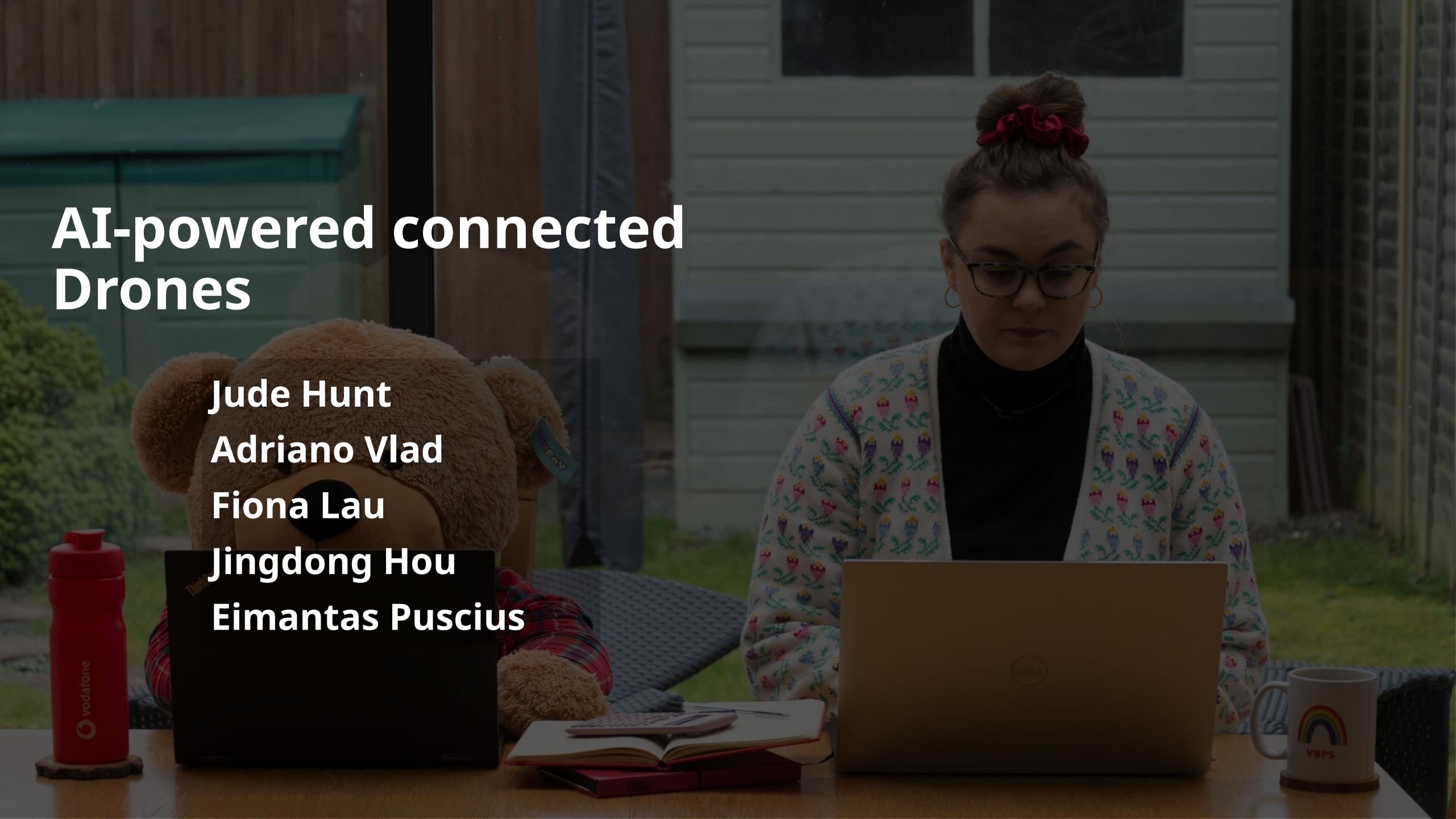


Network as a Platform

Drones en la red



AI-powered connected Drones



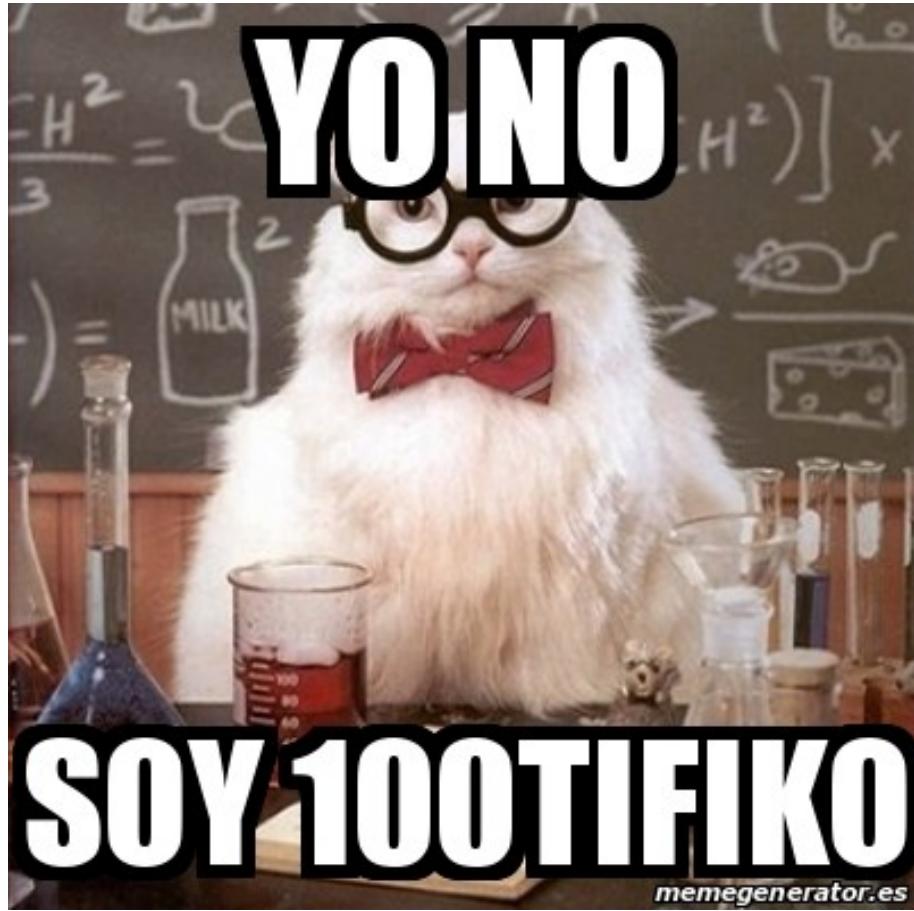
Jude Hunt
Adriano Vlad
Fiona Lau
Jingdong Hou
Eimantas Puscius

vodafone

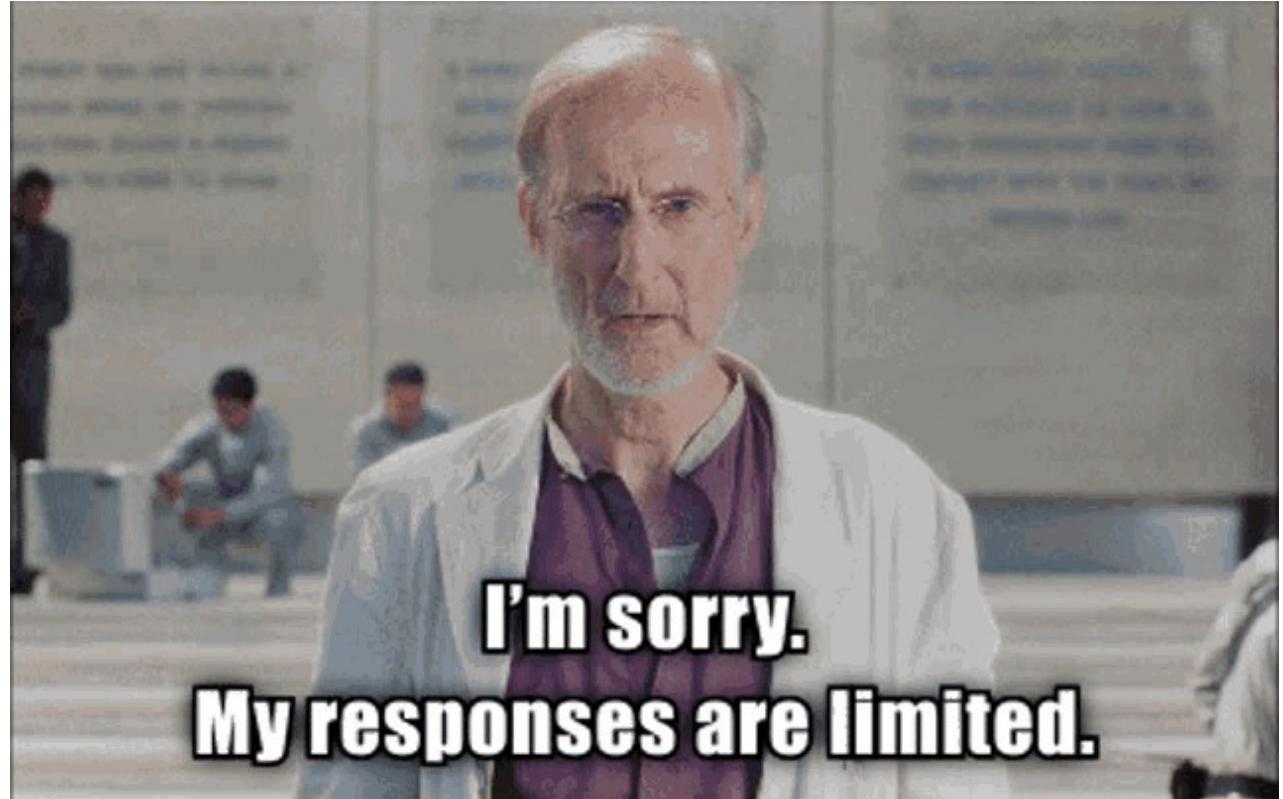
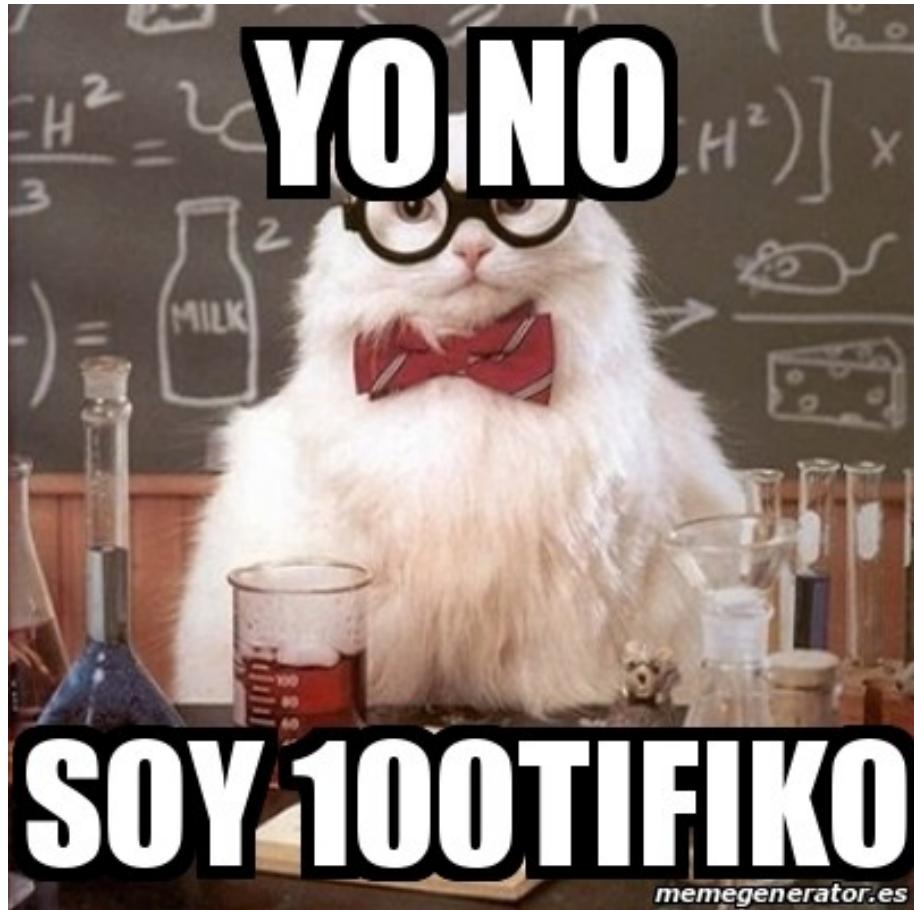
DELL

