The Gauging and Modelling of Rivers in the Sky

David Lavers[1], Mark Rodwell[1], David Richardson[1], Marty Ralph[2], Jim Doyle[3], Carolyn Reynolds[3], Aneesh Subramanian[4], Vijay Tallapragada[5], Florian Pappenberger[1]

[1]ECMWF, Reading, U.K.

[2]CW3E, Scripps Institution of Oceanography, University of California, San Diego

[3]Naval Research Laboratory, Monterey, California

[4]University of Colorado Boulder, Colorado

[5]NOAA/NWS/NCEP/Environmental Modeling Center, College Park, Maryland

EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

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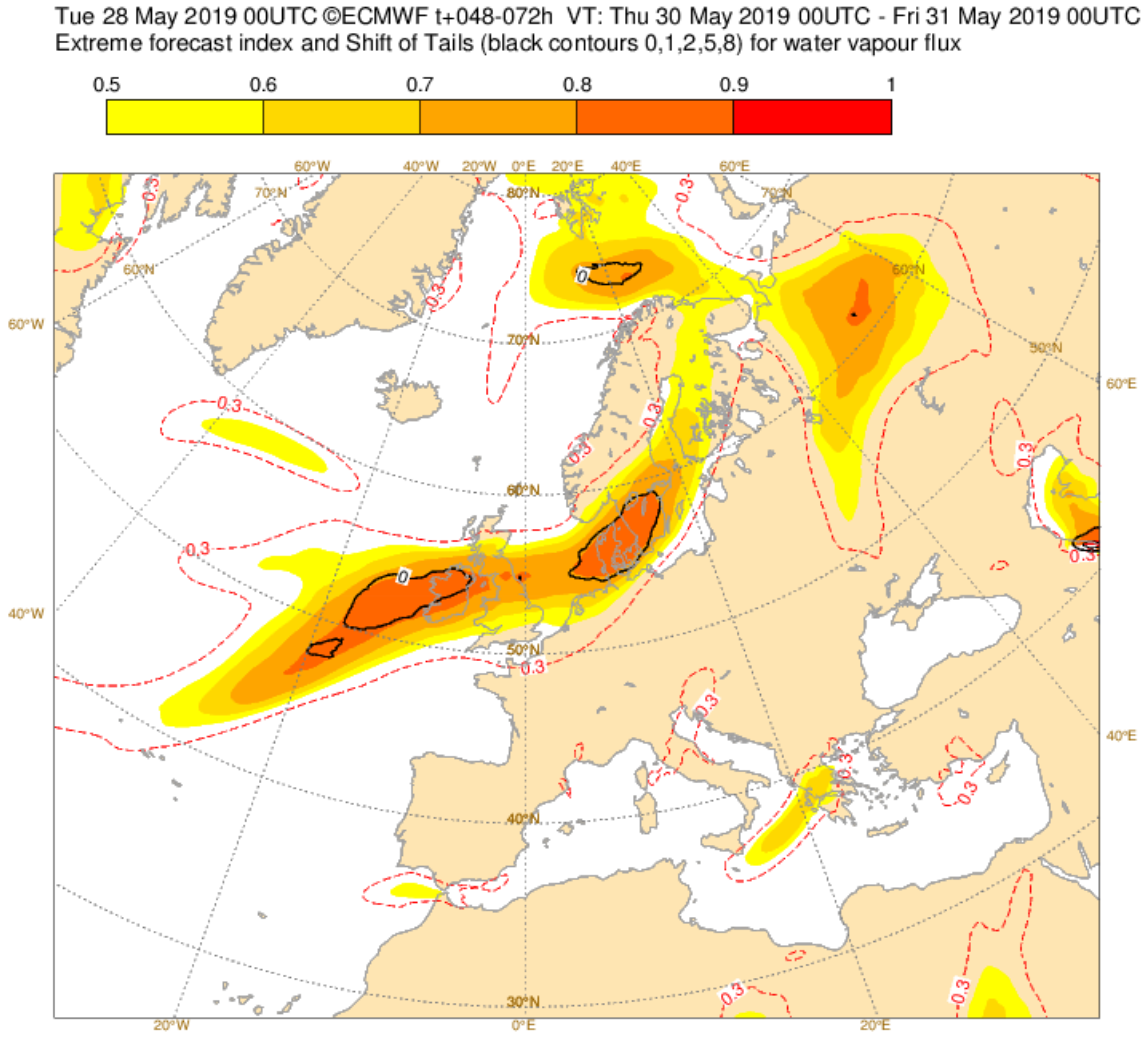
Atmospheric River Forecasting

- Extreme Forecast Index (EFI) for water vapour flux.
- Compares ensemble forecast with the model climate.
- May provide increased awareness of extreme rainfall and ARs.
- Implemented in 46r1.



