

PP C2I - ICON-LAM at IMS

IMS COSMO team

COSMO virtual GM September 2020



ICON-IL-IFS

- **Platform**: The "Time Critical Suite" for running ICON-LAM model was prepared on the ECMWF HPC (*Thanks a lot to: Bojan Kasic & Cristian Simarro, ECMWF*)
- Model setup: Domain: 4-45.5E/25.5-53N

Resolution: ~2.5km horizontal, 65 levels vertical

Range: 78h

IC/BC: det. IFS

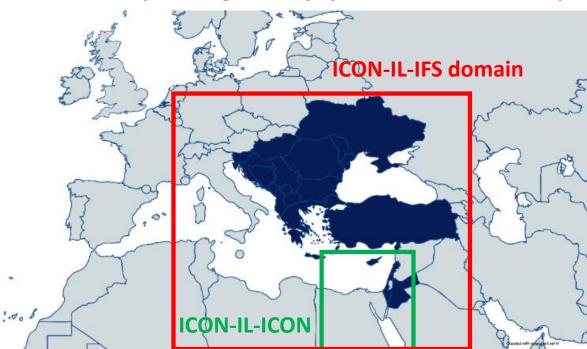
SBU/run: ~50K

• Oper. runs: 2 runs/day (00, 12 UTC)

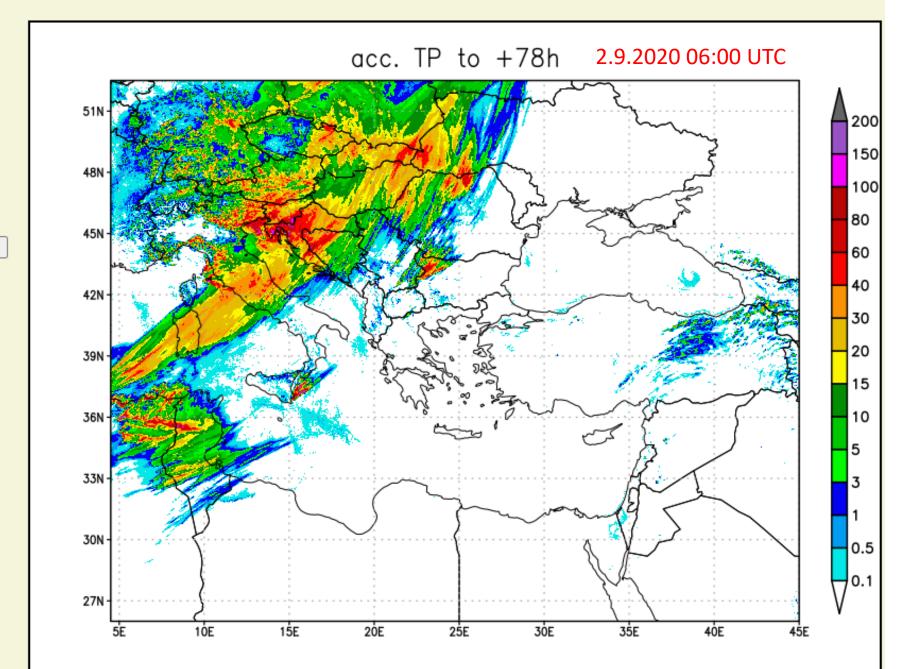
SBU/year: **36.5M** (not including runs for model tuning) Storage: **~150 T/year**

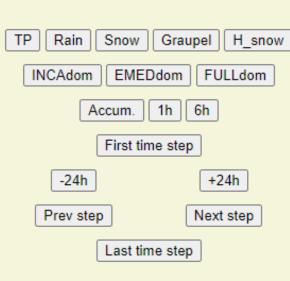
- Data assimilation: Planned for future
- Model tuning: Planned for future

WMO project SEE-MHEWS-A Multi-Hazard Early Warning Advisory System for South-East Europe



ICON SEE forecast for 31/08/2020 00 UTC







Verification over Israel – test cases

Wintertime rain events:

