IGS, NAREF & CBN Velocity Fields for Monitoring GIA in Canada

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COST ES0701 WG2
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Dresden, Germany
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Natural Resources Canada | Ressources naturelles Canada

Canada

Outline

IGS Repro1 weekly solutions (CGPS)

NAREF velocity solution (CGPS)

CBN velocity solution (campaign GPS)

Future plans

IGS Repro1

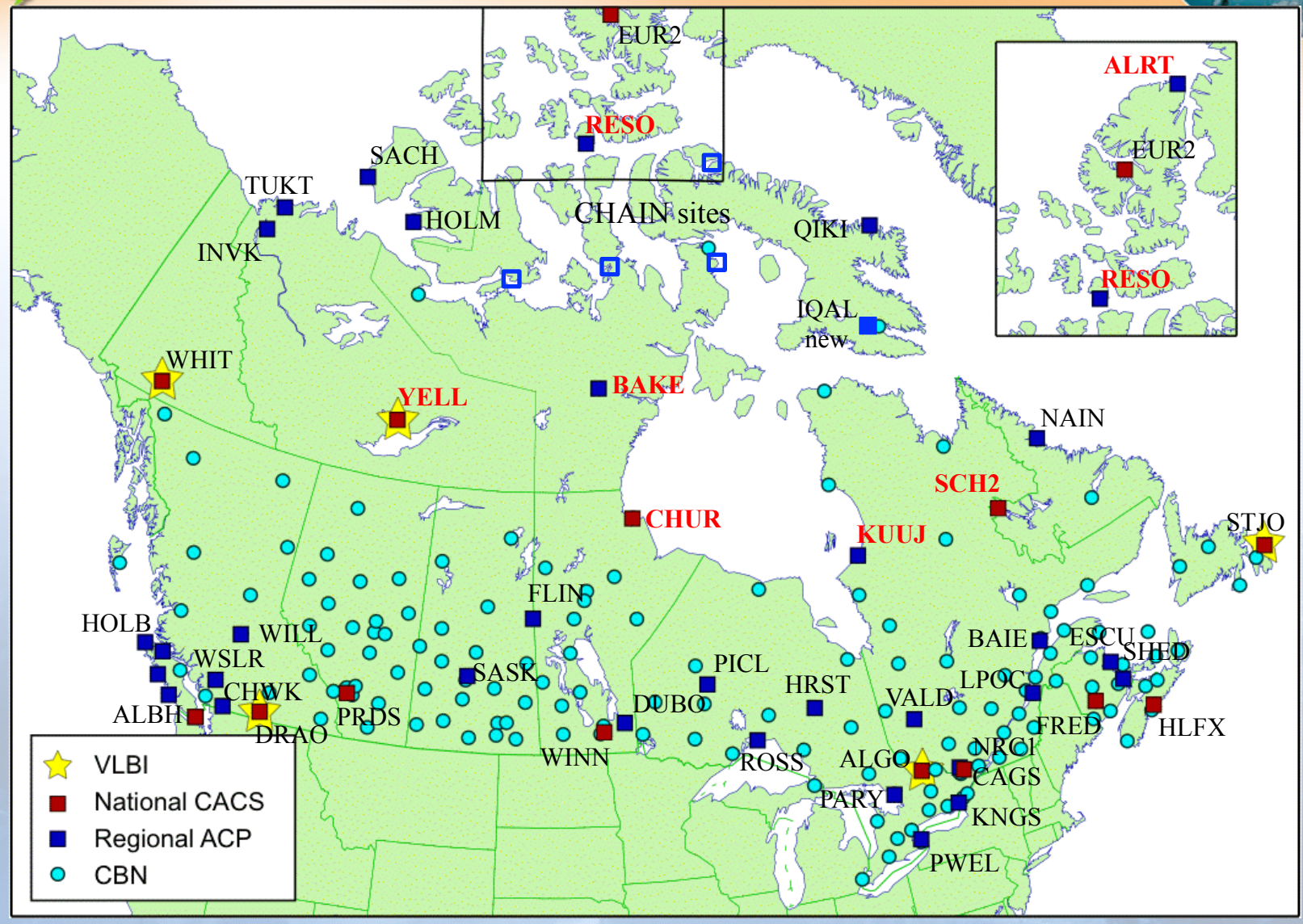
Repro1 Weekly Coordinate Solutions

- IGS-AC Mail of 5 Mar 2010
  Weekly summaries, ERP and SSC files distributed to IGS ACs
- Aligned to IGS05
- "Almost final" results
- Not expected to change much (maybe only the oldest solutions)
- Will be posted soon to CDDIS

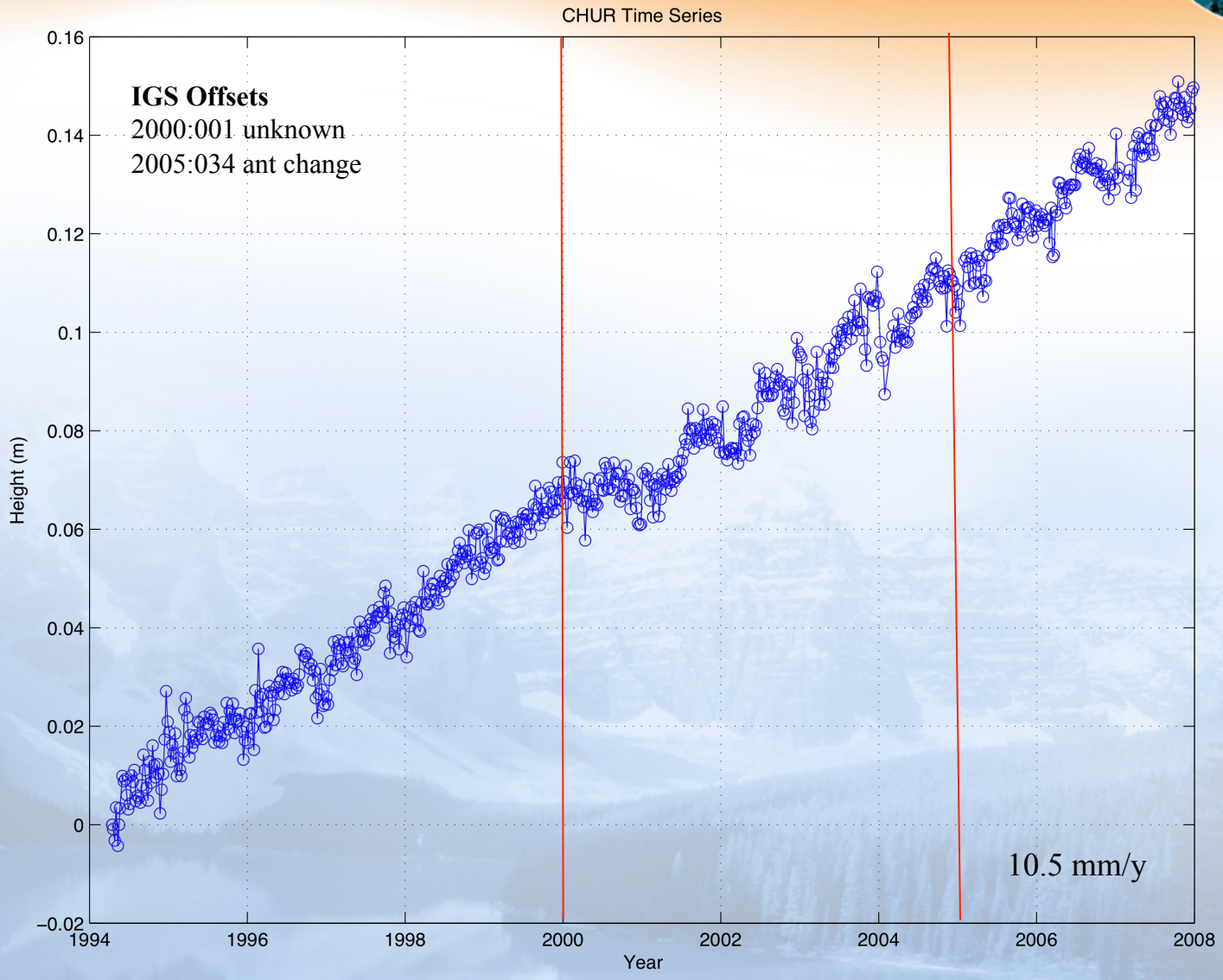
Summary statistics

- ~700 stations
- >1 yr of data at all stations
- ~80 non-official IGS stations without DOMES numbers included due to long time series (will be getting DOMES)

