HIRLAM/HARMONIE physics developments

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Convection challenge

- 21-07-09
- Naxos
- Foto by wife of KNMI forecaster (Vergouw)

HIRLAM fysica

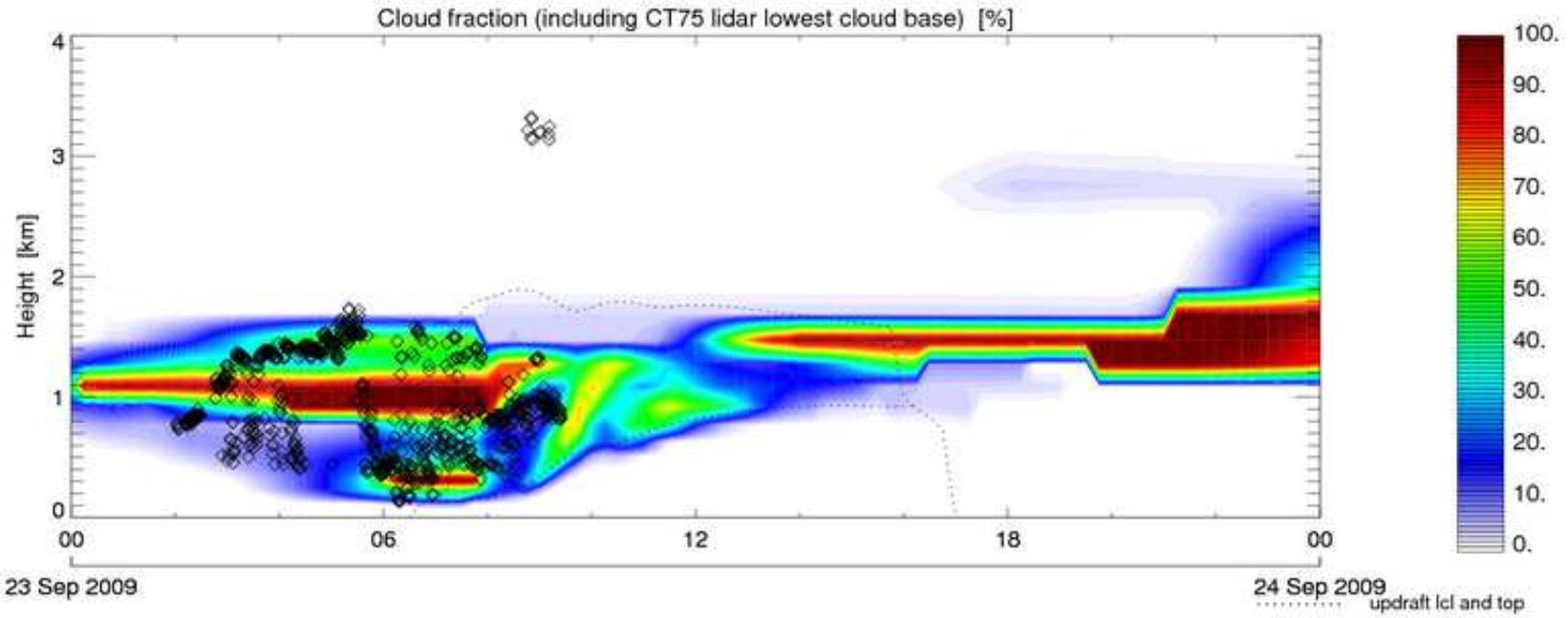
- KPT/CPT, EDMF in KPT
- Search for convection improvements, impact SLHD
- Application AROME: Lightning intensity based on graupel
- New version of RK
- Impact orographic roughness
- Impact radiation on lowest model level