VBPS

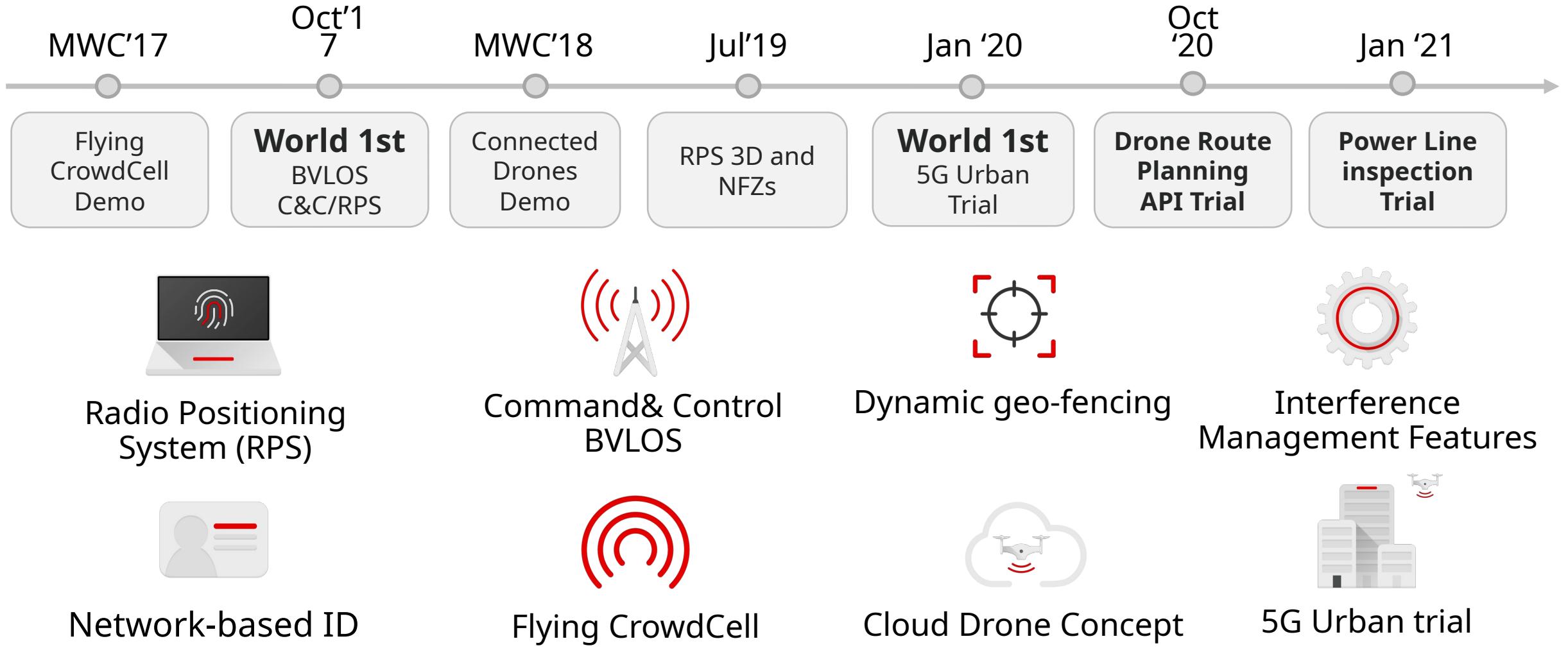
Drones en la red



Drones en la red



Drones en la red



www.vodafone.com/what-we-do/technology/connected-drones



Drones en la red | Drone Corridors

Skyway, based in Reading - £12.9 million to use drones to quickly and efficiently survey infrastructure, such as motorways and ports, reducing the need for costly transport system closures and improving delivery times

<https://www.gov.uk/government/news/new-aerospace-innovation-to-propel-uk-to-growth-and-greener-skies-backed-by-273-million>



[Home](#) > [Business and industry](#)

Press release

New aerospace innovation to propel UK to growth and greener skies backed by £273 million

Solar powered aircraft, ultra-efficient wings and medical treatment carrying drones are just some of the technologies the government will back.

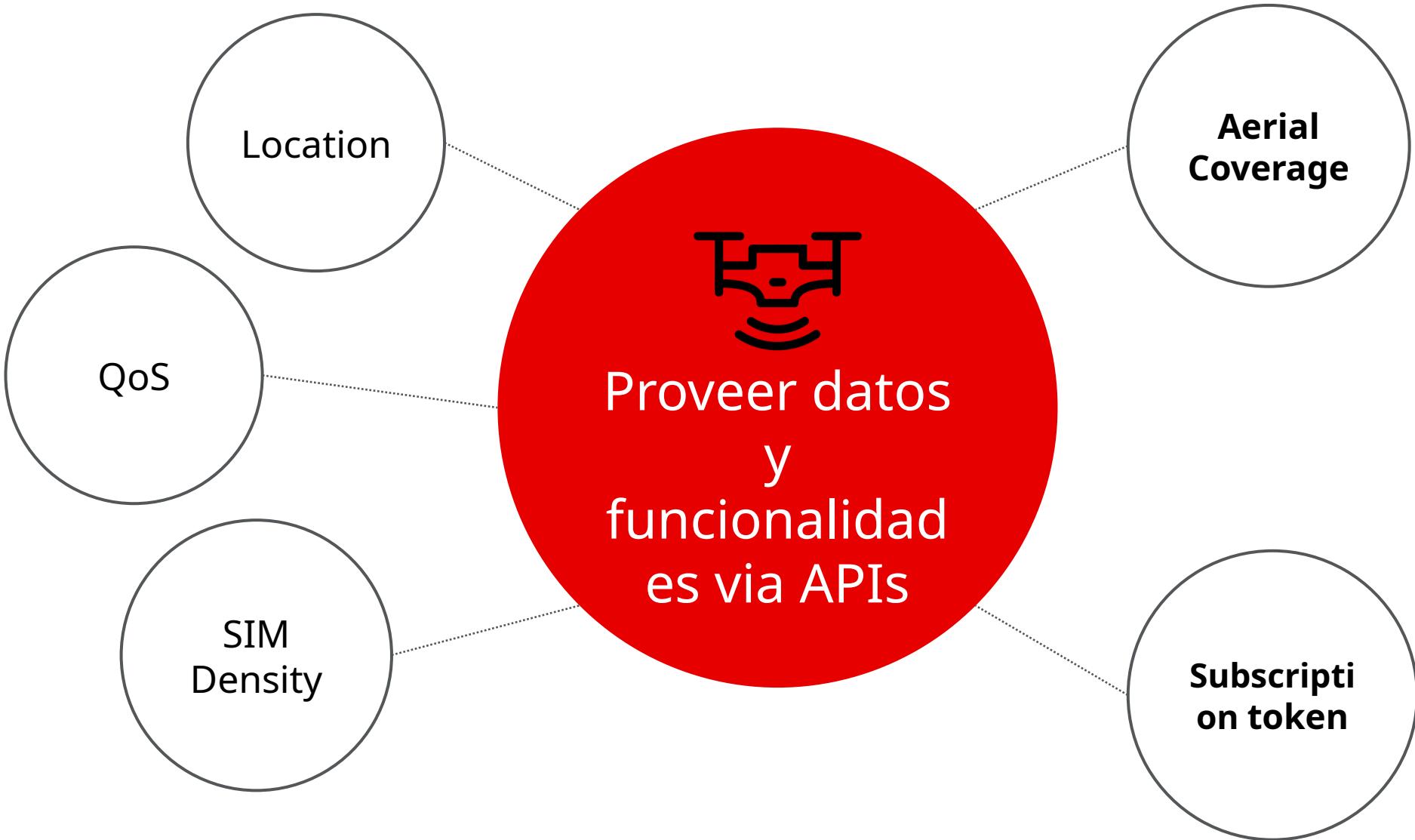
From: [Department for Business, Energy & Industrial Strategy](#), [Department for Transport](#), [UK Research and Innovation](#), [The Rt Hon Kwasi Kwarteng MP](#), and [Robert Courts MP](#)

Published 18 July 2022

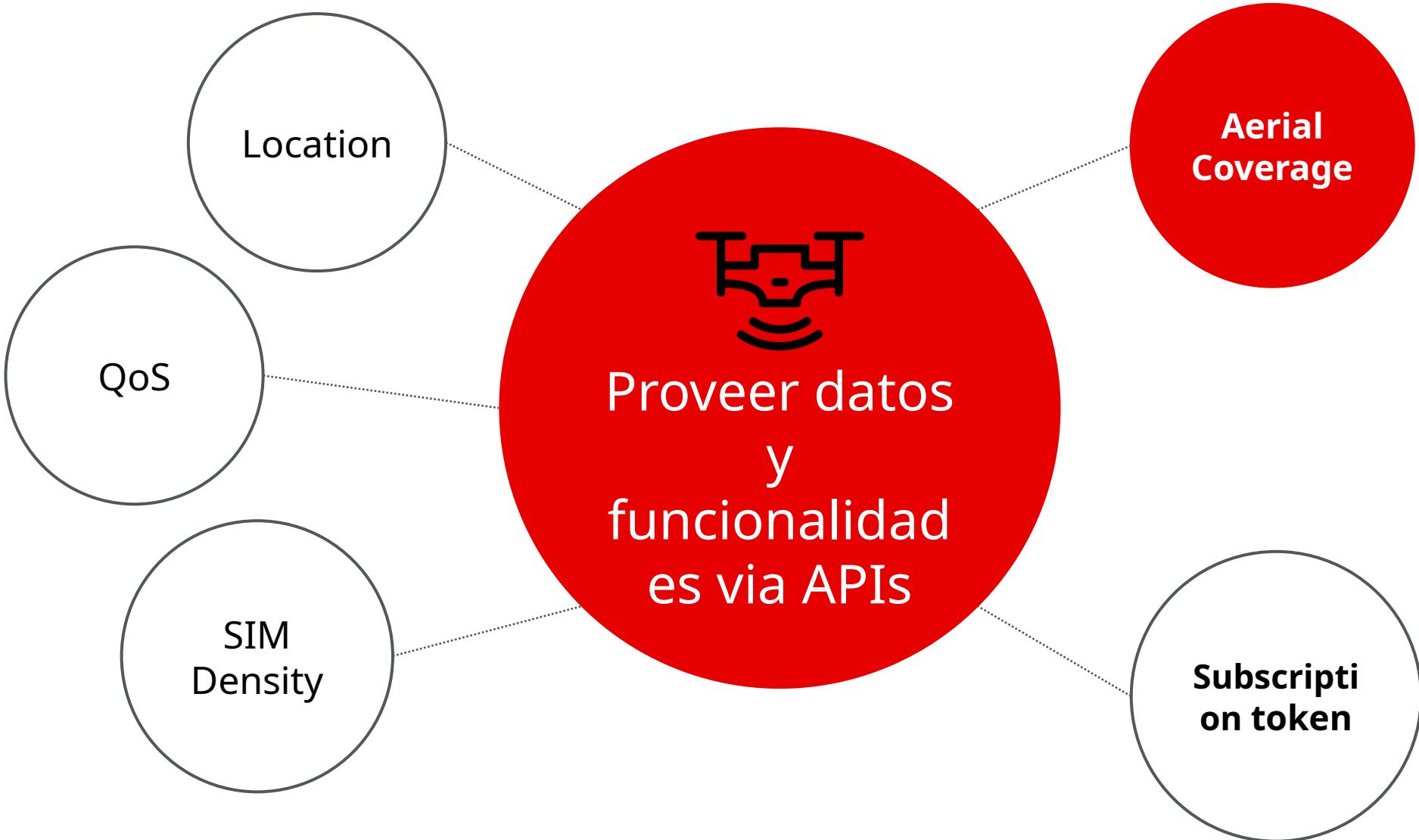
Last updated 18 July 2022 — [See all updates](#)



