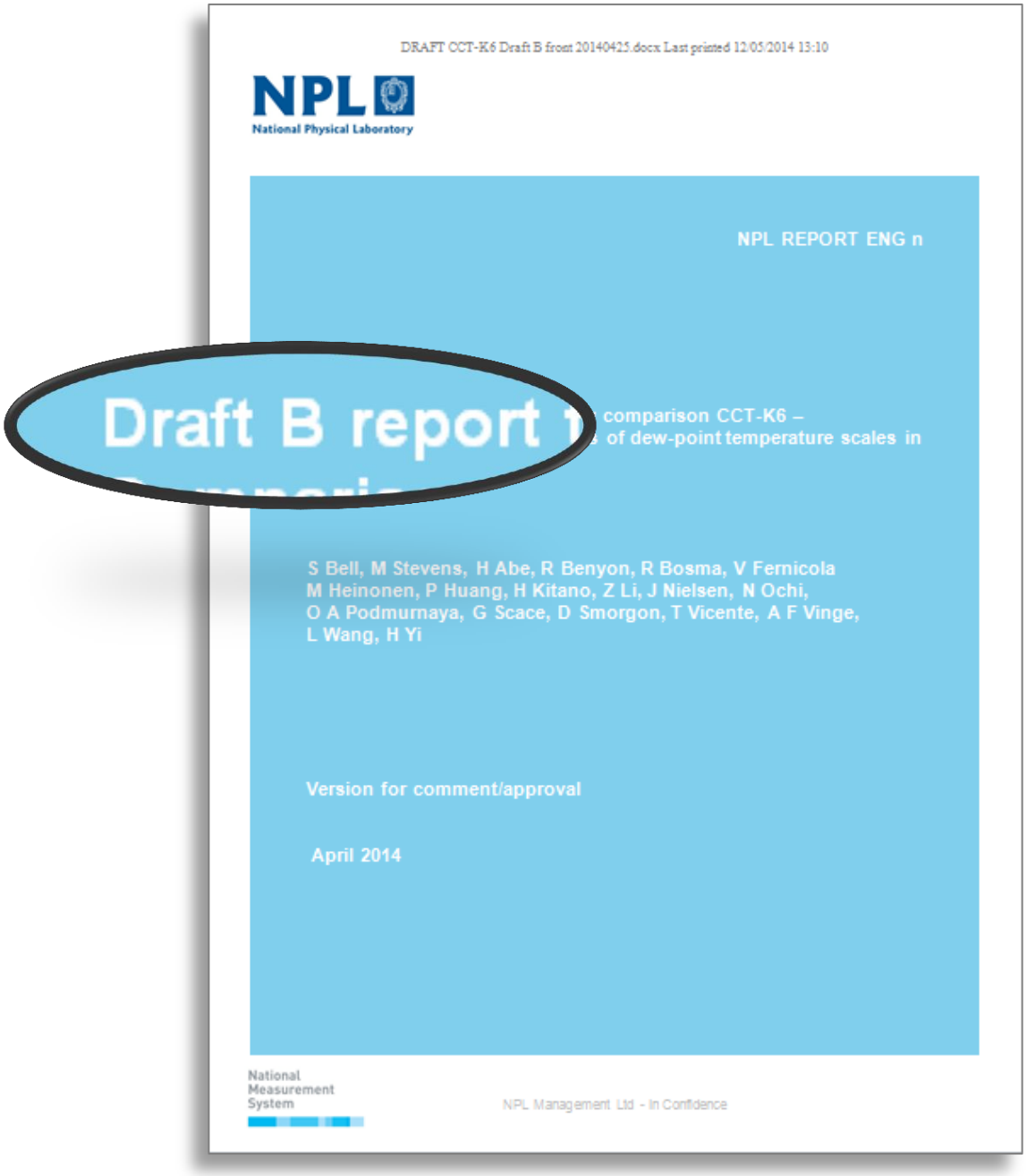
CCT/14-64

Update on CCT-K6
key comparison in dew-point temperature -50 °C to +20 °C

Stephanie Bell, NPL

Meeting of CCT, 2014



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CCT-K6 (details - reminder)

