

# Measured and modelled UV-radiation in Norway

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# Measured and modelled UV-radiation in Norway (and Tibet)



## - Master-theses

- I. Medhaug: Reconstruction of UV-radiation and its potential implications on development of skin cancer (2007)
- O. Sætre: Observed and modelled UV-radiation in Bergen (2006)
- B.B. Sjølingstad: Reconstruction of UV radiation: UV exposure of the Arcto-Norwegian cod egg population (2007)
- Deyang: Measured and modelled solar radiation in Tibet (2009)

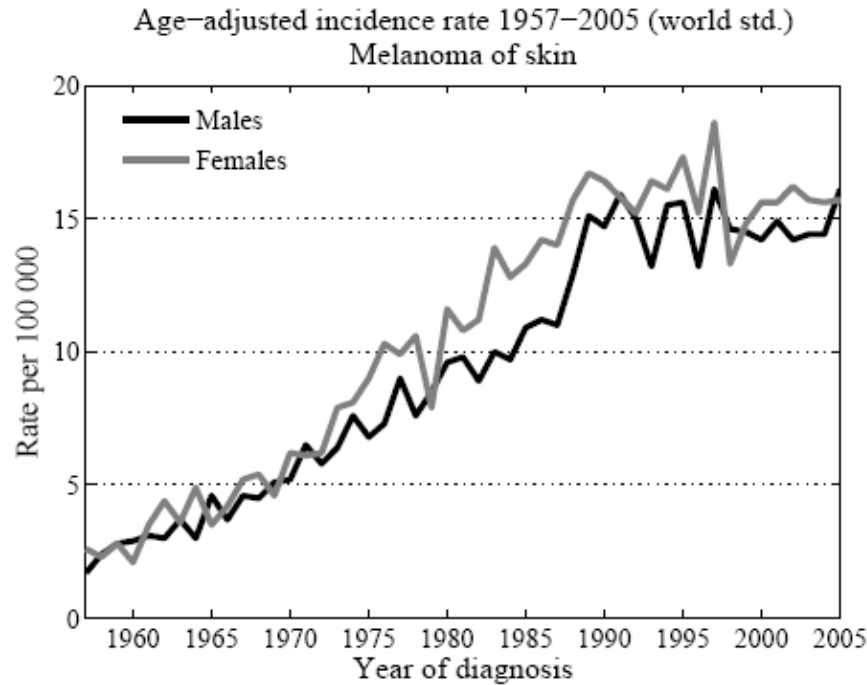
## - New measurements:

Measurements of solar and terrestrial radiation at an oil platform  
(EKOFISK)

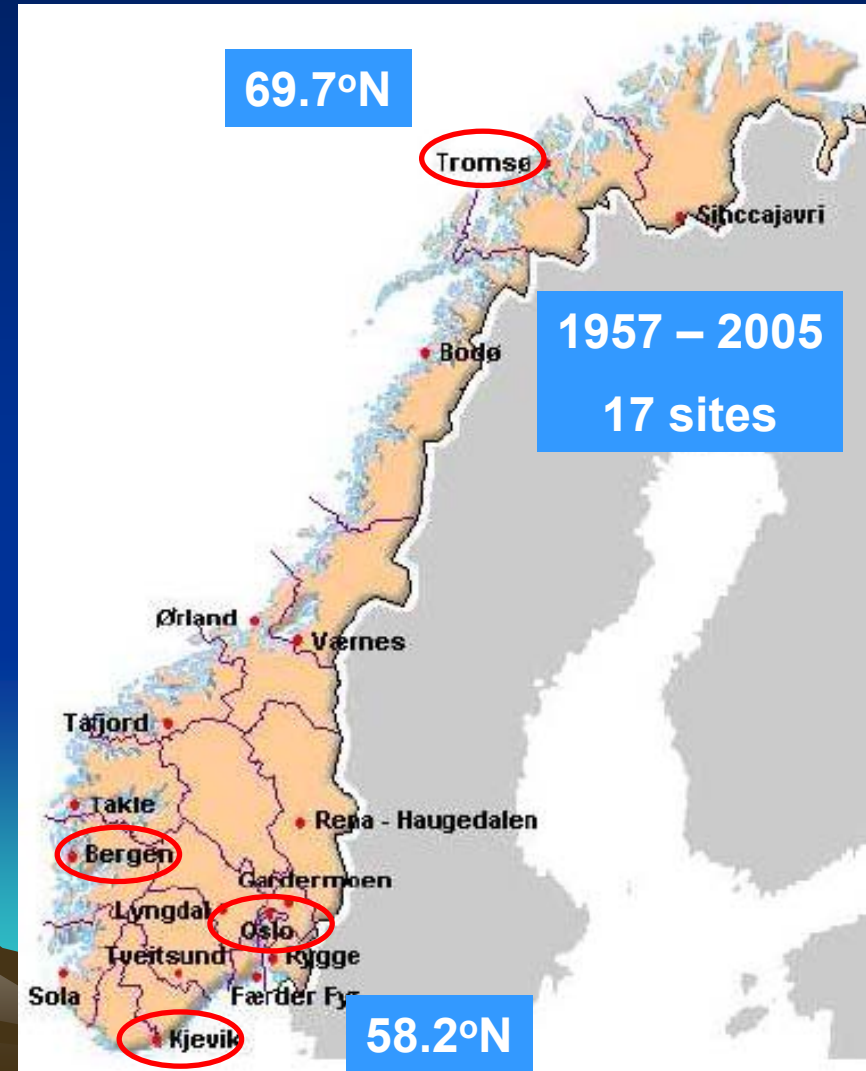




# I. Medhaug: "UV-radiation and its effect on skin cancer in Norway"



## Reconstruction of UV-radiation One station in each county



## Estimation of UV radiation

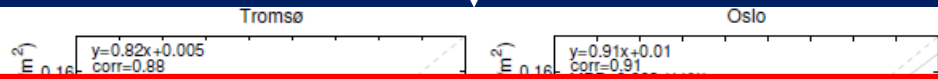
### STAR - model (two versions):

