Relationship of Seasonal Climate Forecast Error to Uncertainty in Soil Moisture Initializations

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Introduction

- Accurate initialization of General Circulation Models (GCMs) with realistic global field of soil moisture data can improve the seasonal and subseasonal predictions of atmospheric states.

- In the second Historical Forecasting Project (HFP2), the third generation Canadian Center for Climate Modeling and Analysis (CCCMA), atmospheric General Circulation Model (GCM3) was run to produce a series of four-month hindcasts from 1969 to 2002.

- Land surface wetness state was initialized from model climatology estimates rather than realistic estimates of the initial soil moisture state.

Objectives:

- Investigate the effect of soil moisture initialization on the monthly predictions of air temperature and precipitation.

- Identify the regions on the globe where soil moisture initialization errors has the highest influence on the seasonal forecast skill.

Methodology:

- Monthly total precipitation and average air temperature were produced by GCM3 at CCCma over the period of 1979-2002.

- Global estimation of soil moisture was obtained using the Canadian LAnd Surface Scheme (CLASS, V3.4) which was forced offline with bias corrected reanalysis data.

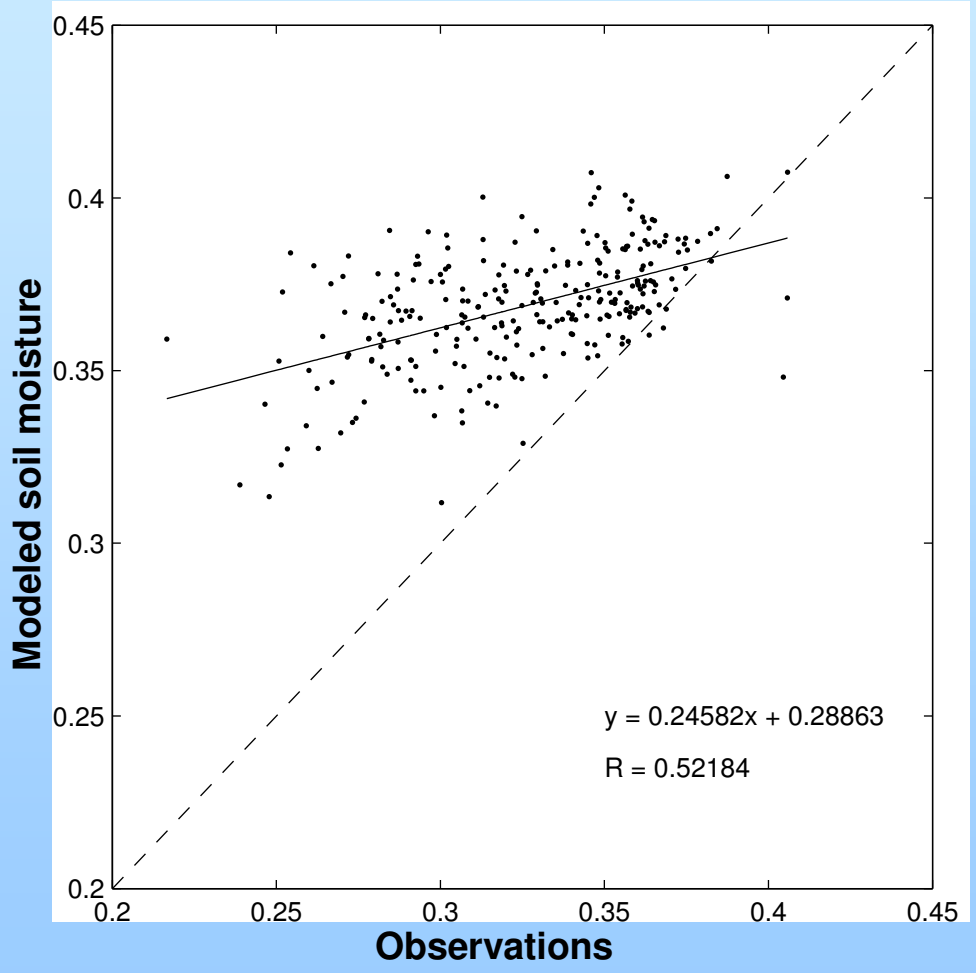
Methodology:

- Soil moisture Initialization errors (SM_IE) were calculated based on the differences between CLASS generated soil moisture data and the model climatology for each boreal warm season month over the period of 1979-2002.