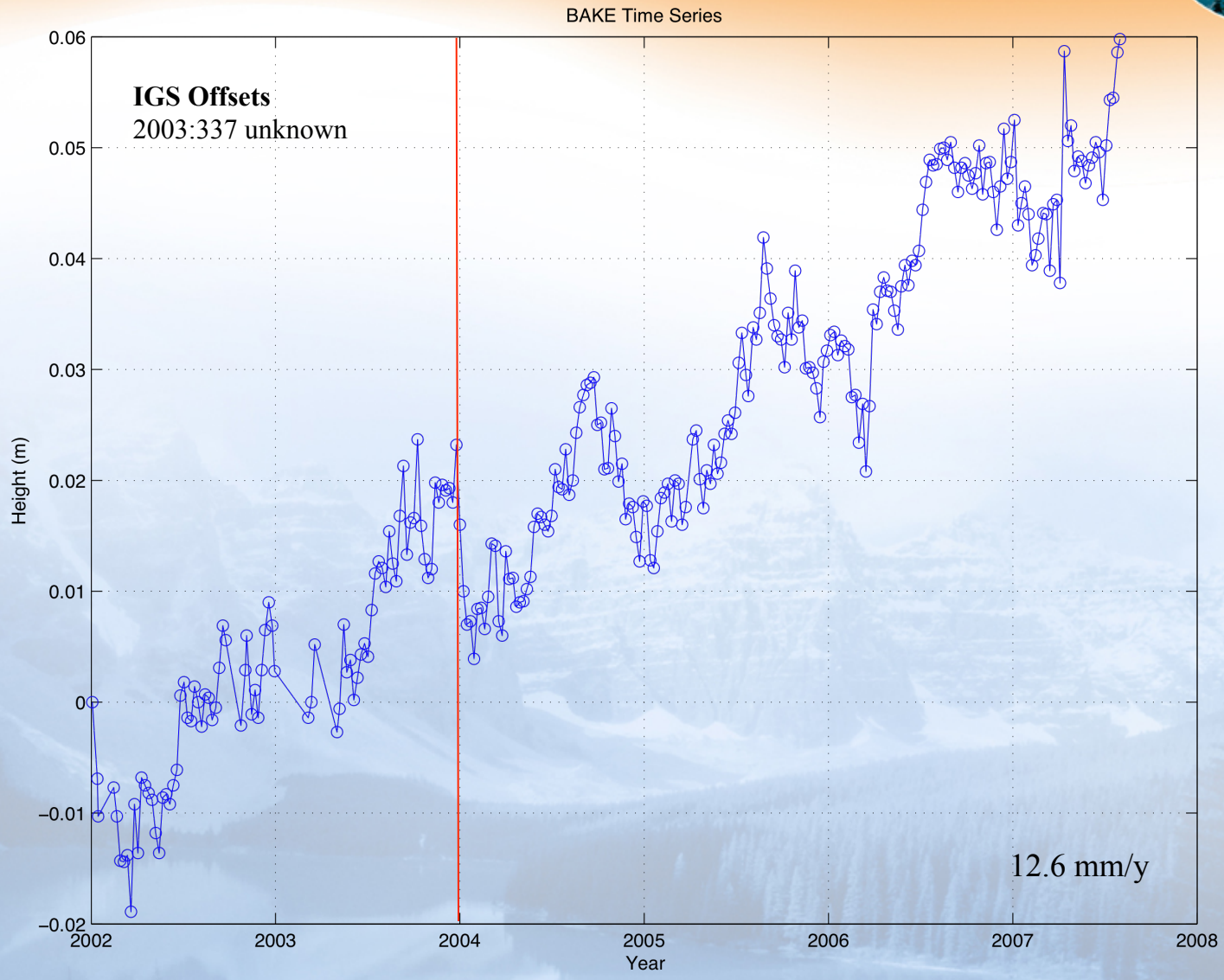
Canadian IGS Sites



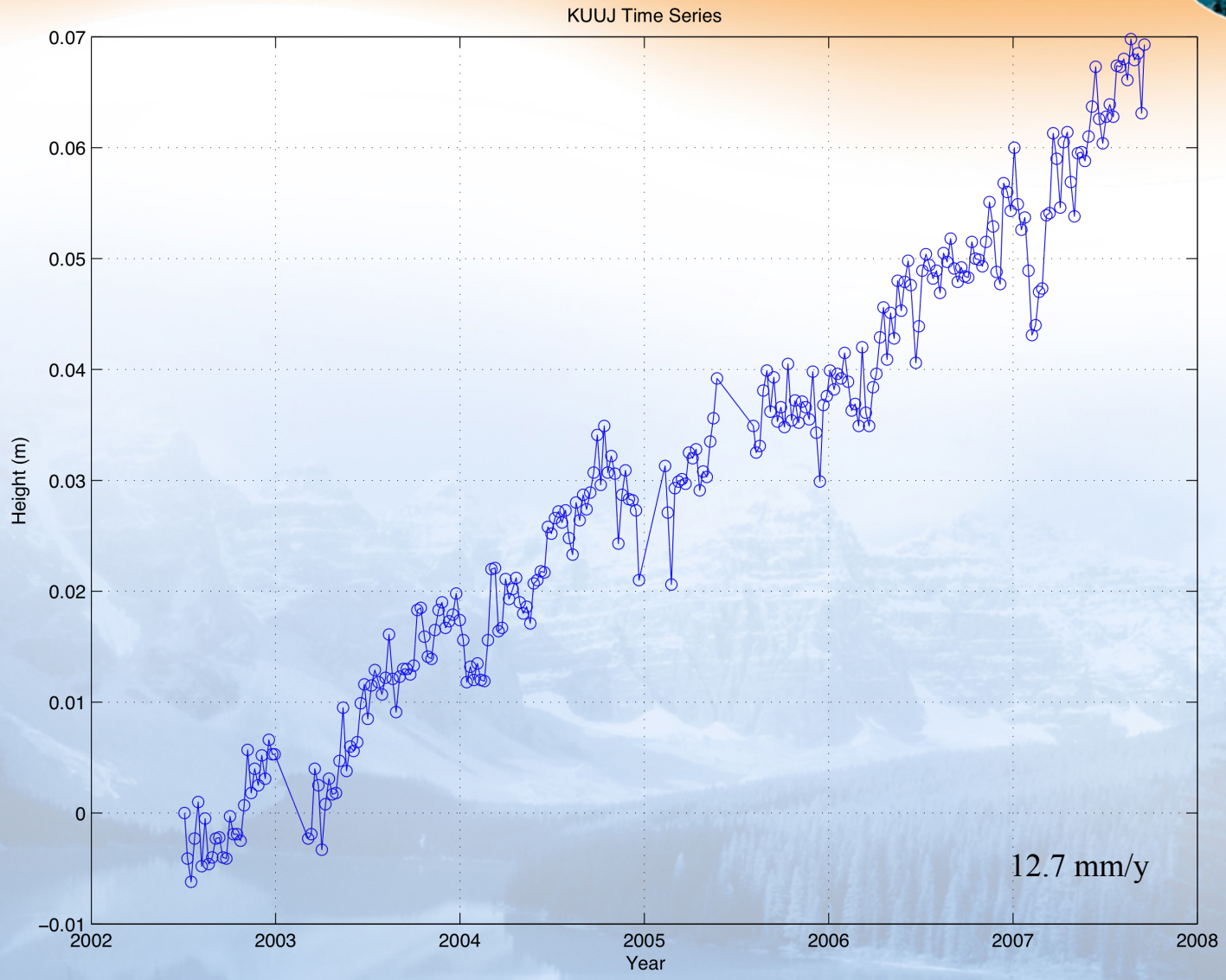
CHUR Vertical Time Series



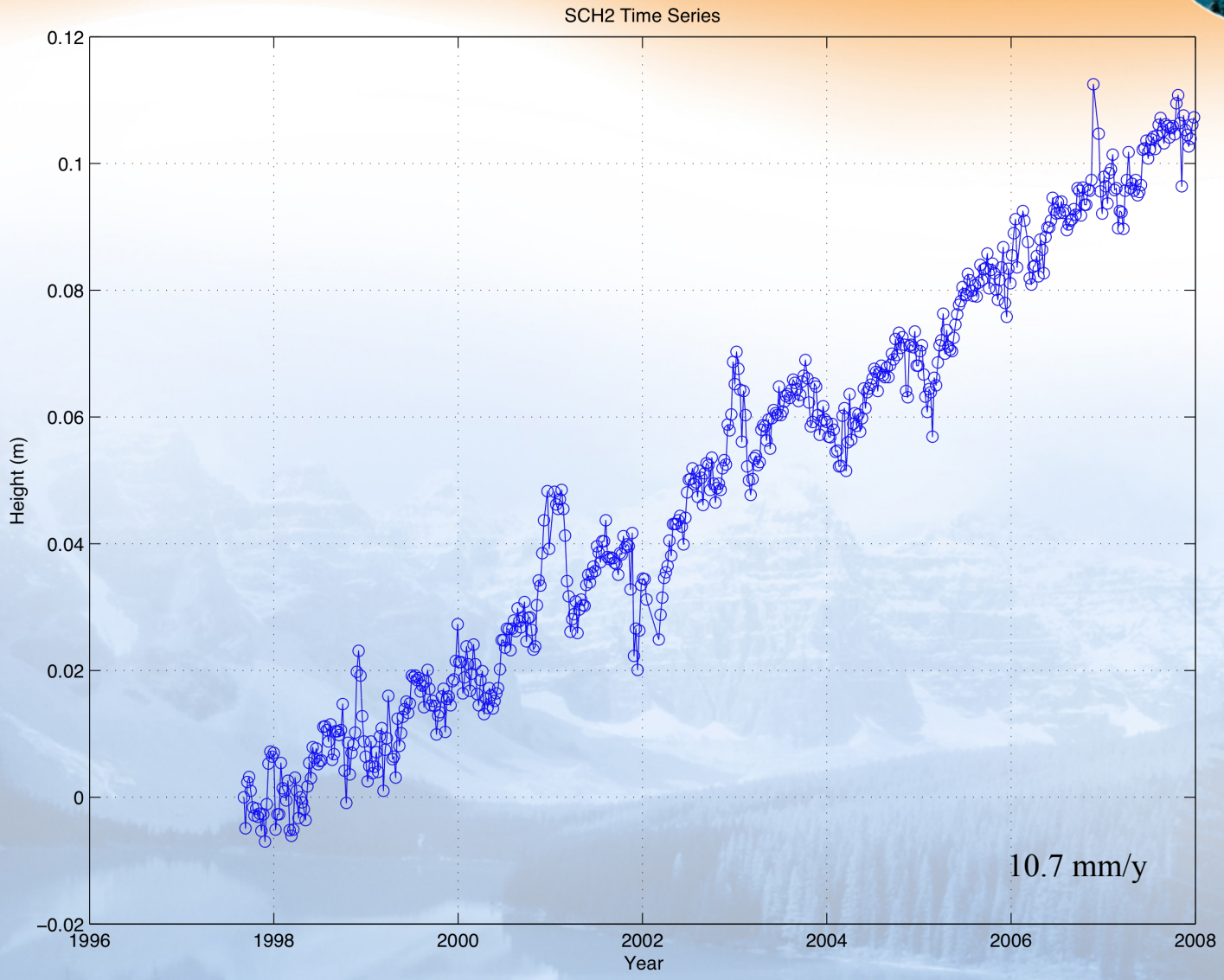
BAKE Vertical Time Series



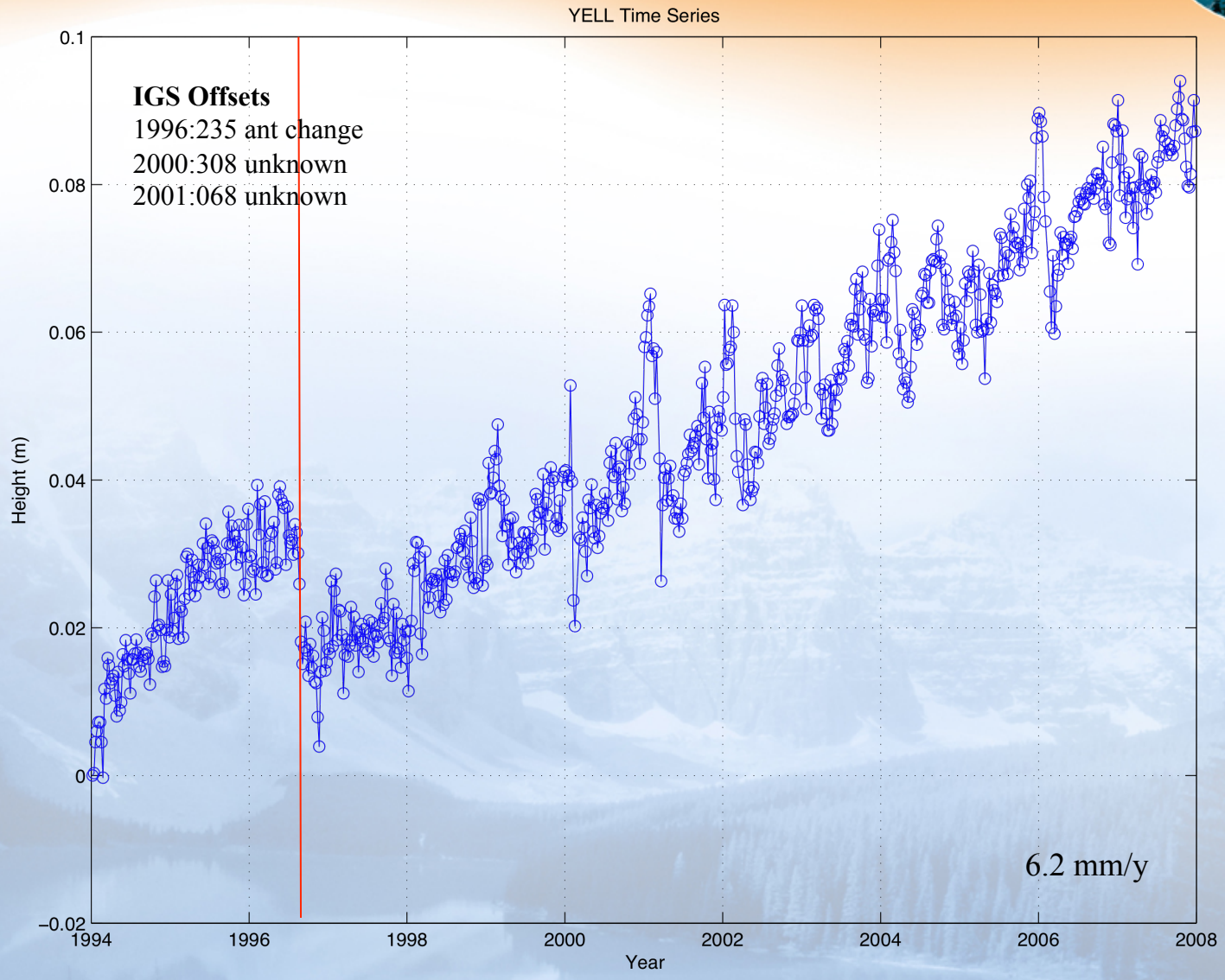
KUUJ Vertical Time Series



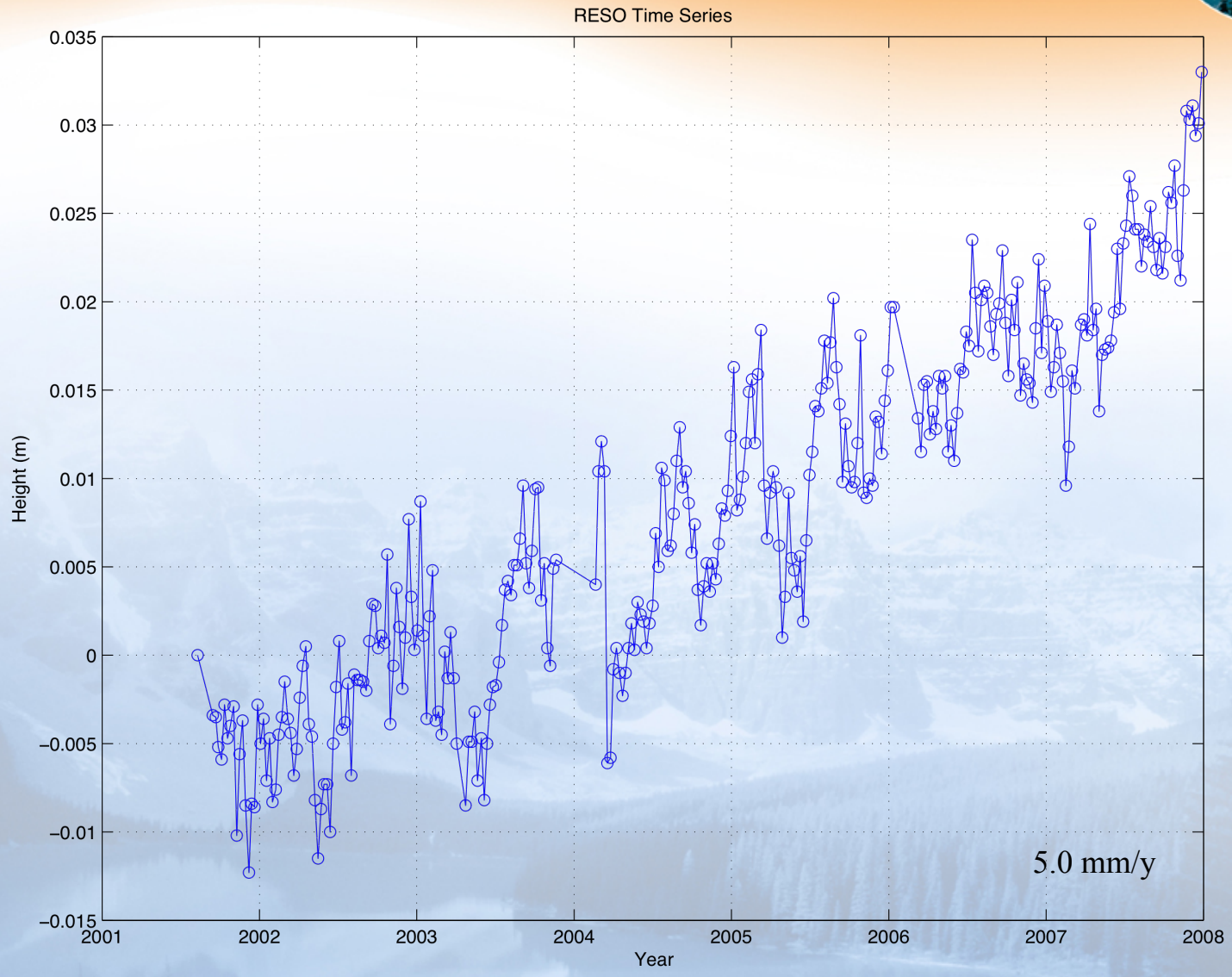
SCH2 Vertical Time Series



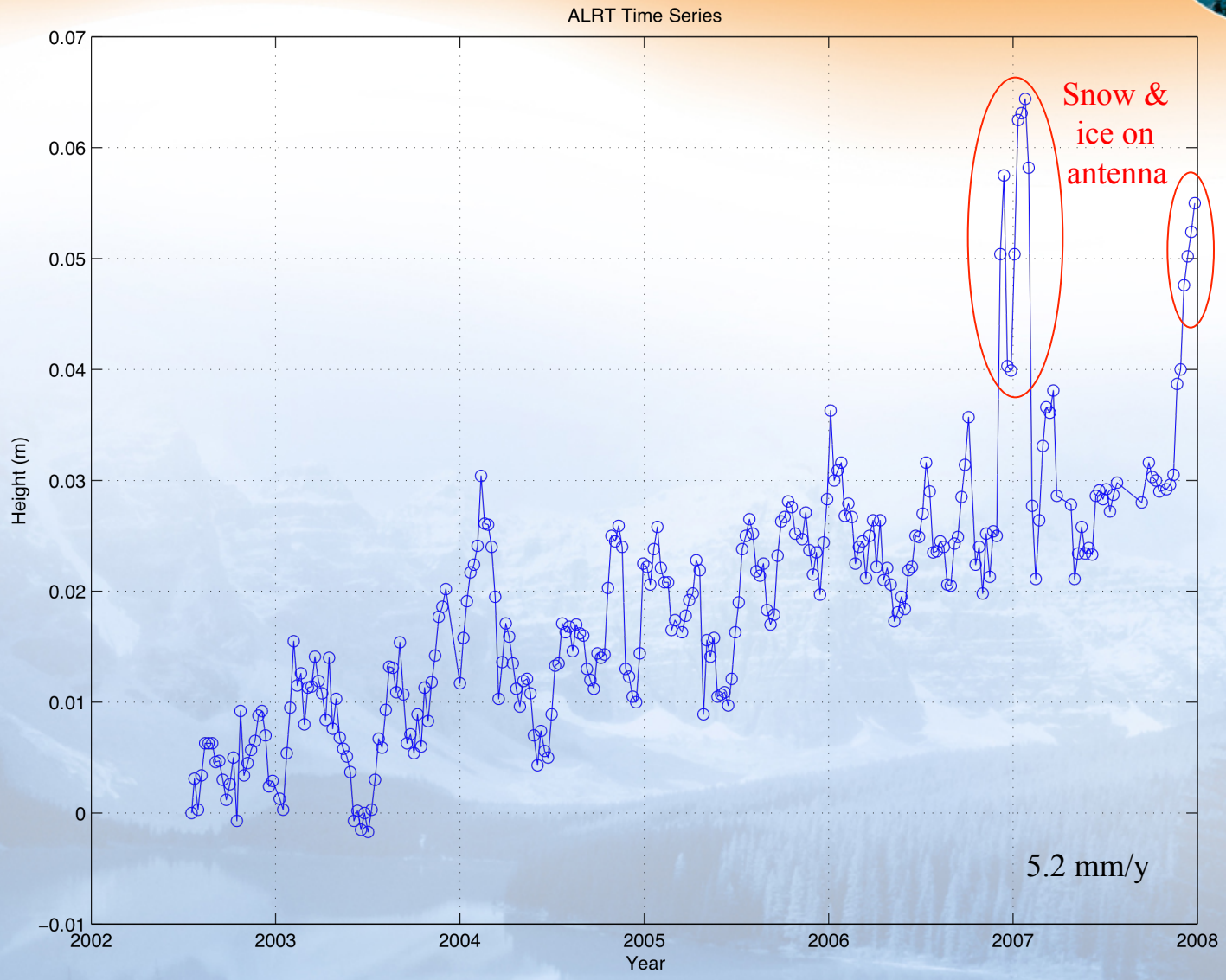
YELL Vertical Time Series



RESO Vertical Time Series



ALRT Vertical Time Series



NAREF

NAREF – North American Reference Frame Working Group

