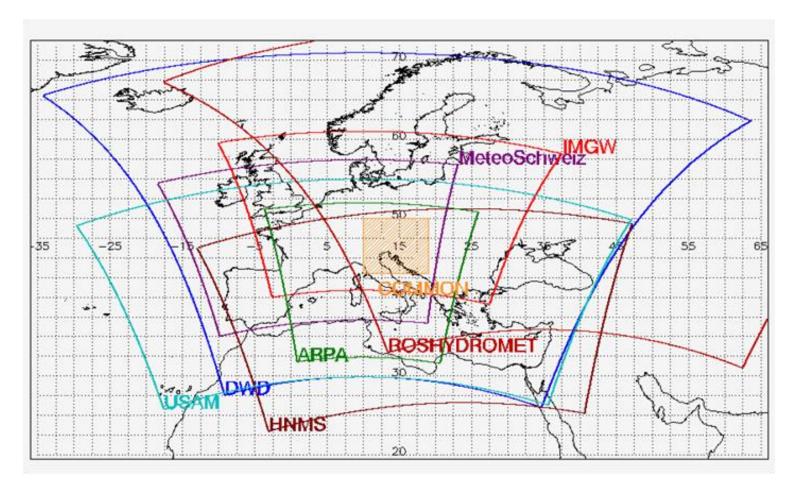


Verification Overview (based on CP activity: JJA2018-MAM2019)

Alexander Kirsanov & WG5

Verification Overview, COSMO GM, 9-12 Sept 2019, Rome

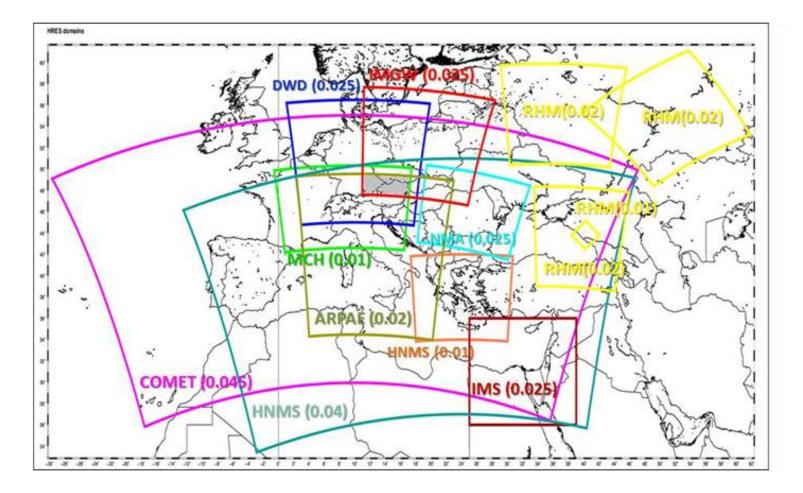
VERIFICATION OVER THE COMMON AREA



COSMO-GR4, COSMO-5M, ICON-EU, IFS, ICON, COSMO-ME, COSMO-PL, COSMO-RU7

Annual reports and Seasonal analytics are located at the website: <u>http://cosmo-model.org/content/tasks/verification.priv/</u>

VERIFICATION OVER THE COMMON AREA 2: FINE RESOLUTION



COSMO-D2, IFS, ICON, COSMO-IT, COSMO-PL

Annual reports and Seasonal analytics are located at the website: <u>http://cosmo-model.org/content/tasks/verification.priv/</u>

General Information on Scores

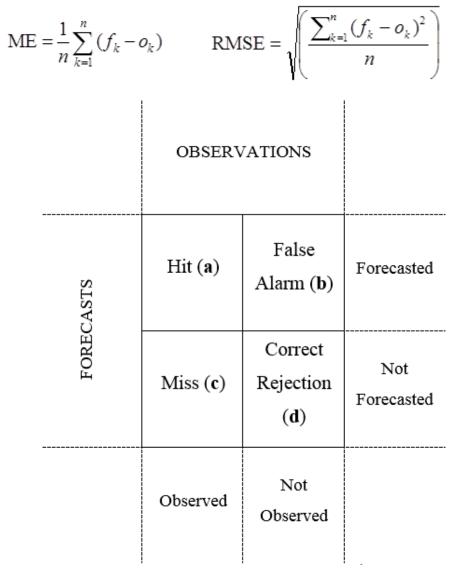
Continuous parameters

Temperature at 2 m Dew point temperature at 2 m Pressure reduced to Mean Sea Level Wind speed at 10 m Total cloud cover

Dichotomic parameters

Total Precipitation Total cloud cover Wind gust at 10 m

$$FBI = \frac{a+b}{a+c} \qquad TS = \frac{a}{(a+b+c)}$$
$$ETS = \frac{a-a_r}{a+b+c-a_r}, \quad where \quad a_r = \frac{(a+b)(a+c)}{a+b+c+d}$$

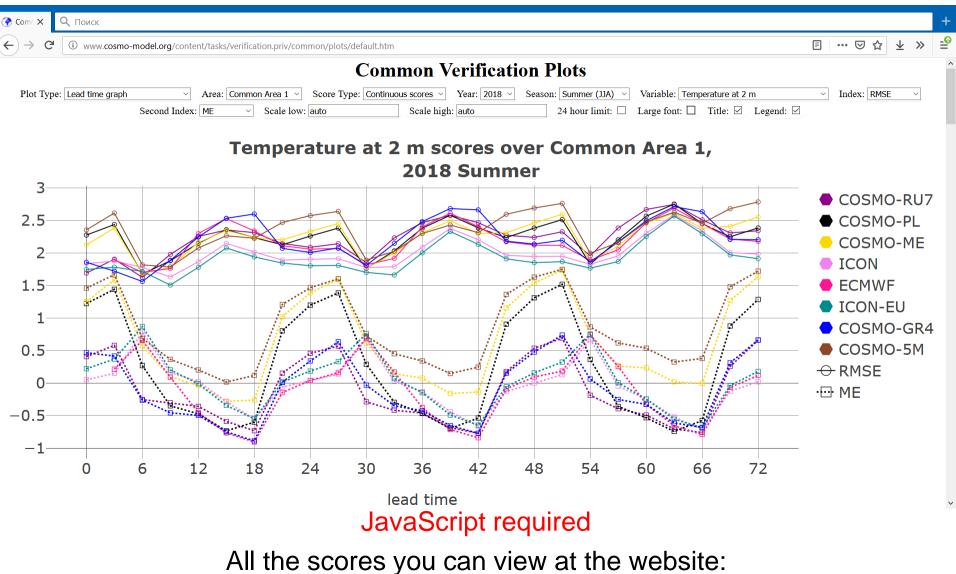


All the scores you can view at the website:

