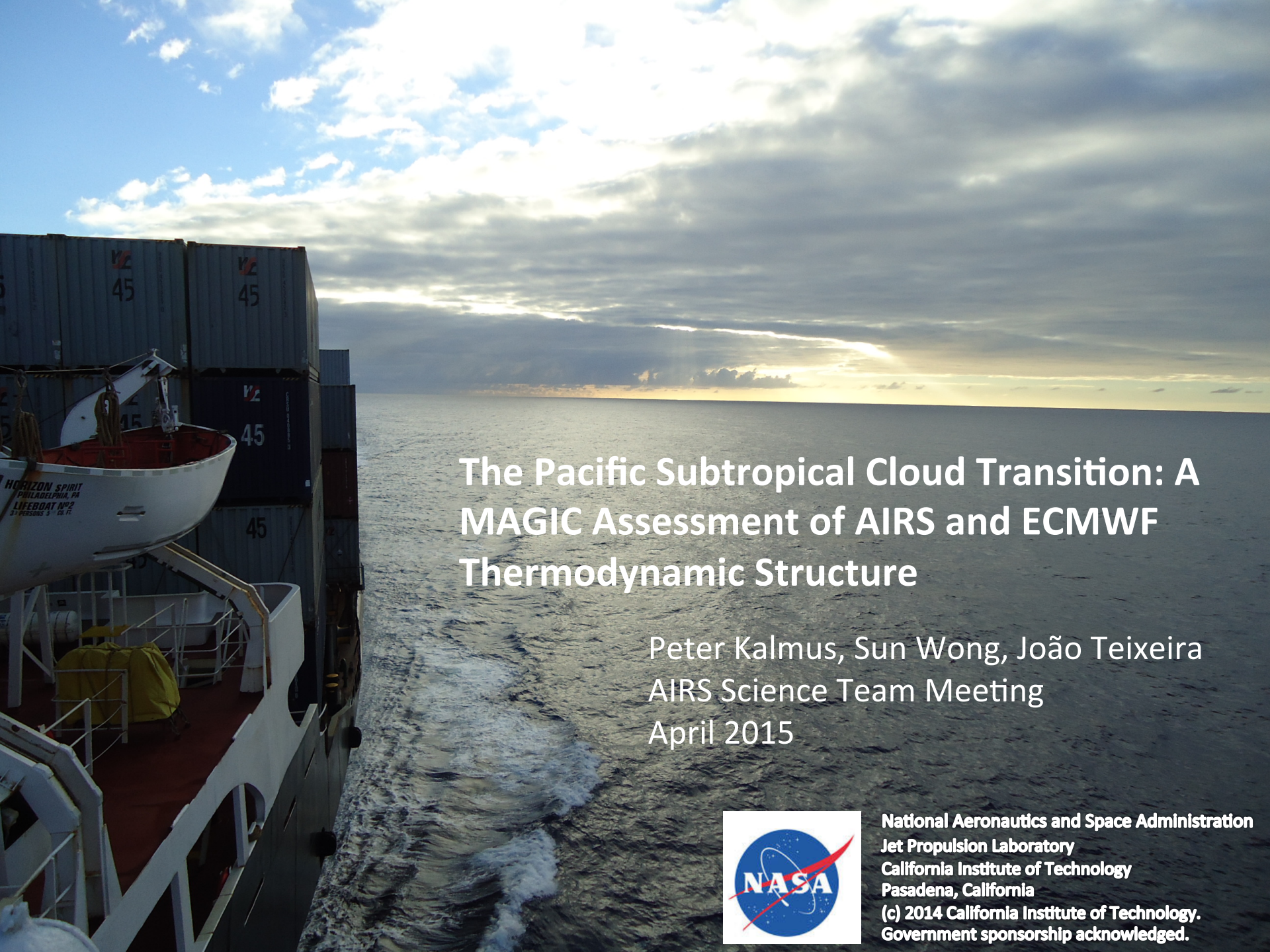

The Pacific Subtropical Cloud Transition: A MAGIC Assessment of AIRS and ECMWF Thermodynamic Structure

Peter Kalmus, Sun Wong, João Teixeira

AIRS Science Team Meeting

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National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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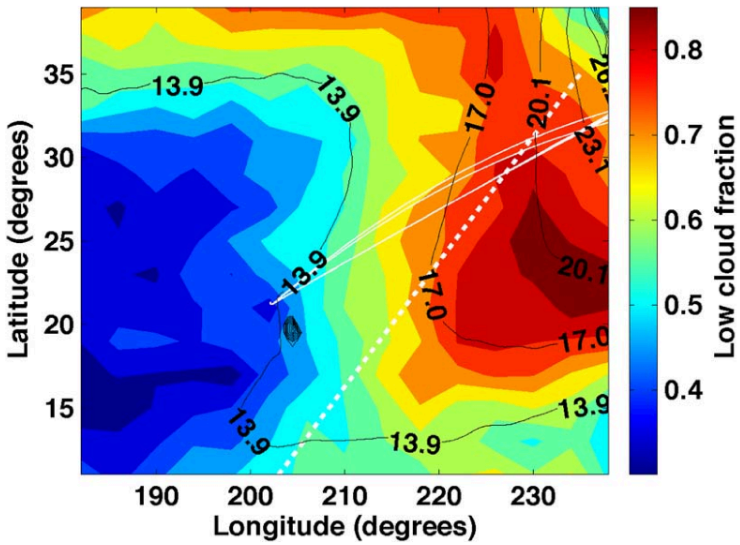
The Pacific Subtropical Cloud Transition: A MAGIC Assessment of AIRS and ECMWF Thermodynamic Structure

Peter Kalmus, Sun Wong, and João Teixeira

***Abstract*—We use radiosonde data from the ship-based Marine ARM GPCI Investigation of Clouds (MAGIC) campaign in the northeast Pacific to validate temperature and moisture profiles from the satellite-based Atmospheric Infrared Sounder (AIRS) instrument and from European Centre for Medium-Range Weather Forecasts (ECMWF) ERA-Interim reanalysis data. We find that AIRS and ECMWF rms errors and biases are largest near the boundary layer inversion. In the mean vertical profile over the entire MAGIC track, the largest AIRS biases for T and q are 0.4 K and -0.6 g kg^{-1} at 516 hPa and 866 hPa, respectively. We also find that AIRS and ECMWF slightly underestimate the boundary layer height in the region.**

***Index Terms*—Clouds, infrared spectroscopy.**



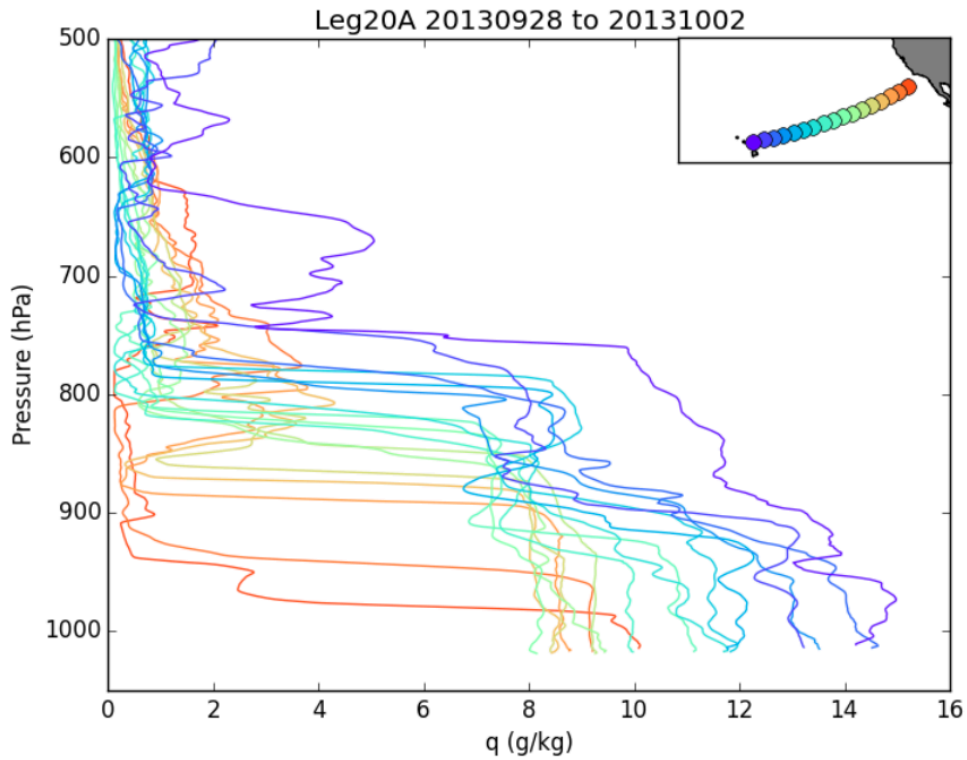
Black contours are lower trop. stability.
White lines are MAGIC tracks.
White dashed line is GPCI transect.

