Evaluation of snow models: SnowMIP2 and future high resolution evaluation

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Outline

- New collaborator to IP3
  - Processes and parameterisation themes: forest-snowpack models (working with Richard Essery)
  - Links between modelling and remote sensing
- SnowMIP2
  - Evaluation of forest-snow process models
- Ground-based FMCW radar

SnowMIP2: Why, what and how?

- Current Land Surface Schemes (LSS) in models either neglect or use highly simplified representations of physical processes controlling the accumulation and melt of snow in forests
- Snow Model Inter-comparison Project 2 (SnowMIP2)
  - Quantify uncertainty in simulations of forest snow processes
  - Range of models of varying complexity (not just LSS)
- Primarily evaluate the ability of models to estimate SWE
  - 33 models (CRHM and CLASS involved)
  - 5 locations: 3 presented herein (Switzerland, Canada, USA)
  - 2 sites per location: forest and clearing (open)

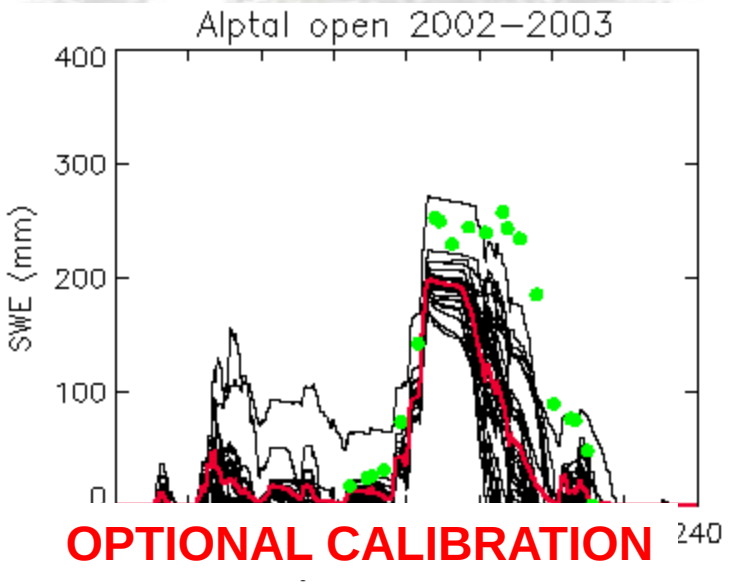
Model inputs

- Meteorological driving data :
  - Precipitation rate (rain and snow)
  - Incoming SW and LW
  - Air Temperature
  - Wind Speed
  - Relative humidity
- Site specific data:
  - Tree height
  - Effective LAI
  - Instrument heights
  - Snow free albedo
  - Soil composition
- Initialisation data:
  - Soil temperature profile
  - Soil moisture
- Calibration data:
  - In-situ snow water equivalent (SWE) from Year 1, forest sites

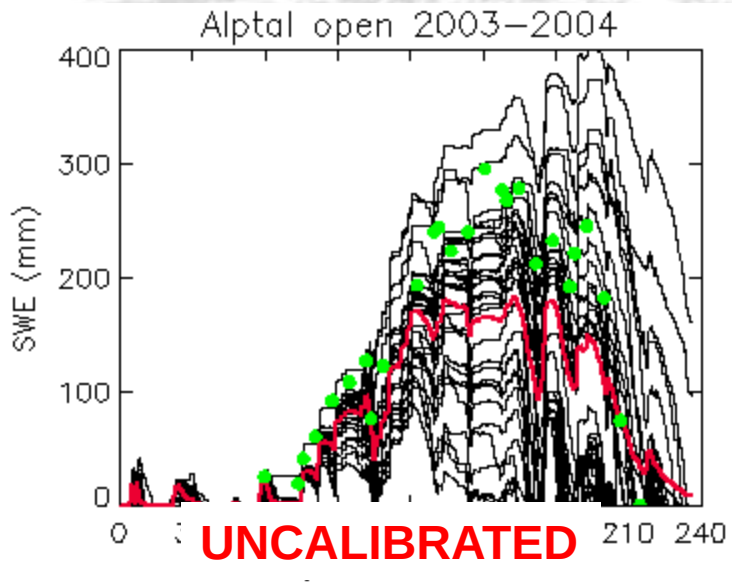
Model outputs

- Energy fluxes
  - Radiative, turbulent, conductive, advected and phase changes
- Mass fluxes
  - sublimation, evaporation, transpiration, phase change, infiltration, runoff, unloading, drip
- State variables
  - mass (solid and liquid), temperature

Alptal, Switzerland (47°N, 8°E)

