National Aeronautics and Space Administration

Pre-Workshop

Exploring the Planetary Science Achievable from a Balloon-Based Observatory

Planetary Atmospheres Applications

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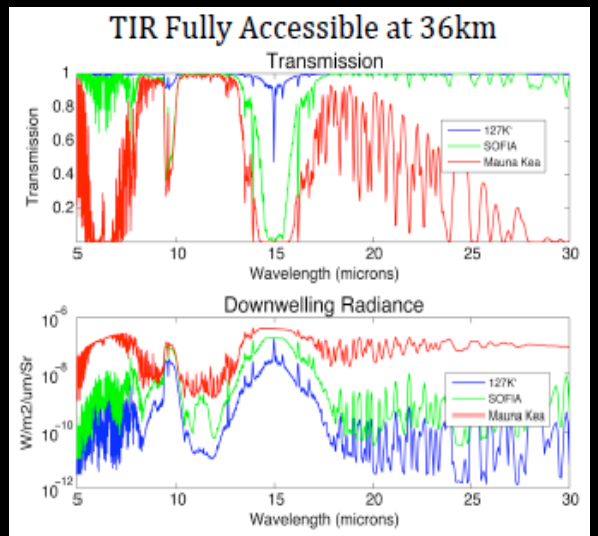
Why Balloons for Planetary Atmospheres?

1. Telluric Interference
2. Timescale of Deployment
3. Length of Observation
4. Observation Strategy

Telluric Interference

Absorption, emission, and scattering in Earth's atmosphere is a hindrance to major planetary atmosphere observation goals:

- Composition/Structure
- Dynamics
- Surface (atmospheric windows)



At 36 km, transmission is nearly 100% throughout the TIR and downwelling radiance is several times less than at 40K', and orders of magnitude less than at Mauna Kea. O_3 and CO_2 minimally absorb.

Hibbits et al., 2011

Icarus 212 (2011) 493–503

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Icarus

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Is there methane on Mars?

Kevin Zahnle [a,*], Richard S. Freedman [a], David C. Catling [b]

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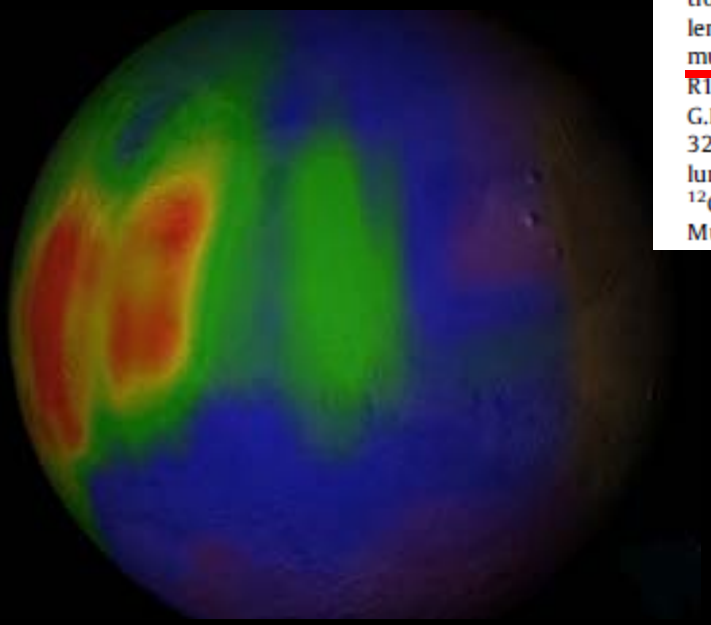


