Convergence - beyond basic stats

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SATURN UGM
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Transport
for
London

Convergence
Beyond Basic Statistics

Background

- **Convergence**
  - Important for Stability of the model and for the highway model interactions with both our TfL developed demand model called MoTiON (**M**odel **o**f **T**ravel **i**n Lond**ON**) and with external economic analysis applications such as TUBA.
- **Convergence Measures**
  - Proximity (% GAP) **0.035** & Stability (% Flow) less than **<1%** Change on **>96%** of links
- **Issue in LoHAM**
- Concerned about large number of trips in LoHAM matrices that are between locations that will not effect results in the vicinity of London, e.g. There are 519,612 PCU trips internally between zones in the sector covering The Midlands, North and Scotland in the 2019 AM Peak hour.
- This has implications for
  - *Economic appraisal*
  - *Model validation*
  - *Model convergence*
  - *Model run times*
- LoHAM P5.1 is a well validated and converged model now using KONSTP = 5
- However convergence could be improved across the strategic model area to improve cost skims interacting with both MoTiON and economic analysis packages such as TUBA.
- Can removal of these external to external trips help improve these?

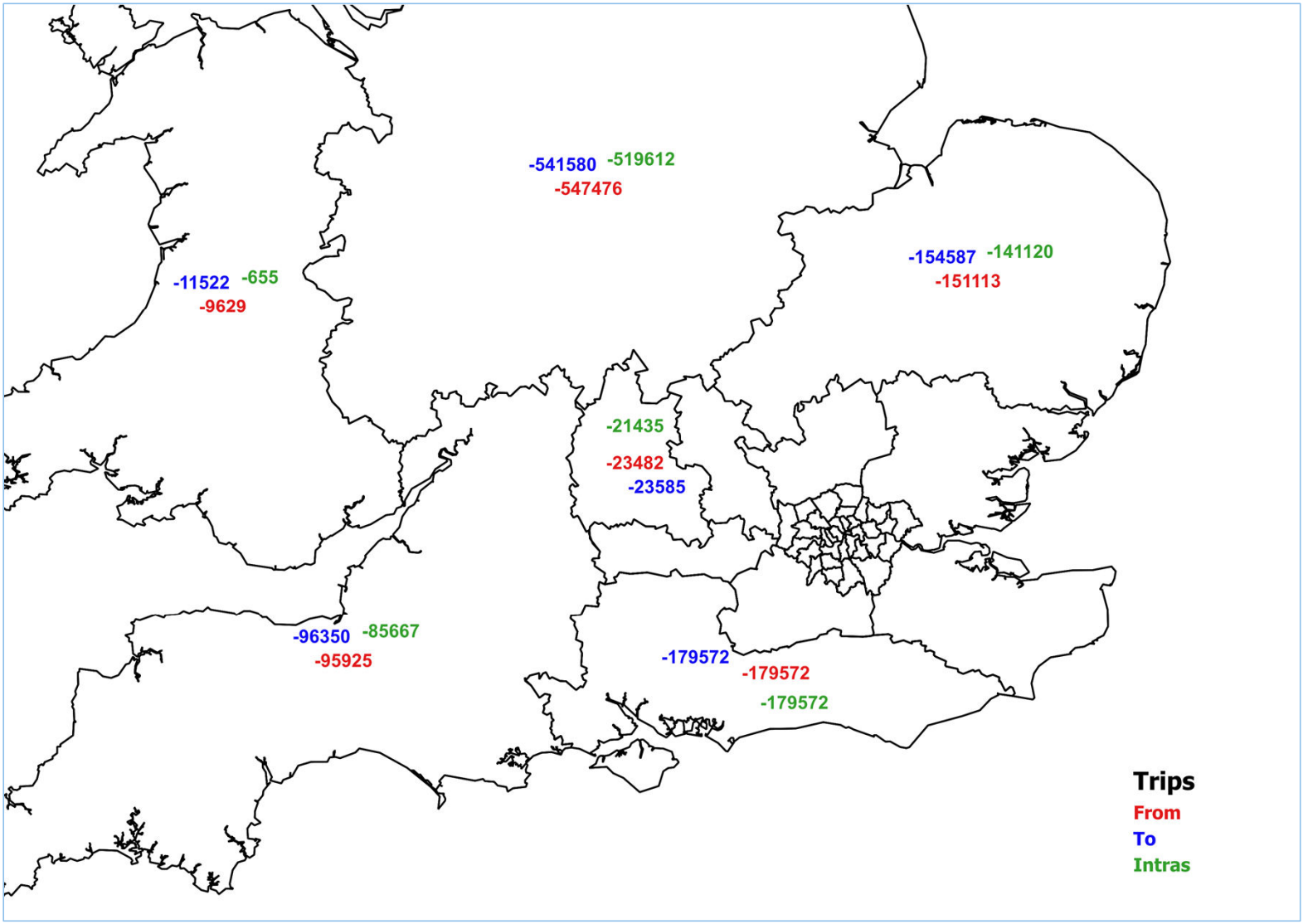
UC	Prior	Removed	% Removed
1	181403	99951	55.1%
2	63198	33852	53.6%
3	1142525	512013	44.8%
4	399936	173413	43.4%
5	31686	236	0.7%
6	12869	0	0.0%
7	112875	48134	42.6%
8	120667	55827	46.3%
9	161615	83772	51.8%
Total	2226776	1007196	45.2%