KPT/CPT

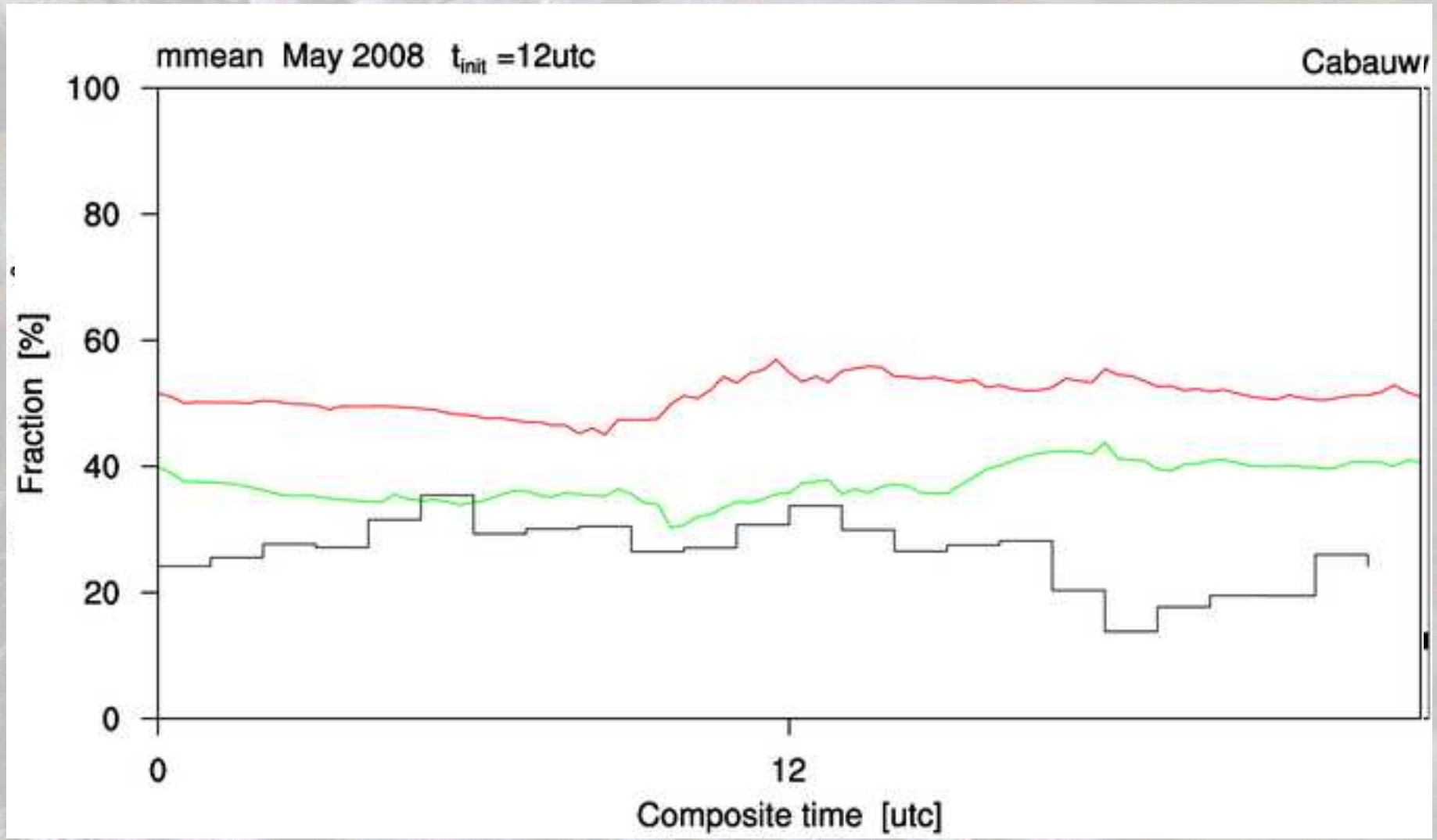
- KNMI/Cabauw parameterization testbed
- Environment to run 1D models with daily forcing from 3D model
- Comparison with observations from different special sites (Cabauw, Chilbolton, Lindenberg) and different cases (ARM etc).
- Possibility to derive statistics over longer period and comparison between models and model versions
- Good test for new/updated parameterizations

Examples KPT

Cloud fraction



Examples KPT

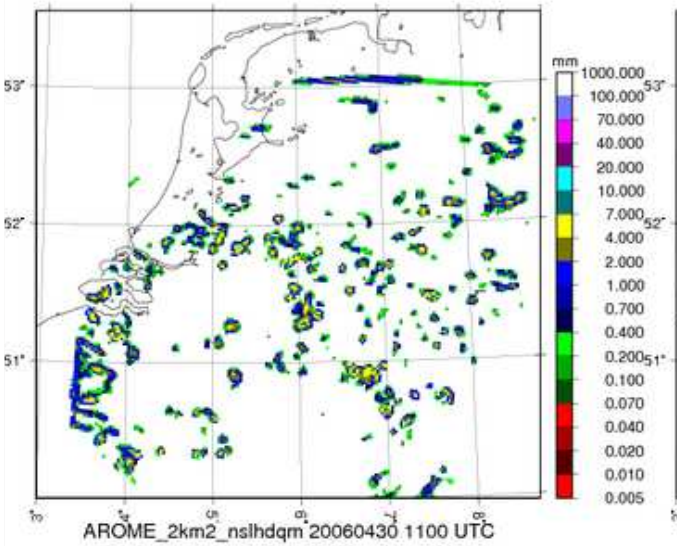


Impact dynamics on convection

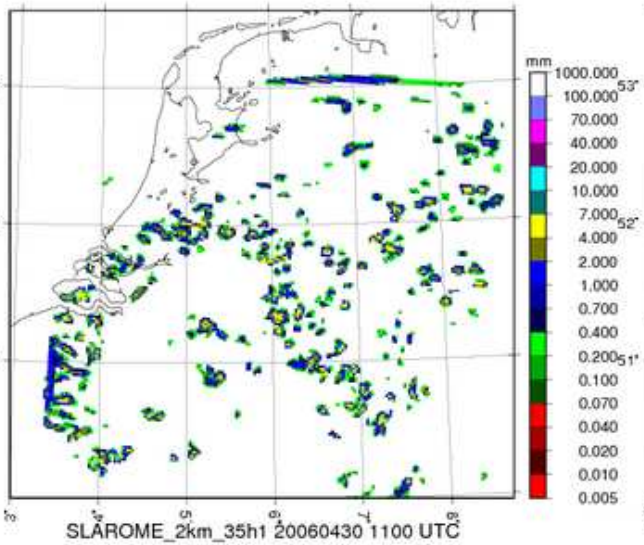
- Differences between AROME and ALARO without deep convection scheme
- Differences partly due to difference in horizontal diffusion
- SLHD removes energy on short and longer scales.
- Differences to be seen in vertical divergence, precipitation and energy spectrum