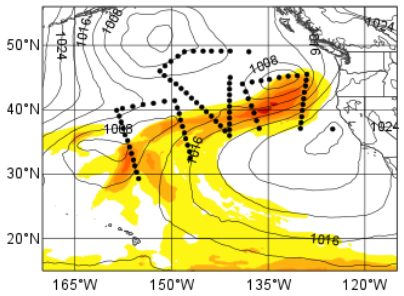
Atmospheric River Reconnaissance (AR recon)

- January / February 2018 and February / March 2019.
- 12 Intensive Observation Periods (IOPs).
- Three aircraft (NOAA GIV and two C130s).
- ARs are important for extreme rainfall and atmospheric circulation and predictability.
- Opportunity to identify model problems.

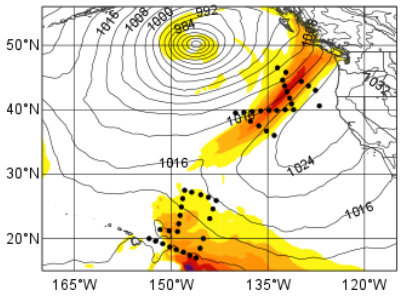
IOPs

2018

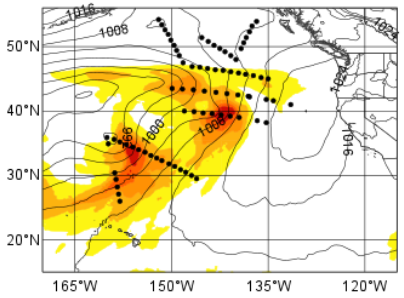
a. IOP1 00UTC 27 Jan. 2018



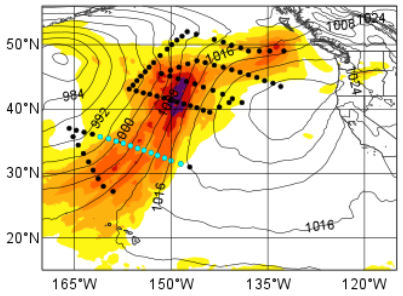
b. IOP2 00UTC 29 Jan. 2018



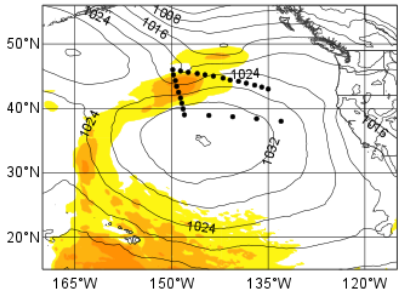
c. IOP3 00UTC 01 Feb. 2018

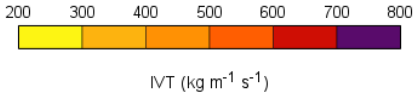


d. IOP4 00UTC 03 Feb. 2018



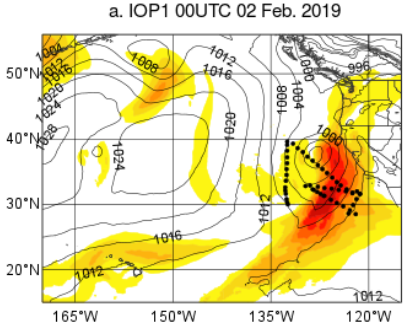
e. IOP5 00UTC 28 Feb. 2018



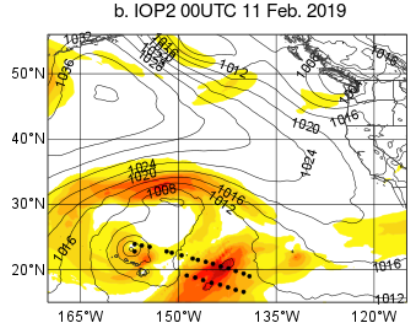


2019

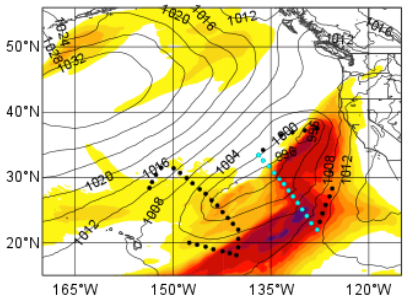
a. IOP1 00UTC 02 Feb. 2019



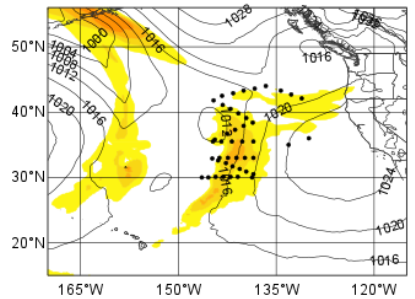
b. IOP2 00UTC 11 Feb. 2019



c. IOP3 00UTC 13 Feb. 2019



d. IOP4 00UTC 24 Feb. 2019



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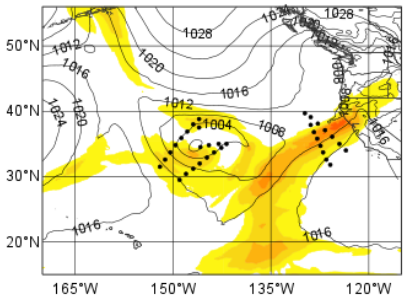
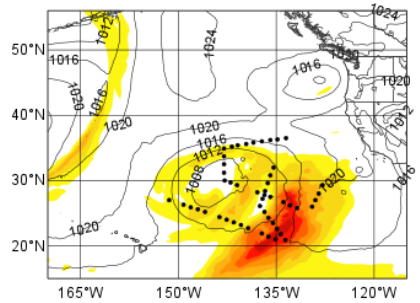
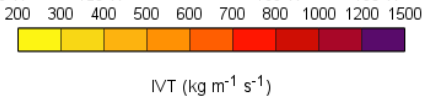


