

NATURAL RESOURCES CANADA - INVENTIVE BY NATURE

National & International Reference Frames

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Natural Resources
Canada

Ressources naturelles
Canada

Canada

International Terrestrial Reference Frame

■ ITRF2014

- Released January 22, 2016
- Uses data up to 2015.0 (GPS to 2015.1)
- Uses repro2 solutions from IGS analysis centres
- Provides estimates of
 - Annual & semi-annual terms for modelling seasonal signals
 - Post-seismic deformation models
- Coordinate reference epoch: 2010.0
- Transformation ITRF2014 -> ITRF2008 (very small – few mm)
 - TX = 1.6 mm + 0.0 mm/y RX = 0 (*same orientation as ITRF2008*)
 - TY = 1.9 mm + 0.0 mm/y RY = 0
 - TZ = 2.4 mm – 0.1 mm/y RZ = 0
 - DS = -0.02 ppb + 0.03 ppb/y



IGS Reference Frame

- **Current reference frame: IGb08**
 - Based on ITRF2008
 - Introduced October 10, 2012 (GPS week 1709)
 - Repro2 completed but no official IGS repro2 combined orbits produced (using CODE orbits for CACS/CBN reprocessing)
- **IGS14**
 - Will be based on ITRF2014 (repro2 coordinate solutions)
 - Presently deciding on list of “frame” stations to define IGS14
 - Expect ITRF2014 coordinates to be adopted for frame stations



WGS 84

- GPS realizations of WGS84 (no change since 2015)

	Ref. Epoch	Based on	Implemented in Broadcast Orbits
WGS 84 (G730)	1994?	ITRF91	1994-06-29
WGS 84 (G893)	1997.0	ITRF94	1997-01-29
WGS 84 (G1150)	2001.0	ITRF2000	2002-01-20
WGS 84 (G1674)	2005.0	ITRF2008	2012-02-08
WGS 84 (G1762)	2005.0	ITRF2008	2013-10-16

- Coordinates & velocities

- NGA site coordinates/velocities from ITRF2008
- USAF site coordinates estimated – velocities from nearby IGS/CORS
- Coordinates for orbit determination updated semi-annually to account for tectonic motion



NAD83 Realizations

Version(epoch)	Frame	Adopted	Based on
v0 Original		1986-1993	Horizontal adjustments
v1 (1988.0?)	CSRS96 1996		Transformation from ITRF93?
v2 (1997.0)	CSRS98/CSRS	1998	Transformation from ITRF96 *
v3 (1997.0)		2000	Transformation from ITRF97 (first complete CBN)
v4 (2002.0)		2002	Transformation from ITRF2000
v5 (2006.0)		2009	Transformation from ITRF2005
v6 (2010.0)		2012	Transformation from ITRF2008
v7 (2010.0)		Late 2016	Transformation from ITRF2014 (within a few mm of v6)

* definition of NAD83(CSRS=CSRS98)



Adopted Realizations

CGS	v6 (2010.0) on CACS/CBN, mixed versions all else
CHS	v5 (2006.0); moving to v6
BC	v4 (2002.0) ; Van. Is. public v3.0 (1997.0); moving to v6
AB	v4 (2002.0) for 1140 subset, v0 all else; moving to v6
SK	v2 (1997.0)
MB	v6 (2010.0)
ON	v6 (2010.0) for 8300 subset; v0 for all else
QC	v2 (1997.0) & v0 for stations before 2009
NB	v2 (1997.0)
PEI	v6 (2010.0) on ACS; v2.0.0 (1997.0) on HPN; NAD27 all else
NS	v6 (2010.0) on NSACS; v3.1 on HPN; ATS77 all else
NL	v6 (2010.0)
Territories	v4 (2002.0) for SGB; mixed all else



