SnowPEx – Satellite Snow Product Intercomparison and Evaluation Experiment (6/2014 – 5/2016)

# Overview of SnowPEx Snow Water Equivalent Activities

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# Recap of Workshop 1: SWE splinter session discussions/decisions

- SWE is the parameter to be assessed, additional parameters (i.e. melt onset) may follow later; grain size, stratigraphy, etc., while important for passive microwave snow products, will not to be considered in this phase
- NH - 25km EASE-grid2, no permanent ice, 2002-2011 (AMSR-E era)
  - NASA AMSR-E standard
  - NASA AMSR-E prototype
  - GlobSnow
- Range of algorithmic approaches: pmw standalone; pmw+climatology; pmw+daily weather station observations
- Project partners responsible for each reference dataset will contribute to a central repository for consistent application of the matchups and statistics
- Only coincident samples (found in each and every product) will be evaluated, initial target period is all available data since 2002 but may be refined: equal balance between time & space & region & snow class must be pursued to minimize sampling biases
- Dense network data and gridded non EO-products will be used for evaluation, sparse network data will not be used in this phase

# SnowPEx SWE Datasets

snowpex

EC

| Dataset | Method | Ancillary/ Forcing Data | Resolution | Time Series | Reference |
|---|---|---|---|---|---|
| GlobSnow | Passive microwave + in situ | Weather station snow depth measurements | 25 km | 1979-2015 | Takala et al (2011) |
| NASA AMSR-E standard | Standalone passive microwave | | 25 km | 2002-2011 | Kelly (2009) |
| NASA AMSR-E prototype | Microwave + ground station climatology | Weather station snow depth climatology | 25 km | 2002-2011 | TBD |
| ERAint-Land | HTESSEL land surface model | ERA-interim | 0.75° x 0.75° | 1981-2010 | Balsamo et al (2013) |
| MERRA | Catchment land surface model | MERRA | 0.5° x 0.67° | 1981-2010 | Rienecker et al (2011) |
| Crocus | ISBA land surface + Crocus snow model | ERA-interim | 1° x 1° | 1981-2010 | Brun et al (2013) |
| GLDAS-2 | Noah 3.3 land surface model | Princeton Met. | 1° x 1° | 1981-2010 | Rodell et al (2004) |

