What Does the Sky Tell Us About the Camera?

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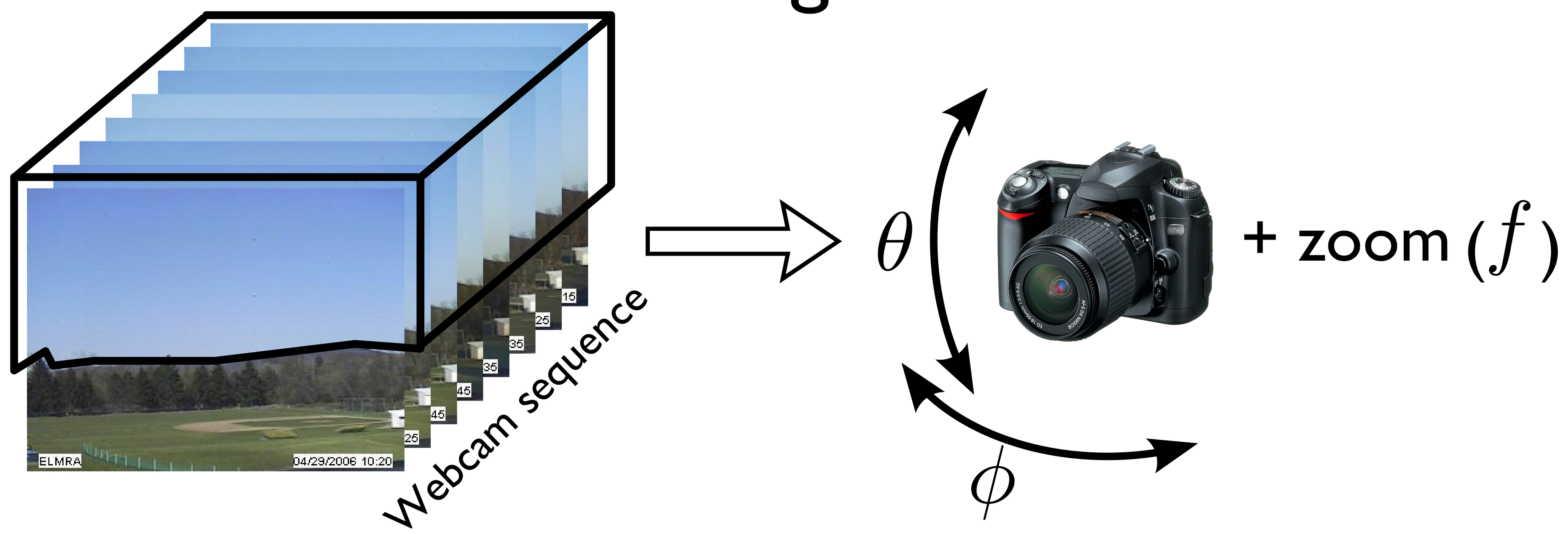
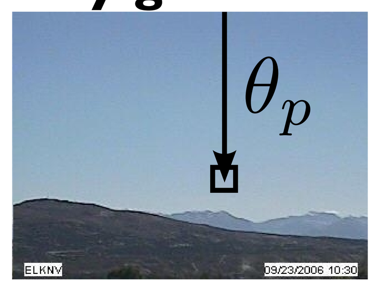
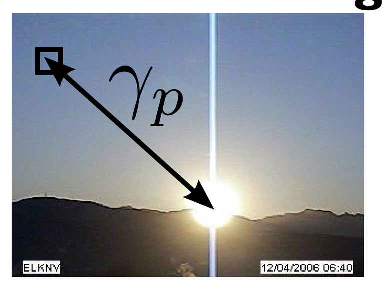
Our goal



Physically-based sky model (Perez, '93)





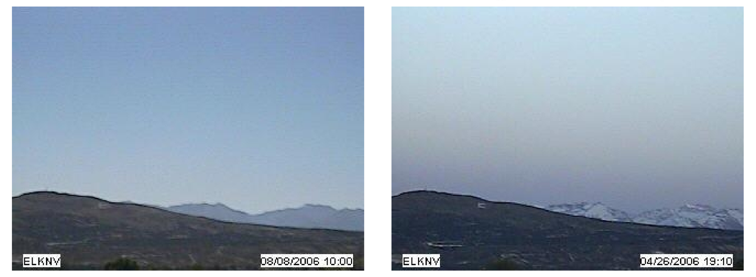
$$l_p = [1 + a\exp(b/\cos\theta_p)] \times [1 + c\exp(d\gamma_p) + e\cos^2\gamma_p]$$

