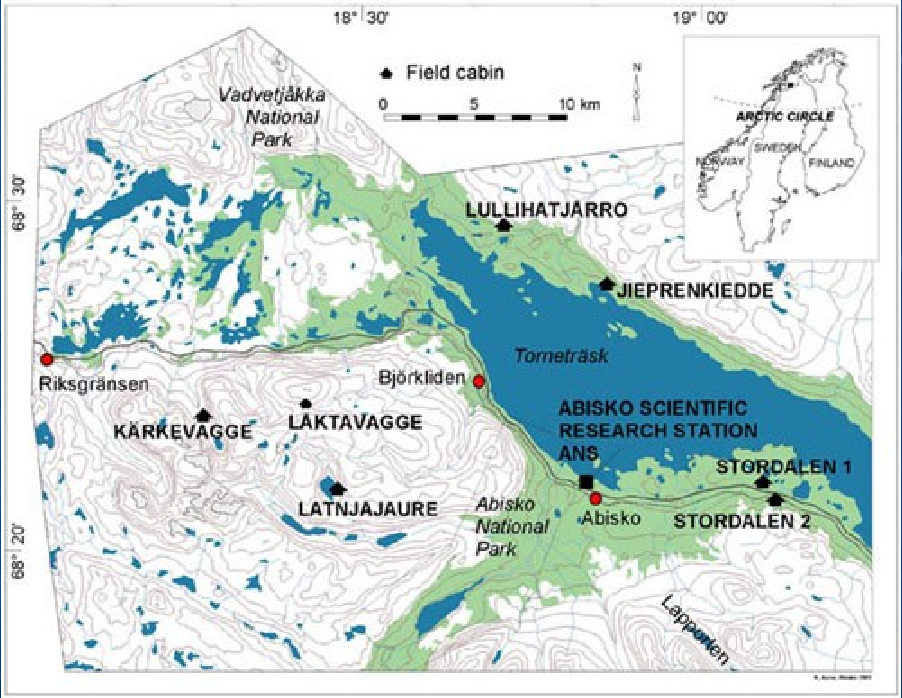
Climate impacts assessment in the Abisko region – temperature redistribution on meters scale

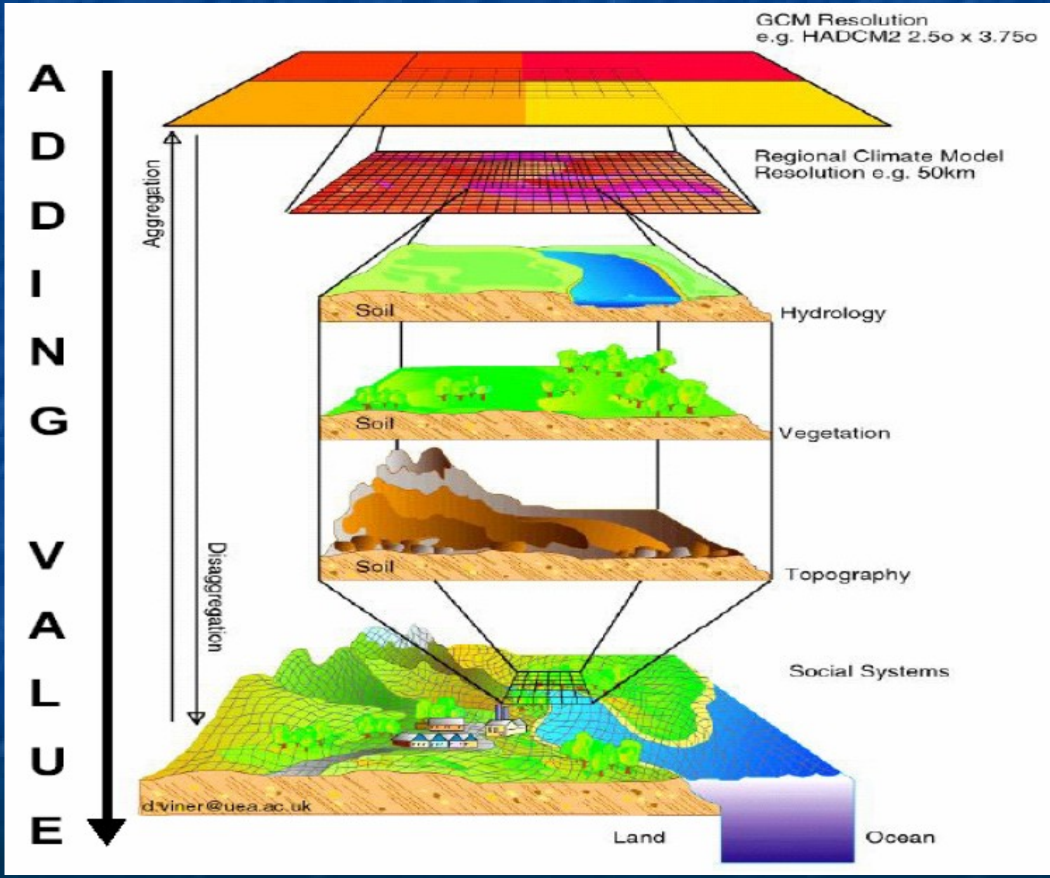


Reporter: Zhenlin Yang, PhD student in Lund University

Sep 21, 2008

Project Framework

- Driven by climate data- Statistical-empirical method
- Use LPJ-GUESS, a well-developed dynamic vegetaion model
- Validate with experiment works over 100 years in Abisko
- Results: the climate impacts on the local scale



