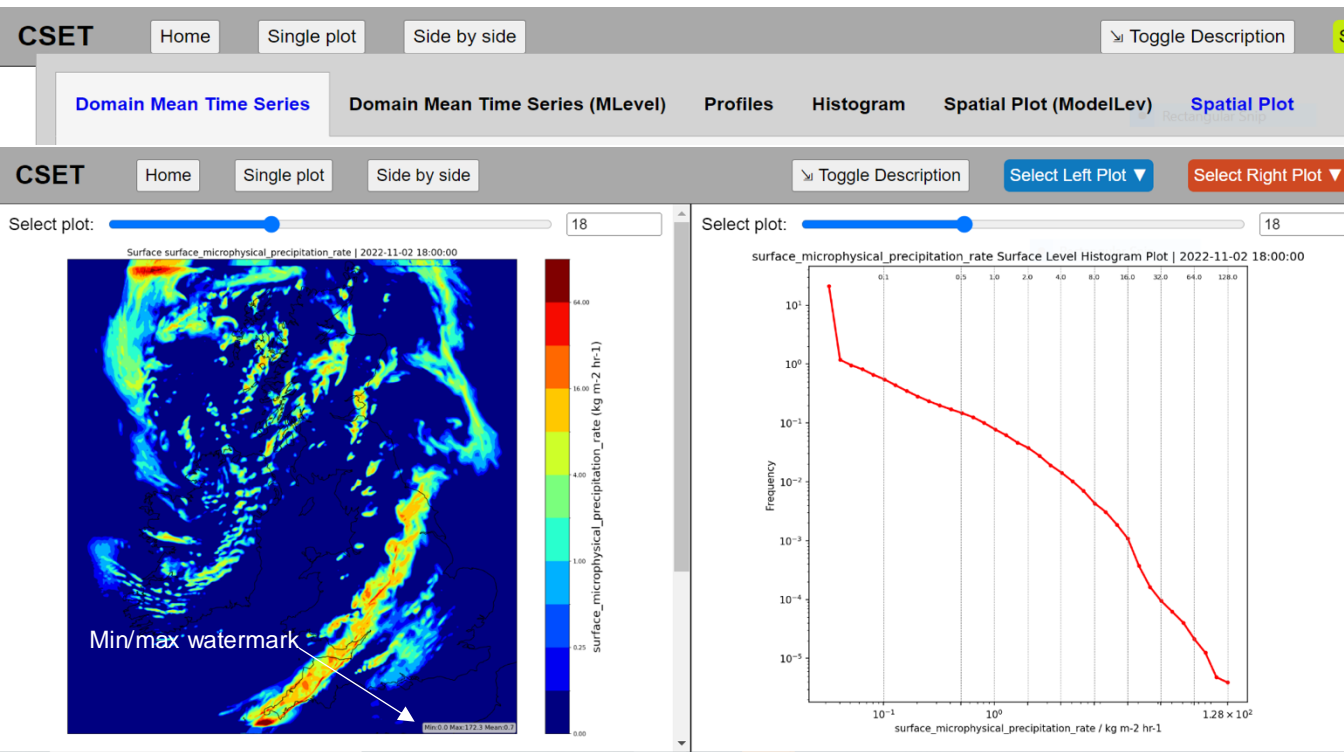
$$1 - \left( \frac{SBCAPE}{MUCAPE} \right)$$

ON THIS PAGE
Generic Operators
CSET.operators.aggregate
time\_aggregate()
CSET.operators.transsect
calc\_transsect()
CSET.operators.collapse
collapse()
CSET.operators.constraints
combine\_constraints()
generate\_area\_constraint()
generate\_cell\_methods\_constraint()
generate\_level\_constraint()
generate\_stash\_constraint()
generate\_time\_constraint()
generate\_var\_constraint()
CSET.operators.filters
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filter\_multiple\_cubes()
CSET.operators.misc
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combine\_cubes\_into\_cube\_list()
division()
multiplication()
noop()
remove\_attribute()
subtraction()
CSET.operators.plot
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plot\_line\_series()
plot\_vertical\_line\_series()
scatter\_plot()
spatial\_contour\_plot()
spatial\_pcolormesh\_plot()
CSET.operators.read
NoDataWarning

