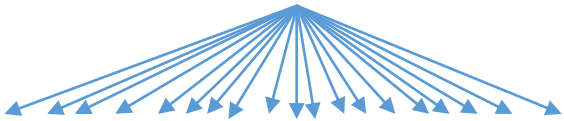# Comparison of ICON-EPS and COSMO-EPS over the Eastern Mediterranean

Pavel Khain, Alon Shtivelman, Anat Baharad, Yoav Levi

Israel Meteorological Service

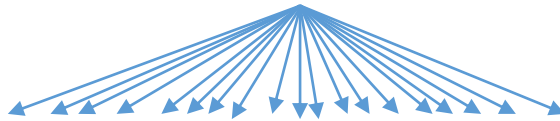ICCARUS, WG7, March 2022

Overview

Which option of ensemble
structure is better?

No model physics perturbation   SPPT   SPPT+PP

18 methods to choose the BC   18 methods to choose the BC   18 methods to choose the BC

Overview

Which option of ensemble structure is better?
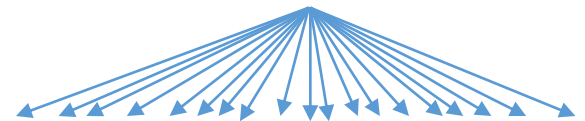
No model physics perturbation

SPPT

SPPT+PP

18 methods to choose the BC

18 methods to choose the BC

18 methods to choose the BC

PP

Add ICON-EPS
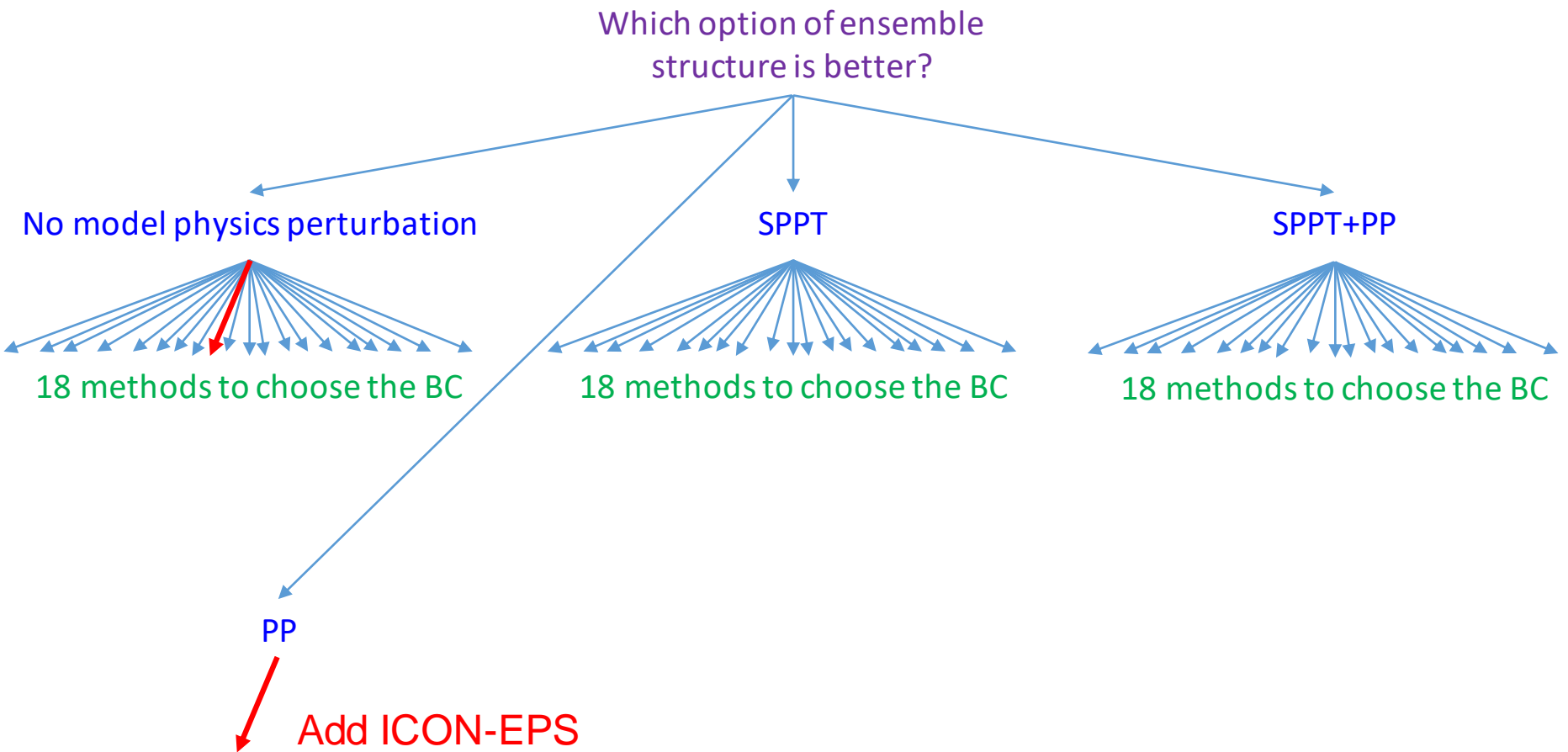
Observations Representativity Error
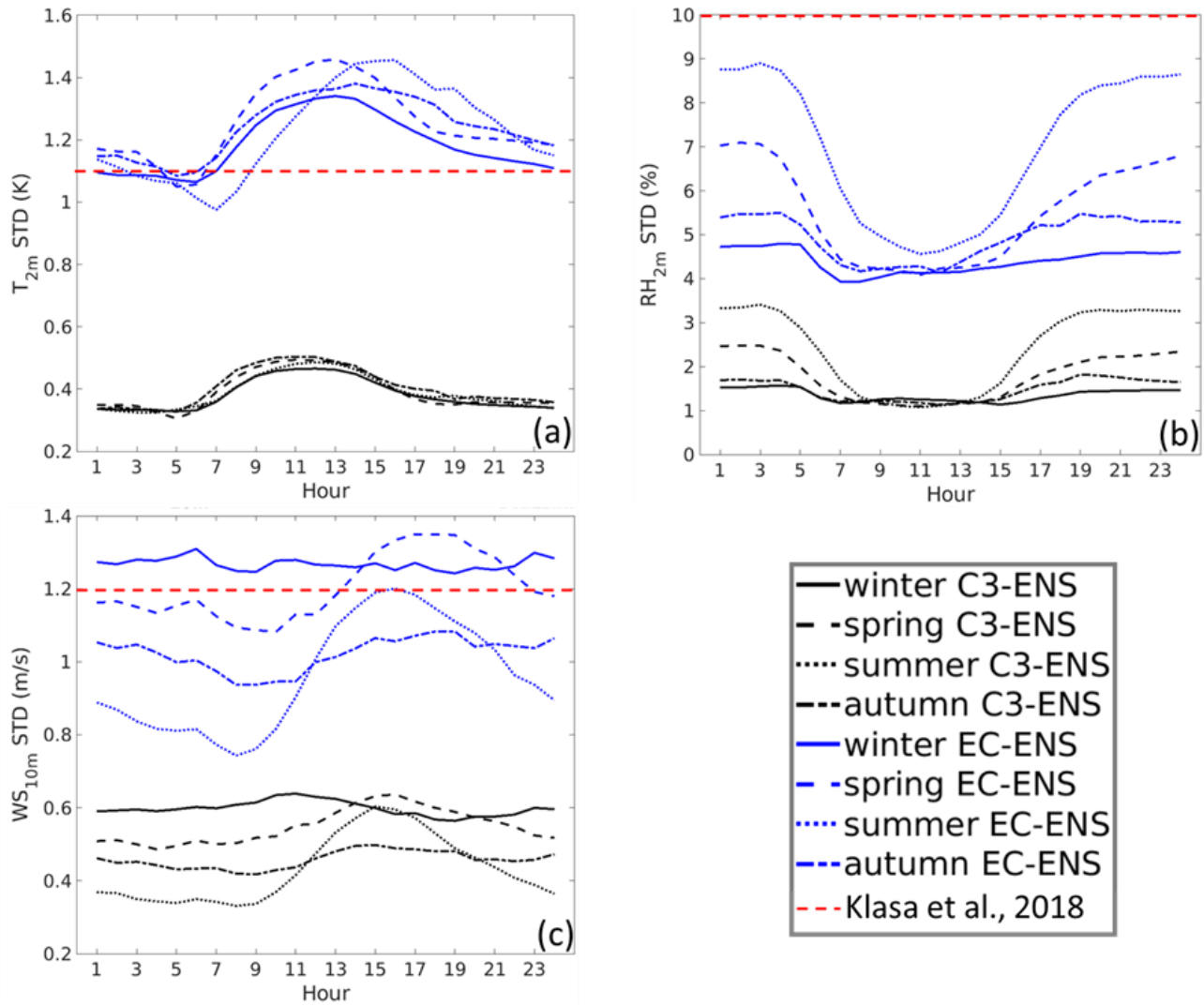
Observations Representativity Error (ORE) versus time of the day for EC-ENS (blue) and C3-ENS (black). Panels a-c present the ORE for 2m-temperature, 2m-relative humidity and 10m-wind speed, respectively. The winter, spring, summer and autumn seasons are represented by solid, dashed, dotted and dash-dotted lines, respectively. The dashed red line represents the ORE used in Klasa et al., 2018.

