Requirements for utilization of radiance data in climate analysis

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What is a *Fundamental* Climate Data Record (FCDR)?

To what extent should inter-calibration be carried out for climate use of radiance records?

A reanalysis centre carrying out radiance assimilation requires:

•uniform calibration (or re-calibration) of records from individual satellites, adjusting for instrumental drifts only if they cannot be modelled

•metadata and modelling of instrument characteristics to enable mapping from assimilation-model values to what is actually measured

•software (RTTOV, CRTM, …) to enable mapping from model values to what is actually measured

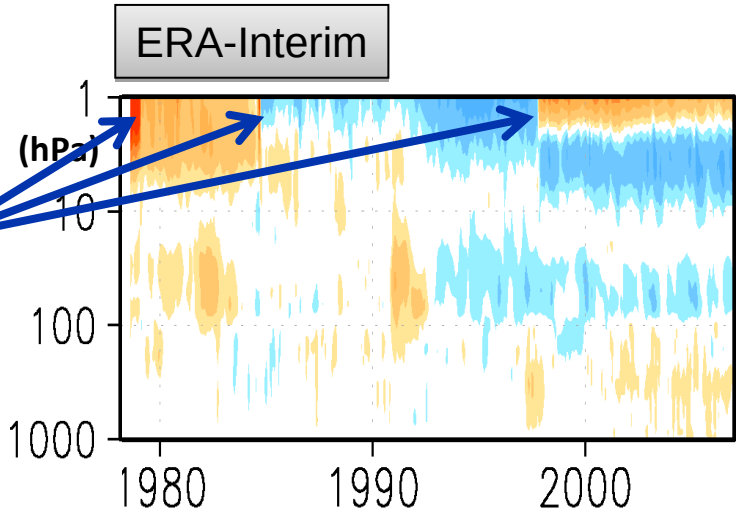
•inter-calibration (through SNO technique or variational bias correction) only to the extent that inter-satellite differences cannot be modelled

and progress is likely to be iterative

Do other climate users of FCDRs for these radiances have simpler requirements for inter-calibrated records?

Improvement in assimilation of uppermost sounding SSU and AMSU radiances

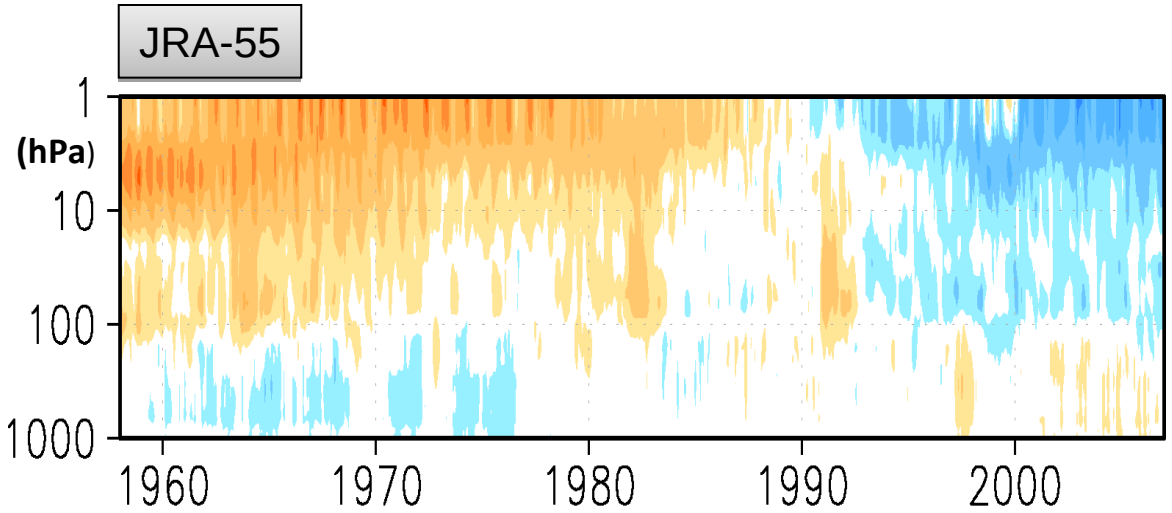
Three large discontinuities above 10hPa associated with start of SSU-3 assimilation, shift to NOAA-9 and introduction of AMSU A



