User needs reliable and actionable information for decision-making.

**Goal of S2S project**

Many decisions in agriculture, water, disaster risk reduction and health fall into the sub-seasonal to seasonal (S2S) range. The goal of a new WWRP/THORPEX-WCRP joint research project is to improve forecasts and understanding on the S2S scale, and promote uptake by operational centers and use by the applications community.

*The WWRP/WCRP S2S project (2013)*
The APCC’s Subseasonal Forecasting Activity

(July 24, 2018)

Hae-Jeong Kim*, Yoo-Rim Jung, A-Young Lim, Chang-Mook Lim and Yoo-bin Yhang
APEC Climate Center
Mission of the APEC Climate Center

To enhance the socio-economic well-being of member economies by utilizing up-to-date scientific knowledge and applying innovative climate prediction techniques.

**Climate Prediction**
APCC produces value-added, reliable, and real-time climate prediction information and provides the APEC region with it.

**Interdisciplinary Research**
APCC leads in the development of interdisciplinary research and application techniques at the climate-environment-society nexus.

**Climate Information Services**
APCC strives to be a key climate database center to distribute climate data, information products, and related tools.

**International Cooperation**
APCC guides developing countries from the APEC region toward building their own capacity to produce reliable climate prediction information.
APCC Activities

Climate Prediction & Information Service

✓ http://www.apcc21.org
Seasonal Forecast

• Producing skillful real-time climate predictions and developing reliable climate prediction system based on a **Multi-Model Ensemble (MME)** technique.

• MME seasonal prediction is one of the most reliable seasonal forecast information at present.

---

**Anomaly Pattern Correlation**

- **Temperature**
  - PCC (Pearson Correlation Coefficient)
  - Individual models vs. MME

- **Precipitation**
  - PCC (Pearson Correlation Coefficient)
  - Individual models vs. MME

---

*Min et al. (2017), Climate Dynamics*
APCC MME Prediction System

- The world’s largest MME system based on international cooperation to generate monthly rolling 3-month and 6-month MME climate outlooks.

### Multi-institutional Cooperation

<table>
<thead>
<tr>
<th>Economy</th>
<th>Organization/Institute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Bureau of Meteorology (BoM)</td>
</tr>
<tr>
<td>Canada</td>
<td>Meteorological Service of Canada (MSC)</td>
</tr>
<tr>
<td>China</td>
<td>Beijing Climate Center (BCC)</td>
</tr>
<tr>
<td></td>
<td>Institute of Atmospheric Physics of China (IAP)</td>
</tr>
<tr>
<td>Chinese Taipei</td>
<td>Central Weather Bureau of Chinese Taipei (CWB)</td>
</tr>
<tr>
<td>Italy</td>
<td>Euro-Mediterranean Center on Climate Change (CMCC)</td>
</tr>
<tr>
<td>Japan</td>
<td>Japan Meteorological Agency (JMA)</td>
</tr>
<tr>
<td>Korea</td>
<td>Korea Meteorological Administration (KMA)</td>
</tr>
<tr>
<td></td>
<td>Pusan National University (PNU)</td>
</tr>
<tr>
<td>Peru</td>
<td>Servicio Nacional de Meteorología e Hidrología (SENAMHI)</td>
</tr>
<tr>
<td>Russia</td>
<td>Hydrometeorological Centre of Russia (HMC)</td>
</tr>
<tr>
<td></td>
<td>Main Geophysical Observatory of Russia (MGO)</td>
</tr>
<tr>
<td>UK</td>
<td>Met Office</td>
</tr>
<tr>
<td>USA</td>
<td>Center for Ocean-Land-Atmosphere Studies (COLA)</td>
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<tr>
<td></td>
<td>International Research Institute for Climate and Society (IRI)</td>
</tr>
<tr>
<td></td>
<td>National Aeronautics and Space Administration (NASA)</td>
</tr>
<tr>
<td></td>
<td>National Center for Environmental Prediction (NCEP) / National Ocean and Atmospheric Administration (NOAA)</td>
</tr>
</tbody>
</table>
APCC Activities

