

Surface State Flag from ERS data

Presentation to
SCIRoCCo project team
ESA

Presented by
Isabella Pfeil
TU Wien



scirocco
scatterometer instrument
competence centre

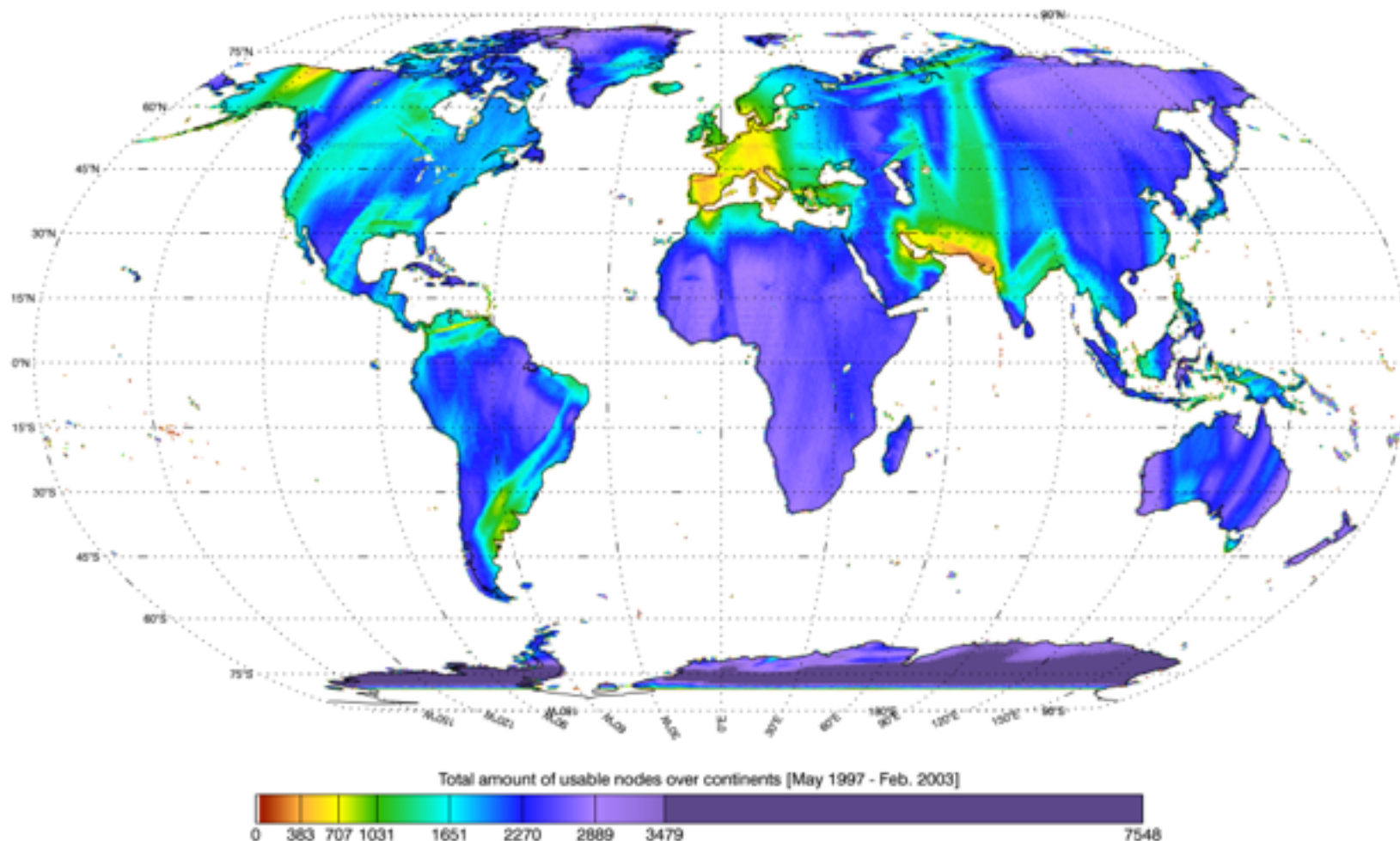
Initial situation

	ASCAT	ERS
F/T parameters	✓	-
Surface State Flag	✓	-

Objective

	ASCAT	ERS
F/T parameters	✓	✓
Surface State Flag	✓	✓

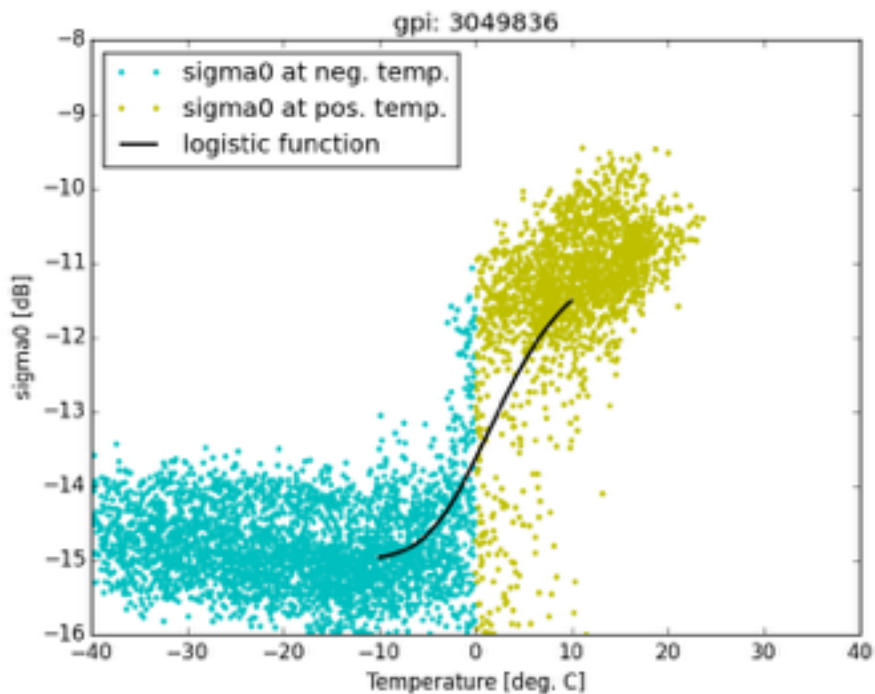
ERS data coverage



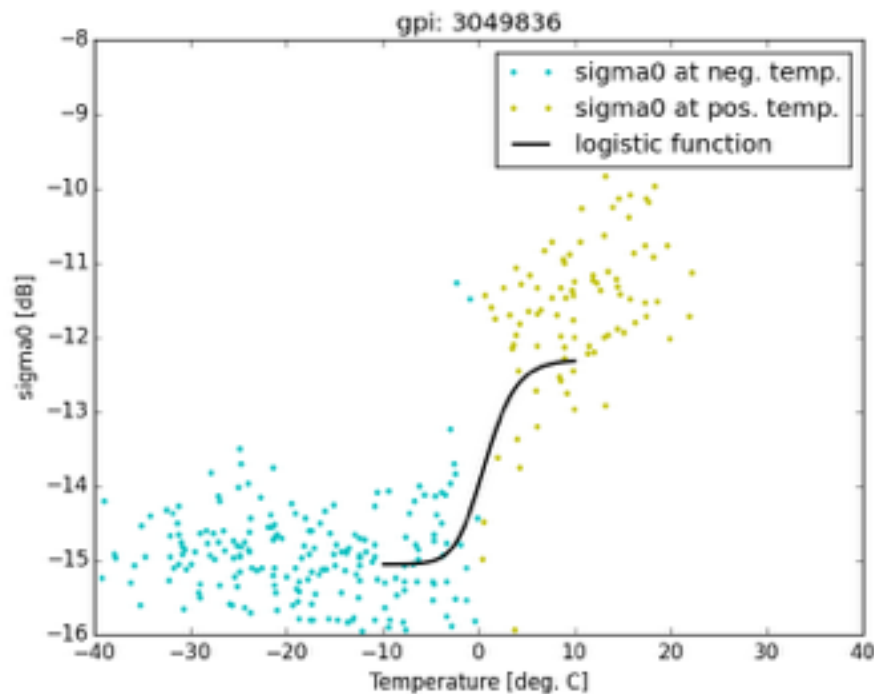
Temperature – Backscatter

Examples of the behavior of normalized backscatter with respect to temperature:
Alaska, Happy Valley (Wooded Tundra) / 69.16°N, 148.84°W

ASCAT



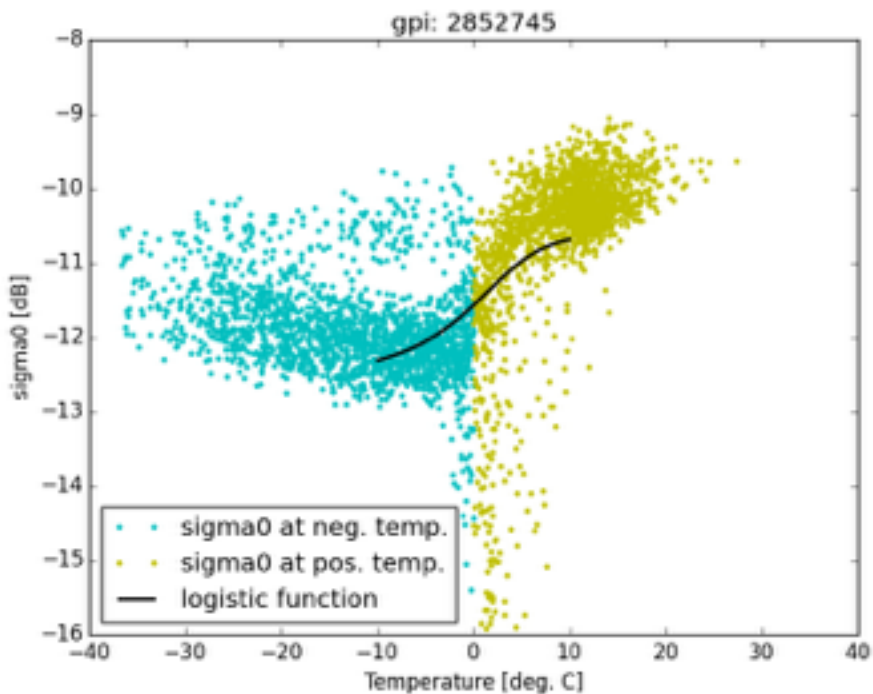
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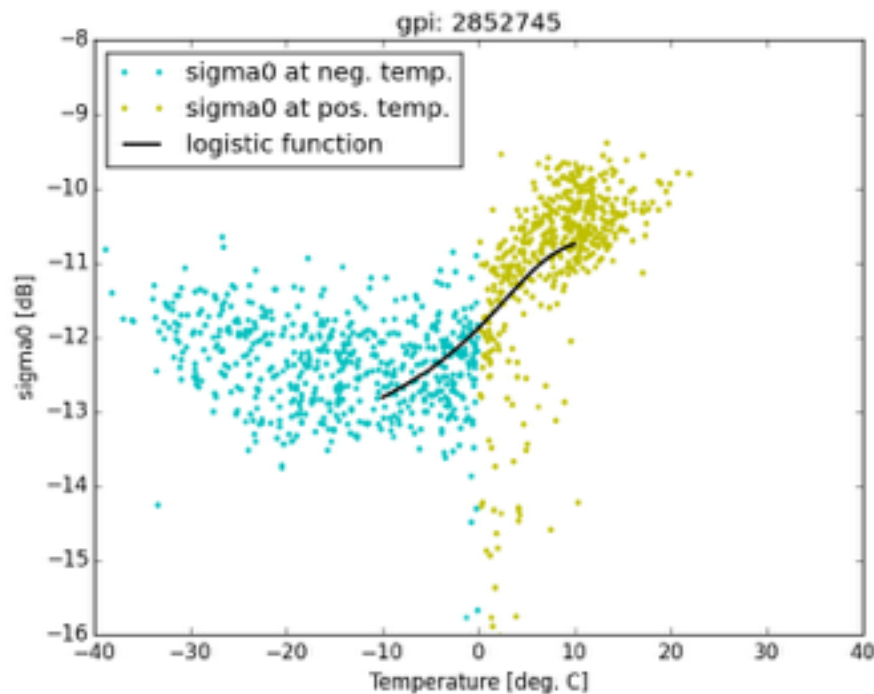
Temperature – Backscatter

