

# Három dimenziós jelenségek a műholdas felhő megfigyelésekben

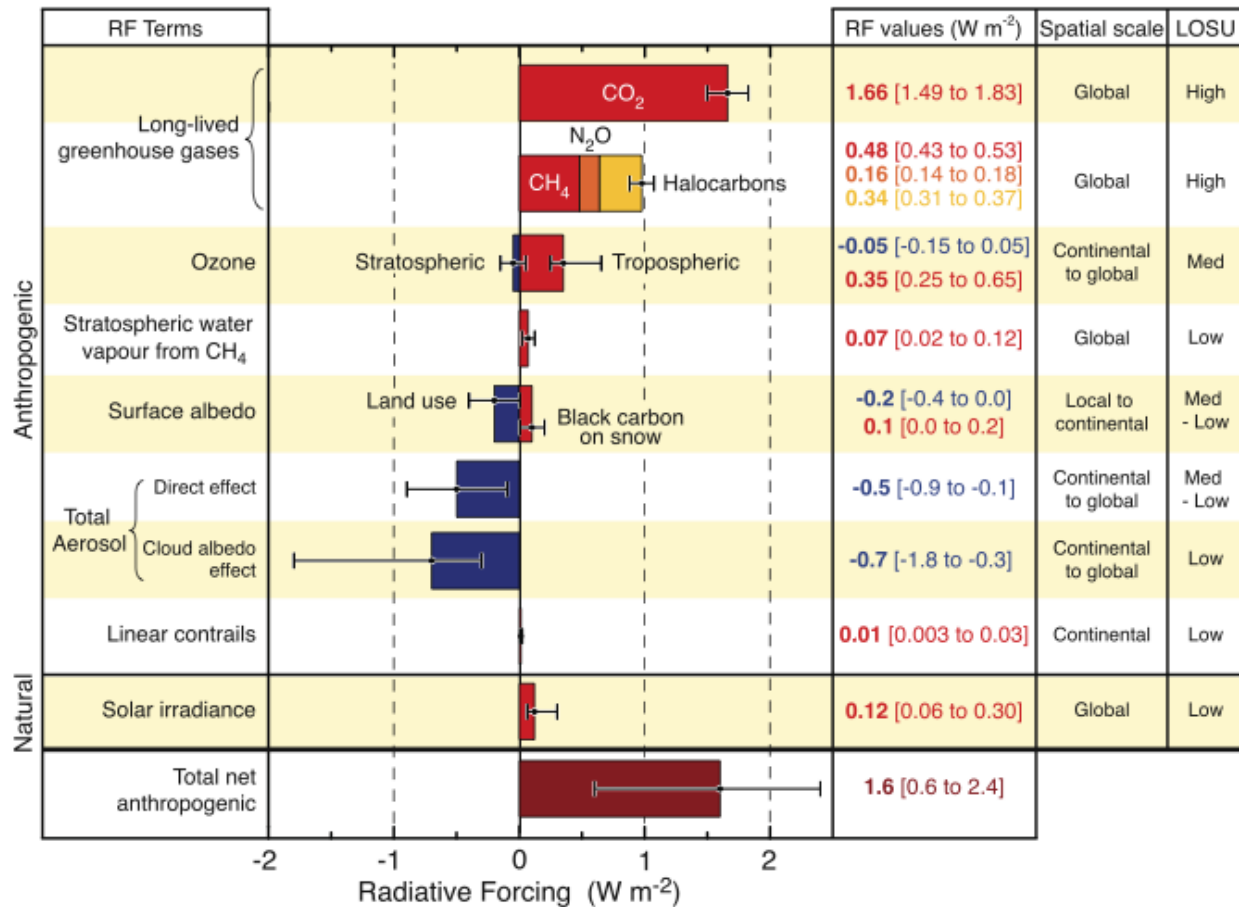
Várnai Tamás

University of Maryland, Baltimore County, JCET  
NASA Goddard Space Flight Center



# A Föld energia-háztartása

RADIATIVE FORCING COMPONENTS



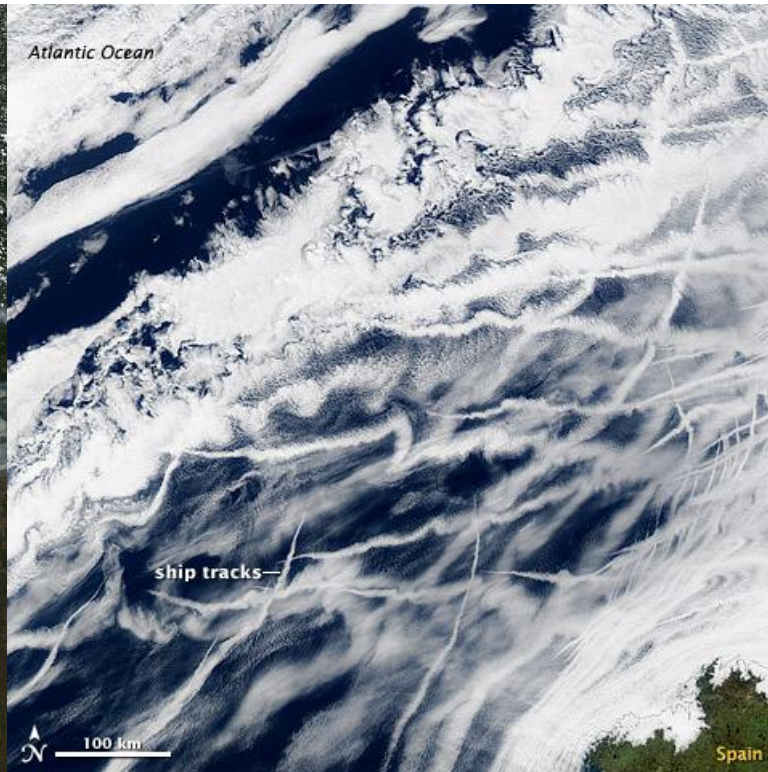
©IPCC 2007: WG1-AR4

# Aeroszol-felhő kapcsolatok

Kialakulás



Fényesség, eső/élettartam



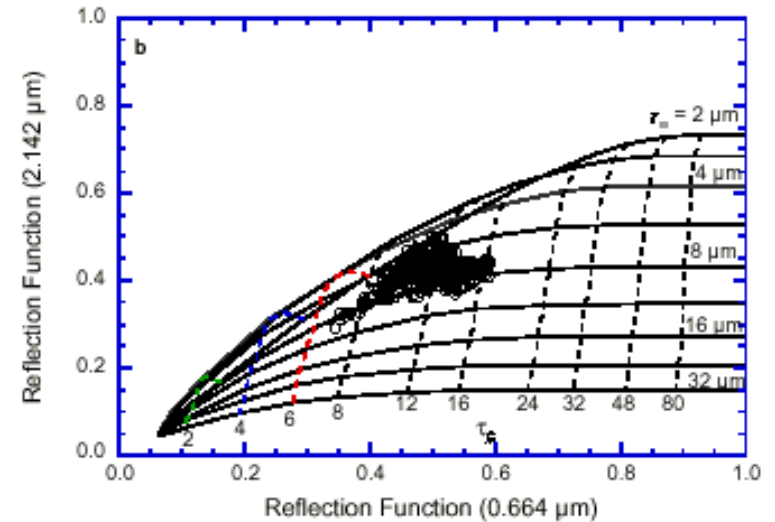
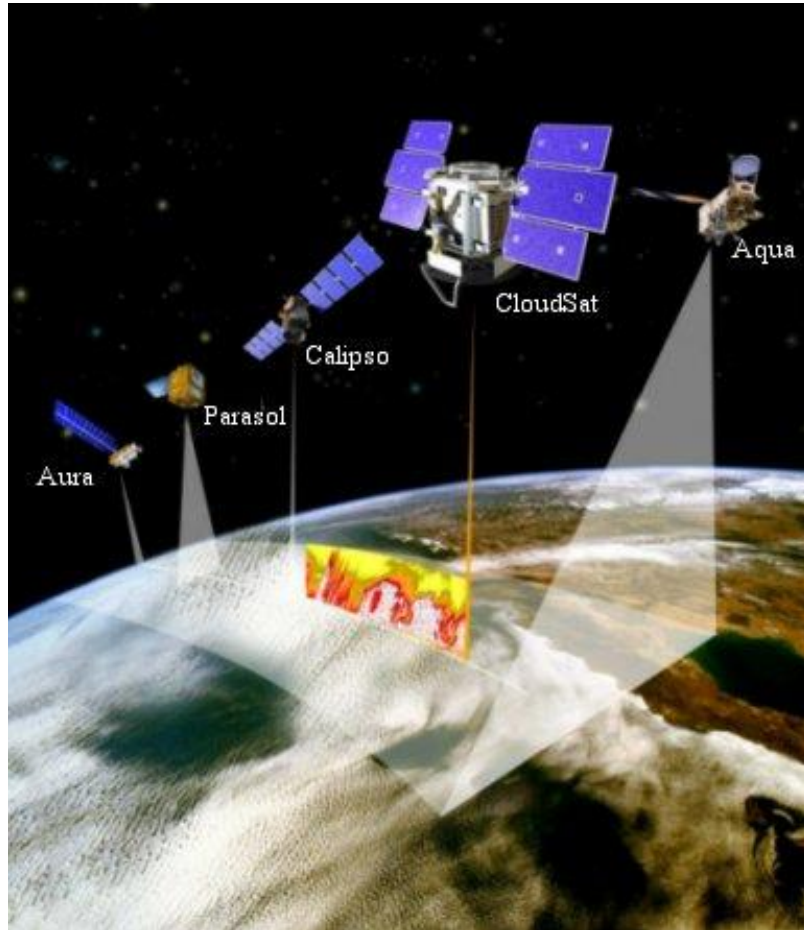
Fagyási magasság/eső

Fagyási szint (tiszta)

Fagyási szint (szennyezett)



