Section 5: DEVELOPING A DIGITAL SPATIAL NETWORK FOUNDATION FOR SPARROW

BASED ON EPA'S REACH FILE VERSION 1.0 (RF1)

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Why select Reach File 1 (RF1) as the stream-reach network for basing SPARROW modeling applications?

RF1

- Contains database of interconnected stream segments comprising surface water drainage for conterminous U.S.
- Contains stream-reach attributes supportive of spatial analysis and mapping applications
- Topological structure is conducive for water-quality modeling applications
- Available and in an Arc/Info format

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Enhancements to Network in Support of SPARROW Modeling

ERF1 and ERF1-2 – Description of Networks

- Based on 1:500,000 scale of conterminous U.S.
- Vector coverages
- Units in meters
- Resides in Albers Conic Equal Area projection, NAD 83
- ERF1 reach-node orientation is FNODE to TNODE, flowing upstream
- ERF1-2 reach-node orientation is FNODE to TNODE, flowing downstream

- ERF1 contains vector watershed boundaries based on the 8-digit cataloging unit number

- ERF1-2WS contains raster 1-km cell-size DEM-based watershed boundaries, Lambert Azimuthal projection, NAD 27

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ERF1 – Enhanced version of RF1

- Designed to support regional and national water-quality and river-flow modeling and transport investigations based on water-quality monitoring network data

- Network used to determine flow pathways between point and nonpoint sources of pollutants and downstream water-quality monitoring stations

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Enhancements to RF1

- Addition of reservoir centerlines
- Reach connectivity (verified by TRACE upstream)
- Missing values for average velocity and positive mean streamflow were calculated using regression equations relating velocity to long-term mean streamflow and stream order (Smith et al., 1997)
- Coastal shorelines and major estuary boundaries added to ERF1 using NOAA's version of RF1
- Reach topology checked and TERMFLAG assignments made to reaches
- -9999.99 value assigned to missing or zero MEANQ values and negative RCHTOT and RESTOT values

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Computing RCHTOT for ERF1

Reach Time-of-Travel:

- Reach time-of-travel computed for flow in units of days:
  - computed as quotient of reach length and reach velocity
  - velocity estimates based on time-of-travel studies
  - zero assigned to reaches missing time-of-travel value

RCHTOT = C1 * LENGTH / MEANV

C1 – conversion factor: 0.00003797 ft-day/meter-second

LENGTH – length in meters of arc [reach segment]

MEANV – mean velocity in feet per second

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Computing RESTOT for ERF1

Reservoir Residence Time

- RESTOT computed for ERF1 centerlines matching USGS reservoir base file:

RESTOT = NORMCAP / MEANQ-OUT * C2(2)

NORMCAP = normal capacity in acre-feet from USGS reservoir file

MEANQ-OUT = mean streamflow for immediate reach downstream of reservoir

C2 = conversion factor of 0.50416 cubic feet-day/acre feet-second

- RESTOT computed for reservoirs from USGS base file matching RF1:

RESTOT = NORMCAP / MEANQ * C2

MEANQ = RF1 reach mean streamflow

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ERF1-2 – Enhanced River File Version 2.0

Designed to provide DEM-based estimates of reach drainage area founded on the 1-km flow data for North America in support of predictive water-quality modeling of stream nutrient transport.

Enhancements to ERF1-2

- Incremental and total drainage area (derived from 1-km DEM data)
- Time-of-travel estimates recomputed
- Calculated mean flow and velocity for newly split reaches
- Drainage area calculations used to estimate nutrient contribution to outflow
- Split reach nodes represent NASQAN and NAWQA fixed monitoring sites
- Assign unique ID (E2RF1##) and STAID to upstream reach
- Fractional diversion [nutrient] loads assigned to reaches

