Evaluating two cloud parametrization schemes using ARM and Cloud-Net observations

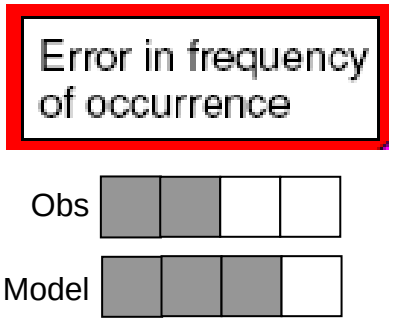
Cyril Morcrette, Jon Petch &
Ewan O'Connor (Finnish Meteorological Institute/Reading University)
June 2011

© Crown copyright Met Office

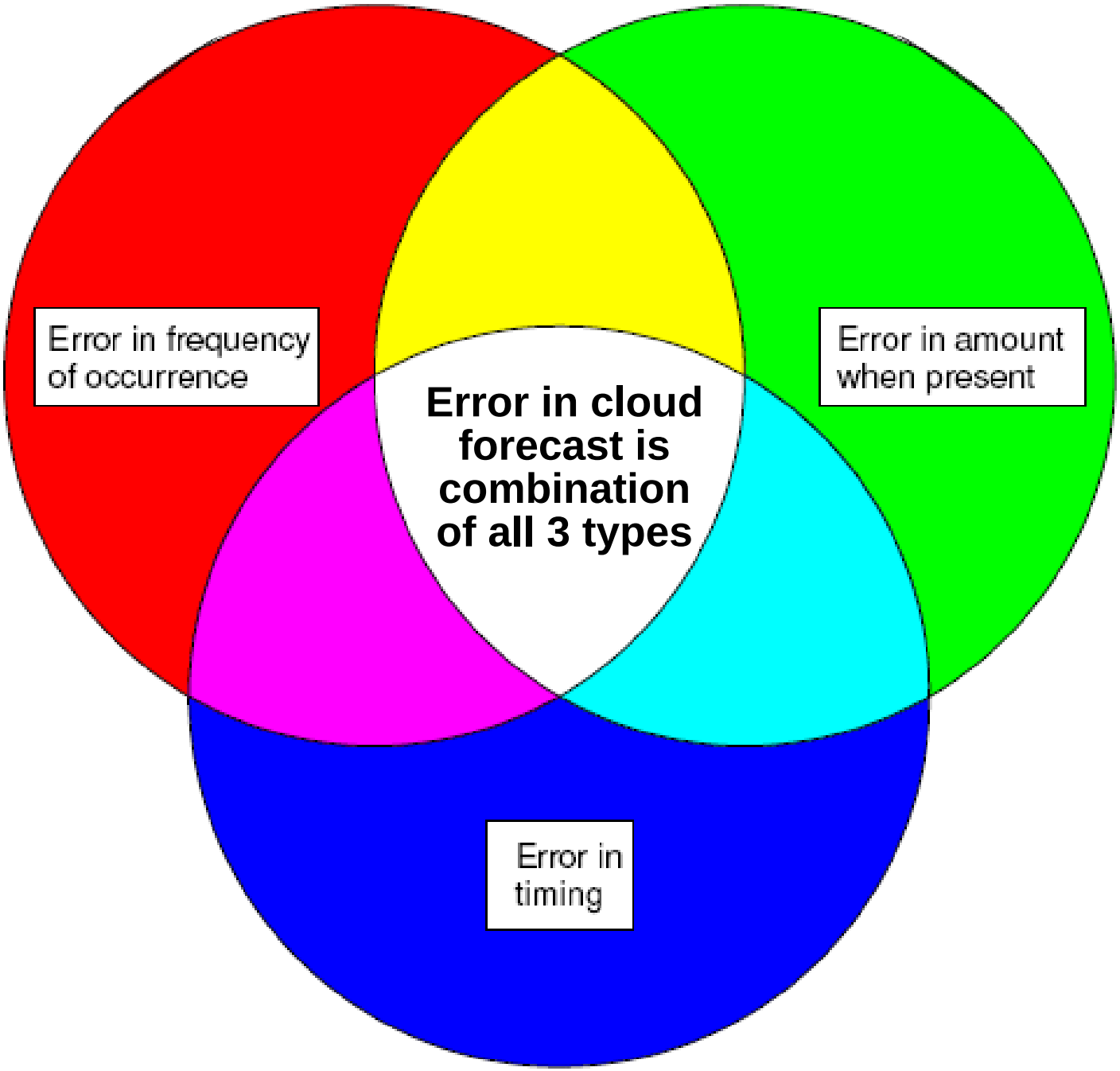
- Imagine you have 2 sets of cloud forecasts:
  - 2 different models or
  - same model, 2 different cloud parametrization schemes
- **Which one is “better” ?**
- “Better” one has smaller errors.
- But there are different types of cloud errors…

