

# Sentinel-1 (SAR) Processing for Flood mapping

Accessing and Using Synthetic Aperture Radar  
(SAR) Data

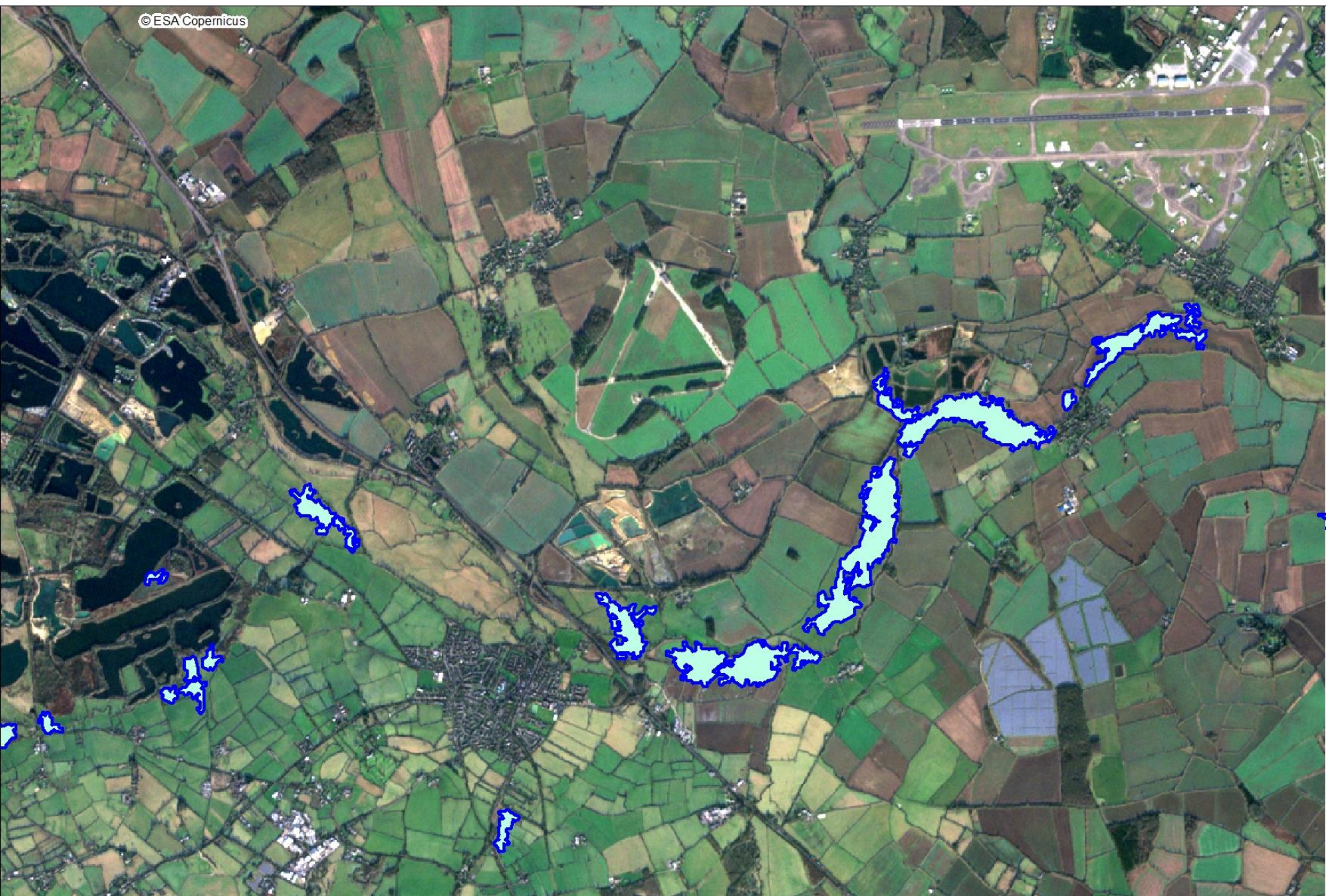
Crispin Hambidge  
Senior Geomatics Analyst  
11<sup>th</sup> November 2020



# SAR applications in the EA

- Flood extent mapping
  - Incident rapid response service
  - Slower 'peace time' response service
- Flood depth/volume mapping
  - Calculating requirements for pumping resources
- Currently exploring:
  - Soil moisture applications
  - Interferometric SAR applications