Drones en la red | Drone APIs

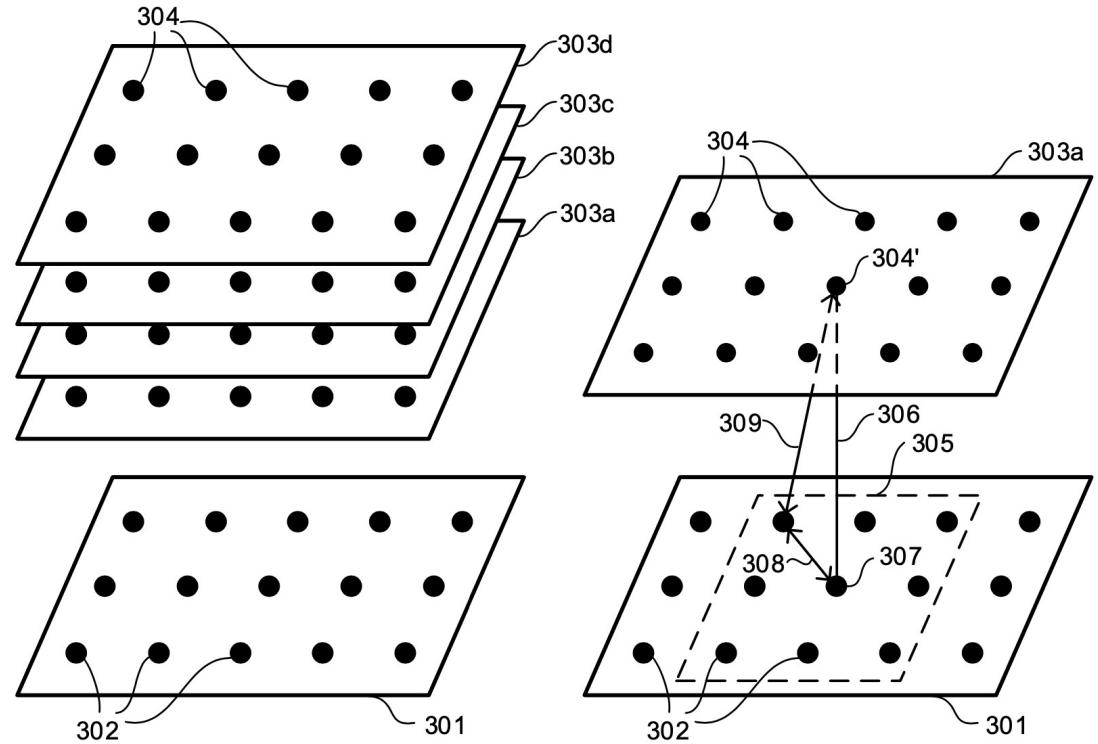


Drones en la red | Drone APIs



Aerial Coverage | Cobertura mediante ML

- **Motivación:** estimar la cobertura de red aérea y exponerlo via API
- **Enfoque tradicional:** Modelo de propagación basado en mediciones de la red real y otras fuentes de datos. (Costoso y necesita de terceros)
- **ML:** utilizar Machine Learning para estimar cobertura en diferentes alturas utilizando datos de tierra como input
 - Reference Signals Received Power (RSRP): Intensidad de la señal
 - Reference Signals Received Quality (RSRQ): Calidad de la señal
 - Altura





Coverage Map Model: Top_nn comparison

Jude Hunt - Research &
Innovation



Introducción

- El modelo de mapa de cobertura actualmente recupera los puntos top_nn más cercanos en tierra a cada punto en el cielo
- Este estudio investiga qué valor de top_nn es más efectivo, del 1 al 30
- Comparación con diferentes modelos:
 - Regresión KNN
 - Regresión lineal
 - Árbol de decisión
 - Random forest
 - AdaBoost
 - Gradient Boosting



Resultados – MSE para RSRP

	knn	lr	dt	rf	ada	gb
top_nn						
1	1.894718	35.902074	1.738572	1.738720	41.487538	29.873429
2	2.069605	35.872498	1.738572	1.738528	41.550748	29.536598
3	1.896450	35.836276	1.738572	1.738445	40.659169	29.153042
4	1.921278	35.789542	1.738572	1.738790	41.447965	28.752105
5	1.898469	35.642721	1.738572	1.738679	41.086249	28.595751
6	1.912034	35.638979	1.738572	1.738512	41.895333	28.485537
7	2.333067	35.537585	1.738572	1.738788	40.818327	28.359868
8	1.838906	35.538523	1.738572	1.738598	40.371892	27.919376
9	3.042085	35.007681	1.738572	1.738185	40.598307	27.876472
10	4.629516	34.766127	1.738572	1.738716	40.607573	27.939331
11	1.808188	34.677150	1.738572	1.738401	40.404933	27.733759
12	1.747678	34.626527	1.738572	1.738527	41.026076	27.581019
13	1.821077	34.552945	1.738572	1.738795	41.968129	27.587012
14	1.989926	34.549726	1.738572	1.738558	40.932735	27.417703
15	1.765601	34.502207	1.738572	1.738161	40.811086	27.238872

	knn	lr	dt	rf	ada	gb
top_nn						
16	4.522944	34.499654	1.738572	1.738742	40.663314	27.190869
17	1.839890	34.490192	1.738572	1.738485	41.362767	27.276421
18	1.858591	34.484785	1.738572	1.738670	40.036523	27.271422
19	1.864834	34.440607	1.738572	1.738747	40.614654	27.166953
20	1.775937	34.371483	1.738572	1.738143	41.119556	26.985694
21	1.795496	34.342279	1.738572	1.738559	41.111249	26.900780
22	1.758100	34.311050	1.738572	1.738338	40.573346	26.810645
23	1.844926	34.291741	1.738572	1.738620	40.352105	26.263826
24	1.804653	34.253510	1.738572	1.738676	41.014972	26.326617
25	1.981625	34.178159	1.738572	1.738315	40.967777	26.372488
26	1.760021	34.054340	1.738572	1.738529	40.673904	26.341645
27	1.809714	33.992567	1.738572	1.738709	41.327862	25.962710
28	1.814540	33.963232	1.738572	1.738468	41.606596	26.130524
29	1.771187	33.895669	1.738572	1.738590	41.120552	26.097496
30	2.126324	33.788305	1.738572	1.738771	39.863323	25.889104



Resultados – MSE para RSRQ

	knn	lr	dt	rf	ada	gb
top_nn						
1	0.384265	9.641224	0.255881	0.255900	9.236563	8.316532
2	0.472724	9.636203	0.255881	0.255971	9.206440	8.273362
3	0.371123	9.634096	0.255881	0.255928	9.204210	8.229592
4	0.384172	9.615344	0.255881	0.255794	9.277997	8.135425
5	0.377651	9.607680	0.255881	0.255880	9.221917	8.105470
6	0.358674	9.595064	0.255881	0.255912	9.213884	8.113689
7	0.590460	9.571694	0.255881	0.255931	9.293024	8.076106
8	0.266517	9.550773	0.255881	0.255866	9.233159	8.000968
9	0.283705	9.408116	0.255881	0.255871	9.258788	7.961131
10	0.389252	9.338122	0.255881	0.255905	9.284080	7.968139
11	0.311759	9.315270	0.255881	0.255898	9.201168	7.882716
12	0.264375	9.314809	0.255881	0.255921	9.279293	7.883836
13	0.262940	9.309794	0.255881	0.255875	9.191657	7.826802
14	0.326127	9.288759	0.255881	0.255901	9.208612	7.831990
15	0.287696	9.288432	0.255881	0.255875	9.265124	7.728110

	knn	lr	dt	rf	ada	gb
top_nn						
16	0.407267	9.284907	0.255881	0.255931	9.315949	7.730706
17	0.320701	9.283533	0.255881	0.255845	9.222613	7.725053
18	0.273572	9.276598	0.255881	0.255810	9.136946	7.699699
19	0.278631	9.266828	0.255881	0.255957	9.260101	7.663308
20	0.265308	9.239314	0.255881	0.255915	9.245008	7.601062
21	0.273401	9.222325	0.255881	0.255936	9.223680	7.603949
22	0.266872	9.200977	0.255881	0.255806	9.234505	7.591191
23	0.282679	9.193084	0.255881	0.255933	9.359267	7.511761
24	0.277953	9.174065	0.255881	0.255923	9.408435	7.499711
25	0.382225	9.166901	0.255881	0.255905	9.395510	7.454403
26	0.265418	9.150899	0.255881	0.256021	9.226958	7.399990
27	0.274592	9.147874	0.255881	0.255943	9.184426	7.452668
28	0.292839	9.147288	0.255881	0.255822	9.264518	7.400880
29	0.305107	9.133826	0.255881	0.255900	9.226632	7.353270
30	0.416007	9.132877	0.255881	0.255953	9.438937	7.378304



Conclusiones

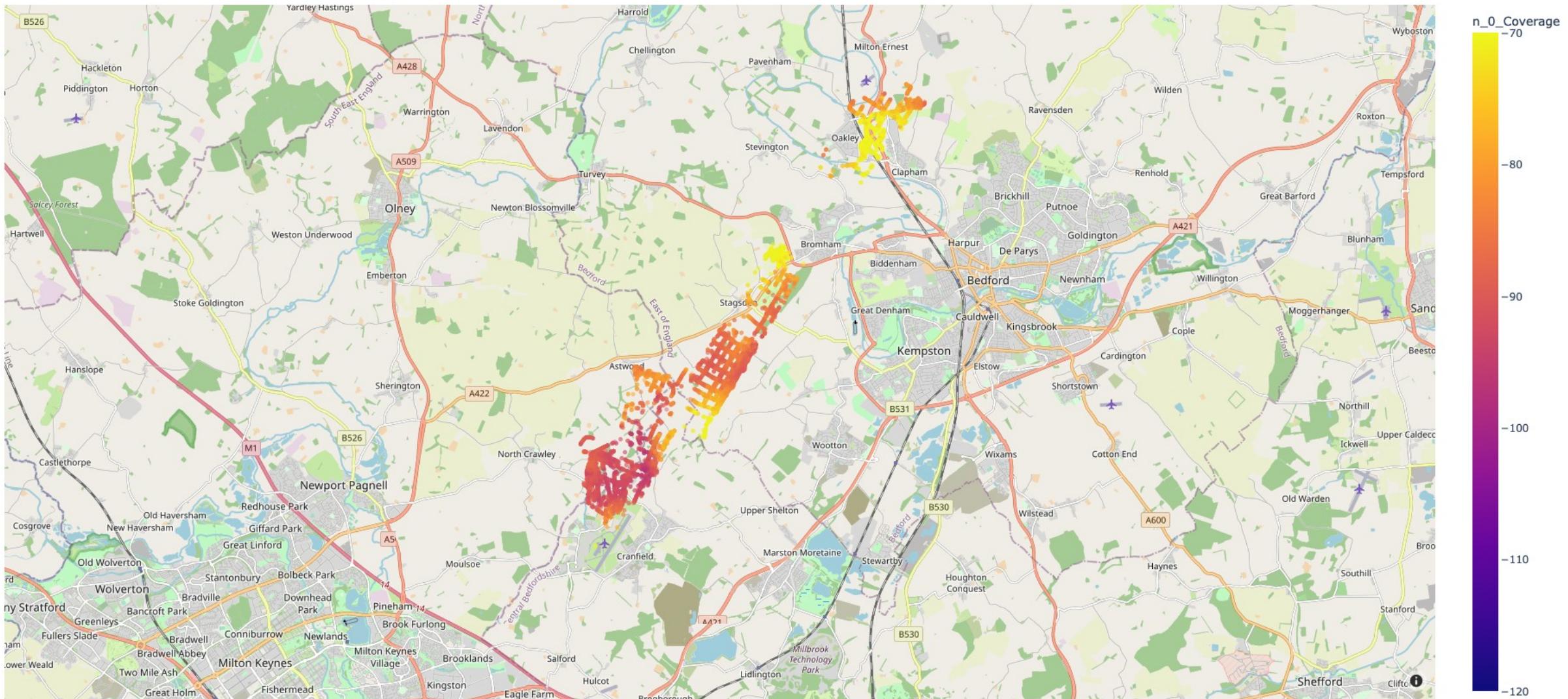
- La regresión lineal y AdaBoost tuvieron malos resultados
- Los árboles de decisión, KNN y Random Forest se desempeñaron mejor
- Los árboles de decisión tuvieron resultados idénticos independientemente de `top_nn`
 - hubo variación a mayor precisión
 - sugiere que los árboles de decisión son robustos y que las funciones adicionales proporcionadas tuvieron un efecto mínimo.
- Random forest también tuvo una variación mínima.
 - Tiene sentido, ya que estos se construyen a partir de árboles de decisión.
 - La variación parece aleatoria, basada en la inicialización del bosque en lugar de un efecto de `top_nn`
- En KNN se vieron grandes variaciones en el valor de `top_nn`
- Todos los árboles de decisión funcionaron mejor que KNN tanto para RSRP como para RSRQ
- Recomendación: árboles de decisión con `top_nn=1` para un cálculo mínimo,