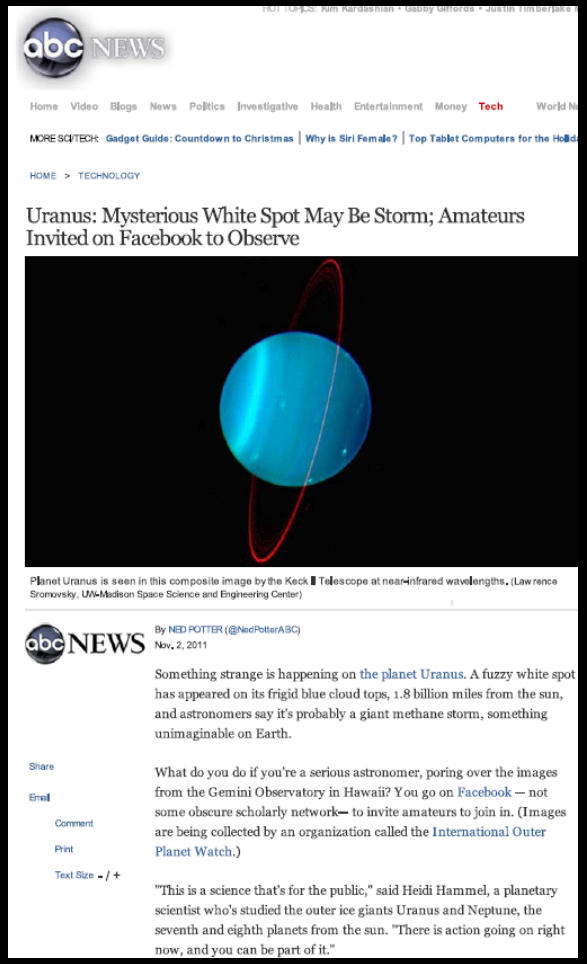
absorption lines that would be present on Earth or Mars at the wavelengths of the published observations. These reveal strong competing telluric absorption that is most problematic at just those wavelengths where methane's signature seems most clearly seen from Earth. The competing telluric lines must be removed with models. The best case for martian methane was made for the $^{12}CH_4$ ν_3 R0 and R1 lines seen in blueshift when Mars was approaching Earth in early 2003 (Mumma, M.J., Villanueva, G.L., Novak, R.E., Hewagama, T., Bonev, B.P., DiSanti, M.A., Mandell, A.M., Smith, M.D. [2009]. Science 323, 1041–1045). For these the Doppler shift moves the two martian lines into near coincidence with telluric $^{13}CH_4$ ν_3 R1 and R2 lines that are 10–50× stronger than the inferred martian lines. By contrast, the $^{12}CH_4$ ν_3 R0 and R1 lines when observed in redshift do not contend with telluric $^{13}CH_4$. For these lines, Mumma et al.'s observations and analyses are consistent with an upper limit on the order of 3 ppbv.

Timescale of Deployment

Atmospheres don't follow space mission schedules.

Rapid deployment capabilities are advantageous for dynamic atmospheres.

Rallying amateur astronomers using Facebook is powerful, but observations still suffer from Earth's atmospheric interference.



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Uranus: Mysterious White Spot May Be Storm; Amateurs Invited on Facebook to Observe

Planet Uranus is seen in this composite image by the Keck II Telescope at near-infrared wavelengths. (Lawrence Sromovsky, UW-Madison Space Science and Engineering Center)

abc NEWS

By NED POTTER (@NedPotterABC)
Nov. 2, 2011

Something strange is happening on the planet Uranus. A fuzzy white spot has appeared on its frigid blue cloud tops, 1.8 billion miles from the sun, and astronomers say it's probably a giant methane storm, something unimaginable on Earth.

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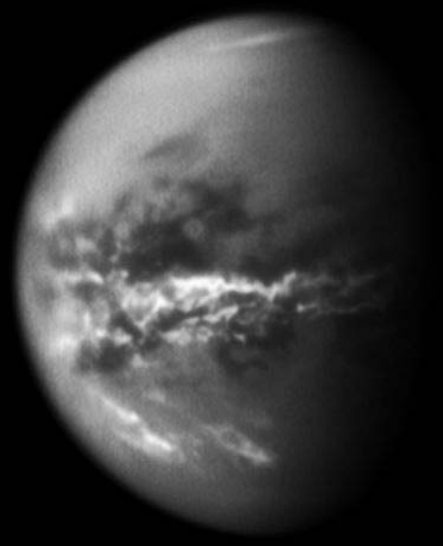
What do you do if you're a serious astronomer, poring over the images from the Gemini Observatory in Hawaii? You go on Facebook — not some obscure scholarly network— to invite amateurs to join in. (Images are being collected by an organization called the International Outer Planet Watch.)

"This is a science that's for the public," said Heidi Hammel, a planetary scientist who's studied the outer ice giants Uranus and Neptune, the seventh and eighth planets from the sun. "There is action going on right now, and you can be part of it."

Length of Observation

- Long-term, continuous monitoring from ground is rare.
- Spacecraft observe continuously, but not typically at the same location.
- Must piece together dynamic evolution using snapshots.
- Observational frequency may not match frequency of observed phenomena.