Verification of near surface variables

Winter: 22/12/2019-10/01/2020, 05/02/2020-16/02/2020 – 61 runs
Summer: 27/08/2020-07/09/2020 – 24 runs

- We use unbiased RMSE and a spread boosted by observations representativity error
  (Bouttier et al., 2012; Klasa et al., 2018; Westerhuis et al., 2016, Ben Bouallegue, 2020)

- The verification was performed against 81 automatic weather stations

Winter 2020: 2m Temperature
COSMO: No physical perturbations
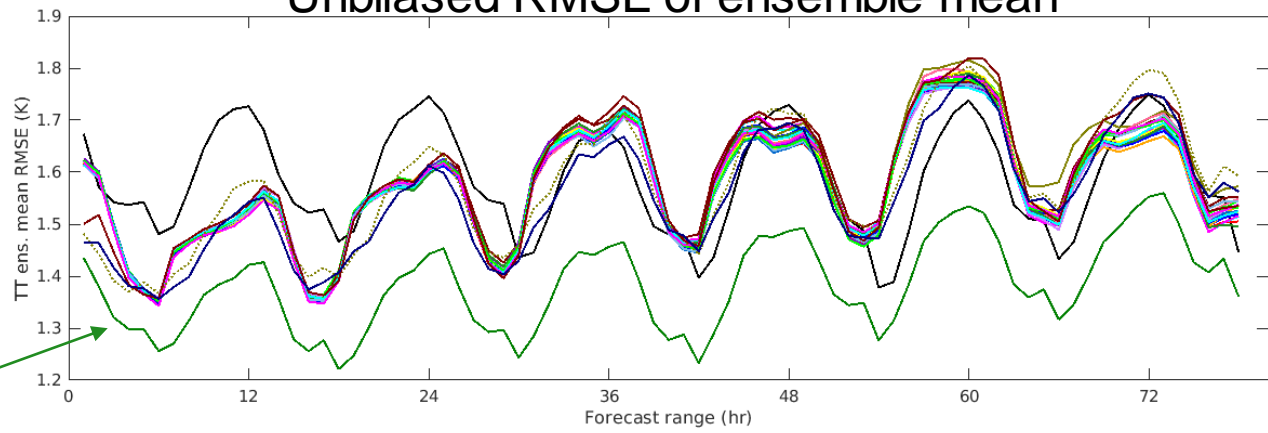## ICON: No physical perturbations

Unbliased RMSE of ensemble mean

22	1.586	EC_50
03	1.568	C3_50
05	1.571	cape_sort
20	1.580	cape_tcw_sort
14	1.575	vortic_sort
15	1.575	vortic_msl_sort
06	1.573	geo_msl_sort_96
23	1.586	cape_repr
21	1.585	cape_tcw_repr
04	1.570	vortic_repr
07	1.573	vortic_msl_repr
09	1.573	geo_msl_repr_96
18	1.577	italy_repr_96
12	1.574	rand
08	1.573	cape_repr2
17	1.576	cape_tcw_repr2
10	1.573	vortic_repr2
13	1.574	vortic_msl_repr2
11	1.573	geo_msl_repr2_96
16	1.575	italy_repr2_96
19	1.578	oper
24	1.587	ifs_sppt
02	1.555	ifs_pp
01	1.383	ICON

Boosted spread-skill ratio

ICON
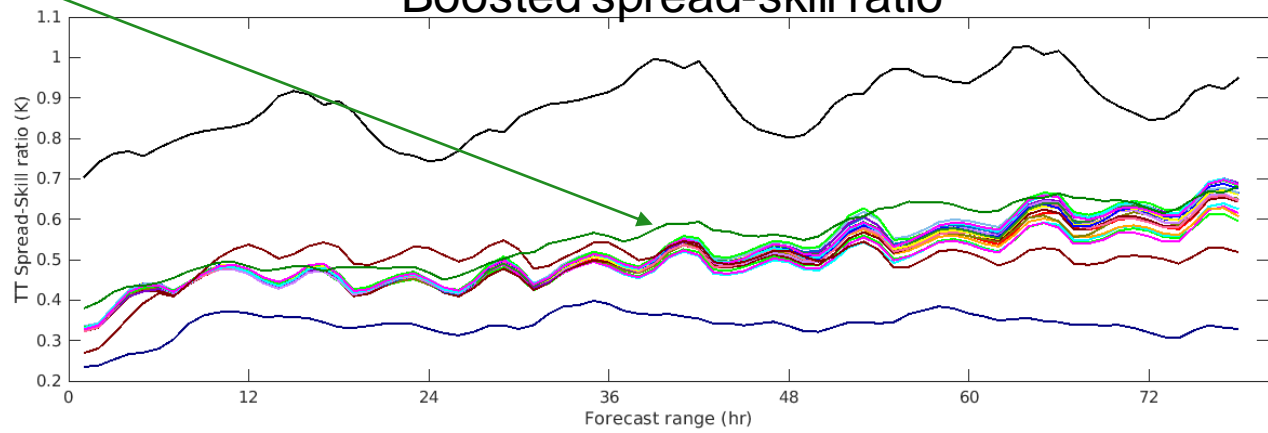
02	0.879	EC_50
11	0.515	C3_50
16	0.503	cape_sort
21	0.491	cape_tcw_sort
22	0.491	vortic_sort
23	0.490	vortic_msl_sort
19	0.501	geo_msl_sort_96
17	0.503	cape_repr
18	0.501	cape_tcw_repr
12	0.513	vortic_repr
09	0.515	vortic_msl_repr
14	0.509	geo_msl_repr_96
15	0.506	italy_repr_96
13	0.513	rand
10	0.515	cape_repr2
08	0.516	cape_tcw_repr2
05	0.524	vortic_repr2
04	0.525	vortic_msl_repr2
07	0.517	geo_msl_repr2_96
06	0.519	italy_repr2_96
20	0.497	ifs_sppt
24	0.340	ifs_pp
03	0.552	ICON

Winter 2020: 2m Temperature
COSMO: SPPT
ICON: PP
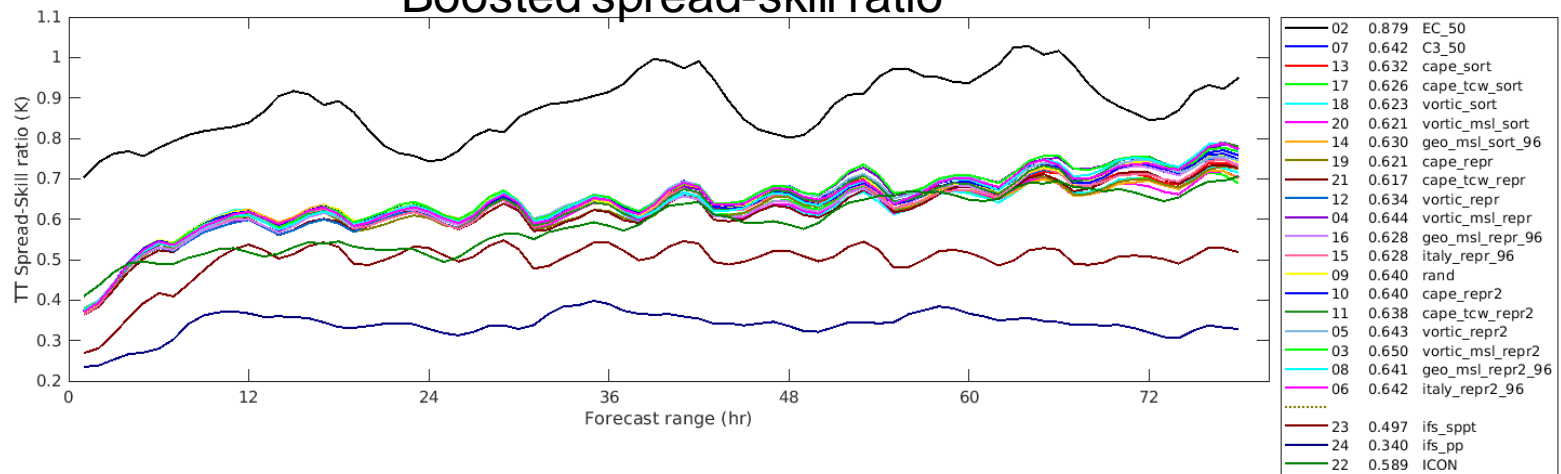
Unbliased RMSE of ensemble mean