Weather coefficients

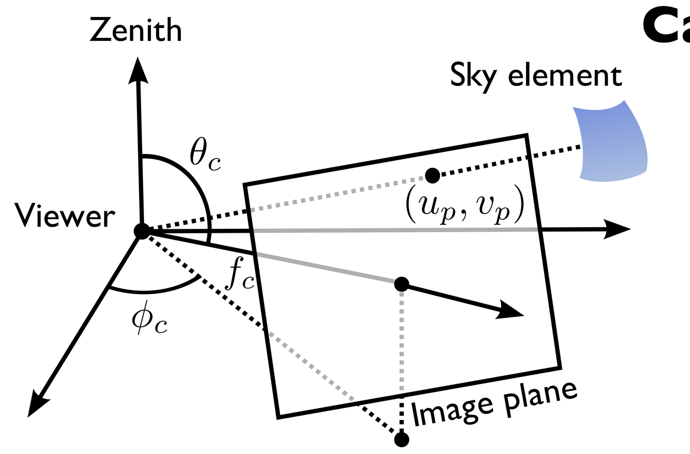
for clear skies,

$a=-1, b=-0.32, c=10, d=-3, e=0.45$

can also be parameterized by turbidity (Preetham, '99)



Camera parameters

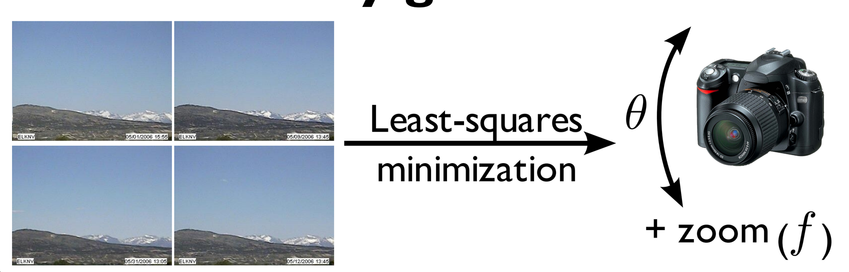


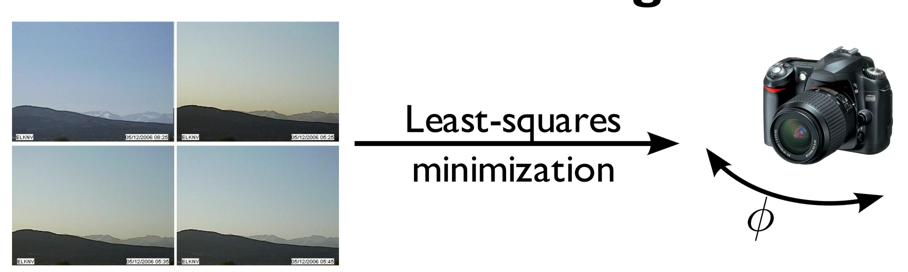
$$\theta_p = \arccos\left(\frac{v_p\sin\theta_c - f_c\cos\theta_c}{\sqrt{f_c^2 + u_p^2 + v_p^2}}\right)$$

$$\gamma_p = \arccos\left(\cos\theta_s\cos\theta_p + \sin\theta_s\sin\theta_p\cos(\phi_p - \phi_s)\right)$$