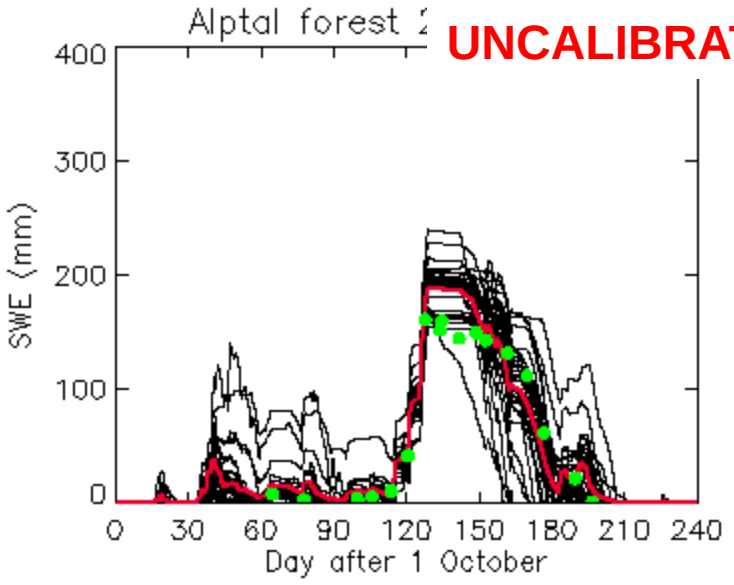


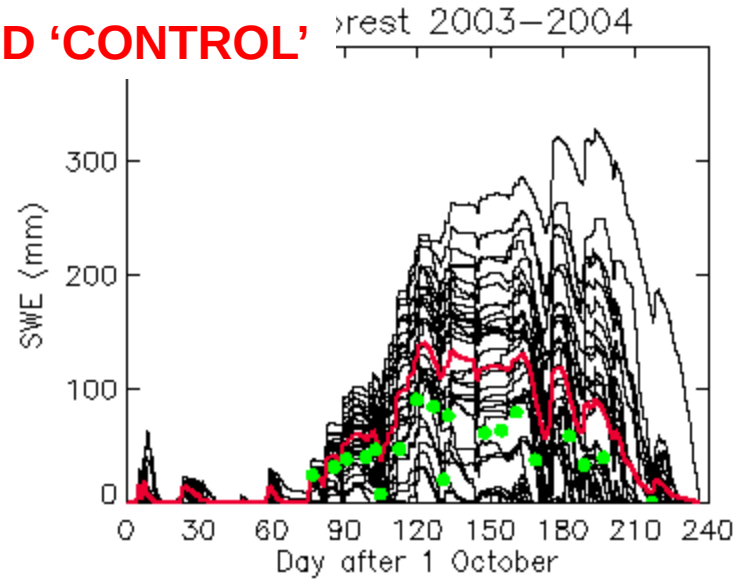
OPTIONAL CALIBRATION



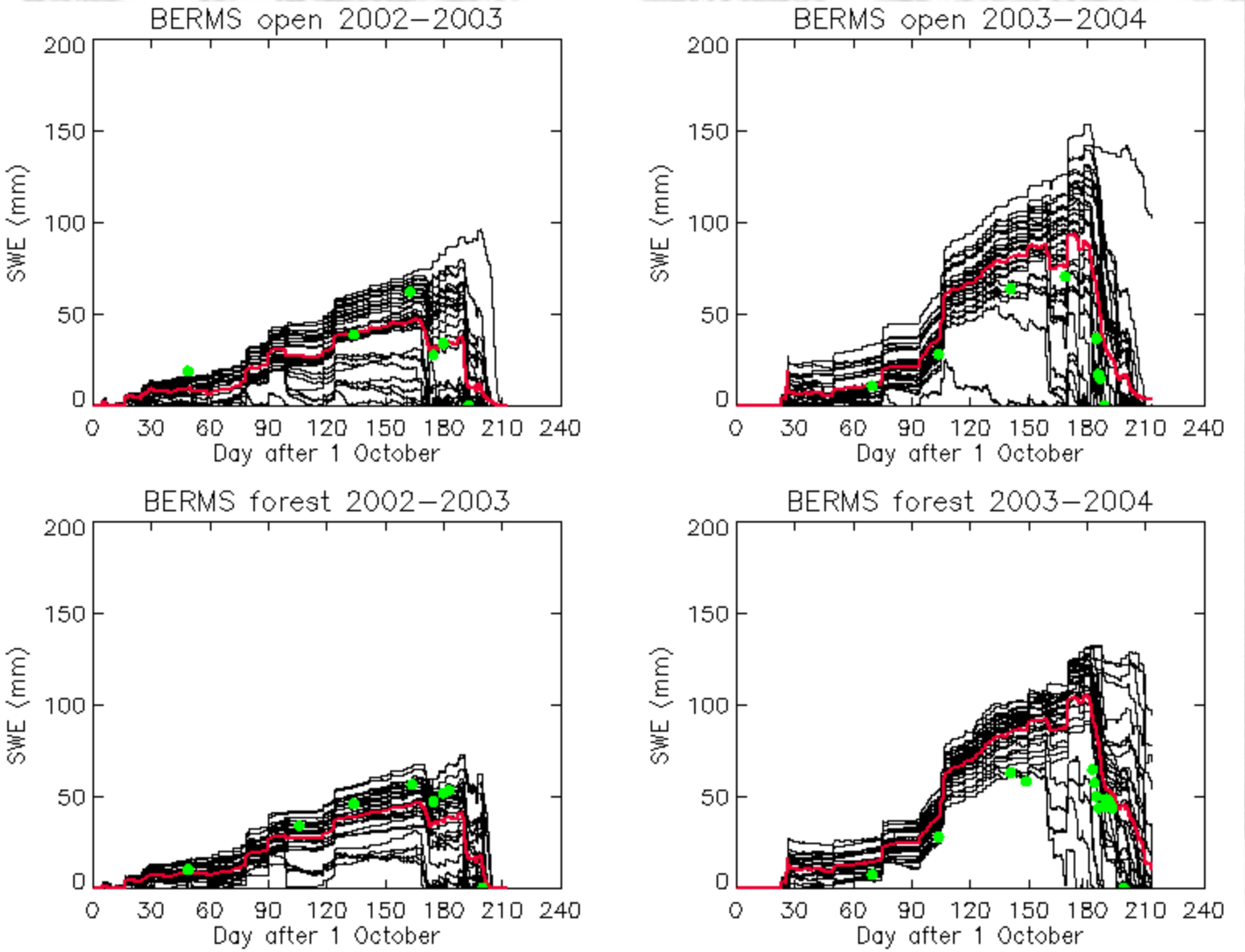
UNCALIBRATED

UNCALIBRATED 'CONTROL'

