

UM at KMA: Issue on Spurious Grid-Scale Precipitation in UM-Regional

Numerical Model Development Division/KMA
Forecast Research Lab., NIMR/KMA

Presented by Sang-Ok Han



➤ **UM status at KMA**

- *Prepared by Dong-Joon Kim from Numerical Model Development Division*

➤ **Status of SGSP in KMA UM-regional system**

- *Prepared by Eunha Lim and Jeong-Ock Lim from Numerical Model Development Division*

➤ **Characteristics of SGSP in UM-regional**

- *Prepared by Sang-Ok Han from Forecast Research Lab./NIMR*



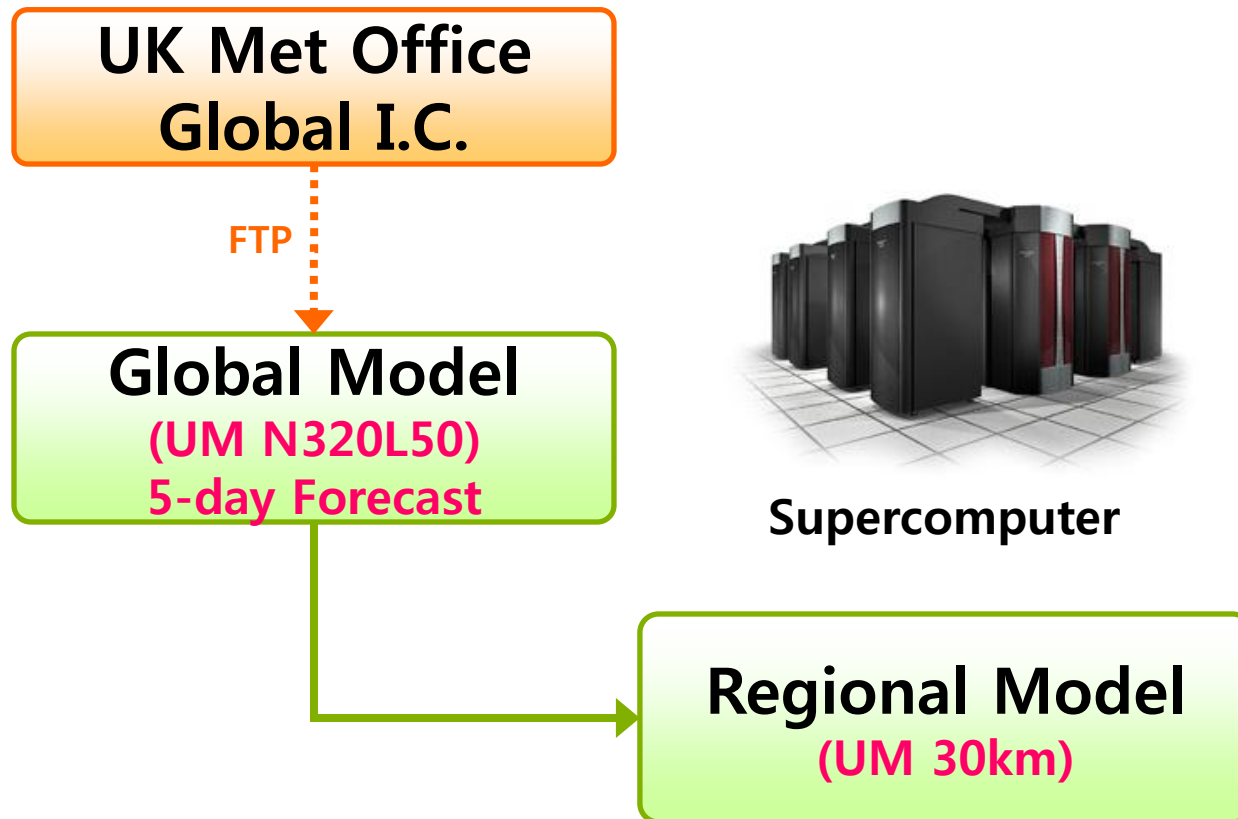
UM STATUS AT KMA

- ❖ **KMA decided to import the Unified Model as a next-generation NWP system (Q4 '07)**
- ❖ **Routine operation of global/regional UM started (Q2 '08)**
 - Initialized from UK Met Office's initial condition
- ❖ **Global D.A. cycle for UM including ODB implementation ('08~'09)**
- ❖ **Migration of UM system to the 3rd supercomputer (Q4 '09)**
- ❖ **Parallel run of UM system on Cray XT5 (March '10)**
- ❖ **Operational run of UM system on Cray XT5 (May '10~)**