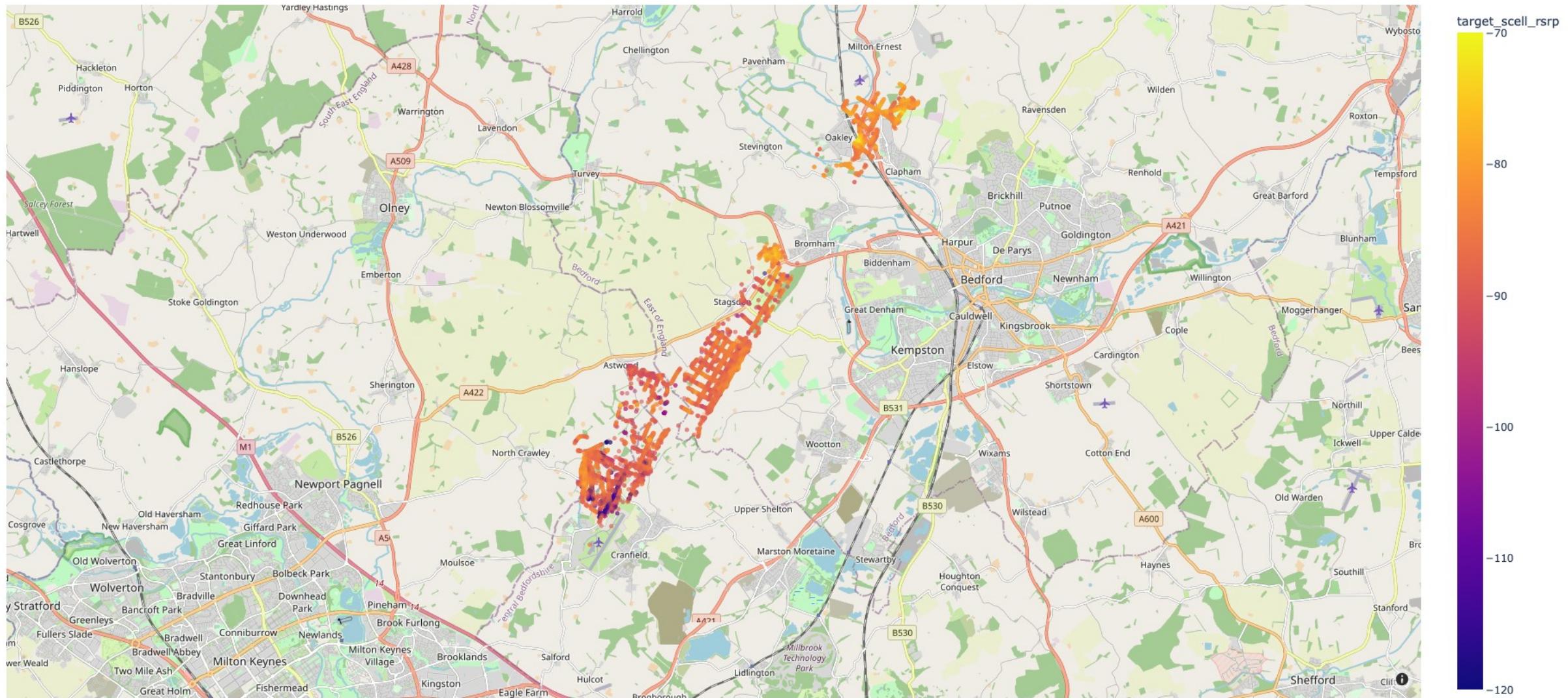
Resultados de los modelos de mapas de cobertura (RSRP)