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ERF1-2

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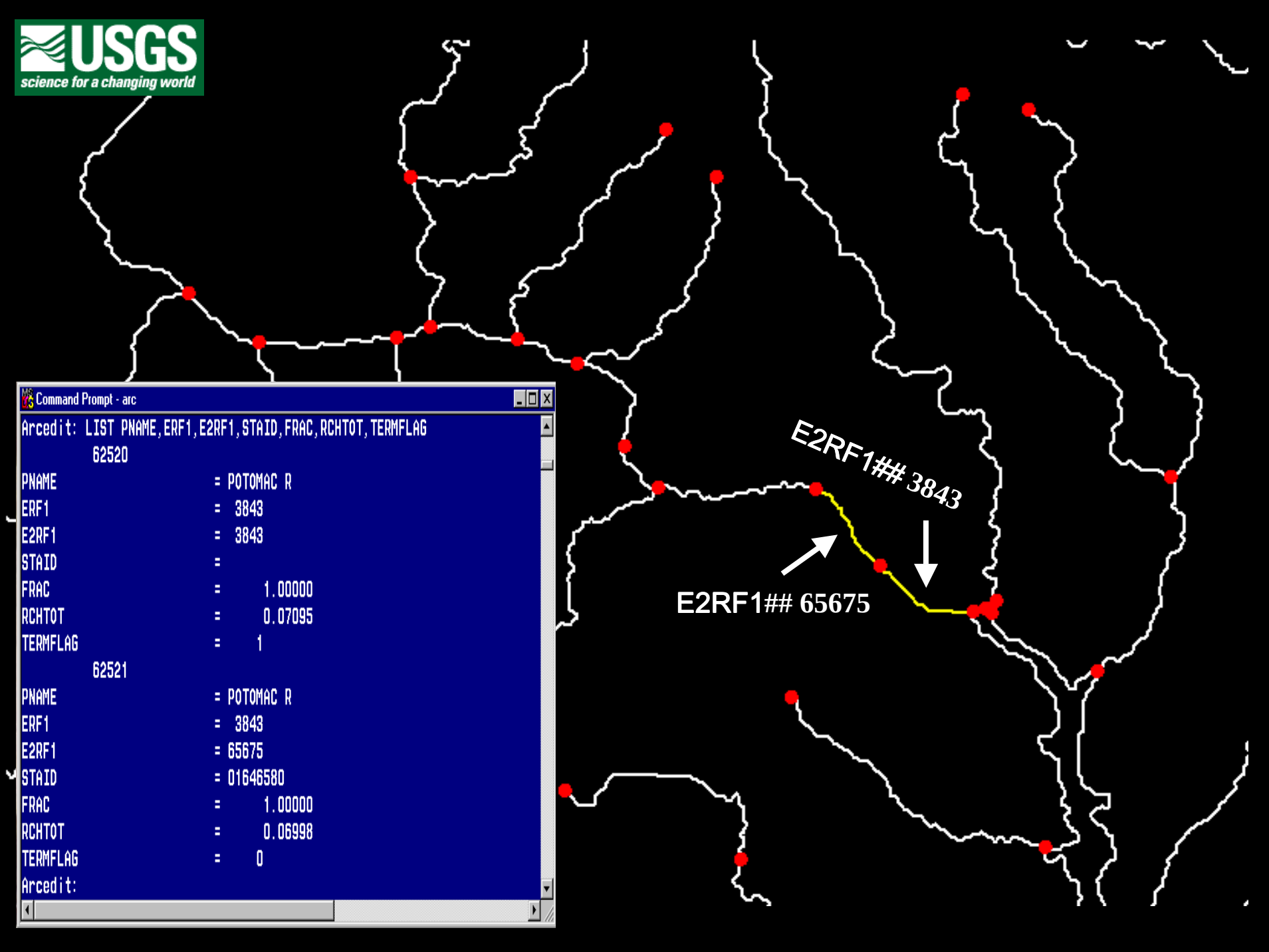

Command Prompt - arc
Arcedit: LIST PNAME,ERF1,E2RF1,STAID,FRAC,RCHTOT,TERMFLAG
62520
PNAME = POTOMAC R
ERF1 = 3843
E2RF1 = 3843
STAID =
FRAC = 1.00000
RCHTOT = 0.07095
TERMFLAG = 1
62521
PNAME = POTOMAC R
ERF1 = 3843
E2RF1 = 65675
STAID = 01646580
FRAC = 1.00000
RCHTOT = 0.06998
TERMFLAG = 0
Arcedit:
E2RF1## 3843
E2RF1## 65675