Impact dynamics on convection

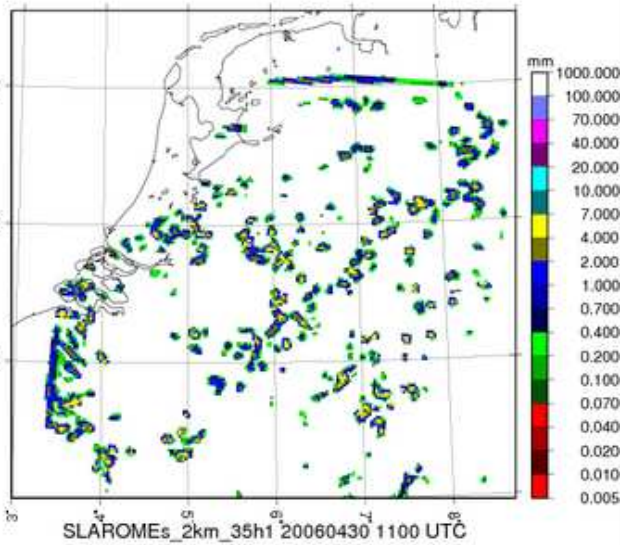
AROME_2km2_l 20060430 1100 UTC



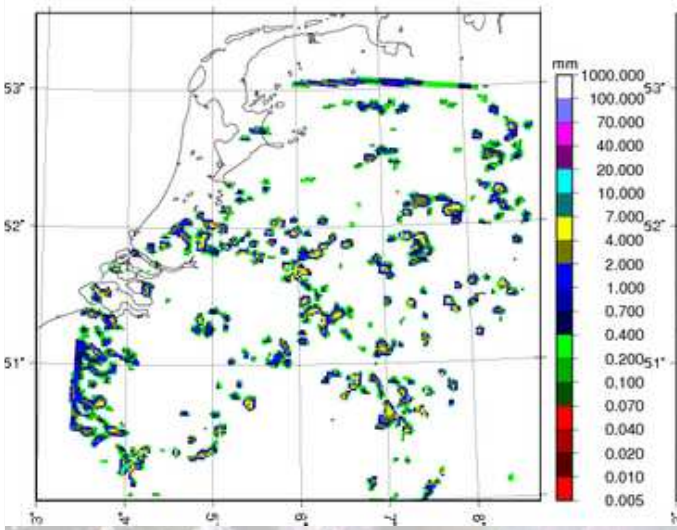
AROME_2km2_nslhd 20060430 1100 UTC



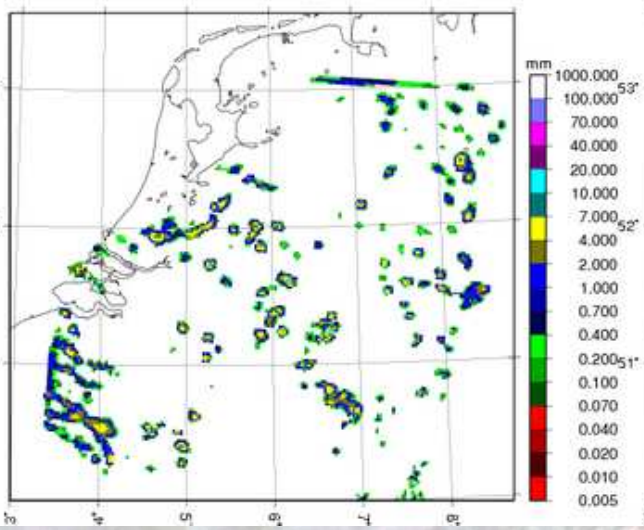
AROME_2km2_nqm 20060430 1100 UTC



