

# WPŁYW WŁAŚCIWOŚCI OPTYCZNYCH ATMOSFERY NA WYMIANĘ CO<sub>2</sub> MIĘDZY EKOSYSTEMEM TORFOWISKOWYM I ATMOSFERĄ

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KATEDRA EKOLOGII I OCHRONY ŚRODOWISKA

UNIwersytet Przyrodniczy w Poznaniu

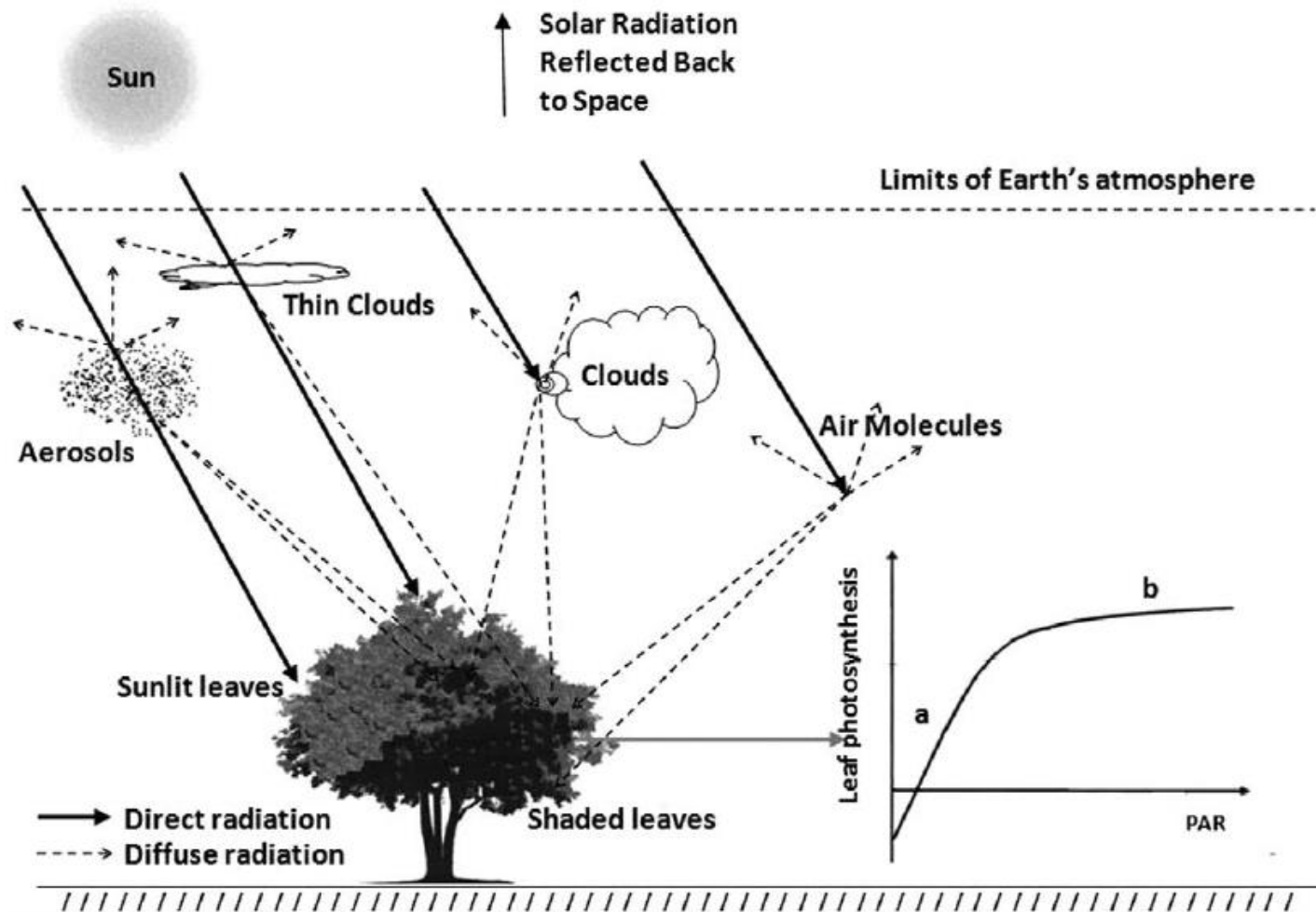


# TORFOWISKA



- Pokrywają tylko **3% powierzchni lądu** jednocześnie **zwierają 30% globalnego węgla glebowego**
- Skomplikowane ekosystem, bogate w bioróżnorodność i bezpośrednio zależne od warunków wodnych (**środowiska heterogeniczne**)
- Przewidywany wzrost temperatur oraz zaburzenia w bilansie wodnym mogą doprowadzić do sytuacji, w której ekosystemy te **staną się emiterami netto węgla do atmosfery.**

# PROMIENIOWANIE BEZPOŚREDNIE I ROZPROSZONE



# ROZPRASZANIE PROMIENIOWANIA

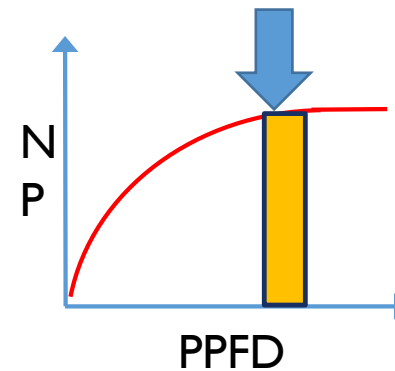
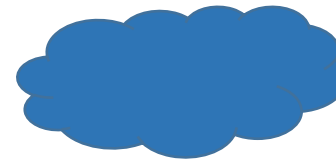
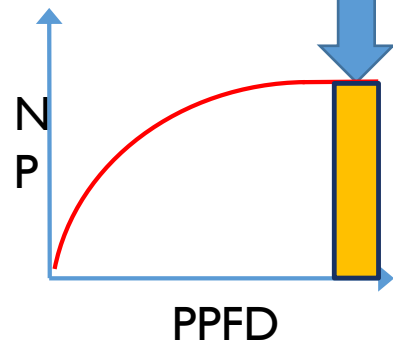
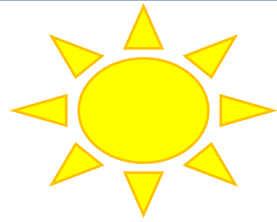
PROMIENIOWANIE  
BEZPOSREDNIE



