

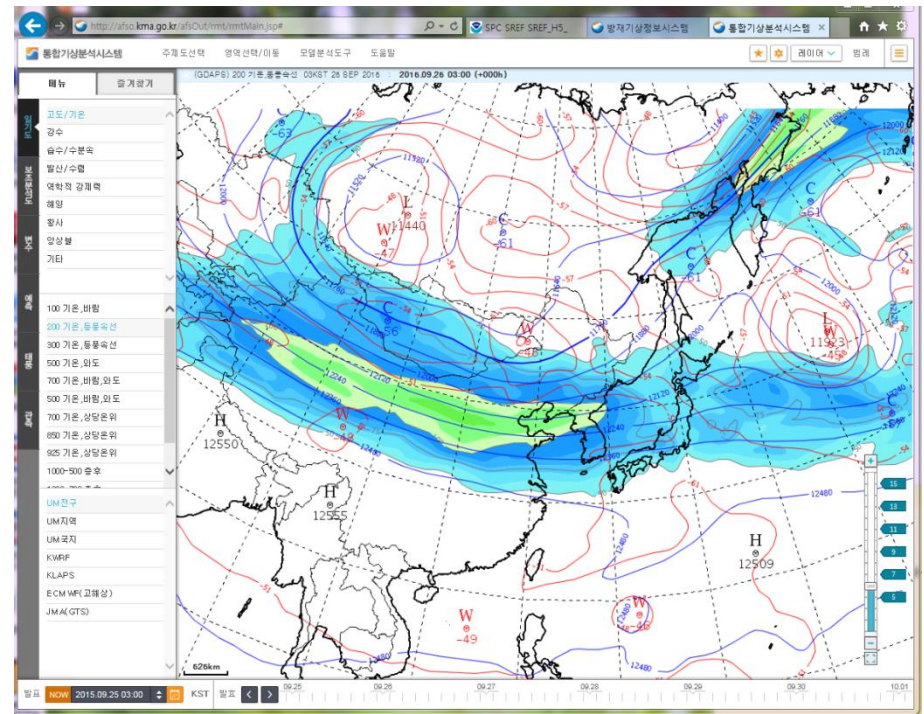
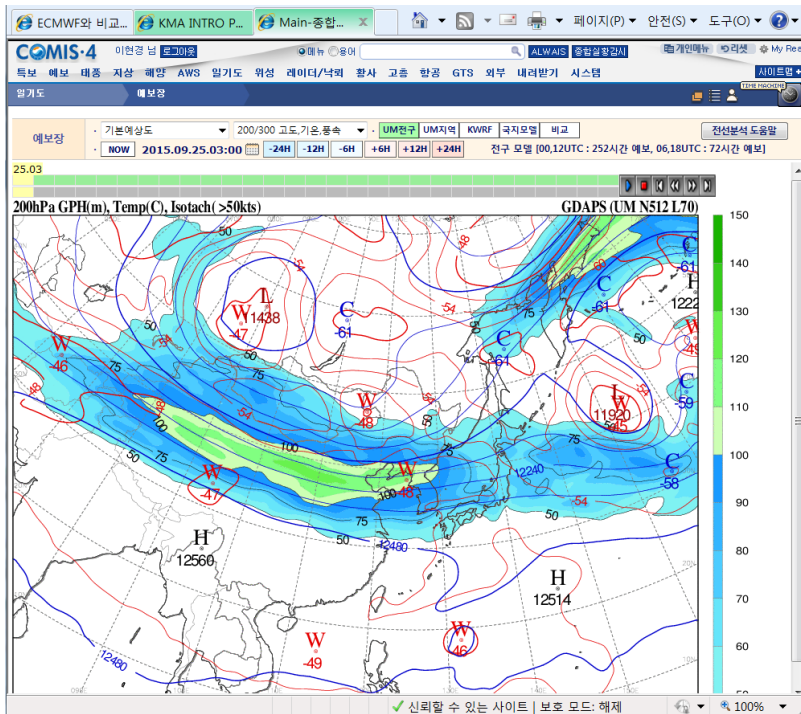
Operational Visualization process and tools of NWP model output in KMA

Seon-joo PARK/ Hyun-Kyoung LEE, Yeong-Hwa Kim²,
Jeong-Hwan Lee², Seung-Beom Kim¹, Sang-won Joo¹

NIMR/KMA¹ , KMA²

Visualization types

- Image-based visualization
- Web-based visualization



HPC introduction

- 4th Super computer of KMA
- Installation November 2014~ early 2016

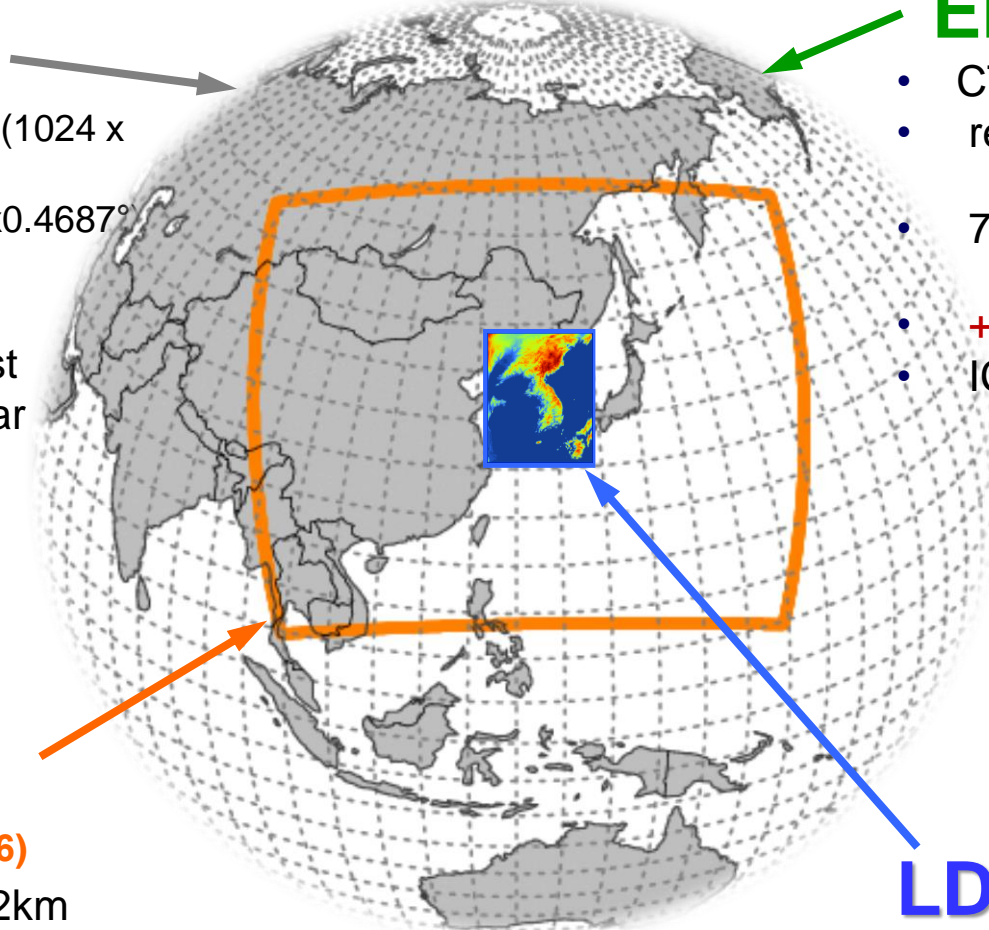
System architecture	Peak Perf. (TF)	Processor type & Memory	# Nodes	Login nodes	I/O System
CRAY XC40-LC (3 cabinets)	447	Intel haswell 2.6GHz 24cores/node 128GB/node	computational (448nodes) Pre-post (12nodes)	4 set	3.3PB > 50GB/sec
CRAY XC40-LC (16 cabinets*2set)	5,800	Intel haswell 2.6GHz 24cores/node 128GB/node(comp) 258GB/node(pre-post)	computational (2,904nodes*2set) Pre-post (56nodes*2set)	8 set	> 13.5PB > 248GB/sec



Operational NWP Models

GDAPS('11.6)

- resolution : N512 (1024 x 768)
(~25km / 0.3515°x0.4687°)
- 70 layers
(top ~ 80km)
- **+12 days** Forecast
- Initialized by 4dVar



Ensemble('11.5)

- CTRL+23 members
- resolution: N320
(~40km / 0.5625°x0.375°)
- 70 layers
(top ~ 80km)
- **+12 days** Forecast
- IC: GDAPS(11.5)

RDAPS('11.6)

- resolution : ~12km
(540x432 / 0.11°x0.11°)
- 70 layers (top ~ 80km)
- **+87 hrs** Forecast
- Initialized by 4dVar