June 2006 version of ECMWF assimilation system

No allowance for inter-satellite SSU cell-pressure differences in RTTOV

No variational bias adjustment for SSU-3 (up to 1998) and AMSU A-14 (from 1998)



December 2009 version of JMA assimilation system

Allowance for inter-satellite SSU cell-pressure differences in RTTOV (Kobayashi et al., 2009)

Variational bias adjustment for all SSU and AMSU A channels

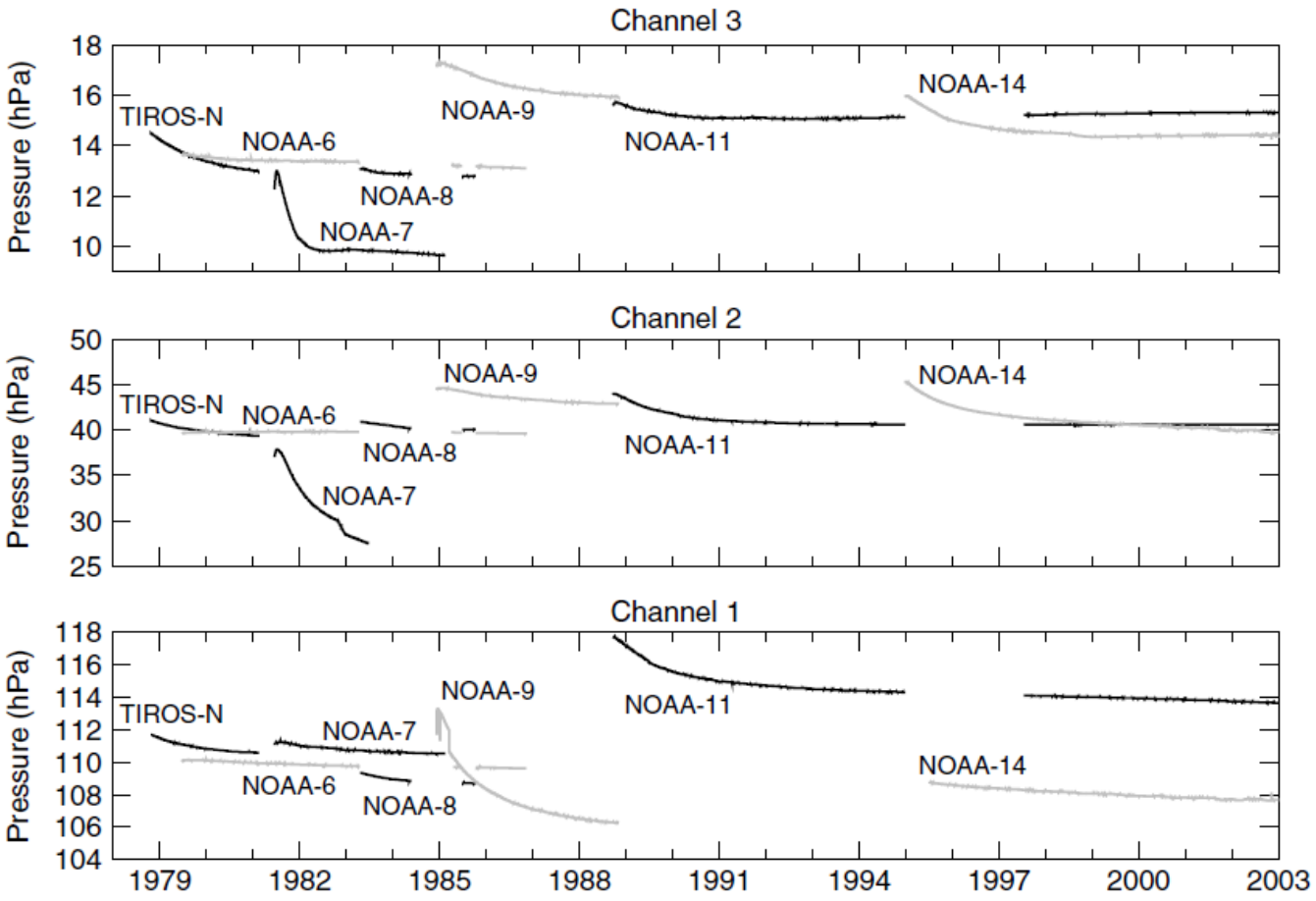
Temperature anomalies relative to 1980 to 2001

