



Scaling data access in Visual Weather

Ján Valky

Innovation Department

Jozef Matula

CTO

16th Workshop on Meteorological Operational Systems

ECMWF Reading, United Kingdom, 1st–3rd March 2017

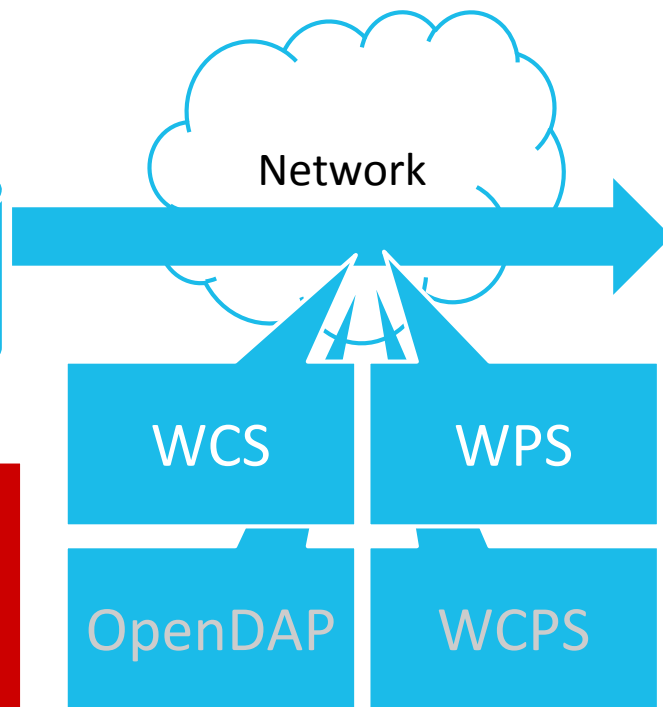


Introduction - Traditional data handling

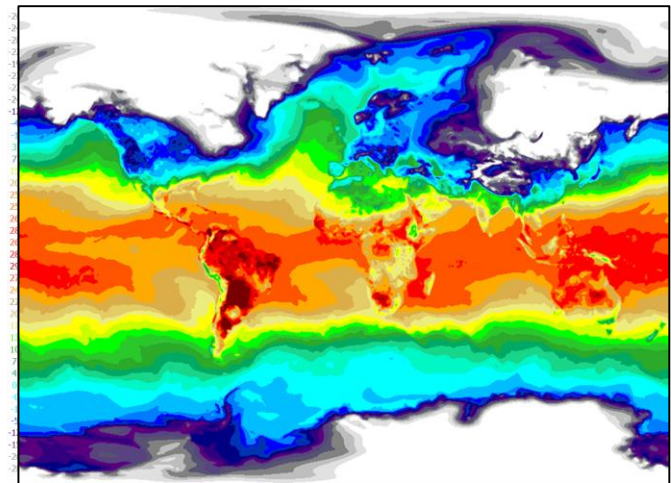
Supercomputer



Processing is close to data source



End user





Why people love the Cloud?

Scalable processing
power (hardware)

Better connectivity to
Internet

Introduction - "Cloud" data handling

Supercomputer



How to transfer data in reasonable time?

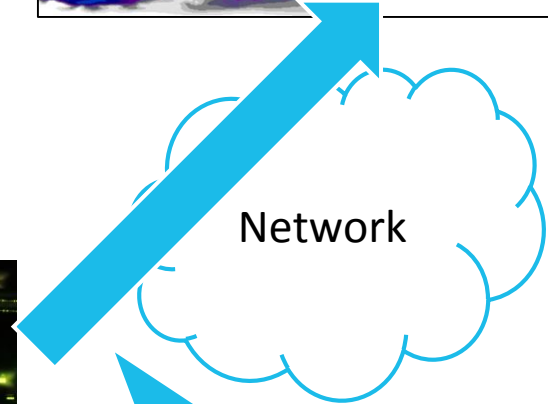
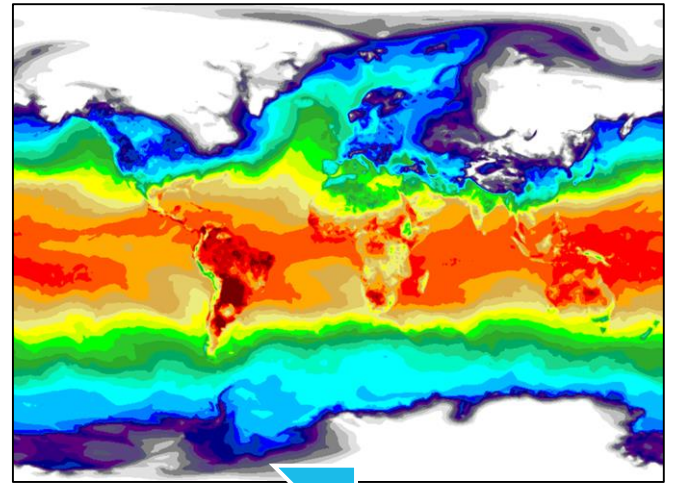


How to transfer something what can be reused?

Datacenter



End user



WCS/WPS



Real world physics

Typically
constant

$$t = \frac{d}{v}$$

Costs
money

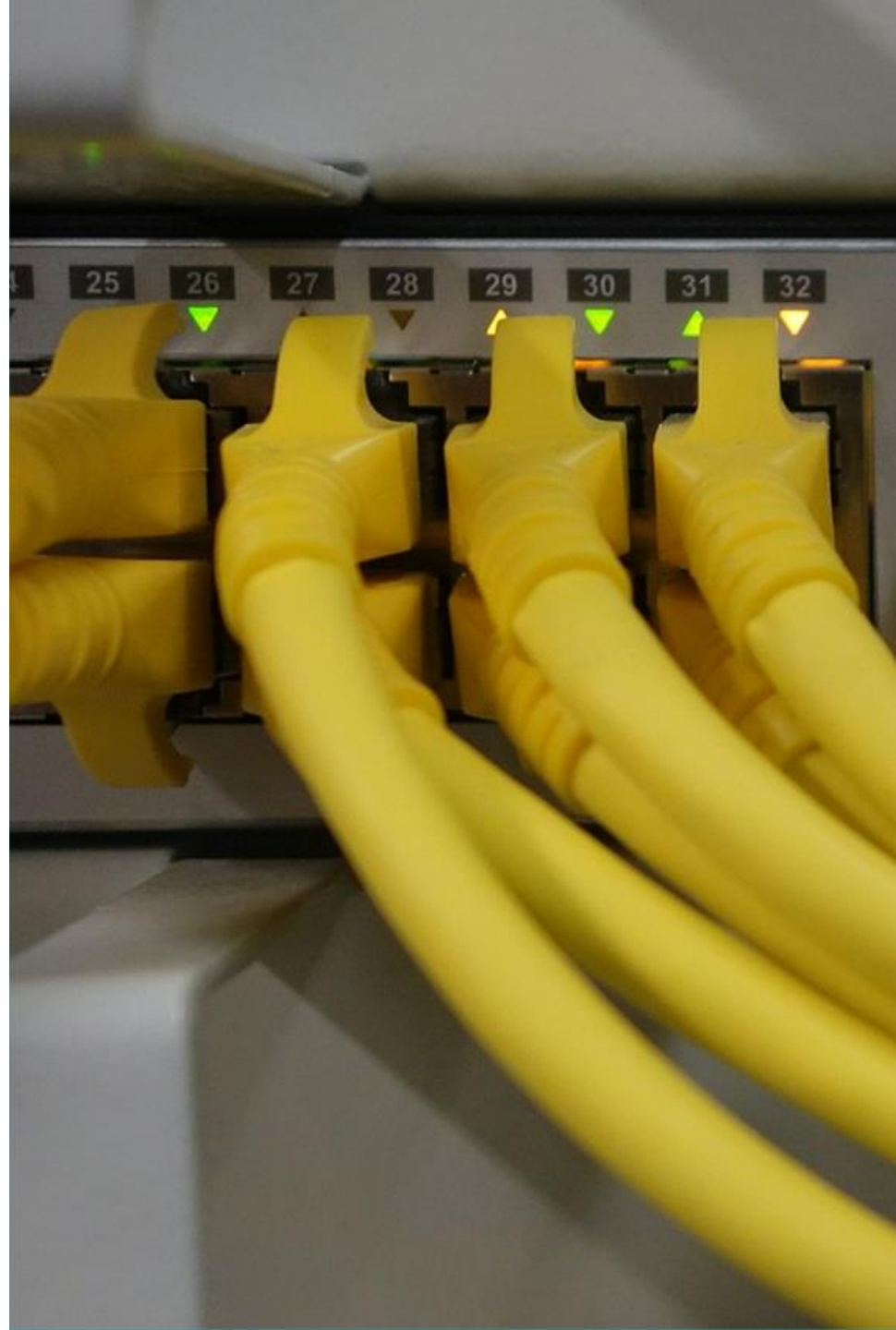
Digital data transfer “physics”

???