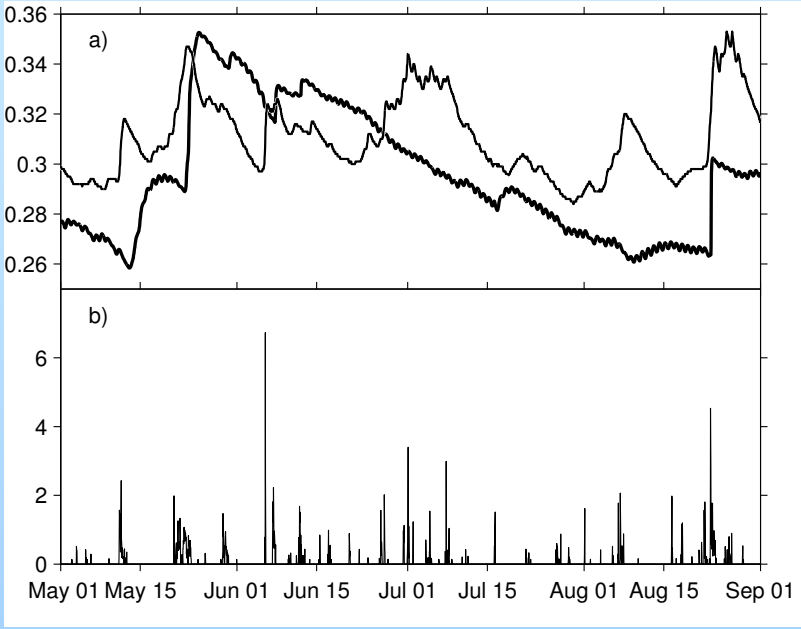
- Forecast errors of monthly average air temperature and monthly total precipitation were estimated by comparison to bias corrected reanalysis data.

- Correlation coefficient between SM_IE and forecast errors and its significance was obtained by Monte Carlo simulation.

Comparison of the modeled soil moisture against measurements

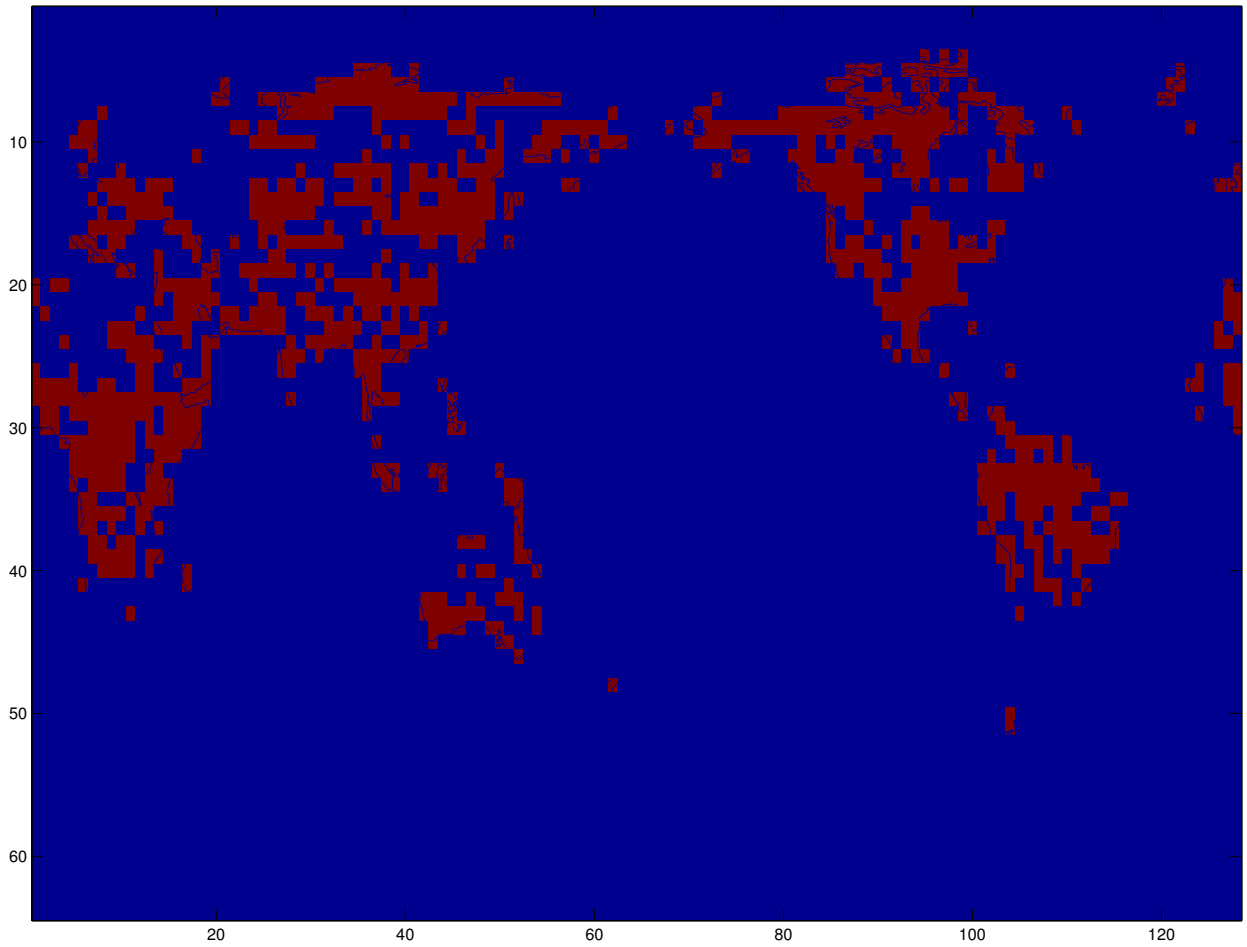


Illinois (1981-2004)

