地基红外高光谱温室气体反演研究与卫星验证

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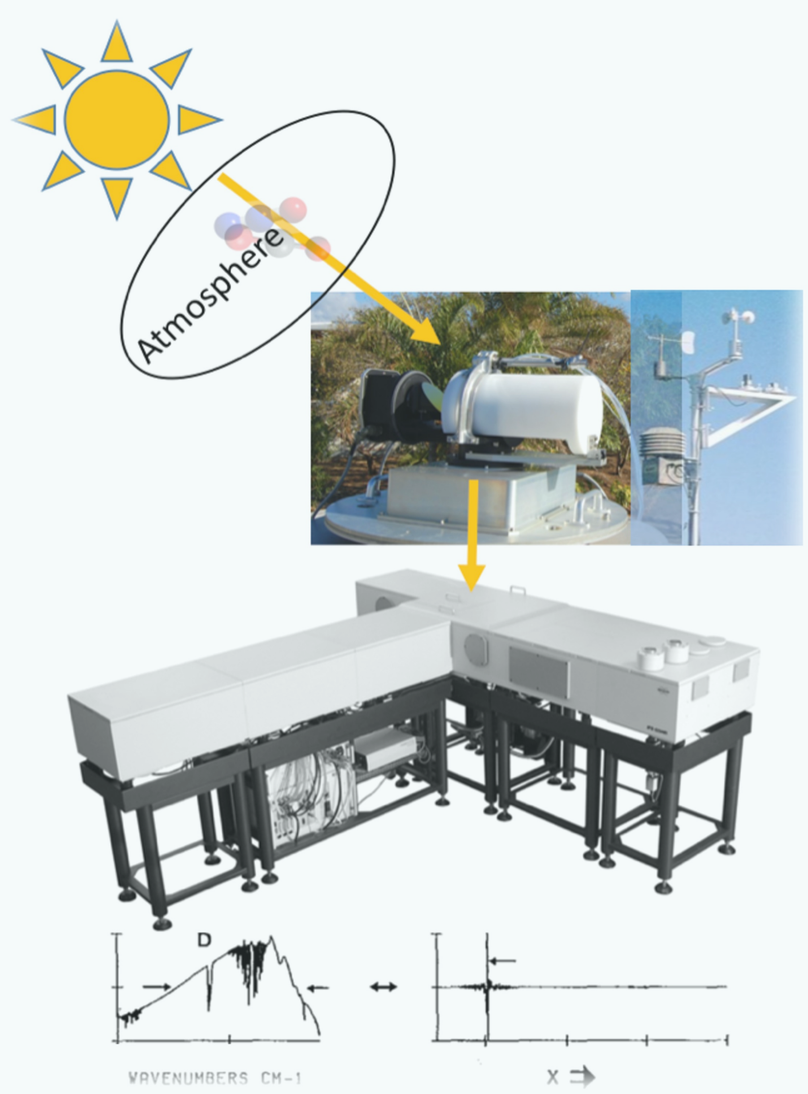
地基傅立叶光谱仪（FTIR）观测系统