© Crown copyright Met Office

Cloud errors can be:



© Crown copyright Met Office


Error in frequency of occurrence
Error in amount when present
Error in cloud forecast is combination of all 3 types
Error in timing

Here is an evaluation of cloud forecasts
which aims to
separately quantify each of these types of cloud errors.

© Crown copyright Met Office

Methodology for comparing NWP to Cloud-Net/ARM

- Use 4 one-month periods: April, July, October, December 2007

- Use 5 sites:
  - Chilbolton (UK)
  - Darwin (Australia)
  - Lindenberg (Germany)
  - Murgtal (Germany)
  - Southern Great Plains (SGP, Oklahoma, US)

- Run the Met Office global NWP model from 12Z ECMWF ERA-interim.

- 36 hr forecast. Look at output from 00Z to 24Z (i.e. T+12 to T+36).

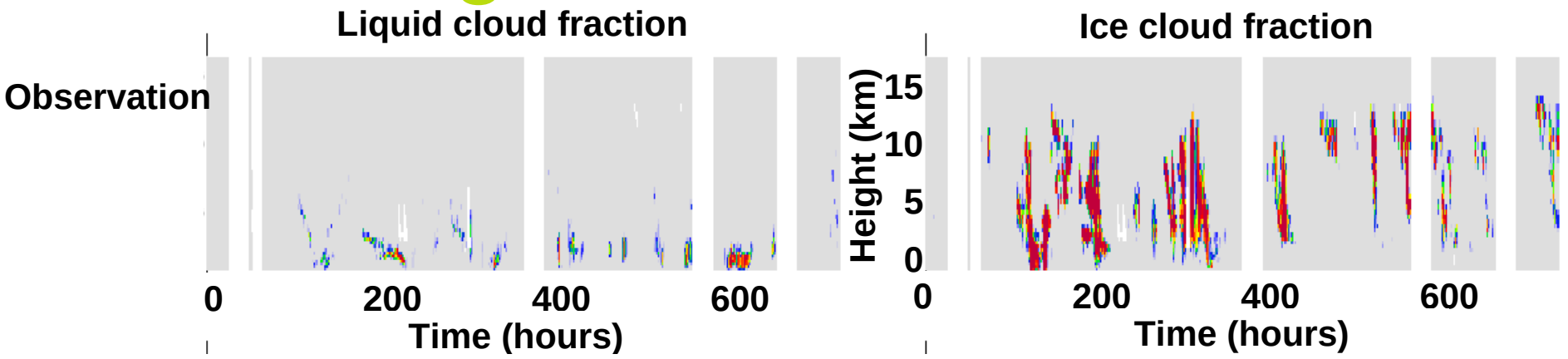
- Grid-length ~40 km, 70 levels.

- Run forecasts 2 times: once using diagnostic cloud scheme (Smith 1990) and once using prognostic scheme “PC2” (Wilson *et al.* 2008).