Boosted spread-skill ratio

Winter 2020: 2m Relative Humidity
COSMO: No physical perturbations
ICON: No physical perturbations

Unbliased RMSE of ensemble mean

24	14.798	EC_50
07	11.357	C3_50
08	11.362	cape_sort
03	11.323	cape_tcw_sort
09	11.367	vortic_sort
06	11.342	vortic_msl_sort
05	11.335	geo_msl_sort_96
22	11.499	cape_repr
16	11.426	cape_tcw_repr
20	11.452	vortic_repr
15	11.418	vortic_msl_repr
17	11.437	geo_msl_repr_96
21	11.469	italy_repr_96
12	11.408	rand
14	11.414	cape_repr2
11	11.386	cape_tcw_repr2
18	11.441	vortic_repr2
10	11.376	vortic_msl_repr2
19	11.446	geo_msl_repr2_96
13	11.409	italy_repr2_96
23	11.580	oper
02	11.200	ifs_sppt
04	11.328	ifs_pp
01	11.032	ICON

Boosted spread-skill ratio

23	0.326	EC_50
08	0.471	C3_50
18	0.459	cape_sort
19	0.454	cape_tcw_sort
21	0.452	vortic_sort
20	0.453	vortic_msl_sort
15	0.461	geo_msl_sort_96
17	0.460	cape_repr
16	0.460	cape_tcw_repr
12	0.465	vortic_repr
11	0.468	vortic_msl_repr
14	0.462	geo_msl_repr_96
13	0.463	italy_repr_96
09	0.469	rand
10	0.469	cape_repr2
06	0.472	cape_tcw_repr2
05	0.476	vortic_repr2
03	0.480	vortic_msl_repr2
07	0.471	geo_msl_repr2_96
04	0.477	italy_repr2_96
22	0.437	ifs_sppt
24	0.278	ifs_pp
02	0.497	ICON

8

Winter 2020: 2m Relative Humidity
COSMO: SPPT
ICON: PP

Unbliased RMSE of ensemble mean

24	14.798	EC_50
06	11.359	C3_50
10	11.411	cape_sort
04	11.337	cape_tcw_sort
09	11.397	vortic_sort
07	11.381	vortic_msl_sort
05	11.357	geo_msl_sort_96
23	11.624	cape_repr
18	11.473	cape_tcw_repr
16	11.460	vortic_repr
14	11.442	vortic_msl_repr
20	11.508	geo_msl_repr_96
21	11.522	italy_repr_96
11	11.415	rand
17	11.473	cape_repr2
12	11.429	cape_tcw_repr2
15	11.451	vortic_repr2
08	11.391	vortic_msl_repr2
19	11.494	geo_msl_repr2_96
13	11.439	italy_repr2_96
22	11.580	oper
02	11.200	ifs_sppt
03	11.328	ifs_pp
01	10.958	ICON

Boosted spread-skill ratio

23	0.326	EC_50
05	0.563	C3_50
11	0.554	cape_sort
14	0.553	cape_tcw_sort
16	0.549	vortic_sort
18	0.547	vortic_msl_sort
12	0.553	geo_msl_sort_96
20	0.541	cape_repr
19	0.542	cape_tcw_repr
13	0.553	vortic_repr
09	0.557	vortic_msl_repr
15	0.549	geo_msl_repr_96
17	0.548	italy_repr_96
06	0.561	rand
10	0.556	cape_repr2
08	0.559	cape_tcw_repr2
03	0.566	vortic_repr2
02	0.570	vortic_msl_repr2
07	0.560	geo_msl_repr2_96
04	0.564	italy_repr2_96
22	0.437	ifs_sppt
24	0.278	ifs_pp
21	0.533	ICON

9

Winter 2020: 10m Wind Speed
COSMO: No physical perturbations
ICON: No physical perturbations

Unbliased RMSE of ensemble mean

23	1.769	EC_50
02	1.682	C3_50
06	1.691	cape_sort
08	1.692	cape_tcw_sort
11	1.694	vortic_sort
10	1.693	vortic_msl_sort
12	1.694	geo_msl_sort_96
20	1.709	cape_repr
18	1.701	cape_tcw_repr
09	1.692	vortic_repr
16	1.699	vortic_msl_repr
15	1.695	geo_msl_repr_96
19	1.702	italy_repr_96
03	1.690	rand
13	1.694	cape_repr2
17	1.700	cape_tcw_repr2
07	1.691	vortic_repr2
14	1.695	vortic_msl_repr2
05	1.691	geo_msl_repr2_96
04	1.690	italy_repr2_96
24	1.851	oper
21	1.710	ifs_sppt
22	1.748	ifs_pp
01	1.639	ICON

Boosted spread-skill ratio

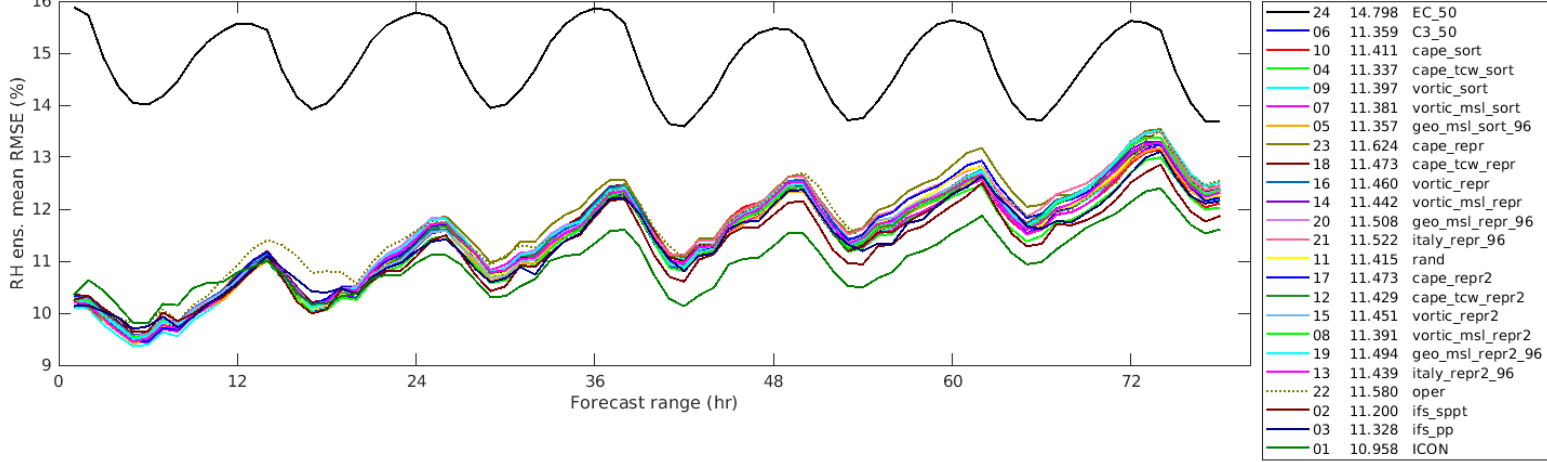|		
02	0.820	EC_50
08	0.690	C3_50
16	0.675	cape_sort
18	0.670	cape_tcw_sort
21	0.663	vortic_sort
22	0.662	vortic_msl_sort
19	0.670	geo_msl_sort_96
20	0.670	cape_repr
17	0.672	cape_tcw_repr
13	0.683	vortic_repr
12	0.684	vortic_msl_repr
14	0.680	geo_msl_repr_96
15	0.680	italy_repr_96
10	0.688	rand
11	0.686	cape_repr2
09	0.689	cape_tcw_repr2
05	0.697	vortic_repr2
04	0.698	vortic_msl_repr2
07	0.692	geo_msl_repr2_96
06	0.695	italy_repr2_96
23	0.646	ifs_sppt
24	0.494	ifs_pp
03	0.732	ICON

