Operational centers or institutions sending their seasonal forecasts
Proabilistic

Multi-Model Probabilistic MME for Precipitation

Deterministic

Multi-Model Deterministic MME for Precipitation

Multi-Model Probabilistic MME for Air temperature at 850mb

Multi-Model Deterministic MME for Air temperature at 850mb
CliPAS supports APCC as a research component

1. Multi-model ensemble prediction
2. Dynamic subseasonal (intraseasonal) prediction
3. High-resolution modeling
1. Current Skill of MME system

- Tier-1 vs. Tier-2
- CliPAS vs. DEMETER
The Current Status of HFP Production

Two-Tier systems

Statistical-Dynamical SST prediction (SNU) -> AGCM

- FSU
  79-04, 2 seasons
- SNU/KMA
  79-02, 4 seasons
- ECHAM(UH)
  79-03, 2 seasons
- *NCEP
  81-04, 4 seasons

- GFDL
  79-04, 2 seasons
- CAM2 (UH)
  79-03, 4 seasons
- IAP
  79-04, 4 seasons

One-Tier systems

- CGCM
- NASA
  80-04, 2 seasons
- SNU
  80-02, 4 seasons
- UH Hybrid
  82-03, 2 seasons
- POAMA(BMRC)
  80-02, 4 seasons
- CFS (NCEP)
  81-04, 4 seasons
- SINTEX-F
  82-04, 4 seasons
- NCEP
  79-05, 4 seasons

* NCEP two-tier prediction was forced by CFS SST prediction
One-Tier vs Two-Tier / Climatology

Climatological Bias of Precipitation

 CliPAS/T2

CliPAS/T1

JJA

DJF

CliPAS/T2 – OBS

CliPAS/T1 – OBS

DEMETER

Climatological Bias of Precipitation

One-Tier MME Prediction vs. Two-Tier MME Prediction

Local SST skill vs. Monsoon Precipitation skill

Increased feedback from local surface SST

ENSO SST skill vs. Monsoon Precipitation skill

Improved ENSO teleconnection

Graphs showing correlation between ENSO SST skill and Monsoon PRCP skill for One-Tier MME and Two-Tier MME.
It is documented that the prediction skill of tier-1 systems is better than the tier-2 seasonal prediction system in boreal summer over both A-AM and ENSO regions in terms of pattern correlation skill and normalized RMS error.
Where radiative flux control the SST

1. Radiative flux would lead the SST anomalies
2. Temporal correlation between PRCP & SST can be a negative sign
Atmosphere forces the ocean where the correlation coefficients between rainfall and SST show negative.
CliPAS vs DEMETER MME Prediction

A-AM Region

(a) A-AM Region

ENSO Region

(b) ENSO Region
Multi-Model Ensemble (MME)

Optimal Selection of a Subgroup of Models

Example: East Asian Domain [105-145E, 20-45N]
The best MME skill is obtained using 4 models.
MME1

\[ P = \frac{1}{M} \sum_i F_i \]

- Simple composite
- Equal weighting

MME2

\[ P = \sum_i a_i F_i \]

- Super ensemble
- Weighted ensemble using SVD

MME3

\[ P = \frac{1}{M} \sum_i \hat{F}_i \]

- Corrected Ensemble
- Simple Composite after Applying SPPM

MME3.1

\[ P = \frac{1}{M} \sum_i \hat{F}_i \]

- Corrected Ensemble
- Simple composite after Applying SPPM with criterion
Correlation Skill of MMEs using 15 models

Number of Selected model for MME3.1
2. High resolution modeling

Tropical cyclone and MJO
**Tropical cyclone activity simulation project**

**Participant institutes**
- NASA/GSFC
- GFDL
- NCEP
- Seoul National University
- COLA
- Tokyo University
- FSU
- FRCGC
- BMRC
- ECMWF

**Subject**
- 1997/1999
- 2004/2005
- Tropical cyclone simulation
- MJO/ISO impact on tropical cyclone

**Requirement**
- 0.5 degree resolution or better

**CLIVAR project**

Leaded by Siegfried D. Schubert (NASA/GSFC) & In-Sik Kang (SNU)
Endorsed by CLIVAR/AA Monsoon Panel

