

Improved use of SEVIRI infrared observations in cloudy regions

Robert Tubbs, Pete Francis (Met Office, Exeter, UK)



Contents

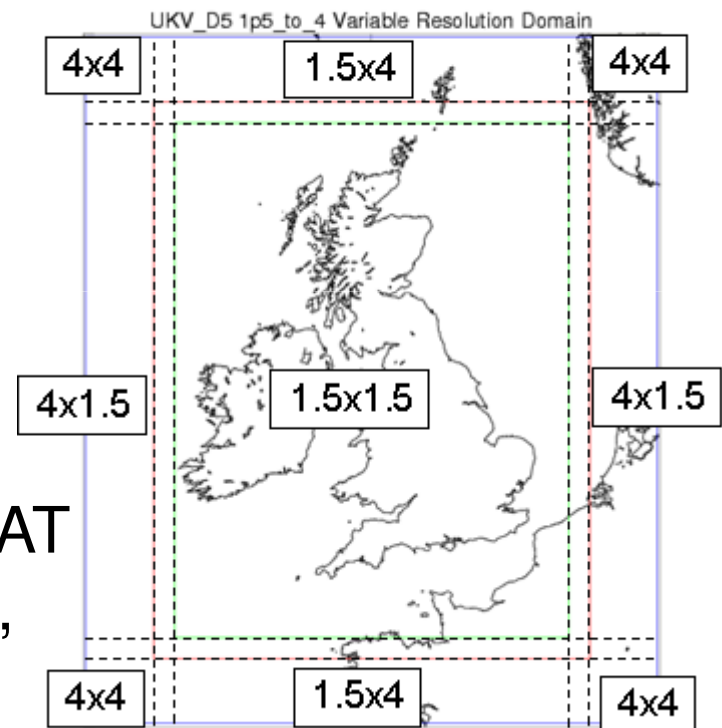
- Introduction
 - UKV model and use of SEVIRI IR observations from Meteosat Second Generation (MSG) satellites
- New approach for Cloud-Top Pressure (CTP) calculation
 - CTP calculated in first stage of the data assimilation instead of as an offline pre-processing step
- Trial results
- Conclusions and future work
 - Hoping for operational implementation later this year

Introduction

UKV model and use of SEVIRI IR observations from Meteosat Second Generation (MSG) satellites

UKV 1.5km NWP model

- The UKV is the Met Office regional model covering the UK, with 1.5km grid spacing over the UK (but stretched grid cells at the edges).
- Lateral boundaries are constrained by the Met Office global model
- The UKV system uses 3-hourly FGAT 3D-Var data assimilation of surface, sonde, aircraft, Doppler radar and satellite observations and latent heat nudging of radar-derived rain rates.