External to External Trips Removed in LoHAM

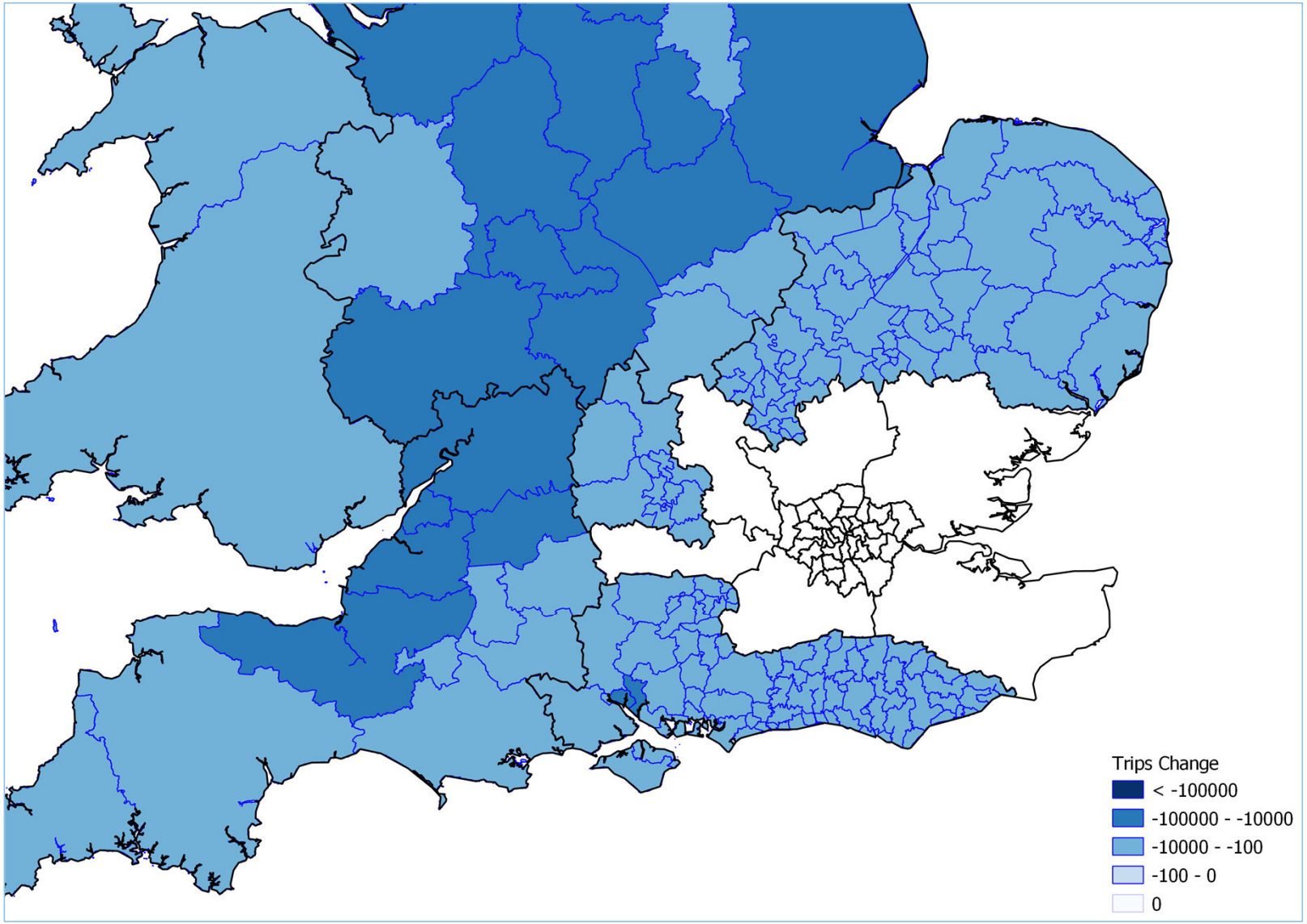
Total PCU	OXF	EAN	SC	SW	WAL	MNS
Oxfordshire	21268	665	746	2047	75	3167
East Anglia	573	141109	248	289	78	9994
South Coast	833	378	179486	5087	145	1174
South West	2060	352	5688	85667	2626	5572
Wales	89	90	178	2481	655	6403
The Midlands, North and Scotland	3665	13468	1276	6152	8242	519612