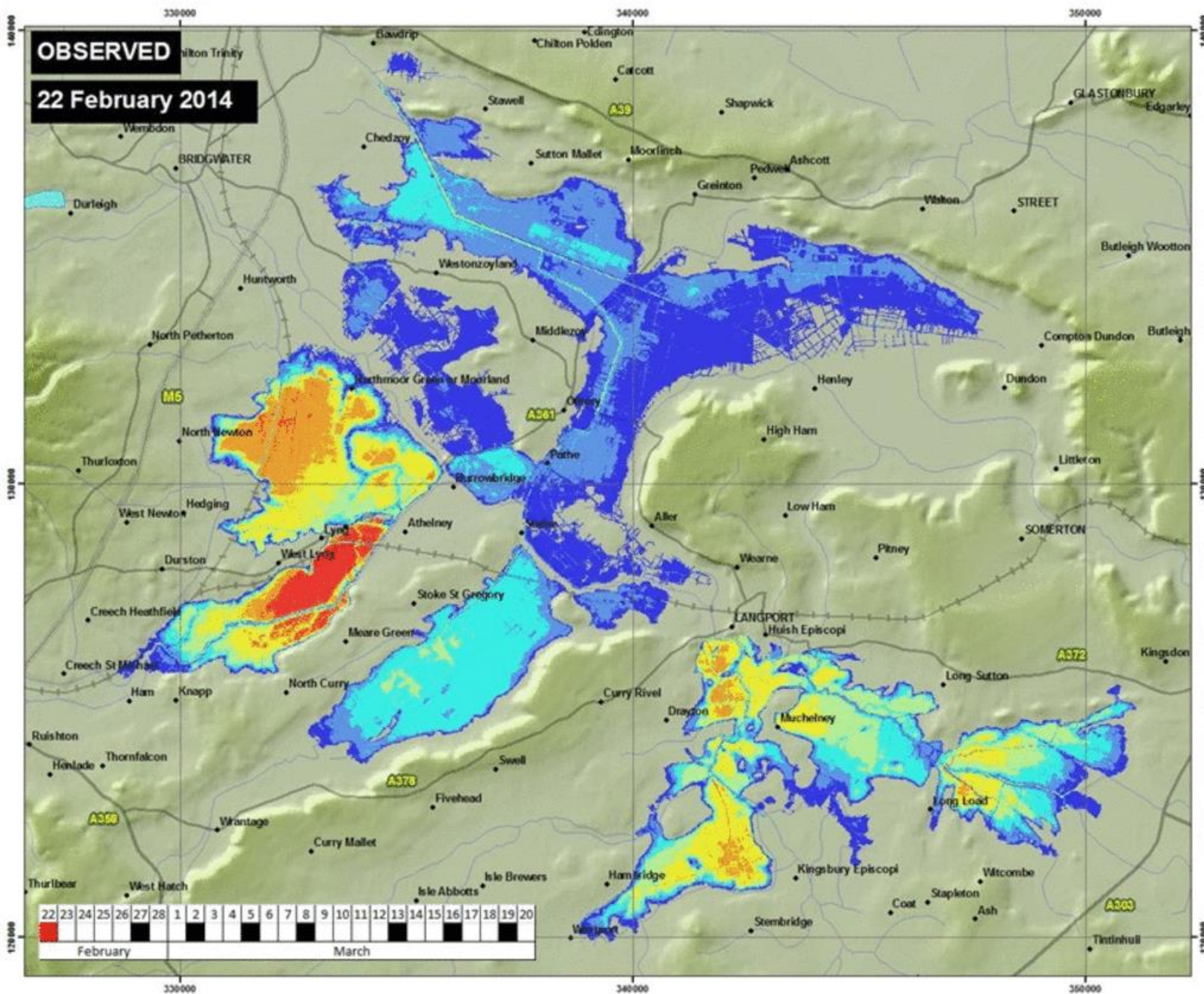


Sentinel-2 5<sup>th</sup> January 2017\* with Flood Outlines

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### SOMERSET LEVELS

22nd February 2014  
Satellite/LIDAR Data Analysis  
Estimated Flood Extent/Depth

1:75,000

0 2 4  
kilometres

Projection: Ordnance Survey 1936

**Legend**

- TOWNS/VILLAGES
- Estimated Flood Depth (m) 22 Feb
  - <0.4
  - 0.4 - 0.8
  - 0.8 - 1.2
  - 1.2 - 1.6
  - 1.6 - 2
  - 2 - 2.4
  - >2.4
- Watercourses
- Primary Road
- Motorway
- A Road
- Railway
- Permanent Still Waterbodies

Estimated flood extent on 22/02/2014 of the Somerset Levels approx. 9,700 ha using DTM and SPOT method or 8,900 ha using SPOT only method (contact Geomatics for further info).

The flood extent was estimated from SPOT5 data acquired on: 22nd February 2014 at 10:41 UTC.

Depth data were inferred from archive LOAR DTM data.

Estimated depth error 23 cm RMSE.

**Geomatics**  
Map generated by Environment Agency National Operations, Geomatics

© Environment Agency 2014  
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Ordnance Survey 100024199. StreetView - OS  
© Imagery sourced from GeoPond/Esri

