Global Entry Corridor:

Accurate tool for landing site selection in planetary exploration

D.Bonetti, R. Haya Ramos. DEIMOS Space, Spain.

1. Introduction

Probes for interplanetary exploration are always optimum solutions in terms of cost, designed to safely achieve the mission objectives.

Exploration probes must be robust enough to compensate with **margins** the expected environmental variability they are going to face. Robustness implies flexibility but extra margins imply extra costs.

It is not possible to land a planetary probe in any point of the desired target planet. Typically there are regions that are not compliant with the **engineering requirements** and regions that are less interesting from a **scientific objectives** point of view.

Identification of these landing areas is a task involving several different aspects of the mission.

2. Global Entry Corridor

When the planet is surrounded by an atmosphere, one of the key drivers of an interplanetary exploration mission is to survive the critical **entry phase**.

The entry corridor is the classic concept implemented in the analyses: the **Local Entry Corridor** (LEC) provides the corridor limits for a given single set of boundary conditions relying on accurate multiple simulations of the entry in worst case conditions.

The **Global Entry Corridor** (GEC) is an extension of the LEC to a planetary or regional level taking into account the characteristics of each site (topography, atmosphere, arrival conditions...). One of the tool outputs are longitude-latitude **entry performances maps** constrained by the engineering requirements.

3. Filtering Maps

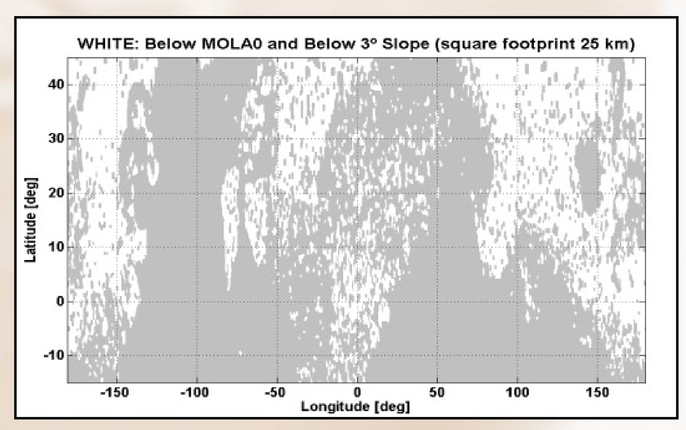
As an example of the of the criteria for the selection of candidate landing sites, in the frame of the **ESA Exomars Mission** the following filtering conditions have been considered:

Terrain filtering:

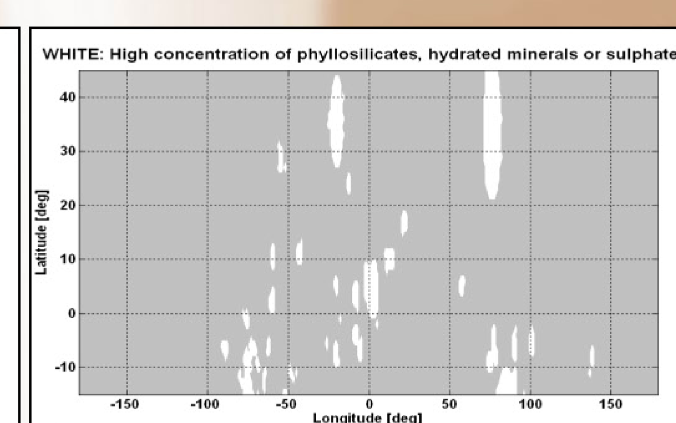
- Latitude band
- Terrain slope
- Maximum landing site topographic altitude
- Landing site footprint: shape and size

Scientific objective:

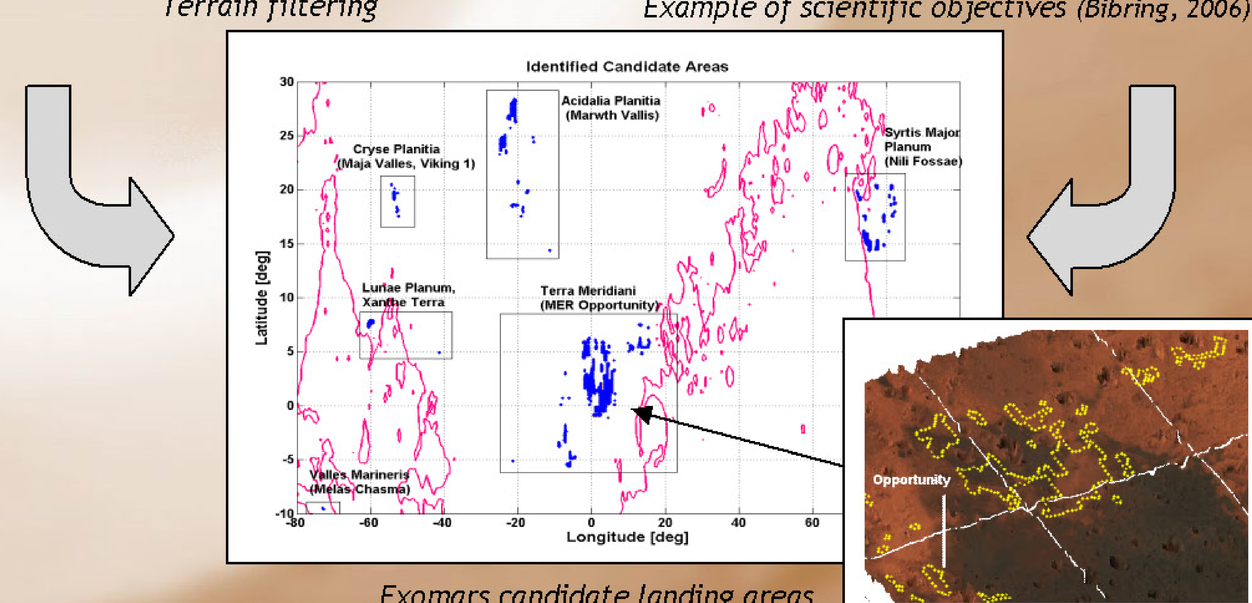
- Phyllosilicates and hydrated minerals rich areas (based on public information available and not on official mission requirements documents)



