DAWN Pulsed Coherent Doppler Wind Lidar Engineering/Science Parameter Tradeoffs

(Hold each expression constant for parameter trades)

1. Before Lidar Design and Fabrication

$$\frac{z_{AIRCRAFT}^2\,\Phi_{MIN}^{1,1,1}\left[C_1\ln\left(V_{SEARCH}\,\Delta z\,4/\left(c\lambda\cos(\theta)\right)\right)+C_2\right]}{ED^2T^2\left[\cos(\theta)\right]^{1.5}\,\beta_{MIN}}\sqrt{\frac{N_{AZIMUTHS}\,V_{AIRCRAFT}}{(PRF)\,\Delta x\,\Delta z}} \qquad (1)$$

2. After Fabrication, Before Data Collection

$$\frac{z_{AIRCRAFT}^2\left[C_1\ln\left(V_{SEARCH}\,\Delta z\right)+C_3\right]}{T^2\beta_{MIN}}\sqrt{\frac{N_{AZIMUTHS}\,V_{AIRCRAFT}}{\Delta x\,\Delta z}} \qquad (2)$$

Trade aircraft height and velocity, vertical and horizontal resolution, minimum detectible aerosol level, atmospheric transmission, number of measured azimuth directions, and velocity search space

3. After Data Collection, Before Dissemination

$$\frac{\left[C_1\ln\left(V_{SEARCH}\,\Delta z\right)+C_3\right]}{\beta_{MIN}\sqrt{\Delta x\,\Delta z}} \qquad (3)$$

Trade vertical and horizontal resolution, minimum detectible aerosol level, and velocity search space

z = altitude [m] $z_{AIRCRAFT}$ = aircraft altitude

R = range of lidar to target [m]

$R_{MAX} = z_{AIRCRAFT} / \cos(\theta)$

θ = laser beam nadir angle [radian] $[30°]$

Φ = detected coherent photoelectrons per shot per range gate [-]

$C_2\Phi_{MIN}^{1,1,1}$ = 1 shot &1 m range gate & 1frequency bin search BW $(N_{SEARCH}=1)$ minimum Φ $\left[\sqrt{m}\right]$

$N_{SEARCH} = 4\Delta R V_{SEARCH}/(c\lambda)$ [–]

ΔR = Data processing range gate length [m]

V_{SEARCH} = search band for wind velocity [m/s]

Δz = height resolution $= \Delta R\cos(\theta)$ $[m]$

$c\lambda/4 \approx 150$; $c\lambda/(4\Delta R) \approx 150/\Delta R$

c = speed of light [m/s]

λ = laser wavelength [m] $\left[2.05\ 10^{-6} m\right]$

E = lidar laser pulse energy [J] [250 mJ]

D = circular receiver collection diameter [m] [0.15 m]

T = 1-way atmospheric intensity transmission [-]

β = aerosol backscatter coefficient $\left[m^{-1}sr^{-1}\right]$

$N_{AZIMUTHS}$ = number lidars scanner azimuths per repeat pattern [-]

$V_{AIRCRAFT}$ = Aircraft horizontal velocity [-]

Δx = along-track horizontal resolution [m]

GRIP science team input requested for stages 2 & 3.
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