Met Office plans for the development of a climate record from HIRS and IASI

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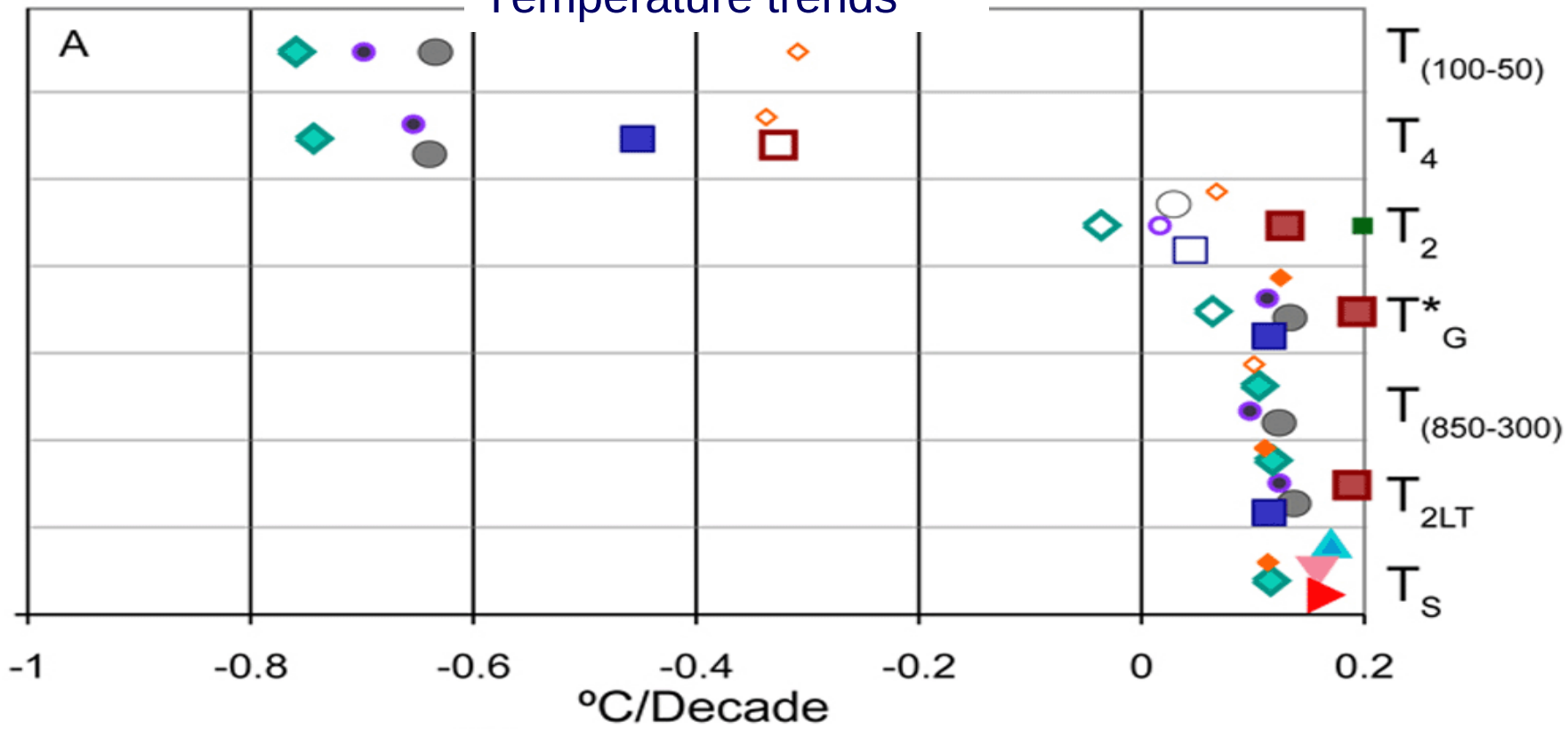
Why observe climate?

