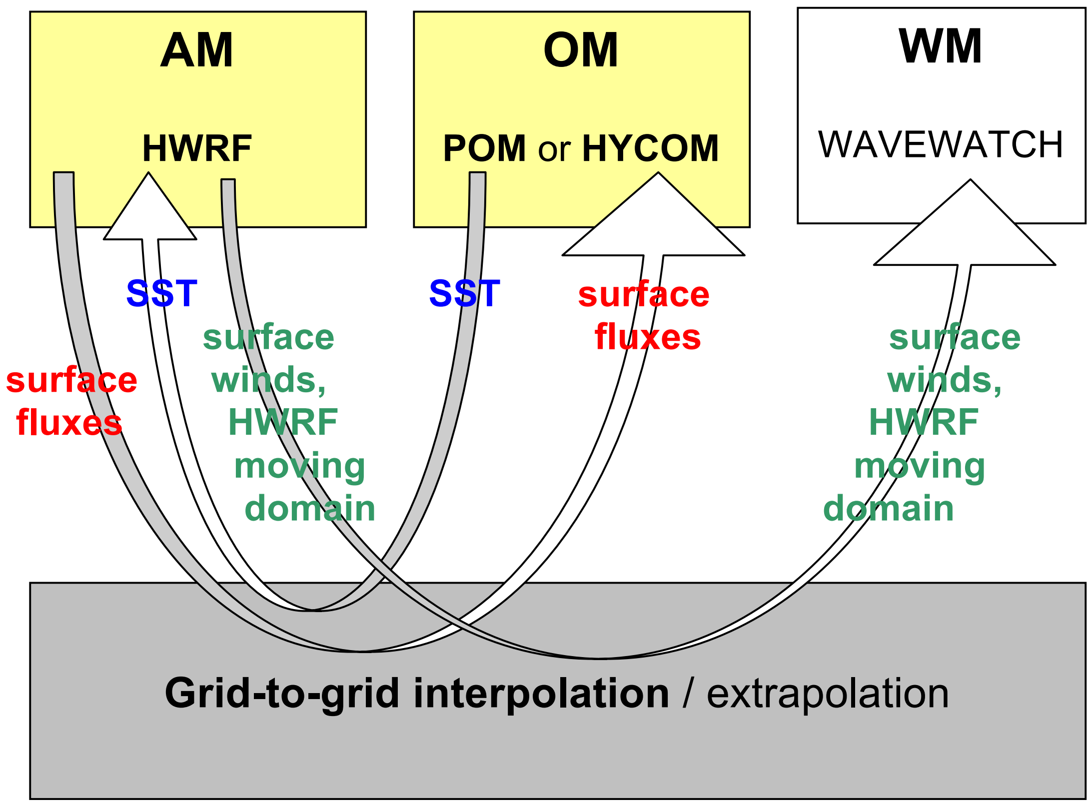
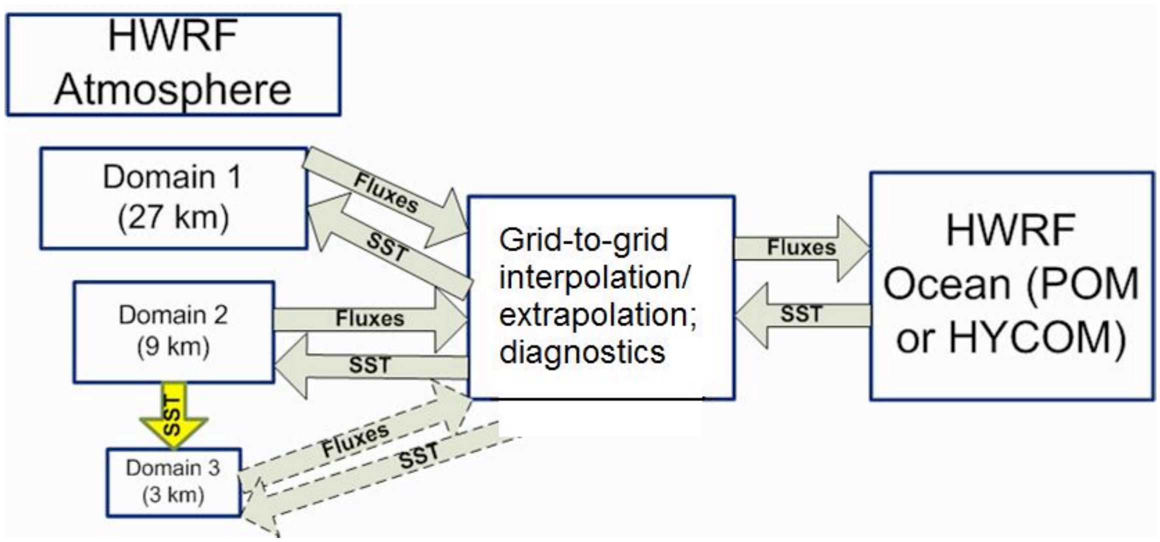
The Coupled System