- IAG Regional Subcommission 1.3c (Regional Reference Frames for North America)
- Densification of ITRF in North America
- Consolidating regional networks into a continental one
- Integrating into ITRF via IGS global network

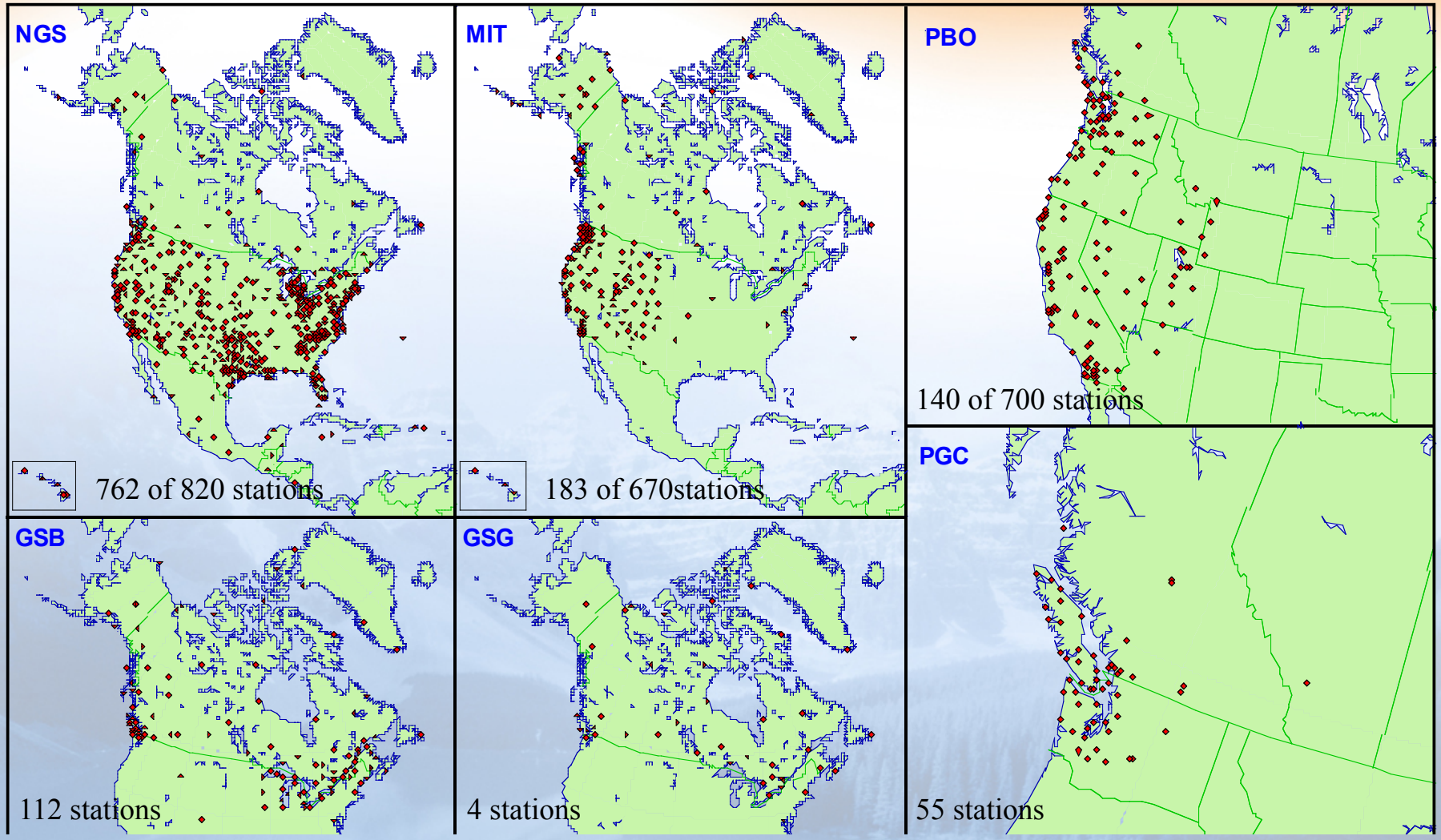
Coordinate & Velocity Solutions

- Weekly combinations of regional solutions – *behind schedule*
- Periodic cumulative (velocity) solutions

Current Results

- *Cumulative solution based on relative antenna PCV and old IGS orbits*
- Waiting for final IGS repro1 orbits to reprocess with absolute PCV

NAREF Contributors (Week 1399)