$$t \sim \frac{\textit{size}}{\textit{bandwidth}}$$

Costs
money

Limited
resource

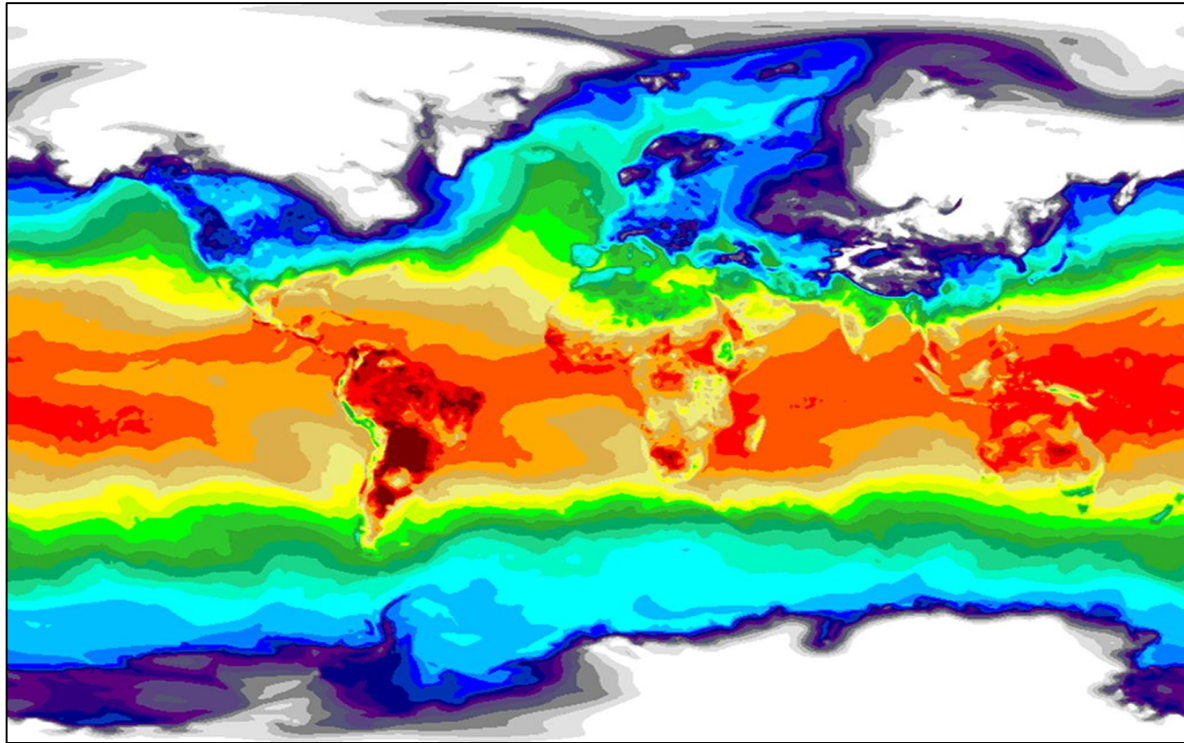




Visual 
Weather

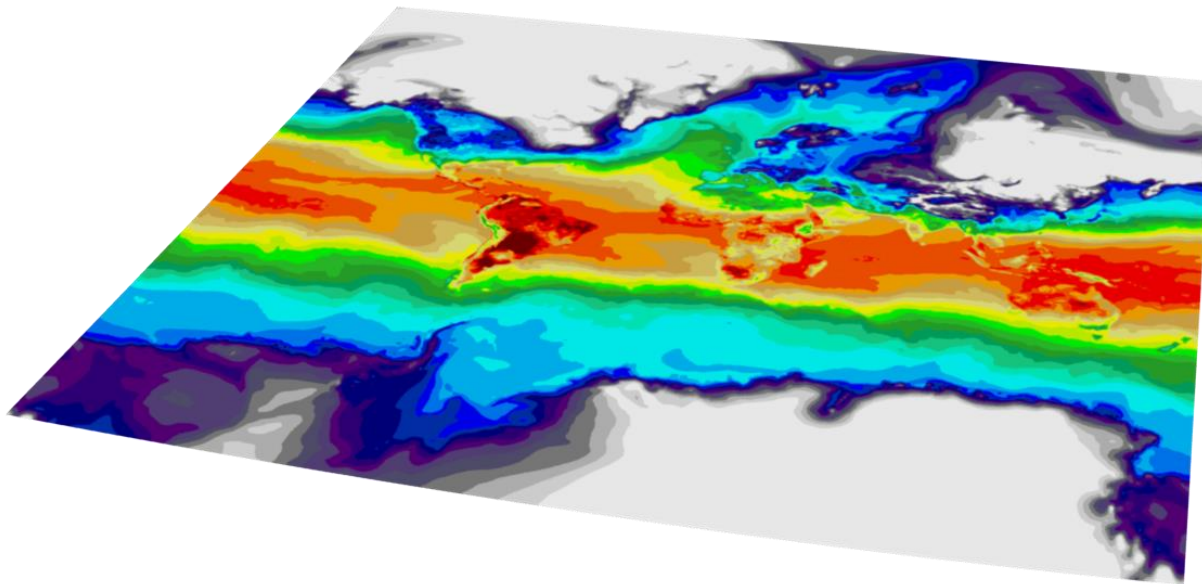
Making Data Smaller

With increasing NWP resolutions...

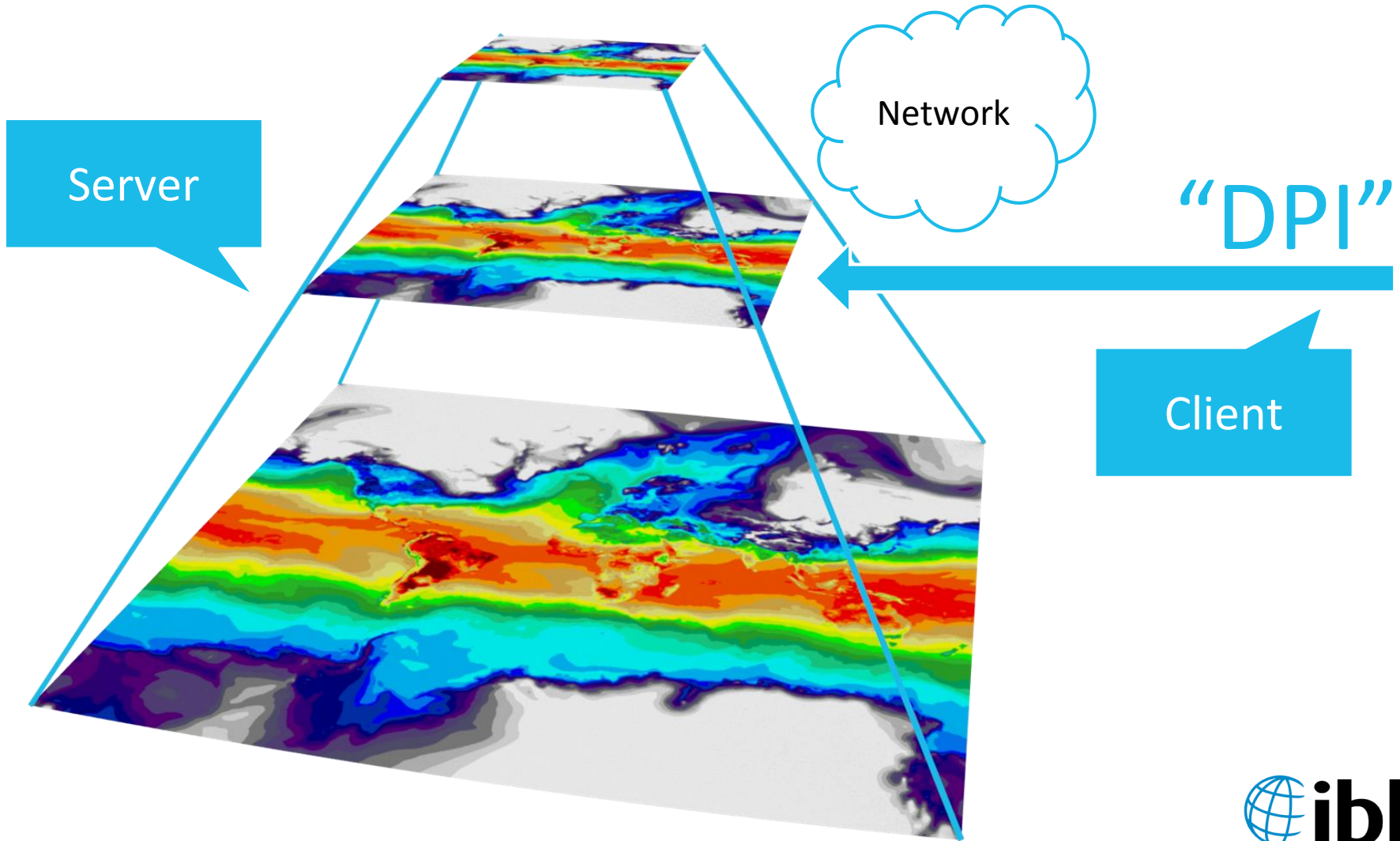


We have more grid points than pixels on screen (NWP, satellite imagery)