Examples of the behavior of normalized backscatter with respect to temperature:
Russia, Apuka (Herbaceous Tundra) / 60.97°N, 168.27°E

ASCAT



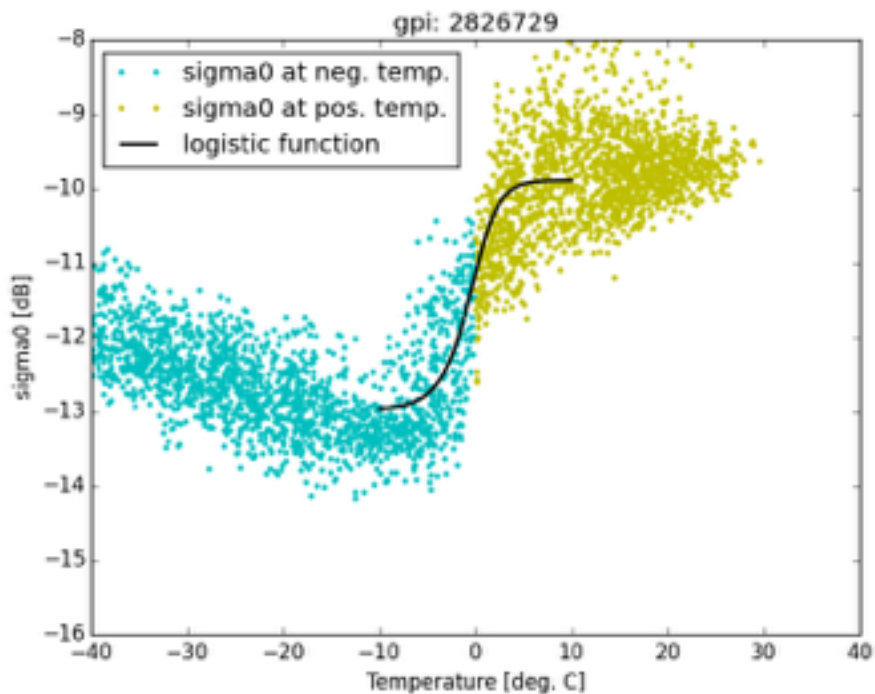
ERS



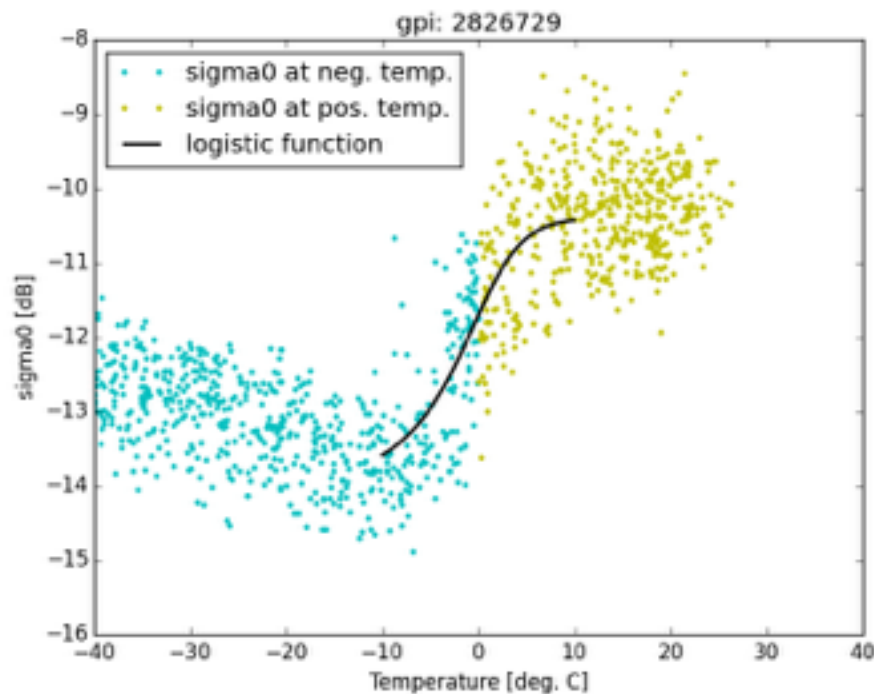
Temperature – Backscatter

Examples of the behavior of normalized backscatter with respect to temperature:
 Russia, Buyaga (Deciduous broadleaf forest) / 60.08°N, 126.19°E

ASCAT



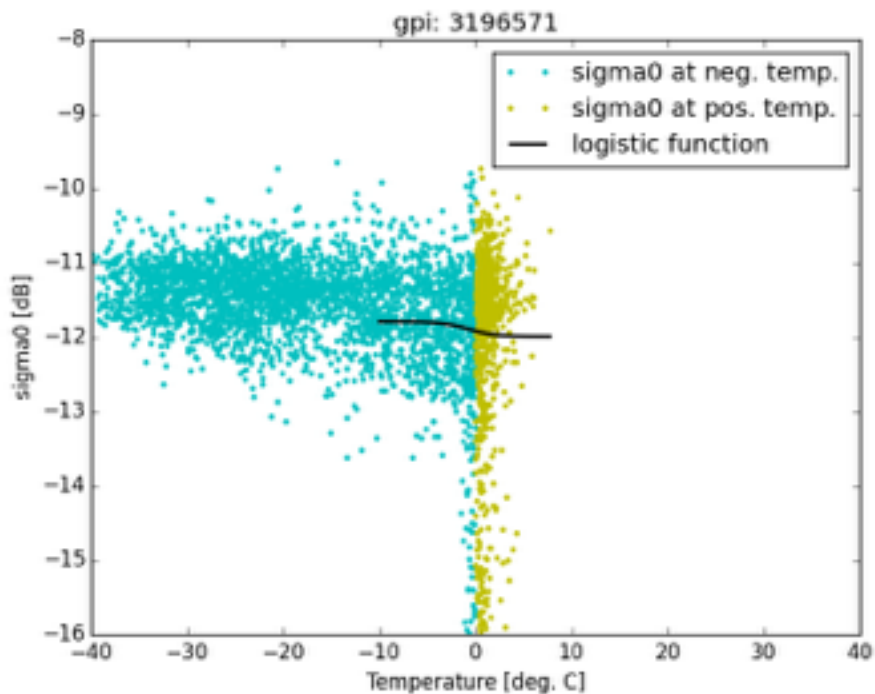
ERS



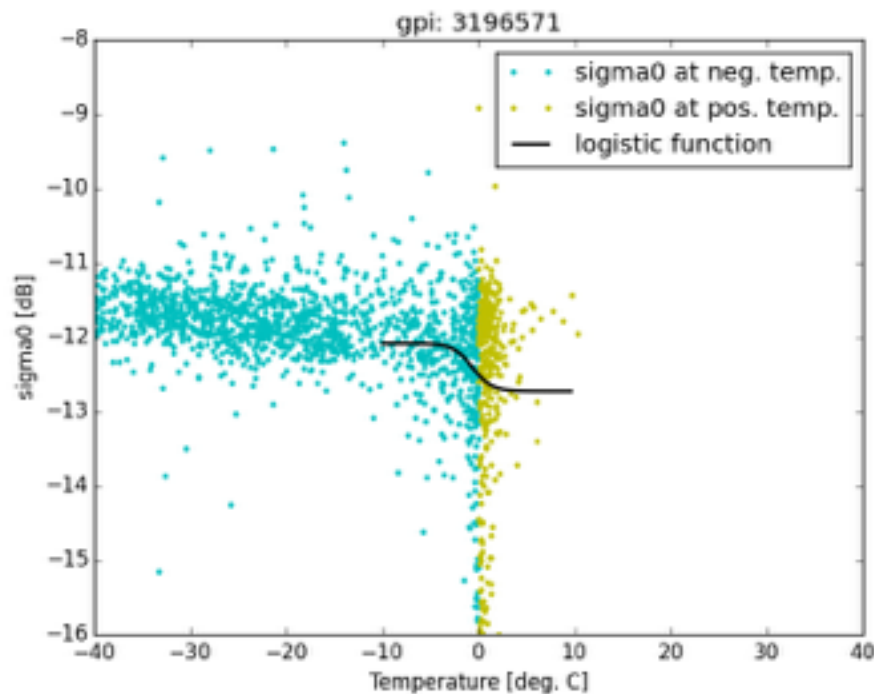
Temperature – Backscatter

Examples of the behavior of normalized backscatter with respect to temperature:
 Russia, Solnechnaya Bay (Ice) / 78.34°N, 104.69°E