LDAPS('12.5)

- resolution : 1.5km (744x928)
- 70 layers (top ~ 40km)
- **+ 36 hrs** Forecast
- Initialized by 3dVar

Operational NWP Models

	Model	Resolution	Target Length	Target / Purpose	Graphic program
Seasonal	GloSea5(Global)	N215(60km) L85	220 days(M2) 60 days(M2)	Seasonal prediction (~6months)	Grads/ NCL
Medium-range	GDAPS (Global)	N512(25km) L70	T+288 (00/12) T+87 (06/18)	Global deterministic	NCAR graphic/ NCL
	Global EPS (Global)	N320 L70 M24	T+288	Global probabilistic	
(Very) Short-range	RDAPS (E.Asia)	12km L70	T+87	East Asia / Short-range	NCAR graphic/ NCL
	LDAPS (Korea)	1.5km L70	T+36	Korea / Short-range	
Applica-tion Models	Wave Watch III	55km	T+288	Global	NCAR graphic/ NCL
		8km	T+87	Northeast Asia	
		1km	T+72	Coastal	
	ADAM (Dust & Aerosol)	30km	T+72	Asia dust	
	DBAR (Typhoon)	35km	T+72	Track	
	Tide/Storm Surge	9km	T+87	Northeast Asia	

~130,000 charts/day

General procedure for images

Adapting a split method according to NWP model dissemination schedule (3hrs, 6hrs, 12hrs)

[1st] basic weather charts using model output

[2nd] weather chart using secondary variables

UM pp files

GRIB
(*.gb)

Binary (*.gdat)

Secondary
variables
(*.dat)

charts
(*.gif)

Pa000
Pa001
:

Checking to exist pp
files

um2grib

kwgrib

FORTTRAN

ncarg,
Imagemagick

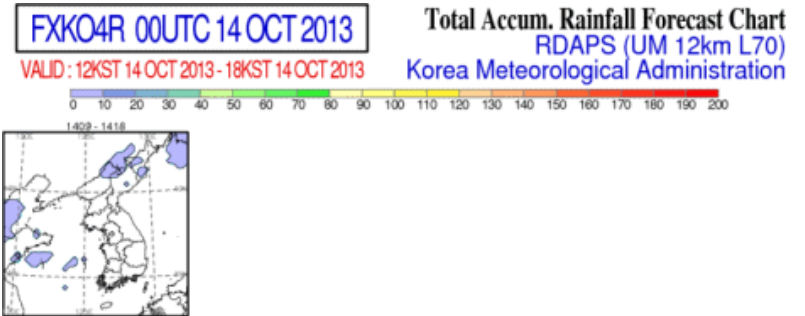
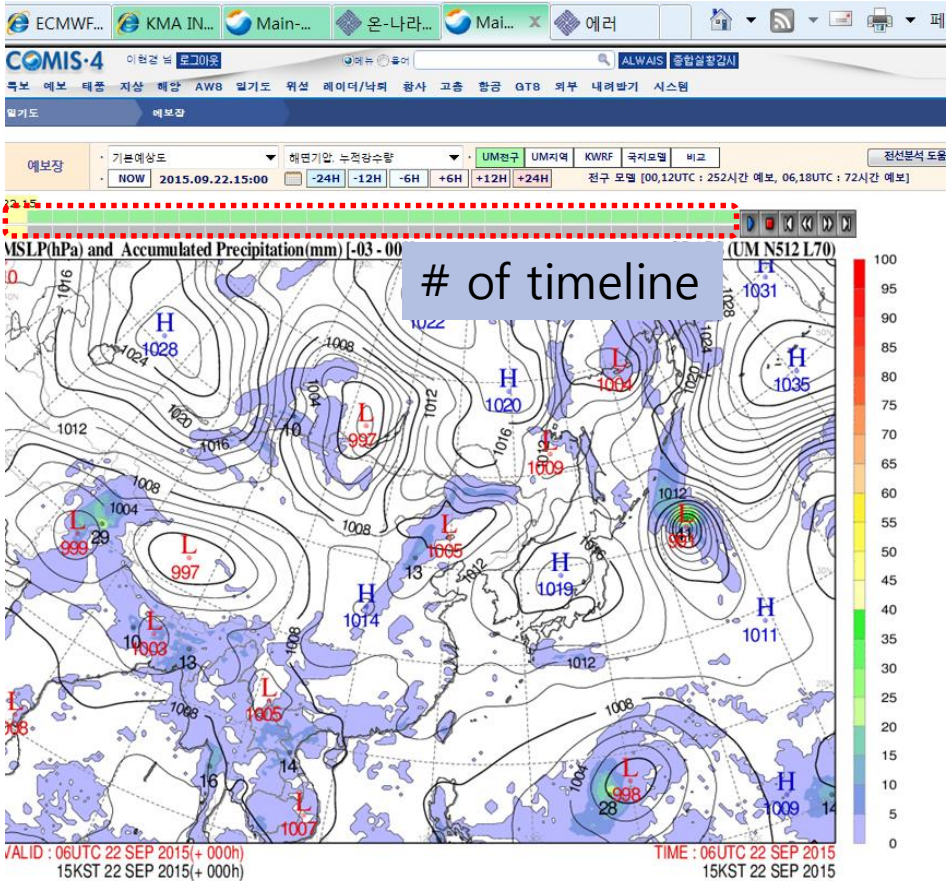
[1st] basic charts

- (split)Asia/Korea forecast charts ,
Convective charts...
- accumulated charts, time-series
charts...

[2nd] charts using secondary variables

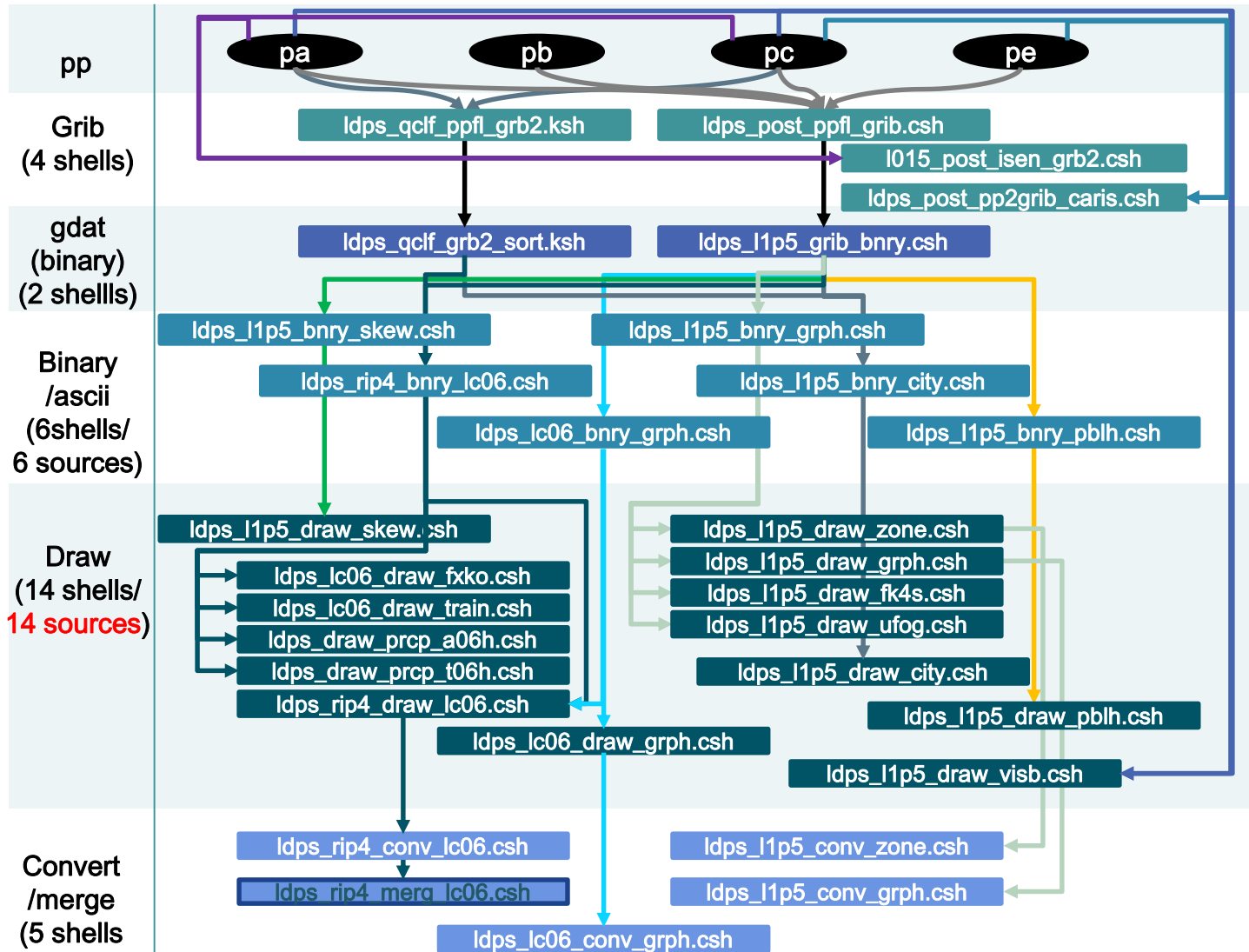
- (Split) skew-T charts, Auxiliary charts
- low pressure-track, fog, lightning index..