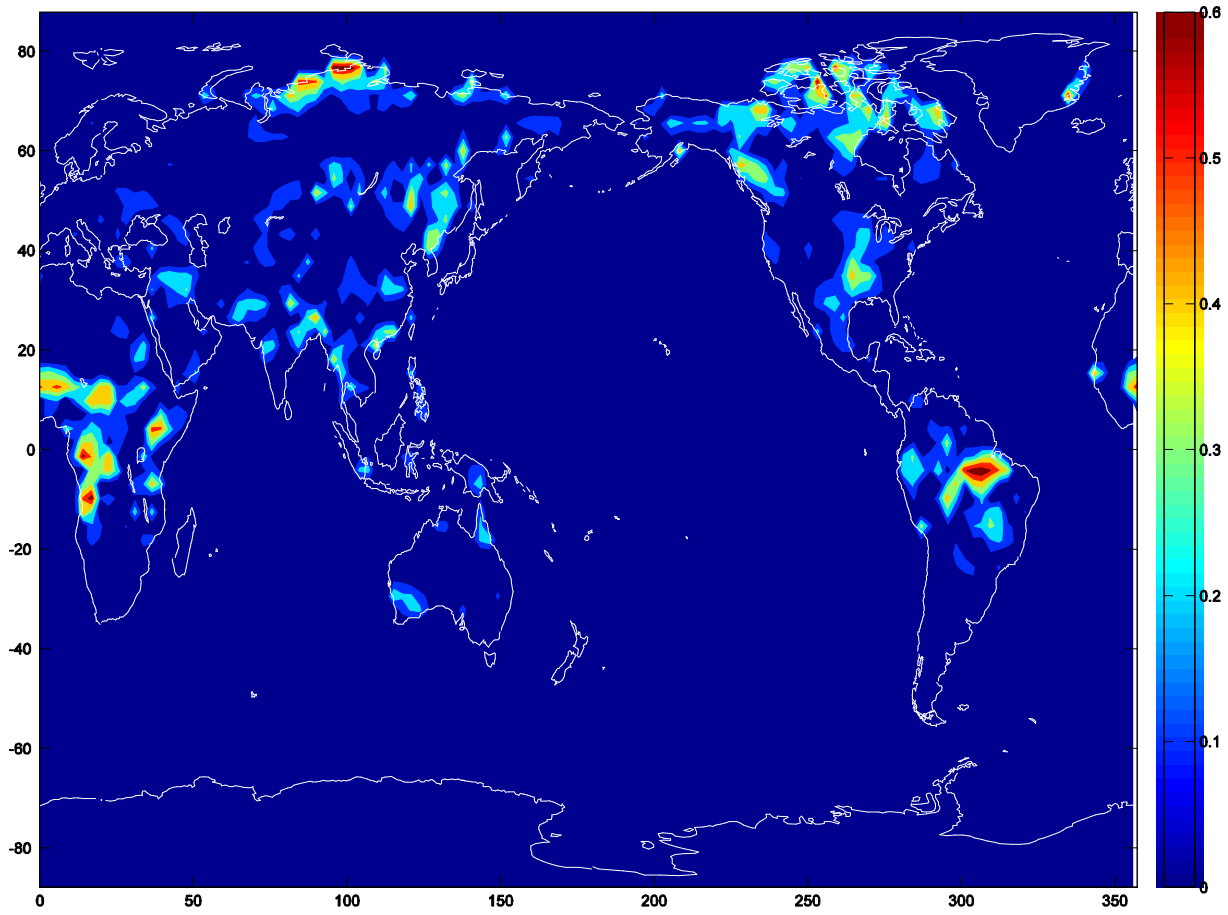


Alberta (May – Aug. 2004)