Overview of previous works

- Running et al 1987

$$T = (0.5 * f(e) + 0.5) * T_{max} + (0.5 * f(e) - 0.5) * T_{min}$$

- Moore et al 1993

$$T = T_a + \beta_1 * elevation + \beta_2 (S_i - \frac{1}{S_i})(1 - \frac{LAI_i}{LAI_{max}})$$

- Pinde 2000; Shengli,2008

$$\mathrm{T} = T_a + \beta_1 * elevation + \beta_2 * radiation + \beta_0$$

- Lookingbill and Urban 2003

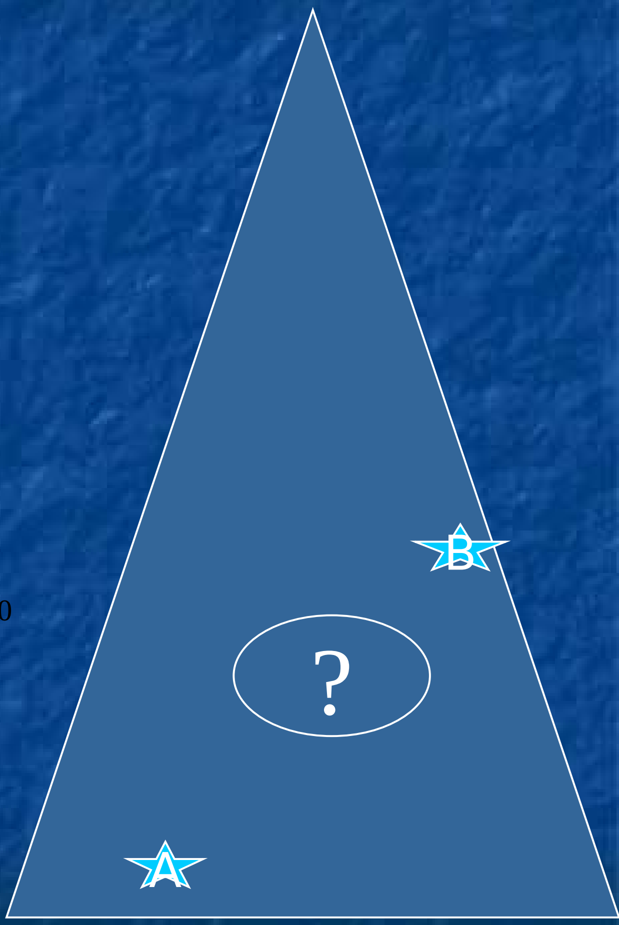
$$T = T_a + \beta_1 elevation + \beta_2 \log(dstrm) + \beta_3 radiation + \beta_0$$

- Chung and Jin 2004

$$T - \frac{?\frac{Ti}{di^2}}{?\frac{1}{di^2}} = [z - \frac{?\frac{Ti}{di^2}}{?\frac{1}{di^2}}]\Gamma + [s - \frac{?\frac{Ti}{di^2}}{?\frac{1}{di^2}}]\Delta + \beta_0$$

- Weiss,2005; Van de Ven,2007

$$T = T_a + \beta_1 elevation + \beta_2 slope + \beta_3 TP + \beta_4 abs(TP) + \beta_0$$