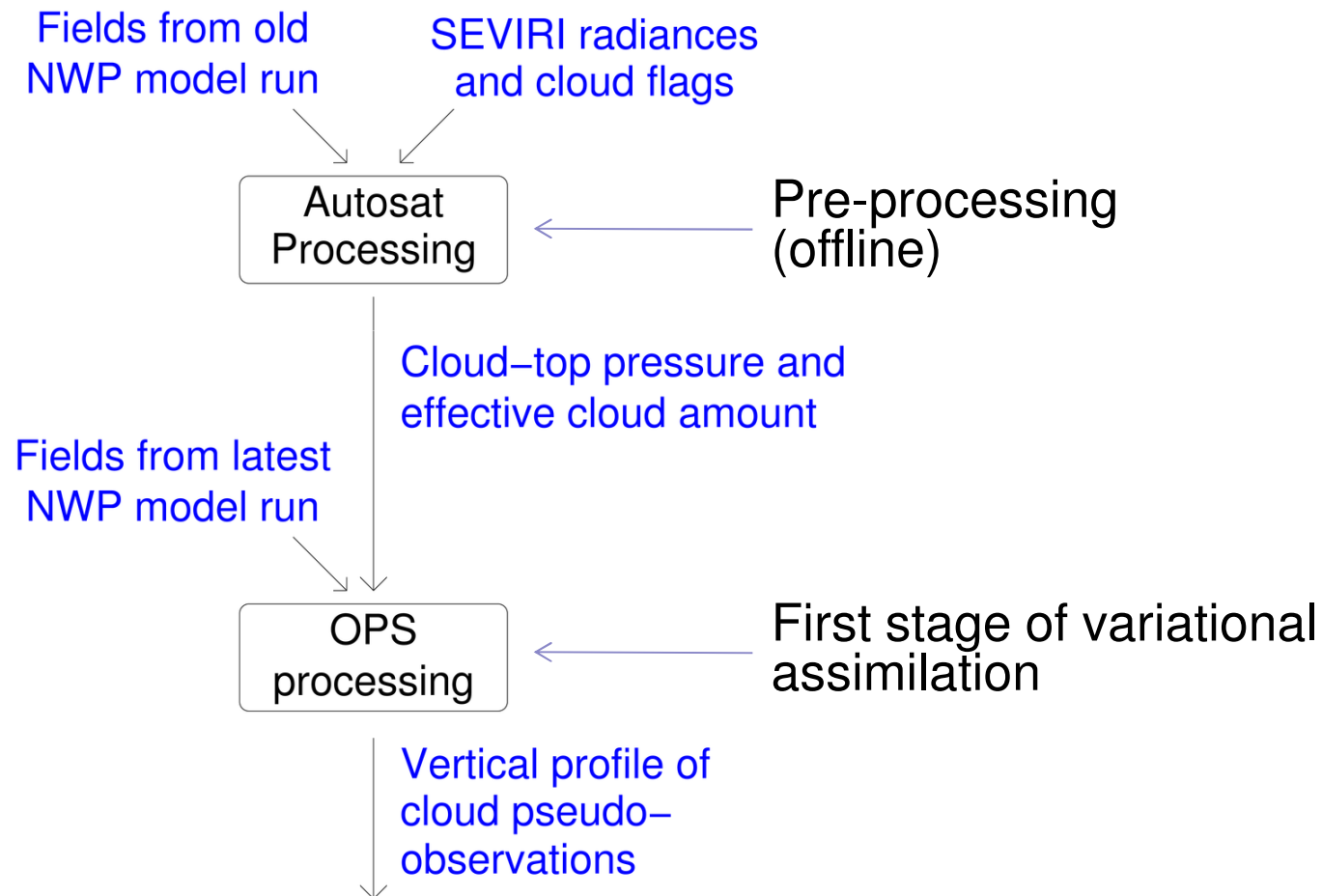




Use of SEVIRI data in the UKV

- SEVIRI observations are currently pre-processed to determine a cloud fraction and a cloud-top pressure.
- Radiance observations are assimilated in 3D-Var if they will not be significantly contaminated by cloud (if they are either cloud free, or the cloud top determined is below most of the channel weighting function).
- The cloud fraction and cloud-top pressure information are assimilated into 3D-Var via increments to the total humidity at the cloud top and in the column above the cloud (assuming the observed cloud fraction near top of cloud, and zero cloud fraction in the column above the cloud).

