The JMA operational seasonal forecast system and applications

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Outline

1. The JMA operational Seasonal Ensemble Prediction System (EPS)

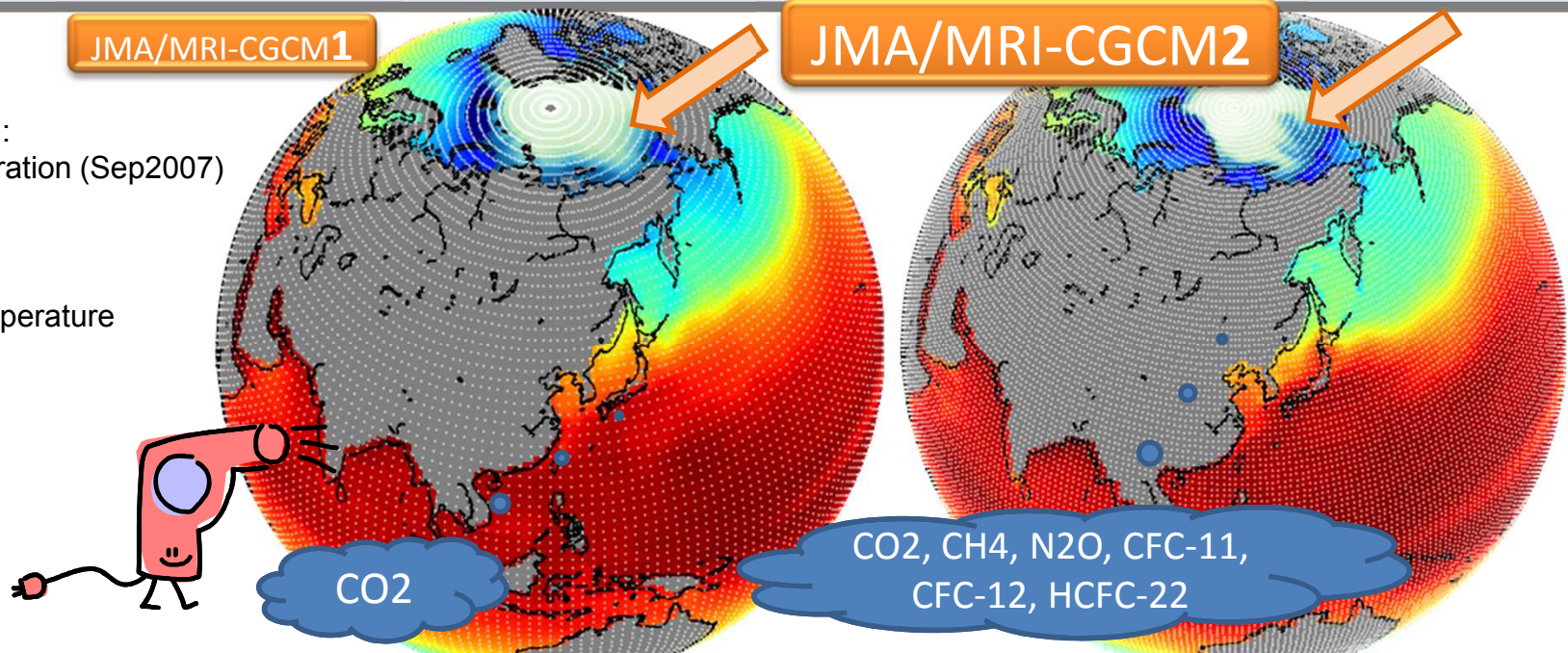2. "**ITACS**" : The *I*nteractive *T*ool for *A*nalysis of the *C*limate *S*ystem

Current and *Next version* of the JMA operational Seasonal EPS

JMA/MRI-CGCM**1**

JMA/MRI-CGCM**2**

white-blue shades :
    sea ice concentration (Sep2007)
white dots :
    AGCM grids
rainbow shades :
    sea surface temperature

CO2

CO2, CH4, N2O, CFC-11, CFC-12, HCFC-22

	JMA/MRI-CGCM1 (Feb. 2010 -)	*JMA/MRI-CGCM2 (Feb. 2015? -)*
Atmosphere (JMA –AGCM)	*TL95L40*, ~180km, Up to *0.4hPa*	*TL159L60* , ~110km, Up to *0.1hPa* Stochastic Tendency Perturbation *GHG forcing* in the IPCC RCP4.5 scenario
Ocean (MRI.COM : Usui et al 2006, Tsujino et al 2010)	1.0º (lon) x 0.3-1º (lat) L50 *Sea-ice climatology*	1.0º (lon) x 0.5º (lat), tripolar, L52 *Sea-ice dynamics*
Coupler (Scup : Yoshimura and Yukimoto 2008)	1-hour coupling interval *Momentum and heat flux adjustment*	1-hour coupling interval *No flux adjustment applied*