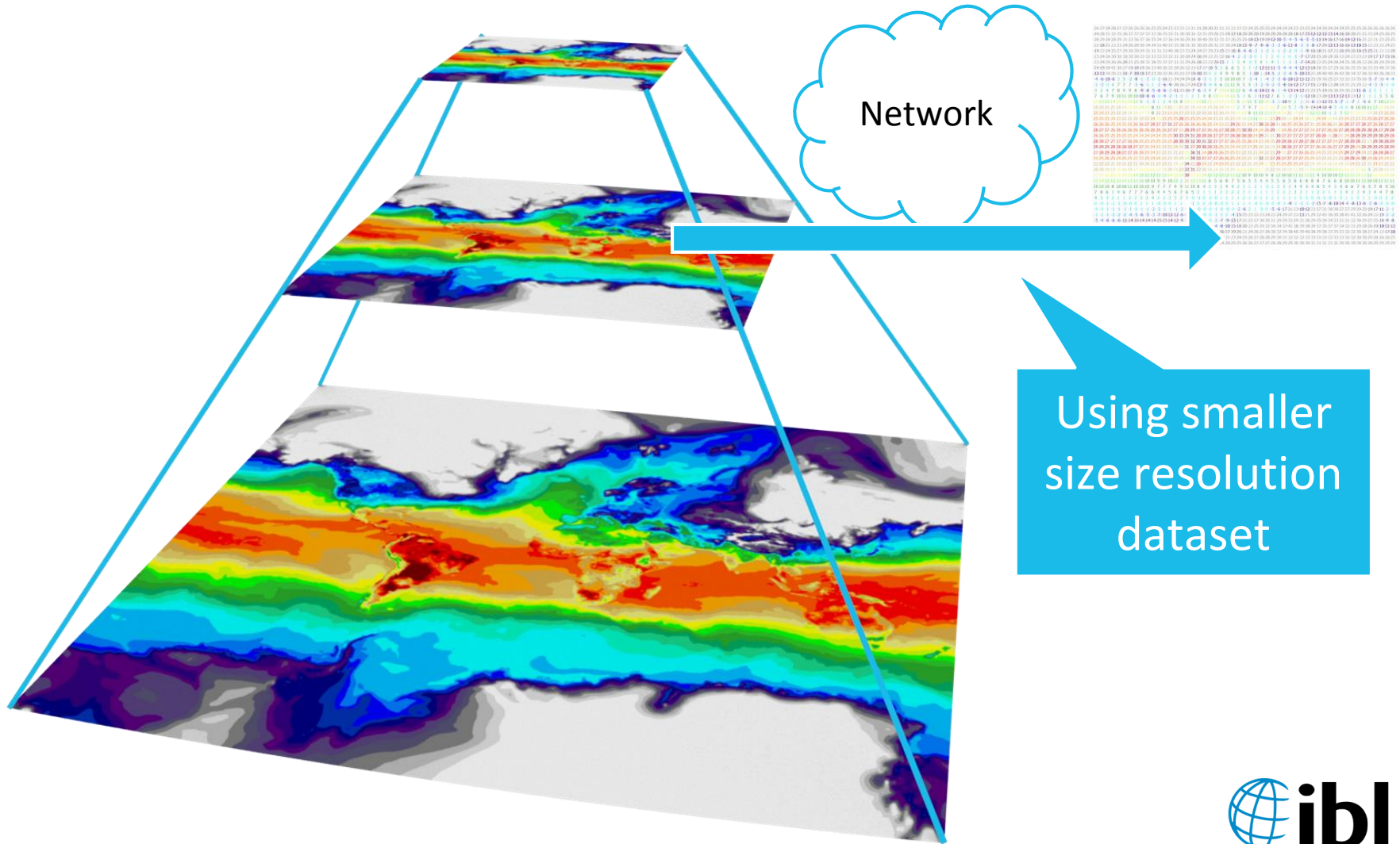
Access degraded resolution



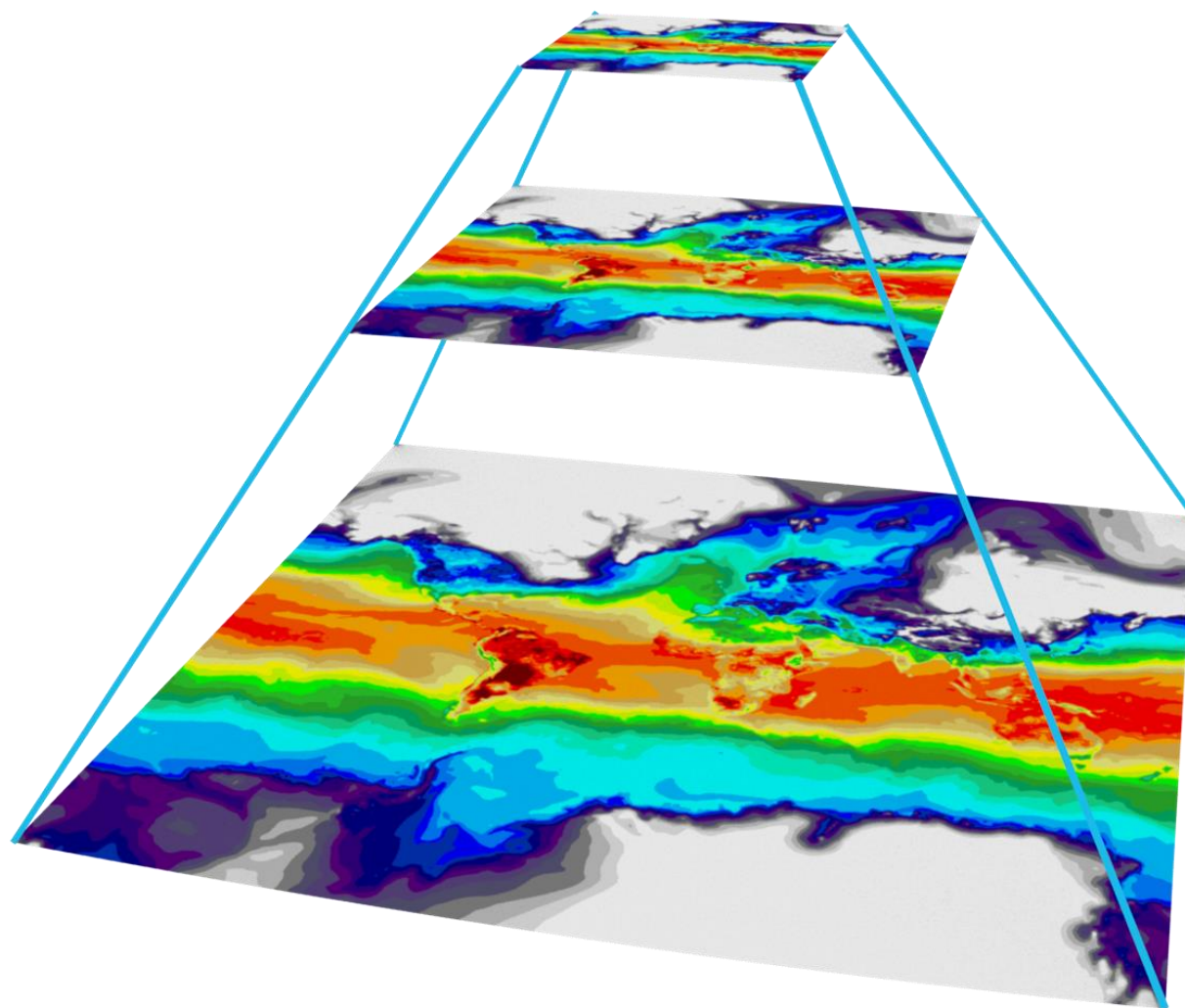
Access degraded resolution



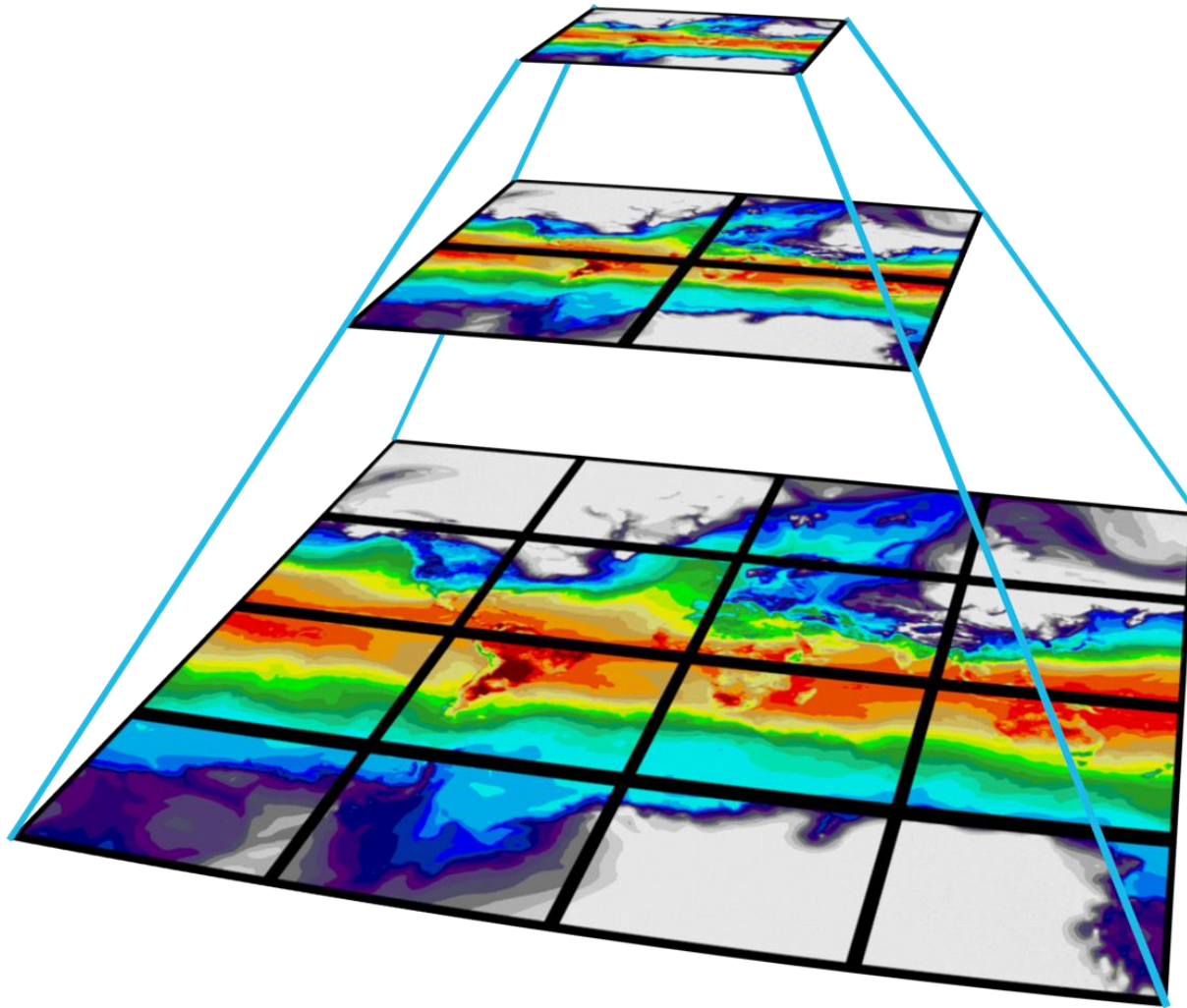
Access degraded resolution



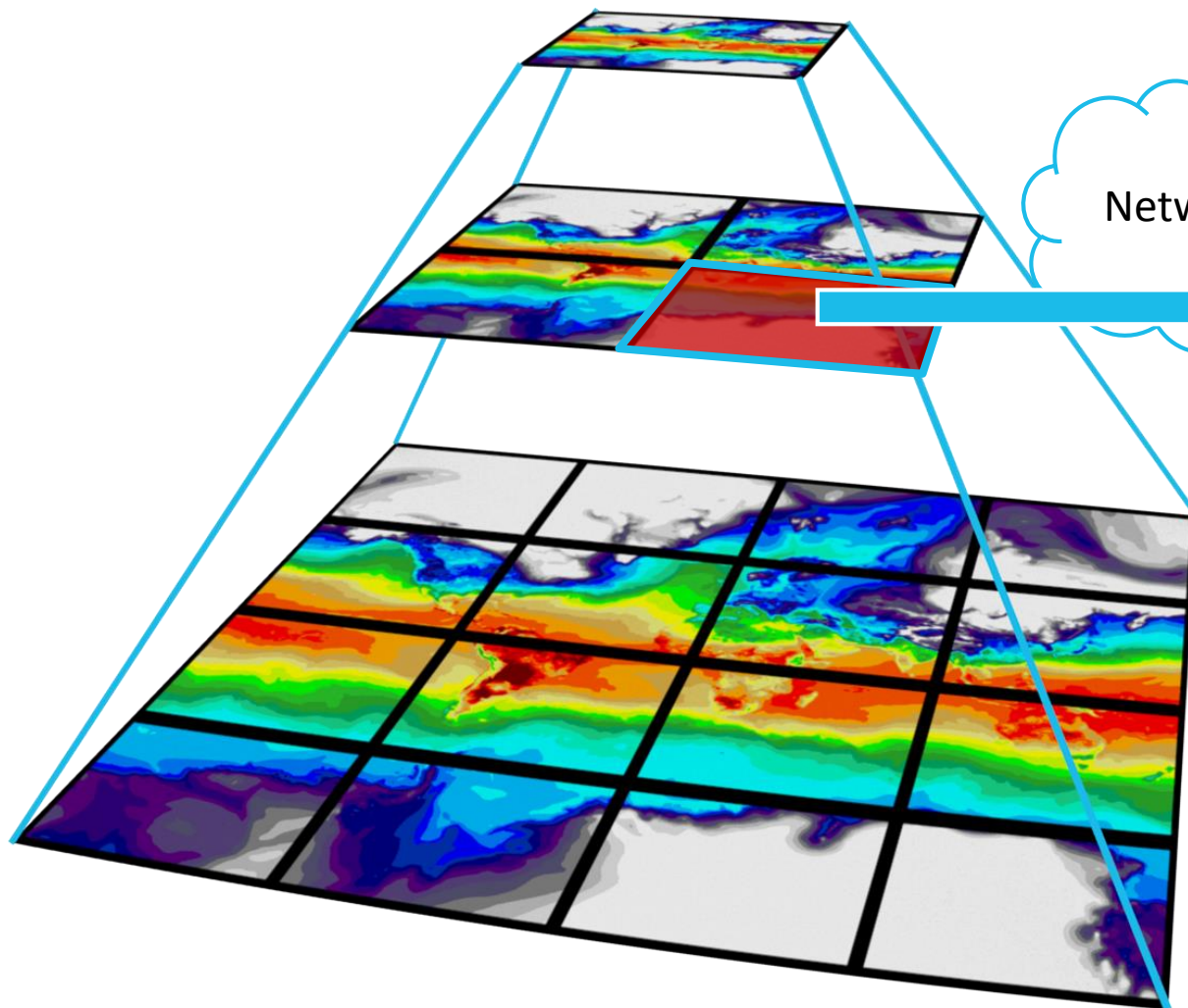
Next step - Tiling



Next step - Tiling



Tiling - Small area, middle resolution



```

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
26 24 23 24 20 29 28 27 28 27 28 27 27 27 27 27 28 27 28 29 28 23 19 29 30 28 29
23 25 20 20 19 24 28 28 27 27 27 27 26 26 26 27 27 29 29 24 29 29 29 28 29
22 21 24 22 23 29 10 27 27 26 26 25 24 23 23 24 25 29 27 29 24 22 28 28 28 27
21 19 32 27 28 27 27 27 25 24 23 22 21 21 23 28 28 26 30 24 26 25 24 23
21 20 24 11 7 25 25 25 24 22 19 19 18 18 18 18 18 24 22 22 21 24 23 22 23