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



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

## Reconstructed vs Measured erythemal UV



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

### Clear sky:

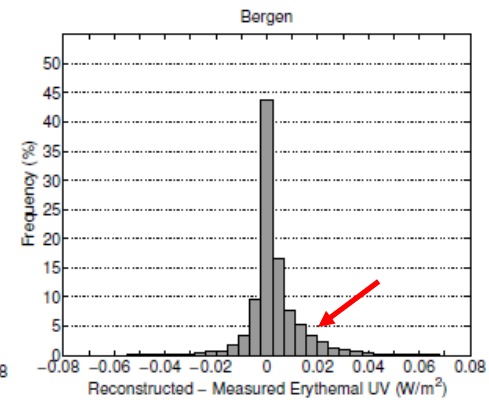
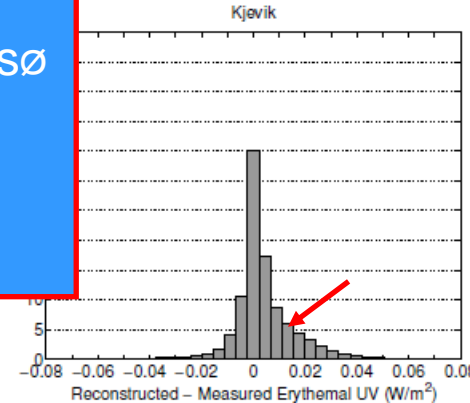
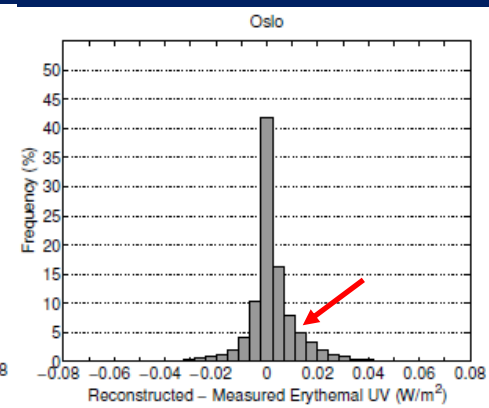
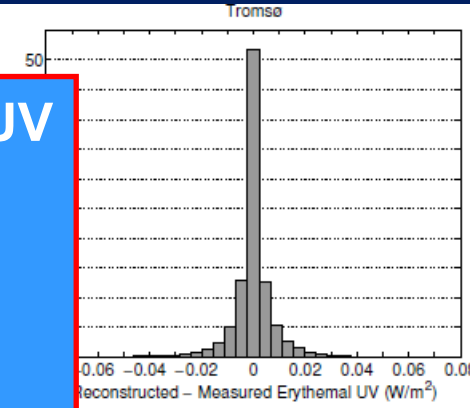
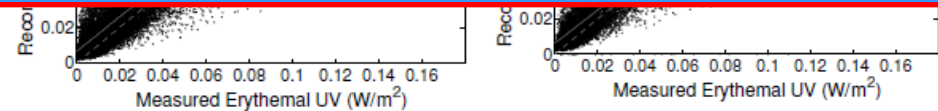
- Slight overestimation (1-7 %) at all stations

### Overcast:

- Overestimation of 10-20 % for all but Tromsø

### Overall:

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



## Distribution of Reconstructed – Measured erythemal UV

Solar elevation >10°

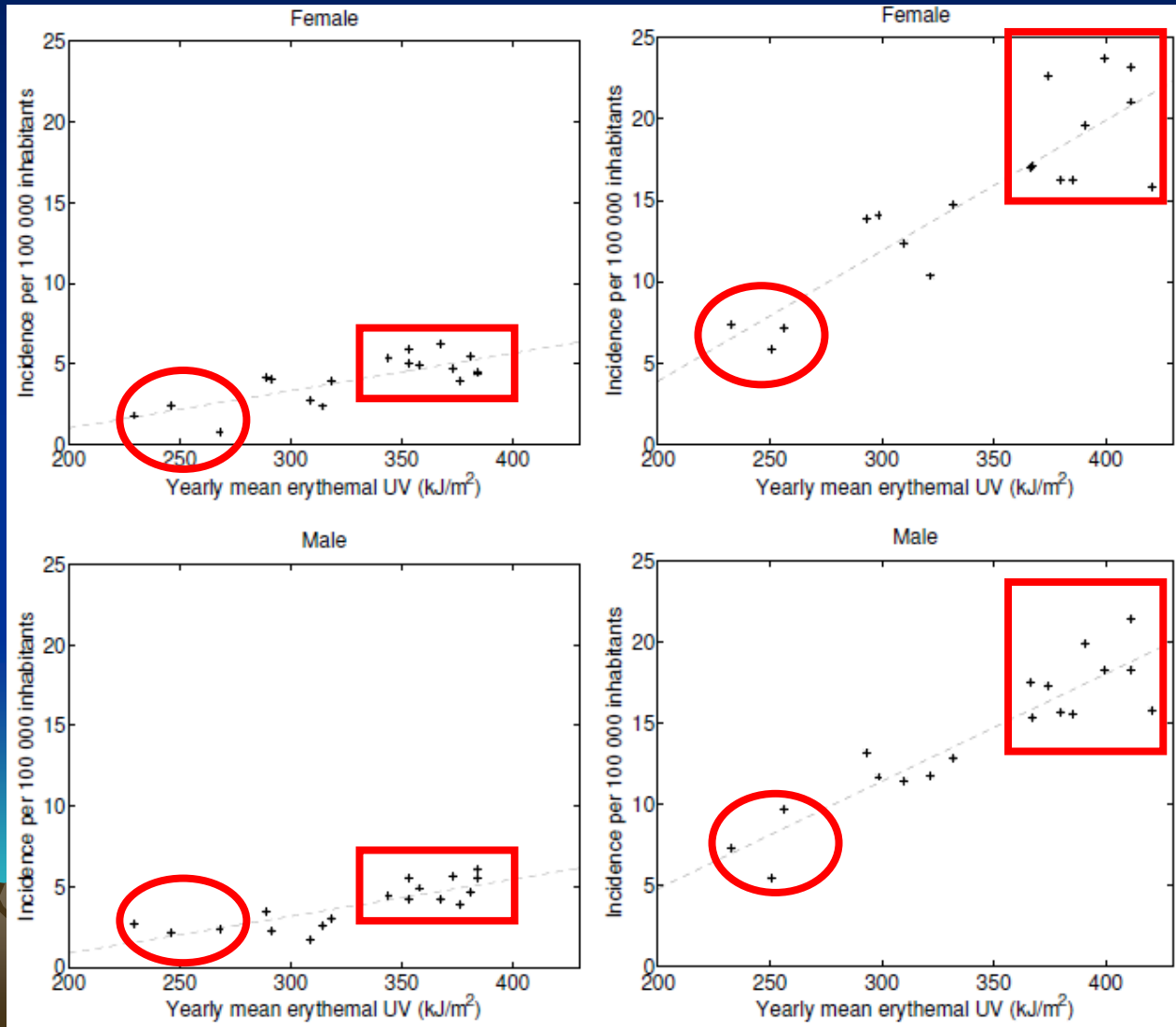


# I. Medhaug: "UV-radiation and its effect on skin cancer in Norway"

## Incidence rate of malignant melanoma vs Erythemal UV

1960 - 1970

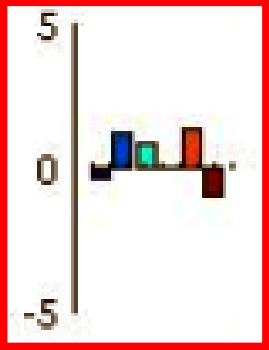
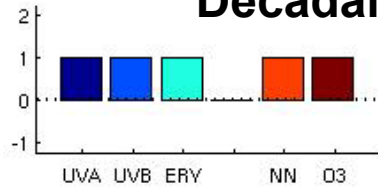
1990 - 2000