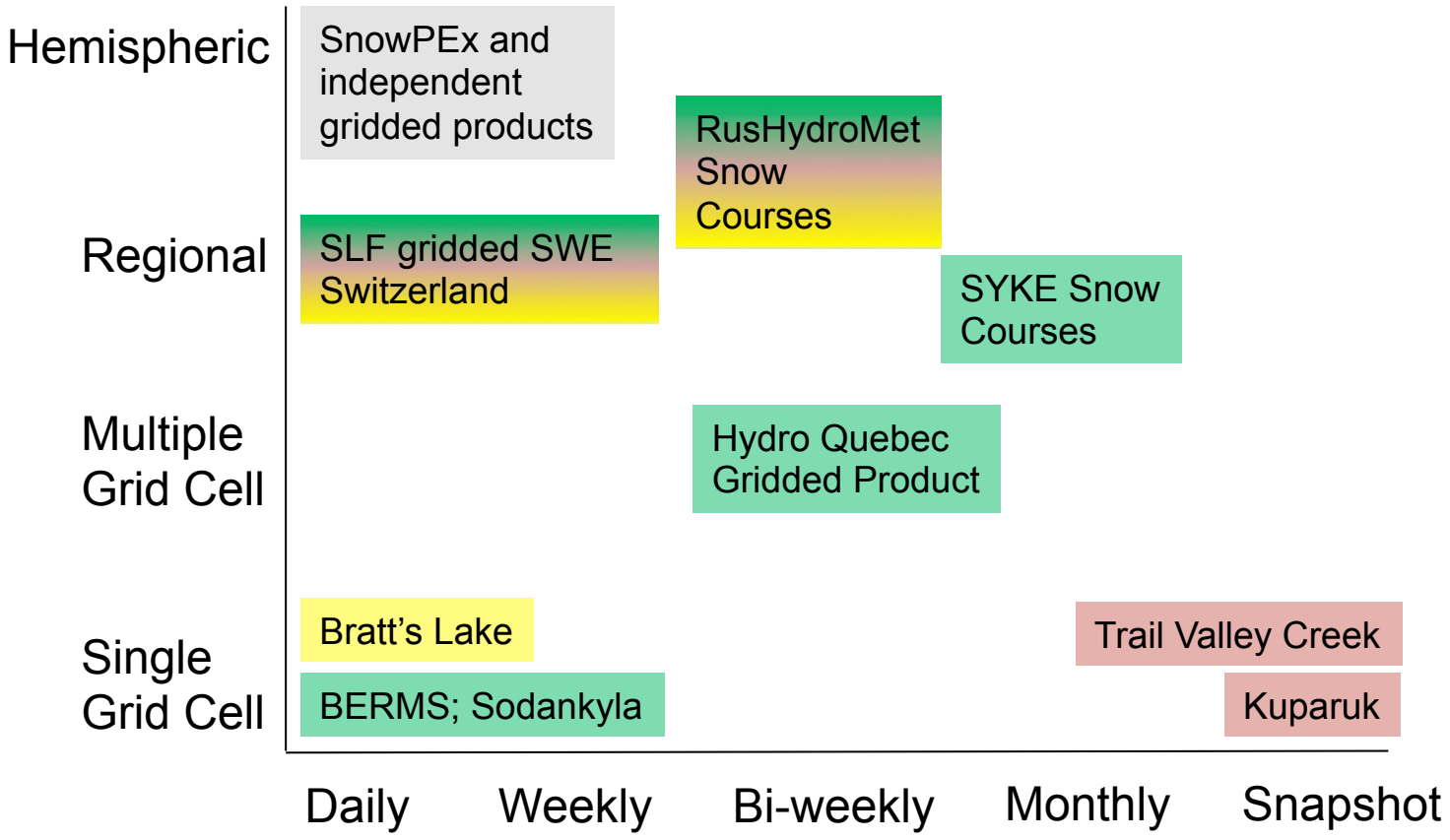
# SnowPEx SWE Datasets

| Dataset | Abbreviation | Snow Scheme | Land Model | Forcing Data | Resolution | Reference |
|---|---|---|---|---|---|---|
| GlobSnow | GS | satellite passive microwave + *in situ*[1] | | | 25 km | Takala et al. (2011) |
| ERA-I-Land | E | simple | HTESSEL | ERA-Interim | 3/4° × 3/4° | Balsamo et al. (2013) |
| MERRA | M | intermediate | Catchment | MERRA | 1/2° × 2/3° | Rienecker et al. (2011) |
| Crocus | C | complex | ISBA | ERA-Interim | 1° × 1° | Brun et al. (2013) |
| GLDAS-2 | G2 | simple | Noah 3.3 | Princeton Met. | 1° × 1° | Rodell et al. (2004) |
| GLDAS-1* | G1n | simple | Noah 2.7 | GDAS+CMAP | 1° × 1° | Rodell et al. (2004) |
| | G1m | simple | Mosaic | | | |
| | G1v | intermediate | VIC | | | |
| | G1c | intermediate | CLM | | | |
| Can. Met. Centre* | CMC | simple + *in situ*[2] | | GEM | 35km | Bransnett (1999) |
| MERRA-Land* | ML | intermediate | Catchment | MERRA | 1° × 1° | Reichle et al. (2011) |

