Considerations for Planetary Science from Balloons

Presented to

NASA's Balloon Working Group

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Considerations for Planetary Science from Balloons

- Background & Introduction
- Science
- Platform Considerations
- Programmatics
- What is Desired

Background & Introduction

- **The 2013 Planetary Science Decadal report (Ref. 1) addressed high-altitude balloon platforms for planetary science with the following quote from the executive summary:** "Balloon- and rocket-borne telescopes offer a cost effective means of studying planetary bodies at wavelengths inaccessible from the ground."

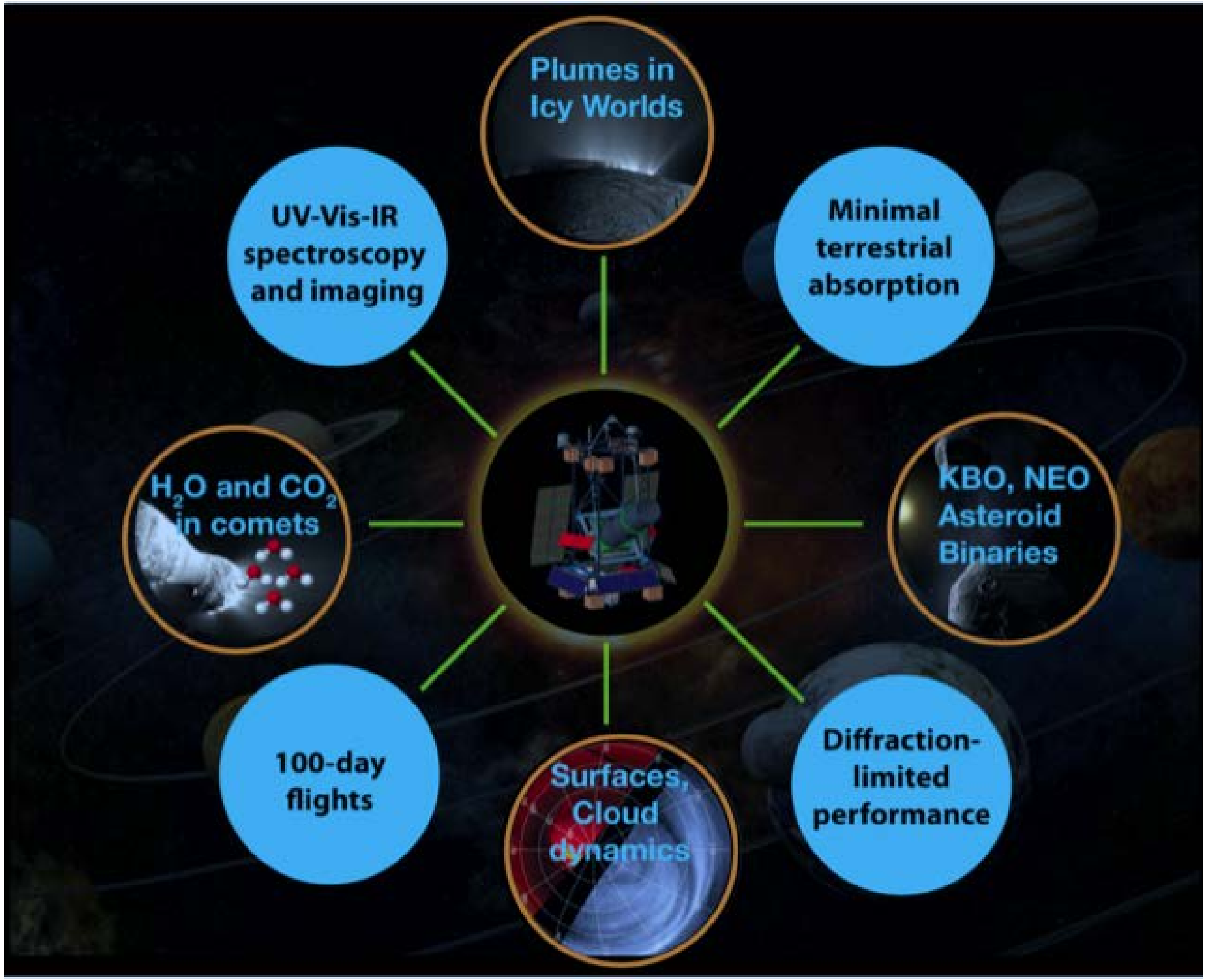
- Although NASA's Science Mission Directorate regularly flies balloon missions into the stratosphere, **there are no opportunities to fly or even propose a balloon mission for planetary science.**