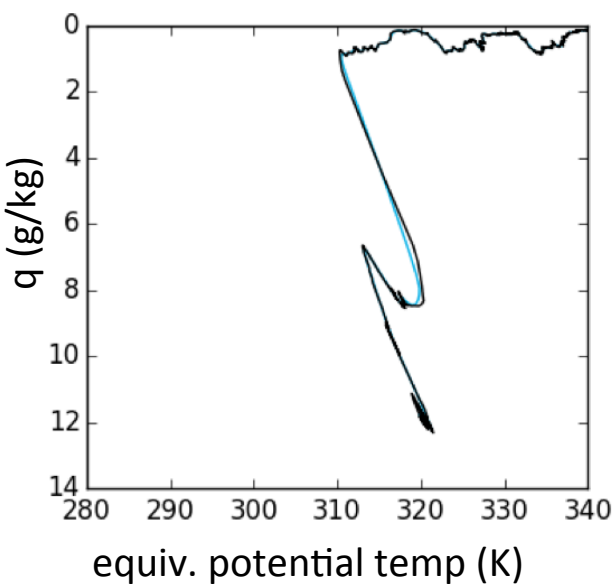
MAGIC
Marine ARM GPCI Investigation of Clouds

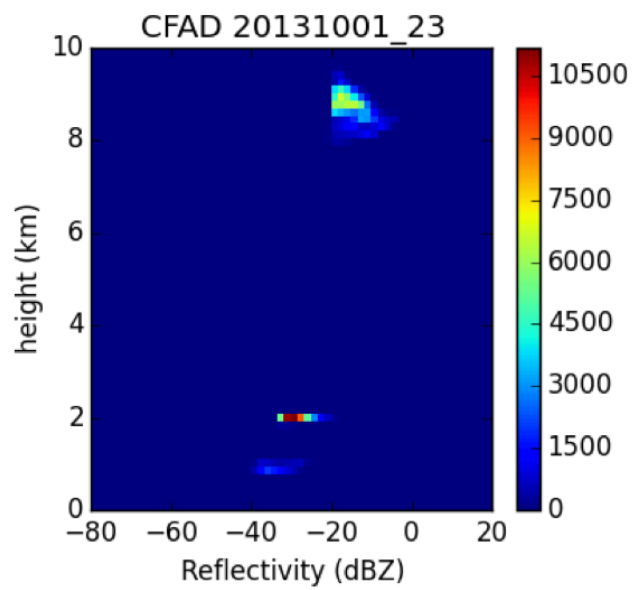
ARM mobile facility installed on a container ship

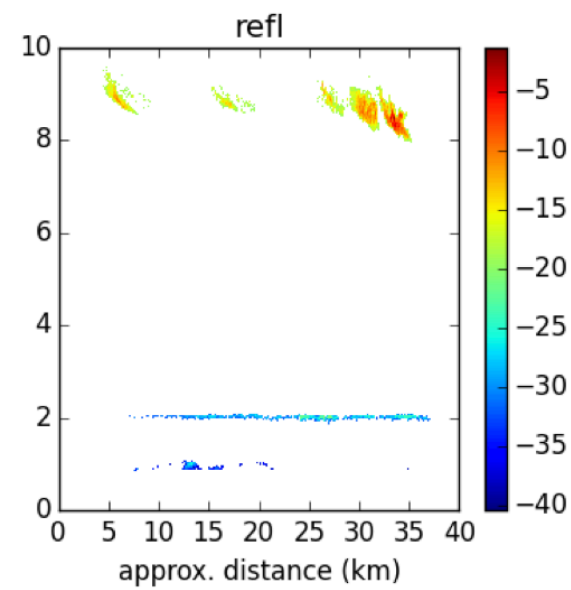
Radars, lidars, ceilometer, MWR, aerosol suite, sondes & more

19 round trips trips between LA and Honolulu, 9/2012 – 10/2013


Leg20A 20130928 to 20131002
Pressure (hPa)
q (g/kg)


q (g/kg)
equiv. potential temp (K)


CFAD 20131001_23
height (km)
Reflectivity (dBZ)

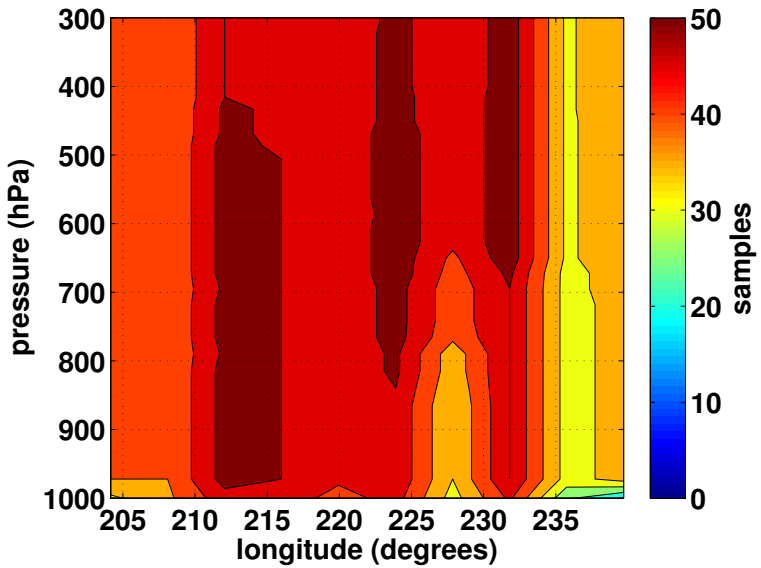

refl
approx. distance (km)