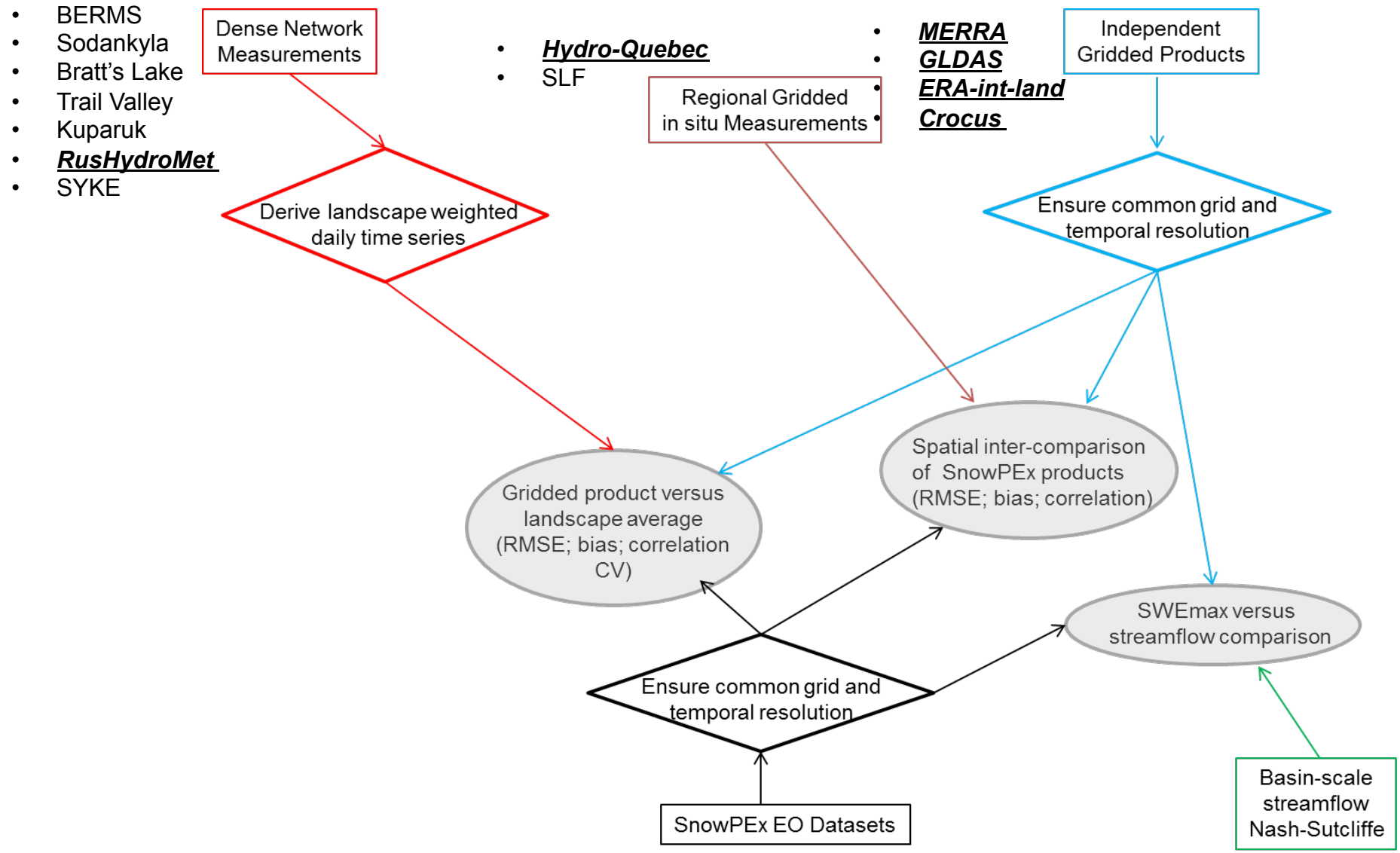
# Reference Data for SWE Evaluation

| *Dataset* | *Region* | *Snow Class* | *Method* | *Time Period* | *Temporal Resolution* | *Contact* |
|---|---|---|---|---|---|---|
| Boreal Ecosystem Research and Monitoring Sites | Saskatchewan | Taiga | Sonic snow depth | 1997-2014 | Daily | H Wheater, U. Saskatchewan |
| Environment Canada – Bratt's Lake | Saskatchewan | Prairie | Sonic snow depth; manual surveys | 2011- | Daily | C Smith, Environment Canada |
| FMI – Sodankyla | Finland | Taiga | Sonic snow depth; cosmic | 19xx-2014 | Daily | J. Pulliainen, FMI |
| Trail Valley Creek | Northwest Territories | Tundra | Sonic snow depth | 2002-2014 | Daily (with gaps) | P. Marsh, WLU |
| Finnish Environment Institute Snow Surveys | Finland | Taiga | Manual snow course | 19xx-2014 | Monthly | S. Metsämaäki, SYKE |
| RusHydroMet Snow Surveys | Russia | Prairie; Taiga; Tundra | Manual snow course | 1966-2009 | Bi-weekly | O. Bulygina, RIHMI-WDC) |
| Hydro-Quebec Snow Survey Network | Quebec | Taiga | Kriged snow course | 1999-2013 | SWEmax | D. Tapsoba (IREQ) |
| Kuparuk River Basin Surveys | North Slope | Tundra | Manual | 2006-2013 | SWEmax | S. Steufer (UAF) |
| SLF Gridded SWE | Switzerland | Open; Alpine | Observations + distributed snow model | 1998-2014 | Daily | T. Jonas (SLF) |

# Assessment of Reference Data for Sampling Bias



# SnowPEx SWE Workflow



# SnowPEx SWE Status Update

- Product acquisition and pre-processing:
  **-Participating SnowPEx and independent gridded SWE products in place**

- Reference datasets:
  **-Acquired; distribution generally restricted but available upon request**

- Gridded dataset inter-comparison:
  **-Completed (presentation by Lawrence; J. Climate paper)**

