DISTRIBUTED SNOW SURVEYS IN STATKRAFT

Knut Sand

Statkraft Energi AS

HUVA dagen, Dec. 2, 2015

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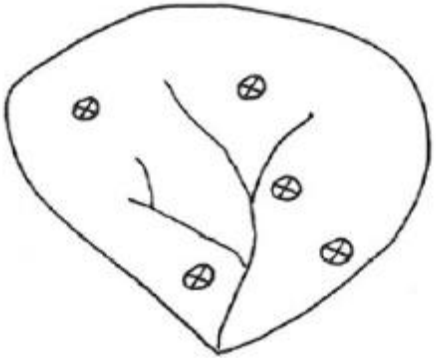
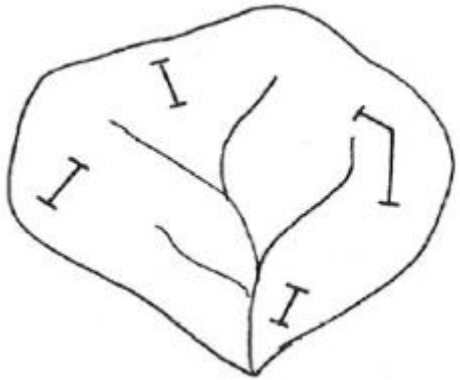
Traditional methods



- **‘Snow stations’** (11 catchments)
  - Mean snowdepth (one value) at each ‘snow station’
  - One snow density measurement at mean snowdepth

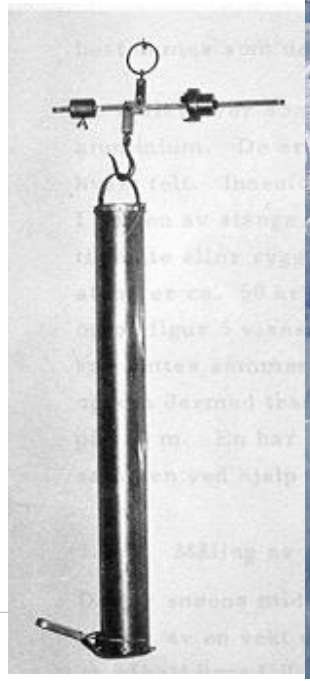


- **Snow courses** (17 catchments)
  - Snow depth at equal intervals along each snow course (20-40 values)
  - One snow density measurement at mean snowdepth

Traditional tools

- Snow probe

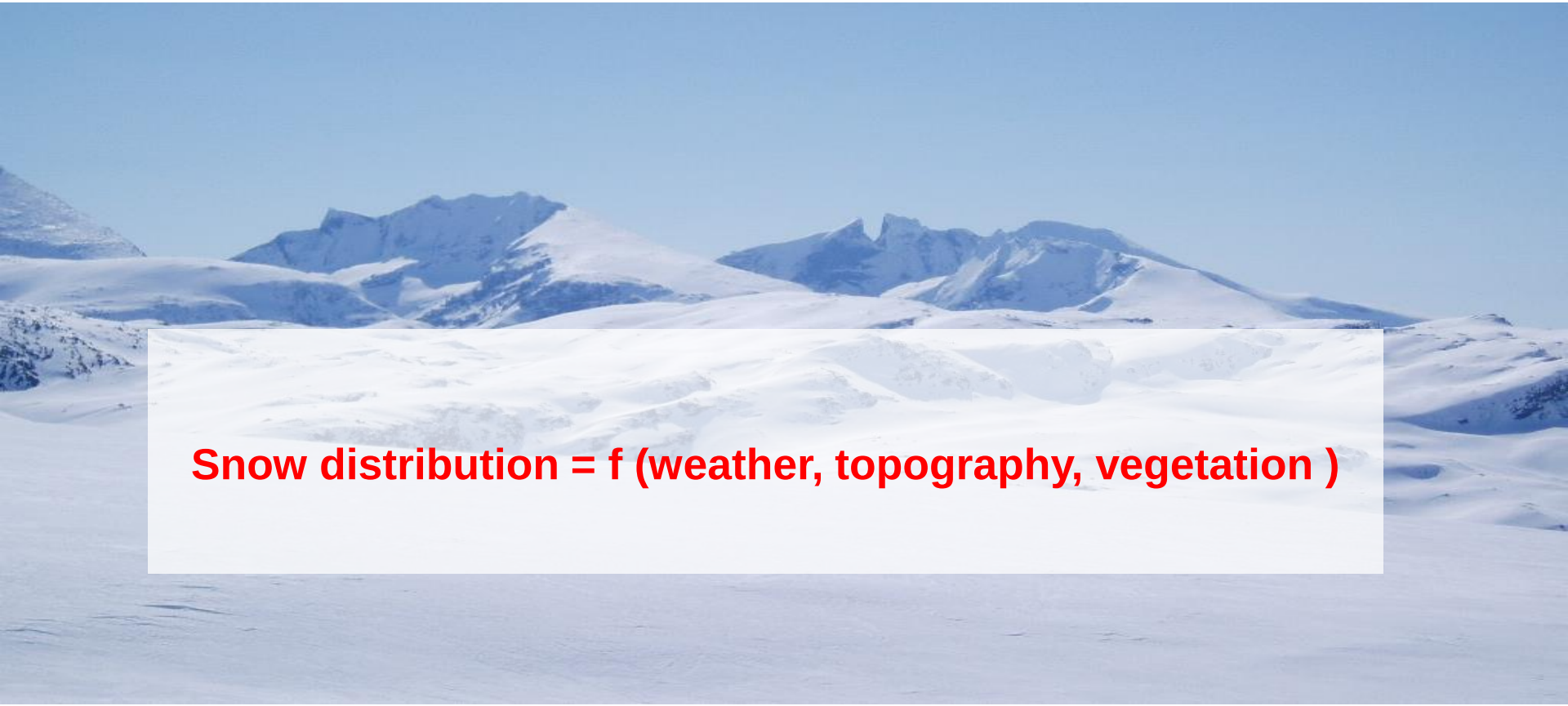
- Songa density sampler



2008:
New approach to representative snow surveying

- **Objective:**
  - **Measure representative (true)……..**
    - ✓ **snow storage (SWE)**
    - ✓ **snow distribution**

Hypothesis:

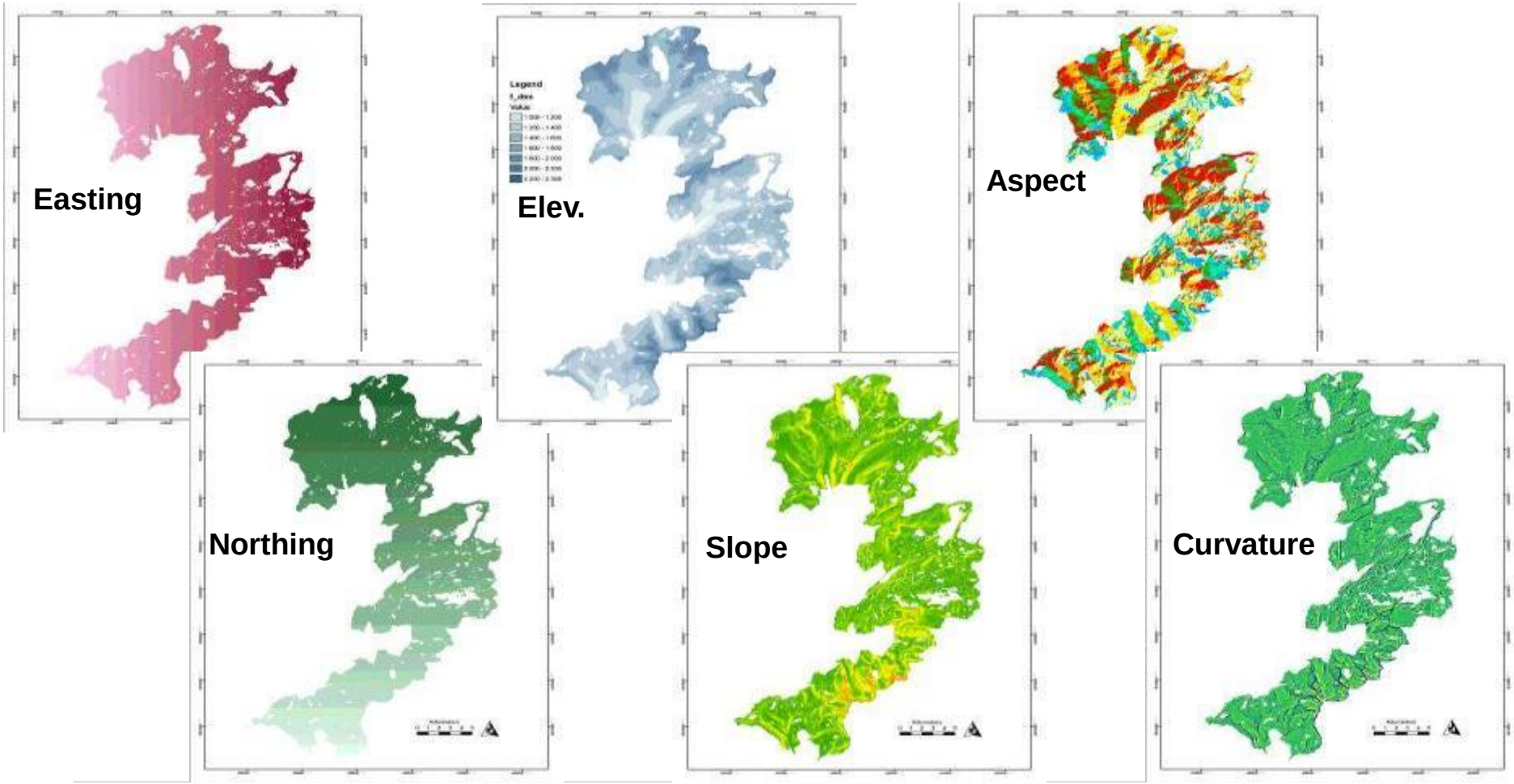


Snow distribution = f (weather, topography, vegetation)

Selected parameters controlling snow distribution

- **Topography**
  - Easting
  - Northing
  - Altitude
  - Slope
  - Aspect
  - Curvature
- **Vegetation**
  - Forested areas
  - Open areas
- **Weather**
  - Precipitation
  - Temperature
  - Wind
  - …..

Topographic description of a catchment



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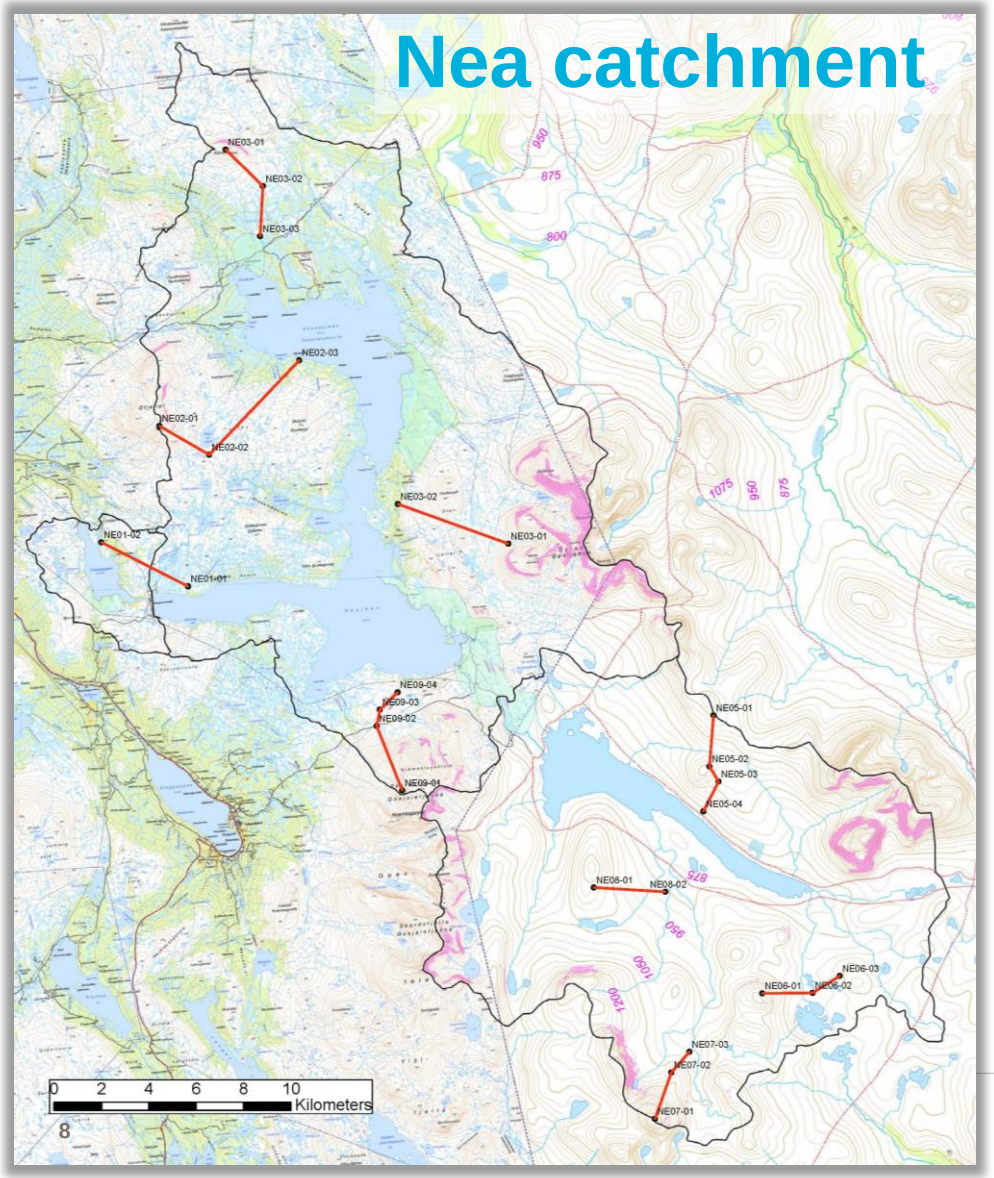
Nea catchment