f. IOP6 00UTC 01 Mar. 2019

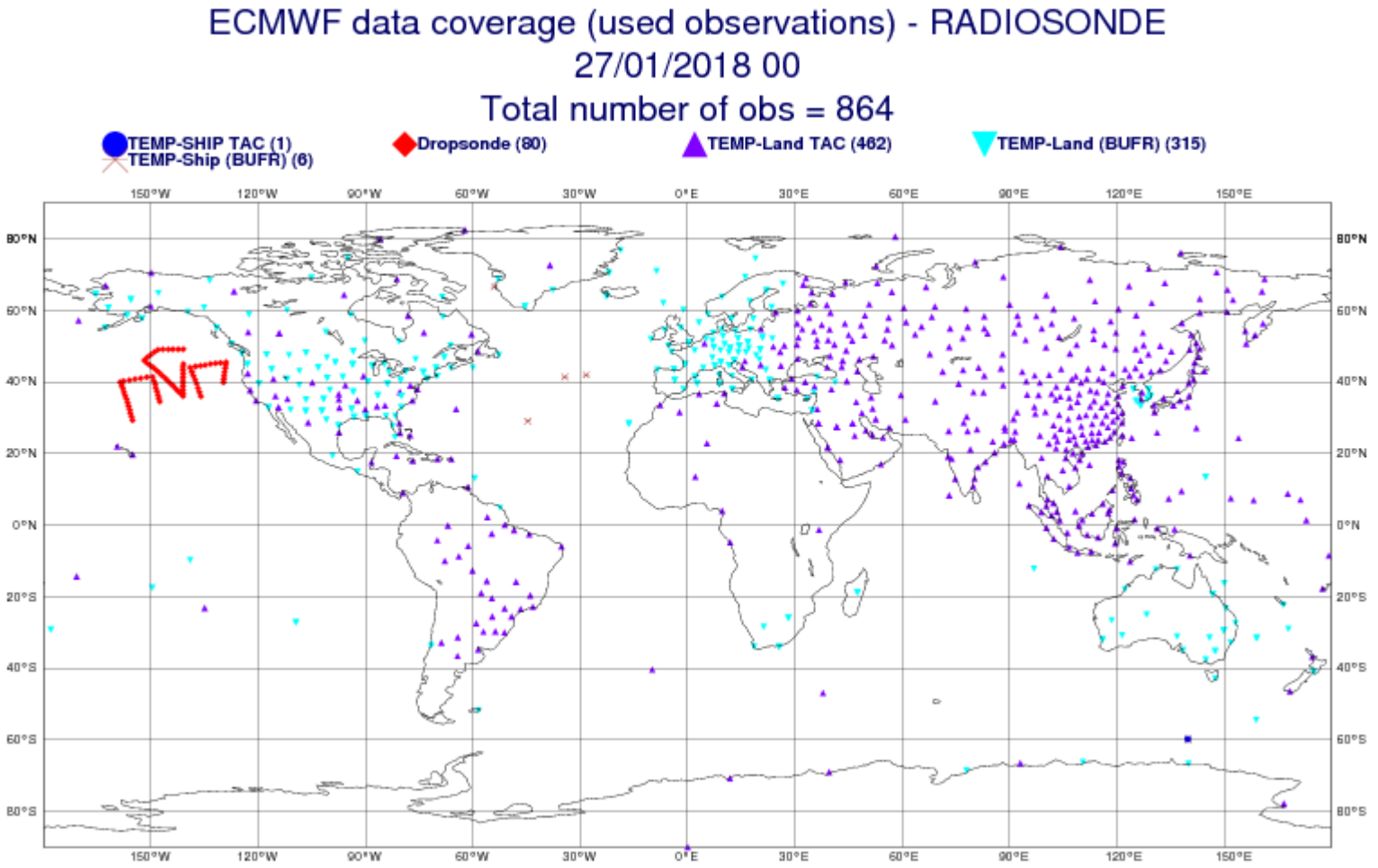




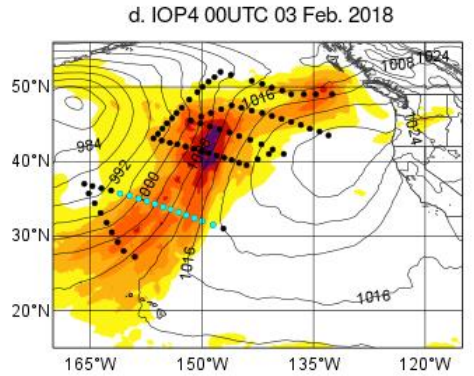
Analysis – part 1

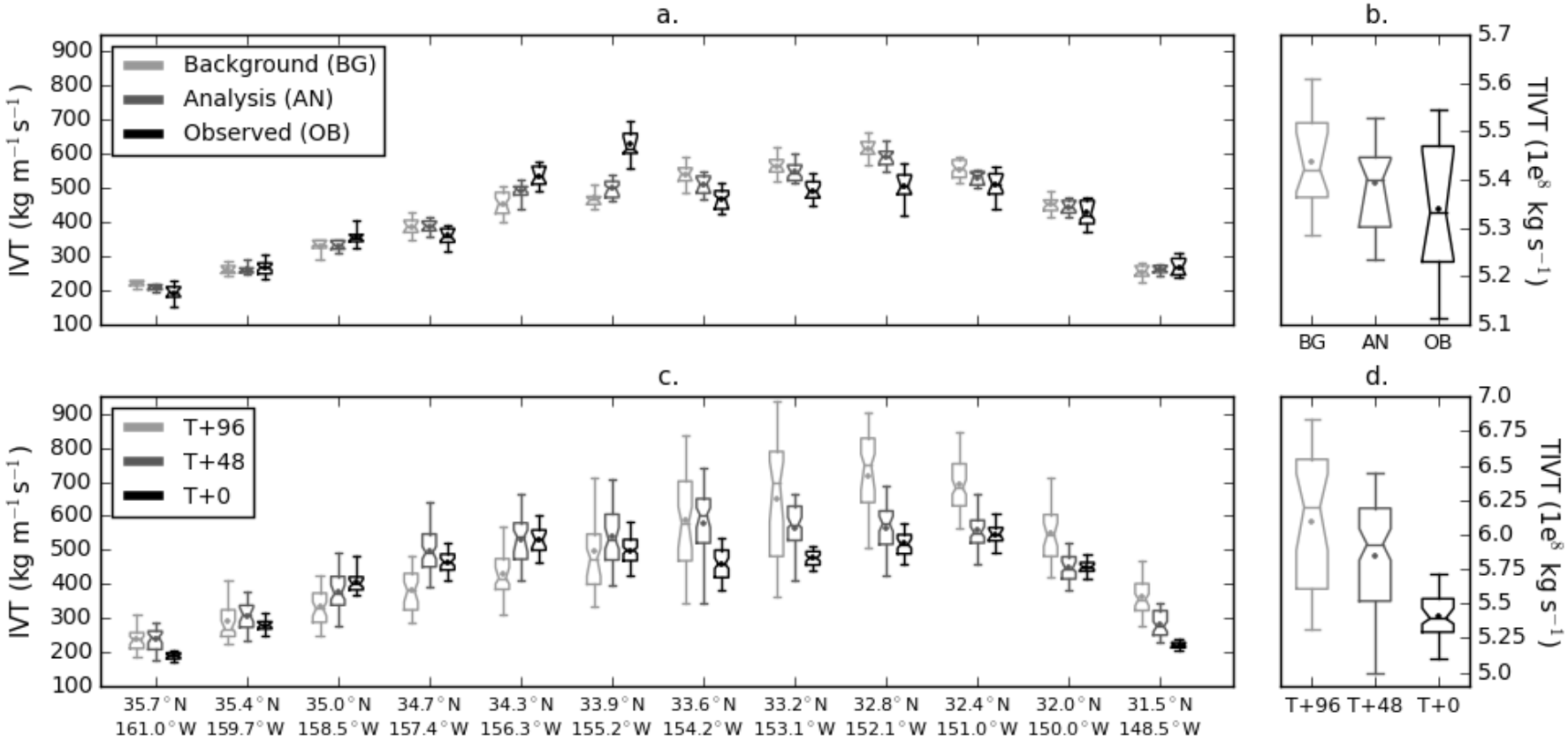
- Dropsondes were assimilated in real-time.
- Use ECMWF ensemble of data assimilations (EDA). At the time, the 25 members produced the 50 perturbed ensemble forecasts.
- Water vapour flux (IVT) calculated at each dropsonde location.
- Mostly used three pressure levels (925, 850, 700 hPa).
- Assess the background, analysis, and observed values.
- AR transects evaluated and IVT uncertainties investigated.