Current CTP derivation



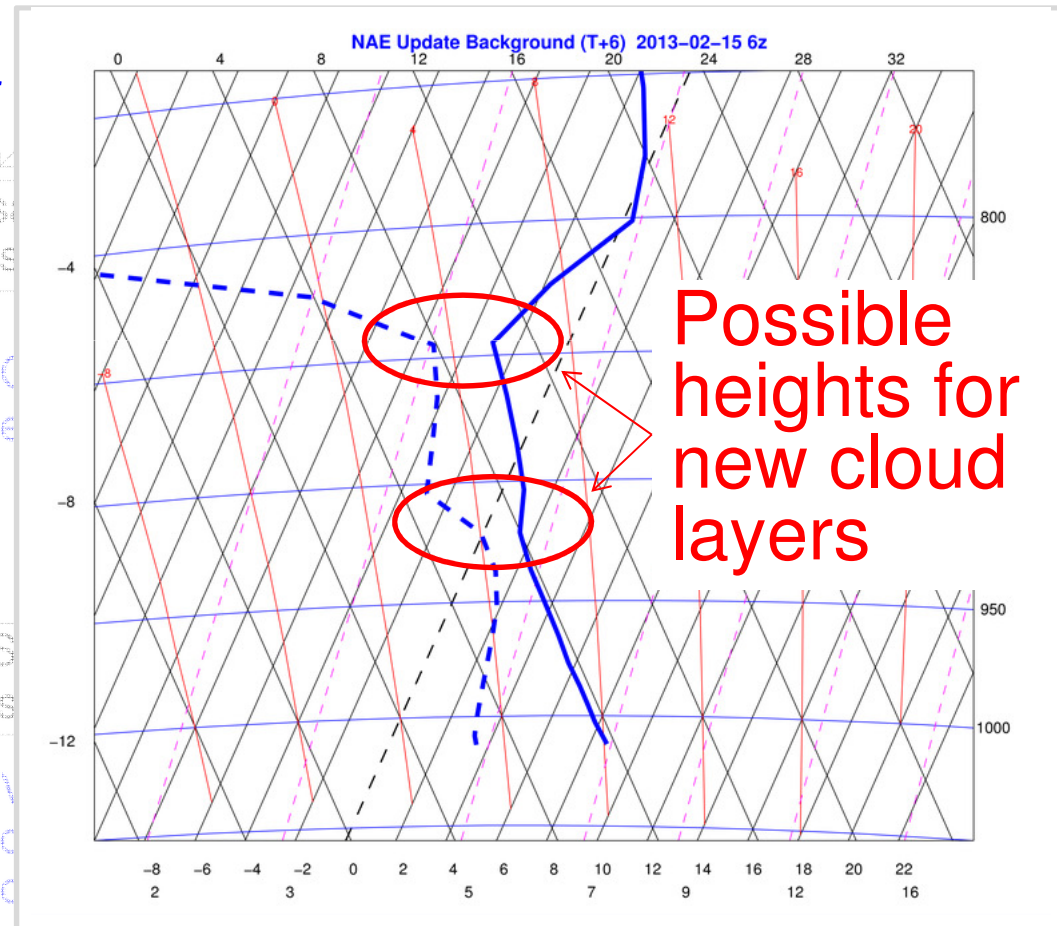
Current CTP derivation

Fields from old
NWP model run

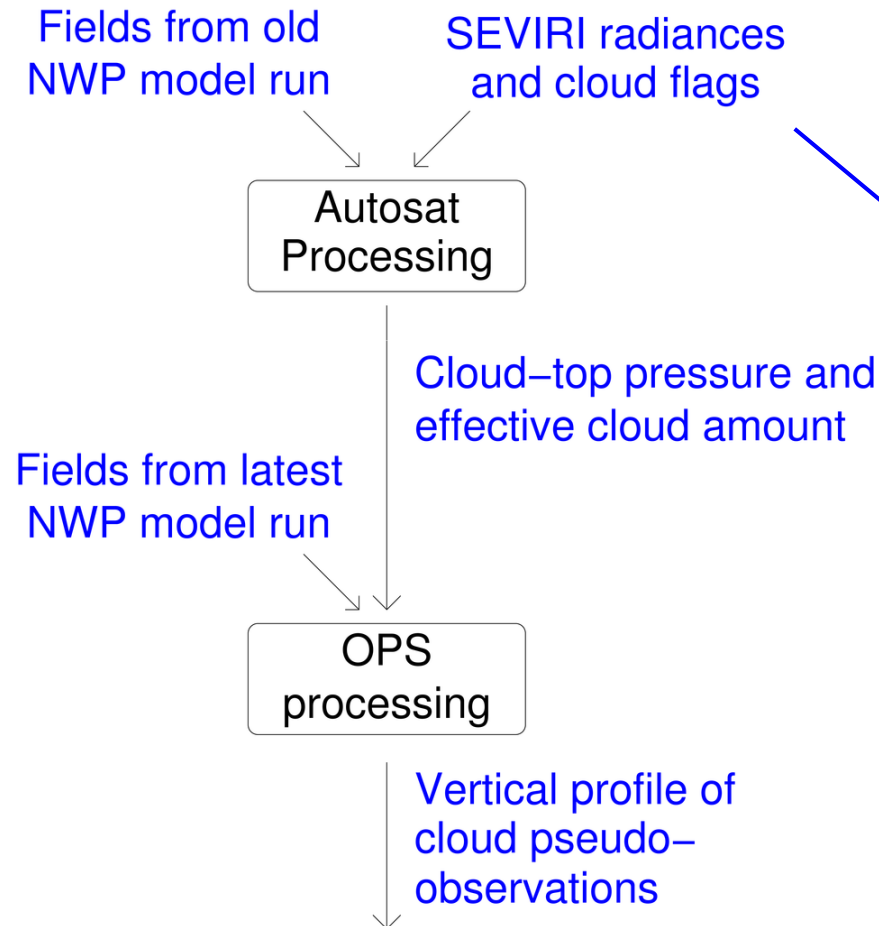
Autos
Process

Fields from latest
NWP model run

OPS
process

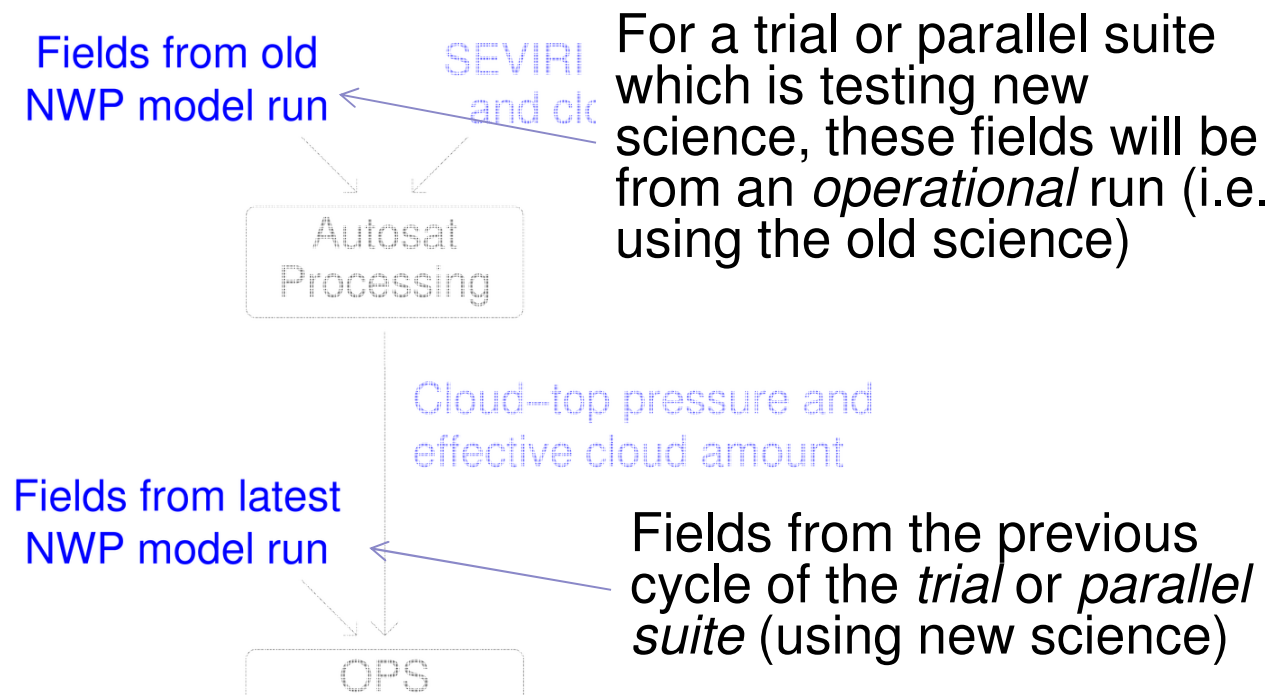


Current CTP derivation



CTP only diagnosed if the observed radiances are consistent with the temperature of a possible cloud layer in the model

