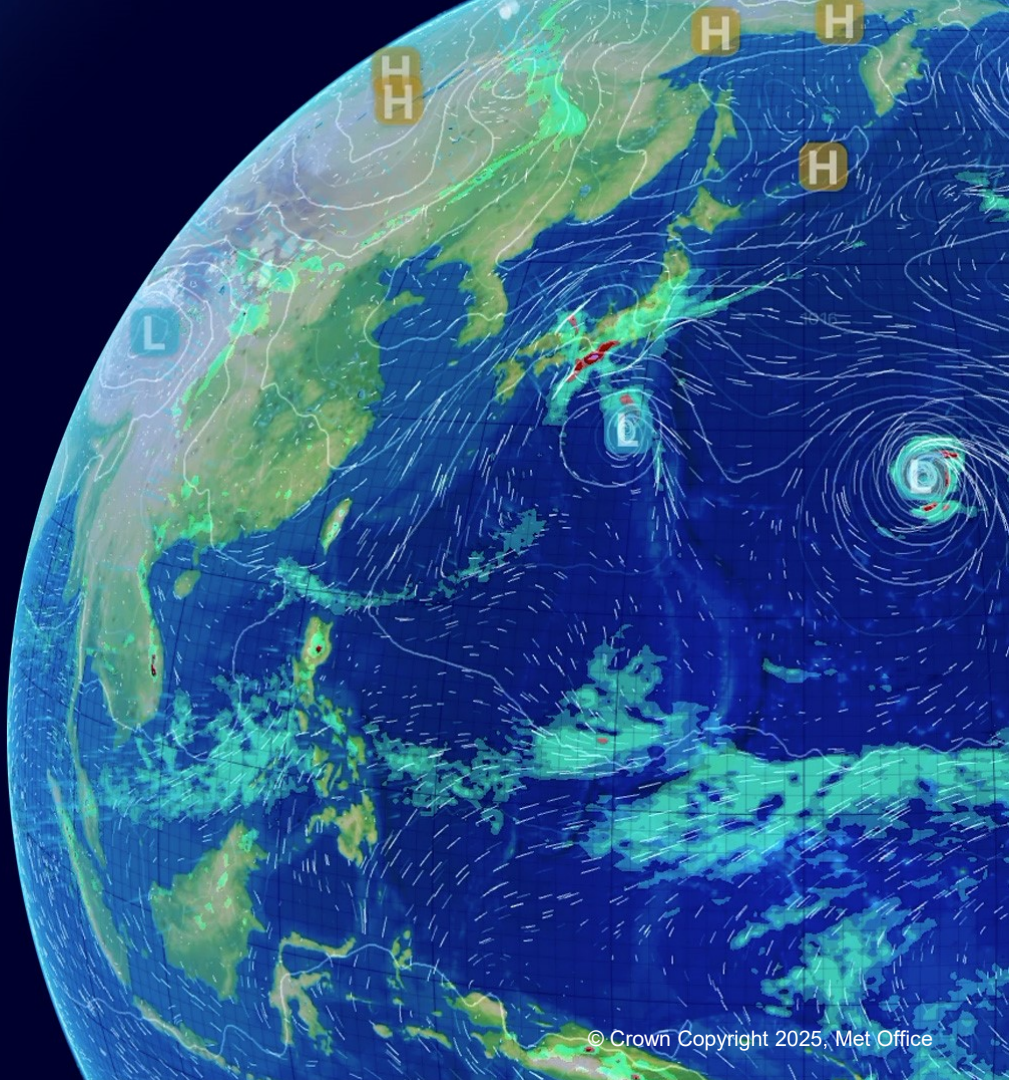


Developing a High-Resolution LAI Ancillary Using Modern Satellite Observations

Joshua Dale – 12-month Industrial Placement

Jennifer Brooke, Martin Best

16/09/2025 – JULES Annual Meeting



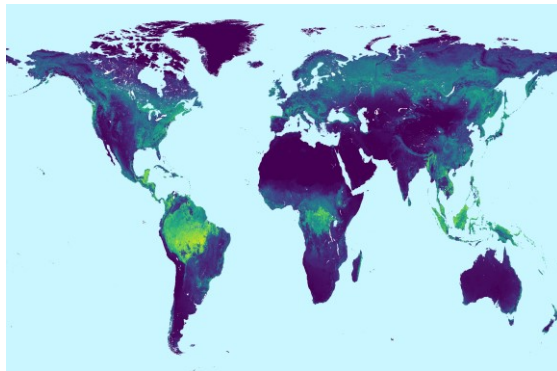
What is an ancillary?