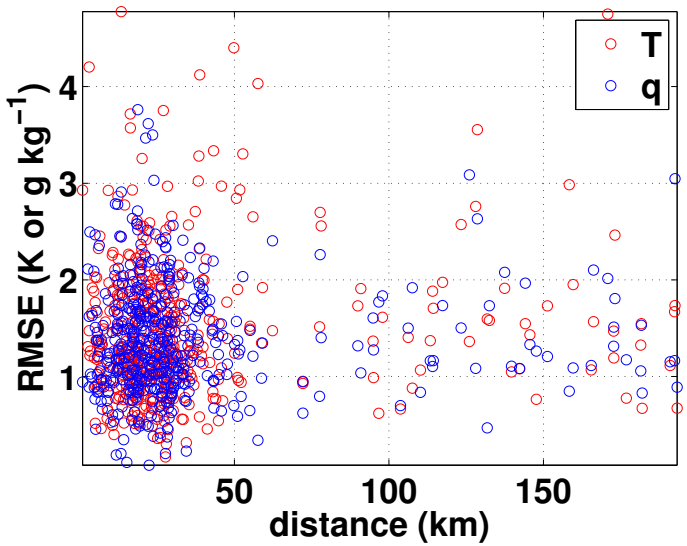
Sonde / AIRS collocation

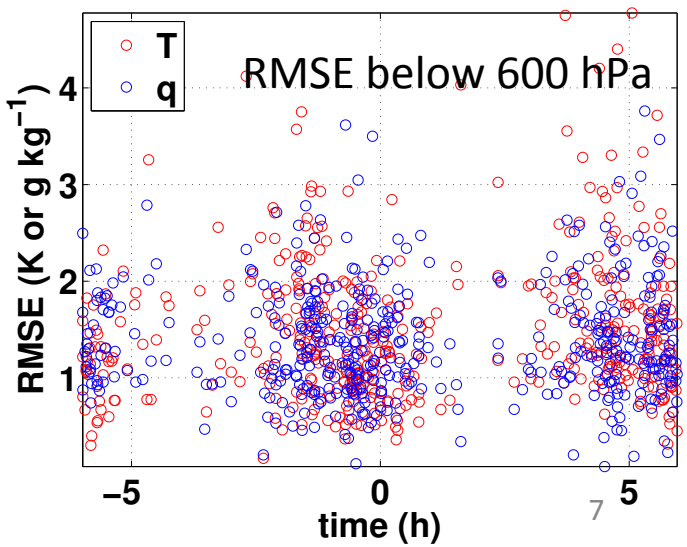
start with 550 sondes

±6 hours and 200 km, cuts out 83 sondes

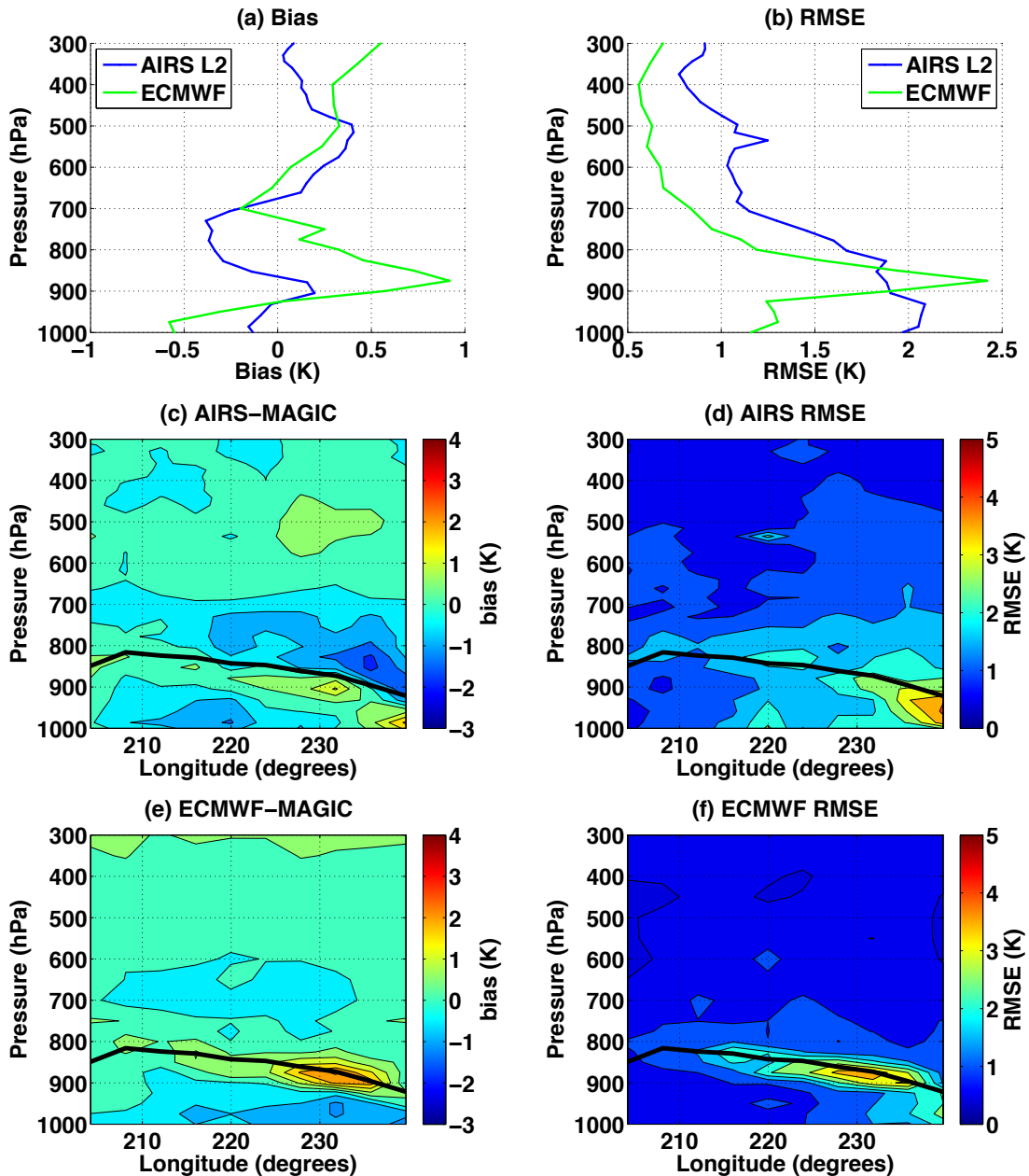
QC 0 or 1; AIRS cuts applied to ECMWF





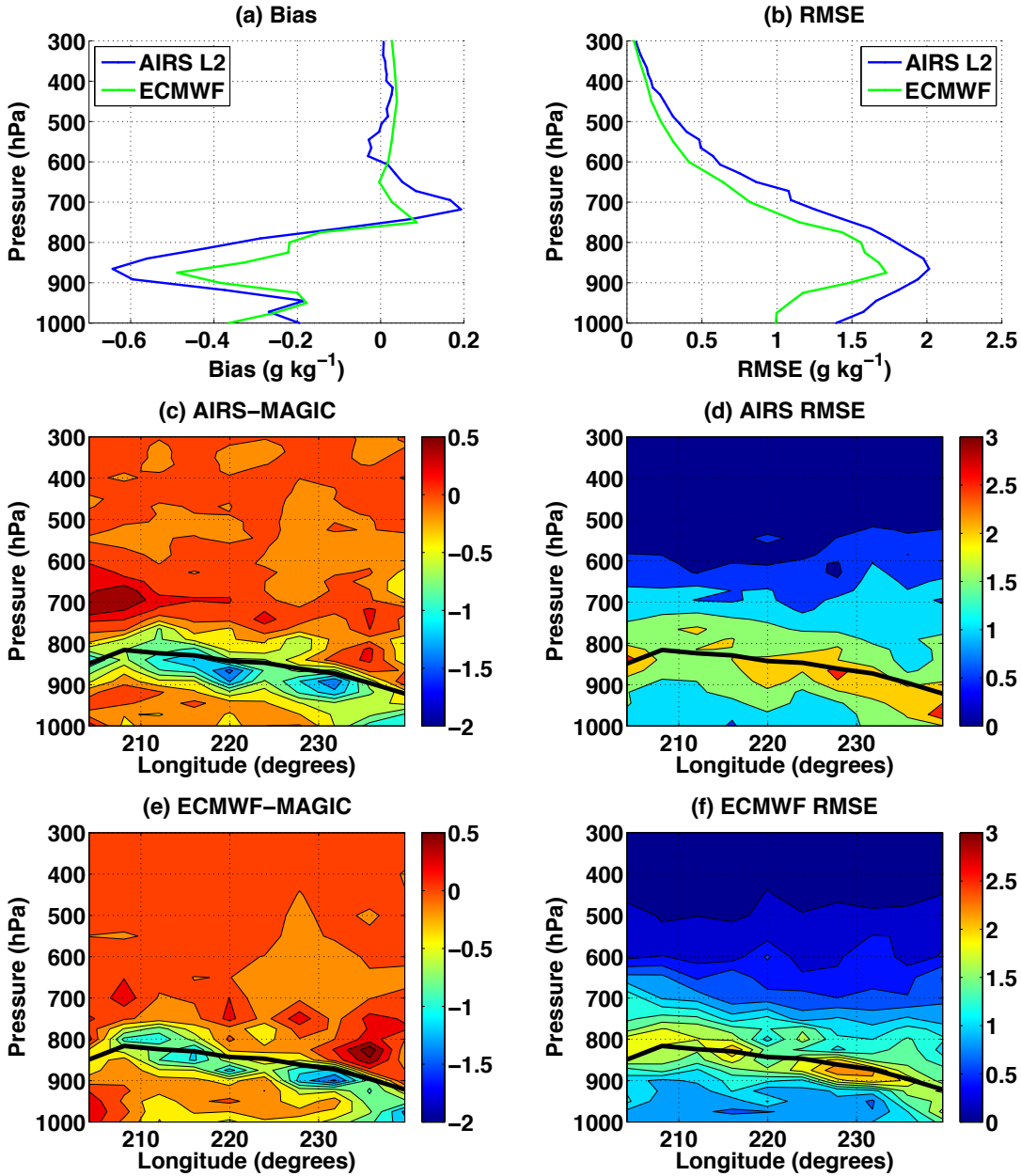


Temperature bias and RMSE



AIRS v6 compares favorably to ECMWF in BL

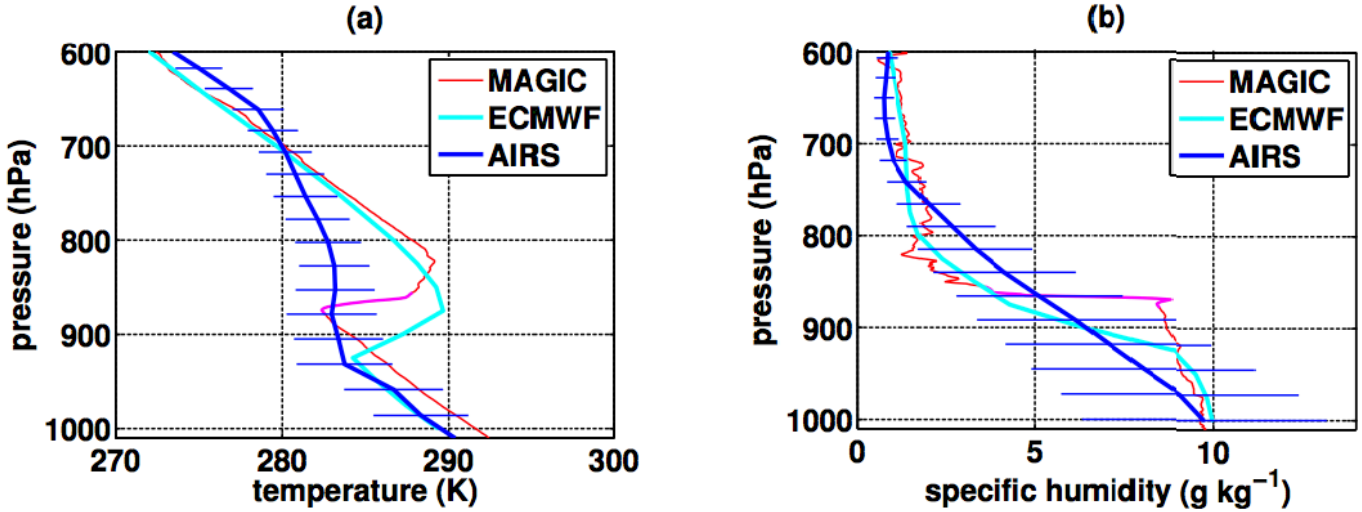
Specific humidity bias and RMSE

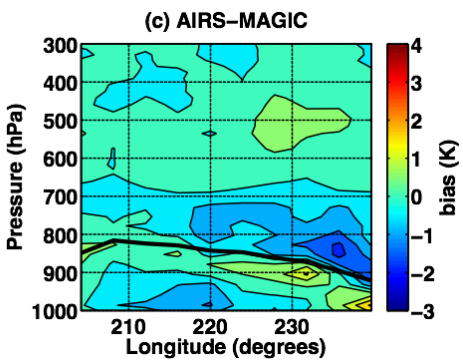


colorbars are g/kg

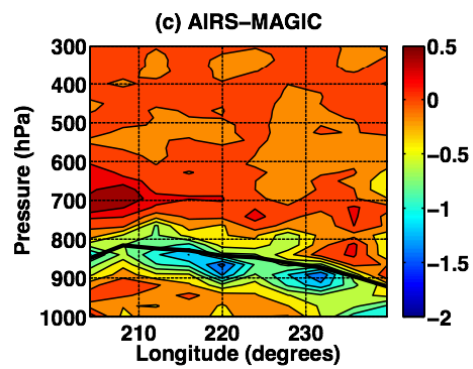
Typical profiles

These profiles help explain features in the contour plots. October 29 (near 23:00 UTC, 225◦ E)