# Műholdas felhőmérések : $\tau$ , $r_e$



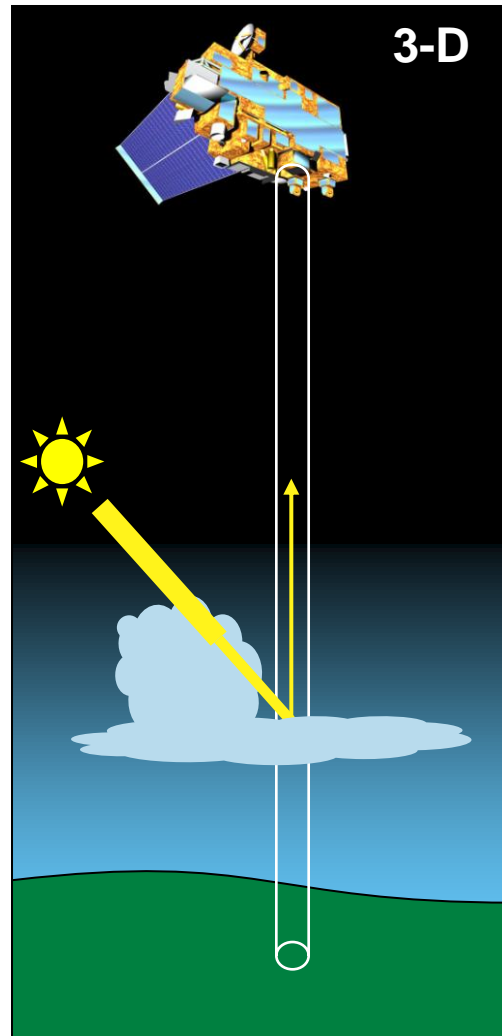
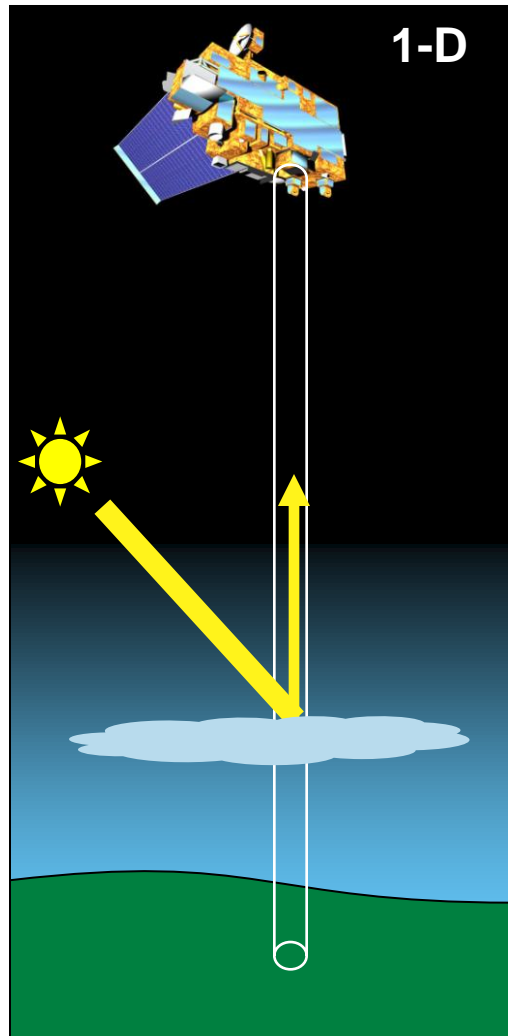
King et al. (1998)

Optikai vastagság ( $\tau$ )  
Csepp méret ( $r_e$ )

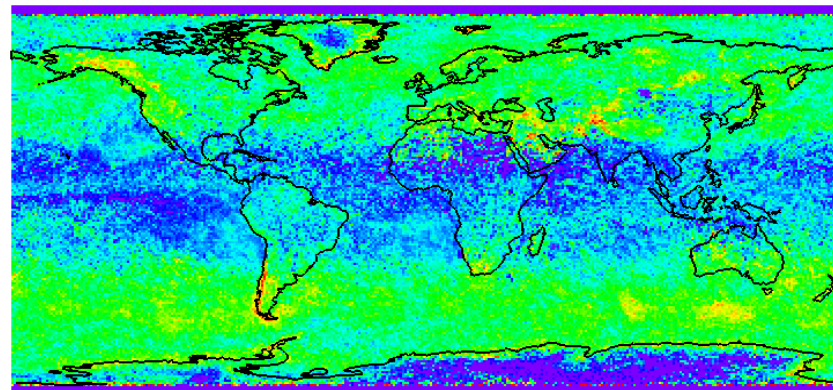
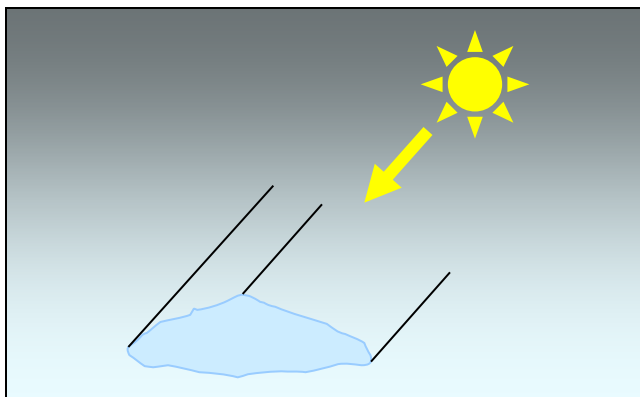


Víztartalom  
Cseppek száma

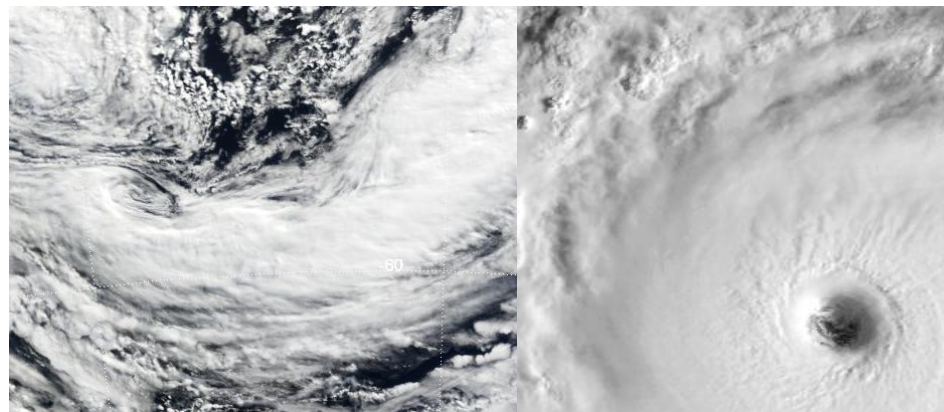
# 1-D és 3-D



# Aszimmetria



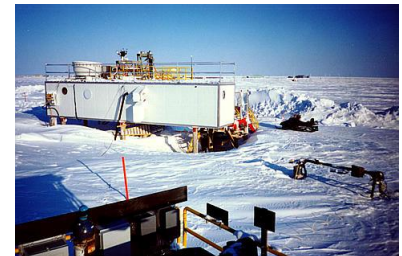
2005 évi átlag,  $\tau$  relatív különbség (%)



# ARM állomások

Három év:

- Oklahoma: 1999-2001
- Alaszka: 2005-2007



# ARM felhő mérések

Cloud radar



Lidar



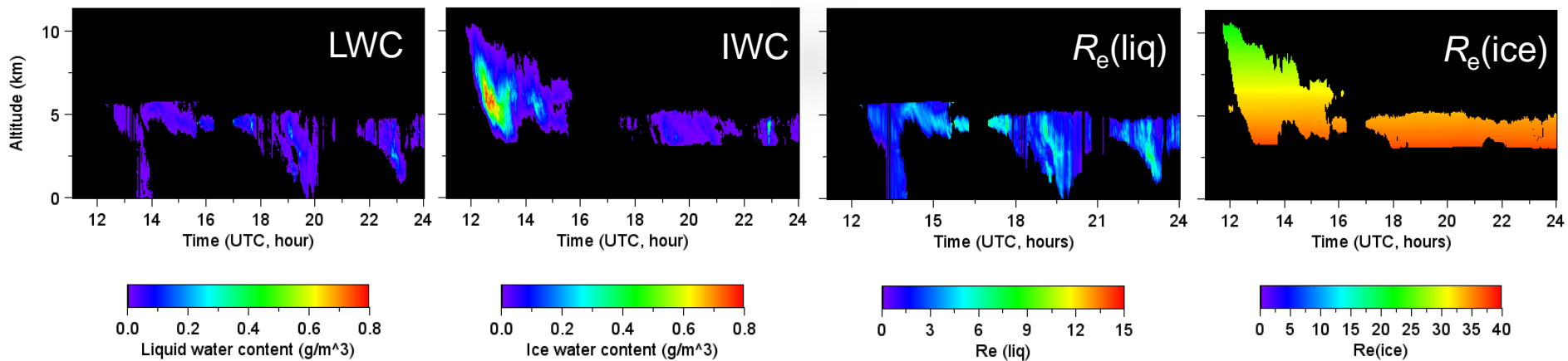
Microwave radiometer



Radiosonde

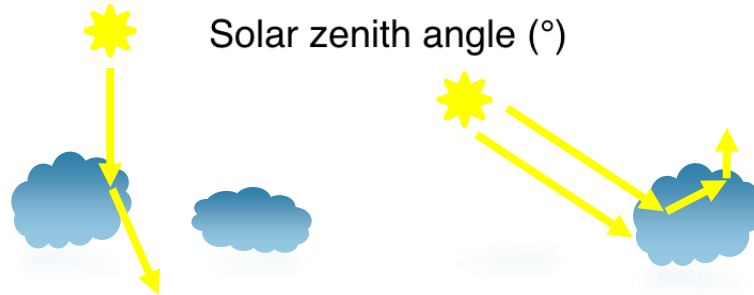
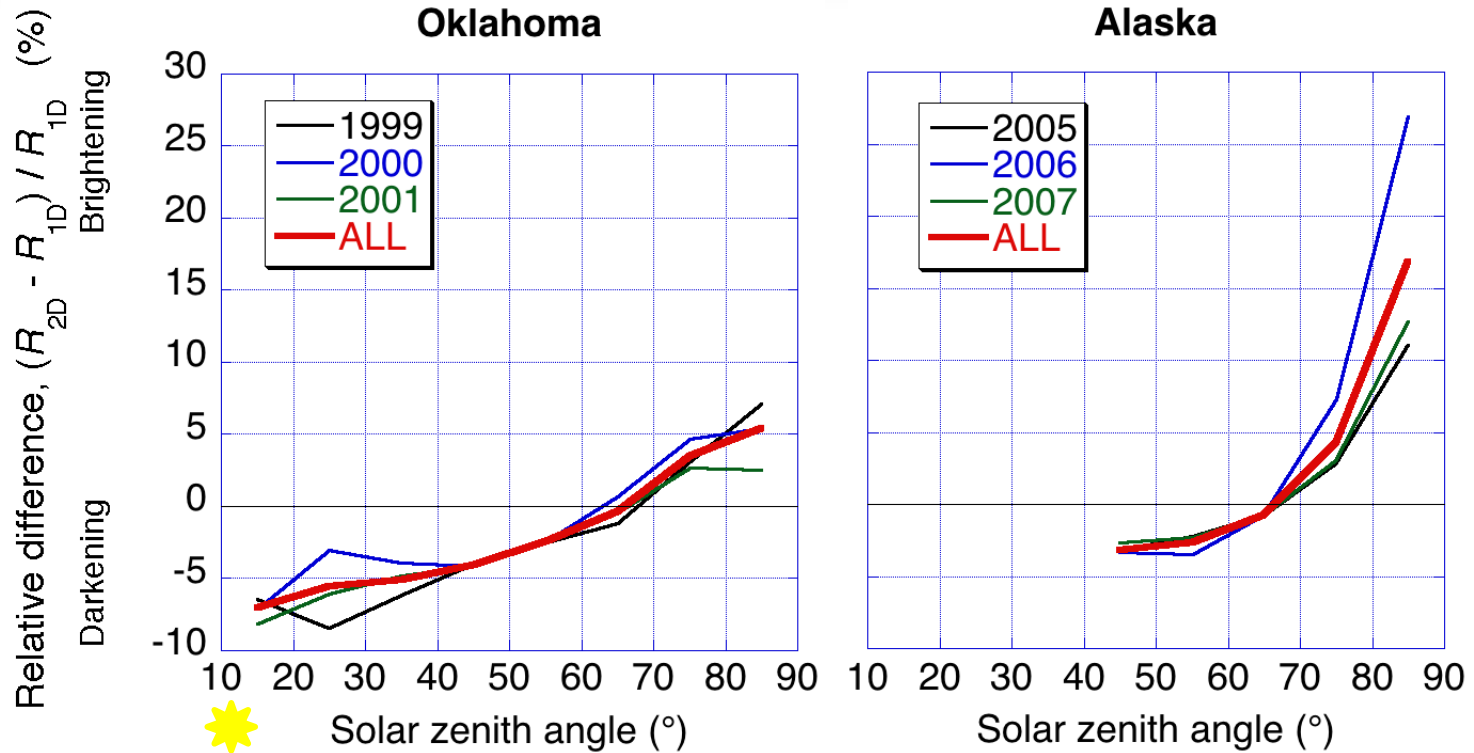