香河站地基FTIR观测系统采用了全自动的观测模式

组成部分：自动太阳跟踪器；自动气象站；傅立叶光谱仪

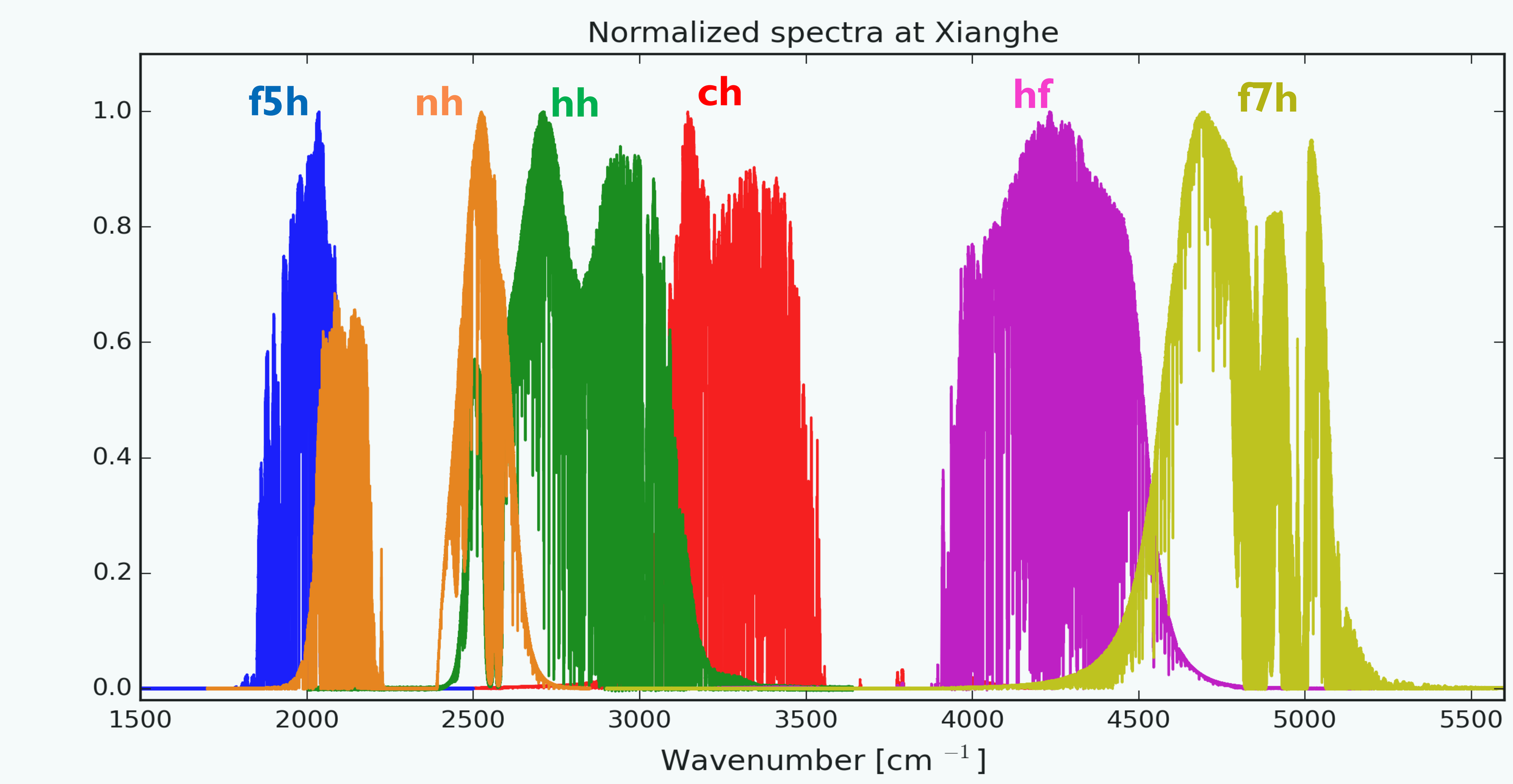
自动化系统：自动气象站观测太阳直接辐射和雨量，通过 BARCOS软件[1]可以实现太阳跟踪器的自动打开和关闭

观测原理：通过太阳跟踪器将太阳直射光引入光谱仪，采用迈克尔逊干涉的原理，获得太阳辐射干涉光谱，经过快速傅立叶变换，得到辐射光谱，其光谱分辨率可达 0.0035 – 0.02 cm^{-1}

