Measured and modelled UV-radiation in Norway

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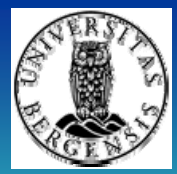
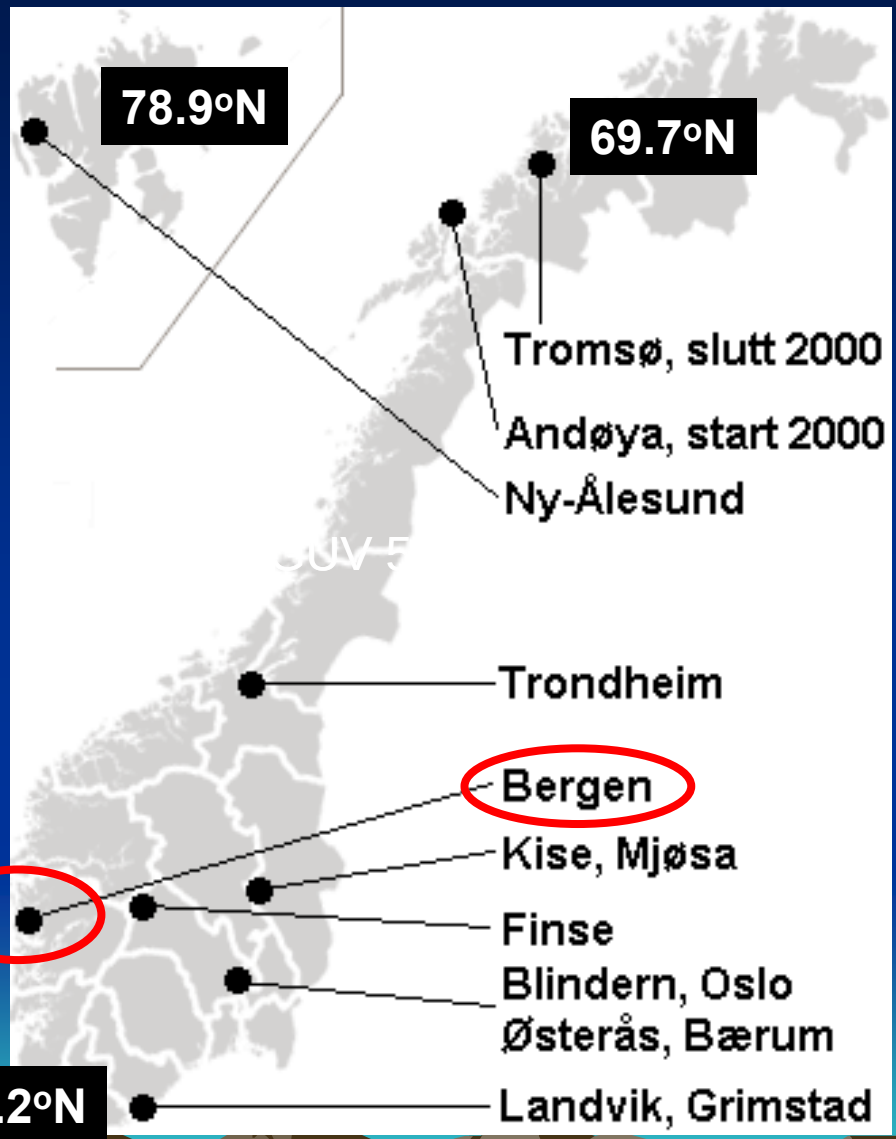


Norwegian UV network



Norwegian Radiation Protection Authority (NRPA)

GUV 541

Test site : COST726 Long term changes and climatology of UV radiation over Europe

Geophysical Institute (60.4ºN, 45 m.a.s.l.)
University of Bergen

Radiation Observatory

Geophysical Institute (45 m.a.s.l.)

Shortwave (solar) radiation

1. Sunshine duration
2. Global (total) solar radiation
3. Diffuse solar radiation
4. Direct normal radiation

Geophysical Institute (45 m.a.s.l.)

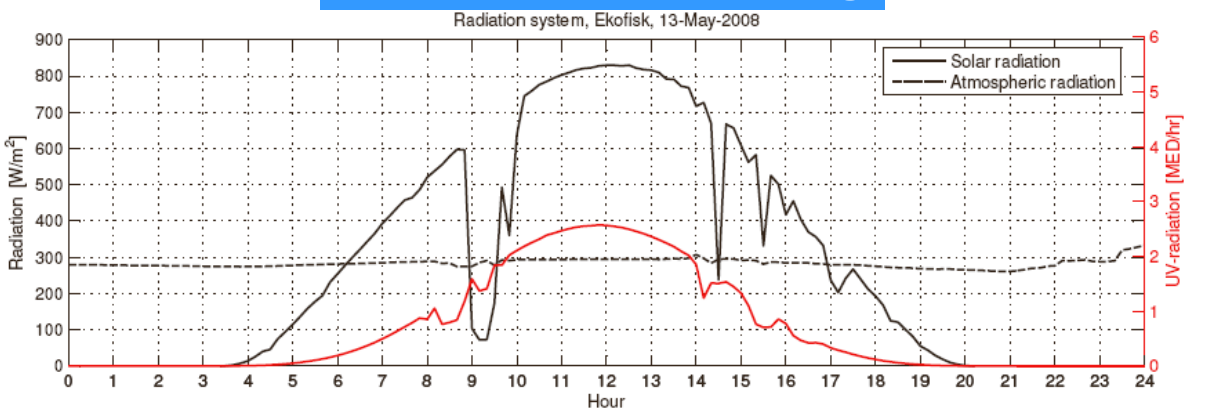
Shortwave (solar) radiation

5. UV radiation

Part of the
Norwegian UV network

Radiation measurements over ocean (pilotproject)

