

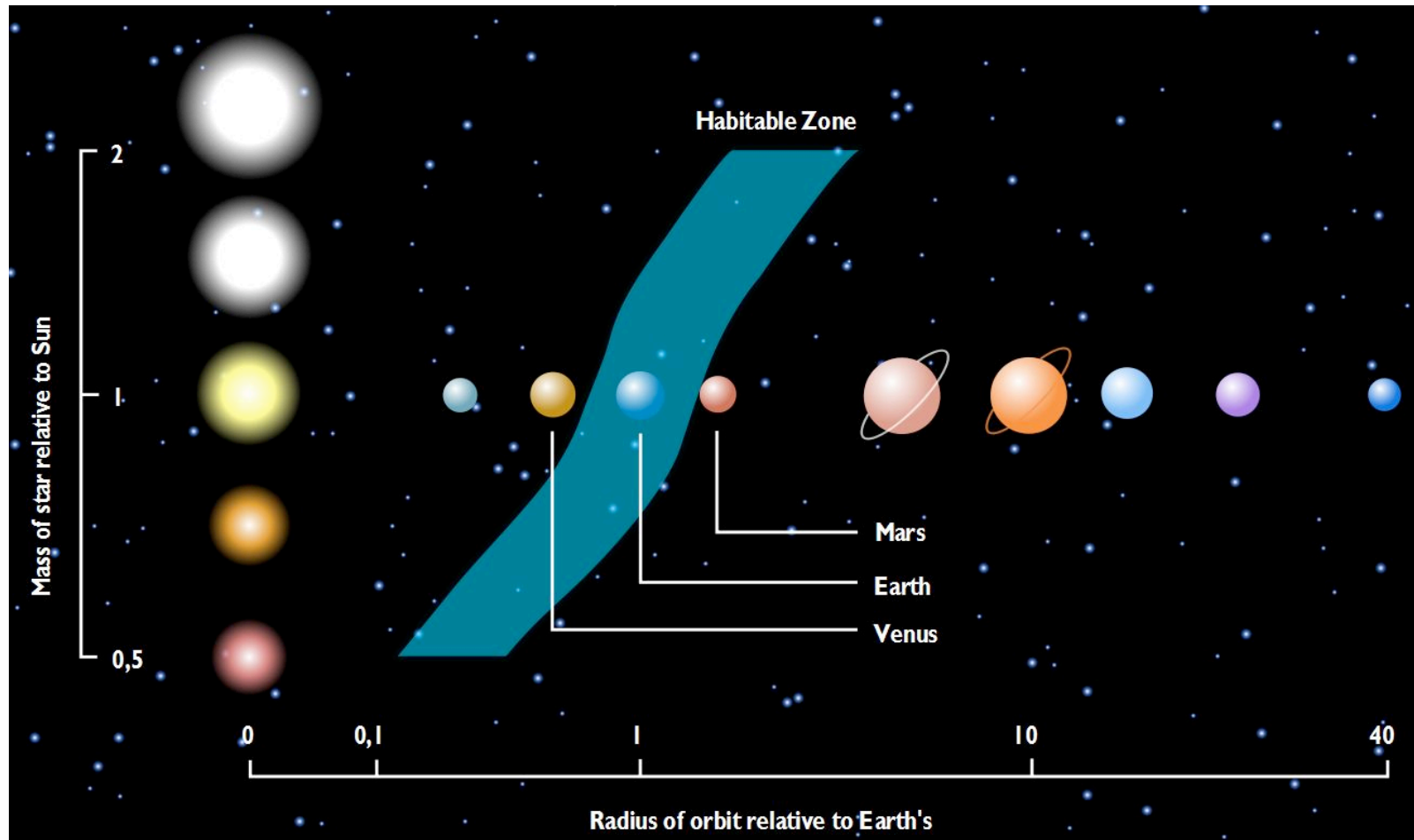
The EPOXI View of Earth



Nick Cowan (University of Washington)

KITP (May 18, 2010)

“Habitable” Planets

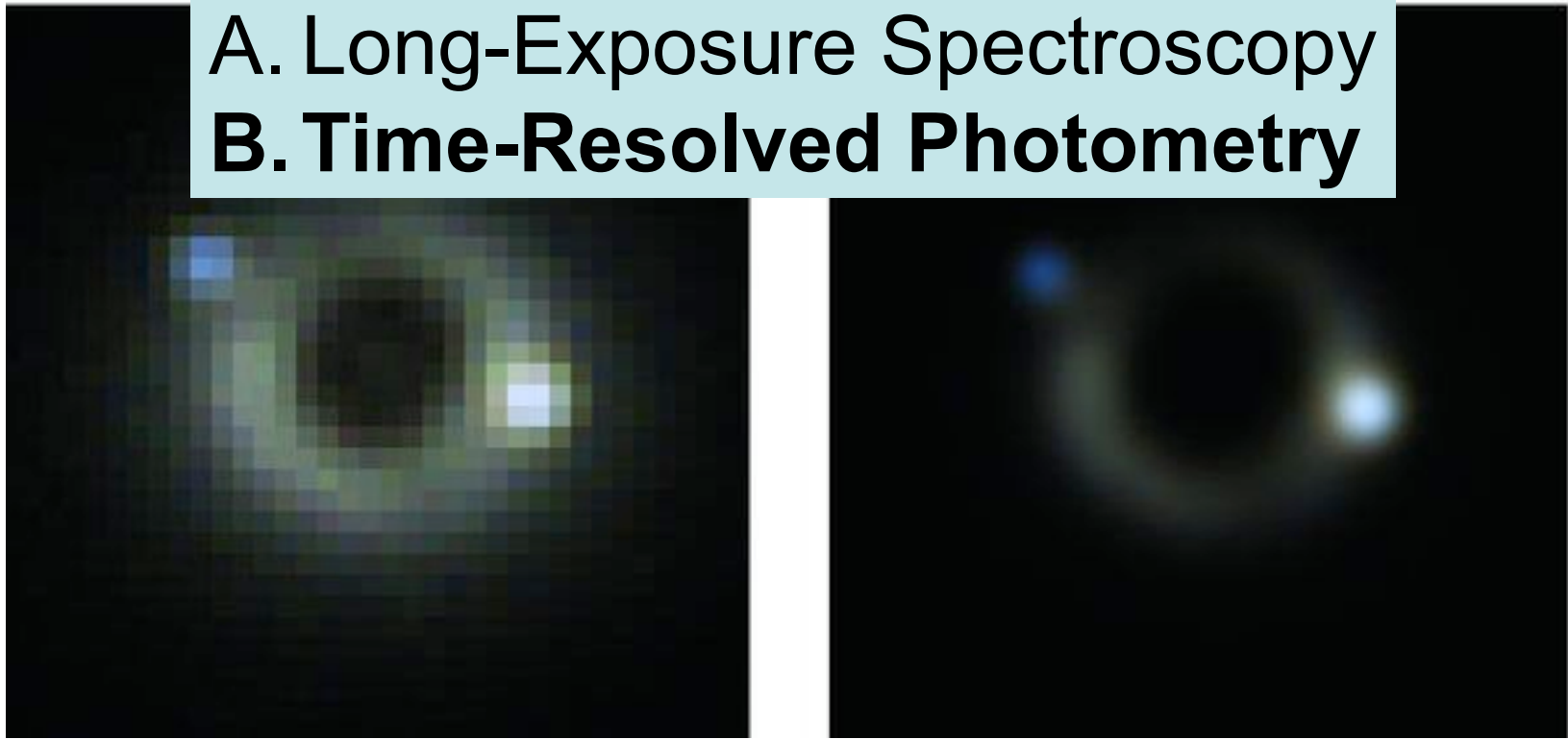


Looking for Water

- Water in atmosphere?
 - H₂O vapor
 - Variable cloud cover
 - Water on surface?
 - Color of oceans
 - Glint of oceans
 - Polarization from oceans
- Long-Exposure Spectroscopy
- Yearly Variability
- Daily Variability
-

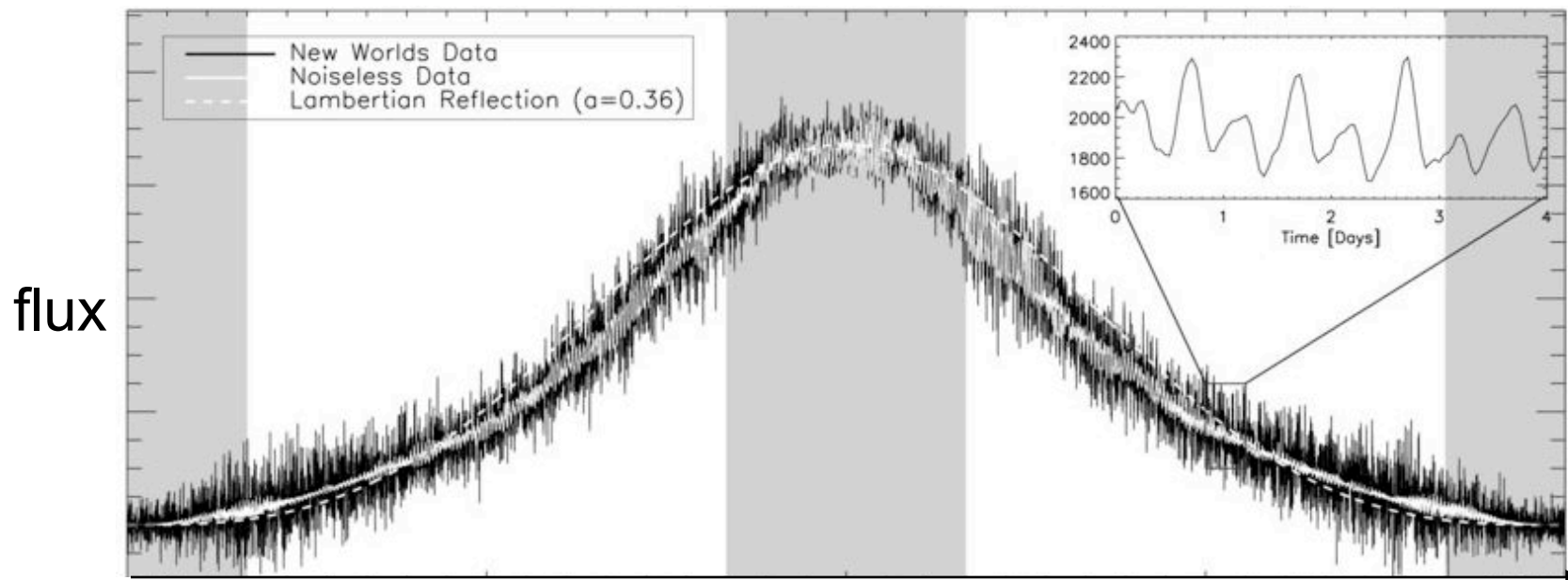
NWO, THEIA, TPF/Darwin, etc. (n+1 decades from now)

A. Long-Exposure Spectroscopy
B. Time-Resolved Photometry



(Simulated image from Oakley & Cash 2009)