Examples of applying split method



Flowchart of post processing (LDAPS)

main shell: main_ldps_post_all_job.csh



pp: post processed file
 pa: model levels
 pb: pressure levels
 pc: single levels
 pe: single levels(stability)

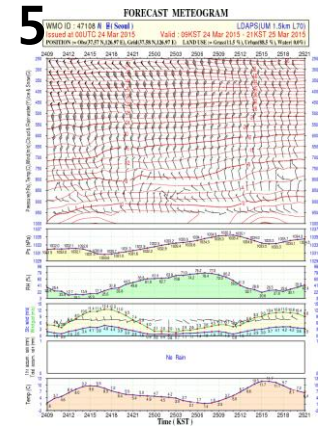
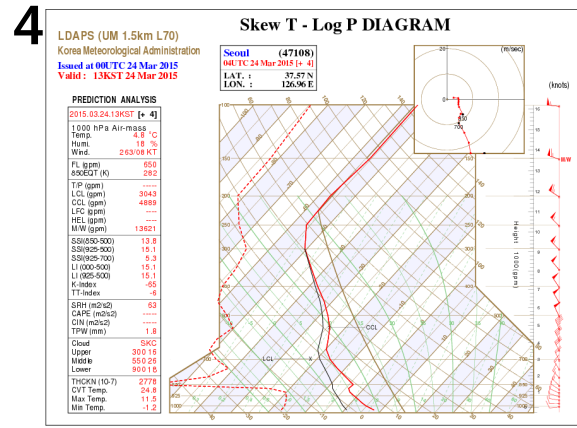
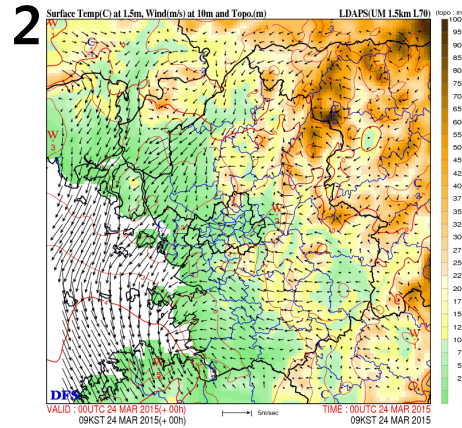
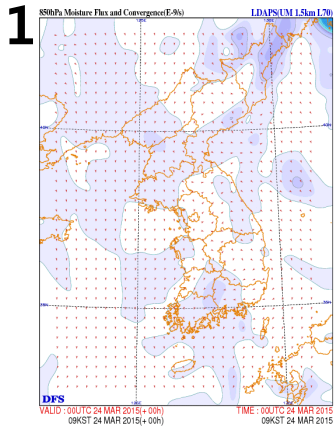
Using NCAR graphic
 + user-defined library/
 Subrutine(FORTRAN)

LDPS Graphic outputs

- Run time : 95 mins/00,12UTC, 30mins/06,18UTC
- # of charts : 5,668 per time (22672/day, ~ 16%)
- Chart types : 66 type

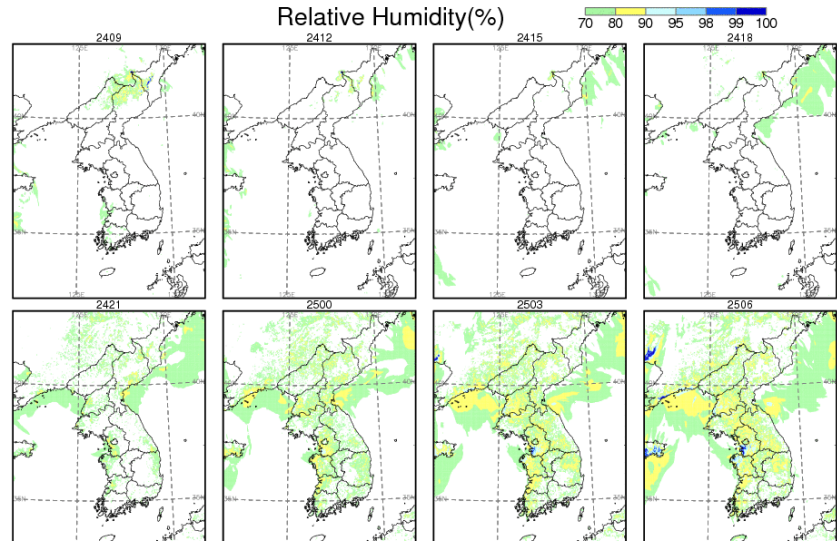
Class		# of type	# of charts	Remarks
1	weather charts	53	1,961	53 types x 37times
2	Local area weather charts	5	1,480	5 types x 8 regions x 37 times
3	Postage style chart	5	5	Accumulated rainfall(4)& RH(1)
4	Skew-T log charts	1	2,183	59 points x 37 times
5	Vertical time series	1	70	70 points
6	Instability time series	1	6	6 regions
total		66	5,668	

LDPS Graphic outputs

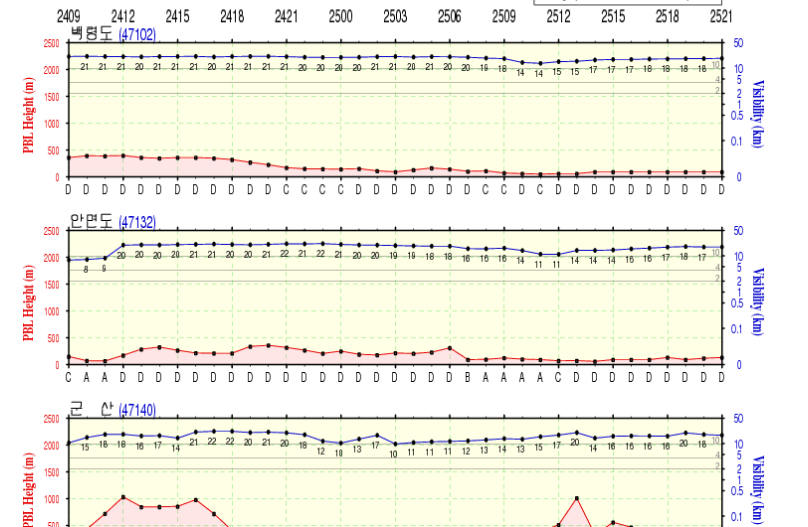


3 FXKO4S 00UTC 24 MAR 2015
 VALID : 09KST 24 MAR 2015 - 21KST 25 MAR 2015

3hr Surface Relative Humidity Chart
 LDAPS (JM 1.5km L70)
 Korea Meteorological Administration