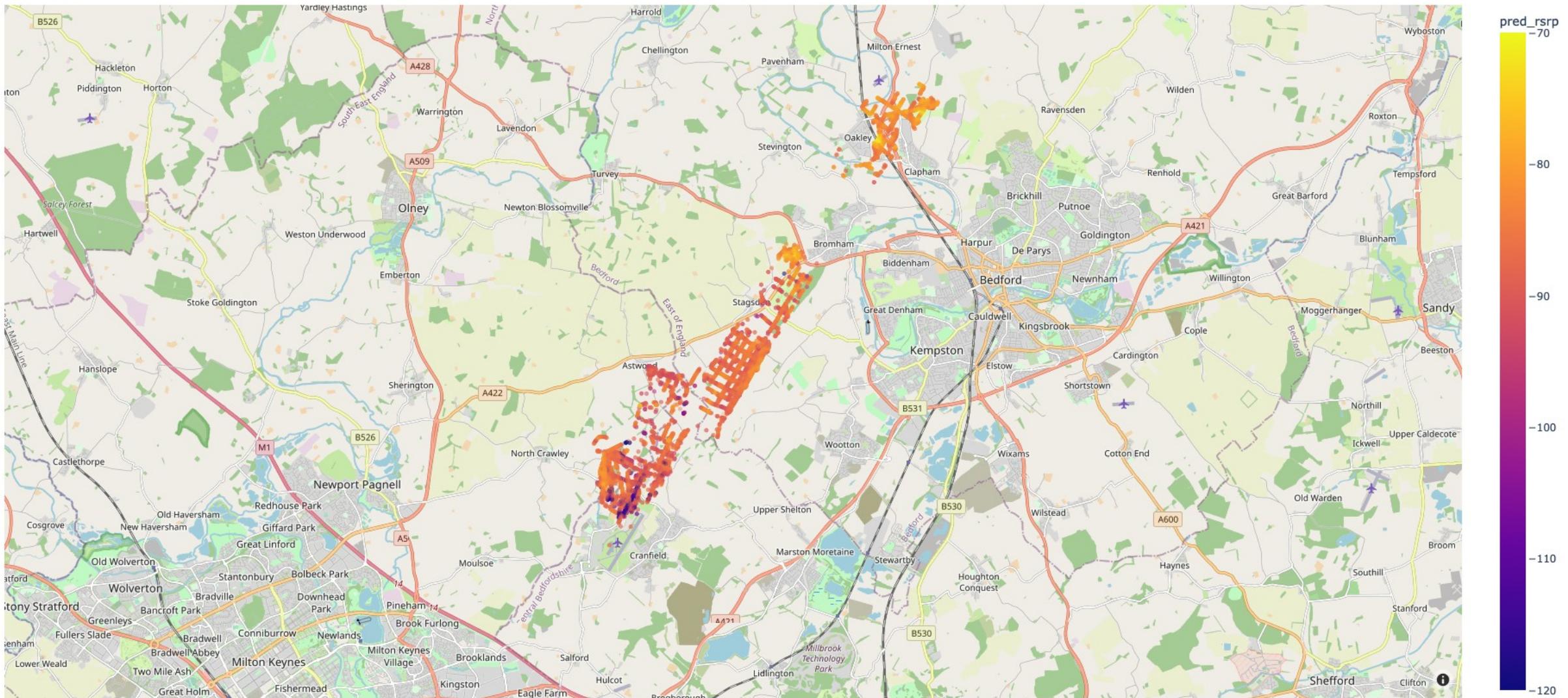
RSRP ground truth at ground level



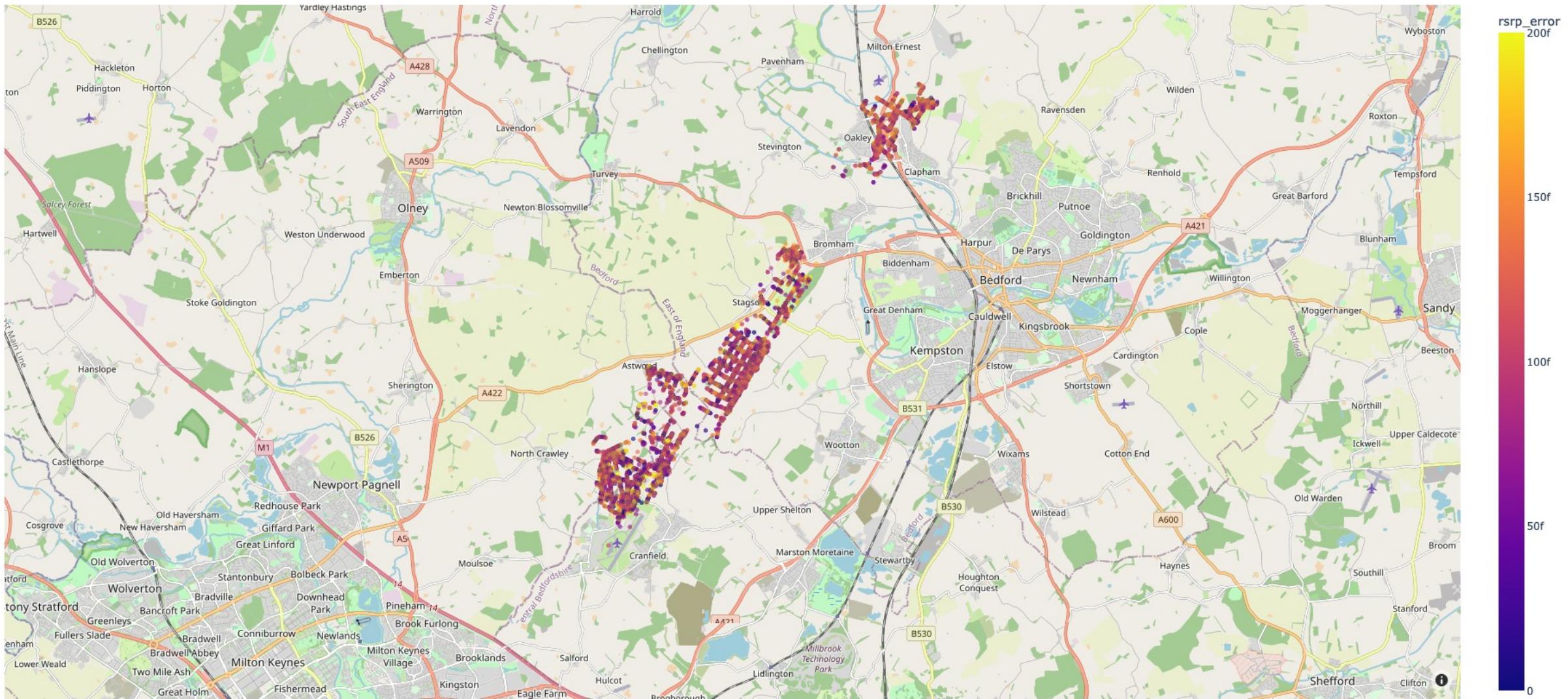
RSRP ground truth at altitude



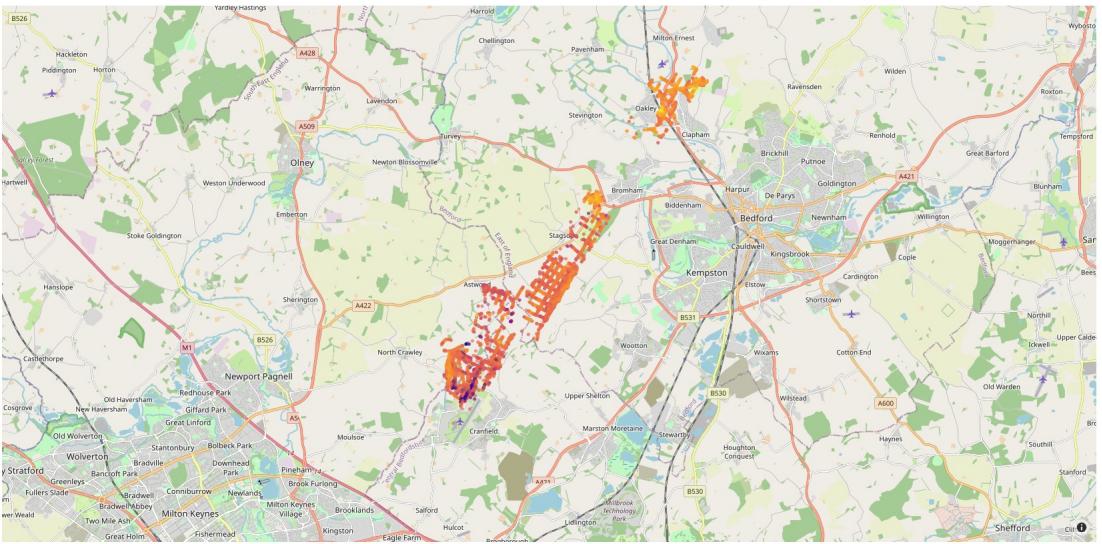
RSRP predictions at altitude



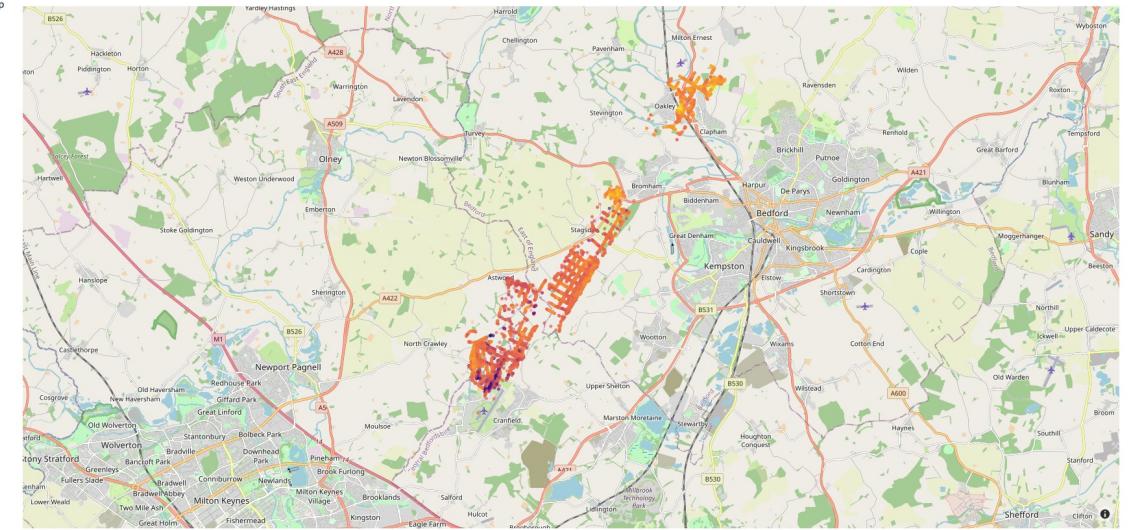
RSRP absolute errors at altitude



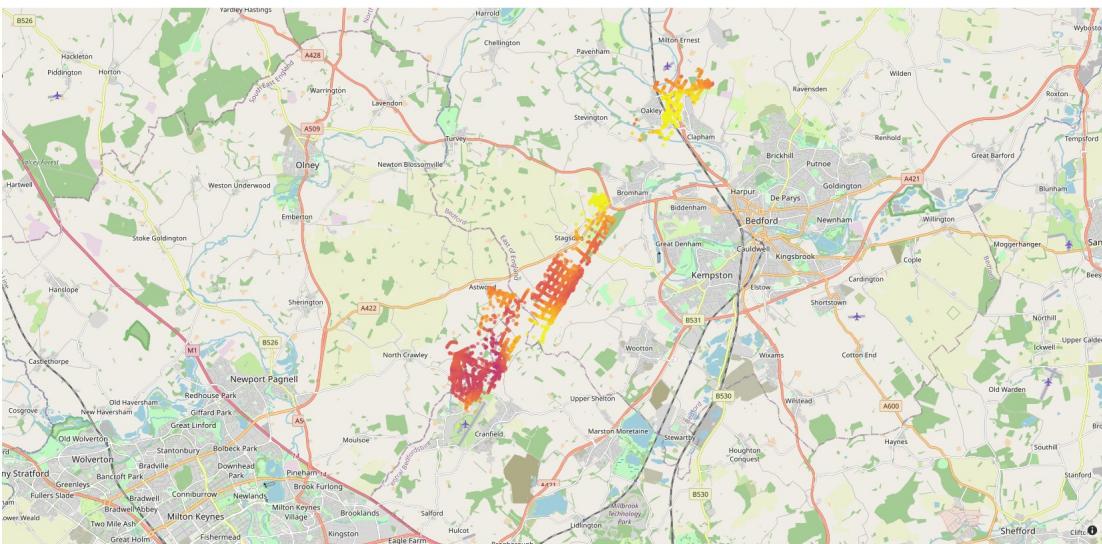
RSRP ground truth at altitude



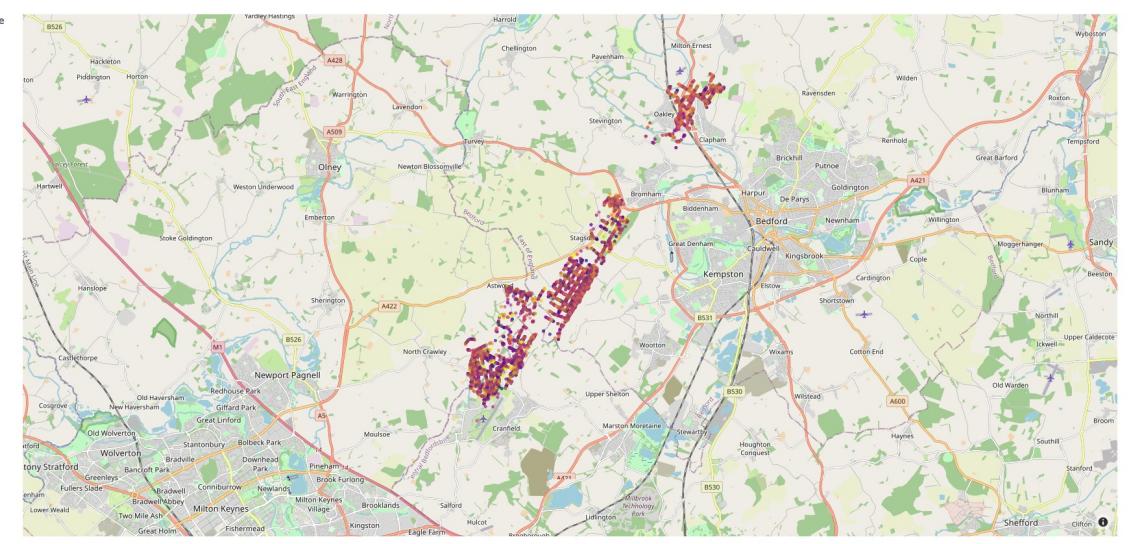
RSRP predictions at altitude



RSRP ground truth at ground level



RSRP absolute errors at altitude



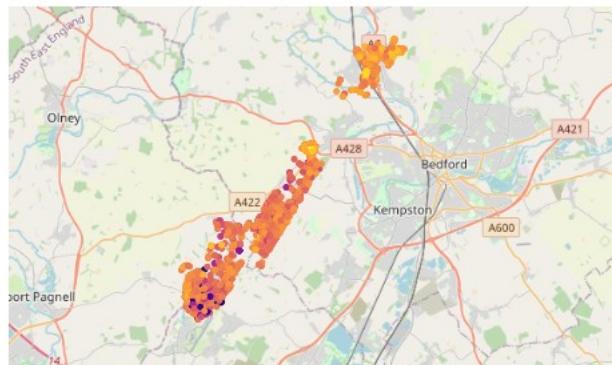
Whoops!



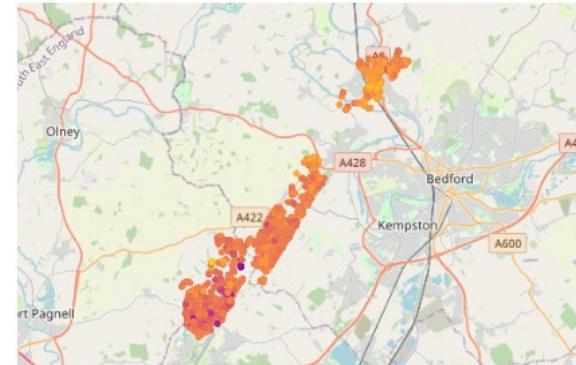
Los resultados eran demasiado buenos para ser verdad...

- Muchas de las muestras de prueba ya habían sido entrenadas debido a valores duplicados
- Eliminar estos valores redujo la precisión del modelo, ¡pero aún así no está mal!
- Eliminar estos valores también significa que solo estamos usando 8000 filas de datos de entrenamiento
 - Vamos a volver a entrenar en todos los vuelos de drones para ver el efecto; como puede ver a continuación, solo estamos usando algunos de los vuelos.