Derived Works Product

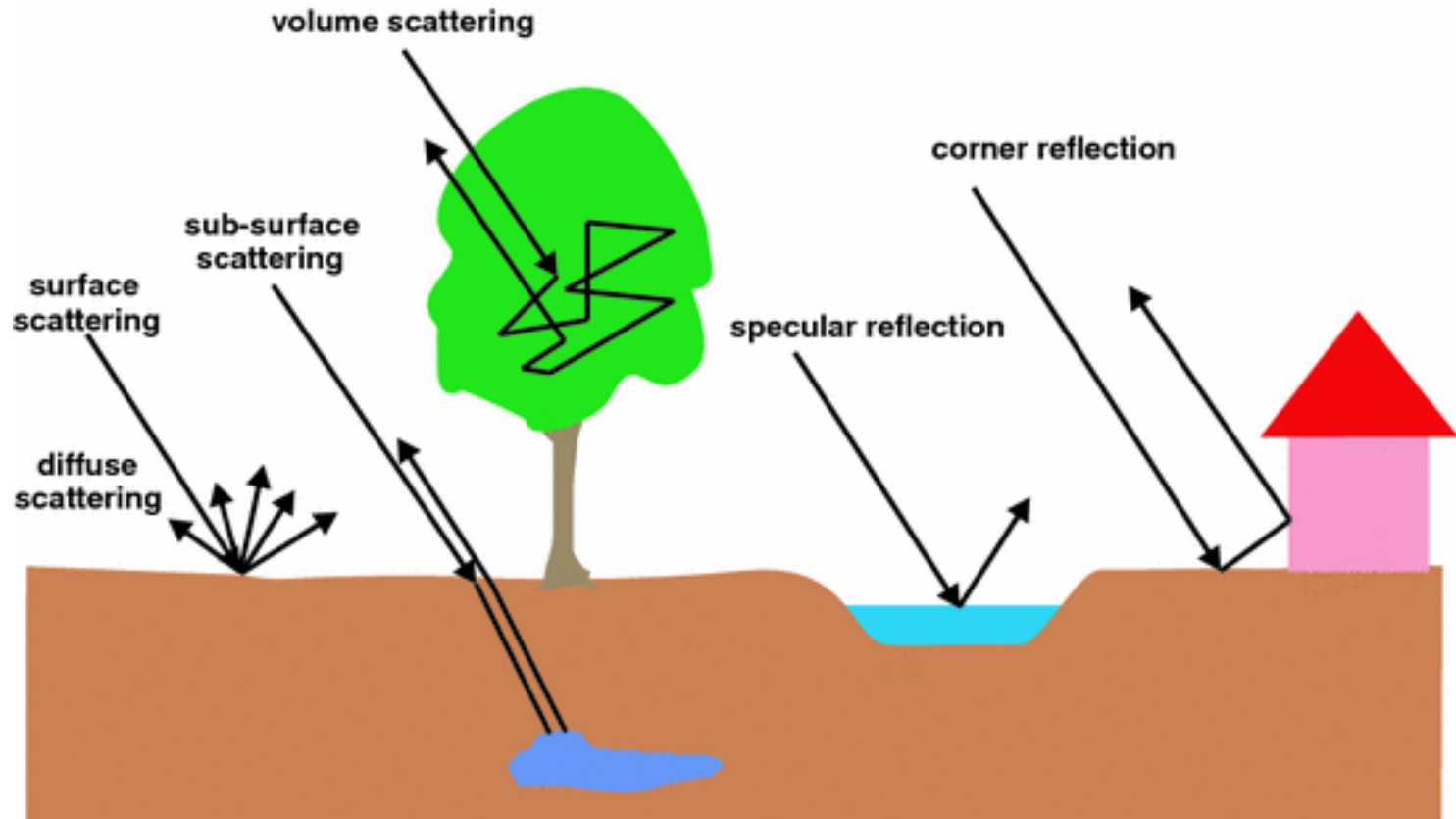
Produced:  
12th March 2014



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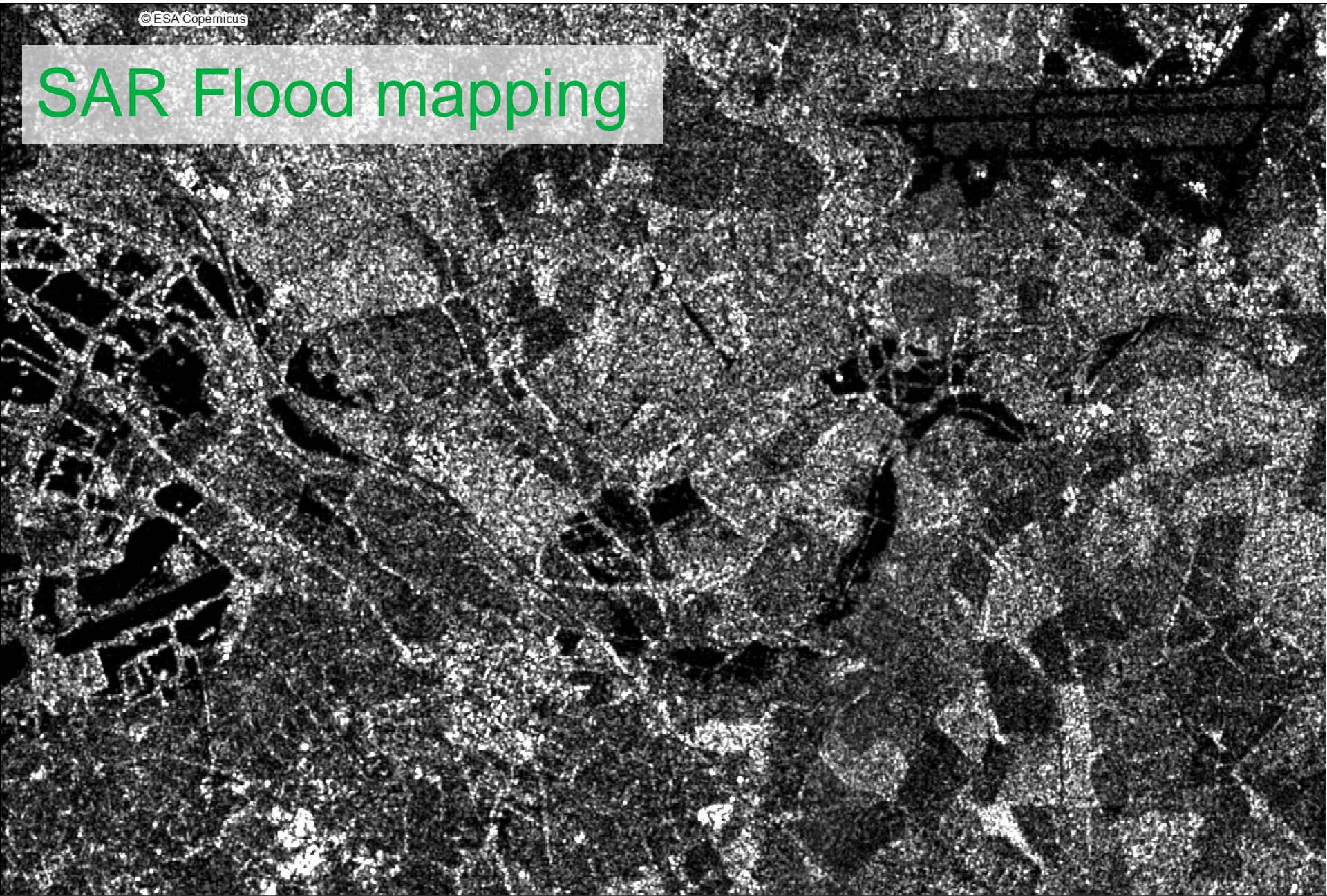
# SAR image interpretation (simplified!)



Awange J.L., Kyalo Kiema J.B. (2013) Microwave Remote Sensing. In: Environmental Geoinformatics. Environmental Science and Engineering. Springer, Berlin, Heidelberg. [https://doi.org/10.1007/978-3-642-34085-7\\_9](https://doi.org/10.1007/978-3-642-34085-7_9)



# SAR Flood mapping



Sentinel-1 22<sup>th</sup> November 2016 with Lee 7x7 filter. VH polarisation



# SAR Flood mapping

- SAR imagery benefits:

- Works in most weather conditions (not very windy though)
- Relatively consistent datasets
- Predictable image capture



# SAR Flood mapping

- SAR flood imagery limitations:

- Noisy imagery
- Affected by wind
- Urban areas and field boundaries poorly mapped
- Outputs easily mis-understood



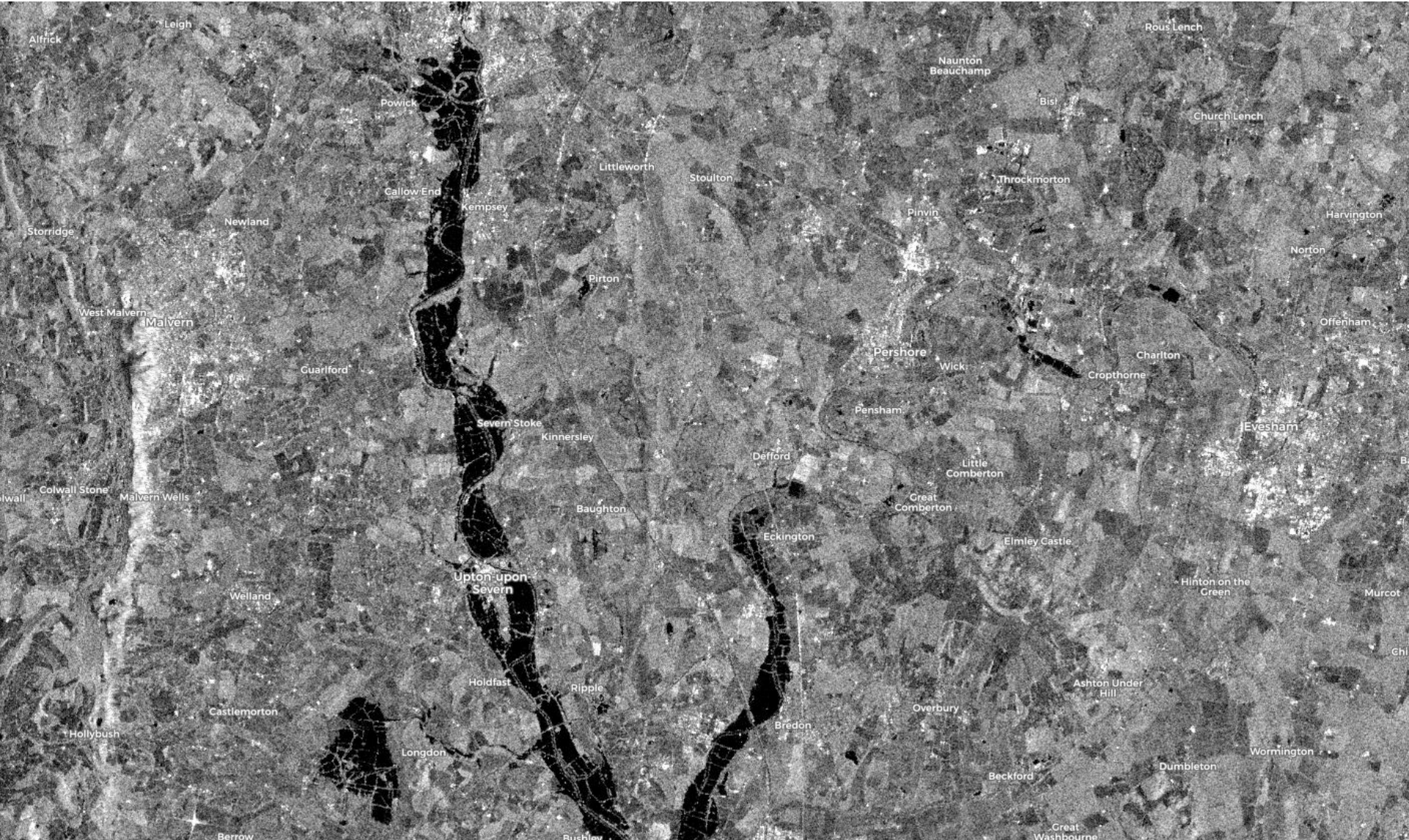
# Sentinel-2 image 18<sup>th</sup> November 2019