1st Phase of UM Implementation : Cold-Start

하늘을 친구처럼
국민을 하늘처럼

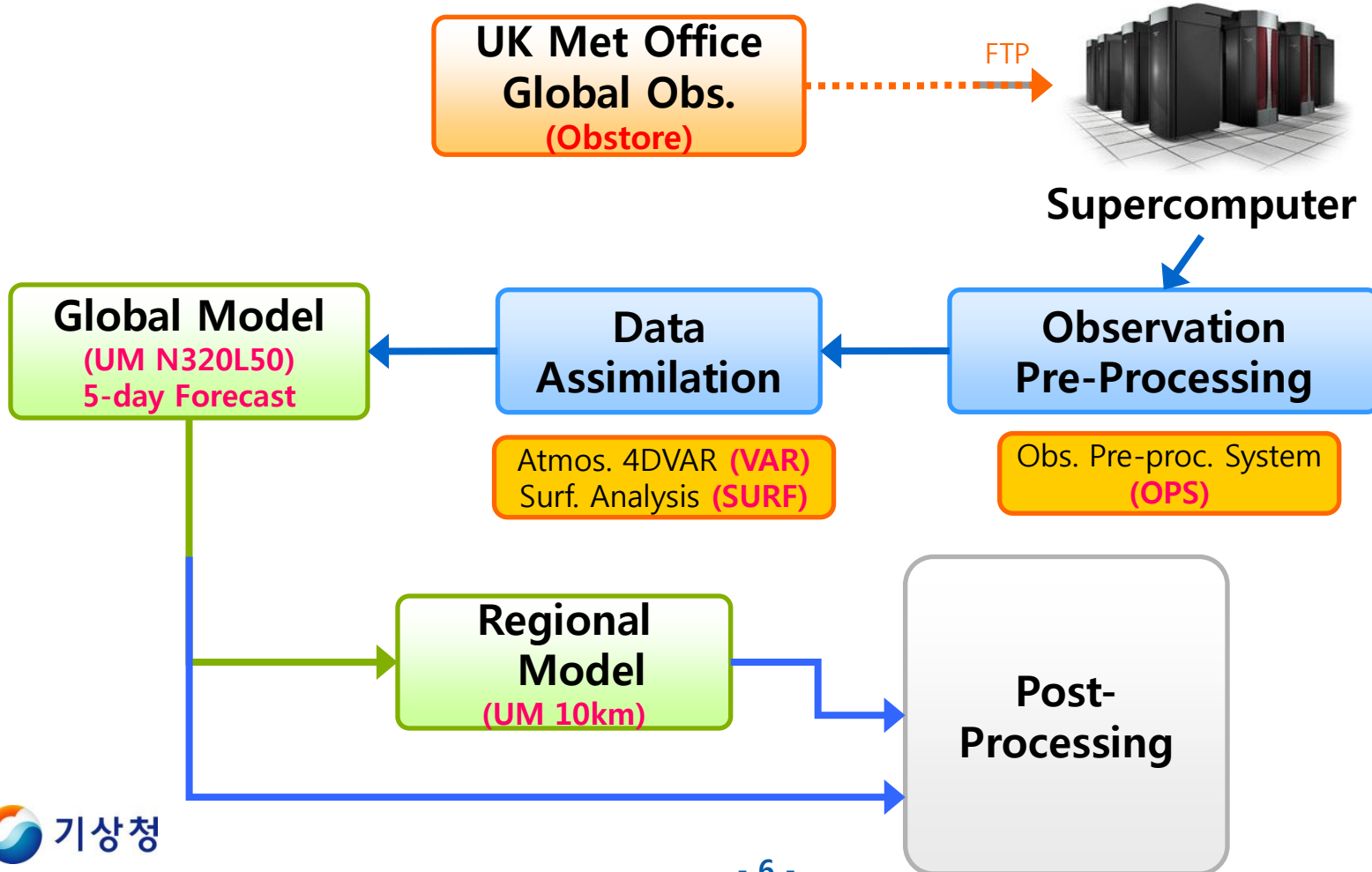
Period : 2008.06 ~ present



2nd Phase of UM Implementation : Global Cycle

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국민을 하늘처럼

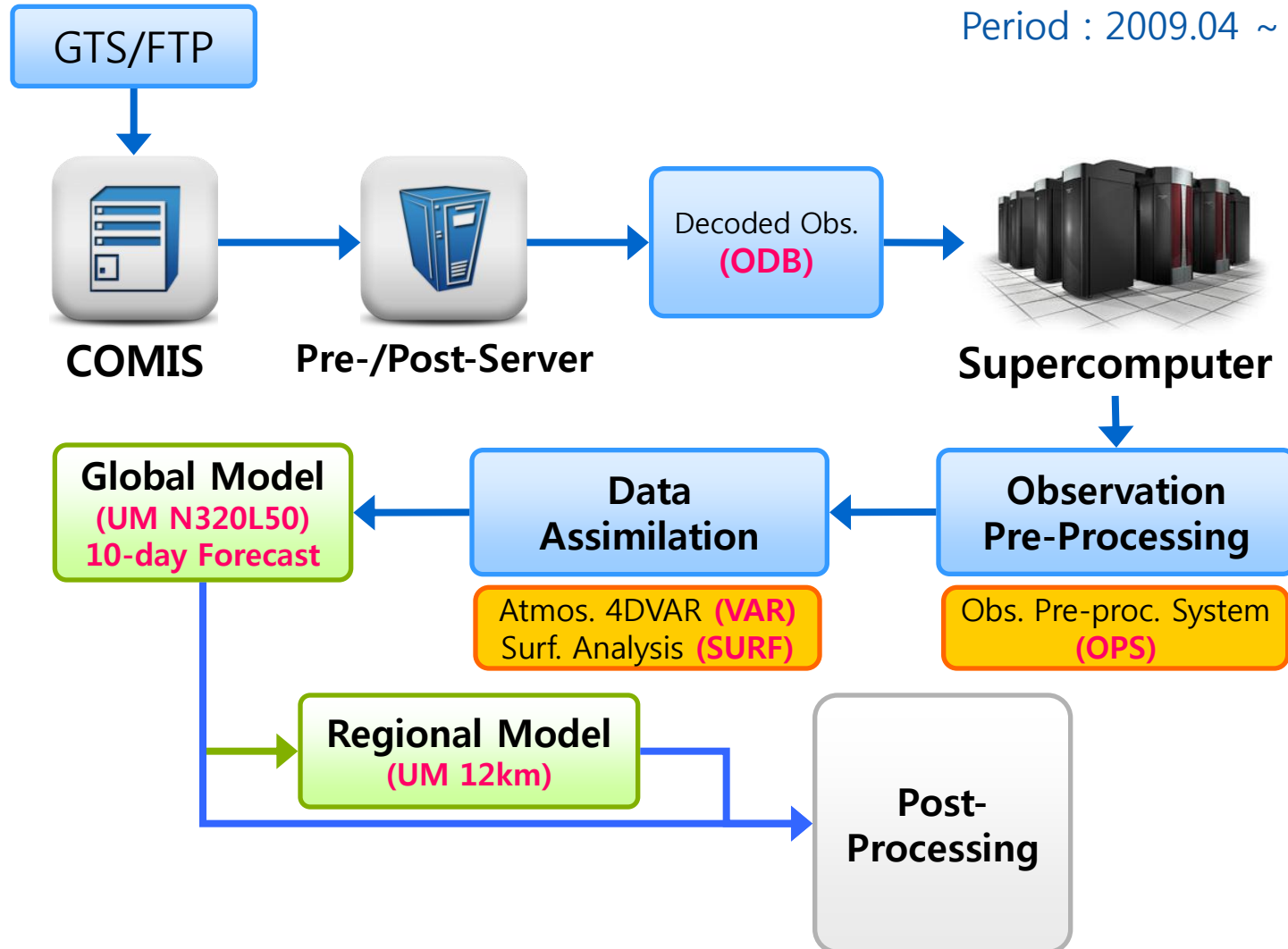
Period : 2009.01 ~ 2010.03



3rd Phase of UM Implementation : Global Cycle

하늘을 친구처럼
국민을 하늘처럼

Period : 2009.04 ~ present

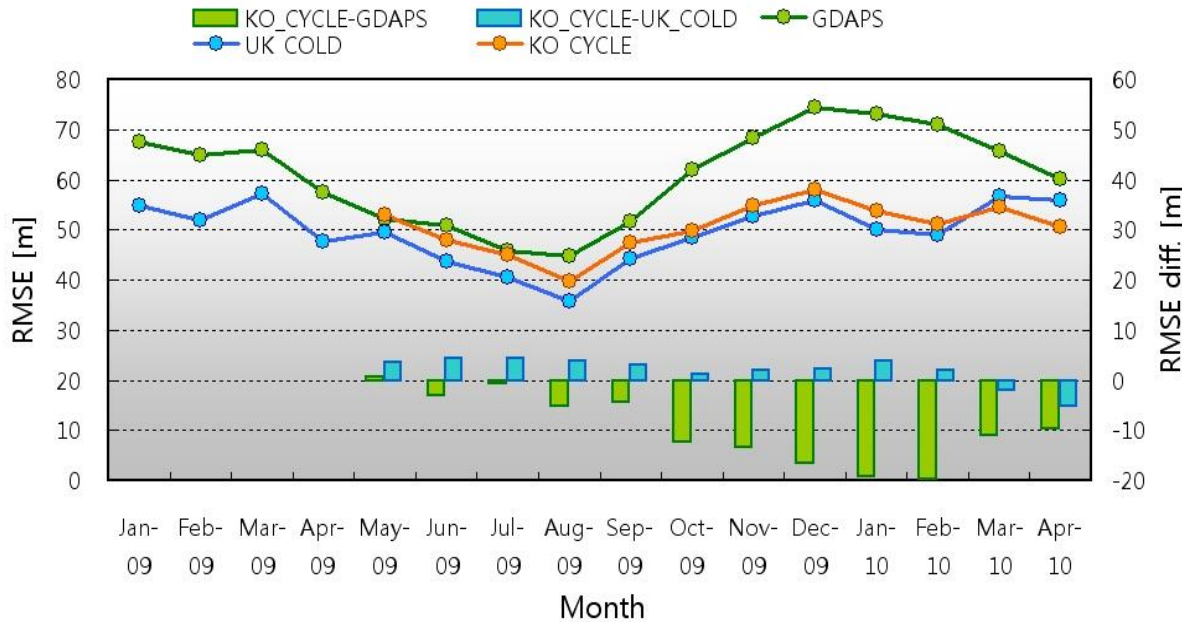


3rd Phase of UM Implementation : Global Cycle

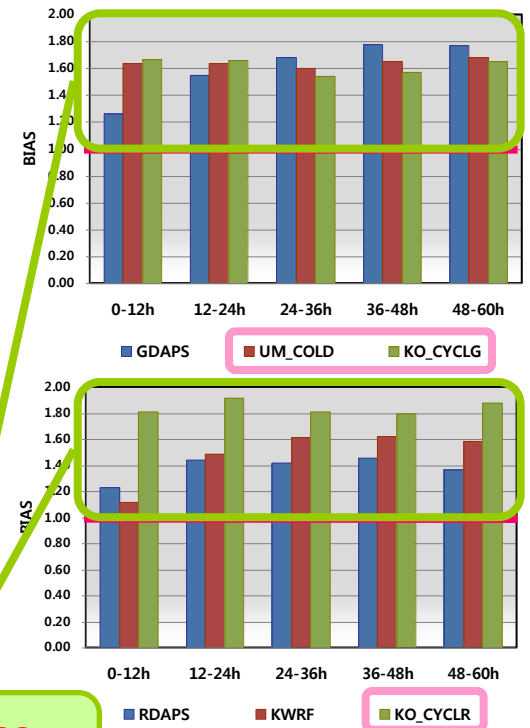
하늘을 친구처럼
국민을 하늘처럼

Period : 2009.04 ~ present

500hPa Geop.Height RMSE / N.H. / +5days



BIAS of Precip. Forecast



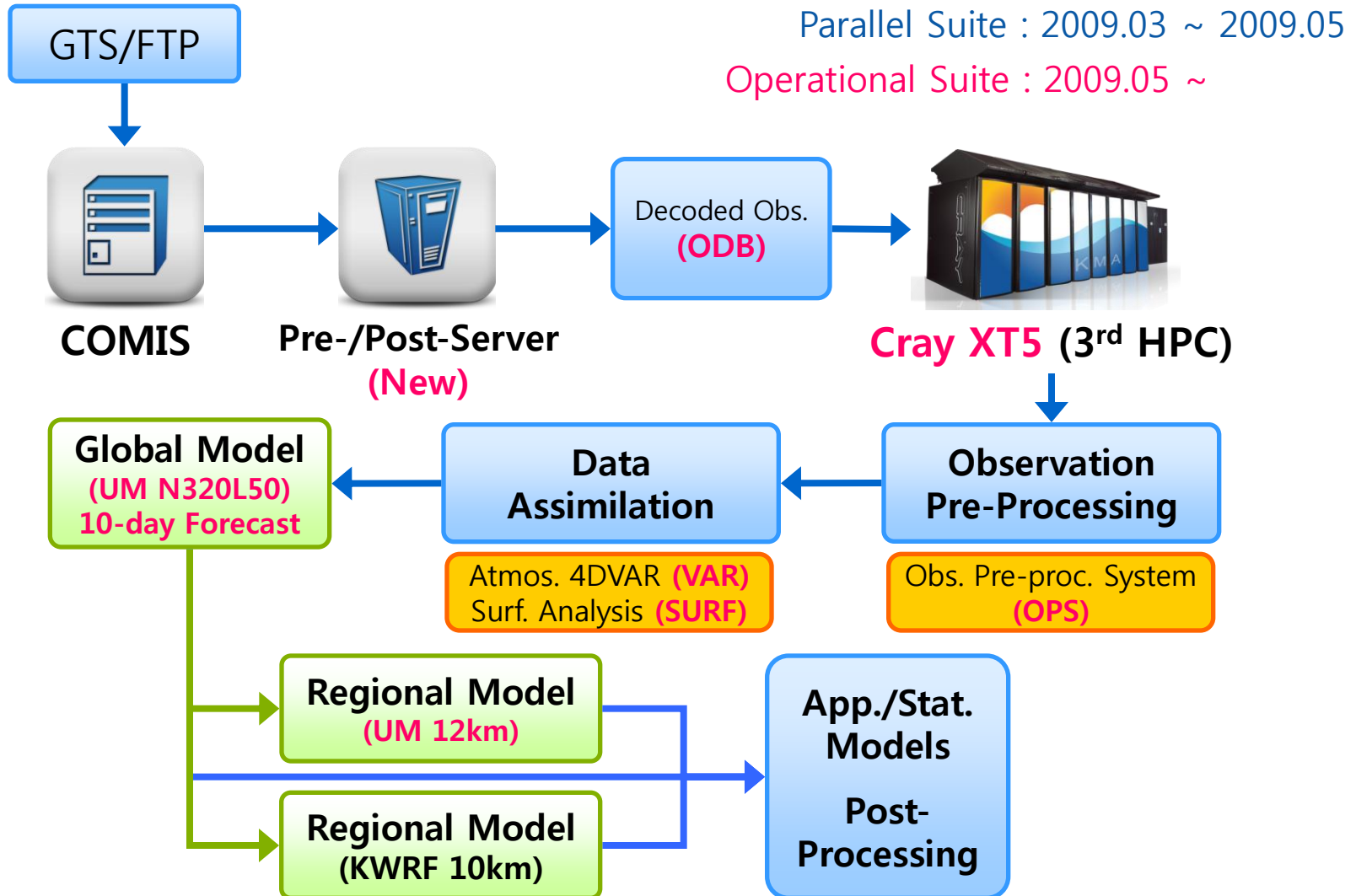
Positive Bias
for Light Precip.

0.1mm/12hrs

- ❖ **Global UM (4DVAR cycle)** : significantly outperforms GDAPS
- ❖ **Regional UM (cold-run)** : generally good, but needs to be optimized (tuned) more.
 - Better performance is expected with regional 4DVAR

