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Distribution and evolution of surface reflectivity in Switzerland between 1980 and 2008

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COST 726 Final Workshop

Warsaw, Poland

13-14 May 2009

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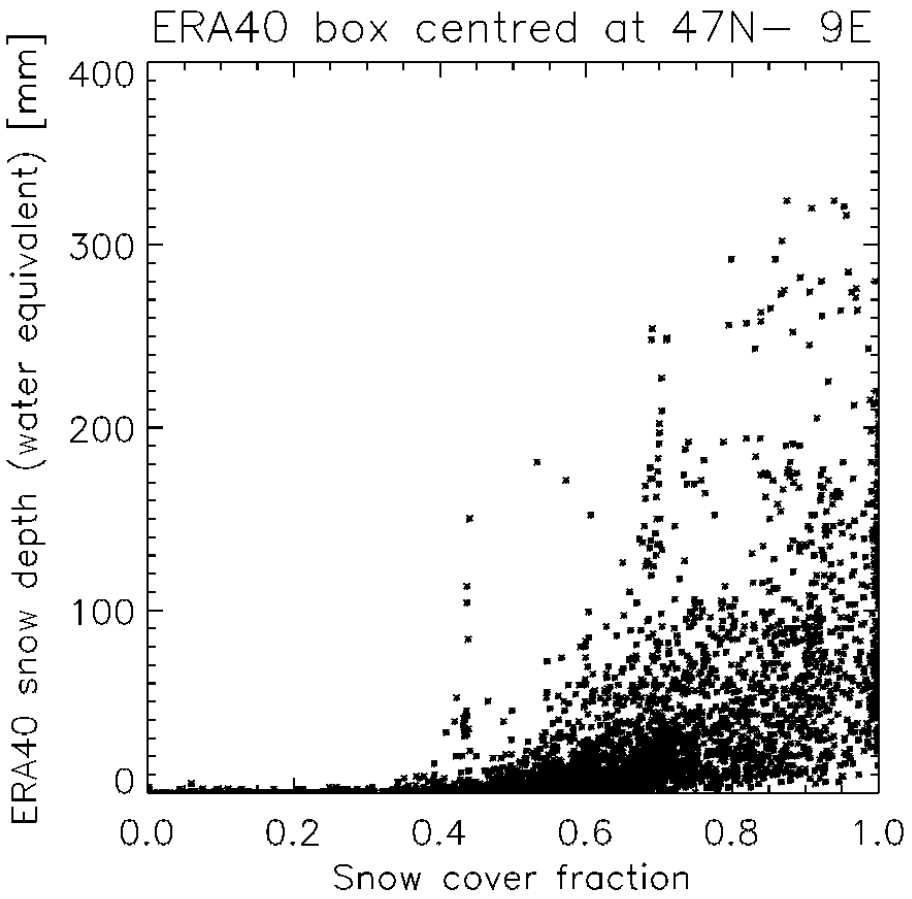
Distribution and evolution of surface reflectivity in Switzerland between 1980 and 2008

Content:

- COST 726 albedo estimation technique
- Alternate dataset for Switzerland
- Comparison using 2 Alpine ERA cells
- Did snow cover change in the last 25 years?
- Conclusion