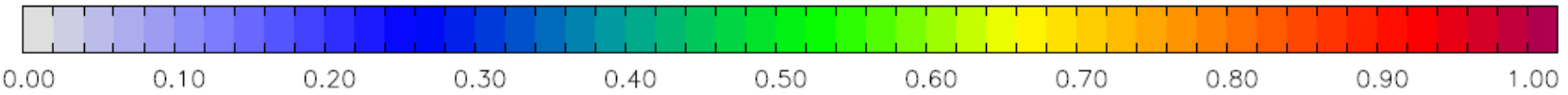
- Use “Cloud-Net” methodology to average observation onto model grid.

© Crown copyright Met Office

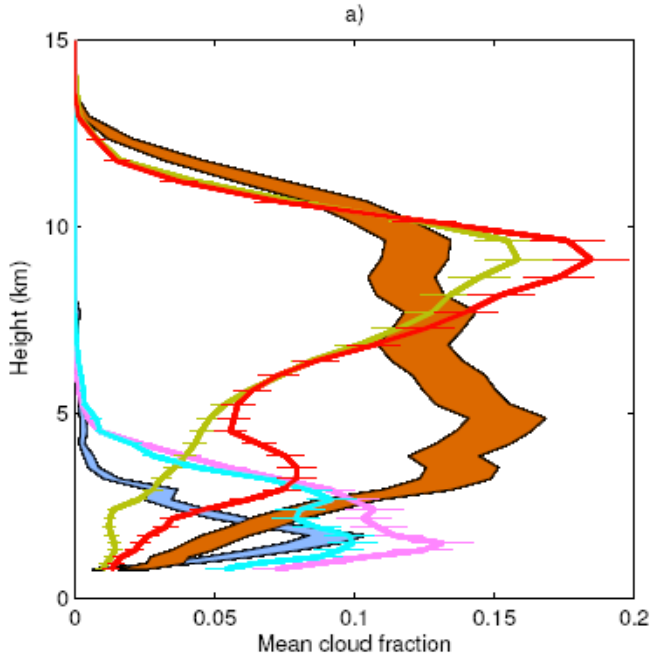