Southern

Northern

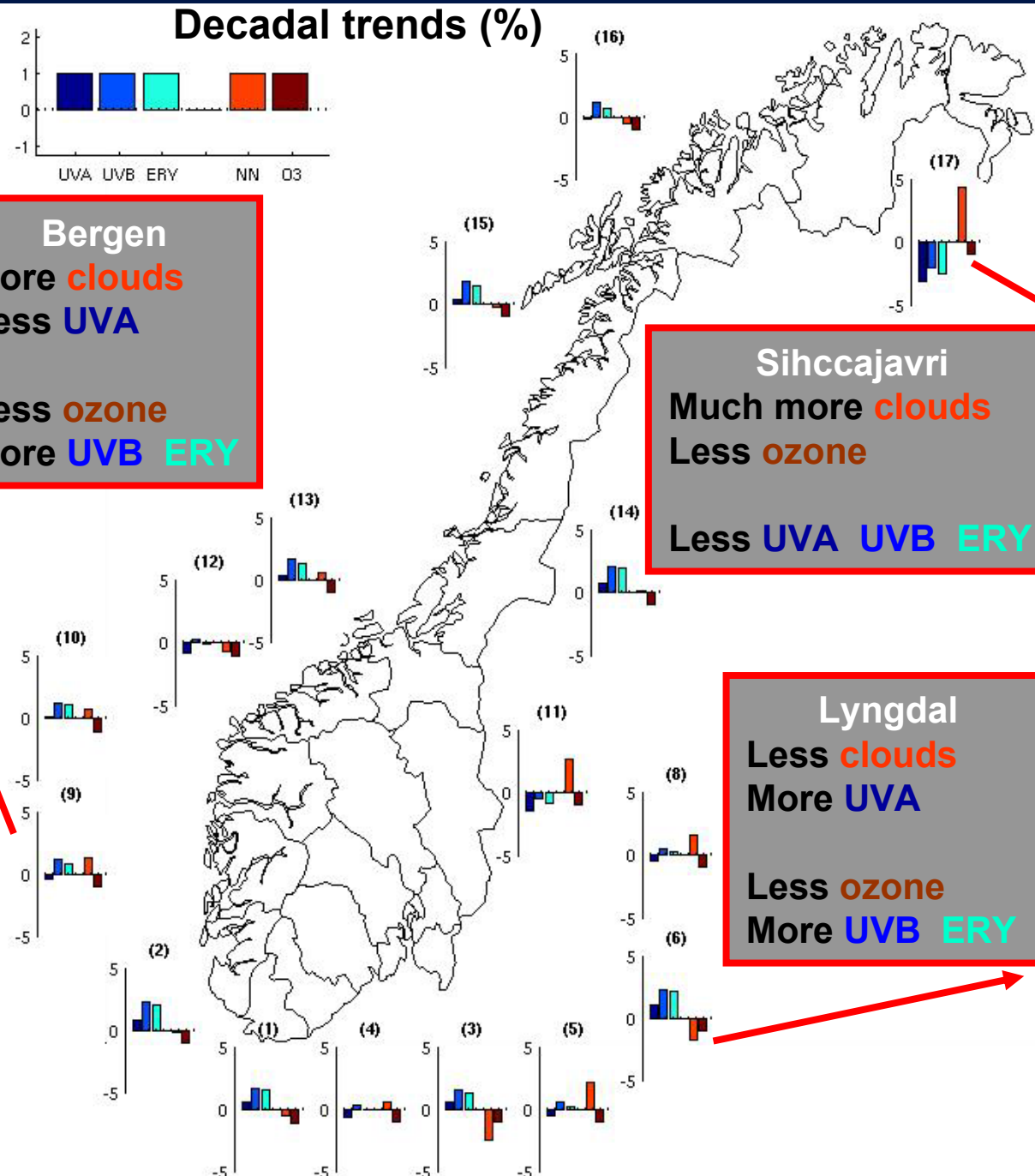
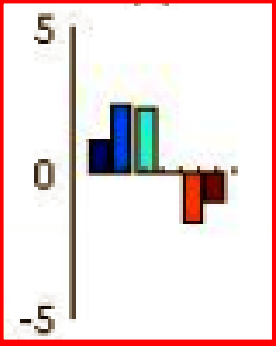
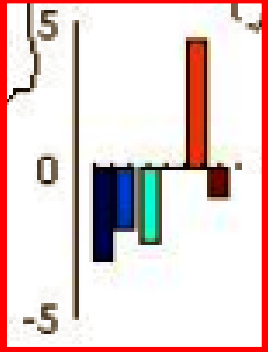
# Decadal trends (%)



**Bergen**  
 More **clouds**  
 Less **UVA**  
 Less **ozone**  
 More **UVB ERY**

**Sihccajavri**  
 Much more **clouds**  
 Less **ozone**  
 Less **UVA UVB ERY**

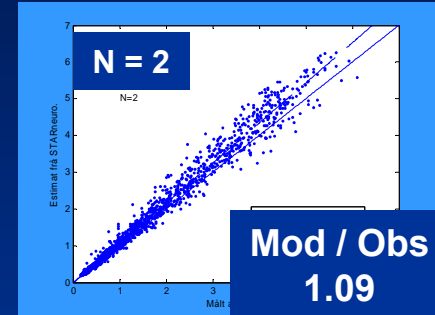
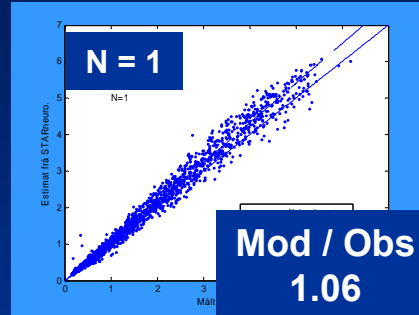
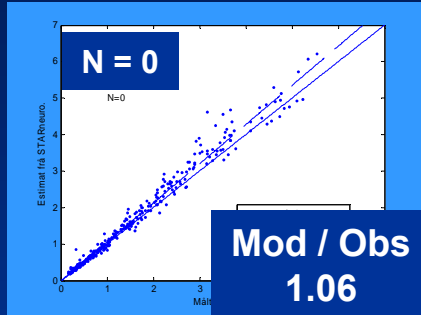
**Lyngdal**  
 Less **clouds**  
 More **UVA**  
 Less **ozone**  
 More **UVB ERY**



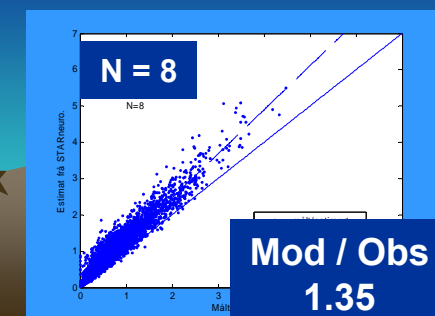
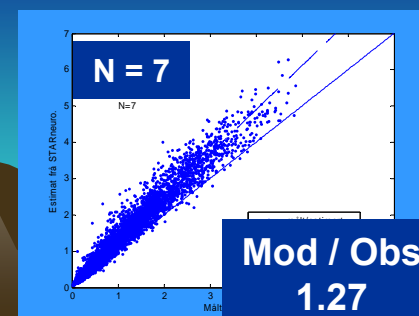
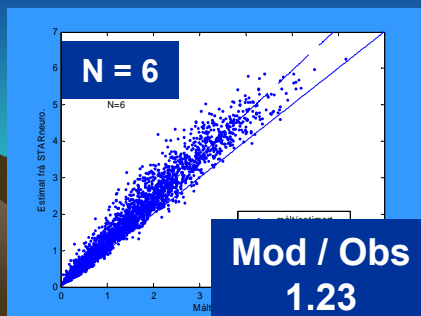
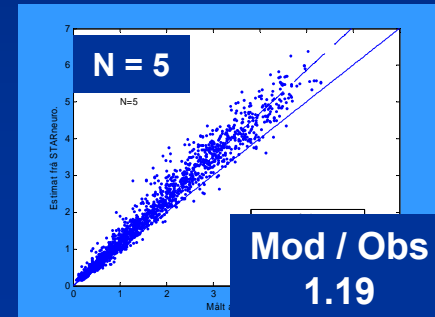
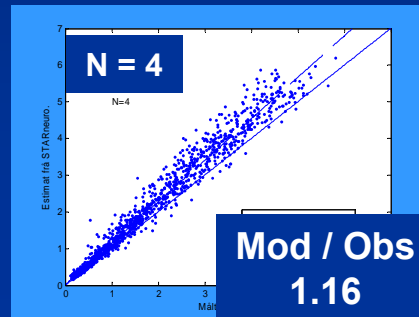
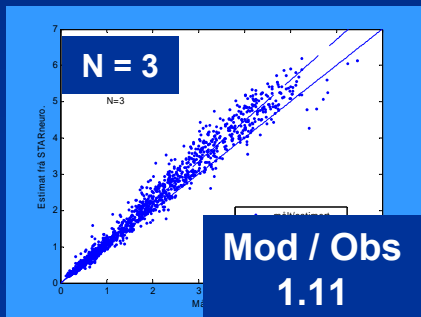