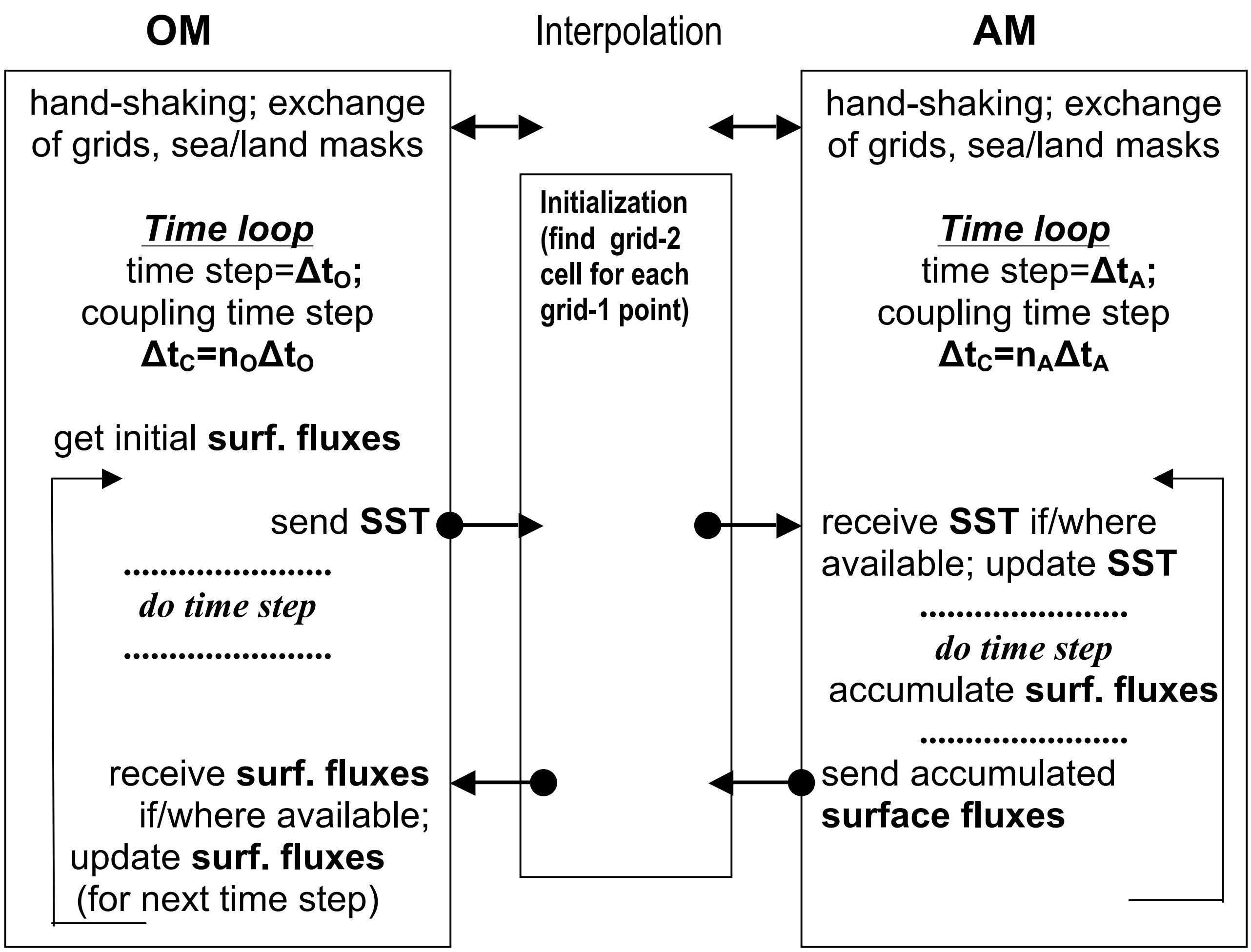


(additional **WM**⇄**AM** and **WM**⇄**OM** communications in progress)

Data flow in operational coupled HWRF



RUN-TIME COMMUNICATIONS



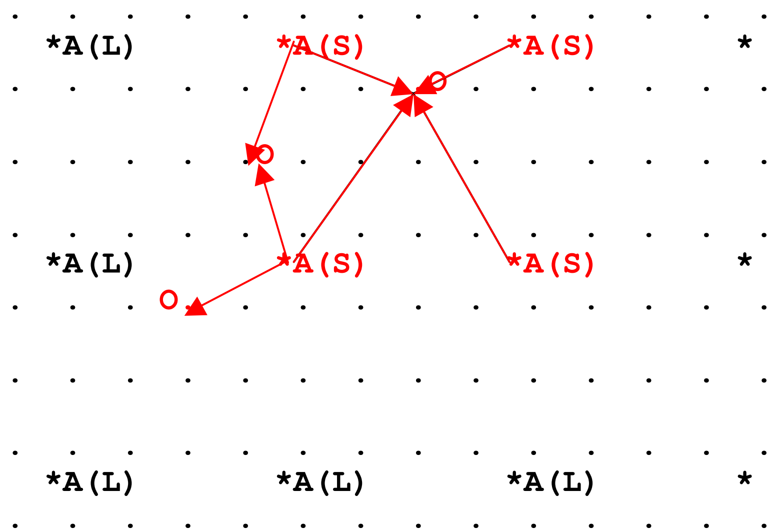
- if Component's GP is not a sea GP, Component sends a special value, to be discarded by interpolation procedure

- if no data is obtained at a GP by interpolation procedure, background data is used

- each Component can be run either in the coupled system or standalone, with the same code/executable (if there is nothing to communicate with, Component works standalone)