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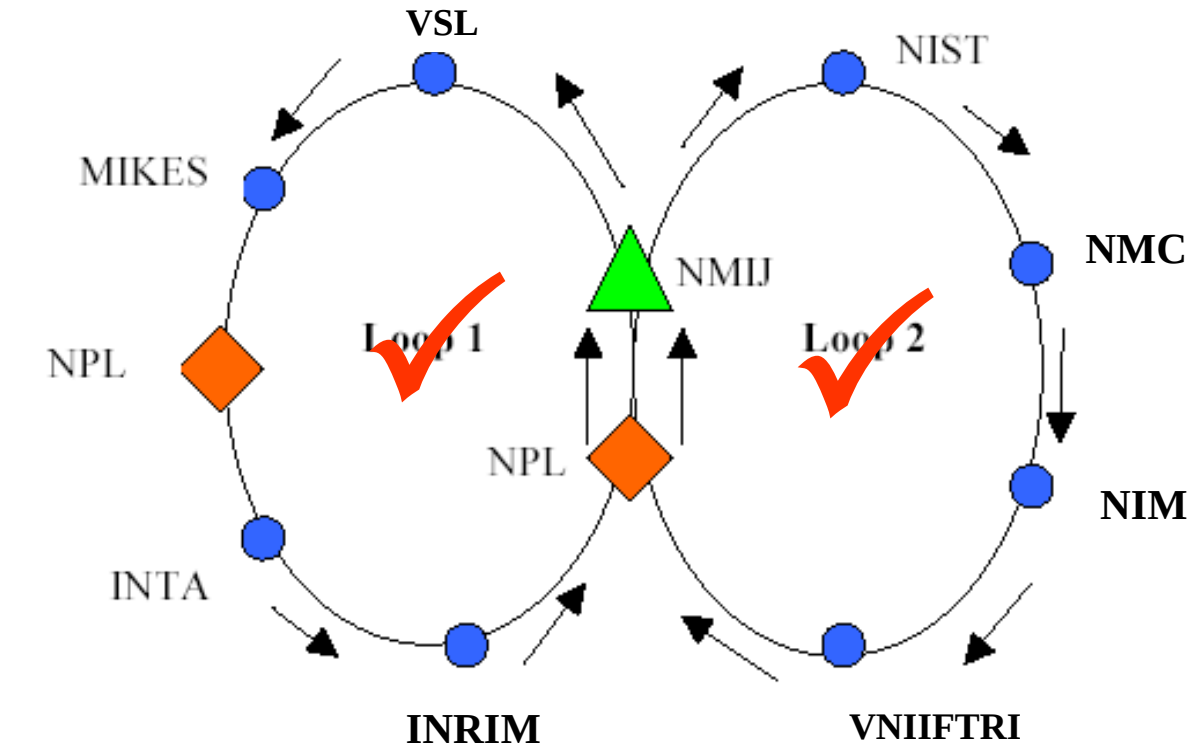
- Key comparison at dew/frost-point values of -50 ºC, -30 ºC, -10 ºC, +1 ºC and +20 ºC
- Comparison of realisations of local scales of dew/frost-point temperature of humid gas
- Two chilled-mirror hygrometers measured together. 4 x reproduced (repeat) measurements.
- Results reported:
  - applied (standard) dew- or frost-point temperature
  - measured dew- or frost-point temperature (reading of hygrometer PRT embedded in hygrometer mirror, when stable condensate layer is present)
- *key comparison reference value* (KCRV) at each measured value - weighted mean

CCT-K6 Participants

- INTA (Spain)
- INRiM (Italy)
- MIKES (Finland)
- NIM (China)
- NIST (USA)
- NMC A-STAR (Singapore)
- NMIJ (Japan)
- NPL (UK, Pilot)
- VNIIFTRI ESB (Russia)
- VSL (Netherlands)

CCT-K6 measurements completed



Pilot	
Assistant Pilot	
Participants	

Status of CCT-K6

Draft A Report 2012 and 2013 versions:

- participant results and uncertainties
- performance of transfer standards
- graphs and tables of equivalence
- provisional key comparison reference values (KCRVs)

Draft A agreed by all participants. Partially presented at TEMPMEKO 2013

Draft B Report 2014 *as above plus*:

- revised KCRVs at -50 °C and -30 °C (excluding agreed outliers)
- extra checks, corrections and editorial improvements

Draft B in process of agreement by participants

CCT-K6 – what took so long?