**STAR – model ("Trained" on data from Garmisch-Partenkirchen)**  
**Model results vs ground measurement for different cloud amounts N**

**Measured**

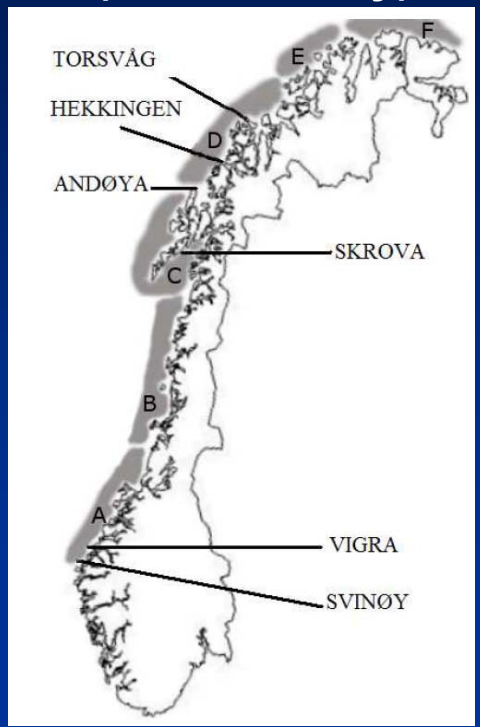


**Modelled**





# 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)

+

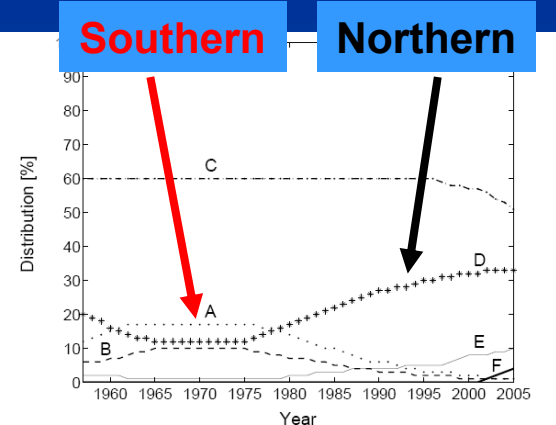
Relative weight of the spawning areas

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



Total Cod UV-index

(for the total Norwegian cod stock)





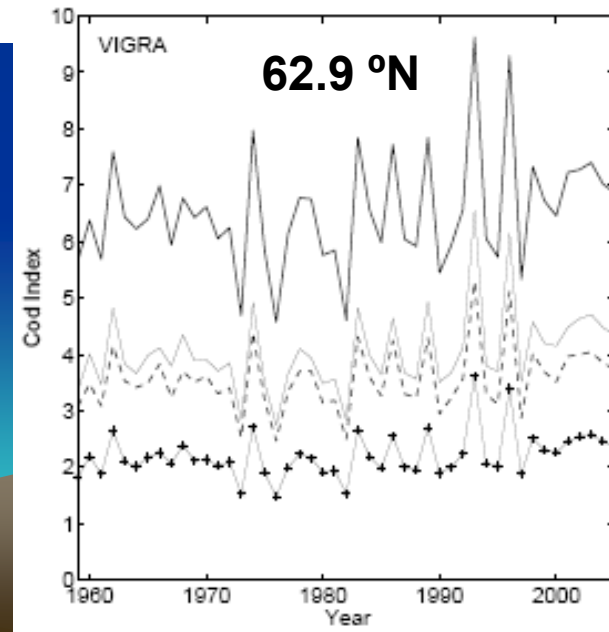
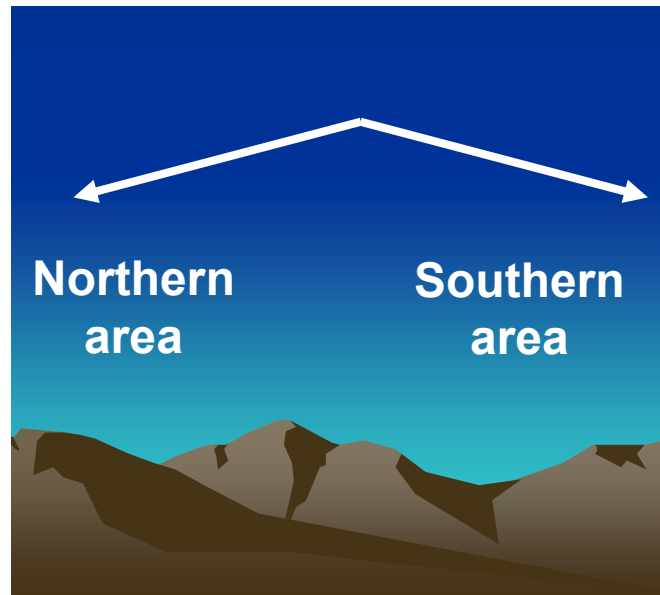
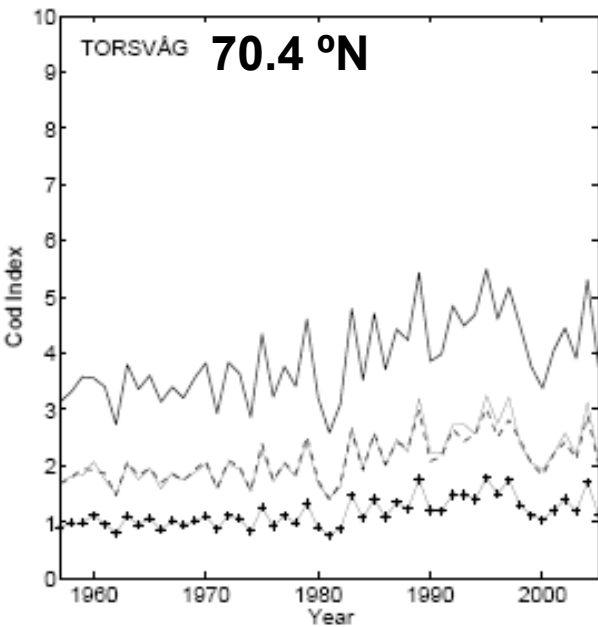
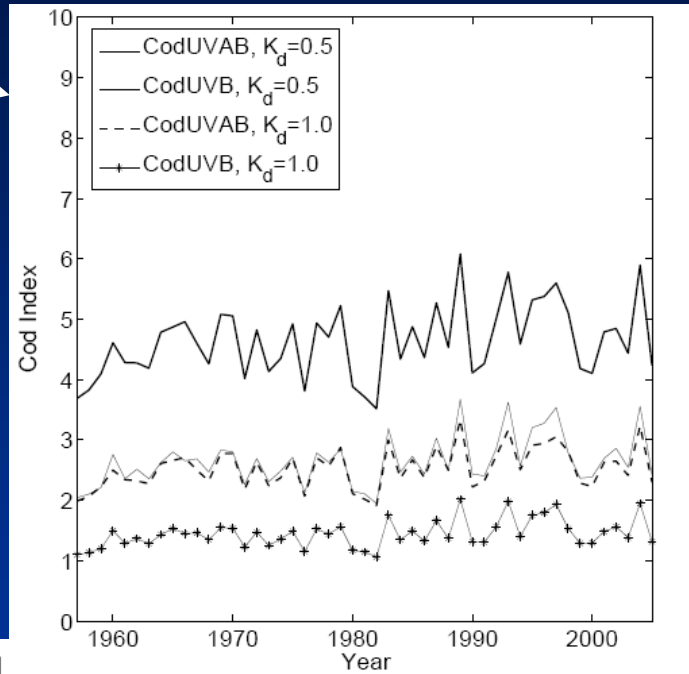