Watershed Development for ERF1-2

Generating Watersheds

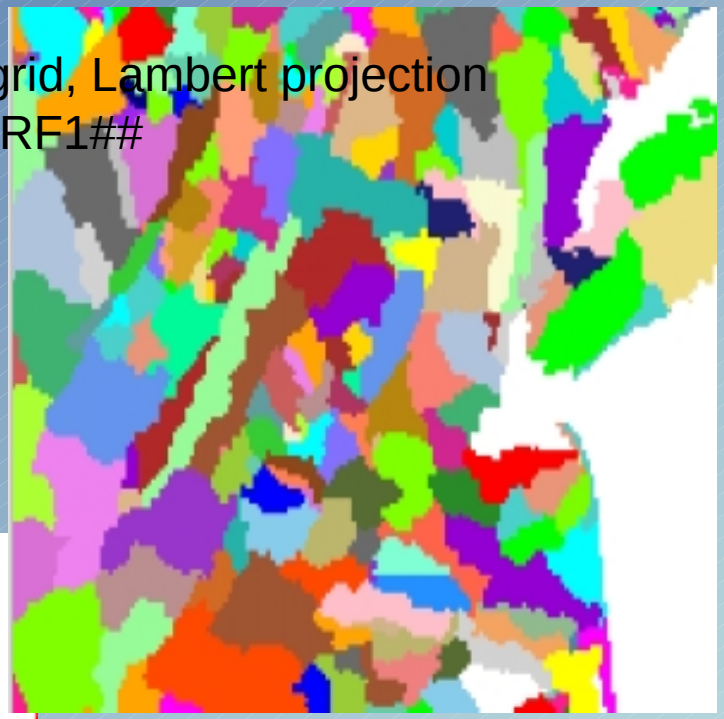
- Coverage projected to Lambert Azimuthal Equal Area, NAD 27
- Generated 1-km cell-size raster grid
- VALUE set to E2RF1## unique identifier
- Grid registered to extents of reach and flow direction grid; masked to U.S. boundaries
- Generated 1-km cell-size raster grid, ERF1-2WS in Lambert Azimuthal Equal Area projection

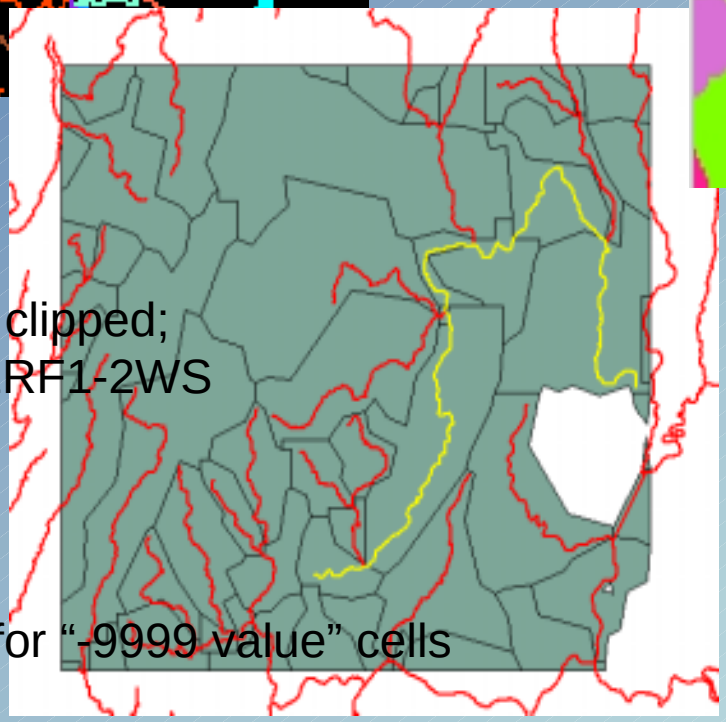
Editing Watersheds

- Areas with “no value” cells were filled (*cv.menu*)
- Selected clipped cells representing specific reach basins merged with base watershed grid to correct flow

Watershed Development for ERF1-2

1-km raster grid, Lambert projection
VALUE = E2RF1##





Selected cells clipped;
merged with ERF1-2WS

Filled in value for “-9999 value” cells

Refinements to Network and Grid

Area accumulations
Arc and node topology checked
Fractional diversion loads updated
Generated vector polygon coverage of watersheds