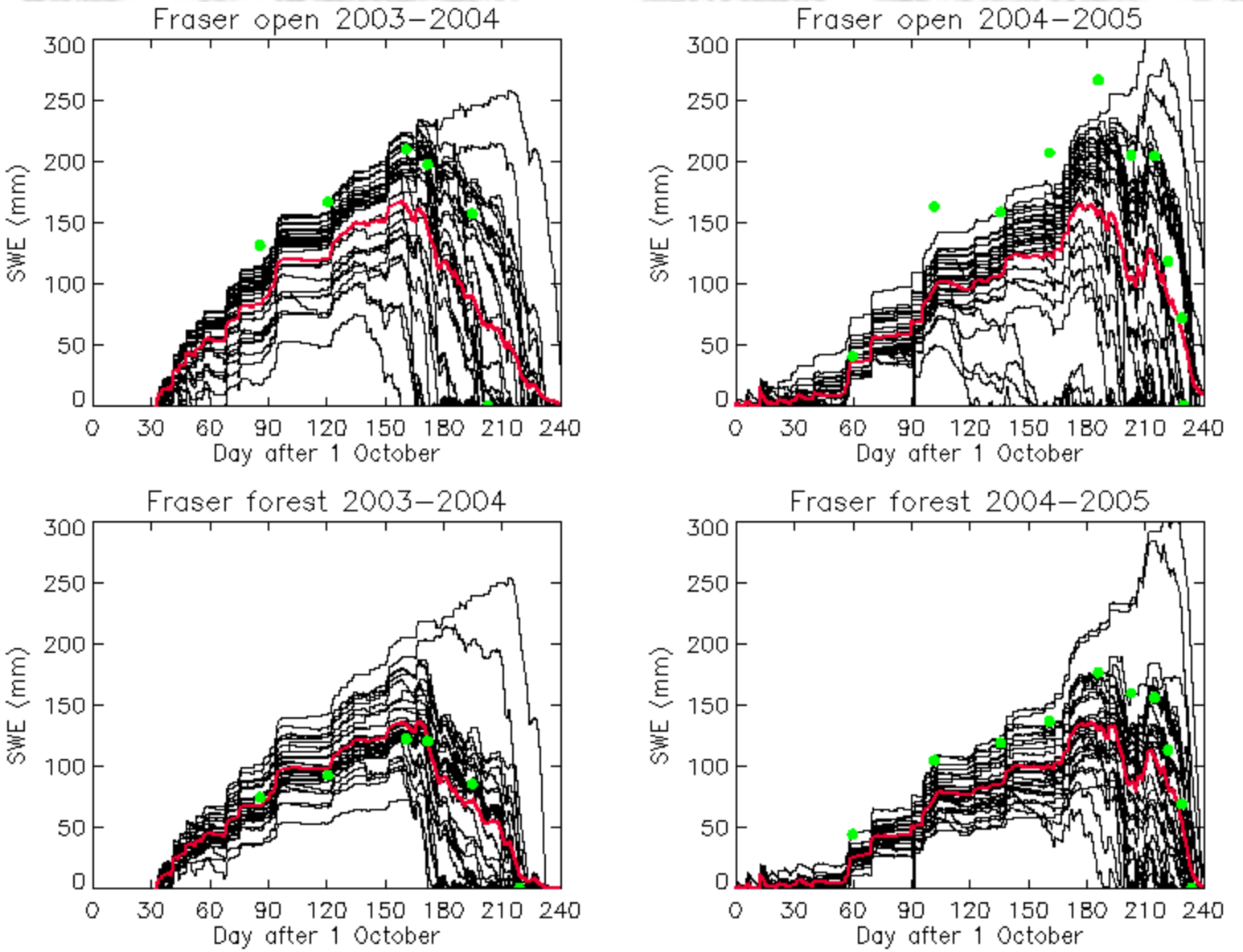




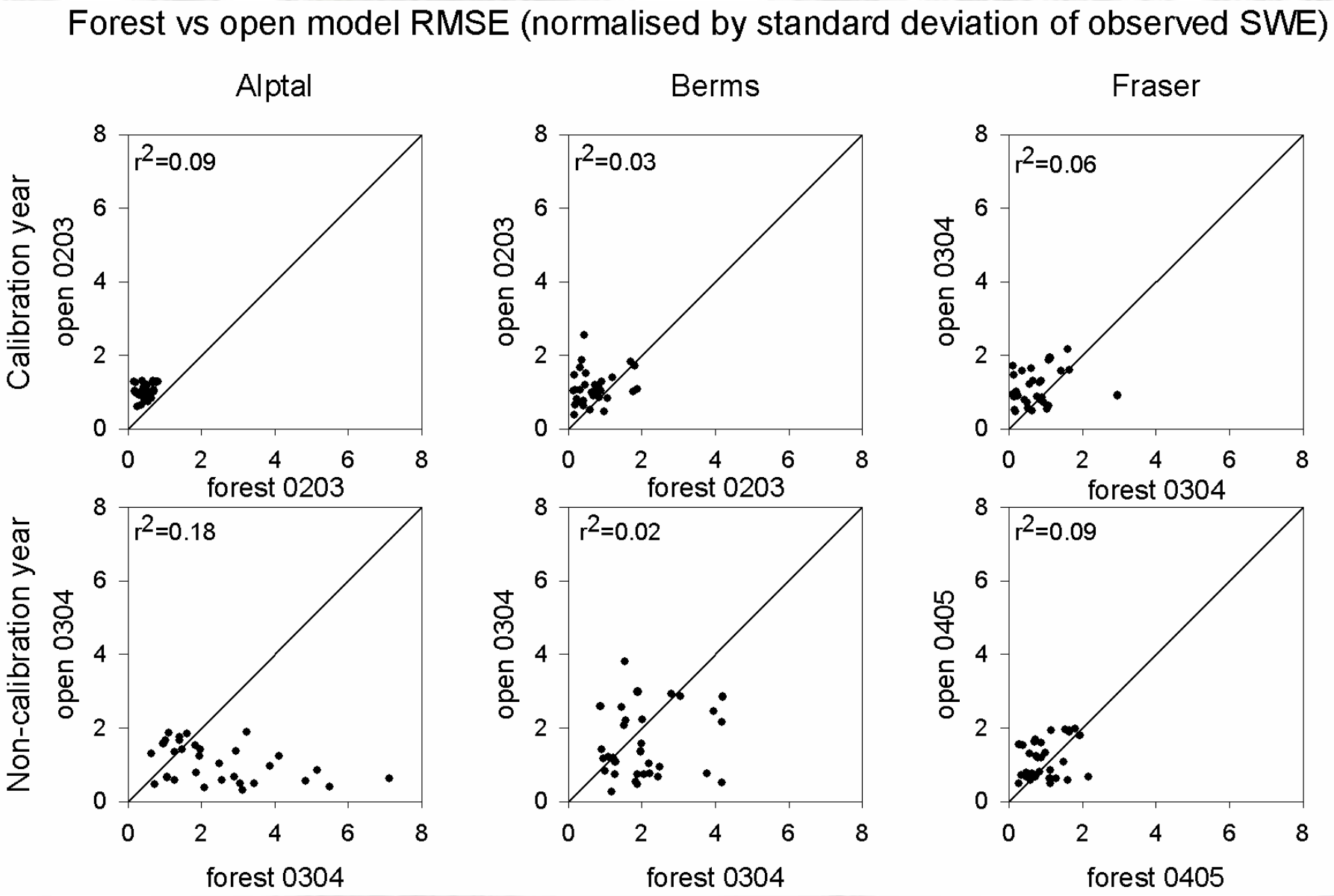
BERMS, Saskatchewan, Canada (53°N, 104°W)



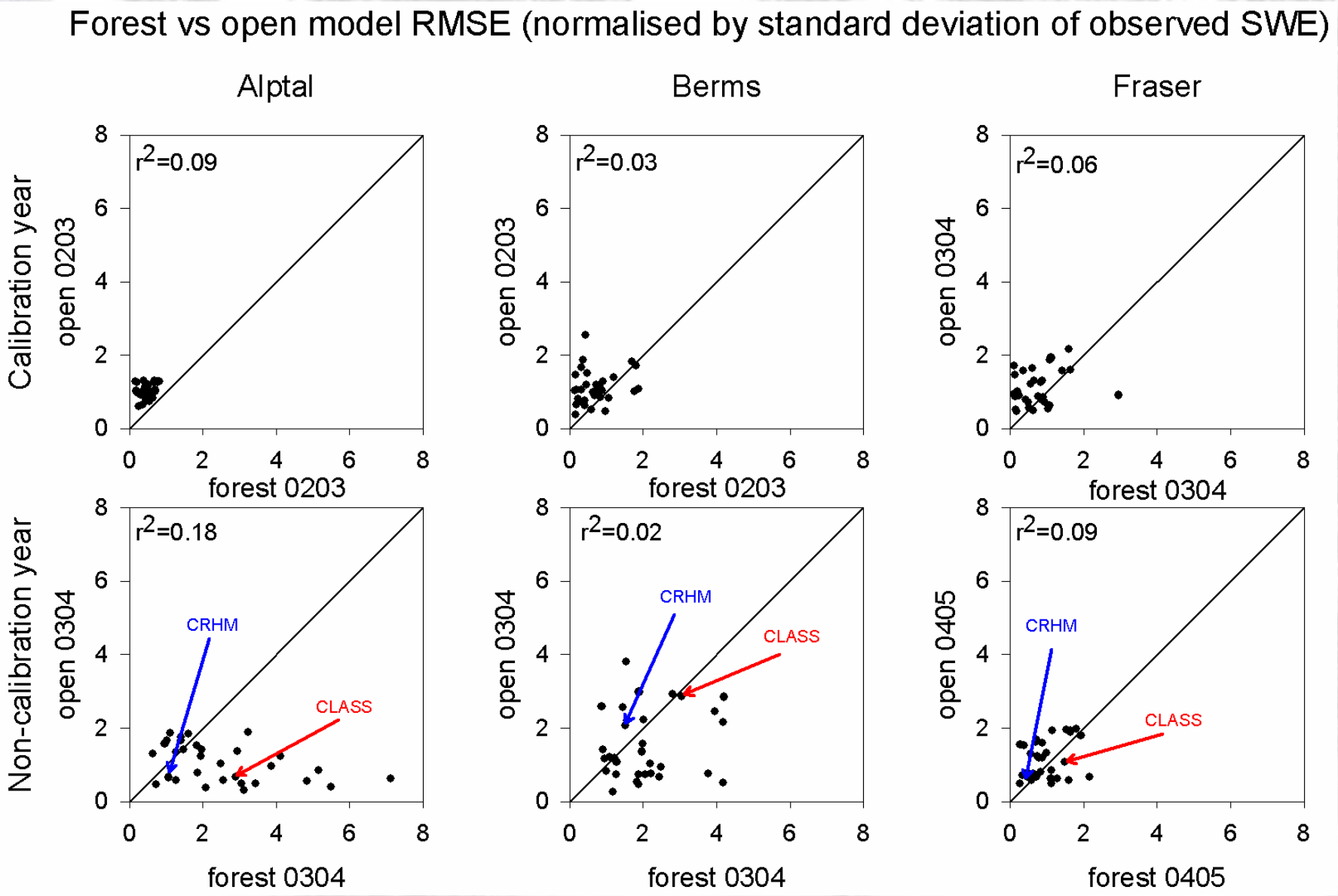
Fraser, Colorado, USA (39°N, 105°W)



