Selection of a subset of IASI channels for near real-time dissemination

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IASI is currently due to be launched on the MetOp-1 satellite in April 2006. Global IASI Level 1C data will be distributed to many users on the GTS. Here bandwidth limitations will probably require that channel selection will be used, at least on Day 1. Currently AIRS is distributed in near real time to NWP centres in a similar manner with 324 out of 2378 channels being provided (the data volume is further reduced by distributing only one field of view in nine).

A subset of IASI channels that may be distributed should be chosen such that the total loss of information is a minimum. This may be achieved through consideration of the loss of information content in the context of retrievals using a short range NWP forecast as prior information. Before the final channel selection, extensive pre-screening should be performed to ensure channels are not chosen where there are large forward model errors or interfering species.

This poster describes a proposed methodology for the selection of this subset of channels. The exact content of a selected set of channels will be highly dependent on the precise application to which it is being applied. As techniques and modelling accuracy evolve, the "optimal" set of channels will also change. Therefore, the aim with this study is not to produce an absolutely "optimal" set of channels, as this is almost certainly not possible for all applications, but a conservative but close to optimal set of channels for physical retrievals of the atmospheric state.

References

Rodgers, C.D. (1996). Information content and optimisation of high spectral resolution measurements. *SPIE*, **2380**, Optical spectroscopic techniques and instrumentation for atmospheric and space research II, Paul B. Hays and Jinxue Wang eds., pp. 136–147.

Rodgers, C.D. (2000). Inverse methods for atmospheres: Theory and Practice. *World Scientific Publishers*, Singapore.

Criteria

The main quantities to be considered in the choice of channels are:

- Temperature profile, Humidity profile, Ozone profile

Secondary quantities may include:

- Minor gas (e.g., CO_2, CO, CH_4) profiles, cloud properties, surface emissivity

Channels that are usable in daytime, as well as at night, are preferred.

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Method

The methodology is based on the information content-based channel selection of Rodgers (1996, 2000) using degrees of freedom for signal (DFS) as a figure of merit but has been modified to account for uncertainties arising from the non-linearity of the water vapour and ozone Jacobians for temperature and also to account for the fact that some channels will not be usable in the daytime but may still contain extra useful information at night.

The channel selection is performed for a range of atmospheres simultaneously. This is done by calculating the DFS changes (on adding a given channel) on each of a range of atmospheric profiles. The chosen channel is that which causes the greatest total change in DFS for all the profiles.

The method is implemented as follows:

- Pre-screen the channels to exclude channels with excessive forward model error.
- Perform an initial analysis for temperature only with only the CO2 channels (which have relatively constant temperature Jacobians) being considered.
- With the temperature channels chosen above pre-selected, perform the DFS analysis once more with the water vapour channels included and with both water vapour and temperature retrievals allowed.
- Optionally repeat the above for trace gas (CO_2, O_3, CH_4, CO, N_2O etc.) retrievals, if required.
- Next allow solar channels (and optionally channel affected by non-LTE effects) to be considered.
- Manually select additional channels useful in the determination of cloud properties and surface emissivity, if required.