Operational Phase : Global Cycle @ 3rd HPC

하늘을 친구처럼
국민을 하늘처럼



UM Configurations in KMA

하늘을 친구처럼
국민을 하늘처럼

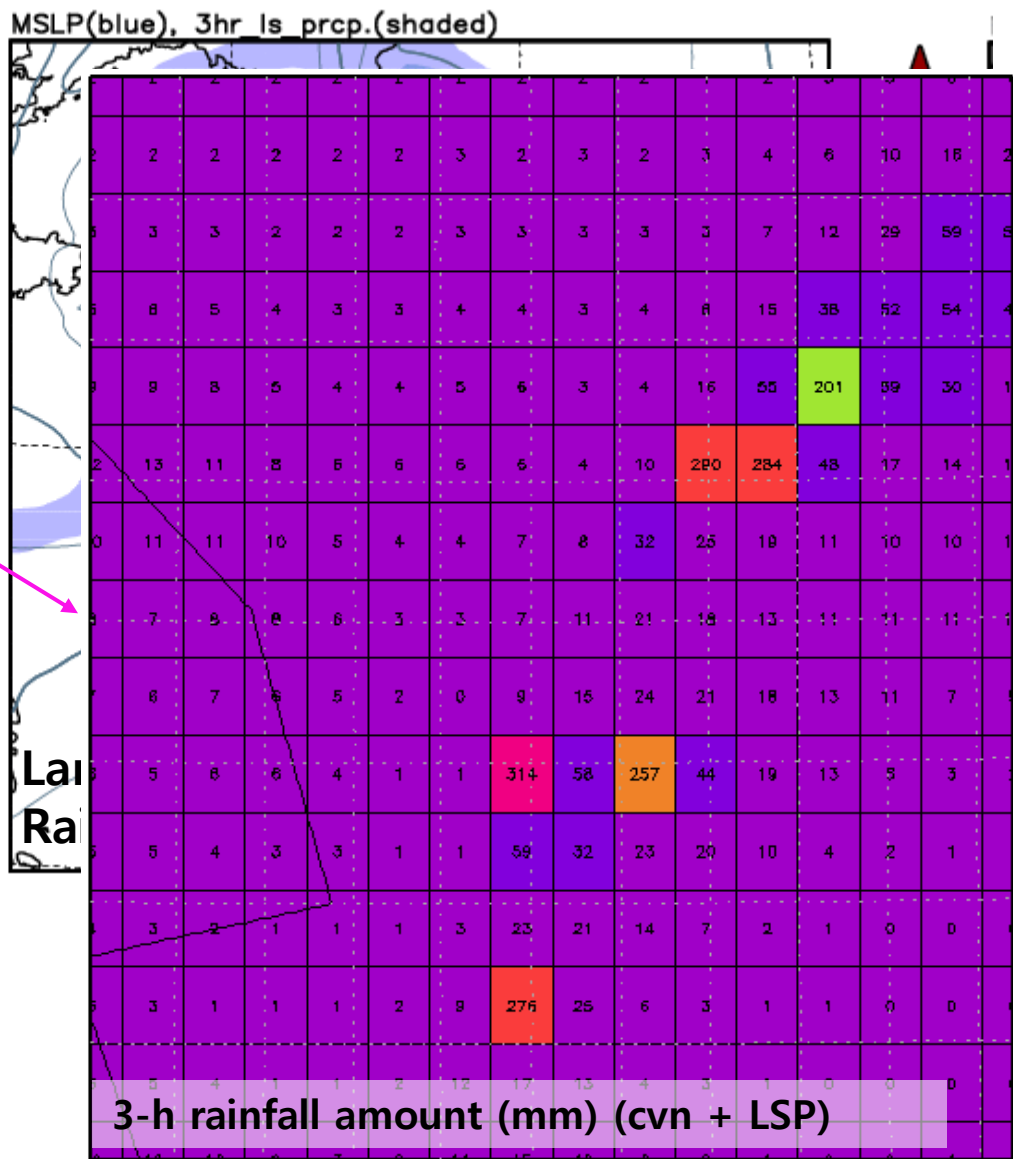
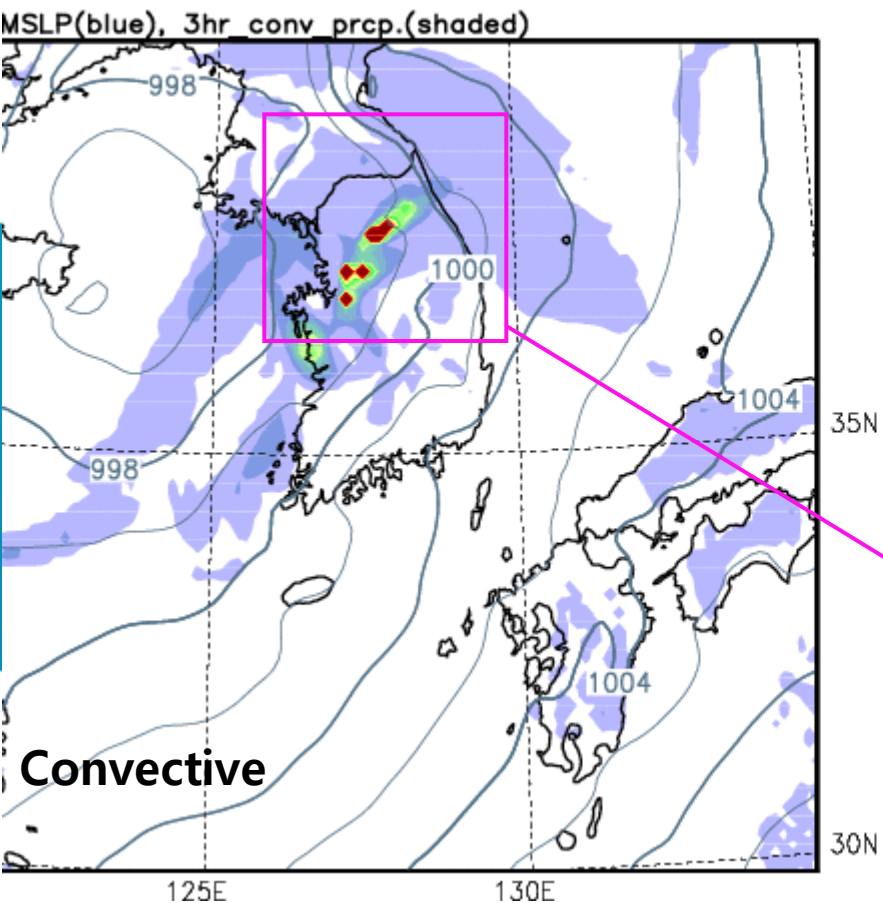


	UM-GLOBAL	UM-REGIONAL
Governing Eq.	Complete equation (Non-hydrostatic)	
Horiz. Resolution	N320 (40km 0.5625x0.375)	12km (0.11x0.11)
Vertical Layers	L50 (top ~ 63km)	L38 (top ~ 39km)
Forecast Length	10.5 days (252 hours)	3 days (72 hours)
Timestep Size	900 sec	240 sec
I.C./ Data Assimilation	4DVAR	Downscaling from global initial condition
Spatial Discretization	Finite Difference method	
Time integ. / Advection	Semi-implicit Semi-Lagrangian scheme	
Radiation Process	Spectral band radiation (general 2-stream)	
Surface Process	MOSES-II land-surface scheme	
PBL Process	MOSES-II Non-local PBL	
Convection Process	CMODS convection scheme	
Microphysics	Improved mixed-phase scheme	
Gravity Wave Drag	G.W. drag due to orography (GWDO)	
Surface B. C.	Climatology or SURF (Surface analysis)	
Operation Frequency	Twice daily (00/12 UTC) / 6hour D.A. cycle	Twice daily (00/12 UTC)

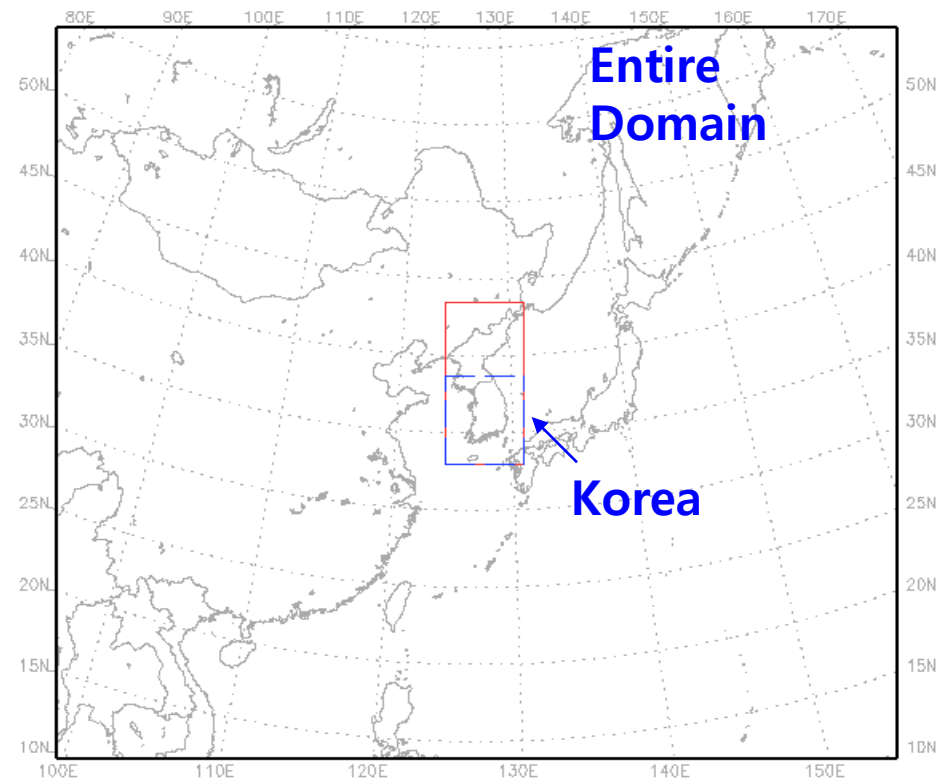


STATUS OF SGSP IN KMA UM- REGIONAL SYSTEM

Res_12km_OPER / IC:2010070200 / Valid:09Z02JUL2010(+9hr)



SGSP definition for statistics

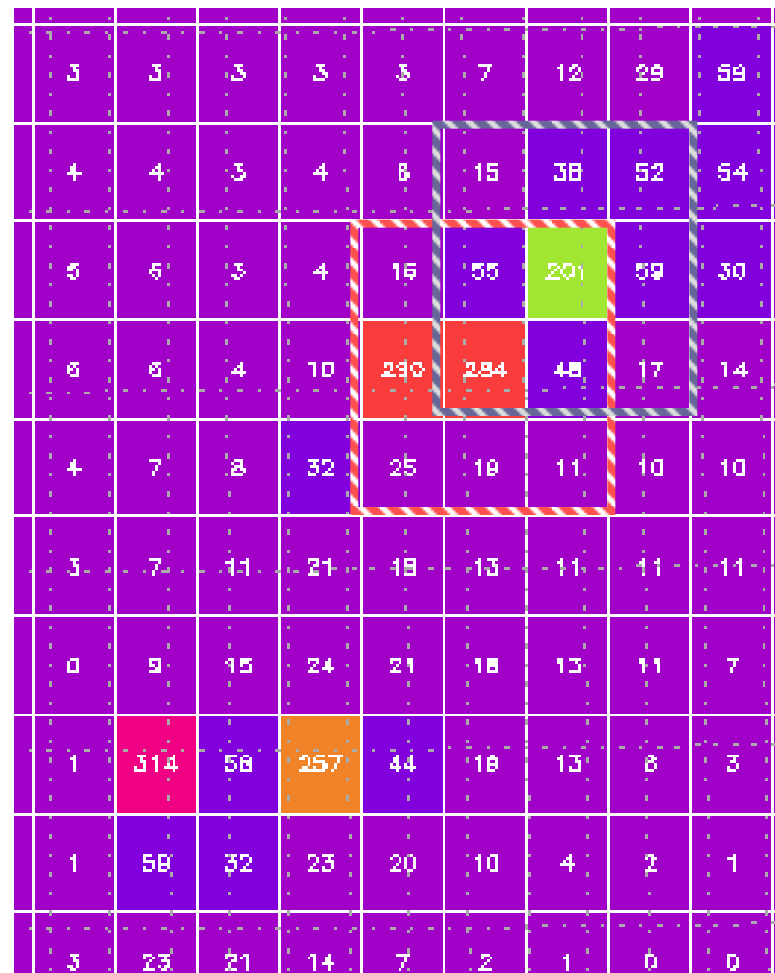






P_1	P_2	P_3
P_8	P_0	P_4
P_7	P_6	P_5

P_x : 3hr acc. prcp. (mm)