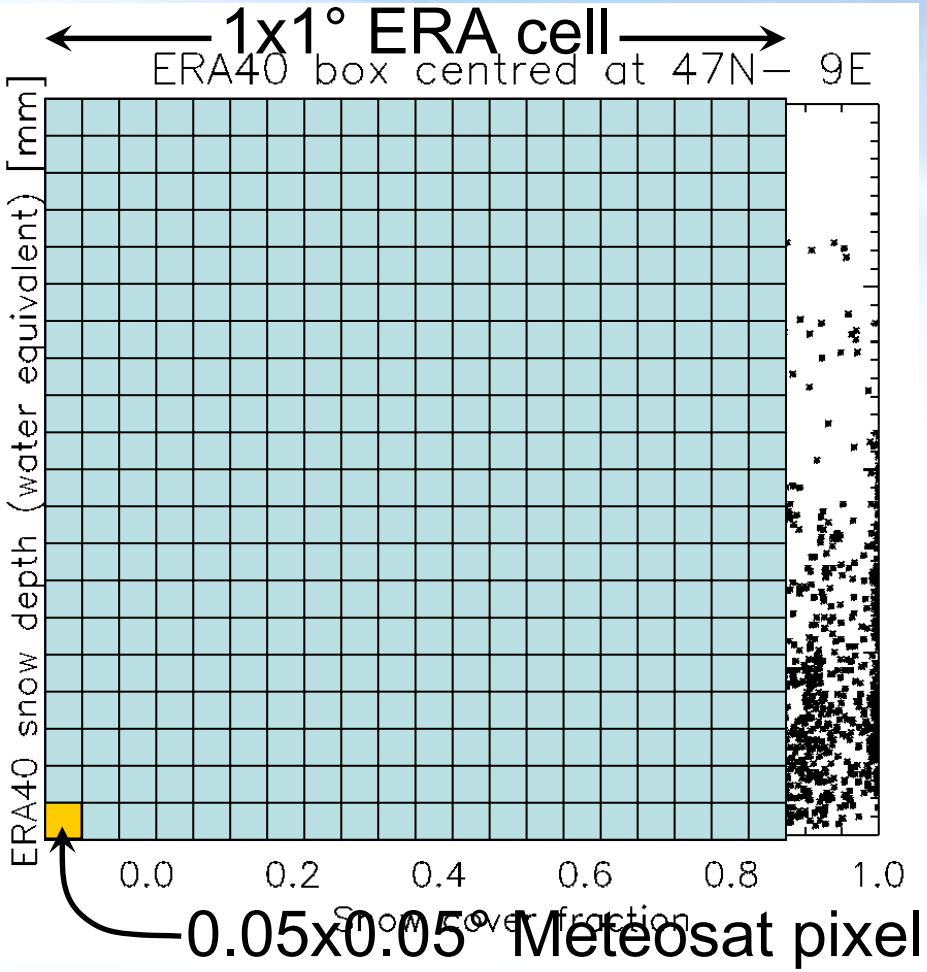
COST 726 albedo estimation technique

- The primary source of information for inferring UV albedo is the presence or absence of snow
  - The snow cover is estimated using the ERA40 snow cover
- However, ERA40 cells are large and do not allow sufficiently detailed description of complex topography



COST 726 albedo estimation technique

- The primary source of information for inferring UV albedo is the presence or absence of snow
  - The snow cover is estimated using the ERA40 snow cover
- However, ERA40 cells are large and do not allow sufficiently detailed description of complex topography
- A more detailed description is derived from a METEOSAT-based UV albedo dataset for 1984-2003
  - This additional dataset allows describing a sub-grid at 0.05x 0.05° resolution with more detailed in the topography



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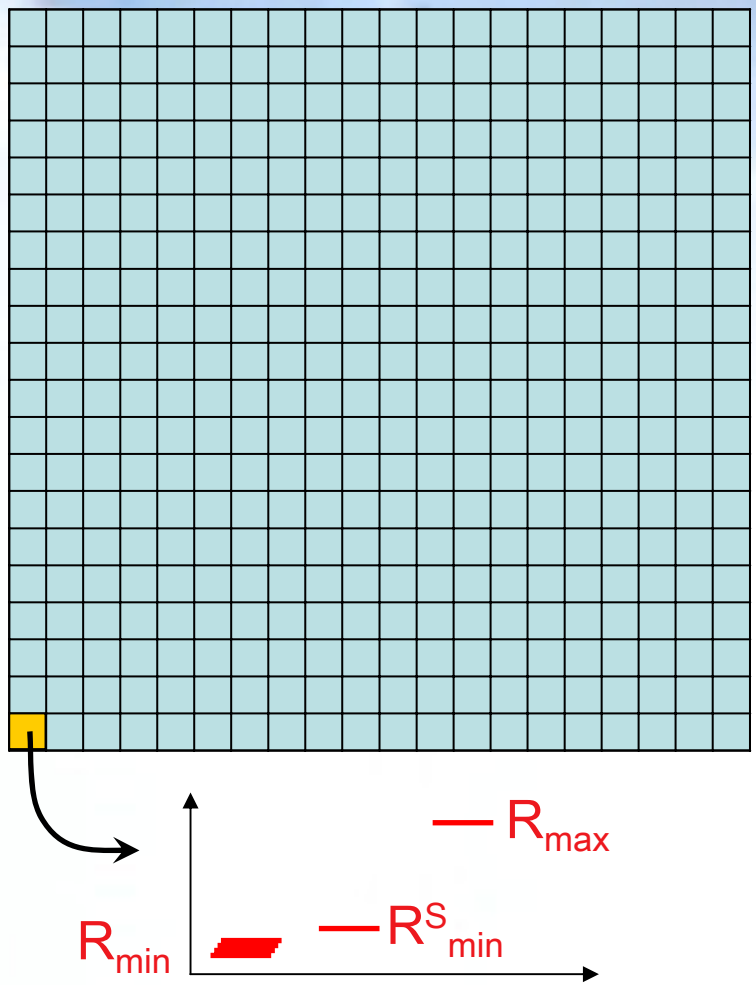
COST 726 albedo estimation technique

- For each METEOSAT pixel the following quantities are defined using the METEOSAT UV albedo dataset

R_{min}
- The minimum albedo over the whole period (depend on doy)