Climate Prediction & Information Service

✓ http://www.apcc21.org

Expansion into subseasonal forecast
by providing BSISO real-time forecasts
BSISO (Boreal Summer Intraseasonal Oscillation) Prediction

- Since 2013, APCC has expanded climate service from seasonal to subseasonal timescale by providing BSISO real-time forecasts for upcoming 20 days. It is available from May to October at APCC webpage and updates everyday.
- For the real-time forecast, the Lee et al. (2013) BSISO index is applied.
BSISO (Boreal Summer Intraseasonal Oscillation) Prediction

- The wet and dry spells of the BSISO strongly influence extreme hydro-meteorological events, major driving forces of natural disasters.
- BSISO1: canonical northward propagating BSISO over ASM region with 30-60 days quasi-oscillating period
BSISO (Boreal Summer Intraseasonal Oscillation) Prediction

- The wet and dry spells of the BSISO strongly influence extreme hydro-meteorological events, major driving forces of natural disasters.

- BSISO2: pre-monsoon and onset mode with periods of both around 30 days and 10-20 days
# APCC BSISO Prediction System

- **Multi-Institutional Cooperation**

<table>
<thead>
<tr>
<th>Institute</th>
<th>Model</th>
<th>Ensemble Size</th>
<th>Forecast Period</th>
<th>Update frequency</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCEP</td>
<td>Climate Forecast System</td>
<td>4</td>
<td>40 days</td>
<td>Once a day</td>
<td>T126 L64</td>
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<tr>
<td></td>
<td>Global Forecast System</td>
<td>1</td>
<td>16 days</td>
<td>Once a day</td>
<td>T574, T190 L64</td>
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<tr>
<td>Australia</td>
<td>POAMA 2.4 multi-week model</td>
<td>33</td>
<td>40 days</td>
<td>Twice per week</td>
<td>T47 L17</td>
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<tr>
<td>ECMWF</td>
<td>ECMWF Ensemble Prediction System</td>
<td>51</td>
<td>32 days</td>
<td>Twice per week</td>
<td>T639, T319 L62</td>
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<tr>
<td>Taiwan CWB</td>
<td>CWB EPS T119</td>
<td>6</td>
<td>40 days</td>
<td>Every 5 days</td>
<td>T119 L30</td>
</tr>
</tbody>
</table>
## Required data

Specifications for the type and format of data needed from the operational centers in order to participate in the activity

<table>
<thead>
<tr>
<th>Fields</th>
<th>OLR, and u850 totals (anomaly fields optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>2.5° in latitude (10°S, 7.5°S, 5°S, ..., 40°N) and longitude (40°E, 42.5°E, 45.0°E, ..., 160°E) Daily averaged (00-24Z)</td>
</tr>
<tr>
<td>Update frequency</td>
<td>Daily, or less for those systems run at a reduced frequency</td>
</tr>
<tr>
<td>Additional data</td>
<td>At beginning of transfer, send analysis data for past 120 days</td>
</tr>
<tr>
<td>Format</td>
<td>ASCII</td>
</tr>
</tbody>
</table>
Operation Schedule

1. **Data Collection**
   - FTP
   - Model forecast
   - Observation
   - Pre-processing

2. **Quality Check**
   - Communication with model providers

3. **BSISO projection**
   - **Verification**
     - (previous forecast, accumulated forecast)
   - **Graphic**
     - (BSISO phase diagram, 5-day mean OLR anom.)
   - **Application**
     - (Prob. forecast for Heavy Rainfall occur.)

4. **Dissemination**
   - Interpretation & description of prediction
   - Weekly meeting

Time:
- 9:20
- 11:00
- 12:20
- 13:00 (every day)
BSISO Forecast Products

- Daily forecast of BSISO index
- 5-day mean OLR anomaly
- Probability of heavy rainfall for week 1 & 2 predicted by BSISO index
- Verification results (hindcast, realtime forecast)
Performance of APCC BSISO

BSISO 1

Potential Predictability

Correlation

BSISO 2

Potential Predictability

Correlation

BOM  CFS  ECM  UKM  CWB

BSISO 1

RMSE

Amplitude error

Phase error

BSISO 2

RMSE

Amplitude error

Phase error
Better forecast? *practical use*

- Seasonal Forecast
- BSISO Forecast
- Climate Monitoring
- CLIK
- Data Service
- CLIPs

- Reliable forecast
- Reasonable interpretation
- Recognition of the value
- Actionable information
Weekly meeting based on BSISO index forecast

Verification

Moni.