Terrain filtering



Example of scientific objectives (Bibring, 2006)



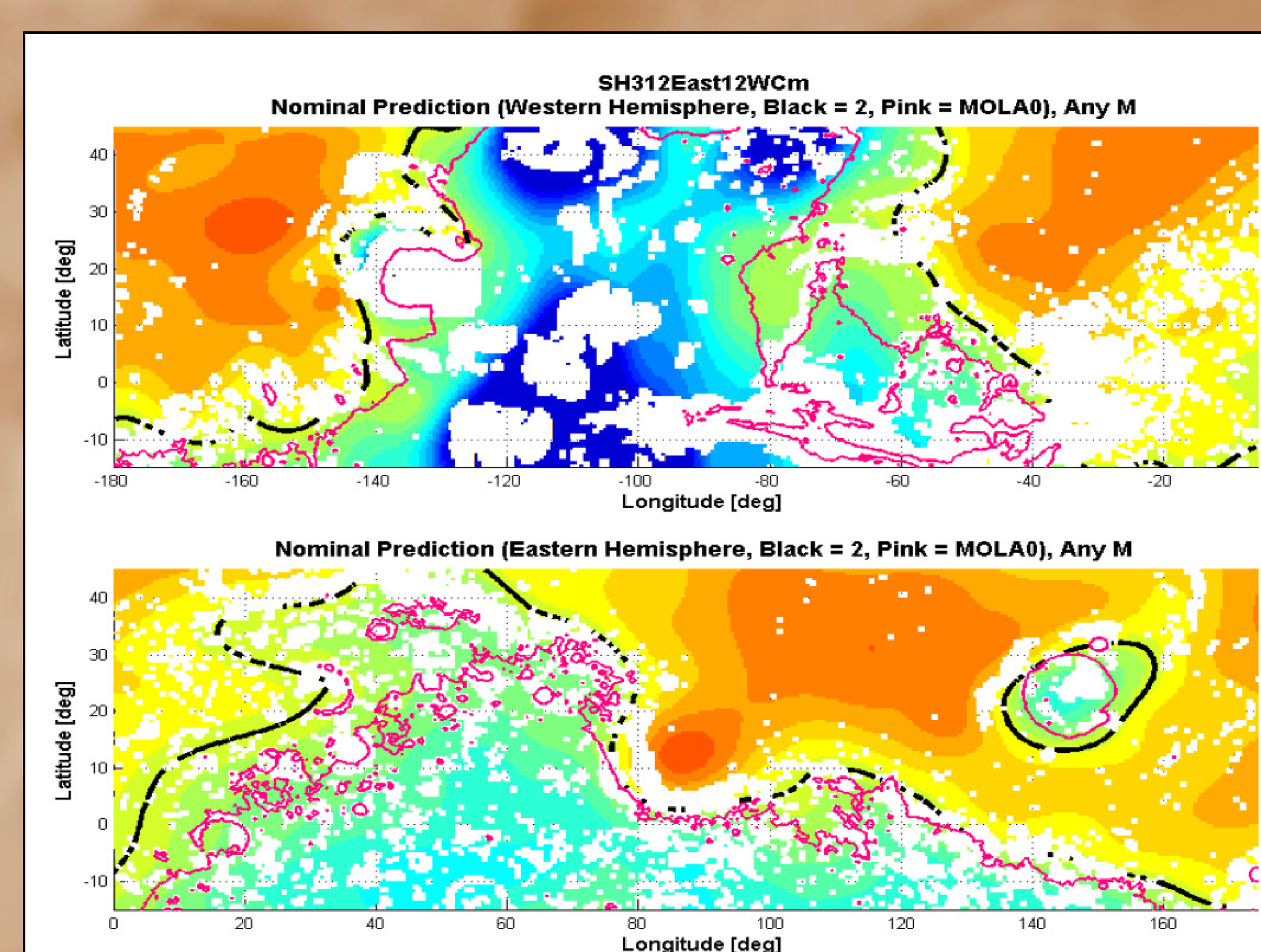
Exomars candidate landing areas

4. GEC Performances Maps

Given the GEC variability on the boundary conditions (landing site coordinates among others), one of the graphical outputs of the GEC are **planetary contour maps** that provide an accurate overview of selected performances.