R^{S}_{min}
- The minimum albedo when pixel is flagged as snow-covered

R_{max}
- The maximum albedo over the whole period



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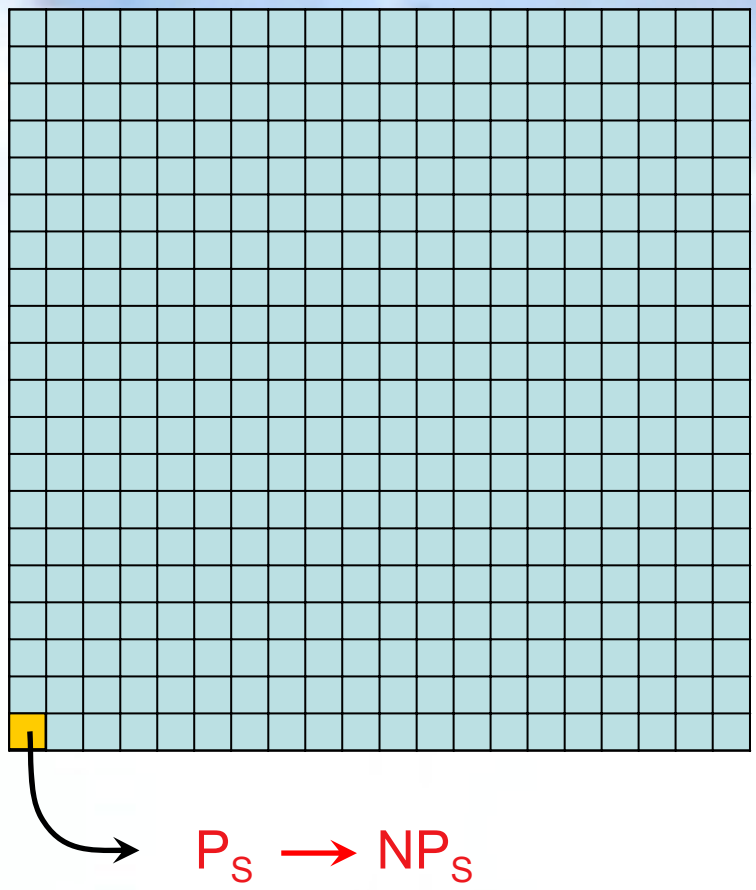
- Similarly for each pixel, a probability to be snow-covered

P_S
- Pixel snow-cover probability to be (# day s.-c. / total day)

NP_S
- Normalized s.-c. probability (P_S / $max_{cell}[P_S]$)



COST 726 albedo estimation technique

- For each ERA cell, a normalized snow depth NSD is defined:

  $NSD = SD / max_{ERA\_time}[SD]$

- A relationship is first established to determine whether a METEOSAT pixel is snow-free or not based on the ERA cell snow depth.

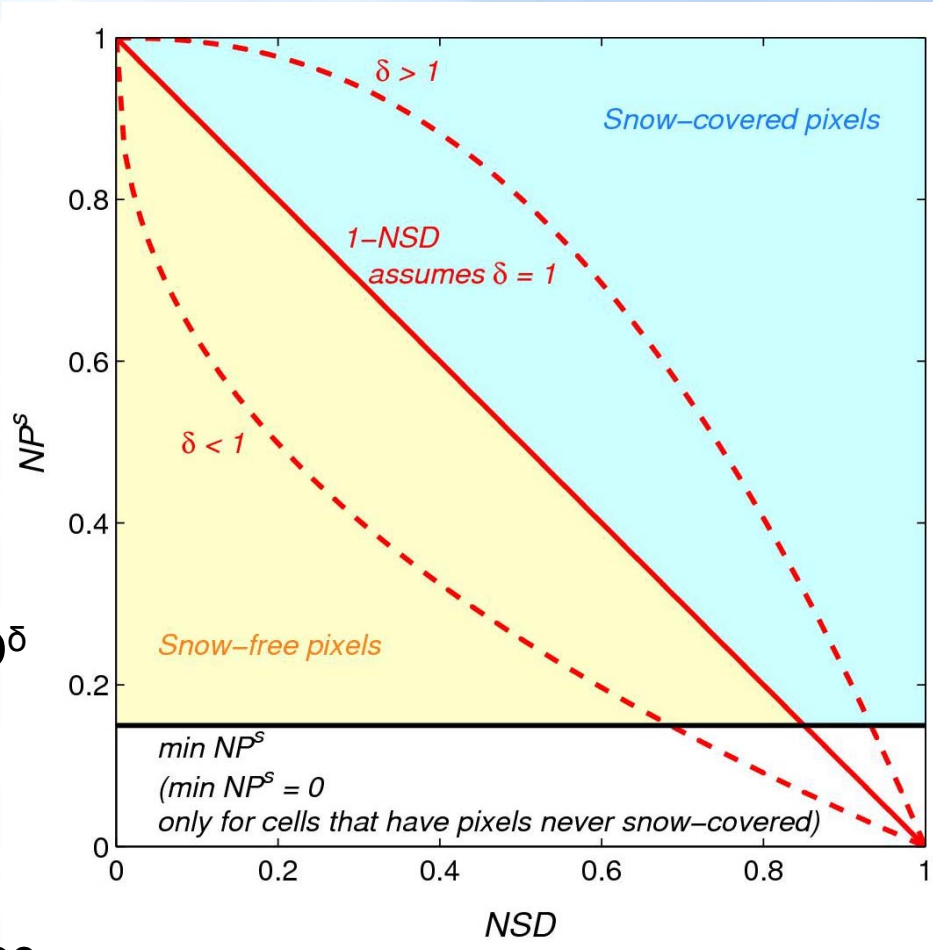
- Snow-covered pixels are given an albedo of