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2001	NPL appointed as pilot
2002	Pilot initial study/measurements
2003 to 2009	Participant measurements (9 labs) 10 instrument breakdowns and repairs (relevant action agreed with participants throughout) 2 queries from participants about suspected measurement problems Additional measurement checks by NPL as pilot, and by INTA (6 separate occasions) Final measurements by NPL (pilot)
2010	Additional measurements by INTA
2012	Draft A report (two versions)
2014	Draft B report

CCT-K6 – concerns

- Many travelling standard problems and repairs
  - Root cause of problems was use of old instruments
  - Many extra pilot checks made
  - No sign of discontinuities in performance ☺
- Instrument long-term stability a concern, due to long duration and some ambiguity in drift data
- Slowness of CCT-K6 is a concern:
  - for linking to other comparisons
  - for repeat cycle of comparisons (APMP and other K6 equivalents ready to repeat now)

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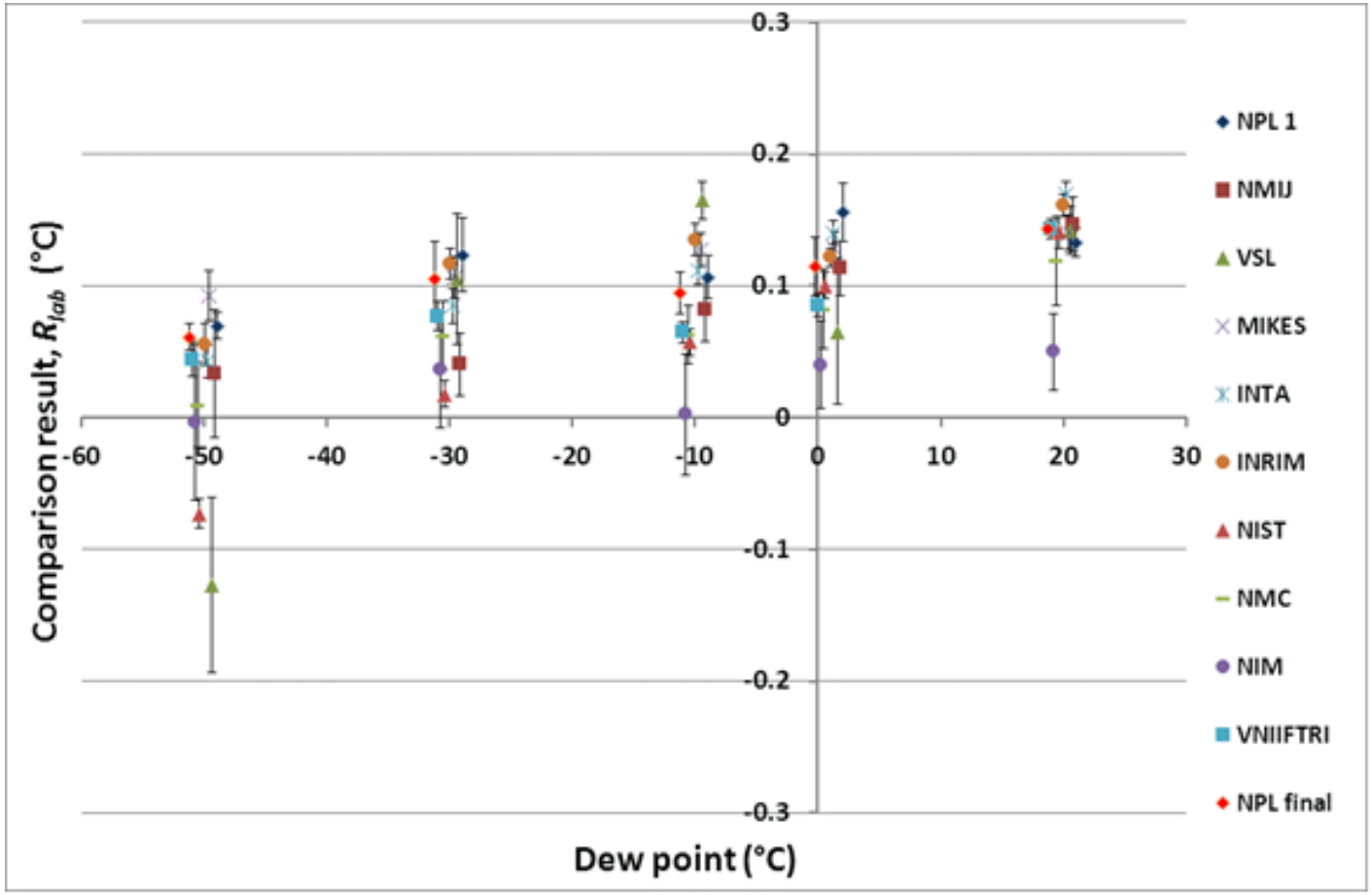
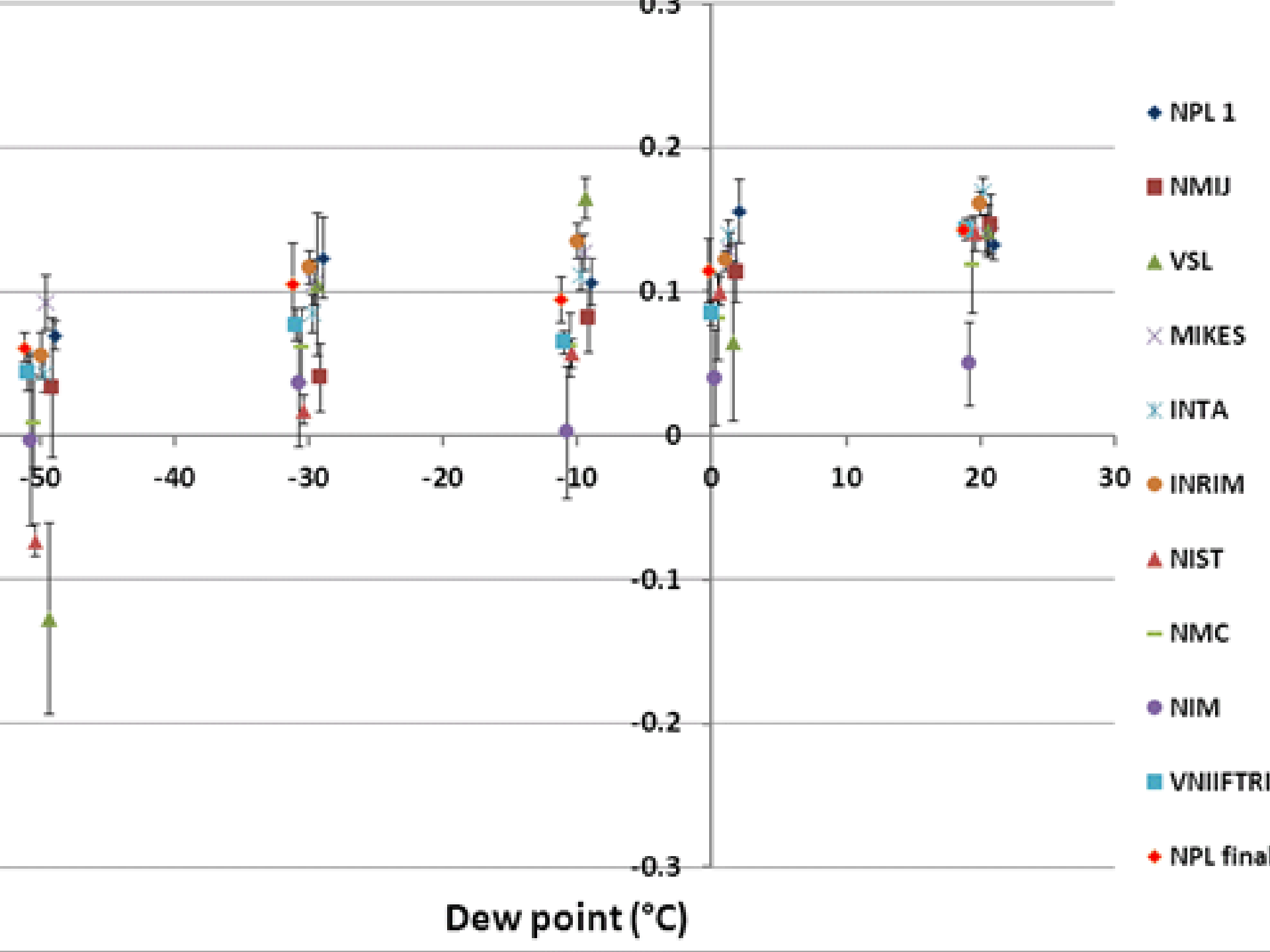
So, finally, some results