- Topography
  - Topographic characteristics of snow courses should be equal to topographic characteristics of catchment
- Vegetation
  - Forest cover % of the catchment should be reflected in the snow courses
- Weather
  - The same weather influences the snow distribution along the snow courses as over the catchment

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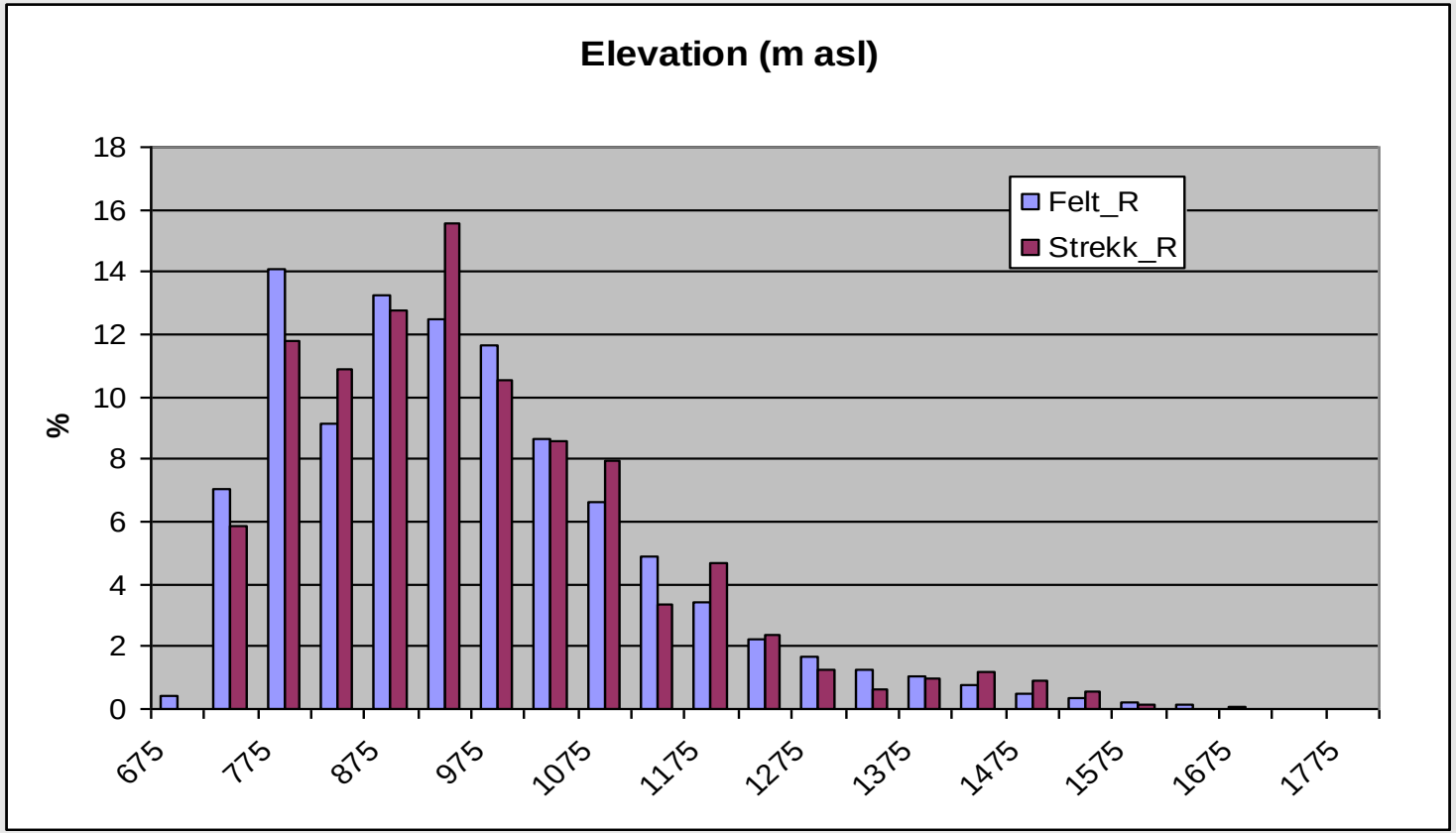
Distribution of elevation



