

Satellite Radiance Data Assimilation at KMA (Korea Meteorological Administration)



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4p.05

Korea Meteorological Administration
Numerical Modeling Center

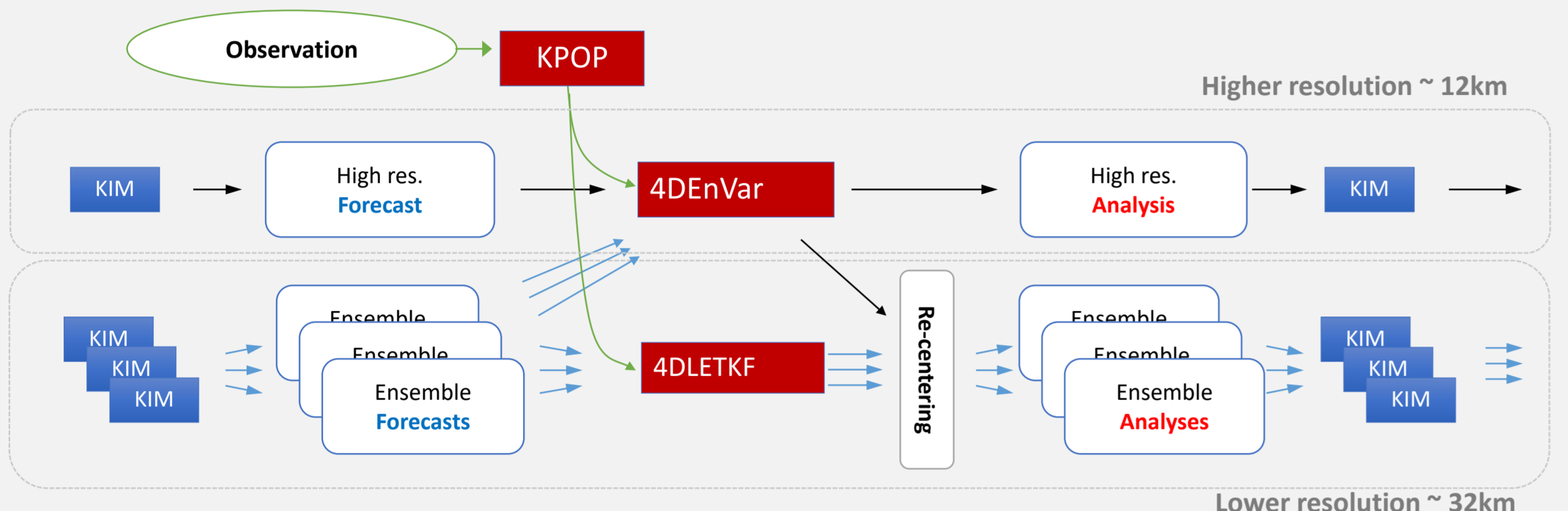
Configuration of the global NWP system at KMA

NWP: KIM (Korean Integrated Model) launched April 2020

- Spatial resolution: ne360np3 ~ 12km, Cubed sphere grid system
- Vertical resolution: 91 levels, up to 0.01 hPa