Time-height cross-sections

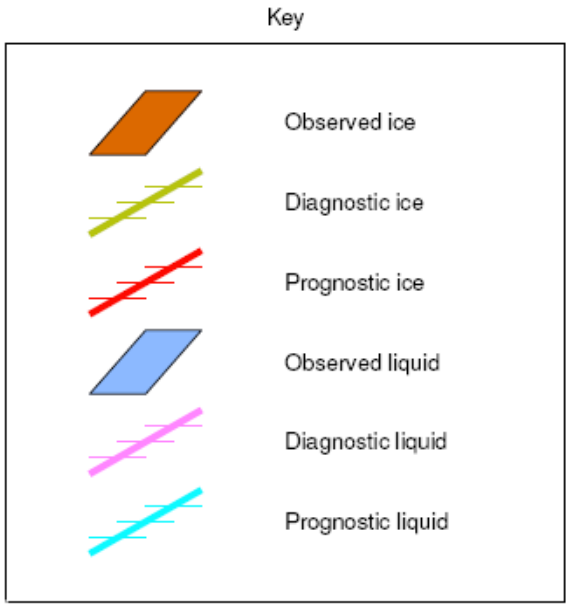


April 2007 SGP

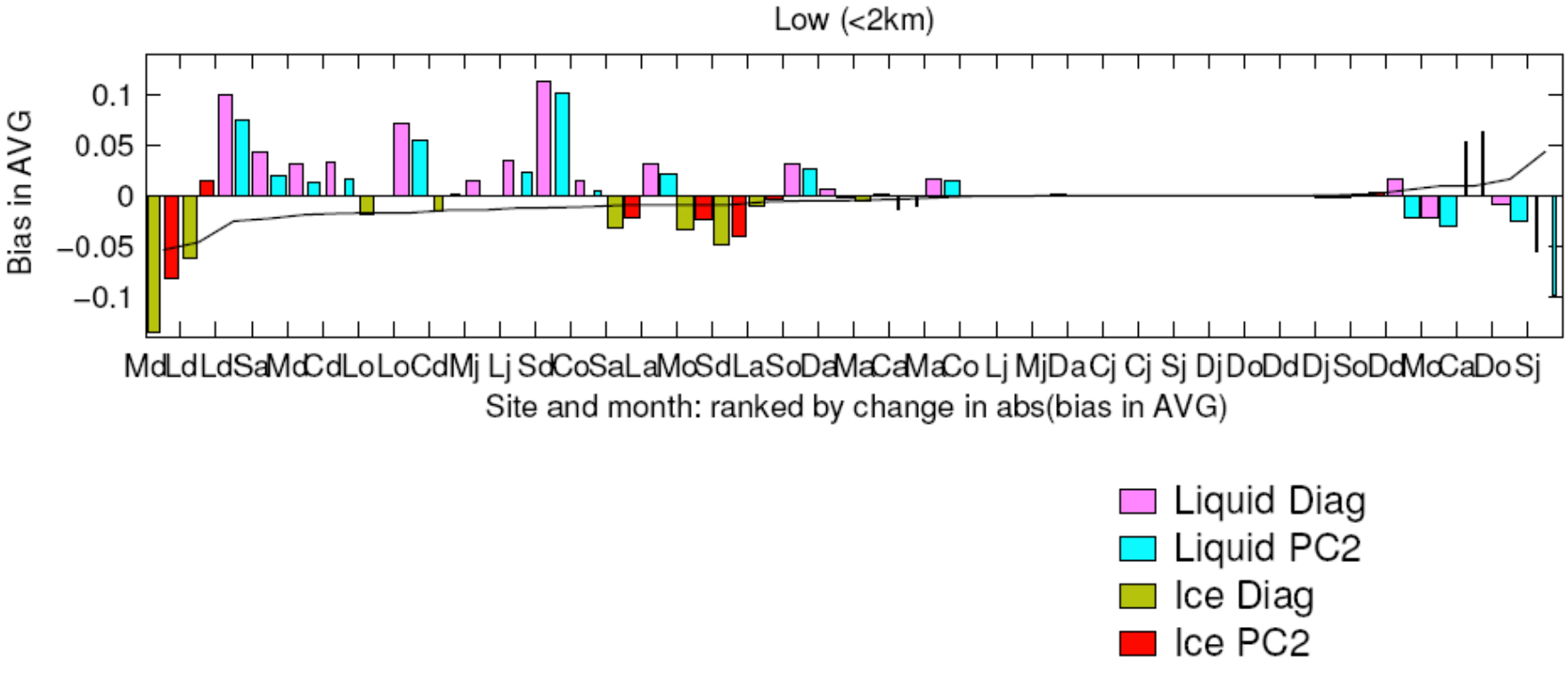


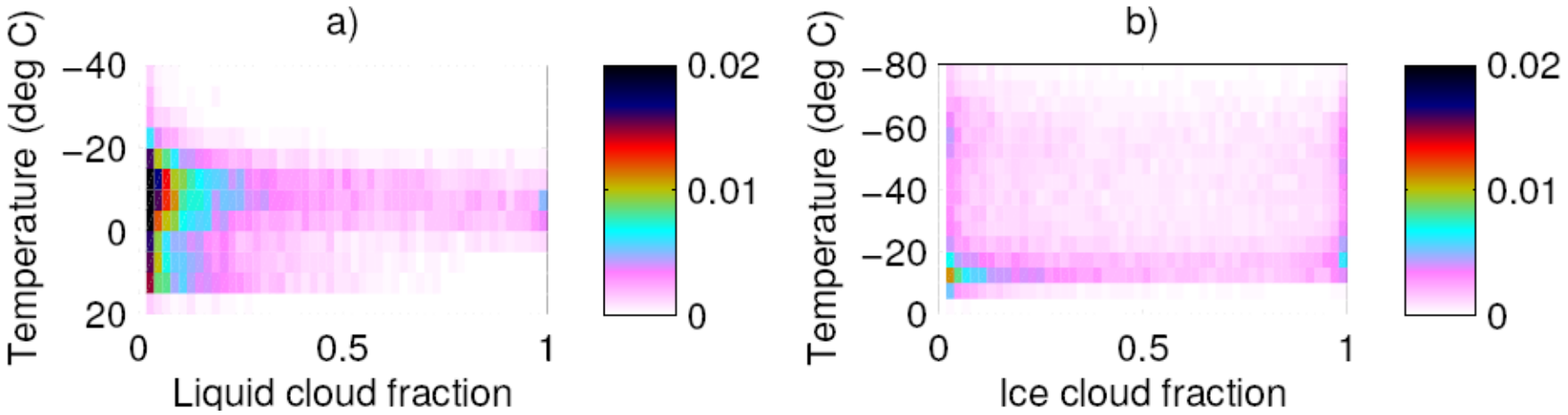
© Crown copyright Met Office