- Working with Planetary Science Division (PSD) Director to consider options – This is a part of responding to guidance provided

Planetary Science Supported by Balloon Observations

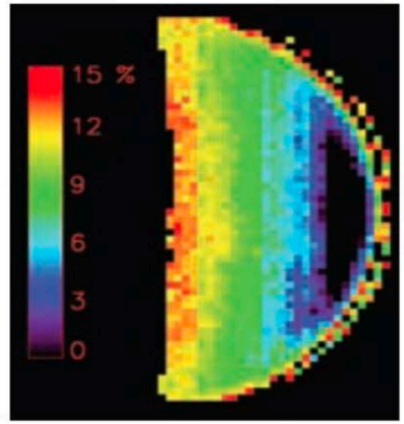
Blue circles: Principal advantages offered by a balloon-borne telescope

Orange circles: Example planetary science cases that could be addressed with balloon-borne observations



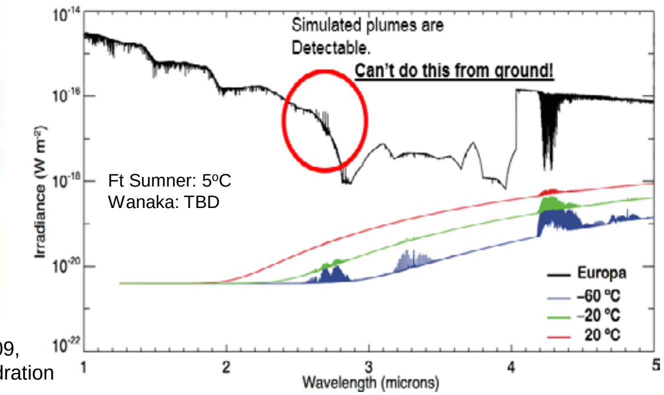
Example Science Cases: IR

- Exploring the temporal variability of lunar water in the 3 µm region would reveal the diurnal variability of water ice, which has important implications for both lunar volatile evolution studies and NASA's lunar exploration initiatives.



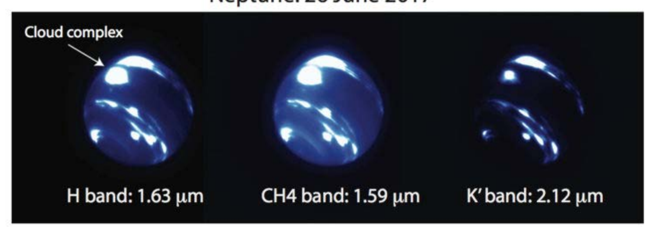
Map of lunar hydration feature band depth in June 2009, looking down on the north pole, showing strongest hydration at terminator; from Sunshine et al. (2009)

IR Analysis for Europa

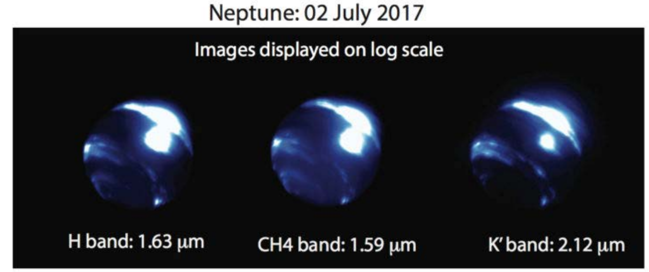


- High-resolution spectroscopy on a balloon platform can provide unique molecular identification of water plumes in icy environments, e.g. Europa, not achievable from the ground.

Neptune: 26 June 2017



Neptune: 02 July 2017



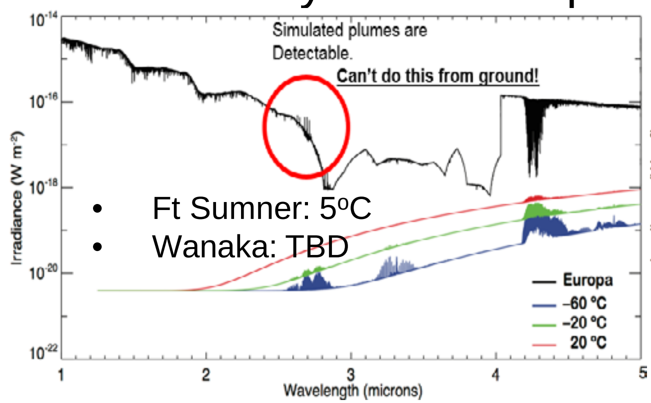
- Studying the temporal evolution of storm clouds in ice giant atmospheres provides insight into their thermodynamics.