# Annual Cod UV-index

Overall

For the entire cod-egg population

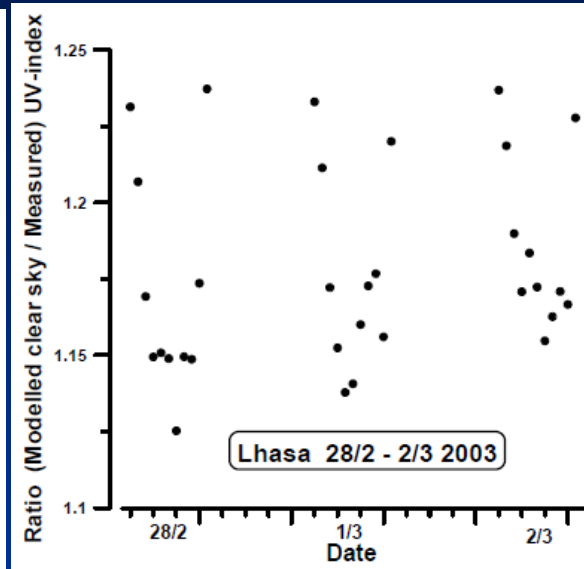
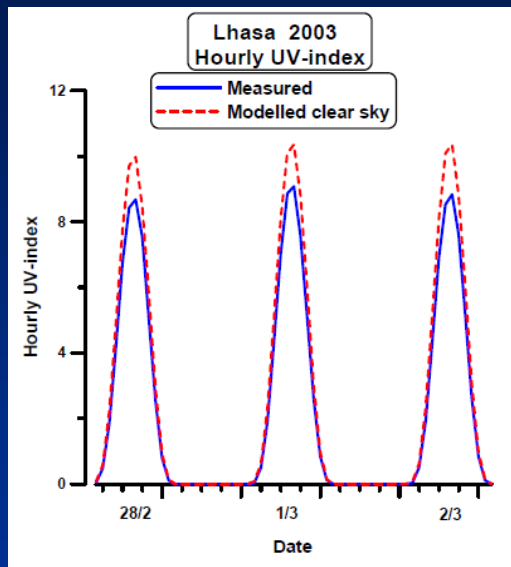
Weighted according to the relative weight of the spawning areas



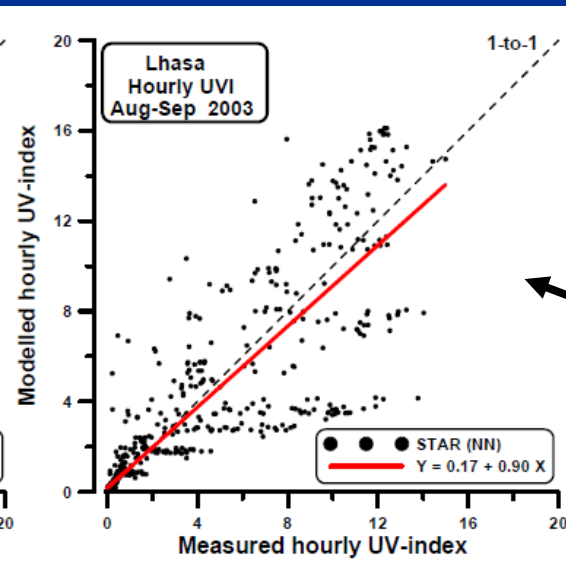
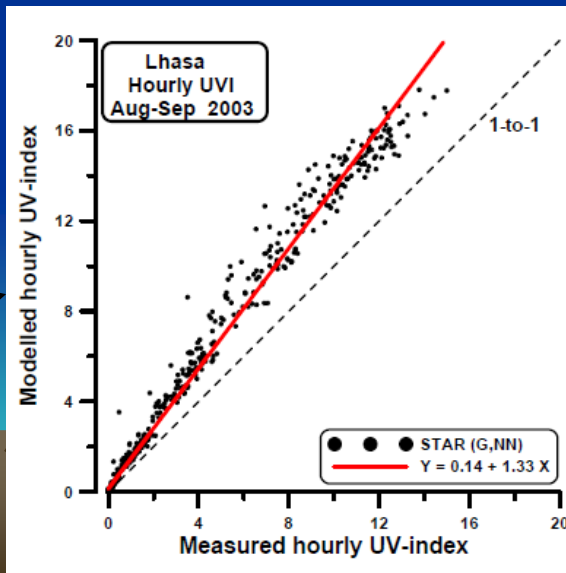


Measured vs modelled hourly UV-index in Lhasa, Tibet

Clear sky



Overall



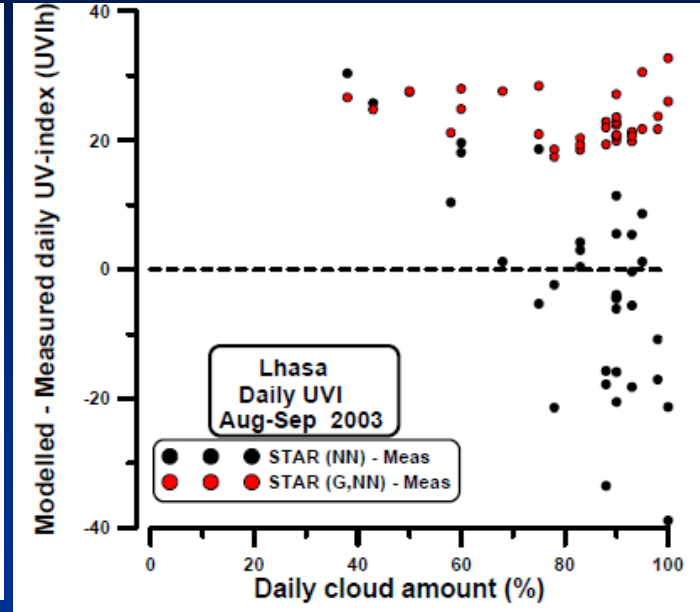
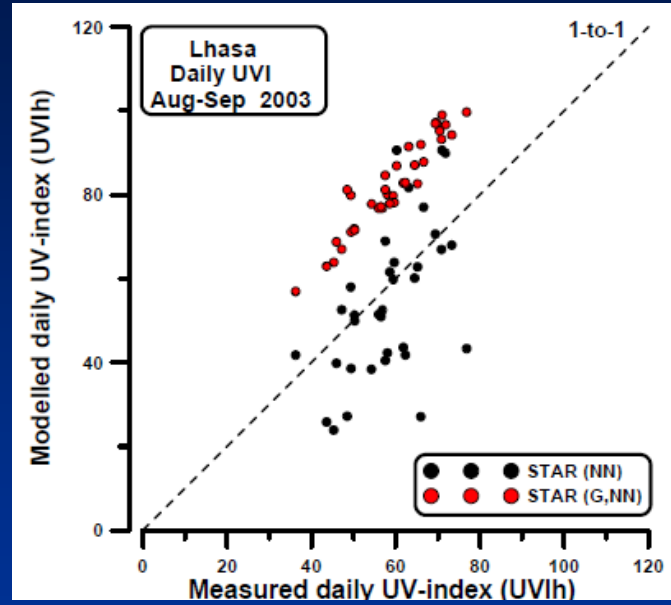
STAR (G,NN)