  $R_{pixel} = R^S_{min} + (R_{max} - R^S_{min}) \times NSD^{\delta}$

- Snow-free pixels albedo is

  $R_{pixel} = R_{min}(doy)$

  δ power factor adjusted so that ERA and Meteosat average albedo agree



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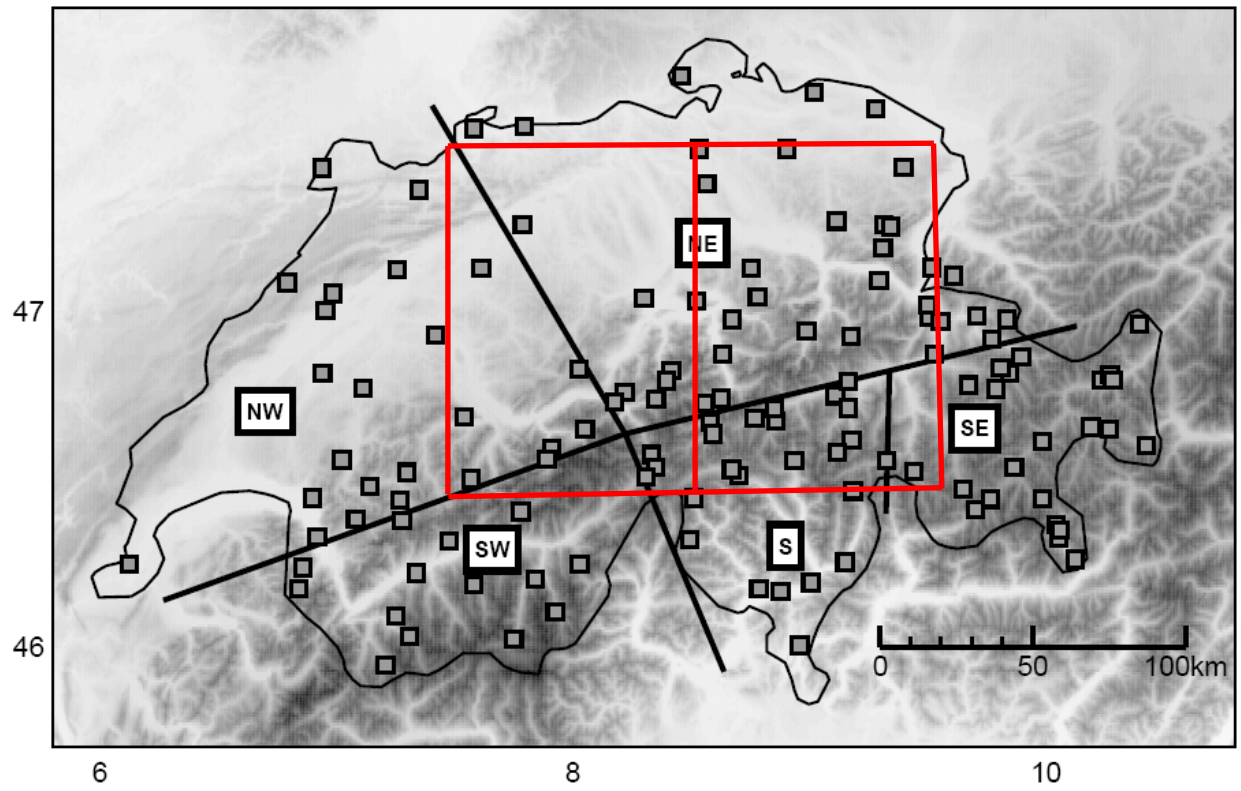
Snow-cover in Switzerland

- 125 Snow-observing stations in Switzerland with at least 25 extended winter seasons over 1980-2008
- Measuring-stick “technology”



