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Operational use of spaceborne L-band sensors for flood warning

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Argentina's National Space Program of space science and technology comprehends the launching of two SAOCOM satellites by 2010-2011. Supplied with L-band synthetic aperture radar (SAR), they will be operated jointly with the four Italian COSMO-Skymed satellites, thus constituting the SIASGE constellation with the main purpose of emergency management, prevention and mitigation of natural disasters. The present submission is about one of the three strategic applications (i.e. those whose economic benefit enter the economic feasibility study of the mission): Risk and Hydrological Emergency Management, being carried out by the Hydrological Warning System for the Del Plata Basin, operated by the National Institute for Water (INA), of Argentina. Although different uses are intended for the remote SAOCOM data, the focus here is set on the design of techniques that incorporate the estimation of surface soil moisture content into an operational real-time flood warning system, through radar signal analysis. Three concurrent facts support the application: (a) spaceborne L-band sensors are known to provide the best technologically-feasible surface soil moisture content estimates, (b) reasonably high spatial and temporal resolutions and areal coverage are ensured with the SAR sensors of the SAOCOM system, and (c) soil moisture content determines the basin potential for flood generation in the light of a quantitative precipitation forecast (QPF). Inspired in the US-NWS Flash Flood Guidance (FFG), the present methodology consists in comparing the quantitative precipitation forecast for the subsequent specified time interval over a given basin with the amount required by that basin for attaining a flooding condition at its outlet. If the forecast precipitation depth exceeds that requirement, a warning may be issued to the local emergency service. The duration of the time interval results from a trade-off of the temporal resolution, the declining reliability of the QPF with increasing horizons,

and the time-response of the basin. Far from the 6-hour interval of the US-FFG, the duration had to be set somewhere between one and three days, thus causing the drop of the term Flash from the name of the application: Flood Guidance. The basin requirement to attain a flooded condition depends not only on basin physiographic and drainage network configurations (quantified through the threshold runoff, i.e. the effective rainfall necessary for flooding), but also on the current soil moisture condition (which will determine how much of the total rainfall will be abstracted prior to the generation of direct runoff). A Monte Carlo simulation has been carried out in order to estimate the Probability of Detection (POD) and the False Alarm Rate (FAR) of the system, for which different combinations have been proposed for the triad [precipitation, forecast error, flood-guidance error] probability distributions: Exponential and Gamma, for the first element, and Uniform and Beta, for the last two elements. Reasonably good results have been found, though more heavily jeopardized by the uncertainty of the QPF.