Forecast

Meeting

Every Mon.
Better forecast from better understanding on BSISO

Weekly meeting based on BSISO index forecast

Before meeting:
- Construction of analysis system for BSISO related atmospheric status
- Searching climate issues and analyze them for previous week

Verification  Monitoring  Forecast

OBS fields estimated by BSISO index: 20170616

- (a) OLR & 850hPa Wind
- (b) PRCP
- (c) SLP & Moist. Flux & Moist. Conv.
- (d) T2M

B1: 1
B2: 6

T2M, SH, RH, MSLP, OLR, Z, OMEGA, U, V, SST, PRCP

from ERA interim, NCEP/DOE, NOAA, GPCP, APHRODITE
Better forecast from better understanding on BSISO

Weekly meeting based on BSISO index forecast

Before meeting:
- Construction of analysis system for BSISO related atmospheric status
- Searching climate issues and analyze them for previous week

Verification
Monitoring
Forecast

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from ERA interim, NCEP/DOE, NOAA, GPCP, APHRODITE
Better forecast from better understanding on BSISO

Weekly meeting based on BSISO index forecast

Before meeting
- Construction of analysis system for BSISO related atmospheric status
- Searching climate issues and analyze them for previous week

BSISO activity

Verification

8 June 2017 - 16 June 2017
Better forecast from better understanding on BSISO

Weekly meeting based on BSISO index forecast

Before meeting:
- Construction of analysis system for BSISO related atmospheric status
- Searching climate issues and analyze them for previous week

BSISO activity

BSISO effect

Probability of heavy rainfall determined by predicted BSISO

CLIMATE PREDICTION CENTER, NOAA
Conveyor generated contours
Based on preliminary data
Weekly meeting based on BSISO index forecast

Before meeting
- Construction of analysis system for BSISO related atmospheric status
- Searching climate issues and analyze them for previous week
Better forecast from better understanding on BSISO

Weekly meeting based on BSISO index forecast

Before meeting:
- Construction of analysis system for BSISO related atmospheric status
- Searching climate issues and analyze them for previous week

Monitoring

Asia monsoon region
Atmospheric circulation pattern

OBS fields estimated by BSISO index: 20170616
B1: 1
B2: 6

(a) OLR & 850hPa Wind
(b) PRCP
(c) SLP & Moist. Flux & Moist. Conv.
(d) T2M
Weekly meeting based on BSISO index forecast

Before meeting

- Construction of analysis system for BSISO related atmospheric status
- Searching climate issues and analyze them for previous week

- Southwest Monsoon Onset Monitoring (20180604)

Asia monsoon region

Atmospheric circulation pattern

India

Monsoon onset, heat wave

Possible Onset Date:

(5/29)
Before meeting:
- Construction of analysis system for BSISO related atmospheric status
- Searching climate issues and analyze them for previous week

Weekly meeting based on BSISO index forecast

**Asia monsoon region**
- Atmospheric circulation pattern

**India**
- Monsoon onset, heat wave

**S. Korea**
- Changma, heat wave

**OBS fields estimated by BSISO index:** 20160630

B1: 4
B2: 8
Better forecast from better understanding on BSISO

Weekly meeting based on BSISO index forecast

**Before meeting**
- Construction of analysis system for BSISO related atmospheric status
- Searching climate issues and analyze them for previous week

- Verification
- Monitoring
- Forecast
Weekly meeting based on BSISO index forecast