Model uncertainties: forest vs open

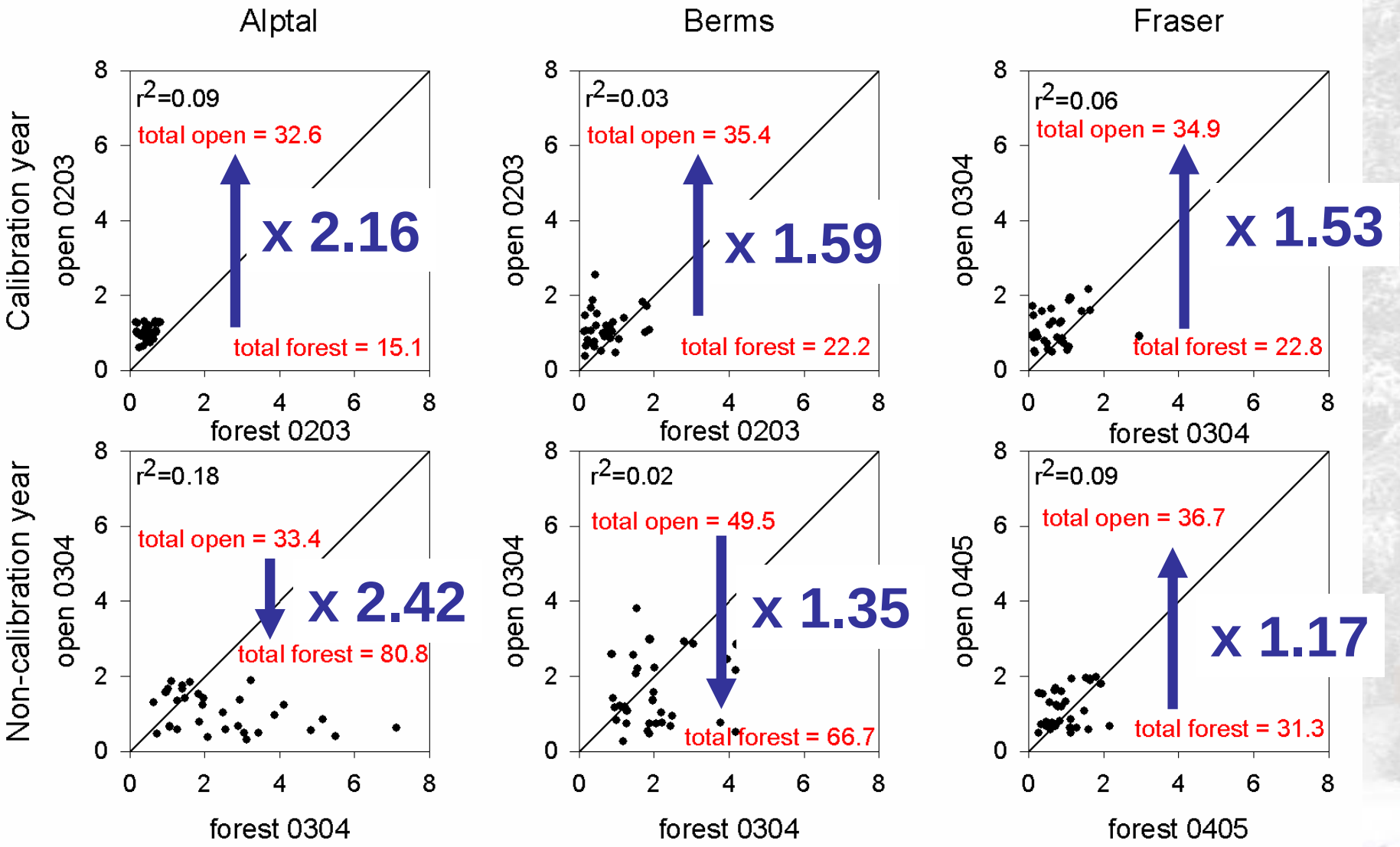


Model uncertainties: a Canadian perspective



Model uncertainties: forest vs open

Forest vs open model RMSE (normalised by standard deviation of observed SWE)



