Land surface spinup for episodic modeling

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Soil moisture spinup

Experiments with self-spinup
BLLAST case in France, June 2011
Goal: Correct conditions at midday to investigate of afternoon transition

Why self-spinup? Highly-resolved analyses are not available or reliable

What?
WRF 9/3 km grids initialized with ERA-Interim every day at 0000 UTC
Soil moisture and temperature initialized from ERA-Interim at 0000 UTC 1 June, then self-cycled for 30 days (cycle 1)
Cycle 2 initialized 0000 UTC 1 June with WRF soil moisture and temperature from cycle 1 at 0000 UTC 1 July

Three configurations of two LSMs:
1. Noah with default four soil layers (thicknesses 0.1, 0.3, 0.6, 1 m)
2. PXLSM with default two layers (thicknesses 0.01, 0.99 m)
3. Noah with thinner top layer (thicknesses 0.01, 0.3, 0.6, 1 m)

What is spinup supposed to do?

1. Increase spatial variation of soil variables (downscaling) (DEMONSTRATED)

2. Remove biases overall and/or in specific locations, land use or soil types (PARTIALLY DEMONSTRATED)

3. Reduce scaling differences due to LSM formulation

4. Compensate for errors in parameters or formulation (LSM, PBL, etc.)

Soil moisture during spinup demonstrating downscaling

ERA moisture dries out after ~ 8 June, std.dev. has no trend

WRF moisture decreases except in early June when it rains

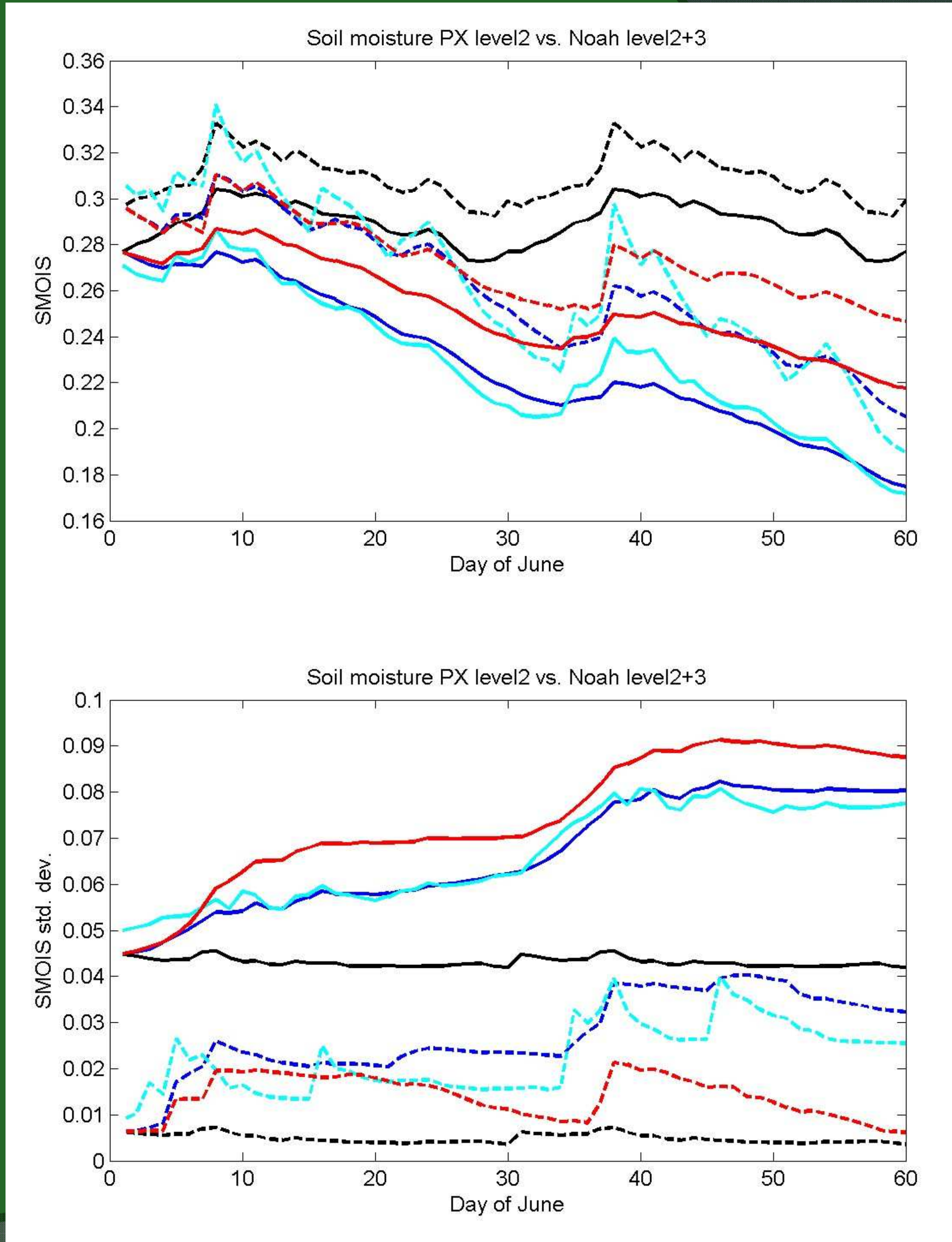
WRF std.dev. increases especially when it rains

