RAL-3

Updates on the third Regional Atmosphere and Land configuration in the UM

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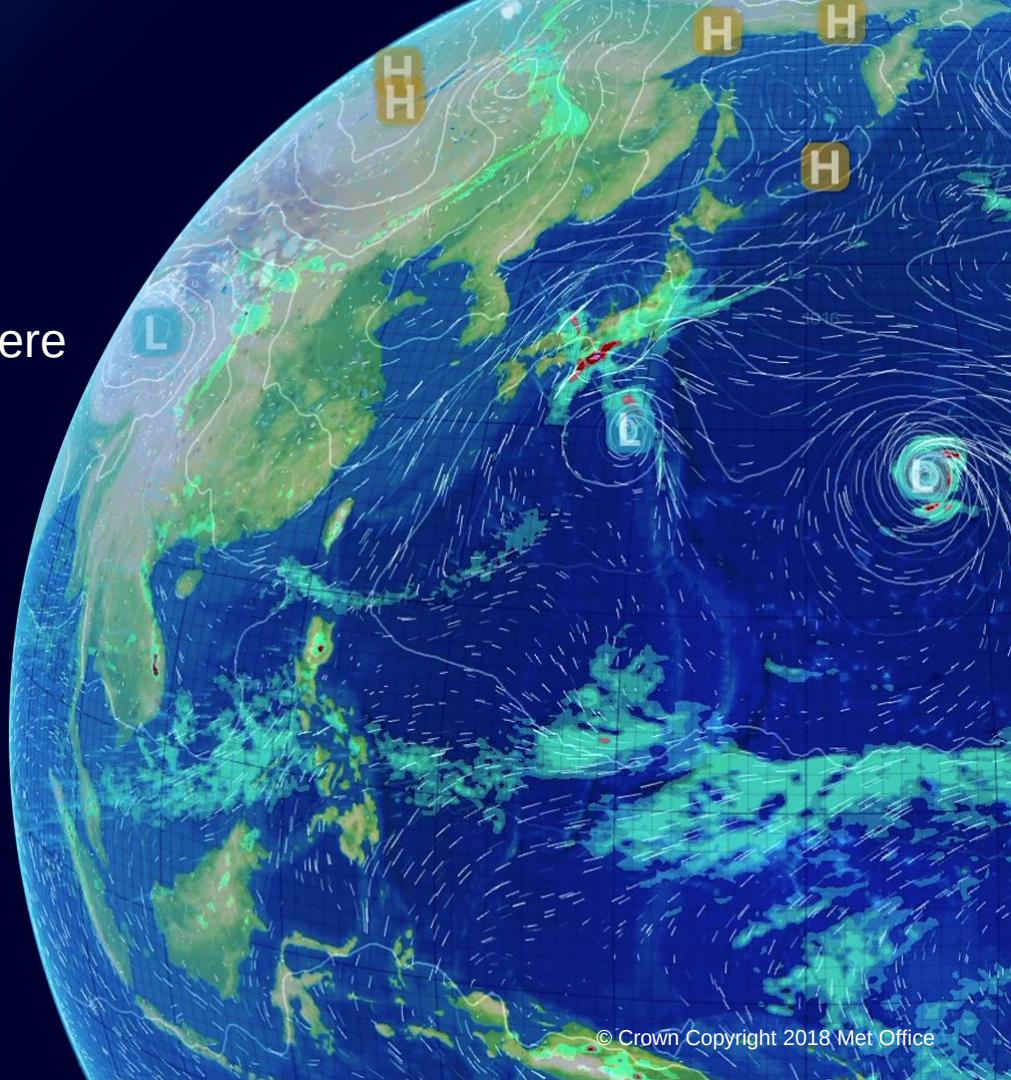
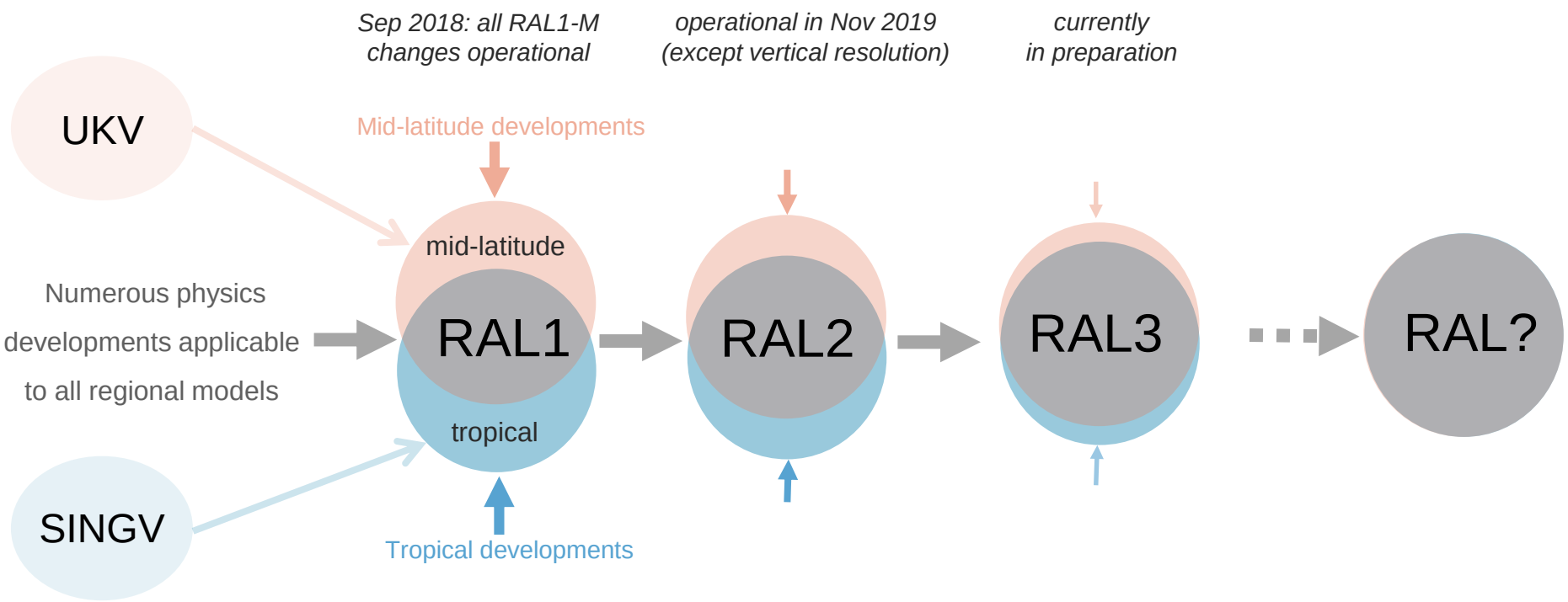