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

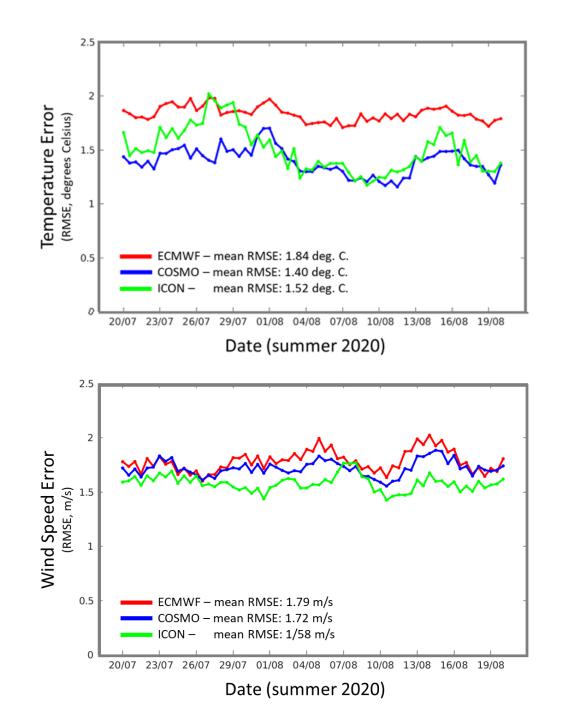
	C	TT or_rmse_n	1.79	1.48	1.61
2m temperature		TT or rmse d	1.92	1.58	1.95
		TT pl rmse n	1.62	1.47	1.55
		TT pl rmse d	1.57	1.38	1.49
	Ć	RH or_rmse_n	10.79	10.68	11.44
2m rel. humidity		RH or rmse_d	11.52	11.16	12.87
		RH pl_rmse_n	9.75	10.38	11.01
	- (RH pl_rmse_d	10.74	11.13	11.42
	Ć	WS or_rmse_n	1.92	1.88	1.9
10		WS or rmse_d	2	2.14	2.24
10m wind sp	beed \prec	WS pl_rmse_n	1.76	1.79	1.78
		WS pl_rmse_d	1.92	2.04	2.09
	Ć	WD or rmse n	0.85	0.93	0.89
		WD or_rmse_d	1.16	1.2	1.29
10m wind direc	τ tion \prec	WD pl_rmse_n	0.99	1.13	1.02
		WD pl_rmse_d	1.36	1.34	1.44
	C :1 (PT 24 48 72	0.71	0.68	0.72
Temperature pro	offies \leq	PT 12 36 60	0.68	0.64	0.66
	f :1)	PQ 24 48 72	0.56	0.59	0.55
Mixing ratio profiles ~		PQ 12 36 60	0.62	0.64	0.63
Mind vootor ore	files (PW 24 48 72	2.62	2.56	2.59
Wind vector pro	mes	PW 12 36 60	2.47	2.67	2.74
		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
Precipitation (1-FSS)		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
Winter-rain		SUMMARY	0	0.02	0.006
events:					
ICON is better			ECMWF	ICON-IL	COSMO-IL

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

	TT or_rmse_n	2.11	1.87	1.97
2m temperature	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
	RH or_rmse_n	14.42	12.98	13.42
2m rol humidi	RH or_rmse_d	9.14	12.45	8.96
2m rel. humidit	RH pl_rmse_n	12.05	11.09	10.17
	RH pl_rmse_d	9.8	10.56	9.66
	WS or_rmse_n	1.61	1.56	1.52
10m wind speed	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 directior	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
- · · · ·	PT 24_48_72	1.09	0.99	1.06
Temperature profile	es < _{РТ 12_36_60}	0.91	0.91	0.91
N 41 1 1 1 C 1	PQ 24_48_72	1.06	1.07	1.04
Mixing ratio profile	es < PQ 12_36_60	1	1	1.01
Mind voeter arefi	FW 24_48_72	2.32	2.4	2.47
Wind vector profil	es < PW 12_36_60	2.3	2.26	2.43
Winter-dry	SUMMARY	0	0.017	0.0098
events:				
ICON is better		ECMWF	ICON-IL	COSMO-IL
ICON IS DELLEI				

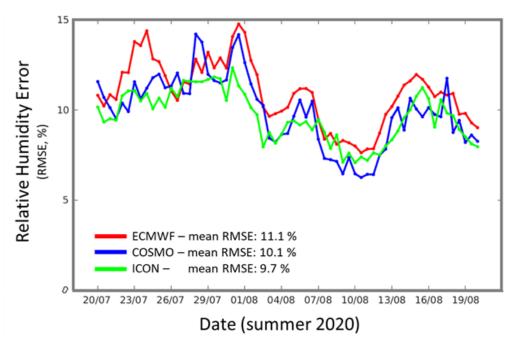
Summertime events: 2017060700, 2017063000, 2017071700, 2017080100, 2017082500, 2017090500, 2018060300, 2018071100, 2018072000