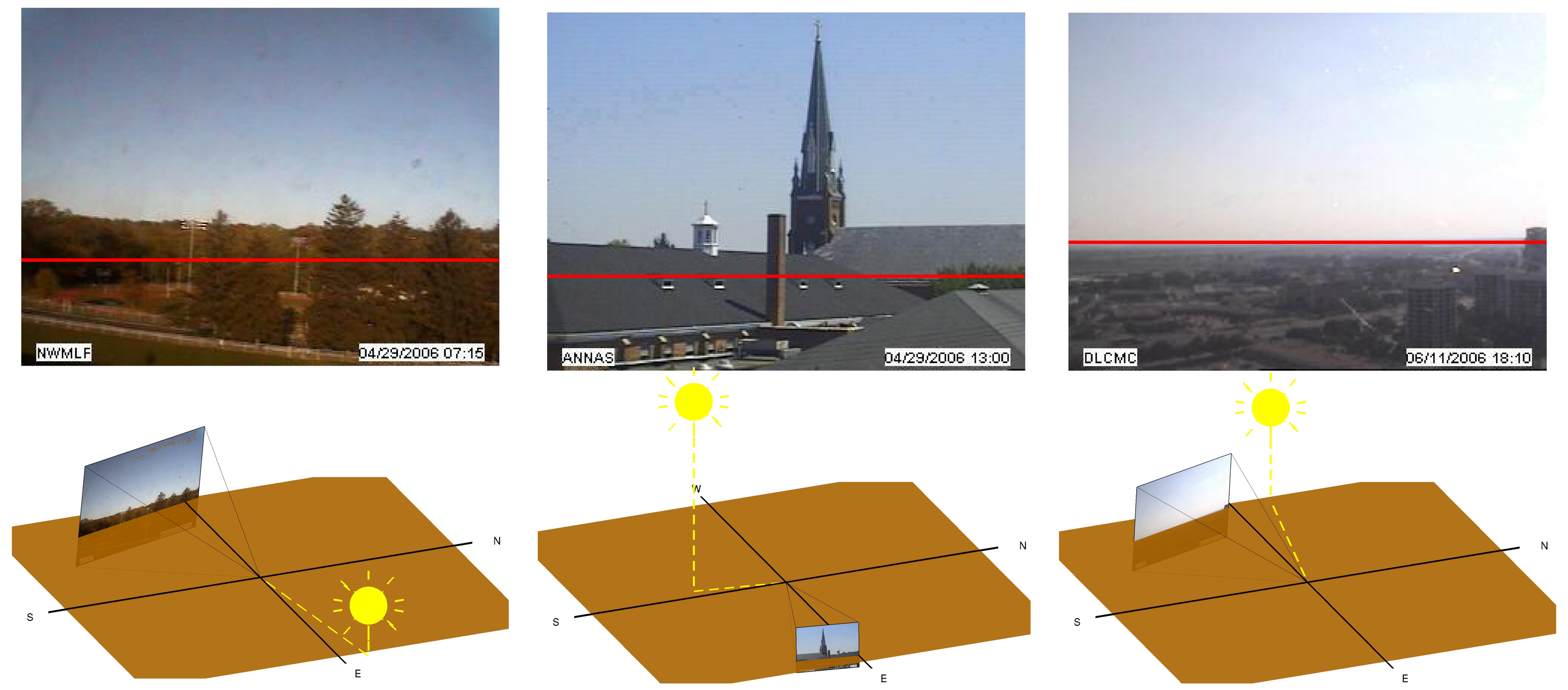
$$\phi_p = \arctan\left(\frac{f_c\sin\phi_c\sin\theta_c - u_p\cos\phi_c + v_p\sin\phi_c\cos\theta_c}{f_c\cos\phi_c\sin\theta_c + u_p\sin\phi_c + v_p\cos\phi_c\cos\theta_c}\right)$$

