The Climate Service Based on Climate Observation in China

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BCC’s Mission

- **Monitor** and diagnose global atmospheric and oceanic conditions, as well as extreme climate events, especially in East Asia
- **Issue global climate predictions and impact assessments** at monthly, seasonal and inter-annual time scales, particularly in East Asia
- **Implement climate service in China**
- **Research** on climate and climate change issues (e.g. China IPCC & UNFCCC technical support)
The Role of BCC

National Climate Centre (NCC, 1995)

WMO Regional Climate Centre in RA II (RCC, 2009)

Global Producing Centre for long-range forecast (GPC, 2006)

Center for Extreme Events Monitoring in Asia (CEEMA, 2010)

East Asian Monsoon Activity Centre (EAMAC, 2006)
China Framework of climate service (CFCS)

Decision Makers
Public Community
Climate-sensitive Sectors

Agriculture
Hydrology
Energy

Two-way Information Sharing
User training & Feedback
User interface Plan
and Partnership
Jointly-issuing Risk Warning
Tailored Services & Products

Climate Security
Climate Impact
Climate Capacity
Climate Resource
Climate Proofing

Disaster Survey
Vulnerability
Risk Warning
Risk Transfer

Climate Monitoring
Climate Prediction
Climate system models

Database

GCOS CCOS
Outline

- Climate Service in China
- Challenges between Service and Observation
- Future Observation Needs
What We Do

Climate Monitoring for Global and National Scale (such as temperature and precipitation)
Tropical Convection, Snow Cover

OLR

MJO

MJO phase [RMM1, RMM2]

Season (T639+FYB): 2015-11 to 2016-01

Forecast: 2015-12 to 2016-01

Phase 7 (Western Pacific) Phase 6

Phase 1 (Western Hem, Africa) Phase 8

Phase 2 (Indian Ocean) Phase 3

Snow Cover Area

(a) Northern Hemisphere

(b) Europe

(c) North America

Snow Days

Daily Change of Snow Cover

Climate Monitoring Division/NCC/CMA
Sea Ice

Sea Ice Concentration in the Northern and Southern Hemisphere

Sea Ice Area

Sea Ice Area in China

Climate Monitoring Division/NCC/CMA
Vegetation Cover, Climate Impact Assessment

The monthly and annual change of vegetation index

Drought Comprehensive Monitor

Drought Influence Areas
Weather and Climate Events  Warning and Assessment

Extreme Events in the World

Extreme Events in China

Disaster Risk Assessment and Early Warning

<table>
<thead>
<tr>
<th>Site</th>
<th>Estimated depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muzheng</td>
<td>1.2</td>
</tr>
<tr>
<td>Rongche ng</td>
<td>0.7</td>
</tr>
<tr>
<td>Dingqiao</td>
<td>1.1</td>
</tr>
<tr>
<td>Maotan</td>
<td>0.3</td>
</tr>
<tr>
<td>Xinqiao</td>
<td>0.6</td>
</tr>
</tbody>
</table>
Priority of FY satellite data

- Good real-time
- More detailed feature description for the variables

The FY-3B global OLR product (left) and NOAA-18 product (right) on 11-15 Dec (unit: w/m²)

The spatial resolution of FY is 0.5° × 0.5°, the download data of NOAA data is 2.5° × 2.5°
Good quality of some products

The global ozone distribution image of FY-3A/TOU(a), AURA/OMI(b), METOP/GOME-2(c), 21 March 2009

Spatial distribution similarity

Comparison of total ozone and ground observation results for FY-3/TOU and AURA/OMI in Aug-Dev. 2008
(a) LINDENBERG site (52.210° N, 14.120° E); (b) Xianghe Site (39.975° N, 116.37° E)

Consistent with the actual observation (W. H. Wang, 2010)
Develop the Climate System Models

- TCC
- Hadley
- IAP
- NCEP

China Multi-models Ensemble

- Extended term prediction
- Monthly prediction
- Seasonal, yearly prediction
- Decadal prediction
- Climate change projection
- Climate assessment

Global Climate Phenomenon Prediction & Application System (GCPPAS)

Improve physical process and model resolution
12 models among 18 coupling models in the CMIP5 can better simulate the variation characteristics of sea surface and subsurface anti-phase of the Atlantic sea surface temperature. BCC_CSM1 is one of 12 models.
Beijing Observation Site (54511)
The station underwent 10 times of relocations in the past 100 years, unfortunately it is still surrounded by the buildings

(Ren et al., 2015)

How to reflect the real fact of climate change?