Winter 2020: 10m Wind Speed
COSMO: SPPT
ICON: PP

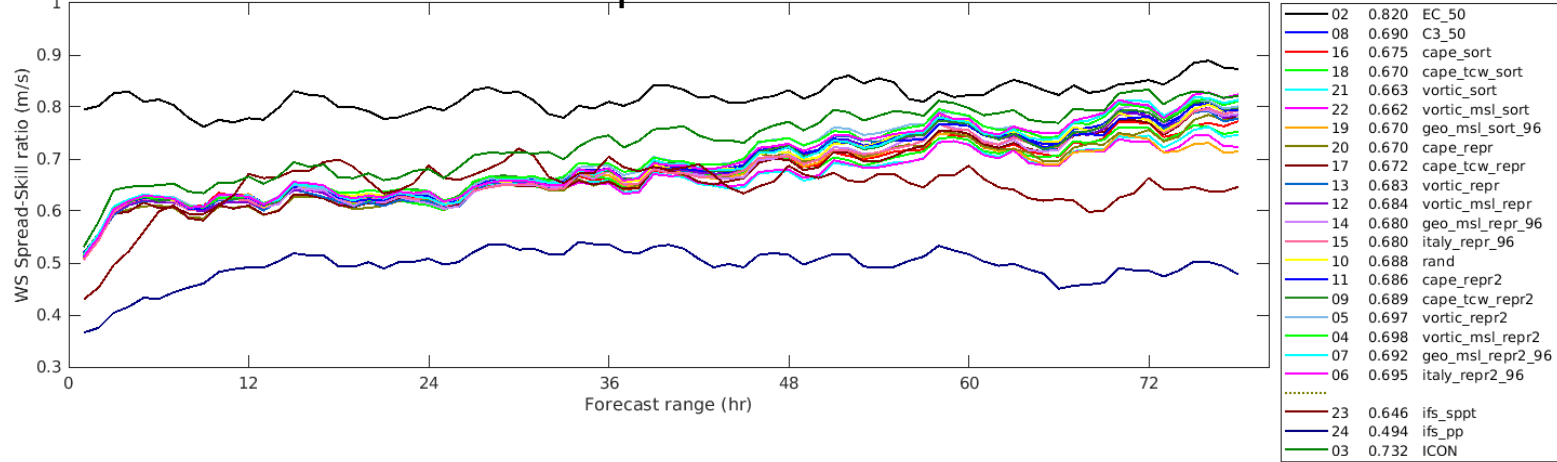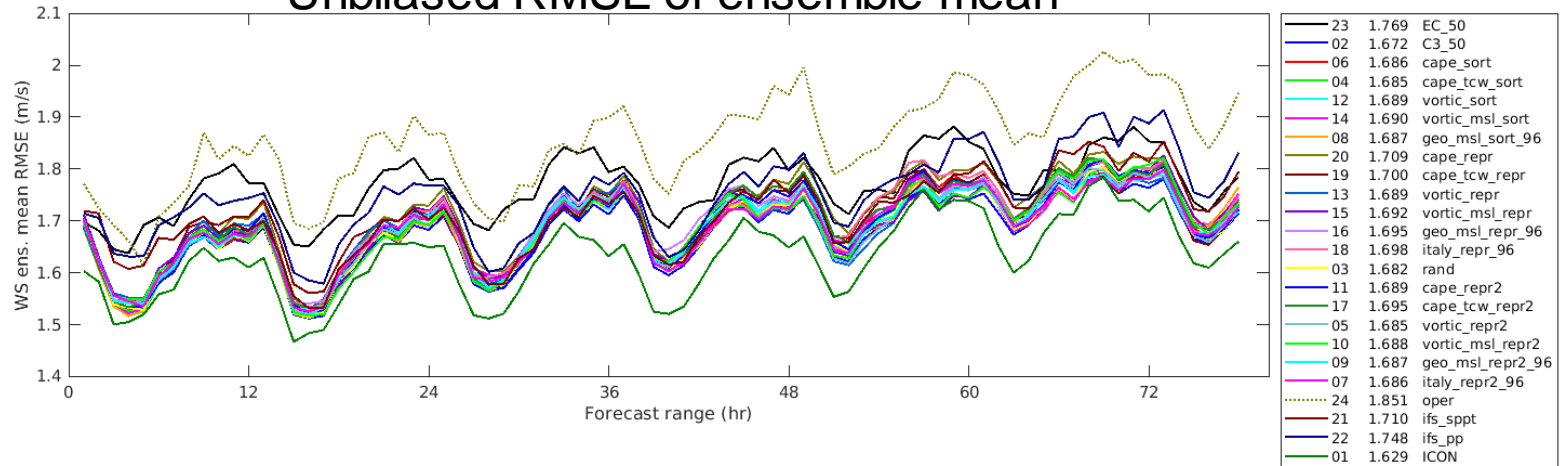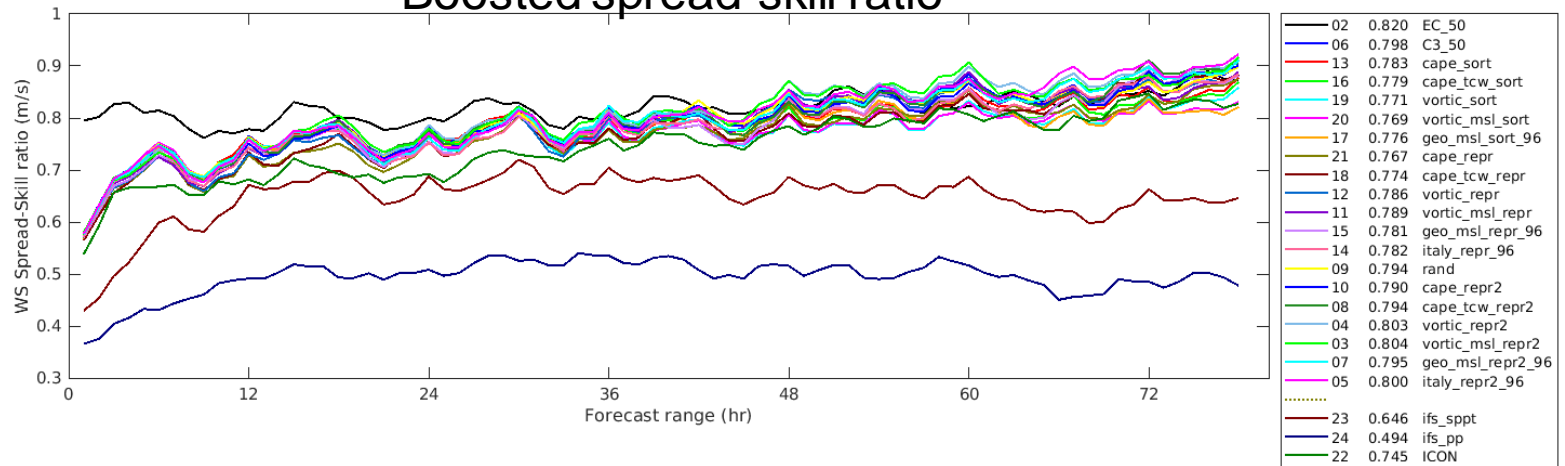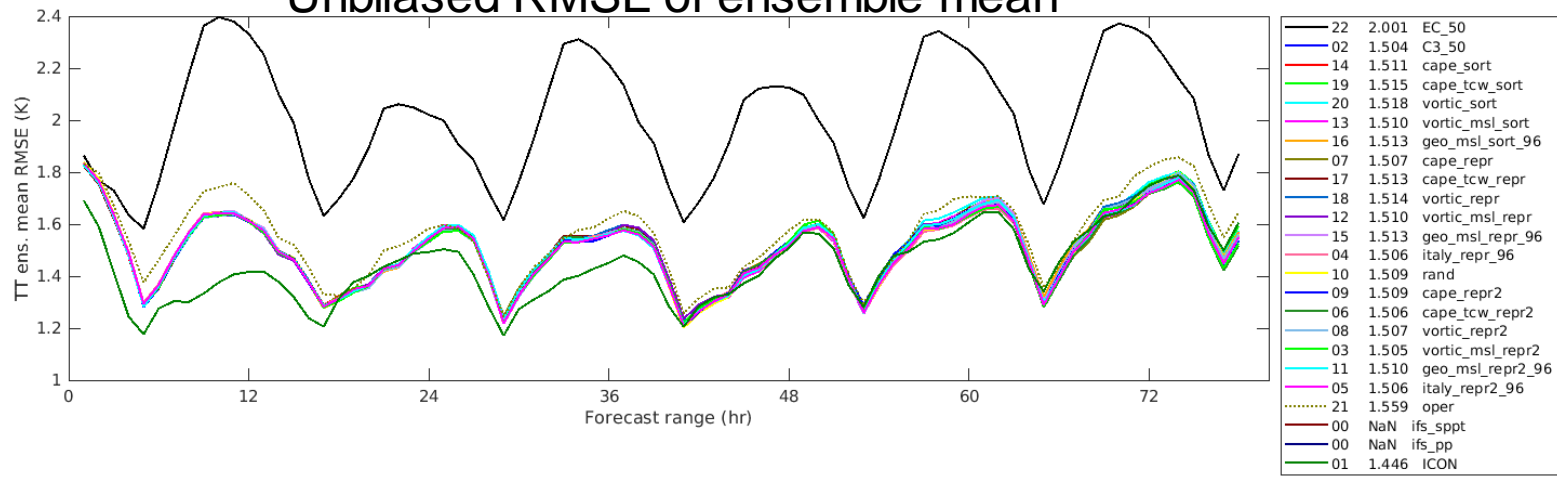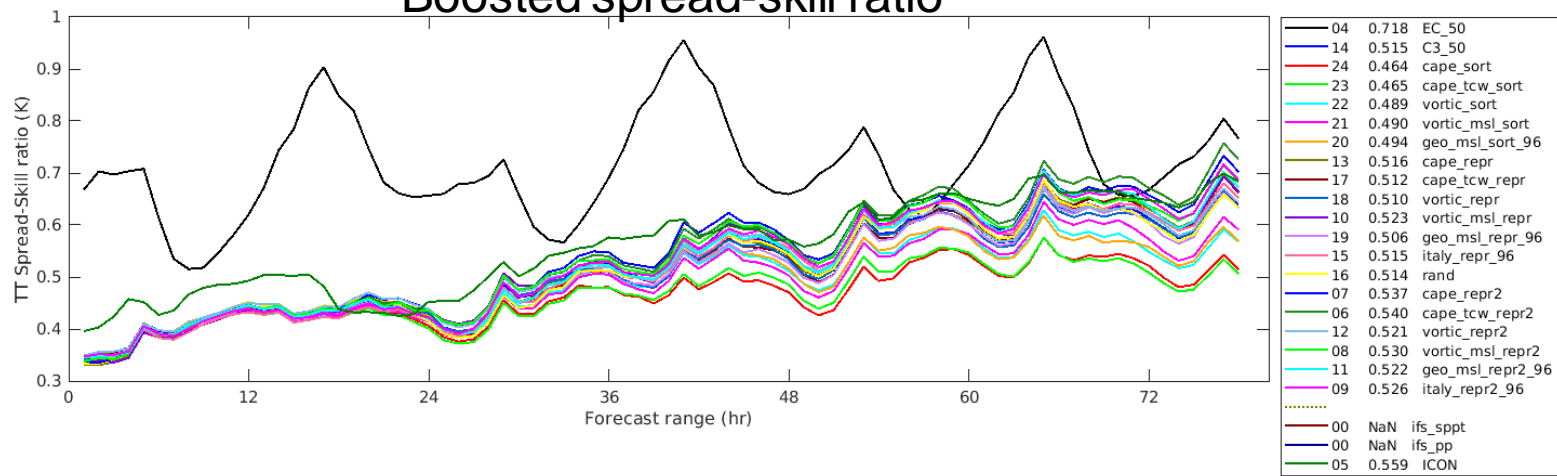Unbliased RMSE of ensemble mean