GI-UiB / NRPA / Met Inst

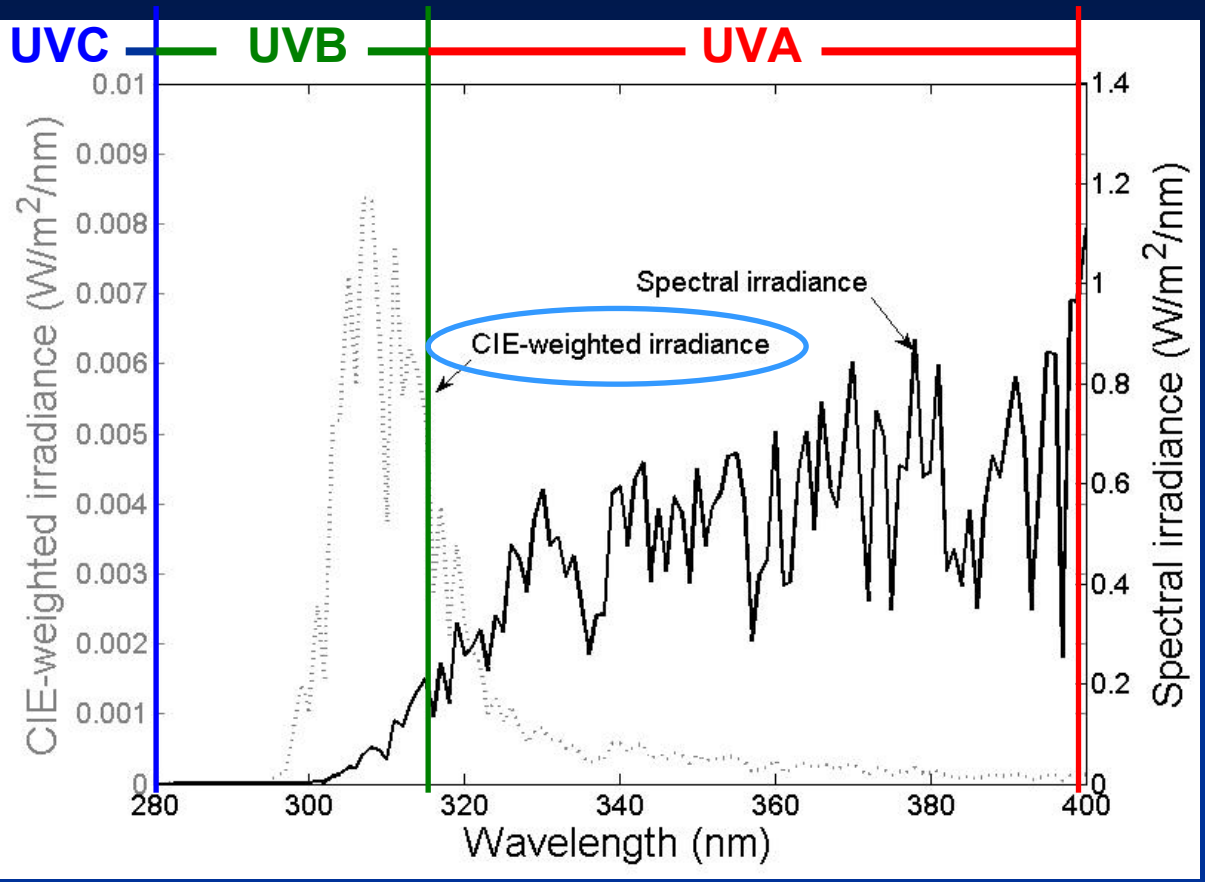


Total
Solar irradiance

UV

Longwave
(terrestrial) radiation

On UV radiation



UVC (absorbed at high levels)
UVB (clouds and ozone)
UVA (clouds)

Biological effects of UV-radiation:

Spectral irradiances multiplied by action spectrum representative for sunburn (CIE-weighted irradiance)

Important parameters affecting UV:

- solar elevation
- total atmospheric ozone amount
- cloud amount and optical thickness
- surface albedo
- atmospheric turbidity
- air pressure

Estimation of UV radiation

STAR - model (two versions):

- STARsci for clear sky
- STARneuro under actual cloud cover
  - –"Trained" on data from Garmisch-Partenkirchen

Lindfors - model:

- Based on radiative transfer model libRadtran

Input to models:

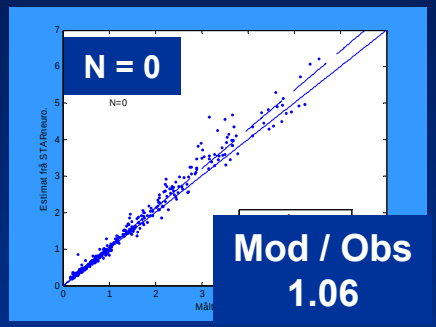
- Solar elevation
- Cloud amount
- Global irradiance
- Ozone
- Air pressure
- Ground albedo
- Aerosol optical depth

