Space-based Microwave Reference Radiometer

P. Rosenkranz
MIT (retired)

see “Climate-quality calibration for low Earth-orbit microwave radiometry”
at http://www.doi.org/10.3390/rs12020241 (open access)

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Characteristics Important for a Reference Radiometer

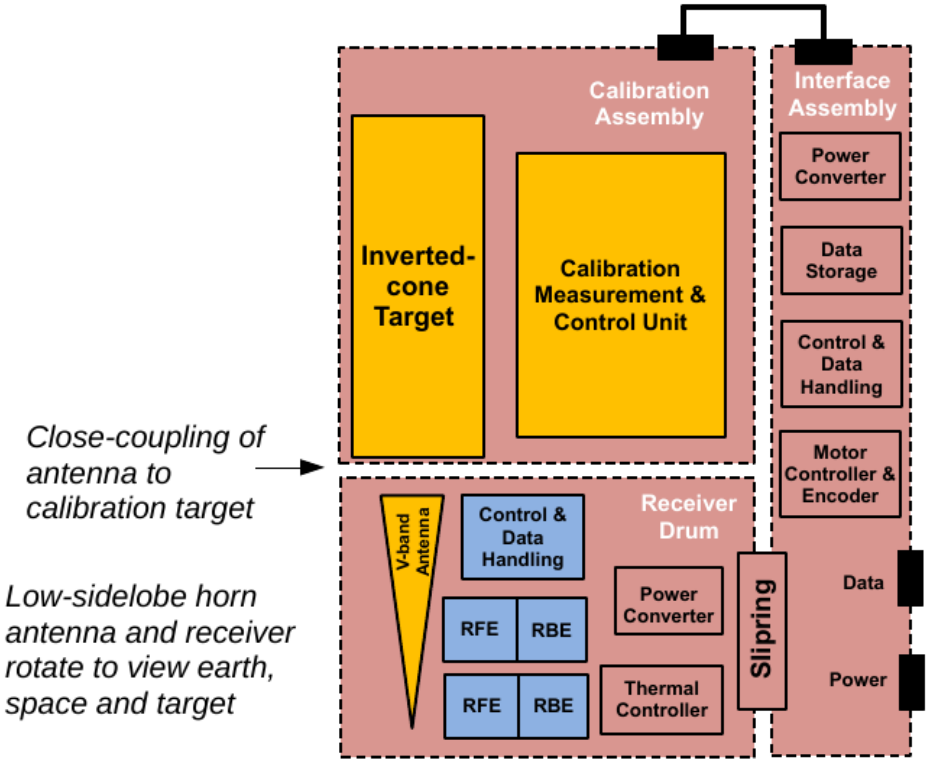
- linearity
- frequency stability
- calibration stability
- low antenna sidelobe levels
- stabilized orbit altitude