14 13 15 18 11 10 17 17 14 14 14 14 14 14 14 14 14 14 14 14 15 14 14 15 14 14 15 14
10 11 11 13 11 9 10 10 10 12 13 13 14 15 11 10 15 14
6 6 8 8 8 7 6 6 8 10 10 11 12 10 10 11 11 11
3 4 4 5 4 6 5 4 3 4 6 6 7 6 5 7 8 9 10
1 1 1 1 1 2 2 3 2 1 1 2 2 1 1 3 4 3 3 4 3 4 4 7 8
1 0 1 1 1 1 1 1 0 0 0 0 0 0 0 1 0 1 1 1 0 0 2 2
1 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 1 0 0 0 0 2
2 1 0 0 5 6 17 21 23 10 12 22 27 31 30 30 27 27 29 25 19 17 11 2 1
-23 22 23 24 22 24 29 27 22 13 21 29 32 42 36 39 38 41 11 32 26 24 22 19 2 2
-23 27 30 31 29 29 33 29 31 28 29 35 39 34 33 1 32 30 29 27 25 18 9 8
-22 29 32 34 34 37 41 38 39 38 39 37 35 37 1 31 29 28 26 19 10 11 13
-24 26 27 28 30 32 34 38 40 39 40 38 39 7 32 30 28 27 24 23 17 10
-26 27 28 28 29 30 31 32 32 33 33 3 32 32 30 29 28 26 26 25
-26 27 27 27 28 28 29 29 30 30 1 30 30 30 30 29 29 29 29
    
```