$$\bar{P} = \frac{P_1 + P_2 + P_3 + \dots + P_8}{8}$$

- $P_0 \geq 150\text{mm}$
- $P_0 - \bar{P} \geq 120\text{mm}$

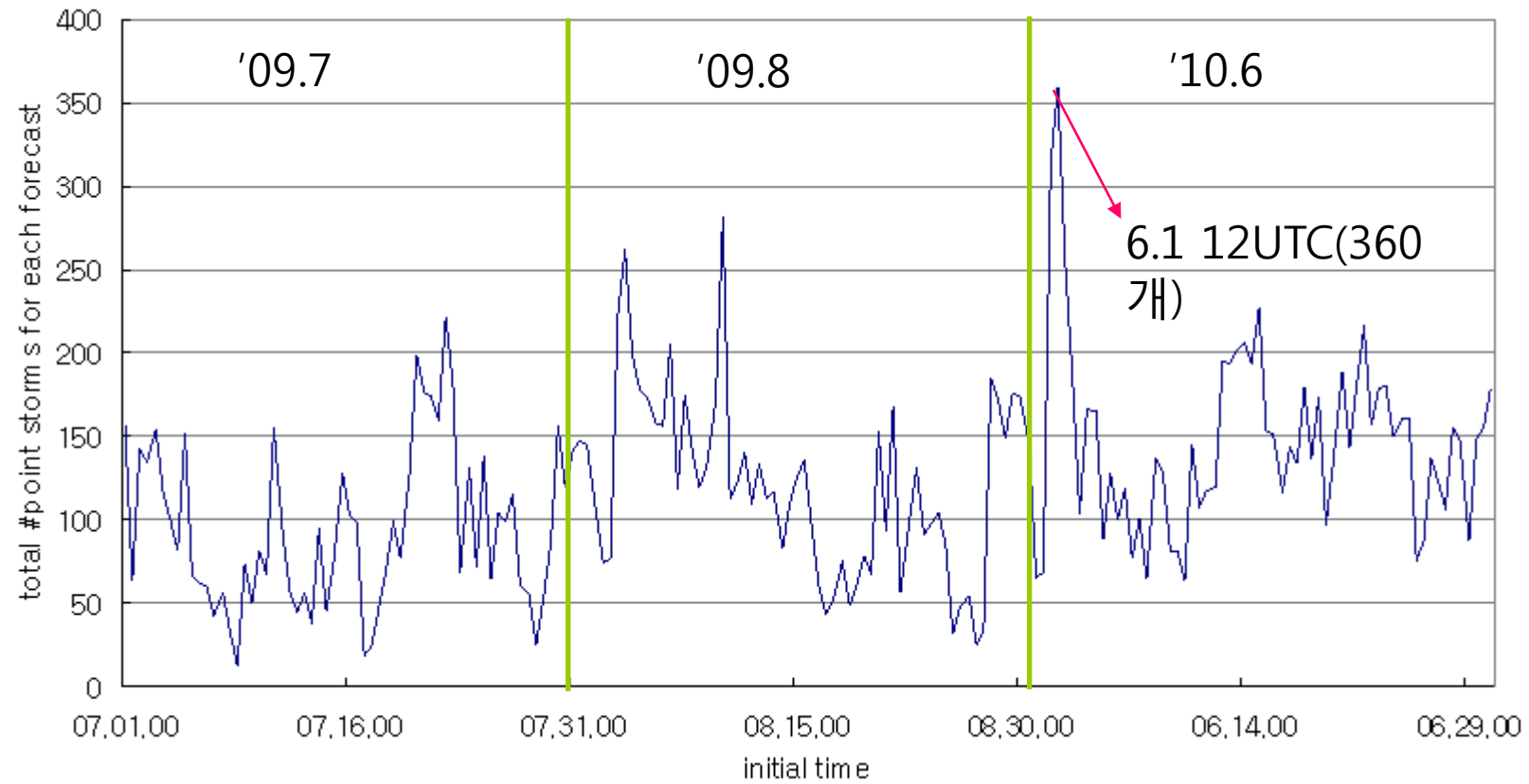


- ex)
-  • $P_0 = 284$
 -  • $\bar{P} = 83.125$
 -  • $P_0 = 201$
 -  • $\bar{P} = 71$

Number of SGSP for every 72-h forecast

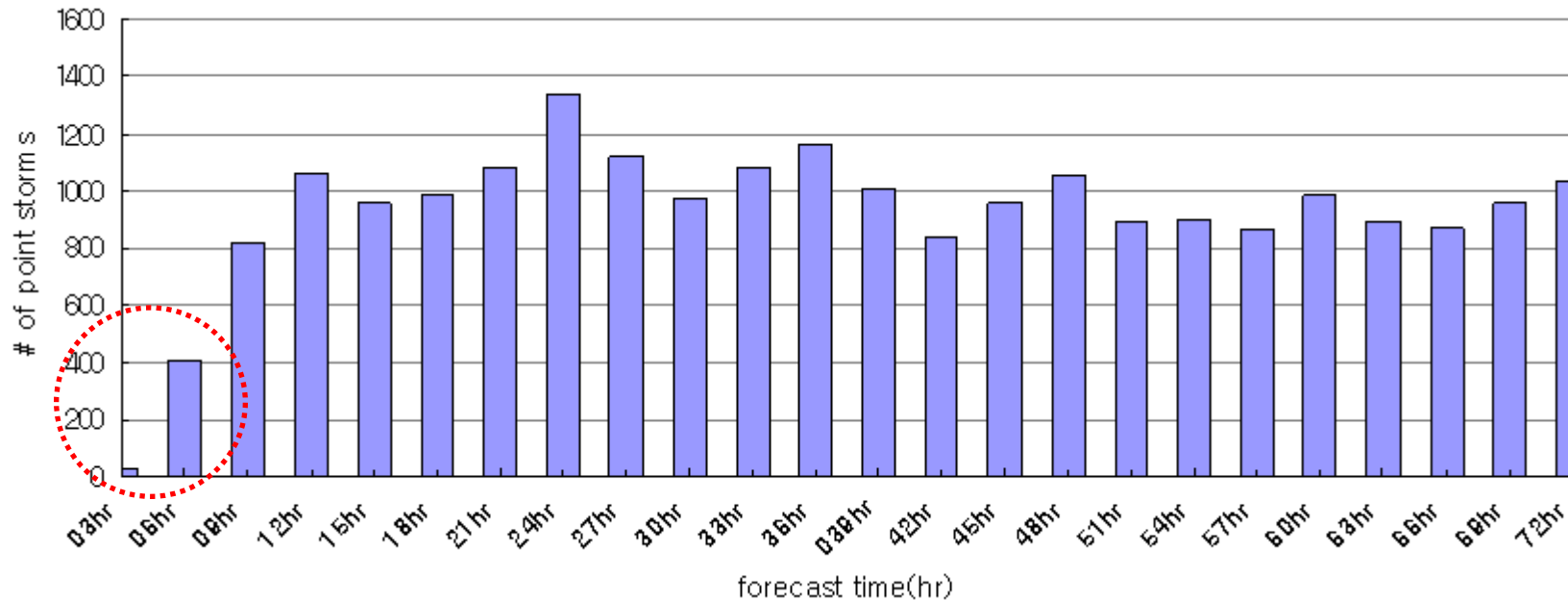
- period: '09.7,8, '10.6 (3 summer months)
- domain: entire

Total # of SGSP = 14,327

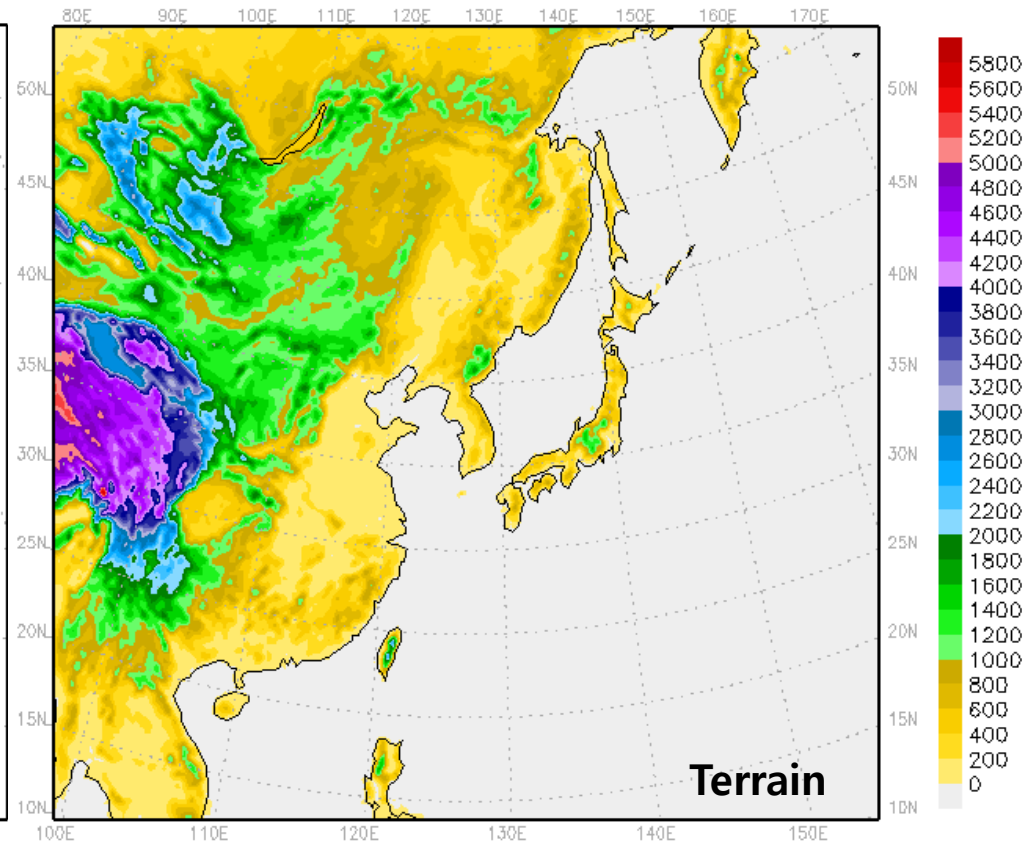
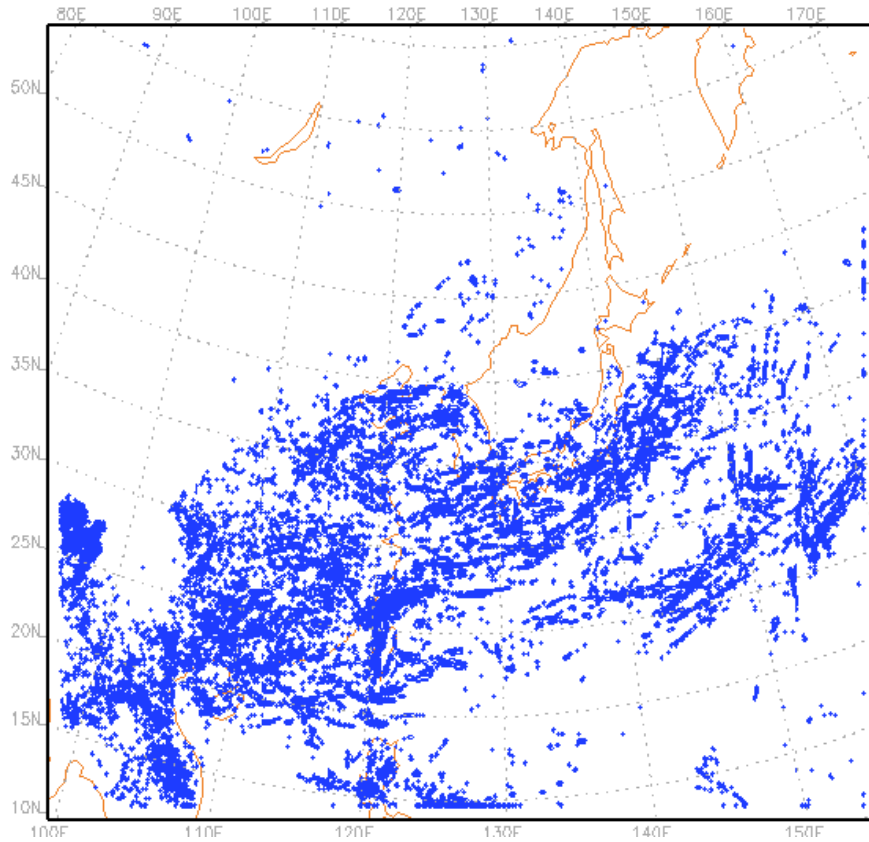


