New operational ICON-LAM over South East Europe and preliminary tests of its shallow convection schemes

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Thanks to:
Daniel Rieger, Maike Ahlgrimm, Daniel Reinert, Florian Prill, Frank Helmut,
Bojan Kasic, Cristian Simarro

COSMO General Meeting, September 2020

Outline

1. New operational ICON-LAM over South East Europe, verification

2. Why would we like to focus on the Shallow Convection Parametrization (SCP)?

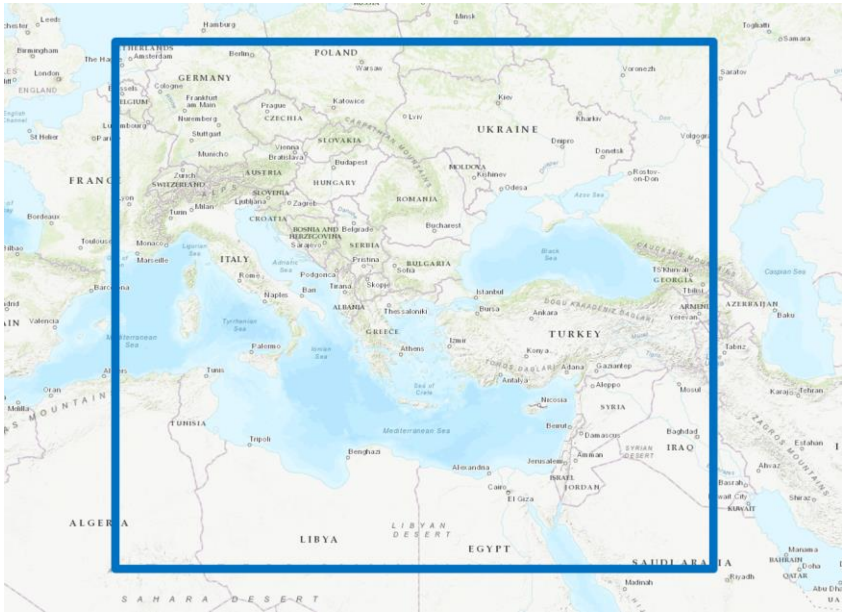
3. Preliminary tests of ICON SCPs

4. Plans

New operational ICON-LAM over South East Europe

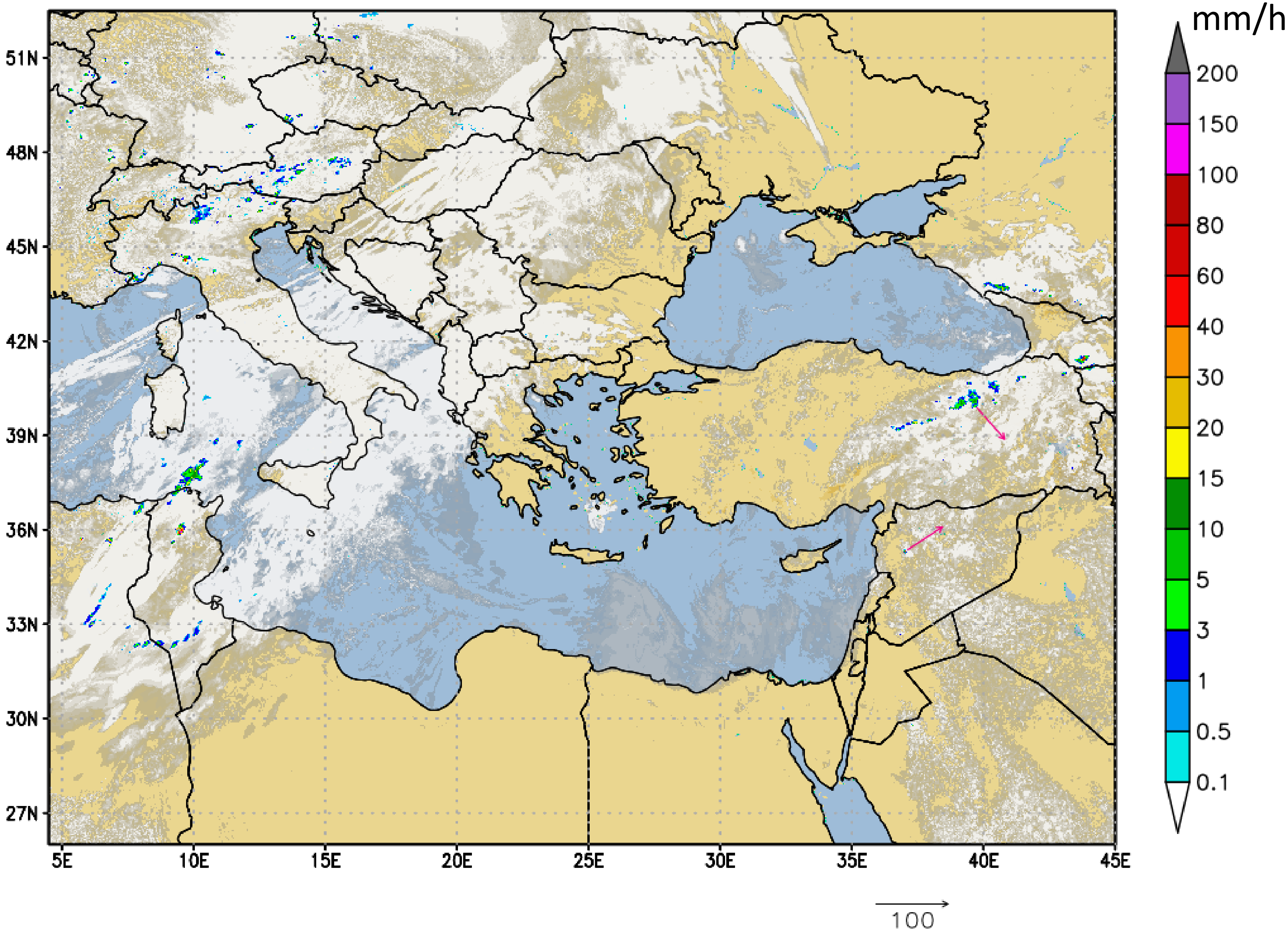
- **Goal:** For our own needs and encouraged by WMO SEE-MHEWS-A (Multi-Hazard Early Warning Advisory System for South-East Europe)
- **Platform**: The "Time Critical Suite" for running ICON-LAM ("ICON-IL-IFS") model was prepared on the ECMWF HPC
- **Model setup:** Domain: **4-45.5E/25.5-53N**
  Resolution: **~2.5km** horizontal, 65 levels vertical
  Range: **78h**
  IC/BC: **det. IFS**
- **Oper. runs:** **2 runs/day** since June 2020
- **Data assimilation:** Not yet

ICON-IL domain

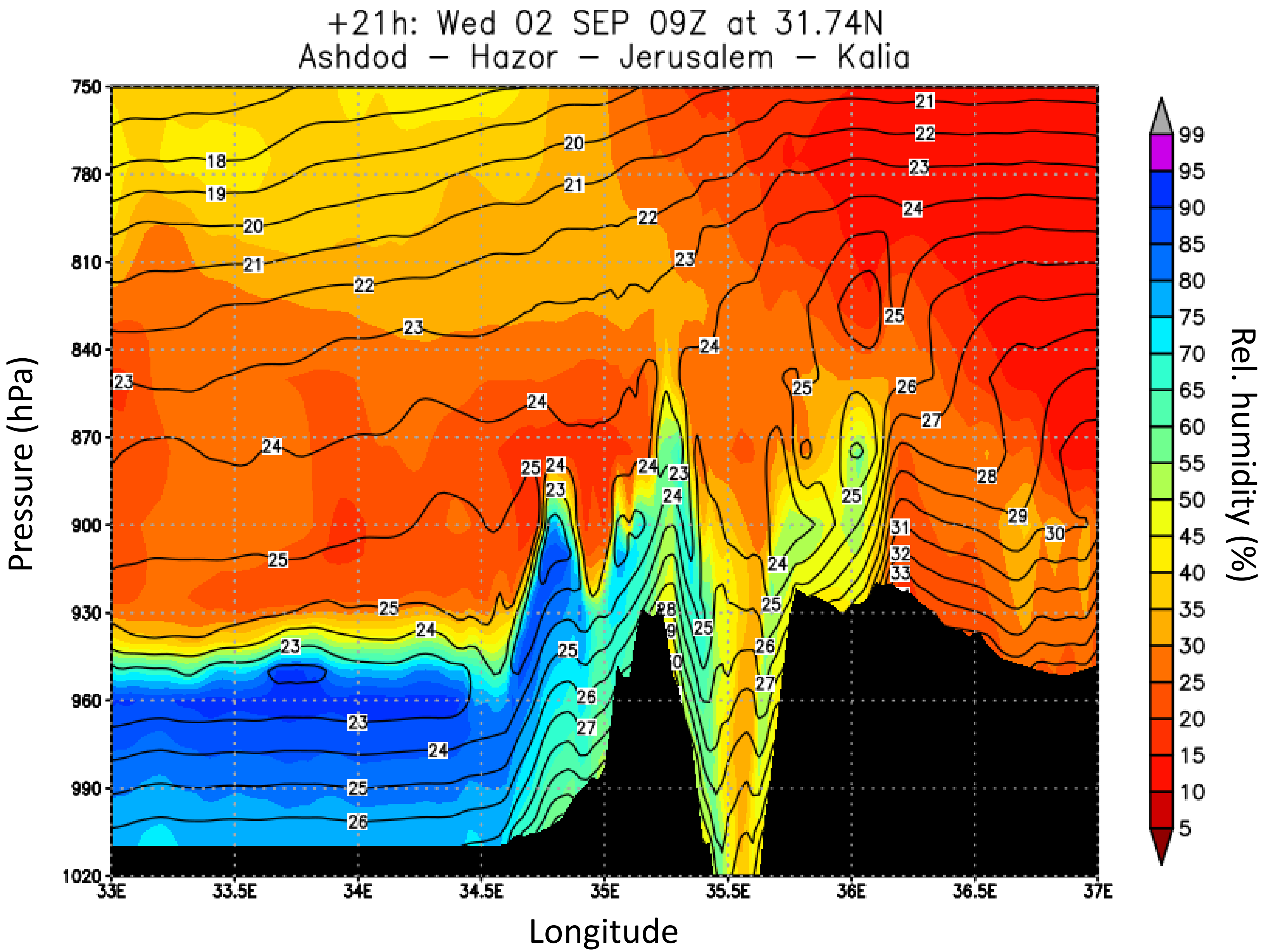


Some precipitation in Frankfurt area today afternoon?