Characteristics Not Important

- spatial resolution
- radiometer noise
- sun-synchronous orbit

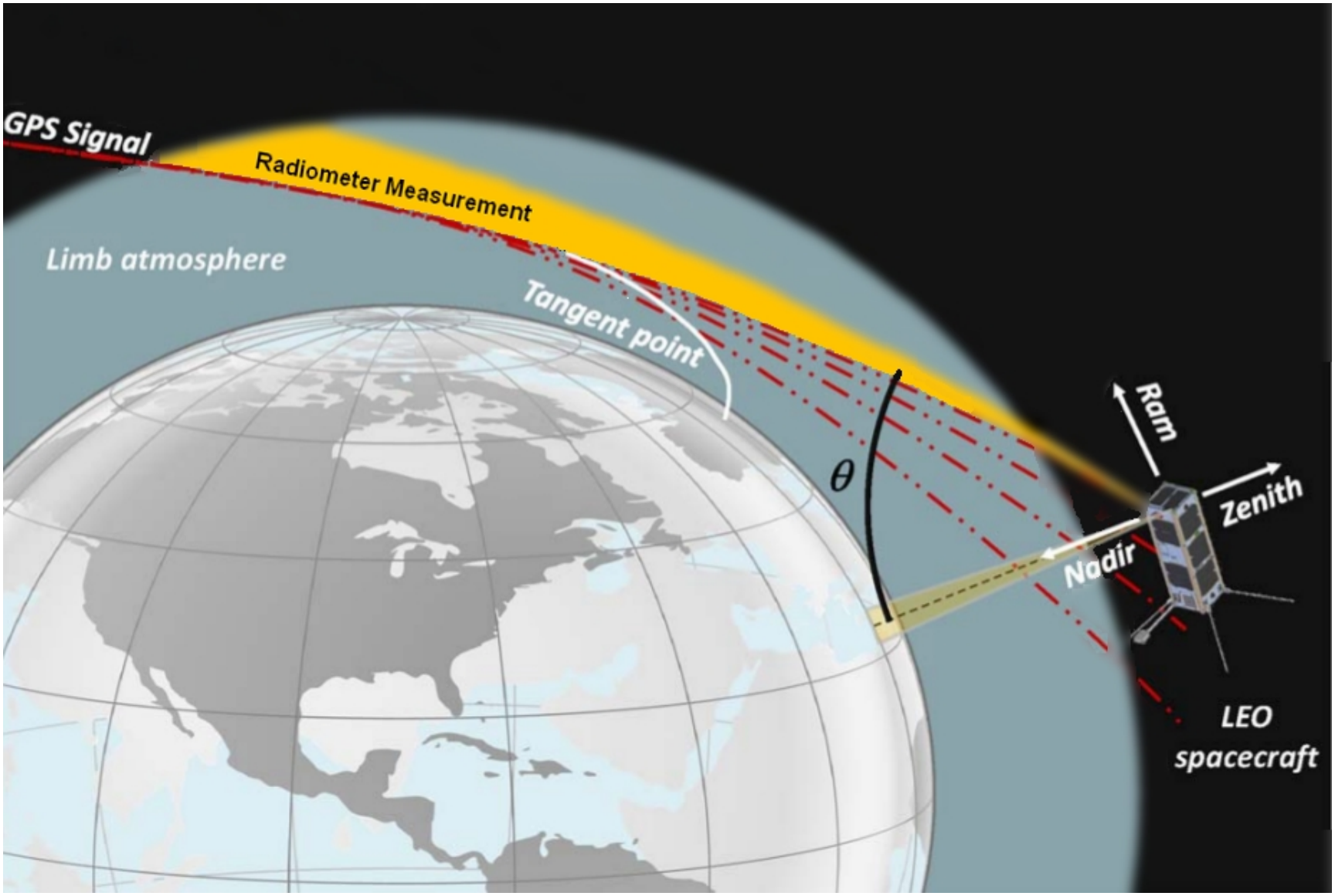
Desirable Radiometer Features

1. phase-locked local oscillator(s)
2. 3- or 4-point calibration (e.g. target, space, noise diode)
3. reduced sensitivity to gain fluctuations (e.g. Dicke switching)
4. low-sidelobe antenna
5. dual polarization, for comparisons to rotating-pol instruments like ATMS
6. temperature control of radiometer and target

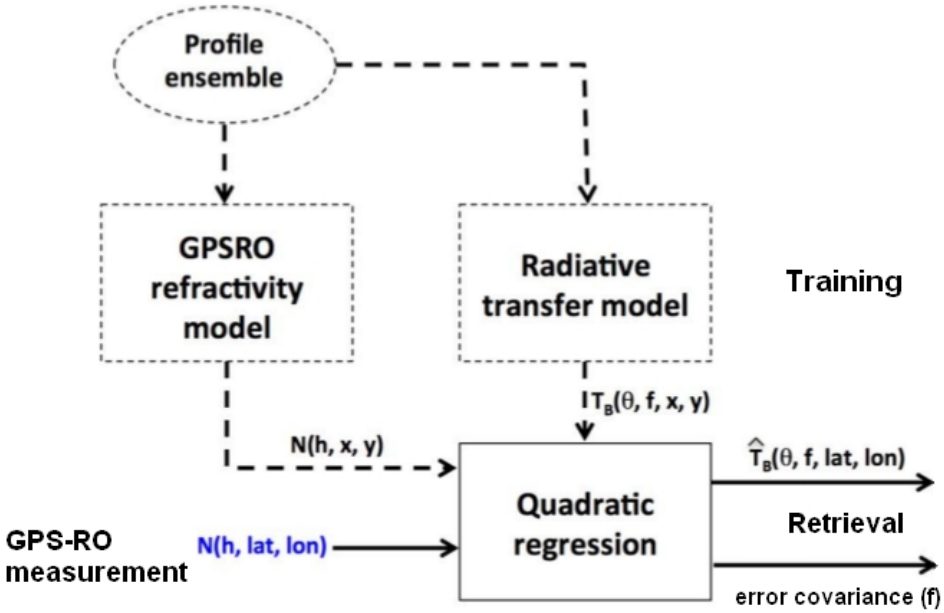


from “Designing a climate-monitoring microwave radiometer” http://www.doi.org/10.1109/USNC-URSI-NRSM.2017.7878313

