ICS632 FINAL PROJECT

--- GMT Optimization

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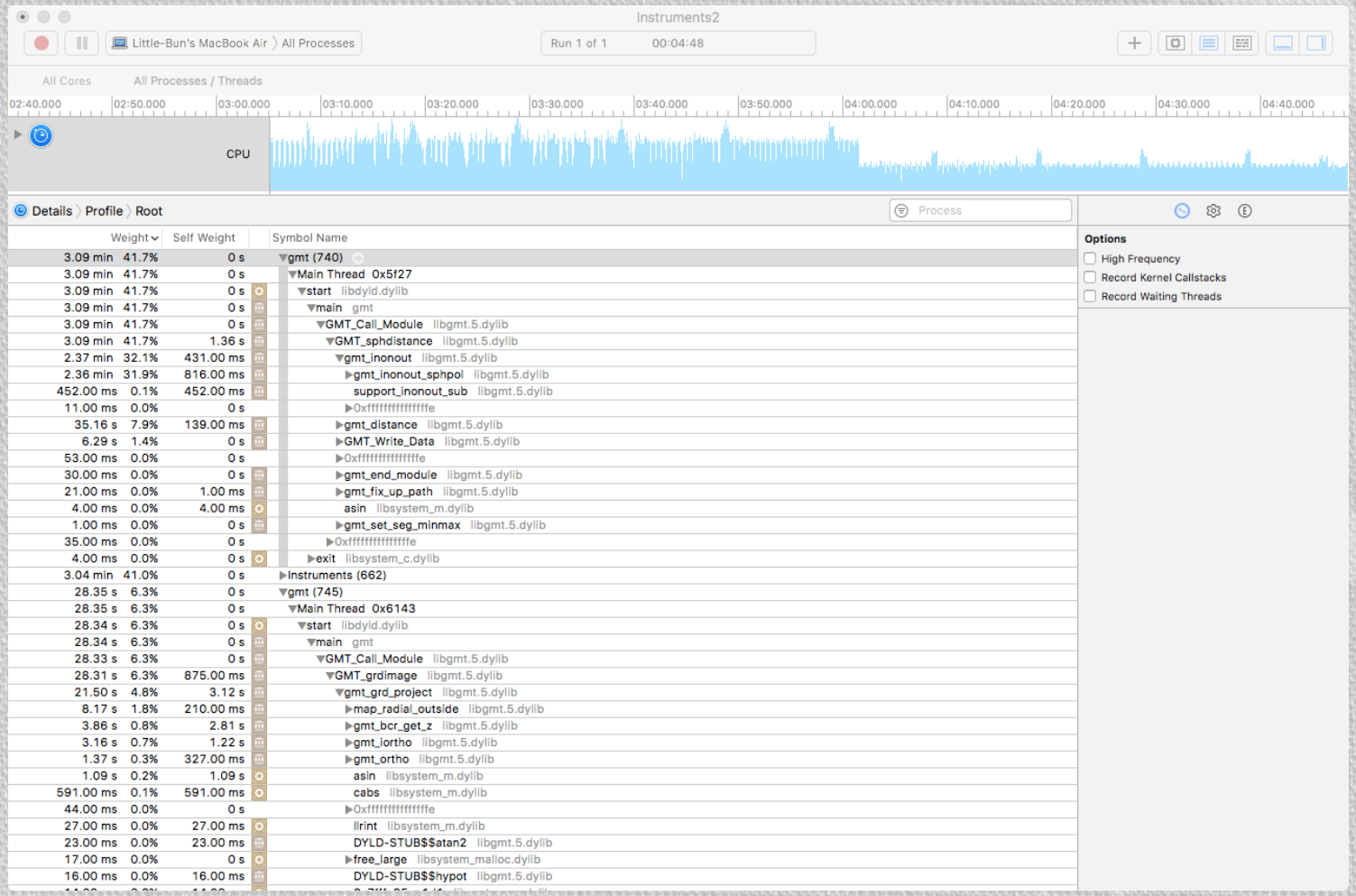
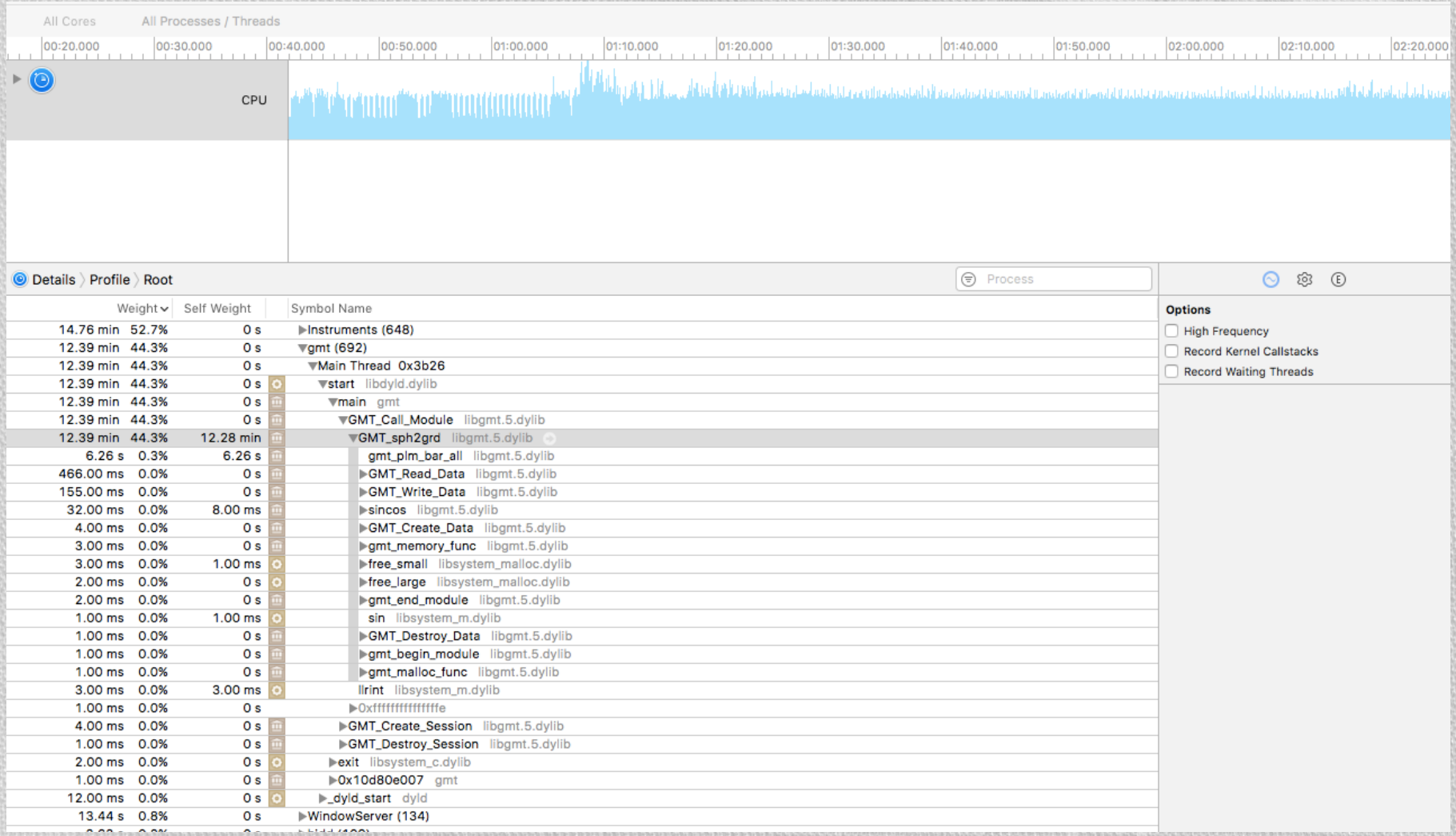
What I have done?