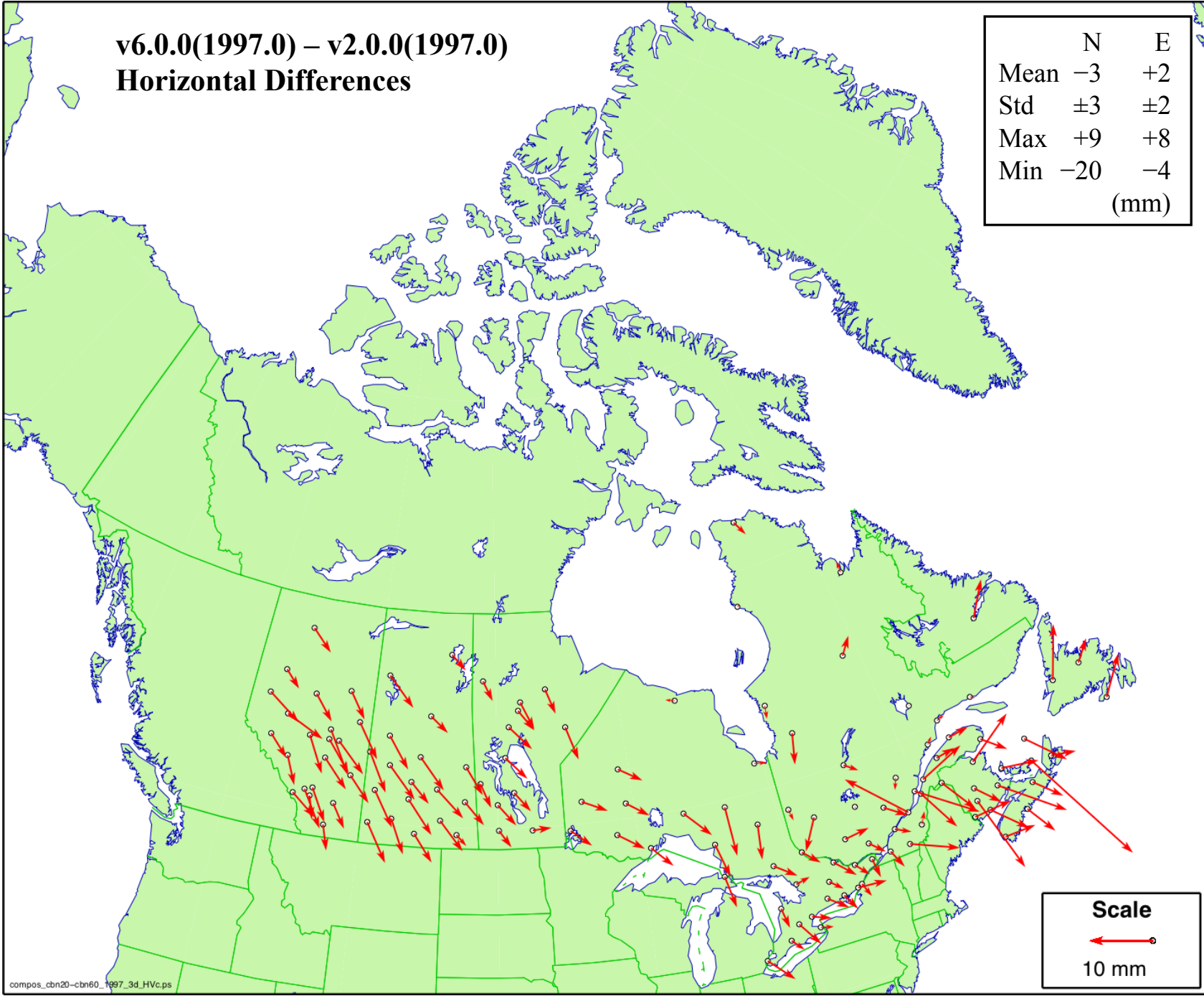
NAD83(CSRS) v6 vs Previous Realizations

- Can propagate v6 coordinates back to previous epochs
- Accounts for most of the differences between realizations (crustal motion)
- **Small (~1 cm) residual differences remain** due to:
 - Errors & biases in previous adjustment methodologies
 - Accumulation of uncertainties in velocities when propagating to older epochs
 - Position offsets (discontinuities) due to equipment changes, earthquakes, etc.
- See comparisons of RACS/CBN v6 to previous realizations after propagating to same epochs (next 8 slides)



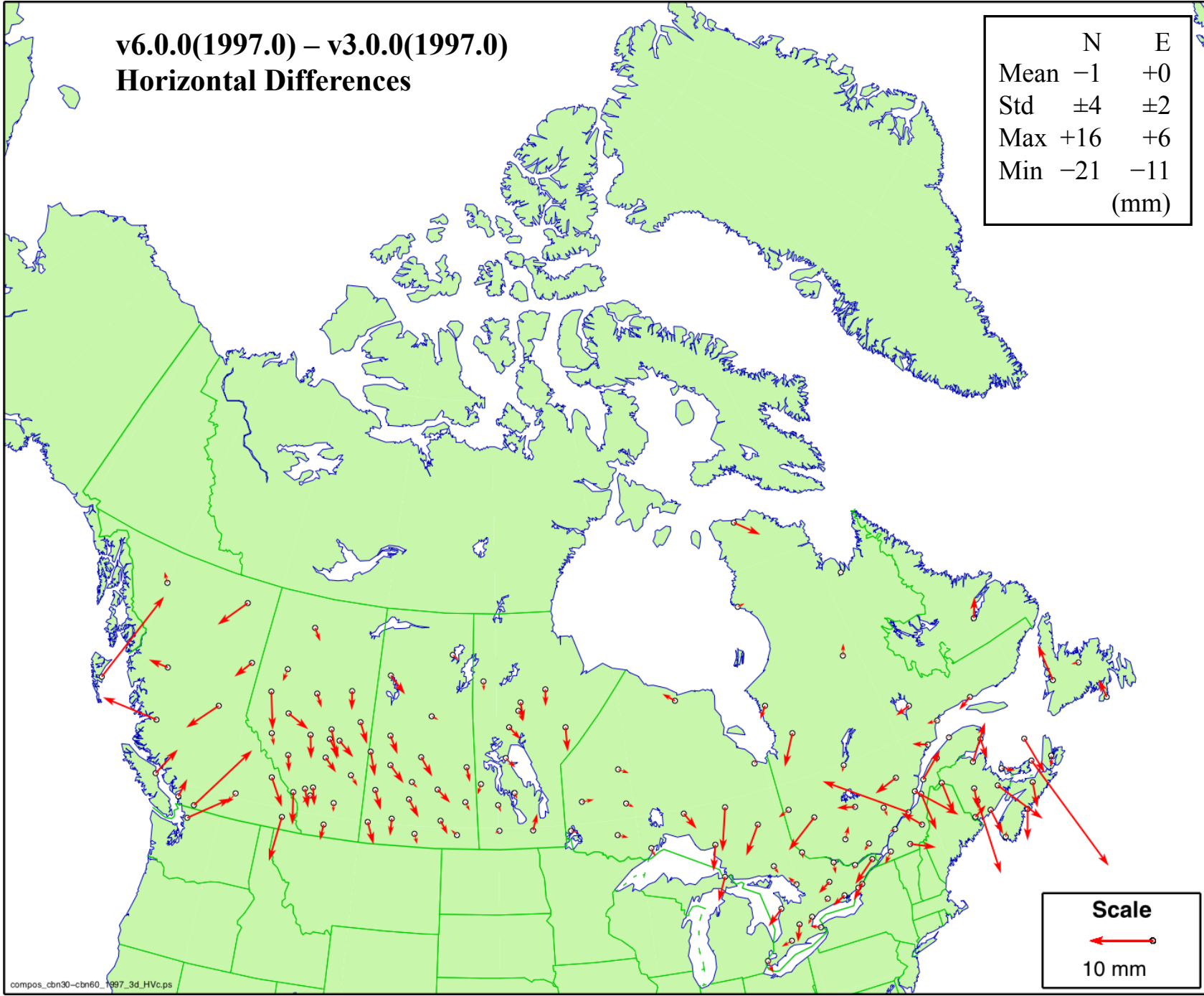
v6.0.0(1997.0) – v2.0.0(1997.0)
Horizontal Differences