Current CTP derivation

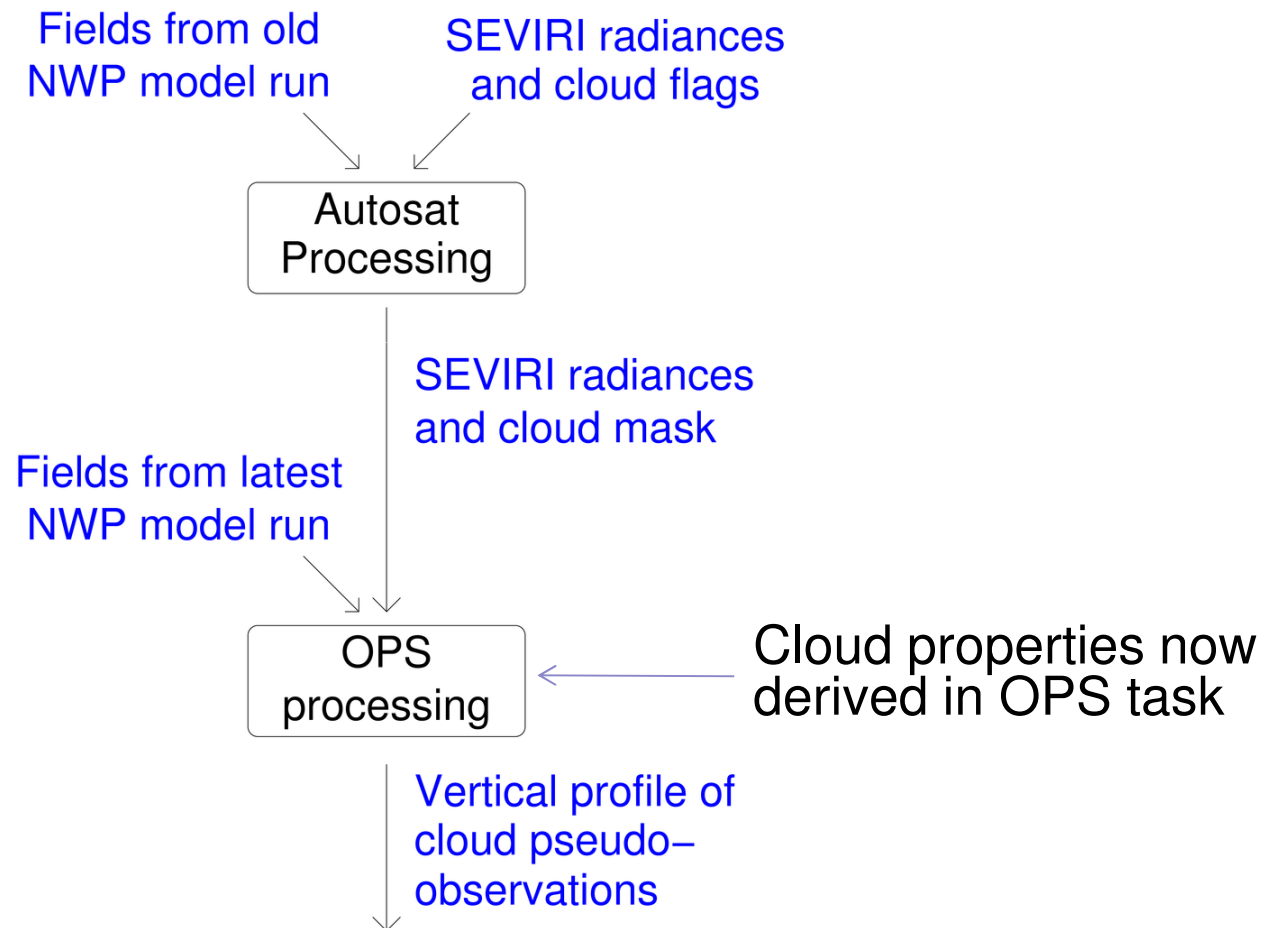


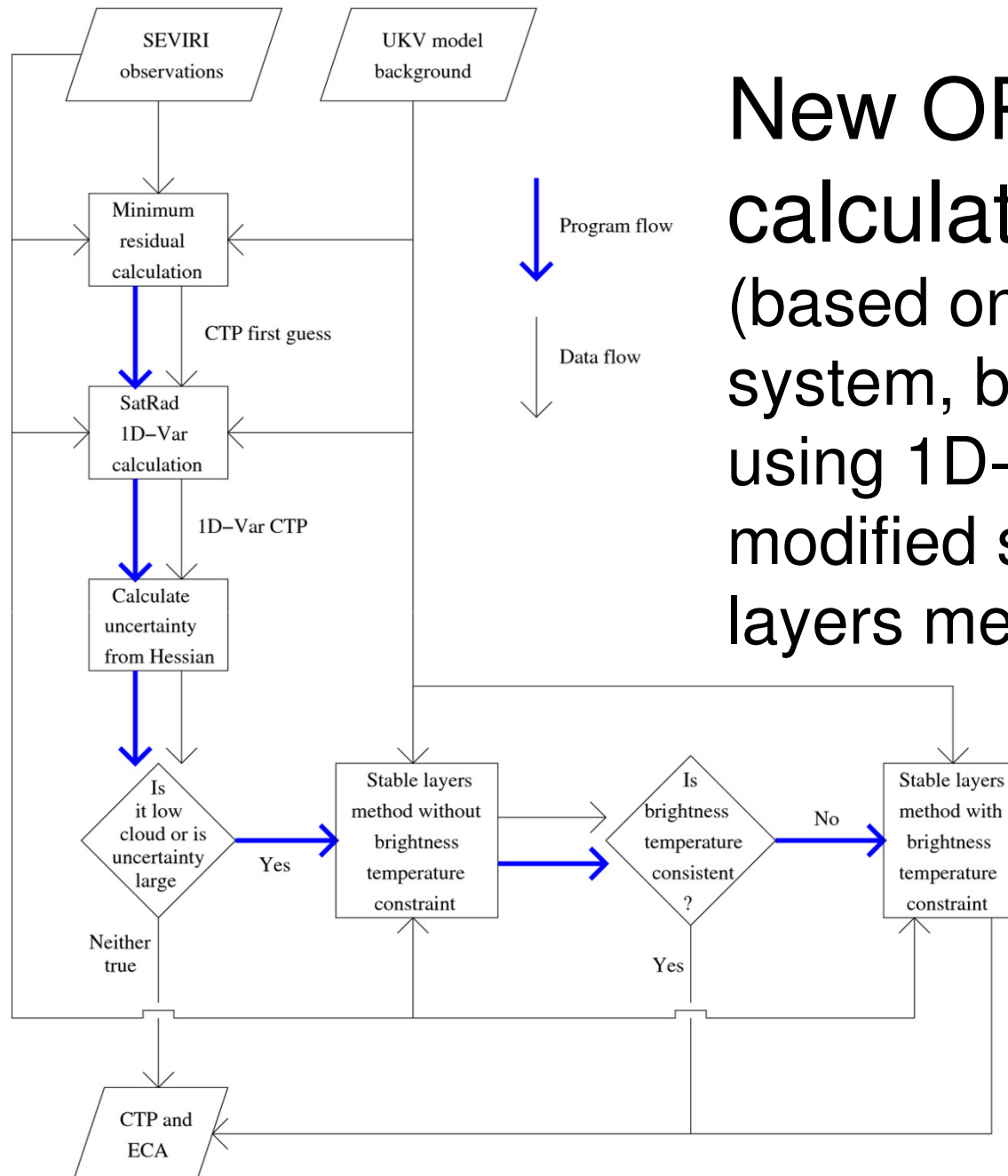
This reliance on pre-processed pseudo-observations of cloud derived using an operational NWP model means that no trials or parallel suites are really *independent trials*

New approach for CTP calculation