The problems of present models

- Pre-assumed linear regression structure of model

$$T = T_a + \beta_1 factor1 + \beta_2 factor2 + \beta_3 factor3 + \beta_0$$

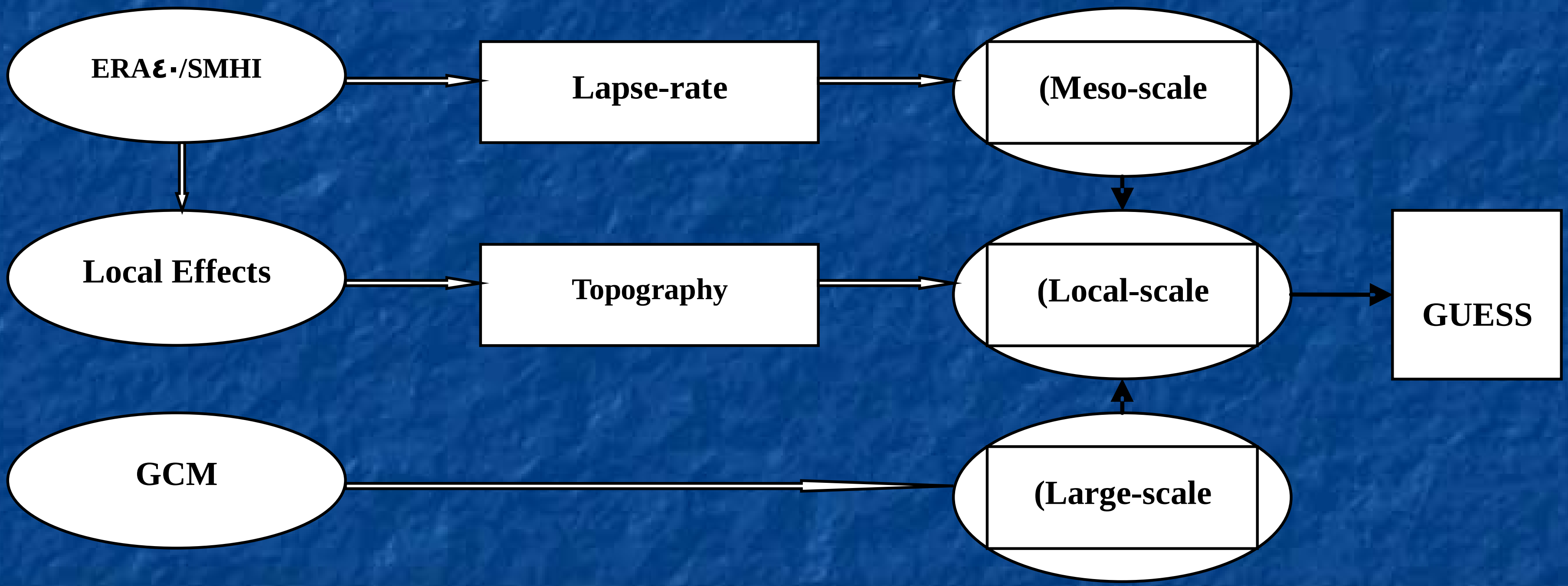
- Lack of mechanism, statistical based selection of factors
- Simple interpolation assumes smooth surface in mountain regions with complex topography
- Self-correlation between factors
- Validation

  Short-term field work (mainly on summer)

  Ignorance of night and winter

  Confusion between air temperature or vegetation temperature

How?


ERA٤٠/SMHI
Lapse-rate
(Meso-scale
Local Effects
Topography
(Local-scale
GUESS
GCM
(Large-scale

Data Source

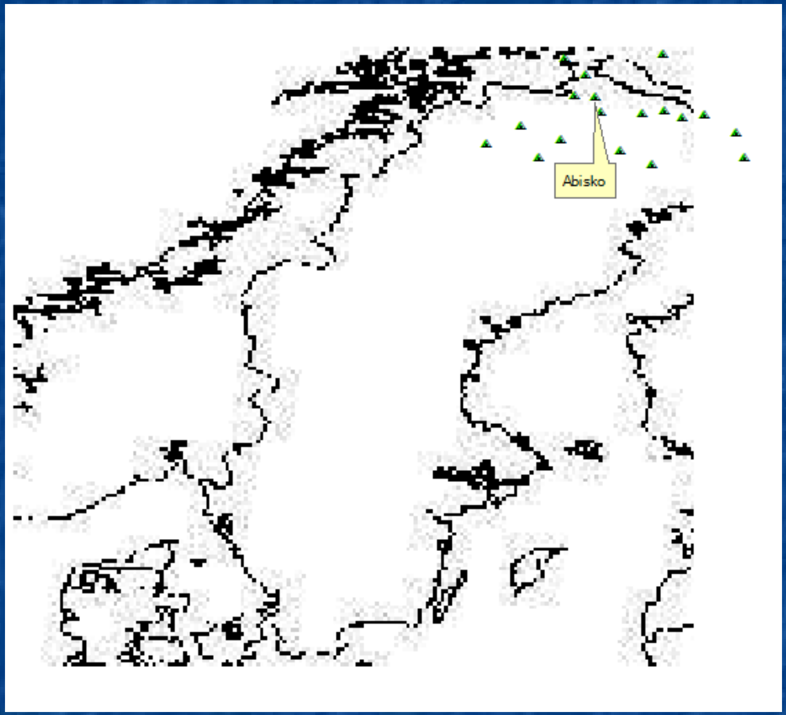


Fig.1 Choices of meteorological stations (green signals) used in the derivation of meso-scale climatology