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and

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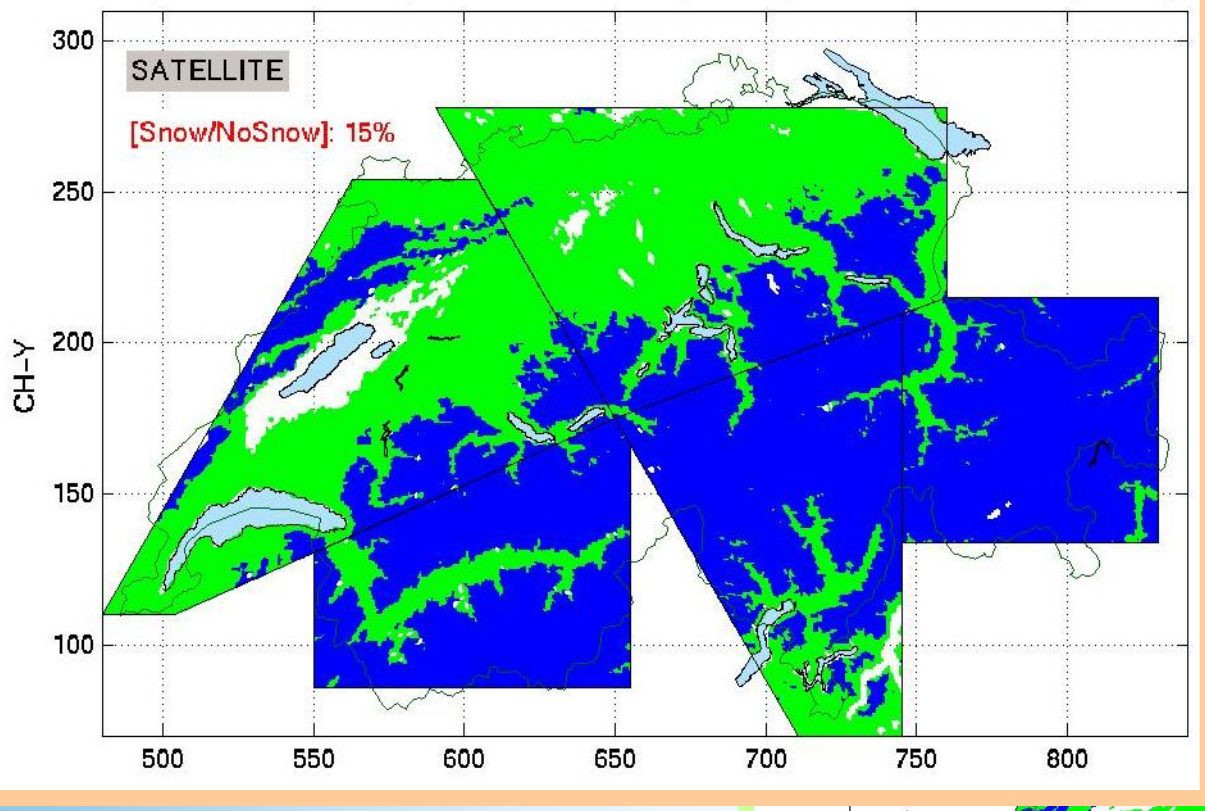
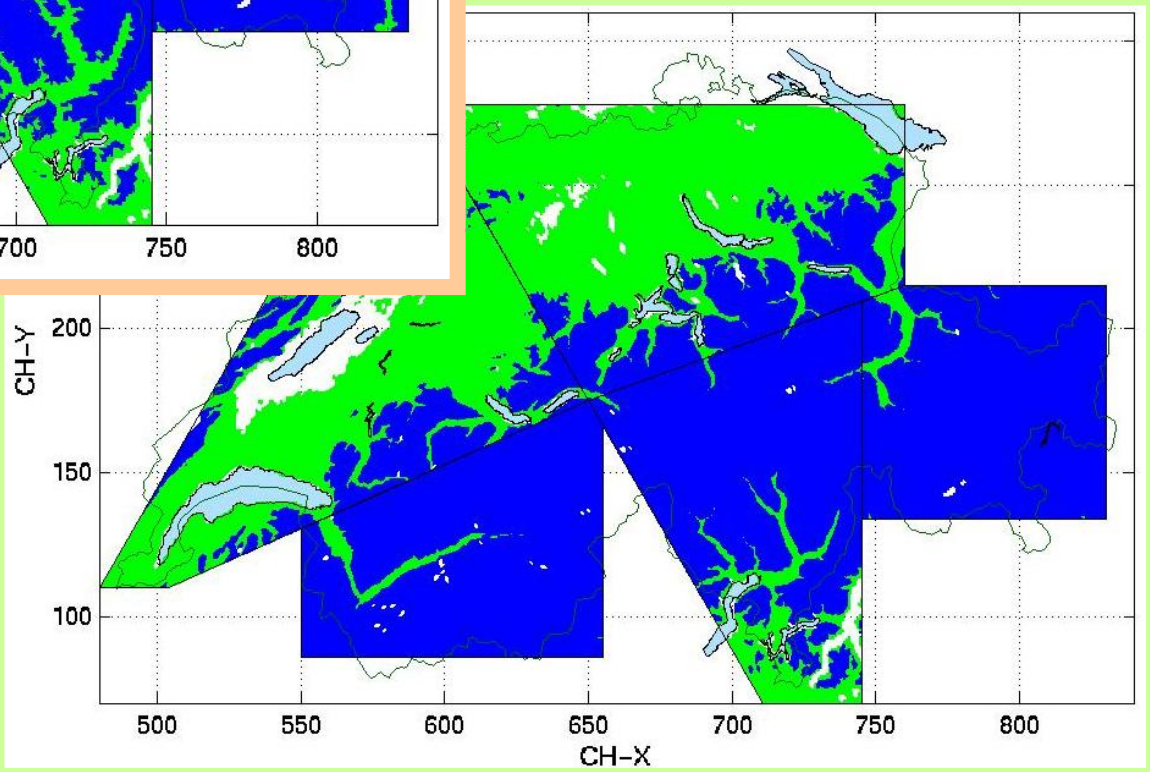
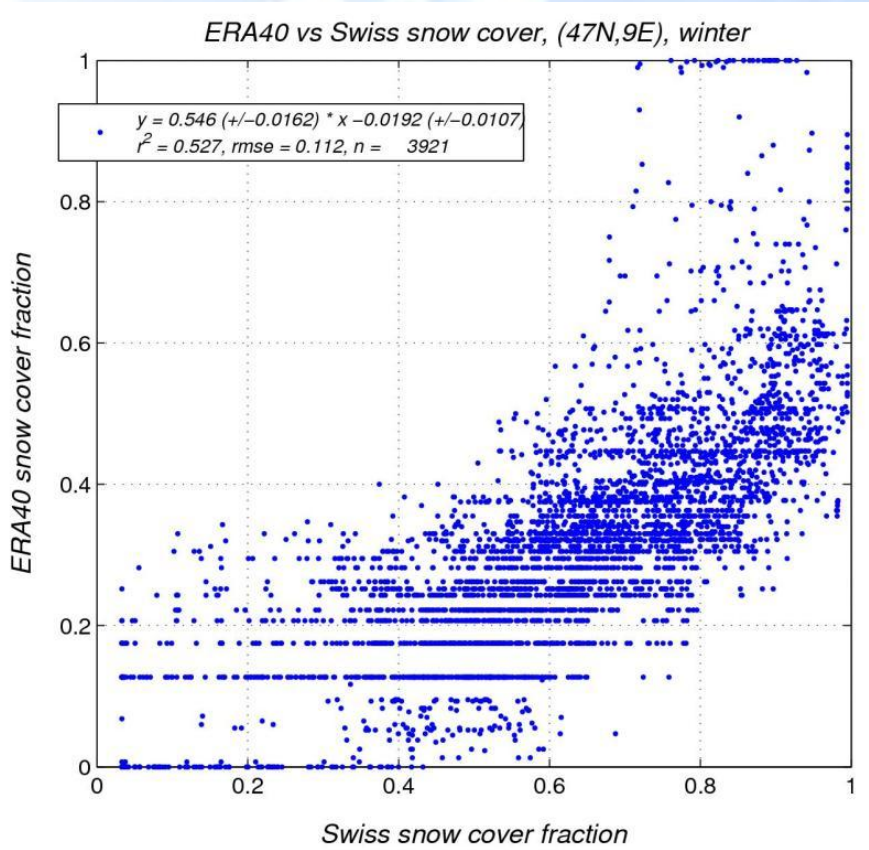




