Effects of observation uncertainties in verification practices

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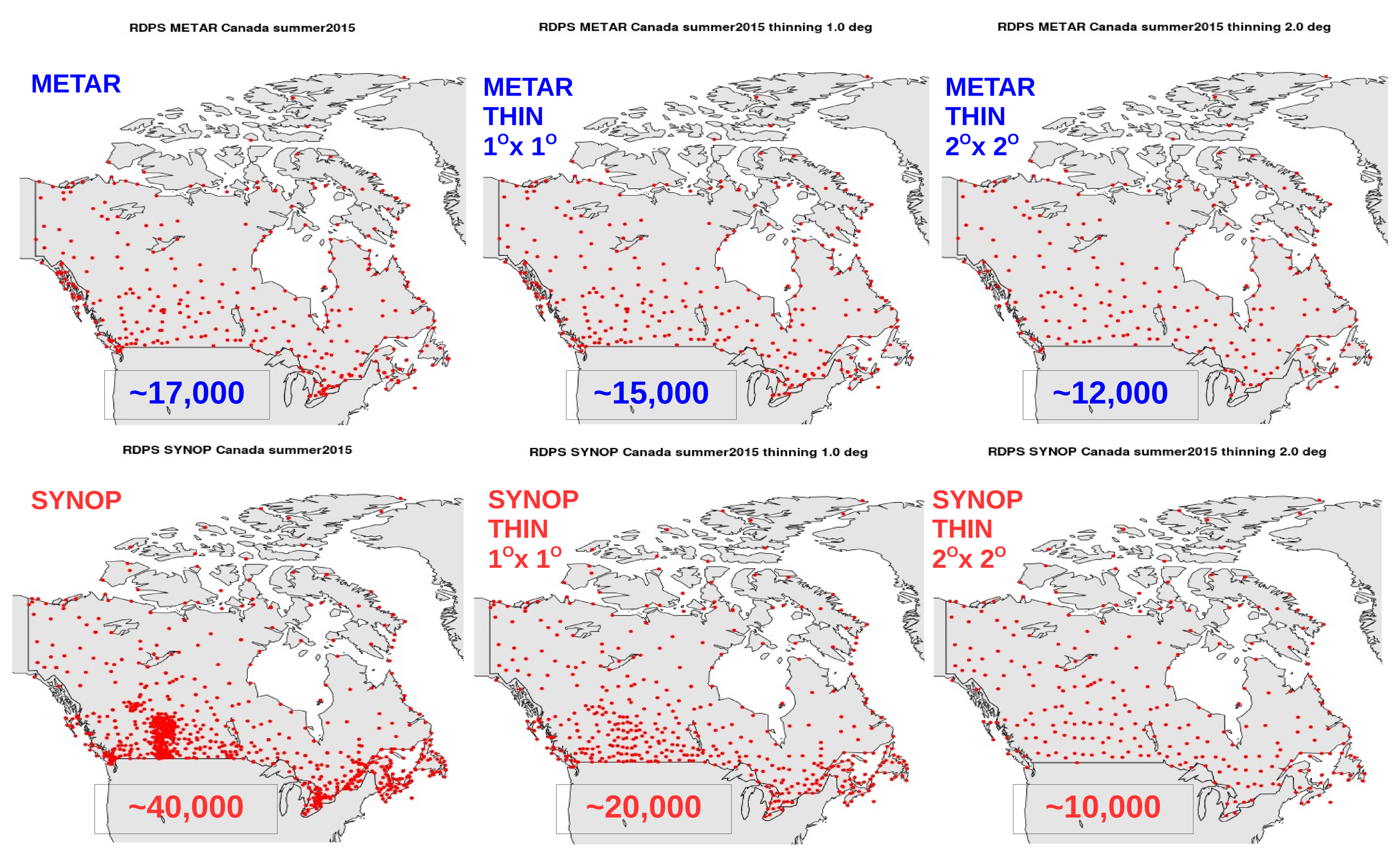