Number of SGSP for each forecast time

- period: '09.7,8, '10.6 (3 summer months)
- domain: entire



Spatial Distribution of SGSP



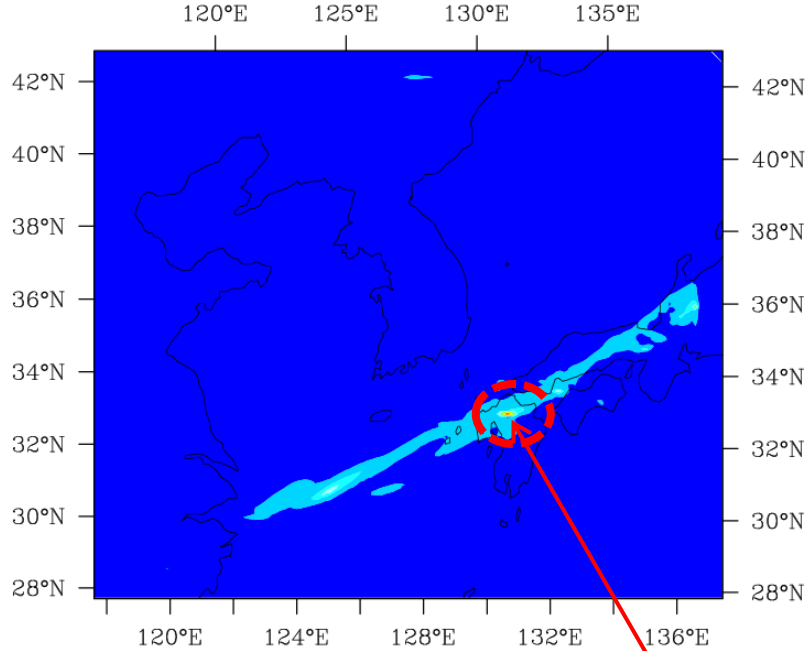


CHARACTERISTICS OF SGSP IN UM-REGIONAL

45-Hour Forecast from Init 00UTC June 29, 2009

SGSP - 2009063021

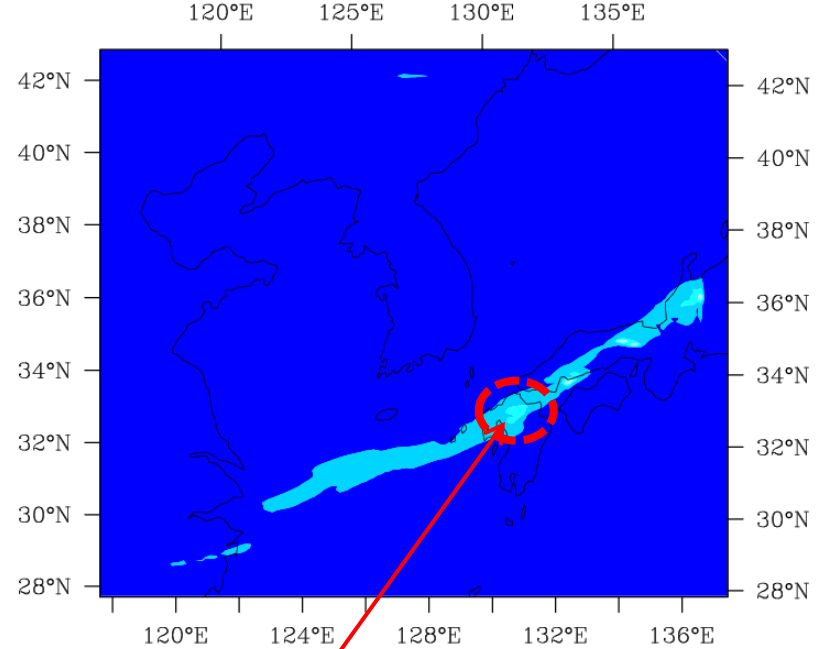
3-h accumulated precipitation kg m^{-2}



SGSP

NoSGSP - 2009063021

3-h accumulated precipitation kg m^{-2}



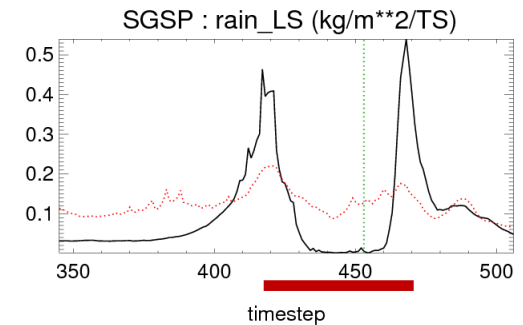
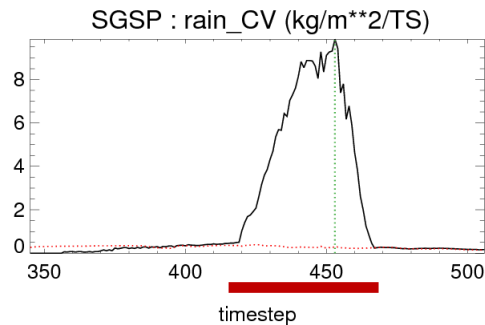
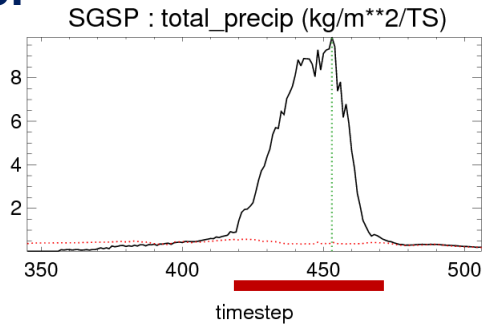
SGSP removed

Diff. between SGSP and NoSGSP runs

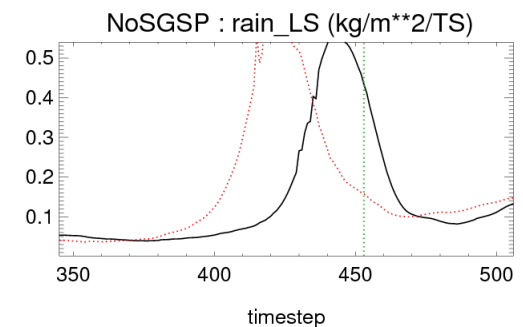
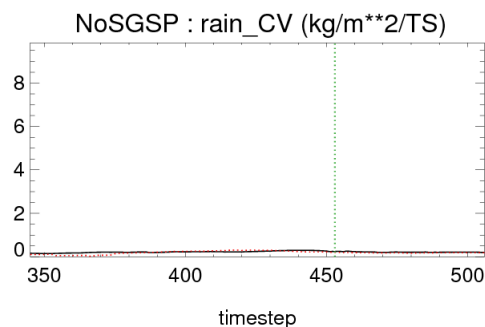
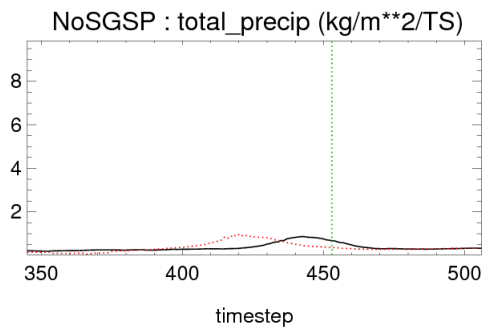
		SGSP	NoSGSP
Convection	# of CVN calls	3	2
	detrn scheme	Adaptive det. (deep & mid cvn)	smoothed adaptive det. (deep, mid & shall cvn)
	Ref. CAPE time scale	960 sec.	800 sec.
			deep CMT using KTERM instead of NTPAR
	subcloud mixing		<ul style="list-style-type: none"> - revised sh cumulus parcel pertub - limit initial parcel perturb. - use new termination condtion
Boundary Layer	Version	<8A> MOSES-II	<8C> revised treatment of entrn flux & new scalar flux-gradient
	stbl BL mixing scheme	SHARPEST over sea; MES tails over land	Equilibrium stable BL
			<ul style="list-style-type: none"> - use enhanced mix length in Recharadson no. scheme - Mix length not reduced above BL - Allow local scheme above unstbl BL top
	free atm turb. mix opt	0	3
			<ul style="list-style-type: none"> - restrict magnitude of friction velocity - enhance entrn mixing in stratocumulus - correct sfc exchange iteration

Single-Level Variable Time-Series in Model Timestep

SGSP



NoSGSP



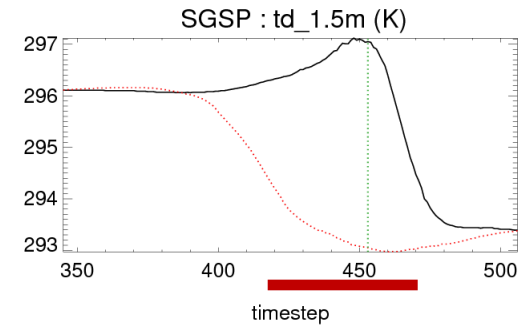
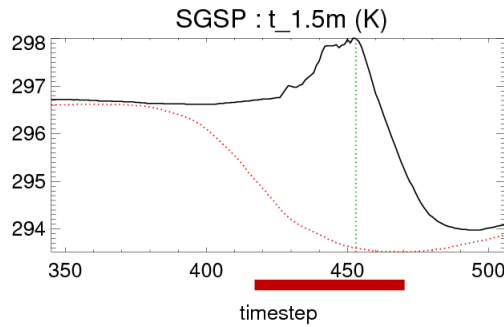
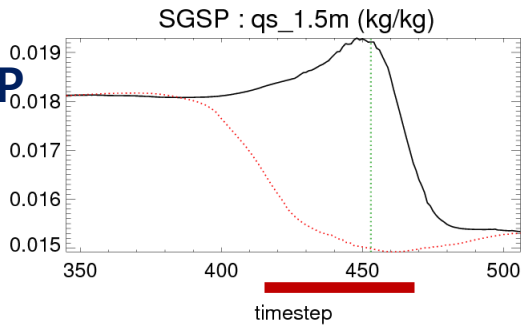
Total Precip.