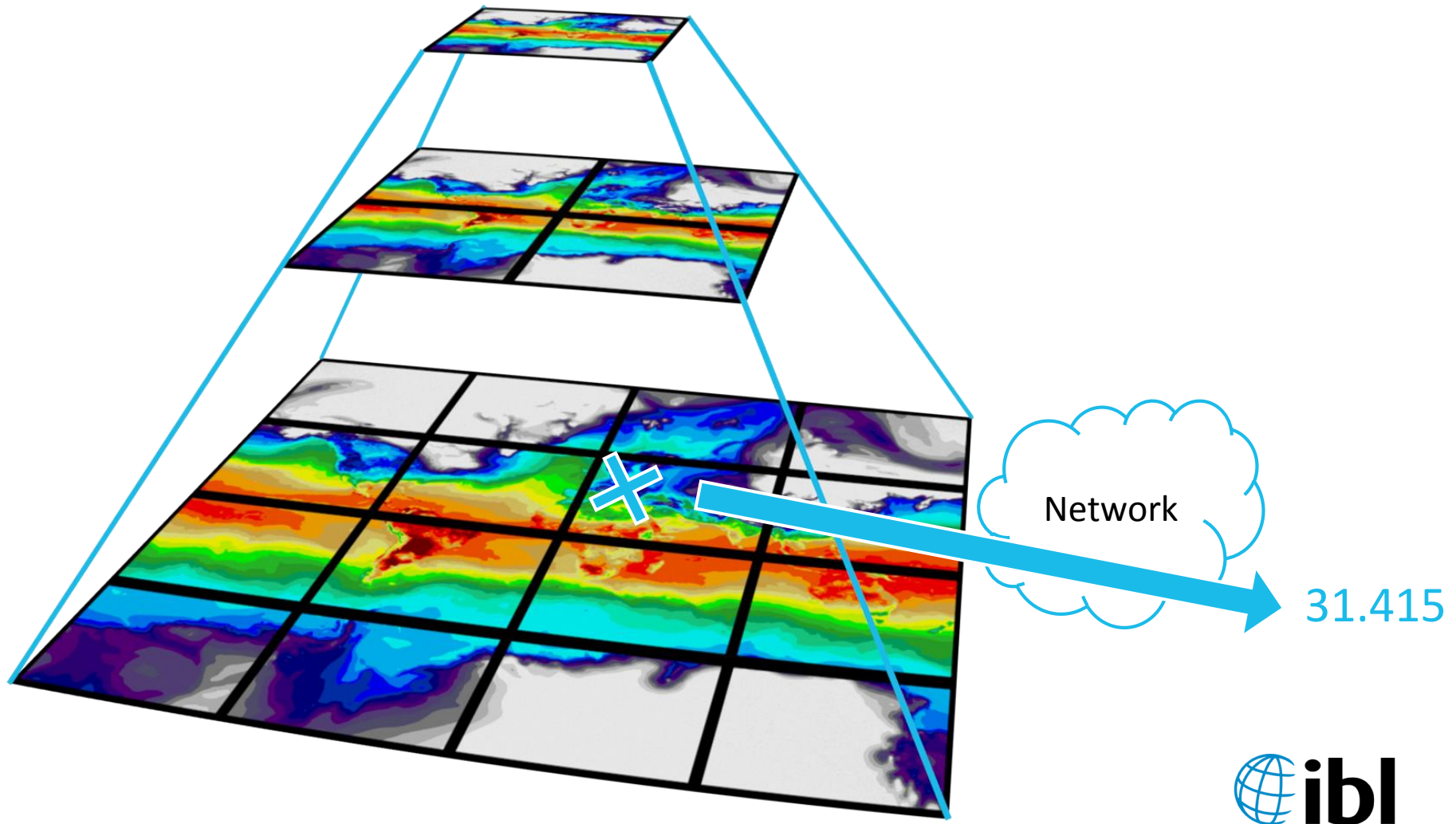
Data tile can be cached by the client



Visual 
Weather

Different Data Access Intents

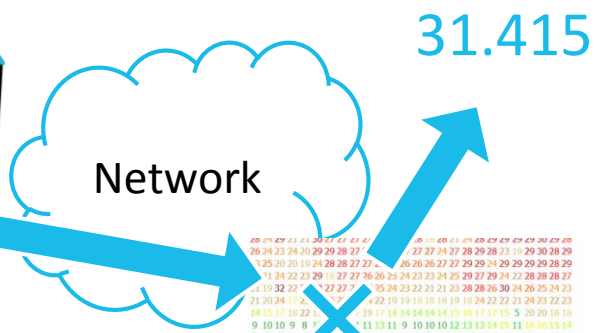
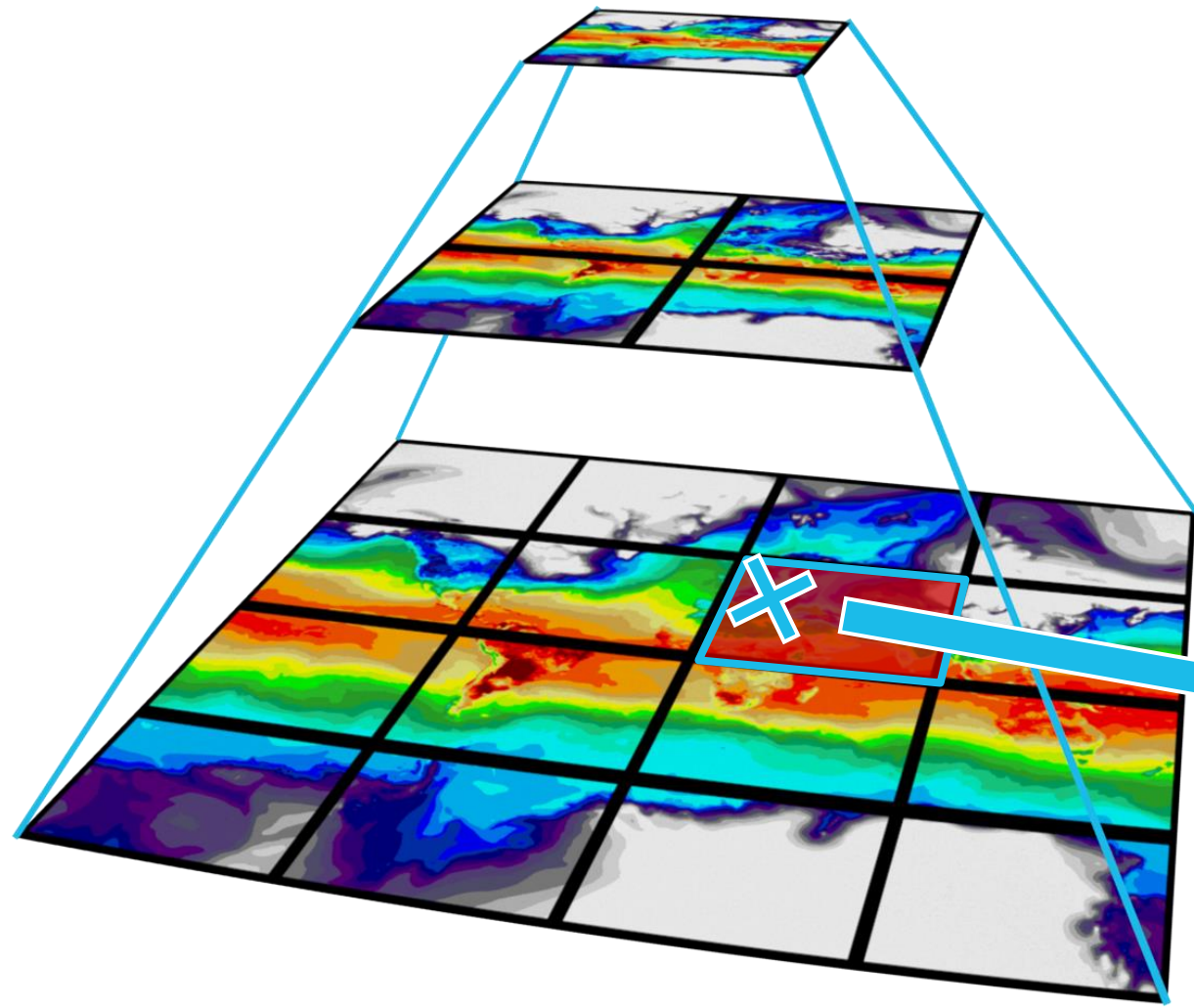
Single point query (server side interpolation) Visual Weather



$$t \sim \frac{\textit{size}}{\textit{bandwidth}}$$

Physical distance becomes important variable in the equation.

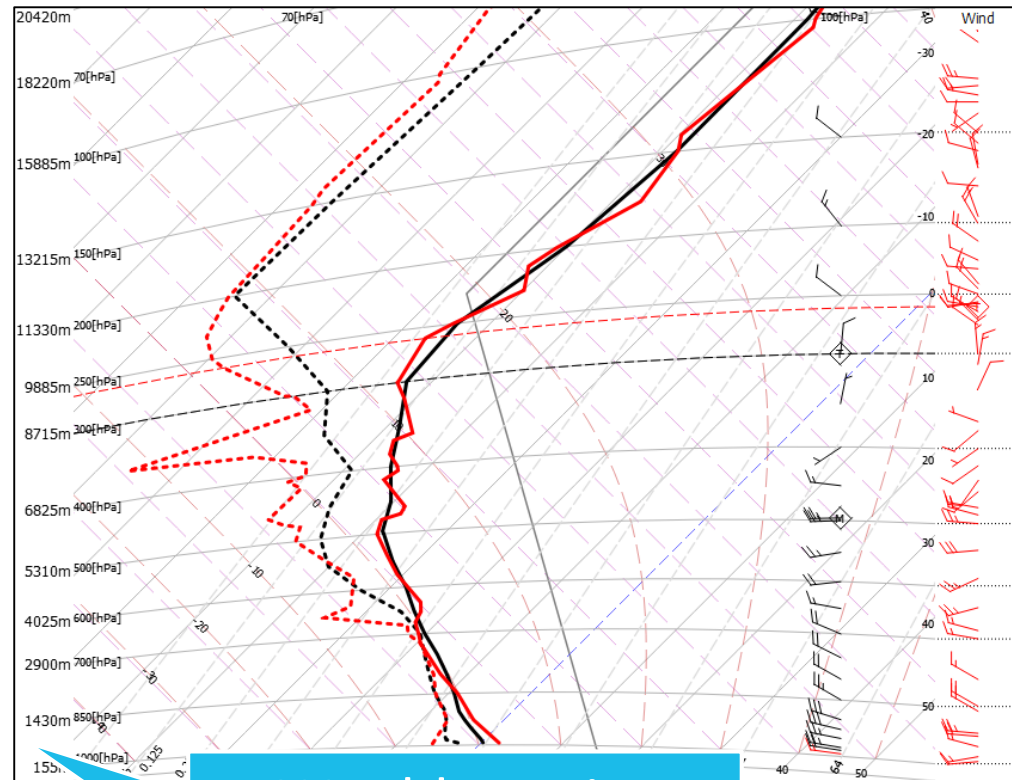
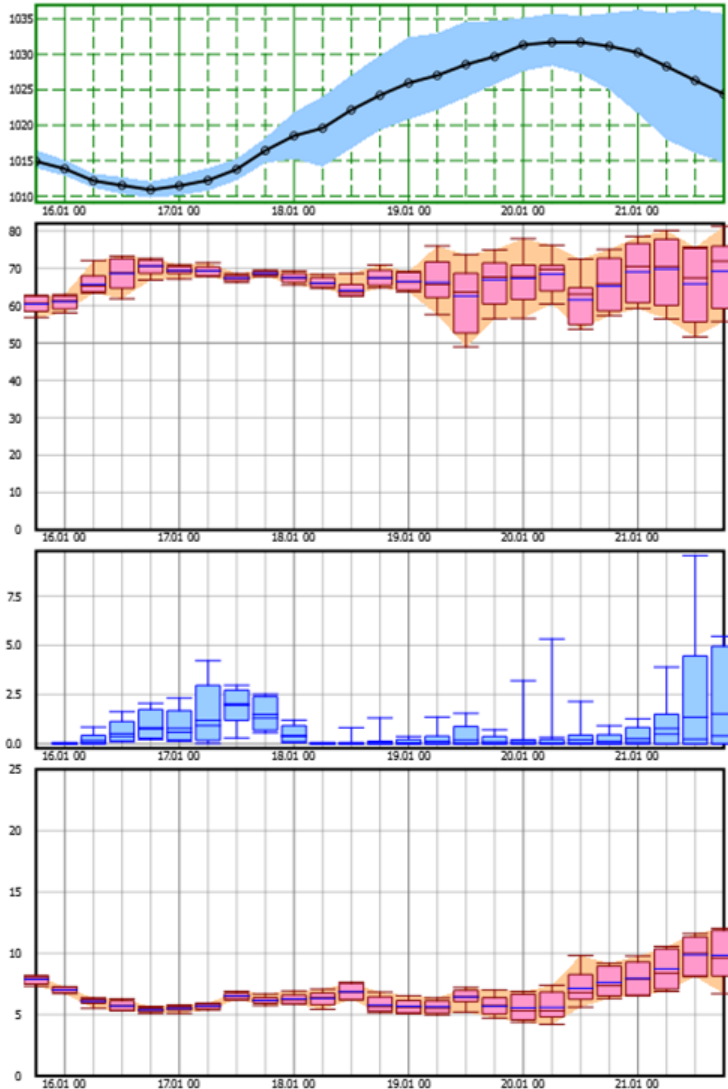
Single point query (client side interpolation)



