First results from a novel causal framework for studying aerosol-cloud Interactions

Michael DeCaria, Peter Jan van Leeuwen, Sonia Kreidenweis,

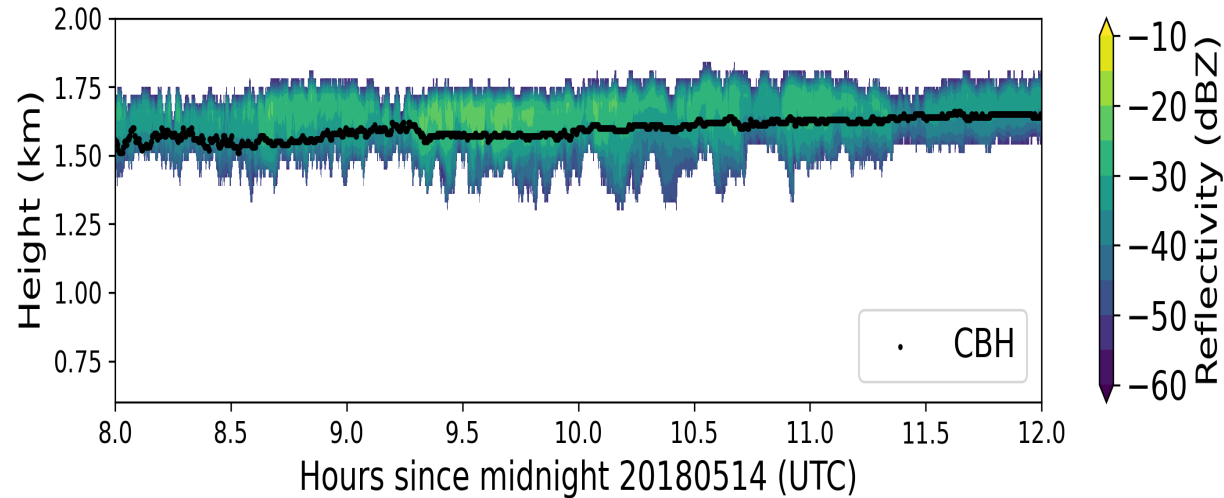J.-Y. Christine Chiu, Ching-Shu Hung

Thu 10 Aug 2023

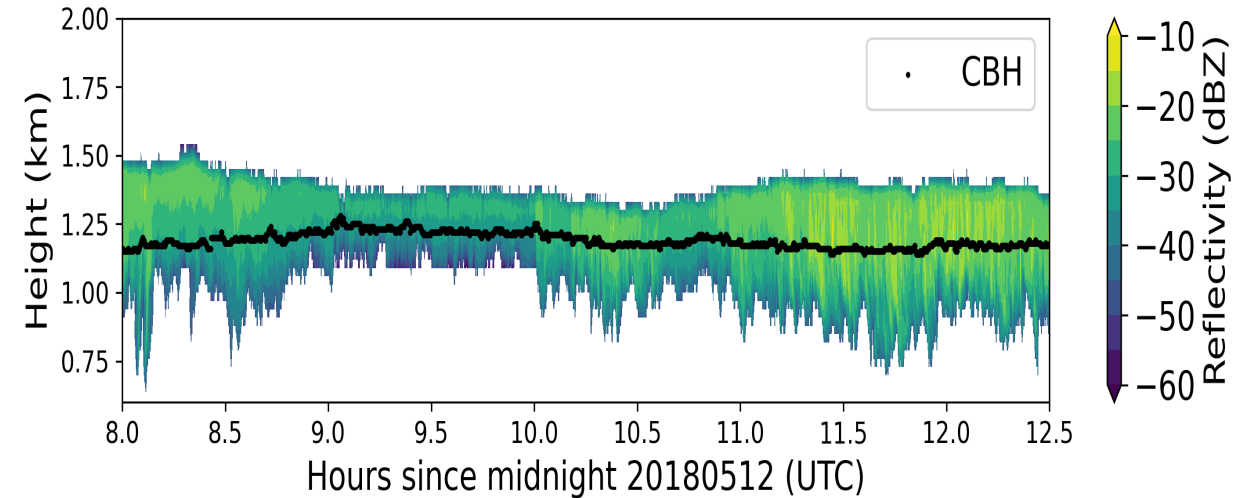Joint ARM User Facility and ASR PI Meeting