CCT-K6 overall results



Results as reported values for mean (mid-point) of Hyg1 and Hyg2. Error bars show participant reported standard uncertainties (*k*=1). (Instrument drift not included here)


0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-50
-40
-30
-20
-10
0
10
20
30
Dew point (°C)
NPL 1
NMIJ
VSL
MIKES
INTA
INRIM
NIST
NMC
NIM
VNIIFTRI
NPL final

CCT-K6 – points of interest

Reporting also covers:

- How we decided the instruments were unaffected by operating problems
- How we considered instrument drift
  - drift assessment gave conflicting information in some of the range
    - uncertainty allowance is made for this
  - but overall drift did not appear to be significant
- Consideration of outliers and KCRV

CCT-K6 – outliers and KCRV

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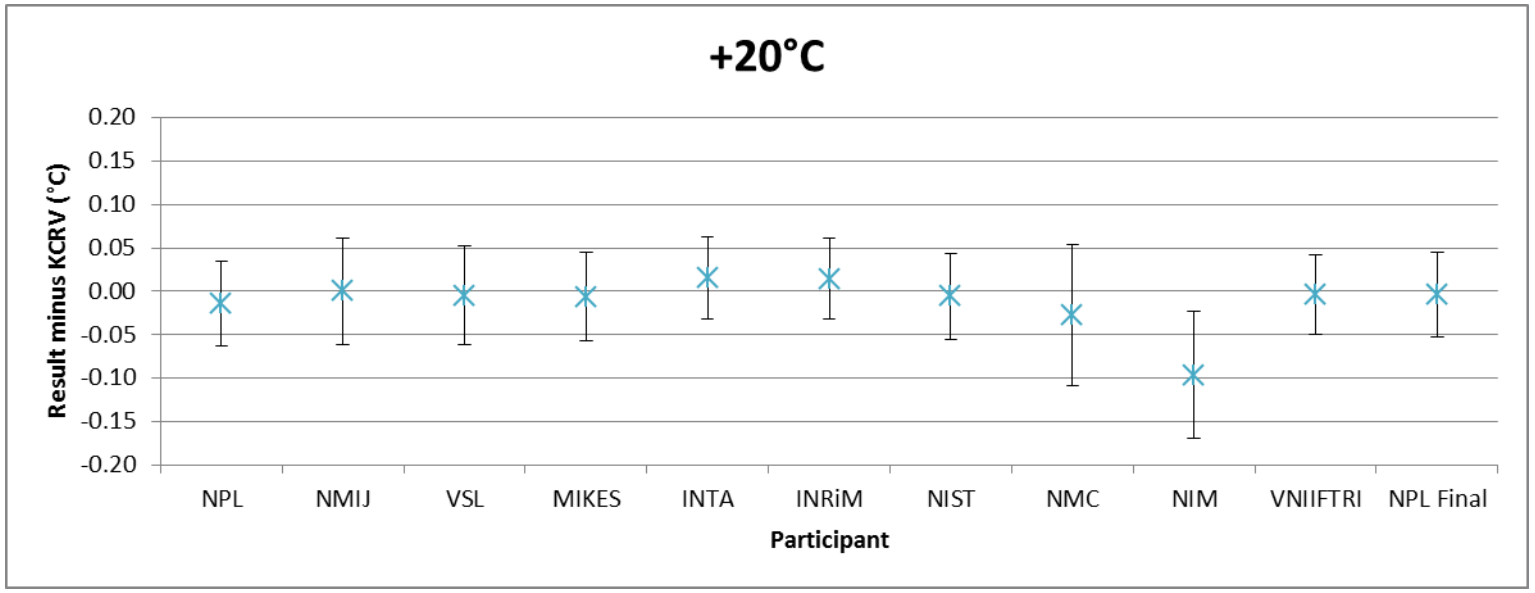
- Three individual results (out of 50) were considered as possible significant outliers
- Decision: is it ***necessary*** to exclude any outliers from KCRV?
- Criteria:
  - chi-squared test: outlier included → dataset fails test ✘
    outlier excluded → dataset passes test ✓
  - impact on KCRV of inclusion/exclusion
- KCRV at -50 °C and -30 °C, recalculated, excluding two outlying results
- Impact of outliers on KCRV weighted mean
  - change of 0.027 °C at -50 °C, and 0.018 °C at -30 °C
- The outlying results (NIST) have a credible explanation. Action has been taken to increase CMC uncertainty.