Wind vector profiles PW 24_48_72 PW 12_36_60 1.89 1.95 2.07 Summer events: SUMMARY 0 0.018 0.053 ECNAVAE ICONUL COSMOUL					
2/in temperature Tr pl_rmse_n 1.78 1.76 1.55 2m rel. humidity RH or_rmse_n 12.06 1503 11.45 2m rel. humidity RH or_rmse_n 6.95 6.89 6.11 10m wind speed WS or_rmse_n 1.77 1.54 1.77 10m wind speed WS or_rmse_n 1.77 1.54 1.77 10m wind direction WD or_rmse_n 0.97 0.62 0.35 10m wind direction WD or_rmse_n 0.97 0.62 0.35 10m wind direction WD or_rmse_n 0.65 0.72 0.7 WD or_rmse_n 0.65 0.72 0.7 0.65 WD or_rmse_n 0.65 0.72 0.7 0.7 WD pl_rmse_n 0.65 0.35 0.85 0.72 0.7 WD pl_rmse_n 0.65 0.72 0.7 0.7 0.95 Wind vector profiles PV 24.48.72 1.6 1.12 0.96 1.12 0.96 Wind vector profiles PW 24.48.72 1.6 1.87 1.98 1.95 2.07		TT or_rmse_n	1.86	1.6	1.53
Image: Summer events: Image: Tp p[.mse_n] 1.78 1.76 1.55 Image: Tp p[.mse_n] 1.20 1.20 1200 1200 Image: Pp P[.mse_n] 12.06 1200 1200 14.15 Image: Pp P[.mse_n] 12.06 1200 1200 14.15 Image: Pp P[.mse_n] 9.4 7.86 6.99 6.11 Image: Pp P[.mse_n] 9.4 7.86 6.26 6.28 Image: Pp P[.mse_n] 9.4 7.86 6.26 6.28 Image: Pp P[.mse_n] 1.7 1.54 1.77 Image: Pp P[.mse_n] 1.7 1.54 1.77 Image: Pp P[.mse_n] 0.68 0.37 0.98 Image: Pp P[.mse_n] 0.57 0.62 0.55 Image: Pp P[.mse_n] 0.68 0.72 0.7 Image: Pp P[.mse_n] 0.68 0.75 0.83 0.8 Image: Pp P[.mse_n] 0.68 0.75 0.83 0.8 Image: Pp P[.mse_n] <td rowspan="2">2m temperature</td> <td>⊷ 🗸 TT or_rmse_d</td> <td>1.62</td> <td>1.4</td> <td>1.17</td>	2m temperature	⊷ 🗸 TT or_rmse_d	1.62	1.4	1.17
2m rel. humidity RH or_rmse_n 12.06 20.03 31.45 2m rel. humidity RH or_rmse_n 6.35 6.89 6.11 10m wind speed WS or_mse_n 7.36 6.28 6.28 10m wind speed WS or_mse_n 0.38 0.97 0.98 10m wind speed WD or_mse_n 0.94 0.37 0.98 10m wind direction WD or_mse_n 0.97 0.98 0.7 10m wind direction WD or_mse_n 0.84 0.79 0.7 WD or_mse_nd 0.84 0.79 0.7 0.65 WD or_mse_nd 0.99 1.12 0.96 0.7 Wind vector profiles PQ 12.36.60 1.6 1.51 1.47 Wind vector profiles		TT pl_rmse_n	1.78	1.76	1.55
2m rel. humidity RH or_rmse_d 6.95 6.89 6.11 H pl_mse_n 9.4 7.44 8.49 H pl_mse_d 7.96 5.35 6.29 10m wind speed WS or_mse_n 1.7 1.54 1.77 10m wind speed WS or_mse_n 0.37 0.98 0.97 0.98 10m wind direction WD or_mse_n 0.57 0.62 0.5 0.5 WD or_mse_n 0.66 0.72 0.7 0.96 0.97 WD or_mse_n 0.66 0.72 0.7 0.96 0.97 0.62 0.5 0.97 0.62 0.5 0.97 0.62 0.5 0.97 0.76 0.97 0.76 0.97 0.76 0.97 0.76 0.97 0.76 0.97 0.76 0.97 0.76 0.97 0.76 0.97		TT pl_rmse_d	1.29	1.17	0.98
2111 ref. humidity RH p_mmse_n 9.4 7.84 8.49 10m wind speed WS or_mse_n 1.7 1.54 1.77 10m wind speed WS or_mse_n 0.98 0.97 0.98 10m wind speed WD or_mse_n 0.98 0.97 0.98 10m wind direction WD or_mse_n 0.97 0.662 0.53 10m wind direction WD or_mse_n 0.68 0.72 0.7 WD or_mse_d 0.68 0.72 0.7 0.64 remperature profiles PT 24_48_72 0.99 1.12 0.96 Mixing ratio profiles PO 24_4872 1.6 1.51 1.51 Wind vector profiles PW 24_48_72 1.89 1.95 2.07 Wind vector profiles PW 12_36_60 1.86 1.67 1.98 Summer events: SUMMARY 0 0.018 0.053		RH or_rmse_n	12.06	10.03	11.45