48	47	49	41	41	30	27	24	21	18	15	12	9	6	3	0	-3	-6	-9	-12	-15	-18	-21	-24	-27	-30	-33	-36	-39	-42	-45	-48	-51	-54	-57	-60	-63	-66	-69	-72	-75	-78	-81	-84	-87	-90	-93	-96	-99	-102	-105	-108	-111	-114	-117	-120	-123	-126	-129	-132	-135	-138	-141	-144	-147	-150	-153	-156	-159	-162	-165	-168	-171	-174	-177	-180	-183	-186	-189	-192	-195	-198	-201	-204	-207	-210	-213	-216	-219	-222	-225	-228	-231	-234	-237	-240	-243	-246	-249	-252	-255	-258	-261	-264	-267	-270	-273	-276	-279	-282	-285	-288	-291	-294	-297	-300	-303	-306	-309	-312	-315	-318	-321	-324	-327	-330	-333	-336	-339	-342	-345	-348	-351	-354	-357	-360	-363	-366	-369	-372	-375	-378	-381	-384	-387	-390	-393	-396	-399	-402	-405	-408	-411	-414	-417	-420	-423	-426	-429	-432	-435	-438	-441	-444	-447	-450	-453	-456	-459	-462	-465	-468	-471	-474	-477	-480	-483	-486	-489	-492	-495	-498	-501	-504	-507	-510	-513	-516	-519	-522	-525	-528	-531	-534	-537	-540	-543	-546	-549	-552	-555	-558	-561	-564	-567	-570	-573	-576	-579	-582	-585	-588	-591	-594	-597	-600	-603	-606	-609	-612	-615	-618	-621	-624	-627	-630	-633	-636	-639	-642	-645	-648	-651	-654	-657	-660	-663	-666	-669	-672	-675	-678	-681	-684	-687	-690	-693	-696	-699	-702	-705	-708	-711	-714	-717	-720	-723	-726	-729	-732	-735	-738	-741	-744	-747	-750	-753	-756	-759	-762	-765	-768	-771	-774	-777	-780	-783	-786	-789	-792	-795	-798	-801	-804	-807	-810	-813	-816	-819	-822	-825	-828	-831	-834	-837	-840	-843	-846	-849	-852	-855	-858	-861	-864	-867	-870	-873	-876	-879	-882	-885	-888	-891	-894	-897	-900	-903	-906	-909	-912	-915	-918	-921	-924	-927	-930	-933	-936	-939	-942	-945	-948	-951	-954	-957	-960	-963	-966	-969	-972	-975	-978	-981	-984	-987	-990	-993	-996	-999	-1002	-1005	-1008	-1011	-1014	-1017	-1020	-1023	-1026	-1029	-1032	-1035	-1038	-1041	-1044	-1047	-1050	-1053	-1056	-1059	-1062	-1065	-1068	-1071	-1074	-1077	-1080	-1083	-1086	-1089	-1092	-1095	-1098	-1101	-1104	-1107	-1110	-1113	-1116	-1119	-1122	-1125	-1128	-1131	-1134	-1137	-1140	-1143	-1146	-1149	-1152	-1155	-1158	-1161	-1164	-1167	-1170	-1173	-1176	-1179	-1182	-1185	-1188	-1191	-1194	-1197	-1200	-1203	-1206	-1209	-1212	-1215	-1218	-1221	-1224	-1227	-1230	-1233	-1236	-1239	-1242	-1245	-1248	-1251	-1254	-1257	-1260	-1263	-1266	-1269	-1272	-1275	-1278	-1281	-1284	-1287	-1290	-1293	-1296	-1299	-1302	-1305	-1308	-1311	-1314	-1317	-1320	-1323	-1326	-1329	-1332	-1335	-1338	-1341	-1344	-1347	-1350	-1353	-1356	-1359	-1362	-1365	-1368	-1371	-1374	-1377	-1380	-1383	-1386	-1389	-1392	-1395	-1398	-1401	-1404	-1407	-1410	-1413	-1416	-1419	-1422	-1425	-1428	-1431	-1434	-1437	-1440	-1443	-1446	-1449	-1452	-1455	-1458	-1461	-1464	-1467	-1470	-1473	-1476	-1479	-1482	-1485	-1488	-1491	-1494	-1497	-1500	-1503	-1506	-1509	-1512	-1515	-1518	-1521	-1524	-1527	-1530	-1533	-1536	-1539	-1542	-1545	-1548	-1551	-1554	-1557	-1560	-1563	-1566	-1569	-1572	-1575	-1578	-1581	-1584	-1587	-1590	-1593	-1596	-1599	-1602	-1605	-1608	-1611	-1614	-1617	-1620	-1623	-1626	-1629	-1632	-1635	-1638	-1641	-1644	-1647	-1650	-1653	-1656	-1659	-1662	-1665	-1668	-1671	-1674	-1677	-1680	-1683	-1686	-1689	-1692	-1695	-1698	-1701	-1704	-1707	-1710	-1713	-1716	-1719	-1722	-1725	-1728	-1731	-1734	-1737	-1740	-1743	-1746	-1749	-1752	-1755	-1758	-1761	-1764	-1767	-1770	-1773	-1776	-1779	-1782	-1785	-1788	-1791	-1794	-1797	-1800	-1803	-1806	-1809	-1812	-1815	-1818	-1821	-1824	-1827	-1830	-1833	-1836	-1839	-1842	-1845	-1848	-1851	-1854	-1857	-1860	-1863	-1866	-1869	-1872	-1875	-1878	-1881	-1884	-1887	-1890	-1893	-1896	-1899	-1902	-1905	-1908	-1911	-1914	-1917	-1920	-1923	-1926	-1929	-1932	-1935	-1938	-1941	-1944	-1947	-1950	-1953	-1956	-1959	-1962	-1965	-1968	-1971	-1974	-1977	-1980	-1983	-1986	-1989	-1992	-1995	-1998	-2001	-2004	-2007	-2010	-2013	-2016	-2019	-2022	-2025	-2028	-2031	-2034	-2037	-2040	-2043	-2046	-2049	-2052	-2055	-2058	-2061	-2064	-2067	-2070	-2073	-2076	-2079	-2082	-2085	-2088	-2091	-2094	-2097	-2100	-2103	-2106	-2109	-2112	-2115	-2118	-2121	-2124	-2127	-2130	-2133	-2136	-2139	-2142	-2145	-2148	-2151	-2154	-2157	-2160	-2163	-2166	-2169	-2172	-2175	-2178	-2181	-2184	-2187	-2190	-2193	-2196	-2199	-2202	-2205	-2208	-2211	-2214	-2217	-2220	-2223	-2226	-2229	-2232	-2235	-2238	-2241	-2244	-2247	-2250	-2253	-2256	-2259	-2262	-2265	-2268	-2271	-2274	-2277	-2280	-2283	-2286	-2289	-2292	-2295	-2298	-2301	-2304	-2307	-2310	-2313	-2316	-2319	-2322	-2325	-2328	-2331	-2334	-2337	-2340	-2343	-2346	-2349	-2352	-2355	-2358	-2361	-2364	-2367	-2370	-2373	-2376	-2379	-2382	-2385	-2388	-2391	-2394	-2397	-2400	-2403	-2406	-2409	-2412	-2415	-2418	-2421	-2424	-2427	-2430	-2433	-2436	-2439	-2442	-2445	-2448	-2451	-2454	-2457	-2460	-2463	-2466	-2469	-2472	-2475	-2478	-2481	-2484	-2487	-2490	-2493	-2496	-2499	-2502	-2505	-2508	-2511	-2514	-2517	-2520	-2523	-2526	-2529	-2532	-2535	-2538	-2541	-2544	-2547	-2550	-2553	-2556	-2559	-2562	-2565	-2568	-2571	-2574	-2577	-2580	-2583	-2586	-2589	-2592	-2595	-2598	-2601	-2604	-2607	-2610	-2613	-2616	-2619	-2622	-2625	-2628	-2631	-2634	-2637	-2640	-2643	-2646	-2649	-2652	-2655	-2658	-2661	-2664	-2667	-2670	-2673	-2676	-2679	-2682	-2685	-2688	-2691	-2694	-2697	-2700	-2703	-2706	-2709	-2712	-2715	-2718	-2721	-2724	-2727	-2730	-2733	-2736	-2739	-2742	-2745	-2748	-2751	-2754	-2757	-2760	-2763	-2766	-2769	-2772	-2775	-2778	-2781	-2784	-2787	-2790	-2793	-2796	-2799	-2802	-2805	-2808	-2811	-2814	-2817	-2820	-2823	-2826	-2829	-2832	-2835	-2838	-2841	-2844	-2847	-2850	-2853	-2856	-2859	-2862	-2865	-2868	-2871	-2874	-2877	-2880	-2883	-2886	-2889	-2892	-2895	-2898	-2901	-2904	-2907	-2910	-2913	-2916	-2919	-2922	-2925	-2928	-2931	-2934	-2937	-2940	-2943	-2946	-2949	-2952	-2955	-2958	-2961	-2964	-2967	-2970	-2973	-2976	-2979	-2982	-2985	-2988	-2991	-2994	-2997	-3000
----	----	----	----	----	----	----	----	----	----	----	----	---	---	---	---	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