Radar wind profiler





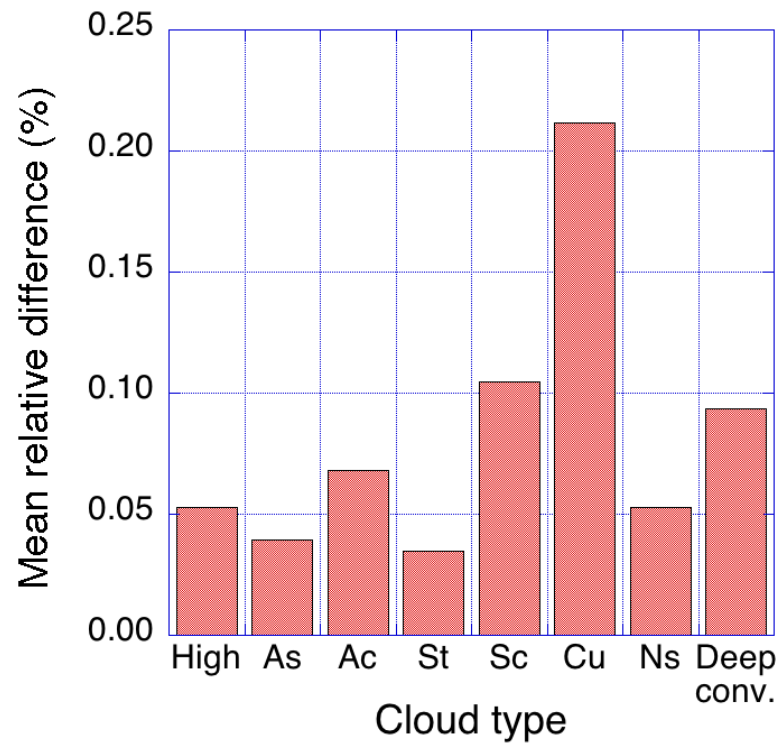
# Átlagos 2-D hatás



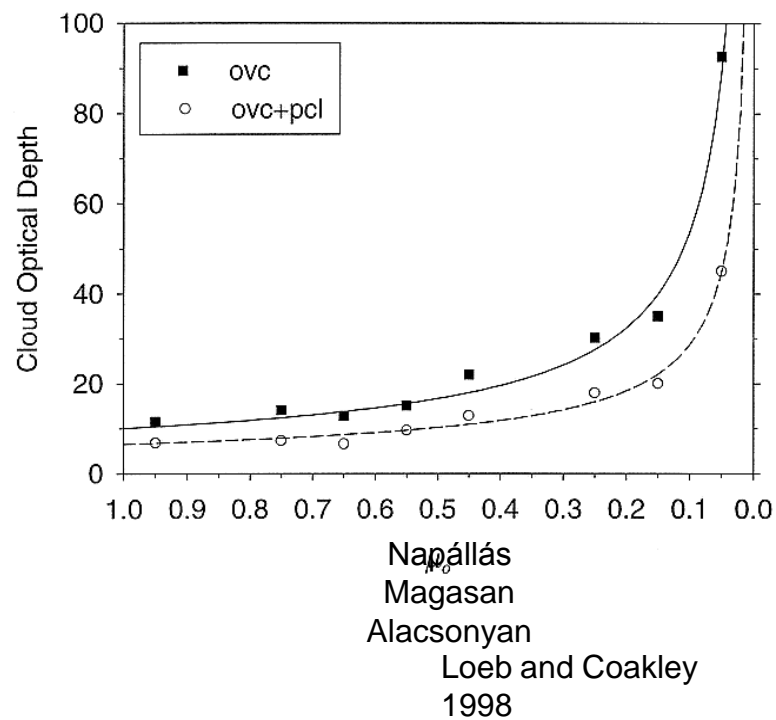
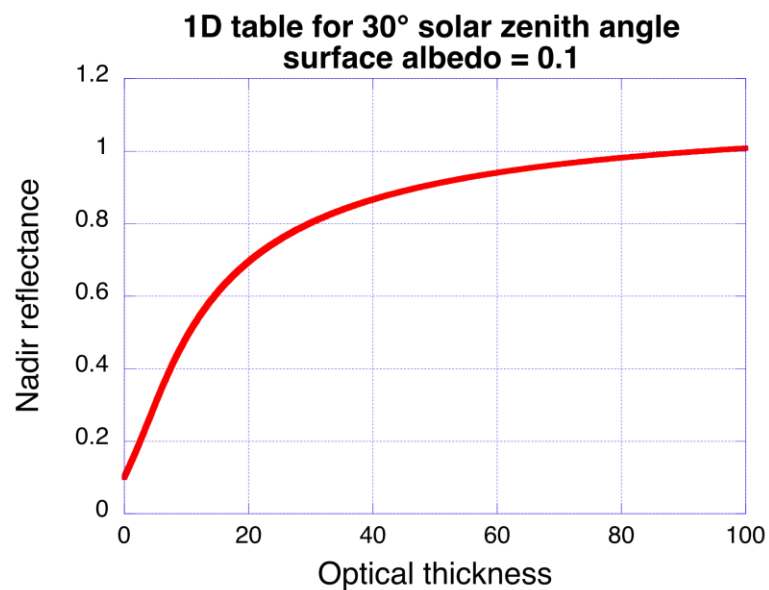
# Felhőtípus

Relative difference of mean values

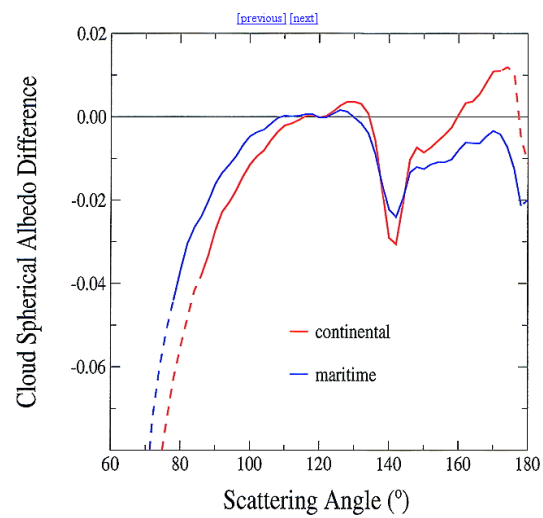
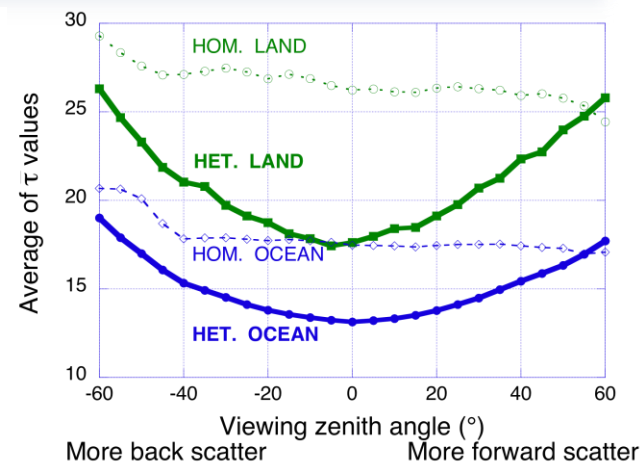
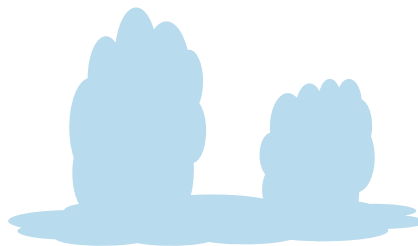
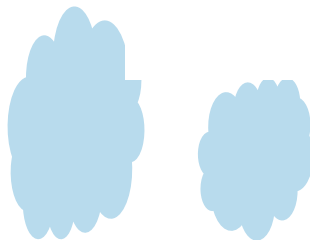
$$|R_{2D} - R_{1D}| / R_{1D}$$