Boosted spread-skill ratio

Summer 2020: 2m Temperature
COSMO: No physical perturbations
ICON: No physical perturbations

Unbliased RMSE of ensemble mean

22	2.001	EC_50
02	1.504	C3_50
14	1.511	cape_sort
19	1.515	cape_tcw_sort
20	1.518	vortic_sort
13	1.510	vortic_msl_sort
16	1.513	geo_msl_sort_96
07	1.507	cape_repr
17	1.513	cape_tcw_repr
18	1.514	vortic_repr
12	1.510	vortic_msl_repr
15	1.513	geo_msl_repr_96
04	1.506	italy_repr_96
10	1.509	rand
09	1.509	cape_repr2
06	1.506	cape_tcw_repr2
08	1.507	vortic_repr2
03	1.505	vortic_msl_repr2
11	1.510	geo_msl_repr2_96
05	1.506	italy_repr2_96
21	1.559	oper
00	NaN	ifs_sppt
00	NaN	ifs_pp
01	1.446	ICON

Boosted spread-skill ratio

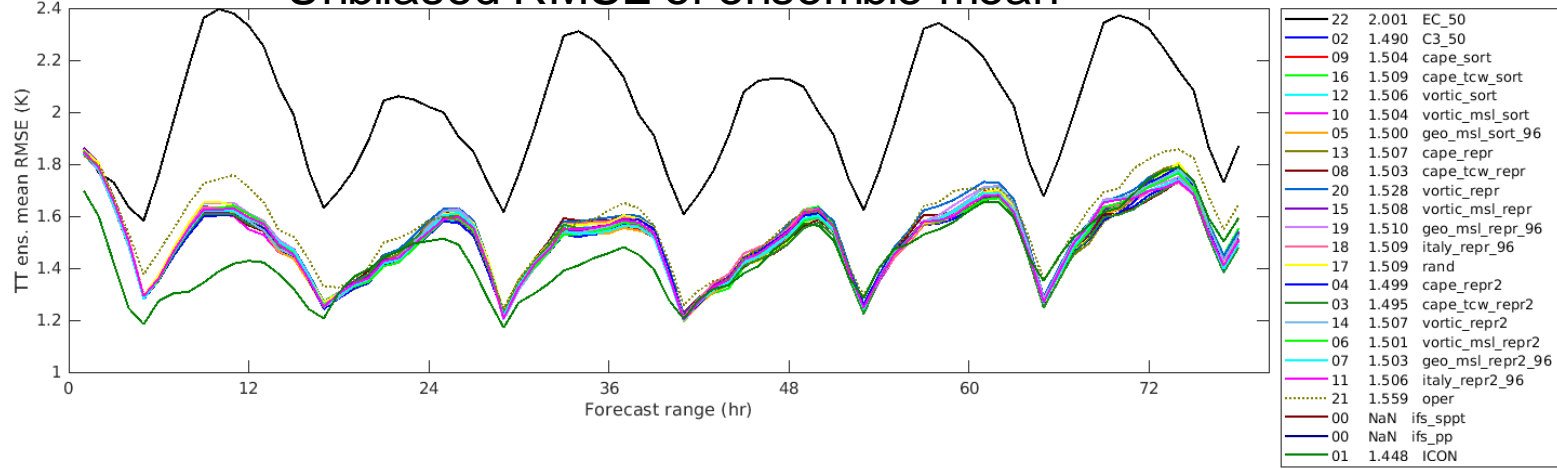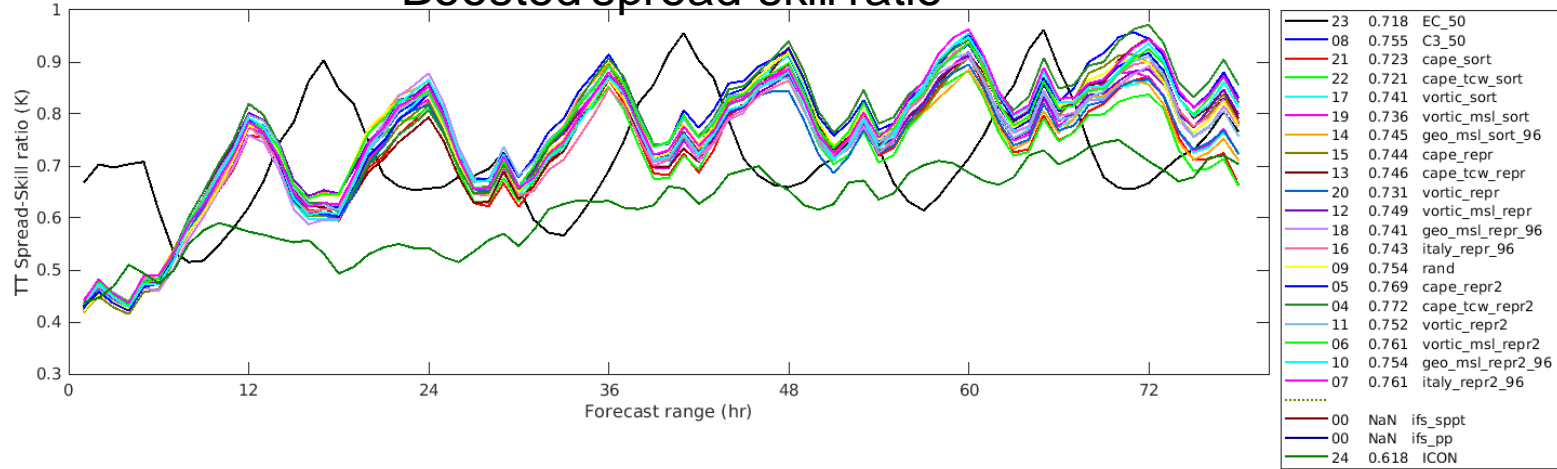|		
04	0.718	EC_50
14	0.515	C3_50
24	0.464	cape_sort
23	0.465	cape_tcw_sort
22	0.489	vortic_sort
21	0.490	vortic_msl_sort
20	0.494	geo_msl_sort_96
13	0.516	cape_repr
17	0.512	cape_tcw_repr
18	0.510	vortic_repr
10	0.523	vortic_msl_repr
19	0.506	geo_msl_repr_96
15	0.515	italy_repr_96
16	0.514	rand
07	0.537	cape_repr2
06	0.540	cape_tcw_repr2
12	0.521	vortic_repr2
08	0.530	vortic_msl_repr2
11	0.522	geo_msl_repr2_96
09	0.526	italy_repr2_96
00	NaN	ifs_sppt
00	NaN	ifs_pp
05	0.559	ICON