Fitting the model to images

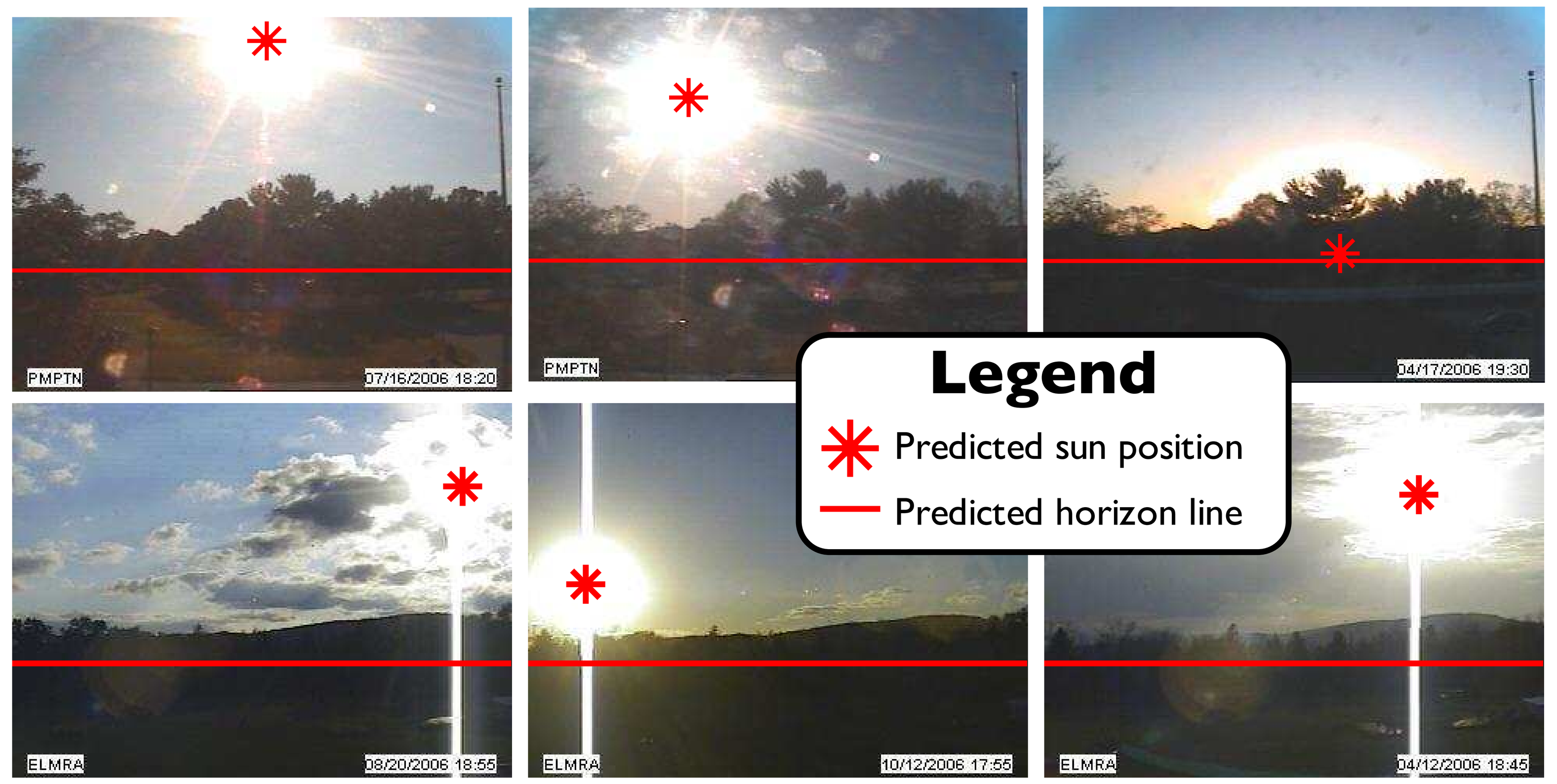