STAR (NN)

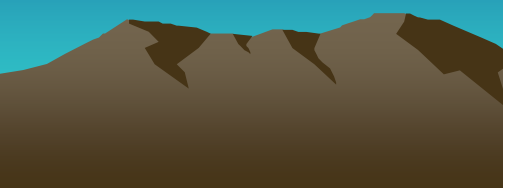
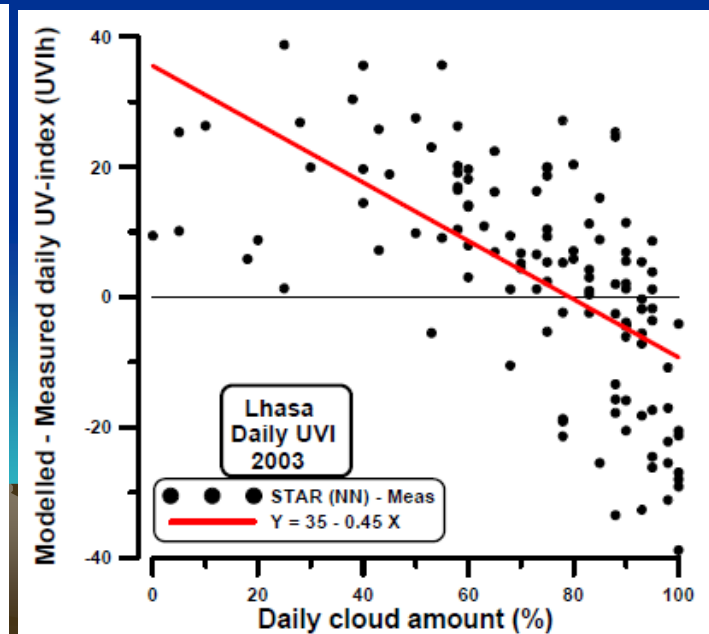
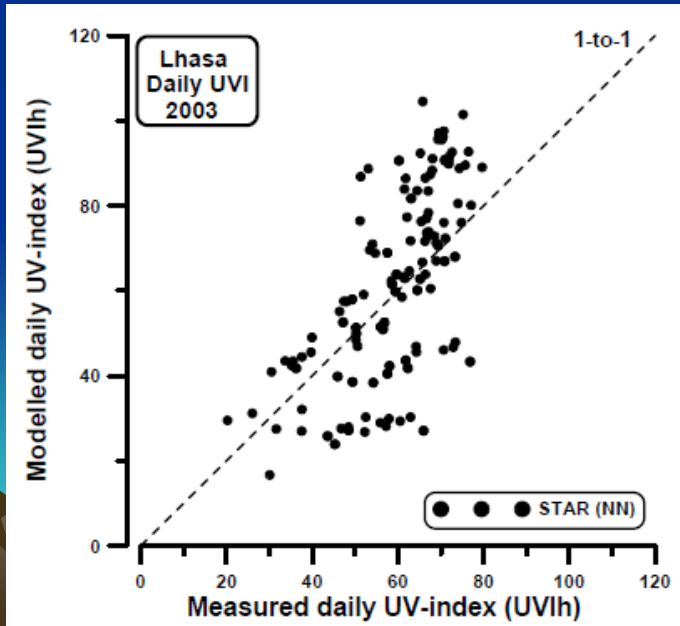


# Measured vs modelled daily UV-index in Lhasa, Tibet

Input to STAR  
Global radiation (G)  
&  
Cloud amount (NN)



Input to STAR  
Cloud amount (NN)  
(whole dataset)