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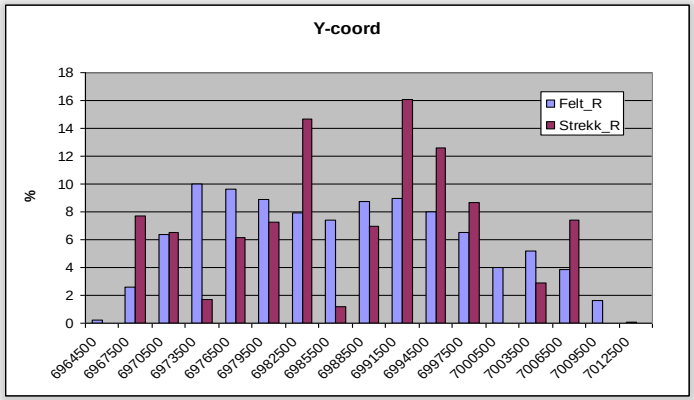
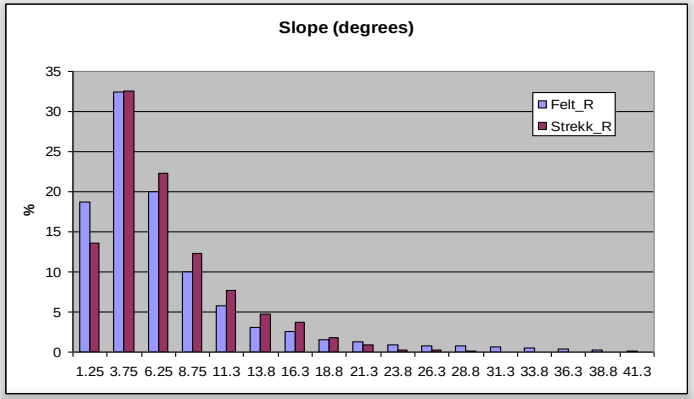
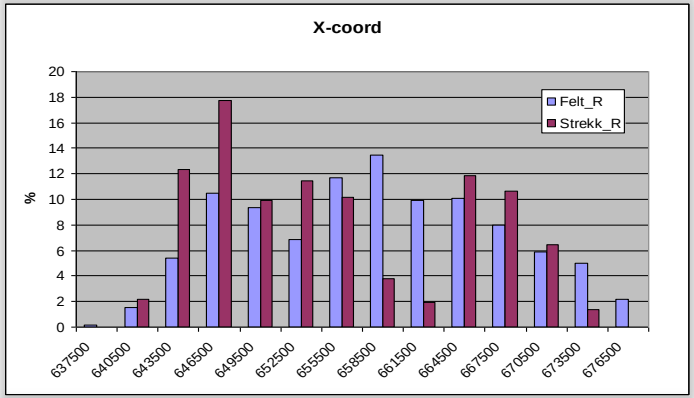
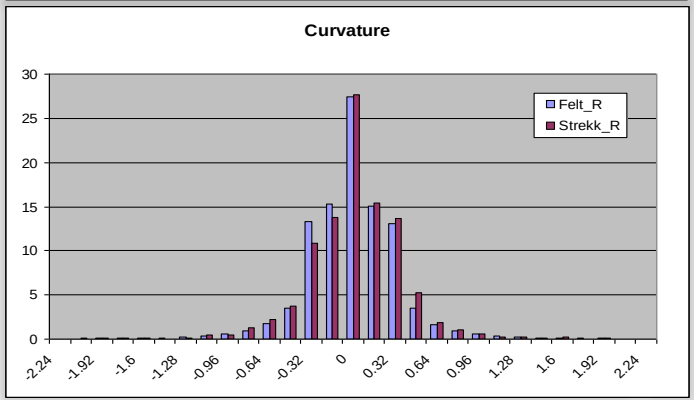
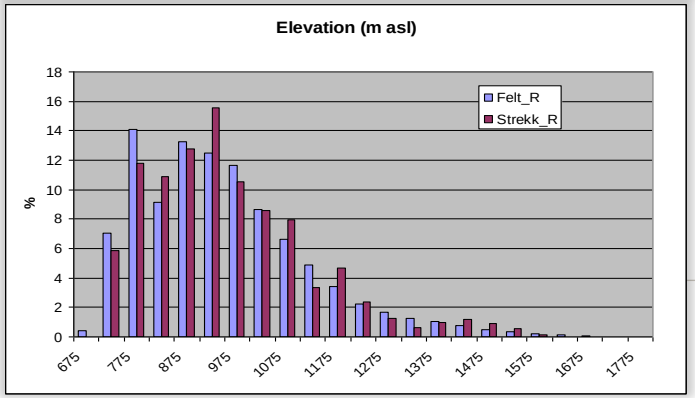
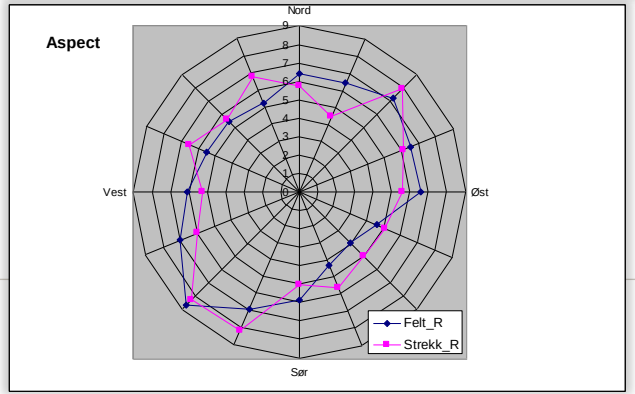

Y-coord
%
Felt_R
Strekk_R
6964500 6967500 6970500 6973500 6976500 6979500 6982500 6985500 6988500 6991500 6994500 6997500 7000500 7003500 7006500 7009500 7012500

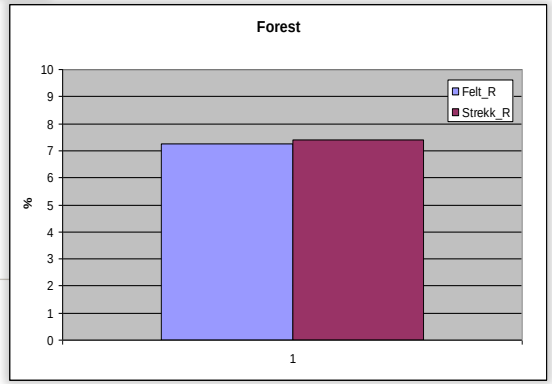

Slope (degrees)
%
Felt_R
Strekk_R
1.25 3.75 6.25 8.75 11.3 13.8 16.3 18.8 21.3 23.8 26.3 28.8 31.3 33.8 36.3 38.8 41.3


X-coord
%
Felt_R
Strekk_R
637500 640500 643500 646500 649500 652500 655500 658500 661500 664500 667500 670500 673500 676500

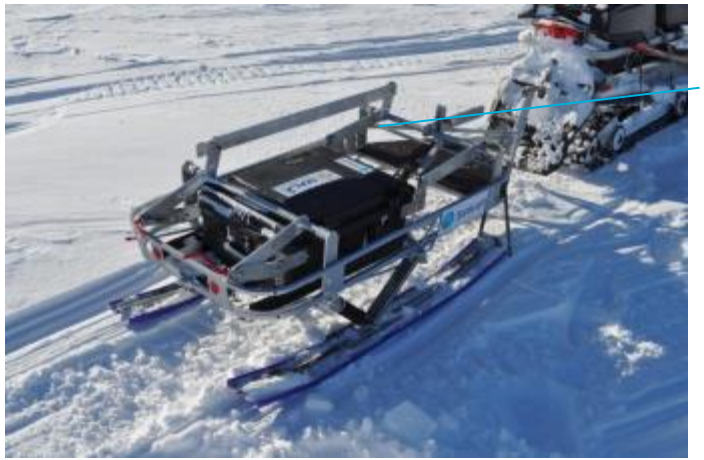

Curvature
Felt_R
Strekk_R
-2.24 -1.92 -1.6 -1.28 -0.96 -0.64 -0.32 0 0.32 0.64 0.96 1.28 1.6 1.92 2.24