RAL - the “Regional Atmosphere and Land” configuration

- Large range of convection permitting models → risk of proliferation of model configurations
- Difficult to design a coherent programme of model development and ensure that research findings are relevant to the most up-to-date model configurations
- The aim: A single configuration for use in NWP operations, climate applications and research projects
- Currently focussing model development on two key model configurations distinguishing between mid-latitude and tropical configurations (RAL-M, RAL-T)



Ongoing work to remove “legacy differences” between model configurations: Mid-latitude vs Tropics, Short-range NWP vs Climate, Global vs Regional

Science changes considered for RAL3

- **Bimodal cloud scheme**
- package of land surface changes to consolidate Regional and Global settings
- package of changes to microphysics
- …

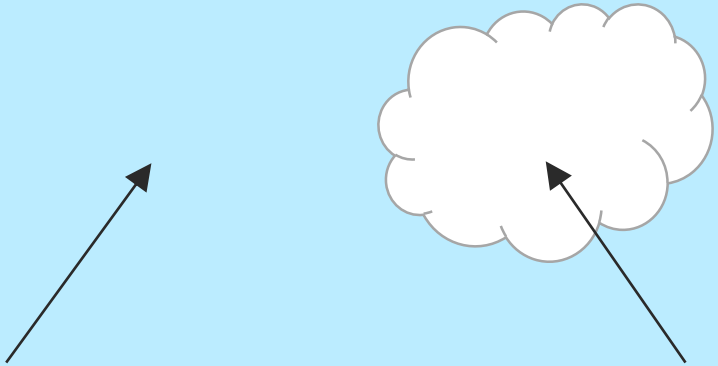
Bimodal Cloud Scheme

Bimodal scheme is based on Smith cloud scheme currently used in mid-latitude RAL

Important step towards unification of mid-latitude and tropical RAL configuration

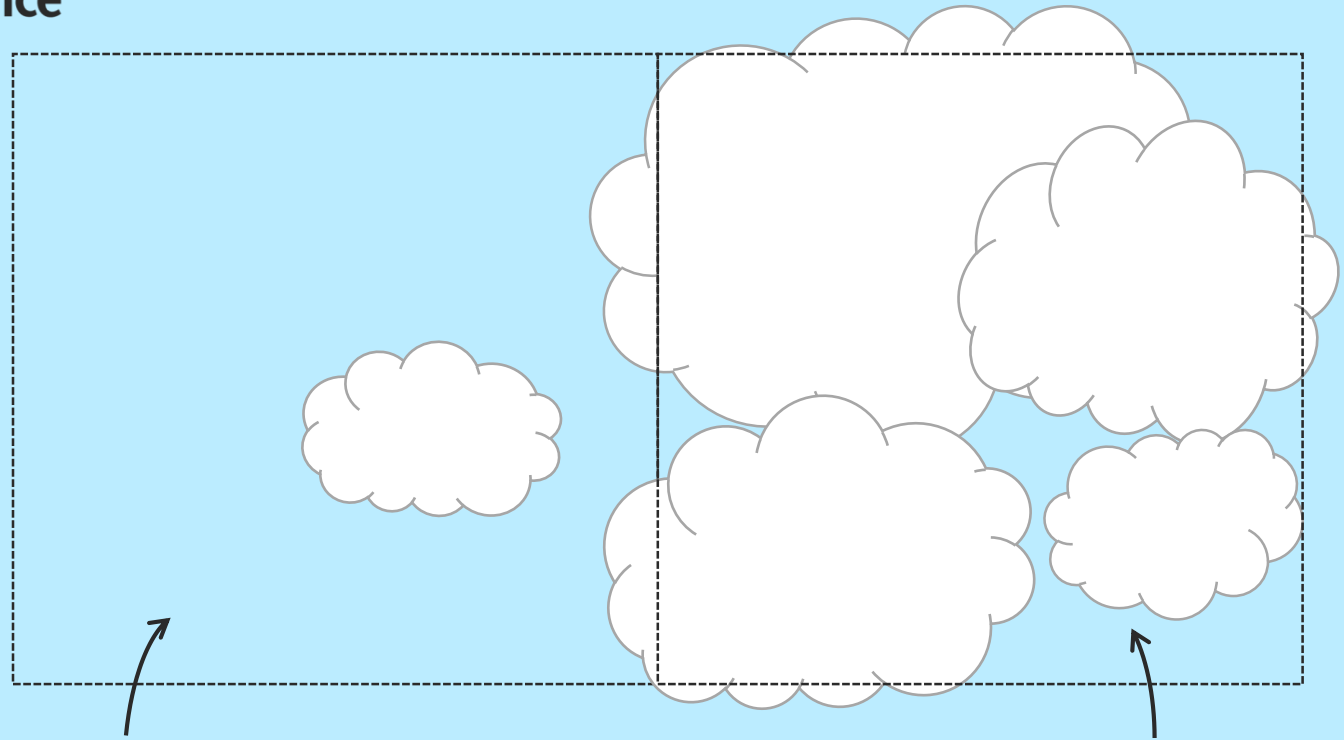
- replacing the Smith scheme in RAL2-M
- replacing PC2 in the tropical version RAL2-T