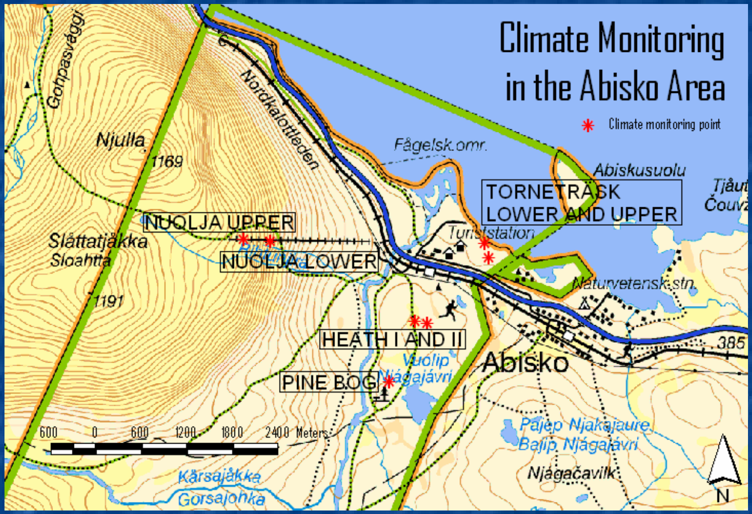


Fig.2 Choices of meteorological stations (red signals) used in the derivation of micro-scale climatology

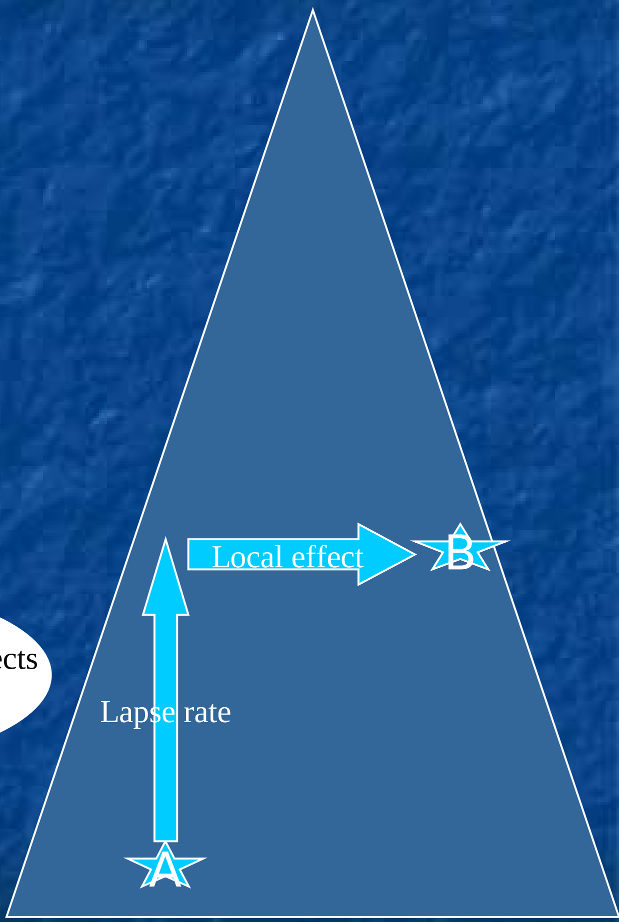
Interpret the temperature difference

$$\frac{\bar{\theta}}{z_{sfc}} = \frac{[\theta]}{z} + \frac{\theta^{*}}{z_{sfc}}$$

Observed temperature variation

Variation due to elevation in the vertical direction

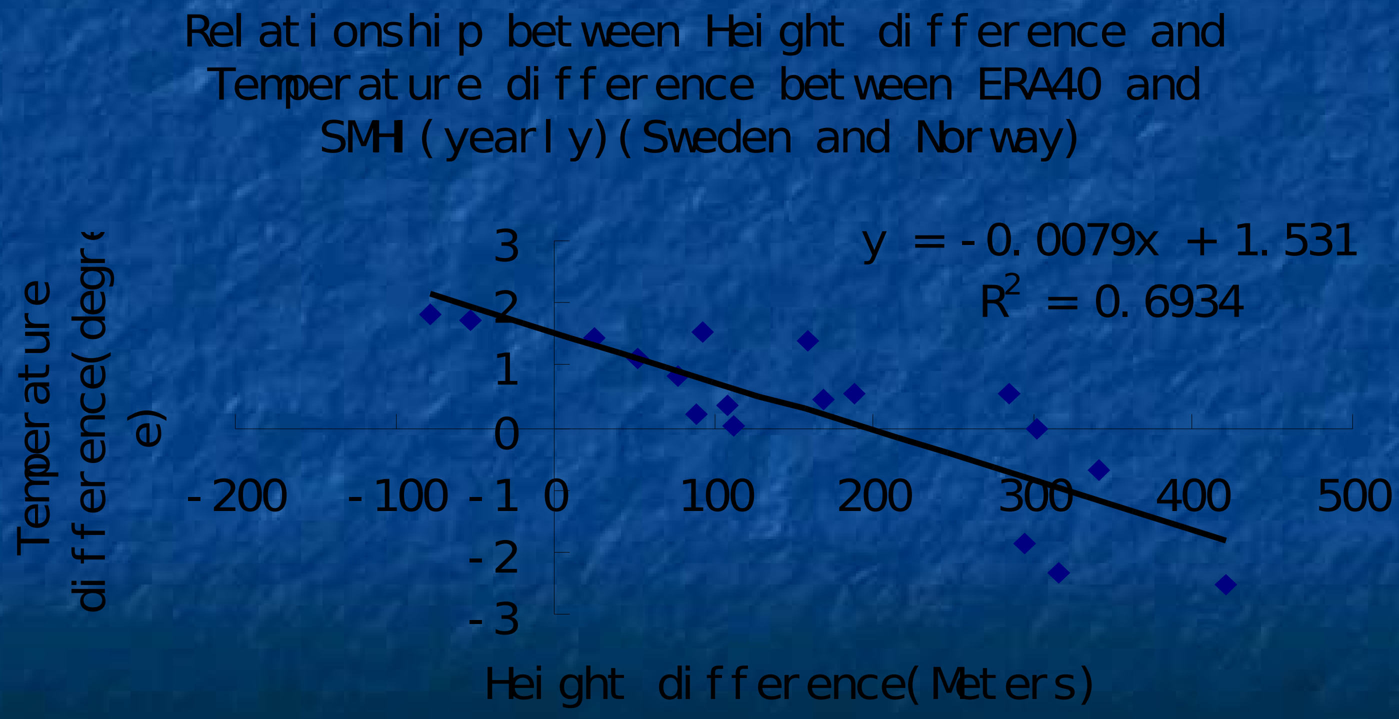
Variation due to the local effects in the horizontal direction