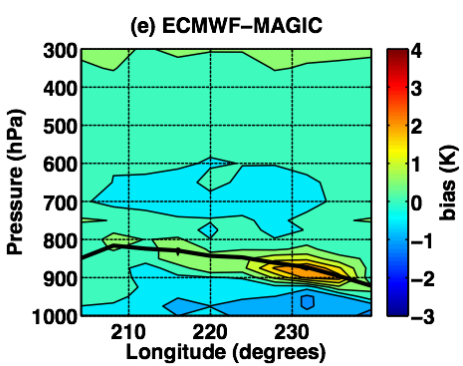




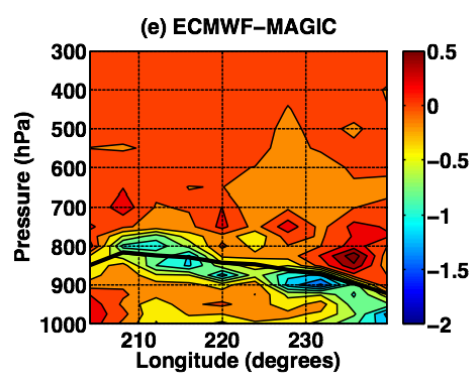
AIRS:
cold bias above BL



AIRS & ECMWF:
wet bias above BL
dry bias below



ECMWF:
warm bias below

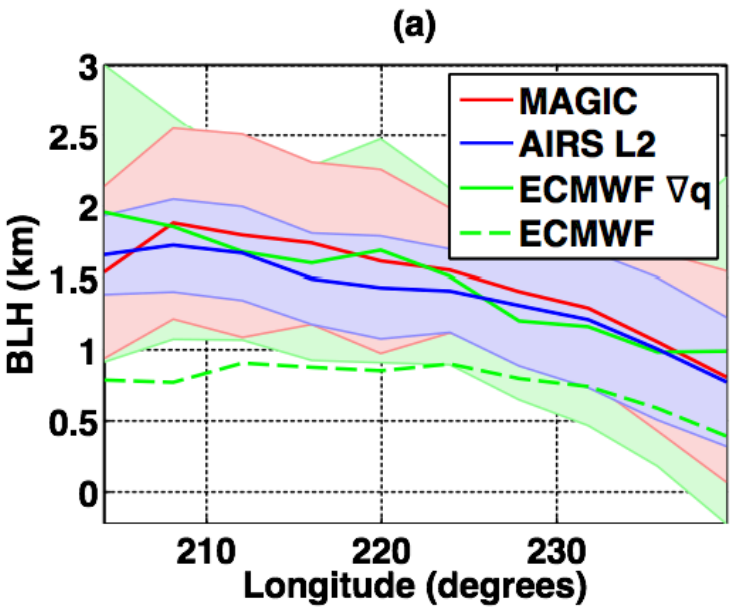


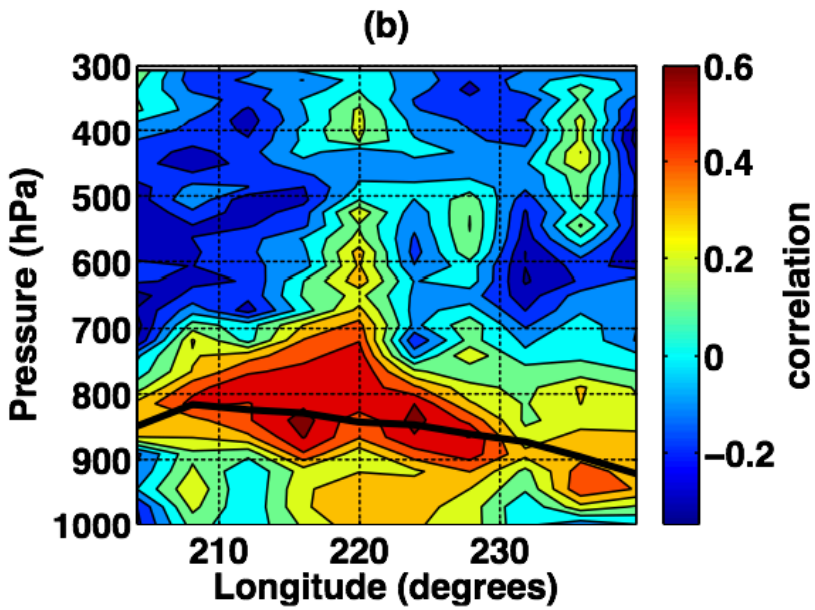
Max errors, in table form

	Max. bias	pressure	Max. RMSE	pressure
AIRS, T	0.4 K	516 hPa	2.1 K	932 hPa
ECMWF, T	0.9 K	875 hPa	2.4 K	875 hPa
AIRS, q	$-0.6\,\mathrm{g\ kg^{-1}}$	866 hPa	$2.0\,\mathrm{g\ kg^{-1}}$	866 hPa
ECMWF, q	$-0.5\,\mathrm{g\ kg^{-1}}$	875 hPa	$1.7\,\mathrm{g\ kg^{-1}}$	875 hPa
[7], T	-0.7 K	600 hPa	1.5 K	560 hPa
[7], q	$-2.0\,\mathrm{g\ kg^{-1}}$	1000 hPa	$2.9\,\mathrm{g\ kg^{-1}}$	820 hPa

[7] is Martins et al. 2010, *GRL,* RICO campaign

Boundary layer height



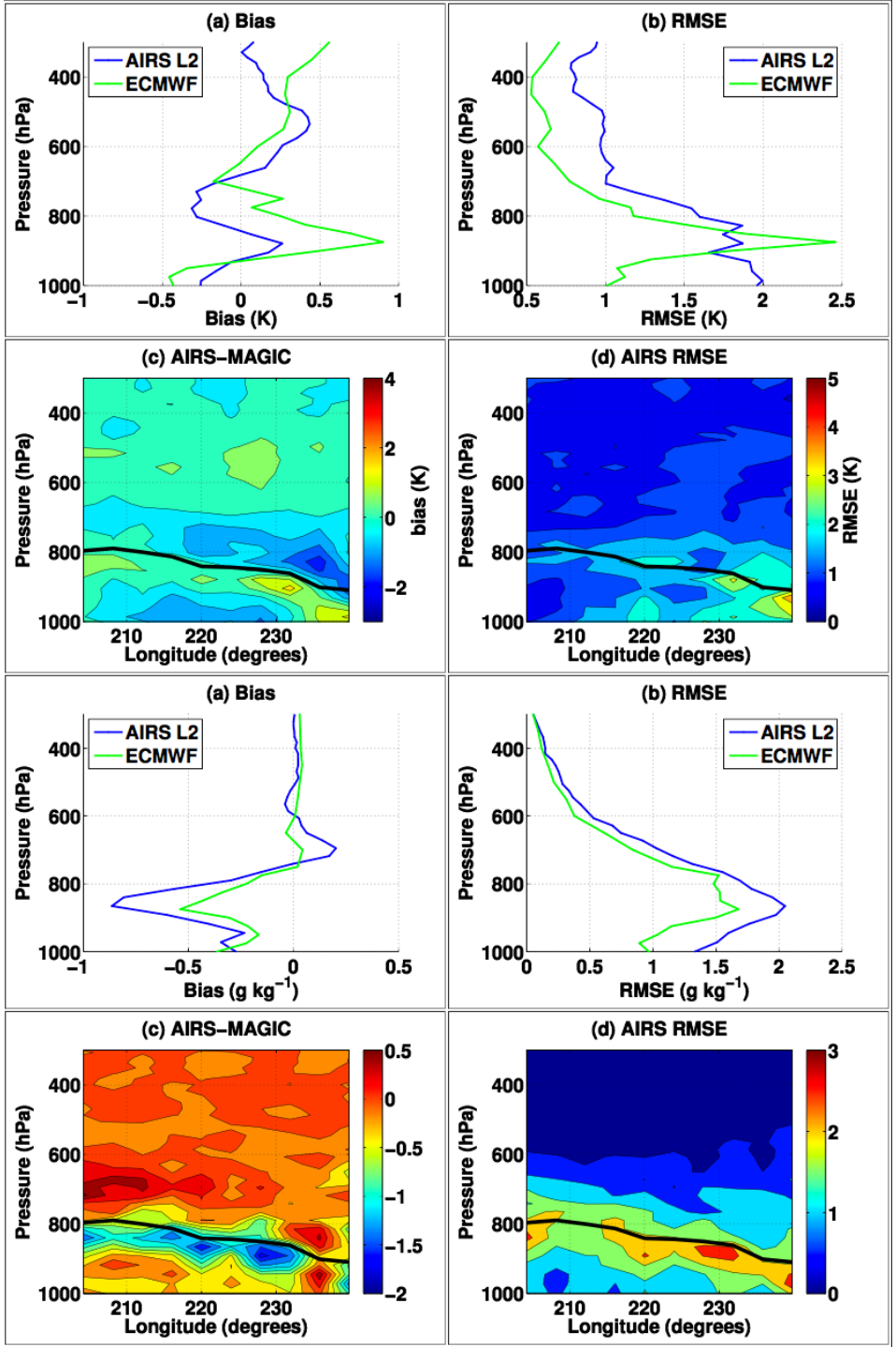


Mean BLH in 10 longitude bins

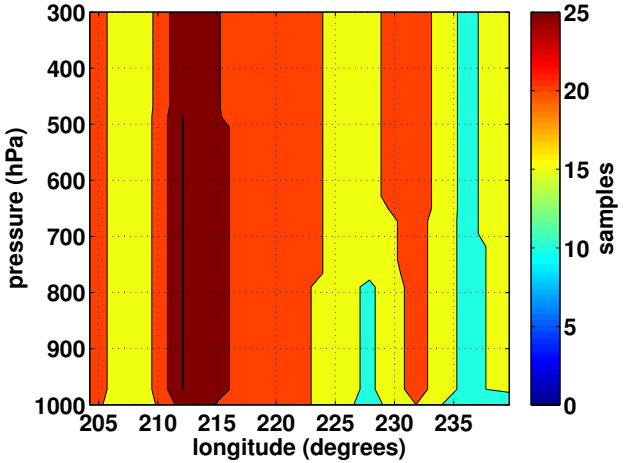
AIRS and ECMWF max grad q
100m and 10m low on average