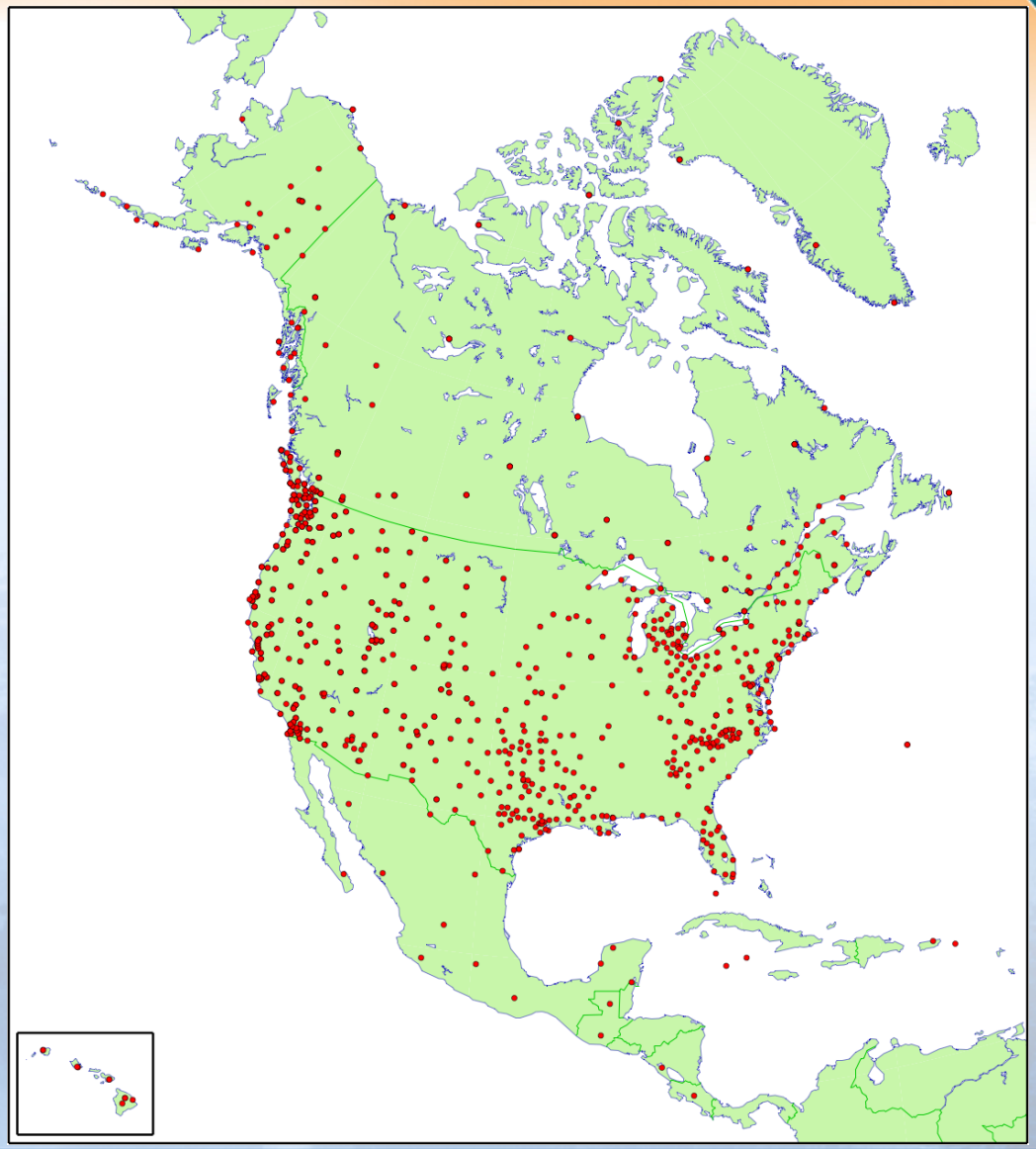


NAREF Combination Network

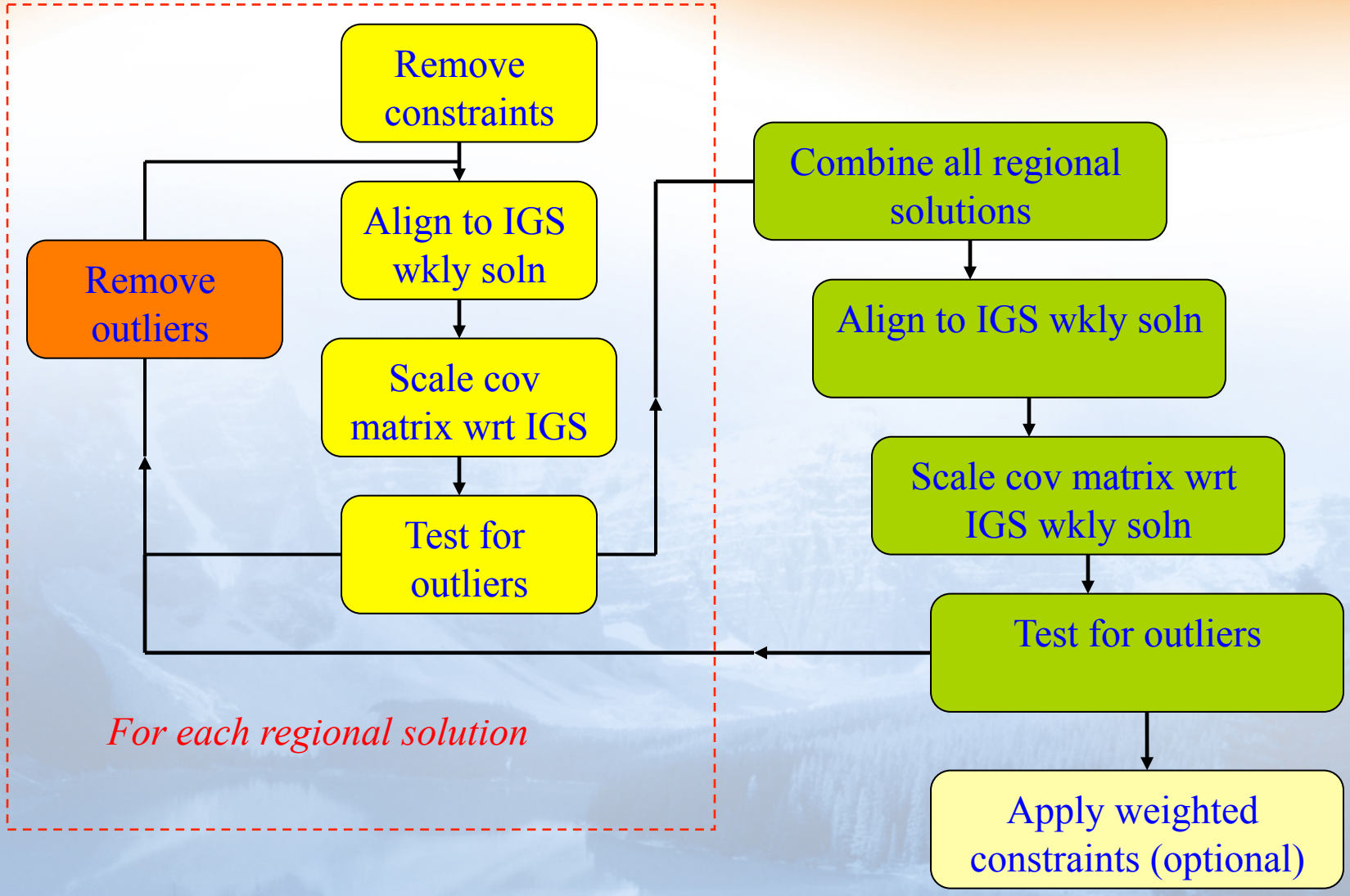
GPS Week 1399

708 stations total

56 regional IGS RF stations



Weekly Combination Procedure



NAREF Cumulative Combination

1) Removed a priori constraints from weekly NAREF solutions
2) Aligned weekly solutions to IGS05
   - 7 parameter transformation
   - Used 11 N.A. sites in IGS05 – *will use ~50 global site for repro*
   - Propagated IGS05 to epoch of week
3) Combined aligned weekly solutions & estimated *linear velocities only*
   - Used official IGS/ITRF discontinuity table + NAREF discontinuities
4) Applied velocity equivalence constraint across discontinuities where appropriate
5) Re-aligned cumulative solution to IGS05 (14 parameters)
6) Analysed (visually) residual time series for additional discontinuities
   - Add to discontinuity table and redo from step (3)

NAREF Velocity Solution

Summary statistics

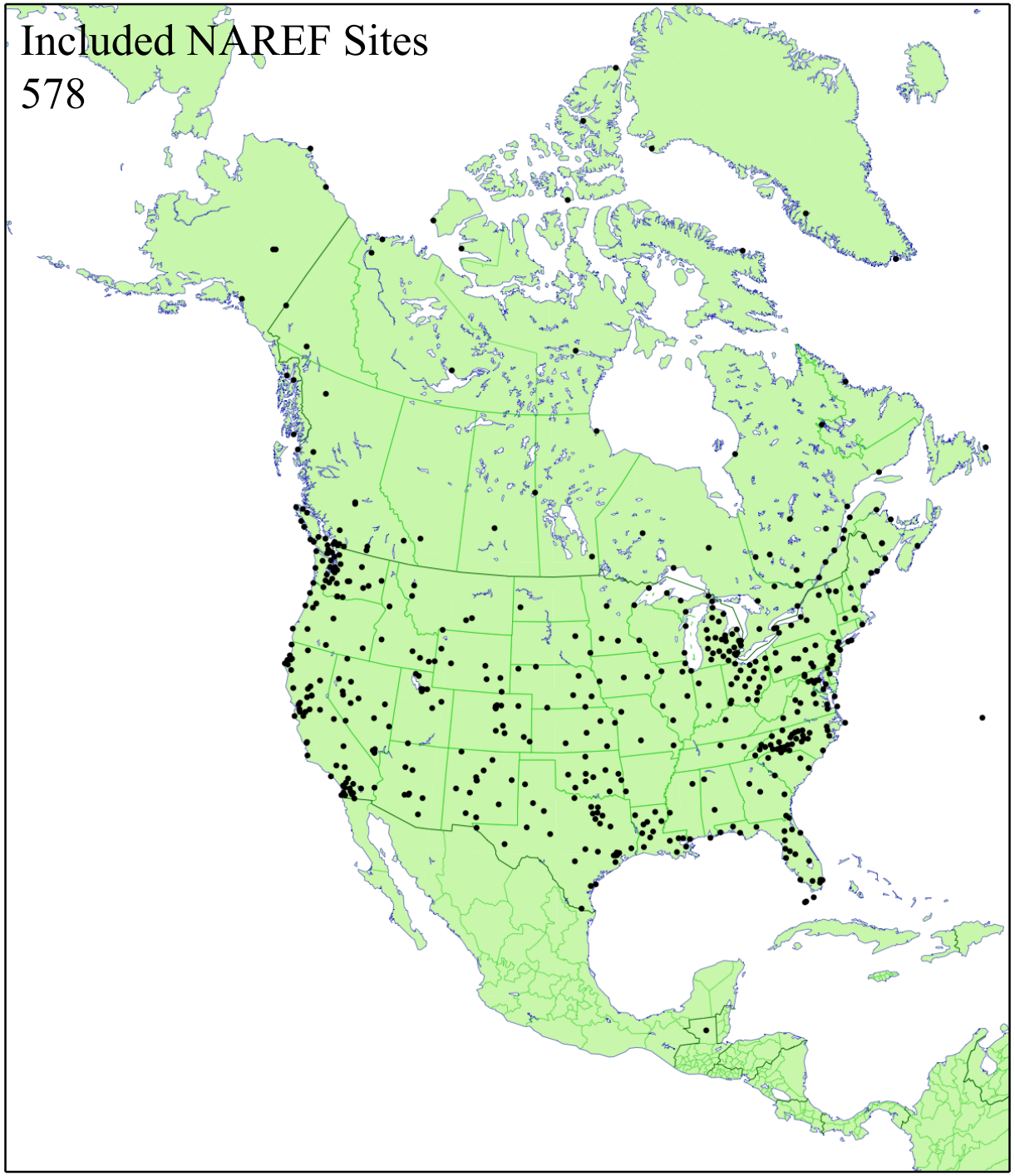
- Time span of weekly solutions — 2001-2006 (wks 1195-1399)
- Number of weekly solutions used — 305
- Number of stations available — 906
- Number of stations used — 578 (328 omitted*)