The deviation of urbanization of annual average surface temperature in China between 1961-2008 (Ren et al., 2015)
FY-3C products are cold SST deviation of 1°C in the equatorial Pacific

Warm bias 1°C ~1.5°C in high latitude and polar sea
Time series of two sets of sea ice products (HadISST and OISST) are longer and good consistency except between 1999 and 2009. However, they are low spatial resolution.

The spatial resolution of FY and NSIDC sea ice product is moderate, and the timing process is also relatively clear. They can be used to study the sea ice in the key areas of the Arctic.

(Y. Y. Ren, 2015)
The large cold bias of FY-3C SST in the East Pacific, North American coast

- The FY-3C SST data bias is not stable, the maximum deviation is about 1°C.
- Except the Nino1.2 area, the average temperature of the other 3 sea areas is lower than the Reynolds observations.
- The inversion accuracy of FY-3C infrared sea surface temperature products need to be further improved.
Based on FY LST data, develop the land surface assimilation test system.
After the assimilation of FY3 data, the correlation coefficient of the surface soil moisture improved, and the RMSE reduced by about 25%;

The scattered points of soil moisture are more consistent with the GLDAS, and more evenly distributed around the diagonal;

Compared to GLDAS, the humidity of BCC_AVIM model is apparently larger. After the assimilation of FY3 data, the systematic deviation of the soil moisture eliminated, and the PDF bias shows a better normal distribution.
The big challenge for renewable energy

By 2050, 2.4 billion kW of wind power and 2.7 billion kW of solar power will be installed, which accounts for 64% of China's total power generation.

The wind and solar resources distribution with high spatial and temporal resolution is essential to the planning of energy storage and power dispatching.
Wind Energy Resource Assessment System

- Meteorological Observation Data
  - 30 years, 10950 days

- Typical Day Choosing Scheme
  - Classification
  - Wind and Climate
  - GIS Analysis
  - for exploitable wind resources

- Statistical Analysis
- Output of Global Spectral Model
- Meteorological Observation Data

- Mesoscale Model + Dynamic Diagnosis
- Weather Class 1
- Weather Class 2
- Weather Class 3
- Weather Class 256

- Y = \sum_{i=1}^{n} Y_i
- Simulating of 24 hours for Y days in total

- Hourly output of 1st day
- Hourly output of 2nd day
- Hourly output of 3rd day
- Hourly output of 4th day
- ...
The wind distribution at height of 80m, 100m and 120m represent the exploitable wind resources in present, near future and 2050, respectively.

The higher the height, the more wind power potential in inland. Although the wind map has high spatial resolution of 1km*1km, it is just an average result, no temporal variation.
The Gaps Still Remain…

- The rare global atmospheric observation in some areas. Oceanic observation is incomplete. The data availability is not timely;
- In view of user-oriented climate service, the quality of high spatial resolution data is insufficient;
- The quantitative application of satellite data is obviously insufficient; (FY satellite data is short time series and can not reach the application accuracy. The application of EU and US satellites products is restricted by the network transmission and data sources)
- Lack of integration application of social economic data and observation data
Future Needs

Application of multi source satellite data in climate impact assessment

➢ To carry out the application of vegetation growth monitoring and assessment in the climate impact assessment;

➢ Based on the comparison and analysis of satellite drought monitoring products and meteorological drought monitoring products, the application of satellite remote sensing products in comprehensive drought evaluation should be carried out and improved;

➢ To carry out the long time series operation of water characteristics monitoring.
## Observation Data of Ocean General Circulation Model