Bands 12, 11 and 4

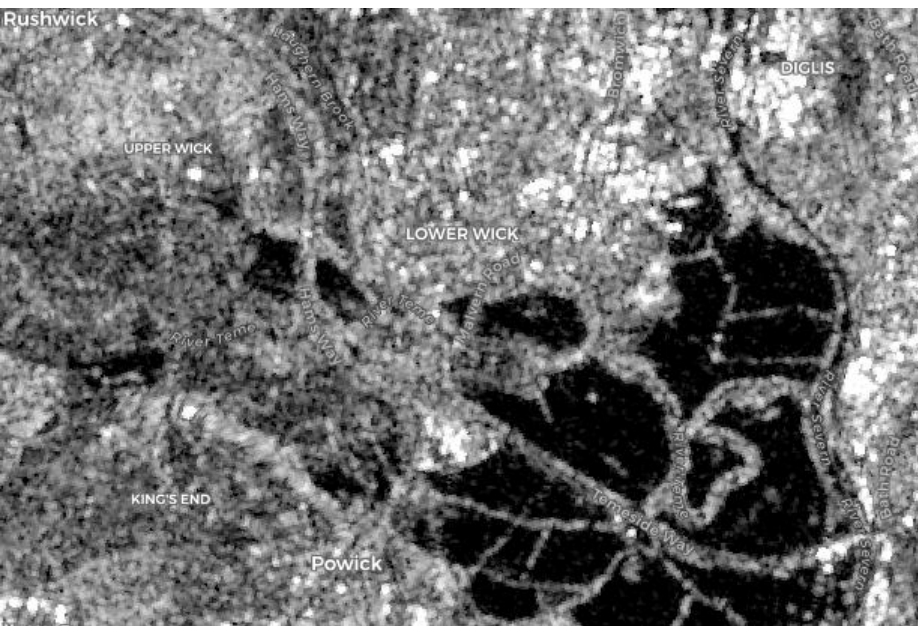


# Sentinel-1 VV image 19<sup>th</sup> November 2019





# Sentinel-1 VV vs Sentinel-2 detail



# SAR Flood mapping Workflow

- Imagery acquisition (flood image *and* pre-flood image)
  - EODS or ESA SciHub
- Primary image processing (if ESA SciHub-acquired)
  - Subset
  - Radiometric calibration
  - Speckle filter
  - Ortho-correction – reprojection (OSGB)
- Pre-VH/Pre-VV/Flood-VH/Flood-VV composite generation
- Training sample selection
- Random forest classification
- GIS editing (Slopes/hills/urban/forests masked)
- Manual editing





Insert search criteria...

Display 1 to 6 of 6 products. Order By: Ingestion Date

Request Done: (  
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Mission: Sentinel-1 Instrument: SAR-C Sensing Date: 2018-04-05

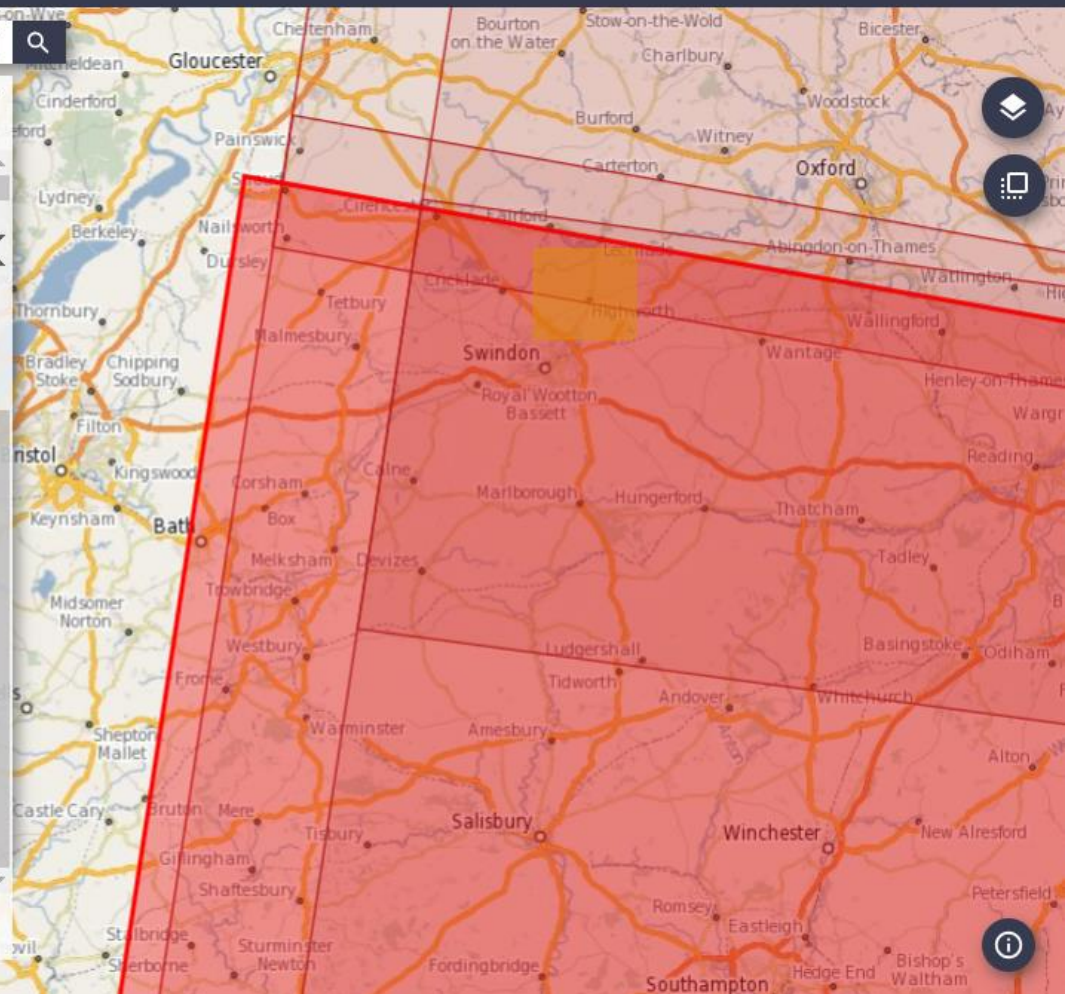
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Mission: Sentinel-1 Instrument: SAR-C Sensing Date: 2018-04-05

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Download URL: <https://scihub.copernicus.eu/odata/v1/Products>  
Mission: Sentinel-1 Instrument: SAR-C Sensing Date: 2018-04-05