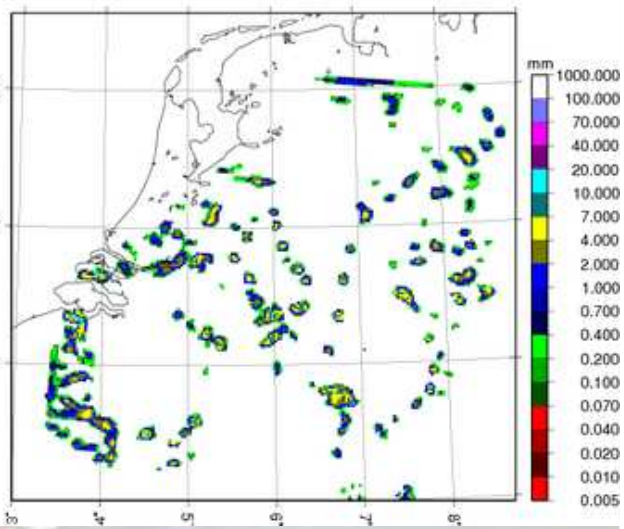
AROME_2km2_nslhdqm 20060430 1100 UTC



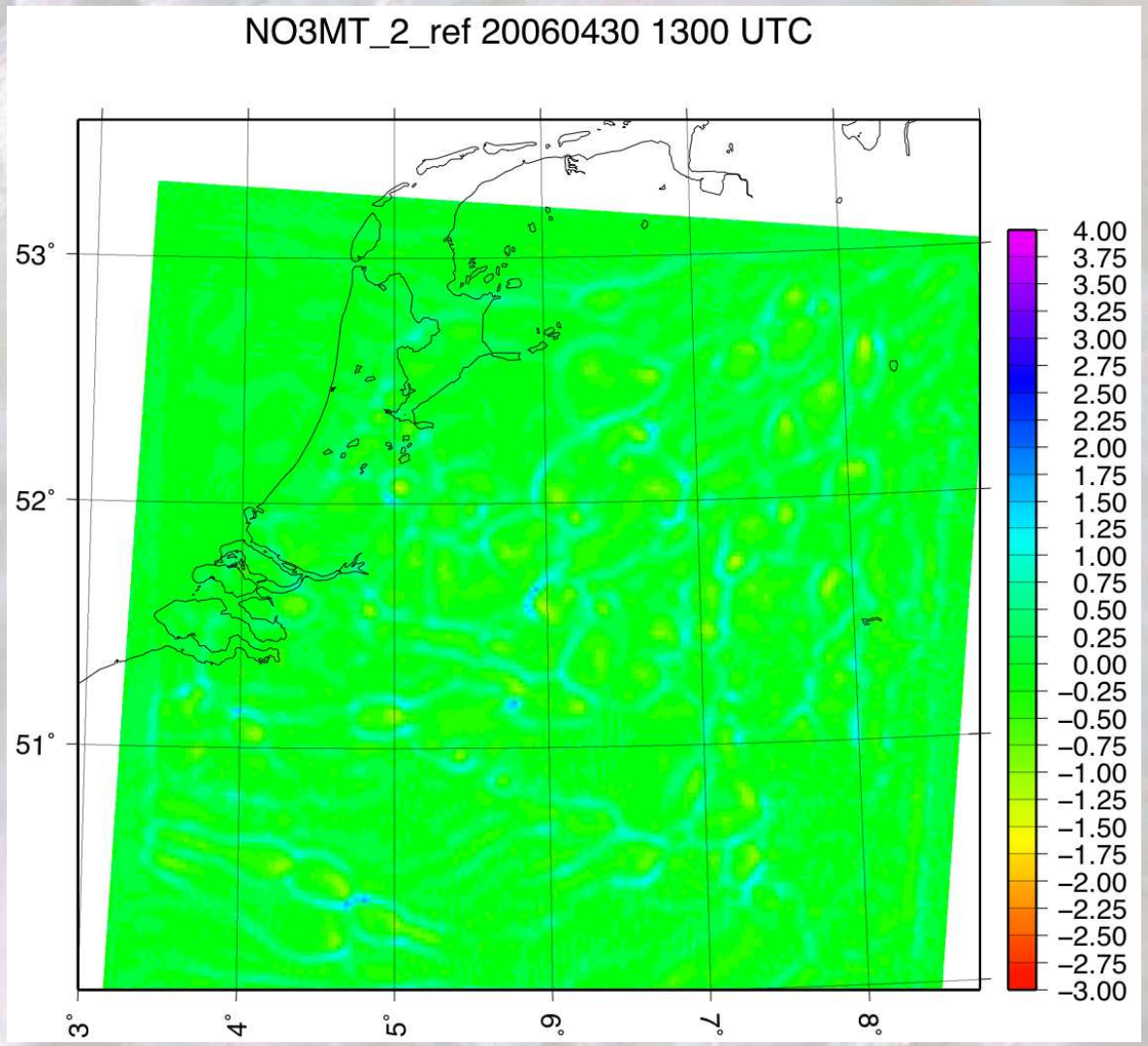
SLAROME_2km_35h1 20060430 1100 UTC



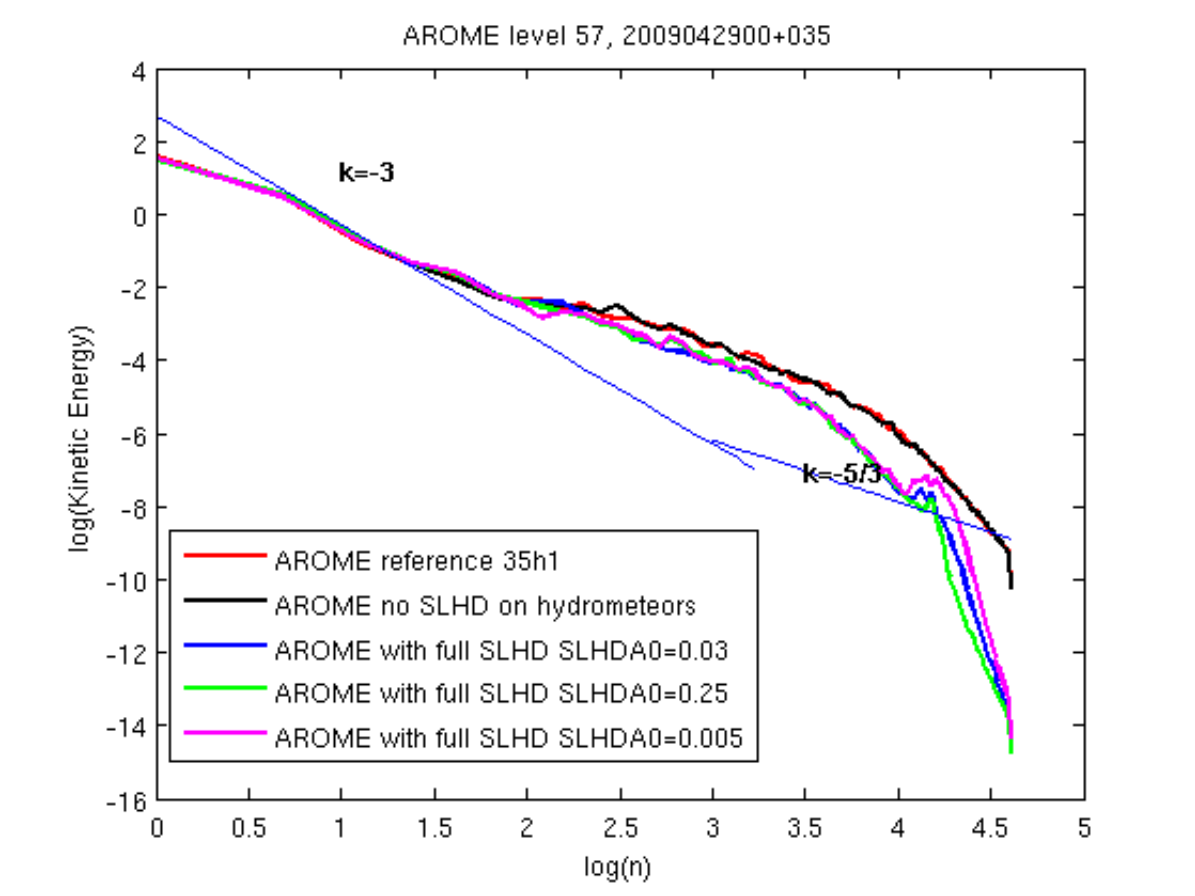
SLAROMEs_2km_35h1 20060430 1100 UTC