Warm Boundary Layer Process Working Group Breakout

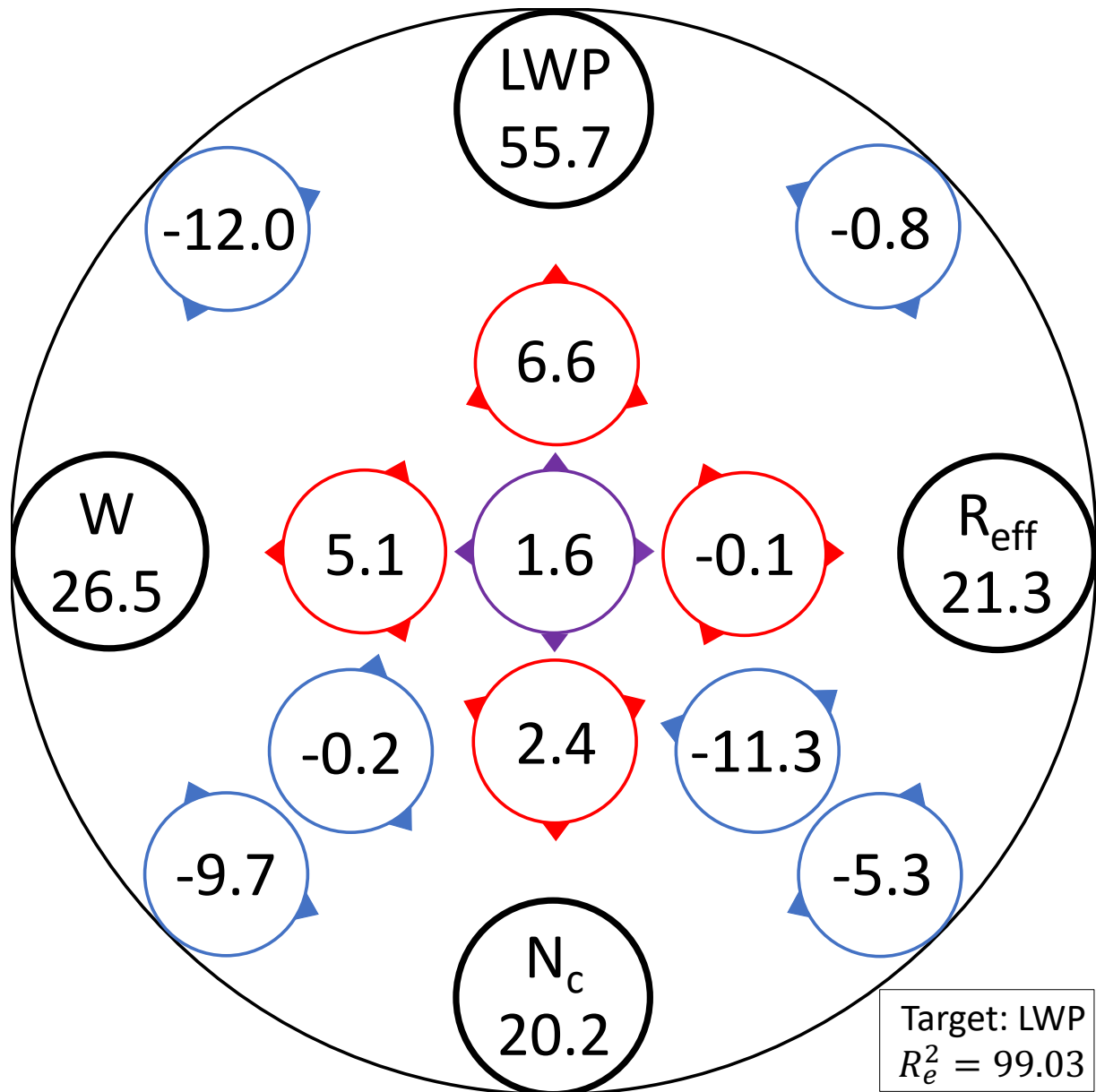# Marine boundary-layer clouds: two cases