Removed	1007197

Trips removed between external sectors for LoHAM 2019 AM Prior



External to External Trips From zones removed for LoHAM 2019 AM Prior

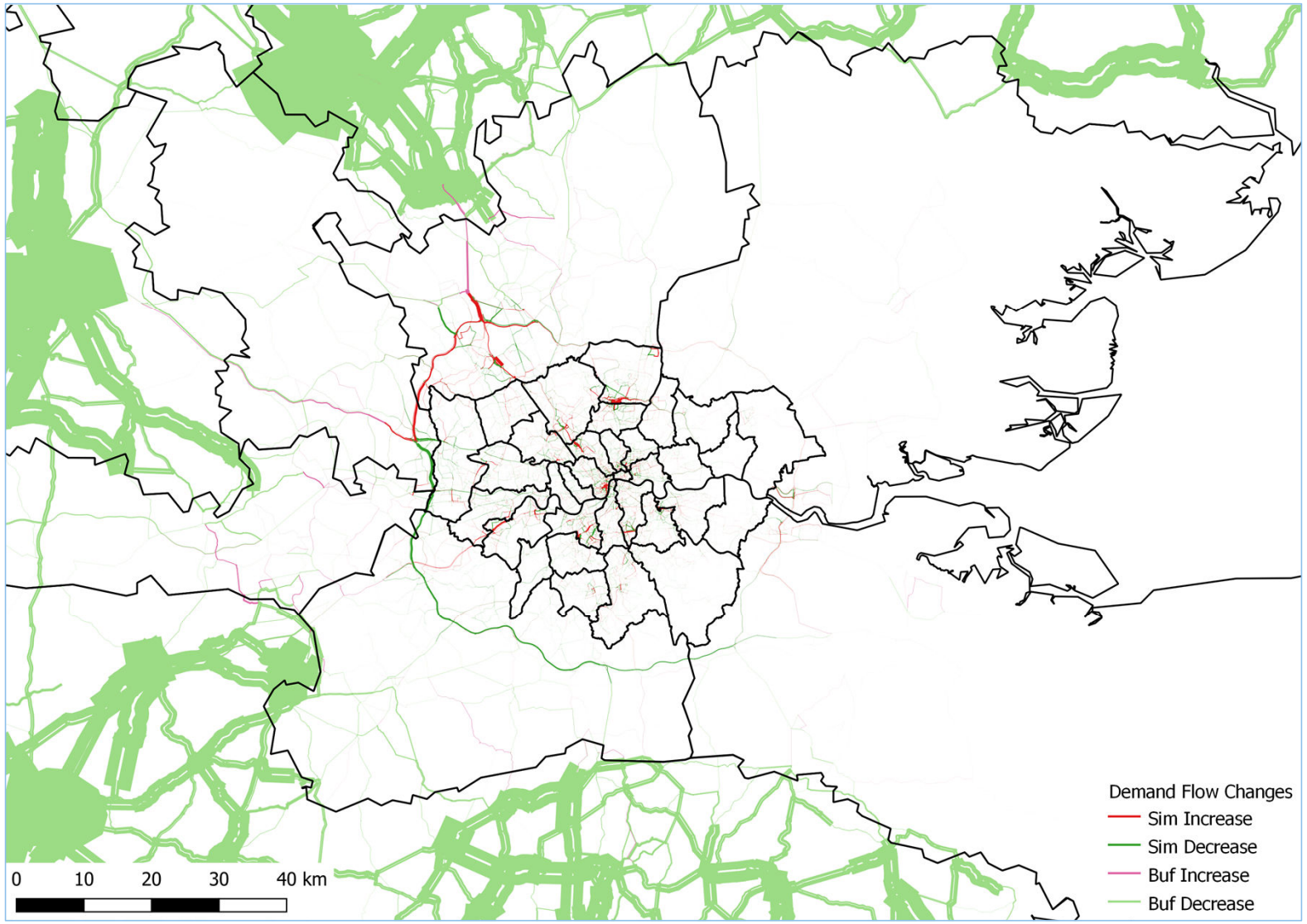


Assignment Check

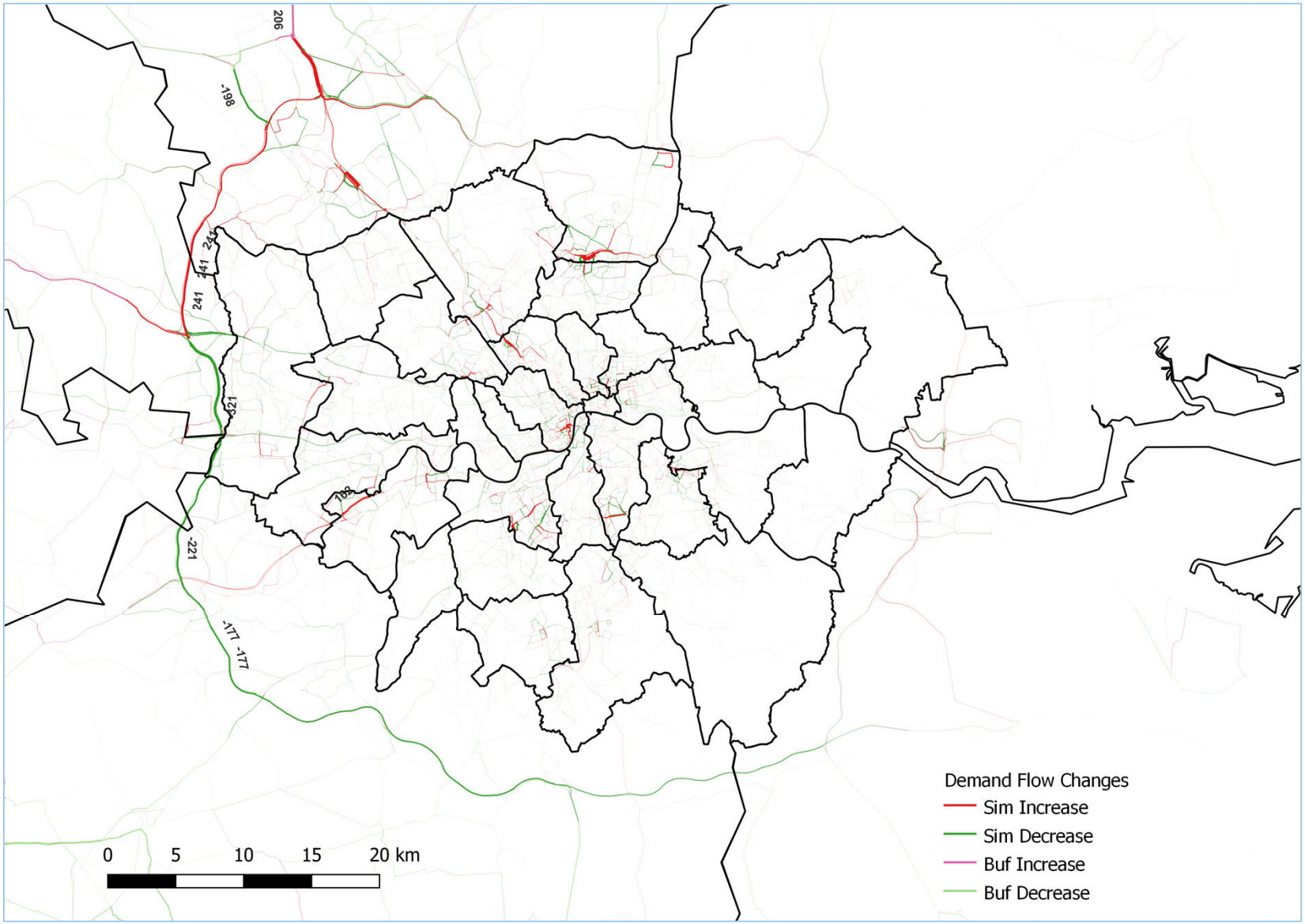
- LoHAM was now run with the new matrix with the external to external trips removed
- Checked assignment results to make sure that the link flows in the vicinity of Greater London do not change
- Outside London there are big reductions in link flows
- Inside and around London there are only small changes – both up and down – well within the noise of assignment iterations