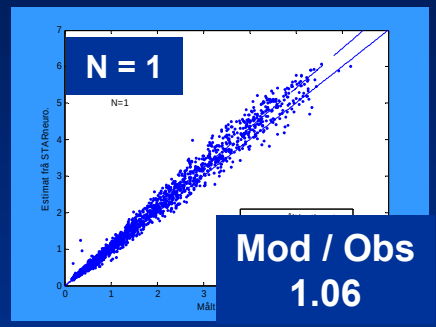
STAR – model ("Trained" on data from Garmisch-Partenkirchen)

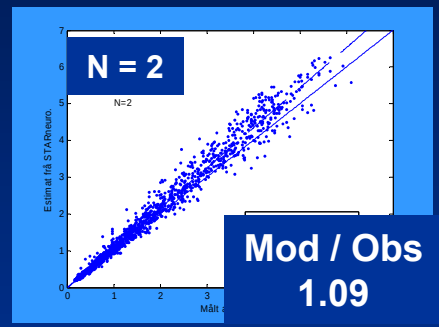
Model results vs ground measurement for different cloud amounts N

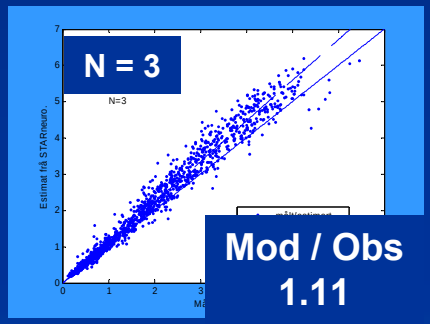
Measured

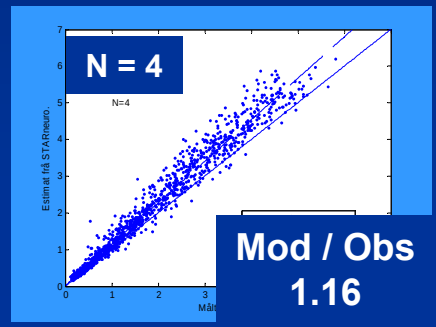
Modelled

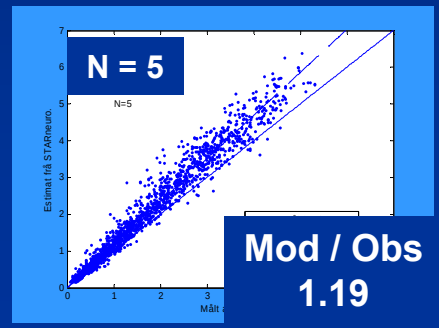


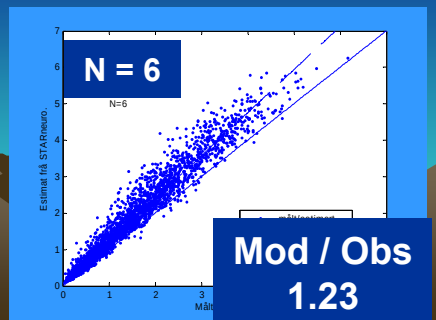


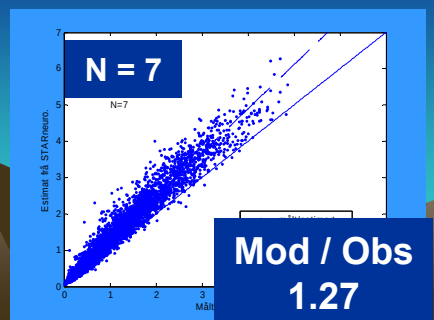


