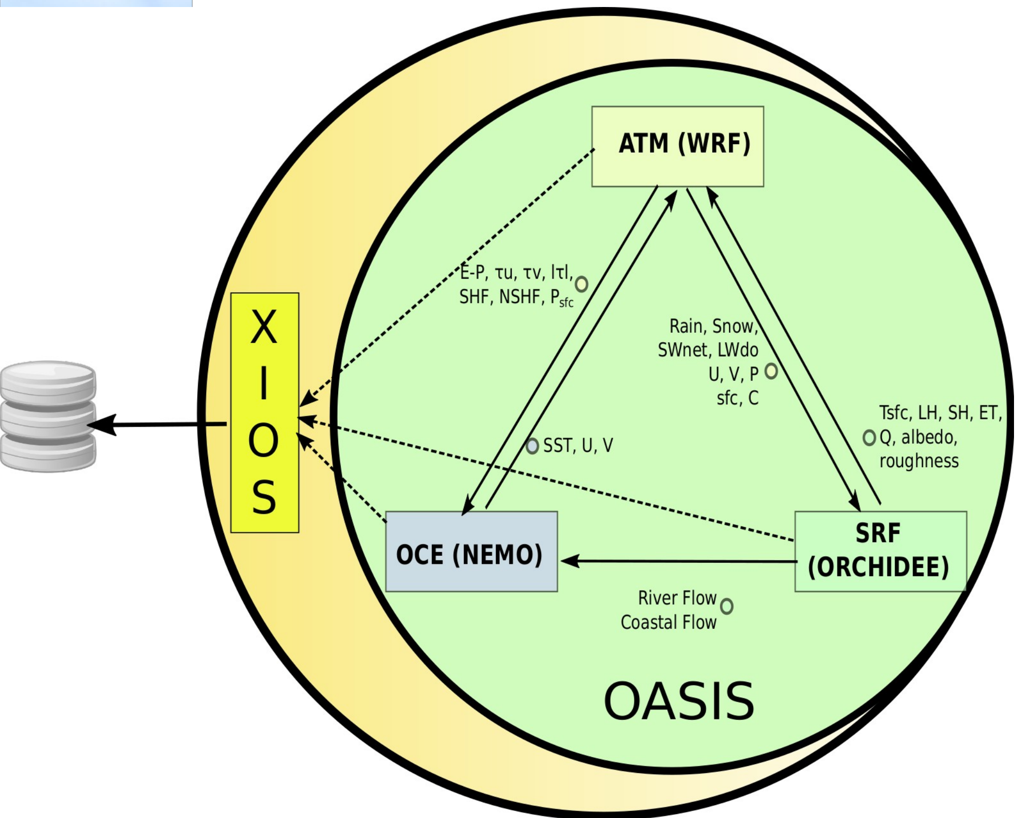
The coupling strategy for RegIPSL



- IPSL components of the global Earth system model are used regionally.
- For the atmosphere WRF is used while a new model is under development.
- All couplings are performed with OASIS.
- All models output with XIOS.
- The same workflow as the global ESM is used.

Original features :

- The land surface model is not part of the atmosphere
- Communicates with the atmosphere and ocean through OASIS
- The high resolution information of river flow is directly transmitted to the ocean.

Institut Pierre Simon Laplace

Difficulties of computing Surface/Atmosphere fluxes

Sensible heat is used here as a simple flux computed between the two components :

$$H^{t+1} = \rho C_d^i \left|\vec{V}\right| \left(\theta_a^i - \theta_s^j\right)$$

