

A Global Observing Campaign to Characterize Tides and their Influence from the Troposphere to the Thermosphere

Overview

Although atmospheric tides were the first of the large scale global waves to be identified in the atmosphere, our understanding of their behaviour remains incomplete. They are closely linked to solar heating throughout the atmosphere but their source mechanisms are not fully understood and non-linear interactions are likely to play a role in the creation of some modes. The sun-synchronous (migrating) diurnal and semi-diurnal tides have been extensively studied but even for these modes, the short term variability, vertical structure and dissipation remains unresolved. Recent work has identified the existence of strong non-sun synchronous (non-migrating) modes and their role in geographic variations in the strength of observed diurnal and semidiurnal oscillations.

Above the stratosphere, the influence of tides is ubiquitous. They dominate the dynamical variability, significantly impact the local time variations in constituents and the associated chemistry and strongly modulate the propagation conditions experienced by upward propagating gravity waves. In the ionosphere they are thought to cause the observed Sq variations in the current systems.

In current general circulation models, tidal modes are closely linked to the parameterizations of radiative heating, convection, clouds and latent heat. As such comparisons between models and observed tidal signatures provide a sensitive means of evaluating and validating these parameterizations. For the most part, the study of tidal modes (other than the migrating diurnal tide) in general circulation models has been neglected.

The resolution of many of the outstanding problems concerning the existence and impact of tides in the atmosphere requires global and extensive observation campaigns, a vigorous analysis effort and comparison with global models.

- Such campaigns must involve both satellite and ground based observations. The satellite coverage will provide observations of global extent but poor local time coverage whereas individual ground base observations will provide good local time coverage of a regional character. The identification of short term variations in the sun synchronous and non-sun synchronous modes cannot be made with confidence without these two types of observations.
- Observations of the background wind and temperature fields and large scale wave fields are necessary to allow the tidal propagation and interactions to be determined. Seasonal variations in the amplitude of the westward diurnal tide are thought to be due to variations in the background zonal mean wind. In addition, non-linear interactions with planetary waves have been identified as potential sources for some tidal modes.
- Heating throughout the atmosphere is important to identify the source functions for a number of the modes. By default, modes not appearing in the heating must be forced through other mechanisms

- As tidal features appear in many observables, a broad range of types of observations is needed to allow the full characterization of tides and their influence. These include the dynamical observables of meridional and zonal wind and temperature, constituents and airglow, electron density and ionospheric currents. The identification of periodicities in these variables and in their short term variations is important for diagnosing possible gravity wave/tidal interactions.
- The value and relevance of the observations depends on appropriate analyses of the tidal signatures to confirm source mechanisms, propagation characteristics, and impacts.

It is recognized that comparisons with models will provide insights into the mechanisms involved in the propagation and influence of tides and the observations will serve as a means of model validation. To foster interaction between the modelling community and the observing community, model runs for similar time periods as the observing campaigns are solicited and considered an integral part of this observing campaign.

Goals and Organization

The purpose of this project is

1. To provide coordinated, multi-measurement, global data sets of tidal signatures at several times of the year.
2. To understand the forcing and propagation of tidal modes and their role in the dynamics and constituent distributions of the atmosphere.
3. To compile rich and comprehensive data sets of the atmosphere that will serve as snapshots of the state of the atmosphere, useful for modelling and assimilation efforts in the future.
4. To facilitate and encourage the scientific collaborations necessary for the achievement of these goals.

These goals will be achieved through global observations campaigns and the associated analysis of the data. Two workshops will be held to support the analysis of this data and comparison with model results. The first workshop will be held after several successful observing campaigns and will concentrate primarily on presenting the observations and the second will be held a couple of years later and will concentrate on the analysis of the data and comparison with and validation of global models.

The activities associated with this effort will be facilitated by a team with a broad range of expertise and international representation. They will select the timing for the observation campaigns, promote and coordinate participation in these campaigns, assist in the setting up of the resulting data sets, and ensure the scientific community is aware of this data and involved in its analysis.

Campaign Description

Several global observing campaigns are proposed for the characterization of tides in the Earth's atmosphere. The time periods will be chosen to sample the conditions during several seasons, allow the associated variations in the tidal modes to be determined. To

explore possible correlations with ENSO and the QBO a campaign during the the NH spring solstice season will be scheduled for every year. The first of these campaigns is scheduled for September/October, 2005.

The observations for each campaign will be identified and made accessible for the scientific community through appropriate agreements with the scientists associated with the various data sets.

Observations are solicited which will allow the diagnosis of:

- Tidal modes throughout the atmosphere in temperature, wind, airglow, constituents, electron density, currents.
- Local time variations in the upward flux of gravity waves.
- The global mean wind and temperature structure from the ground to the thermosphere.
- Atmospheric heating throughout the atmosphere. In particular tropospheric heating (direct water vapour heating, latent heat release) and stratospheric heating (absorption of solar radiation by ozone) are of particular interest as these two sources are thought to drive the diurnal and semidiurnal components respectively. In addition, chemical heating and CO₂ cooling near the mesopause, along with tidal modulation of atomic oxygen and CO₂ are of interest.
- Large scale planetary waves

It is envisioned that the resulting data set will be used both for direct analyses of the conditions present in the atmosphere during the observing campaign and for comparisons with conditions diagnosed in models of various complexities. As a result in addition to the observations, model simulations of conditions appropriate to the various observing campaigns are also solicited.

For more information on this campaign or to express interest in participating contact William Ward at wward@unb.ca.