−5 −4 −3 −2 −1 −0.4 0.4 1 2 3 4 5

Plots presented by K. Onogi to CGMS

Variations in pressures of CO_2 cells in SSU PMR

From Kobayashi et al. (2009)



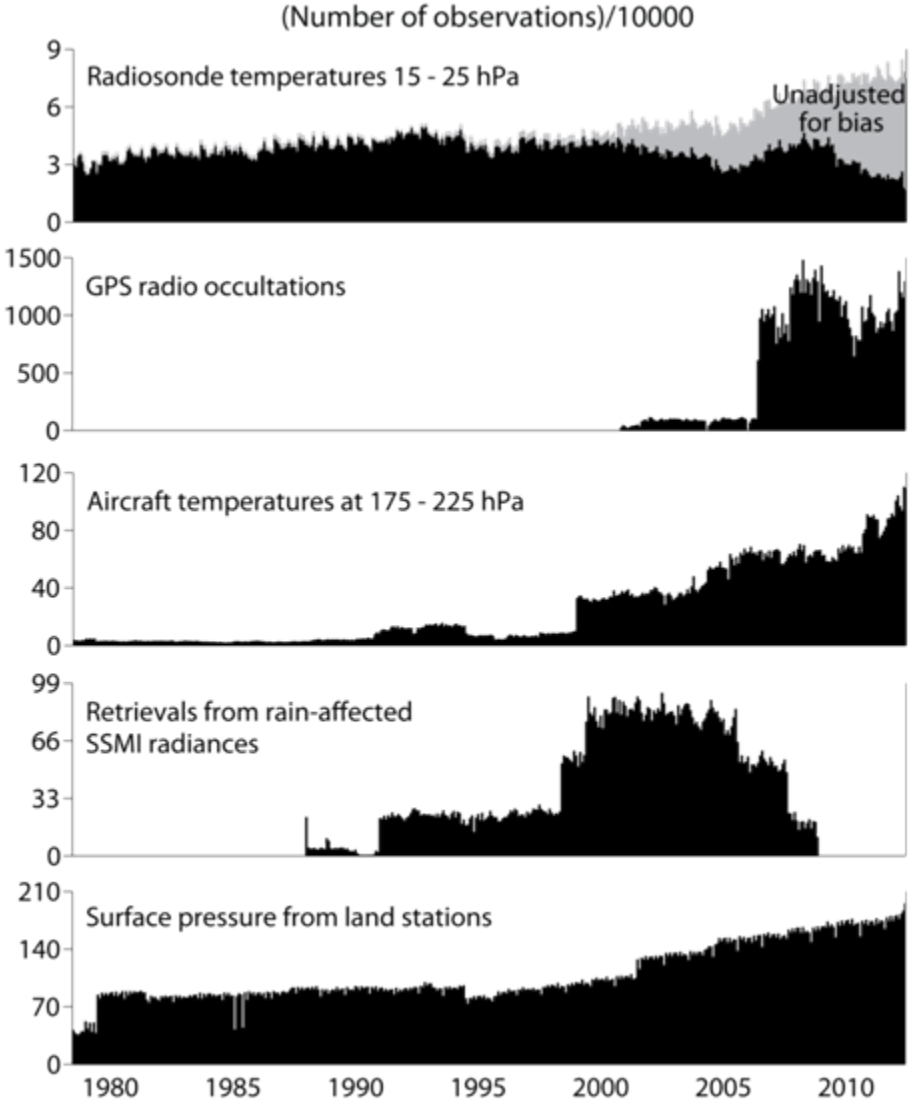
NOAA-9, -11 and -14 instruments have higher cell pressures