- Files that provide our models with external datasets
- Can be global or regional
- Land surface representation essential for high resolution NWP

e.g.



Land cover



LAI

Why do we need ancillaries?

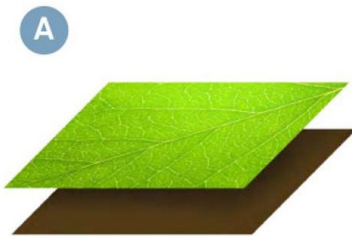
- Provide forecasting models with up-to-date, realistic land surface information
- Without them, models cannot deliver accurate forecasts

Static ancillary issues

- Permanent land surface changes can propagate errors through to forecasts
- Affects regional and global forecasts

What is Leaf Area Index – LAI?

- Quantifies the amount of leaf material in a canopy
- The fraction of photosynthetically active radiation (400-700 nm) absorbed by green vegetation
- Measured on a scale of 0 to 7
- Dimensionless



$$\text{LAI} = \frac{1\text{m}^2 \text{ leaf}}{1\text{m}^2 \text{ ground}} = 1.0$$



$$\text{LAI} = \frac{3\text{m}^2 \text{ leaf}}{1\text{m}^2 \text{ ground}} = 3.0$$

4km MODIS LAI Ancillary – What we're using now

- Based on MODIS–Terra raw data (prepared by Boston University)
- 2005 to 2009 temporal span
- Spatial resolution 4km / 0.04167°

Methodology

- Fill missing values using nearest-neighbour
- Compute monthly means
- Revise extreme values

Resolving extreme LAI values

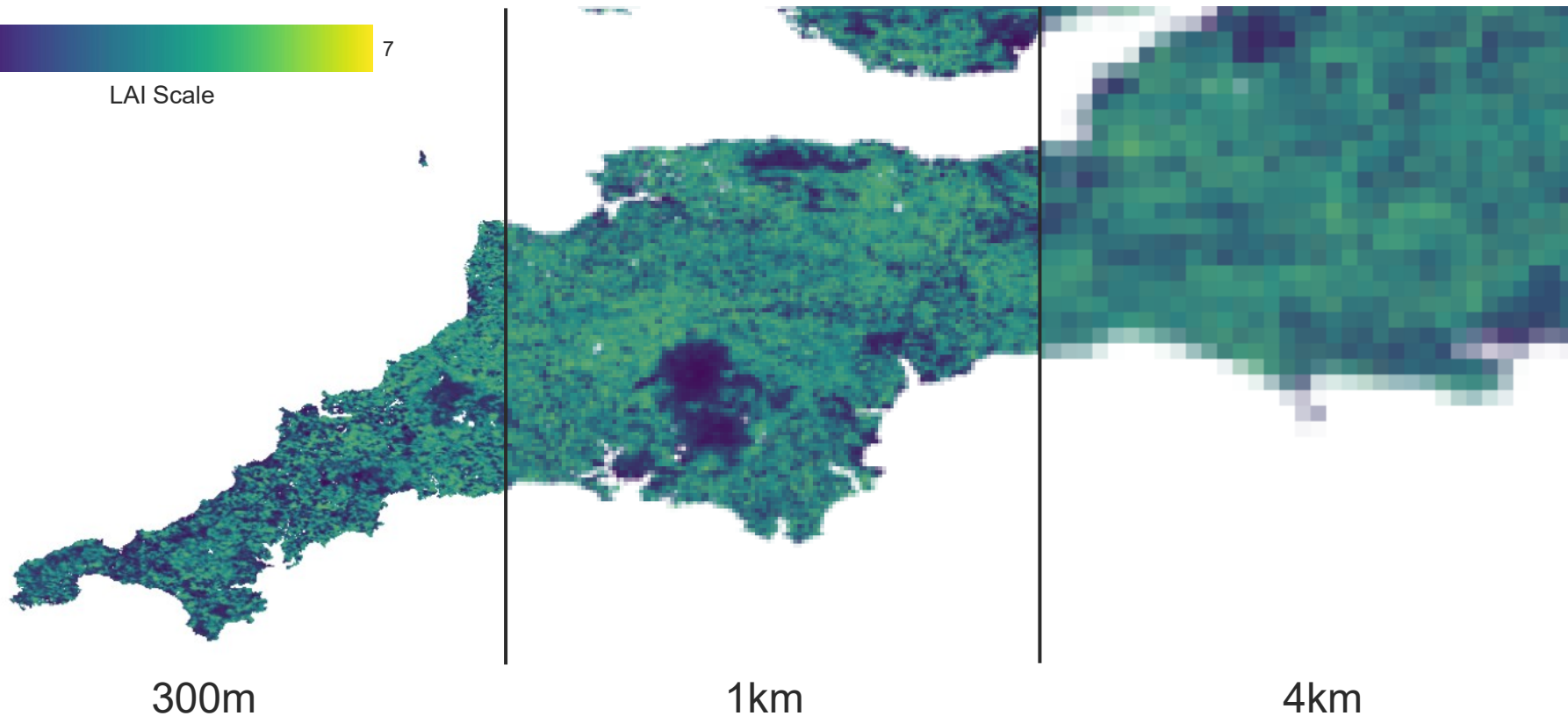
- Current ANTS code can produce extreme LAI values,
e.g. a max of 47 for broadleaf trees
- Problem occurs when the land cover ancillary says there is a very small vegetated fraction, but the LAI ancillary says that the LAI for the region is high.
- Worse at higher resolutions.