20200901:12Z + 26h:15m



We currently have ~28^{o}C here in Jerusalem



Verification: winter rainy events

Wintertime rain events:

2016121200, 2016122300, 2017021100, 2017021400, 2017041200, 2017112000, 2017120500, 2018010500, 2018011800, 2018021600, 2018042500, 2018042600, 2020010200, 2020010300, 2020010700, 2020010800

		ECMWF	ICON-IL	COSMO-IL
2m temperature	TT or_rmse_n	1.79	1.48	1.61
	TT or_rmse_d	1.92	1.58	1.95
	TT pl_rmse_n	1.62	1.47	1.55
	TT pl_rmse_d	1.57	1.38	1.49
2m rel. humidity	RH or_rmse_n	10.79	10.68	11.44
	RH or_rmse_d	11.52	11.16	12.87
	RH pl_rmse_n	9.75	10.38	11.01
	RH pl_rmse_d	10.74	11.13	11.42
10m wind speed	WS or_rmse_n	1.92	1.88	1.9
	WS or_rmse_d	2	2.14	2.24
	WS pl_rmse_n	1.76	1.79	1.78
	WS pl_rmse_d	1.92	2.04	2.09
10m wind direction	WD or_rmse_n	0.85	0.93	0.89
	WD or_rmse_d	1.16	1.2	1.29
	WD pl_rmse_n	0.99	1.13	1.02
	WD pl_rmse_d	1.36	1.34	1.44
Temperature profiles	PT 24_48_72	0.71	0.68	0.72
	PT 12_36_60	0.68	0.64	0.66
Mixing ratio profiles	PQ 24_48_72	0.56	0.59	0.55
	PQ 12_36_60	0.62	0.64	0.63
Wind vector profiles	PW 24_48_72	2.62	2.56	2.59
	PW 12_36_60	2.47	2.67	2.74
Precipitation (1-FSS)	FSS 6	0.42	0.41	0.37
	FSS 12	0.43	0.45	0.4
	FSS 18	0.33	0.33	0.35
	FSS 24	0.37	0.3	0.32
	FSS 30	0.31	0.24	0.28
	FSS 36	0.36	0.36	0.36
	FSS 42	0.46	0.36	0.38
	FSS 48	0.48	0.39	0.43
	FSS 54	0.37	0.38	0.3
	FSS 60	0.44	0.4	0.31
	FSS 66	0.35	0.43	0.41
	SUMMARY	0	0.0212	0.0062

---> Better score vs. IFS

Winter-rain events: ICON is better

**New* turbulence

Verification: winter dry events

Wintertime dry events:
2017043000, 2017102100, 2017120200, 2017122000, 2018010800, 2018011100, 2018020900, 2018022000, 2018022300, 2018030600, 2018040100

		ECMWF	ICON-IL	COSMO-IL
2m temperature	TT or_rmse_n	2.11	1.87	1.97
	TT or_rmse_d	1.87	1.83	1.82
	TT pl_rmse_n	2.3	2.04	2.04
	TT pl_rmse_d	1.67	1.61	1.64
2m rel. humidity	RH or_rmse_n	14.42	12.98	13.42
	RH or_rmse_d	9.14	12.45	8.96
	RH pl_rmse_n	12.05	11.09	10.17
	RH pl_rmse_d	9.8	10.56	9.66
10m wind speed	WS or_rmse_n	1.61	1.56	1.52
	WS or_rmse_d	1.43	1.41	1.63
	WS pl_rmse_n	1.3	1.27	1.2
	WS pl_rmse_d	1.2	1.29	1.38
10m wind direction	WD or_rmse_n	0.85	0.82	0.78
	WD or_rmse_d	0.93	0.84	0.96
	WD pl_rmse_n	0.75	0.63	0.69
	WD pl_rmse_d	0.84	0.84	0.96
Temperature profiles	PT 24_48_72	1.09	0.99	1.06
	PT 12_36_60	0.91	0.91	0.91
Mixing ratio profiles	PQ 24_48_72	1.06	1.07	1.04
	PQ 12_36_60	1	1	1.01
Wind vector profiles	PW 24_48_72	2.32	2.4	2.47
	PW 12_36_60	2.3	2.26	2.43
	SUMMARY	0	0.0169	0.0098

--> Better score vs. IFS

*New turbulence

Winter-dry events: ICON is better

Verification: summer dry events

Summertime events:
2017060700, 2017063000, 2017071700, 2017080100, 2017082500, 2017090500, 2018060300, 2018071100, 2018072000

		ECMWF	ICON-IL	COSMO-IL
2m temperature	TT or_rmse_n	1.86	1.6	1.53
	TT or_rmse_d	1.62	1.4	1.17
	TT pl_rmse_n	1.78	1.76	1.55
	TT pl_rmse_d	1.29	1.17	0.98
2m rel. humidity	RH or_rmse_n	12.06	10.03	11.45
	RH or_rmse_d	6.95	6.89	6.11
	RH pl_rmse_n	9.4	7.64	8.49
	RH pl_rmse_d	7.96	6.26	6.29
10m wind speed	WS or_rmse_n	1.7	1.54	1.77
	WS or_rmse_d	1.43	1.46	1.43
	WS pl_rmse_n	0.98	0.97	0.98
	WS pl_rmse_d	1.03	1.24	1.21
10m wind direction	WD or_rmse_n	0.57	0.62	0.5
	WD or_rmse_d	0.84	0.79	0.76
	WD pl_rmse_n	0.68	0.72	0.7
	WD pl_rmse_d	0.49	0.49	0.45
Temperature profiles	PT 24_48_72	0.99	1.12	0.96
	PT 12_36_60	0.75	0.83	0.8
Mixing ratio profiles	PQ 24_48_72	1.6	1.51	1.55
	PQ 12_36_60	1.39	1.6	1.47
Wind vector profiles	PW 24_48_72	1.89	1.95	2.07
	PW 12_36_60	1.86	1.87	1.98
	SUMMARY	0	0.0180	0.0525

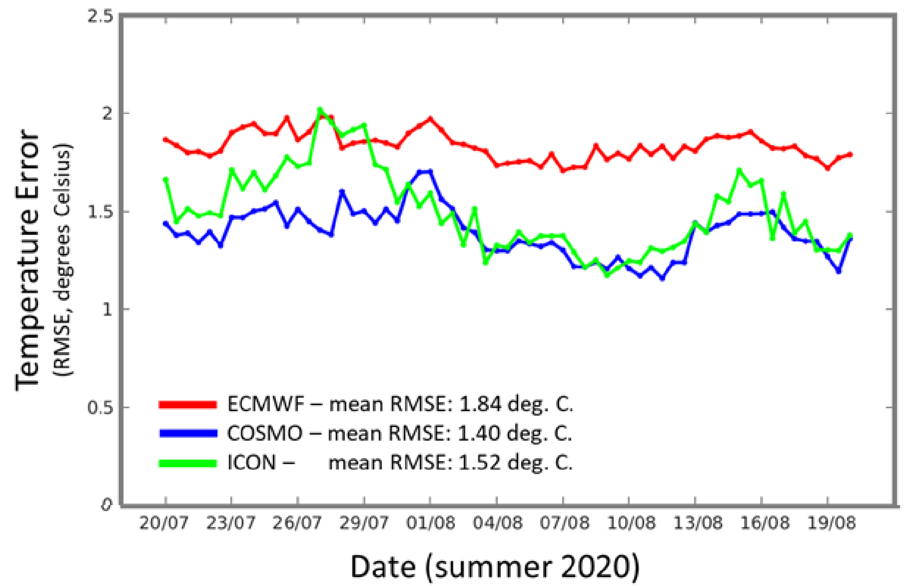
---> Better score vs. IFS

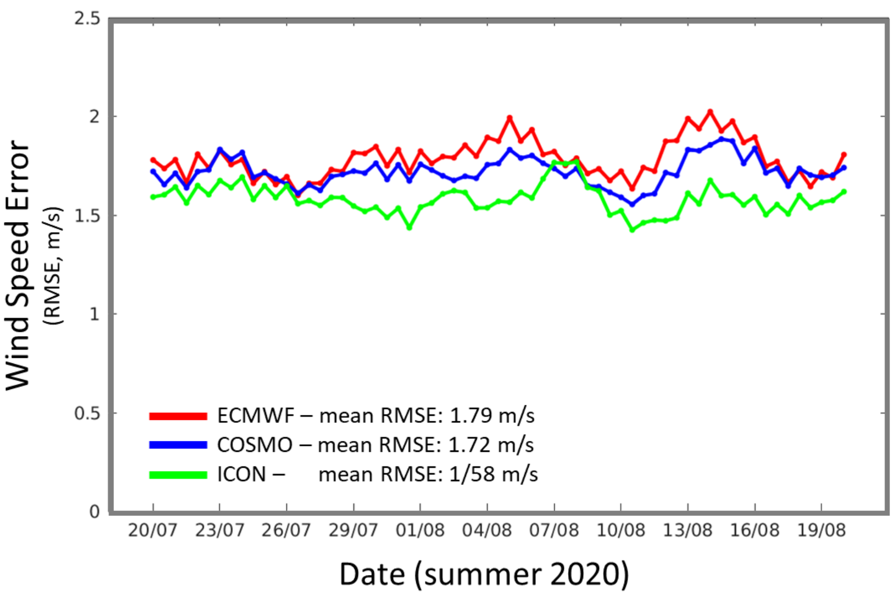
Summer events: COSMO is better

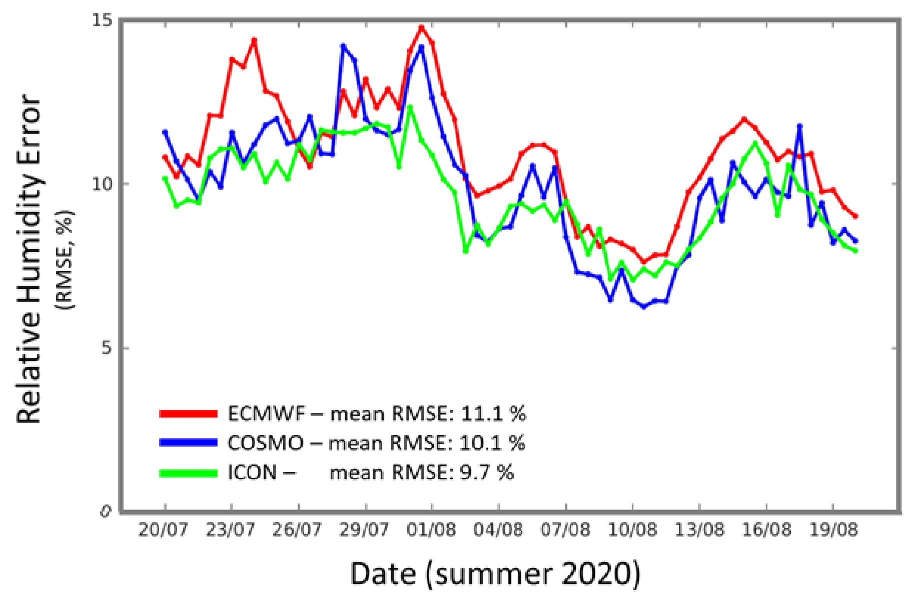
*__Old__ turbulence

Verification: last month (all stations, all times)