van Weverberg et al. – paper submitted to Monthly Weather Review



relative humidity < 100%

relative humidity > 100%



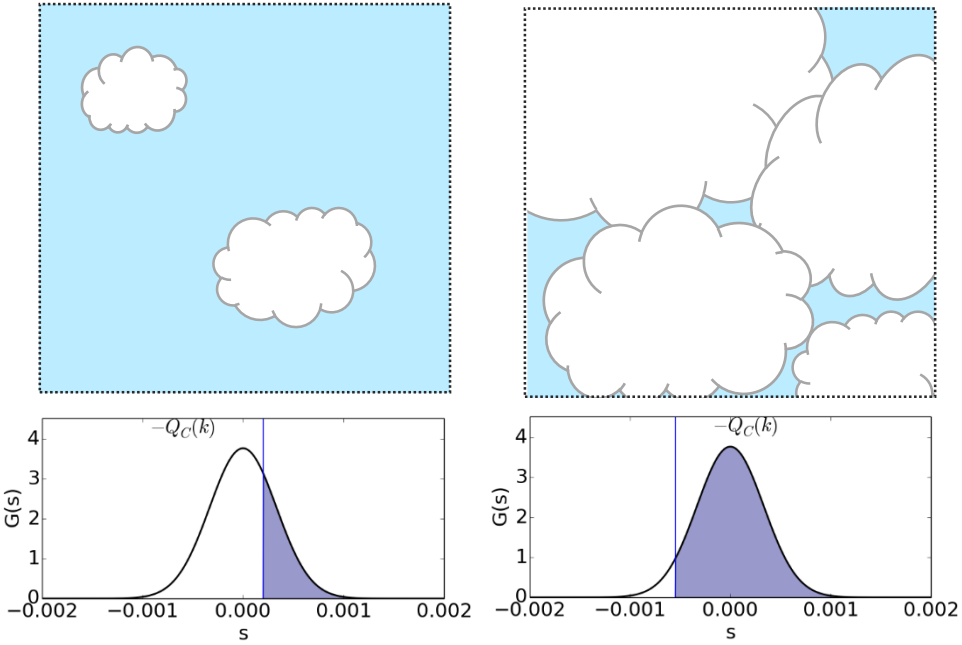
grid box mean relative humidity < 100%

→ not necessarily completely cloud free

grid box mean relative humidity > 100%

→ not necessarily completely cloudy

Current unimodal Smith scheme



Assume distribution of subgrid variability *s* around mean Q_c

As grid-box mean conditions (Q_c) cool or moisten: integrate over larger portion of *s* distribution.

When Q_c increases to 0 (i.e. grid-mean = water saturation), half the grid-box is cloudy

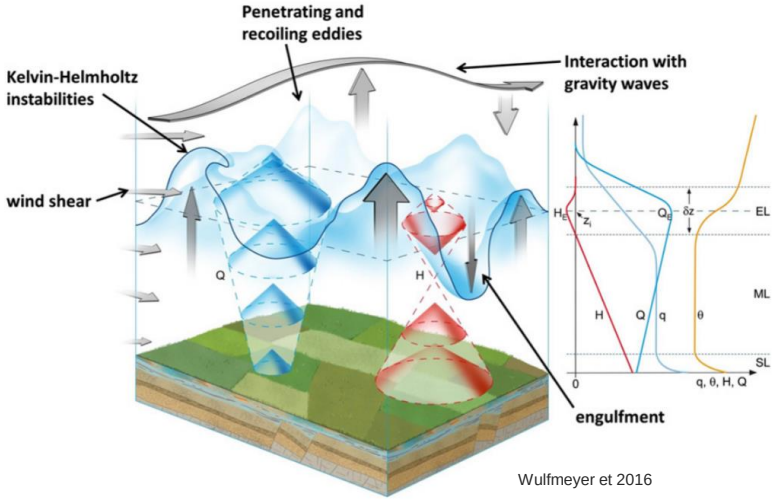
The problem: Need super-saturated grid box for cloud cover > 50%

→ Smith scheme typically under-forecasting cloud, empirical adjustment needed

Bimodal cloud scheme

→ a more physical approach to improve stratocumulus

Entrainment zone near top of boundary layer with large temperature and moisture variance



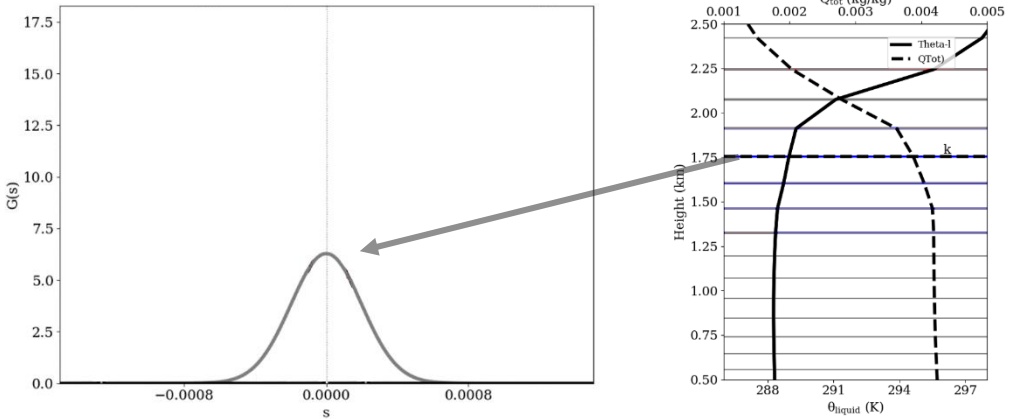
Wulfmeyer et 2016

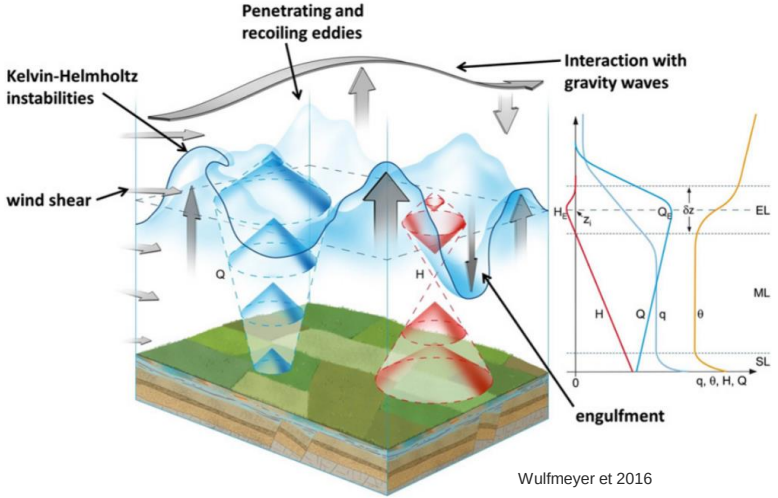
Bimodal cloud scheme

→ a more physical approach to improve stratocumulus

Entrainment zone near top of boundary layer with large temperature and moisture variance