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ERF1-2 Watersheds

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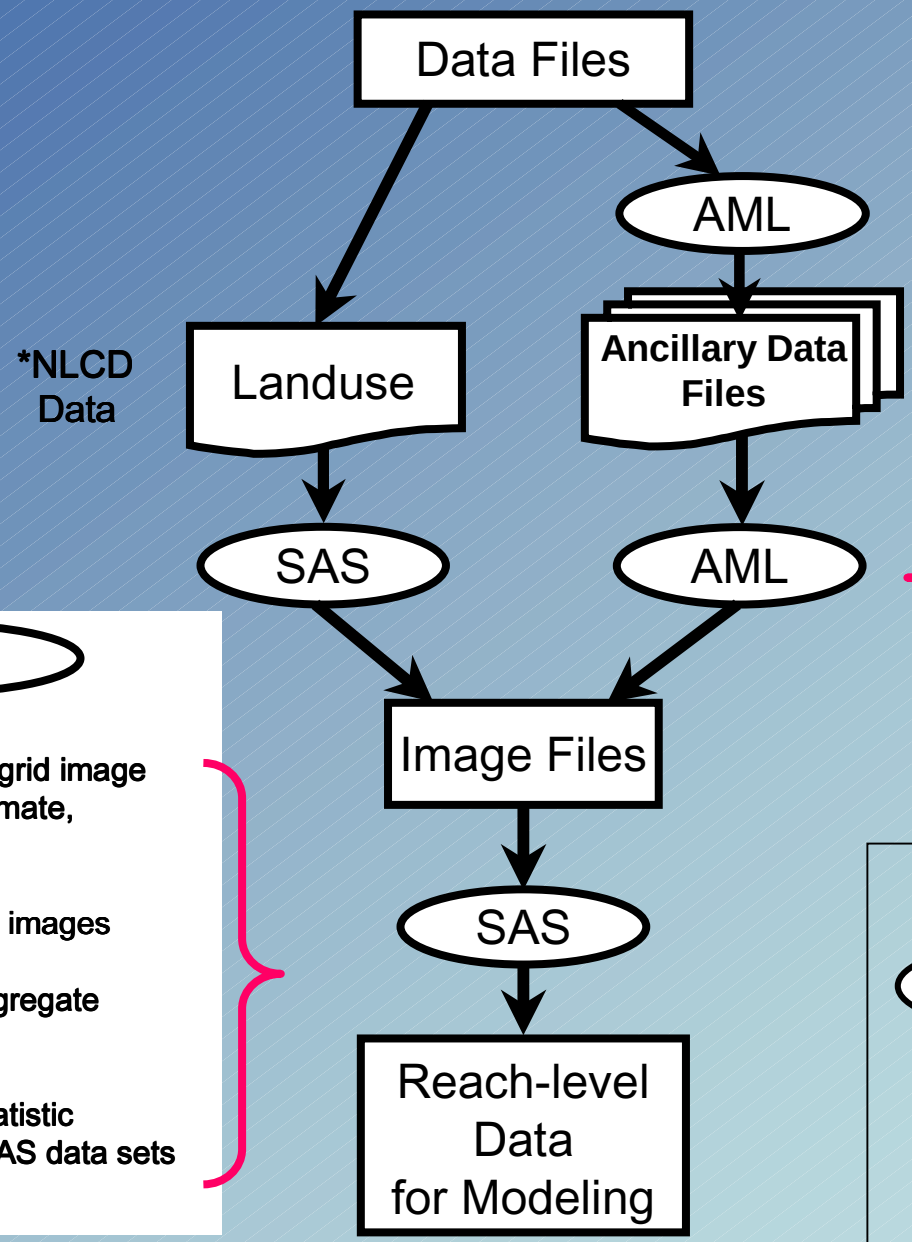
Data Processing Steps for National SPARROW Model



AML

1. Original Climate Grid (multiple steps)
2. Lambert Grid
3. Aligns w/ERF1_2WS
4. Grid Image

SAS

1. Overlay ERF1_2WS w/ grid image for the attribute (i.e., Climate, Temperature)

*2. Overlays w/ NLCD grid images

*3. Computations to disaggregate county to NLCD cells

4. Compute a summary statistic (mean, sum); store in SAS data sets

- KEY -

Program

Directory

*Selected operations (e.g. fertilizer, manure, AgCensus area)

Qualities of ERF1-2

Enhancements to spatial network advance water-quality modeling capability

[RFl]
- Surface water drainage network of stream segment
- Stream-reach topology supports water-quality modeling
- Stream-reach attributes support mapping and spatial analysis

[ERF1]
- Reservoir and reach time-of-travel
- Improved estimates for mean flow and velocity recomputed
- Node connectivity for stream reaches validated

[ERF1-2]
- Added monitoring sites serve as point sources for nutrient loading
- Incremental and total drainage areas beneficial to estimating nutrient loads and river transport
- Recomputed reach time-of-travel improves accuracy of estimation for stream loads
- Provides nutrient outflow concentration estimates for watersheds in the conterminous US based on elevation data

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Disadvantages of ERF1-2 spatial data network for water-quality modeling

- Limitations to accuracy of stream topology
  - Stream channels do not match map topology
  - Smaller streams not represented (limits addition of monitoring stations)

- 1:500,000 scale affects coastal mapping

- Large data set
  - Over 60,000 reaches are included in network
  - Slows processing time
  - Large memory requirement for processing and data storage