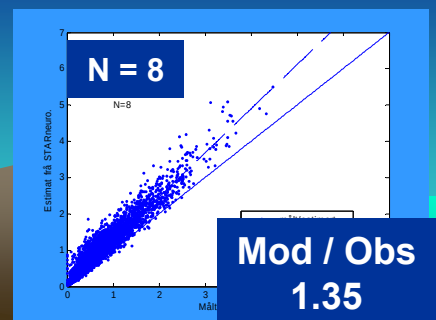




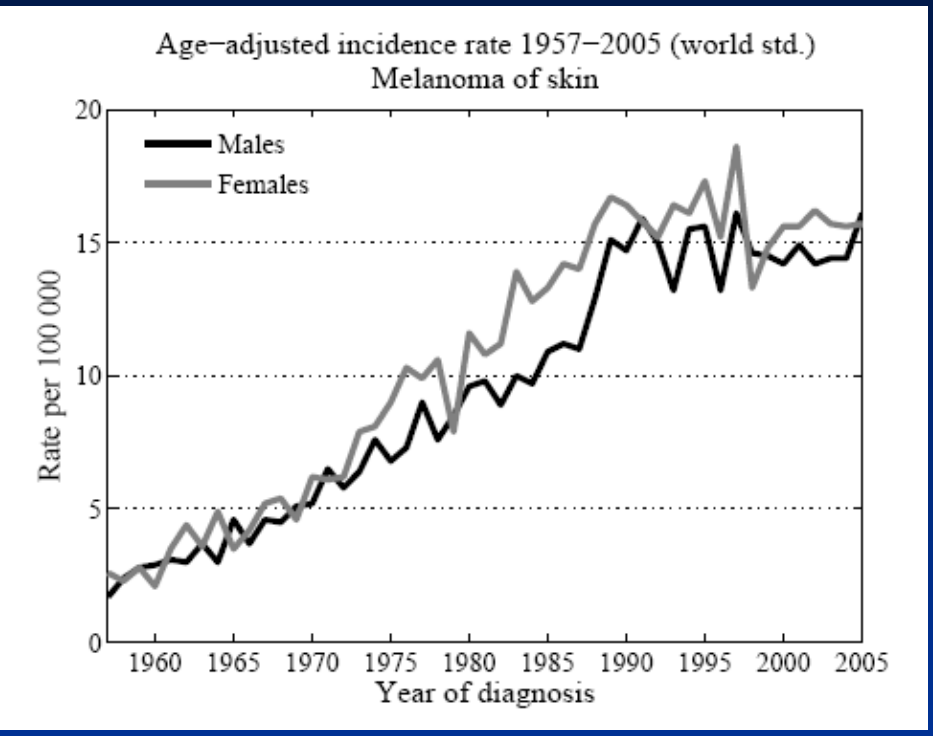




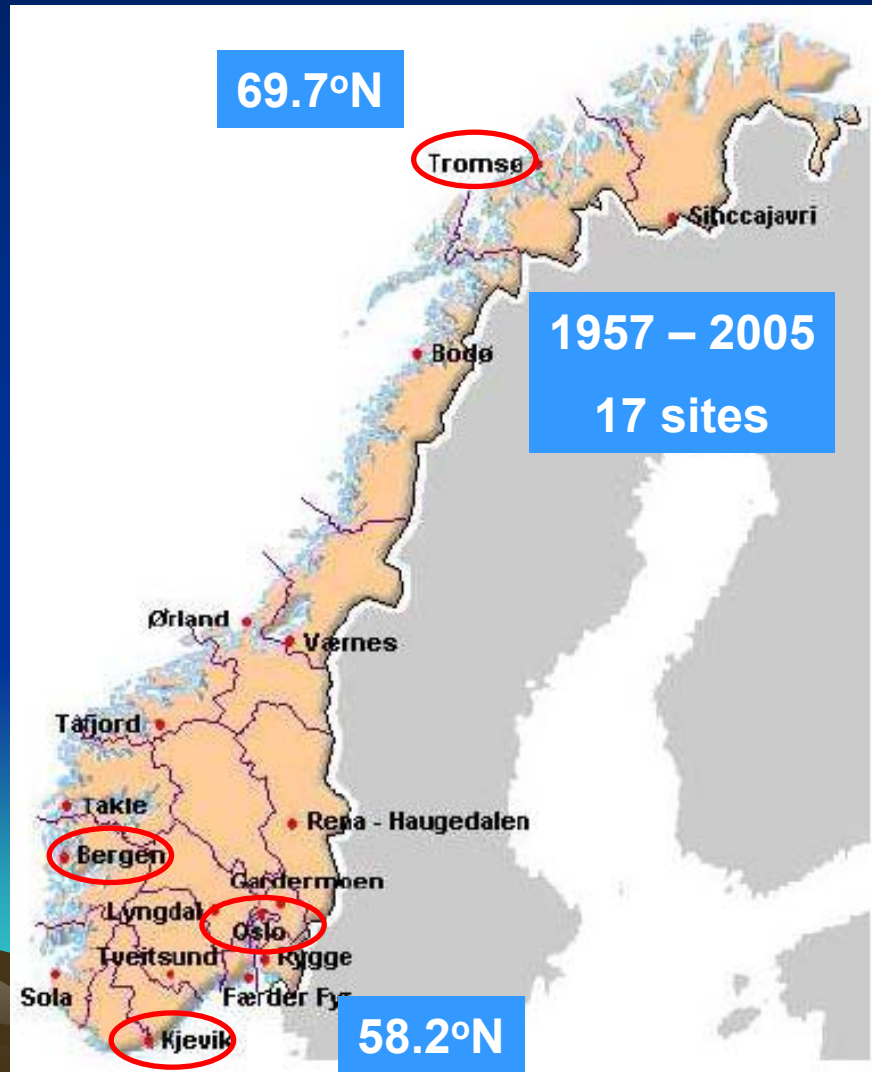




I. Medhaug: ”UV-radiation and its effect on skin cancer in Norway”



Reconstruction of UV-radiation
One station in each county



Comparison modelled vs measured UV
Tromsø – Bergen – Oslo – Kjevik

Clear sky:
- Slight overestimation (1-7 %) at all stations