Data interpolation

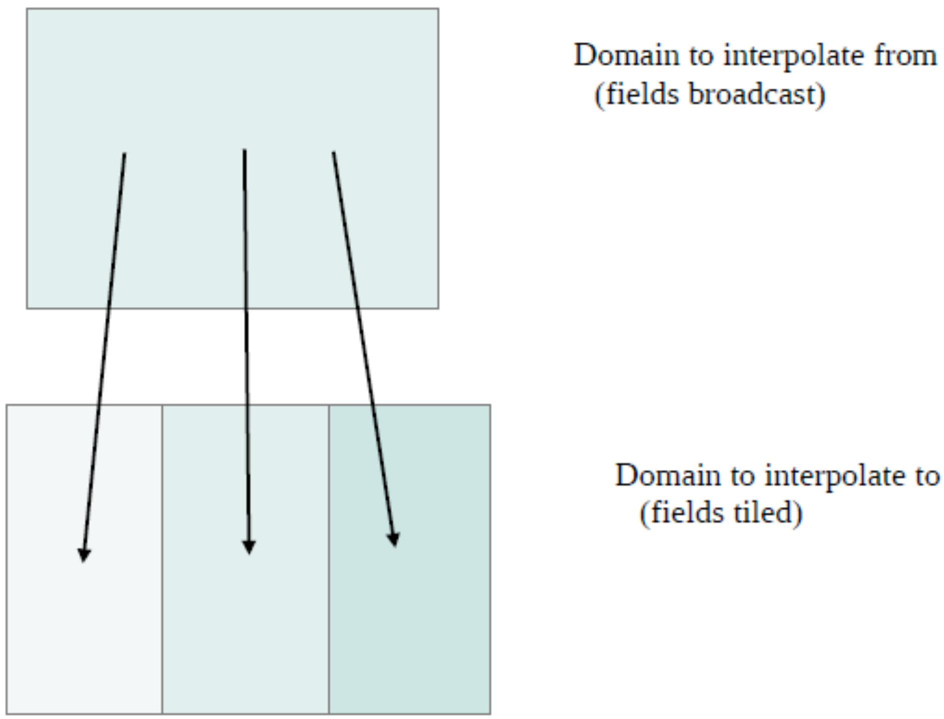
• Interpolation: bilinear in elementary grid cells, sea points to sea points only



• Data not supplied by interpolation, due to domain and sea-land mask inconsistencies, are provided by:

- background (e. g. GFS) data
- extrapolation on domain's sea-point-connected component, for a specified number of grid steps, with (AM SST) or without (OM surface fluxes) relaxation to background data

Parallelized interpolation



Interpolation initialization: for each domain 2 gridpoint $\mathbf{p}_{ij}$ find domain 1 elementary grid cell $\mathbf{C}_{kl}$ such that $\mathbf{p}_{ij}$ lies inside $\mathbf{C}_{kl}$

Data:

- the domains are not necessarily quadrilateral
- elementary grid cells $\mathbf{C}_{kl}$ are quadrilateral but not necessarily the elementary cell **(k,l), (k+1,l), (k+1,l+1), (k,l+1)** in terms of indexing
- gridpoints are represented by their latitudes/longitudes (or other common coordinates); grids are general (not latitudinal/longitudinal)

Methods:

- direct search: $\mathbf{\sim N^4}$ operations: inefficient. Cannot be pre-computed once and forever, as each forecast uses its own domains
- **current method**: $\mathbf{\sim N^3}$ operations. Algorithm: go along a “continuous” path on grid 2; check if the current segment of the path crosses domain 1 boundary an odd number of times, thus determining if the current domain 2 gridpoint lies inside domain 1; if it does, search for the grid 1 cell using the one found for the previous domain 2 gridpoint as a 1st guess and if necessary continuing the search in expanding rectangles
- Implication for the case of AM moving nested grid: initialization performed for a “total” grid covering the entire static domain and including all possible positions of the moving grid as sub-grids. Alternative: dynamic (run-time) initialization

EFFICIENCY

T_1 – WCT of Component 1
T_2 – WCT of Component 2
T_C – WCT of interpolation + of intercomponent communications
T – WCT of Coupled System

"Ideal communication setup" definition: for given T_1, T_2, T_C T is a minimum (neither Component waits for the other Component). "Ideal" does NOT mean that $T_C=0$; however, if $T_C=0$ then for the "ideal" case $T=\max(T_1,T_2)$.

For "ideal communication setup" with separate interpolation process(-es) (current design):

$$T=\max(\min(T_1,T_2)+T_C,\max(T_1,T_2))$$

I.e. **if $T_1 \geq T_2$ then**

$$\mathbf{T=\max(T_2+T_C,T_1)}$$

For "ideal communication setup" without separate interpolation processes:

$$T=\max(T_1+T_{C1},T_2+T_{C2})$$

On Jet, T_c=60 s. per model forecast day for 2013 version;
T_c=15 s. per model forecast day for 2014 version
(SST extrapolation optimized)