ASCAT



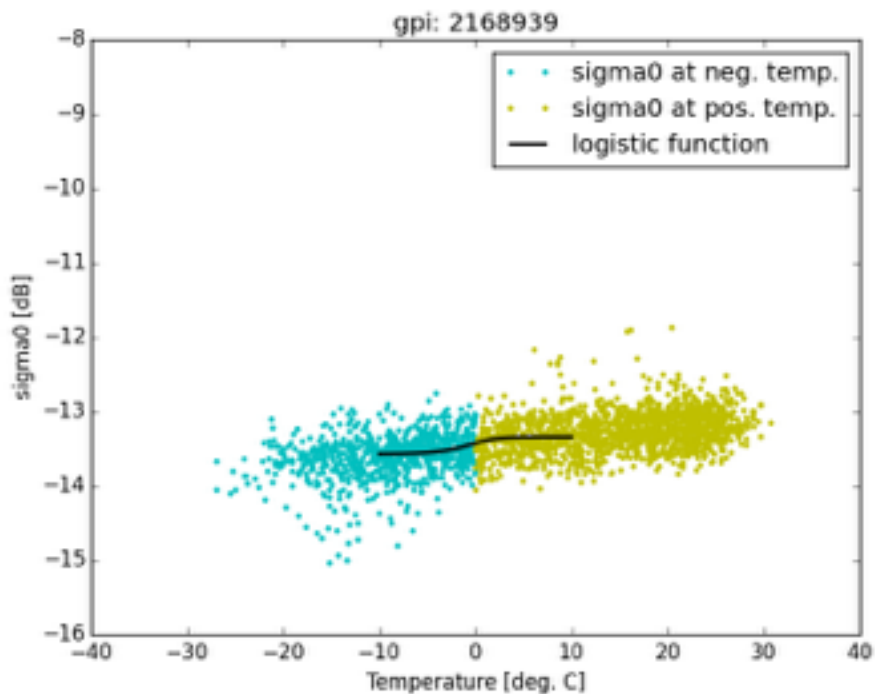
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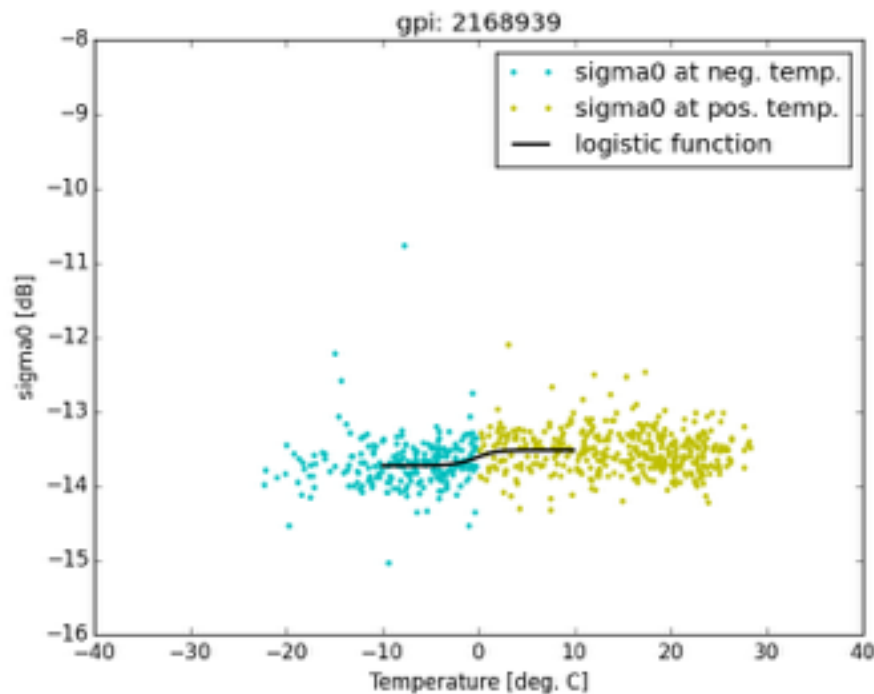
Temperature – Backscatter

Examples of the behavior of normalized backscatter with respect to temperature:
 China, Mazong Shan (sparsely vegetated area) / 41.76°N, 97.25°E

ASCAT



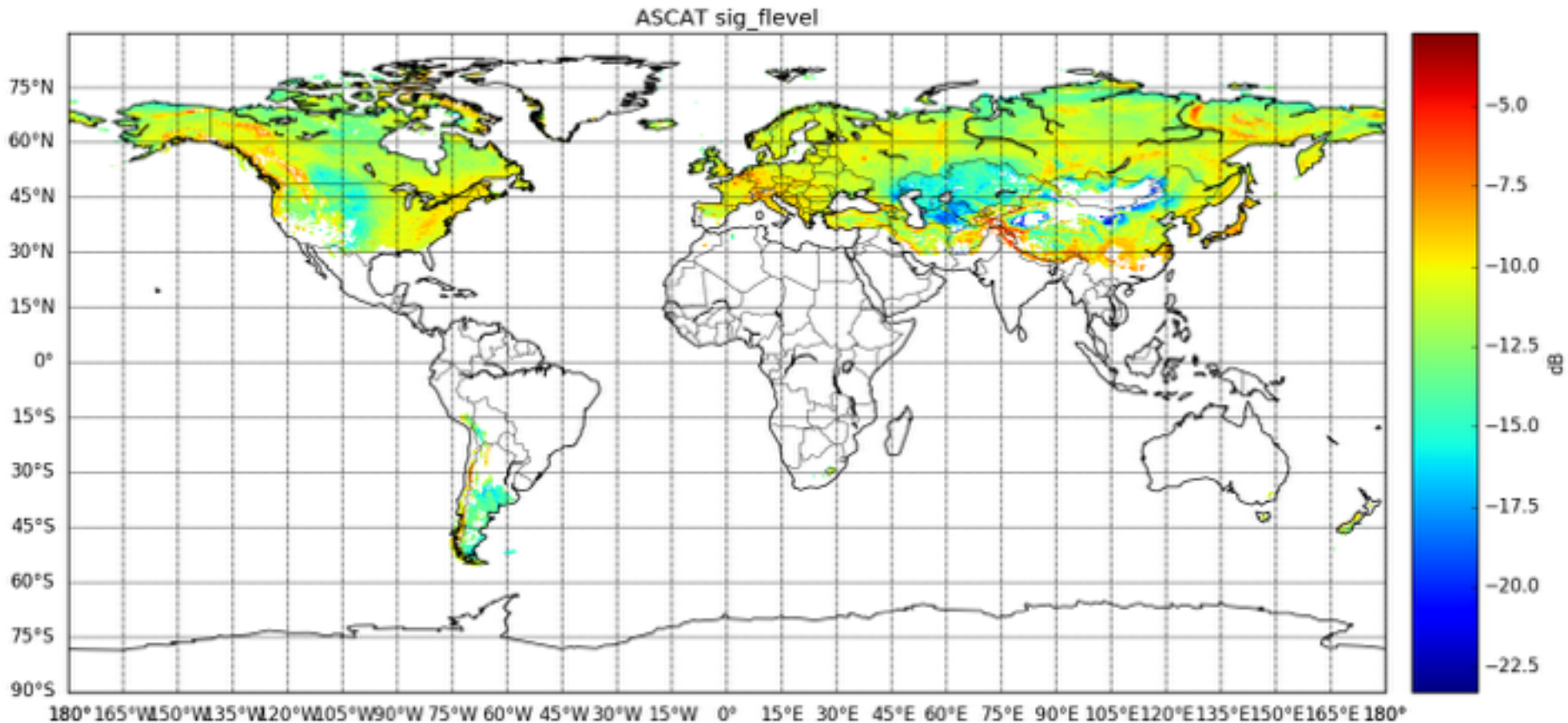
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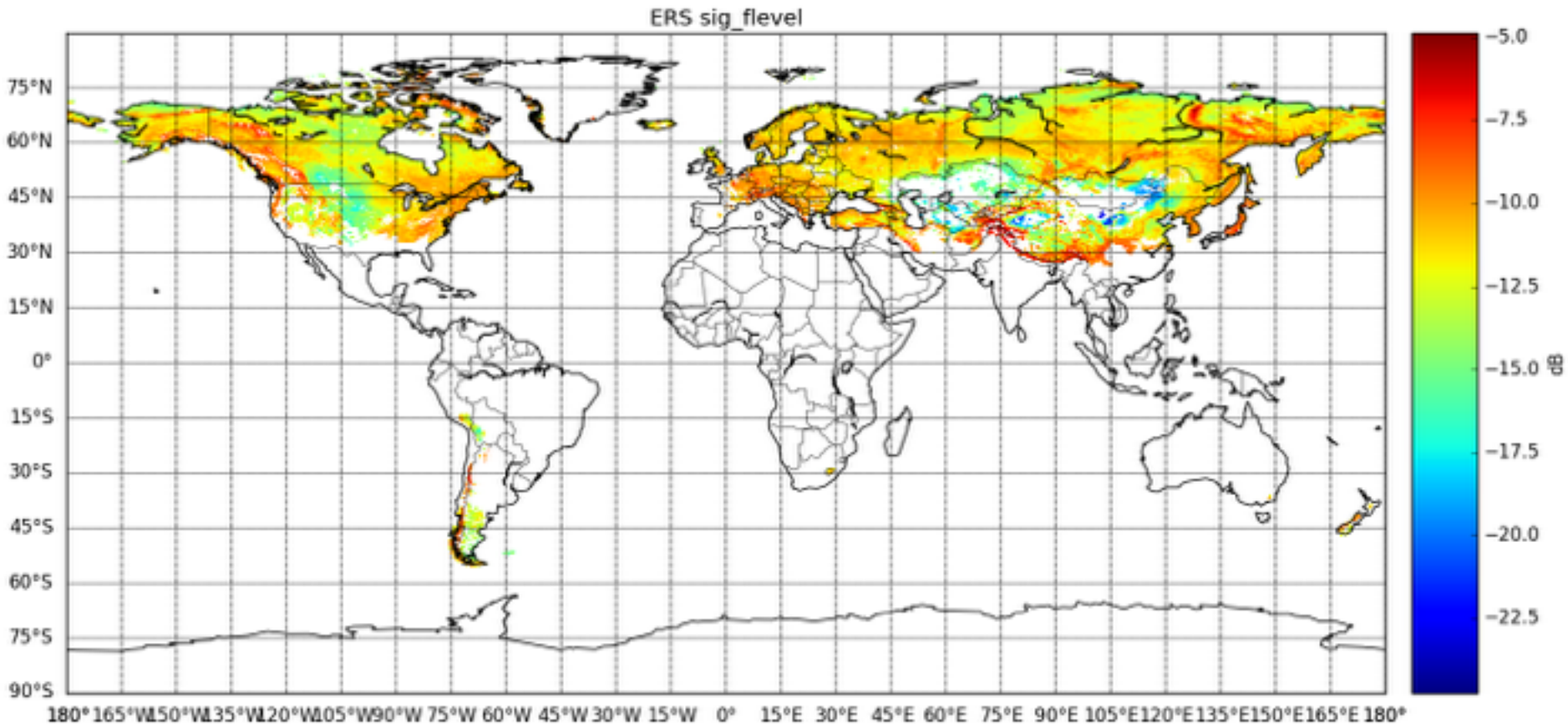
F/T parameters (static for each grid point)

Name	Description
Freeze/thaw threshold	Threshold below which the surface state can be flagged as frozen: inflection point of logistic function between $\pm 10^{\circ}\text{C}$
Steepness of linear regression during frozen period	Steepness of linear regression between -35 and -5°C
Snowmelt/water level	Statistical outlier method; outlier with highest backscatter value = snowmelt threshold (\sim snowmelt onset, inundation) // lowest backscatter measurement if no outlier is detected
Transition point 1, 2	Day of year when transition between winter and summer (1) and summer and winter (2) happens
Standard deviation frozen	Standard deviation of normalized backscatter during frozen period
Sigma mean summer, winter	Mean normalized backscatter in summer/winter
Permanent ice flag	True if logistic function has a negative behavior

F/T parameters – ASCAT frozen level (static for each grid point)