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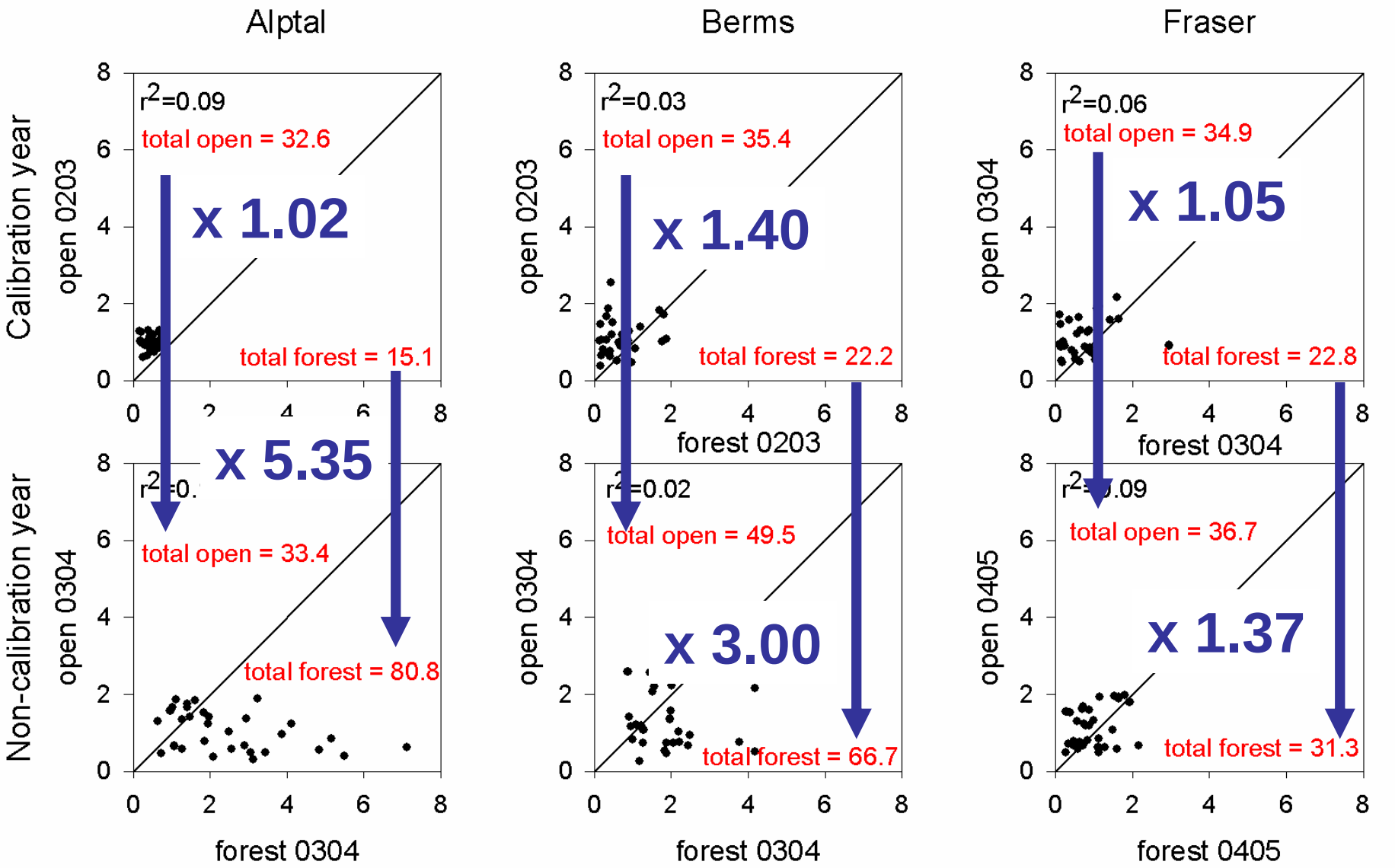