PROMIENIOWANIE  
ROZPROSZONE

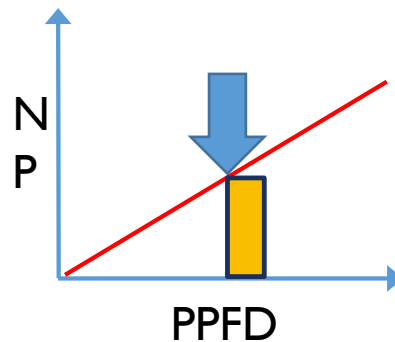
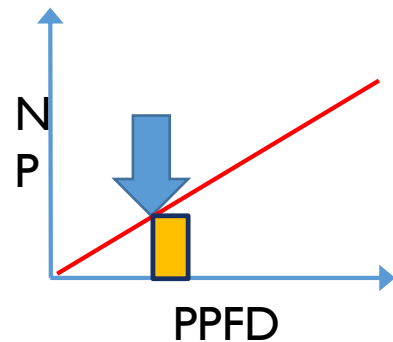
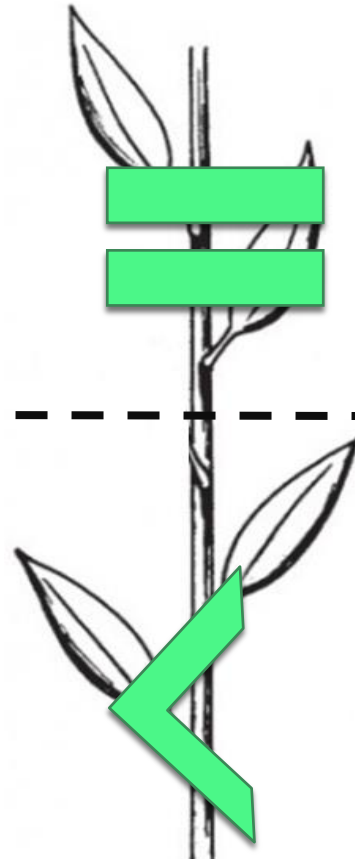


# AKTYWACJA DOLNYCH LIŚCI



NP – strumień netto  $\text{CO}_2$  fotosyntezy liści

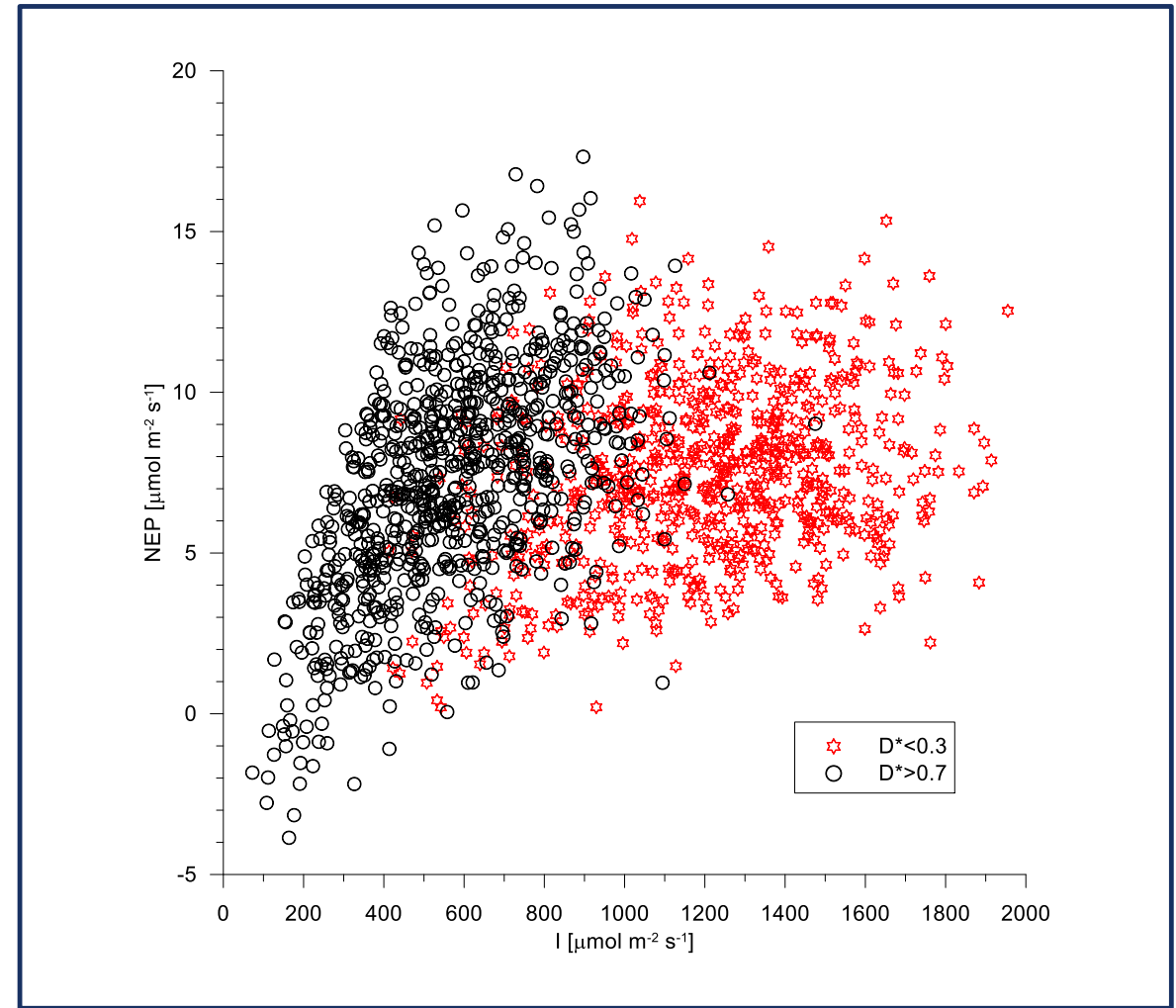
PPFD - gęstość strumienia promieniowana fotosyntetycznie aktywnego