The final channel selections are critically examined to ensure that they are reasonable and so that if there are any obvious gaps in the selection these may be addressed.
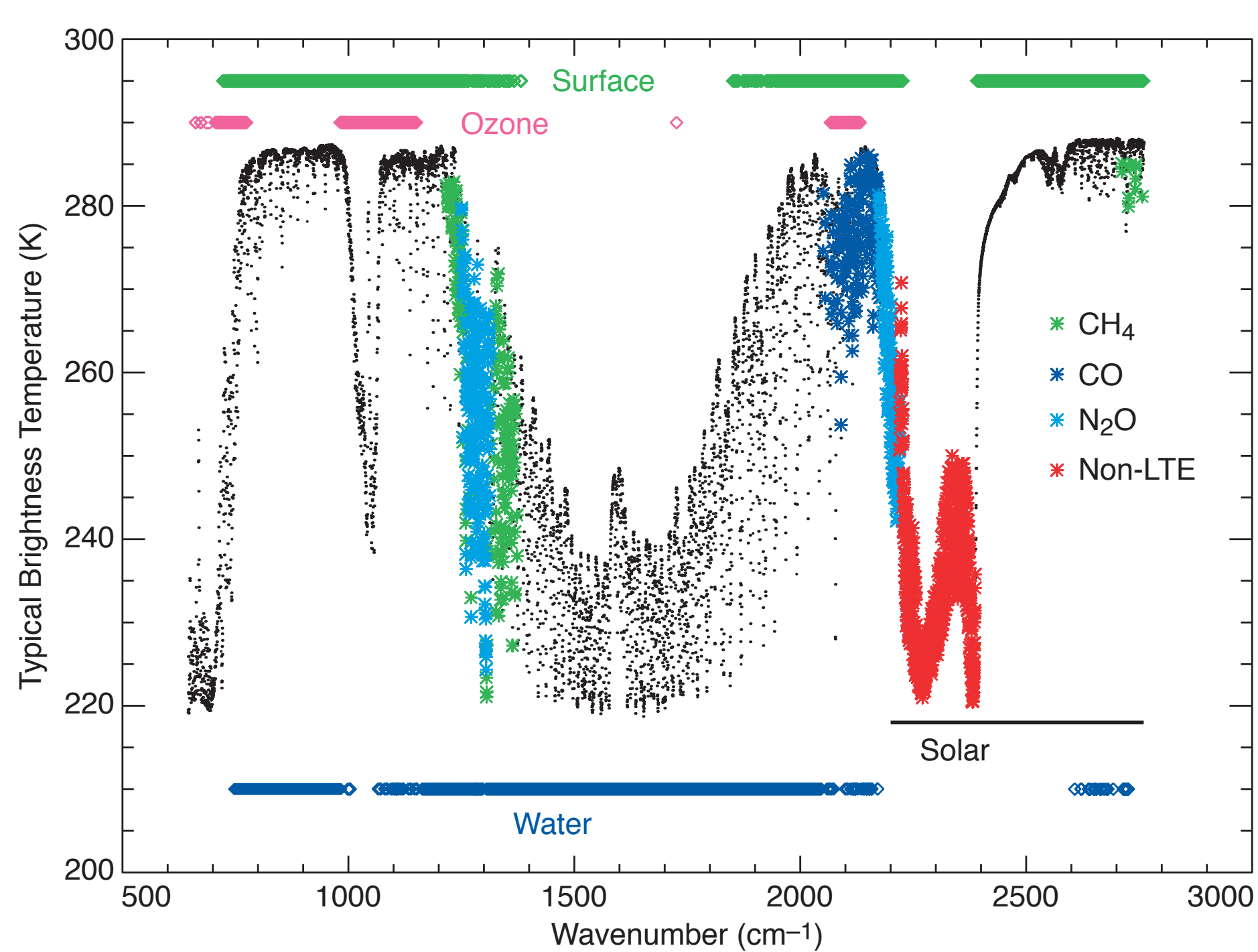
Example channel selection