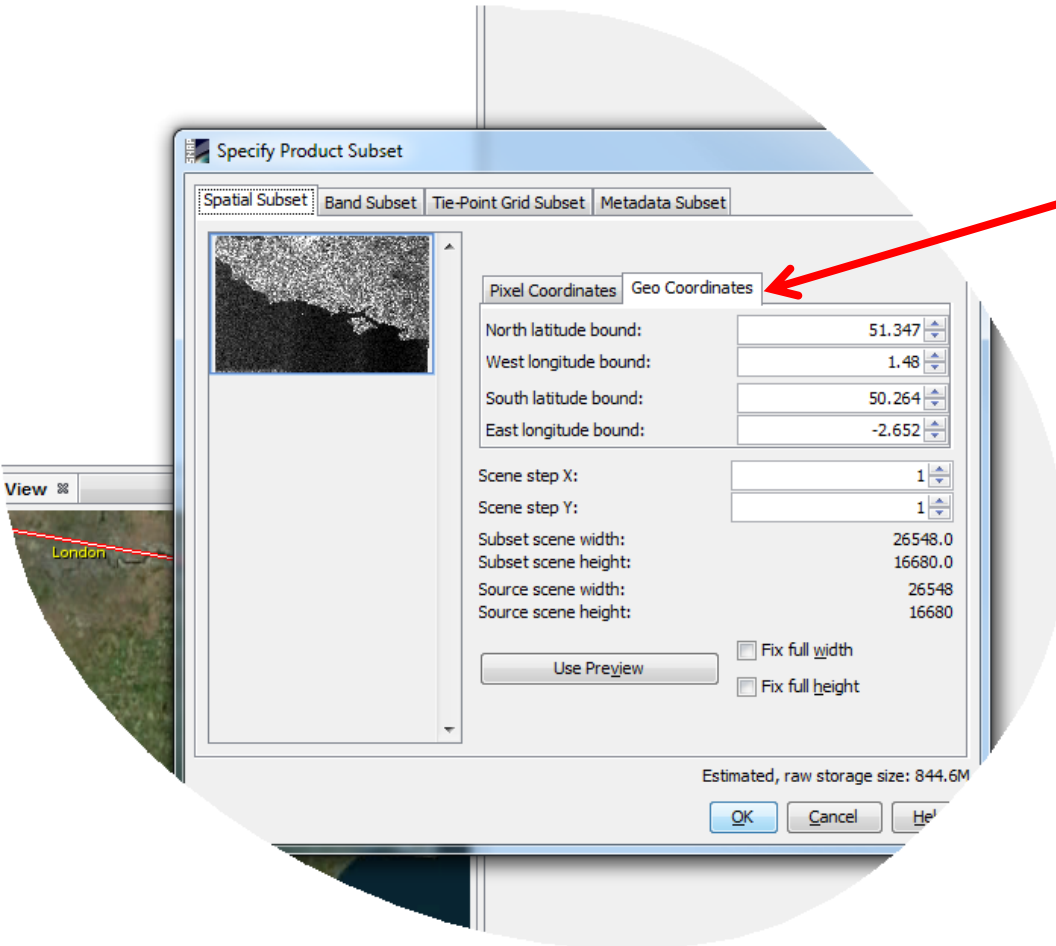
25 << < page: 1 of 1 > >> CLOSE



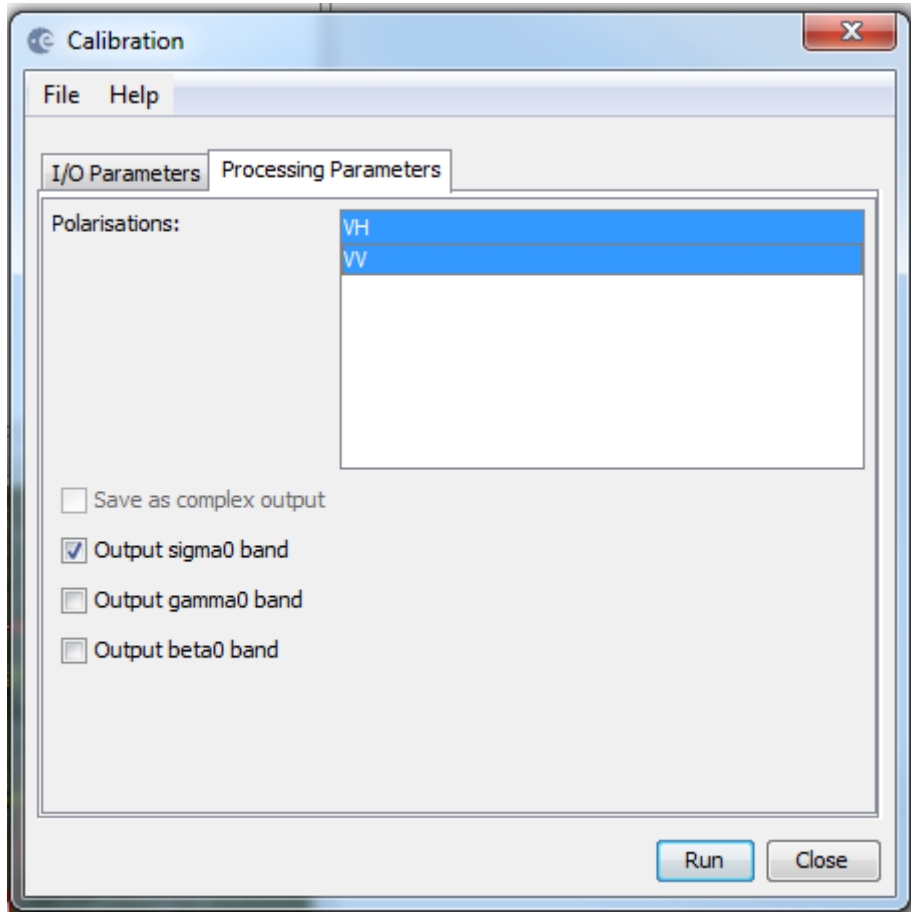
- Select the relevant GRDH image

## 9. Subsetting (If you want to)

- Use Geo-Coordinates rather than Pixel Coordinates



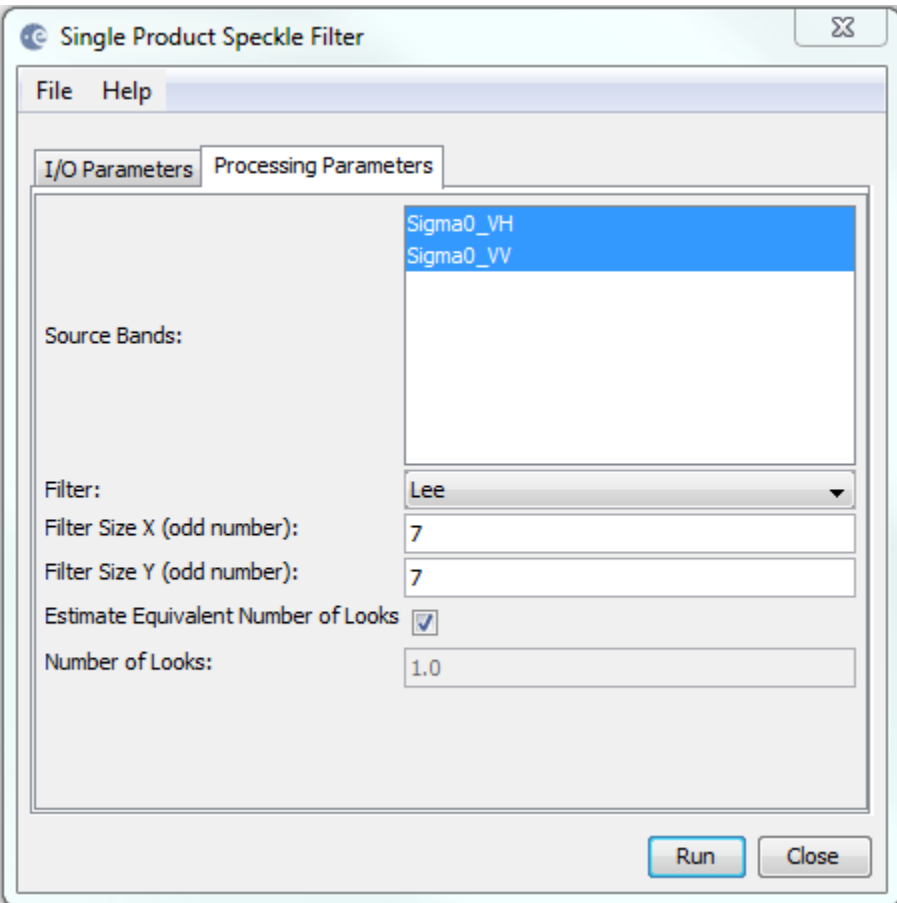
# 12. Calibrate image



- Highlight both the VH and VV polarizations

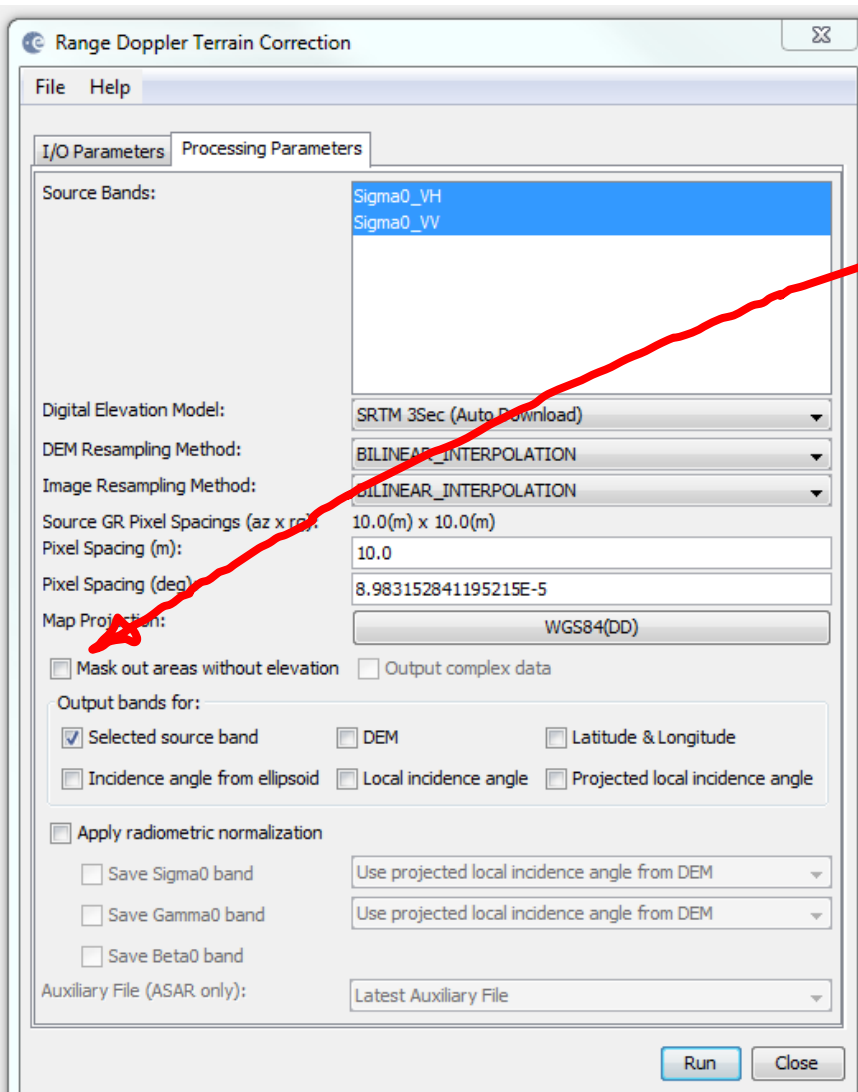