Non-drizzling

Drizzling

We use

1. Liquid water path (LWP)

2. Vertical velocity (W) near cloud-base

3. Cloud number concentration (N_c)

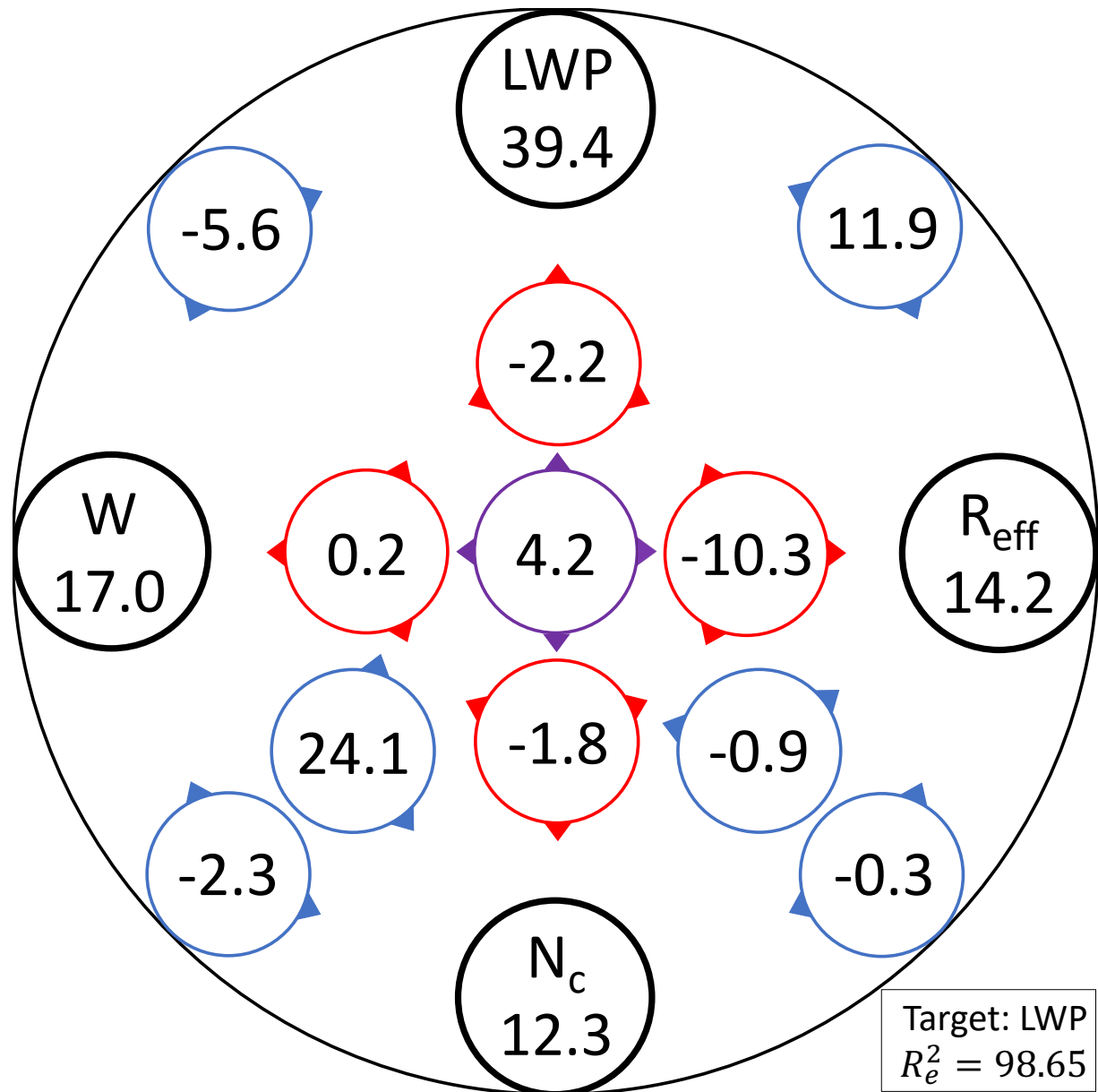4. Cloud effective radius (R_{eff})