**DOLNE LIŚCIE**

# Strumień netto CO<sub>2</sub> (NEP) vs. gęstość strumienia promieniowania fotosyntetycznie aktywnego (I)

czerwone kółka – warunki bezchmurne  
czarne kółka – warunki pochmurne



# PRODUKTYWNOŚĆ TORFOWISK W KONTEKŚCIE WYSTĘPOWANIA CHMUR I AEROZOLI W ATMOSFERZE

- **ROZPRASZANIE (SCATERING)** – ZWIĘKSZA ZDOLNOŚĆ EKOSYSTEMU DO POCHŁANIANIA CO<sub>2</sub>
- **POCHŁANIANIE (ATTENUATION)** – REDUKUJE ZDOLNOŚĆ EKOSYSTEMU DO POCHŁANIANIA CO<sub>2</sub>

# KONCEPCJA STRUKTURY MODELU

Ocena reakcji ekosystemu na zmiany parametrów optycznych atmosfery powinna być dokonana w oparciu o **równoległe i zintegrowane badania ekosystemu i atmosfery**



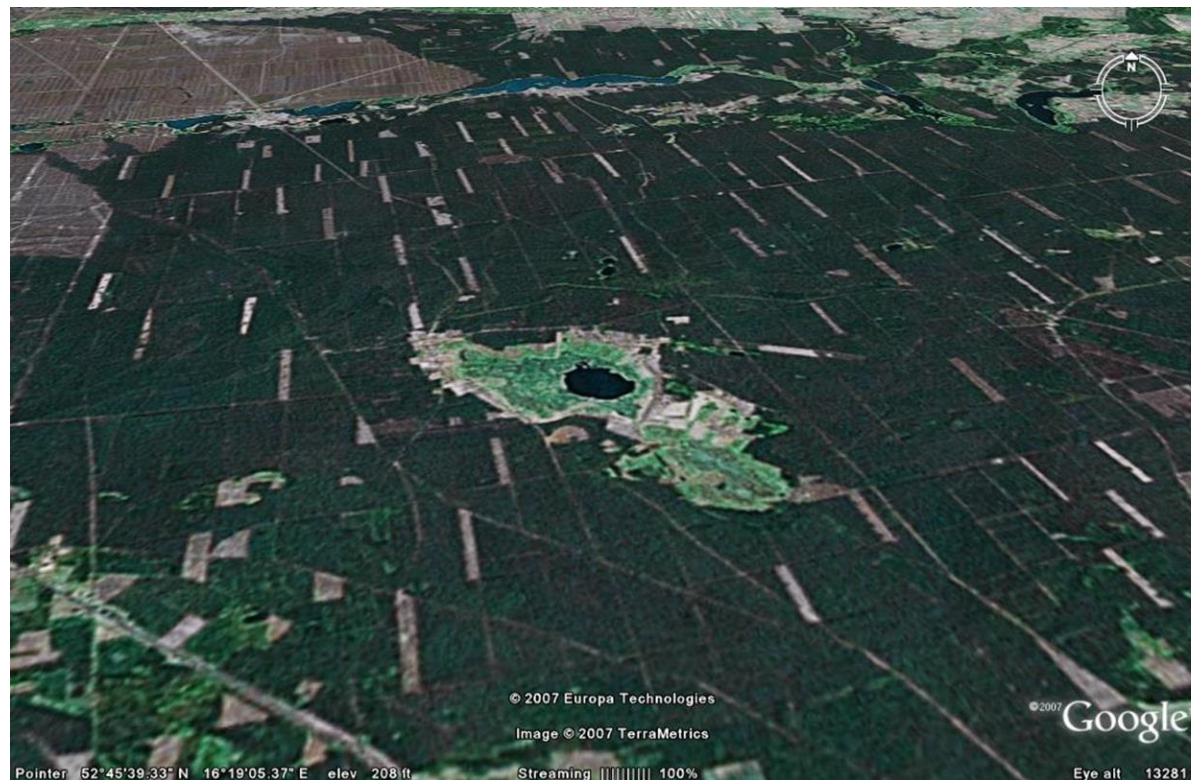
ATMOSFERA  
(chmury+aerozole)

EKOSYSTEM



# MIEJSCE POMIAROWE

- PoIWET site located in Rzecin village (52°45'N, 16°18'E, ca. 54 m a.s.l.)



