

# NASA Astrobiology Institute Strategic White Paper



Courtesy F. Valero

## Astrobiology and Earth Science from ON or NEAR the Moon.

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Astrobiology Institute White Paper

# What is needed?

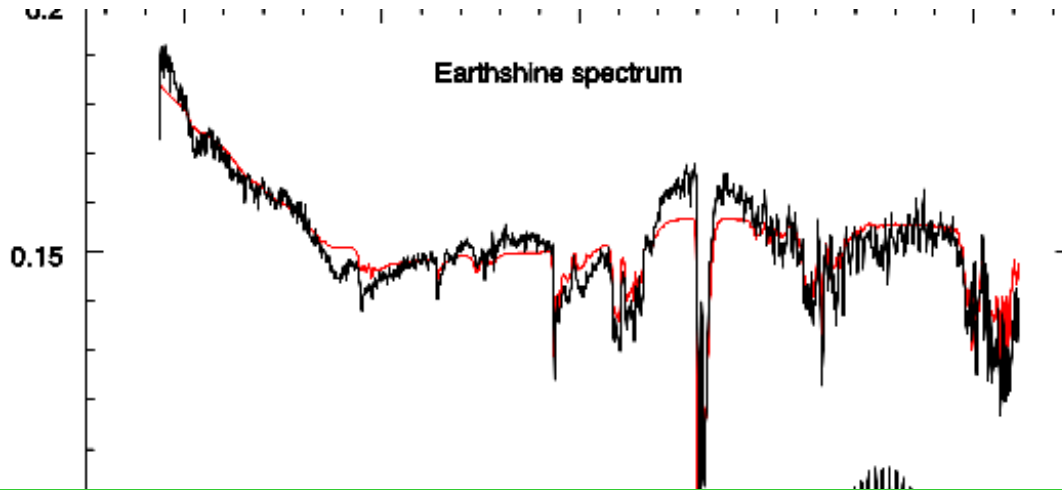
## Astrobiology (Prepares for TPF & beyond)

- Ground truth verified methods for observing Earth-like planets.
  - **Is there liquid water - surfaces, clouds?**
  - Interpretation of time variable observations.

## Earth Science (Poor person's DSCOVR)

- Full Earth for weather, climate & change.
  - Moon advantage includes mid-IR images for the "nighttime" data.
  - Inter-calibrates current satellite data.

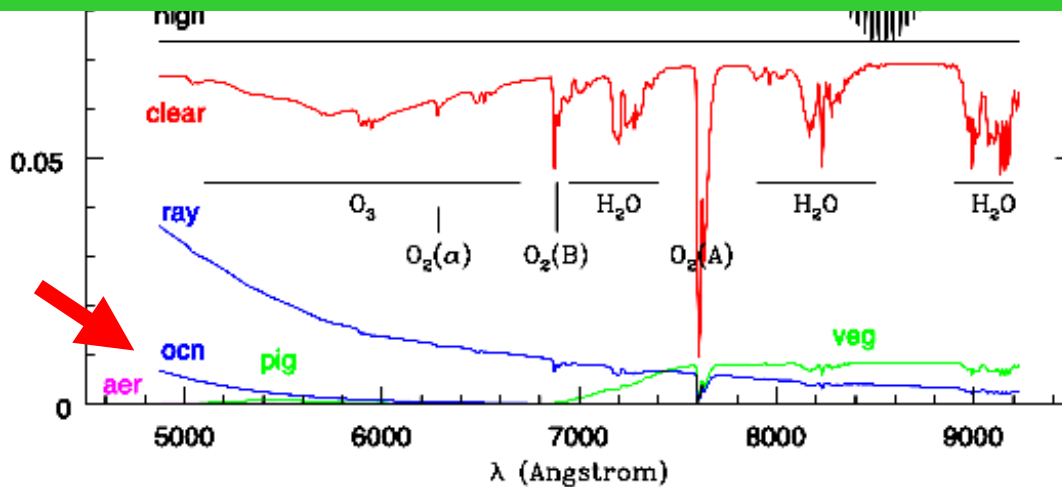
# Visible Spectrum of Earth



Spectral variation allows identification of some reflection components. **Liquid is not obvious!**