PX moisture decreases more slowly than Noah (thicker layer)

PX std.dev. is greatest in whole domain, but least in 10x10 box

Thinner 1st layer in Noah makes it more responsive but changes longer-timescale behavior little

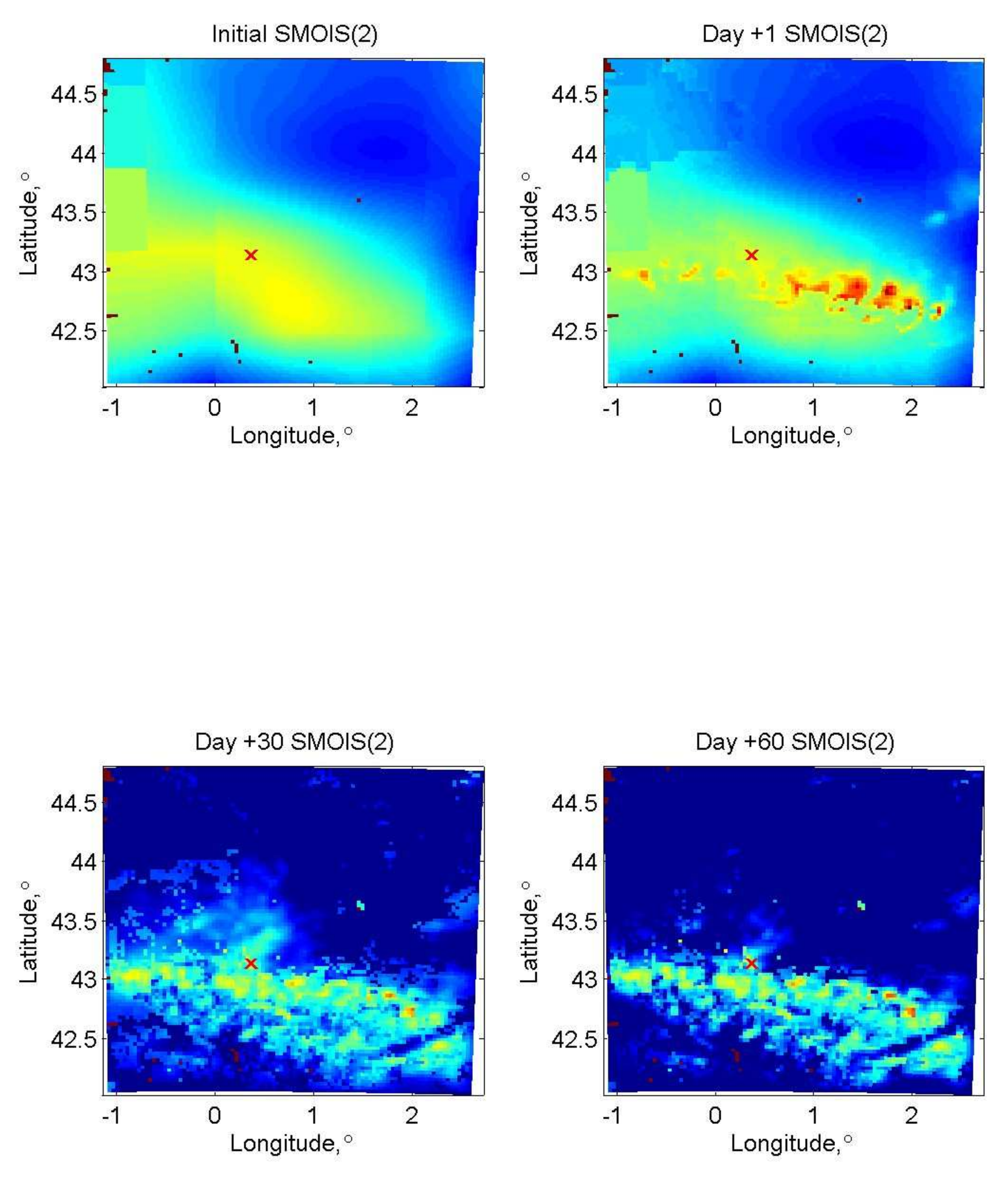
Black = ERA
Blue = Noah, defaults
Cyan = Noah, ZS(1)=.005
Red = PXLSM
Solid = whole domain average
Dashed = 10x10 avg northeast of site



