Mapping and on-line dissemination of biologically effective UV radiation data over Poland (exampled by erythemal UV dose)

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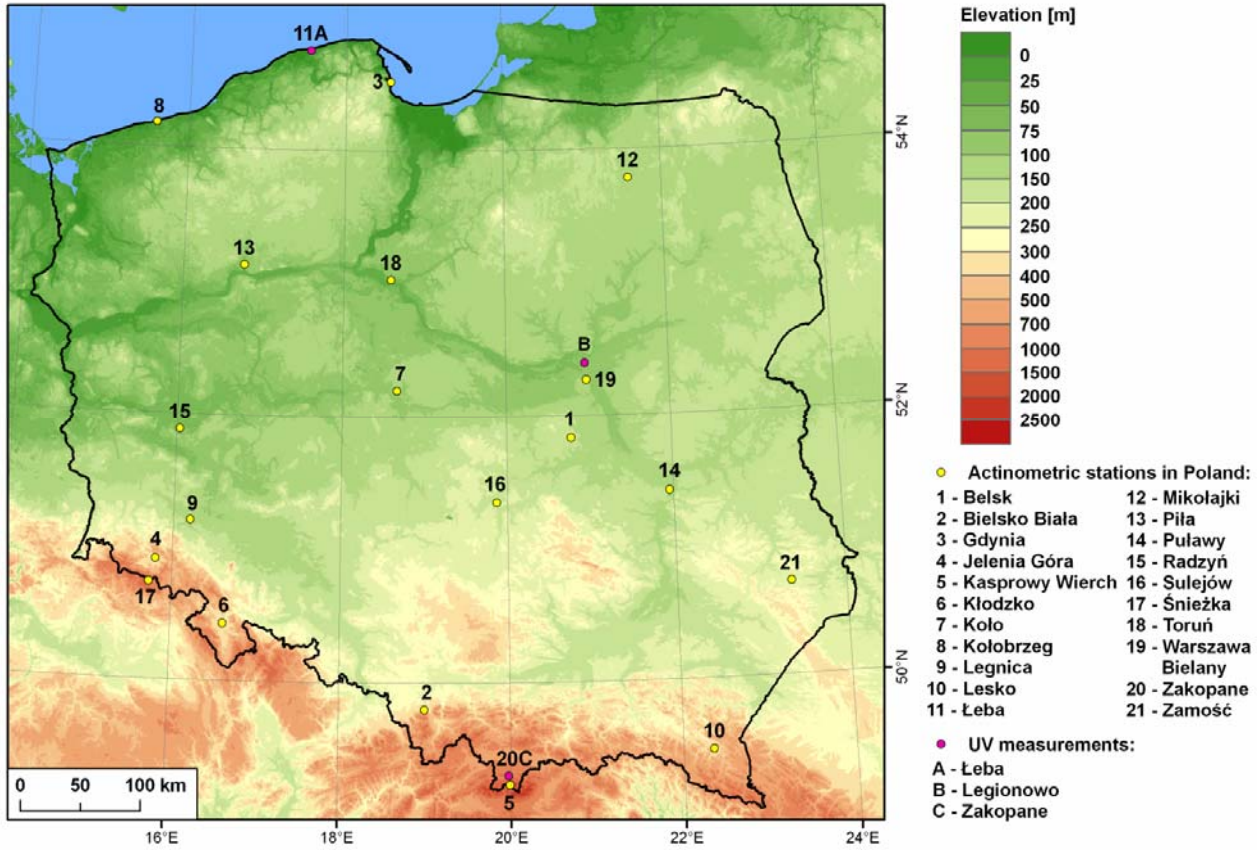
Presentation Contents

- SR/UV measurements in Poland
- UV recontstruction
- Data complimentary analysis
- Spatial interpolation methods
- Prediction error evaluation
- Output map examples
- On-line dissemination strategy
- Conclusion / future challenges