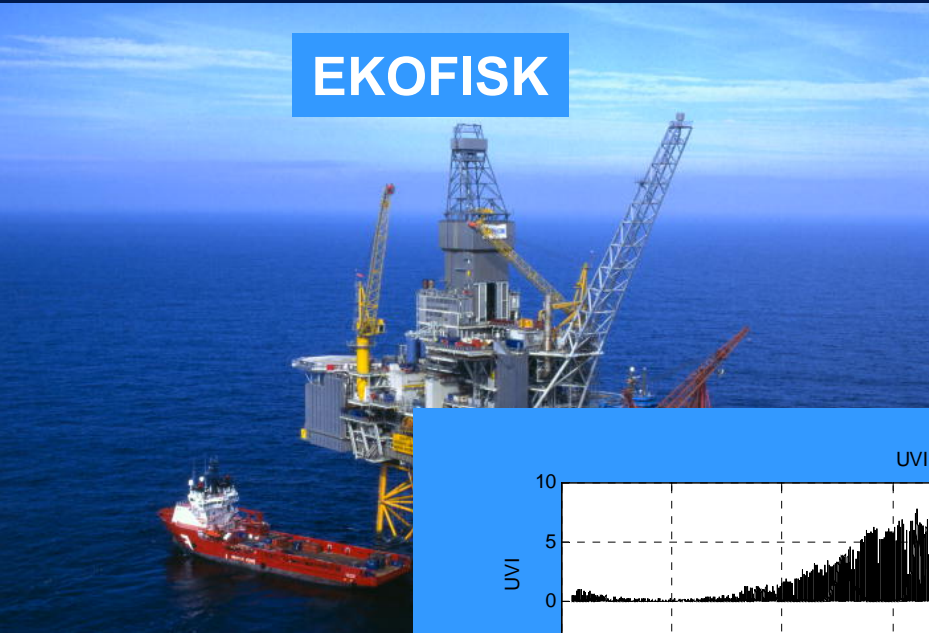


# Radiation measurements over ocean (pilotproject)

GI-UiB / NRPA / Met Inst / ConocoPhilips



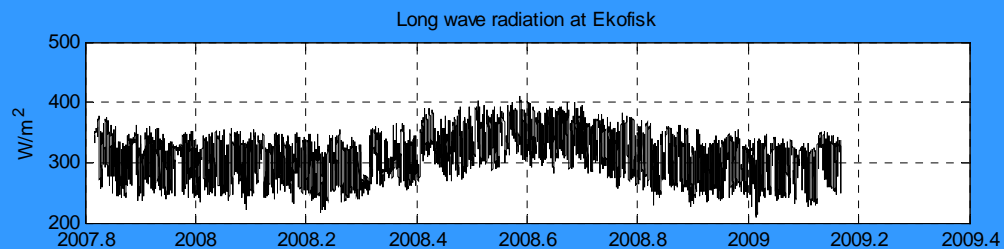
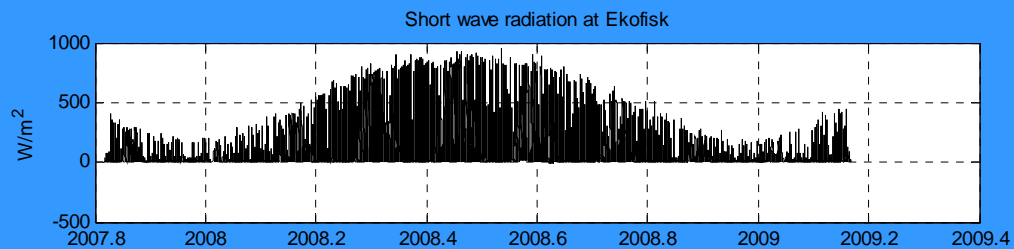
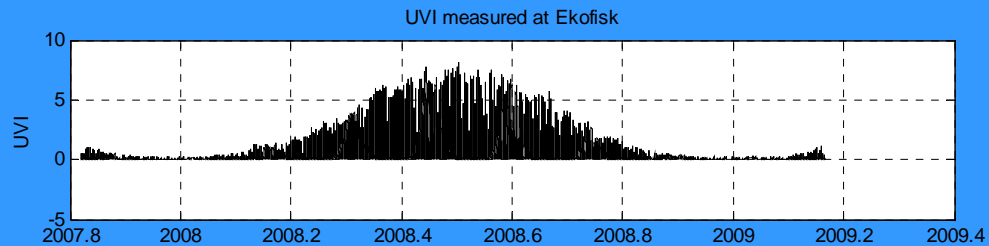
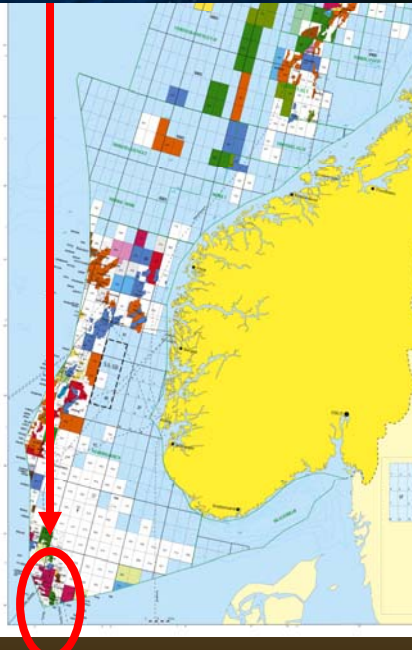
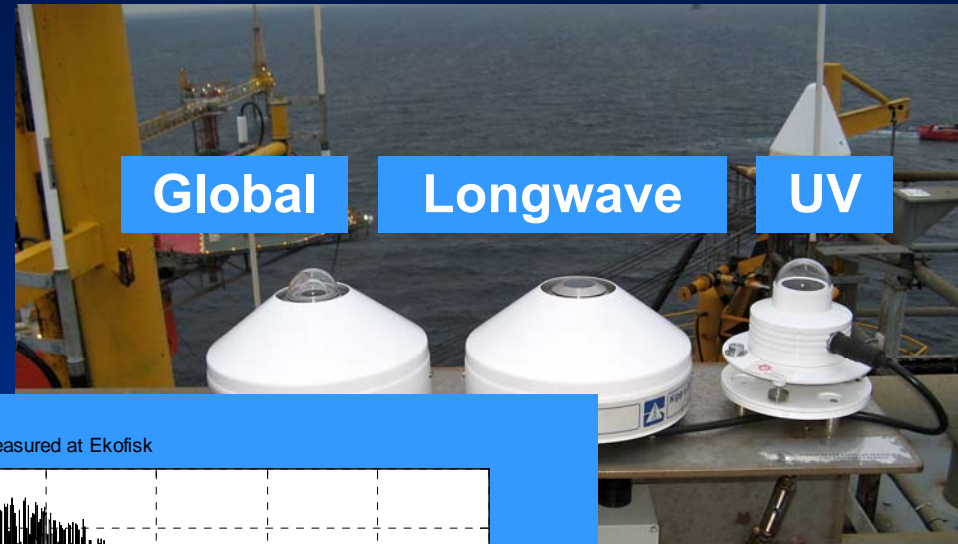
EKOFISK