An example channel selection has been performed using a ECMWF background error covariance matrix. Temperature, water vapour and ozone are considered. The blacklisted channels are shown in Figure 1. The observational plus forward model error covariance matrix is assumed to be diagonal and is illustrated in Figure 2. Figure 3 shows the 300 channels chosen, with the evolution of the number of degrees of freedom for signal with number of chosen channels in Figure 4. Finally a comparison with the 324 channels chosen for the near real time distribution of AIRS data is shown in Figure 5.
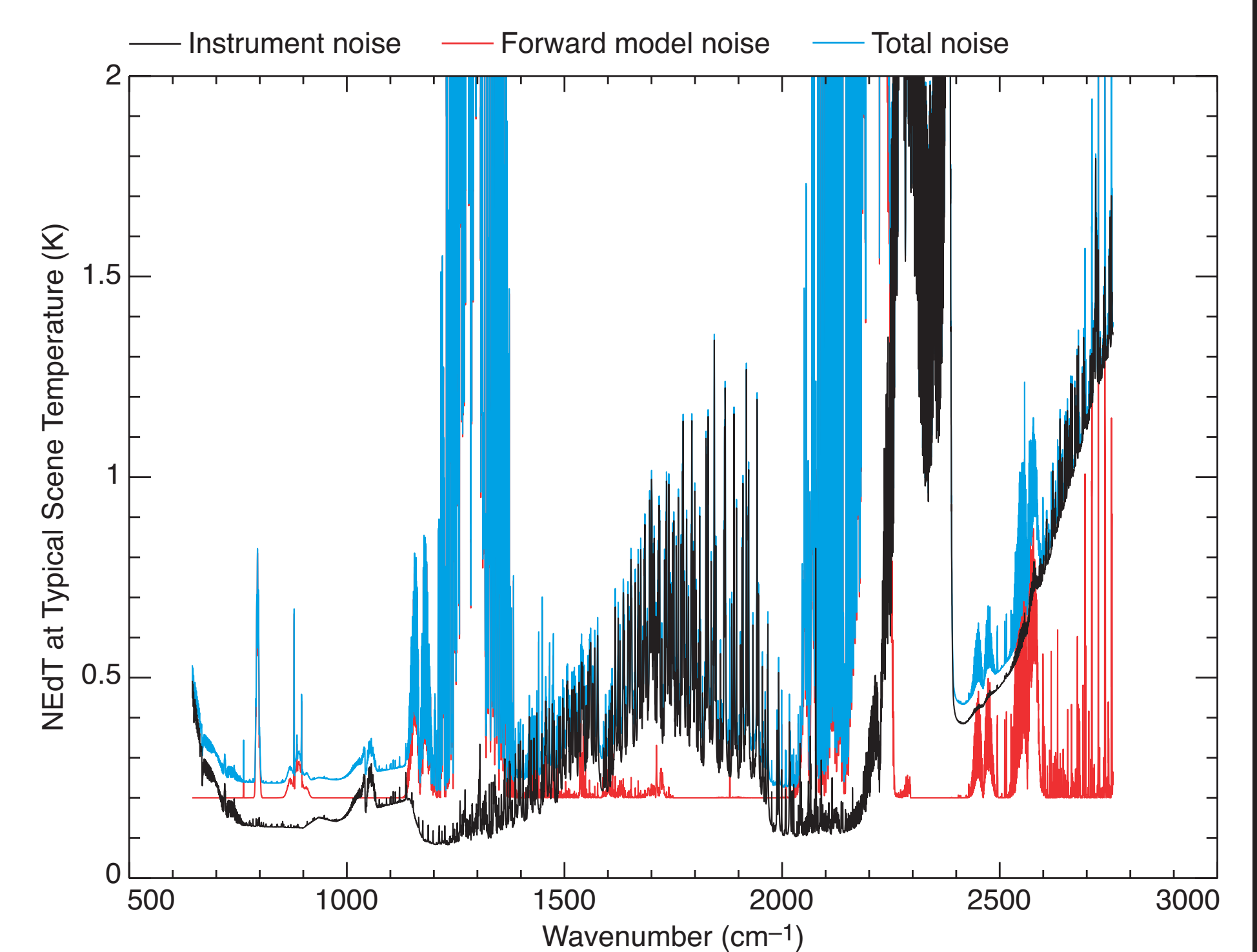

Figure 1 *Blacklisted channels for channel selection. Channels with possible signals from CH_4, CO or N_2O greater than 1K are blacklisted together with those channels in the 4.3μm CO_2 band which are affected by non-LTE effects (although some of these channels are included in the final channel selection). Channels with large contributions from H_2O, O_3, the surface and solar irradiance are also indicated.*