反演原理：建立辐射传输模式，模拟气体的特征吸收谱线，结合最优估计[2]，利用迭代求解目标气体在大气中的浓度

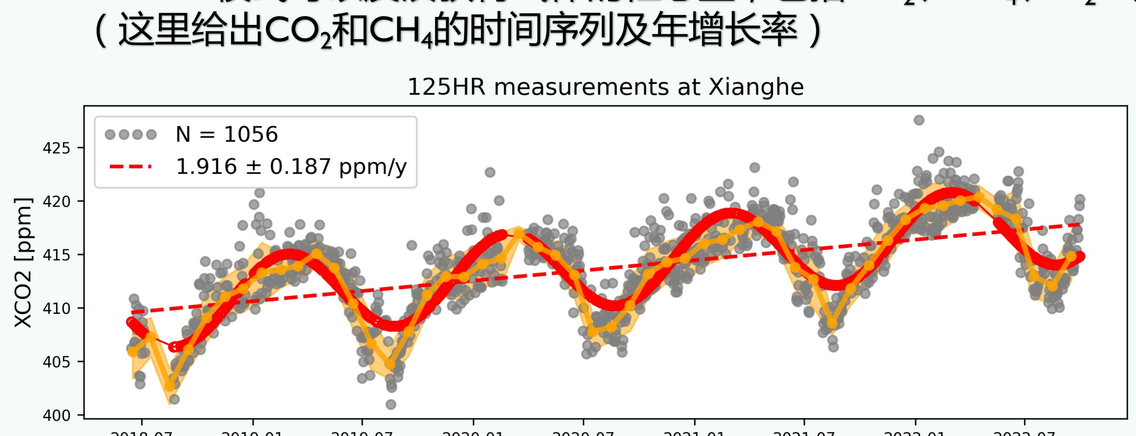
地基FTIR观测模式

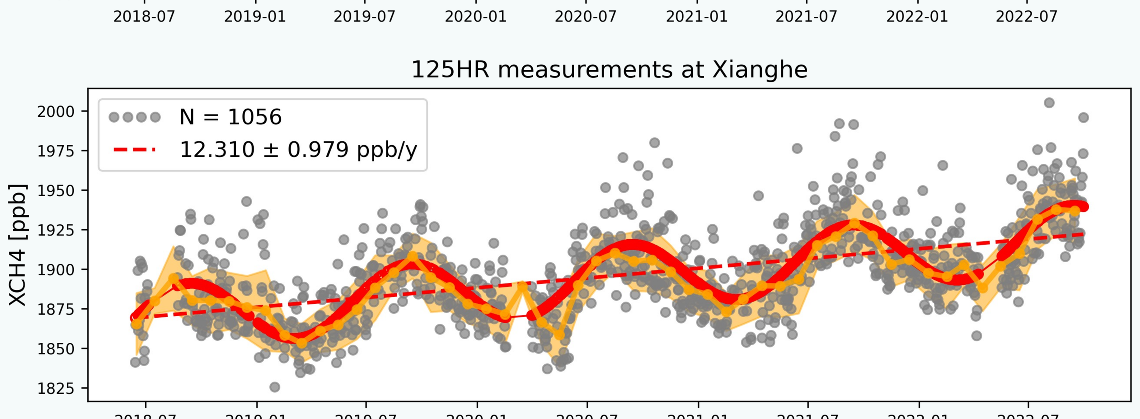
香河站地基FTIR 观测采用了TCCON (Total Carbon Column Observing Network) 和 NDACC-IRWG (Network for the Detection of Atmospheric Composition Change - The Infrared Working Group) 两种观测模式.其中NDACC-IRWG 采用 CaF_2 (分束器)和InSb (传感器)的观测模式，观测范围为1800-5400 cm^{-1}，值得注意的是，为了增加各个波段的光谱信噪比，在光谱仪中安置了6个滤光片，对应采集6个波段上的光谱