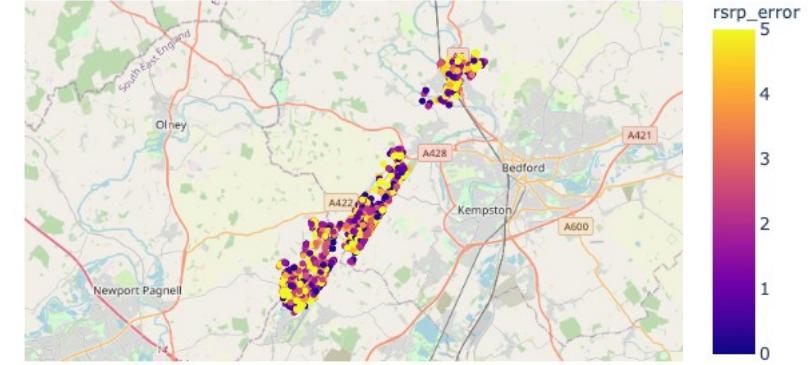
RSRP ground truth at altitude



RSRP predictions at altitude



RSRP absolute errors at altitude



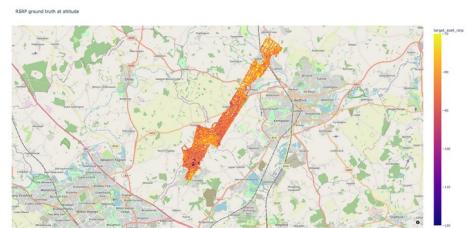
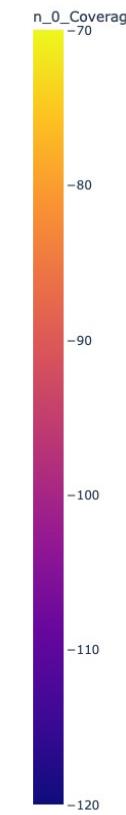
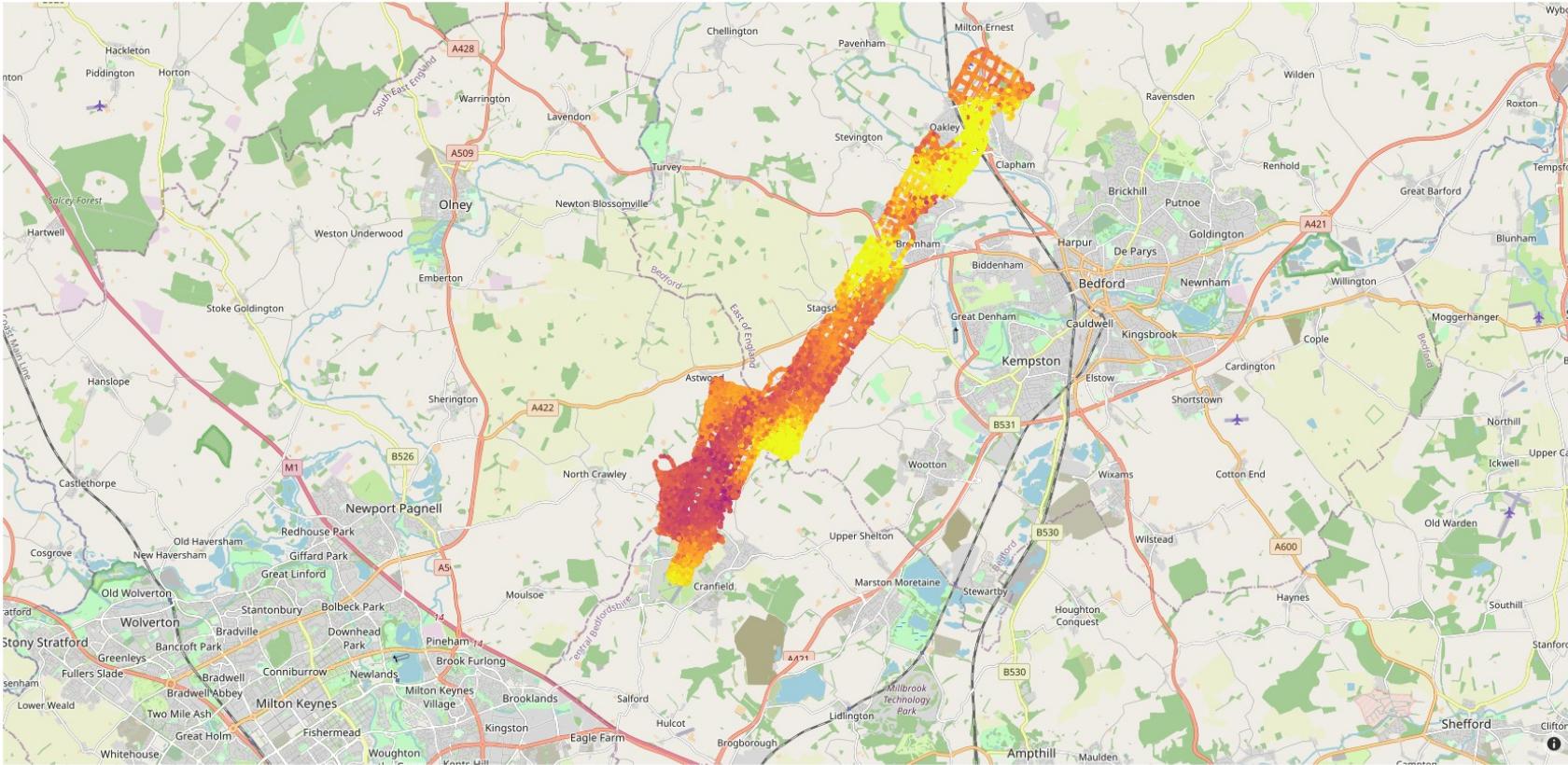
- Dicho esto, las predicciones de la diapositiva anterior no tendrán este problema (pero no podemos validar su precisión y es posible que el modelo se haya sobreajustado)



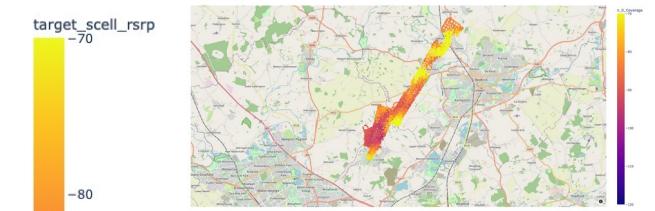
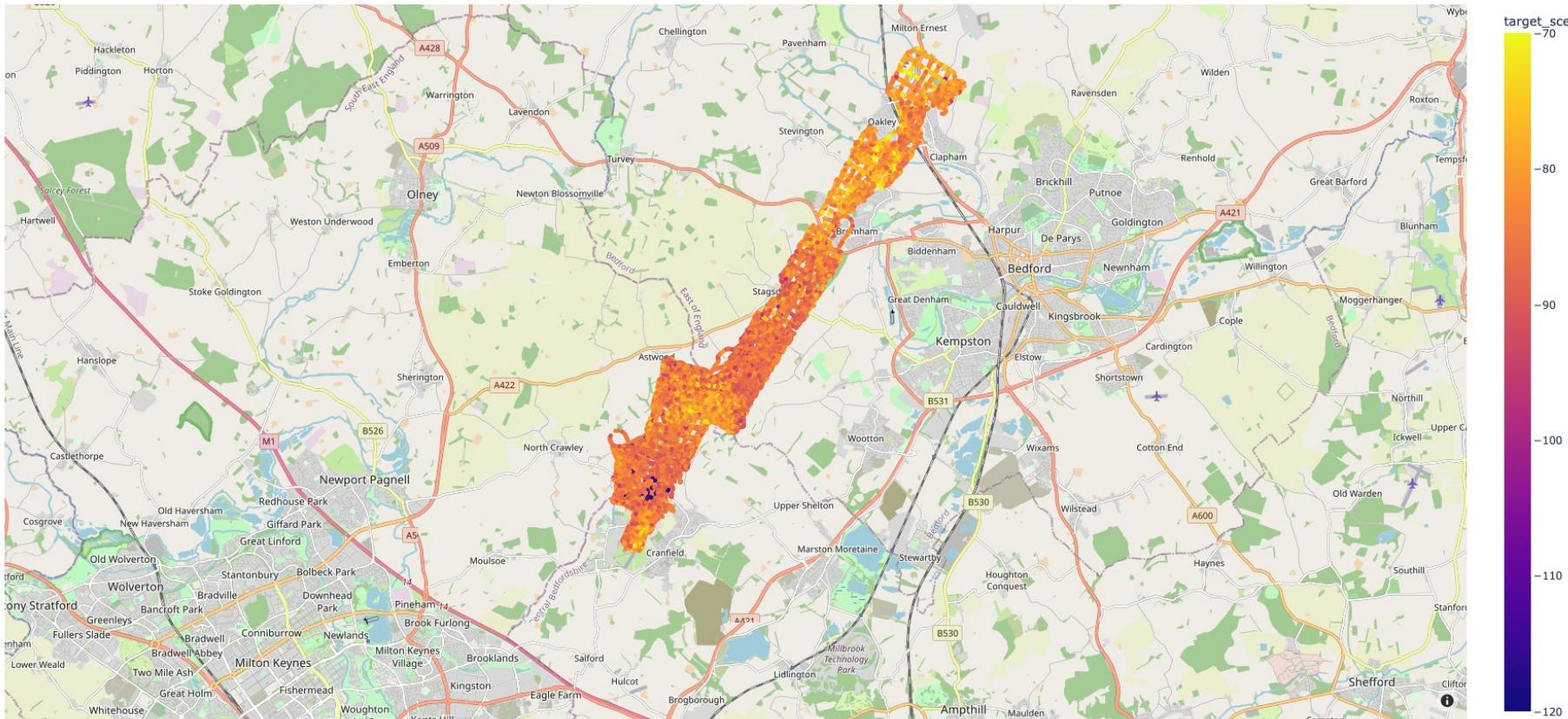
Lo arreglamos!



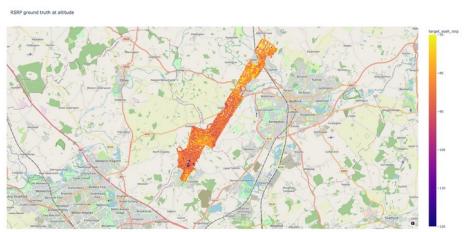
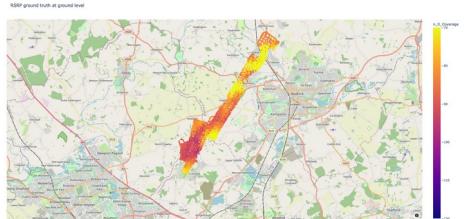
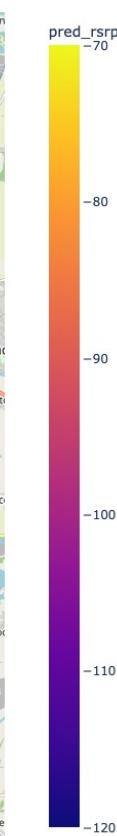
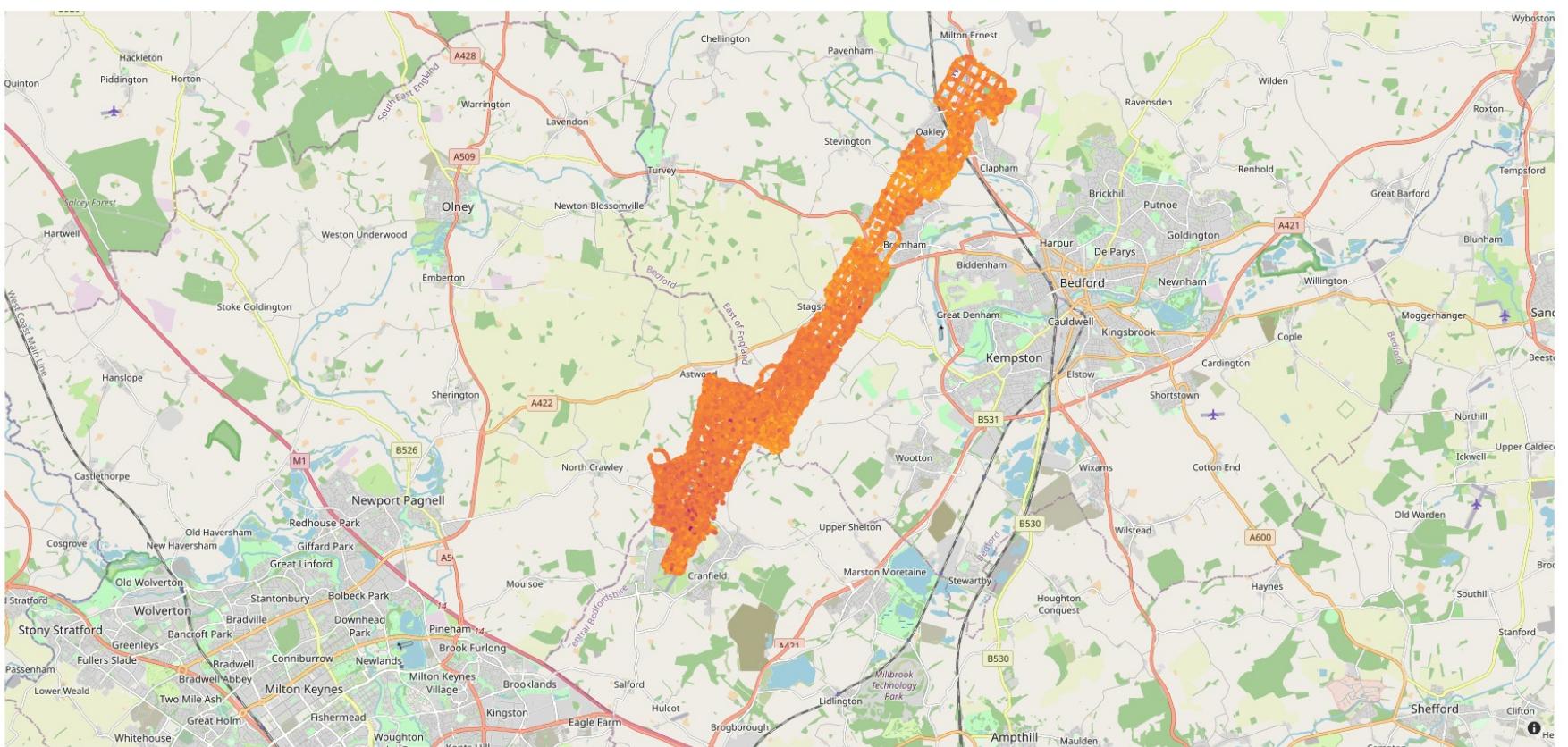
RSRP ground truth at ground level