LWP in future is target

From ARM ENA site and ENCORE retrievals

Marine boundary-layer clouds: causal webs

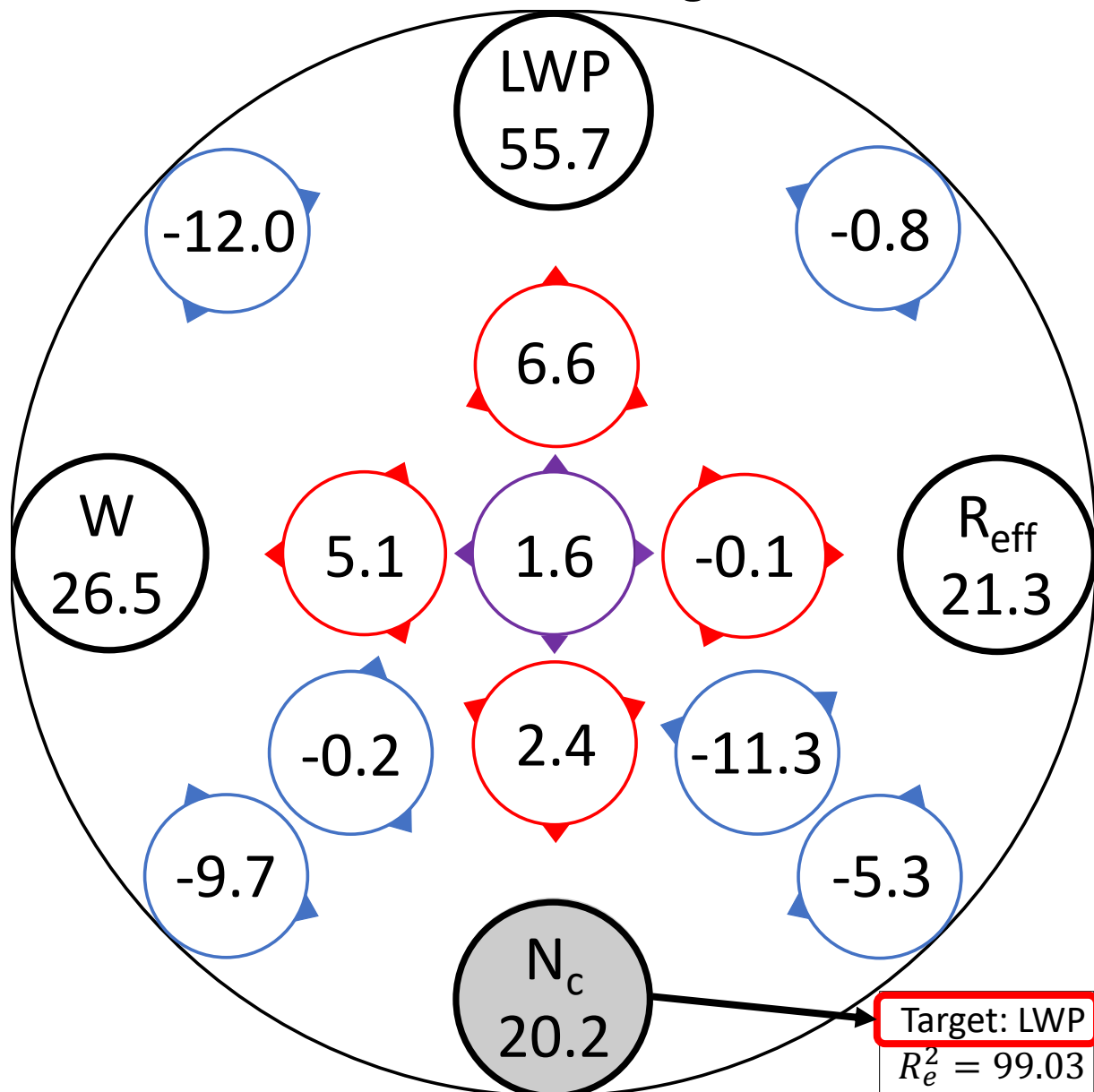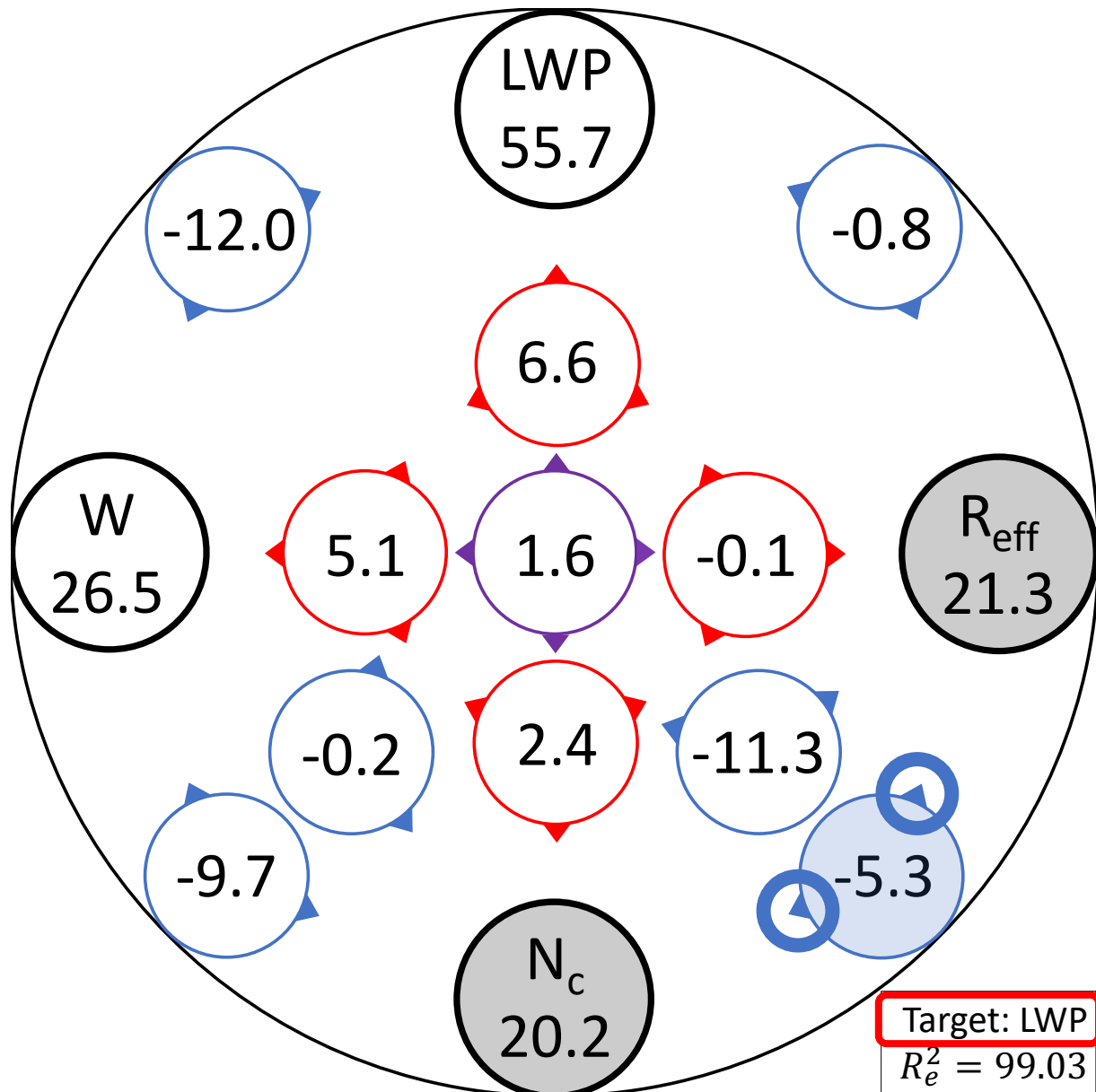