Orbital & Rotational Variability

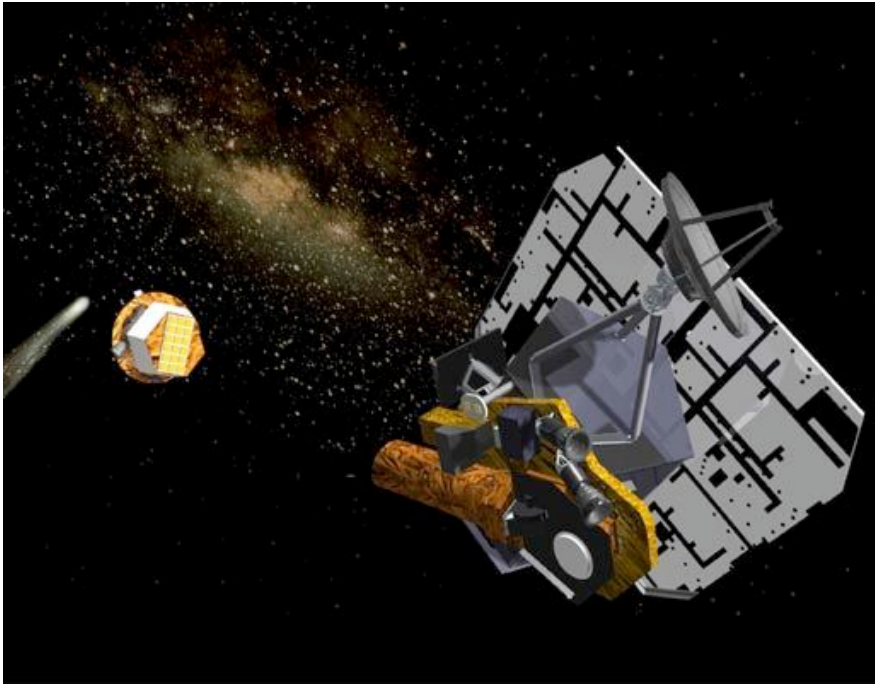


Oakley & Cash (2009)

- Will **not** know A_0 (degenerate with R_p)
- **Will** measure $A(t)/A_0$ and $A(\lambda)/A_0$

EPOXI (PI: A'Hearn)

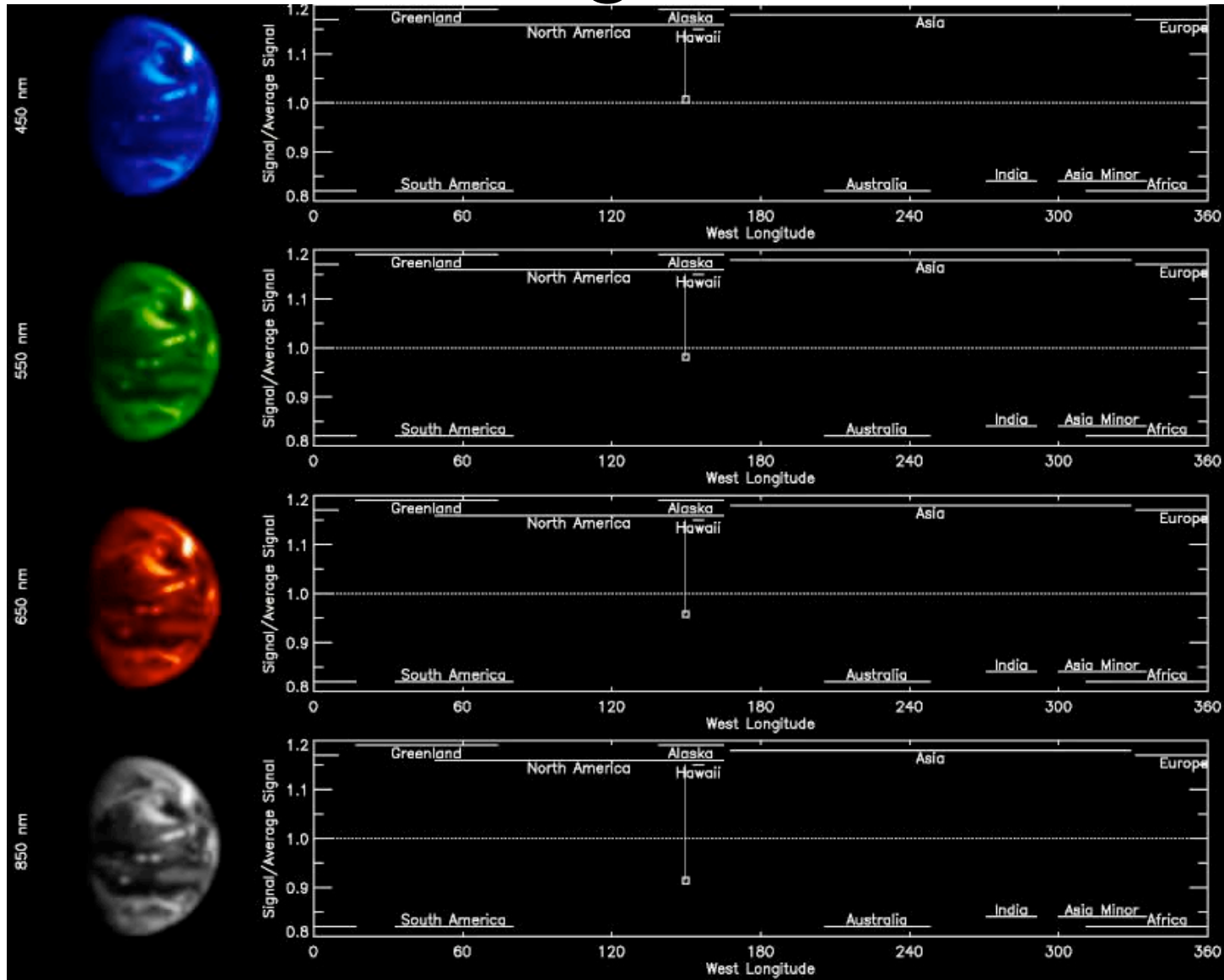
~Deep Impact Part II



EPOCH (PI: Deming)