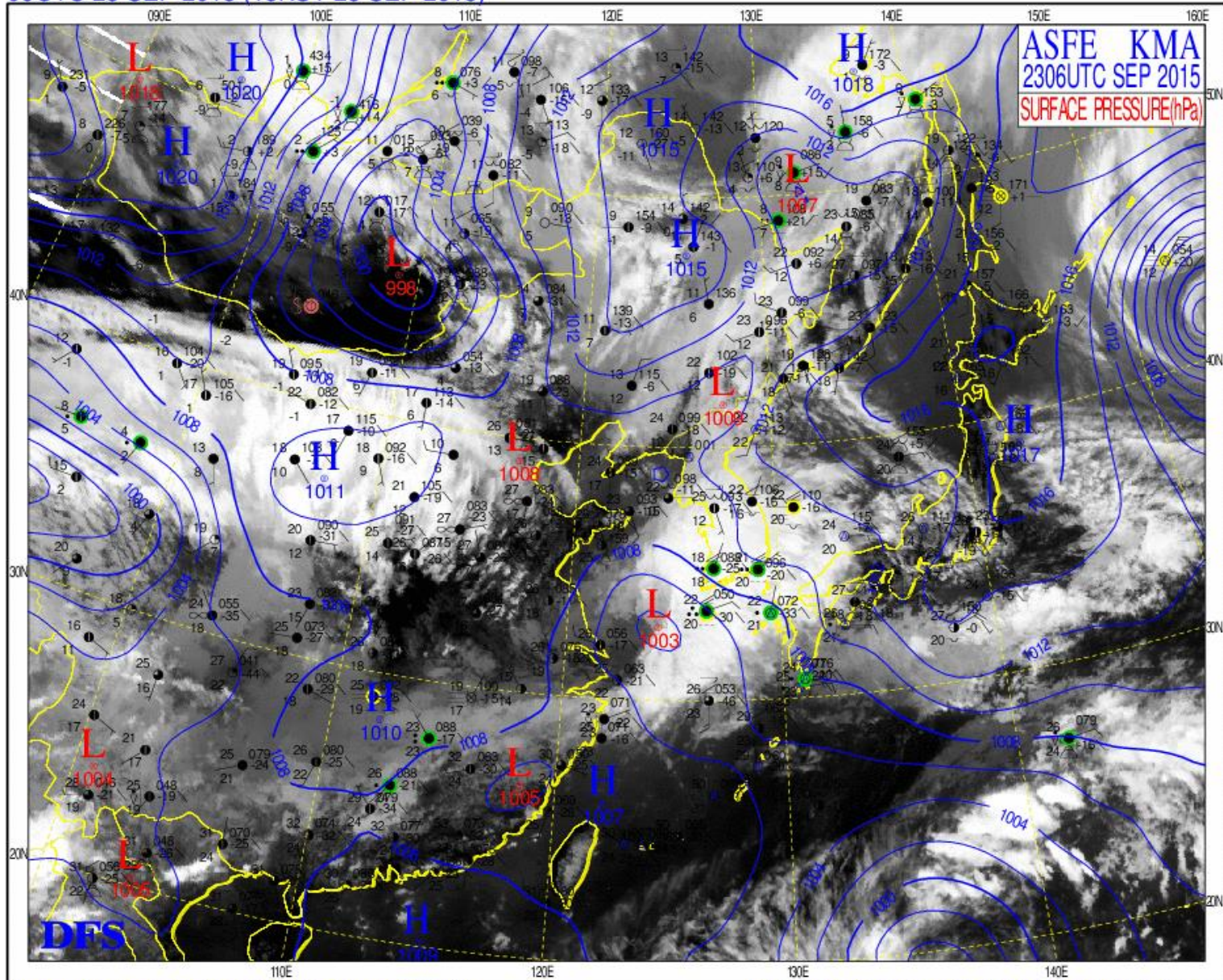


6 PBL Height(m), Stability Class & Visibility(km)
 Issued at 00UTC 24 Mar 2015
 Valid : 09KST 24 Mar 2015 - 21KST 25 Mar 2015



Overlay satellite imagery

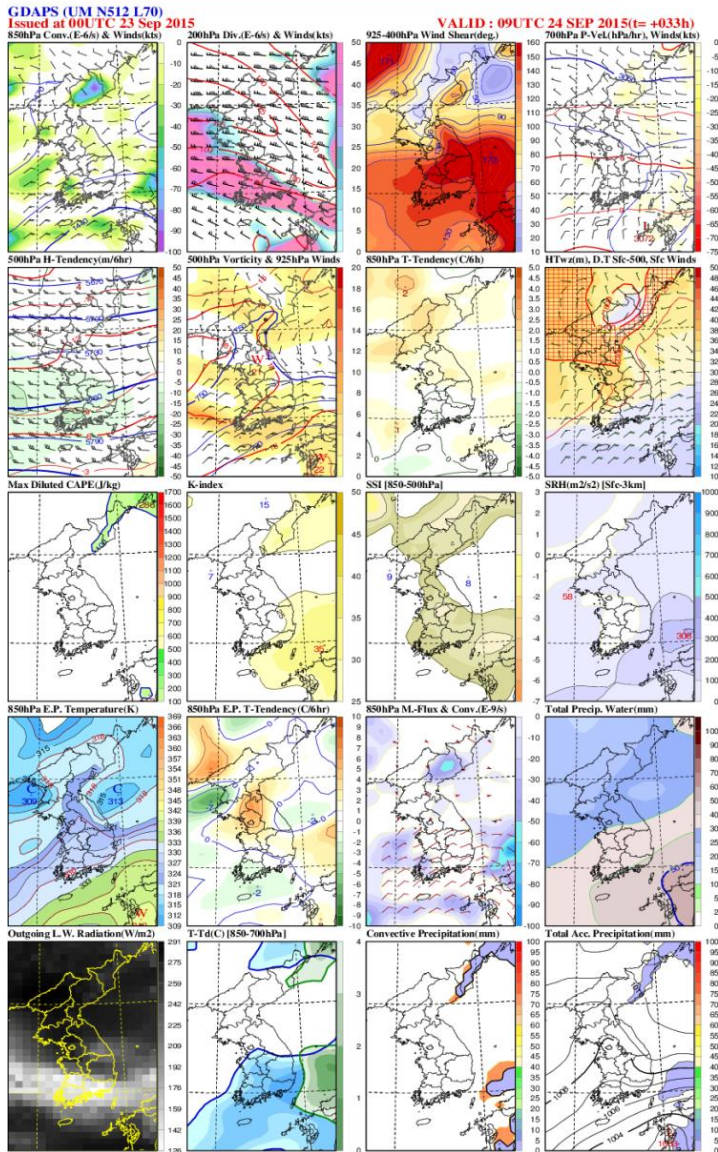
06UTC 23 SEP 2015 (15KST 23 SEP 2015)



Make comprehensive charts for instability

Add grid information

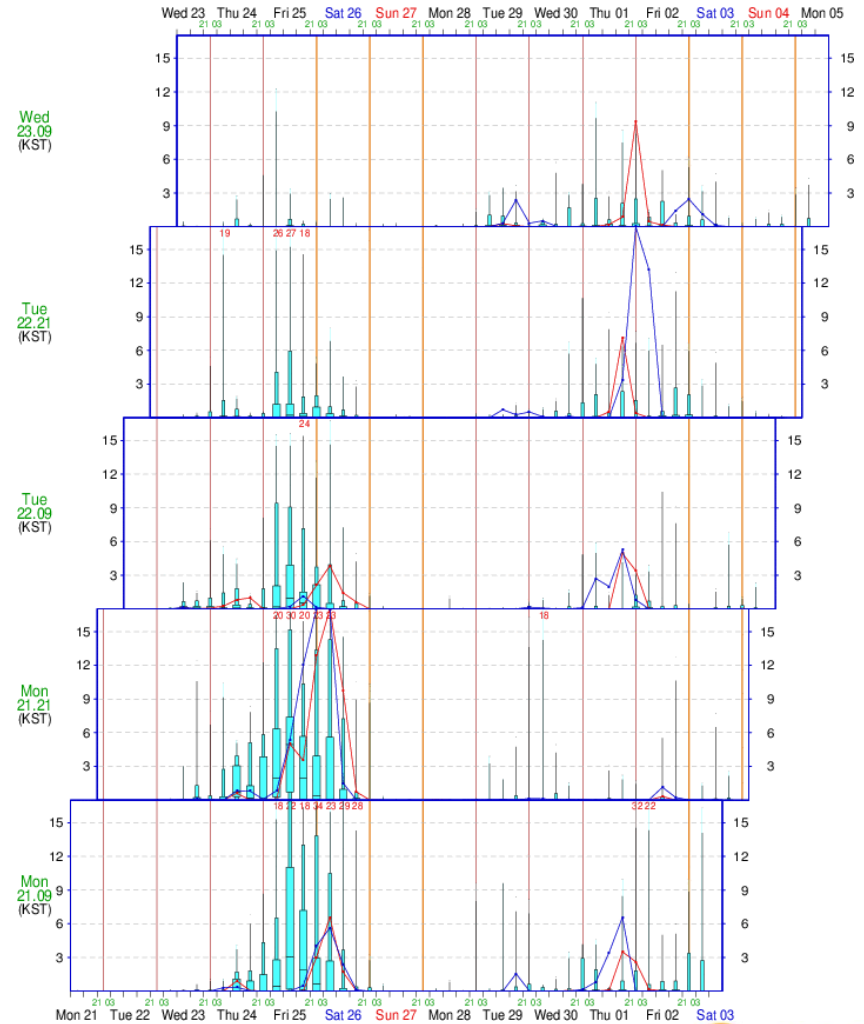
Auxiliary Forecast Chart for Korea



EPSP(UM N320 L70 M24) Meteogram
 N (Seoul)
 EPS point is [ESE 16.1 km] far from Station

Valid : 09KST 23 Sep 2015 - 09KST 05 Oct 2015
 Issued at 09KST 23 Sep 2015

Precipitation (mm/6hr)