current Smith scheme: unimodal pdf





Wulfmeyer et 2016

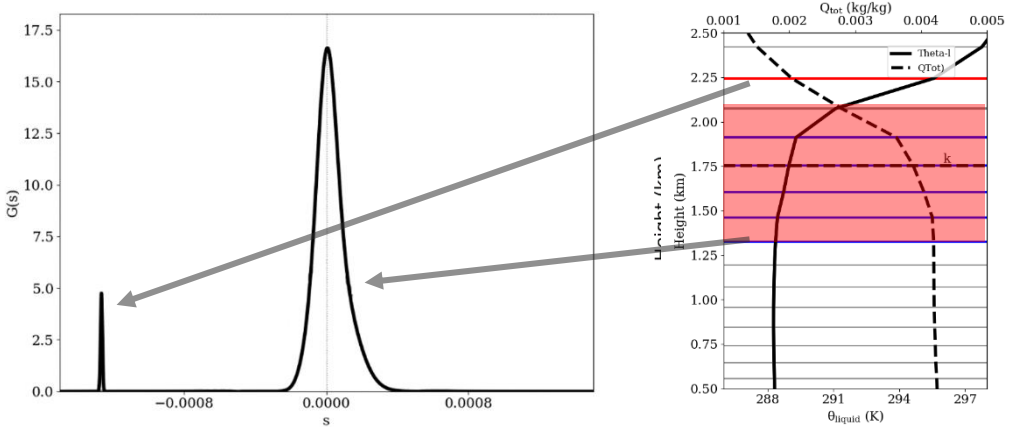
Bimodal cloud scheme

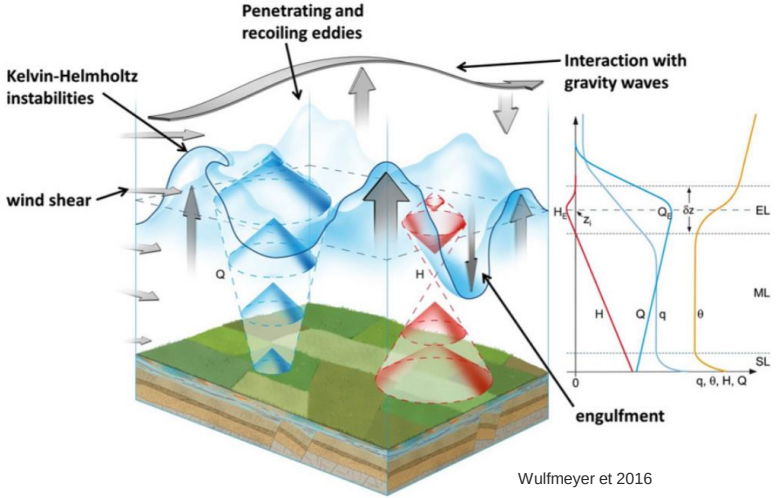
→ a more physical approach to improve stratocumulus

Entrainment zone near top of boundary layer with large temperature and moisture variance

Some variance caused by fluctuations in BL-top:

→ Air from below and above BL-top present at the same time





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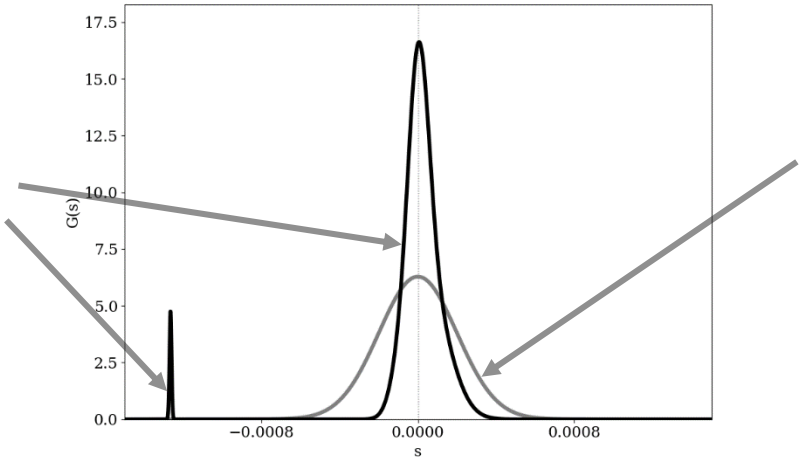
Bimodal cloud scheme