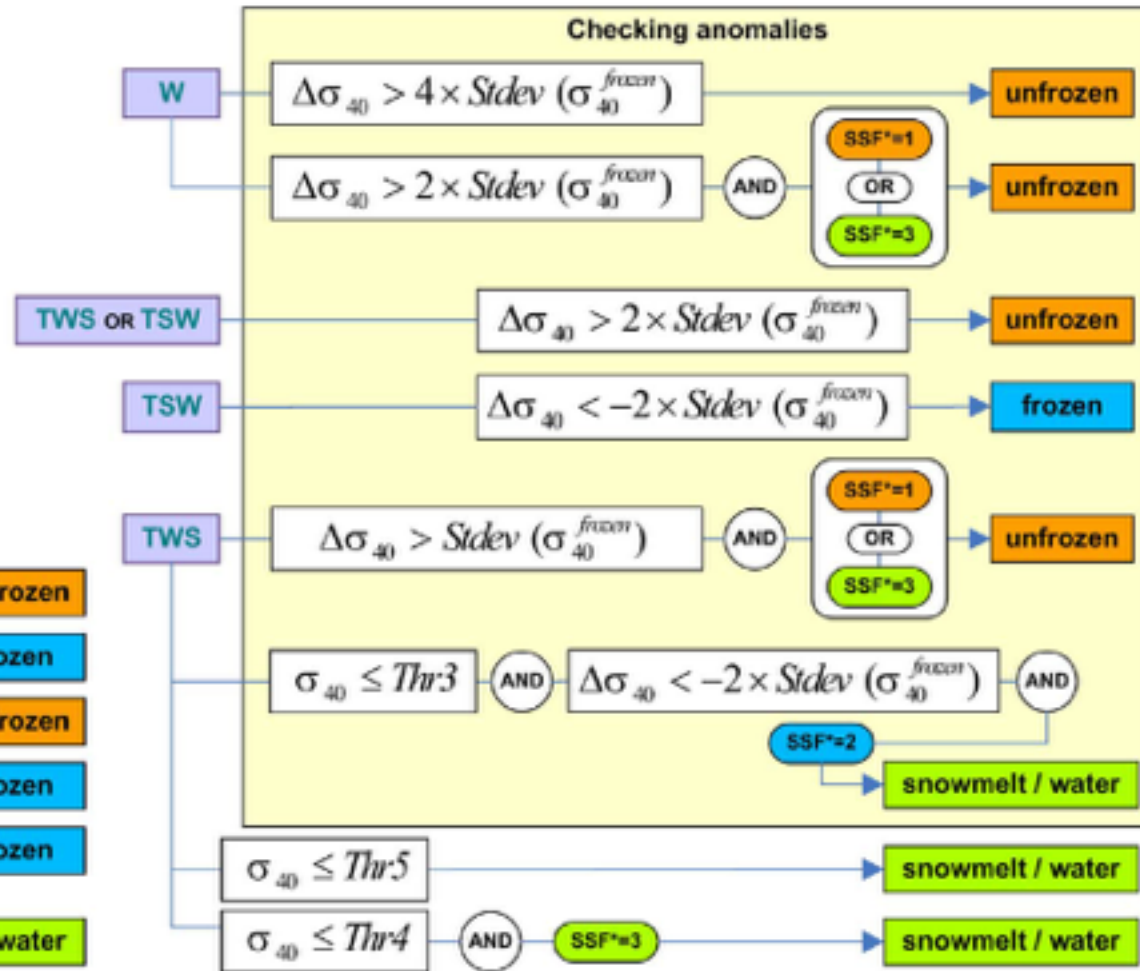
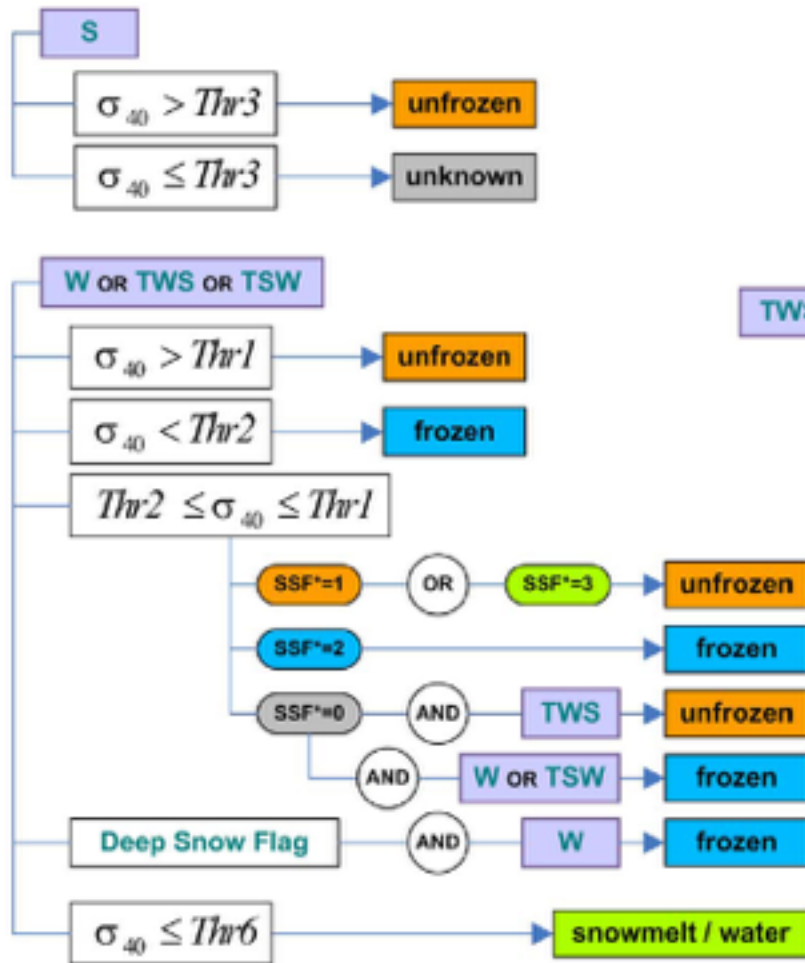
F/T parameters – ERS frozen level (static for each grid point)



Surface State Flag values

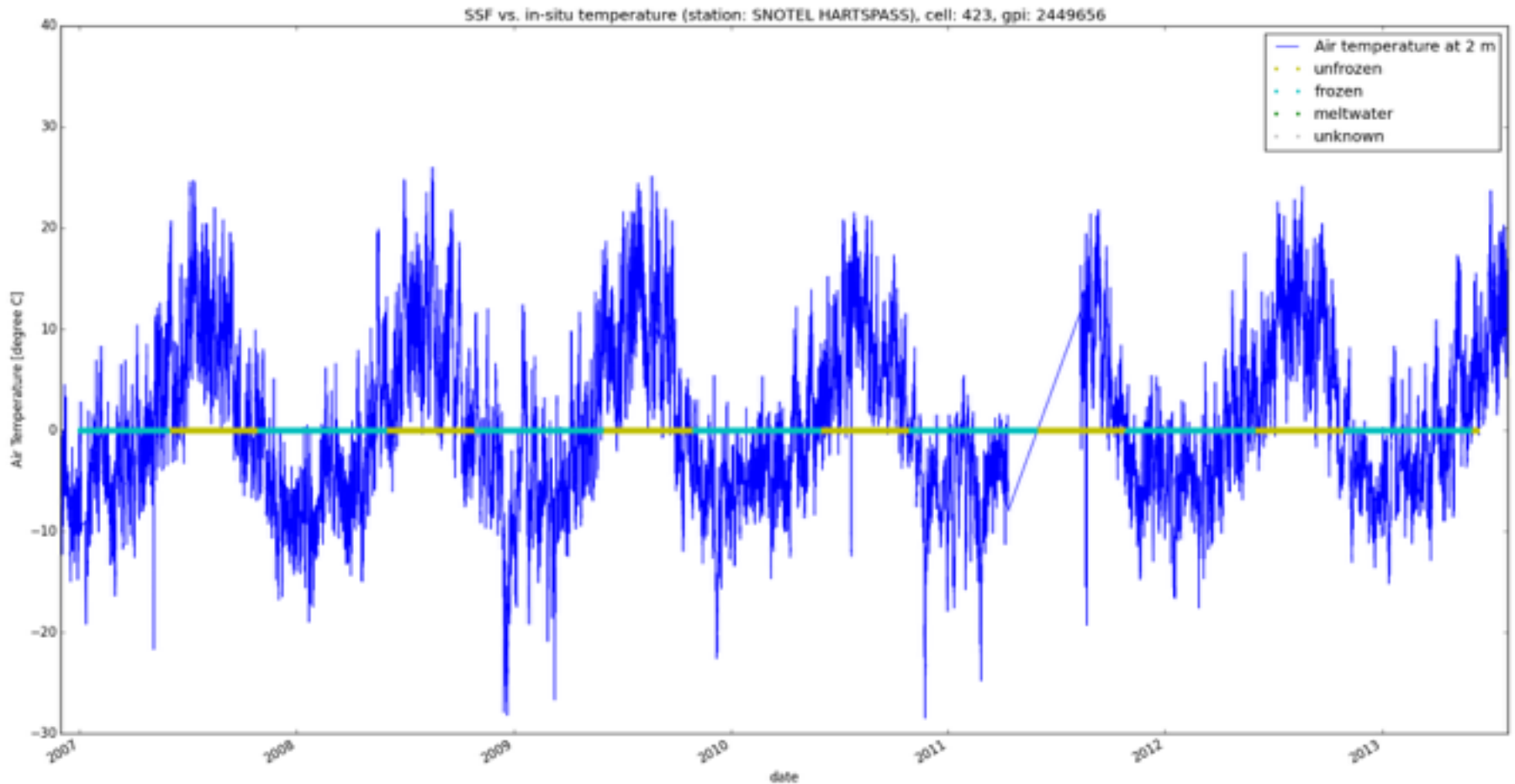
Value	Description
0	Unknown
1	Unfrozen
2	Frozen
3	Snow melt / water on surface

Decision trees for the SSF



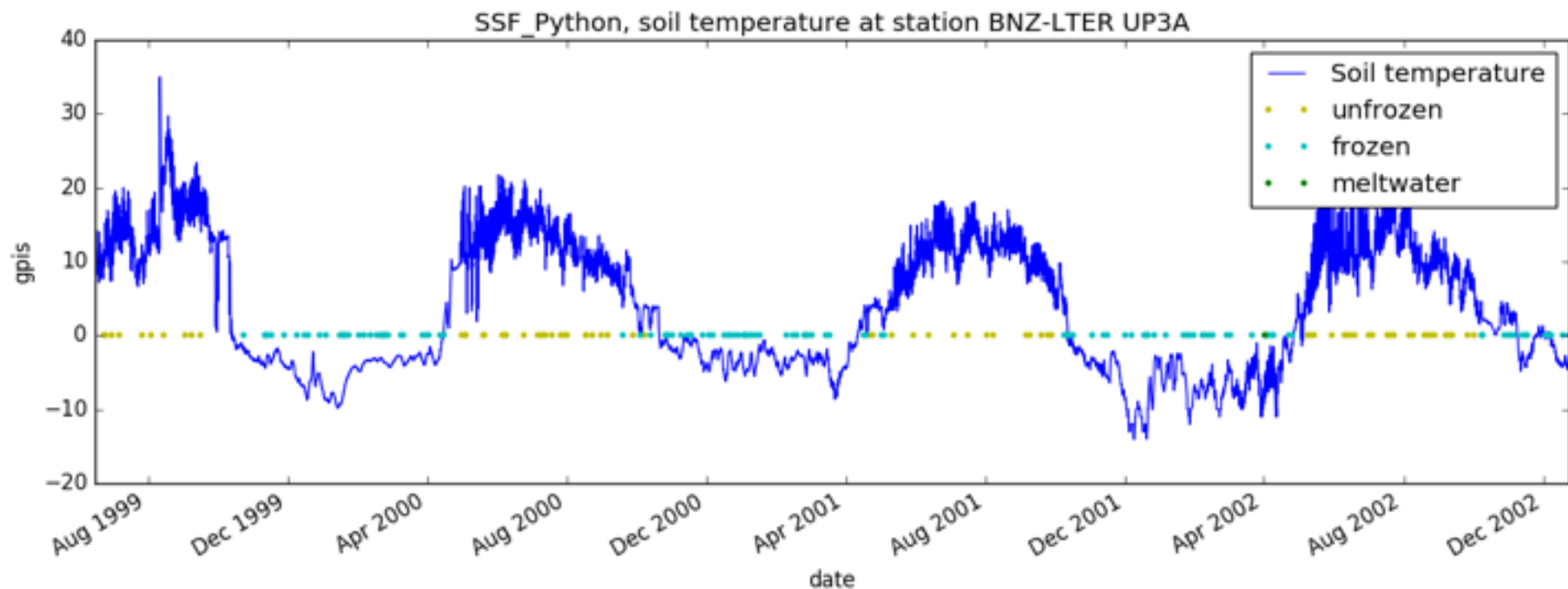
SSF from ASCAT backscatter data

- air temperature at Harts Pass (48.73 N, -120.65 E)