Conv. Rain

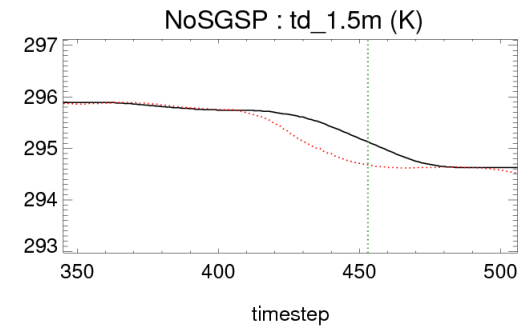
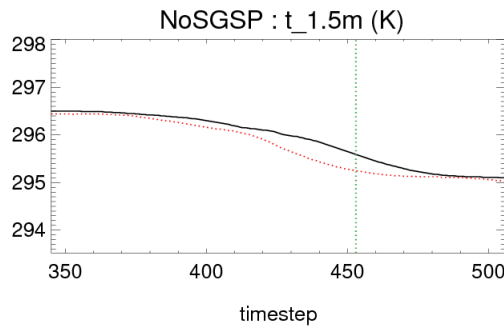
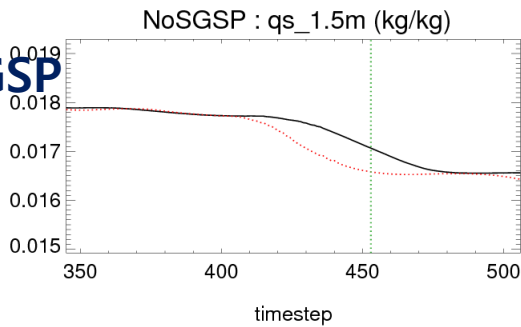
Large-Scale Rain

Single-Level Variable Time-Series in Model Timestep

SGSP



NoSGSP

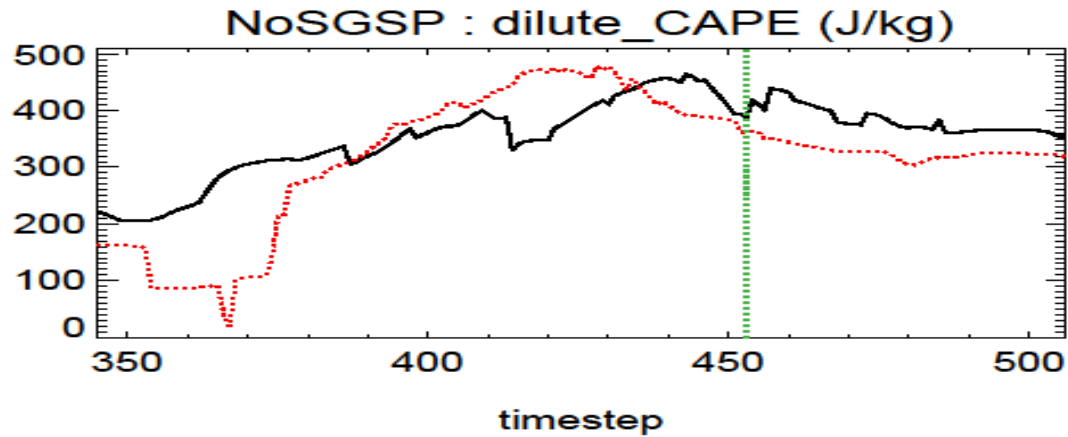
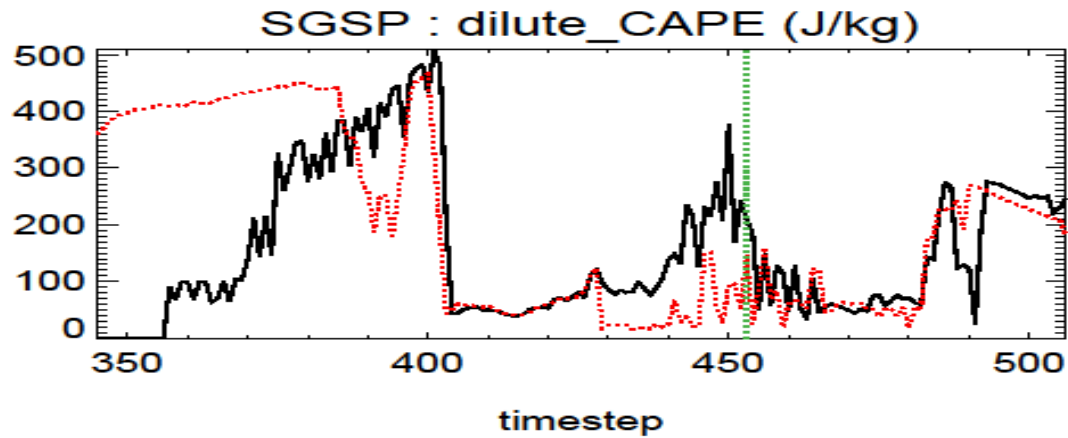


Qs at 1.5m

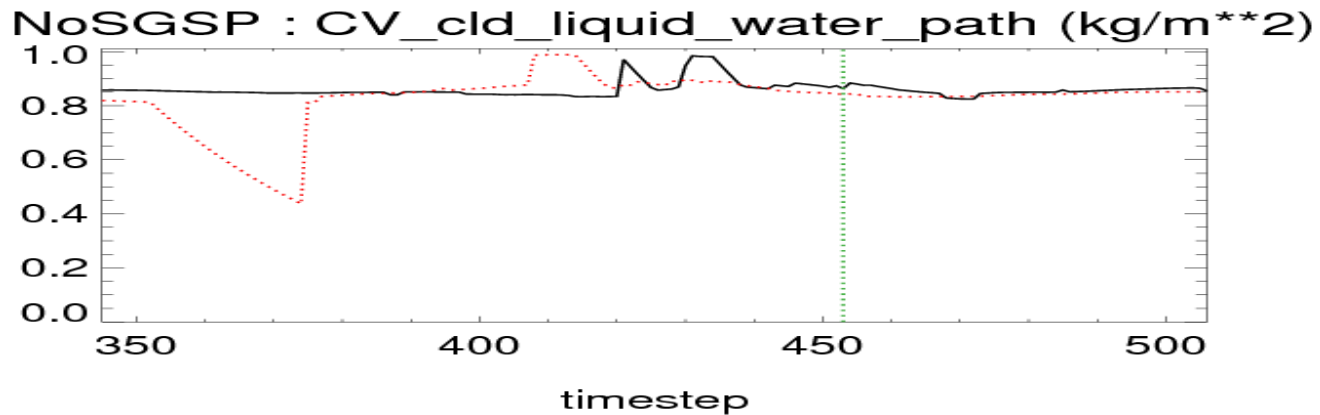
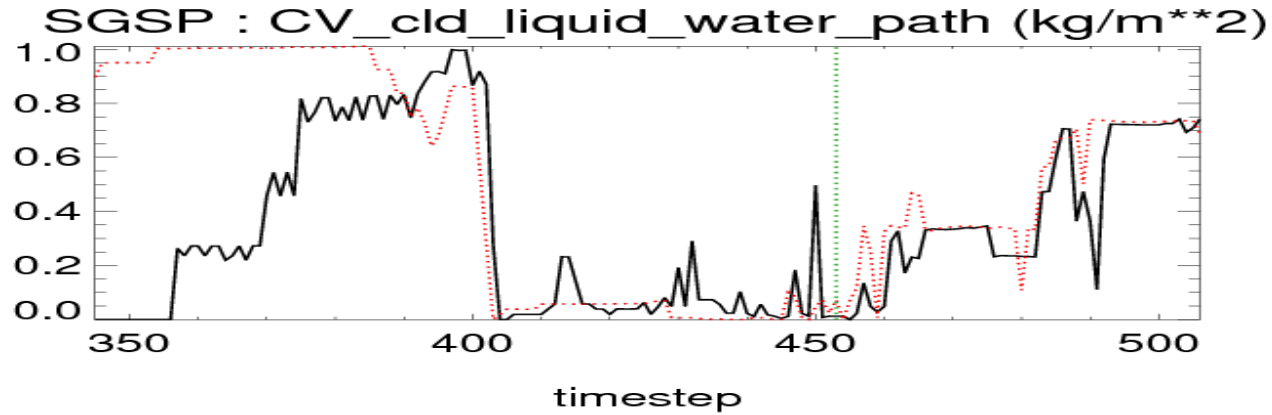
T at 1.5m