→ a more physical approach to improve stratocumulus

NEW

bimodal skewed pdf



CURRENT

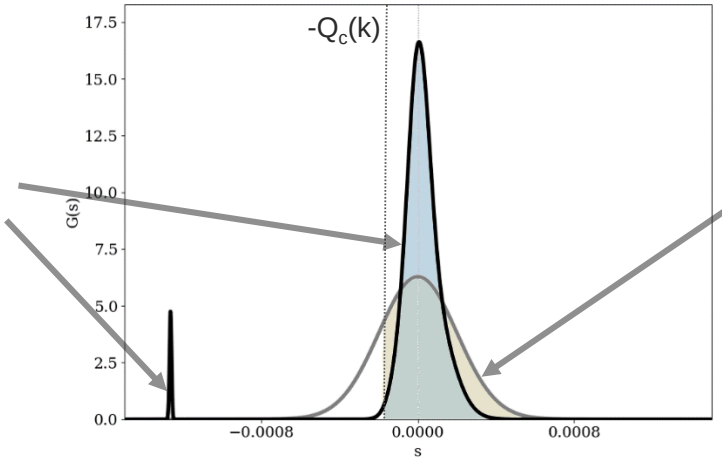
unimodal
symmetric pdf

Bimodal cloud scheme

→ a more physical approach to improve stratocumulus

NEW

bimodal skewed pdf

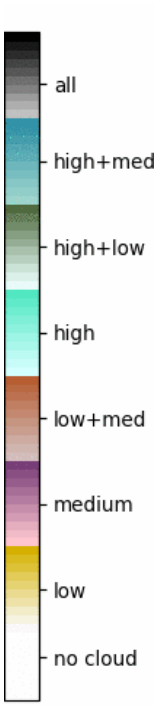


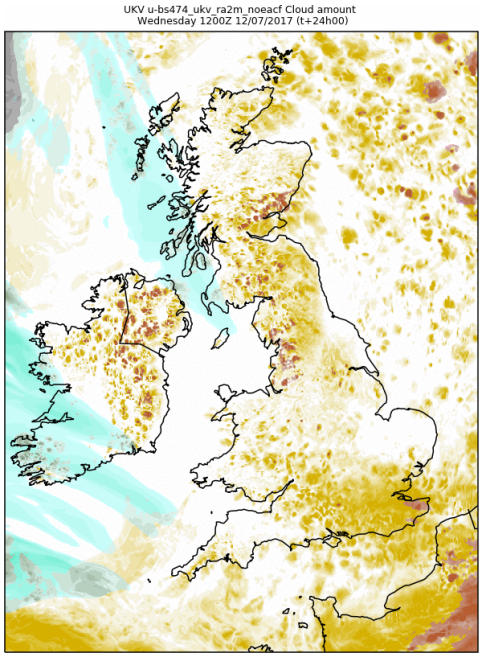
CURRENT

unimodal
symmetric pdf

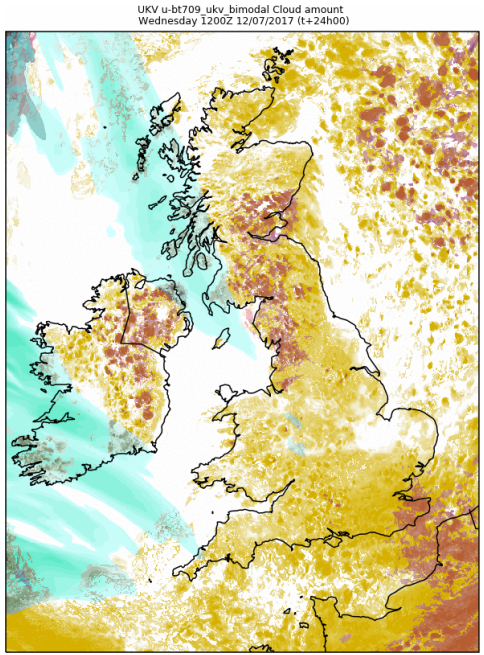
→ **Increased cloud fraction for given grid box mean conditions $Q_c(k)$**

