
Weather Impacts on UAS Performance, Endurance, Stability and Control

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UAS Traffic Management (UTM)

- UTM is premised on the concept of “geofencing” to ensure that UASs fly in their assigned airspace.
- Hence, one of the key challenges with integrating weather into UTM operations is determining the effect of weather on UAS performance, endurance, stability and control.

That is: What impact does weather have on keeping a UAS within its geofence?

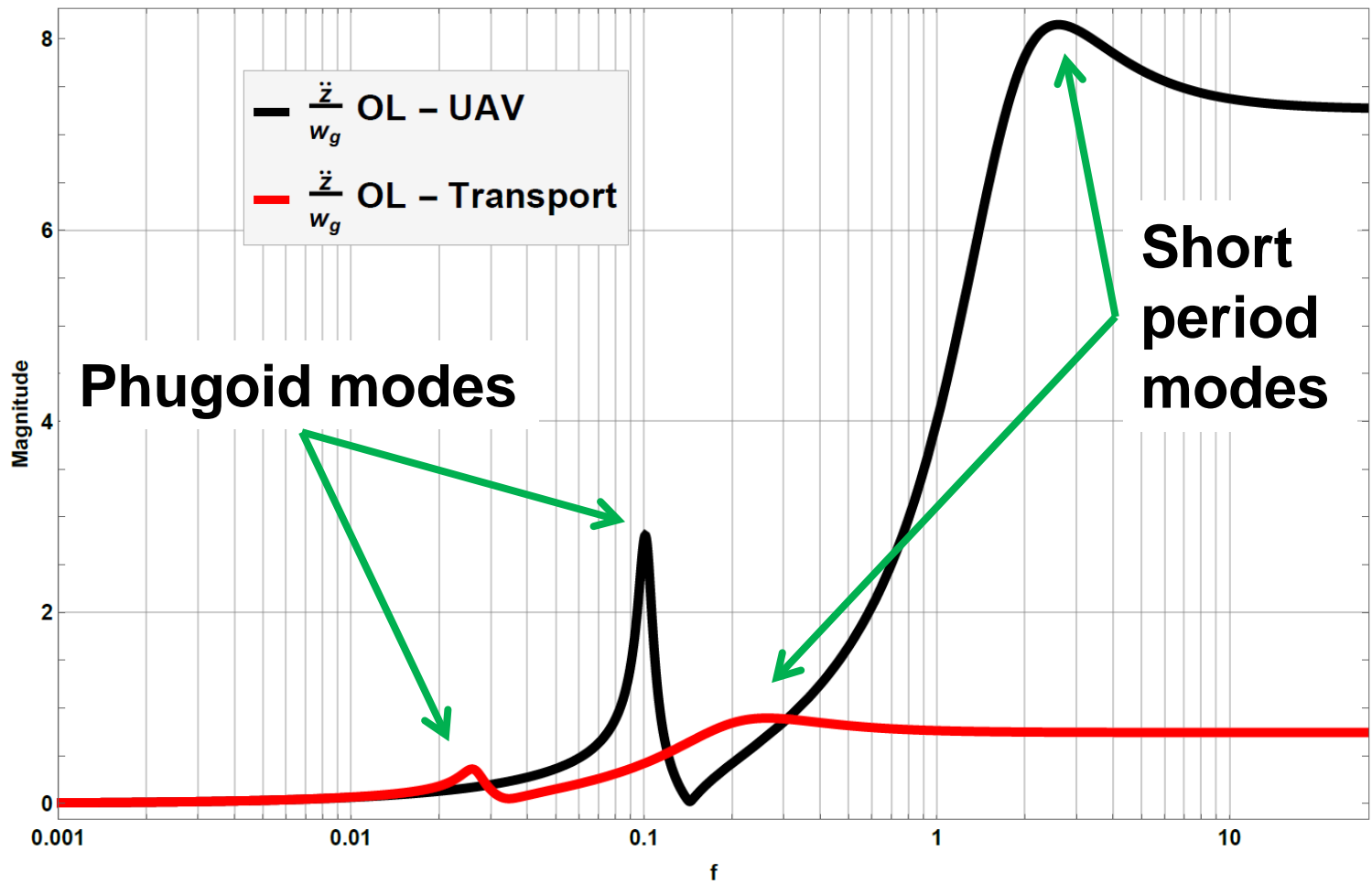
Key Wx Factors Affecting UAS Performance, Endurance, Stability & Control

- Wind
- Wind shear
- Turbulence and discrete gusts
- Heavy precip.
- Icing
- Air density
- Temperature

Let's focus on wind and wind gusts

- Headwind/tailwind can effect performance and endurance.
- Crosswind can effect ability to maintain track.
- Wind gusts can effect stability and control, ability to maintain track and/or altitude.
- Wind gusts can even effect performance and endurance (e.g., energy required to drive control surfaces and throttle).