Big reductions in link flows outside London

Small changes in London



Small changes in London



Convergence

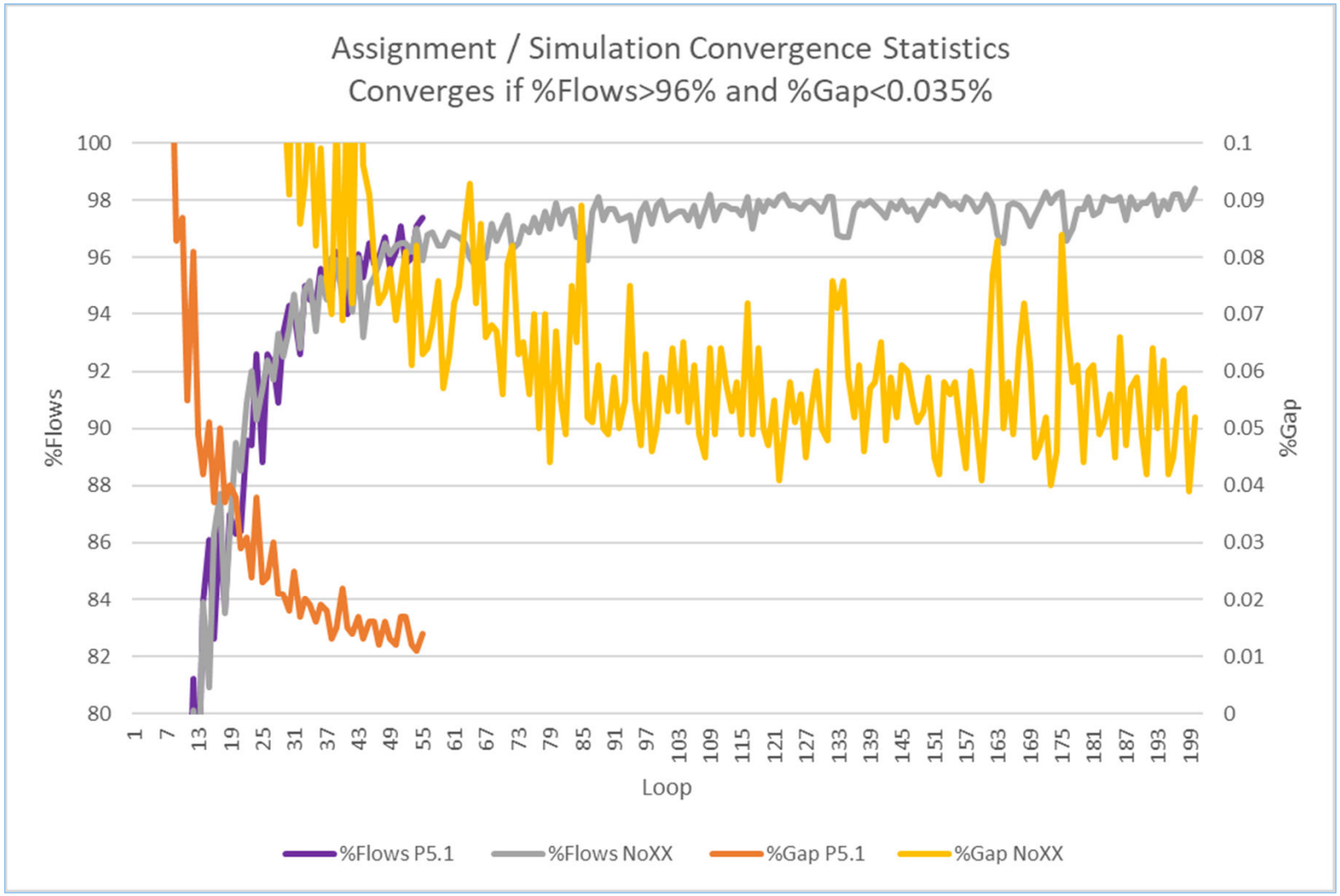
After removal of the External to External trips LoHAM assignment no longer converges to the criteria used for P5.1

P5.1 Assignment / Simulation Convergence Criteria
- %Flows that change by less than 1%> 96%
- AND %Gap < 0.035% on 4 successive iterations

LoHAM P5.1 slightly worse model convergence than P4.3, but AM Peak converges after 55 iterations due to %Flows Criterion being satisfied. %Gap criterion was satisfied after 29 iterations.

After removal of the external to external trips LoHAM assignment doesn't converge. Stops after reaching 200 iterations limit. %Flow satisfied 98.4 but %Gap 0.052.

% Gap & % Flows Convergence Statistics P5.1 vs NoXX



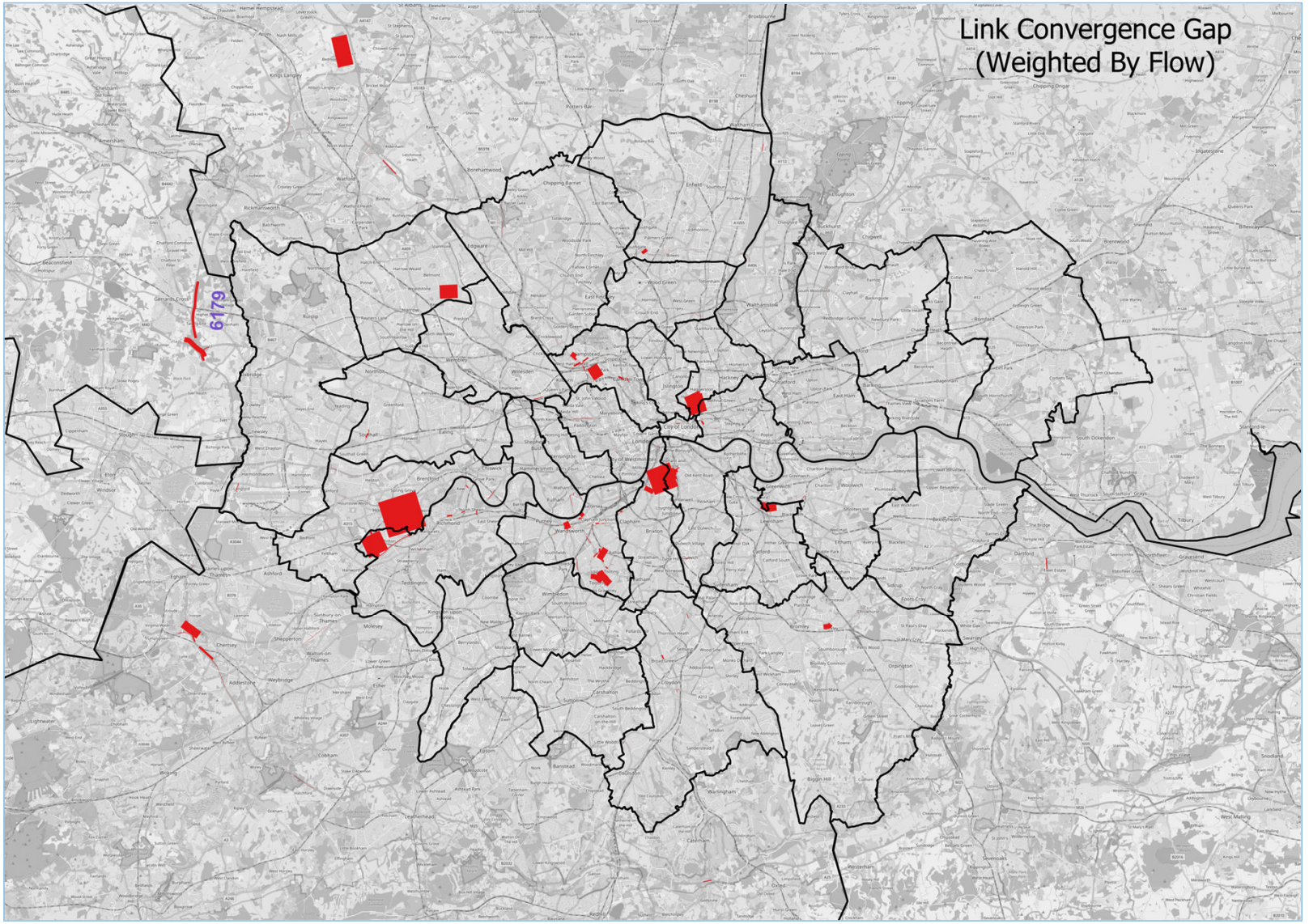
Improving Convergence

The model was now examined to identify areas where there was poor convergence and using general advice from the SATURN Manual (See Section 9.5) adjustments were made to achieve better convergence.