Summer 2020: 2m Temperature
COSMO: SPPT
ICON: PP
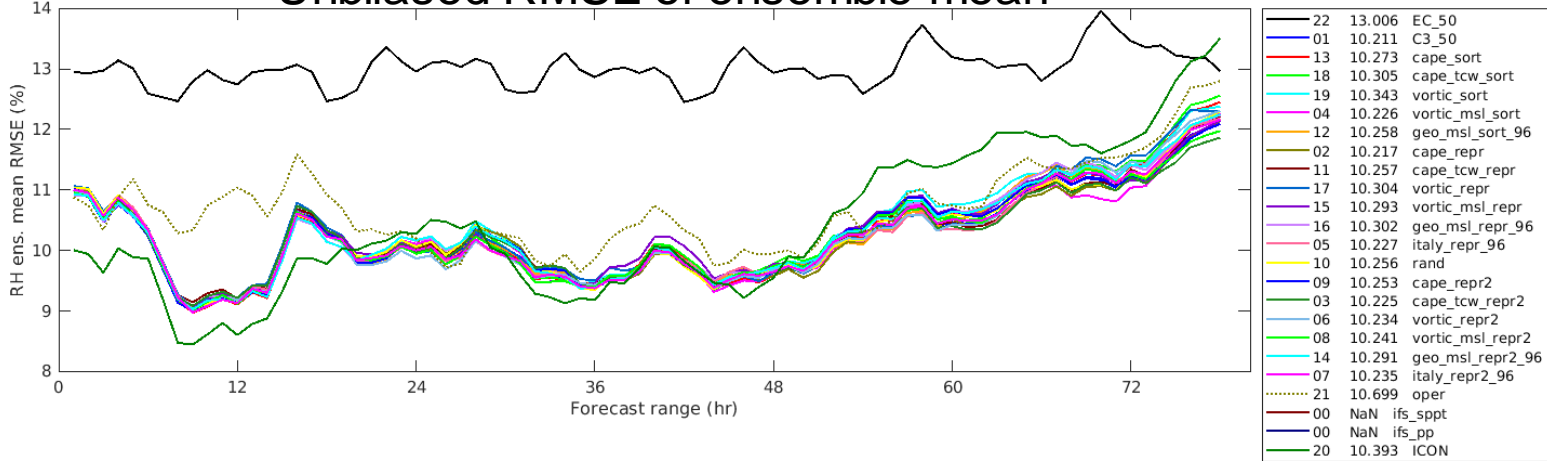

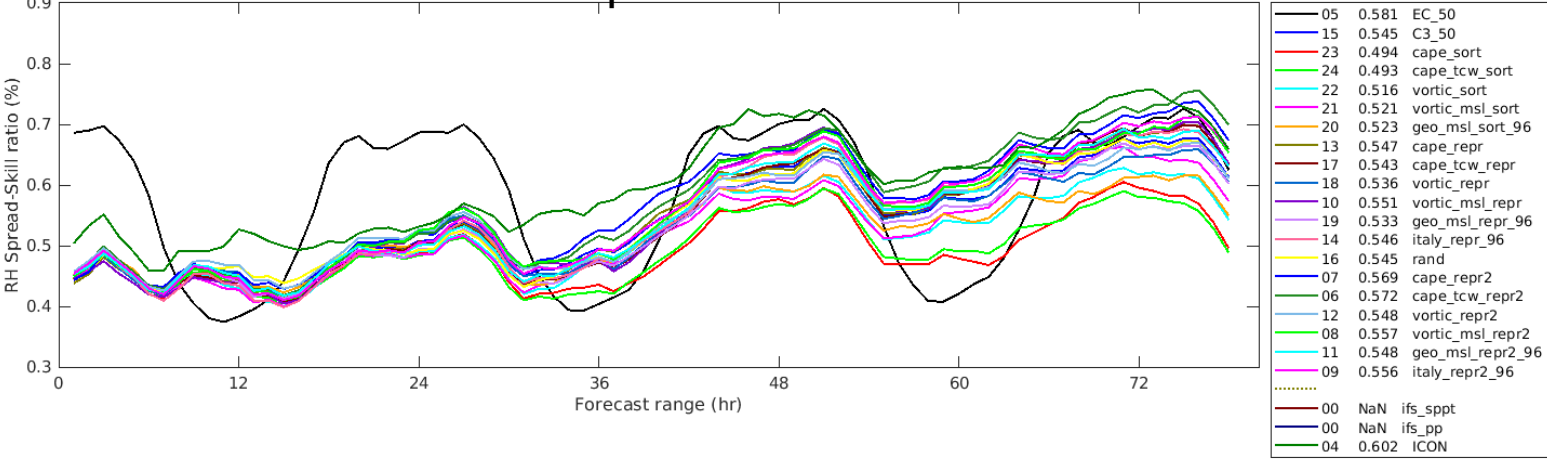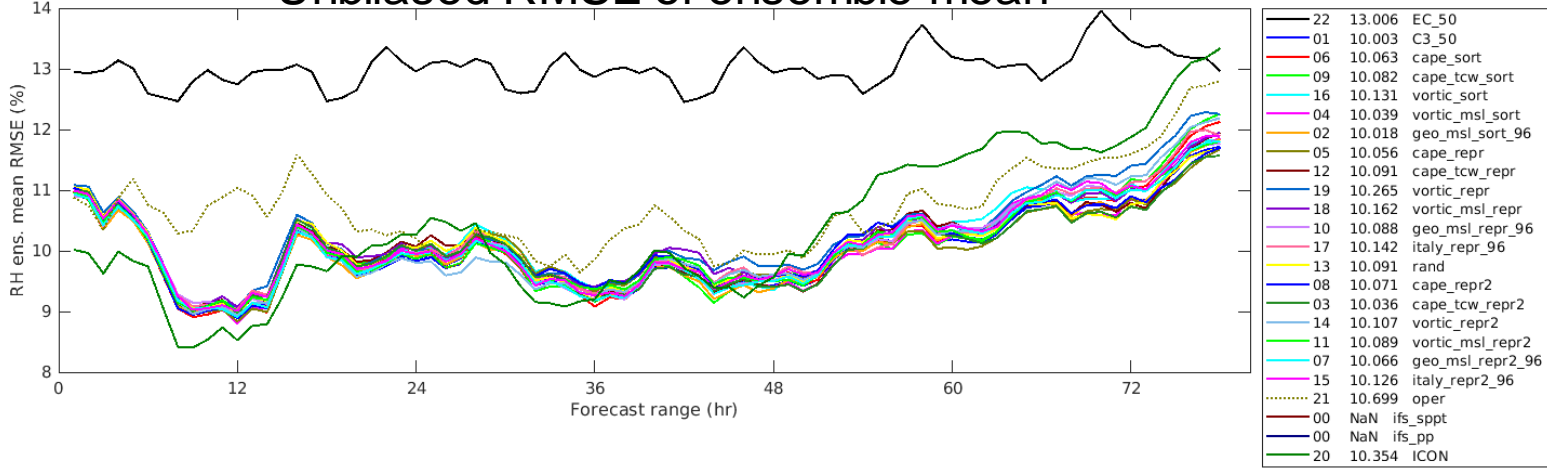Unbliased RMSE of ensemble mean

Boosted spread-skill ratio

Summer 2020: 2m Relative Humidity
COSMO: No physical perturbations
ICON: No physical perturbations

Unbliased RMSE of ensemble mean

22	13.006	EC_50
01	10.211	C3_50
13	10.273	cape_sort
18	10.305	cape_tcw_sort
19	10.343	vortic_sort
04	10.226	vortic_msl_sort
12	10.258	geo_msl_sort_96
02	10.217	cape_repr
11	10.257	cape_tcw_repr
17	10.304	vortic_repr
15	10.293	vortic_msl_repr
16	10.302	geo_msl_repr_96
05	10.227	italy_repr_96
10	10.256	rand
09	10.253	cape_repr2
03	10.225	cape_tcw_repr2
06	10.234	vortic_repr2
08	10.241	vortic_msl_repr2
14	10.291	geo_msl_repr2_96
07	10.235	italy_repr2_96
21	10.699	oper
00	NaN	ifs_sppt
00	NaN	ifs_pp
20	10.393	ICON

Boosted spread-skill ratio

05	0.581	EC_50
15	0.545	C3_50
23	0.494	cape_sort
24	0.493	cape_tcw_sort
22	0.516	vortic_sort
21	0.521	vortic_msl_sort
20	0.523	geo_msl_sort_96
13	0.547	cape_repr
17	0.543	cape_tcw_repr
18	0.536	vortic_repr
10	0.551	vortic_msl_repr
19	0.533	geo_msl_repr_96
14	0.546	italy_repr_96
16	0.545	rand
07	0.569	cape_repr2
06	0.572	cape_tcw_repr2
12	0.548	vortic_repr2
08	0.557	vortic_msl_repr2
11	0.548	geo_msl_repr2_96
09	0.556	italy_repr2_96
00	NaN	ifs_sppt
00	NaN	ifs_pp
04	0.602	ICON