Comparisons

- When comparing snow-cover as derived in the COST 726 method and alternate Swiss method
- Both quantities are clearly related, but significant differences exist
- ERA40 cell elevation effect is clearly visible
- Snow-cover as derived with the alternate Swiss method is most likely more reliable

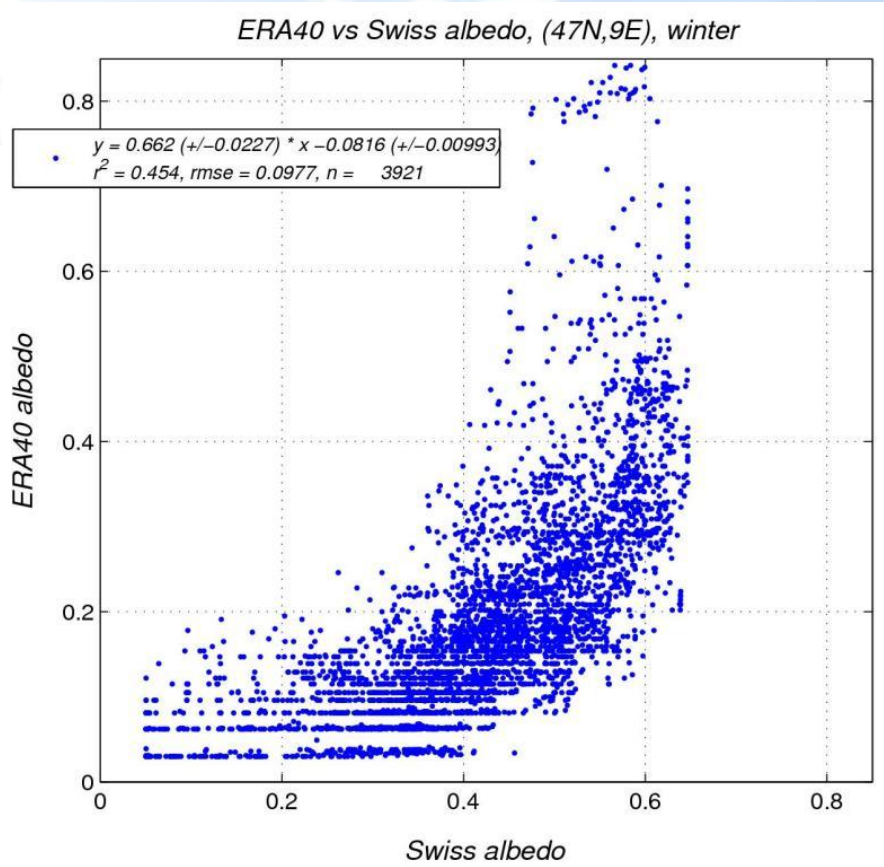
  (snow-cover is more directly derived from measured data with Swiss method)