# MIEJSCE POMIAROWE

- The Rzecin peatland is classified as a transitional peatland
- $P = 550\text{mm}$ ,
- $T_{\text{air}} = 8.2\text{ }^{\circ}\text{C}$



# RZECIN POLWET



• CIMEL



• BF5



• Eddy Covariance system

# ŹRÓDŁA DANYCH



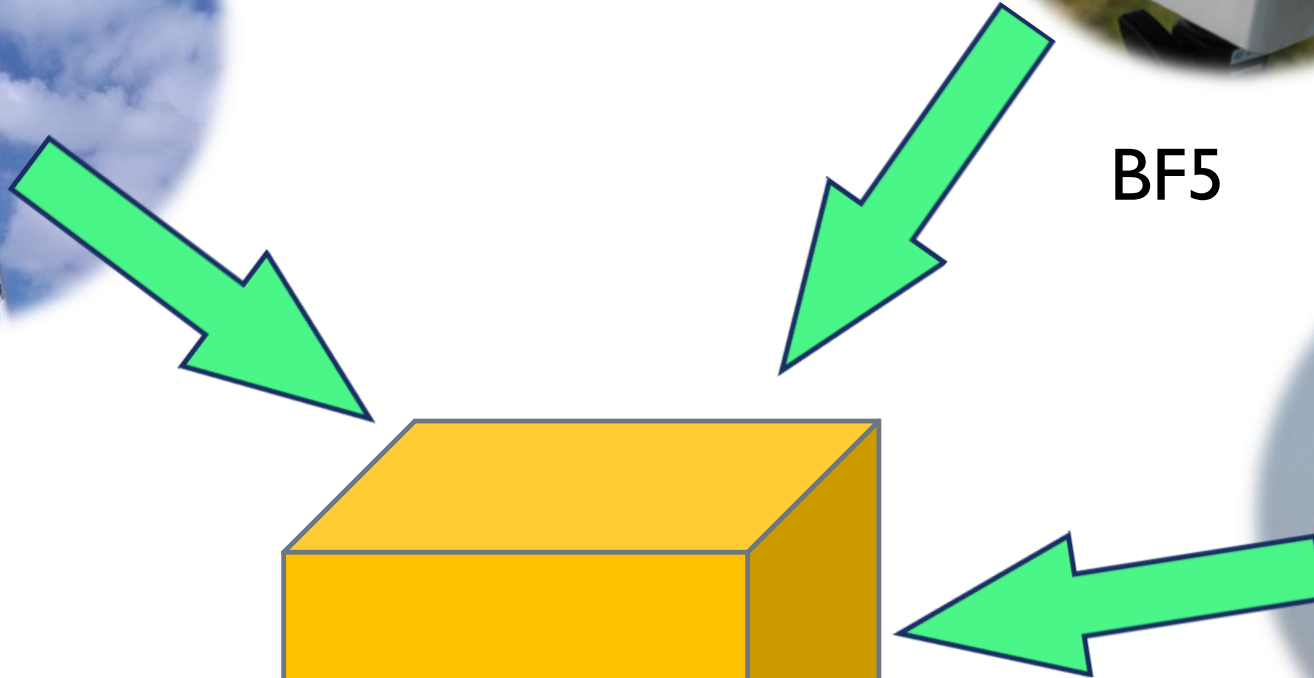
CIMEL



BF5



System Kowariancji  
Wirów



**BAZA DANYCH  
PRACOWNI  
BIOKLIMATOLOGII**

# ŹRÓDŁA DANYCH



NASA GODDARD SPACE FLIGHT CENTER + Visit NASA.gov

## AERONET AEROSOL ROBOTIC NETWORK

+ AEROSOL OPTICAL DEPTH + AEROSOL INVERSIONS + SOLAR FLUX + OCEAN COLOR + MARITIME AEROSOL

AERONET Data Display Interface **version 2 Direct Sun Algorithm**

Site: POLWET\_Rzeclin - Additional Site Information

**DISCLAIMER** AERONET Level 1.0. Real Time Data.  
The following AERONET data are unscreened and may not have final calibration.

The principal investigator(s) of the "POLWET\_Rzeclin" site: Alasdair Mac Arthur  
If you intend to use the following data please contact principal investigator(s) via e-mail: alasdair.macarthur@ed.ac.uk

Return to the World Map | Switch to Version 2 Inversions | Switch to Version 3 Direct Sun

**Data Display** (select each day below):  
MPLNET Images - Availability - More Information  
Show TERRA-MODIS | AQUA-MODIS Rapid Response Images - Availability - More Information  
LandSat Image  
Visible Satellite Images (Check Availability) - More Information  
Infrared Satellite Images (Check Availability) - More Information

**AERONET Data Type:**  
AOD  
Water Vapor  
440-670 Angstrom  
SDA Fine/Coarse AOD  
SDA Fine Mode Fraction

**AOD Level (2016):**  Level 1.0  Level 1.5

**Data Format:**  All points  Daily averages  
**Triplet Error Bars (All Points Only):**  Off  On

**SELECT CHARTS FOR LARGER IMAGES**

MAY
JUN
JUL
AUG
SEP
OCT
NOV

**Choose day of NOV 2016**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
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**AOD Level 1.0 data from NOV of 2016**  
POLWET\_Rzeclin, N 52°45'43", E 16°18'35", Alt 54 m, PI : Alasdair\_Mac\_Arthur, alasdair\_macarthur@ed.ac.uk  
Level 1.0 AOT; Data from NOV 2016

**AOD Level 1.0 data from NOV 27 of 2016**  
POLWET\_Rzeclin, N 52°45'43", E 16°18'35", Alt 54 m, PI : Alasdair\_Mac\_Arthur, alasdair\_macarthur@ed.ac.uk  
Level 1.0 AOT; Data from 27 NOV 2016

**AERONET DOWNLOAD**

- AOD Level 1.0
- AOD Level 1.5
- Raw Almicantars
- Raw Principal Planes
- More AERONET Downloadable Products...