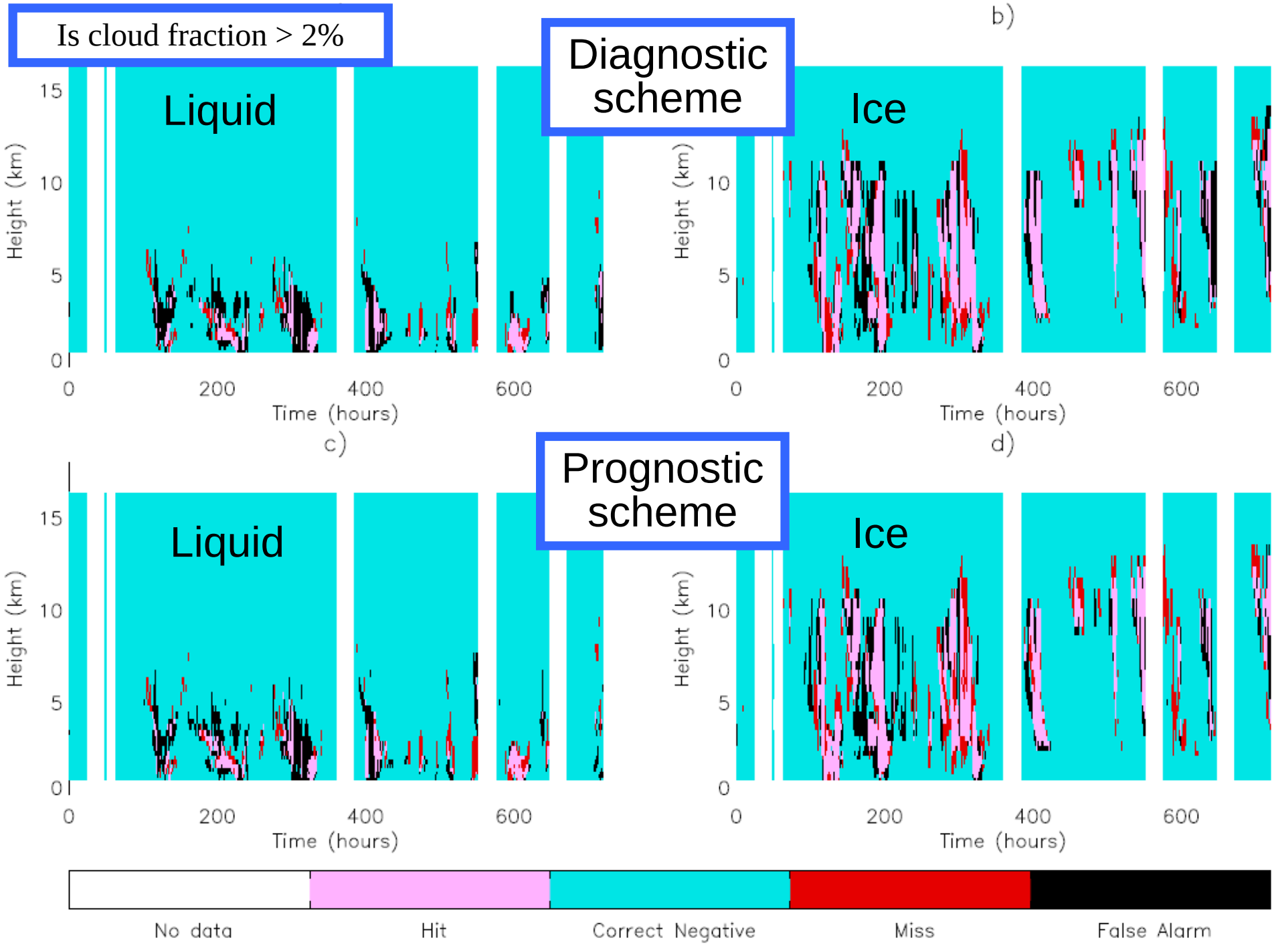


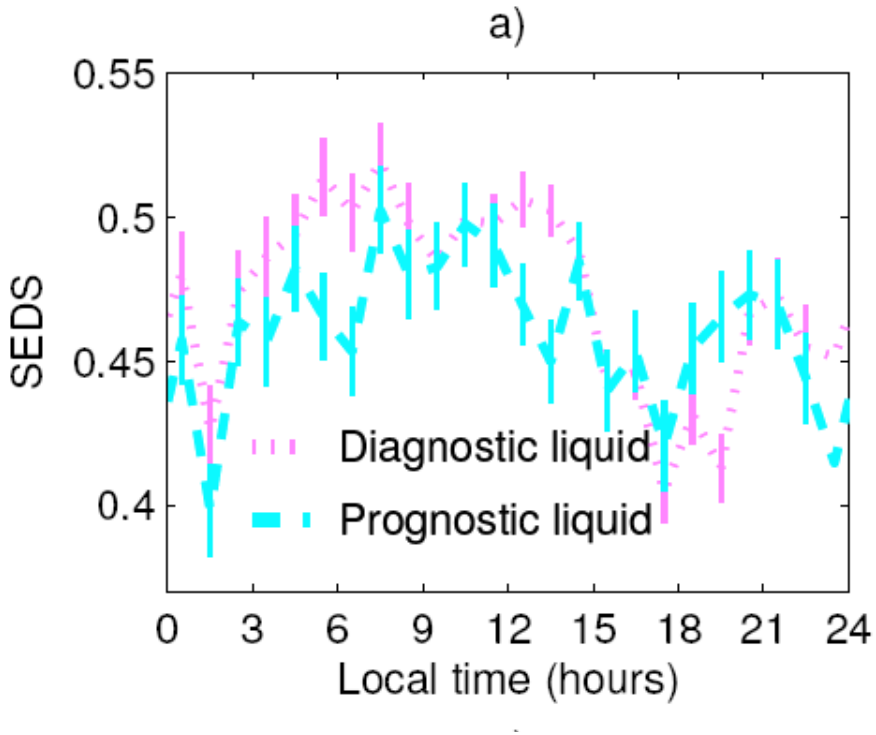
© Crown copyright Met Offi


Low (<2km)
Bias in AVG
0.1
0.05
0
−0.05
−0.1
MdLdLdSaMdCdLoLoCdMj LjSdCoSaLaMoSdLaSoDaMaCaMaCo LjMjDaCjCjSjDjDoDdDjSoDdMoCaDoSj
Site and month: ranked by change in abs(bias in AVG)
Liquid Diag
Liquid PC2
Ice Diag
Ice PC2



If cloud is present, what is the cloud fraction?