- Providing evidence (or not) for policy action (or not)
- Assessing current climate for infrastructure planning.
- Assessing climate variability and change including climate change detection and attribution
- Developing and validating climate models
- Validating long range/short term climate forecasts
- Assessing climate impacts

Temperature trends



1979 - 2004

HadCRUT2v | NOAA/NCDC | HadAT | RSS | ERA-40
NASA/GISS | RATPAC | UAH | VG | NCEP

Squares: Satellite **Circles:** Balloons **Triangles:** Surface only **Diamonds:** Reanalyses

$T_{(100-50)}$: Lower stratosphere | T_4: Lower stratosphere | T_2: Mid to upper troposphere | T^*_T: Tropical troposphere | T^*_G: Troposphere | T_{2LT}: Lower troposphere | $T_{(850-300)}$: Troposphere | T_S: Surface

Source: CCSP Synthesis and Assessment Product 1.1

Objectives

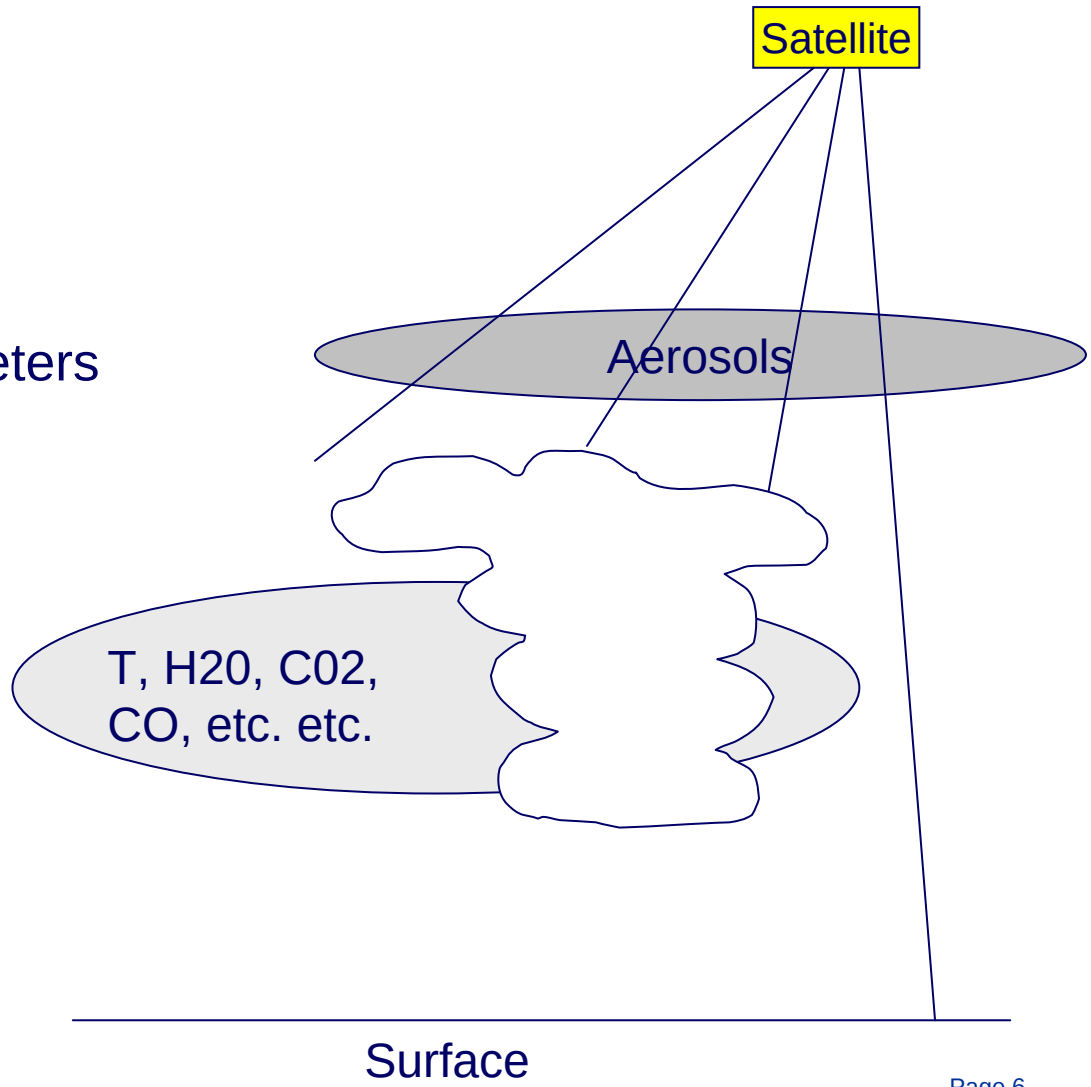
- Provide >30 years of homogenised all-sky IR radiances to:
  - **Quantify and reduce uncertainty in temperature and humidity changes aloft.**
  - **Assess model simulations of recent climate accounting for both model and observational uncertainty.**
  - **Estimate all-sky (and clear-sky) long-wave feedbacks.**
  - **Contribute to the next generation reanalysis projects (e.g. ERA-70)**