Elevation (m asl)
%
Felt_R
Strekk_R
675 775 875 975 1075 1175 1275 1375 1475 1575 1675 1775


Aspect
Nord
Øst
Sør
Vest
Felt_R
Strekk_R


Forest
%
Felt_R
Strekk_R
1

Malå GX450 GPR



Transport mode

Measuring mode

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McCall sampler (Federal snow sampler)

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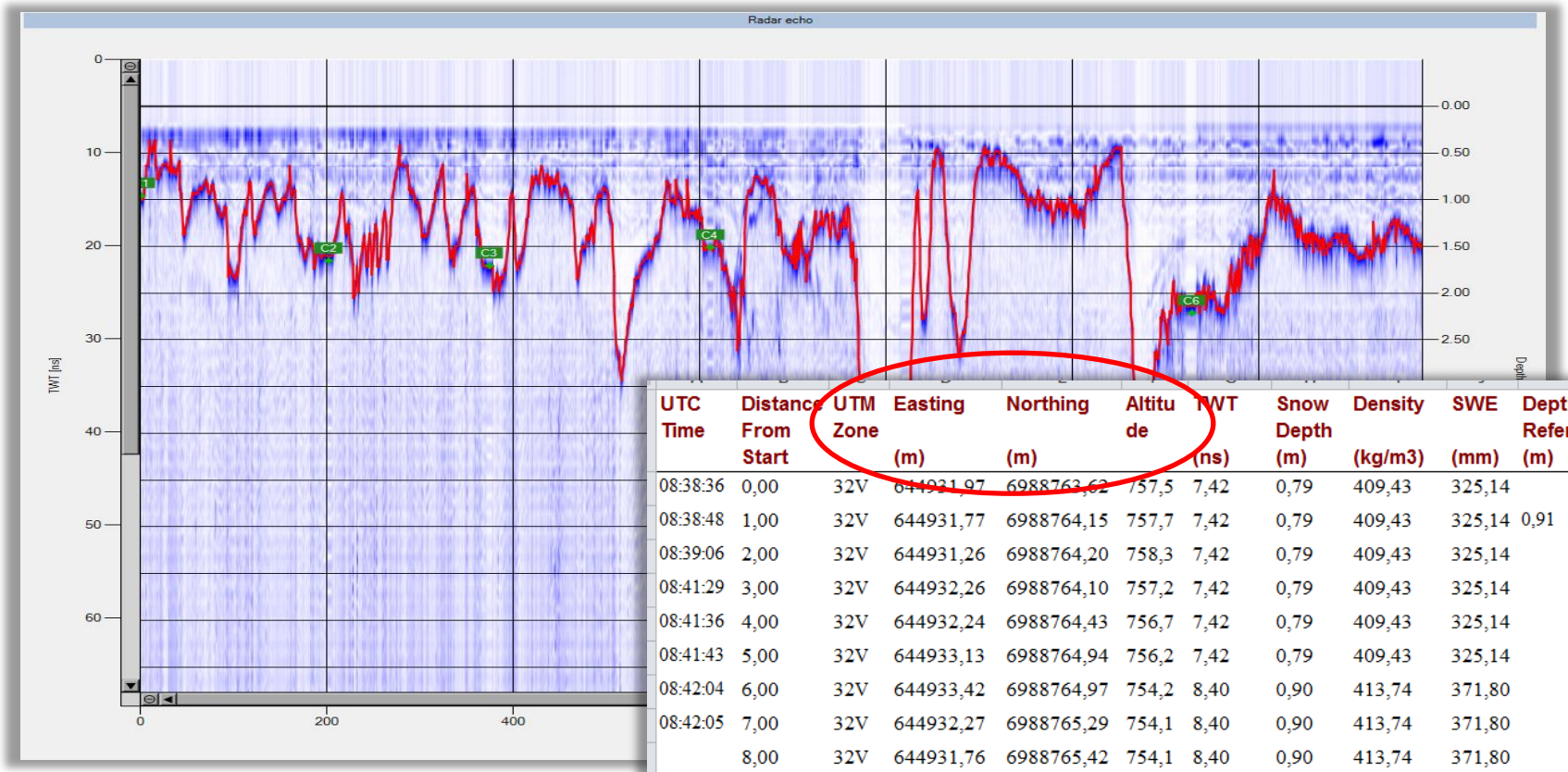
GPR results



UTC Time	Distance From Start	UTM Zone	Easting (m)	Northing (m)	Altitude	TWT (ns)	Snow Depth (m)	Density (kg/m3)	SWE (mm)	Depth Reference (m)
08:38:36	0,00	32V	644931,97	6988763,62	757,5	7,42	0,79	409,43	325,14	
08:38:48	1,00	32V	644931,77	6988764,15	757,7	7,42	0,79	409,43	325,14	0,91
08:39:06	2,00	32V	644931,26	6988764,20	758,3	7,42	0,79	409,43	325,14	
08:41:29	3,00	32V	644932,26	6988764,10	757,2	7,42	0,79	409,43	325,14	
08:41:36	4,00	32V	644932,24	6988764,43	756,7	7,42	0,79	409,43	325,14	
08:41:43	5,00	32V	644933,13	6988764,94	756,2	7,42	0,79	409,43	325,14	
08:42:04	6,00	32V	644933,42	6988764,97	754,2	8,40	0,90	413,74	371,80	
08:42:05	7,00	32V	644932,27	6988765,29	754,1	8,40	0,90	413,74	371,80	
	8,00	32V	644931,76	6988765,42	754,1	8,40	0,90	413,74	371,80	
08:42:06	9,00	32V	644930,55	6988765,73	754	8,20	0,88	412,88	362,39	