FACE VALIDITY, NOT GROUND TRUTH TESTED

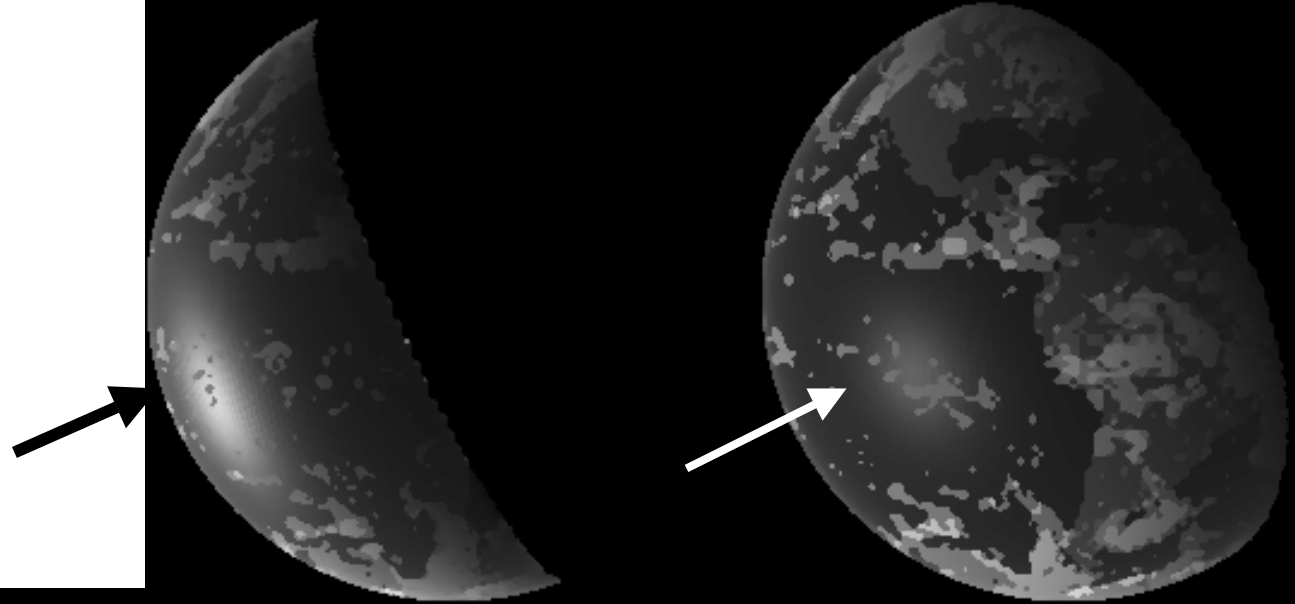


Earthshine only allows a narrow range of phases, and moon polarization limits polarimetry

Woolf, Smith, Traub, & Jucks, ApJ 2002;

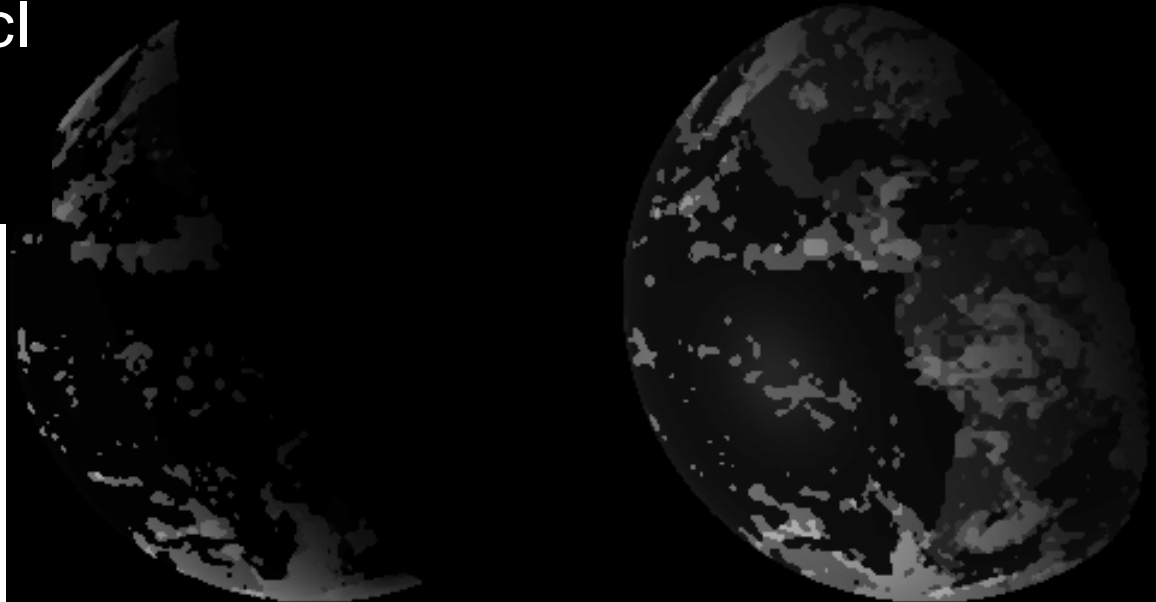
# Ocean Glint in Polarized Light

S-pol



From McCullough STScI  
Changes with angle of  
Reflection.

P-pol



# Polarization Advantage?

Water glint is polarized, but so is...