1. Observe known exoplanets
2. Observe Earth *as an exoplanet*

EPOXI Light Curves

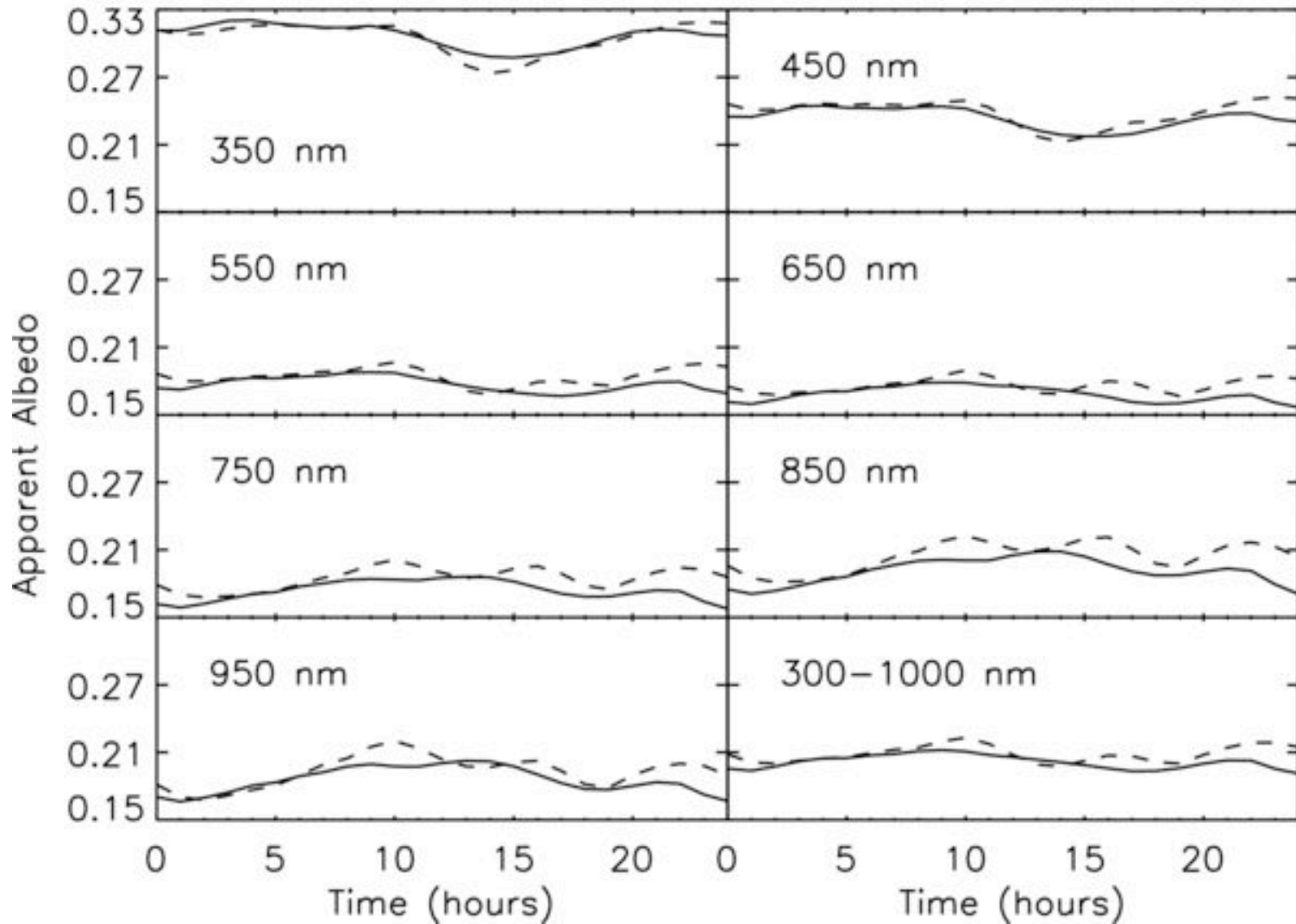


May 18, 2010

Nick Cowan's Talk at ESMSSP

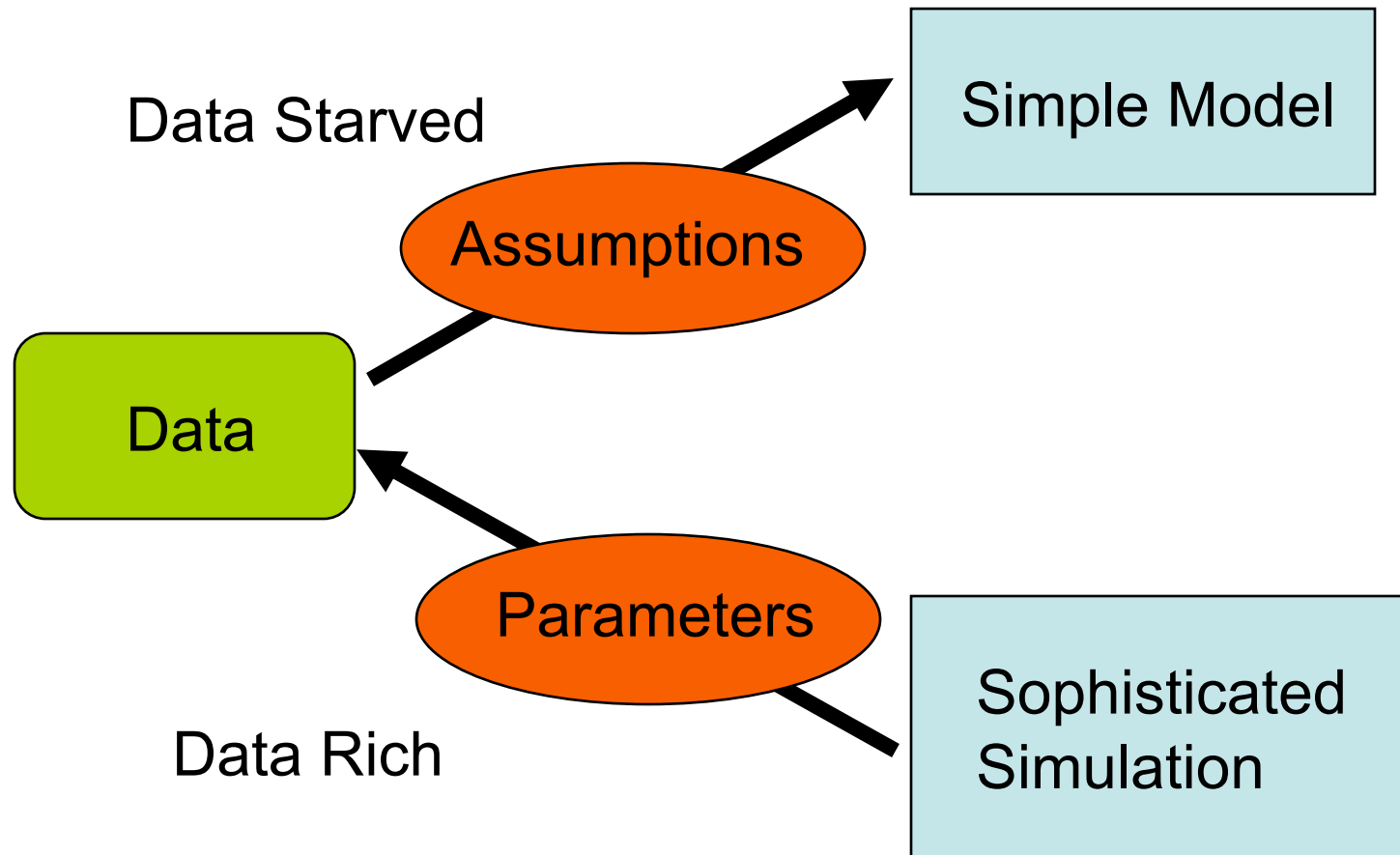
7

EPOXI Light Curves

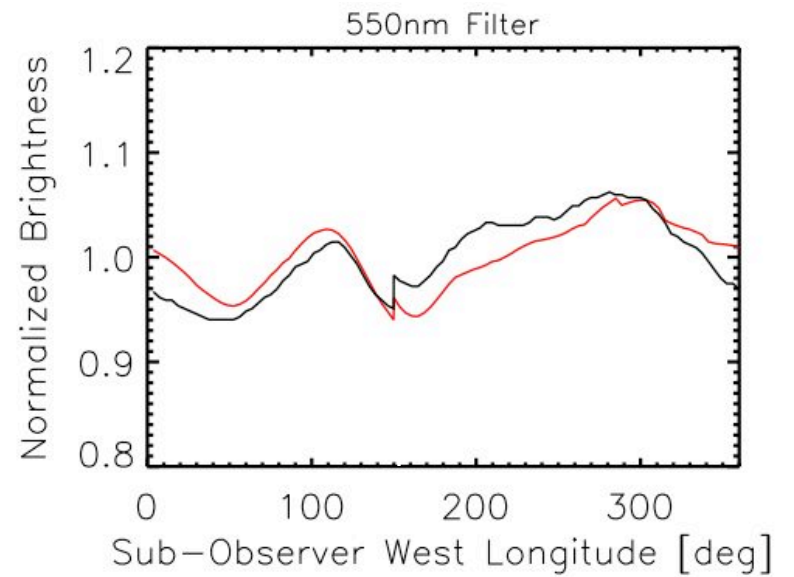
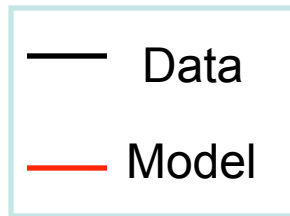
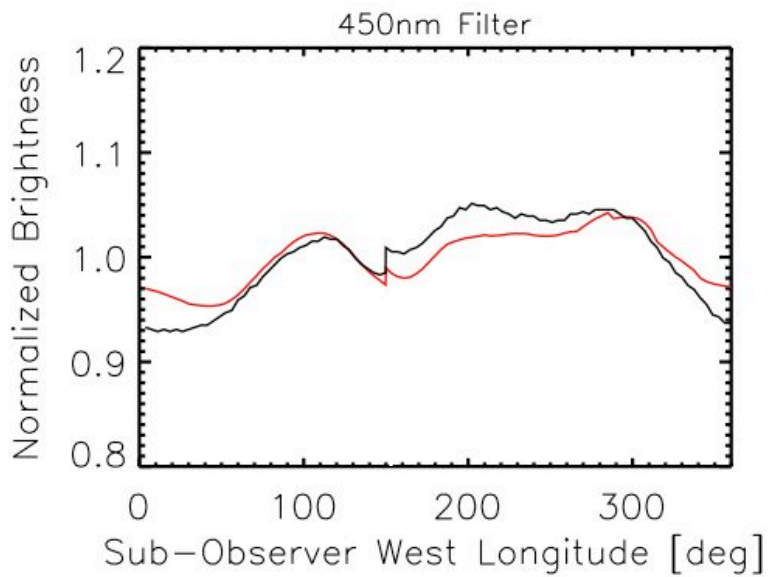


Cowan et al. (2009)

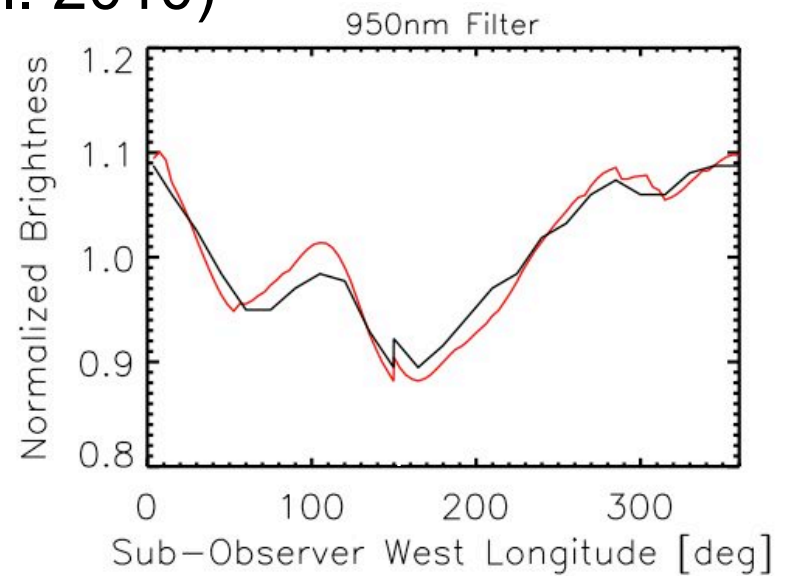
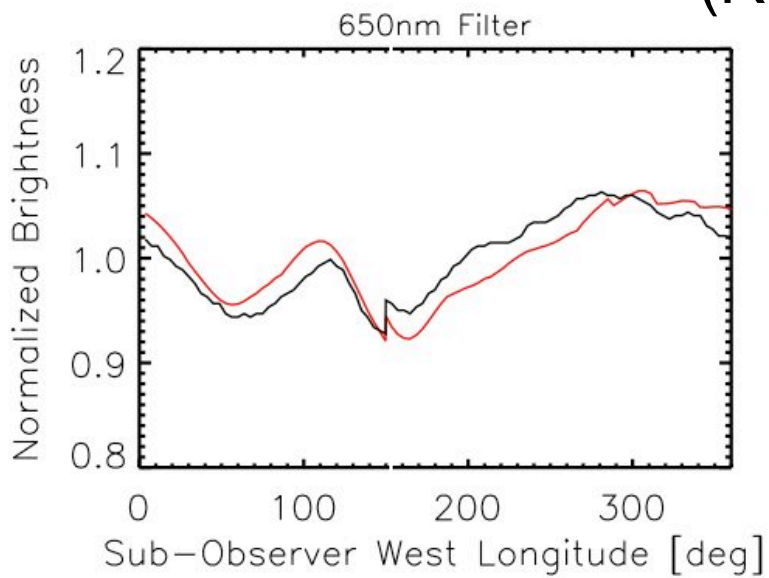
Backward Modeling v.s. Forward Modeling