NOAA-7 instrument leaked CO_2, others may have lost H_20

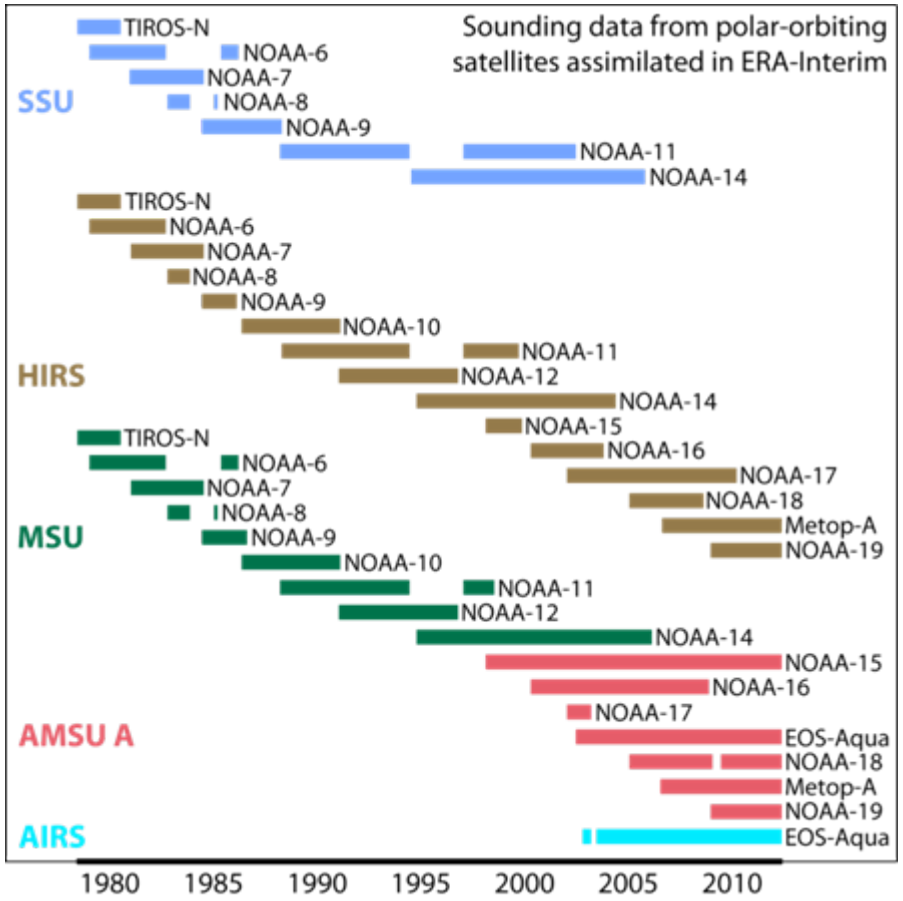
ERA-Interim bias adjustment accounts for differences between NOAA-9, -11 and 14

Best handled through modelling of radiances (RTTOV, …), as adjustment of radiances to a common cell pressure require knowledge of the temperature