Return to the World Map

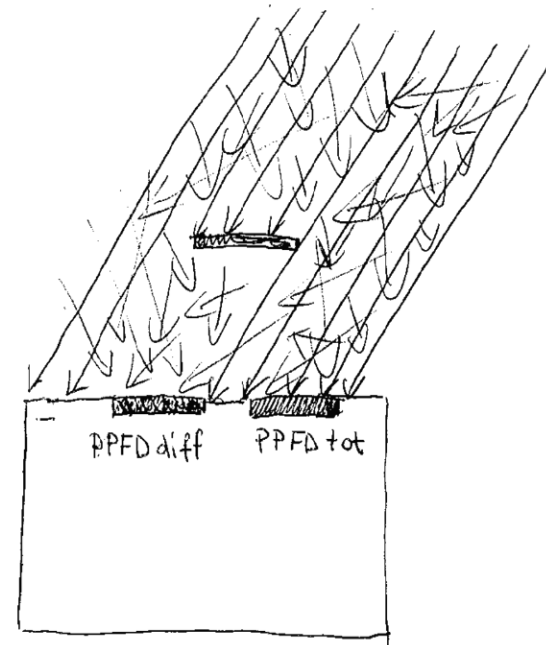
# WSPÓŁCZYNNIK ROZPOROSZANIA (DI)



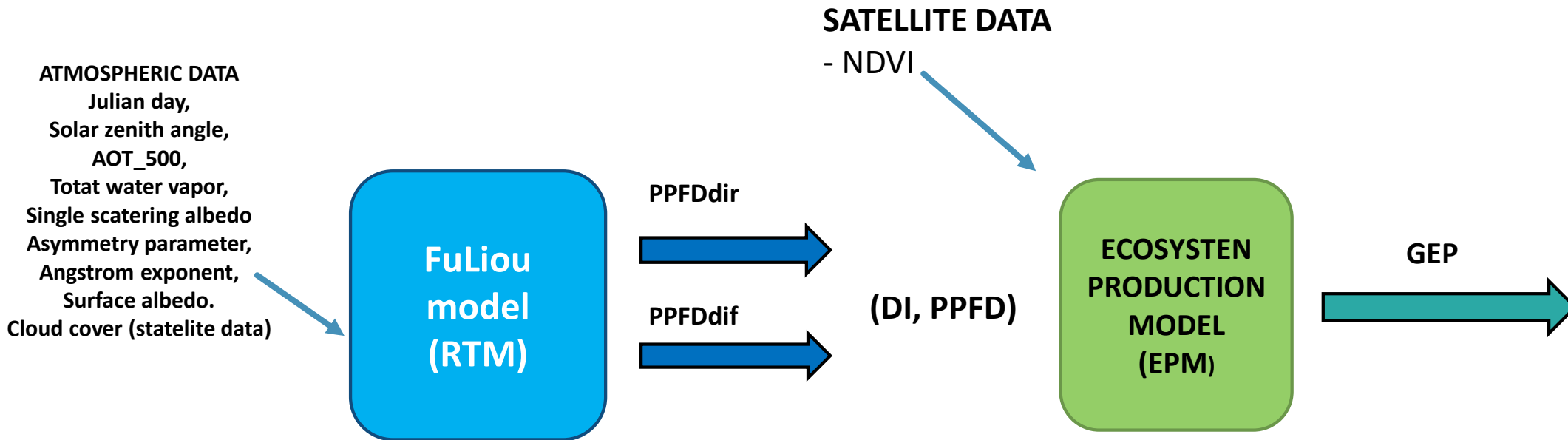
$$DI = I_{diff} / I_{tot}$$

$I_{diff}$  – gęstość strumienia  
PAR rozproszonego

$I_{tot}$  – gęstość strumienia PAR  
całkowitego



# KONCEPCJA MODELU



Fu, Q., and K.-N. Liou, 1992: On the correlated k-distribution method for radiative transfer in nonhomogenous atmospheres. *J. Atmos. Sci.*, 49, 2139–2156.

# ZBIÓR DANYCH

**Zakres czasowy analizowanych danych: 01.05.2018-30.09.2018**

## Dane ekosystemowe

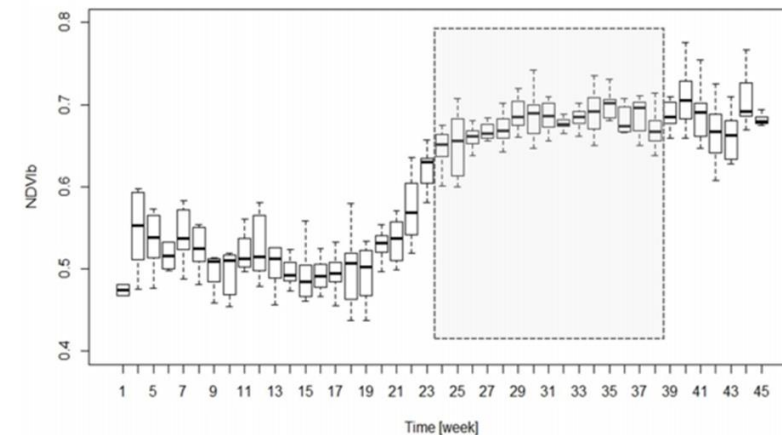
1. GEP-Gross Ecosystem Production (GEP)