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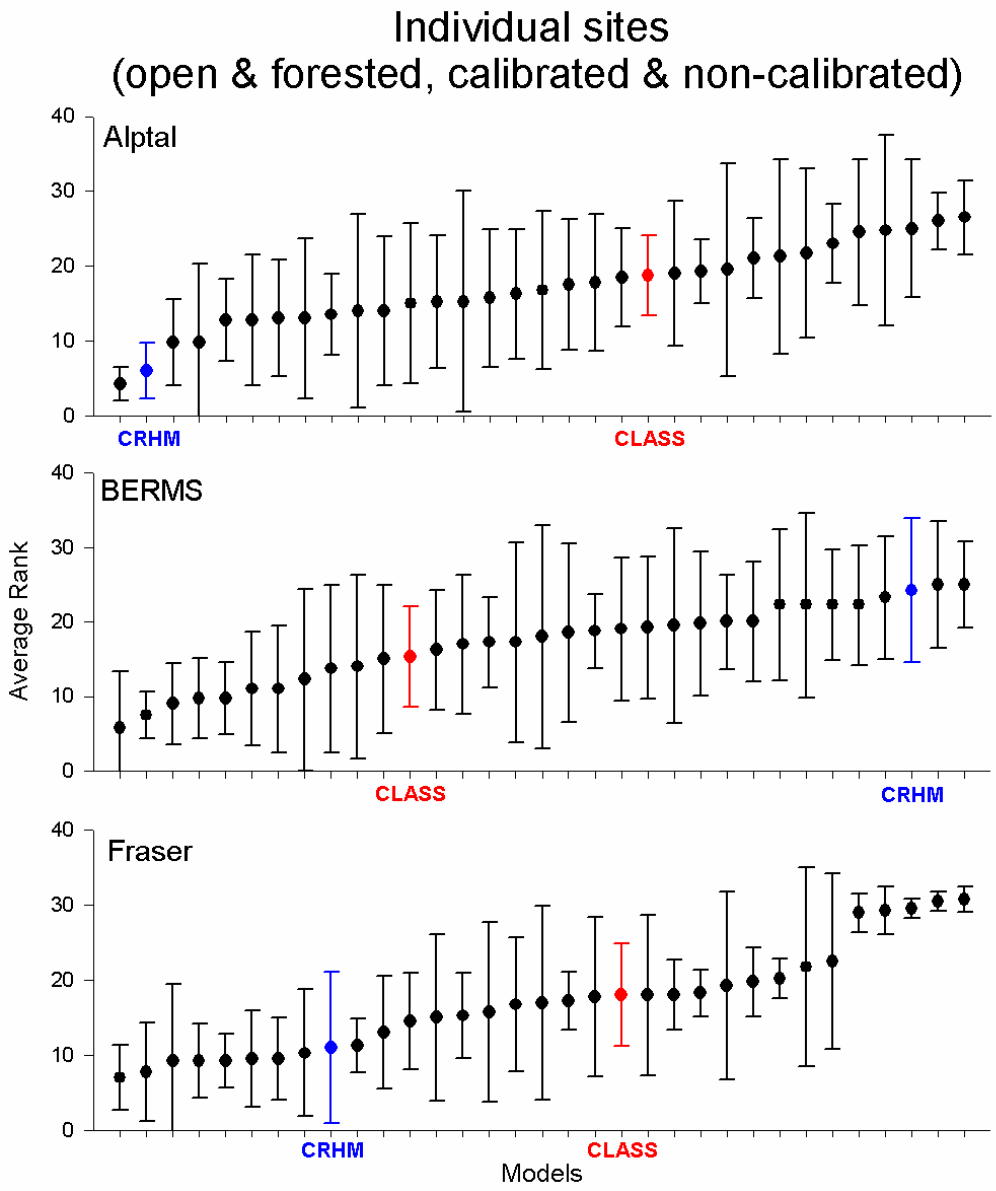
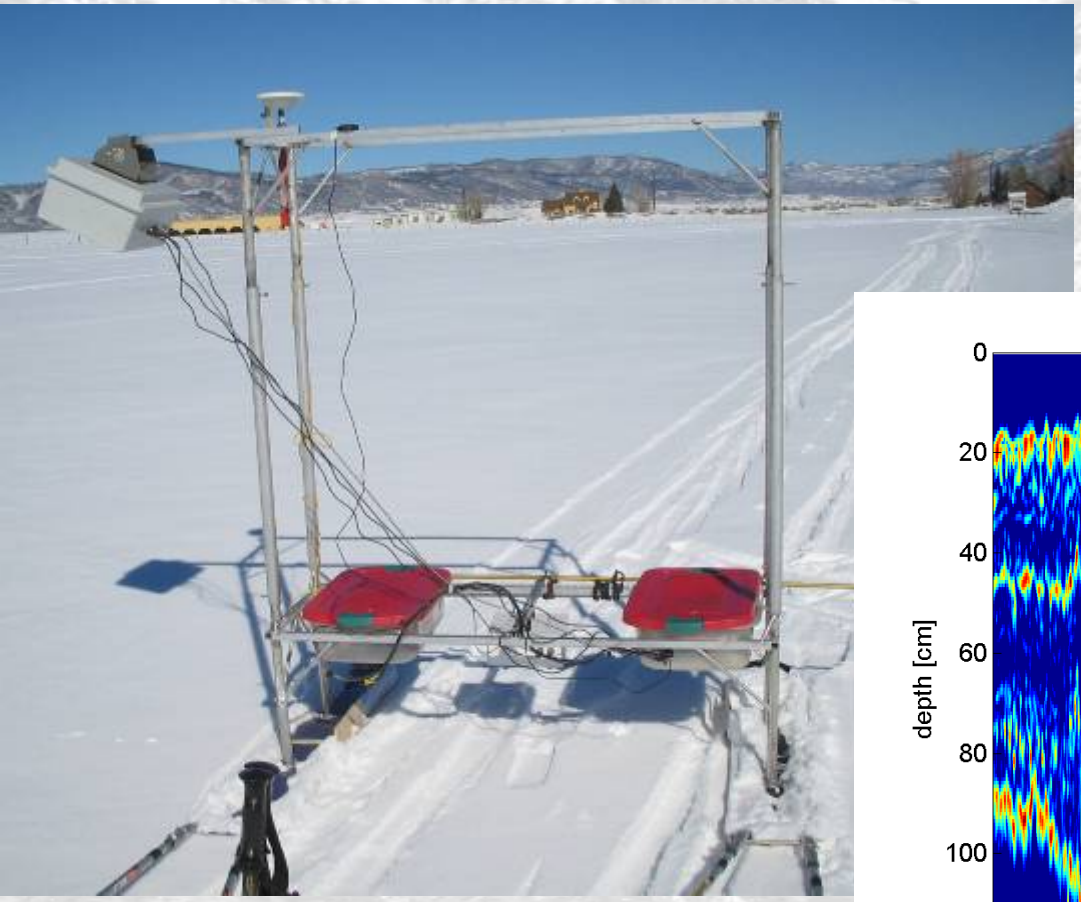