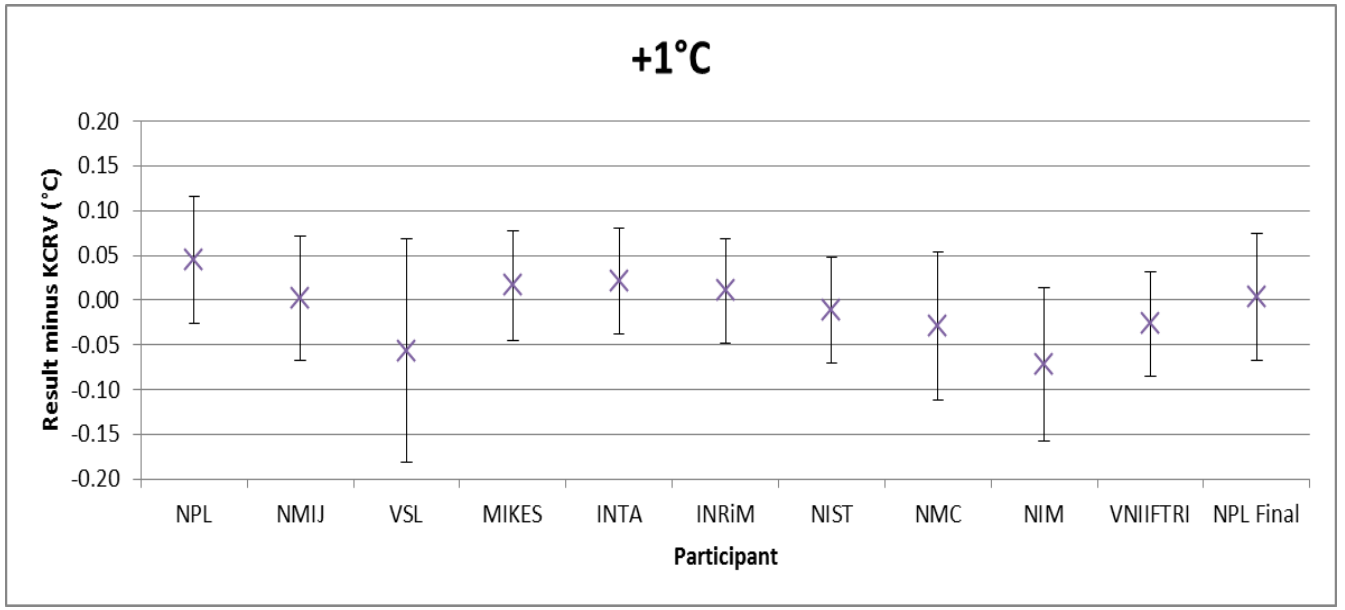
Equivalences

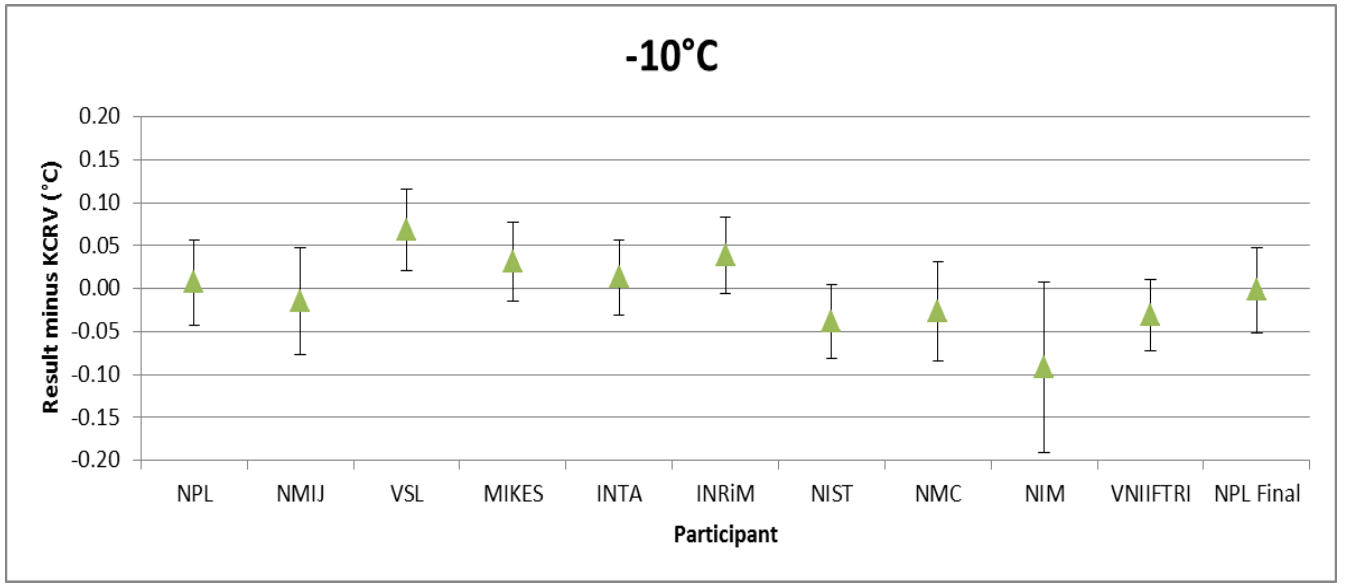
Participant equivalences to KCRV



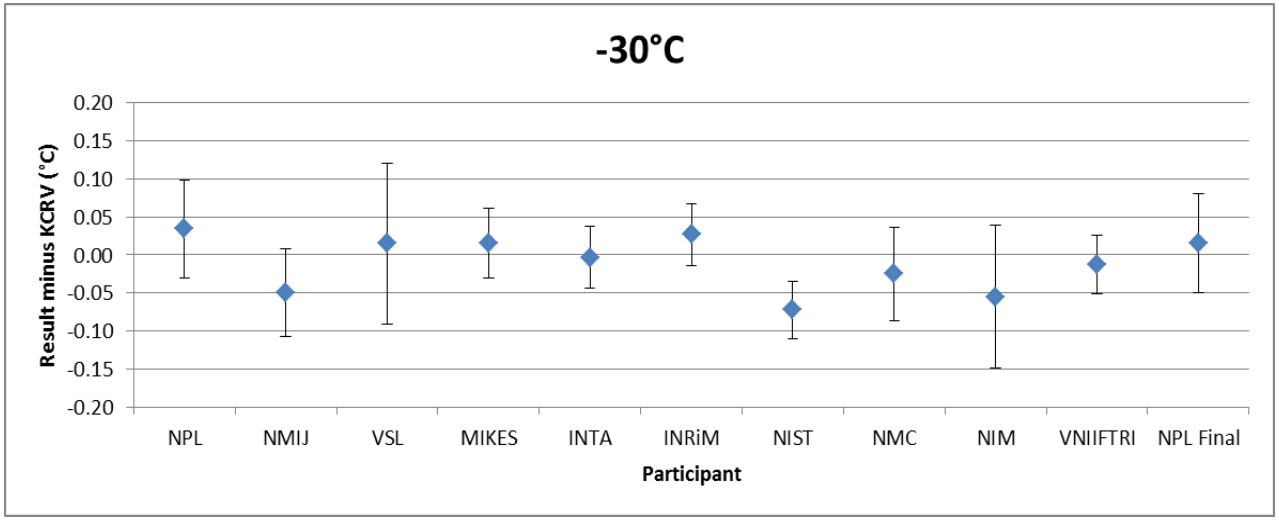
- Error bars are uncertainties at 95 % coverage probability, including instrument uncertainty component
- *NPL Final* results shown only for illustration/drift