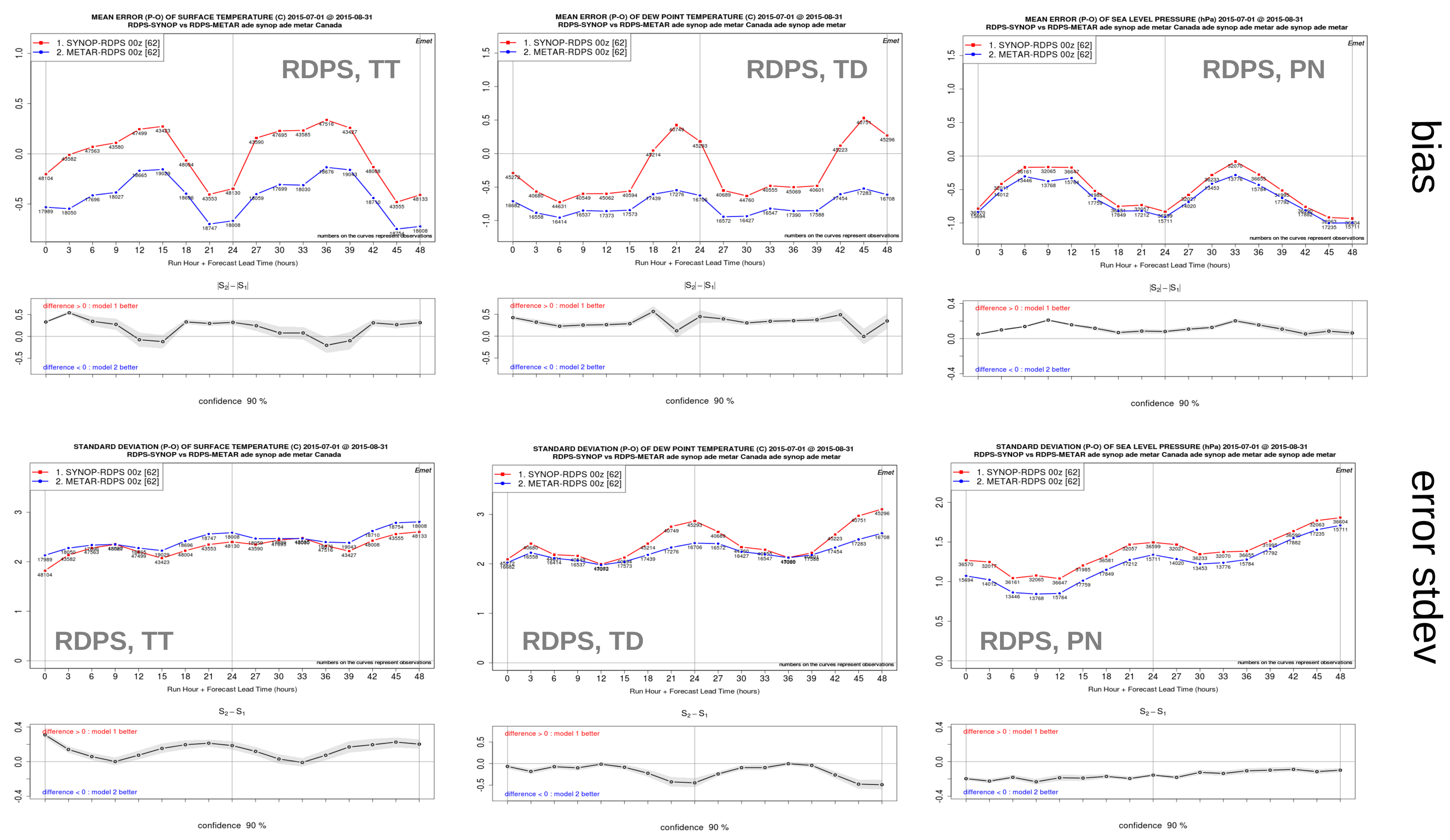
Motivation: Observations can be affected by different types of uncertainties:

- Measurements errors: e.g. instrument failure – can be abrupt or slowly degrading.
- Round-off and reporting procedures: e.g. precipitation trace from gauges reporting in inches vs mm; e.g. no report when no precipitation.
- Quality Control: e.g. elimination of large values; rejection of precipitation measurements in occurrence of strong wind (undercatchment).
- Representativeness and sampling error (both in space and time): is the point-observation representative of the (nearest) model grid-point value? is the observation network homogeneous and representative of the region verified?
- Assumptions of remote-sensing retrieval algorithms.
- Uncertainties introduced by interpolation / gridding procedures.

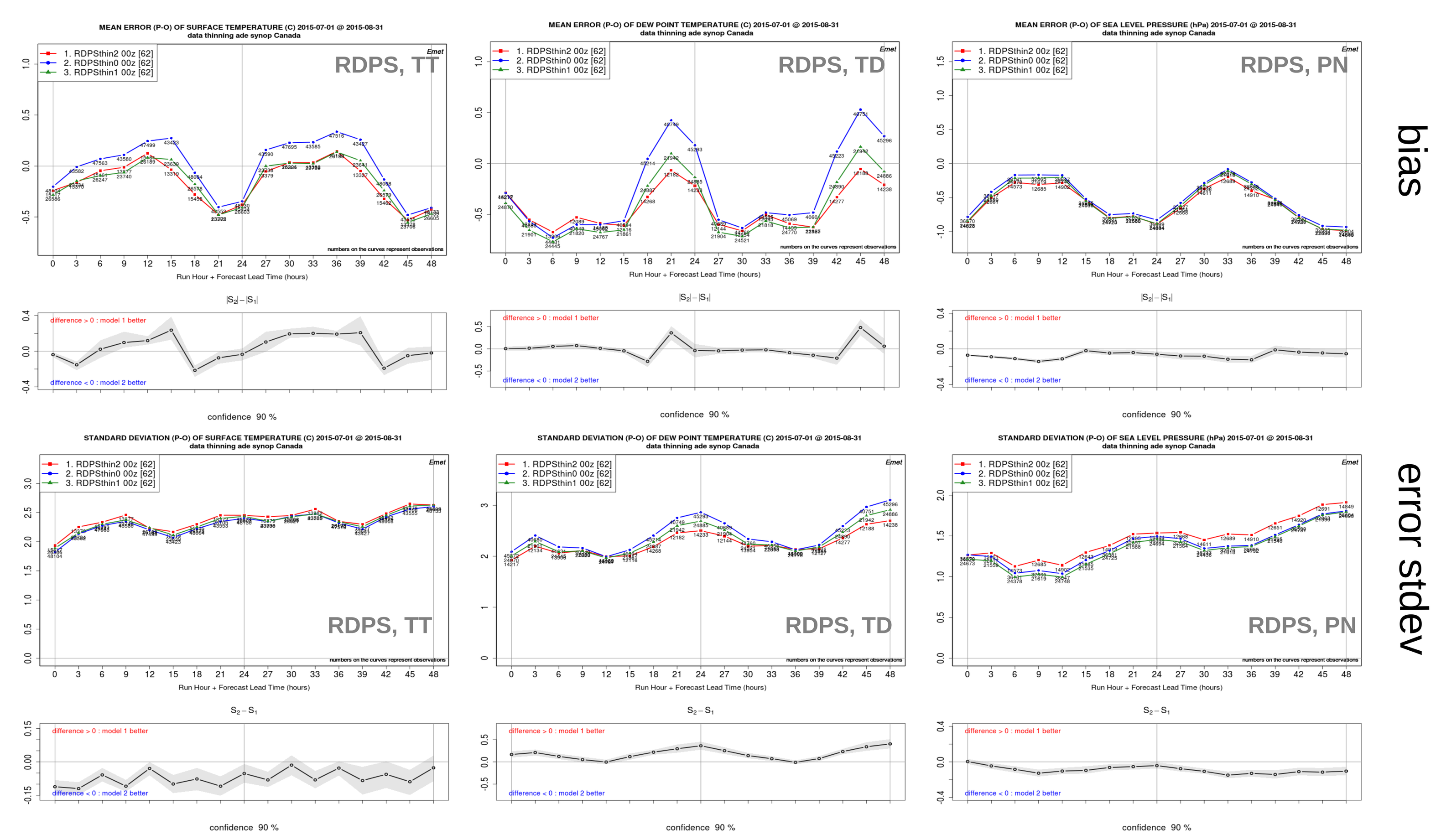
Driving Questions: What are the effects of the observation uncertainties on verification results? Which observation uncertainties have the largest impacts? How can we account for observation uncertainties in verification practices?