Comparisons

- When comparing albedo as derived in the COST 726 method and alternate Swiss method
- Same type of agreement obtained as for snow-cover
- ERA40 cell elevation effect may have been a little compensated
- It is not obvious that albedo as derived with the alternate Swiss method is more reliable

  (Meteosat First Generation product is more directly linked to effective albedo)



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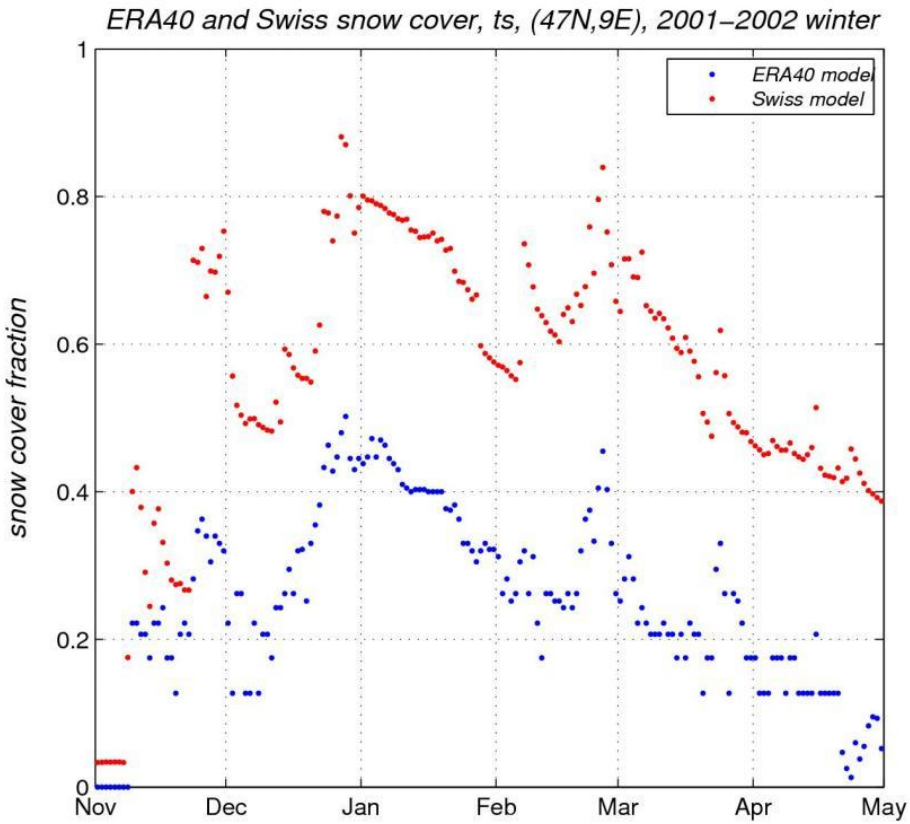
  (Meteosat First Generation product is more directly linked to effective albedo)
- Temporal evolution in both method is clearly related



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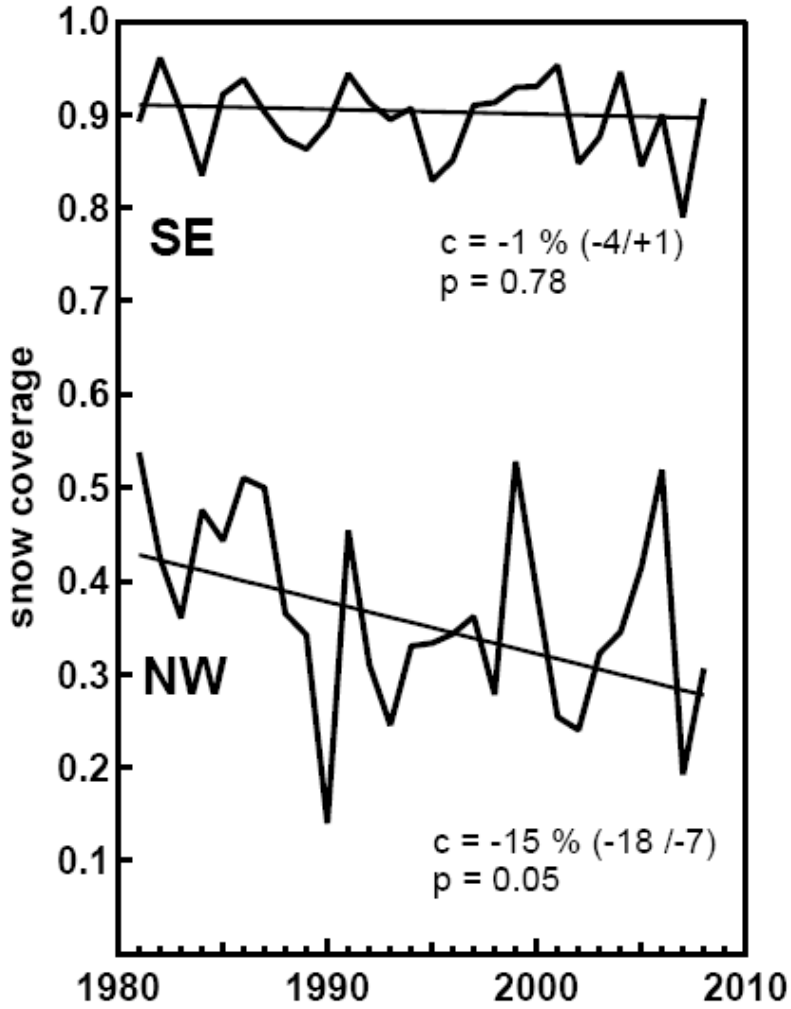
Snow cover change in last 25 years