# Nem-linearitás

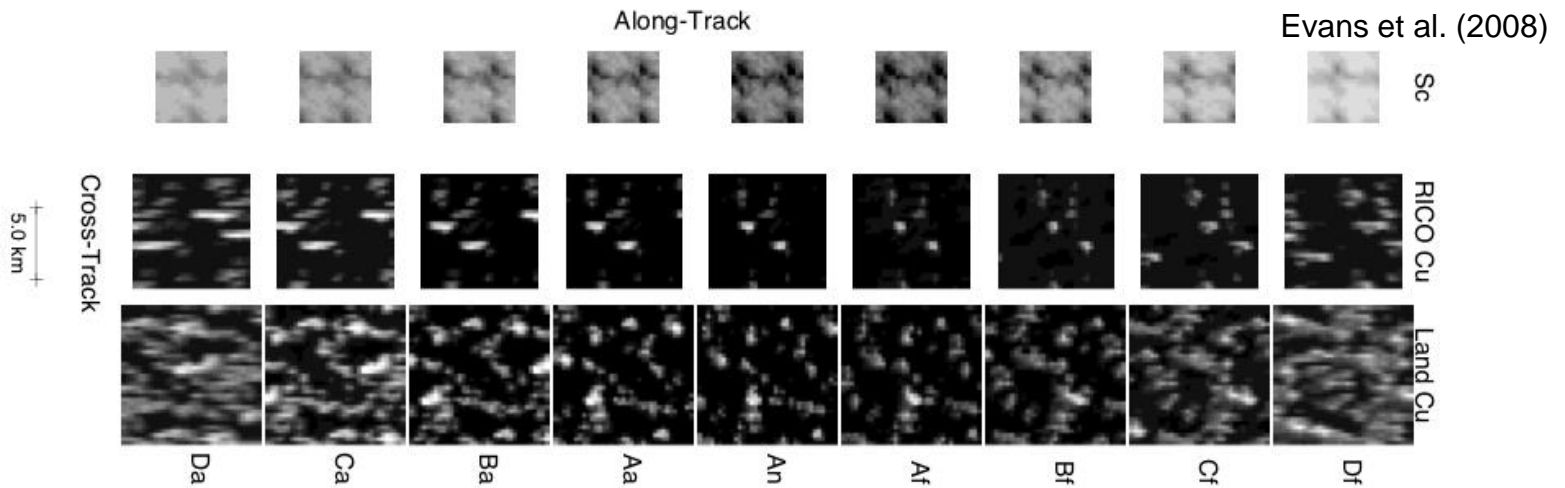
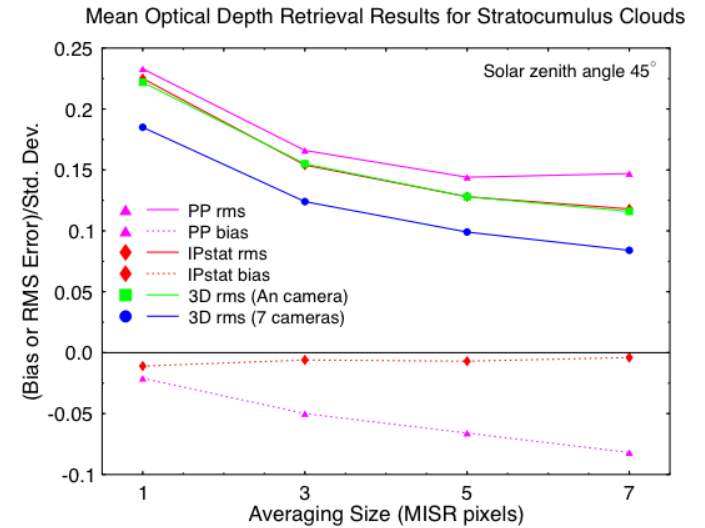
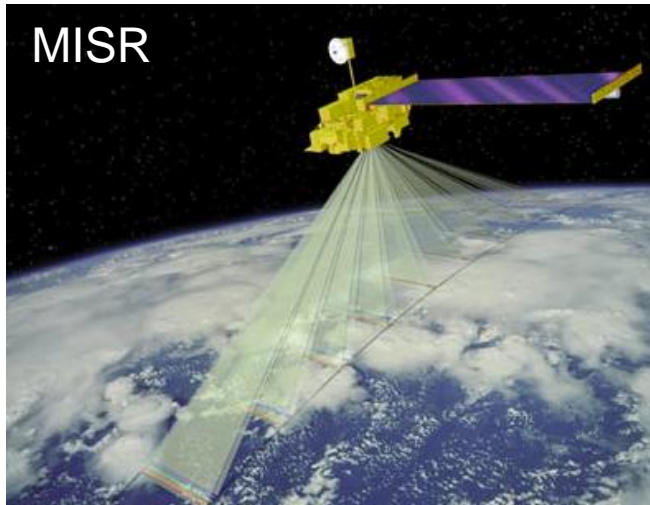


# Látószög



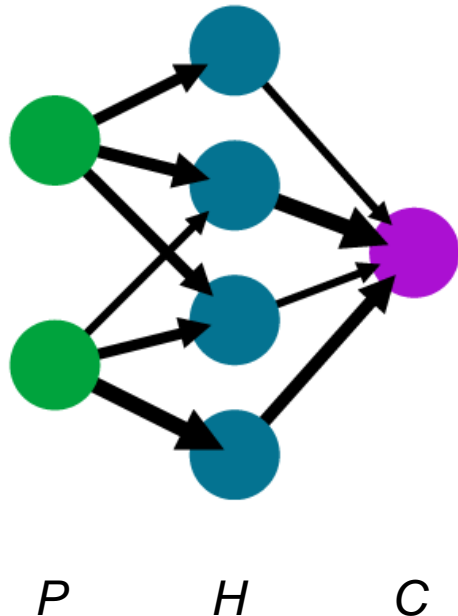
Buriez et al. (2001)

# Lehetőség: több látószög



# Neural nets és textúra

A simple neural network  
input layer   hidden layer   output layer



$$H_j = f \left[ \sum_i W_{ij} P_i \right]$$
$$C_k = f \left[ \sum_j W'_{jk} H_j \right]$$

$$f(z) = (1 + e^{-z})^{-1}$$

$W_{ij}$ ,  $W'_{jk}$  iterációs tanulás révén

P-értékek:

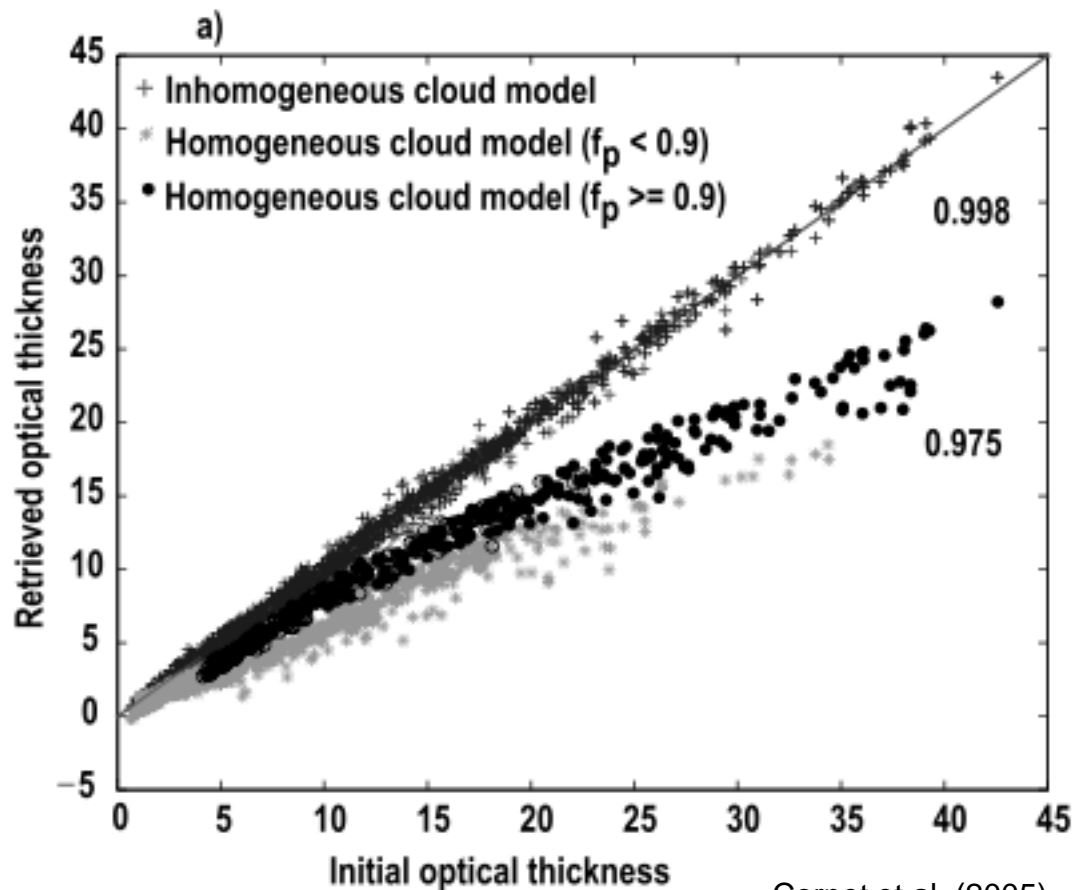
1-D paraméterek: Fényesség több hullámhosszon  
cseppméret, ...

Gradiensek, textúra

C-értékek:

Optikai vastagság,

# Neural net korai eredmények



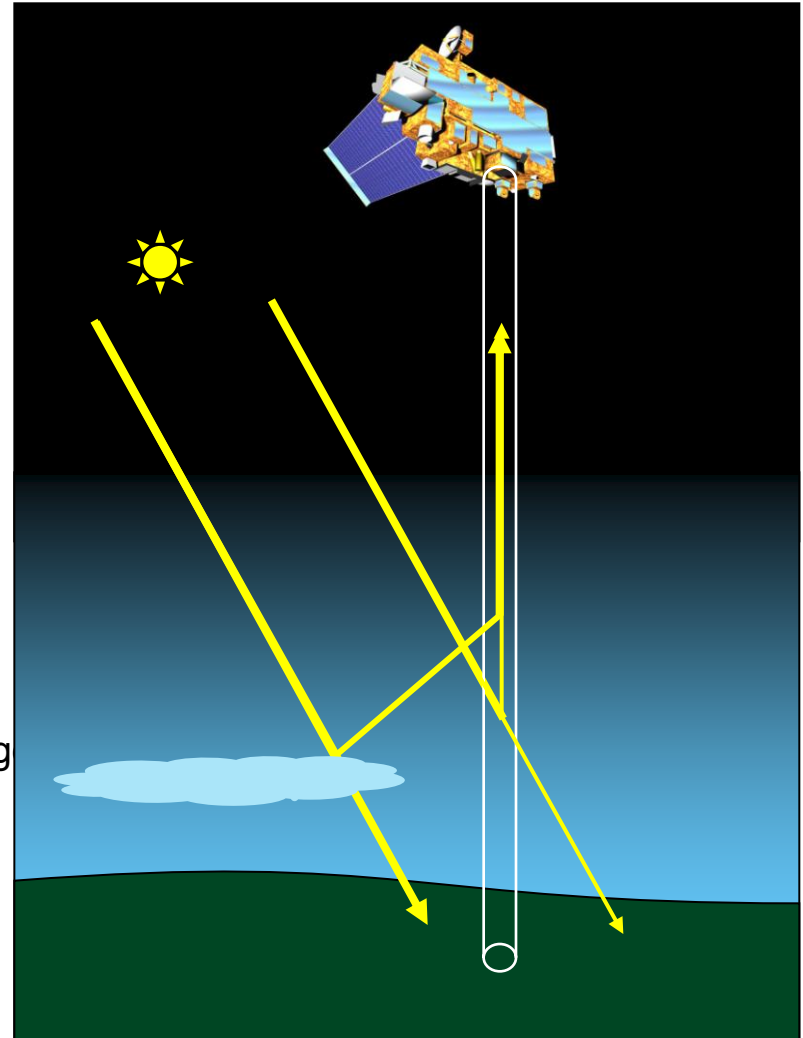
Remény: ARM felhők

# Aeroszolok felhők közelében



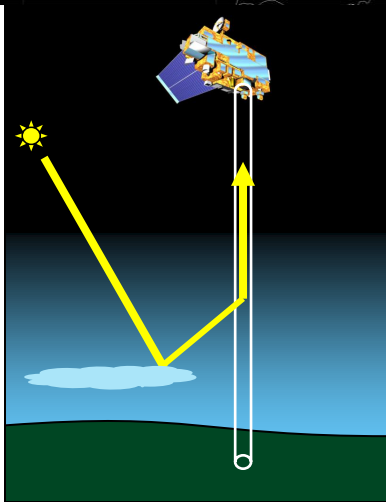
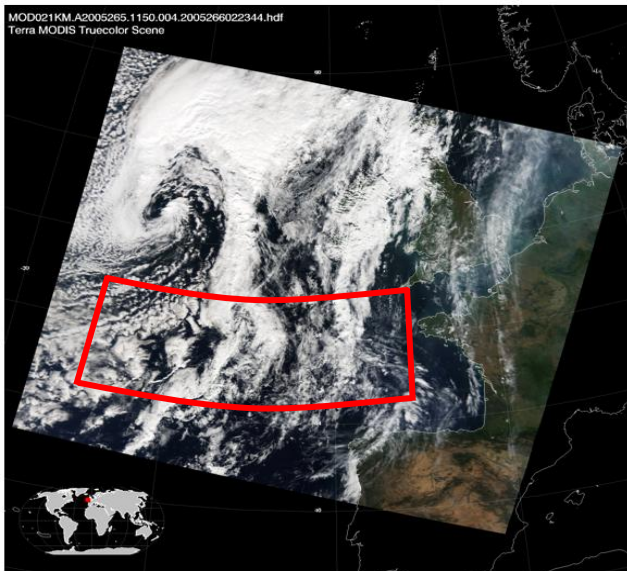
## Probléma:

- Több / vastagabb felhő: 3-D jobban növeli a fényesség
- Még inkább túlbecsüljük az aeroszol-tartalmat
- Úgy tűnhet: magas aeroszol tartalom segíti a felhők képződését és fejlődését

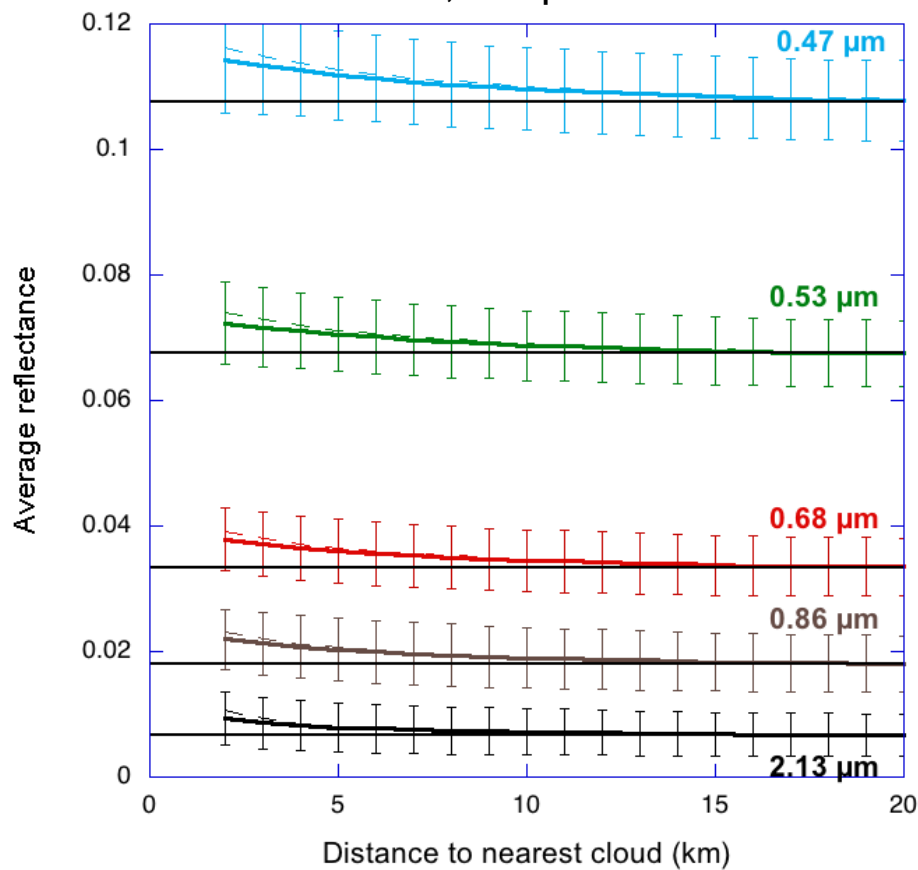




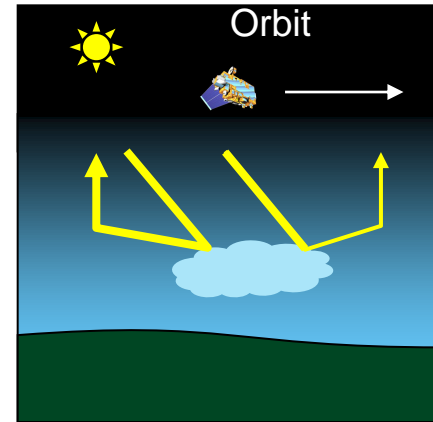
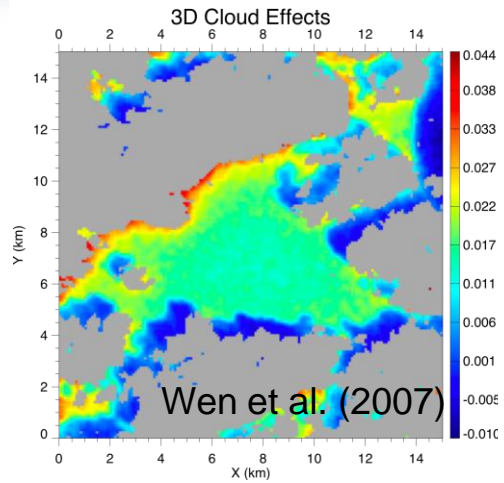
# MODIS eredmények



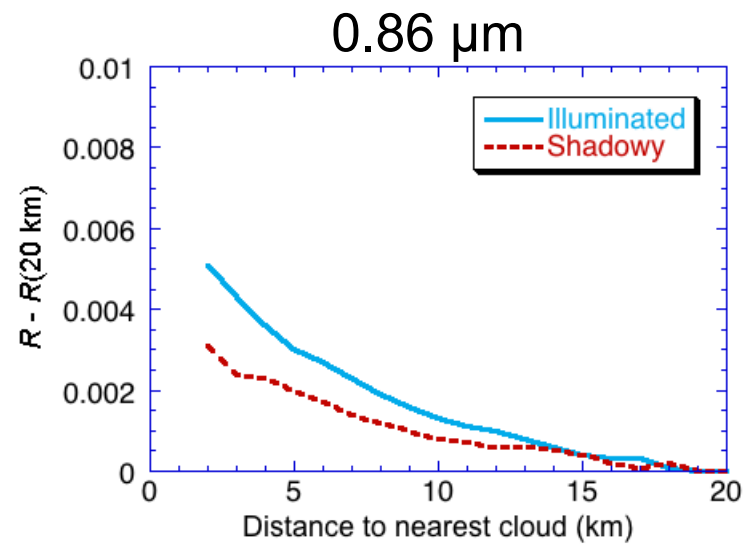
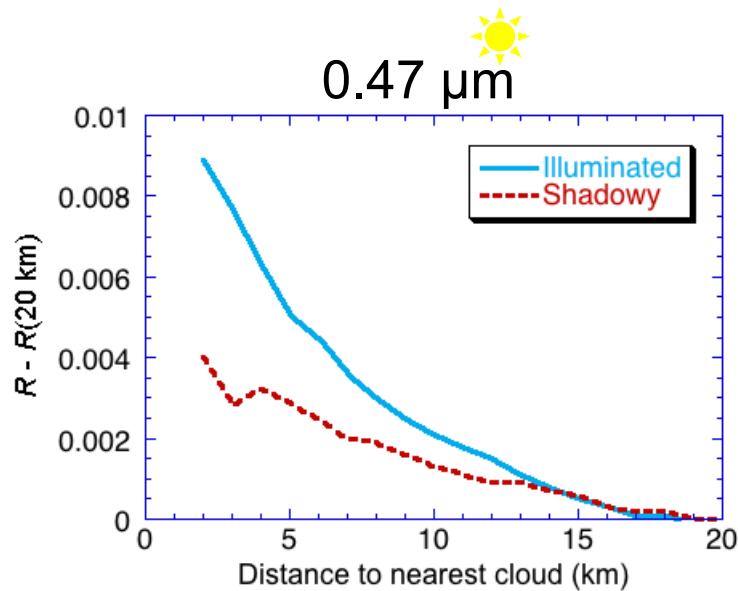
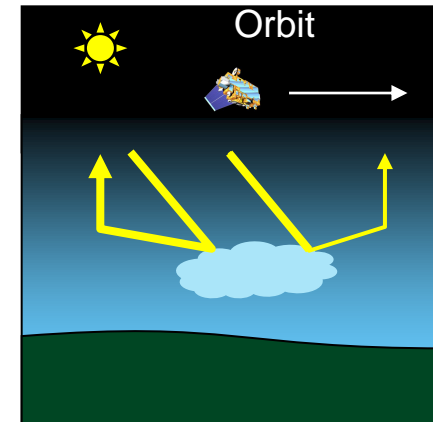
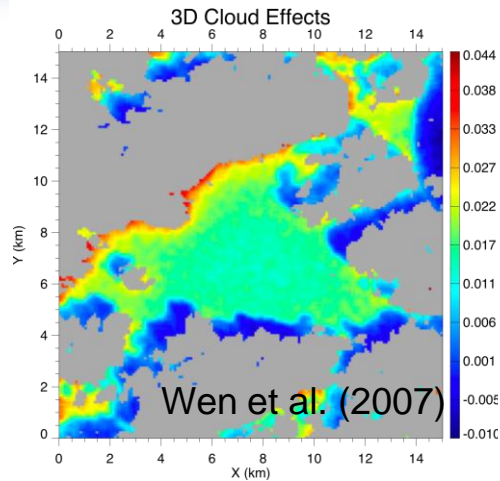
MODIS Terra fényesség  
2000-2007, Szeptember 14-29