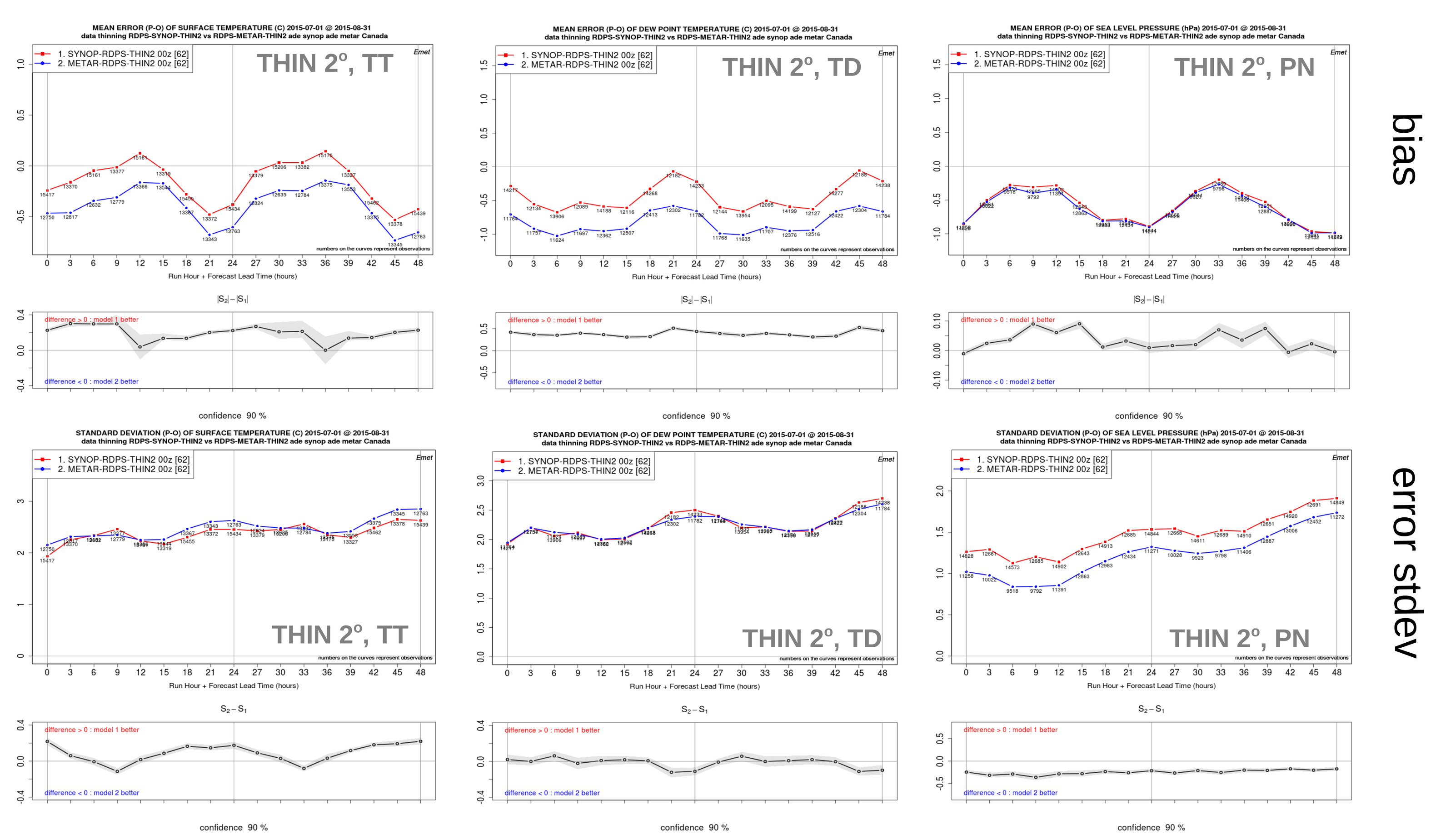
SYNOP vs METAR



thin 0^o (no thinning) - thin 1^o - thin 2^o



SYNOP vs METAR with 2^o thinning



Experiment Design

Aim: identify the observation uncertainties which have largest impact on Canadian operational verification results.

Sources of observation uncertainties:

- Different networks: SYNOP vs METAR
- Spatial sampling: thinning obs network (retain one obs for each 2^ox2^o sector)
- Quality Control
- Representativeness and spatial sampling:
  - verify against analysis values at obs locations
  - filling: from station network to whole domain
- Interpolation and gridding procedures
  - effects of analysis model-dependence
- Neighbourhood and scale-separation:
  - thinning, stations vs gridded obs vs analysis