RH pl_mse_n 9.4 7.64 8.49 10m wind speed WS or_mse_n 1.7 1.54 1.77 10m wind speed WS or_mse_n 0.96 0.97 0.98 10m wind direction WD or_mse_n 0.957 0.62 0.5 10m wind direction WD or_mse_n 0.57 0.62 0.5 10m wind direction WD or_mse_n 0.66 0.72 0.7 WD or_mse_d 0.49 0.45 0.45 remperature profiles PT 24,48,72 0.99 1.12 0.96 Mixing ratio profiles PQ 12,36,60 1.39 1.6 1.47 Wind vector profiles PW 24,48,72 1.86 1.87 1.98 Summer events: SUMMARY 0 0.018 0.053	2m rol humidity	RH or_rmse_d	6.95	6.89	6.11
$\frac{100 \text{ wind speed}}{100 \text{ wind speed}} \begin{cases} WS \text{ or mse} \text{ n} \\ WD \text{ or mse} \text{ n} $		RH pl_rmse_n	9.4	7.64	8.49
10m wind speed WS or_rmse_d WS pl_mse_n WS pl_mse_d 1.43 1.46 1.43 10m wind speed WS or_rmse_n WD or_rmse_d 0.98 0.97 0.98 10m wind direction WD or_rmse_d 0.57 0.62 0.5 10m wind direction WD or_rmse_d 0.84 0.79 0.76 WD or_rmse_d 0.68 0.72 0.7 WD pl_mse_d 0.49 0.49 0.45 remperature profiles PT 24,48,72 0.99 1.12 0.96 Mixing ratio profiles PQ 24,48,72 1.6 1.51 1.55 Wind vector profiles PW 24,48,72 1.99 1.95 2.07 Wind vector profiles PW 24,48,72 1.86 1.87 1.98 Summer SUMMARY 0 0.018 0.053 Summer SUMMARY 0 0.018 0.053		RH pl_rmse_d	7.96	6.26	6.29
Ion wind speed WS pl_mse_n 0.98 0.97 0.98 WS pl_mse_d 1.03 1.24 1.21 10m wind direction WD or_mse_n 0.57 0.62 0.5 WD or_mse_d 0.94 0.79 0.76 0.7 WD or_mse_d 0.99 0.72 0.7 0.7 WD pl_mse_d 0.49 0.49 0.45 0.7 We pl_mse_d 0.49 0.49 0.45 0.8 We pl_mse_d 0.49 0.49 0.45 0.8 Wind speed PT 24.48.72 0.99 1.12 0.96 Wixing ratio profiles PQ 24.48.72 1.6 1.51 1.55 PQ 12.36.60 1.39 1.6 1.47 1.98 Wind vector profiles PW 24.48.72 1.89 1.95 2.07 Wind vector profiles PW 24.48.72 1.89 1.95 2.07 Wind vector profiles PW 24.48.72 1.89 1.95 2.07 Wind vector profiles O 0.018 0.053 0.053 Summer SUMMARY O <td rowspan="4">10m wind speed</td> <td>WS or_rmse_n</td> <td>1.7</td> <td>1.54</td> <td>1.77</td>	10m wind speed	WS or_rmse_n	1.7	1.54	1.77
Ion wind speed WS pl_mse_n 0.98 0.97 0.98 WS pl_mse_d 1.03 1.24 1.21 10m wind direction WD or_mse_n 0.57 0.62 0.5 WD or_mse_d 0.94 0.79 0.76 0.7 WD or_mse_d 0.99 0.72 0.7 0.7 WD pl_mse_d 0.49 0.49 0.45 0.7 We pl_mse_d 0.49 0.49 0.45 0.8 We pl_mse_d 0.49 0.49 0.45 0.8 Wind speed PT 24.48.72 0.99 1.12 0.96 Wixing ratio profiles PQ 24.48.72 1.6 1.51 1.55 PQ 12.36.60 1.39 1.6 1.47 1.98 Wind vector profiles PW 24.48.72 1.89 1.95 2.07 Wind vector profiles PW 24.48.72 1.89 1.95 2.07 Wind vector profiles PW 24.48.72 1.89 1.95 2.07 Wind vector profiles O 0.018 0.053 0.053 Summer SUMMARY O <td>WS or_rmse_d</td> <td>1.43</td> <td>1.46</td> <td>1.43</td>		WS or_rmse_d	1.43	1.46	1.43
$10m \text{ wind direction } \begin{cases} WD \text{ or } mse_n \\ WD \text{ or } mse_d \\ WD \text{ or } mse_d \\ WD \text{ or } mse_n \\ WD \text{ or } mse_d \\ WD \text{ or } mse_n \\ PT 24,48,72 \\ PQ 24,48,72 \\ PW 12,36,60 \\ 1.6 \\ 1$		WS pl_rmse_n	0.98	0.97	0.98