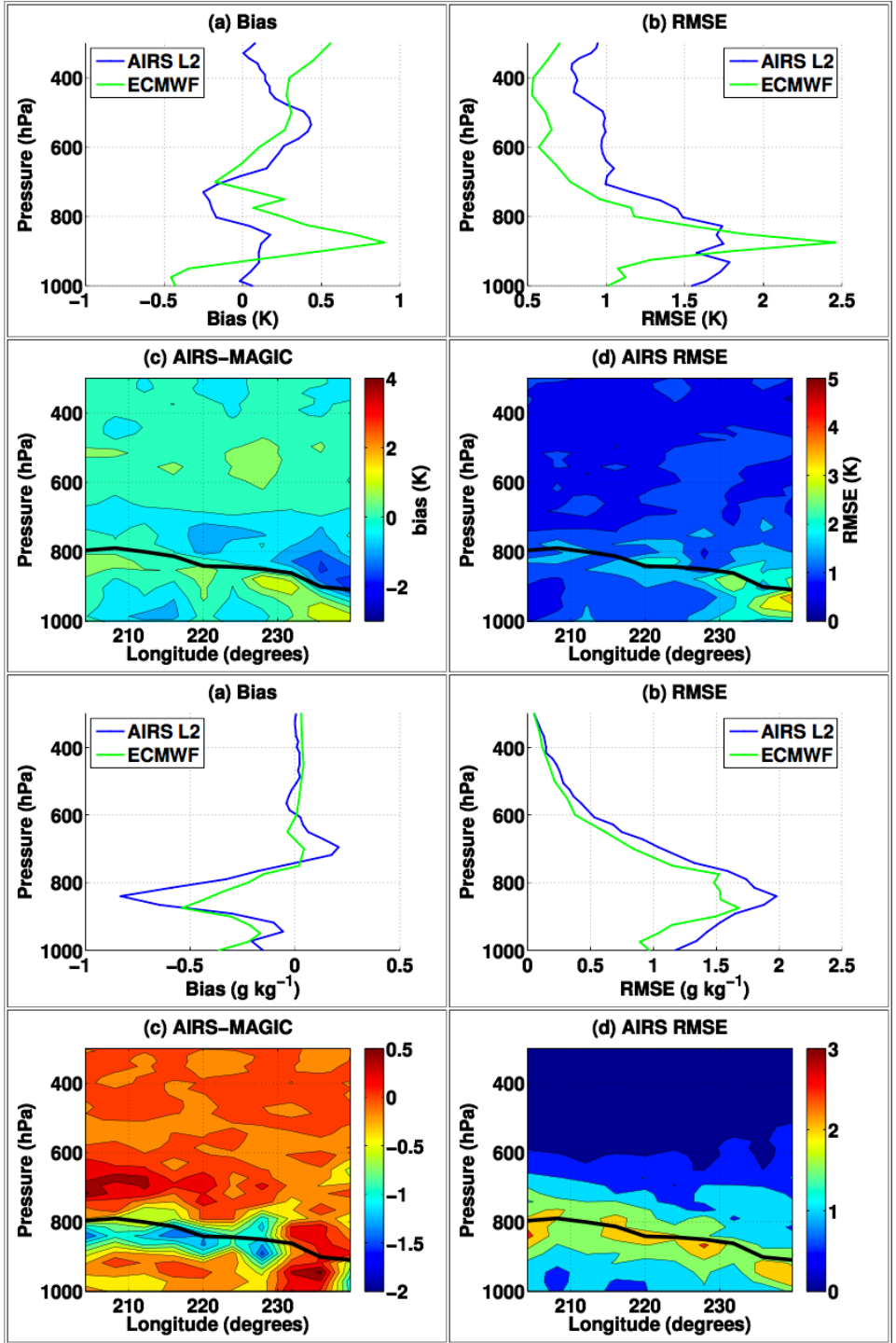
$$r(z) = \frac{1}{n}\sum_{i=1}^{n}\frac{(h_i - \overline{h_i})(q_i(z) - \overline{q_i(z)})}{\sigma_h \sigma_q(z)}$$

Too wet correlates with too high

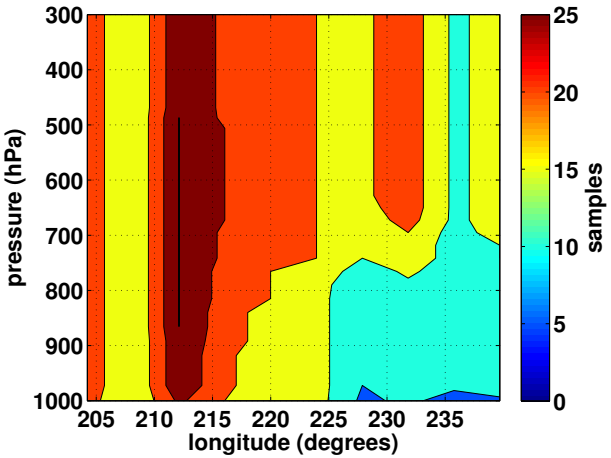

(a) Bias
AIRS L2
ECMWF
Pressure (hPa)
Bias (K)
(b) RMSE
RMSE (K)
(c) AIRS–MAGIC
bias (K)
Longitude (degrees)
(d) AIRS RMSE
RMSE (K)
(a) Bias
Bias (g kg^{-1})
(b) RMSE
RMSE (g kg^{-1})
(c) AIRS–MAGIC
(d) AIRS RMSE

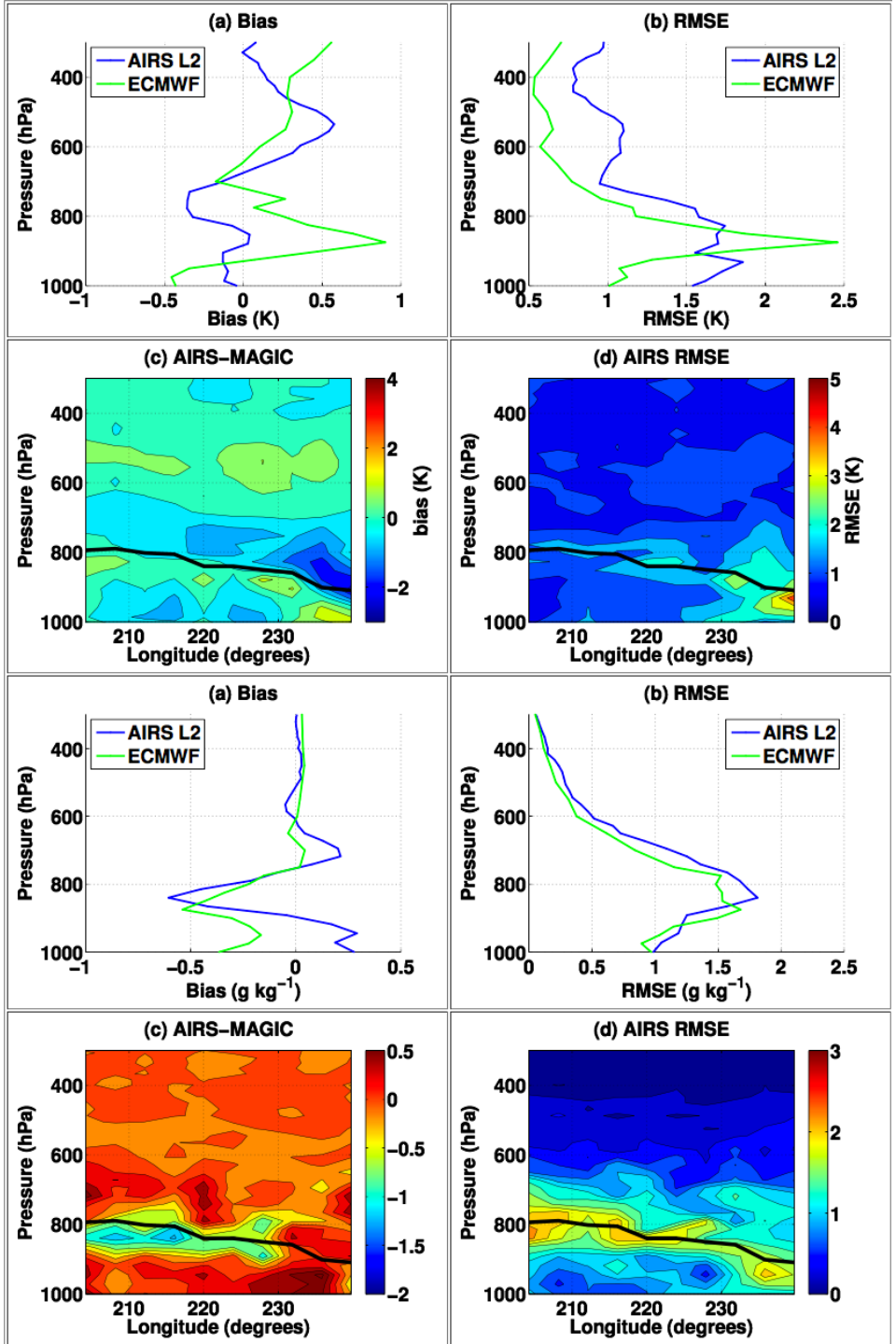
v6


pressure (hPa)
longitude (degrees)
samples

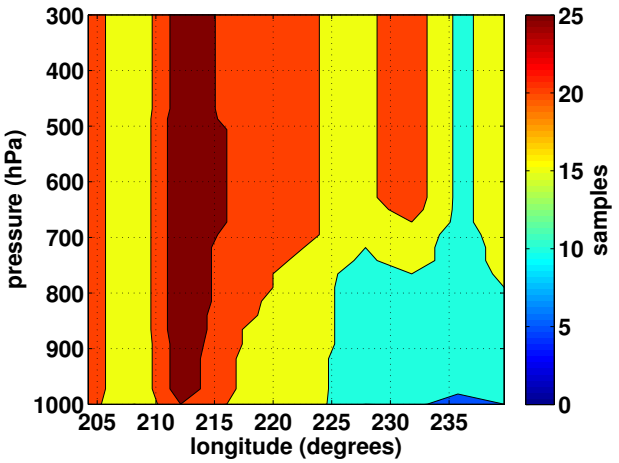

(a) Bias
AIRS L2
ECMWF
Pressure (hPa)
Bias (K)
(b) RMSE
RMSE (K)
(c) AIRS–MAGIC
bias (K)
Longitude (degrees)
(d) AIRS RMSE
RMSE (K)
(a) Bias
Bias (g kg^{-1})
(b) RMSE
RMSE (g kg^{-1})
(c) AIRS–MAGIC
(d) AIRS RMSE

