Post-processing forecasts from a convective-permitting weather model for national flow forecasting

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Water in New Zealand

International tourism overtakes dairy to regain top spot as our biggest export earner
Towards a national flow forecasting system

- Short range: 48h ahead
- Medium range: 72h ahead
- Long range: 15 days ahead
- Seasonal range: 3 months ahead
Weather model: general performance

Cloud-resolving model gives a much more realistic annual mean rainfall distribution

Forecast 1.5km - Convective scale

“Observed” product 5km

June 2014 - June 2015
Observed data at NIWA

“Observed” product 5km, daily (VCSN)

Station data at NIWA


Used for model climatology
Aim – National forecast precipitation calibration

Weather Forecast 1.5km, hourly

Gridded observed data 5km, daily

Hutt catchment

Daily data
Hourly forecasts

Case study:
• 3 year forecast archive
• 12 stations (hourly) elevation 42m-1022m
Rainfall post-processing

Approach #1: Baseline – Hourly data
- Baseline
- Calibration using hourly data

Approach #2: Pseudo-hourly data
- Daily data
- Hourly disaggregation:
  - raw forecast (rain)
  - divide by 24h (no rain)
- Calibration using pseudo-hourly data

Approach #3: Daily data
- Daily data
- Calibration using daily data
- Hourly disaggregation:
  - Historical raw forecasts
Bayesian rainfall forecast post-processor
(Robertson, Shrestha, Wang, 2013, HESS)

Step 1: Correct biases and quantify uncertainty

Simplified Bayesian joint probability (BJP) model (Wang et al 2009)
- Log-sinh transformation (Wang, Shrestha, Robertson, Pokhrel, 2012, WRR)
- Continuous bivariate normal distribution
- Treatment of zero data (Wang and Robertson 2011)

Step 2: Instill temporal and spatial patterns

Schaake Shuffle (Clark, Gangopadhyay, Hay, Rajagopalan, Wilby, 2004, JHM)
Template data: historical observed data

Hourly forecasts

Lead time hour →
Bayesian rainfall forecast post-processor

Step 1: Correct biases and quantify uncertainty

Step 2: Instill temporal and spatial patterns

Template data: historical observed raw forecast data

Approach #3: Daily data

Step 3: Hourly disaggregation and combine overlapping forecasts
Results

Approach #1: Baseline – Hourly data
Approach #2: Pseudo-hourly data
Approach #3: Daily data
Results – Total daily precipitation (1-24h)

Ensemble ranges and observations versus ensemble mean

Approach #1: Baseline – Hourly data
Approach #2: Pseudo-hourly data
Approach #3: Daily data
Results – Reliability of daily total precipitation (1-24h)

PIT: forecast reliability

Approach #1: Baseline – Hourly data

Approach #2: Pseudo-hourly data

Approach #3: Daily data
Results – Hourly disaggregation

Percentage bias per lead time

Approach #1: Baseline – Hourly data
Approach #2: Pseudo-hourly data
Approach #3: Daily data
Results – Hourly disaggregation

**Historical raw forecasts**

**Precipitation disaggregation proportion**

Approach #3: Daily data

Issue time 0300 hours

Edge effects?
Results – Hourly disaggregation

**Historical raw forecasts**

**Stochastic**

**Mixed:** raw forecast (rain)/ stochastic (no rain).

Approach #3: Daily data

- Smaller edge effect
Results – Summary

Approach #1: Baseline – Hourly data
- Ideal case
- Removed bias
- Reliable ensemble

Approach #2: Pseudo-hourly data
- Removed bias
- Larger errors cumulate daily
- Forecast a little narrow, too much temporal correlation?

Approach #3: Daily data
- Removed bias
- Smaller ensemble ranges
- Reliable ensemble (daily totals)
- Edge effects 😞
Conclusions

1. National flow forecasting system for New Zealand

2. BJP rainfall post-processing: Daily data and hourly forecasts

3. Refine approach: Combine daily and pseudo-hourly approaches?

Thank you!