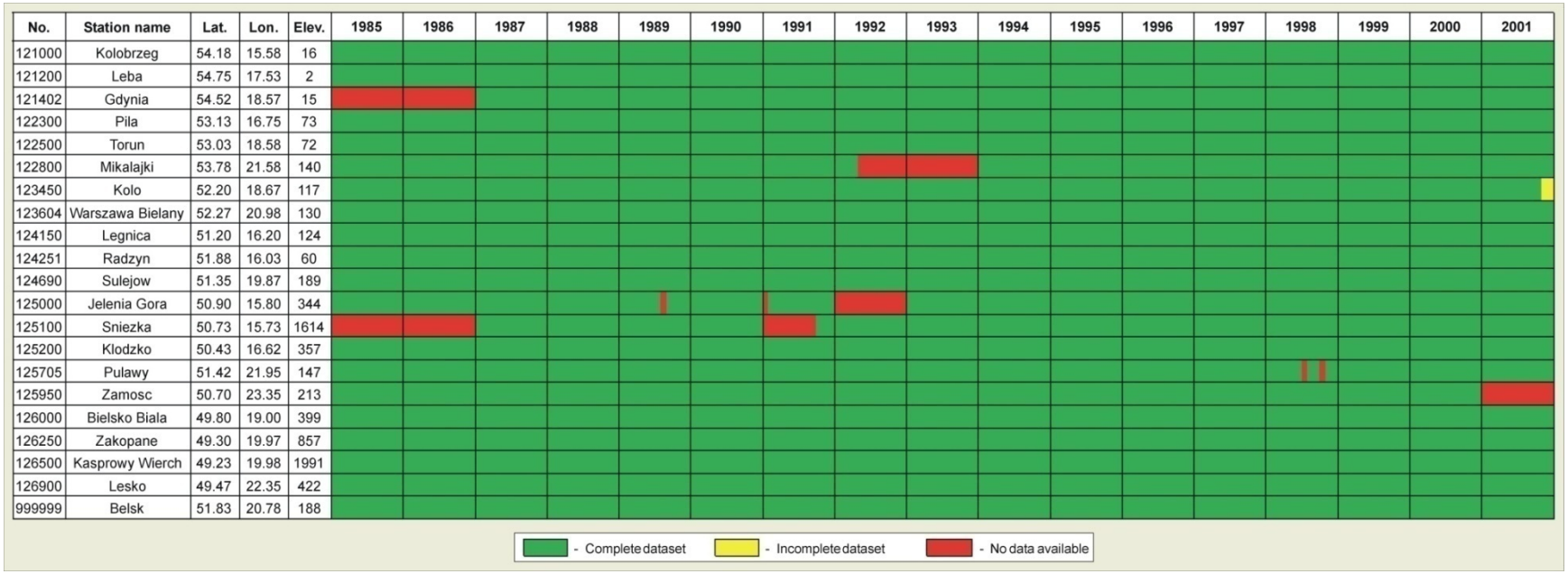
Solar radiation measurements, UV reconstruction



- The UV measurements with Solar Light UV Biometer started from 1994.
- These measurements were used for reconstruction of UV radiation daily doses.
- UV daily doses where reconstructed for the period of 1985-2001 and for different action spectra.

Data Complimentary Analysis

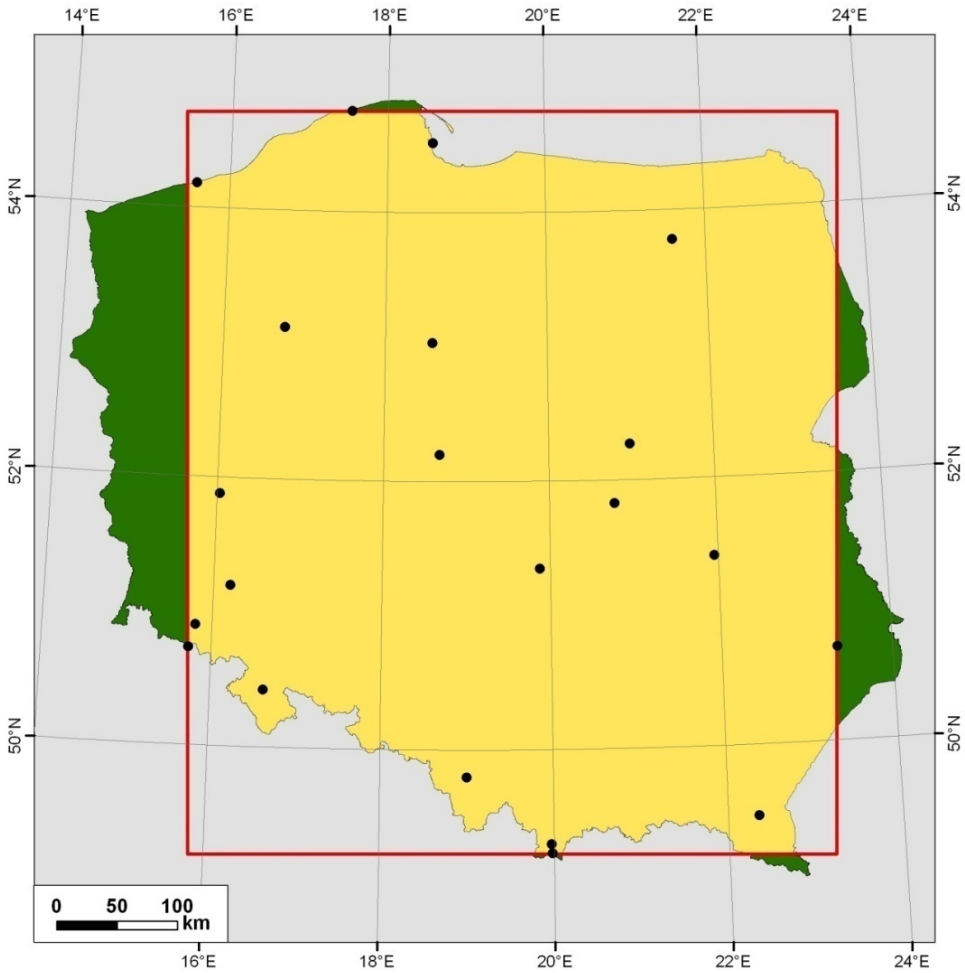
Parameter: Mean monthly UV daily doses
for erythemal action spectrum
[21 sample points, 17 years]