Much Stronger Response to w_g for UAV vs. Transport - w/o Autopilot



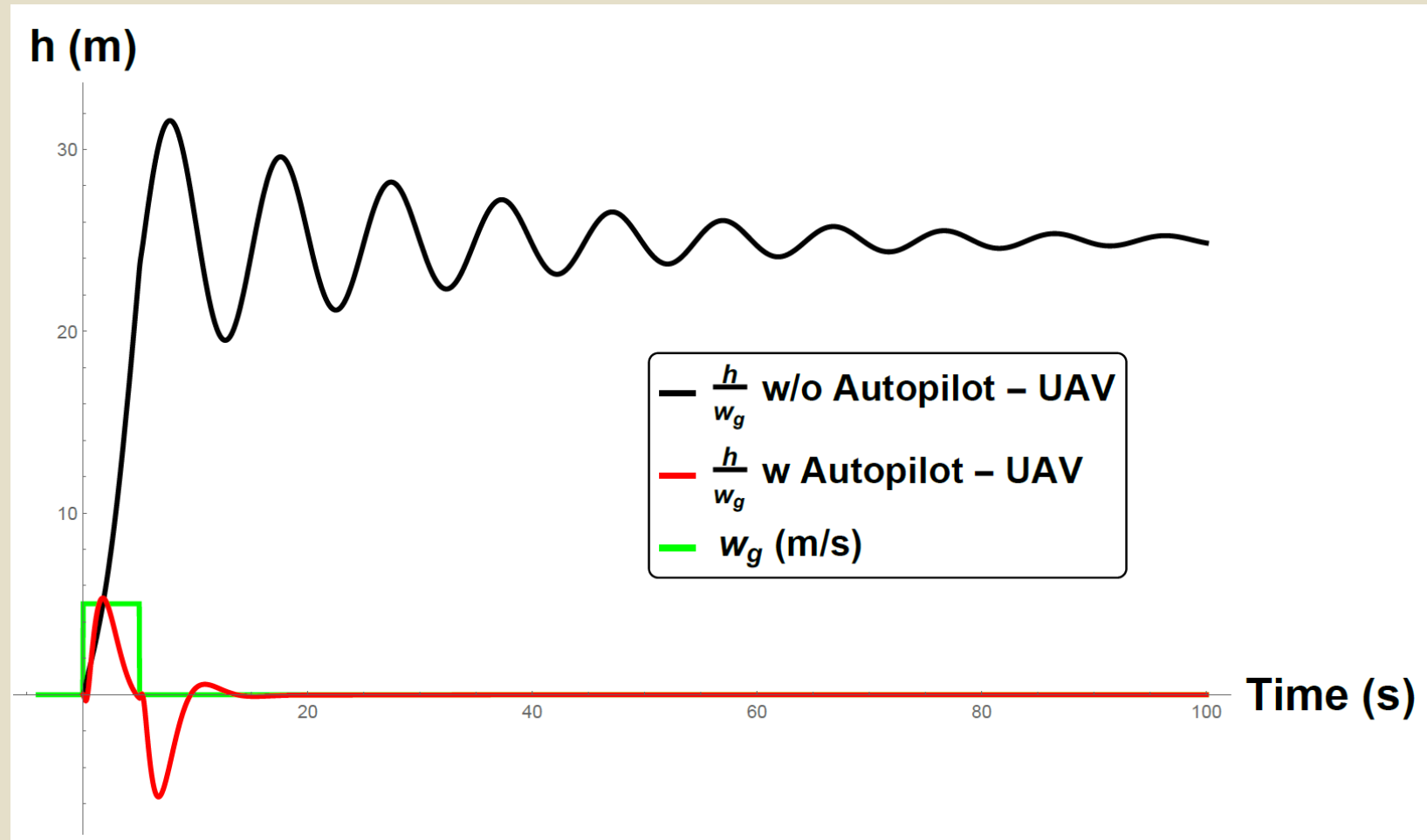
Long wavelengths

Short wavelengths

Autopilot

- In order to fully characterize the effects of wind on UAS flight, we must take into account the specifics of the autopilot.
- Example: altitude hold mode
 - A sophisticated autopilot will use pitch, pitch rate, and perhaps airspeed to control altitude
 - A less-sophisticated one might just use throttle.
 - What happens when updraft overwhelms UAS's ability to hold altitude?
 - What happens when baro pressure measurements are changing due to wind gusts?

Height Response of UAV to Vertical Step Gust w/ and w/o Autopilot



Issues

- Do we need “dynamic geofencing” to account for wx effects, and how would one do that?
 - For spatial and temporal scales of interest for UASs, we would need probabilistic forecasts (e.g., “30% chance of >5m/s updrafts this afternoon.”)
 - Need to take into account terrain and obstructions (e.g., buildings/trees) on wind fields.
 - Need to take into account specifics of vehicle/autopilot system – “translation algorithms”