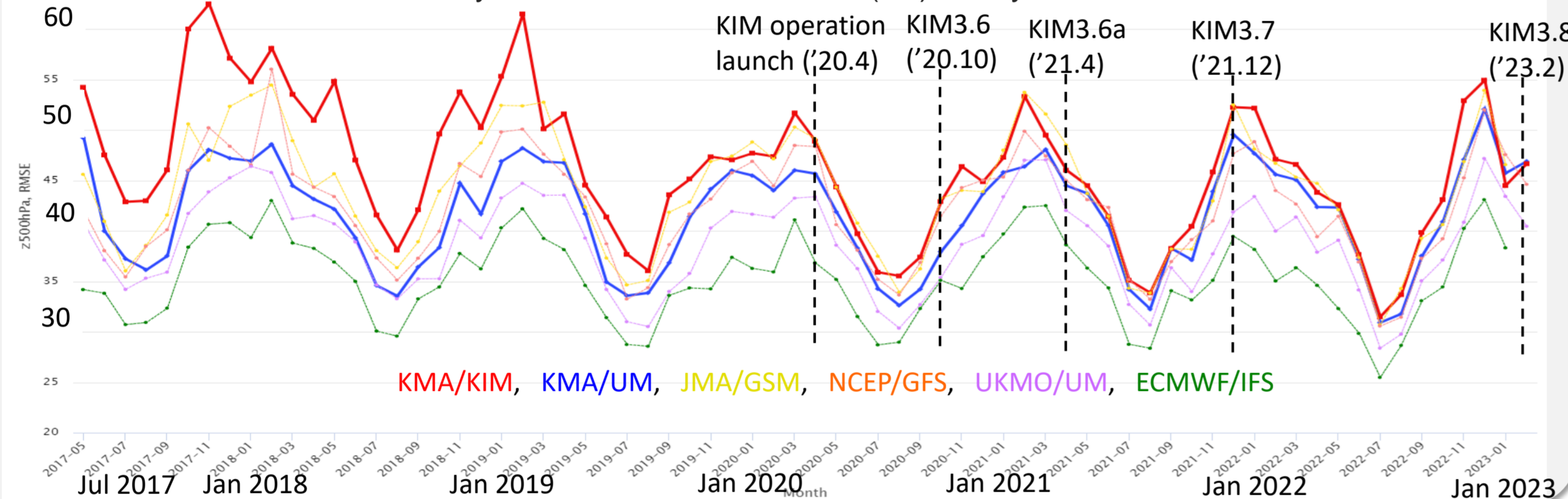
DA: Hybrid-4DEnVar

- Incremental analysis resolution: ne144np3 ~ 32km
- 4 analyses per day with 6hour assimilation window
- Background error covariance is combination (Static : Ensemble = 3:7)
- Ensemble: **4D LETKF**, 50 members, ne144np3 ~ 32km
- KPOP**: KIM Package for Observation Processing
- Radiative transfer model: RTTOV v12.3