Figure 2 *The assumed observational plus forward model noise for the channel selection.*
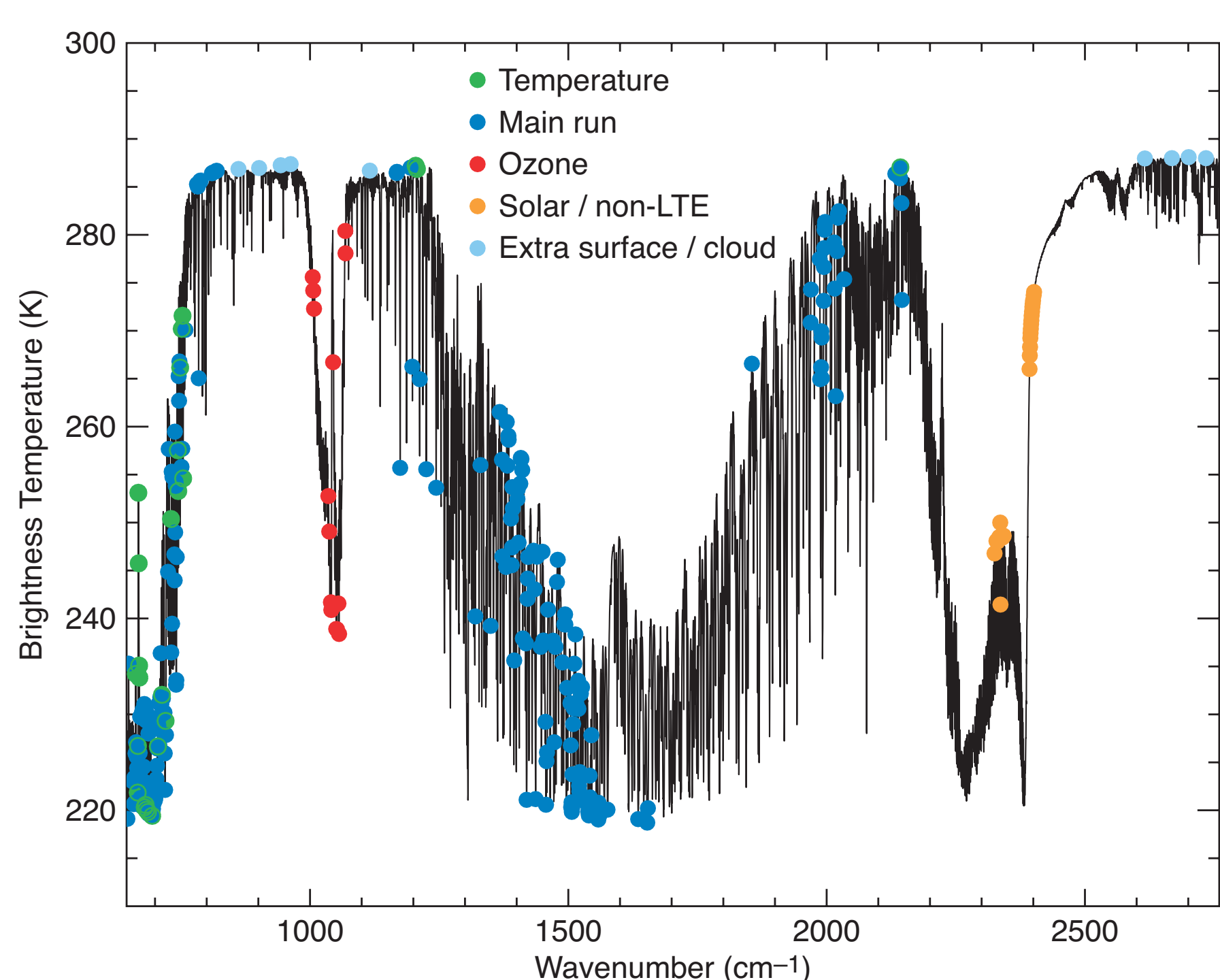