- Even in summer ICON is better in RH_{2m} and WS_{10m}
- All this without tuning for our region

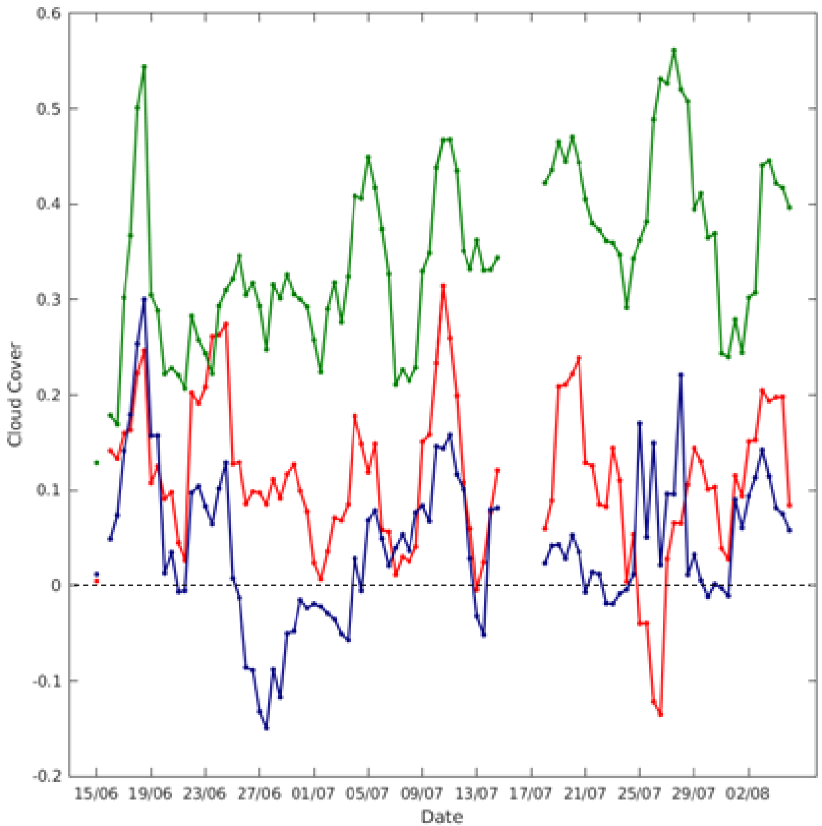






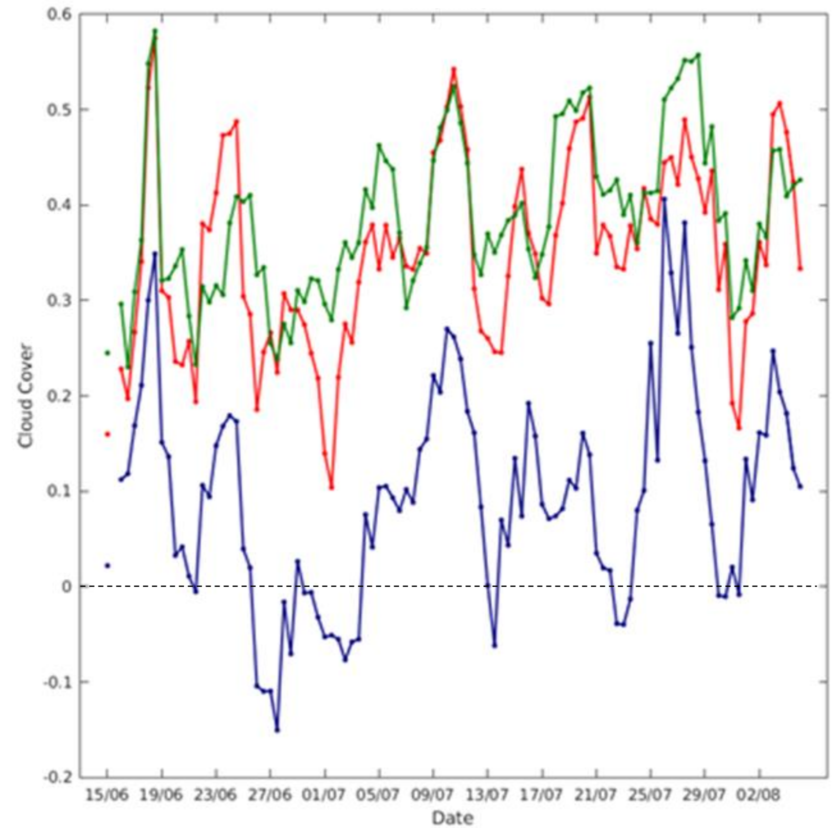
Cloudiness overestimation: verification vs CMSAF satellite

IFS
COSMO-IL
ICON-IL



(1)

Bias in the fraction (over entire verification area) of the “cloudy grid points”. “Cloudy” defined as > 50%.

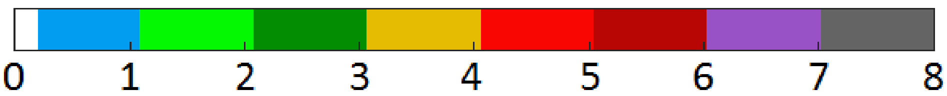


(2)

Bias in the fraction (over entire verification area) of the “cloudy grid points”. “Cloudy” defined as > 0%.

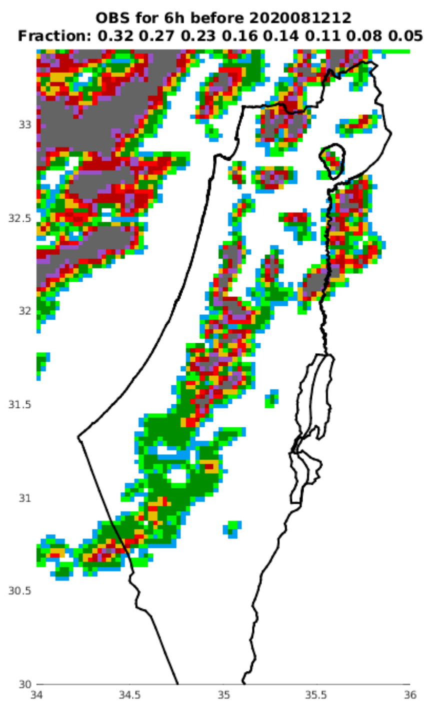
Cloudiness overestimation – of SGS low (water) cloud cover

example 12/8/2020 12UTC

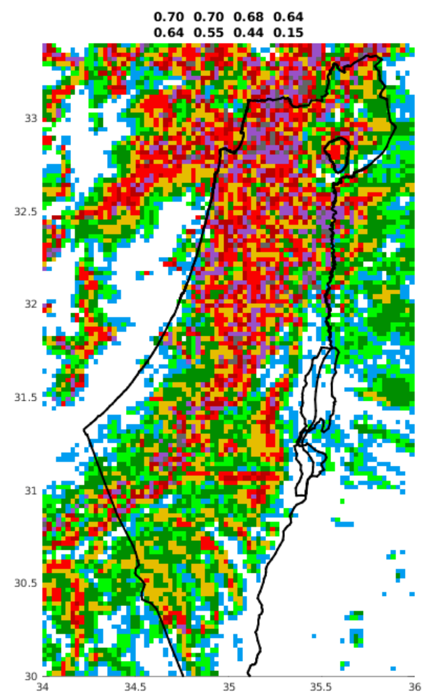


[oktas]

OBS (CMSAF satellite)