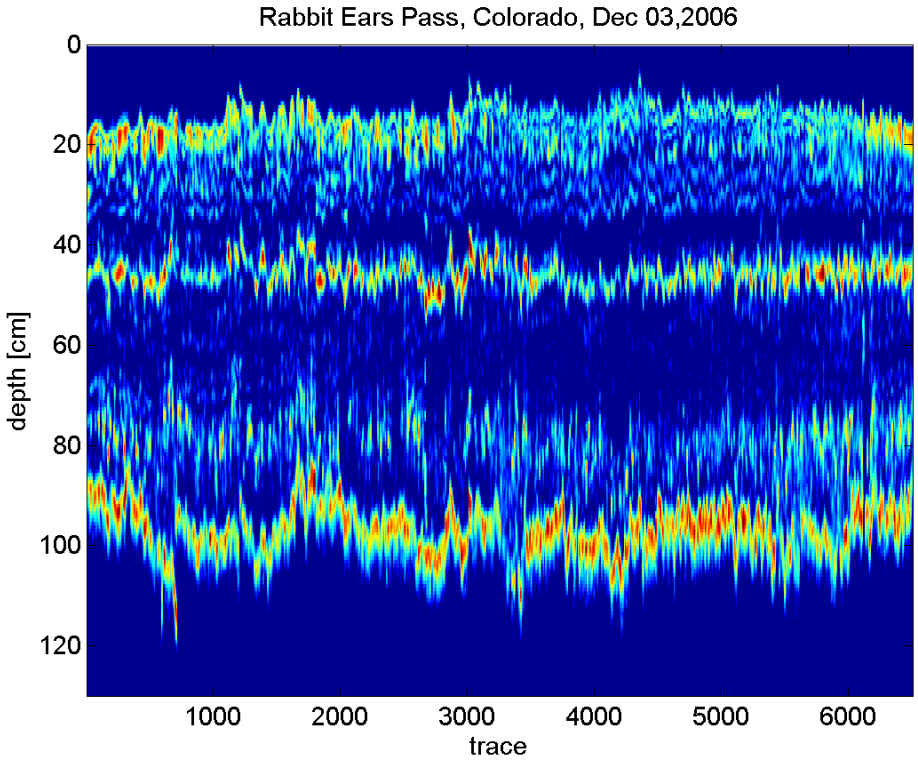
- Models ranked by RMSE
  - 1 = lowest RMSE
  - 33 = highest RMSE
- Mean rank
  - 4 sites at each location
- Consistency of rank (st dev)
- Doesn't explain a lot!
  - Need to categorise by process and compare by rank
- Currently finding out more to enable model categorisation:
  - by process (canopy, snow, soil)
  - by calibration, data manipulation and structure

SnowMIP2: Conclusions

- 33 models successfully participated in SnowMIP2 – thanks to the hard work and goodwill of the participants
- Low correlation coefficients suggests good model performance at forest sites do not necessarily mean good model performance at open sites (and vice versa)
- One year of calibration data in forest models is not necessarily good enough for subsequent years
- It is easier to model inter-annual variability at open sites than forest
- Current work focussed on analysing whether 1) process representation, 2) strength of calibration or 3) canopy complexity makes inter-annual variability of forest snow hard to model

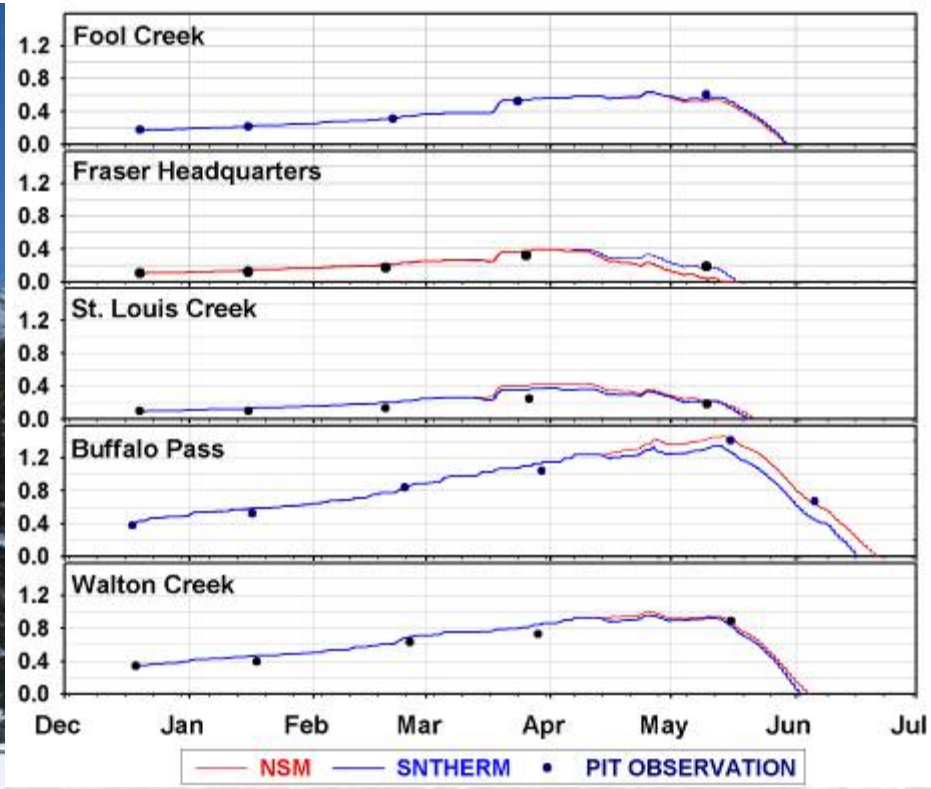
FMCW radar: spatial evaluation





6,511 radar measurements over ~2.5km

FMCW radar: temporal evaluation



- Evaluation of 1-D models
- Evaluation of 2-D models
- Evaluation of radiative transfer models?