Visualizing NWP data with text

Browser: http://uis.comis4.kma.go.kr/comis4/uis/common/index.do#

COMIS-4 이현경 님 로그인 | 메뉴 | ALW AIS | 종합실황감시 | 개인메뉴 | 리셋 | My Real

특보 예보 태풍 지상 해양 AWS 일기도 위성 레이더/낙뢰 황사 고층 항공 GTS 외부 내려받기 시스템

특보 안개/연무 가이던스(집계표)

안개 예측 모델 (집계표) · 전체 · 3시간간격 · 관측(시정계) Rfog(km) Lfog(km) 확률(1km이하) 확률(4km이하) 확률(10km이하)

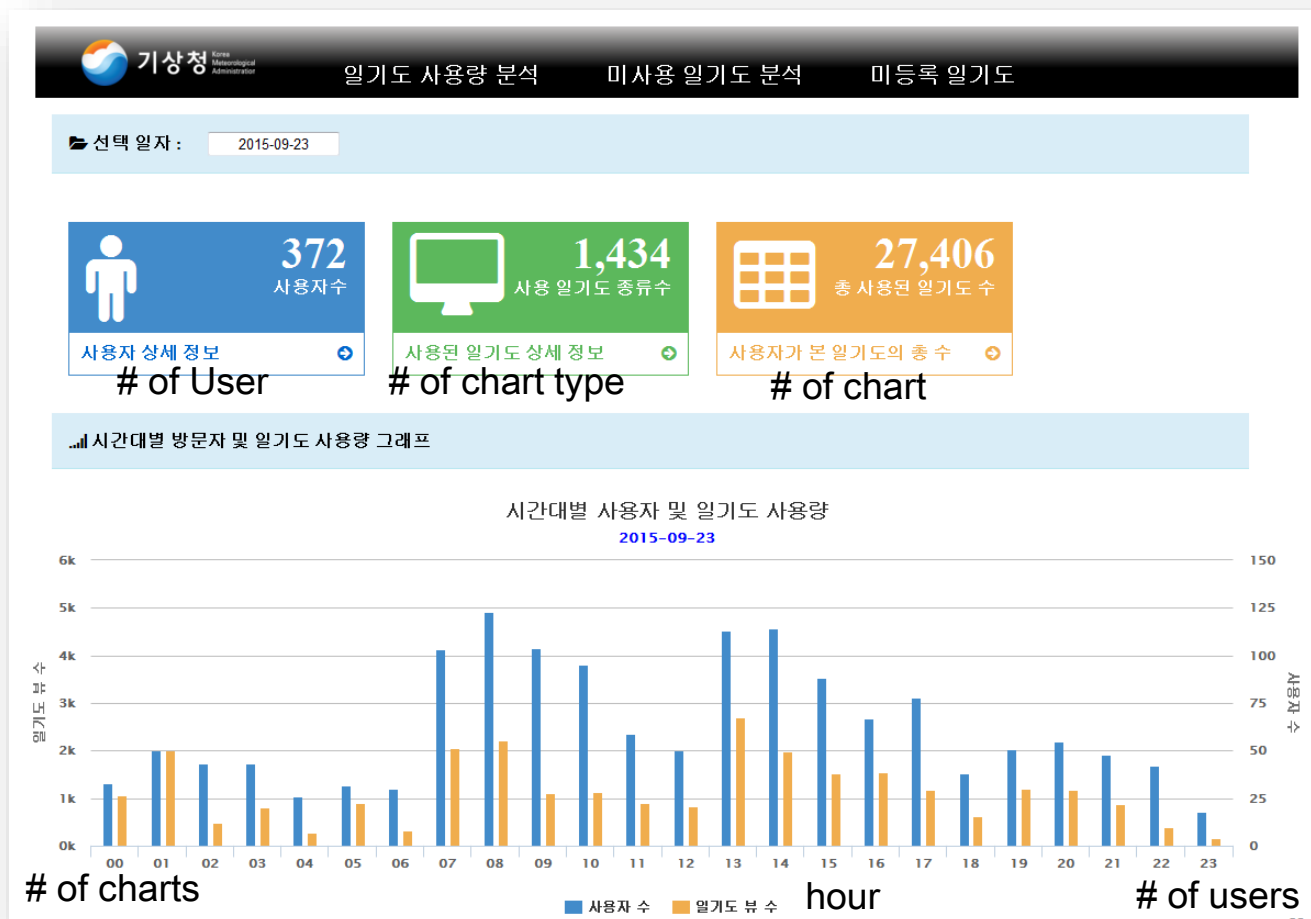
· NOW 2015.09.20.21:00 · -3D -1D -12H +12H +1D +3D · 분포도 · 특보 기준

지역	관측소	종류	시간	1D	2D	3D	4D	5D	6D	7D	8D	9D	10D	11D	12D	13D	14D	15D
안남	920 안남	Lfog																
		Rfog																
		Lfog																
창녕	919 창녕	Rfog																
		Lfog																
		Rfog																
진주	192 진주	Rfog		30.0					20.3	0.4	0.1	0.1	29.2					
		Lfog							10.2									
		확률(<1km)	5	5	1						0	0						
하동	932 하동	Rfog																
		Lfog																
		Rfog	0.1	0.1							30.0							
산청	289 산청	Lfog		0.1	0.1													
		확률(<1km)	26	60	2					76	87	87	1					
		Rfog																
함양	264 함양군	Lfog																
		Rfog																
		Lfog																
거창	284 거창	Rfog																
		Lfog																
		확률(<1km)	64	61	4		0		2	25	45	59	4					1
946 북상		Rfog																
		Lfog																
		Rfog			0.3								0.1	3.4				
합천	285 합천	Lfog	0.8	0.1	0.2													
		확률(<1km)	93	95	8					73	80	85	4					
		Rfog																
915 삼가		Lfog																
		Rfog												13.9	10.8			
		Lfog																
통영	162 통영	Rfog																
		Lfog																
		확률(<1km)									0	0						

PHP programming

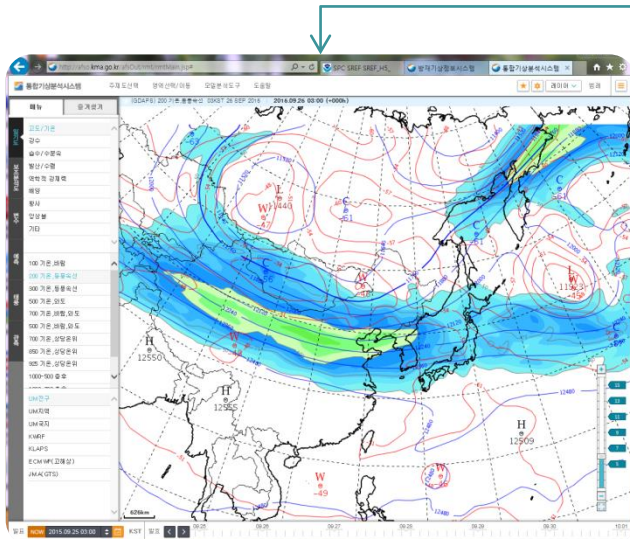
Monitoring charts usage

- Monitor to access weather charts in near real time
- Analysis internal forecasters' chart usage



IMAS: Integrated Meteorological Analysis System

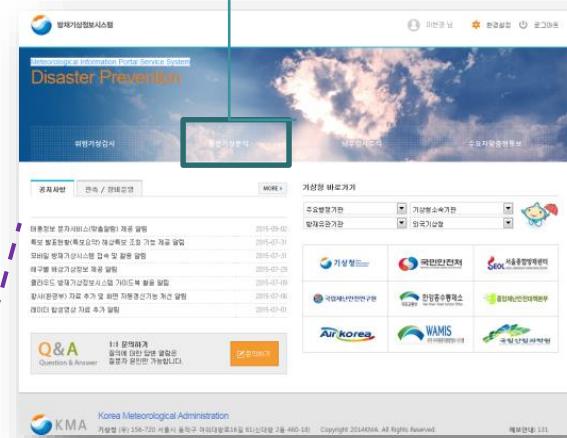
Web based application to explore and visualize not only NWP data but other meteorological data such as satellite, radar, surface observation..