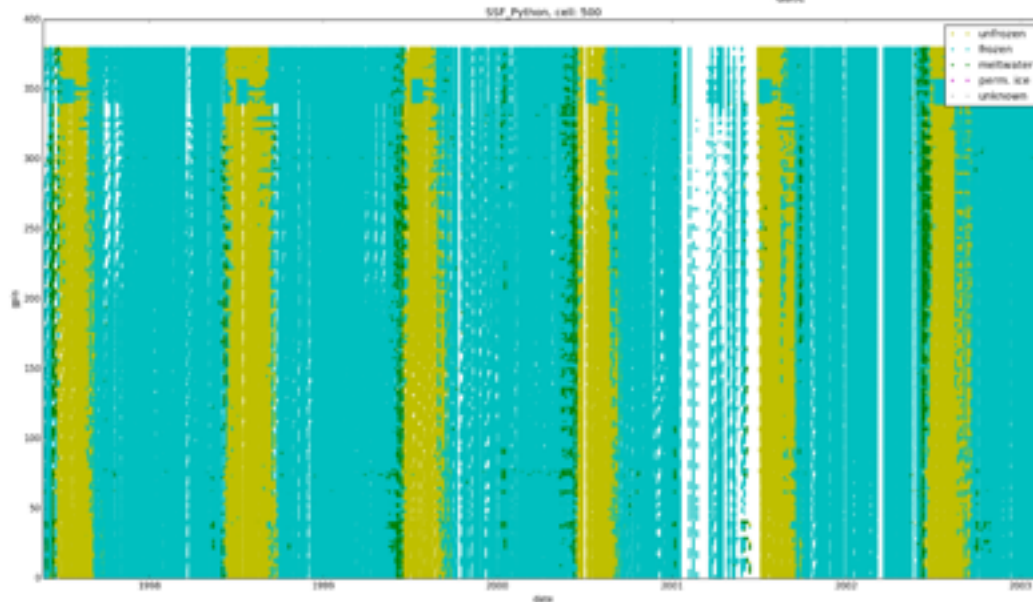
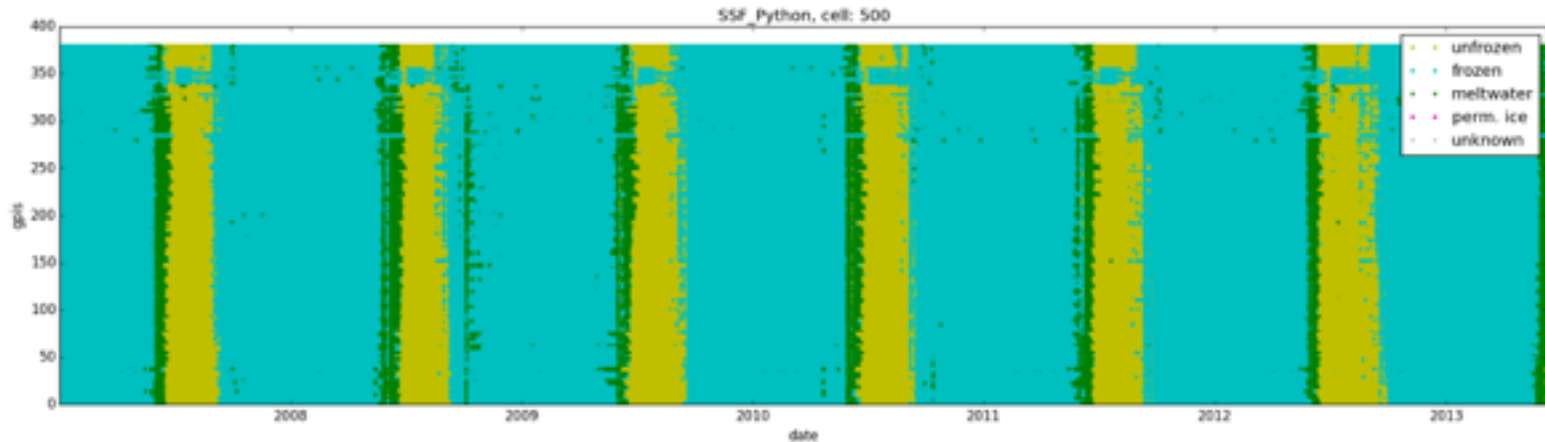


SSF from ERS backscatter data

- air temperature at UP3A (64.77 N, -148.28 E)



SSF from ASCAT and ERS data

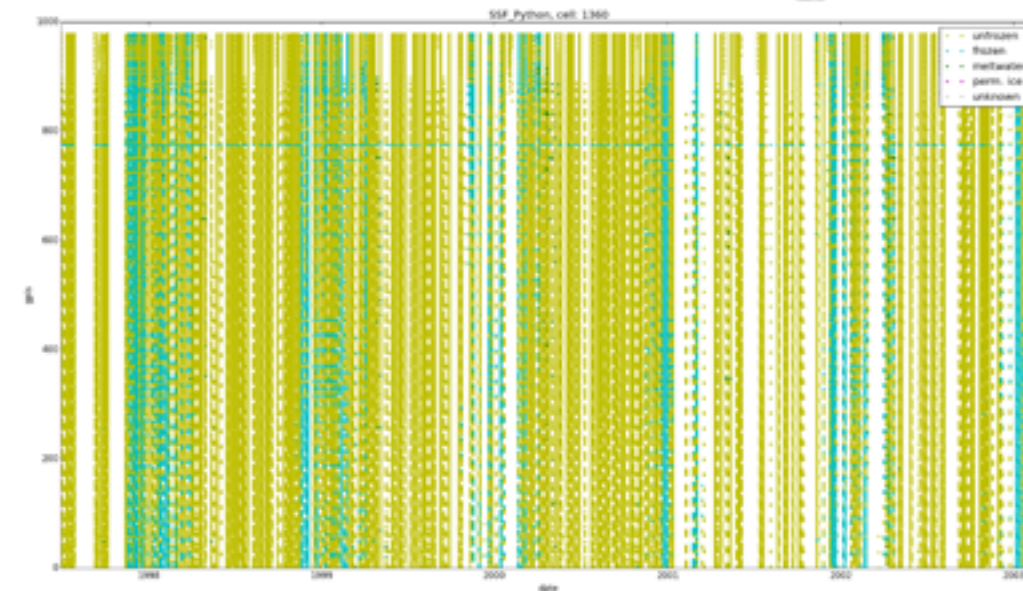
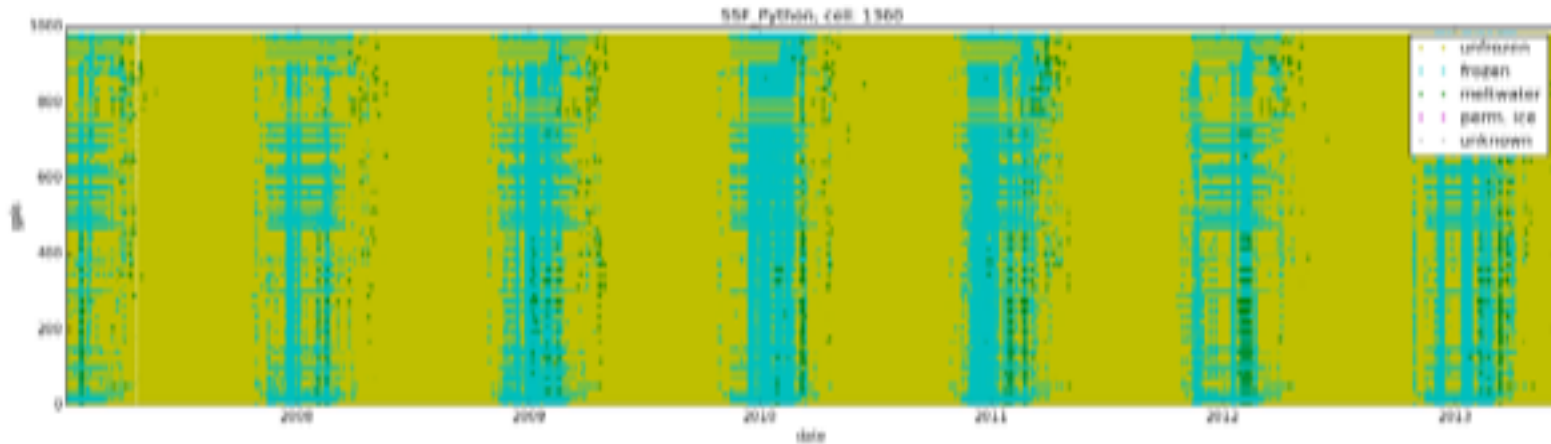


Top: ASCAT
Bottom: ERS

Mind the different date ranges!

357	393	429	465	500	537	573	609	645	681	717	753	789	825	861	897	9
0	7	208	526	125	89	425	629	426	426	426	129	129	488	488	426	4
356	392	428	464	500	536	572	608	644	680	716	752	788	824	860	896	9
70	140	280	560	1120	1680	1680	1680	1680	1680	1680	1680	1680	1680	1680	1680	4
355	391	427	463	499	535	571	607	643	679	715	751	787	823	859	895	9
708	712	767	768	773	767	775	768	768	771	768	767	768	762	764	764	3
354	390	426	462	498	534	570	606	642	678	714	750	786	822	858	894	9
360	911	909	907	907	905	902	907	912	909	908	910	905	909	904	9	3
353	389	425	461	497	533	569	605	641	677	713	749	785	821	857	893	9
1078	1078	1078	1078	1080	1078	1082	1078	1081	1078	1078	1078	1078	1084	1078	1078	4
352	388	424	460	496	532	568	604	640	676	712	748	784	820	856	892	9
580	1036	1034	1036	1036	1036	1035	1035	1034	1036	1034	1037	1035	1037	1036	1034	3
351	387	423	459	495	531	567	603	639	675	711	747	783	819	855	891	9
0	200	1026	1024	1027	1026	1027	1026	1027	1026	1026	1026	1026	1027	1026	1026	4
350	386	422	458	494	530	566	602	638	674	710	746	782	818	854	890	9
0	19	1023	1026	1023	1026	1027	1026	1027	1026	1026	1026	1026	1026	1026	1026	0
1048	1047	1051	1052	1053	1052	1052	1051	1052	1052	1052	1052	1052	1051	1052	1052	4