Asian Summer Monsoon

Observation (GPCP)

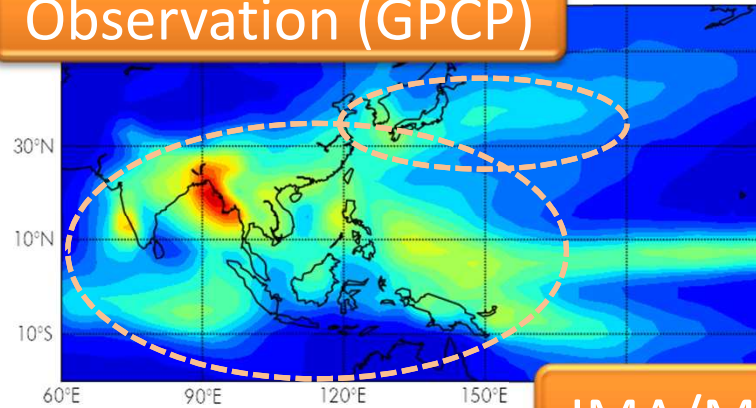JMA/MRI-CGCM1 [JJA, 1996-2009]

JMA/MRI-CGCM2

Fig . Summertime (JJA) daily precipitation
climatology for 1996-2009 (mm/day)
(a)GPCP(Adler et al 2003)
(b)JMA/MRI-CGCM1
(c)JMA/MRI-CGCM2
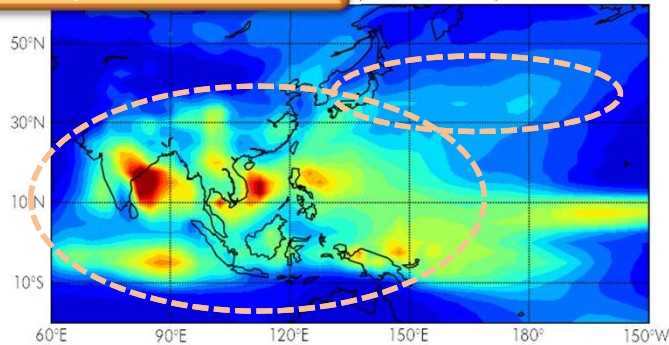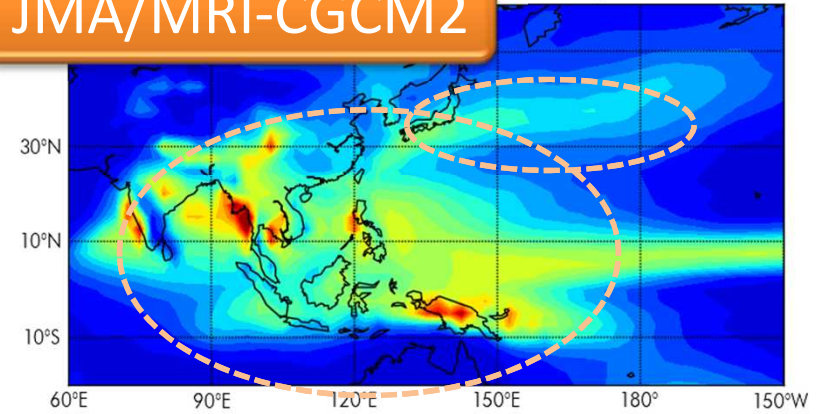(Forecast initial date :
1May)
[mm/day]

➢ Improved representation of the Asian summer monsoon

➢ Higher horizontal resolution in AGCM

    ➢ Seasonal typhoon forecast

Sea ice model

☐ The sea ice model reasonably reproduces mean distribution of sea ice edges and year-to-year variability of sea ice area in the Arctic.

☐ The forecast skill is greater when initiated in the melting season and verified for the growing season (e.g. Chevallier and Salas-Melia 2012).

☐ The major source of forecast skill comes from the long-term decrease of sea ice area.

