Development of Hydro-meteorological information Monitoring and Prediction Tech.

for supporting of Flood Warning System

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Hydrometeorology (HyMet)

- Utilize and reproduce information produced btw atmosphere and surface for the water resources management
- Use the information to monitor and predict meteorological disasters, e.g. flood and drought
Application of HyMet Information

**Met. Info.**
- **Observation** (AWS, Radar)
- **Short-term Prediction** (~6 hr/ 48 hr, ~1 km/ 5 km)
- **Mid/long-term Prediction** (~6 months, 5 km~)
- Climate scenario

**Appl. for Met.**
- Improve Met. Model (Initial data)
- Drought monitoring/prediction
- High impact weather monitoring
- Validation of Satellite retrieval

**HyMet Info.**
- Surface runoff
- **Soil moisture**
- Ground temp.
- Ground water table depth
- Evapotranspiration
- Latent/Sensible/Ground heat

**Appl. for Hydro.**
- Hydraulic structure/ water resources management
- River flood/ flash flood prediction
- Drought monitoring/prediction
- Projection of the future water resources

Production of User-friendly Hydrometeorology information
Overview

Goal

- Development of HyMet monitoring and prediction technology to support management of flood and water resources management in coping with high impact weather in Korea

Contents

- Observation of HyMet information
  - Met. info., soil moisture, H₂O/CO₂ flux, etc.

- Modeling of HyMet information using LSM
  - QPF, soil moisture, runoff, evapotranspiration, latent heat, sensible heat, ground heat, etc.

- Areal rainfall map based on radar data
Observation Sites (1)

- HyMet observation sites at the basin of Andong-dam
  - Validation of HyMet information simulated from LSM
  - Assimilation of observation data into the model
  - Properties of HyMet information
### Observation Sites(2)

#### Observation instruments

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Components</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visibility</td>
<td>Visibility</td>
<td>6</td>
</tr>
<tr>
<td>AWS</td>
<td>Tipping buckets, Pyranometer, Wind–speed/direction, Temp., Humidity, Soil moisture, Ground temp.</td>
<td>7</td>
</tr>
<tr>
<td>Stereo camera</td>
<td>Sky &amp; Instrument monitoring</td>
<td>7</td>
</tr>
<tr>
<td>Weighing rainfall gauge</td>
<td>Precipitation</td>
<td>7</td>
</tr>
<tr>
<td>Flux tower</td>
<td>Sensible/Latent/Ground heat, CO₂/H₂O flux, Net radiation</td>
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</table>

#### Specification

<table>
<thead>
<tr>
<th>Sites</th>
<th>Components</th>
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</thead>
<tbody>
<tr>
<td>AWS(5)</td>
<td>DC, SR, NM, GS, PH Pyranometer, WS/WD, Soil moisture, Surface temp. Visibility, Weighing rainfall gauge, Camera</td>
</tr>
<tr>
<td>FLUX tower</td>
<td>OD, WC 3D Ultrasonic WS/WD, CO₂/H₂O analyzer, Net radiation sensor, Ground heat, etc.</td>
</tr>
</tbody>
</table>
Observation sites (3)

- Gridded monitoring system of HyMet info. (Webpage: http://190.1.18.175)
- Display of data collection status and temporal variation of met. parameters
Production of HyMet info. from Land Surface Model (LSM)

- Need technologies for production of high spatial resolution HyMet info. based on LSM to monitor and predict meteorological disasters over large areas.
Model-based HyMet Info. (2)

- Real-time production of gridded HyMet info. of high resolution (1 hr/ 1 km) based on LSM, TOPLATS
- Produce the 14 components, e.g. runoff, soil moisture, ground water depth, evapotranspiration, and latent/sensible heat.
- Real-time validation of the modeled data with observation data
• Performance analysis of precipitation prediction based on basins
  - Needs of accuracy tests and optimal prediction info. for effective use of precipitation prediction for water resource/flood management.
  - Calculation and validation of predicted areal rainfall
  - Production of the basin-based rainfall data from the KMA prediction data