Evolution of the observing system



Some other types of observation assimilated in ERA-Interim

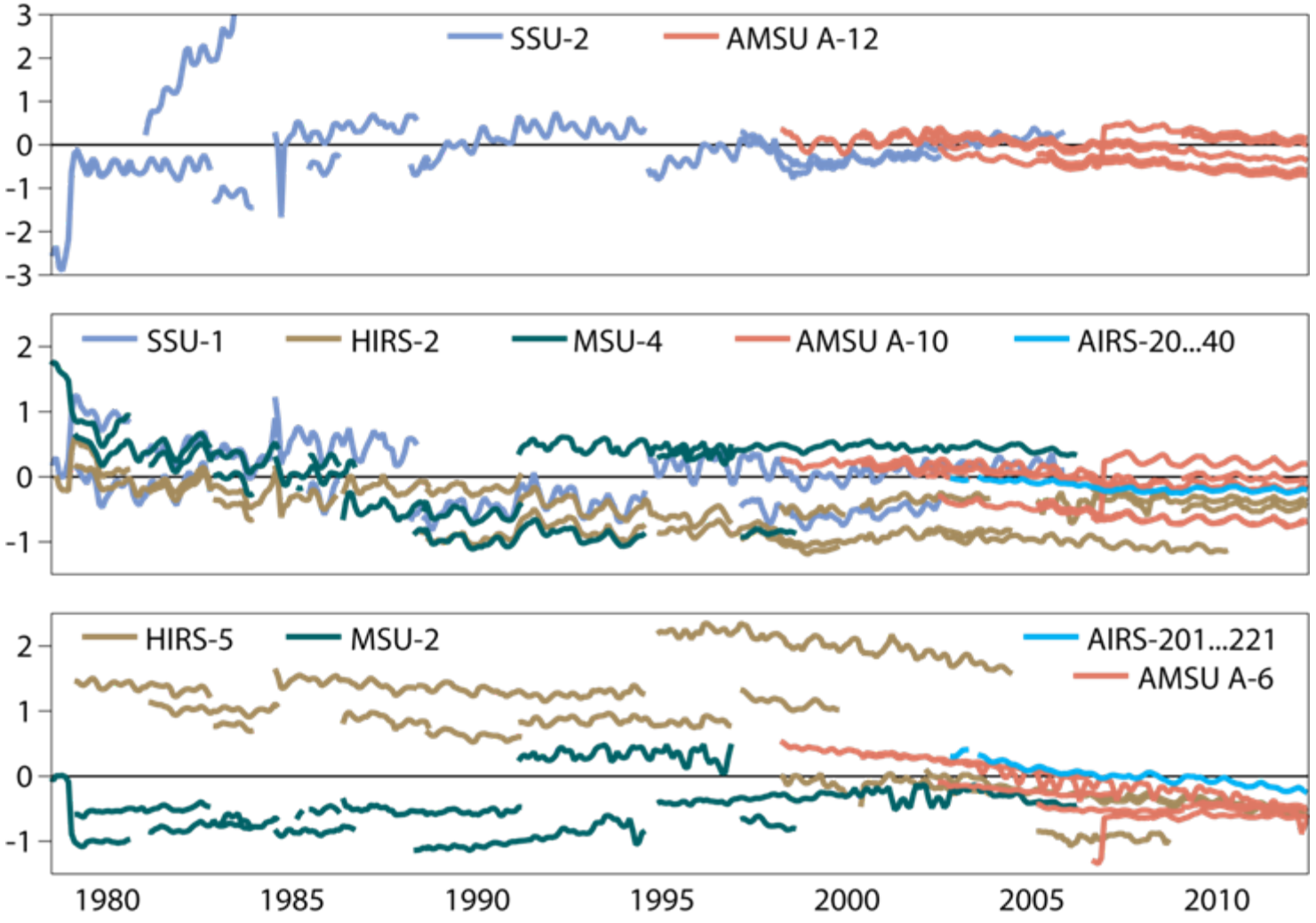


Coverage is for SSU-1, HIRS-2, MSU-4, AMSU-A10, AIRS-40

Data from IASI and NPP could not be used in 2006 version of assimilation system frozen for ERA-Interim. Use of data from Metop-B was not activated in 2012

Data from FY-3 are also a candidate for use in future reanalyses

Bias estimates (K) for some sounding channels used in ERA-Interim



Analysis fits bias-adjusted radiances closely

Key for realism of analysed variability and trends is the reliability of the bias adjustments

Estimates of global-mean biases are shown for tropospheric and lower to middle stratospheric channels