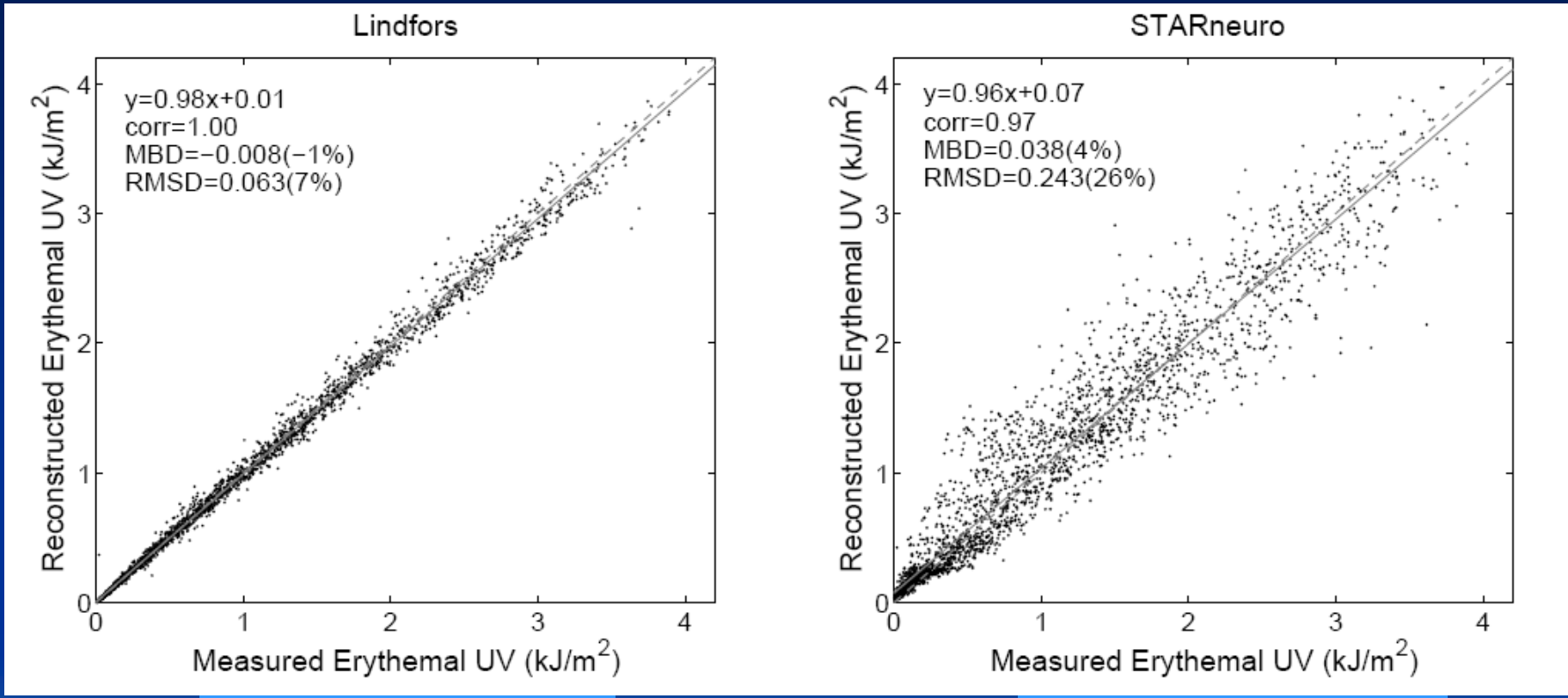
Overcast:
- Overestimation of 10-20 % for all but Tromsø

Overall:
- 0 % deviation for Tromsø
-11-16 % overestimation for the other

I. Medhaug: ”UV-radiation and its effect on skin cancer in Norway”

Daily values

Bergen



Global radiation as additional input

Only regular cloud info as input

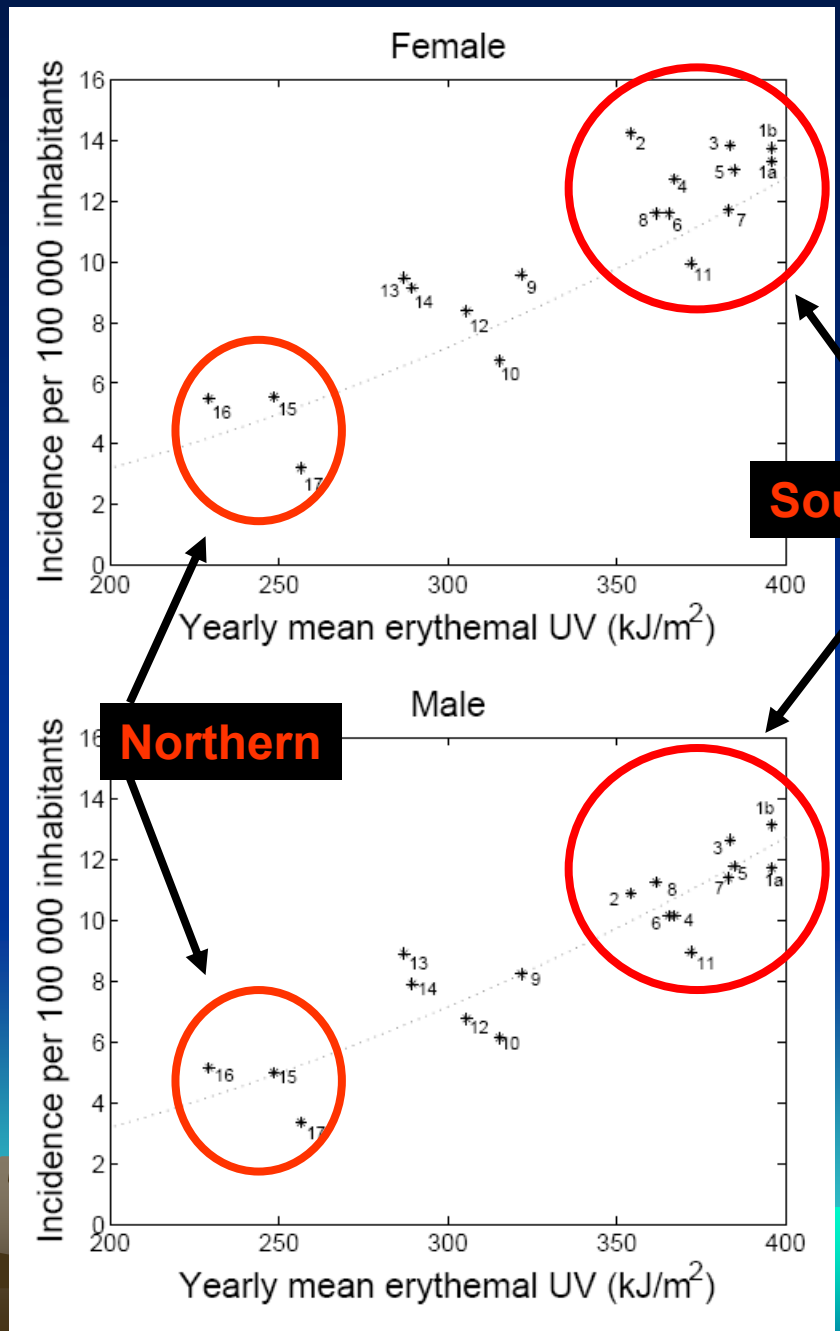
I. Medhaug: ”UV-radiation and its effect on skin cancer in Norway”