Reprocessing IR Sounders for Climate

- Given a possible resource of at least 4.5 person years between 2007-2009:
  - Is it worth doing? Yes
  - What lessons have we learnt from previous efforts?
  - How should it be done for maximum benefit?

Last two questions to direct methodology.

- Climate sensitive parameters
  - Cloud properties (fraction, temperature)
  - Relative Humidity
  - Atmospheric and surface temperature
  - Surface properties
  - Greenhouse Gases
  - Aerosols
- Measurement sensitive parameters
  - Spectral response
  - Radiometric response (gain)
  - Pre and post-launch calibration
  - Fov response (+spatial sampling)
  - Viewing geometry



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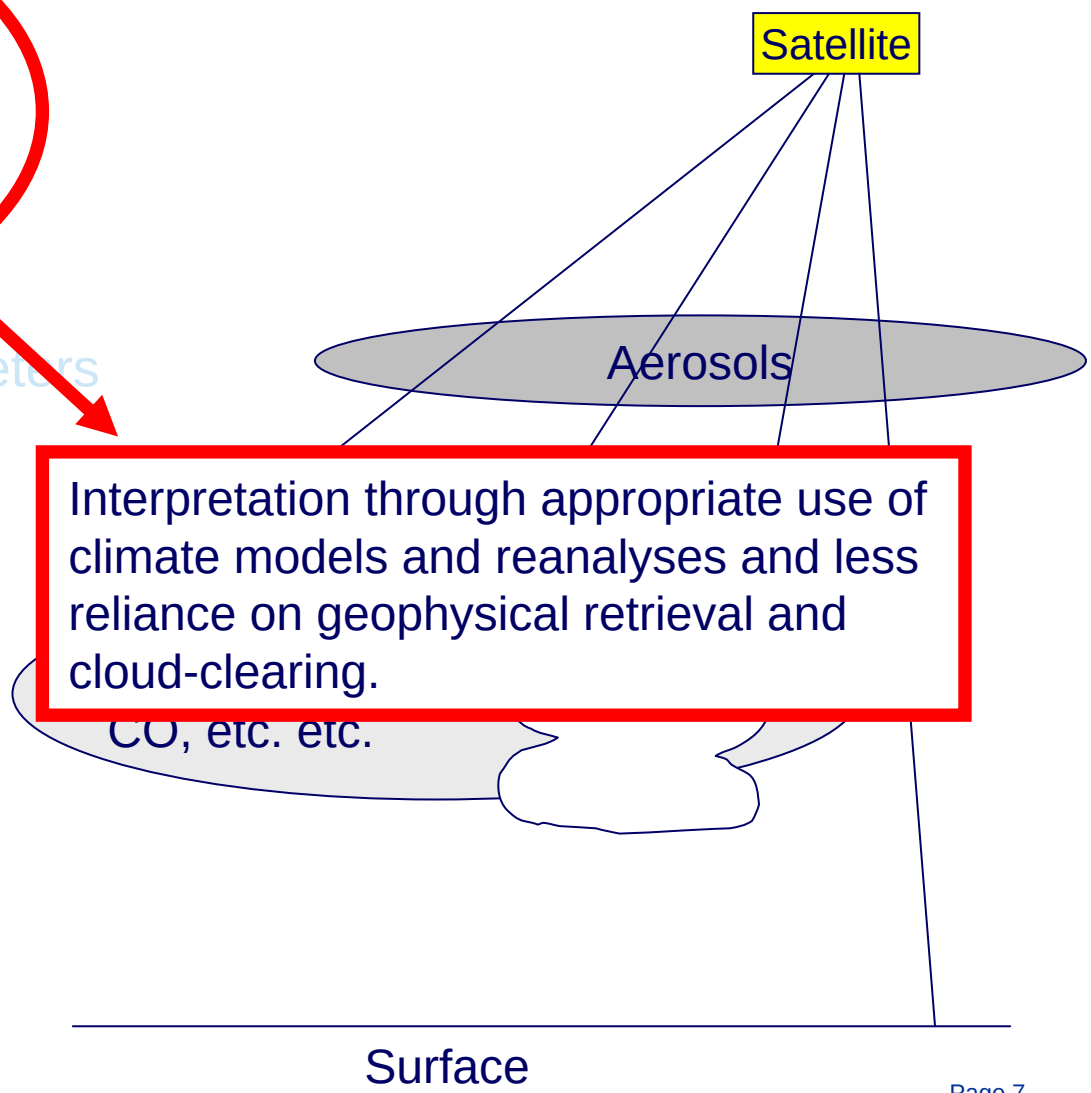