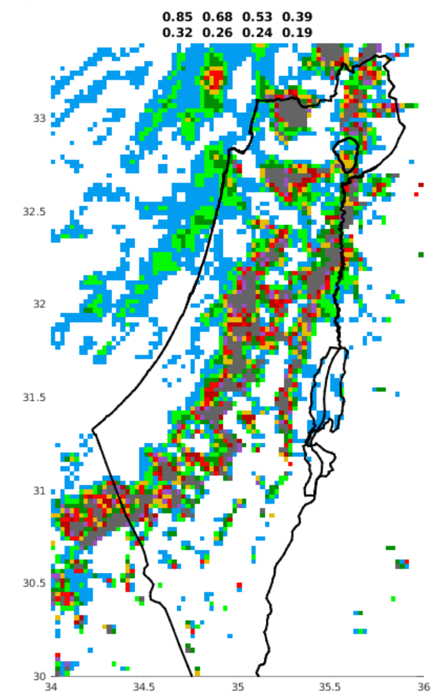


ICON-IL



Over estimation

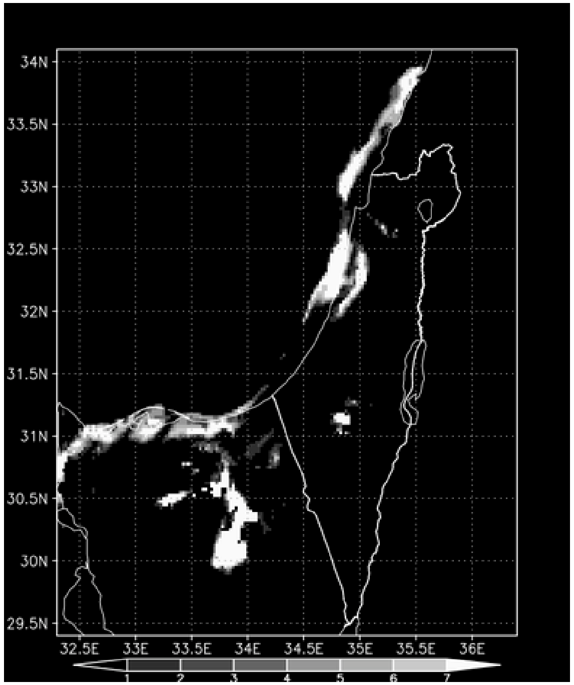
COSMO-IL



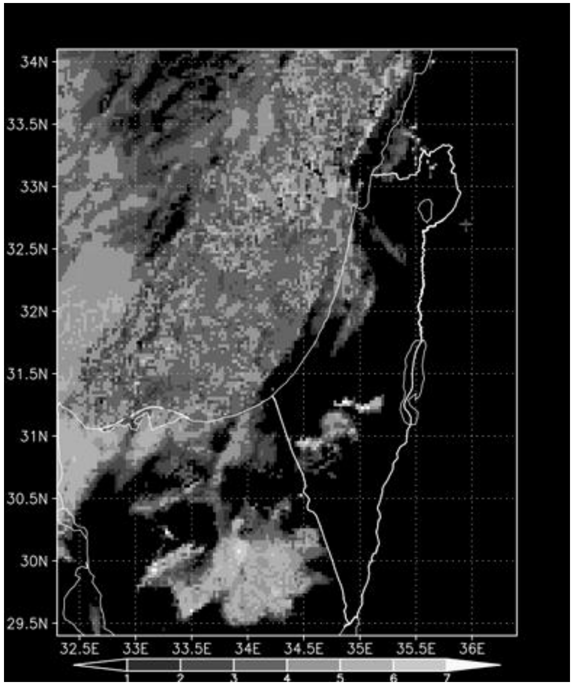
good

Cloudiness overestimation – of SGS low (water) cloud cover

COSMO-IL



ICON-IL



Low cloudiness example (20200829:00UTC)

Outline

1. New operational ICON-LAM over South East Europe, verification
2. Why would we like to focus on the Shallow Convection Parametrization (SCP)?
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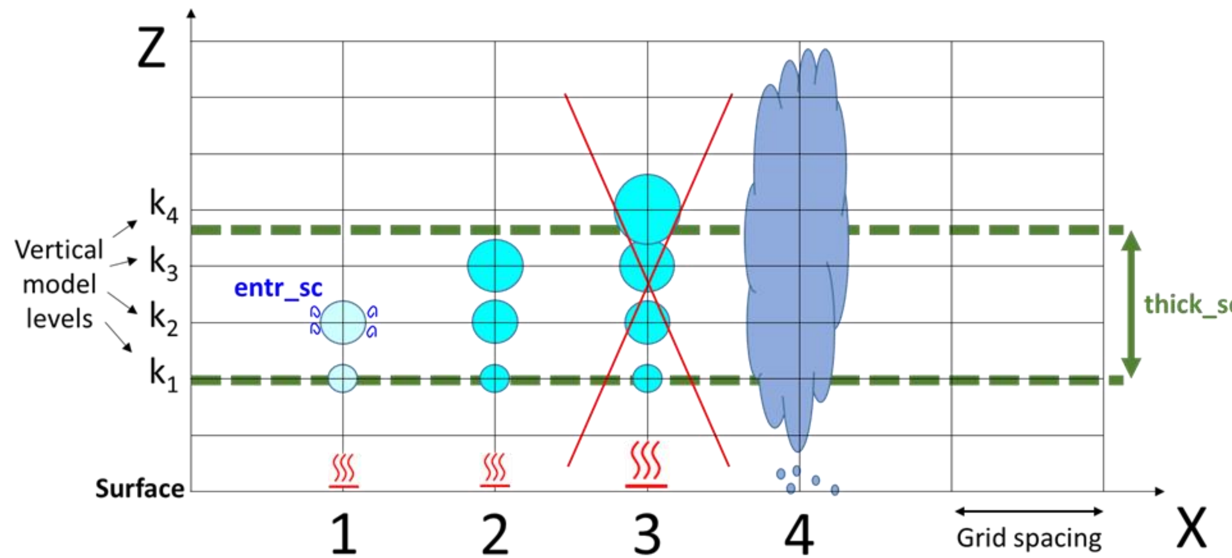
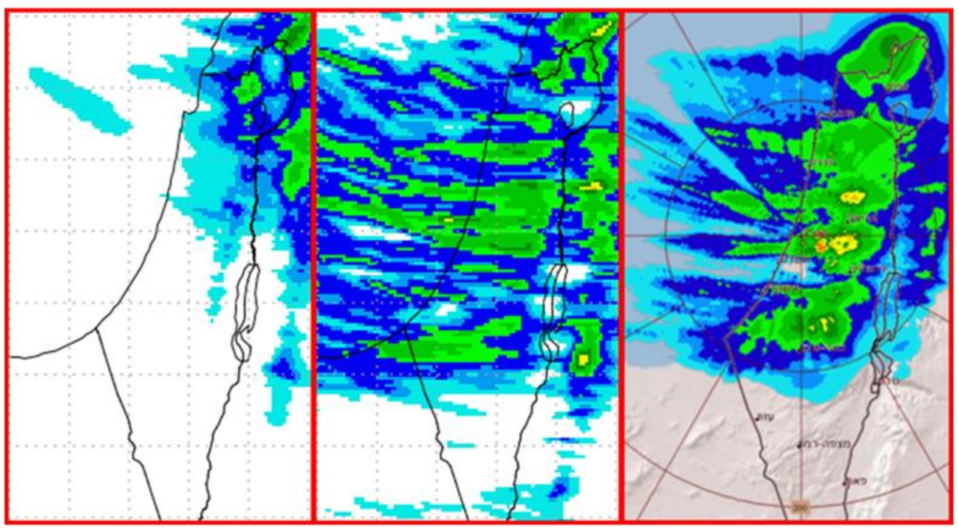
Why focus on the Shallow Convection Parametrization (SCP)?

Brief reminder of COSMO SCP:



Influence of shallow convection parametrization on model forecast
(Example of 6h precipitation forecast from 1/1/2016 00 UTC + 18h)

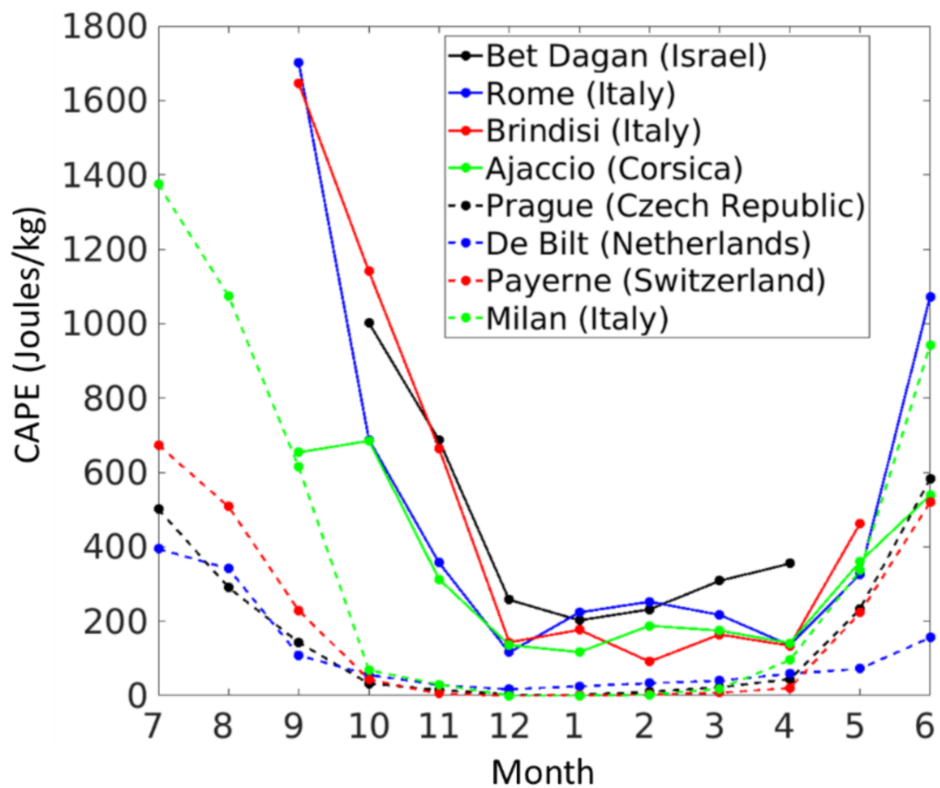


Forecast with very active SCP	Forecast with tuned SCP	Radar-rain gauge composite

Khain P., Y. Levi, H. Muskatel, A. Shtivelman, E. Vadislavsky, N. Stav (2020): "Effect of shallow convection parametrization on cloud resolving NWP forecasts over the Eastern Mediterranean". Atmos. Res. 247, 105213.
https://doi.org/10.1016/j.atmosres.2020.105213

Why focus on the Shallow Convection Parametrization (SCP)?