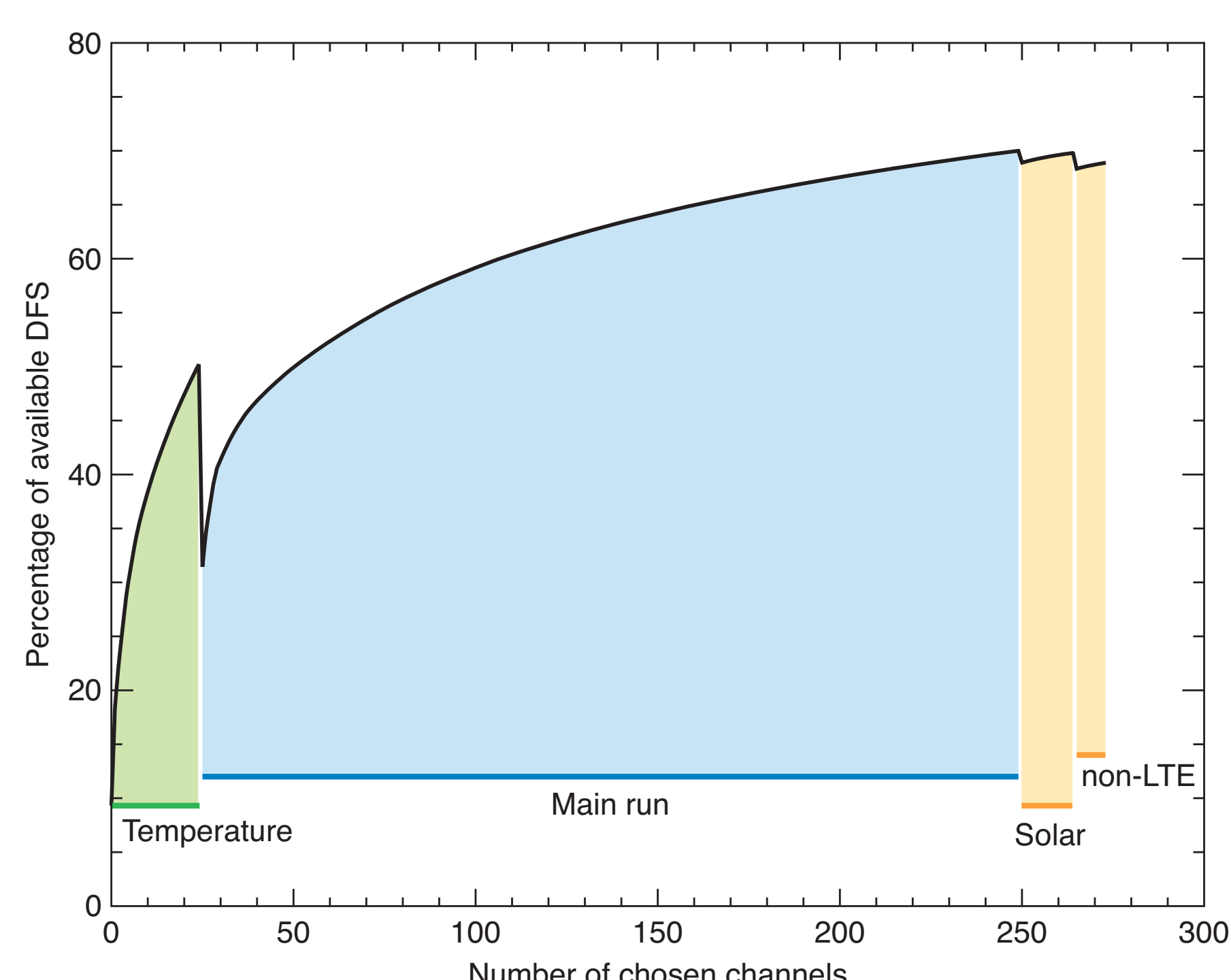**Figure 3** *300 channels chosen with the methodology described in the text.*