Assimilated dropsondes

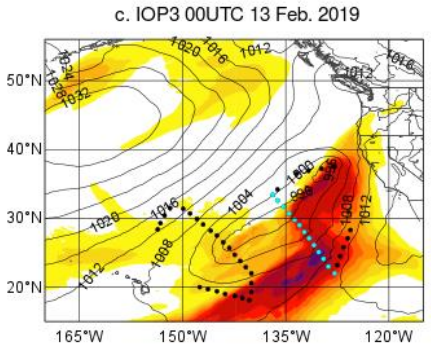


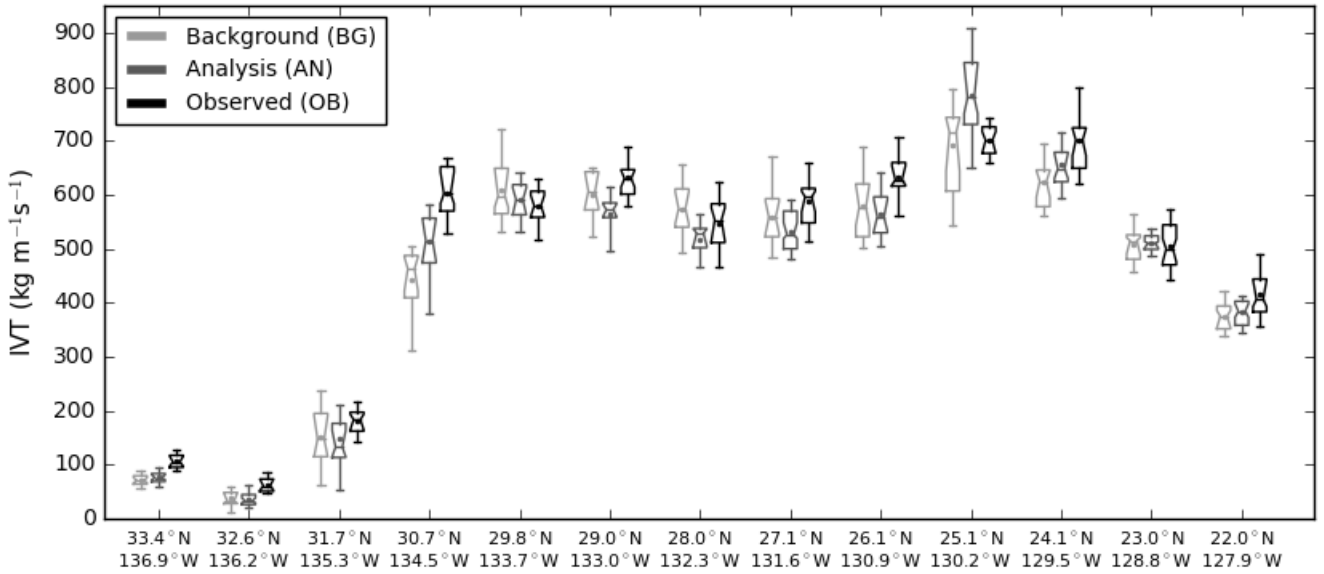
An AR transect in 2018



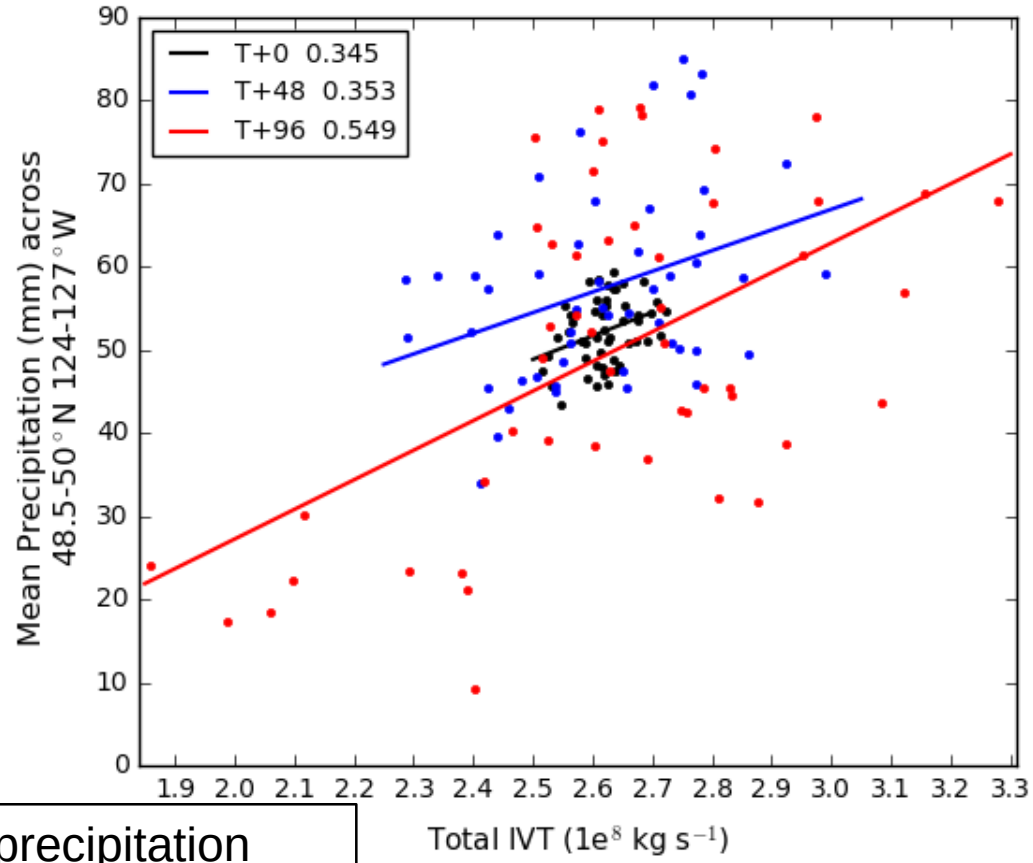


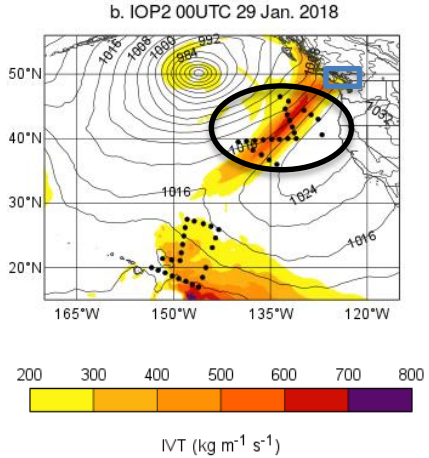