Where and when COSMO SCP is significant? In areas/seasons with moderate CAPE



COSMO SCP
is significant

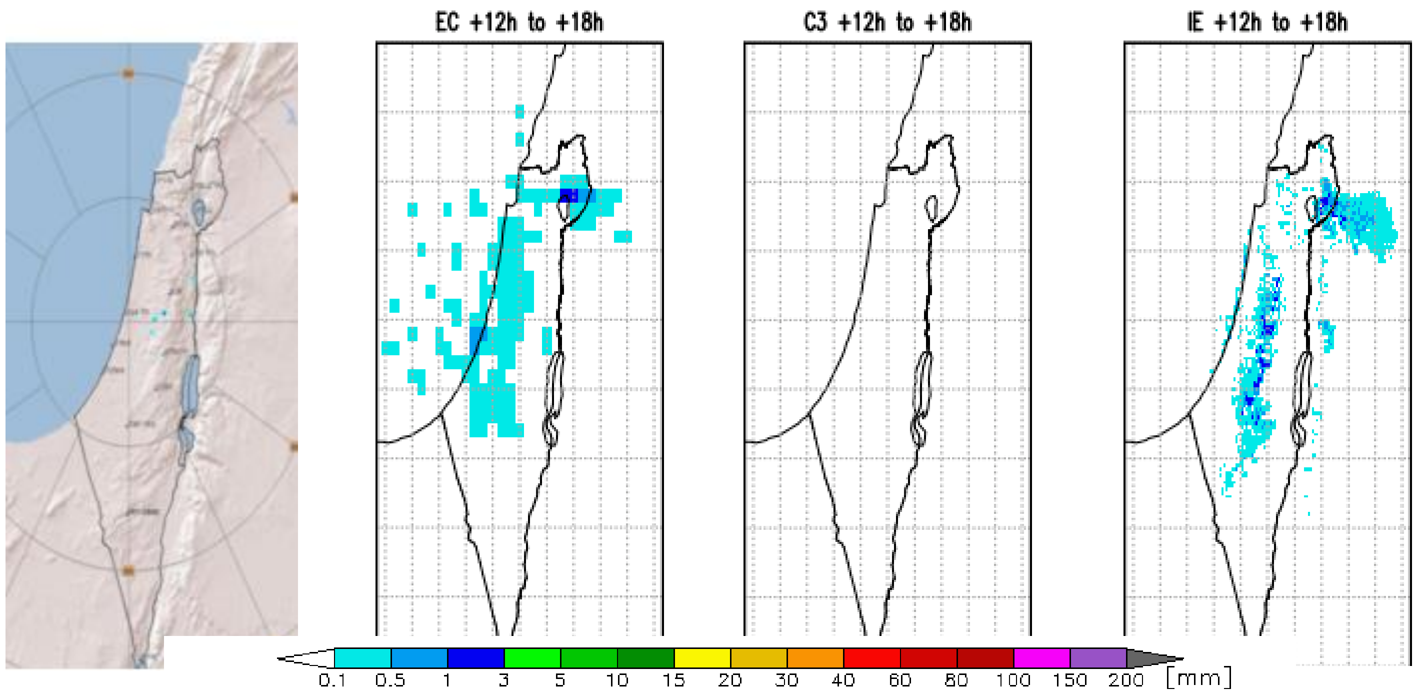
Why focus on the Shallow Convection Parametrization (SCP)?

In COSMO SCP did not produce precipitation and in moderate CAPE spoiled grid scale precip.

But in ICON SCP itself produces precipitation!

Example: Israeli summer 5/7/2020 06UTC

RADAR IFS COSMO-IL ICON-IL



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Preliminary tests of ICON Shallow Convection Parametrizations

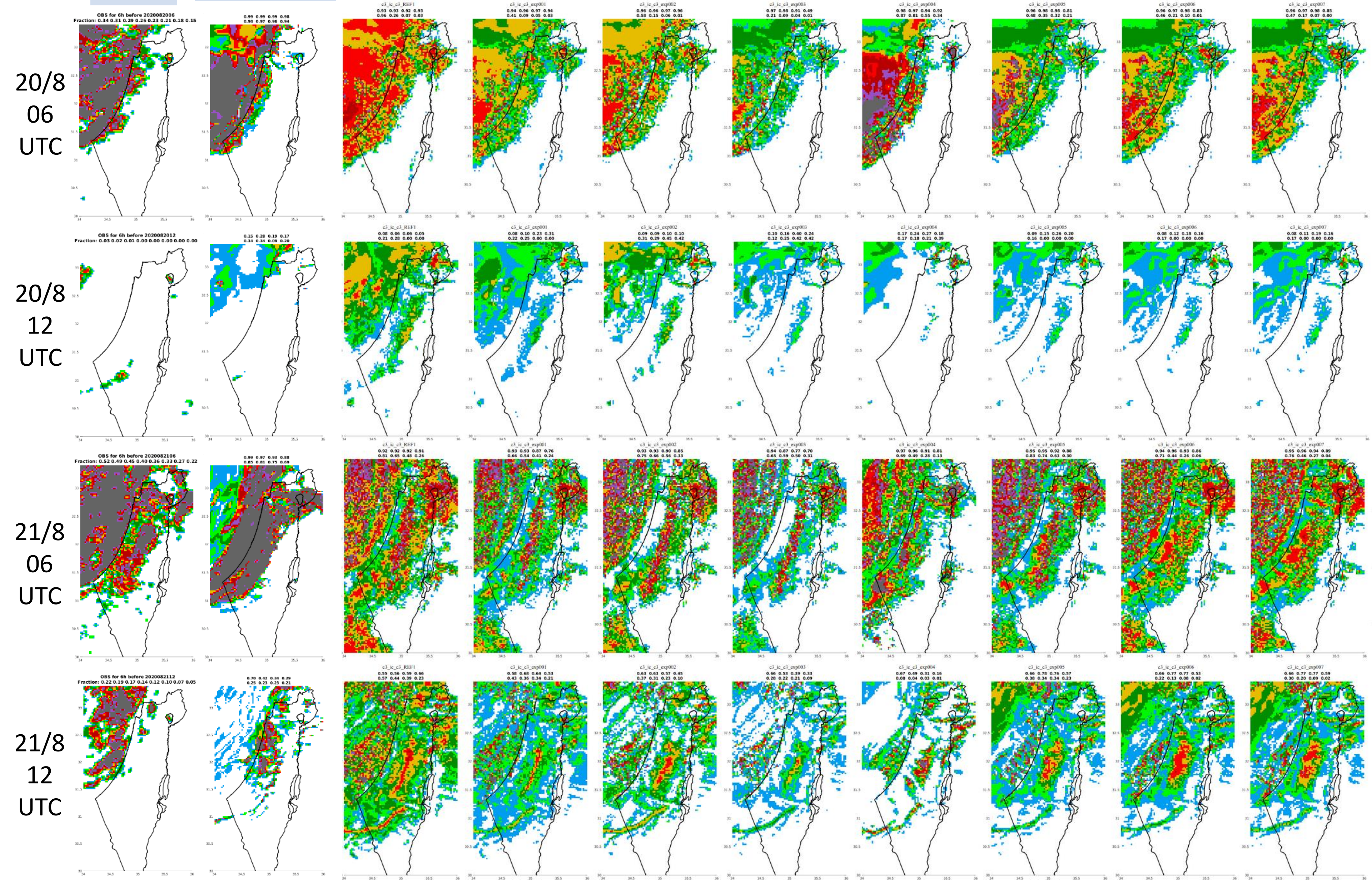
	REF1	exp001	exp002	exp003	exp004	exp005	exp006	exp007
	Master version from GIT Aug 2020	REF1 without **lcalib_ clcov**	REF1 reduced **tune_box_ liq_asy**	Combined **exp001** and **exp002**	REF1 with **COSMO SGS cloud cover**	exp003 **without res. dep. SCP tuning**	exp005 with **explicit stochastic scheme**	exp005 with **SDE stochastic scheme**
lcalib_ clcov	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
tune_box _liq_asy	3.25	3.25	2.5	2.5	3.25	2.5	2.5	2.5
inwp_ cldcover	1	1	1	1	3	1	1	1
lrestune _off	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE
lstoch _conv	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE
lstoch _sde	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE

Note! lcalib_clcov tunes cloud cover output without any effect on the rest of the model

Summer shallow convection

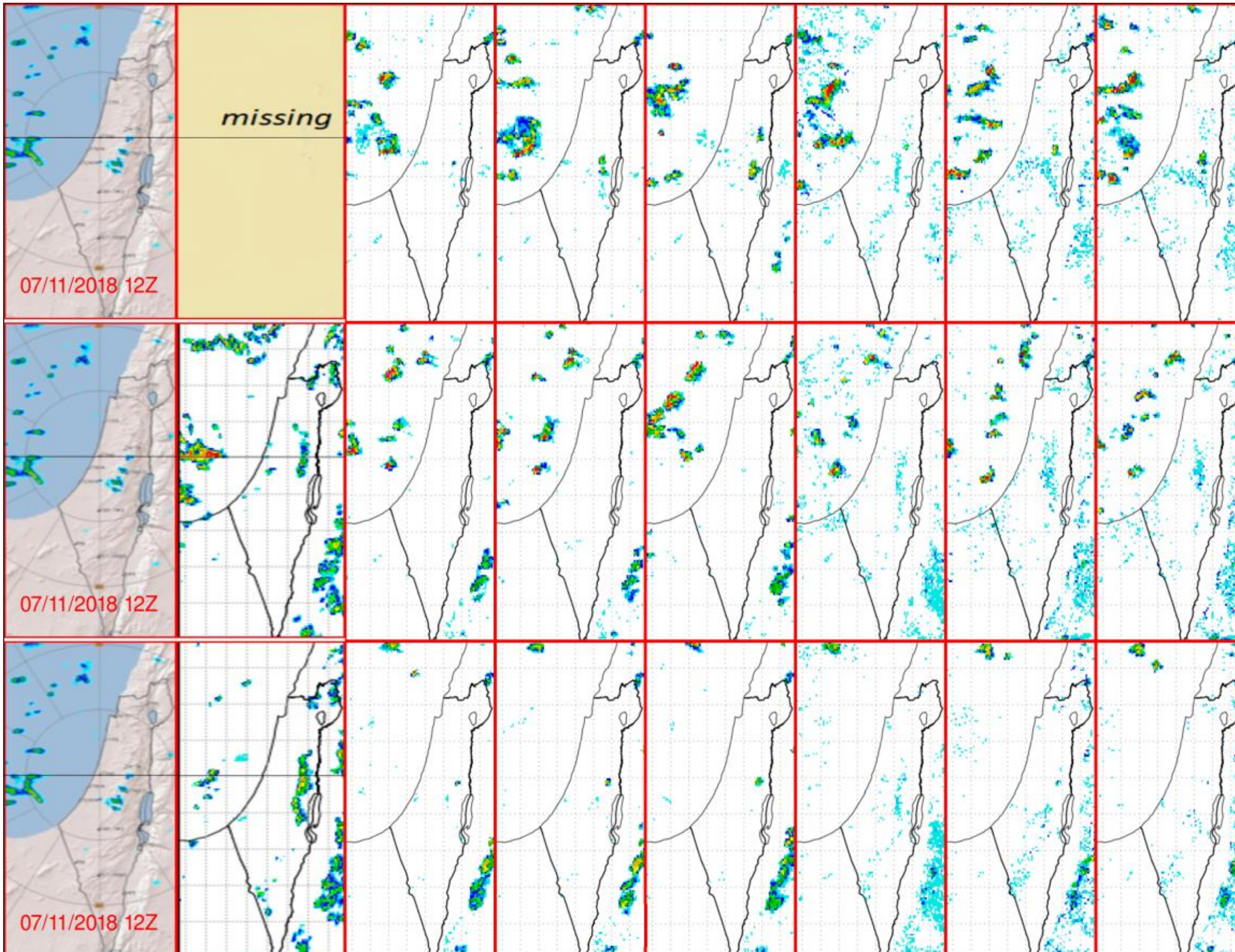
REF1	exp001	exp002	exp003	exp004	exp005	exp006	exp007
Master version from GIT Aug 2020	REF1 without **lcalib_clcov**	REF1 reduced **tune_box_liq_asy**	Combined **exp001** and **exp002**	REF1 with **COSMO SGS cloud cover**	exp003 **without res. dep. SCP tuning**	exp005 with **explicit stochastic scheme**	exp005 with **SDE stochastic scheme**