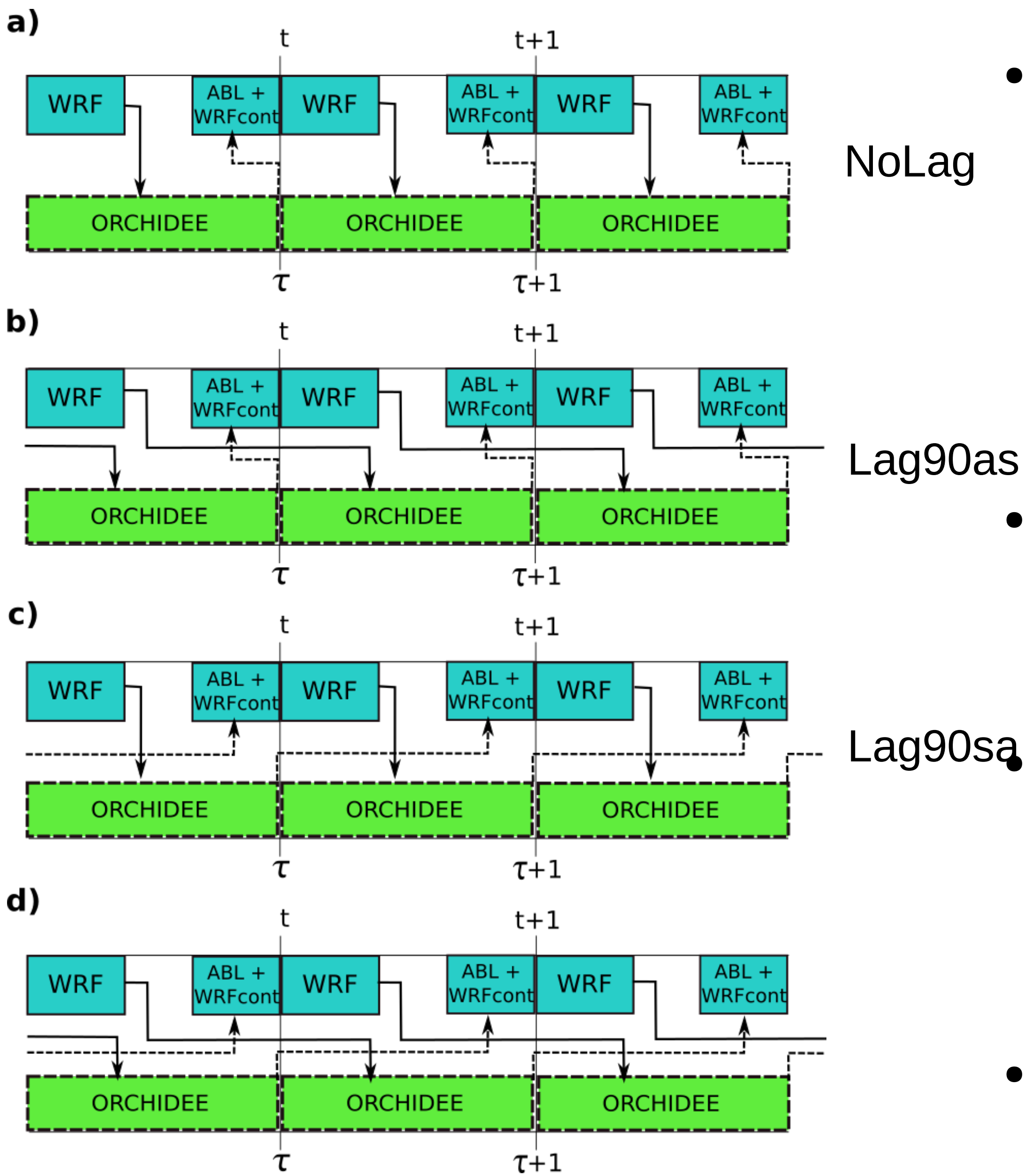
All atmospheric variable are computed by the ABL scheme. Sensible heat is one of its inputs.

At which time step is each variable to be taken ?

- i=t+1, j=τ+1 : Implicit coupling to ATM
- i=t+1, j=τ : Semi-implicit coupling to ATM
- i=t, j=τ+1 : Explicit coupling to ATM

How are t and τ related ? If t=τ then the ATM has to wait for the SRF but other solutions are possible.

Task parallel Coupling



- As the physics within WRF are at the same time steps as the dynamics, the coupling to the surface is at high frequency.
- OASIS allows us to evaluate different coupling strategies.
- Surface drag (surface layer turbulence) is computed in the WRF block of the atmosphere.
- Only after this step is data sent to ORCHIDEE.