4km MODIS LAI – Why we're planning to replace it

- Short climatology (5 years) – greatly affected by extremes in weather
 - e.g. can be biased due to a long period of drought
- No urban coverage – Large urban areas (e.g., London) poorly represented
- Coarse resolution (4 km)
 - A higher resolution LAI ancillary may reduce the extreme LAI value spikes

Resolution Comparison



New LAI Data Products

- New high-resolution options
- New LAI derivation algorithms

Organisation	Platforms	Resolution ↓	Temporal Resolution	Longitude Coverage	Latitude Coverage
Copernicus	SPOT, PROBA-V	1000m	10 days	Global	80° N to 60° S
NASA MODIS	Aqua, Terra	500m	8 days	Global	Global
Copernicus	PROBA-V, Sentinel-3	300m	10 days	Global	80° N to 60° S

- Selected Copernicus 1 km 10-day LAI

Preprocessing Methodology – Raw data product → Pre-processed master file

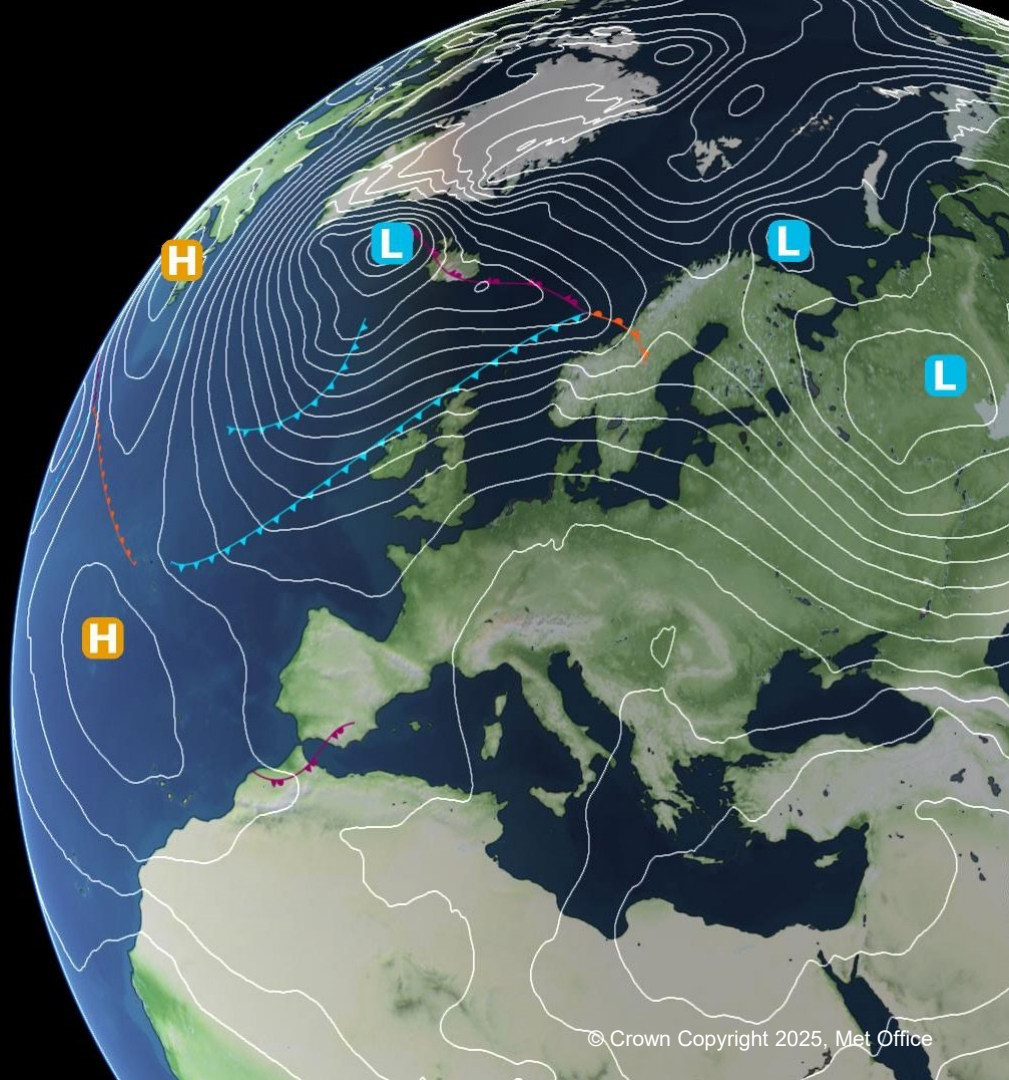
- Use latest revision of each 10-day product