OBS **COSMO-IL**



Autumn convection

OBS	COSMO-IL	REF1	exp003	exp004	exp005	exp006	exp007
		Master version from GIT Aug 2020	Combined **exp001** and **exp002**	REF1 with **COSMO SGS cloud cover**	exp003 **without res. dep. SCP tuning**	exp005 with **explicit stochastic scheme**	exp005 with **SDE stochastic scheme**



Autumn convection

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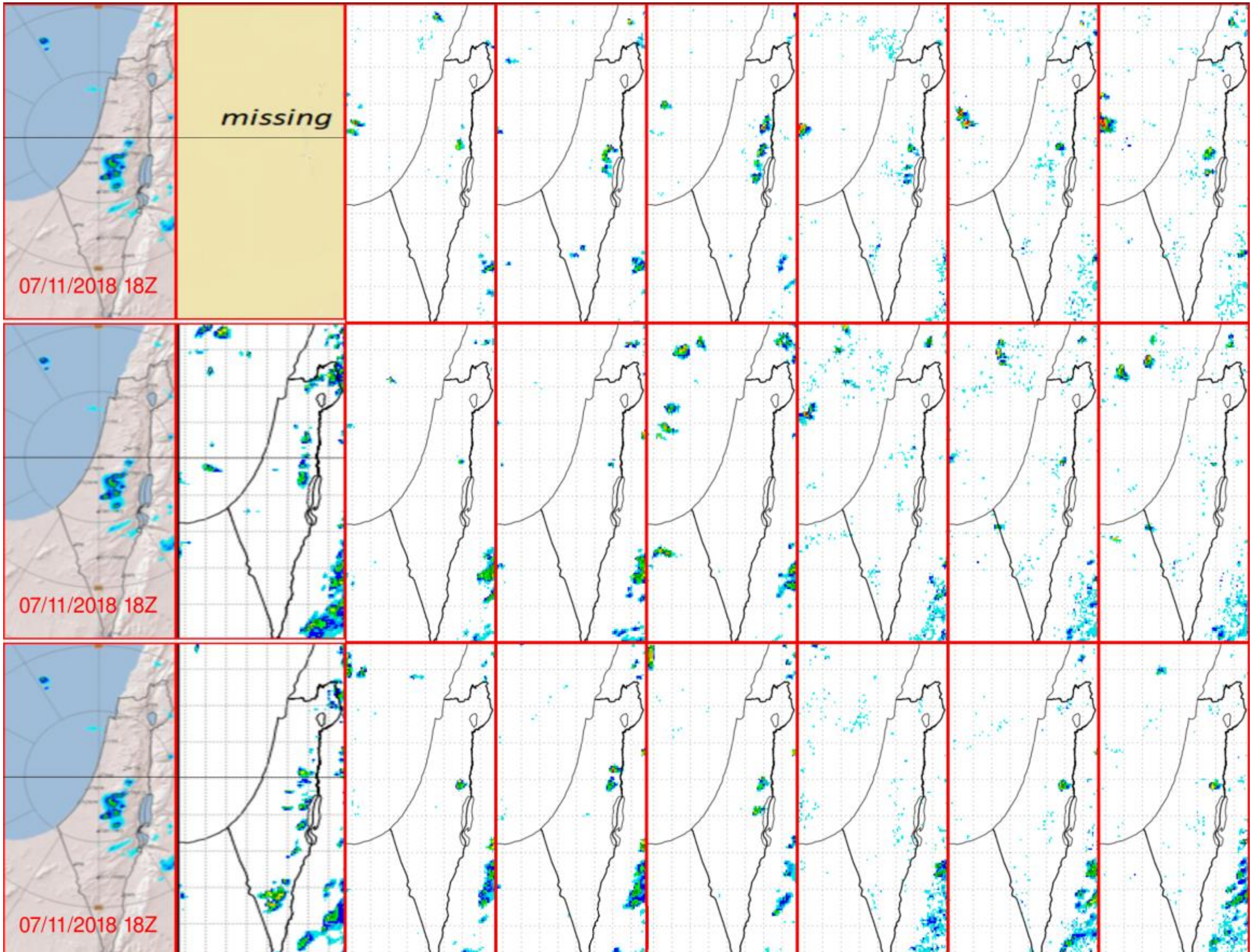

Autumn convection

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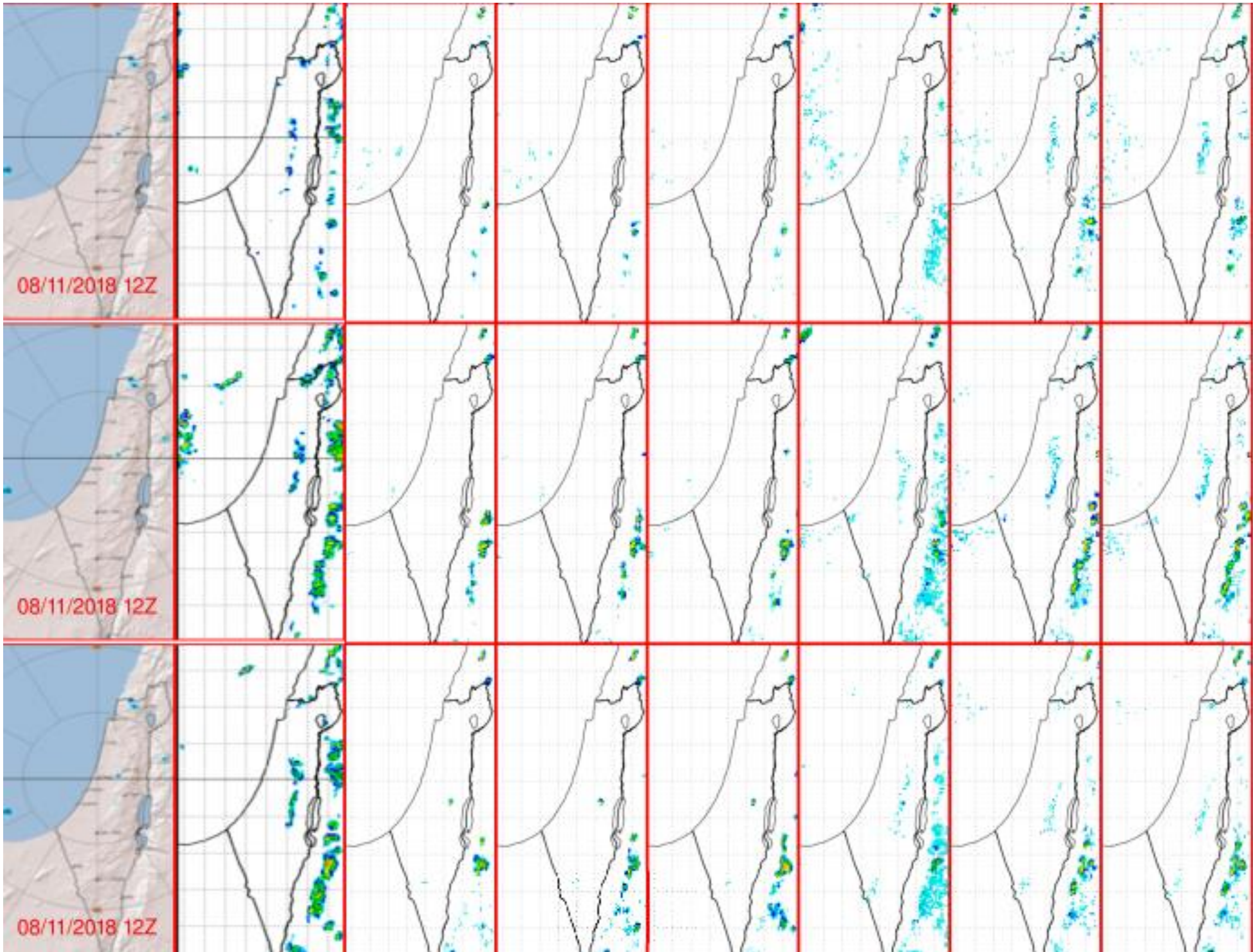
		Master version from GIT Aug 2020	Combined **exp001** and **exp002**	REF1 with **COSMO SGS cloud cover**	exp003 **without res. dep. SCP tuning**	exp005 with **explicit stochastic scheme**	exp005 with **SDE stochastic scheme**