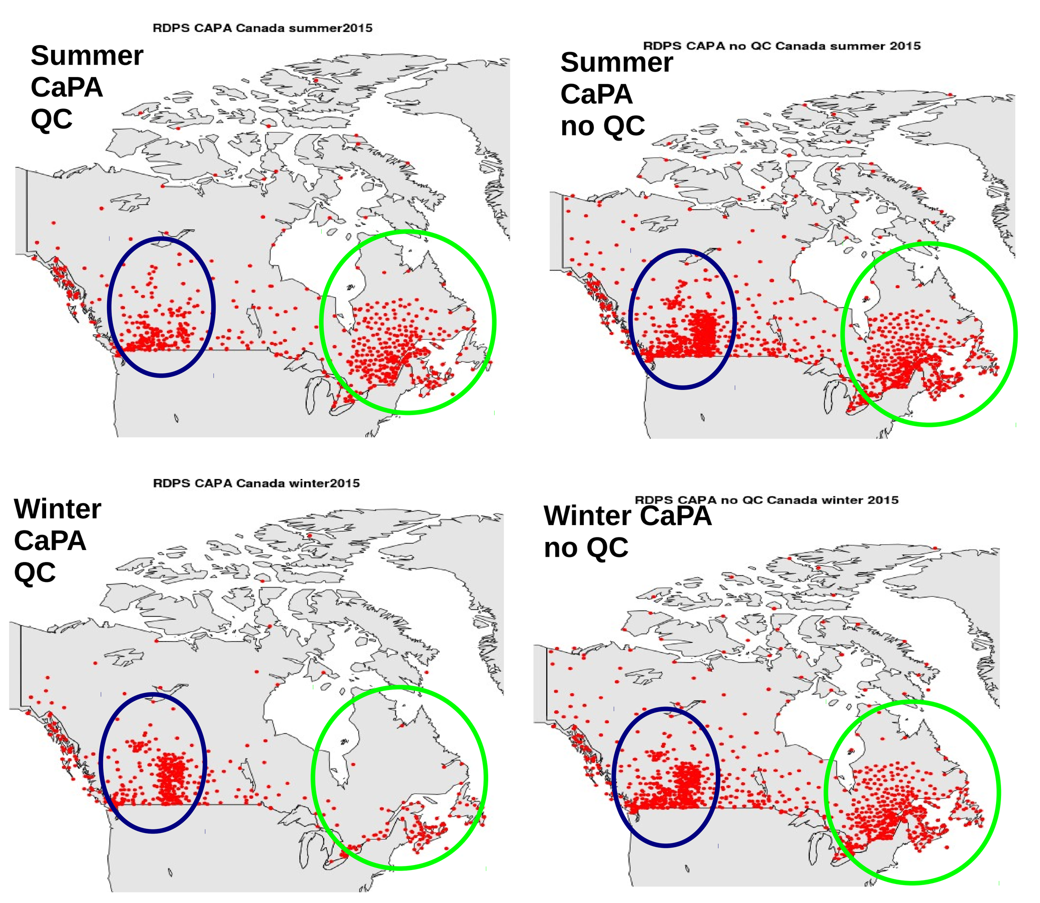
Variables:
TT = 2m (surface) air temperature
TD = 2m dew point temperature
PN = mean sea level pressure
UV, WD = wind speed and direction
PR6h = 6-hour accumulated precipitation

NWP systems: we compare RDPS (~10 km) versus HRDPS (~2.5 km).

Domain: Canada.
Sub-domains: Alberta, Quebec (thinning and Quality Control).

Two seasons: July-Aug (summer) and Jan-Feb (winter), 2015.

Quality Control vs no Quality Control



6-hour accumulated precipitation :