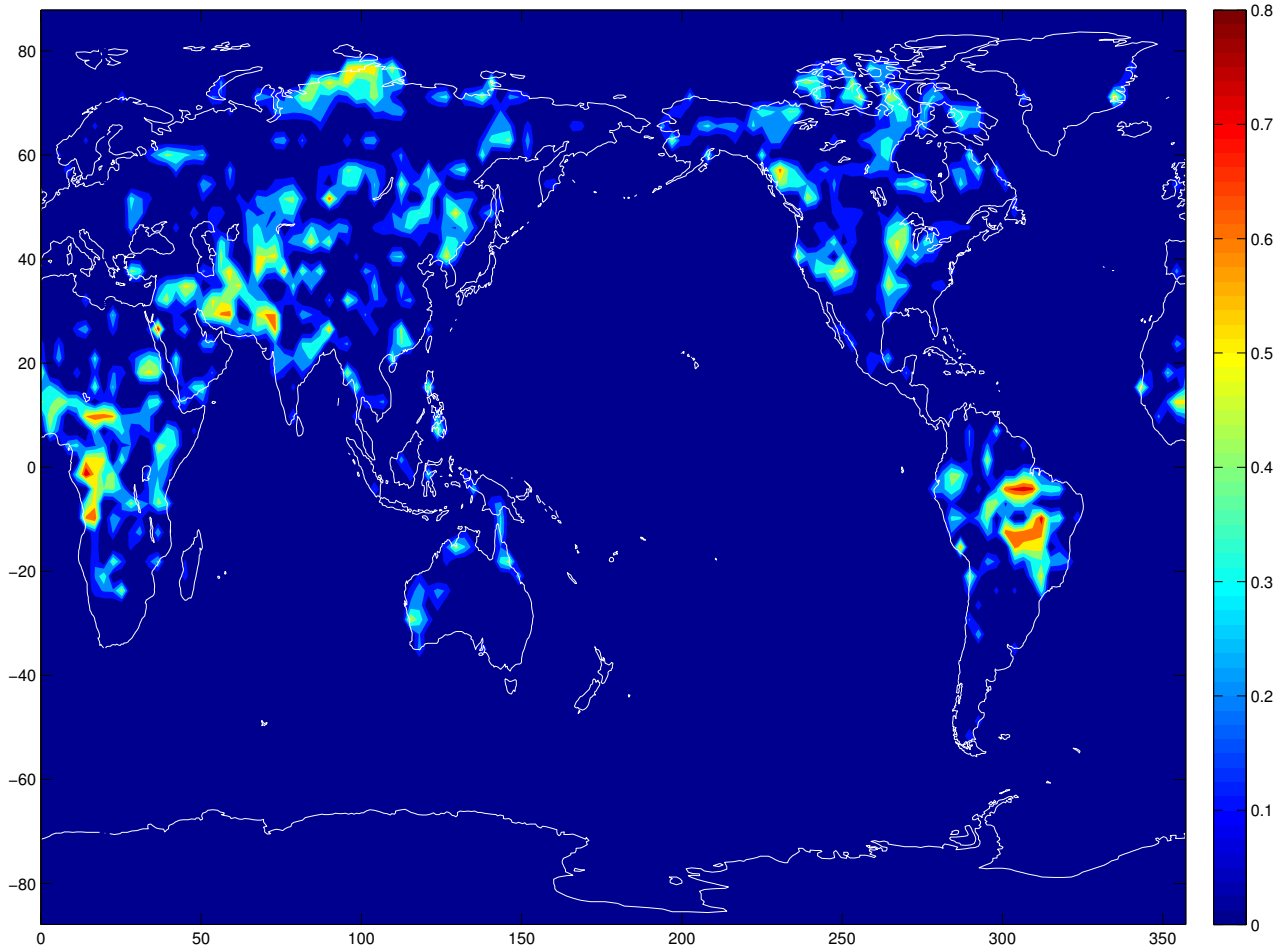
T-test between the soil moisture initialization errors (SM_IE) of the worst air **temperature** forecasts and SM_IE of the best air **temperature** forecasts



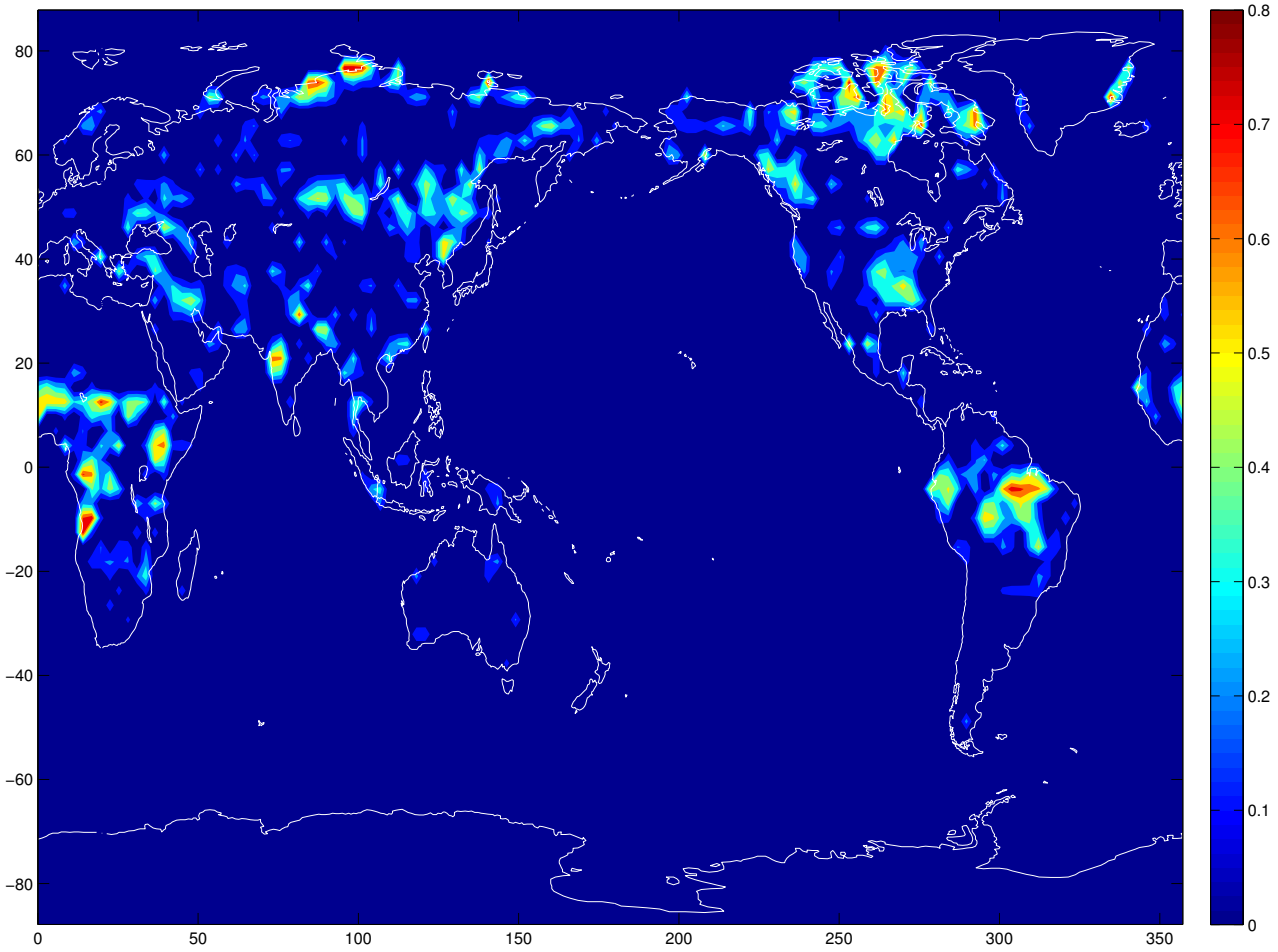
Correlation coefficient between SM_IE and monthly average **air temperature** forecast errors