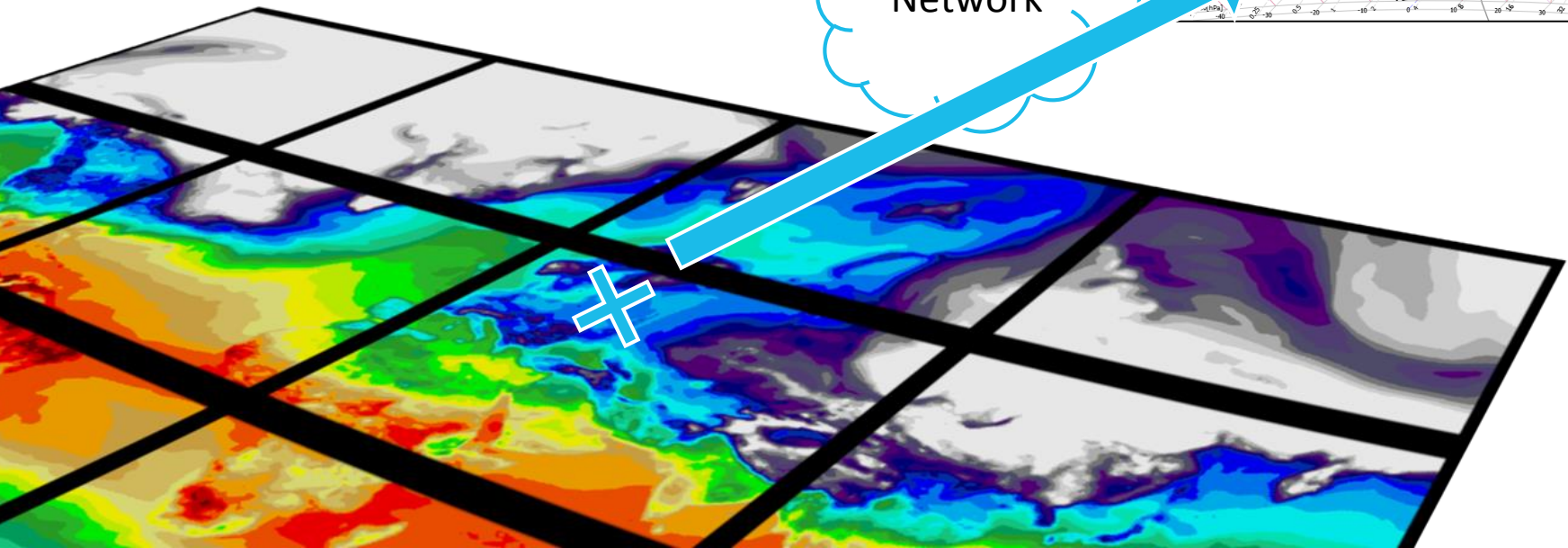
Time and vertical profiles

MSLP RH 2m, T 2m and PPN Ensemble Forecast for 44°02'N 14°36'E

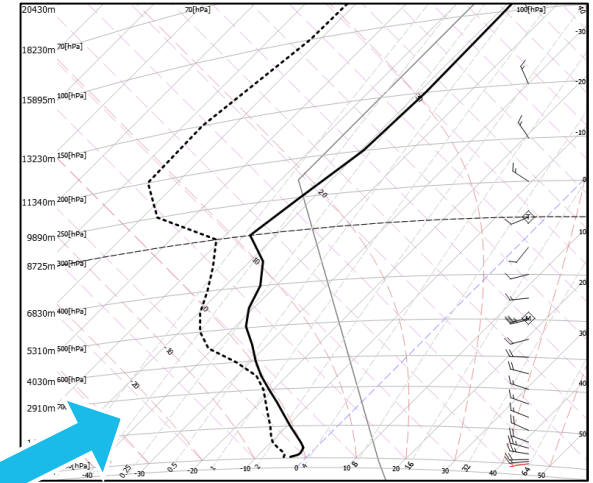


Would require transferring 100s-1000s of tiles

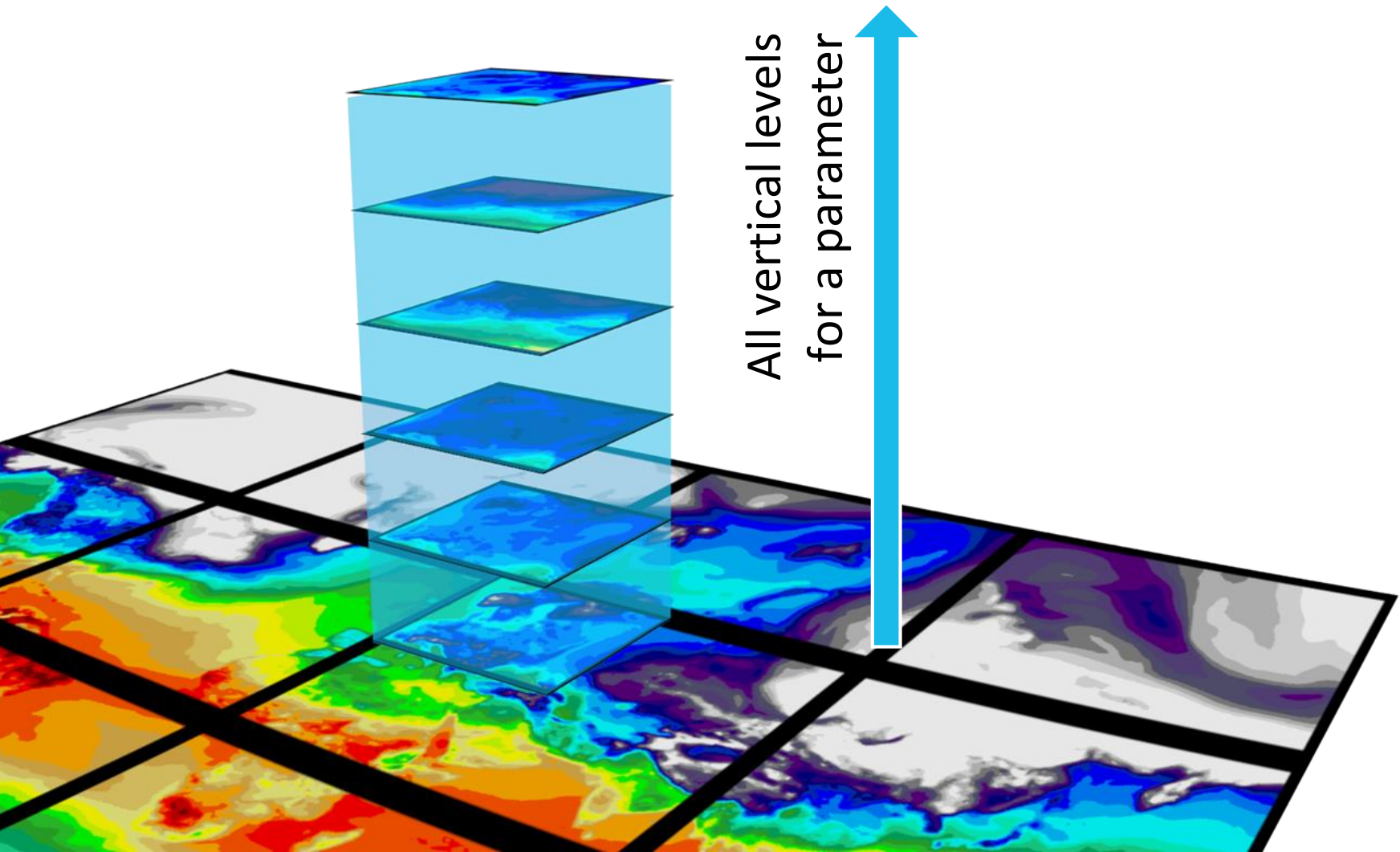
Point vertical query (client side interpolation) Visual Weather