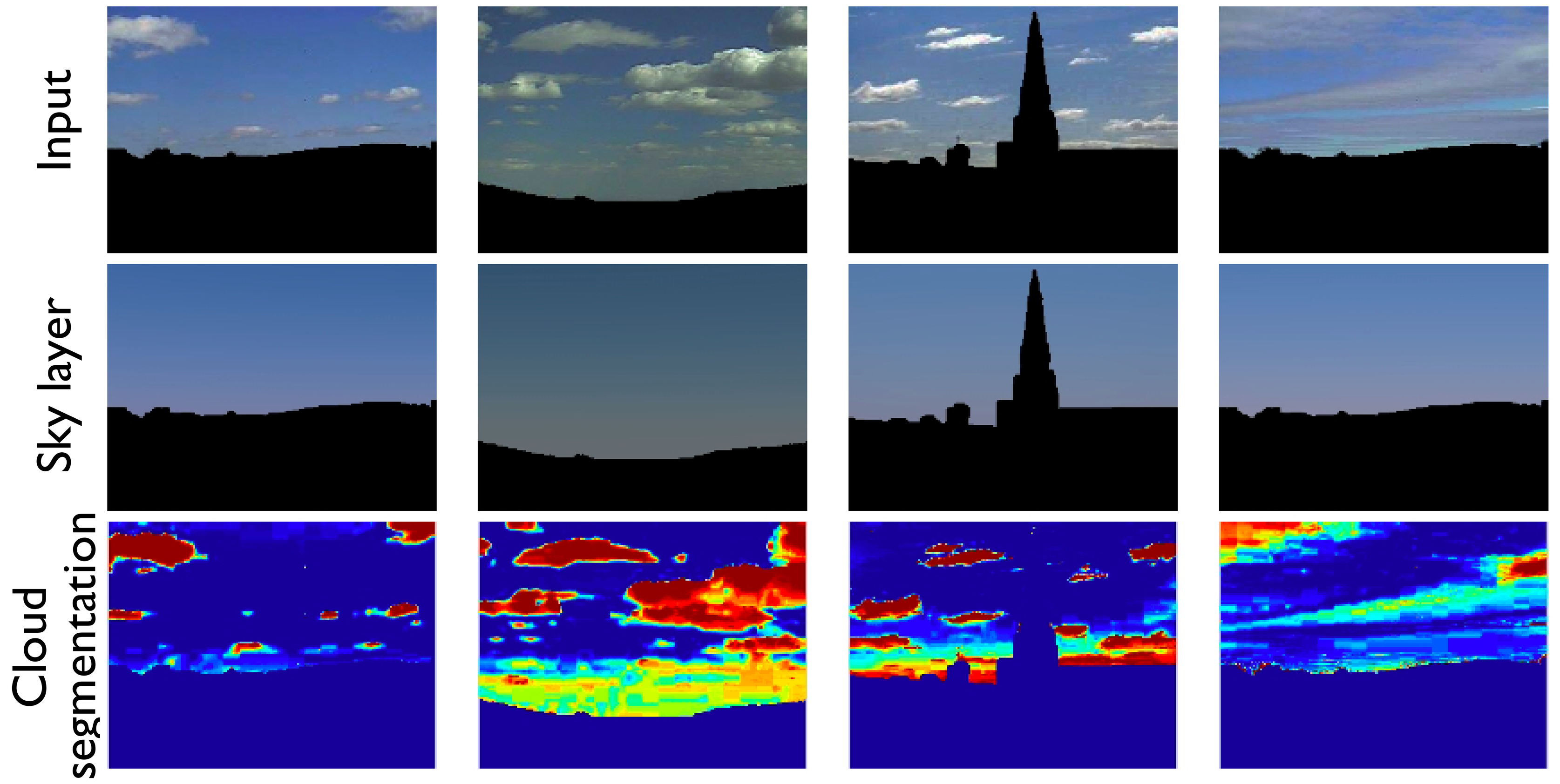
Camera geometry from sky appearance