CTP calculated in first stage of the data assimilation instead of as an offline pre-processing step

New CTP derivation



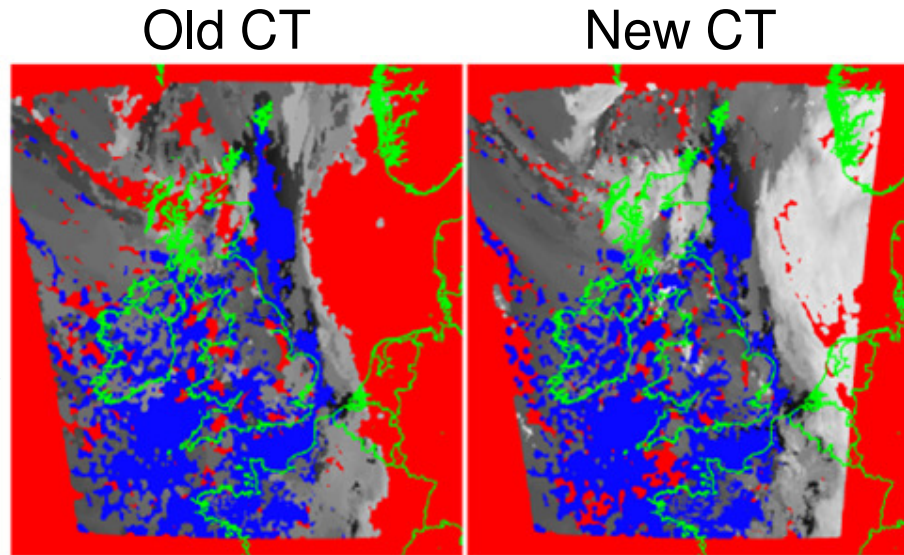


New OPS CTP calculation

(based on Autosat system, but now using 1D-Var and modified stable layers method)



Autosat CT
model level
(greyscale)
– only low
cloud

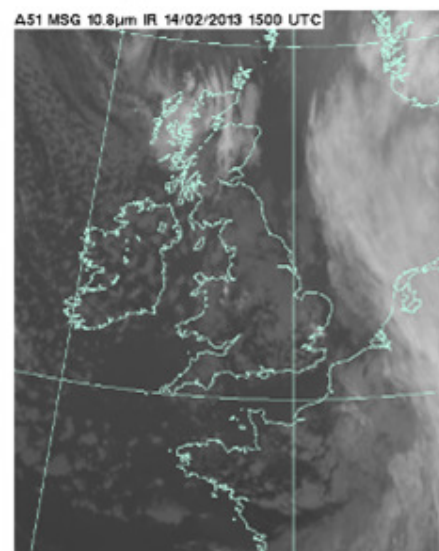


OPS CT
model level
(greyscale)