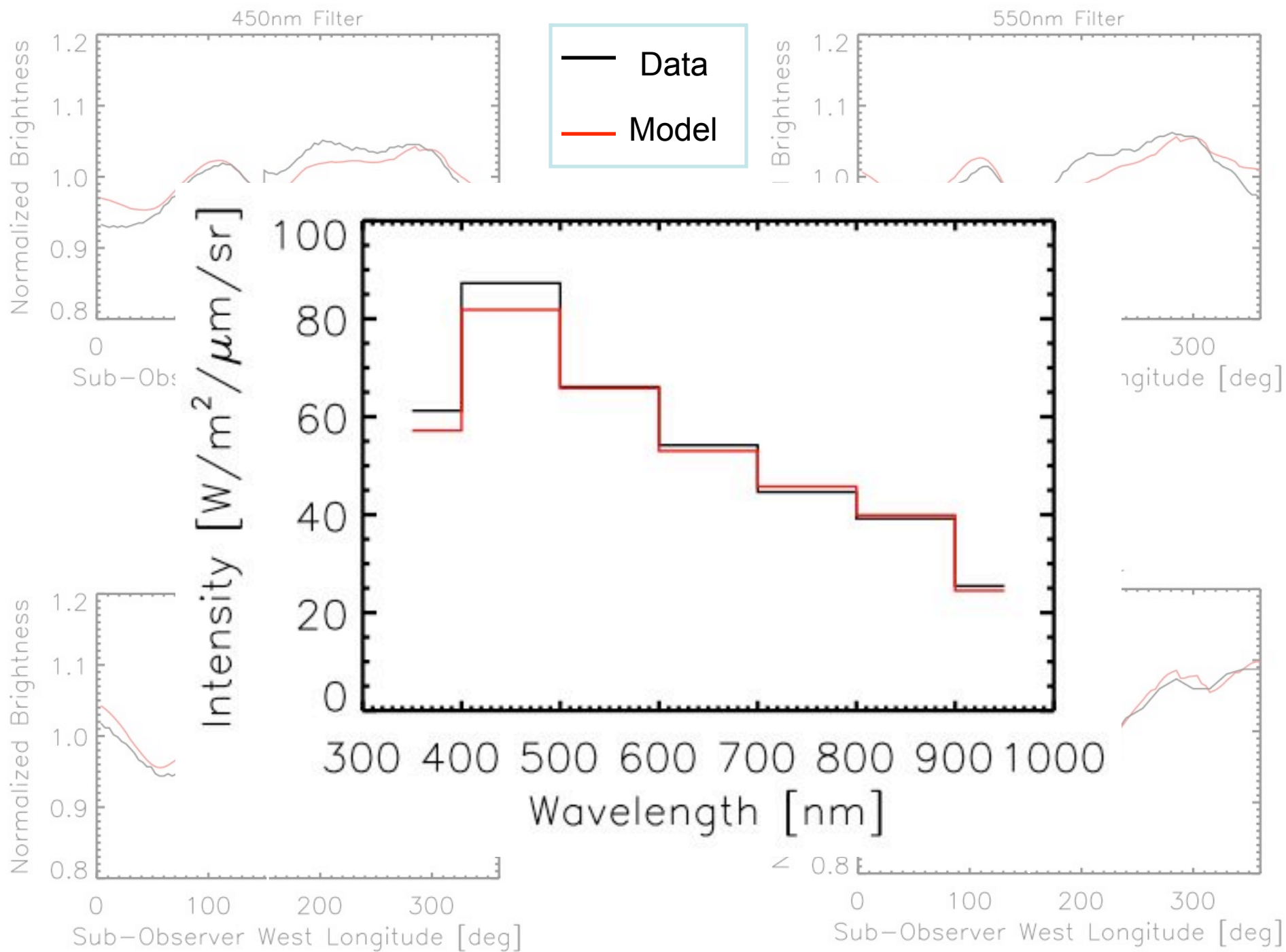


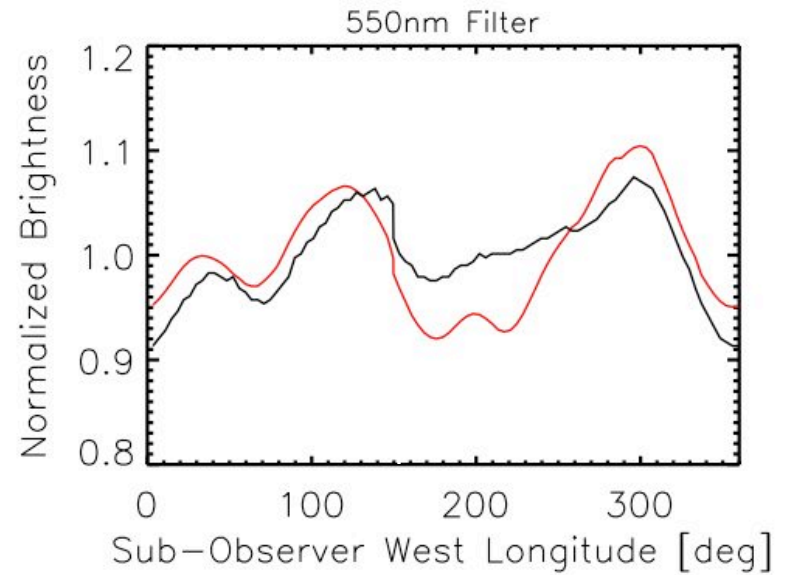
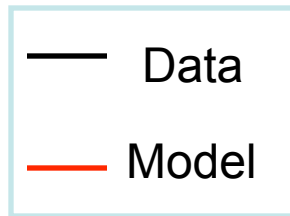
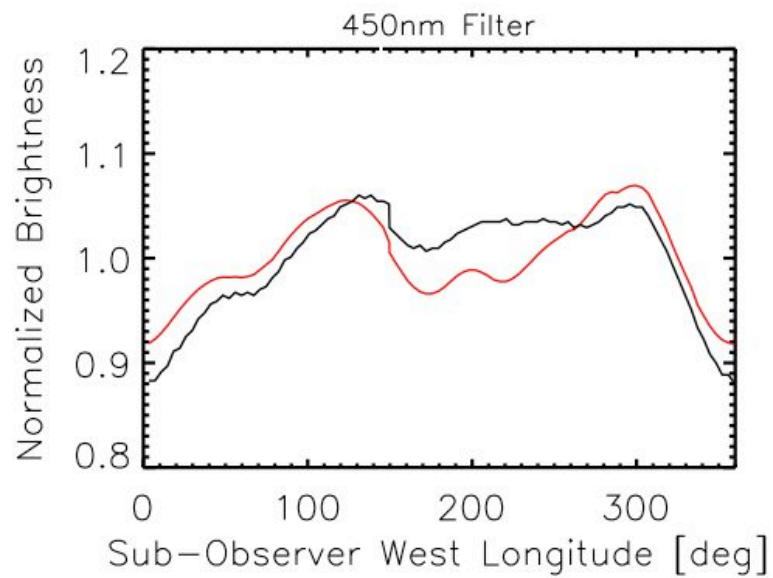
Forward (Predictive) Modeling



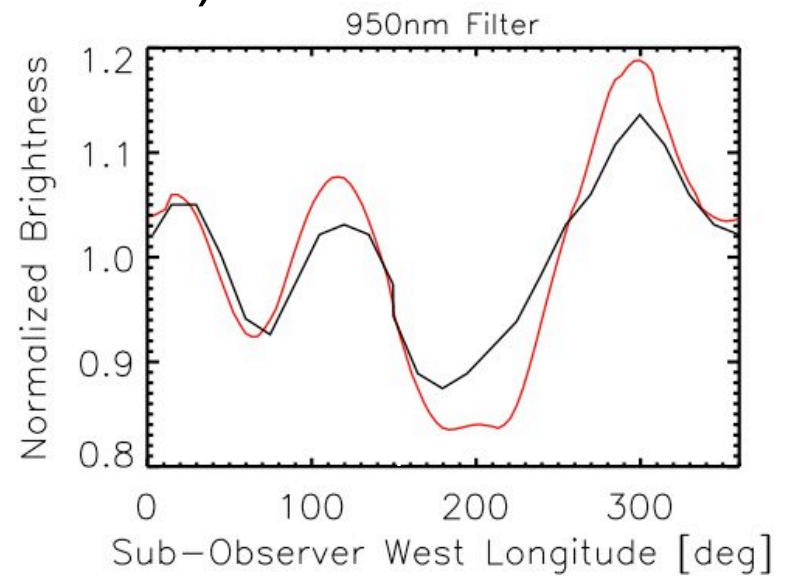
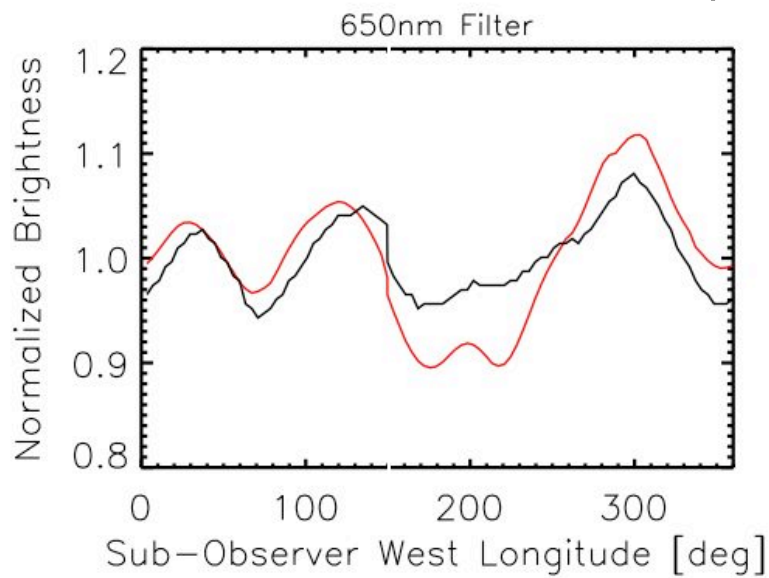
March 19th, 2008
(Robinson et al. 2010)