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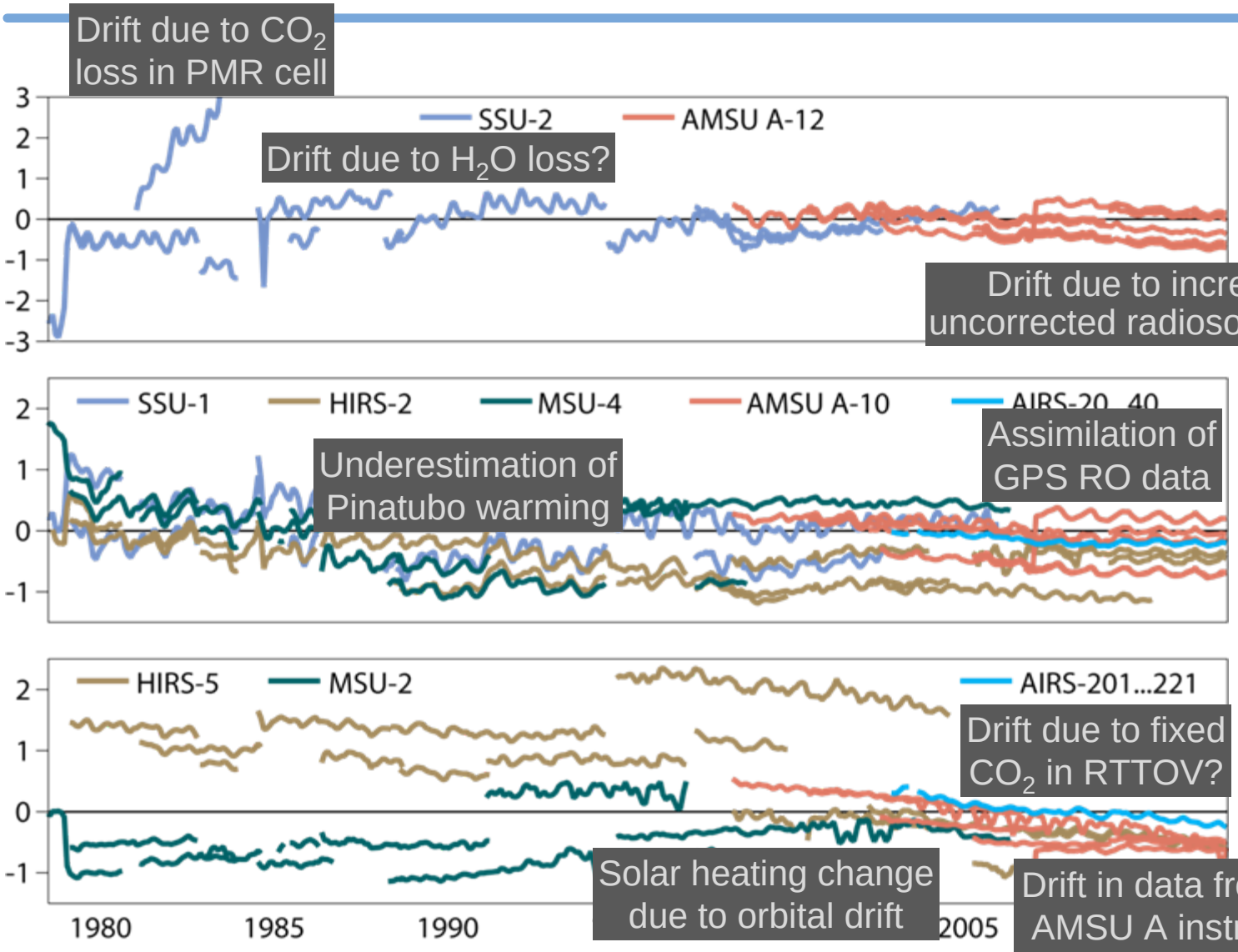

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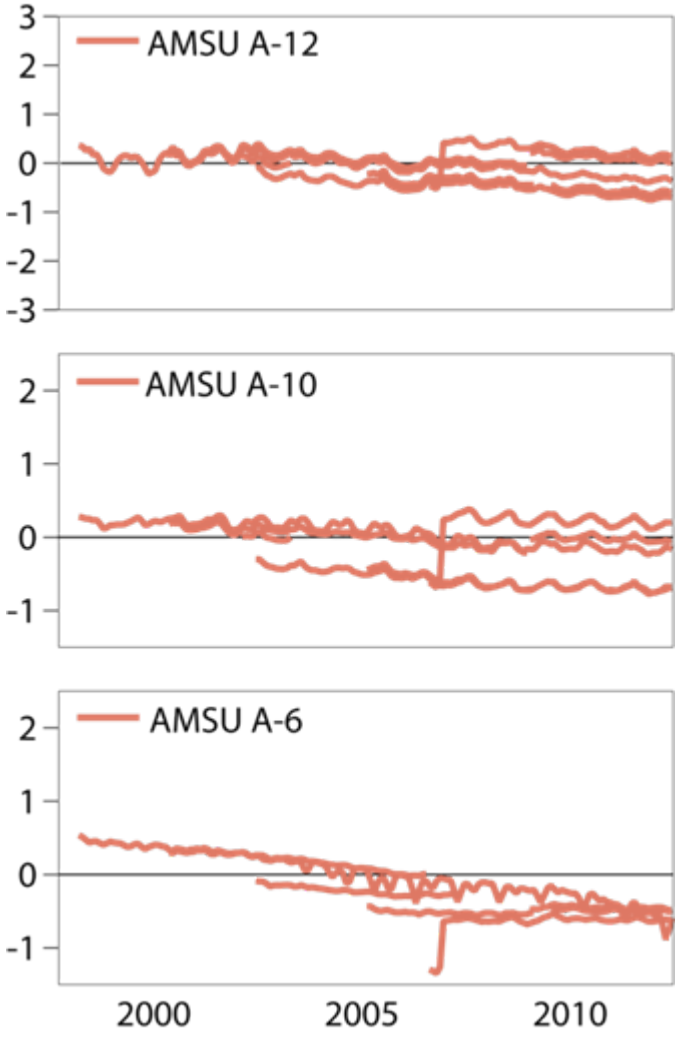
Accounting for frequency shifts for microwave sounders