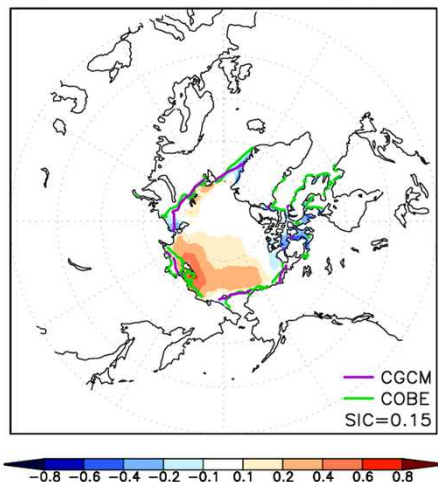☐ This partly explains the model's improved representation of the linear warming trend in 2m temperatures in the Arctic.

Fig . Mean positions of sea ice edge (15% level of SIC) in September at lead time of 5 months in the model (purple line) and in the analysis (green line, COBE-SST(Ishii et al. 2005)), and mean error of sea ice concentrartion(shades).
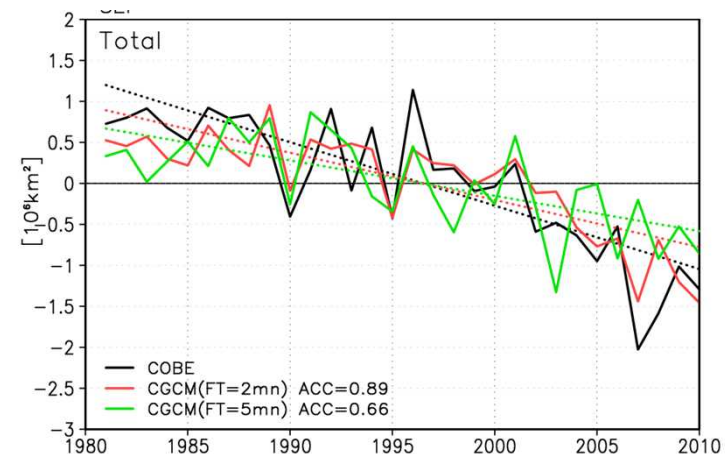
Fig . Analysed (black) and forecasted anomalies of sea ice extent (solid line) in September at lead times of 2 (red) and 5 months (green) and their trends (left, dash line).
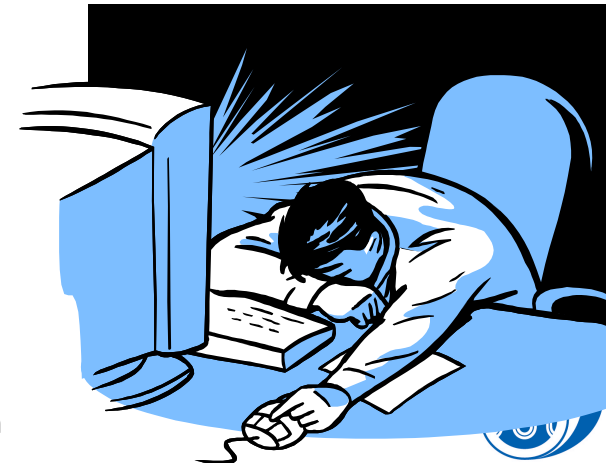
We need an analysis tool that …

More and more components are being incorporated in climate models (sea ice, stratosphere, aerosols), enabling recent progress in operational forecast.

But still,

➢ model outputs need to be checked/corrected before used, based on :

   ➢ model bias and forecast skill

      ➢ estimated with the long-term *hindcasts.*

In checking these, an analysis tool would help which

➢ is easy enough for operational use

➢ includes ready-to-use datasets .