Science
IR Summary

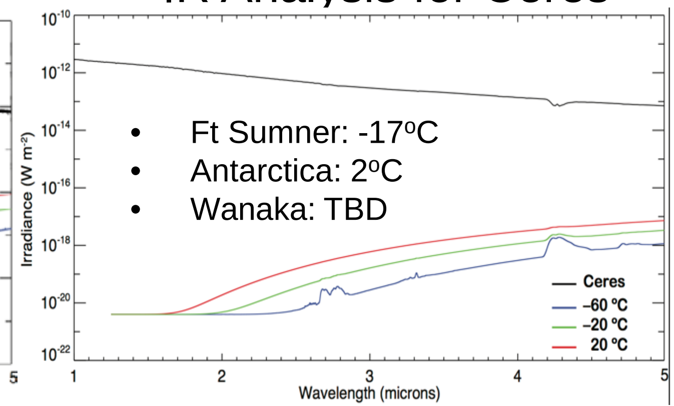
- Analysis shows a planetary balloon platform with a 1 meter telescope can achieve a broad range of IR science, not well suited to ground based observatories
- Science can be done at even the warmest conditions
- IR observations can be done in both daytime and nighttime conditions
- High resolution spectroscopy broadens the IR science achievable

1-Hour exposure:
Target Flux is well above Noise Floor

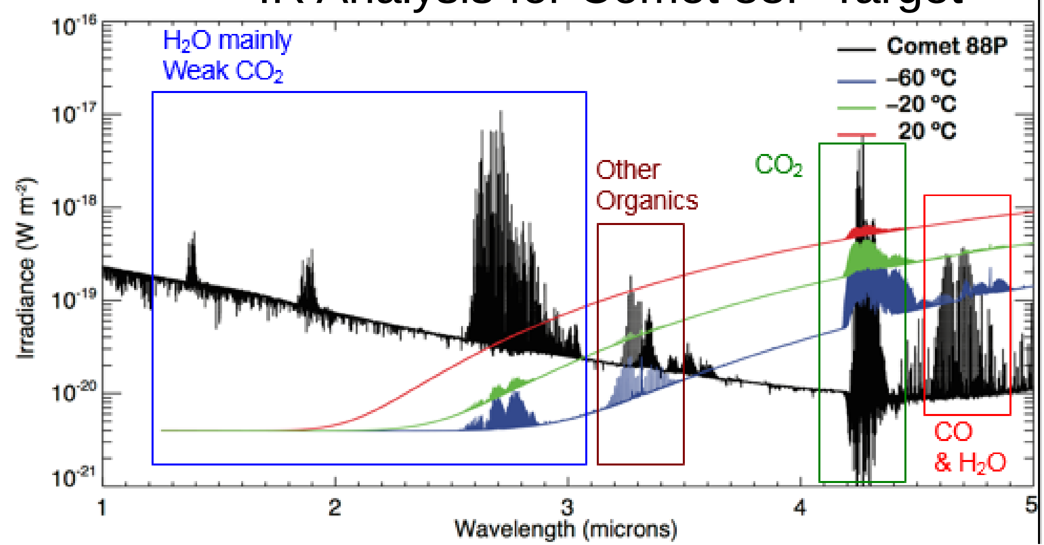
IR Analysis for Europa



IR Analysis for Ceres



IR Analysis for Comet 88P Target



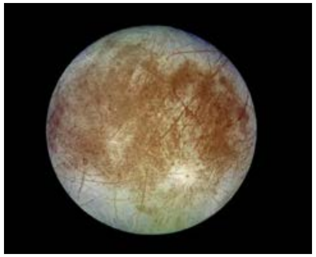
- Ft Sumner: 0°C to -20°C: Study H_2O, CO_2, Other Organics
- Antarctica: temps as low as -40°C: Study H_2O, CO_2, Other Organics, possibly CO

Science

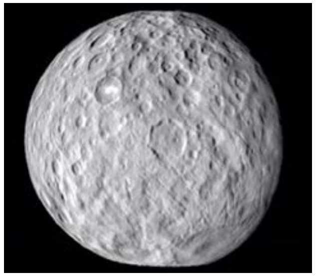
A balloon platform with 1 meter telescope and IR instrument with active cooling is ideal for IR monitoring of temporal variations on planetary bodies associated with eruptions of volatile materials

Enables repeated observations over months to observe periodic eruptions that are hard to capture from the ground or from other assets that can't devote multiple observation opportunities.