9.5.1 Improved Convergence

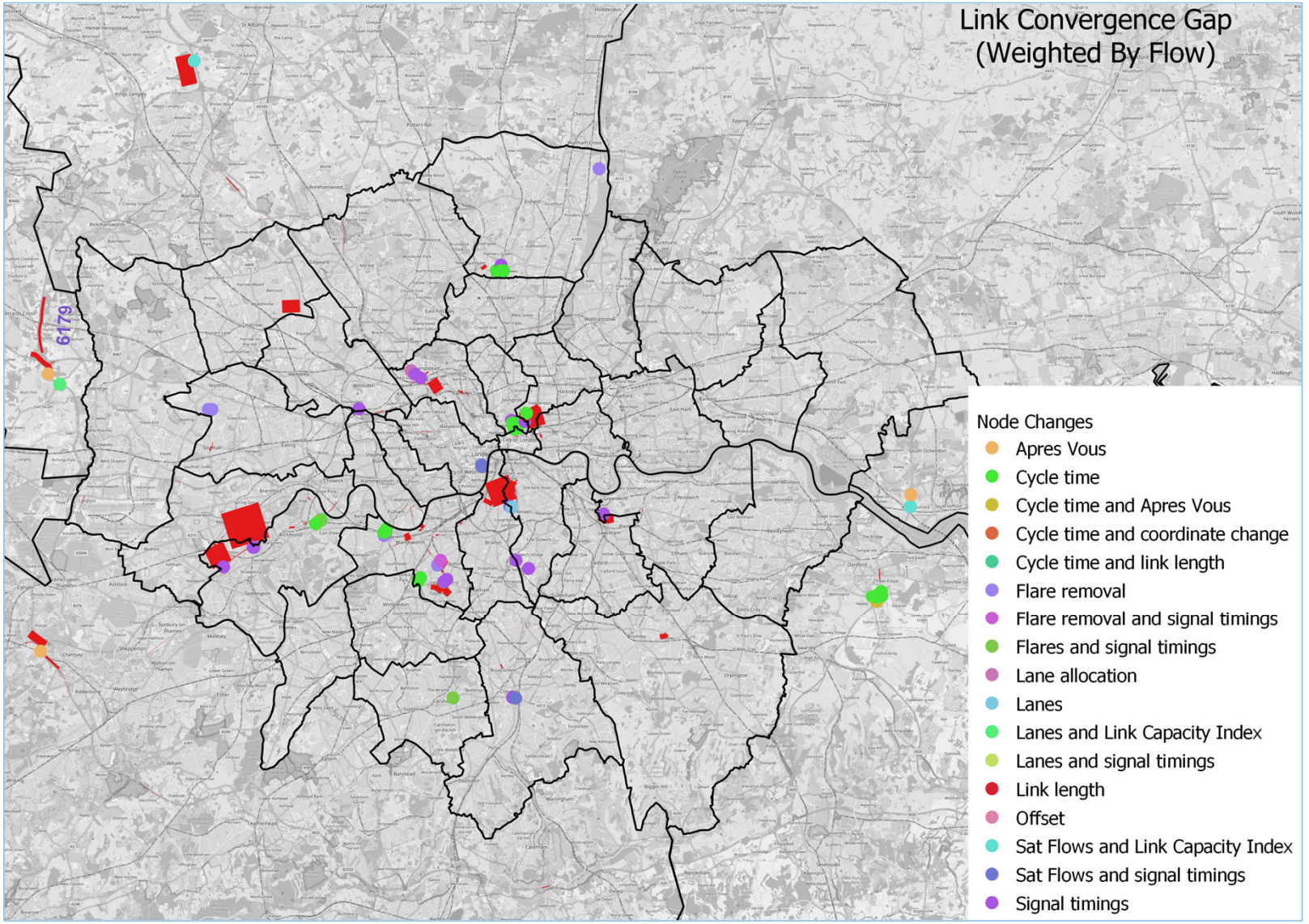
Unfortunately there are no precise rules for what to do if your network does not converge as well as you might expect or require. "All happy networks are alike but an unhappy network is unhappy after its own fashion". The following are therefore only suggestions as to what you might try; if they work, fine - if they don't, keep on trying!

