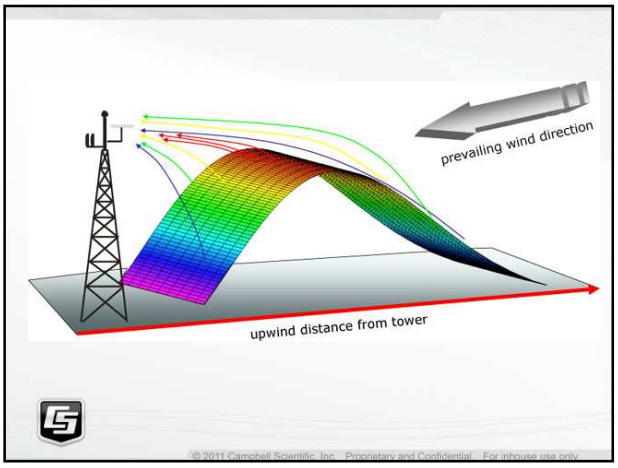
通量源区的意义及模型与应用

周新华

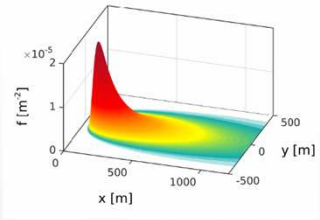
Campbell Scientific, US

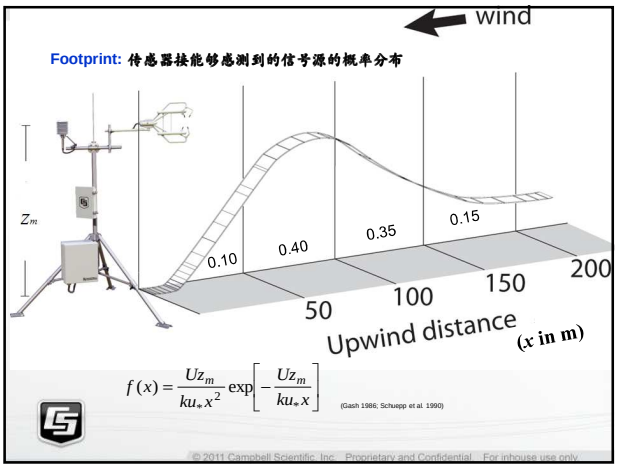
第14次 ChinaFLUX 通量理论与技术培训

2019年8月7日



$$F_\alpha(0,0,z_m) = \int_{-\infty}^{\infty}\int_{0}^{\infty} F(x,y,0)\, f(x,y,z_m)\,dxdy$$

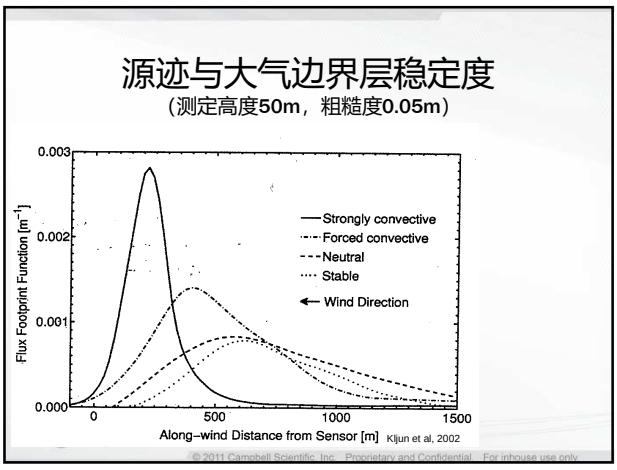




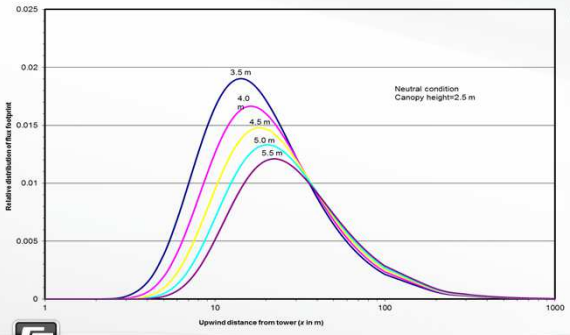
$$f(x) = \frac{Uz_m}{ku_*x^2}\exp\left[-\frac{Uz_m}{ku_*x}\right]$$ (Gash 1986; Schuepp et al. 1990)