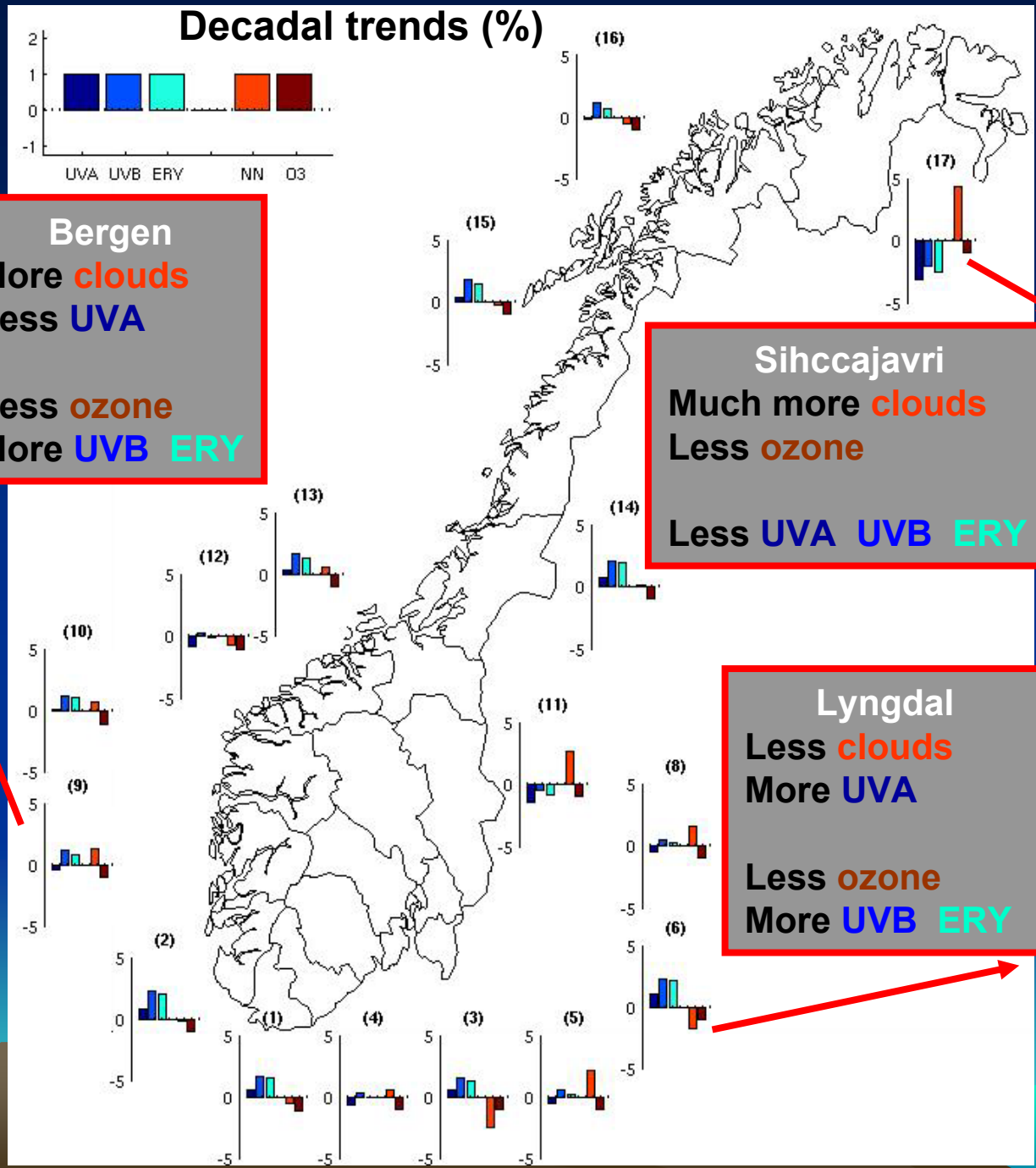
Incidence rate of malignant melanoma

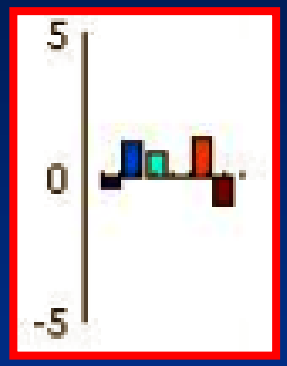
vs

Erythemal UV

(averages for 1957-2005)





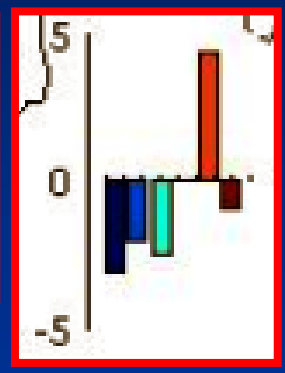


Bergen
More clouds
Less UVA

Less ozone
More UVB ERY

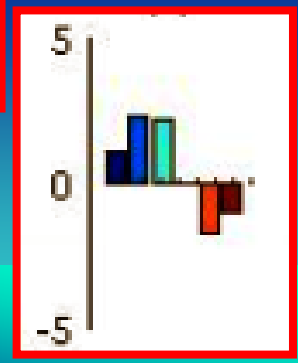
Sihccajavri
Much more clouds
Less ozone

Less UVA UVB ERY

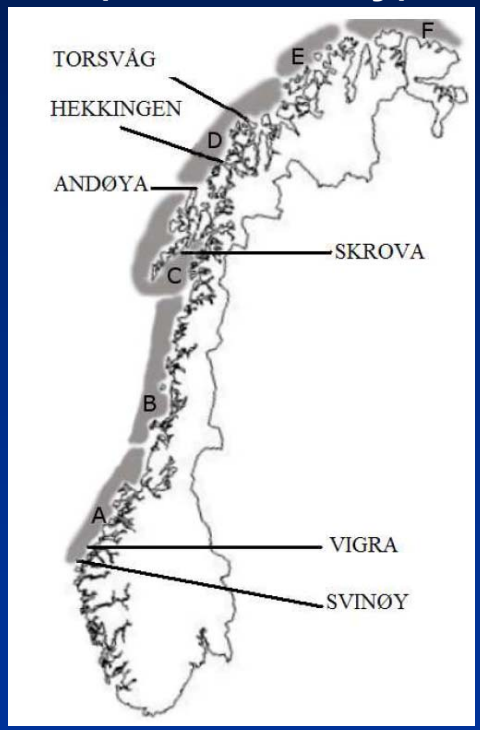


Lyngdal
Less clouds
More UVA

Less ozone
More UVB ERY



Model UV at spawning areas
(March – May)