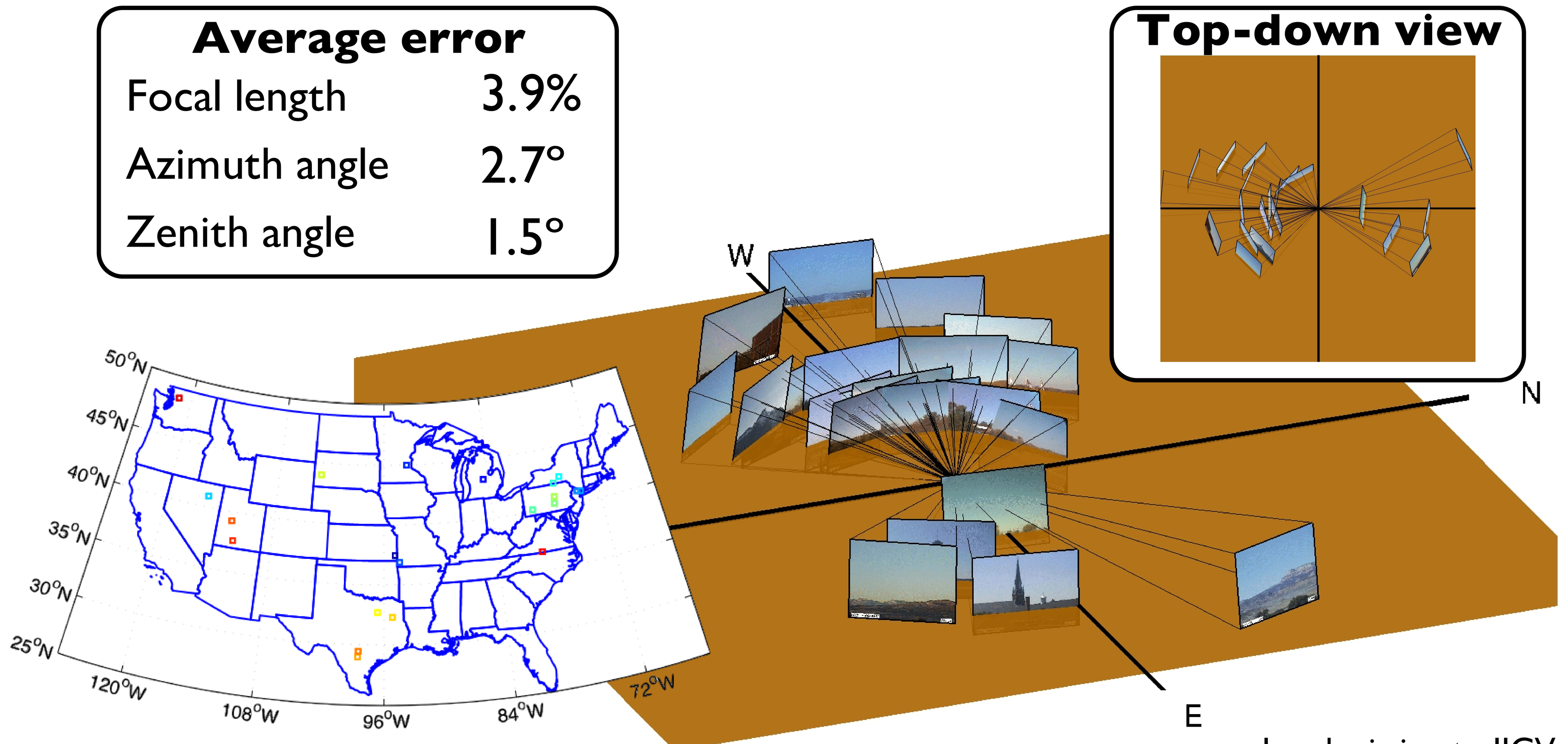
Validation using sun position prediction