源迹与大气边界层稳定度

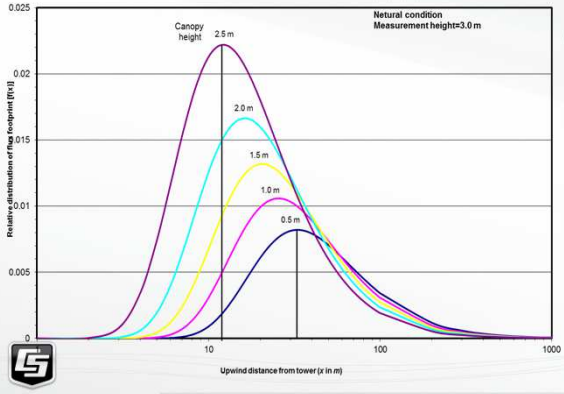
（测定高度50m，粗糙度0.05m）



源迹与观测高度



源迹与冠层高度



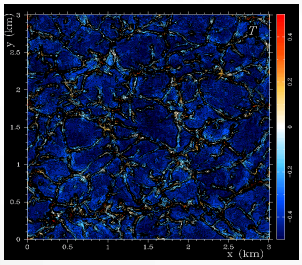
$$F_\alpha(0,0,z_m)=\int_{-\infty}^{\infty}\int_{0}^{\infty}F(x,y,0)\,f(x,y,z_m)\,dxdy$$

均匀下垫面

$$F(x,y,0)=C$$

$$F_\alpha(0,0,z_m)=F(x,y,0)$$

非均匀空间 (Spatial Heterogeneity)



二维空间函数

$F(x,y,0)$

三空间函数

$F(x,y,z)$

Tsutomu WATANABE

$$F_\alpha(0,0,z_m)=\int_{-\infty}^{\infty}\int_{0}^{\infty}F(x,y,0)\,f(x,y,z_m)\,dxdy$$

$f(x,y,z_m)$

1.数字模拟
2.解析模型

Kormann and Meixner (2001) 通量足源模型

$$f_y(x,z)=\frac{1}{\Gamma(\mu)}\xi^{\mu}\left(\frac{z^{m+1}}{x^{\mu+1}}\right)\exp\left(-\xi\frac{z^r}{x}\right),$$

$$r=2+m-n$$

$$\mu=\frac{m+1}{r}.$$

$$\xi=\frac{U}{\kappa r^2}$$

$u(z)=Uz^m$

$K(z)=\kappa z^n$

r – 形状因子
m – 水平风速垂直扩线指数
n – 气漩涡动扩散系数直扩线指数
κ – Kppa 数
U – 水平风速垂直扩线常数

Kljun et al (2004) 通量源区模型

$$-200 \le (z_m - d)/L \le 1$$

$$u_* \ge 0.2$$

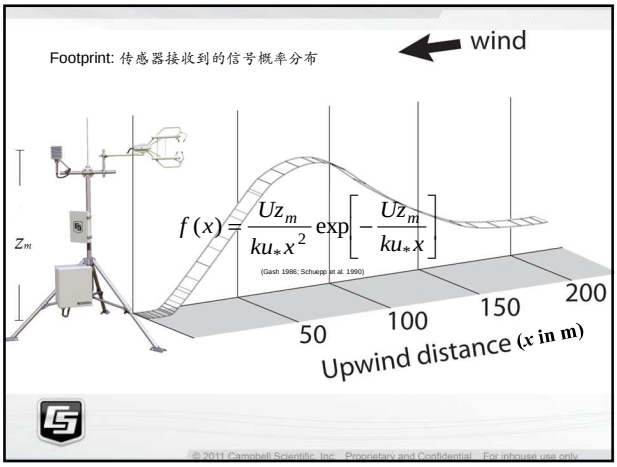
$$z_m - d \ge 1 \text{ m}$$

$$F_*(X_*) = k_1 \left(\frac{X_* + k_4}{k_3} \right)^{k_2} \exp\left[k_2 \left(1 - \frac{X_* + k_4}{k_3} \right) \right]$$

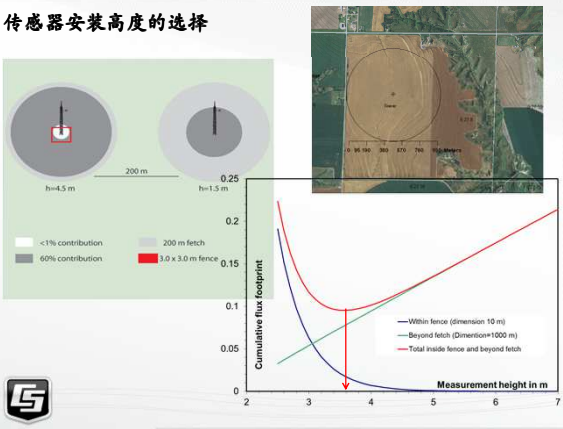
$$X_* = \left(\frac{\sigma_w}{u_*} \right)^{a_1} \frac{x}{z}$$

$$F_* = \left(\frac{\sigma_w}{u_*} \right)^{a_2} \left(1 - \frac{z}{h} \right)^{-1} z f_y(x, z)$$