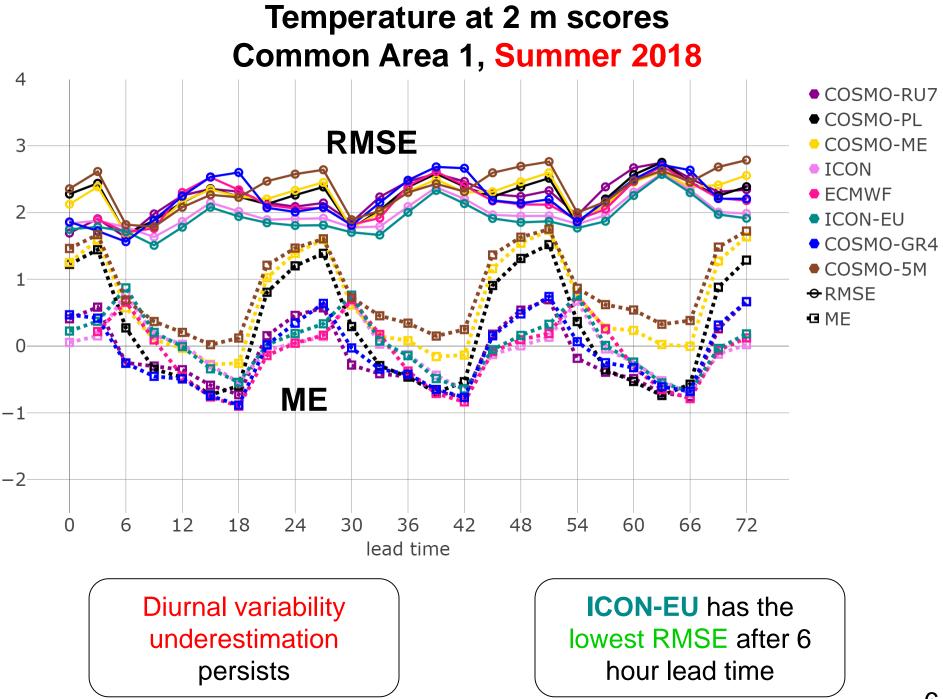
http://cosmo-model.org/content/tasks/verification.priv/common/plots/default.htm