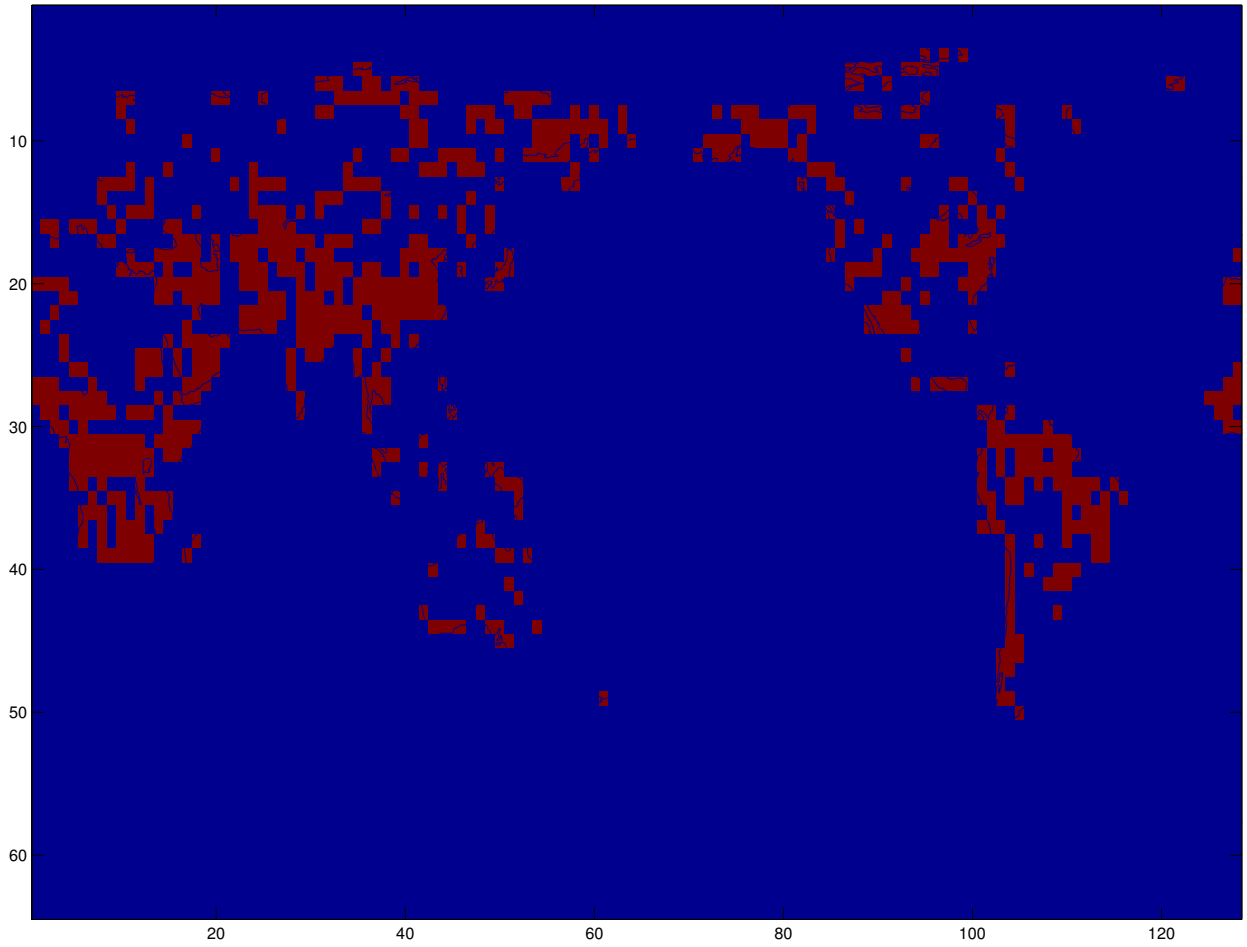
Correlation coefficient between SM_IE and monthly **air temperature** forecast errors when CLASS soil moisture is much **drier** than climatology (25 percentile)