SSF from ASCAT and ERS data



Top: ASCAT
Bottom: ERS

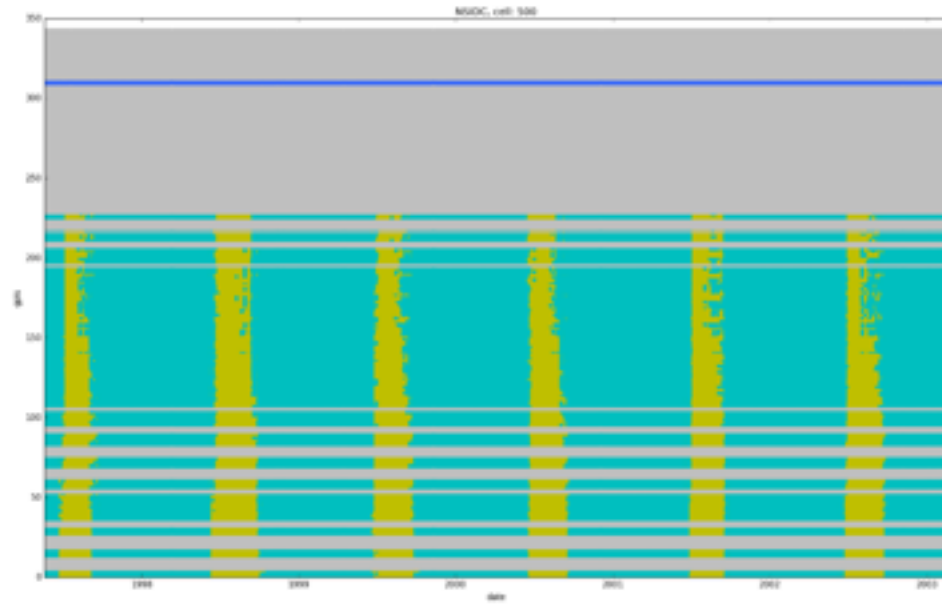
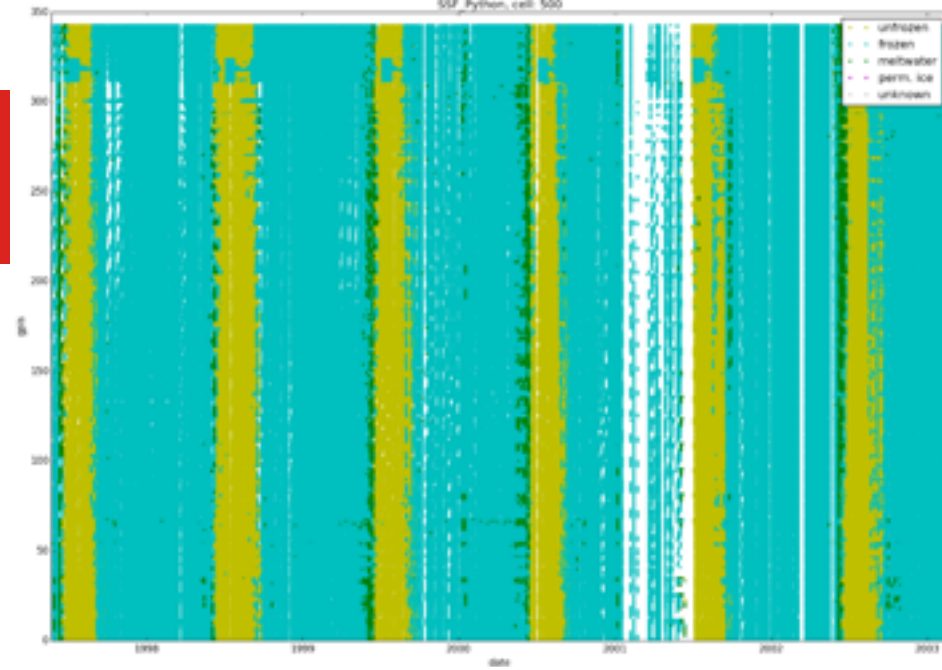
Mind the different date ranges!

1328	1364	1400	1436	1472	1508	1544	1580	1
0	0	0	540	212	208	101	0	
1327	1363	1399	1435	1471	1507	1543	1579	1
0	1	443	763	769	770	760	698	
1326	1362	1398	1434	1470	1506	1542	1578	1
118	784	906	849	907	907	908	906	
1325	1361	1397	1433	1469	1505	1541	1577	1
84	885	1063	934	1030	1080	1079	1077	
1324	1360	1396	1432	1468	1504	1540	1576	1
80	1087	1182	1194	1196	1194	1196	1194	

Reference Dataset		ASCAT SSF	ERS SSF
International Soil Moisture Network (ISMN)	Air and soil temperature at different network stations	✓	✓
National Snow and Ice Data Center	Arctic Soil Freeze Thaw Status from SMMR and SSM/I	✓	✓
Global Land Data Assimilation System (GLDAS)	Soil temperature (0.00-0.10 m)	✓	✓
Global Land Data Assimilation System (GLDAS)	Surface temperature	✓	✓

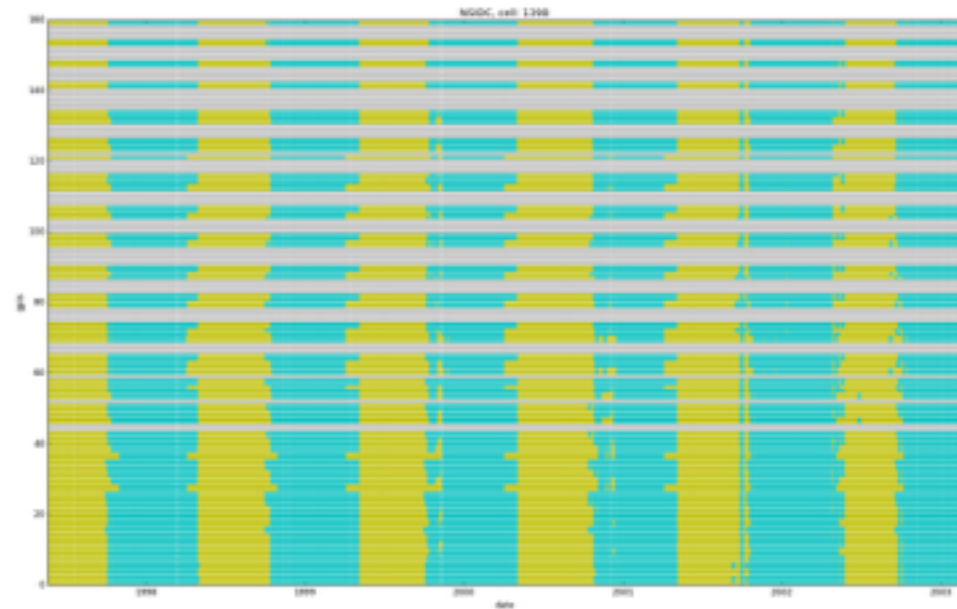
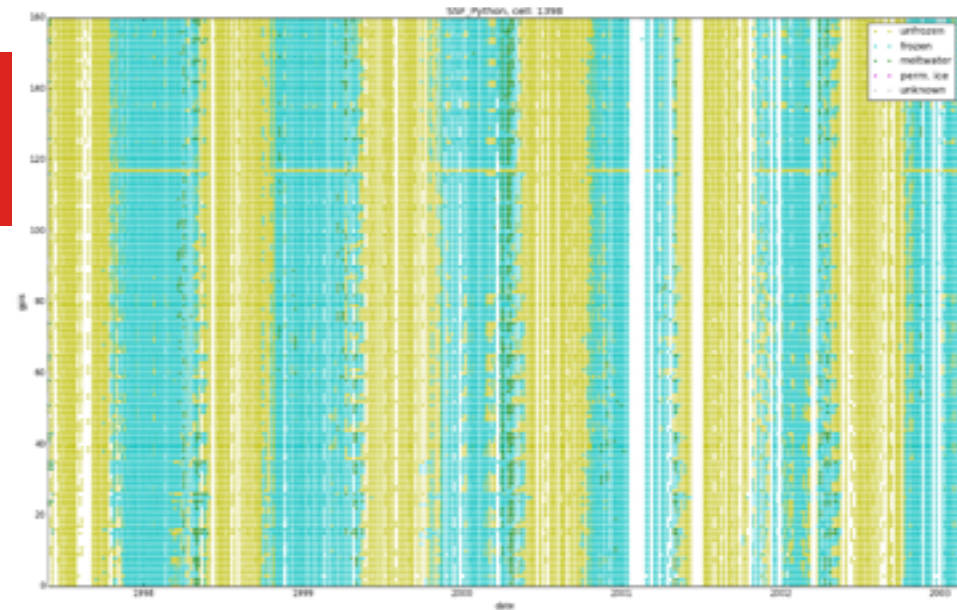
Northern Canada (cell 500)

357	393	429	465	501	537	573	609	645	681	717	753	789	825	861	897	933
0	7	208	344	480	616	752	888	1024	1160	1296	1432	1568	1704	1840	1976	2112
356	392	428	464	500	536	572	608	644	680	716	752	788	824	860	896	932
70	130	260	390	520	650	780	910	1040	1170	1300	1430	1560	1690	1820	1950	2080
355	391	427	463	499	535	571	607	643	679	715	751	787	823	859	895	931
268	272	267	269	271	267	271	269	268	271	268	607	269	262	264	50	2
354	390	426	462	498	534	570	606	642	678	714	750	786	822	858	894	930
900	911	909	907	903	905	910	907	722	395	644	876	801	889	318	0	1
353	389	425	461	497	533	569	605	641	677	713	749	785	821	857	893	929
1070	1079	1078	1078	1080	1078	1082	1078	805	452	541	872	1078	1066	918	121	4
352	388	424	460	496	532	568	604	640	676	712	748	784	820	856	892	928
580	1306	1394	1396	1390	1395	1395	1394	1396	1354	1387	1395	1397	1396	1156	0	1
351	387	423	459	495	531	567	603	639	675	711	747	783	819	855	891	927
0	209	1375	1376	1378	1371	1377	1376	1372	1350	1376	1378	1377	1376	992	0	1
350	386	422	458	494	530	566	602	638	674	710	746	782	818	854	890	926
0	19	1411	1440	1447	1440	1447	1445	1447	1441	1449	1450	1470	594	300	0	1
349	385	421	457	493	529	565	601	637	673	709	745	781	817	853	889	925