Version 1 since 2012
Version 2 since 2015



KMA forecasters



(<http://afso.kma.go.kr>)

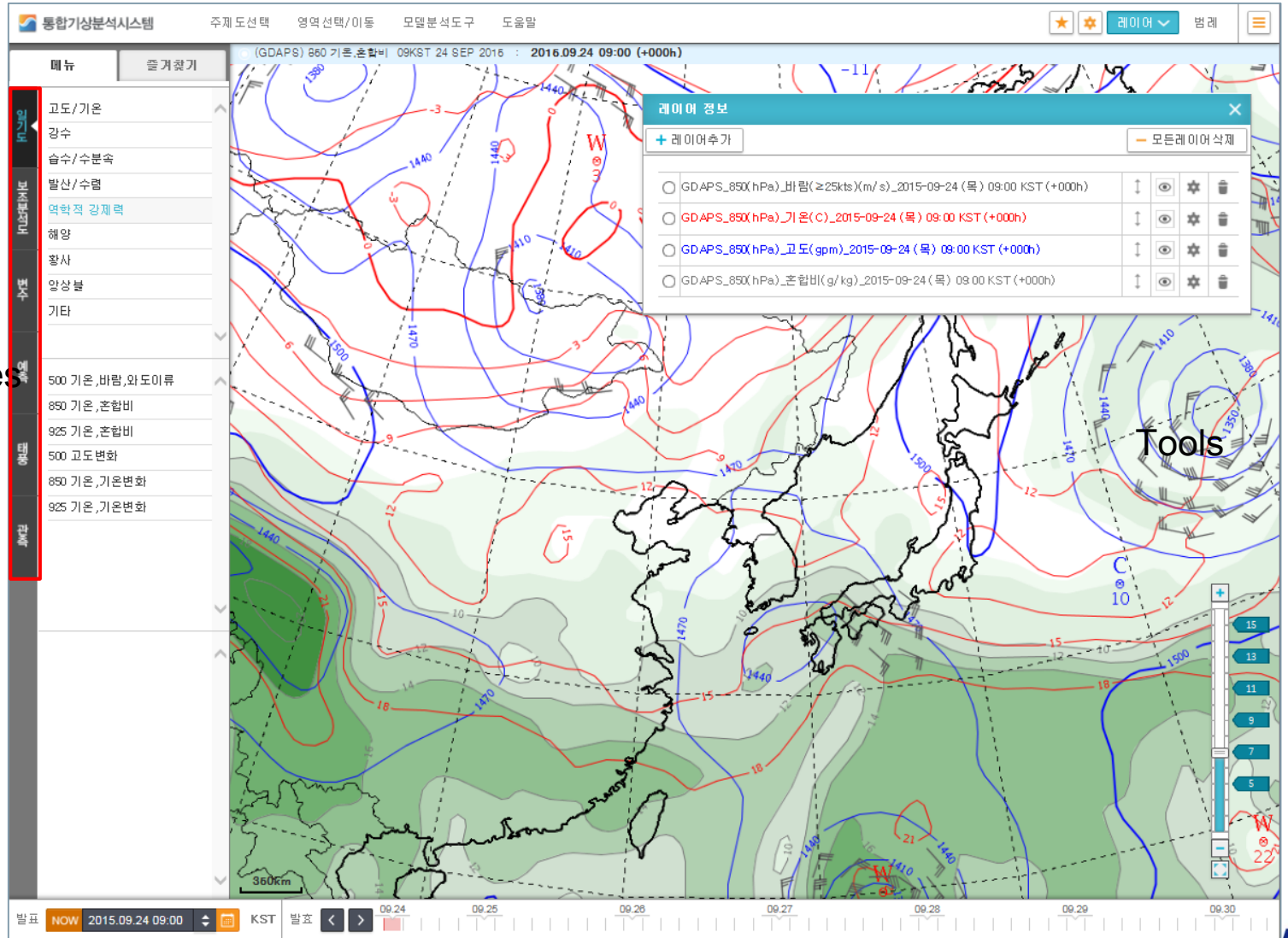
Authorized users
(using Internet)



Interactive features

- Zoom in, Zoom out, Overlay
- GIS information(River, Mountain, Road...)
- Control time – Animate, Change base-time
- Measure distance, location
- Analysis tools: Cross-section, time series,
- Design and save as 'favorite' products to re-use
- Add or remove layers

User-interface



<Categories>

1. Weather chart

2. Anxilliay chart

3. Model Variables

4. Typhoon

5. Observation

User-interface

GIS Themes

- 위성영상
- 도로
- 철도
- 강/하천
- 산
- 해수욕장
- 행정동경계
- 도경계
- 시군구경계
- 주요도시경계
- 국립공원경계
- 특보구역
- AWS관측지점
- ASOS관측지점
- 음영기복도

Area/Location

중심위도

중심경도

줄레벨

이동

지역 직접입력

줄레벨

이동

Analysis tool

- 시계열
- Time series/
- 예상단열선도
- Cross-sections
- 습사정도추적
- 시간-고도
- 변수-고도
- 연직층

The screenshot shows the KMA GIS interface with the following components:

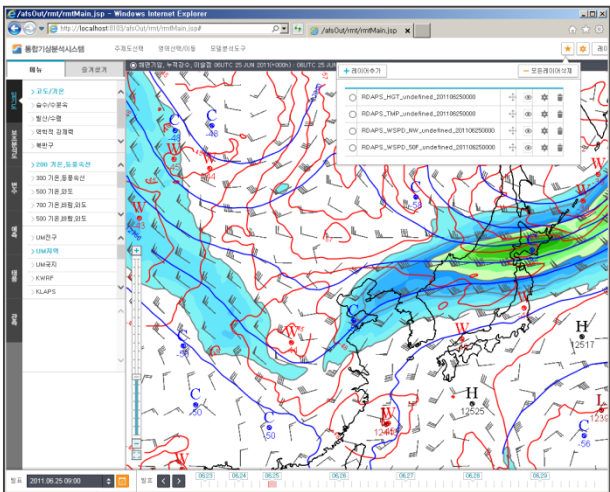
- Top Bar:** "통합기상분석시스템" (Integrated Weather Analysis System), "주제도선택" (Theme Selection), "영역선택/이동" (Area Selection/Movement), "고도분석도구" (Elevation Analysis Tool), "도움말" (Help).
- Left Panel:** "메뉴" (Menu) with "즐거웠기" (Liked) button. A vertical sidebar contains "비고" (Remarks), "비고/이동" (Remarks/Movement), "수위" (Water Level), "수위/이동" (Water Level/Movement), "역학적 강제력" (Dynamic Forcing), "해양" (Ocean), "황사" (Dust), "이상불" (Abnormality), "기타" (Other), "500 기온,비림,와도리류" (500 Temp, Precip, Vorticity), "850 기온,혼합비" (850 Temp, Precip), "925 기온,혼합비" (925 Temp, Precip), "500 고도변화" (500 Height Change), "850 기온,기온변화" (850 Temp, Temp Change), "925 기온,기온변화" (925 Temp, Temp Change).
- Main Map:** Weather map of Korea showing pressure (hPa), temperature (C), wind speed (m/s), and precipitation (g/kg) contours. Includes a "360km" scale bar.
- Right Panel:**
 - 레이어 정보 (Layer Info):** "레이어" (Layer) section with "모든레이어삭제" (Delete All Layers) button. Lists layers like "GDAPS_850(hPa)_비림(≥25kts)(m/s)_2015-09-24 (목) 09:00 KST (+000h)".
 - Tools:** A vertical toolbar with icons for pan, zoom, and other map functions.
 - Zoom-bar:** A vertical zoom control with buttons for 15, 13, 11, 9, 7, 5.
 - Time-lines:** A horizontal timeline at the bottom showing dates from 2015.09.24 to 2015.09.30.
- Overlays:**
 - Favorites:** A window showing saved layers like "RDAPS_EPOT_undefined_201106250000".
 - UTC/Local time:** A window for "설정" (Settings) with "기준시설정" (Reference Time Setting) set to "UTC".

Data

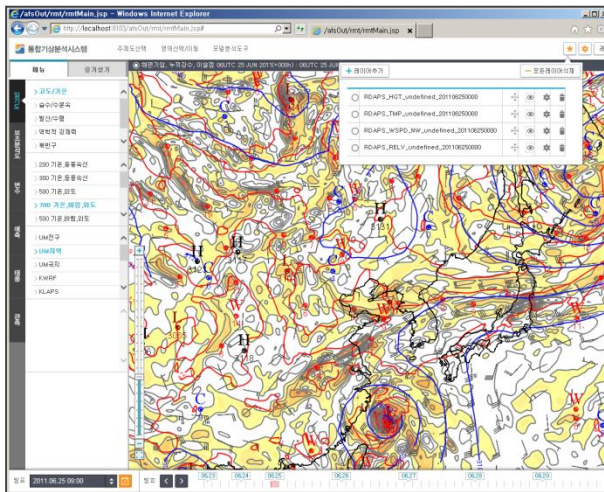
NWP	<ul style="list-style-type: none">• UM-Global (regrid: 0.35156 * 0.234375 -> 40km LCC)• UM-Regional(12km LCC)• UM-Local(1.5km LCC)• UM Ensemble(mean/anomaly)• Wave model, Asian Dust model• ECMWF	11 types (2,996 scenes)
Meteorological Observation	<ul style="list-style-type: none">• AWS, SYNOP, METAR, BUOY..• Radar, Lightning• Satellite – COMS, MTSAT, NOAA, ASCAT...	31 types (177 scenes)
Typhoon/ guidance	<ul style="list-style-type: none">• Typhoon information, Typhoon model output• Fog guidance	7 types (18 scenes)