- (Chung and Yun 2004; Mahrt 2006)

Temperature variation due to elevation difference

- $\text{Temperature}_{era40\text{-}smhi}$ = Lapse rate* $\text{Elevation}_{era40\text{-}smhi}$ +system bias+Lake effect

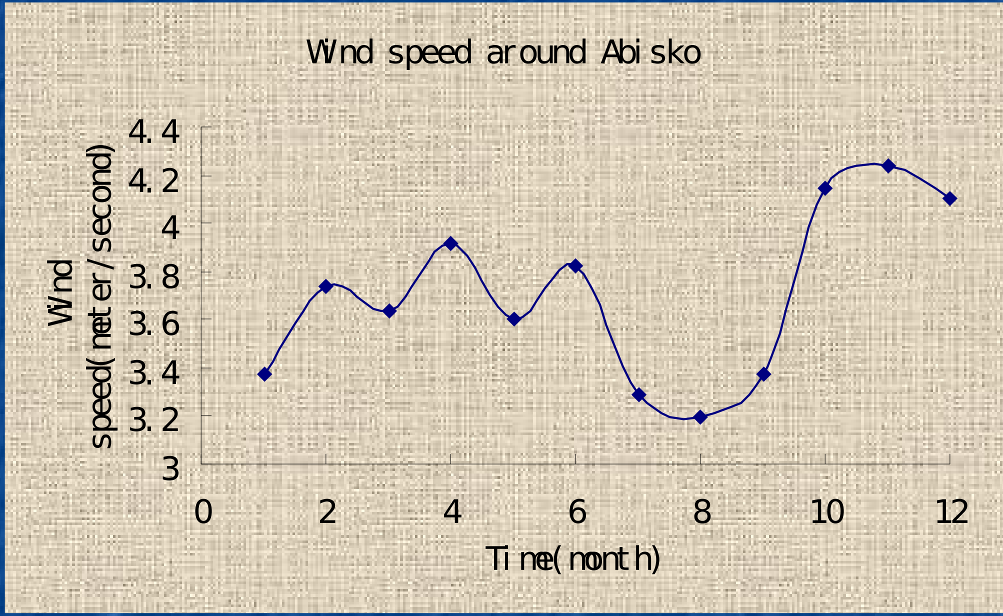


Temperature variation due to elevation difference

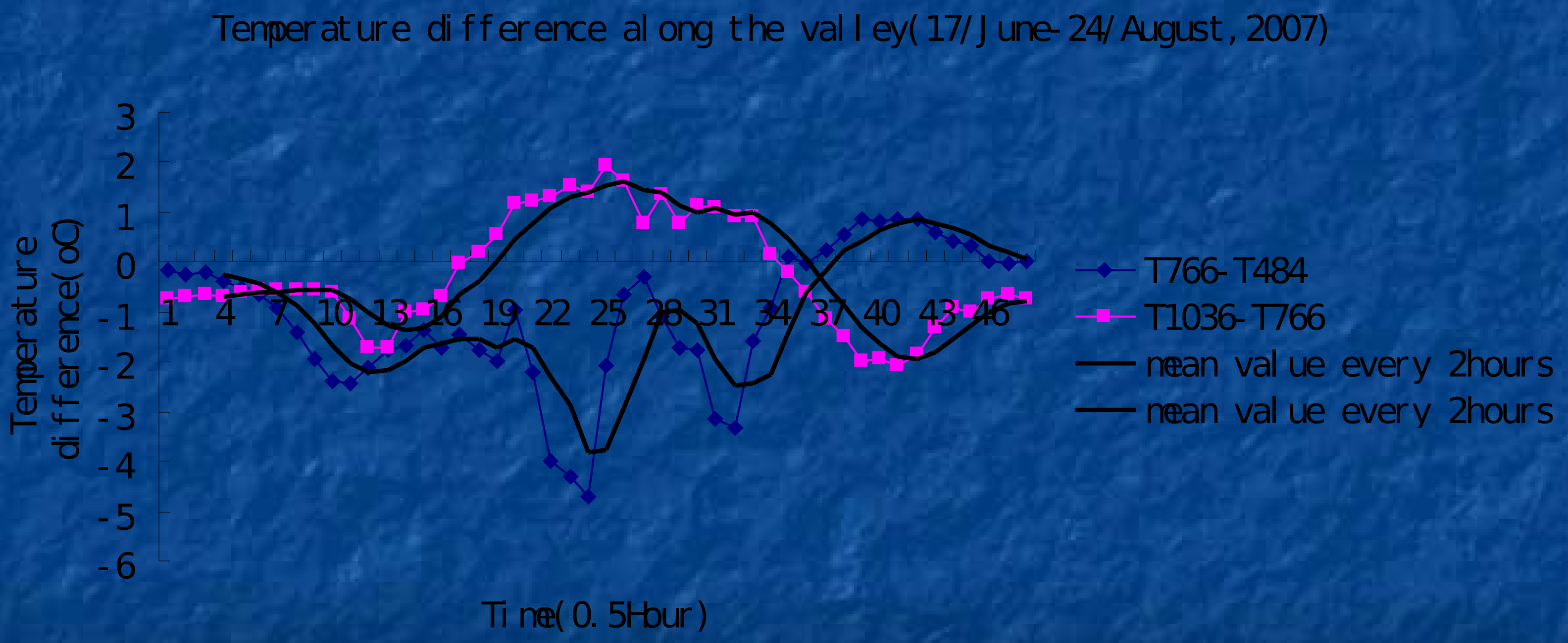
- $Temperature_{era40-smhi}$ = Lapse rate* $Elevation_{era40-smhi}$ + system bias(partly lake effect)

Region	Season	Lapse rate(degree /-1000m)	System bias of ERA40(degree)	R2	T-test(0.01 level)
Sweden and Norway	All the year	7.9	1.531	0.6934	Significant