Spectrally weighted UV-radiation at sea surface

+

UV-transmission in ocean

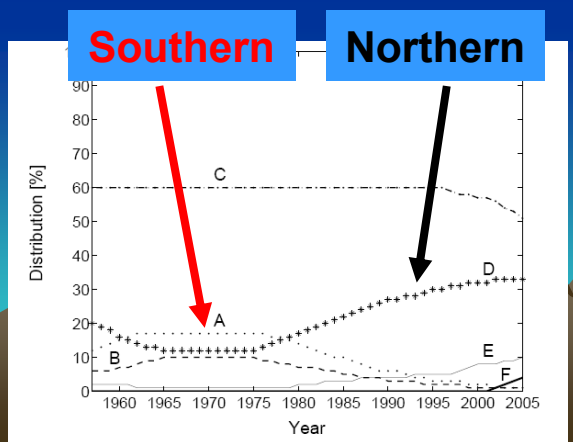
+

Vertical distribution of cod-eggs (wind speed)

↓

Local Cod UV-index
(Quantify potential UV effect on cod eggs passively drifting)

+



Relative weight of the spawning areas

Shift towards north with time
(caused by increasing sea temperature)

↓

Total Cod UV-index
(for the total Norwegian cod stock)

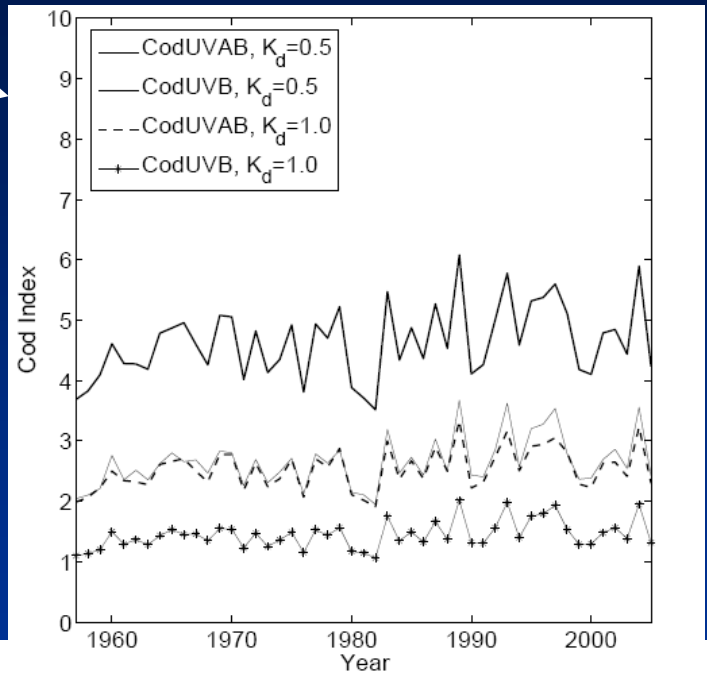
B. B. Sjølingstad: "UV-radiation and its effect on Arcto Norwegian cod"