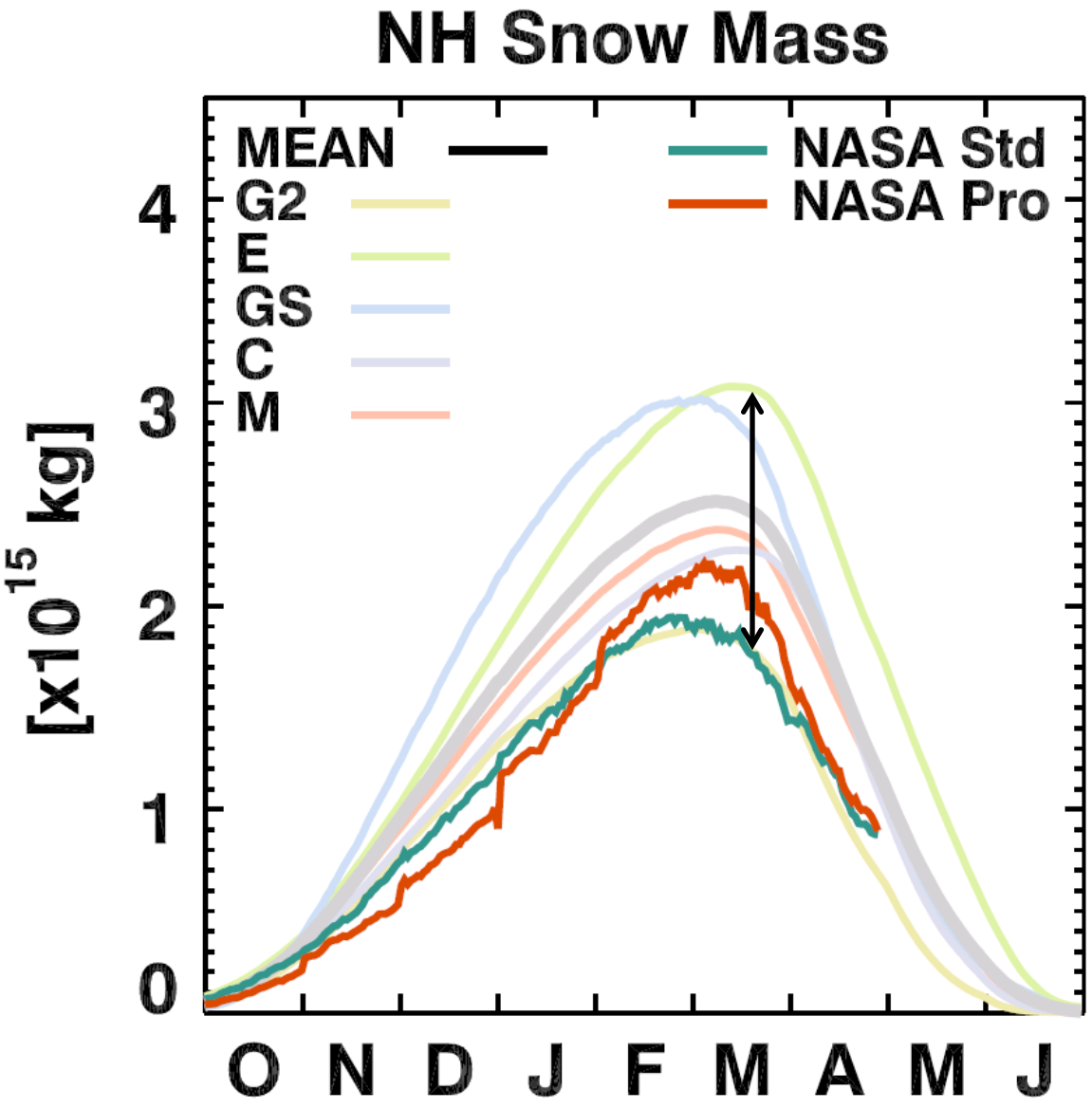
- Comparison with in situ reference datasets (SYKE; FMI; RusHydroMet):
  **-evaluation of SnowPEx and gridded SWE products completed (presentation by Kari)**

- Comparison with in situ reference datasets (North American; SLF):
  **-evaluation of SnowPEx and independent gridded products underway (presentation by Ross)**