	N	E
Mean	-3	+2
Std	±3	±2
Max	+9	+8
Min	-20	-4
	(mm)	



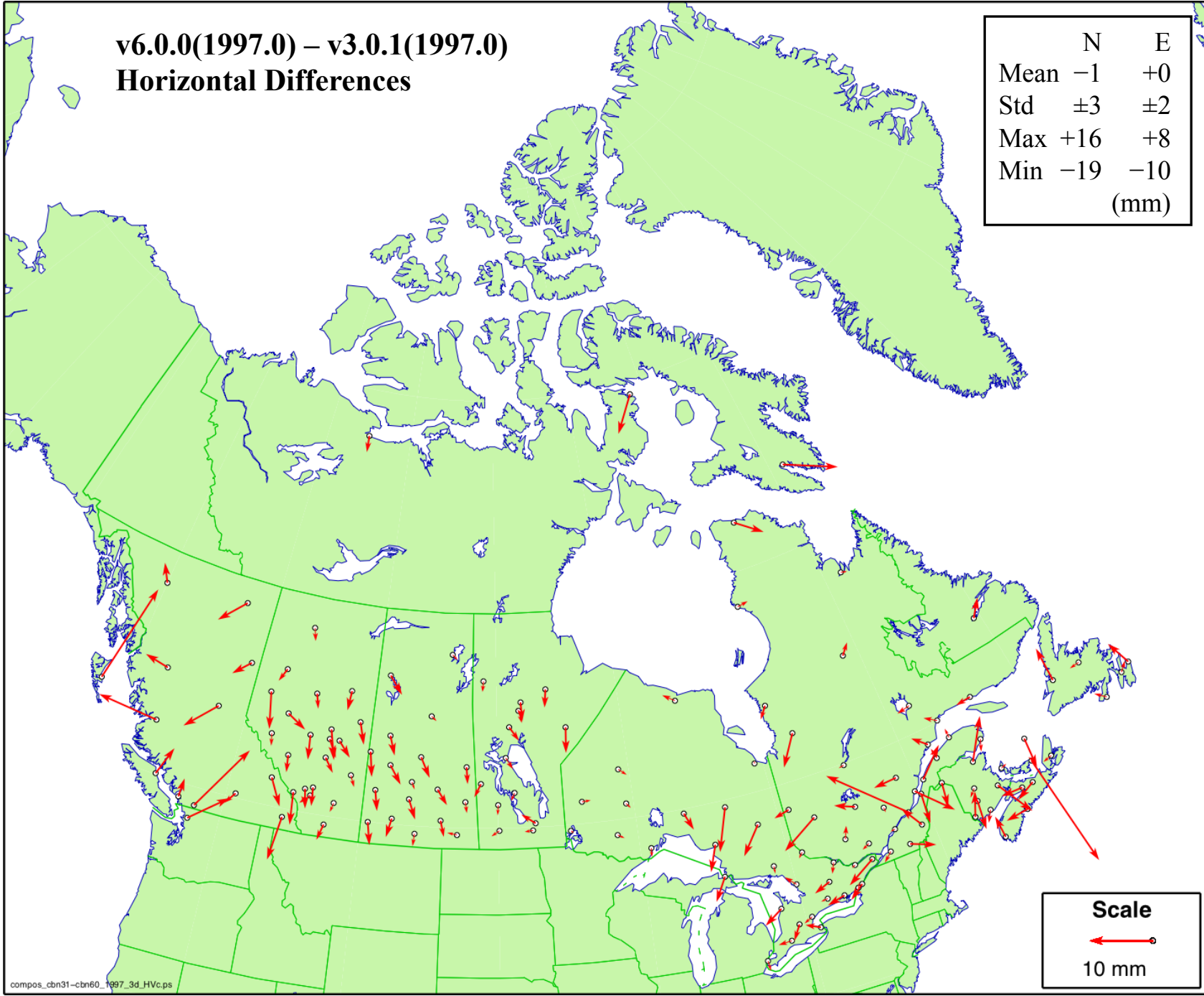
v6.0.0(1997.0) – v3.0.0(1997.0)
Horizontal Differences

	N	E
Mean	-1	+0
Std	±4	±2
Max	+16	+6
Min	-21	-11
	(mm)	