   ➢ observation/analys + forecast/hindcast

"**ITACS**" : The *I*nteractive *T*ool for *A*nalysis of the *C*limate *S*ystem

Server

response →

← request

Client
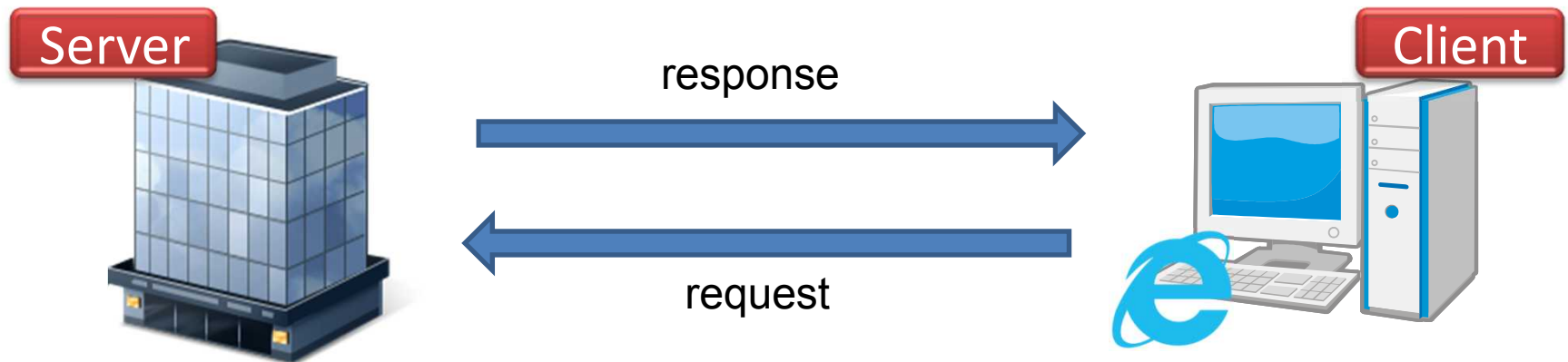
data, analysis software, graphic software

- ➤ *A web-based data analyzer & visualizer*
- ➤ Various datasets ready
- ➤ Results shareable via a URL
- ➤ Legacy Fortran/C codes + Ruby + JavaScript + GrADS
- ➤ Open to *domestic researchers* and *NMHSs* since 2009
  - ➤ 100+ users from 37 countries

User Interface

14th workshop on meteorological operational systems, S. Hirahara
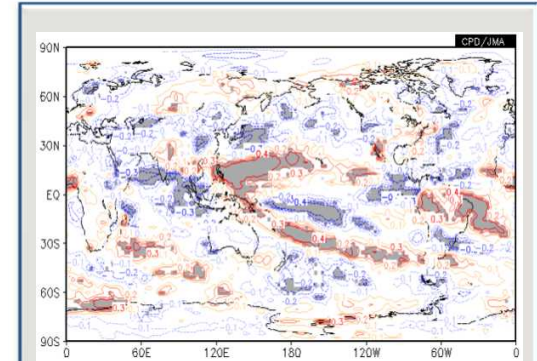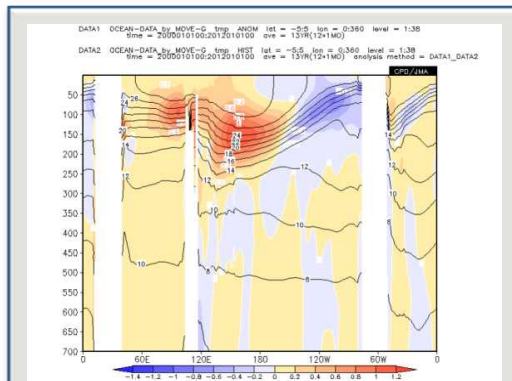
Examples

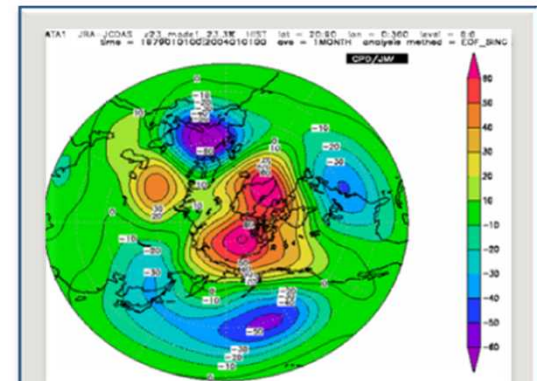Wave Activity Flux at 200hPa in DJF 2011-2012
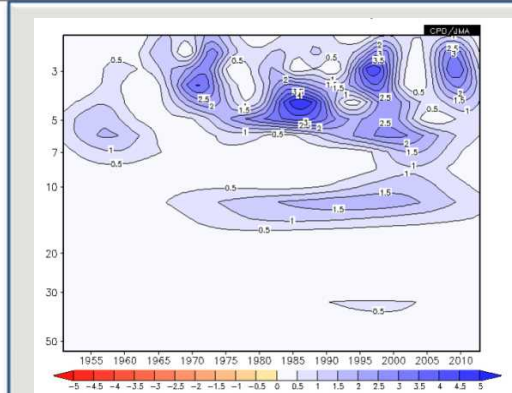
Wavelet Analysis on
NINO 3.4 index