KIM performance

Monthly mean RMSE of 500hPa GPH (NH) at 5day forecast

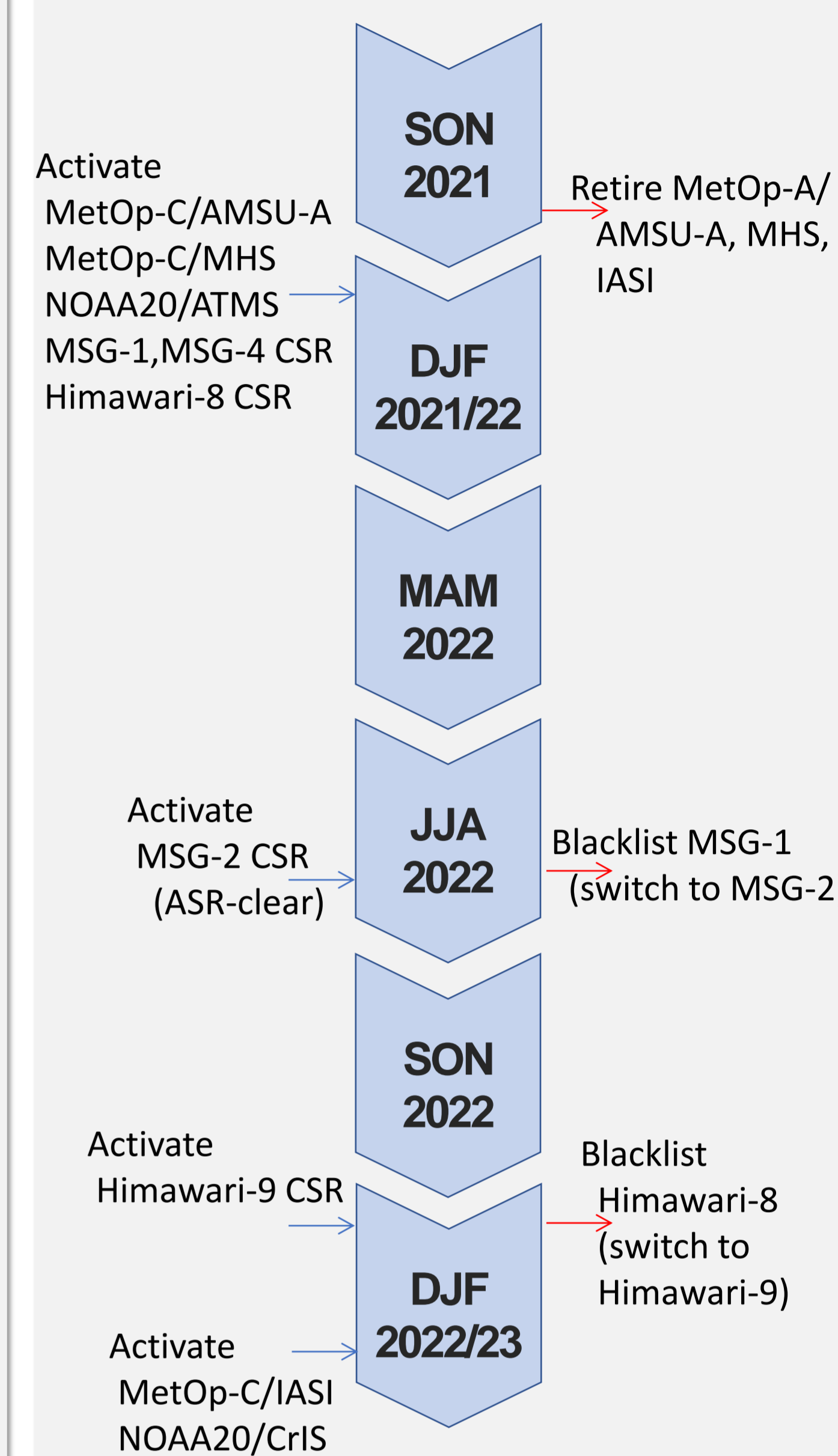


Current use of radiance instruments

A – Assimilated at 4DEnVar and 4DLETKF
E – Under evaluation
A^v – Assimilated only 4DEnVar
X – Failed/withdrawn
Changes since ITSC-23 are highlighted through orange shading

Satellite	MW Temperature sounder	MW Humidity sounder	MW Imager	IR broadband sounder or imager	IR hyperspectral sounder
NOAA-15	A	X			
NOAA-18	A	A			
NOAA-19	A	A			
NOAA-20	A	A			A
S-NPP	A	A			A
MetOp-A	X	X			X
MetOp-B	A	A			A
MetOp-C	A	A			A
FY-3C		A ^v			
FY-3D		E			
GCOM-W1			A		
GPM			E		
MSG-2				A ^v	
MSG-4				A ^v	
Himawari-9				A ^v	
GK-2A				E	
GOES-16				E	
GOES-18				E	
FY-4A					E

Timeline of main instrument changes since ITSC-23 (radiances only)



MW sounders and imagers

Main changes

- Expanding the ATMS water vapor channel 21, 22 [KIM3.7, Dec 2021]
- AMSUA ch10-14 over land [KIM3.8, Feb 2023]