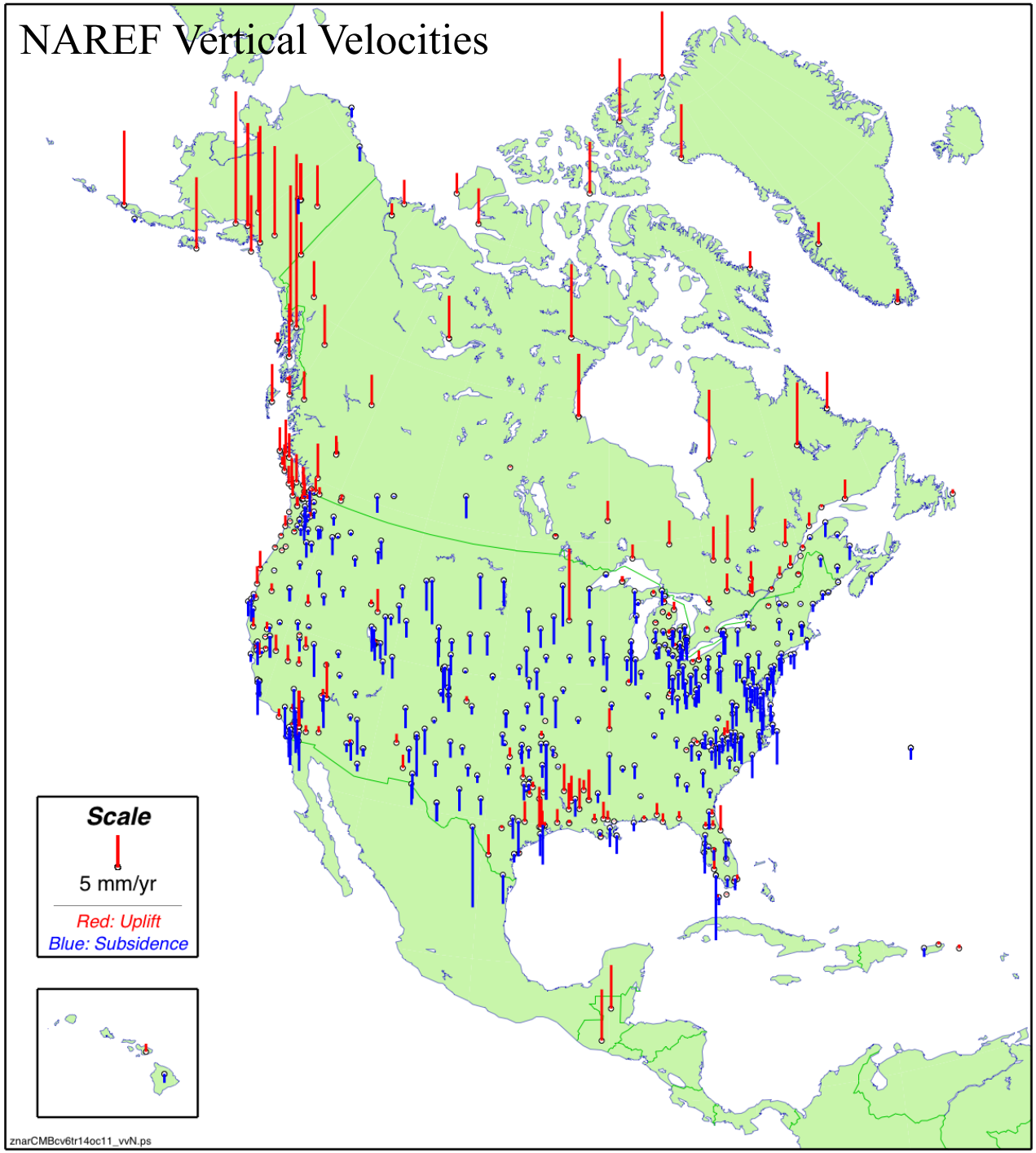
*Reasons for omitting sites

- Short time span (less than 2 yr) — ~260 sites
- Collocated/redundant sites (mainly USCG sites) — ~50 sites
- "Bad" time series (noisy, gaps, multiple offsets) — ~20 sites

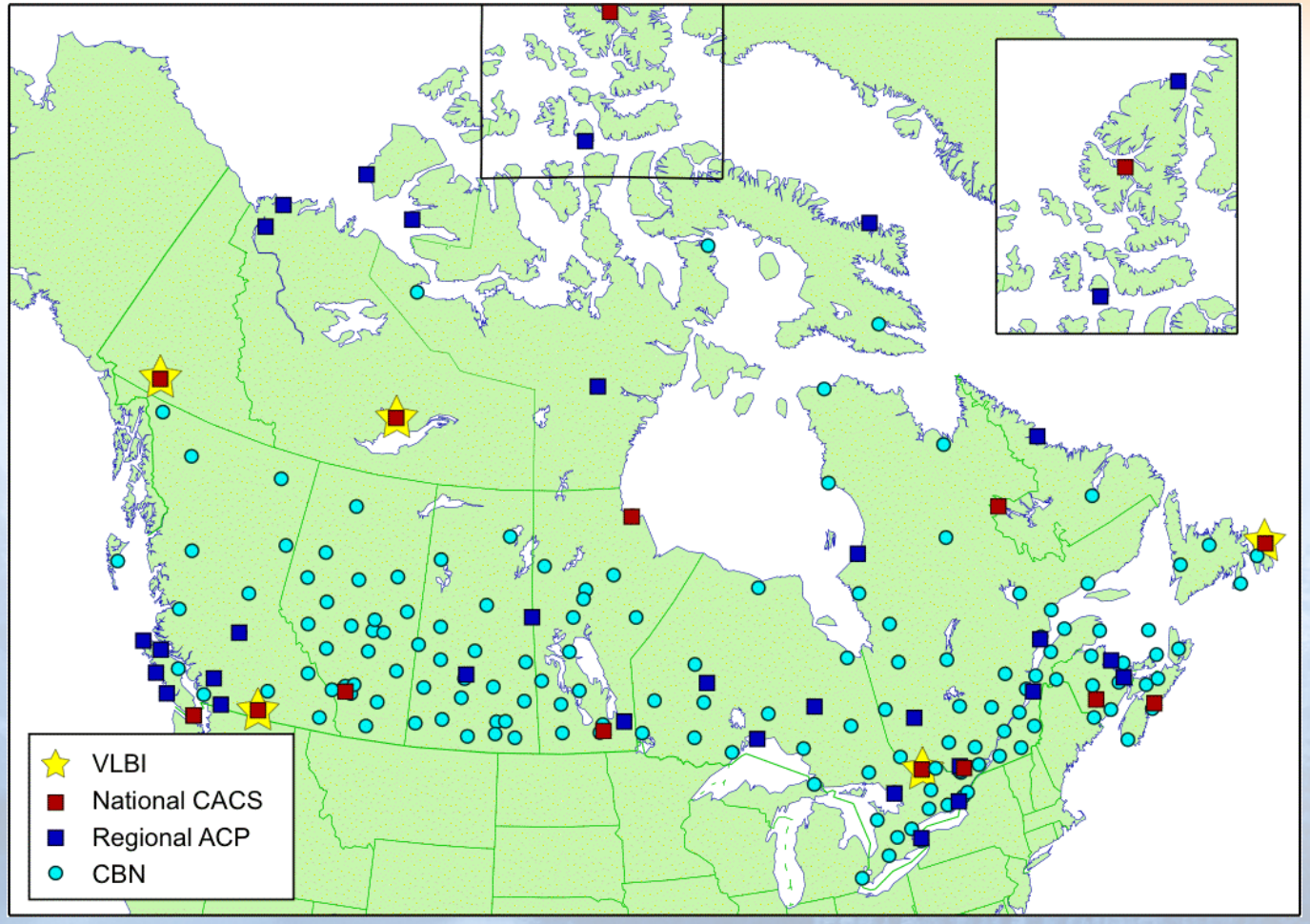
Non-linear motions

- No periodic or other non-linear motions accounted for
- Only linear velocities used


Included NAREF Sites
578


NAREF Vertical Velocities
Scale
5 mm/yr
Red: Uplift
Blue: Subsidence
znarCMBcv6tr14oc11_vvN.ps

Canadian Base Network (CBN)



CBN Monumentation

- Concrete or metal pillars anchored to bedrock except in Prairies
- Forced centering antenna mounts
- Same monumentation as most IGS sites in Canada

CBN Data & Campaign Solutions

CBN survey campaigns

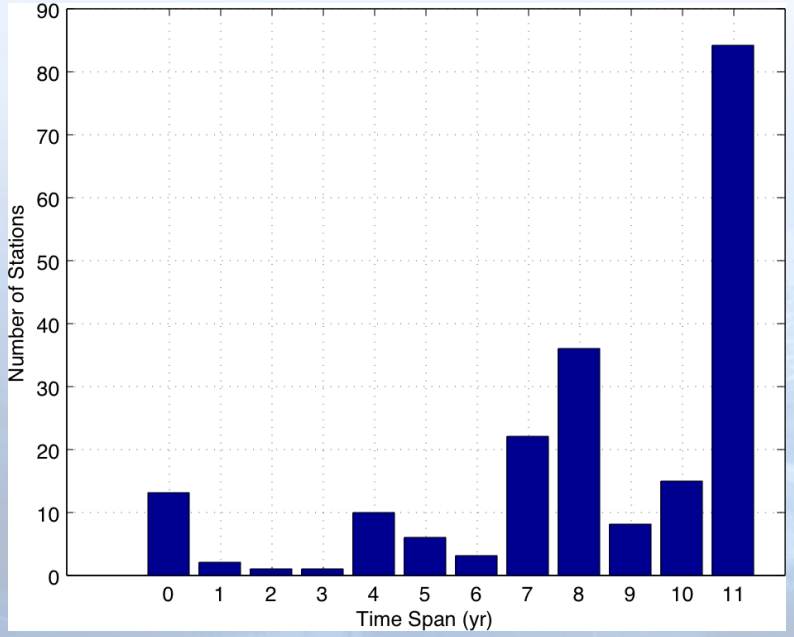
- Network of stable pillars with forced-centering mounts (same as most IGS sites in Canada) – anchored to bedrock in GIA area
- Using 38 repeated campaign surveys from 1994 to 2010
  - 1st major campaign 1994-1999 (no 1998)
  - 2nd major campaign 2001/2002
  - 3rd major campaign 2005/2006
  - Dozens of smaller campaigns (several with only one CBN)
- Each stations occupied multiple times in each major campaign
  - 3-5 independent occupations
  - 24 hr observation sessions

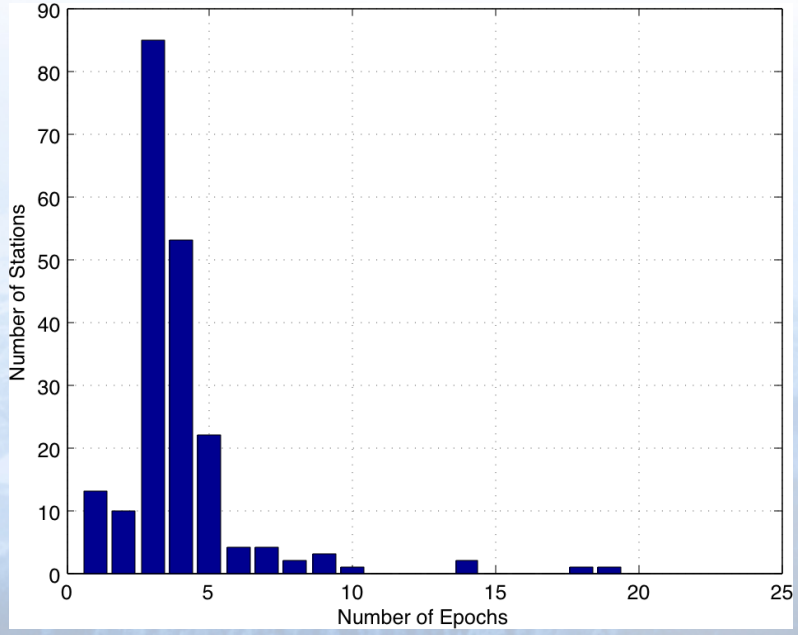
GPS processing with Bernese GPS Software v5.0