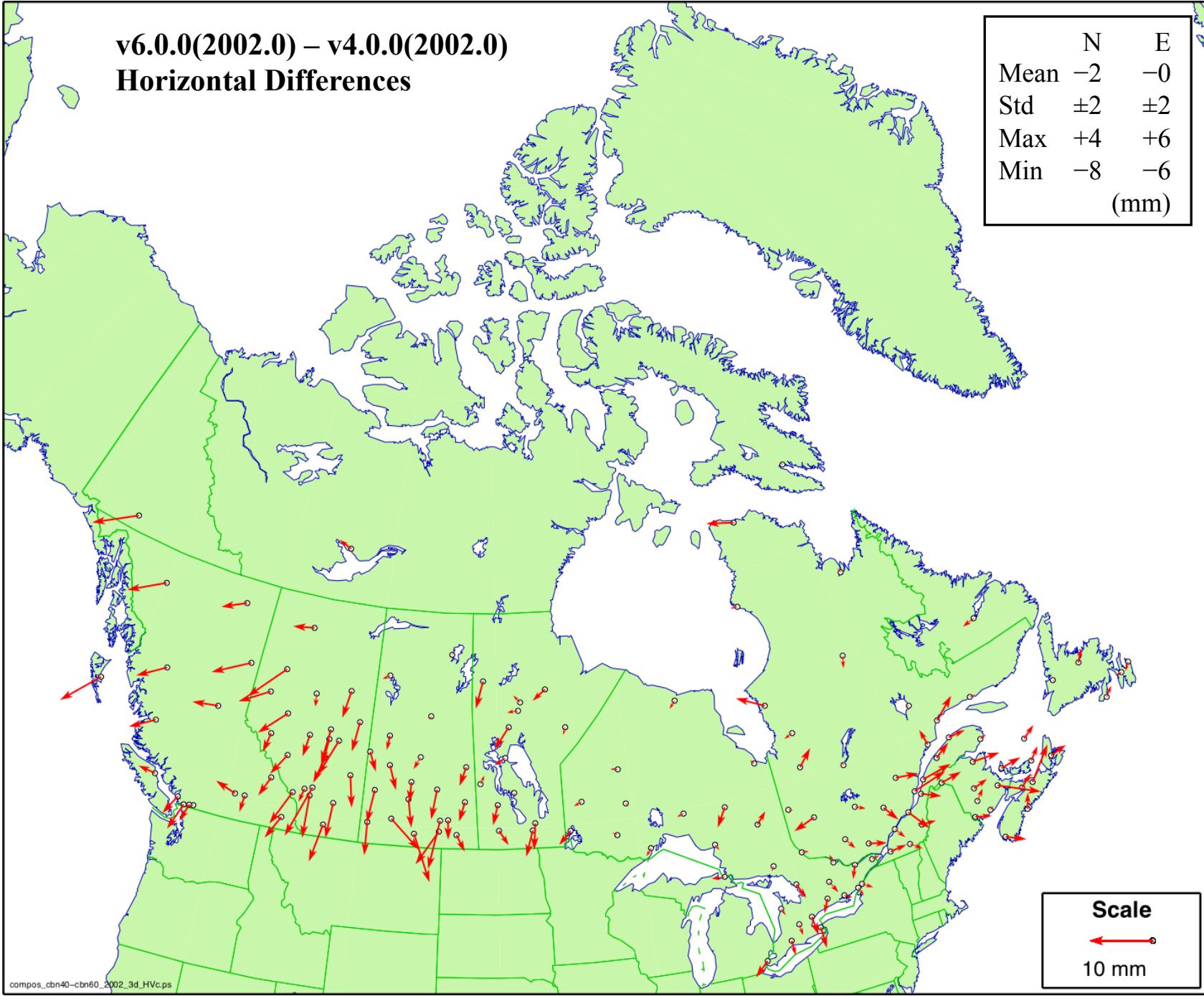
v6.0.0(1997.0) – v3.0.1(1997.0)
Horizontal Differences

	N	E
Mean	-1	+0
Std	±3	±2
Max	+16	+8
Min	-19	-10
	(mm)	



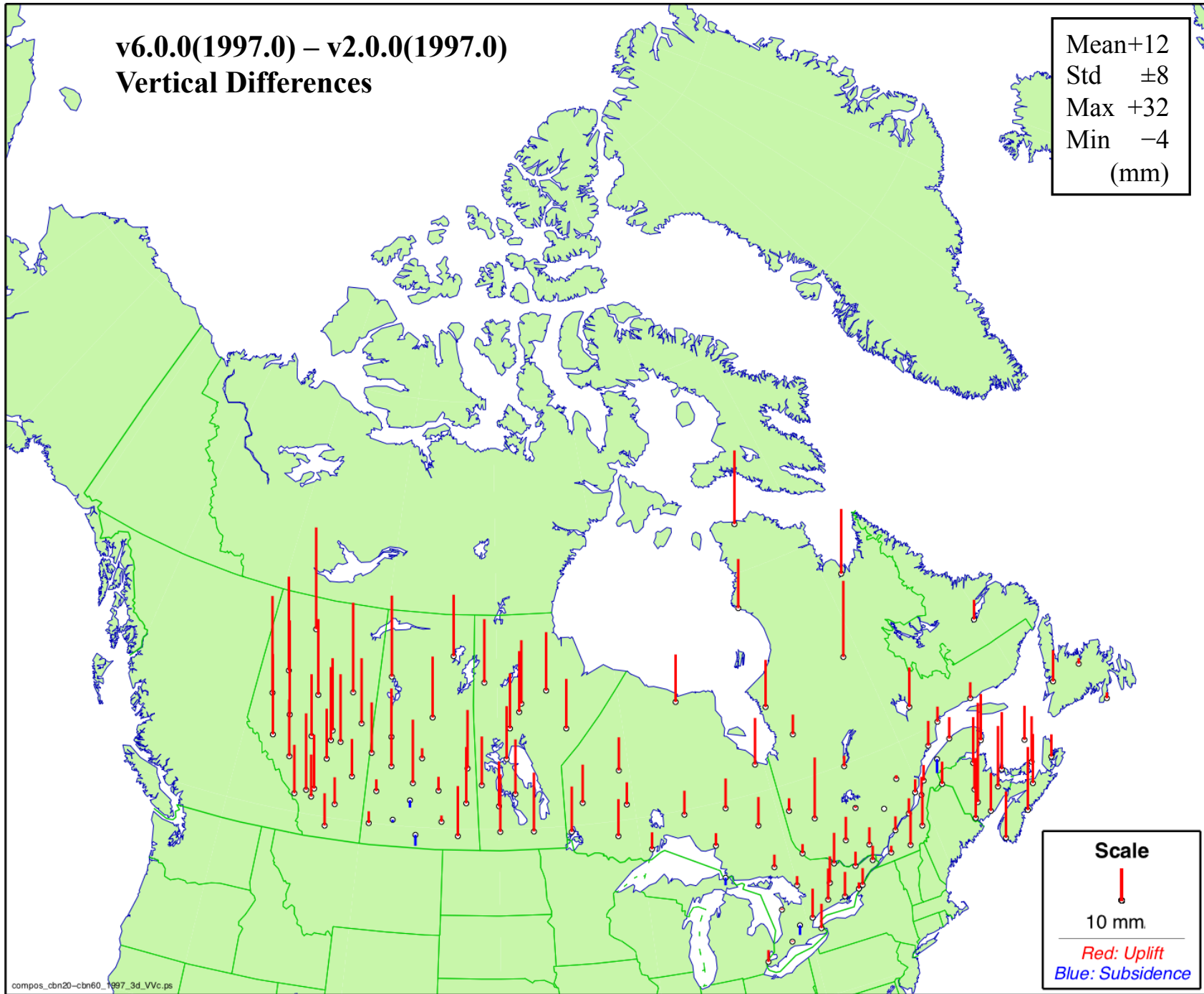
v6.0.0(2002.0) – v4.0.0(2002.0)
Horizontal Differences