# 14. Speckle Filtering

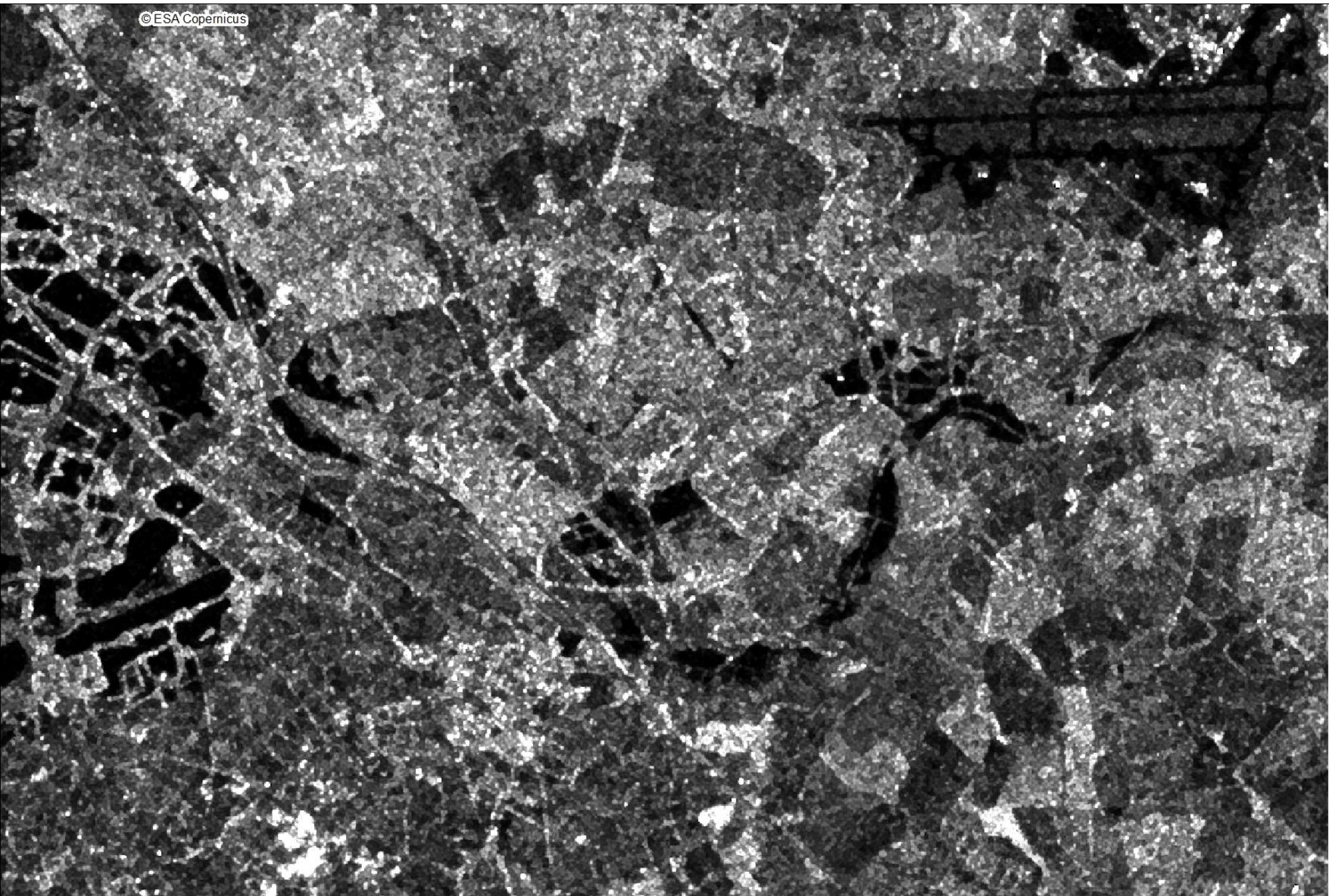


- Leave the I/O Parameters as they are
- In Processing Parameters tab:
- Highlight VH and VV
- Select Filter type “Lee”
- Filter size between 3 and 7 in both X and Y. Would actually recommend using 5 and 5!
- Hit “Run”
- NB Larger number will result in harsher smoothing
- Close the dialogue box