Interpretation through appropriate use of climate models and reanalyses and less reliance on geophysical retrieval and cloud-clearing.

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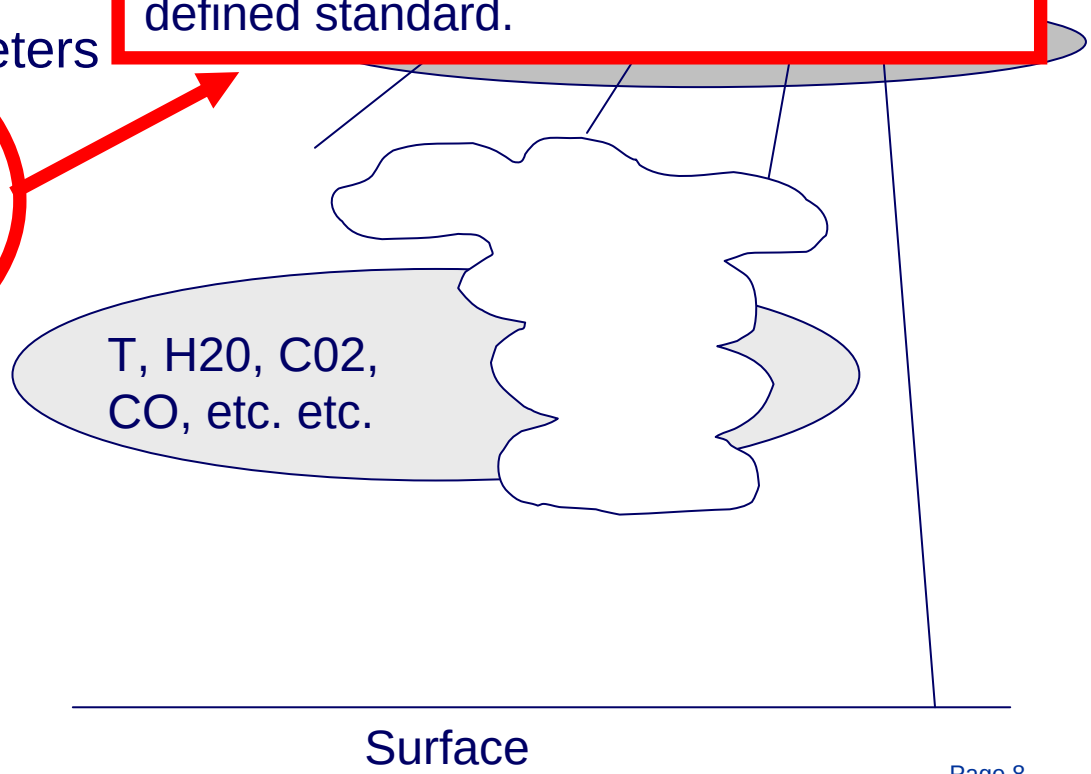
Challenge is to create a data record with static observational properties. E.g. Spectral response, spatio-temporal sampling etc. This requires some “correction” of all observations to a pre-defined standard.