	N	E
Mean	-2	-0
Std	±2	±2
Max	+4	+6
Min	-8	-6
	(mm)	



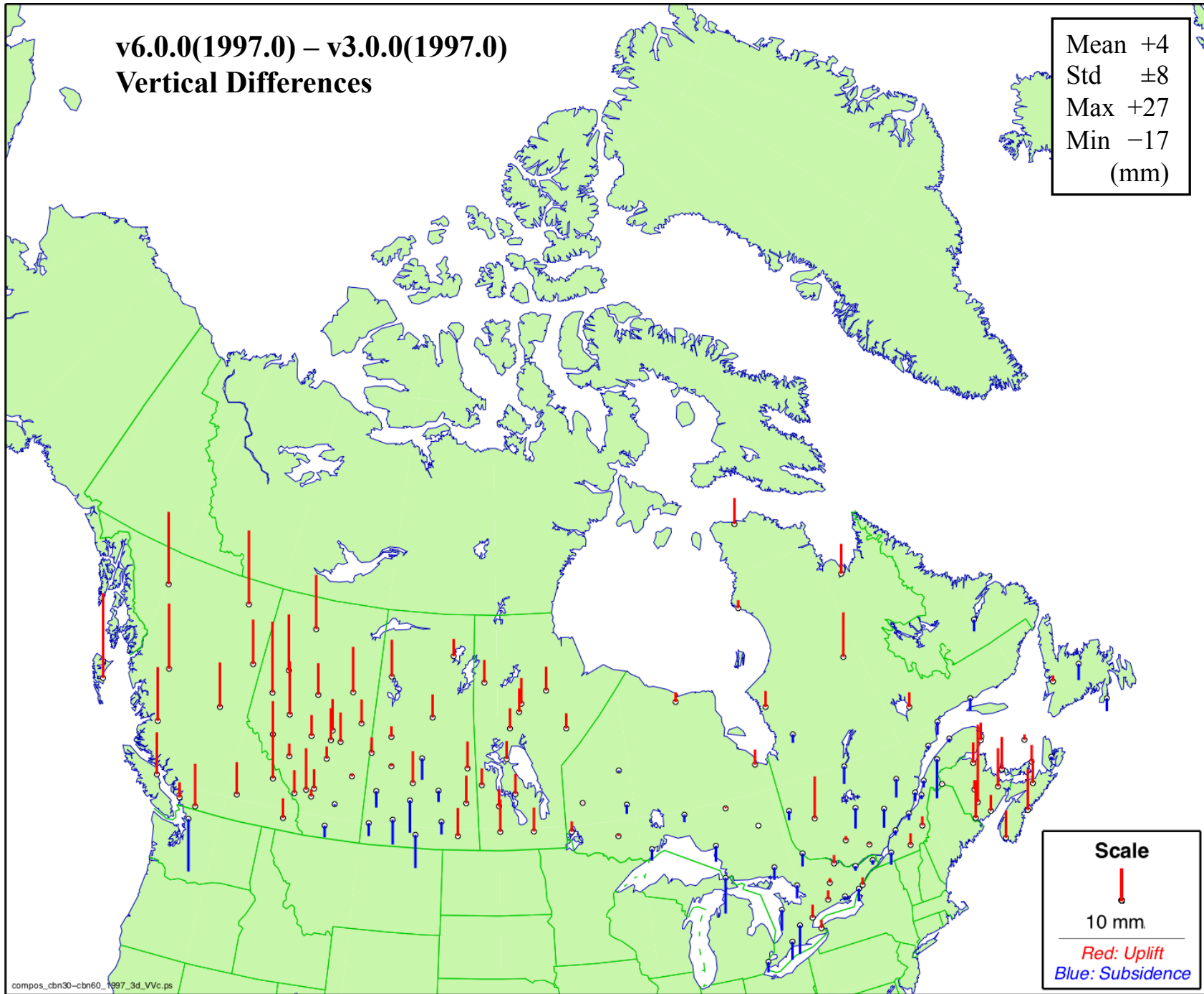
v6.0.0(1997.0) – v2.0.0(1997.0)
Vertical Differences

Mean+12
Std ±8
Max +32
Min -4
(mm)