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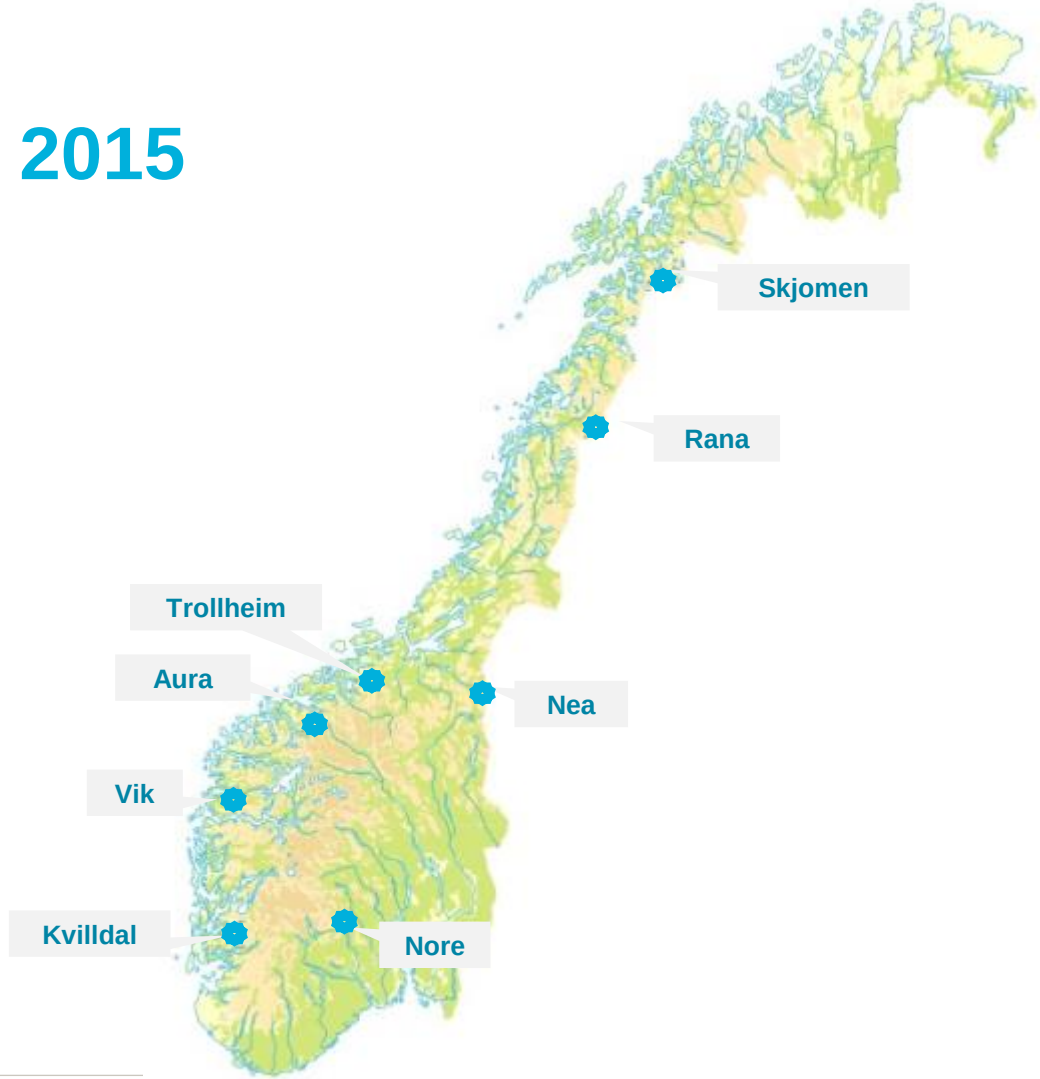
GPR snow surveys 2015

- Nea
- Trollheim
- Aura
- Rana
- Skjomen
- Vik
- Kvilldal
- Nore



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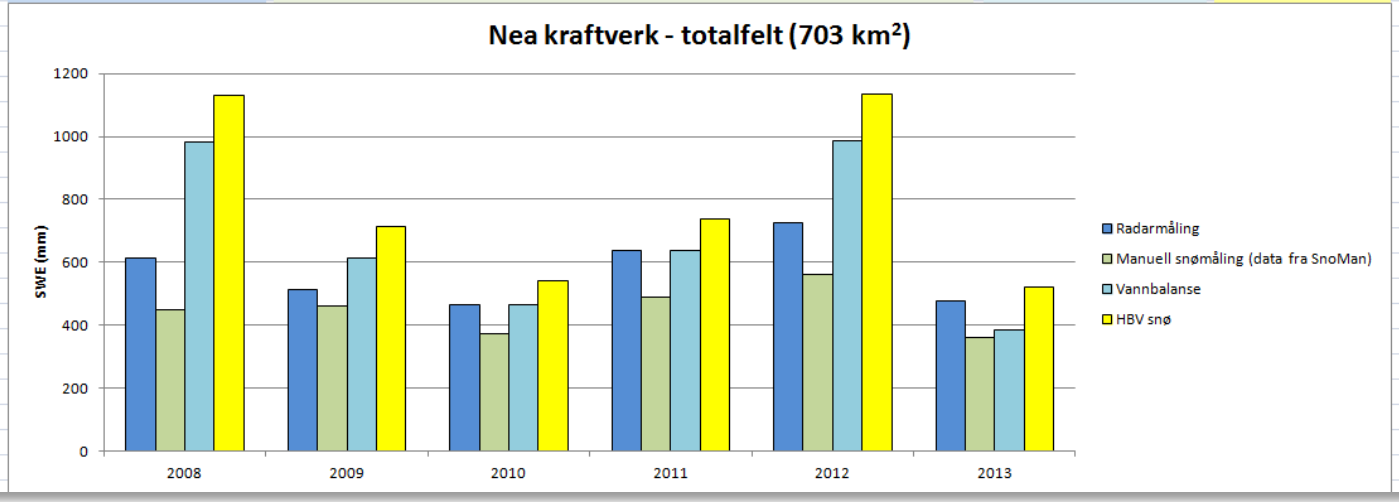
Observed SWE

Felt:	Nea kraftverk (totalfelt)										
ÅR	Radarmåling		Manuell snømåling (data fra SnoMan)					Vannbalanse		HBV snø	
	Dato	Målt SWE (mm)	Dato	Målt SWE (mm)	Nedbør i perioden (mm)	Korr. til dato for radarmåling (mm)	Radar vs.manuell	Beregnet SWE (mm)	Radar vs. Vannbalanse	Beregnet SWE (mm)	Radar vs. HBV snø
2008	22.04.2008	614	02.04.2008	430	20	450	136%	981	63%	1130	54%
2009	16.04.2009	515	25.03.2009	437	26	463	111%	613	84%	712	72%
2010	14.04.2010	465	07.04.2010	364	10	374	124%	465	100%	543	86%
2011	14.04.2011	639	05.04.2011	446	44	490	130%	637	100%	737	87%
2012	13.04.2012	725	30.03.2012	486	76	562	129%	987	73%	1134	64%
2013	11.04.2013	477	03.04.2013	347	15	362	132%	384	124%	522	91%
							127%				