Diagnostics

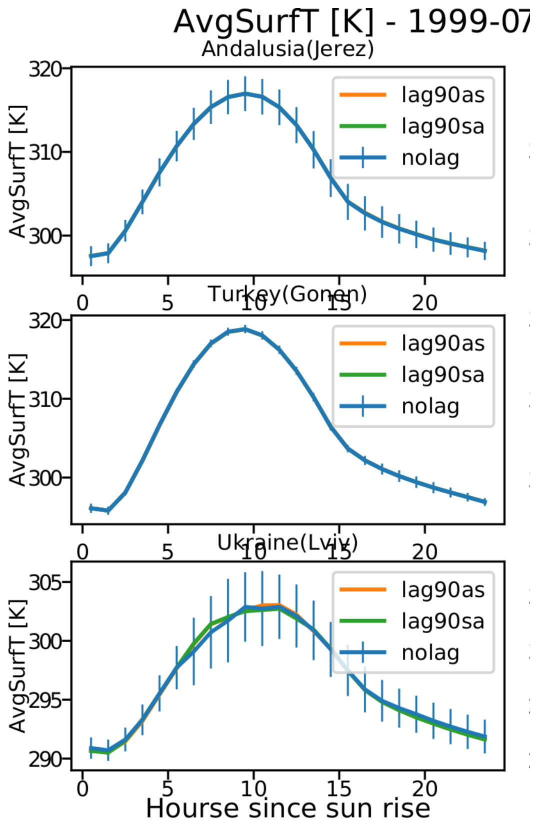
- A 20km resolution July run is used. Time step is 90s
- Composite diurnal cycles relative to the time of sunset or sunrise (7 cycles).
- The quality of the composite is evaluated with the standard deviation around the mean.
- HAMP : Hourly amplitude of change of the variable.
- NNI : Numerical noise index in % :

$$NNI(X(t)) = \frac{max(X_{t,t+1}) - min(X_{t,t+1})}{0.5(X_t + X_{t+1})}$$

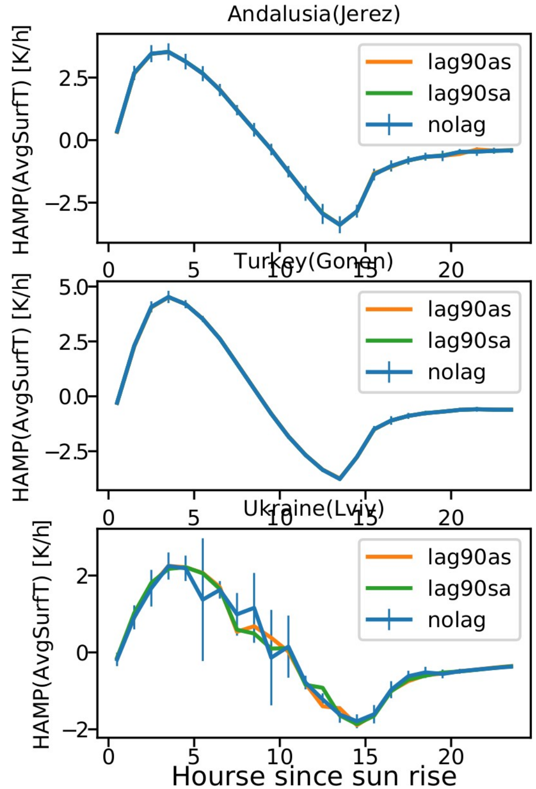
NNI takes into account the extrema over the hourly timestep of the diagnostics. Output to calculate is not available for all variables.

