Flight Sensitivity for ISRU Lunar Oxygen Export

How influential are the flight cost differences depending on the global lunar location?

Why is location dependency relevant? → Production efficiency changes by location (soil material, solar energy).

For a given scenario: Produce and export 15 tons of Oxygen to a propellant depot per year.

Determining the optimum of the supply chain (minimum machinery mass for production & fuel mass for logistics).

Task Procedure

1. Identifying all factors in calculations for process-mass that change with a different regolith composition

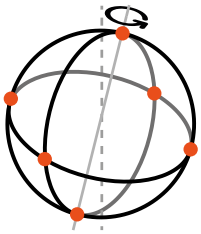
Process	Factor
Ilmenite Reduction	% Ilmenite → TiO2 as proxy
Molten Regolith Electrolysis (MRE)	3 classes Highlands, High-Ti Mare, Low-Ti Mare
Molten Salt Electrolysis (MSE)	...
maybe (Carbothermal Reduction)	

➤ Result: parametric function of all processes combined into full landscape: factors → best process

2. Understand the general landscape of expected deltaV and draw conclusions

   Where are extreme points for certain destinations and can a gradient be assumed?

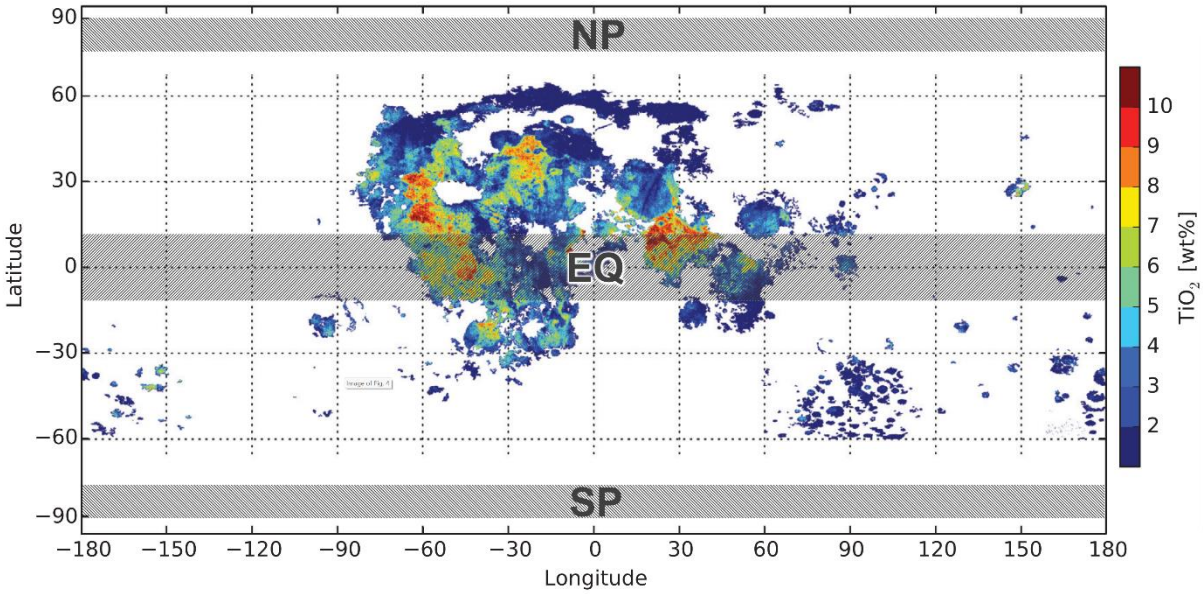
   Which regions can be expected to have a similar deltaV to group them together?