Global

Longwave

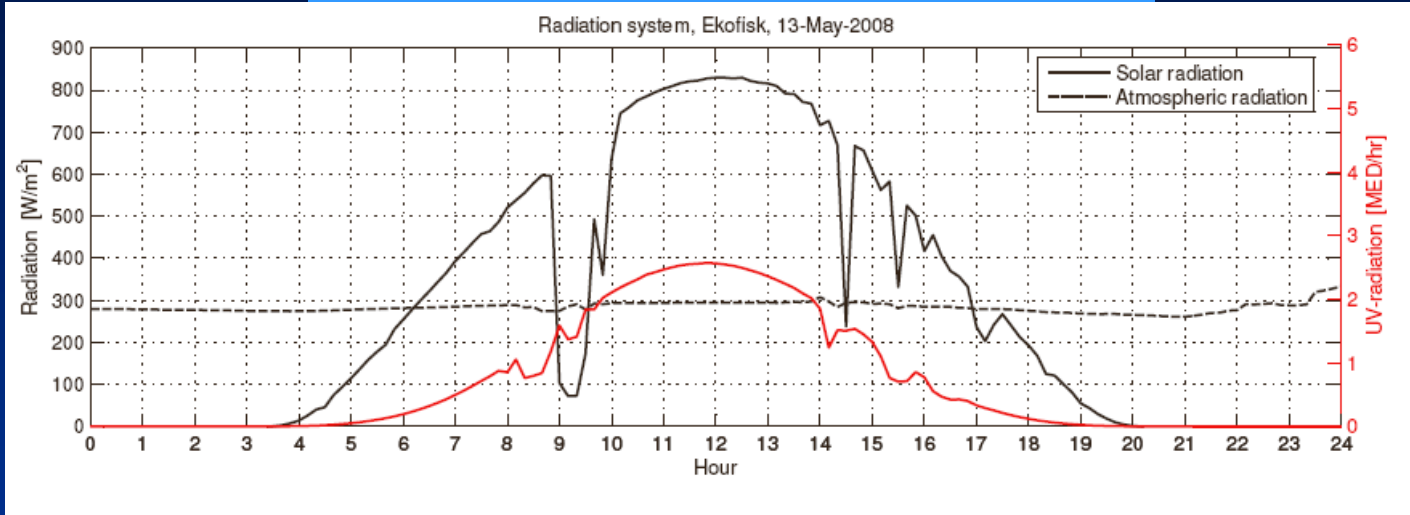
UV



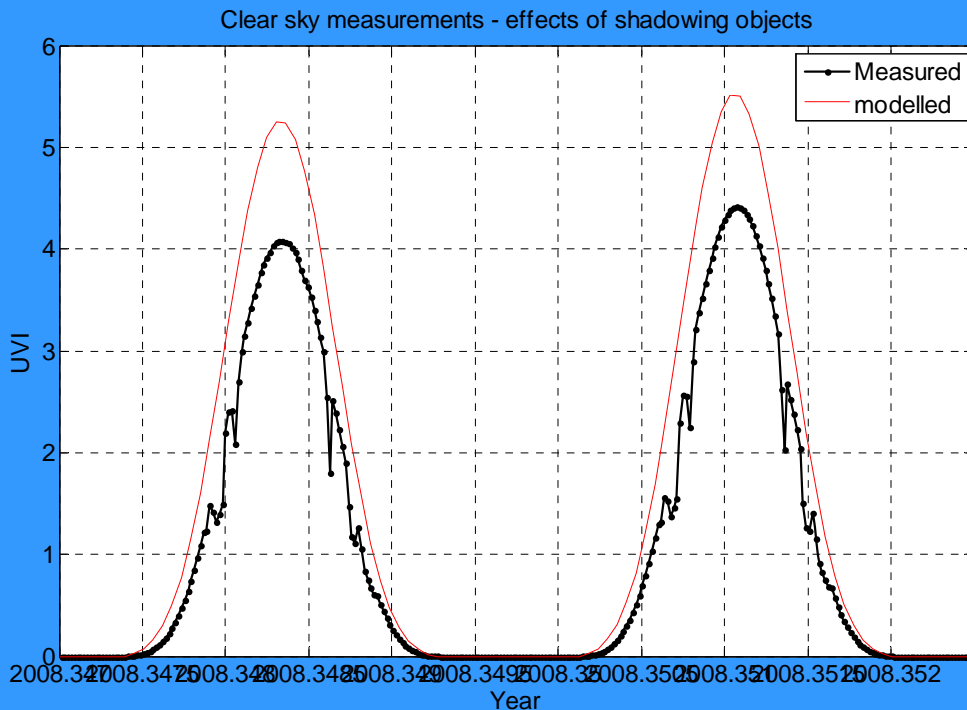
# Radiation measurements over ocean (pilotproject)



## Problems with shading / calibration



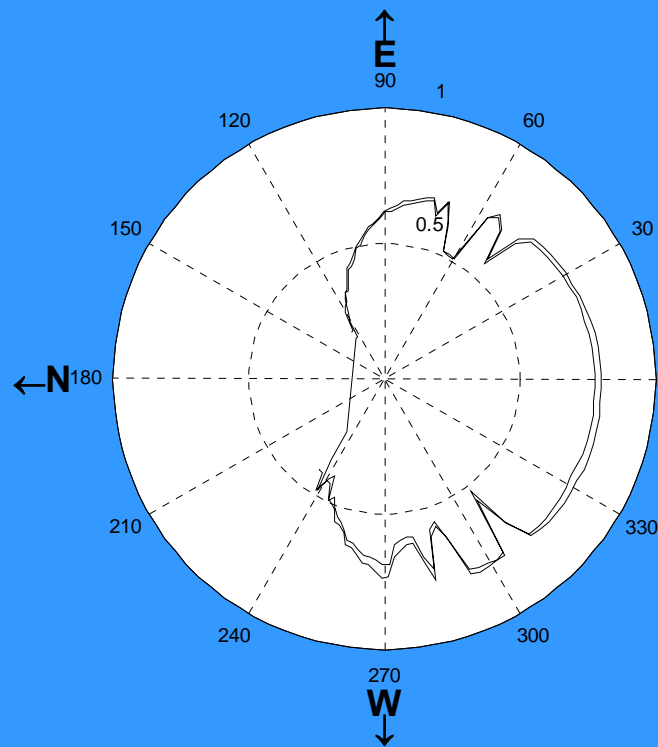
Measured and modelled  
clear sky UVI  
Day 127 and 128 in 2008



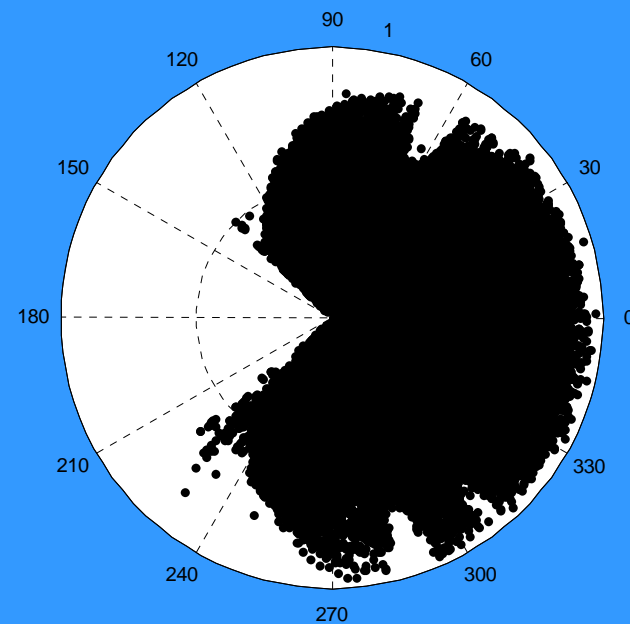
# Radiation measurements over ocean (pilotproject)



## Ratios UVI measured to UVI modelled, vs azimuthal direction



**Day 127 and 128 in 2008**



**All UVI ratios**

# Outcome from University of Bergen Geophysical Institute



## Measurements:

- Data from Bergen used for the test of models
- Measurements of solar and terrestrial radiation at an oil platform (EKOFISK)

## Publications:

### - Papers

- Lindfors, Anders; Kaurola, Jussi; Arola, Antti; Koskela, Tapani; Lakkala, Kaisa; Josefsson, Weine; Olseth, Jan Asle; Johnsen, Bjørn : A method for reconstruction of past UV radiation based on radiative transfer modeling: Applied to four stations in northern Europe, **JOURNAL OF GEOPHYSICAL RESEARCH**, 112, 2007
- Medhaug, I., J.A. Olseth and J. Reuder, 2009, UV radiation and skin cancer in Norway. Submitted to **JOURNAL OF PHOTOCHEMISTRY AND PHOTOBIOLOGY**, 2009



# Outcome from University of Bergen Geophysical Institute



## - Presentations at Conferences/Meetings:

- Sætre, O. and Olseth, J.A., 2006, Measured and modelled UV-radiation in Bergen. **Nordic Ozone Group (NOG) meeting**, Copenhagen 27. - 28. April 2006.
- Olseth, Jan Asle; Medhaug, Iselin; Reuder, Joachim; Sjølingstad, Brynhild Berge; Sæter, Ottar, 2007, UV-radiation in Norway: Measurements, reconstructions, and applications., Proceedings of the **UV Conference "One century of UV radiation research"**, 18-20 Sept. 2007, Davos, Switzerland, 199-200.
- Medhaug, Iselin; Olseth, Jan Asle; Reuder, Joachim. 2008, Reconstruction of UV-radiation in Norway. **EGU General Assembly 2008**; 13. – 18.04.2008.
- Medhaug, Iselin; Olseth, Jan Asle; Reuder, Joachim, 2008, UV-radiation and skin cancer in Norway. The **26th Nordic Meteorologists' Meeting**, Reykjavik, Iceland, 02. - 06.06.2008.
- Olseth, Jan Asle; Medhaug, Iselin; Reuder, Joachim; Sjølingstad, Brynhild Berge; Sætre, Ottar, 2008, Measured and modelled UV radiation in Norway. The **26th Nordic Meteorologists' Meeting**, Reykjavik, Iceland, 02. - 06.06.2008.



# Outcome from University of Bergen Geophysical Institute



## - Master-theses

- O. Sætre:** Observed and modelled UV-radiation in Bergen (2006)
- I. Medhaug:** Reconstruction of UV-radiation and its potential implications on development of skin cancer (2007)
- B.B. Sjølingstad:** Reconstruction of UV radiation: UV exposure of the Arcto-Norwegian cod egg population (2007)
- Deyang:** Measured and modelled solar radiation in Tibet (2009)



**Thank you**

**Greetings from Geophysical Institute, University of Bergen**

# Cloud effect in Lhasa, Tibet