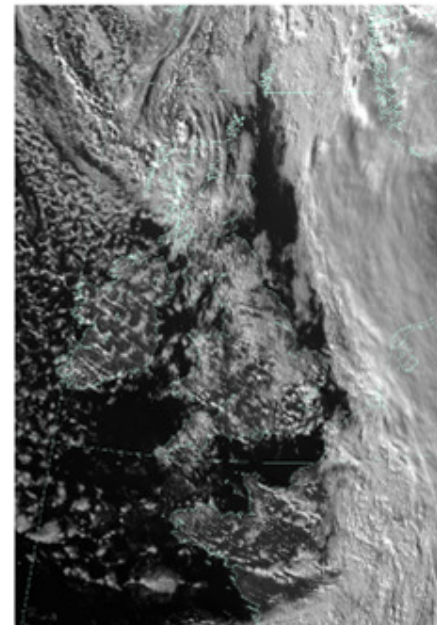
Blue = no cloud
Red = uncertain
(missing data)



IR window
channel
observations



10.8 μ m radiances



Visible rads

Visible channel
observations

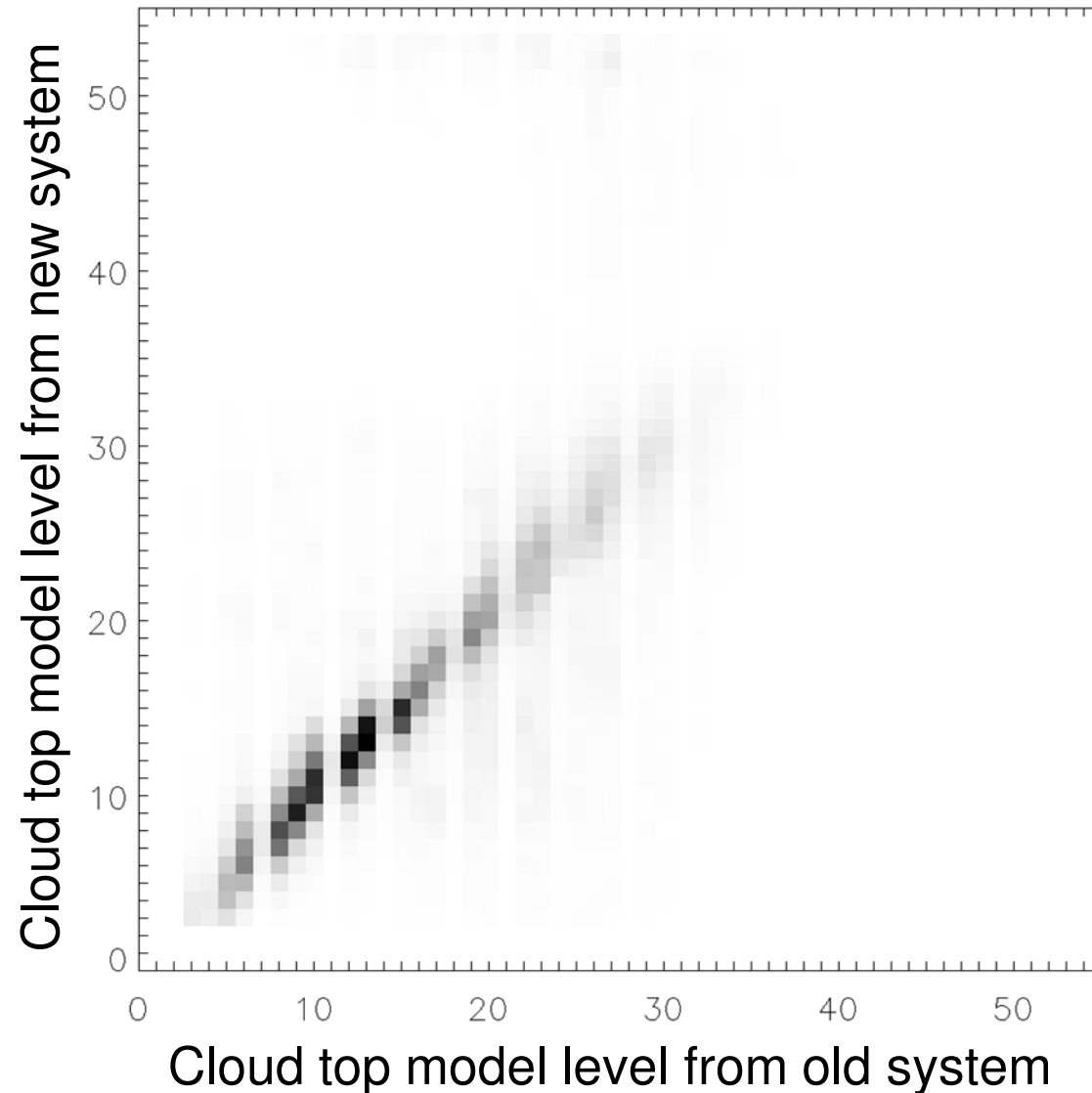
14/02/2014
example

Trial results



Comparing old and new CTPs

2D histogram
(linear greyscale)
of OPS cloud top
(CT) NWP model
level against CT
model level
derived on
Autosat for the
same SEVIRI
observation
Shows
reasonable
consistency
(July 2013)