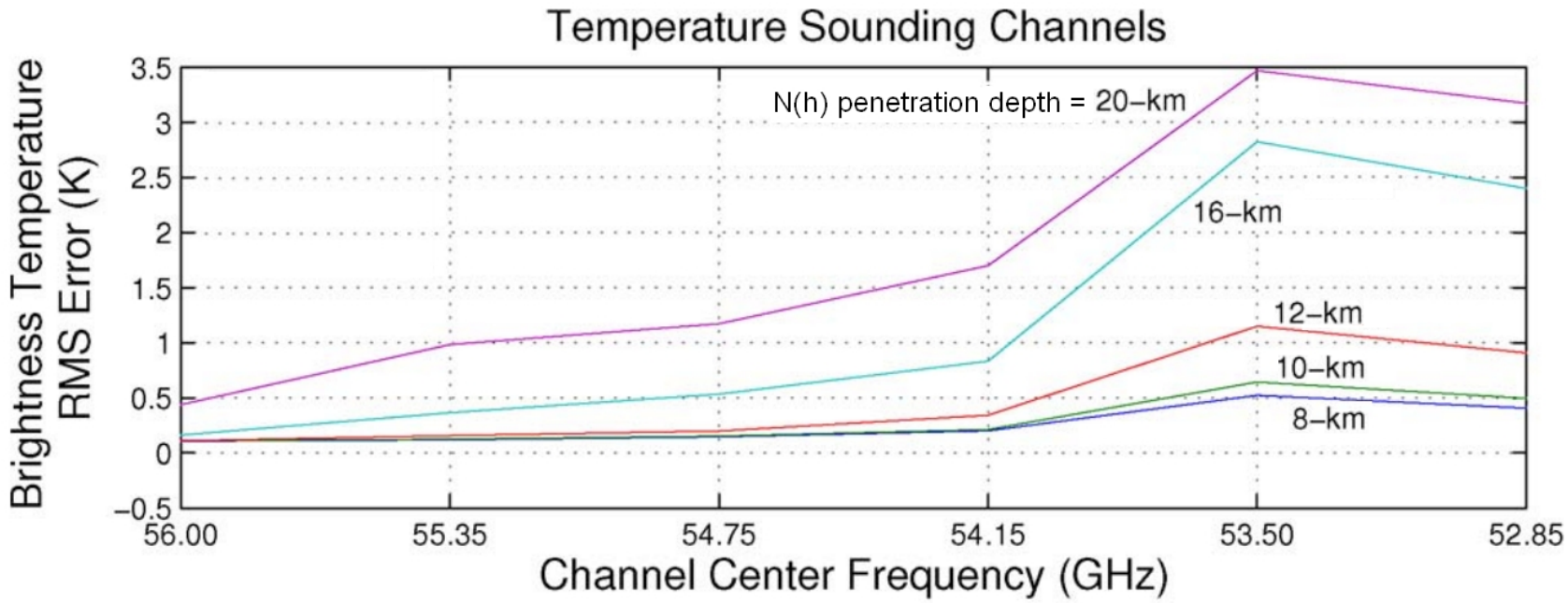
7. (O_2 band) scan includes the earth limbs, for comparisons with navigation-satellite occultations



radiometer and GPS receiver on spacecraft



Refractivity is proportional to gas density in the upper part of the atmosphere, while microwave brightness temperature on the wing of the 60-GHz band is approximately proportional to density squared, yielding a quadratic relation between them.



from “Radiometer calibration using colocated GPS radio occultation measurements”
http://www.doi.org/10.1109/TGRS.2013.2296558 (open access)