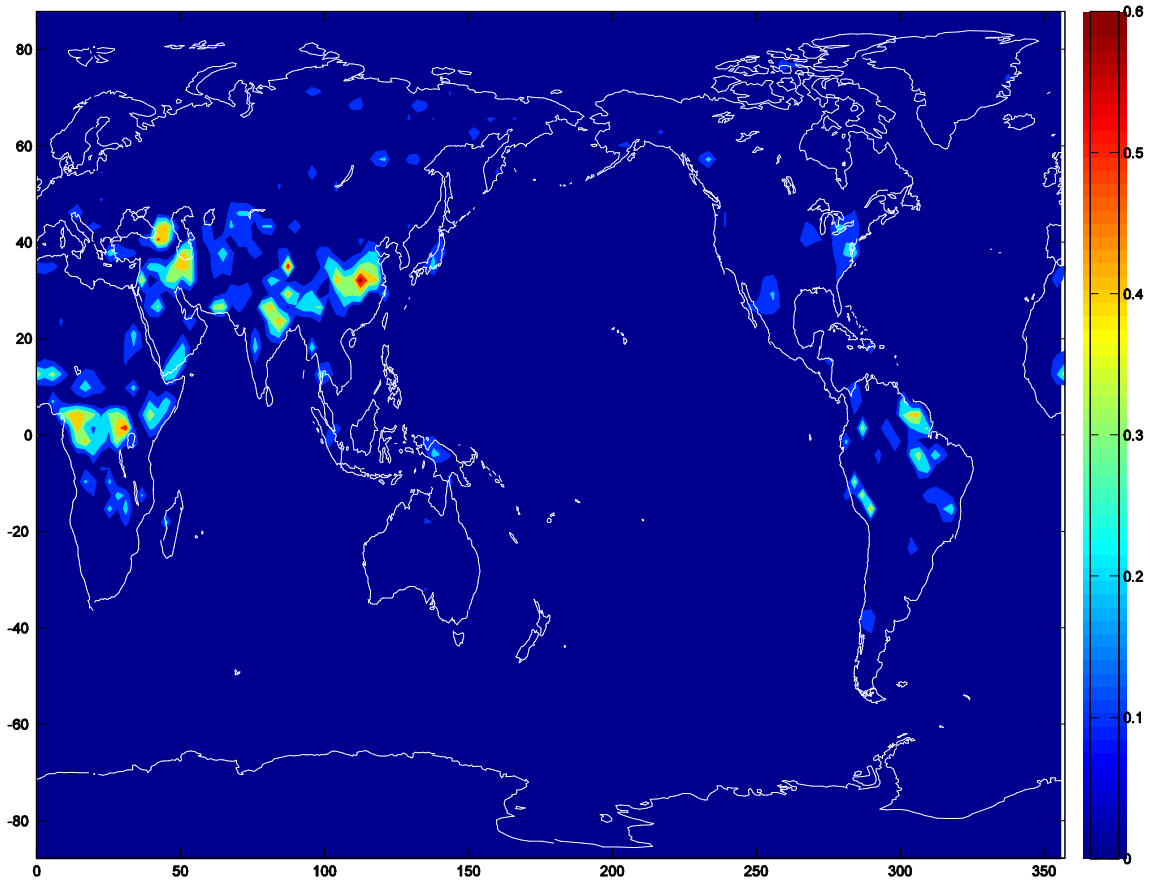
Correlation coefficient between SM_IE and monthly air **temperature** forecast errors when CLASS soil moisture is much **wetter** than climatology (75 percentile)