- Same processing strategy as for continuous GPS
- *Reprocessed with absolute antenna PCV & CODE repro1 orbits*

CBN Statistics

- Number of stations (incl. IGS sites) 206
- Total number of parameters 1,170

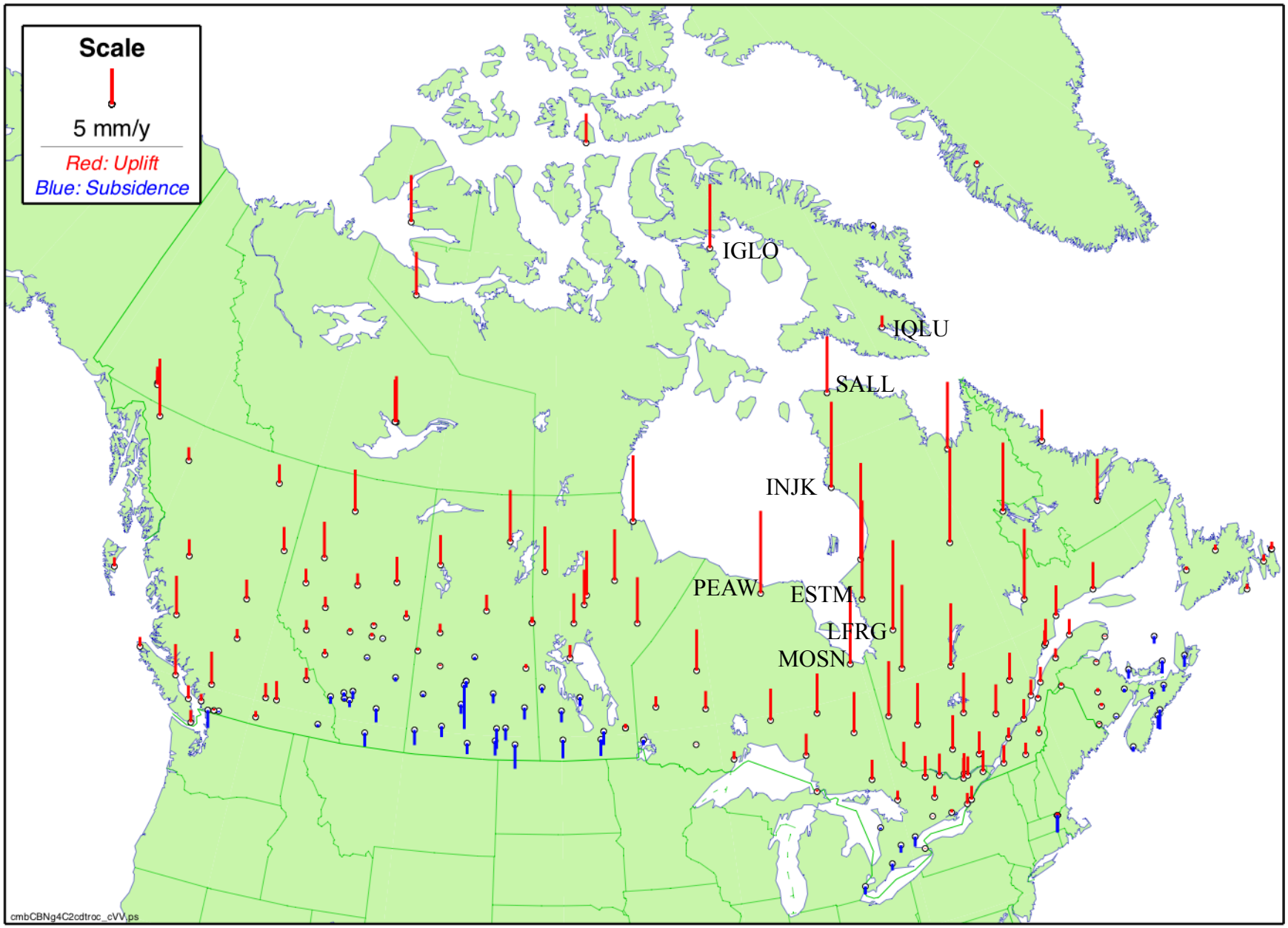




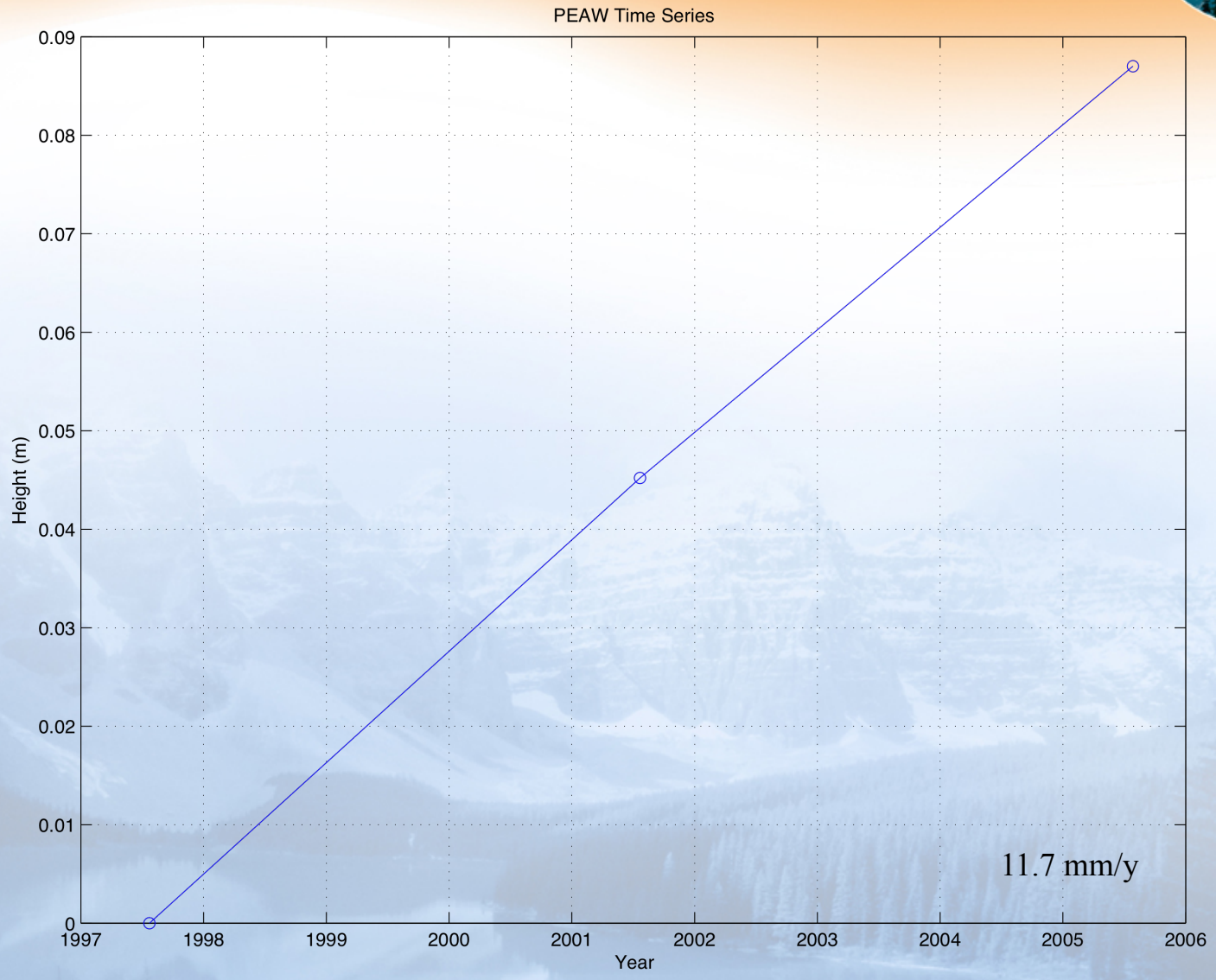
CBN Cumulative Solution

1) Removed a priori constraints from individual CBN solutions
2) Aligned solutions to common sites in IGS05
   - 7 parameter transformation
   - IGS05 propagated to epoch of each CBN solution
3) Each CBN covariance matrix scaled by WRMS of residual from alignment
4) Combined all aligned/scaled CBN solutions (summation of normals) & estimated velocities
   - Used official IGS/ITRF discontinuity table for IGS sites
   - Optionally included translations for each solution
5) Applied velocity equivalence constraint across discontinuities where appropriate
6) Re-aligned cumulative solution to IGS05 (14 parameters)
7) Optionally included IGS05 solution as a priori constraints