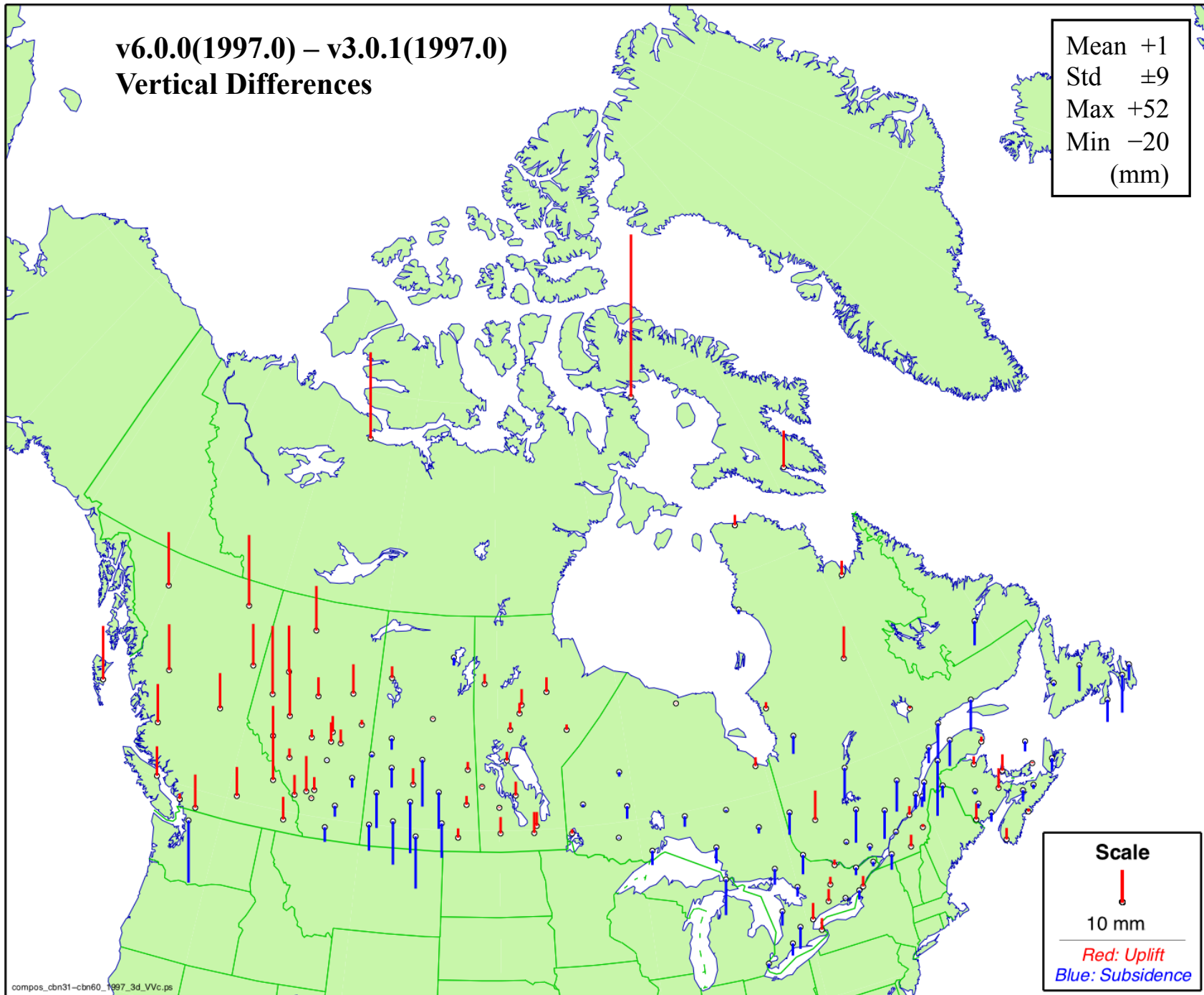
v6.0.0(1997.0) – v3.0.0(1997.0)
Vertical Differences

Mean +4
Std ±8
Max +27
Min -17
(mm)