No.	Station name	Lat.	Lon.	Elev.	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
121000	Kolobrzeg	54.18	15.58	16																	
121200	Leba	54.75	17.53	2																	
121402	Gdynia	54.52	18.57	15																	
122300	Pila	53.13	16.75	73																	
122500	Torun	53.03	18.58	72																	
122800	Mikalajki	53.78	21.58	140																	
123450	Kolo	52.20	18.67	117																	
123604	Warszawa Bielany	52.27	20.98	130																	
124150	Legnica	51.20	16.20	124																	
124251	Radzyn	51.88	16.03	60																	
124690	Sulejow	51.35	19.87	189																	
125000	Jelenia Gora	50.90	15.80	344																	
125100	Sniezka	50.73	15.73	1614																	
125200	Klodzko	50.43	16.62	357																	
125705	Pulawy	51.42	21.95	147																	
125950	Zamosc	50.70	23.35	213																	
126000	Bielsko Biala	49.80	19.00	399																	
126250	Zakopane	49.30	19.97	857																	
126500	Kasprowy Wierch	49.23	19.98	1991																	
126900	Lesko	49.47	22.35	422																	
999999	Belsk	51.83	20.78	188																	

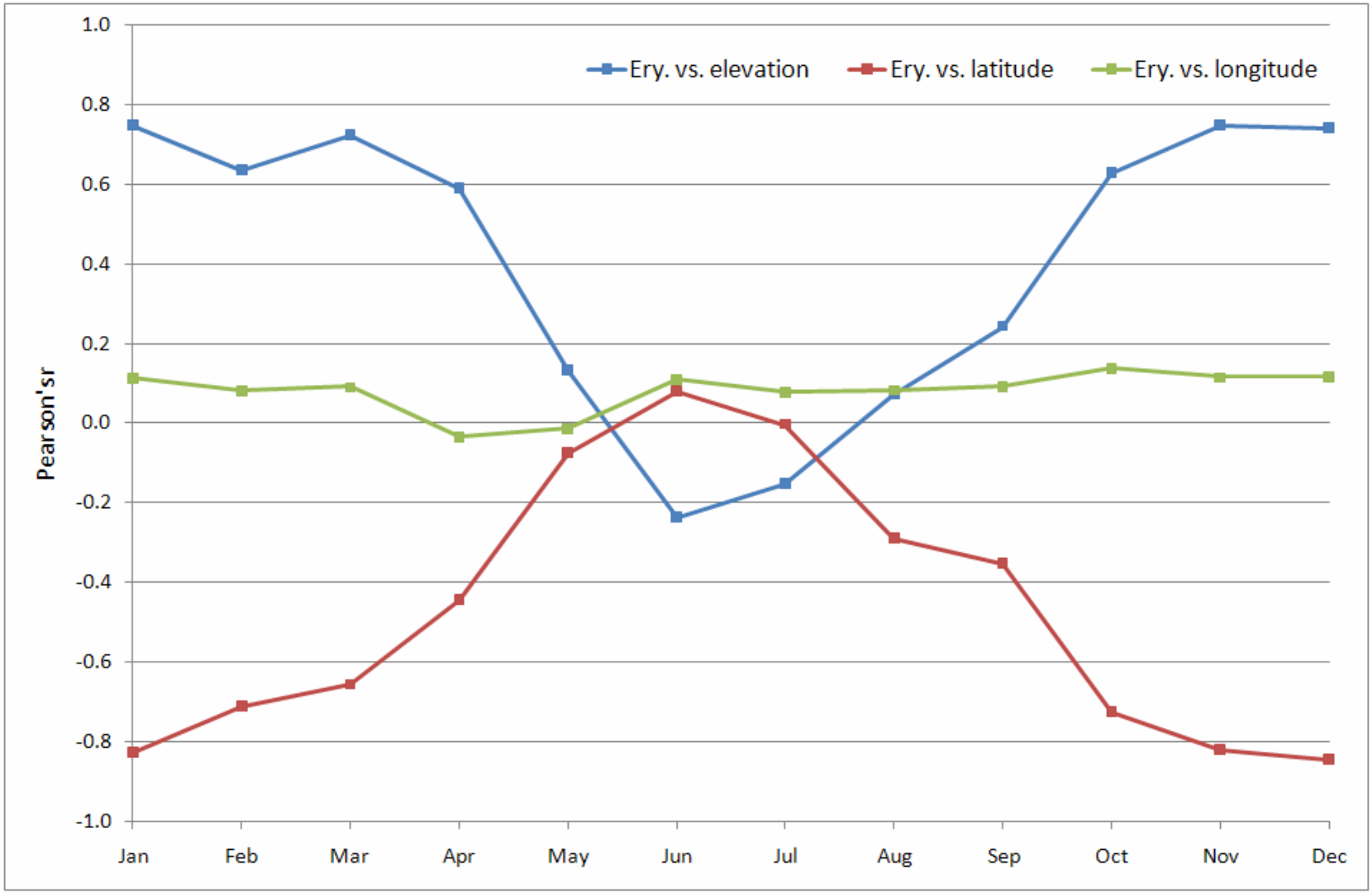
Spatial interpolation tests were performed for the selected years.
ArcGIS 9.2 with Geostatistical Analyst was used