Areas of poor convergence identified

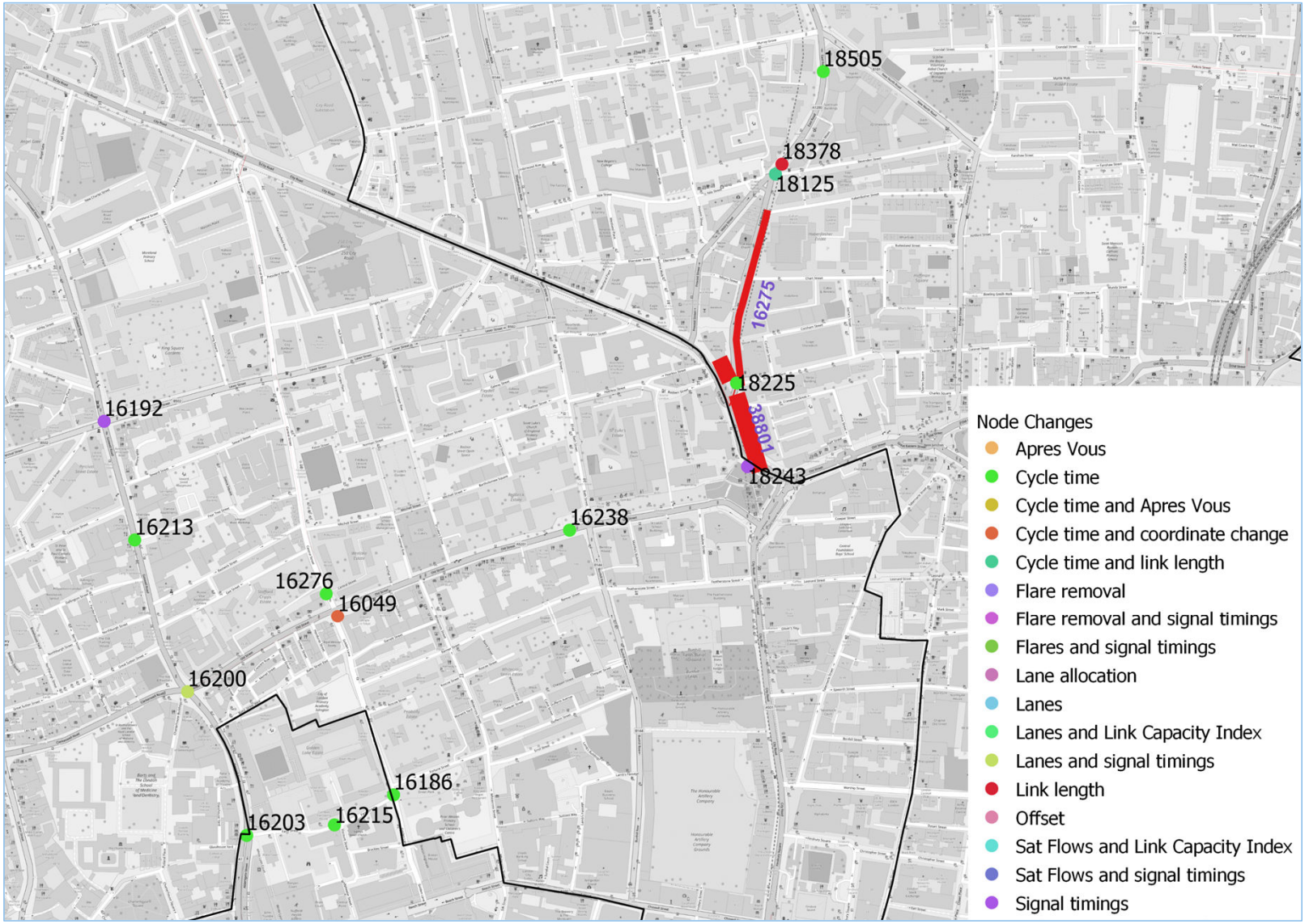


Changes made to 118 nodes to fix areas of poor convergence.

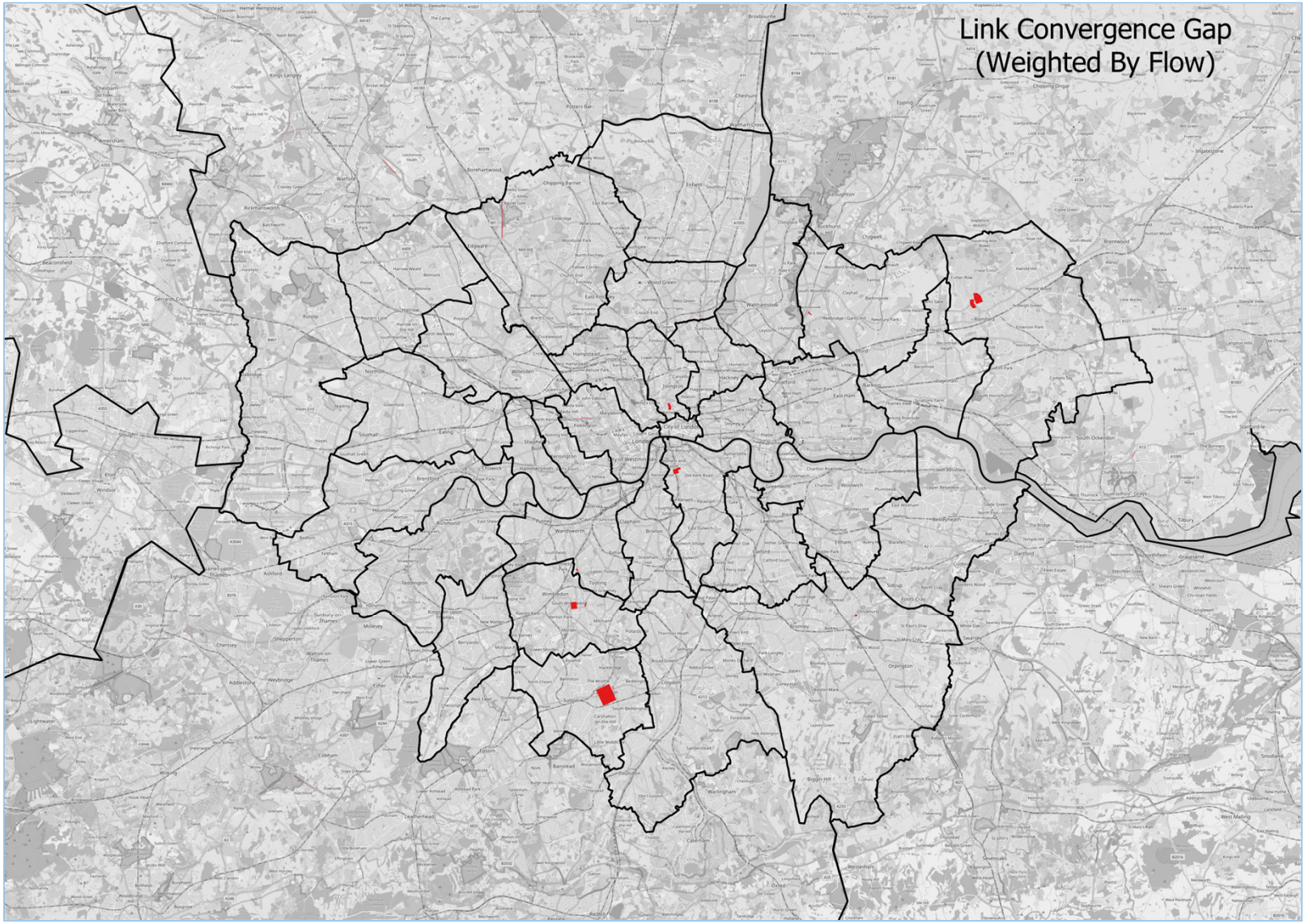
Also fixed some link distance errors and associated KNOBS parameters and GIS files.