Surface Temperature

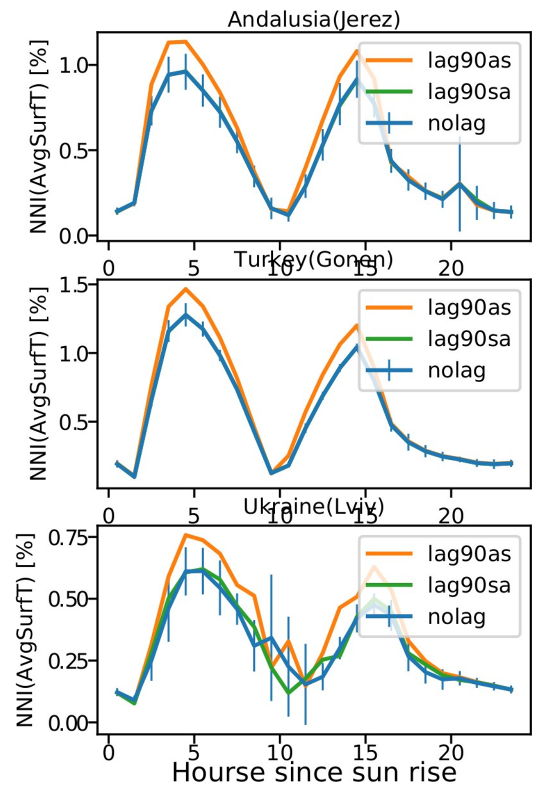
AvgSurfT



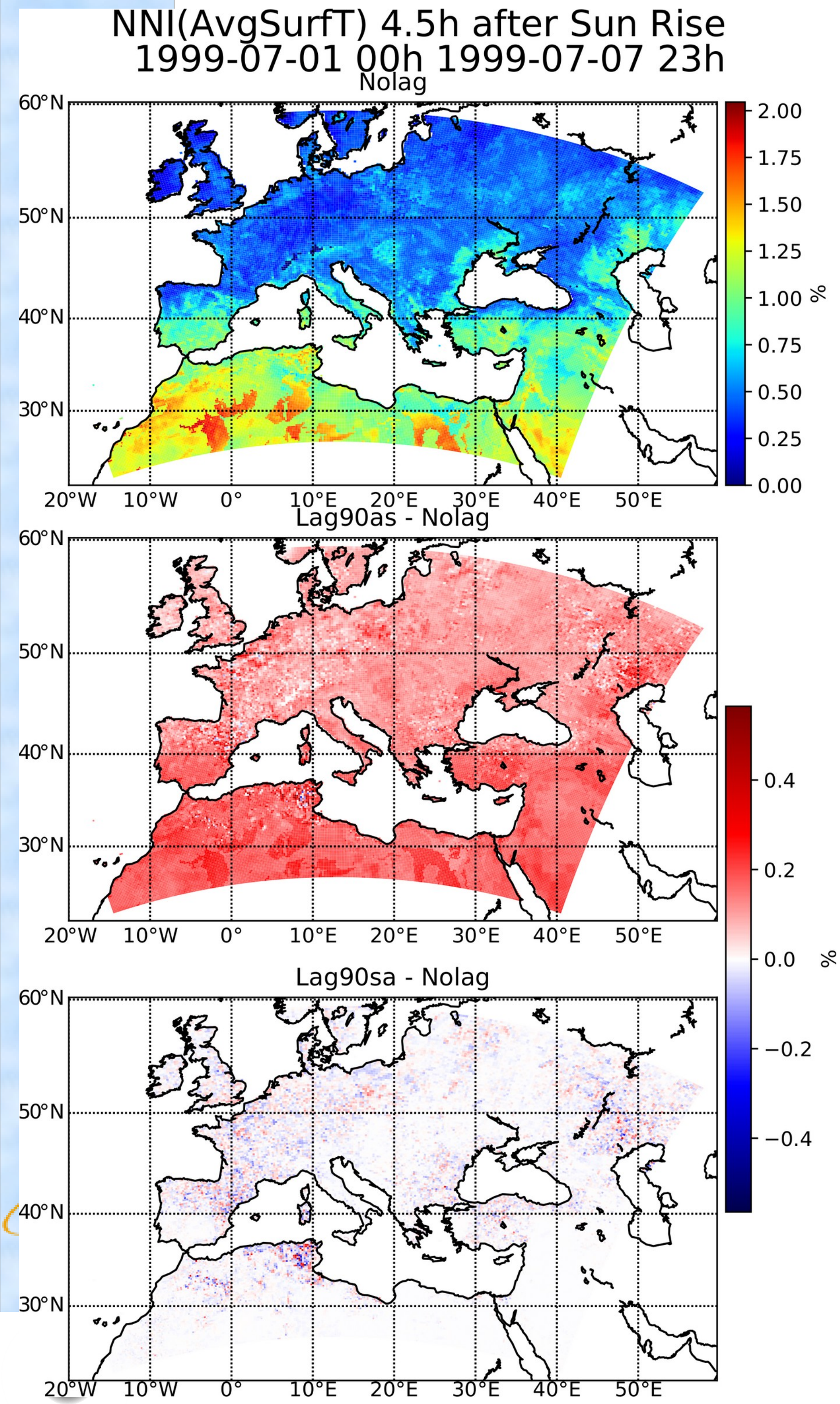
HAMP



NNI



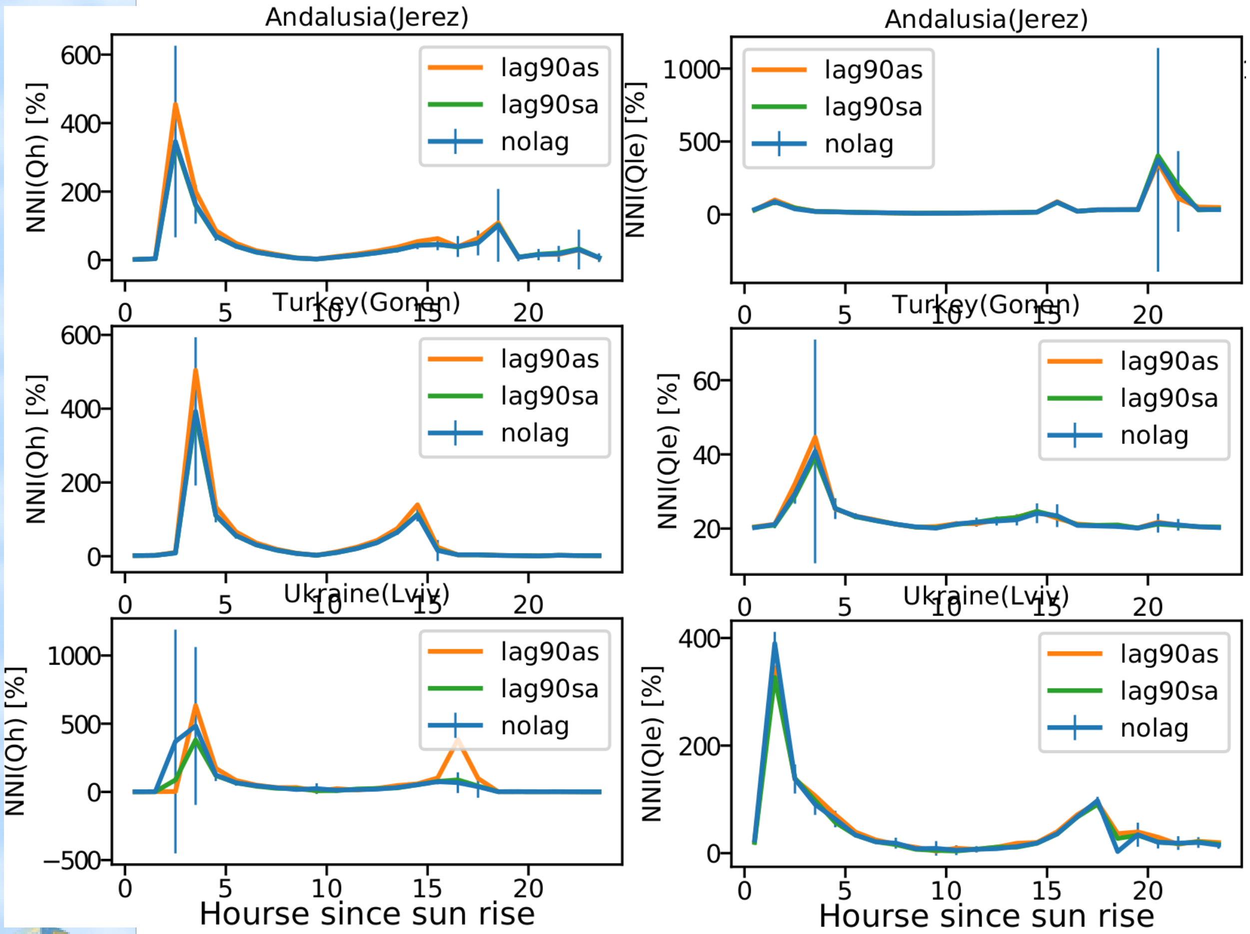
- As noted before the numerical noise is larger in Lag90as. Only 1% of the mean temperature.
- The impact on the mean diurnal cycle is very small.
- The effect is largest 4.5h and 14-16 hours after sunrise.