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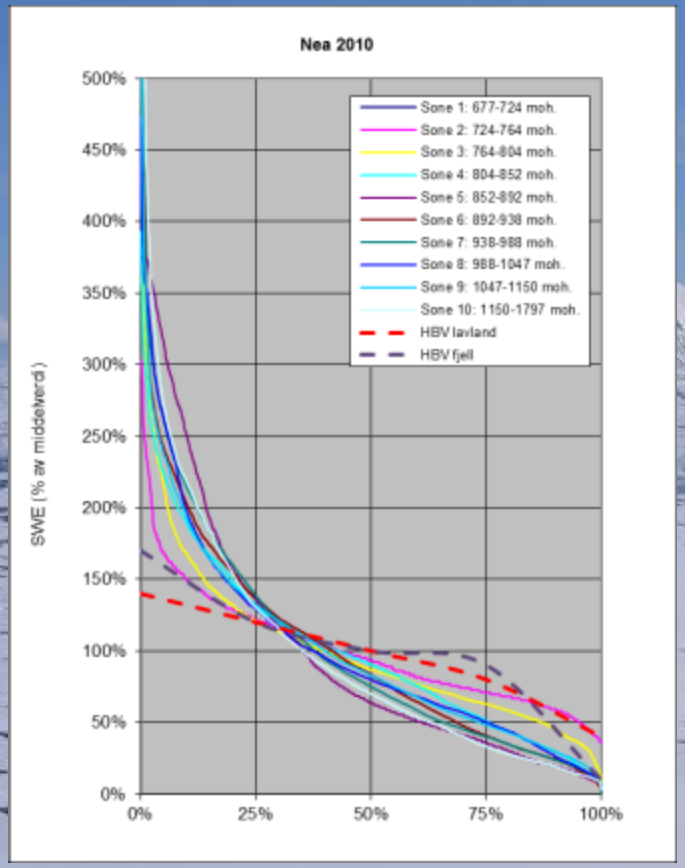
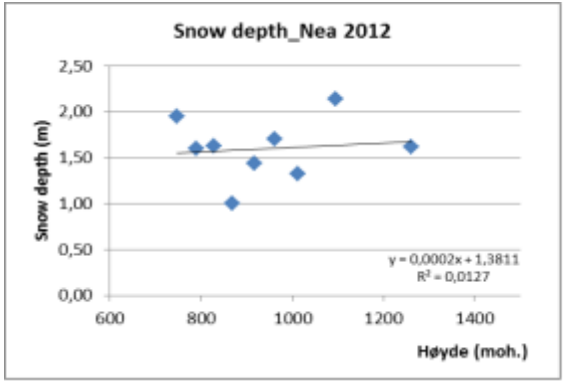
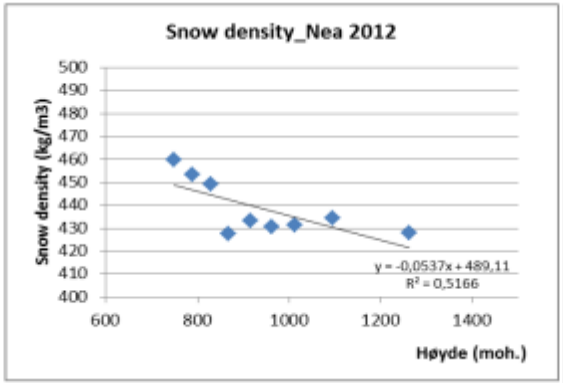
Observed snow distribution

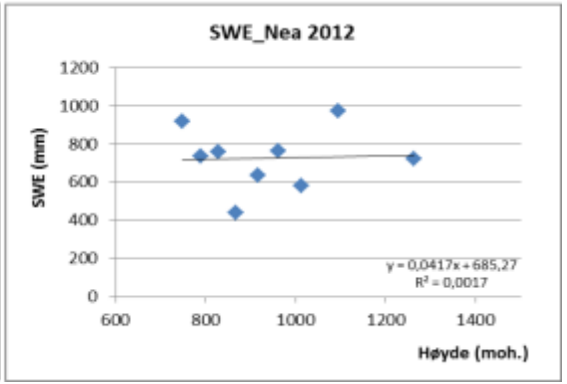


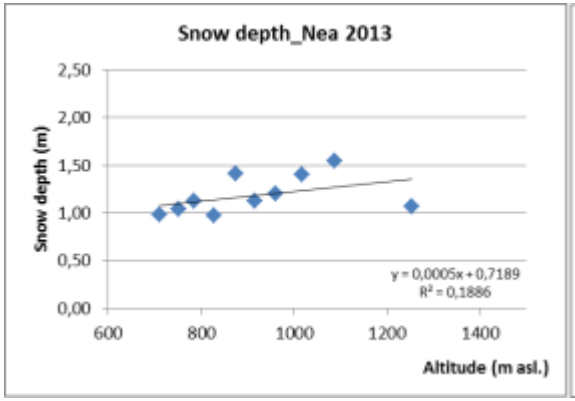
- Significant differences between elevation zones

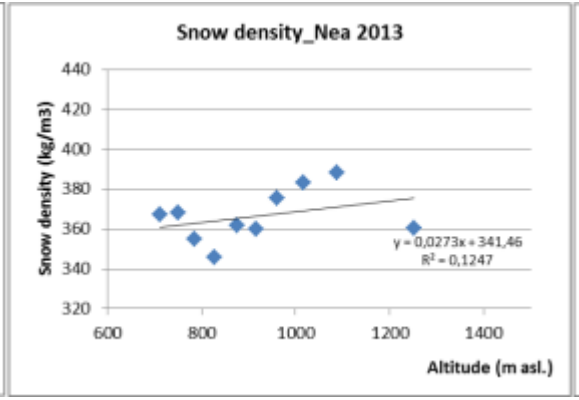
More observations …….