Interpolation Method



Universal kriging assumes a general linear trend model.
Therefore is said to be very useful and efficient in case of extrapolation beyond the area narrowed by the sample points

Looking for predictor variables



Universal Kriging or CoKriging?

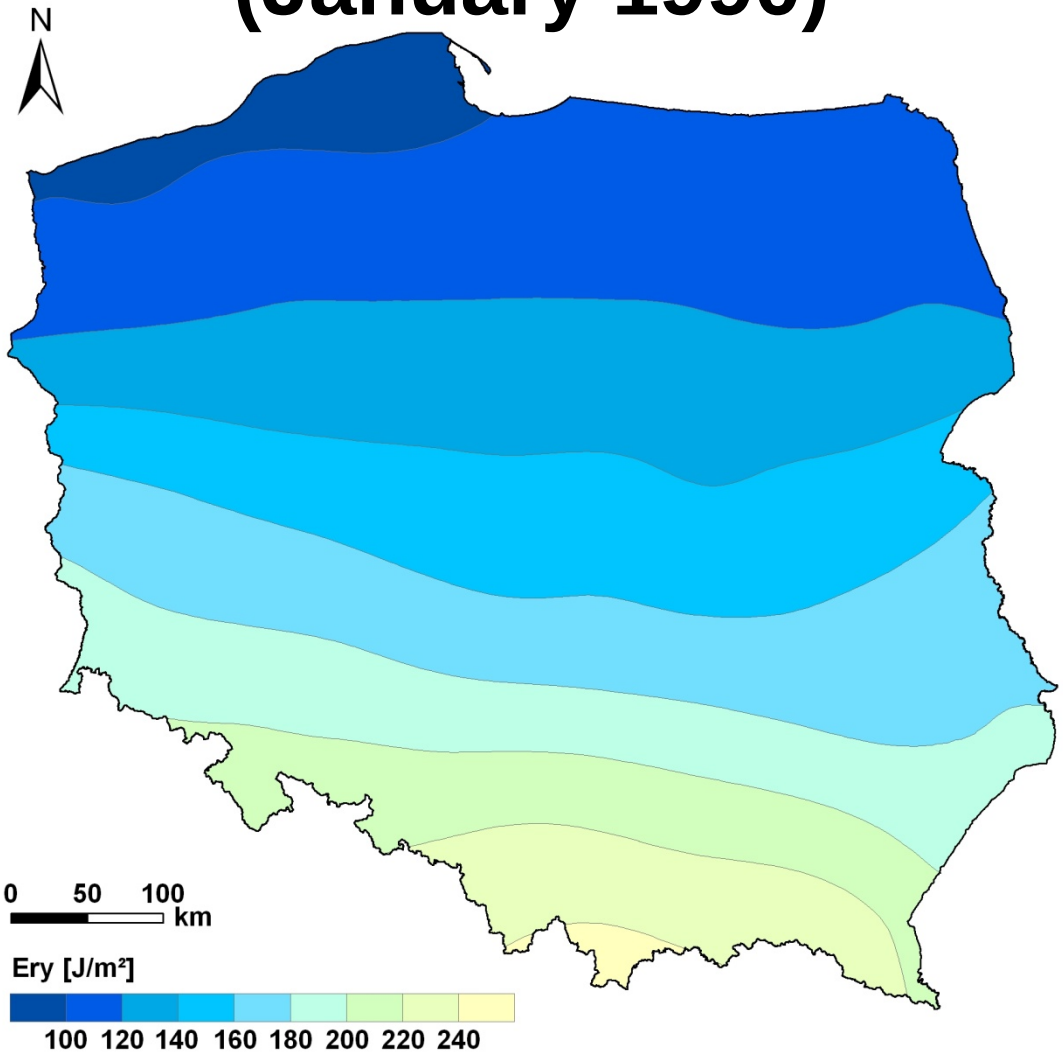
Ery-1990	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
UK (RMSE)	24.33	**47.62**	131.90	140.50	144.90	179.80	**204.40**	**118.60**	**90.18**	62.71	29.97	17.59
UK (MPV)	124.05	409.18	872.64	1320.35	2619.03	2687.87	2543.57	2176.55	907.87	659.30	143.19	106.16
UCoK (RMSE)	**23.99**	48.35	**126.50**	**139.90**	**141.80**	**176.80**	205.10	119.60	90.48	**59.83**	**28.28**	**14.78**
UCoK (MPV)	129.93	422.62	898.78	1324.10	2585.75	2668.91	2548.59	2179.98	912.59	677.30	148.78	113.20