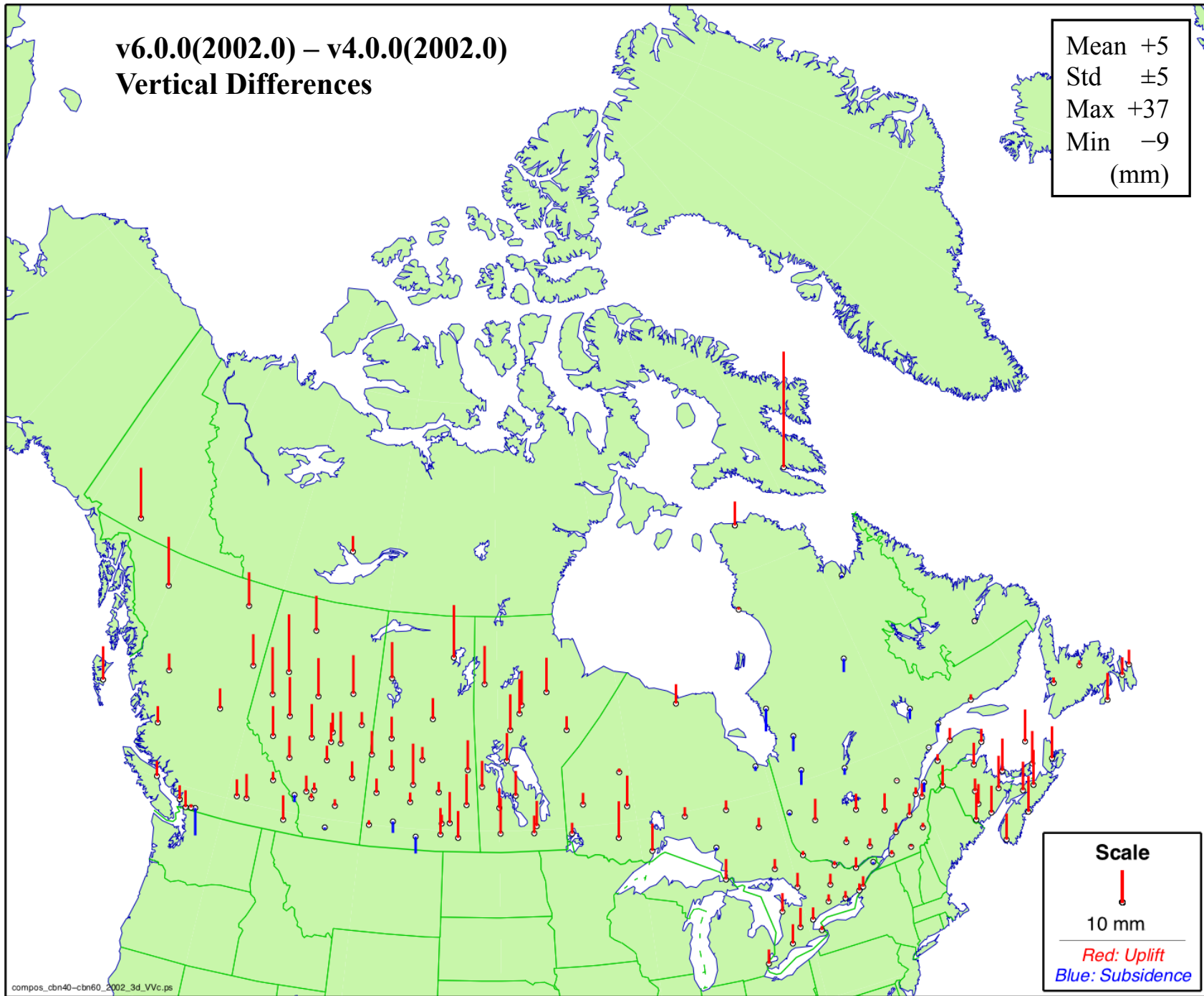
v6.0.0(1997.0) – v3.0.1(1997.0)
Vertical Differences

Mean +1
Std ±9
Max +52
Min -20
(mm)

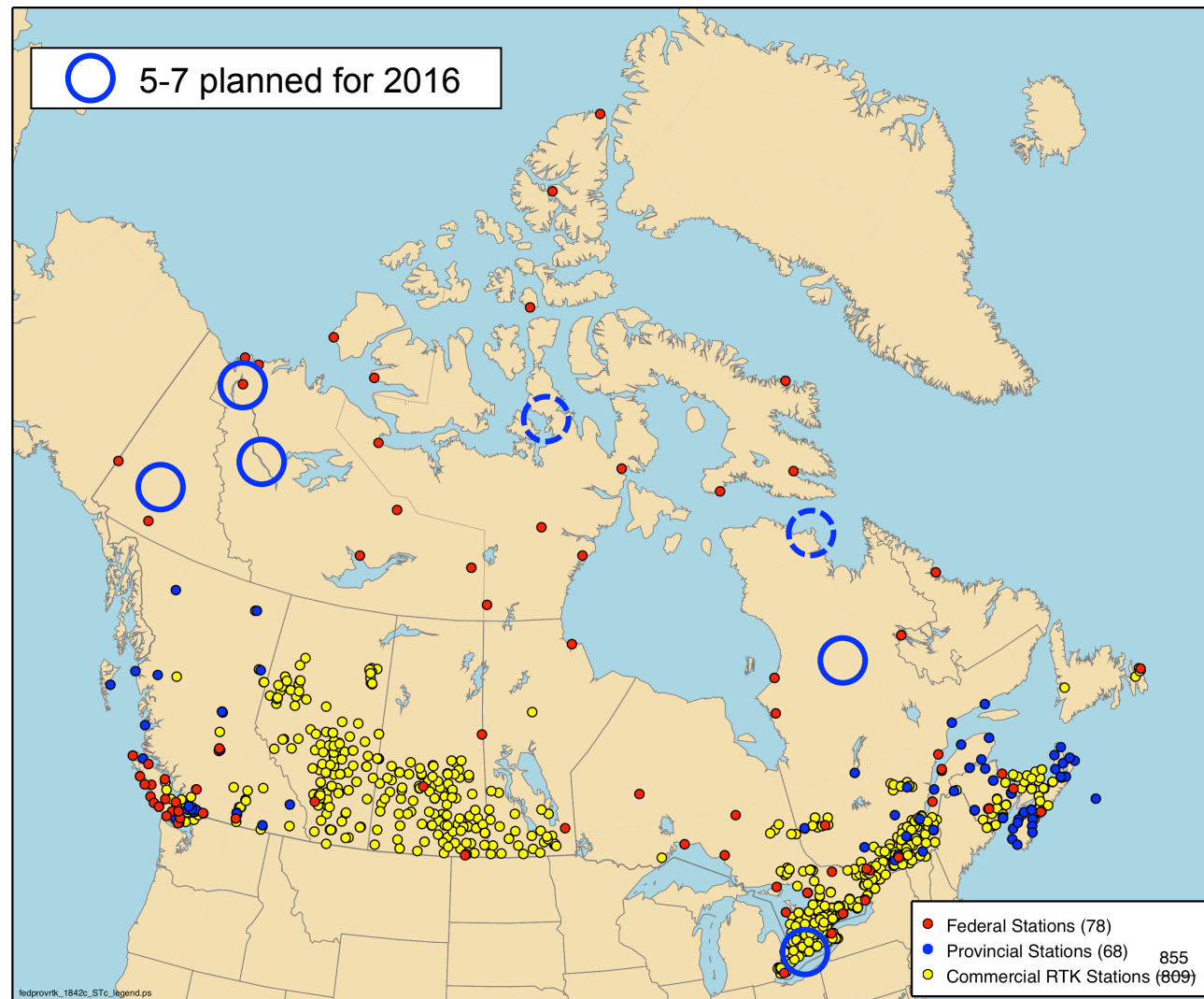


v6.0.0(2002.0) – v4.0.0(2002.0)
Vertical Differences

Mean +5
Std ±5
Max +37
Min -9
(mm)



