Skin sea surface temperature retrievals

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Abstract

To use ATSR for climate change purposes or investigation of subtle effects such as skin-bulk differences we need SST retrievals that are essentially free from artefactual trends and biases. We present a comprehensive reworking of ATSR dual-view retrieval that has substantially removed the following defects in the prelaunch scheme: post-Pinatubo volcanic aerosol bias (~-1.5 K) and trend; water vapour related biases; systematic across-track biases; and bias from changing detector temperatures. Developments in the radiative transfer modelling used for coefficient derivation include updated treatment of water vapour absorption, surface emissivity and aerosol scattering parameterisation. We have also demonstrated that a serious degradation in retrieval quality occurs if inappropriate assumptions about instrumental noise are made. Validation suggests bias of <0.1 K in tropical regions and standard deviation of 0.25 K from dual-view retrievals using the 11 & 12 micron channels, even under the heavy Pinatubo aerosol loadings early in the ATSR mission. We point to a strategy for long-term bias minimisation for climate change research.

Pinatubo aerosol

To a good approximation, brightness temperature deficits caused by stratospheric aerosol are linear in aerosol amount, as verifed by radiative transfer modelling. This linearity allows retrieval coefficients for SST to be derived which are immune to stratospheric aerosol: mathematically speaking, the coefficients are orthogonal to the mode(s) of brightness temperature variation caused by aerosol.

Water vapour biases

Biases ~-0.3 K in SST under wet atmospheres have been traced to an inadequate formulation of the infrared ‘water vapour continuum absorption’ (that part of the absorption by water vapour not directly attributable to absorption lines). Implementing an updated formulation, these wet atmosphere biases disappear, and observed and modelled brightness temperature distributions match more closely.

Detector temperature bias

The gradual increase through the ATSR mission in the detector temperatures caused a change in the 12 micron channel instrumental response. By modelling this explicitly, coefficients dependent on detector temperature have been obtained. Application of these has been shown to stabilise ATSR SSTs in comparison with in situ measurements.

Strategy

Detailed forward modelling to derive retrieval coefficients has a major advantage in developing long-term SST data. Future validation exercises will improve confidence in the SSTs throughout all the ATSR missions, as the lessons learned can be applied retrospectively to earlier data.

Further reading

Merchant, Harris, Murray and Zavody, Towards the elimination of bias in satellite retrievals of sea surface temperature. Part 1: Theory, modelling and inter-algorithm comparision, accepted *J. Geophys. Res.* 1999.

Also links from: http://www.met.ed.ac.uk/