Ery-2000	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
UK (RMSE)	25.79	43.46	92.20	172.80	128.10	157.40	**167.40**	127.20	**65.02**	38.29	22.79	13.84
UK (MPV)	145.28	333.96	760.03	1918.95	2787.47	3333.25	2144.32	2434.41	1292.69	663.38	192.39	89.22
UCoK (RMSE)	**24.38**	**38.38**	**83.40**	**163.60**	**122.20**	**154.10**	168.40	**121.40**	67.18	**34.24**	**20.72**	**11.86**
UCoK (MPV)	152.69	347.01	787.42	1957.35	2790.66	3348.46	2151.15	2450.60	1305.15	664.95	197.43	93.39

The best empirical semivariogram model selection

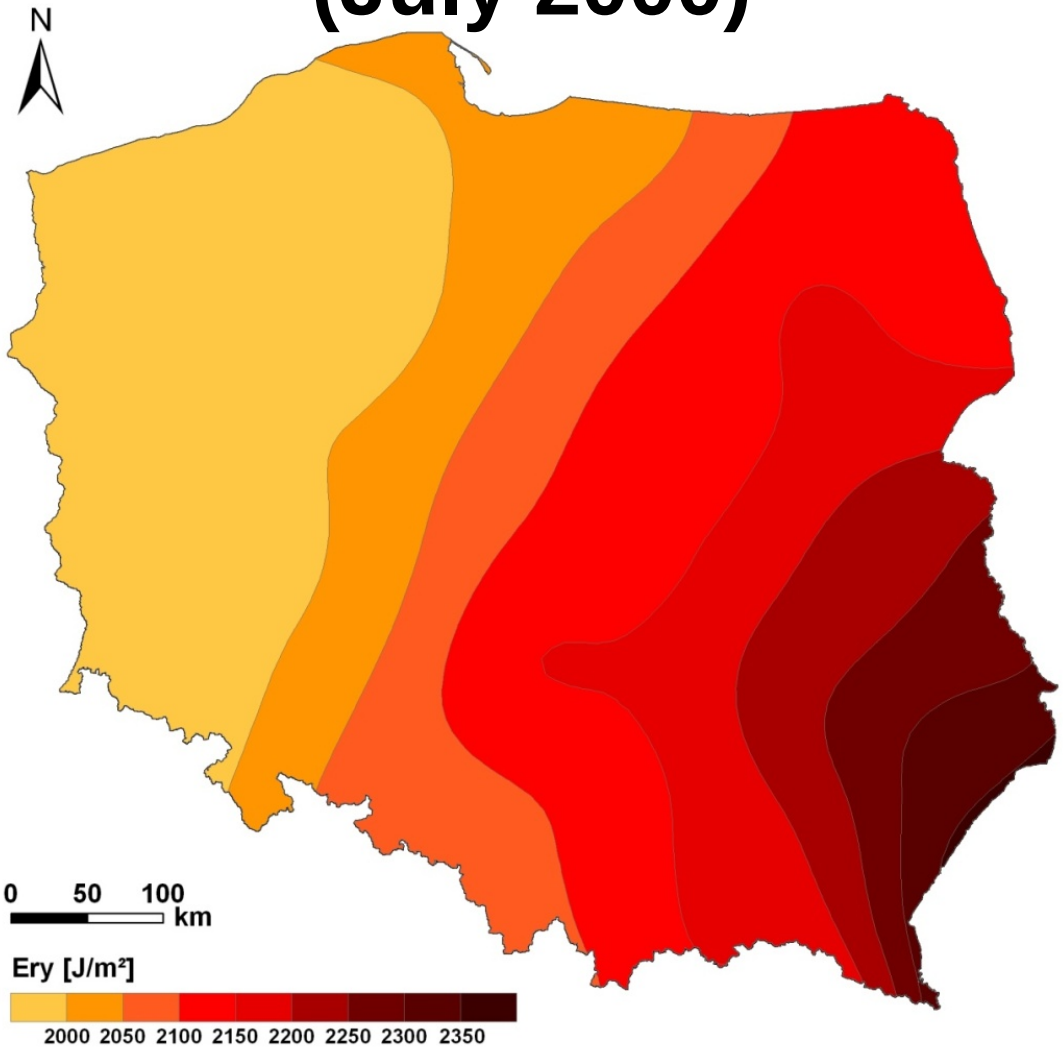
Models	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Circular	-0.46	-0.94	-1.41	-1.89	0.04	-0.44	1.35	-0.70	0.14	-0.45	0.01	-0.08
Spherical	-0.52	-0.96	-1.63	-2.04	0.09	-1.34	1.30	-0.45	0.16	-0.47	0.00	0.08
Tetraspherical	-0.56	-1.01	-1.51	-1.79	0.09	-1.34	1.35	-0.25	0.18	-1.03	-0.06	-0.07
Pentaspherical	-0.36	-0.95	-1.04	-1.29	0.09	-1.69	1.40	-0.25	0.23	**-1.31**	-0.11	-0.08
Exponential	**-0.74**	**-1.56**	**-2.49**	**-2.24**	-0.96	**-3.69**	0.80	-0.65	-0.05	-1.22	**-0.32**	**-0.37**
Gaussian	-0.02	0.10	0.15	0.46	0.19	2.31	2.10	0.90	-0.01	0.43	-0.11	-0.11