# Aszimmetria

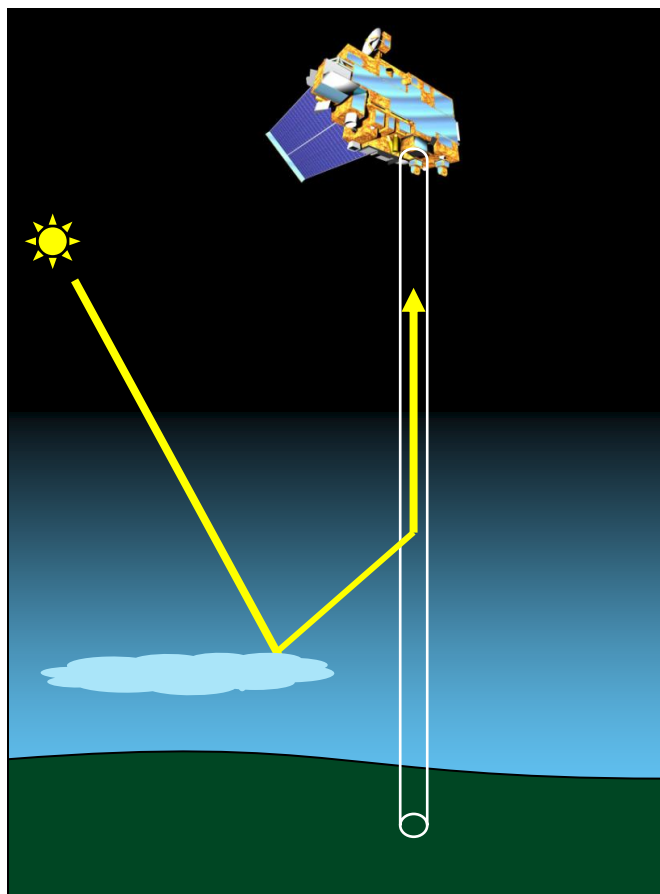


# Aszimetria

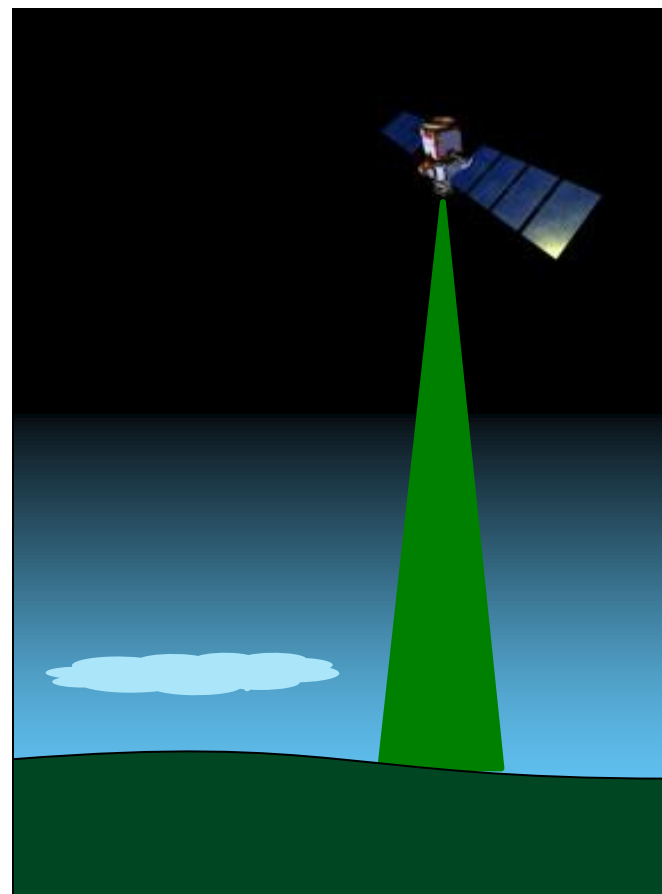


# 3-D: MODIS vs. CALIPSO

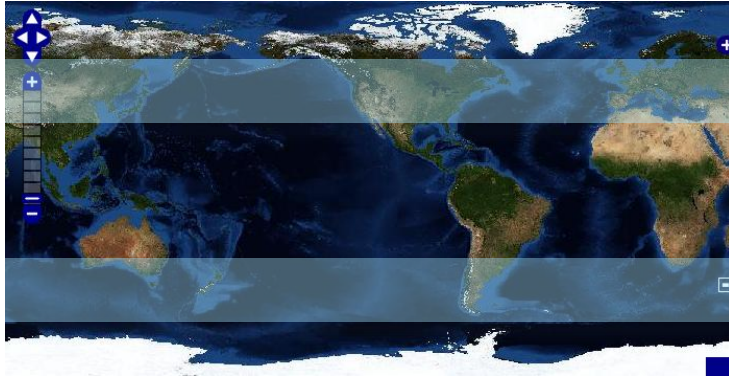
MODIS: 3-D jelenségek



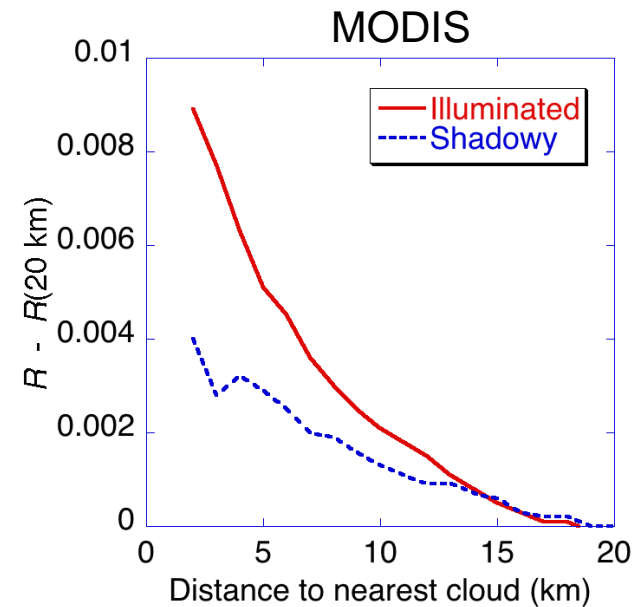
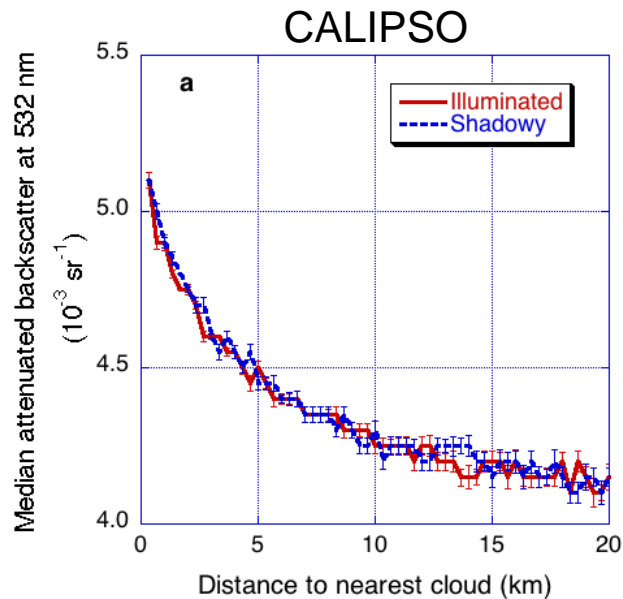
CALIPSO: nincs 3-D jelenség



# CALIPSO eredmények



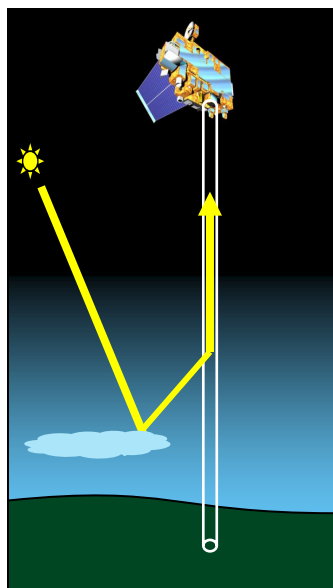
2008 Szept. 15-Okt. 14  
30° -60° , óceánok



# Lehetőségek

## Óvatosság, szelektív adat-használat

Textúra



Egyszerű analitikus modellek

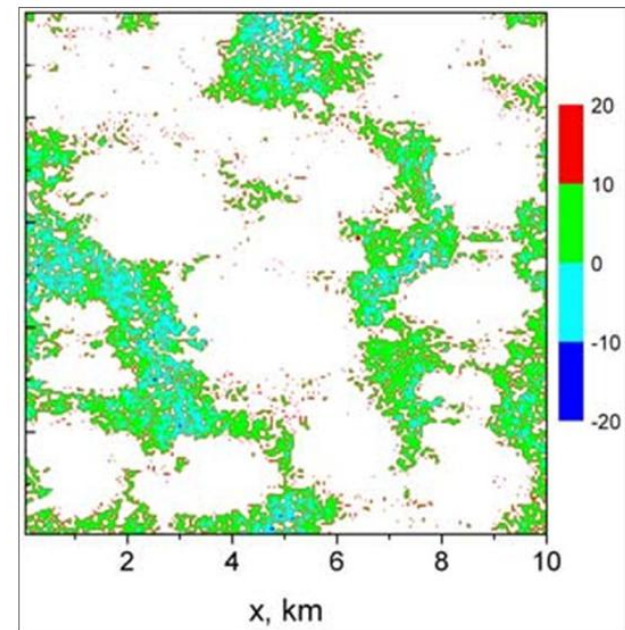


Marshak et al. (2008)

3-D módszerek

$R_1$ ,  $R_2$ ,  $R_3$ , helyett

$R_1/R_2$ ,  $R_2/R_3$ ,



Kassianov and Ovtchinnikov (2008)

# Összefoglalás

Három dimenziós jelenségek bonyodalmakat okoznak a visszavert napsugárzás értelmezésén alapuló műholdas felhő- és aeroszol-mérésekben (pl. részecskék száma és mérete).

Óvatosságra van szükség, hogy e bonyodalmak ne torzítsák a felhők és az antropogén aeroszolak éghajlati hatásáról alkotott képünket.

Többféle módszer is ígéretesnek tűnik a problémák kezelésére, de még egyik sem alkalmas a feladatra.