10m wind direction WD or mse_d WD pl_rmse_n WD pl_rmse_d 0.84 0.79 0.76 WD pl_rmse_n WD pl_rmse_d 0.68 0.72 0.7 remperature profiles PT 24_48_72 0.99 1.12 0.96 remperature profiles PT 24_48_72 0.75 0.83 0.8 Mixing ratio profiles PQ 24_48_72 PQ 12_36_60 1.6 1.51 1.55 Wind vector profiles PW 24_48_72 PW 12_36_60 1.89 1.95 2.07 Summer events: SUMMARY 0 0.018 0.053		WS pl_rmse_d	1.03	1.24	1.21
Tom wind direction WD pl_rmse_n 0.68 0.72 0.7 WD pl_rmse_d 0.49 0.49 0.45 remperature profiles PT 24_48_72 0.99 1.12 0.96 remperature profiles PT 12_36_60 0.75 0.83 0.8 Mixing ratio profiles PQ 24_48_72 1.6 1.51 1.55 Wind vector profiles PW 24_48_72 1.89 1.95 2.07 Wind vector profiles PW 12_36_60 1.86 1.87 1.98 Summer SUMMARY 0 0.018 0.053 ECMIW/E LCONI II COSMO II	10 ma universitations	WD or_rmse_n	0.57	0.62	0.5
WD pl_rmse_n 0.68 0.72 0.7 WD pl_rmse_d 0.49 0.49 0.45 remperature profiles { PT 24,48,72 0.99 1.12 0.96 Mixing ratio profiles { PQ 24,48,72 0.75 0.83 0.8 Mixing ratio profiles { PQ 12,36,60 1.6 1.51 1.55 Wind vector profiles { PW 24,48,72 1.89 1.95 2.07 Wind vector profiles { PW 12,36,60 1.86 1.87 1.98 Summer events: SUMMARY 0 0.018 0.053		WD or_rmse_d	0.84	0.79	0.76
PT 24,48,72 PT 12,36,60 0.99 1.12 0.96 Mixing ratio profiles { PQ 24,48,72 PQ 12,36,60 0.75 0.83 0.8 Mixing ratio profiles { PQ 24,48,72 PQ 12,36,60 1.6 1.51 1.55 Wind vector profiles { PW 24,48,72 PW 12,36,60 1.89 1.95 2.07 Summer SUMMARY 0 0.018 0.053 ECN/W/E ICON III COSMO II	Tom wind directio	WD pl_rmse_n	0.68	0.72	0.7
Mixing ratio profiles $PQ 24_{48}72$ 1.6 1.51 1.55 Mixing ratio profiles $PQ 12_{36}60$ 1.39 1.6 1.47 Wind vector profiles $PW 24_{48}72$ 1.89 1.95 2.07 Wind vector profiles $PW 12_{36}60$ 1.86 1.87 1.98 Summer events: SUMMARY 0 0.018 0.053		WD pl_rmse_d	0.49	0.49	0.45
Mixing ratio profiles $PQ 24_{48}72$ 1.6 1.51 1.55 Mixing ratio profiles $PQ 12_{36}60$ 1.39 1.6 1.47 Wind vector profiles $PW 24_{48}72$ 1.89 1.95 2.07 Wind vector profiles $PW 12_{36}60$ 1.86 1.87 1.98 Summer events: SUMMARY 0 0.018 0.053	Temperature profiles $\left\{ \begin{array}{c} PT 24_{48_{72}} \\ PT 12_{36_{60}} \end{array} \right\}$		0.99	1.12	0.96
Mixing ratio profiles $PQ 24_{48}72$ 1.6 1.51 1.55 Mixing ratio profiles $PQ 12_{36}60$ 1.39 1.6 1.47 Wind vector profiles $PW 24_{48}72$ 1.89 1.95 2.07 Wind vector profiles $PW 12_{36}60$ 1.86 1.87 1.98 Summer events: SUMMARY 0 0.018 0.053			0.75	0.83	0.8
Wind vector profiles PW 24_48_72 PW 12_36_60 1.89 1.95 2.07 Summer events: SUMMARY 0 0.018 0.053 ECNAVAE ICONUL COSMOUL	Mixing ratio profiles $\left\{ egin{array}{c} PQ \ 24_48_72 \\ PQ \ 12_36_60 \end{array} ight.$		1.6	1.51	1.55
Summer SUMMARY 0 0.018 0.053 0.053			1.39	1.6	1.47
Summer SUMMARY 0 0.018 0.053 0.053	Wind vector profiles $\left\{ \begin{smallmatrix} PW \ 24_48_72 \\ PW \ 12_36_60 \end{smallmatrix} ight.$		1.89	1.95	2.07
			1.86	1.87	1.98
	Summer	SUMMARY	0	0.018	0.053
	events: COSMO is better		ECMWF	ICON-IL	COSMO-IL