Impact dynamics on convection



Impact dynamics on convection

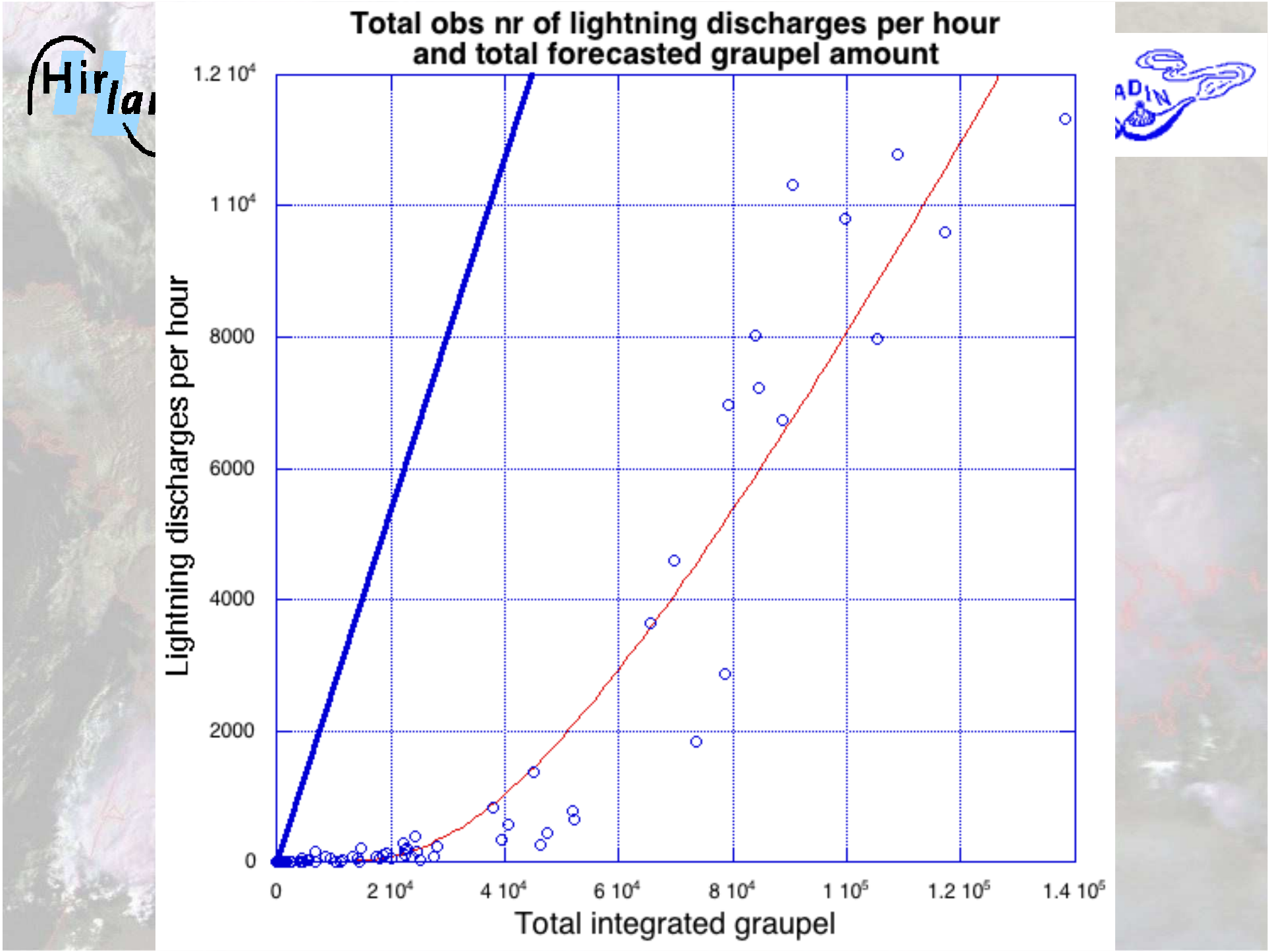


Application of AROME

- Graupel plays large role in charge separation in thunderstorms
- Relation between graupel and observed lightning intensity

