A Dynamical Approach in Forecasting Annual Rainfall of Hong Kong

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Annual Rainfall Forecast for HK (tercile category)

- Provided to the public since 2001
- Director of HKO to communicate the forecast to the media at the annual press event (March)
- Pre-2009 methodology based on a conceptual model (HKO Tech. Note 104)
- Climate factors: ENSO status, strength of preceding winter monsoon

The HKO Conceptual Model

- sE0 and E1 years tended to be wet
- L1 years tended to be normal
- No ENSO signal (NE):
- Weak preceding winter monsoon – wet year
- Strong preceding winter monsoon – dry year

Estimate ENSO prob. from SST forecast (IRI)

$$\begin{pmatrix} P(BN) \\ P(NN) \\ P(AN) \end{pmatrix} = \begin{pmatrix} P(BN|sE0) & P(BN|E1) & P(BN|L1) & P(BN|NE) \\ P(NN|sE0) & P(NN|E1) & P(NN|L1) & P(NN|NE) \\ P(AN|sE0) & P(AN|E1) & P(AN|L1) & P(AN|NE) \end{pmatrix} \begin{pmatrix} P(sE0) \\ P(E1) \\ P(L1) \\ P(NE) \end{pmatrix}$$

Compute conditional prob. from historical data

Performance of the conceptual model

Year	HK rainfall	Forecast	
2001	Wet	Normal	All wrong !!
2002	Wet	Normal	
2003	Dry	Wet	
2004	Dry	Normal	
2005	Wet	Normal	
2006	Wet	Normal	
2007	Dry	Normal	
2008	Wet	Normal	

Very difficult: $(2/3)^8 = 0.039$

Less difficult: $C_{8,n}\ (1/3)^n\ (2/3)^{(8-n)}$, $n=1,2,..,5$

JMA/TCC

気象庁 Japan Meteorological Agency

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Download GPV files

Notice

- TCC provides GPV data for long-range forecast through TCC website, which has been made available to registered National Meteorological and Services (NMHSs). A warning e-mail message titled [JMA/JDDS Your password will expire in a few days] will be automatically sent to user's registered e-mail address every day from seven days before the expiry. On receiving this message, users should access the website http://ds.data.jma.go.jp/changepasswd/ to set a new password, otherwise the account will be locked at the end of seven-day period.

Main Products

NWP Model Prediction

- 1-month (19 Sep 2008)
- 3-month (16 Sep 2008)
- 7-month (16 Sep 2008)
  - Statistics
  - All Member