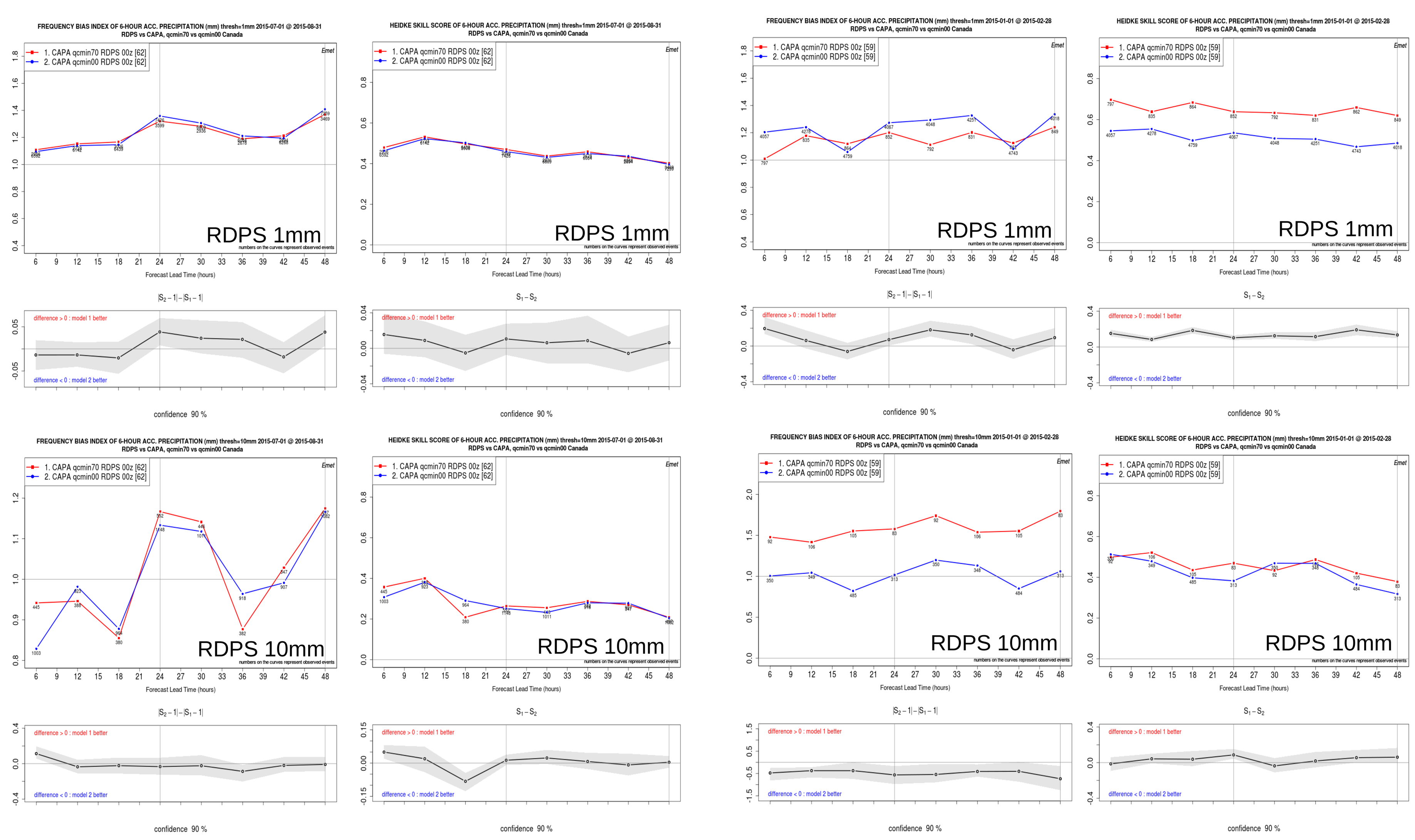
Summer sample size:
1mm QC = 3,000
1mm noQC = 6,000
10mm QC = 400
10mm noQC = 1,000

Winter sample size:
1mm QC = 800
1mm noQC = 4200
10mm QC = 100
10mm noQC = 400

Quebec winter: tipping bucket gauges freeze

Summer FBI, HSS

Winter FBI, HSS



Results

Different networks and thinning, TT, TD, PN, continuous scores, summer 2005:
Bias exhibits diurnal cycle; error stdev exhibit diurnal cycle and increase with lead time.

Verification against **different networks (SYNOP vs METAR) exhibits larger differences than thinning** (SYNOP vs SYNOP thinned or METAR vs METAR thinned).
Thinning at 2^o leads to more homogeneous and similar spatial sampling and sample size: reduces the differences between SYNOP and METAR.

Bias curves against SYNOP are systematically higher than those against METAR (SYNOP stations lead to diagnose more overforecast than METAR stations). SYNOP stations are equipped with a Stephenson screen, whereas METAR stations are not: SYNOP observations are colder than METAR observations!

Quality Control versus no Quality Control, PR6h, categorical scores:
Summer 2015: no significant differences in verification results.
Winter 2015: for the FBI, QC affects curves behaviour (diurnal cycle vs constant); 1mm HSS is significantly better for Quality Controlled observations.

Conclusions: Verification against different networks / with or without thinning / with or without quality control: exhibits significant differences, affect interpretation of verification results (e.g. over/under estimation for the bias, ranking for error stdev).

To account for observation uncertainties in verification practices:
1. identify major sources of observation uncertainties, quantify their effects.
2. correct observation uncertainties (known unknown) → quality control
3. incorporate observation uncertainty in verification results (unknown unknown)
→probabilistic approach + confidence intervals (bootstrap)