$$I = 0.2\left[\int \rho\left(q_g + q_s + q_i\right)dz\right] \quad WRF\ /USA$$

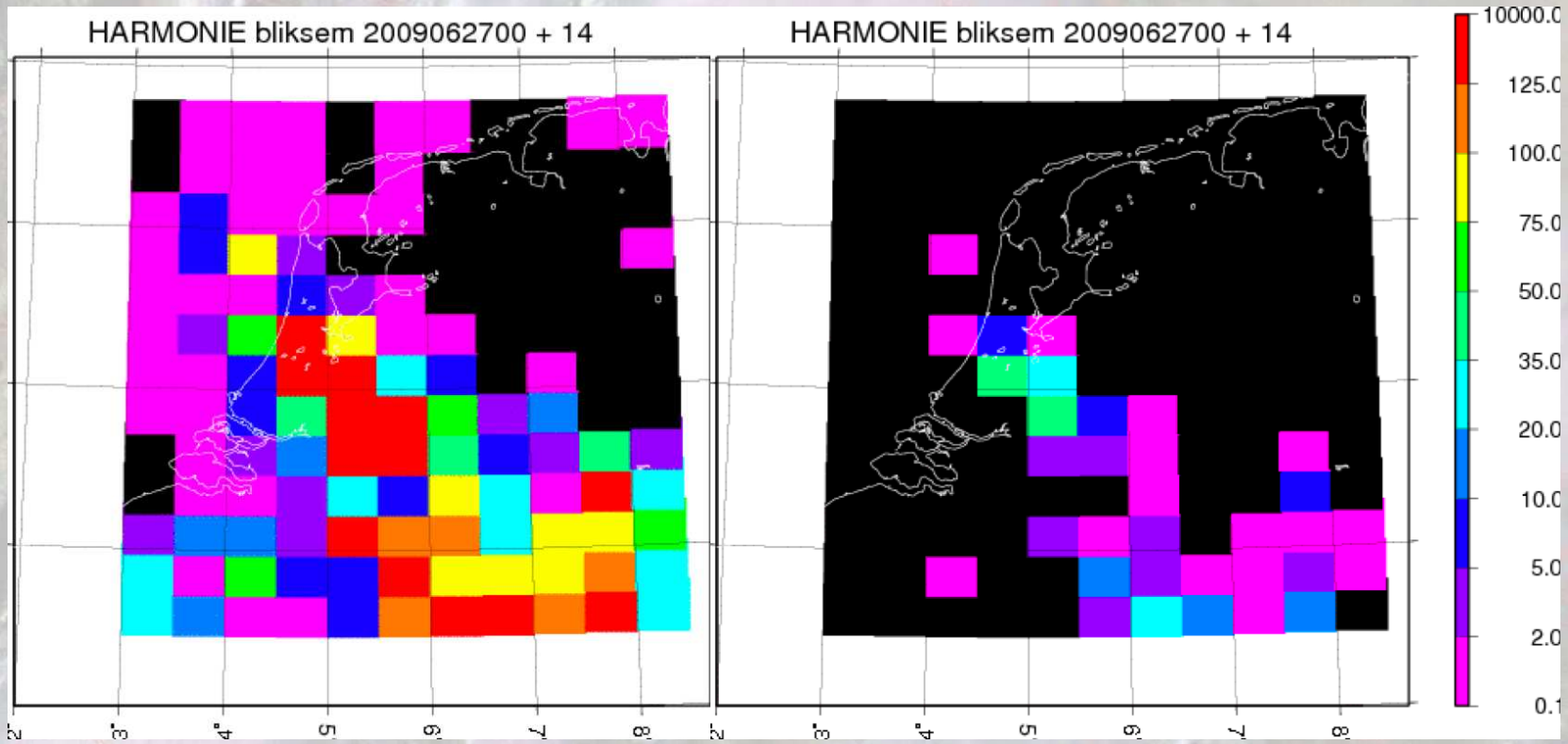
$$I = a_1\left(\int \rho\left(q_g\right)dz\right)\left[\arctan\left(a_2\left[\int \rho\left(q_g\right)dz\right]\right)\right]^3 \quad AROME\ /NL$$


Total obs nr of lightning discharges per hour
and total forecasted graupel amount
Lightning discharges per hour
Total integrated graupel
1.2 10^4
1 10^4
8000
6000
4000
2000
0
0
2 10^4
4 10^4
6 10^4
8 10^4
1 10^5
1.2 10^5
1.4 10^5