香河地基FTIR温室气体观测时间序列

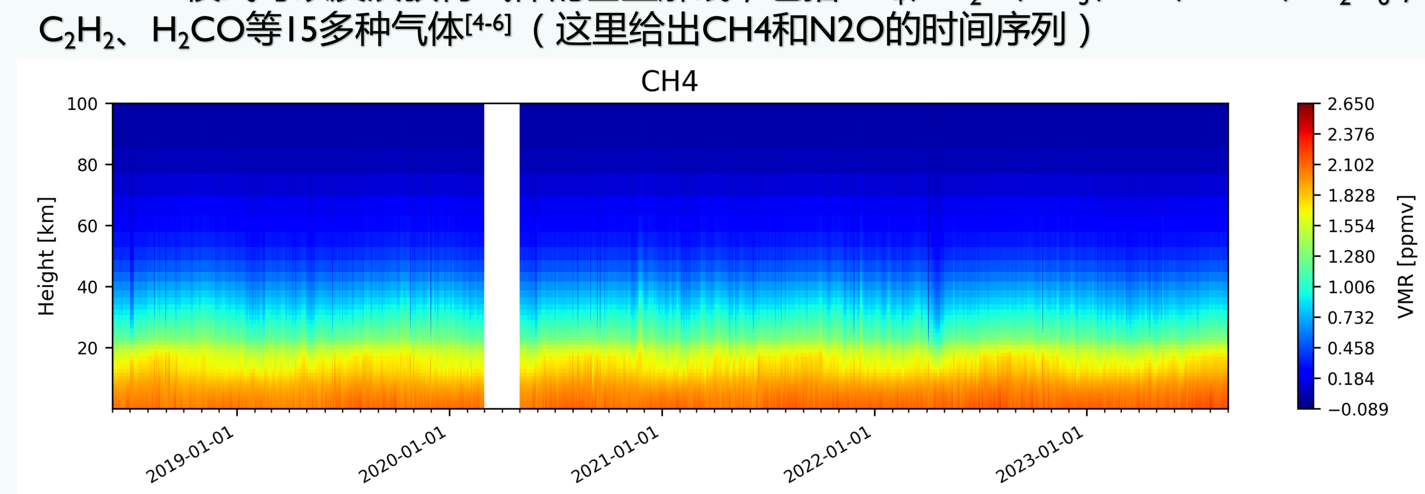
TCCON模式可以反演获得气体的柱总量，包括CO_2、CH_4、N_2O、CO、H_2O、HDO等10余种气体[3]（这里给出CO_2和CH_4的时间序列及年增长率）

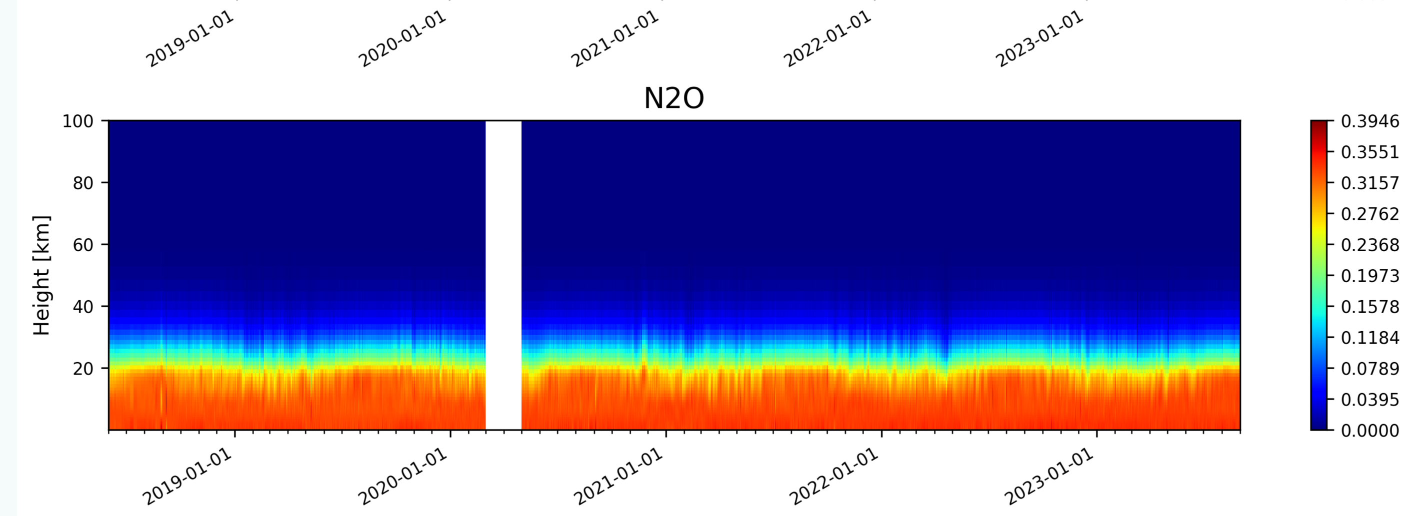




	香河TCCON	夏威夷站
CO_2	1.916ppm/year	2.38ppm/year
CH_4	12.31ppb/year	14.37ppb/year
N_2O	1.139ppb/year	1.178ppb/year