Td at 1.5m

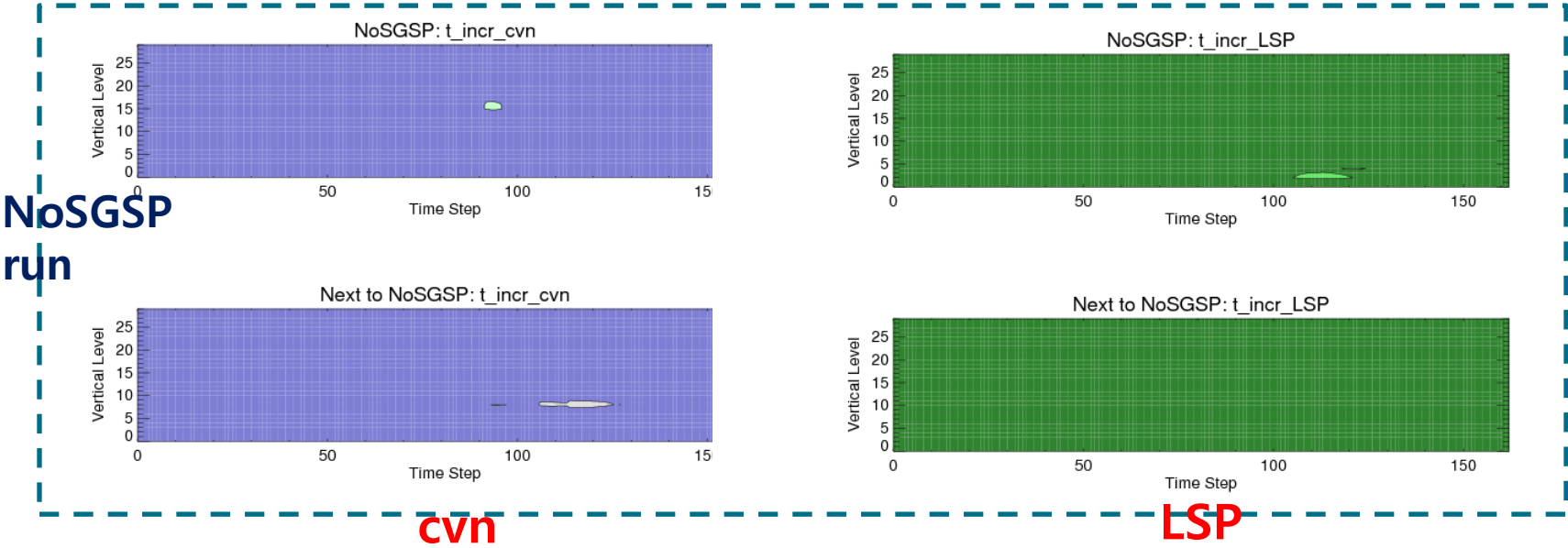
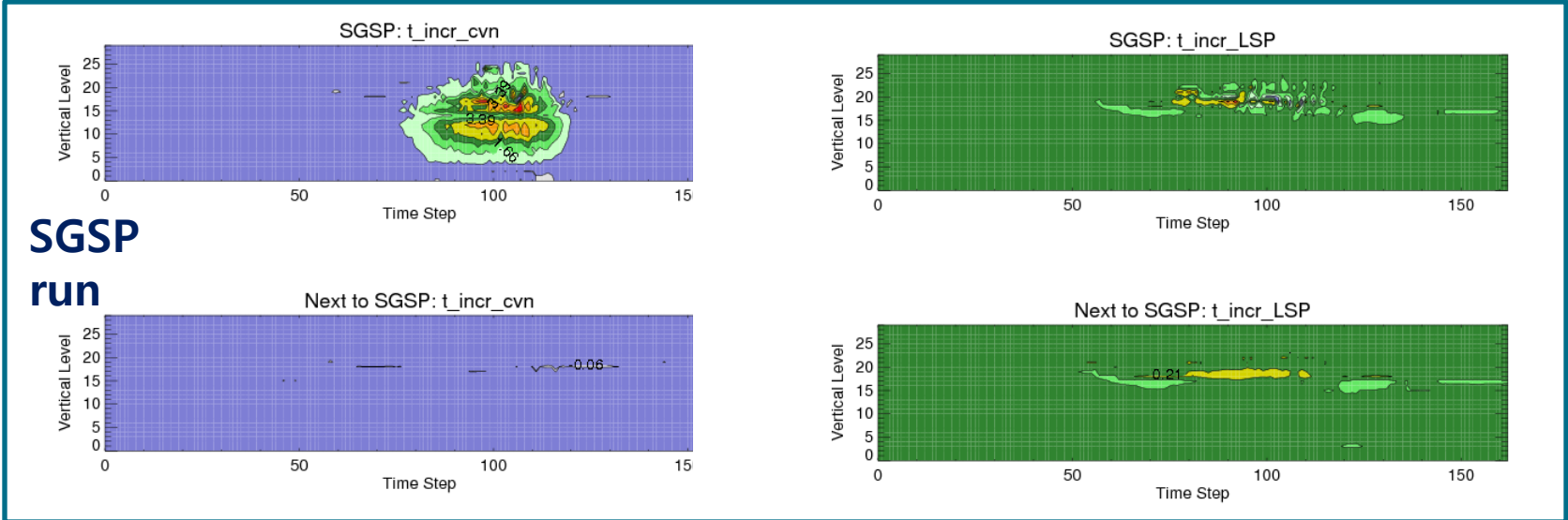
Single-Level Variable Time-Series in Model Timestep