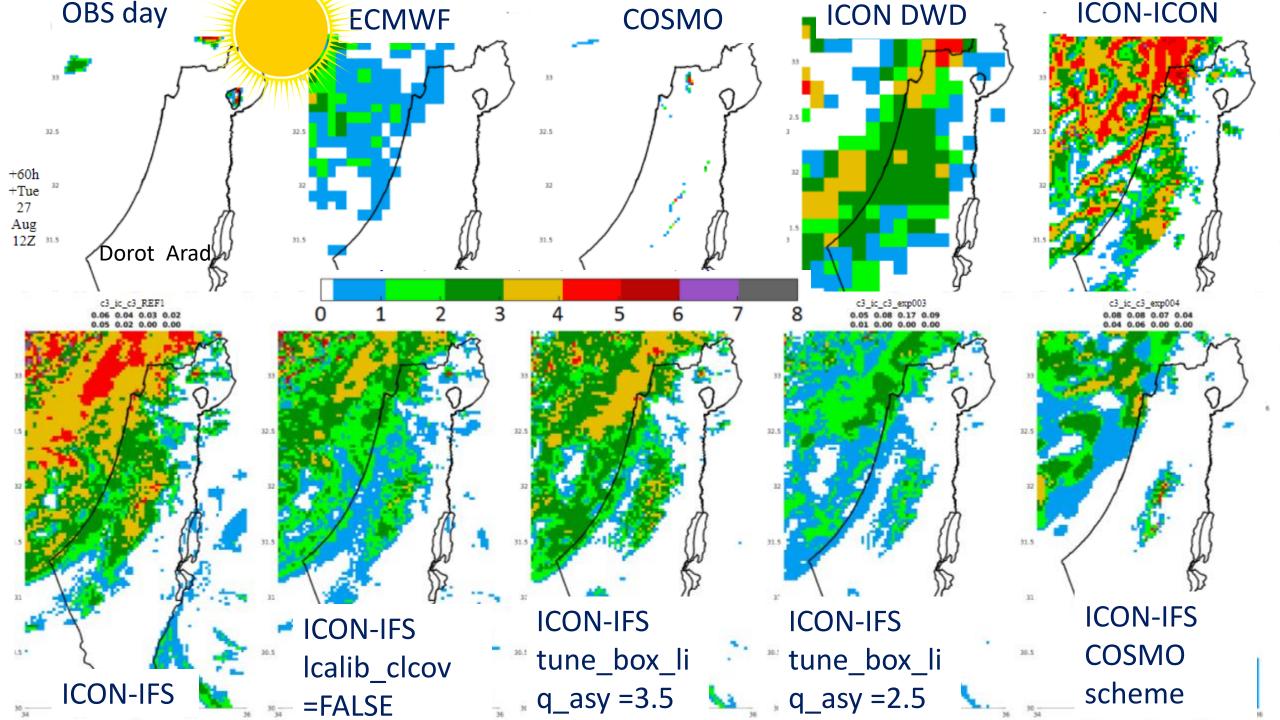
Last month verification (all stations, all times)