Increased cloud amounts with bimodal cloud scheme

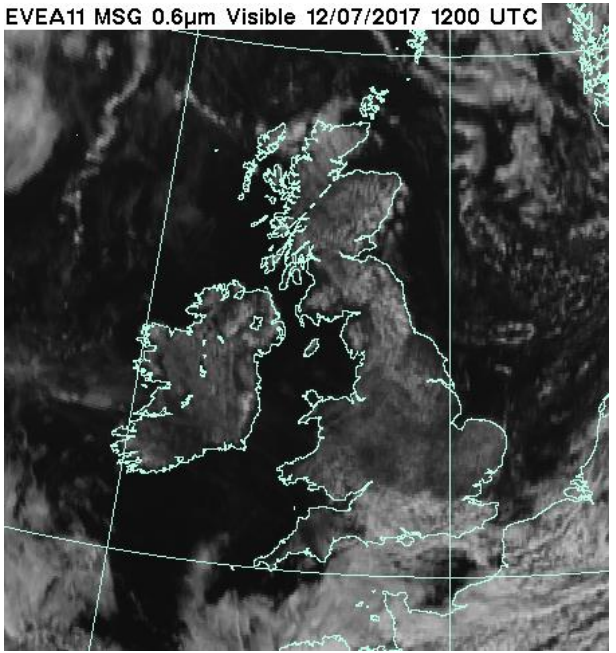




Smith Scheme



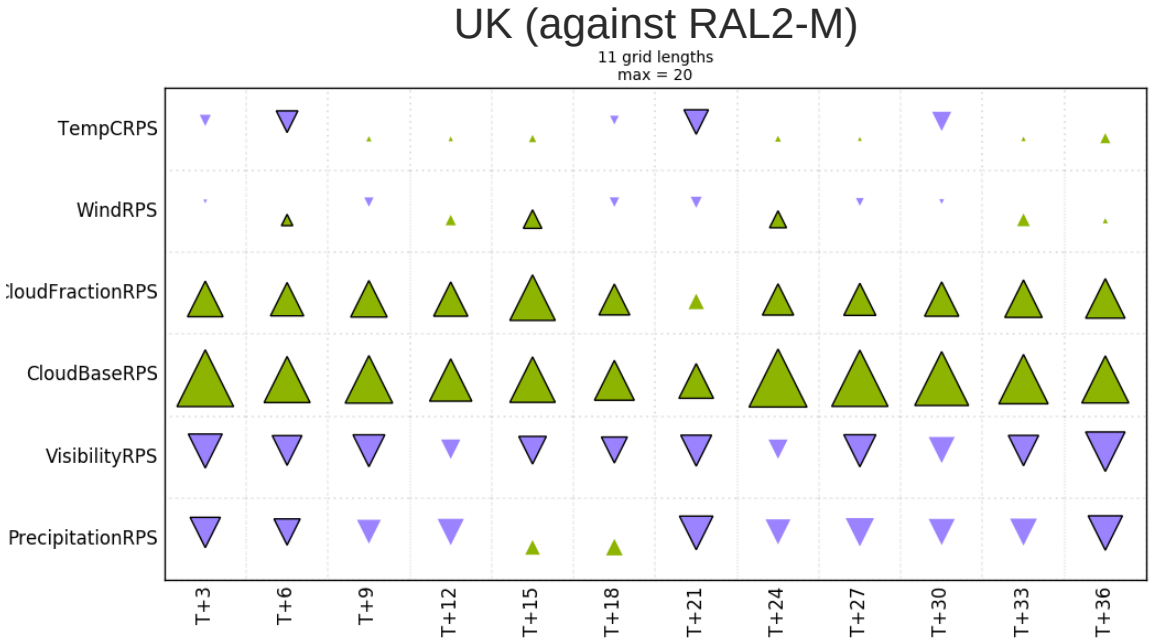
Bimodal Scheme



Met Office

better
worse

Bimodal cloud scheme is outperforming RAL2-M in UK case study tests



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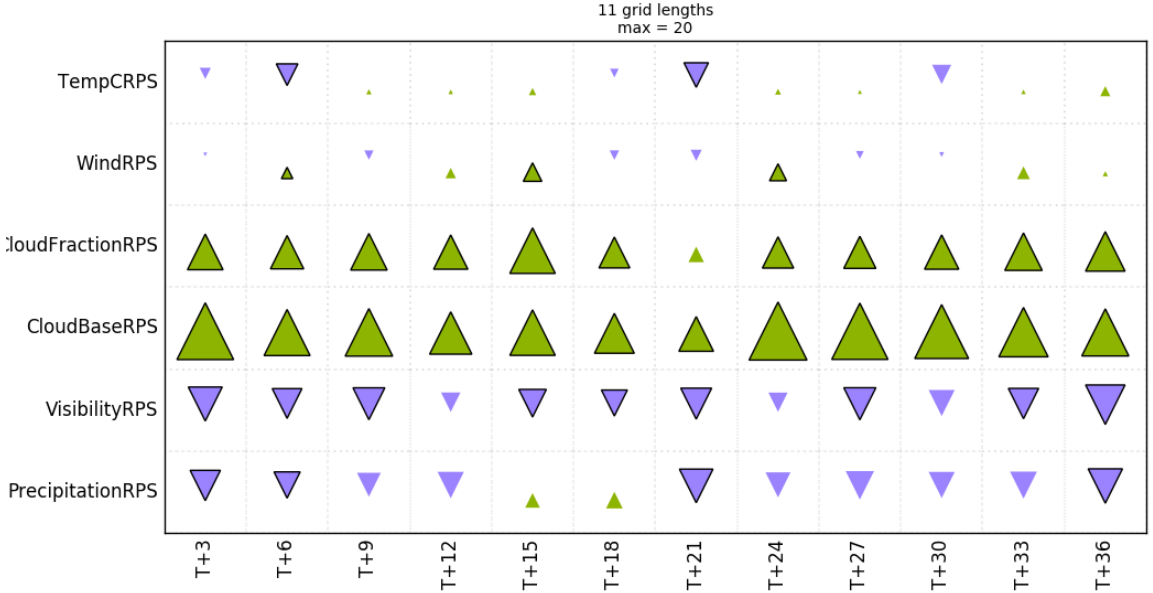
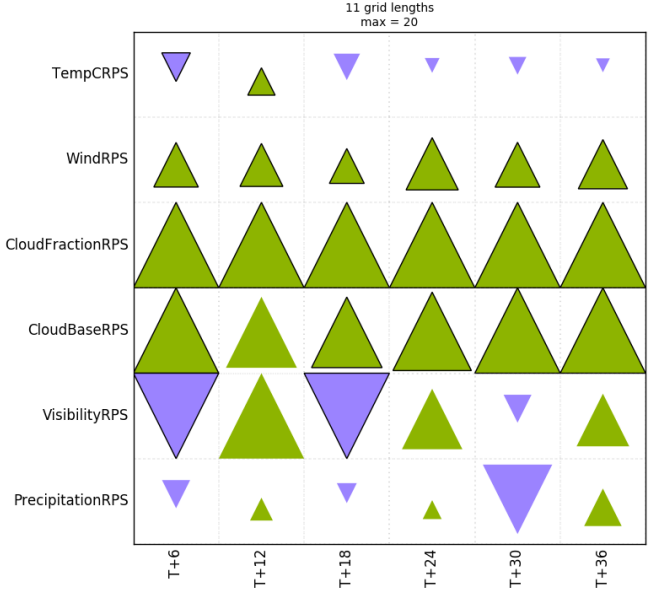
Bimodal cloud scheme is outperforming RAL2-M in UK case study tests

… and in RAL2-T tests over Darwin

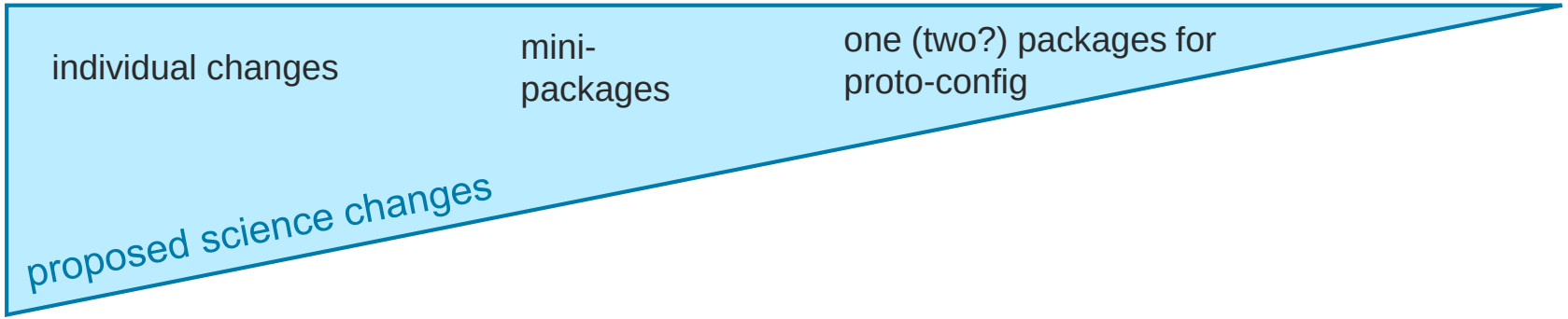
UK (against RAL2-M)