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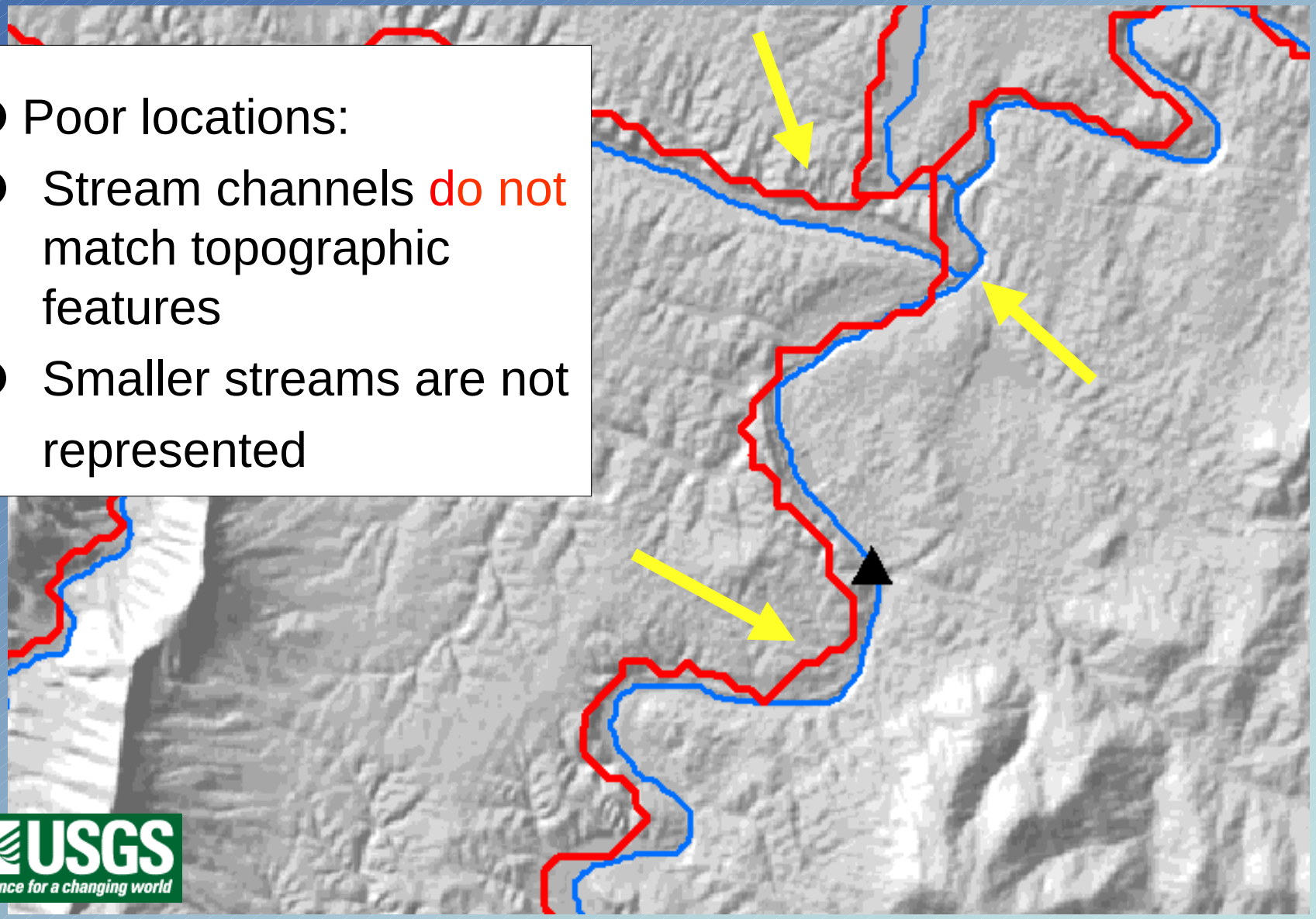
Limitations of RF1 (in red)

- Poor locations:
  - Stream channels do not match topographic features
  - Smaller streams are not represented



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Suggestions for Network Development

Become familiar with

- Modeling applications - to make an informed decision for selecting a suitable stream network

- Related literature and/or other model applications

- The data:
  - Data sources
  - Data collection periods and represented time-frame
  - Algorithms used to compute data
  - Actual data being represented (percent of population, etc.)
  - Units of measurement; scale and spatial distribution of data

- Processing software such as SAS, AML or FORTRAN

- Share information
- Check data accuracy frequently
- Check sources

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