Sweden	All the year	4.1	1.303	0.4847	Significant
Sweden and Norway	Feb-Apr	10.1	2.0656	0.6132	Significant
Sweden and Norway	May-July	8.0	1.0284	0.7815	Significant
Sweden and Norway	Aug-Oct	6.2	0.6636	0.7076	Significant
Sweden and Norway	Nov-Jan	7.3	2.3358	0.2543	Insignificant

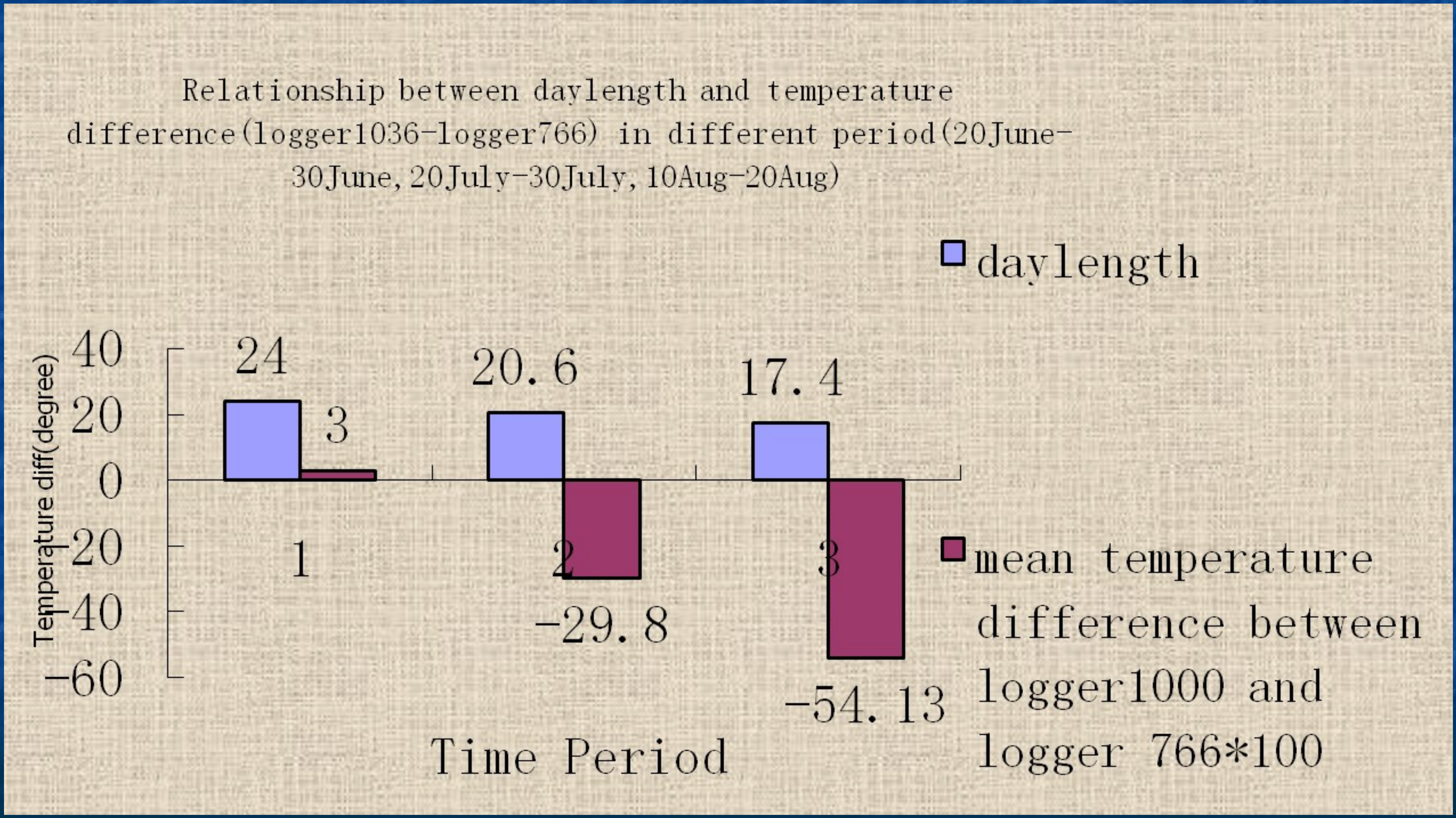
- During day-time, the amount of solar radiation is key factor determining the temperature variation while during the night-time, the prevailing wind speed will determine the development of temperature variation. (Bogren,2000)