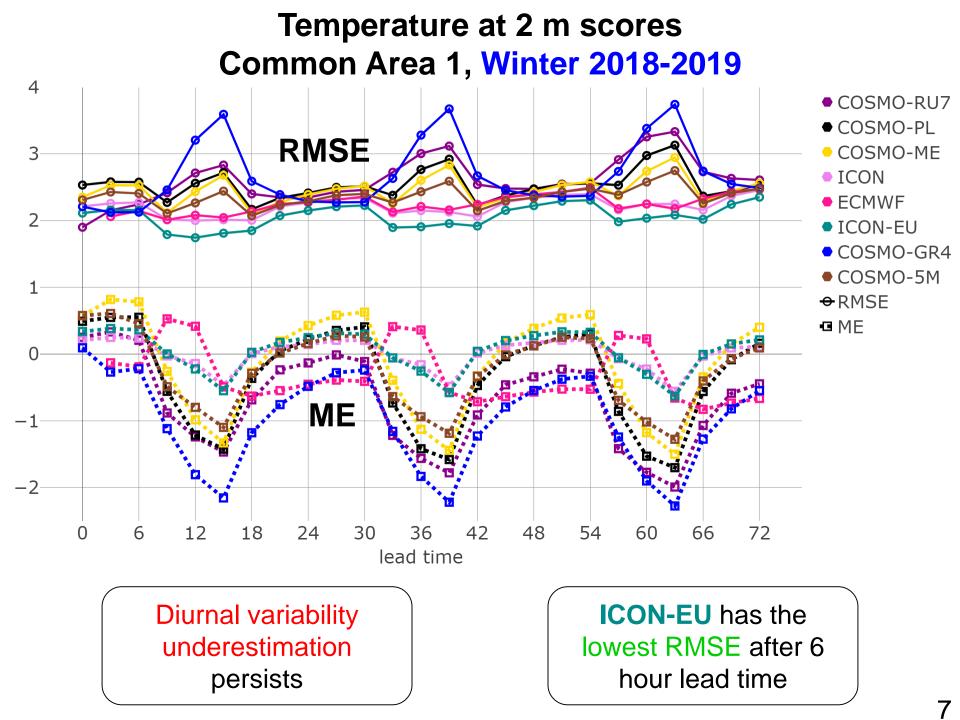
Common Plots Interactive view

<u>http://www.cosmo-model.org/</u> -> COSMO Tasks -> Verification



http://cosmo-model.org/content/tasks/verification.priv/common/plots/default.htm

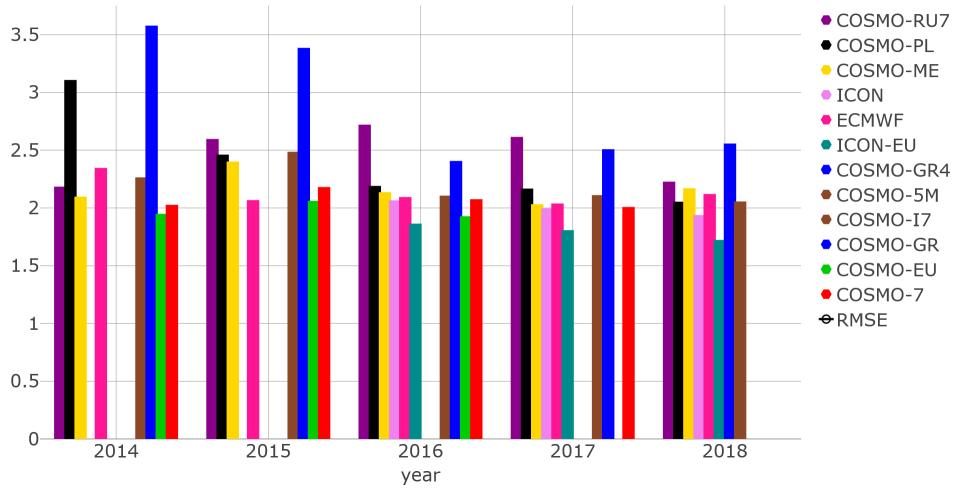




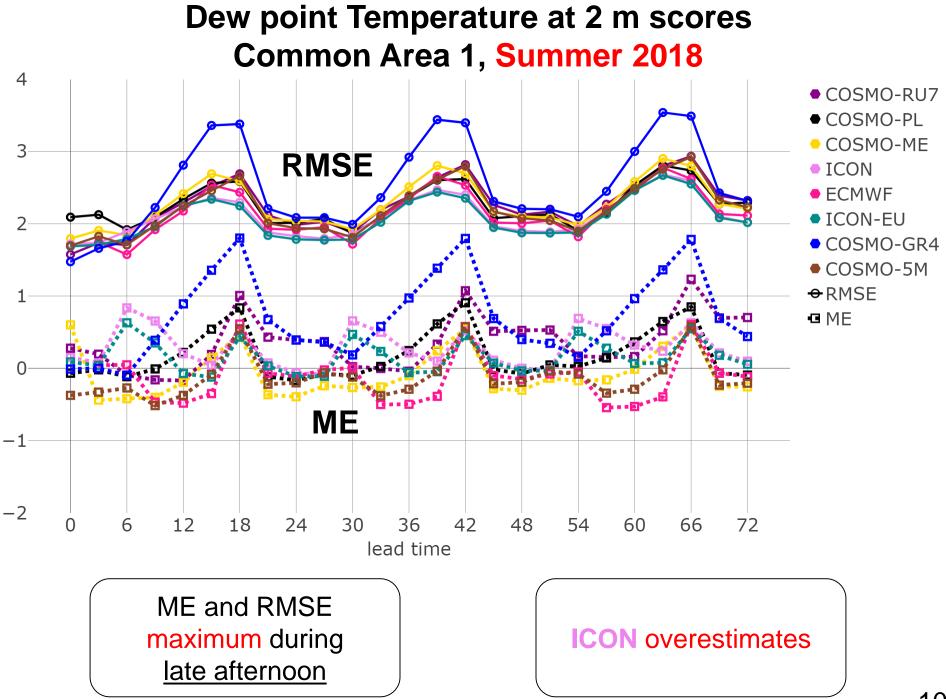
Temperature at 2 m scores Common Area 1, ICON-EU RMSE

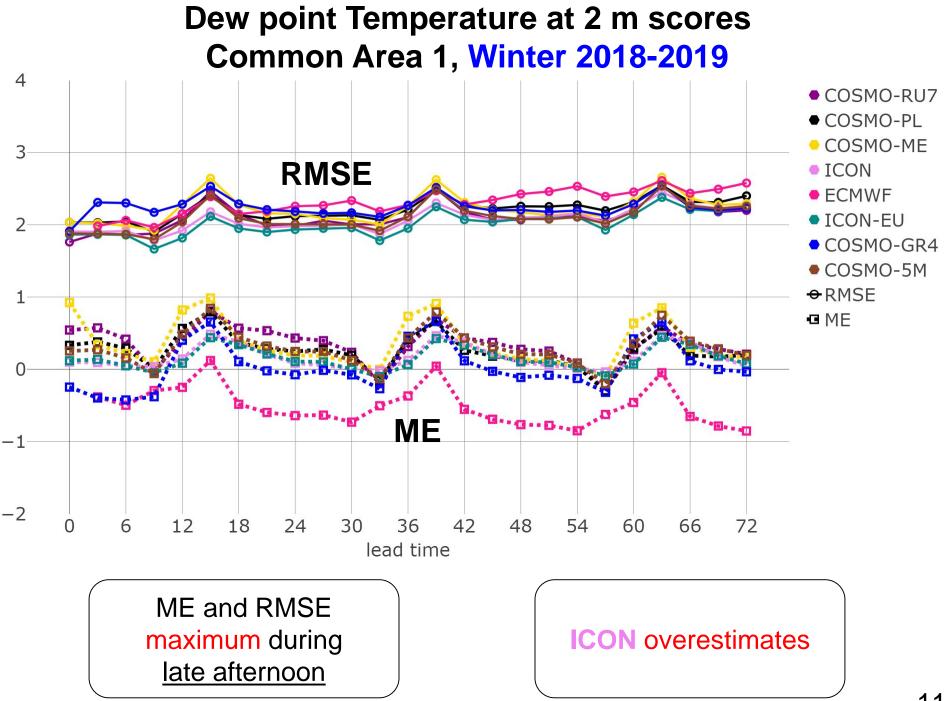
Summer	1.74	1.78	1.71	1.50	1.78	2.07	1.94	1.84	1.80	1.81	1.70	1.66	2.00	2.33	2.13	1.91	1.85	1.86	1.76	1.87	2.25	2.57	2.29	1.97	1.91	2.4
Autumn	1.89	1.97	2.00	1.70	1.54	1.55	1.61	1.84	1.96	2.01	2.01	1.79	1.71	1.70	1.67	1.89	2.01	2.09	2.11	1.98	2.04	2.00	1.83	2.04	2.18	2.2
Winter	2.11	2.15	2.15	1.79	1.74	1.81	1.84	2.07	2.14	2.20	2.22	1.89	1.90	1.95	1.91	2.15	2.22	2.29	2.30	1.98	2.03	2.08	2.01	2.24	2.35	1.8
Spring -	1.81	1.85	1.64	1.37	1.53	1.74	1.68	1.75	1.84	1.90	1.70	1.54	1.73	1.95	1.84	1.83	1.93	1.99	1.76	1.73	2.02	2.26	2.07	1.96	2.05	1.6
	0		6		12		18		24		30	lea	36 d ti	me	42		48		54		60		66		72	1
			<u>d</u>	ayt	Sur im nax	e F	<u>RM</u>	SE	<u>.</u>								<u>ni</u>	-	ttin	inte ne (im	<u>RN</u>		<u>E</u>			8

