

The regime is similarly unable to contribute related data sets on forest canopy structure characteristics and soil moisture, as these require input from a lidar instrument and a passive microwave radiometer respectively.

How Well, on Balance, Could the Regime do the Job Right Now?

The Open Skies cameras package deployed operationally at the present time compares unfavorably with the users' data needs required by the Kyoto Protocol. A guestimate arrived at for this study suggests that the regime could satisfy less than 20 percent of the users' data needs. This somber assessment should however be balanced by two qualifications which should be noted on the positive side of the ledger.

Should the Open Skies SAR instrument be capable operating in polarimetric mode, the door would open to high-resolution data that then could be used for estimating vertical structure and properties of forested areas and vegetated surfaces, including biomass volume and characteristics, its growth dynamics and floral biodiversity. A polarimetric SAR holds the potential²⁶ of providing high-quality data that is not simply complementary to radiometric imagery but which is in many respects directly substitutable for it.

While it is an established fact that wildland fire is the main mechanism of carbon release in northern latitudes, the question of whether fires render the boreal ecosystems a net "source" or "sink" of carbon remains an area of high scientific uncertainty. The fact that historically the boreal fires issue has been poorly documented and reported by the Russian authorities²⁷ compounds the extent of this uncertainty even further. As recent research shows, however, a C-band SAR can be used to recover the patterns and extent of burn scars in boreal forest areas long after the actual fires have burned.²⁸ A C-band SAR is sensitive to long-term moisture and roughness patterns that persist in the post-fire environment for long time and that, potentially, could make such SAR surveys particularly valuable for taking a "retrospective look" in order to detect and delineate the burned areas now long overgrown with fresh vegetation.²⁹ One can thus envisage an Open Skies SAR mission staged to help firming up the carbon emission numbers for areas where they are "soft" or simply are not available.

What are the Points where the Open Skies Regime Carries a Clear-Cut Advantage over Satellite Observations, and vice versa?

In case of carbon budget audits or investigations, the relative advantage for each of the two systems is largely defined in the trade-off between how much surface detail data should be collected (spatial resolution) and how much area should be observed at a given time (spatial coverage) and how often. The advantage rests with the Open Skies regime in the former case and with the satellite observations in the latter. The regime holds the advantage for conducting observations at local scales, while the satellites are the preferred mode of observation at national, regional and international scales.

There are, however, circumstances in the Kyoto monitoring process when access to details will make a difference. And it is in the details that possibility lies for improving carbon emission estimates. For example, mapping and inventorizing an area by forest type (down to species level and stand age), detecting, mapping and measuring vegetated areas damaged by fire or illegal logging activity, or compiling land cover change maps and statistics, are activities that all require high-resolution EO data – from both

²⁶ See especially, European Space Agency, *Roundtable: New Radar Imaging Technologies For Earth Observation*. Observing the Earth Report (July 19, 2002), pp. 2-3.

²⁷ Eric S. Kasischke, et al., "Satellite Imagery Gives Clear Picture of Russia's Boreal Forest Fires." *EOS Transactions* 80 (1999), pp. 141 and 147. See also: David Herring and Robert Simmon (Design), *Evolving in the Presence of Fire*. A NASA Earth Observatory Features Report (October 1999), pp. 6-7.

²⁸ L. L. Bourgeau-Chavez, et al., "The Detection and Mapping of Alaskan Wildfires Using Spaceborne Imaging Radar System." *International Journal of Remote Sensing* 18:2 (1997), pp. 355-373; L. L. Bourgeau-Chavez, et al., "Mapping Fire Scars in Global Boreal Forests Using Imaging Radar Data." *International Journal of Remote Sensing* 23:20 (October 2002), pp. 4211-4234, and Brigitte LeBlon, et al., "Fire Danger Monitoring Using ERS-1 SAR Images in the Case of Northern Boreal Forests." *Natural Hazards* 27 (2002), pp. 231-255.

²⁹ This is in contrast to multi-spectral radiometers, the utility of which is largely restricted to spotting the initial changes in temperature and vegetative cover.