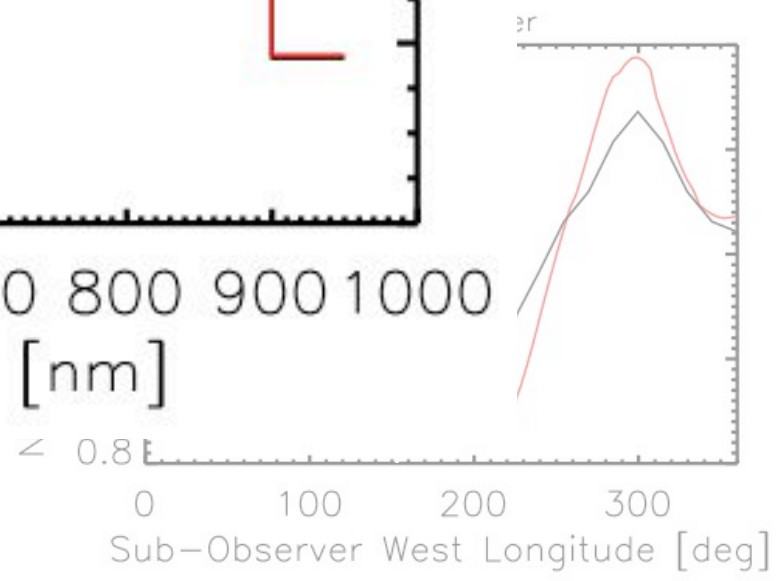
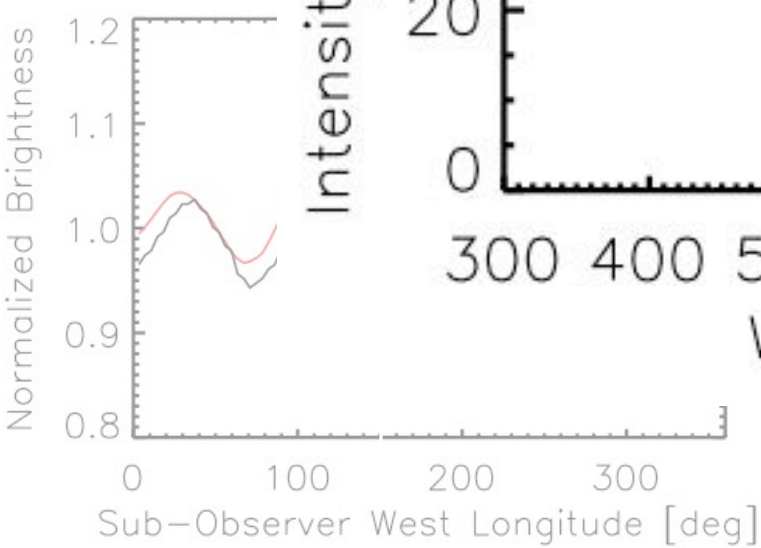
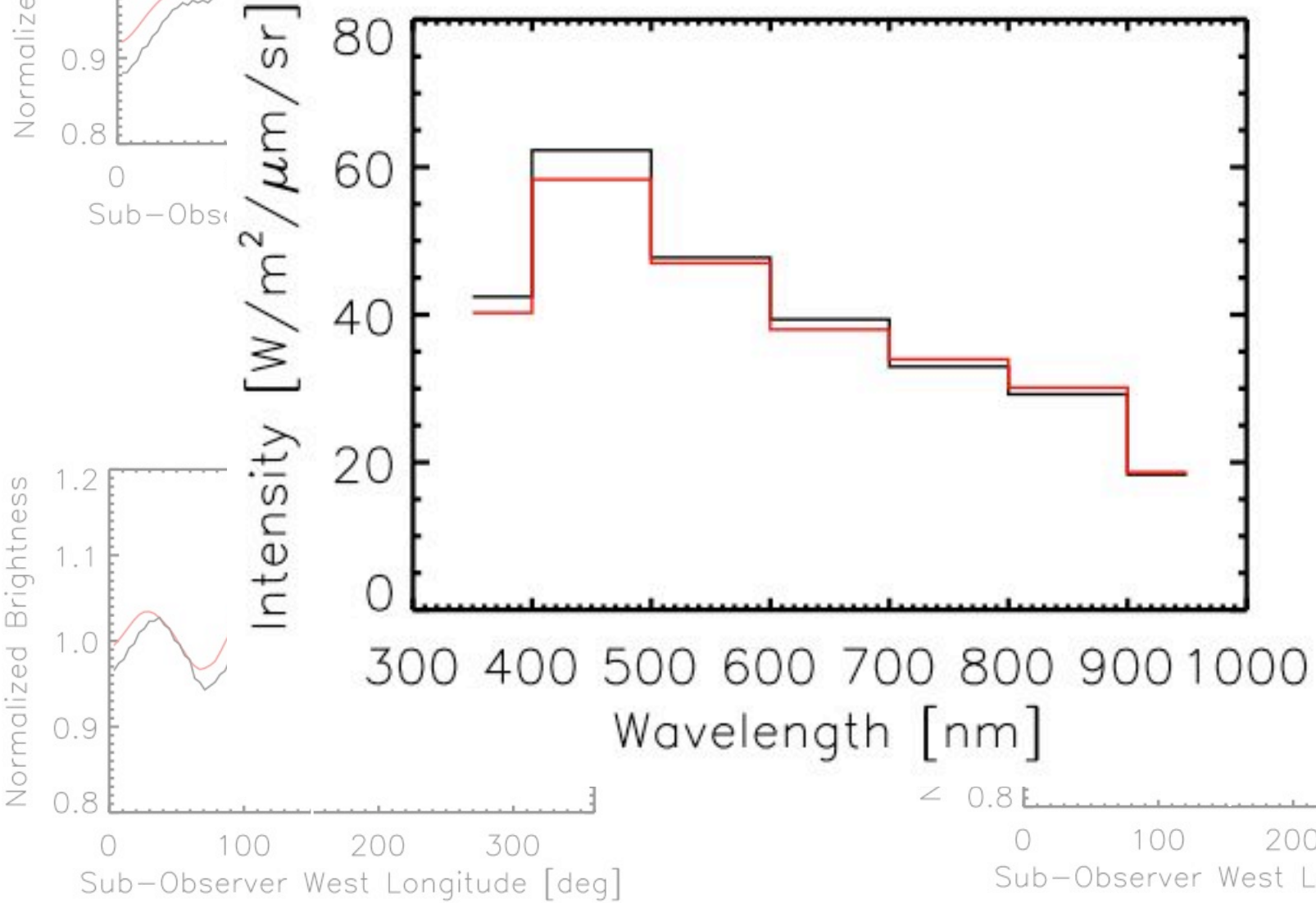
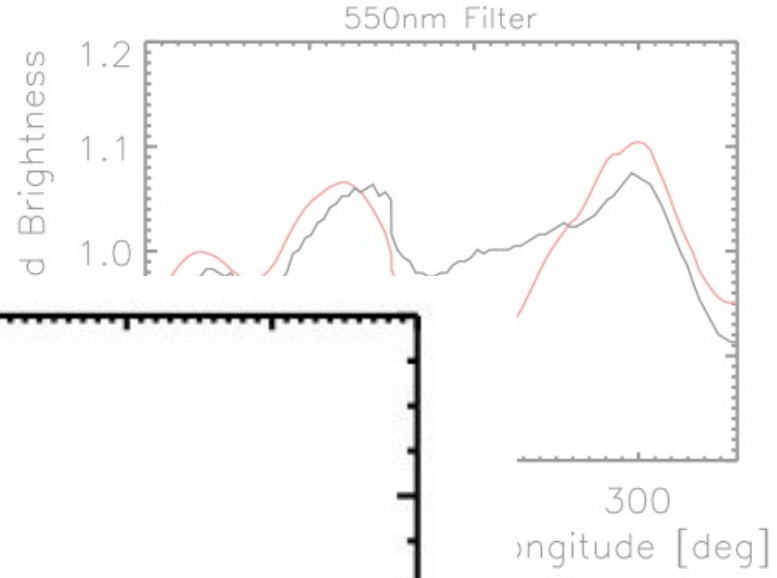
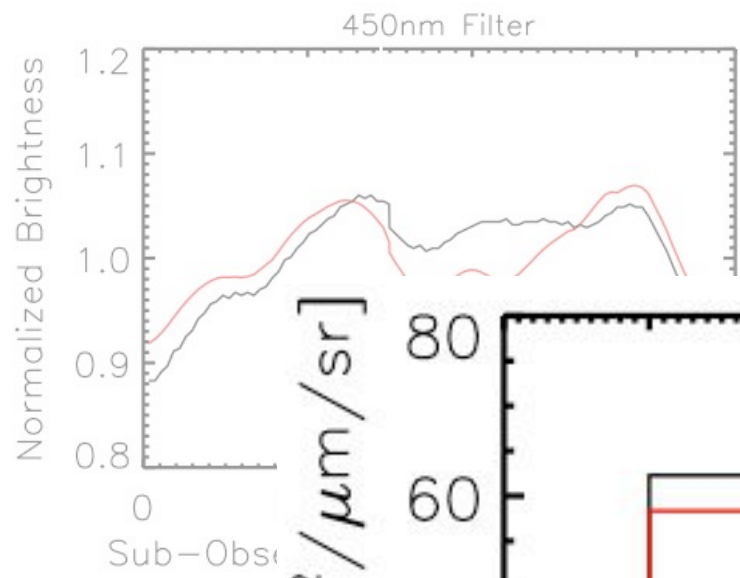






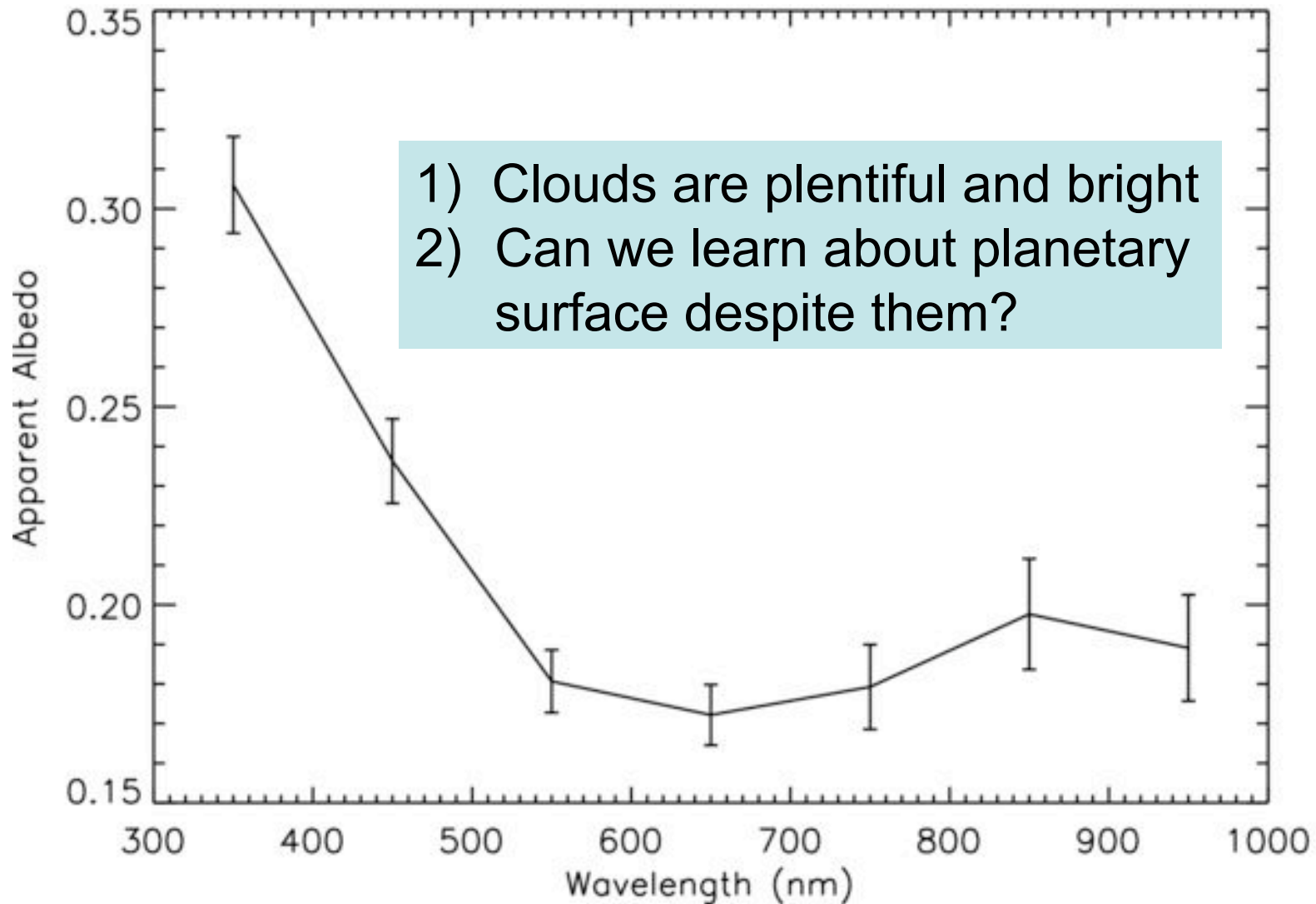
June 5th, 2008
(Robinson et al. 2010)