➤ Result: Regions with approximate homogeneity and a reference point for calculation
maybe even a deltaV map can be created when gradient assumption is given

3. Associate regions (e.g. [North pole, Equator, South pole]) with a factor range as a restriction

   Maps for all factors:
   - Solar energy / Illumination map
   - Ilmenite map (over TiO2 map as proxy)
   - Classification map: Highlands, High-Ti Mare, Low-Ti Mare



➤ Result: Region → factor map → best process

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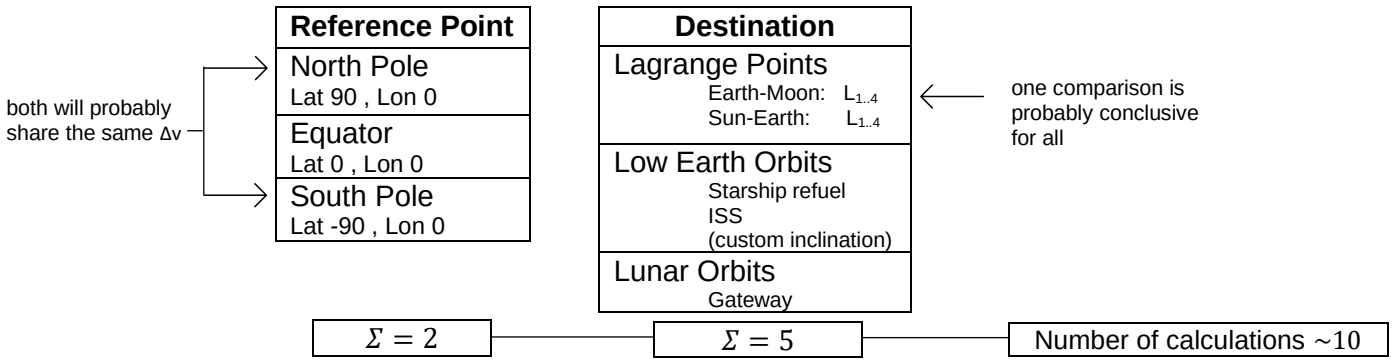
4. Calculate the deltaV of each route from reference point to destination and back

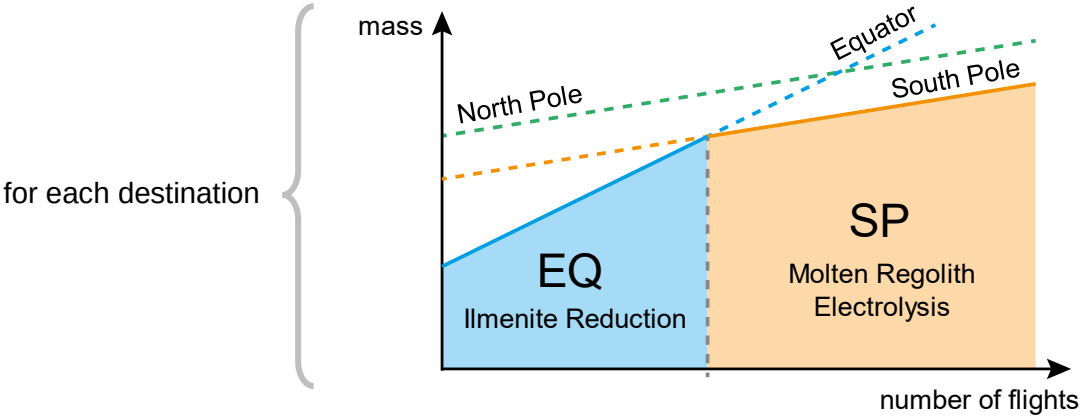


➤ Result: deltaV → fuel usage (kg) per flight for a reference logistics launcher

5. Combine ISRU machinery mass for production & fuel mass for logistic flights

   Build a reasonable equation to unite the mass efforts (some kind of weighted sum)

   - Considering that the launchers fuel is unlike the ISRU machinery not completely brought from earth to the lunar surface
   - the liquid Oxygen of the launcher could be provided by the ISRU production itself
     → feedback into production mass requirement



➤ Result: best location and process for a given destination and number of flights

6. Specify the importance of the flight introduced expenses

   Perform a sensitivity analysis
   Testing for scalability of the production mass related to real-world applications

➤ Result: Is the influence of the flight neglectable or not for the decision where to locate an ISRU plant
   If not neglectable → a deltaV influence map could be given to include this into future decision making