Temperature at 2 m RMSE Common Area 1, 12 hour lead time, Autumn

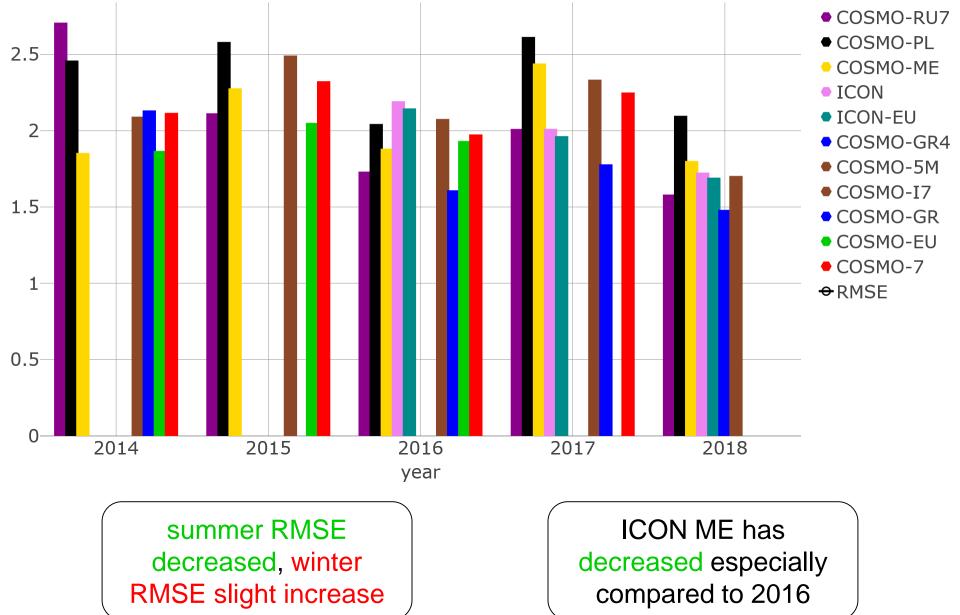


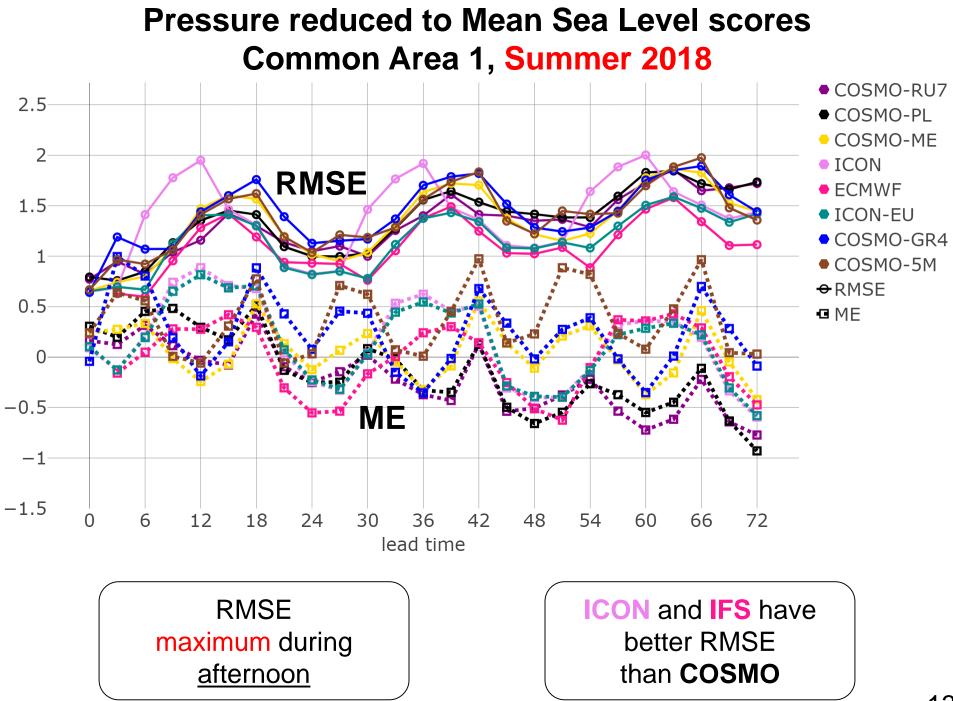
RMSE generally decreased slightly compared to the previous year, except for winter.