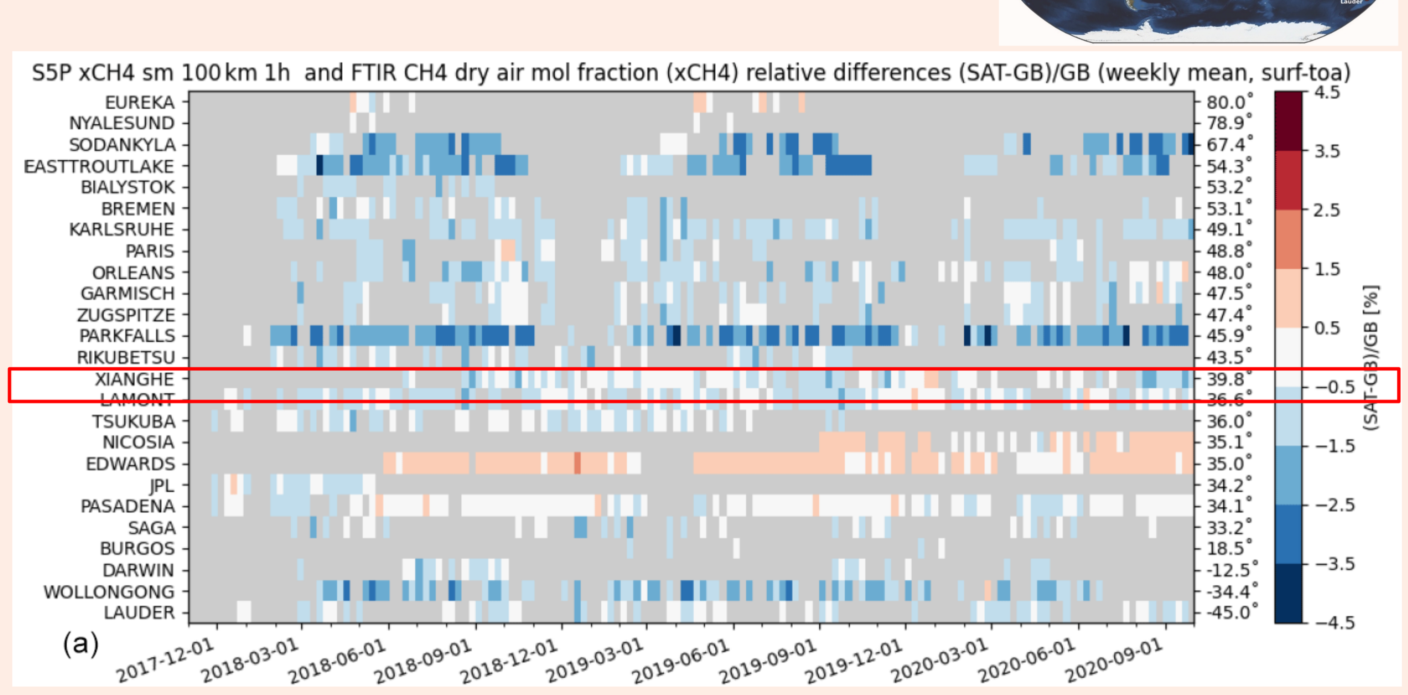
NDACC 模式可以反演获得气体的垂直廓线，包括CH_4、N_2O、O_3、HF、HCL、C_2H_6，C_2H_2、H_2CO等15多种气体[4-6]（这里给出CH4和N2O的时间序列）