Node changes to fix areas of poor convergence

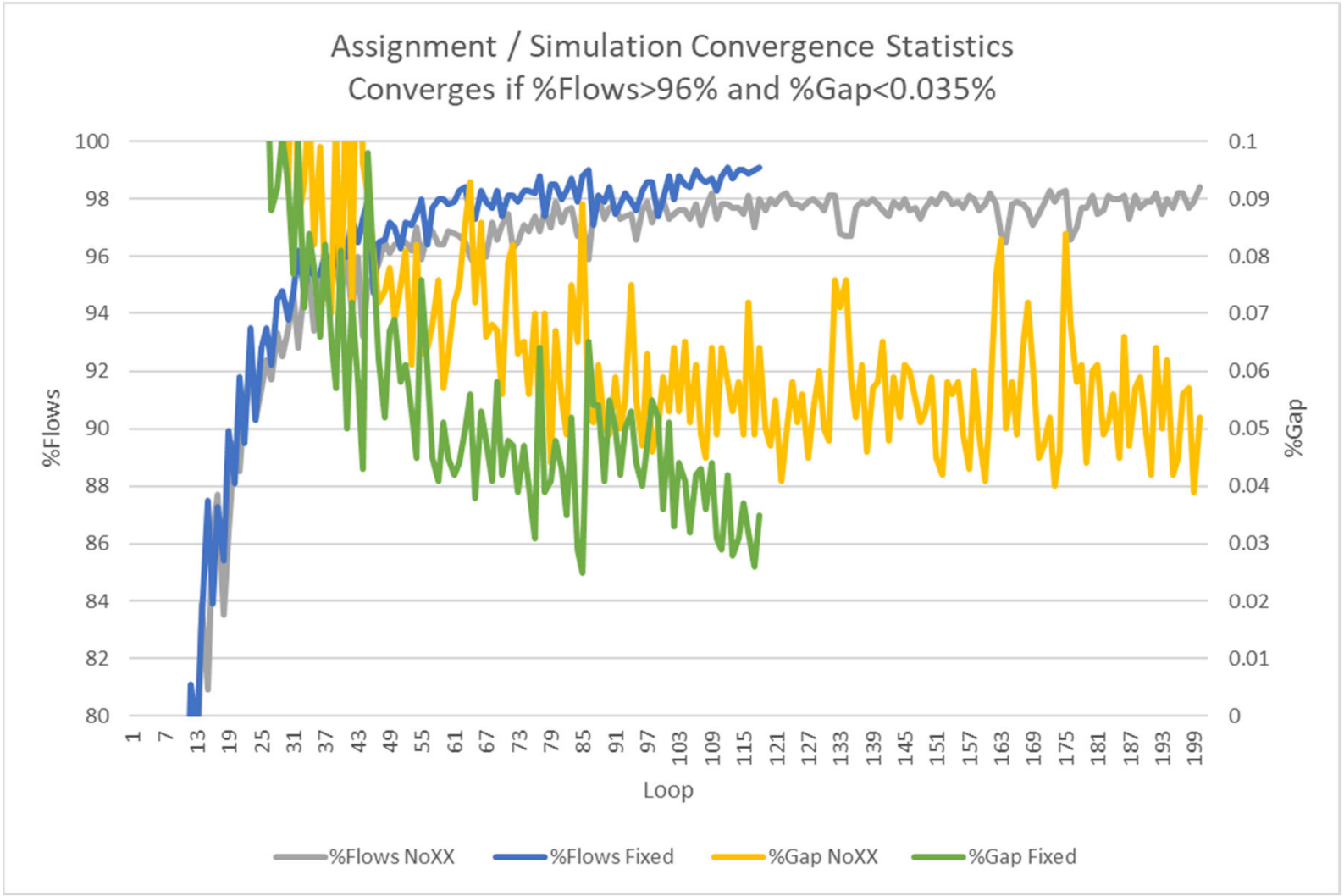


Areas of poor convergence reduced



% Gap & % Flows Convergence Statistics NoXX Original vs Fixed.

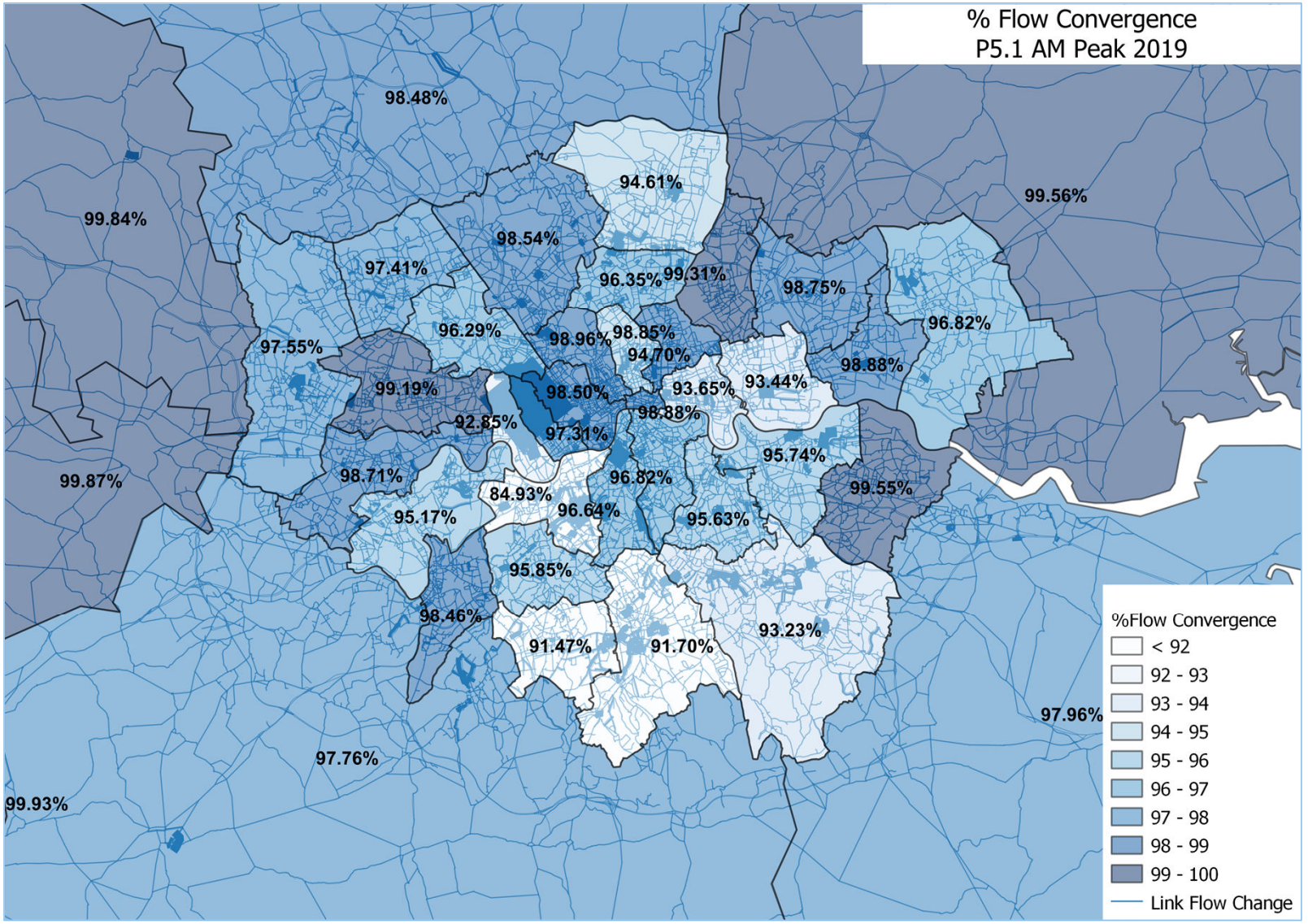
Now converges after 118 iterations.