Regression Analysis between OLR and NINO.3 index with six months lag

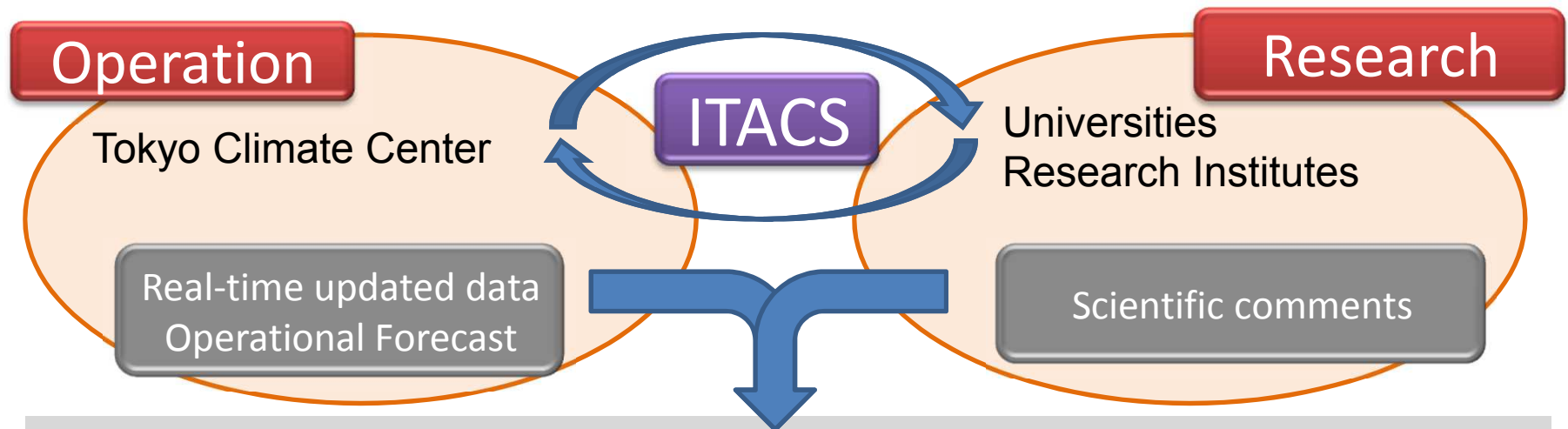Composite map of ocean subsurface temperature in recent years (2000-)

EOF Analysis on 500hPa Height in Jan.

Operation - Research
in climate monitoring

The Advisory Panel on Extreme Climate Events (since 2007-)

Operation

Tokyo Climate Center

ITACS

Research

Universities
Research Institutes

Real-time updated data
Operational Forecast

Scientific comments

➤ *Quick, coordinated analysis on the ongoing extreme climate event*
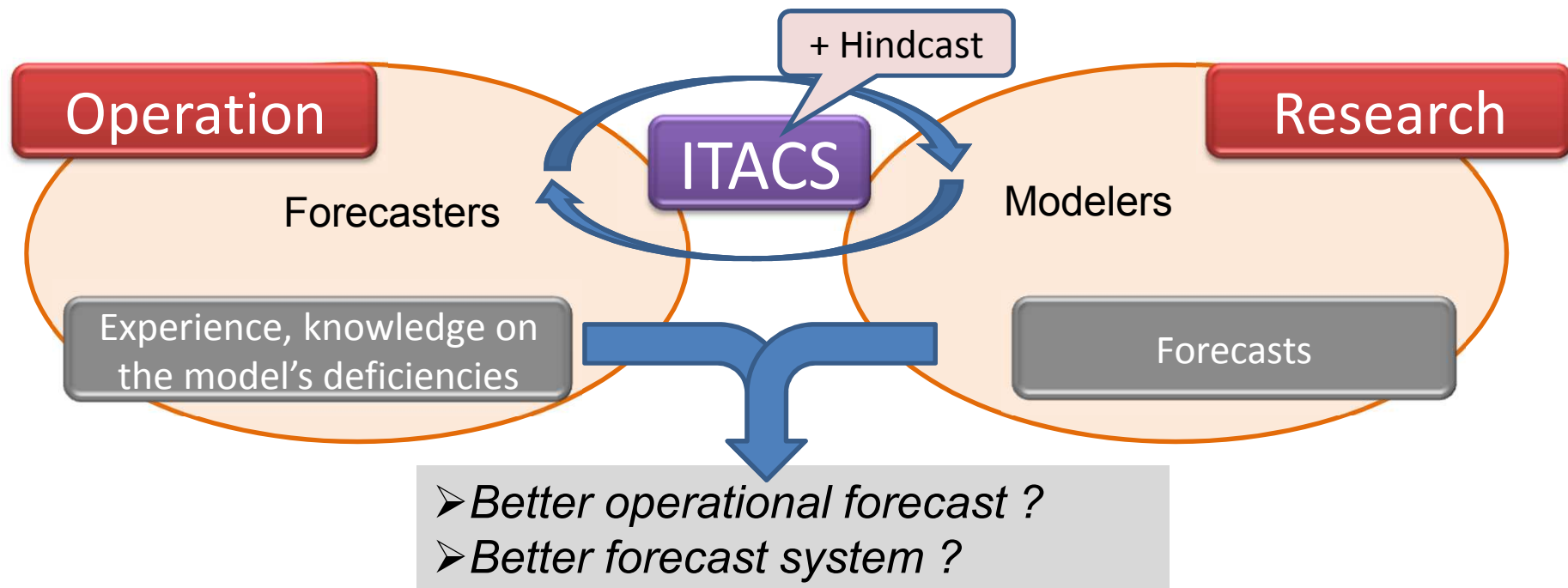➤ *Outlook for the event based on the latest operational forecast*