Under developing

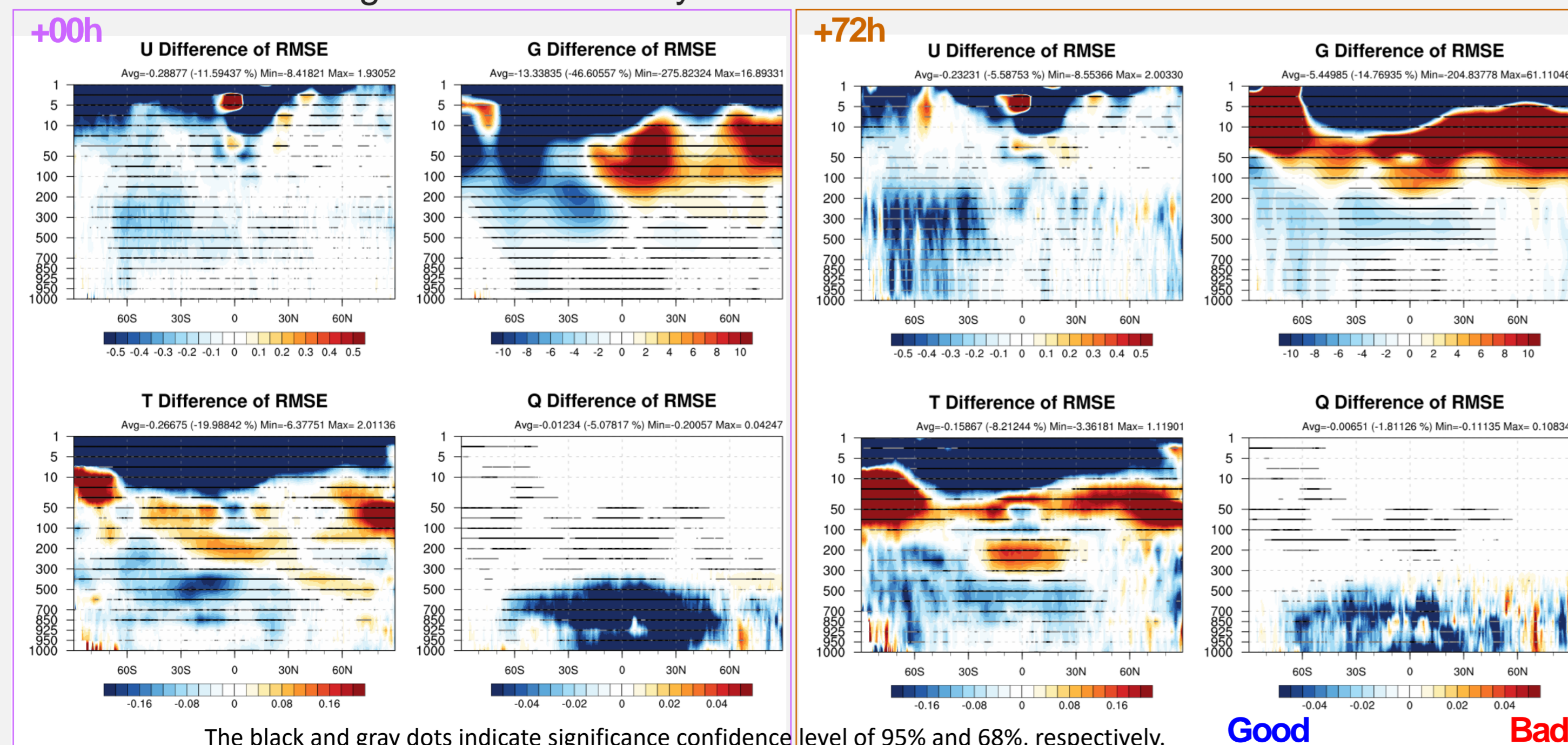
- All-sky assimilation of MHS → 9p.01 (Sihye Lee), 9p.03 (Han-Byeol Jeong)
- ATMS using over sea ice → 10p.06 (Jisoo Kim)
- Bias correction stabilizing → 12p.04 (Hyeyoung Kim)

Impact of MW radiances on KIM forecasting

- MW radiances: AMSUA, MHS, ATMS, AMSR2 vs. denial experiment
- Verification period: 1–31 July, 2022
- Improvement rate of RMSE against ECMWF analysis [%]

	Globe						North Hemisphere						South Hemisphere						Tropics					
	0	24	48	72	96	120	0	24	48	72	96	120	0	24	48	72	96	120	0	24	48	72	96	120
Q 700hPa	9.09	5.67	3.62	2.63	2.39	1.80	5.76	3.16	1.33	0.61	1.00	0.68	11.48	7.65	6.22	4.75	3.43	3.03	10.85	6.84	4.53	3.57	3.21	2.32
WS 250hPa	5.51	4.75	4.65	3.69	3.32	2.66	2.05	1.94	1.23	0.41	0.88	1.04	10.61	9.27	9.67	6.80	5.29	3.60	3.11	2.89	1.88	2.85	2.79	2.81
WS 500hPa	6.13	6.01	5.18	4.07	3.08	2.63	2.99	2.17	1.14	1.59	1.05	1.07	8.75	9.19	7.80	5.38	3.77	3.18	4.95	3.78	3.01	2.46	2.69	2.40
WS 850hPa	2.59	3.27	3.72	3.41	2.53	1.89	1.30	1.28	1.26	0.96	1.42	0.31	4.30	5.85	6.16	5.20	3.26	2.42	1.67	1.61	1.93	1.92	1.65	2.05
GPH 250hPa	18.58	12.32	10.96	7.18	5.23	3.50	4.68	4.28	3.02	3.47	2.70	1.04	35.30	17.44	13.75	7.85	6.10	4.37	9.67	9.34	16.44	13.04	7.19	5.58
GPH 500hPa	23.12	18.05	13.16	8.93	6.58	4.43	23.62	11.20	6.58	5.31	3.57	1.44	23.30	17.78	13.33	8.60	6.77	4.74	21.15	29.89	30.67	26.83	20.58	15.65
GPH 850hPa	7.68	7.10	7.65	6.93	6.41	4.57	2.63	-1.14	0.99	2.22	2.05	1.20	9.14	12.29	10.79	8.25	7.54	5.38	9.61	2.89	3.39	6.25	4.87	5.41
T 250hPa	1.05	-1.38	0.70	1.27	1.01	0.43	3.53	0.87	0.52	0.88	1.19	0.34	7.47	6.21	7.40	6.16	3.71	2.10	21.18	-22.15	-18.56	-17.28	-14.53	-11.51
T 500hPa	10.78	10.60	9.28	6.90	4.67	3.17	0.41	5.30	4.59	3.83	2.14	1.49	13.20	10.78	9.97	7.10	4.76	3.29	16.74	15.50	13.52	11.06	8.88	7.11
T 850hPa	6.77	4.63	3.70	2.94	2.67	3.29	2.24	2.14	1.50	0.88	0.99	0.57	6.94	4.02	3.55	3.47	3.15	4.70	9.59	7.26	6.08	4.42	3.75	3.36