Darwin (against RAL2-T)



The RAL3 testing procedure

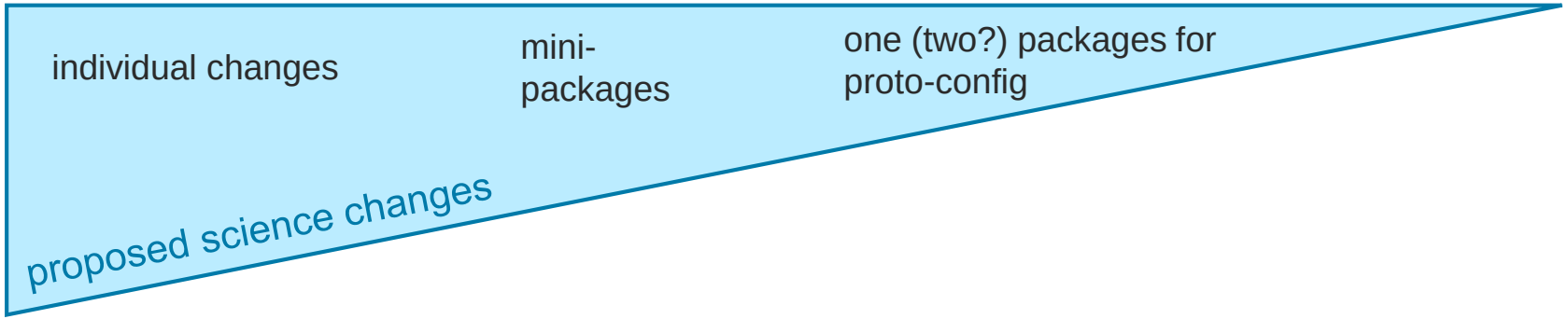


The RAL3 testing procedure

NWP operations climate applications research projects

UK case studies, climate runs, data assimilation trials, ensemble trials, sub-km tests, coupled runs, UM Partner case study tests, near real time forecasts, …

applications for RAL



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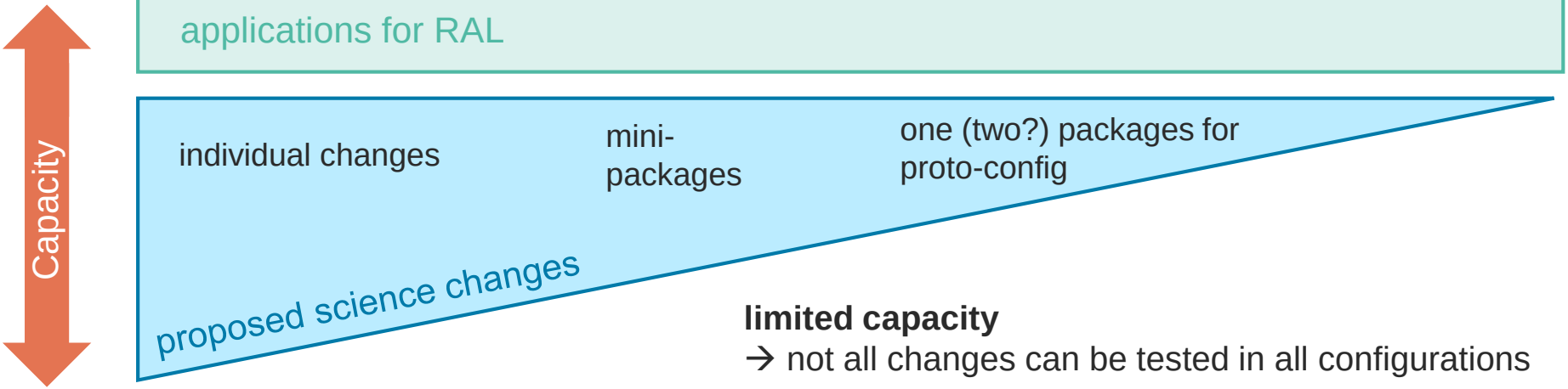