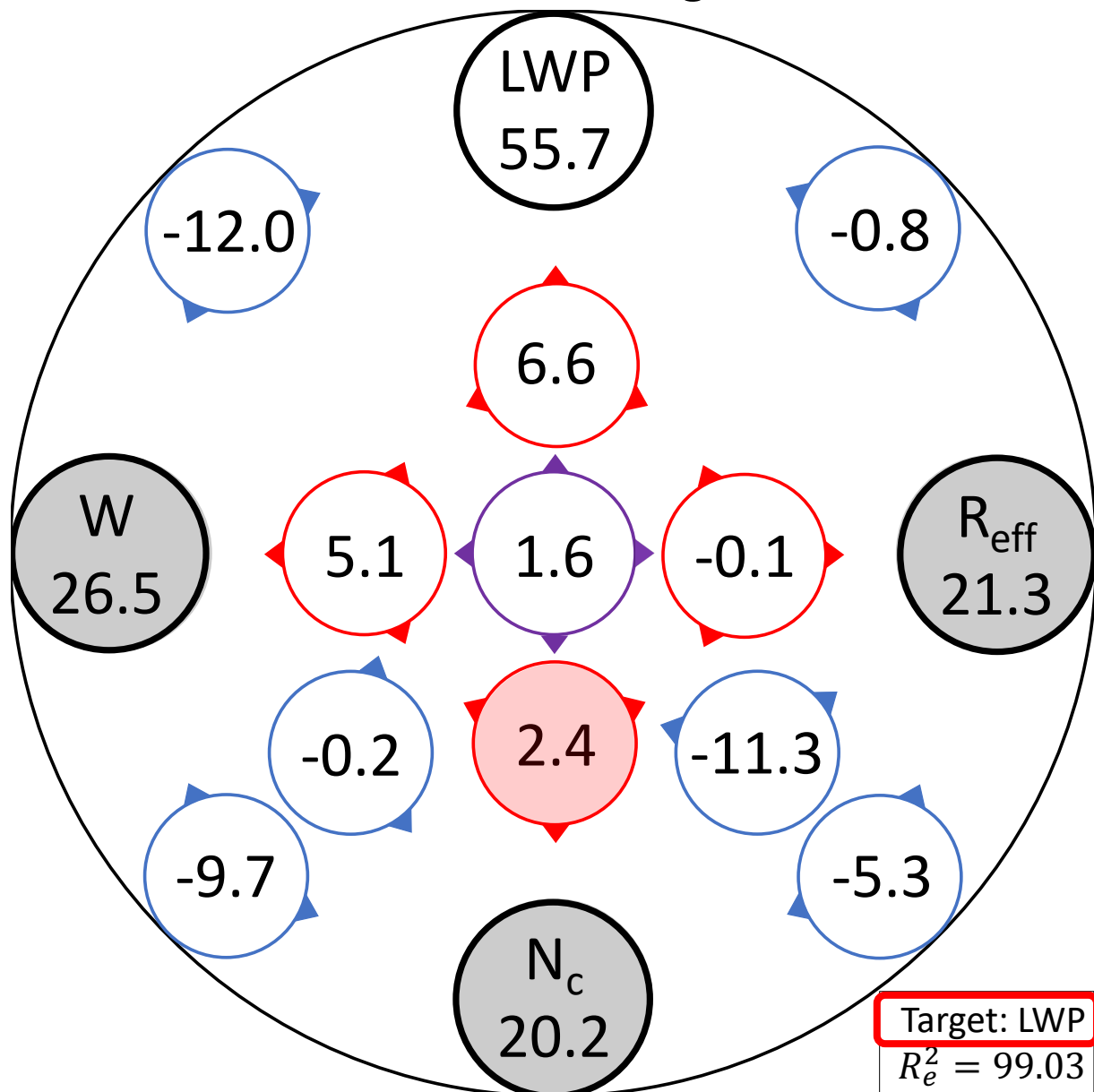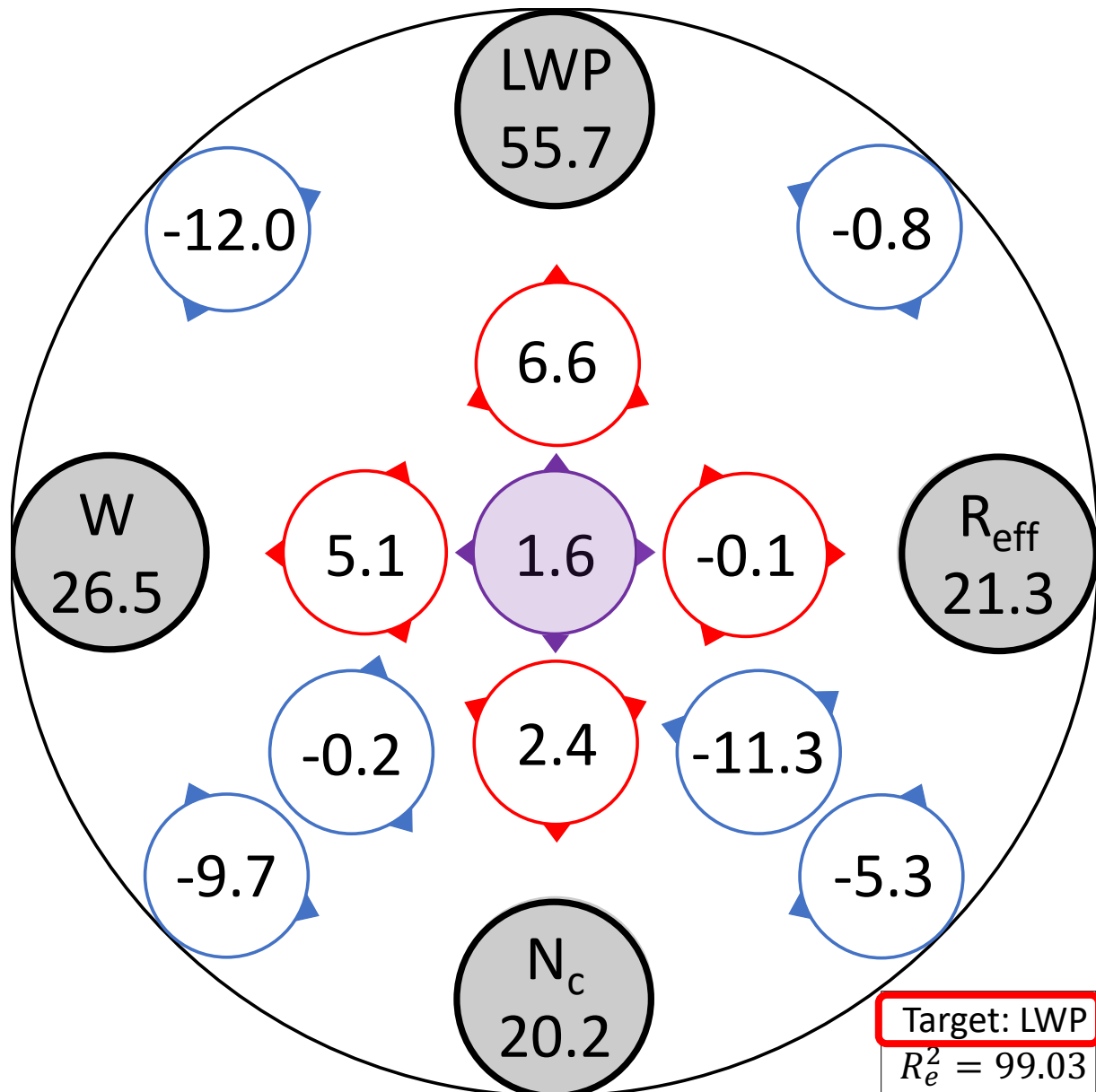# Marine boundary-layer clouds: causal webs
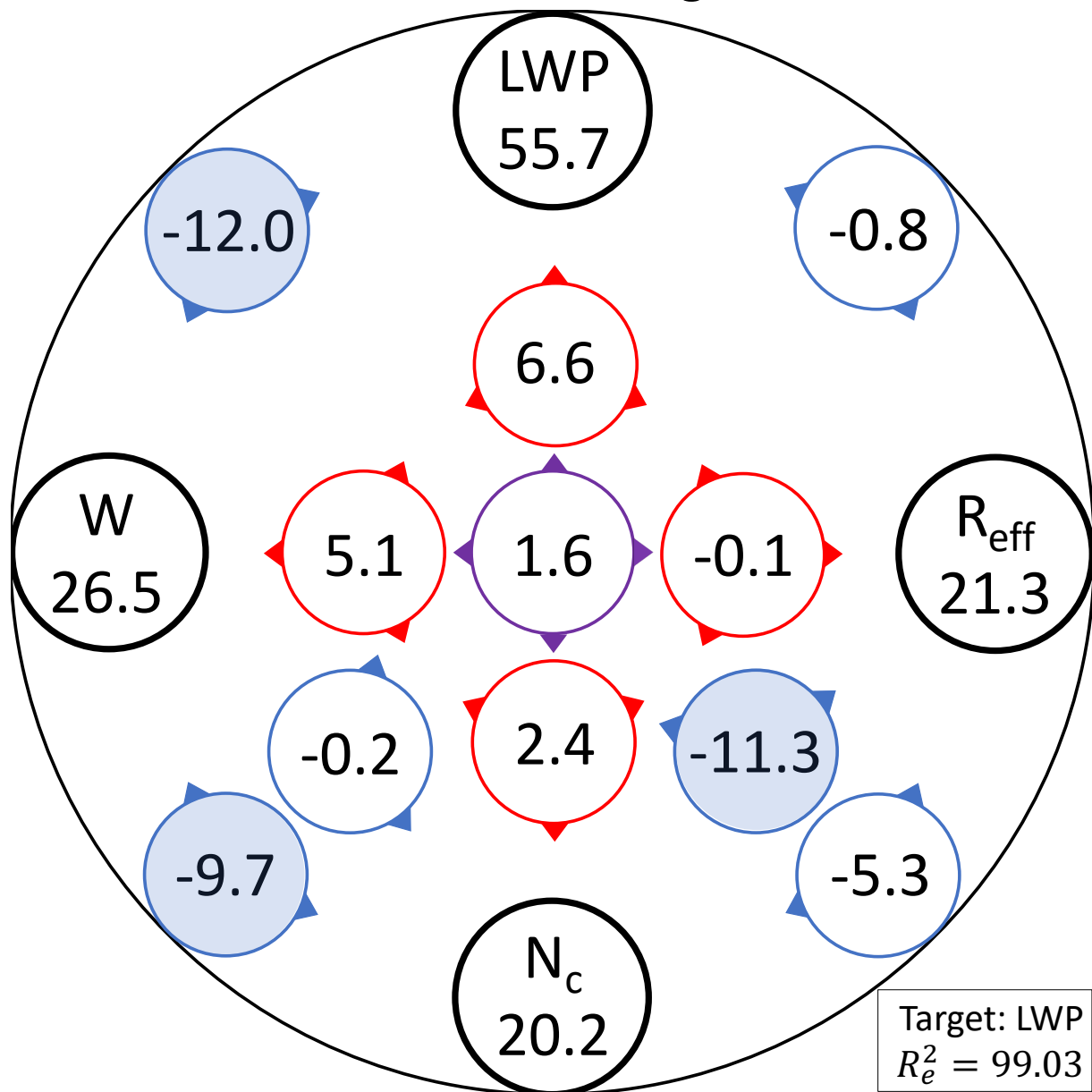
Marine boundary-layer clouds: causal webs