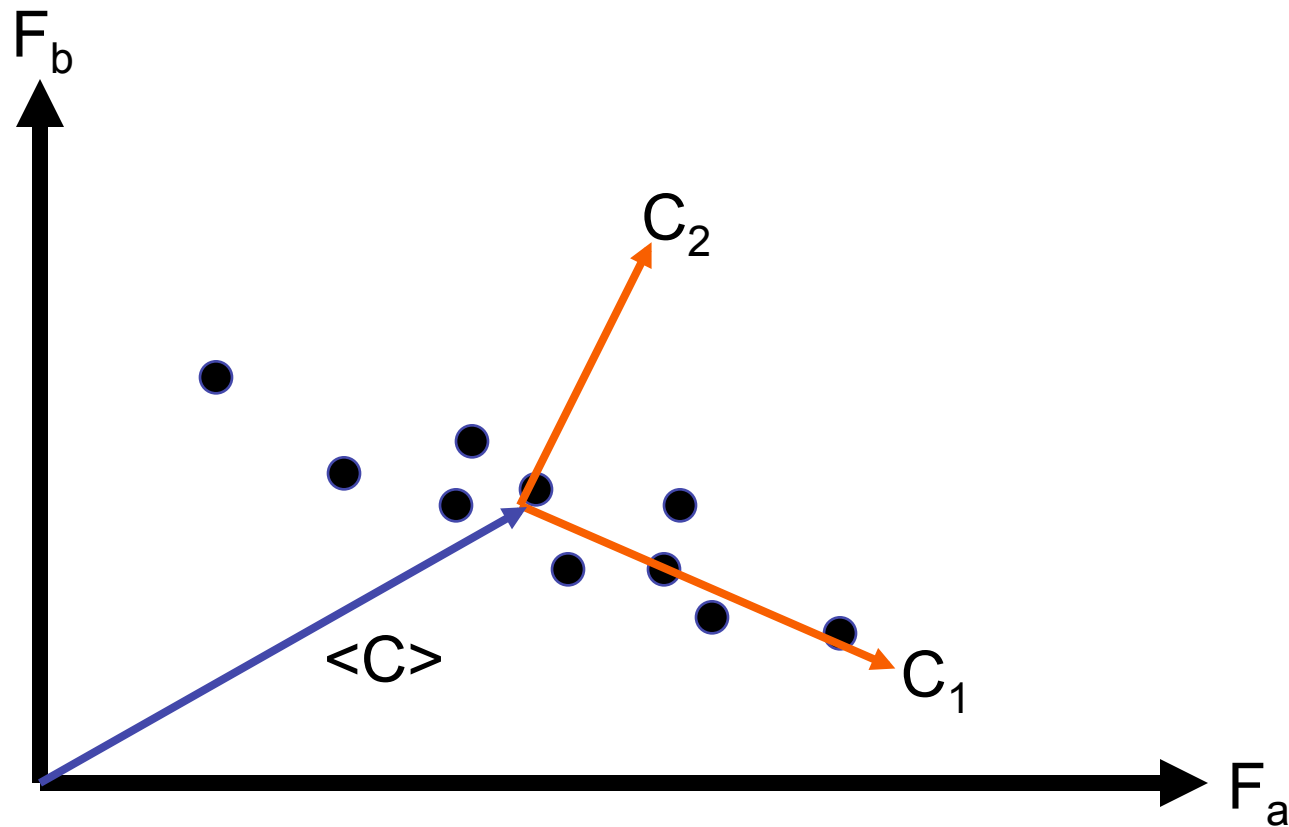
Backward (Interpretive) Modeling

Time-Averaged Spectrum

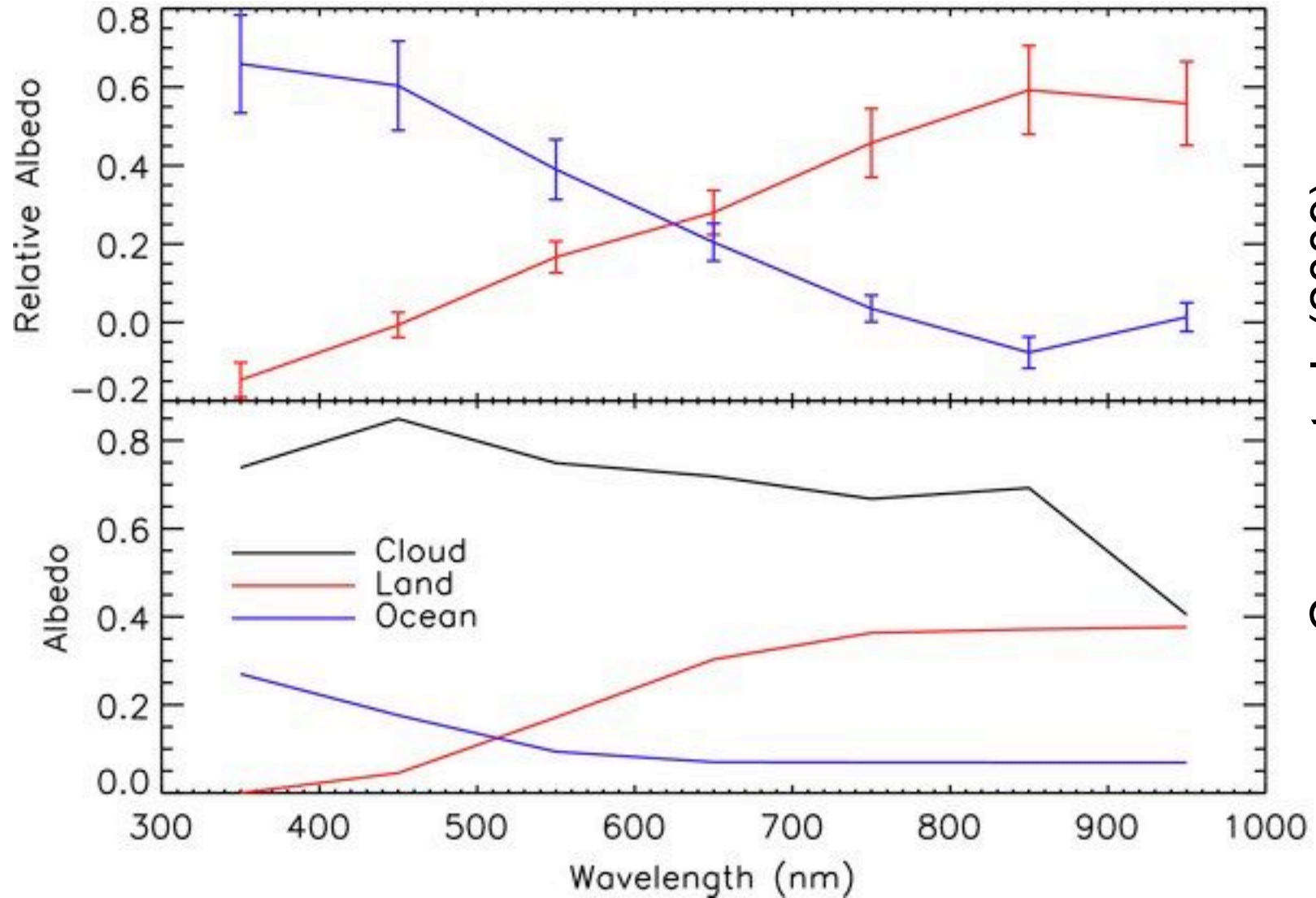


Cowan et al. (2009)

Principal Component Analysis

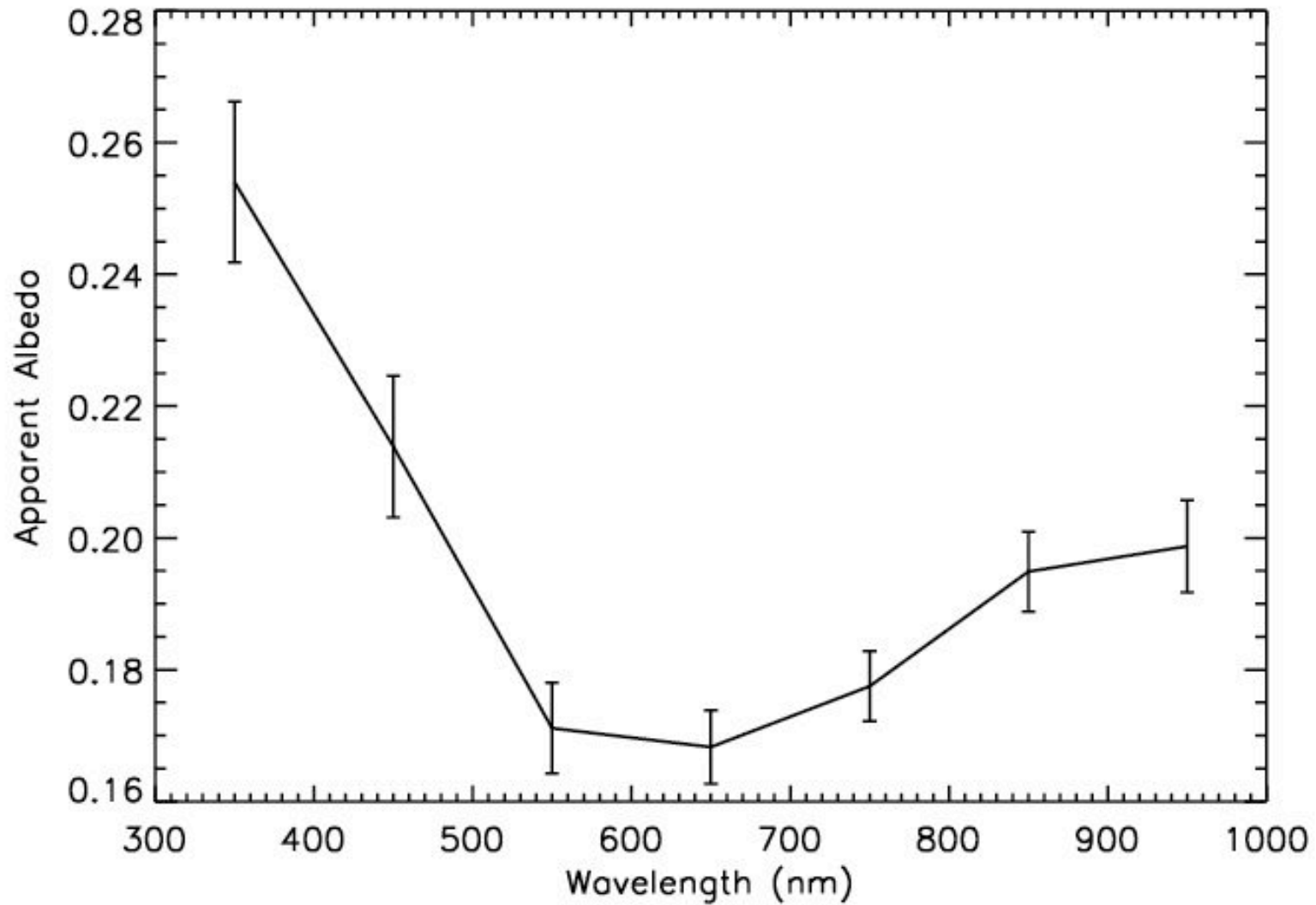


Eigencolors



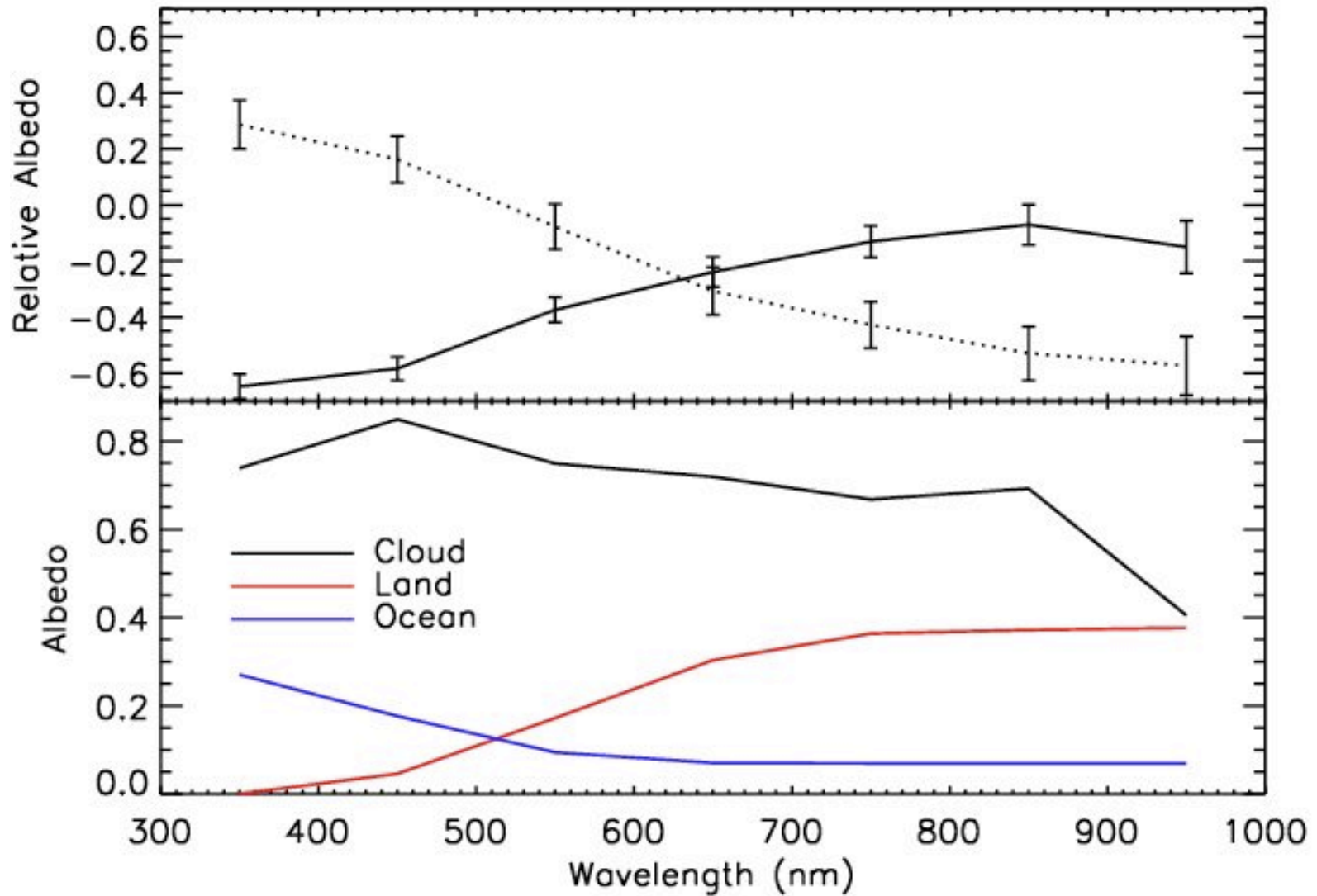
Cowan et al. (2009)