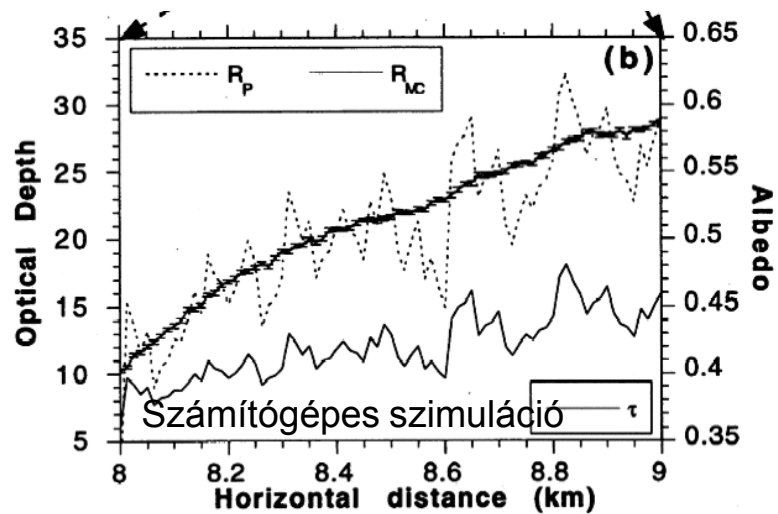
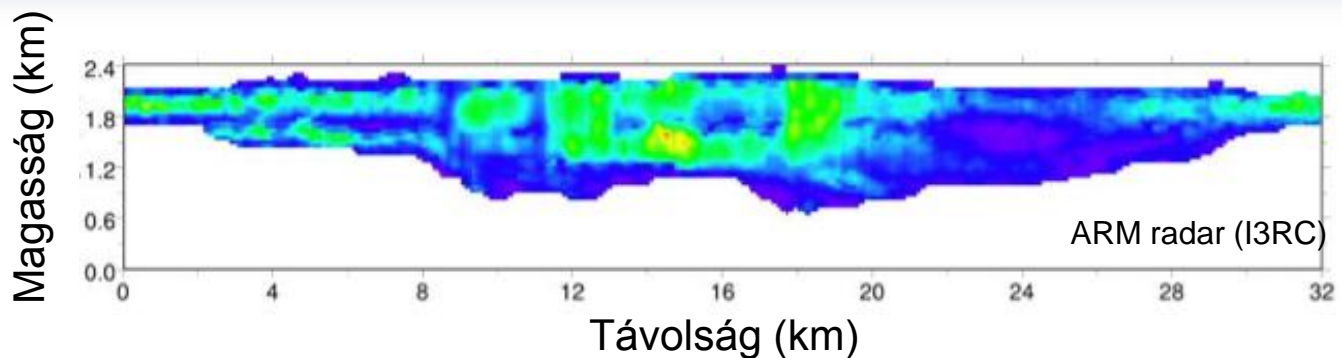
# Tartalom

- Bevezetés: Felhők, aeroszolok, és műholdak
- 3-D jelenségek felhő mérésekben
- 3-D jelenségek aeroszol mérésekben
- Összefoglalás



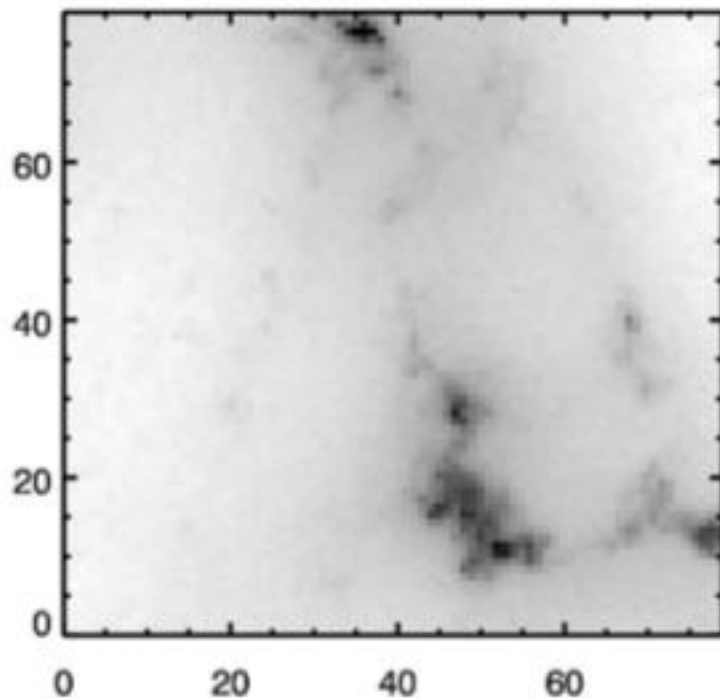


# Nagyfelbontású képek: diffúzió

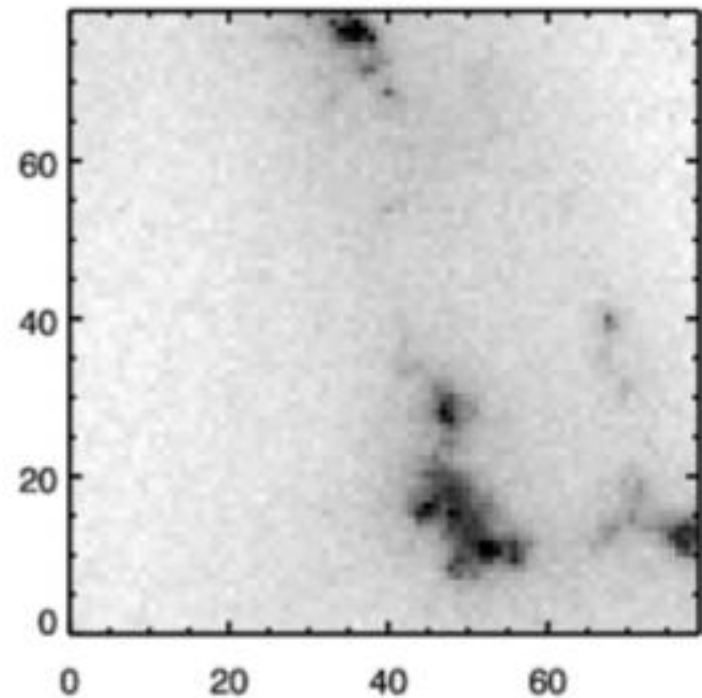


# Lehetséges megoldás: plusz zaj

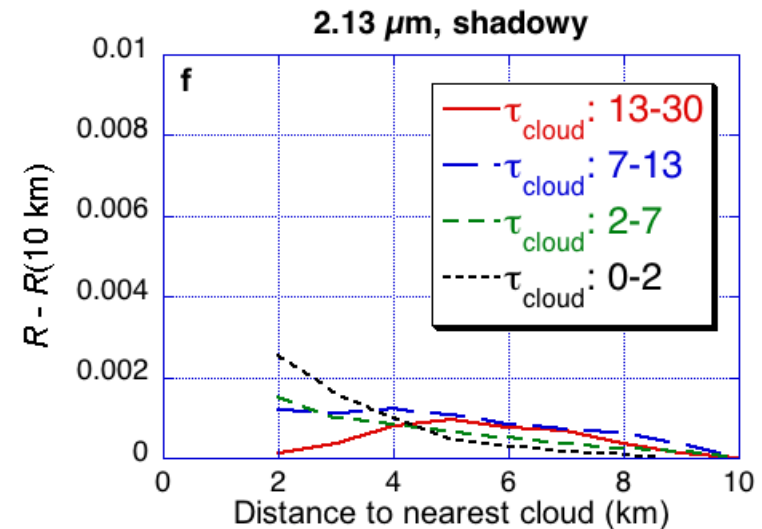
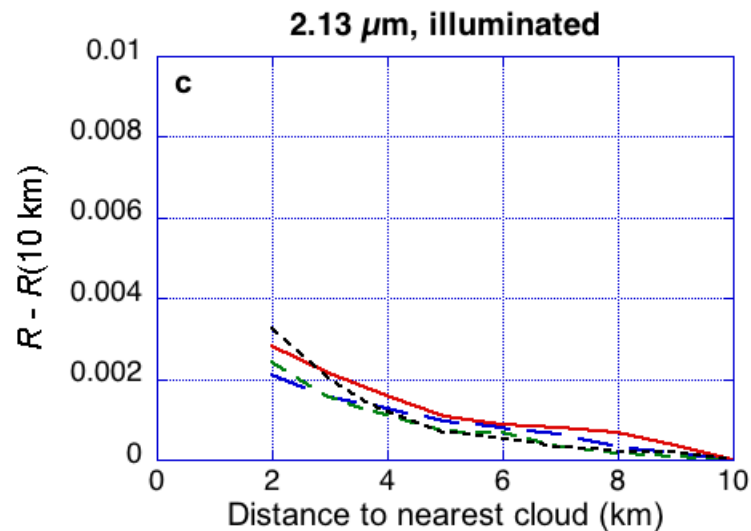
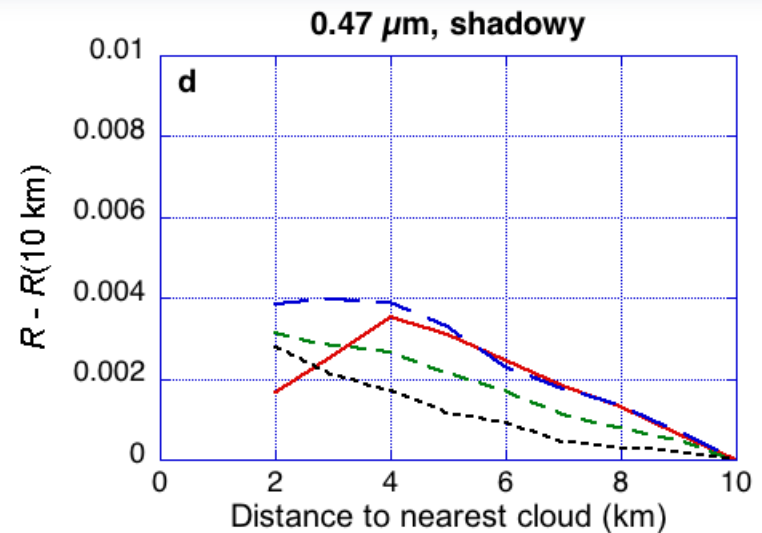
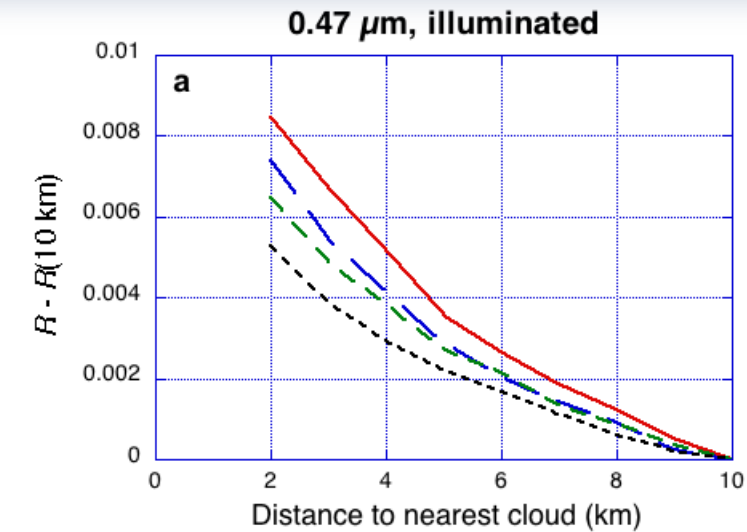
observation