An AR transect in 2019





Precipitation uncertainty



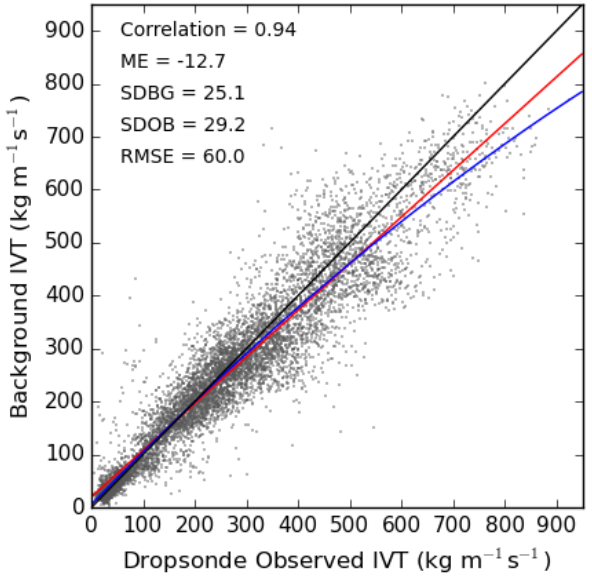


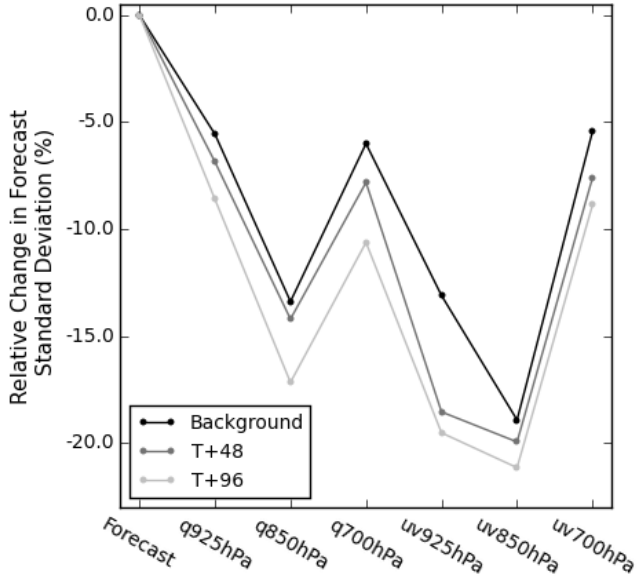
Mean model precipitation across southwestern Vancouver Island (48.5°N-50°N 124°W-127°W)