Single-Level Variable Time-Series in Model Timestep

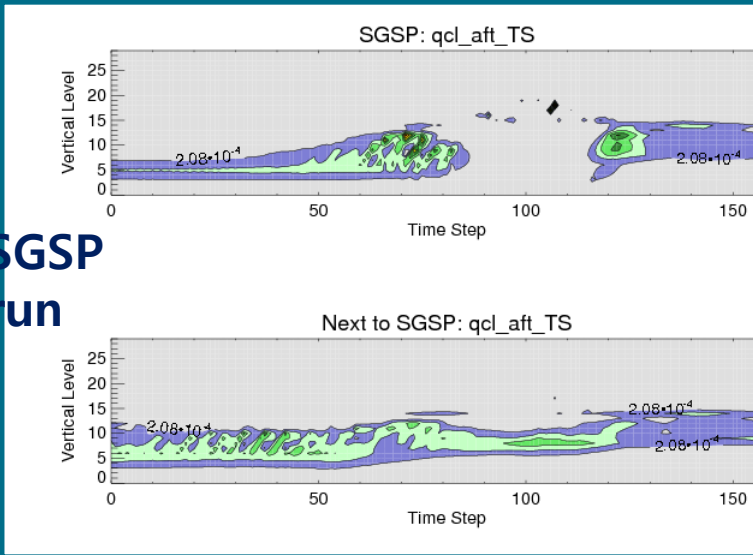


Level-Timestep Plot of Variables: T Increment

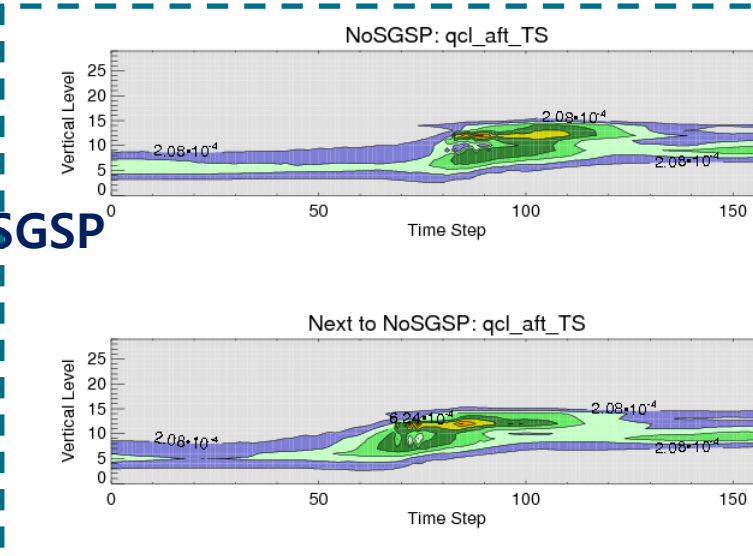


Level-Timestep Plot of Variables: **qcl** & **qcf**

**SGSP
run**



**NoSGSP
run**

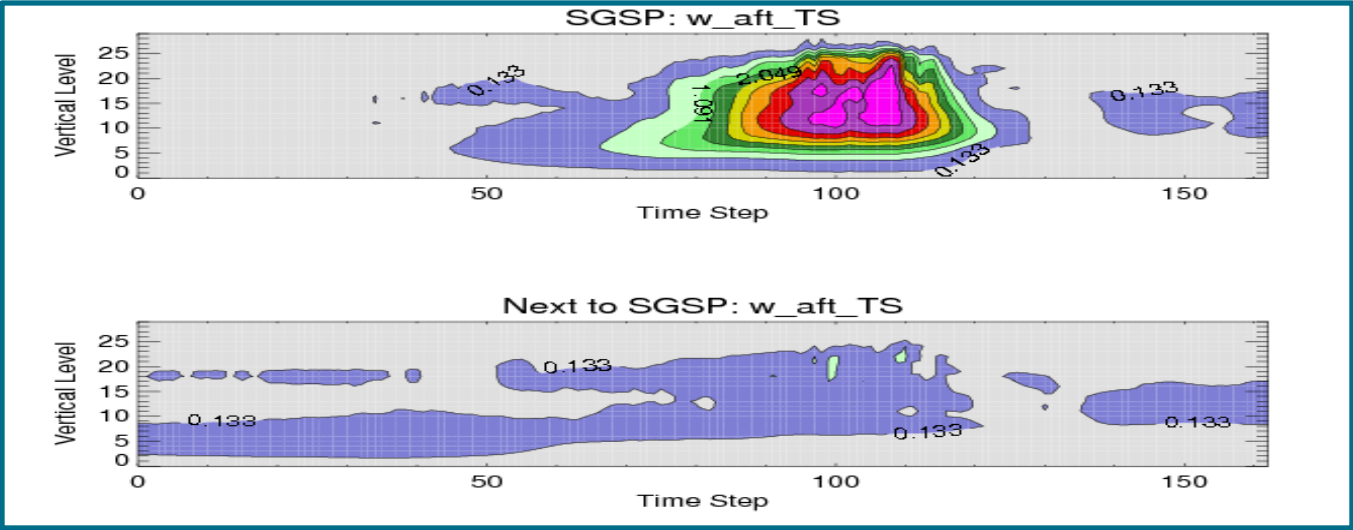


qcl

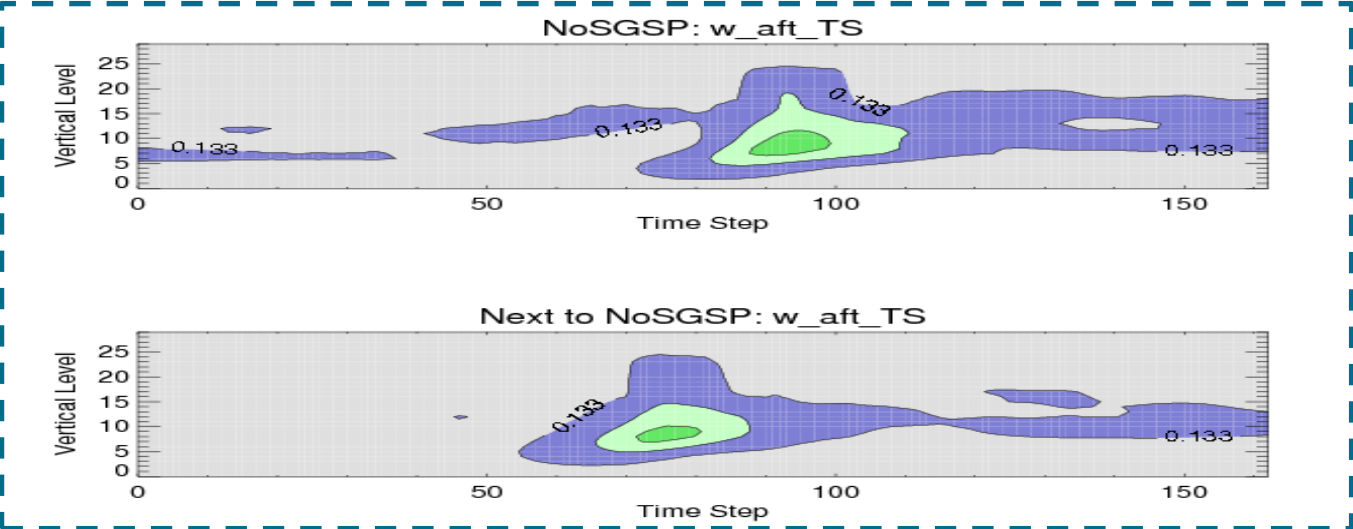
qcf

Level-Timesteep Plot of Variables: **Vertical velocity**

**SGSP
run**

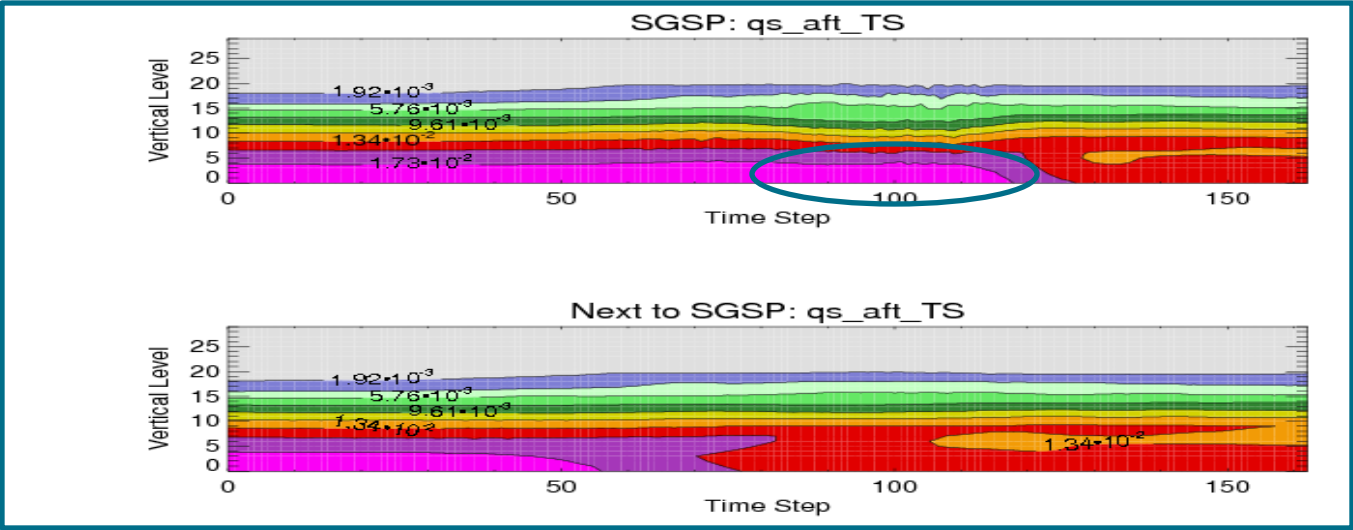


**NoSGSP
run**

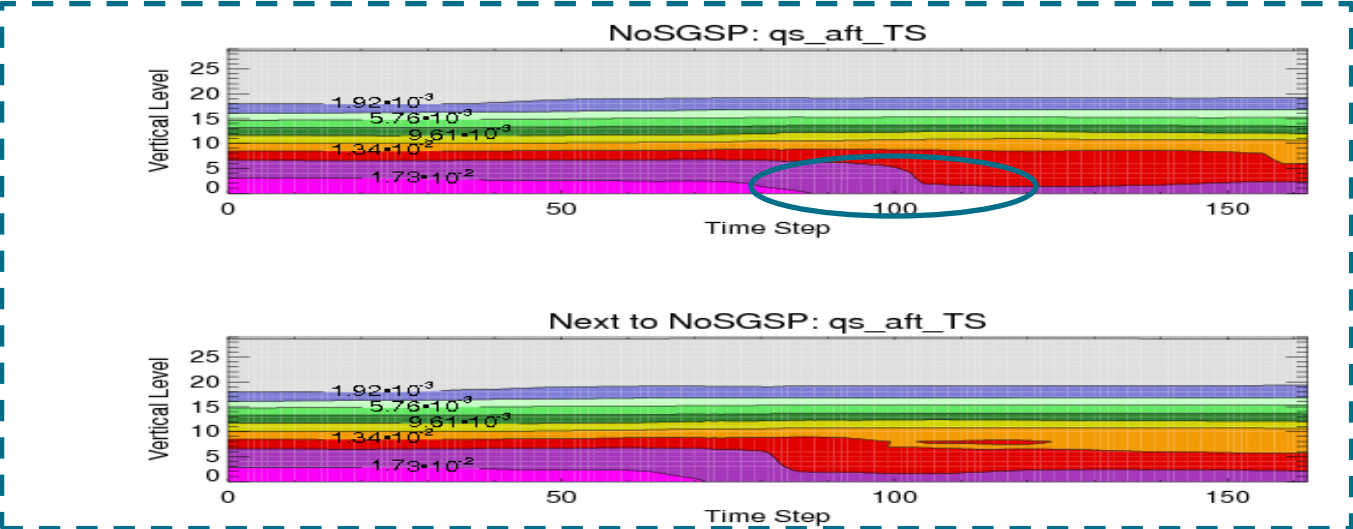


Level-Timestep Plot of Variables: **qs**

SGSP
run



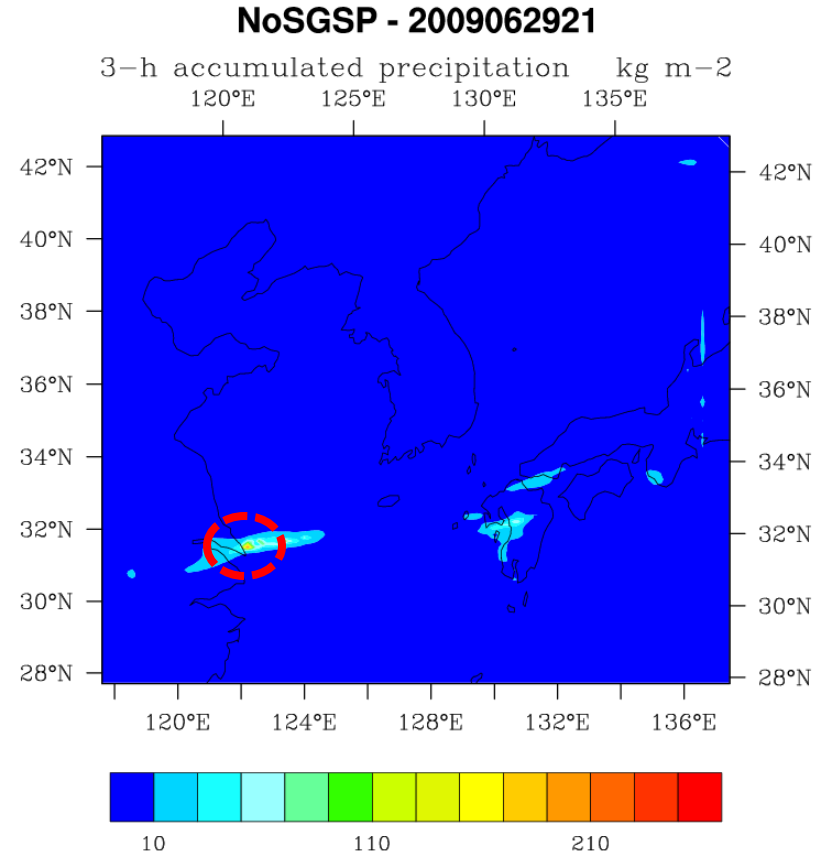
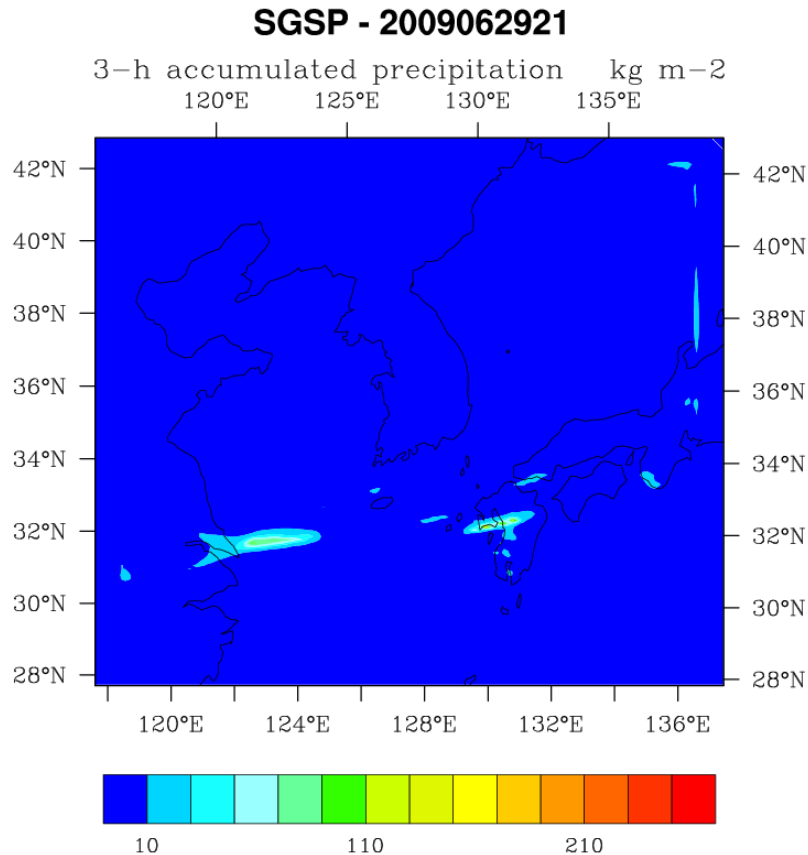
NoSGSP
run



Key Remarks on the SGSP characteristic in UM-Regional

- ✓ The SGSP was caused by convective rain
- ✓ CAPE was removed abruptly in the SGSP grid
- ✓ Cloud liquid water rained out quickly
- ✓ Near-ground high specific humidity maintained during the SGSP
- ✓ Q_s , T , and T_d at 1.5m tend to increase gradually and then drop rapidly during the SGSP.
- ✓ Spurious convective activity resulted in intense vertical velocity and temperature increase

SGSP in NoSGSP run at other locations and times



Further research is encouraged!!!!!!!!!!!!!!!!!!!!!!

**Thank you for
paying attention**
감사합니다

A decorative horizontal band with a blue gradient background. On the right side, there are several overlapping, light blue circular outlines of varying sizes, creating a modern, abstract design.

STATUS

- The new operational NWP system started its operation ('10.5~)
 - Global UM (N320L50 / global 4DVAR cycle) – replace GDAPS
 - Regional UM (12km L38 / initialized from global UM) – replace RDAPS
- Platform : Cray XT5 (1st phase of 3rd supercomputer, 27.65Tflops)
- Number of observations used in UM system : ~80% compared to UKMO
- Performance of global UM : outperforms old system by more than 15%

PLANS

- Global UM with higher resolution (2011)
 - Resolution : N512(~25km) L70
 - Additional C
- Regional UM-4DVAR system (2011)
 - Resolution : 12km L70
 - 6-hour 4DV
- UM-based global EPS operation (2011)
 - UM-based regional EPS operation (2012)
- High-impact weather forecasting system based on UM (2012)
 - 1.5km resolution (variational grid) / Radar data assimilation