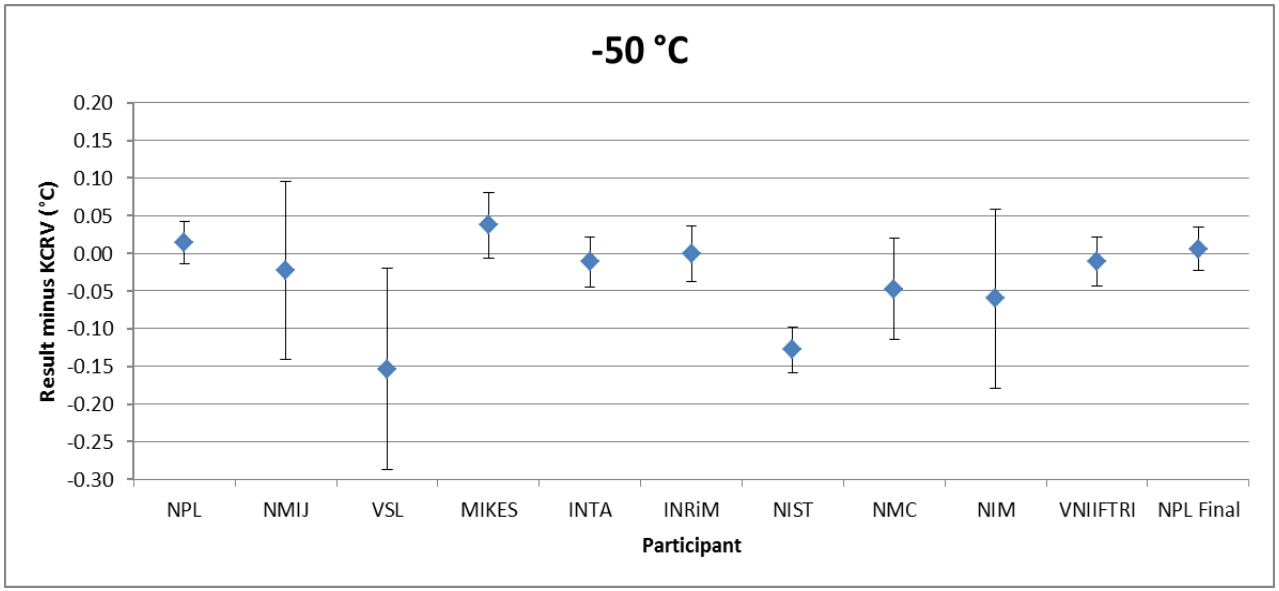
Participant equivalences to KCRV





Participant equivalences to KCRV





Summary of CCT-K6

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- Participants achieved mostly good agreement
- Travelling standard hygrometer problems were a concern
- Drift assessment produced conflicting information, but overall drift did not appear to be significant

- Next:
  - Draft B report to CCT WG7
  - Linkages of other comparisons to KCRV

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