# 17. Ortho-Correction



- Select both VH and VV
- Un-tick “Mask out areas without elevation”
- Hit “Run”
- This is the longest process and could take up to half an hour for a full scene
- The output will be in WGS84 projection



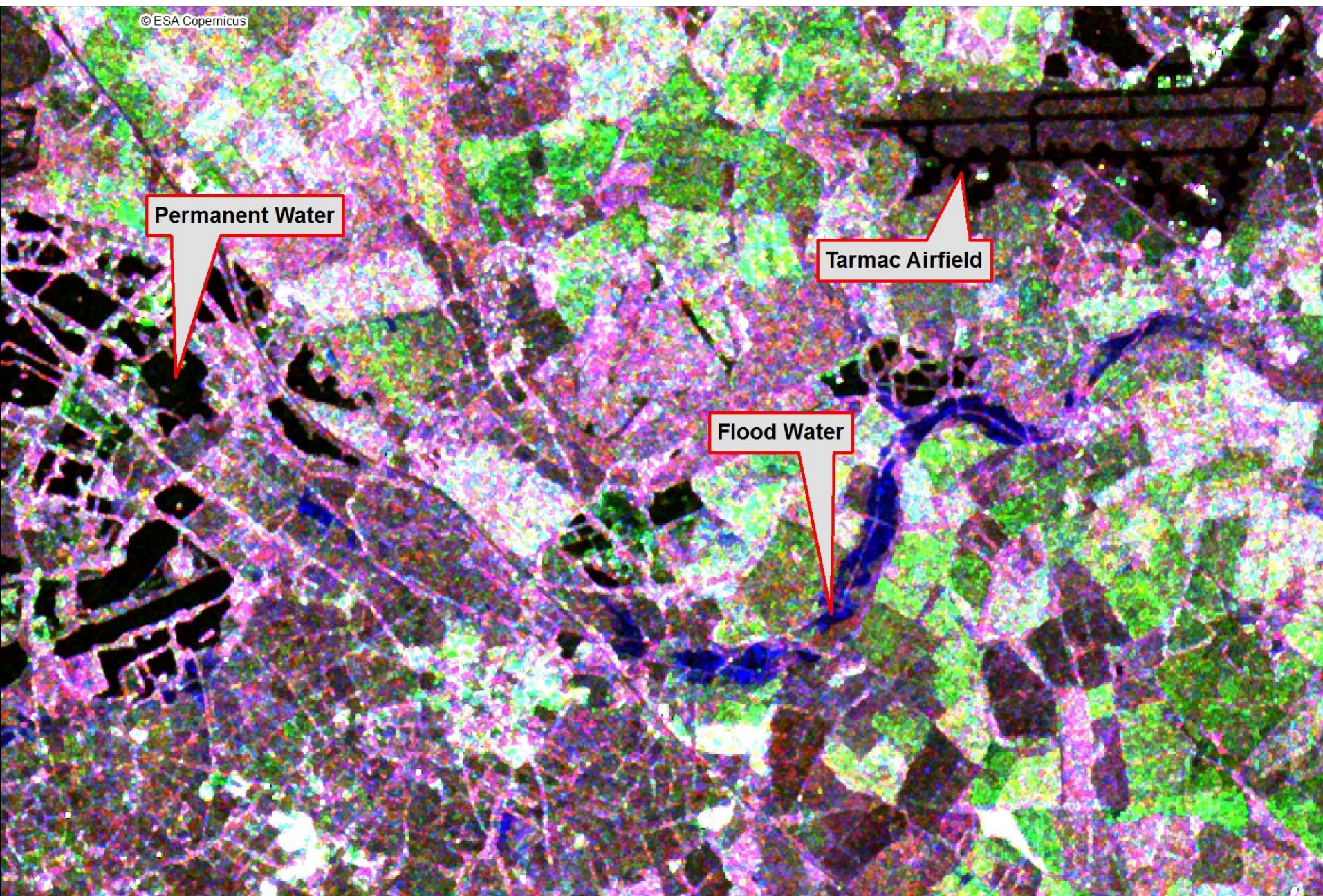
Sentinel-1 22<sup>th</sup> November 2016 ARD with Refined Lee filter. VH polarisation