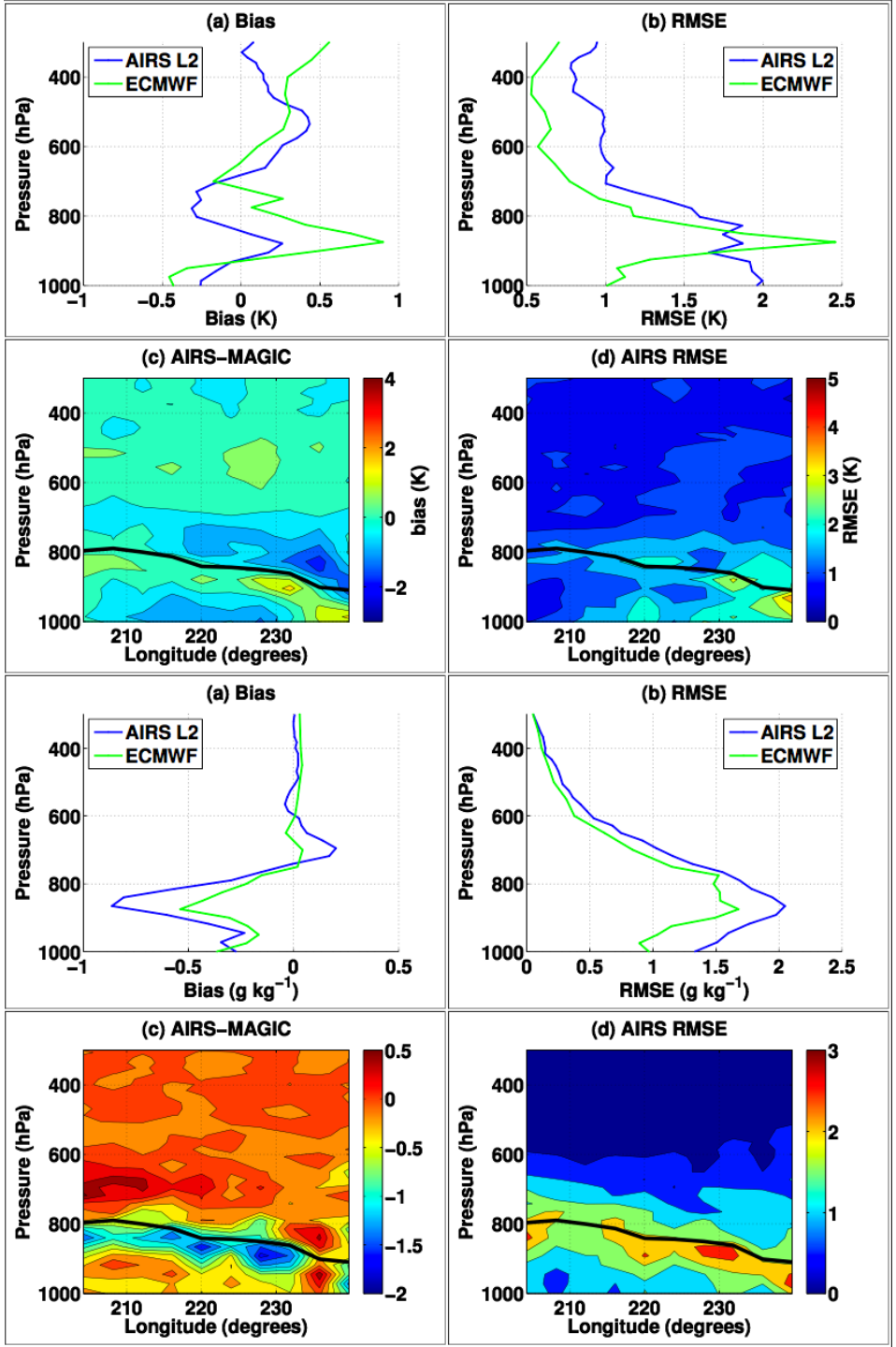
v6.1


pressure (hPa)
longitude (degrees)
samples

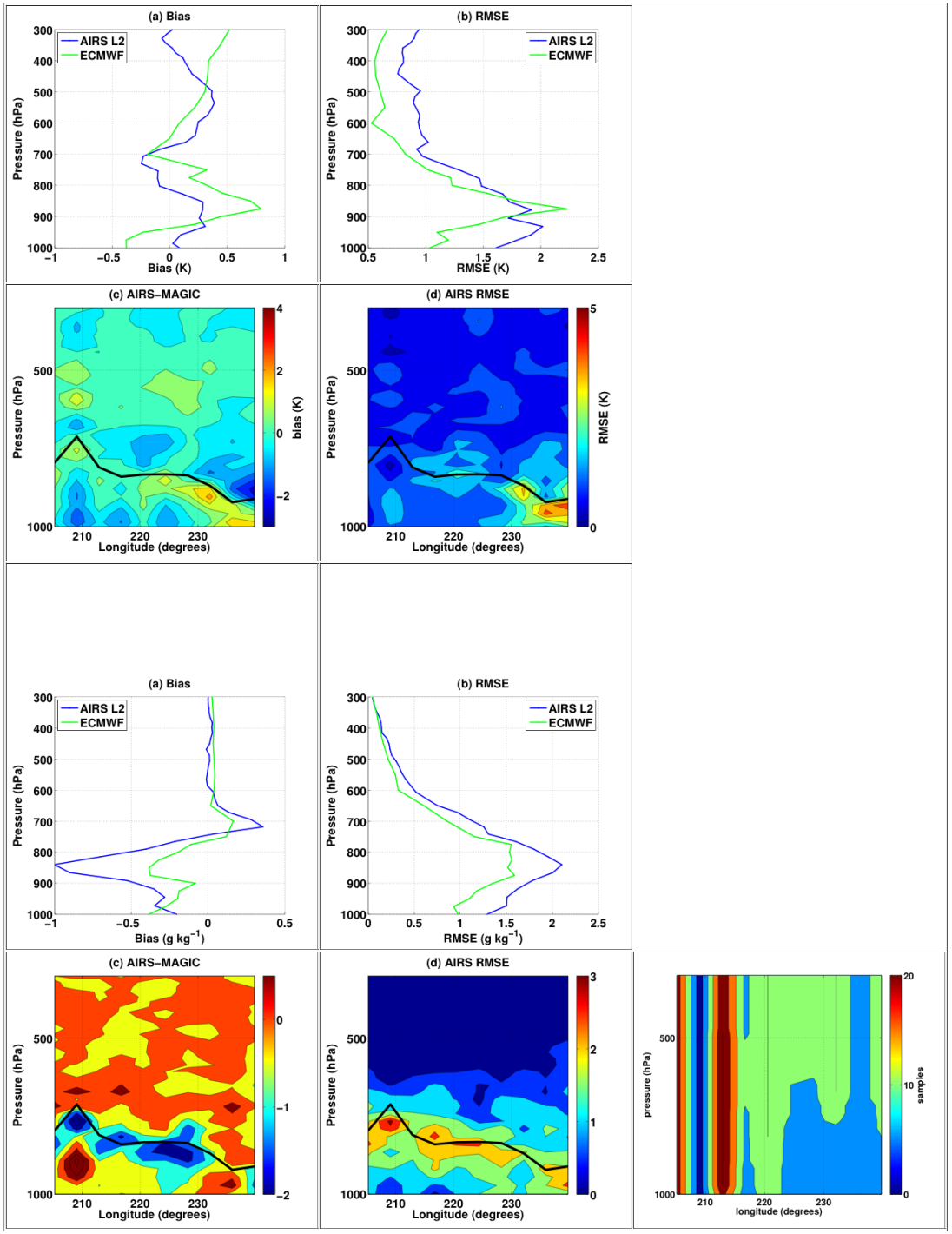

(a) Bias
AIRS L2
ECMWF
Pressure (hPa)
Bias (K)
(b) RMSE
RMSE (K)
(c) AIRS–MAGIC
bias (K)
Longitude (degrees)
(d) AIRS RMSE
RMSE (K)
(a) Bias
Bias (g kg^{-1})
(b) RMSE
RMSE (g kg^{-1})
(c) AIRS–MAGIC
(d) AIRS RMSE