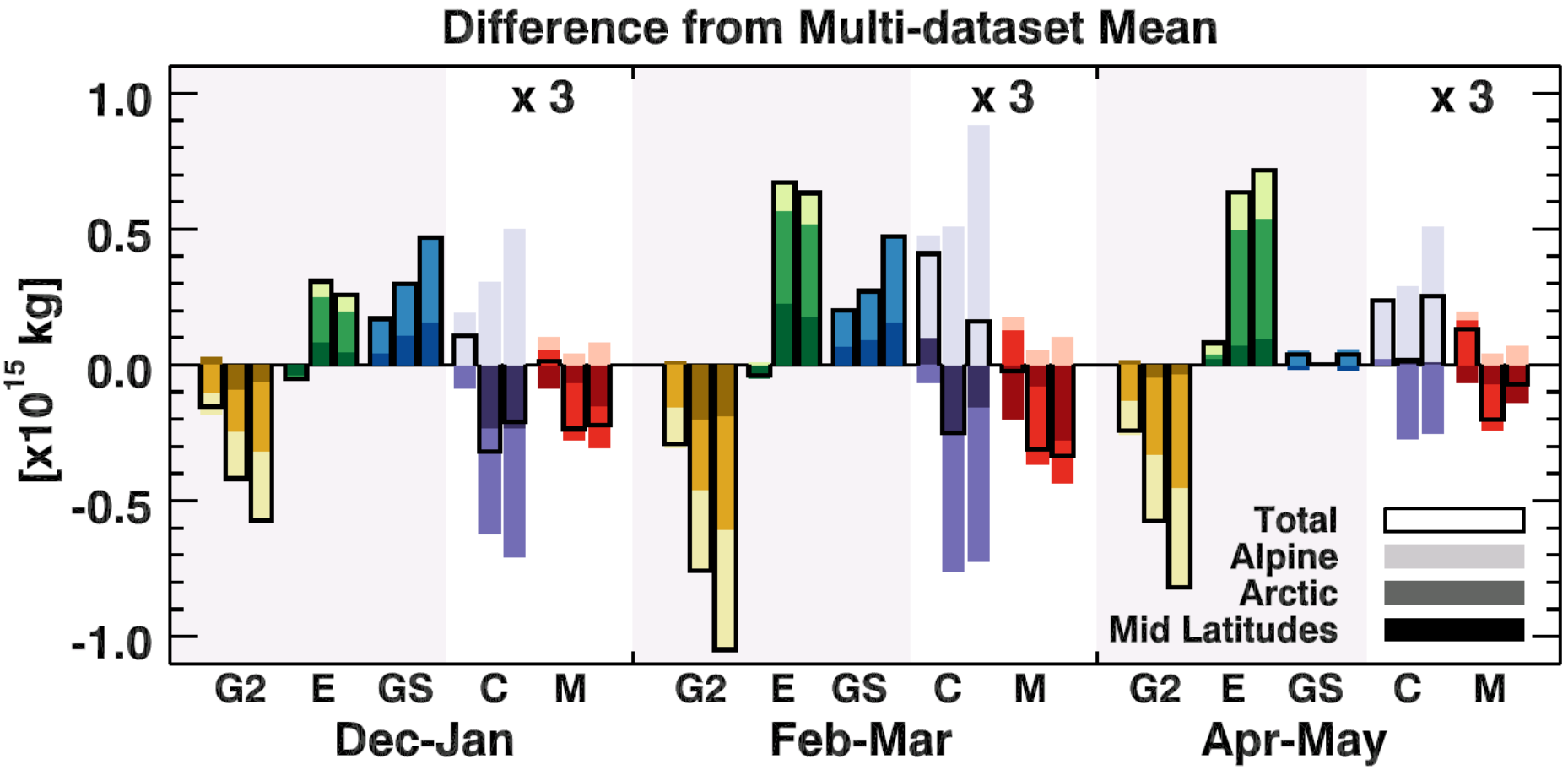
- Watershed analysis
  **-in progress (presentation by Carrie)**