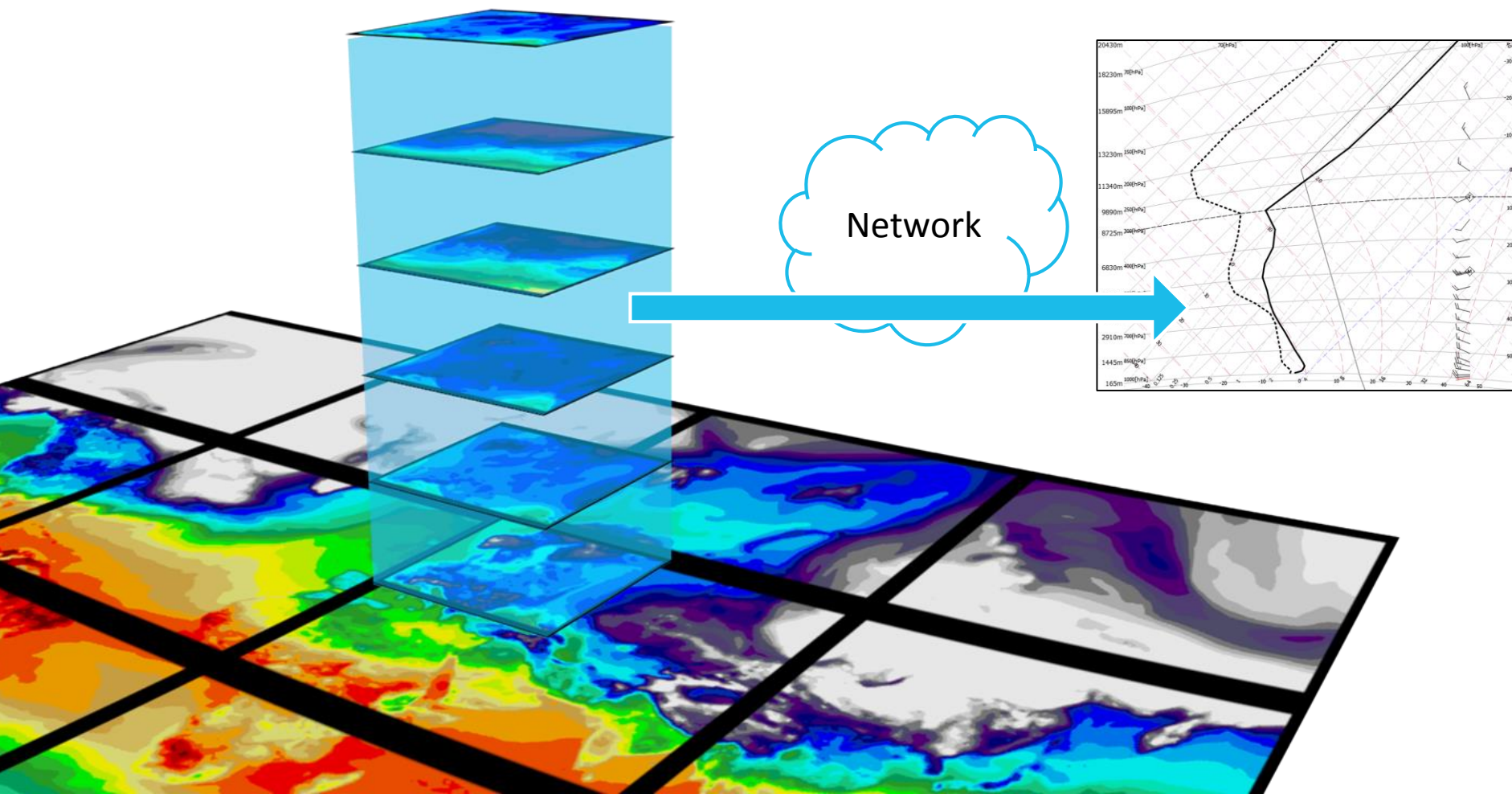
Network



Point vertical query (client side interpolation) Visual Weather

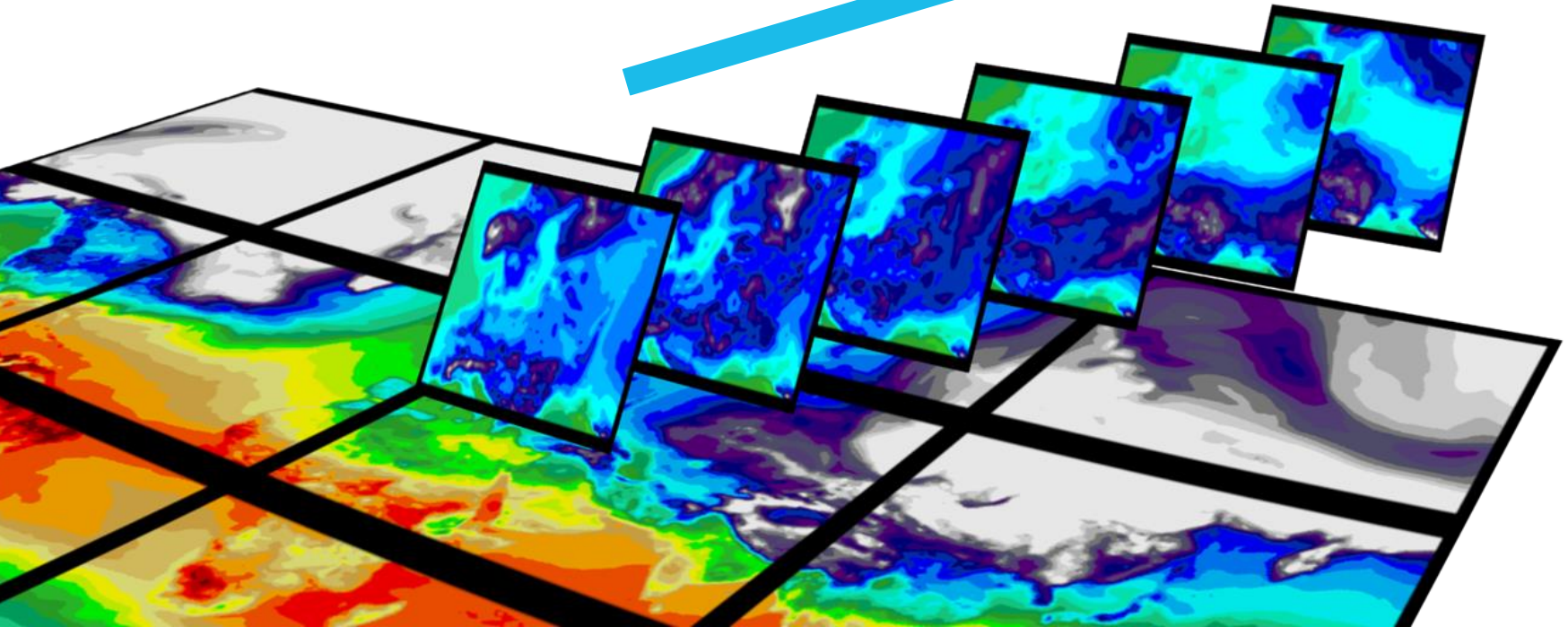


Point vertical query (client side interpolation)

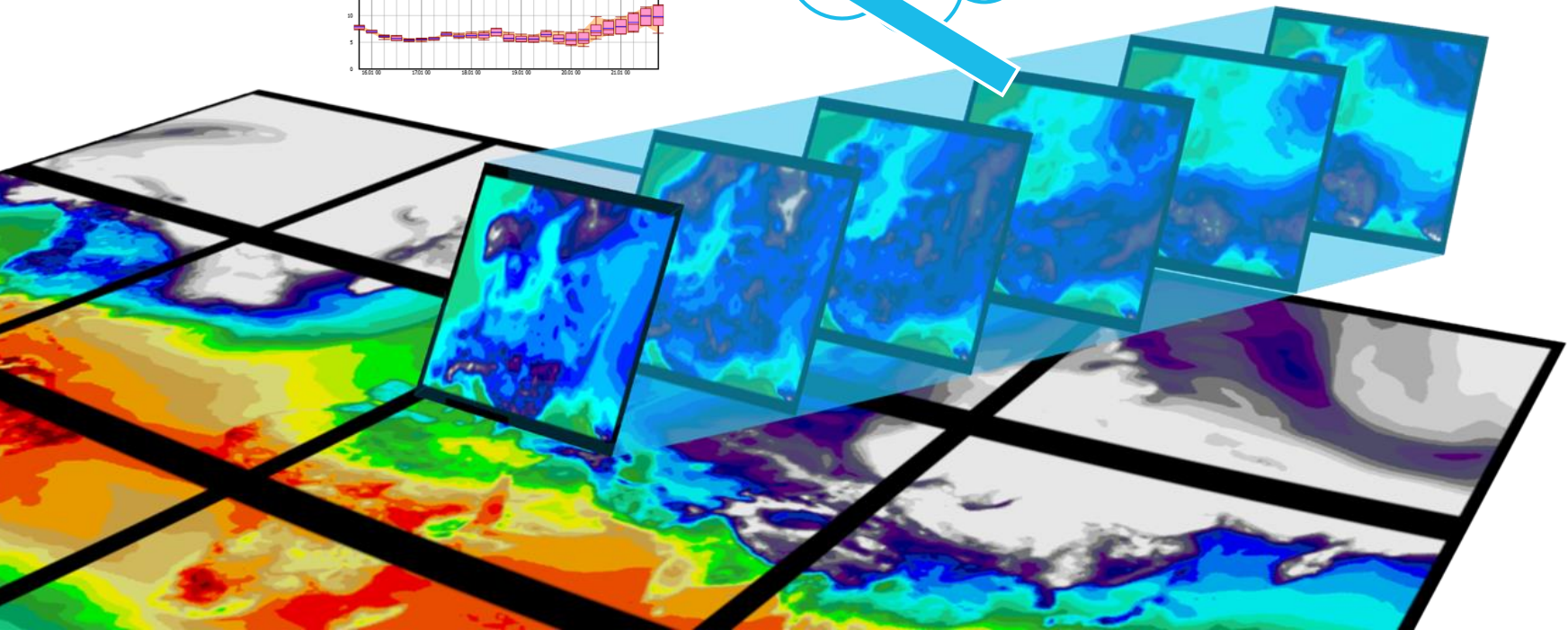
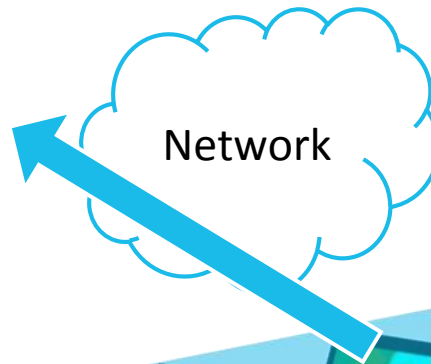
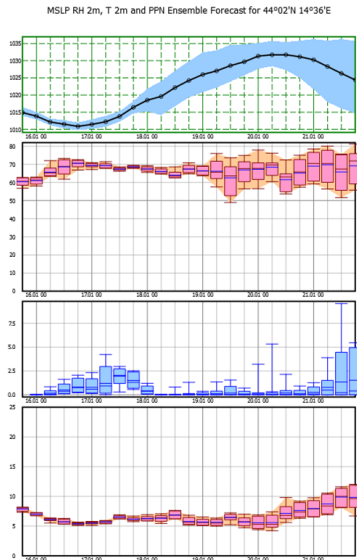


Time series query (client side interpolation)

All forecast steps
for a parameter



Time series query (client side interpolation)



- Understand what client does and what he may do next.
- Make data subsets cache-able.
- Expressed more technically:
 - Split source dataset into “tiles” on server side (considering resolution required by the user, make it transferrable, minimise request-response latencies)
 - Ensure data “tiles” or “tile sets” are cacheable and reusable for the client.
 - Minimise number of requests by building specialised “tile sets” for different access intents (geospatial maps vs. vertical profiles vs. time series etc.)

- Built-in into Visual Weather's WCS 2.x implementation, very "raw" extension.
- Correlation with OGC WC-**Tile-S** activities.
- Tiling has 2 important technical implications:
 - Data being processed is collocated in memory.
 - Allows better parallelisation in modern CPUs.



Questions?

Jozef.Matula@iblsoft.com • www.iblsoft.com