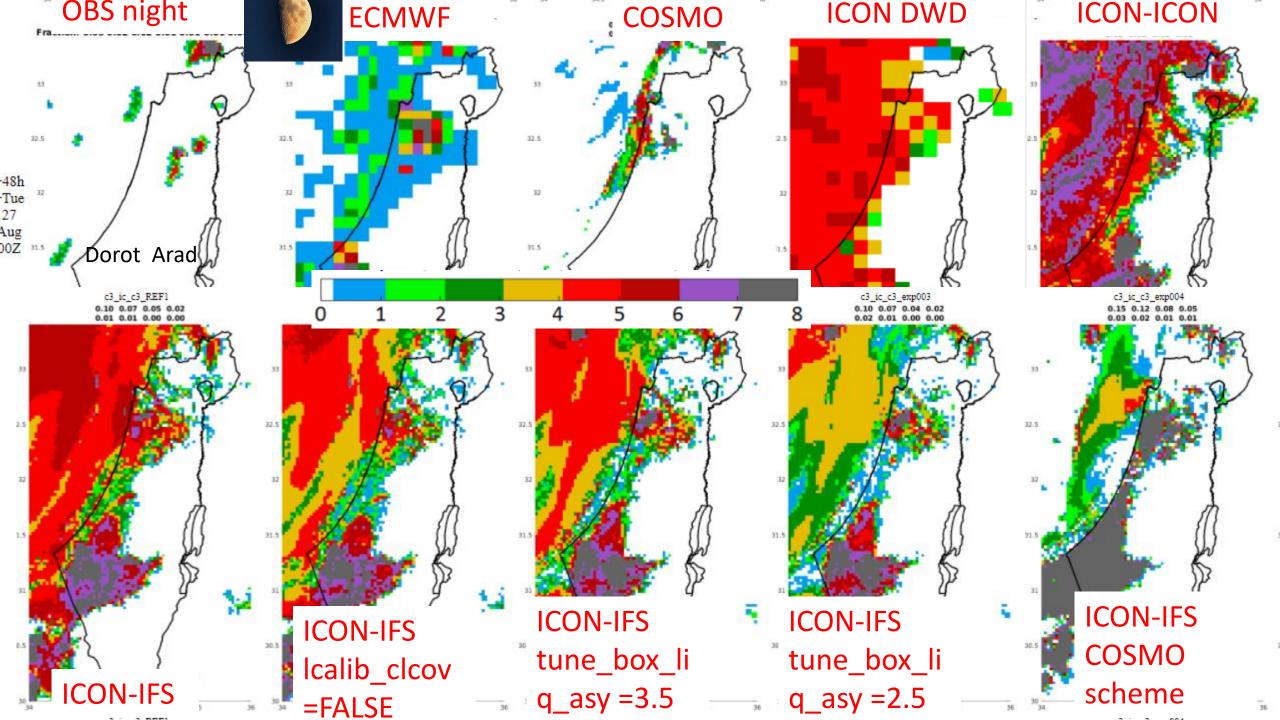
Encouraging results for ICON-LAM



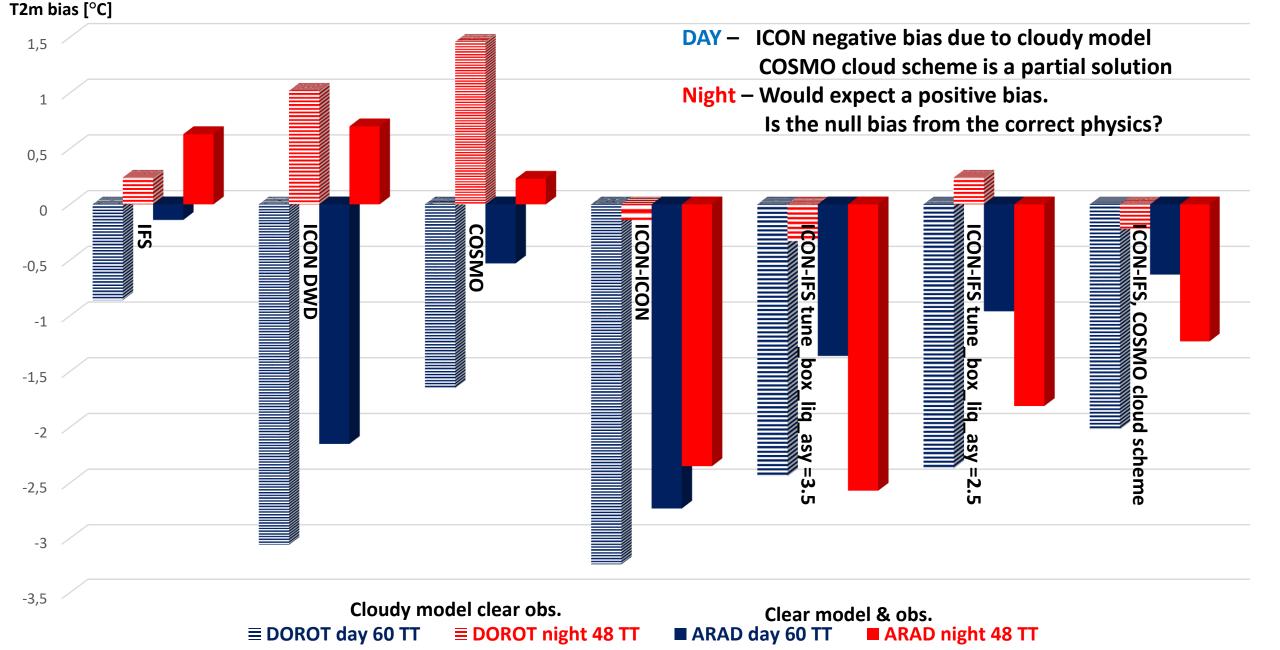


ICON Cloudiness overs-estimation

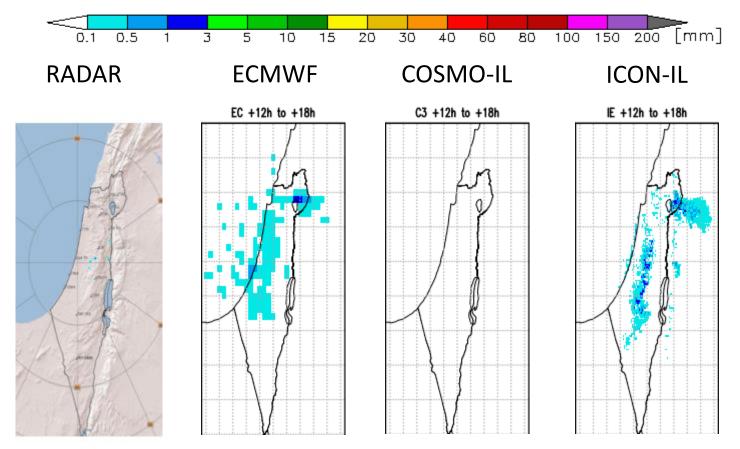




T2m bias for the 25.8.2019 00Z run DOROT = cloudy ICON, ARAD = clear ICON



Tiedtke-Bechtold scheme - drizzle problem typical example 5/7/2020 06UTC



During summer there is strong inversion over Israel so and precipitation is very rare.

Since ICON shallow convection scheme allows precipitation, its rain pattern is similar to that of ECMWF, which overestimates precipitation during summer. COSMO shallow convection scheme does not allow precipitation, and grid scale precipitation obviously does not develop. That yields some underestimation of precipitation (when it rarely occurs)



Conclusions

- ICON-LAM has promising results
- We are working to solve ICON cloud overestimation
- ICON-LAM will become time critical on ECMWF HPC by Nov. 2020