Difference of RMSE against ECMWF analysis



- The impact of MW on KIM forecasting is mostly positive except for 10–300 hPa temperature and geopotential height.

IR sounders and imagers

Main changes

- GK-2A optimization for thinning and blacklisting [KIM3.7, Dec 2021]

Under developing

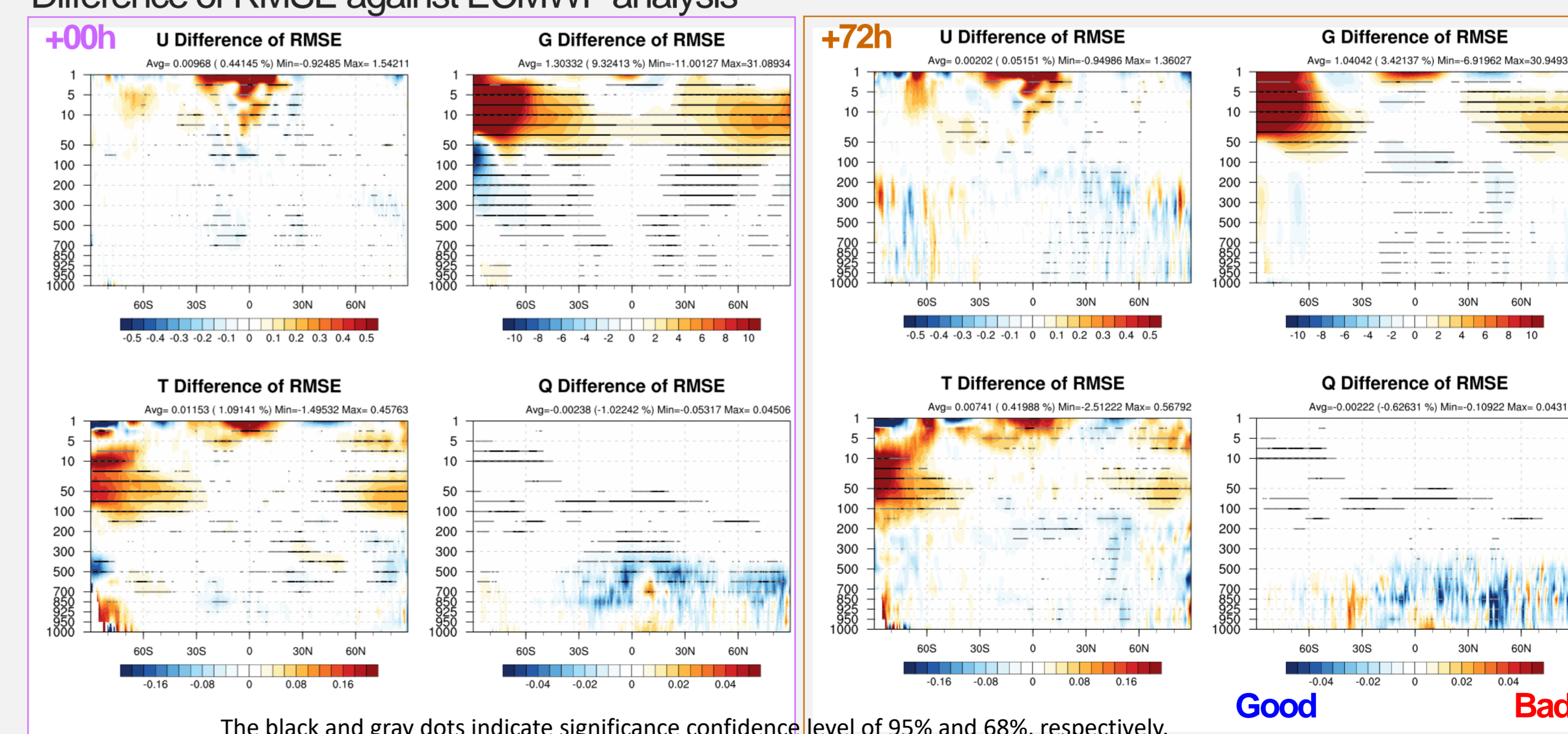
- IASI channel selection → 12p.05 (Ahreum Lee)
- Inter-channel correlated observation error for IASI
- Optimize thinning, blacklisting, bias correction, and observation error