v6.19


pressure (hPa)
longitude (degrees)
samples

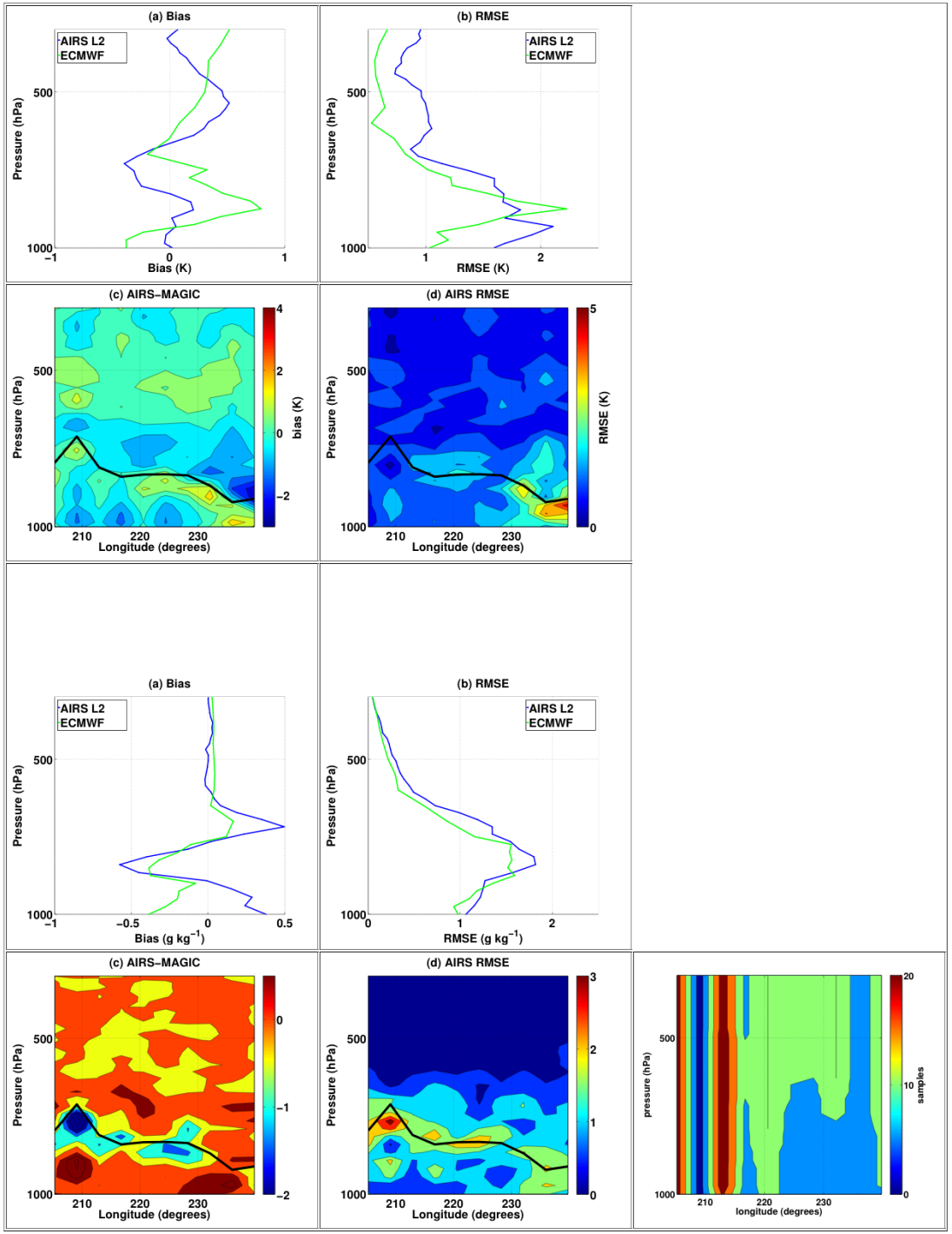

(a) Bias
AIRS L2
ECMWF
Pressure (hPa)
Bias (K)
(b) RMSE
RMSE (K)
(c) AIRS–MAGIC
bias (K)
Longitude (degrees)
(d) AIRS RMSE
RMSE (K)
(a) Bias
Bias (g kg^{-1})
(b) RMSE
RMSE (g kg^{-1})
(c) AIRS–MAGIC
(d) AIRS RMSE

v6



v6.1 day only

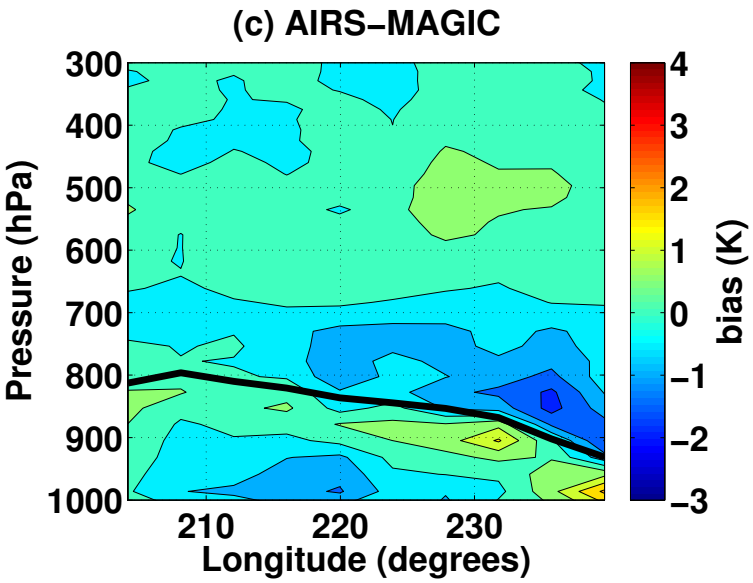
note dry bias
in lower trop

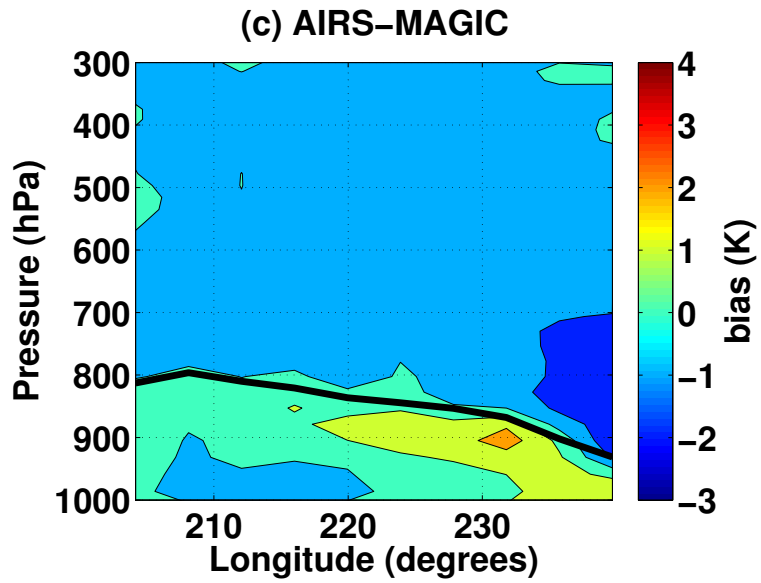


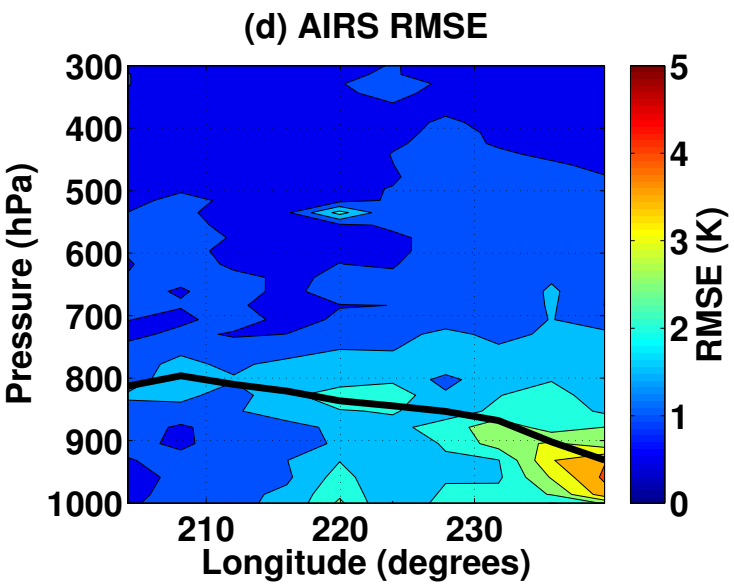
v6.19 day only

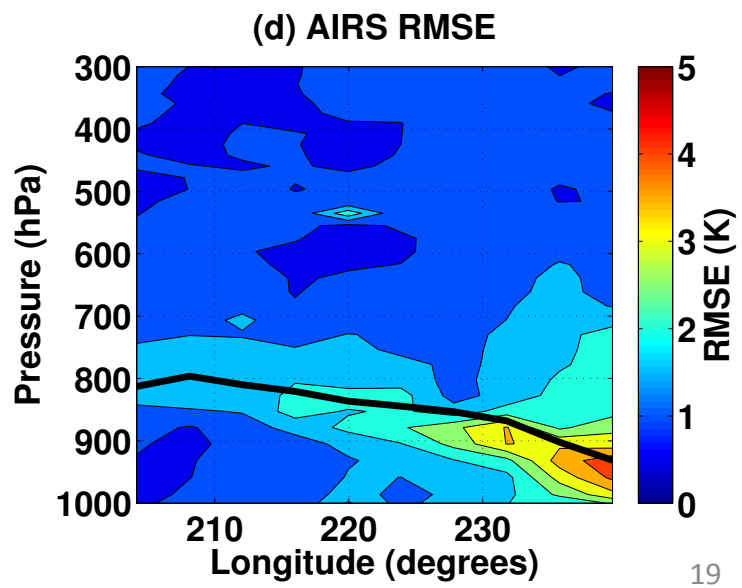
v6 L2 retrieved (TAirSup)