Marine boundary-layer clouds: causal webs

Non-drizzling

LWP
55.7

-12.0

-0.8

6.6

W
26.5

5.1

1.6

-0.1

R_{eff}
21.3

-0.2

2.4

-11.3

-9.7

-5.3

N_c
20.2

Target: LWP
$R_e^2 = 99.03$

Marine boundary-layer clouds: causal webs

Non-drizzling

LWP
55.7

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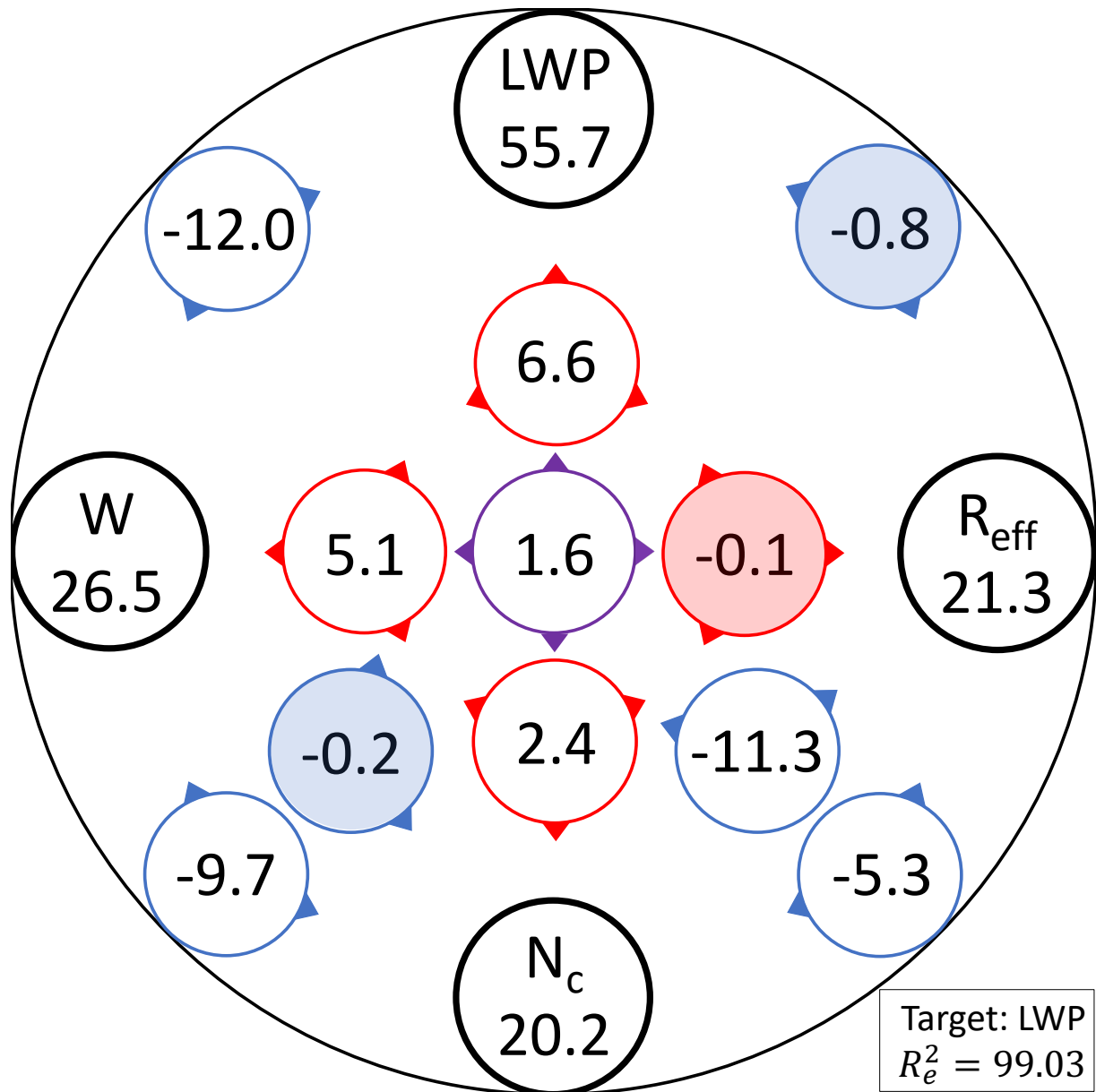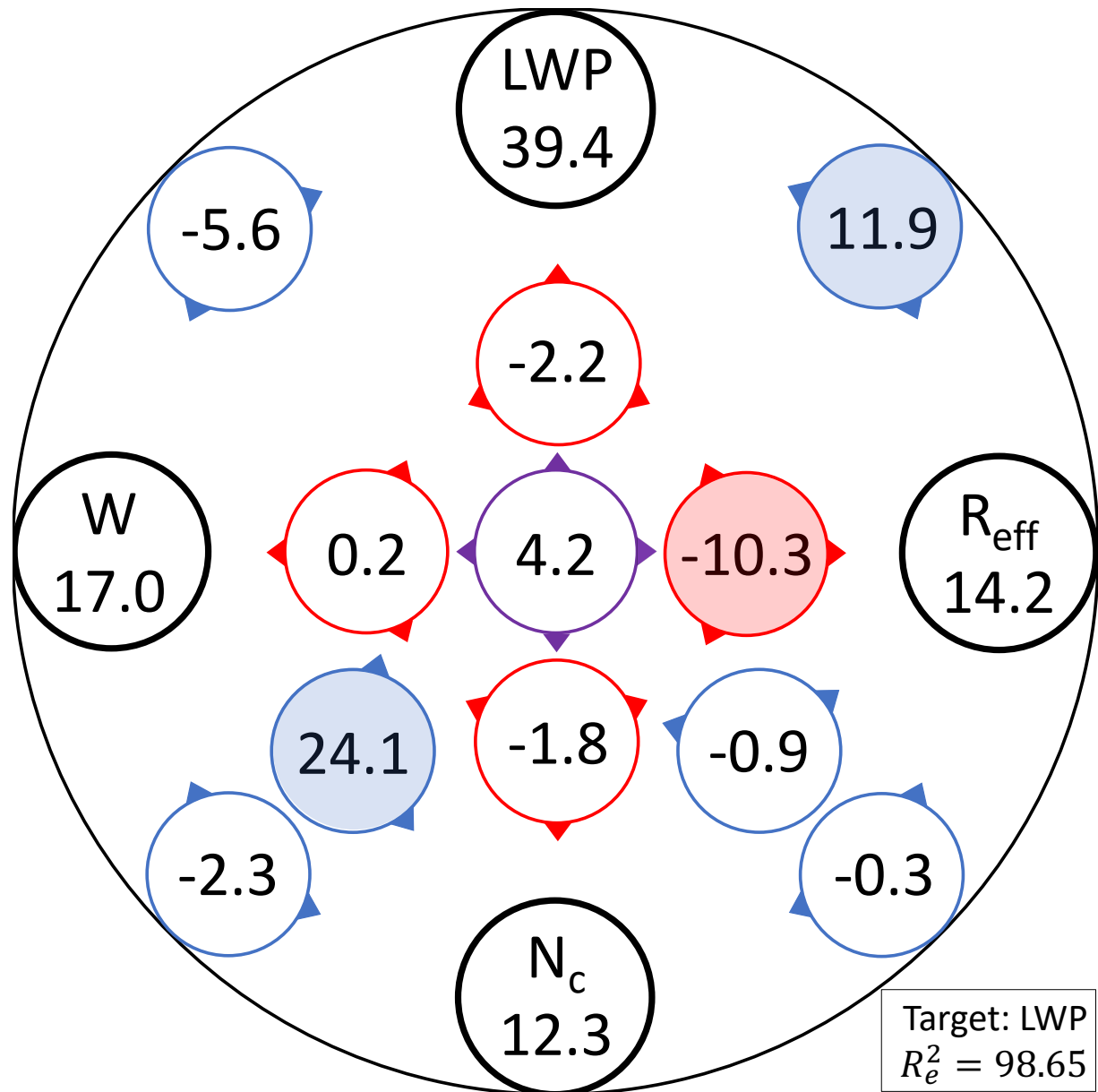
Marine boundary-layer clouds: causal webs

Marine boundary-layer clouds: causal webs

Conclusions

- New causal framework can **qualify and quantify process *interactions***

- Combined with expert knowledge, **new physics can be discovered**

- Our initial results show
  - … interactions, mediations, and competition between the drivers' effects
  - … the two systems have different underlying physics

Future work

- Incorporate more variables and examine more cases
- Understand why some variables are more difficult to incorporate than others, e.g. cloud condensation nuclei concentration