<table>
<thead>
<tr>
<th>Name</th>
<th>Horizontal Resolution</th>
<th>Vertical Resolution</th>
<th>Time Resolution</th>
<th>Period</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>WOA09</td>
<td>1°, 5°</td>
<td>0-1500m</td>
<td>monthly</td>
<td>Climate state</td>
<td>temperature, salinity, dissolved oxygen</td>
</tr>
<tr>
<td>WOA09</td>
<td>1°, 5°</td>
<td>0-500m</td>
<td>monthly</td>
<td>Climate state</td>
<td>silicate, phosphate, nitrate</td>
</tr>
<tr>
<td>WOCE</td>
<td>0.5°</td>
<td>0-6000m</td>
<td>monthly</td>
<td>Climate state</td>
<td>temperature, salinity, oxygen content, silicate, phosphate, nitrate</td>
</tr>
<tr>
<td>Argo</td>
<td>1°</td>
<td>0-5000m</td>
<td>monthly</td>
<td>2004-</td>
<td>temperature, salinity</td>
</tr>
<tr>
<td>OISST</td>
<td>0.25°</td>
<td>Sea surface</td>
<td>monthly</td>
<td>2002-</td>
<td>sea surface temperature</td>
</tr>
</tbody>
</table>

### The need of high resolution ocean model:
- **Horizontal resolution**: LASG/IAP 1/10°, BCC 1/6°, observation 1/4°
- **Vertical resolution**: surface and subsurface by in-situ and satellite, lack of long time deep ocean data
- **Variable**: Velocity observation should be strengthen
- **Time**: daily cycle simulation requires the high frequency observation data of the daily time scale.

### The need of simulation of marine biogeochemical processes:
Add more observation variables, e.g. chlorophyll, nitrite, pH, total alkalinity, phytoplankton, zooplankton, ammonia, total phosphorus, total nitrogen, total dissolved inorganic carbon, dissolved organic, etc.
Future model prediction system

Coordinate Initialization

NCEP R1 (re-forecast)  NCEP FNL (real-forecast)  BCC GODAS (Ocean state)  BCC Precip

Data Preprocessing Module (interpolation, initial fields, restoring fields)

ATM (NCEP R1/FNL: U, V, Ps, T)  CPL (NCEP sfc flux; BCC Precip)  OCN (BCC GODAS2: T, S)

LND  ICE

Mem1 GMT00  Mem2 GMT06  Mem3 GMT12  Mem4 GMT18

Running BCC-CSM2-MR

Data Postprocessing Module (interpolation, netcdf to grib, grib formation, result check)

S2S prediction system
The Demand for Data Assimilation (FY satellite)

- **Oceanic Assimilation:** Improve the accuracy of the satellite product; Develop the inversion algorithm on key oceanic domain; Increase satellite data products, e.g. sea surface Altimetry Data, sea surface wind velocity.

- **Land Assimilation:** Provide quality information and basic parameter information with products; Improve product precision; Increase satellite data products.

- **Sea ice initialization:** Increase the sea ice observations, e.g. sea ice extent, etc.
Assessment for Model

- Add the observation data: deep soil temperature and humidity, ground downward radiation flux, earth biochemistry process, e.g. aerosol, the distribution of atmospheric chemistry, the distribution of ecological factors;
- Improving the matching of the observed data in the distribution, accuracy and other aspects;
- Adjust the obvious difference between different data, e.g. precipitation between CMAP and GPCP, cloud and radiation.
Demand: The wind and solar resources observation data with high horizontal and temporal resolution, as well as energy consumption data.

We are working on the combination of the wind map in 1km*1km resolution by selective modelling and the sequential simulation in 15km*15km resolution to set up the data base of wind resources with high horizontal resolution of 1km*1km, high temporal resolution of 1 hour and the time period from 1995 to 2014.
Summary

- Improve in situ observation gaps in many land areas of Africa and Southern America;
- Consider the site selection representative balance of comprehensive and regional climate change research and adaptation;
- Make full use of satellite data, strengthen the construction of information evaluation and standardization;
- Strengthen the observation on natural-physical and social-economic system.
Thank you