- Alternate Swiss method is based on dataset characterized by its high stability (method, number of stations)
- Trends can be assessed with Mann-Kendal tests, and Sen slope estimator (robust statistics)
- Significant trends were found for regions that include lower elevations
- Trends in Alpine regions were not significant
- Change is likely linked to end of 1980's diminution of spring snow-cover



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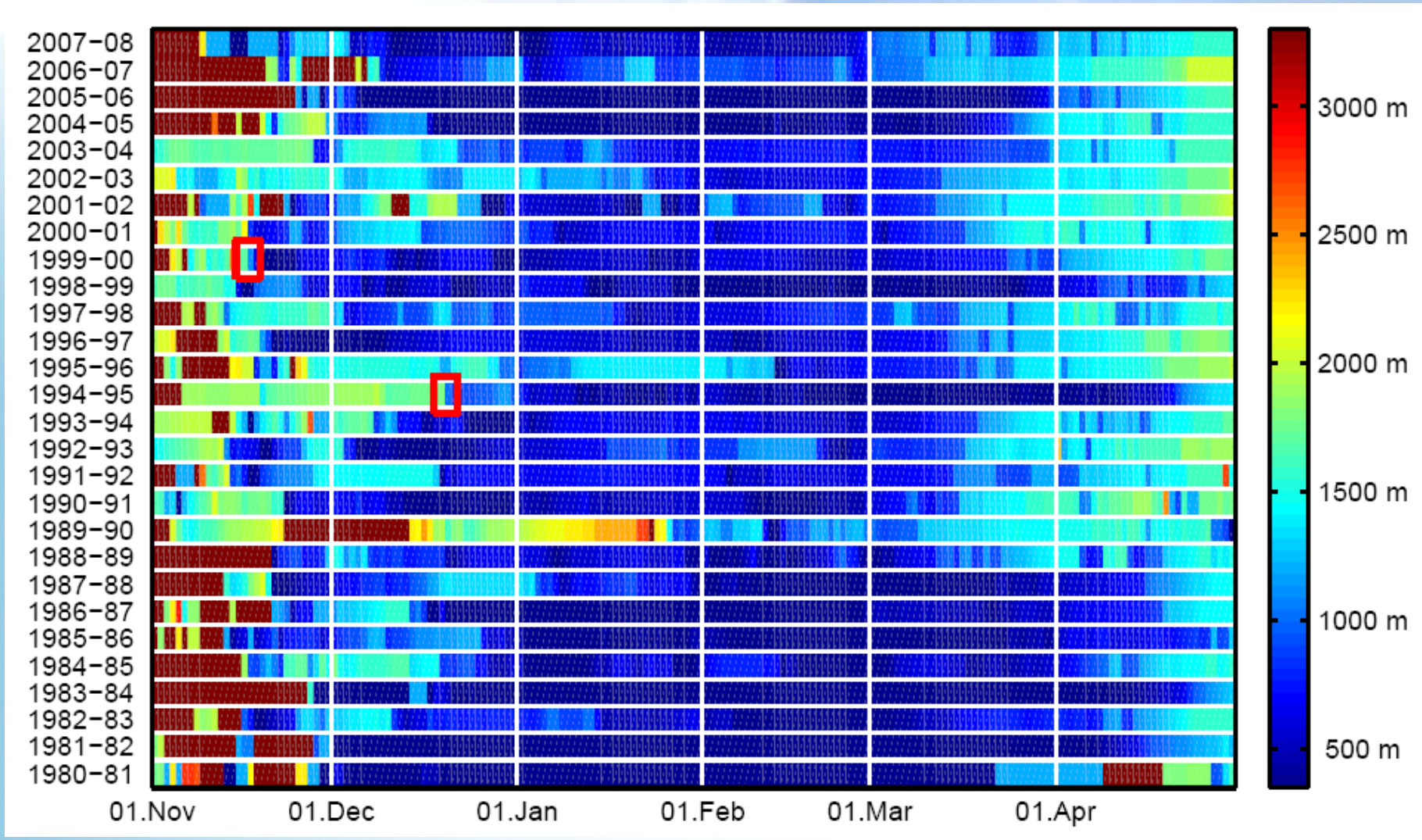

Conclusion

- Albedo is an input affected by a significant uncertainty in case snow is present
- Because of sensitivity, the effect of albedo uncertainty is reduced when propagated to UV radiation
- The COST 726 albedo estimation method allows inferring the time evolution due to snow cover daily variations; however the uncertainty is significant
- Significant changes are observed in the snow cover in Switzerland between 1980 and 2008
- These changes are mostly observed at low elevation

Thank you

Questions? / Comments!