Impact on radiances

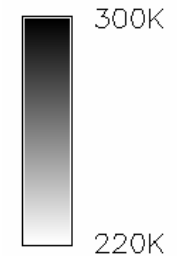
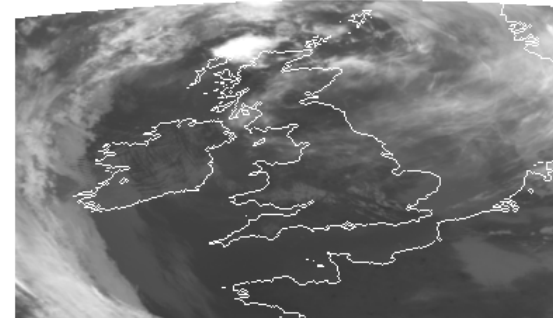
Observed and
simulated
window channel
radiances
(SEVIRI 10.8 μ m
channel)

SEVIRI
observations

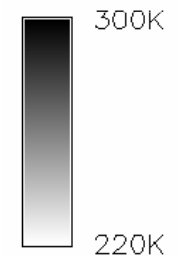
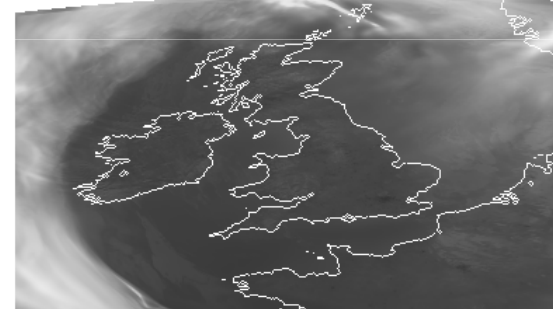
Model
background
(T+3 forecast
from previous
cycle)

Model T+0
with $\frac{1}{2}$ of
Incremental
Analysis Update
(IAU) applied

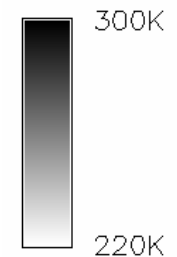
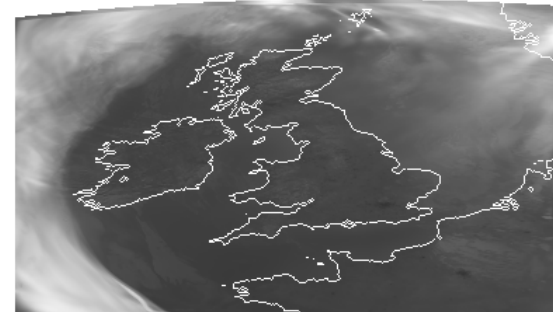
Observations 2013/02/17 15Z



Background 2013/02/17 15Z



Analysis 2013/02/17 15Z



Impact on radiances

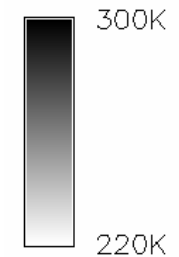
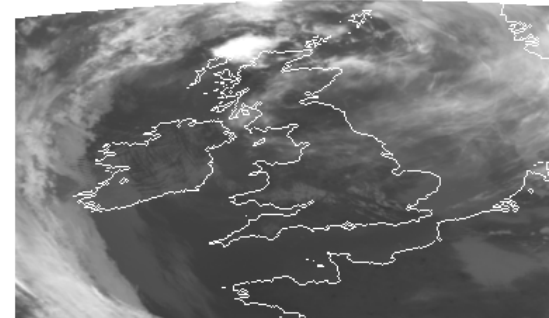
Analysis is clearly
closer to
observations than
background

Statistically
significant over the
period analysed

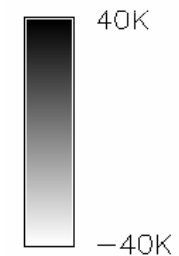
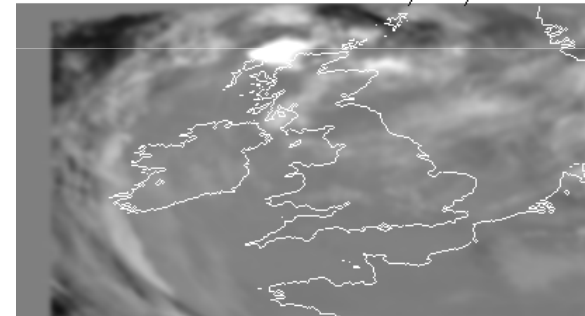
“Analysis” here is a
T+0 forecast with
half of the IAU
applied

SEVIRI
observations

Observations 2013/02/17 15Z

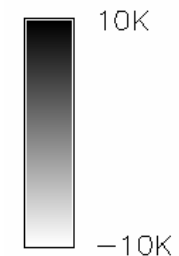
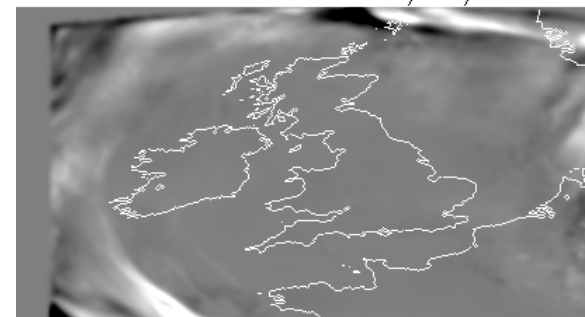