14

Summer 2020: 2m Relative Humidity
COSMO: SPPT
ICON: PP

Unbliased RMSE of ensemble mean

22	13.006	EC_50
01	10.003	C3_50
06	10.063	cape_sort
09	10.082	cape_tcw_sort
16	10.131	vortic_sort
04	10.039	vortic_msl_sort
02	10.018	geo_msl_sort_96
05	10.056	cape_repr
12	10.091	cape_tcw_repr
19	10.265	vortic_repr
18	10.162	vortic_msl_repr
10	10.088	geo_msl_repr_96
17	10.142	italy_repr_96
13	10.091	rand
08	10.071	cape_repr2
03	10.036	cape_tcw_repr2
14	10.107	vortic_repr2
11	10.089	vortic_msl_repr2
07	10.066	geo_msl_repr2_96
15	10.126	italy_repr2_96
21	10.699	oper
00	NaN	ifs_sppt
00	NaN	ifs_pp
20	10.354	ICON

Boosted spread-skill ratio

24	0.581	EC_50
08	0.720	C3_50
22	0.684	cape_sort
21	0.687	cape_tcw_sort
20	0.696	vortic_sort
18	0.701	vortic_msl_sort
15	0.708	geo_msl_sort_96
13	0.711	cape_repr
16	0.707	cape_tcw_repr
19	0.698	vortic_repr
12	0.714	vortic_msl_repr
17	0.705	geo_msl_repr_96
14	0.708	italy_repr_96
10	0.718	rand
05	0.732	cape_repr2
04	0.735	cape_tcw_repr2
09	0.719	vortic_repr2
06	0.726	vortic_msl_repr2
11	0.717	geo_msl_repr2_96
07	0.721	italy_repr2_96
00	NaN	ifs_sppt
00	NaN	ifs_pp
23	0.634	ICON

Summer 2020: 10m Wind Speed
COSMO: No physical perturbations
ICON: No physical perturbations
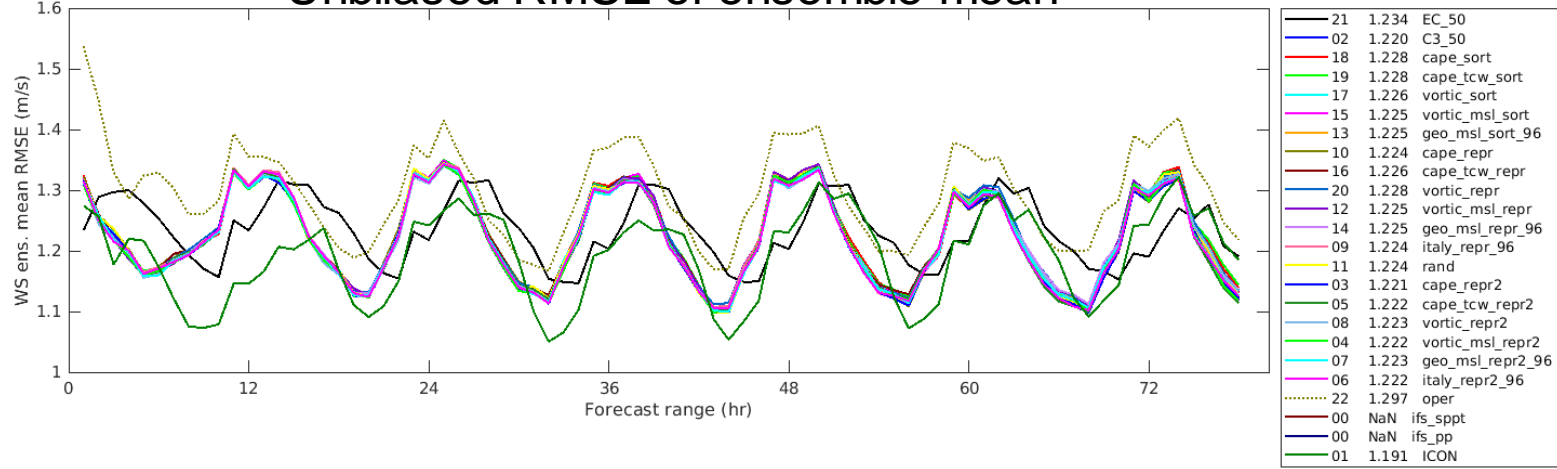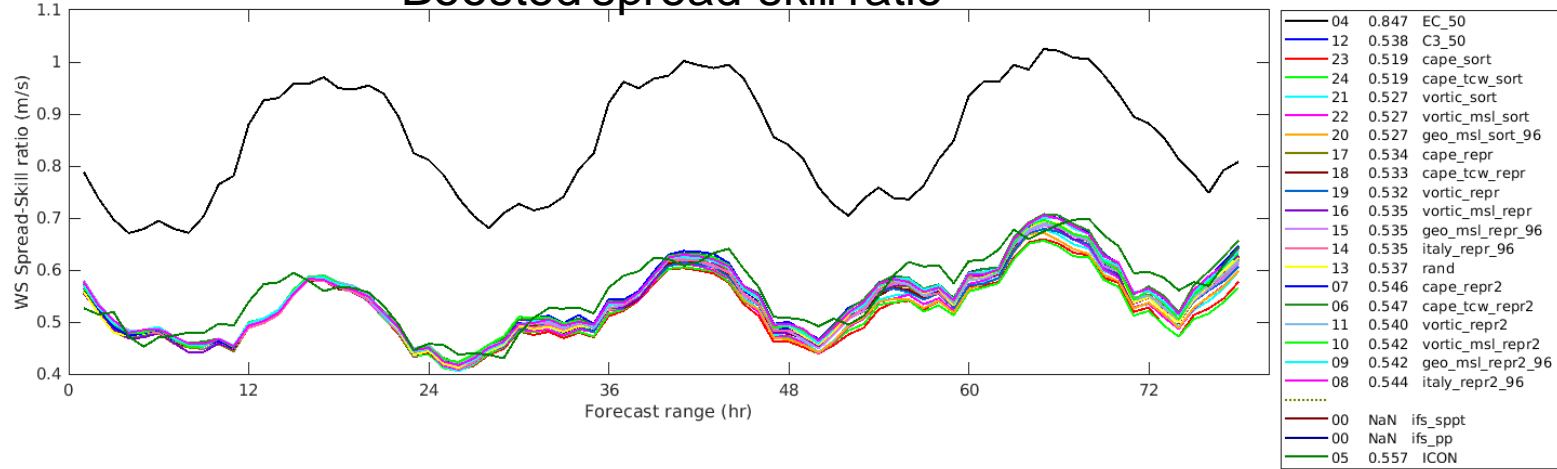
Unbliased RMSE of ensemble mean

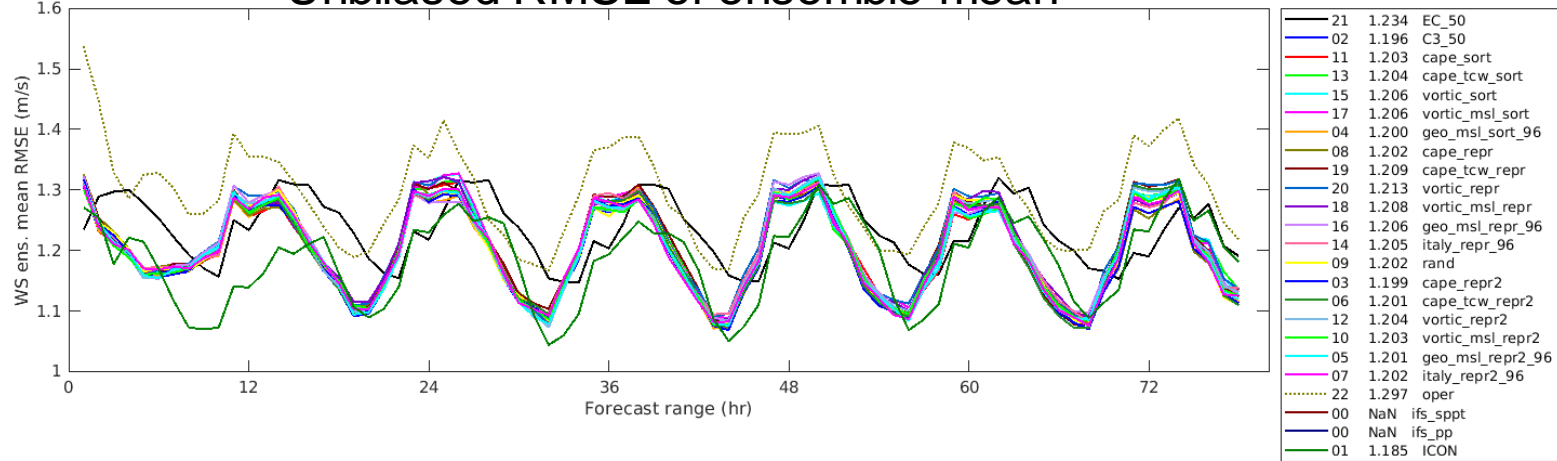|		
21	1.234	EC_50
02	1.220	C3_50
18	1.228	cape_sort
19	1.228	cape_tcw_sort
17	1.226	vortic_sort
15	1.225	vortic_msl_sort
13	1.225	geo_msl_sort_96
10	1.224	cape_repr
16	1.226	cape_tcw_repr
20	1.228	vortic_repr
12	1.225	vortic_msl_repr
14	1.225	geo_msl_repr_96
09	1.224	italy_repr_96
11	1.224	rand
03	1.221	cape_repr2
05	1.222	cape_tcw_repr2
08	1.223	vortic_repr2
04	1.222	vortic_msl_repr2
07	1.223	geo_msl_repr2_96
06	1.222	italy_repr2_96
22	1.297	oper
00	NaN	ifs_sppt
00	NaN	ifs_pp
01	1.191	ICON

