CONFORMAL OVERSET GRIDS

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The well-known inefficiencies and numerical problems in numerical weather prediction associated with the convergence of meridians and the polar singularies of a latitude-longitude-based grid system have spurred the development of polyhedron-based alternative grids, such the cubed sphere and the (triangular-gridded) icosahedron. Moreover, except at the vertices, the continuous mappings for these configurations can be made perfectly conformal (angle preserving), which substantially simplifies the adaptation of existing grid-based regional models to these global geometries. However, the unavoidable vertex singularities on *continuous* polyhedral grids still remain too strong to avoid severe numerical difficulties for any model based on spatial finite differencing. "Oversetting" is a remedy that preserves smooth grid

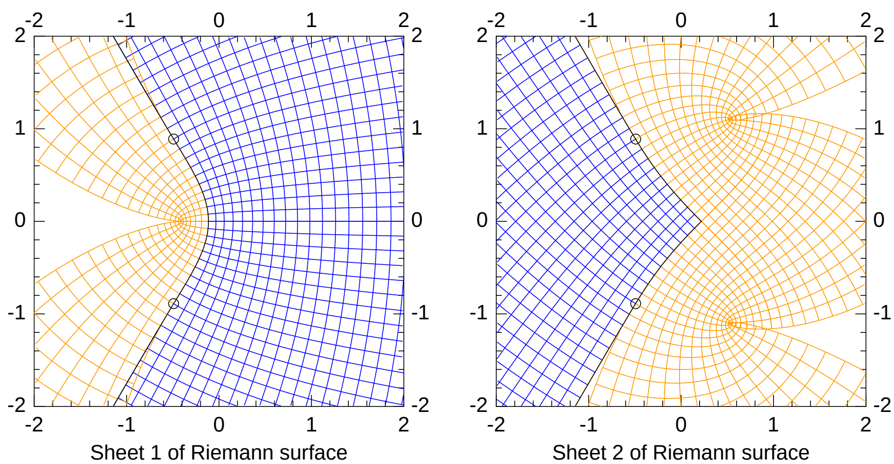

Figure 1: Detail of junction of three square map panels of the physical solution domain (blue grids) and their extrapolation (orange) that enable oversets for consistent blending of model solutions each time step. The strong mapping singularities are expelled from the physical portion of the grid, leaving only the very weak 'branch point' singularities (indicated as small circles) at the edges separating one map panels from its paired neighbors

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continuity across the middle sections of each edge of the original generating polyhedron, but which relinquishes continuity in the vicinity of each vertex in favor of artificially grafted smooth replacements and extensions of the grid there to provide a region of self-overlapping that is free of strong map singularies. Oversetting requires instead a frequent interpolation and merging of the locally duplicated solutions. A purely localized disfigurement of the grid in this way, however carefully smoothed and blended, cannot preserve the desirable property of conformality.

We have developed new techniques that do enable a globally consistent and perfectly conformal polyhedral mapping to be constructed with the oversets automatically supplied in the regions where there would otherwise be vertex singularities (Fig. 1). The methods are based on the construction of complex analytic functions that involve Riemann surfaces where the inverse mapping (sphere to polyhedron) is at least two-valued. Moreover, the technique is capable of an immediate and potentially valuable extension (e.g., Fig. 2) to smooth mappings no longer constrained to correspond to *convex* polyhedra, and which enables the resolution of the generated grid to possess multiple regions of locally enhanced resolution. Such configurations suggest more unified alternatives to the traditional separation of models for global, regional and various further nested tasks of operational models.

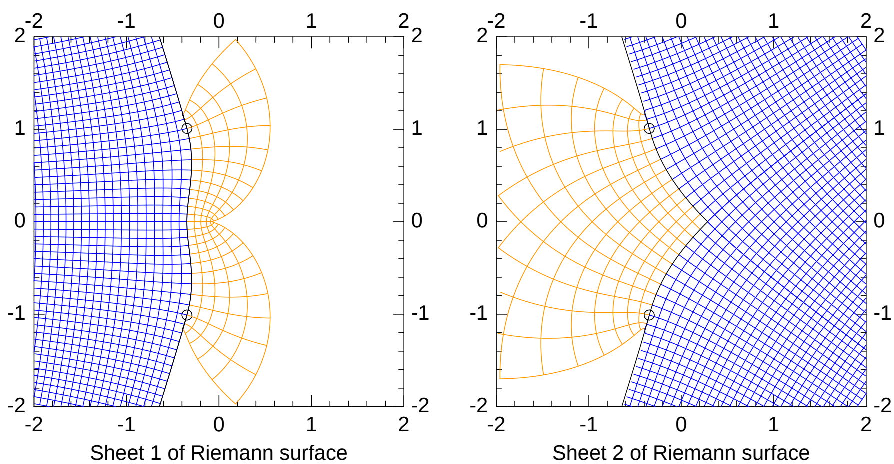

Figure 2: The Riemann surface solution showing a junction of map panels (blue grids) and their extrapolation (orange) to a region from which consistent oversets of the grid can be created. This case, with five square map panels meeting, no longer corresponds to any convex polyhedron, but configurations of this kind can be exploited to provide enhanced resolution at selected geographical locations of a single unified global grid.