Hindcast GPV Data

3-month
Monthly mean data / Daily data
7-month
Monthly mean data

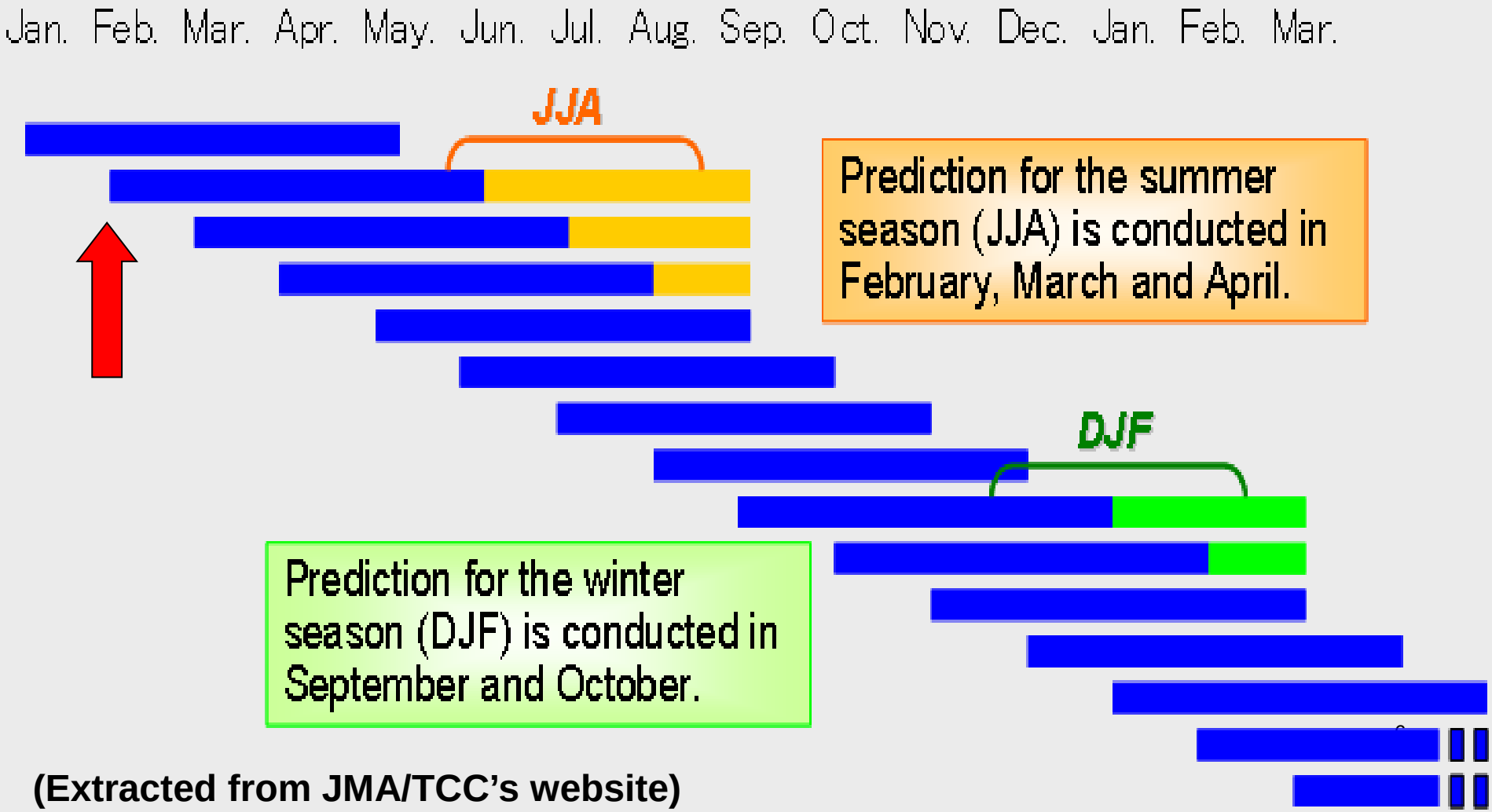
Tips

- Visualization with GrADS

(Extracted from JMA/TCC's website)

Operation of 7-month EPS by JMA/TCC

Model operation : annual



(Extracted from JMA/TCC's website)

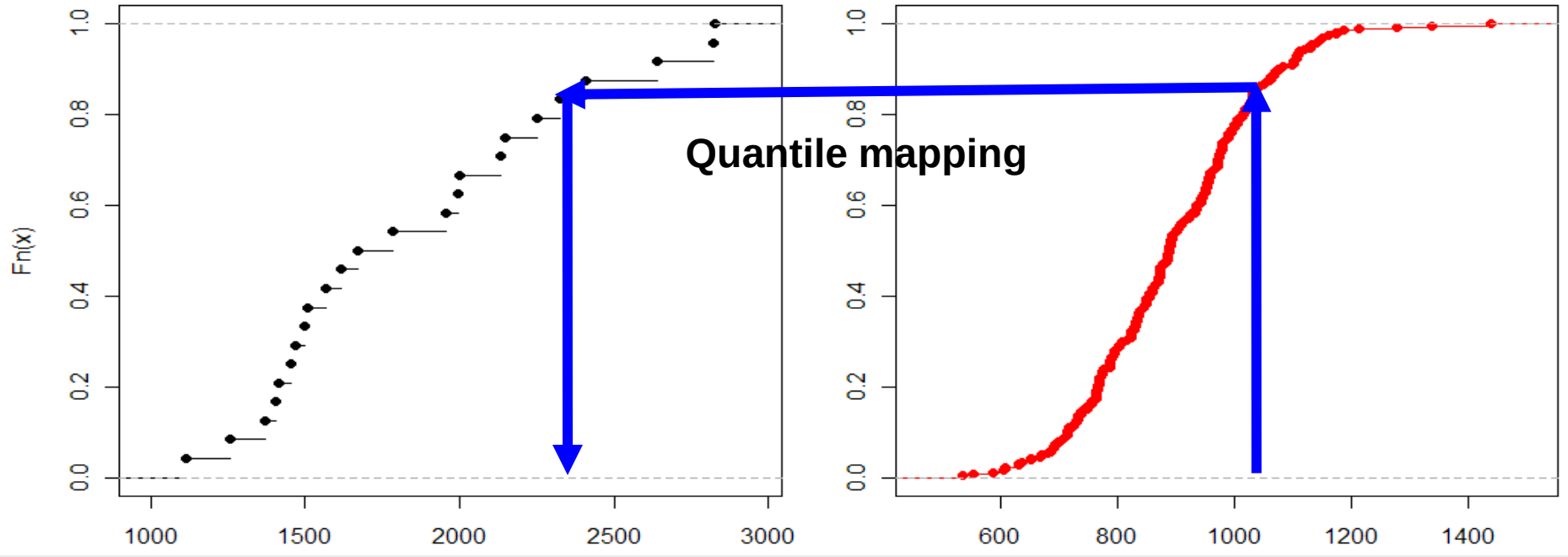
Post-2009 Methodology of Forecasting Annual Rainfall