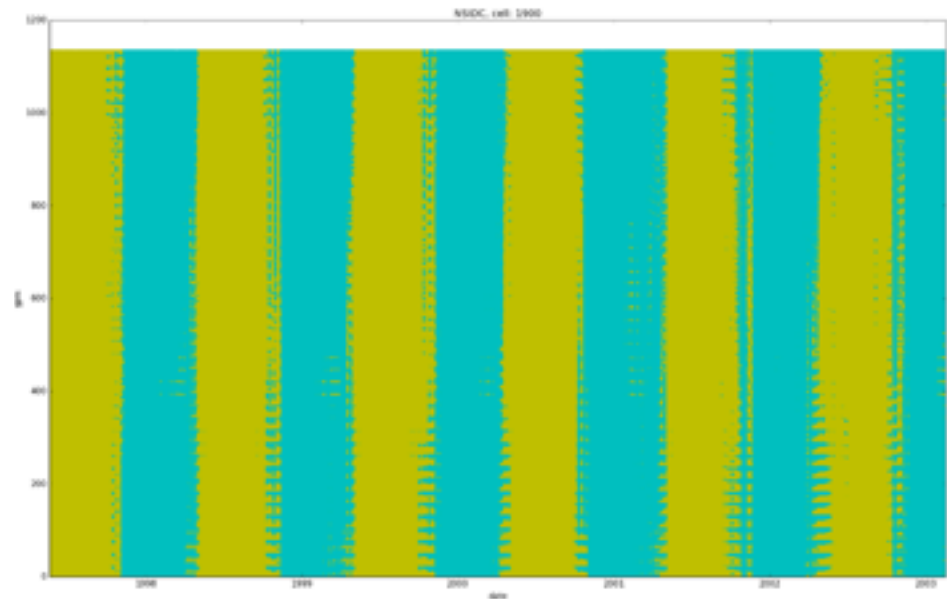
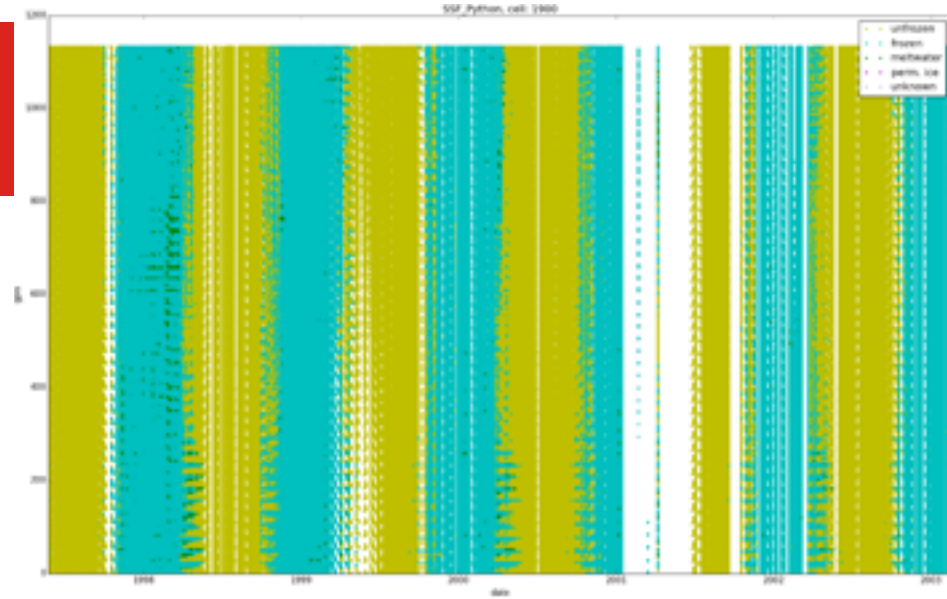
Norway (cell 1398)

2	1328	1364	1400	1436	1472	1508	1544	1580	1616
0	0	0	0	140	212	208	103	0	0
1	1327	1363	1399	1435	1471	1507	1543	1579	1615
0	0	1	443	763	769	770	769	698	0
0	1326	1362	1398	1434	1470	1506	1542	1578	1614
7	138	744	906	849	907	907	908	906	0
9	1325	1361	1397	1433	1469	1505	1541	1577	1613
5	84	849	1063	934	1030	1080	1079	1077	0
8	1324	1360	1396	1432	1468	1504	1540	1576	1612
3	895	1087	1192	1194	1196	1194	1196	1194	0
7	1323	1359	1395	1431	1467	1503	1539	1575	1611

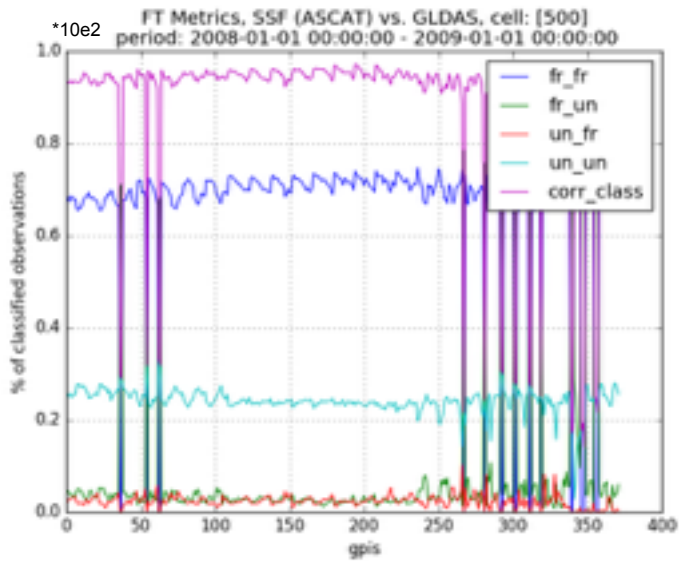


Russia (cell 1900)

489	1725	1761	1797	1833	1869	1905	1941	1977	2013	2049	2085	2121	2157	2193	2229	2265	2301	2337	2373	2409	2444
52	181	225	269	313	357	401	445	489	533	577	621	665	709	753	797	841	885	929	973	1017	1061
488 <th>1724</th> <th>1760</th> <th>1796</th> <th>1832</th> <th>1868</th> <th>1904</th> <th>1940</th> <th>1976</th> <th>2012</th> <th>2048</th> <th>2084</th> <th>2120</th> <th>2156</th> <th>2192</th> <th>2228</th> <th>2264</th> <th>2300</th> <th>2336</th> <th>2372</th> <th>2408</th> <th>2444</th>	1724	1760	1796	1832	1868	1904	1940	1976	2012	2048	2084	2120	2156	2192	2228	2264	2300	2336	2372	2408	2444
487 <td>1723</td> <td>1759</td> <td>1795</td> <td>1831</td> <td>1867</td> <td>1903</td> <td>1939</td> <td>1975</td> <td>2011</td> <td>2047</td> <td>2083</td> <td>2119</td> <td>2155</td> <td>2191</td> <td>2227</td> <td>2263</td> <td>2299</td> <td>2335</td> <td>2371</td> <td>2407</td> <td>2443</td>	1723	1759	1795	1831	1867	1903	1939	1975	2011	2047	2083	2119	2155	2191	2227	2263	2299	2335	2371	2407	2443
486 <td>1722</td> <td>1758</td> <td>1794</td> <td>1830</td> <td>1866</td> <td>1902</td> <td>1938</td> <td>1974</td> <td>2010</td> <td>2046</td> <td>2082</td> <td>2118</td> <td>2154</td> <td>2190</td> <td>2226</td> <td>2262</td> <td>2298</td> <td>2334</td> <td>2370</td> <td>2406</td> <td>2442</td>	1722	1758	1794	1830	1866	1902	1938	1974	2010	2046	2082	2118	2154	2190	2226	2262	2298	2334	2370	2406	2442
485 <td>1721</td> <td>1757</td> <td>1793</td> <td>1829</td> <td>1865</td> <td>1901</td> <td>1937</td> <td>1973</td> <td>2009</td> <td>2045</td> <td>2081</td> <td>2117</td> <td>2153</td> <td>2189</td> <td>2225</td> <td>2261</td> <td>2297</td> <td>2333</td> <td>2369</td> <td>2405</td> <td>2441</td>	1721	1757	1793	1829	1865	1901	1937	1973	2009	2045	2081	2117	2153	2189	2225	2261	2297	2333	2369	2405	2441
484 <td>1720</td> <td>1756</td> <td>1792</td> <td>1828</td> <td>1864</td> <td>1900</td> <td>1936</td> <td>1972</td> <td>2008</td> <td>2044</td> <td>2080</td> <td>2116</td> <td>2152</td> <td>2188</td> <td>2224</td> <td>2260</td> <td>2296</td> <td>2332</td> <td>2368</td> <td>2404</td> <td>2440</td>	1720	1756	1792	1828	1864	1900	1936	1972	2008	2044	2080	2116	2152	2188	2224	2260	2296	2332	2368	2404	2440
483 <td>1719</td> <td>1755</td> <td>1791</td> <td>1827</td> <td>1863</td> <td>1899</td> <td>1935</td> <td>1971</td> <td>2007</td> <td>2043</td> <td>2079</td> <td>2115</td> <td>2151</td> <td>2187</td> <td>2223</td> <td>2259</td> <td>2295</td> <td>2331</td> <td>2367</td> <td>2403</td> <td>2439</td>	1719	1755	1791	1827	1863	1899	1935	1971	2007	2043	2079	2115	2151	2187	2223	2259	2295	2331	2367	2403	2439
482 <td>1718</td> <td>1754</td> <td>1790</td> <td>1826</td> <td>1862</td> <td>1898</td> <td>1934</td> <td>1970</td> <td>2006</td> <td>2042</td> <td>2078</td> <td>2114</td> <td>2150</td> <td>2186</td> <td>2222</td> <td>2258</td> <td>2294</td> <td>2330</td> <td>2366</td> <td>2402</td> <td>2438</td>	1718	1754	1790	1826	1862	1898	1934	1970	2006	2042	2078	2114	2150	2186	2222	2258	2294	2330	2366	2402	2438
481 <td>1717</td> <td>1753</td> <td>1789</td> <td>1825</td> <td>1861</td> <td>1897</td> <td>1933</td> <td>1969</td> <td>2005</td> <td>2041</td> <td>2077</td> <td>2113</td> <td>2149</td> <td>2185</td> <td>2221</td> <td>2257</td> <td>2293</td> <td>2329</td> <td>2365</td> <td>2401</td> <td>2437</td>	1717	1753	1789	1825	1861	1897	1933	1969	2005	2041	2077	2113	2149	2185	2221	2257	2293	2329	2365	2401	2437
480 <td>1716</td> <td>1752</td> <td>1788</td> <td>1824</td> <td>1860</td> <td>1896</td> <td>1932</td> <td>1968</td> <td>2004</td> <td>2040</td> <td>2076</td> <td>2112</td> <td>2148</td> <td>2184</td> <td>2220</td> <td>2256</td> <td>2292</td> <td>2328</td> <td>2364</td> <td>2400</td> <td>2436</td>	1716	1752	1788	1824	1860	1896	1932	1968	2004	2040	2076	2112	2148	2184	2220	2256	2292	2328	2364	2400	2436



