SMOS Vicarious calibration:
Sun and Moon options and requirements
05/07/2001

1. Context

So as to have a vicarious calibration target for SMOS, the possibility to use the Moon and the Sun as point sources was considered. Even though this option is still under study it is necessary to estimate the requirements for the mission specifications. This note intends to have a first go at it.

It must be stressed that most of the considerations here after are preliminary and subject to changes. However the requirement in terms of pointing accuracy should be rather valid.

2. Position of problem

The Moon and the Sun offer the possibility to view a "hot" point source with a cold background. This being said things are not so simple as:

- The background is not that uniform and can vary significantly wrt to the target position. There are even areas not mapped at L band.
- The Sun's emission does vary significantly with time. If we do not have easy access to data from monitoring centres (i.e., accurate monitoring 1% expected?), such target can only be used as a hot source vs cold background (i.e. work on reconstruction)
- The Moon also varies with time (if only Moon phases and reflected solar contribution about 1% on average?), and its brightness temperature is not fully known. Moreover it is not very high (250 K) and, as the Moon (and Sun) intercepts a small percentage of a basic "pixel" (about 6 %) the contrast will be even smaller (about 15 K)

Consequently, the main conclusions could be that:

- Such targets (Sun and Moon) are not useful (TBC) for calibrating the NIR elements:
  - Sky not known well enough
  - Small contrast over the large main lobe
  - Side and back lobes contributions to be taken into account (TBC)
- They might be useful as a point source target (interferometer). But in this case:
  - When observed, the targets should be in a "calm" area in terms of galactic noise (i.e. avoid galactic plane) and in known areas.
  - Only use the Sun when "calm" or if monitoring data is available
  - Use the Moon during the dark Moon phases (to avoid sun's variations and spatial variability of temperature)
- This would require:
  - Better knowledge of the Moon (brightness temperature at L band
  - Being able to integrate long time periods over the Moon
  - Fine choice of occurrences when optimal viewing conditions are met
- Finally checking for other sources might be useful

3. Application to SMOS

Considering all what is given above, It is obvious that Sun and Moon calibration must not be drivers for SMOS. Such targets should only be used if they can be "seen" by a very straightforward rotation of the platform.
As suggested already, we could consider letting the platform drift by stopping the Earth pointing until the target is in the FOV. Take measurements and then finish the rotation to get back to the nominal pointing position.
We could consider imaging the target while it is drifting in the FOV, as close to the centre as possible (TBC) until it is in a high resolution pixel (TBD). Stop the rotation and integrate for some time (a few min?), and then let drift again.
This obviously requires that the Target can be seen with such a movement. One point still to be addressed is whether it is useful to take this opportunity to view the "cold sky " during such a rotation provided no hot source (Earth, Cygnus, Sun, ….) is in the FOV (70°!), the sky is relatively known (as it is not uniform) and we can have some use for such data. An integration time of a minute or less should be sufficient for the NIR (a slow drift might even be sufficient), but 20 to 40 min would be required for the interferometer over deep sky (feasibility?).

4. Impact on SMOS Requirement

As state above, the Moon or Sun corresponds roughly to a solid angle of 0.5°. Consequently the pointing accuracy of Proteus is adequate.
Such measurements will probably not be required frequently (apart maybe during the first weeks of operation). Moreover the right conditions might not be frequently encountered. A safe bet could be once a month or less
Finally one should be aware that pointing towards the sky has to consequences: (i) side and back lobes must be very low and known; (ii) the instrument and bus not being in the normal position, thermal consequences have to be evaluated.

5. Conclusion

Such vicarious calibration is possible but with an outcome which is not 100% ascertained. We suggest considering this option further, but, in the mean time, no hard constraints should be put on the mission, as the current characteristics seem sufficient.

One can refer to two documents to go more in depth if required:

- J.Y Delahaye et al. paper and report on the calibration of ground based radiometers (sky characteristics, knowledge of the galactic contribution
- N. Floury note "Sky noise - Perturbations of a radiometric L- Band measurements (?)
- P. Waldteufel, First considerations on the possibility to perform SMOS calibration on deep sky (6/6/2000)