- 1. Use gprof/Mac instrument find critical part (*Ahmdal's Law*)



What I have done?



What I have done?

- 2. Switch the order of if-else condition. Move the frequently matched condition above.

```
if (P->pole) {  /* Case 1 of an enclosed polar cap */
        if (P->pole == +1) {    /* N polar cap */
                if (plat < P->min[GMT_Y]) return (GMT_OUTSIDE); /* South of a N polar cap */
                if (plat > P->lat_limit) return (GMT_INSIDE);   /* Clearly inside of a N polar cap */
        }
        if (P->pole == -1) {    /* S polar cap */
                if (plat > P->max[GMT_Y]) return (GMT_OUTSIDE); /* North of a S polar cap */
                if (plat < P->lat_limit) return (GMT_INSIDE);   /* Clearly inside of a S polar cap */
        }

        /* Tally up number of intersections between polygon and meridian through P */

        if (support_inonout_sphpol_count (plon, plat, P, count)) return (GMT_ONEDGE);   /* Found P is on S */

        if (P->pole == +1 && count[0] % 2 == 0) return (GMT_INSIDE);
        if (P->pole == -1 && count[1] % 2 == 0) return (GMT_INSIDE);

        return (GMT_OUTSIDE);
}

/* Here is Case 2.  First check latitude range */

if (plat < P->min[GMT_Y] || plat > P->max[GMT_Y]) return (GMT_OUTSIDE);

/* Longitudes are tricker and are tested with the tallying of intersections */

if (support_inonout_sphpol_count (plon, plat, P, count)) return (GMT_ONEDGE);   /* Found P is on S */

if (count[0] % 2) return (GMT_INSIDE);

return (GMT_OUTSIDE);   /* Nothing triggered the tests; we are outside */
```

What I have done?

- 3. Inline function / Macro

- 4. Implement sqrt function used by “sphdistance”

```
float Q_rsqrt( float number )
{
    long i;
    float x2, y;
    const float threehalfs = 1.5F;

    x2 = number * 0.5F;
    y  = number;
    i  = * ( long * ) &y;                       // evil floating point bit level hacking
    i  = 0x5f3759df - ( i >> 1 );               // what the fuck?
    y  = * ( float * ) &i;
    y  = y * ( threehalfs - ( x2 * y * y ) );   // 1st iteration
//  y  = y * ( threehalfs - ( x2 * y * y ) );   // 2nd iteration, this can be removed

    return y;
}
```

From Wikipedia

What I have done?

- 5. OPENMP Parallelize

```
#pragma omp parallel for private(col, side, ij, f_val, n_set)  //num_threads(6)
        for (p_col = west_col; p_col <= east_col; p_col++) {   /* March along the scanline using col >= 0 */
          //int id = omp_get_thread_num();
          //if (id == 0) printf("Running %d threads \n", omp_get_num_threads());
```

sphdistance

```
#ifdef _OPENMP
#pragma omp parallel for private(col,node,sum,kk,L,M) shared(Grid,row,n_columns,L_min,L_max,P_lm,C,Cosm,S,Sinm)
#endif
```

Spharm

What I have done?

- MPI (In progress)
- Idea: each non-master process compute some parts of the grid, and send it to master.
- Issue: the output is not correct, probably race condition.

```
#ifdef MPI
            int data[1];
            if(myrank == 0) {    // master
               MPI_Recv(data,1,MPI_INT, node/num_procs+1,0,MPI_COMM_WORLD, &status);
               side = data[0];
            } else {
               side = gmt_inonout (GMT, grid_lon[col], grid_lat[row], P);
               data[0] = side;
COMM_WORLD, &s               MPI_Send(data,1,MPI_INT, 0,0,MPI_COMM_WORLD, &status);
            }
#endif
```

Result

- Switch the order of if-else condition. (1.2 seconds less on 10 trials run)
- Inline / MACRO (0.2 seconds more …)
- Fast inverse sqrt (1 second less)
- OPENMP (speedup of 2.5 with 5 cores for sphdistance, speedup of 15 with 20 cores for spharm)