Impact of IR radiances on KIM forecasting

- IR radiances: IASI, CrIS, CSR of geos (GK2A, MSG, Himawari) vs. denial experiment
- Verification period: 1–31 July, 2022
- Improvement rate of RMSE against ECMWF analysis [%]

	Globe						North Hemisphere						South Hemisphere						Tropics					
	0	24	48	72	96	120	0	24	48	72	96	120	0	24	48	72	96	120	0	24	48	72	96	120
Q 700hPa	1.05	0.92	0.77	0.77	0.80	0.46	1.52	1.23	1.18	0.91	1.23	1.36	0.89	0.43	0.12	0.07	-0.21	-0.46	0.73	0.84	0.64	0.88	0.75	-0.00
WS 250hPa	0.91	0.87	0.36	0.20	0.64	0.66	1.19	0.99	0.57	0.37	0.98	0.82	1.10	0.76	0.13	-0.04	0.29	0.37	0.46	0.86	0.30	0.13	0.58	0.64
WS 500hPa	1.37	1.06	0.57	0.43	0.50	0.27	1.65	1.51	1.60	1.76	1.46	0.96	1.15	0.68	-0.15	-0.36	-0.05	-0.00	1.38	1.22	1.09	0.88	0.76	-0.08
WS 850hPa	0.33	0.64	0.50	0.52	0.23	0.42	0.67	0.98	1.24	0.85	1.21	0.90	0.51	0.66	0.23	0.10	-0.56	0.09	-0.24	0.22	0.01	1.05	1.03	0.67
GPH 250hPa	0.55	1.92	1.00	1.28	1.75	1.11	-5.75	0.65	1.28	1.97	2.22	0.30	6.04	1.19	0.05	0.60	1.25	1.08	-0.82	4.93	4.33	1.70	2.46	3.40
GPH 500hPa	4.44	0.83	0.56	1.43	1.68	0.78	2.65	1.28	2.63	3.14	2.76	1.33	5.41	0.86	-0.15	0.67	1.07	0.40	4.21	-0.37	-0.06	0.24	0.34	-0.10
GPH 850hPa	1.64	1.22	1.57	1.69	1.33	1.74	3.62	2.26	3.28	3.32	2.57	2.96	0.32	0.29	0.25	0.62	0.49	1.39	2.31	1.98	4.80	4.65	3.88	0.87
T 250hPa	0.27	0.85	1.00	0.88	0.97	0.87	1.71	1.29	1.21	1.02	1.13	0.65	0.52	0.72	0.50	0.23	0.19	0.36	-2.56	0.41	1.57	2.34	3.16	3.91
T 500hPa	1.58	1.16	0.59	0.67	0.72	0.57	2.13	2.10	1.51	1.43	0.83	0.54	0.55	0.61	0.15	0.35	0.61	0.53	2.24	0.79	0.31	0.14	0.09	0.35
T 850hPa	1.37	0.72	0.50	0.60	0.41	1.06	0.08	0.32	0.69	1.23	1.23	0.74	0.81	0.13	-0.16	-0.30	-0.39	1.35	2.99	1.75	1.30	1.45	0.83	-0.26

Difference of RMSE against ECMWF analysis



- The impact of IR on KIM forecasting is mostly less positive than that of MW.
- Strong degradation is seen over Antarctica