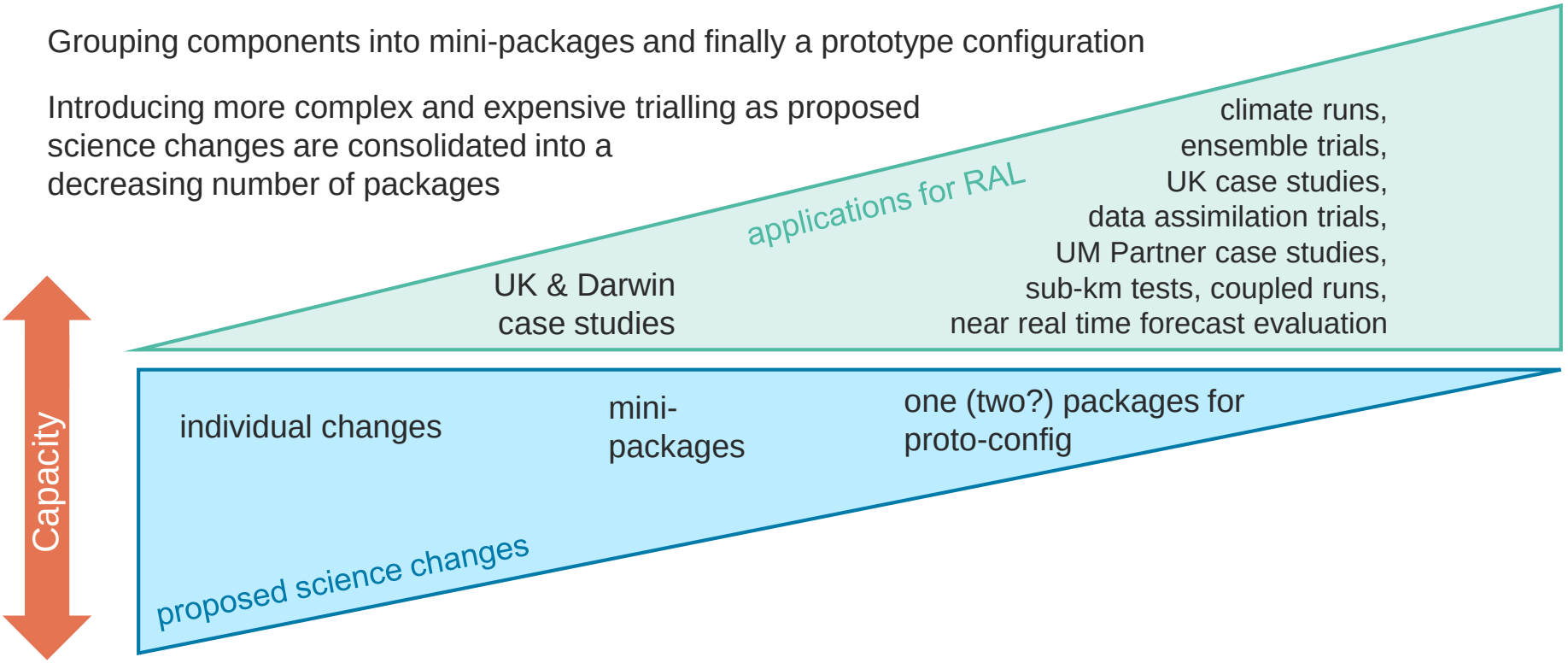
limited capacity
→ not all changes can be tested in all configurations

The RAL3 testing procedure

Component testing of individual changes in mid-latitude and tropical case studies

Grouping components into mini-packages and finally a prototype configuration

Introducing more complex and expensive trialling as proposed science changes are consolidated into a decreasing number of packages



RAL3

- Bimodal cloud scheme is showing promising increase to stratocumulus in the UK…
- … and improvements over PC2 scheme in the tropics
- Testing of several mini-packages in progress
- Preparations underway for testing science changes in more expensive trial environments

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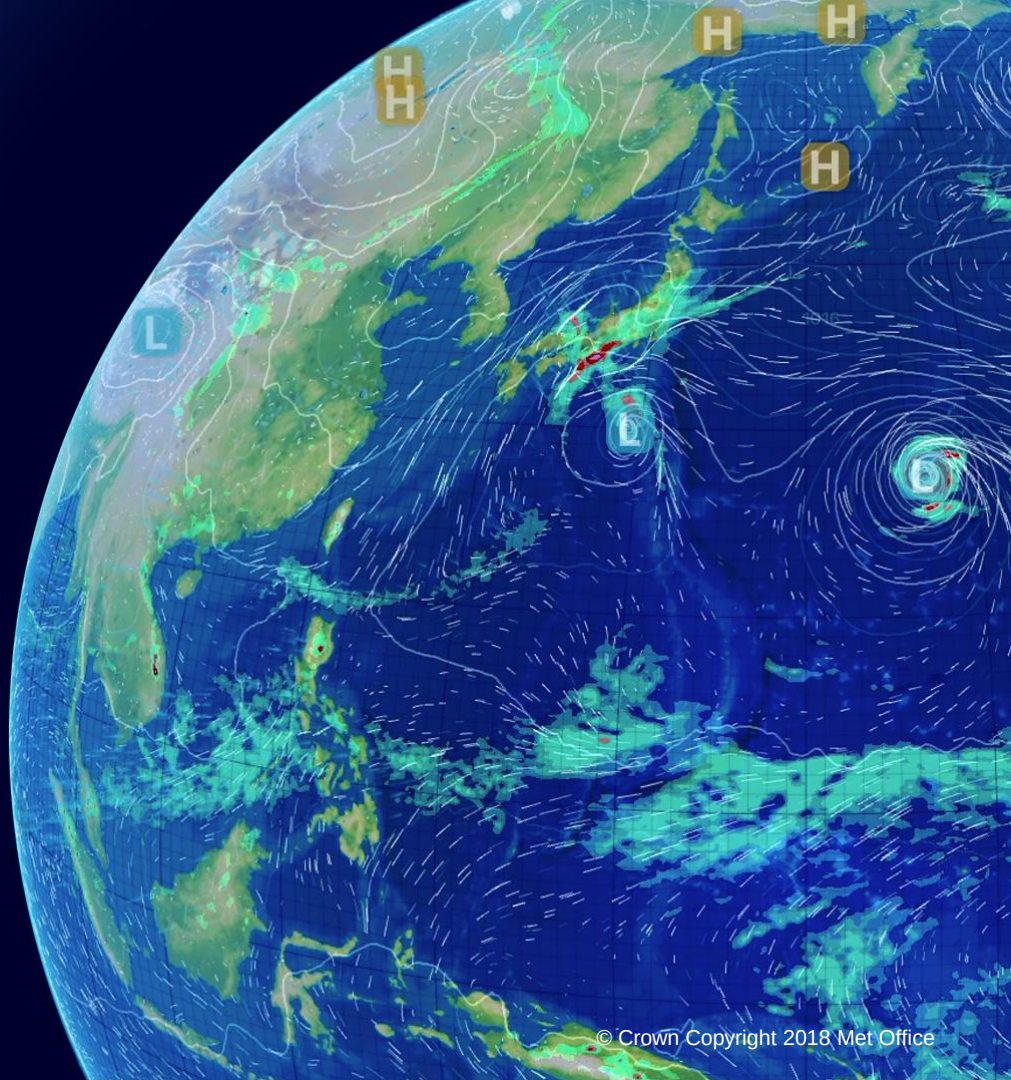

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