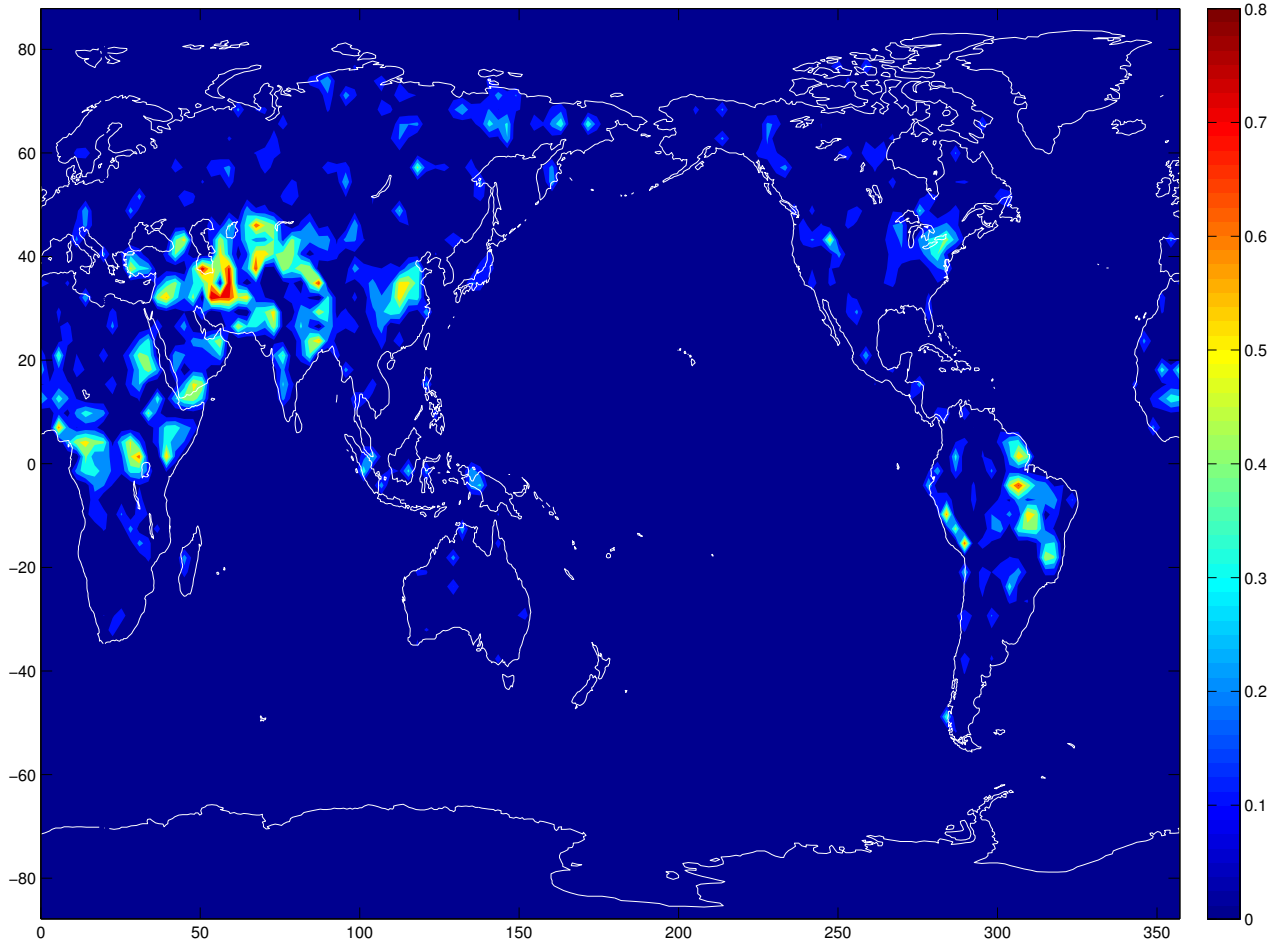
T–test between SM_IEs of the worst **precipitation** forecasts and SM_IEs of the best **precipitation** forecasts



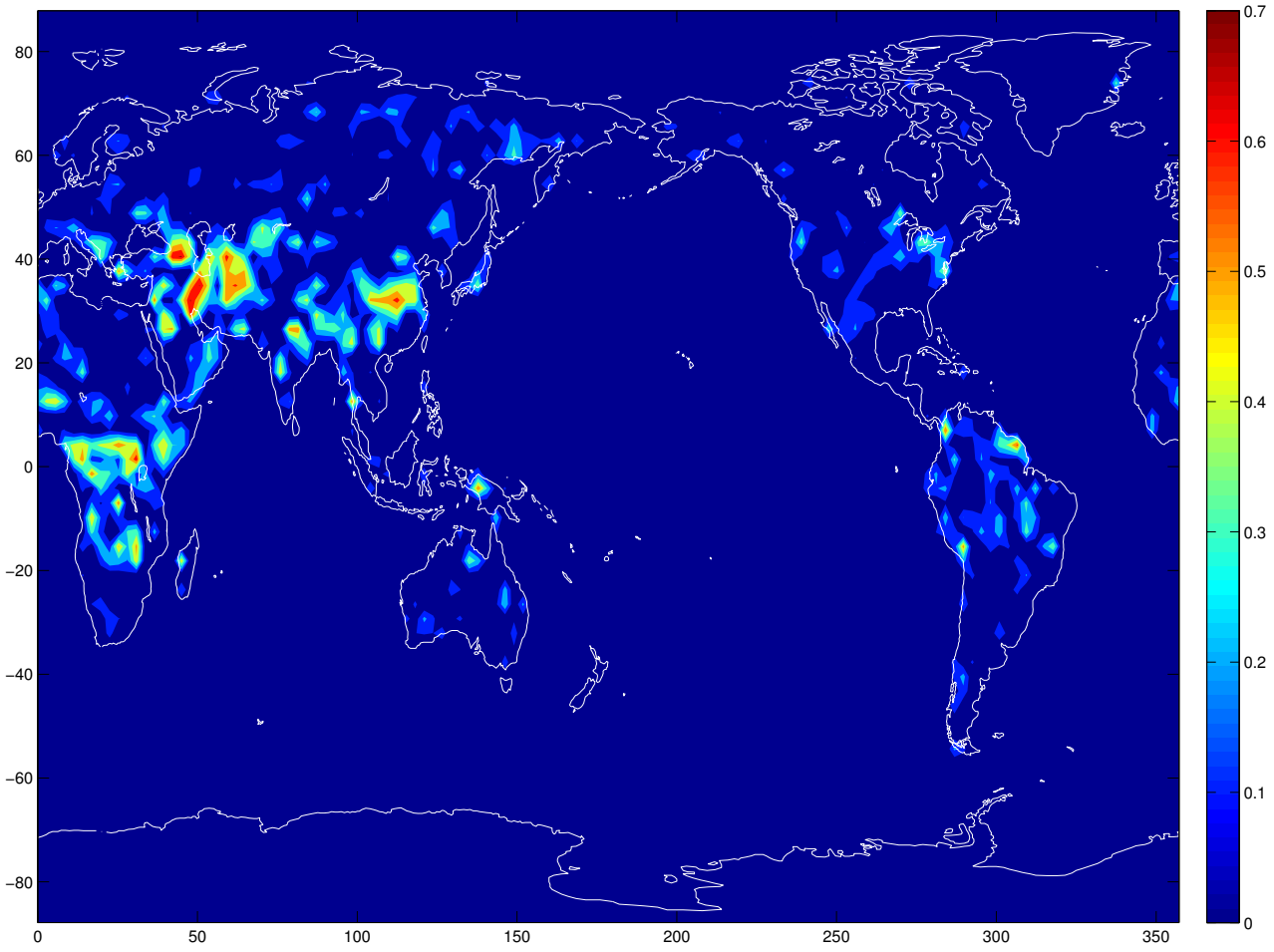
Correlation coefficient between SM_IEs and monthly **precipitation** forecast errors (May- Sep)