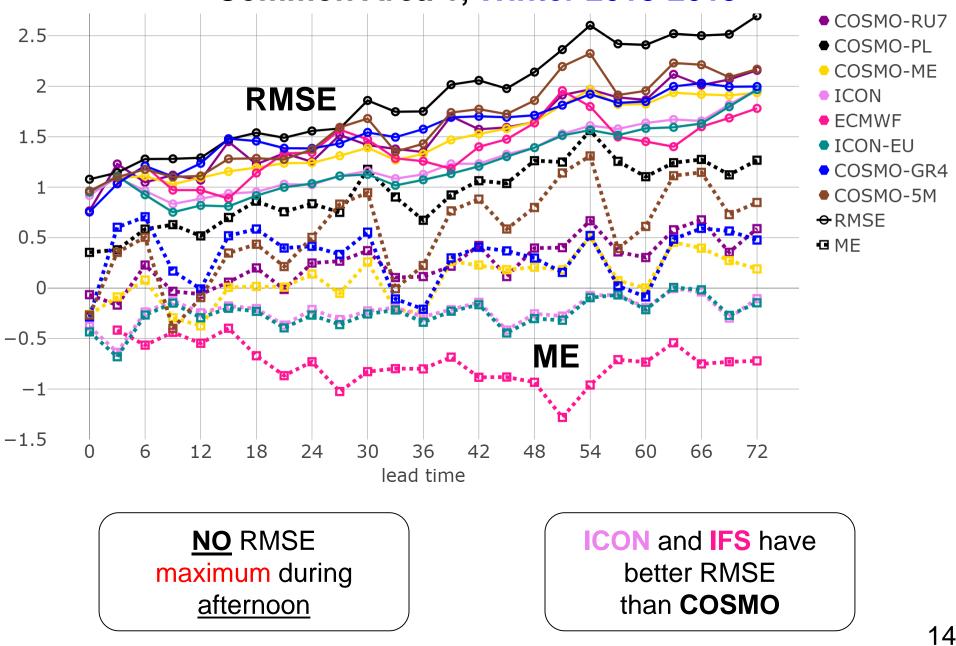


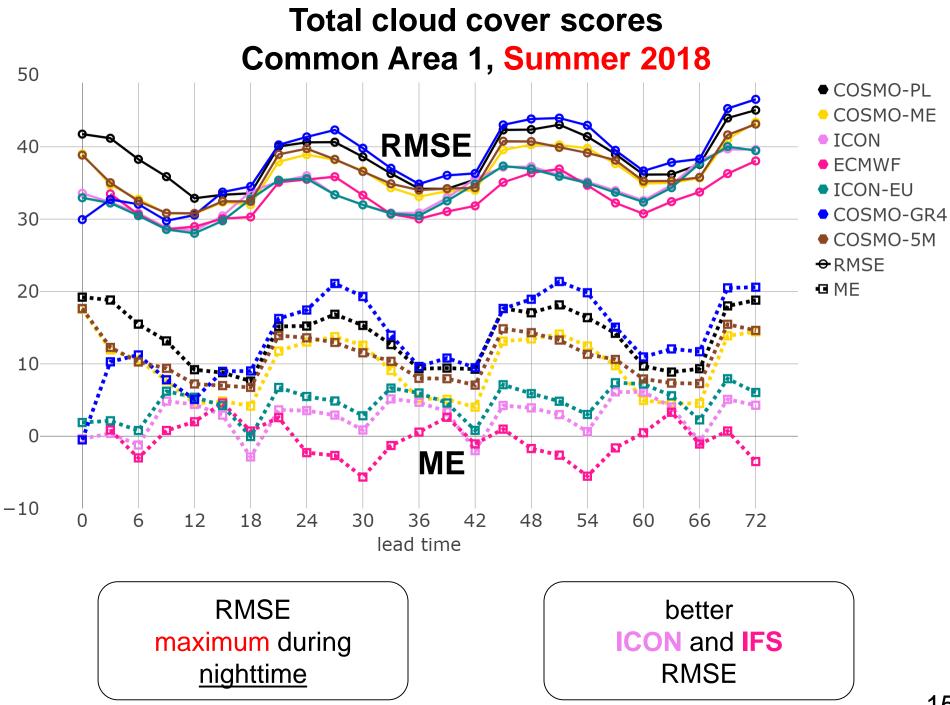
Dew point Temperature at 2 m RMSE Common Area 1, 00 hour lead time, Summer

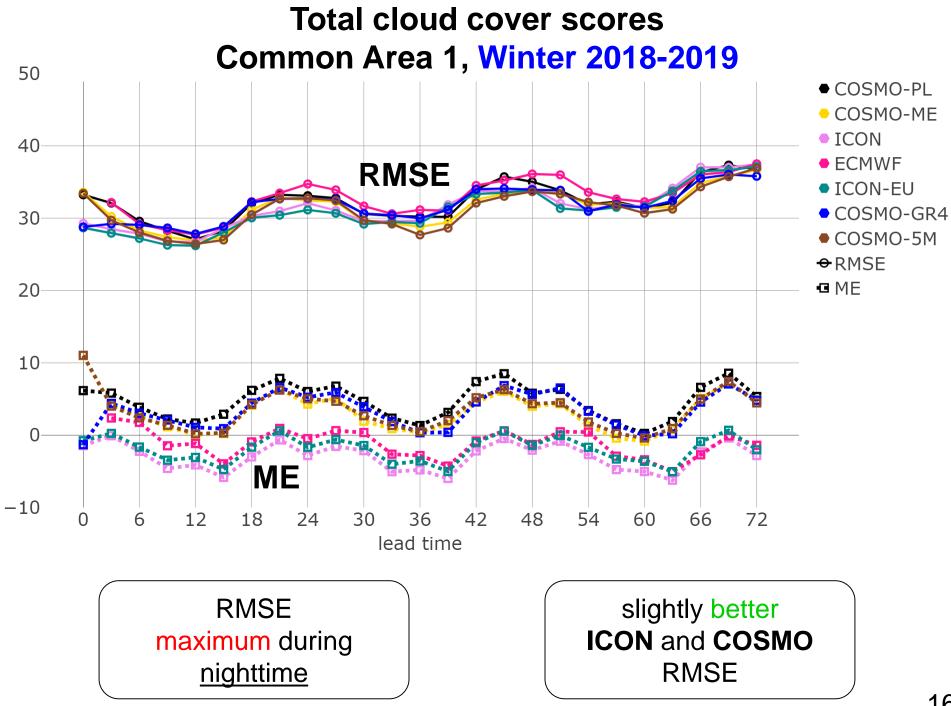




Pressure reduced to Mean Sea Level scores Common Area 1, Winter 2018-2019







25-75% Total cloud cover FBI Common Area 1, ICON-EU

Summer	0.89	0.79	0.72	0.78	0.68	0.58	0.52	0.75	0.91	0.83	0.71	0.75	0.64	0.58	0.50	0.78	0.92	0.82	0.71	0.75	0.62	0.57	0.50	0.75	0.88	1.4
Autumn	0.92	1.01	0.76	0.75	0.74	0.62	0.70	0.88	0.91	0.94	0.74	0.73	0.71	0.64	0.66	0.88	0.95	0.95	0.79	0.77	0.73	0.64	0.71	0.97	0.95	1.2
Winter	0.85	0.94	0.75	0.73	0.71	0.71	0.82	0.87	0.98	0.92	0.80	0.74	0.78	0.71	0.82	0.89	0.90	0.97	0.85	0.76	0.71	0.69	0.83	0.85	0.89	0.8
Spring	0.83	0.88	0.69	0.61	0.61	0.61	0.63	0.70	0.86	0.83	0.71	0.65	0.59	0.61	0.59	0.71	0.84	0.79	0.72	0.64	0.64	0.62	0.59	0.73	0.92	0.6
	0		6		12		18		24		30	lea	36 d ti	me	42		48		54		60		66		72	
				fo	r 2	<u>5-7</u>	st 7 <u>5%</u> 1 cc	<u>6</u>										otal nde	clo	ouo						17