IASIPP for climate

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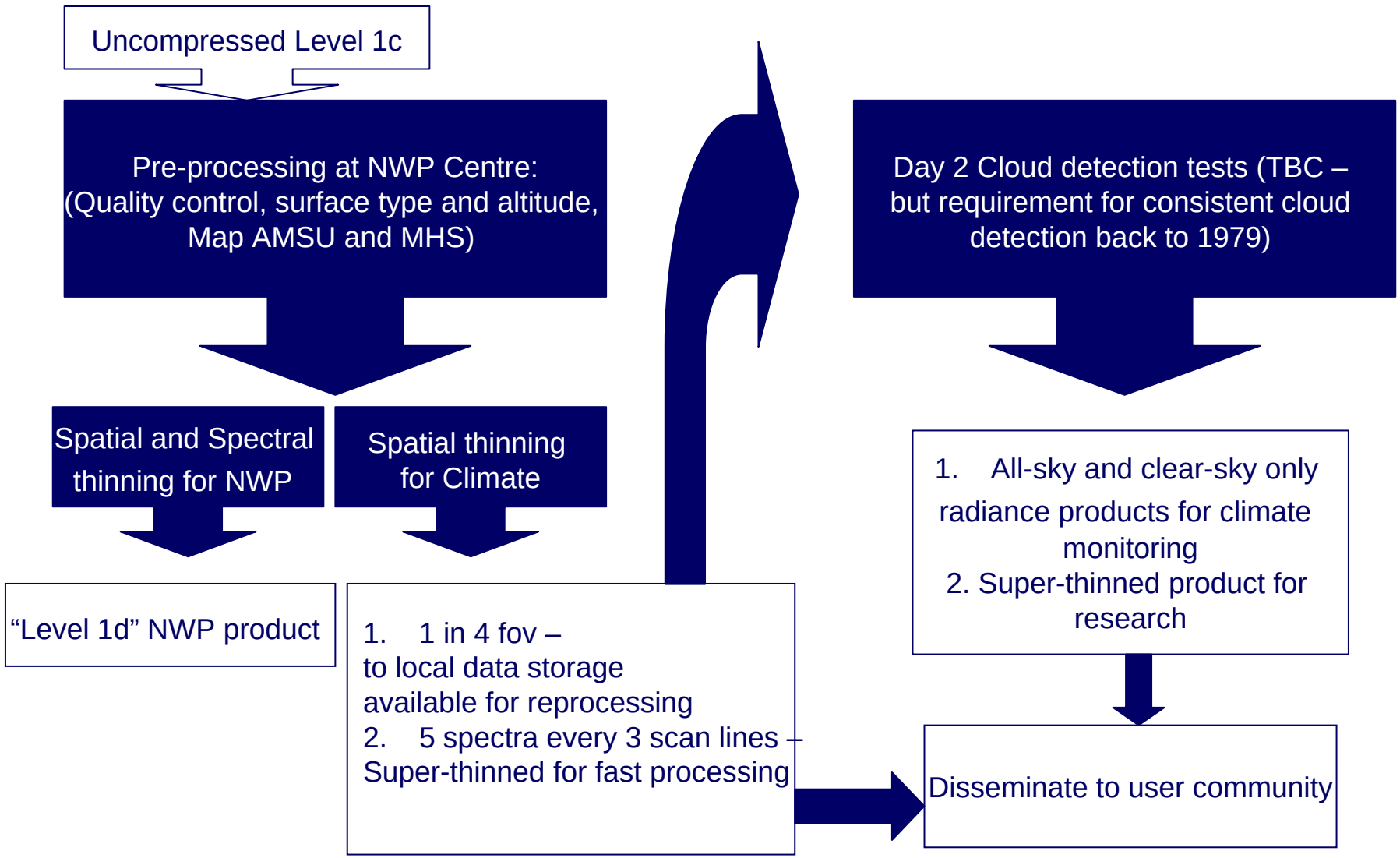
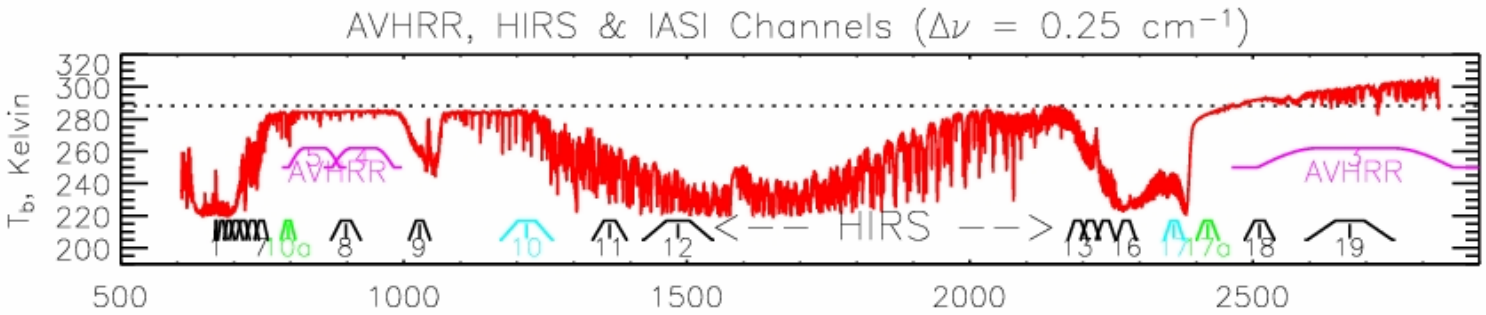