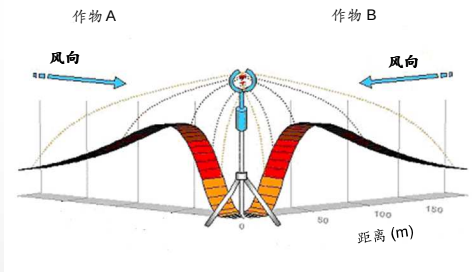
Footprint: 传感器接收到的信号概率分布



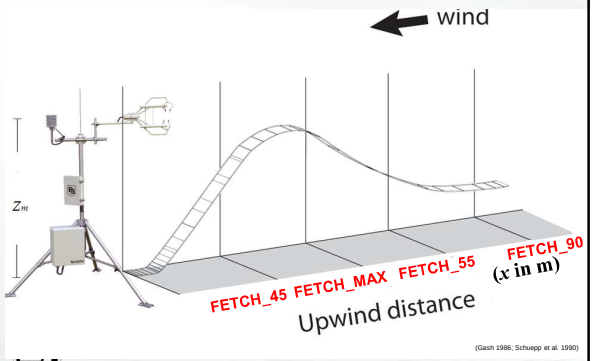
传感器安装高度的选择

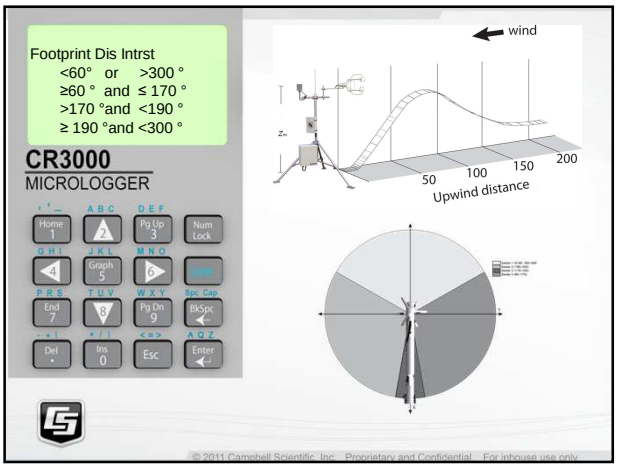


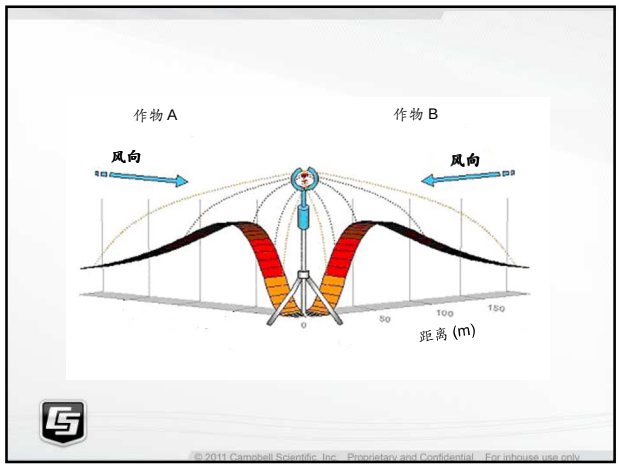
Fluxes over Sugar Cane– Maui, USA

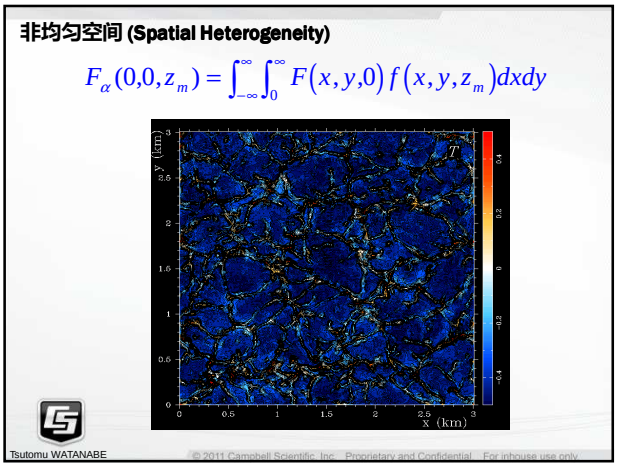


Footprint: 通量网要求的源迹数据




Footprint Dis Intrst
<60° or >300 °
≥60 ° and ≤ 170 °
>170 °and <190 °
≥ 190 °and <300 °
CR3000
MICROLOGGER
wind
50
100
150
200
Upwind distance


作物 A
作物 B
风向
风向
距离 (m)


非均匀空间 (Spatial Heterogeneity)
$F_\alpha(0,0,z_m) = \int_{-\infty}^{\infty}\int_{0}^{\infty} F(x,y,0)\, f(x,y,z_m)\,dxdy$
y (km)
x (km)
Tsutomu WATANABE


Questions ?


谢谢!