Soil moisture during spinup demonstrating downscaling

Detail emerges quickly, seems fully established by 30 days, but std.dev. (previous figure) continues to increase when it rains

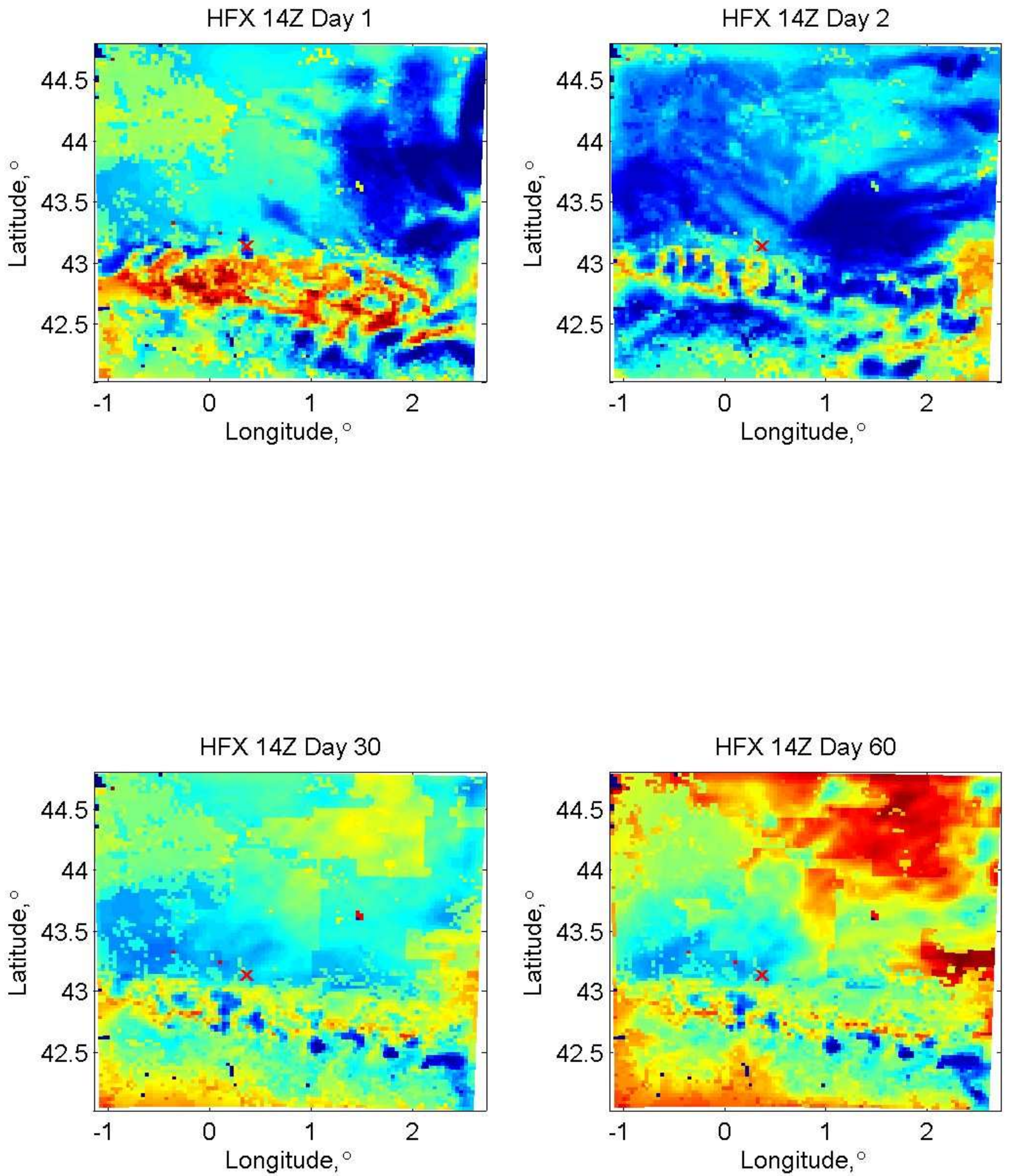
Lannemezan (red X) is within the mountain moist zone in ERA, moisture there gradually decreases with spinup and gradients in its vicinity increase