---

**Tropical cyclone activity simulation project**

<table>
<thead>
<tr>
<th>Participant institutes</th>
<th>Subject</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA/GSFC</td>
<td></td>
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<td>GFDL</td>
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<td>NCEP</td>
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<td>Seoul National University</td>
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<td>COLA</td>
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<td>Tokyo University</td>
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<td>FSU</td>
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<td>FRCGC</td>
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<td>BMRC</td>
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<tr>
<td>ECMWF</td>
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</table>

**20km resolution model simulation (6 ensembles)**

<table>
<thead>
<tr>
<th>SST</th>
<th>Period</th>
<th>Some Interesting Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>May 15- Nov 30</td>
<td>La Nina conditions</td>
</tr>
<tr>
<td>1997</td>
<td>May 15 – Nov 30</td>
<td>El Nino conditions</td>
</tr>
</tbody>
</table>

**Some Interesting Events**

- **Period**: May 15 – Nov 30
- **SST**: 1997
- **SST**: 1999
- **CLIVAR project**
- **Endorsed by CLIVAR/AA Monsoon Panel**
- **Lead by**: Siegfried D. Schubert (NASA/GSFC) & In-Sik Kang (SNU)
High resolution modeling

June 1999 – 20km resolution

Satellite observation
Time: 06Z JUN 12 1999

Comparison between observation, finite volume and spectral AGCM
High resolution modeling

Climatology
Precipitation
MJO Propagation

- 200hPa velocity potential (1999)

The FIRST Ensemble case

The FIRST Ensemble case

200hPa velocity potential (1999)

The FIRST Ensemble case
200hPa velocity potential (1999)

ENSEMBLES in 20km High resolution!
Using quasi-geostrophic approximation,

\[
\frac{\partial \bar{Z}}{\partial t} = -\frac{f}{g} \nabla^{-2} [\nabla \cdot (\bar{V}' \zeta')]
\]

Transient eddy forcing
1997 DJF

Using 2~8 day filtered 200hPa u-wind (u') / v-wind (v')
a) Precipitation
b) Wind speed
c) Radial velocity
d) Tangential velocity
e) q anomaly
f) Temp. anomaly
High resolution modeling - Tropical Cyclone

Typhoon Genesis

<table>
<thead>
<tr>
<th>Year</th>
<th>OBS</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>145.82</td>
<td>156.3</td>
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<tr>
<td>1999</td>
<td>135.41</td>
<td>144.55</td>
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<tr>
<td>Diff. (1997-1999)</td>
<td>10.41</td>
<td>11.75</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>OBS</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>12.57</td>
<td>11.08</td>
</tr>
<tr>
<td>1999</td>
<td>18.46</td>
<td>16.17</td>
</tr>
<tr>
<td>Diff. (1997-1999)</td>
<td>-5.89</td>
<td>-5.09</td>
</tr>
</tbody>
</table>

- All of typhoons simulated by 6 ensembles
- 1997 Observation (Tokyo-Typhoon center)
- 1999 Observation (Tokyo-Typhoon center)
Mean Location of Typhoon Genesis

1997
- Each ensemble
- 6-Member Ensemble mean
- Observation (Tokyo-Typhoon center)

1999
- Each ensemble
- Ensemble mean
- Observation (Tokyo-Typhoon center)

Typhoon Genesis
High resolution modeling - Tropical Cyclone

Typhoon Passage Frequency

OBS

1997 observation (RSMC)

1997 model

20km GCM

1997

1999 observation (RSMC)