0-25% Total cloud cover FBI Common Area 1, ICON-EU

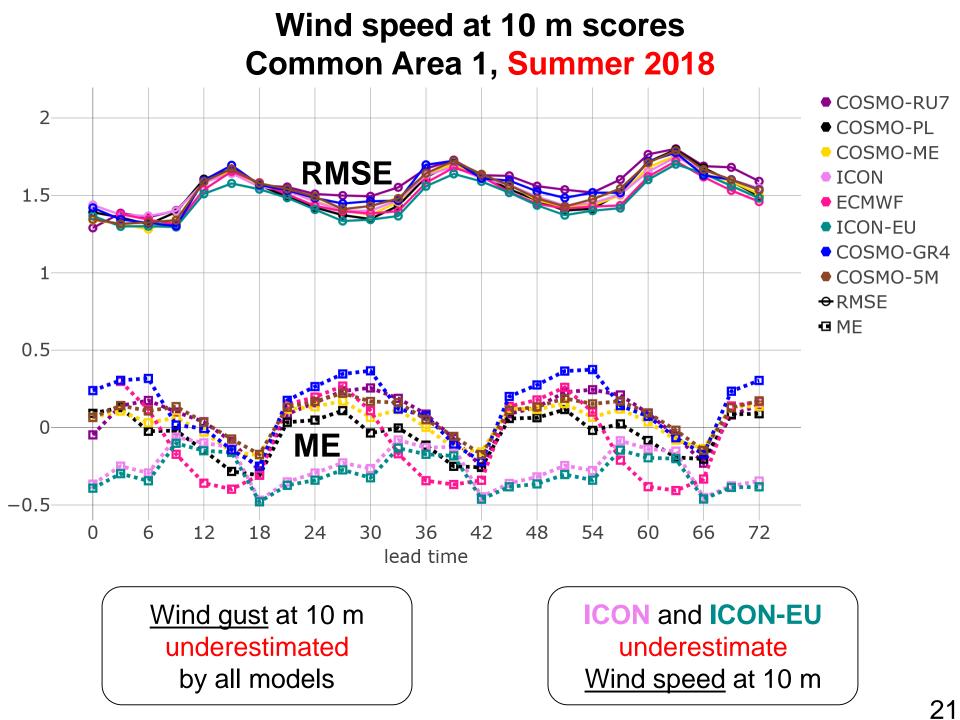
Summer	0.87	0.85	0.91	0.73	0.74	0.87	1.03	0.78	0.79	0.79	0.86	0.73	0.76	0.86	1.01	0.76	0.77	0.79	0.86	0.71	0.73	0.84	0.97	0.75	5 0.78	1.4
Autumn	0.76	0.74	0.87	0.94	0.91	0.99	0.86	0.76	0.78	0.77	0.88	0.94	0.88	0.97	0.88	0.79	0.78	0.79	0.86	0.89	0.87	0.97	0.86	0.76	5 0.78	1.2
Winter	0.93	0.86	0.96	1.07	1.06	1.10	0.94	0.86	0.92	0.89	0.93	1.10	1.03	1.12	0.93	0.85	0.95	0.85	0.92	1.06	1.08	1.14	0.92	0.87	0.97	1 0.8
Spring -	0.84	0.77	1.00	0.94	0.96	1.07	0.97	0.75	0.77	0.77	0.94	0.89	0.94	1.02	0.99	0.72	0.71	0.73	0.91	0.86	0.89	1.05	0.96	0.76	5 0.74	0.6
	0		6		12		18		24		30	lea	36 d ti	me	42		48		54		60		66		72	
				T	Sľ	nig	>7 her mn	•										tal nde	clo		d C					18

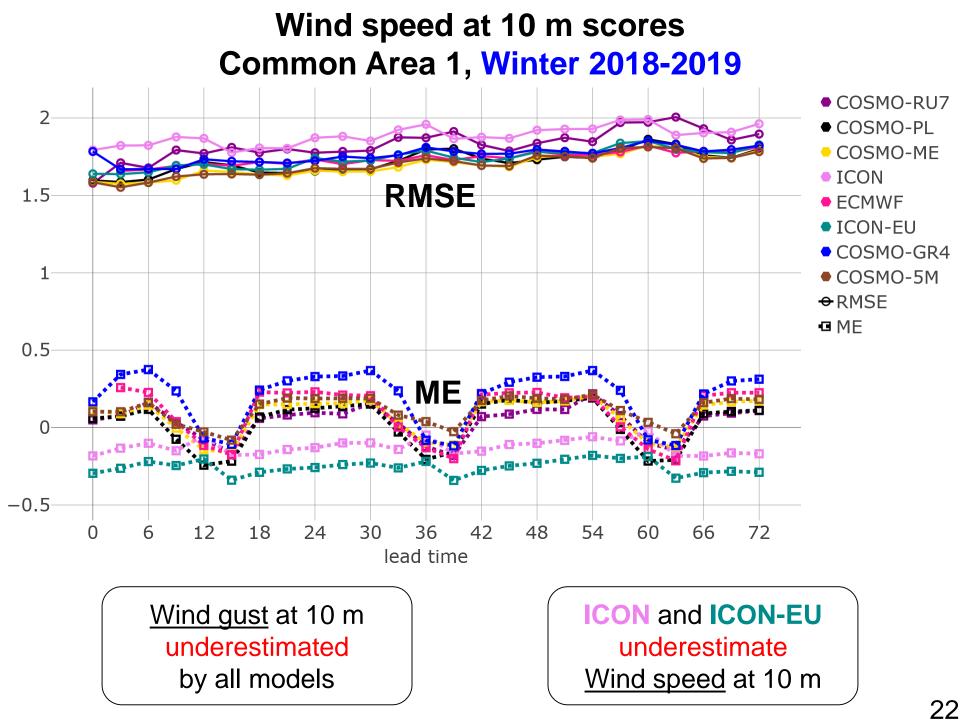
75-100% Total cloud cover FBI Common Area 1, ICON-EU

Summer	0.89	0.94	0.90	1.04	1.07	1.07 0.97	1.10	0.99	0.99	0.97	1.09	1.10	1.08	1.00	1.10	1.01	1.00	0.98	1.11	1.16	1.11	1.05	1.15	1.04	1.4
Autumn	1.03	1.00	0.95	0.88	0.89	0.92 1.01	1.08	1.02	1.01	0.95	0.89	0.93	0.92	1.02	1.05	1.00	0.99	0.93	0.91	0.93	0.93	1.01	1.02	1.00	1.2
Winter	0.93	0.92	0.91	0.88	0.87	0.84 0.90	0.93	0.89	0.92	0.91	0.86	0.85	0.84	0.91	0.93	0.91	0.92	0.89	0.87	0.86	0.84	0.91	0.93	0.90	1 0.8
Spring -	0.95	0.97	0.90	0.96	0.96	0.92 0.93	1.08	0.98	0.99	0.92	0.96	0.97	0.94	0.94	1.09	1.03	1.04	0.93	0.97	0.96	0.92	0.96	1.05	0.97	0.6
	0		6		12	18		24		30	lea	36 d ti	me	42		48		54		60		66		72	
				T	Sh	<u>nd >7</u> nighe sumr	r										ove	ere	SN esti % 7	ma	ite				19

75-100% Total cloud cover FBI Common Area 1, COSMO-PL

Summer	1.46	1.42	1.36	1.35	1.25	1.25	1.16	1.34	1.30	1.38	1.37	1.34	1.28	1.25	1.22	1.46	1.37	1.41	1.42	1.42	1.29	1.27	1.22	1.49	1.44	1.4
Autumn	1.23	1.21	1.15	1.02	0.99	1.03	1.16	1.20	1.18	1.17	1.12	1.05	1.00	1.02	1.13	1.16	1.14	1.15	1.12	1.05	1.03	1.02	1.10	1.13	3 1.15	1.2
Winter	1.05	1.03	1.00	0.99	0.97	1.00	1.06	1.08	1.04	1.05	1.02	0.99	0.97	1.02	1.09	1.10	1.03	1.05	0.99	0.97	0.95	5 1.00	1.08	1.10	1.03	1 0.8
Spring -	1.13	1.13	1.06	1.02	0.98	1.00	1.07	1.23	1.16	1.16	1.09	1.05	0.98	0.98	1.06	1.22	1.15	1.17	1.10	1.08	1.00	0 1.01	1.08	1.23	1.17	0.6
'	0		6		12		18		24		30	lea	36 d tii	me	42		48		54		60		66		72	
				2 <u>5%</u> T urir	Sľ	nigł	ner	•										ove	ere	SN esti %	ma	ate				20