*LCC: Lambert Conformal Conic

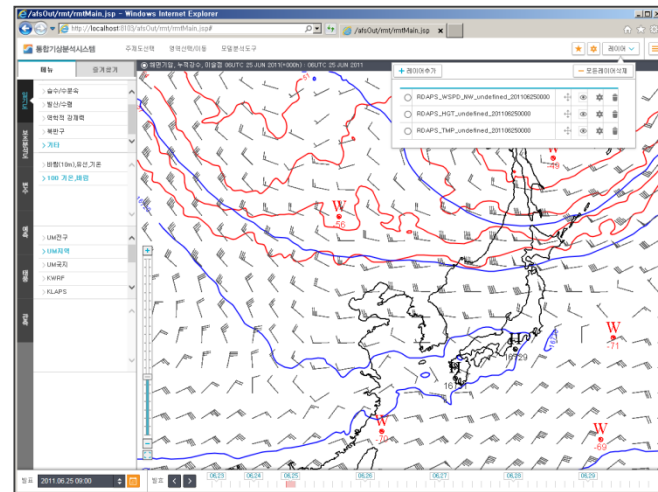
Various charts



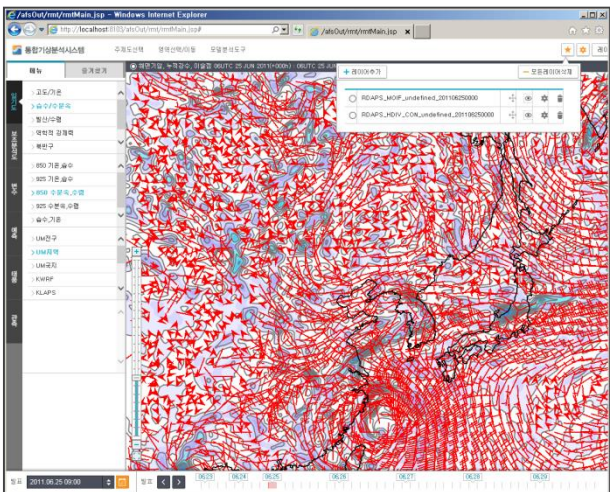
300hPa Temp, isotach



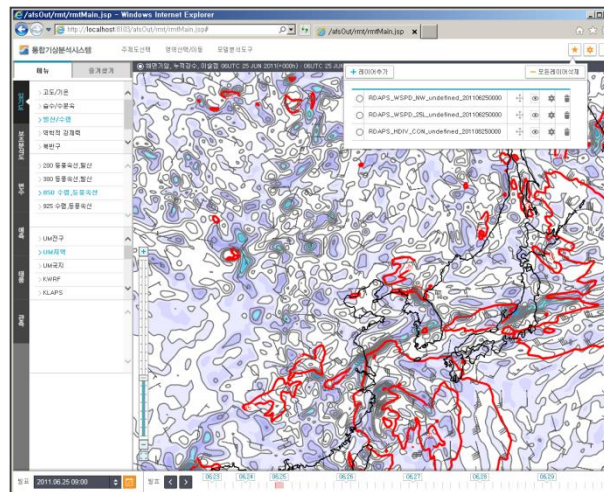
700hPa Temp, wind, Vorticity



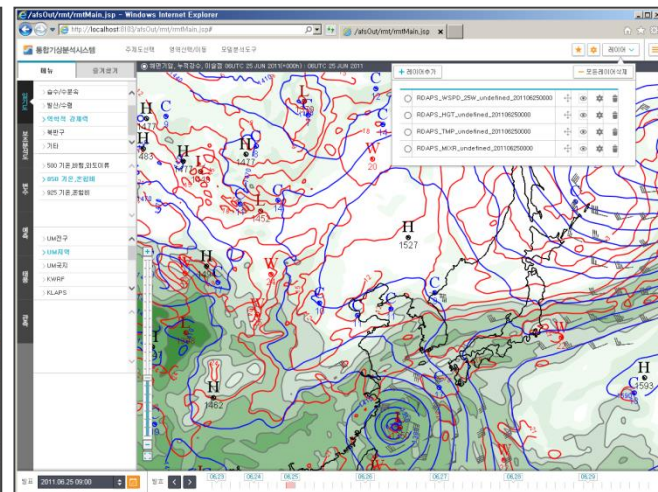
100hPa Temp, Wind



850hPa moisture, Convergence



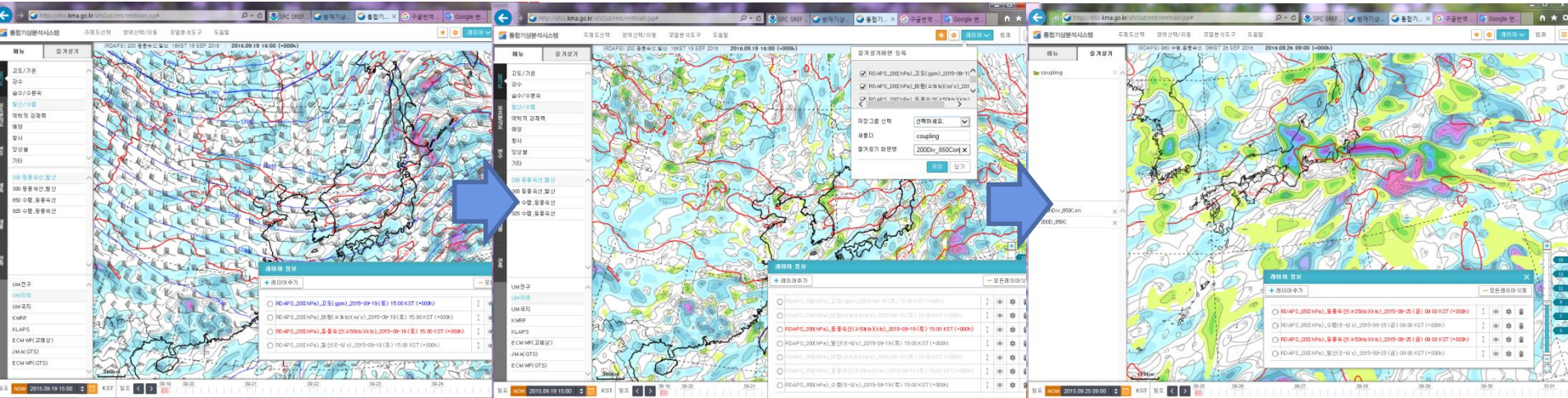
850hPa Divergence, isotach



850hPa Temp, Mixing ratio

Customized charts

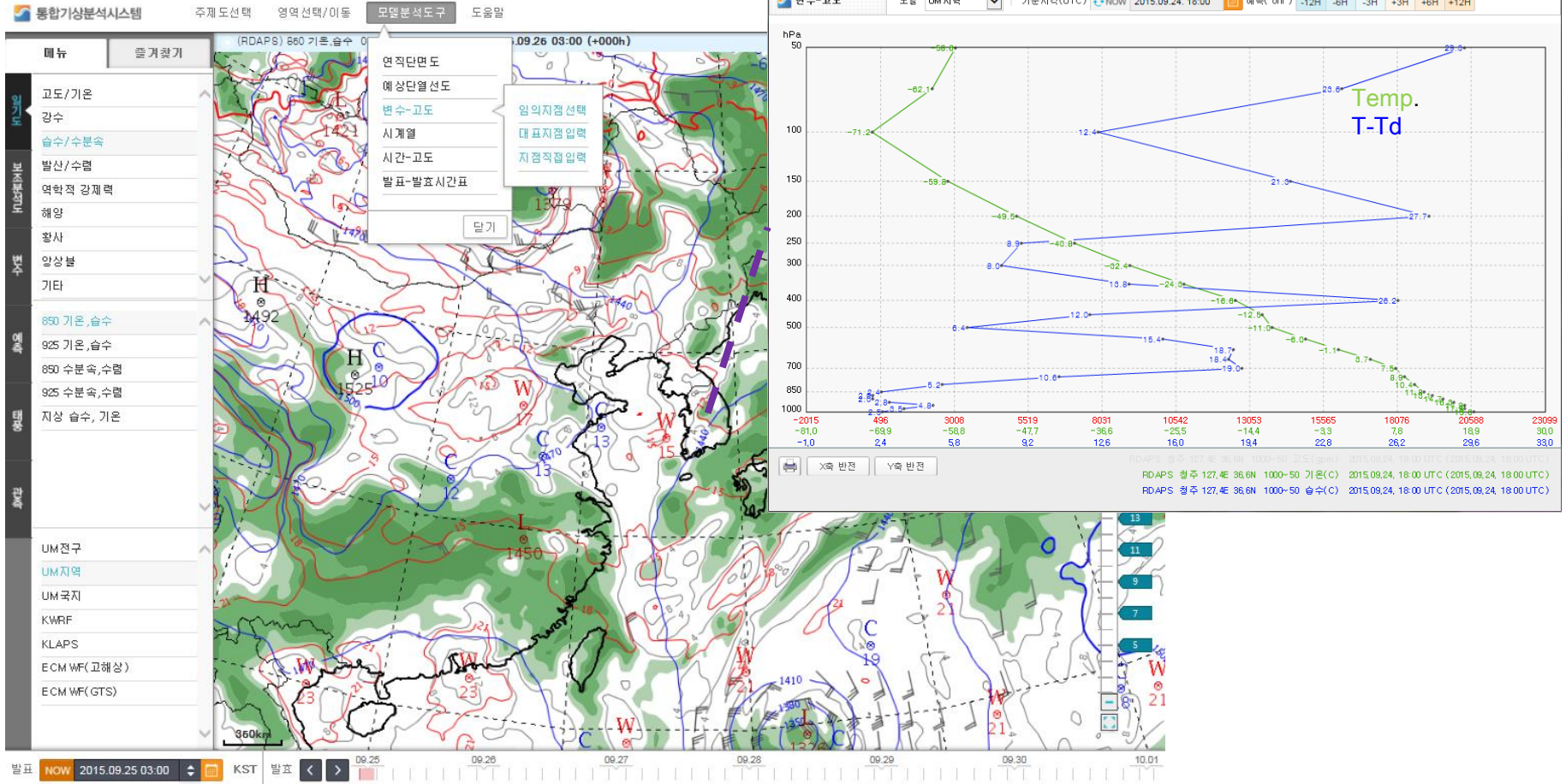
- Using layer + favorites menu



- Select 200hPa divergence chart & add 850hPa convergence chart
- Delete unnecessary layers & set my favorite
- Check 'my favorite'

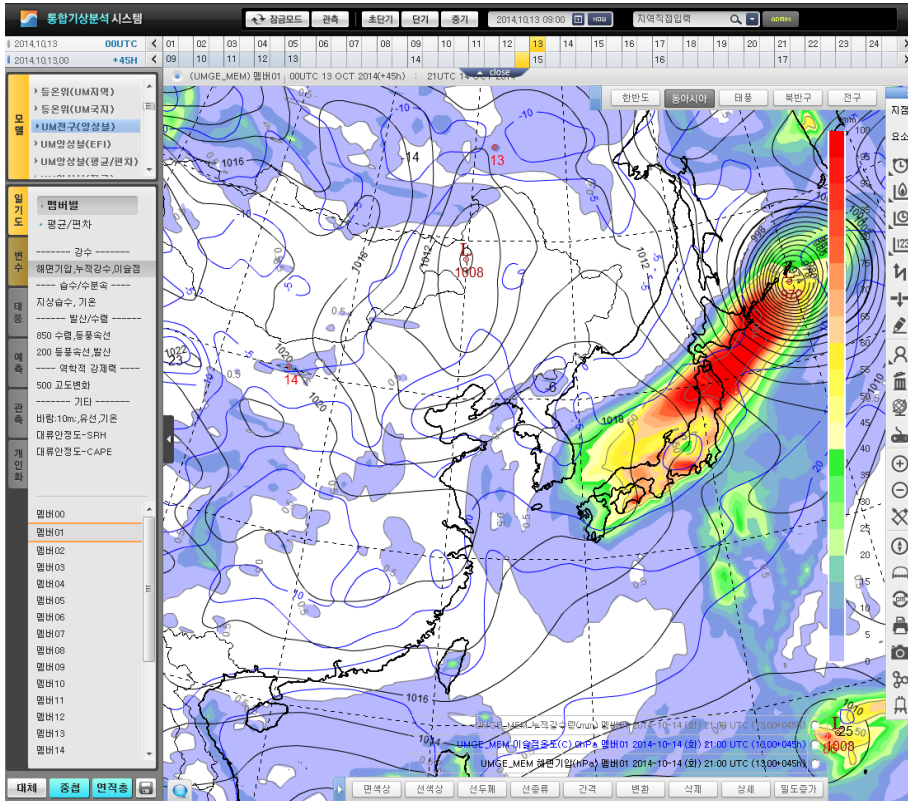