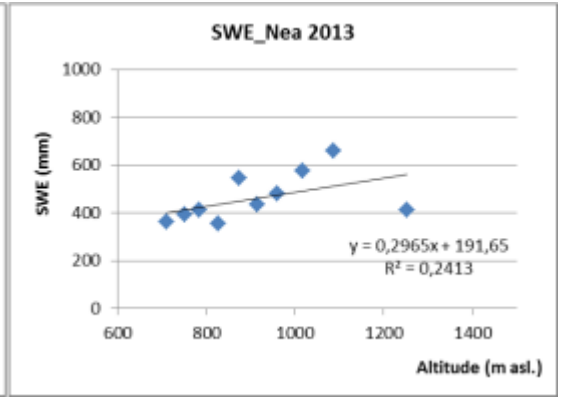












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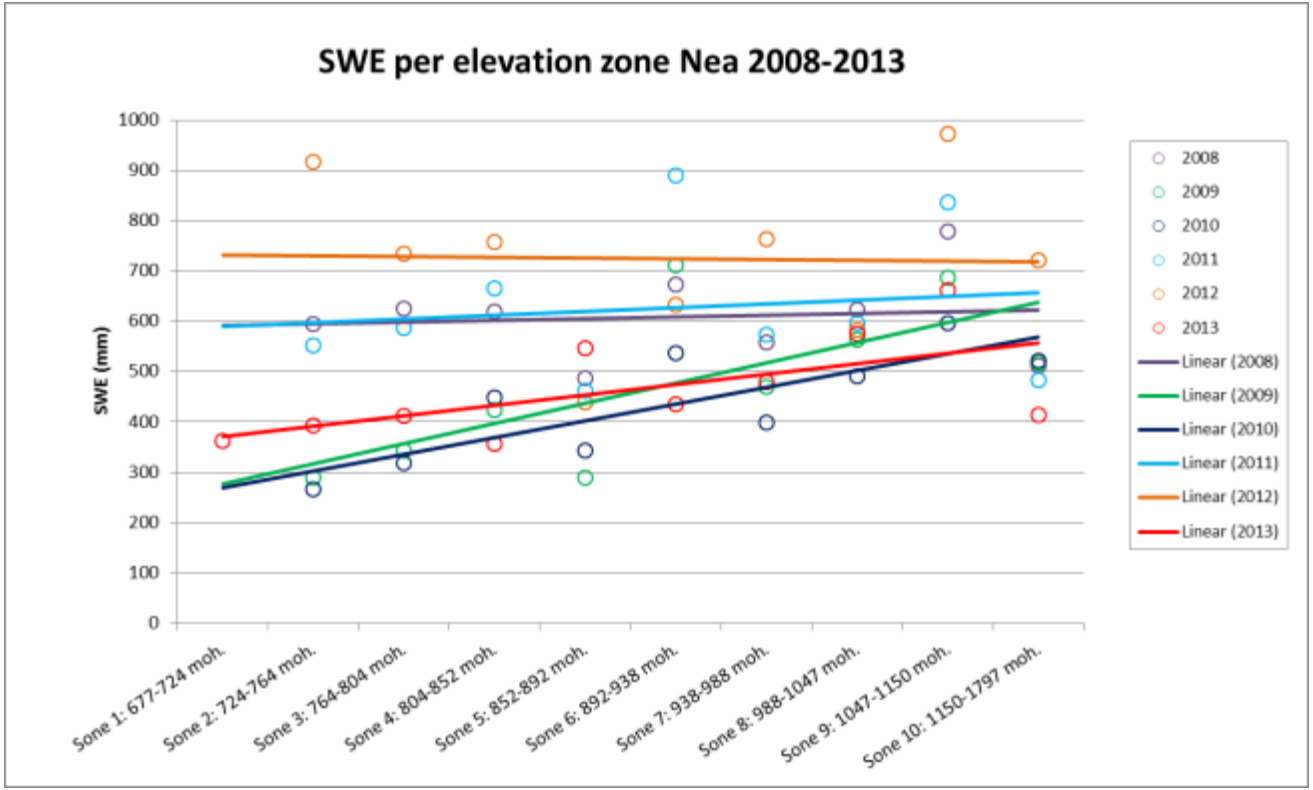
Elevation gradient - or not?



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Statistical analysis of snow adjustments per HBV-model

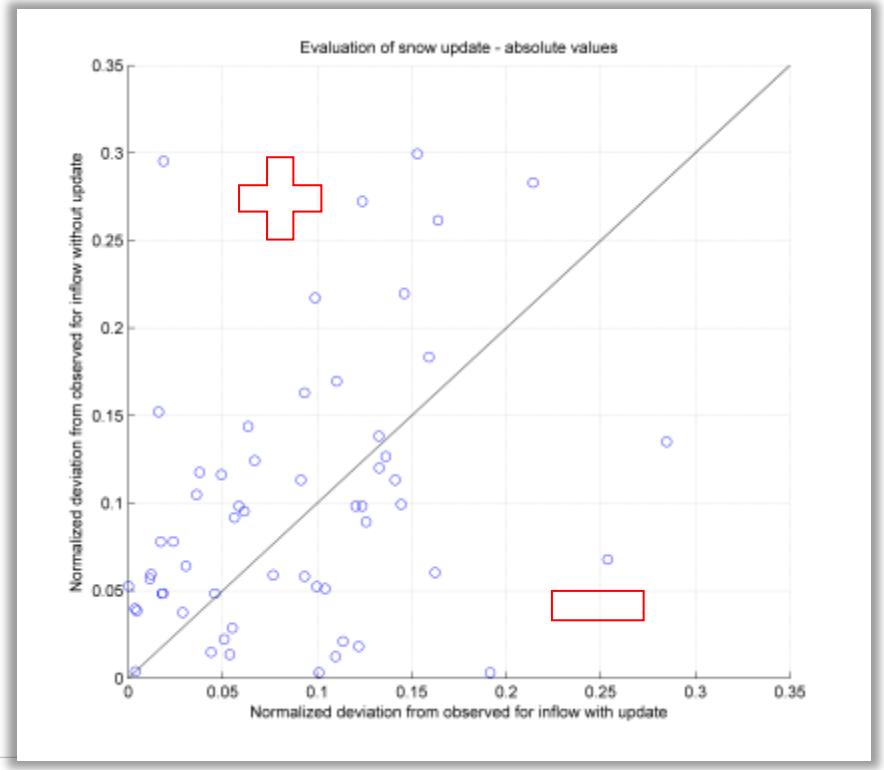
Method:

- Calculate absolute normalised deviation from observed inflow for inflow simulations <u>with</u> and <u>without</u> snow update during April-September:

  score = abs(q_sim – q_obs) / q_obs

- Calculated for 145 models
- Remove ties after rounding scores to second decimal
- 57 models with significant differences
- Count wins and losses
- Disclaimer: Estimates for observed inflow are not final and may be revised

Wins : 33 Losses: 24



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Thank you !
LYNX