For ballistic entry probes (i.e. Exomars and Mars Next) the most synthetic view of the entry phase performances is given by the flight path angle (FPA) **entry corridor width** at the Entry Interface Point.

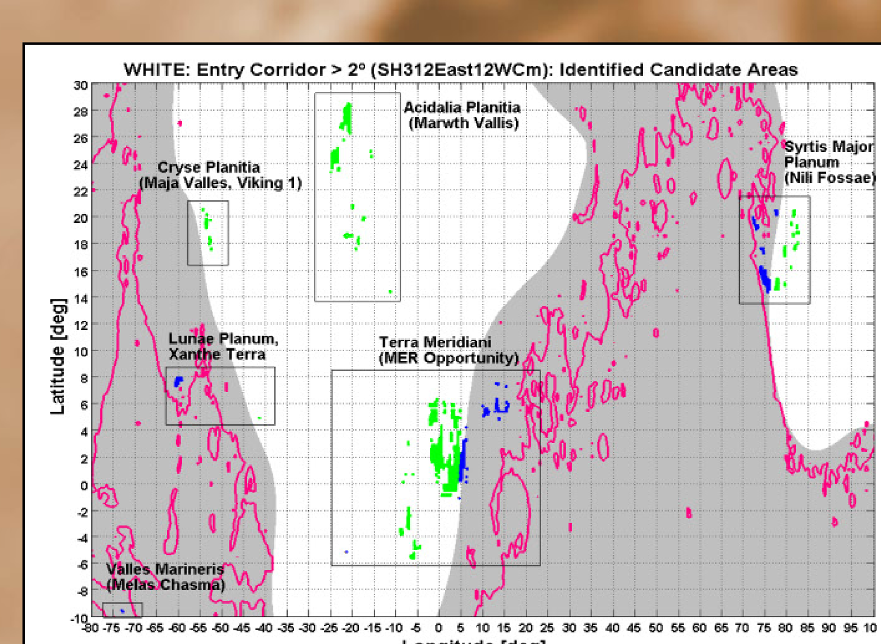
When related to the Mars topography, these maps reveal a strong **correlation** between the landing site altitude and the entry corridor, driven by the minimum altitude at the first parachute deployment.



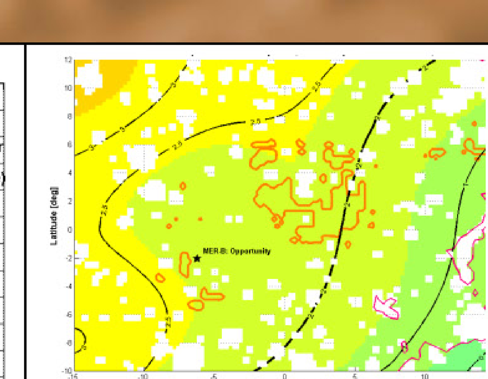
Exomars GEC Map of the FPA Corridor at EIP

5. Landing Sites Selection

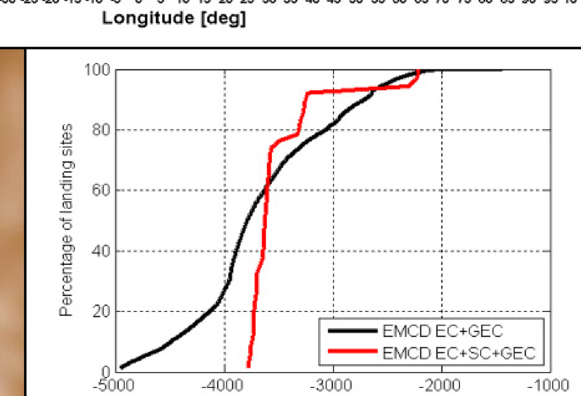
The **multi-layers overlap** of maps of filtering criteria and GEC performances drives the identification of planet areas compatible with the mission constraints that are also appealing from a scientific point of view.



Exomars candidate landing sites (green).



GEC FPA Map and candidate areas



GEC statistical analysis

6. Conclusions

The GEC tool main features are:

- Easy and efficient tool: allows focusing the analysis on the interesting and feasible areas and provides fast support to the design team.
- Planetary or regional analysis can be run.
- Proven practical application to European exploration projects (Exomars and Mars Next).

DEIMOS Space S.L.U.
Ronda de Poniente, 19
Edificio Fiteni VI, Portal 2-2
28760 Tres Cantos (Madrid)
SPAIN

Tel.: +34 91 806 34 50
Fax: +34 91 806 34 51
deimos@deimos-space.com
www.deimos-space.com