Ground scattering, Rayleigh scattering ,

Vegetation scattering,

Cloud polarization (measures  $\mu$ )

Separate by using **spectral character, phase, season & weather variation.**

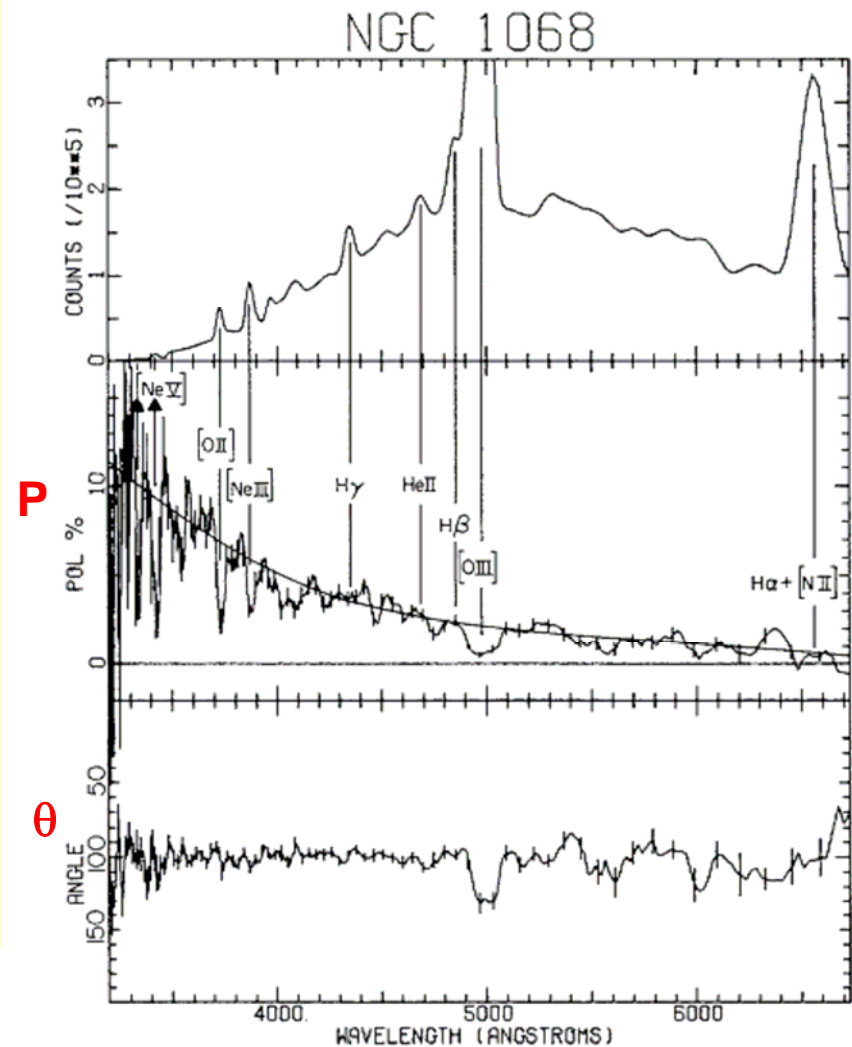
1. Spectropolarimetry vs phase angle plus time variations may discriminate.
2. **Imager ground truth is needed to validate single point data interpretation.**

# Spectropolarimetry discriminates with $P\%$ & $\theta$

Spectropolarimetry discovered vertical structure in a single pixel object.  $H\beta$  and  $[OIII]$  arise in different layers.

Implication for planets  
Polarizing processes with different spectra,  $P, \theta$  can be separated

Angel, Stockman, Woolf,  
Beavers & Martin Ap.J.1976



# On-Board Instruments

(Note: visual images to resolution of our title page are a fraction of a megapixel, obtainable with a few mm dia. lens of 70mm focal length.)

- 0.3-1.7 microns spectropolarimeter(s).
- 0.2-40 microns calorimeter
- 1.7-25 microns spectrometer(s)
  
- 0.34-0.8 microns imagers, including polariz<sup>n</sup>.
- Mid-IR imager (uncooled)

# Options for Placement

- Solar power is near-continuously available to a spacecraft at **Moon-Earth L1**, or **a lunar polar satellite**.

**Closer to Earth**, the Earth limb is lost.

**Further sites**, Earth-Sun L1, telescope is 5x linear larger, pointing precision is 5x higher. Night view is unobtainable.

From **"outpost"**, Earth often below the horizon.

Dust may present problems.

On the Moon, **where Earth is seen**, power unavailable for 14 days.

# For the Public & Education

“Earth from Space” showed how small and interacting we all are.

“Earth rotating seen from the Moon” shows how day and night work.

We watch weather patterns move across where we live.

Public will love it -

want to see it on their evening weather report.

# Astrobiology

To interpret  
extrasolar planets,  
we need to interpret  
the light from point.

We learn how from  
**observing Earth**

# Earth Science

Environment selects  
life-forms (Darwin)

**Observe Earth.**  
Use intelligence.  
Change course as  
needed!

Life-forms modify  
Environment.