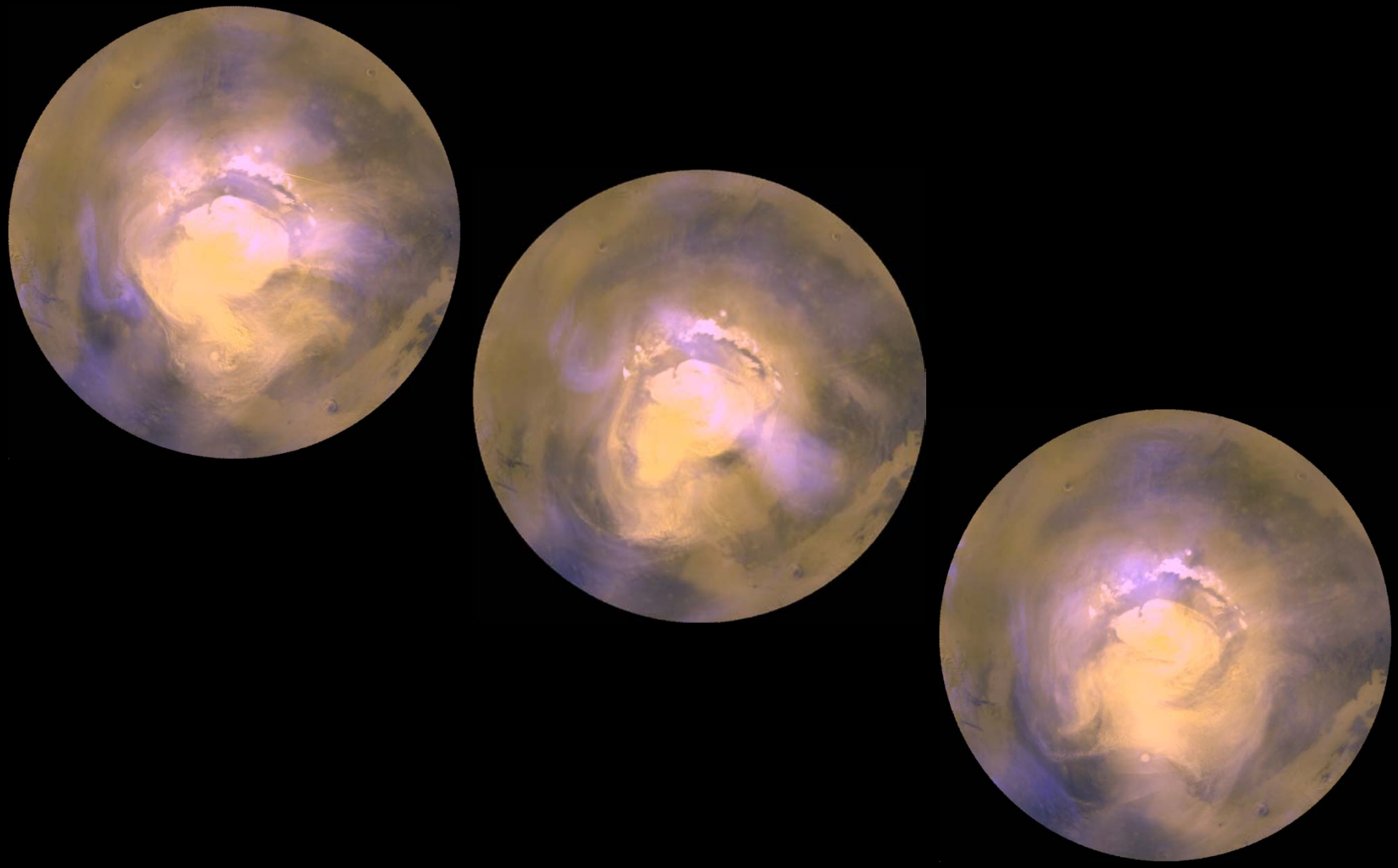


Where did these clouds come from?
How long have they been here?
How are they changing?

Observation Strategy

- Orbiting spacecraft generally do not provide synoptic observations over the disk.
- Observational aliasing can be significant.
- Synoptic (same time) observations are a foundation of terrestrial meteorology.

Pseudo-Synoptic Maps from Orbit

- Constructed from strips of orbital images from approximately the same local time.
- Significant aliasing of phenomena at harmonics of orbital period.
- These problems are eliminated by balloon observation.

3 Sols of Pseudo-Synoptic Images of Mars