ECM fields estimated by BSISO index: 20170608(+0day)  B1: 5  B2: 8

Forecast
Better forecast from better understanding on BSISO

Weekly meeting based on BSISO index forecast

Before meeting
- Construction of analysis system for BSISO related atmospheric status
- Searching climate issues and analyze them for previous week

At meeting
- Discussion on verification for previous week, current status, and prospect BSISO activity and atmospheric condition for next two weeks
Monitoring
Forecast

At meeting: Discussion on verification for previous week, current status, and prospect BSISO activity and atmospheric condition for next two weeks

Verification
Monitoring
Forecast

Better forecast from better understanding on BSISO

Weekly meeting based on BSISO index forecast

Before meeting
: Construction of analysis system for BSISO related atmospheric status
   Searching climate issues and analyze them for previous week

At meeting
: Discussion on verification for previous week, current status, and prospect BSISO activity and atmospheric condition for next two weeks

After meeting
: Writing BSISO weekly bulletin
Better forecast from better understanding on BSISO

Extended forecast over Asia-monsoon region estimated by BSISO forecasts

Forming into the BSISO Weekly Bulletin (at the pilot stage for regular operation)

- Updated every Monday from May to Oct.

### Verification

- Period: 08 June – 16 June
- BSISO 1: nonactive
- BSISO 2: activated

### Monitoring

1. Indian monsoon area
   - Currently +IOD
   - BSISO and related large-scale systems
   - BSISO indices: Anomalous

### Forecast

1. ECMWF (J.C. 15 Jun)
   - BSISO1: P18→nonactive→P34
   - BSISO2: P4→nonactive

   **[S.Korea]**
   - L5=20: Long-term cold
   - L6=14: Short-term cold
   - L5→20: Cold
   - 500hPa: Cold
   - T850: Cold
   - 750hPa: Cold
Better forecast from better recognition of the value

Development of a guideline to increase practical use of BSISO forecast

Heavy rainfall forecast based on BSISO index forecast [ECMWF]

- Ex> Japan flood, 398mm/4hr, July 6, 2017

ISGPI forecast estimated by BSISO index forecast [ECMWF]

- Ex> Tropical Cyclone Mora-17, May 28, 2017

APEC Climate Center
Better forecast from better recognition of the value

Development of a guideline for heavy rainfall probability forecast over Mekong river basin

Probability table marked with favorable wind condition which can contribute strong Indo-China monsoon and bring heavy rainfall.
Better forecast by actionable information

**Heavy rainfall forecast**

<table>
<thead>
<tr>
<th>BOM</th>
<th>CFS</th>
<th>GFS</th>
<th>UKM</th>
<th>ECM</th>
<th>CWB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Probability of heavy rainfall determined by predicted BSISO

- **WEEK 1**
  - ECM: 19/06/2017

- **WEEK 2**

© APEC Climate Center

**BSISO forecasts**

**Flood Inundation Mapping**

- **High flood stage inundation map:**
  - Example hydrograph of a flood:
    - Inundation maps translate flood data into operational maps that communicate risk and the consequences of current and forecasted flooding.

- **Low flood stage inundation map:**
Interdisciplinary Research
APCC Activities

International Cooperation

✓ APCC’s S2S Training Program (1-week)
  • Every 2 years, APCC has trained about 20 participants from developing countries
  • 2014 : S2S to cope with high impact weather
  • 2016 : S2S to cope with extreme hydrological events
  • 2018 : APCC in the forefront of S2S Forecast
Summary

• APEC Climate Center (APCC) is a leading operational center providing seasonal forecast based on the Multi-Model Ensemble (MME) prediction system.

• APCC has produced real-time BSISO forecast using multi-models based on the international cooperation.

• The goal of APCC’s BSISO forecasting activity is to produce better forecast by promoting practical use of real-time BSISO information.
Summary

• Along with pursuing more reliable forecast, we’ve made an effort to improve our understanding on BSISO forecast and created user friendly information.

• In order to arouse the people to the worth of BSISO forecast, the possibility of BSISO application is estimated and which would be the cornerstone for making actionable information.

• APCC’s BSISO forecasting activity has become the origin of APCC’s S2S Training program that takes places every two years.