>0.2 mm Total precipitation in 6 hours FBI Common Area 1, ICON-EU

Summer	1.58	2.18	1.87	1.25	1.73	2.22	1.93	1.30	1.69	2.34	1.98	1.33	2
Autumn	1.35	1.36	1.62	1.45	1.44	1.35	1.56	1.37	1.34	1.25	1.55	1.36	1.5
Winter	1.50	1.50	1.61	1.50	1.54	1.47	1.69	1.53	1.56	1.54	1.7	1.49	0.5
Spring-	1.40	1.62	1.61	1.45	1.50	1.68	1.65	1.54	1.59	1.75	1.73	1.55	0.5
	6	12	18	24	30	36 lead	42 time	48	54	60	66	72	0
		over	<u>nm</u> To <mark>estim</mark> de" pe	ated				<u>>(</u>	<mark>DN ov</mark> D.2 mr ore tha	<u>m</u> Tot.	prec.		23

>0.2 mm Total precipitation in 6 hours FBI Common Area 1, COSMO-PL

Summer	1.77	2.23	1.31	0.81	1.39	2.31	1.30	0.82	1.51	2.38	1.34	0.90	2
Autumn	1.23	1.19	1.17	1.13	1.26	1.19	1.23	1.09	1.17	1.12	1.11	1.04	1.5
Winter	1.47	1.48	1.63	1.52	1.56	1.55	1.81	1.63	1.60	1.51	1.76	1.62	0.5
Spring -	1.31	1.51	1.40	1.31	1.39	1.56	1.48	1.27	1.42	1.67	1.51	1.33	0.5
	6	12	18	24	30	36 lead	42 time	48	54	60	66	72	_0
		over	nm To restim de" pe	ated				<u>>(</u>).2 mi	r <mark>erest</mark> m Tot. an CC	prec.		24

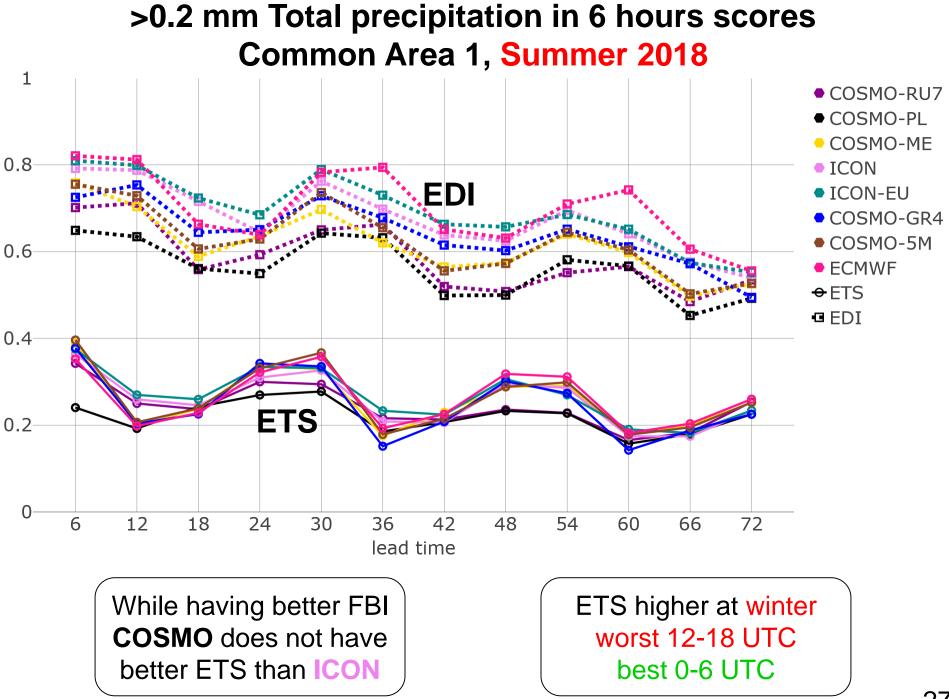
>10 mm Total precipitation in 6 hours FBI Common Area 1, ICON-EU

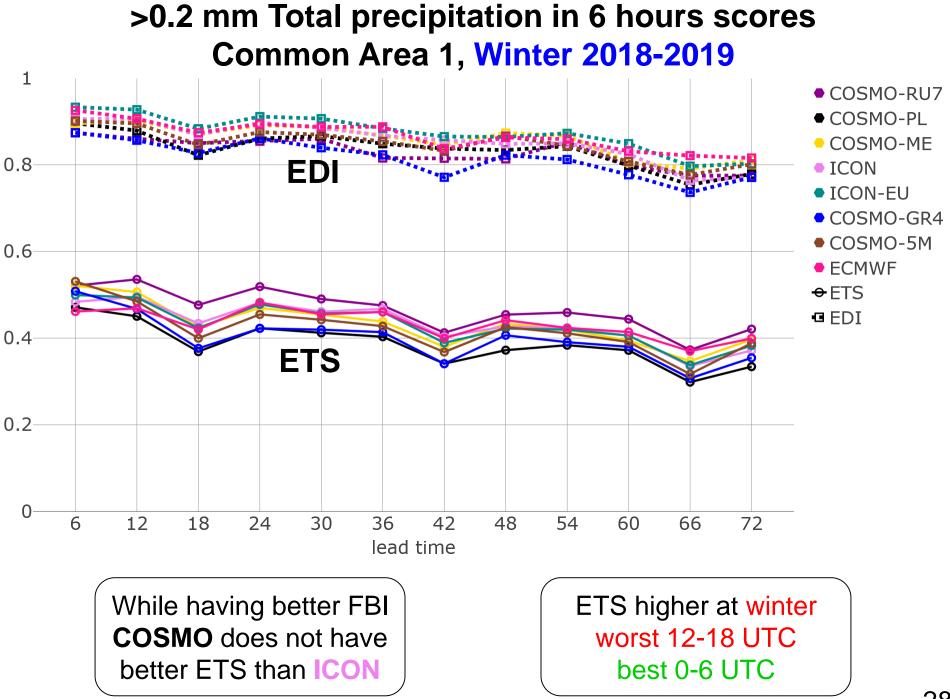
													2
Summer	0.85	0.88	0.26	0.42	0.77	0.75	0.21	0.34	0.88	0.67	0.31	0.46	
Autumn	0.80	0.76	0.65	0.68	0.85	0.73	0.69	0.78	0.61	0.47	0.5	0.46	1.5
Winter	1.27	1.04	1.47	1.2	0.92	1.13	1.52	1.38	0.82	1.18	1.55	0.94	0.5
Spring -	0.87	0.88	0.72	0.88	1.03	1.02	0.86	1.07	1.16	0.92	0.78	0.81	0
	6	12	18	24	30	36 lead	42 time	48	54	60	66	72	•
		<u>>10 n</u>	unde <u>nm</u> To ring <u>J.</u>	t.prec	;			low	er FB	MO h I than Ig <u>win</u>		V	