- Trend analysis
  **-in progress (presentation by Lawrence)**

# Snow Mass Climatology

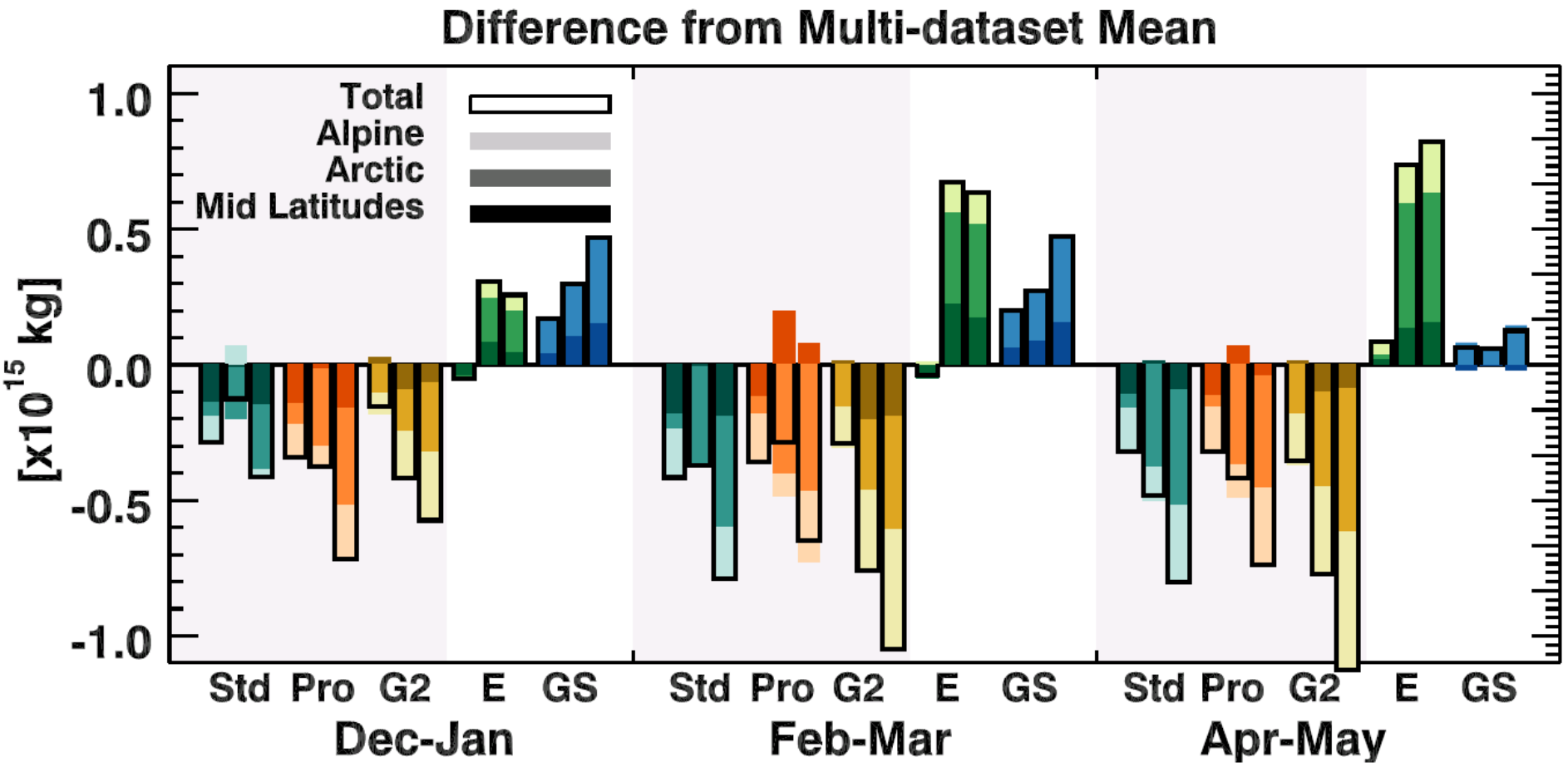


# Difference From Multi-Dataset Mean

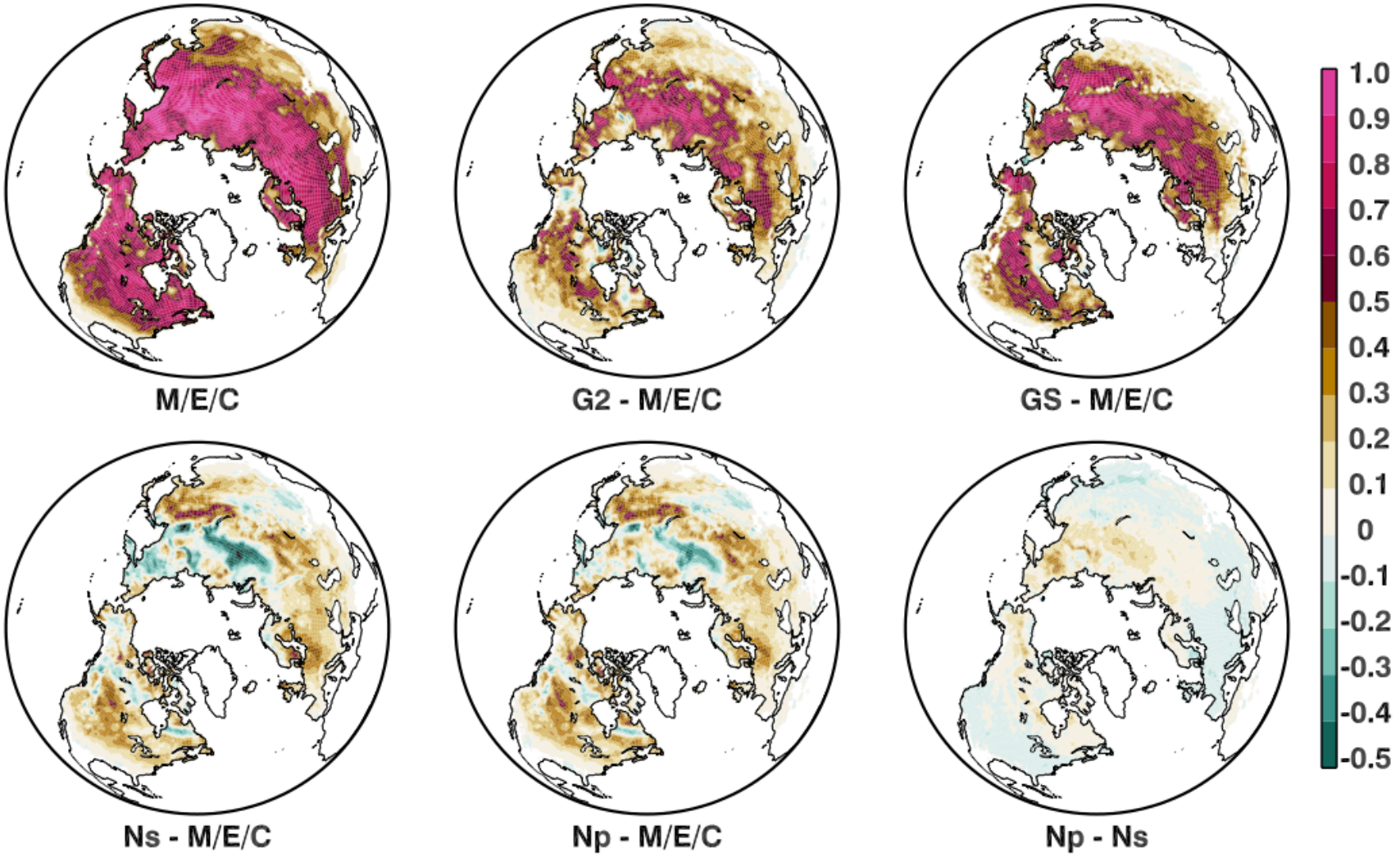



*Mudryk et al., J. Climate, in press*

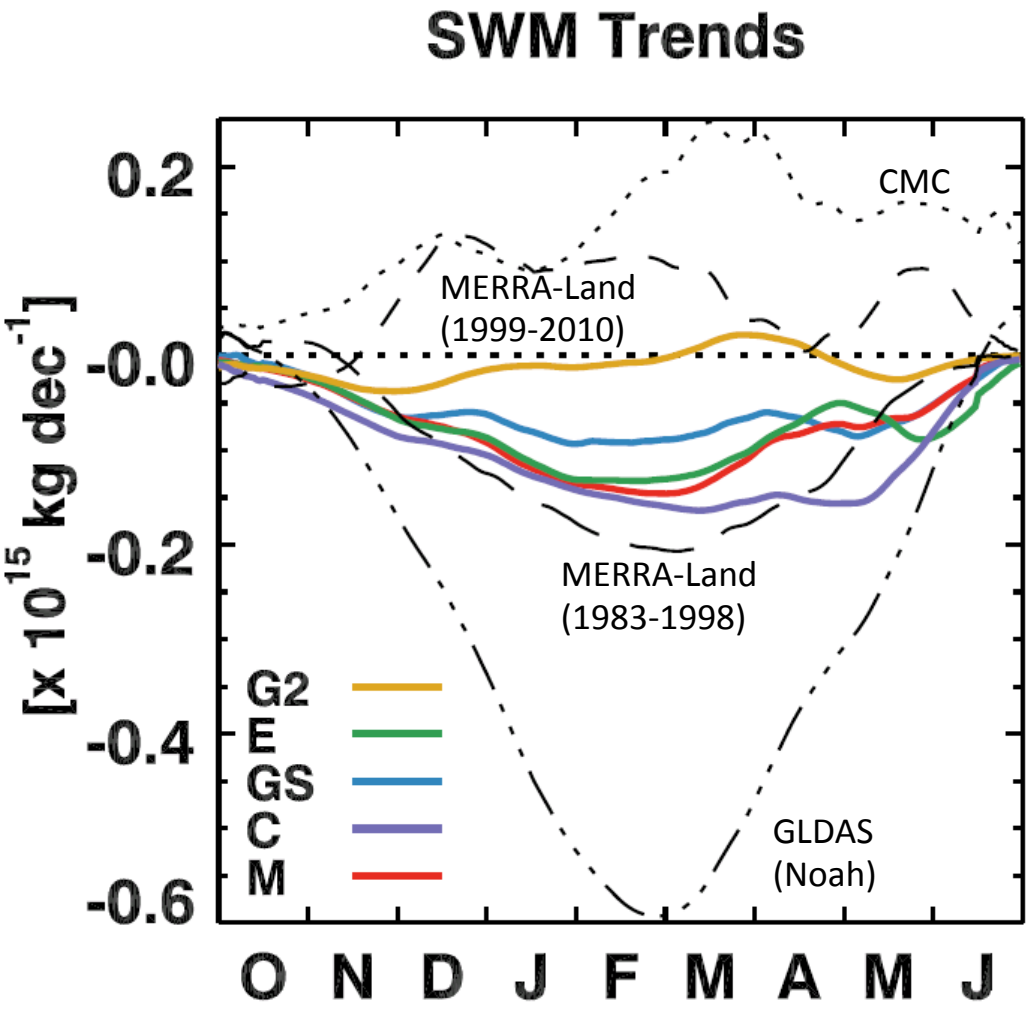
# Difference From Multi-Dataset Mean



# Anomaly Correlation



# Trends


SWM Trends
0.2
-0.0
-0.2
-0.4
-0.6
[x 10^15 kg dec^-1]
O N D J F M A M J
CMC
MERRA-Land