$$1 - \left( \frac{SBCAPE}{MUCAPE} \right)$$



# Met Office CSET supports RAL3-LFRic evaluation



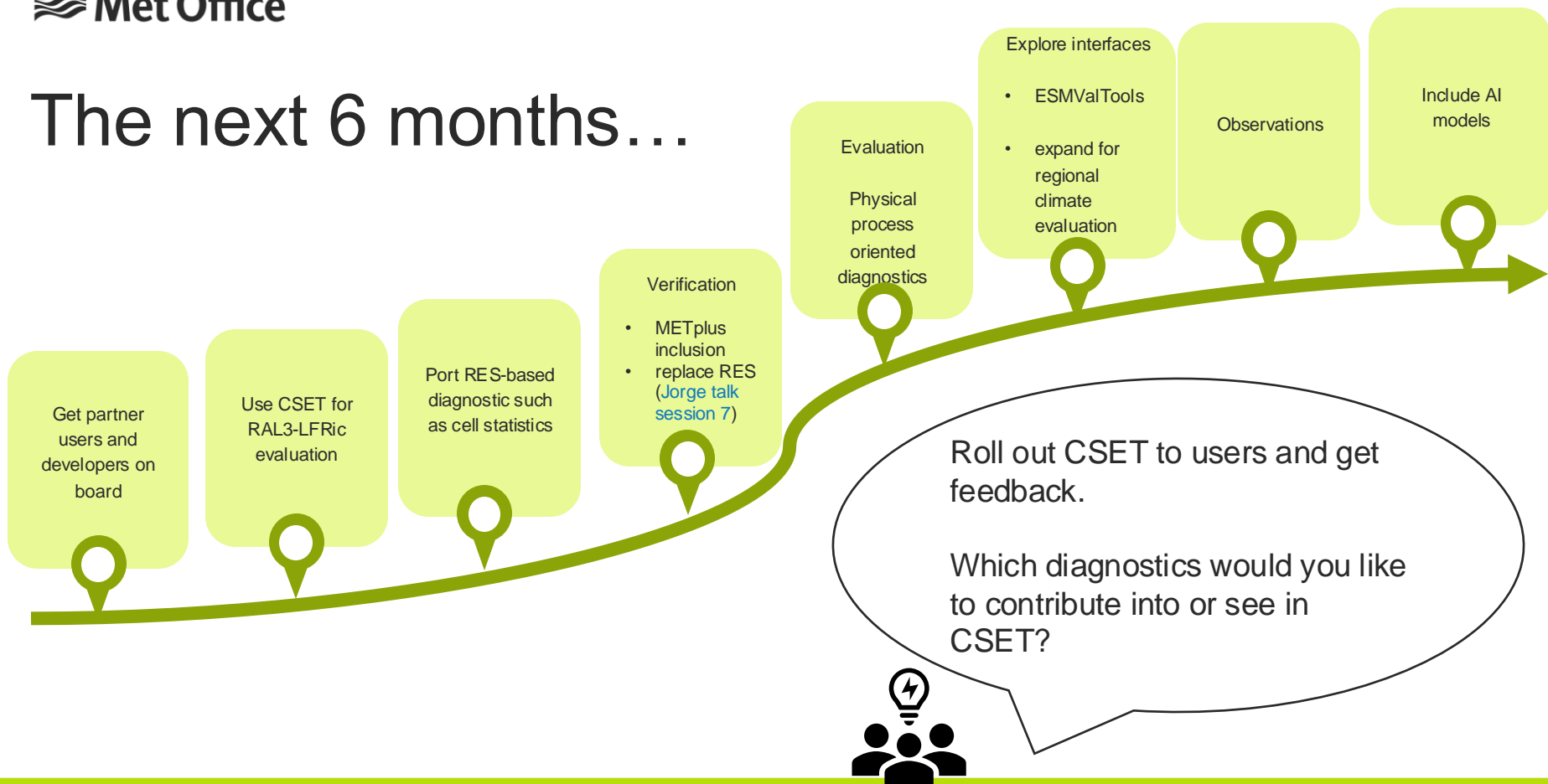
Multi-case study capability

Trial capability

Data time cycling

Use CSET for RAL3-LFRic assessment (~35 RAL3-LFRic cases have run with CSET)

# The next 6 months...



# We welcome new developers and users!

## Links to further information:



- [CSET SharePoint page](#)
- [Software requirements specification](#)
- [Potential diagnostics list \(working document\)](#)
- [Architecture design](#)
- [Evaluation strategy](#)

## Documentation



- Main documentation: [metoffice.github.io/CSET](https://metoffice.github.io/CSET)



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## The code



- <https://anaconda.org/conda-forge/cset>
- [CSET code](#) and workflow

## Get engaged



- Open issue on CSET GitHub
- Talk to us
- CSET surgeries coming
- CSET tutorial on Friday