INTRODUCTION

The Brazilian Amazon region is the greatest rainforest in the world, with an area comparable to the western Europe. This region is undergoing complex and fast changes influenced by natural factors (as rain, flooding and droughts) and human activities (forest fires, deforestation, wood and mineral extraction)

It is of extreme importance for Brazil in ecological, economic and strategic terms to have a good monitoring system for the management of the natural resources and the environmental protection of this region. Such a monitoring system must have the capability of fast responses to the natural or man made events, leading to the necessity of a fast access to information and a high rate of data acquisition, which are not available today. One important factor that precludes the satisfactory monitoring of tropical regions is the association of the low revisit rate of the available satellite remote sensing systems with the severe cloud covering conditions presented by those regions. Indeed, most satellites utilize sun-synchronous orbits, with revisit period from 5 to 30 days, which is not adequate to monitor a number of fast changing phenomena.

The SSR system presents an innovative solution to monitor the Amazon region, through a small remote sensing satellite placed in an equatorial orbit and a near real time data transmission scheme. This system takes advantage of the geographic localization of the Amazon region, near the equator, providing several passes over the region each day.

Besides the standard centralized mission center, the system will also provide the capability to perform the distribution of the SSR data directly to users through small and low cost stations.

THE SSR MISSION

The SSR mission aims at providing the scientific community, governmental and private authorities with near real time reception of images of the Amazon region, comprised between parallels 5° N and 15° S, as shown in Figure 1.

The SSR is a Low Earth Orbit satellite on the class of 400 kg, placed in an equatorial (i=0°) orbit, at a height of about 905 km. The on-board instrument will cover the equatorial region, from 5°N to 15°S, corresponding to a swath width of nearly 2200
km. This orbit provides a revisit rate of less than 2 hours, with up to 5 useful image acquisitions during daylight.

The main applications of the SSR are deforestation, forest fire detection, river floodings, oceanography, land cultivation, desertification, mineral exploitation and vegetation health.

In order to fulfill these applications, the SSR will carry an optical instrument, capable of covering the specified swath width of 2200km, (from $5^\circ$N to $15^\circ$S), corresponding to a total field-of-view of about $88^\circ$, in all bands listed in Table 1 with the required spatial resolution.

Figure 1: SSR World Coverage Area

Table 1 - SSR Bands and Resolutions

<table>
<thead>
<tr>
<th>Bands</th>
<th>Wavelength</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>0.440 to 0.505 µm</td>
<td>100m</td>
</tr>
<tr>
<td>B2</td>
<td>0.530 to 0.575 µm</td>
<td>100m</td>
</tr>
<tr>
<td>B3</td>
<td>0.650 to 0.680 µm</td>
<td>100m</td>
</tr>
<tr>
<td>B4</td>
<td>0.845 to 0.885 µm</td>
<td>100m</td>
</tr>
<tr>
<td>B5</td>
<td>0.895 to 0.990 µm</td>
<td>300m</td>
</tr>
</tbody>
</table>
THE SSR PAYLOAD

Due to its unusual orbit and large swath width, this system brings some difficulties and challenges compared to systems with satellite in sun-synchronous orbits.

One of peculiar characteristics is the wide variation range of solar angle over the target. In a equatorial orbit, in a 12 minutes pass the satellite will span 4 time zones. This means that in a single image, the local time in one extreme of this image will be 4 hours less than the local time in the other extreme, causing great change in the illumination level and the size of the shadows. Besides that fact, the satellite will pass over a region several times during the day, during the morning, near noon and in the afternoon.

Another important factor is the extreme off-nadir angle necessary to image regions with latitude of 15°S.

There will be a significant increase of the path length through the atmosphere, introducing fading and distortions that will require special atmospheric correction techniques. In addition, on the same basis, the shadowing effect of the eclipse of one target by the other will require specific attention.

In order to assess the technical feasibility of the payload and the effect of these factors in image quality, a phase A/B study for the SSR payload was performed. As part of this study an airborne flight campaign was performed in the Amazon region, using the HyVista hyperspectral camera.

The preliminary results of the study show that the majority of the SSR requirements can be fulfilled with a payload composed by two instruments: a VIS/NIR and a MIR/TIR band camera system. It was concluded that due to power and mass limitations of the satellite, it will not be possible to meet the geometric resolution and the swath width for the MIR/TIR cameras. It was also found that a significant loss in the image quality will occur for latitudes between 13°S and 15°S. Nevertheless, due to its high revisit rate, images from these region can be useful for certain applications.

The introduction of the TIR camera was recommended due to its suitability to perform fire detection during sun light conditions.

This paper presents the results of the payload preliminary design and the conclusions drawn from the post campaign analyses.