(1999-2010)
MERRA-Land
(1983-1998)
GLDAS
(Noah)
G2
E
GS
C
M

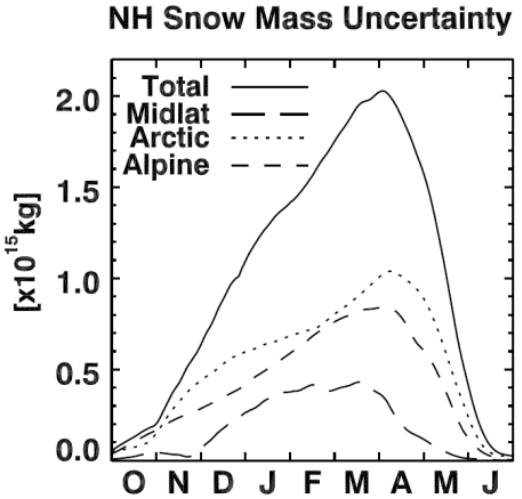
# Summary

Analysis workflow refined since workshop 1:

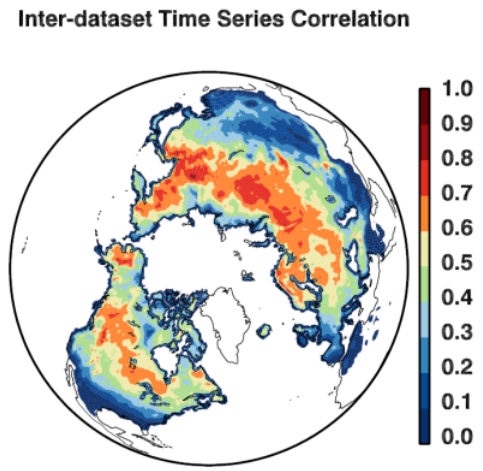
1. comparison with reference datasets (Kari/Ross): determination of bias
2. comparison between spatial datasets (Lawrence): determination of spread
3. watershed scale analysis (Carrie): hydrological impacts
4. trend computations (largely forthcoming): climate analyses

- SnowPEx results will make important contributions to CMIP6 (Chris) and new snow mission concept studies at CSA, ESA, and JPL.

***For satellite derived snow water equivalent, we acknowledge fundamental challenges to the retrieval of SWE from conventional satellite measurements: new novel mission concepts are required***




Uncertainty in snow mass climatology evenly distributed across snow types




Peak inter-dataset agreement across the boreal forest