Autumn convection

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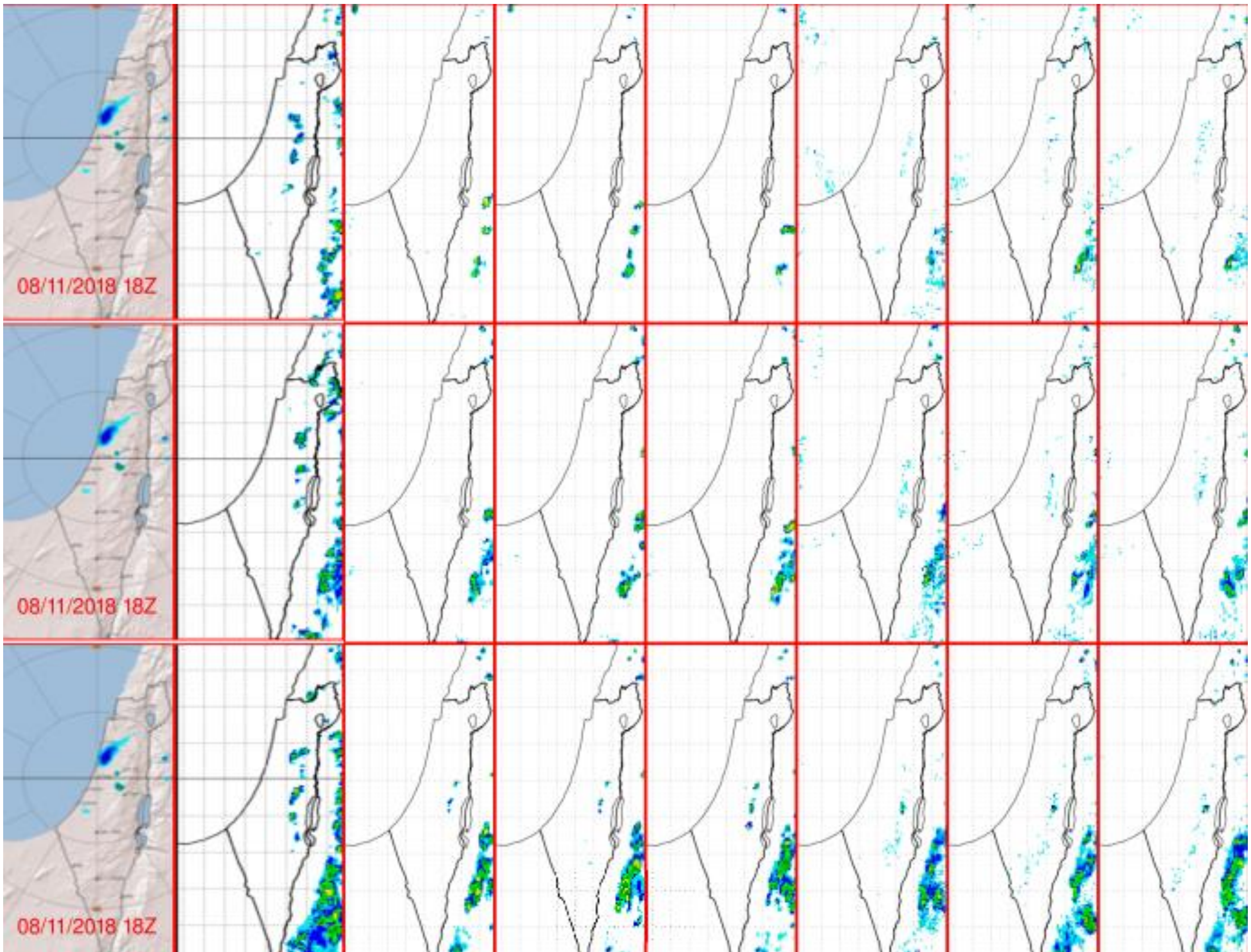
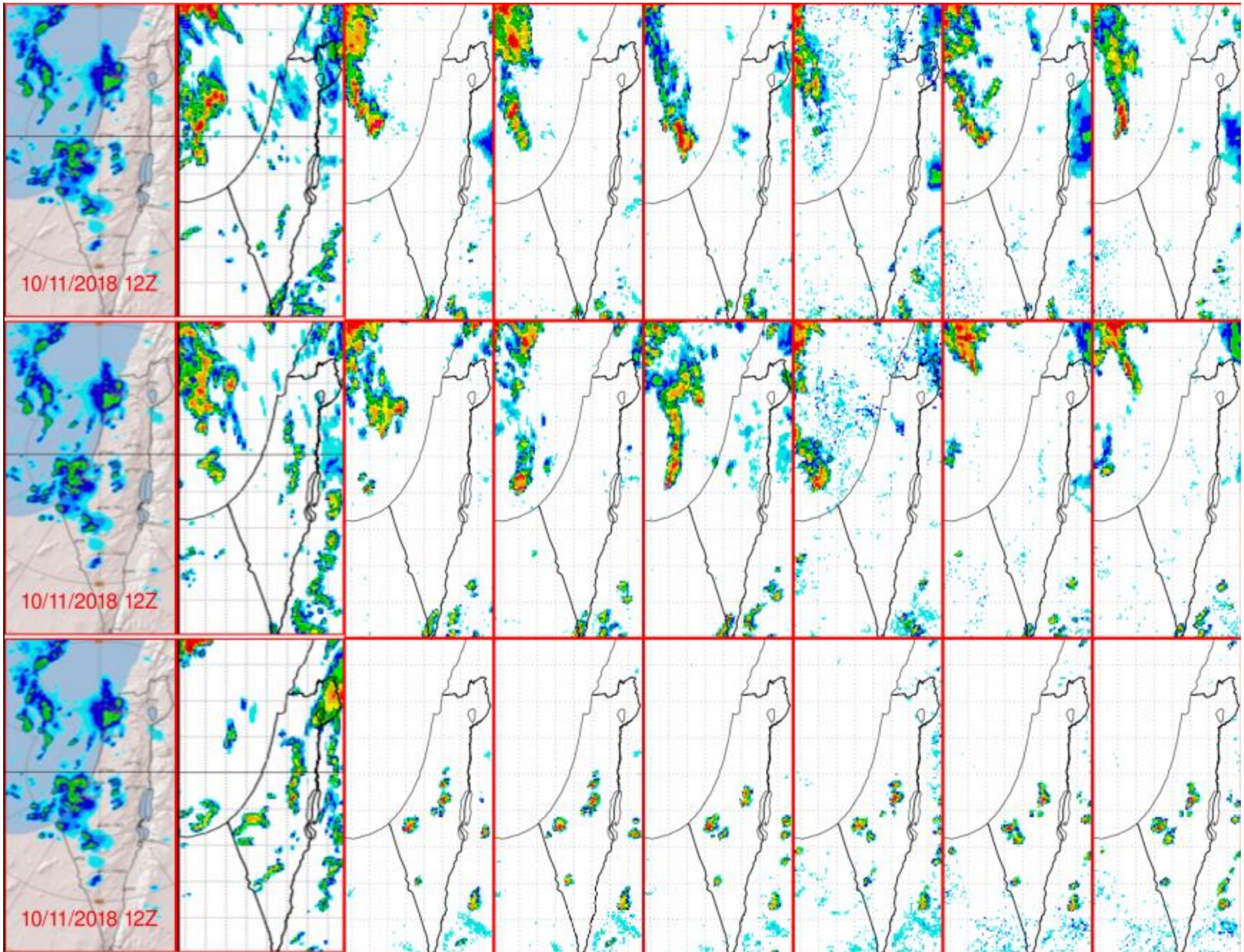
OBS	**COSMO-IL**	Master version from GIT Aug 2020	Combined **exp001** and **exp002**	REF1 with **COSMO SGS cloud cover**	exp003 **without res. dep. SCP tuning**	exp005 with **explicit stochastic scheme**	exp005 with **SDE stochastic scheme**



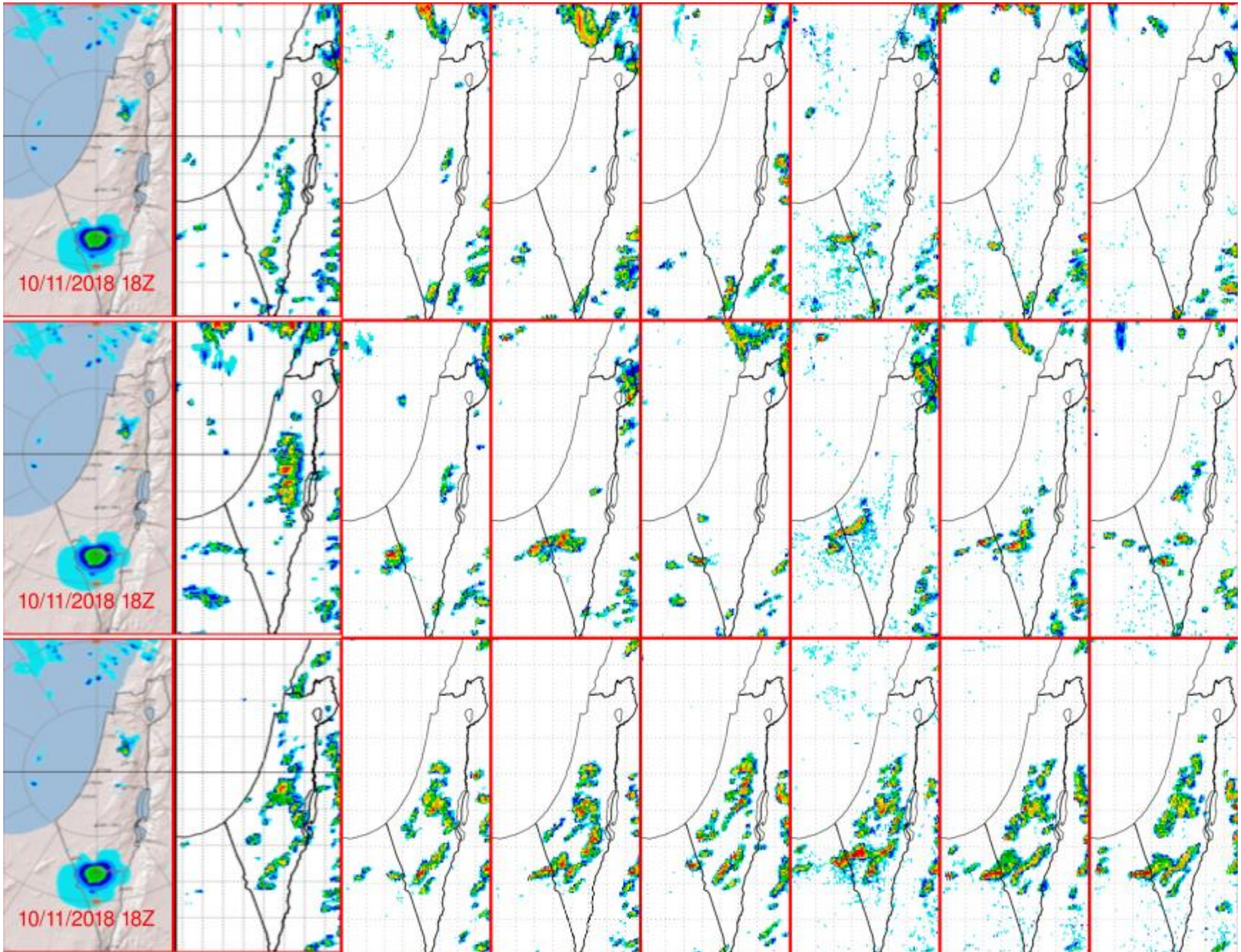
Autumn convection

OBS	COSMO-IL	REF1	exp003	exp004	exp005	exp006	exp007
		Master version from GIT Aug 2020	Combined **exp001** and **exp002**	REF1 with **COSMO SGS cloud cover**	exp003 **without res. dep. SCP tuning**	exp005 with **explicit stochastic scheme**	exp005 with **SDE stochastic scheme**