ERA-Interim bias adjustments show similar drifts for all instruments for higher sounding channels such as 10 and 12. This is likely due to separate problems in the ERA-Interim data assimilation.

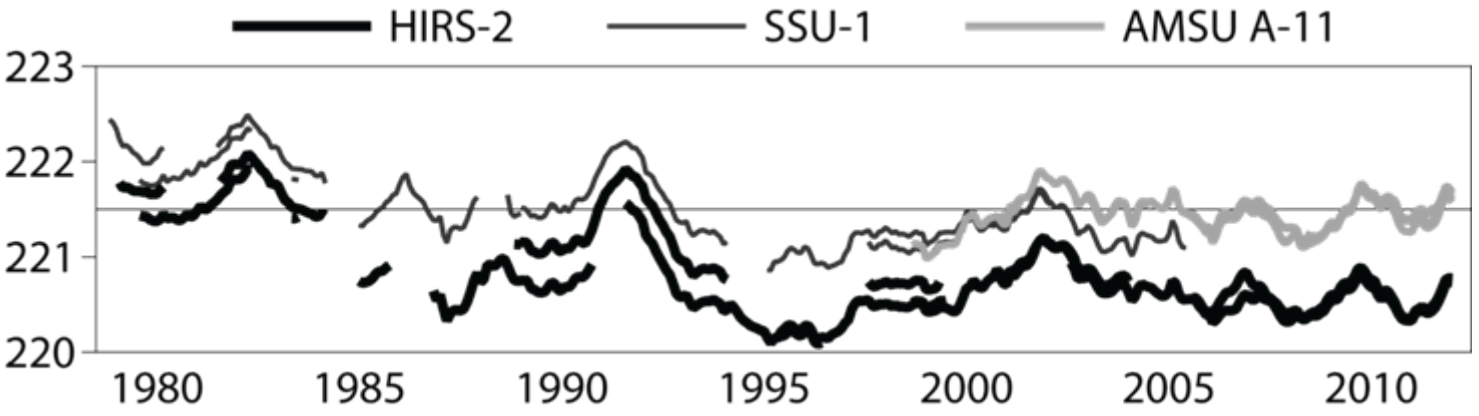
Drifts vary from instrument to instrument for lower sounding channels.

Lu and Bell (2013) argue that this is due to drift in pass-band central frequencies (shown also to be an issue for MSU-3). Frequencies had previously been found to be uncertain for the MTS on FY-3A.

Lu and Bell note that channels 9-14 of AMSU A have active frequency locking

Accounting for drift in the RT modelling used to map from model to measurement improves fit to model observations in various ways

Need for better spectral response functions for HIRS



Plot shows 12-month running means of bias-adjusted brightness temperatures from ERA-Interim. SSU-1 values are reduced by 5.5K.

Variations are largely consistent from instrument to instrument, but different HIRS instruments do not line up especially well.

This may be because of bias due to poorly specified spectral response functions in the RT modelling used to map from model to measurement (RTTOV). Such bias would be compensated by unphysical adjustment of measured values.

What are the requirements of GSICS for the GCOS Reference Upper-Air Network?