2D Update

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2D WDD was the code’s first test outside 3D methods.

• For this first 2D experience, some code infrastructure was modified.

• Future 2D methods should be very simple to implement.

• Currently, we finished testing:
  ⇒ *WDD method.*
  ⇒ *XY geometry.*
  ⇒ *Level-symmetric quadrature set.*

• Our next steps are:
  ⇒ *RZ level-symmetric quadrature.*
  ⇒ *RZ-WDD method.*
  ⇒ *Implement support for 2D Corner Elements.*
  ⇒ *XY and RZ methods that use corner elements (DFEMs, CBMs)*
The modifications to the sweeping routine were simple.
Most of the coding relied on existing infrastructure.

Spatial Discretization Method:
XY_Wt_Diamond_Difference
Wt_Diamond_Difference

Cells:
- RectangularCell
  - HexahedralCell

Edges:
- 2D_Edge
  - 3D_Edge

Grid:
- ArbitraryPGrid

Grid:
- LogicallyRectangularGrid
  - LogicallyHexahedralGrid

PRange Manager

Inputs
- Templated
- Rewritten
We designed 4 test cases to target specific portions of the sweep solver.

- The pRange object must order the sweeps in the correct order.
- In every cell of the grid the sweep solver load the following information:
  - 2D_Edge object must provide the correct incoming flux information.
  - Cell object must provide the correct material properties.
  - Cell object must provide the correct cell dimensions.
  - Quadrature object must provide the correct sweeping direction, and weight.
  - The element must provide the particle source.
  - The exiting flux must be loaded on the 2D_Edge.

- Solutions were obtained by hand or using PARTISN.
First, we tested cell interface communication.

1.2 mfp
4 cells

\[ \sigma_t = 0.3 \]
\[ \sigma_s = 0.0 \]
\[ S_{ext} = 0.0 \]

B.C.:
\[ \psi_{inc,L} = 7.0 \quad \psi_{inc,R} = 0.0 \]
\[ \psi_{inc,T} = 0.0 \quad \psi_{inc,B} = 0.0 \]
Second, we tested Source Iteration.

\[ \sigma_t = 0.5 \]
\[ \sigma_s = 0.375 \]
\[ S_{ext} = 0.0 \]

B.C.:
\[ \psi_{inc,L} = 20.0 \quad \psi_{inc,R} = 13.0 \]
\[ \psi_{inc,T} = 0.0 \quad \psi_{inc,B} = 0.0 \]
Third, we tested material properties different in each cell.

- $9.0\sigma_t$ mfp with 9 cells
- $1.65$ mfp with 6 cells
- $1.1$ mfp with 6 cells

Material Properties:

<table>
<thead>
<tr>
<th>Material</th>
<th>$\sigma_t$</th>
<th>$\sigma_s$</th>
<th>$S_{ext}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 cells</td>
<td>0.3</td>
<td>0.27</td>
<td>0.0</td>
</tr>
<tr>
<td>6 cells</td>
<td>0.2</td>
<td>0.15</td>
<td>0.0</td>
</tr>
<tr>
<td>6 cells</td>
<td>0.2</td>
<td>0.15</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Boundary Conditions (B.C.):

- $\psi_{inc,L} = 7.0$
- $\psi_{inc,R} = 7.0$
- $\psi_{inc,T} = 5.0$
- $\psi_{inc,B} = 6.0$
Fourth, we tested the extraneous source.

\[ \sigma_t = 0.3 \quad \sigma_t = 0.2 \]

\[ \sigma_s = 0.27 \quad \sigma_s = 0.15 \]

\[ S_{\text{ext}} = 3.0 \quad S_{\text{ext}} = 0.0 \]

B.C.:

\[ \psi_{\text{inc},L} = 0.0 \quad \psi_{\text{inc},R} = 0.0 \]

\[ \psi_{\text{inc},T} = 0.0 \quad \psi_{\text{inc},B} = 0.0 \]
Tests passed. We have now merged our 2D code to the main branch.

- Code 2D WDD solutions now agree with PARTISN solutions.
- After merger, the implementation of new spatial discretizations will be very simple for methods in XY geometry with only a single element per cell.
  ⇒ Next step 2D Corner Elements.
- Some work has begun to prepare the code for RZ geometries. Some new infrastructure is required.
  ⇒ RZ quadratures have “starting” directions and differencing parameters.
  ⇒ In RZ, directions must be ordered during sweeps (dependencies).
- Overall, the code will be very simple to use to test new spatial discretizations.
  ⇒ Also, once a discretization is in, it is “automatically” massively parallel.