

# Optimizing physics subroutines for multithreaded processors

## ESCAPE

#### • What is ESCAPE?

ESCAPE is a H2020 Project about

Energy efficient and

SCalable

Algorithms for

weather Predction at

Exascale

## • What is the goal?

The goal is to demonstrate improvements in performance for a selected set of algorithms referred to as "dwarfs".

DMI works on a dwarf version of the ACRANEB2 radiation scheme, which has been optimized for running on multithreaded processors.

## • Why?

The current 1D physics schemes are embarrassingly scalable. Still we show that they can be made much more efficient than at present.

• But is not OpenMP implemented already?

Only coarse-grained OpenMP has been implemented in HARMONIE, which is far from optimal (O'Brien, All Staff Workshop, 2015). Quote from the presentation:

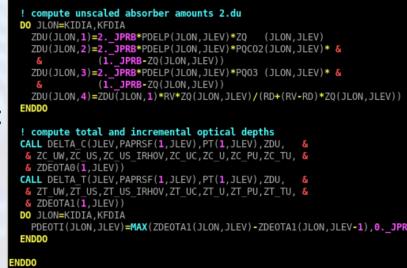
"Performance is poor partly because HARMONIE runs out of memory before running out of threads!

Changes should be made to avoid memory blow-up!"

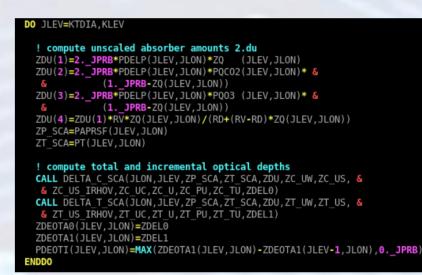


#### • How can it be done?

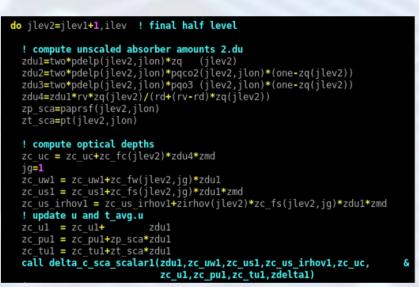
1. Original loop:



2. Switched loop order and reduced array sizes:



3. As above but scalar variables used as far as possible:



As it can be seen, this is not complicated, nor is the new code unreadable.

ACRANEB2 has more than 15 500 lines. The other physics routines have less. Improvements as these are feasible implement throughout these!

Relative physics time	Lines (approx.)	subroutine	Function
22.6%	4300	ARO_RAIN_ICE	Precipitation microphysics
17.4%	3800	VDFHGHTHL	Shallow mass flux mixing
13.0%	5700	ARO_TURB_MNH	Turbulence sources and TKE evolution
12.2%	5800	ARO_SHALLOW_MF	Turbulence mass flux and divergence
5.9%	1500	ARO_ADJUST	Adjustment of cloud liquid and frozen water
4.4%	3100	APL_AROME	Main physics routine (local lines only)
Sum = 75.51%	Sum = 24200	6 of 17 subroutines	