Europa: Eruptions from Europa are likely water vapor however, this is hard to detect and still not completely confirmed. To confirm the activity a high cadence of observations is required.



Ceres: The Dawn mission to Ceres has discovered a cryovolcano on its surface and the likelihood that liquid water can still exist in its subsurface. The existence of a cryovolcano is evidence of past activity and the presence of liquid water allows future activity to remain a possibility.



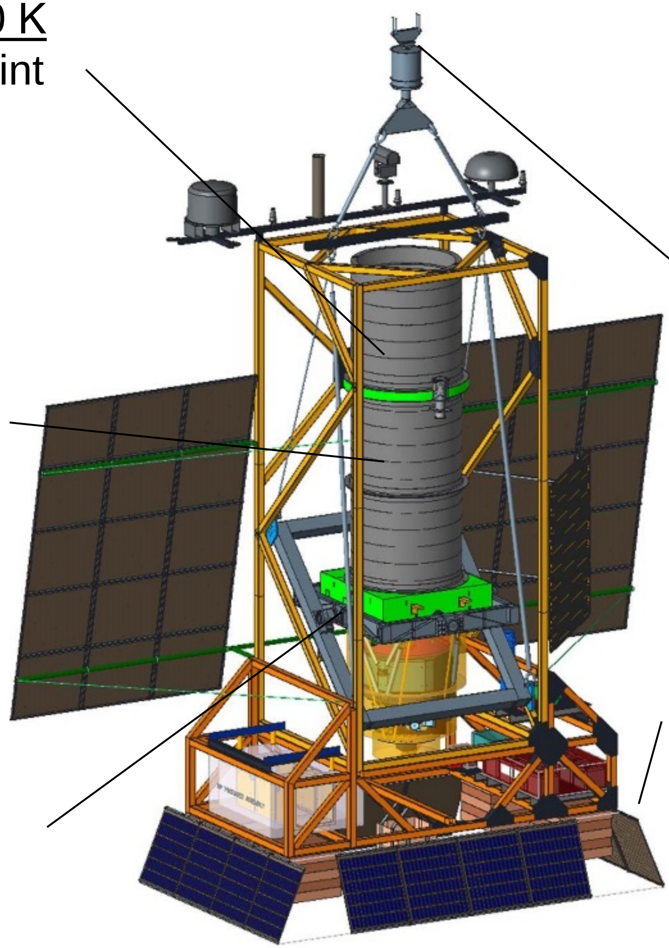
Comets: Comets are most active as they approach the Sun in their orbit. The compositions of the solar induced outgassing can vary in time. Missions can study comet tails and the variation in the outgassing composition.

Ultimate IR Platform

Telescope temperatures ≤ 250 K
- Allow for observations of faint Solar Stem objects

Telescope Aperature ≥ 1m
- Allows cost effective collection of light for greatest Signal to noise ratios

Capability of ≤ 0.5” pointing stability
- Allows for observations of extended objects and multiple short duration exposures



Flights of ≥ 33 km in altitude
- Minimizes the effects of Earth’s atmosphere on observations in the IR

Temporal Coverage ≥ 90 days
- Long duration flights allow for monitoring of time variable processes on Solar System targets

Note: This is the ideal platform / mission: a lot of IR science can be accomplished with platforms of lower capabilities Telescope Aperature ≥ 1m

Programmatic Considerations

1. Compelling and cost effective planetary science is achievable

2. Needed platform (E.g. pointing) capabilities demonstrated on several missions

3. For next steps - focus on NIR-MIR

4. Observatory approach highly desired but not required

5. Several options could be used to allow a planetary balloon mission submission

What is Desired

1. Identify a mechanism for balloon borne planetary science missions to be proposed
    1. Opportunity to compete science / per mission dollar
2. Address recommendation of current Planetary Decadal Survey
3. Suggest using observatory model (compete science /per flight) but observatory would be NASA / PSD asset
    1. Other models viable as well
4. Request Balloon Working Group consider a finding for PSD to identify mechanism to allow for proposing a planetary balloon mission
5. Can BWG review and/or “endorse” planetary decadal white paper?