Earth from Above



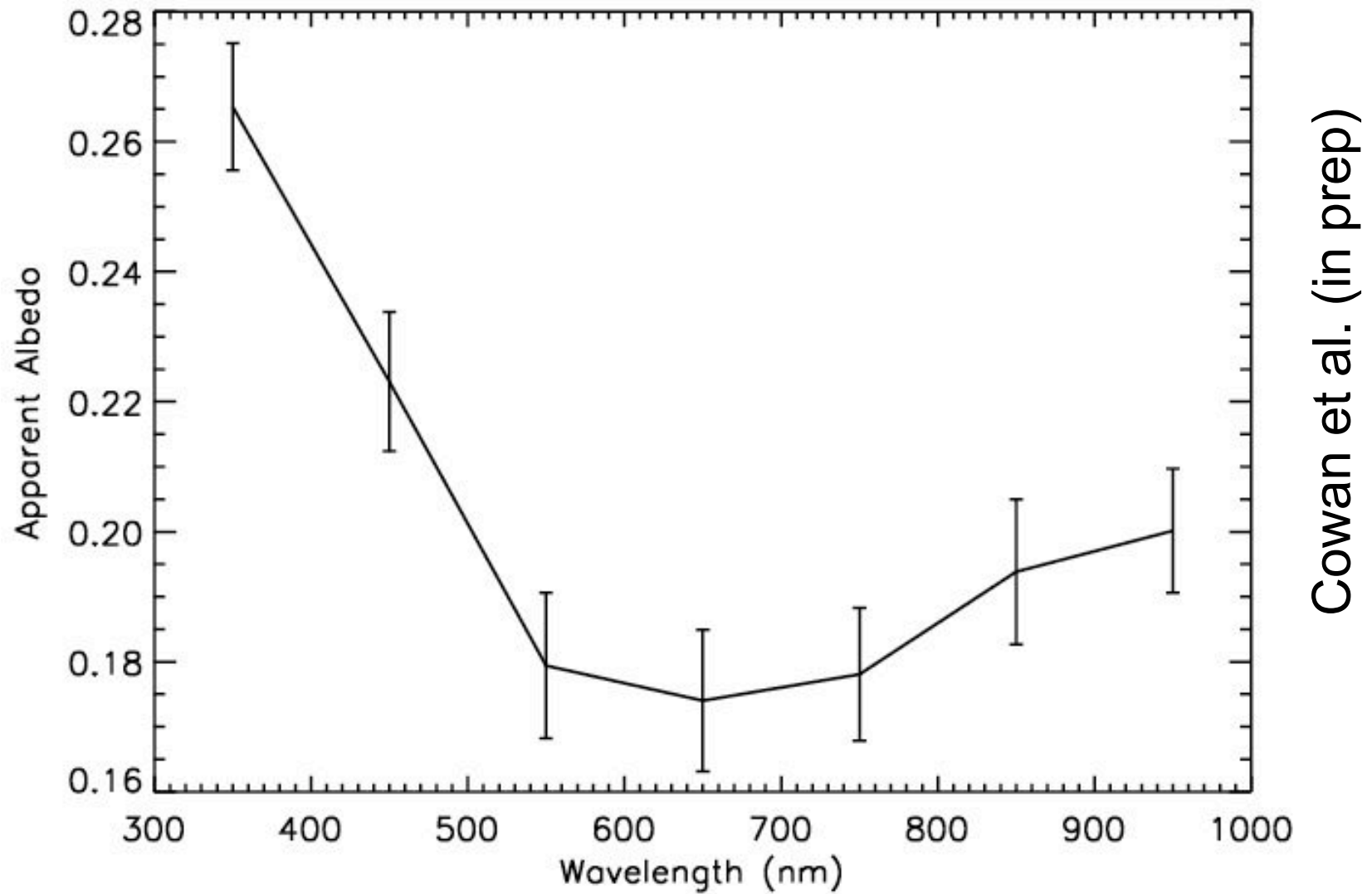
Cowan et al. (in prep)

Northern Eigencolors



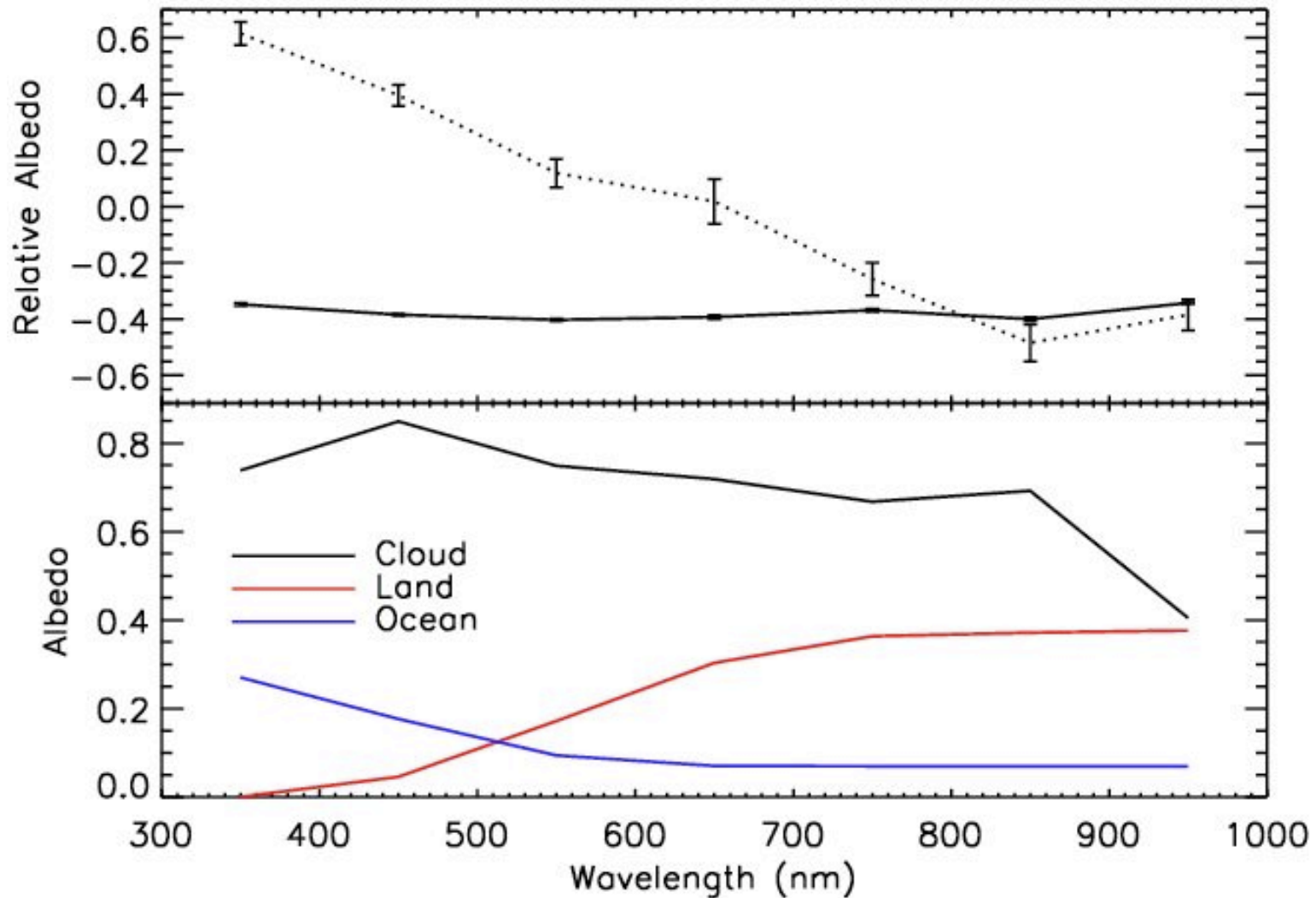
Cowan et al. (in prep)

Earth from Below



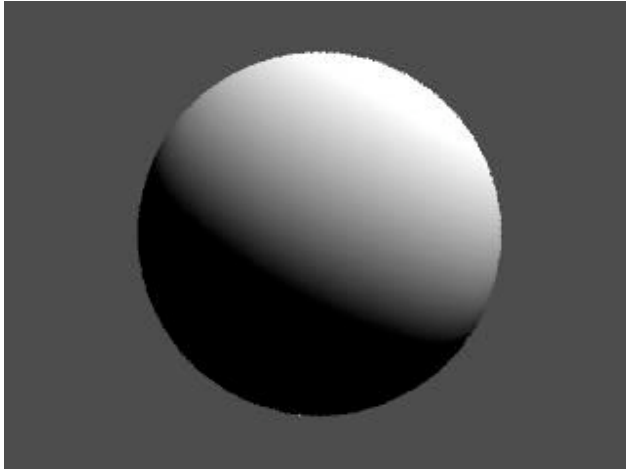
Cowan et al. (in prep)

Southern Eigencolors



Cowan et al. (in prep)