Boosted spread-skill ratio

04	0.847	EC_50
12	0.538	C3_50
23	0.519	cape_sort
24	0.519	cape_tcw_sort
21	0.527	vortic_sort
22	0.527	vortic_msl_sort
20	0.527	geo_msl_sort_96
17	0.534	cape_repr
18	0.533	cape_tcw_repr
19	0.532	vortic_repr
16	0.535	vortic_msl_repr
15	0.535	geo_msl_repr_96
14	0.535	italy_repr_96
13	0.537	rand
07	0.546	cape_repr2
06	0.547	cape_tcw_repr2
11	0.540	vortic_repr2
10	0.542	vortic_msl_repr2
09	0.542	geo_msl_repr2_96
08	0.544	italy_repr2_96
00	NaN	ifs_sppt
00	NaN	ifs_pp
05	0.557	ICON

Summer 2020: 10m Wind Speed
COSMO: SPPT
## ICON: PP

Unbliased RMSE of ensemble mean

Boosted spread-skill ratio

Verification of precipitation

ICON-EPS vs. COSMO-EPS

- 61 winter runs verified against the Radar composite (QPE).

- 6 hourly precipitation, forecast ranges 12-78h. Averaged over not up-scaled thresholds of 0.5, 1, 2 and 5 mm/6h, and up-scaled thresholds of 10 and 20 mm/6h.

- The error bars were obtained using boot strap method.
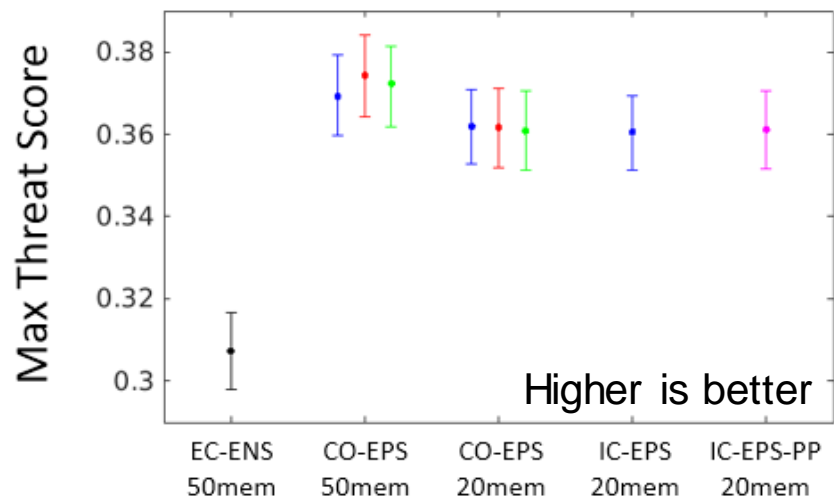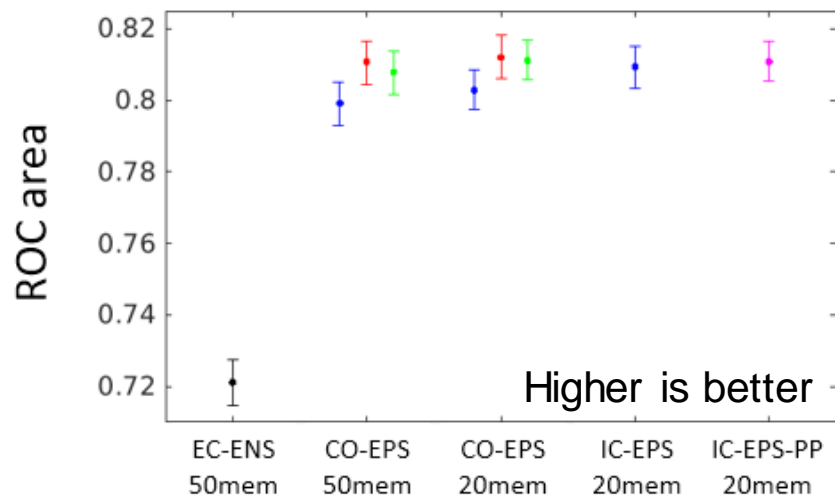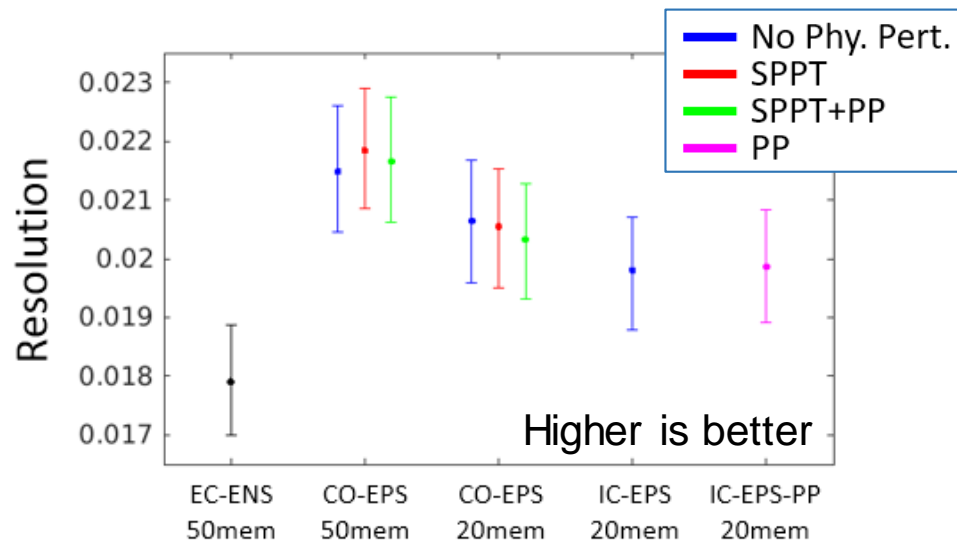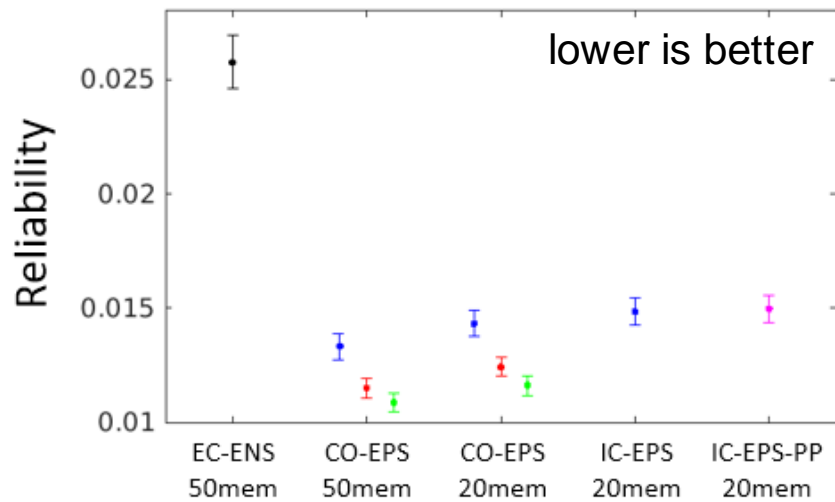
Summary

1. For COSMO-EPS we use random EC-ENS members for BC, together with SPPT perturbations

2. <u>Near surface fields</u>: ICON-EPS are better than COSMO-EPS in RMSE of ensemble mean (skill), but worse in spread-skill ratio!

3. <u>Precipitation</u>: ICON-EPS is a bit worse than COSMO-EPS in precipitation scores

4. <u>Conclusion</u>: Waiting for SPPT in ICON ☺

Thanks!