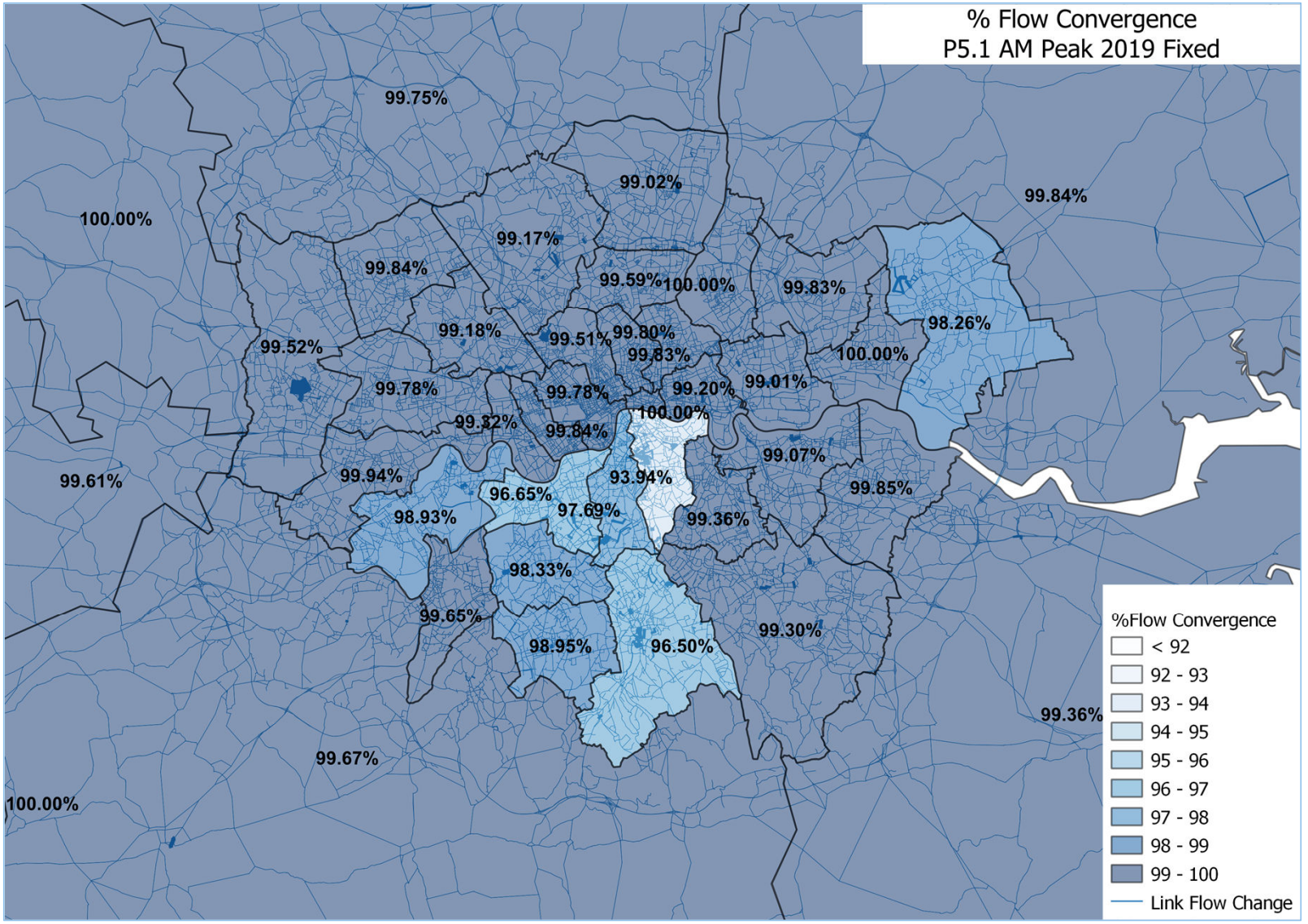
Flow Convergence P5.1 AM 2019 By Sector

Can use P1X/SATDB Link Output - % ISTOP Flow Convergence

11 Boroughs don't quite satisfy %flow convergence criterion (>96%)



Flow Convergence satisfied almost everywhere after network fixes applied, but full P5.1 matrix used.



Results

- The large number of trips in the LoHAM trip matrices between locations far away from the vicinity of London:
  - Does not affect assignment results
  - Mask areas where there is poor convergence within London

- Removing the trips has allowed
  - The model to be adjusted (Log files produced) to improve convergence in these poorly converging areas and thus get LoHAM to converge to both Flow and Gap criteria for London

- For Flow Convergence
  - Sector results show P5.1 AM Peak 2019 doesn't converge in all Boroughs
  - Implementing model adjustments from external to external trips results in much more consistent flow convergence across London. Model now converges in virtually all sectors.

Conclusions

- Convergence across a large scale strategic highway model is both challenging and interesting.
- Overall network can converge to TAG Criteria but may not in local areas within the model.
- Can find the areas where model not converging well and fix so they converge better.
- Note: Problem initially found by removing external to external trips, but not currently planning to remove these permanently.
- Model now converges to higher %Flow Convergence criterion across the whole model. Will ensure this is true in LoHAM P6.
- Will give better stability of results for economic analysis (TUBA, etc) and for MoTiON.
- Runtimes neutral as model converges to original criterion in fewer iterations, but allows higher convergence to new criterion.
- The 64bit SATURN 11.7 will also help with runtimes and allow us to implement more strict convergence criteria.

Contact

and

Resources

HAMS@tfl.gov.uk

https://tfl.gov.uk/corporate/publications-and-reports/strategic-transport-and-land-use-models

thank you

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