Spatial distribution of change

- The maps are for 4.5h after sunrise.
- All points have the same solar time.
- The increase of NNI is quite homogeneous.
- Some regions have a lower impact of the coupling because of surface properties (wet soils or snow cover)

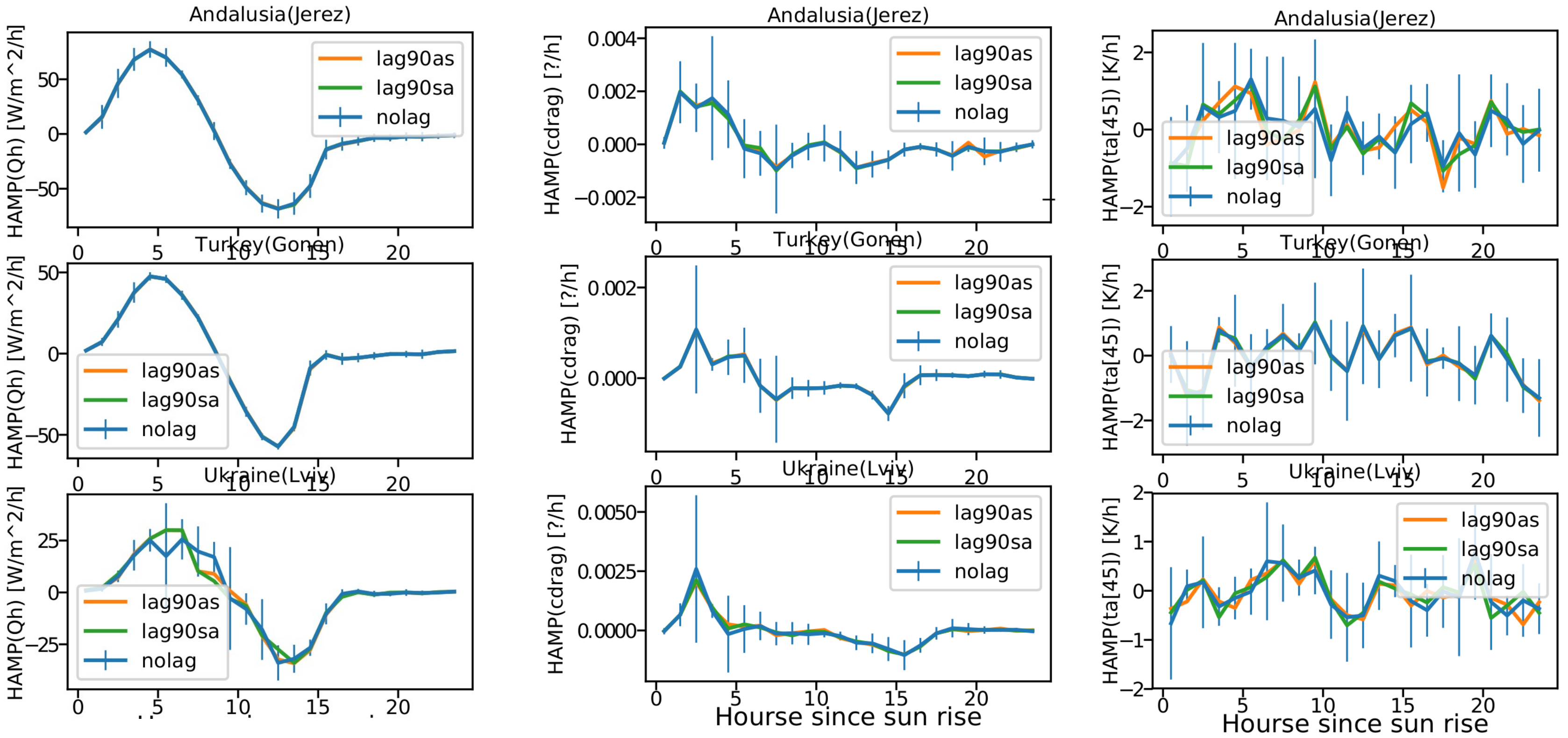
The surface fluxes show same behaviour on NNI



- In the turbulent fluxes Lag90as also stands out.
- The impact is earlier in the day
- The difference seems weaker than for surface temperature.
- The afternoon signal is less clear.

The NNI peak of the fluxes is earlier because the mean flux is close to zero at that time of the day.

The driving variables of the fluxes (No NNI available)



- Fluxes change most in the morning. It is thus logical that they are most sensitive at that time.
- The surface layer turbulence increases in the morning as well.
- First level atmospheric temperature changes more slowly.

Hypothesis

- In Lag90sa (c) :
  (closer to Nolag):
  - *WRF computes surface drag with ATM conditions at t*
  - *ORCH uses this drag computed at the same time*

- Lag90as (b):
  - *WRF computes the surface drag with ATM conditions at t*
  - *ORCH uses this surface drag at t+1*