➤The common infrastructure (a data server, analysis tools, and a simple user-interface) has played a big role in this framework.
➤"what kind of physical processes made the forecast good/bad for this event?"

Extremely cold winter in the East Asia (DJF 2011-2012)
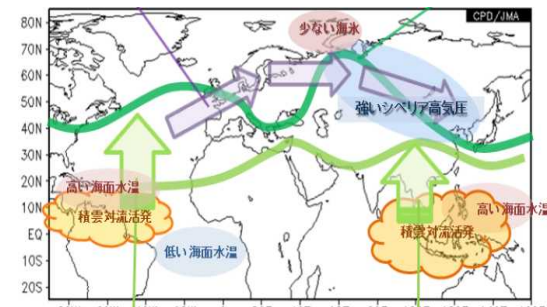
Operation to Research
in seasonal forecasting

ITACS is currently used when forecasters want to know statistical estimation based on observation/analysis to understand the accuracy of their forecasts.

A technical infrastructure is desirable, that provides a more casual way to do analysis with observation/analysis and forecast/hindcasts to *share knowledge* on a model we use.

Next ITACS will include decades of *hindcasts* to improve the forecast system.

Summary

- The JMA seasonal EPS is to be upgraded in early 2015.
- ITACS will be upgraded soon to *include the hindcasts* for the current operational model.

- This kind of tools has been revealed to be useful in operational climate monitoring and forecasting.
- One way of boosting up operation-research cycle is *a handy tool* and *easy access to observation/analysis and* *forecast* *including* *hindcast*.

Thank you for your attention

愛託す (ITACS brings you love)

Acknowledgement :
GrADS is kindly provided as an open source software by
the Center for Ocean-Land-Atmosphere Studies (COLA), USA.

Available Datasets

➢ **CLIMAT** reports (stored at JMA since 1982)

➢ Atmospheric reanalysis , **JRA-25** (Onogi et al. 2007)

➢ Sea Surface Temperature, **COBE-SST** (Ishii et al. 2005)

➢ Ocean reanalysis, **MOVE** (Usui et al. 2006)

➢ The NOAA Interpolated **Outgoing Longwave Radiation** (Liebmann and Smith 1996)