Heat flux during spinup

Heat flux from Noah has detail immediately despite smooth soil moisture because it uses soil and vegetation types

Day 30 and day 60 have similar spatial pattern but magnitude has increased



Soil moisture during spinup compared to data (SMOSMANIA)

Eight sites in France within domain 2 (much site-to-site variation, not shown)

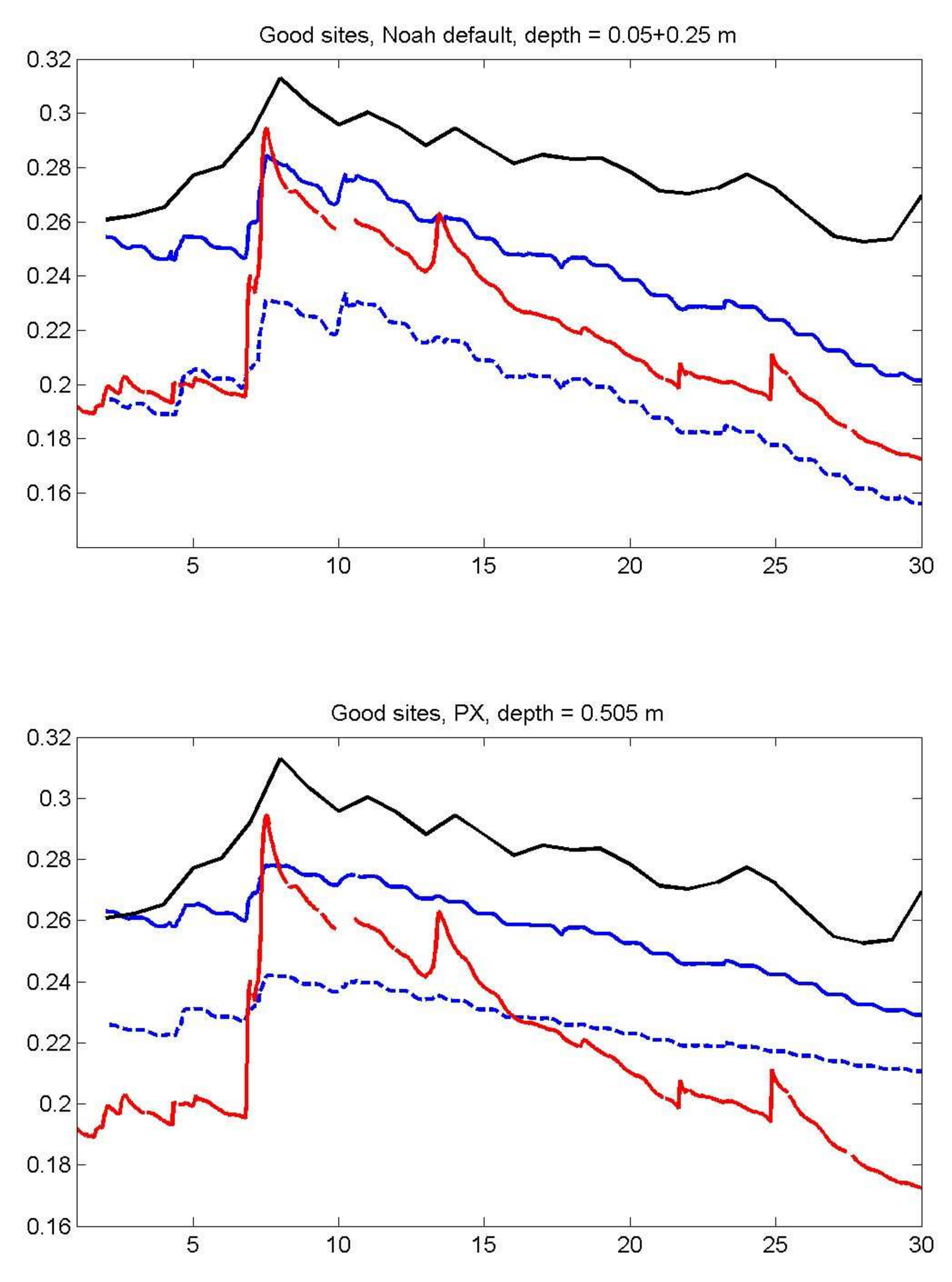
ERA too moist

Noah drying similar to obs
Noah Cycle 1 and 2 straddle obs

PX drying too slow (thicker layer, not strictly comparable since obs only go to 0.3 m depth)

From this, we would expect best performance from either Noah or PX cycle 2

Black = ERA
Blue = WRF
Red = SMOSMANIA
Solid = cycle 1
Dashed = cycle 2



Sounding comparison

Seven ~1700 UTC soundings (24,25,26,27,30 June, 1,2 July)