Autumn convection

OBS	COSMO-IL	REF1	exp003	exp004	exp005	exp006	exp007
		Master version from GIT Aug 2020	Combined **exp001** and **exp002**	REF1 with **COSMO SGS cloud cover**	exp003 **without res. dep. SCP tuning**	exp005 with **explicit stochastic scheme**	exp005 with **SDE stochastic scheme**



Autumn convection

OBS	COSMO-IL	REF1	exp003	exp004	exp005	exp006	exp007
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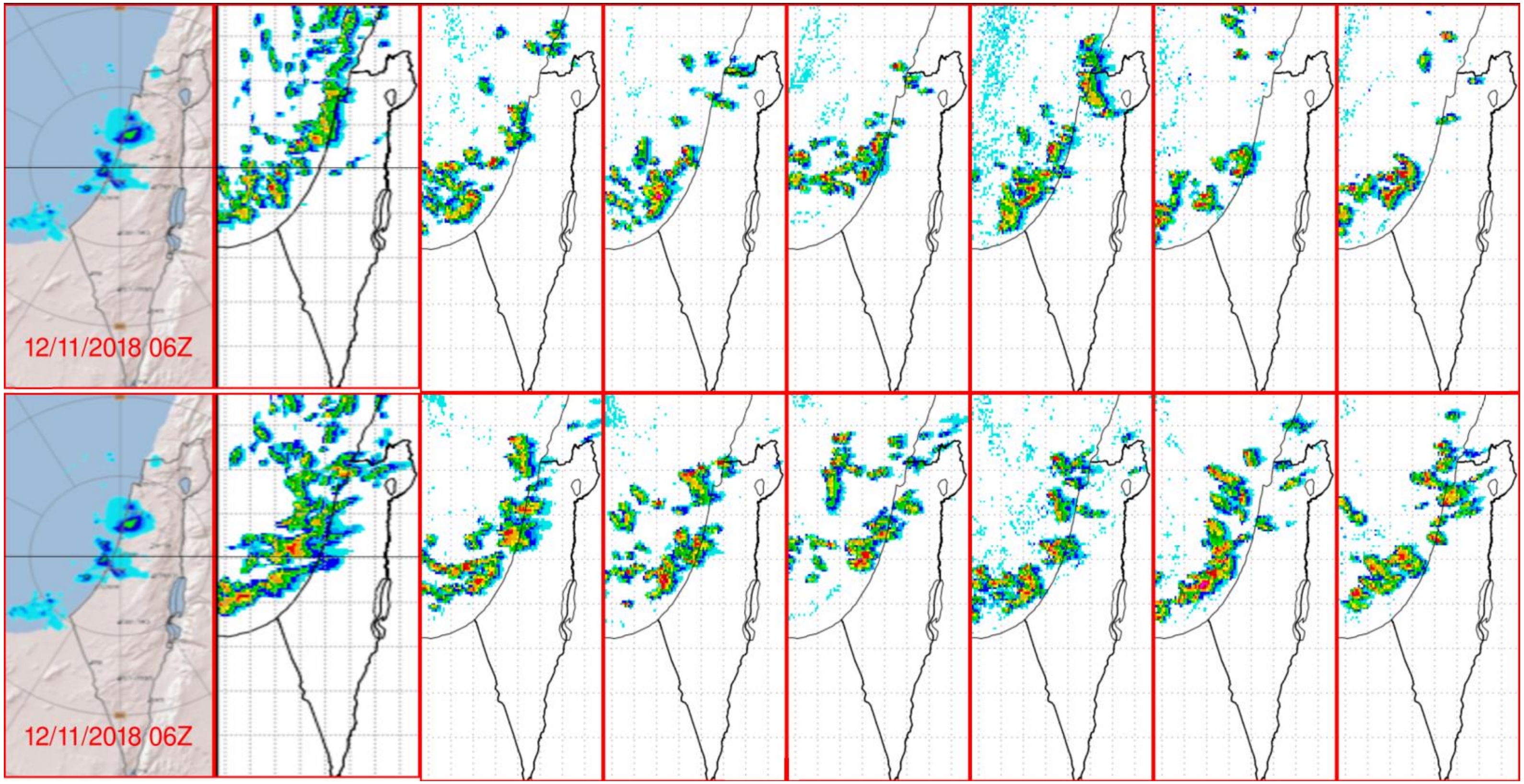
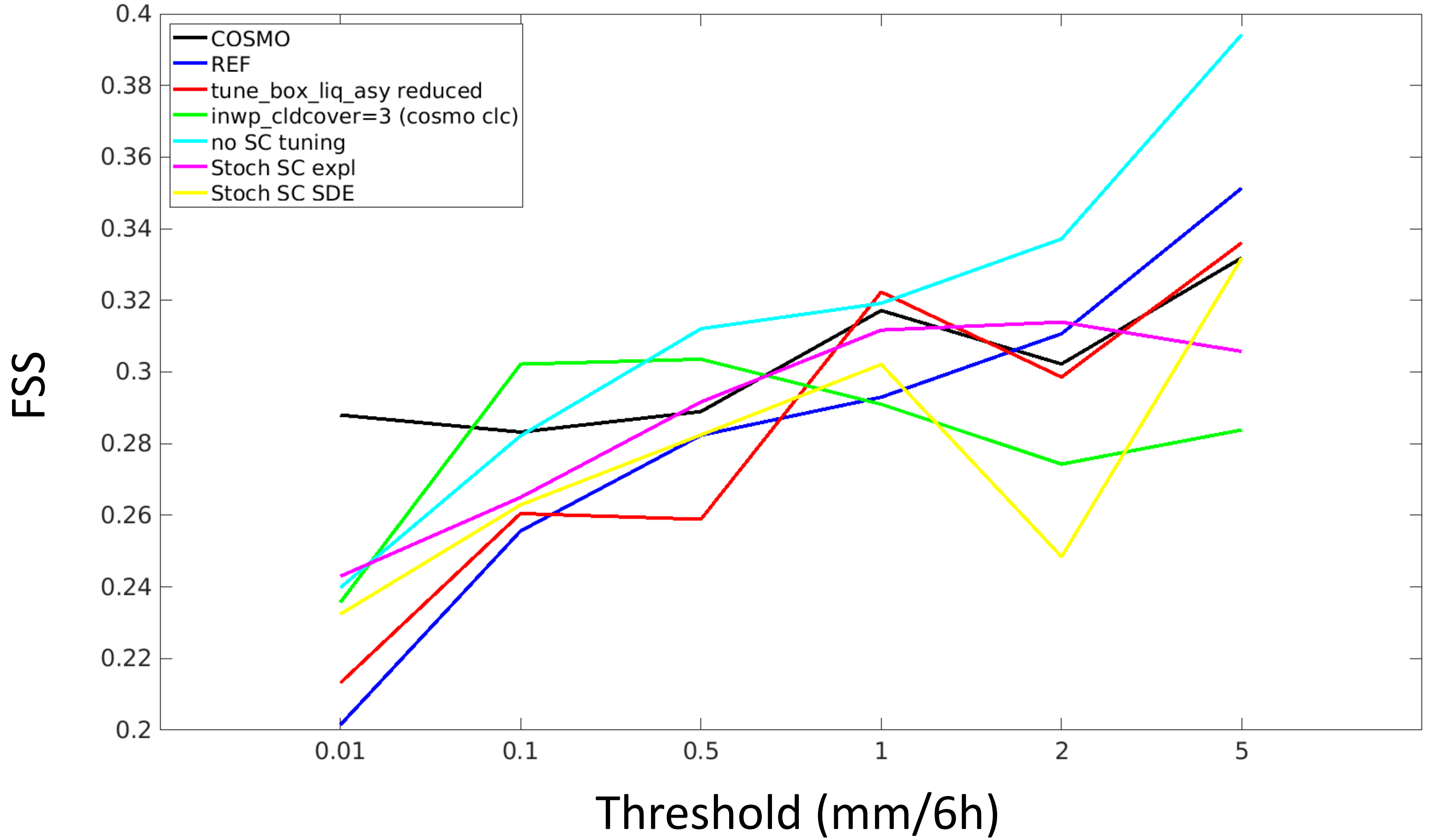


Autumn convection verification (to few cases…)



Preliminary conclusions

1. Low (water) cloud cover spread overestimated in all vers.
2. But cloud cover high values are underestimated

3. Precipitation in Eastern Mediterranean winter (moderate CAPE) is good (not shown)
4. Precipitation in Eastern Mediterranean autumn (high CAPE) is better (lower “cover”) but too strong COSMO spots are still there!

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Plans

1. Investigation and testing ICON SCP schemes (and their cloud cover) vs. observations and LES BOMEX/RICO simulations

2. More realistic estimation of effective radius in SCP:

The formula $\overline{R_{eff}} = c_1 \left(\frac{LWC}{QNC}\right)^{c_2}$ is very problematic because both LWC and QNC are very noisy in horizontal (in cloud). However below the level of collisions (~12 micron) Reff is not noisy, and can be calculated by: $\overline{R_{eff}} = 1.15 \left(\frac{LWC_{ad}}{QNC_{cl.b}}\right)^{1/3}$

Khain, P., R. Heiblum, U. Blahak, Y. Levi, H. Muskatel, E. Vadislavsky, O. Altaratz, I. Koren, G. Dagan, J. Shpund, and A. Khain, 2019: Parameterization of Vertical Profiles of Governing Microphysical Parameters of Shallow Cumulus Cloud Ensembles Using LES with Bin Microphysics. J. Atmos. Sci., 76, 533–560.

This is certainly valid for shallow convection, and should be implemented in SCP
(it is implemented in COSMO v5.6 but not in ICON)

Thanks!