Correlation coefficient between SM_IE and monthly **precipitation** forecast errors when CLASS soil moisture is much **drier** than climatology (25 percentile)



Correlation coefficient between SM_IE and monthly **precipitation** forecast errors when CLASS soil moisture is much **wetter** than climatology (75 percentile)



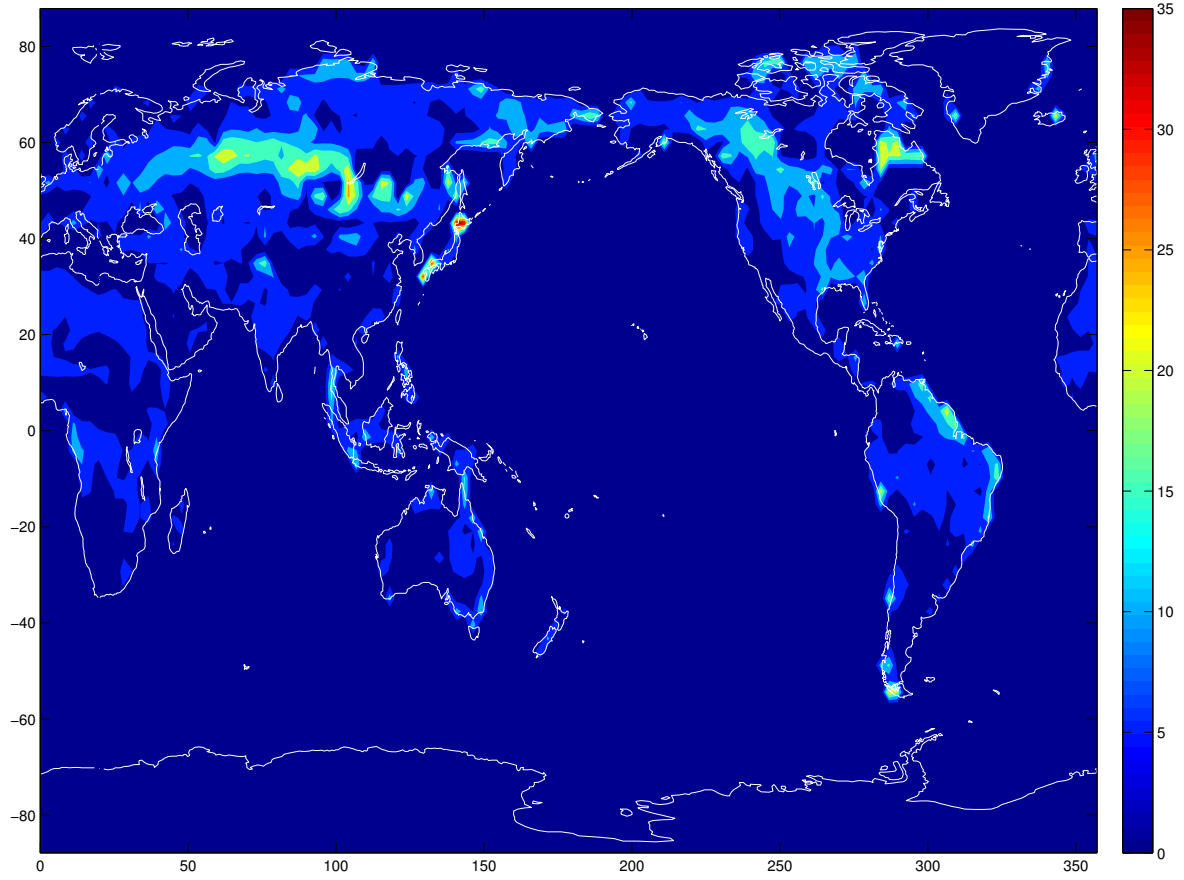
Summary:

• Using forecast data from HFP2 and offline soil moisture data from CLASS, we identified the relationship between monthly average air temperature/ total precipitation forecast errors and soil moisture initialization errors.

•Soil moisture initialization errors have the greatest impact on the seasonal forecasts of precipitation and temperature over equatorial Africa, India and east Asia.

• For temperature the magnitude and the areal extent of this effect was greater than that for precipitation.

Mean absolute error of CLASS soil moisture data and Climatology soil moisture (May-Sep)



$$\mathrm{MAE} = \frac{1}{n}\sum_{1}^{n} \left| \theta_{CLASS} - \theta_{Climat.} \right|$$