Rational Quadratic	-0.50	-1.11	-1.46	-1.04	**-1.11**	-1.19	1.80	-0.55	-0.04	-0.86	-0.16	0.06
Hole Effect	2.23	3.70	6.23	6.11	0.79	1.76	-5.65	0.70	**-0.23**	2.44	0.66	0.28
K-Bessel	-0.35	0.28	-0.01	-0.09	0.04	2.16	2.10	2.55	-0.09	0.76	-0.07	0.17
J-Bessel	1.65	1.78	3.03	3.51	0.74	1.71	**-8.65**	**-3.90**	-0.17	0.75	0.18	-0.08
Stable	-0.35	0.64	0.16	0.26	0.04	1.71	2.10	2.60	-0.12	0.97	-0.01	0.02

Mean Erythemal UV Dose (January 1990)



Method: Universal Cokriging (var.: elevation, latitude) with exponential semivariogram model

Mean Erythemal UV Dose (July 2000)



Method: Universal Kriging with J-Bessel semivariogram model

Web mapping

Web Mapping = WebGIS = Internet GIS:

- solution for delivering maps, GIS data and services via Internet
- based on client/server architecture

Internet Atlas (e-Atlas) = a set of internet maps; larger web-based project

Advantages of e-Atlases:

- Can reach wider audience,
- Cheaper production,
- Updates less expensive and quicker
- provide a larger number of maps and map types
- integrate with and benefit from other web resources
- Sometimes offer raw data downloads and possibility of printing features on demand