## Dane Meteorologiczne

1. TA – temperatura powietrza
2. VPD – niedosyt wilgotności
3. DI - współczynnik rozpraszania

## Dane satelitarne

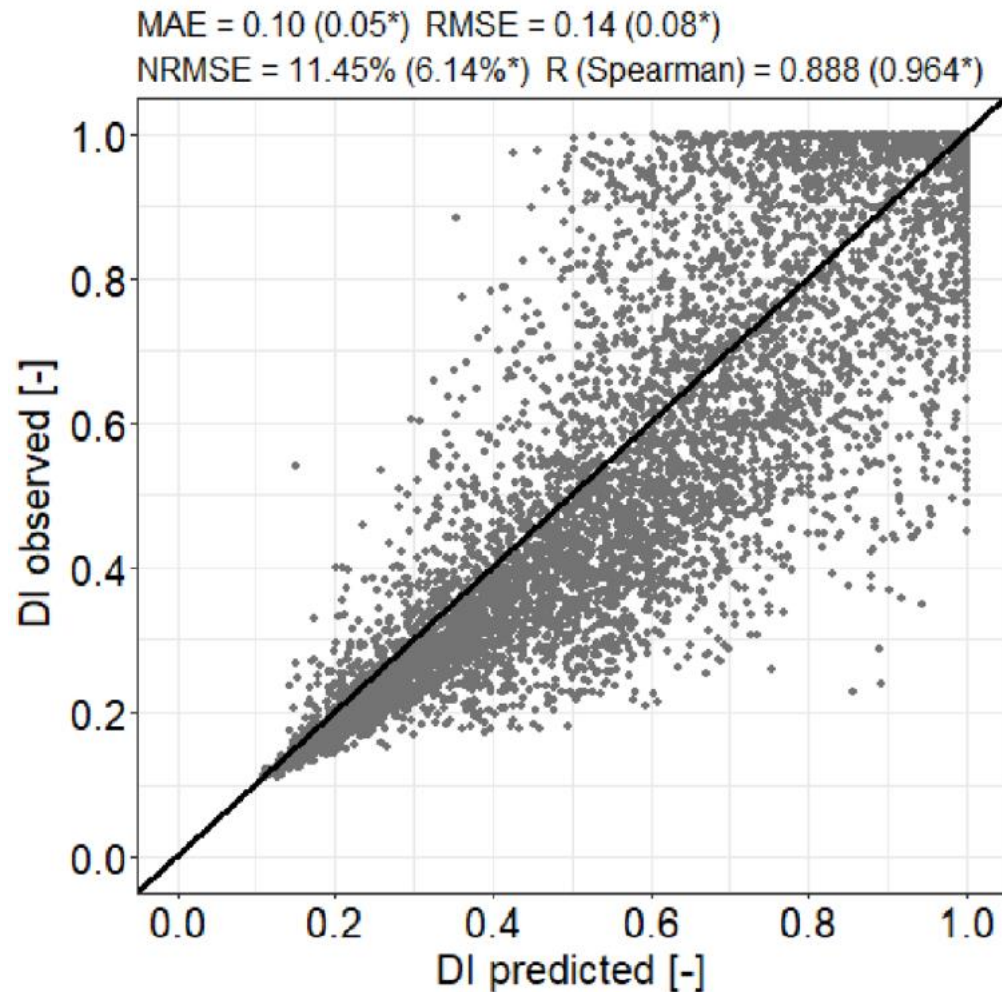
1. NDVI – standaryzowany współczynnik roślinności
2. CC – współczynnik pokrycia chmurami



**Figure 3.** The seasonal run of weekly populations of broad-band normalized difference vegetation index (NDVIb) collected at Rzecin peatland in 2016. The grey rectangle indicates the extracted period (weeks 24–38). Error bars indicate minimum and maximum values, the top of the boxes shows 25th percentile and the bottom 75th percentile, and horizontal line is median value.



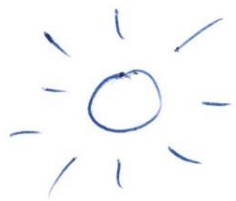
# MODEL TRANSFERU RADIACYJNEGO (RTM)



**Figure 1.** Symulowanie (predicted) and zmierzone (observed) wartości współczynnika rozpraszania (DI)

# DIFFUSE RADIATION REGIMES

'SUNNY'



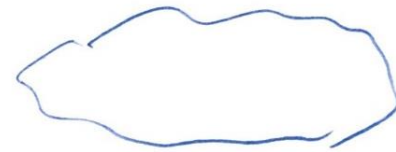
$DI = 0.0 - 0.3$

'INTERMEDIATE'



$DI = 0.3 - 0.8$

'CLOUDY'



$DI = 0.8 - 1.0$

JULY

DI = 0.0 - 0.3

$$GEP = (V_{max} \cdot PPFD) / (K_m + PPFD)$$

Estimate Std. Error t value Pr(>|t|)

Vmax -8.659 0.776 -11.159 <2e-16 \*\*\*

Km 321.672 132.068 2.436 0.0158 \*

DI = 0.3 - 0.8

Estimate Std. Error t value Pr(>|t|)