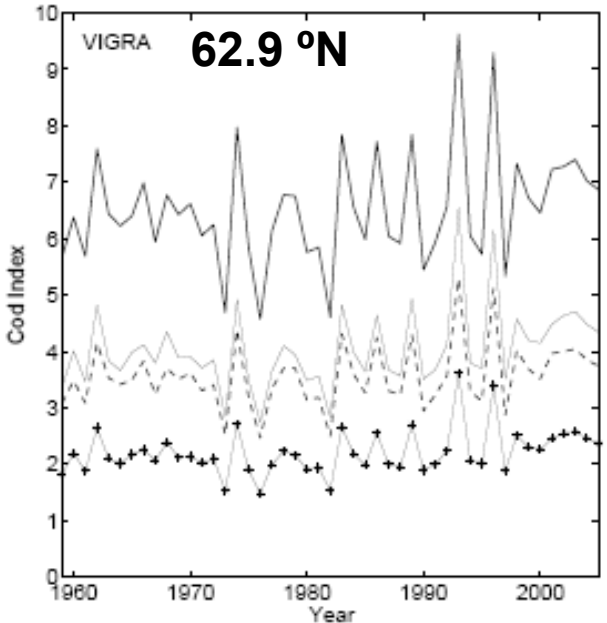
Annual Cod UV-index

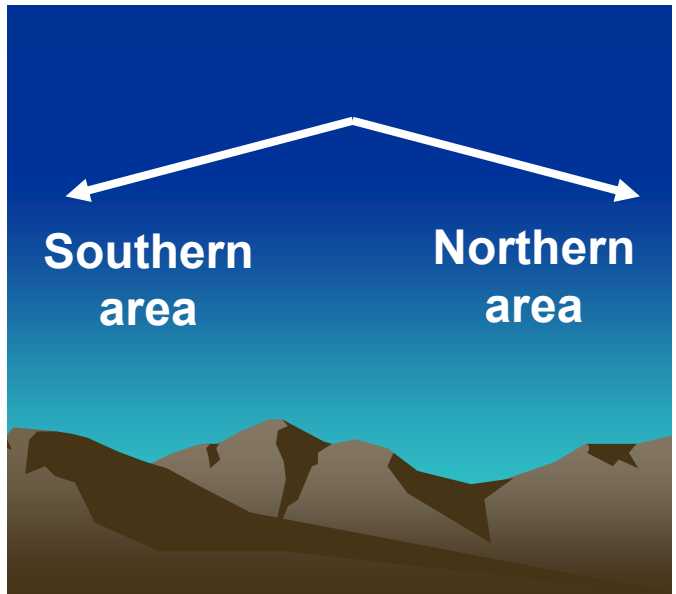
Overall

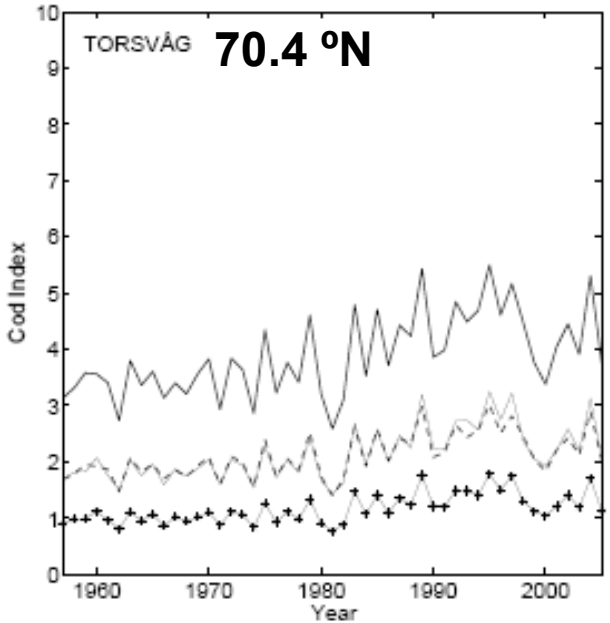
For the entire cod-egg population

Weighted according to the relative weight of the spawning areas









Conclusions

What have the students done?

- Reconstructed Erythemal UV for different regions in Norway (58 - 70ºN) for a period of 50 years
- Compared reconstructed and measured UV
- Developed a new method for estimation of potential UV-effect on cod-eggs
- Investigated the effect of UV on human beings and fish

What to do in the future?

- Use the reconstructed UV data for further investigations on more complex relationships between UV and biology

Thank you

Take care !!!