Total IVT flux valid at 00UTC 29th January 2018 averaged over the four transects

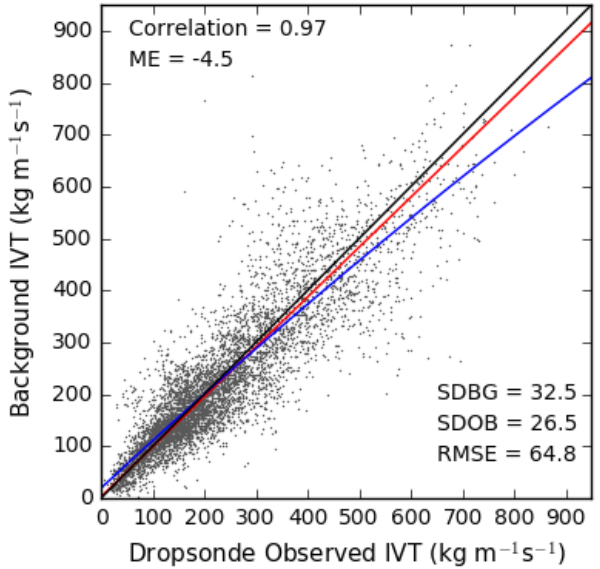
Water vapour flux (IVT) uncertainty

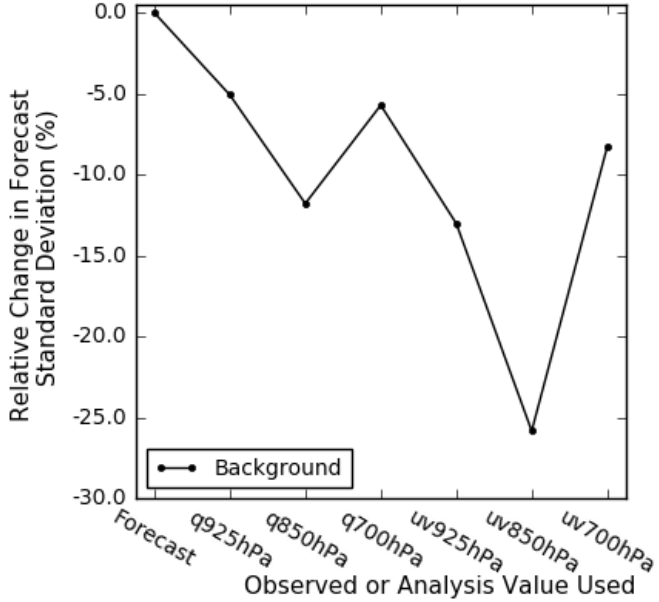
2018





2019



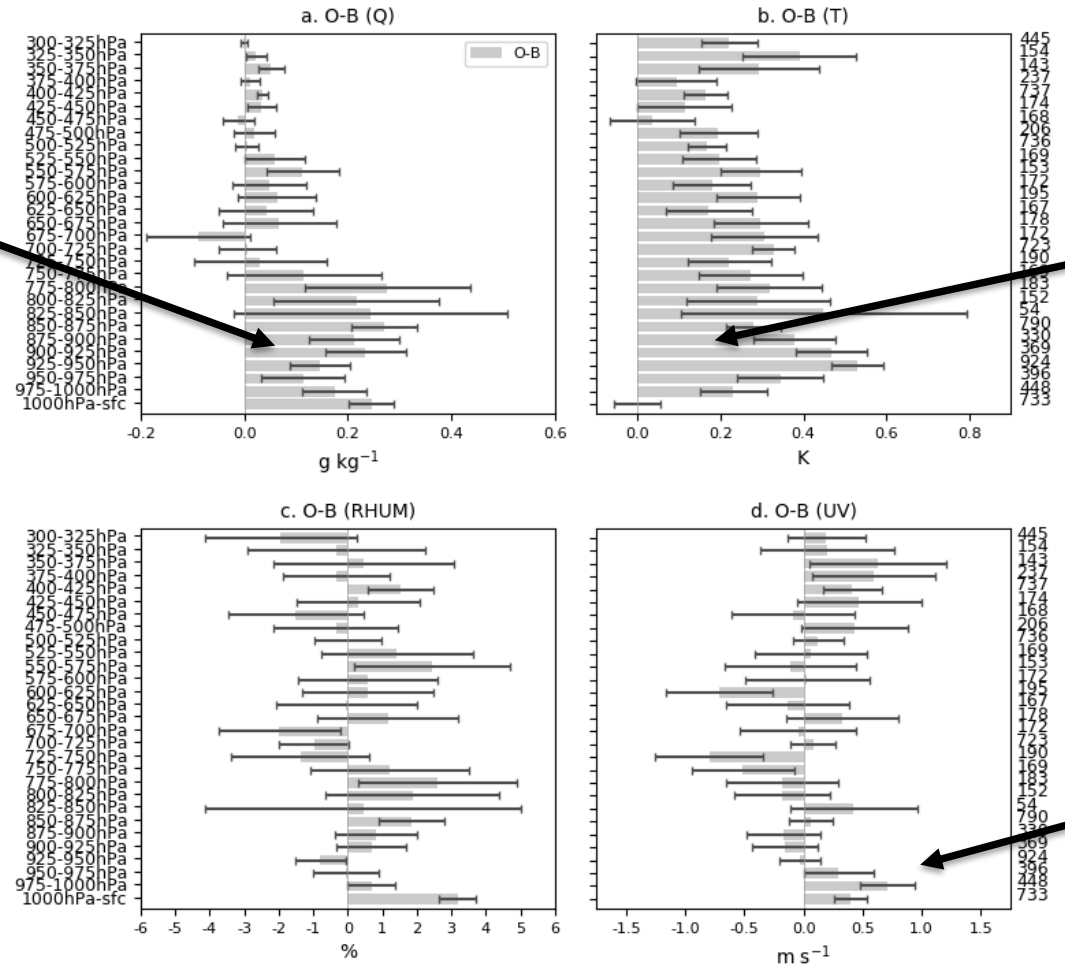


Analysis – part 2

- ECMWF ensemble of data assimilations (EDA).
- Use all available assimilated pressure levels.
- Calculate average observation – background (O – B) statistics in 25hPa layers.
- Assess specific and relative humidity, temperature, and winds.
- Investigate pressure level water vapour fluxes.