Selected on-line dissemination tools

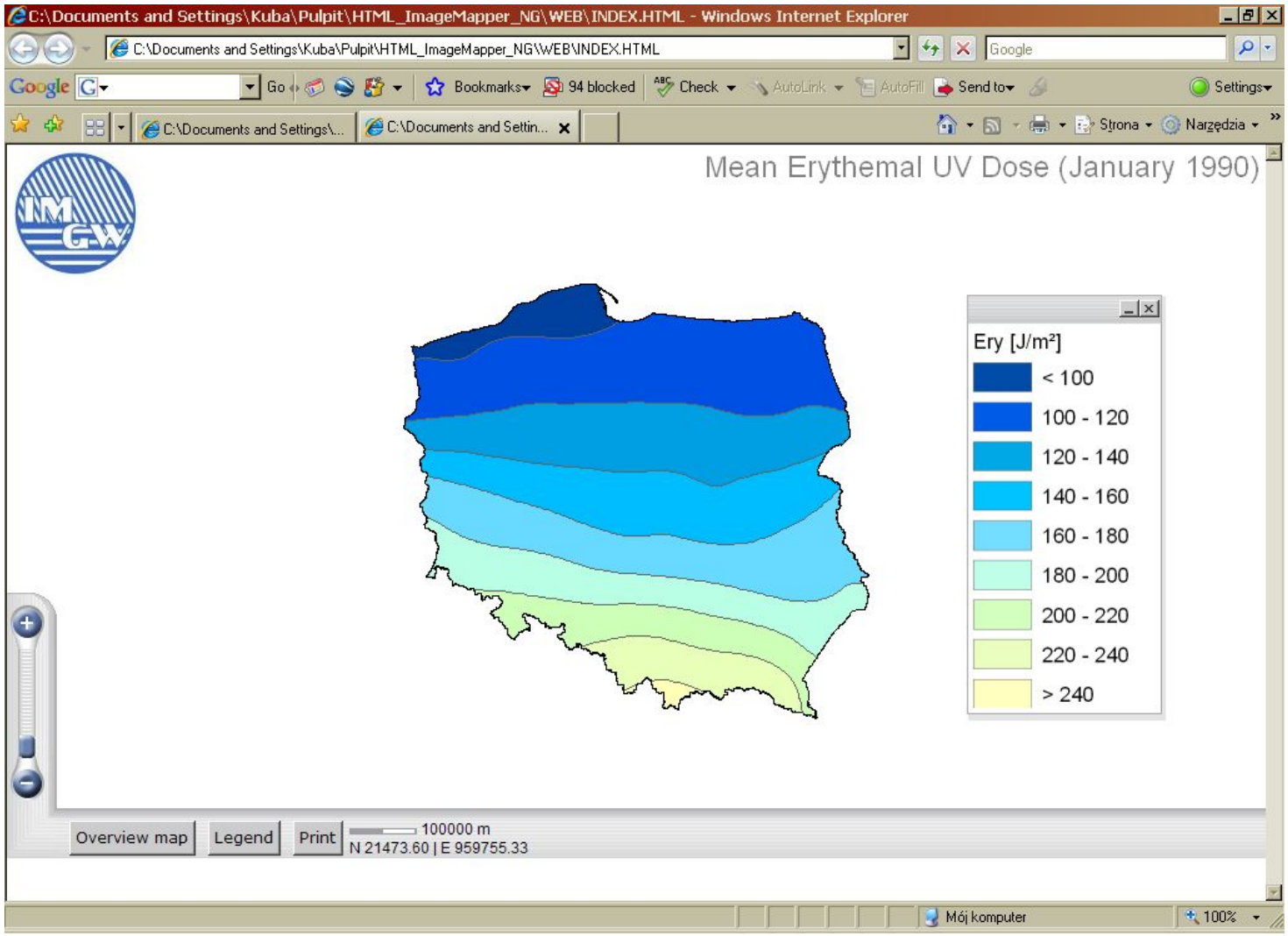
HTML Image Mapper NG
(Alta4 Geoinformatik AG)

- ArcGIS plug-in
- Easy and fast way to transform ArcGIS maps and data into interactive internet maps
- Output is pure HTML and JavaScript
- Works from CD-ROM and DVD-ROM (off-line productions)
- Allows to define quality and interactions the users should get.
- User view data by means of web browser.