➢ **Arbitrary time series** submitted online by users

➢ Ensemble forecasts of the JMA **One-Month EPS (ens. mean only)**

- Staratocumulus (Wood and Bretherton 2006)
- Cloud overwrap (Nagasawa, 2013)
- Sub-cloud model (Jacob and Siebesma 2003)
- Second-order moment advection (Prather 1986)
- Skin SST (Takaya et al 2010) etc.
- *Sea ice (Smolarkiewicz 1984; Hunke and Lipscomb 2006)*
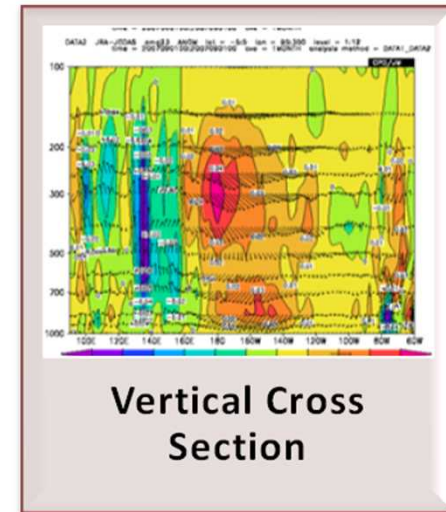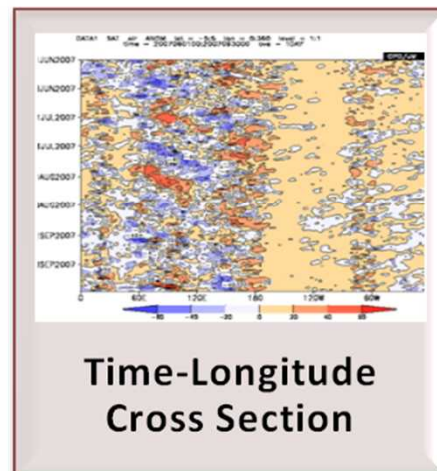- Stochastic Tendency Perturbation : Palmer et al 2009
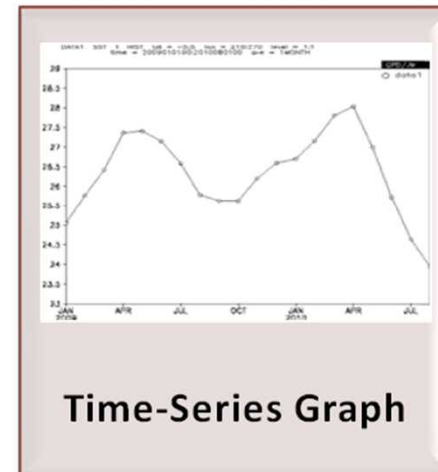
Examples
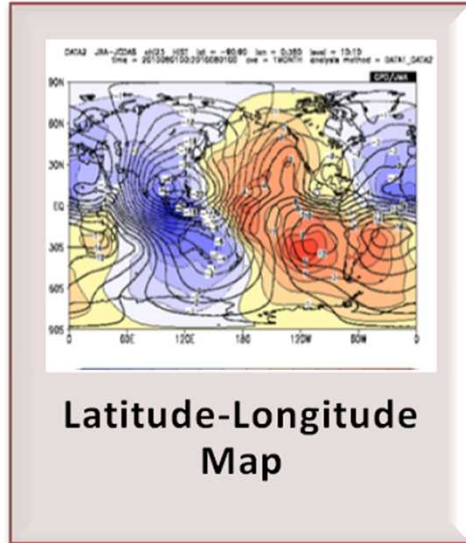
Latitude-Longitude Map
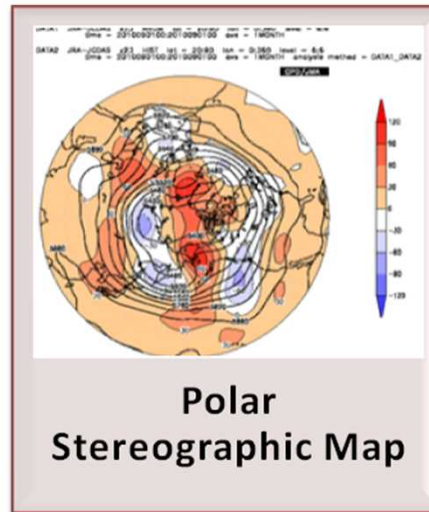
Polar Stereographic Map