Near end of each cycle

Direct initialization from ERA (+) is biased cool and moist

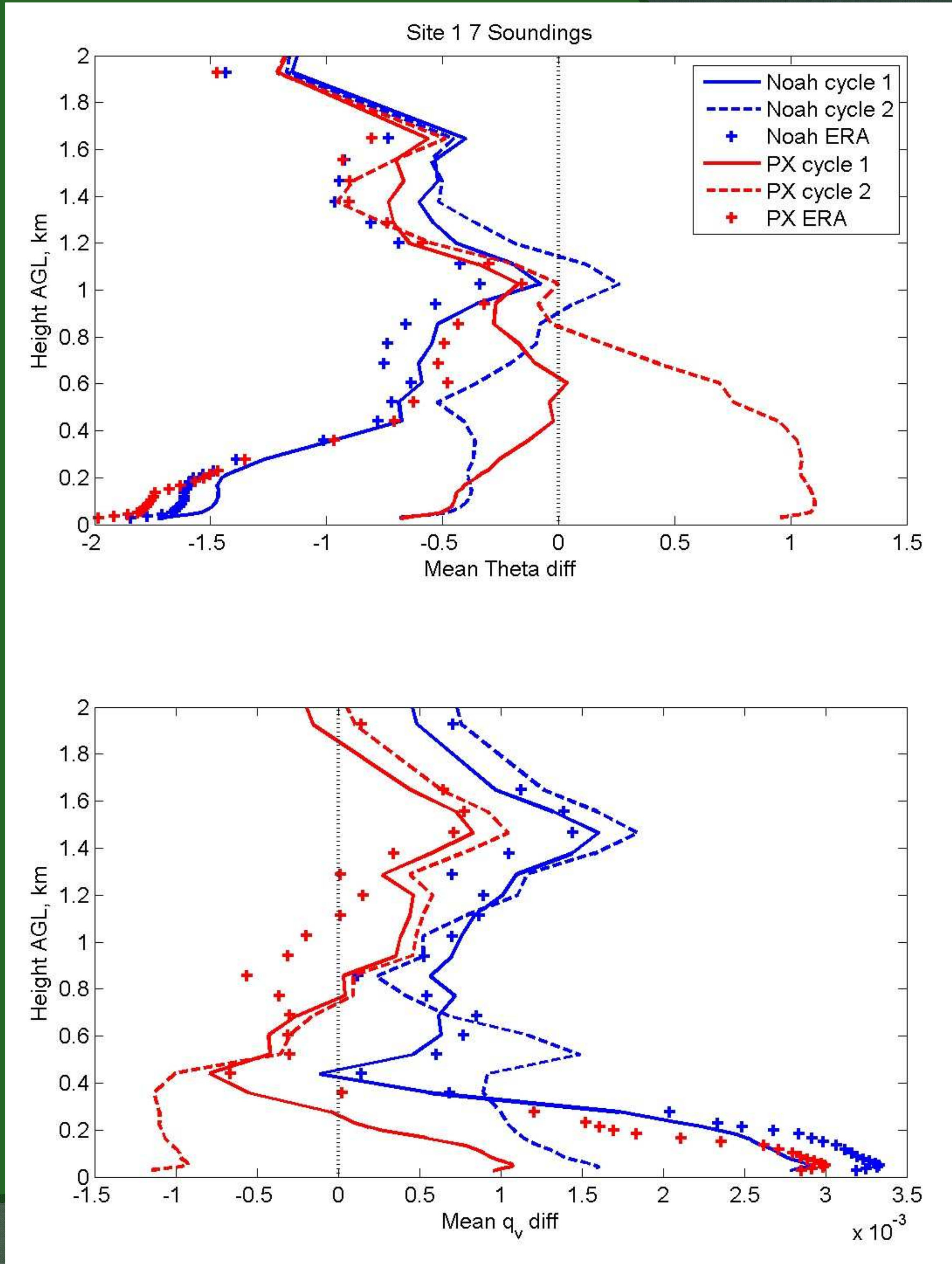
Errors are significantly reduced by one cycle of PXLSM or two cycles of Noah

PX overshoots with two cycles

Individual soundings show best performance from Noah cycle2 or PX cycle1, neither is obviously better