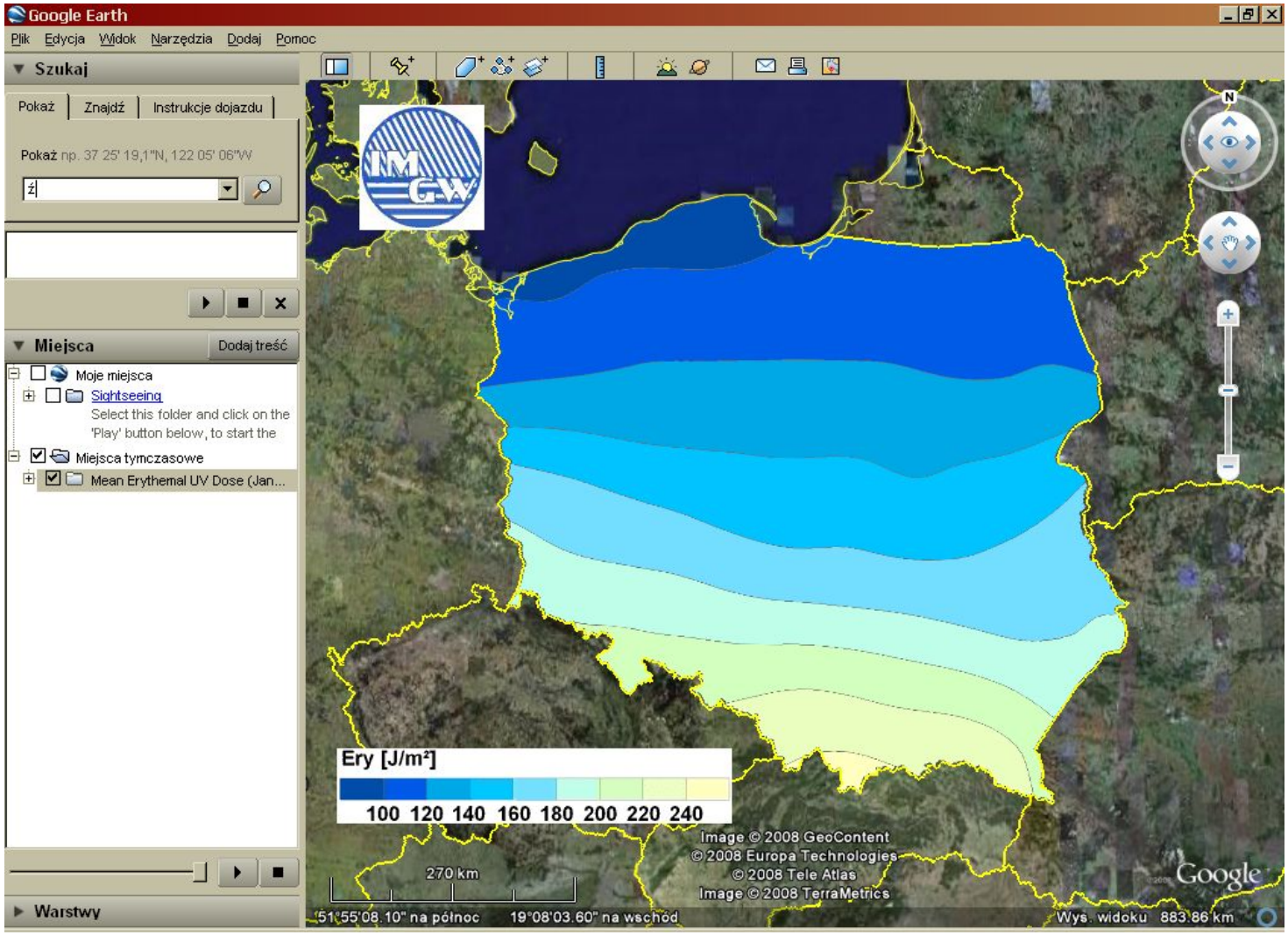
Google earth
(Keyhole Inc./Google)

- Is the most popular virtual globe browser
- User view data by means of google earth browser – a special application which needs to be installed on the user's machine.
- Allows users to interactively display and investigate geographic data (primarily satellite and aerial images and terrain models, but also 2- and 3-D vector data)
- Introduces own XML-based format (.kml, kmz)
- ArcGIS 9.2 maps can be directly exported to .kml/.kmz format
- Internet connection is needed, off-line productions impossible
- Very popular among internet users around the World, sometimes taken as unprofessional

HTML Image Mapper NG
- internet service



Google Earth – internet service



Conclusion and future challanges

- GIS is very useful for applications on UV climatology
- Universal Cokriging (additional variables: elevation and latitude) with exponential semivariogram model seems to be the most reliable interpolation method of the Erythemal UV dose in winter season so far.
- Spatial distribution of the erythemal UV dose in summer season not easy to explain (possible reason - cloud cover?)
- Selected web mapping tools meet requirements for publishing UV radiation maps on internet
- More interpolation method will be tested, including residual kriging
- Satellite cloud mask will be applied to explain spatial distribution of the erythemal dose in summer season
- Another action spectra will be included in the UVBE radiation e-Atlas: VitD production, DNA damage
- Knowledge on UV radiation needed!

Thank you for your attention!

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