TAirSCCNN

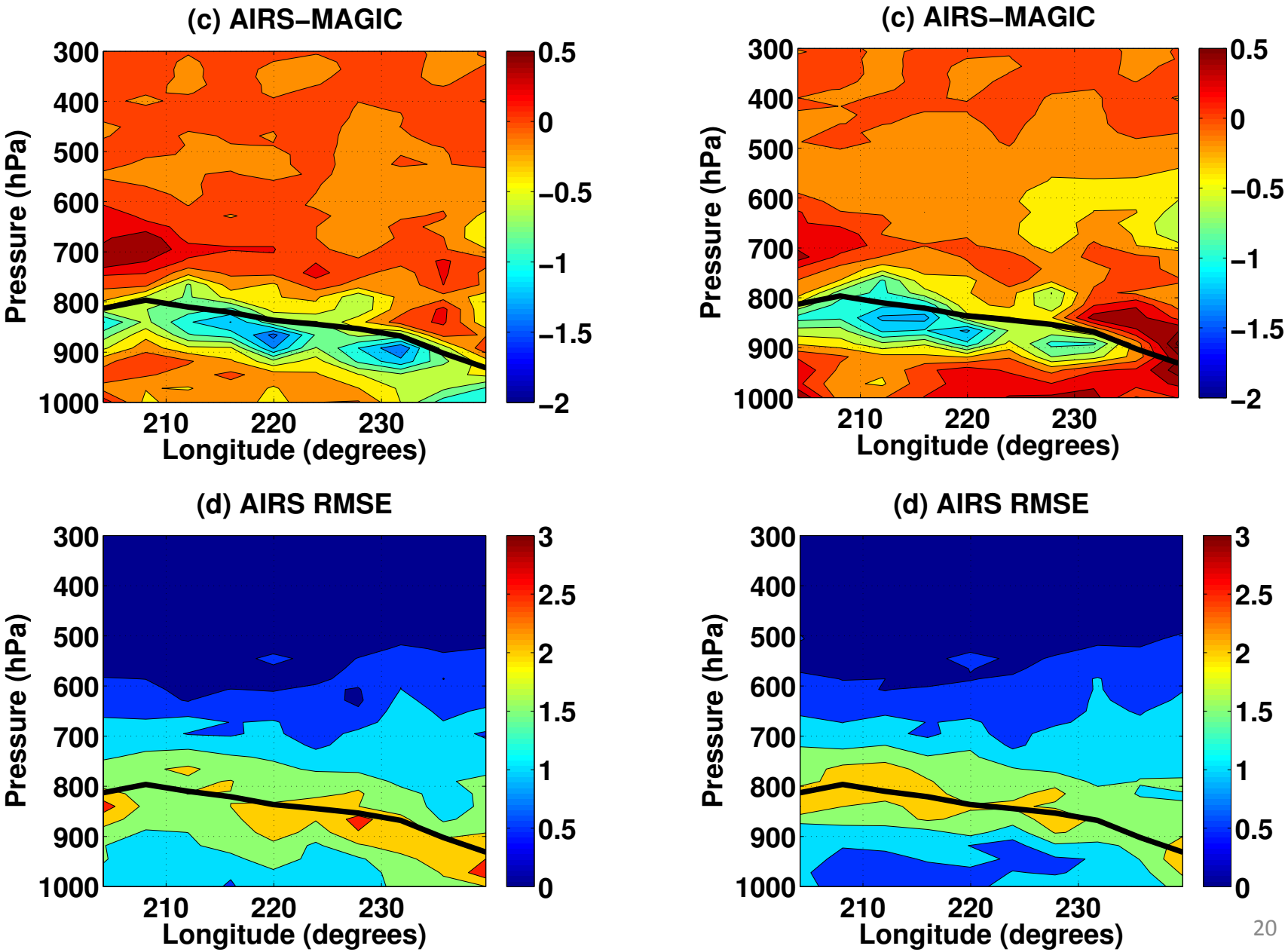








v6 L2 retrieved (H2OCDSup) H2OCDSCCNN



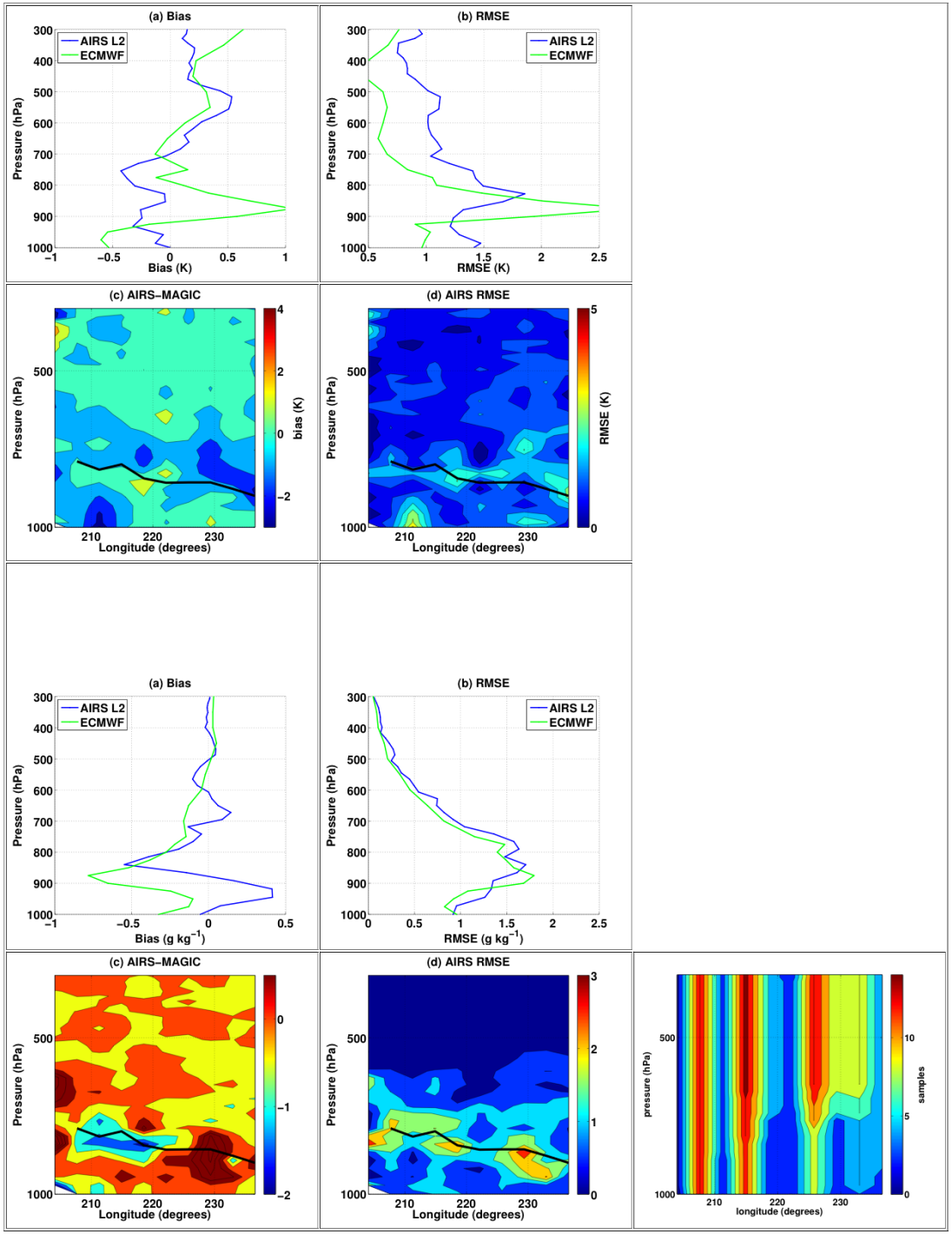
Yesterday I ran v6.19 a priori to compare to v6.19 retrieval,
but the figures are sitting on a server that's down for maintenance.

Summary

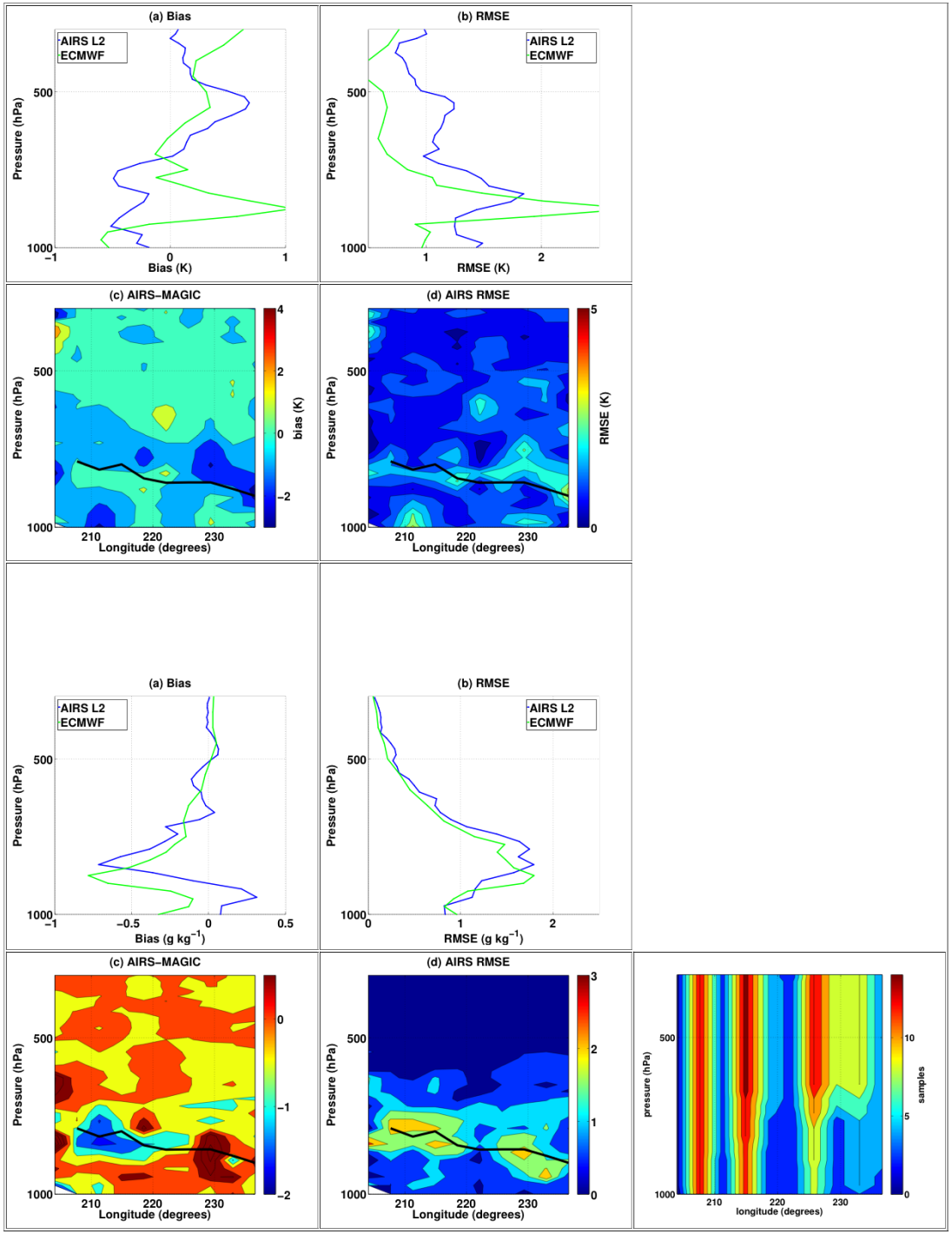
- MAGIC sondes:
  - a unique validation data set over an interesting region
  - a good way to get a quick ``sanity check'' validation

- In this region:
  - Neither AIRS or ECMWF capture strong inversions
  - ECMWF a bit better than AIRS v6, except BL temperature
  - AIRS v6.19 a bit better than ECMWF

- I'm happy to help anyone use the sondes, or other MAGIC data sets.



v6.1 night only



v6.19 night only