O-B 2013/02/17 15Z



O-B

A-B 2013/02/17 15Z



A-B

(only 1/2 of IAU
applied, but greyscale
range 4× smaller)

Difference plots blurred (“neighbourhood verification”)

© Crown copyright Met Office

4th ISDA 26/02/2015



Verification results

- For a 1-month trial in summer 2013, the new OPS CTPs gave 0.5% improvement in Met Office “UK Index” over the old CTPs for surface weather (and >1% improvement over a trial with no CTP assimilation)
- OPS CTPs also gave significant improvements in upper-air temperature and humidity (not in UK Index)

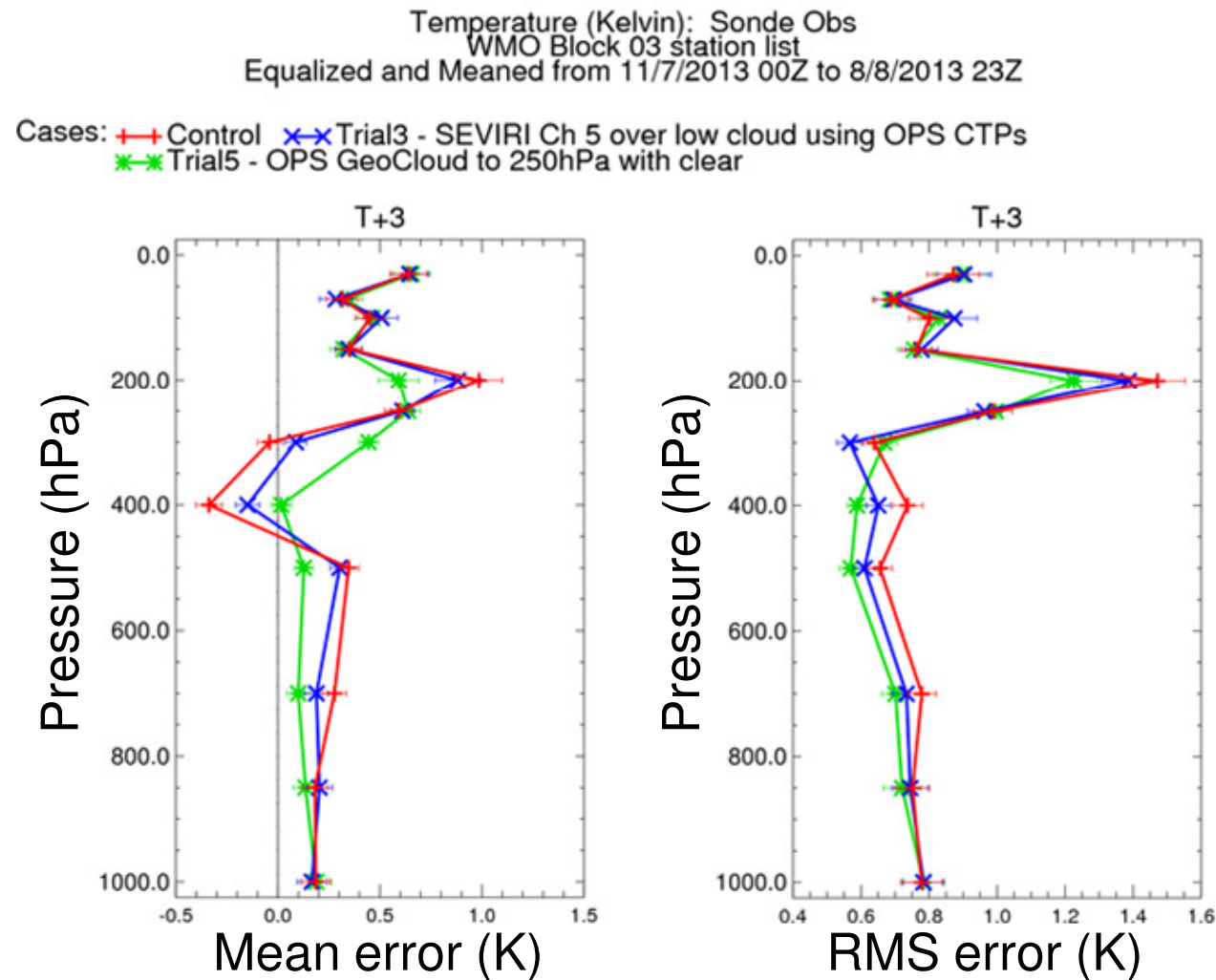
Verification results - temperature

1 month of
verification
against
radiosondes

Control

New CTPs for
radiance
assimilation
QC

New CTPs for
cloud pseudo-
observations





Verification results

- For a 1-month trial in summer 2013, the new OPS CTPs gave 0.5% improvement in Met Office “UK Index” over the old CTPs for surface weather (and >1% improvement over a trial with no CTP assimilation)
- OPS CTPs also gave significant improvements in upper-air temperature and humidity (not in UK Index)
- Trials underway for winter 2013 and summer 2014 – both look promising so far

Conclusions and future work



Conclusions and future work

- CTPs produced in the OPS part of the data assimilation system seem sufficiently good quality to replace CTPs calculated offline on the Autosat system
- Two more trials underway (early results look promising)
- Hoping to switch to the new CTP calculation operationally later this year
- Should be possible to produce OPS CTPs for the global model, including for other Geostationary satellites and for UM LAMs run by other weather services



Any Questions?
robert.tubbs@metoffice.gov.uk