Vmax -12.6667 0.9308 -13.608 < 2e-16 \*\*\*

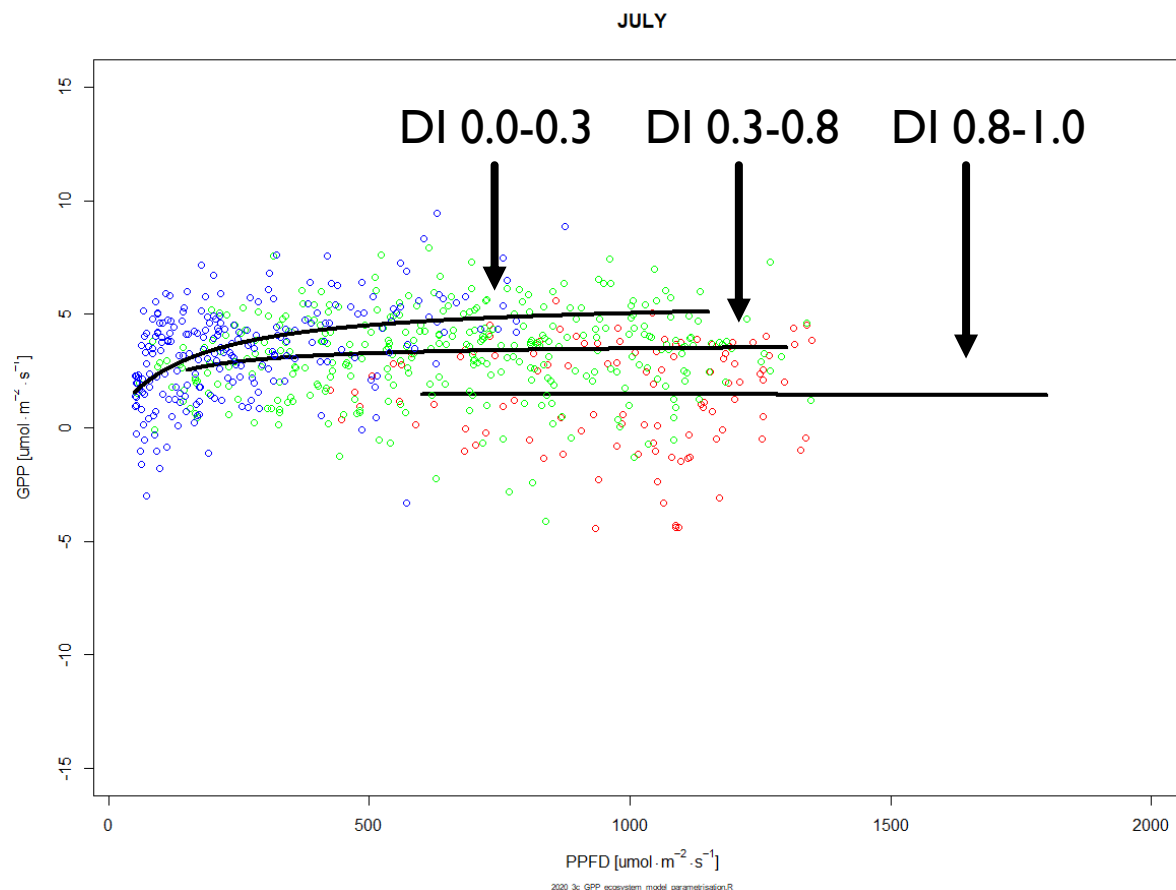
Km 526.9796 99.1510 5.315 1.67e-07 \*\*\*

DI = 0.8 - 1.0

Estimate Std. Error t value Pr(>|t|)

Vmax -15.691 1.327 -11.825 < 2e-16 \*\*\*

Km 389.641 67.075 5.809 1.93e-08 \*\*\*



$$GPP = (V_{MAX} \cdot PPFD) / (K_M + PPFD)$$

$$V_{max} = A \cdot NDVI + B \cdot DI + C$$

$$K_m = A \cdot NDVI + B \cdot DI + C$$

**Table 2.** Parameters values and statistics

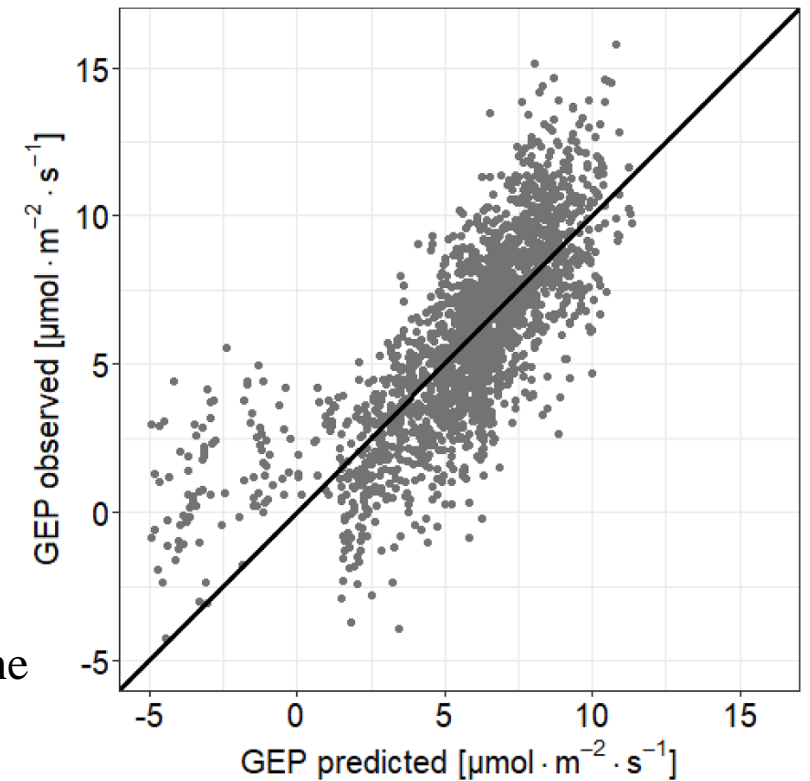
Parameter	A	B	C	R <sup>2</sup>
K <sub>m</sub>	245.7 **	487.5 **	-1868.3 **	0.622
V <sub>max</sub>	-6,643 ***	-10.4 ***	45.4 ***	0.933

# ZAŁOŻENIA SYMULACJI GEP

**Symulacje wartości GEP zostały wykonane dla następujących warunków optycznych atmosfery:**

1. referencyjne
2. AOT +0.05
3. AOT +0.10
4. AOT +0.15
5. AOT +0.20
6. SSA = 0.8
7. SSA = 1.0