>10 mm Total precipitation in 6 hours FBI Common Area 1, COSMO-5M

													2
Summer	0.84	1.16	0.27	0.55	1	0.97	0.33	0.48	0.94	1.36	0.30	0.60	1 -
Autumn	0.54	0.96	0.76	0.96	1.27	1.04	1	0.96	1.06	0.84	0.98	0.92	1.5
Winter	0.62	0.79	1.09	0.91	0.76	0.76	1.43	0.93	0.62	0.74	1.03	0.85	1
Spring -	0.59	0.85	0.77	1.02	1.24	1.15	0.94	1.41	1.29	0.91	0.74	1.03	0.5
	6	12	18	24	30	36 lead	42 time	48	54	60	66	72	0
	CO		unde							MO h			
1		<10 n	nm To	t nror					or FR	I than			

>10 mm Tot.prec less during JJA, SON lower FBI than ICON during <u>winter</u>





>0.2 mm Total precipitation in 6 hours ETS Common Area 1, ICON-EU

Summer	0.37	0.26	0.25	0.33	0.7
Autumn	0.44	0.48	0.39	0.41	0.5 0.4
Winter	0.49	0.49	0.42	0.47	0.3
Spring-	0.48	0.43	0.40	0.45	0.1
	6	12 lead	18 time	24	_0
	COSMO-D better E during sur	TS	better <u>></u>	I <mark>O-D2</mark> has <u>10 mm</u> ETS g autumn	29

>0.2 mm Total precipitation in 6 hours ETS Common Area 2, COSMO-D2

Summer	0.43	0.32	0.32	0.33	0.7
Autumn	0.49	0.50	0.41	0.44	0.5
Winter	0.50	0.46	0.36	0.44	0.3
Spring	0.47	0.44	0.37	0.39	0.1
	6	12 lead	18 time	24	0
	COSMO-D better E during sur	TS	better <u>></u>	O-D2 has <u>10 mm</u> ETS g autumn	30

>10 mm Total precipitation in 6 hours ETS Common Area 1, ICON-EU

			- -		0.7
Summer	0.26	0.20	0.07	0.12	0.6
Autumn	0.20	0.25	0.14	0.26	0.5 0.4
Winter	0.45	0.37	0.32	0.35	0.3
Spring -	0.32	0.32	0.19	0.26	0.1
	6	12 lead	18 time	24	0
	ICON h better <u>>10 m</u> during DJF ar	Im ETS	better <u>></u>	I <mark>O-D2</mark> has <u>10 mm</u> ETS g autumn	31

>10 mm Total precipitation in 6 hours ETS Common Area 2, COSMO-D2

					0.7						
Summer	0.20	0.21	0.13	0.13	0.6						
Autumn	0.30	0.33	0.26	0.24	0.5						
Winter	0.30	0.27	0.26	0.35	0.3						
Spring	0.18	0.20	0.15	0.14	0.1						
	6	12 lead	18 time	24	0						
	ICON h better <u>>10 m</u> during DJF ar	<u>im</u> ETS	COSMO-D2 has better <u>>10 mm</u> ETS during autumn								

CONCLUSIONS

- ICON performs well. It has lower RMSE, especially after 9 hour lead time, compared to COSMO and IFS.
- Summer daytime and winter nighttime T2M RMSE is the highest for ICON. Diurnal variation underestimated.
- ICON tend to overestimate TD2M. ME and RMSE reaches maximum diurnal values during the late afternoon.
- TCC ME>0 at night (observation specifics?).
- 25-75% TCC events have lower TS. <25% and >75% TCC events are forecasted less successfully during summer, 25-75% TCC events more successfully.
- COSMO overestimates the frequency of >75% TCC (including overcast) conditions much more than ICON.
- ICON generally underestimate wind speed. All models tend to underestimate >15 m/s wind gust frequency.

CONCLUSIONS

- The common feature of overestimating low threshold precipitation frequency and underestimating high threshold precipitation frequency persists.
- Both ETS and FBI decrease for higher precipitation thresholds.
- ICON has generally higher FBI for low threshold precipitation events than COSMO: "drizzle" problem persists.
- While having better FBI, COSMO does not have better ETS than ICON: ICON has generally slightly better ETS than COSMO with similar diurnal and seasonal variation.
- ETS of precipitation events is the best during winter, the lowest score values during summer. The worst ETS values generally occurring at 12-18 UTC, the best at 0-6 UTC.
- COSMO-D2 has better ETS during summer than ICON and during autumn for high threshold precipitation events. ICON is still better for high precipitation events during winter and spring. 34

Thank you for your attention

Total cloud cover TS, Summer 2018 Common Area 1, ICON-EU

75-100% -	0.52	0.53	0.53	0.53	0.52	0.52	0.52	0.46	0.48	0.51	0.53	0.50	0.48	0.48	0.50	0.44	0.47	0.48	0.48	0.45	0.46	0.43	0.45	0.41	0.43	0.55 0.5
threshold 512% -	0.26	0.24	0.29	0.37	0.42	0.34	0.28	0.24	0.23	0.25	0.28	0.32	0.37	0.32	0.25	0.23	0.22	0.22	0.25	0.30	0.34	0.30	0.22	0.22	0.21	0.45
0-25% -	0.57	0.57	0.57	0.53	0.44	0.47	0.49	0.52	0.52	0.55	0.53	0.50	0.41	0.42	0.45	0.48	0.50	0.51	0.50	0.45	0.39	0.39	0.43	0.45	0.48	0.35 0.3
	Ō		- 6		12		18		24		30	le	36 ad tin	ne	42		48		54		60		66		72	0.25
		The lowest TS <u>for 25-75%</u> Total cloud cover													25-75% Total cloud cover underestimated										36	