Reflected Light



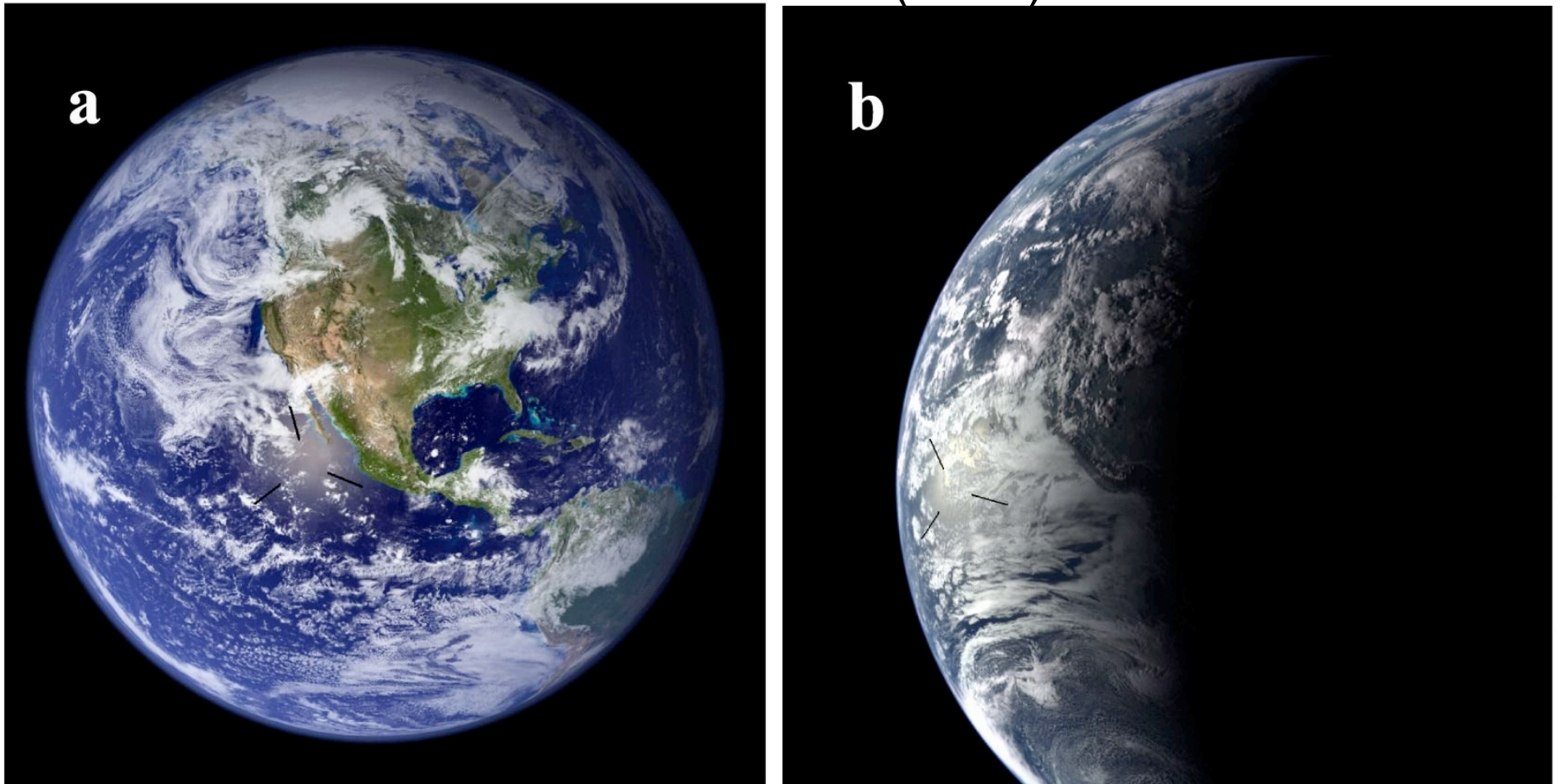
Diffuse (Lambert) Reflection



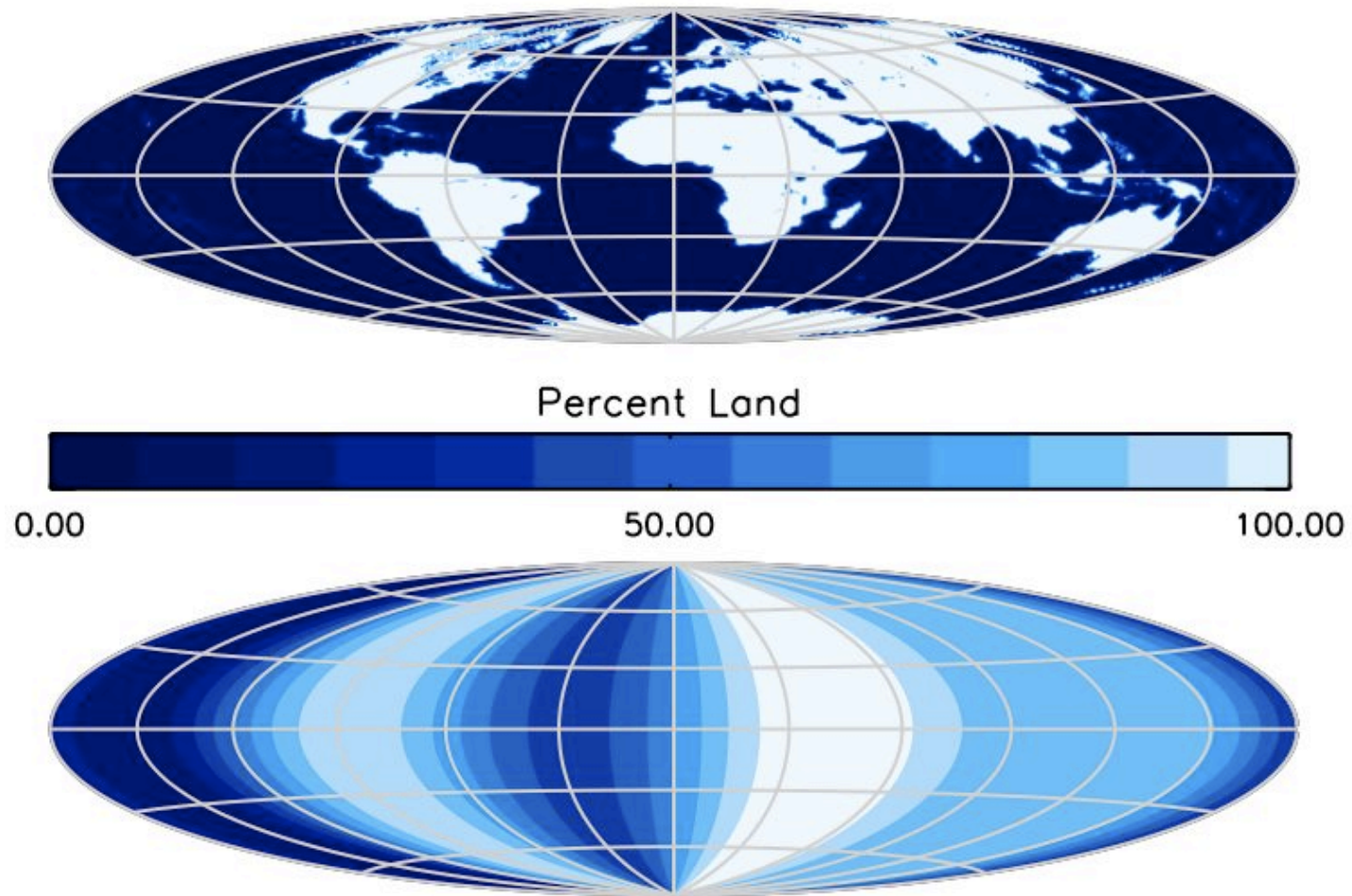
Specular (Shiny) Reflection

Specular Reflection (it's small)

Williams & Gaidos (2008)

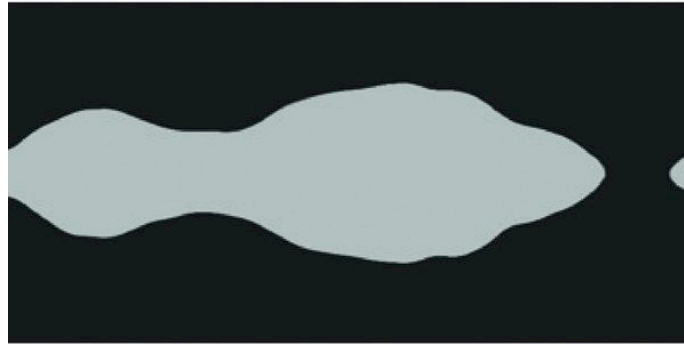


Equatorial Map



Cowan et al. (2009)

A Different Kind of Map



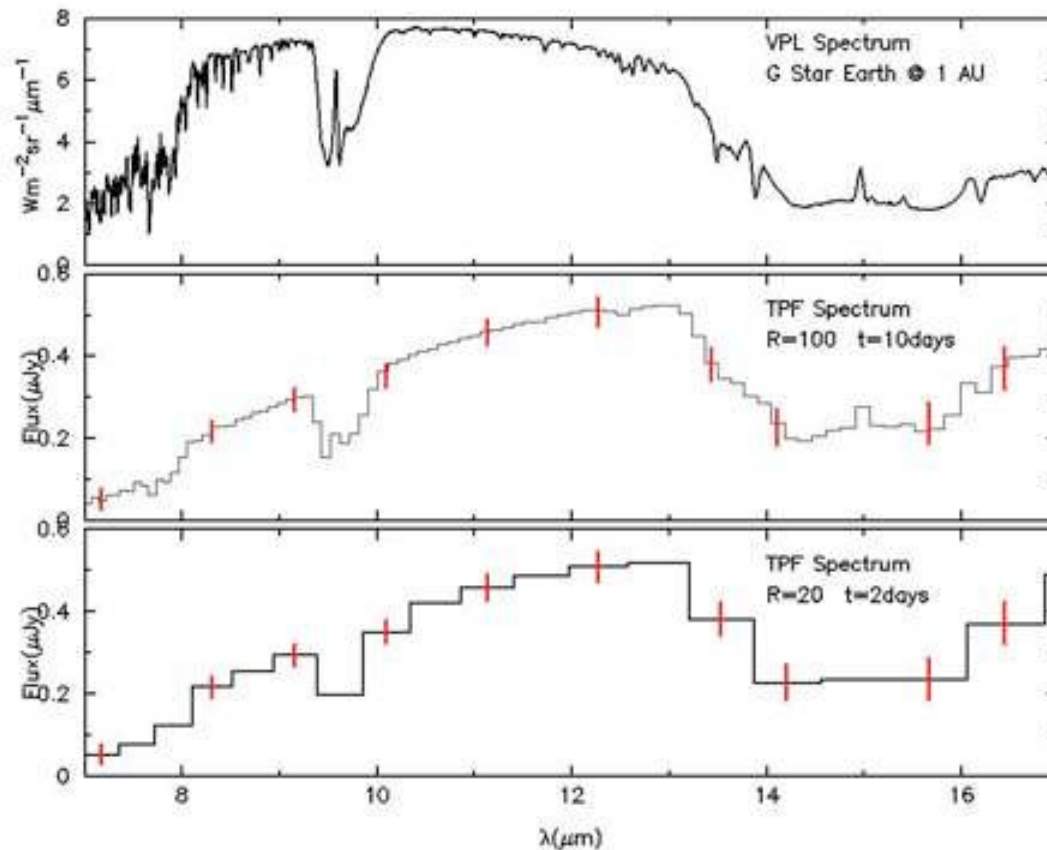
- 1) Simulated **white light** curve of Earth with real cloud cover
- 2) Can't recover major landforms

Oakley & Cash (2009)



Conclusion

Time-Resolved, Multi-Band Photometry
Complements Time-Averaged Spectroscopy



From VPL