For each month:

- Include all data from last 5 years – for testing methodology
 - extend temporal span after initial testing
- Mask values using status flags
- Compute monthly mean using all valid observations
- Pad data latitudinally to achieve circular coverage

Aside: Deep Zoom Images

- What is a deep doom image (DZI)?
- How can they be leveraged to explore earth observation data?
- DZI usage in LAI ancillary research

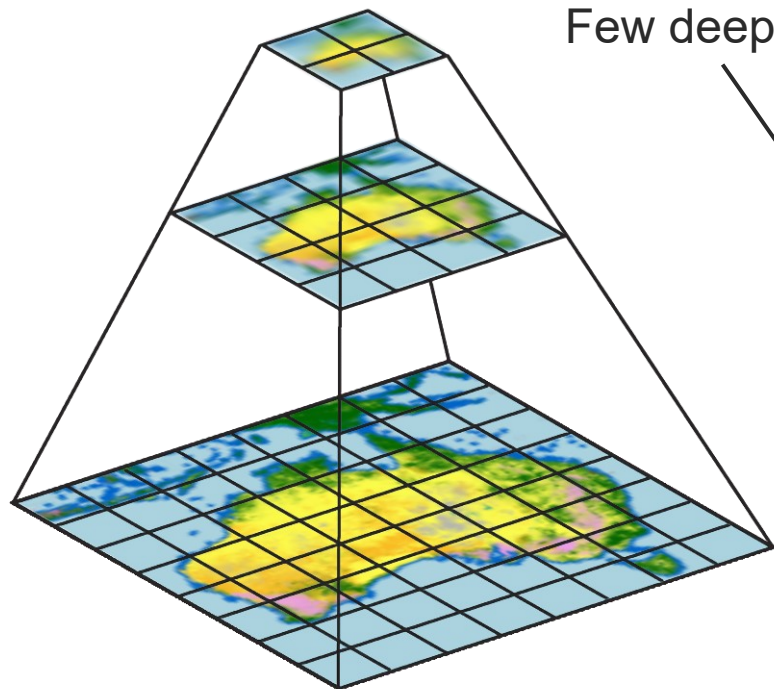


What is a Deep Zoom Image?

A deep zoom image is an efficient way to view very high-resolution images

- Image is split into deep-tiles
- Deep-tiles arranged in a pyramid of resolutions
- Can be created from earth observation data for instant viewing of high-resolution datasets

How does DZI work?