IASIPP for climate



- Climate requirement for continuity of observations.
- MetOp provides opportunity for integration of IASI with the legacy HIRS instrument.
- Provide equivalent HIRS radiance.
  - Comparison to in-orbit HIRS/4.
  - Quantify historical HIRS SRF bias and uncertainty.
  - Maintain continuity of observations 1979-20??

HIRS reprocessing

Changes in channel/filter response

- Some existing methods for calibration:
  1. Forward model the bias from the given HIRS SRF.
     - Fails when SRF poorly characterised.
  2. Compare radiances from GOES and Meteosat.
     - Must account for sampling errors and different SRF.
  3. Calibrate to AIRS/IASI radiances
     - Lack of historical observations and same problems as 1.
  4. SNO
     - Mostly arctic atmospheres used – N8-N9 difficult
  5. Correct bias in aggregated values.
     - Mask non-linear effects. Too crude for some applications?

HIRS - reprocessing

- Level 1b with consistent calibration. Cloud detection consistent with IASIPP both all-sky and clear-sky only radiances to be considered.

- Step 1 – Estimation of known biases
  - Spectral Response – Using given instrument specifications.
  - Orbit decay – Affecting off-nadir views, simulate radiance and correct as function of viewing geometry.
  - Orbit drift – Requires good estimate of diurnal cycle. Use Geo's and models.
  - Changing FOV
  - Others (e.g. SSU interference)

HIRS - reprocessing

- Step 2 – Residual biases
  - Utilise satellite overlaps to quantify remaining biases (e.g. SNO)
  - Attribution of remaining biases:
    - Poor calibration
    - Poorly defined SRF
    - Inadequate bias correction
    - Others…
  - Challenges:
    - HIRS/2 to /3 to /4 channel reassignment
    - N8 to N9 transition (Reanalysis or Geos as bridge?)
    - Comprehensive uncertainty estimates on climatology and trends.

Summary - I

- IR sounders have already proven themselves as a valuable resource for climate research both directly, and through reanalyses.
- Homogenisation of historical data needs to be an evolving process in order to capture structural uncertainty.
- Methodological choices hinge on the research objectives of the resultant dataset.
- Aim to provide 30 year record of IR brightness temperatures from HIRS and IASI, corrected to a consistent spatio-temporal and spectral sampling.

Summary - II

- Where possible apply all bias adjustments that can be analytically determined (the knowns).
  - SRF, Orbit drift, Orbit decay, fov characteristics
- Biases must be functions of atmospheric state and viewing geometry with comprehensive uncertainty estimates.
- Unkown biases to be treated separately
  - e.g. SRF drift or poor characterisation.
  - SNO
- Details are still to be confirmed – Close collaboration with ECMWF, NCDC, and others with expert knowledge essential.
- Feedback and comments are welcomed…This project must meaningful contribute to international climate research and extend our current understanding of these data.

NOAA-14 and climate

- GCOS Climate monitoring principle:
  - “Use of Functioning baseline instruments…should be maintained for as long as possible, even when these exist on de-commissioned satellites.”
- NOAA-14 SSU and HIRS/2 overlap with ATOVS and potentially MetOp.