Validation from Field work



Validation from Field work



Empirical result of local effects

Solar elevation

Topography

Cloud

Wind

$$\frac{\theta^*}{\Delta z_{sfc}} = (2.7 + 0.46\beta) * Cos(aspect) * Sin(slope) * (1 + b_1 N^{b_2}) * (Dayl / 24)$$

β:solar elevation at noon; N: cloud cover

Summary

$$\frac{\bar{\theta}}{\partial z_{sfc}} = \frac{[\theta]}{\partial z} + \frac{\theta^*}{\partial z_{sfc}}$$

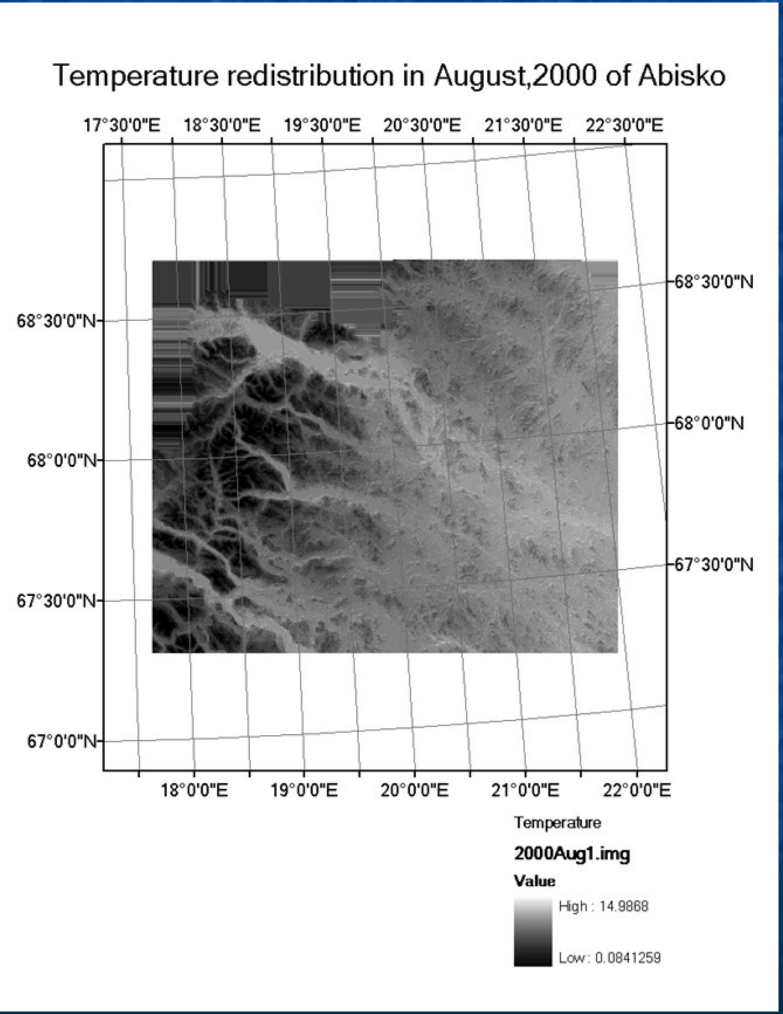
$$\frac{[\theta]}{z} = \frac{(Temdif - sysbias)}{Elediff} * elevation * dayl / 24$$