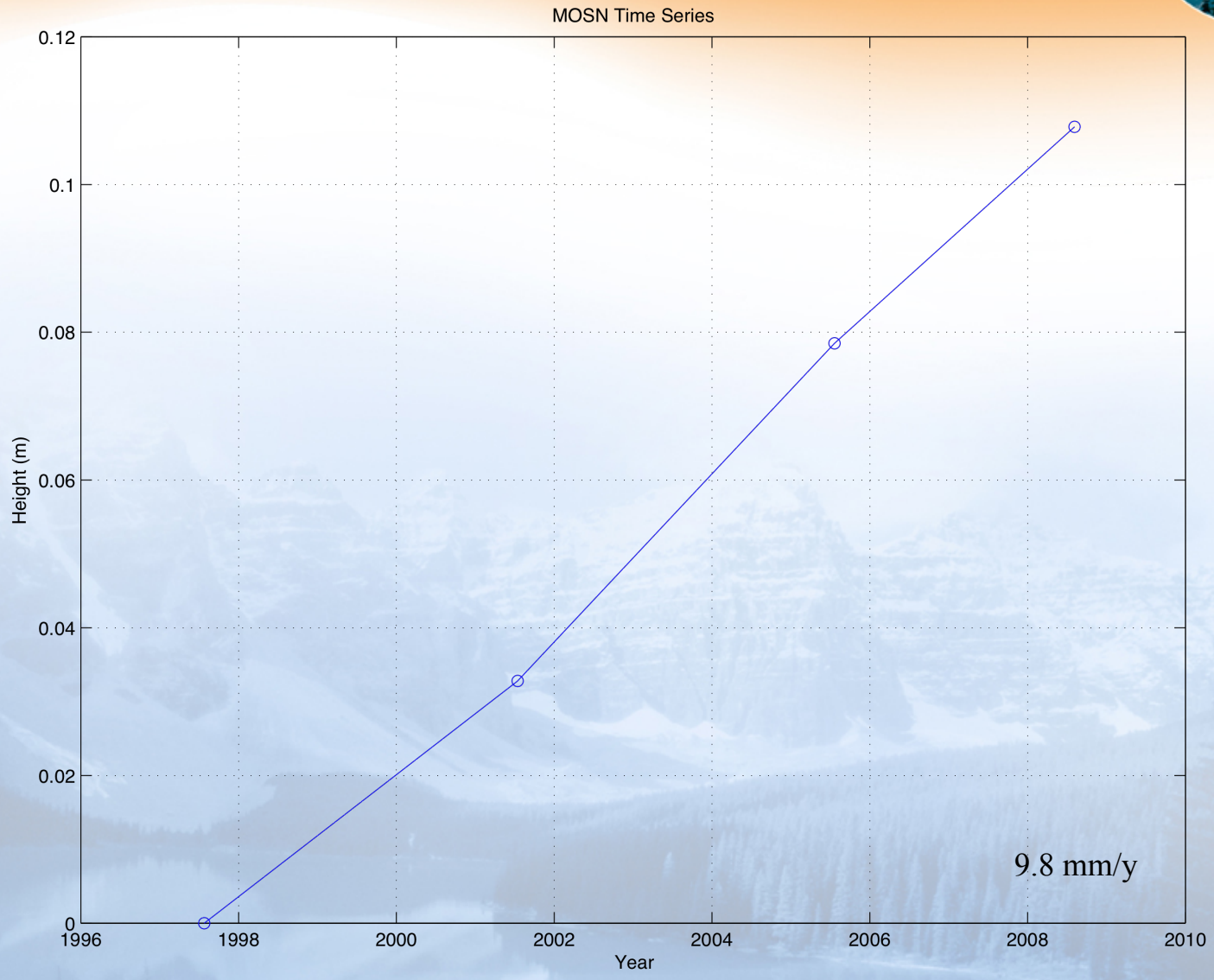
CBN Vertical Velocities



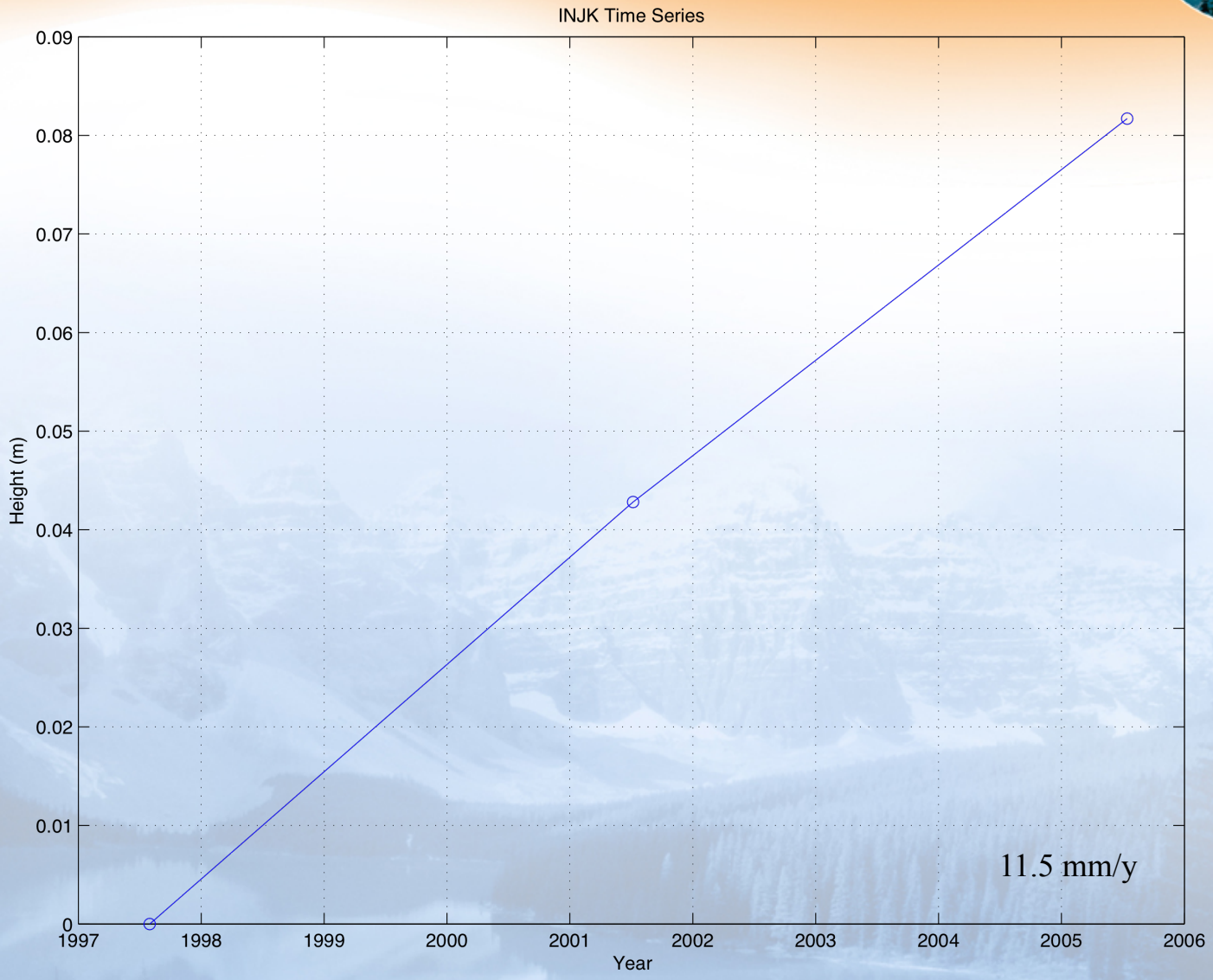
PEAW Vertical Time Series



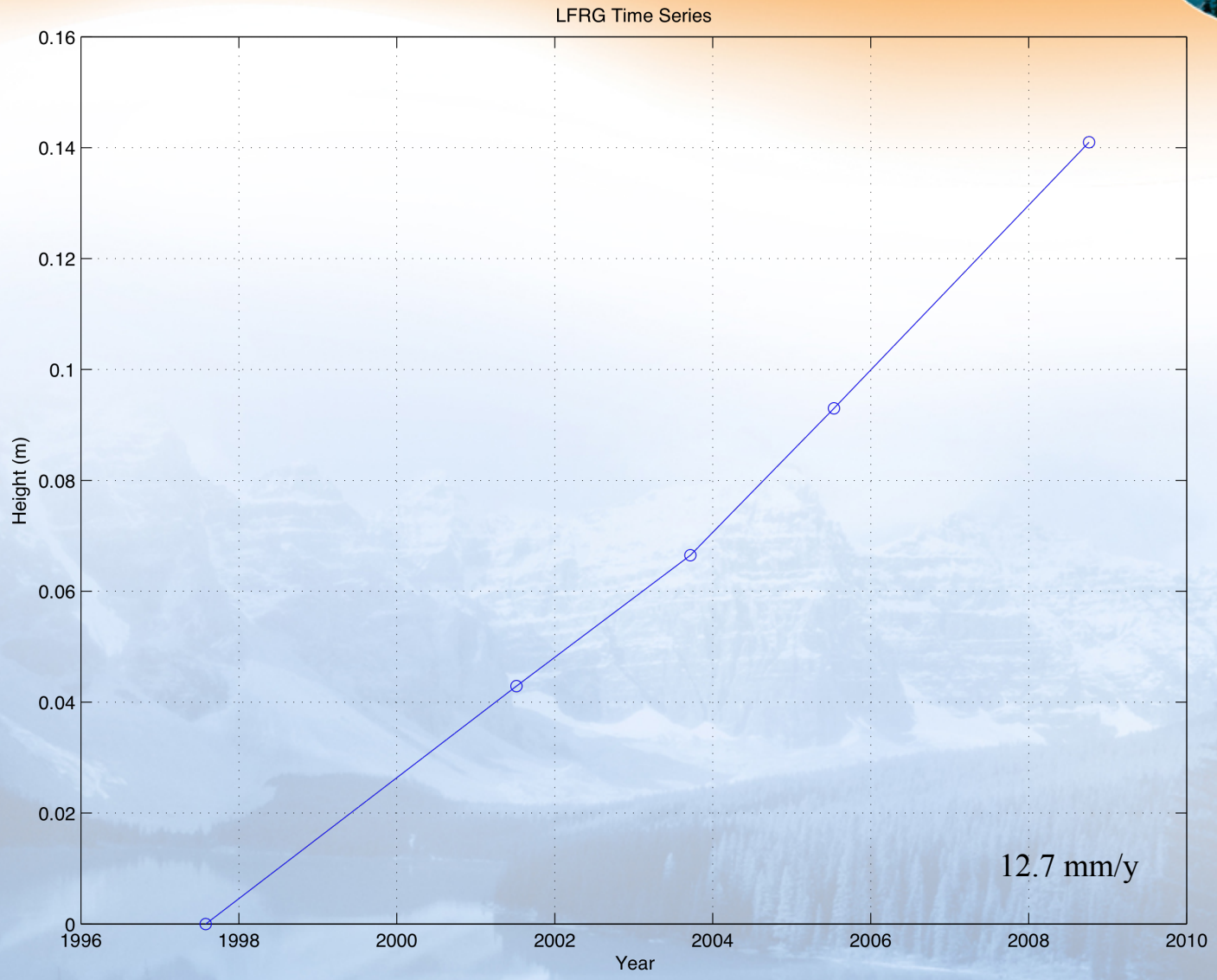
MOSN Vertical Time Series



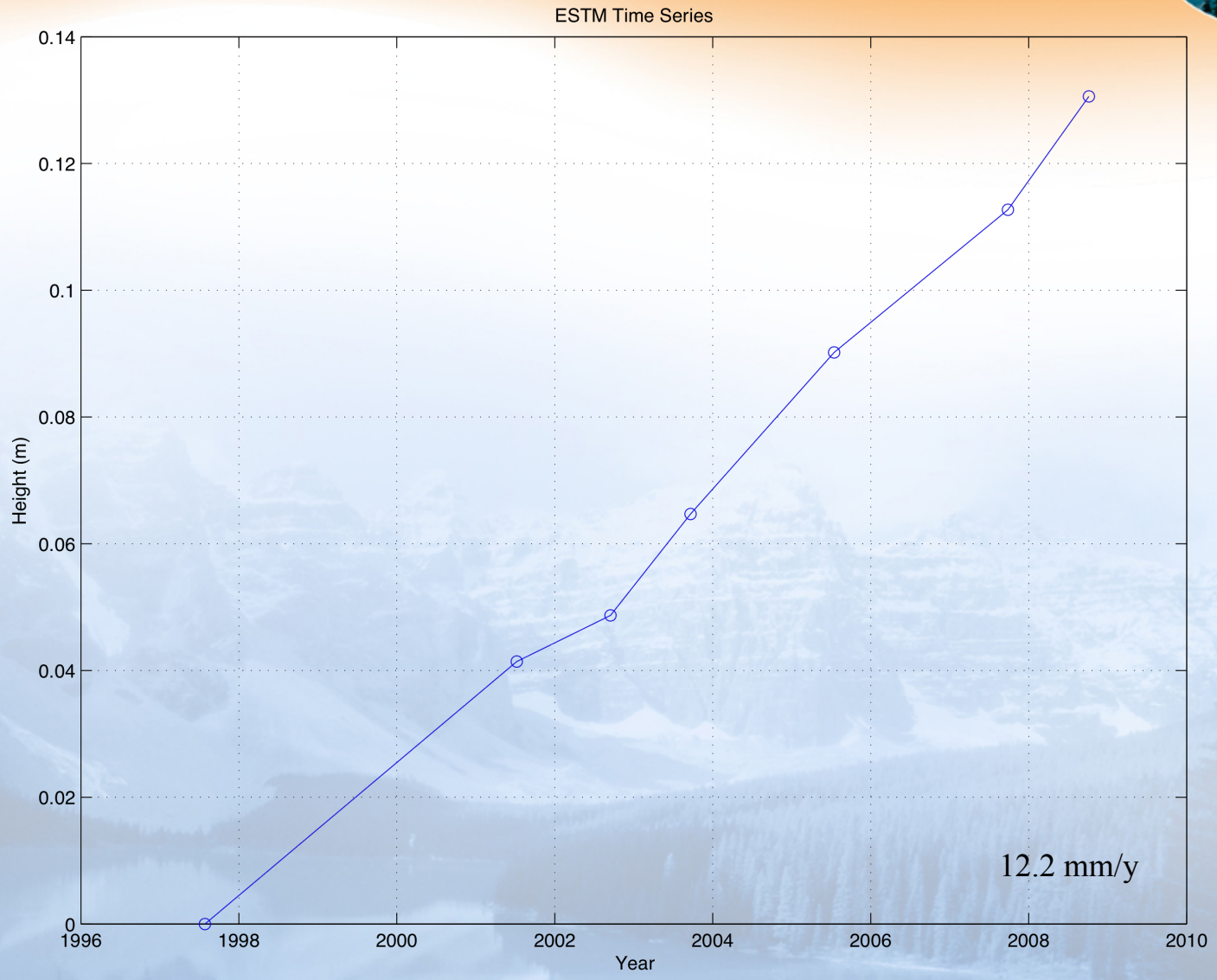
INJK Vertical Time Series



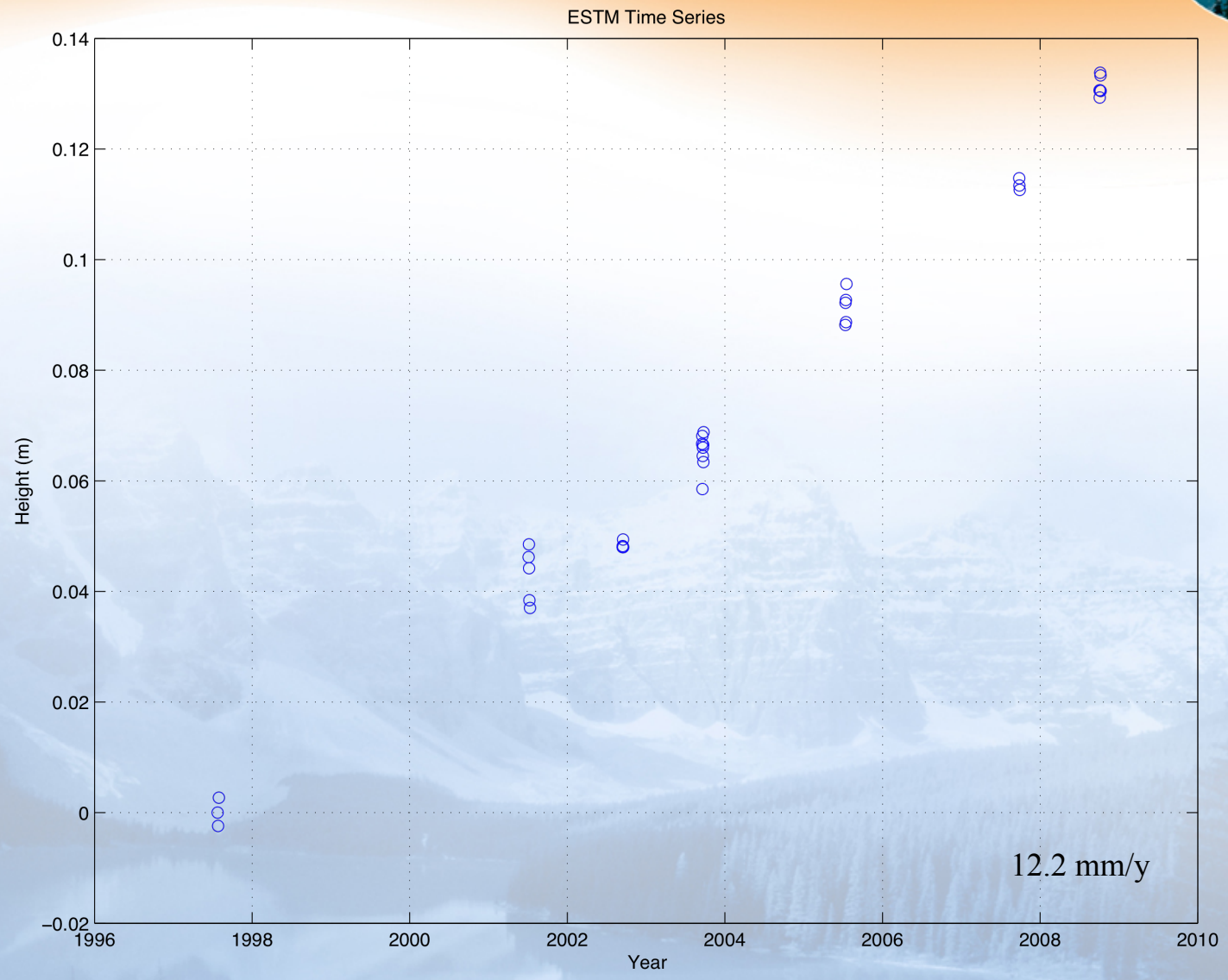
LFRG Vertical Time Series

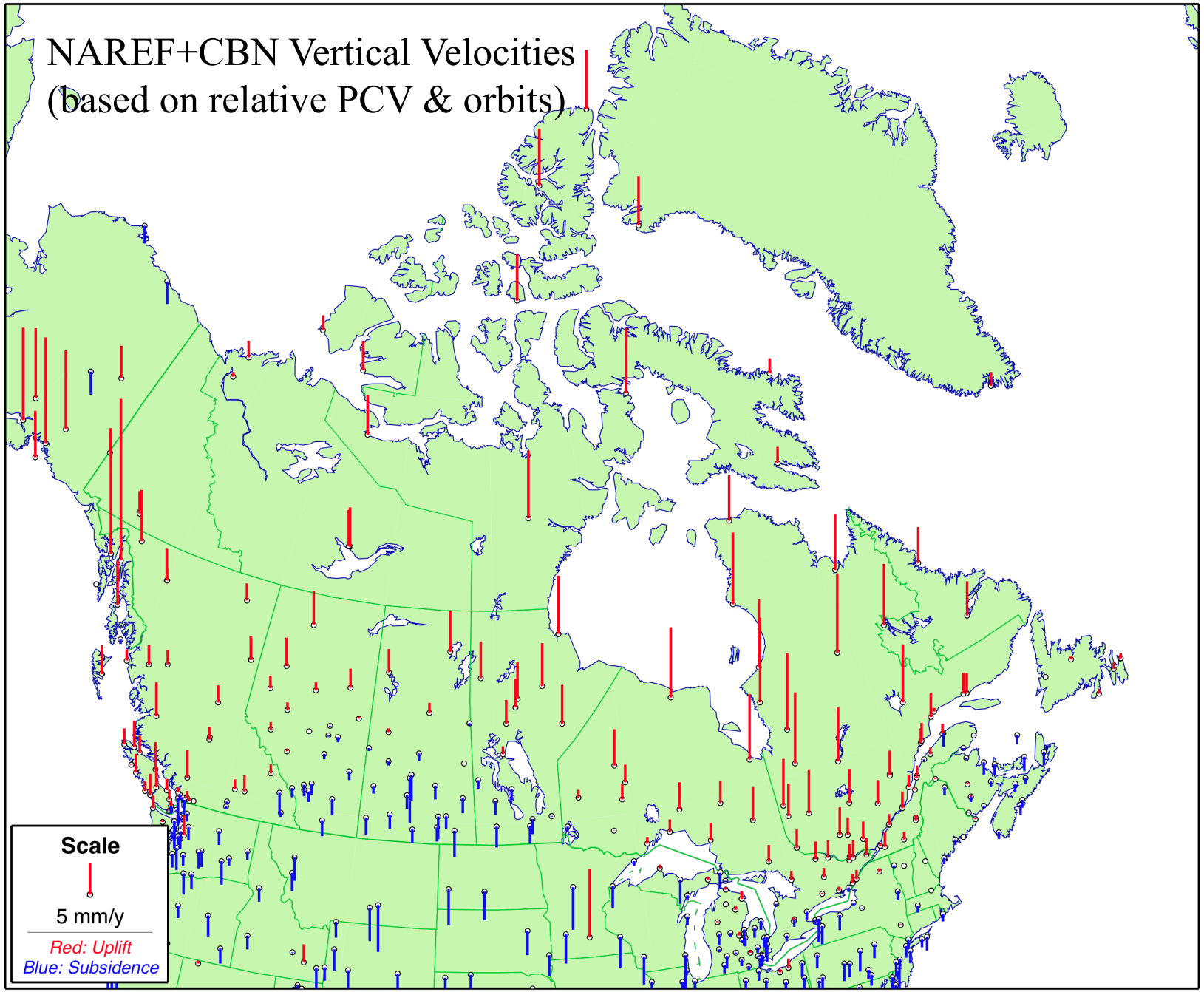


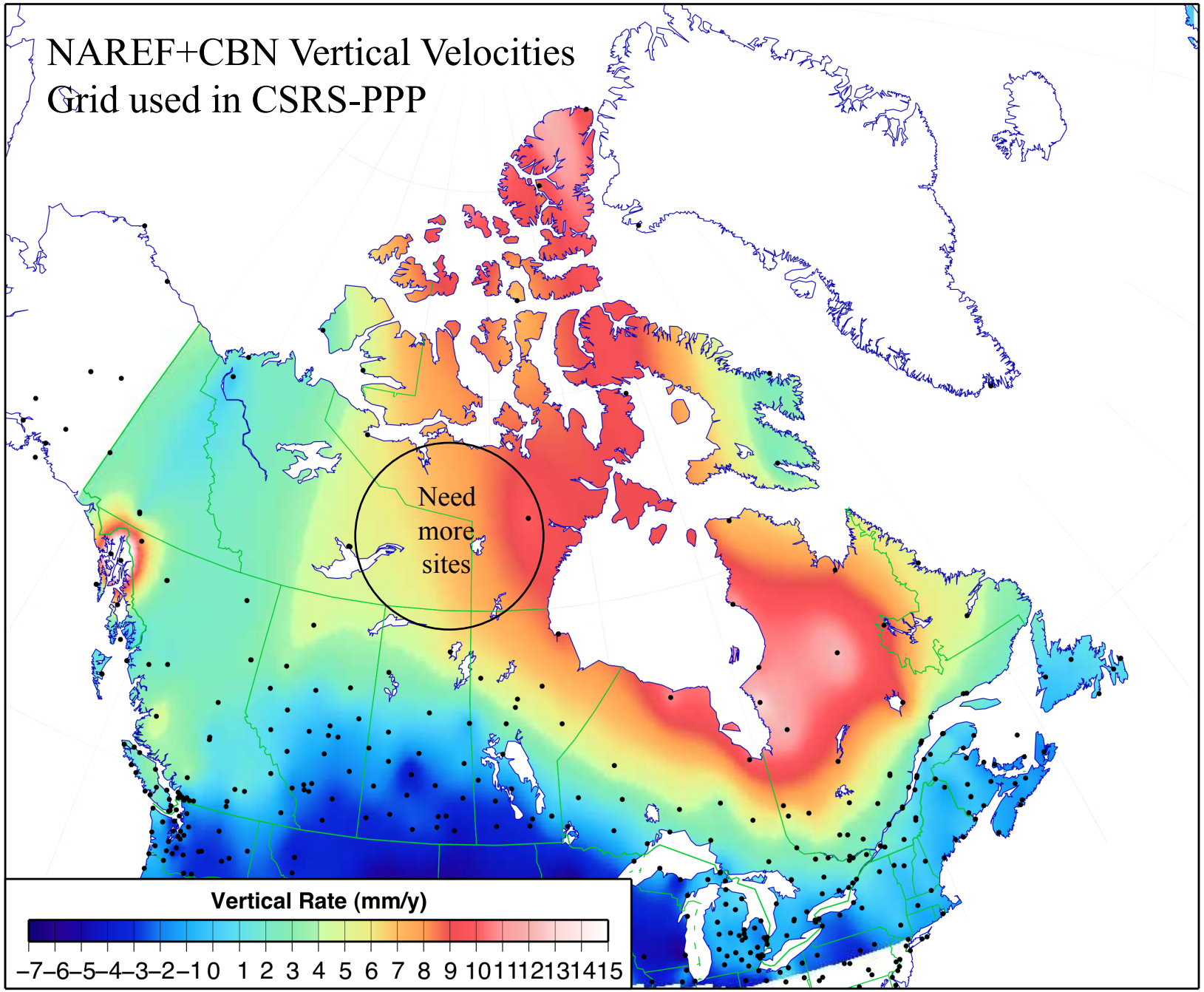
ESTM Vertical Time Series



ESCU Session Time Series




NAREF+CBN Vertical Velocities
(based on relative PCV & orbits)
Scale
5 mm/y
Red: Uplift
Blue: Subsidence


NAREF+CBN Vertical Velocities
Grid used in CSRS-PPP
Need more sites
Vertical Rate (mm/y)
−7 −6 −5 −4 −3 −2 −1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Future Work

Reprocess data with IGS Repro1 orbits

NAREF

- GSD, MIT/PBO & PGC waiting for final repro1 orbits
- SIO finished (based on SIO repro1 orbits
- NGS finished (based on NGS repro1 orbits)

CBN

- Waiting for final repro1 orbits

Include more NAREF stations & data

- Fourth CBN campaign survey in 2010/11
- Will include all sites submitted by contributors back to 1994
- Will add semi-continuous sites west of Hudson Bay
- Will include more global stations for better frame realization

Upgrade SINEX software to handle >2000 stations