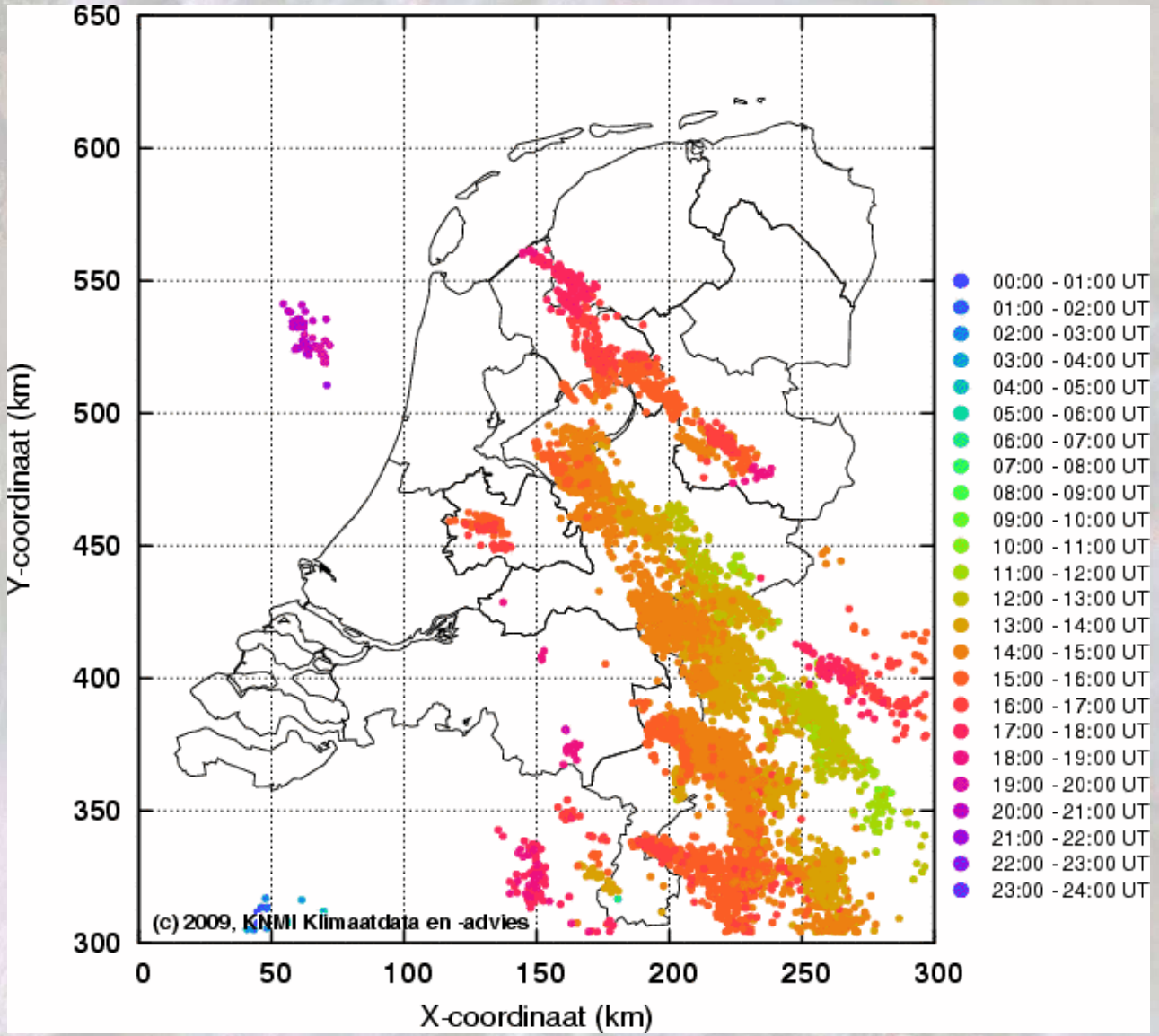
Application of AROME

WRF relation

AROME-relation



Application of AROME



New version of KF-RK

- Original version of Rasch-Kristjansson scheme (condensation) has tendency to overpredict small precipitation amounts
- Too much precip from shallow cumulus with warm cloud tops
- New version improves behaviour considerably, especially much better for small precipitation amounts

New version of KF-RK

Contingency table for Precipitation (mm/12h)
Area:EWGLAM
Period: 200702
Limits 0.1000000015 0.3000000119 1.000000000 3.000000000 10.00000000 30.00000000 100.0000000
Each class is data <= limit, the very last > last limit
Total number of values 38233

		OBSERVATION							
		14575	422	251	77	32	3	0	0 | 15360
		4297	330	377	113	55	4	0	0 | 5176
		4294	648	1081	446	154	20	0	0 | 6643
	721	1884	518	1673	1215	652	60	2	0 | 6004
		433	160	703	1126	1756	309	7	0 | 4494
		17	11	31	64	224	184	14	0 | 545
		0	0	0	0	1	4	6	0 | 11
		0	0	0	0	0	0	0	0 | 0
SUM		25500	2089	4116	3041	2874	584	29	0 | 38233
		OBSERVATION							
		18172	716	565	177	81	15	0	0 | 19726
		2806	321	539	160	52	7	1	0 | 3886
		2537	490	969	473	173	18	1	0 | 4661
	newsnow7122	1492	390	1354	1085	655	57	0	0 | 5033
		460	163	654	1073	1654	284	7	0 | 4295
		33	9	35	72	259	199	16	0 | 623
		0	0	0	1	0	4	4	0 | 9
		0	0	0	0	0	0	0	0 | 0
SUM		25500	2089	4116	3041	2874	584	29	0 | 38233