Is cloud fraction > 2%
Diagnostic scheme
Prognostic scheme
Liquid
Ice
b)
c)
d)
Height (km)
Time (hours)
0
200
400
600
5
10
15
No data
Hit
Correct Negative
Miss
False Alarm


a)
0.55
0.5
0.45
0.4
SEDS
Diagnostic liquid
Prognostic liquid
0
3
6
9
12
15
18
21
24
Local time (hours)

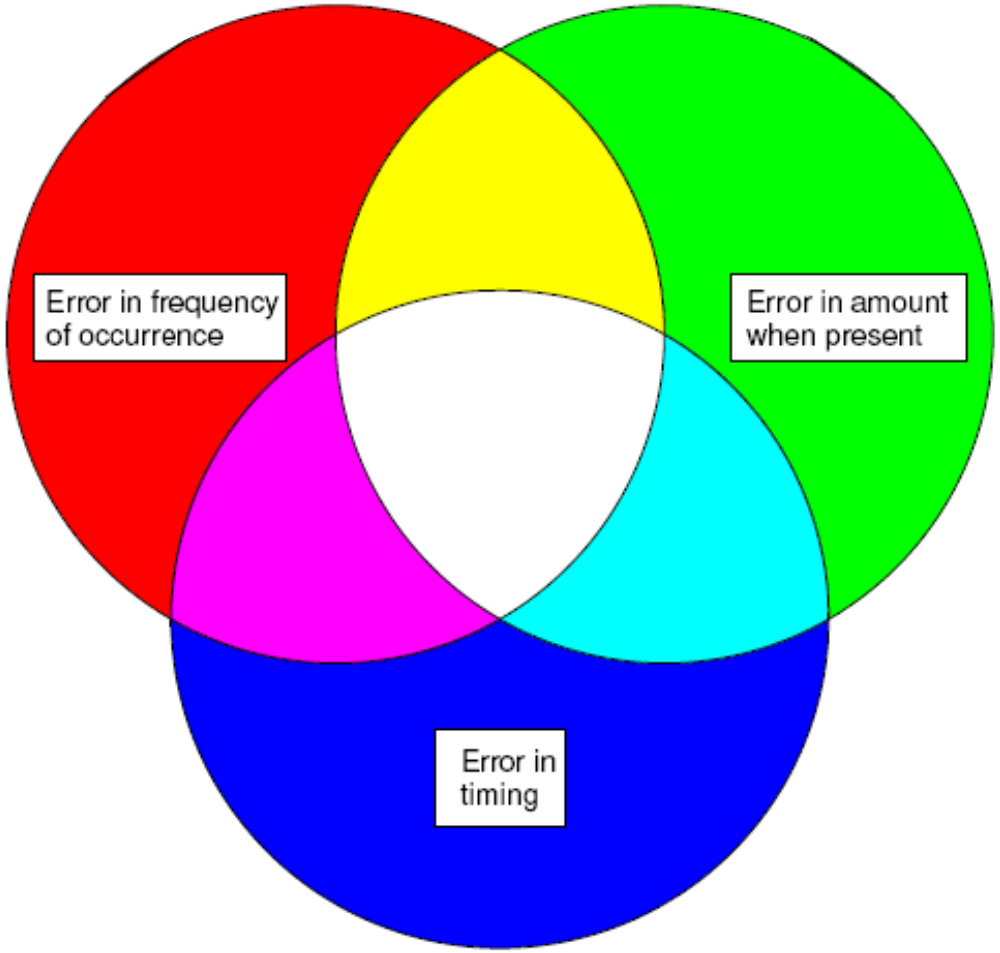
Errors in cloud parametrization scheme

Errors in other parametrization schemes

Large-scale errors in T and q

There are different types of cloud errors…

… and they are caused by different things.



© Crown copyright Met Office

Conclusions

- There are multiple sources of cloud error.
- Changes to model are likely to impact some cloud errors while leaving others unchanged.
    - e.g. new cloud scheme likely to affect FOO and AWP, but not going to directly affect timing.
- Need to use metrics that are sensitive to all aspects of the cloud error.
- Do not just use 1 metric that focuses on 1 type of cloud error.
- Think about whether metric is likely to show improvement when the cloud scheme is changed.
- **Good choice of cloud-error metrics can help in model development.**

Questions

© Crown copyright Met Office