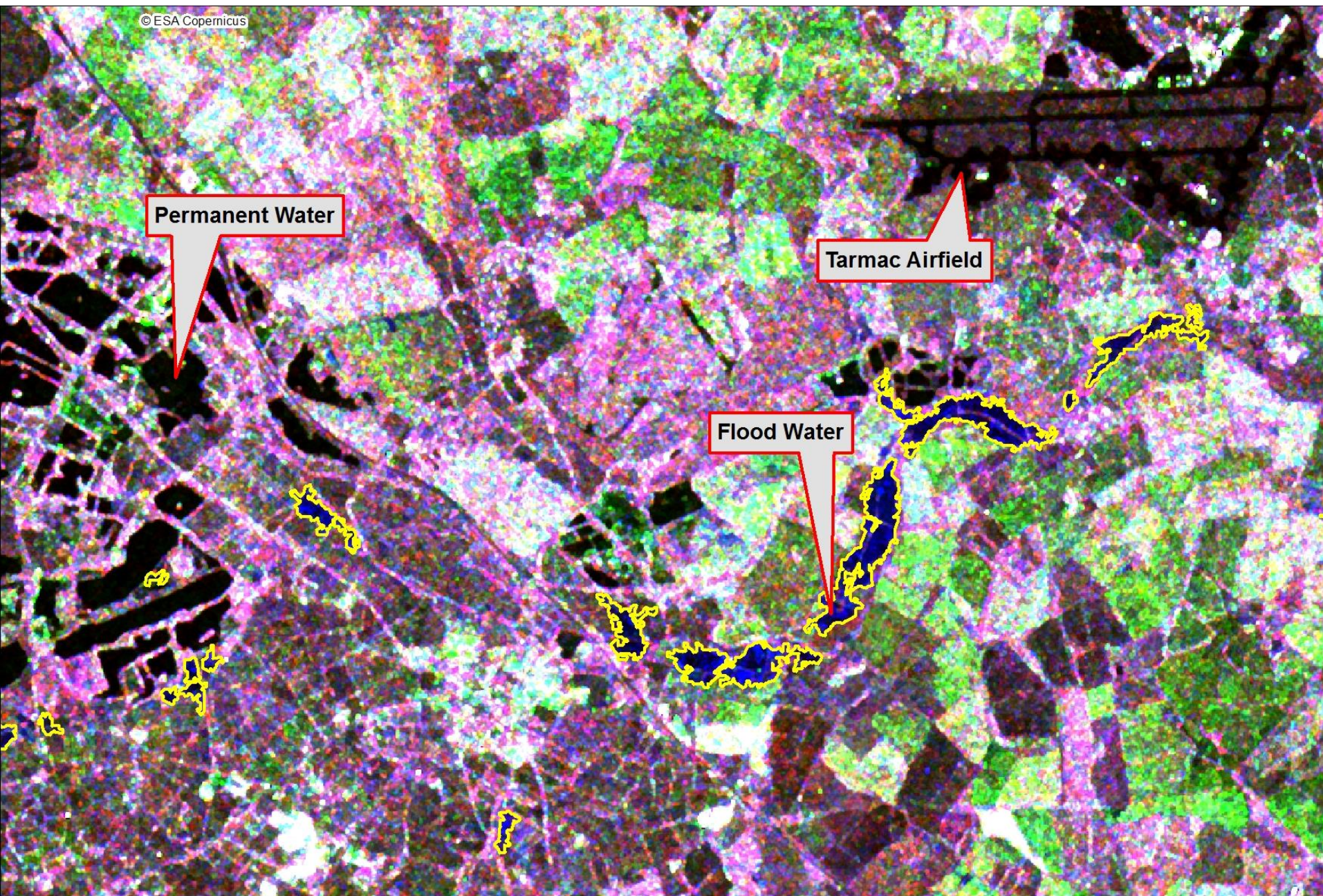
Sentinel-1 22<sup>th</sup> AND 10<sup>th</sup> November 2016 ARD composite image stack





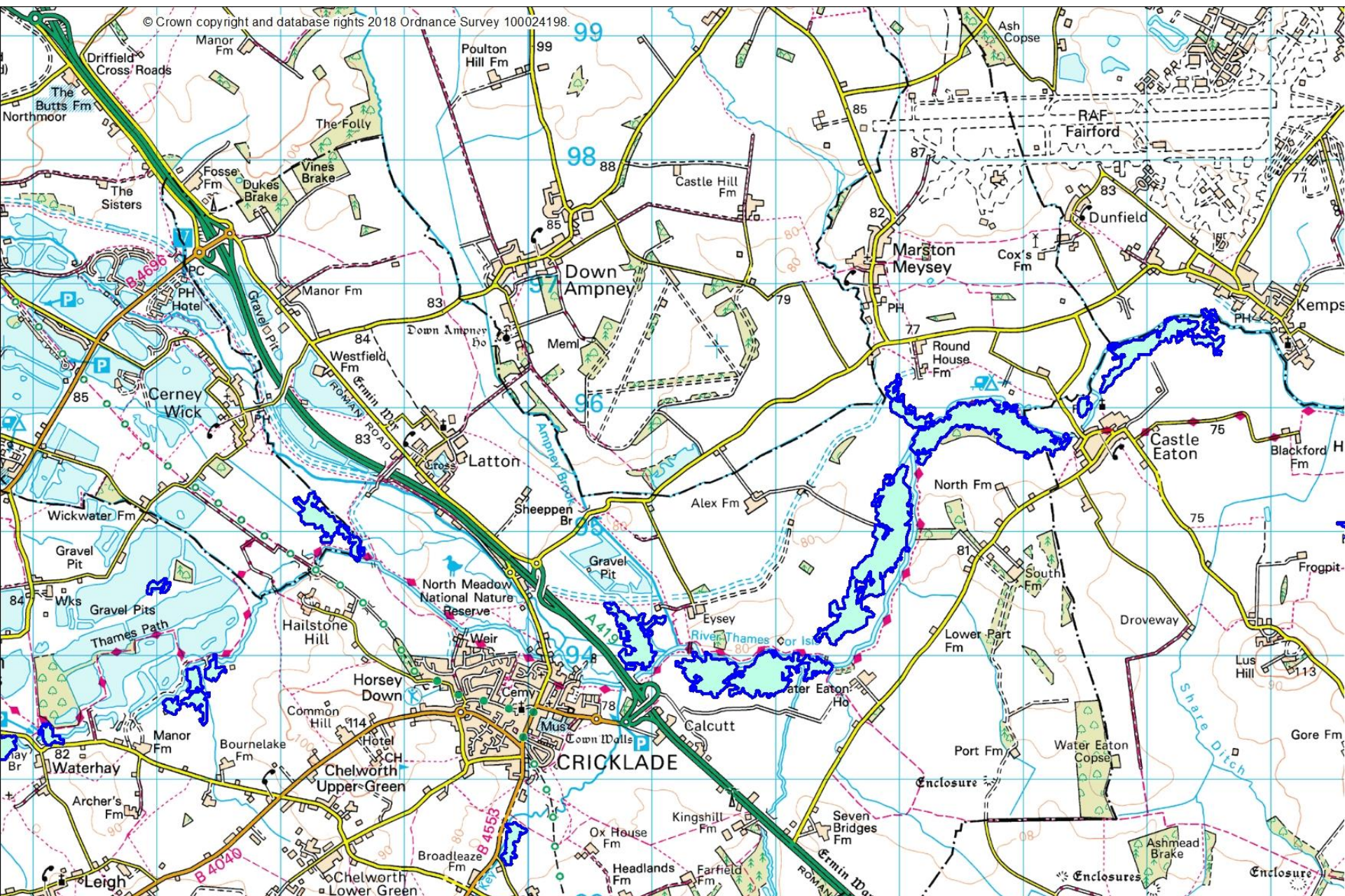
Sentinel-1 22<sup>th</sup> AND 10<sup>th</sup> November 2016 ARD composite image stack





**Sentinel-1 22<sup>th</sup> AND 10<sup>th</sup> November 2016 composite image stack Flood Outline**





**Ordnance Survey Basemapping with Flood Outlines after post processing with Slope/height and urban masks etc**



# Thank you for listening!

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