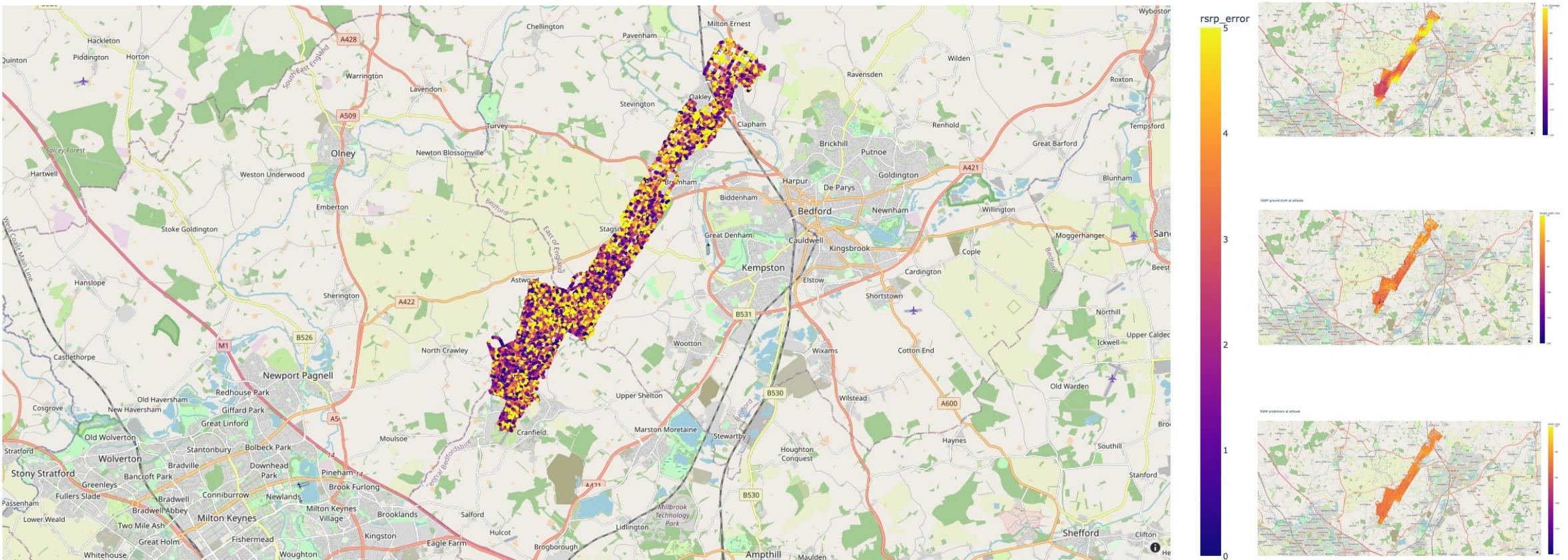
RSRP ground truth at altitude



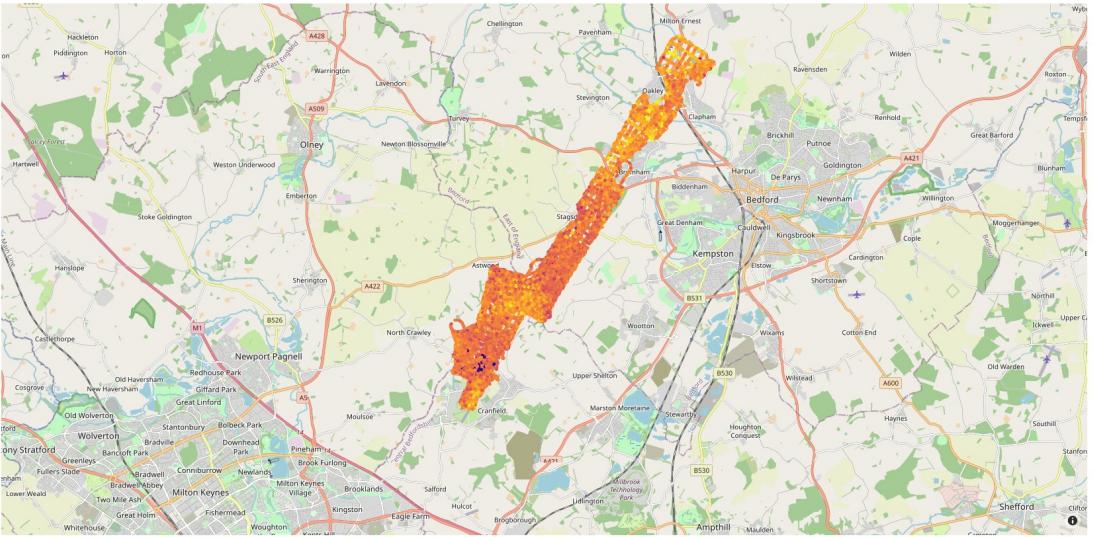
RSRP predictions at altitude



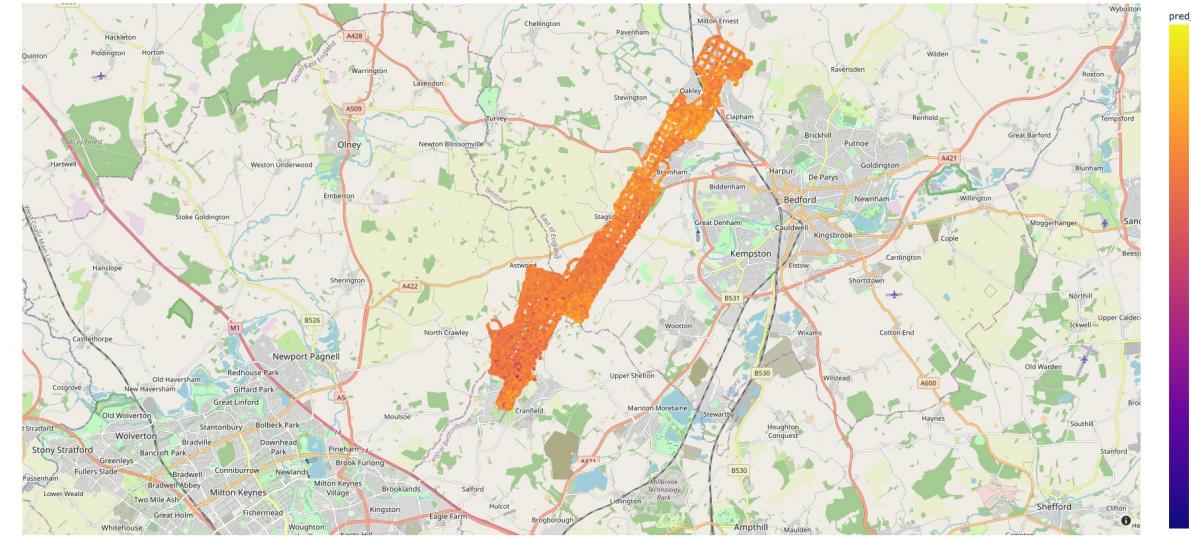
RSRP absolute errors at altitude



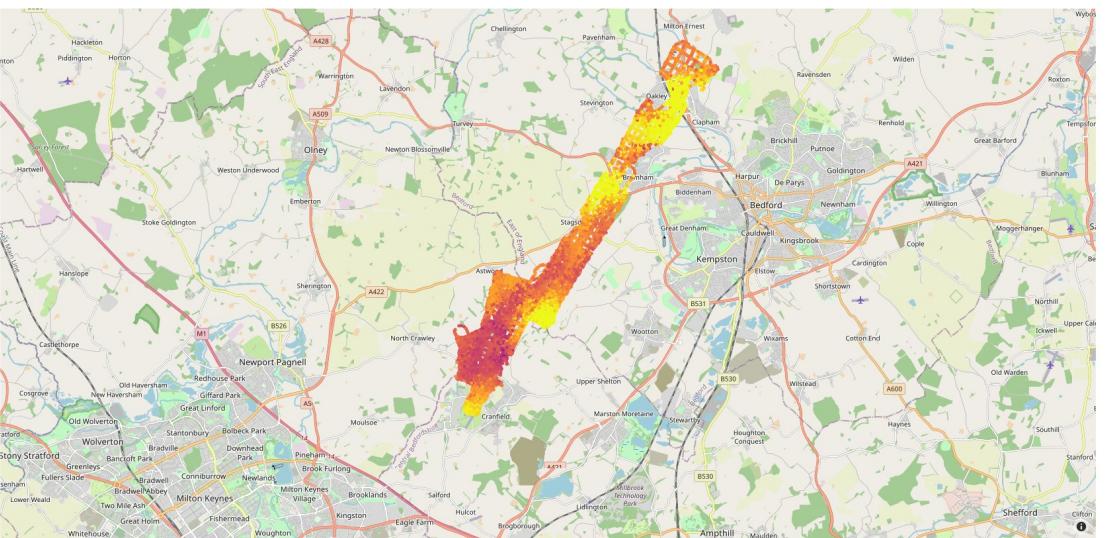
RSRP ground truth at altitude



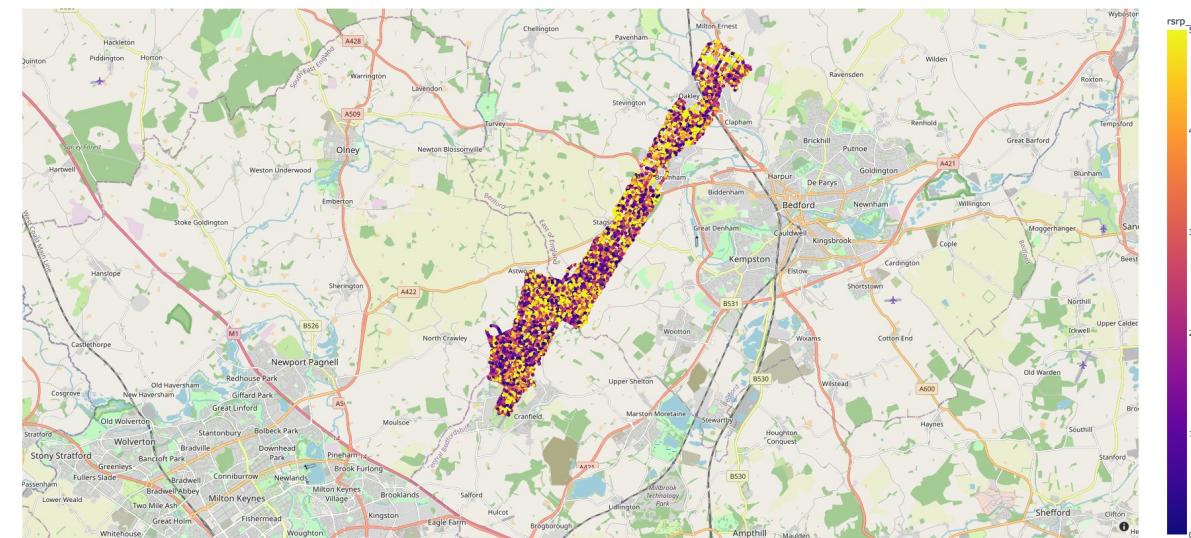
RSRP predictions at altitude



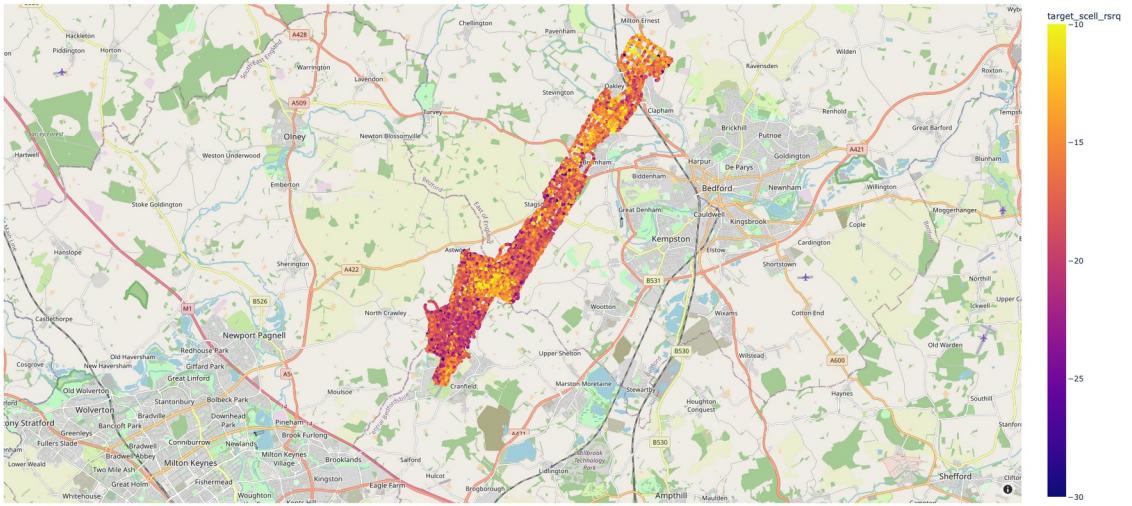
RSRP ground truth at ground level



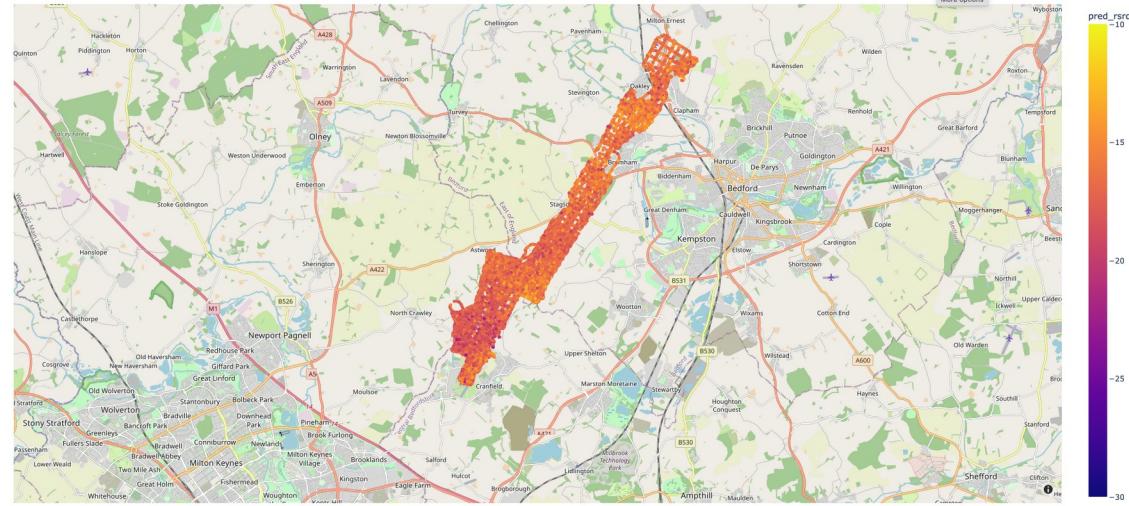
RSRP absolute errors at altitude



