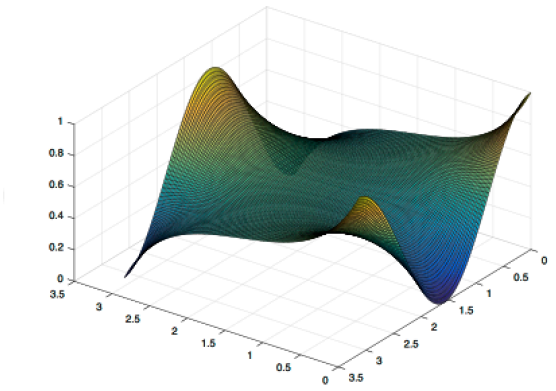
Notes about the runs of the code:

- the mac implementation of the omp did not allow to use the variables of the omp library (for the gcc of the version 4.8), thus I was unable to test the functionality of the code in full capacity.
- the mac OpenMPI library was giving a random errors, and was compiled only with mpc++ compiler (in he Makefine the mpcc compiler was used to run the code on Androit, however with no success)

Serial execution:

Grid size	Average Temp	Time
128	0.49732517	25.53592491
256	0.49720709	313.78936768
512	0.49714664	6032.96337891

Surface of the last grid:



OMP execution: (all that worked for me)

Number of cores	Grid size	Average Temperature (rounded to the 2 decimals)	Time
1	128	0.50	20.53
	256	0.50	328.26
	512	0.50	6363.11
2	128	0.50	27.09
	256		
	512		
4	128	0.50	48.75
	256	0.50	648.35
	512		

8	128	0.50	41.77
	256	0.50	424.84
	512	0.50	6866.23

MPI execution: (all configurations that worked)

Number of cores	Grid size	Average Temperature	Time
1	128	0.36422769	16.74820518
	256		
	512		
2	128	2*0.24945551	8.93414116
	256	2*0.24923697	188.92697144
	512		
4	128	4*0.13244267	7.94728708
	256	4*0.13379771	139.42268372
	512	4*0.13379771	766.22576904

Running on the cluster error:

```
[[pkanel@adroit3 apc_hw4]$ #SBATCH -N 1
[[pkanel@adroit3 apc_hw4]$ #SBATCH --ntasks-per-node=8
[[pkanel@adroit3 apc_hw4]$ #SBATCH -t 0:15:00
[[pkanel@adroit3 apc_hw4]$ #SBATCH --mail-type=begin
[[pkanel@adroit3 apc_hw4]$ #SBATCH --mail-type=end
[[pkanel@adroit3 apc_hw4]$ #SBATCH --mail-type=fail
[[pkanel@adroit3 apc_hw4]$ #SBATCH --mail-user=pkanel@princeton.edu
[[pkanel@adroit3 apc_hw4]$ for nx in 128 256 512; do srun ./heat_mpi $nx > heat_m
pi.$nx.8.out; done
srun: error: Unable to allocate resources: Requested time limit is invalid (miss
ing or exceeds some limit)
srun: error: Unable to allocate resources: Requested time limit is invalid (miss
ing or exceeds some limit)
srun: error: Unable to allocate resources: Requested time limit is invalid (miss
ing or exceeds some limit)
[pkanel@adroit3 apc_hw4]$
```

Running locally error:

```
At least one pair of MPI processes are unable to reach each other for
MPI communications.  This means that no Open MPI device has indicated
that it can be used to communicate between these processes.  This is
an error; Open MPI requires that all MPI processes be able to reach
each other.  This error can sometimes be the result of forgetting to
specify the "self" BTL.

  Process 1 ([[53438,1],2]) is on host: Polinas-MacBook-Pro
  Process 2 ([[0,0],0]) is on host: unknown!
  BTLs attempted: self sm vader

Your MPI job is now going to abort; sorry.
```

4. OMP vs MPI

Given the runs of the code that I was able to make, for the

mac the MPI seems to perform a better job (parallel jobs are more equally distributed), while for the OMP the jobs loading balance was bad, which causes the execution time be of the order of the serial execution.

Despite the nonstable performance, the OpenMPI gives boost to the performance of the code. The omp deals with the shared variables that are needed to be synchronized, thus it takes more time to complete the parallel sections of the code, then the distributed approach of MPI. I would prefer the distributed approach for this case to save time on the synchronization requests, given that the data is divided equally among the processes.