- Apply bias correction to JMA Mar-Aug f/c against HK obs. (leave-1-out)
- Forecast HK annual rainfall =

Jan-Feb actual + **Bias-corrected Mar-Aug f/c** + **Sep-Dec climatology**

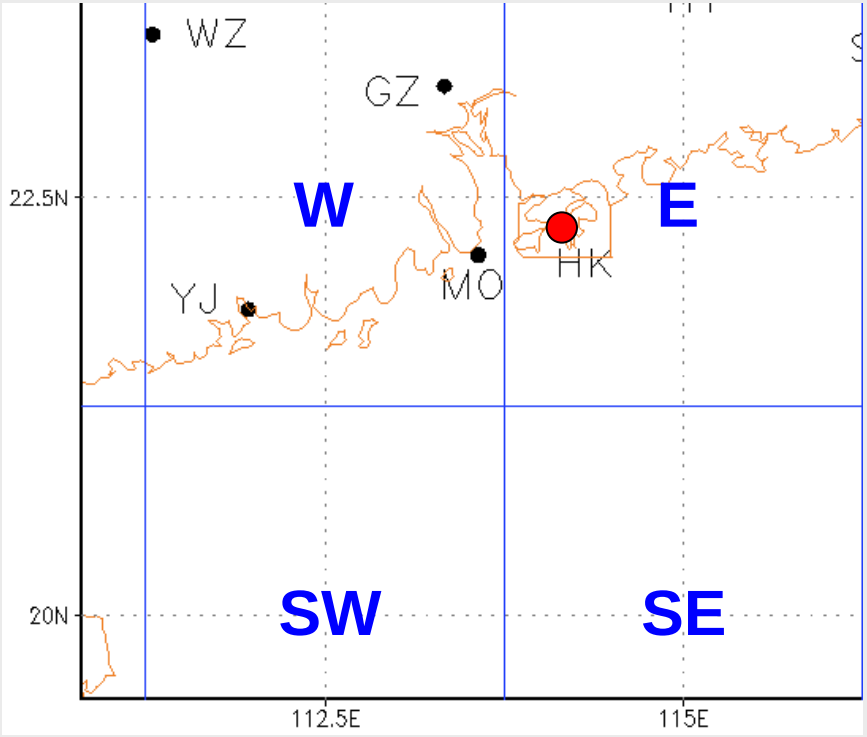
Bias Correction Methods

- Event bias correction
  (corrected fc = original fc X correction factor)
- Linear regression
- Quantile mapping



HKO Rainfall **JMA Forecast**

Nearby Grid Points



Data Set

- JMA hindcast + forecast: 1984-2008 (25 yrs)
- HK rainfall: 1978-2008 (for bias-correction and Sep-Dec climatology calculation)
- Cross validation approach

Verification Result

- Bias-correction: Quantile mapping
- Grid point: SE
- No. of correct forecast[1](1984-2008): **10**
- Climatological forecast[1] (forecast normal every year): **8**

Note[1] : 1971-2000 climate normal in use

Conclusion

- Forecasting annual rainfall of HK is very challenging. The HKO conceptual model doesn't seem to work.
- We are now able to formulate the annual rainfall forecast based on JMA dynamical model output.
- The new method beats climatology and can further develop into MME with more model data becoming available.
- Availability of digital forecast and hindcast data is essential.

Forecast for 2009: below normal

Up to 9 Jul 2009: 936 mm, below normal

Normal regime of HK yearly rainfall: 2140 – 2630 mm

Thank you
& Acknowledgement

The Observatory gratefully acknowledges JMA/TCC for providing digital long-range forecast and hindcast data to support HKO's formulation of annual rainfall forecast.

Specification of current JMA's climate models

One-month

- TL159: 1.125deg
- L60: top=0.1hPa
- Ensemble size: **50**
- I. Perturbation: **BGM/LAF**
- Frequency: **Once a week on Thursday/Friday**
- Forecast period: **34 days**
- Land: SiB
- SST: **Persisted anomaly**

Early Warning

- Forecast period: **17 days**
- Frequency: **Once a week on Sunday/Monday**

3-month/Seasonal

- TL95: 1.875deg
- L40: top=0.4hPa
- Ensemble size: **51**
- I. Perturbation: **SV**
- Frequency: **Once a month**
- Forecast period: **120/210 days**
- Land: SiB
- **SST: Prescribed using persisted anomaly, climatology and ENSO prediction by CGCM**

El Niño

Atmosphere

- TL95: 1.875deg
- L40: top=0.4hPa

Ocean

- 1º (lon) x 1º (lat), (1º (lon) x 0.3º (lat) near equator) 50 vertical levels

- Ensemble size: **12**
- I. Perturbation: **LAF (5 days interval)**
- Frequency: **once a month**
- Forecast period: **15 months**
- Land: SiB

(Extracted from JMA/TCC's training material)