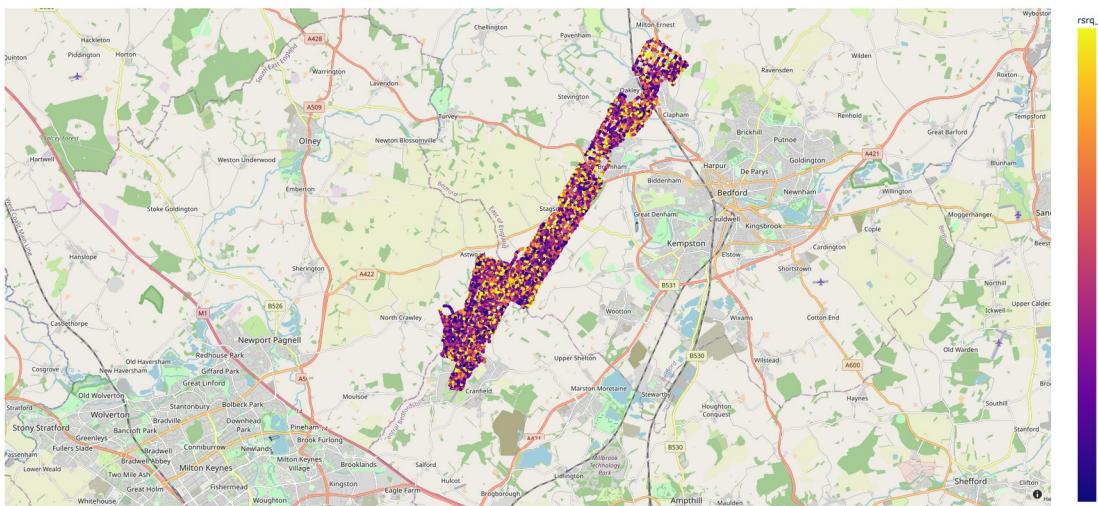
RSRQ ground truth at altitude



RSRQ predictions at altitude



RSRQ absolute errors at altitude



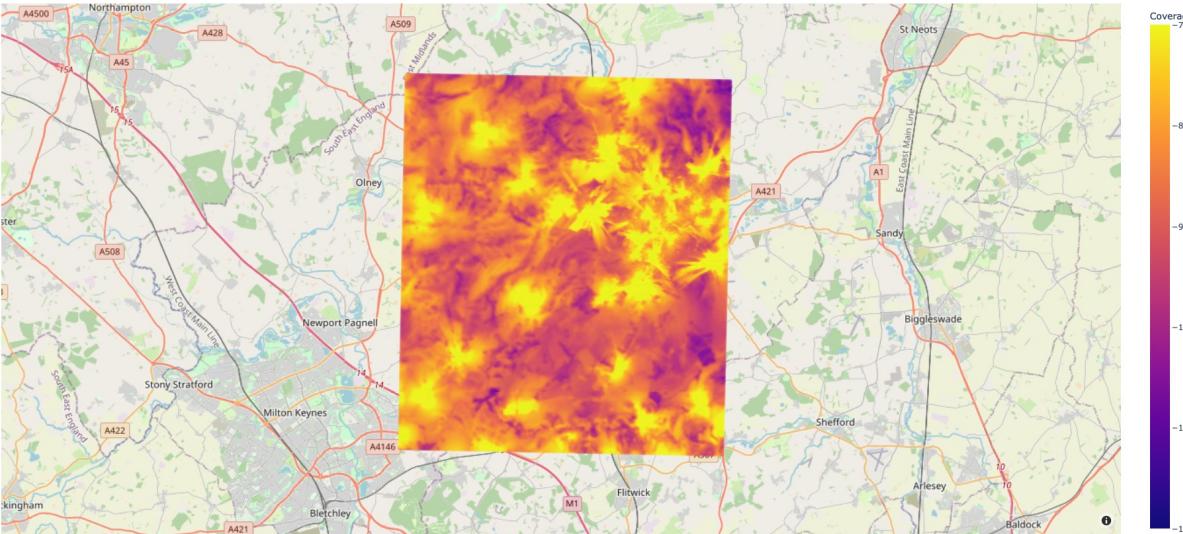
pred_rsrq

target_scell_rsrq

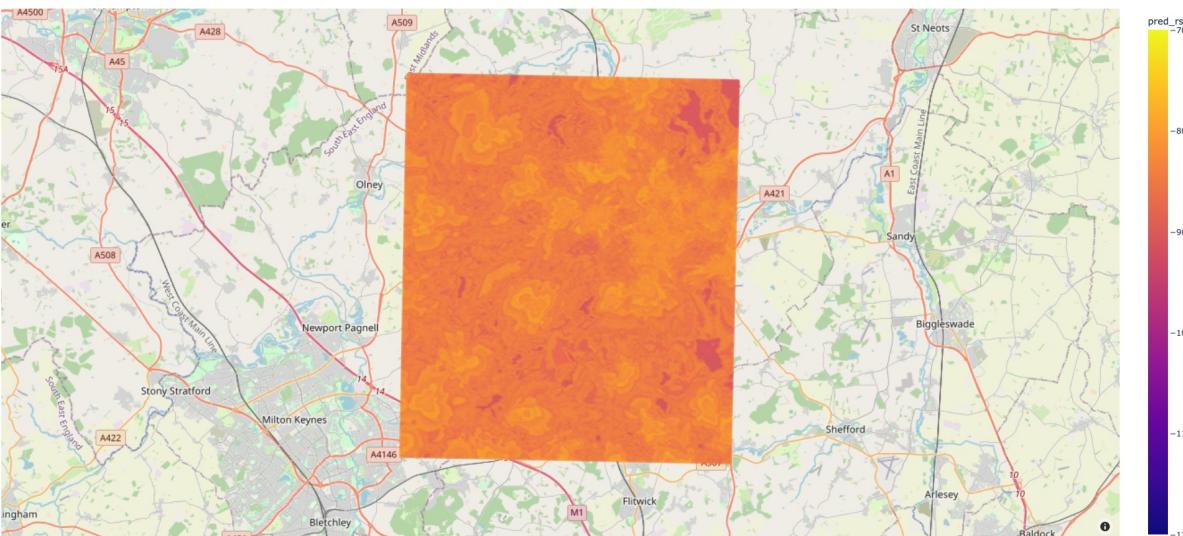
rsrq_error

RSRP Predictions Everywhere

RSRP ground truth at ground level

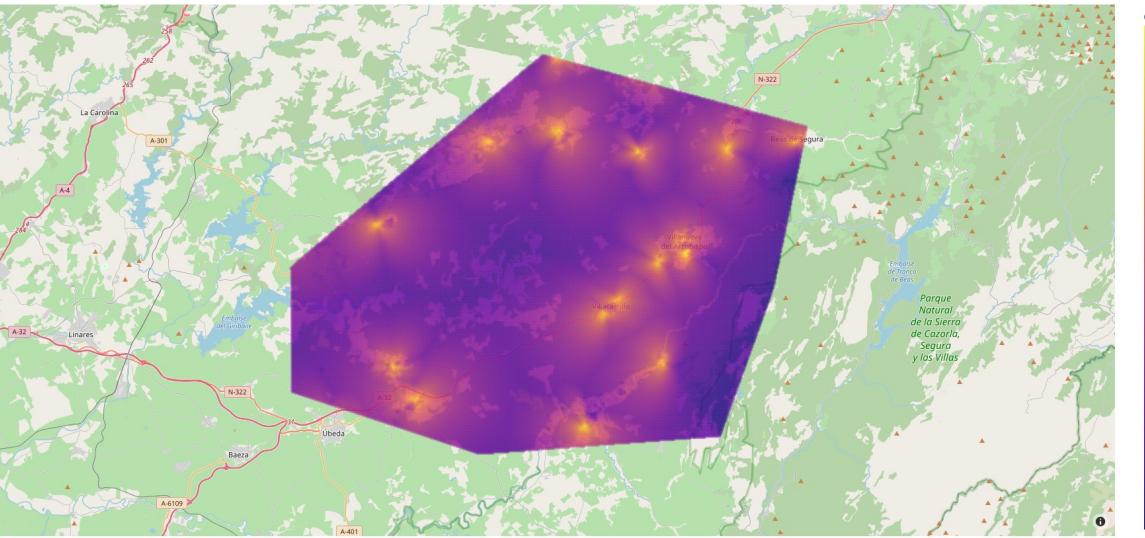


RSRP predicted at 250m altitude



RSRP Predictions Everywhere

ATLAS - RSRP ground truth at ground level



ATLAS - RSRP predicted at 250m altitude