### Validation
- **Period:** Jun. - Aug., 2010 (3 months, summer)
- **Model:** Obs. (RAR), Very Shortterm (VSRF, MAPLE, KLAPS), Shortterm (UMRG, KWRF)
- **Qualitatively:** ACC, BIAS, POD, FAR, CSI, ETS, HK, HSS
- **Quantitatively:** ME, MAE, RMSE, CORR
- Production and validation of the basin-based optimal precipitation prediction using the blending method
  - Apply the long-term mean CSI as weighting factors depending on prediction models (Kilambi and Zawadzki, 2005)
  - Analysis period: Jun. - Aug., 2011 (3 months, summer)
  - Model: Very-shortterm(MAPLE, KLAPS), shortterm(UMRG, KWRF)
• Investigate water resources where the ground-based observations are not available
• Production of the basin-based radar areal rainfall map

Radar areal rainfall map

- Production of the gridded areal QPE using spatial correction method for the 117 basins
- Verification of the map with quantitative index (e.g., ME, MAE, RMSE, CORR) using cross-validation
- Comparison with the surface rainfall map produced with the Thiessen method

AWS No. (642)  Thiessen map(117)

\[ R_{\text{corr}}(i, j) = R_{\text{radar}}(i, j) F(i, j) \]

\[ F(i, j) = \frac{\sum w_n(i, j)G_n(i, j)}{\sum w_n(i, j)R_{\text{obs}}(i, j)} \]

\[ w_n(i, j) = \exp \left( -\frac{d_n^2(i, j)}{\sigma^2} \right) \]

\[ d_n^2(i, j) = \text{Distance (km) between } n^{th} \text{ rain-gauge and grid (i,j)} \]

\[ \sigma = 1.5 \text{ km} \text{ : Smoothness} \]

1. Radar rainfall
   - Volumetric Reflectivity for each radar
     QC algorithm^1
   - 1 km x 1 km CAPPI at 1.5 km from the sea level (reflectivity)
   - M-P relationship^2
     - 1 km x 1 km of CAPPI at 1.5 km from the sea level (Rainfall intensity)
     - Merging
       - 1 km x 1 km of CAPPI at 1.5 km from the sea level (daily rainfall, each radar)

2. Rain-gage rainfall
   - Daily rain-gauge rainfall each site

3. Daily spatial correction (Rc)

\[ \text{Accumulated rainfall (Monthly & Yearly)} \]

(ex) F(i,j) 산출 예시

G1, R1  G2, R2  G3, R3

\[ F(i, j) = \frac{w_1G_1 + w_2G_2 + w_3G_3}{w_1R_1 + w_2R_2 + w_3R_3} \]

\[ w_i = \exp \left( -\frac{d_i^2}{\sigma^2} \right) \]

*Zhang et al. (2004)*
*2 = 2008^14* (Marshall and Palmer, 1948)
*^ Maximum value
Radar Areal Rainfall Map (2)

- Operational tests and validation
  - The grid- and basin-based monthly/yearly rainfall map (2006 ~ 2010)
  - Real-time display and validation ([http://190.1.18.175](http://190.1.18.175))

- Real-time display of rainfall measured by Radar and AWS
- Display of Monthly/yearly rainfall map and verification index

**Verification index**

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<tr>
<th>Location</th>
<th>Radar</th>
<th>ME</th>
<th>MAE</th>
<th>RMSE</th>
<th>PE</th>
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**Temporal variation**
Application of the HyMet info. data

HyMet Monitoring

Heavy rainfall, drought monitoring

Development of Observation Techniques
→ High quality info. from advanced HyMet Obs. Techniques

KMA QPE/QPF Optimal Precip.

Land Surface Model (TOPLATS-AWS, WRF)

QPE/QPF

Real-time and predicted HyMet info.

HyMet Tech.

High resol. Map

Comparison Model & Obs.

Water resources, Flood, Agriculture, Policy decision making

Drought Cold-weather damage Atmos.-weather model performance

수문기상 기술개발 기반구축 및 현업지원

Flood & Water resources Management
Thank you
감사합니다