Observation – Background (O – B)

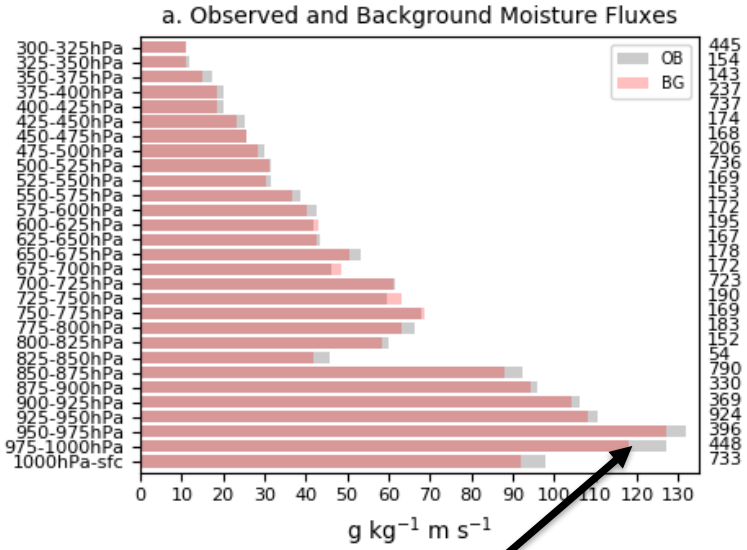
Dry bias - observations have higher specific humidity.

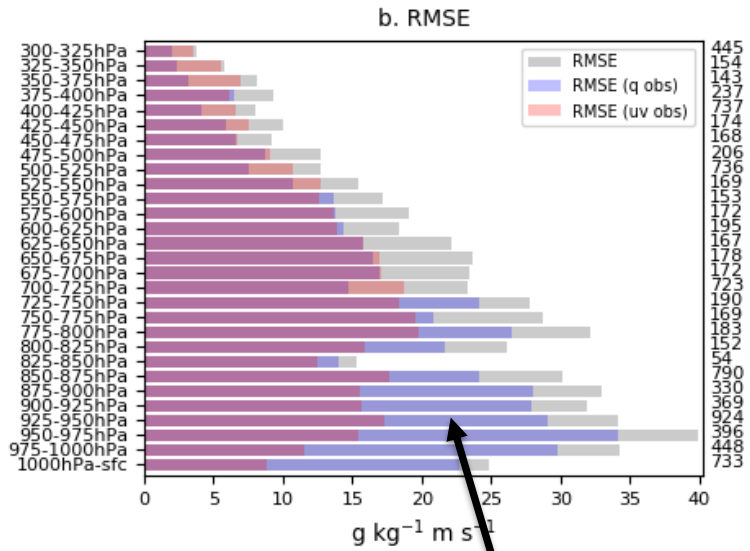


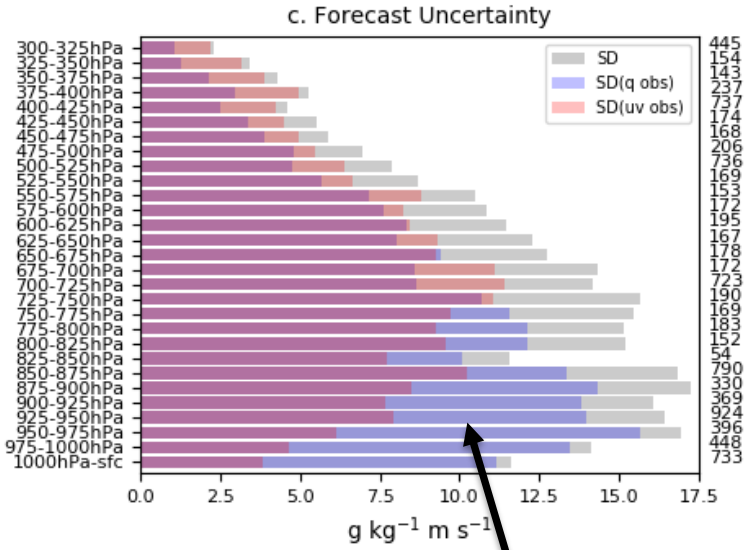
Cold bias - observations are warmer than the model.

Winds are stronger in the observations in the planetary boundary layer (PBL).

Water vapour fluxes: observed values, RMSE, and uncertainty







Observed water vapour fluxes are higher.

Accurate winds reduce RMSE more than specific humidity at low levels; opposite at high levels.

Accurate winds reduce uncertainty more than specific humidity at low levels; opposite at high levels.

Conclusions – Part 1

- 11 IOPs during AR Recon 2018 and 2019.
- AR structure and IVT magnitude generally well captured.
- Using few pressure levels (925, 850, 700 hPa), uncertainties in winds at 850 hPa cause the most IVT uncertainty.
- Specific humidity is also subject to relatively large uncertainties.

Conclusions – Part 2

- Using all pressure levels, a dry and cold bias is found in the model.
- Observed winds are stronger than the model winds in the planetary boundary layer.
- Water vapour fluxes are underestimated throughout the atmosphere.
- Winds cause most error and uncertainty at lower levels; specific humidity causes more error and uncertainty at higher levels.
- New observations (e.g. from satellite) may improve initialisation of these variables.