1999 model

1999
High resolution modeling - coupled model

ERSST

30km

SST

TRMM

30km

PRCP
Thank you!
## Model Descriptions of CliPAS System

### APCC/CliPAS Tier-1 Models

<table>
<thead>
<tr>
<th>Institute</th>
<th>AGCM</th>
<th>Resolution</th>
<th>OGCM</th>
<th>Resolution</th>
<th>Ensemble Member</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMRC</td>
<td>BAM3d 3.0d</td>
<td>T47L17</td>
<td>ACOM2</td>
<td>0.5-1.5° lat x 2° lon L25</td>
<td>10</td>
<td>Zhong et al., 2005</td>
</tr>
<tr>
<td>FRCGC</td>
<td>ECHAM4</td>
<td>T106 L19</td>
<td>OPA 8.2</td>
<td>2° cos(lat)x2° lon L31</td>
<td>9</td>
<td>Luo et al. (2005)</td>
</tr>
<tr>
<td>GFDL</td>
<td>AM2.1</td>
<td>2° lat x 2.5° lon L24</td>
<td>MOM4</td>
<td>1/3° lat x 1° lon L50</td>
<td>10</td>
<td>Delworth et al. (2006)</td>
</tr>
<tr>
<td>NASA</td>
<td>NSIPP1</td>
<td>2° lat x 2.5° lon L34</td>
<td>Poseidon V4</td>
<td>1/3° lat x 5/8° lon L27</td>
<td>3</td>
<td>Vintzileos et al. (2005)</td>
</tr>
<tr>
<td>NCEP</td>
<td>GFS</td>
<td>T62 L64</td>
<td>MOM3</td>
<td>1/3° lat x 1° lon L40</td>
<td>15</td>
<td>Saha et al. (2005)</td>
</tr>
<tr>
<td>SNU</td>
<td>SNU</td>
<td>T42 L21</td>
<td>MOM2.2</td>
<td>1/3° lat x 1° lon L32</td>
<td>6</td>
<td>Kug et al. (2005)</td>
</tr>
<tr>
<td>UH</td>
<td>ECHAM4</td>
<td>T31 L19</td>
<td>UH Ocean</td>
<td>1° lat x 2° lon L2</td>
<td>10</td>
<td>Fu and Wang (2001)</td>
</tr>
</tbody>
</table>

### APCC/CliPAS Tier-2 Models

<table>
<thead>
<tr>
<th>Institute</th>
<th>AGCM</th>
<th>Resolution</th>
<th>Ensemble Member</th>
<th>SST BC</th>
<th>Reference</th>
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</thead>
<tbody>
<tr>
<td>GFDL</td>
<td>AM2</td>
<td>2° lat x 2.5° lon L24</td>
<td>10</td>
<td>SNU SST forecast</td>
<td>Anderson et al. (2004)</td>
</tr>
<tr>
<td>IAP</td>
<td>LASG</td>
<td>2.8° lat x 2.8° lon L26</td>
<td>6</td>
<td>SNU SST forecast</td>
<td>Wang et al. (2004)</td>
</tr>
<tr>
<td>NCEP</td>
<td>GFS</td>
<td>T62 L64</td>
<td>15</td>
<td>CFS SST forecast</td>
<td>Kanamitsu et al. (2002)</td>
</tr>
<tr>
<td>SNU/KMA</td>
<td>GCPS</td>
<td>T63 L21</td>
<td>6</td>
<td>SNU SST forecast</td>
<td>Kang et al. (2004)</td>
</tr>
<tr>
<td>UH</td>
<td>CAM2</td>
<td>T42 L26</td>
<td>10</td>
<td>SNU SST forecast</td>
<td>Liu et al. (2005)</td>
</tr>
<tr>
<td>UH</td>
<td>ECHAM4</td>
<td>T31 L19</td>
<td>10</td>
<td>SNU SST forecast</td>
<td>Roeckner et al. (1996)</td>
</tr>
</tbody>
</table>
First Step: Prior prediction selection
- Select qualified predictor grid based on correlation for training period of cross validation
- Gather split predictors and regard as a predictor pattern

Second Step: Pattern Projection
- Construct covariance pattern between observation and reconstructed model pattern
- Obtain prediction by projecting model pattern on the covariance pattern

\[ X_p(t) = \sigma_Y \sum_{i,j} \frac{\text{COV}(i,j) \cdot X(i,j,t)}{\sigma_X^2(i,j)} \]

Third Step: Optimal choice of prediction
- Judge whether the predictand is predictable at each grid point using double cross-validation with the threshold correlation of 0.3. If the prediction skill of double cross validation with the selected predictor pattern is not exceed the threshold value, we give up prediction at the grid point.

2. Simple multi-model composite using available predictions