**Figure 3.** Symulowanie (predicted) and zmierzone (observed) wartości produkcji ekosystemu brutto (GEP)



**Table 2**

The monthly values of GEP ( $\mu\text{mol CO}_2 \cdot \text{m}^{-2} \cdot \text{s}^{-1}$ ), PPFd ( $\mu\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$ ), DI (dimensionless), NDVI (dimensionless) as estimated for different optical properties of the atmosphere for increasing aerosol optical depth ( $\Delta\text{AOD}$ ), non-absorbing and absorbing aerosol for different single scattering albedo (SSA) during growing season of 1st May – 30th September of 2018 at Rzecin peatland. Note that: \* denotes% of relative changes of estimated values and \*\* denotes% of relative changes calculated for AOD (dimensionless) change in a given range.

		$\Delta\text{AOD}$ observed SSA					SSA observed AOD		NDVI Mean
		real AOD	+0.05	+0.1	+0.15	+0.2	1.0	0.8	
MAY	GEP	5.52	5.73 (3.8%)**	5.92 (7.2%)**	6.08 (10.1%)**	6.22 (12.7%)**	5.59 (1.3%)*	5.28 (-7.9%)*	0.711
	PPFD	1018	1005 (-1.3%)**	992 (-2.6%)**	979 (-3.8%)**	967 (-5.0%)**	1033 (1.5%)*	966 (-3.8%)*	
	DI	0.51	0.55 (7.8%)**	0.58 (13.7%)**	0.61 (19.6%)**	0.64 (25.5%)**	0.52 (2.0%)*	0.49 (-10.9%)*	
JUN	GEP	8.03	8.13 (1.2%)**	8.22 (2.4%)**	8.30 (3.4%)**	8.37 (4.2%)**	8.05 (0.2%)*	7.79 (-4.2%)*	0.774
	PPFD	956	947 (-0.9%)**	937 (-2.0%)**	928 (-2.9%)**	918 (-4.0%)**	961 (0.5%)*	912 (-3.7%)*	
	DI	0.6	0.63 (5.0%)**	0.66 (10.0%)**	0.69 (15.0%)**	0.71 (18.3%)**	0.6 (0.0%)*	0.58 (-7.9%)*	
JUL	GEP	7.18	7.33 (2.1%)**	7.45 (3.8%)**	7.57 (5.4%)**	7.66 (6.7%)**	7.21 (0.4%)*	6.98 (-4.8%)*	0.749
	PPFD	979	968 (-1.1%)**	957 (-2.2%)**	947 (-3.3%)**	937 (-4.4%)**	986 (0.7%)*	938 (-3.1%)*	
	DI	0.54	0.58 (7.4%)**	0.61 (13.0%)**	0.64 (18.5%)**	0.67 (24.1%)**	0.55 (1.9%)*	0.52 (-10.3%)*	
AUG	GEP	6.22	6.39 (2.7%)**	6.54 (5.1%)**	6.66 (7.1%)**	6.77 (8.8%)**	6.26 (0.6%)*	5.94 (-7.0%)*	0.717
	PPFD	929	918 (-1.2%)**	907 (-2.4%)**	896 (-3.6%)**	886 (-4.6%)**	938 (0.9%)*	868 (-5.4%)*	
	DI	0.57	0.61 (7.0%)**	0.64 (12.3%)**	0.67 (17.5%)**	0.7 (22.8%)**	0.58 (1.8%)*	0.55 (-9.8%)*	
SEP	GEP	5.13	5.31 (3.5%)**	5.45 (6.3%)**	5.57 (8.6%)**	5.68 (10.7%)**	5.17 (0.7%)*	4.91 (-7.5%)*	0.649
	PPFD	708	698 (-1.4%)**	689 (-2.7%)**	679 (-4.1%)**	670 (-5.4%)**	714 (0.8%)*	671 (-3.8%)*	
	DI	0.63	0.67 (6.3%)**	0.7 (11.1%)**	0.73 (15.9%)**	0.75 (19.0%)**	0.63 (0.0%)*	0.61 (-9.0%)*	
AVG	GEP	6.42	6.58 (2.5%)**	6.72 (4.7%)**	6.84 (6.5%)**	6.94 (8.2%)**	6.46 (0.6%)*	6.18 (-6.0%)*	0.718
	PPFD	918	907 (-1.2%)**	896 (-2.4%)**	886 (-3.5%)**	876 (-4.6%)**	926 (0.9%)*	871 (-4.0%)*	
	DI	0.57	0.61 (7.0%)**	0.64 (12.3%)**	0.67 (17.5%)**	0.69 (21.8%)**	0.58 (1.1%)*	0.55 (-9.5%)*	

## PODSUMOWANIE

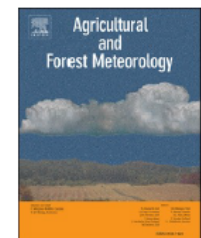
- Wzrost AOD o wartość 0.20 względem warunków referencyjnych spowodował wzrost GEP o 8.2% w sezonie wegetacyjnym
- Wzrost wartości SSA z poziomu referencyjnego 0.96 do 1.0 wywołało pomijalny wzrost GEP (0,6%)
- Redukcja wartości SSA z poziomu referencyjnego do 0.8 spowodowała redukcję GEP torfowiska o 6.0%
- Obserwowany na Polskę spadek AOD będzie w przyszłości skutkował redukcją zdolności absorpcyjnych CO<sub>2</sub> torfowisk



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### Estimation of the effects of aerosol optical properties on peatland production in Rzecin, Poland

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**DZIĘKUJĘ ZA UWAGĘ**