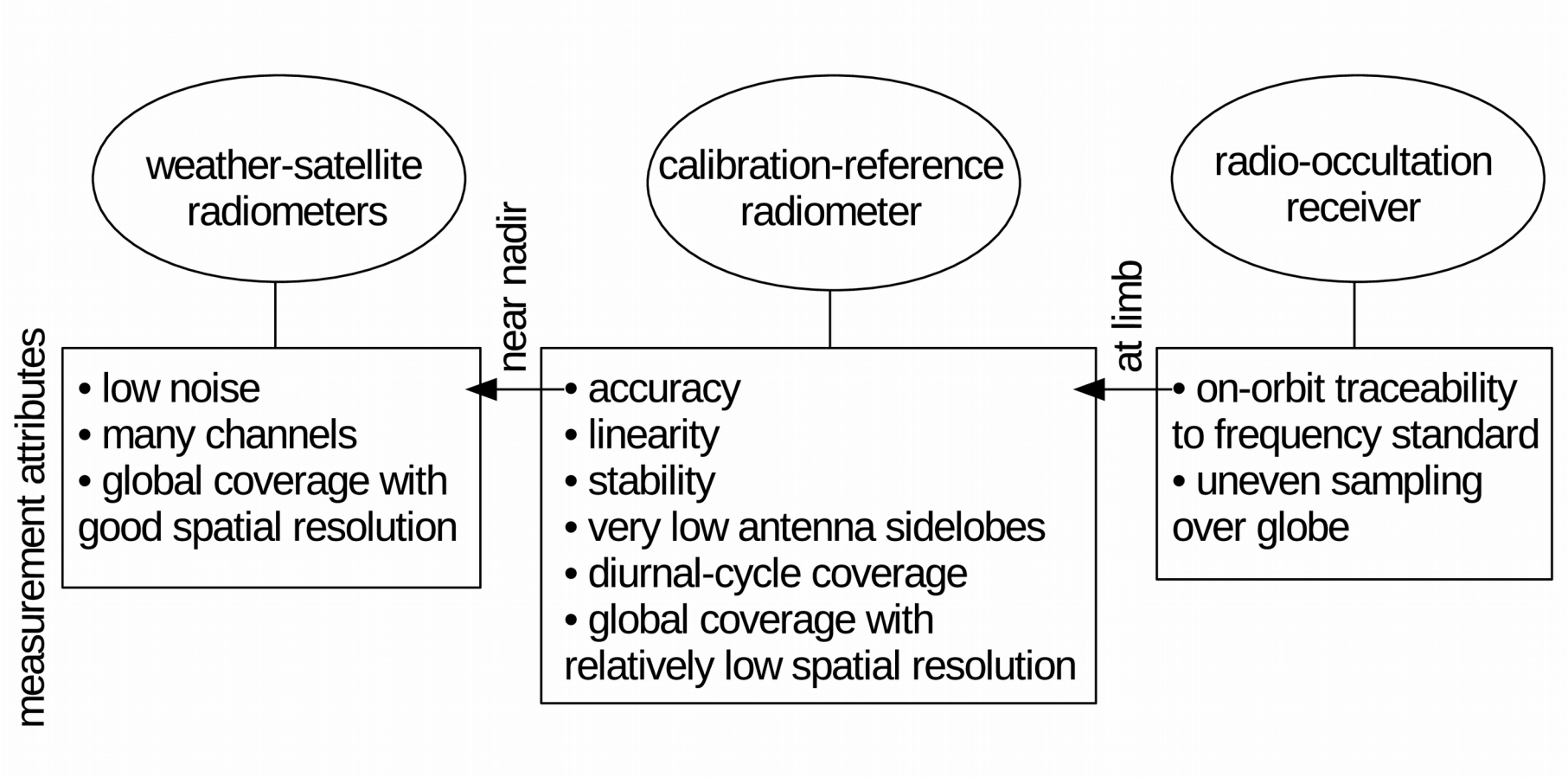
GPS-Radio Occultation Addresses Long-term Stability

- traceable to a frequency standard
- removal of offsets between reference radiometers by double-differences, without overlap of instrument lifetimes
- verification or adjustment of radiometer calibration stability in orbit

[adjustment precision] = [error per occultation]·[12 / number of occultations] ^{½}

example: Assume 4000 selected occultations per year, evenly spaced in time, and rms error = 0.2 K for each occultation.

Then the precision of GPS-RO calibration = 0.01 K in one year.


weather-satellite radiometers
calibration-reference radiometer
radio-occultation receiver
near nadir
at limb
measurement attributes
• low noise
• many channels
• global coverage with good spatial resolution
• accuracy
• linearity
• stability
• very low antenna sidelobes
• diurnal-cycle coverage
• global coverage with relatively low spatial resolution
• on-orbit traceability to frequency standard
• uneven sampling over globe