Design and early results from a coupling of HYCOM and OLAM (The Ocean-Land-Atmosphere Model)

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OLAM background

1. OLAM is based partly on RAMS, a limited area atmospheric model specializing in mesoscale and cloud scale simulations.

2. The original motivation for OLAM was to provide a unified global-regional modeling framework in order to avoid the disadvantages of limited area models.
Many applications of regional and global numerical models require high resolution only in a limited area of a much larger model domain.

Local mesh refinement enables such model configurations with a minimal expenditure of computational resources.
OLAM:

Triangular grid cells
No map projection
Seamless local mesh refinement
Triangular mesh offers quasi-uniform global coverage
It also allows local refinement with no overlapping of grid cells and no special nest communication
Each cell communicates directly with neighbors regardless of resolution
OLAM: Relationship between triangular and hexagonal cells (either choice uses Arakawa-C grid stagger)
OLAM:
Hexagonal grid cells
Coupler for OLAM and HYCOM - Two primary requirements:

1) Exchange fluxes of sensible heat, water vapor, momentum, precipitation (rain, snow, hail, etc.), other (CO2).
2) Manage execution of both models so that they remain synchronized.

Software exists to couple different models (e.g., ESMF).

However, it is straightforward to write an efficient and fully conservative coupler.
Overlay of **ATMOSPHERE** and **OCEAN** meshes:
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**FLUX CELLS**
Flux cells are polygons that are constructed from overlay of atmosphere and ocean meshes.

Their size, shape, location, and connection to both meshes is determined during model initialization and all information is stored in lookup tables.
Atmosphere – Ocean fluxes:

Loop over all surface **flux cells**; for each cell:

**Look up:**
- Flux cell area
- Atmospheric cell index \((i)\) and physical values
- Ocean cell index \((i,j)\) and physical values

**Evaluate:**
- Surface turbulent fluxes
- Radiative fluxes

**Apply:**
- Turbulent fluxes (vapor, heat, momentum)
- Radiative fluxes
- Precipitation fluxes (rain, snow, hail, etc.)

Fluxes through each flux cell are weighted by area of that cell.

All flux transfers conserve mass, energy, and momentum.
Managing execution of both models: Synchronization

Method 1: Communicate solely by MPI

Method 2: Call one model as a set of subroutines from the other
A problem of particular interest:

What role do hurricanes play in projected climate change?

How are hurricane frequency, intensity, timing, and location impacted by projected climate change?

How would changes in hurricanes feed back on global climate?

(Hurricanes may cause net warming of tropical ocean.)