$$\frac{\theta^*}{\partial z_{sfc}} = (2.7 + 0.46\beta) * Cos(aspect) * Sin(slope) * (1 + b_1 N^{b_2}) * (Dayl / 24)$$

$$Tem_{grid} = T_{stat} + \frac{(Temdif - sysbias)}{Elediff} * elevation * Dayl / 24 + (2.7 + 0.46\beta) * Cos(aspect) * Sin(slope) * (1 + b_1 N^{b_2}) * (Dayl / 24)$$

β:solar elevation at noon; N: cloud cover

Temperature redisreibution on meters scale



Calibration and validation- Future work

- Calibration need to be done
- Field work is designed to test the variation of temperature according to the distance to the Törnetrask lake.

MARIE CURIE ACTIONS

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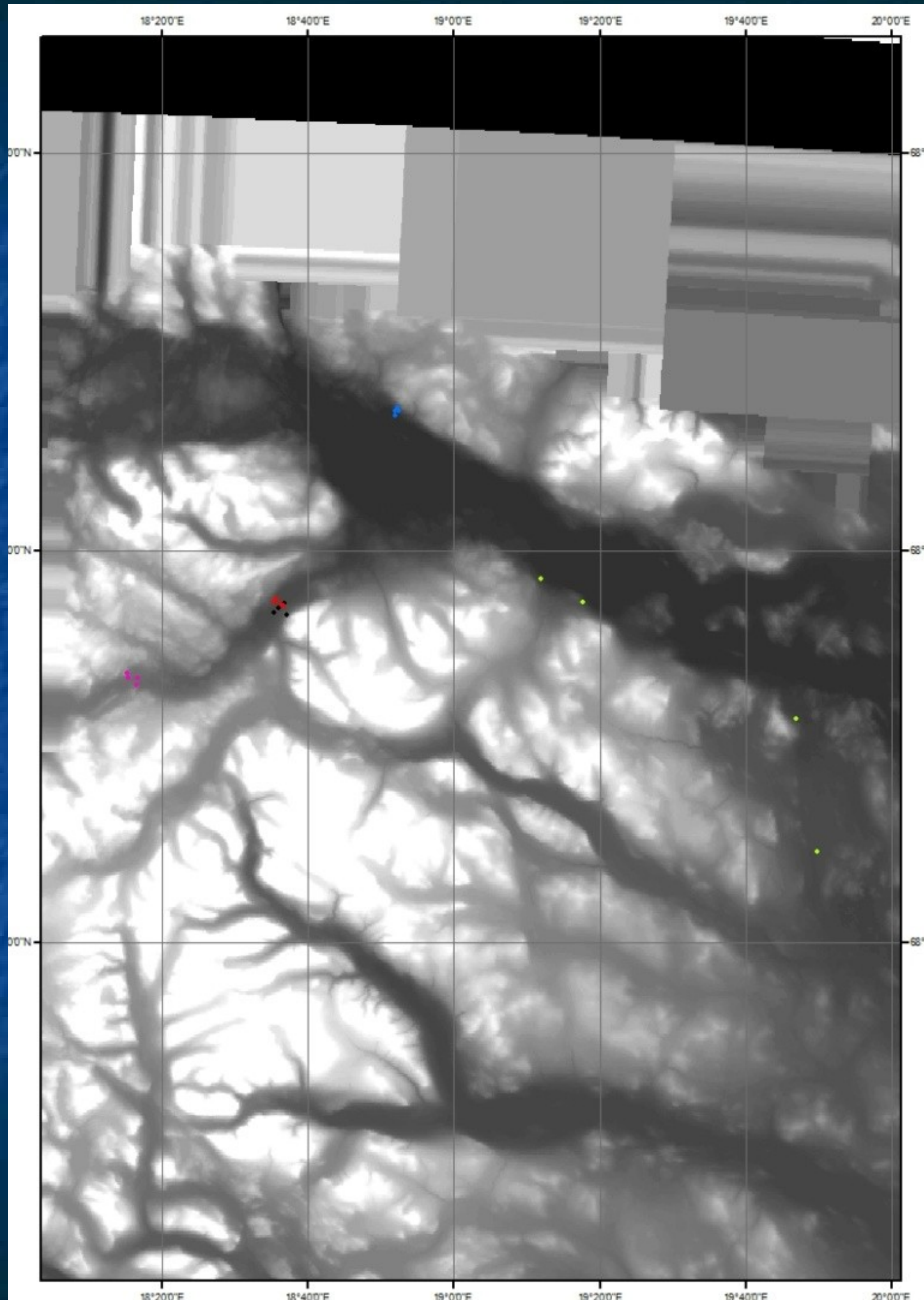

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