Current Active Networks



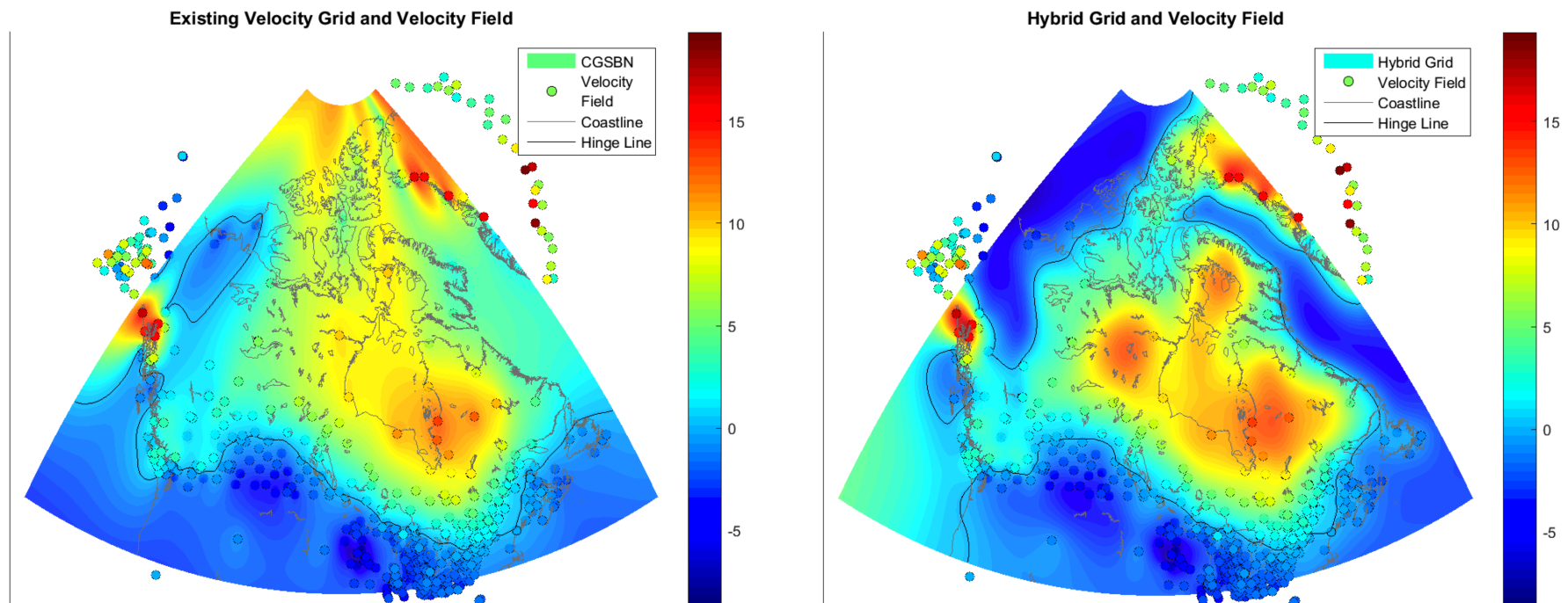
New NAD83(CSRS) v6.1 Solution in Prep

- Previous v6.0 solution based on data up to 2011.3
- New v6.1 will be based
 - Data up to 2016.5
 - Bernese GNSS Software 5.2
 - CODE repro2 orbits (no IGS repro2 orbits available)
 - Reprocessing all CACS, RACS, provincial ACS and neighbouring US CORS
- New velocity model (grid)
 - Previous v6.0 velocity grid based on interpolation of GPS velocity field to grid
 - Problem: few GPS stations in north => poor velocity grid
 - New v6.1 velocity field grid will incorporate ICE-6G GIA model



New NAD83(CSRS) v6.1 Velocity Model

- New hybrid grid based on ICE-6G GIA model constrained to GPS
- Improves GPS model where GPS coverage is poor (in north)
- Not much change in southern parts



NAD83 Replacement

- U.S. plans to replace NAD83 & NAVD88 by 2022
- Will be based on latest ITRF fixed to the North American tectonic plate
- Also implementing a new geoid-based vertical datum
- US-Canada vertical datums will be compatible (same W_0)
- Geometric reference frames will not be (> 1 m difference)
 - Need to consider moving to same reference frame in Canada for compatibility in bordering regions
- CGS & NGS discussing naming and methodologies for defining the new datums



International Great Lakes Datum

- Vertical datum for monitoring & managing water levels in the Great Lakes & St. Lawrence River
 - IGLD 1985 current datum
 - Need to update for crustal motion (GIA) every 25-35 years
 - **Next update planned for 2017-2023 (IGLD 2020)**
 - Will be based on a North American geoid compatible with CGVD2013
- GPS Campaign Surveys
 - Used to monitor stability of IGLD benchmarks and improve crustal motion model in the region
 - Past surveys: 1997, 2005, 2010
 - **Completed survey in summer 2015 (Aug-Sep) – with CBN's in region**
 - **New survey expected in summer 2020**