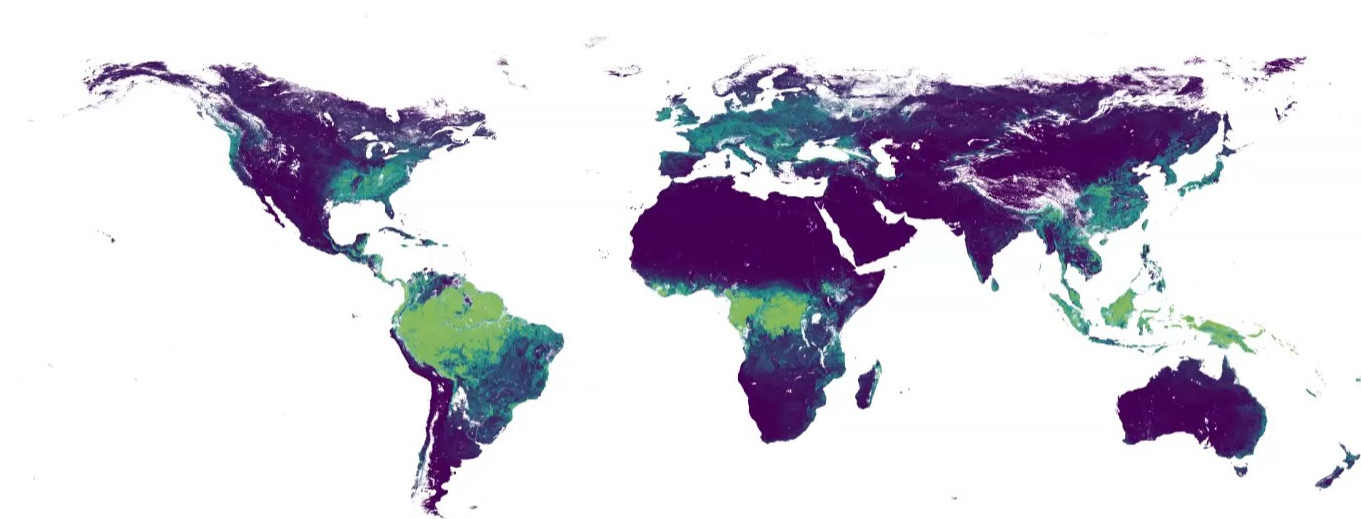
Few deep-tiles

Many deep-tiles

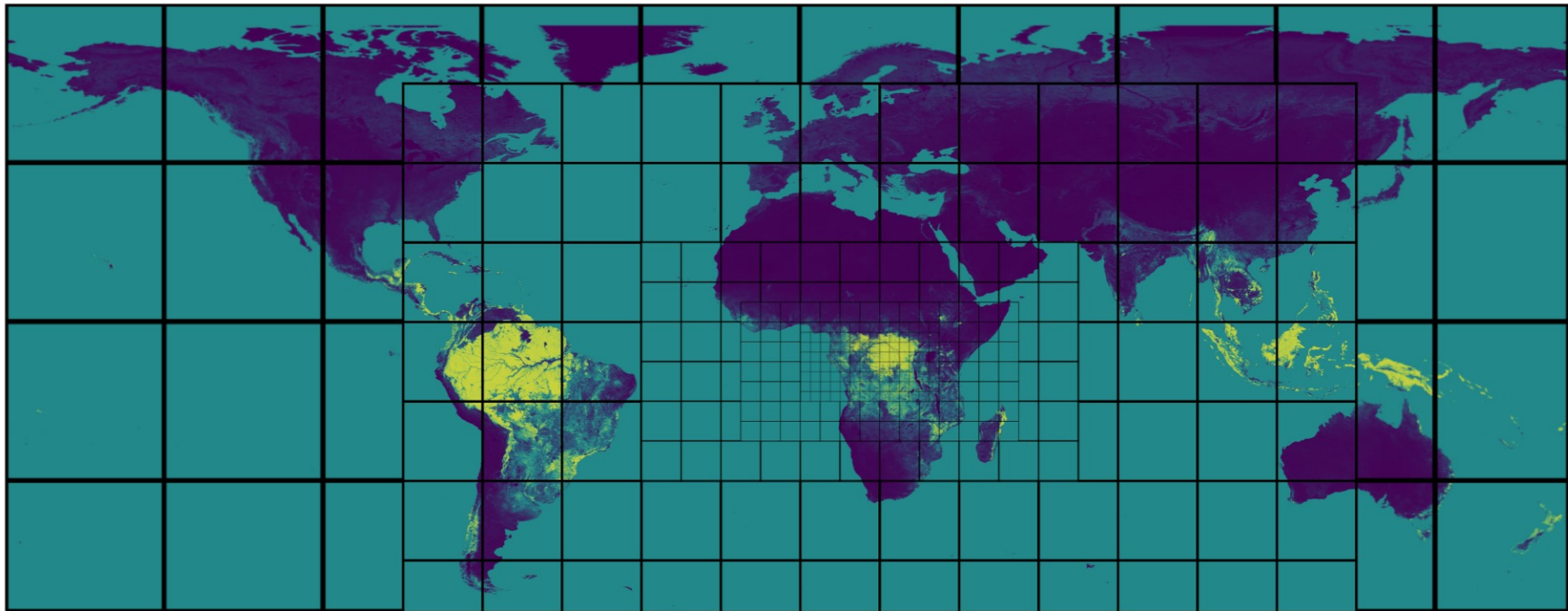
At each level of the pyramid:

- The resolution of each deep-tile stays the same
- The number of deep-tiles increases
- Hence, the image resolution increases

Deep Zoom Images



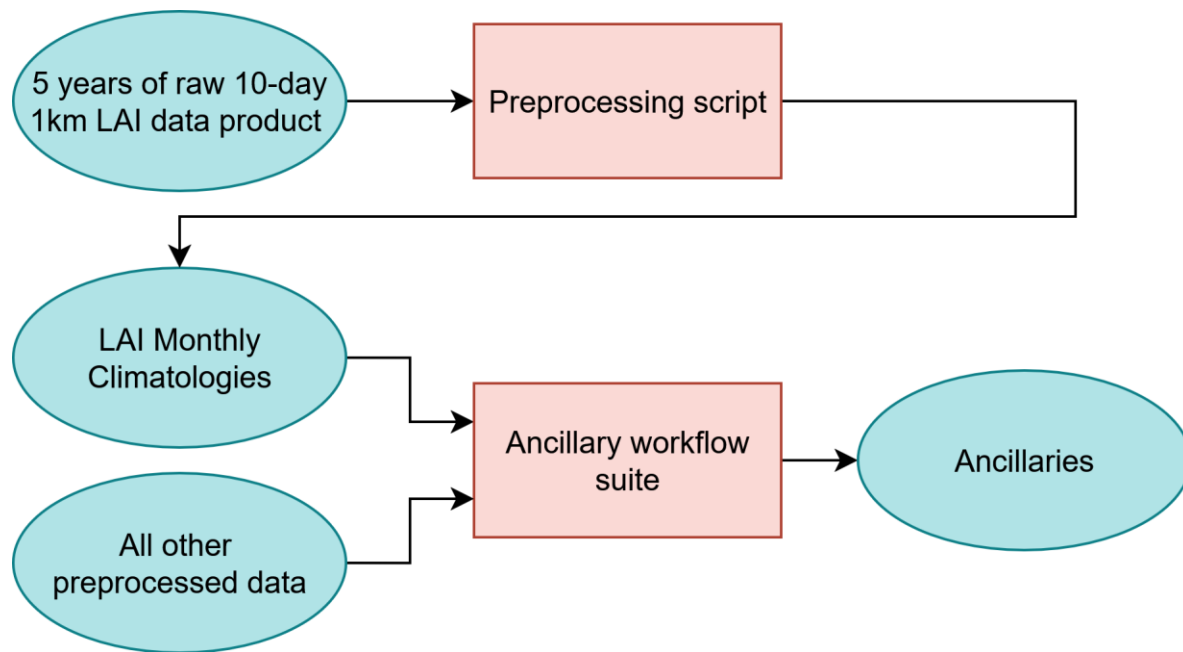
Deep Zoom Images



Role of DZI in creating the new LAI Ancillary

- Viewing datasets while scoping
- Sight check new climatologies
- Spot artefacts or missing regions in data
- Can be used to produce local difference plots on-the-fly, without having to load an entire dataset.

The Land Ancillary Suite



- Processes master files
- Performs re-gridding
- Saves ancillaries to disk

Land Cover and LAI

	Current	A	B
LAI	MODIS 4km LAI	ESA-based LAI	MODIS 500m LAI
Land Cover	ESA CCI Land Cover	ESA CCI Land Cover	IGBP Land Cover

Conclusions & next steps

- Some current ancillaries are at coarse resolutions
 - New, high resolution satellite observations available
 - Leverage Deep Zoom
-
- Testing and evaluation of new 1km Copernicus-based ancillary
 - With a focus on regions with known issues