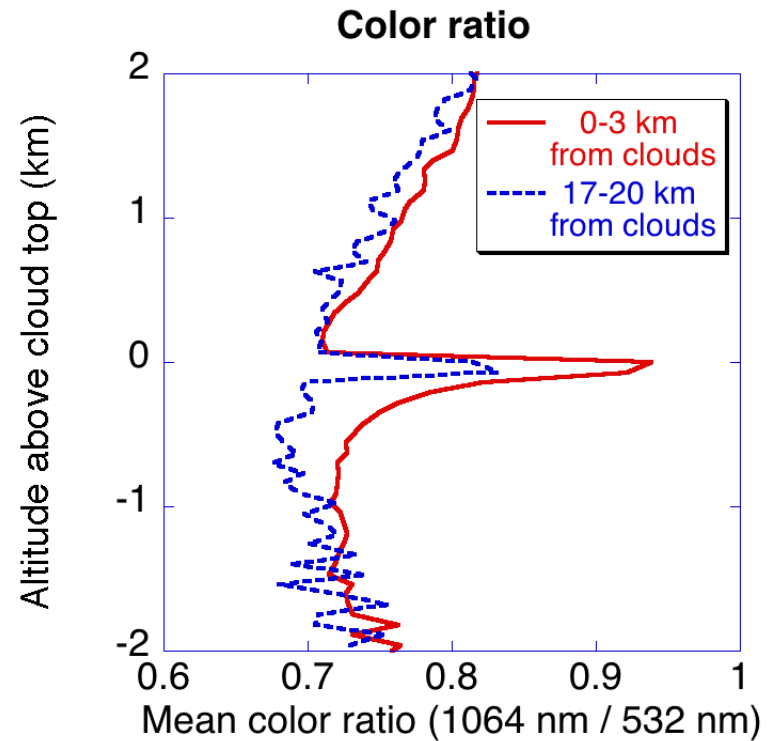
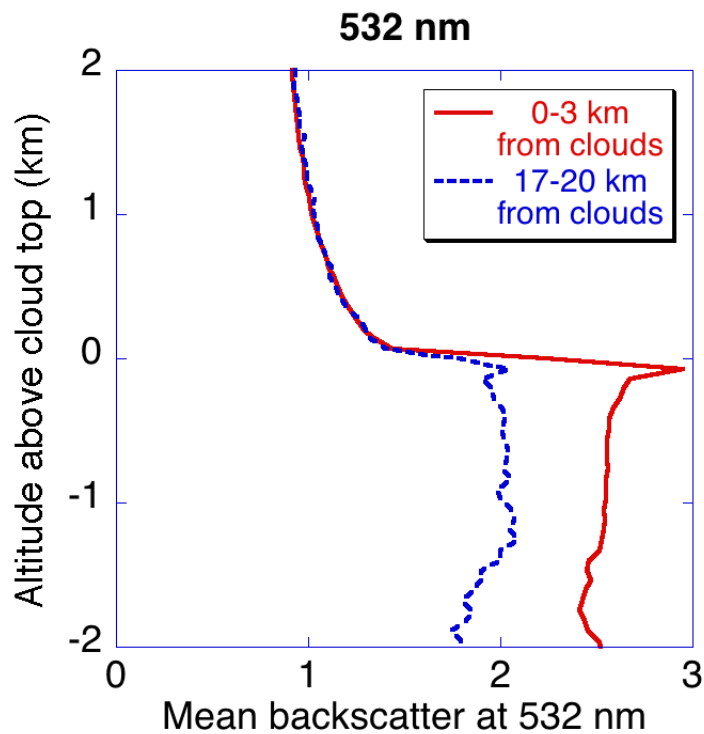
step 6



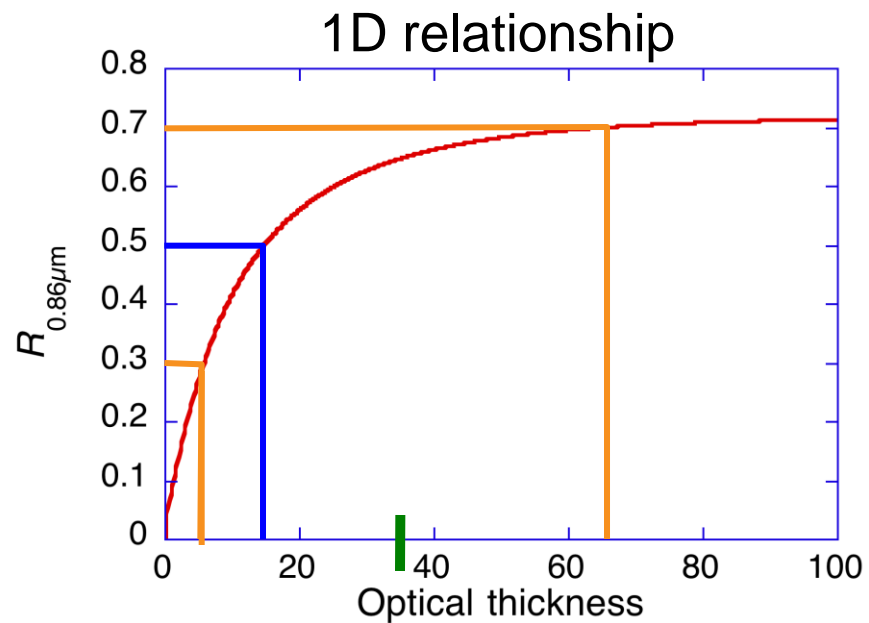
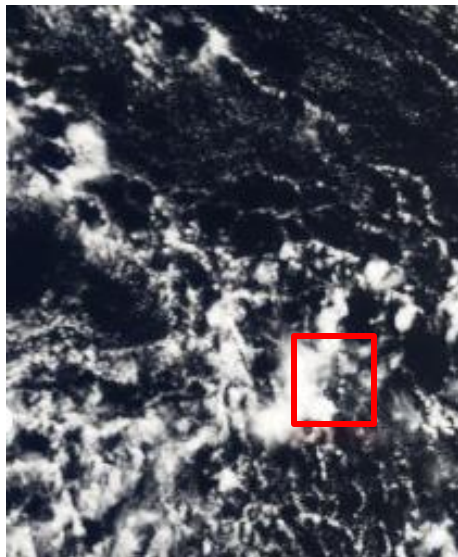
# Felhők optikai vastagsága



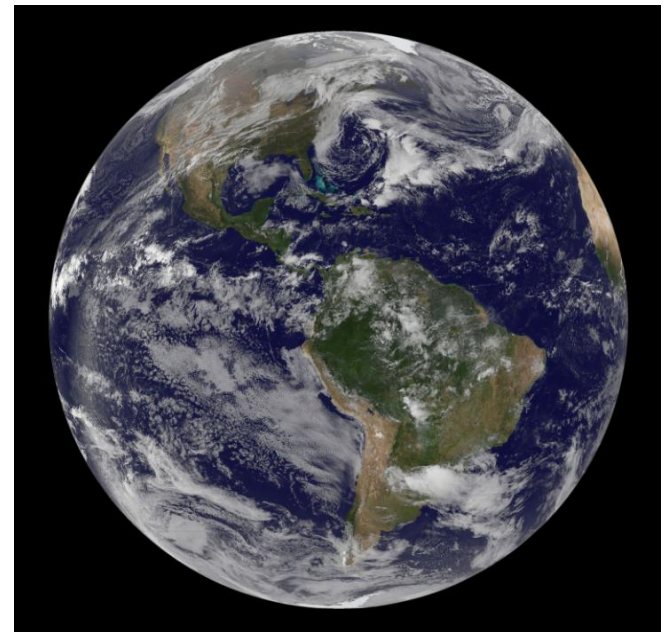
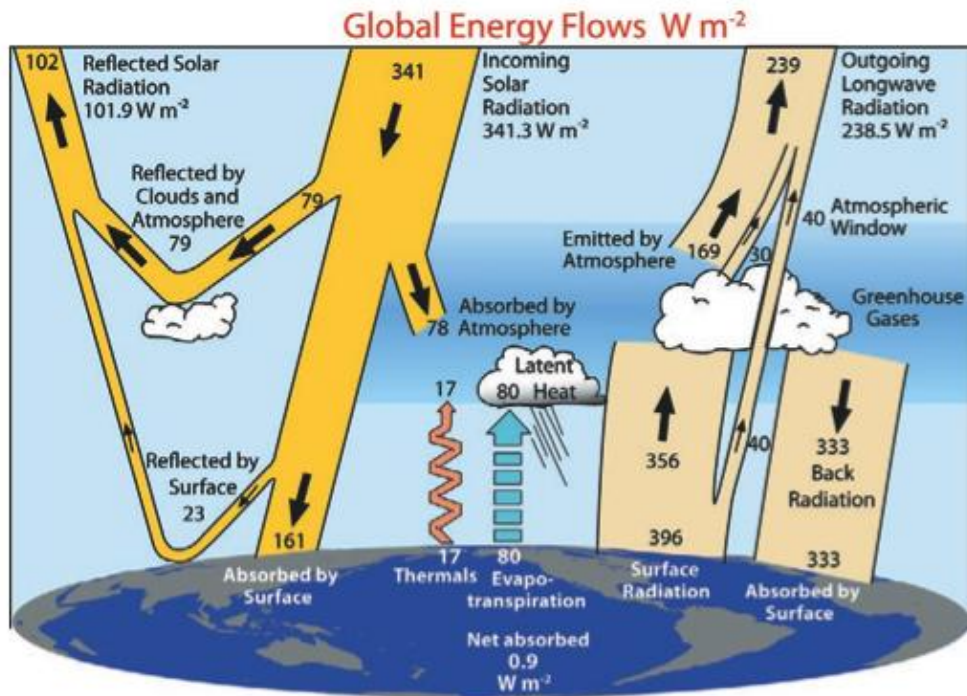
# Vertikális struktúra



# Nem lineáris kapcsolat



# Felhők sugárzasi hatása



GOES-12, 2009. Nov. 11.

FIG. 1. The global annual mean Earth's energy budget for the Mar 2000 to May 2004 period ( $W m^{-2}$ ). The broad arrows indicate the schematic flow of energy in proportion to their importance.

Trenberth et al. (2009)