Analysis tools

variable-height chart at a certain point

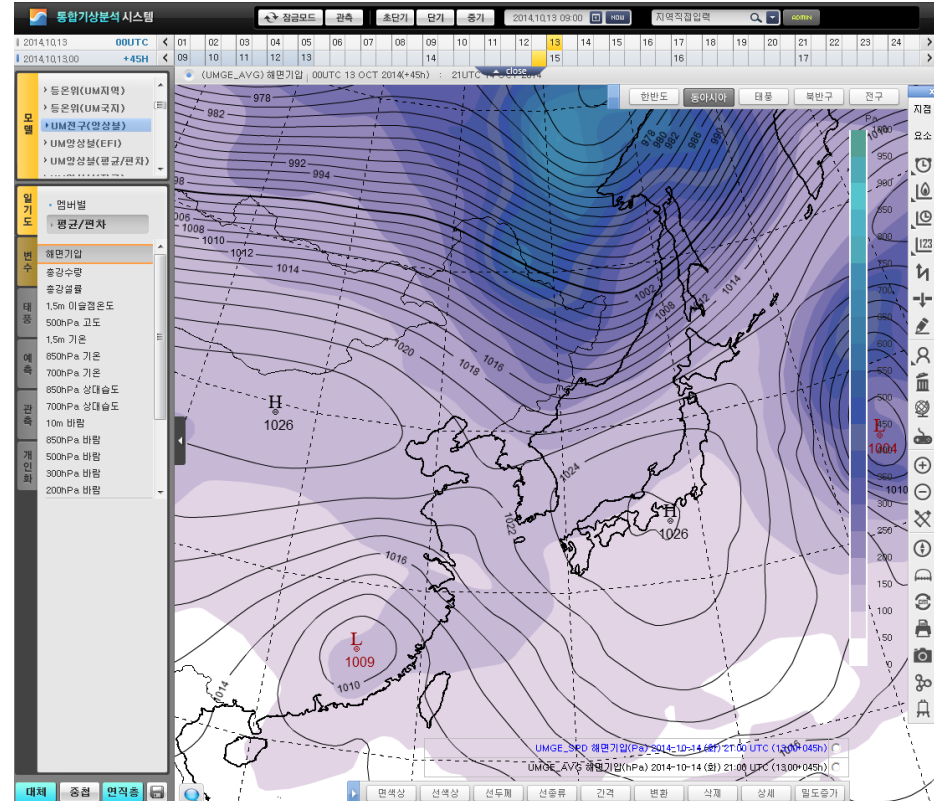


Ensemble charts

Member 01: MSLP, rain



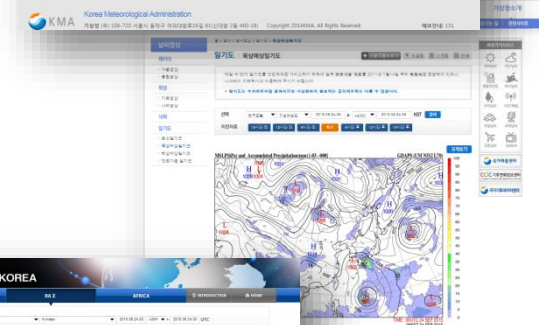
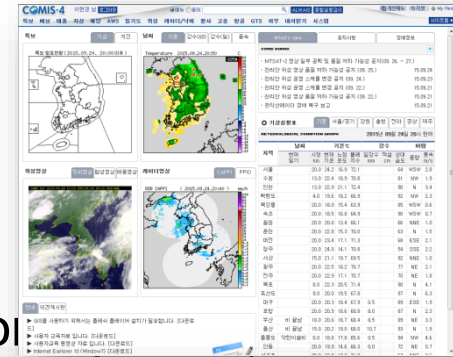
Mean, Anomaly of MSLP



• UM GDAPS ENSEMBLE(+228hr, 3hr) : 24 members & mean, spread

Data Services

- For forecasters
 - COMIS (4th Comprehensive Meteorological Information)
 - IMAS
- For government-related agencies
 - IMAS and image-based charts on the disaster pre weather information system
- For public/ international users
 - KMA Home page
 - Including Philippine area charts
- For researchers
 - Model experiments
 - Internal monitoring charts



Thank you

감사합니다