Vertical Cross Section

Time-Longitude Cross Section

Time-Series Graph

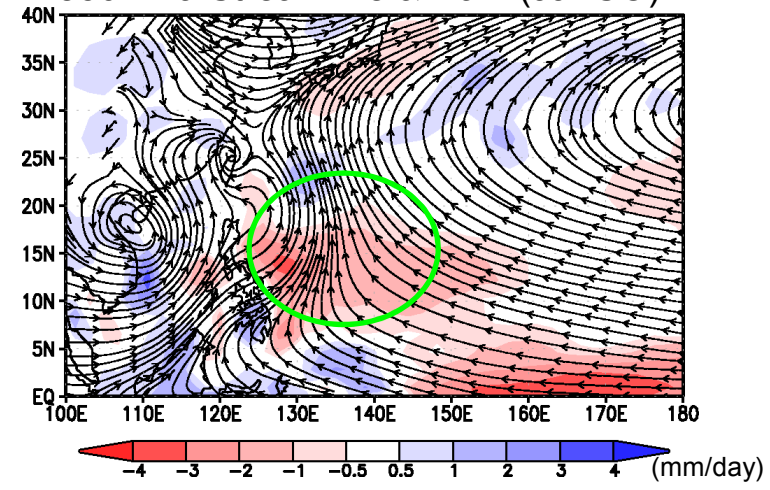# Typhoon Forecast : 1998

Analysis
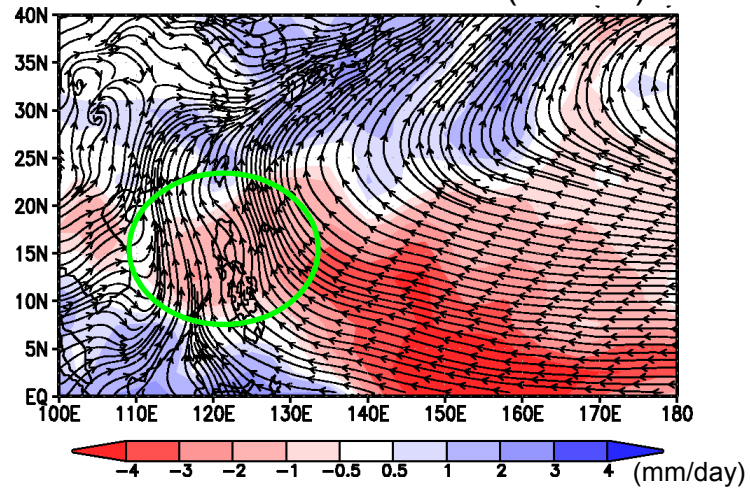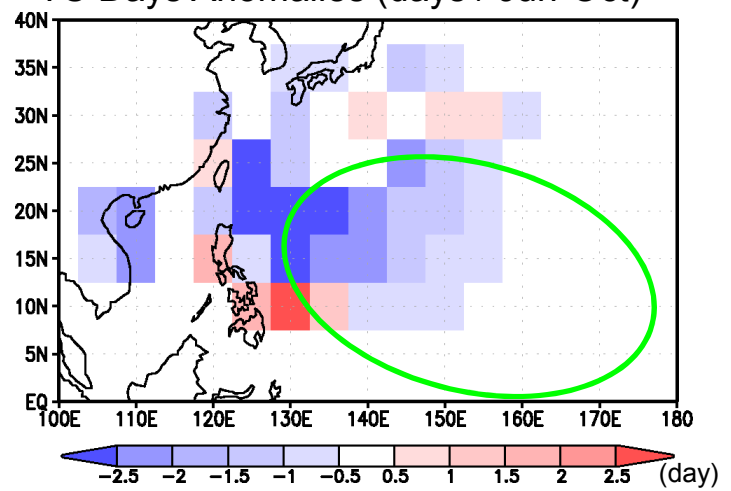
Forecast (ensemble)
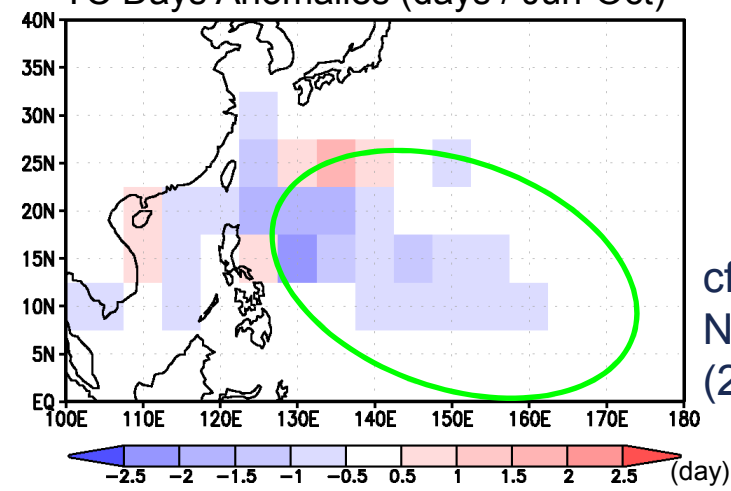
850-hPa Streamline & Rain (JJASO)

850-hPa Streamline & Rain (JJASO)

TC Days Anomalies (days / Jun-Oct)

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cf.) Nakazawa (2001)