Figure 4 *Evolution of the DFS during the channel selection.*
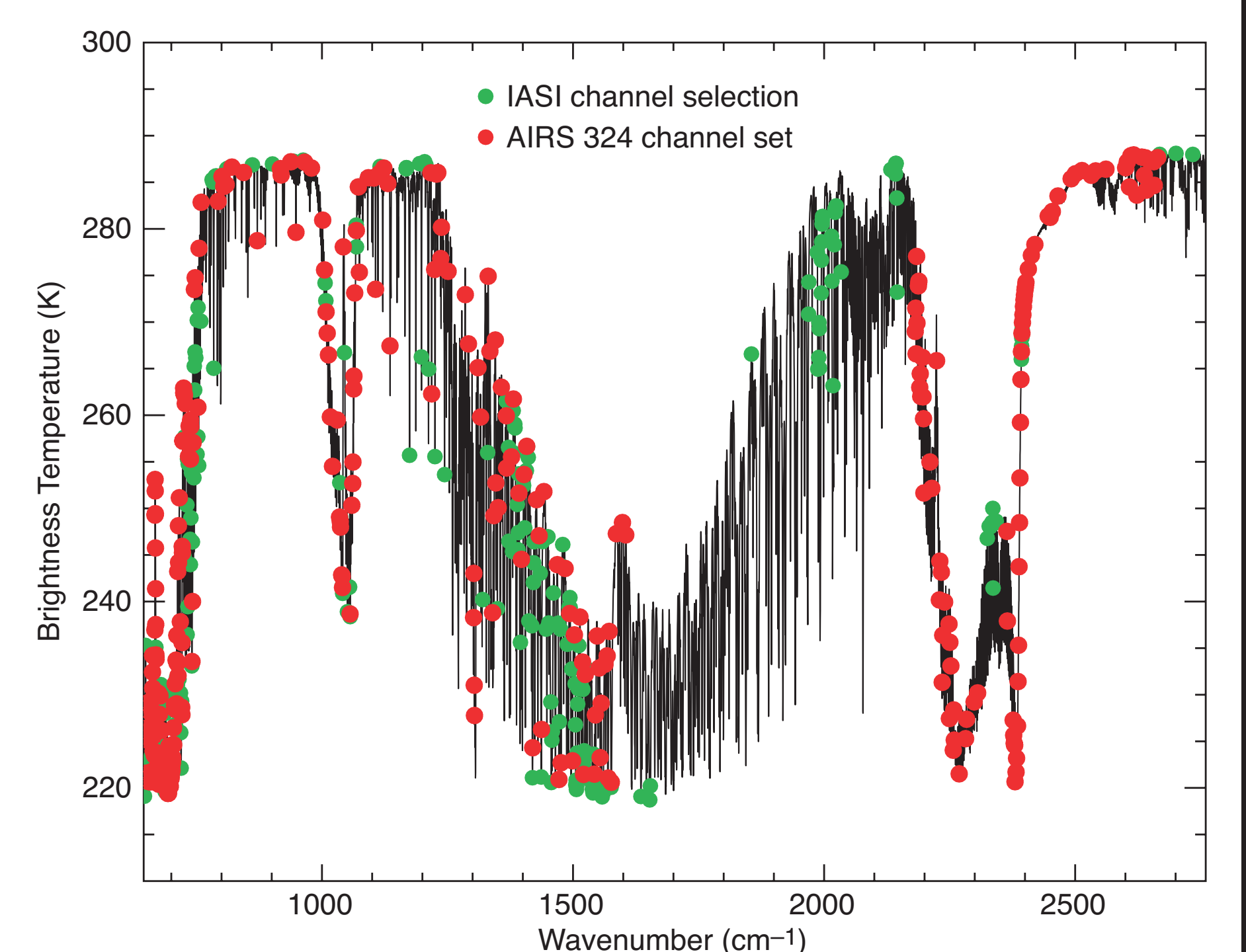

Figure 5 *A comparison of the 324 channels distributed for AIRS and the 300 channels chosen for IASI.*