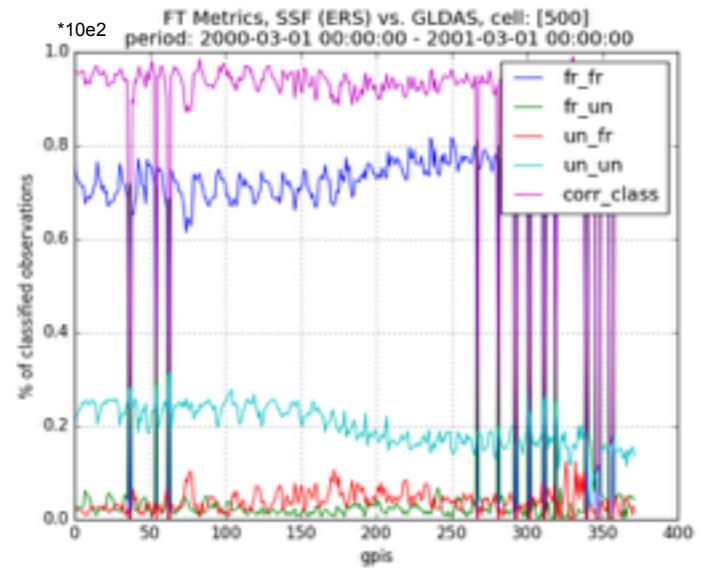
Validation: SSF – GLDAS temperature



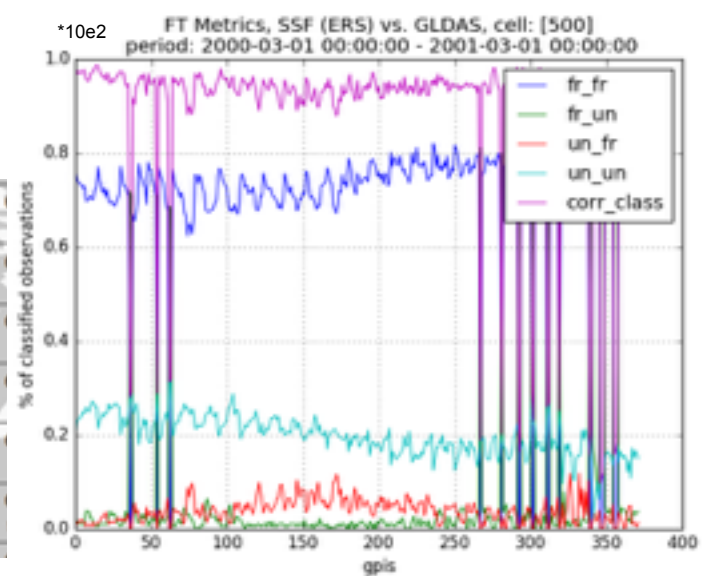
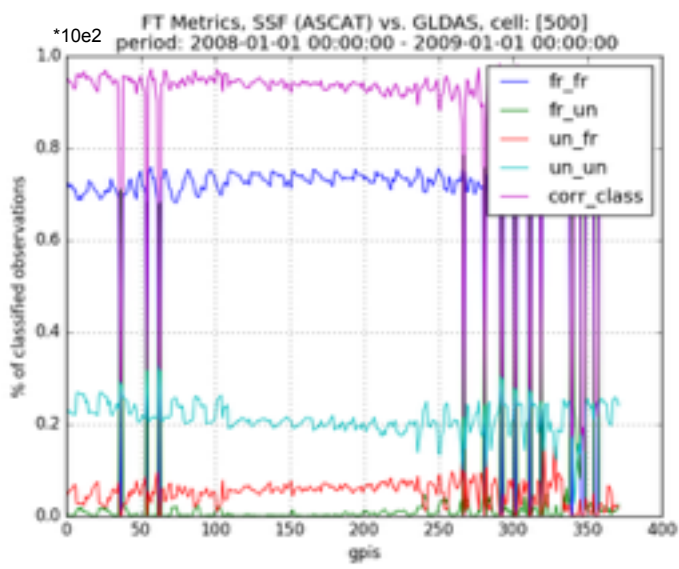
← ASCAT

ERS →

Top: surface temperature

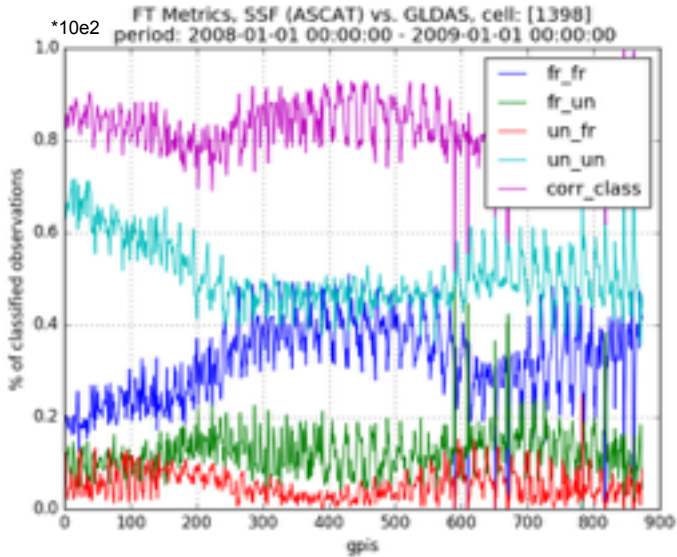


Bottom: soil temperature

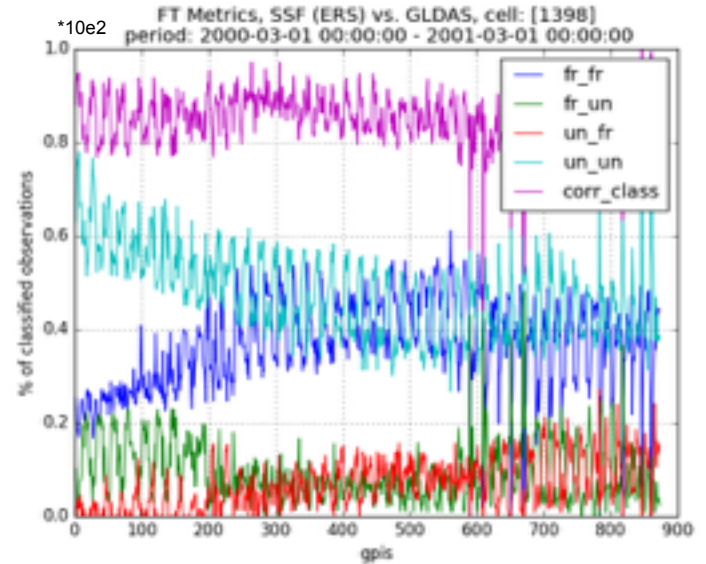


357	393	429	465	501	537	573	609
0	7	208	344	480	616	752	888
356	392	428	464	500	536	572	608
70	130	190	250	310	370	430	490
355	391	427	463	499	535	571	607
260	272	284	296	308	320	332	344
354	390	426	462	498	534	570	606
900	911	922	933	944	955	966	977
353	389	425	461	497	533	569	605
1070	1079	1088	1097	1106	1115	1124	1133
352	388	424	460	496	532	568	604
540	1096	1194	1292	1390	1488	1586	1684

Validation: SSF – GLDAS temperature

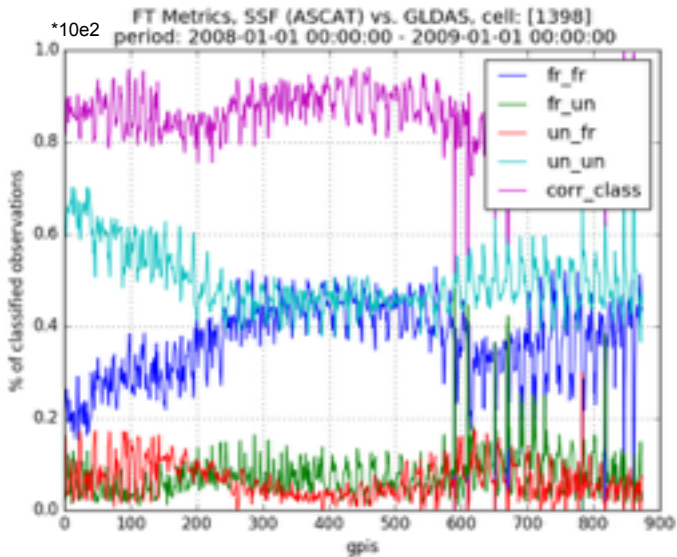


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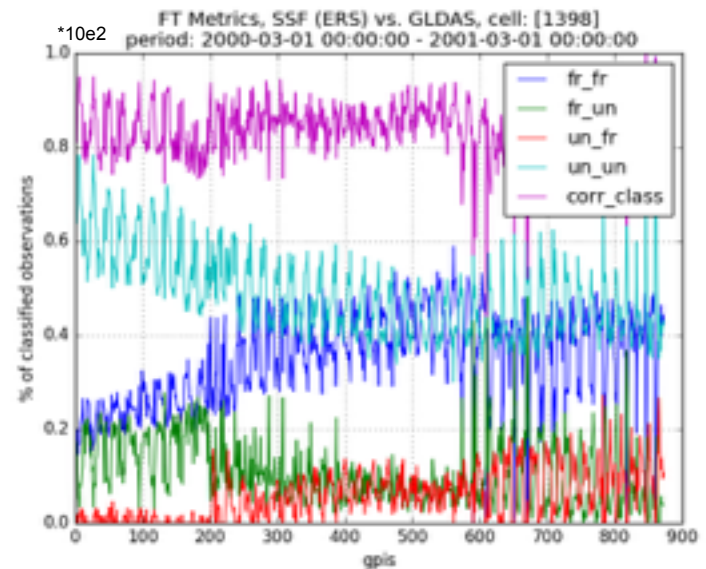


Top: surface temperature

Bottom: soil temperature

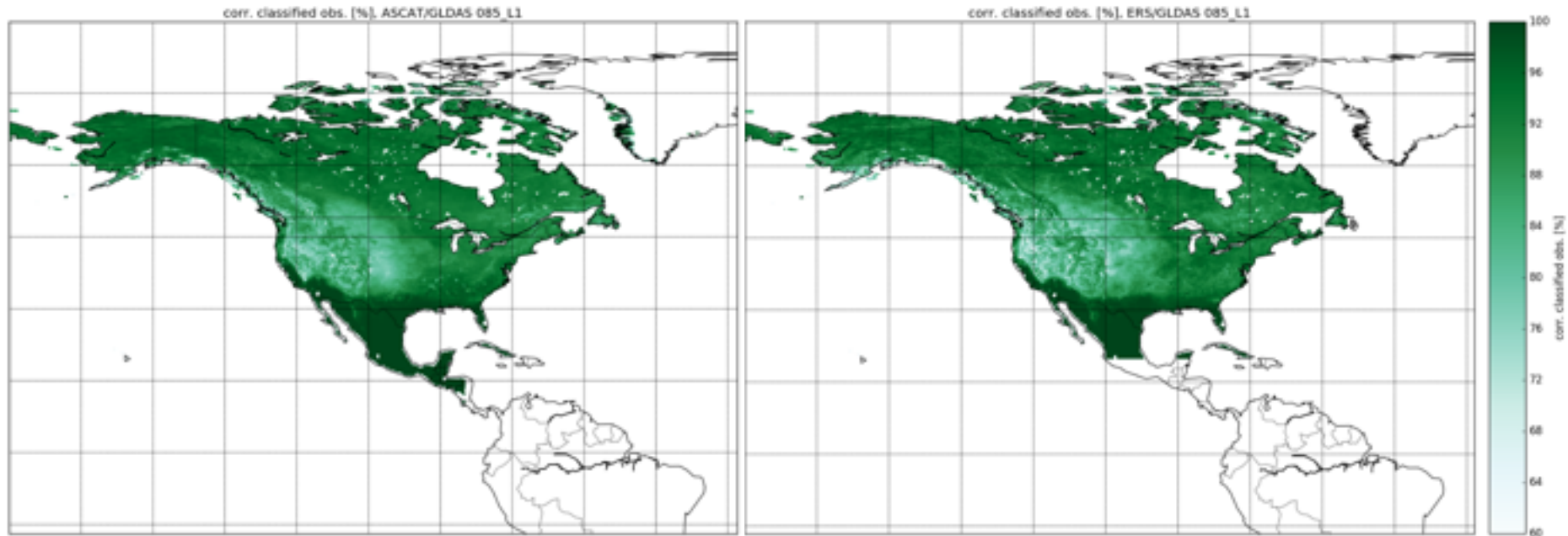


2	1328	1364	1400	1436	1472	1
3	0	0	0	140	212	
4	1327	1363	1399	1435	1471	1
5	0	1	443	763	769	
6	1326	1362	1398	1434	1470	1
7	138	744	906	849	907	
8	1325	1361	1397	1433	1469	1
9	84	849	1063	934	1030	



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- Limiting factor: data density
- Good results for higher data density compared to different validation datasets
- Outlook:
 - Why does the process fail in regions with low data density?
 - What can be done against it?