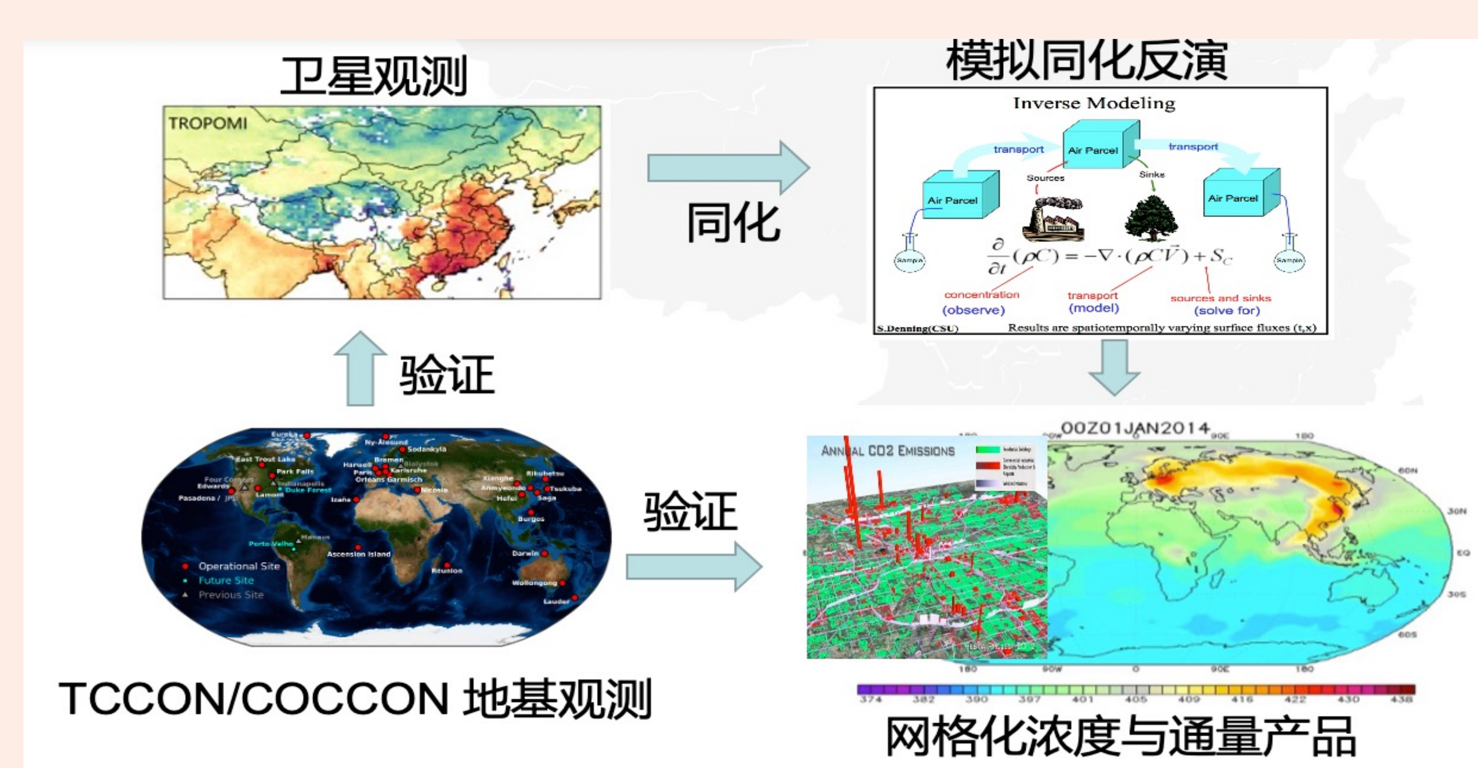


卫星/模式验证

作为TCCON标准站点之一，参与TROPOMI（CH_4和CO）、OCO-2/3（CO_2）、GOSAT-1/2的全球地基验证[7]



地基FTIR的观测资料作为模式同化验证资料，支撑碳同化反演系统[8]



展望 维护仪器的正常运行，定期对观测镜子进行清洗、定期进行标气观测、保证观测光谱的质量。香河站地基FTIR的TCCON与NDACC观测数据持续支撑卫星验证（S5P, GOSAT, IASI等），服务我国碳卫星观测。地基FTIR的观测数据还将用于研究华北地区的空气成分变化，包括气体的日变化、季节变化、长期趋势等，为大气化学模式提供数据支持。进一步推广和发展中国区域地基温室气体遥感观测网络。

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