Biases above BL are also cool and moist, little influenced by spinup

Noah 10mm (not shown) is a little better than Noah 10cm



Frequent soundings

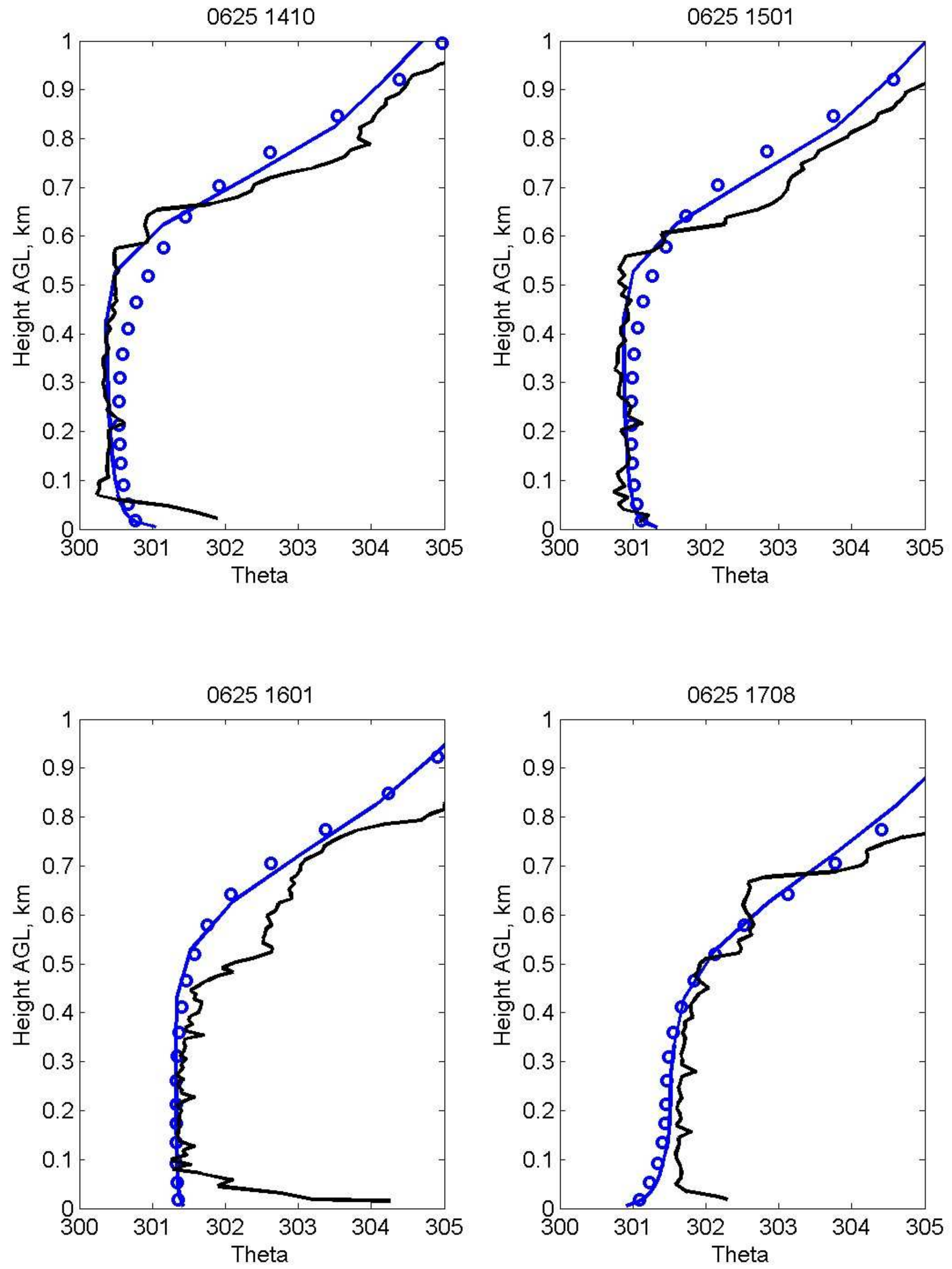
25 June is the most canonical afternoon, but not rise in PBL height between 1601 and 1708

MYJ (solid) and TEMF (circles) PBLs on MYJ/Noah cycle2 soil

Both runs capture PBL evolution reasonably well, BUT
MYJ is plotted with 0.2K added and height multiplied by 1.2
TEMF height multiplied by 1.1

So TEMF is doing a little better (less correction needed)

Model stabilizes sooner than reality



Conclusions and further work

Spinup increases spatial variation of soil variables (downscaling)
- Initial adjustment is quick (a day or two)
- Adjustment continues over months

Spinup removes the moist bias of ERA-Interim

No evidence for reduction of scaling differences due to LSM formulation
- Two LSMs show rather different behavior even after long spinup

Over-drying can compensate for too little entrainment in PBL scheme
- Not clear how to do this prospectively (for forecasting)
- No evidence of general compensation for errors in parameters or formulation

Major flaw: Results depend on quality of modeled precip, which is unreliable

Data needed for “completion”:
- Representative fluxes and soil parameters for field site grid box