Based on conversation with Todd Pedersen, 3 June 2020.

Goal: Demonstrate ability to predict general propagation characteristics and ability to optimize cloud deployment location to shadow a specified target region in realtime. This effort is sponsored by a third party and AFRL needs to demonstrate to the customer that they can understand and interpret conditions and expected outcomes in real time. The launch date is now Feb 2021.

The “optimization” is not really an automated process at this point, but rather the need for a tool that will quickly provide easily accessible results to the user. I am surmising that visualization will be required for this. Essentially, he wants a tool that will allow them to quickly see the effects of where a given release occurs and allow them to explore the trade space. One of the main tradeoffs he identified was the effect of altitude on cloud characteristics: lower altitude results in smaller, denser cloud whereas higher altitude leads to larger, less concentrated cloud.

They are not worried about early time (~first 2 minutes) and are mainly concerned with the evolution after the initial burst. He said they have a “one-line” model for how the cloud evolves (I think ERT has this?) and is concerned that we will get bogged down with accuracy at the expense of computing time; rapid results are needed. He does not think magnetized ray tracing will support the temporal constraints and said he did not think the errors inherent in neglecting the magnetic field would be prohibitive. We should analyze the geometry and verify/bound the errors based on our previous analysis with Pharlap.

The strategy that Nelson described about 2D homing the natural ionosphere to identify the ray paths that we want to perturb is a good starting point. After that the cloud can be inserted between a range of altitudes on either up- or down-going rays. I haven’t seen the model, but I assume that cloud “size” is determined purely by amount of material, time and altitude. This should be specified for us, or we can make it a variable to facilitate exploration of different scenarios. There are not too many dimensions to this thing at this point, I don’t think, so it seems doable. We will need fast reliable 3D ray tracing and possibly investigate simple lens calculations for at least of range of frequencies for given cloud parameters.

Constraints for PRECISE specifically:

1. Flight trajectory is fixed to the western-most azimuth allowed from Wallops Island. This will place the downleg propagation effects over Puerto Rico. They are awaiting confirmation that Wallops can actually support that azimuth. Upleg effects will be over the ocean.
2. Release timers can be adjusted (determine release point) within ~1 hr of launch.
3. Release altitudes: 150 - 200 km (in general could be ~100+ to F2 peak)
4. Release can be upleg or downleg (3 releases, 2 canisters per release, 10-20 secs apart). We should start to get an idea of what the extent of such a cloud will be now.
5. Key parameter to consider is altitude/size/dilution trade-off (lower alt: smaller denser cloud)
6. Closer to source has larger solid angle and ray deviation (kmg), but could be more vulnerable to drift (trp).

It seems to me that a true optimization procedure requires a quantified definition of desired outcome, and that is probably a moving target right now and may differ depending on use case. It sounds like the mission with PRECISE is to block a certain frequency range from a certain region and demonstrate that the technology can be understood and implemented in real-time. This seems to me like the use of real-time ionospheric measurements is required and I’m not sure that Todd understands there is no plan to ingest data in the java-version of the code. I will revisit that with him later.