Separation of sky and cloud layers



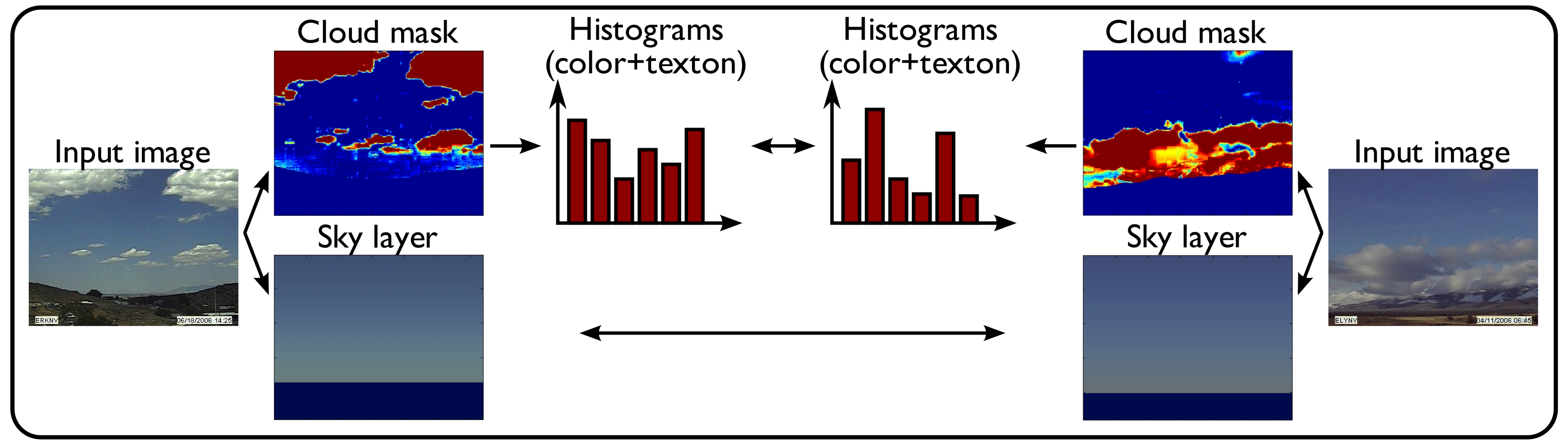
Calibrating the webcams of the world

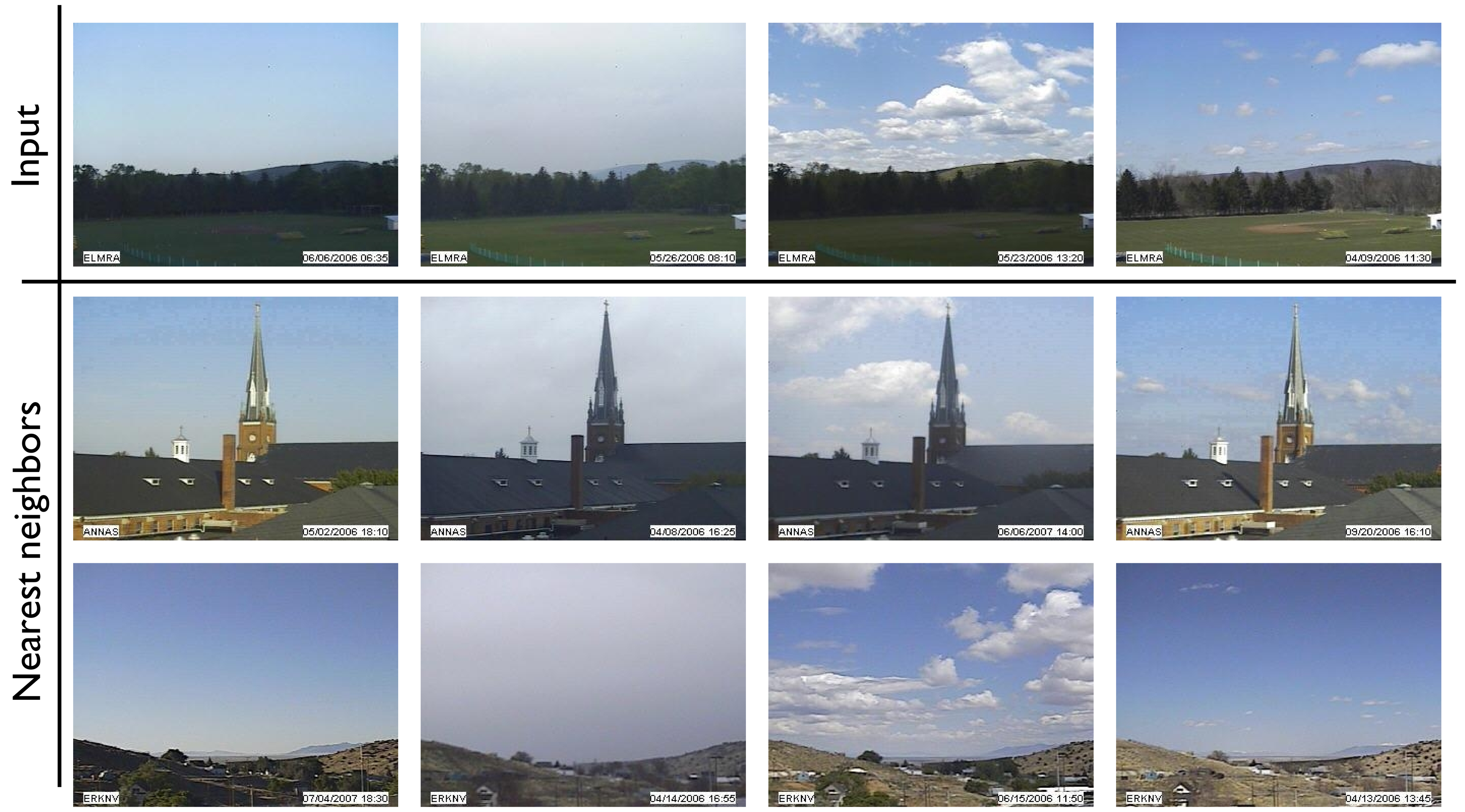


Average error	
Focal length	3.9%
Azimuth angle	2.7°
Zenith angle	1.5°

In submission to IJCV

Matching skies across image sequences





All webcam sequences are taken from the AMOS database (Jacobs, '07)