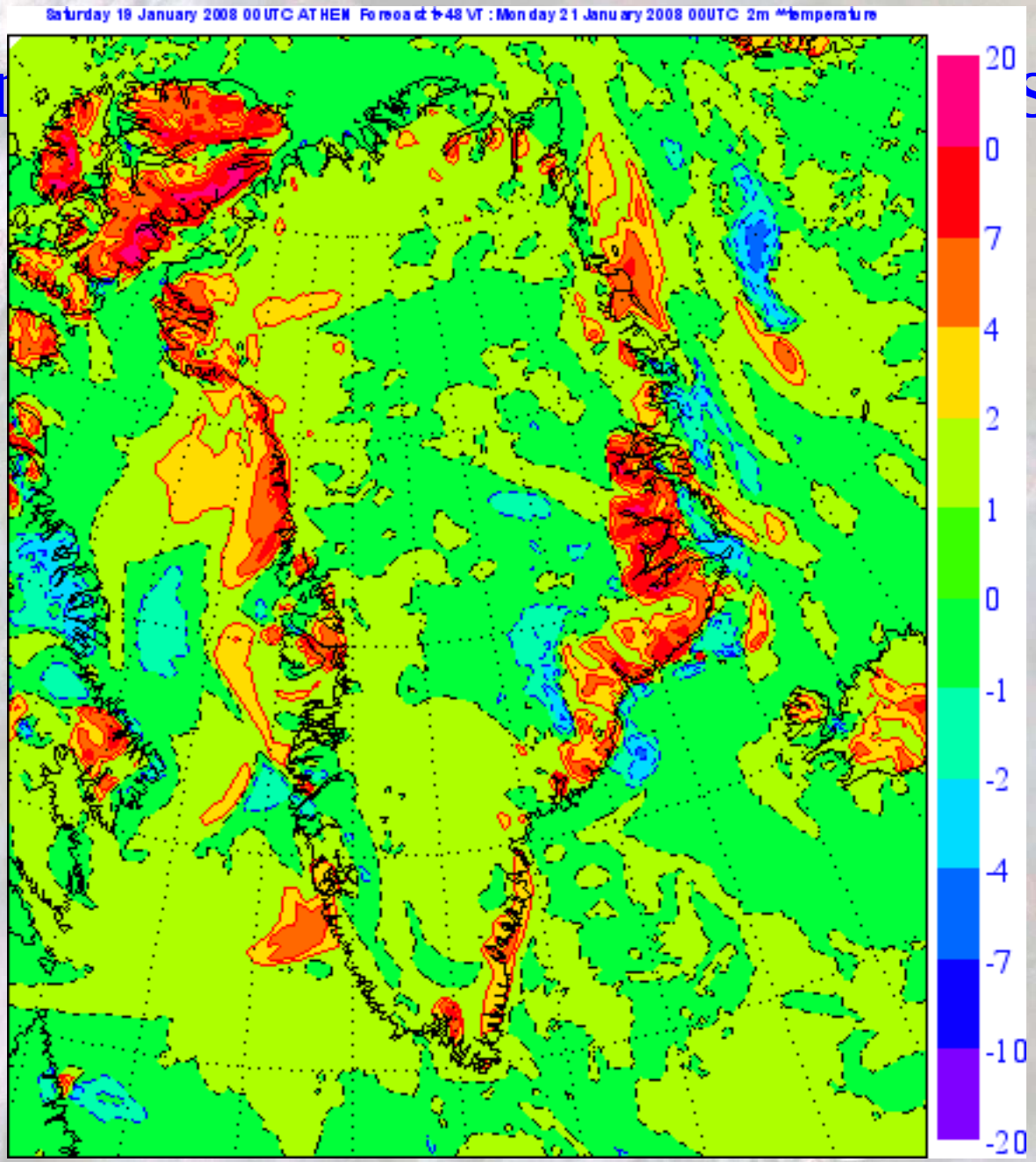
New version of KF-RK

Contingency table for Precipitation (mm/12h)
Area:EWGLAM
Period:20060725-20060824
Limits 0.1000000015 0.3000000119 1.000000000 3.000000000 10.00000000 30.00000000 100.0000000
Each class is data <= limit, the very last > last limit
Total number of values 47714

		OBSERVATION							
	22129	342	438	215	220	66	4	0	23414
	4212	227	342	168	130	57	3	0	5139
	4553	452	842	427	362	130	8	0	6774
721	2772	498	1027	750	778	229	17	0	6071
	1250	226	817	853	1120	564	37	0	4867
	179	48	136	204	401	345	50	0	1363
	12	0	7	10	8	39	10	0	86
	0	0	0	0	0	0	0	0	0
SUM	35107	1793	3609	2627	3019	1430	129	0	47714
				OBSERVATION					
	26099	627	763	388	342	107	4	0	28330
	2759	274	438	218	187	46	2	0	3924
	2697	307	691	390	363	115	8	0	4571
newsnow7122	2071	294	804	577	616	220	11	0	4593
	1233	248	759	789	1059	510	41	0	4639
	238	43	147	252	436	406	52	0	1574
	10	0	7	13	16	26	11	0	83
	0	0	0	0	0	0	0	0	0
SUM	35107	1793	3609	2627	3019	1430	129	0	47714

Impact orographic roughness

- Orographic roughness reduces wind speed
- This reduces surface flux of heat
- Less exchange between surface and atmosphere
- Surface cools much more, much lower T2m
- No cooling of atmosphere, weaker katabatic flows


Saturday 19 January 2008 00UTC ATHEN Forecast +48 VT : Monday 21 January 2008 00UTC 2m Temperature
20
0
7
4
2
1
0
-1
-2
-4
-7
-10
-20

Radiation in cold conditions

- HIRLAM has problem with temperature gradient problem at lowest model levels
- Too few occasions with large temperature gradient between surface and lowest level
- Earlier cause sought in surface and surface exchanges
- Probably caused by long wave radiative cooling of lowest model level

Radiation in cold conditions